Master WATCHMAKING

SHOP TRAINING JOB GUIDES

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

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LESSON 1

Fundamental Principles, Equipment, Casing

—

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MASTER WATCHMAKING

A Modern, Complete, Practical Course

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 1
Sections 1 to 40

Lesson 1. — Fundamental Principles, Equipment, Casing Watches

Section 1 IN Watchmaking as in any vocation, your degree of success will come according to your love for the work and the amount of time and labor you are willing to put into it.

To the man who likes things mechanical and takes pride in doing his work just a little bit better than the other fellow, there is a fascination in Watchmaking difficult to describe to the uninitiated, and an opportunity for financial returns which few outsiders appreciate.

No matter how long he has followed this trade, there is always the greatest satisfaction to such a man in seeing a fine timepiece again functioning properly, the result of his own skill in taking it, a broken or abused movement, utterly useless, and restoring it to its original condition.

However, such skill can be attained only by conscientious effort, wisely directed, and an irrepressible determination to "make good".

The success of my resident school has been due largely to my having been able to direct each student, to see that he followed the instructions exactly, mastering each step or problem before being allowed to advance to another, and worked diligently all the time he was in attendance.

If you are willing to give the same amount of conscientious effort that you would be compelled to give were you in a first class resident school, I see no reason why you cannot make the same degree of progress.

Sec. 2 — Method of Studying the Lessons

My endeavor has been to make this course so simple that a student with no experience in this line, one who has never seen the inside workings of a watch, may follow with ease every step from taking the movement out of the case to the matching of the escapement in a modern timepiece. Not only will he understand it but if he performs each operation until he has really mastered it, he will be surprised at the progress he makes and the ease with which he is able to do work that would now seem utterly beyond him.

The mere act of reading these lessons as you would a work of fiction will help you very little in attaining a mastery of Watchmaking. They should be studied by taking one problem at a time, never leaving this one until it is thoroughly understood and mastered.

The first step should be to *read carefully the entire lesson* endeavoring of course to understand every portion of it. If any part should not be entirely clear, start again at the beginning and read until you come to the first point that seems the least particle confusing. Such confusion is generally caused by misunderstanding some previous paragraph, and in order to clear this up it will be necessary for you to go back to the beginning and over the entire preceding paragraphs of that particular subject.

This rule should be followed with all your lessons. If necessary study them over and over. The same method should also be followed in doing the practical side of the lessons. Whatever you may be doing, fitting mainsprings, cleaning, jeweling, turning, assembling — if at any point you see where you can improve it, start again and when you come to that certain part, make it better. This should be your constant aim, to always improve the quality of your work.

In this practical work don't be satisfied when you have merely succeeded in doing the work once. Do it until you are expert in that particular thing. If you are putting a mainspring in a barrel do it over and over until you can almost do it with your eyes shut. In this way you not only get ability to do good work but you acquire speed as well.

One of the advantages of our method of studying this fascinating subject is that you are not held back by some other student. You are in a class by yourself and your progress is determined entirely by the way you apply yourself to the work. One thing I want you to guard against. Right at first there is a tendency to rush your work — in other words trying to get it out quickly without really keeping up to the standard that I want. Just remember that to make a success you must first master each step in every job and then your speed will come with practice. *The man who aims at perfect work soon surpasses the man who merely works to get his job done.*

Sec. 3 — Watch Repairing

The average man associates the word Watch with the combination of the watch movement and the case in which it is carried. These two are separated into two classes by those who are engaged professionally in this line, and the work of making and repairing them differs greatly, the man who works on watch cases being known as a casemaker while the workman who specializes on watch movements is known as a watchmaker.

By the term watchmaker throughout the jewelry trade, is meant one who repairs rather than one who actually manufactures watch movements. In the present day, watch factory methods have reduced the making of watches to a point where the factory worker generally specializes on one operation, working on some certain part, and it may be not even knowing what office that part performs in the completed watch.

Such a worker might be an expert in his one specialty on one make of watches — in fact he is a "factory expert" — but as a watchmaker in the true sense of the word he needs much further training. The factory man even in most advanced work, works only on one make of watch and that in the latest model while the Master Watchmaker must be able to repair any make of watch, Swiss or American, regardless of age or model.

In our lessons, Watchmaker refers to the repairer of watch movements. However, the man who really wishes to qualify as an expert must be able to calculate and make some of the parts, and thoroughly understand the relations and actions of the different mechanisms that go to make up the complete watch.

Sec. 4 — First — Master the Larger Sizes

In these instructions we will divide the work into two general groups, POCKET WATCHES and WRIST WATCHES, and all our preliminary work will be upon the pocket watches. The mechanism of these two groups is of the same order, the parts of wrist watches necessarily being smaller and more delicate than are those of the larger pocket watches.

Do not attempt to work upon wrist or bracelet watches until you have thoroughly mastered the pocket size watches. I know that after you are able to do the work of the first few lessons on large watches there is a great temptation to try your hand upon the small sizes, but if you will hold off until you have acquired the proper skill in handling small parts, you should then have no difficulty in repairing the small size watches for which the experts get such big prices.

Sec. 5 — Table or Bench

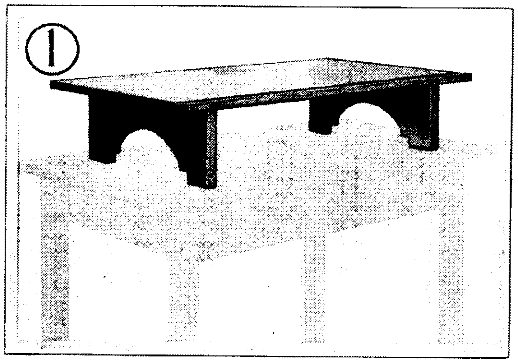
The repairing of watches is a clean occupation so that it is not necessary for the prospective Watchmaker to don overalls or go out to the garage to practice his chosen profession.

It is essential that you have a bench or table of some kind on which to work. The kitchen, library or dining table is from 30 to 31 inches high and for fine work is too low for a comfortable position. It is most important that you have a working surface of the correct height from the floor if you are to do your work without tiring. With the top of your bench at the right height and a chair or stool to match, it is possible to work for long periods without fatigue.

Sec. 6 — Watchmakers Auxiliary Home Bench

In our resident school, especially among the night students, I found a demand for some kind of a portable bench for home work. Owing to the fact that many of our students were staying with private families where there was not much room to spare, it was necessary that it occupy as little floor space as possible without sacrificing the size of its working surface.

This idea of an auxiliary bench to be used in connection with a table occurred to me and the model shown in figure 1 was thus developed. This has proven most convenient for the beginner who does not wish to invest in a regular watchmakers bench. By using it on top of a dining room table, a library or kitchen table it is possible to have a real practical bench of the correct height, strong and durable yet light enough to be lifted easily on and off any convenient table.



There are two supports which bring the surface to just the right height to make the most comfortable working position and these supports are protected by felt pads so there is no danger of marring the finish on any piece of furniture with which it is used. Its solid top is finished with a groove near the front edge as are the most expensive watchmaker's benches. It is large enough to mount a watchmaker's lathe with motor, yet easily stored in a small closet when not in use.

All in all this Auxiliary Home Bench makes an ideal accessory for Watchmakers and is recommended not only to our students in their home work but also to the Master Watchmaker who wishes to have a portable bench which is accessible at all times for any extra work he may wish to do at home.

Sec. 7 — The Master Bench

For those who wish a Master Watchmaker Bench, I would recommend the model shown in figure 2. Here is a bench that is an ornament to any home or store, beautifully finished, with ample storage space — one that will last for a life time and serve you well.

This flat top bench has eight drawers and a compartment with door in lower right hand corner. Underneath the long center drawer can be seen the "apron slide", A in figure 2. This is a frame on which should be tacked a canvas, muslin or oil cloth bottom. The purpose of this apron is to catch anything which may slip off the bench or from the hands while seated at the bench.

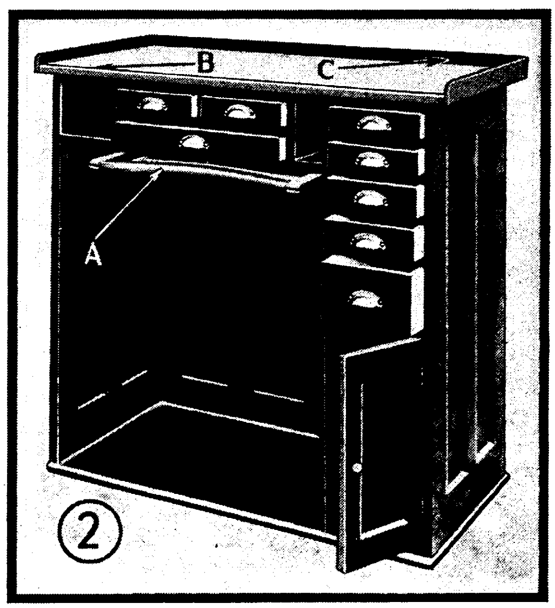
About ⅜ of an inch from the front edge of the top at B is a groove running the entire length of the bench. This groove catches many small pieces that might otherwise roll off. The other three sides of the top are protected by solid guard rails as shown at C.

This bench also can be furnished with drawers all the way down on the right side which some watchmakers prefer to the cupboard-like arrangement shown here.

Sec. 8 — Working Surface

The top of a bench does not present the best kind of a surface to work upon. It is much easier to see and work against a white background avoiding as much as possible any glare. Some Watchmakers use a piece of glass with white paper underneath but this is not always satisfactory as the hard surface of the glass is liable to damage certain parts of the watch if they are dropped upon it and there is more or less direct reflection of light, causing glare, unless it is ground glass. Others use a sheet of paper such as linen surfaced writing paper. This however, is soiled or torn easily and liable to rub into a sort of lint which has a tendency to stick to the watch parts.

I have found a much better working surface to be a flat piece of fairly heavy white celluloid with a matte or dull surface. It is not necessary that this cover a large portion of the bench. A piece 8 inches long and 5 inches wide is large



enough and placed directly in front of you when seated at the bench and with the front edge flush with the back edge of the groove will be found most satisfactory. Test by trial the best location for you to work upon and then tack to the bench. Should the celluloid become soiled it can be cleaned easily with soap and water.

Do not lay any heated objects upon the celluloid and be careful not to get a flame too close.

Sec. 9 — Keep Your Bench In Order

A standard bench is provided with drawers in which to keep your tools and these should be placed and arranged so that you will know where each tool is and can reach it with the least effort. It is a good idea to have the drawers partitioned into various sized compartments.

In place of partitions you can use different sizes of pasteboard boxes. If boxes are used, see that you have enough to completely fill the drawer so that they cannot shift around. In the upper center drawers place your most used tools such as tweezers, screw drivers, bench keys, calipers, gauges, etc.

With the exception of tweezers, screw drivers, loupes or other tools which you are constantly using it is well to get in the habit of replacing each one in its proper place as soon as you are through with it. Not only does a profusion of tools scattered over the top of your bench make a bad impression upon your customers but it tends to slow you up as well. Train yourself to be systematic in all your work. Have a place for everything and then see that everything is in its place. When you leave your bench after a day's work see that all the small tools are cleared away and then when you start work the next day, take out these tools only as you need them.

Sec. 10 — Proper Light

Whatever you use, bench or table, try to have it located near a well lighted window. It is better to have a good natural light, North preferred, than to depend upon any artificial light.

If you find it necessary to use artificial light do not use it too strong. A 40 or 60 watt frosted light is strong enough and will not dazzle and tire the eyes as a stronger one will.

This should be so situated that the light will shine directly on the work but not into the eyes. Where electric current is available this can be arranged by means of an ordinary desk or bench lamp with shade.

Sec. 11 — Height of Seat

Nearly all beginners use too high a seat while working. With a stool or chair too high the body must assume a stooped position which proves tiresome within a comparatively short time.

The standard height of the watchmaker's bench is 38 inches and for the average man an ordinary straight back chair with a seat seventeen or eighteen inches from the floor proves very satisfactory when used with such a bench. At first this may seem a trifle low but after one gets used to it, he can work much longer without fatigue than with a higher one.

While working at the bench the apron should be drawn out until it touches the body and the elbows may rest upon the frame work of the apron slide. This allows the body to assume an easy position and brings the work in just about the right location to be examined and observed.

In the more advanced work when using the lathe, extra height should be added to the chair or stool to make it about 22 inches from the floor. This may be in the form of a pad five inches thick.

Many workmen at the bench use an ordinary four legged stool of a height best suited to their own individual needs.

Sec. 12 — Pocket Watches

The first watches seem to have been made about the year 1500. About 1587, Watchmaking as an industry was introduced into Geneva, Switzerland by Ch. Cusin although a few watches had been made in Switzerland previous to that date. Enamel dials were invented in 1635 by Paul Viet, a Frenchman. The balance spring was invented in 1658.

Until 1687 watches had been made with only an hour hand but at this time the minute hand was introduced. However, the minute hand had been used in clocks as early as 1610.

About 1700, jewels as bearing for the pivots came into use. The compensating balance was first introduced in 1749.

About 1780 the second hand came into use.

The earlier watches were all hand made, each watch with its case presenting an individual problem.

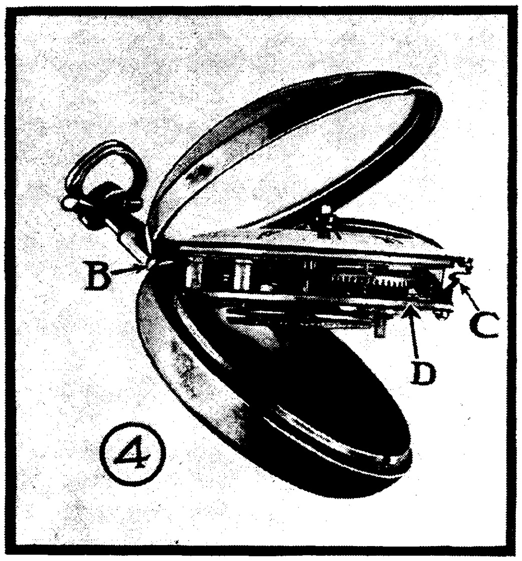
Sec. 13 — Sizes of American Watches

In 1849 Aaron L. Dennison an American Watchmaker began to build machinery for manufacturing watches on the interchangeable system.

In order to do this successfully it was necessary to have certain standard sizes and some system for determining these sizes. Mr. Dennison has been credited with having originated the method for sizing that has become a standard for American manufacturers of watches. His system was based upon the English inch and thirtieths of an inch.

The first watch made by Mr. Dennison and his associates of the American Horologe Company was 18 size and this size was determined by taking one inch and adding 6|30 of an inch for "fall", then each additional 1|30 of an inch formed a size. Thus the 18 size watch would measure one inch, plus 6|30, plus 18|30 which equals one and 24|30 inches the full diameter of the watch measuring on the pillar plate.

This so called allowance for "fall" was borrowed from the English. The English Watch Movements were usually hinged to the cases as shown in the Old English Verge in figure 4, and



the top plate, indicated by the arrow D was made enough smaller in diameter to permit the movement to "fall" or drop into its position in the case without striking.

In the American sizes from 16 size down to naught (0) size, only 5|30 was added for fall. Thus a 16 size movement measures one inch, plus 5|30 (fall) plus 16|30 (for size) equals 1 21|30 inches. 12 size measures 1 inch, plus 5|30 plus 12|30 equals 1 17|30 inches etc.

Thus was begun the making of watches to standard sizes, and as a natural sequence the making of parts that were of standard sizes and interchangeable in watches of the same make and like models.

This first factory was started in Boston and in 1854 was moved to Waltham, Mass.

Some idea of the wonderful strides that have been made, can be obtained when we learn that in 1854 this factory was employing ninety hands and making about five watches a day.

Today by means of improved methods and automatic machinery some of which almost seems human in its work, one of the leading factories has a capacity of over 4500 watches a day, while employing over 4000 people.

Sec. 14 — Swiss Watches

The Swiss manufacturers lagged behind the American in their adoption of automatic machinery and the making of interchangeable parts. It has been but a comparatively few years since it was no uncommon thing to find in the same Swiss watch, train bridge screws of different sizes — even different pitch of thread.

It was customary in taking apart these older Swiss movements to have a *"screw stand"*, consisting of a round plate drilled with a series of holes into which the workman placed the screws in the order in which he removed them so that when he assembled his watch, the screws could be replaced in their proper holes without confusion.

In the modern Swiss watches as made by the leading factories this fault has disappeared and the factory material is now on an interchangeable basis, making it possible to get material and parts for these watches as well as for American.

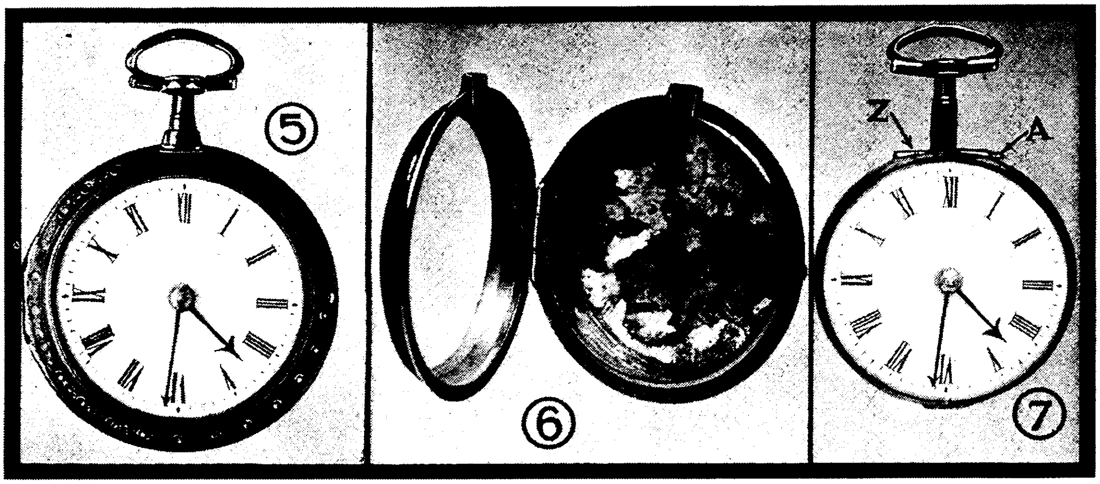
As the interchangeable feature of Watchmaking came into its own, the manufacture of cases came to be independent of the Watch factory, so that today the manufacturing of cases is an entirely different industry from that of manufacturing watch movements.

Sec. 15 — Casing of Pocket Watches

The older pocket watches were cased in double cases consisting of an inner and outer case. In figure 5 is shown an old English Verge movement in such a pair of cases.

The outer case closes with a snap fit and is opened to the position shown at figure 6 as we would a modern snap case. The inner case containing the movement fits into this outside part and can be lifted out as in figure 7.

The movement is hinged or jointed to this inner case by the same pin which connects the two parts of the inner case. At Z in figure 7 is shown this joint with its pin protruding from the other end at A. At B in figure 4 is shown the joint when this case is opened.

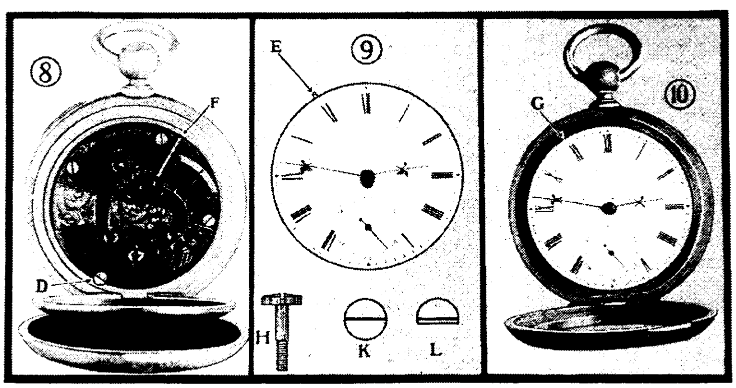


At C in figure 4 is shown the catch which holds the movement in the case and this catch must be pressed in order to lift the movement to the position shown in figure 4. To take the movement entirely out of the case it is necessary to push the pin from the joint at A in figure 7, this being the same joint shown at B in figure 4.

Sec. 16 — Case Screws

In the American system of casing movements, the movement was not jointed to the case but held in place by means of case screws.

These case screws at first were merely short screws similar to pillar screws and screwed into the top plate so close to the outside edge that the heads projected far enough outside the plate to catch on the case and thus hold the movement in place. At D in figure 8 is shown such a case screw.



In the lower plate, that is on the dial side of the movement, was placed a pin, E in figure 9. This pin fitted into a hole drilled in the case directly under the point of the arrow G in figure 10. In this way the movement would be held in the case at two opposite points, the case screw at D and the pin which would be on the dial side and directly under the point of the arrow F in figure 8.

This pin also served another important purpose. By means of it the movement was always placed in the case in a fixed position so that the figure 12 on the dial was in exact line with the center of the pendant as shown in figure 10.

Sec. 17 — Half Head and Full Head Case Screws

Next the case screws were made long enough to extend through the top plate and threaded into the lower plate. These screws were made with half heads, so that by turning the screw half way round, the movement was released and could be taken out of the case. These half head screws however, being of tempered steel, had the effect of a milling cutter and in some instances by much use, the screw would cut through the softer metal of the case making it necessary to put a washer under the head of the screw in order to hold the movement in the case.

This cutting of the case by the half head case screws has been overcome by using full head screws instead, and with this style it is best to take the screw entirely out before removing the movement from the case.

By half head is meant a screw in which nearly half the head is cut away. Full head screws are those in which the heads are left full round as the screw at D figure 8.

At H in figure 9 is a drawing of a full head case screw. At K is shown a full head screw as it appears from above and at L a half head.

Sec. 18 — Modern Casing

Formerly the retail dealer in American watches was accustomed to buy separate movements and cases and then do his own "casing" by which is meant the fitting of the watch movement to the watch case. In American watches this "casing" was not at all difficult on account of the precision with which both the movements and the cases were made. Thus it would require very little skill to fit any standard American made 16 size open face movement into a 16 size open face case made by some other American manufacturer — sometimes in pendant set movements a slight alteration in the stem or adjustment of the sleeve. In lever set movements it might be necessary to file a slot in which the lever could slide.

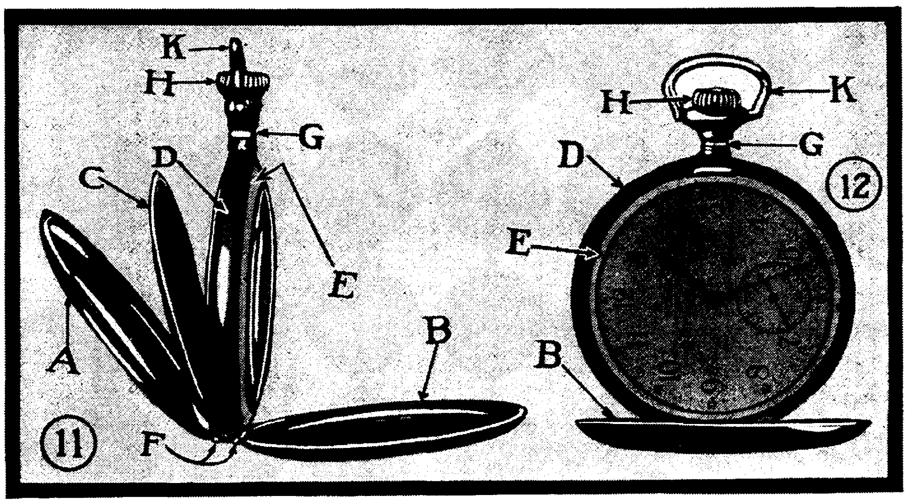
The Swiss movements, cased in American or Imported cases, presented a more difficult problem on account of their lack of being standardized to the extent that the American products were.

Now nearly all American and Swiss movements are being cased by the manufacturer or importer, coming to the retail dealer ready to be delivered to his customers so that the watchmaker has less of this work to do than formerly. However, it will be necessary for you to do some casing in any store but by understanding the relationship of certain parts which will be explained to you, this work should offer very little difficulty.

Sec. 19 — The Hunting Case

Formerly the Hunting Case was popular in both men's and ladies' watches, but today the favorite in all sizes is the Open Face. By Hunting Case we mean that kind of a case with two lids or backs as shown in figure 11, one of which, on the dial side, can be opened by pressing on the crown at H.

The different parts that make up a Hunting Case are as follows: the two backs A and B in figure 11, B on the dial side in the language of the casemaker known as the "front back" and A as the "back back". Generally this is shortened to "front" and "back".



C is the "cap".
D is the "center".
E in which the watch glass or crystal is fitted is the "Bezel".

The two "backs" are hinged to the "center" by what are known in the trade as "joints" as shown at F.

The "cap" also is connected to the "center" by means of a "joint".

The "bezel" is snapped on the "center".

G is the "pendant".
H is the "crown".
K is the "bow".

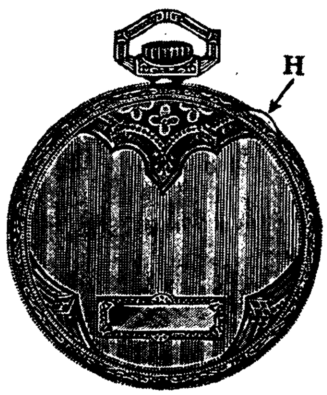
The "stem" by means of which the watch is wound is attached to the "crown", generally being screwed into that part so that the "crown" and "stem" act as one solid unit.

In figure 12 is shown a dial view of the Hunting Case with front opened. In this photograph the letters represent the same parts as in figure

11. Thus the arrow D indicates the center, B the front, K the bow, H the crown, G the pendant, and E the bezel.

Sec. 20 — Open Face Cases

The Hunting Case is rapidly becoming a thing of the past, the open face case now being the only style of pocket watch that is carried by modern retail jewelers. However, like other older time-pieces there will be some Hunting Cased watches brought to the watch repairers for a long time to come.



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Like everything else there is a constant evolution in the styles of watch cases. Some of these changes are brought about in a comparatively short time as when the ladies' bracelet watch was introduced. Others come much more slowly as the change from the Hunting style to the Open Face. Of late years there has been a tendency toward pocket watches of more distinctive shapes and designs as compared to the round shapes that have been standard for so many years. Manufacturers have recognized this tendency and created a variety of new and interesting patterns. Some of the popular shapes are the Pentagon or five sided, the Octagon or eight sided, the Decagon or ten sided, the square and cushioned shaped cases, all of these in open face models.

Sec. 21 — Assembling "Snap" Cases

In Open Face cases the bezels and backs are assembled either by having them threaded and then screwed into place or by having such a close fit that it is possible to snap the parts together. This latter style is known as a "Snap Case".

In some snap cases the back and bezel are jointed to the center while in others they are entirely free.

When the back and bezel are jointed to the center, the case would then be much like the Hunting Case shown in figures 11 and 12, if the cap and bezel were removed and the front was cut out to take a watch glass or crystal.

When the back and bezel of a snap case are attached to the center by joints, they of course always will occupy the same position when snapped together, but where the bezel and back come off entirely it is necessary to have some means of replacing them as they were originally, especially on engraved cases in order that the engraving may be in the position intended by the manufacturer or engraver.

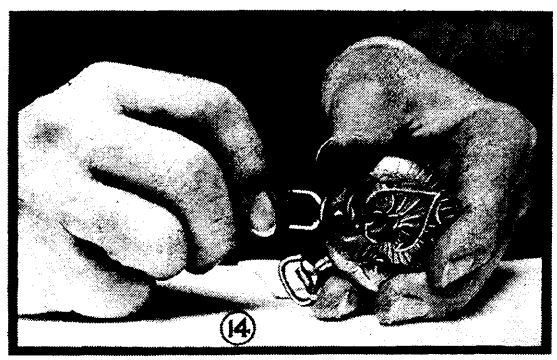
Sec. 22 — Position of the Lip

In this style of the regular round case there is generally a lip for the case opener to rest against or if not a lip, a small cut out place to facilitate the entering of a case opener or other wedge shaped object.

In replacing a back and the same of course applies to the bezel, this lip or cut out should be a little to the right side of the pendant as shown at H in figure 13.

As stated before this lip is for the purpose of inserting a thin blade, such as a case opener, in order to pry open the case.

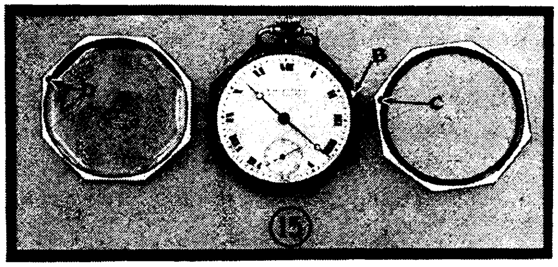
In figure 14 is shown the manner of holding a case when opening it with a case opener.



The case opener which is thin at the edge is inserted between the center and back and by means of a twisting motion pries open the case. Care must be used in order that the edge of the case opener does not come in contact with the movement caused by using too much pressure or that it doesn't slip across and mar the case.

Sec. 23 — Assembling Fancy Shaped Cases

The Fancy Shaped Cases come under the class of "snap cases" and are generally provided with a key or pin on the center which fits into a "key seat" or opening on the bezel or back.



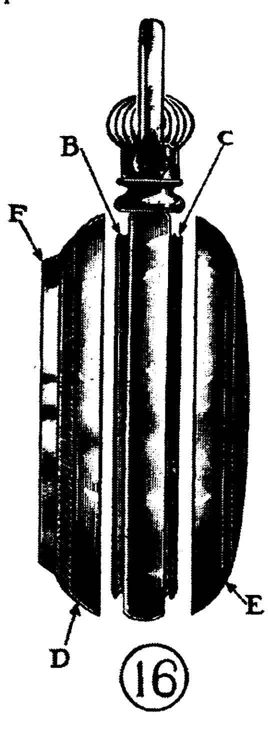
In figure 15 is shown a movement in an octagon shaped case with the bezel and back removed from the center. At B is shown the key on the dial side and at C is shown the key seat on the bezel.

In replacing the bezel it is necessary that the key seat be exactly over the key.

On the other side of the center there is a similar key which fits into the key seat on the back shown at D.

Sec. 24 — Screw Bezel and Screw Back Cases

The screw bezel and screw back case is one of the most common styles used in open face pocket watches.



In figure 16 I have purposely used a cut of an old style heavy screw bezel and back case in order that you may see more easily the method of assembling it.

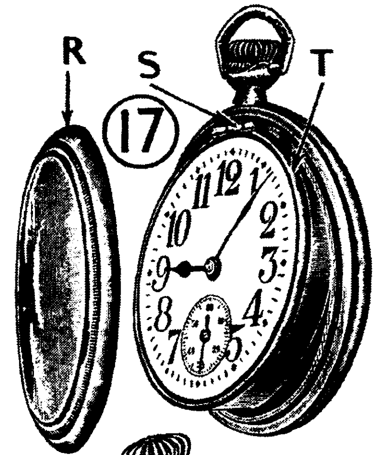
As you can see from the drawing the "center" is threaded on each side at B and C. In assembling the case the back E is screwed up tightly on thread C and the bezel D, into which the glass F is snapped, is screwed on B. Each of these is a right hand thread.

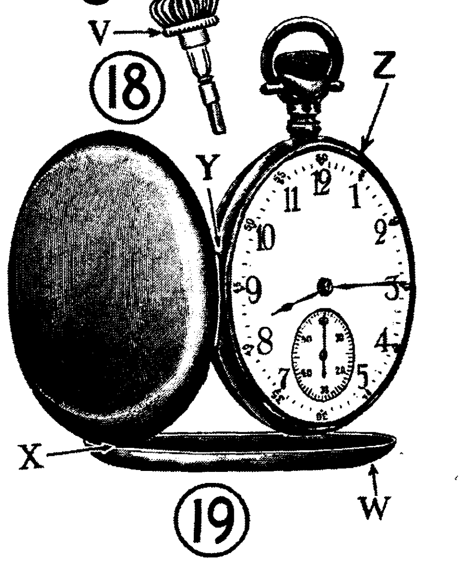
The screw bezel and back case is generally abbreviated by the manufacturers and jobbers as S. B. and S. B.

Sec. 25 — Swing Ring Cases

Figure 17 shows a swing ring case. In this the back is solid — in other words the back and center are all in one piece while the bezel R is a Screw Bezel.

The ring T into which the watch movement is fitted is jointed to the case at the point S and in taking out or replacing the movement it is necessary to swing the ring out much further than is shown here to get at the case screws and to do this it is necessary to first pull the stem out to the setting position. At the lower edge of the ring you will find a groove or lip in which to place the edge of your case opener. This is necessary as the swing ring fits closely and the edge being flush with the case is hard to start otherwise.





Even then there may be a slight sticking as it is opened due to the stem holding in the movement. If so, you may be compelled to twist the stem back and forth by means of the crown, at the same time pulling out on the swing ring.

In figure 18 is shown a dust proof assembly of Crown, Stem and Sleeve, which is used in many Swing Ring Cases.

At V is a nut which screws down on the *outside* of the pendant of the case. Inside this nut is a leather washer which together with the solid back makes this style case practically dust proof.

In making any adjustments in the position of the sleeve or to remove the stem and sleeve it is first necessary to unscrew the crown from the stem and then the nut V from the pendant.

Figure 19 shows a case in three parts in which the bezel W is jointed to the back at the point X. The movement holding ring Z to which is attached the pendant, is jointed to the side of the back at Y which permits the movement to be easily fitted. This is a snap case.

Sec. 26 — Practical Elementary Training

When a watch comes to you for repairs it is already cased as a general rule, so that your first step in making the necessary alterations or replacements will be to take the movement out of the case.

It is necessary that you understand the various types of cases that have been shown in this lesson because in your work as a Watchmaker you will be called upon to take movements out and recase them in all these styles.

Another necessary step is to have the proper tools for each problem that comes up and then practice until you are really competent to use them in a professional way. It hardly pays to attempt to do this work with poor tools.

The real expert would be greatly handicapped in attempting to do the quality of work expected of him if compelled to use inferior tools, and the beginner is often discouraged without realizing how much easier it would be to do his work provided he had the right equipment. For that reason I have selected just the ones that I have found to be best suited for each particular class of work and advise you to provide yourself with these sets. Get them in perfect order — do not attempt to do your work with second hand tools of whose condition you are not yet competent to judge.

Sec. 27 — Your First Job

In your elementary work it is best to have as your first practice watch, one that is not too valuable and also one that is fairly large, in order that the parts may be as strong as possible. By this I mean a standard grade of watch, not the cheap clock watches that are found on the market.

Although the 18 size watch is rather out of date as far as being sold in the modern retail jewelry store, there are still many of this size in use and they no doubt will be brought in for repairs for a long time to come.

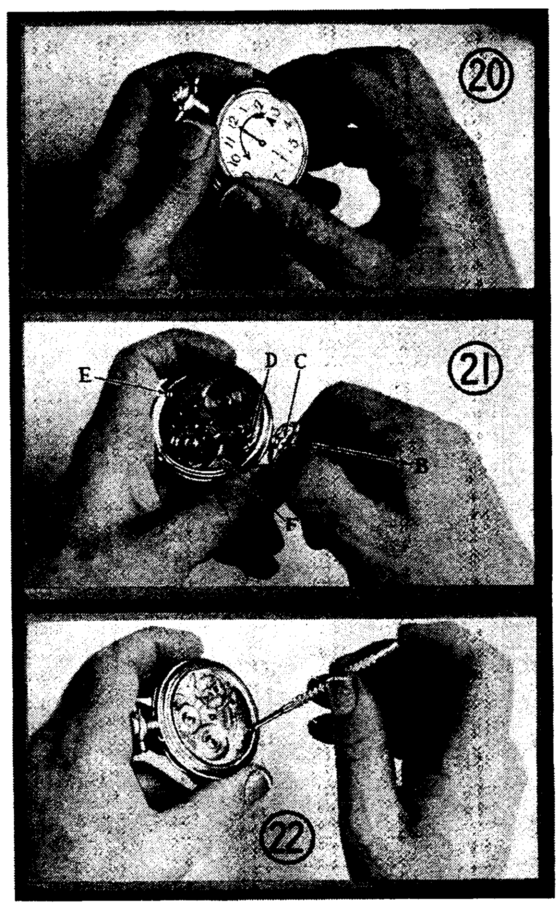
It should not be difficult to secure one of these larger style movements, and owing to its size this is a nice model for you to use in your first problem of taking out and replacing a movement in its case.

However, if you do not have access to such a large watch, a 16 size or 12 size will do, but I would advise you not to use smaller than 12 size on the first few lessons.

If it is pendant set, the same watch may be used in several of the lessons that follow, but if possible it is better to vary the make of watch on which you practice, so that you may become acquainted with the models made by the different factories.

Sec. 28 — Remove Bezel and Back

Starting at the beginning the first step will be to remove the movement from the case, and in order to do this, take off the bezel and back. In unscrewing a bezel hold it in the position shown in figure 20, twisting the bezel to the



left in the direction of the arrow A. Turn the watch over and do the same thing to the back. Our watch then will appear as shown in fig. 21.

If instead of a S. B. and S. B. your first job should be upon a jointed case then of course you merely open front and back with your case opener.

In all probability this watch will have a pendant set movement, but whether pendant or lever set, in order to take it out of the case it will be necessary to pull out the stem to a pendant set position by grasping the crown as shown in figure 21 and pulling straight out in the direction of arrow B.

Sec. 29 — Cases Without Sleeves

In some of the older style cases for *lever set* movements where there is no sleeve, you will find a screw in the pendant of the case at a point indicated by the arrow C figure 21 which fits in a slot in the stem, thus holding the stem in proper position. In such a style case it is necessary to back this screw out far enough to allow the stem to be withdrawn from the case by means of the crown and then it is an easy matter to slip the movement out.

Sec. 30 — Using a Screw Driver

At this point it is well to test your ability to manipulate a watch screw driver.

The head of the screw driver turns freely on the shank so that by placing the first finger on this head and holding the shank between the thumb and second finger you can turn the shank and of course the blade with it, by merely rolling it between the thumb and finger. See figure 22.

At times where the screw is difficult to start some prefer putting the head of the screw driver in the palm of the hand and using the first and second fingers on one side and the thumb on the other to secure a little more leverage in turning.

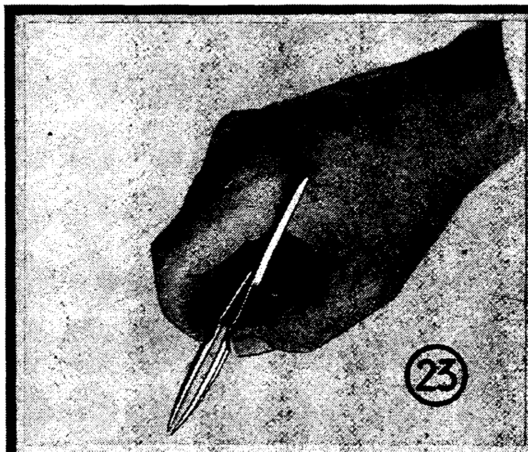
Sec. 31 — Selecting Proper Size of Screw Driver

In selecting a screw driver for any particular screw try to have the blade as near as possible the same width as the diameter of the screw head in order to prevent twisting the point of the blade or marring the head of the screw, also where a screw is in a recessed plate never have the screw driver any larger than the head of the screw, otherwise you will mar the plate.

Sec. 32 — Use Tweezers When Handling Watch Parts

Use the proper size screw driver and turn each screw D and E figure 21 until it is entirely free. Then with your tweezers lift each case screw out and place in your material tray.

The most common and natural way of holding the tweezers when manipulating any small object is as shown in figure 23. Here you can see the tweezers are held in much the same way that a pencil is held in writing. One side rests upon the second finger while the pressure necessary to hold an object is applied by means of the thumb and first finger.



23

24

Sometimes where more force is necessary as in pulling at some part that has become stuck, the tweezers are held inside the hand as shown in figure 24, the pressure being applied by means of the first and second fingers on one side and the thumb on the other. It is also more convenient at times, to handle the tweezers this way in holding small objects than as first described. Practice each method and you will soon find yourself using the one that is best adapted for the work you are doing.

Nearly all beginners use too much pressure on the tweezers. Use only enough to maintain the necessary grip when picking up or placing any watch parts or material. By using unnecessary pressure there is always danger of snapping the piece out of the tweezers.

At first it will seem awkward to handle small objects in this manner but with practice it will come easier until finally you will have no trouble in manipulating the smallest parts with tweezers.

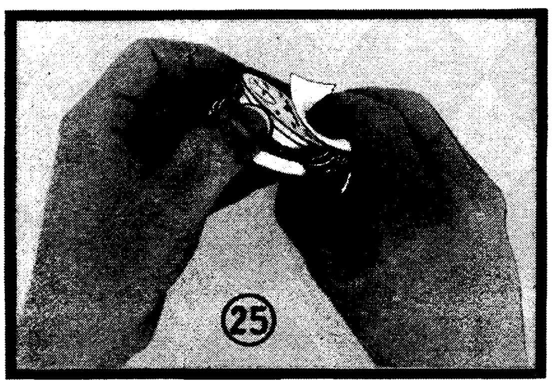
Sec. 33 — Taking Movement From Case

Having removed the case screws, a slight pressure on the movement usually will cause it to slip from the case into the hand held ready to catch it.

If the movement sticks slightly it may be forced from the case using the thumb nail of the right hand as shown in figure 25. By bending the thumb at the first joint in order to bring the nail in contact with the movement, rather than the ball of the thumb you avoid getting unsightly finger marks on the watch plate.

Sec. 34 — Do Not Get Fingermarks On Movement

Here let me warn you against getting finger marks on either plate or dial of a movement. When you press the movement out of the case, grasp it by the *edge*. Whenever you pick up a movement, pick it up by the *edge*.



In taking the movement out of the case, it is well to place a piece of watch paper between the fingers and the dial as shown in figure 25.

Sec. 35 — Use a Material Tray and Movement Cover

At the beginning of your work get into the habit of placing the small parts in some kind of a material tray or cup which you should have placed in a convenient position on your bench. When you remove the case screws place them immediately in your material tray.

While working upon the case, having removed the movement, should you allow the movement to set uncovered upon your bench it woud be liable to accumulate some dust and there is a risk of something falling upon it and breaking some delicate part. Therefore as soon as you take the movement out of the case it is well to set it in a material tray or on a piece of watch paper and cover it with the movement cover. In this way it is protected from any stray dust that may be in the air.

Sec. 36 — Polish the Case

Whenever you clean or repair a watch it is also necessary to thoroughly clean the case so that no dirt remaining may come in contact with the movement. In the lesson on cleaning watches I will give you in detail the best methods for cleaning the case but at this time it is not necessary for you to attempt such a thorough cleaning of the watch case on which you are working.

However it is well to wipe off all dirt or oil that may be on the watch case and then after being sure that it is dry, polish with a double polishing cloth.

This cloth has two surfaces, the inside or red cloth being for polishing and the outside cloth to protect the hands from this red color.

In using this polishing cloth see that the watch case is dry but if badly tarnished a slight moistening by blowing on the tarnished part will aid in restoring the original finish.

Of course in using this cloth to polish the case it is necessary to have replaced the back and bezel or in a jointed case to have closed the back and front.

Sec. 37 — Using the Polishing Cloth

Then by opening the polishing cloth as you would a book, placing the case between the two red sides, gripping the outside cloth in the hands and rubbing vigorously, you can restore the polished finish to a large degree.

This cloth can be used for polishing other objects in gold or silver such as jewelry, silverware, table ware and trophies. The red color is harmless and can be washed. If any powder remains on the surface of the object cleaned it can be removed by using the outside cloth. This will also give an additional polish.

Sec. 38 — Replace Movement in Case

After polishing your case remove the bezel and back, see that the crown is in the setting position then replace your movement in the case by starting the stem in the winding arbor and allowing the balance of the movement to slip easily into the case. In doing this keep the dial side uppermost so there will be less danger of the movement falling out.

After you have the movement in its proper position, hold it in the left hand if you are right handed, with the nail of the first finger pressed against the dial side while gripping the case with the thumb and second and third finger, as shown in figure 26. Holding it in this position

turn the hand over so that the dial side of the watch is down. With your tweezers in your right hand pick up one of the case screws and place in position. Then with a screw driver turn this screw down until it is just holding the movement in place. Do the same with the other case screw.

Sec. 39 — See That Movement Is Centered

Before you screw the case screws clear down, press the crown into the winding position so that you will be sure to have the movement centered properly in the case. If you do not do this you are liable to have it slightly to one side with the stem going in at an angle which will make it bind somewhat while winding. Having the stem in the winding position before setting the case screws, turn the crown back and forth to see that the stem turns easily. If it does then set your case screws down in place. Case screws however, are not set as tightly as other screws in the movement. If too tight the heads are easily broken off by a jar that might not injure the movement. However do not make this an excuse for having the case screws turned into place too lightly. Turn down tight but not as far as it is possible to turn them.

Now examine dial and back of movement for finger marks, thereby gauging your ability to handle a movement without leaving such traces of an amateur. Replace the bezel and back on the case. Again try the winding and setting by means of the crown, wipe off any further finger marks on back or glass and credit yourself with having finished your first step in your progress toward becoming a Master Watchmaker.

Sec. 40 — Practice for Speed

The mere act of going once over the work described in each of the Master Lessons that are given you or the completing of the step by step methods shown in the Master Work Sheets does not make for finished skill in Watchmaking. If you are to be a Master Watchmaker you must have speed as well as ability and you must practice every problem described until you can do the work in the time specified on the Master Work Sheet. Some are able to acquire this speed with only a few hours practice while others must go over the work many times before being able to make the grade.

However you should realize that only by such effort can you attain the goal and that these problems once mastered are the real steps toward your success.

A watch is a machine; when it is right it will perform properly and not before. The man who works upon this machine should never slight any part, but should always strive to do his very best. Remember that you can never do your work too well.

First then, master the *How* of doing each proposition before attempting to acquire speed. After you are able to do your work as it should be done, practice each step over and over, never letting down on the quality. You will be surprised how easily the work comes after the first few problems if you will follow these simple directions and always strive to make each following job the best you have ever done.

TABLE OF CONTENTS: Unit WI - Lesson 1

JOB SHEETS

CASING WATCHES: Open Face Case

TOOLS, EQUIPMENT AND SUPPLIES:

Assembly tweezers - Case opener - Screwdrivers

PROCEDURE	REFERENCE
A. HOW TO REMOVE MOVEMENT FROM AN OPEN FACE CASE	Les. 1
1. Remove bezel.	Sec. 28
2. Remove back.	
3. Pull out crown into setting position.	
4. Remove case screws	Sec. 30, 31, 32
5. Remove movement from case.	Sec. 33, 34, 35
B. HOW TO REPLACE MOVEMENT IN AN OPEN FACE CASE	
1. Replace movement in case.	Sec. 38
2. Push stem into winding position, replace case screws.	Sec. 39
3. Replace back and bezel.	

INFORMATION:

Markings generally used for Karat Gold - Gold Filled - Rolled Gold Plate - Silver and Stainless metals used in watch cases. "Karat" is a measure of fineness - 24 karat is fine gold. One karat equals 1/24, thus 14 karat gold is 14/24 fine gold and the balance of 10/24 is alloy. The usual alloy metals are silver, copper, zinc and nickel.

A. KARAT GOLD (abbreviations 10K, 14K, etc.)
Cases stamped 10 Karat (10K), 14 Karat (14K), 18 Karat (18K) are sometimes spoken of as solid gold cases. Colors of gold can be yellow, red or pink, green and white.

a. Red Gold (Pink gold)
Gold alloyed with copper.

b. White Gold
Gold alloyed with a white metal - usually nickel or paladium in sufficient quantity to efface the yellow color.

c. Green Gold
Gold alloy containing a relatively high proportion of silver.

B. GOLD FILLED (abbreviation G.F.)
This term refers to articles made of base metal, upon one or more sides or surfaces of which a shell of Karat Gold is affixed. The term "Gold Filled" is used when the karat gold covering the article is 1/20 or more of the total weight. For example: 1/10 - 14 gold filled.

C. ROLLED GOLD PLATE (abbreviation R.G.P.)
Same as gold filled, except for thinner platings. In both cases the gold must be of at least 10 Karat fineness and the fractional karat gold content must be shown. For example: 1/30 10K R.G.P.

D. GOLD ELECTROPLATE
Usually made by electrolytically depositing fine gold on base metal.

E. SILVER
Sterling silver contains 925 parts fine silver with 75 parts some other metal, usually copper. U.S.A. Coin silver is 900 parts silver, 100 parts copper.

F. NICKEL SILVER - GERMAN SILVER - SILVERINE - SILVEROID - ETC.
So called because of some color resemblance to the precious white metal, not because of any silver content.

G. STAINLESS METAL
Generally used for backs of watch cases using R.G.P. bezel or for water-resistant cases.

CASING WATCHES: Two-piece Wrist Watch Case

INTRODUCTORY INFORMATION

The most common case used for mens and ladies wrist watches. It is generally spoken of as a dress watch.

TOOLS, EQUIPMENT AND SUPPLIES

Case opener or bench knife

PROCEDURE

A. HOW TO REMOVE MOVEMENT FROM A TWO-PIECE WRIST WATCH CASE

1. Hold case with back up, crown toward you.
2. On the right end of the back of the case locate either a lip or groove. Pry upward at this point with case opener. Back of case containing the movement will snap free of the bezel.
3. The movement generally fits snugly into the back of the case and may be removed by jiggling the crown. If this does not free the movement it may be necessary to pry carefully upward on the protruding edge of the pillar plate with case opener or blade of bench knife. Care should be used so as not to damage train wheels, balance wheel or barrel which may have little clearance when movement is lifted from the back.

B. HOW TO REPLACE MOVEMENT IN A TWO-PIECE WRIST WATCH CASE

1. Set back of case on a block or similar elevation with stem slot to the right and edge of case back even with the edge of the block. (This is to prevent crown from resting on the block)
2. Place movement in the case back aligning stem with stem slot.

   NOTE:
   If crown is one of the various types of dust proof crowns, pull stem into setting position. Some movements are fitted with a dust guard. This is a small tube through which the stem passes, attached to a tissue thin flexible metal flange between the case and the movement. Another type of dust guard is notched. This type fits over a lip in the case.
3. Snap movement and back into bezel.

UNIT	W1
LESSON	1

Master Watchmaking

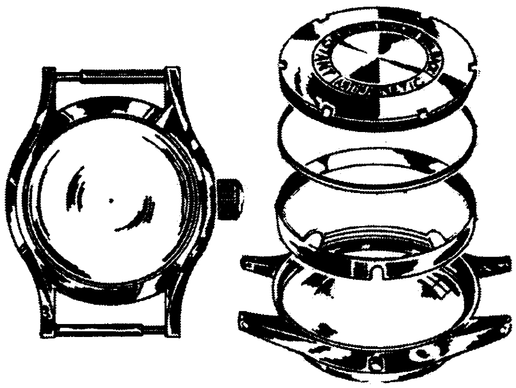
CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W1-J3

CASING WATCHES: Water-proof, Water-tight, Water-resistant cases.

INTRODUCTORY INFORMATION

Backs on this type case have various indentations such as a knurl, slot, flat, hole, etc. A key or case wrench is applied to unscrew the back. Case wrenches for individual models are not always available. In general, a good universal type of case wrench is desirable as it may be adjusted to fit practically all of this type case. Hold the case in a case vise for safe handling. Damaged gaskets should be replaced with new ones.



TOOLS, EQUIPMENT AND SUPPLIES

Assembly tweezers - Case wrench - Case vise - Screwdrivers

PROCEDURE

A. HOW TO REMOVE A MOVEMENT FROM A SCREW BACK WATER-PROOF, WATER-TIGHT OR WATER-RESISTANT CASE

1. Place case in case vise.
2. Select case wrench to fit the knurling or indentations on back.
3. Unscrew back counter-clockwise.
4. Remove lead or rubber gasket. (Some remain on back)
5. Release the stem and crown by turning set lever screw (detent screw) about $1\frac{1}{2}$ turns in a counter-clockwise direction - Les. 2, Sec. 61.
6. Remove the case from case vise.
7. Pull stem and crown from the case. If stem does not come out, unscrew set lever screw a bit more.
8. Lift out movement retainer ring. (This ring may be gripping the movement so firmly that the movement comes out with the ring)
9. Lift out movement.

(Over)

PROCEDURE Continued

B. HOW TO REPLACE MOVEMENT IN A SCREW BACK WATER-PROOF, WATER-TIGHT OR WATER-RESISTANT CASE

Note: Check the relation of hands to each other and the dial. Les. 11, Sec.278.

1. Place movement in the case with stem opening in movement aligned with stem opening in the case.

2. Place stem in position.

3. Tighten set lever screw to lock stem in position. Test by pulling stem into setting position and setting the hands.

4. Replace movement retainer ring.

5. Replace gasket. (Use new one if necessary)

6. Clamp case in case vise.

7. Place back on case.

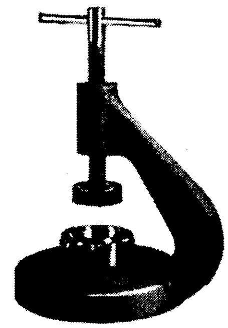
8. Tighten back with case wrench.

UNIT	W1
LESSON	1

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W1-J4



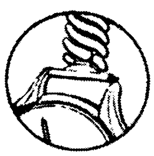
CASING WATCH: Benrus Waterproof -
Information by Benrus Watch Co.

TOOLS, EQUIPMENT AND SUPPLIES

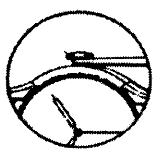
Opening and closing fixture

PROCEDURE

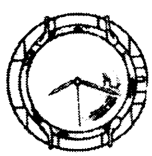
A. HOW TO OPEN A BENRUS WATER-PROOF WATCH



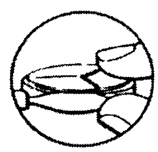
1. Detach bracelet.



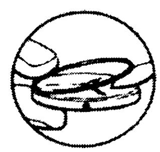
2. Remove the crown by first pulling into setting position. Put tweezers between crown and case and pull until crown and part of stem comes off (this is a two-piece stem).



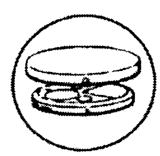
3. Select the proper plastic opening fixture and top pad for the case you want to open. Place same in staker. (To fit top pad on threaded spindle, use screw driver through the hole in the base of staker and loosen screw on the bottom of threaded spindle inside of pad). Put watch in fixture, crystal up, and turn handle until back drops out. Make sure case sleeve is in the cutout provided in fixture.



4. With extreme care, lift the crystal off the back. To prevent any injury to crystal, use a sharp knife for this purpose.

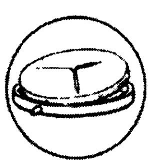


5. Now, gently remove the metal reflector on top of dial. Be careful not to bend it.

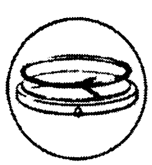


6. Push part of stem remaining in movement into winding position. Remove the movement from the back by turning it upside down.

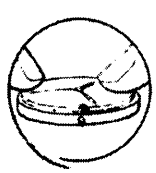
B. HOW TO CLOSE A BENRUS WATER-PROOF WATCH



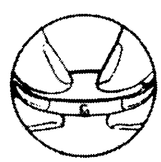
1. Replace opening fixture with red closing fixture. The same top pad is used to open and close the case.
2. Place movement into back by fitting the short stem into case sleeve.



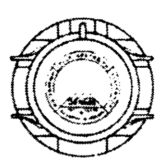
3. Gently place reflector ring on the shoulder surrounding the dial.



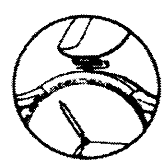
4. Place crystal over the shoulder surrounding the dial (make sure crystal is not chipped or damaged around the edge. This will cause leakage).



5. Push the back assembly into the bezel.



6. Put watch in red closing fixture, back up, turn handle until back is flush with bottom of bezel all the way around (if back does not go in straight, take watch out again and separate bezel and back assembly and start over again).



7. Insert the crown with a slow twirling motion until the tooth of the stem engages the concealed part of the stem in movement.

UNIT	W1
LESSON	1

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W1-J5

CASING WATCHES: Hunting case

TOOLS, EQUIPMENT AND SUPPLIES

Assembly tweezers - Case opener - Screwdrivers

PROCEDURE — REFERENCE

A. HOW TO REMOVE MOVEMENT FROM A HUNTING CASE — Les. 1 - Sec. 19

1. Open "back" with case opener.
2. Open "cap" with case opener.
3. Remove case screws. — Sec. 30, 31, 32
4. Press crown in, this will open "front back"
5. Remove bezel(handle carefully, the glass is very thin). — Sec. 22
6. Pull crown out to setting position.
7. Remove movement from case.

B. HOW TO REPLACE MOVEMENT IN A HUNTING CASE

1. Replace movement in case by inserting end of stem in winding arbor and let movement slide into its proper position. (Make certain stem is in setting position)
2. Press crown into winding position.
3. Replace case screws.
4. Test winding to see that stem turns freely.
5. Close "cap" and "back".
6. Replace bezel.
   NOTE: Place bezel in seat on hinged side and with thumb on each side of bezel apply pressure while gradually sliding thumbs upward toward pendant.

(8-55)W1-J5

CASING WATCHES: Swing ring case

TOOLS, EQUIPMENT AND SUPPLIES

Assembly tweezers - Case opener - Screwdrivers

PROCEDURE	REFERENCE
A. HOW TO REMOVE A MOVEMENT FROM A SWING RING CASE	Les. 1, Sec. 25
1. Remove bezel. (Screw type)	Fig. 17
2. Pull crown into setting position.	
3. Lift ring and movement with case opener.	Fig. 17
4. Remove case screws.	Sec. 30, 31, 32
5. Remove movement from ring.	

B. HOW TO REPLACE MOVEMENT IN SWING RING CASE

1. Insert movement in ring (make certain winding arbor square is centered in hole of ring).
2. Replace case screws.
3. Swing movement and ring into back of case with stem and crown in setting position, turn crown to assure square of stem engages with square of arbor.
4. Test winding to see that stem turns freely.
5. Replace bezel.

HAMILTON SERVICE BULLETIN 201

ESSENTIAL INFORMATION

ON OPENING, CLOSING, AND OTHER CASE SERVICE OPERATIONS ON THE

BRANDON*

A

HAMILTON cld

MODEL

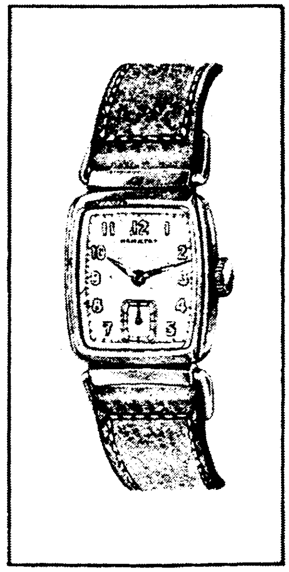
Grade 980—17 Jewels

10K NATURAL GOLD FILLED

18K Applied Gold Numerals on Silver Dial

* Case Construction Patent Pending

BRANDON—A HAMILTON cld MODEL



Description

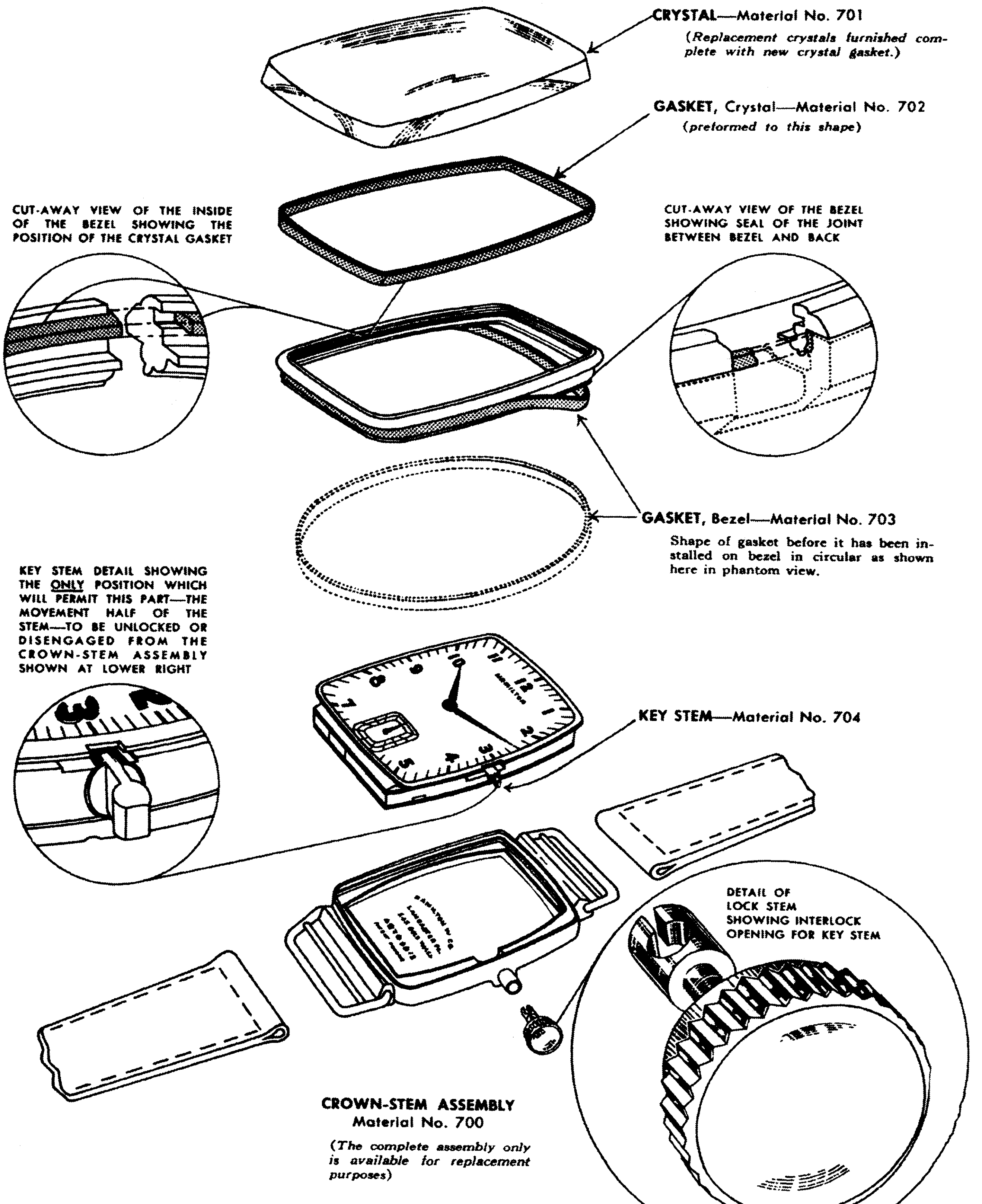
The Brandon is another Hamilton first . . . a watch that is engineered for protection as well as performance. It is unique in design, construction and styling; it is simple and foolproof to service or repair; and requires no special tools or fixtures to open or close the case.

The Brandon is unlike any other watch case designed to give maximum protection to the movement from dust and moisture. It is a styled watch—that is, it isn't the traditional round shape. It is of simple two-piece construction; it is made of gold-filled stock; it is fitted with a tempered *glass* crystal instead of the unstable plastic usually used; and, since the bezel and back fit with telescopic friction, it can be opened with only a conventional blade-type case opener.

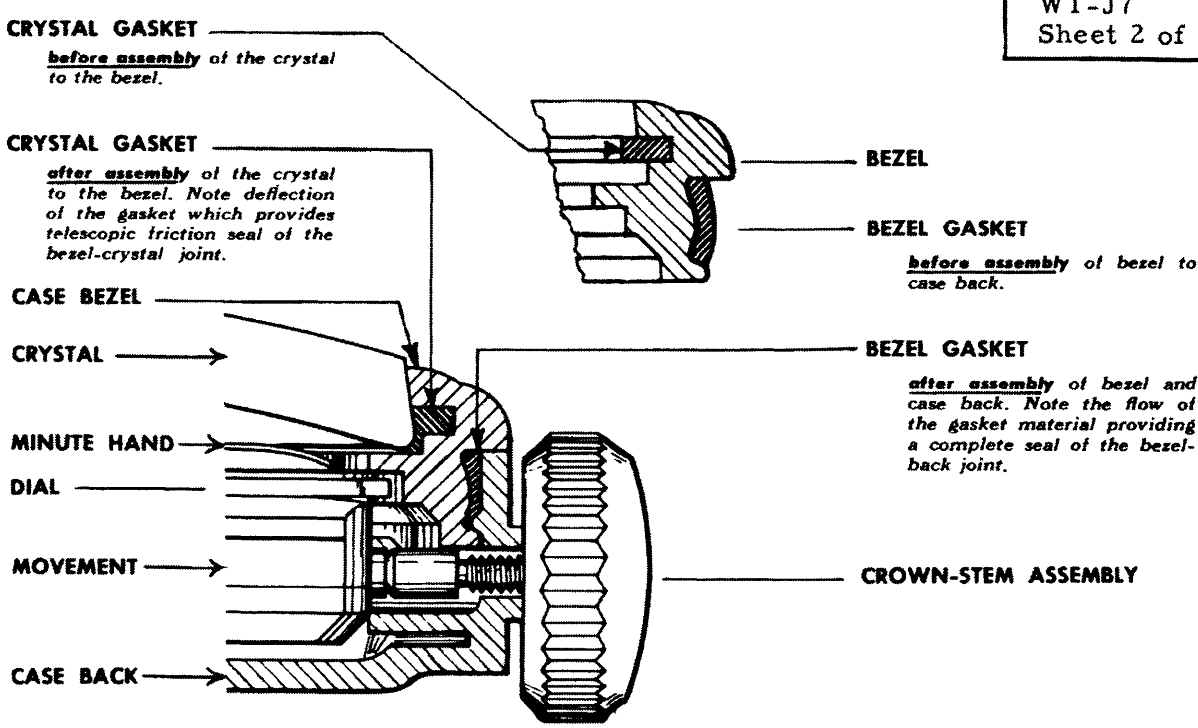
The Brandon was engineered, developed, and styled by the Hamilton Watch Company for professional men, sportsmen, and all others who require the performance of a fine watch and the ultimate in the protection of that performance. An "exploded" view as well as cross-sectional views of the Brandon Case is provided on pages two and three to illustrate its construction. Instructions for opening and closing the case, case-service operations, and ordering of replacement parts are covered on page four of this bulletin to assist watchmakers servicing the model.

(Over)

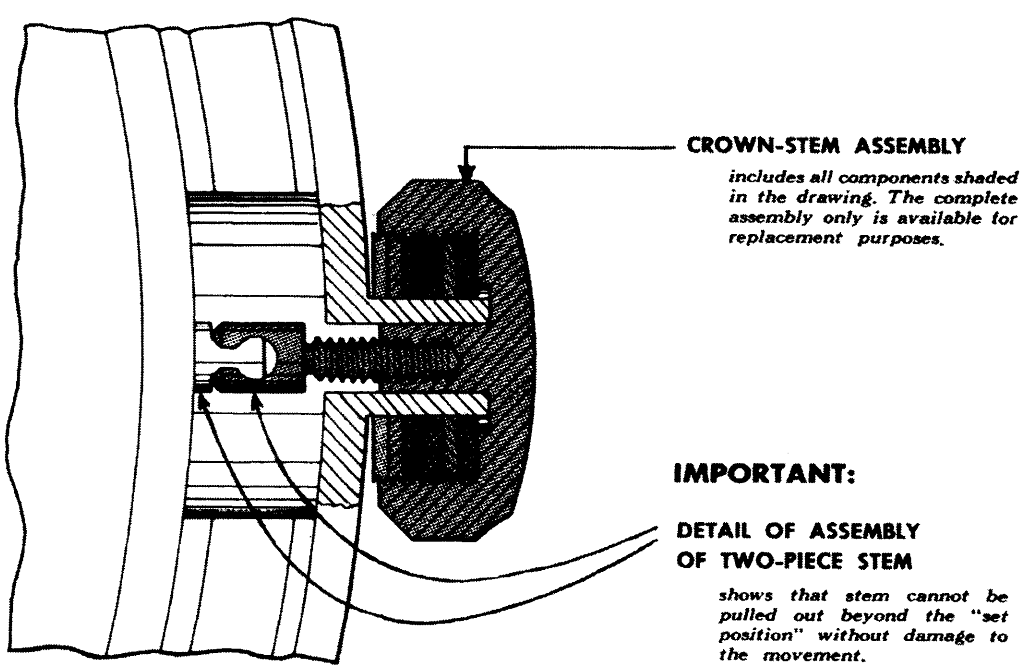
EXPLODED VIEW OF CASE ASSEMBLY



CROSS SECTION DETAIL OF CASE ASSEMBLY



CROSS SECTION DETAIL OF CROWN-STEM ASSEMBLY



How to open the Brandon case

Hold the watch in a dial-up position. Insert a case opener under the slight lip on the bezel at 6 o'clock, and gently pry open as in opening a conventional watch case. Because the case bezel and case back fit together with telescopic friction on the sides as well as on the ends, the bezel does not snap free from the back when the case opener is inserted under the case lip. It will be necessary to lift the bezel free from the case back.

How to remove the movement from the case

Do not attempt to pull the crown out—beyond the set position. The crown-stem construction on the Brandon is of an interlocking type—not the claw type usually employed—so it can *not* be pulled out without damage to the stem until the movement is removed from the case back.

Do this to remove movement from case: with the bezel removed, turn the crown until the interlocking key joint of the (two-piece) stem (to right of 3 o'clock on the dial) is parallel to the top and bottom of the case; then simply invert the case over the (tissue-covered) palm of the hand and the movement will drop out. Should the movement tend to stick, return the case to "dial-up" position, check the alignment of the interlocking joint of the two-piece stem and re-invert the case. If the movement then does not come out of the case, return to the dial-up position and carefully insert a case opener between the movement and case at 6 o'clock to loosen it. The movement can then be lifted free of the case.

How to replace the movement in the case

Turn the crown so that the Lock Stem—the part containing the female interlocking slot in the crown half of the stem (between 3 o'clock and the case edge) is parallel to the top and bottom of the case. Turn the Key Stem—movement half of the stem—so that it will key or interlock with the Lock Stem or crown half of the stem. Then insert the movement in the case in the usual manner and replace the bezel. The easiest way to replace the bezel is to begin the reseating of it at either the 12 or 6 o'clock end and work towards the opposite end. Be careful not to dislodge or distort the bezel gasket. When the bezel is properly seated, the bezel and the back should be firmly pressed together to insure a tight fit.

How to replace a broken crystal

With the bezel held between the index finger and thumb of each hand—bezel inside towards you—exert a firm even pressure with both thumbs until crystal is released. If crystal is cracked or broken, use care to prevent cutting thumbs. *If the crystal is broken a new, genuine Hamilton crystal and crystal gasket must be fitted to restore the original protective qualities of the case.* These components are available only at the Hamilton factory. Replacement crystals are supplied complete with gaskets. With the new crystal gasket properly seated, a new crystal is installed by simply positioning it in the bezel opening from the front and seating it by applying firm, even pressure with the thumbs.

How to replace a broken stem

Stem breakage occurring in the Lock Stem—the crown half of the stem—requires a new Crown-Stem assembly, Material No. 700. Breakage in the Key Stem—the movement half of the stem—requires a new part, Material No. 704, which is replaced in the conventional manner.

Where and how to order crystals, gaskets, stems, and crowns

Genuine Hamilton replacement Crystals, Gaskets, Key Stems, and Crown-Stem Assemblies for the Brandon are available only at the Hamilton factory. It is of primary importance that only genuine replacement parts be used, otherwise the original protective qualities of the case can not be assured. Address all orders for replacements to the CASE-ORDER Department. And please use both part name and material number on orders for replacement parts.

BRANDON. REPLACEMENT PARTS

Available Only at the Hamilton Factory

Part Name	*Material No.*
Crown-Stem Assembly	700
Crystal	701
Gasket, crystal, grey plastic	702
Gasket, bezel, black Neoprene	703
Key-Stem (Movement Half of Stem)	704

CLEANING CASE: Pendant Type

INTRODUCTORY INFORMATION

A customer judges a watch by appearance as well as performance. Therefore, every effort should be made to give the watch case the best appearance that is possible.

TOOLS, EQUIPMENT AND SUPPLIES

Soap (laundry) - Stiff brush - Ethyl Alcohol (solvent #1)

PROCEDURE

HOW TO CLEAN A PENDANT TYPE CASE

1. Wash case thoroughly with soap and water using a stiff brush.

2. Rinse with warm water.

3. Dry bezel and crystal with soft cloth. (Crystals other than glass are damaged in alcohol)

4. Dip remaining parts of case in alcohol, flush alcohol through stem and sleeve. If a hunting case, flush thoroughly in back of lift springs to remove all traces of water.

5. Dry with soft cloth.

6. Warm over heat until all trace of alcohol is removed.
NOTE: If crystal is loose, cement edges with crystal cement, see Lesson 3.

UNIT	W1
LESSON	1

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W1-J9

CLEANING CASE: Two-piece Wrist Watch Type

TOOLS, EQUIPMENT AND SUPPLIES

Soap (laundry) - Stiff brush

PROCEDURE

HOW TO CLEAN A TWO-PIECE WRIST WATCH CASE

1. Wash case thoroughly with soap and water using a stiff brush.

2. Rinse with warm water.

3. Dry with soft cloth.

NOTE: If crystal is loose, cement edges with crystal cement, see Lesson 3

POLISHING CASES: Karat Gold (10k, 14k, etc.), Silver case (Sterling - Coin), Nickel Silver case (German Silver, Nickeloid, etc.), Platinum.

TOOLS, EQUIPMENT AND SUPPLIES

Polishing motor - Polishing head - Tripoli buff - Rouge Buff - Tripoli - Rouge

PROCEDURE

HOW TO POLISH A CASE

1. Remove all foreign matter. (Wash if necessary)
2. If crystal is other than glass it should be removed. (See lesson #3 for replacement)
3. Polish with tripoli.
4. Wash thoroughly in soap and water to remove all traces of tripoli.
5. Wipe dry with soft cloth.
6. Polish with rouge.
7. Wash thoroughly in soap and water to remove all traces of rouge.
8. Dry with soft cloth.
9. Seal crystal with crystal cement, see lesson #3.

NOTES:

Remove leather straps when polishing. Cord bands, such as silk or nylon, can be left on and washed with case. Metal or expansion bands should not be polished with tripoli but do not have to be removed from case. It is important that all expansion type bands be dipped in alcohol after washing in water and dries with soft cloth and warm over heat to remove alcohol.

UNIT	W1
LESSON	1

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W1-J11

Mido MULTIFORT Superautomatic Powerwind

CASING WATCHES: Mido Multifort Powerwind

Information by Mido Watch Company of America, Inc.

TOOLS, EQUIPMENT AND SUPPLIES

Case wrench - Case vise - Screwdrivers - Tweezers - Pegwood

PRODEDURE

A. HOW TO REMOVE MIDO MULTIFORT POWERWIND FROM CASE

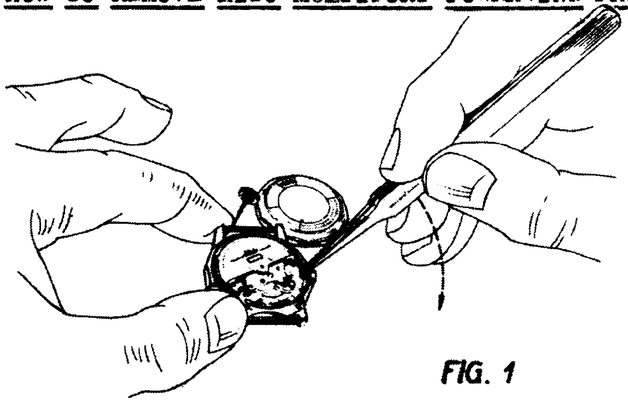


FIG. 1

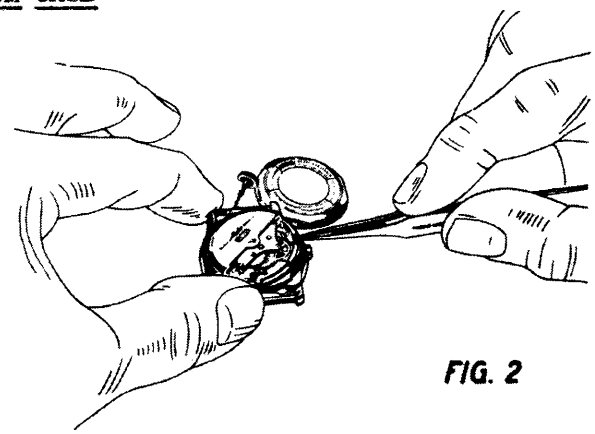


FIG. 2

1. Unscrew back of case with proper wrench.
2. Pull out stem in handsetting position, loosen detent screw and remove stem.
3. Insert tweezer into stem hole of the movement (Fig. 1), lift movement (Fig. 2), now loose, out of the case.

B. HOW TO REPLACE MIDO MULTIFORT POWERWIND IN CASE

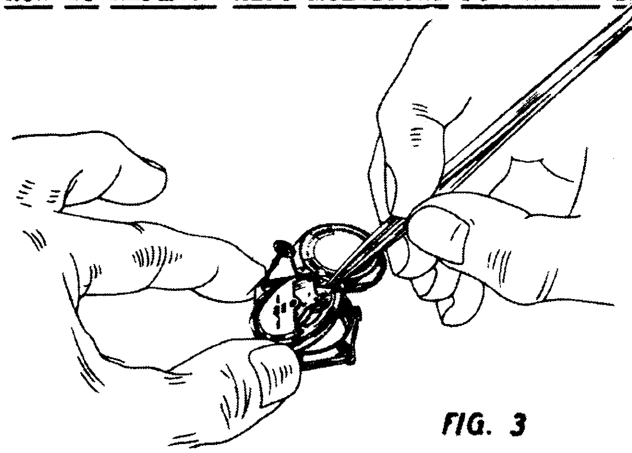


FIG. 3

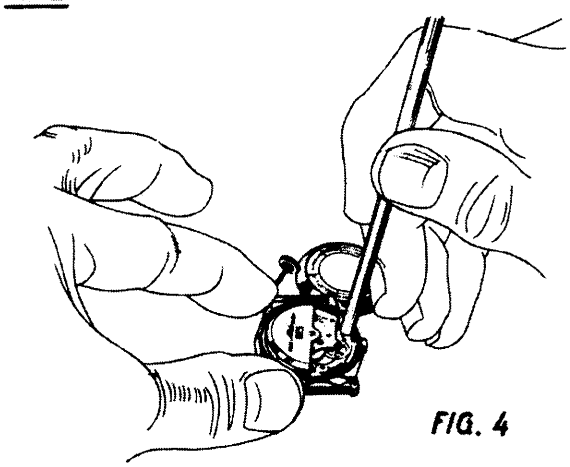


FIG. 4

1. Hold and insert movement into the case oposite stem hole (Fig. 3) under the bent ring of the case.
2. Push movement strongly down into the case (Fig. 4), with a wooden stick on the barrel bridge.
3. Insert stem, screw on tightly detent, close the case, and check air- and waterproofness with the MIDO SUPERWATERTEST machine.

(8-55)W1-J11

57 2205

UNIT	W1
LESSON	1

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W1-J12

CASING WATCHES: Open Face Case with Swiss Type Setting Mechanism

INTRODUCTORY INFORMATION

There are some models of Swiss and American watches that have a stem which is part of the movement. In order to remove this type of movement from the case it is necessary that the stem be removed. The stem is locked into the movement by a set lever and screw (detent and detent screw). The reference is lesson 9, section 233.

TOOLS, EQUIPMENT AND SUPPLIES

Assembly tweezers - Case opener - Screwdrivers

PROCEDURE

	REFERENCE
A. HOW TO REMOVE MOVEMENT FROM AN OPEN FACE CASE	
1. Remove back of watch case.	Sec. 24, 28
2. If snap case, open with case opener.	Sec. 20, 21, 22
3. Remove stem.	Les. 9 - Sec. 233
4. Remove bezel.	
5. Remove case screws.	Sec. 16, 17, 29, 30, 31, 32
6. Remove movement from case.	Sec. 33, 34

B. HOW TO REPLACE MOVEMENT IN AN OPEN FACE CASE

1. Replace movement in case aligning stem opening in movement with stem opening in pendant.
2. Insert stem.
3. Tighten set lever screw.
4. Test stem by pulling into set position and turning.
5. Replace case screws and again test stem to see that it is not binding.
6. Replace bezel and back.

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 2

Crowns, Stems, Sleeves and Bows

—

Sections 41 - 65

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

A Modern, Complete, Practical Course

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 2

Sections 41 to 65

Lesson 2. — Crowns, Stems, Sleeves and Bows.

Section 41 EXCEPT in Railroad watches, the modern watch is "pendant set". By this we mean that to set the hands, the crown (and of course with it the stem) is pulled out to a different position than when winding the mainspring. In one position the winding parts are thrown into gear while in the other the setting parts are brought into play.

This necessitates some means of holding the winding stem in two different positions. In most American pocket watches this is accomplished by means of an adjustable "sleeve" screwed into the pendant of the case and through which the stem extends.

At 1 in figure 27 is shown the stem and sleeve assembled, ready to be inserted in the pendant of an Open Face case. The upper part of the sleeve at H is threaded and the inside of the pendant of the case is likewise threaded so that the sleeve with the stem attached is screwed into the proper position in the pendant by means of a sleeve wrench.

At 2 is shown the sleeve alone and at 3 the stem.

The lower part of the sleeve at J is divided into four parts so that it really makes four steel fingers. These fingers grip the stem in either one of the slots K or L holding it in position, yet allowing the stem to turn freely inside the sleeve.

When the stem is in the winding position these fingers grip the upper slot at K. When the watch is to be set the stem is pulled straight out until the fingers of the sleeve are forced over the shoulder on the stem and are holding in the slot L. Bear in mind that this sleeve, once placed in its position in the case is stationary; the stem slides within this sleeve.

As seen at 1 the stem is held by the sleeve in the winding position.

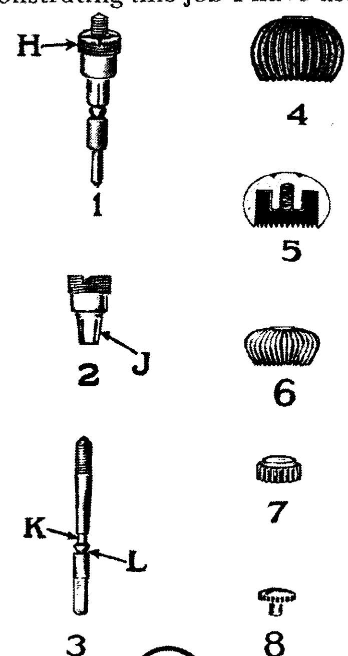
The crown as shown at 4 is screwed on the upper end of the stem after the sleeve with stem is in place in the pendant of the case.

At 5 is shown a sectional view of the crown, the center being drilled and threaded to fit the upper threaded part of the stem.

The crown shown at 4 is known as a round crown, used only on the older style cases, 6 is a more modern antique shape while 7 and 8 are crowns used on Wrist and Bracelet watches.

Sec. 42 — Movement from Case

In demonstrating this job I have used a twelve



27

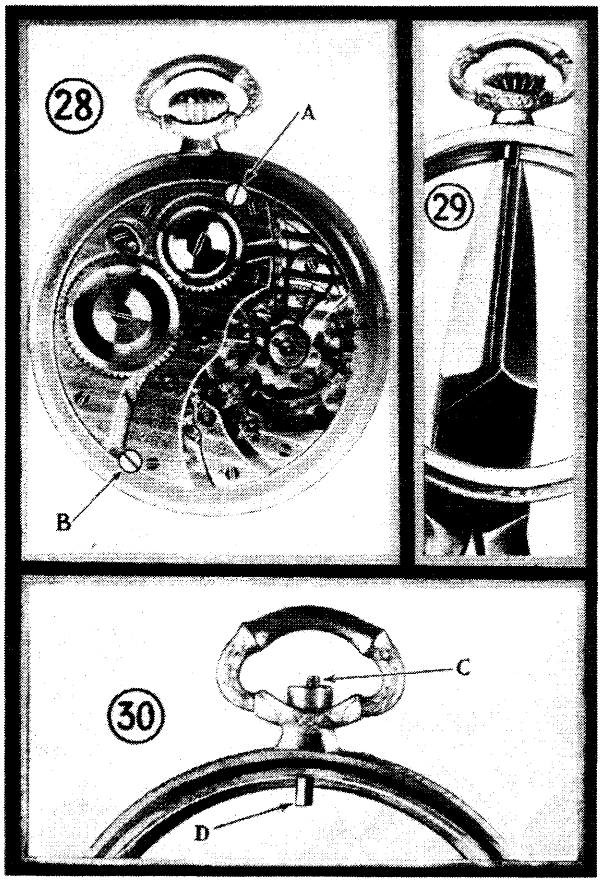
size Illinois movement in a S. B. and S. B. Case. After removing the back from the case the movement will appear as in figure 28.

The two case screws at A and B are full head as explained before. In section 17 I explained that it was best to take out the full head case screws whereas with half head it was only necessary to turn them part way around when taking the movement from the case.

With this case it is only necessary to remove the screw B and then by loosening A a few turns and pulling the crown out to the setting position the movement comes easily from the case.

Sec. 43 — Removing the Crown

In order to get at the sleeve after the movement is out of the case, it is first necessary to remove the crown from the stem and this is done



by holding the lower end of the stem by means of a pair of flat pliers held in one hand as shown in figure 29 and with the fingers of the other hand twist the crown to the left continuing to turn it until it is separated from the stem. Now it will appear as in figure 30, the upper threaded end of the stem from which the crown has been removed showing at C while the lower or square end may be seen at D, this photo being enlarged in order to show these parts better.

Sec. 44 — Using a Sleeve Wrench

One of the popular forms of sleeve wrenches is shown in use in figures 31 and 32. Each of the several prongs on this model is shaped at the end into a wrench giving a variety of sizes suitable for most of the sleeves in pocket watches. In adjusting the sleeve, a prong is selected of the proper size and shape to go inside the pendant and fit into the slots in the upper part of the sleeve. These slots can be seen at the top of the sleeve in 1 and 2 in figure 27. Some sleeves have two slots on the top, while others have four. On the sleeve wrench some of the prongs are made with two projecting lugs and others with four to fit the two styles of sleeves. When selecting the proper prong on the wrench observe whether you need it for two or four slots.

When adjusting the sleeve the crown is removed from the stem but the stem is left in its place through the center of sleeve.

Another type of sleeve wrench has but four prongs, suitable for the smaller sleeves and is known as a bracelet sleeve wrench. This wrench works on the same principle as the one shown in figure 31 and 32.

Sec. 45 — Removing Sleeve and Stem

Selecting a prong of the right size to go into the pendant without friction and of a style to suit the sleeve, place the tip in the slots of the sleeve inside the pendant as shown in figure 31. Be sure that your sleeve wrench prong is not too large in diameter or it may cut and ruin the threads on the inside of the pendant. With the wrench in the position shown in figure 31 it is now possible to twist the sleeve to the left and as you continue turning, the sleeve and with it the stem will gradually come out as shown in figure 32, where the threaded part of the sleeve is shown at E part way out of the pendant. Continue until the sleeve is free when it may be removed from the case.

At figure 33 is shown the assembled sleeve and stem as lifted part way out.

After removing from the case, the sleeve may be pulled off the threaded end of the stem as shown in the enlarged view in figure 34.

Sec. 46 — New Sleeves

In any watch depending upon a sleeve to hold the stem in proper position for winding or setting, you as a watchmaker will have jobs coming in needing replacements of these parts — a new sleeve, stem or crown. A customer brings in his watch complaining that it suddenly gains or loses an hour or more without apparent cause. Upon testing you may find that the stem slips from the winding to the setting position and the chances are that the lower part of the sleeve which grips the stem has become worn to such an extent that it will not hold the stem in place. Sometimes one or more of the steel finger-like tips has been broken. In either case replace with a new sleeve.

Sec. 47 — New Crowns

When your customer complains that his watch winds too hard you may find upon examination that the crown is worn so that it tends to slip between the fingers unless gripped tight enough to tire the hand. Occasionally the crown may be too small in diameter. In either event replace with a new crown of proper shape and size.

Again the stem may be broken right at the crown with a small piece of the steel remaining inside so that it is impossible to twist it out. If the crown is of gold, gold filled or nickel the piece of stem can be dissolved by means of a dilute solution of sulphuric acid or a saturated solution of alum in water. The sulphuric acid solution is made by pouring one part of the acid slowly into three or four parts of water. Never pour the water into the acid as this causes a violent chemical reaction. Even when pouring the acid slowly into the water there will be quite a little heat generated. This solution should be made in a glass or porcelain cup and the crown immersed in it. Of course there should be no oil or grease on the piece of stem imbedded in the crown if the solution is to work at its best. The solution should start working on the steel part at once as can be seen by a tiny row of bubbles arising from it. This should continue until the steel is entirely dissolved.

Be careful not to get any of the sulphuric acid solution on your clothes, as it will destroy any cotton threads or goods with which it comes in contact. Also avoid inhaling the fumes.

A saturated solution of alum in water will affect steel the same way and on account of its being less dangerous might be better for the beginner to use. It works slower than the acid solution. The action of either of these solutions can be hastened somewhat by heating.

Before attempting to dissolve the steel end of a stem from a crown it is best to examine the crown to see that it is worth the extra effort.

The majority of watchmakers do not go through this process except with a valuable crown but instead sell the customer a new stem and a new crown whenever such a job comes in.

Sec. 48 — New Stems

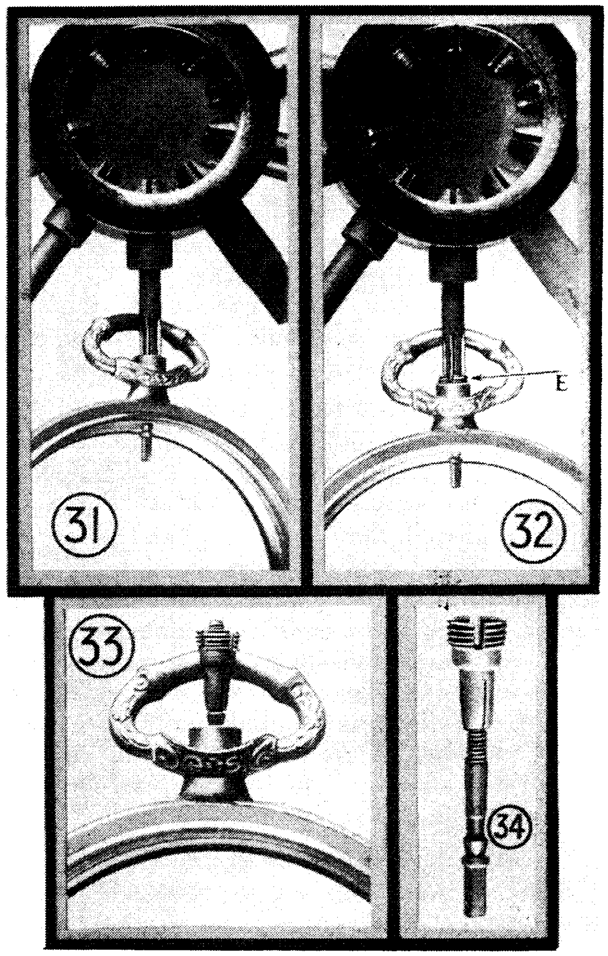
If the stem is broken or worn, select a new one of proper shape and size, and after pushing the old stem out of the sleeve, press the new one far enough through that the fingers of the sleeve are in the proper notch on the stem. The stem is placed in the sleeve by starting the threaded portion through the lower or finger end and pressing into place, see figure 34. It often requires quite a pressure before it goes into place.

Whenever you find it necessary to put in a new stem, be sure to try the square of the stem in the winding arbor of the movement to see that it fits properly. Also try the threaded end in the crown to be sure that the threads are of correct pitch and diameter.

These tests only take a few seconds and always should be made.

Sec. 49 — Replacing Stem and Sleeve

In replacing the stem and sleeve assembly in the case it is necessary to adjust the sleeve so that when the stem is pushed in, it will wind



and when it is pulled out you will be able to set the hands. In removing an old or broken sleeve or stem, it is a good plan to remember approximately how far the sleeve was screwed in the pendant so that when you replace the new one you can place it in about the same position as it was before.

After turning in the sleeve and stem to the distance you judge is correct, screw the crown on the end of the stem and then replace the movement in the case. Do not try the winding and setting until the case screws are in place and holding the movement in the same position it will occupy when the job is completed and ready to be given to the customer.

If you find that you can set the hands correctly but upon pushing in the crown and stem to the winding position you cannot wind the watch, the sleeve has not been screwed in far enough. Then remove the crown and screw down the sleeve until it winds properly.

Should you find that the watch winds properly in the case but does not set when the stem is pulled out to the setting position it will be necessary to turn the sleeve out until it will set.

If you have difficulty in making it set or wind, which you do not seem able to overcome by making these adjustments, there may be some trouble in the setting arrangement in the movement itself. Take the movement out of the case and test with one of your bench keys, selecting a key of proper size. Press the key into the movement and try the winding. Then pull the key out slightly and see that the setting is O. K. If the set and wind work outside the case you should have no trouble in adjusting the sleeve so they will work while in the case.

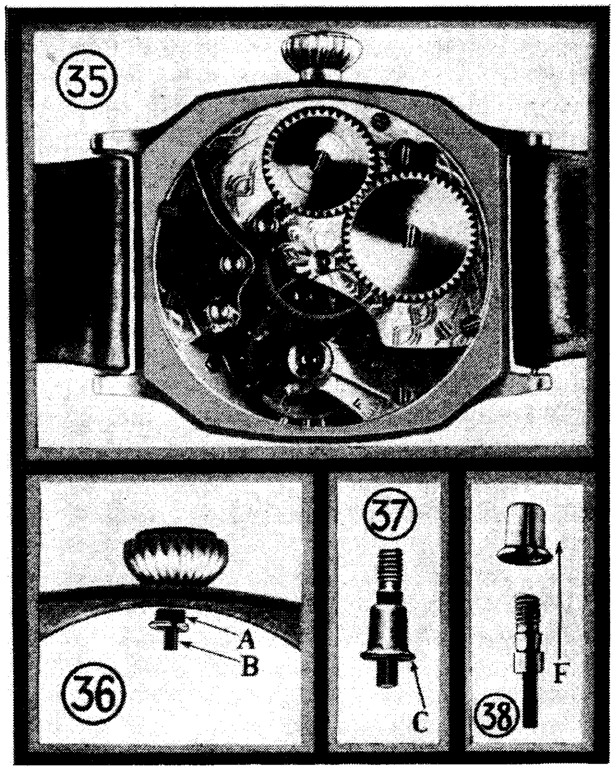
Sec. 50 — New Stem Too Long

In replacing a new stem for an old one you occasionally may find the square is so long that it would be impossible to make the watch set without having the sleeve too far out of the pendant. Then it is only necessary to file off the proper amount from the lower end of the square to make it work. The same is true of the other end. If the threaded part is so long that the crown is held too high, this end should be cut off. But be sure the fault lies in the stem being too long before you start filing. If you must file take off a little bit at a time. It is an easy matter to cut off too much.

Sec. 51 — Oiling Stem and Sleeve

If the stem and sleeve are dry it is necessary to oil the parts where they come in contact with each other. This will make it easier to move the stem back and forth when shifting from winding to setting position and will eliminate a slight squeak that may occur in winding and setting when these parts are not oiled.

To take care of this, place a very small amount of watch oil at the point K or L on the stem (see 3 in figure 27) after the stem is in the sleeve.



Sec. 52 — The Reversible Sleeve

Another type of sleeve used on some models of watch cases is called the reversible sleeve.

Figure 35 is a view of a Waltham Wrist watch with the back removed. This is the snap form of case so that the back is pried off with a case opener. Before removing the movement it is also necssary to take off the front. In many of these wrist watches there are keys and key seats to help locate the exact position of front and back as explained in section 23 of lesson 1. In this one it is not necessary to have such help in locating the position of the back.

After taking out the case screws and removing the movement from the case, the crown, stem and sleeve will appear as in figure 36. Here you will notice that the sleeve at A is not held firmly in the case but when the movement is taken out falls to the position shown.

By gripping the square at point B with a pair of pliers the crown may be twisted off as described before. The stem and sleeve come out easily and will appear as in figure 37. Here you will notice that the sleeve itself has no threaded portion, merely the shoulder at C. When the stem and sleeve are in the case the sleeve is held in its proper position by the pressure of the movement against this shoulder C. There is a slight recess in the case into which this shoulder is pressed by the watch movement so that only when the movement is in the case is the stem and sleeve in position to function properly.

In figure 38 the stem and sleeve are shown separated.

In comparing this assembly with that of the other type of sleeve you will notice that the larger portion of the sleeve is toward the square end of the stem. In other words in replacing this the threaded portion goes through the sleeve in the direction of the arrow F figure 38.

Sec. 53 — Bows

In figure 39 are shown some of the numerous shapes of bows used on pocket watches. The round form shown at M is used only on the older models. The plain antique at N is a later model than the round bow. At O is shown a French Antique bow and at P a so called stream line bow. All these bows are plain polished.

Some of the modern bows as now furnished on watch cases are gettting away from these plain standard shapes and are found in a variety of designs. At S, T, U, V and W are shown the pendants and bows of several different American made cases.

The majority of bows are held in position on the case by merely springing them into place. The pendant has a recessed place or ear, on each side into which the end of the bow fits. The bow is usually sprung on by spreading it with a pair of bow pliers or a bow expander until it will just slip into place. Sometimes a bow is too loose and it is then necessary to close it up slightly by means of a bow plier or a bow tightener.

Sec. 54 — Bows with Pegs

Some of the fancy bows are held in place by screw pegs and these bows are removed or replaced by means of the screw pegs and without being compelled to spring the bow in place. At Q in figure 39 is shown one of these bows with one of the screw pegs removed and shown by itself at R.

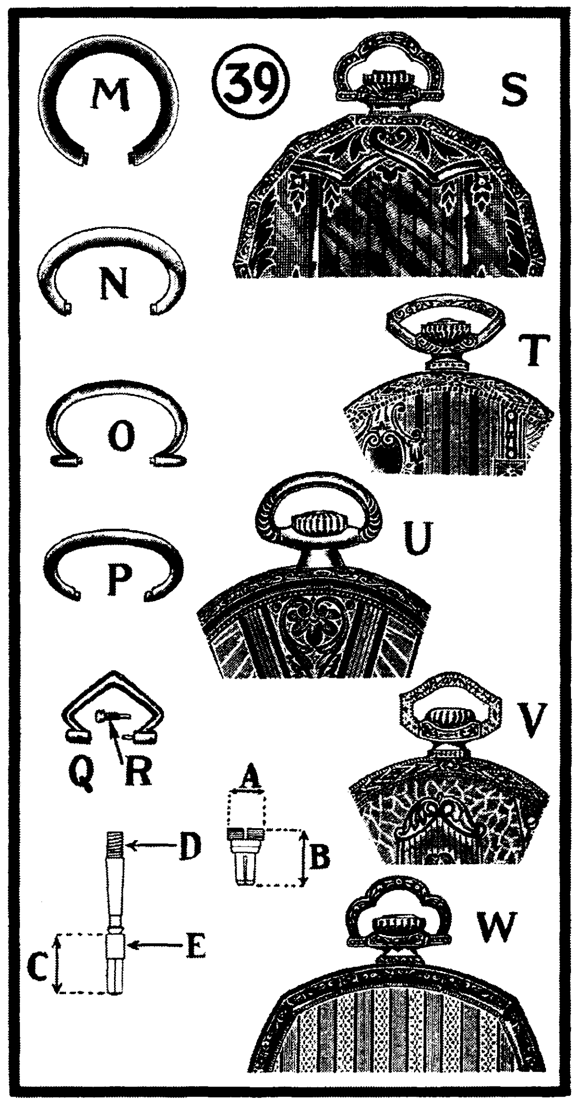
Sec. 55 — Necessary Material

Watchmakers whether in a retail jewelry store or in an exclusive repair shop, find it necessary to carry a line of the different parts or materials needed in the work of servicing and repairing time pieces. Crowns, stems, sleeves and bows are some of the things that are used almost daily. It is not necessary to get these in large quantities but by buying in small assortments it is possible to have a supply that will fit most of the jobs that come in.

Having the material right on hand makes it possible to get the jobs out sooner and this will be more satisfactory to the customer than to wait several days and also saves valuable time for the workman. Again in buying your material in assortments, you make quite a saving on the cost when compared to the price charged for matching a single piece.

If you have one of the better assortments of stem and sleeves, you will find that there is a compartment for each size and make so that it is not at all difficult to make your selection.

In some of the cheaper assortments it is possible to get a nice variety at a moderate price but the pieces are not separated and you will have to pick each piece by comparison.



Sec. 56 — Selecting a Sleeve

In a sleeve it is necessary that the threaded portion A figure 39 is the correct diameter, that the threads are of correct pitch and the length B is right.

Using your old sleeve as a pattern select one from your assortment that seems about the same size. Lay the new one right along side the old one and see that it is the same length and as near as possible the same diameter. Test the diameter A figure 39 by trying the sleeve in the pendant of the case. Slip the stem in the sleeve and try with the case and movement.

If you find it necessary to order a new sleeve, give the size of the case for which it is intended and the manufacturers name or trade mark found in the back. Also be sure to send in the old sleeve as a sample. In ordering *any* piece of material for a watch or case *always* send in the old piece as a model from which to make a selection. This is very important and will often save delays and misunderstandings.

Sec. 57 — Fitting Stems

In the better assortments of stems, as in sleeves, each size and model is in a separate compartment. In picking out a stem from a mixed lot see that the square is of proper size and that the distance from the end of the square to the slot for the sleeve, C figure 39, is correct, that the round part at E is about the same length as the old one and that the whole stem is at least as long as the old stem. See that the threaded portion D fits the crown properly. If the lower end C figure 39 should be too long it is possible to file off the end of the square, provided of course that the round part E does not extend down too far.

When ordering a stem for a case give same particulars as in ordering a sleeve and don't forget to send the sample stem.

Sec. 58 — Replacing Crowns

In replacing a crown see that the new one is of proper shape and color to match the bow and case, that the threaded portion fits the stem and that the crown is free on the pendant of the case. Of course it should be of the same quality as the case, a gold crown on a solid gold case, a gold filled crown on a gold filled case and a nickel crown for a nickel case.

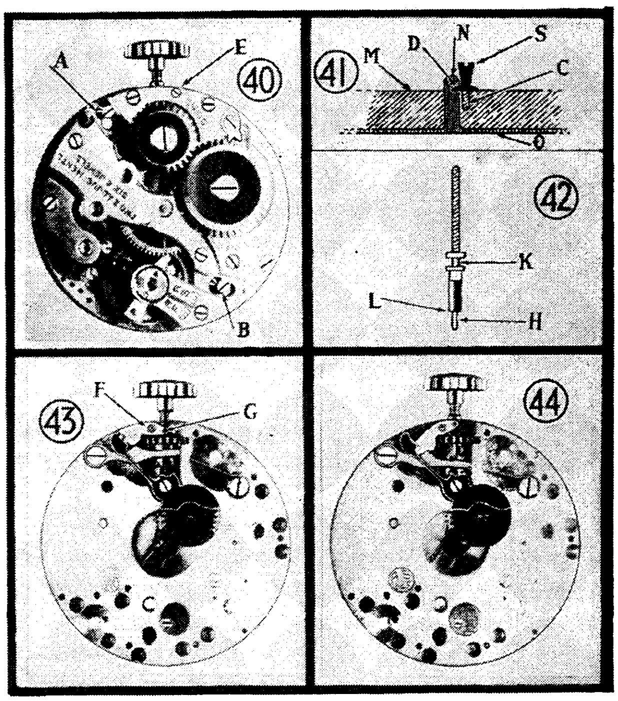
In ordering a new crown it is well to give size and style of case and of course send old crown for sample. If crown is lost send case with stem in place and crown can be supplied to match size, color and shape of case.

Sec. 59 — New Bows

It is well to carry an assortment of bows to match the average job that is brought in. As watches come in for repairs make a note of the styles carried by your customers. In this way you can select your stock of materials and findings more intelligently.

You are always safe in having an assortment of antique bows in different sizes in gold filled as these are staple supplies that must be carried at all times. It will hardly pay for you to attempt carrying the many fancy shapes at first. It is better to order these as you need them.

In selecting a bow for a round case, as a general rule it is possible to use one found in one of the regular assortments of bows, either in an old model round if it is a real old case with round crown or an antique bow to match an antique crown on a more modern case. The bow of course must be of such a size that when it is sprung on the pendant there will be no play or shake. It must match the case in color and quality.



Sec. 60 — Swiss Stem and Crown

As already stated the position of the wind and set mechanism in most American Pendant Set Pocket Watches is controlled by a sleeve and this sleeve is held in the *case.*

In most Swiss watches this mechanism is held in position by a set lever in the movement itself and this lever is connected to and controlled by the stem.

In the American system the sleeve and stem are assembled with the *case.* In the Swiss style referred to, the stem is made by the manufacturer of the *movement* and comes with it.

In this section of the work I am not going into detail as to the mechanism of winding and setting parts in Swiss movements as this will be dealt with in a future lesson under Winding and Setting Mechanisms. In this lesson however, I want you to become familiar with the way the stem operates on the set lever.

Sec. 61 — Swiss Style of Setting

In figure 40 at E you will see the head of the set lever screw. This set lever screw extends down through both plates and is threaded into the set lever on the dial side as seen at F in figure 43. On the other side of the set lever is a pin the riveted end of which shows at G. This pin fits into a slot in the stem and when the set lever screw F is tightened it holds the pin in the slot so that as the stem is pulled out to the position shown in figure 44 it pulls the set lever right along with it throwing the parts into the setting position. And when it is pushed back it carries the set lever back to its former position with the mechanism in the winding position as shown in figure 43.

In figure 42 is shown a drawing of one of these stems. As you will notice it differs somewhat from the style of American stem which I have already shown you. At the lower end, H, is shown the pilot. This fits in a hole in the plate of the watch to keep the stem properly aligned. At K is shown the slot into which the pin on the set lever fits.

You will notice that the upper end of this stem is threaded for a much longer distance than the American style. This long thread enables the watchmaker to fit this stem to practically any thickness or width of case or length of pendant, and in fitting one of these stems it is cut off on the threaded end until it is the proper length so that the crown projects the right distance from the case.

Sec. 62 — Ordering Swiss Stems and Crowns

In ordering a new stem or crown it is best to send a sample of the old one. This is possible with the stem as it is nearly always in the movement even if the crown is gone. Often, however the crown is lost but with an assortment of crowns it is an easy matter to select one matching the case.

In selecting a new stem for a Swiss watch endeavor to have the pilot about the same length and diameter as the old one, the square the same length and the slot K the same distance from the lower end of the square at L. Of course if you have the old crown it is necessary to see that the threads fit.

Stem and crown replacements in Swiss wrist and bracelet watches are a profitable part of the watchmaker's business and it is necessary that you become familiar with this work.

However, I want to warn you again not to work upon the smaller watch movements. As a general rule the beginner is safe in replacing stems and crowns on these smaller watches but should never attempt to work on the train, escapement or any of the more delicate parts until he has gone much further with his lessons.

Sec. 63 — Types of Dial Screws

In most American movements the dial is held in place by means of dial screws inserted in the edge of the pillar or lower plate, the ends of these screws coming in contact with and holding the dial feet. When the dial feet are held in this way you can see that it is necessary to have the movement out of the case before removing or replacing a dial.

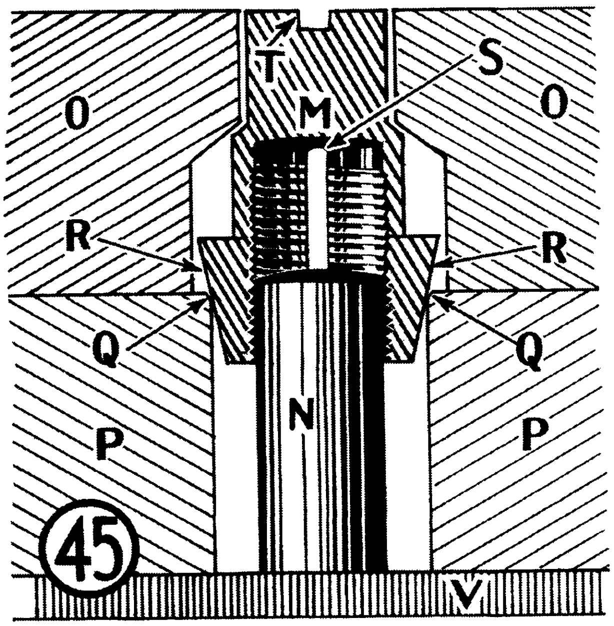
In the Swiss style shown here it is possible to remove or replace the dial while the movement is in the case. In other words, if it is necessary to take off the dial at any time to examine the pillar plate you can do so without taking the movement out of the case. Whenever you make repairs which require the removal of the dial on this type of watch, it is good practice to postpone replacing the dial until you have the movement in the case. This gives you an opportunity to see that the winding and setting mechanism is assembled correctly.

Figure 40 shows a typical Swiss 10½ ligne movement slightly enlarged. Instead of having the dial screws in the edge of the pillar plate they are placed on the plate as shown at A and B. Pins or dial feet are fastened to the dial and project through the holes in the plate seen right beside the screws. By means of these dial feet the dial is held in its place on the other side of the pillar plate.

In figure 41 is shown a drawing of one of these dial screws as fitted in the plate. N represents the dial foot extending through the plate M and attached to the dial O. S is the dial screw, the threaded part of which at C screws into the plate. The base of the screw fits in a slot in the dial foot as shown in the drawing at D. Part of the base of this dial screw is cut away, somewhat like the head of a half head case screw so that the dial foot can be pushed through the plate far enough for the slot to come in line with the base of the dial screw.

Before doing this the dial screw should be screwed down on the plate with the open side of the base directly over the dial foot hole. See A figure 40. After pressing the dial in place so that the foot comes through the hole, the screw is backed out and the base of the screw fitting in the slot of the foot, lifts the dial foot until the dial is held against the plate on the other side.

This dial screw having a right hand thread is turned down, or to the right when you release the dial foot and backed out, or to the left when you wish to tighten it.



Sec. 64 — A Later Type of Swiss Dial Screw

Another type of Swiss dial screw is shown in figure 45. Here the hollow dial screw M is somewhat in the form of a split chuck fitting in a recess formed by holes drilled through the two plates, the hole in the upper plate being small enough at the top to prevent the dial screw from falling out. In this drawing O represents the upper plate and P the lower plate. The edge of the recess in the lower plate is slightly beveled at Q and the portion of the dial screw at R is cut on a taper. The hollowed out portion of the dial screw is threaded and slotted, having four slots similar to the one shown at S.

This screw fits over the dial foot N and is tightened by pressing down with the screw driver in the slot at T, the tapered side of the screw at R pressing against the plate at Q forces the threads into the soft metal of the dial foot N. Then by turning the screw to the right with a screw driver in the slot T the threads act on the metal of the dial foot at the same time drawing the dial V firmly against the lower plate P. The dial screw being of tempered steel and the foot N being of soft copper allows the hollow thread of the screw to hold firmly on the dial foot.

In loosening this type of a dial screw it is only necessary to give it a partial turn to the left when it immediately frees itself from the dial foot. The same is true in tightening it, that is, it requires only a part of a turn after pressing the screw down to hold the dial foot and the dial firmly in place.

Before taking off the dial on either of these types of Swiss movements it is necessary to remove the minute and second hands. The hour hand may be left attached to the hour wheel and brought away from the movement with the dial. After the dial is removed the dial side of the movement will appear as in figure 43.

Sec. 65 — Be Fair to Your Customer and to Yourself

It is not the best policy to do repairs right before your customer. Of course if it is work done without pay you are justified in giving a demonstration of your skill and speed. There is always a temptation to show off, to let your customer see how quickly and perfectly you can do some of the minor jobs in watch repairing. However, this often makes him feel that you are not giving a square deal if you charge for doing something which may take only a few minutes. He does not stop to think that only after much study and practice are you able to determine just what is the trouble and turn out first class work in such a short period of time. In replacing parts, a new stem and crown for instance, even though you may be able to do it at once it is best to have the customer leave the watch and promise it for a future date, rather than to do the work while he waits. But be sure it is finished when promised.

At times you may have customers come in with a stopped watch where there is a temptation to overcharge. I have seen a watchmaker get $3.00 for repairing a watch where the only thing that was needed was an adjustment of the second hand to such a height that it would not catch on the hour hand, the work of only a few seconds. His defense was that he was not charging for the time it took him to do this but rather for his skill and ability to make the proper adjustment. I believe you will find that if you do such little jobs as this right before your customer and then charge him nothing, you will be the gainer in the long run. Such acts establish confidence not only in your ability but in your honesty as well and nowhere else is honesty appreciated more by the public than in the jewelry and watchmaking profession.

TABLE OF CONTENTS: Unit WI - Lesson 2

JOB SHEETS

STEM: Pendant Type With Screw Sleeve

TOOLS, EQUIPMENT AND SUPPLIES:

Sleeve Wrench - Flat Pliers - Screwdrivers - File - Case Opener

PROCEDURE — REFERENCE

HOW TO REPLACE NEW STEM IN PENDANT TYPE CASE USING SCREW TYPE SLEEVE

1. Remove movement from case. — Les. 1
2. Remove crown. — Les. 2 - Sec. 43
3. Remove stem and sleeve assembly. — Sec. 44 - 45
4. Select new stem. — Sec. 48
5. Insert stem into sleeve. Oil at point of contact. — Sec. 49 - 51
6. Screw sleeve with stem into pendant to approximate position of original.
7. Replace crown.
8. Replace movement. Put case screws in place and tighten.
9. Snap crown into winding position. Check winding.
10. Pull crown into setting position. Check setting.
11. Make required adjustment to stem. Re-check winding and setting. — Sec. 50

SLEEVE: Screw Type

TOOLS, EQUIPMENT AND SUPPLIES:

Sleeve wrench - Flat pliers - Screwdrivers - Case opener - Assembly tweezers

PROCEDURE	REFERENCE
HOW TO REPLACE SCREW TYPE SLEEVE	
1. Select the correct sleeve.	Les. 2, Sec. 46
2. Assemble stem and sleeve. Oil at point of contact.	Sec. 48 - 51
3. Screw stem and sleeve assembly into pendant to approximate position of the original.	Sec. 49
4. Put on crown	
5. Replace movement in case. Tighten case screws.	Les. 1
6. Check winding and setting.	Les. 9
7. If sleeve position requires adjustment, remove movement and crown and make adjustment.	
8. Make final check for proper function of the stem and sleeve.	

UNIT	WI
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Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W2-J3

STEM: Reversible Sleeve Type

INTRODUCTORY INFORMATION

These stems are selected by the size of the square, length and the tap size. Send sample of stem and sleeve when ordering.

TOOLS, EQUIPMENT AND SUPPLIES:

Flat pliers - Bench block - Case opener - Screwdrivers

PROCEDURE	REFERENCE
HOW TO REPLACE NEW STEM IN CASE WITH REVERSIBLE TYPE SLEEVE	
1. Remove movement from case.	Les. 1
2. Remove crown from stem. Stem and sleeve should slip out.	Fig. 29 - 37
3. Remove stem from sleeve.	Fig. 38
4. Select stem.	
5. Insert stem into sleeve.	Fig. 38
6. Replace stem and sleeve and screw on crown.	
7. Replace movement.	Les. 1
8. Make certain movement is in line and will wind and set properly.	
9. Replace back and bezel.	

NOTE: If crown does not fit close to case ring when in winding position, make required adjustment to threaded portion of stem.

(8-55) W2-J3

UNIT	WI
LESSON	2

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JOB SHEET
W2-J4

SLEEVE: Reversible Type

TOOLS, EQUIPMENT AND SUPPLIES:

Sleeve wrench - Screwdrivers - Case opener - Assembly tweezers - Flat pliers

PROCEDURE	REFERENCE
HOW TO REPLACE REVERSIBLE SLEEVE	
1. Select the correct sleeve.	
2. Assemble stem and sleeve.	Sec. 52
3. Oil point of contact between stem and sleeve.	Sec. 51
4. Place stem and sleeve in pendant and put on crown.	
5. Replace movement in the case.	
6. Check winding and setting for proper function.	
7. Make required adjustment.	
8. Final check for proper function.	

NOTE: When ordering an individual sleeve, send sample sleeve and the stem. If sample sleeve is not available send case also.

STEM: Swiss Type

TOOLS, EQUIPMENT AND SUPPLIES:

End cutting pliers - File - Pinvise - Screwdrivers - Case opener - Assembly tweezers

PROCEDURE — REFERENCE

HOW TO REPLACE NEW SWISS STYLE STEM

1. Remove movement from case. Three piece and water-proof type of case require removal of stem before movement can be taken out. — Sec. 60, 61; See W1 - J3.
2. Remove the old stem. — Sec. 61
3. Identify movement and select stem. — Les. 4
4. Insert new stem into movement. Make sure it is in winding position.
5. Replace movement into case and cut off the excess threaded portion which protrudes from case.
6. Remove stem.
7. Place stem in lathe or pinvise and smooth end of threaded portion with a file or stone.
8. Replace crown.
9. Replace stem and crown in movement.
10. Tighten set lever screw.
11. Replace movement in case.

UNIT	WI
LESSON	2

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W2-J6

STEM: Two-piece Snap-in

INTRODUCTORY INFORMATION

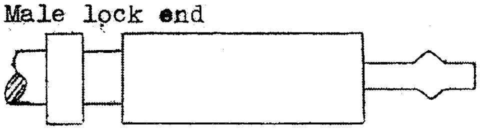
This type of stem is most commonly used with water resistant cases which do not have a removable back. The stem comes in two pieces which interlock when snapped into position. The two pieces are called the stem and the crown neck.

In order to remove the movement from the case the crown and crown neck must be detached from the stem. This is done by gripping crown firmly and pulling outward. After removing the movement from the case the set lever screw can be released to remove the stem.

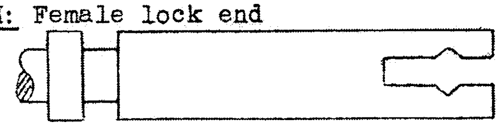
Stems and crown necks come in a variety of lengths. Stems may have either a male tip locking end or a female lock slot. Crown necks also come in a variety of lengths and are available with both male and female lock ends with either male or female thread.

When ordering stems or crown necks always send correct identification of the movement. (Lesson 4.) If a sample of the part required is not available and included with order, the following must be furnished: distance between set lever slot and end of stem, indicate whether male or female stem. When ordering crown neck furnish length, indicate whether male or female locking and thread. The watchmaker generally carries a small selection of different lengths of stems and crown necks for replacement purposes.

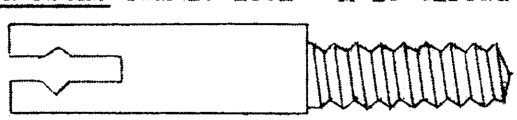
STEM: Male lock end



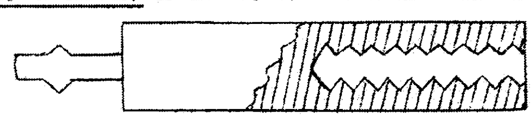
STEM: Female lock end



CROWN NECK: Female lock - Male thread



CROWN NECK: Male lock - Female thread



NOTE: Crown necks also with both ends female or both male.

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - Flat pliers

PROCEDURE

HOW TO FIT TWO-PIECE STEM

1. Select the correct stem for the movement.

(OVER)

PROCEDURE CONTINUED

2. Insert stem in the movement.

3. Tighten set lever screw.

4. Test for proper function of the stem.

5. Put movement in back of case.

6. Assemble bezel, crystal and back.

7. Select the correct crown neck.

8. Screw the crown neck into the crown.

9. Place crown and neck in stem opening of the case.

10. Turn crown slowly as you press inward until parts snap in place and interlock.

11. Test winding and setting.

NOTE: If only stem is being replaced follow steps: 1, 2, 3, 4, 5, 6, 9, 10, 11.

If only crown neck is being replaced follow steps: 4, 5, 6, 7, 8, 9, 10, 11.

UNIT	WI
LESSON	2

Master Watchmaking

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JOB SHEET

W2-J7

CROWN: Pendant Type

TOOLS, EQUIPMENT AND SUPPLIES:

Case opener - Screwdrivers - File - Flat pliers

PROCEDURE	REFERENCE
HOW TO REPLACE NEW POCKET WATCH CROWN	
1. Remove movement from case.	Les. 1
2. Select crown of proper size, shape, tap size and color to fit case.	Sec. 47
3. Place crown over the pendant opening. (Should fit freely.)	
4. Screw crown on stem.	
5. Snap crown into winding position and make sure the crown covers the pendant opening.	
NOTE: If crown does not cover pendant opening, a shorter post crown is required. If it does not snap into winding position a longer post crown is required.	
6. Replace movement into case.	

CROWN: Regular Swiss Type Bracelet

TOOLS, EQUIPMENT AND SUPPLIES:

Case opener - Screwdrivers - File - Flat pliers

PROCEDURE

HOW TO REPLACE NEW CROWN (WRIST WATCH)

1. Remove the movement from the case.
2. Remove the stem from the movement.
3. Select a crown of the color, size, opening, post length and thread size to fit the case and stem.
4. Screw crown on stem.
5. Replace stem and crown in movement.
6. Replace movement in case.
7. Check for proper clearance of crown and case.
8. Check for proper winding and setting.

NOTE: If winding and setting are not functioning properly the following corrections may be necessary:

Crown resting against the case, movement not winding properly; this is generally an indication that a crown with longer post or a new stem is needed.

Too much clearance between case and crown; either replace crown with short post crown or reduce the length of the thread on stem.

CROWN: Water-proof

INTRODUCTORY INFORMATION

In selecting a crown for a water-proof case, it is necessary to know the tap size, the case pipe or tube diameter, length of crown post, and color.

TOOLS, EQUIPMENT AND SUPPLIES:

Flat pliers - Screwdrivers - Case opener - Case vise

PROCEDURE

HOW TO REPLACE NEW WATER-PROOF CROWN

1. Open case.

2. Remove stem from movement.

3. Place crown over case pipe tube. Make certain it fits all the way down to the case ring. (The crown has a gasket inside so it will fit quite tight.)

4. Screw crown on stem.

5. Replace stem into movement.

NOTE: If crown does not fit down to case ring, the stem can be shortened.

If crown will not snap into winding position you should replace with a crown with a longer post or replace with a new stem.

BOWS: Antique, Round, Fancy

TOOLS, EQUIPMENT AND SUPPLIES:

Combination bow pliers (opening and closing)

PROCEDURE	REFERENCE
HOW TO REPLACE NEW BOW	
1. Select bow of proper size and style to fit the case.	Les. 2. Sec. 53, 54
2. Spring bow open with bow pliers and snap in place on pendant.	
3. Check for snug fit.	
4. If too loose, tighten with bow pliers.	

NOTE: When ordering a new bow, indicate style of bow, size of case, color and measurement between contact points.

STEMS: Tap Sizes

INTRODUCTORY INFORMATION

Information on tap sizes, Swiss & American.

SWISS STEMS sizes Tap #0 to #10.

Tap	*O.D. in MM	Inches
0	2.05	.081
1	2.00	.079
2	1.85	.073
3	1.65	.065
4	1.55	.061
5	1.45	.058

Tap	*O.D. in MM	Inches
6	1.35	.053
7	1.25	.049
8	1.15	.045
9	1.05	.041
10	.95	.037

AMERICAN STEM sizes from 18s to 3/0

Size	*O.D. in MM	Inches
18s	2.27	.089
16s	1.45	.058
12s	1.18	.046

Size	*O.D. in MM	Inches
6s	1.18	.046
0s	1.18	.046
3/0s	1.18	.046

*Outside Diameter.

TOOLS, EQUIPMENT AND SUPPLIES:

Stem with known tap size, wood, plastic or metal handle. Drill.

PROCEDURE

HOW TO MAKE A TAP GAUGE

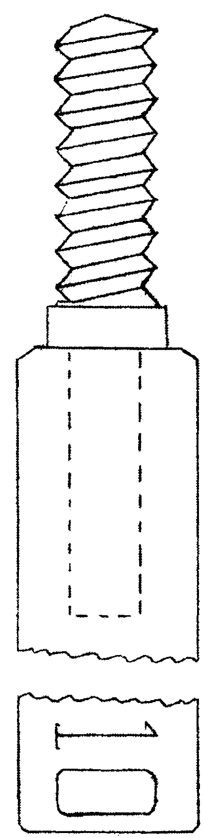
1. Select stem with known tap diameter.

2. Break off pilot.

3. Drill hole in handle slightly smaller than the square on stem.

4. Mount stem in handle.

5. Mark tap size on handle.



NOTE: These sizes may vary as much as .03 to .04 of a millimeter, but are generally close enough to determine the right tap size of a crown.

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 3

Fitting Watch Crystals and Watch Attachments
for Practice and Profit

—

Sections 70 - 86

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Lesson 3

Sections 70 to 86

FITTING WATCH CRYSTALS AND WATCH ATTACHMENTS FOR PRACTICE AND PROFIT

Sec. 70 — Millimeter — A Unit of Measure

Throughout your course and career in Watch Repairing, make it a practice to carefully determine the exact measurement of every piece of material used for replacements. Do not attempt to "guess." Guesswork is the method invariably used by careless workmen. Watches are made to exact measurements and gauges must be used to determine correct measurements for replacing or making parts.

Several standards of measurement are used by watchmakers. The English measures of length consisting of the inch, foot, etc., are not practical for our work. For instance, the inch is divided into so many divisions—16ths, 32nds, 64ths, 128ths, and 1000ths—that it requires mathematical skill to figure out the decimal equivalent of the parts of an inch. One cannot tell instantly that 7/64ths of an inch written decimally equals .10938 inch unless he has the equivalents memorized or a printed table at his elbow. Both methods are in common use.

In your work, you will use a unit of measure called a millimeter. The metric unit of length is the meter which is equal to 39.37 English

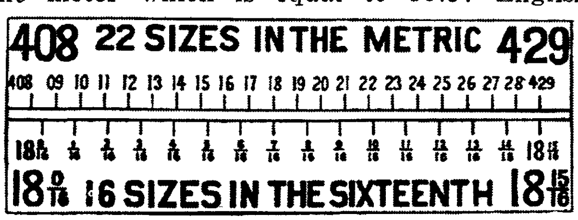


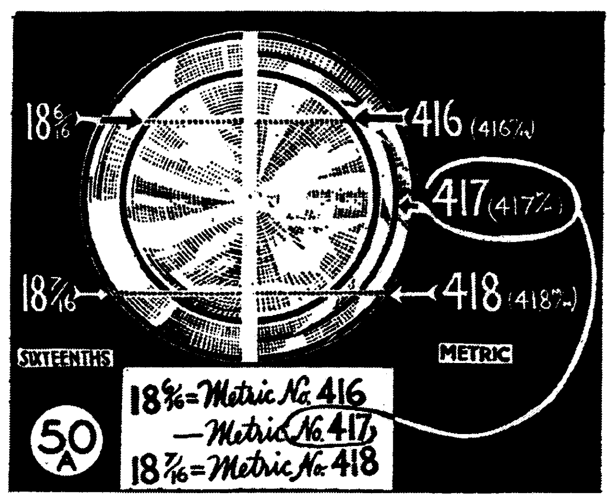
FIG. 50

inches. The millimeter is the one-thousandth part of a meter and the abbreviation is mm. Thus 1 mm equals 1 millimeter, 6 mm equals 6 millimeters, 20 mm equals 20 millimeters.

Pivots in watches, outside diameters of jewels and jewel holes are gauged in hundredths of a millimeter. Later a micrometer will be used which measures to 1/100 of a mm. Mainsprings and watch glasses are being gauged by the metric system much more than formerly.

Sec. 71 — Lignes

The French "ligne" (line) is also used in watchmaking. The sizes of French and Swiss watches are designated in lignes. The ligne is 1/11 of an English inch and 1/12 of a French inch. A ligne equals 2.25 mm.



Sec. 72 — Comparison of Sixteenth and Metric Systems

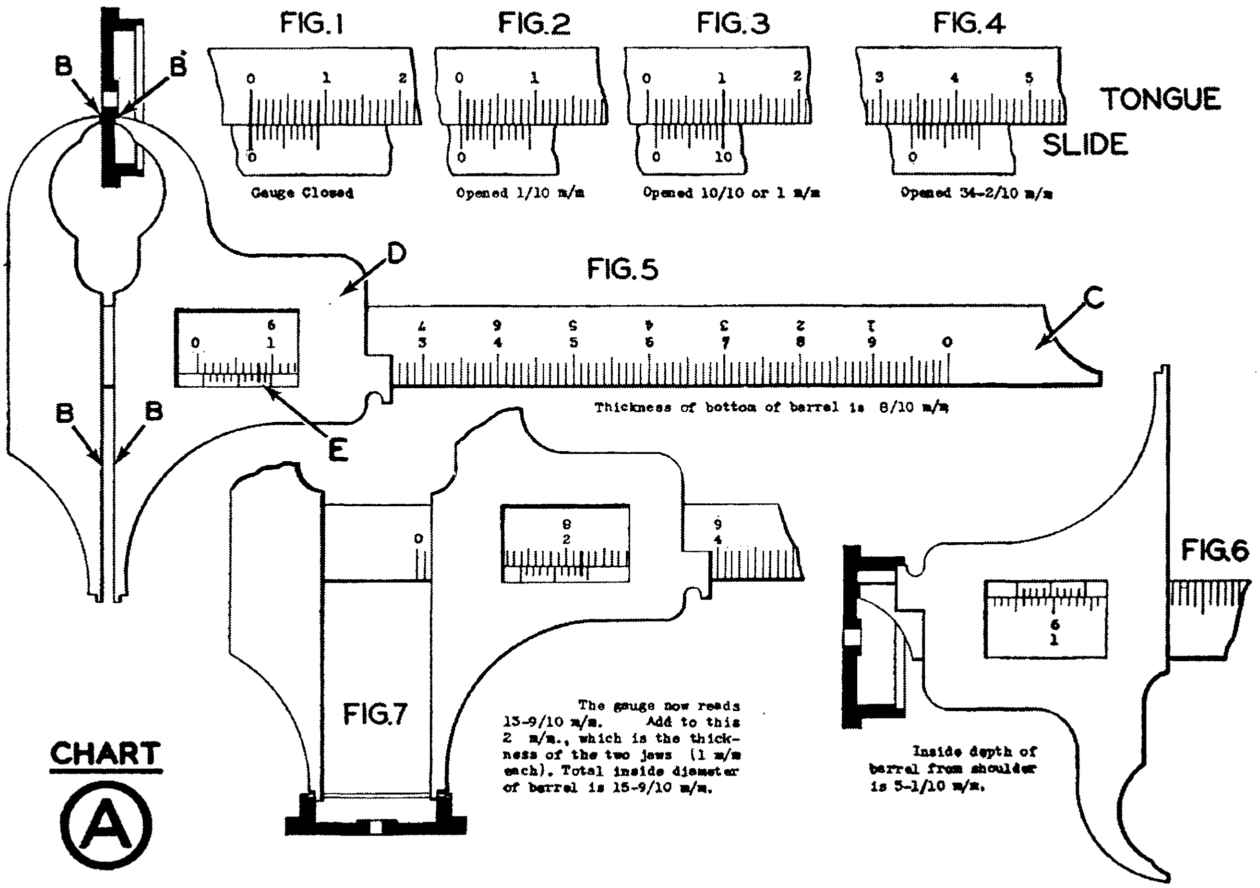
Among the older watchmakers, there are many who use the sixteenth system. Figure 50 shows the units of 18s divided into sixteen parts, 18-0/16th to 18-15/16ths. The most modern system is the METRIC SYSTEM. In figure 50, notice the metric numbers 408 to 429, divided into 22 parts of 1/10th of a millimeter each. You have 22 sizes in the metric system and only 16 sizes in the sixteenth system. In other words you have more in-between sizes, figure 50A.

Sec. 73 — Reading a Millimeter Gauge

Chart A, figure 5, illustrates a common type of millimeter gauge. The jaws at B, figure 5, are for outside measurements. C is the tongue. D is the slide which contains a scale at E. This scale is NOT divided into millimeters. It is a Vernier Scale, and is used to divide a millimeter into 10 equal parts, making it possible to measure in tenths of a millimeter with a gauge of this type.

Notice the first ten divisions from 0 to 1 on the tongue, figure 1. Each one of these divisions equal 1 mm. The Vernier Scale located on the slide (figure 1) is divided into 10 equal sections and these ten divisions equal 9 divisions on the tongue. If the slide were moved so that the second line on this slide coincides exactly with the second line on the tongue scale, figure 2, the jaws of our caliper would be open one-tenth of a millimeter—3 lines two-tenths, 4 lines three-tenths, etc. Figure 3 shows a reading of 1 mm. If the line marked 0 on the slide, figure 3, were moved to the next line on the tongue, it would read 2 mm and so on up the tongue which has a total of 100 mm. The small inverted figures on the tongue, figure 5, are for reading when the gauge is used for depth measurements as illustrated in figure 6.

Figure 4 illustrates the slide measuring 34-2/10ths millimeters. Count the number of lines on the tongue before the 0 on the Vernier Slide. This is 34. Now notice which line on the Vernier Scale coincides with a line on the tongue scale (only one will coincide exactly); in this particular case, it is the third line or the end of the second division. This equals 2/10ths of a millimeter. Now add 34 plus 2/10ths written 34.2 mm. All measurements are read exactly the same way in measuring the depth, figure 6, and outside measurements, figure 5.



Inside measurements are taken as shown in figure 7. In this particular case, the gauge reads 13.9 mm. However, as this reading is the measurement between the jaws, it is necessary to add 2 mm, the thickness of the two jaws (one mm each), to the total making a total inside measurement of 15-9/10ths mm. It will take some time to become accustomed to measuring in millimeters if you have never used the metric system before. You should practice by using your millimeter gauge at every opportunity. There is very little in watch repairing, especially in the more advanced work, that does not require the use of either a millimeter gauge or micrometer.

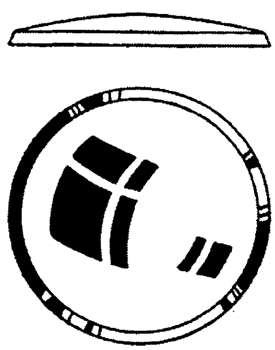
Interest, accuracy and progress in watchmaking will be assured when reading of the millimeter gauge is mastered.

Sec. 74 — Profits from Watch Crystals

The fitting of watch crystals or watch glasses is a lucrative part of the watch repair business. Practically every watch purchased in the United States is brought into the watch repair shop for a new crystal at some time. It is an essential part of the repair business and the watch repair man can create an abundance of good will and an excellent profit if he can give quick service. The repair man who is on his toes realizes that quick service without sacrificing quality is a sure way to keep his customers. Many stores carry an immense stock of crystal blanks. It would be impossible for the beginner to stock the thousands of sizes and shapes of watch crystals. Part of this lesson will explain how you can make watch crystals fit practically any style watch case with a little practice and without a great deal of investment.

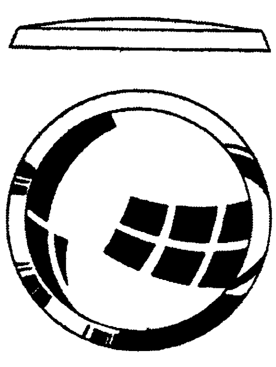
Sec. 75 — Fitting Round Watch Glasses

The first step is the fitting of round watch glasses. Glass is probably the best material for use in protecting the face of a watch. Glass has one fault; it will break. However, it



MICONCAVES

Miconcave crystals are finished with a sharp beveled edge and used on the ordinary open face watch case.

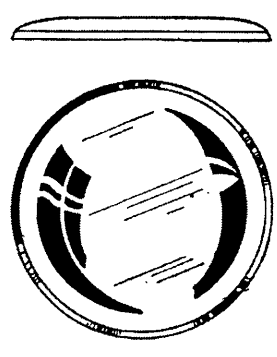


EXTRA THICK MICONCAVES

The extra thickness adds double strength. Edges are sharp and clean cut. Recommended for use on silver and silverine open face watches—such as are carried by railroad engineers, etc.

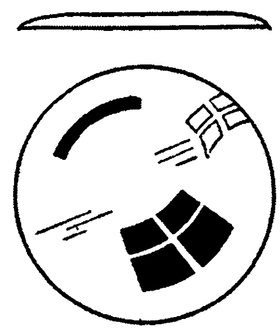
LENTILLES

A high grade watch glass, intended for use on the better grade open face watches. Their streamline dome shape is a true compliment to the better quality open face watch.



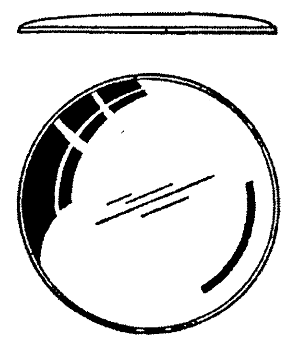
EMPIRE CHEVEES

Less expensive, but equally as practical as Lentille Chevee Crystals. A thin, bevel-edged glass for bracelet and pocket watches. Unexcelled for the thin model lower priced, open face watches.



LENTILLE CHEVEES

Similar in shape and of the same quality as the Lentille crystal. The height of the Lentille Chevee near the edge is the same as at the center, giving the hands sufficient room to pass. Especially adapted for high grade thin model watches.

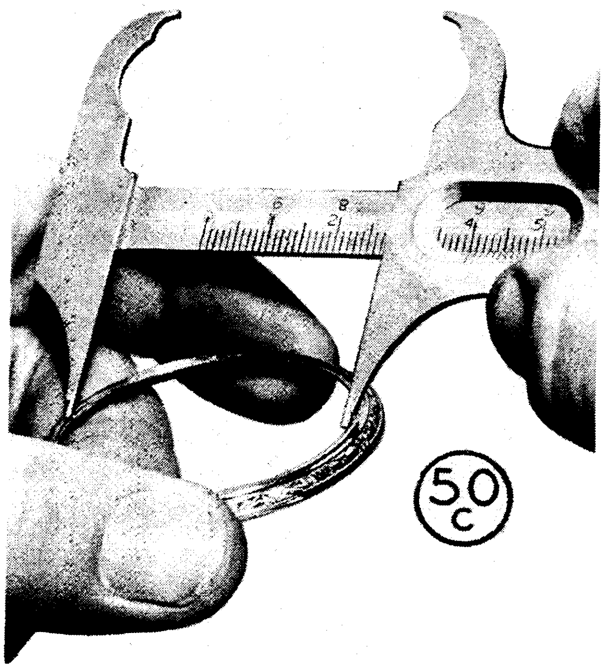


GENEVAS

Geneva crystals are furnished in various heights for closed face or hunting watch cases.

FIG. 50B

does not scratch easily and if "snapped in" properly, it will not come out. You may have customers who are constantly breaking crystals and will desire one that will not break. A good repair man is always equipped to give his customers what they prefer. Unbreakable watch glasses are clear and flexible. The round No Breaks are most always inserted with force. The main objection to non-breakable watch



glasses are that they will scratch and, in some instances, when too much pressure is exerted on the center of the non-breakable glass, there is a possibility that the hands or the center pinion may be damaged. Some have a tendency to shrink and, after a long period of time, there is a possibility of the non-breakable crystal falling out.

Sec. 76 — Types of Round Crystals

In figure 50B are shown the characteristics of round glasses with the trade names listed below each illustration.

For all practical purposes, the Lentille is probably the most satisfactory for use on open face watches, as it allows more room for the hands and is neater.

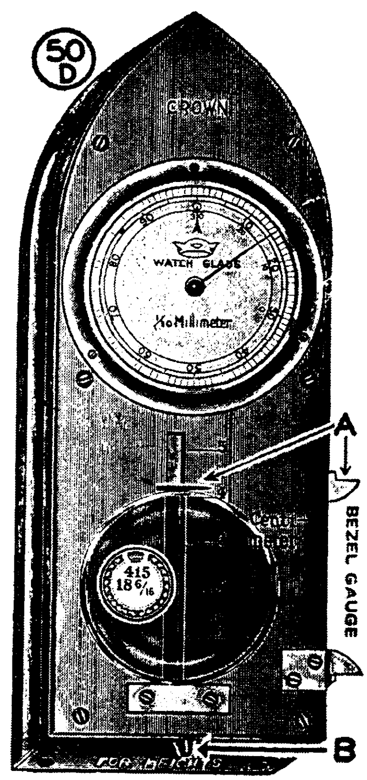
The Miconcave and extra thick Miconcave are used on the older types of watches and on railroad models where more strength is needed than can be supplied by a Lentille.

Sec. 77 — Fitting Crystal to Open Face Watch

To fit a watch glass to an open face watch, remove bezel. Be certain the bezel is clean and that no broken bits of glass or dirt remain. Figure 50C illustrates the method used in measuring a bezel with a millimeter gauge. The reading of the scale in this case is exactly 39.5 mm. However, we are not using the inside of the jaws which is the distance the 39.5 mm represents. It is necessary to allow for the thickness of the jaws (1 mm each) or 2 mm making our actual measurement 41.5 mm. On the modern metric crystal charts the decimal point and the mm are dropped leaving only the figure 415 which represents the size of our crystal. 41.4 mm equals No. 414; 21.6 mm equals No. 216, etc.

Figure 50D illustrates a type of crystal gauge which measures in the metric system.

In figure 50-D notice the two arrows at A. The longer arrow indicates the movable jaw used to measure the outside diameter of a round watch glass. The shorter arrow indicates the



movable jaw used to measure the opening in the bezel. The divisions shown on the vertical scale are centimeters which we convert into millimeters as follows:

1	Centimeter	=	10	Millimeters
2	"	=	20	"
3	"	=	30	"
4	"	=	40	"
5	"	=	50	"

The circular scale is divided into tenths of a millimeter. The total is obtained by combining the reading on the vertical scale and circular scale:

Example:
Reading on Vertical Scale: 40 mm
Reading on Circular Scale: 1.5 mm

Total: 41.5 mm

Remove the decimal point and the size of glass illustrated is 415.

Sec. 78 — Inserting

In the modern shop, you would select from stock glass No. 415. If the glass selected did not snap in, you would try another of the same measurement until you found the correct size.

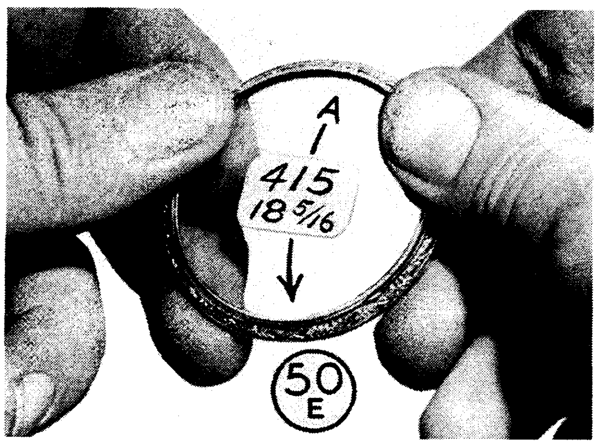


Figure 50E shows how to insert glass. Put glass in lower edge of bezel with thumbs and fingers, draw the glass in direction indicated by Arrow A until glass snaps in. Remove label, clean watch glass both inside and out, dry thoroughly and replace on case.

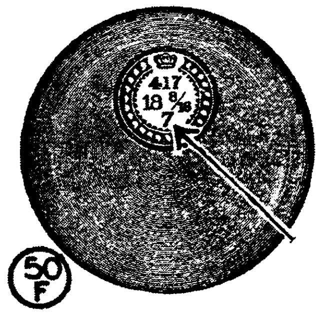
Sec. 79 — The Geneva Crystal

The Geneva is used only on hunting case watches, Lesson 1, figure 11. These crystals are very thin and although the sizes are metrically the same, they would break if used on an open face watch.

For measuring the height of Geneva crystals, the gauge illustrated in figure 50D can be used as follows: Press the underside of the watch glass against the small rod projecting through the lower end of the gauge at B and the pointer will indicate the height on the inner circle figures 0, 10, 20, and 30 as follows:

24=Height 4
20=Height 5
16=Height 6
12=Height 7
8=Height 8

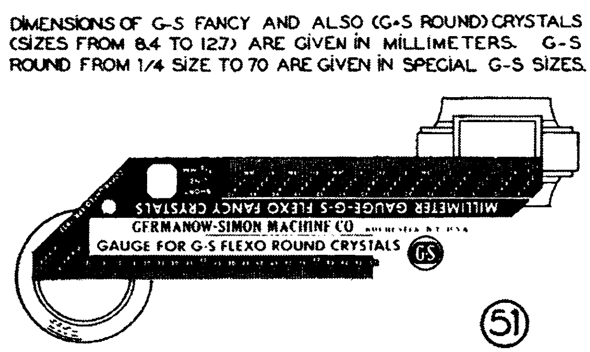
Notice in figure 50F this label has a small number printed on it, in this case, No. 7. This refers to the height of the crystal. In the older types of hunting case watches, this number would usually be No. 5, meaning 5 high. The different heights are 4, 5, 6, 7 and 8. The thinner



models use 7 or 8 high. There are so few of these watches in use today it is hardly profitable for the average man to carry a complete stock of Geneva glasses. It is more profitable to order from a regular material house. Be sure when ordering to send the bezel and, if possible, the case so that the correct height may be selected.

Sec. 80 — Selecting Fancy Watch Crystals

Figure 51 is a crystal gauge for measuring fancy and round crystals. When measuring a fancy case with a G-S Crystal Gauge, it is difficult to obtain its exact size to a tenth of a millimeter. SOME G-S Crystals are made 1 to 4 TENTHS OVERSIZE to fit cases which vary



slightly in size. Therefore, when selecting a crystal, always try a size from 1 to 4 tenths smaller. You will often find that this crystal will fit correctly with very little filing, if any.

More than ever the fancy watch crystals are becoming more popular. There are thousands of different sizes and shapes.

This is the Chart of KK Fancy Crystal Shapes

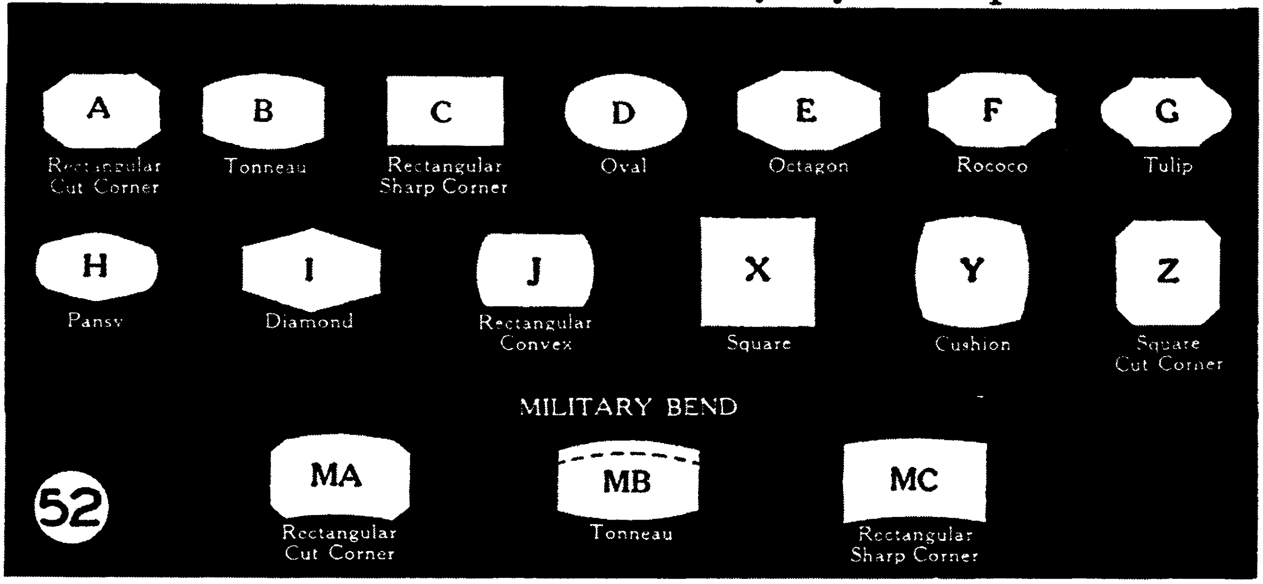
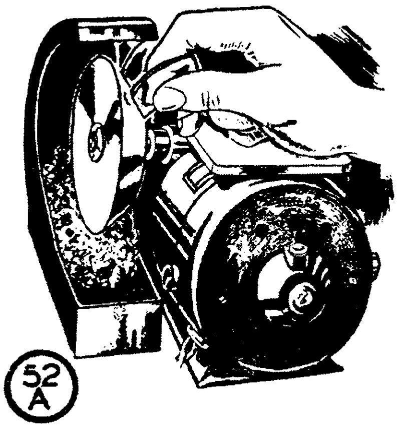
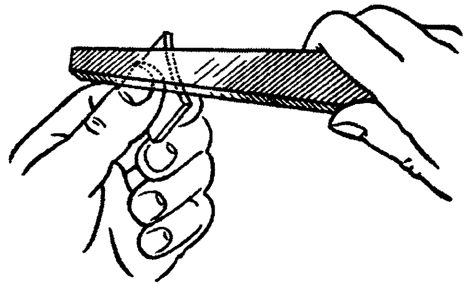
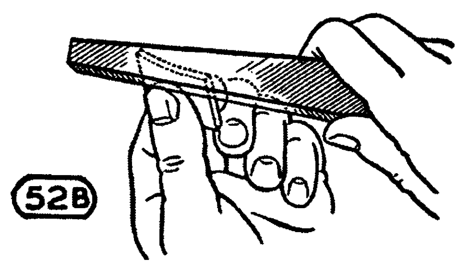


Figure 52 shows an illustration of a few of the many shapes. These shapes can be obtained in glass or non-breakable and usually have to be touched up with a glass grinding wheel, figure 52A, or with a file, figure 52B, for the non-breakable.

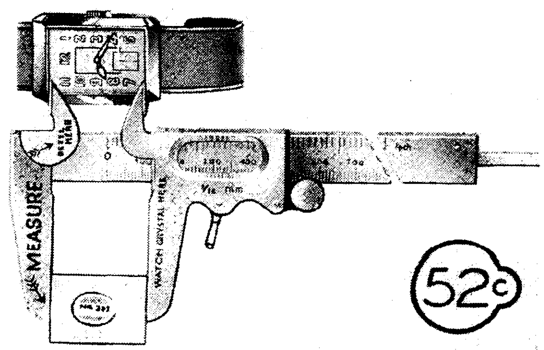




Wrong way of filing—Do not file crosswise.



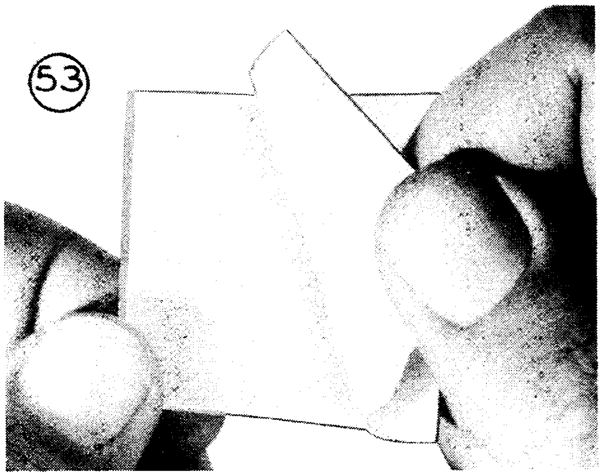
Right way of filing—Hold as illustrated with the thumb on dome side of crystal. File lengthwise on edge and form a slight bevel on crystal.

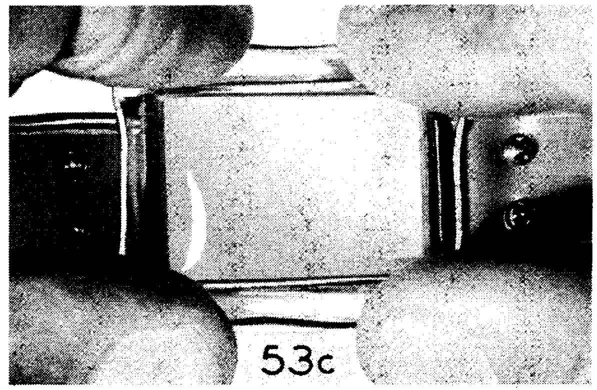


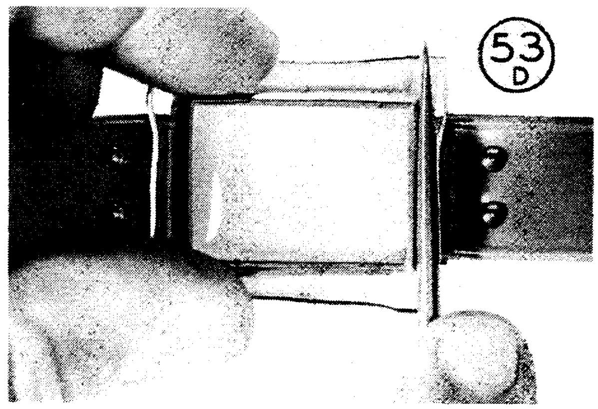
In ordering fancy crystals, first determine the shape as in figure 52. Measure the length and width in mm, fig. 52C, or as illustrated in fig. 51. Now select your crystal according to shape, length and width and fit into bezel. There are many shapes on the market and you should obtain a crystal catalog from the concern you select as your supply house.

Sec. 81 — Tools and Material to Make Your Own Crystals

As has been explained, the better equipped shops carry many different styles and shapes of watch crystals. This enables them to give quick service. However, for the man starting in







business, it is profitable to make his own crystals. This also gives practice fitting different shapes of bezels. When you have advanced far enough to take a job it will be a simple matter to touch up crystal blanks that come very close to being the correct size. For this lesson, we will need beside our crystal blanks, the following:

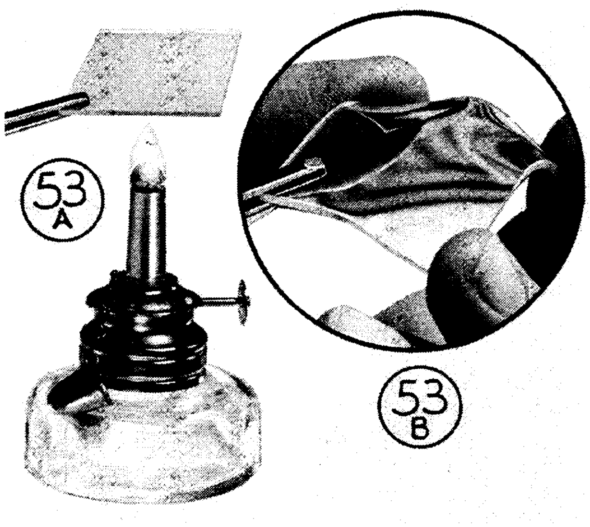
Alcohol lamp
Flat file
Cutting pliers
Coping saw
Crocus cloth
Silver paste
Crystal cement
Stylus or awl
Dome shaped glass lense or paper weight
Soldering tweezers

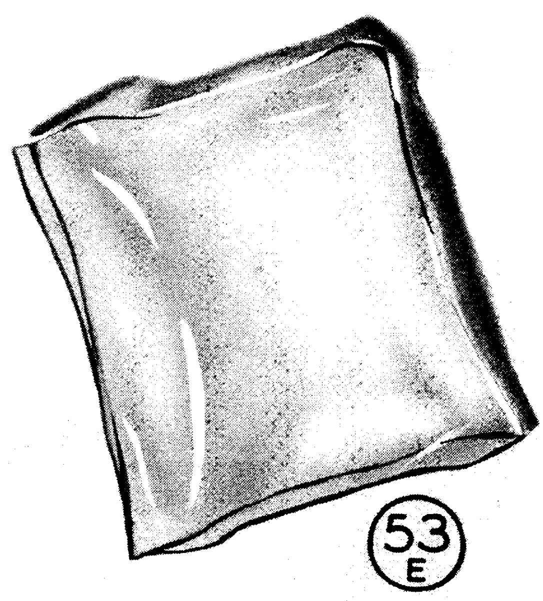
Clean bezel thoroughly, removing dirt and bits of broken crystal.

Sec. 82 — Cutting and Shaping Material

The procedure in cutting and shaping material is as follows:

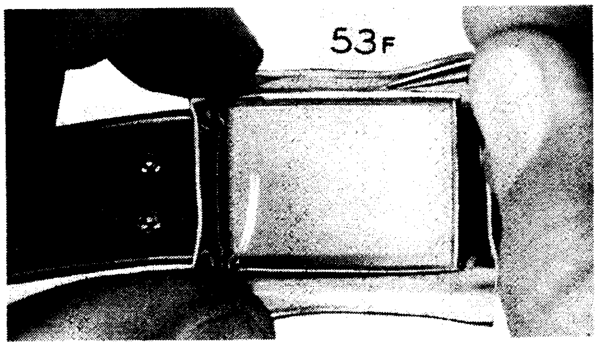
Remove paper cover from crystal blank, figure 53. The size of the crystal blank should be





approximately ½ inch longer and wider than the bezel to be fitted.

Heat crystal blank over alcohol lamp as shown in figure 53-A until blank is soft and pliable.



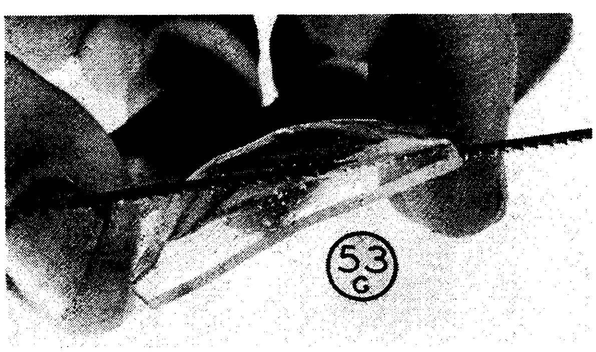
Quickly place blank over frame of bezel, figure 53-C, and with fingers mould edges over sides of case.

Carefully apply heat to ends of blank and using the awl form over each end of case as in figure 53-D.

The blank should appear similar to the one illustrated in figure 53-E. The amount of curve or dome to the crystal should be of sufficient height so that the hands will have ample clearance.

With a scribe, scratch outline of the bezel as in figure 53-F allowing about 1/16th inch for finishing.

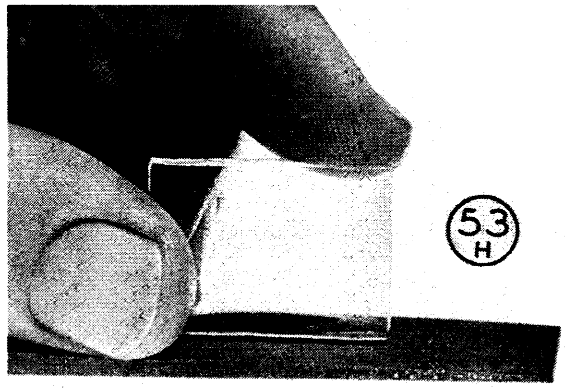
Using coping saw, cut away surplus material from both ends and sides, figure 53-G.



Place flat file on bench and draw crystal across cutting teeth of file, figure 53-H, until edges are straight and smooth and crystal will snap in bezel.

To polish edges of crystal repeat the above method, using crocus cloth and silver paste, figure 53-J.

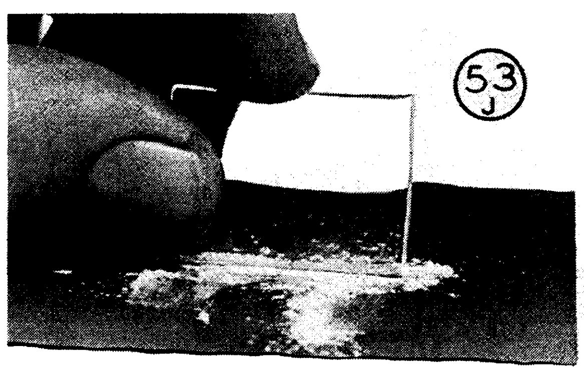
This is the simpler form of watch crystal and if on your first attempt you do not get a perfect fit, do not be discouraged. It will take practice but eventually you will be able to turn them out rapidly.



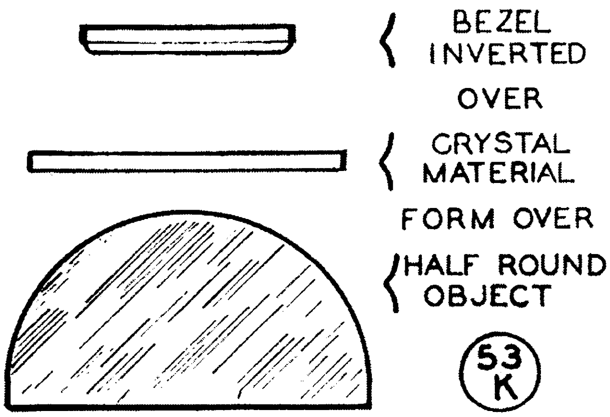
NOTE: Always file two opposite sides to fit first.

Sec. 83 — Doming Round Crystals

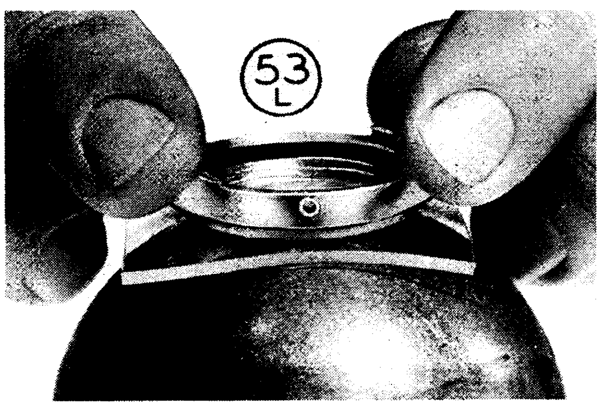
Your ingenuity will be taxed in making the various sizes and shapes that will be encountered. Individual instructions cannot be given on the thousands of different sizes and shapes. These instructions are basic instructions. In fitting other crystals such as square, round, etc., it is necessary to dome our crystal by another method. It would be fine if a mold for each different size could be made, but this is im-



practical and expensive. A round glass paper weight, optical lense or wood block about 2 inches in diameter and 1½ inches high with a smooth surface can be used for this purpose. Figure 53-K is a sectional view of such an object.

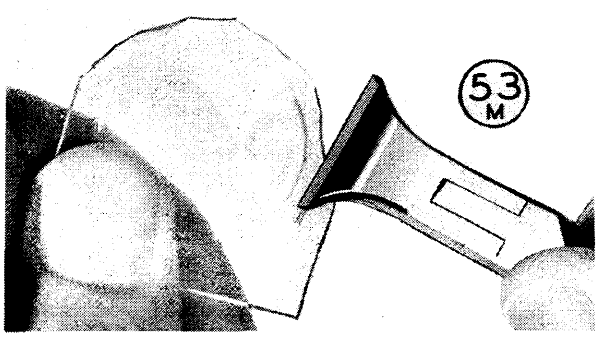


After selecting a blank, heat over alcohol lamp as before until blank is pliable. Now quickly place blank over block and with the bezel to be fitted inverted, hold blank until cool, figure 53L. Remove and you will have an outline of the bezel in the blank which now should be domed



high enough for hands to pass. At this point, there are likely to be a few bubbles in the glass. If so, pass blank through flame two or three times until bubbles disappear. Trim and finish as before.

Use cutting pliers instead of saw to trim crystal blank as illustrated in figure 53-M.



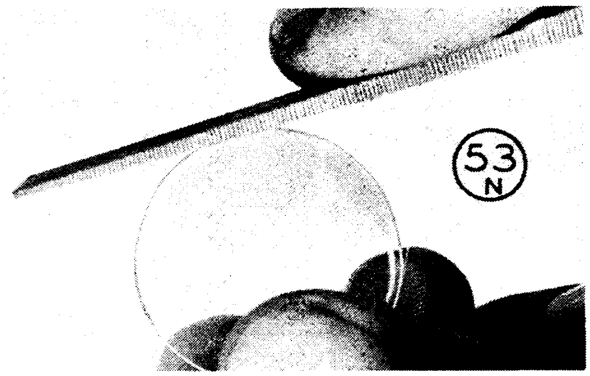
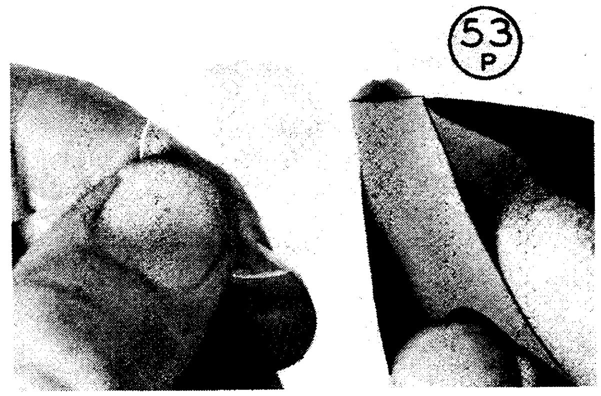


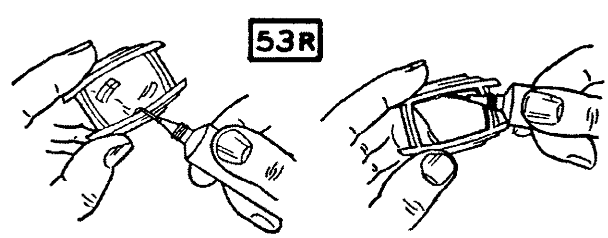
Figure 53-N illustrates the method used to file a round crystal.

Figure 53-P illustrates the use of crocus cloth or crocus cloth and silver paste to polish edge.

Use the methods described or combination of methods best suited for each job.



After crystal is snapped in, flow crystal cement around edge of bezel sealing it against dust, figure 53R. A properly fitted crystal should snap in; the cement is used primarily to exclude dust. Practice on as many different types of watch bezels as possible and you will soon be in a position to turn them out rapidly. It will not be hard to reach the speed of 3 to 5 an hour at substantial profit.



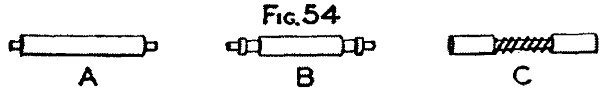
1. For Dustproofing—After crystal is inserted, apply point of tube around outside edge of groove and crystal. Press tube very lightly, cement will fill in any openings.

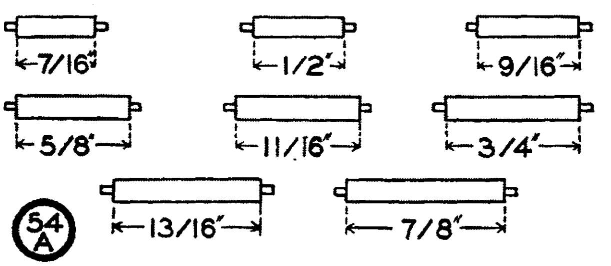
2. For Cementing — When crystals are fitted improperly, loose or in very shallow grooved cases, apply cement direct to groove; then insert crystal.

Sec. 84 — Spring Bars

This is another profitable part of your business. Most men's wrist watches and some models of ladies' sport watches use leather straps to

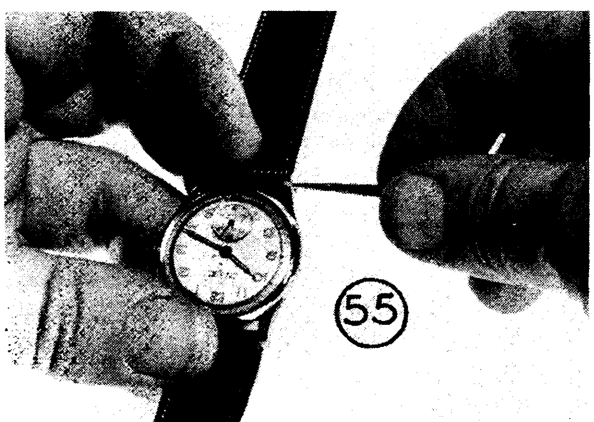
FIG. 54





54A

keep watch in place. The majority of leather straps are held in place by spring bars, figure 54. This is enlarged to show detail. Figure 54A shows actual sizes with the corresponding measurement listed below each spring bar. Figure 54 illustrates three types of spring bars: A, the single shoulder, B, the double shoulder, and C, the Female spring bar used with cases



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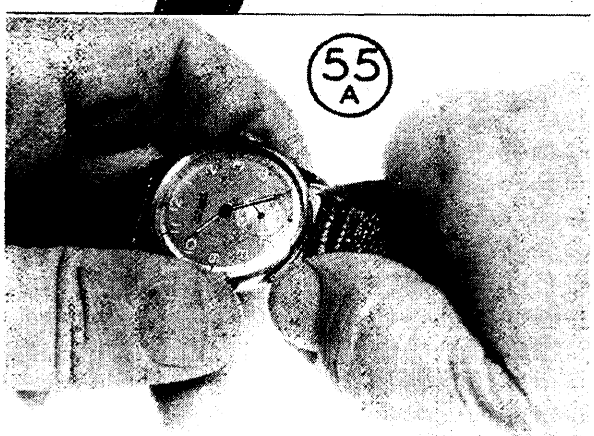

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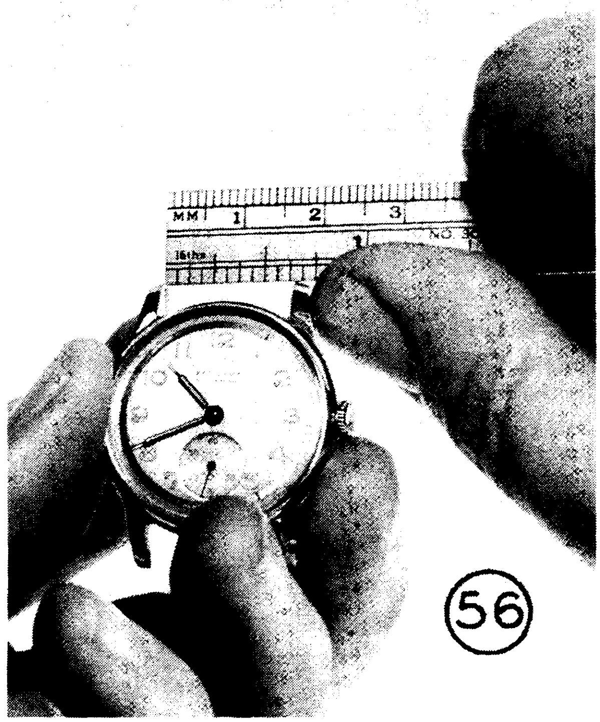
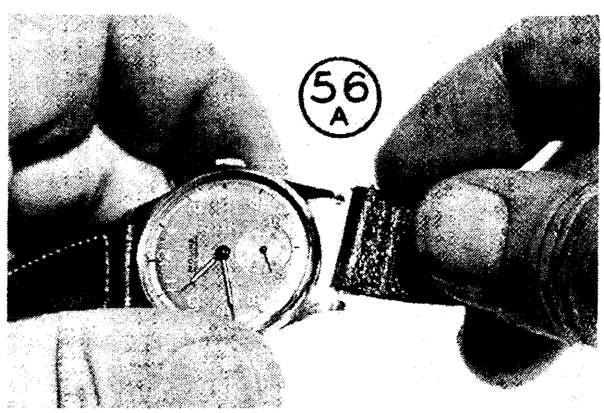


56

having pins instead of holes in the lugs of the case figure. The double shoulder spring bar is the one preferred in most cases. Remove as in figure 55 or figure 55A.

Sec. 85 — Fitting Watch Straps

Leather straps can be purchased from 1/2 inch to 15/16 inches wide. In order to select the correct size of strap or spring bar, measure distance between lugs, figure 56, with an ordinary rule which measures in sixteenths of an inch. Select strap of the same width and after slipping spring bar through strap, figure 56A, replace on watch. Usually the shorter piece of strap contains the buckle and is replaced between lugs on section of case near the figure twelve on dial.

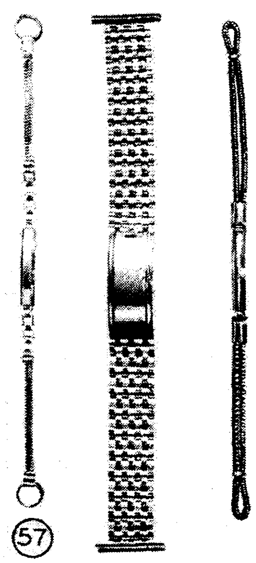


56A

Always determine which way customer prefers strap by examining position of buckle when removing old strap. There are many good qualities of straps and your dealer can supply most any kind desired. In most cases, the regular length is used but there are times when a man with an extra large wrist needs an extra long strap or, in other cases, where it is necessary to use an extra short strap. In either case, when ordering straps, be sure and specify Regular, Extra Long or Extra Short. Example:

1 Regular Calfskin $\frac{5}{8}$ Inch Regular
6 Pigskin
- 2 Regular $\frac{3}{4}$ Inch
- 2 Extra Short $\frac{5}{8}$ Inch
- 2 Extra Long $\frac{1}{2}$ Inch

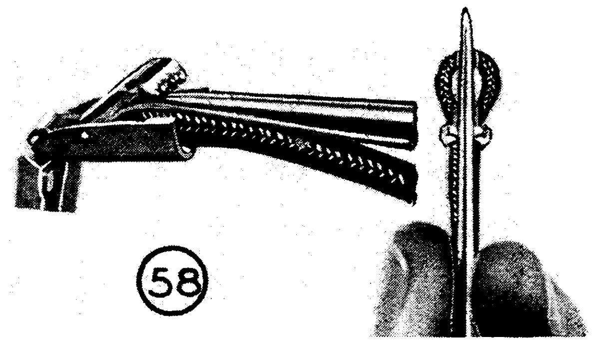
Keep a good supply of spring bars and straps on hand. The $\frac{5}{8}$ inch width is the most commonly used.



Sec. 86 — Replacing Cords

Most ladies' watches, especially the smaller sizes, are held in place on the wrist by cord or metal bands. Figure 57 illustrates three common types of watch bands or watch attachments. A is a metal watch band for ladies' watches. B is a metal watch band for men's watches. C is the cord type of attachment used mainly on ladies' watches. In most cases, metal bands cannot be repaired except by the factory. The cord type ladies' watch band frequently needs new cords and these are easily replaced at a profit.

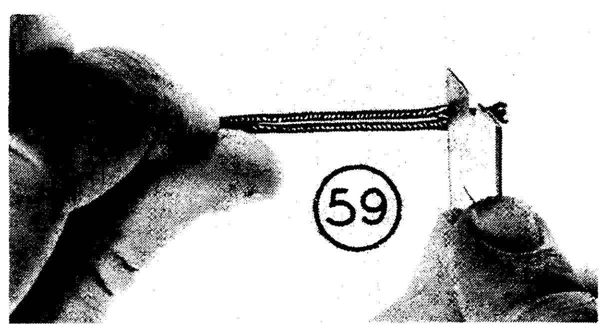
When the cord is worn out on band, it is only necessary to replace the cord. The metal attachments, in most cases, are used over again. Metal bands come in a great many styles

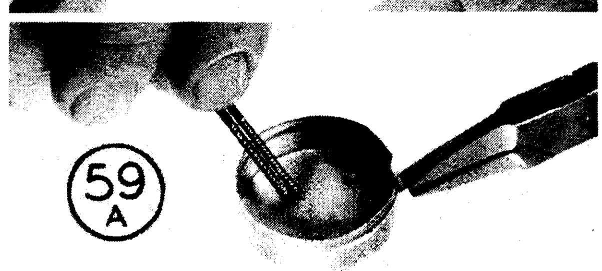


and from a variety of manufacturers. Usually when broken, the customer is delighted if shown a new one. However, replacing cord bands is another way to give a customer quick service. It is only a matter of a few minutes and small investment to replace cords quickly. There are several different diameters of cords used and other colors than black, such as rose and brown, are available. The most used size is called .075.

Material: Cord
Ordinary Paraffin
Alcohol Lamp
Awl

Melt a small amount of paraffin into a metal container such as a material box, figure 59-A. Remove the catches and the small clamps at each end of cord with awl, figure 58. Cut a piece of new cord for each side exactly the same length as the ones you are replacing. Use a razor blade, figure 59. Heat wax until it is melted and dip ends of cord into melted parafine and remove quickly, figure 59-A. Let cool, replace cords, clasps and clamps and job is done.





HOW TO FIT G-S FLEXO ROUND CRYSTALS

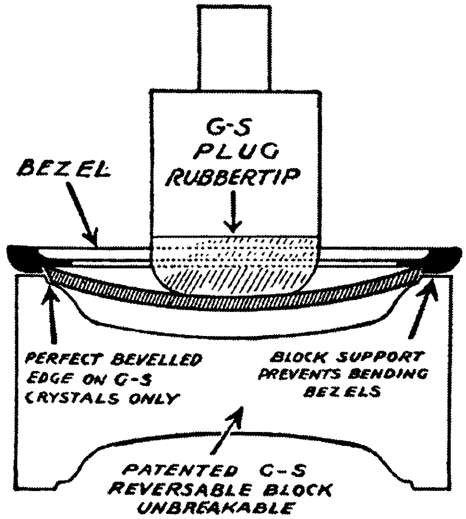
1. Measure bezel with G-S gauge exactly across center. The size is where the line on gauge meets groove. Use crystal not more than ½ size larger than bezel.

Example—when bezel measures 40½—use crystal size 41. **Do not use size 41½.**

Exception—For pocket watches with deep grooved bezel, a crystal one size larger may be necessary. Never stretch crystal over one size larger than bezel.

2. Select block marked No. 41, (same size as crystal). Number in center of each block indicates number of plug to be used.

3. Lay crystal in groove of block (sharp edge up). Hold bezel over crystal (do not lay it down). Press foot pedal lightly to hold crystal in place. Then catch edge of crystal on groove of bezel on one side and gently with gradually increasing pressure on foot lever reduce crystal enough to snap into bezel groove. (When crystal is inserted do not remove hands from bezel until foot pressure is released.)

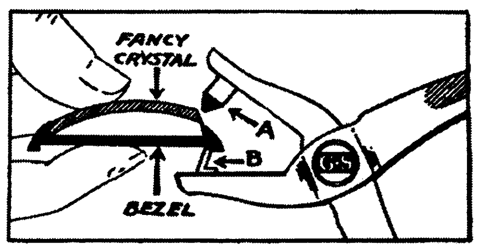


This illustration shows the only practical and successful Round crystal inserting method.

G-S Crystal is placed in groove of Block. Plug is pressed down in center, the beveled edge of crystal raises on the curve of block, entering the groove of bezel, holding firmly under compression.

HOW TO USE THE G-S FANCY CRYSTAL INSERTER

When fitting a G-S Fancy crystal, it is often difficult to force the final edge of the crystal into the bezel with fingers. Crystal can be forced into bezel more easily and quickly with the aid of a G-S Crystal inserter, as illustrated.



G-S Crystal Inserter—Patent No. 1916024

1. Do not apply inserter on crystals that are too large. Crystal should be only a trifle larger than case, and fitted into most of the groove by hand before inserter is applied.
2. Hold the fitted part of crystal and bezel tightly with fingers as illustrated.
3. Place anvil (B) of inserter on inside of bezel.
4. Hold bezel or case parallel to lower jaw of inserter so that rubber (A) is in contact with exposed edge of crystal. With a rocking motion, apply SLIGHT PRESSURE, while gradually following exposed edge of crystal until completely inserted. BE VERY CAREFUL ON THIN SOFT METAL CASES.

COURTESY GERMANOW-SIMON MACHINE CO.

<u>TABLE OF CONTENTS:</u> Unit W1 - Lesson 3

<u>JOB</u> <u>SHEETS</u>

UNIT	W I
LESSON	3

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W3-J1

CRYSTAL: Round glass

TOOLS, EQUIPMENT AND SUPPLIES

Case opener

PROCEDURE	REFERENCE
A. HOW TO FIT A ROUND GLASS TO AN OPEN FACE CASE	Lesson 3
1. Remove bezel.	
2. Clean bezel.	
3. Determine inside diameter of bezel.	Fig. 50C - 50D
4. Select glass.	Fig. 50B
5. Insert crystal and cement.	Fig. 50E
6. Clean.	Sec. 78
7. Replace bezel on case.	
8. Check hands.	
B. HOW TO FIT A ROUND GLASS TO A HUNTING CASE	Lesson 3
1. Remove bezel.	
2. Clean bezel.	
3. Determine inside diameter of bezel.	Fig. 50C - 50D
4. Determine height. (Heavy case height 6) (Medium case height 7) (Average heavy height 8)	Fig. 50F
5. Select glass.	
6. Insert crystal and cement.	Fig. 50E
7. Clean.	Sec. 78
8. Replace bezel on case.	
9. Check hands.	

CRYSTAL: Round unbreakable

INTRODUCTORY INFORMATION

Unbreakable watch crystals are rapidly replacing watch glasses. Made of a different type of plastic which has been developed to retain its transparency and not be affected by solvents such as alcohol, benzine and watch cleaning solutions. However, it is recommended that non-breakable watch crystals be cleaned only with water.

TOOLS, EQUIPMENT AND SUPPLIES:

Crystal gauge or Millimeter gauge - Inserter set

PROCEDURE

HOW TO REPLACE ROUND UNBREAKABLE CRYSTALS

1. Remove bezel.

2. Clean bezel.

3. Measure bezel with crystal gauge.

4. Select crystal - Depending on the assortment on hand, allow 1/4 size larger or if using the metric system about 15/100 mm larger or if using the inch system about 6/1000 of an inch larger.

5. Select male and female plug and place in the inserting tool. Diameter of female plug should be slightly less than the full diameter of the crystal. Male inserter plug should be about 2/3 of the inside diameter of the bezel.

6. Place bezel over male inserter plug.

7. Place crystal on male inserter plug and hold in position with female inserter plug brought into position so crystal is centered.

8. Apply pressure which will push edge of crystal down until bezel will slip over edge of crystal.

9. Turn crystal back and forth while releasing pressure slowly to seat crystal.

10. Clean crystal and replace bezel on case.

11. Check hands.

CRYSTALS: Fancy shaped

INTRODUCTORY INFORMATION

The beginner will generally find it more profitable to send his fancy crystal making to a material dealer who can handle this work.

TOOLS, EQUIPMENT AND SUPPLIES:

Glass grinding wheel - Crystal gauge - Crystal cement

PROCEDURE	REFERENCE
HOW TO FIT FANCY SHAPED WATCH CRYSTAL	
1. Remove movement from case.	
2. Remove broken glass and clean bezel.	
3. Determine shape.	
4. Measure length and width with crystal or millimeter gauge.	
5. Shape glass on grinding wheel until it snaps into bezel.	Fig. 52A
5a. If unbreakable type, shape with file.	Fig. 52B
6. Cement edge and allow to dry.	Fig. 53R
7. Clean with damp cloth and replace movement.	
8. Check hands.	

SPRING BARS

TOOLS, EQUIPMENT AND SUPPLIES:

Spring bar remover

PROCEDURE	REFERENCE
HOW TO REMOVE AND REPLACE SPRING BARS	
1. Check holes in lugs of case to determine if they are through.	
2. If holes are through the lugs, use pin end of spring bar remover to depress and release the spring bar.	Fig.55
3. If holes do not come through, insert flat end of spring bar remover (or suitable substitute) between lug and shoulder of spring bar and force back the end.	
4. In the case of a metal band which fits snugly between the lugs, a jeweler's saw may be used to cut the spring bar.	
5. Measure space between lugs.	Fig.56
6. Select and replace spring bar.	Fig.56A

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 4

Nomenclature and Sizes of Watches

—

Sections 106 - 123

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

MASTER WATCHMAKING

A Modern, Complete, Practical Course

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 4
Sections 106 to 119

NOMENCLATURE AND SIZES OF WATCHES

In former years, about the only place on a watch case where the designer could give vent to his talents was on the ornamentation. It was not unusual to see a man carrying a large heavy gold case with raised gold ornaments, hand engraved, perhaps with one or more diamonds set in it, having a round bow strong enough to carry such a heavy piece of adornment.

The shapes, sizes and parts of bow and crown were conventionalized and all manufacturers followed practically the same model.

Gradually sizes were reduced, movements made thinner, dials made more ornamental, bows and crowns were designed to harmonize with the rest of the case, so that today the modern watch is not only a serviceable time piece but a thing of beauty as well.

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The first men's wrist watches followed the same lines as pocket watches, round cases with a lug or attachment to which a strap or bracelet could be fastened. As the popularity of these styles increased, more attention was given to the shape of the case, so that now wrist watches have square, rectangular and oval shapes.

Earlier models of ladies' watches were made in 10 size and were in hunting cases. Today this size is used for thin model pocket watches.

Ladies' watches were reduced first to 6 size, then to 0 and 000 size, and were popular until the arrival of the bracelet watch.

With the advent of the bracelet watch, designers gradually produced more watches made in the oval or rectangular shape.

The most popular shapes found in bracelet watches are round, rectangular, cushion, diamond, oval and octagon.

Watch cases are made of nickel, stainless metal, silver, yellow, green and white gold, rolled gold plate, gold filled and platinum.

Sec. 106 — The Watch Movement

Follow the instructions in the order in which they are given. Close attention will make the various steps easy which will lead to your success as a Master Watch Repairer.

The beginner often tries to force parts together when such action is not needed, with the result that some of the more fragile pieces may be bent or broken. Before attempting to force any part of the watch into its position, be sure that you have the part in the proper location and above all things, "use force sparingly."

In your study and practice, try to obtain movements that can be easily taken apart and reassembled. Do not start on the clock watches — the so-called dollar watches.

For your first attempt, obtain a watch movement of the older style 16 size Elgin, Waltham or Hamilton, similar to figure 60. Any of these sturdy movements can be easily procured in most localities at a low cost. However, any three-quarter plate or bridge model American movement will be satisfactory for the beginner, provided it is a 12 size or larger.

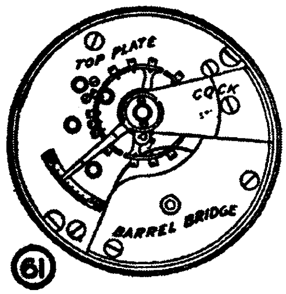
Figure 61 illustrates an 18 size full plate movement.

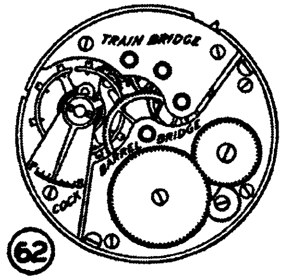
Figure 62 illustrates a drawing of a 16 size ¾ plate movement.

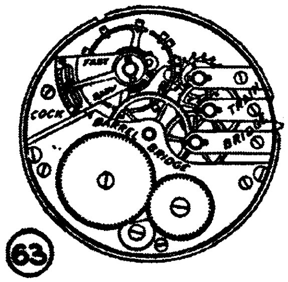
Figure 63 illustrates a drawing of a 16 size ¾ plate bridge model.

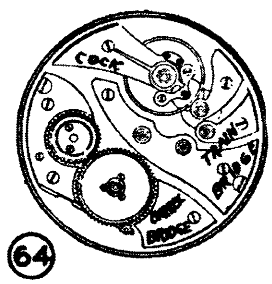
Figure 64 illustrates a 12 size bridge model.

Learn to speak of a watch as a 16 size ¾ plate Elgin or 12 size bridge model, etc.









Sec. 107 — Hunting and Open Face Watches

Most American pocket watches are either Hunting or Open Face. The difference is readily understood if you will remember that an open face model winds at 12 and a hunting face model winds at 3 regardless of the style of the case.

Watches winding at 3 were made originally for hunting cases and watches winding at 12 were made for open face cases. Now there are many watch movements formerly in hunting cases that, for one reason or another, have been transferred to open face cases. In these instances, you may have an open face watch with a hunting movement watch winding at 3 instead of 12. You may find some hunting case watches that wind at 12.

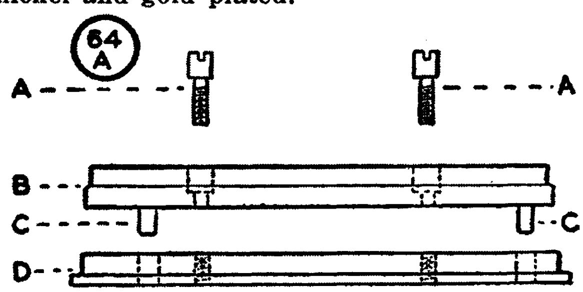
From now on, we will refer to a watch as a 16 size ¾ plate hunting movement or a 12 size open face bridge model, etc.

Men's or ladies' Swiss watches are not referred to as hunting or open face movements. This will be explained later in this lesson. Practically all wrist watches wind at 3.

Sec. 108 — The Plates

The plates of a watch are made of a flat piece of metal of uniform thickness. The lower plate sometimes referred to as the pillar plate is used as a base for assembly. The dial and portions of the winding and setting parts are supported by this plate. Upon the lower plate are erected pillar posts to which the top plate is held in place by screws. In some of the very old watches the top plates were held in place by tapered brass pins forced through holes in the pillar posts. These methods of securing plates are generally found in the older watches of which the 18 size American movements are excellent examples.

The plates of most watches are held together by a combination of screws and steady pins which are illustrated in figure 64-A. The lower or pillar plates of watches of like size are similar in shape. Size of the watch is determined by the size of this plate. The plates of watches are made of solid nickel, solid brass, as well as nickel and gold plated.



A.---------PLATE SCREW.
B.---UPPER PLATE OR BRIDGE.
C.-----------STEADY PIN.
D.--LOWER OR PILLAR PLATE.

Formerly the brass plates finished with a matt surface and a very light plate of gold were most common and were known as gilt plates. After being cleaned and handled a few times, the light gilding would be worn off leaving a dingy looking set of plates.

Silver and nickel plates are the most popular types used today.

Sec. 109 — Top Plate

18 size and old model watches are about the only watches that have a top plate. Top plates have been replaced by bridges. These bridges serve the same purpose but are much easier to assemble.

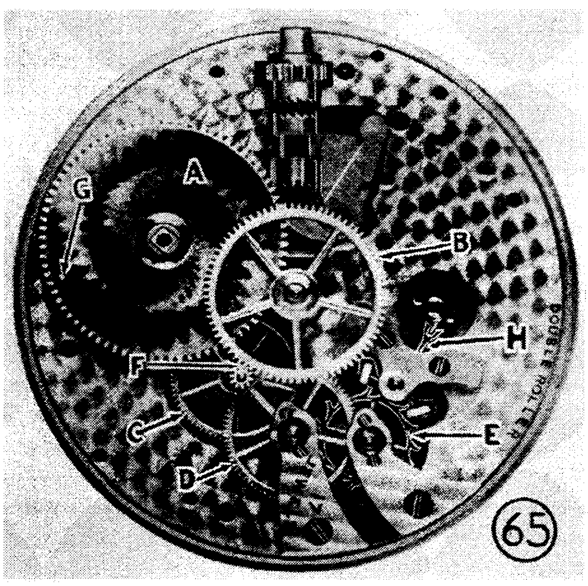
Sec. 110 — What is Meant by The Train?

A series of connected gearings is called a train. Thus in a watch or clock, the series of gears which transmit the power from the mainspring to the escapement is the train.

By the escapement is meant that part or device in a watch or clock which controls the power and distributes it uniformly. In other words, it keeps the train moving at an even speed.

Sec. 111 — Wheels and Pinions

The wheel which receives the power and gears it into a much smaller wheel is called a pinion. This pinion is fastened to another wheel,



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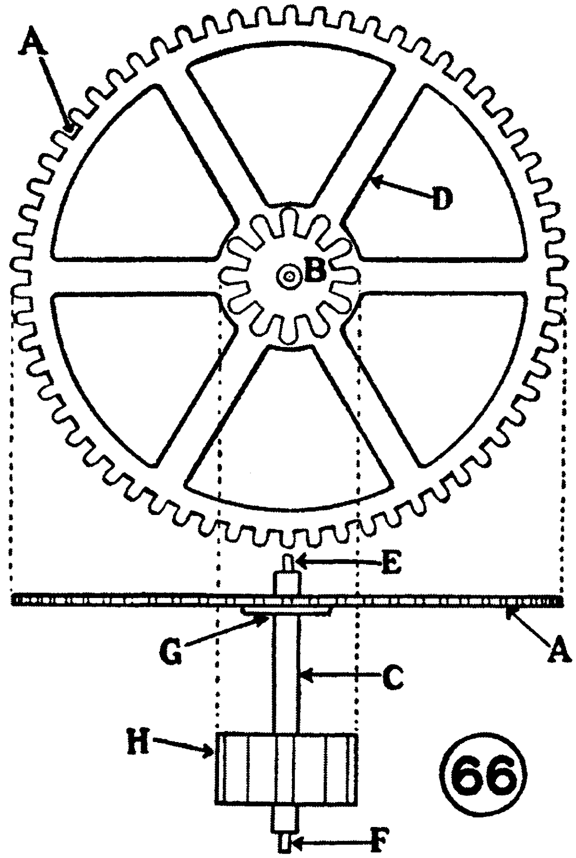
the two having a common center; this second wheel gears into a third pinion on which is also fastened a wheel, and so on to the last pinion and wheel. The wheels are generally made of brass and the pinions of steel. In watches the wheels are usually gold plated but in some cases are made from rolled gold plate.

In figure 65 is shown the train of an Illinois watch movement. The wheels and pinions are lettered beginning with the barrel or first wheel at A. The next is the second wheel or center wheel at B, third wheel at C, fourth wheel at D and escape wheel at E.

Each of the wheels from the center wheel down is carried on a pinion and these pinions are numbered in the same way, 2nd or center pinion, 3rd pinion, 4th pinion and escape pinion. The wheels gear into these pinions and thus transmit the power from the mainspring, which is contained in the barrel or first wheel. In this photograph may be seen the center wheel gearing into the third pinion at F.

Sec. 112 — Teeth and Leaves

Figure 66 is a drawing of a wheel and pinion showing end and side view, in which A represents the wheel and B the pinion. The indenta-



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tions on the outer circumference of the wheel are called teeth, while those on the pinion are called leaves.

The six spoke-like parts, at D, are called arms, this being a six arm wheel.

The part C together with the leaves H and the pivots at E and F are all cut from one piece of steel. In the center of the wheel is a hole of such diameter that the pinion, when forced through at G, will be tight enough to keep the wheel from slipping on the pinion when power is applied. Usually the center of the wheel is reinforced with a thicker piece of brass in order to give a greater bearing surface for the pinion as shown at G.

In most American watches, the wheels of the train outside the center are fitted to the pinion in this manner. Where a greater percentage of power is applied a larger shoulder is cut on the pinion, directly on the leaves and this is fitted in the center hole of the wheel, the steel being riveted or staked over the brass of the wheel.

Generally in clocks you will find that wheels are fastened to the pinions in this way.

In the finer grade of Swiss watches, the pinions are nearly always staked on the wheel and are finished with a long undercut. The beautiful finish given these Swiss pinions is something that the watchmaker should strive to equal in his own work.

Sec. 113 — Oscillations of a Pendulum or Balance

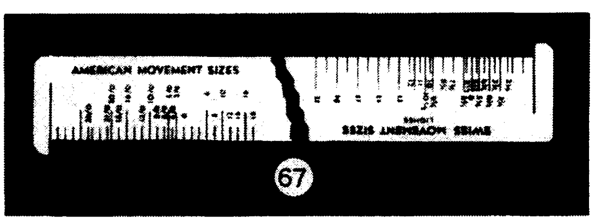
The balance wheel of a watch or the pendulum of a clock oscillates (swings back and forth) in regular periods of time, depending in the one case upon the diameter and weight of the balance together with the length and strength of the hairspring, and in the other, upon the length of the pendulum.

The rate of a timepiece depends upon the regularity of these oscillations which are induced by the impulses given through the escapement, which in turn receives the power by means of the train.

Sec. 114 — Purpose of the Train

The whole purpose of the time train then is to apply the power to keep these oscillations going and to calculate and indicate just how many oscillations occur during a given period.

For instance, the fourth wheel of a watch, with its pinion (carrying the second hand) makes one complete turn in one minute. The train must be so arranged that the center wheel with its pinion (carrying the minute hand)



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makes a complete turn in one hour. Hence, the fourth wheel must make sixty turns to one of the center wheel.

Learn the names of each and every part of these watches. Do not be content to read this over once and take it for granted you can remember the terms. Each time you work on a watch, repeat to yourself the name of the part you are working upon. If you do not know, refer

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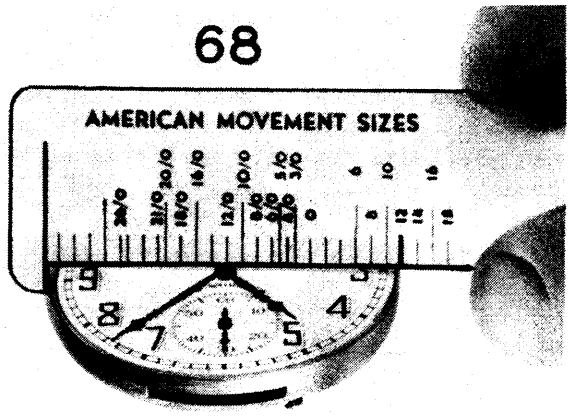


to illustrations. In figure 65, you will notice how many wheels actually exist in the train of the average watch:

A Mainspring Barrel and Arbor
B Center Wheel and Pinion
C Third Wheel and Pinion
D Fourth Wheel and Pinion
E Escape Wheel and Pinion
H Pallet Fork and Arbor

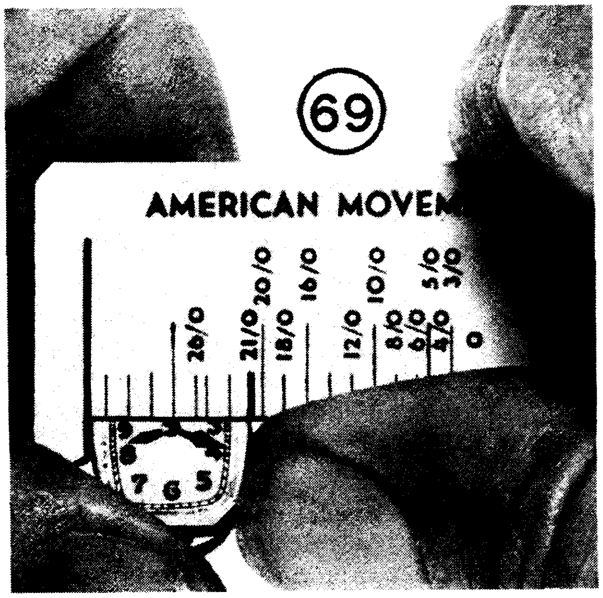
These, plus the balance, comprise the actual parts that make the watch run and probably 80% to 90% of repairs are concerned with these few wheels. Of course, there are more wheels in other types of watches, such as Automatic Wind, Repeaters, Chronographs, and Sweep Second watches, but even in the above-named watches there are basically the same number of wheels that give cause for repair.

Sec. 115 — Sizes of Watches

In watchmaking, you will learn to know and speak of a watch by its name and size, or, as in Swiss watches, by the manufacturer's name and the size. Swiss watches are imported into this country by the millions, under many different names. However, the watch movements are made in relatively few factories. For identification purposes in the Swiss watches, the Newall Fingerprint system of Swiss watches is explained. There are other systems but they are similar. Some watch material supply houses furnish gauges similar to figure 67.

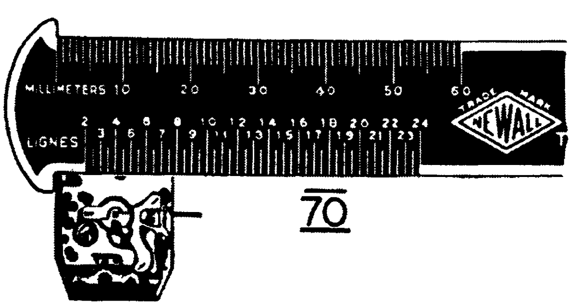
American watches are measured in sizes such as 18 size, 16 size, 3/0 size and 21/0 size. See Sec. 117. Using the gauge illustrated in figure 67, measure across the pillar plate in round watches at their widest point.

Figure 68 illustrates the correct method of measuring a 12 size movement. To measure the size of an American movement that is any other



shape than round, measure across the shorter distance as in figure 69, which, in this case, is a 21/0 size (pronounced twenty-one-oh-size).

Swiss watches are not measured in sizes, but in lignes. Figure 70 illustrates how to correctly measure a 7¾ ligne (pronounced seven and three-quarter line) Swiss watch with a ligne



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gauge. In some Swiss watches you will find that the dial extends over the pillar plate so it will be necessary to remove the dial, in order to accurately determine the correct size. You should obtain a catalog illustrating these different sizes and "Fingerprints" from your watch material dealer.

The charts illustrated in Secs. 116 and 117 are a comprehensive list of the different sizes of watches, both American and Swiss. The measurements obtained with your millimeter gauge are compared with the list of watch sizes. Example: If the pillar plate measures 45.7 mm, you will see that an 18 size watch measures 45.7 mm. Therefore, figure 71 is 18 size. Remember this: the first factor to be determined is whether or not the watch is an American or a Swiss watch. For example, a 10/0 American watch measures 22 mm; a 9¾ ligne Swiss watch measures 21.99, practically the same size. However, you would not say it was a 10/0 size unless it was an American made watch.

Below are listed a great many different sizes. This is for your reference, and as you progress with the work it will be interesting to note that only a few Swiss sizes are used in our every day work such as 5½ ligne, 6½ ligne, 8¾ ligne, 9¾ ligne, 10½ ligne, etc. With continued practice you should be able to identify the size of watches without referring to the chart.

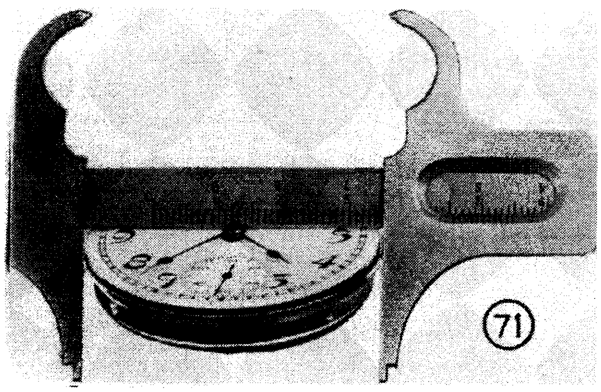
Sec. 116 — Sizes of Swiss Watches

LIGNES	MM	LIGNES	MM
3	6.77	11¾	26.51
3¼	7.38	12	27.07
3½	7.87	12¼	27.63
3¾	8.42	12½	28.20
4	9.03	12¾	28.79
4¼	9.59	13	29.33
4½	10.15	13¼	29.89
4¾	10.72	13½	30.45
5	11.28	13¾	31.02
5¼	11.84	14	31.58
5½	12.40	14¼	32.15
5¾	12.97	14½	32.71
6	13.53	14¾	33.27
6¼	14.10	15	33.84
6½	14.66	15¼	34.40
6¾	15.23	15½	34.98
7	15.79	15¾	35.53
7¼	16.35	16	36.09
7½	16.92	16¼	36.66
7¾	17.48	16½	37.22
8	18.05	16¾	37.78
8¼	18.61	17	38.35
8½	19.17	17¼	38.91
8¾	19.74	17½	39.48
9	20.30	17¾	40.04
9¼	20.87	18	40.60
9½	21.43	18¼	41.17
9¾	21.99	18½	41.73
10	22.56	18¾	42.30
10¼	23.14	19	42.86
10½	23.69	19¼	43.42
10¾	24.45	19½	43.99
11	24.81	19¾	44.55
11¼	25.38	20	45.12
11½	25.94		

Sec. 117 — Sizes of American Watches

One Ligne = 2.258 MM.
One Inch = 25.4 MM.

SIZE	MM	SIZE	MM
18	45.7	6/0	25.4
16	43.1	8/0	23.7
14	41.5	10/0	22.0
12	39.8	12/0	20.31
10	38.1	14/0	18.6
8	36.4	15/0	17.8
6	34.7	16/0	16.9
4	33.0	18/0	15.2
0	29.6	20/0	13.5
3/0	27.9	21/0	12.7
4/0	27.09	22/0	11.8
5/0	26.2	26/0	8.5



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Sec. 118 — Important Factors for Identifying American and Swiss Movements

A Swiss watch is one which is made in Switzerland. A Swiss watch may also consist of a movement made in Switzerland and contained in a watch case made in the U. S. A. An American watch is one which is made and cased in the U. S. A. The most common are Elgin, Waltham, and Hamilton. But the watchmaker may still find many other watches produced by manufacturers who are no longer in business. Among these are Illinois, South Bend, Rockford, Burlington, Studebaker (made by South Bend). In fact, there are thousands of watches, both American and Swiss—some many years old —which are still in use. This fact, together with the many new models turned out now, makes the problem of identification seem complex when parts are needed. However, there are only a few ways to identify movements whether they are American or Swiss.

Movements are either round or shaped. Shaped movements are any shape other than round. This applies to both American and Swiss movements.

Another designation of movements is by their distinguishing features. Some possible variations are listed below:

Regular Lever Movement. This has a detached lever escapement. The jeweled lever movement is the most common type of watch which the watchmaker is called upon to repair. Therefore, this course is based on this type of movement.

Bascule Setting. (Employs a Rocker Arm instead of a Clutch.)

Pin Lever (or Pin Pallet). The pallets are in the form of pins instead of pallet stones. Found in mass-produced, inexpensive American and Swiss watches.

Chronographs. A movement equipped with a center second hand which can be started, stopped, and returned to zero. It differs from a timer because it also carries the normal hour and minute hands, indicating the time of day. (Principally Swiss.)

Self-Winding Watch (or Automatic Wind Watch). This is a watch with a device whereby the movements of the wearer keep the mainspring wound.

Roskopf. A type of movement without the conventional center wheel. The cannon pinion fits *loosely* on a center arbor, and is driven by the minute wheel, which is fastened friction-tight to the mainspring barrel cap. Roskopf watches generally have pin lever escapements, which are sometimes erroneously termed Roskopf escapements. Actually, very few pin lever watches are Roskopf watches.

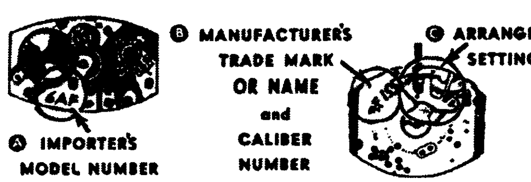
Cylinder. Refers to the type of escapement.

Both Cylinder and Roskopf are considered unreliable and the watchmaker usually will find it not profitable to repair them.

AMERICAN movements are identified principally by:

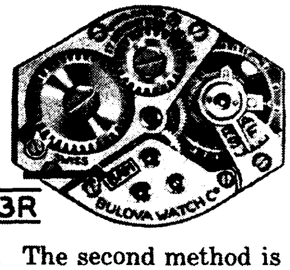
The manufacturer's name
Size
Movement and/or model number or name
Number of jewels
and in the case of pocket watches, whether
Hunting (winds at 3), or
Open face (winds at 12).

There are three common ways to identify SWISS movements:

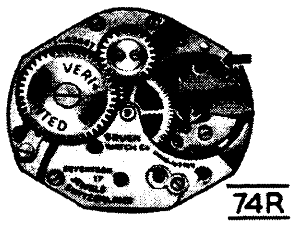


72R

A. Large *importers*—among them Bulova, Benrus and Helbros—have their name and model designations stamped on the upper plates or bridges, figure 73R. The name of the importer plus the model designation is positive identification of the movement regardless of the name appearing on the dial.



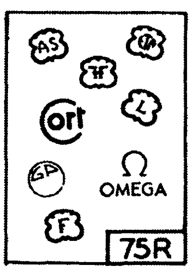
73R



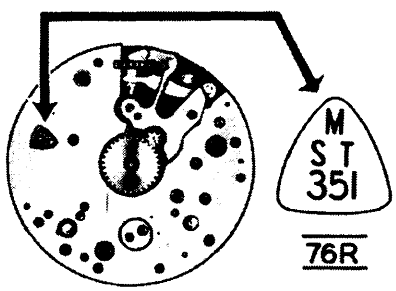
74R

B. The second method is the name or trade mark of the *manufacturer* plus the caliber or reference number. Names of manufacturers are usually found stamped on the upper bridges of plates. Caliber or reference numbers in these instances are under the balance wheel on the lower plate (figure 74R), or between the barrel and train bridges on the lower plate. In some cases it is necessary to remove the balance cock and balance to see the caliber or reference number. This type of model identification is common with Gruen movements.

An alternate identification is by factory trade mark. There are many of these trade marks. A few are shown in figure 75R. This trade mark is stamped on the dial side of the lower plate, figure 76R, and is also positive identification and should be used when method A does not apply.



75R



76R

NOTE: There are a few exceptions to the above. Some factories, such as ETA, stamp their insignia or trade marks on the dial side of the lower plate, but stamp their caliber or reference number on the lower plate under the balance wheel.

C. The method of identifying movements by their setting parts is rapidly falling into discard, because identification is not always positive. However, if the methods shown in A and B above cannot be applied, then the illustrations of setting parts found in most material catalogs can be used. Not all material dealers use the same methods of identification. However, because the basic principle is the same, only one of many systems is explained here.

The Newall "Finger Print System":

Models are listed under Newall series numbers and will be found in two sections. Fancy shape movements are located in the first section; round shape movements in the second. Movements within each section are arranged by size. Each section begins with the smallest movement and proceeds to the larger sizes.

To locate the proper Newall series number for a movement, first identify its shape. Next, remove the dial and measure across the pillar plate with a movement gauge or millimeter gauge (figure 70) to get the correct size. Now turn to the proper section, whether fancy or round and locate the size in the section. Compare the setting parts of the movement with the illustrations and the proper Newall series number will be established.

Buren

77R

The number shown in figure 77R shows the serial number to be 1101. This number would be given when ordering parts from *any* material dealer. However, the series number should be preceded by the caption *Newall*. Thus, Newall Series Number 1101.

In the Newall catalog, a number of the illustrations of setting parts incorporate the symbol DISC. This symbol denotes manufacture of movements and material for this particular model has been discontinued by the factory. However, it does not mean material is no longer available, for in some instances stocks of materials are in the possession of the manufacturer, the importer or the distributor.

The mechanics of most material catalogs are the same and are clearly explained at the beginning. No matter what system you use, proper identification is most important, both to you, who want to obtain the correct material, and the dealer, who wants to get it to you as quickly as possible.

Sec. 119 — How to Order Material for American and Swiss Watches

The material dealer from whom you order parts cannot possibly have every part for every watch which has ever been made. However, in many cases, he is able to obtain material for obsolete and old movements. At times parts may be ordered from Switzerland. The important point is that ordering parts by just giving the name of the movement or by individual names found on the dial is not enough and is not always reliable.

Give the material dealer as much information as possible. Most dealers now prefer complete information in order to eliminate the matching of samples, which may or may not be correct. Sending samples of material has been an accepted practice for many years, but with the ever increasing reliability of the material catalogs, this practice is also being discarded. Nonetheless, the burden of identification and correct name of the desired parts is still the watchmaker's responsibility and anything which contributes to that end should be considered. The more exact information you give, the less chance there is for error and delay on the part of the dealer.

After correct identification, the next important step is to give the CORRECT NAME of the *part* desired. Next, the *quantity*. If only one is wanted, write *1 only*. If three are wanted, write *3* or ¼ *dozen*, and so on.

Here are some samples of parts orders for American watches:

Hamilton, 16s, 21 jewel, Htg. (Hunting), ¾ plate. Movement No. 1,051,201. Grade 993.
1 only balance staff (double or single roller).
Pivot ______ (State pivot diameter required).
1 only balance jewel in setting (State *cock* or *foot*).
Hole ______ (Give diameter of hole wanted.)

Elgin, 8/0, 17 jewel, Movement No. V805,299, Grade 555.
1 only mainspring, double brace ______ (width), ______ (strength), ______ (length).
¼ doz. stems.

Waltham, 6½ ligne, 15 jewel, Oval Movement No. 26,469,011, Model 650.
1 only balance complete (State whether flat hairspring or Breguet hairspring). ¼ doz. dial screws.

When ordering material for Swiss watches, you need to give the material dealer:

Either the Importer's name and model designation, *or*, the Manufacturer's name or trade mark with the caliber number or reference number.
Size of movement.
Number of jewels.
THE CORRECT NAME OF THE PART.

IMPORTANT: It is often necessary to give additional information because of variations in manufacture. Therefore, when ordering:

Parts, such as:	*Be sure to specify:*	*Abbreviated thus:*
Escape wheels and pinions	Both pivots conical	c/c
	Both pivots straight	s/s
	Lower pivot conical	s/c
	Lower pivot straight	c/s
Cannon pinions	Give height in millimeters	
Hour wheels	Give height in millimeters	
Balance staffs	Give collet and roller measurements in millimeters, especially with Gruen. Also, whether shockproof, Incabloc or regular.	
Balance complete	Shockproof, Incabloc or regular.	
Hairspring	Breguet or flat.	
Regulators	State if shockproof, Incabloc or regular model and whether hairspring is a flat or Breguet (Overcoil).	
Minute wheels	Long pinion for curved models. Short pinion for flat models.	
Pallet arbors	Thread or friction fit.	

Here are some samples of parts orders for Swiss watches:

BULOVA 6AP

1 only mainspring ______ (width), ______ (strength), ______ (length).
¼ doz. stems.

FF60

¼ doz. balance staffs
1 pair gilt hands (give length in millimeters).

GRUEN 430

1 balance complete (Specify whether Breguet or flat hairspring).

Newall Series Number 1101

1 escape wheel and pinion s/s
1 mainspring barrel
1 barrel arbor

IF THE INFORMATION YOU HAVE IS INCOMPLETE, SEND A SAMPLE.

There is generally quite a substantial saving to be had by purchasing frequently used watch material in quantities of ¼ dozen or more at a time. This is an excellent method of building your own master material cabinets. It not only saves money on each piece, but it also helps you give your customer quicker service when you have the material on hand.

MASTER WATCHMAKING

SECTIONS — 120, 121, 122, 123

Lesson 4.

NOMENCLATURE AND CORRELATION

CHICAGO SCHOOL of WATCHMAKING

CHICAGO, ILLINOIS

FOUNDED 1908

REVISED 1955 PRINTED IN U. S. A 58 992

Sec. 120 — NOMENCLATURE

(The terms used in any Art or Science)

Sec. 121, 122 and 123 consist of three pages. Sec. 121 pertains to the generally accepted nomenclature of Swiss watch parts. This section also illustrates the correlation of the parts. Sec. 122 refers to the nomenclature of a 16 size Elgin movement; Sec. 123 of an 18/0 Grade 989 Hamilton movement. The principal parts with the correct terms or names opposite the illustrations (Sec. 121) are numbered from 1 to 50, and lettered A, B, C, etc., in the correlation illustration (Sec. 121). Compare these as follows:

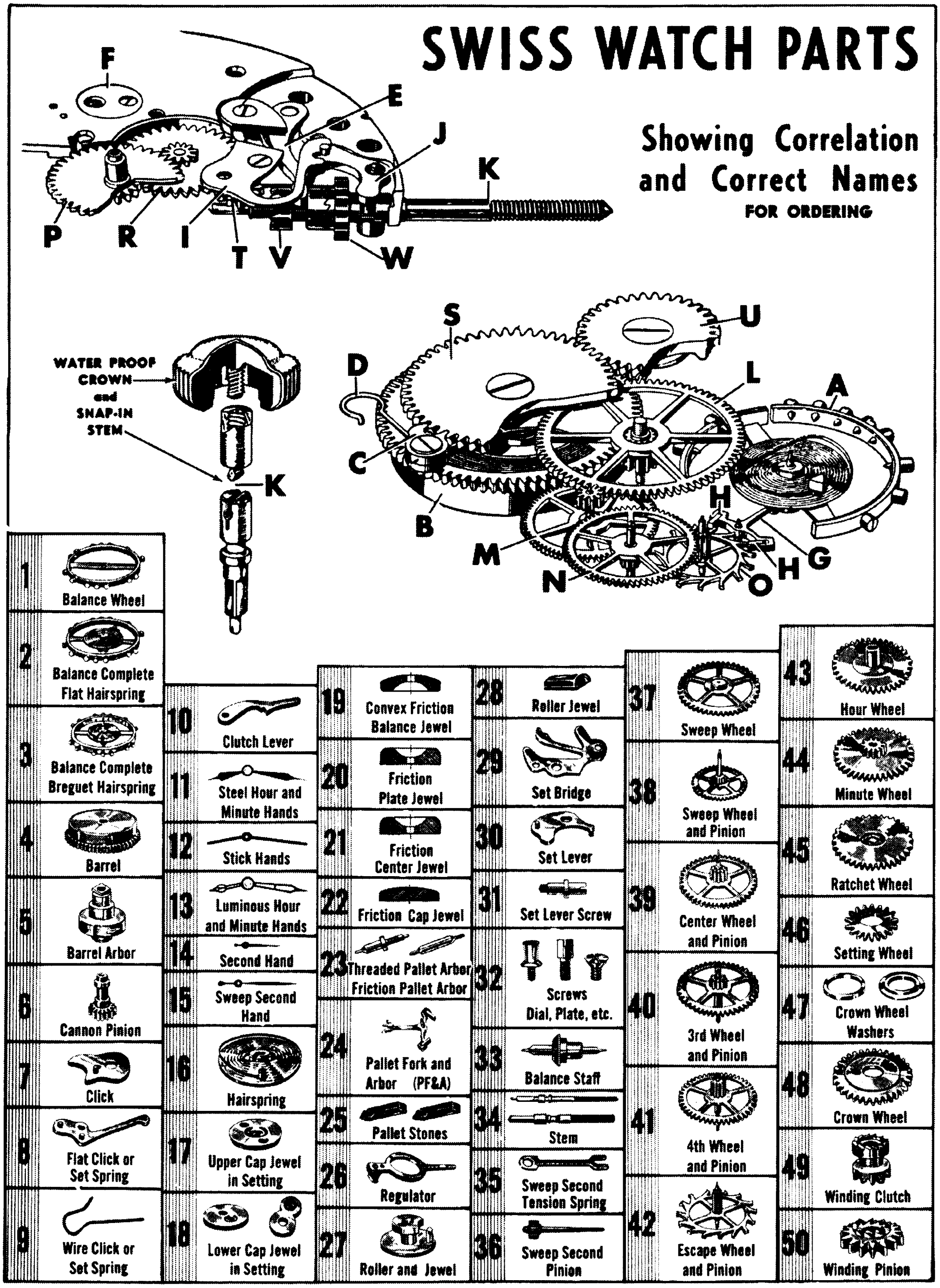
Letter - - - - - compares with - - - -	Name of Parts	**Number**
A	Balance complete with Breguet Hairspring	3
B	Barrel with Mainspring	4
C	Click	7
D	Click Spring	9
E	Clutch Lever	10
F	Lower Cap Jewel in Setting	18
G	Pallet Fork and Arbor (PF&A)	24
H	Pallet Stone Set in PF&A	25
I	Set Bridge (although illustration is not same style as)	29
J	Set Lever	30
K	Stem (2 Styles shown)	34
L	Center Wheel and Pinion	39
M	3rd Wheel and Pinion	40
N	4th Wheel and Pinion	41
O	Escape Wheel and Pinion	42
P	Hour Wheel	43
R	Minute Wheel	44
S	Ratchet Wheel	45
T	Setting Wheel (Visible under Set Bridge I	46
U	Crown Wheel	48
V	Winding Clutch	49
W	Winding Pinion	50

Now compare the letters (A, B, C, etc., Sec. 121) with corresponding numbered parts (1, 2, 3, etc.) and try to find these parts in Sec. 122 and 123. For example:

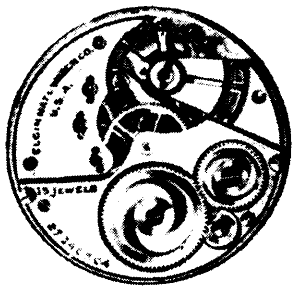
Letter A, Sec. 121 Number 3, Sec. 121 Number 104, Sec. 122 Number 217, Sec. 123	Are all Illustrations of a Complete Balance

Use this method to familiarize yourself with the names and parts shown. The ease with which you will be able to name the different watch parts and order material will soon be apparent to you, as well as others with more experience.

Sec. 121 — Nomenclature and Correlation: Swiss Watch Parts

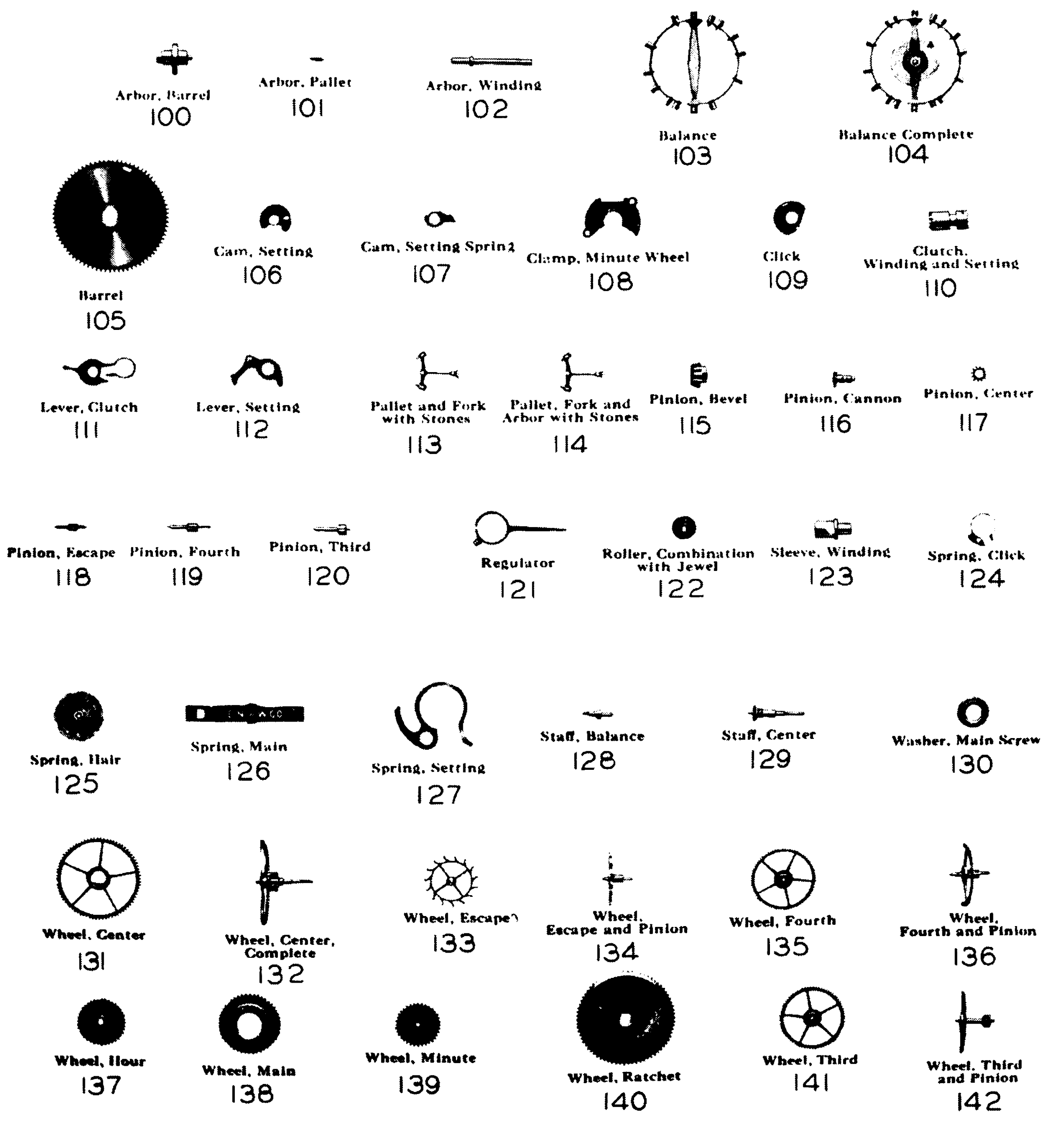


Sec. 122 — Nomenclature: Elgin Watch Parts

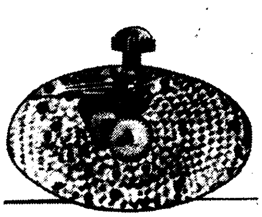


The illustrations in this section show in a general way the shapes and kinds of material used in practically all Elgin Watches.

The movement shown is a 16 size Pendant setting watch, and the named parts below are the principal ones in the watch. This type of watch was also made lever setting and some of them had steel barrels.

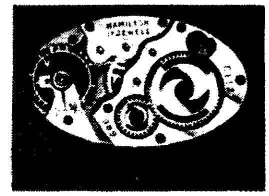


Sec. 123 — Nomenclature: Hamilton Watch Parts

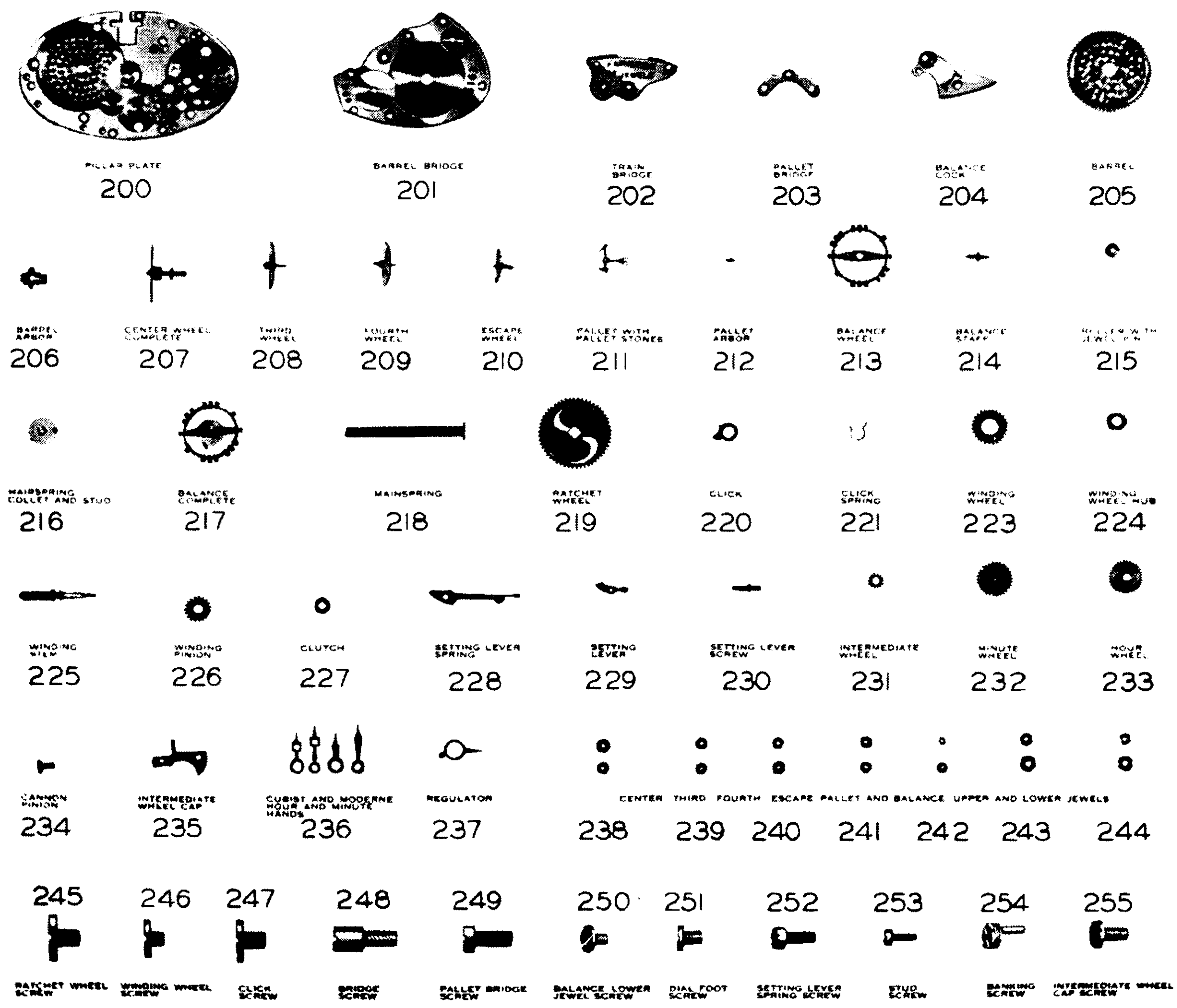


Dial Side of Movement

A Factory Nomenclature of Individual Parts or sub-assembled parts of the Hamilton 18/0 Grade 989 Movement is shown below:



Train Side of Movement



" The better part of every man's education is that which he gives himself."

-- James Russell Lowell

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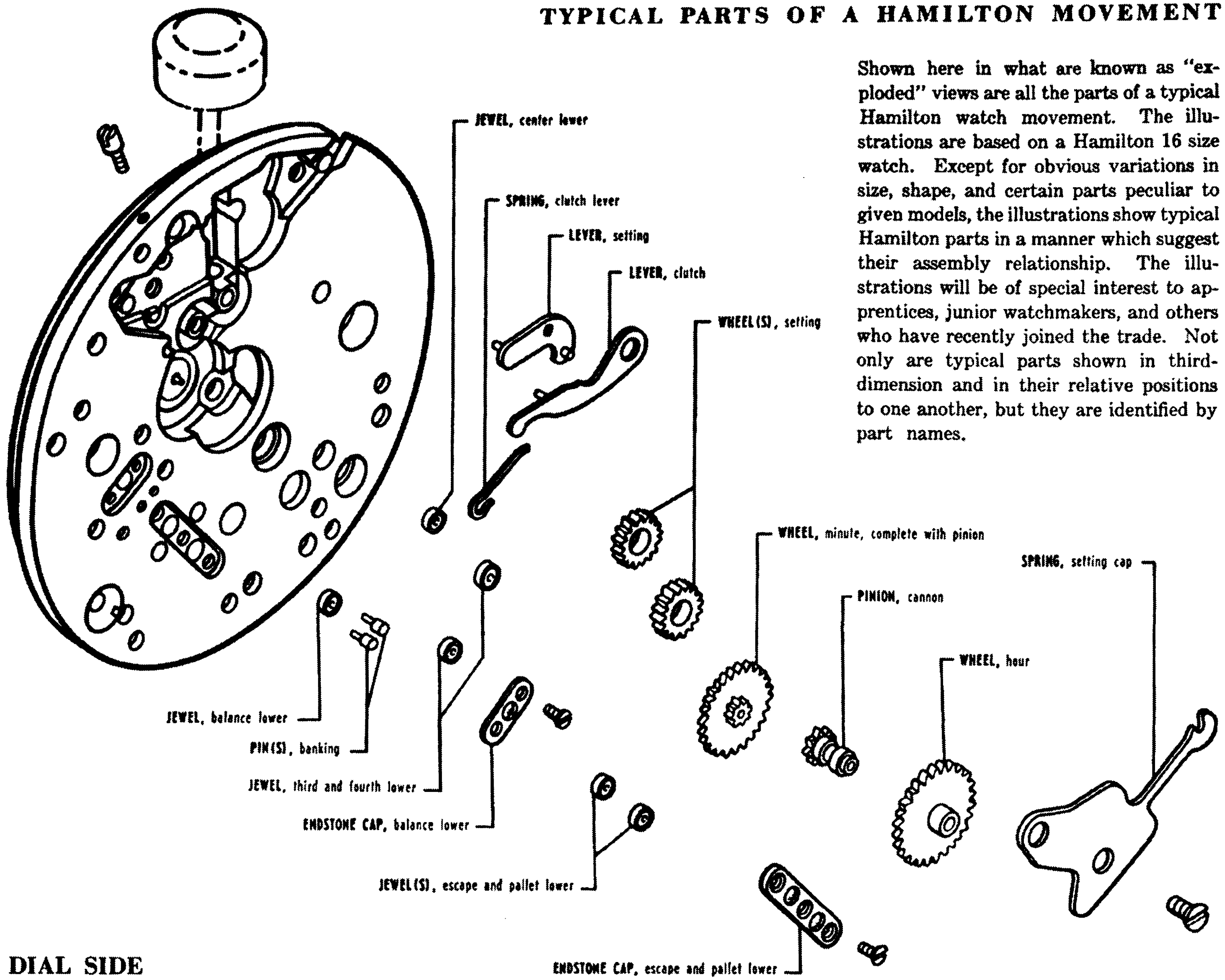
TYPICAL PARTS OF A HAMILTON MOVEMENT

Shown here in what are known as "exploded" views are all the parts of a typical Hamilton watch movement. The illustrations are based on a Hamilton 16 size watch. Except for obvious variations in size, shape, and certain parts peculiar to given models, the illustrations show typical Hamilton parts in a manner which suggest their assembly relationship. The illustrations will be of special interest to apprentices, junior watchmakers, and others who have recently joined the trade. Not only are typical parts shown in third-dimension and in their relative positions to one another, but they are identified by part names.



DIAL SIDE

CHICAGO SCHOOL
OF WATCHMAKING

HAMILTON WATCH MOVEMENT

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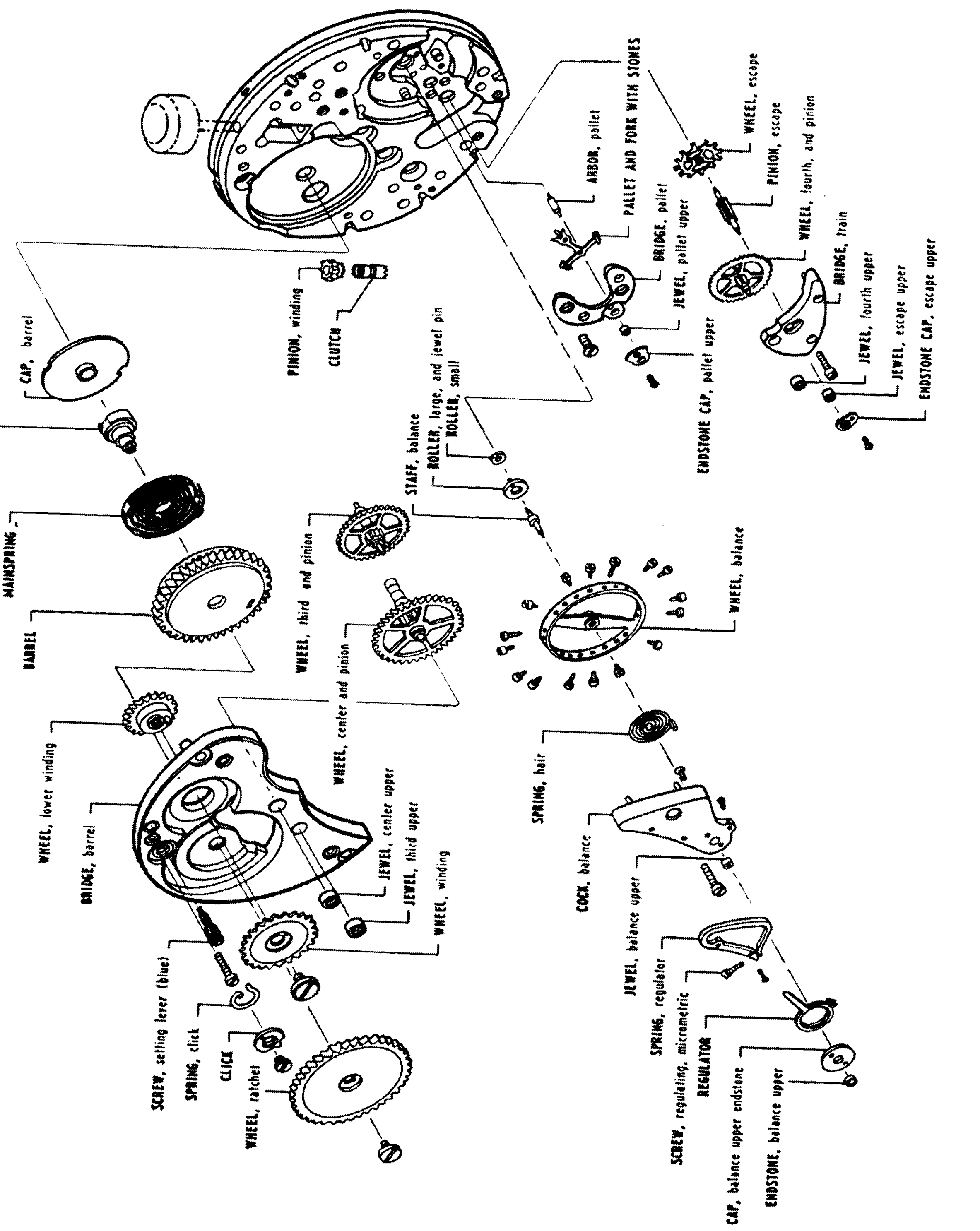


TRAIN SIDE

CHICAGO SCHOOL
OF WATCHMAKING

TABLE OF CONTENTS: Unit W1 - Lesson 4

JOB SHEETS

MOVEMENT SIZE: American or Swiss

INTRODUCTORY INFORMATION:

Determining the size of a movement is very important as it is used as a part of movement identification. (Sec. 115) There are two common methods of determining size: Use of Millimeter Gauge, taking measurement directly across the pillar plate and using the conversion table to determine the size (Sec. 116 & 117) or using a movement gauge on which the various sizes are marked off. The Millimeter Gauge is the more accurate.

TOOLS, EQUIPMENT AND SUPPLIES:

Millimeter gauge or movement gauge

PROCEDURE

HOW TO DETERMINE THE SIZE OF A WATCH MOVEMENT

1. Remove movement from case.

2. Measure directly across the pillar plate from point stem enters movement.

   NOTE: Movement gauges generally have a scale for both Swiss and American, use the scale that corresponds to the origin of the watch. If the dial extends beyond the edge of the pillar plate, it may be necessary to remove the dial. If Millimeter gauge is used, refer to charts in sections 116 and 117 to determine American or Swiss size.

ORDERING PARTS: American and Swiss watches

INTRODUCTORY INFORMATION

Ordering parts for either American or Swiss is alike in this respect; the dealer must have complete identification of the movement and a clear listing of the parts desired using correct names.

PROCEDURE

A. INFORMATION TO BE FURNISHED WHEN ORDERING PARTS FOR AMERICAN WATCHES

1. Name of Watch.

2. Size.

3. Model name or number. If model can not be determined, furnish serial number of the movement.

4. Number of jewels.

5. If a pocket watch, indicate whether Open Face or Hunting movement.

6. Specify part or parts desired.

B. INFORMATION TO BE FURNISHED WHEN ORDERING PARTS FOR SWISS WATCHES

1. A. Make and model designation. (Sec. 118)
   or
   B. Trade mark or Manufacturer and Calibre number.
   or
   C. Identification of setting parts.
   NOTE: If identification B or C is used you should first determine size to aid in identification. (See Job Sheet W4-J1)

2. Specify part or parts desired.

SAMPLE ORDERS: American

1 Mainspring
Waltham 18/s 17 Jewel, Hunting,
Serial number 16,188,003

1 Escape wheel and pinion
Elgin 21/0s, 17 Jewel Model 662

SAMPLE ORDERS: Swiss

1 Balance complete with flat
Hairspring FF 120

1 Breguet hairspring
Bulova 6AH

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 5

Mainsprings in Watches

—

Sections 125 - 162

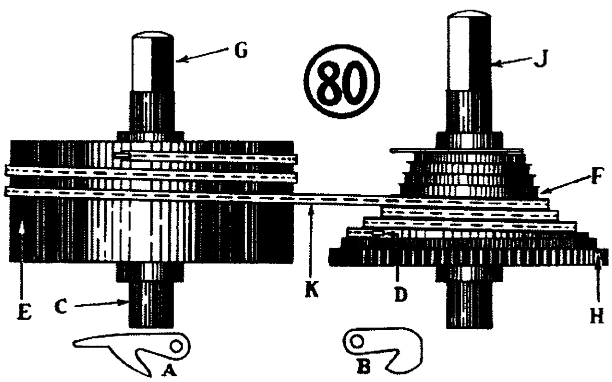
CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

Lesson 5 — Mainsprings in Watches

Section 125 THE early watch mainspring moved around the arbor of the wheel in much the same way as in a clock, and was limited in the extent of its expansion by four upright pins driven into the plate of the watch with the arbor as a center.

The next step was the introduction of the barrel to contain the mainspring. The barrel is a metal box of cylindrical shape in which the mainspring is confined. This barrel was used in connection with a fusee.



Sec. 126 — The Fusee

The FUSEE, sometimes spelled FUZEE, is an ingenious cone shaped arrangement, with a spiral groove, mounted on a toothed wheel, the first wheel of the watch, which gears into the center pinion. The barrel containing the mainspring is without teeth and turns on a stationary axis. The barrel and fusee at first were connected by a piece of gut, but later this was replaced by the fusee chain as shown at K figure 80.

The arrangement of the fusee and barrel with properly formed mainspring practically equalizes the motive force in the watch.

Figure 80 is a drawing of a fusee and barrel from an imported chronometer. The step like arrangement F represents the fusee while the first wheel is shown at H. This wheel gears into the center pinion. The fusee may be turned upon the wheel for the purpose of winding the chain from the barrel.

Sec. 127 — Fusee Chain

This steel fusee chain, somewhat resembling a miniature bicycle chain, has a hook at each end, one hook with a brace extending at the tip as shown at A being hooked into the barrel and the other hook shown at B into the fusee.

Sec. 128 — The Barrel

The mainspring itself is contained in the Barrel E, the outside end of the mainspring being hooked into the shell of the barrel and the inside end being hooked to the arbor C which extends straight through and on which the barrel turns. When the mainspring is connected, one end with the barrel, and the other end with the arbor, it is easy to see that any circular force given to the arbor C will be transmitted to the barrel through the mainspring. If the arbor C is held by some means and the barrel forcibly turned, it will cause the mainspring to be wrapped around the arbor, inside the barrel.

The natural elasticity of the mainspring in trying to assume its original position will cause a pull to be exerted on the barrel and this in turn by means of the chain will be extended to the fusee and first wheel at H, thus transmitting the power to run the train.

Sec. 129 — Assembling Fusee and Chain

In assembling these parts the chain is first wound around the barrel by turning the square at G, which is a continuation of the arbor C, using care to have the chain spaced evenly on the barrel and leaving only enough of the chain extending from the barrel to hook into the fusee at D.

The point D should be adjusted so that it is as near as possible to the barrel before hooking in the chain. The square end of the arbor at G is long enough to permit a ratchet wheel being mounted upon it.

After the chain is wound around the barrel and one end fastened to the fusee, the square at G is given from ½ to ¾ of a turn and the click set against the ratchet wheel to hold it in this position, thus having a reserve power of at least ½ turn of the mainspring when the watch is entirely run down.

When the ratchet on the barrel arbor is once properly set it is not moved afterwards. The mainspring is wound by turning the square on the fusee at J, figure 80, carrying the chain with it and unwinding it from the barrel. As shown in the drawing it is about half way down.

In the modern watch the bulky fusee has given way to the "going barrel" and "motor barrel". It is probable that you as a watchmaker will not be called upon to repair a watch having a fusee, unless it is one kept as an antique. However in the larger time pieces with detent escapement, such as ships chronometers, the fusee is still used and if you happen to be located in a seaport you may have many opportunities of working upon these interesting instruments.

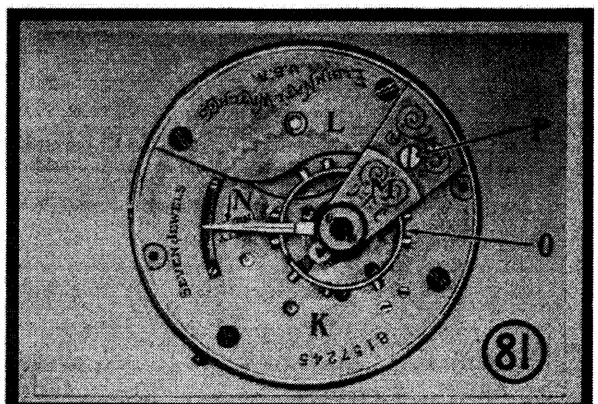
Sec. 130 — The Going Barrel

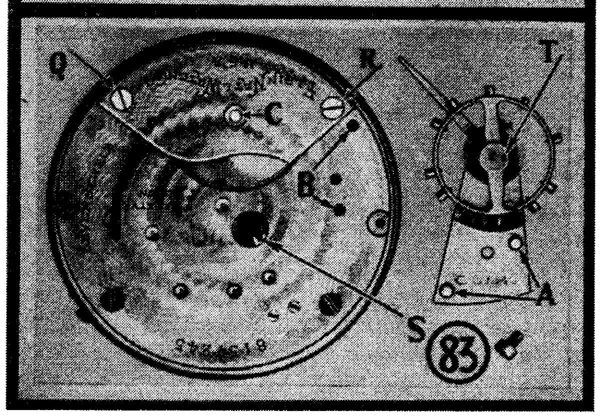
Let us now take up the study of the Going Barrel. By this we mean a barrel which has teeth cut in its circumference, these teeth gearing directly into the leaves of the center pinion. This then is also the first wheel in the train and when the watch is running the barrel turns and transmits the power from the mainspring through the train to the escapement.

Your first practical work on a mainspring in a Going Barrel is best done on an 18 or 16 size American movement. If you do not have a movement similar to the one shown here, use any American made movement, Waltham, Illinois, Hampden etc. Even an old model Key Wind movement is suitable, the only difference being in the winding and setting arrangement. In the demonstration work for this lesson I have taken an 18 size full plate Elgin movement. After removing from the case it will appear as in figure 81. In this photograph K is the top plate, L the barrel bridge, M the balance cock or balance bridge, N the regulator and O the balance wheel or balance.

Sec. 131 — Remove the Balance

In a full plate movement of this type it is best to remove the balance with the balance cock before attempting to take out the mainspring barrel. With the proper size screw driver remove the balance cock screw at P figure 81 then take hold of the balance cock with your tweezers as shown in figure 82 and carefully lift it up bringing the complete balance suspended by the hairspring. When you set the





balance down turn the balance cock right over so that it will set upside down as in figure 83.

If we were to rely entirely upon the balance cock screw P figure 81 to keep the balance cock in its proper location, it would be necessary to adjust it each time we assembled these parts in order to have the upper balance hole jewel exactly over the lower balance hole jewel. You will find on the lower side of the balance cock where it comes in contact with the upper plate, two *steady pins,* see A fig. 83. These pins are fastened firmly in the balance cock and fit closely in the two holes at B in the plate. By means of these steady pins the balance cock is kept in its proper place on the plate.

If your movement has a dust band it is necessary to remove it. The one shown here is snapped in place and can be removed by prying off with a screw driver as shown in figure 84. It is quite a common thing to find movements cased by some repairer with the dust band left off but you should make it a rule to always replace it on every movement that is supplied with one when it comes to you. In replacing a dust band see that the hole for the stem is exactly over the winding pinion in the movement. Many movements in the newer models are not supplied with dust bands.

Sec. 132 — Let Down the Power

Before going any further it is well to test the power, that is, see if there is any power from the mainspring to the train of the watch, and if so, "let it down". In this model there is a small hole in the lower plate into which may be introduced a wire, and by pressing down on this wire as at S figure 85 and at the same time holding the power with the bench key in the winding arbor at T the power may be eased down by allowing the key to revolve slowly in the hand.

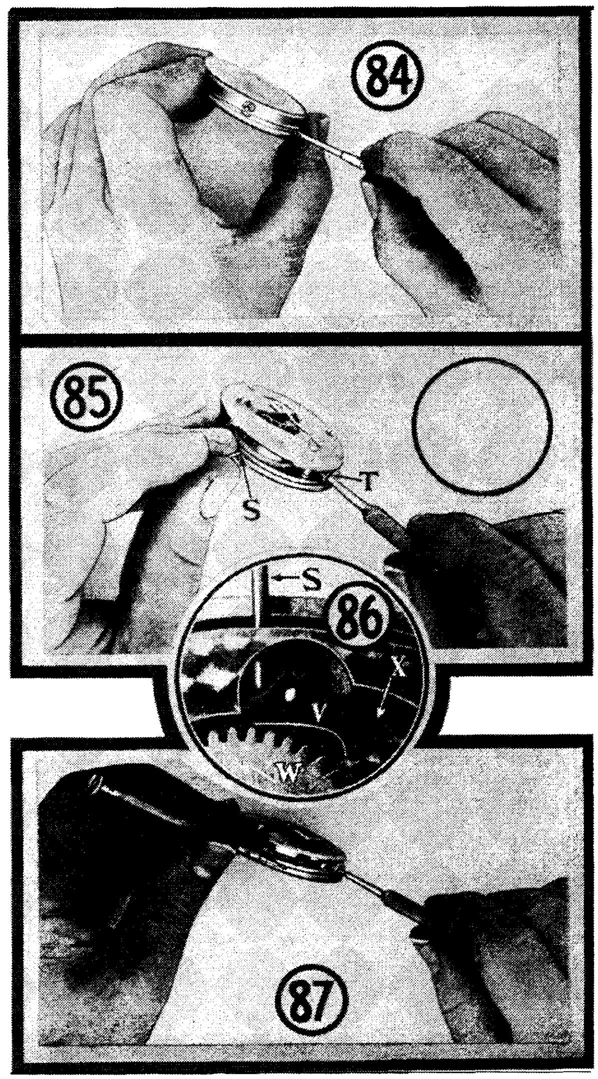
At figure 86 is shown (much as it appears when viewed through an eye glass) how the wire S extends through the hole in the edge of the pillar plate and presses against the end of the click V raising the other end away from the teeth of the ratchet wheel at W so that this wheel may turn backwards in letting down the power. At X is the click spring, which holds the click against the ratchet wheel teeth. The ratchet wheel, click and click spring also may be seen approximately actual size in figure 90.

In some models of movements the end of the click extends to the edge of the pillar plate and while letting down the power this may be held back by a small screw driver as in the Waltham movement in figure 87 which demonstrates the method used with this model.

Sec. 133 — Always Test Amount of Power

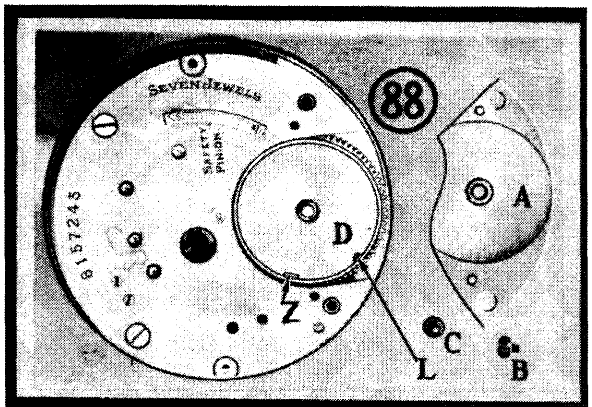
Though a mainspring may be broken it is well to see if there is any power left in the barrel by going through the same procedure as just outlined. If the mainspring is broken near the outer end, there still might be enough power to cause damage when you lift out the barrel without having "let down" the power.

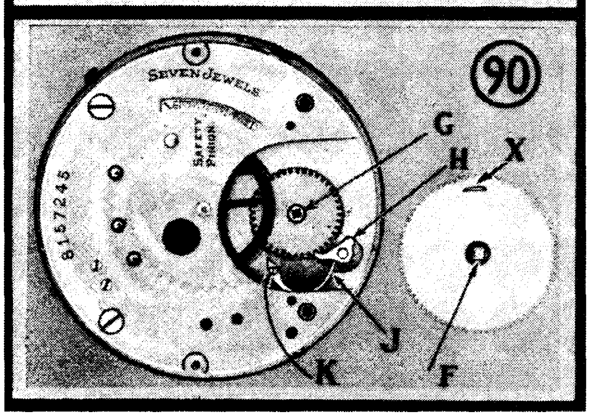
If the mainspring is not broken and is wound to anywhere near the full amount, much damage may be caused by attempting to take the watch apart without "letting down" the power.



Sec. 134 — Remove the Barrel Bridge

After letting down the power the next step is to remove the barrel bridge by taking out the screws Q and R figure 83 and lifting it off with your tweezers to the position shown in 88. Here may be seen the barrel bridge A with the two screws B and C which held it in place and the barrel D in the position that it occupies in the watch. On the barrel bridge also may be seen the two steady pins which perform the same office for this bridge as those previously mentioned do for the balance cock.





Sec. 135 — Take Out Barrel

Now that your power is all down the barrel may be removed by taking hold of the end of the barrel arbor as shown in figure 89 and carefully lifting it out, bringing the barrel right along with it.

In figure 90 the barrel is turned over showing the lower side and at F the square of the barrel arbor which fits into the square hole in the ratchet wheel at G with the click in its place at H and the click spring J pressing against it. The click spring is held in position by means of the click spring screw at K.

Sec. 136 — The Cap

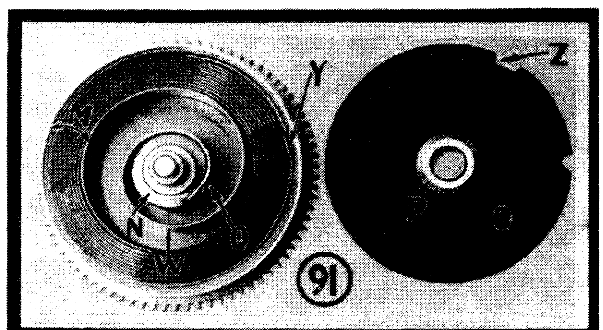
The cap fits in the barrel with a snap fit and may be removed by prying off with a screw driver or other lever like instrument. The cap has an opening at the edge in which to insert the screw driver at L figure 88. Of course, the cap is pried out after you have taken the barrel from the movement.

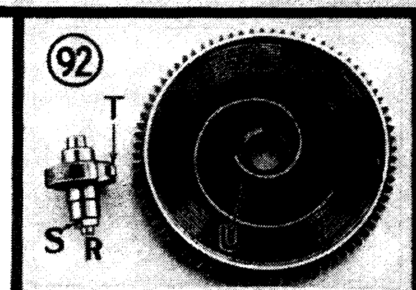
Having removed the cap, the barrel with the mainspring appears as in the enlarged photo in figure 91 in which M represents the coils of the mainspring, N the barrel arbor and O the cap removed and with the inner side out. As you can see at P the cap is reinforced around the center by a thicker portion of metal so that it gives a heavier bearing and support for the upper end of the arbor.

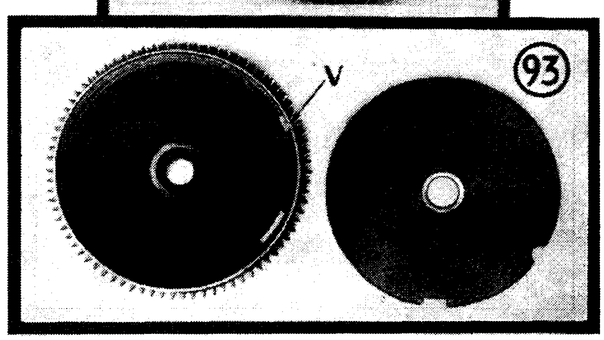
Sec. 137 — The Barrel Arbor

By arbor we mean an axle or spindle. Thus we here have the barrel arbor to which one end of the mainspring is attached and which in a going barrel, turns only when the mainspring is being wound. There are other arbors, the pallet arbor, setting arbor, winding arbor and sometimes the balance staff is called the balance arbor.

In most watches with going barrels the barrel arbor and hub are in one piece. By the hub







we mean the center part of larger diameter which carries the pin or hook for the inside end of the mainspring.

In some of the old Swiss watches the hub screws onto the arbor and it is necessary to unscrew this before it is possible to separate the arbor from the barrel.

The barrel arbor shown here is of one solid piece and by disconnecting the inside end of the mainspring from the hook at Q you will find it possible to lift the arbor right out of the barrel as in figure 92 in which the arbor is shown at R. The barrel is also furnished with a re-inforcement in the center for the purpose of giving a heavier bearing at this end for the barrel arbor. In this picture you can see the square on the barrel arbor at S which fits into the square hole of the ratchet wheel shown at G figure 90. At T, figure 92, is shown the hook which fits into the hole in the inner end of the mainspring at U.

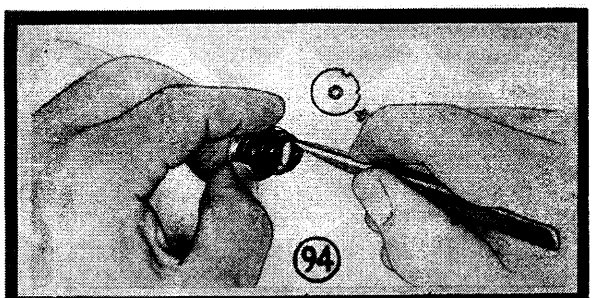
Sec. 138 — Taking Out the Mainspring

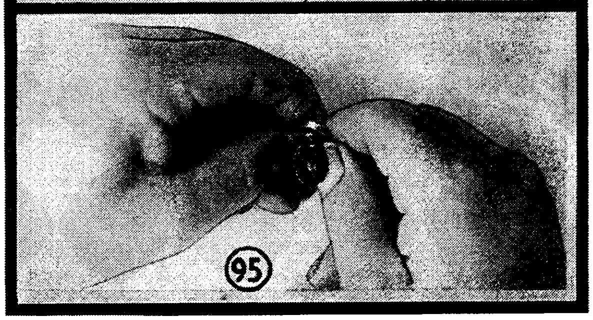
Now you are ready to remove the mainspring from the barrel. Hold the barrel in the left hand in the position shown in figure 94, and grasp the inside coil of the mainspring with a pair of tweezers, pulling it out so that three or four of the inner coils are outside as shown in the photograph, holding the balance of the coils in the barrel with the thumb of the left hand.

Lay your tweezers down and slip the thumb of the right hand under the extended coils of the mainspring as shown in figure 95. Now you control the balance of the coils in the barrel with the thumb of the right hand and by releasing your hold with the left hand the natural resiliency of the mainspring will force the coil out on this side. By alternating the position of your hands, that is by holding the coils in the barrel, first on one side and then on the other the mainspring can be released one half a coil at a time until it is entirely out of the barrel and only holding at the extreme end or "tip". This can be easily released and you have removed your first mainspring from a watch.

Be careful that you do not release your hold on the barrel and mainspring else they may suddenly shoot out of your hands. Should such an accident occur examine your barrel very carefully to see that it is not damaged. Often teeth are bent in this way and great care must be used in straightening them.

After you have removed the mainspring, the barrel and cap will appear as in figure 93. At





V is the hook in the barrel over which the hole in the tip of the mainspring fits.

Sec. 139 — Form of Tips

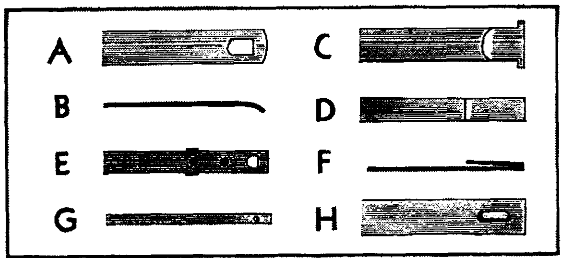
The outer end of a mainspring is commonly called the "tip" and its shape varies with the watch for which it is intended. There are several styles of tips on mainsprings but each is for the same purpose — to have some kind of an attachment to make the end of the mainspring hold securely on the inside of the barrel yet easily released when it is necessary to remove the mainspring on account of its being broken or set.

Sec. 140 — Hole End

The first and simplest style of "tip" is a hole end as shown at A in figure 96. With this style of a tip it is best as a general rule to curve the end of the mainspring right at the tip so that it will conform to the shape of the barrel as shown in the drawing of the side view at B. If this is not done the mainspring will often pull off the hook.

Sec. 141 — T End

C shows another style of "tip" known as the "T" end. With this style it is not necessary to have a hook in the barrel, but instead a hole in the bottom of the barrel and a hole or notch in the cap. One end of the "T" fits into the hole in the bottom and when the cap is pressed into its place on the barrel the other end of the "T" fits into the hole in the edge of the cap thus holding the tip securely in place. In figure 65 at G is shown the end of such a tip in an Illinois movement. (See Lesson 4)



96

Sec. 142 — Tongue End

The tongue end is shown at D. This style tip is used in many Swiss watches although not so popular with American manufacturers. F is a side view of this tongue end.

Sec. 143 — Double Brace

The style of "tip" used on the mainspring which we have been showing in this lesson figures 91 and 92, is called a "double brace hole end", and is shown at E. As you can see there is a hole which fits over the hook in the barrel. This style is held in place by means of the double brace, one end of which fits into a slot in the barrel, as shown at X figure 90, while the opposite end which can be seen at Y in figure 91, projects far enough to be held by the slot in the cap shown at Z figure 88 also Z in figure 91.

At G and H, fig. 96, are shown two types of pin ends. The pin on the tip, of this type of mainspring ends, fits into a hole of proper size in the wall of the barrel. The type shown at H is often used on mainsprings for ships chronometers in barrels used with a fusee.

These are the more popular forms of mainspring tips or ends but there are others which you will find in our mainspring charts, showing widths, strengths and shape of tips on 135 different Mainsprings for American Watches.

Sec. 144 — Factory Packing of Mainsprings

Formerly it was the custom for manufacturers to pack mainsprings in lots of one dozen of a size as shown at H in figure 98, but in recent years the individually packed mainsprings have become more popular with watchmakers until now nearly all of the better mainsprings as they come from the factory are held in separate containers, each in an envelope or wrapper.

Figure 98 shows three mainsprings in different styles of individual containers, F being held in a heavy piece of aluminum wire, G in a flat card container and K with a fine wire twisted around and holding it.

Notice that none of these springs is wound as tightly as it would be in the barrel of a watch. New mainsprings often lie in stock for rather long periods and if they were wound up nearly to the limit there would be a tendency for the coils to set in this position and not give the best of service.

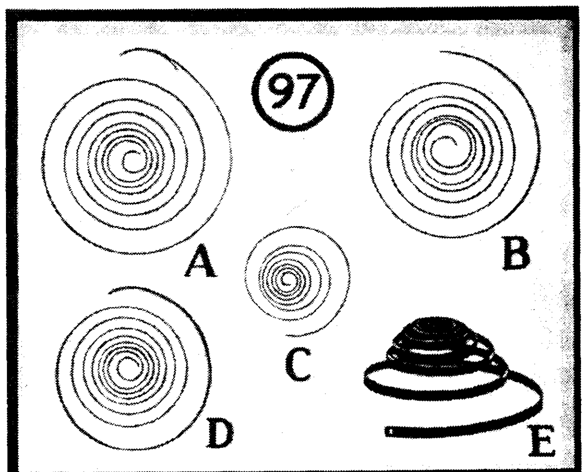
In removing the spring from its container hold the coils by the edge and let them expand slowly, never let them come out all at once.

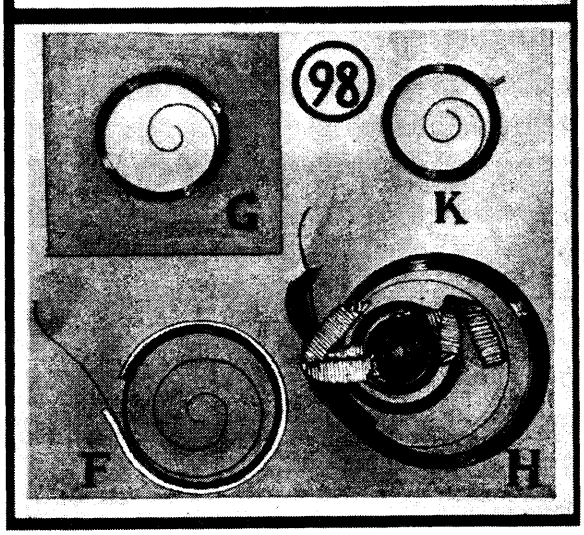
Sec. 145 — A Watch Should Run Over 30 Hours

The mainspring in a modern watch must be of such strength and temper that it will have enough power to make the balance take a good motion after a 24 hour run and yet it must not be so strong that it gives the balance an excessive motion when first wound up. Some of the modern Railroad Watches will run for 60 hours with one winding and an ordinary grade of watch should run from 32 to 36 hours.

Sec. 146 — Replacing the Mainspring

Many watchmakers replace mainsprings in barrels with their fingers, without the use of a mainspring winder. In doing this they reverse





the process of taking the mainspring out as we have shown you in previous paragraphs. The "tip" of the mainspring is caught in the barrel and then the balance of the mainspring is backed into it by pressing first on one side and then on the other. In doing this, however, you are bound to distort the mainspring and cannot get the best service out of it.

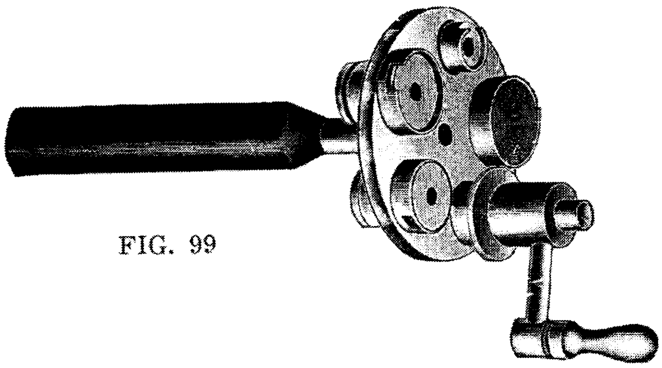


FIG. 99

Sec. 147 — Distorted Mainsprings

E figure 97 shows a mainspring as it appeared after having been replaced with the fingers by an amateur watchmaker. As you can see the mainspring is so badly distorted that there would be a constant friction on the cap and bottom of the barrel as the mainspring expands.

By all means get a good mainspring winder and use it every time you replace a mainspring.

There are several styles of mainspring winders on the market that use the same principle. That is by using a barrel small enough to slip inside the mainspring barrel in the watch. The mainspring is first wound into the winder barrel and then transferred to the barrel of the watch without distortion.

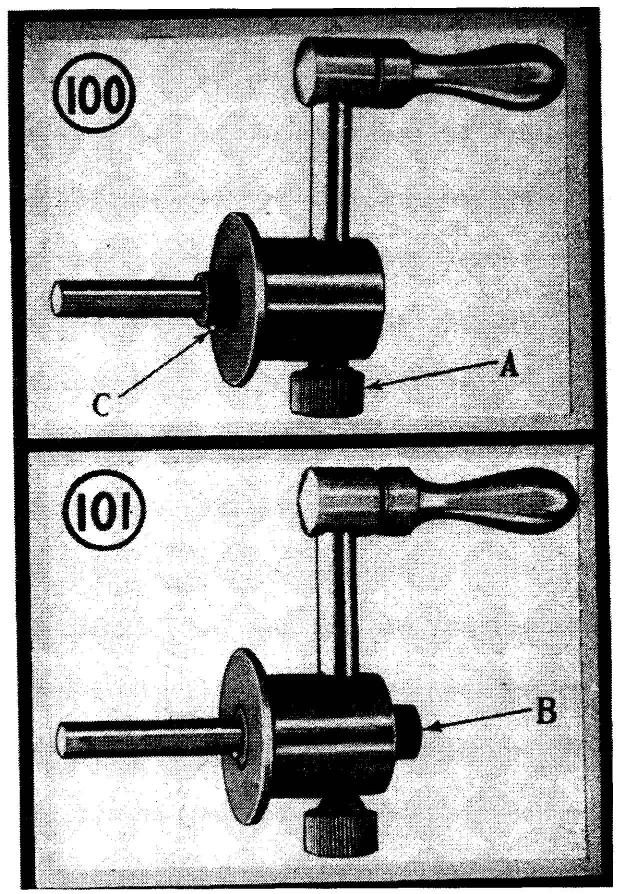
Sec. 148 — A Satisfactory Mainspring Winder

In figure 99 is shown a type of mainspring winder that proves satisfactory in all sizes of pocket watches and also can be used on some of the larger of the wrist watches. In this style the different sized barrels are arranged on a round plate fastened on a handle. The winder arbor is separate and can be used in combination with any of the barrels.

In using this type of mainspring winder, select one of the barrels that fits easily inside the mainspring barrel in which you are going to place the mainspring. If you are using a 16 or 18 size watch it would necessitate taking the largest barrel on the winder.

This winder has two arbors, the larger one held in place by the set screw at A, figure 100. When the screw is released the larger arbor springs back to the position shown in figure 101. Here the smaller arbor is in position for use on small barrels. In pocket watches the larger arbor should be used and may be brought into position by pressing at B, at the same time turning down the set screw A in order to hold the arbor in this position shown in figure 100.

The inner end of the mainspring should be shaped to fit closely around this arbor by means of the mainspring coiling pliers shown at figure 102. One of these jaws is convex and the other concave so that by grasping the inside end of the mainspring and squeezing with the pliers it can be shaped to the curve needed.



Sec. 149 — Operating the Winder

Hook the inside end of the mainspring over the pin in the arbor at C, figure 100 and then press into the proper sized barrel as shown in figure 103 holding it in this position while turning to the left with the right hand. At G figure 103 is shown the appearance of the mainspring when first started in the winder barrel.

Continue to wind until the mainspring is in the barrel as shown at H in figure 104 with only the tip extending enough to enable you to hook the outer end into the mainspring barrel of the

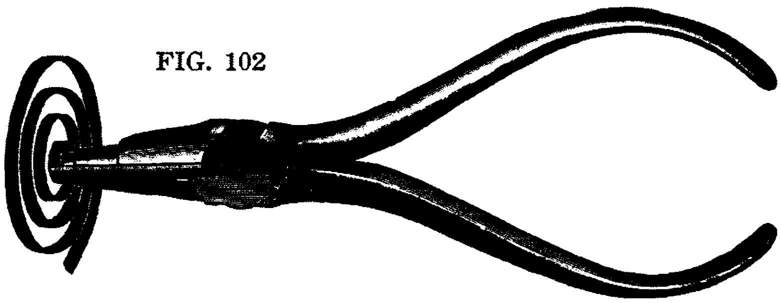


FIG. 102

watch. Reverse the motion of the winder in your right hand until the inner end of the mainspring is free from the hook on the winding arbor. Now it is ready to transfer to the barrel of the watch.

Sec. 150 — Transferring to Watch Barrel

Catch the outer end or tip of the mainspring over the hook in the watch barrel, at the same time slipping the watch barrel over the winder barrel.

Press the watch barrel firmly against the mainspring at the same time pressing with the thumb against the ejector part of the winder at D as shown in figure 104. In this position press the ejector at D hard enough to transfer the mainspring into the watch barrel at E. As shown here the finger is pressing directly upon the barrel but in actual practice it is best to place a piece of watch paper between finger and barrel in order to avoid leaving finger marks.

After getting the mainspring into the barrel, examine it to see that the end is properly hooked. At first, you may have difficulty in keeping the tip of the mainspring on the hook in the barrel as you press the mainspring out of the winder. Sometimes this is caused by having too much of the mainspring projecting from the winder barrel and sometimes by not holding the watch barrel firmly enough against the mainspring when transferring it.

When replacing T end mainsprings, have only the tip projecting from the winder barrel and even then you may have some trouble in keeping the tip from slipping out of the hole in the watch barrel when transferring from the winder barrel. If this happens you may be able to push the tip to its proper place after it is in the watch barrel, by means of a screw driver.

Sec. 151 — Directions of Coils

Of course when you replace a mainspring in a barrel of a watch it is not difficult to notice which way the old mainspring was wound into the barrel and replace the new one in the same direction. In this barrel, we speak of the mainspring as being wound to the right. If you will look at figures 91 and 92 you can see what is meant by having the mainspring wound to the right.

In the mainspring winder as seen at H in figure 104 the mainspring is wound or coiled to the left but when transferred to the barrel of the watch the spring lies coiled to the right as seen in figures 91 and 92.

Sec. 152 — A Rule to Remember

There is a rule in this connection that is well for you to remember and applies to mainsprings in "going barrels". Just remember that when the cap of a barrel is up when in its position in the watch as in figure 88 the mainspring winds to the right in the barrel.

If the cap is down as in figure 65 the mainspring winds to the left. In nearly all watches with going barrels, outside of 18 size you will find the cap down.

After assuring yourself that the tip of the mainspring is properly hooked, replace the arbor in the position shown in figure 91. The inner end of the mainspring must be so shaped that it will fit closely around the arbor as shown here. For this purpose use the mainspring coiling pliers. Set the arbor in place and see just where the inner end of the mainspring must be bent to fit properly. Take out the arbor and then make the necessary bend by gripping the mainspring at the proper point with the coiling pliers. Do not squeeze too hard. A little practice will soon show you the proper amount of pressure to use.

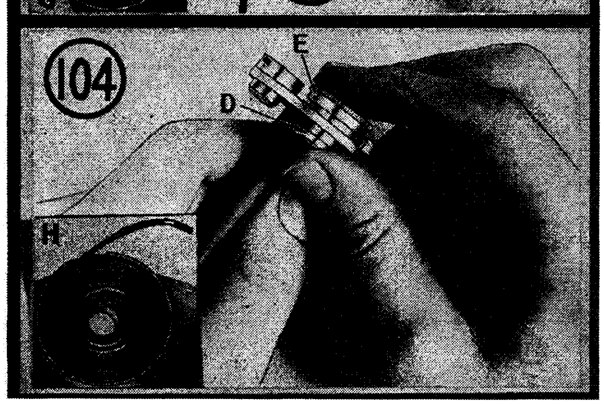
Sec. 153 — Oiling Mainspring and Arbor

The coils of the mainsprings must now be oiled. The oil to use should be somewhat heavier than watch oil and of a quality that will easily spread. Most watchmakers use clock oil for this purpose but the type of so called *non-spreading* clock oil *should not* be used on the mainspring.

The proper way to apply the oil is by means of a clock oiler. Dip the tip of the oiler into the clock oil and transfer a small drop to the coils of the mainspring in the barrel. Do this at four different points on the mainspring. The oil should immediately disappear between the coils. There should be enough oil to lubricate all the coils but do not apply too much. If the oil remains in a body on top of the coils you have applied more than is necessary. Also place a small drop of oil on the flat outer side of the inner coil at W figure 91 spreading it lengthwise in each direction from this point in order that this coil may be assured lubrication.

The price of watch and clock oil seems excessive to the uninitiated but the best quality of oil for this purpose is cheapest in the long run. In experiments in school work I have found some oils that at the end of a twelve months period have evaporated and left only a gummy sediment. Even after six months in a running watch such oils leave the pivots so dry that the motion slows down and in some instances the watches have stopped from lack of lubrication. A first class oil properly applied will be on the job as a good lubricant even after a year's service. When we consider the exceedingly small amount of oil necessary to oil a complete watch it is easy to see that the difference in cost per watch between the highest priced oil and the cheapest amounts only to a small fraction of a cent and it hardly pays to take the risk of poor service and dissatisfied customers for such a small saving.

Snap the cap back into the barrel using care to see that the slot Z of the cap is set directly



over the brace at Y figure 91 and that the reinforced portion of the cap at P is set next to the mainspring. Occasionally a beginner will replace the cap wrong side out and when he has assembled the rest of his movement finds that "something's wrong" because the movement won't perform as it should. Watch every step in assembling a watch. After you have practiced enough, you will be able to tell at a glance whether the parts are arranged as they should be but at first you should study each step and be sure you are right before going on to the next step.

In snapping the cap back into the barrel use watch paper so that the fingers do not come in direct contact with either the cap or barrel, press one edge of the cap into place and while holding that edge in position against the barrel, push the opposite edge of the cap into place by pressing it firmly against the edge of your bench until it snaps into position.

Apply a small amount of clock oil at each end of the arbor where it comes through the barrel. When the dial is left on the plate as has been done here, it is also necessary to place a small drop of oil in the hole in the lower plate into which the lower pivot of the arbor fits. This is done by lifting out the ratchet wheel and applying the oil directly under G, figure 90. If the dial is off this part is oiled from the other side, after the barrel has been replaced.

Sec. 154 — Assembling

Replace the barrel in the watch in the position shown in figure 88, taking care to see that the ratchet wheel, click and click spring are in their proper places. In your first attempt you may have some slight difficulty in getting the square of the arbor in its proper place in the ratchet wheel.

After setting the barrel in its place twist the arbor around toward the right (in order not to unhook the inner end of the mainspring) by means of a pair of brass lined pliers or heavy tweezers, as shown in figure 89 until the lower square end of the arbor drops into the square hole of the ratchet wheel. Pliers work better than tweezers as you can grip the end of the arbor more firmly.

Replace the barrel bridge and set the two screws in place. Many beginners in assembling a watch do not set the screws tight enough, so see that you screw these screws down fairly hard, not hard enough to strip the threads from the plate, but so that it takes a little effort to start the screws out. Now your movement will appear as in figure 83. Place a small drop of clock oil on the pivot of the mainspring arbor where it comes through the barrel bridge at C figure 83.

Sec. 155 — Tests

Apply a little power by using your bench key and giving it three or four turns while winding; listen for the sound of the click as it falls into the teeth of the ratchet wheel.

If when you release your key after winding, the power of the mainspring turns it back to its first position it is probable that your click or clickspring is not in its proper place. It will act the same way when the click spring is broken.

If when winding there seems to be no resistance of the mainspring — it is probable that the inner end is not properly hooked on the arbor.

If after you have wound several turns there is a sound of something slipping and apparently no power, the outer end or tip may be unhooked.

In replacing a new mainspring having a double brace or T end, always compare it with the thickness of the barrel and cap to see that the brace or tip does not extend beyond these parts and if you find that it does, grind or file off the proper amount to make it flush with the outside when assembled. Some do this after the mainspring has been placed in the barrel but it is just as easy to shorten these parts before as after and then there is no danger of having ugly file marks, the marks of the unskilled workman, left on the finished surface of the barrel. If the tip is left projecting from the barrel it is liable to catch on the center wheel or other part and stop the watch.

Sec. 156 — Replacing Balance

After finding that the mainspring and winding parts are working, replace the balance and balance bridge. If the power is transmitted properly to the fork it will be held over on one side as may be seen at S figure 83.

In order to have the watch run, the roller jewel (seen on the roller at T figure 83) must enter the fork from the open side, in this example at the right. Hold the balance bridge as in figure 82 but instead of holding it directly over its final position as shown here twist it around with a circular motion to the left until the roller jewel is on the open side of the fork.

Lower the balance bridge until the lower pivot of the balance staff is in the lower balance jewel, then twist the bridge around to its proper place as in 82 and your roller jewel should enter the fork and the balance start immediately to oscillating.

Sec. 157 — Use Care

Use care in replacing the balance. The pivots are small and easily bent. These parts should slip into place without using much pressure. You may need some practice before you can do it correctly every time, but it's surprising how soon these things come to you by doing them over and over.

Much care should be used in setting in place the balance bridge screw. As you screw it home see that each balance pivot is in its proper place and that the balance wheel is perfectly free.

This may be tried by giving the movement a slight twist with the left hand and if the balance should suddenly stop as you twist the screw, find out what is holding it. Do not set the screw tight unless the balance is free to vibrate.

Sec. 158 — Watch The Hairspring

In manipulating the balance into its proper place, it is suspended from the bridge by means of the hairspring so do not give any sudden jerk or hard pull as you are liable to damage your hairspring.

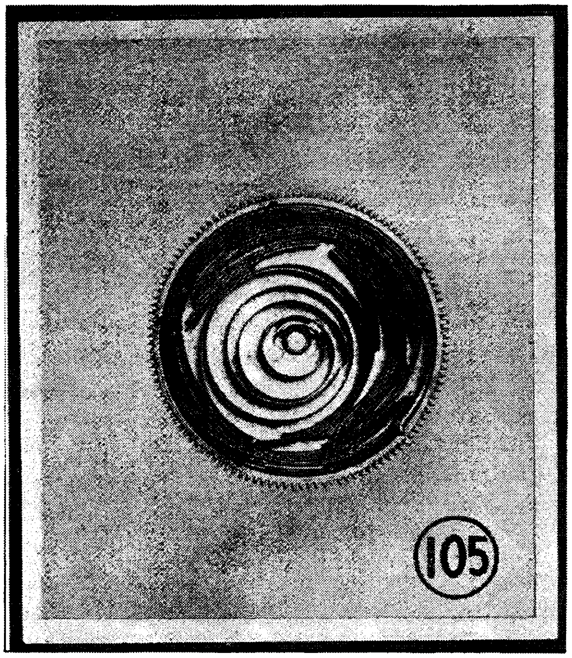
Replace the movement in the case, set your case screws in their proper positions, and notice how many finger marks you have left on the dial and plates. They can be removed sometimes with a clean polishing cloth, but the proper way is to use more care and protect with watch paper so that the fingers do not touch the parts.

Sec. 159 — Preliminary Tests

The first test given a watch when brought in for repairs is to try the winding. Often a customer, especially with a watch having a small or worn crown, complains that his watch stops, and upon examination you may find that he is only winding it a few turns. Again another customer may be afraid to wind his watch as it should be wound, for fear he'll break the mainspring.

Test your own ability and count how many turns it takes you to wind your watch after it has run 24 hours. It is not necessary to turn the crown in one direction only — rather roll it back and forth between the thumb and first finger and count this back and forth motion as one. By knowing how many turns it needs you can tell whether a watch is entirely run down when brought to you.

If when you attempt to wind a watch you can turn the winding stem any number of times without resistance from the mainspring it is probable that the mainspring is broken and should be replaced with a new one.



Sec. 160. — What Causes a Mainspring to Break

Regardless of how careful the manufacturer may be in tempering or how great the care used in handling the mainspring, there still remains the danger of sudden breakage through unexplained causes.

There seems to be no satisfactory explanation of just what causes some mainsprings to break, while others, made from the same steel and under the same conditions do not. Mainsprings that are tempered highly enough to perform the best are liable to break and the fact that one brand of mainsprings causes no trouble due to breakage while another brand does occasionally break, should cause the watchmaker to suspect that the first kind is softer and more apt to set. There's an old saying among Watch Experts that "a broken mainspring is better than a set mainspring", meaning that there is no question as to the cause of trouble from a broken mainspring while the cause of poor motion from one that is set, is not as easy to locate.

No doubt you will find some rather odd examples of broken mainsprings in your work. As a general thing when a mainspring breaks in a watch it will break near the outer or inner end and in only one or two places, but occasionally you will find one like the one shown in figure 105 which has apparently "exploded".

During the summer months there is a greater percentage of mainsprings breaking than any other season of the year. Some claim that this is caused by electrical disturbances in the air and as proof, the fact has been cited that often workmen in shops where a large number of watches were hanging on the racks have noticed the breaking of several mainsprings at almost the same time; this being followed in some cases by an electrical storm.

Rust no doubt is one of the common causes of breakage in mainsprings. There are watchmakers who cannot touch steel without causing it to rust, and yet many of them insist on putting in mainsprings by hand, not only causing the spring to rust, but distorting it as well. The fact that such a percentage of breakage occurs during the time when the air holds the most moisture would also cause us to suspect rust as a partial cause at least.

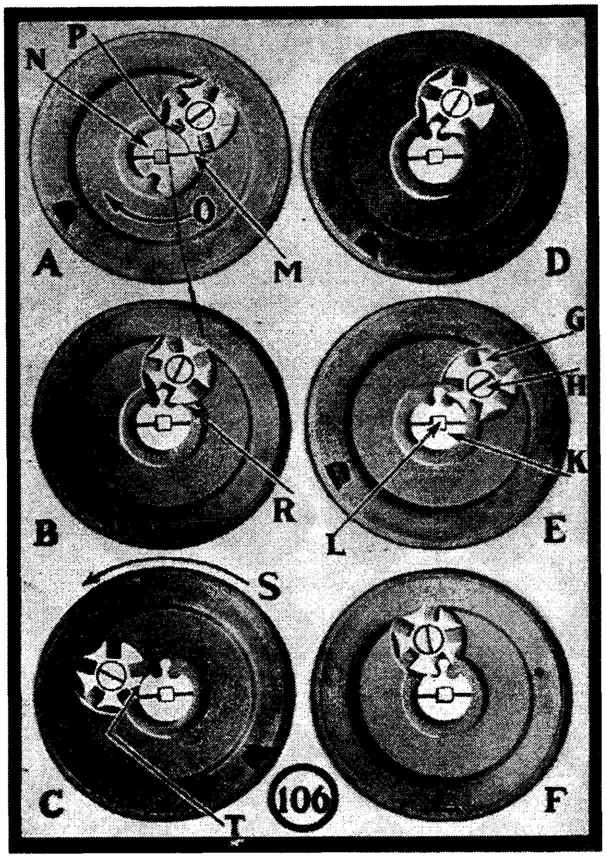
The mainspring should be kept well oiled at all times not only for its lubricating effect but also to help prevent rust.

Sec. 161 — Stop Work

As already explained the fusee was developed in order to equalize the power of the mainspring as the movement runs down.

There is another mechanism known as the *Stop Work,* which prevents the mainspring from being wound completely up and also prevents it from running entirely down, thus using that portion of the mainspring during which the power is applied most nearly equal.

The arbor of the going barrel as demonstrated in the preceding sections of this lesson is supported at both ends, the upper end by the barrel bridge and the lower by the pillar plate. Occasionally you will come in contact with another style of going barrel which is supported only at the upper end. This type, known as an "overhanging barrel" generally will be found where economy of space is desirable, such as in complicated watches or thin models. The barrel shown in photos A to F fig. 106, is of this type although you will also find stop work applied to the other style of barrels.



The stop work consists of two parts, the one at G in photo E figure 106 being somewhat in the shape of a Maltese Cross which turns upon a shoulder in a recessed portion of the barrel, being held in place by the screw at H. The other part of the stop work known as the male shown at K, is placed firmly upon the end of the barrel arbor at L and has a projection or *tooth* which gears into the notches of the cross. This part as shown here must be removed in order to take the cap from the barrel as in replacing the mainspring or cleaning the watch. The cross however may be left in its position.

If you examine the cross you will see five arms, the ends of four of these being concave while the fifth is convex.

In assembling the stop work the mainspring is first wound up as far as it will go after which the cross is so arranged that the convex end at M will be in the position shown in photo A. The male part is then pressed lightly on the square of the arbor and *above* the surface of the cross as shown at N. Now the power is let down and as this is done the arbor turns in the directions of the arrow O carrying the male part with it until the tooth is directly above the notch in the cross at P.

The part on the arbor should then be pressed down as far as it will go with the tooth engaged with the first notch of the cross as shown in photo B. If you attempt to wind the mainspring with the stop work in this position you will find that the arbor is prevented from turning further by the convex arm at R, thus preventing the mainspring from being completely wound around the arbor by nearly three fourths of a turn.

As the watch runs down the barrel turns around the arbor, which is stationary, in the direction of the arrow S photo C, which also shows the position of the stop work after the barrel has made part of a turn. In going in this direction the concave end of the arm at T allows the cross to move around the circular portion of the male part as shown until the second notch catches on the tooth (see photo D) and starts to turn the cross up another notch and so it proceeds turning up one notch for each turn of the barrel until it again comes to the convex arm of, the cross which stops its turning further in this direction as shown in photo F. Thus the stop work prevents the mainspring being wound to the limit and also does not allow it to expand to its full capacity.

In winding the watch this process is reversed, the arbor turning and the tooth on the male part picking up a notch on the cross for each turn until it can be turned no further as shown in photo B. If the mainspring should be broken the stop work performs in the same manner and you will not be able to use the test described in the last paragragh of section 159.

Sec. 162 — Later Improvements

You should now be ready to master later improvements relating to the mainspring and our next lesson will make you acquainted with motor barrels, safety pinions, recoiling clicks and give demonstrations of assembling different makes of jeweled barrels. These are found on the higher grades of American watches and in order to be a Master Watchmaker it is essential that you understand the benefits obtained by these improvements and that you are thoroughly familiar with the methods of assembling them.

TABLE OF CONTENTS: Unit W2 - Lesson 5

JOB SHEETS

MAINSPRINGS: Watches Having Fusee

TOOLS, EQUIPMENT AND SUPPLIES:

Tweexers - screwdrivers - movement winder - winding key - oil - oiler - mainspring winder

PROCEDURE — REFERENCE

HOW TO CHANGE A MAINSPRING IN A WATCH HAVING FUSEE — Sections 125-126-127-128-129

1. Remove balance and cock.
2. Release power.
3. Remove barrel bridge.
4. Turn barrel around so you can unhook chain.
5. Lift barrel from movement.
6. Remove barrel cap.
7. Remove barrel arbor and mainspring.
8. Replace proper spring.
9. Replace arbor and oil.
10. Replace cap and test arbor end shake. (A small amount of end shake is necessary.)
11. Place barrel in movement.
12. Replace barrel bridge.
13. With key on barrel arbor, hook the end of the chain to barrel and coil chain around barrel.

    NOTE: If chain slides down on barrel or under barrel, a slight amount of oil or grease on barrel edge will hold chain in place while winding chain around barrel.

14. With key on winding arbor your watch should start to wind.

    NOTE: If watch does not wind but chain is uncoiling from barrel, your spring is not hooked in barrel arbor.

    If chain does not coil around first wheel, your chain has unhooked from the first wheel.

UNIT	II
LESSON	5

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W5-J2

MAINSPRINGS: Swiss or American Watch with exposed ratchet and crown wheel

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers - screwdrivers - mainspring winder - movement holder - oil - oiler - bench key

PROCEDURE	REFERENCE
HOW TO REPLACE A MAINSPRING IN A SWISS OR AMERICAN WATCH WITH EXPOSED RATCHET AND CROWN WHEEL	
1. Release power.	
2. Remove ratchet wheel screw. (American all right hand thread, some Swiss left hand thread.)	
3. Remove barrel bridge.	
4. Remove barrel.	
5. Remove cap, arbor and spring.	Sec. 136-137-138
6. Select new mainspring.	Les. 7, Sec. 199
7. Wind new spring into proper mainspring winder.	Fig. 104
8. Inject spring into barrel making sure it's hooked.	Sec. 150
9. Replace arbor.	Fig. 91, Sec. 152
10. Oil spring and arbor.	Sec. 153
11. Replace cap. Test for arbor end shake.	
12. Place barrel in movement.	
13. Replace barrel bridge and screws, checking to see that crown wheel teeth mesh with winding pinion.	
14. Replace ratchet wheel and screw.	
15. Test winding.	

MAINSPRINGS: Full Plate Movement

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench key

PROCEDURE	REFERENCE
HOW TO REPLACE A MAINSPRING IN A FULL PLATE MOVEMENT	
1. Remove balance cock and balance wheel.	Sec. 131
2. Let down power.	Sec. 132-133
3. Remove barrel bridge.	Sec. 134
4. With tweezers lift barrel arbor up (Fig. 89) then slide barrel out of movement.	Sec. 135
5. Remove barrel cap and arbor.	Sec. 136-137
6. Remove mainspring.	Sec. 138
7. Select new mainspring.	Les. 7, Sec. 199
8. Select proper mainspring winder.	Sec. 148
9. Wind spring in barrel of winder.	Sec. 148-149-152
10. Inject spring from winder into barrel, making sure end is hooked.	Sec. 150
11. Replace barrel arbor.	Sec. 152
12. Oil spring and arbor.	Sec. 153
13. Replace cap, making sure that it is in line if you have a "T end" or a double brace.	
14. Test arbor for end shake, a small amount is necessary.	
15. Replace barrel and barrel bridge.	
16. Check winding.	
17. Replace balance and cock.	

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 6

Motor and Jeweled Barrels

—

Sections 165 - 181

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

A Modern, Complete, Practical Course

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 6

Sections 165 to 181

Lesson 6. — Motor and Jeweled Barrels.

Section 165 WHEN the mainspring breaks and its power is released all at once, there is a sharp recoil on the barrel and when this is transmitted to the train there may be pivots and teeth not strong enough to stand the blow. Before the advent of the safety pinion it was no uncommon thing to find broken or bent train pivots and teeth due to this recoil from a broken mainspring.

Sec. 166 — The Safety Pinion

The introduction of the safety pinion protected the train from this shock. This pinion is mounted on the center staff in such a way that it can turn in one direction but is held in its proper position when the power is applied from the barrel.

One form is shown in figure 110, in which the pinion A is hollow and threaded to fit the threaded part of the center staff at B. When the pinion is screwed in place the power from the barrel has a tendency to tighten it on the staff.

Should the mainspring break in the watch the recoil forces the barrel in the other direction and loosens the pinion from the staff allowing the barrel to spin without damage to the teeth or pivots. In figure 111 the pinion is shown in about the position it would assume when driven off by the recoil of a broken mainspring. Before replacing in the watch the pinion should be screwed down to the shoulder at C.

Later the motor barrel of the type shown in the next section was introduced and this too protects the train from the shock of a broken mainspring, in fact it is sometimes called the safety barrel.

Sec. 167 — The Motor Barrel

In the going barrel as we learned in our previous lesson, the teeth for the first wheel of the watch train are cut in the barrel making it the first wheel of the watch. In the motor barrel shown here, the barrel and first wheel are two separate parts and are connected to each other by the mainspring — one end of the mainspring being hooked to the barrel and the other end to the first wheel.

A very good example for the students first work in this type of barrel is found in a Waltham 16 size movement shown in figure 114. This model is known as a three quarter plate movement as opposed to the older full plate model used in our last lesson and is much easier for the beginner to take down and reassemble. Practically all pocket watches now are either three quarter plate or bridge models.

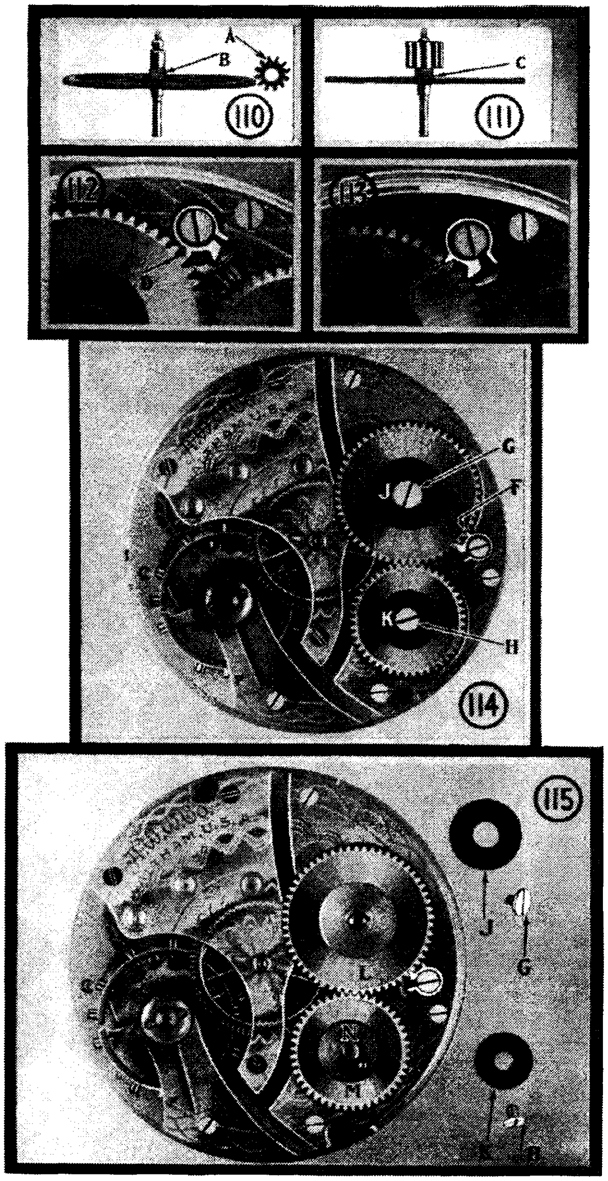
Sec. 168 — Recoiling Click

This movement has exposed winding wheels with a recoiling click. The advantage of this style is that after winding as far as possible the click allows the ratchet wheel to back up and the coils of the mainspring are not drawn too tightly together. With the click shown in our last lesson in figure 90 it is possible to wind the coils of the mainspring so closely together that there is a sort of adhesion produced by friction on each other and the balance does not attain a full motion until the watch has run long enough to loosen these coils.

In figure 112 is shown this recoiling click, over twice its actual size, just ready to drop off the tooth of the ratchet wheel. After it has dropped into the space at D the power of the mainspring pulls it back as shown at E figure 113 and F figure 114, thus allowing the ratchet wheel to "recoil" or back up slightly after having been wound to its highest point.

Sec. 169 — Replacing a Mainspring in Motor Barrel

With this model it is not necessary to remove the balance in order to get at the mainspring. The winding wheels and click being exposed some prefer to let down the power before taking the movement from the case. This can be done by holding the crown while pressing back the click by means of a screw driver. If the movement is out of the case use the proper



sized bench key as described in the previous lesson to release the power.

Next take out the two screws at G and H figure 114 and remove the two steel discs J and K after which it will appear as in figure 115 in which J represents the ratchet wheel disc, G the ratchet wheel screw, K the crown wheel disc and H the crown wheel screw.

Lift off the ratchet wheel at L and the crown wheel at M. When you remove the crown wheel at M it will bring with it the crown wheel washer at N. It is not necessary to take off the crown wheel in order to replace a mainspring as the barrel bridge is easily removed with this wheel in place but as this lesson is to familiarize you with this part of the watch it is well to take it down just as I have done in these illustrations.

In figure 116 are these parts as they appear after being removed. L the ratchet wheel, M the crown wheel, and N the crown wheel washer. Notice the hole at O in the crown wheel washer which fits over the screw P on the barrel bridge.

The hole Q in the ratchet wheel is finished square as may be seen in this photograph and fits over the square end of the barrel arbor at R. In figure 115 this can be seen as it appears when assembled.

Sec. 170 — Remove the Barrel Bridge

Loosen and remove the barrel bridge screws at S figure 116, and with a pair of tweezers lift off the barrel bridge to the position shown in figure 117. This leaves the barrel and first wheel at T exposed. The Barrel Bridge at U is turned over in order that you may see how it appears from the lower side.

In section 131 of the last lesson I described and showed the steady pins on the balance cock of the movement used in demonstrating a going barrel. Not only are steady pins used on the balance cock but on any bridge which it is necessary to locate accurately on one of the plates. On the bottom of the barrel bridge in figure 117 are shown the two steady pins at A, which fit into the holes B on the lower plate.

Steady pins should be so fitted in their holes that there is no side play yet must allow the bridge to be released easily when the screws are removed. These requirements are met in the Waltham style of steady pins, which are tapered and fit in holes bored to match the pins. This insures an easy method of separating or assembling the bridges and balance cock.

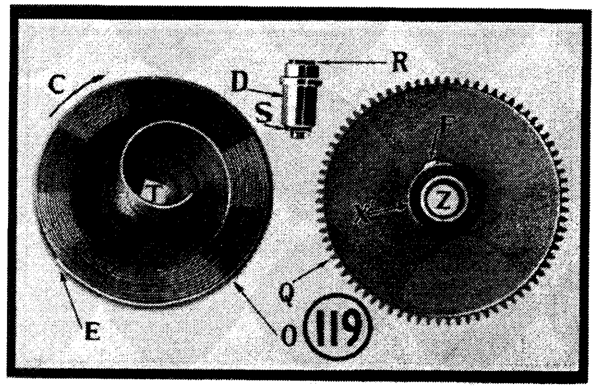
The barrel with the first wheel is easily lifted out as shown in figure 118. It is seen turned over with the steel barrel, V, uppermost. The barrel arbor may be lifted out or it could have been removed when in the position shown in figure 117, by grasping the barrel arbor with a pair of tweezers and lifting straight up.

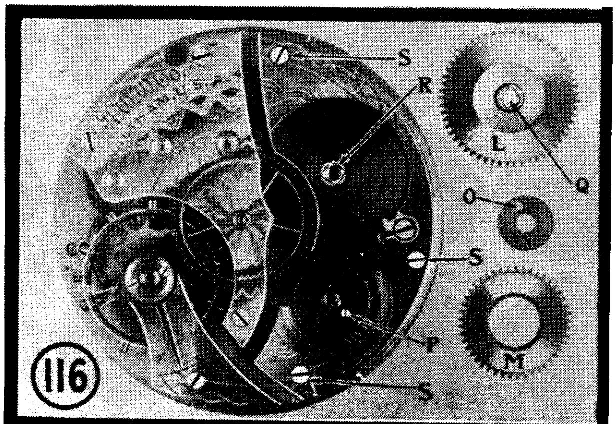
Sec. 171 — Disengage Inner End of Mainspring

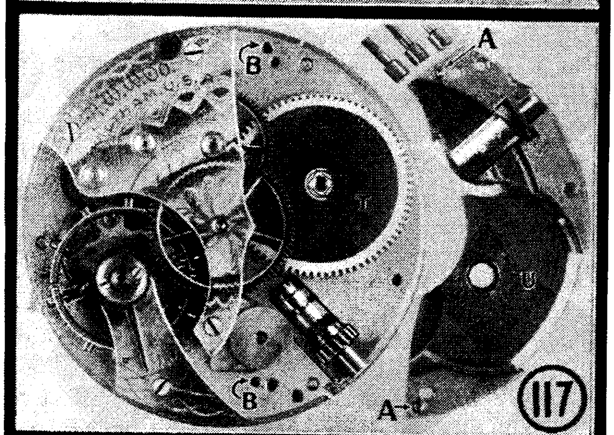
Take hold of the barrel with one hand and the first wheel with the other and disengage the inner end of the mainspring by twisting toward the right.

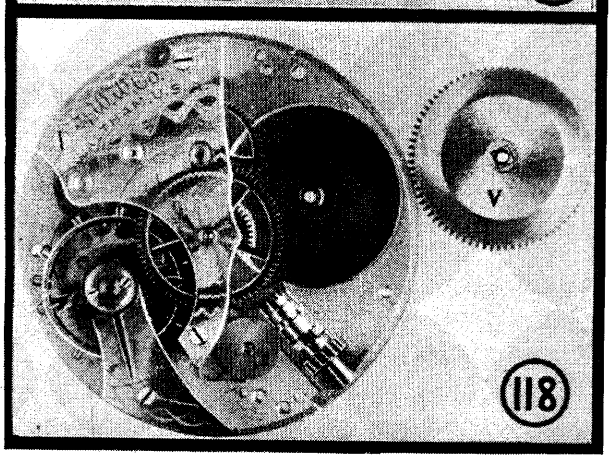
In figure 119 is shown an enlarged view of the barrel at O with the mainspring in place, the barrel arbor at D and the first wheel or main wheel at Q. The mainspring has a hole end that slips over the hook in the barrel at E. As explained before this type of mainspring should be bent to a shorter curve right at the tip in order to keep it from pulling off the hook. This bend can be seen at E.

In the going barrel described in our last lesson, the barrel turned with the wheel and the arbor turned only while the watch was being wound. In this style of barrel the arbor turns while the watch is being wound and the lower square end at S fits into the square hole of the barrel at T causing the barrel to turn with the arbor. That portion D of the arbor fits in the hole in the first wheel at Z and is the axis









upon which the first wheel turns when the watch is running.

The hub at X with its hook for the inner end of the mainspring at F instead of being secured to the barrel arbor is fastened to the first wheel.

Sec. 172 — Ratchet Wheel, Arbor and Barrel, Turn As One Piece

When the ratchet wheel L figure 115 is turned in winding the watch, it turns the arbor, the upper square of the arbor at R figure 116 being held in the square hole in the ratchet wheel at Q figure 116. The arbor extending through and turning on the inside of the first wheel at Z figure 119 also turns the barrel in the direction of the arrow C.

The inner end of the mainspring being hooked to the hub on the first wheel at F is held still as the barrel revolves in winding and the mainspring is wound around the hub at X and the power is applied to the first wheel from this hub.

If the mainspring breaks the recoil is taken through the barrel and ratchet wheel rather than through the first wheel and train, consequently no shock is transmitted through the train to the injury of the smaller parts.

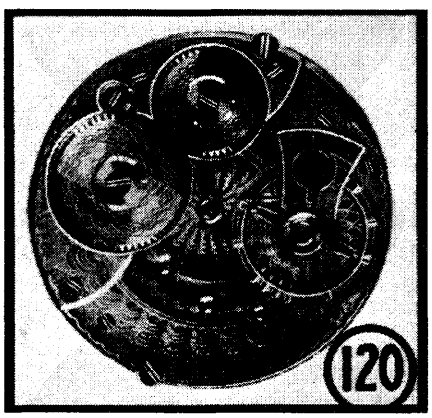
In replacing a mainspring in this model select a barrel in your winder of the proper size to fit this steel barrel and wind in your mainspring, leaving enough of the tip protruding, to hook easily into the watch barrel, and transfer from the winding barrel to the watch barrel. Notice that this mainspring is coiled to the left in the watch barrel.

Shape the inner end to fit closely around the hub on the first wheel, testing it to see that it is hooked, and then oil your mainspring as in the going barrel. Adjust the hole in the first wheel until it is directly over the square hole in the barrel and put a small amount of clock oil on the part D, slip the arbor into position and manipulate by grasping the square at R with a pair of tweezers, until the lower square end slips into the square hole in the barrel and it will appear as shown in figure 118.

Sec. 173 — Assembling This Type.

Assemble these parts by reversing the process of taking down, set the barrel in its position as in figure 117 being careful not to allow the lower square of the arbor at S figure 119 to slip out of the square hole in the barrel at T.

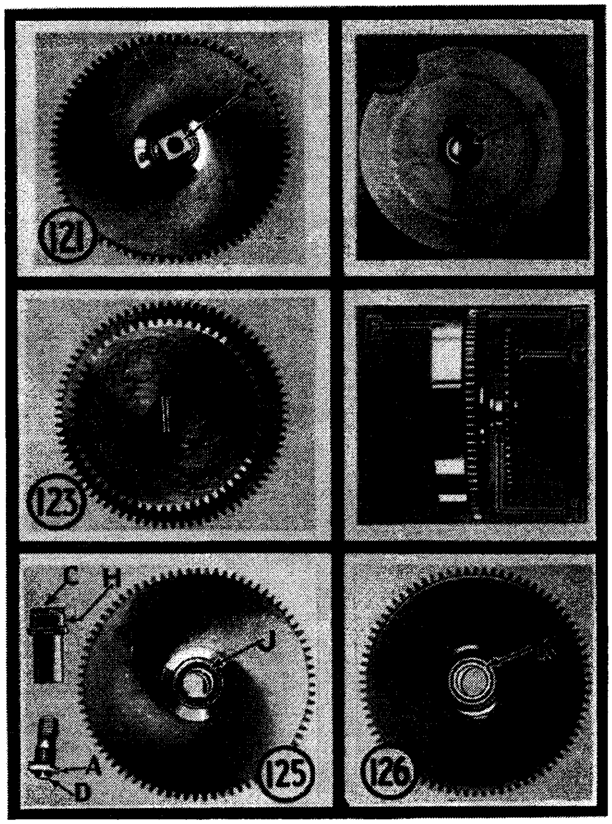
Replace the barrel bridge and set the screws as in figure 116. With your oiler place a small amount of clock oil where the upper end of the barrel arbor comes through the barrel bridge and also a like amount where the lower end or pivot of the arbor comes through the bottom plate. Set the crown wheel in place. Place a little clock oil in the shoulder of the crown wheel where the crown wheel washer came in contact with it. Now set the crown wheel washer in its place with the hole O figure 116 directly over the screw P. Replace the ratchet wheel with the square hole fitted on the square of the winding arbor and the click on the outside of the wheel as in figure 115. Place the steel discs in the proper positions and set the screws holding them in place and your movement should appear as in figure 114.



Sec. 174 — Jeweled Barrel

The addition of jewels for bearings in watches in place of the metal bushings which were formerly used has been a great factor in reducing the friction found in the train and escapement. Many of the uninitiated get the idea that the jewels are placed in a watch merely for their intrinsic and ornamental value, the same as diamonds in a watch case.

This is not the reason but rather on account of their extreme hardness and the fine polish that can be given to them are they used as



bearings to reduce the friction of the pivots. The hole jewels used for this purpose in the train are made of hard stone such as ruby, sapphire or garnet. Each has a hole drilled through it, this hole being highly polished and of a diameter to fit the pivot for which it is intended.

As jewels became popular in watches, customers were inclined to judge the value of a watch by the number of jewels that it contained. Some manufacturers endeavoring to get as many jewels as possible in their watches placed jewels at each end of the barrel arbor, these jewels being set in the upper and lower plates. If you will refer to section 137 in lesson 5 you can see that the only time such jewels would reduce friction would be in winding the watch because the barrel arbor in the type of barrel then in use, that is the going barrel, turns only when the watch is being wound.

However, with the introduction of the motor barrel it became possible to use jewels that would actually reduce the friction on these heavier parts when the watch was running.

Sec. 175 — Waltham Jeweled Barrel

In figure 120 is shown a Waltham movement in which is found a barrel much on the order of the one I have been describing in previous sections of this lesson. This barrel however is jeweled but may be removed from the movement by taking off the ratchet wheel and barrel bridge the same as with the other one.

Figure 121 shows the top of this jeweled barrel and figure 122 the lower side. At A in figure 122 is a shoulder or flange on the lower end of the arbor which holds the steel barrel B in place.

The arbor in this jeweled barrel consists of two parts as shown in figure 125, the upper part with its square at C being the same end that is shown at C in figure 121 and the lower part with the pivot D and the shoulder at A is the part that shows in figure 122.

In order to take this barrel apart it is necessary to unscrew these two parts of the arbor which is done by placing the ratchet wheel on the square end holding it there with the ratchet wheel screw as shown in figure 123. Figure 124 is a side view of this assembly with the ratchet wheel and ratchet wheel screw in place, in which E represents the barrel, F the first wheel and G the ratchet wheel, while the arbor may be seen extending out of the first wheel at H. This corresponds to the part H of the arbor shown in figure 125.

Grasp the barrel part E in one hand and the ratchet wheel G in the other and twist to the left, just as you would in taking off the screw bezel of a watch case. When you do this the upper portion of the barrel arbor may be removed with the ratchet wheel while the lower part will come out of the barrel section.

The jewels are set in the main wheel, one of them being in the upper part as indicated by the arrow at J figure 125, and the other one in the lower part of the hub as shown at K in figure 126.

In replacing a mainspring we go through the same operation that we did in replacing one in the motor barrel shown in figure 119.

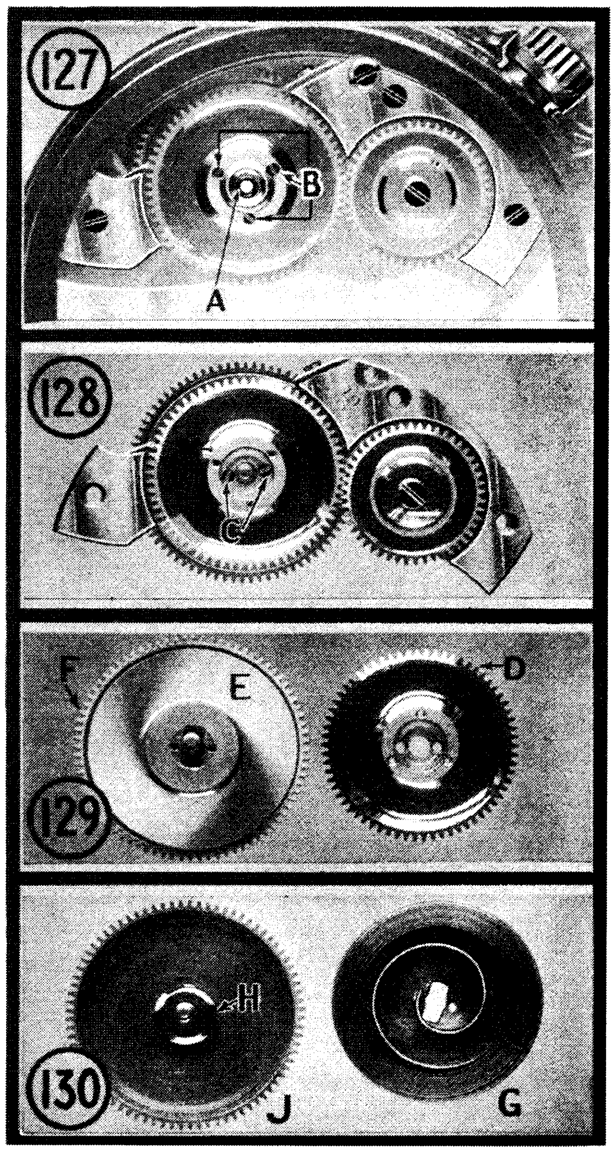
Sec. 176 — Howard Barrel with Jewels

In the Howard Watch, the winding parts of which are shown in figure 127, the jeweling of the barrel is treated in a different way.

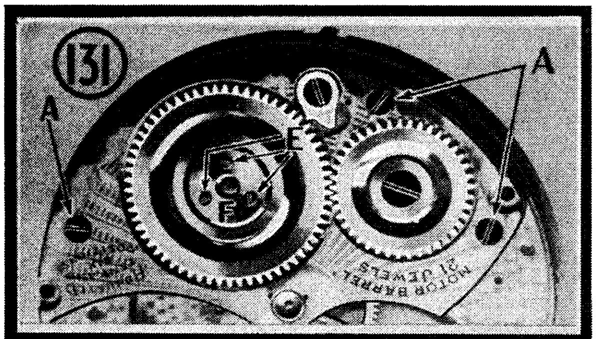
The jewel at A is in the setting held in a recess in the ratchet wheel by means of the three screws at B. Removing these three screws and lifting out the jewel in its setting, the ratchet wheel appears as in figure 128. In this photograph I have shown this assembly with the barrel bridge removed from the plate in order to avoid confusion.

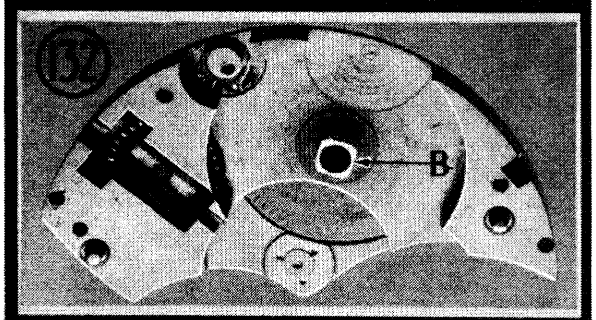
The ratchet wheel is secured to the steel barrel by means of the two screws shown at C in figure 128. By removing these two screws you are able to lift off the ratchet wheel and separate the barrel and first wheel from the barrel bridge as in figure 129, where D is the ratchet wheel, E the barrel and F the first wheel of the watch. After releasing the inside end of the mainspring from the arbor which is connected with the first wheel F, the barrel can be lifted out as shown in figure 130 where the barrel with its mainspring is seen at G and the first wheel at J.

The arbor, first wheel and the hub H act as one piece and when the watch is being wound the ratchet wheel and barrel rotate much the same as the Waltham Jeweled Barrel described in the previous section.



In this type the effect of having the first wheel running in jeweled bearings is reached by a different plan, the ends or pivots of the arbor running in the jewels, the upper one in a setting held in the ratchet wheel — A figure 127 — the lower jewel in the lower or pillar





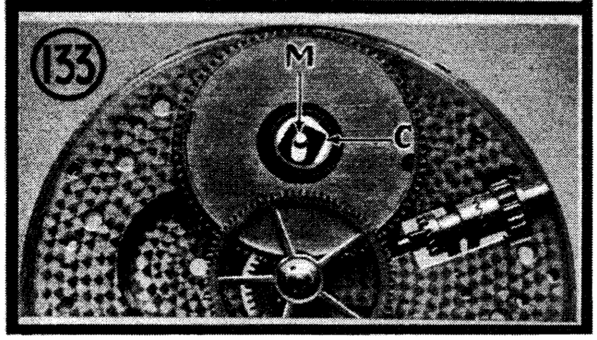


plate of the movement. The jeweled bearings being placed at the extreme ends of the barrel arbor permit the use of smaller pivots, thus reducing the friction to a minimum. This advantage of smaller pivots in the jewels is also found in the Illinois and Hamilton types described in the next two sections.

Sec. 177 — Illinois Barrel

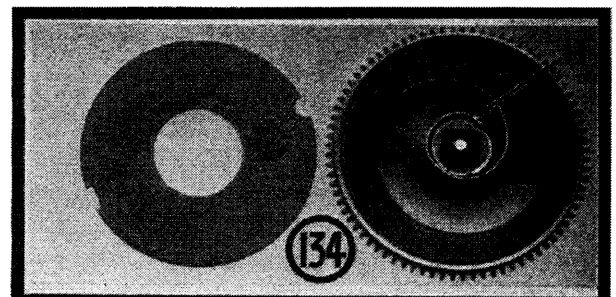
In figure 131 is shown the barrel bridge of a 16 size Illinois movement in its position on the lower plate, together with the ratchet and crown wheel.

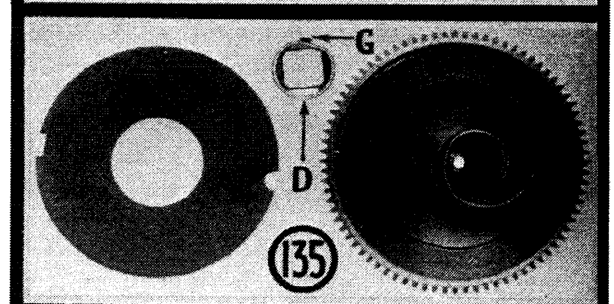
This type of Illinois barrel is different from the other models shown in that it is not necessary to take apart the ratchet unit in order to get at the barrel. Remove the three bridge screws shown at A, and it is possible to lift the barrel bridge and with it the ratchet unit without disturbing the barrel.

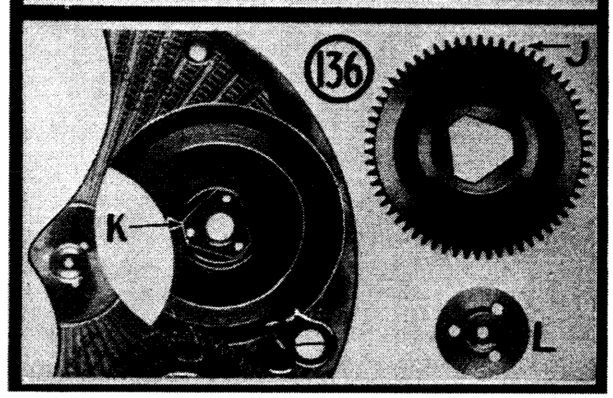
Figure 132 is this assembly on the barrel bridge after it has been lifted off the bottom plate and turned over in order to show it from the other side. Figure 133 shows the way the barrel appears after lifting off the bridge. The square on the ratchet hub at B, figure 132, fits into the square hole of the snailed hub at C figure 133.

In figure 134 is shown the barrel with the cap or barrel cover removed and again in figure 135 the barrel and cap with the snailed hub taken out and shown at D. This hub carries the hook at G on which the inner end of the mainspring catches. See H in figure 134.

Only when you want to make a thorough cleaning of the watch is it necessary to take







apart the ratchet unit and to do this remove the three screws shown at E in figure 131, lift out the cap F and remove the ratchet wheel. The parts are shown in figure 136 where J represents the ratchet wheel with the triangular shaped opening which fits over the tri-squared top of the ratchet hub at K. At L is shown the lower side of the ratchet cap. This cap is made of nickel and the bearing for the upper end of the barrel staff or arbor at M figure 133 is in the cap. In the 23 jeweled movement this cap is fitted with a jewel for the barrel staff bearing. In cleaning this unit it is necessary to clean each part individually and re-oil as you assemble it.

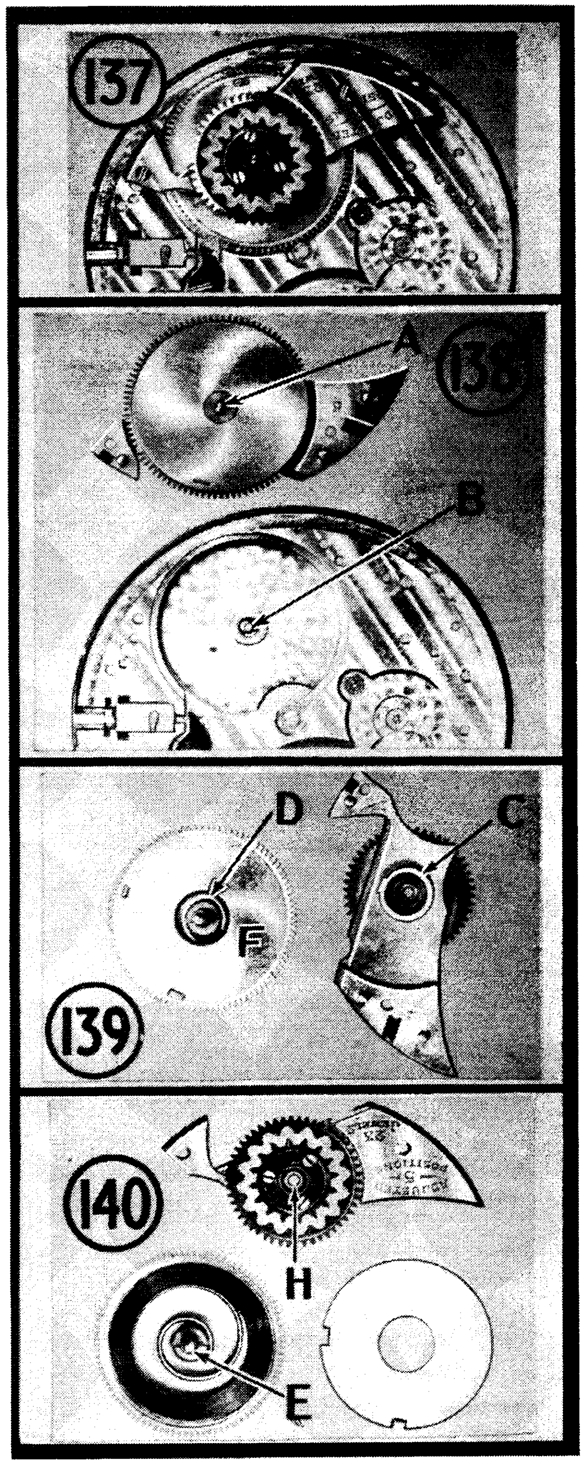
In replacing the barrel bridge with ratchet unit attached as shown in figure 132 and with the barrel in its place on the lower plate as in figure 133, come down from the top with the barrel bridge with the square at B over the motor barrel staff at M and gently press on the barrel bridge. See that your center wheel and pinion is in place and with your tweezers revolve the ratchet wheel and the parts should fall together easily. Place the barrel bridge screws in place, tighten down and your assembly is complete.

Sec. 178 — Hamilton Barrel with Jewels

The barrel from a 12 size, 23 jeweled Hamilton watch shown in figure 137, like the Illinois, may be removed without taking the ratchet unit apart. Loosening the barrel bridge from the plate and turning it over as in figure 138 gives an opportunity to view the lower part of the barrel and the pivot at A which fits in the lower jewel set in the plate at B. By manipulating the barrel and unhooking the inner coil of the mainspring from the hub it is possible to separate the parts as shown in figure 139 in which C is the hub, D the inner coil of the mainspring and F the cap of the barrel. In order to oil the barrel bridge for ratchet wheel and hub or when cleaning the watch, it is necessary to disassemble these parts and this is accomplished by grasping the barrel bridge and ratchet wheel in the left hand and with a pair of brass lined pliers grip the hub (C figure 139) and turn toward you.

Figure 140 shows the bridge with the upper jewel in its place in the ratchet unit, also the cap removed from the barrel showing the position of the coils of the mainspring. E is the upper pivot of the barrel arbor which fits in the jewel at H.

Right at this time you may not have the opportunity of working upon these different styles of motor and jeweled barrels but as they come in to you for repairs, it will be



possible to take them down without trouble if you follow the instructions found in this lesson.

It is an easy matter to handle them providing you know how they are assembled but difficult to study out the proper steps in taking apart and re-assembling without such knowledge.

Sec. 179 — Earning While Learning

Having mastered this and the preceding lessons, you may feel inclined to realize some financial returns on your knowledge thus acquired. This, of course, depends upon your ability, previous experience, and the circumstances under which you work. Some states require you to be a registered watchmaker before you enter the field of watchmaking. In others, you can do work if you are an apprentice under the supervision of a watchmaker who is registered. (The laws vary in license states.) In most states, watch repairing, like many other fields, is open to the individual's talent and does not require a license.

This does not imply that an incompetent workman can succeed. Your best chance for success rests upon your ability to do expert watch repairing and to give the public its money's worth.

Because you have satisfactorily progressed with your lessons to this point, it does not follow that you now are qualified to handle all watch repair work. Trying to do all kinds of repair at this time may easily lead to trouble and dissatisfied customers. It is better to wait until you are further trained to make general repairs.

Remember, the person who carries a watch wants the same time keeping qualities it had when it came from the factory. Most of all, he wants reliable service at a fair price rather than inferior work at cut rates. Be fair to your customer and to yourself. If you are not able to make repairs for people, however much you would like to, explain your reasons to them. You won't hurt their feelings but you might hurt their watch.

If you are in a position to accept minor repairs, do not attempt anything with which you are not familiar.

Sec. 180 — A Good Rule to Follow

A rule that has helped many watchmakers toward success is not to make five and ten cent adjustments on watches. Moving the regulator, tightening a screw, or similar minor adjustments, which take only a moment's time, should be considered opportunities to establish "good will." Doing small favors like these make people look upon you as a friend and influences them into being future customers.

It takes practice on many types of watches before you will recognize the repairs which are required; therefore, practice on watches—and lots of them—until you acquire the ability to make repairs quickly and efficiently. Build your name as one who is learning to be a Master Watchmaker, tend strictly to your learning, and it won't be too long before you will be entitled to do work and get a proper return for it.

Sec. 181 — Learn the Vocabulary of Your Vocation

Make it a point to become familiar with the proper technical or trade names of the different parts of a watch so that you can talk of them with other members of the trade and make yourself understood. It is no uncommon thing to hear of a "ring" on a watch case when "bow" is meant, "shaft" for "balance staff", "chain drive" for "fusee", "Face" for "Dial" etc.

In these lessons be sure you know the proper pronunciation of the words used. Do not pronounce bow as you would the bow of a ship but rather as you would in bow and arrow. In this new vocabulary which you are learning, make use of your dictionary. Look up the pronunciation of each new word and then memorize it. Make it a habit to talk about your work with your friends and members of your family and in your conversation use these new words. See if they know the correct names used in describing parts of a watch but do not go beyond your own depth! Keep on the safe side and discuss only that with which you are thoroughly familiar. In other words, don't discuss Escapements while you are still studying Mainsprings in Watches.

Looking Forward

In the lessons so far it has been taken for granted that the mainspring in each practice watch was of correct dimensions for that particular movement but in the next lesson you will be taught the methods of selecting mainsprings and also shown some interesting experiments relating to the proper length required to get the most service from them.

Your lesson will include several charts showing the Dennison and Metric measurements along with an illustration of each tip on 135 mainsprings. These charts will help you select mainsprings for American watches. For Swiss and other American mainsprings not listed, use a material catalog.

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JOB SHEETS

UNIT	II
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Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W6-J1

MAINSPRINGS: Waltham Motor Barrel

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench key

PROCEDURE	REFERENCE
HOW TO REMOVE AND REPLACE MAINSPRING IN WALTHAM MOTOR BARREL	
1. Let down the power either before or after removing the movement from the case.	Sec. 169
2. Remove the ratchet wheel.	
3. Remove the barrel bridge.	Sec. 170
4. Lift out barrel with first wheel and arbor.	
5. Remove barrel arbor.	Sec. 171
6. Disengage the inner end of mainspring from hub on first wheel and separate the first wheel from the barrel.	
7. Remove the mainspring.	
8. Select new mainspring if needed.	
9. Insert mainspring in the barrel and oil.	
10. Place first wheel on barrel engaging the hub with the mainspring.	Sec. 173
11. Replace arbor and oil.	
12. Put barrel assembly in the movement.	
13. Replace barrel bridge and ratchet wheel.	
14. Check winding.	

NOTE: When installing a new spring it is adviseable to form the outer end of the spring to conform with the curvature of the barrel so it will engage with the hook and not slip when wound.

UNIT	II
LESSON	6

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W6-J2

MAINSPRINGS: Waltham Jeweled Barrel

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench keys

PROCEDURE | REFERENCE

HOW TO REMOVE AND REPLACE MAINSPRING IN WALTHAM JEWELED BARREL — Sec. 175

1. Let down the power either before or after removing the movement from the case.
2. Remove the ratchet wheel.
3. Remove the barrel bridge.
4. Lift out barrel with first wheel and arbor.
5. Replace ratchet wheel and screw.
6. Unscrew the two piece arbor.
7. Disengage the inner end of the mainspring from the hub on first wheel and separate the first wheel from the barrel.
8. Remove the mainspring.
9. Select new mainspring, if needed.
10. Insert new mainspring in the barrel and oil.
11. Place first wheel on barrel, engaging the hub with the mainspring.
12. Replace the two piece arbor and tighten.
13. Remove the ratchet wheel.
14. Put barrel assembly in the movement.
15. Replace barrel bridge.
16. Replace ratchet wheel.
17. Check winding.

MAINSPRINGS: Howard Jeweled Barrel

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench keys

PROCEDURE	REFERENCE
HOW TO REMOVE AND REPLACE MAINSPRING IN HOWARD JEWELED BARREL	Sec. 176
1. Let down the power either before or after removing the movement from the case.	
2. Remove screws and jewel setting in ratchet wheel.	Fig. 127
3. Remove ratchet wheel.	Fig. 128
4. Remove barrel bridge.	
5. Unhook mainspring and separate first wheel from barrel.	Fig. 130
6. Remove mainspring.	
7. Select new mainspring if needed.	
8. Insert mainspring in barrel and oil.	
9. Place first wheel on barrel engaging inner end of mainspring with hub.	
10. Put barrel assembly in movement.	
11. Replace barrel bridge.	
12. Replace ratchet wheel.	
13. Replace jewel setting.	
14. Check winding.	

UNIT	II
LESSON	6

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W6-J4

MAINSPRINGS: Illinois Motor Barrel

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench keys

PROCEDURE | REFERENCE

HOW TO REMOVE AND REPLACE MAINSPRING IN ILLINOIS MOTOR BARREL

1. Let down the power either before or after removing the movement from the case.
2. Remove the barrel bridge without disturbing the ratchet wheel. Sec. 177
3. Lift out the barrel.
4. Remove the cap from the barrel.
5. Remove the mainspring.
6. Select a new spring if needed.
7. Insert spring in barrel and oil.
8. Replace barrel cap.
9. Put barrel in movement.
10. Replace barrel bridge and ratchet wheel.
11. Check winding.

MAINSPRINGS: Hamilton Jeweled Barrel

TOOLS, EQUIPMENT AND SUPPLIES:

Screwdrivers - tweezers - movement holder - mainspring winder - oil - oiler - bench keys

PROCEDURE	REFERENCE
HOW TO REMOVE AND REPLACE MAINSPRING IN HAMILTON JEWELED BARREL	Sec. 178
1. Let down power either before or after removing the movement from the case.	
2. Remove the barrel bridge. (Barrel is attached and will come out with bridge.)	Fig. 137-138
3. Unhook inner end of mainspring and lift off barrel.	Fig. 139
4. Remove barrel cap.	
5. Remove the mainspring.	
6. Select new mainspring if needed.	
7. Insert mainspring in barrel and oil.	
8. Replace cap.	
9. Engage inner end of spring, assemble barrel, hub and ratchet assembly.	
10. Replace barrel and bridge.	
11. Check winding.	

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 7

Selecting the Mainspring

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Sections 185 - 200

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

A Modern, Complete, Practical Course

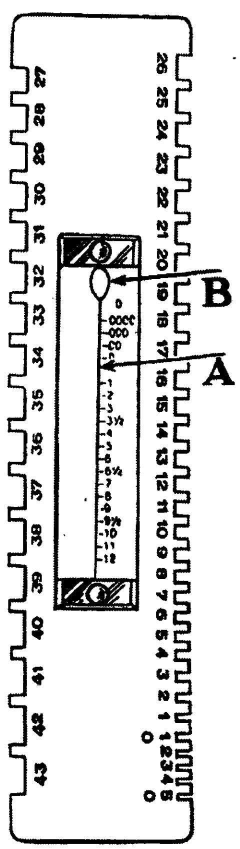
CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 7
Sections
185 to 200

Lesson 7 — Selecting the Mainspring

Section 185 IN the preceding lessons you have learned the importance of replacing set mainsprings, the necessity of using good oil and how it is applied, the more popular forms of tips made by manufacturers, and certain tests that are used in locating errors in winding caused by either broken or improperly attached mainsprings. You have been shown the proper methods of placing mainsprings in watches without distorting them and have been impressed with the importance of using a good winder in your work.



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All these things are essential but your knowledge has little value unless applied to a mainspring that is suited to the watch you are working upon. Not always will you find the old one of proper size and you must be capable of judging by its appearance in the barrel whether it is of standard dimensions and if wrong, to select one that is right. Should a broken mainspring as it lies in the barrel, appear to be of correct size it is best to replace it with one of the same dimensions as to width, thickness and length, and with the proper tip.

Sec. 186 Dennison Type of Gauge

Your first step then is the selection of a good mainspring gauge. The one illustrated in figure 145 has been standard for a long time, but in recent years mainsprings are being gauged more and more by means of the metric system with its measures of greater accuracy.

Sec. 187 — Width

This gauge in figure 145 consists of a plate with notches of varying widths around the edge. In gauging for width, the mainspring is tried in these until one is found in which the flat side of the mainspring will just fit. If it will enter the notch marked 18 when held flat against the gauge, but will not enter 17 we consider the mainspring 18 wide by this system

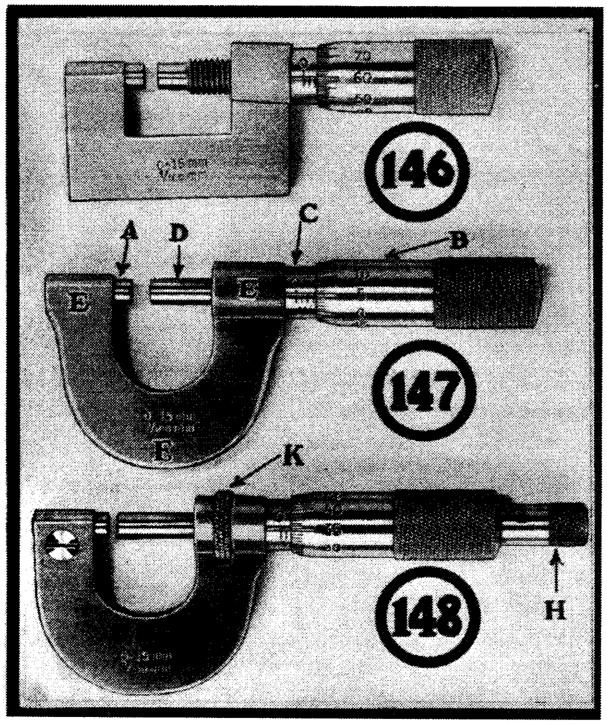
Sec. 188 — Strength

The thickness or strength of a mainspring is shown by the tapered slot at A. Push the mainspring, tip end first, through the hole at B, and lightly press down in the slot until it stops and note what figure is opposite the lower edge. This figure will give you the strength.

In listing dimensions from this gauge the width and strength are often shown with an x between as follows: 19x5 meaning that the mainspring is 19 wide, by 5 strength.

This type of gauge is not always accurate. The difference between each succeeding notch is approximately one tenth of a millimeter, number 1 being one millimeter wide, number 2 one and one tenth millimeters, number 3 one and two tenths millimeters (1.2mm), number 11, two millimeters — number 21, three millimeters, etc. In some watches mainsprings are used with a width of 10½, 11¾ or 19½ according to this method, but with this gauge there is no way of measuring such widths accurately.

The slot for measuring the thickness becomes worn and even on new gauges there often will be found a variation, if comparisons are made between given positions on the scales. Again the numbers on the slot are confusing in that the larger the number the smaller the actual measurement, number 5 on the thickness gauge measuring about .18 mm while number 10 is equivalent to .11 mm.



Sec. 189 — Gauging by the Metric System

The metric system was rendered legal for all transactions in the United States by an Act of Congress, approved July 28, 1866, and is now legal or obligatory in all commercial countries. In many parts of the world including Europe, more metric measurements are in use than any other system.

The metric unit of length for watchmakers is the millimeter, or one thousandth of a meter, and this is being used more and more in the gauging of watch parts and material. One inch equals almost exactly 25.4 millimeters.

The diameters of pivots are gauged in hundredths of a millimeter as are the holes in jewels. The outside diameters of balance jewels and train jewels are gauged in tenths of a millimeter while roller jewels are gauged in hundredths of a millimeter. All fancy watch glasses or crystals are gauged in tenths of a millimeter and many manufacturers of round ones are also gauging their products in tenths of a millimeter.

There are several types of metric gauges that are used for different purposes, such as the pivot gauge divided into hundredths of a millimeter; vernier slide caliper for inside and outside diameters, combined with a depth or shoulder gauge, measuring in tenths of a millimeter; the degree type of gauge, or spring caliper with vernier capable of measuring to 1/100 mm and the finest and most accurate of all, when properly made, the micrometer caliper in hundredths of a millimeter, which can be used in measuring dimensions of staffs, pinions, wheels, pivots, jewels, mainsprings and which should be found in every Master Watchmakers set of tools.

Sec. 190 — The Metric Micrometer Caliper

In figure 147 is shown a popular type of metric micrometer caliper. The spindle D is attached to the thimble B and they turn as one piece, the spindle passing through the sleeve C. The sleeve C is fastened to the frame E and remains as a fixed part of the frame. Part of the spindle is threaded to fit threads inside the sleeve. When the thimble is revolved to the left it causes the spindle to recede from the anvil A and when turned the other way the spindle advances toward the anvil.

The piece to be measured is held between the anvil A and the end of the spindle D. The spindle is then brought against the piece by turning the thimble B. This should only be turned as far as it will go with a light pressure.

Memorize these parts:

A—Anvil

B—Thimble

C—Sleeve

D—Spindle

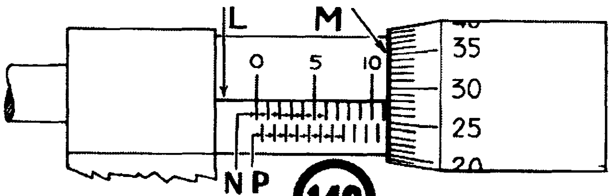
E—Frame

The amount of the opening is indicated by the lines and figures on the thimble and sleeve. The thread on the concealed part of the spindle is of such a pitch that one turn advances the spindle and with it the thimble, one half or 50/100 of a millimeter. The short vertical lines on the sleeve correspond to the pitch of the thread. The upper series of these lines indicated by N touch the horizontal line L as shown in the drawing at figure 149 and indicate the millimeters. The lower short vertical lines at P are half way between the upper lines N and indicate the half millimeters. Every fifth line of the upper series is longer than the rest and numbered, 0, 5, 10 etc. These numbers indicate the number of millimeters when the thimble is opened to this point.

The beveled edge of the thimble at M is marked with 50 divisions, every fifth division being numbered from 0 to 45. Knowing that one whole turn of the thimble moves the spindle lengthwise 50/100 of a millimeter it follows that turning the thimble 1/50 of a complete turn or the distance from one division line to the next on the thimble will move the spindle 1/50 as far or 1/100 of a millimeter.

Sec. 191 — Reading the Micrometer

A little practice will enable you to read your micrometer on any sized opening up to its capacity., Start by turning the spindle until it



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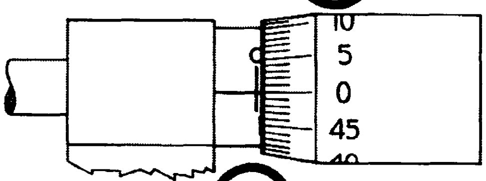

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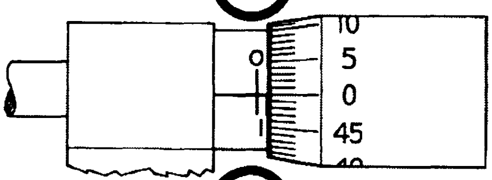

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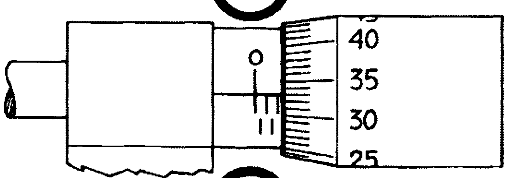

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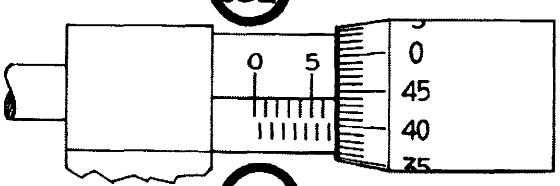

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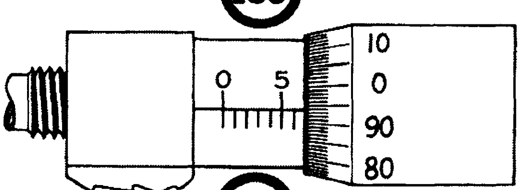


154

is against the anvil. The beveled edge of the thimble then should be even with the zero line on the *sleeve* and the zero line on the *thimble* should coincide with the *horizontal* line L on the sleeve.

Occasionally you may find that the anvil and spindle do not come together on account of there being dust between them. If your lines do not coincide as described above, draw the spindle away from the anvil and insert a clean piece of watch paper, then turn the spindle until the paper is held but can be withdrawn without tearing. After pulling the paper out, without releasing the spindle, no doubt you will find that your caliper registers correctly.

When measuring with a micrometer caliper always bring the anvil and spindle together with a light pressure. By using undue force it is easy to spring the tool and ruin it for accurate measurements. For this reason the beginner will get better results by having his micrometer equipped with a ratchet stop and thus get the same amount of pressure at all times.

Having your micrometer caliper closed to register at 0, open it by giving one full turn of the thimble until the 0 on the thimble again registers on the horizontal line on the sleeve as illustrated at figure 150. Notice that the beveled edge of the thimble now coincides with the first of the lower series of vertical lines on the sleeve, indicating one half or 50/100 of a millimeter usually written .50 mm. (see figure 150). If you turn the thimble two full turns from the anvil until it is even with the first of the upper series of vertical lines counting from the 0 line it indicates one millimeter, written 1 mm. (see figure 151).

When the horizontal line on the sleeve does not coincide with the 0 line on the thimble it is necessary to add the extra hundredths indicated. In figure 152 the thimble is a trifle past the 2 millimeter line and the 33 line on the thimble coincides with the horizontal line on the sleeve this showing exactly two and thirty three hundredths millimeters, written 2.33 mm.

In figure 153 the thimble is drawn out still further. Here it is past the line indicating 6.50 mm and shows .44 on the thimble. Adding 6.50 and .44 gives 6.94 mm.

The pitch of the spindle thread on the micrometer shown in figure 146 is coarser and one turn of the thimble moves the spindle exactly one millimeter instead of one half millimeter as in the other. On this spindle there is but one series of vertical lines, each line being one millimeter apart.

On the thimble there are 100 divisions, each division indicating one one-hundredth of a millimeter. Thus if you back the spindle from the anvil one full turn it will have moved exactly one millimeter. The drawing at figure 154 shows the difference between the two methods of indicating the same measurements. The drawing at 154 shows 6.94 mm by this system and figure 153 shows 6.94 mm by the other system.

Figure 148 shows much the same type of micrometer as figure 147 with the addition of a ratchet stop and lock nut. The ratchet at H will slip when more than a certain amount of pressure is applied on the spindle and removes the danger of springing the tool. The lock nut at K enables you to lock the micrometer in any position.

A satisfactory way to hold the micrometer is shown in figure 155. Here the frame is held against the hand by the second finger leaving the thumb and first finger to manipulate the thimble.

Sec. 192 — Metric Width

In measuring a mainspring to find its width in millimeters the outer coil is held between the frame and anvil as shown in figure 156 and the thimble is turned until the mainspring is held with slight pressure, after which the reading is taken as explained before. The measurement for the metric width is expressed in millimeters and for this particular mainspring it is two and eighty three hundredths millimeters or in decimals, 2.83 mm.

Sec. 193 — Metric Strength

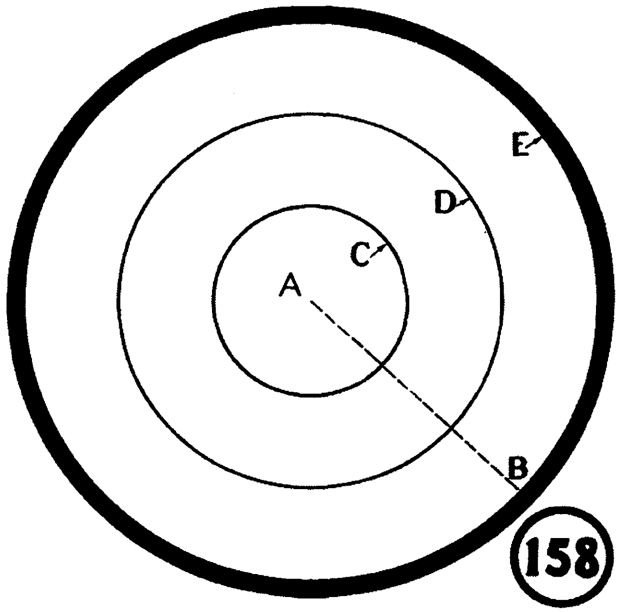
To obtain the strength or thickness of an old mainspring it is sometimes necessary to straighten a portion of it, especially if it is set. Otherwise the curved part lying between the spindle and anvil, will give a higher reading than the actual strength of the mainspring. By holding the spring between the fingers as in figure 157 it is possible to straighten out enough of it to gauge the actual thickness by applying the micrometer caliper to this straight portion.

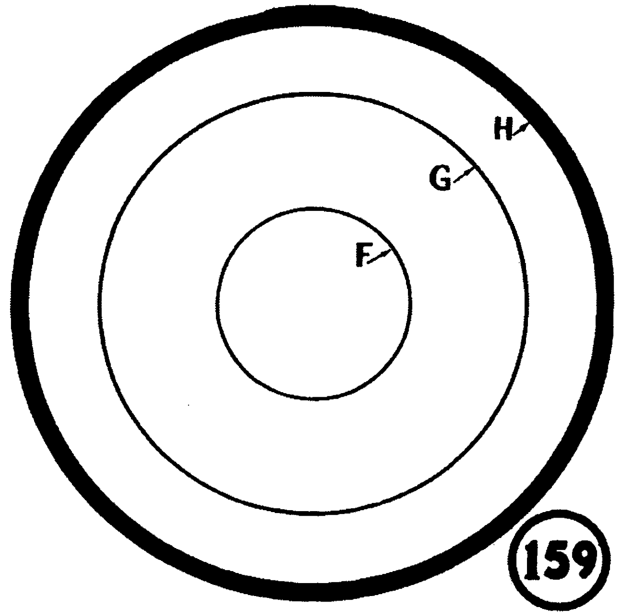
It is seldom necessary to take the measurements on new mainsprings especially for American watches, as in the better grades, each one comes packed in a separate envelope with the Dennison and metric measurements plainly marked on the outside, but you may have occasion to measure new ones for Swiss movements or to check up on American sizes and it is possible to follow this same procedure without injury to the spring.

Sec. 194 — Length

The length of a mainspring determines the number of coils in the barrel. If your mainspring is of correct thickness and length, it will occupy the proper space in the barrel and will have the right number of coils.

The average watch should have 11 or 12 coils in the barrel and these coils should occupy one half the area between the arbor and the outer shell of the barrel. If you will exam-





ine the photograph in figure 91 lesson 5 you will see there are almost 12 coils counting from the tip inward toward the arbor.

Some of the finer R. R. movements are fitted with longer and thinner mainsprings having more coils, yet occupying the proper amount of space in the barrel — one half the area between the arbor and the outer shell — this giving a longer running period on one winding. A very good example of this type is shown in figure 134 from a Bunn Special Railroad movement. This mainspring with nearly 14 coils occupies one half the area between the hub and the outer shell of the barrel and is known as a 60 hour mainspring.

Sec. 195 — A Rule to Remember

One of the rules applying to the mainspring is that in order to obtain the greatest number of turns the length and strength should be such that the occupied part of the barrel outside of the arbor is equal to that of the unoccupied part; in other words a mainspring should occupy one half of the area between the outer diameter of the arbor and the inside shell of the barrel. Some watchmakers apply this rule by dividing the radius into three equal parts, giving the arbor one third, the unoccupied part one third and that part occupied by the mainspring, one third.

This rule applies fairly well as far as the arbor is concerned as you will find it is generally just about one third the inside diameter of the barrel — in the majority of watches being under rather than over this proportion, but the distance from the arbor to the inner shell of the barrel should be divided into two equal areas, when comparing the open space with that of the space occupied by the mainspring, and the area of these two equal spaces are not contained as equal radial measurements.

In figure 158 I have drawn two circles inside an outer circle in order to divide the radius A B into three equal parts. This however does not mean that the total space, enclosed by C is equal to the total space between the circle C and D or that the space between C and D is equal to the space between D and E. As a matter of fact as the diameters increase the areas increase.

In figure 159 the circle F is the same size as C in figure 158 but the circle G divides the space between F and H into two equal *areas*, that is the area of the space between the circles F and G is the same as that of the space between G and H. If the heavy circle H were to represent the shell on the watch barrel and the circle F the diameter of the arbor, a properly fitted mainspring will exactly fill the space between G and H when entirely run down and in like manner occupy the space between F and G when wound tightly around the arbor. You will find that the diameter of the circle G representing the inner coil of the mainspring when run down is almost exactly three fourths the diameter of the circle H representing the inside shell of the barrel.

Keeping this in mind it is an easy matter to tell by the appearance of a mainspring in the barrel whether it is of correct thickness, provided you know how many coils it should have. By knowing what proportion the mainspring should occupy you can figure out its proper strength for any barrel.

In like manner, knowing the strength of a given mainspring it is possible to figure how many coils should be in the barrel to give the best results.

Sec. 196 — To Calculate Strength

Here is a simple rule that will give you the approximate strength of a mainspring with any given number of coils where you have the inside diameter of the barrel and the diameter of the arbor.

(a) Subtract one half the diameter of the arbor from one half the inside diameter of the barrel (AB minus AC figure 158).

(b) Take 38¼ per cent of this difference.

(c) Divide the result by the number of coils desired and this will give proper strength of mainspring to give most turns on the barrel.

Let us take as an example the Hamilton barrel shown in figure 140.

The inside diameter is 15.5 mm.

The diameter of the hub, (F in figure 159) is 5 mm.

Number of coils 12.5

(d) Subtracting one half the diameter of the arbor (2.5 mm.) from one half the inside diameter of the barrel (7.75 mm.) we obtain 5.25 mm.

(e) 38¼ per cent of 5.25 mm. gives 2 mm.

(f) Dividing 2 mm by 12.5 (number of coils) gives .16 mm as the proper strength for a mainspring for this movement.

Sec. 197 — To Calculate Number of Coils

Given the strength of a mainspring to find number of coils.

(g) Divide 38¼% of space by strength of spring.

In the above barrel if the mainspring we wish to put in the barrel is strength .16 mm. Divide 2 mm (e in sec 196) by .16 mm equals 12½, number of coils for best results.

Sec. 198 — Some Interesting Experiments

The majority of watchmakers have their own ideas as to the amount of space that a mainspring should occupy in a barrel but few know the correct method of determining this space and what the proper proportions are. You will find that a great many go on that idea of one third of the space on the radius as explained in section 195.

The watchmaker of an investigating turn of mind will get some rather interesting results if he will go to the trouble of making a few experiments on an ordinary grade of watch. He will find that some factories provide their watches with mainsprings that are too long. In order to overcome friction and poor adjustment on these movements it is necessary to provide springs of goodly strength and in doing this they apply a stronger spring of the same length as the weaker springs on higher grade movements.

In my work of instructing I have made various experiments and have shown where more turns of the barrel often could have been secured by shortening the mainspring. At A figure 160 is a barrel from a 16 size 7 jeweled American watch with a 16 size mainspring as recommended by the manufacturer of the movement. This mainspring is .20 mm thick and would be accepted as the proper size by a great many watchmakers.

The unoccupied space on the radius of the barrel is about the same as that covered by the mainspring and as I have said before, this is the rule that many watchmakers use in determining whether the mainspring is of correct strength and number of coils.

Experiment A.

If we compare this portion however to the drawing in figure 159 we find that the mainspring is occupying altogether too much of the barrel. In experimenting with this mainspring barrel in the movement, I found that by winding it up as far as it would go and then allowing it to run down, the minute hand made 36 2/5 revolutions or if we could imagine that the watch would run as long as this with its escapement in place, 36 hours and 24 minutes.

Experiment B.

I next took this mainspring out of the barrel, broke off 33 millimeters from the outside end, put on a new tip and wound it into the barrel as shown at B. Replacing in the movement and winding up as before, it ran down with 37 2/3 turns of the minute hand. Here you see the mainspring was 33 millimeters shorter and yet ran an hour and 16 minutes longer.

Experiment C.

Again I removed the mainspring and broke off 29 millimeters from the end and replaced in the barrel as shown at C. Upon winding this mainspring and letting it run down it showed turns amounting to a trifle more than 38 hours.

Experiment D.

Next I broke off 25 millimeters more and the mainspring appeared as in D. When this was wound up and allowed to run down it showed 38 hours and 14 minutes, a gain of nearly two hours over the full length mainspring shown at A.

If you will examine the proportions shown in D you will find that they approach very nearly our ideal shown in the drawing in figure 159.

I continued breaking off portions of the mainspring and testing them with the train in the movement with the following results:

Experiment E.

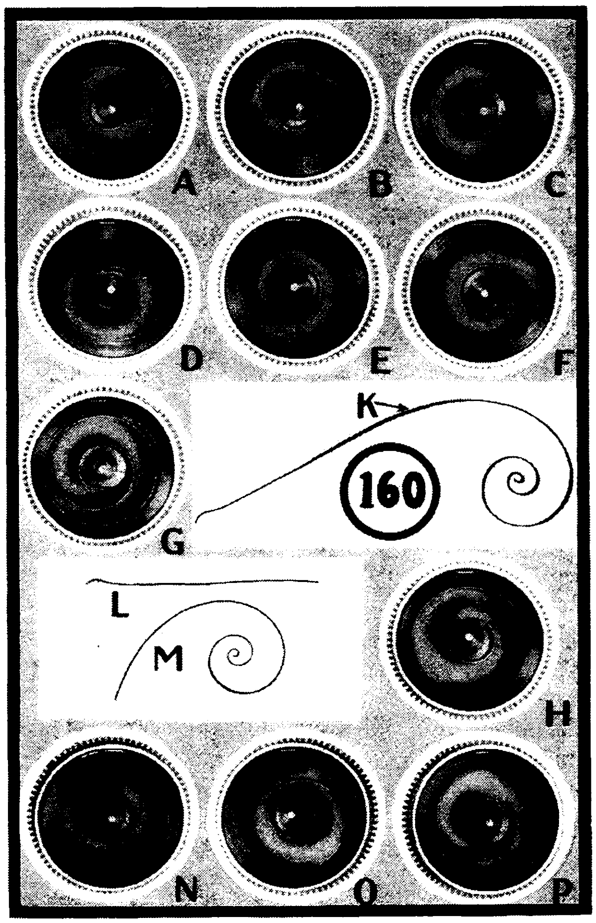
The portion of mainspring shown at E, 25 millimeters shorter than D, ran 37 hours and 58 minutes.

Experiment F.

F. 25 millimeters shorter than E ran nearly the same as E, 37 hours and 52 minutes.

Experiment G.

Finally I broke off 50 millimeters more making the mainspring at G 50 millimeters shorter than F yet it ran down showing 36 hours and 42 minutes.



Comparing figure A with figure G you should appreciate the fact that having a longer mainspring does not always make the watch run a greater length of time. Here in figure A we have the full length mainspring which gives turns amounting to 36 hours and 24 minutes. At figure G the same mainspring after breaking off a large portion and then having been wound up so many times that it began to show the effects on the inner coil, which is set, gives more turns than in A.

Experiment H.

Taking another new mainspring of the same make and the same strength as the one used in experiment A, I broke it off at the point K, thus dividing it into two parts as shown at L and M, the portion L being about 180 mm. or a trifle over seven inches long. I then placed a tip on the end of portion M and wound it into the barrel as shown at H. Placing this shorter mainspring in the movement and winding it up completely I found that it made turns equivalent to 37 hours and 22 minutes before it was completely run down.

Here again, is demonstrated the paradox of making a mainspring give more turns to the barrel by taking off a generous portion. It would appear as though much of the part L of this mainspring was of little value in the watch as we get better results by using the part M alone. Comparing the results of this short mainspring with the complete mainspring used in the barrel at A, we find that this short one ran 58 minutes longer than when using the entire spring.

If we substitute a weaker mainspring of about the same length, we may expect a greater number of turns as a result of winding it up and letting it run down. What we gain in turns however, we lose in power. Thus it is that the finer the workmanship on a movement in a given size the less the strength needed in the mainspring to give a proper motion to the balance.

Experiment N.

In this same movement I placed a mainspring with a thickness of .16 mm which filled the barrel as shown at N figure 160. This spring you will observe has only a fraction more than the number of coils in the stronger spring shown at A but comes nearer to occupying the ideal space in the barrel.

On account of the better proportions of space and mainsprings we should expect this to give more turns on the barrel than any of the previous mainsprings.

The result of winding and allowing it to run down gave a number of turns equal to 51½ hours.

Experiment O.

Breaking off 31 mm, which gave approximately one coil less as shown in O, gave the number of turns equal to 53⅓ hours, a gain of nearly two hours.

Another test was then tried with No. 0 by placing the balance and escapement in the movement, winding the mainspring up to its limit and allowing the watch to run in one position until it stopped which it did in 51 hours and 58 minutes, this lacking about 1⅓ hours of running as long as it did when there was no resistance to the train.

Experiment P.

As a further test I broke off 24 mm more as shown in P and allowed it to run down which it did with a number of turns equal to 52½ hours as compared with 53⅓ hours with O.

Here it is evident that I have broken off a trifle too much, and the mainspring occupies less than one half the actual area between the arbor and inner rim of the barrel, and does not give as much power as with the length shown at O.

You should now see the fallacy of thinking that because a watch does not run as long as should be expected, it has a mainspring that is too short. There are probably more mainsprings by a large majority of a greater length than is necessary than there are mainsprings too short, being carried in watches today.

From these last three experiments you might get the idea that all that is necessary is to keep reducing the strength of the mainspring and the watch will give better service but this will not prove true. The power needed is determined to a great extent upon the condition of the movement. Thus it is that a 21 jeweled grade uses a weaker spring than does a 7 or 15 jeweled movement made by the same manufacturer. Not only do the extra jewels reduce the friction in the train but in the higher grade movements the escapements are matched closer.

It is not customary to break off the end of a mainspring in order to get the correct length for American watches. As a general rule you will find that some manufacturers have a tendency, especially in the lower grades, to use springs of too great a length, but it will hardly pay for you to change the length of every one you put in.

The better way is to put each one of your repair jobs in such good condition that a weaker mainspring will make the watch motion properly.

Sec. 199 — Choosing a Mainspring for An American Watch

Before taking any mainspring from its barrel examine carefully to see that it occupies the proper space, has the correct number of coils and that the upper edge of the outside coil comes a trifle below the shoulder in the barrel where the cap snaps in place, this showing the proper width.

Remove the mainspring and gauge it for width and strength. Notice the type of tip and then from the mainspring chart you should be able to select the proper mainspring for that movement.

On the following pages you will find descriptive charts of mainsprings for eleven different American made Watches. Some of the factories making these movements have gone out of business but as long as these watches continue to be brought in for repairs it is necessary to list mainsprings to fit them even as it is necessary to list those for discontinued models made by the more successful factories.

In these charts the various types of tips are illustrated and this will help you in selecting a mainspring to match any particular one. Following the style column is given the company's number, then the size followed by the column giving the description of that particular mainspring or the movement for which it is intended. The next two columns give the Dennison width and strength as found by the gauge shown in figure 145.

The columns designated as Width Metric and Thickness Metric are the ones to be used for those using the metric system of gauging. Under the Width Metric Column are shown the widths of the mainsprings in millimeters and in the next column are shown the Strengths or Thicknesses in Millimeters, usually in hundredths and occasionally in thousandths of a millimeter.

Suppose that a 16 size Hamilton Watch is brought to you and you find it needs a new mainspring. How will you go about selecting a new one? After seeing that it fills the proper proportion of the barrel, remove and measure its width and thickness. You find that it has a T end and measures 2.85 mm. wide and .19 mm. thick. Looking on the chart, under Hamilton, 16 size, you find that number 355 in the first column is the one needed. In like manner you can find the proper spring for any American Watch.

Sec. 200 — Carrying Mainsprings in Stock

Broken mainsprings are among the most common replacements made by the Master Watchmaker and it is of the greatest importance that he shall have a fairly complete assortment on hand in order to give his customers prompt service. It is not necessary that this should consist of a great quantity of each size nor that you carry every number listed on our charts. Generally you will find that certain makes of watches are most popular and your stock of mainsprings should be heaviest on these lines. You can purchase assortments already made up in sizes to suit nearly every purse. By purchasing an assortment you are able to buy at the dozen or gross price which makes quite a saving as compared to the cost when only one mainspring is selected.

The cost of good quality mainsprings is so small compared to the retail price for replacing them in watches, that it does not pay to buy the cheapest quality or job lots. The cheaper mainsprings nearly always will be found of inferior quality and the few cents more profit will hardly make up for the loss of a good customer when such a mainspring "sets" in his watch.

CHART SHOWING WIDTH AND STRENGTH IN MILLIMETERS and EQUIVALENT IN DENNISON NUMBERS

WIDTH		WIDTH		WIDTH		WIDTH		STRENGTH	
M.M.	Denn.	M.M.	Denn.	M.M.	Denn.	M.M.	Denn.	M.M.	Denn.
.50	5/0	1.80	9	3.40	25	5.00	41	.20	3½
.60	4/0	1.90	10	3.50	26	5.10	42	.19	4
.70	3/0	2.00	11	3.60	27	5.20	43	.18	5
.75	2/0½	2.10	12	3.70	28			.17	6
.80	2/0	2.20	13	3.80	29			.16	6½
.85	1/0½	2.30	14	3.90	30	STRENGTH		.15	7
.90	1/0	2.40	15	4.00	31	M.M.	Denn.	.14	8
.95	½0	2.50	16	4.10	32	.29	0000	.13	9
1.00	1	2.60	17	4.20	33	.27	000	.12	9½
1.10	2	2.70	18	4.30	34	.28	00	.11	10
1.20	3	2.80	19	4.40	35	.25	0	.10	11
1.30	4	2.90	20	4.50	36	.24	0½	.09	12
1.40	5	3.00	21	4.60	37	.23	1	.08	13
1.50	6	3.10	22	4.70	38	.22	2	.07	14
1.60	7	3.20	23	4.80	39	.21	3	.06	15
1.70	8	3.30	24	4.90	40			.06	16

Always use a Metric Gauge for measuring mainsprings. Most Dennison gauges are not accurate. After being in use a short time, the thickness gauge becomes spread or worn. If your Dennison gauge does not give the same reading as shown on the above chart when compared with metric measurements, it should not be used.

Accurate gauging of mainsprings can be accomplished only by using a precision gauge calibrated in hundredths of millimeters.

MAINSPRINGS FOR AMERICAN WATCHES

WALTHAM

Our No.	STYLE	Co.'s No.	Size	Description	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
130		2232	8 day	Auto & Desk..	37	1½	4.60	.22	30
100		2202	18	Old Model....	19½	2	2.85	.22	23
101		2203	18	17J	20	2	2.90	.22	21
102		2204	18	Nar'w Bar'l...	16	2	2.50	.22	21
103		2205	18	Wide 7 to 15J.	21	2	3.00	.22	21
104		2222	18	Mod. 1892....	23	5	3.25	.18	25
107		2208	16	Lever Set.....	14	2	2.30	.22	21
108		2218	16	P. S. 7 to 15J.	19	4	2.80	.19	25
106		2227	16	P.S. 17 to 23J	19	5	2.80	.18	25
109		2210	14	Lever Set.....	12	2½	2.10	.21	19
110		2211	14	L. & P. S.....	16	2	2.50	.22	19
112		2224	12	Hook End....	12½	7	2.15	.15	19 1/4
113		2224A	12	Hole End.....	12½	7	2.15	.15	19 1/4
128		2234	12	Colonial A....	4	5½	1.30	.175	19
129		2237	12	Colonial B ...	8	6	1.70	.165	19 1/4
114		2214	10	¾ Plate K. W	14	3	2.30	.21	19
115		2215	6	Lever Set.....	10	2	1.90	.21	16
116		2217	6	L. & P. S.....	10	4	1.90	.19	16
117		2219	6	Steel Bar'l....	12	7	2.10	.15	16
118		2216	1 & 0	S. W	8	6	1.70	.165	16
120		2228	0	Model 1900...	8	9	1.70	.13	15
119		2220	0	Model 1891 ..	6	7	1.50	.15	16
121		2230	0	Model 1907 ..	12	9½	2.06	.12	15
122		2221	00	S.W. & P.S ..	6	7	1.55	.15	14 1/2
123		2226	Jewel Series	6/0 Mod. 1898	6	9½	1.50	.12	13 1/2
124		2235		6/0-Mod. 1912	4	9	1.30	.13	13 1/2
125		2229	10L	Ten Lignes...	6	11	1.50	.10	10 1/4
126		2233	9L	1913 Model...	2	11	1.08	.10	10 1/4
127		2236	7½L	5¼L. Rect...	2	13	1.10	.08	9
131		2238	7¼L	Rectangular...	4	11	1.30	.11	12 1/2
132		2239	6½L	Oval . .	2	12	1.10	.09	

HAMILTON

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
351		15	18	17J	19	3¼	2.85	.205	22
352		15	18	19 to 21J	19	3½	2.85	.20	22
354		232	18	Motor Barrel...	22	5	3.10	.18	25 1/2
353		14	18	Motor Barrel ..	23	5	3.20	.19	25 1/2
355		318	16	17J	19	4	2.85	.19	22
356		317	16	19 to 21J . .	19	5	2.85	.18	22
358		534	16	Motor Barrel...	19	6½	2.75	.16	22
359		1228	12	Motor Barrel..	8	5	1.70	.18	20 1/2
361		1536	0	Lady Ham....	5	7	1.40	.15	14
362		1535	0	Motor Barrel ..	5	7½	1.40	.145	14
363		1721	6/0	17J	4	8½	1.30	.135	11 1/4
364		2321	6/0	17J.	5	9½	1.40	.12	
365		2621	6/0	979 Model......	5	9¾	1.40	.115	
366		2721	18/0	6¾L Oval......	2	12	1.10	.09	

ILLINOIS

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
400		53	18	19 to 23J........	20	3¼	2.90	.202	21 1/2
402		53	18	Up to 17J.......	20	2	2.90	.22	21 1/2
404		365	16	Old Model.......	16	3	2.50	.22	20
406		573	16	N. M. to 17J.....	18	3½	2.70	.205	20 1/2
407		573	16	N. M. 19-23J....	18	5	2.70	.18	20 1/2
405		124	16	N. M., Wide.....	20	4	2.90	.19	20 1/2
409		1759	16	60 Hour.........	21	6½	3.00	.16	27 1/2
408		1952	16	Mot. Bar........	17	6	2.70	.18	22 1/2
410		1236	12	New Model......	11	4	2.00	.19	18 1/2
411		1845	12	Mot. Bar.......	5	5	1.40	.18	18 1/2
412		1953	12	M.B. Thick Model	11	6	2.00	.17	18 1/2
413		171	6	.. . .	9	5	1.80	.18	14
414		981	0	....	8	8	1.70	.14	13
416		1422	6/0	....	3	9	1.20	.13	10 1/2
419		358	12/0	....	3	9½	1.20	.12	
417		2092	18/0	Tongue End....	3	10	1.20	.11	9 3/4

MAINSPRINGS FOR AMERICAN WATCHES

ELGIN

Our No.	STYLE	Co.'s No.	Size	Description	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
221		4457	37	8 Day........	37	0	4.63	.24	29
202		812	18	17 J	20	1½	290	.225	21½
203		812	18	7 to 15J......	20	1	290	.23	21½
201		812	18	21 to 23J......	20	2½	290	.22	21½
200		1956	18	Steel Barrel ...	30	5	390	.18	25½
204		817	16	17 to 21J......	17	4	265	.19	21½
206		817	16	7 to 15J......	17	3½	265	.205	21½
207		2542	16	Steel Barrel....	17	4	264	.19	21
208		1712	12	Steel Barrel....	13¾	4	223	.19	20
209		1720	12	Wide..........	13¾	4	223	.19	20
210		2339	12	Narrow.......	11½	4	205	.19	20
211		2874	12	Thin Model....	7	5	165	.18	20¼
212		824	6	15J...........	10	5	190	.18	17½
214		825	0	Narrow.......	4	7	127	.16	16
215		2097	0	Wide..........	7½	8	165	.14	16½
216		2097	3/0	D. B..........	8	8	165	.135	16½
222		4789	4/0	Legionnaire....	10	10	190	.11	15½
217		2705	5/0	7J...........	4	8½	125	.13	10¾
218		2890	5/0	15J...........	4	10	125	.115	11½
219		2890	6/0	15J...........	4	10	125	.115	11½
220		1957	10/0	15J...........	4	10	125	.115	9¾

HOWARD

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
600		55	18	Old Model... ...	19	3½	2.80	.20	23½
602		328	16	23J. New Model..	18	6	2.70	.17	21½
603		329	16	19J. New Model...	18	5	2.70	.18	21
604		552	12	17-21J. New Model	10	7	1.90	.15	19½
605		553	12	17-21J. New Model	8½	7	1.75	.15	19
606		796	10	Tongue End... ..	6	7	1.50	.15	16

INGERSOLL MODELS

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
654		344	16	Trenton.	15	1½	2.40	.225	17½
650		365	16	Ing. Trenton......	15	3½	2.40	.20	19
651		1365	16	Ing. Reliance.....	11	1	2.00	.23	17½
652		2365	16	Ing. Reliance.....	12	2½	2.10	.21	18½
653		316	12	Ing. Waterbury....	12	7	2.10	.15	19¾
655		6335	6/0	Alden.	7	7	1.60	.15	

SETH THOMAS

Our No.	STYLE	Co.'s No.	Size	Description	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
701		536	18	New Style........	24	4½	3.30	.185	21¼
702		729	18	Cent., wide..	24	2	3.30	.22	20

MAINSPRINGS FOR AMERICAN WATCHES

NEW YORK STANDARD

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
500		2189	18	Reg. Model......	20	1	2.90	.23	20
501		2190	18	New Model......	21	1½	3.00	.23	20
502			16	Excelsior........	14	2½	2.30	.215	22 1/2
505		3196	16	New Model......	16	2	2.50	.22	20 1/2
504		3349	16	Thin Model......	15½	2	2.45	.22	20 1/2
513		1321	16	Crown..........	15½	5	2.45	.18	20
506		4144	12	Model "B"......	10	2	1.90	.22	19
507		4284	12	Model K........	9	3½	1.83	.20	18
514		1322	12	Crown..........	11	5	2.00	.18	19
509		7080	10	Model K........	6	6½	1.50	.16	16 1/4
510			6	Reg. Model......	10	4½	1.90	.185	16 1/2
511		5134	6	New Model......	10	5	1.90	.18	16
512		6133	0	New Model....	6	7	1.50	.15	15
515		1323	000	Crown..........	7	7	1.60	.15	13
516		1324	10/0	Crown..	3	12	1.20	.09	9 1/2

SOUTH BEND

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
550		19528	18	1st and 2nd Model..	21	3¾	2.97	.195	21 1/2
551		217528	16	1st Model.........	17	5	2.59	.18	20 1/2
552		27528	16	2nd Model.........	19	5	2.82	.18	21 3/4
553		55528	12	1st Model.........	11	5½	1.98	.175	19
554		3528	6	1st Model.........	10	4½	1.88	.185	16 1/2
555		22528	0	3rd Model.........	7½	8	1.65	.14	13 1/2

ROCKFORD

Our No.	STYLE	Co.'s No.	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
450		644	18	1888 Model......	20	2	2.90	.22	22
451		822	16	New Model......	18	3½	2.70	.20	20 1/2
452		932	12	New Model......	11	5½	2.00	.172	18 3/4
453		1077	0	1st Model....	8	8	1.70	.14	13 3/4

HAMPDEN

Our No.	STYLE	Co.'s No	Size	DESCRIPTION	Average Dennison Width	Average Dennison Strength	Width Metric mm	Thickness Metric mm	Length Inches
301		1696	18	7 to 15J. ...	20	1	2.90	.23	21 3/4
300		1696	18	17 to 23J........	20	3	2.90	.205	21 3/4
302		2696	16	Model 1890......	20	4	2.90	.19	21 3/4
303		3696	16	¾ Plate Mod....	18	3	2.65	.20	21 1/2
304		3696	16	Bridge Mod......	18	4½	2.65	.185	21
305		4697	16	Pat. Barrel......	18	5	2.65	.18	21
306		5697	16	Pat. Barrel......	18	5	2.70	.18	21 1/2
307		6696	12	7 to 17J........	9	5	1.80	.18	18 1/2
308		12696	12	Paul Revere....	5	5½	1.35	.172	19
309		8696	6	7 to 15J..	8½	6	1.75	.165	16 1/4
310		9696	3/0 5/0	7 to 15J	5½	6½	1.45	.16	13
311		15696	8/0	Mary Jane.... Josephine.....	3½	8	1.23	.14	8 1/4
312		11696	11/0	... .	3	10	1.20	.11	9 1/4
313			5½L	Rectangular..	1	12	1.00	.09	

MAINSPRINGS FOR AMERICAN WATCHES

SIZE	CO.NO.	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	METRIC LENGTH	END	DESCRIPTION
FOR:	**ELGIN**									
8 DAY	4457	75	37	0	29	4.63	.25	737	DB&H	
18	812	76	20	3	21½	2.90	.21	546	DB&H	21 JLS.) 18S FULL PLATE
18	812	77	20	2½	21½	2.90	.215	546	DB&H	15 JLS.) 18S ¾ PLATE WITH
18	812	78	20	2	21½	2.90	.22	546	DB&H	7 JLS.) GOING BARREL
18	812	79	20	1	21½	2.90	.23	546	DB&H	7 JLS.)
18	1956	81	30	6	25½	3.90	.17	648	HOOK	21 JLS.) 18S ¾ PLATE WITH
18	1956	80	30	5	25½	3.90	.18	648	HOOK	19 JLS.) STEEL SAFETY BARRELS
16	6164	125	20	4	24¼	2.93	.19	622	DB&H	GRADES 571 THRU 575 INCLUSIVE
16	817	82	17	4½	21½	2.60	.185	546	DB&H	21 JLS.) ALL 16S MODELS
16	817	83	17	4	21½	2.60	.19	546	DB&H	17-19 JLS.) WITH GOING
16	817	84	17	3¾	21½	2.60	.195	546	DB&H	17-19 JLS.) BARRELS
16	817	85	17	3½	21½	2.60	.20	546	DB&H	7-15 JLS.)
16	2542	86	17	5	21	2.60	.18	533	S.B.	19 JLS.) ALL 16S WITH STEEL
16	2542	87	17	4	21	2.60	.19	533	S.B.	17 JLS.) SAFETY BARRELS
12	1712	88	13	4½	20	2.26	.185	508	S.B.	7-15 JLS.) 2ND & 3RD MODELS
12	1712	89	13	4	20	2.26	.19	508	S.B.	7 JLS.) WITH STEEL BARRELS
12	1720	90	13	4½	20	2.26	.185	508	DB&H	
12	1720	91	13	4	20	2.26	.19	508	DB&H	
12	2339	92	11	4½	20	2.00	.185	508	DB&H	15 JLS.) 2ND & 3RD MODELS
12	2339	93	11	4	20	2.00	.19	508	DB&H	7-15 JLS.) WITH THIN GOING
12	2339	94	11	3¾	20	2.00	.195	508	DB&H	7 JLS.) BARRELS
12	2874	95	7	5	20¼	1.60	.18	514	DB&H	19 JLS.) 4TH MODEL
12	2874	96	7	4½	20¼	1.60	.185	514	DB&H	17-19 JLS.) STREAMLINE AND
12	2874	97	7	4	20¼	1.60	.19	514	DB&H	17 JLS.) CORSICAN
10	5726	127	7½	7	17½	1.65	.15	445	DB&H	17-21 JLS.) 5TH & 6TH MODELS
10	5726	126	7½	6	17½	1.65	.17	445	DB&H	15 JLS.) WITH GOING BARREL
6	824	99	10	6	17½	1.90	.17	445	DB&H	7-15 JLS.) 1ST & 2ND
6	824	98	10	5½	17½	1.90	.175	445	DB&H	7-15 JLS.) MODELS
0	825	100	4	7	16	1.30	.15	406	DB&H	7-15 JLS.) 1ST MODEL
0	825	101	4	6¾	16	1.30	.155	406	DB&H	7-15 JLS.)
3/0&0	2097	102	7½	8	16½	1.65	.14	419	DB&H	7-15 JLS.) 2ND & 3RD MODELS
3/0&0	2097	103	7½	7½	16½	1.65	.145	419	DB&H	7 JLS.) WITH GOING BARRELS
4/0	4789	104	10	10	15¾	1.90	.11	400	DB&H	17 JLS.) 1ST MODELS
4/0	4789	105	10	9½	15¾	1.90	.12	400	DB&H	7-17 JLS.) WITH GOING
4/0	4789	106	10	9	15¾	1.90	.13	400	DB&H	7 JLS.) BARRELS
5/0	2705	107	3½	9	10¾	1.25	.13	273	DB&H	15 JLS.) 1ST MODEL USED
5/0	2705	108	3½	8½	10¾	1.25	.135	273	DB&H	15 JLS.) ONLY IN GRADE 380
6/0	2890	109	3½	11½	11½	1.25	.095	292	DB&H	15 JLS.) 1ST & 2ND
6/0	2890	110	3½	11	11½	1.25	.10	292	DB&H	7-15 JLS.) MODELS
6/0	2890	111	3½	10	11½	1.25	.11	292	DB&H	7-15 JLS.)
6/0	2890	112	3½	9¼	11½	1.25	.125	292	DB&H	7 JLS.)
8/0	5219	121	7½	10	12	1.65	.11	304	DB&H	15-17 JLS.) 1ST MODEL
10/0	1957	115	3½	11	9¾	1.25	.10	248	DB&H	15-17 JLS.) 1ST MODEL
10/0	1957	113	3½	10	9¾	1.25	.11	248	DB&H	7-15 JLS.) 4TH & 5TH MODELS
10/0	1957	114	3½	9¼	9¾	1.25	.125	248	DB&H	7-15 JLS.)
15/0	5550	123	3½	10	12¼	1.27	.11	311	DB&H	17-21 JLS.) 1ST MODEL
20/0	5015	119	2	12	8¼	1.10	.09	210	DB&H	15-17 JLS.) 1ST MODEL, OVAL
21/0	5327	122	3¾	11¾	9½	1.28	.095	241	DB&H	7-15-17 JLS.) 1ST MODEL
21/0	5724	124	3½	12½	7-3/8	1.25	.085	187	DB&H	19 JLS.) 4TH MODEL WITH GOING BARRELS
26/0	5131	120	2	13	8¼	1.10	.08	210	DB&H	7-17 JLS.) 1ST MODEL

10/0 SIZE MAINSPRINGS GENERALLY MAY BE USED FOR 16/0 AND 18/0 SIZES   58 2357-1

						METRIC				
SIZE	CO.NO	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	WIDTH	STR.	LENGTH	END	DESCRIPTION
FOR:	**HAMILTON**									
18	14	225	23	4½	25	3.25	.185	635	HOOK	
18	15	226	19	3½	21	2.80	.20	533	TEE	
18	15	228	19	3¼	21	2.80	.205	533	TEE	
18	15	227	19	3	21	2.80	.215	533	TEE	
18	232	229	22	5	25	3.10	.18	635	MB	
16	534B	252	21	6¾	23½	3.00	.155	597	MB	MODEL 992B
16	317-318	231	19	5	21	2.80	.18	533	TEE	
16	317-318	230	19	4	21	2.80	.19	533	TEE	
16	318	232	19	4½	21	2.80	.195	533	TEE	
16	534	235	19	6¾	22	2.80	.165	559	MB	MODEL 992
16	534	234	19	6½	22	2.80	.16	559	MB	MODEL 992
12	1228-3028	236	8	5½	21¼	1.70	.175	540	MB	REGULAR
12	6021	250	6	6	17¼	1.52	.17	438	DB	MODELS 917,921,923
12	3328	238	5	6½	18½	1.40	.16	470	MB	MODEL 400
0	1536	239	5½	7¾	14	1.45	.145	356	TEE	MODEL 981,983
0	1535	240	5½	7¾	14	1.45	.145	356	MB	MODEL 985
6/0	2621	245	5	9¾	11½	1.40	.115	292	TEE	MODEL 979
6/0	2521	244	5	9½	11½	1.40	.12	292	TEE	MODELS 987A,987S,987, 987F,979
6/0	2321	243	5	9¼	11½	1.40	.125	292	TEE	MODELS 986A,987E
6/0	1721-1921	241	5	8½	10	1.40	.135	254	TEE	MODELS 986,988
8/0	7221	253	6	11½	13¾	1.50	.095	349	DB	MODELS 747,748
12/0	4128	246	3	9¾	14½	1.20	.125	368	TEE	MODEL 401
14/0	5021	249	4	10	11½	1.30	.11	292	DB	MODELS 980,982
18/0	2721	247	2	12½	11	1.10	.085	279	TEE	MODEL 989
21/0	7421	254	5	14	8½	1.40	.07	216	TONGUE	MODEL 750 - 17 JEWELS
21/0	2921	248	1	13½	10	1.00	.075	254	TEE	MODELS 997,995,995A,721
22/0	6221	251	5	14½	7¾	1.40	.065	197	DB	MODEL 911
FOR:	**HAMPDEN**									
18	1696	371	20	3	21¾	2.90	.21	552	TEE	
18	1696	370	20	2	21¾	2.90	.22	552	TEE	
16	2696	372	20	4	21¾	2.90	.19	552	TEE	MODEL 1890
16	5697	377	18	6	21½	2.65	.165	546	HOLE	
16	4697	376	18	5	21	2.65	.18	533	BRACE	
16	3696	375	18	4½	21	2.65	.185	533	TEE	MODEL 1902
16	3696	374	18	4	21	2.65	.19	533	TEE	MODEL 1902
16	3696	373	18	3½	21	2.65	.20	533	TEE	MODEL 1902
12	7696	384	9	7	18½	1.80	.15	470	TEE	MODEL 1910
12	7696	385	9	6	18½	1.80	.17	470	TEE	MODEL 1910
12	6696-7696	378	9	5	18½	1.80	.18	470	TEE	MODEL 1910
12	12696	379	5	5½	19	1.35	.175	483	TEE	
6	8696	380	9	6	16¼	1.80	.17	413	TEE	ALL JEWELS
3/0	9696	381	5	6½	13	1.40	.16	330	TEE	M.STARK-DIADEM
8/0	15696	382	3	8	8¼	1.20	.14	210	TEE	M.JANE-JOSEPHINE
11/0	11696	383	3	11	9-1/16	1.20	.10	230	TEE	ALL JEWELS

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FOR: **HOWARD**

SIZE	CO.NO	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	METRIC LENGTH	END	DESCRIPTION
18	55	446	20	3	23½	2.90	.21	597	HOLE	
18	55	445	19	3	23½	2.80	.21	597	HOLE	
16	328	447	18	6	21½	2.70	.17	546	HOLE	
16	329	448	18	5	21	2.70	.18	533	TEE	
12	552	449	10	7	19½	1.90	.15	495	HOLE	
12	553	450	9	5½	19	1.80	.175	483	TEE	
10	796	451	6	7	16	1.50	.15	406	TONGUE	

FOR: **ILLINOIS**

SIZE	CO.NO	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	METRIC LENGTH	END	DESCRIPTION
18	47301	295	20	3½	21½	2.90	.20	546	TEE	OLD NO.53 1ST TO 6TH MODELS
18	47302	296	20	3	21½	2.90	.21	546	TEE	OLD NO.53 1ST TO 6TH MODELS
18	47303	297	20	2	21½	2.90	.22	546	TEE	OLD NO.53 1ST TO 6TH MODELS
16	47309	298	21	6¾	27	3.00	.155	686	MB	60 HOUR 13TH-14TH-15TH MODELS
16	47333	305	20	3½	20½	2.90	.20	521	TEE	OLD NO.124 4TH & 5TH MODELS - THICK BARREL
16	47314	299	18	5	20½	2.70	.18	521	DB	OLD NO.573 21-23 JEWELS SMALL BARREL
16	47315	300	18	4½	20½	2.70	.185	521	DB	OLD NO. 573 SMALL BARREL
16	47316	301	18	4	20½	2.70	.19	521	DB	OLD NO. 573 17-19 JEWELS SMALL BARREL
16	47317	302	18	3½	20½	2.80	.20	521	DB	OLD NO. 573 7-15 JEWELS SMALL BARREL
16	47326	303	18	6	22½	2.70	.17	572	MB	OLD NO. 1954 11TH & 12TH MODELS
16	47327	304	18	5½	22½	2.70	.175	572	MB	BUNN SPECIAL OLD NO. 1954 11TH & 12TH MODELS
16	47320	307	18	5	22½	2.70	.18	572	DB	OLD NO. 1770 LARGE BARREL 6TH TO 9TH MODELS
16	47321	308	18	4½	22½	2.70	.185	572	DB	OLD NO. 1770 LARGE BARREL 6TH TO 9TH MODELS
16	47334	306	16	3	20	2.50	.21	508	TEE	OLD NO. 365 1ST-2ND-3RD MODELS THIN BARREL
12&13	47336	309	5	6½	18½	1.34	.16	470	MB	OLD NO. 1845 EXTRA THIN 1ST TO 3RD MODELS
12&13	47337	310	5	6	18½	1.34	.17	470	MB	OLD NO. 1845 EXTRA THIN 1ST TO 3RD MODELS
12&13	47338	311	5	5	18½	1.34	.18	470	MB	OLD NO. 1845 EXTRA THIN 1ST TO 3RD MODELS
12	47349	314	11	7	18½	1.99	.15	470	MB	OLD NO. 1953 5TH & 6TH MODELS
12	47350	315	11	6½	18½	1.99	.16	470	MB	OLD NO. 1953 5TH & 6TH MODELS
12	47343	312	11	6	18½	1.99	.17	470	DB	OLD NO. 1236 1ST TO 4TH MODELS
12	47344	313	11	5	18½	1.99	.18	470	DB	OLD NO. 1236 GOING BARREL 1ST TO 4TH MODELS
6	47353	333	9	6½	14	1.80	.16	356	TEE	ALL JEWELS 1ST MODEL
0	47357	316	8	9¼	13	1.70	.125	330	TEE	OLD NO.981) 1ST TO 4TH
0	47358	317	8	9	13	1.70	.13	330	TEE	OLD NO.981) MODELS AND
0	47359	318	8	8½	13	1.70	.135	330	TEE	OLD NO.981) IMPROVED 4TH
6/0	47363	319	3	9¼	10½	1.18	.125	267	DB	OLD NO.1422 O.F.) 1ST TO
6/0	47364	320	3	9	10½	1.18	.13	267	DB	OLD NO.1422 O.F.) 3RD
6/0	47365	321	3	8	10½	1.18	.14	267	DB	OLD NO.1422 O.F.) MODELS.
6/0	47370	322	5	10	12½	1.41	.11	318	DB	OLD NO.1095 HTG) 4TH TO
6/0	47371	323	5	9¾	12½	1.41	.115	318	DB	OLD NO.1095 HTG) 6TH MODELS
12/0	47376	324	3	9½	14½	1.18	.12	368	DB	OLD NO. 358) 1ST
12/0	47377	325	3	9¼	14½	1.18	.125	368	DB	OLD NO. 358 ALL JLS) MODELS
18/0	47383	326	3	12	10	1.20	.09	254	DB	OLD NO. 2092) 1ST TO 5TH
18/0	47384	327	3	11½	10	1.20	.095	254	DB	OLD NO. 2092) MODELS 15
18/0	47385	328	3	11	10	1.20	.10	254	DB	OLD NO. 2092) JEWELS
18/0	47380	332	3	11	12	1.20	.10	305	TONGUE	OLD NO. 2092 1ST MODEL-HOOK IN BARREL
21/0	47387	329	1	13	8-3/10	1.00	.08	211	DB	)
21/0	47388	330	1	12¾	8-3/10	1.00	.0825	211	DB	) 1ST MODEL
21/0	47389	331	1	12½	8-3/10	1.00	.085	211	DB	)

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SIZE	CO.NO.	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	METRIC LENGTH	END	DESCRIPTION
FOR INGERSOLL RELIANCE										
16	1365	872	11	2	17½	2.00	.22	445	TEE	
16	2365	873	11	2	18½	2.10	.22	470	HOLE	
FOR: INGERSOL TRENTON										
16	365	802	15	3½	19	2.40	.20	483	TEE	
FOR: INGERSOL WATERBURY										
12	316	942	12	6	19½	2.10	.17	495	TONGUE	
FOR: NEW YORK STANDARD										
18	2189	585	20	1	20	2.90	.23	508	HOLE	
18	2190	586	20	1	20	2.90	.23	508	TEE	
16	1032	588	16	3½	21	2.50	.20	533	HOLE	
16	1321	655	15½	5	20	2.45	.18	508	TEE	
16	3196	590	15½	2	20½	2.45	.22	511	TEE	
16	3349	589	14	3	20½	2.30	.21	521	TEE	
16	1730	587	14	1	22½	2.30	.23	572	HOLE	
12	1322	656	11	5	19	2.00	.18	483	TEE	
12	4144	591	10	2	19	1.90	.22	483	TEE	
12	4282	593	9½	4	16	1.85	.19	406	TONGUE	
12	4284	592	9½	3½	18	1.85	.20	457	TONGUE	
10	7080	594	5¾	5¾	16¼	1.50	.168	413	TONGUE	
10	7080	595	5¾	4	16¼	1.50	.19	413	TONGUE	
6	5134	597	10	5	16	1.90	.18	406	TEE	
6	727	596	10	4½	16½	1.90	.185	419	HOLE	
0	6133	598	5½	7	15	1.45	.15	381	TEE	
3/0	1323	657	7	7	13	1.60	.15	330	TEE	
10/0	1324	658	2½	12	9½	1.15	.09	241	TEE	
FOR: ROCKFORD										
18	644	728	20	2	22	2.90	.22	559	TEE	
16	822	729	18	3½	20½	2.70	.20	521	TEE	
12	932	730	11	5½	18¾	2.00	.175	476	TEE	
6	544	731	12	5½	18½	2.10	.175	470	TEE	
0	1077	732	8	9	13¾	1.70	.13	349	TEE	
FOR: SETH THOMAS										
18	536	1073	24	3¾	21¼	3.30	.195	540	TEE	
18	141	1072	24	2	21	3.30	.22	533	TEE	
18	729	1074	24	1½	20	3.30	.22	508	TEE	
18	828	1075	20	2	20	2.90	.22	508	TEE	
16	2106	1076	14½	2	21	2.40	.22	533	TEE	
12	2521	1077	11	3½	21	2.00	.20	533	TEE	
6	1026	1078	10	3¾	14½	1.90	.195	362	TEE	
FOR: SOUTH BEND										
18	29528	517	21	4½	21½	2.97	.185	546	TEE	THICK
18	19528	516	21	3¾	21½	2.97	.195	546	TEE	THICK
18	69528	515	21	3	21½	2.97	.21	546	TEE	
16	47528	523	19	6	21-7/10	2.80	.17	551	TEE	THICK
16	67528	522	19	5½	21-7/10	2.80	.175	551	TEE	
16	37528	521	19	5	21-7/10	2.80	.18	551	TEE	
16	27528	520	19	4	21-7/10	2.80	.19	551	TEE	THICK
16	217528	519	17	5	20½	2.59	.18	521	TEE	
16	17528	518	17	3½	20½	2.59	.20	521	TEE	THICK

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SIZE	CO.NO.	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	METRIC LENGTH	END	DESCRIPTION
FOR: **SOUTH BEND** CONTINUED										
12	35528	526	11	6	19	1.98	.17	483	TEE	
12	55528	525	11	5½	19	1.98	.175	483	TEE	ALL MODELS
12	25528	524	11	5	19	1.98	.18	483	TEE	
6	3528	527	10	4½	16½	1.85	.185	419	TEE	ALL MODELS
0	22528	529	7½	8½	13½	1.65	.135	343	TEE	
0	12528	528	7½	8	13½	1.65	.14	343	TEE	ALL MODELS
0	32528	530	6	8	13-1/6	1.50	.14	335	TEE	
FOR: TRENTON										
16	567	1002	15	7½	17½	2.40	.215	445	TEE	
FOR: **WALTHAM**										
8 DAY	2232	150	37	2	30	4.60	.22	762	HOLE	SIZE 37
8 DAY	2232	151	37	1	30	4.60	.23	762	HOLE	SIZE 37
18	2203	152	20	3	21	2.90	.21	533	TEE	MODELS 1877 & 1879 17-21 JLS
18	2203	153	20	2½	21	2.90	.215	533	TEE	MODELS 1877 & 1879 17-21 JLS
18	2203	154	20	2	21	2.90	.22	533	TEE	MODELS 1877 & 1879 15 JLS
18	2203	155	20	1½	21	2.90	.225	533	TEE	MODELS 1877 & 1879 7-15 JLS.
18	2205	156	21	3	21	3.00	.21	533	TEE	MODEL 1883 17-21 JEWELS)
18	2205	157	21	2½	21	3.00	.215	533	TEE	MODEL 1883 17-21 JEWELS)
18	2205	158	21	2	21	3.00	.22	533	TEE	MODEL 1883 17-21 JEWELS)
18	2205	159	21	1½	21	3.00	.225	533	TEE	MODEL 1883 7-15 JEWELS)
18	2222	160	23	6	25	3.20	.17	635	HOLE	MODEL 1892 7-15 JEWELS)
18	2222	161	23	5	25	3.20	.18	635	HOLE	MODEL 1892 21-23 JEWELS)
18	2222	162	23	4	25	3.20	.19	635	HOLE	MODEL 1892 17-19 JEWELS)
16	2218	164	19	4½	25	2.80	.185	635	HOLE	MODEL 1888 7 JEWELS
16	2218	165	19	4	25	2.80	.19	635	HOLE	MODEL 1888 7 JEWELS
16	2218	166	19	3½	25	2.80	.20	635	HOLE	MODEL 1888 7 JEWELS
16	2227	167	19	7	25	2.80	.15	635	HOLE	MODELS 1899-1908 21-23 JLS
16	2227	168	19	6½	25	2.80	.16	635	HOLE	MODELS 1899-1908 21-23 JLS
16	2227	169	19	6	25	2.80	.17	635	HOLE	MODELS 1899-1908 17-19 JLS
16	2227	170	19	5	25	2.80	.18	635	HOLE	MODELS 1899-1906 17-19 JLS
16	2227	171	19	4	25	2.80	.19	635	HOLE	MODELS 1899-1908 7-15 JLS.
16	2247	224A	17	6	21¼	2.60	.17	540	DB&H	MODEL 1945 R.B. 7 JEWELS
16	2208	163	14	2½	21	2.30	.215	533	TEE	MODEL 1872
14	2211	173	16	2	19	2.50	.22	483	TEE	MODEL 1884
14	2210	172	12	3	19	2.10	.21	483	TEE	MODEL 1874
12	2224A	183	12½	9	19¼	2.15	.13	489	HOLE	MODEL 1894 17-21 JEWELS
12	2224A	184	12½	8	19¼	2.15	.14	489	HOLE	MODEL 1894 7-15 JEWELS
12	2224A	185	12½	7	19¼	2.15	.15	489	HOLE	MODEL 1894 7-15 JEWELS
12	2224A	186	12½	6½	19¼	2.15	.16	489	HOLE	MODEL 1894 7 JEWELS
12	2224	182	12½	7	19¼	2.15	.15	489	HOOK	BUTTON END
12	2237	179	8	7	19¼	1.70	.15	489	HOLE	COL. B. MODEL 1924
12	2237	180	8	6½	19¼	1.70	.16	489	HOLE	COL. B. MODEL 1924
12	2237	181	8	6	19¼	1.70	.17	489	HOLE	COL. B. MODEL 1924
12	2234	174	4	9½	19	1.30	.12	483	HOLE	COL. A
12	2234	175	4	9	19	1.30	.13	483	HOLE	COL. A
12	2234	176	4	8	19	1.30	.14	483	HOLE	COL. A
12	2234	178	4	6½	19	1.30	.16	483	HOLE	COL. A
12	2234	177	4	5	19	1.30	.18	483	HOLE	COL. A
6X8	2215	187	10	3	16	1.90	.21	406	TEE	MODEL 1873
6X8	2215	188	10	2	16	1.90	.22	406	TEE	MODEL 1873
6	2219	191	12	8	16	2.10	.14	406	HOLE	MODEL 1890
6	2219	192	12	7	16	2.10	.15	406	HOLE	MODEL 1890
6	2219	193	12	6½	16	2.10	.16	406	HOLE	MODEL 1890
6	2217	190	10	5	16	1.90	.18	406	TEE	MODEL 1889
6	2217	189	10	4	16	1.90	.19	406	TEE	MODEL 1889
1	2216	194	8	6	16	1.70	.17	406	TEE	MODELS 1882, 1887

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SIZE	CO.NO.	NU VIGOR NUMBER	WIDTH	STR.	LENGTH	METRIC WIDTH	METRIC STR.	LENGTH	END	DESCRIPTION
FOR:	WALTHAM CONTINUED -									
0	2230	200	11¾	10	15	2.06	.11	381	HOLE	MODEL 1907
0	2230	201	11¾	9½	15	2.06	.12	381	HOLE	MODEL 1907
0	2230	202	11¾	9	15	2.06	.13	381	HOLE	MODEL 1907
0	2230	203	11¾	8	15	2.06	.14	381	HOLE	MODEL 1907
0	2228	197	8	10	15	1.70	.11	381	HOLE	MODEL 1900
0	2228	198	8	9½	15	1.70	.12	381	HOLE	MODEL 1900
0	2228	199	8	9	15	1.70	.13	381	HOLE	MODEL 1900
0	2220	195	6½	8	16	1.55	.14	406	HOLE	MODEL 1891
0	2220	196	6½	7	16	1.55	.15	406	HOLE	MODEL 1891
6/0	2248	2248	6	10	11½	1.50	.11	292	DB&H	MODEL 1945 R.B.
6/0	2226	204	6	10	13½	1.50	.11	343	HOLE	MODEL 1898 HTG & MODEL 1942
6/0	2226	205	6	9½	13½	1.50	.12	343	HOLE	MODEL 1898 HTG & MODEL 1942
6/0	2226	206	6	9	13½	1.50	.13	343	HOLE	MODEL 1898 HTG & MODEL 1942
6/0	2235	207	4	10	13½	1.30	.11	343	HOLE	MODEL 1912 J.S. SIZE 1912 O.F.
6/0	2235	208	4	9½	13½	1.30	.12	343	HOLE	MODEL 1912 J.S. SIZE 1912 O.F.
6/0	2235	209	4	9	13½	1.30	.13	343	HOLE	MODEL 1912 J.S. SIZE 1912 O.F.
10L	2229	210	6	12	10¼	1.50	.09	260	HOLE	
10L	2229	211	6	11	10¼	1.50	.10	260	HOLE	
10L	2229	212	6	10	10¼	1.50	.11	260	HOLE	
9L	2233	213	1½	11	10¼	1.08	.10	260	HOLE	
9L	2233	214	1½	10	10¼	1.08	.11	260	HOLE	
8¾L	2242	221	5	12	8¾	1.40	.09	222	HOLE	870 ROUND
7½L	2236	215	2	13	9	1.10	.08	229	HOLE	SAME AS 5¼L ROUND
750	2243	222	2	12	13	1.10	.095	330	HOLE	BARREL SHAPE 7½L
750B	2250	224C	2½	10½	12¼	1.15	.105	311	DB&H	7½L BARREL SHAPE R.B.
7¼L	2238	217	4	12	12¼	1.30	.09	311	HOLE	RECTANGULAR
7¼L	2238	216	4	11	12¼	1.30	.10	311	HOLE	RECTANGULAR
675	2249	224D	2½	15	8½	1.15	.06	216	TONGUE	R.B.
678	2251	224E	4	13½	9½	1.30	.075	241	DB&H	R.B. BARREL SHAPE
670	2244	224	2½	15	8	1.15	.06	203	HOLE	ROUND
6½L	2239	218	1½	11½	9½	1.05	.095	241	HOLE	SAME AS 450M
450	2241	223	1½	11½	10½	1.05	.095	267	HOLE	RECTANGULAR
4L	2240	220	2	12	8	1.10	.09	203	HOLE	400 RECTANGULAR
4L	2240	219	2	11	8	1.10	.10	203	HOLE	400 RECTANGULAR

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Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 8

Assembling Watches

—

Sections 205 - 218

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

Lesson 8 — Assembling Watches

Section 205 THE trains and escapements of modern watches, large or small, are much the same, and when you understand the mechanism and relation of the different parts in one you will have little difficulty in mastering others.

In demonstrating this first lesson on taking down and assembling a watch movement I have used a 16 size Elgin, three quarter plate model, shown in figure 169.

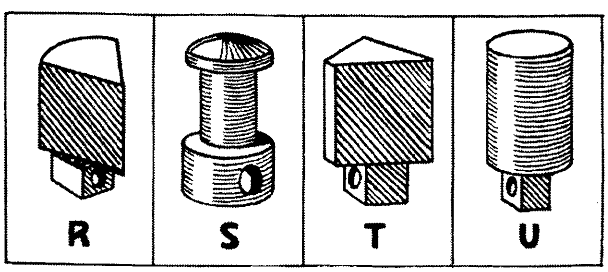
It is expected by this time that you will have no trouble taking the movement out of the case and that you realize the necessity of letting down the power before going further.

Sec. 206 — Balance, Hairspring and Hairspring Stud

The balance with hairspring is the most delicate part of a watch, and it is well to remove this first when taking a movement apart. The outer end of the hairspring is pinned into the stud which is held in the balance cock by means of a screw. In order to do this it is necessary to have the hairspring between the balance and the balance cock.

The earlier American watches were equipped with an "undersprung balance", that is the hairspring was under the balance — between it and the top plate — and the outer end of the hairspring was held in a heavy stud attached to the plate by means of a screw. (See figure 8 in lesson 1).

Do not get the idea that all modern hairspring studs are shaped alike or treated the same in taking down and assembling the movement with which they are connected. In figure 165 are drawings of four different styles of studs in common use. The one shown at R is the style found in the 16 size Elgin movement used with this lesson, S is the Hamilton type of stud described in the next section, T the Waltham model described in section 208 while U is the conventional round stud. A later type of round stud has one side flattened and is known as a D stud. Another style has a groove running lengthwise into which the stud screw sets, thus holding it in a fixed position. In movements fitted with these last three studs, the balance cock generally is lifted out with hairspring and balance attached as shown in figure 82 in lesson 5, and the stud is released from the cock after the whole assembly has been lifted away from the movement.

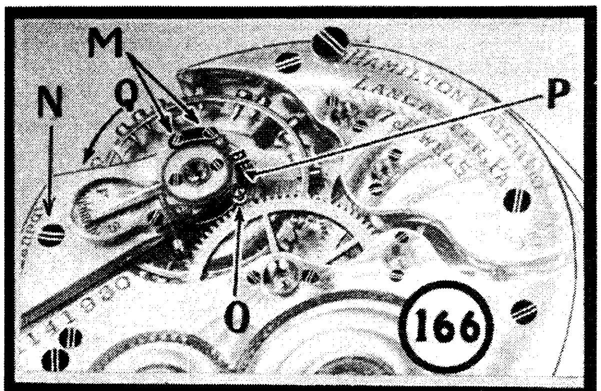


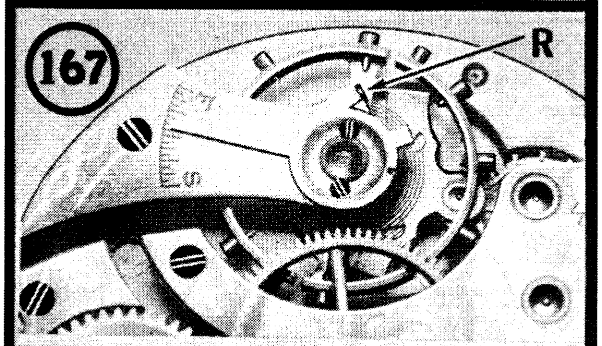
No. 165

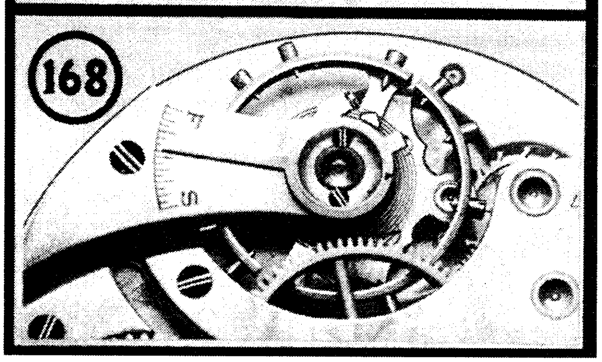
Sec. 207 — Hamilton Type of Stud.

With the Hamilton floating stud shown at S, figure 165, it is possible to remove and replace the balance with hairspring attached without danger of distorting the overcoil. To do this unscrew the two stud cap screws at M, figure 166, about one and a half turns before taking out the balance cock screw at N. Do not attempt to pick the stud from under the stud cap as this is liable to bend the hairspring at the curb pins, but after taking out the screw N, lift the balance cock with the balance suspended by the hairspring, up and away from the movement in order that the balance may not catch on the center wheel. By tilting the balance cock toward the stud side, the stud will fall out.

In replacing, pick up the balance by the arm or rim, using the tweezers, and place in position on the lower plate with the lower pivot in the balance jewel and the roller jewel or jewel pin in the slot of the fork. Move the balance around until the stud is outside the curb pins, set the balance cock in place, and turn







down the screw N, noting that the balance is free while doing this. Now the stud floats free on the outside of the curb pins at P as seen at O. Holding the movement in its movement holder in the left hand, with the forefinger of the same hand swing the balance around to the left in the direction of the arrow Q.

With your tweezers in the right hand, slip the upper shoulder of the stud under the cap with the overcoil of the hairspring on the outside of the curb pins. Slip the overcoil between the curb pins and allow the balance to swing back until the roller jewel is in the fork and the overcoil is free between the curb pins. Hold the balance in this position and tighten the two stud cap screws at M.

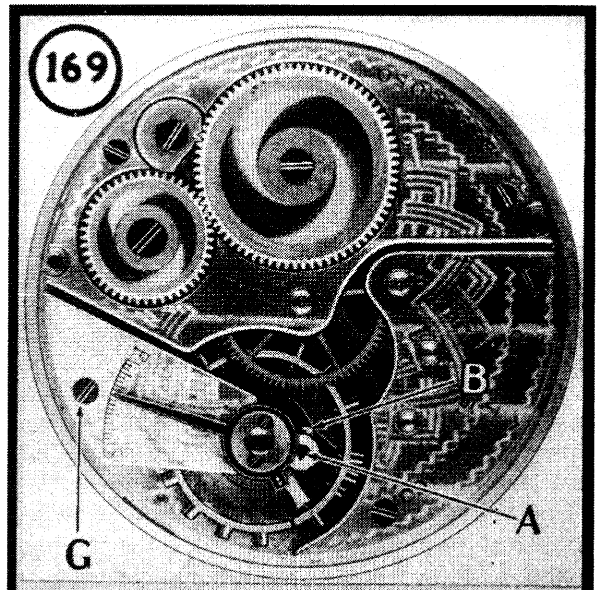
Sec. 208 — Waltham Hairspring Stud.

The Waltham stud, shown in figure 167 is triangular shaped and is released from the bridge before removing the balance cock screw. All that is necessary is to turn back the stud screw at R enough to allow the stud to be released, after which the balance cock screw is loosened and the bridge removed.

In replacing the balance with hairspring and stud attached, set the assembly in place with the stud floating between the curb pins and the stud screw, as shown in figure 168, using care to see that the roller jewel is in the slot in the fork before tightening down the balance cock screw. After doing this, hold the movement on edge and swing the stud into position, securing it there by means of the screw at R as in figure 167.

Sec. 209 — Elgin Stud

The three cornered stud shown at A figure 169 is a typical Elgin style stud similar to R in



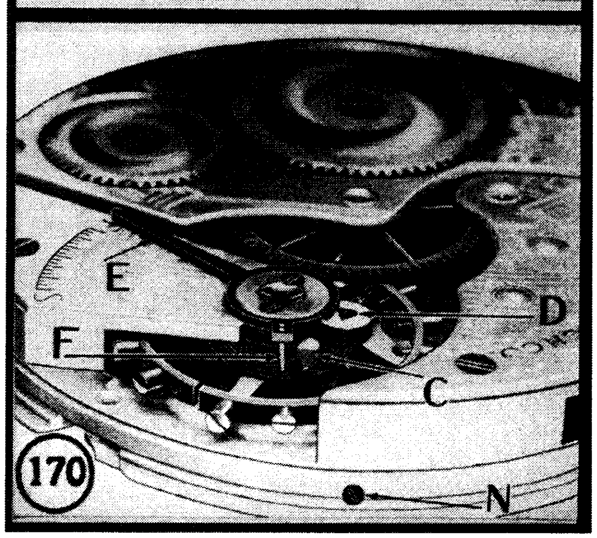
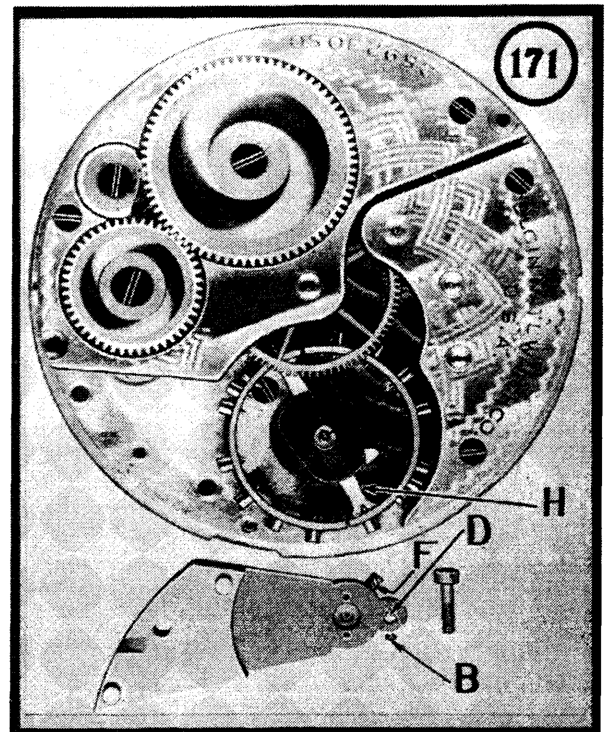


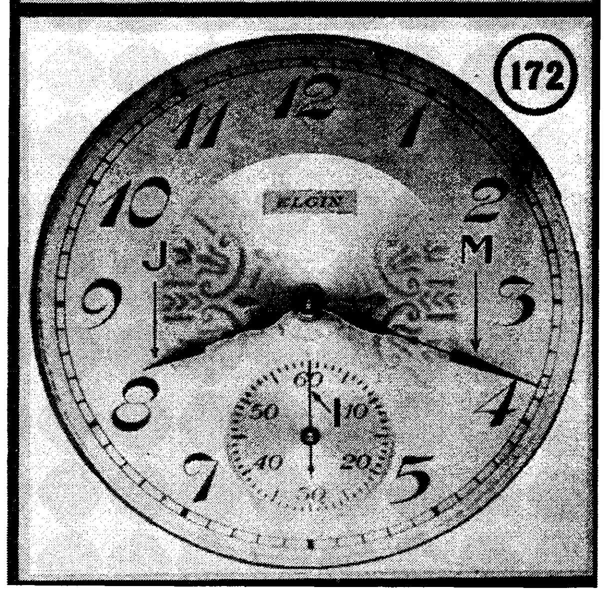
figure 165, and fits in a triangular shaped hole in the bridge being held in place by the stud screw at B. In taking the balance out, loosen this screw and carefully push the stud down until it is free of the bridge as shown in the enlarged view at figure 170 in which C is the stud after having been pushed free from the hole D in the cock. Here the regulator E has been pushed over far enough to give more room for the stud between the curb pins at F and the projecting end of the balance cock in which is located the stud hole D. Be sure and do this *before* you loosen the balance cock screw at G figure 169.

After freeing the stud, take out the balance cock screw, lift off the balance cock turning it over as shown in figure 171, and study it from the lower side. At F are the two curb pins commonly called the regulator pins. D is the hole for the hairspring stud and B the stud screw. Before proceeding further it is well to turn the stud screw in as far as it will go so there will be no danger of its being lost. The balance may now be lifted out and set to one side by grasping the arm at the point H using your tweezers in doing this. Be careful not to bend the lower pivot.

Although many watchmakers take the balance and balance cock out before loosening the stud screw as explained in Section 131 of Lesson 5, I have found that the average beginner runs less risk of distorting the hairspring when he follows the method just described in connection with this model of Elgin movement.

Having taken care of the balance, turn your movement over and set it in the movement rest, dial up, with hands attached as shown in figure 172. I is the second hand which revolves once a minute, M the minute hand which revolves once an hour and J the hour hand which makes one revolution in 12 hours.





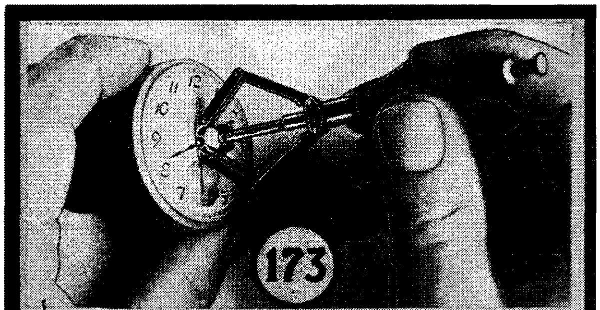
Sec. 210 — Removing the Hands

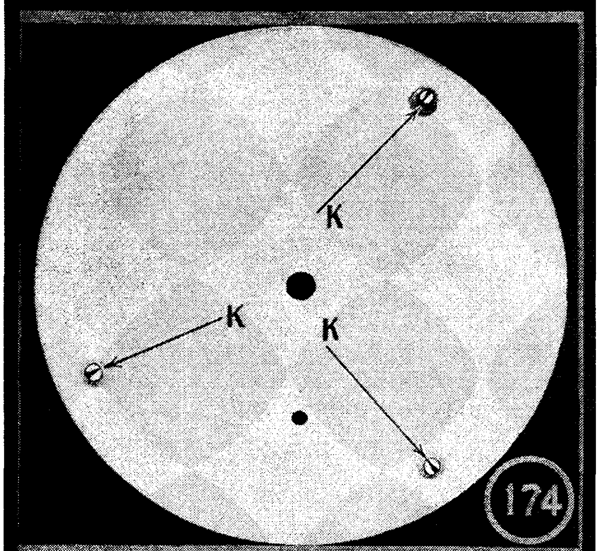
Use a hand remover to take off the hour and minute hands as shown in figure 173. Press on the top to spread the jaws and slip them under the hour hand at the center. Then by pressing down on the handle as shown here, the two hands will be pried off. It is well to slip a small sheet of celluloid between the hand remover and the dial to prevent scratching the dial.

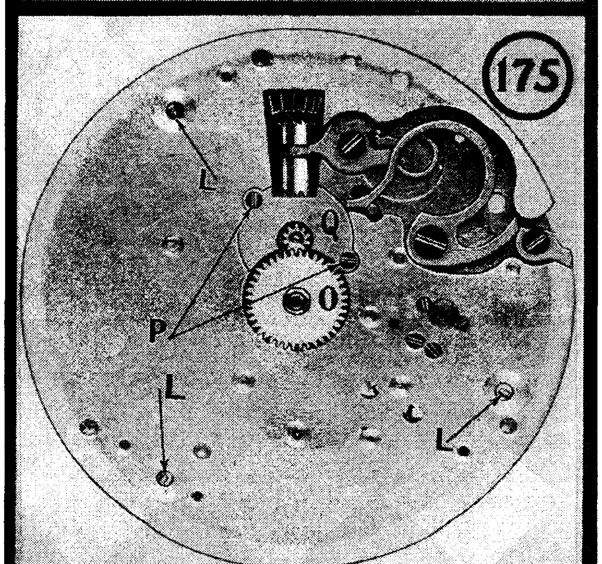
The second hand may be removed by using two thin bladed screw drivers, one under each side in the center, twisting the blades until the hand is released from its position on the 4th pinion. Here too it is well to slip a piece of celluloid between the screw driver blades and the dial.

The dial has three pins fastened to the back which fit into holes in the pillar plate and are held in place by means of small screws at the edge. These pins are the *Dial Feet* and the screws that hold them in place are *Dial Screws.* In figure 174 is shown the back of the dial with the dial feet indicated by the arrows K. At N in figure 170 is shown the location of one of the dial screws.

Locate the dial screws along the edge of the plate and with a screw driver that properly fits the head, turn each screw partly out, just enough to free the dial foot. With a fairly wide screw driver pry the dial up from the plate using great care not to injure it. Pry at two or three places, it being best to do this at the points where the dial feet are located. If the dial does not come off easily it may be that the dial







screws are not backed out far enough. Although the metal type of dial will stand more springing without injury than an enameled one, it must be handled with care to avoid scratching. In removing an enameled dial there is the danger of prying a little too hard, with a resulting crack in the enamel.

As soon as you take off the dial it is well to turn the dial screws in as far as they will go to prevent their dropping out and getting lost. The movement will now appear as in figure 175 with the tips of the three dial screws extending into the dial foot holes at L.

The hour wheel which carries the hour hand is shown at O. With your tweezers lift it off, take out the two screws at P and remove the *minute wheel clamp* at Q.

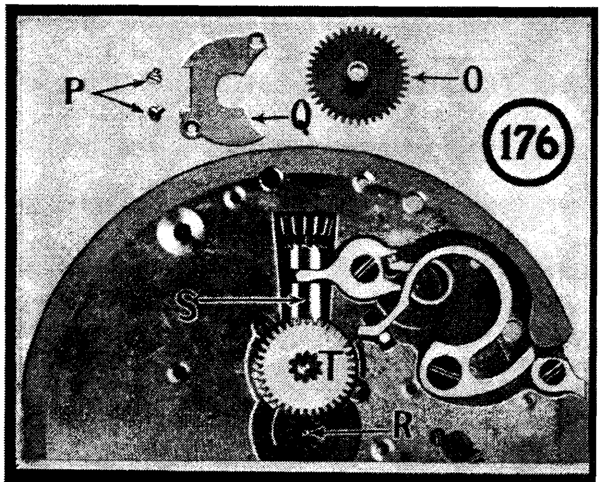
This part of your movement will now appear as at figure 176 with the hour wheel O, the minute wheel clamp Q and the two minute wheel clamp screws P along side. The minute hand is carried on the *cannon pinion* at R. This cannon pinion fits on the center staff with sufficient friction to carry the hands around with the center staff as it turns, yet free enough to be turned on the center staff when setting the watch, without bending any teeth.

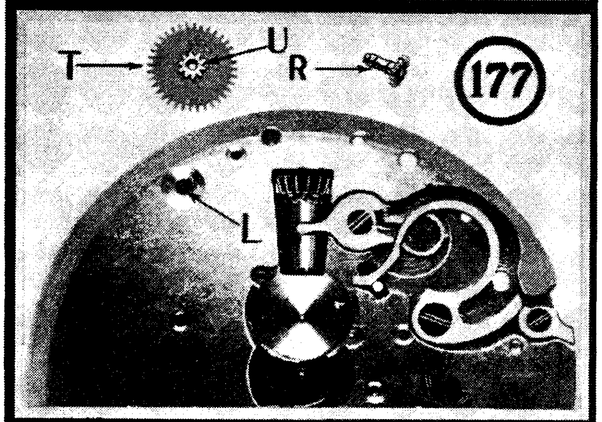
The clutch S, is in the setting position with its teeth engaging the teeth of the minute wheel T. In setting the watch the clutch is turned by means of the stem in the winding arbor and its power is transmitted through the minute wheel to the cannon pinion and minute hand.

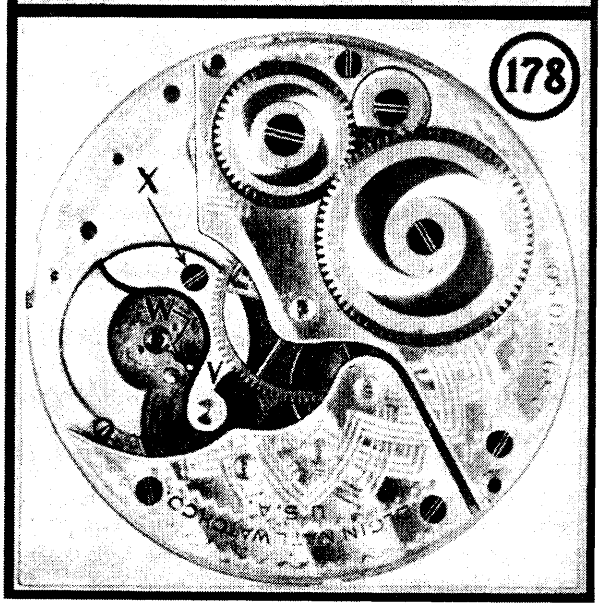
The cannon pinion may be removed by grasping it with a pair of strong tweezers and pulling straight out. If it is extra tight use a pair of brass lined pliers to remove it. The minute wheel is lifted out of its place and the movement from the dial side will appear as in figure 177. At T may be seen the minute wheel with the cannon pinion at R. The minute wheel has a small pinion attached at U, and it is this pinion that gears into the hour wheel as seen in figure 175.

Now return to the train side of the watch by turning it over and placing it on the other side of the movement rest.

The power having been let down, take out the *pallet fork* by removing the *pallet bridge screw* at X figure 178, and the *pallet bridge* V. In taking out any bridges from a movement see that none of the pivots is caught in a pivot hole as they are easily broken. Where a bridge is unusually tight it can be loosened by inserting the blade of a screw driver with a twist-







ing motion. Sometimes you will find a slot cut in the edge of the bridge for this purpose.

Before you remove the pallet fork, notice particularly how it is placed in the watch and replace it in the same position when assembling. If the model is one with a single roller the guard pin will set at a right angle to the fork and project upward. If a double roller, the guard dart will be below and parallel with the fork. The model shown here has a double roller and the guard dart at W is below the fork.

After removing the pallet bridge, the pallet fork with pallet arbor attached is easily lifted out, and the movement appears as in figure 179 with the pallet bridge at Y, the pallet fork and arbor, often abbreviated as the *P. F.* and *A*, at Z, and the pallet bridge screw at X. Viewing the pallet fork and arbor from the lower side at Z gives you an opportunity to see how the guard dart is attached at the slotted end of the fork.

The Train Bridge is now removed by taking out the screws at B and lifting the bridge out of its place as shown in figure 180, in which A is the Train Bridge and B the train bridge screws. The 3rd, 4th and escape wheels and pinions are now seen in their proper positions.

These may be lifted out, taking the escape wheel first, then the 4th wheel and finally the 3rd wheel. Notice that the 4th pinion has a long pivot on the lower end. This long pivot carries the second hand and cannot be removed from the movement until the second hand has been taken off.

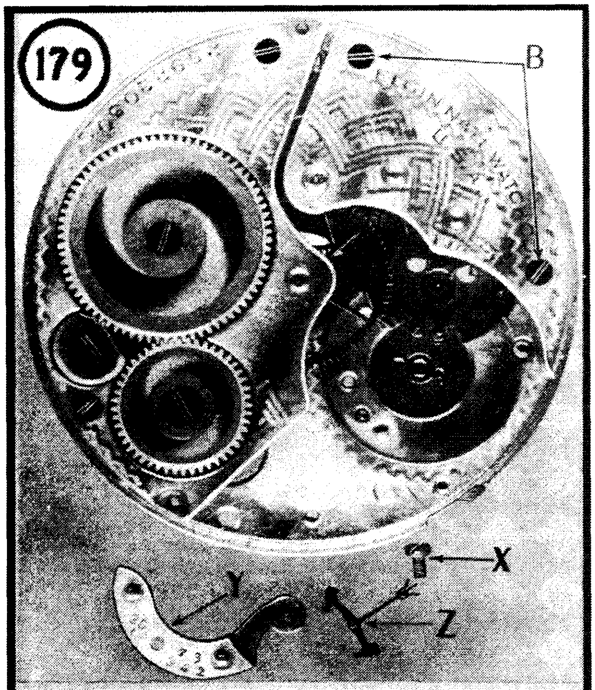
Now remove the barrel bridge by taking off the ratchet wheel at C, the crown wheel at D and then the Barrel Bridge screws. At this point you might have some difficulty in releasing the crown wheel screw at E. This screw has a *left hand thread* and in removing it should be turned to the *right*.

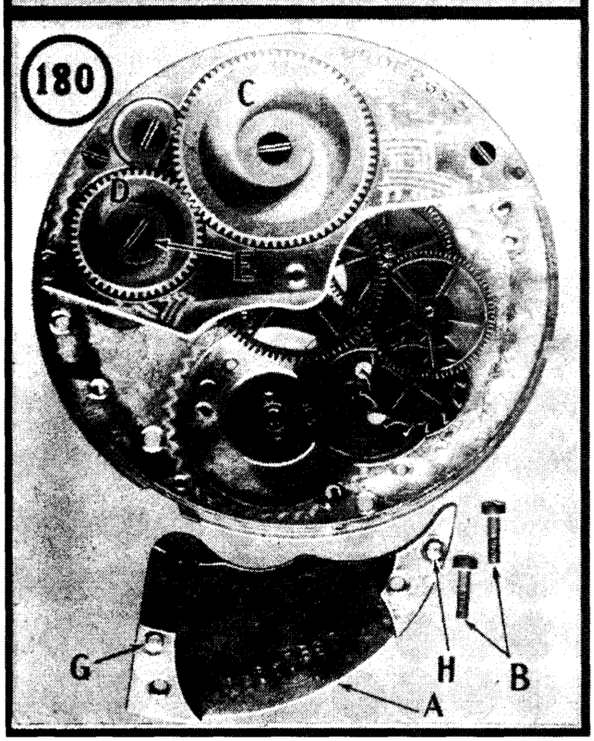
If in loosening a screw in the winding parts of any watch, it does not start as easily as you might expect, try twisting it the other way for you will frequently find such screws with left hand threads. Beginners often forget this and in attempting to force such a screw, use too much pressure and break the head leaving the threaded portion imbedded in the bridge.

Manufacturers differ sometimes as to the trade name of parts. The manufacturers of this movement list the wheel at D as the *main wheel* while others designate the first wheel shown at Q in figure 119, in lesson 6 as the *main wheel*, and the wheel which corresponds to this main wheel is called the *crown wheel* shown in figures 115, 128 and 131.

In these lessons I will give the technical and trade names which I have found to be most used among the members of the trade.

With the barrel bridge removed, the movement appears as in figure 181, the center wheel at E and the barrel at F. These may be lifted





out of their places and the plate will appear as in 182. This is a going barrel and the cap being *down* we know by our rule of a former lesson that the mainspring coils to the left in the barrel. In this model is found also a safety pinion on the center staff.

At this point it is well to examine every wheel and pinion using your double loupe to see that there is no dirt in any of the teeth or leaves and that none of the teeth is bent. Should you find dirt in the leaves or teeth, *peg it out*. This is done by sharpening a piece of pegwood to a point much as you would a fine pointed pencil and rubbing this point back and forth wherever needed.

In this watch I found oil smeared over the plate from G to H figure 181, showing that whoever repaired it last used too much oil when reoiling. Too much oil does as much damage as too little oil although in this particular instance not much harm would result in the time keeping parts.

In this first attempt at taking down and assembling a watch I would advise you to take no more parts off the plate. The object of this lesson is to train you in manipulating such parts as constitute most of the time keeping portion of the watch. All the rest will be taken up in succeeding lessons and in a way I really believe will give a better insight into their workings than could be given now.

When assembling a watch movement use an assembling block and lay the lower plate in the recessed part as shown in figures 181. 182 and 183.

Sec. 211 — Study the Train

Before starting to reassemble this movement place the whole train upon the plate as shown in figure 183 and study it thoroughly. Notice that the leaves of the third pinion and escape pinion are above their wheels when assembled. So in placing them on the plate, first set the escape wheel and pinion in its proper place, next the third wheel and pinion and then the barrel. The leaves of the fourth and center pinions being below their respective wheels are set in last.

After they are placed, see that the teeth of each wheel come in proper contact with the leaves of the succeeding pinion, that is, the teeth in the barrel should be lined up with the leaves of the center pinion, the teeth of the center wheel with the leaves of the third pinion and so down to the escape pinion.

At first you may have some difficulty in telling the difference between the third and fourth wheel, but by noting that the fourth pinion has a long lower pivot which carries the second hand, you should have little trouble on that score. If a watch has no second hand you can tell the difference by examining the teeth and leaves. The teetn and leaves of the third wheel and pinion are somewhat coarser than those of the fourth wheel and pinion.

Sec. 212 — Assemble the Train

Start assembling the movement by placing the train on the plate *without* the barrel as this may be easily slipped into place after you have set the train bridge in position. Now place the train bridge with the two steady pins G and H in figure 180 directly over the holes J and K in figure 183.

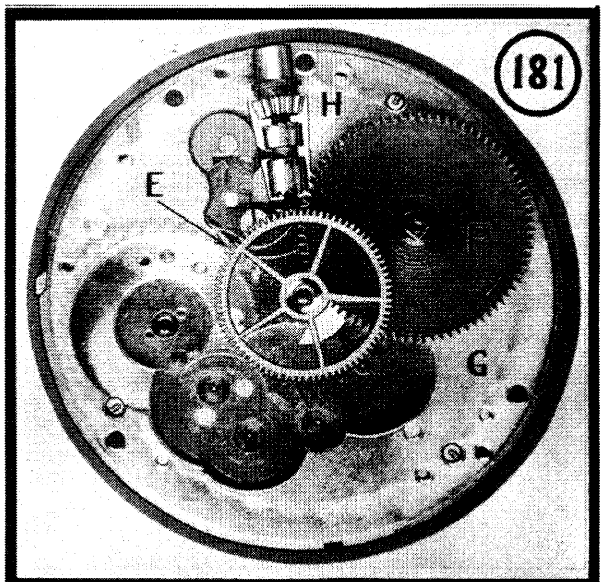
Take the movement holder and watch assembly in the left hand, holding the train bridge in its proper position as shown in figure 184 — using watch paper to protect from finger marks — and with a pair of fine pointed tweezers manipulate the upper pivot of each pinion into its proper pivot hole in the train bridge. At times you will find one of the upper pivots slightly longer than the others. If so fit the longest pivot first. Hold your work as close to the top of the bench as possible and do not put too much pressure on either the plates or the pinions. At first you will have a tendency to force the pivots into place but will soon learn that it is merely a matter of getting the pinions straight up and down and when the pivots are brought to the proper position very little effort is required to guide them into place.

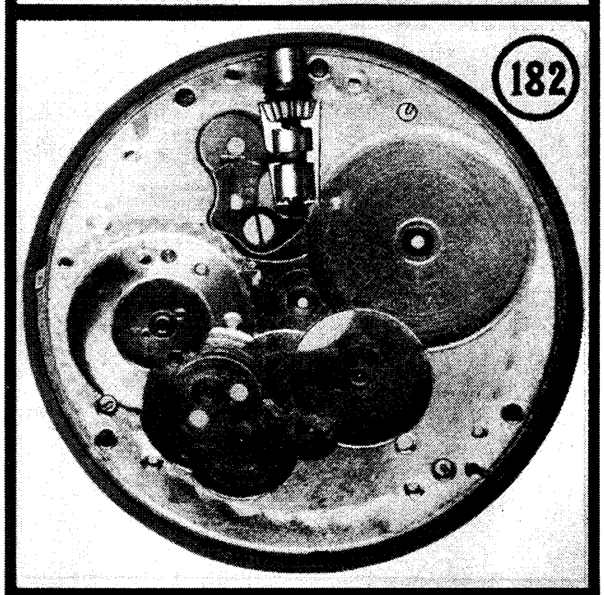
Still holding the bridge in place with the left hand, with the tweezers pick up one of the screws for the train bridge and set it in place, then with the proper size screw driver turn the screw down being careful to see that none of the pivots gets out of place. In the same way replace the other train bridge screw and then with your tweezers test each pinion by moving it up and down to see that it is perfectly free and has end shake.

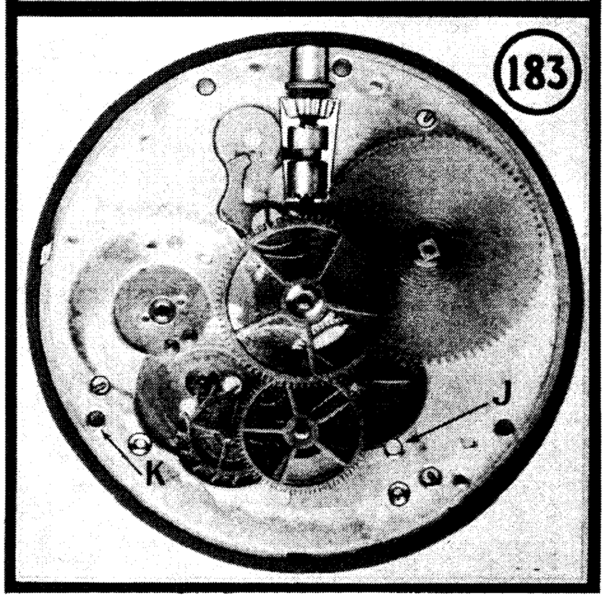
Slip the barrel under the center wheel with the square end of the arbor up as shown in figure 185 and replace the barrel bridge, fitting the upper pivots of the center staff and the barrel arbor in their proper holes. This bridge will usually fall right into place and you should experience no trouble here. Set the screws in the barrel bridge and your train is now assembled and should appear as in figure 186.

Although I am not asking you to oil this watch, I want to show you two places that many Watchmakers overlook. On this model it is well to place a small amount of clock oil on the raised ring under the ratchet wheel at M figure 186 and also on the one under the crown wheel at L. This often will make quite a difference in the amount of strength required in winding.

The crown wheel with washer is next put in place, being held by the crown wheel screw. Adjust the ratchet wheel with the square hole



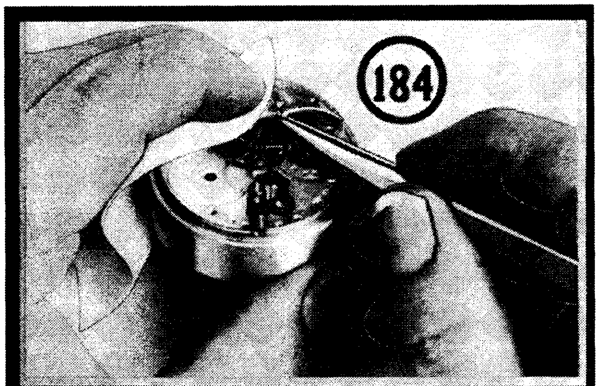


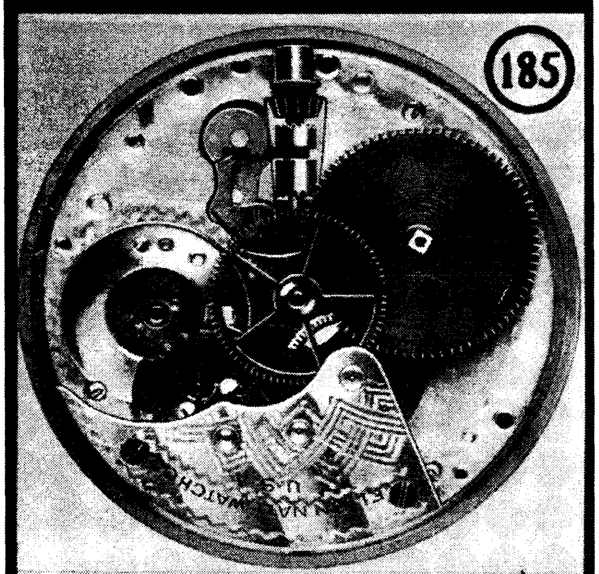


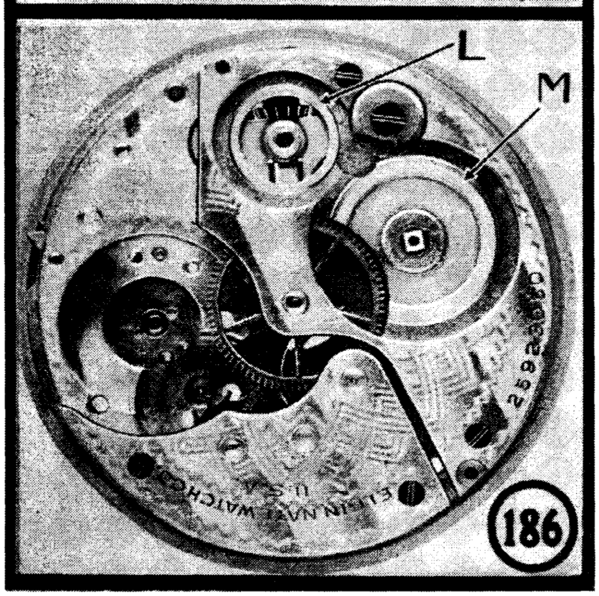
properly set over the square of the barrel arbor and secure with the ratchet wheel screw.

Sec. 213 — Test the Train

At this time you should test the freedom of







your train. Take a bench key of proper size to fit the winding arbor, press in far enough to shift the parts to the winding position and give the key three or four turns. If everything is as it should be the wheels in the train will immediately start revolving with such rapidity that finally the momentum will carry them beyond a "state of rest" after which they will back up in the other direction or *recoil.* The recoil is gauged by watching the fourth wheel.

If your train runs down freely even though there is no recoil let it go at that, as in this example we are only practicing assembling and the lack of recoil might be caused by gummy oil, a set mainspring or some other cause which you will master later on.

The pallet fork is now set in place with the lower pivot of the pallet arbor in its proper pivot hole. Adjust the pallet bridge in position and if in dropping the bridge in place the upper pivot does not at once enter the pivot hole it is an easy matter to guide it into place with your tweezers.

Apply power to your train by giving the winding arbor three or four turns with your bench key. This will hold the fork over against one of the banking pins as shown at O in figure 188. If you now take the point of your tweezers and press the fork away from the banking pin it immediately should fly over to the other banking pin. Move the fork back and forth and study the action of the escape wheel teeth in giving these impulses to the fork.

Sec. 214 — Action of the Escapement

It is here that the power of the train is transmitted to the balance. The balance (wheel), hairspring and roller with the roller jewel are all fastened together on the balance staff and act as one piece. The slot in the fork strikes the roller jewel, throwing the balance around in a circular motion, but the hairspring, the outer end being fastened to the balance cock, resists this motion and finally brings the balance to a stop and immediately forces it to turn in the opposite direction.

As it returns to its original position the roller jewel enters the slot in the fork pushing it away from the banking pin just as you have done with your tweezers. At once the escape wheel tooth throws the fork in the other direction and the same thing occurs again. The slot in the fork strikes the roller jewel throwing the balance in the opposite direction only to be stopped and brought back by the hairspring and so it continues at the rate of 300 vibrations each minute.

Such is the action of the lever escapement and when you have mastered one you have made good progress toward mastering them all. As the watch comes from the factory the escapement has been adjusted to perform properly but often it is thrown out of order by inferior workmen and you are never sure that the escapement is correct until you have examined it. In later lessons we will take up the proper matching of the escapement in a thorough manner showing you how to test for errors and how to make the correct adjustments.

Sec. 215 — Replacing the Balance

In replacing the balance and balance cock, it is best to assemble these parts before placing in the watch. Lay the balance cock on the bench in an inverted position as shown in figure 171, first seeing that the stud screw at B is out far enough to allow the stud on the hairspring to enter the hole D without difficulty. *Do not* take this stud screw entirely out of the balance cock.

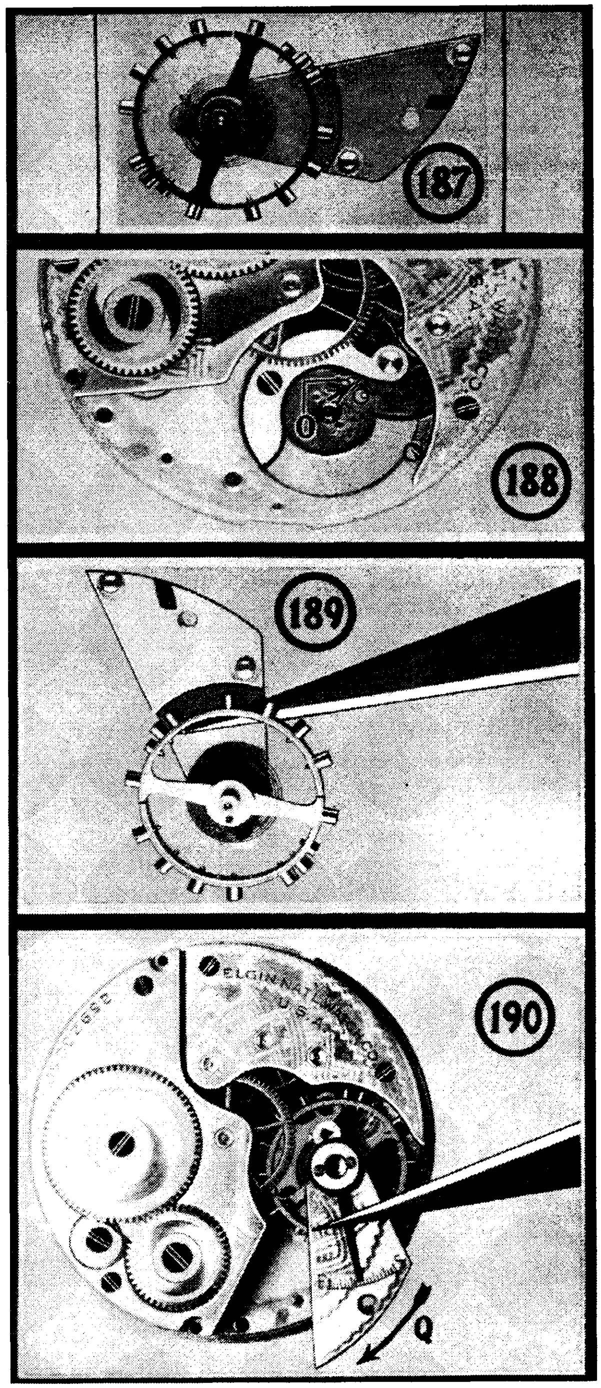
With the balance cock in this position lay the balance on top with the upper pivot of the staff in the jewel and the stud directly over the hole. See that the overcoil (the coil that is raised above the body of the hairspring) lies directly between the curb pins (regulator pins) and lightly press the stud into its place, using care not to hit the hairspring. Your hairspring should now lie level or parallel with the balance cock. Still holding it in this position set your stud screw by means of a small screw driver and your assembled balance and cock should appear as in figure 187.

Now slip your tweezers under the balance cock as shown in figure 189 and turn it over, allowing the balance to hang suspended by the hairspring.

As you have already applied power to the train, the fork should be resting against one of the banking pins. If it is not resting against the one further from the edge of the plate, move it over to that position as shown at O, figure 188.

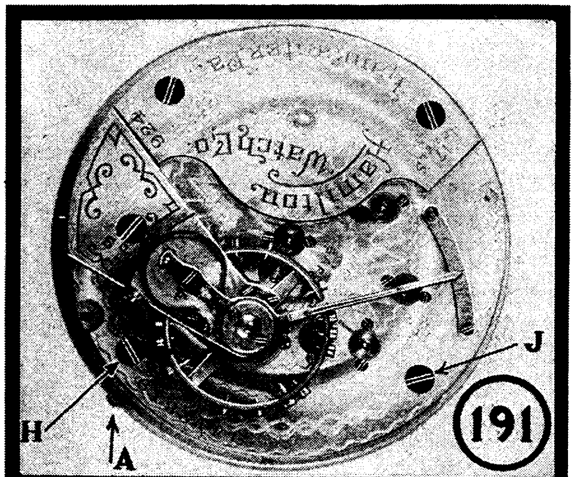
In replacing the balance in the watch be sure that the roller jewel will swing into the slot of the fork from the open side. If the jewel were to get outside the slot the watch could not run.

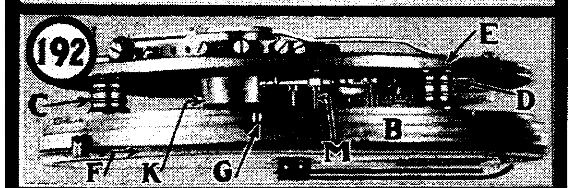
Do not attempt to set the balance bridge straight down into position but rather swing it in from the side. Holding it as shown in figure 190 slip the balance under the center wheel and then bring it down until the lower pivot of the staff is resting in the center of the lower jewel. Now your roller jewel is opposite the open side of the fork.

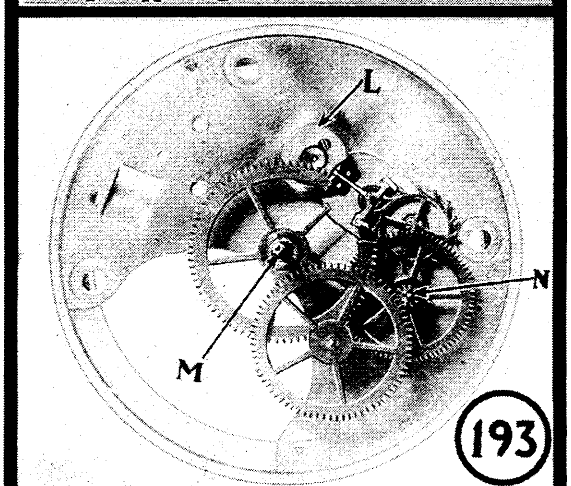


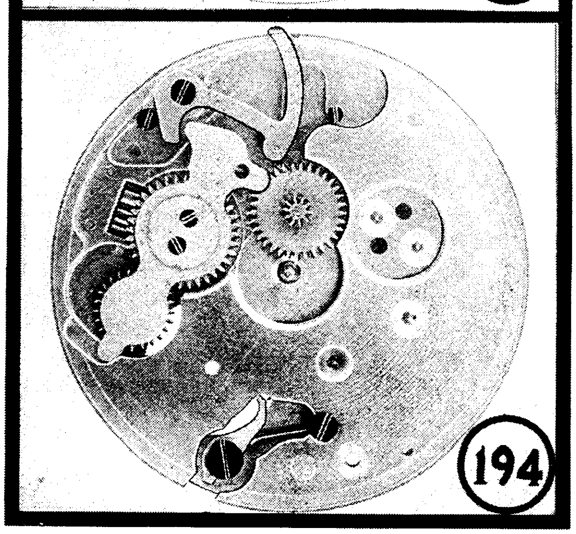
With the balance in this position twist the balance cock to the left as indicated by the arrow Q until the steady pins on the balance cock are directly over their holes in the lower plate. Lower into place, adjust the pivots in their jewels and see that the balance is free to turn in both directions. If everything seems O. K. set your balance cock screw and your watch should start right off.

In setting the balance cock in place you may at first get the roller jewel on the wrong side of the fork. If so do not attempt to force it over









to the other side, but lift up the entire assembly and try it again. After you have practiced this a few times it will make no difference which way the fork is banked. You can see from which direction the roller jewel must enter and manipulate the balance cock accordingly.

Sec. 216 — Replacing the Cannon Pinion

After satisfying yourself that your watch movement is functioning properly, turn it over on your movement rest and replace the cannon pinion. The cannon pinion should press down on the center staff with no difficulty by merely using a stiff pair of tweezers. In a higher jeweled watch where the pivot of the center staff fits in a jewel as in a 17 or 21 jeweled watch, it is well to support the lower end with a stump in order to prevent loosening or breaking the jewel.

Replace the minute wheel, its clamp and screws; set the hour wheel in place over the cannon pinion. See that the teeth and leaves are all in proper alignment, and then set the dial in place after backing out the dial screws.

If necessary to press a dial into place do so directly over the dial feet and thus avoid springing the dial. This applies especially to enameled dials as they crack or chip very easily. See that it is down far enough to rest on the plate all the way round, then set the dial screws to hold it in place.

Next press the hour hand in place on the hour wheel. The hour hand should be close enough to the dial to give room for the minute hand and yet not catch on the second hand. Adjust the hour hand parallel with the dial. In making the adjustment of the hands with a metal dial do not let your tweezers slip or drag as such dials show the slightest scratch.

Before placing the minute hand, turn the hour hand until it points exactly to some hour, 3 or 9 for example, then place the minute hand to point exactly at 12 and press it down on the cannon pinion. Placing the hands in this way at some exact hour causes them to "register correctly".

The second hand is now pressed on the long pivot of the fourth pinion which extends up to the center of the *second bit* in the dial.

After these are placed, use your bench key in the winding arbor with the parts in the setting position and turn the hands around the dial noting whether they clear each other at all points.

If the watch is now cased see that the minute hand does not rub on the glass.

Sec. 217 — Assembling a Full Plate Movement

One of the older types of watch movements, the full plate model, offers some difficulty to the beginner who attempts to take down and assemble it without instructions.

By a full plate model is meant one similar to the one shown in figure 81 in lesson 5 or figure 191 in this lesson. The trouble usually encountered by beginners is caused by not freeing the lower pallet arbor pivot from its jewel or pivot hole in the lower or pillar plate, before lifting off the top plate.

Figure 192 shows a side view of this movement looking at it in the direction of the arrow A, figure 191. The lower plate, B in figure 192 is called the pillar plate, and to it are attached the pillars, C and D, which support the top plate E. Here also may be seen the dial F and one of the dial screws G.

In taking this model apart, it is best first to remove the balance and balance cock. Next take off the barrel bridge and lift out the barrel. Take out the pillar screws, two of which are shown at H and J, figure 191, these screws extending through the top plate into the two pillars C and D figure 192. Now you are ready to lift off the top plate but in doing this you must be sure that the lower pivot of the pallet arbor is free.

At K in figure 192 is shown the potance and this is what causes most of the trouble in taking down or assembling this type of full plate movement. This potance is a support for the lower balance jewels, being attached to the top plate. Another view of the potance is at L figure 193. The end of the fork extends inside the potance, and in lifting the top plate the potance will catch on the end of the fork lifting it up and unless the lower pivot is freed from the lower pallet arbor jewel, break or bend that pivot or break the jewel.

All that is necessary in taking off the top plate is to so raise it that there is just room enough to permit the pivot on the lower end of the pallet arbor, M figure 192, to be lifted out of the jewel or pivot hole in the pillar plate by reaching in with the tweezers. After this the top plate may be lifted off without further trouble.

In assembling this style of movement many watchmakers set the wheels of the train in place on the pillar plate and then with the pallets and the escape wheel and pinion set in place on the top plate, tip the two plates together manipulating the pivots into the proper holes. The beginner will find it much more convenient to set up the train and pallets on the top plate, first setting the plate in one of the assembling blocks as shown in figure 193. Here the center wheel is partly cut away in order to show the pallets and how the end of the fork projects into the potance.

The pivots on the center staff at M and the fourth pinion N are much longer than the others and in lowering the pillar plate into the position shown in figure 194 the center staff is first fitted through the center jewel, the fourth pivot through the fourth jewel and finally the other pivots into their proper jewels. After all the pivots are in position the movement is turned over, while holding the plates, and the pillar screws are set in place. The balance of the movement is then assembled as has been described.

Sec. 218 — Be Careful

The main thing in watch repairing is to use care in all your work. Get into this habit and it soon becomes second nature to do your work as it should be done the first time over.

The inexperienced individual is inclined to use too much muscular energy at times. If a part does not readily go into place, he endeavors to force it. This is not necessary as these parts fit together with a precision that the average man is not used to and when lined up, go together with very little effort. If you come to a point where it seems you must clamp down hard in order to assemble a watch, examine closely and no doubt you will find something out of place.

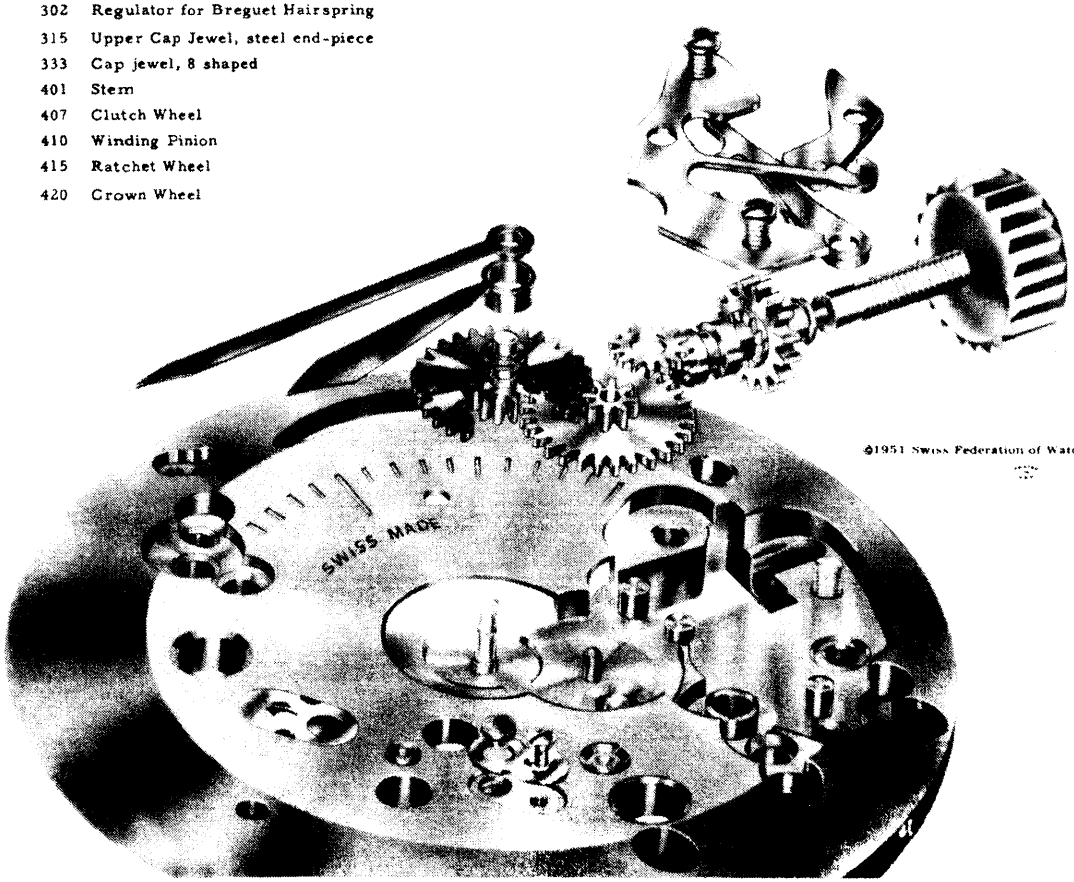
The beginner generally thinks that the taking down and assembling of a watch is a very difficult thing to master, this being in line with the belief that a watch is such a complicated machine. In going through this lesson you must have realized that there are not a great number of difficulties to overcome nor are there as many parts to learn as most people suppose. Occasionally I have asked prospective students how many wheels they supposed were in the time-keeping part of the watch—how many in the train and have had them estimate all the way up to seventy-five and even one hundred.

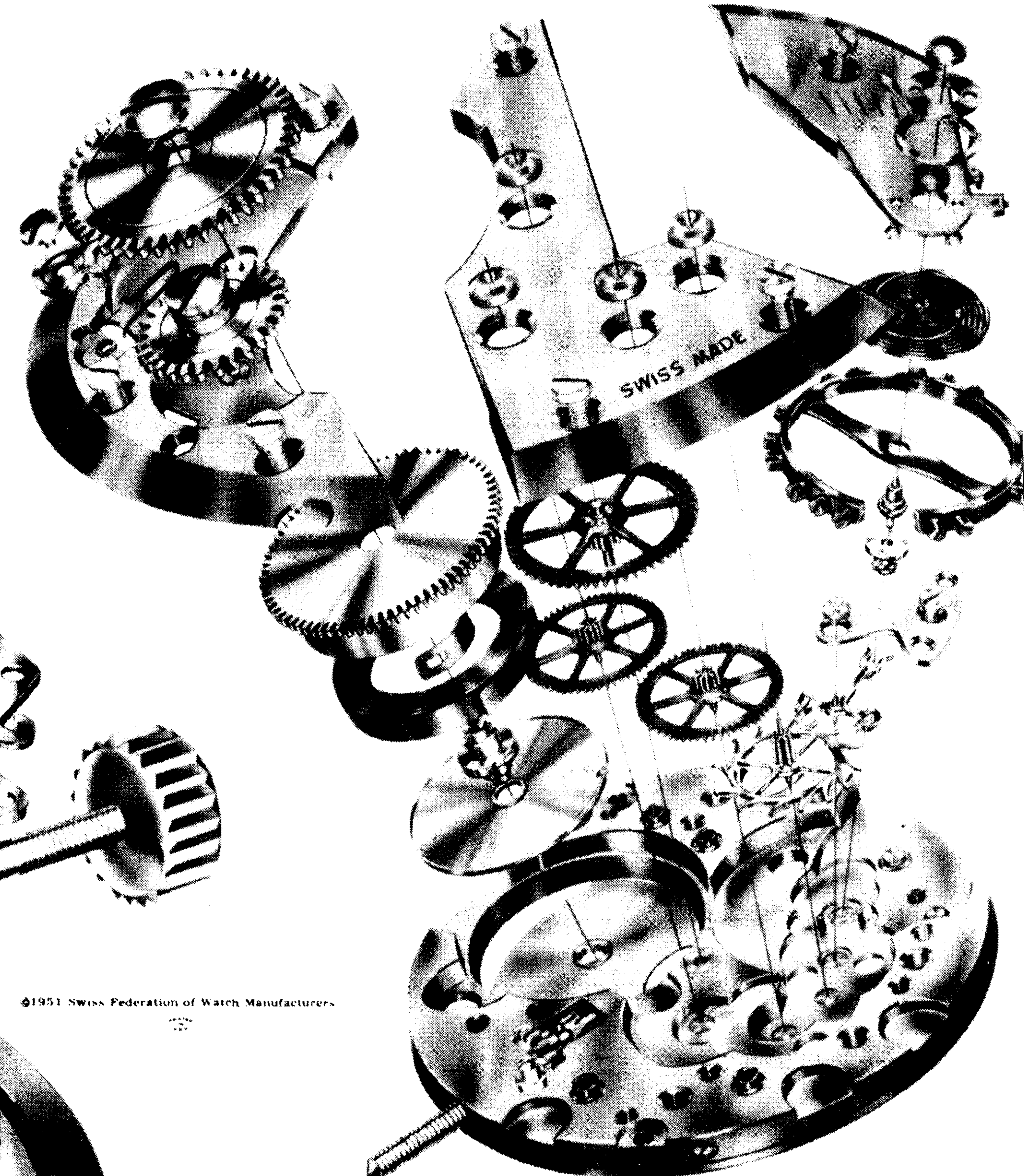
Do you realize that between the plate and bridges of this movement there are exactly six wheels including the barrel, escape wheel and balance. Yet when you have mastered and can replace each part connected with these wheels and their pinions and thoroughly understand the action of the escapement, you have mastered the majority of the repairs that come to the average Watchmaker.

Behind the Dial of the Fine Swiss Watch

Official Swiss Parts Identification

NO.	NOMENCLATURE	NO.	NOMENCLATURE
100	Plate	425	Click
105	Barrel Bridge	435	Yoke (Clutch lever)
110	Train Wheel Bridge and Jewels	440	Yoke Spring
122	Balance cock for Breguet Hairspring	443	Setting Lever (Detent)
125	Pallet Clock and Jewel	445	Setting Lever Spring
185	Barrel Drum	450	Setting Wheel
190	Barrel Cover	703	Escape Wheel and Pinion with lower conical pivot
195	Barrel Arbor	710	Jewelled Pallet Fork and staff
201	Center Wheel and Pinion	720	Pivoted Balance Wheel
210	Third Wheel and Pinion	723	Balance Staff
224	Fourth Wheel and Pinion with Second Hand Bit	730	Roller with Jewel Pin
240	Cannon-pinion (Steel)	735	Breguet Hairspring, regulated, stud and collet
260	Minute Wheel	770	Mainspring
302	Regulator for Breguet Hairspring		
315	Upper Cap Jewel, steel end-piece		
333	Cap jewel, 8 shaped		
401	Stem		
407	Clutch Wheel		
410	Winding Pinion		
415	Ratchet Wheel		
420	Crown Wheel		





These exploded views of a fine Swiss watch are reproduced by courtesy of The Watchmakers of Switzerland Information Center Inc.

The WATCHMAKERS OF SWITZERLAND

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 9

Winding and Setting Mechanisms

—

Sections 220 - 234

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

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CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 9

Sections 220 to 234

Lesson 9. — Winding and Setting Mechanisms.

Section *220* BEFORE having had a chance to handle the different models of watch movements, you may be somewhat confused when attempting to assemble the setting and winding parts.

It is a good plan to study the action and be sure you understand the office of each piece before taking any mechanism apart. If you come in contact with an unfamiliar type make a rough sketch showing just how the parts match with each other. There are not a great number of different types of winding and setting mechanisms and after you have had an opportunity to study them as they come to you for repairs, you will have little trouble in replacing any of the pieces and with practice can tell, when shown a setting part for an American watch, the factory from which it came and what its function is.

In the key wind watch, the winding and setting was performed on separate squares but in the stem wind and stem set movement both of these actions are accomplished by means of the one stem.

As shown in a previous lesson the sleeve in a pendant set case is liable to wear or become broken and allow the stem to slip from the winding to the setting position. Again one might neglect pressing the stem back after setting his watch, or even in handling it the stem could be brought out of the winding position, any of these preventing the proper performance of the hands in indicating the correct time.

While the convenience of the pendant set watch makes it more popular with the average person, the positive action of the lever set mechanism has been recognized as being better for Railroad Watches, consequently one of the requirements for a watch to pass Standard Railroad Inspection is that it be lever set.

Sec. 221 — An Older Type of Lever Set

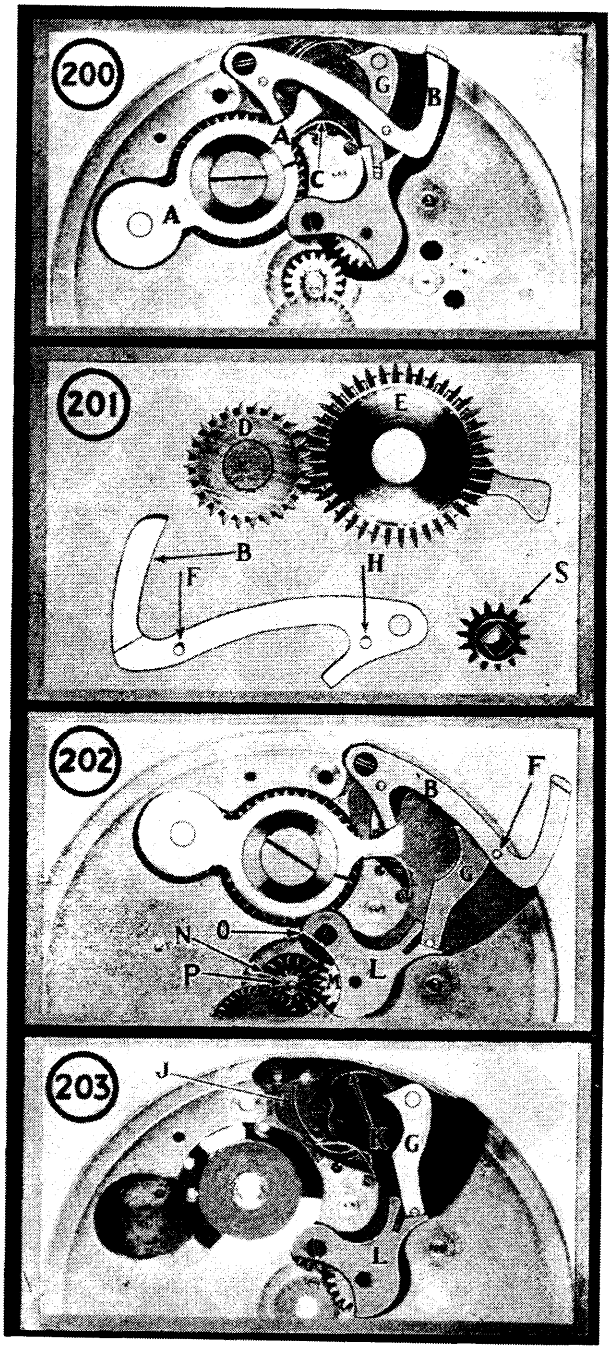
The principles of the winding and setting mechanisms are much the same in all watches, that is the stem turns the winding arbor which is connected with the ratchet wheel by a series of gears when winding, or with the cannon pinion when setting. The older forms of stem winding and setting mechanisms were quite complicated and not always as dependable in their action as the ones of today.

Figure 200 is a view of the dial side of an 18 size American made movement with the dial removed, showing one of the older types of lever setting mechanisms. The shifting of the parts from the winding to the setting position shown in figure 202 is accomplished by a series of levers and springs controlled by the setting lever B.

In figure 200 the mechanism is in the winding position with the lever B pushed in and the vibrating arm spring C pressing the vibrating arm A and this holds the interwind wheel which is underneath, against the ratchet wheel.

In figure 201 is shown the vibrating arm turned over to expose the interwind wheel at D and the crown wheel or main wind wheel at E. B is the setting lever also turned over showing the pins on the lower side, the setting cam G in figure 200 and 202 being controlled by pin F, while the setting lever spring J in figure 203, presses against the pin H, figure 201, and holds the setting lever firmly when in the winding position.

When the lever B is pulled out as shown in figure 202, the pin F slides along the edge of the setting cam G and allows it to shift to the position shown in figures 202 and 203 being forced over by the setting spring K, figure 203. In this position it so presses the setting bar L that the setting wheel M, figure 202, is engaged



with the wheel N which is attached to the cannon pinion P. Thus if the crown wheel is turned while in this position it engages the intermediate set wheel at O and this conveys the power from the setting wheel to the cannon pinion P which carries the minute hand.

In figure 204 is shown the other side of the plate with the winding bridge, ratchet wheel, click and click spring. This winding bridge may be removed by taking out the two screws R and S after which it will appear as in figure 205 with the bevel pinion in position at V. At S, figure 201, the bevel pinion standing on end shows the square hole into which the square of the winding stem fits. When this pinion is turned by means of the stem, the beveled leaves engage the teeth of the crown wheel and turn either the winding or setting, depending upon the position of the vibrating arm.

T in figure 204 shows where the interwind wheel engages the ratchet wheel when in the winding position.

Sec. 222 — A Modern Type of Lever Setting

In the more modern type of watch the change from the setting to the winding is achieved by means of a sliding clutch. In figure 206 are shown the parts of a Hamilton type of lever setting mechanism. A is the clutch lever and spring, B the setting lever or shipper, E the winding pinion, F the clutch and G the winding arbor. The clutch F has a square hole running lengthwise through the center which fits over the square portion H of the winding arbor. The clutch slides freely on this square and is shifted back and forth by the clutch lever and spring A.

One end of the clutch has ratchet teeth at J to match the ratchet teeth in the lower side of the winding pinion at K, while the other end at L matches the teeth of the interset wheel at M in figure 207.

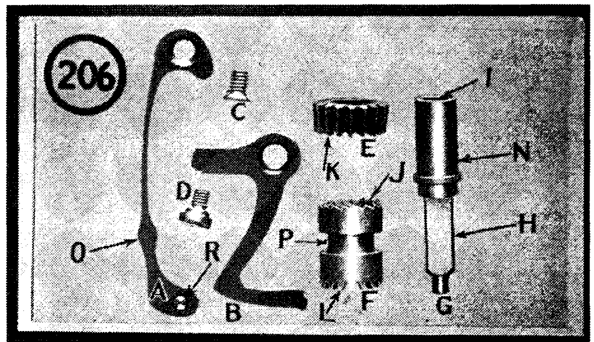
The winding pinion E has a hole through it which is fitted to turn freely on the round portion of the winding arbor at N. The thicker portion of the clutch lever and spring at O fits in the slot P of the clutch and when these parts are assembled and the setting lever is pressed into the winding position shown in figure 207, the tension of the clutch lever and spring holds the ratchet teeth of the clutch in contact with the ratchet teeth of the winding pinion.

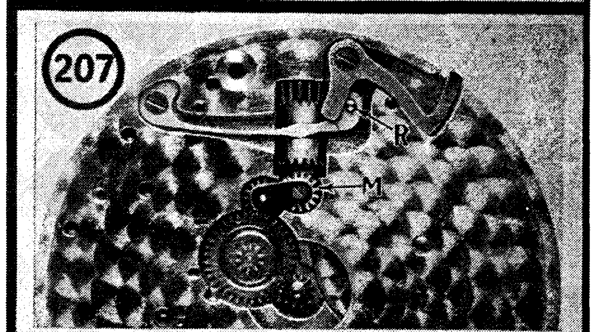
When the setting lever is pulled out to the setting position the end of it is pressed against the pin R of the clutch lever and spring and forces it to the position shown in figure 208. This carries the clutch along the square portion of the winding arbor and the lower end is engaged with the teeth of the interset wheel M and this conveys the power through the setting wheel S and the minute wheel T to the cannon pinion U.

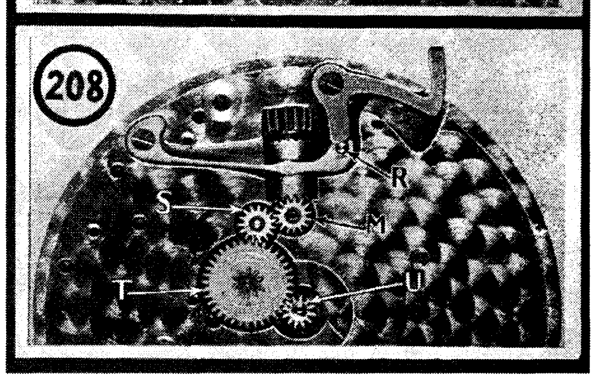
This action may be somewhat confusing at first but if you will remember that the power from the stem is conveyed by the winding arbor directly to the clutch and that the winding pinion does *not* turn except when engaged with the clutch, it may help you to recall how these parts should be placed.

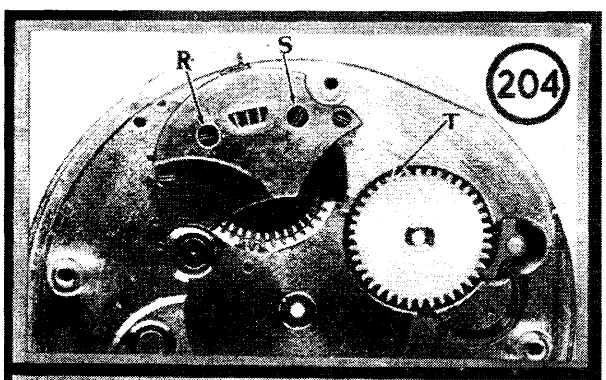
In figure 209 is shown the other side of the plate when these parts are in the winding position and at figure 210 with the setting lever pulled out to the setting position. The clutch and winding pinion in 209 correspond to the position shown in 207, while 210 corresponds to 208. As may be seen in figure 209 the winding pinion is held in place on the winding arbor by the slot in the plate at V which prevents it from creeping away from the clutch and disengaging the teeth. When assembling these parts the clutch and winding pinion are placed on the winding arbor and then set in position on this side of the plate as shown in figure 209 and 210.

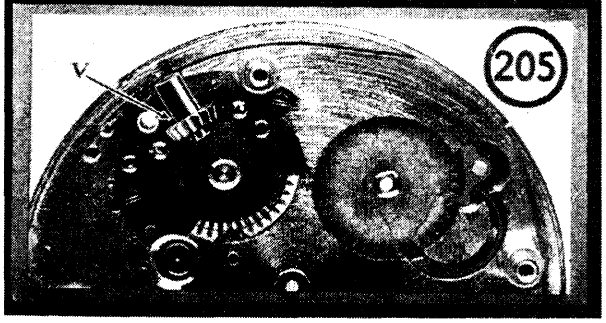
In figure 211 is shown the crown or winding wheel W and the ratchet wheel X, when the movement is assembled. At 212 is shown a side view of the crown wheel on which are two sets of teeth at right angles with each other, see Y and Z. When the clutch is engaged with the winding pinion and the winding arbor is turned by the stem — the winding arbor having a











square hole shown at I in figure 206 into which the square of the stem fits — the leaves of the winding pinion shown at V in figure 209 are engaged with the lower teeth Z on the crown wheel and the upper teeth at Y are engaged with the ratchet wheel as shown in figure 211.

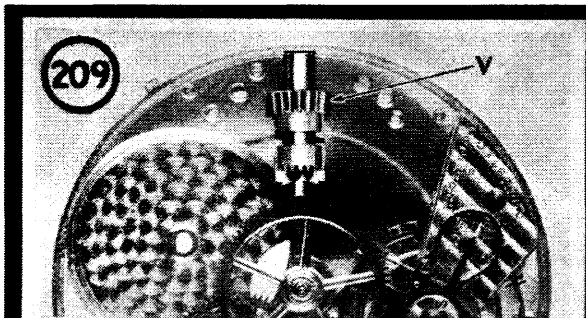
The clutch being held against the winding pinion by the tension of the clutch spring as in figure 207 and the teeth on each of these being ratchet shaped, when the winding arbor is turned backwards the ratchet teeth of the clutch rise and fall in the ratchet teeth of the winding pinion and make the familiar clicking or sound of the *backwind.* When the winding pinion is turned forward the clicking that is heard is caused by the rise and fall of the click at Q, figure 211, in the teeth of the ratchet wheel.

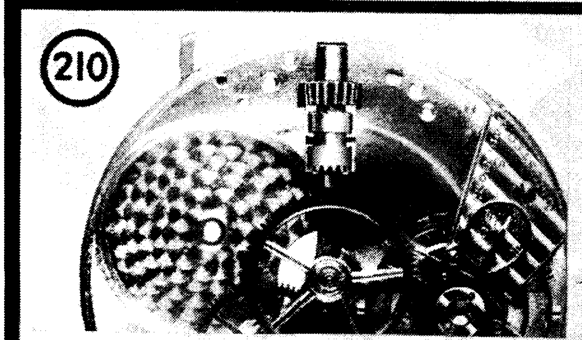
Sec. 223 — A Waltham Lever Set

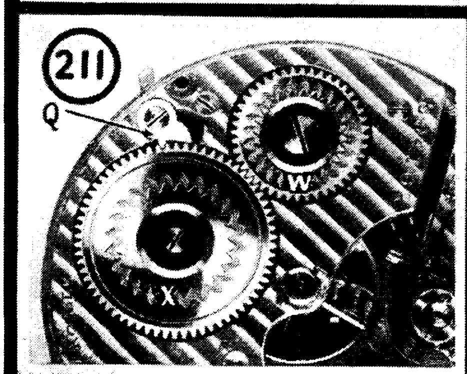
Figure 214 shows another type of lever setting mechanism used on some models of the Waltham watch, with the setting lever at A and the shipper lever at B.

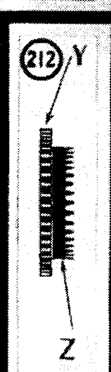
In figure 213, E is the winding pinion, F the clutch, G the winding arbor, H the setting wheel cap, I the setting wheel and J the winding arbor bearing. The end of the winding arbor at K fits into the hole of the winding arbor bearing at L.

On the shipper lever at C, figure 214, is a pin which projects on the under side and fits the slot in the clutch at O, figure 213. When the setting lever is shifted to the setting position the shipper lever is forced down and carries with it the clutch which engages the interset wheel under the setting cap at D, figure 215.









The winding arbor bearing is put in place from the movement side of the plate as shown at M in figure 216. The setting wheel is placed on its shoulder from the dial side and this assembly is held in place with the setting wheel cap screw N which screws through the setting wheel cap D, figure 215, into the winding arbor bearing M, figure 216.

Sec. 224 — Illinois Type of Lever Set

Figure 217 shows the setting arrangement of a high grade Illinois watch movement, the Bunn Special, in which A is the clutch lever, B the clutch lever spring, C the setting lever, and D the setting lever spring. One looped end of the setting lever spring is held by the screw at E while the other end fits over the pin on the lower side of the setting lever at F.

Figure 218 shows the position of these parts when the setting lever is shifted to the setting position and with the plate over the setting wheel removed.

The setting mechanism of the modern lever set watch is not complex in its action and after you understand the mechanical principles of the clutch and winding pinion in its relation to the crown wheel and setting wheel you should be able to re-assemble any of them.

Sec. 225 — Modern Pendant Setting Mechanisms

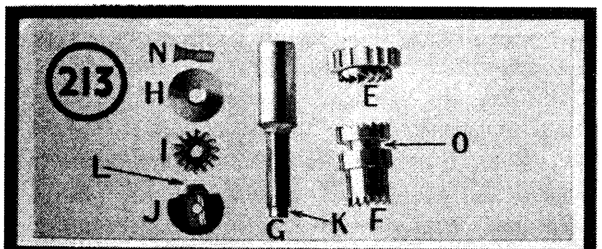
In some of the earlier models of Pendant set watches, before the use of the clutch, vibrating arms or yokes were used. These earlier forms were somewhat complicated but in all modern types you will find the mechanism much simplified and as in the case of the lever set, after you have once mastered the arrangements of the parts you should assemble easily either American or Swiss styles.

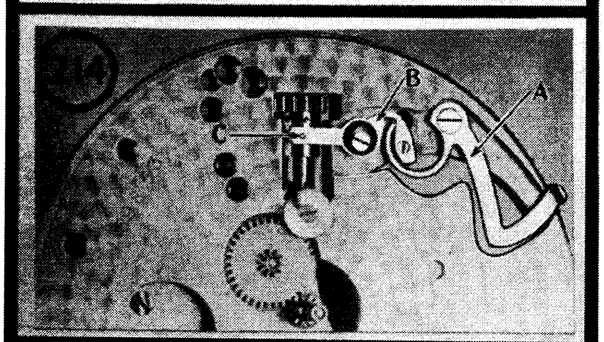
The use of the sliding clutch does away with the yoke and has been adopted by practically all watch manufacturers both in pendant and lever set movements.

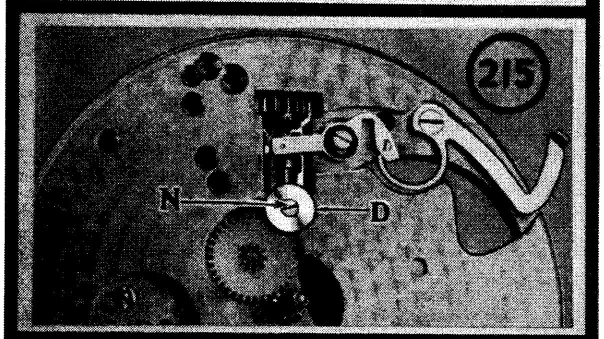
Sec. 226 — Waltham Pendant Set

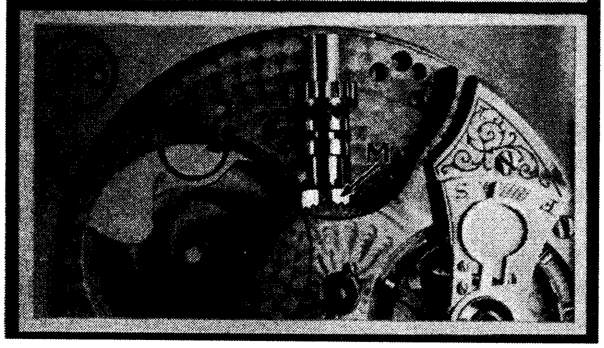
The Waltham pendant set mechanism shown here is used in connection with the stem and sleeve described in lesson 2.

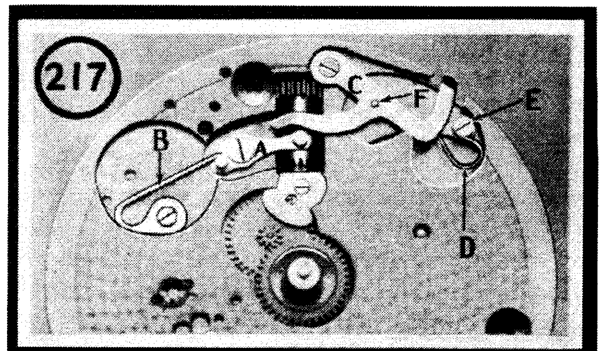
If you will compare the parts in figure 219 you will see that they are much the same as those used in the lever set in figure 213 with the addition of the plunger or push pin at R figure 219. In this photograph I have shown the other side of the winding arbor bearing to enable you to see the shoulder at S on which the setting wheel rests.

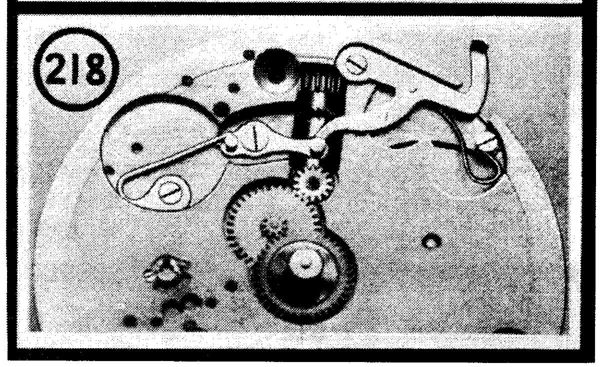












In examining the lever set watches we found that most of the mechanisms for changing the position of the clutch was on the dial side of the pillar plate while in this pendant set movement the majority of the parts are between this plate and the barrel bridge.

In figure 220 is shown the mechanism for shifting from the setting to winding in its position on the lower or pillar plate. These parts are held in place by the shipper cap shown at A and this cap is held by the screw B. By removing this screw and lifting off the cap the parts will appear as shown in figure 222. C is the shipper lever, D the shipper, while the triangular shaped spring shown at E is the shipper spring.

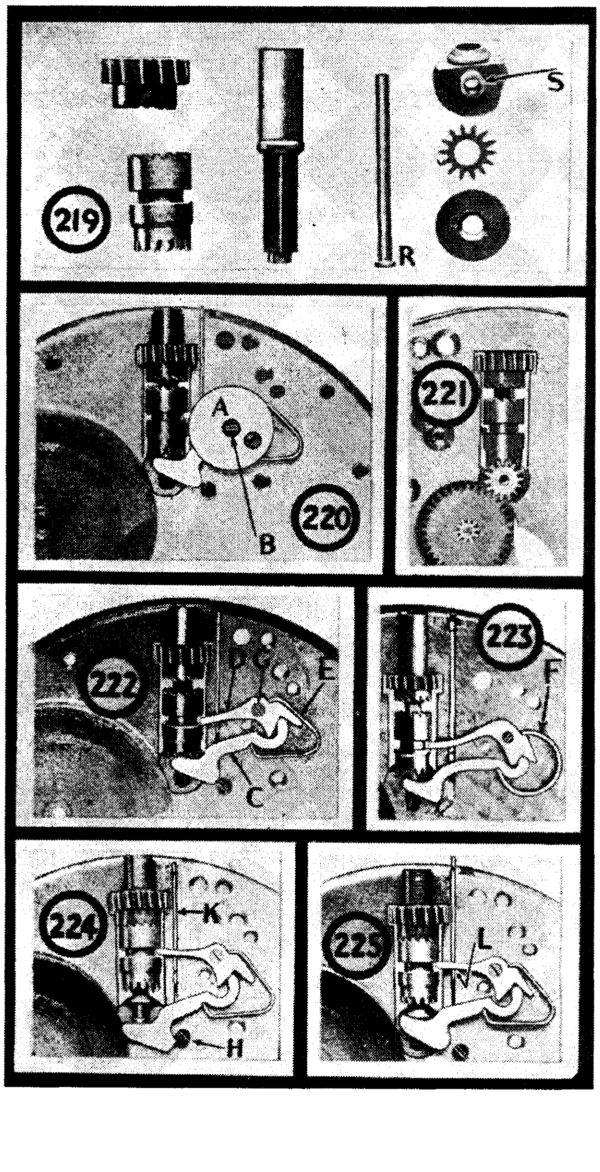
This shipper spring in some models is round as shown at F, figure 223, but its action is the same in either shape. The shipper performs the same office here that the clutch lever did in the lever set model in figure 214, that is it controls the position of the clutch.

Sec. 227 — Setting Position

The position shown in figures 220 and 222, is the one that these parts will assume when the movement is out of the case or when the stem is pulled out to the setting position. The shipper D is pivoted on the screw G. The position of the shipper is controlled by the shipper lever C and the shipper spring E. As shown here the shipper spring presses the lever against the end of the shipper furthest from the clutch and the shipper being pivoted at G, the end which lies in the slot of the clutch is pressed downward carrying the clutch with it, until it engages the setting wheel, see figure 221.

Sec. 228 — Winding Position

When the stem in the pendant set case is pressed into the winding position by means of the crown and is held in that position by the sleeve as explained in Lesson 2, the plunger or push pin which extends through the winding arbor is pushed down to the position shown in 224 and the end of the plunger presses the shipper lever down past the stop screw H and forces the end of the shipper and with it the clutch upward into the winding position, that is with the ratchet teeth of the clutch in the ratchet teeth of the winding pinion. In taking down this mechanism it is not necessary to remove this screw it being left in the plate at all times even when cleaning the watch.



Care should be used to see that the shipper spring E or F does not spring away from you. In assembling it is well to place your shipper and shipper lever in position, then slip one end of the shipper spring in place and holding the two parts down hook the other end in its position. After doing this immediately replace the shipper cap and set the screw to hold it.

This mechanism is hard to assemble without instruction and the beginner usually is confused as to the position of the shipper and the shipper lever but anyone should be able to see the proper location of these parts by consulting these enlarged photographic studies.

Sec. 229 — When Timing Movement Outside the Case

When a lever set movement is out of the case the winding and setting will act as it would when in the case but this is different with a pendant set movement. The only thing that keeps the pendant set mechanism in winding position while in its case is the position of the stem, this in turn being held by the sleeve. When the movement is removed from the case this is released and the shipper spring through the shipper lever forces it to the pendant set position.

When the cannon pinion turns while in the setting position, it turns the minute wheel, setting wheel, clutch and winding arbor. If you will examine figure 221 you will see what I mean. When the cannon pinion is compelled to turn all these parts, its load is increased and unless it fits tighter than is necessary, is liable to slip on the center staff or if the cannon pinion is too tight it will slow down the motion or in some instances stop the watch.

Occasionally movements are allowed to run outside the case and unless there is some means of keeping the parts in the winding position this unnecessary friction will cause the watch to run at a different rate than when cased. For this reason pendant set watches have some method of throwing the parts into the winding position when outside the case.

In the Waltham movement shown here this is accomplished by means of the shipper bar at K in figure 224. The outer end extends to the edge of the plate where there is a notch in which to insert a screw driver or the tip of the tweezers and pull this shipper bar out which causes the hook on the other end at L to catch the shipper and shift it and the clutch to the winding position as shown in figure 225. As long as these parts are in this position the watch cannot be set from the winding arbor but will perform as it does when in the case with the stem pushed in.

It sometimes happens that you may neglect to press this shipper bar back to its proper position. For this reason it is well to always test the winding and setting with your bench key before recasing any movement.

Sec. 230 — Elgin Pendant Setting

Figure 227 shows part of the pillar plate from a 16 size Elgin movement with the winding and setting parts in place on the dial side. Figure 226 shows the other side of this same plate.

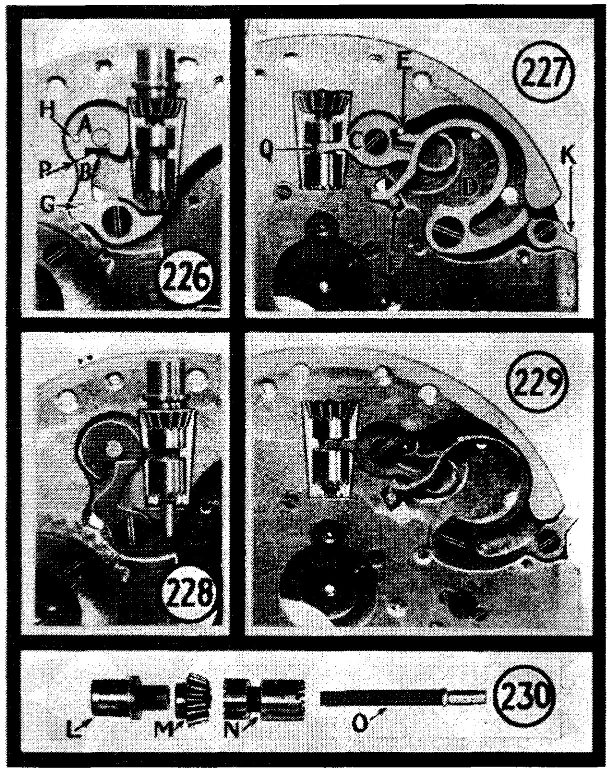
Here is a bevel or winding pinion together with a winding and setting clutch, much on the order of ones you have studied in previous sections, but controlled by a different plan.

The letters indicate the parts as follows:

A—Setting Cam
B—Setting Lever
C—Clutch Lever
D—Setting Spring
K—Setting Spring Cam

Figures 226 and 227 show the parts in the setting position. The setting spring D figure 227, presses the pin F down and this pin being attached to the setting lever B figure 226, at the point G, forces the setting lever over until the end at P pushes the setting cam A upward. At H on the setting cam is attached a pin which extends through the plate and may be seen at E figure 227. As the pin is pressed upward it forces the other end of the clutch lever at Q downward and this carries the winding and setting clutch into the setting position, gearing into the minute wheel as shown in figure 227.

When the stem is pressed into the movement, the winding arbor which also acts as a push pin, pressing down on the lower end of the

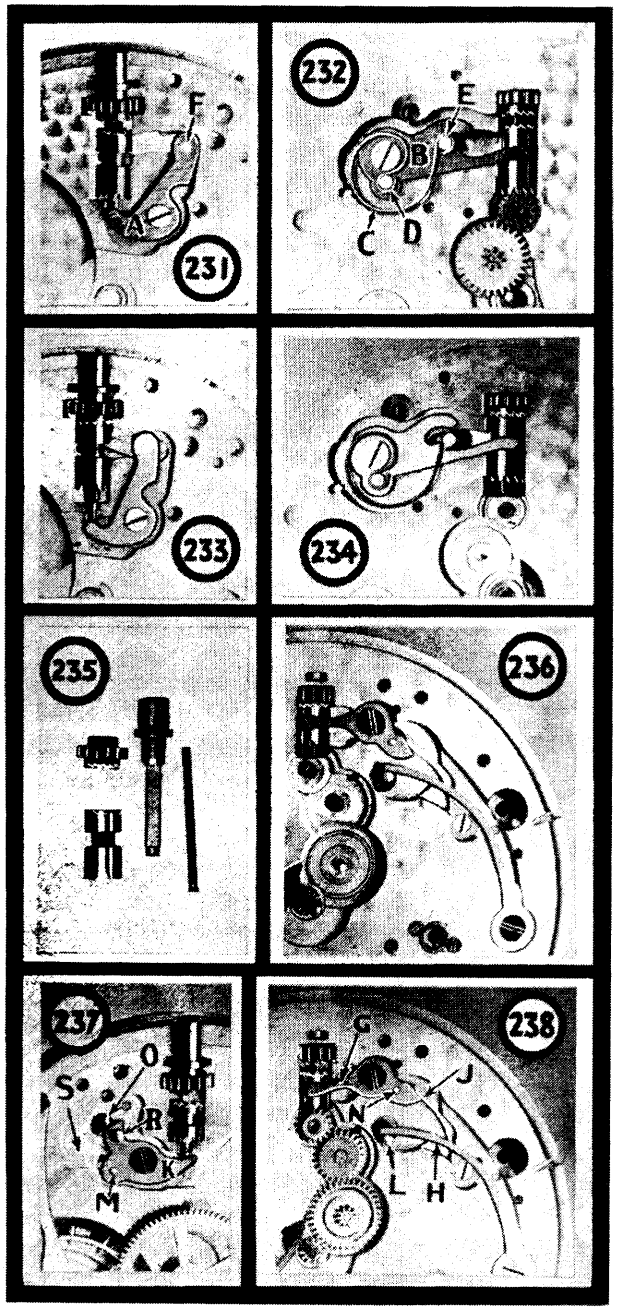


setting lever forces the setting cam over and this raises the end of the clutch lever and carries the winding and setting clutch into the winding position shown in figures 228 and 229.

At K figure 227 is the setting spring cam which serves the same purpose as the shipper bar on the movement described in Section 229. When the movement is in its case, the setting spring cam should be in the position shown in figure 227. If you wish to disengage the clutch from the minute wheel, in order to let the movement time outside the case, push the setting spring cam to the position shown in figure 229 and then with your bench key press the winding arbor to the winding position. The pressure of the setting spring on the pin F having been released by moving the setting spring cam, the parts will remain in this winding position. The setting spring cam may be changed from one position to the other without removing the dial. In casing this type of movement be sure to have the setting spring cam in the position shown in figure 227. If left projecting as in figure 229 it might be broken when pressing the movement into the case.

In figure 230 are shown the following:

L—Winding sleeve
M—Bevel Pinion or winding pinion
N—Winding and setting clutch



O—Winding arbor which also serves as a push pin.

In assembling these parts it is only necessary to line them up as shown in this photograph. The bevel pinion sets on the small shoulder of the winding sleeve, the square of the winding arbor goes through the winding and setting clutch extending into the winding sleeve. When assembled this unit will appear as in figures 226 and 228.

Sec. 231 — Illinois Pendant Set

Figures 231 to 235 show the setting parts of a 12 size Illinois movement not at all complicated and easy to understand. A, figure 231, is the locking lever, B figure 232 the clutch lever and C the clutch lever spring. As shown in figure 232 one end of the clutch lever spring is hooked over the pin at D on the clutch lever and the other end over the pin E which is on the upper end of the locking lever at F figure 231. This spring pulls the pin E into the slot of the clutch lever forcing the end which extends into the clutch, downward to the setting position as shown in figure 232.

When the push pin is forced down, it presses the locking lever over to the position shown in figure 233, thus forcing the pin on the other end past the shoulder in the slot of the clutch lever in figure 234, and this permits the clutch lever to spring upward into the winding position shown in figure 234.

In figure 235 are shown the parts with which you should be familiar by this time, the bevel pinion, the winding and setting clutch, the winding arbor and the pendant push pin. These parts are shown in the assembled unit in figures 231 and 233.

Sec. 232 — A Hamilton Pendant Set

Figures 236 to 238 show a type of Hamilton pendant set mechanism, simple and positive in action.

In figure 238:

G is the clutch lever

H the setting lever spring

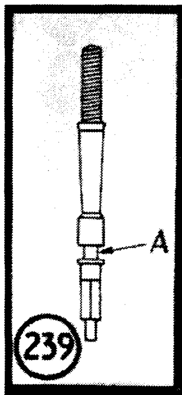
J the clutch lever spring

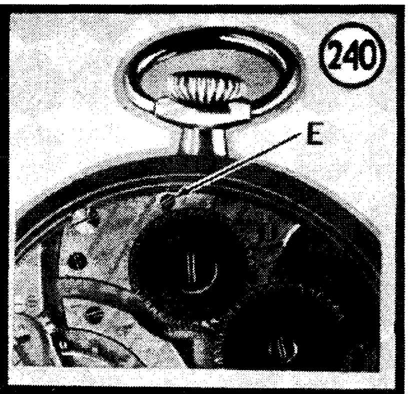
K in figure 237 the pendant set lever.

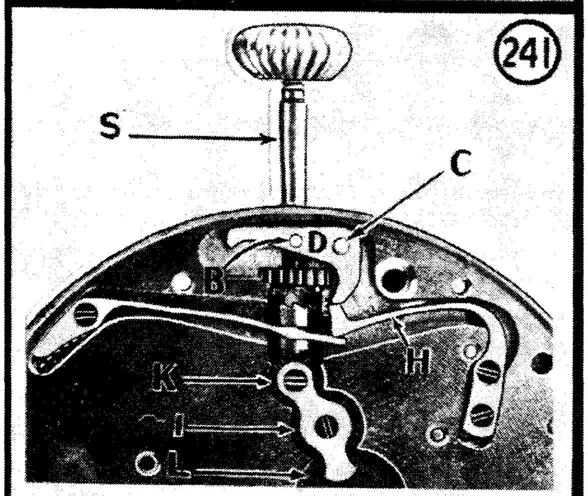
The pin at L figure 238 is fastened to the set lever at M figure 237 while the pin O figure 237 is fastened to the clutch lever at N figure 238. In the setting position the stronger setting lever spring H figure 238 forces the pin at L downward pressing that end of the set lever K figure 237 downward, the upper end pressing the pin at O upward and this presses the end of the clutch lever, which connects with the clutch, into the setting position shown in figure 238.

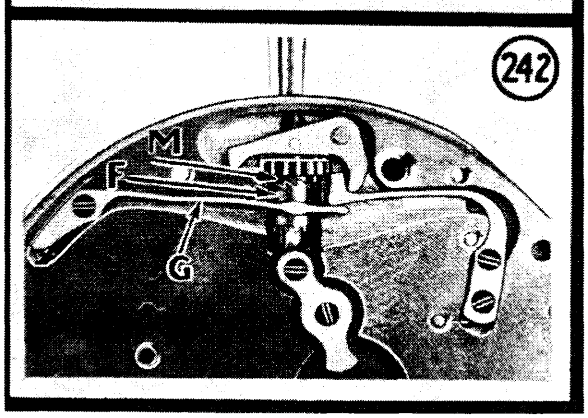
When the push pin is pressed down to the winding position by means of the stem, the pendant set lever K figure 237 is forced away from the pin O and this permits the weaker clutch lever spring at J figure 238 to press the end of the clutch lever and with it the winding and setting clutch into the winding position shown in figure 236.

In this movement will be found a cam fitting in the space at S, one side of which comes in contact with the pin R on the setting lever. This cam (not shown in the photograph) has a pin attached which extends up through the top plate terminating in a screw head and by inserting a screw driver in the slot of this head the cam may be turned to the left causing it to press against the pin R in the setting lever, figure 237 and forcing it into the winding position so the movement may run out of the case with the setting and winding parts in the same position as when in the case with the stem pushed in. The screw head which connects with this cam may be known by its color, it being dark blue while the bridge screws are bright finished. When the movement is replaced in the case be sure that the cam is so turned that the setting works properly.









Sec. 233 — A Different Type of Mechanism

The majority of Swiss pocket watches, some American models and practically all Swiss wrist and bracelet watches have a pendant set mechanism that does not require the use of a sleeve.

Figures 241 and 242 show enlarged views of the setting arrangement of a 12 size South Bend movement with the dial removed. This gives a good idea of the general principles of most pendant set mechanisms which do not depend upon a pendant sleeve.

In this model the setting lever D, figure 241, has a pin projecting from the lower side, the end of which may be seen at B and this pin fits in the slot of the stem at A figure 239. In the photograph in figure 241 the stem is shown at S, where it has been pulled out to the setting position carrying with it the setting lever.

In figure 242 the setting lever is shown in the normal position, that is with the stem pressed in. The winding and setting clutch F slides back and forth on the square of the winding arbor or stem and is controlled as to its position by the clutch spring G. When you pull on the stem it brings the setting lever to the position shown in figure 241 and the end of the setting lever forces the setting lever spring H down to the position shown here and it in turn presses down upon the clutch spring which carries the setting clutch downward until the lower end engages the teeth in the intermediate setting wheel at K, this in turn being connected to the cannon pinion by the larger intermediate setting wheel I and the minute wheel L.

When the crown and stem are pressed in, the setting lever slips off the set lever spring allowing it to resume its normal position as shown in figure 242, freeing the clutch spring which then forces the clutch to engage with the winding or bevel pinion M and this in turn winds the mainspring through the crown wheel and ratchet wheel on the other side of the movement, see figure 240.

In taking this type of movement from the case the screw at E figure 240 is turned to the left to loosen the setting lever D figure 241 and free the pin B from the slot in the stem. This is similar to the Swiss movement shown in figures 40, 43 and 44 in lesson 2, the screw at E, figure 240, extending down through the two plates and being threaded into the setting lever at C figure 241.

Sec. 234 — Examples of Swiss Setting Parts in Wrist Watches

In figure 243 are shown the setting parts of one type of setting mechanism as employed in a Swiss wrist watch. The part A is the setting lever or detent, B the yoke lever or clutch lever and C the yoke spring or clutch lever spring. This type of setting works on much the same principle as was described in section 233. When the stem is pushed in, the yoke lever holds the clutch in mesh with the winding pinion being held in that position by the spring C. When the stem is pulled out as in figure 244 it presses the end of the setting lever against the yoke lever which carries the clutch down until engaged with the intermediate set wheel and is locked in this position by the point on the yoke lever being held in the notch on the setting lever at E in figure 244.

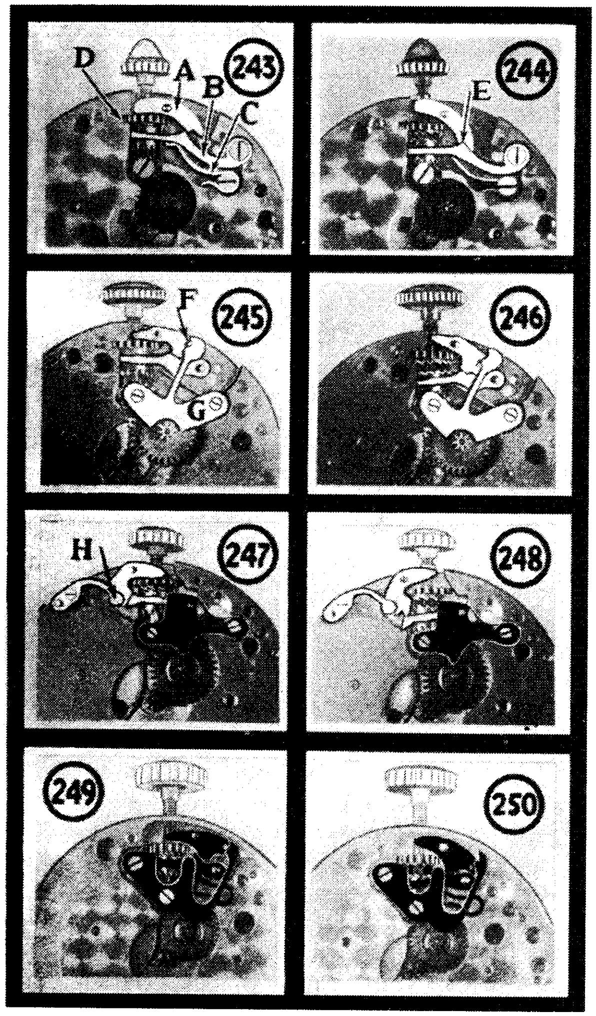


Figure 245 shows a Swiss type of setting and winding with a yoke bridge or setting wheel bridge, at G. Here the parts are locked into the winding position by means of the notch on the arm extending from the yoke bridge to the pin on the setting lever at F. When the stem is pulled out the lever is held in this setting position by the arm pressing against the pin as shown in figure 246.

In figures 247 and 248 is shown a different type of yoke bridge and here the setting lever works on the yoke lever from the left side and is locked in position by the pin on the end of the setting spring at H figure 247.

In figure 249 is another type of yoke bridge with the arm extending from the end to lock the setting lever in position much as the one does in figure 245. Figure 250 shows this same assembly in the setting position.

One of the systems of selecting material for Swiss watches is based largely upon the size of the movement and the shape of the parts I have been describing. Make yourself familiar with these three pieces, which are found in the great majority of Swiss wrist and bracelet watches and from the distinctive shape of which it is possible to identify the factory in which the watch was made.

1.—Setting lever or detent.

2.—Yoke lever or clutch lever.

3.—Setting wheel bridge or yoke bridge.

TABLE OF CONTENTS: Unit W3 - Lessons 8 - 9

JOB SHEETS

DISASSEMBLY: 12/s Or 16/s Elgin Open Face

NOTE: In each watch there are several different sizes of screws. It is important that these screws be put back in their correct position. We suggest that as the odd sizes of screws are removed they be put back in the plate after the part they were holding has been removed. This will eliminate the possibility of misplaced screws. When you become familiar with the various screws and are able to recognize their correct position in the watch, this practice may be discontinued.

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer - Mainspring winder - Jewel pusher

PROCEDURE	REFERENCE
HOW TO DISASSEMBLE 12/s OR 16/s ELGIN OPEN FACE	
1. Remove movement from case and place in movement holder.	Les. 1
2. Let down power.	Les. 5, Sec. 132
3. Loosen stud screw, remove balance cock and balance wheel.	Fig. 169
4. Remove hands, dial, hour wheel and cannon pinion.	Fig. 170-173-175-177
5. Remove minute wheel clamp and minute wheel.	Fig. 175-176
6. Remove clutch lever and setting spring.	Les. 9, Sec. 230
7. Turn movement over and remove pallet bridge and fork.	Fig. 178-179
8. Remove ratchet wheel and crown wheel.	Fig. 180
9. Remove train and barrel bridge.	
10. Remove train wheels and barrel.	
11. Remove barrel cap, arbor and mainspring.	
12. Lift out winding pinion and clutch assembly, separate the four parts of this assembly.	Les. 9, Sec. 230
13. Remove setting cam and setting lever.	Fig. 226
14. Remove balance cap jewels from balance cock and pillar plate.	Les. 10, Sec. 240; Les. 13

NOTE: Observe the difference in size and appearance of these two jewel settings so you will remember when replacing which one belongs in the balance bridge and pillar plate.

UNIT	W III
LESSON	8-9

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W8-9-J2

ASSEMBLY: 12/s Or 16/s Elgin Open Face

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - mainspring winder jewel pusher

PROCEDURE | REFERENCE

HOW TO ASSEMBLE 12/s OR 16/s ELGIN OPEN FACE

1. Place pillar plate on movement rest, dial side up.
2. Replace balance cap jewel.
3. Turn pillar plate over and replace setting lever and cam.
4. Assemble winding sleeve, winding pinion, clutch and winding arbor and put in place.
5. Place all train wheels on plate in the order listed: 1. Escape wheel and pinion, 2. 3rd wheel and pinion, 3. 4th wheel and pinion, 4. Center wheel and pinion. — Fig. 183
6. Replace train bridge and screws. — Fig. 184
7. Assemble mainspring, arbor and cap in barrel.
8. Replace barrel and bridge. — Fig. 185
9. Replace crown wheel and screw. (Turn screw counter clockwise to tighten.)
10. Replace ratchet wheel and screw.
11. Turn movement over and replace cannon pinion and minute wheel and clamp.
12. Replace clutch lever and setting spring.
13. Test winding and train - should revolve freely.
14. Turn movement over and replace P. F. & A. and bridge.
15. Replace balance cap jewel and assemble balance and hairspring to balance bridge. — Sec. 215
16. Replace balance bridge and wheel in movement.
17. Turn movement over and replace hour wheel, dial and hands. — Les. 11

(9-55) W8-9-J2

DISASSEMBLY: 12/s Or 16/s Elgin Hunting

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer - jewel pusher

PROCEDURE

		REFERENCE
	HOW TO DISASSEMBLE 12/s OR 16/s ELGIN HUNTING	
1.	Place movement in movement holder and let down power.	Les. 5, Sec. 132
2.	Loosen stud screw, remove balance cock.	Sec. 209
3.	Remove balance wheel.	
4.	Remove hands, dial, hour wheel and cannon pinion.	Sec. 210
5.	Remove minute wheel clamp and minute wheel.	
6.	Remove clutch lever and setting spring.	Sec. 230
7.	Turn movement over and remove pallet bridge and fork.	Fig. 178-179
8.	Remove ratchet wheel and crown wheel.	Fig. 180
9.	Remove train and barrel bridge.	
10.	Remove train wheels and barrel.	
11.	Remove barrel cap, arbor and mainspring.	
12.	Lift out winding pinion and clutch assembly and separate the four parts.	Sec. 230
13.	Remove setting cam and setting lever.	
14.	Remove cap jewels from pillar plate and balance cock.	Les. 10 & 13

UNIT	W III
LESSON	8-9

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W8-9-J4

ASSEMBLY: 12/s Or 16/s Elgin Hunting

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - hand remover - cannon pinion remover - mainspring winder - jewel pusher

PROCEDURE	REFERENCE
HOW TO ASSEMBLE 12/s OR 16/s ELGIN HUNTING	
1. Place pillar plate on movement rest, dial side up.	
2. Replace balance cap jewel.	
3. Turn plate over and replace setting lever and setting cam.	
4. Assemble winding sleeve, winding pinion, clutch and winding arbor and put in place.	
5. Place all train wheels on plate in the order listed: 1. Escape wheel and pinion. 3. 3rd wheel and pinion. 2. 4th wheel and pinion. 4. Center wheel and pinion.	Sec. 212
6. Replace train bridge and screws.	Fig. 184
7. Assemble mainspring, arbor and cap in barrel.	
8. Replace barrel and bridge.	Fig. 185-186
9. Replace crown wheel and screw.	
10. Replace ratchet wheel and screw.	
11. Turn movement over and replace cannon pinion, minute wheel and clamp.	
12. Replace clutch lever and setting spring.	
13. Test winding and train - should revolve freely.	
14. Turn movement over and replace P. F. & A. and bridge.	
15. Replace balance cap jewel and assemble balance and hairspring to balance bridge.	Sec. 215
16. Replace balance bridge and wheel in movement.	Fig. 190
17. Turn movement over and replace hour wheel, dial and hands.	Les. 11

DISASSEMBLY: 12/s Or 16/s Waltham

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer - jewel pusher

PROCEDURE | REFERENCE

HOW TO DISASSEMBLE 12/s OR 16/s WALTHAM

1. Place movement in movement holder and let down power.
2. Loosen stud screw and remove balance cock. — Sec. 208
3. Turn movement over and remove hands and dial, hour wheel, cannon pinion and minute wheel.
4. Remove intermediate set wheel. NOTE: The bearing on which the intermediate set wheel is setting is also the bearing for push pin.
5. Turn movement over and remove pallet bridge and fork.
6. Remove ratchet wheel.
7. Remove crown wheel screw and crown wheel. (NOTE: Right thread turn counterclockwise to release.)
8. Remove train and barrel bridge.
9. Remove train wheels and barrel.
10. Remove barrel cap, arbor and mainspring.
11. Remove shipper cap, shipper spring, shipper lever and shipper. — Les. 9, Sec. 226-227-228-229
12. Remove clutch and winding pinion assembly, separate the 5 parts.
13. Remove balance cap jewels from pillar plate and balance cock. — Les. 10-13

ASSEMBLY: 12/s Or 16/s Waltham

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - mainspring winder

PROCEDURE — REFERENCE

HOW TO ASSEMBLE 12/s OR 16/s WALTHAM

1. Place pillar plate in movement holder, dial side up and replace balance cap jewel.
2. Place pillar plate on movement rest, dial side down.
3. Assemble and replace the winding pinion and clutch assembly.
4. Replace shipper, shipper lever, shipper spring and cap.
5. Place all train wheels on plate in the order listed:
   1. Escape wheel and pinion. 3. 3rd wheel and pinion.
   2. 4th wheel and pinion. 4. Center wheel and pinion.
6. Replace train bridge and screws.
7. Assemble mainspring, arbor and cap in barrel.
8. Replace barrel and barrel bridge.
9. Replace crown wheel and screw. (Turn screw clockwise to tighten.)
10. Replace ratchet wheel and screw.
11. Test winding and train - should revolve freely.
12. Replace P. F. & A. and bridge.
13. Replace balance wheel in movement. — Fig. 168
14. Replace balance cap jewel and put balance bridge in place.
15. With stud in place at proper height, tighten stud screw. — R Fig. 167, Sec. 208
16. Replace intermediate setting wheel and cap.
17. Replace cannon pinion, minute wheel and hour wheel.
18. Replace dial and hands.

UNIT	W III
LESSON	8-9

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W8-9-J7

DISASSEMBLY: 18/s Elgin

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer - jewel pusher

PROCEDURE	REFERENCE
HOW TO DISASSEMBLE 18/s ELGIN	
1. Place movement in movement holder.	
2. Loosen stud screw.	Lesson 5
3. Remove balance bridge and balance wheel.	Lesson 5
4. Let down power.	Lesson 5
5. Turn movement over and remove hands and dial.	
6. Remove hour wheel and cannon pinion.	
7. Remove minute wheel.	
8. Remove vibrating arm, crown wheel and intermediate winding and setting wheels.	Les. 9, Sec. 221
9. Turn movement over and remove barrel bridge and barrel.	Lesson 5
10. Remove barrel cap, arbor and mainspring.	
11. Remove ratchet wheel.	
12. Remove plate bridge screws.	Sec. 217
13. Turn movement over holding upper bridge in place. Then lift lower plate up.	
14. Remove all train wheels and P. F. & A. from upper plate or train bridge.	
15. Remove balance cap jewels from potance and balance cock.	

(10-55) W8-9-J7

ASSEMBLY: 18/s O. F. Elgin

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - mainspring winder

PROCEDURE

REFERENCE

HOW TO ASSEMBLE 18/s O. F. ELGIN

1. Replace balance cap jewels.
2. Set upper plate or train bridge in a movement holder, upside down. — Sec. 217
3. Insert P. F. & A. in opening of potance. — L Fig. 193
4. Put escape wheel in proper jewel or hole making sure that the escape wheel teeth line up with pallet stones.
5. Put fourth wheel in position with long pinion up.
6. Put center wheel in position with long pinion up.
7. Put third wheel in position.
8. Take pillar plate and lower it over train wheels. NOTE: The center pinion is the longest, so that should first be through, then line the fourth pinion in it's proper jewel. Holding the pillar plate in place line the other three pinions in their proper jewels.
9. Holding pillar plate at edges turn movement over and put in bridge screws.
10. Insert ratchet wheel, be sure click is in position.
11. Assemble mainspring, arbor and cap in barrel.
12. Replace barrel and bridge.
13. Turn movement over and install cannon pinion and minute wheel.
14. Replace crown wheel, intermediate winding and setting wheel and vibrating arm.
15. Replace hour wheel, dial and hands.
16. Replace balance wheel and balance cock.

UNIT	W III
LESSON	8-9

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W8-9-J9

DISASSEMBLY: Swiss AS 970

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer

PROCEDURE

HOW TO DISASSEMBLE SWISS AS 970

1. Remove hands, dial, hour wheel and cannon pinion.
2. Turn movement over and loosen stud screw. NOTE: Do not push on stud.
3. Remove balance bridge and balance wheel. (Tilt movement holder on bench and jiggle as you lift balance bridge, balance wheel should come free of movement.)
4. Turn bridge and wheel over and lay it flat on bench plate.
5. Holding bridge down firmly, select proper screwdriver and turn hairspring gate half way. NOTE: If there is not a slot for screwdriver, gate may have a hole, use a small pin to open regulator gate.
6. Turn bridge over and push on stud, balance and hairspring should come free of bridge.
7. Let power down.
8. Remove pallet bridge and fork.
9. Remove train bridge.
10. Remove ratchet wheel and crown wheel. (Both screws turn clockwise to loosen.)
11. Remove barrel bridge and barrel.
12. Remove barrel cap, arbor and mainspring.
13. Remove train starting with: a. Center wheel. b. 3rd wheel. c. 4th wheel. d. Escape wheel.
14. Remove two screws holding set bridge and carefully remove clutch lever and spring.
15. Remove minute wheel and intermediate wheel.
16. Remove all cap jewels.
17. Release set lever, pull out stem, remove clutch and winding pinion.

ASSEMBLY: Swiss AS 970

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - mainspring winder

PROCEDURE

HOW TO ASSEMBLE SWISS AS 970

1. Place pillar plate on movement holder.

2. Replace all cap jewels.

3. Place all train wheels on plate in order listed below:
   A. Escape wheel
   B. 4th wheel
   C. 3rd wheel
   D. Center wheel.

4. Replace train and escape wheel bridges.

5. Assemble mainspring, arbor and cap in barrel.

6. Replace barrel and bridge.

7. Replace crown and ratchet wheel.

8. Replace cannon pinion.

9. Replace clutch winding pinion, stem, intermediate set wheel, minute wheel and set bridge.

10. Replace P. F. & A. and bridge.

11. Assemble balance wheel and hairspring to cock.

12. Holding bridge take screw driver and turn gate closed, making sure that outer coil is in regulator pins.

13. Replace balance assembly in movement.

14. Replace hour wheel, dial and hands.

DISASSEMBLY: AS 1194 Direct Drive Sweep Second

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - hand remover - cannon pinion remover - assembly tweezer

PROCEDURE

HOW TO DISASSEMBLE AS 1194 DIRECT DRIVE SWEEP SECOND

1. Remove movement from case.

2. Remove hands and dial.

3. Remove hour wheel and cannon pinion.

4. Turn movement over and loosen stud screw. (NOTE: Do not push on stud.)

5. Remove balance bridge and balance wheel.

6. Turn bridge and wheel over and lay flat on bench plate.

7. Holding bridge down firmly, select proper screwdriver and turn hairspring gate quarter turn in either direction.

8. Turn bridge over and push on stud, balance should come free of bridge.

9. Let power down.

10. Remove pallet bridge and fork.

11. Remove train bridge.

12. Remove escape wheel, 4th (sweep) wheel and 3rd wheel.

13. Remove ratchet and crown wheel.

14. Remove barrel bridge and barrel.

15. Remove barrel cap, arbor and mainspring.

16. Remove center wheel bridge and center wheel.

17. Remove set bridge.

18. Remove minute wheel and intermediate set wheel.

19. Carefully remove clutch lever and spring.

20. Remove stem, clutch and winding pinion.

21. Remove all cap jewels.

ASSEMBLY: AS 1194 Direct Drive Sweep Second

TOOLS, EQUIPMENT AND SUPPLIES:

Movement holder - screwdriver - assembly tweezer - mainspring winder

PROCEDURE

HOW TO ASSEMBLE AS 1194 DIRECT DRIVE SWEEP SECOND

1. Replace all cap jewels.
2. Replace center wheel and bridge.
3. Assemble mainspring, arbor and cap in barrel.
4. Replace barrel and bridge.
5. Replace crown and ratchet wheel.
6. Replace escape wheel, 3rd wheel and 4th (sweep) wheel.
7. Replace train bridge and screws. (Check for train recoil.)
8. Replace cannon pinion.
9. Replace clutch, winding pinion and stem.
10. Replace clutch lever and spring, intermediate set wheel minute and set bridge.
11. Replace P. F. & A. and bridge.
12. Assemble balance wheel and hairspring to cock.
13. Holding bridge, use screwdriver to close regulator gate. (Be sure outer coil of hairspring is in between regulator pins.)
14. Replace balance assembly in movement.
15. Replace hour wheel, dial and hands.

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 10

Cleaning Watches

—

Sections 235 - 259

CHICAGO SCHOOL OF WATCHMAKING

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Lesson 10

Sections 235 to 259

CLEANING WATCHES

SEC. 235 — Necessity for Cleaning

One of the most common services which the watchmaker is called upon to perform is the cleaning of watches. The general repair of a watch is not complete until it has been cleaned thoroughly, oiled properly and brought to time. In a general overhaul the replacement of parts and the repairs necessary to put the watch in first class order must be done before the watch is cleaned. The actual cleaning does not require a great amount of skill provided you are able to take apart and reassemble a watch in a workmanlike manner. Every part must be absolutely clean and then kept that way until the movement is back in the case. Of course, this cannot be accomplished until the movement has been taken apart, including the winding and setting parts, and all cap jewels removed and cleaned before reassembling. The difference between the so-called "cheap" cleaning job and that done in a shop catering to better-class work most often is merely a difference in thoroughness.

As a general rule, a watch does not get dirty as we think of dirt on larger machinery. The modern watch case, if closed tightly, protects the movement against particles of dirt and lint, but in spite of the care manufacturers take to exclude dirt, dust is bound to penetrate into the movement one way or another. The particles of lint and dust work into the train and increase friction, eventually causing the watch to stop. When the oil becomes impregnated with dust, abrasive action follows and the highly polished surfaces of the pivots become roughened and, if left without cleaning and oiling, the pivots may be cut to such an extent as to ruin them. Rough pivots and gummy oil, or lack of oil, cause undue friction which, in turn, slow down the motion and change the rate of the watch.

When a watchmaker takes in a watch to be cleaned he frequently finds, upon taking it apart, that other repairs are necessary. If the watch belongs to a regular customer it is fair to suppose that unless it has met with an accident it is in good condition otherwise than the thickening of oil and accumulation of dirt. It is therefore good practice to make a thorough examination of the parts during the process of taking it apart, and a final examination after the parts have been thoroughly cleaned.

At this point the student is handicapped because of his inability to make all the necessary repairs. As he progresses with the lessons these repairs will be made. However, we will suggest a short form of examination for the student to follow.

SEC. 236 — Examination of Parts

Examine the case. See if it closes tightly, both front and back. Examine the crystal and run fresh cement in bezel if necessary. See if the case shows dents or other evidences of misuse. This may be an indication of the sort of treatment to which it has been subjected and is often a guide to the watchmaker in determining the cause of trouble. Check winding and setting before removing from the case. Frequently a watch winds or sets hard when in the case, due to faulty alignment of the movement with the pendant. If pendant set, check the winding and setting before removing from the case.

Remove movement from the case and make certain the case screws hold the movement firmly in place. Remove dust band. Check hands to see if they are fitted properly. The hour and minute hand should fit securely; the second hand just tight to be movable on the fourth pinion pivot without endangering the train or escapement. After the hands and dial have been removed, examine the dial wheels, including the cannon pinion, minute and hour wheels.

See that the hour wheel has sufficient sideshake to be free on the cannon pinion without rocking, and that the length of the pipe is just sufficient to be visible beneath the hand shoulder of the cannon pinion.

Examine the balance wheel. Stop it at the point of rest, then release it, allowing it to gradually come up to a motion. If the balance is out of true in the round it can be easily determined by looking directly down upon the balance. Look at the balance from the side to see if it is out of true in the flat.

Examine the hairspring in the same manner to detect errors in the round and flat. When a spring is true in the round there will be no appearance of jumping; the coils will appear to uniformly dilate and contract. The hairspring must be level and centered. These conditions and the method of correcting them will be taken up in future lessons.

Examine the escapement. Bring the roller jewel in perfect line with the balance staff and pallet arbor. This is the point of rest. Try the shake of the fork slot of the roller jewel. This is done by grasping the fork with a pair of fine pointed tweezers and carefully moving from side to side while holding the balance.

Remove the balance and examine the pivots on the balance staff. See that they are straight and have no grooves. Students often injure the ends of balance pivots by forcing the balance cock into place when the pivot is not in the jewel hole.

Make sure the roller jewel is securely set, perfectly upright, and is not chipped.

Let down the mainspring and remove the pallets. Examine the pallet stones for imperfections. Check the guard pin. Check the pivots on the pallet arbor. Examine each and every wheel and pinion as it is removed. Examine other parts as they are removed. When you are capable of making all repairs you will find that it pays to find and correct these repairs before cleaning a watch.

SEC. 237 — Common Cleaning Method

There are many different methods used in cleaning watches. Prepared cleaning solutions sold by material houses are probably the most common type used today and are used in place of cyanide.

One of the most common methods of cleaning a watch is to use benzine or naphtha to cut the old oil and grease, scrub with soap solution, dip in a potassium cyanide solution in order to brighten the plates and wheels thoroughly, rinse with clean water, dip in alcohol and dry in sawdust. As far as the actual cleaning of the watch and parts are concerned, little improvement has been made over this process. Cyanide of potassium is such a deadly poison and must be handled so carefully that we strongly advise against its use at any time. Much time and care must be used in brushing every particle of the sawdust from the parts lest a small particle be overlooked and eventually work its way into the train or escapement.

In the modern system of cleaning about to be described, advantage is taken of certain chemicals which eliminate the necessity of using sawdust and which clean with less effort than the method described. There should be no compromise as to the thoroughness of your work. EVERY PART MUST BE CLEANED.

SEC. 238 — Modern Cleaning Method

The method we are going to explain is an excellent one and is recommended by several watch factories. If you have occasion to discuss this new and modern method with others, you will, in all probability, find those (especially "old timers") who will disagree with your method. There will be those who say three solutions are enough, that so-and-so brand of cleaner is superior. This is true no matter what you are undertaking and will be prevalent throughout your entire career as a watchmaker. You do not have to accept another person's methods as being correct. If, for some reason or other, you feel that other methods are better than the ones you have been taught, test them. Prove to yourself conclusively that they are better. As you progress even the most up-to-date methods of today will sometimes be improved upon. The methods we teach you are modern, up-to-date and tested. In our opinion they are the best. It is through years of experience that inferior methods have been discarded.

SEC. 239 — Cleaning by Hand

In your first attempt at cleaning a watch use a 12 or 16 size watch movement. In addition to the tools already used you will need the following:

- 7 Glass Jars (½ pint capacity) or Alcohol Cups
- 1 Bunch White Metal or Brass Wire
- Bench Block
- Blower
- Jewel Pusher
- Jewel Screw Drivers, Set of 3
- 1 Bottle of Watch Oil
- Gold Tipped Watch Oiler
- Oil Cup
- 1 Bunch Pegwood
- 1 Hard Watch Brush
- 1 Soft Watch Brush

For practice in cleaning watches any type of glass jar with a wide mouth and a cover will be suitable. Figure 10–1 illustrates ½ pint jar with a screw top which is very satisfactory.

Label jars from 1 to 7 and fill about ⅔ full of solution as follows: carbon tetrachloride in jar #1, denatured alcohol in jar #2, etc.:

No. 1 Carbon Tetrachloride
2 Denatured Alcohol

FIG. 10-1

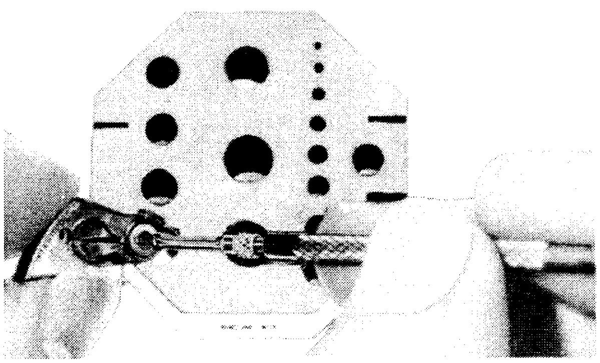


FIG. 10-2

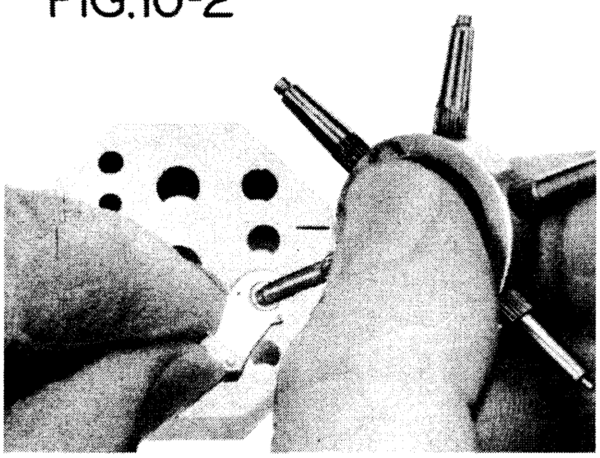


FIG. 10-3

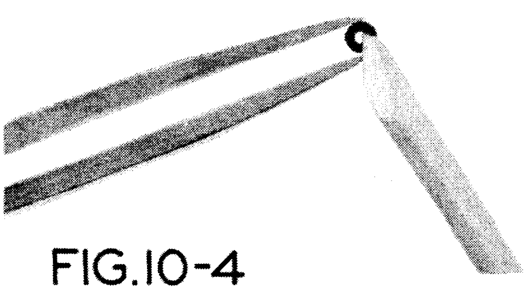


FIG. 10-4

3 Soap Solution (formula to follow)
4 Tap Water (change frequently)
5 Distilled Water
6 Denatured Alcohol
7 " "

The denatured alcohol used in jars #2, #6 and #7 should be of the highest quality. Denatured alcohol that is yellow in color should be avoided.

For making soap solution used in jar #3 secure from your druggist:

2⅔ ozs. Tincture of Green Soap
28 ozs. Household Ammonia
1 gal. Distilled Water

From the gallon of distilled water remove one quart, add the tincture of green soap and ammonia to the remaining distilled water and refill with distilled water. This will give you one gallon of watch cleaning solution for use in cleaning watches manually. The carbon tetrachloride is procurable at a drug store but should the druggist be unable to supply it ask him for a high grade degreasing agent, preferably non-inflammable.

SEC. 240 — Removing Balance and Cap Jewels

Let down the power and completely disassemble your practice movement as described in Lesson No. 8 and place the parts in a movement tray and cover. Keep the plates and wheel segregated. It is necessary to remove cap jewels. The cap jewels are found directly above and below the balance wheel and are the jewels upon which the ends of the balance pivot rotate. This is true in most 7, 15 and 17 jewel watches. In watches of 19 and 21 jewels you will usually find another pair of cap jewels at the end of the escape pinion or pallet arbor, but for your practice work we recommend using only 7, 15 and 17 jewel watches, having upper and lower balance cap jewels only.

Figure 10–2 illustrates removing 2 jewel screws that hold cap jewel in place in the balance cock. After removing jewel screws invert bridge over hole in bench block and push jewels out with jewel pusher as in figure 10–3. Be sure hole in bench block is larger than diameter of jewel settings. You will now find that you have two jewels in settings, one with a hole in it called the balance hole jewel and one without a hole called the cap jewel.

Sharpen one end of a piece of pegwood to a point and the other end to a chisel shape. Dip the pointed end of pegwood into the carbon tetrachloride and clean surface and hole of balance jewel. This will loosen the old oil. The same procedure should be repeated on the flat side of the cap jewel, figure 10–4, using the chisel shaped end of your pegwood. Replace balance jewel in setting in balance bridge, shoulder side down and replace jewel screws. Place cap jewel in material tray and remove the lower balance and cap jewel from pillar and clean in the same manner as the upper jewels. Keep cap jewels separate and remember which is the lower and which is the upper. The reason we replace the balance jewels in the balance cock and the pillar plate is to keep them from getting mixed.

SEC. 241 — Preparatory to Stringing

Examine closely every wheel and pinion and if you find pieces of dirt or rust in any of the teeth or pinion leaves, remove it by means of pegwood, figure 10–5. The gummed oil or pieces of dirt will come off easily enough but if there is rust between the leaves, mix a little Lap Powder with oil to the consistency of thick cream and apply this on the chisel shaped end of the pegwood rubbing back and forth until the rust is all removed. Dip each wheel into carbon tetrachloride (solution #1) and press the leaves of the pinion into pithwood to remove dirt and old oil. Examine carefully under a double loupe. Repeat if necessary.

SEC. 242 — Removing the Mainspring

Many watchmakers do not remove the mainspring from the barrel when cleaning a watch provided the oil seems clean and the mainspring is in good shape, but instead take off the cap and lift out the arbor and clean these two parts separately; then with a clean cloth or watch paper wipe off as much of the old oil as possible on the coils of the spring and inside of the barrel, and apply fresh oil. In this case the barrel should not be put into the solutions as described in the following instructions. However, it is difficult to tell whether the mainspring is set unless it is removed from the barrel and to do a master job of cleaning make it the rule rather than the exception to remove the mainspring.

SEC. 243 — Stringing the Parts

It is necessary to prepare at least three wires to string parts while they are in the different solutions. The illustration at figure 10–6 gives an idea of the form used. This is made from a piece of brass wire about 7/10 mm in diameter. Smaller sizes of wire are used for the small parts and for the train wheels, and the larger size wire for the heavier parts, such as the plates and the bridges.

· On one of the wires which you have prepared, string all the bridges and plates including the pillar plates, barrel and train bridge, pallet bridge, barrel, large winding wheels and balance cock. Hook the end of

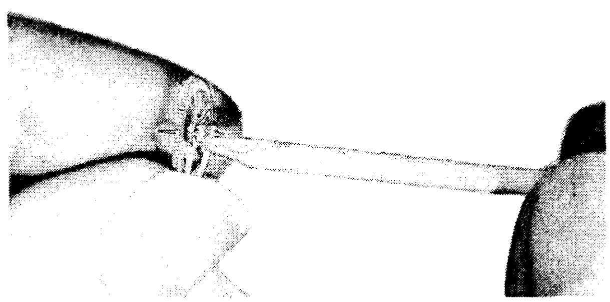


FIG.10-5

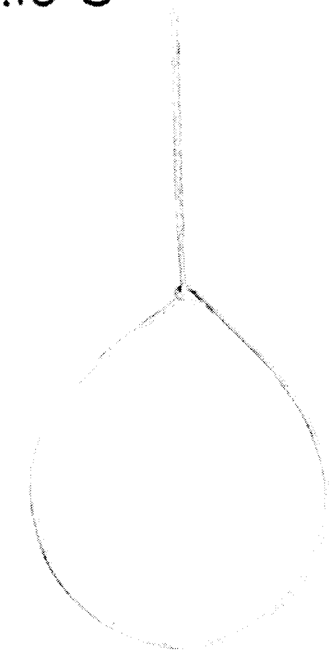


FIG.10-6

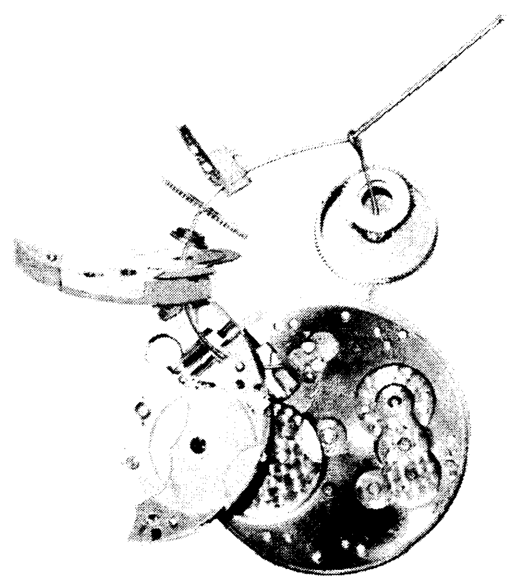


FIG.10-7

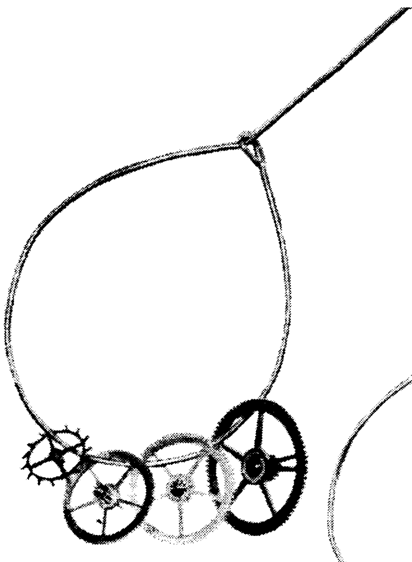


FIG.10-8

FIG.10-9

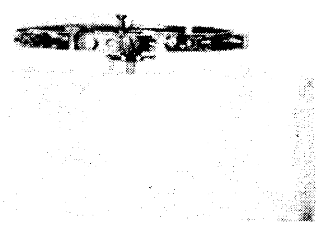


FIG.10-10

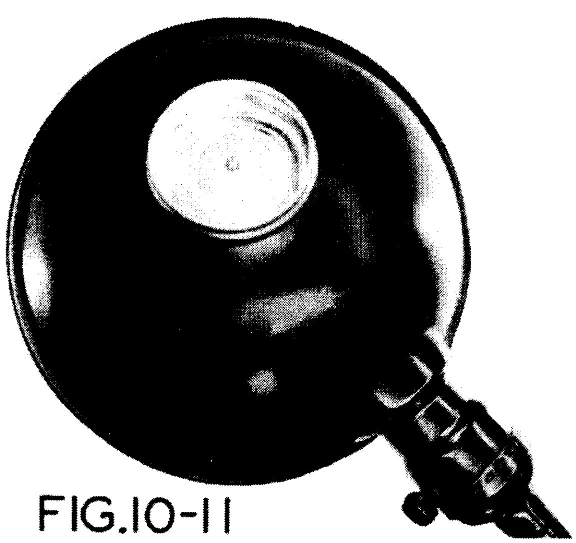


FIG.10-11

the stringing wire and lay to one side, figure 10–7. On another wire string all the wheels except the balance wheel and lay to one side, figure 10–8.

It is best to string the balance with hairspring attached on a separate wire, figure 10–9. Before stringing the balance press the pivot into a piece of pithwood, figure 10–10. Press the pithwood down to the roller on one end and to the hairspring collet on the other. This will remove surplus dirt and oil.

SEC. 244 — Procedure for Cleaning

Plates and Bridges (figure 10–7):

1. Dip into solution #1. Stir rapidly with a circular motion, reversing the direction about every five revolutions, for approximately twenty seconds.
2. Scrub parts thoroughly with the hard watch brush.
3. Repeat step one to rinse parts.
4. Remove and shake off as much solution as possible before placing in solution #2.
5. Stir rapidly in solution #2 for approximately ten seconds to remove carbon tetrachloride.
6. Dip in solution #3 and scrub thoroughly with hard watch brush.
7. Rinse in solution #4 for ten seconds.
8. Rinse in solution #5 for ten seconds.
9. Rinse in solution #6 for ten seconds.
10. Rinse in solution #7 for ten seconds.
11. Remove from solution #7 and shake parts back and forth for about 45 to 60 seconds or until parts are dry.

Now place parts in preheated pan which is fairly warm but not hot. Figure 10–11 illustrates an excellent warming pan which has been riveted on to the reflector of bench lamp. Place a piece of clean watch paper in pan before drying plates and wheels. After they are dry allow the parts to slide off the wire into a clean material tray or piece of watch paper and cover immediately with movement cover.

Train wheels and pinions (figure 10–8): Follow same procedure as in cleaning plates and bridges.

SEC. 245 — Cleaning Balance

Balance wheel (figure 10–9):

1. Dip in solution #1 and stir slowly with a circular motion for about ten seconds.
2. Rinse in solutions #2, #3, #4, #5, #6 and #7 for approximately five seconds for each solution.

Figure 10–12 illustrates the method used in removing the surplus solution from the balance wheel and hairspring with the blower. Hold the balance above a piece of pithwood. The upper balance pivot should be touching the pithwood. Carefully blow through the hairspring and balance wheel until dry. Place on watch paper in warming pan.

The pallet fork and arbor are cleaned by holding the fork in a pair of tweezers and swishing back and forth through solutions #1 and #2. Remove surplus solution by placing fork over pithwood and using blower as in figure 10–13. Press faces of pallet stones into pithwood, then brush carefully with soft watch brush. See that the faces of the pallet reflect light evenly. Be careful that the balance and the pallet fork are not left in any of the alcohol solutions for over five seconds as the alcohol will attack the shellac which keeps these jewels in place.

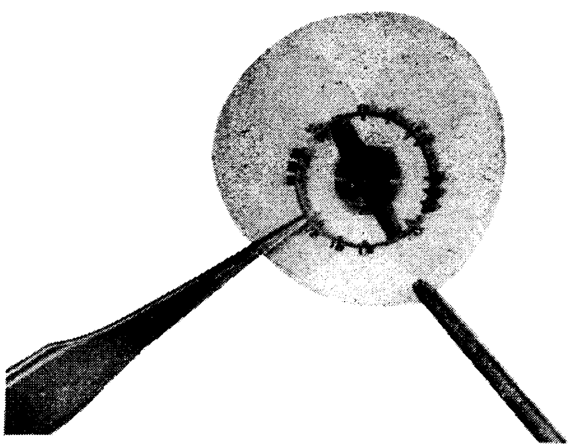


FIG. 10-12

SEC. 246 — Cleaning Small Parts

To clean the screws and small parts which cannot be strung on wire, provide yourself with some sort of strainer. A tea strainer with fine mesh is suitable and prevents the small parts from falling through. Place all the small parts in the strainer and swish it back and forth in solution #1, lift out of the solution and let drain, then through solutions #2 to #7. Lift out and let drain. Invert strainer over a clean lintless cloth held in the palm of the hand allowing all the parts to fall into the cloth, figure 10–14. See that none are left in the strainer.

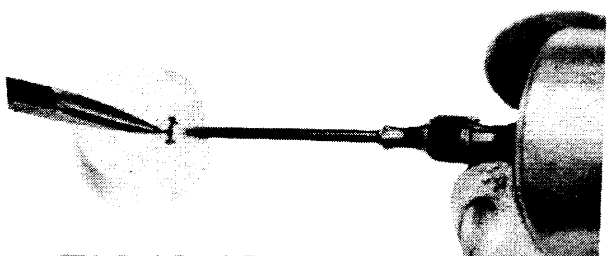


FIG. 10-13

Catch up the corners of the cloth. Hold it closed at the top with one hand and with the other rub the parts against it until dry. Empty the contents carefully on to a piece of watch paper. Inspect. See that they are bright and clean. Should there be any particles of lint on any of the parts, brush with your soft brush, figure 10–15. Use blower if necessary.

SEC. 247 — Cleaning the Mainspring

Clean the mainspring by swishing it in solutions #1 and #2. Dry on a soft cloth. If the mainspring appears clean and you wish to remove the oil from its surface, it is possible to take a piece of watch paper and folding it over the end of the mainspring draw the spring through the paper, figure 10–16. Be careful not to straighten out the mainspring.

Self taught workmen clean poorly. Such work never gives satisfaction. Be satisfied only when you give your very best effort. Build up your reputation by doing good work and you never need to worry about being able to get plenty of watch work.

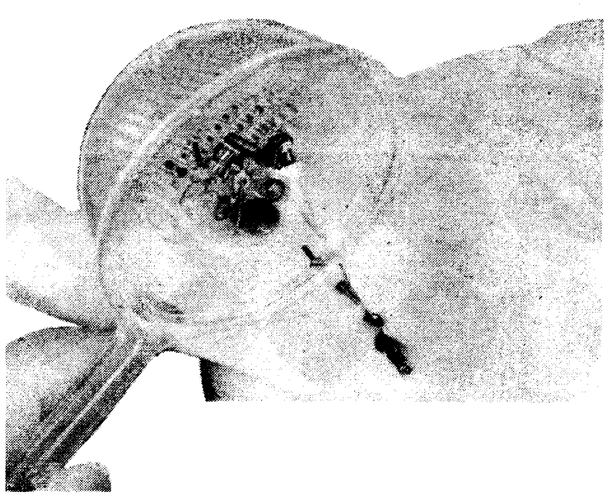


FIG. 10-14

SEC. 248 — Oiling

In reassembling the watch, it is necessary to oil each bearing surface as we assemble and if you follow the instructions carefully, you will not skip any place that requires oil.

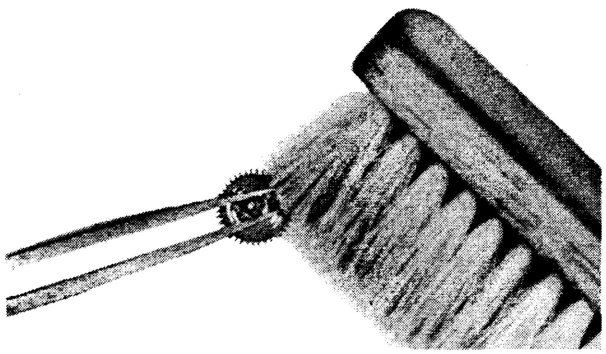


FIG.10-15

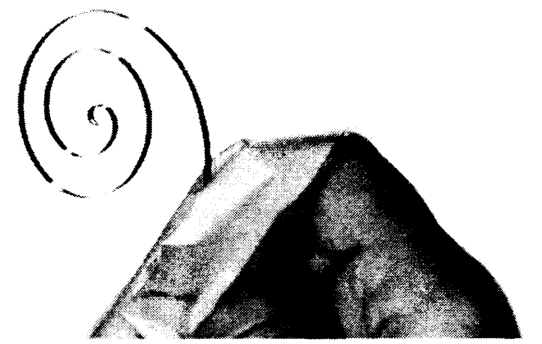


FIG.10-16

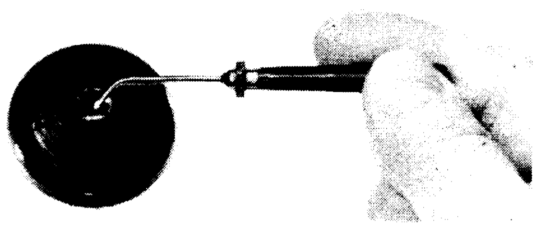


FIG.10-17

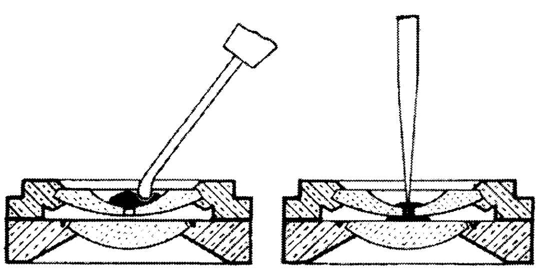


FIG.10-18

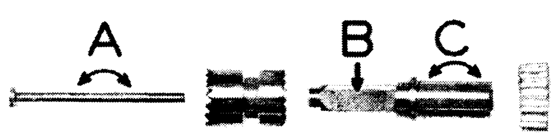


FIG.10-19

It is best to keep your watch oil in an oil cup, figure 10–17. Be certain to replace the cover whenever you are not using the oil. A medium sized drop of oil will oil several watches; consequently, it is only necessary to keep a small amount of oil in the oil cup. It is best to clean the oil cup every day and refill with fresh oil. It is necessary to oil the moving parts of a watch as you would any piece of machinery or wherever friction develops.

SEC. 249 — Oiling Balance Jewels

Replace all cap jewels before assembling the watch. Place a small amount of watch oil in the recess of the balance hole jewel, figure 10–18. Place a needle or a pointed steel wire, which has been dipped in watch oil, in the hole of the jewel. This will force the oil through the balance jewel and down to the cap jewel. When you remove your needle there should be no trace of oil left in the cup of the balance hole jewel. In watches that have cap jewels other than the balance cap jewels such as a 21 jewel watch, which has cap jewels on the upper and lower ends of the escape pinion and pallet fork, the same procedure is followed in cleaning and oiling these additional jewels.

SEC. 250 — Reassembling the Watch

Replace the mainspring and arbor in the barrel and oil as described in Lesson No. 5.

Figure 10–19 shows the winding pinion, winding arbor, clutch and setting plunger from left to right. In this particular style assembly a small amount of oil should be placed on the setting plunger at A. At B oil all four sides of the winding square, being very careful not to get an excess amount of oil on any side of the square. Actually you should not be able to see any oil on the square. Lightly oil the upper portion of winding arbor at C and assemble.

SEC. 251 — Procedure for Oiling Train

The lower plate or pillar plate shown in figure 10–20 should have a small amount of oil placed on the bearings for the winding and setting illustrated by Arrow A, and for the set lever illustrated by Arrow B. Place a small amount of oil on lower plate bearing which receives the barrel arbor, Arrow C.

Figure 10–21 illustrates the barrel and the winding pinion, clutch assembly and setting lever in place. Oil arbor at A and place small amount of oil in center jewel at C and on the upper and lower end of the winding arbor at B. Replace train wheels, train and barrel bridge and crown wheel as in figure 10–22. Place a small amount of oil at A and B, figure 10–22. Oil crown wheel at C. Replace click, ratchet wheel and crown wheels, figure 10–23; oil center wheel at A. 3rd wheel at B, 4th wheel at C and escape wheel at D. Place just enough oil in these jewels so that it will flow through the jewel and around the pivot similar to the darkened portion of figure 10–24.

SEC. 252—Oiling from Dial Side

Turn movement dial side up, figure 10–25, and place small amount of oil on 2 or 3 teeth of the clutch as illustrated by Arrow A. Oil bearings for intermediate setting wheels at B. Some watches have only one intermediate setting wheel. Place small amount of oil at C for clutch lever. Do not oil arbor at D where minute wheel is placed. Previously we oiled the center jewel from the other side but you should check at this time to see if there is enough oil in the oil cup. If not, add to it, Arrow E. Replace cannon pinion and setting parts and place small amount of oil where friction occurs as indicated by Arrows A in figure 10–26. Oil lower 3rd wheel pinion at B, lower 4th wheel pivot at C and lower escape pivot at D.

SEC. 253—Oiling Escape Wheel Teeth

After you have assembled and oiled your watch DO NOT use your blower where it might spread the oil.

With one of your bench keys wind watch three or four turns and observe the action of the train wheels. If it is in first class order, the train will run down, come to a complete stop, and the escape wheel will then reverse its direction, running backward for three or four turns. In high grade watches this action happens so fast that it is necessary to watch the 4th wheel instead of the escape wheel. This is usually an indication that the train of the watch and the winding mechanism are in good order, that is, up to this point. When you are satisfied that the train of the watch is in good order the next step is to oil 4 or 5 teeth of the escape wheel illustrated by Arrow A, figure 10–27. Be careful to oil only the face of the escape wheel teeth. A surplus of oil will collect dirt and dust. As the watch runs the teeth of the escape wheel will carry the oil to the locking and impulse faces of each pallet stone. Replace pallet fork, arbor and pallet bridge. Oil upper pivot as indicated by Arrow A in figure 10–28. Replace the balance and balance cock. See that the roller jewel enters the fork and that the balance is free and has the right amount of end-shake. CAUTION! DO NOT OIL THE ROLLER JEWEL OR PALLET STONES. Turn movement over. Replace minute and hour wheel and oil lower pallet arbor pivot as indicated by Arrow A, figure 10–29. Replace dial and hands.

Wind the movement four or five turns using one of your bench keys. The balance should start off immediately and take about one full turn.

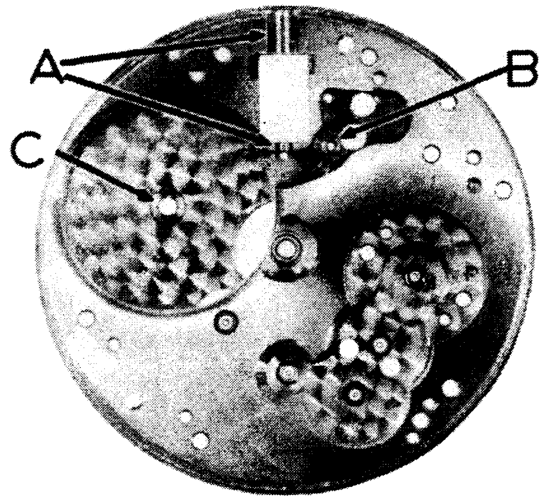


FIG. 10-20

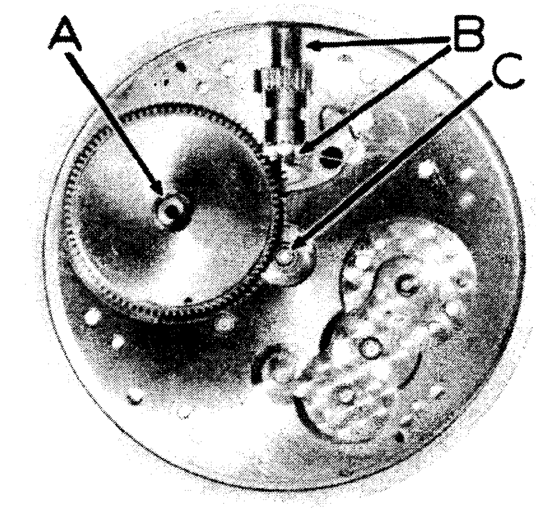


FIG. 10-21

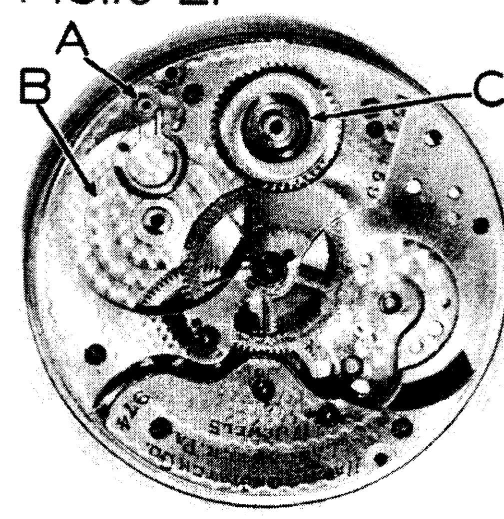


FIG. 10-22

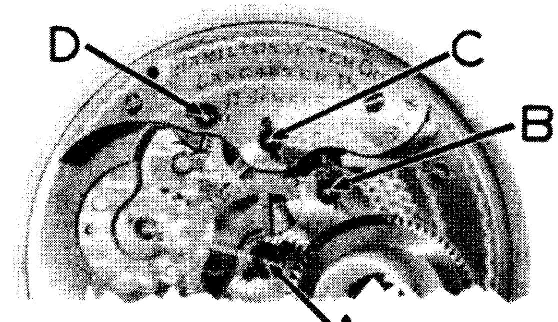


FIG.10-23

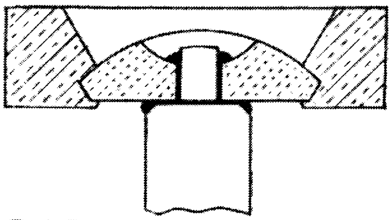


FIG.10-24

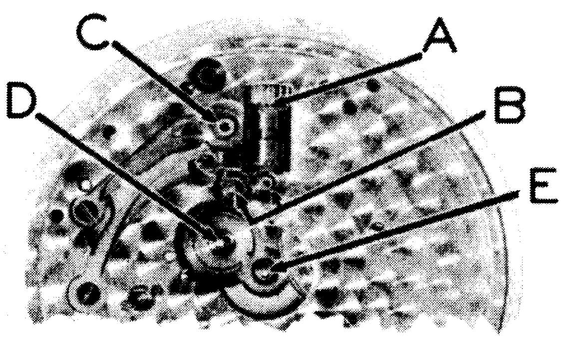


FIG.10-25

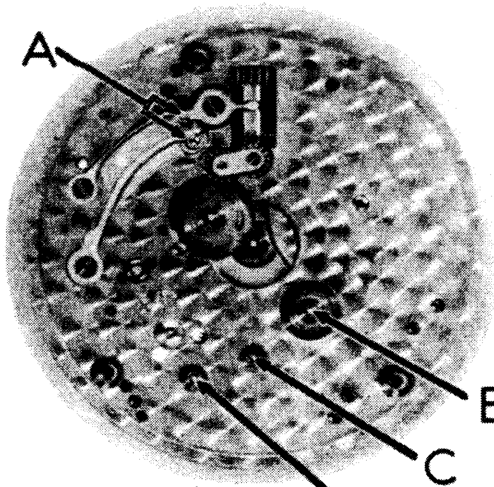


FIG.10-26

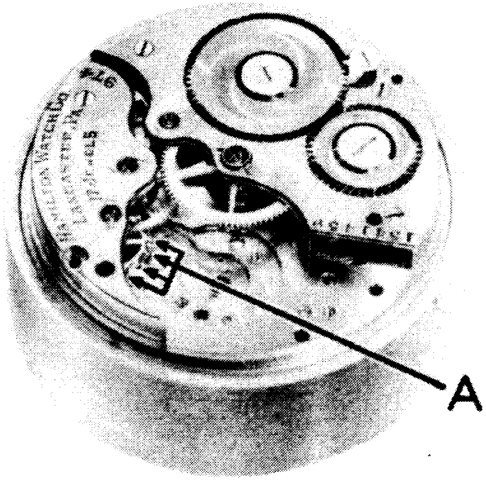


FIG.10-27

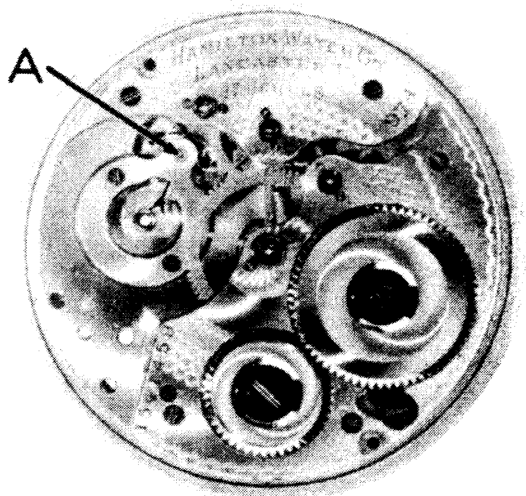


FIG.10-28

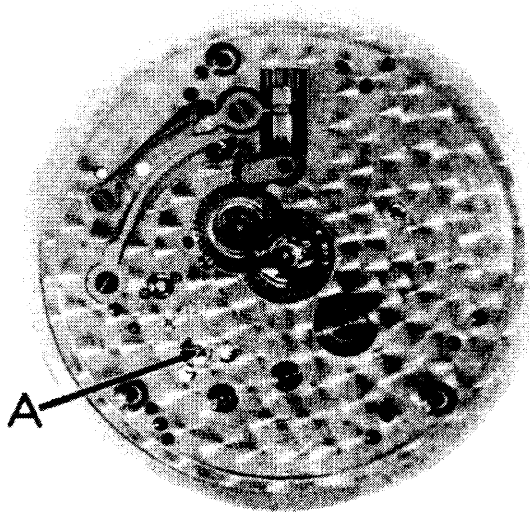


FIG.10-29

SEC. 254 — Cleaning the Dial

There are two common types of dials—the enameled dial and the metal dial. The older style or white enameled dial is made of glass hard enamel baked on a copper base and can be cleaned in any solution used in cleaning watches. Unless very dirty, it is the common practice merely to clean any dirt or finger marks from this kind of dial with a dry clean cloth or even a piece of watchpaper. The figures on this dial are baked into the enamel and there is no danger of rubbing them off when cleaning.

In the better grades of metal dials the numerals are enamel and these dials may be cleaned by dipping in cleaning solutions.

Metal dials frequently are lacquered but in spite of this have a tendency to tarnish. The lacquer may come off in places leaving the dial with a blotched or streaked appearance. A cyanide dip will generally help in brightening a tarnished metal dial but great care must be used. Another method is by means of common baking soda, a small quantity mixed to the consistency of cream being placed on the dial with the finger and rubbed with a light circular motion. When the dial is sufficiently brightened, rinse with water and dry by patting with a soft cloth or place in warming pan.

Metal dials with painted numerals must be handled carefully lest the figures come off. They may be cleaned with prepared dial cleaner. Be careful about rubbing off the figures.

At first you may have difficulty in seeing whether a metal dial has enameled figures or not but after examining a few you should be able to tell at a glance. As a general rule the enameled figures lie flatter on the dial being flush with the metal or even a trifle below the surface while the other type shows the numerals on the metal as though painted or printed on top of the surface of the dial.

SEC. 255 — Cleaning the Case

Whenever you clean and reoil a watch you should also clean the case. If the case has a polished finish and you have access to a polishing motor, it is well to repolish the case. This is about the only part of the watch your customer can see and he is liable to judge your ability by the outside appearance of the completed job. If you are not so equipped, polish as best you can by using a polishing cloth. To wash the case use a stiff brush with soap and ammonia and scrub thoroughly. Rinse in water to remove all traces of soap and then dry with a clean cloth. In spite of your utmost efforts there will be some water remaining around the stem and crown and perhaps the joints of the case. Dip the entire case in a cup of alcohol to remove the last trace of water and then dry again with the clean cloth. Last, heat the entire case pendant down over an alcohol lamp until it is as hot as your hand will bear and the excess alcohol will burn off.

If it is a pendant set case with sleeve, place a small amount of oil on the stem where it comes in contact with the sleeve as has been described in Lesson No. 2. Wash the bezel and glass, wiping dry, and see that there are no marks, streaks or lint left on the glass.

SEC. 256 — Formulas for Cleaning Solutions

Place the regulator in the center of the balance cock. See that the hands are adjusted properly. They should not come in contact with each other at any place. Replace movement in case. Check hands again. They must not touch the glass.

Wind and set the watch. Endeavor to set second hand with the second hand on a watch or clock which keeps correct time.

The following formulas are for your reference. Each of the ingredients may be ordered from your druggist. Be careful in handling the 29% solution of ammonia as it is highly concentrated. Keep from breathing the fumes and only order enough to make the desired, necessary amount of solution.

Solutions for Manual Cleaning Method

1 Part Tincture of Green Soap
3 Parts Ammonia (29% solution)
44 Parts Distilled Water

Solutions for Machine Cleaning Method

1 Part Tincture of Green Soap
2 Parts Ammonia (29% solution)
45 Parts Distilled Water

SEC. 257 — Watch Cleaning Machine

The student will hear a great deal about watch cleaning machines. Today the most modern shops use cleaning machines and when used properly, have increased the profits of the repair department. When watch cleaning machines were introduced there were some claims that it was not necessary to take the watch apart in order to clean it. This brought a sincere condemnation from all expert watchmakers and for a while the machine was not accepted among the trade. However, as with everything that has merit, the machine was gradually accepted by qualified watchmakers who proceeded to experiment with it and the solutions necessary to make the machine produce excellent results. It remains a fact, however, that any machine in the hands of an indifferent workman will-not produce the best results.

There are many good machines on the market similar to those illustrated in this lesson.

SEC. 258 — Machine Cleaning Method

The following is the commonly accepted procedure used with few variations with a machine using the 3 jar method and the prepared solutions furnished by the manufacturer of any particular machine.

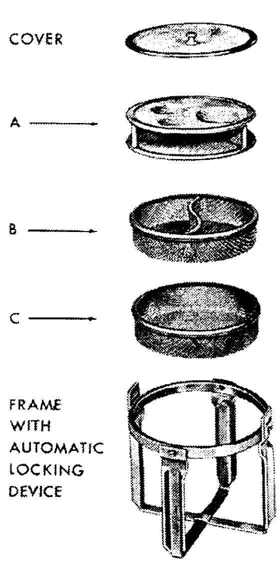
1. Take watch completely apart.
2. Make necessary repairs.
3. Brush parts with carbon tetrachloride or naphtha to remove old oil.
4. Place bridges, plates, barrel, etc., into the largest compartment, C-Fig 10-30.
5. Place all screws, levers, etc., which you know will not slip through holes in basket in separate compartment. B-Fig 10-30.
6. Place train wheels into separate compartment. A-Fig 10-30.
7. Place pallet fork and balance in separate compartment. A-Fig 10-30. (Do not put hairspring in cleaning machine. Clean separately.)
8. Place cover on basket and clamp basket in machine.
9. Run slowly in solution #1 for approximately 60 seconds. The speed can be controlled by the rheostat.
10. Spin off surplus solution in upper half of cleaning jar. Some machines have a separate jar for spinning off solutions.
11. Rinse in solution #2 for approximately 60 seconds.
12. Spin off surplus solution.
13. Repeat operations 11 and 12 with solution #3.
14. Place in heater compartment, spinning for 3 or 4 minutes, or until dry.

    Remove parts carefully and examine.

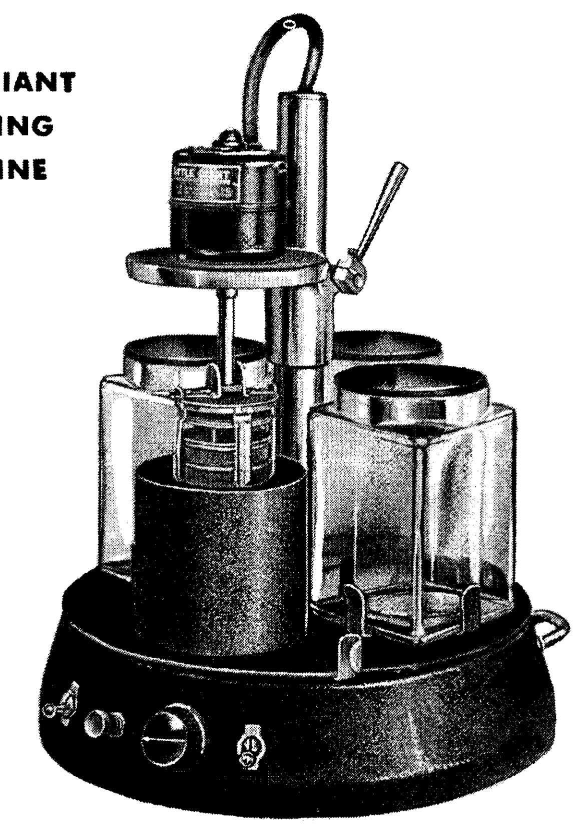
SEC. 259 — Superior Method of Machine Cleaning

The following method is recommended by several of the large American watch factories. Obtain additional jars and use the same solutions in the same order as listed in Sec. 239. This method will produce superior results.

By now you can understand that the cleaning of watches is only one more step toward your goal as a master watchmaker. The many other repairs necessary to put a watch in good order follow in succeeding lessons and you must master each one.



LITTLE GIANT CLEANING MACHINE



Square jars prevent solution from excessive whirling and instead force it through the basket, which results in more thorough cleaning. Has three jars: One for cleaning solution, one for Rinse No. 2 and one for Rinse No. 3. Metal shielded compartment is a drier with an electric heater.

FIG. 10-30

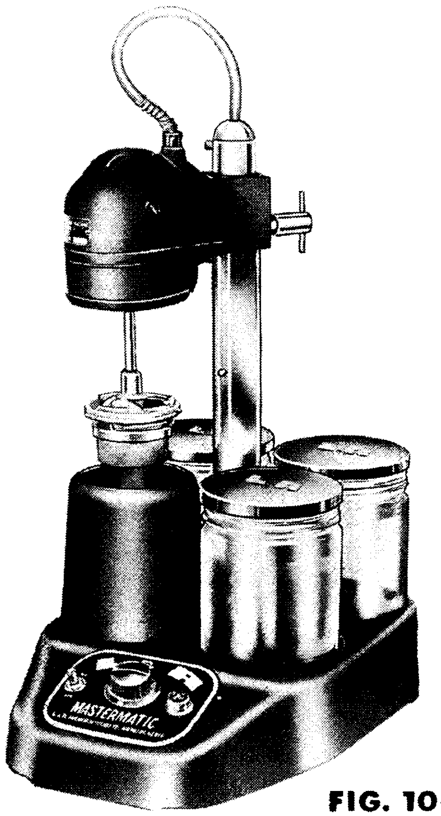


FIG. 10-31

L&R CLEANING MACHINES

FIG. 10-31 - MASTERMATIC

Uses three jars. One for watch cleaning solution No. 1, one for Rinse No. 2 and one for Rinse No. 3. Has a metal-shielded heating unit for drying parts. Comes with or without automatic reverse.

FIG. 10-32 - HEAVY DUTY

This machine is useful where greater production is needed. A special basket holds three separate complete movements. Uses three jars like the Mastermatic. Shielded heating unit.

FIG. 10-33 - AUTOMATIC

A fully automatic machine. Just push button and machine will automatically clean, rinse and dry the watch parts in basket. Shuts off automatically when cycle is complete. Uses three jars like the others.

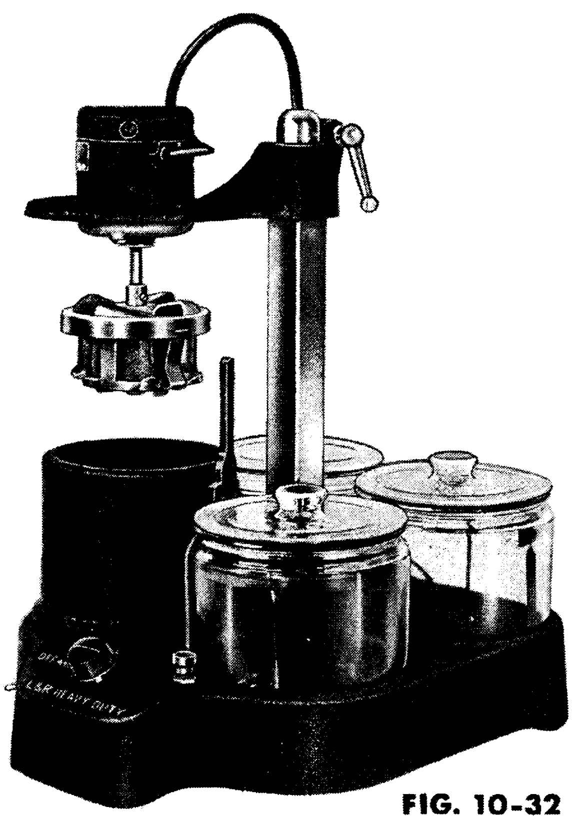


FIG. 10-32

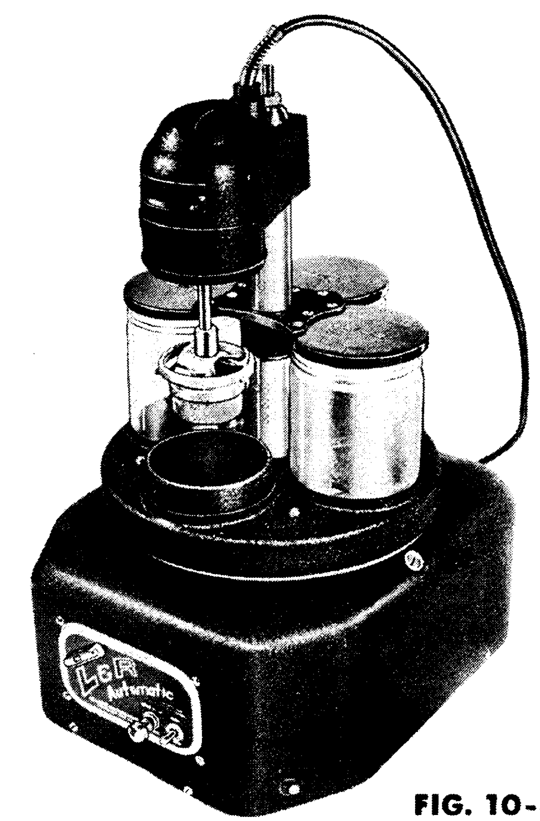


FIG. 10-33

TABLE OF CONTENTS: Unit WIII - Lesson 10

JOB SHEETS

CLEANING WATCHES: Preparation and methods.

INTRODUCTORY INFORMATION

A fine cleaning job can be done by either hand or machine. You may use commercially prepared solutions or you may prepare your own solutions.

PREPARATION FOR CLEANING

Before cleaning the movement should be completely disassembled. Use sharpened piece of pegwood and peg out pinions (Sec. 241.) Break up accumulation of oil and dirt on surfaces of jewels and peg out the holes. Repairs should be performed before cleaning. If hand method of cleaning is used, the parts should be strung on brass wire (Sec. 243.)

AFTER CLEANING

As movement is being assembled, each bearing surface should be oiled. See sections 248 through 253.

HAND CLEANING PROCEDURE

A. USING STRONG SOAP, CYANIDE, ALCOHOL* AND BOXWOOD SAWDUST

1. Scrub with stiff brush and strong laundry soap.

2. Rinse in soft water.

3. Dip in cyanide solution for not longer than 10 seconds.
   NOTE: Cyanide is a deadly poison. Mixed with acid it becomes a lethal gas. Do not allow any part of your body to come in contact and do not inhale the fumes of cyanide. If cyanide comes in contact with the skin wash thoroughly with soap and water.
   NOTE: Cyanide cleaning solution is prepared by disolving one ball in a quart of luke warm water.

4. Rinse in soft water.

5. Rinse in alcohol* to remove water.

6. Dry in warm Boxwood sawdust.

7. Sift sawdust through strainer, remove all watch parts.

8. Brush each part with soft brush to remove sawdust particles, peg each jewel.

(OVER)

B. USING SOAP SOLUTION, ALCOHOL* AND BOXWOOD SAWDUST

1. Scrub with brush and soap solution.
   NOTE: Use formula in section 239 to prepare soap solution, or 1 pint hot water, 1 tablespoon Soilax or Spic and Span and 2 oz. household amonia.

2. Rinse in soft water.

3. Rinse in alcohol*.

4. Dry in warm Boxwood sawdust.

5. Sift sawdust through strainer, remove all watch parts.

6. Brush each part with soft brush to remove sawdust particles, peg each jewel.

HAND CLEANING PROCEDURE:

C. USING CARBON TETRACHLORIDE, SOAP SOLUTION, ALCOHOL* — REFERENCE

1. Scrub in Carbon Tetrachloride. — Section 244

2. Rinse in alcohol*.

3. Scrub in soap solution.
   NOTE: Use formula in section 239 to prepare soap solution.

4. Rinse in two separate jars of distilled or soft water.

5. Rinse in two separate jars of alcohol*.

6. Shake or blow off solution.

7. Dry parts. (Fig. 10-11,12,13,14)

ALCOHOL* - Use a highly refined alcohol, sometimes called Solvent #1.

CLEANING WATCHES: Machine Method.

SUPPLEMENTARY INFORMATION

Cleaning machines do a fine job if proper procedure is followed in preparing the watch and operating the machine. Most machines have three cleaning jars, one jar for cleaning solution and two for rinse. Some machines have 4 jars, the extra jar may be used for a throw off of surplus solutions or as an extra rinse. Most machines have a reversing feature which will allow the basket to spin in both directions, some are automatic, some are manual reverse. The basket may be reversed while in solution but should not be reversed while basket is spinning free of solution. Most machines have a drying well, some use a heating unit and a fan, others just the heating unit. The basket is lowered over this heating unit and revolved slowly. Some heating units have a timing device, others no timing, so on these the operator has to determine the length of time required to properly dry the parts. Length of time in solutions may vary some for different makes of cleaning solutions, instructions are usually printed on the containers. Jars should contain just enough solution to cover basket.

MACHINE CLEANING PROCEDURE

USING COMMERCIALLY PREPARED SOLUTIONS IN CLEANING MACHINE — REFERENCE Sec. 257-258

1. Peg all jewels to remove old oil.

2. Scrub parts in carbon tetrachloride.

3. Distribute parts in cleaning basket and attach to cleaning machine.

4. Lower basket into cleaning solution, allow to soak about 30 seconds and then rotate basket for a period up to 3 minutes.

5. Raise basket just above level of cleaning solution and spin to throw off surplus solution.

6. Lower basket in first rinse and spin for a period of up to 3 minutes.

7. Spin off solution.

8. Lower basket into second rinse and spin for a period of up to 3 minutes.

9. Spin off surplus solution.

10. Lower basket into preheated heating well, revolve basket slowly for a period of 3 or 4 minutes. (Trial and examination of parts will determine correct drying time for your particular machine.)

11. Remove basket and place watch parts in movement tray.

ALCOHOL* - Use a highly refined alcohol, sometimes called Solvent #1.

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 11

Timing, Rating and Regulation

—

Sections 260 - 283

CHICAGO SCHOOL OF WATCHMAKING

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Lesson 11

Sections 260 to 283

TIMING, RATING AND REGULATION

SEC. 260—Timing, Rating and Regulation

Timing, rating and regulation are three different subjects. Timing is the operation required to bring a watch to time after it has been repaired. Rating is the observation and comparison of the variation of the daily rate of a watch after adjusting. Regulation refers to the adjustment of a watch to its owner's personal routine and habits.

In all of our work the lessons call for practice on specific jobs. This lesson on timing does not include rating, adjusting and regulation. The lessons to follow will instruct you in many other repairs which you must learn before you can properly time, rate and adjust a watch. Your practice watch will not always keep correct time in all positions because of your inability to make repairs which are necessary. As you proceed with each of the following lessons, you will understand more clearly the preceding lesson. Master each lesson, strive to do each job a little better. Speed will come only from continued practice, so PRACTICE, PRACTICE, PRACTICE.

FIG. 11-1

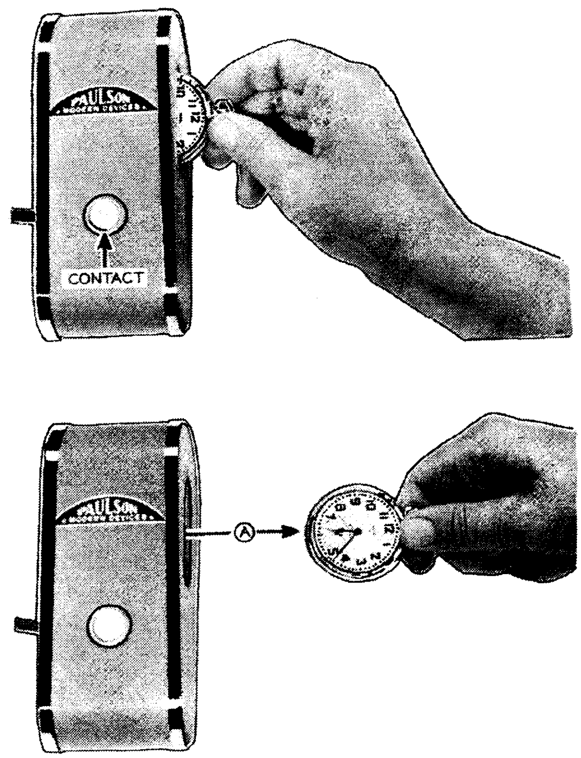


FIG. 11-2

SEC. 261—Testing for Magnetism

Before attempting to make any repairs on a watch it should be tested for magnetism. A quick test can be made when the balance is in motion by placing a small compass which has had the magnetism removed directly over the balance cock, figure 11–1. If the watch is magnetized, the needle on the compass will move quickly from side to side and, in some cases, twirl completely around.

To remove magnetism it is necessary to have a demagnetizer. Figure 11–2 illustrates the demagnetizer in use. This demagnetizer is for use on alternating current only. Hold watch carefully inside demagnetizer as in figure 11–2. Close contact and pull watch away slowly from the demagnetizer in direction of arrow A.

When at arm's length release contact. Test with compass. In some cases, it becomes necessary to take the watch apart and demagnetize each part separately. Make it a practice to test your watch for magnetism and demagnetize if necessary before doing any and all repairs. When a watch is magnetized you cannot bring it to time .

SEC. 262 — Experiment in Magnetism

Most watchmakers use a small magnetic compass to test for magnetism in watches. Before proceeding further with this lesson, let us make a simple experiment.

Material required: 1 Small Magnetic Compass
1 Demagnetizer
1 Piece Steel Rod

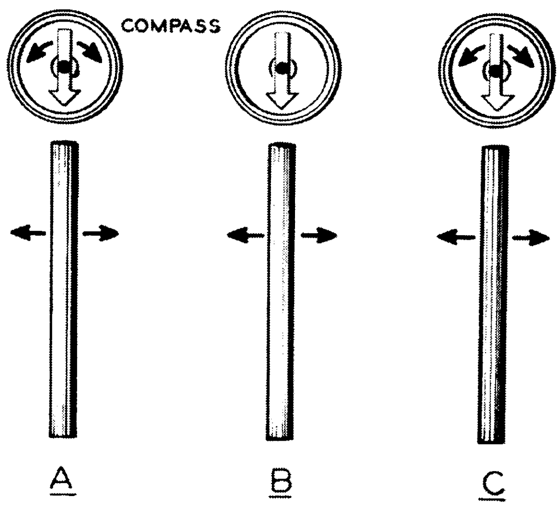


FIG. 11-3

Place your compass on bench, figure 11–3. Move the steel rod toward the compass directly in line with N (north) and, at the same time, move it from side to side as indicated by the arrows, diagram A. The closer the rod gets to the compass the greater the indicator will be agitated.

Now demagnetize the compass (figure 11–2), and repeat the operation, diagram B. This time the compass indicator will remain at rest.

Now magnetize the test rod by placing in demagnetizer, upper illustration of figure 11–2, and close contact. Release contact quickly WITHOUT REMOVING ROD from demagnetizer. The test rod will now be magnetized.

Repeat the previous operation, diagram C, and you will find the indicator of the compass again is agitated.

Suppose we substitute a watch for the test rod. Then in diagram A a watch containing steel parts can agitate the needle of a compass even though the watch is devoid of magnetism. However, in diagram B a watch containing steel parts cannot agitate the indicator of a compass if the watch is devoid of magnetism. But in diagram C a watch containing magnetism will agitate the compass needle even though the compass is devoid of magnetism.

From this test you can observe the fallacy of using a compass which contains a magnetic indicator. Any type of sensitive indicator devoid of magnetism would serve as well. Remember when you have demagnetized your compass it is no longer a compass. It becomes a testing device.

SEC. 263 — Types of Master Regulators

In order to be able to time watches it will be necessary for you to have a Master timepiece. With a radio you will have no difficulty hearing the time signal given on most stations at the half hour and hour. Some jewelers or watch repairmen have a master clock with a seconds beat pendulum. Some have chronometers, others use electric clocks that are controlled by a Master system or any of the above-mentioned devices. A 12, 16 or 18 size watch that is an excellent timekeeper will be suitable.

SEC. 264 — Some Causes of Watches Losing

In the timing of watches, there are a great many factors to be considered. If the watch to be regulated is in perfect order, timing, adjusting and regulation are not difficult.

Some of the most common faults causing watches to lose time are as follows: In pendant set pocket watches, if the sleeve is not adjusted correctly, it will allow the clutch to become engaged in setting position causing the watch to slow down or stop altogether (Lesson No. 2).

Be sure hands fit correctly. Check cannon pinion. If the cannon pinion is loose, your watch will lose erratically. This is a common fault and is easily overlooked by the beginner. Make the following test before removing hands. Test as shown in figure 11–4,

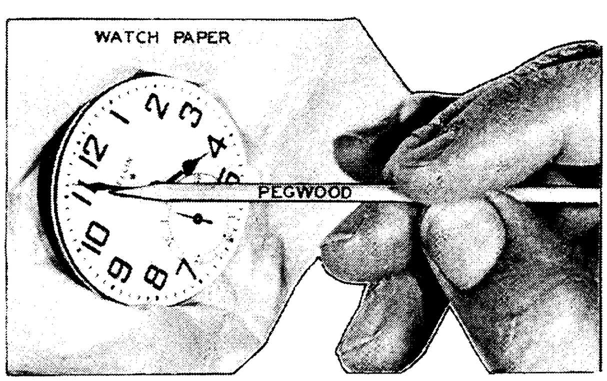


FIG. 11-4

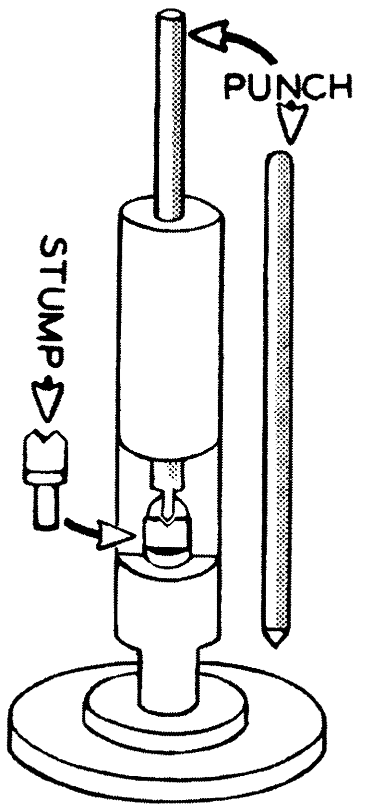


FIG. 11-5

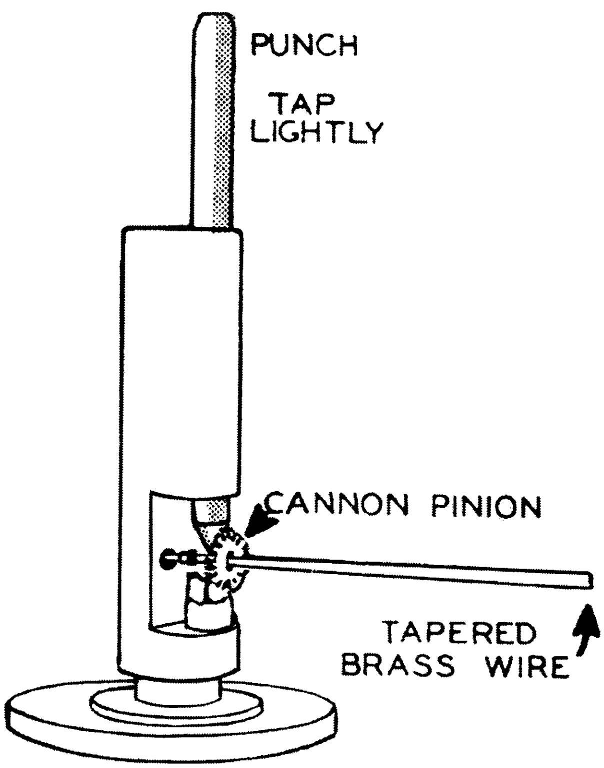


FIG. 11-6

moving minute hand from side to side. If cannon pinion is loose, the minute hand will move freely from side to side but if correct, you will meet with a little resistance. However, it cannot be too tight as it has to slip when setting parts are in the setting position but it must tight enough to turn with the center pinion. Figure 11–5 illustrates a cannon pinion tool used for tightening cannon pinions.

To tighten cannon pinion, place the small pointed punch in position and tap very lightly, figure 11–6. Use caution. A small tapered brass wire inserted into hole in cannon pinion will keep from crushing the pinion. A few light taps will bring better results than one heavy crushing blow.

Some watchmakers use a dull pair of cutting pliers as in figure 11–7.

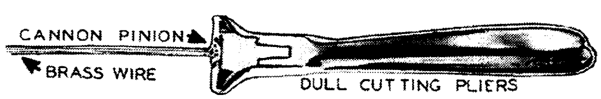


FIG. 11-7

SEC. 265 — The Regulator

Figure 11–8–A shows an Elgin balance cock with the regulator set in its correct position as it comes from the factory. The regulator contains two pins usually made of brass which fit over the outside coil of the hairspring. These pins control the length of the hairspring when the regulator is moved. In most American watches the regulator is snapped in place on the balance cock. In Swiss and American watches using a Swiss type of jewel assembly the regulator is held in place by the upper cap jewel. Moving the regulator toward F (fast) will make the watch run faster. Moving the regulator toward S (slow) will make the watch run slower. On some watches these letters will be A (advance) and R (retard).

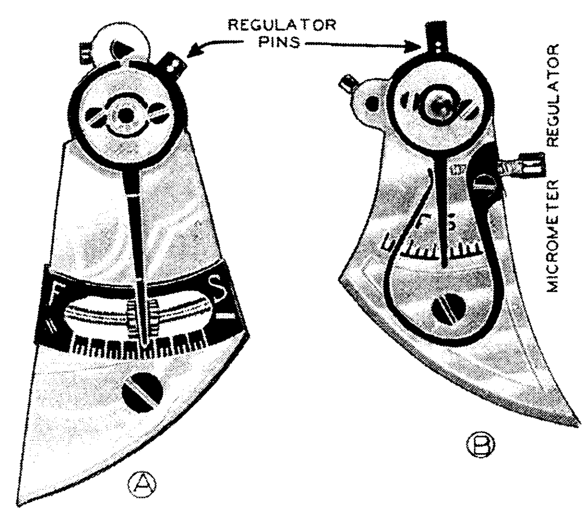


FIG. 11-8

Figure 11-8-B shows another type of regulator which has a micrometer screw that can be moved as much or as little as desired. It is found on better grade watches mostly of the quality used by railroad men. A full turn of the micrometer regulating screw makes a probable difference of from 10 to 25 seconds a day, depending on the make and size of the watch.

SEC. 266—The Regulator Pins

Check regulator pins. If they are too far apart, the watch will lose.

Figure 11-9 is a series of drawings illustrating their types and faults. The regulator pins at A are a common type used in American watches having a flat hairspring. The regulator pins at B, which are shorter, are used in both American and Swiss watches having an

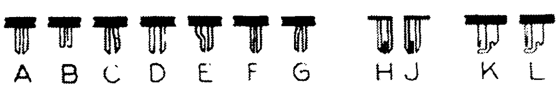


FIG. 11-9

overcoil hairspring. The regulator pins at L are a common type of pin used in Swiss watches having a flat hairspring.

Regulator pins illustrated at H show the proper relation between the outside coil of the hairspring (the heavy black line) and the pins when the balance is at rest. Actually the amount of space between the hairspring and each of the pins is hardly visible even with a double loupe.

If the balance is moved from its position at rest either to the right or left, this coil will rest against one of these pins, in this case the one on the left, diagram J. Now the amount of space between the hairspring and the regulator pin can be determined visually and should be just enough to insure freedom of movement.

Figure 11-9, diagram C, illustrates regulator pins which are too far apart and are brought back to the correct position by bending as illustrated by dotted line. Diagram D illustrates regulator pins which are too far apart and are corrected by adjusting in a manner similar to that shown in diagram E. Diagram F illustrates regulator pins which are too close together and are corrected by adjusting in a manner similar to that shown in diagram G.

SEC. 267—Purpose of Regulator

The purpose of the regulator, which includes the regulator pins, is to lengthen or shorten the hairspring. The actual length of the hairspring is from the stud to the hairspring collet. The length of the hairspring is controlled by the regulator pins in the following manner:

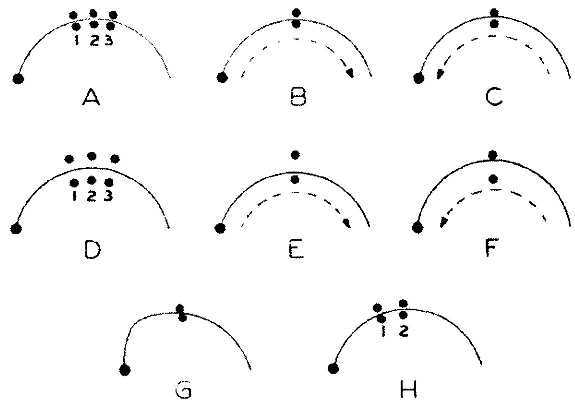


FIG. 11-10

Figure 11-10, diagram A, illustrates three sets of regulator pins (1-2-3). No. 2 represents the position of the regulator pins when the regulator is in the center of the F & S Scale and the balance is at rest. Notice that the hairspring does not touch either of the pins. Moving the regulator toward the "fast" No. 3 would shorten the hairspring and toward the "slow" No. 1 would lengthen the hairspring. Remember in these illustrations the balance is at rest and there is no change in the relation between the pins and the outer coil of the hairspring.

Now move the balance in the direction of the arrow in diagram B and the coil of the hairspring will move against the inside regulator pin. Move the balance in the direction of arrow in diagram C and coil will move against the outer regulator pin. Now as the balance swings back and forth the hairspring moves from one regulator pin to the other in this manner.

Diagram D illustrates three sets of regulator pins in the same position as those shown in A with the balance at rest, but the space between the regulator pins and the outside coil of the hairspring is excessive. In this case, the pins do not control the length of the hairspring as you can see, diagrams E and F. When the balance is moved in the direction of arrows E or F the outside coil of the hairspring does not come in contact with the pins; consequently, the regulator pins have no effect.

Diagram G illustrates regulator pins which are too close together and moving the regulator pins toward "slow" would cause it to bend in a manner similar to the illustration.

Diagram H illustrates what happens when the outside coil does not follow between the pins when the balance is at rest at illustrated in diagram A. In this case the pins at No. 2 are correct. Moving the regulator pins toward "slow" causes the inside regulator pin to contact the hairspring as shown at No. 1. Consequently, the watch may have a tendency to gain instead of lose as indicated on the scale.

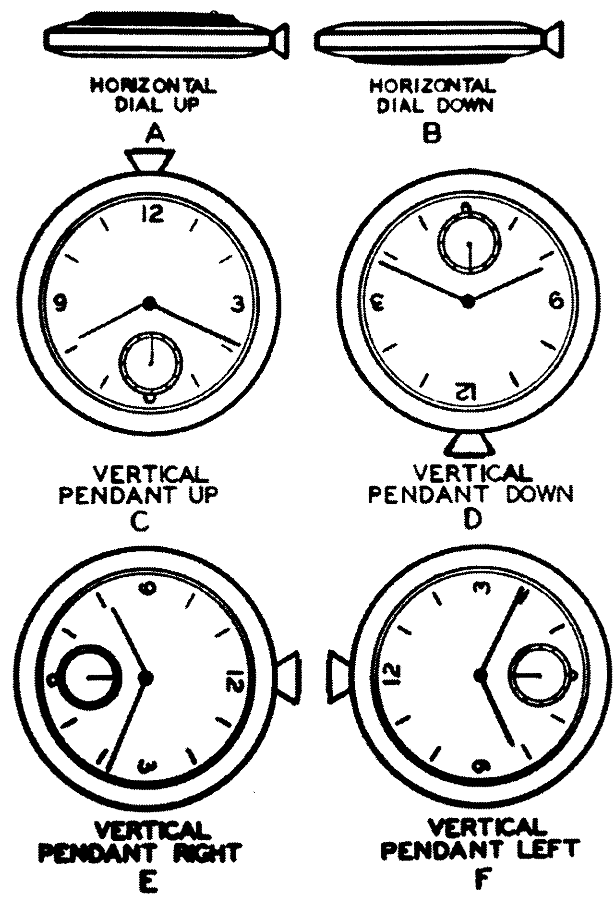


FIG. 11-11

SEC. 268 — Positions Used in Testing Motion

Hold watch dial down and notice motion. A watch in good order should have oscillation of from 1¼ to 1½ turns in this position.

Figure 11–11 illustrates the following positions: A–dial up, B–dial down, C–pendant up, E–pendant right, F–pendant left. These are known as the five positions. The sixth position is pendant down–D. When you see and hear of a watch being adjusted to five positions it means A, B, C, E, and F. These adjustments are usually made at the factory and if the watchmaker uses genuine material and skillfully does his work, he will not have any trouble in getting his repair jobs to keep time.

SEC. 269 — Determining Motion

Figure 11–12 is a drawing used to illustrate the method used to determine the motion of a balance. The balance wheel and arm at rest are shown by the heavy black lines.

If the balance and arm are moved from A to B, which is ¼ of the circumference, and released, the balance will swing back in direction of line CD, and

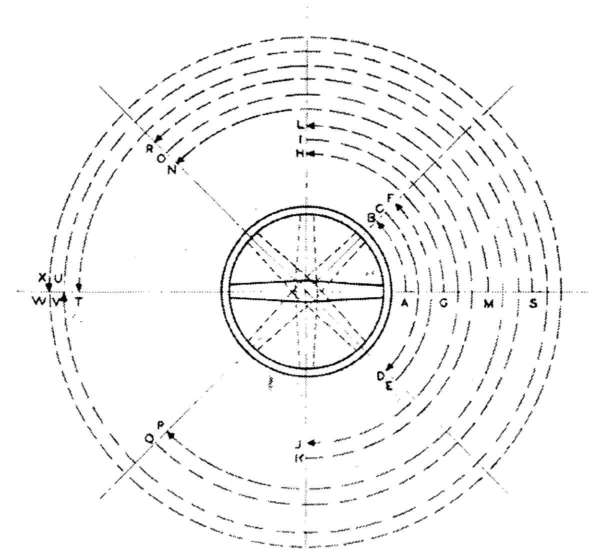


FIG. 11-12

back again from E to F, etc. The balance is then said to motion ¼ of a turn. If the balance moves from G to H and then back from I to J and then from K to L, etc., it will have a motion of ½ turn. M to N and O to P and Q to R illustrate ¾ of a turn. S to T and U to V and W to X, etc., illustrate one full turn.

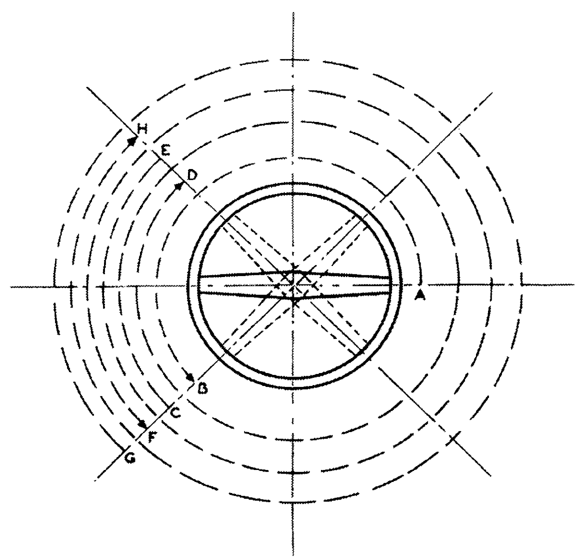


FIG. 11-13

Figure 11–13, A to B and C to D and E to F and G to H illustrate 1¼ turns. At 1½ turns the arms would appear to stop at positions illustrated by center lines.

SEC. 270—Testing Motion in Watch

In practice, stop the balance wheel completely using a bristle from a watch brush, release it and watch it swing back and forth until arms appear to meet at D and C and meet again at E and F. Now the balance has completed one full turn. If the watch is taking the correct motion, it will then appear to cross at E and F until it reaches the maximum swing, which will be from 1¼ to 1½ turns. Notice position of arms in relation to dotted line. This is after the wheel has made one full turn and arms appear to stop at G and H.

A watch should motion the same in position dial up and dial down. If it doesn't, it may be caused by several things among which the most common are dirt and old oil in jewels, burred pivots, hairspring out of level, loose hairspring stud and others. Before timing be certain the watch motions correctly.

After you are satisfied that the balance motions correctly dial up and dial down, test by letting the balance wheel fall toward the pallet fork. In this position a watch will have a tendency to slow down a trifle, not as much in pocket watches as in bracelet watches. However, it should not slow down more than ¼ of a turn.

SEC. 271—Some Common Causes of Watch Gaining

If a watch has an excessive rate of gain, the fault is generally found in the hairspring. However, there are cases when a balance screw may be loose and the screw will fall out. Check the balance wheel and ascertain if you have an equal number of screws on each side of the balance arms. If so, then check the hairspring. If the coils stick together, it may be from oil or magnetism. Check for magnetism. Clean balance and hairspring (Lesson 10) if coils of hairspring are oily.

At times a customer has jarred his watch in such a manner that the outside coil has become caught on the stud or between the regulator pins. Release carefully. The hairspring must be level and parallel to the arms of the balance wheel. The overcoil must pass through the regulator pins and must not touch the under side of the center wheel or balance bridge.

SEC. 272—Making Notes when Regulating

In timing a watch with a second hand set the second hand to coincide with second hand on your master timepiece. Set the minute and hour hands to correspond with hands on master timepiece. Make a note on back of watch tag or piece of paper the exact time the watch was set.

Figure 11-14 illustrates the notations made on the back of a watch tag. Following is an explanation: Monday, February 2, at 10 A.M., the watch was set. At 11 A.M. the watch had gained 5 seconds, entered on tag as +5. In 24 hours this watch would gain approximately 120 seconds (24×5) or two minutes. After making the necessary adjustment, the watch was reset and the ticket marked Reg. (regulate) and Set. At 1 P.M. the watch had gained two seconds, which is at the rate of 24 seconds per day $\frac{(24 \times 2)}{2}$. After making necessary adjustment the ticket was marked Reg. but it was not reset. At 6 P.M. it was still two seconds fast. Tuesday, February 3, at 9 A.M. it was 23 seconds slow which was at the rate of 40 seconds in 24 hours. Regulate and mark ticket Reg. At 6 P.M. watch was ten seconds slow showing a gain of 13 seconds in 9 hours or about 35 seconds per day. Watch was regulated again. Wednesday, February 4, 9 A.M. watch was 7 seconds slow showing a gain of 3 seconds in 15 hours. No regulation was made but watch was set.

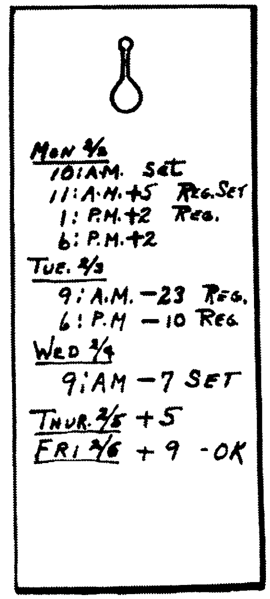


FIG. 11-14

Thursday, February 5—5 seconds fast in 24 hours

Friday, February 6—9 seconds fast in 48 hours

This watch now shows a slightly fast rate which is very desirable. Further regulation would be made from time to time if required.

In the case of a watch without a second hand, set accurately with a master timepiece watch every six hours or so at first. It sometimes takes three, four or five days to regulate accurately. This will explain the reason watchmakers take more time than customers anticipate for repairing.

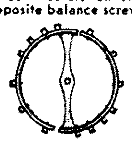
SEC. 273—Hints on Timing Machines

Today in the larger shops the advent of the timing machine enables the watchmaker to time his watches more accurately and speedily than ever before. It is possible to take in a watch for repair and after bringing it to time return it to the customer the same day knowing that the watch will keep accurate time.

You will hear a great deal about time machines. Timing machines are electronic instruments used to test the rate of a watch in any position, enabling the repairman to predict the average rate of the watch to be timed as it will be when the owner carries it. The latest models translate the "tick" into a written record from which the watchmaker makes his observations. These machines are expensive for the beginner. However, the use of timing machines will be given in a later lesson.

TIMING WASHERS for AMERICAN and SWISS WATCHES

Place Washers on two opposite balance screws



Do not place Washers on meantime screws

26 0 to 18 Size

3¾ to 21 Ligne

Size and Rate Per 24 Hours Marked on Bottle

Number Order	American Sizes	Swiss Ligne Sizes	Rate Per 24 Hours
1	26/0-21/0-20/0	3¾ to 5½	20 Seconds
2	26/0-21/0-20/0	3¾ to 5½	40 Seconds
3	26/0-21/0-20/0	3¾ to 5½	1 Minute
4	26/0-21/0-20/0	3¾ to 5½	2 Minutes
5	26/0-21/0-20/0	3¾ to 5½	3 Minutes
6	26/0-21/0-20/0	3¾ to 5½	4 Minutes
7	18/0 to 6/0	6¾ to 9¾	20 Seconds
8	18/0 to 6/0	6¾ to 9¾	40 Seconds
9	18/0 to 6/0	6¾ to 9¾	1 Minute
10	18/0 to 6/0	6¾ to 9¾	2 Minutes
11	18/0 to 6/0	6¾ to 9¾	3 Minutes
12	18/0 to 6/0	6¾ to 9¾	4 Minutes
13	10/0-8/0-5/0	10½ to 11½	20 Seconds
14	10/0-8/0-5/0	10½ to 11½	40 Seconds
15	10/0-8/0-5/0	10½ to 11½	1 Minute
16	10/0-8/0-5/0	10½ to 11½	2 Minutes
17	10/0-8/0-5/0	10½ to 11½	3 Minutes
18	10/0-8/0-5/0	10½ to 11½	4 Minutes
19	4/0-3/0-0	12 to 13	20 Seconds
20	4/0-3/0-0	12 to 13	40 Seconds
21	4/0-3/0-0	12 to 13	1 Minute
22	4/0-3/0-0	12 to 13	2 Minutes
23	4/0-3/0-0	12 to 13	3 Minutes
24	4/0-3/0-0	12 to 13	4 Minutes
25	6-12	15 to 17	20 Seconds
26	6-12	15 to 17	40 Seconds
27	6-12	15 to 17	1 Minute
28	6-12	15 to 17	2 Minutes
29	6-12	15 to 17	3 Minutes
30	6-12	15 to 17	4 Minutes
31	16-18	19 to 21	20 Second
32	16-18	19 to 21	40 Second
33	16-18	19 to 21	1 Minute
34	16-18	19 to 21	2 Minute
35	16-18	19 to 21	3 Minute
36	16-18	19 to 21	4 Minute

FIG. 11-15

SEC. 274—Use of Timing Washers

Example: Watch set at: 9:00 A.M. Set
Reading at: 10:00 A.M. 8 Sec. Fast
Watch is running approximately 192 seconds fast per 24 hours or a trifle over 3 minutes per day

The most common way of slowing this watch down is to use balance washers to add weight to the wheel. Figure 11–15 illustrates a chart from a cabinet of balance timing washers. On the chart is a list of the different sizes of washers contained in the bottles. If the watch is 18 size, we would add a pair of washers from bottle 35 as it is marked three minutes per day. This, in all probability, would bring the watch within the range covered by the regulator and we would then proceed to make the final adjustment with the regulator. However, these washers will act differently on different makes of watches. It might happen that the three minute washers would be too heavy, in which case exchange them for a lighter pair. These washers are obtainable for all sizes of watches. Place washers on screws nearest the balance arms, figure 11–16. Balance screws are best removed and replaced with a balance screw holder, figure 11–17.

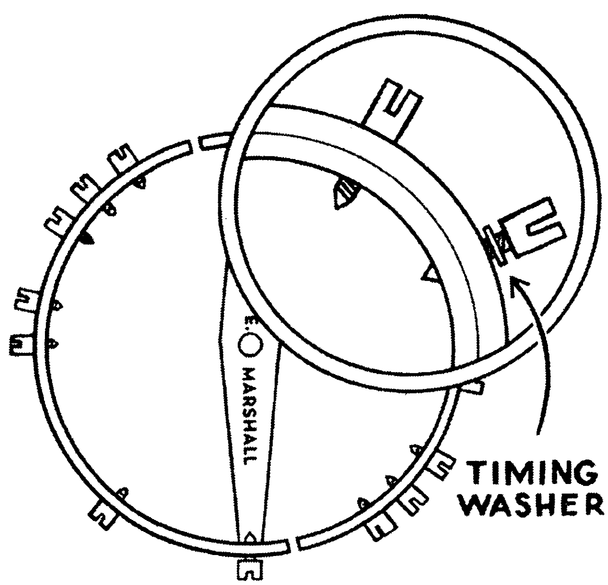


FIG. 11-16

FIG. 11-17

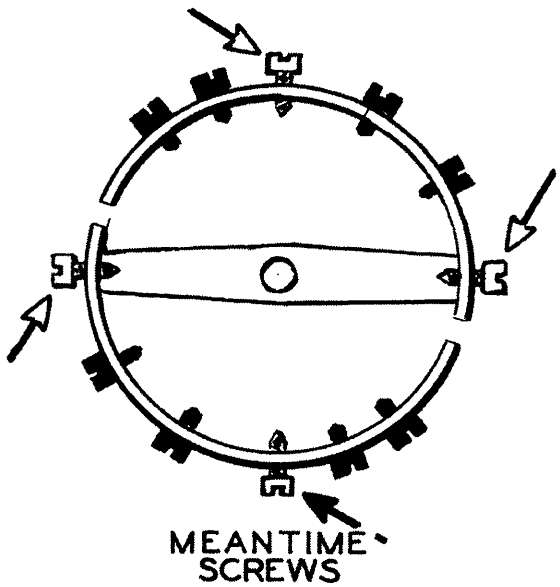


FIG. 11-18

SEC. 275—Meantime Screws

On some balance wheels you may notice one or two pairs of balance screws that are noticeably different from the majority of screws. The heads of the screws are shorter and the threaded portion is longer. These are called meantime screws and are a feature of the Waltham movement. Other watch manufacturers use them in their better grade of movement such as railroad watches and fine pocket watches. These are not found on the majority of Swiss made movements. Figure 11–18 illustrates a balance having 4 meantime screws. Do not change the position of these screws when making repairs on the balance. The position of these screws is changed only when the daily rate is adjusted. Moving a pair of screws toward the center will cause the watch to gain. Moving a pair of screws outward from the center will cause the watch to lose. Always move a pair of screws and move them an equal amount. Caution: Never add timing washers or use an undercutter on the meantime screws.

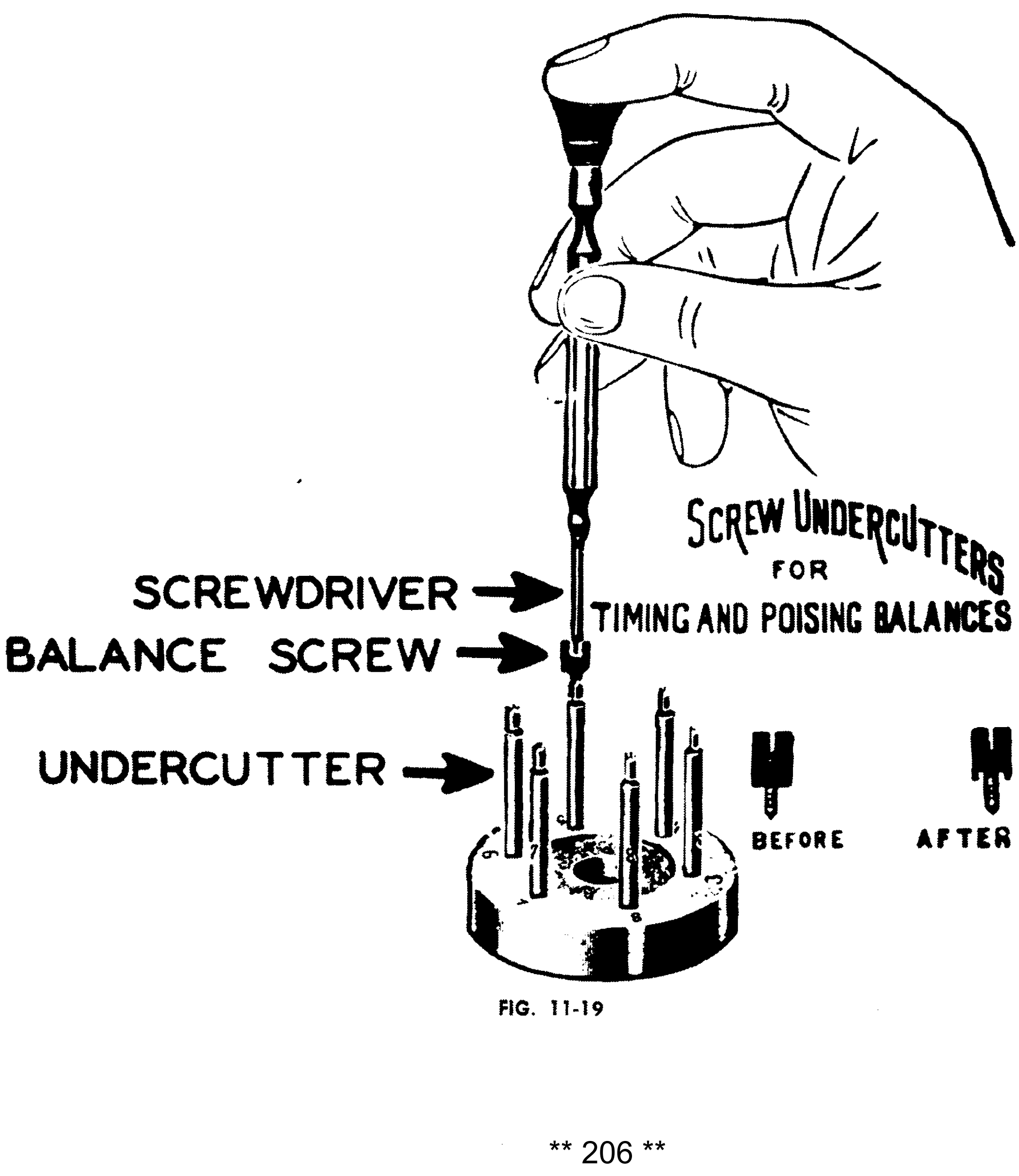


FIG. 11-19

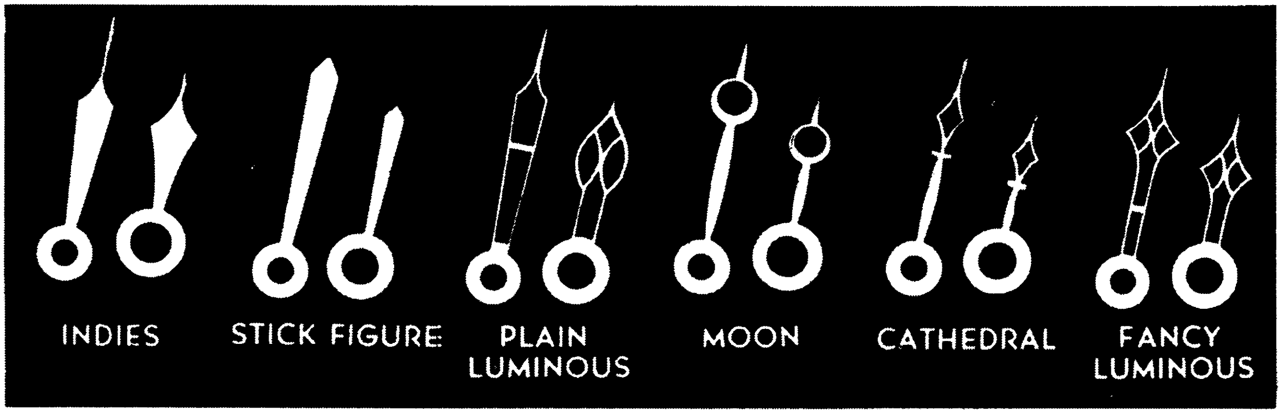


FIG. 11-20

SEC. 276—Use of Undercutter

When a watch runs too slowly—that is, it cannot be regulated by the regulator, it is usually brought to time by removing a little weight from a pair of balance screws. This is done by use of an undercutter, figure 11-19. The use of this tool will be explained thoroughly in lesson on Poising.

For practice on this lesson try timing as many different watches as you can. Do not be afraid to do it over and over. Get the habit of making notes (figure 11-14) when timing a watch. Do not trust to memory.

SEC. 277—Purpose and Types of Hands

It is necessary for you to understand at this time the purpose of the hands, the names of different style hands, and how to adjust and select hands. Inasmuch as you will not have all of the necessary tools at present, it isn't practical for you to replace hands on every watch that needs them. There will be times when you will need a lathe or a staking tool to do this job properly. You will acquire these tools as you progress with your training but it would not be practical for you to make a pipe for a second hand unless you had a lathe; and before you can make a pipe, you would have to have instruction in lathe work. However, the illustrations and the reading matter are for your information and reference work.

Hands are usually made from steel or brass; some are blued and some are gilded, others have luminous paint on them in order that they can be easily read at night. The average watch has three hands. They are the minute hand, which is the longest and which makes one revolution an hour, the hour hand which makes one revolution every twelve hours, and the second hand which makes one revolution a minute. The minute hand is fitted friction tight on the cannon pinion. The hour hand is fitted friction tight on the hour wheel. The second hand is fitted friction tight by means of a tube or pipe over the extended pivot of the fourth wheel.

In replacing hands for most American made watches the hands desired can be ordered by the name and size of watch; for example, 1 pair hands for Elgin 12 size. Figure 11-20 illustrates a variety of styles. It is best to send samples of broken hands or material when reordering.

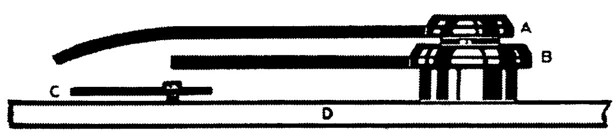


FIG. 11-21

SEC. 278—Relation of Hands

Figure 11-21 is a drawing showing the relation of the hands to each other and to the dial. A is the minute hand, B the hour hand, C the second hand and D is the dial. Notice that the second hand (C) comes very close to the dial surface. Be certain the second hand clears the dial. Sometimes a piece of lint or broken glass wedged between the hand and the dial will cause the watch to stop.

SEC. 279—The Second Hand

The second hand is replaced by pushing pipe over extended pivot of 4th pinion using the flat upper end of tweezers. This must be done carefully so as not to bend the 4th pinion. Figure 11-22 illustrates a pair of pliers used to hold a second hand. At A the second hand is held securely by the pipe and a small pivot broach is used to ream out the hole. Broach hole in the pipe carefully. The second hand should press on easily but securely. At B the hand is held by the pipe but with the end of the pliers. Closing the pliers will close the second hand pipe slightly.

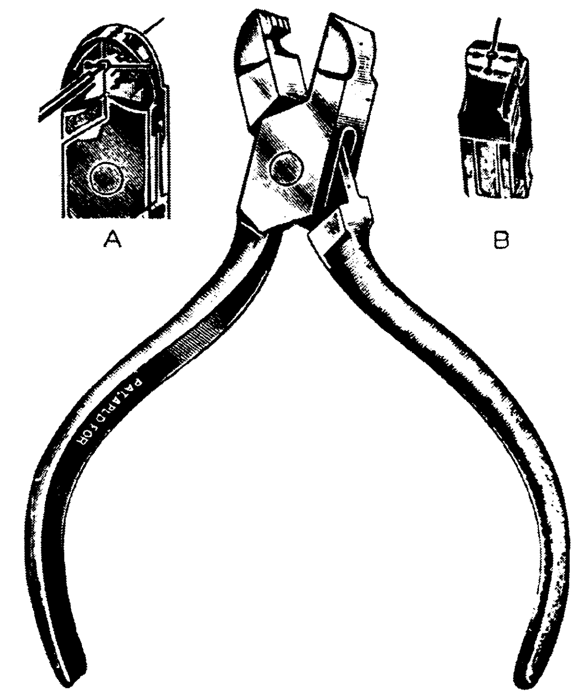


FIG. 11-22

SEC. 280—The Hour Hand

The hour hand has a socket that fits snugly over the tube extending from the hour wheel and the top of the hand should be flush with the top of this tube and parallel to the dial, allowing for clearance between this hand and the second hand. This hand can be put in place by using tweezers, but the proper way is to use a hollow flat face staking tool punch. If a new hand fits too tightly, it can be opened by a cutting broach, figure 11–23. To close the socket, use a concave punch from staking set, figure 11–24.

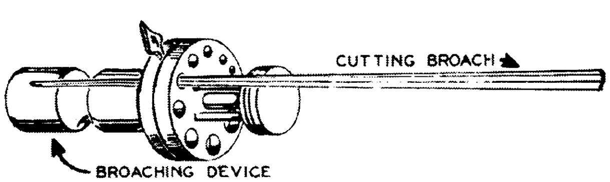


FIG. 11-23

SEC. 281—The Minute Hand

The minute hand can be pressed on with tweezers but it is more practical to use a staking tool, figure 11–25, which has a stump at A upon which the lower end of the Center Pinion is resting. This prevents breaking the lower center jewel. Holes in minute hands are opened

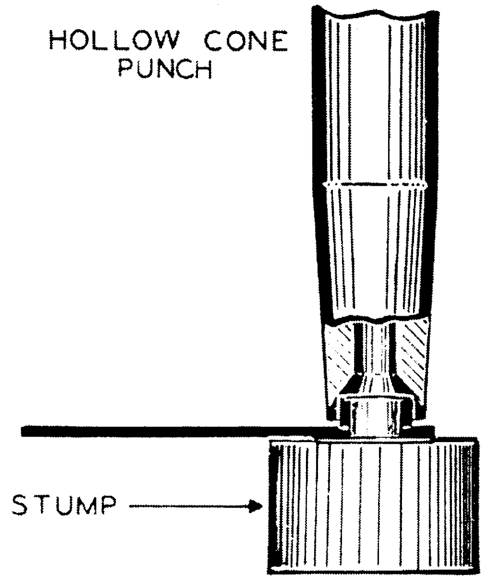


FIG. 11-24

with a broach, figure 11-23, and best closed with staking set using round faced punch, figure 11–26. In replacing hands be careful to see that hands register correctly. Set the pointer of the hour hand at 3. Set the pointer of the minute hand at 12 and replace. Your hands will then register correctly. When the minute hand is directly over any minute mark, the second hand should point to 60.

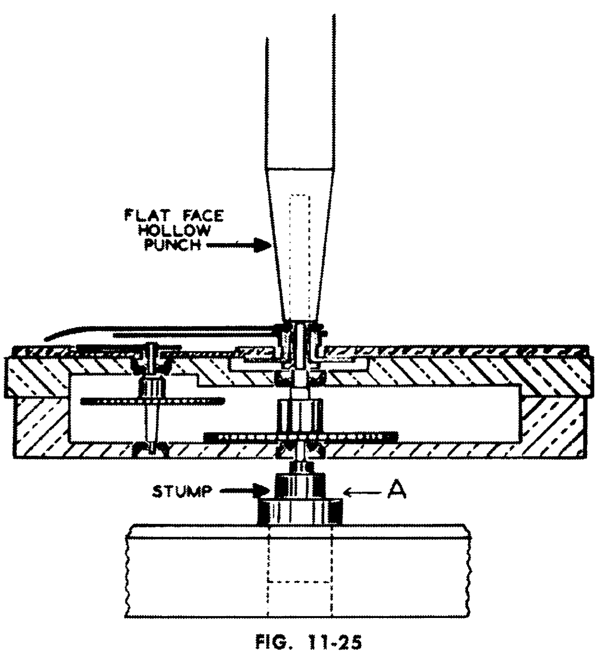


FIG. 11-25

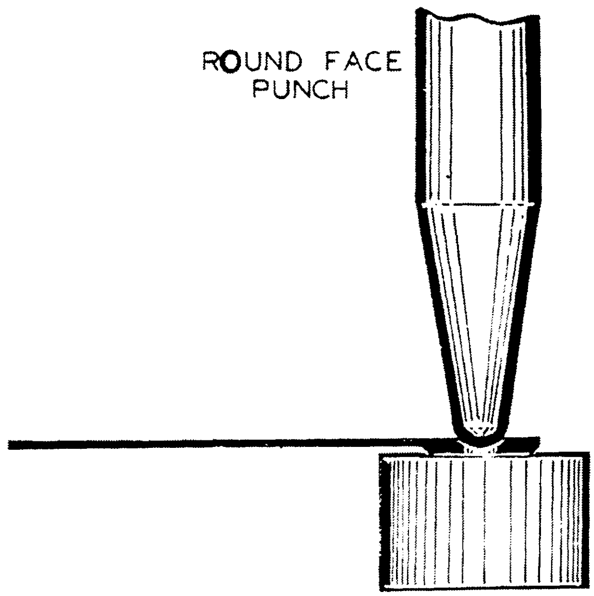


FIG. 11-26

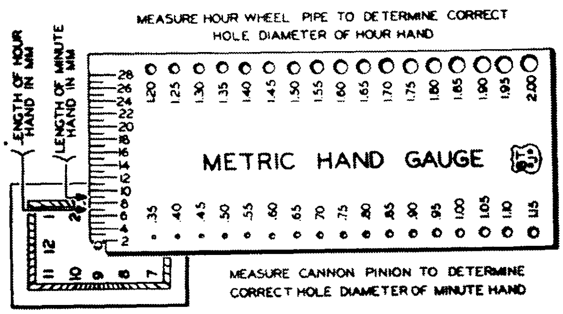


FIG. 11-27

SEC. 282 — Swiss Hand Gauge

Figure 11–27, which is self-explanatory, illustrates a hand gauge for measuring Swiss type hands.

Swiss hands can then be ordered by dimensions:

Example: 1 Blue Minute Hand—Length 12 mm
hole 10

SEC. 283 — Refilling Luminous Hands

It is possible to refill luminous hour and minute hands using a kit similar to figure 11-28. Generally it contains two different shades to match the figures on dial. Heat spatula slightly and with a small amount of paint applied to hand, quickly move spatula backward and forward, figure 11–29, until paint flows freely on hand. If necessary, trim off excess paint with razor blade. Apply paint sparingly; an excessive amount will cause the hands to catch. A sweep second hand is fitted to a pinion making one revolution per minute. In watches of this type, the cannon pinion is hollow. These come in several colors and also with luminous paint. They are replaced best with a punch and stump, figure 11–25.

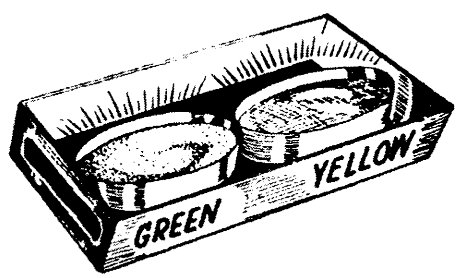


FIG. 11-28

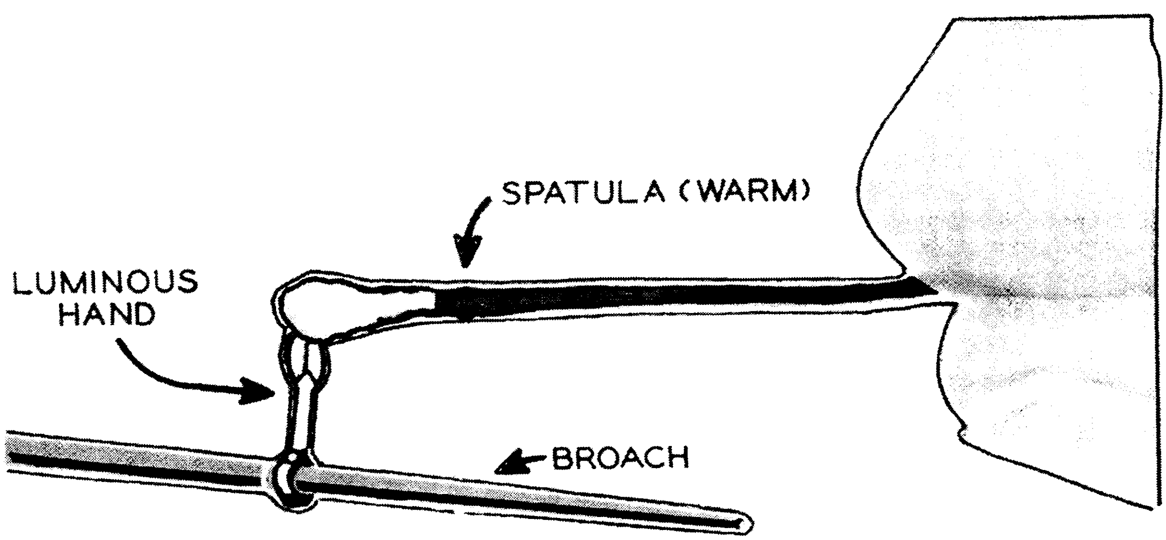


FIG. 11-29

TABLE OF CONTENTS: Unit WIII - Lesson 11

JOB SHEETS

UNIT	W III
LESSON	11

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W11-J1

TIMING, RATING AND REGULATION

TOOLS, EQUIPMENT AND SUPPLIES:

Compass - demagnatizer - tweezers - pegwood - screwdrivers - balance screw holder - undercutters - timing washers

PROCEDURE	REFERENCE
1. Test for magnetism.	Sec. 261
2. Set regulator in center of index.	Sec. 265
3. Check regulator pins.	Sec. 266
4. Test motion.	Sec. 268-269-270
5. Set hands to coincide with master clock or time piece. Start recording rates, entering the time set.	Sec. 272
6. Check watch with master clock at a later time. (2 - 4 - 6 hour intervals are preferred.)	
7. Calculate the amount of time in seconds or minutes your watch has lost or gained, per 24 hour period.	
8. Make a note of the loss or gain and the time of day.	
9. Make adjustment to compensate for loss or gain.	Sec. 267-274-275-276
10. Reset watch with master time piece.	
11. Repeat operations 5-6-7-8-9 until watch keeps satisfactory time.	

NOTE:

Regulate pocket watches to gain about 5 seconds per day in pendant up position.

Regulate wrist watches to gain about 10-15 seconds per day in pendant down position.

Further timing adjustments can be made to meet requirement of the wearer.

REGULATOR PINS:

TOOLS, EQUIPMENT AND SUPPLIES:

Pin vise - needle - regulator pins - bench block - abrasive stone - nippers

PROCEDURE

A. HOW TO REMOVE AND REPLACE A REGULATOR PIN

1. Remove regulator from balance bridge.

2. Push out old pin with fine needle in pin vise.
   NOTE: As pin is tapered, it is pushed out from the bottom side of the regulator.

3. With regulator properly supported, insert new tapered pin from top of regulator to a snug fit.

4. Cut off heavy end of protruding pin at a point approximately it's own diameter above the regulator. Smooth end of pin with fine abrasive stone.

5. Press the stub end firmly into the regulator.

6. Cut off and dress tip of new pin to length of other pin.
   NOTE: If the other pin is gate type, the new pin should be cut slightly shorter than the foot of the gate. Section 266.

7. Make required adjustment to make pins parallel and proper distance apart.

   NOTE: There are no tools specifically designed for adjustment of regulator pins. The normal adjustments may be spacing, bending to make parallel, etc. A small chisel shaped tool and a pair of tweezers can generally be used to adjust pins. Using illustrations D and E in Fig. 11-9 as an example; procedure for changing the left pin in D to look like the left pin in E may be to tilt left pin slightly away from the right pin, make the necessary bends in pin with a pair of tweezers and then tilt the pin back to the position shown in E.

B. GATE TYPE REGULATOR PINS

The construction of this regulator pin is such that it does not allow the hairspring to come out from between the regulator pins. The regulator generally has a slot for a screwdriver so that pin may be turned a quarter turn in either direction to release the hairspring. We recommend replacement of the entire regulator rather than attempting replacement of the gate type regulator pin.

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 12

Factory Set Train Jewels

—

Sections 285 - 302

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

A Modern, Complete, Practical Course

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 12

Sections 285 to 302

FACTORY SET TRAIN JEWELS

SEC. 285

By now you should be well acquainted with the majority of terms used in watchmaking. Additional tools required in most cases will relate to the lesson at hand. From now on your course becomes more intense. We will present each lesson in a more concise form.

SEC. 286—Purpose of the Jewels

The purpose of jewels in watches is a mystery to most people. They may be able to talk glibly of "17 jeweled" watches or perhaps of a full jeweled timepiece but, as a general rule, they have no idea where the jewels are located nor what purpose they serve.

SEC. 287—Jewels as Bearings

Bearings for pivots in the earlier watches were holes drilled in the plates or bridges with metal bushings. Such is the method used for train pivots in some grades of movements manufactured today. Some of the modern watches use metal bushings which are fitted friction tight into the plates or bridges. These bushings can be easily replaced when the pivot holes are worn. When bushings are used, there is more friction and wear as compared with the modern bearings of stone or the so-called "jewels" of the watch. Occasionally students have added fourteen extra jewels to the train and escapement of a seven jeweled movement, thus making it into a twenty-one jeweled timepiece, and invariably were surprised to find that it was necessary to replace the original mainspring with a much weaker one in order to get the proper motion, this being due to the reduced amount of friction in the train and escapement.

Sapphires, rubies and garnets are the most common stones used to make jewels. Cap jewels in some of the older models of high grade watches and chronometers were made of diamond chips and while these are really diamonds, their intrinsic value is not as great as many are inclined to imagine although they serve the purpose as well as an expensive, brilliant cut diamond. Diamonds are not used in the average watch manufactured today.

For average purposes, synthetic sapphires and rubies make the best jewels for bearings in watches. Garnets are usually used in the cheaper grades of watch movements. It is not necessary that watchmakers attempt to manufacture their own jewels.

SEC. 288—7 Jeweled to 23 Jeweled Watches

Seven is the minimum number of jewels in most standard American watch movements. These jewels are as follows: one upper cap jewel, one upper balance hole jewel, one lower balance hole jewel, one lower cap jewel, two pallet stones and one jewel pin or roller jewel. A 15-jeweled watch has an additional four pairs of plate jewels, one each for the upper and lower pivot of the pallet arbor, one for each end of the third, fourth and escape pinions. These jewels are named according to the position they occupy. Thus we have the upper 3rd jewel, 4th jewel, upper escape jewel and upper pallet arbor jewel. On the pillar plate, the opposite jewels are the lower 3rd jewel, lower 4th jewel, lower escape jewel and lower pallet arbor jewel.

By adding an upper and lower center jewel, the total number of jewels is 17. A pair of cap jewels added to the ends of the pallet arbor or the escape pinion would make a total of 19 jewels. A pair of cap jewels added to both the pallet arbor and escape pinion will make a total of 21 jewels. A 23-jewel watch has an additional pair of jewels in the mainspring barrel or at the ends of the arbor (see Lesson 6).

In some watches, jewels are not always matched in pairs and it is quite common to find movements with 6, 9, 11, 16, 17 or 19 jewels. There are also other combinations with which you will become familiar as you progress with your repairing.

SEC. 289—Types of Jewels

The following list of jewels are used in the average watch:

- Train jewels or plate jewels
- Balance hole jewels
- Balance cap jewels or end stones
- Pallet stones
- Roller jewel or jewel pin

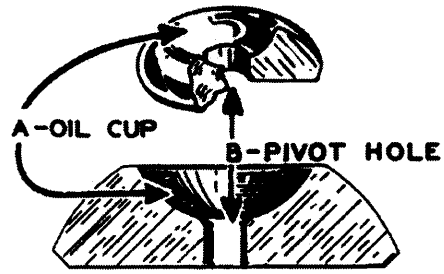

FIG. 12-1

SEC. 290—Train or Plate Jewels

Figure 12–1 illustrates a drawing of a train jewel with a section removed, and a cross-section of this same jewel. A is the oil cup; B is the pivot hole.

Figure 12–2 illustrates a square shoulder pivot used in conjunction with a train jewel. These square shoulder pivots are highly polished and must have sideshake and endshake in order that they may rotate freely.

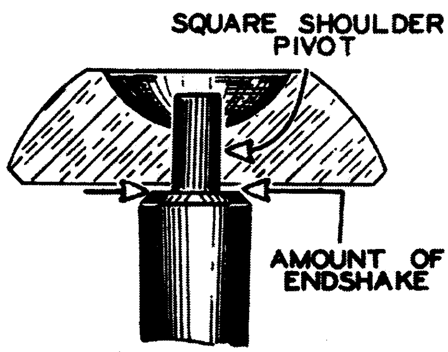

FIG. 12-2

SEC. 291—Sideshake

Sideshake is the freedom between the sides of the square shoulder pivot and the hole in the jewels. The amount of sideshake varies according to the diameter of the pivot. Example: The amount of sideshake in a pallet arbor is less than that in a center wheel. Sideshake is hardly perceptible. It is tested by grasping the pinion with tweezers and endeavoring to move it from side to side. It may be perceptible with your double loupe. In better grade watches, the sideshake can scarcely be seen or felt. If you find an excessive amount of sideshake, there is a possibility that the jewel is broken or that the pivot is cut.

SEC. 292—Endshake

Endshake is tested with the power off. Grasp the pinion with your tweezers and endeavor to move it up and down. This endshake is perceptible on all wheels and pinions including the balance. The space between the face of the train jewel and the shoulder on the pivot, figure 12–2, is the amount of endshake.

To get an idea of the proper amount of both endshake and sideshake, test as many wheels and pinions in different watches as possible.

SEC. 293—Measuring the Hole in a Jewel

Holes in train jewels or balance jewels can be measured by a jewel hole gauge. By slipping the fine needle point in the hole of the jewel and pressing the face of the jewel against the stop, the indicator will register the hole size on the index, figure 12–3. This reading is in hundredths of a mm. Diameters of pivots are measured with the metric micrometer.

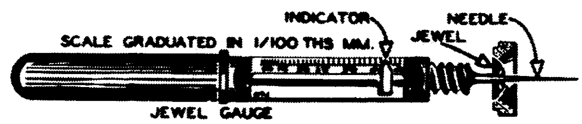

FIG. 12-3

SEC. 294—Determining the Amount of Sideshake by Measurements

Procedure:

1. Measure pivot with metric micrometer and mark down the reading.
2. To ascertain the size of hole in jewel which will allow the proper amount of sideshake with the pivot you have measured, refer to the following chart:

Diameter of Pivots in Hundredths of a mm.	Size of Hole in Hundredths of a mm.
.10 mm.	.11 mm.
.11 "	.12 "
.12 "	.13 "
.13 "	.14 "
.14 "	.16 "
.15 "	.17 "
.16 "	.18 "
.17 "	.19 "
.18 "	.20 "
.19 "	.21 "
.20 "	.22 "
.21 "	.23 "
.22 "	.24 "
.23 "	.25 "
.24 "	.26 "
.25 "	.27 "
.26 "	.28 "
.27 "	.29 "
.28 "	.30 "
.29 "	.31 "
.30 "	.32 "
.31 "	.33 "
.32 "	.34 "
.33 "	.35 "
.34 "	.36 "

.35 "	.37 "
.36 "	.38 "
.37 "	.39 "
.38 "	.40 "
.39 "	.41 "
.40 "	.42 "

SEC. 295—Train Jewels in Setting

Train jewels in American watches are usually set in metal bushings made of brass, oreide, or low carat gold. These settings are usually held in place by jewel screws. Figure 12–4 shows this type of setting: A is the plate, B is the setting, C is the train jewel and D the jewel screws.

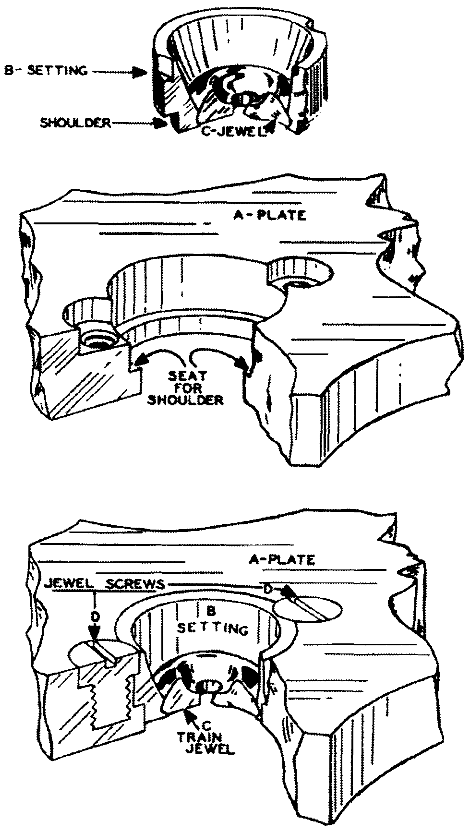

FIG. 12-4

SEC. 296—Replacing Factory Train Jewel

Replace a train jewel setting held by jewel screws as follows:

1. Remove jewel screws.
2. Place plate or bridge over hole in bench block. Be sure hole in bench block is slightly larger than the setting.
3. Force setting out with jewel pusher.
4. Measure pivot with micrometer.
5. Compare measurement with chart, Section 294.
6. Select the proper hole size.

In a shop, you would then select from your stock of material a jewel in a setting with the proper hole diameter which corresponds to the name and size of the watch for which the jewel replacement is to be made.

Without a stock of train jewels, you would order from your supply house as follows:

1 Train Jewel in setting
Name of Watch:
Size of Watch:
Description of jewel (whether upper or lower—center, third, fourth, escape or pallet):
Size of hole desired in hundredths of a mm.:
Send sample whenever possible.

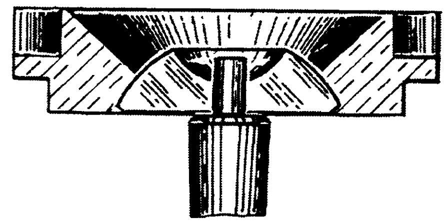

FIG. 12-5

When you have selected the proper jewel for replacement, be sure to test the jewel on the pivot before replacing in watch. The pivot in figure 12–5 fits a little snugly and, in all probability, would cause trouble.

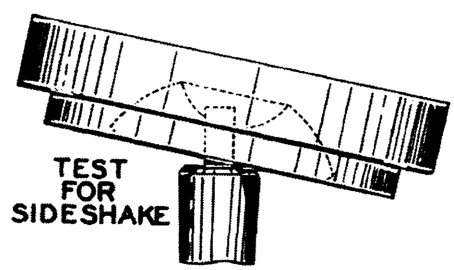

FIG. 12-6

In figure 12–6, the jewel setting is tipped. This shows a slight amount of freedom, which is actually sideshake, between the pivot and hole of the jewel.

The depth of the shoulder determines the amount of endshake and must therefore be correct.

Figure 12–7 illustrates a method of determining whether or not the shoulder on the new setting is exactly the same as the shoulder on the old setting. Figure 12–8 shows the old setting in comparison with one in which the shoulder is cut too deep. Figure 12–9 illustrates too shallow a shoulder. The only way a student could rectify these errors would be to return the setting to his supply house with complete instructions, thus enabling them to make the corrections. When you have progressed into your lathe work, you will learn how to correct a setting that does not conform to your requirements.

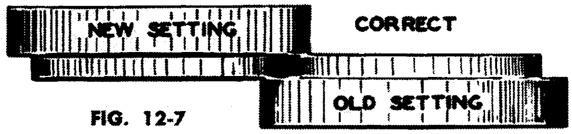

FIG. 12-7

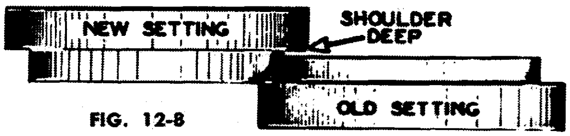

FIG. 12-8

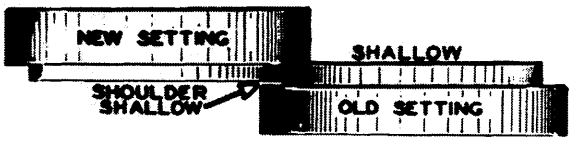

FIG. 12-9

SEC. 297—Raised Setting

Figure 12–10 shows sectional drawing of a train jewel set in a raised setting:

A—Plate
B—Setting
C—Jewel
D—Jewel Screws

Notice that the jewel screws are not set below the surface of the plate. A portion of the setting slightly

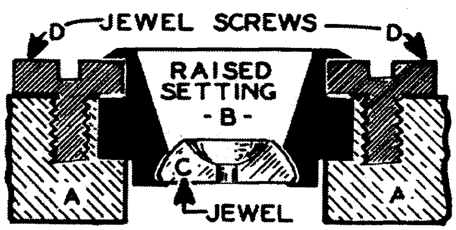

FIG. 12-10

larger than the diameter of the jewel screw is milled out. The portion of the jewel screw head which overlaps the setting keeps this setting in place.

SEC. 298—The Staking Tool

From now on your work will necessitate the use of a staking tool, not only for taking out and replacing jewels but for other jobs such as tightening roller tables, closing holes, endshaking of trains, closing pivot holes in non-jeweled watches, driving out staffs, pinions and arbors, staking balance train, wheels on pinions, driving on rollers, closing hour and minute hands, pressing on hairspring collets, indenting the safety pinion staffs, and many other jobs.

There are many manufacturers of staking tools. A staking tool is comprised of a frame similar to cross section figure 12–11 and an assortment of punches and stumps. Staking tools come with as few as 24 punches and 4 stumps and as many as 133 punches and 25 stumps. In the better grade staking tools the punches can be inverted through a hole in the die plate and used as a stump. This is a distinct advantage, and if possible, is the type of staking tool you should own. There are staking tools with a friction jewelling tool which can be readily attached. In modern shop work we recommend specific tools for specific purposes. In a later lesson you will be shown an excellent friction jewelling device which can be used for many jobs other than friction jewelling. In our opinion, it is a definite advantage to have these two tools as separate units.

As stated before, there are a number of staking tool punches and stumps but it is not necessary for you to learn the purpose of these in one lesson. In fact, the student acquires a more thorough knowledge of the staking tool by learning the use of the different punches and stumps in the regular order of his lessons.

The top of the frame, figure 12–11, is bored to receive any one of the punches and to hold that punch upright and at right angles to the hardened steel die. This die has a series of graduated holes drilled at such a distance from the center that it is possible to bring each hole directly under any punch that may be inserted in the punch guide. The die may be locked in

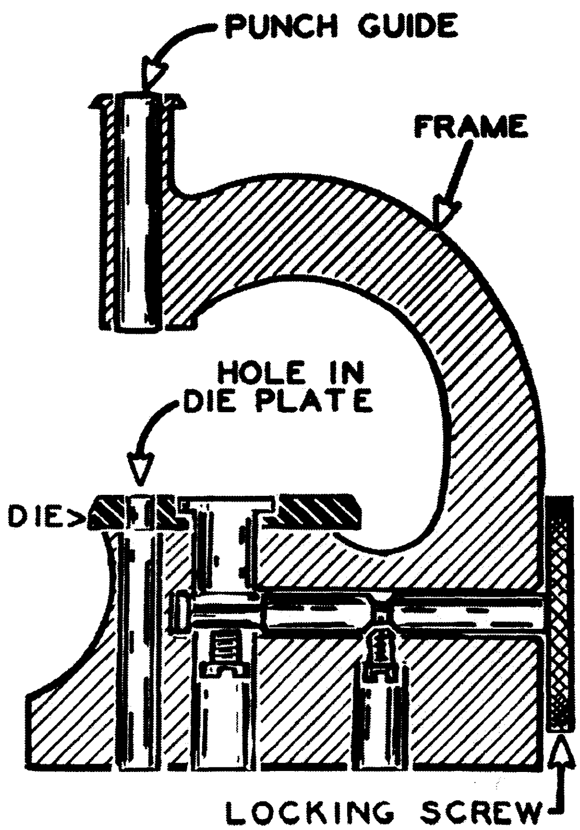

FIG. 12-11

position by means of the locking screw. On the upper part of the frame in the better grades of staking tools is a sustaining device which, with slight friction, holds the punch at any height.

With every staking tool there is a Centering Punch which is used solely for the centering of holes in the dieplate. Figure 12–12 shows the shape of the lower end of this punch and because the upper end is of a design found on none of the other punches, you should have no difficulty in identifying it. If you wish to center any particular hole, the die is unlocked by turning the locking screw and the die revolved until the hole desired is directly under the point of the centering punch. Now press the point of the centering punch firmly into the hole with the die still loose and while holding it there, lock in position with locking screw.

Do not use the centering punch for any other purpose as its needle-like point is easily ruined and rendered unfit for centering small holes.

The four shapes of punches used most are the flat face solid punch, round face solid punch, flat face hollow punch, and round face hollow punch. Figure 12–12 illustrates the following punches: A—centering punch, B—flat face solid punch, C—round face solid punch, D—flat face hollow punch, E—round face hollow punch and F—taper mouth closing punch. Examine your set and identify these punches. Notice there is a greater variety of punches B, C, D and E than of any other.

Having identified these punches, practice centering the different holes in your staking tool die.

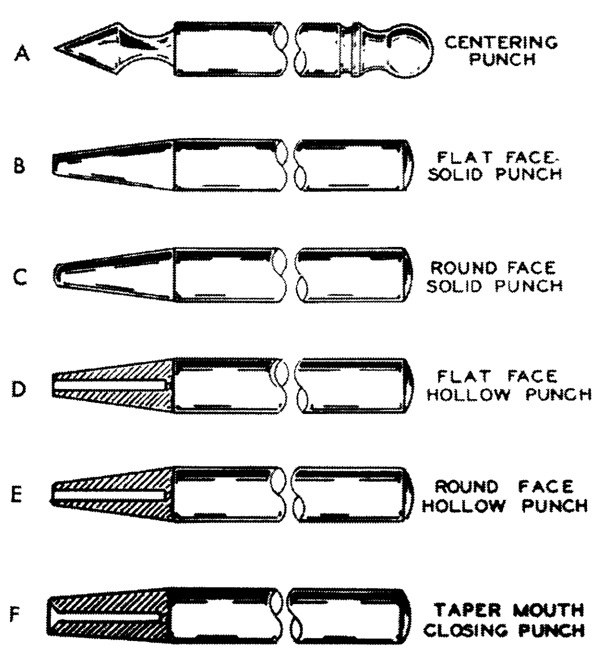

FIG. 12-12

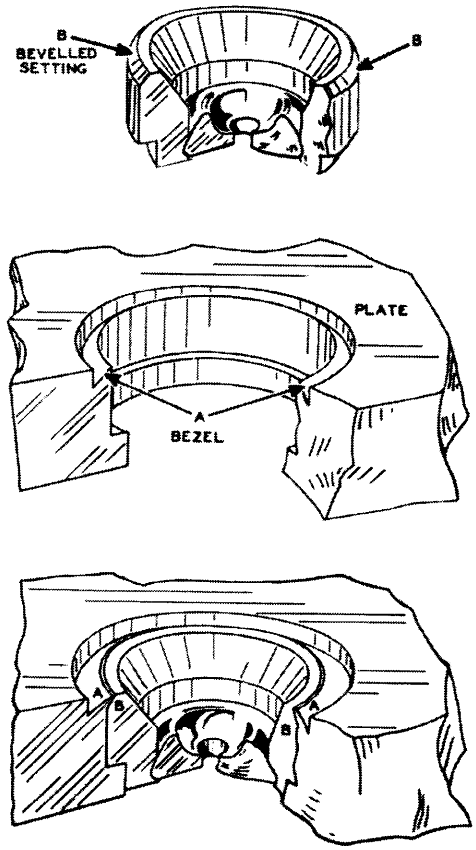

FIG. 12-13

SEC. 299 — Another Type of Train Jewel Setting

The type of jewel setting shown in figure 12–13 is generally found in the pillar plate of some American watches and is held in its place in the plate without the use of jewel screws. The opening in the plate, instead of having recessed places for screws, has a bezel around the edge as shown at A. The upper edge of the jewel setting is beveled slightly, see B, figure 12–13. After the setting has been pressed into position in the plate, the bezel A is burnished tightly over the edge of the setting B thus holding it in place without the use of screws.

To remove a jewel setting just described, select a hole in the staking die that is somewhat larger than the full diameter of the jewel setting and center it using the centering punch. Select a flat faced solid punch, the face of which is smaller than the inner diameter of the jewel setting. Place the pillar plate over the hole in the die with the beveled side of the jewel toward the die. Bring the flat face of the punch down in contact with the jewel setting as shown in figure 12–14, adjusting the watch plate so the punch is in the center of the jewel setting. Hold the punch firmly against the setting and strike the upper end of the

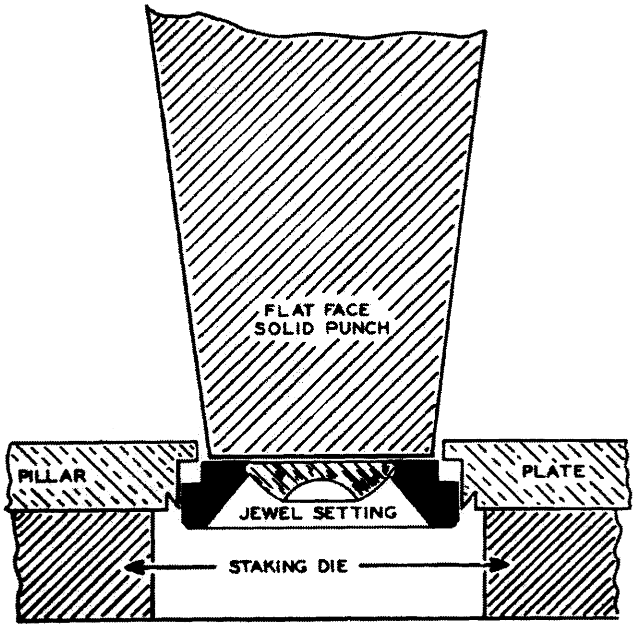

FIG. 12-14

punch a light sharp blow with a brass staking tool hammer. Do not strike too hard a blow and be sure that your punch is not large enough to bind in the opening in the plate as this may injure the shoulder. It is only necessary to drive the setting out of the plate and it is better to use a series of light blows than one heavy one. Never use a steel hammer on your punches. As the setting is driven out of the plate, it forces out the beveled edge of the opening to nearly its original shape.

To replace this type of train jewel setting, proceed as follows:

1. Measure pivot.
2. Compare measurement with chart, Section 294.
3. Select jewel from stock corresponding to name and size of watch.
4. Try pivot for sideshake (figure 12–6).
5. Measure diameter of setting and compare diameter with old setting, using micrometer.
6. Compare shoulders (figure 12–7).
7. Place pillar plate on staking die.
8. Press setting in place with flat face solid punch which is slightly smaller in diameter than the bezel (A–figure 12–15).
9. Select flat face solid punch slightly larger than the diameter of setting and tap slightly. This will force edge of bezel over jewel setting (B–figure 12–15).
10. Test jewel setting with pegwood. It must be tight.
11. It is good practice to run a burnisher around edge of bezel (figure 12–20).

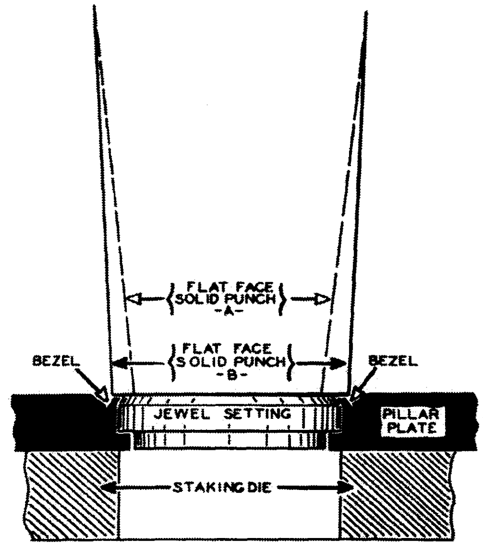

FIG. 12-15

SEC. 300—Friction Train Jewel Setting

It has been the custom of a few watch manufacturers to make the bearings in the plates of their seven jeweled movements in the form of metal bushings which are pressed into openings in the plate and held in place by friction.

Much the same plan has been adopted in fitting jewels in some watches. Figure 12–16 shows a drawing of a friction train jewel setting of this type. Here the opening in the plate has no shoulder and the settings are of such diameter that they are held in place friction tight. The edges of the settings are usually beveled.

To replace a broken jewel and its setting, it is only necessary to drive out the old one using a flat face solid punch as illustrated in figure 12–16. The new setting is replaced from the inner side of the bridge or plate, the beveled edge serving as a guide while placing it in position. If there is too much endshake, the jewel can be driven in enough to make the correct amount.

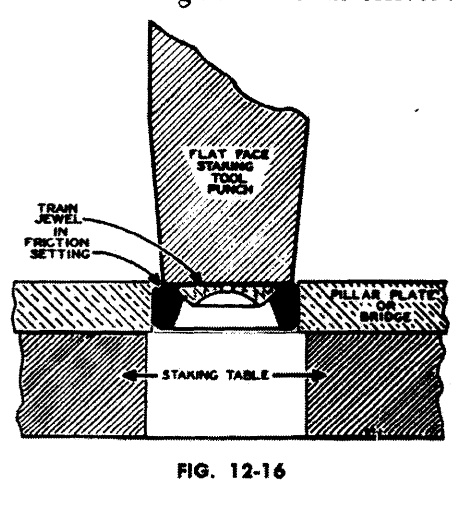

FIG. 12-16

If not enough endshake, drive the jewel a trifle toward the outside.

There are times when the plate or bridge will not rest solidly upon the staking die. If such is the case, a flat face stump can be placed in the largest hole in the die plate which has been previously centered. In this manner, the portion of the bridge or plate surrounding the jewel setting can be properly supported.

The cost of a complete assortment of train jewels in settings for all the different makes of watch movements is so great that only the largest shops attempt to carry them. It is best for the beginner to follow the plan adopted by the great majority of watchmakers and order such jewels as they are needed. Should a watch be brought to you for repairs and you find a broken lower 3rd jewel, order a new one specifying on your order the make and size of movement for which it is intended, which particular jewel it is and also be sure to send the old jewel setting together with the wheel and pinion on which the new one is to be fitted. In this way you will be able to secure a new jewel with correct sized hole, thickness and height.

Thus if you were to order a lower third jewel for a Hamilton 989:

"One only lower 3rd jewel Hamilton 989. Hole Diameter (24), sample enclosed."

In a future lesson on lathe work, you will be shown how with a small investment and at a considerable saving jewels in blank settings can be fitted to most style watches.

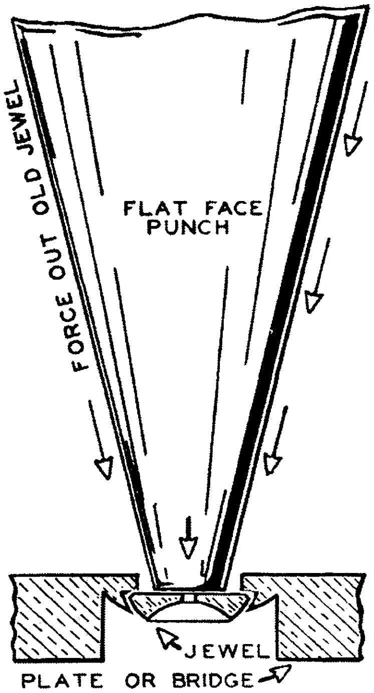

FIG. 12-17

SEC. 301 – Jewels Set in the Plate

You will find in some watch movements, especially those made in Switzerland, jewels set directly in the bridge or plate without the use of bushings or settings, hence the name "plate jewel." In figure 12–17 is shown a cross section of a Swiss type of jewel set directly in the plate. The seat for the jewel is cut directly in the plate as shown in figure 12–17, then a bezel is cut around the opening in order to have a thin edge to burnish over the jewel. Force out a broken jewel with a flat face staking punch.

After the jewel has been pushed out of the seat the edges of the bezel in most cases must be opened a little further until they are straight up and down. This is done with a bezel opener. Bezel openers usually come in sets of three which will cover practically all sizes of jewel bezels found in Swiss wrist and bracelet watches and larger sizes of movements, figure 12–18.

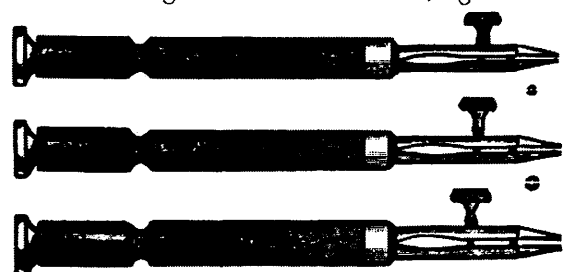

FIG. 12-18

In using the bezel opener, select one on which the jaws when closed will go easily into the old jewel seat and then gradually open the jaws by turning the screw, figure 12–19. Hold the opener much as you

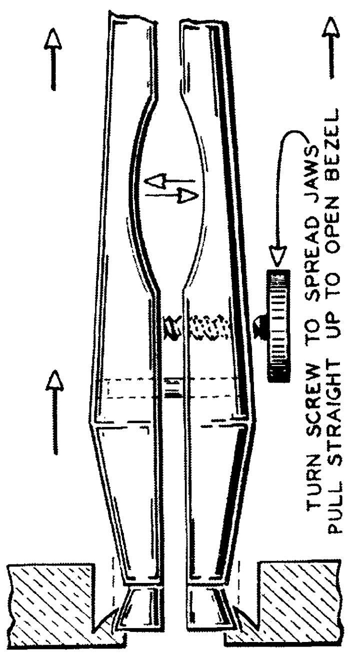

FIG. 12-19

would a screw driver and as the jaws come in contact with the bezel, twist it back and forth between the thumb and fingers keeping it as nearly upright as possible. As you do this, at the same time tightening the tension slightly by means of the screw, the bezel will gradually open until the sides of the seat are nearly straight.

Do not attempt to open the bezel by spreading the jaws of the bezel opener the full amount at one time but rather by applying a little tension after each trial. Be careful not to open the bezel too much. It is better to have the opening in the plate a trifle smaller at the bezel than at the bottom of the seat and then select a jewel than can be forced into the opening.

In selecting the jewel to fit this open bezel, there are three dimensions that must be taken into consideration: the diameter of hole to fit the pivot, the outside diameter to fit the seat in the plate, and the correct thickness which can be judged from the old jewel. As explained before, the pivots and holes in jewels are numbered by hundredths of a millimeter but the outside diameter is measured in tenths of a millimeter. If you have a selection of jewels all supposed to be of a certain outside diameter, you will find by using your micrometer that they may vary somewhat in sizes. Thus in a dozen No. 12 jewels, you will probably find sizes running from 1.15 to 1.25 mm. This gives you an opportunity to select a jewel to within a few hundredths of a millimeter of the size desired. A very convenient way of estimating the outside diameter of a jewel to fit the old seat is by means of your bezel opener. If you will insert the bezel opener and open the jaws until they will just fit without any sideshake in the jewel seat and then withdraw the bezel opener without changing the position of the jaws, it is easy to obtain the measurements in 100ths of a mm.

To replace a train jewel of this type proceed as follows:

1. Force out broken jewel with a flat face staking punch (figure 12–17). The bezel will be forced open to a certain extent.
2. Place bezel opener in seat of setting (figure 12–19).
3. Spread jaws of bezel opener carefully and pull straight out (figure 12–19).
4. Measure across jaws of bezel opener with micrometer. This measurement will be outside diameter of jewel.
5. Measure pivot and compare with chart, Sec. 294. This will be the hole diameter.
6. Select jewel from stock with corresponding outside diameter and hole diameter for replacement.
7. If not in stock, order from material house.

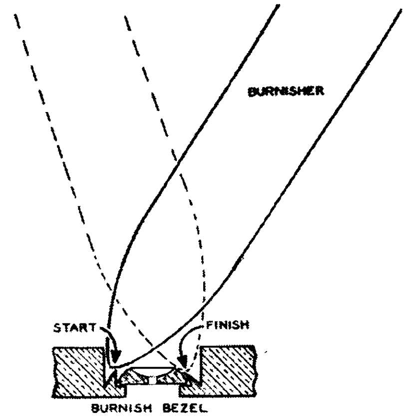

FIG. 12-20

8. Place train jewel in seat (figure 12–20).
9. Figure 12–20 illustrates a hard steel burnisher used to force bezel over jewel. The solid lines of burnisher illustrate the bezel at the start and the dotted lines illustrate the burnisher and the bezel which is now tight against the jewel.

In ordering a new jewel for the type of seat described in this section, it is best to send in the plate with the bezel opened together with the wheel and pinion for which it is intended. In this way a jewel of correct diameter to fit both the seat and the pivot can be furnished.

SEC. 302 — Swiss Watches

As already mentioned, it is very easy to select material for American watches if the sample of the old part is furnished together with the name of the manufacturer and the size of the watch. However, in ordering Swiss material it is necessary to have a little more definite information. There are literally thousands of names of Swiss watches on the market today, each importer perhaps having several different names although there are comparatively few different Swiss factories.

After the watchmaker has established a profitable repair business, it is well to have an assortment of unset jewels. They can be had with sized holes and assorted diameters and in the larger and more complete assortments with sized holes and sized diameters.

The replacing of broken jewels in timepieces is one of the paying services rendered by watchmakers and should be studied and practiced until you are thoroughly proficient in replacing any type with which you may come in contact. Do not be satisfied with merely getting the new jewel in the plate so the endshake is correct but with the appearance of having been secured in the bezel by means of a broken nail and a sledge hammer, but rather endeavor to have each job with a finish that stamps it as the work of a Master Watchmaker.

note:

(Lesson 12 - 14 job sheets combined after Lesson 14)

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 13

Factory Balance Hole Jewels and Roller Jewels

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Sections 305 - 325

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Lesson 13

Sections 305 to 325

FACTORY BALANCE HOLE JEWELS AND ROLLER JEWELS

SEC. 305—Olive Hole Jewels

The train jewels shown in the previous lessons had holes through them, the walls of which were straight. In balance hole jewels, there are two types of holes; one type has straight walls

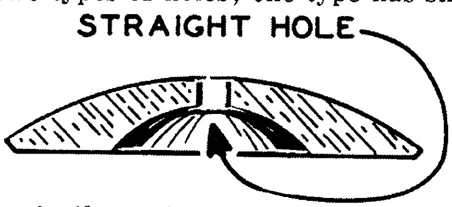


Fig. 13-1

as in the train jewels, figure 13-1, while the other has curved walls and is called an olive hole jewel, figure 13-2. The olive hole gives a smaller bearing surface without sacrificing

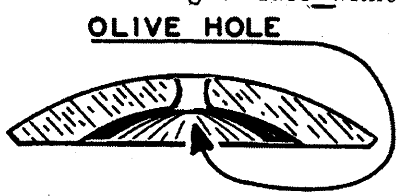


Fig. 13-2

strength and there is less adhesion of oil between the jewel hole and the pivot.

SEC. 306—Balance and Cap Jewel Assemblies

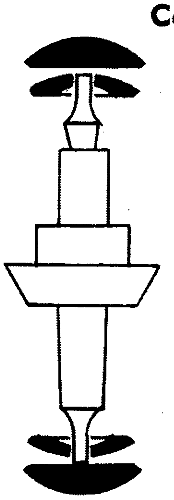


Fig. 13-3

Balance hole jewels are used in connection with cap jewels as bearings for pivots with conical shaped shoulders such as are found on the balance staff. Figure 13-3 is a drawing of cone pivots. In the lesson on train jewels you learned that the side and shoulder of the square shoulder pivot came in contact with the jewel. With a conical pivot, the cone is never in contact with the jewel. The bearing surfaces are at the end and side.

Balance hole jewels are used as bearings for all conical pivots. The name "balance hole jewel" applies to these jewels when they are used as bearings for the balance staff. However, the same type of jewel assembly is used in watches such as railroad

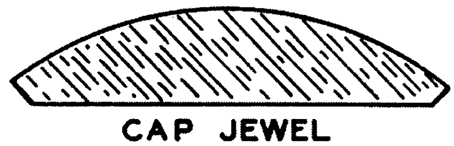


Fig. 13-4

watches where cap jewels are used on pallet and escape wheel assemblies.

The cap jewel, figure 13-4, known also as the end stone, differs from either the balance hole or train jewel in that it has no hole through it but is a plain, highly polished surface, which acts as a bearing for the end of the pivot. The pivot projects through the balance hole jewel and the only part of the pivot that comes in contact with the cap jewel is the end. The cap jewels, one of which is located at each end of the balance staff, determine the amount of end-shake for that particular balance staff.

SEC. 307—Relation of Balance and Cap Jewels to Pivots

In figure 13-5 is shown the relation of the balance hole jewel D, balance cap jewel C, and the balance pivot. Here you can see that the pivot is held in its central position by the hole in the balance hole jewel and that it is kept from extending too far through that jewel by the cap jewel. In this assembly, each jewel is burnished in a setting and the two settings placed in one opening, the two lower jewels or foot jewels in the pillar plate and the upper jewels or cock jewels in the balance cock. The balance jewel assembly in American watches usually is a setting with a shoulder as shown in figure 13-6. The setting for the cap jewel, figure 13-6, generally has counterbored openings for the heads of the jewel screws. Figure 13-6 also shows the position that they occupy when fitted to the balance cock, C representing balance hole jewel in its setting, B the cap

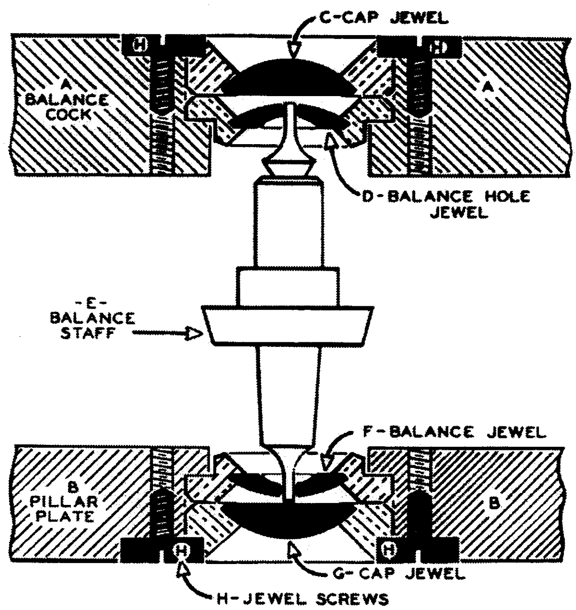


Fig. 13-5

jewel in its setting, D the jewel screws, and A a section of the balance cock.

SEC. 308—Chart to Determine Proper Sideshake

Measure balance pivot with your micrometer and use the following chart to obtain the proper freedom or sideshake:

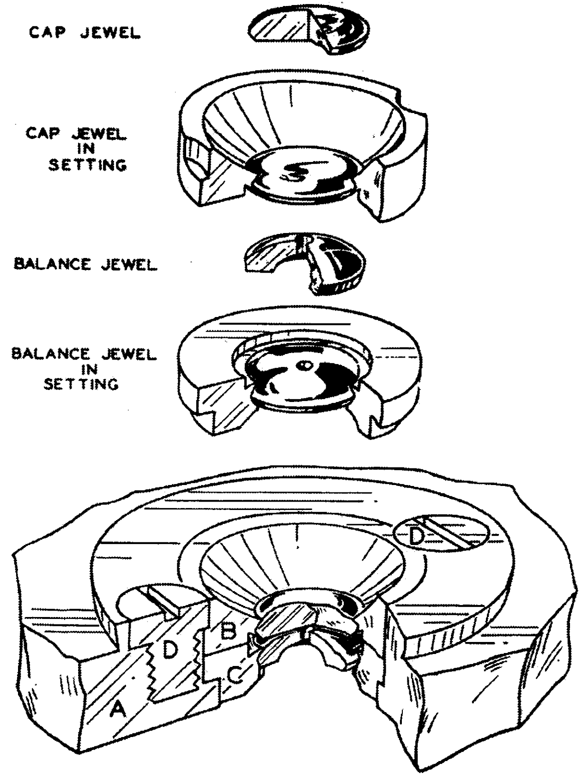
Pivot Measures in 100th of a mm	Use Jewel with Hole
.05	.06
.06	.07
.07	.08
.08	.09
.09	.10
.10	.11
.11	.12
.12	.13
.13	.14
.14	.15

Always test the jewel on pivot before replacing. Jewel holes may vary in size slightly. If a properly set balance jewel is placed over a correctly shaped balance pivot, the pivot should go through easily and extend through the jewel about the same distance as its own diameter. Should the pivot not extend through, it is liable to bind when the movement is in such a position that the pivot is running on the cap jewel.

SEC. 309—Removing Balance Jewel Assembly

The following procedure is used to remove American balance jewel assembly held in place by jewel screws:

1. Remove jewel screws.



A – Balance Cock
B – Cap Jewel In Setting
C – Balance Jewel In Setting
D – Jewel Screws

Fig. 13-6

2. Place cock or pillar plate over large hole in bench block.
3. Select proper size jewel pushers and force balance and cap jewel out.
4. Separate balance jewel from cap jewel.

With a sharp knife, cut off the end of a piece of pithwood to get a clean, flat surface and with this wipe off any dirt or oil that may be on the faces of the two jewels. When a watch has not been cleaned for a long time or when a poor grade of oil has been used, the surface of the jewels may be covered with gummed or dried oil which the pithwood will not remove easily. In such instances, scrape clean the face of the jewels with the end of a piece of pegwood cut to a chisel shape, and then clean with cleaning solution. Examine each jewel separately using a double eye glass to determine if they are cracked or broken, and whether or not the balance hole jewel is chipped around the hole. If cracked, broken or chipped, it should be replaced with a new jewel.

Sometimes the cap jewel may be found with a slight "pit" in the center of its flat surface where it has been in contact with the end stone.

If the cap jewel is cracked or "pitted", it also should be replaced.

Having examined the jewels to see that they are perfect, cleaned the surfaces and pegged out the hole in the balance hole jewel, you are now ready to replace them in the balance cock, but before doing so, be sure to test the balance hole jewel on the balance pivot to see that it fits correctly.

The main reason we insist that students practice upon better grades of watches, and those which have not been worked upon by incompetent workmen, is so that they may be able to acquaint themselves with the correct relations and fittings of the associated parts. If, at this time, you are working upon a watch that is in first class condition, you can obtain a very good idea of the proper relation of the balance hole jewels and the pivots by testing each hole jewel on the proper pivot.

SEC. 310—Replacing Balance and Cap Jewel Assembly

Your first step in replacing the jewels will be to insert the balance hole jewel in the opening in the balance cock and to press it down against the seat, using a jewel pusher. Having done this, press the cap jewel in place using care to see that the counterbores match on the jewels and balance cock. Press the cap jewel down firmly against the balance hole jewel and if it is the correct size, the flat surface of the cap jewel setting will be flush with the top of the opening in the balance cock. Insert the balance jewel screws and turn them down until tight. Be very careful and avoid getting any scratches or marks on the cap jewel setting. As you will observe, this setting is stripped and burnished on the top to a high polish. You should endeavor at all times to protect this fine finish.

Having replaced the jewels, you should now proceed to assemble the balance, making certain that there is the proper amount of endshake and that there is no noticeable sideshake on the balance staff.

In fitting a new balance hole jewel, try the pivot to see that the hole is of proper size and compare the shoulder height of the setting with the old one. If this shoulder is not the same as the old one, it will make a difference in the endshake. The new setting must be of the right diameter to insure its being neither too tight nor too loose. If the old cap jewel setting was of the right thickness, the new one should have the same measurements. A variation in this dimension will make no difference in endshake as long as it is pressed down firmly against the balance hole jewel setting, but if it is a flat setting, it will make a difference in appearance as the top surface should be flush with the balance cock. Should the countersinking at the end of the cap jewel setting be too deep, the balance screw heads may not hold it firmly in place and this loosening of the setting will cause trouble in timing or rating or might even stop the watch under certain conditions.

SEC. 311—Ordering Factory Jewels

To order a balance hole jewel from a material house, it is only necessary to remove both settings, measure the pivot with micrometer, and select or order a complete new jewel and setting, allowing the difference between hole and pivot size as listed in Section 308.

Example:

Pivot measure .11 mm
1-12s Elgin upper balance jewel hole .12
1-12s Elgin lower balance jewel hole .12
To replace cap simply select or order:
1-12s Elgin upper cap jewel
1-12s Elgin lower cap jewel

Always specify whether upper or lower balance or cap jewel when reordering. Lower jewels may not be of the same dimensions as the upper. Compare shoulders and thickness of settings.

SEC. 312—Balance Jewels in Swiss Watches

As you have already learned, the American manufacturers set their balance jewels in separate settings which fit openings in either the balance cock or pillar plate. In most makes of Swiss watches, however, the balance jewels are held in position by a slightly different method.

By removing the balance cock and turning it over, you will find that the jewel screws are inserted from the lower side, extending up through the balance cock, and are threaded into the cap jewel plate. The outer edge of the cap is beveled to match the inside of the regulator. The balance jewel screws, inserted from the lower side, extend up through the balance cock and are threaded into the cap as shown in figure 13-7. When the regulator is in place

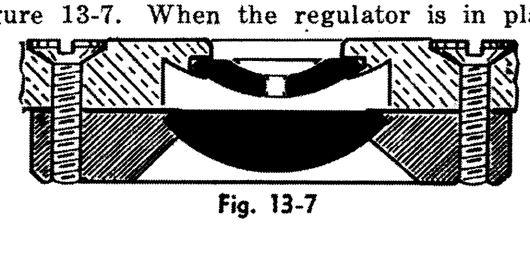


Fig. 13-7

and the cap drawn down by the jewel screws, it is held securely owing to the fact that the outside edge of the cap is larger at the top than at the bottom and acts somewhat as a wedge when drawn down against it.

Here the balance hole jewel shown is burnished directly into the balance cock. This arrangement of the balance jewels is at times confusing to the beginner and occasionally offers some obstacles in his readily assembling such a Swiss movement, especially after he has been working on American watches. The novice can overcome the tendency to set his jewel screws in from the top if he will do the following: Assemble these parts by first laying the cap in front of him in an inverted position, place the regulator over the cap, turn the balance cock upside down and set it so the two screw holes are directly over the holes in the cap, and finally, insert the screws from this side.

SEC. 312—Replacing Swiss Balance Jewel

To replace Swiss balance jewels, force out the old jewel, open bezel with bezel openers, select balance jewel of correct diameter and hole size, replace and burnish (similar to Sec. 301, Lesson 12). However, in modern shop methods, it is more practical to replace this type of balance hole jewel and cap jewel with friction jewels.

SEC. 313—Swiss Friction Settings

Figure 13-8 illustrates the modern balance hole and cap jewel assembly used in Swiss watches. Here the cap jewel is held in place in the cap jewel plate by friction and the plate is held in place by two jewel screws set in from the under side. The balance hole jewel is held in the setting by friction and the setting is in turn a friction setting set in the cock or pillar plate. Replacing this type of jewel comes under friction jewelling.

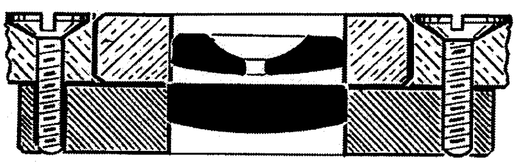


Fig. 13-8

You may find old Swiss watches in which the cap jewel is merely set under the cap without being held in place by the bezel. This naturally does not give the proper distance between the cap jewel and the balance hole jewel since the cap jewel then sets directly on the balance hole jewel and the oil has a tendency to spread away from the pivots.

SEC. 314—Balance and Cap Jewel Assortments

Most watchmakers carry assortments of balance hole and cap jewels to fit the more common American watches. In the better arranged assortments of balance hole jewels in settings each bottle or capsule contains jewels for a specified size of watch and with the assortment is an index showing these makes and sizes. Thus if you wish to replace the upper balance hole jewel of a 16 size Waltham watch, find on the index card the number of the bottle containing the upper balance hole jewel for a 16s Waltham movement. As explained in Sec. 308, if the pivot measures .10 mm, you should select a jewel with a .11 mm hole in order to get the proper amount of sideshake. The jewel selected will not necessarily fit exactly, and it must be tried on the pivot before placing in the watch.

It is not necessary to carry a large assortment of cap jewels as one bottle for each size is sufficient. Nor is it necessary to subdivide the sizes as one cap jewel will suffice regardless of the size of the pivot, provided the setting is of the correct diameter and thickness.

When ordering a single balance hole jewel, state the make and size of watch for which it is intended, whether a cock or foot jewel, and the size hole desired. Send in the old jewel with your order. If not sure of the hole size, send in the balance also. In shipping a balance or any small part of a watch by mail, to protect it in transit, always wrap it in watch paper and place it in a small metal box or container. If a cap jewel is ordered, give make and size of movement and whether cock or foot jewel and send in old jewel setting as a sample.

SEC. 315—Hamilton Balance Jewel Assembly

Figure 13-9 is a cross section of a Hamilton style balance jewel assembly. The balance jewel setting, which is a friction setting, holds the cap jewel in place. Remove and replace with staking tool or jewel pusher.

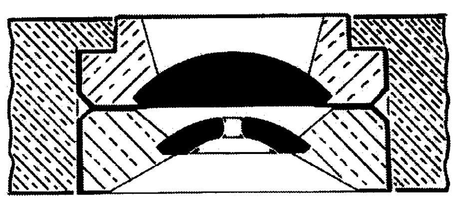


Fig. 13-9

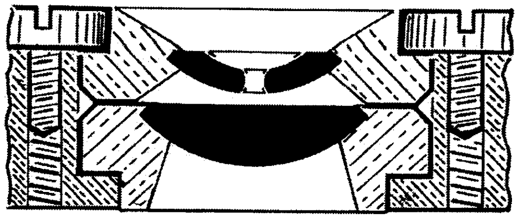


Fig. 13-10

SEC. 316—Illinois Balance Jewel Assembly

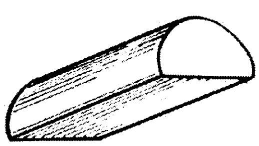
Figure 13-10 illustrates a type of balance and cap jewel setting found in some models of watches, namely, Illinois. The settings are removed and replaced by removing the jewel screws and removing the settings from the under side of the balance cock or pillar plate.

SEC. 317—Purpose of the Roller Jewel

The impulse from the fork is conveyed by means of the jewel pin, or roller jewel as it is more commonly known, and causes the balance to turn. It is sometimes referred to as the impulse pin. This pin or jewel is set in the roller table by means of shellac and the roller is driven on the lower tapered end of the balance staff friction tight. The roller table is made of steel or of softer metals such as nickel, oreide, etc. In some models of watches using a composition roller, the roller jewel is forced into place without the use of shellac or cement.

Roller jewels are made of garnet, sapphire, or ruby. Garnet roller jewels are softer and are broken more easily than ruby or sapphire jewels; the difference in cost is so slight that it is advisable to use the better quality of roller jewels for your repairs.

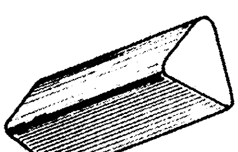
SEC. 318—Shapes of Roller Jewels



HALF ROUND OR
-D- SHAPE

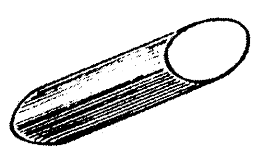
Fig. 13-11

There are several different shapes of roller jewels. The so-called half round is more the shape of a D, as shown in figure 13-11. This type of roller jewel is used in the majority of modern watches. Occasionally you may find watches with triangular shaped roller jewels as shown in figure 13-12. These are used in some of the higher grades of Swiss watches. Another type is the oval roller jewel illustrated in figure 13-13.



TRIANGULAR

Fig. 13-12

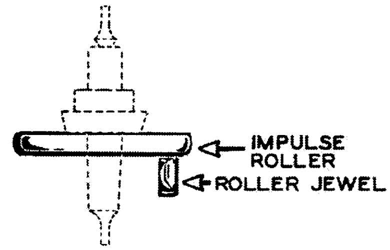


OVAL

Fig. 13-13

SEC. 319—Types of Roller Tables

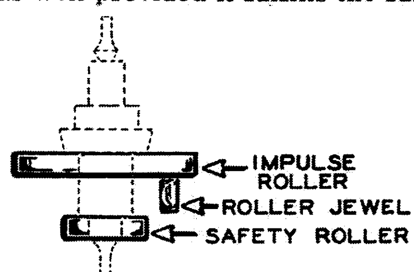
There are three types of rollers or roller tables used in modern watches. Most of the older models of watches are equipped with the single roller as illustrated in figure 13-14, in front of which has been milled out a small section called



SINGLE ROLLER

Fig. 13-14

the passing crescent. Another type, the two piece double roller, consists of two separate rollers. The larger one carries the roller jewel and is known as the impulse roller, while the smaller one contains the passing crescent and is called the safety or guard roller. The balance staff used with this type of double roller has two shoulders and each roller is fitted to its respective shoulder. In figure 13-15 the larger of the two rollers contains the roller jewel while the guard roller, which is below, contains the passing crescent. While the impulse roller is usually thought of as being circular in form, any other shape will perform as well provided it fulfills the function



TWO PIECE
DOUBLE ROLLER

Fig. 13-15

of carrying the roller jewel at the required distance from the balance staff and does not throw the balance out of poise. The most common form of double roller is called the combination roller, figure 13-16. Here the impulse roller

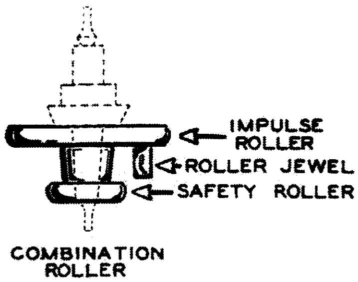


Fig. 13-16

and safety roller are permanently connected by means of a tube or pipe. They are held in place on the balance staff by friction and the staff requires only one seat similar to the one used with a single roller.

SEC. 320—Gauging Roller Jewels

Roller jewels are gauged in hundredths of a millimeter. Thus a roller jewel size 30 measures 30/100 mm across its greatest diameter.

The freedom or "shake" between the roller jewel and the slot in the fork should be approximately .015 to .02 mm. Formerly, it was customary to gauge the roller jewel by holding it with the tweezers and trying the freedom or shake by moving it back and forth in the slot of the fork. Many a jewel has been snapped out of the tweezers while doing this. A roller jewel gauge used in combination with an assortment of roller jewels in metric sizes has done away with this troublesome test and has made the selecting of the roller jewel a comparatively simple problem for any watchmaker to master. Figure 13-17 illustrates a roller jewel gauge which consists of a series of leaves somewhat on the order of a feeler gauge. Each leaf or feeler is stamped with a number which corresponds to the number of sizes used in the roller jewel

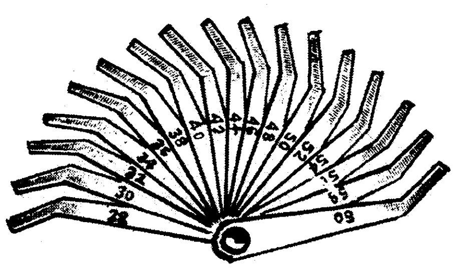


Fig. 13-17

assortment. With this instrument you can readily gauge the width of the slot in the fork, and allowing .01 to .02 mm for freedom or shake, arrive at the correct size of jewel to select from an assortment. It is not necessary to take the watch apart to do this; merely remove the balance cock and balance and select the gauge, the tip of which fits the slot in the fork without shake but yet is not tight enough to stick, figure 13-18. With this gauge it is not necessary to figure the amount of sideshake on the jewel; merely select a jewel approximately .02 mm smaller than the number on the particular

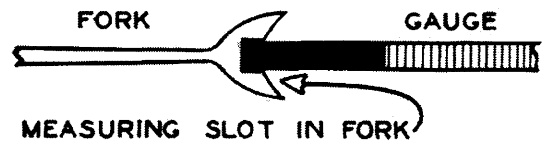


Fig. 13-18

gauge that fits the slot. Example: Gauge stamped 36, select jewel 34. It is advisable to try jewel in fork slot before setting. The following chart gives the most common sizes and their comparative sizes on the gauge:

Slot in fork measures	Use roller jewel
28	26
30	28
32	30
34	32
36	34
38	36
40	38
42	40
44	42
46	44
48	46
50	48

SEC. 321—Preparation For Setting Roller Jewel

A broken roller jewel is a frequent cause of stoppage in a watch and it is an easy matter for the master watchmaker to locate this trouble. Suppose a customer brings a watch to you for repairs. In your examination of the balance staff give the watch a slight circular twist to make the balance swing back and forth. Should you find that while the balance oscillates freely the fork does not move, you can feel justified in making an estimate for a new roller jewel. The jewel usually breaks flush with the roller table and it is an easy matter to press the remaining piece of jewel out of the roller with a pointed steel wire or needle.

Before replacing the new roller jewel, remove all old cement with a chisel-shaped piece of brass wire. Brass is used because it will not mar the surface of the roller yet it is harder than the cement. Figure 13-19 illustrates a tool which can be made from a piece of brass or nickel wire about 2 mm in diameter and approximately 35 mm long. Figure 13-20 is an enlarged view of this tool.

The hole into which the jewel is to be set should be cleaned with a piece of pegwood

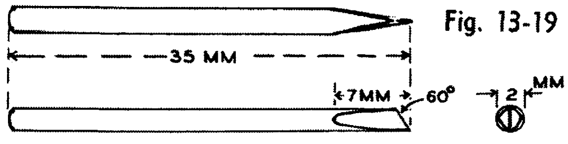


Fig. 13-19

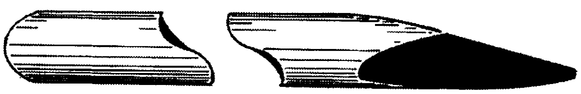


Fig. 13-20

sharpened to a long point. Twist the pegwood, which has been dipped in alcohol, around in the hole until all of the old cement has been removed. Select a jewel to fit the slot in the fork, and see that it is absolutely clean. Holding the jewel in a pair of tweezers, dip it in alcohol and press the jewel into pithwood. It is essential that the hole in the roller and the jewel be perfectly clean in order that the jewel can be set securely. The main cause of loose roller jewels is that the hole and jewel were not absolutely clean or the cement had been overheated.

SEC. 322—Preparing Cement

Practically all roller jewels are held in place by means of cement. Once in awhile you may find one set in a composition roller without cement. These jewels are pressed into position. Liquid cement is not recommended for setting roller jewels. You will find shredded shellac will serve the purpose better and if prepared properly, is more easily handled. Prepare as follows: Heat the end of a stick of lathe cement or shellac in the flame of an alcohol lamp, turning it over and over until the end becomes very soft. Be careful not to burn it. Grasp a small portion of the warmed cement with a pair of tweezers and pull it out into a string of cement. If you desire a thin string, pull it out rapidly and for a thicker string, pull it out more slowly. It is wise to prepare a number of these threads of shellac for future use. See figure 13-21.

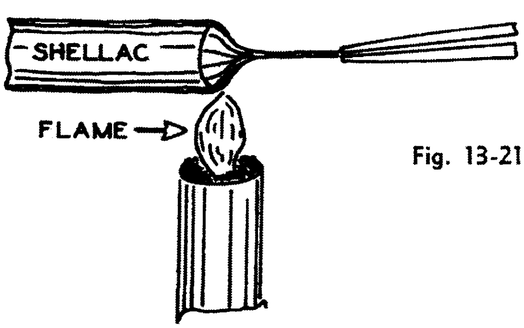


Fig. 13-21

SEC. 323—Setting the Roller Jewel

There are a number of tools on the market designed for use in setting a roller jewel. Some of these will work very well on one type of roller but not on another, or perhaps they will work all right on large sizes of watches but are not very satisfactory for bracelet watches. With other types it is neccessary to remove the roller from the staff.

The combination tool shown in figure 13-22 will be found satisfactory for the average watch and can be used for either single or double rollers without removing the roller from the staff. The combination tool holds the roller table on the edge and conveys the heat applied from the alcohol lamp to the table and jewel while setting or adjusting.

To set a roller jewel, open the jaws of the tool, figure 13-22, by pressing the button at A and catch the roller between the grooved jaws B with the balance above the flat faces of the jaws. The hole which receives the roller jewel should be centered between the jaws and toward the open portion of the jaws. In replacing the jewel it will be necessary to turn the combination tool over. Apply heat to the extreme end of arm C with the flame of your alcohol lamp, and when hot enough to melt the cement, insert the end of a thread of cement into the hole in the roller until it is completely filled. After pulling the rest of the cement away, apply heat to arm C again until cement flows evenly in hole. While the cement is still warm, insert the previously selected and cleaned roller jewel into the hole with the tweezers, pressing it through the warm cement until the jewel is flush with the top of the roller table. Warm again and touch the end of cement

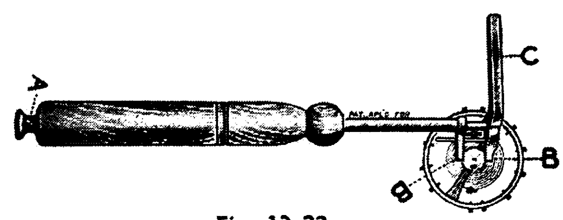


Fig. 13-22

thread to the top of the jewel until it melts over the end of jewel and roller table. Keeping the roller warm, grasp the roller jewel with the tweezers and move it up and down in order that the cement will completely surround the jewel in the hole. Remove and let cool and then with the tool illustrated in figure 13-19, remove all surplus cement from the face and sides of the jewel and also from roller table.

SEC. 324—Straightening Roller Jewel

The roller jewel must be so adjusted that the flat side forms a right angle with an imaginary line drawn from the center of the balance staff through the center of the roller jewel. If after setting the jewel you find the face at an incorrect angle, it can be adjusted by grasping the jewel with the tweezers and twisting it around to the angle desired, figure 13-23. In this case, the tweezers must be moved in the direction of arrow C to line A-B. Do not try to move jewel without preheating the roller table.

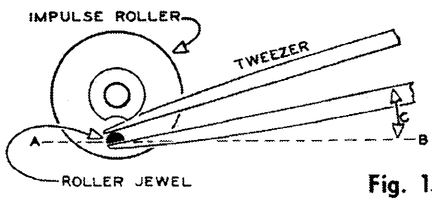


Fig. 13-23

The jewel, when viewed from the front and side, should form a right angle with the roller table. To straighten roller jewel file to the shape shown in figure 13-24-1 & 2 a piece of brass wire about 2 mm in diameter and mount

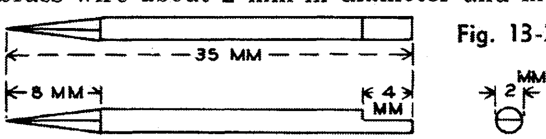


Fig. 13-24-1


Fig. 13-24-2

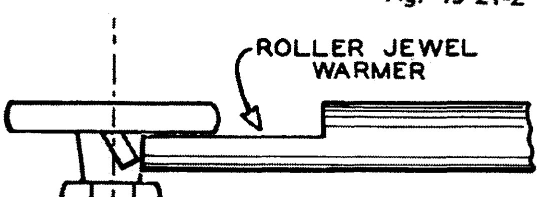
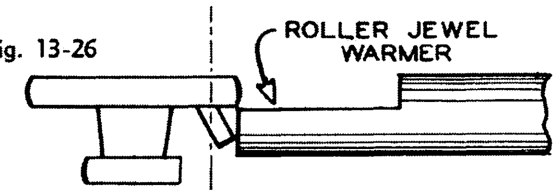


Fig. 13-25

it in a small handle. In using this handy tool, the end is heated with the alcohol lamp and pressed against the jewel as shown in figures 13-25 and 13-26. The heat applied need only be sufficient to soften the cement, after which it is an easy matter to press the jewel into an upright position. At first you may have a tendency to press too hard, pushing the jewel until it stands in the opposite direction. Repeat the operation until jewel is correctly positioned. After a little practice you will find the correct amount of pressure to apply. Care must be taken in applying heat to the roller in order to avoid burning the cement. When the cement becomes glossy and will spread, it will be of the correct temperature. Never heat the roller enough to cause it to discolor.

SEC. 325—Correct Length of Roller Jewel

The length of the roller jewel must be taken into consideration when selecting one for either the double or single roller. For a double roller, the jewel must be long enough to extend through the fork yet not long enough to come in contact with the guard dart. This can be judged by sighting across the guard roller. Figure 13-27 shows the length of the roller jewel. If the roller jewel extends down far enough to come in contact with the guard dart, the watch will stop. The roller jewel in a single roller must be long enough to extend through

Fig. 13-26


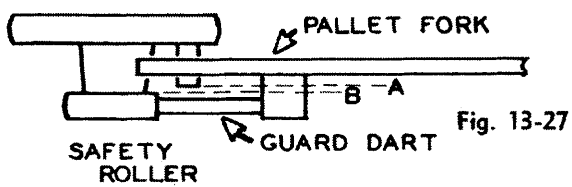
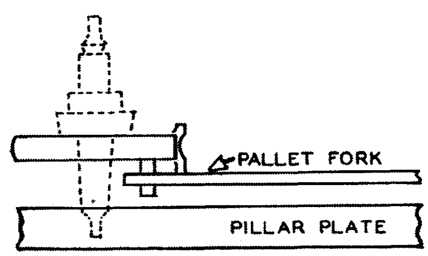


Fig. 13-27

Fig. 13-28


the fork, figure 13-28, but not long enough to rub on the balance jewel setting or plate.

Having set the jewel as directed in Section 323, its face square with the fork and perpendicular to the impulse roller, take hold of it with your tweezers while holding the balance in watch paper. Use your double loupe in examining the jewel to see that it is solidly set. Examine the edge of the roller table and the roller jewel to see if there is any cement other than that surrounding the jewel in the hole. If there is, scrape off all excess using the chisel-shaped brass wire. Examine and clean the passing crescent on all single rollers. Clean and brush carefully with soft brush. DO NOT USE OIL ON THE ROLLER JEWEL.

note:

(Lesson 12 - 14 job sheets combined after Lesson 14)

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 14

Friction Jewelling

—

Sections 330 - 345

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Lesson 14

Sections 330 to 345

FRICTION JEWELLING

SEC. 330 — Purpose of Friction Jewelling

One of the few but great improvements in modern watch repairing has been the advent of FRICTION JEWELLING. The friction jewel serves the same purpose as jewels in setting or those burnished directly into the plates or bridges, and the addition of a good friction jewelling tool is extremely profitable to the watchmaker who desires to speed up his work in an efficient manner. Proper use of the friction jewelling tool will bring real pleasure to many tasks which before took up a great deal of time, and, of course, will build up the profits of the repair department.

There are a great many times in the watchmaker's career when the profit he should have earned from repairing a watch has been turned into a loss due to his failure to accurately estimate and charge for repairs. In estimating repairs, we know that an accurate estimate can be made if the watchmaker will take the watch completely apart and check each part thoroughly to see what repairs are needed. However it is not always practical to estimate a watch in this manner due to the time involved. Consequently, there are times when we find that the watch we have taken in for a cleaning job or for a broken balance staff also has a cracked or broken jewel which must be replaced if we are to turn out first class work. Possibly the jewel may be set directly into the plate or bridge, or the watch may be one for which it is hard to obtain material. Formerly this would require a great deal more work than we had bargained for, but as we have already made the customer a price on the basis of returning his or her watch in first class condition, it is up to the repair man to make the additional repairs at his expense. It is better to do these jobs and not mention the fact to the customer. You will be rewarded by having a satisfied customer.

In the previous lesson the proper method of replacing jewels set in friction setting was explained. Our only concern when replacing a jewel of that type was the diameter of the hole in the jewel, and the outside diameter of the setting.

The method of friction jewelling about to be described deals primarily with the outside diameter of the jewel and the inside diameter of the hole in the setting. Of course the hole in the jewel must be the proper size to fit the pivot. In friction jewelling the outside diameter of the jewel must be greater than the inside diameter of the hole which is to receive it. This difference usually is 1/100 of a millimeter.

SEC. 331 — Types Of Friction Jewelling Tools

The most complete and precise friction jewelling tool at the present time is illustrated in figure 14-1. It is a precision tool for replacing jewels in watches and has additional accessories for straightening balance pivots, replacing hands, and setting pallet arbors in position.

The holes in the pivot straightening tool are accurately calibrated to ¼ of 1/100 of a mm. The pushers, anvils, and reamers are accurate to 1/100 mm. However, this tool will serve the watch repair man better if he knows the principles of jewel replacement. More of this will be taken up in the lessons on lathe work.

Following is a list of the contents included in the tool case, figure 14-1:

- 1 Friction jewelling tool
- 12 Flat pushers
- 5 Anvils
- 11 Concave pushers
- 15 Reamers

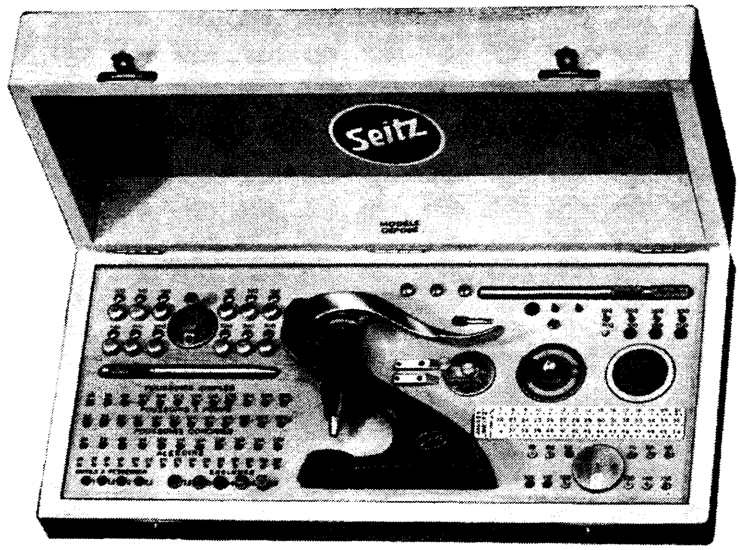


Fig. 14-1

12 Pump pushers
Tools for setting the pallet arbor.
4 Round face hole reducing or closing punches
Face plate with 3 clamps
12 chucks and holders for holding brass settings
Assortment of brass settings
12 Centering points
5 Pushers and 3 anvils for replacing watch hands
3 Chucks with handle
Tool for straightening pivots
Pivot gauge
Centering pump pusher
Grinding stone

Figure 14-2 is the standard outfit which combined with an assortment of friction jewels, will satisfactorily serve the average watchmaker for all general repairs.

Figure 14-3 illustrates a fine friction jewelling tool which is furnished and used with a staking tool set.

SEC. 332 — Description of Arbor Press and Cutters

Figure 14-4 illustrates a friction jewelling tool which is more or less a small arbor press. The hole in the base or die plate is made to receive the anvils. The lever is easily removable when using the reaming tool, figure 14-5. The micrometrical nut at the top of frame is easily read and allows the workman to make precision adjustments when setting a jewel. The handle, figure 14-6, is so made that the pushers can be quickly changed. Figure 14-7 illustrates the base into which the many important pushers, reamers, and anvils are placed, as follows:

Top row—12 flat pushers
2nd row—12 centering pump pushers
3rd row—11 concave pushers
4th row—15 reamers
5th row—Anvils, hole closing punches

The handle which holds the reamers is con-

Fig. 14-2

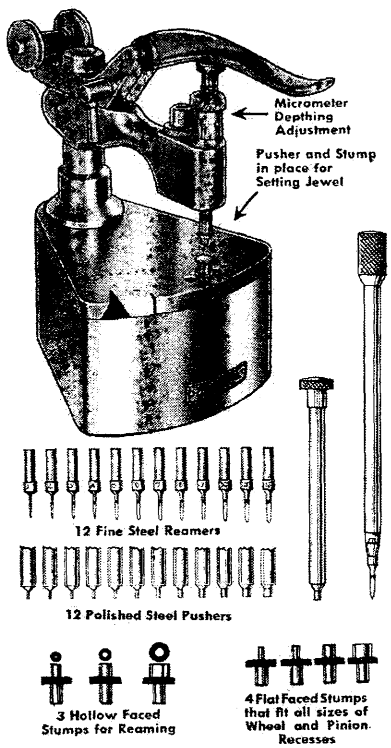


Fig. 14-3

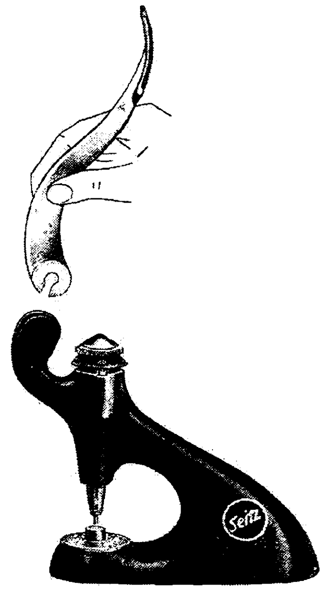


Fig. 14-5

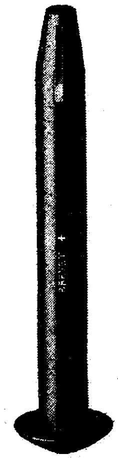


Fig. 14-6

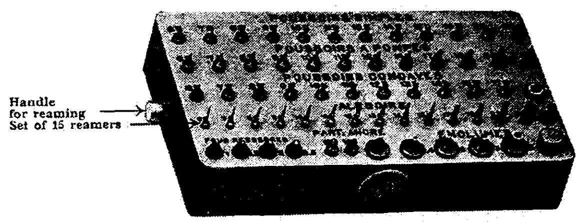


Fig. 14-7

Fig. 14-4

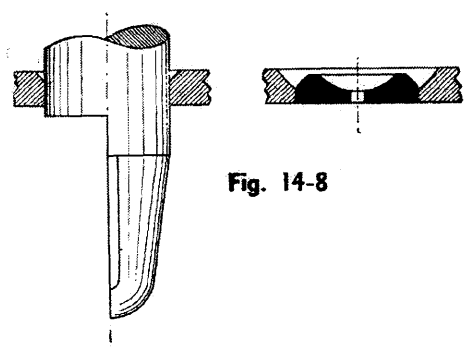


Fig. 14-8

tained in the side of the block. The reamer or smoothing broach is a half-round, tapered cutter which, when used in a plate or bridge, opens a hole to the exact hundredth of a millimeter as stamped on the reamer. The watchmaker uses a jewel which is 1/100 of a mm. larger than the diameter of the reamer. The jewel is then forced into the opening with the proper pusher.

Figure 14-8 is an enlarged view of a reamer showing the completed work of reaming the hole in a plate. The other illustration in figure 14-8 shows the opening after the jewel has been set in place.

SEC. 333 — Types of Friction Jewels

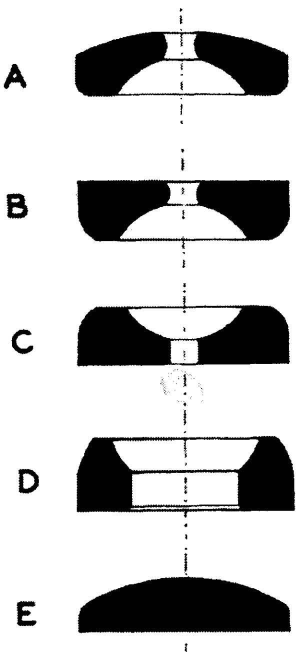


Fig. 14-9

Figure 14-9 illustrates the various types of friction jewels used with a friction jewelling tool. The friction jewel at A is a convex balance jewel with an olive hole. The friction jewel at B is a flat jewel similar to a train jewel which can be used as a balance jewel in some current models of watches. On smaller types of Swiss watches however, it is primarily used as a train jewel for the pivots on the pallet arbor or the escape pinion. The olive hole helps to reduce friction. The friction jewel at C is the regular flat, straight hole train or plate jewel. The friction jewel at D, which is the same shape as the train jewel but has a large hole is used for the center arbor. At E is shown a common type of friction cap jewel.

SEC. 334 — Description of Assortments.

Chart Showing a Complete Assortment of Balance Jewels

Diameters of jewels in hundredths of mm.

	70	80	90	100	110	120	130	140	150	160	180
7	70	80	90	100	110	120	x	x	x	x	x
8	70	80	90	100	110	120	130	140	150	x	x
9	70	80	90	100	110	120	130	140	150	x	x
10	70	80	90	100	110	120	130	140	150	x	x
11	70	80	90	100	110	120	130	140	150	x	x
12	70	80	90	100	110	120	130	140	150	160	180
13	x	x	90	100	110	120	130	140	150	160	180
14	x	x	90	100	110	120	130	140	150	160	180
15	x	x	90	100	110	120	130	140	150	160	180
16	x	x	x	100	110	120	130	140	150	160	180

Fig. 14-10

The above chart, figure 14-10, is a sample of a complete assortment of friction balance jewels with olive holes. The numbers in the first column reading from top to bottom (7, 8, 9, etc.) represent the size of the hole in the jewel. The figures opposite each of these hole sizes represent the outside diameters of the jewels. The average watchmaker does not usually carry as complete an assortment as this and they may be purchased in many different assortments. Train jewels and center jewels are catalogued similarly. Cap jewels are catalogued by outside diameters only, as they are without holes.

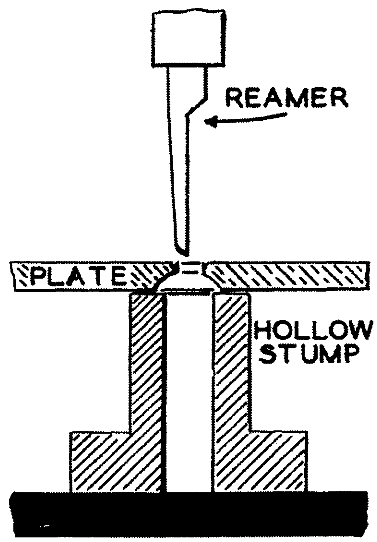


Fig. 14-11

SEC. 335 — Procedure for Replacing Friction Train Jewel

1. Remove broken or cracked jewel from setting. This can be done easily by punching out the jewel from the plate or setting with a pusher that is slightly smaller.
2. Select a reamer that will enlarge the present hole slightly and place this reamer in the holder, figure 14-11.
3. Select the smallest hollow stump that will accommodate the reamer and place in the base of the frame.
4. Hold plate or bridge over hollow stump, figure 14-11.
5. Run reamer **completely through** the plate or bridge. Figure 14-12. These reamers are self-centering and cut slowly.
6. After drilling completely through the plate or bridge, remove reamer and carefully examine hole using a double loupe. If all of the old bezel has been removed the hole will appear bright and shiny.

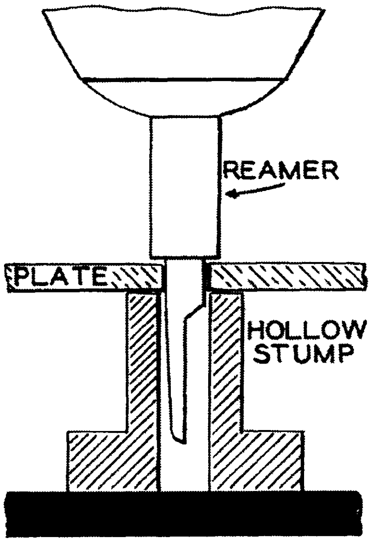


Fig. 14-12

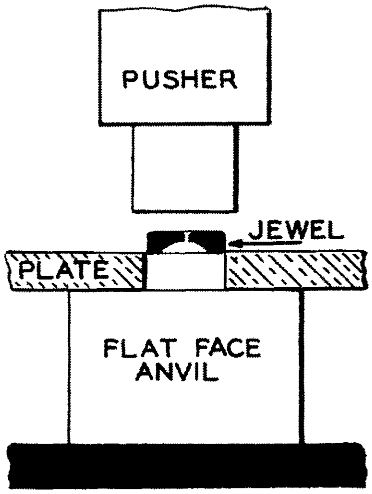


Fig. 14-13

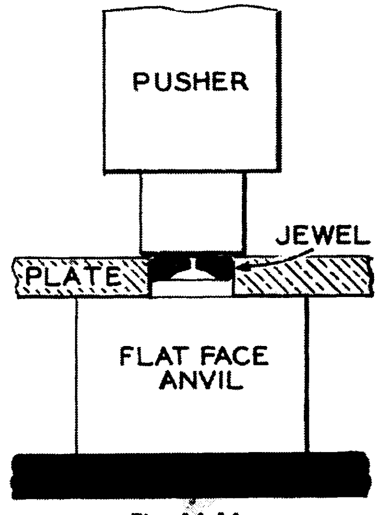


Fig. 14-14

7. If any of the old seat remains, repeat the above operation using the next larger size reamer.
8. Select a train jewel that corresponds to the diameter of the reamer.
   Example: Reamer measures 1.29 mm; use jewel with diameter 130 mm. Reamer measures .99 mm; use jewel with diameter 1.00 mm. The difference of 1/100 mm allows for friction fitting.
9. Select flat face stump upon which to place bridge or plate. If plate is recessed be certain that the stump selected is small enough in diameter to fit into recess.
10. Select pusher slightly larger than the reamed-out hole, and place in frame.
11. Place plate or bridge on flat-face stump, with the inside of the plate facing up.
12. Place jewel in reamed-out hole, oil cup down, figure 14-13.
13. Press on lever gently until the face of the pusher comes in contact with the jewel, increasing the pressure slowly until the jewel has been forced into the hole. The pusher should now be flush with the plate and the jewel securely in place, figure 14-14.
14. Holding the pusher flush against the plate, adjust micrometer nut so that it is impossible to push lever any lower. Release lever and remove plate.
15. Test for end-shake. If more end-shake is required jewel can be pressed below the surface with a pusher slightly smaller than jewel diameter. This amount can be controlled by micrometer nut.

SEC. 336 — Face Plate

Plates and bridges can usually be held with fingers when reaming. If it is desirable to replace the friction jewel in an old setting, make the replacement with the setting in the plate or bridge. The face plate illustrated in figure 14-15 can be used when it is impractical to hold the bridge or setting with the fingers. This face plate will hold small bridges such as the pallet bridge illustrated and comes with additional clamps for holding settings, etc. Since face plate is very light, it will follow the reamer when working, thus avoiding a hole which will not be true. It can also be used when replacing jewels as it holds the bridge or setting securely, enabling the workman to center it easily under the pusher.

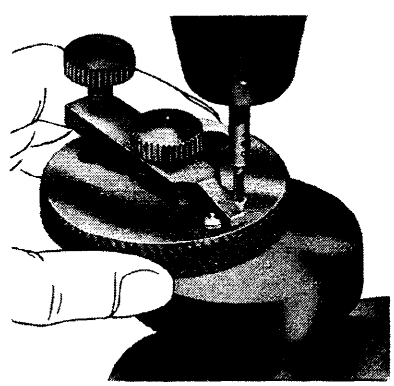


Fig. 14-15

SEC. 337 — Pump Center Pushers

The pushers used to replace the jewel just described are flat face pushers. Another type of pusher is illustrated in figure 14-17. These are pump center pushers and the face of the pusher is hollowed, thus allowing the workman to center the pusher and press into place both flat and convex jewels.

Keep your pushers in first class condition. There are times, especially after constant use, when the faces of the pushers should be reground to prevent breakage of jewels. In order to regrind the face of the centering pump pusher it must be taken apart. Figure 14-18 illustrates a cross section of a centering pump pusher. Press lightly on the top at A with a screwdriver in order to compress the spring, and make a one quarter turn to release the spring and pump. Let us repeat again that it is impossible for a man to do good work with poor tools.

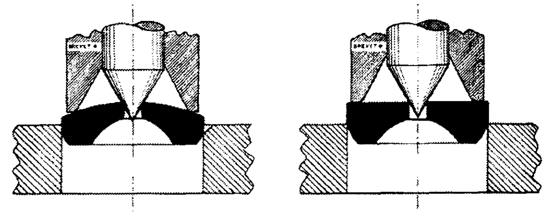


Fig. 14-17

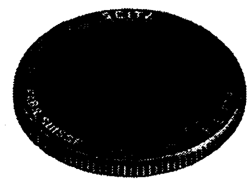


Fig. 14-19

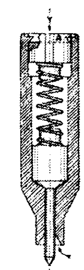


Fig. 14-18

SEC. 338 — "SEITZ" Grinding Stone.

Figure 14-19 illustrates a specially selected stone set into a metal plate. It is used to grind the surfaces of the pushers and anvils flat when the surfaces have become marred or distorted. Figure 14-20 illustrates the correct method used to regrind these articles. Place the pusher to be reground into the handle and press upon the grinding stone. Hold securely and move grinding stone back and forth as shown by the arrow. For regrinding the faces of anvils there is included a small bushing which fits into the handle.

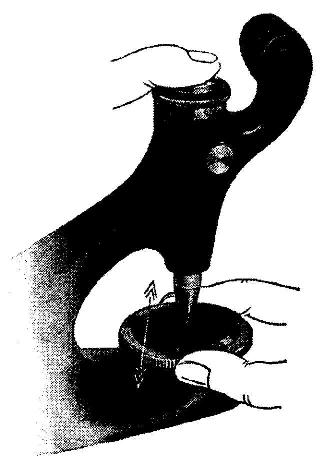


Fig. 14-20

SEC. 339 — Uprighting

Figure 14-21 illustrates a centering pump pusher used to upright a plate or bridge which has a defective hole. The pillar plate is placed on the base of the jewelling tool in such a manner that the jewel in the pillar plate fits directly over the pump center. With the defective upper plate or bridge screwed in place, ream out carefully just enough to correct the defective hole and replace jewel.

SEC. 340 — Hole Reducing Punches

Figure 14-22 illustrates the use of the hole reducing punches found in some friction jewelling tools. In some cases these punches can be used to avoid replacing a jewel which is only loose in the setting, not broken. However, it usually is to the watchmaker's advantage to replace loose jewels with jewels which fit properly.

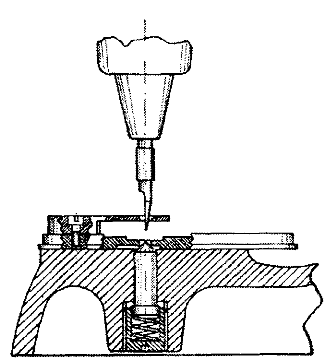


Fig. 14-21

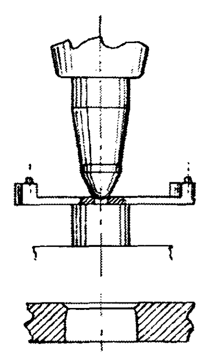


Fig. 14-22

SEC. 341 — Pushers Used With Convex Jewels

Plate and center jewels are replaced in the plate or bridge from the inside. Balance jewels are replaced from the outside of balance bridge or pillar plate. However, the balance jewel must be set slightly below the surface of the bridge plate or setting. This distance below the surface and the reasons were explained in a previous lesson.

Figure 14-23 illustrates the type of pushers used to replace **Convex** balance jewels. This type of pusher will lessen the breakage caused by using a flat pusher. It should be slightly smaller than the diameter of the jewel to be replaced, as this will allow the pusher to go below the surface of the plate or bridge without damaging the edges of the jewel setting. The depth the balance jewel is to be set is controlled by the micrometer nut at the top of the friction jewelling tool. Replacing a friction jewel in a plate or bridge which previously contained a friction jewel does not always require that the hole be reamed out again. Instead a reamer of the correct diameter can be placed in the hole and used as a gauge to select the proper size of friction jewel. Example: If a reamer measuring 1.09 mm fits the hole from which the old jewel has been removed a jewel with a diameter of 1.10 mm would be used for replacement. Always check endshake.

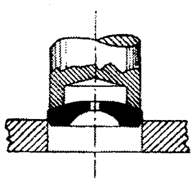


Fig. 14-23

SEC. 342 — Friction Brass Settings

There are times when the watch repair man does not have a friction jewel of large enough diameter to replace a broken jewel. This is often the case with old model watches in which the manufacturer took pride in the large jewels displayed in the plates. For this type of jewel replacement and others where it is impractical or impossible to find a jewel of the correct diameter, brass settings are obtainable in assorted diameters large enough to be set into the plates. These settings come with gauged diameters in metric measurements the same as do the friction jewels, and are set the same as a friction jewel. This provides a new setting into which we can now proceed to fit a friction jewel. Thus you will have a friction jewel set into a setting which in turn is set friction tight into the plate or bridge.

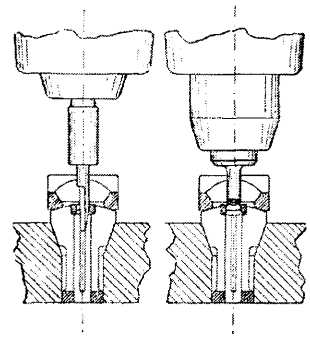
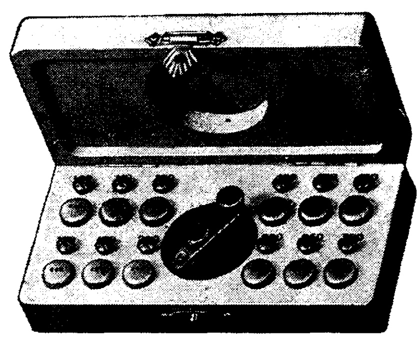


Fig. 14-24

Figure 14-24 illustrates the method of holding a setting of this type in a small chuck for reaming. Choose the brass setting of the desired diameter, place in chuck, place chuck in holder and place clamp over chuck. Small settings must not be tightened too much as they can easily be forced out of shape. Ream out the setting and press jewel into place. Then proceed to replace brass setting in plate or bridge. This type of holder will follow the movement of the reamer, avoiding an off center hole. Figure 14-25 illustrates a set of these chucks complete with the clamp to hold the settings.

Fig. 14-25



SEC. 343 — Friction Cap Jewels

Cap jewels can be readily replaced as the outside diameter of the cap jewel is the only measurement to be considered. They are replaced by using a pusher slightly larger in diameter than the diameter of the jewel selected, which will set the jewel flush with the setting.

SEC. 344 — Incabloc

Incabloc is a self-contained Mechano-Flexible Combined Bearing which protects the pivots. Incabloc maintains the two pivots of the balance staff securely in their accustomed positions, but permits them to shift under the influence of a shock coming from any direction. Immediately after such a shock the Incabloc spring causes the balance to automatically resume its original position. In figure 14-26, A is the block bed

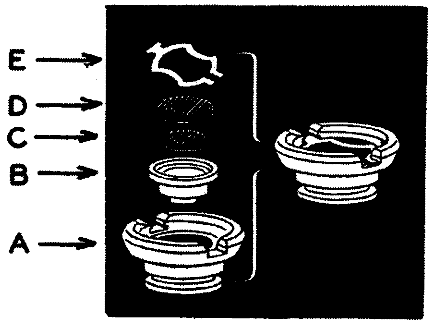


Fig. 14-26

into which the bed or setting for the balance hole and cap jewel is fitted. B is the bed, C the balance hole jewel, D the cap jewel and E the Incabloc spring, which exercises an even and calculated pressure. The block is held in place in the balance cock by a small U-shaped spring. In replacing the balance or cap jewels in the block or cleaning the jewels, it is not necessary to remove the block. Press the open end of the Incabloc spring away from block, figure 14-27, thus releasing one side of the spring. Release opposite side in like manner. Lift up spring carefully noting that it swings up and away from the jewel as on a hinge. It is not necessary to remove the spring any further. You will now have access to the cap jewel which can be readily removed, exposing the balance jewel in setting. A small tool, which will enable the workman to release the Incabloc spring without damage, can be made from a piece of mainspring ground to a long tapered point and mounted in a piece of pegwood. When cleaning a watch these jewels should be put to one side and cleaned separately keeping in mind their respective places in order that they may be replaced in their proper positions. Oil the same as any ordinary balance and cap jewel combinations.

INCABLOC SPRING

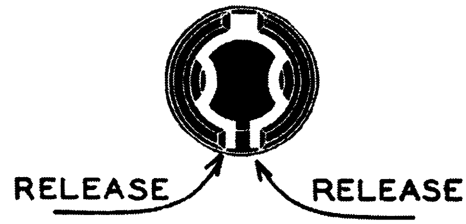


Fig. 14-27

Figure 14-28 illustrates Incabloc assemblies.

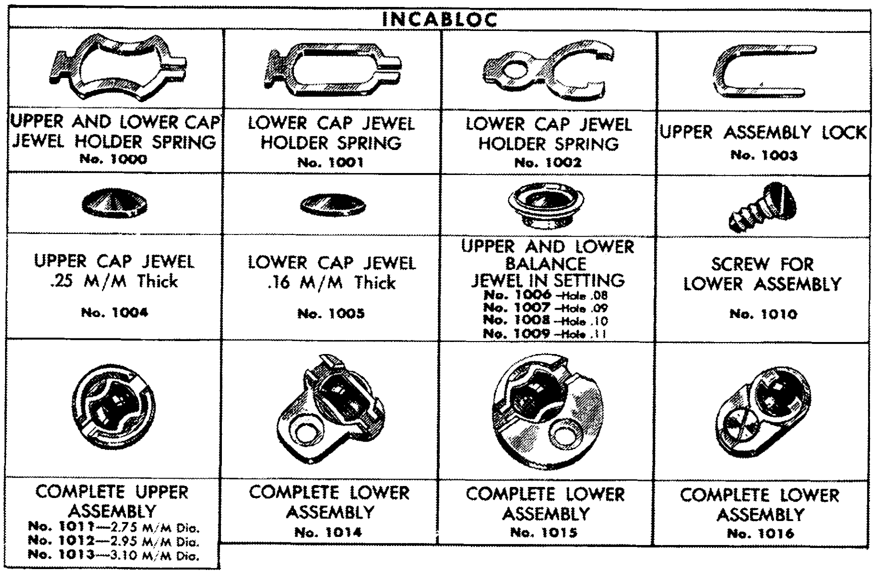
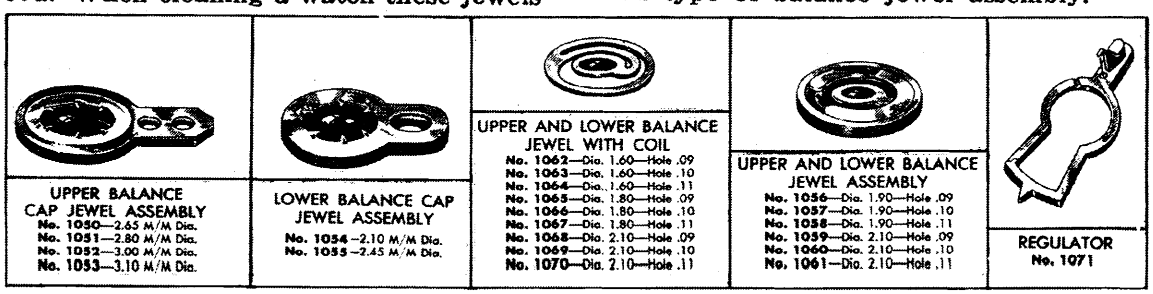


Fig. 14-28 Courtesy C. & E. Marshall Co.

SEC. 345 — Shock-Resist

Figure 14-29 illustrates "Shock-Resist" material. These illustrations will be self-explanatory when you come across watches equipped with this type of balance jewel assembly.



Courtesy C. & E. Marshall Co.

Fig. 14-29

TABLE OF CONTENTS: Unit W IV - Lessons 12-13-14

JOB SHEETS

UNIT	W IV
LESSON	13

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W13-J1

ROLLER JEWELS: Single roller

TOOLS, EQUIPMENT AND SUPPLIES:

Combination Tool - Alcohol Lamp - Chisel-Shape Brass Wire - Roller jewel warmer - Jewel cement - Tweezers - Hairspring remover - Roller jewel gauge.

PROCEDURE

REFERENCE
Lesson 13

HOW TO REMOVE AND REPLACE A "D" SHAPE ROLLER JEWEL IN SINGLE ROLLER

1. Remove balance assembly from movement — Lesson 5 & 8.
2. Remove hairspring. (Optional) — Lesson 15, of Sec. 352
3. Grip roller in jaws of combination tool, heat tool over alcohol lamp and remove roller jewel when cement softens. Fig. 13-22,
4. Remove balance assembly from combination tool and allow to cool. — Sec. 323
5. Clean roller of all cement and foreign matter. — Sec. 321
6. Select replacement jewel. — Sec. 320
7. Grip roller in jaws of combination tool, reheat and apply cement to jewel hole. — Sec. 323
   ALTERNATE METHOD: Insert roller jewel in roller before application of cement.
8. While cement is still soft, set roller jewel in roller. — Sec. 323
9. Reheat and mov e jewel up and down in hole.
10. Examine closely to see that jewel is well cemented.
11. Reheat and make final adjustment so that jewel is firmly set and upright. — Sec. 324

UNIT	W IV
LESSON	13

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W13-J2

ROLLER JEWELS: Double Roller

TOOLS, EQUIPMENT AND SUPPLIES:

Combination tools - Alcohol Lamp - Chisel Shape - Brass Wire - Roller Jewel Warmer - Jewel Cement - Tweezers - Hairspring remover - Roller Jewel gauge.

PROCEDURE	REFERENCE
	Lesson 13
HOW TO REMOVE AND REPLACE A "D" SHAPE ROLLER JEWEL IN DOUBLE ROLLER:	
1. Remove balance assembly from movement. Lesson 5 & 8.	
2. Remove hairspring. (Optional) Lesson 15, of	Sec. 352
3. Grip roller in jaws of combination tool, heat tool over alcohol lamp and remove roller jewel when cement softens. Fig. 13-22.	
4. Remove balance assembly from combination tool and allow to cool.	Sec. 323
5. Clean roller of all cement and foreign matter.	Sec. 321
6. Select replacement jewel.	Sec. 320
7. Grip roller in jaws of combination tool, reheat and apply cement to jewel hole. ALTERNATE METHOD: Insert roller jewel in roller before application of cement.	Sec. 323
8. While cement is still soft, set roller jewel in roller.	Sec. 323
9. Reheat and move jewel up and down in hole.	
10. Adjust roller jewel so as to be just above passing crescent.	Sec. 325
11. Examine closely to see that jewel is firmly cemented.	
12. Reheat and make final adjustments so that jewel is firmly set and upright.	Sec. 324

FRICTION JEWELLING: Train Jewels

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Friction Train Jewels.

INTRODUCTORY INFORMATION:

Friction jewelling is used in many current models of watch movements. Cracked, chipped or broken friction train jewels can generally be replaced with new jewels of the same diameter.

PROCEDURE	REFERENCE
HOW TO REPLACE A FRICTION TRAIN JEWEL IN A WATCH:	
1. Remove broken or cracked jewel.	
2. Examine the hole carefully and determine if it can be used as is.	Step 1, of Sec. 335
NOTE: If the hole in the plate needs to be enlarged, follow:	Steps 2, 3, 4, 5, 6, & 7, of Sec. 335
3. Select Jewel.	Step 8, of Sec. 335 Lesson 12, Sec. 294
4. Select flat stump and pusher.	Steps 9 & 10, of Sec. 335
5. Support place or bridge and press in jewel.	Steps 11, 12, 13, & 14, of Sec. 335
6. Replace wheel and pinion and check end shake.	Step 15, of Sec. 335

UNIT	W IV
LESSON	14

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W14-J2

FRICTION JEWELLING: Balance Jewels

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Friction Balance Jewels.

INTRODUCTORY INFORMATION:

Friction jewelling is used in many current models of watch movements. Cracked, chipped or broken Friction train jewels can generally be replaced with new jewels of the same diameter.

PROCEDURE	REFERENCE
HOW TO REPLACE A FRICTION BALANCE JEWEL:	
1. Remove broken or cracked jewel from balance cock or lower plate.	Step 1 of Sec. 335 Sec. 341
2. Examine hole to determine if it can be used as is.	
NOTE: If hole in plate or bridge needs to be enlarged, follow:	Steps 2, 3, 4, 5, 6 & 7 of Sec. 335
3. Select jewel.	Example of Step 8 of Sec. 335 Lesson 13 of Sec. 308
4. Select flat stump to support plate or balance cock.	Sec. 308
5. Select pusher or bridge slightly smaller than diameter of jewel and press jewel slightly below the surface. The depth should not be less than .02mm and not exceed distance equal to one half pivot diameter.	Sec. 341

UNIT	W IV
LESSON	14

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W14-J3

FRICTION JEWELLING: Cap Jewels.

TOOLS, EQUIPMENT AND SUPPLIES:

Friction jewelling tool - Cap jewel assortment.

INTRODUCTORY INFORMATION:

Friction jewelling is used in many current models of watch movements. Cracked, chipped or broken friction train jewels can generally be replaced with new jewels of the same diameter. If setting is of steel, do not ream as it will damage reamer. Replace setting and jewel.

PROCEDURE	REFERENCE
HOW TO REPLACE A FRICTION CAP JEWEL	
1. Remove broken or cracked jewel from setting.	Step 1 of Sec. 335
2. Examine hole to determine if it can be used.	
NOTE: If hole in plate is to be enlarged, place setting in face plate, follow:	Sec. 336 Steps 2, 3, 4, 5, 6, & 7, of Sec. 335
3. Select flat stump and pusher.	Step 9 & 10, of Sec. 335
4. Select jewel.	Step 8, of Sec. 335 Sec. 343
5. Support setting on stump and press jewel in flush with surface of setting.	Sec. 343

FRICTION JEWEL REPLACEMENT: Train jewels in settings held in place by screws.

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Friction Train jewels.

INTRODUCTORY INFORMATION:

Friction jewelling replacement can be used successfully in many watches which were originally designed for other types of jewel setting. The principals for replacing friction train jewels are the same regardless of the original type of setting. See Job Guide W-14-J1.

PROCEDURE:

HOW TO REPLACE A FRICTION TRAIN JEWEL IN A SETTING HELD IN BY JEWEL SCREWS. (SECTION 296-LESSON 12)

1. Press out damaged jewel with pusher slightly smaller than the jewel. Press toward the bezel side. Support the plate on hollow stump.

2. Using progressively larger reamers, ream the hole until jewel seat and bezel have been cut away completely, leaving a smooth hole with straight walls. Steps 2, 3, 4, 5, 6 & 7 of Sec. 335

3. Select replacement jewel Step 8 of Sec. 335 Lesson 12

4. Press into setting and adjust depth for correct end shake. Step 11, 12, 13, 14 & 15 of Sec. 335

FRICTION TRAIN JEWEL REPLACEMENT: Train jewel settings burnished into plate. (See Sec. 299 - Fig. 12-13)

TOOLS, EQUIPMENT AND SUPPLIES:

Friction jewelling tool - Friction train jewel.

INTRODUCTORY INFORMATION:

Replacing a friction jewel in a setting burnished into the plate requires careful workmanship in order not to loosen the setting in the plate. If the setting becomes loose in the plate, remove setting and follow procedure as outlined in Job Guide W14-J6.

PROCEDURE	REFERENCE
HOW TO REPLACE TRAIN JEWEL IN SETTING BURNISHED INTO PLATE	
1. Support setting on hollow stump.	
2. Remove broken jewel.	
3. Using progressively larger reamers, ream the hole until burnished edge which held jewel and the jewel seat, have been cut away leaving a smooth-walled hole.	Sec. 335
4. Select jewel.	Step 8, of Sec. 335 Lesson 12, Sec. 294
5. Select flat stump and pusher.	Steps 9 & 10, of Sec. 335
6. Support plate or bridge and press in jewel.	Steps 11, 12, 13, & 14, of Sec. 335
7. Replace wheel and pinion and check end shake.	Step 15, of Sec. 335

FRICTION BUSHINGS WITH FRICTION JEWELS:

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Friction Jewels - Friction Bushings.

INTRODUCTORY INFORMATION:

When replacement requires a jewel of extra large diameter it may be necessary to replace with a friction bushing into which the friction jewel is set. Holes in bushings do not come in a large variety of sizes but may be reamed to size of jewel you require. Bushings should be of a thickness not to exceed the thickness of the plate or bridge.

PROCEDURE:

HOW TO REPLACE A FRICTION BUSHING AND JEWEL. Sec. 342

1. Remove damaged jewel or setting from bridge or plate.

2. Using successively larger reamers, ream the hole until the jewel seat is removed leaving a straight-walled hole.

3. Select bushing with diameter .01 mm larger than hole reamed with the thickness slightly less than thickness of plate (to allow for depth adjustment) and with hole nearest to the size jewel you wish to set.

4. If bushing requires reaming for the jewel, place in face plate (Sec. 336) or chuck (Sec. 342) and ream.

5. Select jewel.

6. Set friction jewel in bushing.

7. Press bushing into plate or bridge.

8. Check for endshake.

FRICTION BALANCE JEWEL REPLACEMENT: Balance jewels burnished into plate.

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Balance Jewel.

INTRODUCTORY INFORMATION:

Some watches still in use have balance jewels burnished into the balance cock or plate, when in need of replacement it is advisable to use a friction balance jewel.

PROCEDURE:

HOW TO REPLACE A BURNISHED IN BALANCE JEWEL WITH A FRICTION JEWEL.

1. Push out damaged jewel with a pusher slightly smaller than the jewel, push toward the burnished side of the plate while supporting plate on hollow stump.

2. Using progressively larger reamers, ream the hole until both the burnish and jewel seat has been cut away leaving a smooth-walled hole.

3. Select jewel. Example: Step 8 of Sec. 335 Lesson 13 Sec. 308

4. Using a pusher slightly larger than diameter of the jewel, press jewel into bridge from the top.

5. Select pusher slightly smaller than jewel and press jewel into position slightly below the surface.

   NOTE: There should be a space between the balance hole and cap jewel. The adjustment for this space is made on the balance hole jewel only by setting the hole jewel slightly below the surface of the bridge or plate. The depth below the surface should be about .02 mm. The depth can be controlled when setting the jewel by use of the micrometer depth adjustment on your Friction Jewelling Tool. Using a jewel pusher slightly larger than the diameter of the jewel, press jewel flush with surface of the bridge or plate. Then using a pusher slightly smaller than the jewel, place in jewelling tool, bridge in place, face of pusher against the jewel, pusher resting lightly on the jewel and adjust micrometer stop against the lever, then back off the micrometer approximately .02 mm or the amount of depth you desire.

6. Press jewel in the above amount.

CAP JEWEL REPLACEMENT: Cap Jewels burnished into setting.

TOOLS, EQUIPMENT AND SUPPLIES:

Friction Jewelling Tool - Friction Cap Jewel Assortment.

INTRODUCTORY INFORMATION:

Many watches still in use have cap jewels burnished in the cap jewel setting. If setting is of soft metal, this type of jewel can be replaced with a friction jewel. If setting is of steel the setting and jewel should be replaced.

PROCEDURE:

HOW TO REPLACE A BURNISHED IN CAP JEWEL WITH A FRICTION CAP JEWEL.

1. Push out damaged jewel with pusher slightly smaller than the jewel, push toward the burnished side. Setting should rest on flat hollow stump.

2. Place setting in face plate (Sec. 336) bottom side up.

3. Using progressively larger reamers, ream hole until jewel seat and burnish is removed.

4. Select jewel (.01 mm larger than hole in setting.)

5. With a flat punch press jewel into setting from the underside of the setting flush with bottom surface.

SHOCK PROTECTOR DEVICE: Incabloc.

TOOLS, EQUIPMENT AND SUPPLIES:

Fine tweezers.

SUPPLEMENTARY INFORMATION: See assignment sheet for Lesson 14.

PROCEDURE | REFERENCE

HOW TO DISASSEMBLE AND ASSEMBLE AN INCABLOC SHOCK PROTECTOR DEVICE.

1. Release the open end of the Incabloc spring or Lyre shaped spring using fine tweezers or needle. Release one prong of spring at a time. — Lesson 14 Fig. 14-27

2. When both prongs are released, lift end of spring (the other end is still anchored to the end-piece at its solid end and serves as a hinge.)

3. Lift out the cap and balance jewel assembly.

4. Separate cap jewel from setting or bushing.

   NOTE: Sometimes when the oil is dry the cap jewel may stick in the recessed top of the setting. The cap jewel may be separated using any of the following methods:
   a. Dip entire setting in alcohol.
   b. While holding setting in tweezers slightly above work surface, push oil inserter through the hole in balance jewel.
   c. Hold setting in tweezers and press cap jewel onto gum surface of scotch tape, lifting the setting leaves cap jewel on tape. The balance hole jewel is not removed, it remains in place.

5. Clean cap jewel and hole jewel with setting, allow to dry.

6. Oil Incabloc assembly.

   NOTE: Use either method:
   a. Hold balance jewel setting on work surface with tweezers and apply a small amount of oil to the jewel hole from the rounded side of the jewel. Place cap jewel in place in the setting.
   b. Holding cap jewel, flat side up, on work surface apply small amount of oil in center of the cap jewel, <u>without</u> dipping your oiler in oil cup, apply oil remaining on

SHOCK PROTECTOR DEVICE: KIF 370

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers - Pegwood.

SUPPLEMENTARY INFORMATION: See Assignment Sheet for Lesson 14.

PROCEDURE:

HOW TO DISASSEMBLE AND ASSEMBLE A KIF 370 SHOCK PROTECTOR DEVICE.

1. Remove cap and hole jewel.
   a. Cut end of pegwood to slightly smaller than diameter retaining spring.

   b. Cut a concave cone in the end of the pegwood, this depressed center will allow pressure on the outer edge of the retaining spring.

   c. Press end of pegwood on retaining spring and turn until the three protruding tips of the spring are in line with notches on inner edge of base. Spring may now be lifted out.

   d. Setting containing the balance hole and cap jewel will fall out when bridge or plate is turned over.

   e. Separate cap jewel from the setting by either dipping setting in alcohol or pressing cap jewel on scotch tape.
2. Clean and oil jewel assembly.

   a. Clean as any other type of jewel.

   b. Assemble as follows: Place cap jewel with flat side up on work surface and place balance hole jewel and setting on top of cap jewel.

   c. As the balance hole jewel is mounted with oil cup exposed, this assembly may be oiled in the regular manner, ie, place oil in oil cup and use oil inserter. Hold setting in place on work surface with tweezers while oiling.
3. Place balance hole and cap jewel assembly in plate or bridge.

   a. Place jewel assembly in place in base.

   b. Place retaining spring in place with protruding tips of spring in spaces provided.

   c. Using concave end of pegwood, press downward and turn spring 1/6th turn in either direction to lock spring in place.

SHOCK PROTECTOR DEVICE: Shock-Resist.

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers - Screwdriver.

SUPPLEMENTARY INFORMATION: See Assignment Sheet for Lesson 14.

PROCEDURE | REFERENCE

HOW TO DISASSEMBLE AND ASSEMBLE A SHOCK-RESIST SHOCK PROTECTOR DEVICE.

NOTE: Cap Jewel setting on balance bridge is generally held by screw from under side of bridge. Sec. 345

1. Remove balance assembly from movement.

2. Remove screws holding the cap jewel setting.

3. Clean jewels as any other type of jewel.

4. Place cap jewel setting on work surface with flat side of jewel up. Hold with tweezers as you apply a drop of oil to center of cap jewel.

5. With tweezers, turn setting over and place one bridge or plate, taking care that setting is placed in exactly right position so as not to smear the oil on the jewel. Replace cap jewel screws.

SHOCK PROTECTOR DEVICE: Super-Shock-Resist.

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers.

SUPPLEMENTARY INFORMATION: See Assignment Sheet for Lesson 14.

PROCEDURE:

HOW TO DISASSEMBLE AND ASSEMBLE A SUPER-SHOCK-RESIST PROTECTOR DEVICE.

1. Remove cap and hole jewel and setting.

   a. Using tip of tweezers move one tip of the cap jewel setting to the cut out notch.

   b. With tweezers lift disengaged tip and lift out cap jewel and setting.

   c. With tweezers lift out the balance jewel and setting.

2. Clean jewels as any other type of jewel.

3. Replace balance jewel and setting in the base of the assembly.

4. Place cap jewel flat side up on work surface and hold with tweezers as you apply a drop of oil in the center of the cap jewel.

5. With tweezers, turn cap jewel setting over and place in base of setting with one protruding tip engaged and the other in line with cut out notch.

6. Use tweezers to push tip down and either to right or left a quarter turn to lock the cap jewel setting in place.

UNIT	W IV
LESSON	14

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W14-J13

SHOCK PROTECTOR DEVICE: Monorex.

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers.

SUPPLEMENTARY INFORMATION: See Assignment Sheet for Lesson 14.

PROCEDURE:

HOW TO DISASSEMBLE AND ASSEMBLE A MONOREX SHOCK PROTECTOR DEVICE.

1. Remove cap jewel setting.

   a. Using tip of tweezers, turn the cap jewel assembly by pushing against one of the prongs in line with the slot.

   b. With tweezers, lift the disengaged tip and lift out the cap jewel setting.

   c. With tweezers, lift out the balance hole jewel setting.

2. Clean jewels as any other type of jewel.

3. Replace balance jewel setting in base of assembly.

4. Place cap jewel flat side up on work surface and hold with tweezers as you apply a drop of oil in the center of the cap jewel.

5. With tweezers, turn cap jewel setting over and place in base with one prong engaged and the other in line with cut out notch.

6. Use tweezers to push tip down and either to right or left a quarter turn to lock the cap jewel setting in place.

SHOCK PROTECTOR DEVICE: Ruby Shock.

TOOLS, EQUIPMENT AND SUPPLIES:

Tweezers.

SUPPLEMENTARY INFORMATION: See Assignment Sheet for Lesson 14.

PROCEDURE:

HOW TO DISASSEMBLE AND ASSEMBLE A RUBY-SHOCK SHOCK PROTECTOR DEVICE.

1. Using tip of tweezers against spring prong, turn cap jewel setting until two of the tips have disengaged from the setting, lift out setting.
2. Turn plate or bridge over and balance jewel will fall out.
3. Clean as ony other type of jewel.
4. Place balance jewel in base of assembly.
5. With cap jewel resting on work surface and bottom of cap jewel up, place a drop of oil on face of cap jewel.
6. With tweezers, turn cap jewel setting over and place in base with one prong engaged, another in line with slot.
7. With tweezers, press prong into slot and turn setting until all three prongs are engaged.

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 15

Replacing Factory Balance Staffs

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Sections 350 - 359

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

REPLACING FACTORY BALANCE STAFFS

SEC. 350—The Balance Staff

The balance staff is sometimes referred to as the balance arbor. It is usually made of tempered steel. The balance wheel is attached to the balance staff and the pivots of the staff rotate in the balance jewel assemblies previously described.

Replacing a balance staff properly, together with the truing and poising of the balance wheel, affords an opportunity for the watchmaker to demonstrate his ability as a master workman. It is in this part of the watch that the unskilled workman most often delights in giving horrible examples of "botchwork." While you may come in contact with some of the "botchmaker's" art at other points—such as attempting to splice a mainspring in the center—it is in and around the balance and balance staff that such a person seems to delight in showing the **improper** methods of making repairs. In a great many instances, these errors have been made by using material that did not fit. Perhaps an attempt was made to substitute another make of balance staff. If the staff was too long or too short the balance cock was bent up or down. If the hub of the staff was too small for the balance, soft solder was used to fill in the gap. If the hole in the roller appeared to be too large for the balance staff it was remedied by using glue or cement to hold the roller in place. If the collet shoulder was too small the collet was pinched together, throwing the hairspring out of true and giving a poor holding for the collet. If the hole in the jewels appeared to be too small the pivot was ground or filed by hand until it entered the jewel hole. If the hairspring was too strong for the balance it was weighted down with an excess of washers or soft solder. These examples are not suppositions, but are actual cases as well as many other examples of what an ingenious "botchmaker" will do (when compelled to figure out a method to make repairs) when it would have been much easier to do the work properly in the first place, without danger of placing the watch in such condition that it could not run or be timed properly until practically rebuilt by a master watchmaker. Over a period of years there have been a great many attempts made to prevent poor quality watch repairing. Some states have licensing laws which are set up to protect the public against these practices. However, the one way to be certain that the public is adequately protected is by properly educating the watchmaker to make repairs correctly. The educator can only show the student the correct procedure. The student must practice until he is proficient; and at this time let me remind you again that proficiency can only be accomplished by practice. Do not attempt to make repairs on watches other than those you have for practice work. It is surprising what liberties some people will take with another person's watch rather than admit, even to themselves, that they do not know how to correct a very minor defect.

This lesson is difficult, not because the work is hard to understand but because to do balance staff work properly, you will also require instruction in truing and poising the balance. If a factory balance staff has a pivot that requires polishing or needs to be reduced slightly in diameter, it must be done on a watchmaker's lathe. There are times when the collet shoulder, balance shoulder, or roller table post require slight alterations, and these also require a watchmaker's lathe to complete properly. The purpose of this lesson is to teach you to replace a staff even though you have not had the instruction on lathe work. You must understand this part of staff replacement in order to understand when and how to make alterations with a lathe. This lesson is comparable to learning the letters of the alphabet. After you have mastered the alphabet you learn to combine these letters with each other to form simple words. Then as your education advances your vocabulary increases and you can read or write with ease words which would be difficult if it were not for the proper procedure used to teach you the elementary principles of reading and writing.

SEC. 351—Types of Balance Staffs

Genuine factory staffs are, as a rule, accurately made and easily replaced. When we refer to any piece of watch material as being genuine we mean it was made by the factory which made the watch originally for the particular model of watch in which it is being placed. Any other material, although it would fit properly, is referred to as imitation material. Use genuine material whenever posible. Take your time. Remember the pivots on balance staffs are only two to three times as thick as a human hair and being made of tempered steel can be broken easily.

The dimensions of balance staffs vary for different models even in the same size and make of movement. One of the older American factories, now out of business, had eight models all of the same size, each using a balance staff of different dimensions. This is usually due to a change or refinement in the model. For this reason it is well for the beginner to note the general types of balance staffs used in the different makes and sizes of watches which he handles. Some hubs you will observe are thicker than others or are cut on a different angle. On still others the collet shoulders may vary in diameter for the same models or different models of the same size. In selecting a replacement for a broken staff you must be able to judge which particular number of an assortment is the one required. The final proof of your correct selection is if all parts fit properly and when replaced in the watch, there is the correct amount of sideshake and endshake.

When a watch comes to you for repairs it should always be tested to see if the balance staff is broken. Grasp the arm of the balance wheel with tweezers and endeavor to move it from side to side as in testing for sideshake. If the lower end of the staff can be moved from side to side and also up and down, the chances are that the lower pivot is broken although it may act in much the same manner if the lower jewel is broken. The same test is used for the upper pivot. Often when a watch receives a jar or a fall hard enough to break the balance staff, one or more of the balance jewels may be broken also, so do not rely on such a superficial examination. Only by removing the balance and examining the pivots and jewels with a double loupe can the watchmaker make a fair and intelligent estimate.

SEC. 352—Removing Hairspring

1. Remove the balance with hairspring from the watch
2. Remove hairspring

The hairspring is attached to the balance by means of a collet. The collet is a small circular split brass collar into which the inner end of the hairspring is pinned. The hole through the center of the collet is enough smaller in diameter than the collet shoulder on the staff that it will hold securely when forced into place, usually with a staking punch.

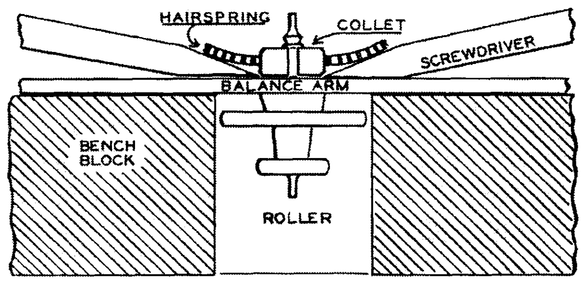


Fig. 15-1

Figure 15-1 illustrates the method of using two screwdrivers to remove the hairspring and collet. However, this method is dangerous as a slip of the screwdriver may cause irreparable damage to the hairspring. Figure 15-2 illustrates the method used in removing the collet by means of a small tool which can be made from a piece of mainspring. The arrow at A represents the twist given the tool in order to spread the collet enough to release the tension, and the arrow at B describes the turning of the collet around the collet shoulder, at the same time pulling slowly upward. The balance is held between the thumb and middle finger left hand while the right hand manipulates the tool. If the tool should slip, it would not be in position to damage the hairspring. Figure 15-3 illus-

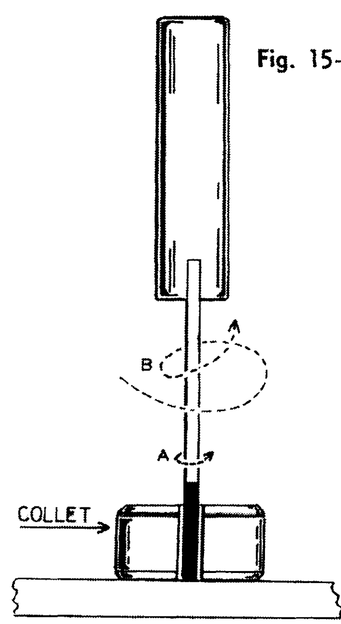
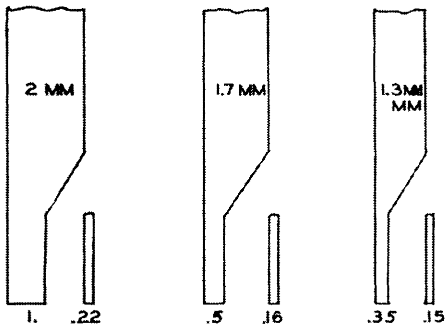


Fig. 15-2

Fig. 15-3



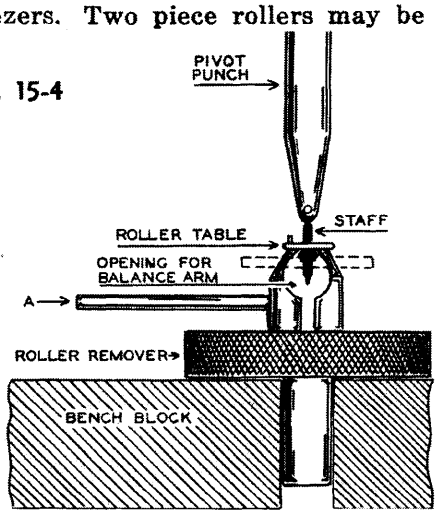
HAIRSPRING REMOVING TOOLS
MATERIAL--MAINSPRINGS
APPROXIMATE DIMENSIONS IN MM.

trates the dimensions of three of these tools which can be made from pieces of mainsprings, the thickness of which is given. As a mainspring is made from tempered steel, it is best to grind the material with a small grinding wheel or an oilstone.

SEC. 353—Removing the Roller Table

In the lesson on setting roller jewels, the three most common types of roller tables were described. There are many types of roller removers on the market, but the Rex roller remover described hereafter will do the job in most cases. Figure 15-4 illustrates the procedure. The roller remover is placed in the die plate of the staking tool or on a bench block. Holding the knurled edge of the roller remover between the thumb and forefinger, open the jaws of the tool by means of the small handle at A. Place the inverted balance over the jaws of the roller remover with the arm of the balance through the opening of the jaws. Carefully tighten the jaws until the roller table is in the position shown. Place the pivot punch, which is furnished with the tool, over the pivot and tap lightly with a brass hammer. This will loosen the roller table enough to be removed with the tweezers. Two piece rollers may be removed by the same method. However, the impulse roller will loosen first and will move up against the safety roller. Another light tap will loosen the safety roller, after which both rollers may be removed.

Fig. 15-4



SEC. 354—Removing the Balance Staff

Many watchmakers make a practice of driving out the balance staff without undercutting. This is done by placing the hub of the balance in a hole large enough to receive it without binding in the die plate of the staking tool, and after centering, punching it out with a pivot punch. This is poor practice and the work of inefficient workmen, for since the staff is made of tempered steel and the upper edge of the balance shoulder is riveted over the arm of the balance, this method has a tendency to enlarge the hole in the arm. In time the arm will be bent to such an extent that it will be difficult to true.

For all practical purposes, a balance staff can be removed from the wheel using a balance staff remover; however, the best method requires the use of the watchmaker's lathe. It will be beneficial to the student if we explain this method now and to demonstrate its value.

Figure 15-5 illustrates a balance staff with the roller removed but still riveted to the balance wheel. The staff in turn is held in a lathe chuck, the latter not illustrated. The staff, which is solid black, shows that portion which is left after part of the hub has been cut away. The dotted lines indicate the hub before it was cut away. Notice that it has been cut below the balance shoulder which is indicated by the dotted line. As you can see, this leaves a very thin rim over the balance arm. Figure 15-6 illustrates the method used to remove the remaining metal. The graver is sharpened to a long point and the cut is started at

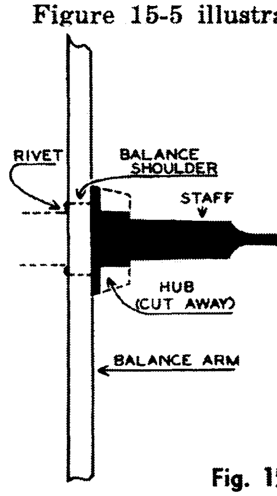


Fig. 15-5

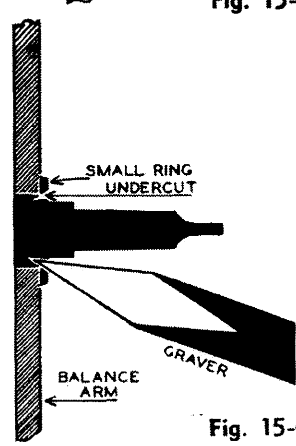


Fig. 15-6

the base of the previous cut. The instant the cutting edge of the graver reaches the balance arm the remaining metal will separate from the staff in the form of a small ring. The wheel can be ready removed over the roller post. As soon as the student has access to a watchmaker's lathe, he should use this method, as it is without a doubt the safest.

Figure 15-7 illustrates a staff remover which is used in conjunction with a staking tool. Remove staff as follows:

1. Select a hole in the die plate of the staking tool large enough to admit the hub of the staff. Make certain the hub does not fit too tightly; it must have a little side play.
2. Center hole selected with center punch.
3. Place balance and staff over hole in die plate.
4. Place staff remover over the arms of the balance and slip punch over upper end of balance staff.
5. Tighten knurled nut so that the balance arm will be held securely in place.
6. Strike punch A sharply with a brass hammer until the slight gap at C is closed. The staff will now be free of the balance arm.
7. Release nut and remove staff remover. The old staff should fall through the staking block. The methods described pertain to the removal of balance staffs which have a riveted edge to hold the balance wheel securely in place.

The most common type of friction staff is used in some models of Waltham watches. It is quickly recognizable by the supposed hub of the balance staff which, if blue, is not part of the balance staff; moreover, the staff is a friction staff. The blued hub is riveted to the arm of the balance wheel and the staff is removed as in figure 15-8. It is an easy matter to remove the old staff and replace it without disturbing the truth or poise of the balance wheel.

1. Select hole in die plate, which will support the blue hub, yet one which is large enough to permit the friction staff to fall through.
2. Center hole and lock die plate in place.
3. Select pivot or cone shape punch and place over staff.
4. A few slight taps with a brass hammer will drive the staff out.

Another type of friction balance staff is found in the 992 Elinvar Hamilton watch. Figure 15-9 illustrates this staff which, when assembled, looks similar to the one piece 16s double roller staff. Therefore, a groove, A, figure 15-9, has been added as a mark of identification. The

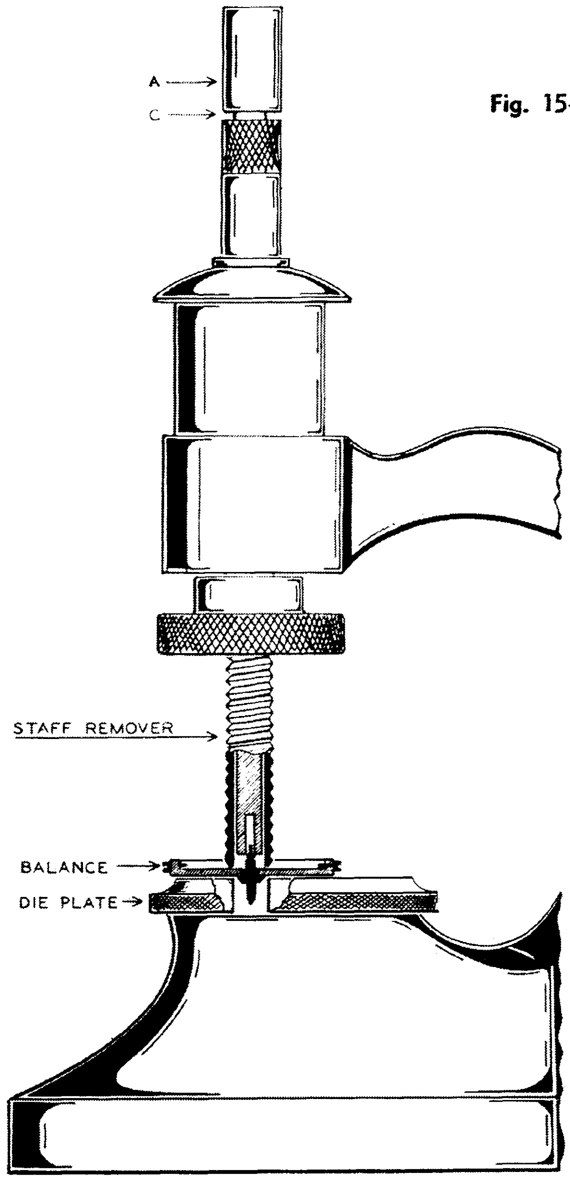


Fig. 15-7

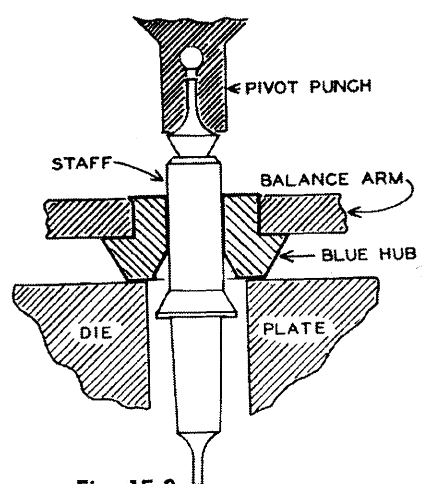


Fig. 15-8

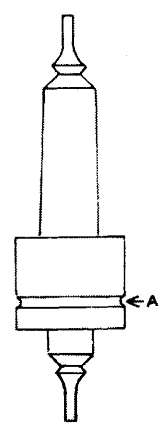


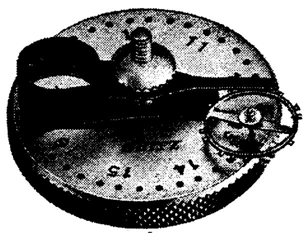
Fig. 15-9

procedure used in removing this type of balance staff is the same as the procedure used in removing the Waltham friction staff.

SEC. 355—Pivot Straightening

Many watchmakers endeavor to straighten pivots when they are bent rather than replace the staff. At times it is possible to straighten a pivot which is only slightly bent by placing it in a watchmaker's lathe and spinning true with the aid of a special pivot straightening tweezer. Figure 15-10 illustrates a pivot straightening

Fig. 15-10



device which is a part of the friction jewelling tool described in the previous lesson. The tool is a round metal plate set with 33 jewels from .08 mm to .16 mm, each hole ¼ of 100th larger than the preceding hole diameter. To straighten a bent pivot proceed as follows:

Example: Bent Pivot—diameter .10 mm

1. Place bent pivot in a hole of larger diameter, perhaps 12 or 13, according to the curve of the bent pivot.
2. Turn the balance carefully with a brush and press lightly on the high side of the balance with a piece of pegwood.
3. Repeat the above operation, each time placing the balance pivot in the next smaller hole until you reach hole 10. The moveable guide is used as an indicator and must not touch the rim of the balance.
4. The pivot should be polished in the lathe at this point.

If upon examination of the balance staff the pivot appears to be cut, the jewel is probably broken or cracked. After replacing the jewel, it is possible in some cases to regrind and polish the pivot satisfactorily, but in most cases it is better to treat a staff which has a cut pivot exactly as you would treat one with a broken pivot. When in doubt, put in a new staff; it is the mark of a fine workman.

Occasionally you will find a pivot which has become riveted on the end due to a jar or fall forcing the pivot directly against the cap jewel. When this occurs it is difficult to remove the pivot from the balance jewel and in some cases it is necessary to remove the cap jewel if possible and stone off the rivet with an oilstone slip. This will in all probability save breaking the hole jewel, but will require a new staff. Figure 15-11 gives the nomenclature of the ordinary balance staff. Throughout your career the proper names and dimensions of the parts of the staff will be referred to frequently.

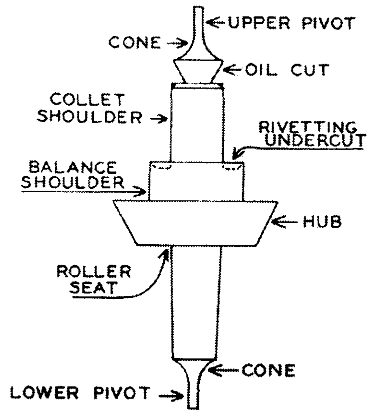


Fig. 15-11

SEC. 356—Matching the Balance Staff

In selecting a new balance staff for a watch it is necessary to know the make, size, and model and then match the staff accordingly. As stated previously, there may be several different models of watches in the same size of the same make. For instance, we may have a 16 size watch which requires a staff with a short hub and another model which may require a long hub, or we may have one with a large collet shoulder and another with a small collet shoulder. You will soon become familiar with the different models and eventually you will recognize the most common numbers by looking at the staff.

After you have selected a staff which you believe to be the correct model, make the following comparisons:

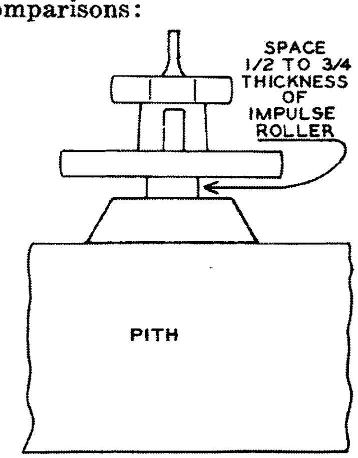


Fig. 15-12

1. Lay the old and new staff side by side and examine under a double loupe.
2. Test roller in position on roller post, figure 15-12. Roller should slip over post until the space between the hub and the impulse roller is approximately ½ to ¾ the thickness of the roller table.
3. Set balance in place on the balance seat. It should fit snugly without any side play. The shoulder should extend high enough above the arm of the balance to be riveted securely, figure 15-13.

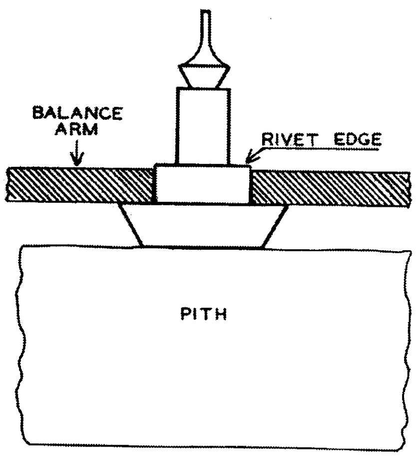


Fig. 15-13

4. Measure the collet shoulder of the old staff with your micrometer and compare with the diameter of the collet shoulder of the new staff. Measurements should be identical.
5. The length of the new staff should be identical with the one to be replaced. Allow about 0.25 mm for each broken pivot.
6. Compare pivot diameters by measuring with the micrometer.
7. Figure 15-14 illustrates another way to test the pivots for size. This test and all of the previous tests should be made before riveting the staff to the wheel. The pivot should enter the hole in the jewel and tip approximately 5 degrees to either side to allow the proper amount of sideshake. If the pivot is too large it will not tip from side to side and if it tips too far over, the pivot is too small for the hole in the jewel.
8. Place staff in lower jewel and replace balance cock. Test for endshake.
9. It is necessary at times to remove the cap jewels and ascertain if the pivot extends through the balance jewel far enough to reach the cap jewel without the cone of the pivot binding in the oilcup. A balance pivot

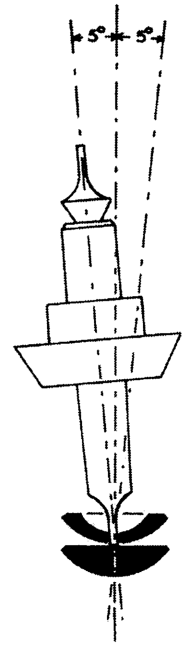


Fig. 15-14

should extend above the upper surface of the balance jewel approximately its own diameter.

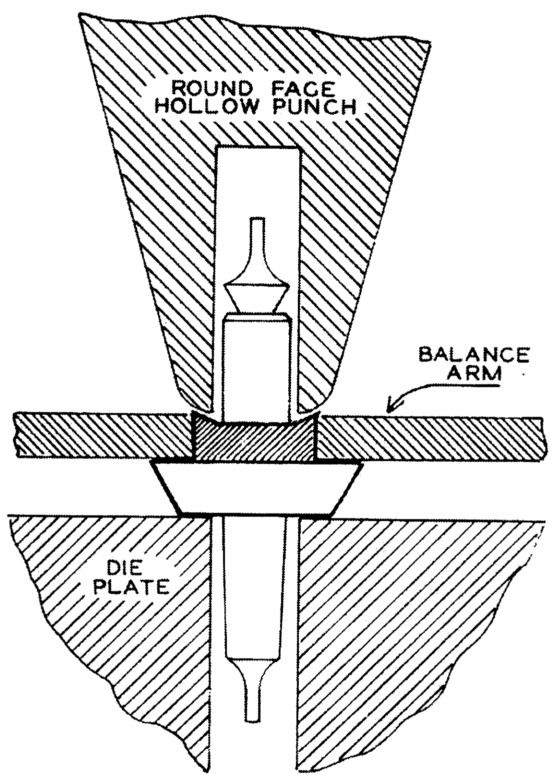


Fig. 15-15

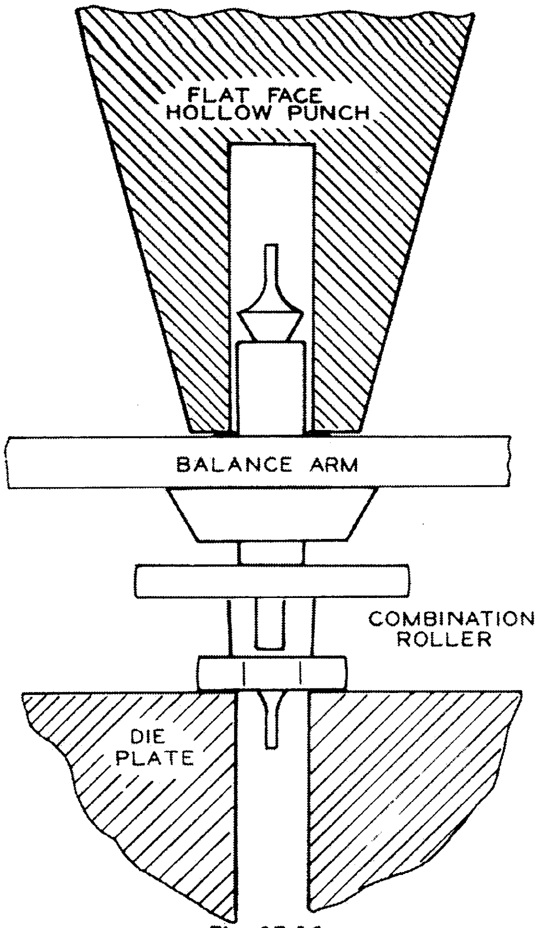


Fig. 15-16

SEC. 357—Riveting the Staff

Replacing a riveted balance staff is not a hard job, but each operation must be carefully executed, and the proper holes in the dieplate of the staking tool, together with the proper punches must be carefully selected.

1. Select hole in die plate which is slightly larger than the roller post.
2. Center this hole with centering punch.
3. Select a round face hollow punch and a flat face hollow punch which will slip over the collet shoulder freely. The round face hollow punch is used to spread the rivet and the flat face hollow punch will smooth and finish the previous operation. Figure 15-15 illustrates the staff in position in the die plate, the arm in position on the balance shoulder, and the round face hollow punch in position for riveting.
4. Tap the punch repeatedly with a brass hammer, at the same time turning the balance wheel slowly with the left forefinger. Do not use a crushing blow with the hammer. Many quick, light strokes of the hammer will do a better job.
5. Test by placing the thumb on the end of the riveting punch and exert as much downward pressure as possible. Try twisting the balance wheel around the staff. If no resistance is encountered the chances are that more riveting will be required. Rivet until secure, finishing with flat face hollow punch. This will require only several light taps with the brass hammer.

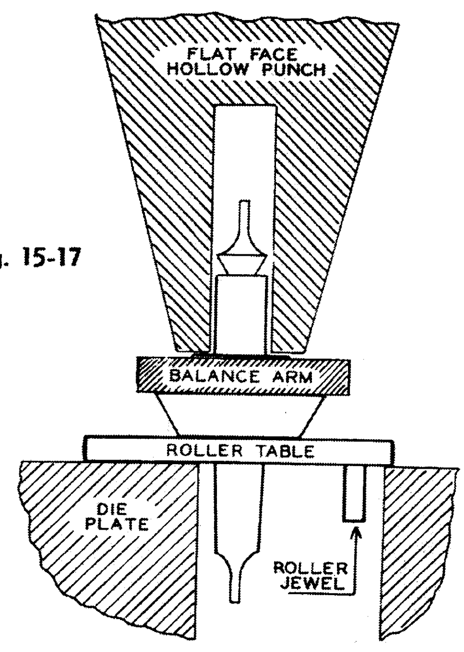
SEC. 358—Replacing the Roller

If the roller to be replaced is a combination roller, the previous operation requiring the use of the flat face hollow punch is repeated with the combination roller in place, figure 15-16. The roller jewel is usually placed at right angles to the arm of the balance wheel.

In replacing a single roller or the impulse roller from a two piece double roller proceed as follows:

1. Loosen die plate.
2. Select hole in die plate large enough to accommodate the roller jewel and the roller post when the roller is in place. The roller jewel should be placed at right angles to the balance arm.
3. Place flat face hollow punch in staking tool and carefully manipulate the staff and roller until they are directly under the punch. When you are certain that neither the staff or roller jewel will be damaged, tap punch with brass hammer until roller is tight against the seat, figure 15-17.

Fig. 15-17



SEC. 359—Replacing Friction Staffs

In selecting a friction staff, the same procedure is followed as in selecting a rivet type staff except that the post which enters the hub must just start into the opening in the hub. The difference must be made up by staking the staff in place.

1. Select a hollow stump which will allow the collet post of the staff to enter without binding.
2. Center stump with centering punch.
3. Drive staff into position using a round face hollow punch which fits freely over the roller post, figure 15-18.
4. Replace roller table as previously described.

It is not possible for the student to make the proper test of the balance wheel and staff in the movement at this time because we have not, as yet covered the truing of the balance in the flat.

Always make the following tests before replacing the hairspring:

1. Test endshake.
2. Balance wheel must clear pallet bridge, Dial Down.
3. Balance wheel must clear balance bridge and center wheel, Dial Up.

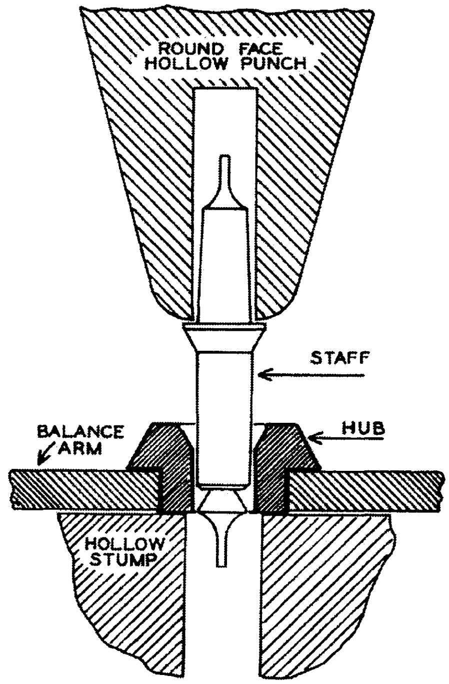


Fig. 15-18

4. Roller clears top of pallet fork, Dial Down.
5. With double roller, roller jewel must clear guard pin, Dial Down.

It is necessary to complete the next lesson on truing and poising before we can complete a satisfactory staff job.

TABLE OF CONTENTS: Unit W5- Lesson 15

JOB SHEETS

UNIT	W 5
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Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W15-J1

REMOVING BALANCE STAFF: Rivetted Type

TOOLS, EQUIPMENT AND SUPPLIES:

Staking Tool - Brass Hammer - Tweezers - Staff Remover* - Lathe*
Graver* - Roller Remover - Hairspring Remover
*Dependent on staff removing procedure used.

PROCEDURE

HOW TO REMOVE RIVETTED TYPE STAFF	REFERENCE
1. Remove balance cock and balance assembly.	Les. 8
2. Remove the hairspring, using hairspring remover.	Sec. 352
3. Remove the roller, using a roller remover.	Sec. 353
4. Remove the staff from the wheel.	Sec. 354

NOTE: When removing a staff, either the rivet or the hub should be cut away before removing the staff. Balance staffs may be made of steel which is harder than the arm of the wheel. When rivetted, the rivet is larger than the hole in the wheel and if this enlarged part of the rivet is driven through the hole, it will spread the hole. However, many watchmakers do not recognize the importance of this procedure and use a staff remover and staking tool to drive out staffs. We will explain three procedures. If the hub of the balance staff is too hard to cut with a regular graver, it should be softened before cutting on the lathe. This is done by heating the staff to a light blue but it must be done without heating the wheel or the arms of the wheel. A good method is to place a brass rod, into which you have drilled a hole, over the end of the staff and then heat the brass rod. This will transmit the heat to the steel. (Les. 31 - Fig. 31-73 is similar)

A HOW TO CUT AWAY THE HUB OF THE STAFF (Prefered method)	Sec. 354
1. Draw temper to a light blue.	Les. 27 - Sec. 464
2. Chuck up staff on collet seat.	
3. Cut away hub of staff.	Sec. 354 - Fig. 15-5 & 15-6

4. Select flat face stump with hole slightly larger than rivetted shoulder of staff and place stump in staking frame, center to frame.

5. Place wheel, bottom side up, on the stump.

6. Using staff removing punch, tap gently to remove staff.

B HOW TO CUT AWAY THE RIVET OF THE STAFF (Alternate method)

1. Draw temper to a light blue. Les. 27 - Sec. 464

2. Chuck up staff on roller seat.

3. Using graver sharpened to long slender taper, cut away the rivet.

4. Place wheel on die plate with hub in hole slightly larger than hub.

5. Fit staff remover and punch in staking frame, tap gently to drive out staff. Fig. 15-7

C HOW TO DRIVE OUT STAFF USING A STAFF REMOVER AND STAKING TOOL

1. Place wheel on die plate with hub in hole slightly larger than hub of staff. Fig. 15-7

2. Fit staff remover and punch in staking frame and tap gently to drive out staff.

3. Examine wheel carefully to determine if hole has spread, best indication of this is a burr formed arround the hole on the bottom side of the wheel. The hole can not be closed but the burr can be smoothed out by laying wheel bottom side down on a flat solid stump and tap gently with flat face solid punch in size larger than the hole in the wheel. If burr is not removed there is a good chance you will not be able to true the balance wheel after staffing.

FOR COMPLETE PROCEDURE FOR REMOVING AND REPLACING STAFFS SEE JOB GUIDE SHEETS W17-J1 through W17-J3

REMOVING BALANCE STAFF WITH SULPHURIC ACID

EQUIPMENT AND SUPPLIES:

Glass jar with ground glass cover or wide mouth bottle with rubber stopper - Sulphuric acid (either chemically or commercially pure) usually obtainable at your druggist - Distilled water - Small brass or copper wire.

INTRODUCTORY INFORMATION:

Many modern watches use balance wheels which contain no steel. The balance staff which is made of steel can be removed without damage to the balance wheel by destroying it with a solution of sulphuric acid and water. The time required is generally from 4 to 10 hours depending upon the solution. The balance wheel will not be changed in any way using this method. However the solution must be handled very carefully as it can be dangerous, and the fumes will have a tendency to rust other steel tools or items in its vicinity. It should be kept in a glass or porcelain container in a safe place. Ordinary baking soda is used to neutralize the solution should it spill.

PROCEDURE:

HOW TO REMOVE A BALANCE STAFF USING A SULPHURIC ACID SOLUTION

1. Place 4 parts of cold distilled water into container.

2. Pour slowly 1 part of sulphuric acid into water.
   Example: 2 oz. distilled water.
   ½ oz. sulphuric acid.

3. Remove hairspring.

4. Remove roller table.

5. Test balance wheel with small magnet. If wheel rim or arm is not attracted by magnet it is safe to use this method. NOTE: Do not touch staff with magnet as the staff is steel and will be attracted to magnet.

6. String balance on small brass or copper wire.

7. Immerse balance in solution and replace cover over wire. The wire will keep cover loose enough so fumes may escape.

OVER

8. When staff is dissolved, removed balance wheel from the solution and rinse thoroughly under running water.

9. Dry balance wheel.

NOTE: This acid solution can be used until it starts to discolor the balance wheel. It should be kept in a safe cool place. When disposing of the solution make certain that plenty of water is used when flushing it away.

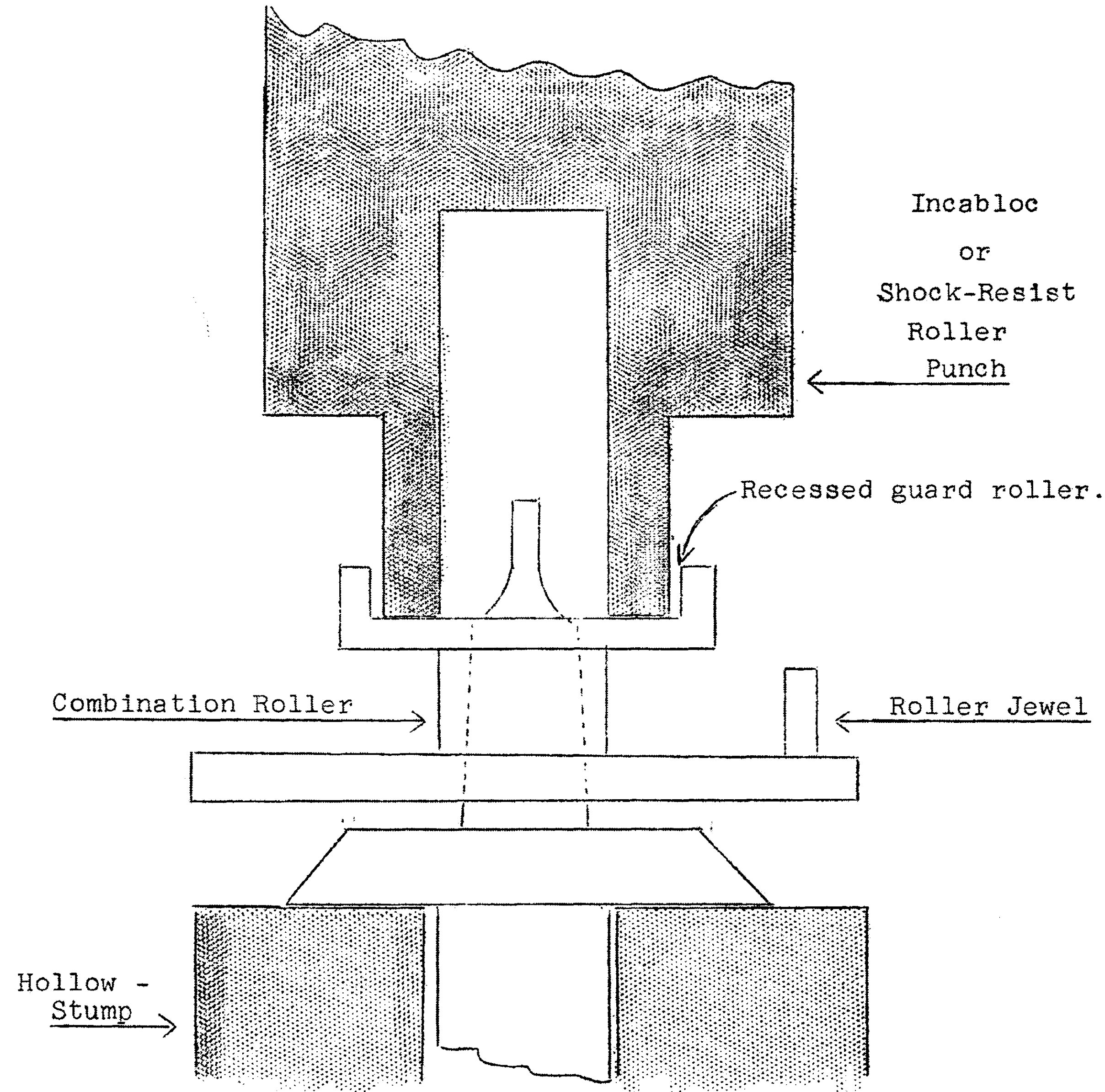
HOW TO REPLACE AN INCABLOC OR SHOCK-RESIST ROLLER WITH RECESSED GUARD ROLLER.

TOOLS AND EQUIPMENT.

Staking Set. Hollow Stump. Special Incabloc or Shock-Resist Punch. Brass Hammer.

PROCEDURE.

1. Place balance wheel over hollow stump with roller shoulder up.
2. Place roller table on staff with roller jewel at right angles to the balance arm.
3. Set punch in recess of guard roller and press or tap into place.



Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 16

Truing Balance Wheels

—

Sections 360 - 365

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

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Founded 1908 by Thomas B. Sweazey

Lesson 16

Sections 360 to 365

TRUING BALANCE WHEELS

SEC. 360—Purpose of Truing

The truing and poising of the balance wheel are very closely related. Truing a balance wheel generally requires a great deal of practice. Your ability to true and poise a balance wheel has a tremendous bearing upon the results you will attain in adjusting and bringing a watch to time. The balance wheel must be true in the flat in order that it may rotate freely between the pallet bridge and the balance cock. The rim must have clearance between the pallet bridge and the center wheel. A balance wheel which is slightly out of true in the flat can be the cause of the watch stopping in certain positions.

A wheel must be true in the round and flat before it can be poised properly. It is impossible for a watch to keep accurate time in the various positions if the wheel is out of poise. Many times the question is asked, "Is it better to have the wheel true or poised?" The two are so closely related that it must be said that a wheel should be trued as nearly perfect as possible and then poised.

Truing in the flat is the adjustment required to have the rim of the balance wheel rotate in the same plane. The wheel is in the flat position when we look across the rim of the wheel.

Truing in the round is the adjustment required to have the rim of the balance concentric with the balance pivots. The wheel is in the round position when we look directly down on the wheel. Poising is the adjustment required to bring the balance wheel to the state of being balanced.

SEC. 361—Types of Balance Wheels

Figure 16-1 illustrates a bi-metallic balance wheel which has an inner rim of steel and an outer rim of brass. This is the most common form of balance wheel, and when the rim is cut toward the end it is known as a compensating balance.

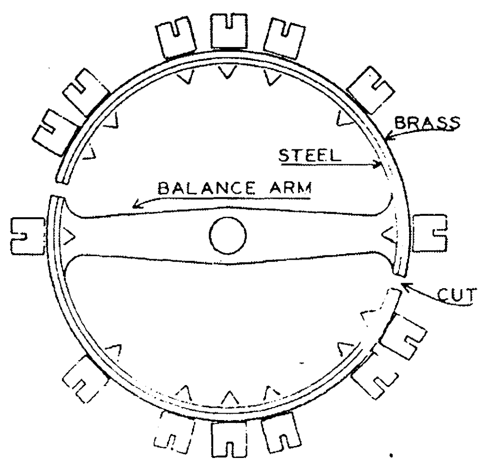

Fig. 16-1

Figure 16-2 is an illustration of a monometallic balance wheel. Notice that the rim of this type of wheel is **NOT** cut. It is sometimes referred to as a **SOLID** balance wheel. The better grades of watches which have monometallic balance wheels use a friction staff also, and it is not often that the watchmaker is required to true this type of wheel, as it is prac-

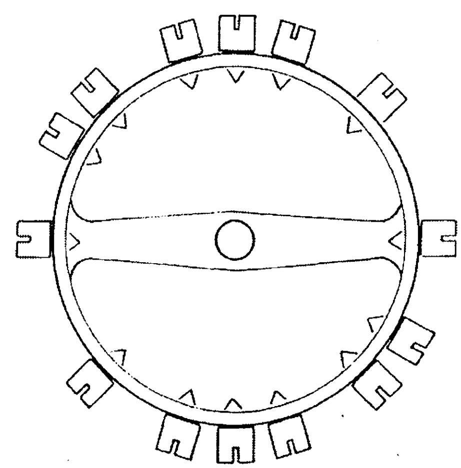

Fig. 16-2

tically impossible for the wheel to get out of true if properly handled. It is practically impossible to true this type of balance in the round. Truing in the flat can be accomplished if the workman is careful and understands thoroughly the principles of truing.

SEC. 362—The Truing Caliper

Figure 16-3 illustrates a parallel jaw truing caliper in which the center screw is used to open and close the jaws of the caliper. When the

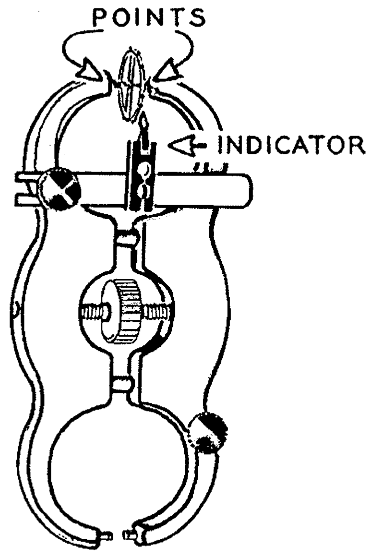

Fig. 16-3

balance staff and wheel are in place the jaws can be adjusted to hold the wheel in position without any further attention from the workman. This is probably the most popular of all truing calipers. The chief disadvantage is the fact that the screw must be loosened each time the balance is removed.

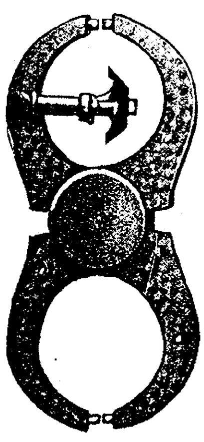

Fig. 16-4

The caliper shown in figure 16-4 does not have a center screw to keep the jaws closed on the cones of the balance pivots, and the workman must therefore exert enough pressure to keep the jaws closed while making any adjustments on the rim of the wheel. The indicator is a little more flexible than in some types because it is swung in a ball and socket.

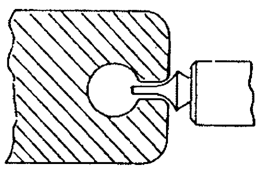

Fig. 16-5

Figure 16-5 illustrates an enlarged view of a point in the jaws of a truing caliper. Notice that the pivot does not come in contact with the point when the jaws are closed. The cone of the pivot rides on the countersink which is designed to receive it, and in this manner adjustments can be made on the rim of the wheel without damaging the pivots.

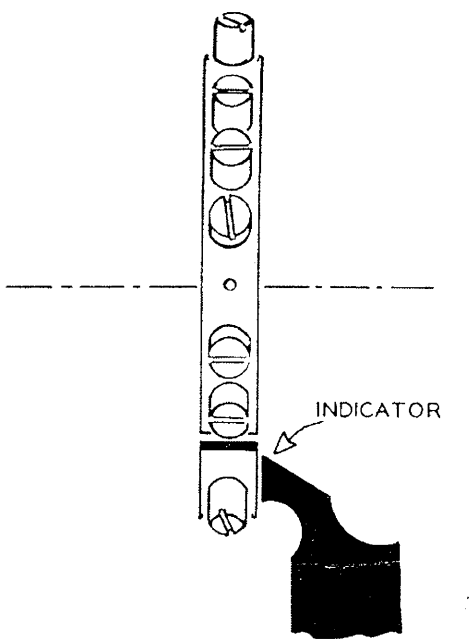

Fig. 16-6

Set the indicator in the position shown in figure 16-6 when truing in the flat. Figure 16-7 illustrates the indicator in the correct position when truing in the round.

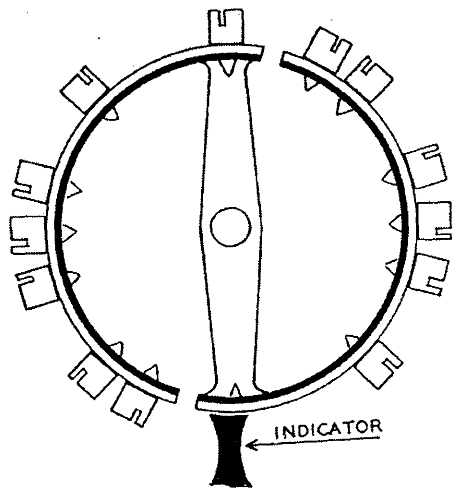

Fig. 16-7

SEC. 363—The Balance Screws

In figure 16-8, the balance screws set in the rim are lettered A, B, C, D, E, F, and G. Notice that set directly opposite each one of these screws on the other half of the rim is a corresponding screw. Example: A-1 is opposite A. B-2 is opposite B, etc. These screws give the balance the proper weight and have been placed in their respective locations by the factory for temperature adjustment. **Do not change their position.** If upon examination of a wheel you should find an unequal number of screws, for instance seven on one side and six on the other, it would be necessary to equalize the number by adding one. The absence of screws does not interfere with truing a balance but will hinder any attempts made to poise the balance or bring the watch to time.

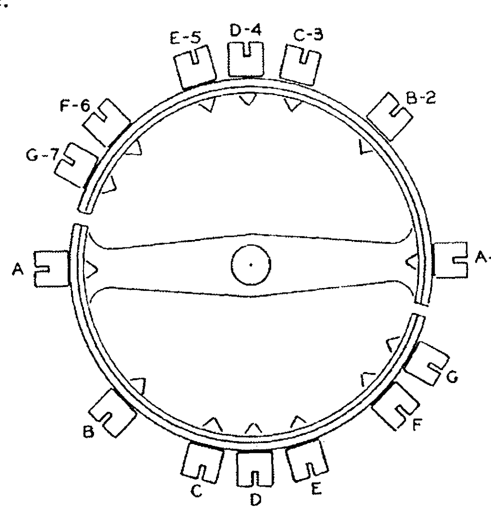

Fig. 16-8

SEC. 364—Truing in the Flat

If the balance wheel was true before replacing a balance staff and you have done your work carefully, you will find very little truing to be done; however, there are a great many times when in overhauling a watch for the first time you will find the balance out of true. Although another workman may not have the ability to true the balance wheel properly, you are not excused for doing the same. Check every balance for true and poise. The results you obtain when bringing a watch to time will depend upon the wheel being trued and poised. Use large balance wheels for practice work.

The following instructions are used in conjunction with the illustrations shown. These illustrations are for the purpose of demonstrat-

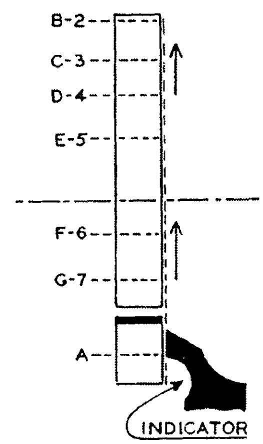

Fig. 16-9

ing the procedure used when truing a balance wheel in the flat. Very few wheels will be out of true as badly as the one shown. The letters A, B, A1, B2, etc., correspond to the centers of the balance screws and their positions on the rim of the wheel as illustrated in figure 16-8.

1. Place wheel in caliper and set the indicator, figure 16-9.
2. Keep indicator as close to the rim as possible.
3. Keep edge of indicator parallel with rim of wheel.
4. The starting point is where the arm joins the wheel.
5. True each half separately.
6. After each bend or alteration, return to starting point.
7. Move wheel in direction of arrow, figure 16-9, until the distance between the rim of wheel and the indicator increases or decreases. For our purpose we will say this distance has increased.

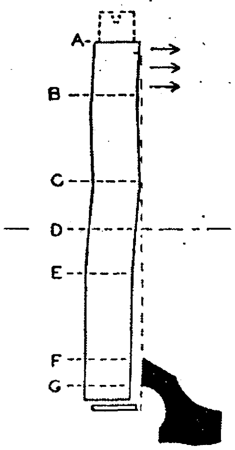

Fig. 16-10

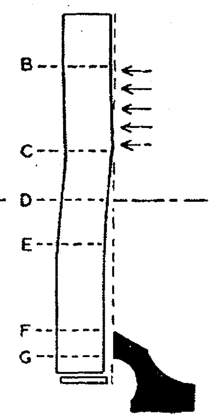

Fig. 16-11

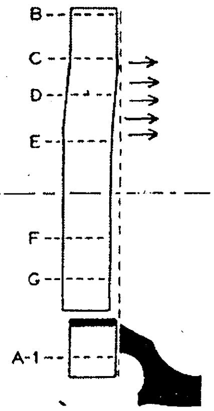

Fig. 16-12

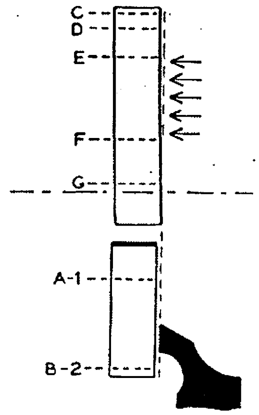

Fig. 16-13

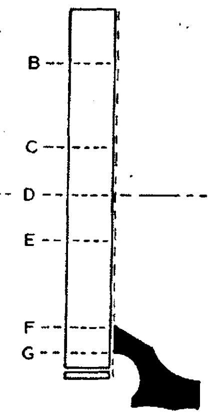

Fig. 16-14

8. Figure 16-10 illustrates this variation between the points A and B. The vertical dotted line is the path of the indicator.
9. Bending the rim of the wheel in the direction of the arrows between A and B will correct this section of the rim. Do not attempt to make any other corrections on the rim until this section is parallel to the indicator.
10. The section between B and C, figure 16-11, has moved toward the indicator. (Always return to starting position after each bend.) This section may be brought parallel to the indicator by bending at B in direction of arrows.
11. Return to starting point and check.
12. Section C to E, figure 16-12, has moved away from the indicator and must be bent at C in the direction of the arrows.
13. Return to starting point and check.
14. The section from E to the end of the rim has moved toward the indicator and must be bent back in the direction of the arrows, figure 16-13. This half of the wheel rim is now perfectly true in the flat and will appear as in figure 16-14.

This example is used to show some of the typical bends required when truing a balance in the flat. The average wheel requires very little bending. Usually one or two slight bends are sufficient to true the rim in the flat; however, remember after each bend to return the rim of the balance to the starting point.

At times you will have to adjust your indicator after each bend and also after returning the rim to its first position. To make the bends, place the rim of the balance between the thumb and second finger of the right hand. The caliper must be held firmly in the left hand. When making a bend, pressure must be exerted by the left hand in order to keep the jaws closed upon the cones of the pivots. Figure 16-15 illustrates the position of the thumb and finger when making a bend in the flat to the left. Notice that the thumb is slightly lower than the finger. The pressure is exerted by the thumb, the finger acting as the fulcrum. When making a bend to

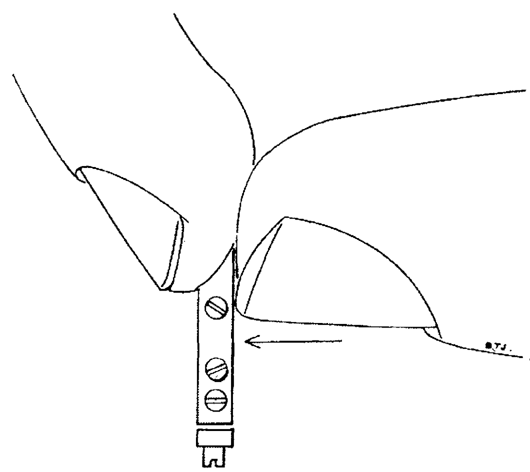

Fig. 16-15

the right the finger is lower than the thumb and the pressure is exerted by the finger, the thumb acting as the fulcrum.

When half of the wheel rim is true in the flat proceed to true the other half as follows:

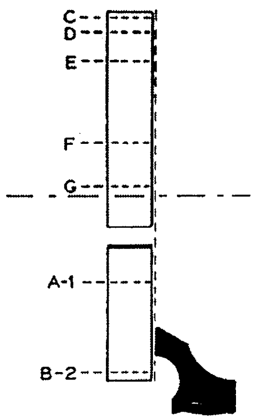

Fig. 16-16

Set indicator at A and turn rim half-way around. A-1 will be the starting point of the second operation, figure 16-16. The distance between the indicator and the rim of the wheel at A-1 should be the same as the distance between the wheel rim and A. If this distance is the same, proceed to true this half of the rim. If the arm of the balance requires bending, use

Fig. 16-17

the wrench illustrated in figure 16-17. Figure 16-18 illustrates the method of using this wrench. Place slot in wrench over arm and move in direction of arrows. It is not usually necessary to remove the wheel from the caliper when using the wrench in the flat. After both

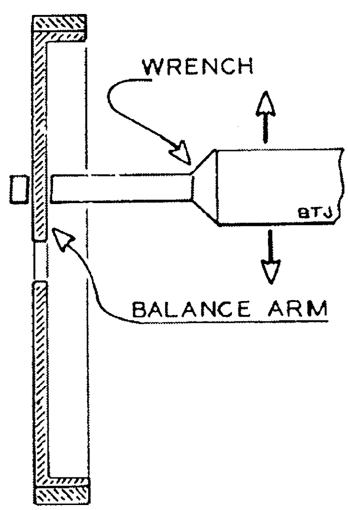

Fig. 16-18

sections of the balance have been trued, release the pressure of the left hand slightly and with the forefinger of the right hand, spin the wheel. If you have followed instructions carefully there should not be any variation of light between the indicator and the rim of the wheel. The wheel will then be TRUE IN THE FLAT.

SEC. 365—Truing in the Round

Truing a balance wheel in the round is similar to truing in the flat except that you will be unable to use your fingers when making the bends in the rim. The wrench illustrated in figure 16-18 is used primarily for this purpose.

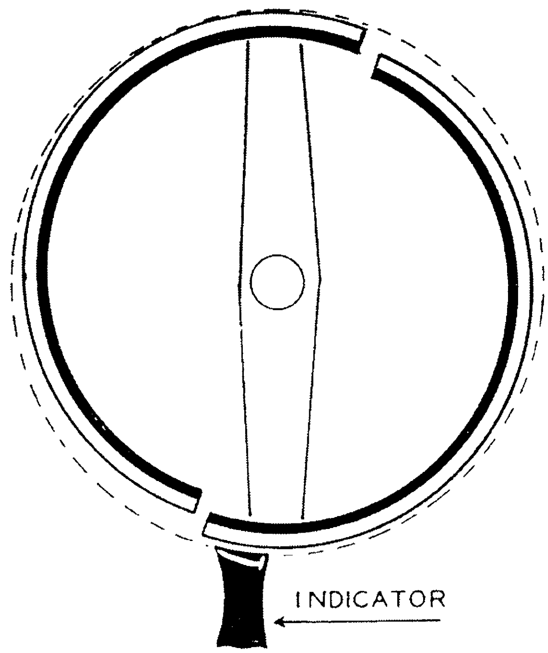

Fig. 16-19

Figure 16-19 is an illustration with both sections bent in. The dotted line indicates the path of the indicator.

1. Set indicator at point where the rim is joined by the arm. Indicator must follow curve of the rim.
2. Turn wheel slowly with forefinger of right hand while holding caliper in left hand. As the arm moves away from indicator the rim moves toward the indicator.
3. Place wrench over rim and bend in direction of arrow, being certain that you are applying pressure with the left hand, figure 16-20. Hold wrench lightly and be certain not to disturb the flat.
4. Bend rim in until it is the same distance

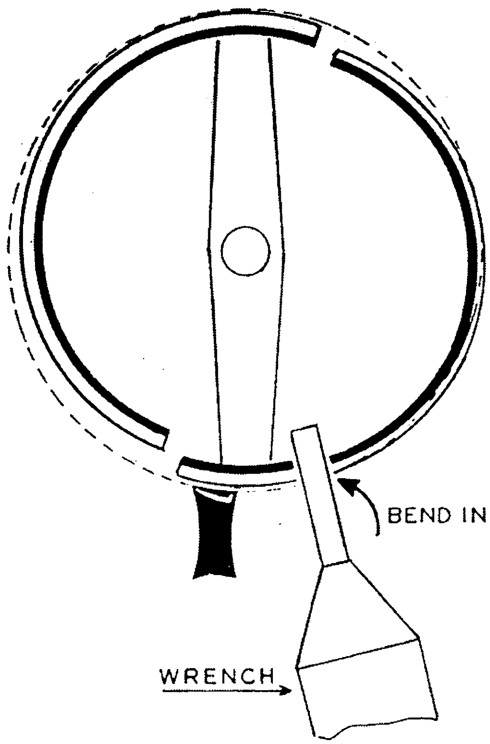

Fig. 16-20

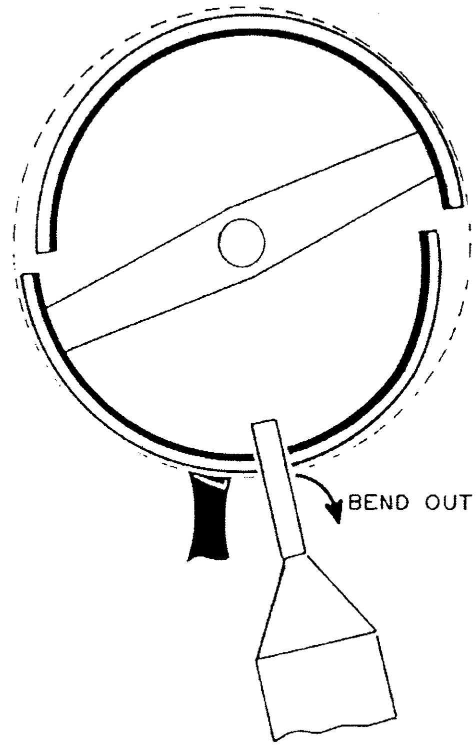

Fig. 16-21

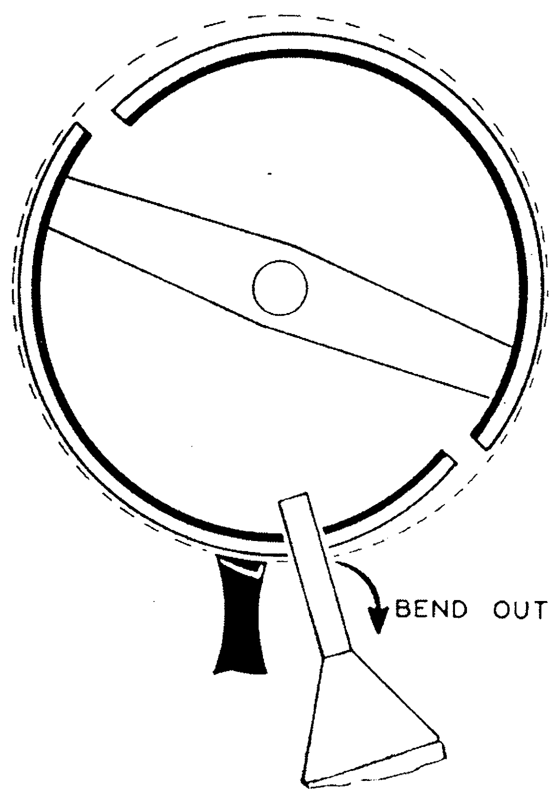

Fig. 16-22

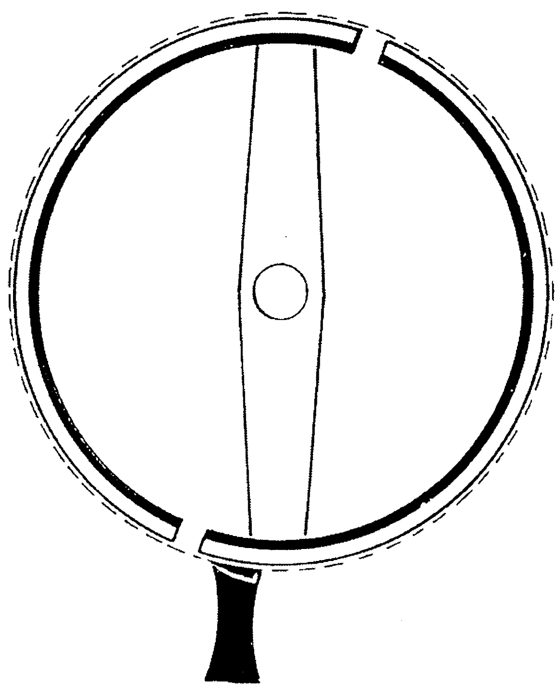

Fig. 16-23

as the starting point from the indicator.

5. Return to starting point, checking carefully the distance between the rim and the indicator. When certain that this section is correct proceed with the next section.

In figure 16-21 the rim of the balance wheel is true to point covered by the wrench. However, it must be bent out as illustrated by arrow. After bending it out check and proceed to next section.

The last section is bent out of true as in figure 16-22. When this half of the rim is true in the round, proceed to true the other half in the same manner. Spin the wheel as you did when checking the flat and the rim should not show any waves of light, figure 16-23.

Figure 16-24 illustrates the method used to true the rim of a balance wheel when one balance arm is shorter then the other. Make the first bend as close to the arm as possible and then proceed to true the rest of the rim as before. Now recheck in the flat. In your first attempts at truing wheels, you will in all probability have to check and recheck the round and flat several times before attaining perfection.

You will find that no matter how long you do watch repair work, there is a certain thrill that always accompanies a job that is well done.

You will soon be able to recognize quickly a balance that is out of true when it is in the watch. After truing the balance, test it in the watch as explained in this section. There may be times when it is necessary to raise or lower the arms slightly in order that the wheel will have the proper clearance. If your wheel seems to run true in the caliper but not in the watch, examine the pivots closely to see if they are

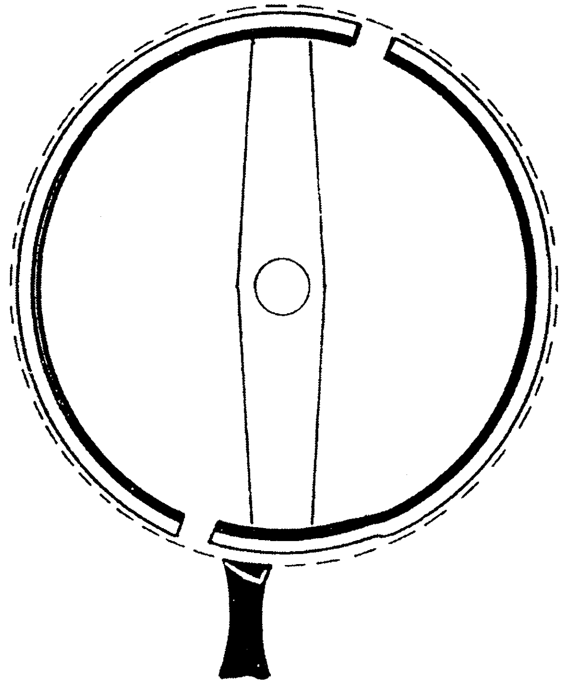

Fig. 16-24

bent. This may have happened if you relaxed the grip on your caliper while you were making a corrective bend. Mastery of truing and poising requires a great deal of practice; therefore, it is wise to obtain as many balance wheels as possible and practice at every opportunity.

As previously stated, the solid balance wheel, if handled properly, seldom gets out of true. However, when this type of wheel is out of true in the flat, it usually can be corrected by raising or lowering the arms slightly. When making bends of this type it is better to remove the wheel from the caliper so as not to bend or break the pivots.

UNIT	W 5
LESSON	16

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W16-J1

TRUING BALANCE WHEELS

TOOLS, EQUIPMENT AND SUPPLIES:

1. Make the tool illustrated in Fig. 13-20, Section 321.

2. Make the tool illustrated in Figs 13-24-1 and 13-24-2, Section 324.

3. Make a set of three hairspring removing tools as illustrated in Fig. 15-3, Sec. 352.

4. Stake staffs in practice wheels. (See Lesson 15 and the Job Sheets in Lessons 15 and 17. Follow steps 12 through 18 on Job Sheet L17-J2.)

5. True practice balance wheels. (See Lesson 16)

6. Poise practice balance wheels. (See Lesson 17)

When you are satisfied with your work above, begin the exam:

PROCEDURE:

USE AN AMERICAN WATCH, preferably 12 or 16 size, 15 or more jewels.

1. Fit a factory staff to this watch, using the procedure outlined on Job Sheets L17-J1 or L17-J2 in this order:

   a. Follow steps 1 through 25 on the Job Sheet.
   b. Remove and replace the roller jewel. (Lesson 13, Sections 320 through 325.)

      NOTE: Replacement of the roller jewel is being done here for this exam because it is convenient and must be done before the wheel is poised. The job could have been done earlier or separately as is usual in repairing.

   c. Follow steps 26 through 30 on the Job Sheet.
   d. Disassemble the movement.
   e. Remove one of the train jewel settings.
   f. Remove jewel from setting and replace with a friction jewel. (See Lessons 12 and 14 Assignment Sheets and the Job Sheets in Lesson 14.)
   g. Replace jewel setting.

2. As watch submitted should be clean, finish disassembly and clean the movement. (Lesson 10 and Job Sheets for Lesson 10.)

3. Reassemble the watch, oil, and regulate.

(Continued)

TRUING BALANCE WHEELS (continued)

USE A SWISS MOVEMENT, preferably about 10 1/2 or 11 1/2 lignes, 15J or more:

4. Fit a factory staff to this watch, using the procedure outlined in Job Sheet L17-J2 in this order:

   a. Follow steps 1 and 2 on the Job Sheet.
   b. Step 3: Remove the upper balance hole jewel and replace with a friction jewel. (See Lesson 13 and the Job Sheets in Lesson 14.)
   c. Step 3: Remove the lower cap jewel from its setting and replace with a friction jewel.
   d. Follow steps 4 through 25 of the Job Sheet. (L17-J2)
   e. Remove and replace the roller jewel. (Lesson 13, Sections 320 through 325.)
   f. Follow steps 26 through 30 on the guide sheet.

5. As watch submitted should be clean, complete disassembly and clean the movement. (Lesson 10 and the Job Sheets in Lesson 10.)

6. Reassemble the watch, oil and regulate.

USE AN AMERICAN 7 JEWEL MOVEMENT, preferably 6,-12 or 16 size:

7. Completely disassemble the movement.

8. Reassemble each wheel and pallet fork individually in movement and check for proper endshake and sideshake. (Lesson 17, Section 372)

9. Close each pivot hole and refit to each pivot as outlined in Job Sheet L17-J6.

10. Remove and replace the pallet arbor. (Lesson 17, Sec. 375 and Job Sheets L17-J4 or L17-J5, depending upon the type of arbor.

11. Clean and oil the movement, reassemble and regulate.

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 17

Poising Balance Wheels

—

Sections 366 - 375

CHICAGO SCHOOL OF WATCHMAKING

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MASTER WATCHMAKING

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CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

Lesson 17

Sections 366 to 375

POISING BALANCE WHEELS

SEC. 366 — Definition of Poising

Poising a balance wheel is the art of obtaining perfect balance.. Too many watchmakers are apt to feel that it is not necessary to check the poise on every wheel. On inexpensive watches where the factory is not too careful about poising balance wheels, it is hard for a watchmaker to bring these wheels into poise. However, in the better grade watches the wheels are poised before the watch is brought to time and if carefully handled by good repair men, these wheels will remain in poise. A watch will not keep accurate time unless the wheel is poised, and immediately after checking the wheel to see if it is true, it should be tested for poise. A balance wheel cannot be poised if it is magnetized and a magnetized balance wheel will act as if it were out of poise. Lesson 11 explains magnetism, and by now you should be in the habit of testing each watch for magnetism.

In poising a balance wheel, remember that the pivots must be perfectly true, the wheel must be true in the flat and in the round and must be free of magnetism. The wheel is poised with the roller table in place, the roller jewel must be set and all excess cement removed, and the wheel and the jaws of the poising tool must be clean. Use pithwood to clean both.

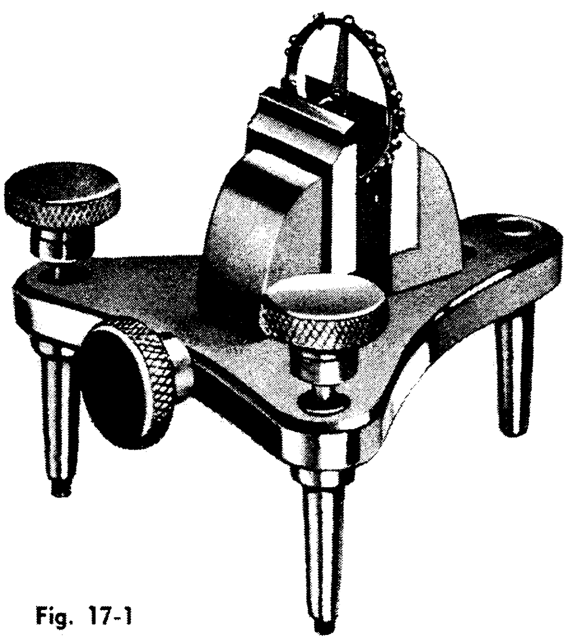

Fig. 17-1

SEC. 367 — The Poising Tool

There are many types of poising tools on the market. One of the most popular models is shown in figure 17-1. Two of the legs are on screws and are used to insure perfect level at all times. The jaws are of synthetic ruby with a high polish. Some poising tools are equipped with a spirit level. Steel jaw poising tools will serve the purpose well but the jaws must be kept at a knife edge and highly polished.

SEC. 368 — Poising the Balance Wheel

1. The balance wheel is set between the jaws of the poising tool with the pivots (not the cones) resting on the polished, knife-like edges of the poising tool, figure 17-2.

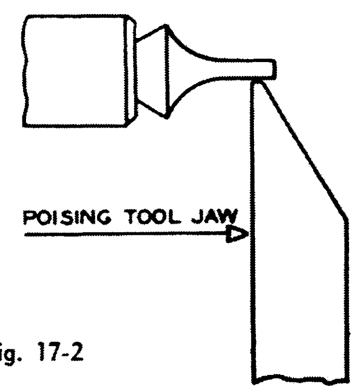

Fig. 17-2

2. Carefully turn balance wheel with pegwood and release.
3. If the wheel is out of poise the heavy side will be at the lowest point on the rim B, figure 17-3.
4. Removing weight from the balance screw located at this point will tend to bring the wheel into poise.

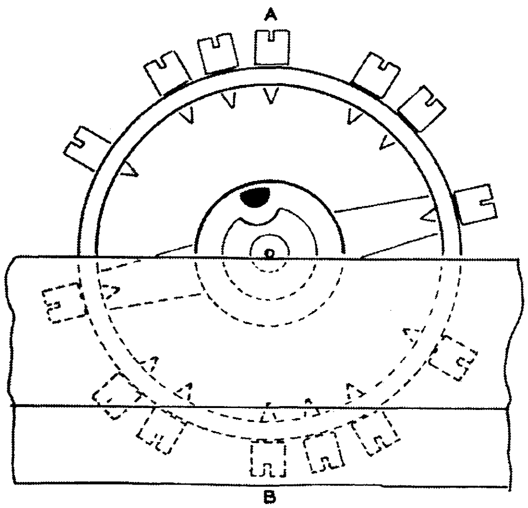

Fig. 17-3

5. Adding weight to the screw A opposite the heavy side A, figure 17-3, will obtain the same result.
6. It is best to add a little weight to the light side and remove a little from the heavy side.

To remove weight, use balance screw undercutter, having hole in the center to allow the threaded portion of the balance screw to enter (figure 11-19, Lesson 11).

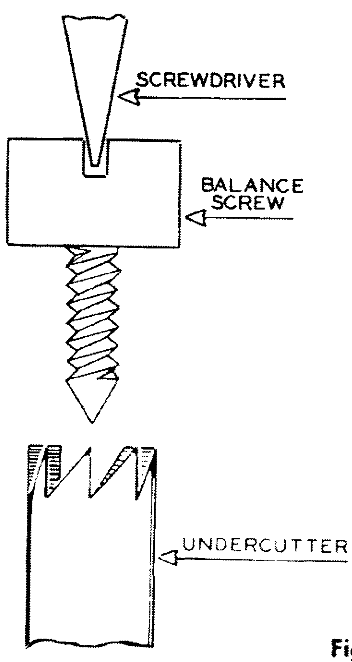

Fig. 17-4

Figure 17-4 illustrates the screw in place over the undercutter. Notice that the undercutter is smaller in diameter than the head of the screw. Turning the screw with a screwdriver will remove a slight amount of metal, depending upon

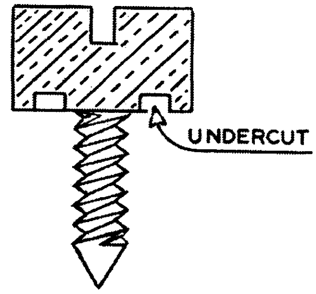

Fig. 17-5

how many revolutions the screw is turned. Do not use too much pressure. Figure 17-5 illustrates a balance screw that has been undercut.

The undercutter mounted in a lathe and the screw held in a balance screw holder is the most satisfactory method of all but is another method that cannot be used without a lathe. The first method works as well but is a little slower.

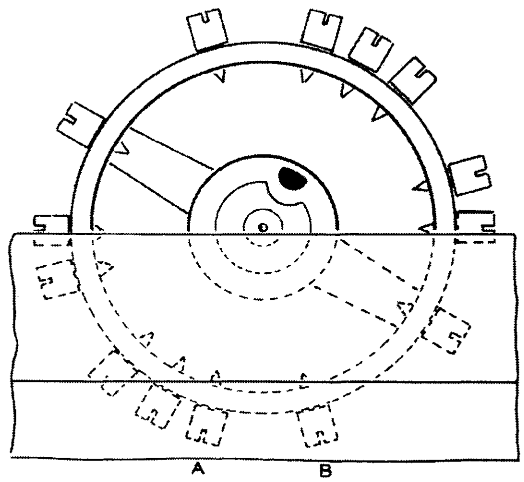

Fig. 17-6

Figure 17-6 illustrates a balance which has come to rest with the heavy side between the screws A and B. In such a case we would remove a little weight from each of the screws A and B with the undercutter.

Light weight timing washers may be added if it is desirable to add weight in order to bring the wheel into poise. In this connection, in our lesson on lathe work we will illustrate the procedure used in making punches for any size balance screw which will in turn allow us to make washers from brass, copper or in some cases gold and platinum. These punches will also serve us well in making special timing washers.

Remove weight from and add weight to the balance wheel carefully as it is very easy to get the wheel out of true. When the balance wheel

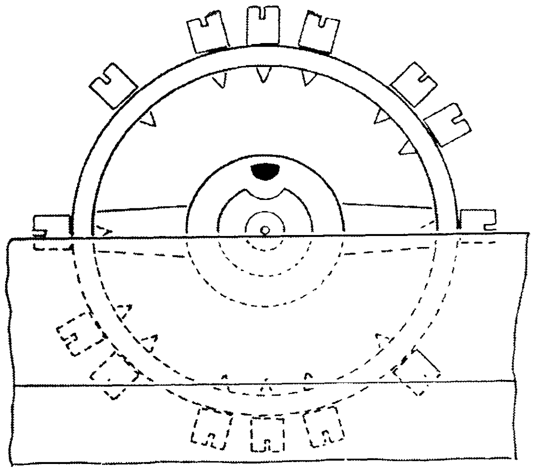

Fig. 17-7

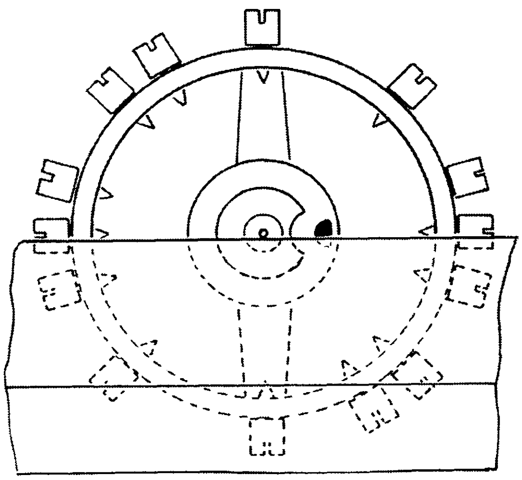

Fig. 17-8

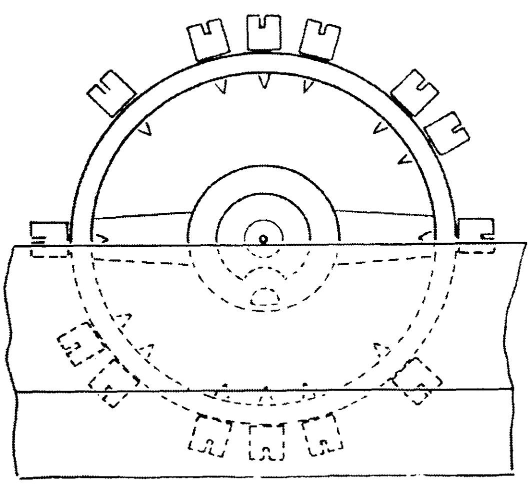

Fig. 17-9

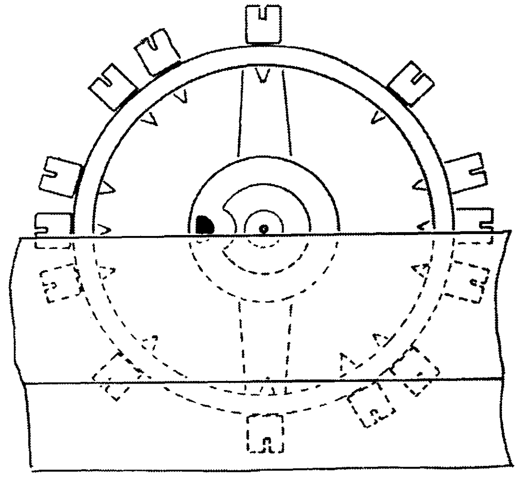

Fig. 17-10

will remain at any position on the jaws of the poising tool, it will be in poise. Try four positions by using the roller jewel as a guide. Figure 17-7 illustrates the roller jewel in a vertical position. Turn the roller jewel a quarter turn to the right, figure 17-8. Turn the roller jewel another quarter turn to the right, figure 17-9, and once more, figure 17-10. Tap poising tool lightly when the wheel is in each of the above positions. If it remains in each of the positions described the wheel will be in poise.

SEC. 369 — Some Observations to Make Before Poising a Balance

In making repairs on watches, it is an excellent idea to make certain notes as follows:

Notice position of regulator before removing balance from the movement. If the regulator is as far toward the F (fast) as possible we would assume this watch has a tendency to run slow. In this case, when poising the wheel it would be better to remove more weight from the balance than we add. Just the opposite is true if the regulator is toward the slow side. In this case it would be reasonable to assume that more weight should be added than removed when poising the balance wheel.

When a balance wheel is ready to be trued in the round and the ends of the balance rim are slightly toward the center, the weight which is contained in the balance rim will be moved away from the center. This will cause the watch to run slower. After the wheel has been trued properly it would in all probability be wiser to remove weight from the balance when poising the balance.

If the rims of the balance had to be trued toward the center it would be wise to add weight to the balance wheel when poising, as truing the ends of the balance rim toward the center moves the weight toward the center, thus causing the watch to gain.

These conditions must be observed carefully when making repairs and the more careful you are with your observations the easier it will be for you to bring your watch to time.

If your watch runs slow after you have trued and poised the balance wheel and the regulator is in the center, it is possible to speed it up by removing an equal amount of weight from a pair of balance screws which are directly across from each other. If the watch runs fast with the regulator in the center, a pair of washers of equal size and weight added to opposite pairs of screws will increase the weight of the balance wheel and cause the watch to slow down. (Lesson 11).

When poising the balance wheel, do not add to or remove weight from the meantime screws, but instead make any required adjustment on the balance screws on either side.

To poise a monometallic balance use the same method as is used to poise the regular balance wheel. However, in watches using this type of balance, you will find that the wheel is seldom out of poise if the staff has been properly replaced. If your wheel is out of poise, be sure to check the pivots carefully to see that they are perfectly true and have a high polish.

SEC. 370 — Swiss Type Balance Screw Cutter

Figure 17-11 illustrates a balance screw cutter which will cut the balance screw without having to remove the screw from the balance wheel. These come in sets of six and are recommended for bringing ordinary Swiss type balances to poise or for timing.

Use as follows:

1. Select collar which fits over balance screw

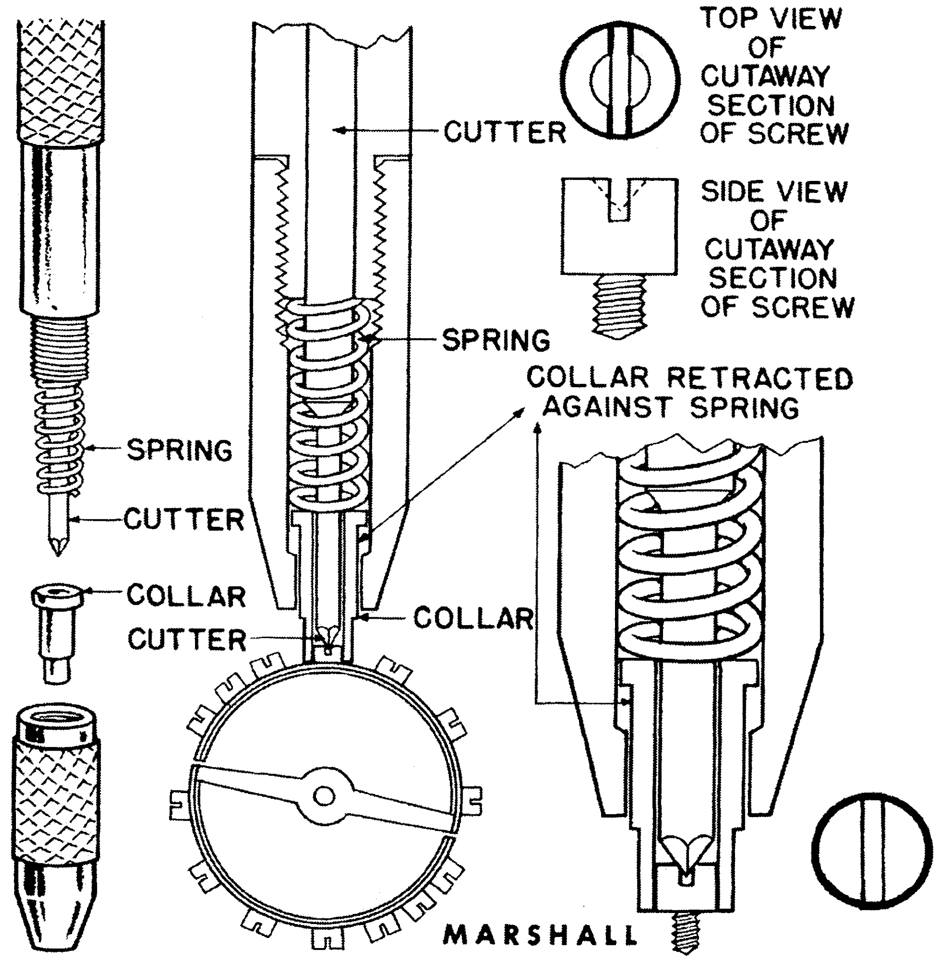

Fig. 17-11

to hold it in position . . . the collar retracts against the spring and automatically centers the cutter.
2. Turn handle as you would a screwdriver. The three bladed cutter countersinks (hollows out) the center of the top of the screw.
3. Remove cutter and test.

SEC. 371 — Train Wheels and Pinions

The wheel and pinions of a watch do not need replacing very often. The pivots are sturdy and it takes a hard knock to break the train pivots. There are times when a student will accidentally break a train pivot; this usually happens when too much force is exerted in assembling the watch. If a train wheel and pivot will not slip into place easily, check carefully to see if you might have overlooked interference at some point. There may be times when it seems as though the wheel and pinion do not fit properly. But REMEMBER that if it fit properly before you took it apart it should go back in easily. Any time you are in doubt, remove all wheels in the train and try the wheel and pinion you are having trouble with, in the watch by itself. This holds true for every operation in watchmaking, wheels and pinions, balance staffs, jewels, winding and setting parts. Try each part separately until you are positive that each and every part is functioning correctly. When you are certain that each part works smoothly, proceed with the next operation.

There are many occasions in which the student will have trouble when making repairs. For example: On certain Swiss watches in which the lower escape pivot is capped, the screw which holds the cap jewel in place can be interchanged with the lower balance cap jewel screw. However, the balance cap jewel screw is slightly longer, and if replaced as the escape cap jewel screw it may protrude enough to cause interference with the escape wheel. This example and many others cannot be considered part of your course as they are primarily due to carelessness or lack of experience. Your ability to locate these difficulties will mean the difference between an expert and a "botchmaker." Ability is determined by the skill in locating trouble quickly and making the necessary repairs.

Figure 17-12 is an illustration of a badly worn square shoulder pivot which should be replaced. Before replacing, however, ascertain the condition of the jewel, as it is possible that a cracked or broken jewel has caused the excessive wear. Or it may have been cut by accumulated dirt

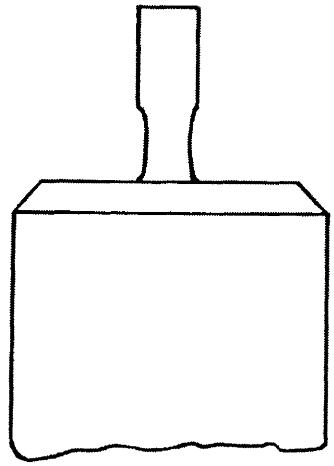

Fig. 17-12

and grime mixed with the old oil. If the jewel is cracked or broken, replace it before attempting to replace the wheel and pinion. In cases where the pivot turns directly into the plate or bushing, it will be necessary to close the pivot hole slightly.

SEC. 372 — Repairing a Worn Pivot Hole

In watches that do not have jewels for bearings the pivots of the train wheel pinions turn directly in the plates or metal bushings and we may find the pivot holes have become worn. This is especially true in watches that have been in use for a good many years. Excessive wear is easily determined by testing for sideshake and if the sideshake is noticeable, it is evident that the pivot hole is too large, figure A-17-13. For a thorough test, examine each wheel and pinion separately, testing for excessive sideshake.

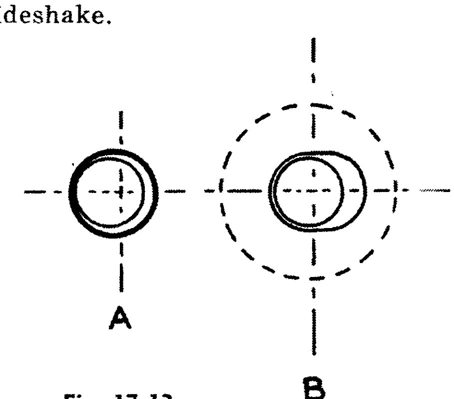

Fig. 17-13

Whenever a watch is taken apart it should be carefully examined to see if any such condition exists. Not all pivot holes that are worn can be satisfactorily closed. Figure B-17-13 shows a pivot hole that is worn so badly that it would be wasted effort to attempt to close it so that it would function properly. The recommended procedure in such a case would be to ream out the old pivot hole with a cutting broach large enough to accept a friction jewel. The large dotted circle in figure B-17-13 represents this hole. This bearing can now be put in first class order easily and quickly by fitting a friction jewel to the opening. If the pivot needs to be polished or replaced this must be done before fitting the friction jewel in order that you may select the proper size pivot hole in the jewel. Before friction jewelling came within reach of the watchmaker, it was necessary to "plug" the plate or bridge with a brass bushing and then drill a pivot hole of the correct size in the bushing. This, of course, has to be done on a watchmaker's lathe and, in some cases, necessitates the use of a face plate to "upright" the bridge or plate.

SEC. 373 — Closing Hole In Plate or Bridge

To close a pivot hole in a plate or bridge, select a flat face staking tool stump that will cover the bearing surface of the hole to be closed, figure 17-14. Select a small round face solid punch that will fit inside the oil cup. Tap the punch lightly until the hole is closed enough that the pivot will not enter it. Select a small pivot broach (a small reamer) that will enter the hole, and carefully open hole by rolling the broach back and forth between your thumb and forefinger. Do this from both sides until pivot fits correctly.

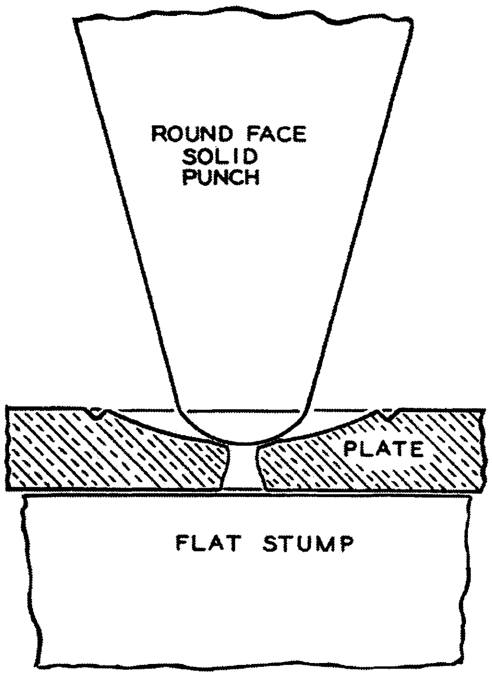

Fig. 17-14

SEC. 374—Ordering Wheels and Pinions

In replacing a worn wheel and pinion in a Swiss watch, it is usually necessary to order the wheel and pinion complete as the wheels are staked on at the factory. This assures the watchmaker of an accurate fit. When replacing a wheel and pinion, carefully try pivot in jewel bearing to determine if pivot fits properly. If the wheel and pinion are from the factory that made the watch, it will usually fit correctly. If the pivot fits a little snugly, it will have to be ground down slightly and repolished. However, that is another job that will have to wait until we reach lathe work.

In most American watches the wheel and pinions can be purchased separately and are of a friction fit. Figure 17-15 illustrates the method used to remove this type of pinion from the wheel. The wheel is placed over a hole in the die plate large enough to receive the pinion leaves. A flat face hollow punch is then used to force out the pinion. The pinion is replaced by reversing the above procedure, figure 17-16.

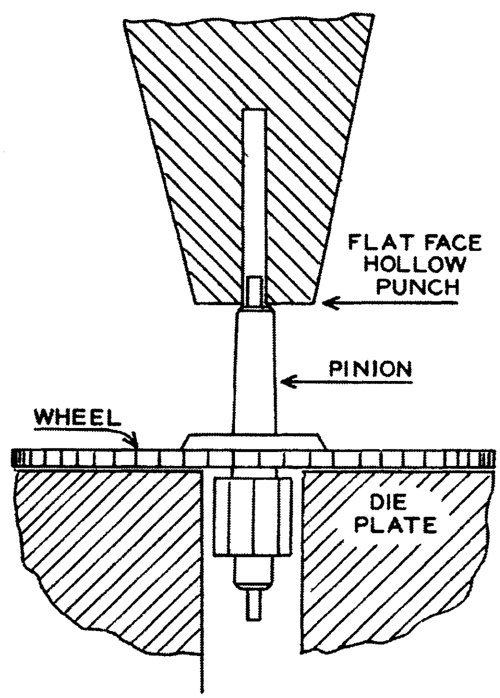

Fig. 17-15

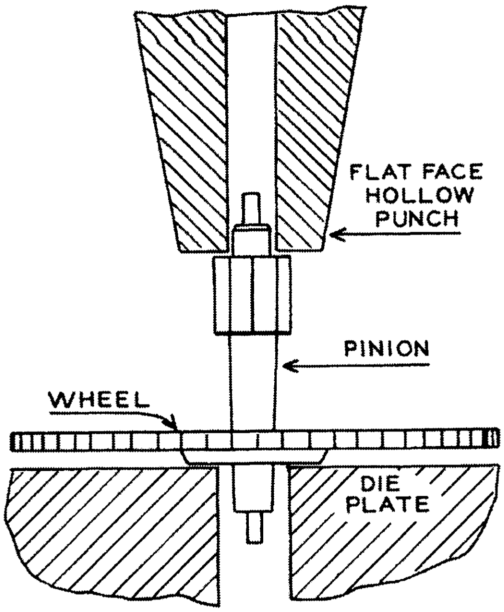

Fig. 17-16

Let us assume that the one we have ordered is the correct size. For practice, take one of your practice watches and remove the pinion from the wheel and then replace it.

When ordering, give the name of the part, describe name of watch and size.

Example: 1 Elgin 16 size 4th Pinion (Enclose sample if possible).

Figure 17-17 illustrates a round face hollow

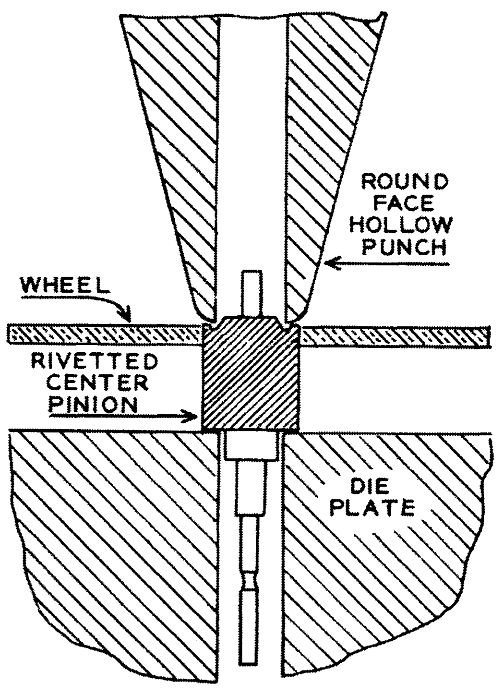

Fig. 17-17

punch used to rivet a center pinion to the center wheel. This procedure, with little variance, is used to tighten wheels which have become loose on other pinions of the rivet type.

SEC. 375 — Fitting Pallet Arbors

It is not often that a watchmaker is called upon to replace pallet arbors. They are rarely broken except through the misfortune of the repair man when replacing a pallet fork and arbor. They are one of the smallest and most delicate parts of a watch and difficult to handle.

The pallet arbors have either square shoulder or conical pivots and are usually very short. Some are threaded while others are friction fit, figure 17-18.

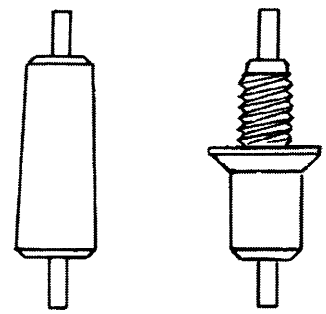

Fig. 17-18

In selecting a new pallet arbor, it is necessary to determine the type—a friction fit or screw type. The screw type can be removed easily by grasping arbor with a small pin vise and turning it out. Before replacing, be sure the lower pivot fits the lower jewel hole correctly and the upper pivot fits the upper jewel hole with proper sideshake.

Place pallet arbor in lower jewel. Put on pallet bridge and test for endshake. It is necessary to have endshake as previously explained in our lessons on jewels and staffs. If everything is now correct, replace arbor in fork. Here we have to mention the lathe again, this time as an excellent way of removing and replacing a pallet arbor in place of a pin vise. In the friction type they may be replaced with a staking tool using a small pivot punch or the tools furnished with the friction jewelling tool previously described. In doing work with a pallet fork and arbor, it cannot be stressed too much at this time that a student must use extreme care in handling each part. Be very careful not to bend the guard pin or loosen the pallet stones. As previously stated, it isn't often that these parts get out of order unless through carelessness of the workman.

More and more you will begin to realize the importance of lathe work. A regular watchmaker's lathe with a few more attachments than that of the average watchmaker's would enable you to manufacture a watch. It would hardly be profitable, but you should see by now that the student needs lathe work in order to become an expert. On the everyday job a lathe is required. Possibly you will only use it two or three times a day, maybe not at all, but it is impractical to think you can be without it; a pivot needs polishing, a jewel hole is out of upright, a balance shoulder must be undercut to stake balance properly. It is indispensable for cutting down roller seat, making tools, balance staff, setting jewels, etc. However, before you do lathe work it is to your advantage to become acquainted with the parts of the watch, their functions and failures. The next series of lessons concerns hairsprings followed by lessons on the escapement. These lessons will require a great deal of concentrated study and practice. There is very little practical work but with the experience gained in these lessons and the following lessons on lathe work your ability to repair watches will grow by leaps and bounds depending of course on the amount of watch repair you do. It is to your benefit to constantly review the previous lessons at every available opportunity.

TABLE OF CONTENTS: Unit W5- Lesson 17

JOB SHEETS

REPLACING RIVET TYPE BALANCE STAFF: Single Roller

TOOLS, EQUIPMENT AND SUPPLIES:

Staking Tool - Brass Hammer - Tweezers - Staff Remover* - Lathe*
Graver* - Roller Remover - Hairspring Remover
*Dependent on staff removing procedure used

PROCEDURE: REFERENCE

HOW TO REPLACE A STAFF IN A WATCH HAVING A SINGLE ROLLER

1. Remove the balance cock and balance assembly. — Les. 8

2. Remove balance and cap jewels. — Les. 10 - Sec. 240

3. If balance hole or cap jewels are cracked or damaged, replace. Make certain upper and lower jewels have holes of same size.

4. Clean and replace balance hole and cap jewels.

5. Remove hairspring. — Sec. 352

6. Using roller remover, remove roller from balance assembly. NOTE: Mark rim of wheel opposite position of roller jewel with colored pencil so roller can be replaced in same position. Mark is easily removed with cleaning solution. — Sec. 353

7. Remove staff from wheel. (See procedures in Job Guide Sheet W15-J1

8. Select replacement staff. — Les. 4 - Sec. 119 & Les. 15 - Sec. 356

9. Place staff only in movement with bridge in place and check end and side shake. — Sec. 356

10. Remove staff from movement.

11. Check wheel and roller on staff to see that they will fit correctly, check collet seat diameter.

12. Select and align the hole in the die plate of staking tool that will accommodate roller seat and give proper support on the bottom of the hub of the staff. — Sec. 357

13. With staff in die plate, set balance wheel in place being sure the wheel is firmly seated against the hub. If not firmly seated, use a flat face hole punch with hole larger than hole in wheel and press wheel down against the hub.

14. Select round face hole punch in size that will go down over collet seat with minimum of clearance. Fig. 15-15

15. Turn punch slowly as you tap on the punch to spread the rivet.

16. Select flat face hole punch with same size hole. Fig. 15-16

17. Turn punch slowly as you tap punch to rivet the staff.

18. Check to determine that staff is firmly rivetted.

19. True the wheel in flat and round. Les. 16

20. Place balance wheel in movement, pallet bridge should be in place, balance bridge in place.

21. Check endshake and free motion.
    NOTE: A good test is to start the wheel turning slowly in either dial up or dial down position. The wheel should revolve freely, slowing very gradually at the same rate of speed in both positions. If wheel is not free in either or both positions, make the following checks to determine the fault:
    a. Magnatism — Lessons 10-11-13-14-30-31
    b. Pivot bent, rough, burred, etc. — Aids to Estimating & Repairing
    c. Rim clearance between center wheel and pallet bridge.
    d. Balance jewels dirty, cracked, chipped or loose.
    e. End shake.
    f. Balance screws protruding too far or timing washers rubbing.
    g. Wheel out of true.
    h. Jewel screws tight.

22. Make necessary correction for freeing motion.

23. Set roller on roller seat with roller jewel aligned with mark you made on rim.

24. Select hole in die plate that will accommodate the staff and the roller jewel and properly support the roller. Fig. 15-17

25. Using the flat face hole punch you used in rivetting, with pressure or a light tap drive the roller into place against the bottom of hub.

26. Poise the balance wheel. Les. 17
    NOTE: On some balance wheels the manufacturer may have inserted either a pair or two pair of meantime screws. They are recognized by a screw shank longer than the other screws and the fact that they are not generally screwed all the way in to the rim of the wheel. A pair of meantime screws (screws placed opposite each other are considered a pair) turned an equal distance in toward the rim of the wheel will increase the rate of the watch by the fact that the movement of the screws has shifted the weight closer to center.

Continued next page

Turning a pair of meantime screws an equal distance away from the rim will slow the rate of the watch as weight has been shifted away from center. The weight of the meantime screws should never be altered by either adding or taking away weight from the screws, they are never used in poising.

27. Recheck step 19, make necessary adjustments.

28. Recheck step 26, make necessary adjustments.
NOTE: If either the truth or poise of the wheel is incorrect, it may be necessary to make correction to both. A wheel that is out of true in round, when trued would be out of poise.

29. Place balance in movement, pallet fork and bridge in place, balance bridge in place. Check the fork and roller action, make necessary adjustments. Lessons 13-21-22-26

30. Replace hairspring, examine for truth, centered, overcoil properly formed, etc. Put in beat. Lessons 26 & 32 pt. 1

31. Oil balance jewels. Les. 10

32. Replace balance assembly and bridge, check for proper motion. Les. 11

UNIT	W 5
LESSON	17

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W17-J2

REPLACING RIVET TYPE BALANCE STAFF: Combination Double Roller

TOOLS, EQUIPMENT AND SUPPLIES:

Staking Tool - Brass Hammer - Tweezers - Staff Remover* - Lathe*
Graver* - Roller Remover - Hairspring Remover
*Dependent on staff removing procedure used.

PROCEDURE: REFERENCE

HOW TO REPLACE A STAFF IN A WATCH HAVING A COMBINATION DOUBLE ROLLER

1. Remove the balance cock and balance assembly. — Les. 8

2. Remove balance and cap jewels. — Les. 10 - Sec. 240

3. If balance hole or cap jewels are cracked or damaged, replace. Make certain upper and lower jewels have holes the same size.

4. Clean and replace balance hole and cap jewels.

5. Remove hairspring. — Sec. 352

6. Using roller remover, remove roller from balance assembly. NOTE: Mark rim of wheel opposite position of roller jewel with colored pencil so roller can be replaced in same position. Mark is easily removed with cleaning solution. — Sec. 353

7. Remove staff from wheel. (See procedures in Job Guide Sheet W15-J1

8. Select replacement staff. — Les. 4 - Sec. 119 & Les. 15 - Sec. 356

9. Place staff only in movement with bridge in place and check end and side shake. — Sec. 356

10. Remove staff from movement.

11. Check wheel and roller on staff to see that they will fit correctly, check collet seat diameter.

12. Select and align the hole in the die plate of staking tool that will accommodate roller seat and give proper support on the bottom of the hub of the staff. — Sec. 357

OVER

13. With staff in die plate, set balance wheel in place being sure the wheel is firmly seated against the hub. If not firmly seated, use a flat face hole punch with hole larger than hole in wheel and press wheel down against the hub

14. Select round face hole punch in size that will go down over collet seat with minimum of clearance. Fig. 15-15

15. Turn punch slowly as you tap on the punch to spread the rivet.

16. Select flat face hole punch with same size hole. Fig. 15-16

17. Turn punch slowly as you tap punch to rivet the staff.

18. Check to determine that staff is firmly rivetted.

19. True the wheel in flat and round. Lesson 16

20. Place balance wheel in movement, pallet bridge should be in place, balance bridge in place.

21. Check endshake and free motion.

    NOTE: A good test is to start the wheel turning slowly in either dial up or dial down position. The wheel should revolve freely, slowing very gradually at the same rate of speed in both positions. If wheel is not free in either or both positions, make the following checks to determine the fault:

    a. Magnatism. Lessons 10-11-13-14-30-31
    b. Pivot bent, rought, burred, etc. Aids to Estimating and Repairing.
    c. Rim clearance between center wheel and pallet bridge.
    d. Balance jewels dirty, cracked, chipped or loose.
    e. End shake.
    f. Balance screws protruding too far or timing washers rubbing.
    g. Wheel out of true.
    h. Jewel screws tight.

22. Make necessary correction for freeing motion.

23. Set roller on roller seat with roller jewel aligned with mark you made on rim.

24. Select hole in die plate that will accommodate the staff and properly support the <u>bottom</u> of the combination roller. Fig. 15-16

25. Using the flat face hole punch you used in rivetting, with pressure or a light tap drive the roller into place against the bottom of hub.

Continued next page

26. Poise the balance wheel. Lessons 17 & 11 - Sec. 275

27. Recheck step 19, make necessary adjustments.

28. Recheck step 26, make necessary adjustments.

NOTE: If either the truth or poise of the wheel is incorrect, it may be necessary to make correction to both. A wheel that is out of true in round, when trued would be out of poise.

29. Place balance in movement, pallet fork and bridge in place, balance bridge in place. Check the fork and roller action, make necessary adjustments. Lessons 13-21-22-26

30. Replace hairspring, examine for truth, centered, overcoil properly formed, etc. Put in beat Lessons 26 & 32 pt. 1

31. Oil balance jewels. Lesson 10

32. Replace balance assembly and bridge, check for proper motion. Lesson 11

UNIT	W 5
LESSON	17

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W17-J3

REPLACING FRICTION TYPE BALANCE STAFF: Waltham

TOOLS, EQUIPMENT AND SUPPLIES:

Staking tool - Brass hammer - Tweezers - Roller remover - Hairspring remover.

PROCEDURE:	REFERENCE:
HOW TO REPLACE A FRICTION STAFF (Waltham)	
1. Remove balance assembly from movement.	Lesson 8
2. Remove balance and cap jewels.	Lesson 10 - Sec. 240
3. Select replacement if either balance hole or cap jewels are damaged.	
4. Clean and replace balance hole and cap jewels.	
5. Remove hairspring.	Sec. 352
6. Mark underside of rim with colored pencil to indicate position of roller jewel	
7. Using roller remover, remove roller from balance assembly.	Sec. 353
8. Select and align hole in die plate of staking tool that will support the bottom of the hub but allow the shoulder on the staff clearance as it is driven out of the hub.	Sec. 354 Fig. 15-8
NOTE: Some staking tools are equipped with special stumps for use in removing and replacing a Waltham friction staff.	T.M. of T.*
9. Using a cross hole staff removing punch, carefully drive out the balance staff.	T.M. of T.*
10. Select the replacement staff.	Lesson 4 - Sec. 119 Lesson 15 - Sec. 356
11. Fit staff in movement with bridge in place and check end and side shake.	Sec. 356
12. Remove staff from movement.	
13. Check wheel and roller on staff to see that they will fit correctly.	

* Tools and Materials of The Trade.

14. Select flat face stump with hole in size that will accommodate collet seat of staff and support arms of wheel. Sec. 359

15. Place stump in staking tool and center hole of stump with centering punch.

16. Rest wheel on stump up-side down. Sec. 359

17. Place collet seat end of staff in hub of wheel. Sec. 359

18. Select round face hole punch in size that will give minimum clearance on roller seat but rest firmly against roller seat shoulder. Sec. 359

19. Tap punch until staff is firmly seated.

20. Place balance wheel in movement, pallet bridge should be in place, balance bridge in place.

21. Check endshake and free motion.

NOTE: A good test is to start the wheel turning slowly in either dial up or dial down position. The wheel should revolve freely, slowing very gradually at the same rate of speed both positions. If wheel is not free in either or both positions, making the following checks to determine the fault: (Lessons 10-11-13-14-30-31)(Aids to Estimating and Repairing)

A. Magnatism
B. Pivot bent, rough, burred, etc.
C. Rim clearance between center wheel and pallet bridge.
C. Balance jewels dirty, cracked, chipped or loose.
D. End Shake.
E. Balance screws protruding too far or timing washers rubbing.
F. Wheel out of true.
G. Jewel Screws tight.

22. Make necessary corrections for freeing motion.

23. Set roller on roller seat with roller jewel aligned with mark you made on rim.

24. Select hole in die plate that will accommodate the staff and the roller jewel and properly support the roller. Sec. 358 Fig. 15-17

NOTE: Double roller see Fig. 15-16

Continued next page

25. Using the flat face hole punch you used in riveting, with pressure or a light tap drive the roller into place against the bottom of hub. Lesson 17

26. Poise the balance wheel.

NOTE: On some balance wheels the manufacturer may have placed one or two pair of meantime screws. They are recognized by a screw shank longer than the other screws and the fact that they are not generally screwed all the way into the rim of the wheel. A pair of meantime screws (screws placed opposite each other are considered a pair) turned an equal distance in toward the rim of the balance wheel will increase the rate of the watch by the fact that the movement of the screws has shifted the weight closer to the center. Turning a pair of meantime screws an equal distance away from the rim will slow the rate of the watch as weight has been shifted away from the center. The weight of the meantime screws should never be altered by either adding or taking away weight from the screws, they are never used in poising, their only use is in timing. Lesson 11

27. Recheck step 20, Make necessary adjustment.

28. Recheck step 27, make necessary adjustment.

NOTE: If either the true or poise of the wheel is incorrect, it may be necessary to make correction to both. A wheel that is out of true in round, when trued would be out of poise.

29. Place balance in movement - pallet fork and bridge in place, balance bridge in place. Check the fork and roller action. Lessons 13, 21, 22, 26

30. Replace hairspring, put in beat. Lessons 26 & 32 pt. 1

31 Oil balance jewels Lesson 10

32. Place balance and bridge in movement.

REMOVING AND REPLACING PALLET ARBOR: Screw Type

TOOLS, EQUIPMENT AND SUPPLIES:

Pin Vise.

PROCEDURE: REFERENCE:

HOW TO REMOVE AND REPLACE SCREW TYPE PALLET ARBOR: Lesson 17 - Sec. 375

1. Grip the bottom of the arbor in either a pin vise or in a lathe chuck.

2. Unscrew the pallet arbor counterclockwise.

3. Select replacement arbor and determine that pivot size and end shake are correct.

4. Place arbor in either a pinvise or lathe chuck and screw fork onto arbor clockwise.

   NOTE: As the pallet fork is delicate and precision adjusted it is important that the fork not be bent, stones shifted and so-forth while removing or replacing the pallet arbor. To minimize the chance of damaging the fork while removing or replacing the arbor, the fork should be gripped or supported as near the arbor as possible.

5. Replace pallet fork in movement. Check endshake.

REMOVING AND REPLACING PALLET ARBOR: Friction Type.

TOOLS, EQUIPMENT AND SUPPLIES:

Staking Tool.

PROCEDURE: REFERENCE:

HOW TO REMOVE AND REPLACE A FRICTION TYPE PALLET ARBOR. Lesson 17 - Sec. 375

1. With pallet fork up-side-down and properly supported on the staking tool and using a flat face hole punch with hole that will just fit over the lower pivot, tap gently to drive out friction pallet arbor.

   NOTE: If arbor is still snug in fork after driving level with fork, it will be necessary to use a punch with end of a smaller diameter than arbor to complete removal of the arbor.

2. Select replacement arbor.

3. Place arbor in movement with bridge in place to determine if end shake is correct.

   NOTE: The friction pallet arbor may or may not be tapered. You should determine if it is tapered and if so the taper end will be the end that protrudes farthest through the pallet fork and would be on the bottom of the pallet fork.

4. Place pallet fork on stump in staking tool which will give proper support to the fork and allow the arbor to be driven into and through the fork without obstruction.

5. Select flat face hole punch with hole of correct size to accommodate the pivot and give proper support on the pivot shoulder.

   NOTE: As the arbor is small and by comparison to other parts difficult to handle, exercise caution in putting this arbor into the fork. We suggest that a light application of oil or beeswax to the face of the punch will cause the pallet arbor to adhere to the punch making it possible to align and insert the arbor with a minimum of difficulty.

6. If the pallet arbor is tapered the small end will enter the fork from the top, if not tapered either end may be inserted in the fork. Tap arbor into the approximate position that the old one was resting.

7. Place the pallet fork in the movement with escape wheel and balance in place.

8. Check the alignment of the pallet stones with the escape wheel teeth and fork with roller.

9. Make necessary adjustment to height of fork.

UNIT	W 5
LESSON	17

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W17-J6

CLOSING PIVOT HOLE IN BUSHING:

TOOLS, EQUIPMENT AND SUPPLIES:

Staking tool - Pivot broaches.

PROCEDURE: REFERENCE:

HOW TO CLOSE A WORN PIVOT HOLE IN BUSHING: Lesson 17 - Sec. 372

1. Set train bridge on stump in die plate of staking tool taking care that stump is correct size to support the bushing. Sec. 373

2. Select round face solid punch in a size slightly smaller than the oil cup depression of bushing.

3. With bushing properly supported and round face solid punch in oil cup side of bushing, tap gently.

   NOTE: It will take practice to close a hole the proper amount and so we suggest that you proceed with care checking carefully and when the pivot just barely starts into the hole it has been closed sufficiently. As this method has not allowed for side shake, it will now be necessary that you open the pivot hole to accommodate the pivot with correct side shake. There are two types of broaches used to open and polish the pivot hole. Cutting broaches to enlarge the hole and round broaches to polish the hole.

4. Using a cutting broach carefully broach pivot hole to the size that will just accommodate the pivot.

5. Using round polishing broach in pivot hole, it will polish and slightly enlarge hole for correct side shake.

6. Replace bridge on movement with only the one wheel in place. Before tightening screws determine if you have end shake. In closing the hole you may have reduced the end shake and in that case it will be necessary to remove bridge and with train bridge supported up-side-down on the die plate and using a flat solid punch, tap bushing gently to give end shake desired. After correcting end shake you may find it necessary to broach and polish the pivot hole again.

7. Recheck with wheel in place making any adjustment necessary until you have proper hole size and end shake.

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 18

Truing Hairsprings

—

Sections 376 - 381

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

SEC. 376—How Hairsprings Are Made

The study of the hairspring is a fascinating subject about which many articles have been written. In our treatment we are restricted to the actual operations required to repair or adjust the hairspring which is furnished with the watch. No attempt is made to delve into the many theoretical discussions and problems.

Although the watchmaker usually buys his own hairsprings and is not concerned with their manufacture, yet almost everyone is curious as to how a hairspring is made. The following description and the method used by early watchmakers is therefore given to satisfy this curiosity.

Tempered steel wire from which hairsprings are made is usually low in carbon. It is first drawn round to a diameter slightly less than the width of the finished flat wire. It is then rolled flat to the required thickness. In drawing and rolling the wire great care must be exercised to avoid breakage or injury to the surface. Frequent annealing is necessary to prevent cracking. The reduction must be done a very little at each drawing and if the rolling is not always begun at the same end the wire will break. For this reason, in drawing and rolling the wire is passed from a spool or arbor through the plate or rolls and wound onto another arbor. It must then be unwound and wound on the original arbor before being again drawn or rolled. To produce a spring of a required strength by bringing the wire to the proper dimensions is a matter of extremely fine measurements. In an 18s hairspring, a difference of one ten thousandth of an inch makes a difference in time of six minutes an hour.

When the hairsprings are to be hardened and tempered they are coiled in a box, usually of copper, as shown in figure 18-1. A, figure 18-1, is a plan and B a perspective view of a hairspring box. It is provided with a hole in the center through which projects the end of an arbor C, which is in turn provided with a screw D. The arbor is slotted for the reception of the ends of the wires and the screw holds them in place. The box shown is for three springs and has three slots each marked F, through which the wire enters. A cap is put down over the wire and the arbor turned until the box is wound full. The spaces between adjacent coils will then be twice the thickness of the wire. Wide coil springs are wound up four in a box; close coil springs, two in a box.

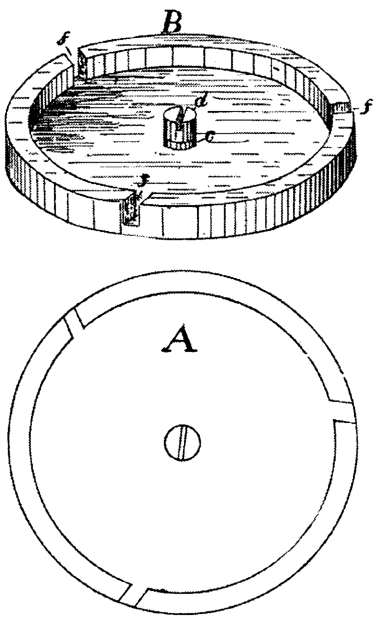

Fig. 18-1

Figure 18-2 will give you an idea of how the springs look when wound in the box. They are then hardened and tempered to a blue. The boxes must be examined after each use and trued out if necessary. Every imperfection in the chamber will be reproduced in the hardened springs.

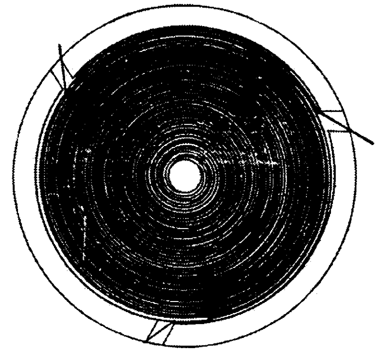

Fig. 18-2

(Insert in Lesson Text 18)

Although hairsprings were originally made of steel, a variety of other metals and alloys are used in present day spring manufacture. Steel hairsprings were subject to temperature changes, magnetism and rust. Early in our present century, Dr. Charles Guillaume, 1920 Nobel Prize winner in physics, invented Invar (from "invariable"), a nickel alloy which was non-magnetic, non-rusting and little affected by temperature changes. Invar was used for mono-metallic balance wheels. Later, in 1913, Dr. Guillaume invented Elinvar, a 36% nickel alloy, harder than Invar, and which came to be widely used for hairsprings. In recent years, manufacturers have produced alloys of higher nickel content, such as the 42% Ni-Span "C."

Beryllium, one of our lightest metals, is also used for hairsprings when alloyed with iron, copper, cobalt, or other metals. The result is harder than Elinvar, but other properties are about the same. Nivarox is one trade name for a beryllium alloy hairspring.

Other metals, such as phosphor bronze, stainless steel, nickel silver, or silver alloys are used for the manufacture of special-purpose hairsprings.

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SEC. 377—Purpose of the Hairspring

Dr. Hook, inventor of the hairspring, enunciated the celebrated maxim, "Ut tensio sic vis" — "As is the tension, so is the power." This principle is inherent in the hairspring and constitutes its chief value as a governor for a watch.

When a watch is in beat, the roller jewel when at rest is on a line drawn from the center of the balance staff to the center of the pallet arbor. This is called "the line of centers."

Let us suppose that a balance which is perfectly in beat is started from the line of centers. The first impulse delivered by the escapement moves the balance through a short arc, producing a certain amount of tension in the hairspring. The tension thus set up is sufficient to carry the balance to an equal distance on the opposite side of the line of centers. In passing to this point it receives another impulse which adds to that power and carries the balance still further. This action continues until it reaches the maximum. The reason that the extent of the arcs of vibration does not increase indefinitely although the impulses continue is that the balance meets with constantly increasing resistance from various sources; resistance from the impact of the jewel pin against the fork and the escape wheel tooth against the pallet stone; resistance from the friction of the balance pivots in their jewels; resistance from the roller jewel against the fork; from the pallets and escape teeth, etc. The greatest, however, is the resistance of the atmosphere to the rim of the balance and its screws. When the point is reached where these various frictions overcome the force of the impulse, the balance comes to rest and the power acquired by this tension of the hairspring reverses the motion of the balance and returns it an equal distance in the opposite direction.

As the impulses decrease in force the extent of the vibrations decreases in the same proportion until, when the watch runs down, they cease altogether.

You may have heard people say, "My watch never stops except when I let it run down." The truth of the matter is that the entire mechanism stops at the end of each vibration of the balance—in the average watch 432,000 times every day.

SEC. 378—Experiment in Isochronism

The balance wheel of a watch or the pendulum of a clock oscillates (swings back and forth) in regular periods of time, depending in one case upon the diameter and weight of the balance together with the length and strength of the hairspring, and in the other upon the length of the pendulum.

The term "Isochronism" is of Greek derivation and means equality of time, referring especially to the pendulum and the theory, "The beats of a pendulum are isochronal." It is important that the student understand exactly what this means although we will not make any isochronal adjustments at this time. Suspend from as high an elevation as possible a long piece of light weight cord or linen thread. A ceiling fixture is ideal. On the other end of the cord approximately six inches from the floor tie a small weight, such as a 12 or 16 size watch case. Obtain a watch with a second hand with which to time the vibrations of our improvised pendulum.

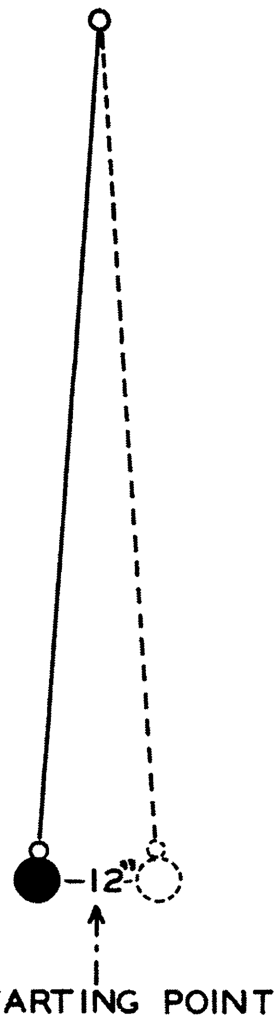


Fig. 18-3

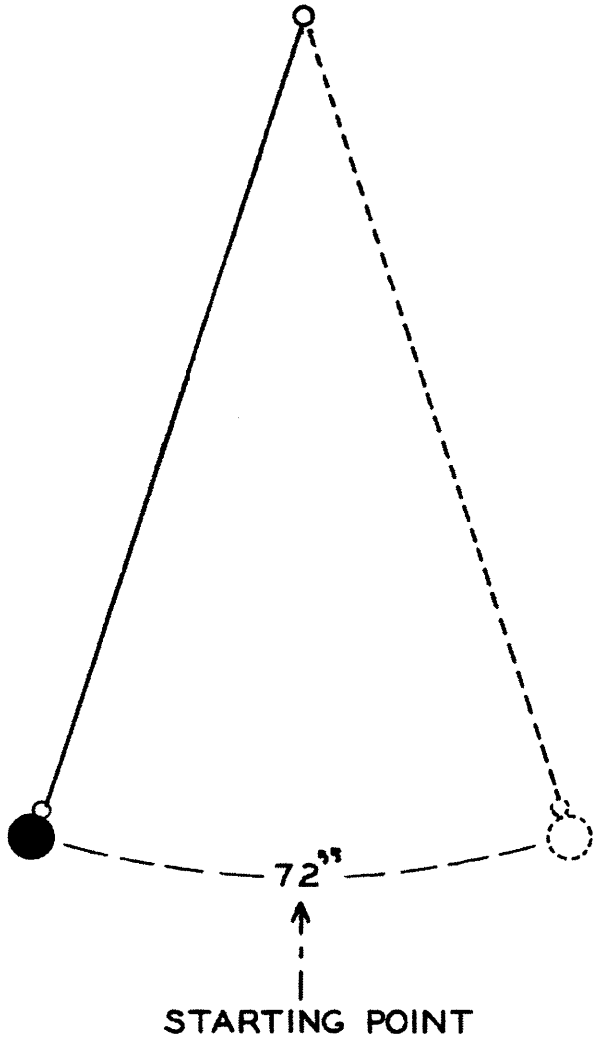


Fig. 18-4

1. With the weight at rest, carefully pull weight back about six inches and then release as shown in figure 18-3.
2. Count the exact number of times the pendulum swings back and forth for 60 seconds. Make a note of the number of vibrations.
3. Repeat steps 1 and 2 but this time pull pendulum back about 36 inches or more, figure 18-4.
4. Compare results. You will find they are the same and from this experiment it is readily seen that the time required for the pendulum to swing through the short arc of twelve inches, figure 18-3, and the long arc of seventy-two inches, figure 18-4, is the same theoretically. However, for all practical work we would have to take into consideration the resistance of the air and in watches, friction of pivots, etc. Isochronal adjustments in a watch are made in order that the watch will have the same, or nearly the same rate whether the balance and hairspring are making a long or a short arc. The longest arc will be found when the mainspring is fully wound and these arcs get shorter as the mainspring unwinds.

SEC. 379—Truing Hairsprings in the Flat

Truing a hairspring in the flat is usually executed with the hairspring and collet on the balance wheel and the balance wheel held in a truing caliper. Release the jaws of the caliper slightly so that the balance will rotate freely. When the coils of the hairspring appear to rotate in the same plane when spinning the balance in the caliper, the hairspring is true in the flat. When truing the hairspring in the flat the bending should be confined as much as possible to the elbow near the collet. Figure 18-5 illustrates the coils of the hairspring when they are tilted up from the pinning point. Figure 18-6 illustrates the coils of the hairspring when they are tilted down from the pinning point. It is much easier before placing the hairspring on the balance and making the final adjustment to slip the collet over a taper pin or broach as in figure 18-7 and level the hairspring as close to the dotted line as possible, using a pair of fine-pointed hairspring tweezers. When making the final correction with the hairspring on the wheel and the wheel in the caliper, concentrate your observations on the 4 or 5 inner coils. A hairspring should never be trued in the flat by twisting a coil in the manner shown in figure 18-8.

Fig. 18-5

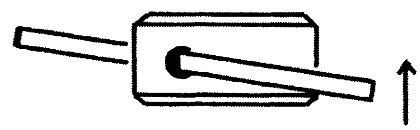


Fig. 18-6

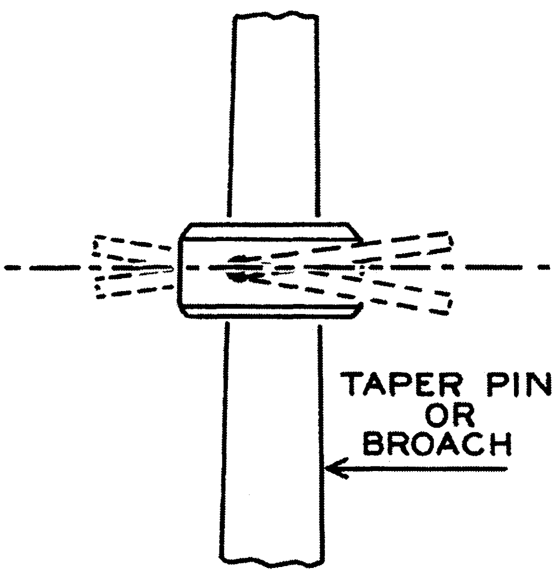


Fig. 18-7

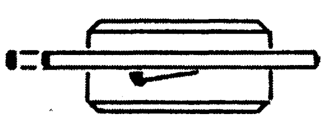


Fig. 18-8

(Note - Insert in lesson text 18 facing Section 379)

Truing Hairsprings in the Flat

As stated in section 379, a hairspring may be examined, errors in flat detected and corrections made on a taper pin before putting on balance wheel. Final examination and minor adjustment are performed on the balance wheel. With hairspring on the balance wheel and in truing calipers, it is not possible to look directly accross the flat of the spring as this view is obstructed by the rim of the balance wheel. The spring should be viewed with the line of vision over the rim of the wheel and in toward the collet. This view will allow you to see half of the spring from the collet to the farthest edge of the spring. Viewing from this angle as you spin the wheel slowly will show up any wobble that would indicate the spring is out of flat. With experience you should be able to pick out the exact point that is low or high. For definitely locating the position, you may use the indicator on the truing calipers much the same as you would for truing wheels.

Correction for an out of flat condition is at the elbow. The method used depends on how much correction is necessary. If spring is quite a bit out of flat you may grasp hairspring at the elbow with fine hairspring tweezers and tilt the body of the spring in desired direction. As an example, in Fig. 18-5 the illustration shows the high side to be to your right. Grasping the hairspring at the elbow and tilting to your right would lower that side of the spring.

Another method, more commonly used, is to press down on the inner coil on the high side of the spring. This pressure should be applied at a point not over a half turn from the inner terminal pinning point. The same correction can be made by lifting on the inner coil. The decision on whether to lift or press downward depends on the location of the error. As an example, Fig. 18-6 shows a spring high on your left. To correct this condition, you should lift the inner coil at the low side. Pressing downward on the left side would not give the desired leverage to make the corrective bend at the elbow. These corrections may be made either on the wheel or on a taper pin. When truing on the wheel, the arms may interfere and thus make it necessary to remove the spring.

Even the most experienced watch repairmen may have to make several attempts before the spring is trued, as there is no way of saying how much pressure to apply in raising or lowering or how much to tilt the tweezers, etc. It will be necessary to rely on your judgement and continued practice will improve your judgement. Keep in mind that this is only one step in truing a hairspring. The spring may also be out of true in the round or you may have moved it out of round when making corrective bends for flat. See section 380 and section 385 in lesson 19.

SEC. 380—Truing Hairsprings in the Round

Truing a hairspring in the round is a difficult operation requiring a great deal of practice. Indeed, it requires an education of the eye to determine the difference between a spring that is perfectly true and one that is nearly so, and still more practice to determine in what direction the greatest difference exists. Truing the spring in the round should be done by bending as near the pinning point as possible never extending beyond the first quarter coil. Experts place the balance and hairspring in a caliper, spin the wheel and observe the action of the first 4 or 5 inner coils of the hairspring. If these coils appear to move smoothly either away from or toward the collet, the hairspring is said to be true in the round. The hairspring should be true in the flat when making this observation.

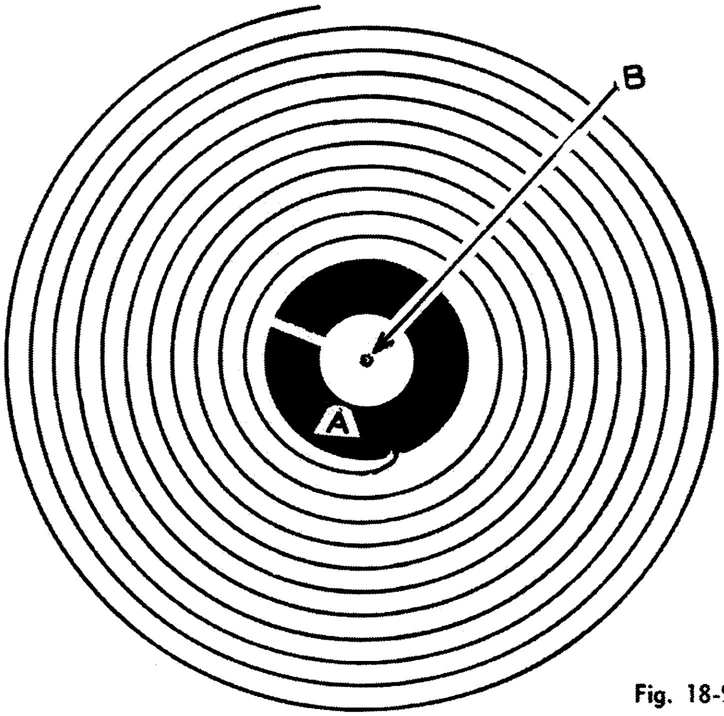


Fig. 18-9

Figure 18-9 illustrates a spiral drawn to represent a hairspring. A represents the collet. When a hairspring is true in the round the center of the spiral and the center of the collet have the common center at B. The slightest variance in centers will cause the hairspring to be out of true.

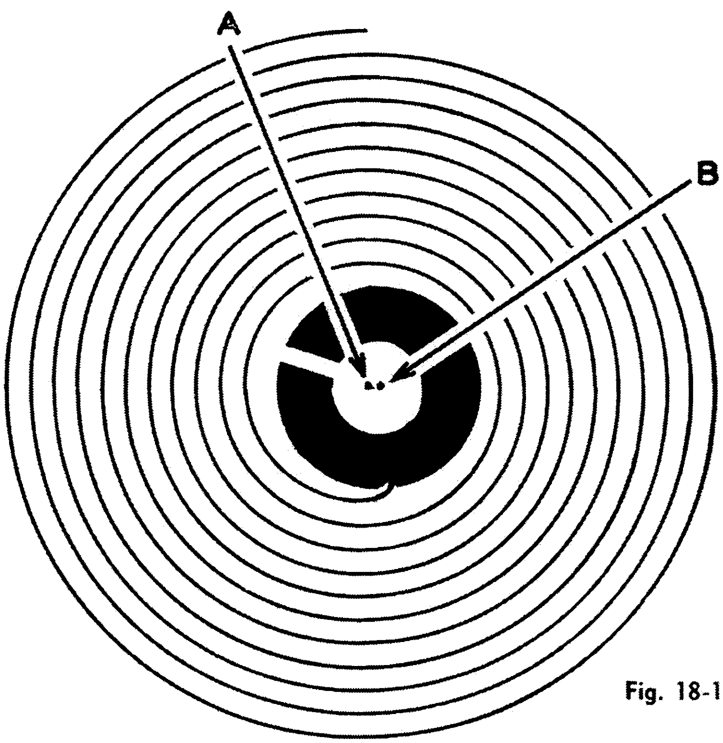


Fig. 18-10

Figure 18-10 illustrates the center of the collet at B and the center of the hairspring at A. These two centers must be made to coincide before the hairspring will be true. When colleting a hairspring the center coils must be broken out enough to allow the center of the collet to be manipulated over the center of the spiral.

(Note - Insert in lesson text 18 facing
Fig. 18-9 and Fig. 18-10)

Truing Hairsprings in the Round

Since the spring is a true spiral, the spacing between coils remains the same throughout the body of the spring. Truing in the round is simply placing the collet in the center of this spiraled hairspring. As already mentioned, corrective bends to move the collet into center may be made at the elbow and in the first quarter of the inner coil only. The only time it should be necessary to make a bend beyond the elbow itself is when it is necessary to alter the elbow by either making it larger or smaller.

The preliminary work of examination and correction is done on a glass work surface, preferably ground glass, Fig. 18-15. The glass surface should be raised above your work bench at least a quarter inch by putting legs under the glass.

Lay the spring on the glass surface and look directly down on it. Keep in mind that the collet is round and the spring is a spiral. The spring, with collet properly centered, shows an ever widening space between the collet and the first coil. This space, starting with the elbow, should increase for a full turn arround the collet and this is what you look for when examining the spring. Keep in mind the space between the collet and the first coil of the spring gradually gets wider. At no two places is this space the same. It should never decrease but always get wider for the full turn. Examine Fig. 19-2 (Lesson 19)(disregard the broken line as it does not apply to this discussion). You will note the above condition.

Moving the collet to the center of the spiral may be done as follows: Grasp spring with tweezers in spot from which correction is needed and with a tapered pin or similar tool, push the collet in direction to center. As an example: Fig. 19-7 shows point at which tweezers grasp the spring and the direction in which the collet must be moved. (The two black dots showing the centers must be brought together) When you have moved the collet to what you believe to be center, examine the spring to see that it is still true in flat. Make necessary corrections. If correction is necessary, the collet may no longer be centered, so examination and possible correction are again necessary. Check and recheck for true in round and flat until both are correct.

Now place hairspring on the balance wheel and examine again for truth in both round and flat. View both from same position. If true, the coils will have a smooth spiraling motion as the wheel is revolved. If not true, the coils will surge toward and away from the center. To determine the exact point of error use indicator on truing calipers as explained in section 380. Minor corrections may be performed on the balance wheel.

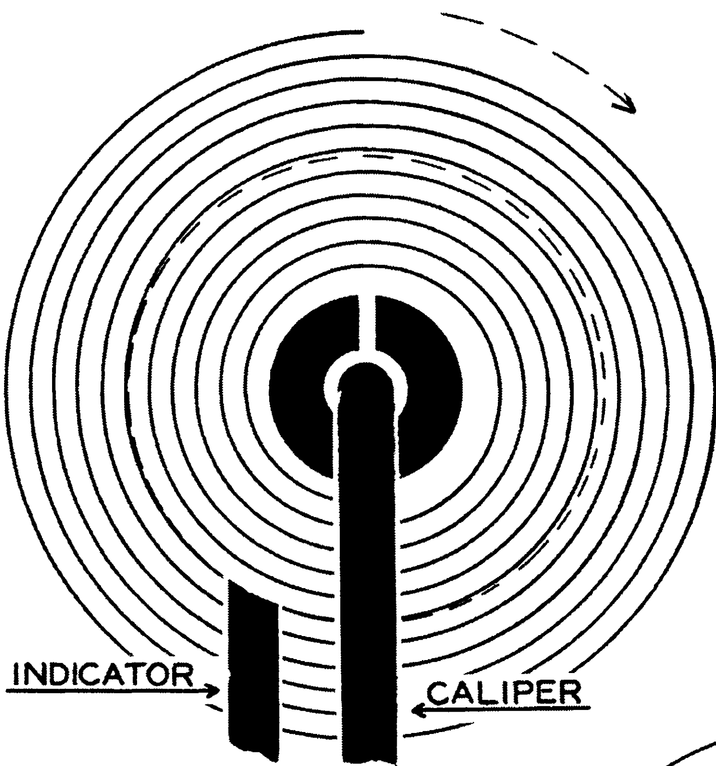


Fig. 18-11

In order to teach the student to make the correct observations, place the balance and hairspring, which is true in the flat, in your truing caliper and set the indicator directly over a coil of the hairspring in the position shown in figure 18-11.

Turn balance $\frac{1}{4}$ turn and indicator will appear to have moved $\frac{1}{4}$ of the distance between coils, figure 18-12.

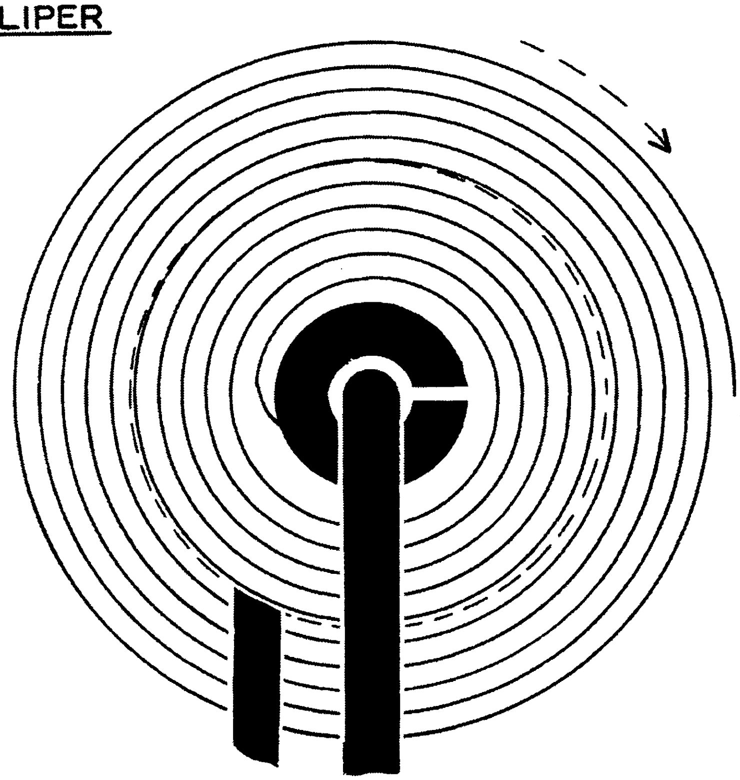


Fig. 18-12

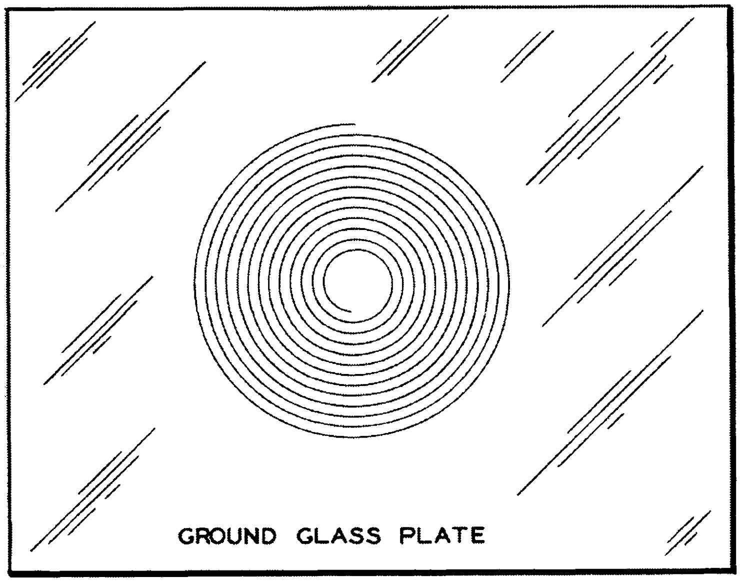


Fig. 18-15

SEC. 381—Locating and Correcting Bends

The student will find it advantageous to make any necessary corrections in the round and flat of the hairspring before placing it on a balance wheel and making the spin test. When working in and around the coils of a hairspring use a piece of glass as the working surface. Ground glass is preferable, figure 18-15. This will drop the shadow of the hairspring coils allowing the workman to see each coil distinctly. Use the best hairspring tweezers available and keep the points protected when not in use. A small pointed steel wire or needle mounted in a small handle can be used to work in between the coils. When making a bend in the coils of a hairspring keep the tweezers vertical, and the pin as close as possible to the tweezer points, figure 18-16.

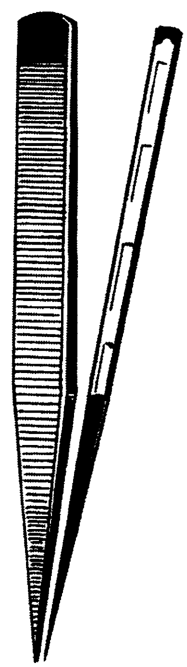


Fig. 18-16

In our work on hairsprings, figure 18-17 will be used to illustrate the following: Fine pointed tweezers, taper pin, and overcoiling tweezers.

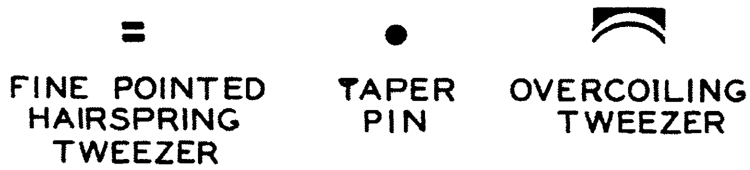


Fig. 18-17

Figure 18-18 illustrates a hairspring which has two bends in it. Bends of this type are traced by following the coil from the **center** until a variation in space between coils is encountered. When the exact point of the bend is located study carefully before attempting to make a correction. In figure 18-18 the first bend has been located and the two dashes represent the points of the hairspring tweezers which have been placed at the bend. The dot represents the pointed steel wire or taper pin. Holding the tweezers and pin close together and vertical, carefully bend hairspring until spiral is perfect again. A slight pressure on the pin will move the center section of the hairspring. The second bend on the outside coil is located by tracing the spiral from the center coil. Place tweezer and taper pin as shown and carefully bend coil in.

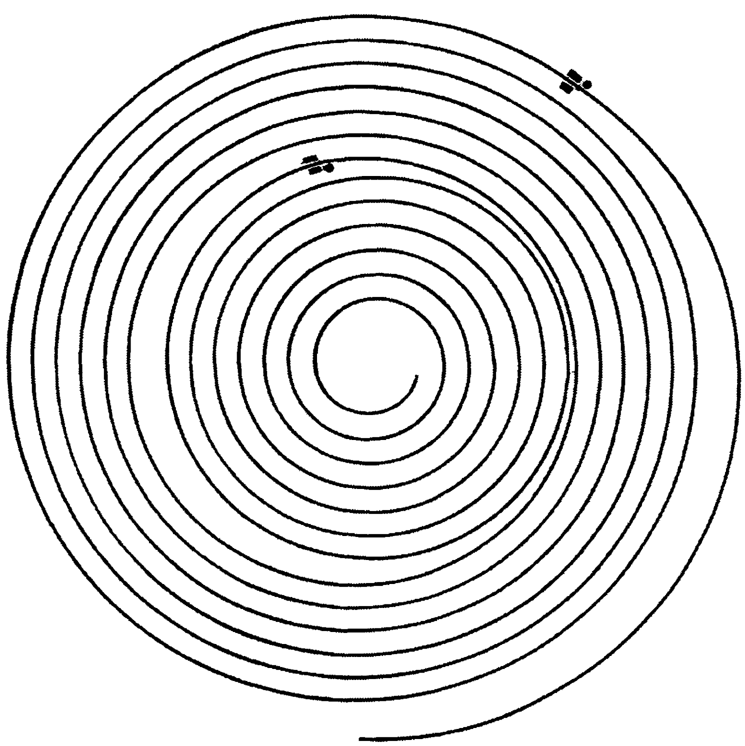


Fig. 18-18

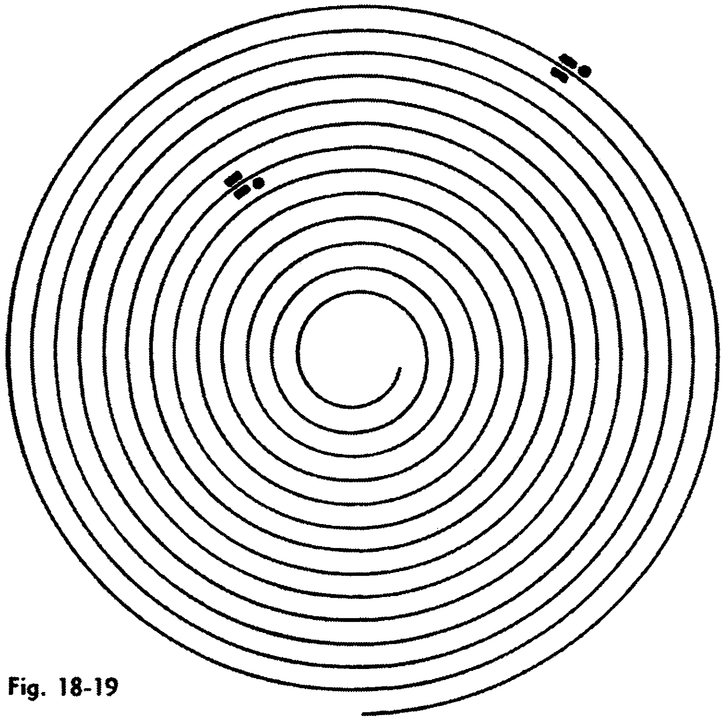


Fig. 18-19

When the coils of the hairspring are spaced as in figure 18-19, the coils of the hairspring are again in a perfect spiral. There are times when, usually due to an accident, several coils of the hairspring may be above or below the plane in which all of the coils should lie. Figure 18-20 illustrates a hairspring in which the collet and a few of the center coils rise above the body of the hairspring. This bend is traced by starting from the pinning point at the collet.

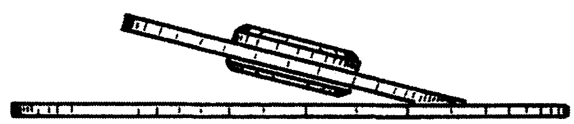


Fig. 18-20

Study the bend carefully because it can be remedied easily if you grasp the coil of the hairspring precisely where the bend is. Figure 18-21 illustrates a cross section of three coils of a hairspring, the center one being the one which is twisted or bent. In this case, lay the hairspring on your ground glass plate and grasp the part of the coil which is correct with a pair of hairspring tweezers, A, figure 18-21. With another pair of tweezers, B, figure 18-21, placed as close as possible to the tweezer A, and on the bent position, bend coil in direction of arrow, and all coils again lie in the same plane.

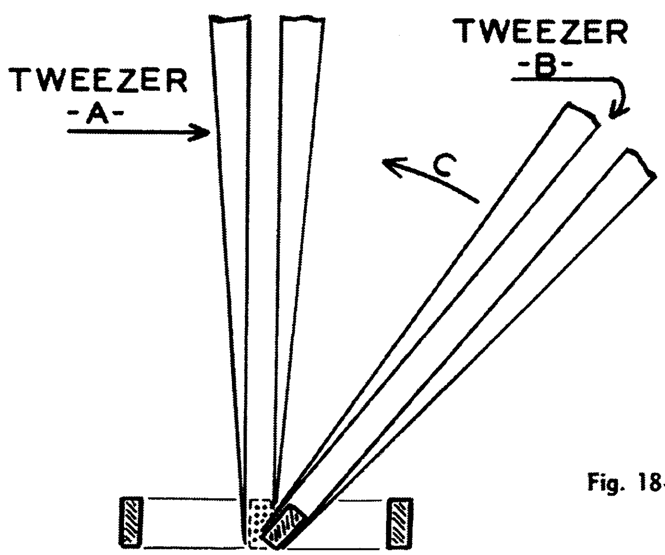


Fig. 18-21

Master WATCHMAKING

SHOP TRAINING JOB GUIDES

LESSON 19

Colleting Hairsprings

—

Sections 385 - 386

CHICAGO SCHOOL OF WATCHMAKING

2330 N. Milwaukee Ave. • Chicago 47, Illinois

SEC. 385—Centering Collet

The results obtained when truing a hairspring in the round or centering the collet are theoretically the same. As the student becomes more proficient at his trade many of the elementary principles he has learned will fade into the background. This is very evident in truing hairsprings in the round. The average watchmaker cannot begin to equal the speed of a factory trained man when it comes to truing a hairspring. A factory trained man can true a hairspring in the round and flat (sometimes with one bend) in a surprisingly short time. They average upwards of 200 a day. This speed comes only with constant practice.

The illustrations to follow show some of the common errors found when a hairspring is out of true in the round or when colleting a hairspring, and the closer the student gets the center of the collet to the theoretical center of the hairspring the less work he will have in truing the hairspring on the wheel. It is possible to make these corrections so exact that when the hairspring is put on the wheel it does not need any further corrections. However, this is the exception rather than the rule. It is, therefore, of the utmost importance that the student learn now the elementary principles of truing a hairspring in the round.

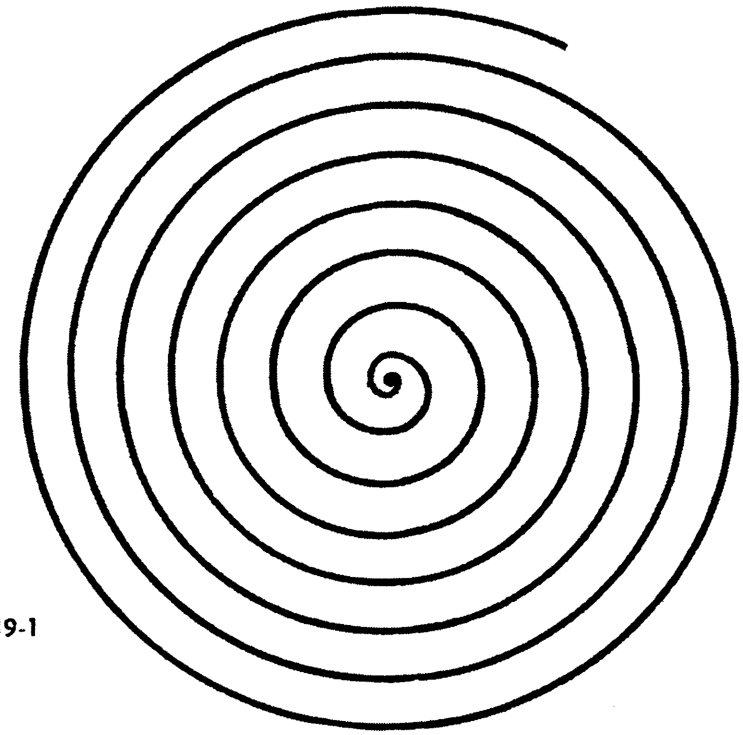


Fig. 19-1

At the expense of repetition let it be understood that when a hairspring is true in the round the exact center of the hairspring and the center of the collet are one and the same. In figure 19-1 the center of the hairspring is located at the inner end of the spiral and if the center of the collet concurred with this center the hairspring would be true in the round.

Figure 19-2 ilustrates an enlarged view of the collet and inner coils of the hairspring. The small dot in the center of the collet is the theoretical center of the **collet** and **hairspring.** In order to illustrate that the removal of an excess amount of center coils does not in any way affect these centers, a dotted line is shown from the outside coil to the collet. This proves that any hairspring can be trued perfectly in the round provided there is enough space around the collet. The student must learn to visualize this.

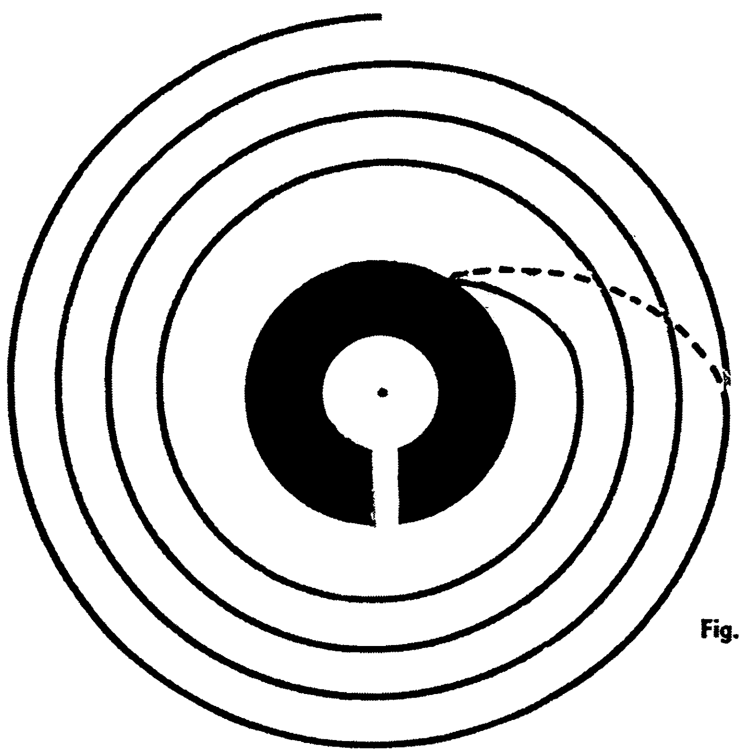


Fig. 19-2

The following illustrations show by the two black dots the theoretical centers of the collet and hairspring respectively. It is easy to see the direction in which the collet must be moved in order to make these centers coincide.

Figure 19-3: The center of the collet is to the left of the hairspring center due to the inside coil being too far from the collet where it leaves the collet. Closing this space until it appears as in figure 19-2 will center the collet. A pair of hairspring tweezers placed in the approximate position shown and carefully closed would bring the desired results.

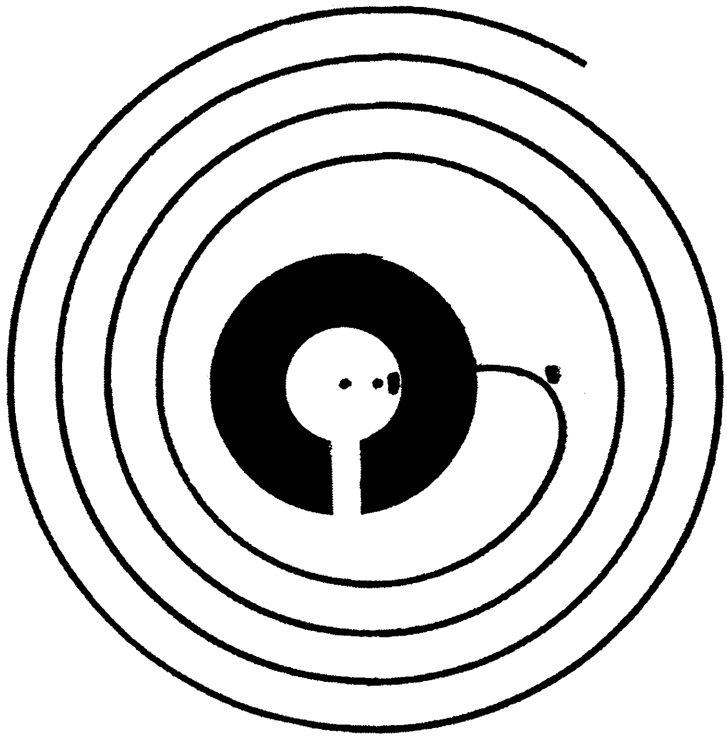


Fig. 19-3

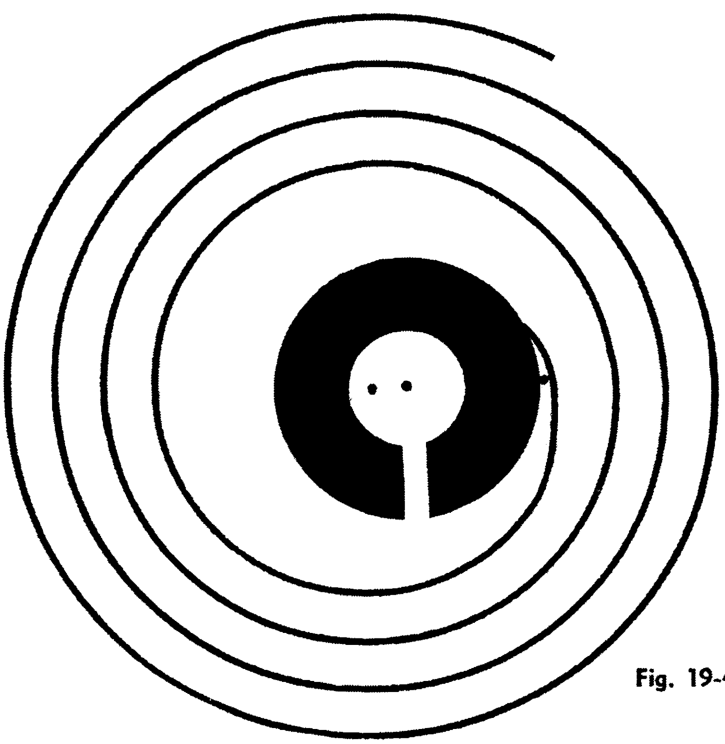


Fig. 19-4

Figure 19-4: The center of the collet is to the right of the hairspring center due to the inside being too close to the collet as it leaves the pinning point. Inserting the taper pin between the collet and the inner coil will force collet in the proper direction. Refer to and compare with figure 19-2.

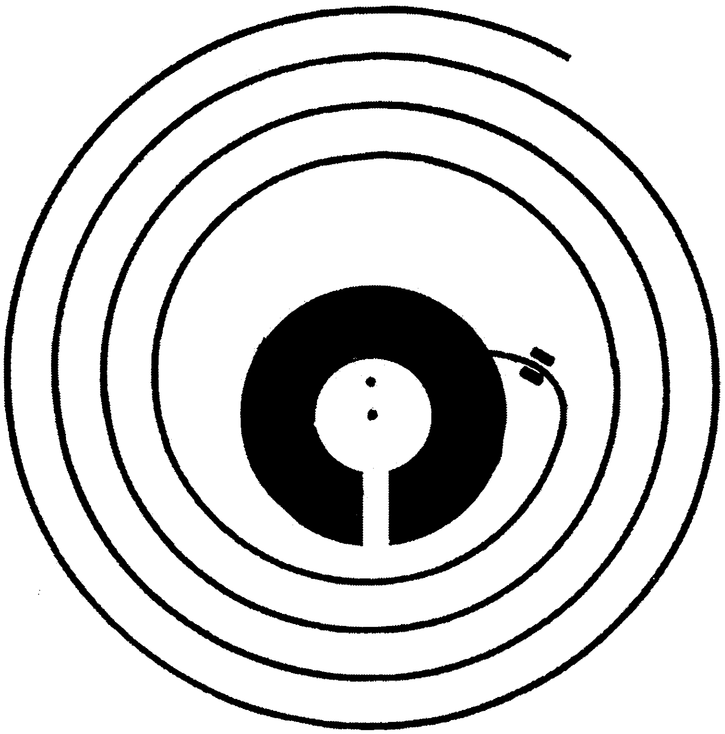


Fig. 19-5

Figure 19-5: The tweezers placed in the proper position and twisted in a manner which would bring the center of the collet toward the theoretical center of the hairspring would be the first correction. If in making this correction the center of the collet should swing slightly to the right of the hairspring center, it may be moved into the correct position with the taper pin.

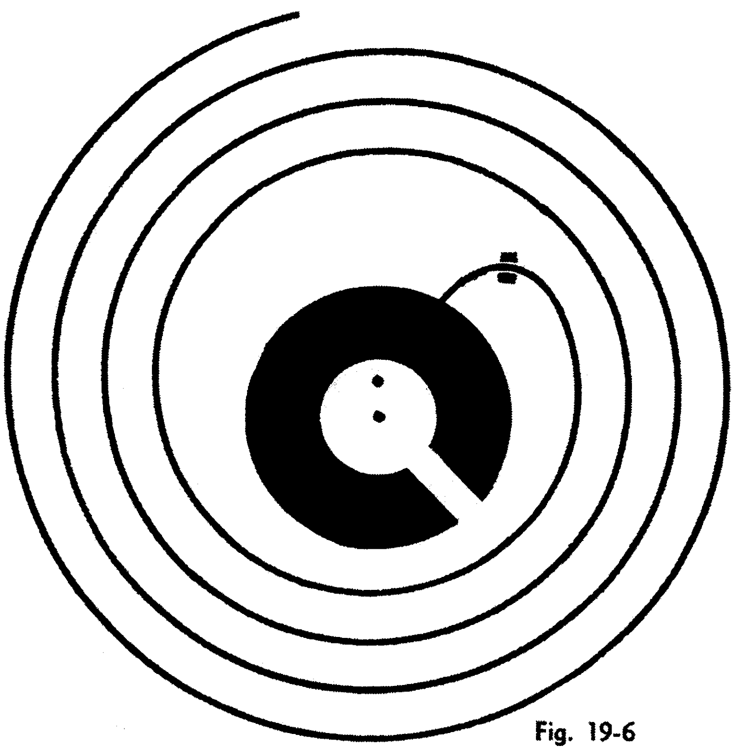


Fig. 19-6

Figure 19-6: To move the center of the collet toward the hairspring center place tweezers in approximate position shown and make the bend. In all probability the center of the collet will swing toward the left slightly making necessary another bend similar to figure 19-3. Check with figure 19-2.

Figure 19-7: The center of the collet should move easily and quickly to the hairspring center by placing tweezers in approximate position shown. In this case the best results would be obtained by applying pressure to the tweezers in order to flatten the curve of the hairspring between the tweezers slightly. Check with figure 19-2.

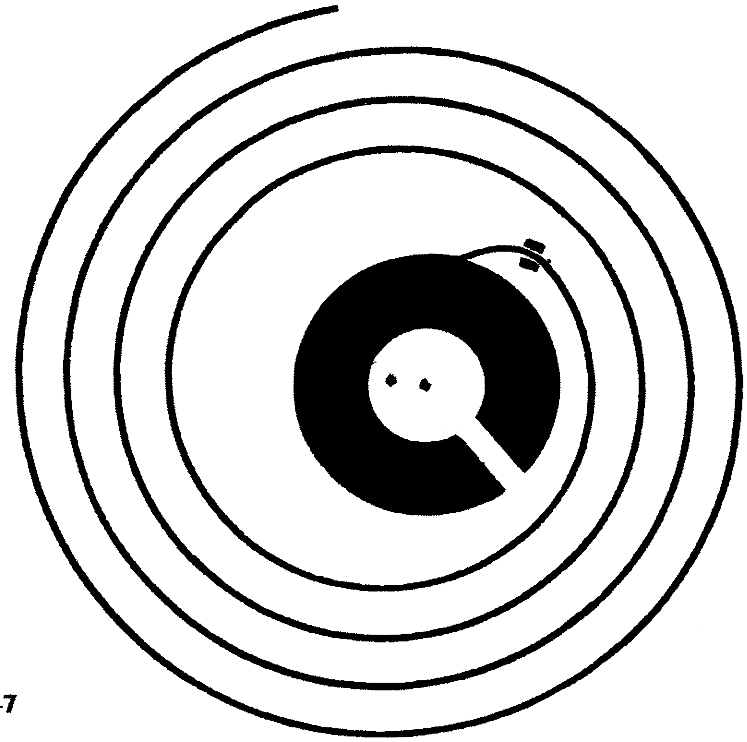


Fig. 19-7

Figure 19-8: The amount of space between the inside coil and the collet is excessive and with the tweezers placed in the approximate position shown carefully exert just enough pressure to close this space. In so doing another bend similar to the one illustrated in figure 19-7 may be required. Check with figure 19-2.

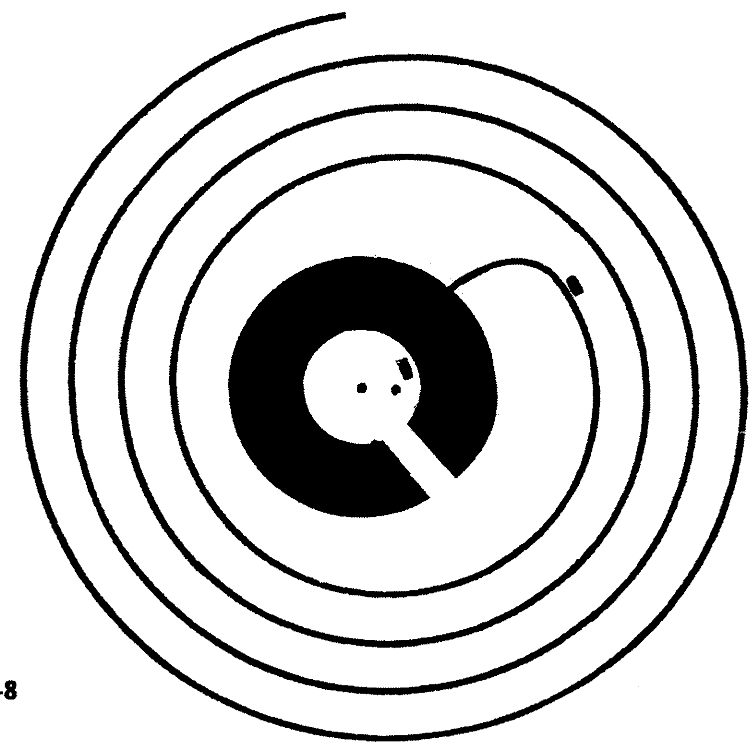


Fig. 19-8

Figure 19-9: The tweezers placed in the approximate position shown should enable the student to bring the center of the collet directly over the hairspring center easily. Compare with figure 19-2.

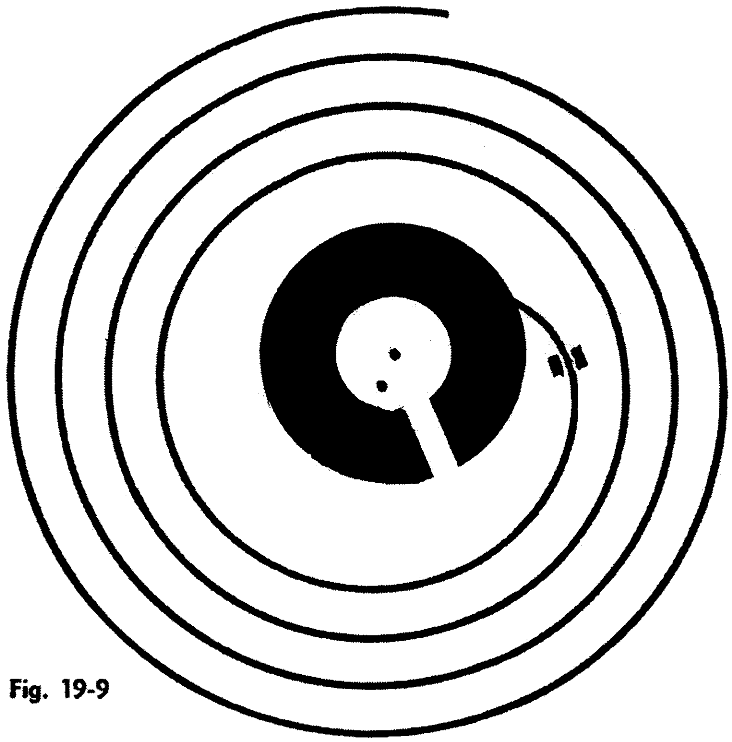


Fig. 19-9

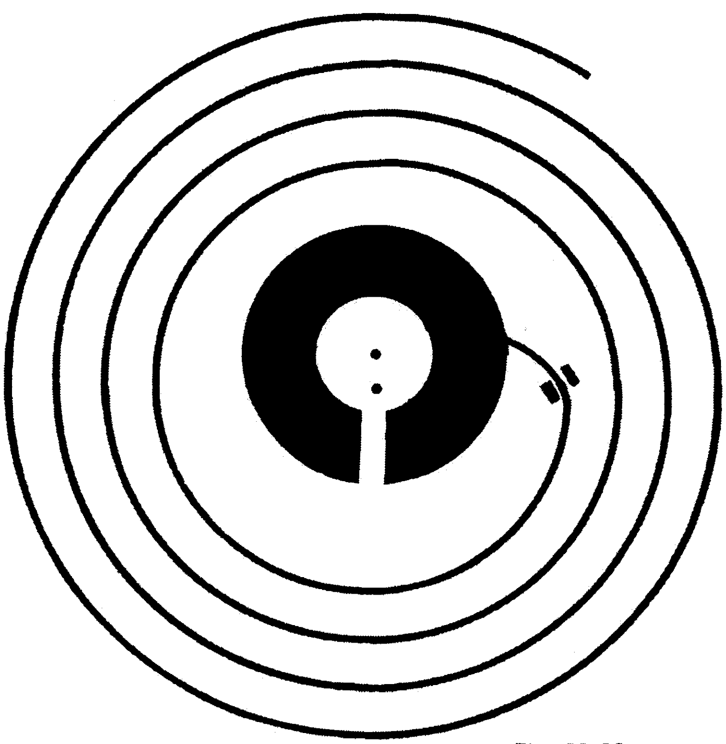


Figure 19-10: This bend is made similar to figure 19-9. Compare with figure 19-2.

Fig. 19-10

SEC. 386—Colleting the Hairspring

These illustrations should help the student when determining the procedure required to bring a collet to center. This is true not only when preparing to true the hairspring in the round but also when colleting a hairspring. If the student has a fairly good conception of the location of the collet center with the hairspring center it will be helpful when colleting a hairspring.

Colleting a hairspring is a job that the watchmaker is not often required to do in this day and age of modern watch repairing. Most new hairsprings come colleted and are selected to fit the collet shoulder properly. At times it is necessary to replace a collet when some careless watchmaker has endeavored to force a collet over a collet shoulder which is too large, which usually causes the collet to crack.

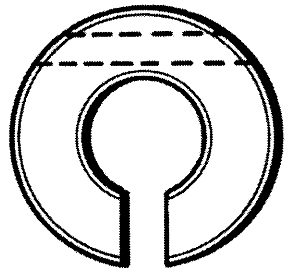


Fig. 19-11

Fig. 19-12

The collet is a small split collar made of spring brass, figure 19-11. Directly opposite the slot in the collet is a small hole, illustrated by the dotted line, large enough to receive the inner end of the hairspring prior to pinning.

The small tapered brass pin illustrated in figure 19-12 is used to pin the hairspring in the collet. They may be purchased from a supply house under the name of hairspring stud pins.

At times the watchmaker is called upon to file his own stud pins or tapered pins of similar design. Figure 19-13 illustrates how this may be done. A small block of wood, preferably hard wood, has a notch cut in it with the edge of a file. The deepest end is toward the front and tapers up the block depending upon the length of taper desired. A piece of brass wire of a small diameter is held in a pin vise and alternately rotated with the left hand while in the notch of the hardwood block. The file illustrated by the dotted line is moved lightly back and forth over the wire until the pin is formed.

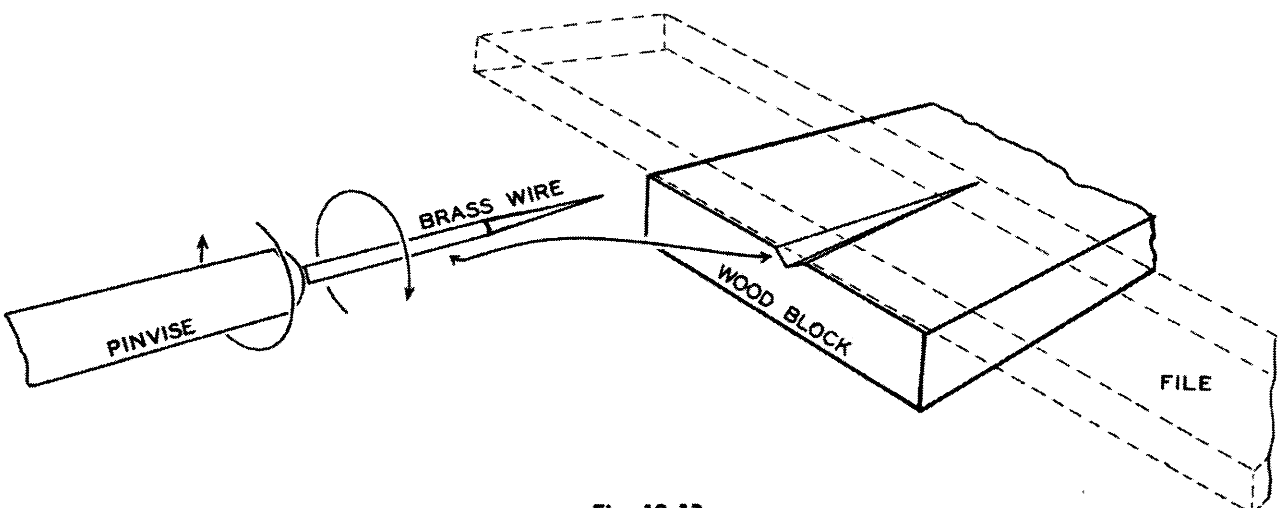


Fig. 19-13

When working on the collet or pinning the hairspring to the collet the collet can be held on a tempered tapered steel pin or a broach, figure 19-14. The pinning hole should be cleaned out with a small broach before attempting to pin the hairspring.

Always try the pin in the hole in the collet before attempting to pin the hairspring. It should go through the collet similar to pin illustrated in figure 19-15.

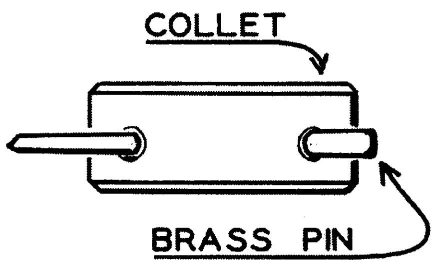


Fig. 19-15

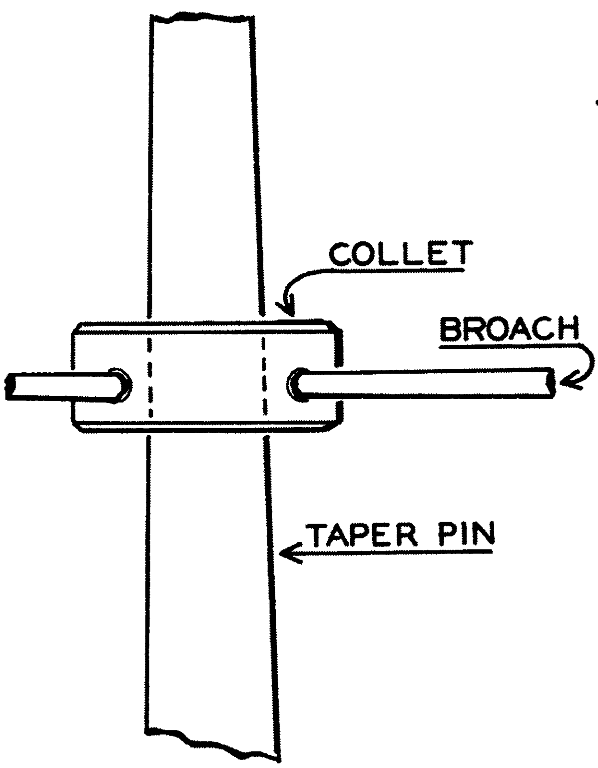


Fig. 19-14

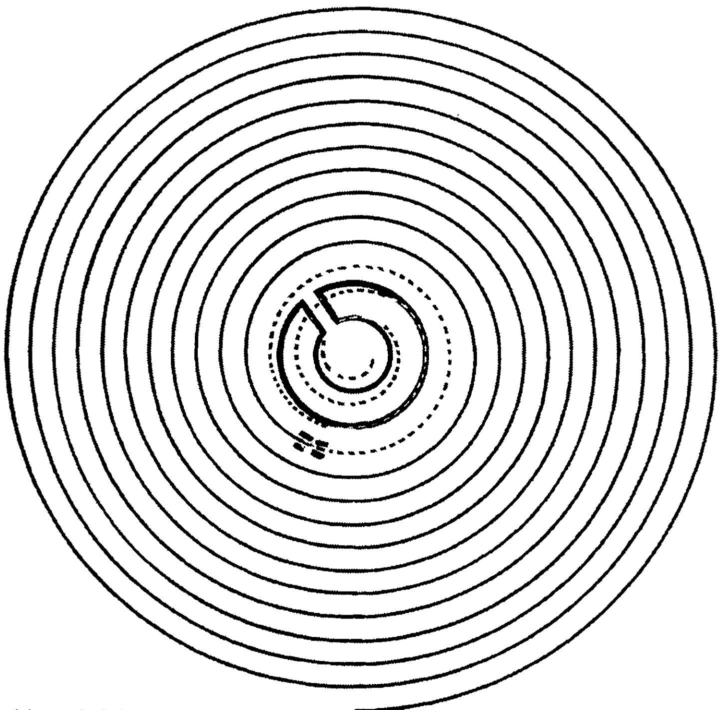


Fig. 19-16

It is sometimes necessary to break out the inner coil of the hairspring in order to get enough space between the coil and the hairspring to true it properly. Figure 19-16 illustrates a hairspring with the collet placed directly over the center of hairspring. Breaking the coil at the point where dotted line joins solid line will allow enough space for the collet. Break at this point by using two pairs of fine pointed tweezers held vertical with the points close together, twisting back and forth.

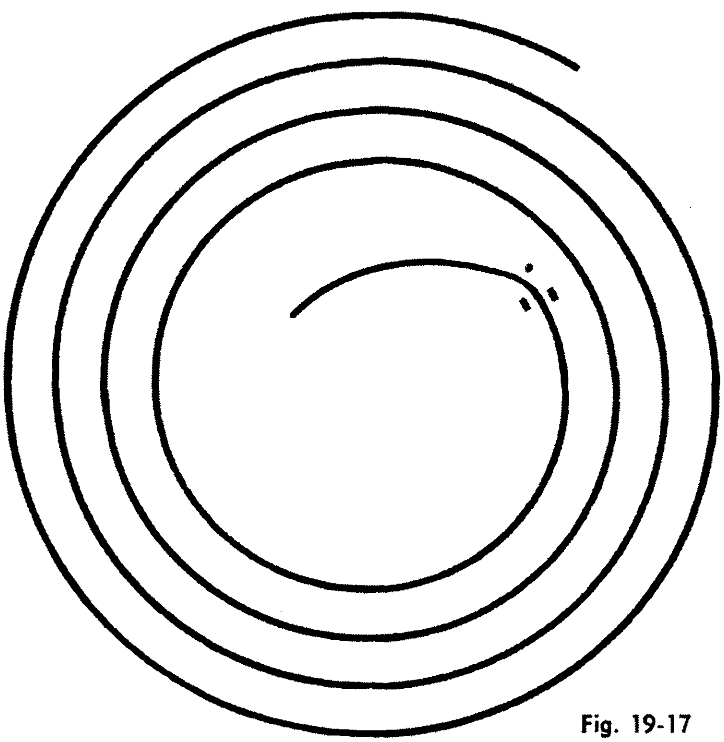


Fig. 19-17

A portion of the inner coil will be bent in the manner shown in figure 19-17, to form the tongue. The length of this tongue should not exceed the length of the hole in the collet. It is formed by holding coil with a pair of hairspring tweezers and bending with taper pin. The tweezers are represented by the two black dashes and the taper pin by the dot.

With the collet in place on the taper pin or broach which you will hold in your left hand, insert the tongue of the hairspring into the hole in the collet, figure 19-18.

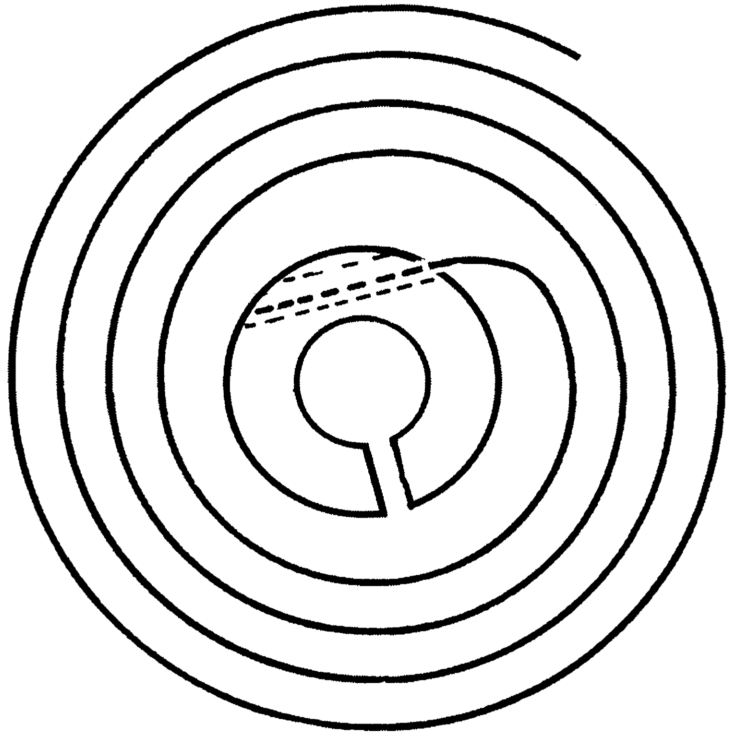


Fig. 19-18

In order to keep the hairspring level you may use the forefinger of your left hand as a guide, letting the hairspring rest upon this finger until the brass pin is in place, figure 19-19.

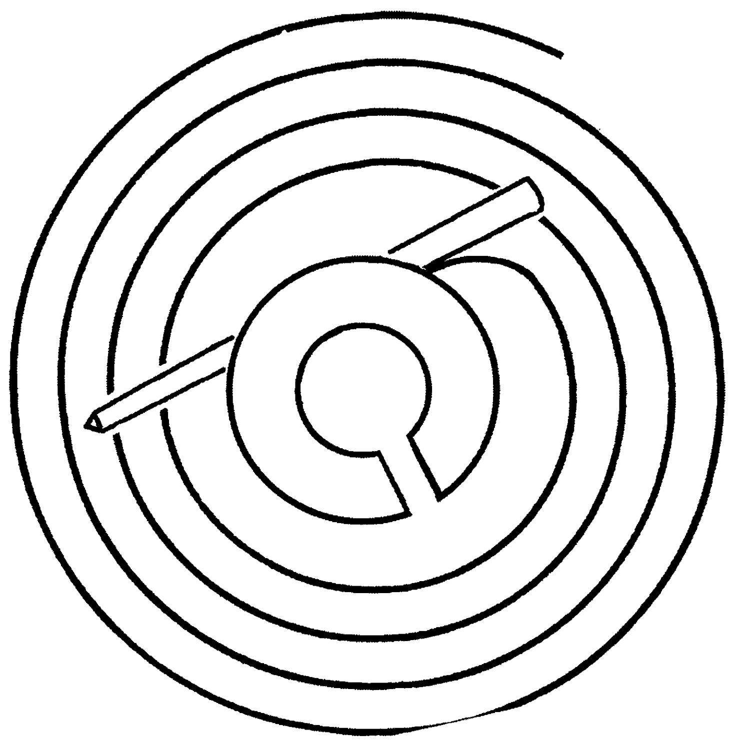


Fig. 19-19

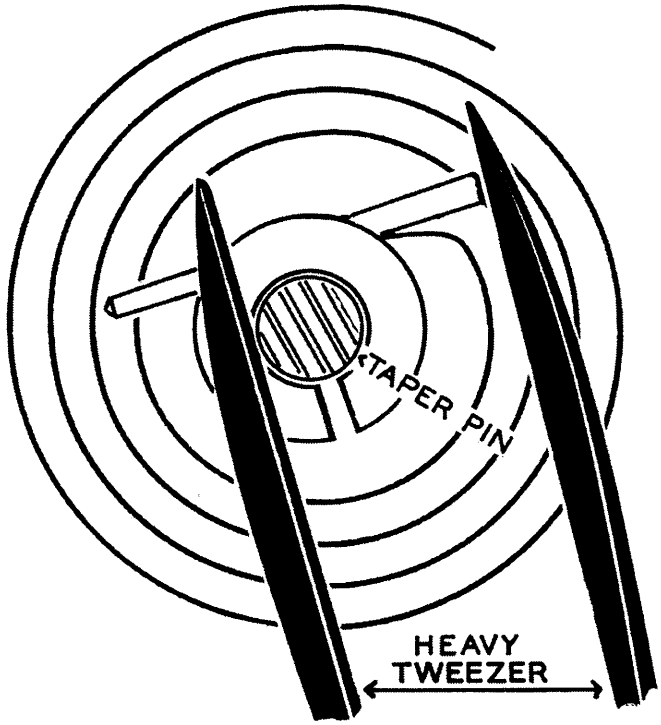


Fig. 19-20

The pin may be forced into place with a pair of heavy tweezers in the manner shown in figure 19-20. However, before forcing the pin in as far as it will go make certain that the inner coil is parallel with the top or bottom of the collet as shown in the upper illustration in figure 19-21. In this illustration the body of the hairspring is held below the hole in the collet by the pin which has not been cut off as yet, but the inner coil is parallel with the upper edge of the collet. When the pin is cut off the body of the hairspring will resume its position in the same plane as the inner coil.

The center and lower illustrations, figure 19-21, show the inner coil out of position prior to forcing the pin in as far as it will go. If the hairspring is pinned properly it will not require much truing in the flat.

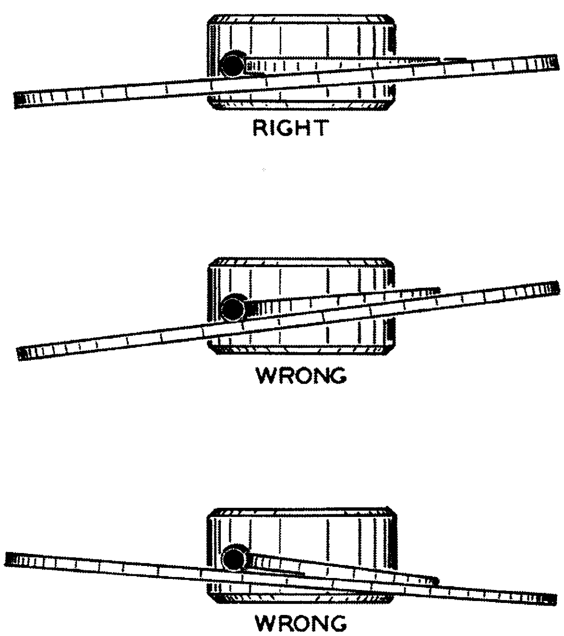


Fig. 19-21

There are other methods of pinning the hairspring to the collet and every watchmaker uses the method he prefers, usually the one he adopted when learning the trade. No matter what method is used the student or watchmaker must use the greatest of care not to make a slip and ruin his work. This is very true when cutting off the pin after it has been forced into place. One of the oldest methods of performing this operation is with a small **sharp** knife or heavy razor blade. If carefully executed it will assure the workman of a clean job and there is no danger of leaving the pin protruding.

The collet is held in place on the taper pin and the end of the knife blade is worked across the pin in a sawing manner. Only the very end of the blade is used. The blade is used tangent to the collet at the pin which is illustrated by the dotted line in the upper illustration of figure 19-22. When the pin is cut almost through the remaining portion may be removed with the tweezers.

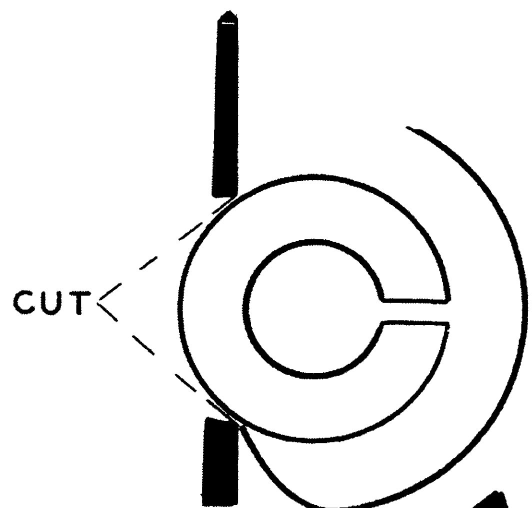
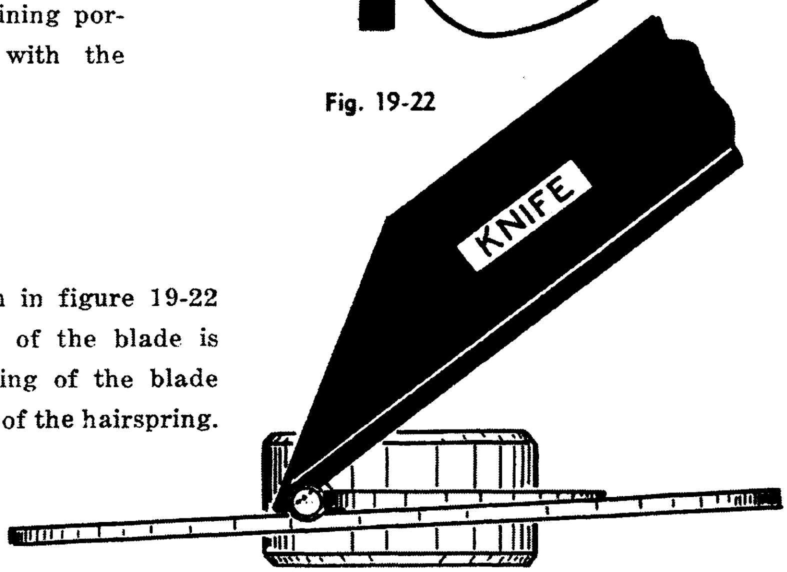


Fig. 19-22



The lower illustration in figure 19-22 shows why only the tip of the blade is used. Any further lowering of the blade would endanger the body of the hairspring.

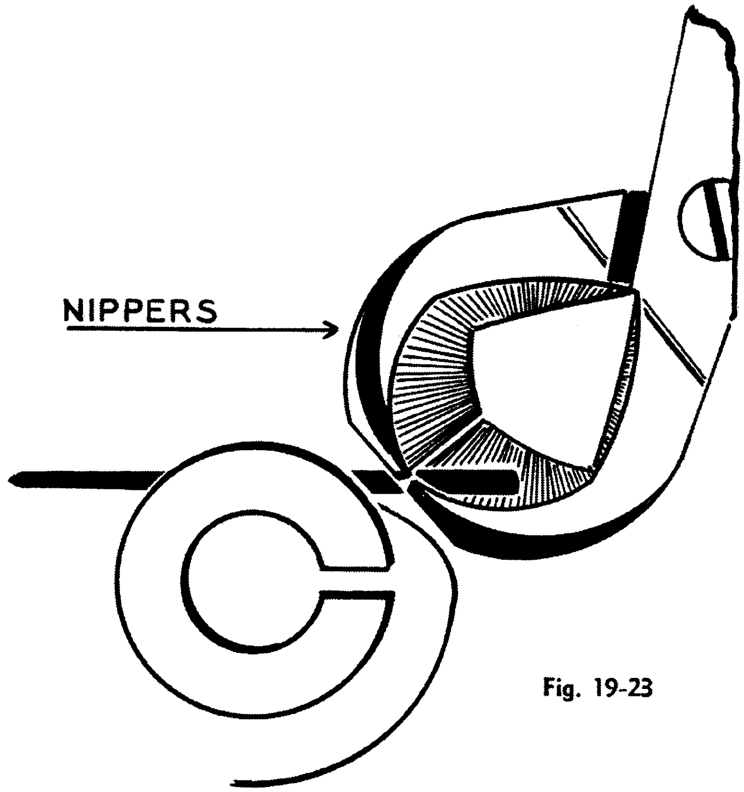


Fig. 19-23

Another method of cutting off the pin is shown above. The jaws of the nippers are ground especially for this purpose and should not be used for any other purpose than cutting small brass pins. The cut off is made before the pin is pushed into place. The protruding end may be removed in the same manner making certain that the nippers are as close to the collet as possible. The methods explained above are the same as will be used when pinning the outside coil of the hairspring to the stud.

(Note - Insert in lesson text 19)

Colleting the Hairspring

If the collet that is in the watch fits correctly and is not damaged, the spring should be recolleted using this collet. You'll note that hole in collet into which hairspring is pinned is not generally centered between top and bottom of collet. The location of this hole and the fact that you are fitting a flat hairspring determines which side of the collet is the top. The top is the side to which the pinning hole is closest. This applies to fitting flat hairsprings only; the opposite is true when fitting an overcoiled spring. If collet needs replacement, select a collet that compares with the original; i.e., correct size to fit collet seat, same height of collet, hairspring pinning hole in same position, etc.

Master WATCHMAKING

SHOP TRAINING
JOB GUIDES

LESSON 20

The Overcoil Hairspring

—

Sections 390 - 393

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SEC. 390—Purpose of the Overcoil

The type of hairspring described in the previous lessons is referred to as a **flat** hairspring because all of the coils lie in the same plane. The hairspring referred to in this lesson is known as the **overcoil** or **Breguet** hairspring. An overcoil hairspring is one in which the outside coil has been raised up and laid over the body of the hairspring. The name Breguet is used by many watchmakers, when referring to an overcoil hairspring, in honor of the horologist Louis Breguet who first conceived the idea of the overcoil. The overcoil is used in the better grades of watches in order that a closer isochronal rate may be obtained.

There are many different shapes of overcoils and many articles and books have been written discussing the theoretical purpose of these various shapes and forms. Our purpose in this lesson is to teach the student watchmaker to form and manipulate the overcoil hairspring irrespective of the factory which designed and manufactured the original spring. It is an easy matter for an experienced watchmaker to recognize the difference between an Elgin and Waltham hairspring by the shape of the overcoil. However, the practical repairman must be able to handle every type of overcoil regardless of manufacture. There are times when it is necessary to form complete new overcoils. He must be able to reshape overcoils which have become bent or distorted or are not the proper height or are improperly centered. The hairspring, if handled properly, will seldom became distorted. In the average repair shops this type of repair is usually encountered when the watch has been previously worked upon by an incompetent workman. It is important that the watchmaker examine the hairspring carefully when making an estimate for repairs.

In order for a hairspring to function properly in the watch we must be sure that:

1. The hairspring is true in the flat and round.

2. The outside coil of a flat or an overcoil hairspring lies between the regulator pins and is concentric with the center of the hairspring when the stud is in position. At the same time the hole in the collet must be concentric with the axis of the balance staff.

3. A flat hairspring must be level with the balance cock and be free of any interference during the winding and unwinding caused by the oscillations of the balance.

4. The section of overcoil which follows through the regulator pins from the stud to approximately an equal distance beyond the regulator pins must be level with the body of the hairspring and parallel to the balance cock and of the proper height in order that the body of the hairspring will be level with the balance arm. It must be free of any interference during the winding and unwinding caused by the oscillations of the balance.

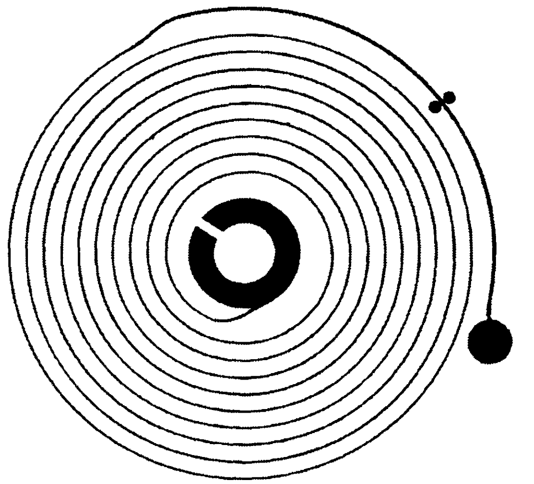


Fig. 20-1

SEC. 391—Types of Overcoils

The flat hairspring illustrated in figure 20-1 shows the outside coil properly formed with relation to the stud and regulator pins. Figure 20-2 illustrates a hairspring with the overcoil properly formed with relation to the stud and regulator pins.

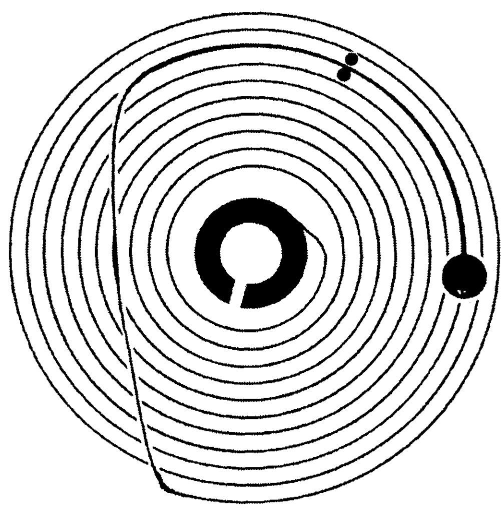


Fig. 20-2

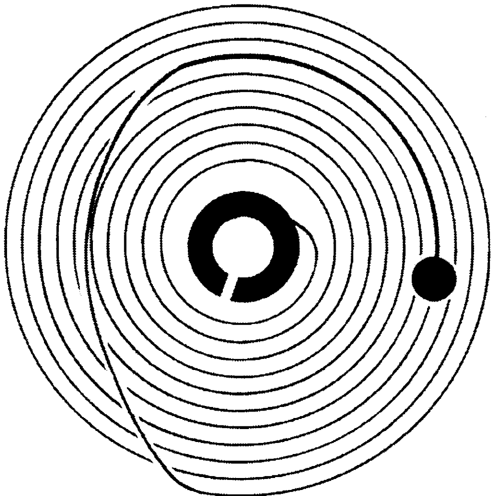


Fig. 20-3

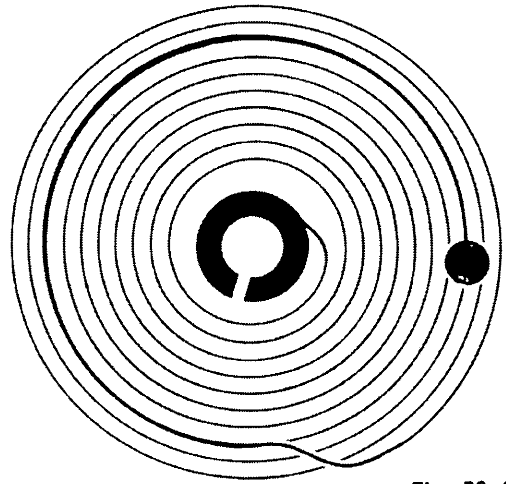


Fig. 20-4

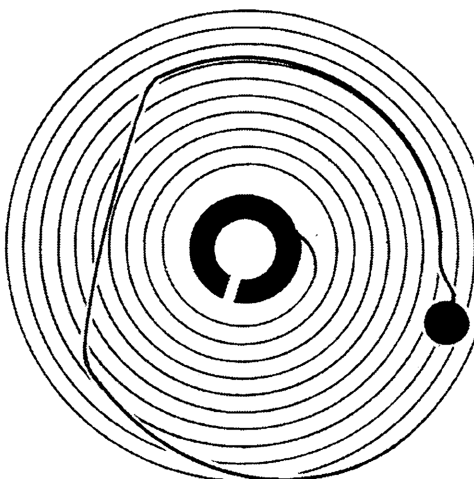


Fig. 20-5

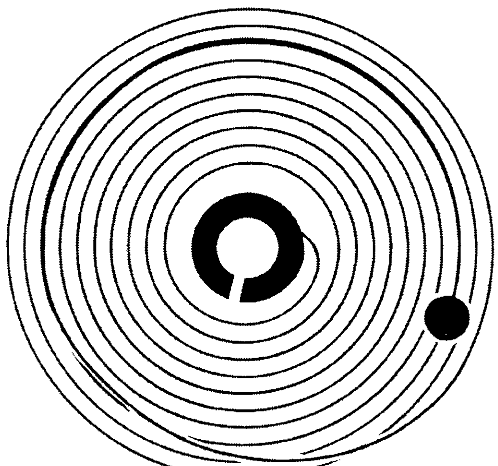


Fig. 20-6

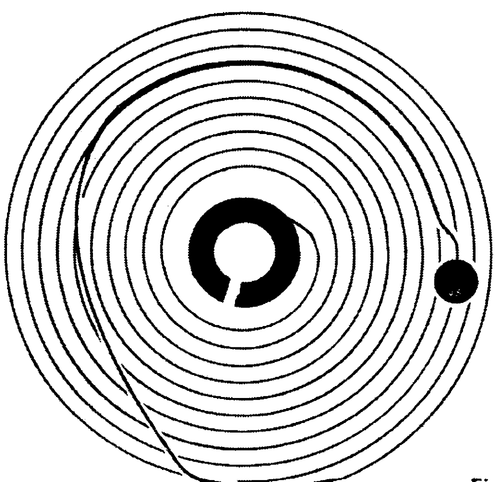


Fig. 20-7

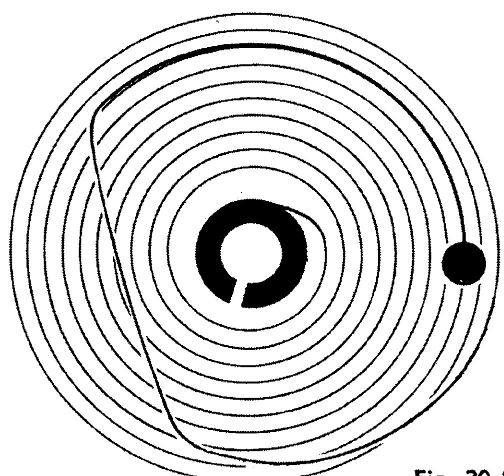


Fig. 20-8

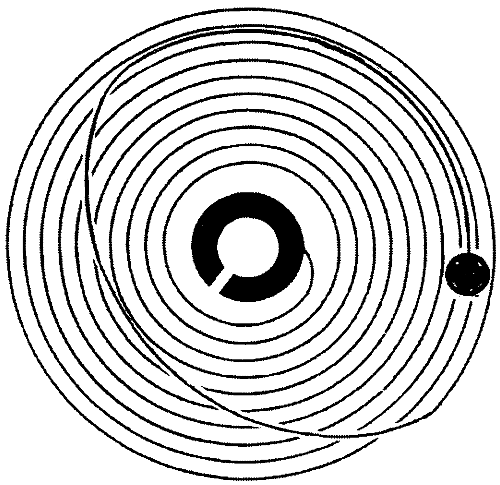


Fig. 20-9

The following illustrations, figures 20-3, 20-4, 20-5, 20-6, 20-7, 20-8, 20-9, are presented to impress the student with the fact that regardless of the shape of an overcoil the section which lies between the regulator pins is primarily the same. Study these illustrations carefully and notice that this section of the overcoil is of the same shape regardless of which coil it follows, the length or shape of the sections bent up from the body of the hairspring, or the position of the stud. These illustrations are not used to show any particular form or shape of overcoil and must not be construed as typical overcoils as found in the modern watch. However the overcoils shown in figures 20-2, 20-6 and 20-9 are more or less the basic types of overcoils in use today. The overcoils in these illustrations all lie in one direction. However, this is only for the purpose of illustration, as they may lie in the opposite direction as well. The direction is determined by the location of the stud and regulator pins on the balance cock.

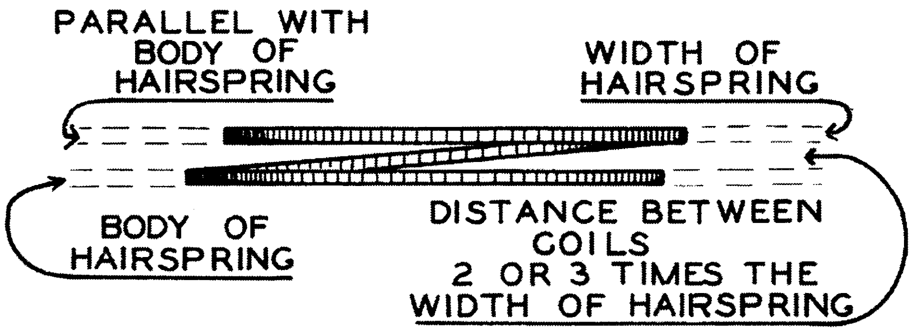


Fig. 20-10

SEC. 392—Height of Overcoil

Figure 20-10 shows a side view of a hairspring with an overcoil raised above and parallel to the body of the spring. The distance between the overcoil and the body of the hairspring is given as approximately 2 or 3 times the width of the hairspring coil. This is the distance we will use for our practice work, but there are times when this distance will not conform strictly to these measurements but is determined by the space allotted between the balance cock and the arm of the balance wheel and location of the hole in the collet into which the inner coil is pinned. Notice particularly that the portion of the overcoil referred to in figures 20-3 through 20-9 must be parallel to the body of the hairspring as shown in figure 20-10.

Figure 20-11 illustrates two distinctive types of bends used to raise the outside coil of the hairspring. The upper illustration is the one we will use in all of our practice work. The lower illustration shows a type of bend formed by the factory at the time the hairspring is hardened and tempered. It is possible for the repairman to make special tools which will enable him to form this type of bend, but for all practical purposes it is not necessary. Even though a hairspring may be distorted, these two sharp, factory-formed bends will rarely become so, and the proper manipulations required to place the hairspring in first class order do not require alterations at these points.

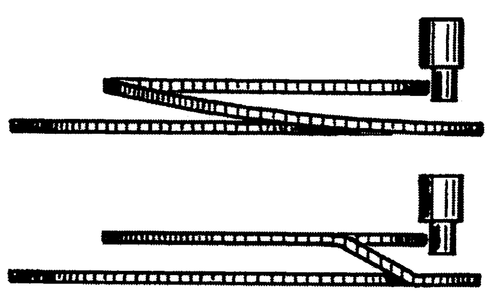


Fig. 20-11

SEC. 393—Raising the Overcoil

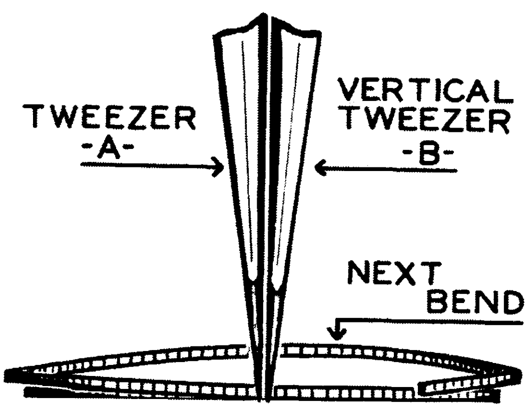


Fig. 20-12

For raising an overcoil the student will need two fine pointed hairspring tweezers and an overcoiling tweezer. Overcoiling tweezers come with points of different curves but in the trade an overcoiling tweezer number 10-1 or 10-0 will handle the average repair job. The first step in raising the overcoil is to lay the hairspring on a flat surface. The ground glass plate previously mentioned is excellent. The two hairspring tweezers are then placed as close together as possible, approximately ⅞ths of the distance from the end of the outside coil, figure 20-12. Place the tweezers in a vertical position as in figure 20-12, A and B. Holding the tweezer B firmly in position, move tweezer A toward you or in a manner which will raise the outside coil as shown. **DO NOT RELEASE TWEEZER B** until the overcoil is of the proper height at the approximate point in the illustration which is indicated by the arrow "Next Bend". By not releasing the tweezer B until the coil is of the right height, it is an easy matter to place tweezer A back in the proper place to raise or lower the coil, whichever may be necessary.

When the proper height has been ascertained, place the tweezers A and B at the point marked "Next Bend", figure 20-12. The two tweezers are held vertical and used in the same manner as when raising the overcoil to level the remaining section of the overcoil. The overcoil should be level with the body of the hairspring as in figure 20-10.

There are times when the overcoil will appear as in the two illustrations shown in figure 20-13. In the upper illustration the overcoil is lower in the center than it is on either end. To correct this, grasp the overcoil at its high point C with two pairs of hairspring tweezers and raise the overcoil so that the section BC is level. In so doing the section AB has been raised above the height desired. This section is lowered to the correct height by the method previously described in making bends in the overcoil with two pairs of hairspring tweezers. (See figure 20-12). The actual forming of the overcoil is best accomplished with the aid of overcoiling tweezers. Some experienced watchmakers learned to form the overcoil with one tweezer and a taper pin.

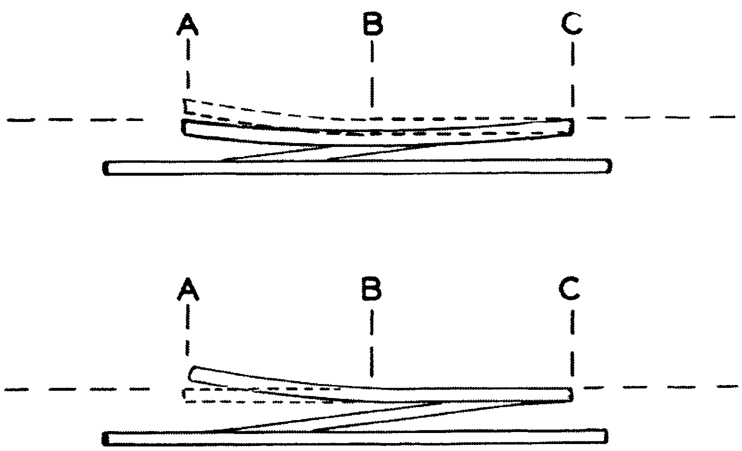


Fig. 20-13

Figure 20-14 illustrates four steps used when forming the overcoil with an overcoiling tweezer.

Step No. 1: The line AB represents the coil of a spring while the dotted section of line AC represents the position this section of coil will be in when bent at O.

Step No. 2: Line AC illustrates the completed bend with the overcoiling tweezers centered directly over the point indicated by the arrow in the previous step.

Step No. 3 illustrates the previous lines AB and AC. The line AD shows the result of too much pressure on the overcoiling tweezer.

Step No. 4 illustrates the method used to bring the line AD back to the position for which it was originally intended (AC). This is accomplished by reversing the overcoiling tweezer as illustrated.

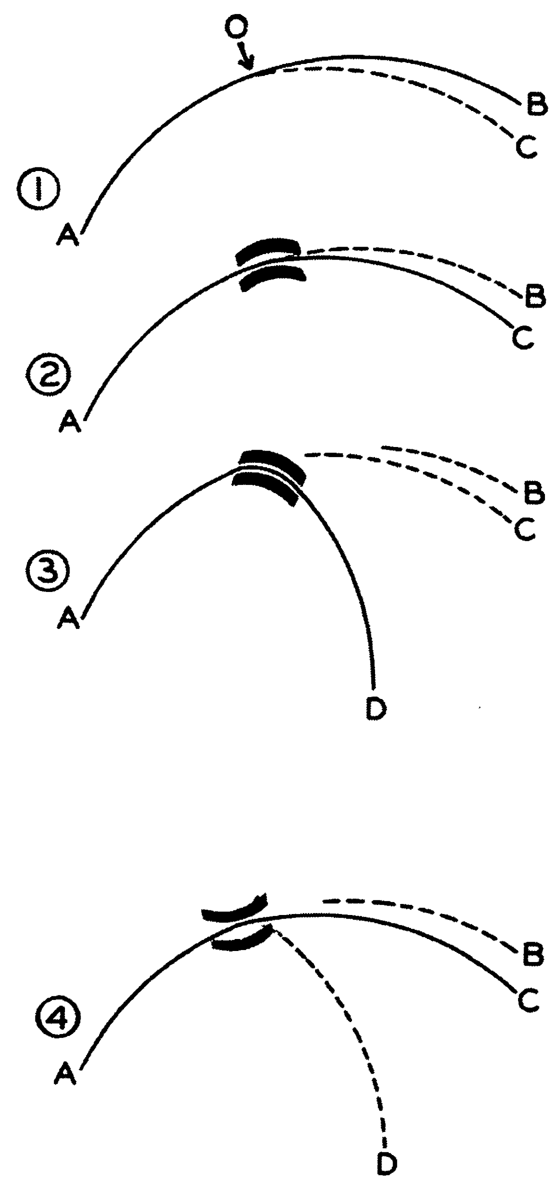


Fig. 20-14

The first bend to make when forming the overcoil of a hairspring is indicated in figure 20-15 by the arrow A. When making this bend, make certain that the overcoil will clear the body of the hairspring. The next bend is determined by the location of the regulator pins when the hairspring is centered over the balance cock. This will be explained more fully in a following lesson. For practice, the student may select any coil, usually the 2nd or 3rd coil of the coils contained in the body of the hairspring, and make the remaining portion follow the coil selected. For our illustration we have elected to make our overcoil follow between the 2nd and 3rd coils and our next bend with the overcoil tweezer will be at the point indicated by the arrow B, figure 20-15.

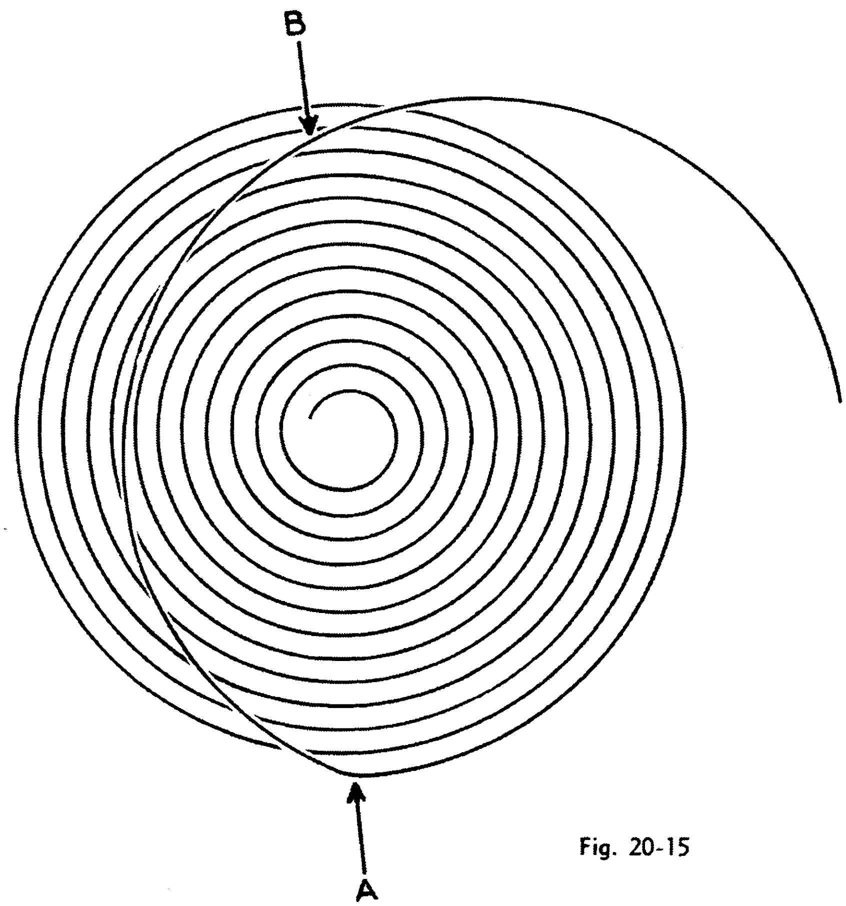


Fig. 20-15

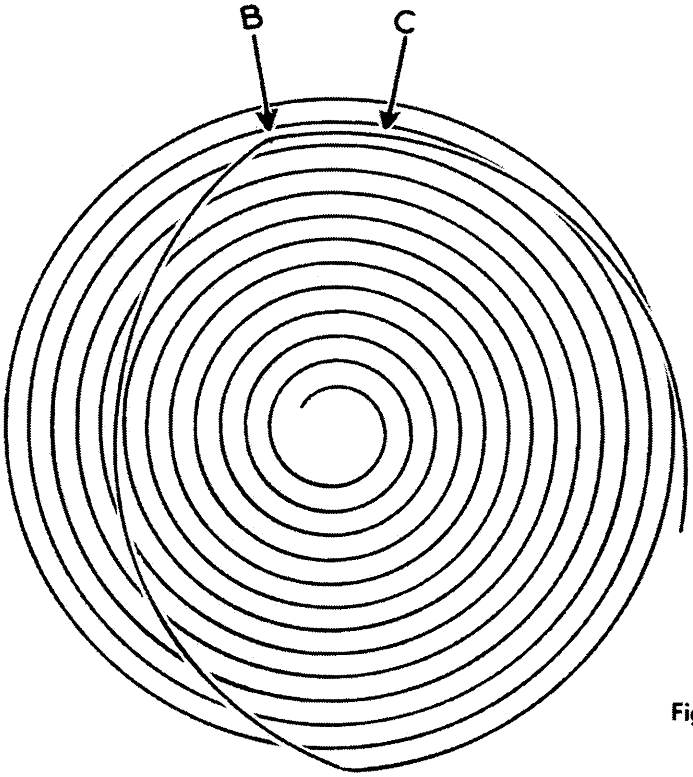


Fig. 20-16

The overcoil will then appear as in figure 20-16 and the next bend will be at the point indicated by arrow C. Continue shaping the coil until it appears as in figure 20-17. After completing the overcoil, check to see that the overcoil is level. Be certain when forming the overcoil in the round to look directly down on the overcoil each time you make an examination.

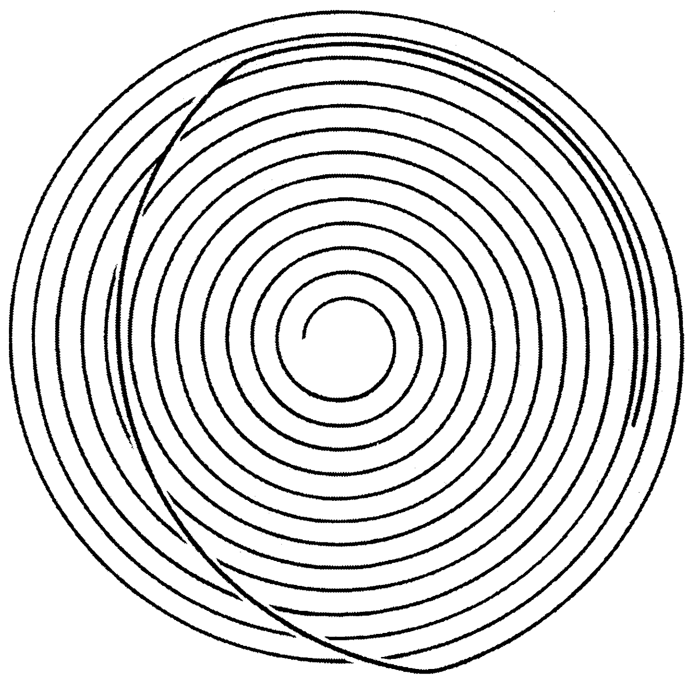


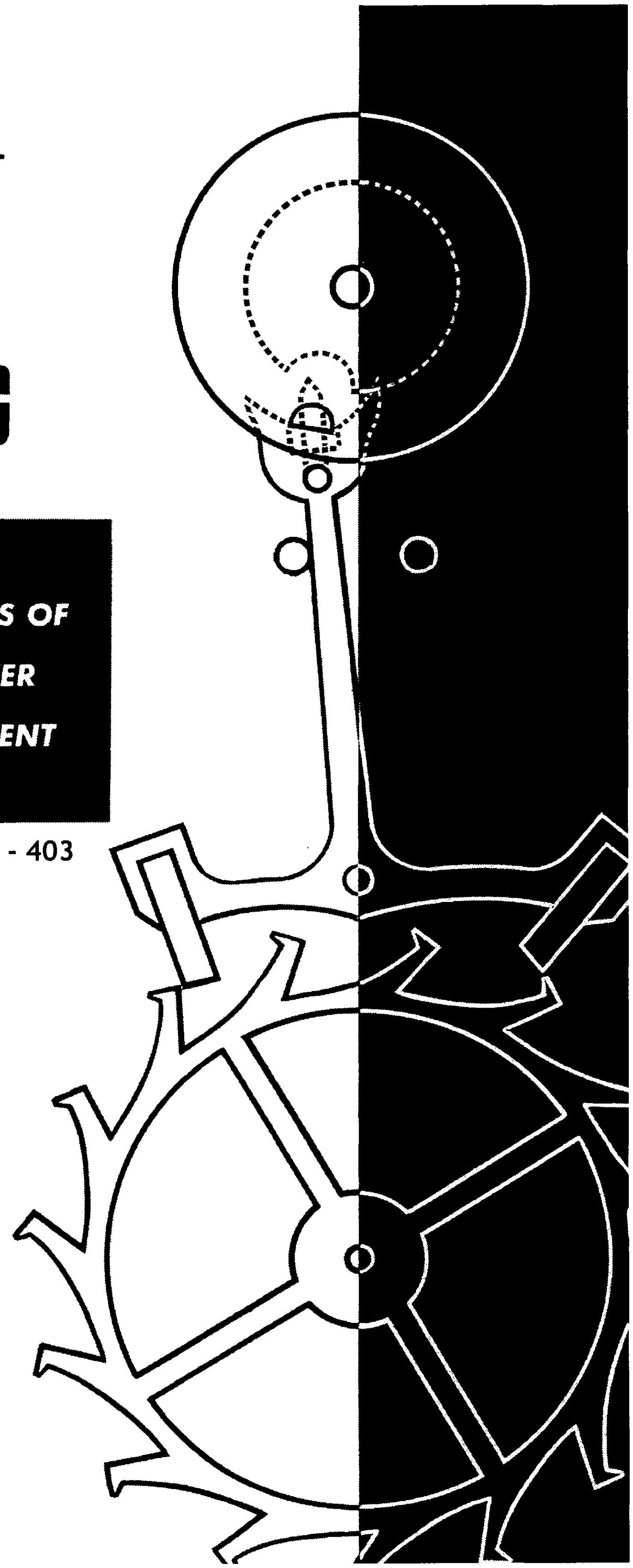
Fig. 20-17

Master WATCHMAKING

LESSON 21

PRINCIPLES OF THE LEVER ESCAPEMENT

Sections 395 - 403



CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by THOMAS B. SWEAZEY

SEC. 395—The Detached Lever Escapement

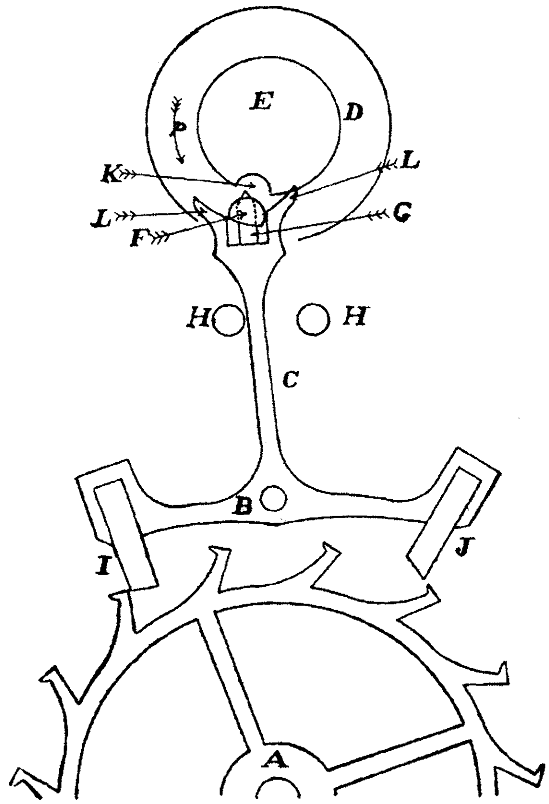


Fig. 21-1

There is no part of a watch that involves so many complications or requires such an amount of study and practice as the escapement. There is no part of its mechanism about which more has been written, yet half has not been told.

In order to adjust an escapement intelligently, a thorough knowledge of the nature of all its functions is essential. Theory and practice are both required. Theory alone will not make a good workman. Practice without theory may do so, after a fashion; the two united make the rapid and skillful workman.

The escapement is complex in its character. The various individual functions are so intimately related to each other that no single one can be altered without affecting others to a greater or lesser degree. The consequence is that a workman will often make an alteration to correct an error, and in doing so will create another error, or aggravate a previously existing one. Without a good theoretical knowledge, hours may be spent over an escapement that, with sound theoretical knowledge, might have been made right in minutes.

The theory will be presented in plain language, accompanied by a multiplicity of illustrations so that the problems involved will be clear. The effects produced by the different alterations that may be made will be described and illustrated, thus directing the practice of the student. Every operation performed will be for definite results, results that may confidently be expected.

SEC. 396—Names of Parts

The term escapement is applied to that part of the watch by means of which the rotary motion of the wheels is transformed into the vibratory motion of the balance. The members included in the escapement are: The escape wheel, the pallets, the fork, the roller jewel and the roller table or rollers. The balance is not properly a part of the escapement. Inasmuch as more than one term is frequently used to designate the same part, it is deemed well to give the different names in general use.

In figure 21-1 the letters refer to the following list:

A—escape wheel.
B—pallets.
C—fork.
D—impulse roller or roller table.
E—safety roller or guard roller.
F—roller jewel, impulse pin—or jewel pin.
G—guard pin or guard dart.
H—banking pins or bankings.
I—receiving stone or R stone.
J—let-off stone—L stone or the discharging stone.
K—passing hollow or roller crescent.
L—fork horns.

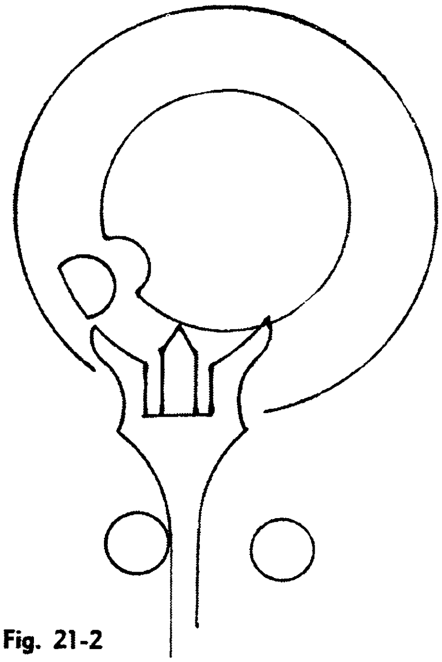


Fig. 21-2

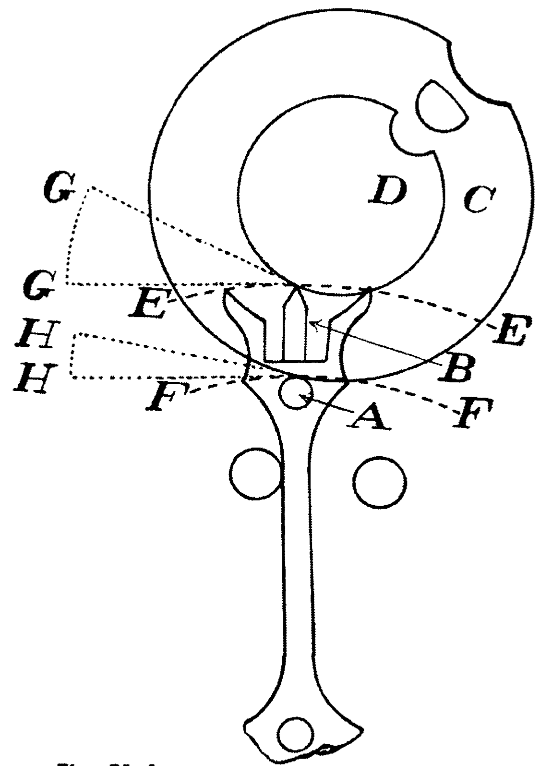


Fig. 21-4

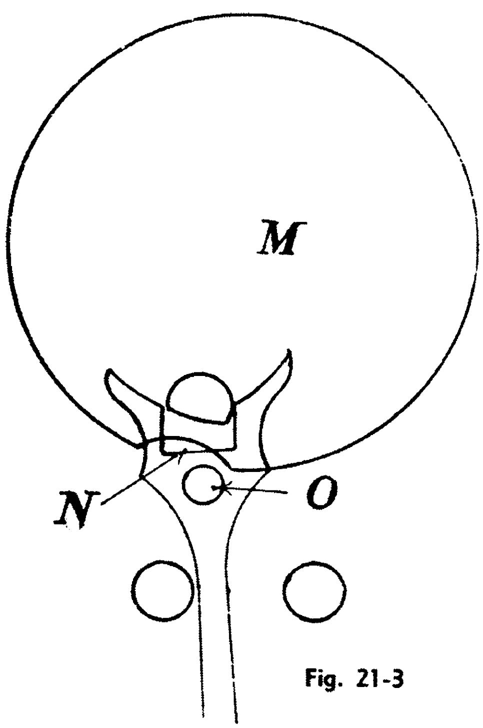


Fig. 21-3

SEC. 397—Comparison Between the Single Roller and the Double Roller Escapements

The difference between the single and the double roller escapement is entirely in the safety action; the escape and pallet action and the fork and impulse action may be identical in both forms.

The guard pin and safety roller are provided for the sole purpose of preventing what is commonly called "overbanking" or more properly speaking, "going out of action."

Referring to figure 21-1 it will be seen that the fork is to the left, and that the roller is making its excursion in the direction indicated by the arrow, **P.** The roller jewel is in the act of unlocking the escapement and in this position the fork cannot go out of action, as it is held in place by the roller jewel. When the roller jewel is out of reach of the fork horn the fork is kept in position by the safety roller; it cannot pass the safety roller until the passing hollow comes into position.

Figure 21-2 illustrates the latter condition. This figure shows the fork at the left as in figure 21-1, but the roller jewel is farther to the left, and out of reach of the fork horn. The fork is now prevented from overbanking by the edge of the safety roller projecting beyond the path of the guard pin. It is not deemed necessary to letter the parts in this drawing.

Figure 21-3 shows a single roller under the same conditions as the double roller in figure 21-1. **M** is the roller table, **N** the passing hollow, **O** the guard pin. The roller table, **M**, performs the offices of both rollers **D** and **E** in figure 21-1. In the double roller, the guard pin projects forward, under and beyond the roller jewel. In the single roller it stands perpendicularly with the fork and is back of the fork slot. The roller table, **M**, not only carries the roller jewel, but its edge in conjunction with the guard pin provides the safety action.

SEC. 398—Advantages Claimed For Each Form of Safety Action

Figure 21-4 shows a portion of an escapement with both forms in combination. The guard pin **A** is for the single roller action; the guard pin **B** is for the double roller action; **C** is the impulse roller in the double roller form; **D** is the safety roller in the double roller form; **C** takes the place of both rollers in the single roller escapement.

The fork is shown against the left banking pin. The broken line **EE** is the path of the double roller guard pin; the broken line **FF** is that of the single roller guard pin. It will be seen that line **EE** penetrates beyond the periphery of the safety roller to a much greater extent than line **FF** penetrates beyond the periphery of the roller **C**. The dotted lines **GG** are drawn tangent to the circumference of the safety roller and to the path of the guard pin at their point of contact in the double roller escapement; the dotted lines **HH** are in the same relation in the single roller escapement. These lines embrace the angles at which the respective guard pins make contact with their rollers. It will be observed that the angle embraced by lines **GG** is more than twice that embraced by line **HH**. It is therefore justly claimed that the double roller is much less liable to allow the escapement to overbank than is the single roller. It is also claimed, justly, that in case the fork is thrown against the roller edge, less resistance is offered to the motion of the balance, owing both to the respective sizes of the rollers and the difference in the angles at which they contact, as shown by the lines **GG** and **HH**.

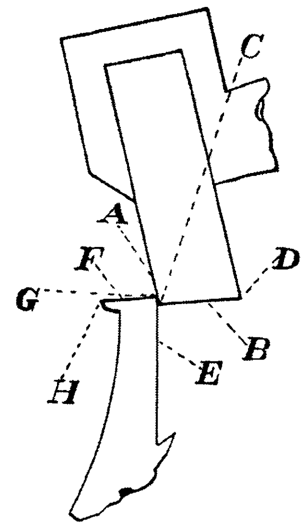


Fig. 21-5

SEC. 399—Loss of Power

Before considering the important subject of loss of power, it might be well to give the terms used to designate the acting parts of the pallet stones and the escape wheel teeth.

The parts of the pallet stone, figure 21-5, are: **A**, the locking face; **B**, the impulse face; **C**, the locking corner; **D**, the releasing corner.

The parts of the escape tooth are: **E**, the locking face; **F**, the impulse face; **G**, the locking corner; **H**, the releasing corner.

There is a great loss of power from the lever escapement even under the most favorable conditions. There is more loss of power entailed in conveying the motion from the escape to the balance than in all other losses of power combined. Of the force conveyed from the mainspring through the train up to the escape wheel teeth, upwards of one-third of the power is lost before it reaches the balance. This will no doubt seem surprising, but it will be explained by figure 21-6 and the specifications connected therewith. In order to avoid confusion, the guard pin and passing hollow, which constitute the safety action, have been omitted from this figure as they have nothing to do with the conveyance of power.

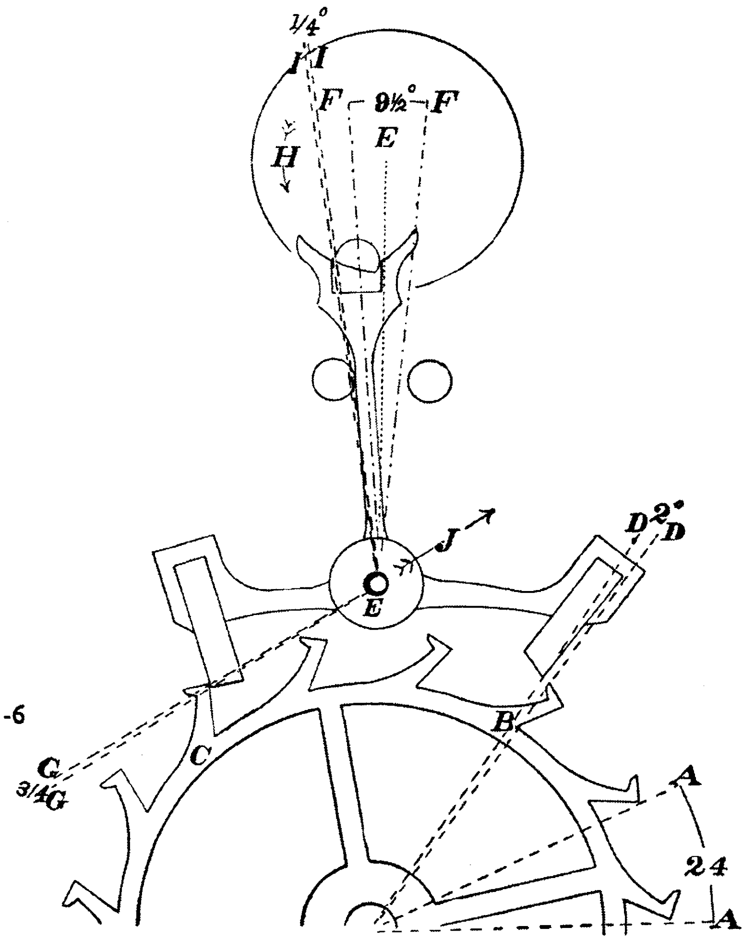


Fig. 21-6

The escape wheel has 15 teeth; the quotient of 360 degrees divided by 15 is 24 degrees; therefore, the angular distance between similar points of adjacent teeth is 24 degrees as shown by lines **AA**. One revolution of the escape wheel causes each tooth to deliver two impulses to the pallets, or thirty impulses in all—one impulse on the receiving stone and one on the discharging stone. This gives 12 degrees of angular motion for each impulse. The entire 12 degrees, however, cannot be used for impulse as a certain amount is necessary for freedom. This freedom is called the drop. In the drawing, tooth **B** has just been released from the discharging stone and tooth **C** arrested by the receiving stone. The angular distance between the releasing corners of the discharging stone and tooth **B** is the amount of the drop; the drop is just that much lost power. The wheel passes through that portion of each revolution without doing any effective work, its force being lost in the impact when it is stopped by the pallet. The amount of drop is usually 2 degrees, as shown by the lines **DD**. This involves a loss of 16-2/3 per cent, exclusive of that in the impact.

In figure 21-6 the arc of impulse of the fork from banking to banking is 9½ degrees as shown by lines **FF**. In the drawing **EE** is the line of centers; the lines **FF** include the arc of vibration. Of this 9½ degrees of vibration, ¾ of a degree must be deducted for lock, as shown by lines **GG** which pass through the locking corners of tooth **C** and the receiving stone. This leaves 8¾ degrees of actual impulse which is a loss of more than 7 per cent; and bear in mind that this 7 per cent loss is 7 per cent of the power left after deducting the loss from drop.

The roller jewel must be allowed some freedom in the fork slot. This freedom is called roller jewel shake, and can be readily understood by referring to the drawing, which shows the fork held against the left banking, the tooth locked on the receiving stone. Let us assume that the roller is making an excursion in the direction indicated by the arrow **H.** In making this excursion, the roller jewel enters the fork slot, and, coming in contact with its right side, moves the fork to the right, thereby unlocking the wheel tooth. When the tooth passes to the impulse face of the stone the fork immediately moves to the right until the left side of the slot makes contact with the roller jewel. This is referred to as roller jewel shake. Its amount is usually ¼ degree, as shown by lines **II.** A loss of 3 per cent is thus incurred. The losses thus far given bring the aggregate up to about 27 per cent, for we must bear in mind that each deduction for loss is the given percentage of the amount remaining after the previous deduction. There remain other losses, such as friction, impact and side shake, the exact amount of which cannot be readily calculated. Perhaps the side shake in the pallet arbor jewels is the most serious of these.

As the various impulses are applied and resistance is encountered by the members of the escapement, their pivots are forced against their bearings in different directions. This may readily be detected through a double eye-glass by looking directly down on the pallet arbor pivot while the balance is in motion. The side shake will show more plainly when the jewel and pivot are clean and unoiled. When the parts are in contact under the conditions shown in figure 21-6 the pallet arbor is pressed against the side of the jewel hole in the direction indicated by the arrow **J.** As the impulses are delivered alternately to the stones, and the resistance of the roller jewel is encountered, the pivot will be seen to rock from side to side in the jewel, thus incurring a loss of power. Hence it is important that the side shake in these jewels be as close as possible.

Another loss of power to which attention is called is the result of the impacts of the escape teeth with the pallet stones, and the roller jewel with the fork. To fully appreciate this, the fact must be kept in mind that the fork is started up from a dead rest at each vibration and that it comes to a sudden stop at the end of each vibration.

Another condition existing in the fork and roller action is that the movement of the fork is practically uniform, while that of the balance varies. A balance having a motion of one turn must necessarily travel at a higher rate of speed than if the vibration were half a turn. When the roller jewel is in contact with the fork, the balance is at its maximum velocity. As the roller jewel first contacts the fork, it releases the escape wheel by unlocking and immediately the resistance of the fork is reversed. It begins to exercise force to accelerate the motion of the balance. but the balance is moving at a higher rate of speed and consequently has a tendency to recede from its pressure—to get away from it, so to speak. The result is that as the motion of the balance increases, the efficiency of the force of the fork decreases.

It will be seen from the foregoing that placing the loss of power at one-third is a very conservative estimate.

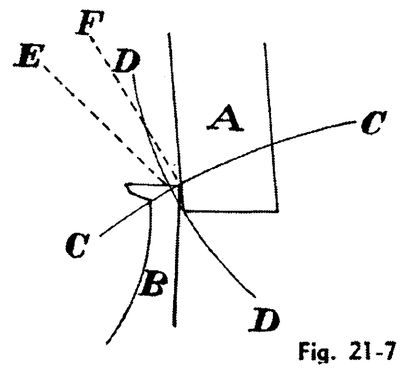


Fig. 21-7

The recoil in unlocking is a source of error that sometimes makes itself felt in adjustment. Figure 21-7 illustrates what is meant. The drawing is made to exaggerate the condition for the purpose of making the point clear.

A is a pallet stone, **B** an escape wheel tooth. The circular line **CC** is the path of the locking corner of the tooth. The circular line **DD** is the path of the locking corner of the stone. In unlocking, the stone passes along the arc **DD** and the tooth along the arc **CC.** The unlocking takes place at **E,** where the lines **CC** and **DD** intersect. It follows then that the tooth must be forced backwards from the point **F,** where it is shown on the drawing, to the point **E,** where it unlocks. This backward motion is known as the recoil. In forcing the escape wheel backwards, the fourth, third, center, and barrel are all in their turn reversed. This actually winds up the mainspring 300 times a minute. True, it is an infinitesimal amount, but let it be understood that the entire impulse delivered by the escape wheel is but a minute fraction of the rotation of the barrel.

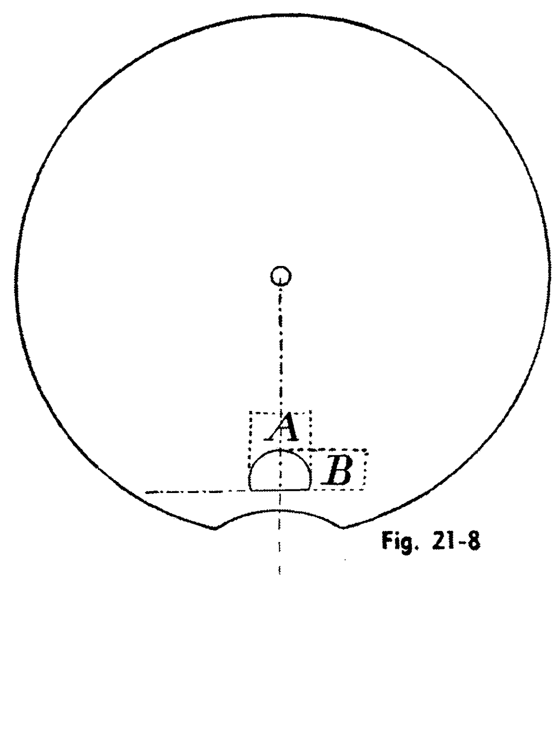


Fig. 21-8

SEC. 400—The Fork and Roller Action

An improperly fitted or incorrectly located roller jewel is perhaps the most common error found in escapements. A roller jewel should have 1½ to 2 hundredths of a millimeter shake in the fork slot. The roller jewel should be set firmly in the roller. It should be perfectly upright, its face square to the front, that is, at right angles with a radial line from the center of the roller, as shown in the broken lines in figures 21-8.

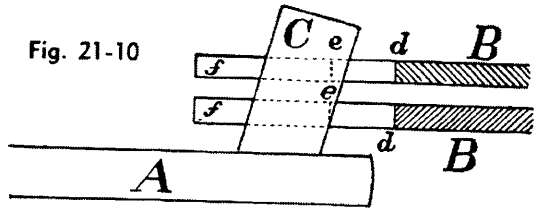
A D-shaped roller jewel should be flattened to about two-thirds of its diameter. The diameter **B** should be two-thirds that of **A.**

Figure 21-9 shows the effect of a roller jewel tilted sidewise. In this figure **A** shows a jewel set upright while **B** shows a jewel set out of upright. Referring to **A,** it will be seen that the roller jewel **c** has a certain amount of sideshake, as indicated by the black portion at the right of the jewel; referring to **B,** the roller jewel **c** being tilted, takes up all the sideshake.

Figure 21-10 shows the effect of tilting a roller jewel forward. In this figure, **A** is a roller, **B** a fork, **C** a roller jewel. The point where the section lining ceases at the lines **dd** is the bottom of the fork slot. The perpendicular dotted lines **ee** represent the front end of the slot, where the curve of the horn **f** begins. The fork is shown in two relative positions to the roller jewel. It is evident that owing to the necessary endshakes of the balance and fork, the fork will vary with regard to longitudinal position on the roller jewel. In the uppermost position, the roller jewel penetrates a greater distance into the fork slot than in the lower. This variation (being liable to constant change) is detrimental to regularity of rate. Its effect on escapement adjustment will be more fully explained as we proceed.

Figure 21-11 illustrates the proper position of the roller jewel when entering or leaving the fork slot. The bankings are set correctly for lock and slide; the escape wheel and pallet are not shown. It will be observed that the face of the roller jewel clears the curve of the fork horn. The fork is against the left banking, but if at this instant it should be moved to the right, the left corner of the slot would come in contact with the face of the roller jewel, thus preventing overbanking.

Fig. 21-10



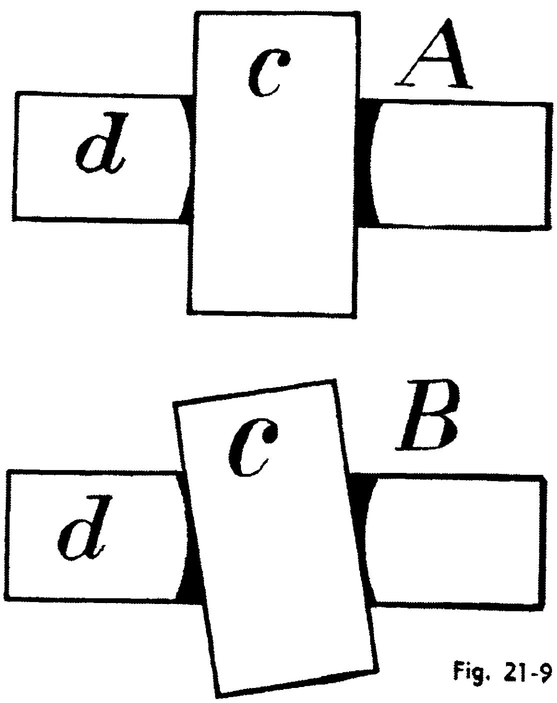


Fig. 21-9

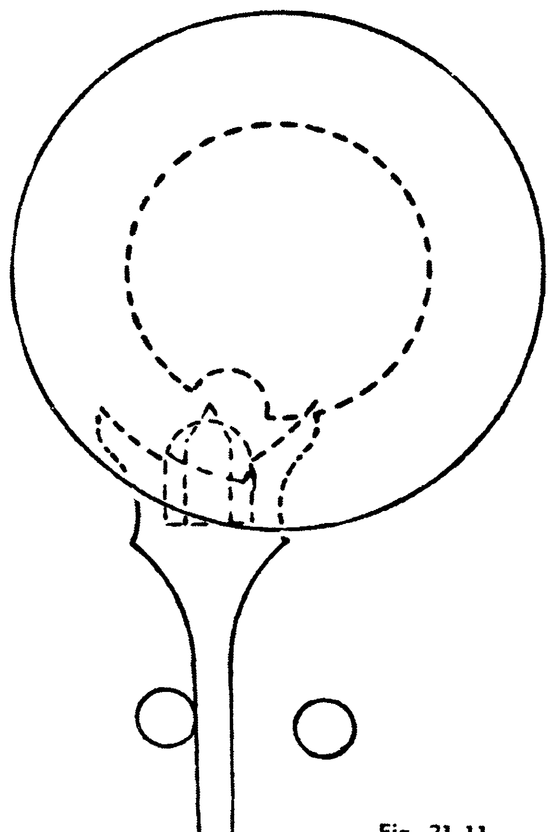


Fig. 21-11

Figure 21-12 below, shows this condition. In this figure the roller jewel is in the same position as in figure 21-11, but the fork is moved to the right, away from the banking pin. The guard pin is not shown, as it is not involved in this action. It will be noticed that further movement of the fork to the right is prevented by the roller jewel and that this also prevents unlocking the escape tooth.

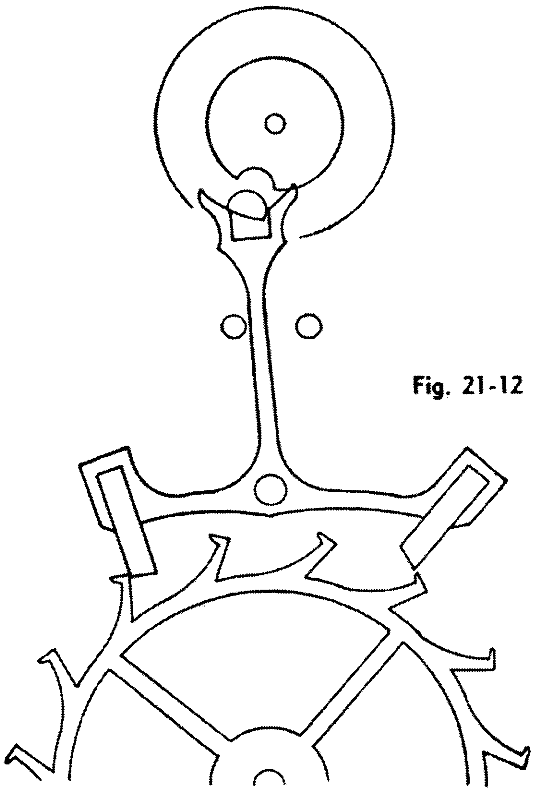


Fig. 21-12

SEC. 401—Correct Position for Roller Jewel

The fork and roller jewel actions can not be readily seen in the watch; the student is therefore compelled to rely to some extent on the sense of touch. How this may be done will now be explained.

Prepare a piece of tissue paper as follows: Take a piece of watch paper, fold it over the top of the index finger of the right hand, securing it with a light rubber band, as shown in figure 21-13. The purpose of this paper is to act as a shield. It permits the finger to be placed upon the balance without danger of smearing it. Placing the finger lightly on the balance, bring the escapement to the position shown in figure 21-14. Now move it in the direction indicated by the arrow until the escape tooth is released by the discharging stone and a tooth drops on

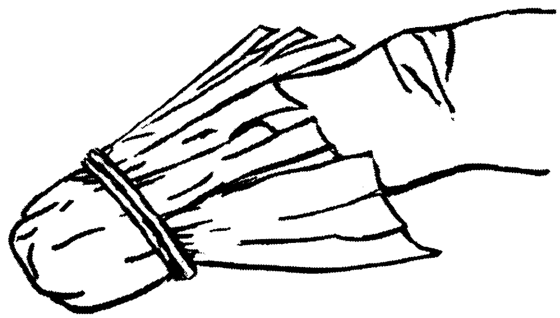


Fig. 21-13

the receiving stone. Stop instantly at this point. Press the fork lightly to the right. If the escape tooth unlocks with this action, the roller jewel is too far back and should be brought forward. Figure 21-15 shows this condition. The fork is shown pressed away from the left banking until it is arrested by the left horn coming in contact with the face of the roller jewel; but before this has taken place the escape tooth has been unlocked and passes on to the impulse face of the pallet stone.

There are two methods by which it may be determined whether or not the roller jewel is too far forward. The balance may be taken out and the escapment banked to drop; that

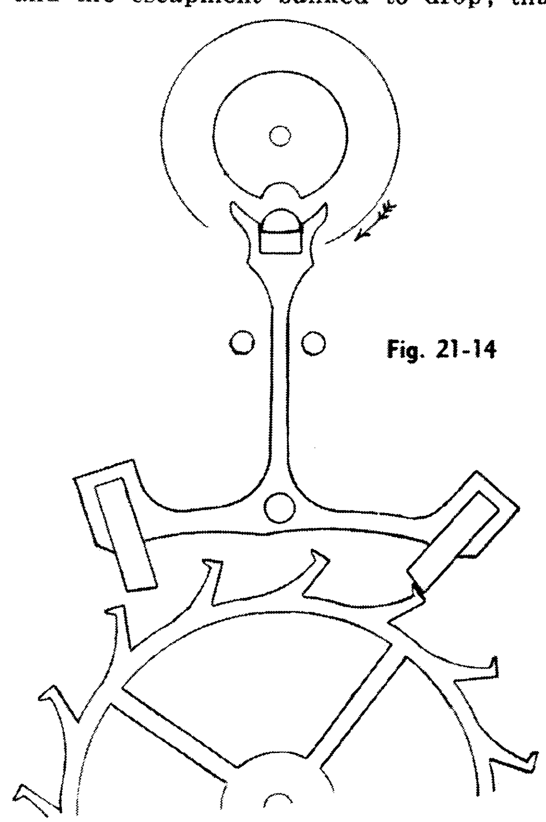


Fig. 21-14

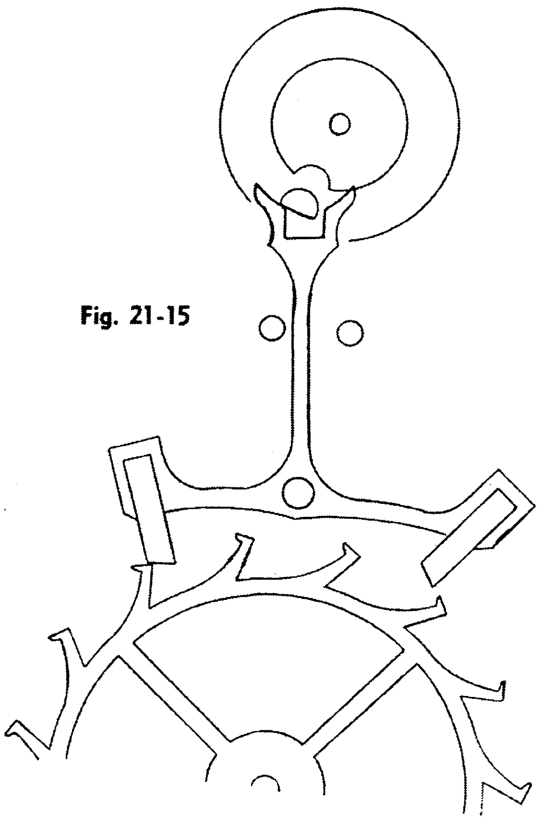


Fig. 21-15

This is frequently done but is entirely wrong, for it gives too much slide. At the locking point, the roller jewel should just pass out of the fork slot without shake. The necessary freedom is given by opening the bankings slightly. Any opening of the bankings beyond this imposes unnecessary work on the balance.

When a banking pin is opened in an escapement banked to drop, it allows the locking face of the pallet stone to slide along the locking corner of the wheel tooth. This is slide—sometimes called run. A perfect understanding of the difference between the terms lock and slide should be acquired.

Lock is the amount that the locking corner of a pallet stone projects beyond the locking corner of an escape tooth at the instant the drop takes place. Lock can only be changed by drawing out or pushing in one or both of the pallet stones. Opening or closing the bankings produces no change in the lock.

When a properly adjusted escapement is in action, a tooth drops on the locking face of a stone. At this moment the fork is a slight distance from one of the banking pins. In its further movement the locking face of the stone slides along the escape tooth until the fork is arrested by the banking pin. This is the slide.

is, the bankings closed up so that the escape wheel will not be released at either side. Now open them until the wheel will be barely released. Leaving them in this condition, replace the balance in such a position that the roller jewel is away from the fork. If on rotating the balance the roller jewel will not enter the fork slot, this is evidence that it is too far forward.

Another way of testing this is by banking to drop while the roller jewel is in the fork slot. If after doing this the roller jewel will not be released by the fork slot, it is evidence that the pin is too far forward.

Figure 21-16 illustrates the first method. The escapement is banked to drop; the roller is assumed to be moving in the direction indicated by the arrow, but the roller jewel is arrested in its motion by the end of the fork horn. It is quite evident that if the roller jewel should be moved back so as to clear the horn, the roller might continue its rotation. Figure 21-17 shows the escape wheel, pallets and fork in the same position as in figure 21-16. The roller jewel here is prevented from leaving the fork slot for the same reason that it is prevented from entering it in figure 21-16.

In either case, opening the bankings would allow the roller jewel to enter or leave the slot.

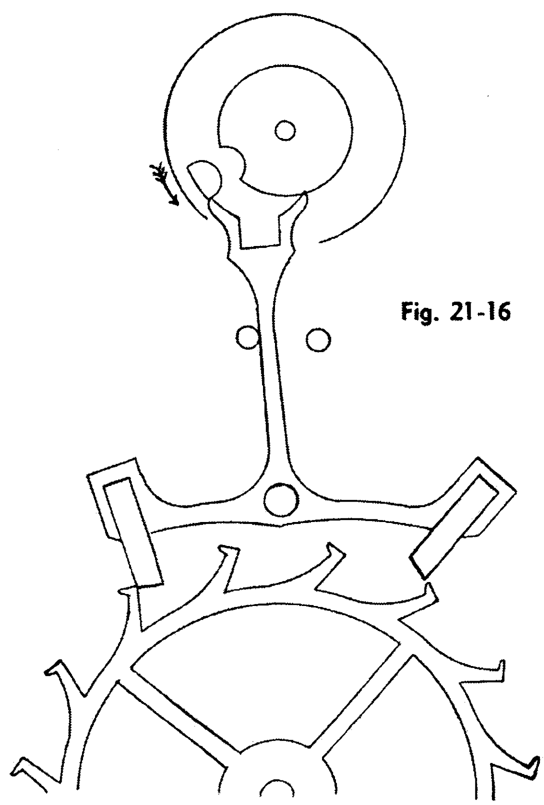


Fig. 21-16

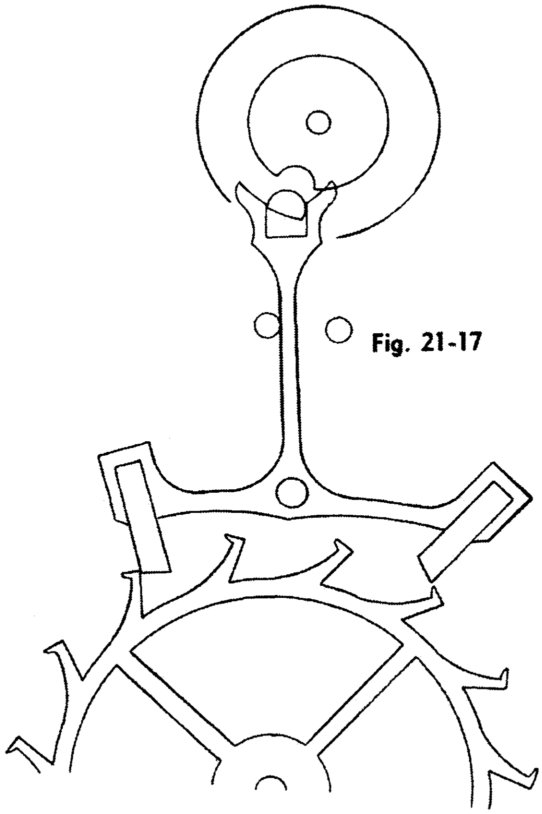


Fig. 21-17

The slide may be increased by opening a banking pin or decreased by closing it, but these operations produce no effect whatever upon the lock.

Figure 21-18 will serve to illustrate the difference between the lock and slide. In this figure the amount of slide is exaggerated for the purpose of making it more readily distinguishable from the lock. The fork and pallets in full lines show the escapement at the lock; the broken lines show it after the slide has taken place.

SEC. 402—The Safety Action

The guard pin in a lever escapement is purely a safety device. It could be dispensed with without impairing the timekeeping quality of a watch, provided the watch was not subjected to any sudden or rapid motion. In order that it may be perfectly reliable as a time-piece a guard pin becomes a necessity. During the free excursion of the balance in the interval between two impulses, the combined action of the guard pin and roller edge prevents the fork going out of position to receive the roller jewel. Without this safety provision a sudden motion given the watch would be liable to cause what is generally called overbanking, or more properly speaking, going out of action.

When the roller jewel leaves the fork slot, the first part of the safety action is secured by the roller jewel and the fork horn. This is due to the fact that the passing hollow cuts away a part of the roller edge and while that cutaway part stands in the path of the guard pin some other means must be provided to prevent going out of action.

Figure 21-19 illustrates the above condition. In this figure the roller is moving in the direction indicated by the arrow. The guard pin, I, is just about to leave the roller edge and enter the passing hollow. Almost immediately the roller jewel will strike the right side of the fork slot, moving the fork and unlocking the escapement. The roller jewel will then be embraced by the fork slot.

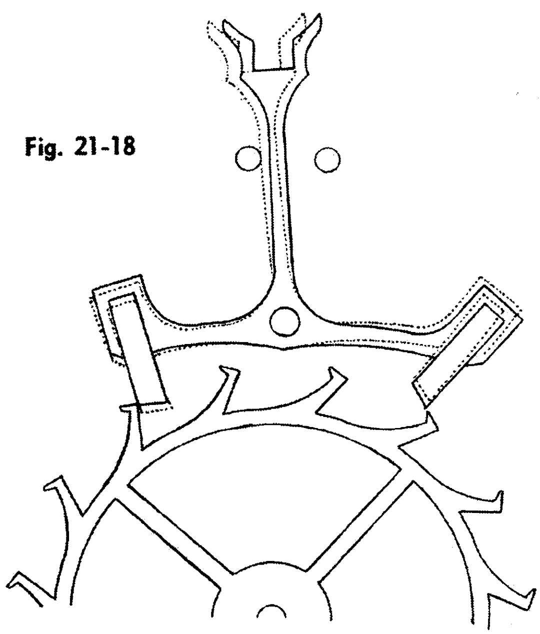


Fig. 21-18

In this drawing the passing hollow is not in position to release the roller jewel until it has been embraced by the fork slot. The passing hollow, however, is rarely as narrow as represented in full lines. As a matter of fact, it would not be practical to make it so. It will be seen that if the passing hollow were as wide as represented by the broken lines, the safety action at the point shown in figure 21-19 would be between the fork horn and the roller jewel. If the fork horn should be cut off entirely, as represented by the broken lines, **3, 3,** the safety action would still be perfect. The passing hollow

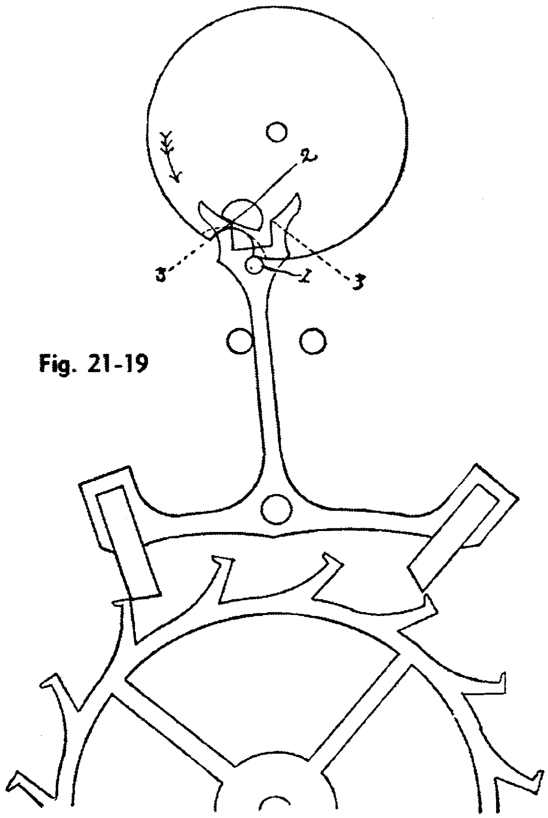


Fig. 21-19

in figure 21-19 represented by broken lines, is wider than is necessary. A passing hollow of a medium width would answer the purpose quite as well. When the roller jewel is made with a circular face as shown, the passing hollow may be left wider without impairing the action, but when the face is flat and the passing hollow wide, the action can not be so nicely adjusted. A double roller should always have an impulse pin with circular face. This condition will become apparent when we reach the description of the double roller escapement. In view of the above, long horns on a single roller escapement are more ornamental than useful.

Figure 21-20 shows how the safety action takes place in the double roller escapement under conditions similar to those prevailing in the single roller shown in figure 21-19. In figure 21-20 the roller is moving in the direction indicated by the arrow and the passing hollow is approaching the guard pin. It will be seen that the roller jewel is still some distance from the fork slot and that before it can enter, the safety action between the guard pin and roller will have ceased. Therefore, a fork horn to provide this safety action is necessary, or else it would go out of action.

When the guard pin in figure 21-20 first comes opposite the passing hollow, the roller jewel will still have a considerable distance to travel before contacting the fork. It is therefore evident that a much greater proportion of the safety action occurs between the roller jewel and fork horn in the double roller than in the single roller escapement.

The curves of the fork horn faces in figures 21-19 and 21-20 are arcs of circles having the same radius, but the centers from which they are described are not in the same location. These arcs are so described that when the fork lies against either banking the curve of the fork horn at that side coincides with the circle described by the face of the impulse pin in its path. In the single roller escapement this is of little importance, but in the double roller it is a great advantage owing to the fact that a greater portion of the safety action must be provided for by the fork horn.

It is a common practice for manufacturers to form fork horn hollows from a common center, in which case the radius must be greater than when two centers are used. These curves are apt to be so wide and to vary so widely from the path of the roller jewel that, especially in a double roller escapement, the safety action may be somewhat uncertain. Add to this a wide passing hollow and we have a combination liable to make trouble and be extremely puzzling to the student.

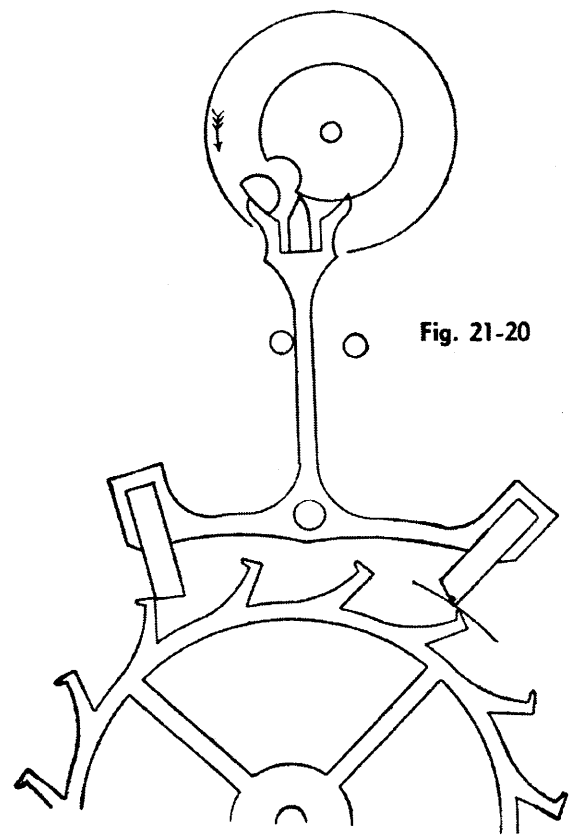


Fig. 21-20

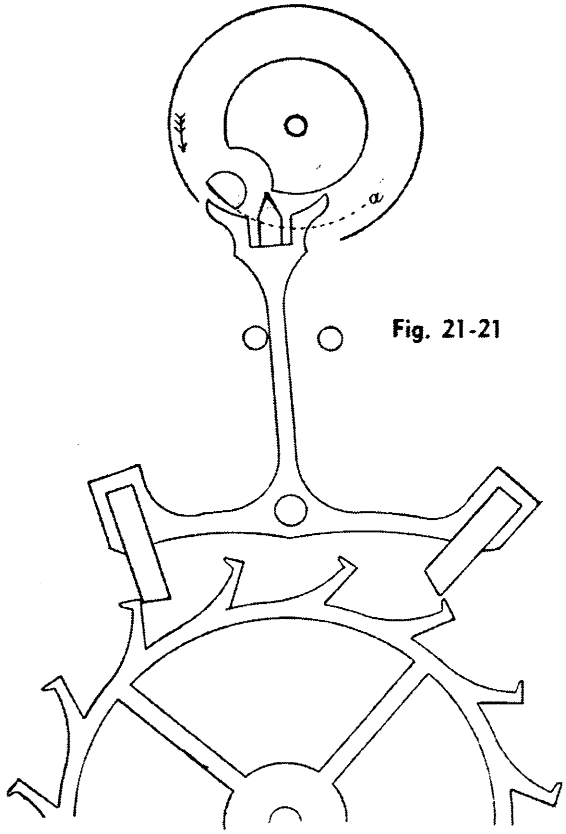


Fig. 21-21

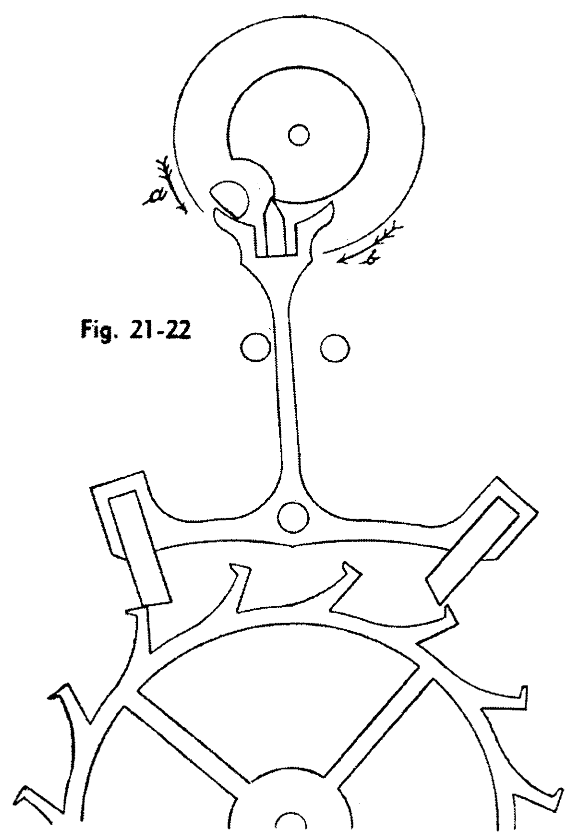


Fig. 21-22

Figure 21-21 illustrates the evil to be apprehended from the condition above described. In this sketch the escapement is shown in the same position as in figure 21-20. The particulars in which escapements differ are: In figure 21-21 the fork horns are curved from a common center, and the passing hollow is wider than in figure 21-20. It will be observed that the curve of the left fork horn does not coincide with the path of the roller jewel, which is the broken line, **a.** The corner of the fork slot is tangent to that line while the extreme end of the fork horn is some distance from it. Under these conditions any sudden jar might throw the fork to the right, thereby wedging the guard pin against the edge of the passing hollow, unlocking the escapement and stopping the watch. This is made clear in figure 21-22.

Figure 21-22 shows the roller in the same position as in figure 21-20. The fork is assumed to have been thrown to the right by a sudden jar. It will be seen that the escapement is now unlocked, an escaped tooth having passed down for a slight distance on the impulse face of the receiving stone. When this occurs and the roller is moving in the direction of the arrow, **a,** it will cause a wedging of the parts that must stop the watch and possibly break the roller jewel, or else bend or break the balance pivot. If it is moving in the direction of the arrow, **b,** it may only trip-check the motion—and pass on, but in that case the escapement must unlock momentarily, causing the watch to lose time to a greater or lesser extent according to the frequency of its occurrence.

It is not intended to imply that every fork in which the curve of the horns is developed from a common center will produce the condition described above. It is only intended to show what may ensue, and to caution the student against neglect in observing this particular feature.

This condition may readily be detected by following the directions below. Turn the balance slowly in either direction until an escape wheel tooth drops on a pallet stone. Then press the fork lightly toward the center position—away from the banking—continuing to turn the balance for about ¼ revolution. If the condition described prevails the escapement will unlock. Now make the same trial on the other stone.

SEC. 403—Guard Pin and Roller Action

In a single roller escapement the guard pin should be upright. Bending it forward, backward, or sideways to adjust the roller shake is not recommended. The evil of this practice will be demonstrated further on.

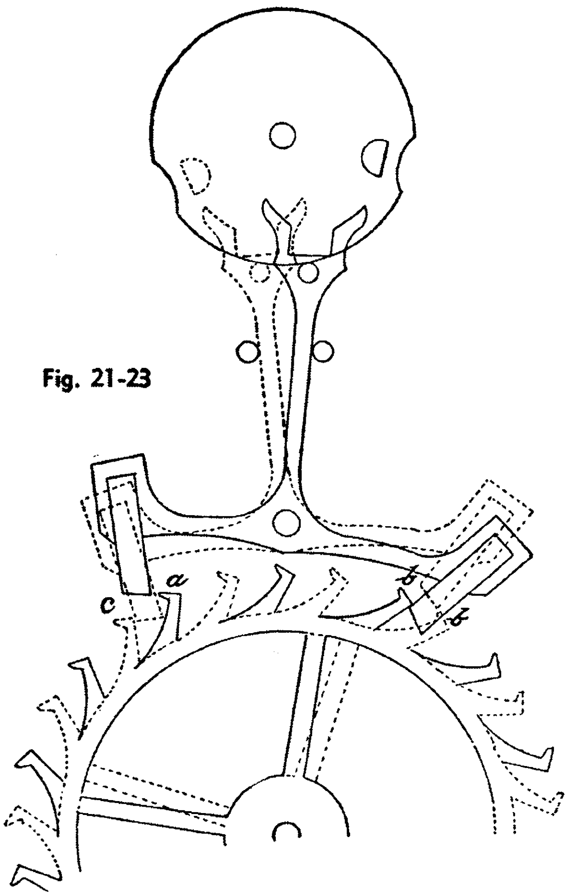


Fig. 21-23

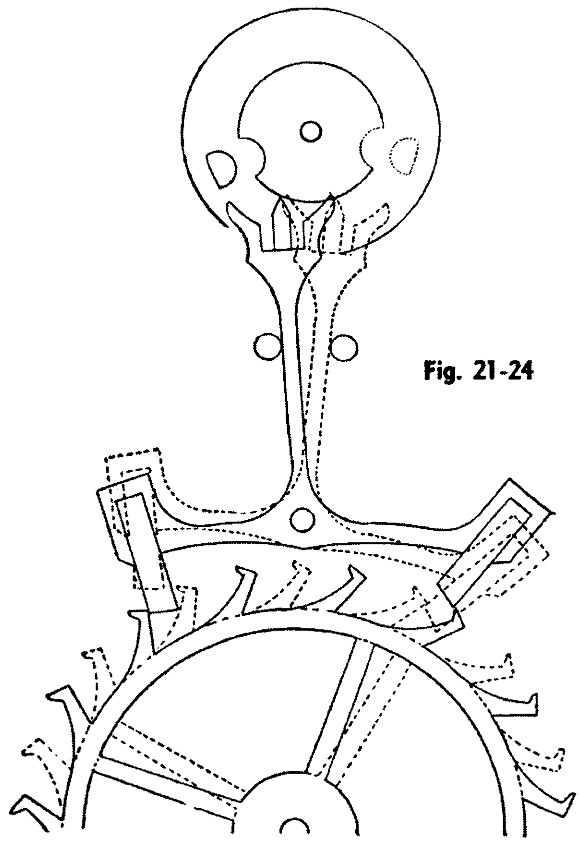


Fig. 21-24

Figure 21-23 shows a single roller escapement banked to drop. In the escape wheel, the full lines show tooth, **a**, of the escape wheel released from the receiving stone. The broken lines show tooth, **b**, after it has passed across the impulse face of the discharging stone, and tooth, **c**, has locked on the receiving stone. It will be observed that the fork lies against the bankings at both sides and that the guard pin contacts the roller at both sides also. This is called "Banked to Drop—No Shake—No Slide," which means that it is banked without either shake between the roller edge and guard pin or slide on either pallet stone.

Figure 21-24 shows the double roller escapement in the same condition as the single roller in figure 21-23. These last two figures show both fork and roller in two positions. Now turn to figure 21-25 which shows the fork in two positions and the roller in one. In this figure the fork, in full lines, is just about to embrace the roller jewel. The safety action which has been, until this instant, between the fork horn and the face of the roller jewel now ceases. In the fork, shown in dotted lines, the safety action is between the edge of the safety roller and guard pin.

Figure 21-26 shows a single roller and figure 21-27 a double roller. By comparing the two it will readily be seen why the single roller is more liable to allow the fork to go out of action than is the double roller. By comparing, in figure 21-26, the broken line **aa** which indicates the path of the guard pin with the broken line **bb**, which is the path it should take, it will be seen that it only requires a slight difference such as might arise from a pallet arbor with too much side shake, to allow the fork to go out of action. The roller is moving in the direction of the arrow and the fork should be at the right with its slot in position to receive the roller jewel. But in going out of action it has passed to the left. The roller jewel is arrested by coming in contact with the outside of the fork horn, and the watch immediately stops.

Now turn to figure 21-27. The two broken lines, **aa** and **bb** are in the same relation to the guard pin as they are in figure 21-26. Although the fork in figure 21-27 is thrown against the roller edge, it can not pass and the escapement is not unlocked. It therefore follows that a slight error which might cause a single roller escapement to go out of action might not seriously affect a double roller.

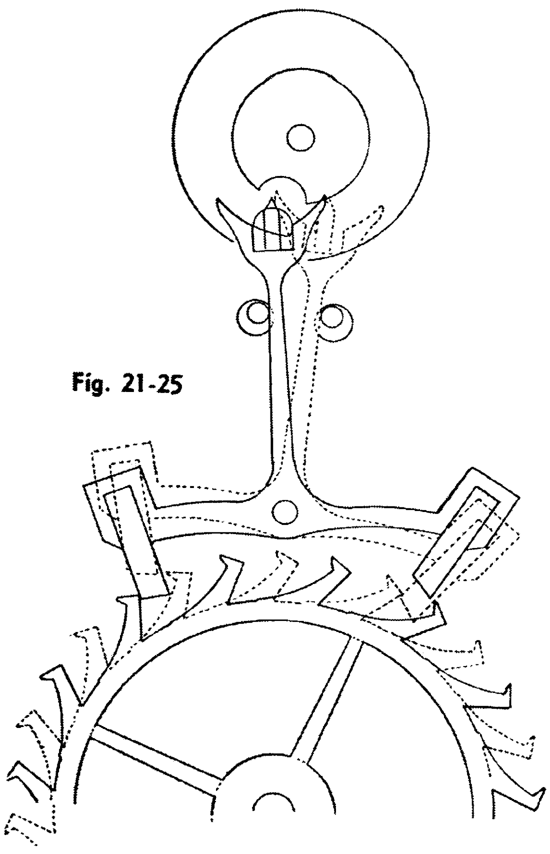


Fig. 21-25

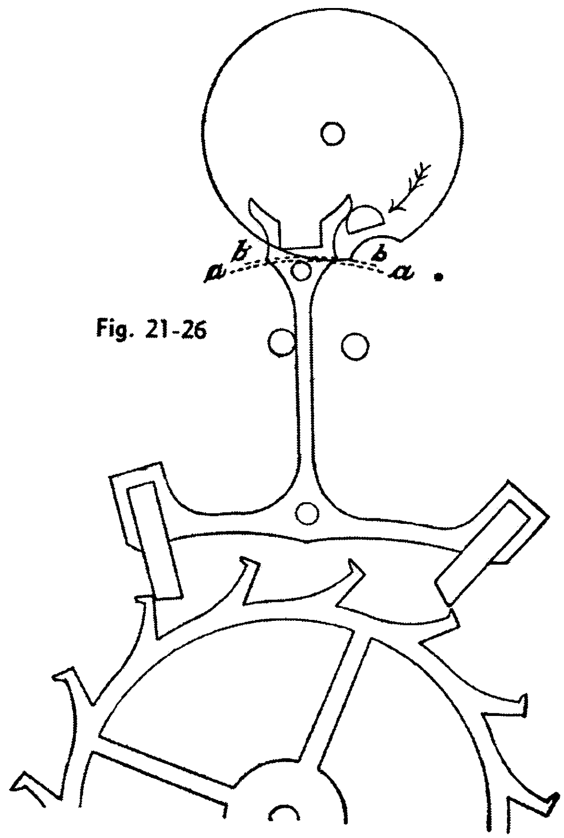


Fig. 21-26

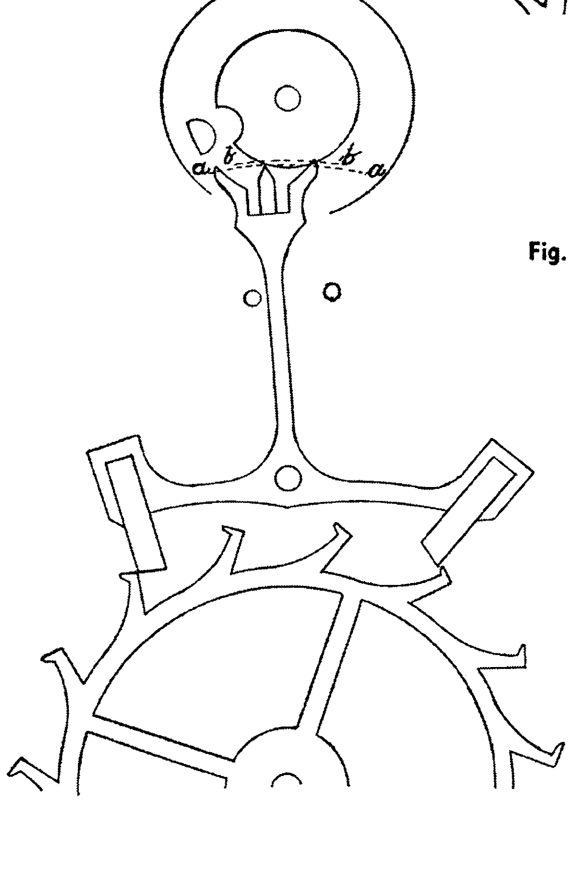


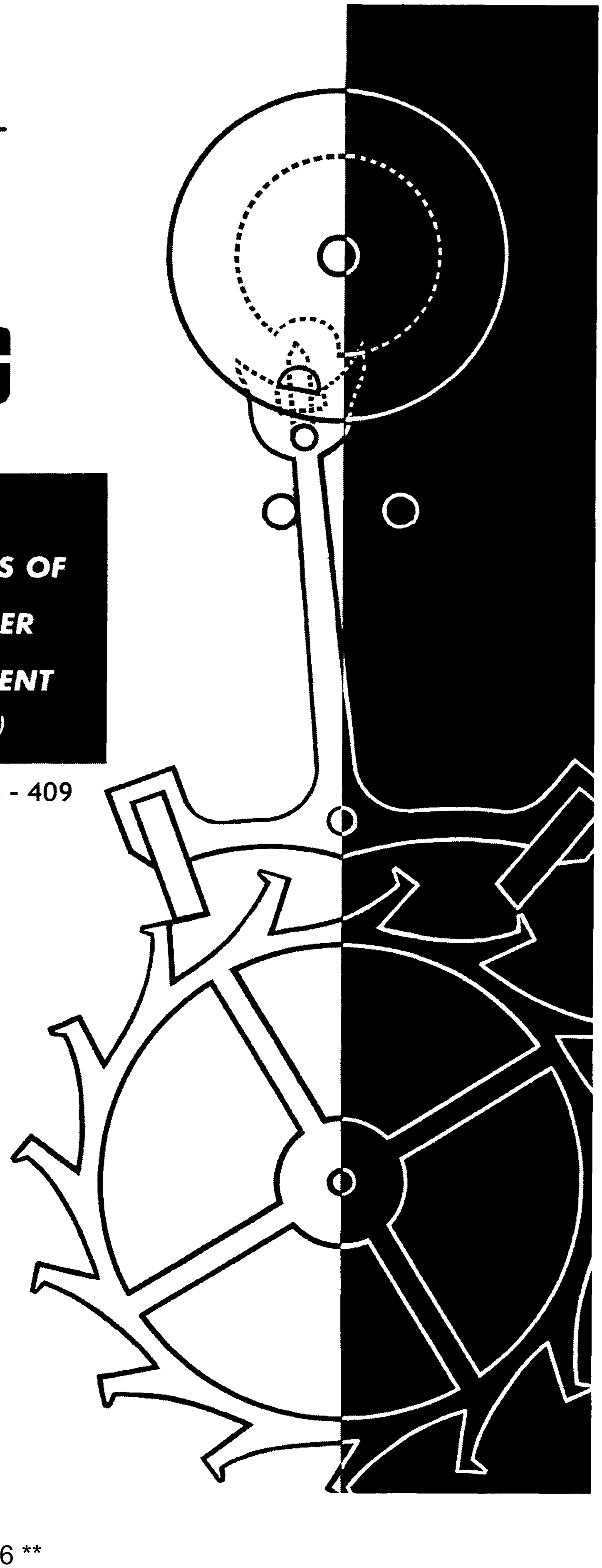
Fig. 21-27

Master
WATCHMAKING

LESSON 22

PRINCIPLES OF THE LEVER ESCAPEMENT
(cont'd)

Sections 404 - 409



CHICAGO SCHOOL OF WATCHMAKING
Founded 1908 by THOMAS B. SWEAZEY

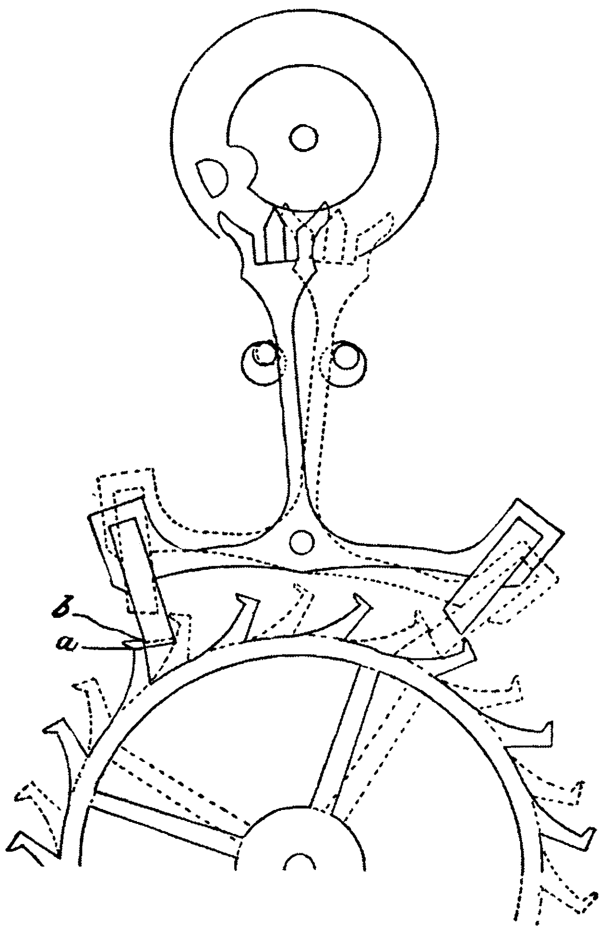


Fig. 22-1

SEC. 404—Unequal Roller Shake

The guard pin should be perfectly central with the fork slot under all conditions. It should never tilt from the perpendicular in a single roller escapement. In a double roller escapement, a line drawn from the point of the dart to the center of the pallet arbor should pass through the center of the fork slot and be parallel with its sides.

Figure 22-1 shows an escapement with unequal roller shake. The full lines show an escape tooth locked by the receiving stone, the guard pin touching the left edge of the safety roller. When the lock takes place on this escapement the locking corner of the tooth strikes the face of the stone at the position shown by the broken line parallel with it, but in order that the dart should free the safety roller, the left banking pin was opened from the position shown as dotted line to that shown as a full line. This allowed the pallet stone to slide down on the tooth until the locking corner of the tooth was at point **b**, and the locking corner of the stone at point **a**. Now inasmuch as the banking pin must be moved even more in order to give sufficient freedom to the safety roller, the distance that the stone projects below the locking corner of the tooth will be further increased to the detriment of the escapement, and entailing a loss of power.

The fork shown in broken lines in the same figure is in the position in which a tooth is released by the receiving stone and is properly locked on the discharging. Examining the position of the dart with reference to the safety roller we find that it is at some distance from its edge. This is the condition technically called "Out of Angle." There are several impractical means resorted to for its remedy. One is to bend the guard pin as shown in figure 22-2. This, however, throws it out of line with the center of the fork slot and should therefore not be tolerated. Another method is to draw out the discharging stone and push in the receiving stone a sufficient amount to correct the out of angle; but moving a pallet stone in or out produces several changes in an escapement and it should never be done without previously thoroughly examining the escape wheel and pallet action so as to avoid the danger of creating another error.

Figure 22-2 shows the effect of bending the guard pin out of line with the center of the fork slot. In this drawing the guard pin is bent to the left to correct the defect in the safety action shown in figure 22-1. This alteration leaves the escapement with correct lock and slide. The safety action is correct so far as the guard pin and roller are concerned, but the impulses, delivered by the pallets to the roller jewel, are at unequal distances from the line of centers. The

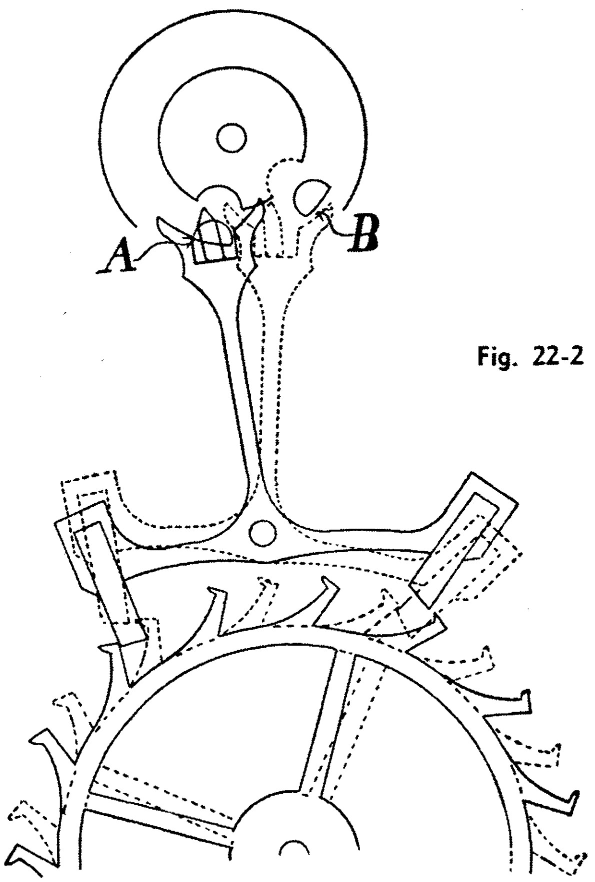


Fig. 22-2

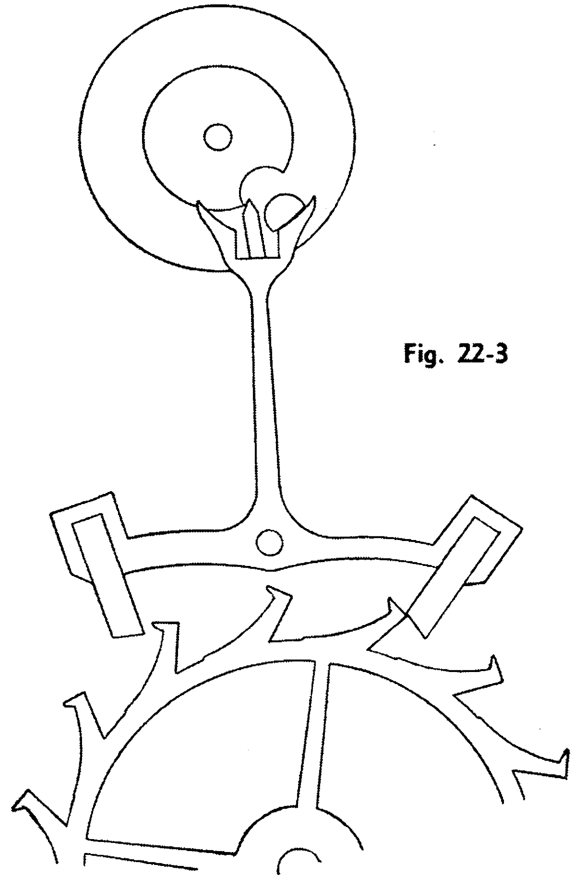


Fig. 22-3

greatest portion of the impulse on the receiving stone is delivered after the line of centers has been passed; the least amount on the discharging stone. A condition of this character would seriously affect isochronism and position adjustment. A more serious error has also been created. Referring to figure 22-2 it will be seen that corner **A** of the fork slot will not permit the impulse pin to pass freely out of it, while at the other side at the point marked **B,** there is more room than is required. This might be remedied by grinding way the left horn of the fork, but it would still leave the unequal impulse.

The condition just described, however, is not the most serious one resulting from bending the guard pin to equalize the roller shake. The escapement is liable to do what is technically called "Trip." The escapement shown in figure 22-2 would do this. If the fork should be pressed to the left when the escape tooth is locked on the discharging stone and the point of the guard pin is opposite the passing hollow, the tooth might unlock from the discharging stone.

Figure 22-3 illustrates the above. In this figure an escapement is shown with the guard pin bent as in figure 22-2. The roller is assumed to have moved from the position there shown to the position shown in figure 22-3, or until the passing hollow is opposite the guard pin. In this position the fork has been pressed to the left. The safety action between the roller jewel and fork horn fails to arrest the movement of the fork until the escapement has unlocked on the discharging stone as shown.

Moving the pallet stones for the sole purpose of changing the roller shake is a method often practiced, but it is not to be advised. It necessitates more time and jeopardizes the escapement action. A pallet stone can not be moved without altering the escapement in at least four particulars: Impulse, draft, lock and drop.

The simplest and best method of making the alteration is to bend the fork. This alters no other functions of the escapement.

Bending a fork is an operation of which many students stand in awe, but there is little danger if done carefully.

Before attempting to bend a fork ascertain whether it is of sufficiently low temper to permit doing so with safety. It is not necessary to disfigure a piece made of steel in order to ascertain whether it is hard or soft. Use a fine, sharp file. Place it on an unpolished part of the piece to be tried. Without actually moving the file,

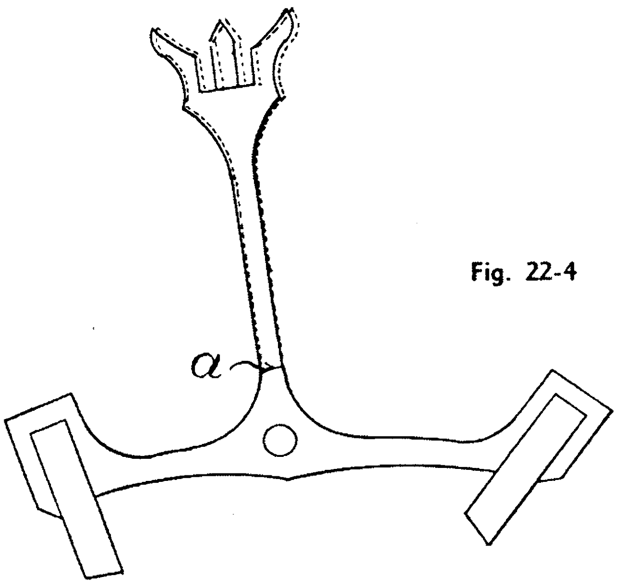


Fig. 22-4

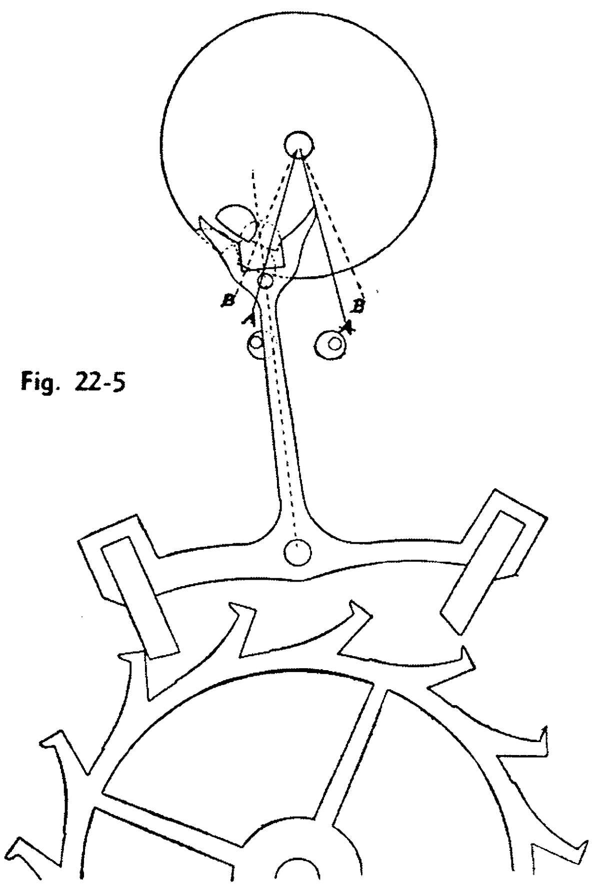


Fig. 22-5

exercise a gentle forward pressure. If the steel is hard it will offer no resistance to the movement of the file. If it is not hard the file will cling to the steel, more or less, in proportion to the temper. A little practice will enable anyone to become expert at this method. It is seldom that a fork is too hard to permit bending, but should it be, there remains but one of two courses to pursue: Let it alone or take the stones out and draw the temper. There is no objection to reducing the temper of a fork to a sufficient amount to allow it to be bent with safety. Figure 22-4 shows where the bend should be made. If it is done at point **a,** a very little bending will be sufficient.

There are several methods practiced in bending a fork. It may be set edgewise on a soft metal block and struck lightly with a punch. It may be bent between dies or jaws of pliers especially shaped for the purpose. Or it may be pened with a hammer.

To summarize the conditions necessary for correct safety action: The guard pin central with the fork slot; the sides of the fork slot parallel and of equal length; the inside curves of the fork horn of the proper arc and equal in relation to the fork slot; the roller jewel squared in front and upright; the edge of the safety roller perfectly polished and free from imperfection; the escapement in angle.

SEC. 405—Guard Pin Too Far Forward

When the guard pin is too far forward the banking pins are sometimes opened to allow the roller to pass. This method should never be resorted to for the reason that it increases the slide as well as the angle of contact between the roller jewel and fork, both of which incur a loss of power.

Figure 22-5 illustrates this condition in a single roller escapement. The single roller is used for the reason that it is desired to show how that form of escapement can be corrected for errors caused by the incorrect distance of the guard pin from the pallet center.

It will be observed that, in order to clear the guard pin from the roller edge, the banking pins have been opened, thus making the slide excessive as indicated by the position of the receiving stone with relation to the tooth which it locks. This imposes additional work upon the balance in unlocking the escapement. It also, as has already been pointed out, increases the angular distance during which the roller jewel and fork remain in contact. The full lines, **AA,** indicate the angle of contact as it should be; the broken lines, **BB,** indicate the angle of contact with the banking pin open to allow the guard pin to clear the roller edge.

The angle of impulse of a roller is where the two radii from the roller center through the roller jewel center intersect lines running from the pallet arbor through the center of the fork slot. In figure 22-5 this angle is shown in broken lines. It will be noticed that the lock in this figure is excessive. If reduced to the proper amount the impulse angle would be as represented by the full lines **AA.**

Experience has taught us that a short arc of impulse produces better results than a long one.

To remedy a guard pin in a single roller escapement which is too far forward, proceed as follows: Push the guard pin through a small piece of tissue paper, the object being to prevent marring the polished face of the fork. With a fine file, dress the pin to a point as shown at **B,** figure 22-6. **A** is the pin before being dressed down. It may be reduced as much as necessary without injury to the safety action. In fact, a V-shaped safety pin is superior to a cylindrical one in this particular.

In the double roller escapement an alteration in the length of the guard pin is so simple that instruction is deemed unnecessary.

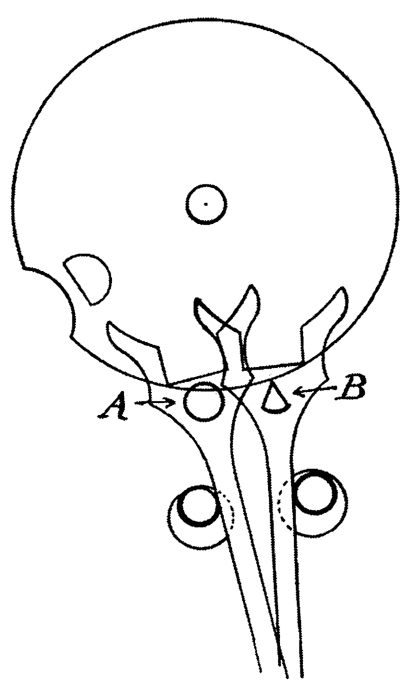


Fig. 22-6

SEC. 406—Guard Pin Too Far Back

A guard pin which is too far back in a single roller can be corrected by simply driving the guard pin out, broaching out the hole in the fork and inserting a larger pin.

The guard pin in figure 21-27 is rather short. It is short the same amount as the guard pin in figure 21-26 is too far back. As has been previously explained, the fork in figure 21-26 would go out of action, but while that in figure 21-27 would not, its action would be improved by stretching the dart.

SEC. 407—The Escape and Pallet Action

The escape and pallet action is the most intricate function of the escapement. A thorough knowledge of it calls for thoughtful study. Yet there is nothing about it that can not be mastered by the student. In treating it, it is deemed best to divide it into five branches: Impulse, Draft, Lock, Slide, Drop.

SEC. 408—Impulse

An escape tooth, in delivering impulse to a pallet, moves in an arc of 12 degrees.

In the ratchet tooth escapement all the impulse is on the pallet; otherwise the same rules apply to it as to the club tooth. A brief description of the ratchet tooth escapement will be given later on.

The chief advantage of the club tooth escapement over the ratchet tooth is that the former can be constructed with less loss of power from drop. A minor advantage is that there is less liability of wedging the guard pin against the roller edge when the train is reversed, which sometime occurs in setting the hands backward.

In the club tooth escapement, the circular

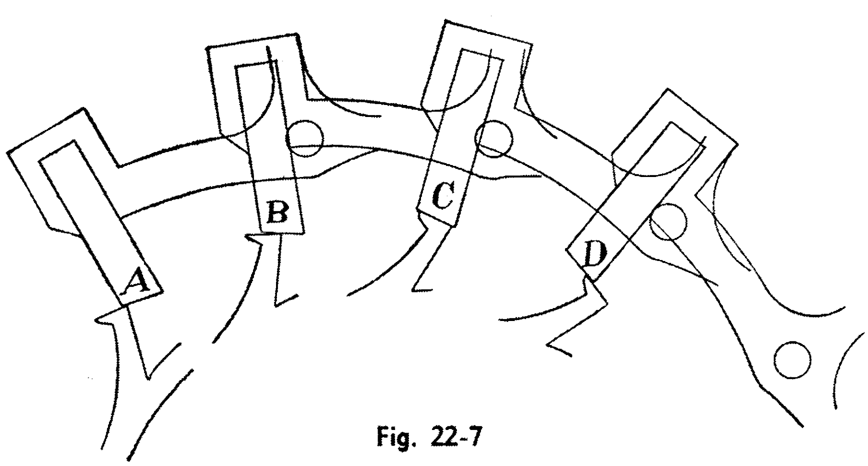


Fig. 22-7

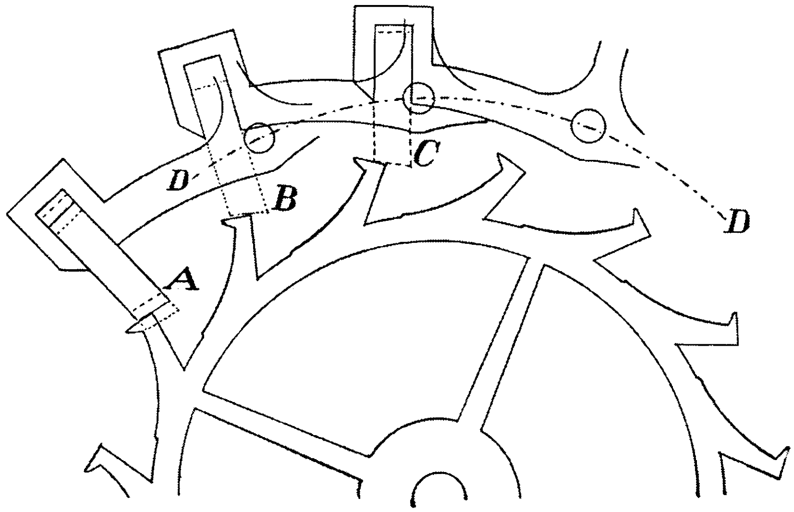


Fig. 22-8

impulse is divided between the wheel tooth and the pallet stone. This division is in various proportion, usually within the narrow limits of four-tenths to the tooth and six-tenths to the stone, and equal amounts to both.

Figure 22-7 illustrates a good type of action. In this drawing an escape tooth is shown in four positions while delivering impulse to the receiving stone. It will be observed that when the tooth begins to pass over the stone, as at **A,** the impulse faces diverge from each other. In this position only the locking corner contacts the impulse face of the stone, and from this point the faces diverge backwards to the locking corner of the stone. At **B** the tooth is shown having passed further along on the impulse face of the stone and a divergence at a somewhat less angle is seen. As the impulse progresses the faces of the tooth and stone coincide in the position shown at **C.** From that point the divergence begins to appear in the reverse direction as at **D,** and continues until the tooth is released. This is called a natural divergence. It is less apt to cause wear and also reduces friction.

As previously stated, an alteration made in an escapement by moving a stone in or out changes the impulse action. Figure 22-8 shows the effect of changing the position of a receiving stone. In order to demonstrate the actual result of moving a stone, the pallets are drawn in three positions in relation to the wheel. At **A,** the stone is shown in correct position in full lines. It is shown in dotted lines drawn out. It is shown in broken lines pushed in. The back as well as the impulse face of the stone is indicated by similar lines. The centers of the three pallets are equi-distant from the center of the escape wheel, as indicated by the line **DD.** The position at **A** is normal; that at **B** is with the stone drawn out to the dotted line; that at **C** is with the stone pressed in to the broken line.

It will be seen that moving the stone outward as at **B** increases the divergence backwards from the locking corner of the wheel; that moving the stone inward as at **C** produces a divergence in the opposite direction. The latter is considered a bad action for the reason that the locking corner of the stone scrapes across the impulse face of the tooth, wearing it away rapidly.

Moving a discharging stone produces results directly opposite to those resulting from moving the receiving stone.

Figure 22-9 shows the effect on the impulse of moving a discharging stone. At **C,** where the stone is pushed in, the divergence is excessive; at **B,** where the stone is drawn outward, the divergence is in the wrong direction; at **A,** where it is in proper position, the divergence is natural.

There is another result from moving a pallet stone which must not be overlooked. It changes the extent of the arc of vibration of the pallets. In other words—changes the lift.

The term "lift" is applied to the thrust given to the pallets by an escape tooth. In the lift the pallets swing on their own center and the extent of that swing is called the arc of vibration. It has been explained that the circular impulse is measured from the center of the escape wheel and is divided between an escape tooth and a pallet stone. The lift is measured from the pallet center and is also divided between an escape tooth and a pallet stone.

Figure 22-10 shows variation in lift caused by changing the position of a receiving stone.

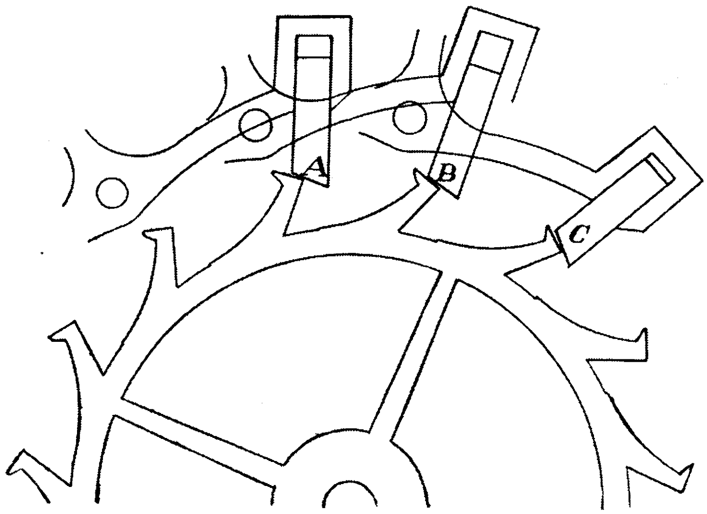


Fig. 22-9

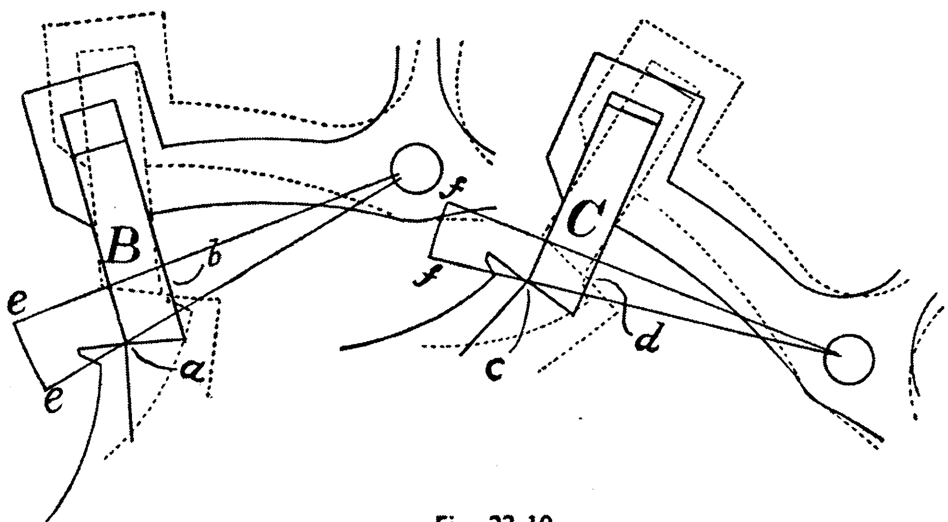


Fig. 22-10

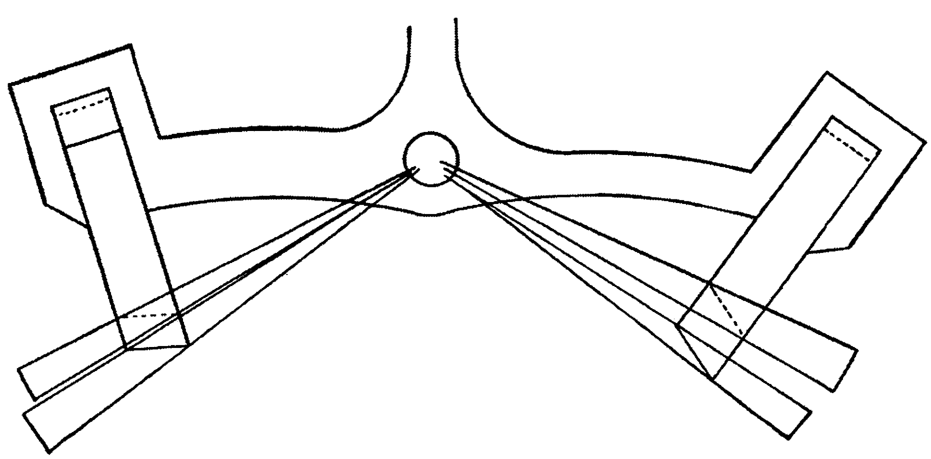


Fig. 22-11

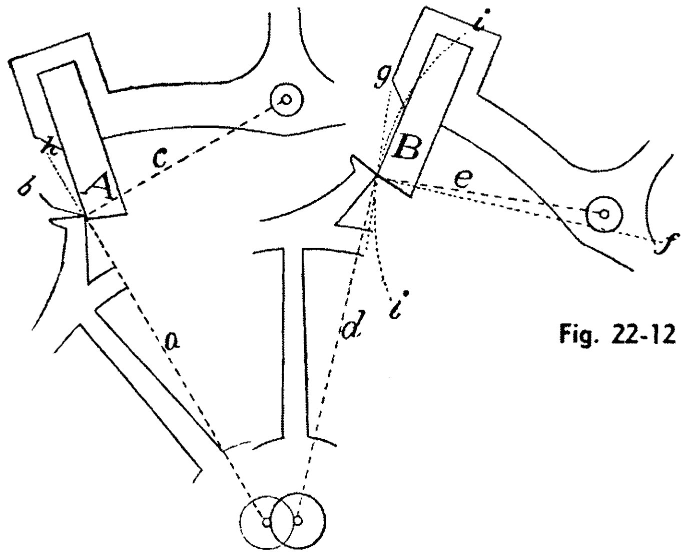


Fig. 22-12

The positions of the stones **B** and **C** are identical with those similarly marked in figure 22-8. That is, they are located in the same position at **B,** figure 22-10, as at **B,** figure 22-8; also at **C,** figure 22-10, as at **C,** figure 22-9. Both wheel and stone are shown in full lines at the beginning of the lift and in dotted lines at the end. Referring to **B,** the lift begins at **a** and ends at **b.** The lines **ee** radiating from the pallet center intersect the pallet stone at the locking corner at the beginning and end of the lift. Referring to **C,** it begins at **c** and ends at **d,** the lines **ff** intersecting at the locking corner. Now it is quite evident that the angle inclosed by the lines **ee** is greater than the angle inclosed by **ff,** which shows that drawing out a receiving stone increases the lift.

Another result brought about by moving a receiving stone would seem anomalous. It is this: While drawing out the receiving stone deepens the lock on both stones, it deepens the lock more on the discharging stone than on the receiving. Drawing out the discharging stone has the opposite effect, deepening it more on the receiving than on the discharging stone.

Figure 22-11 will show more clearly how the difference in the lift is produced. The pallets have both stones shown in two positions. The position with regard to the receiving stone is identical with that shown in figure 22-10. The dotted lines indicating the face and back of the stone correspond with **C,** figure 22-10, and the full lines with **B** in the same figure. In the discharging stone the same conditions are indicated by dotted and by full lines. This figure shows clearly that drawing out the receiving stone increases the impulse, while drawing out the discharging stone decreases it.

SEC. 409—Draft

The draft of an escapement is that power which draws the fork away from the roller after it has delivered an impulse. It is secured by setting the pallet stones at such an angle in relation to the direction in which the force exercised against the locking face is resisted, that it will draw the fork against the banking.

The term "resisted" is used for the reason that a misunderstanding on this point prevails to some extent.

The draft is determined by the inclination of the locking face of a pallet stone from a line drawn at right angles to a radius from the pallet center to the point of contact between the locking corner of the wheel tooth and the locking face of the pallet stone. Figure 22-12 will make this detailed explanation of draft more clear.

At **A** is shown what is known as "Tangential Locking." In this form the broken radial line **a** from the wheel center to the locking point **b** forms a right angle with the broken line **c,** from the pallet center to the same point. In the form shown at **B,** the broken radial lines **d** and **e** do not form a right angle. This is known as non-tangential locking.

In the former case the force exercised by the escape wheel is directly towards the pallet center and the resistance to that force is precisely on the same line. In the latter case the force is directed as indicated by the dotted line **f,** while it is resisted in the direction of the broken line **e.** In other words, at the tangential locking the force and the resistance are on the same line, while at **b** non-tangential the force and the resistance are on different lines. The resistance being in the same direction in both cases, the draft angle must be determined in relation to a radial line from the center of the pallets to the locking point.

The dotted line **g** is termed the tangential line, meaning that it touches the arc **ii** at the intersection of the radial line **e.** The draft angle is laid out from this tangential line. In the escapement shown at **A,** the broken radial line **a** is continued by the full line **h** in order to show that the tangential and the radial lines are in this case identical.

Insufficient draft is a serious error. Where it exists there is a constant liability that when the watch is subjected to some sudden motion, the fork will leave the banking and strike the safety edge of the roller, thus retarding the motion of the balance. It is a waste of time to attempt adjusting a watch having this fault.

A common method of testing the draft of an escapement is to lay the watch in a horizontal position, then draw the fork slightly away from the banking and see that it returns to its original position. It is advisable to try the banking under the most unfavorable conditions to which the watch is likely to be subjected in its owner's possession. First, see that the watch is let down to the point it would have reached after a run of 24 hours, then hold the watch in a vertical position. If the fork is poised it will make no difference in what position the watch is held as long as it is vertical, but if the fork is unpoised it should be held with the heaviest part lying in a horizontal line with its center. If the fork is without a counterpoise the arm would then be horizontal. In this case first try the fork by drawing it slightly away from the banking while the fork is in horizontal position to the right. This will usually be on the receiving stone. Then turn the fork to the left which will be on the discharging stone. The object of using this method is to insure against insufficient draft. If the draft is not sufficient to draw the fork against the banking under the conditions stated, it should be increased.

It is rarely that an escapement is found with too much draft. Should there be a suspicion that such is the case it can be easily determined: Take a small piece of wax and attach it to the fork by inserting it on the guard pin or by any other method that may suggest itself; then try the draft as before. Judgment will dictate the additional weight that should overcome the draft.

Draft can sometimes be changed by tilting a pallet stone in its slot. This, however, cannot be done when the stone is closely fitted. Another method by which the draft may be altered is by pushing in one stone and drawing out the other.

Drawing out the receiving and pushing in the discharging stones increases the draft on both stones. Drawing out the discharging and pushing in the receiving stones decreases the draft on both stones. That is, drawing out the receiving stone causes an escaped tooth to drop farther upon the locking face of the discharging stone, which of course increases the draft on the discharging stone, but it also increases the lock, which must be remedied by pushing in the discharging stone. This causes a tooth to drop farther down on the receiving stone, increasing the draft. A slight movement of the stone in or out will change the draft to a considerable extent. In changing a draft by this method extreme care should be used to avoid introducing other errors.

It should be borne in mind that drawing a receiving stone increases the drop on the discharging stone, but does not alter the drop on the receiving, but in pushing in the discharging stone to correct the lock, the drop is decreased on the receiving stone.

It should also be borne in mind that drawing out the receiving stone increases the divergence of the impulse face of the wheel with that stone, and that pushing in the discharging stone increases the divergence on that stone in the same manner.

That is, drawing out the receiver and pushing in the discharger increases the divergence on both stones.

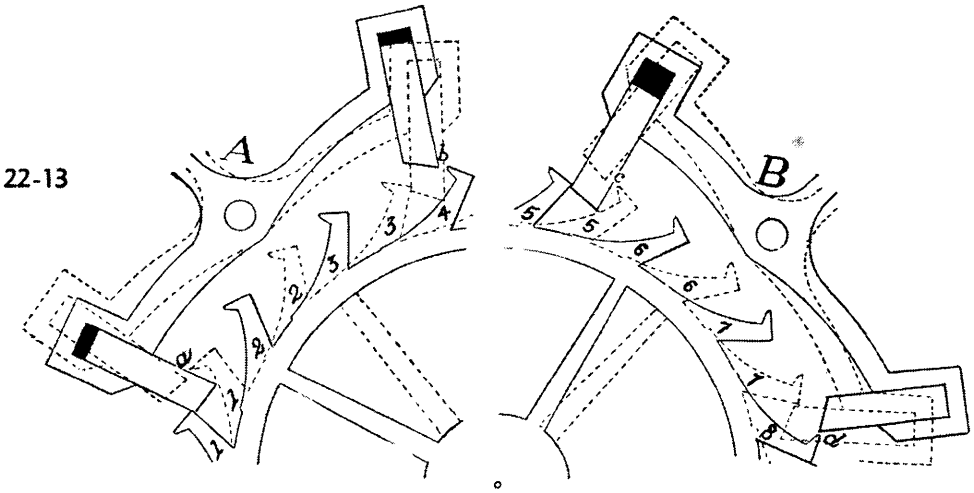
Pushing in the receiver and drawing out the discharger decreases it.

When the draft is altered by pushing and pulling the stones, that operation puts the fork out of angle, which must be corrected by bending. Later on in this work, directions will be given for making a drawing of an escapement.

Figure 22-13 shows effect on the drop of moving a stone. At **A** the pallets and wheel are shown in two relative positions. In the first position they are shown in full lines and the teeth marked **1, 2, 3, 4.** The wheel will move forward when a tooth is released by the receiving stone. The pallets are then in the position shown in dotted lines and the wheel teeth, in dotted lines, are marked **1, 2, 3.** In the drawig shown at **A** the drop is equal. The distance between the releasing corners of the receiving stone and tooth **1,** as shown at **a,** is exactly the same as the distance between the releasing corners at **b.**

Now referring to the pallets shown at **B,** it will be observed that the receiving stone has been drawn out, as indicated by the black space in the pallet slot, and that the discharging stone has been pushed in, as indicated by the disappearance of the black space that was shown in the discharging stone slot in pallets **A.** At **B** the escapement is shown under the same conditions as at **A:** Lock on the receiver in full lines; on the discharger in dotted lines. It will be

Fig. 22-13



plainly seen that the distance between the releasing corners at **c** is greater than at **d.** This is to say that while the lock was equal with the stones in position, as at **A,** drawing out the receiving stone and pushing in the discharging made them unequal, as at **B.**

Figure 22-14 shows a pair of pallets with escape wheel teeth in three positions on each stone. The three positions are indicated by the escape wheel shown in dotted lines and in broken lines. From the points of contact are drawn dotted, broken, and full lines running radially to the pallet center and at right angles to the radii. These lines are marked **a, b, c** on the receiving side and **d, e, f** on the discharging side. The inclination of the locking faces of the stones toward these lines determines the draft. The drawing is for the purpose of showing the opposite effects produced by moving a receiving stone from that produced by moving a discharging stone. Referring to figure 22-14, it must be evident to the observer that the farther up the locking takes place on the receiving stone the less will be the draft, and that the further up it takes place on the locking face of the discharging stone the greater will be the draft.

In case the foregoing is not perfectly clear to the student, let him suppose the tooth locked on the receiving stone at the junction of the lines **cc** and that a tooth dropped on the discharging stone at the junction of the lines **ff.** In this position the draft will be represented by the angle formed between the locking faces of the stones and the lines **c** and **f,** respectively. Now if—leaving the wheel tooth as it is—we draw out the receiving stone until its locking corner coincides with the junction of the lines **aa,** we have not changed the draft; but when the stone is thus drawn out the pallets will have to swing further to release the tooth, with the result that the lock will now take place on the discharging stone at the junction of the lines **dd.** Thus it would be seen that the moving of a stone does not alter the draft on it, but on the opposite stone.

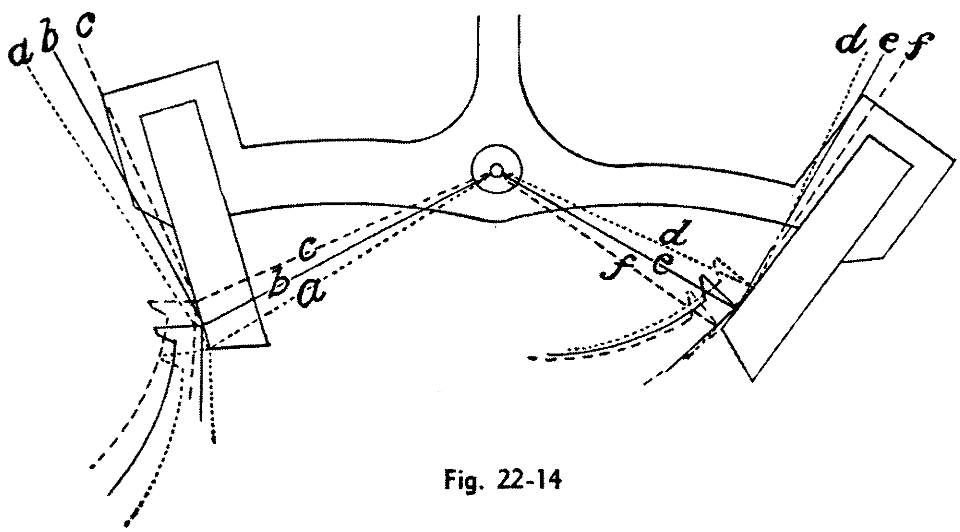


Fig. 22-14

SEC. 410—Lock

Lock is the distance from the locking corner of a pallet stone to the point at which the wheel tooth strikes it at the instant it drops. It should be as little as possible, consistent with the proper allowance which should be made to cover certain unavoidable mechanical defects, such as side-shake in the pivot holes, inaccuracy in the escape wheel teeth, etc. The amount of lock measured in angular distance is about three-quarters of a degree. In actual measurement it would be, on a 16 or 18 size escapement, 2 to 3 hundredths of a millimeter.

Figure 22-15 will give an idea of this amount in proportion to the size of the escapement.

Moving one pallet stone either outward or inward alters the lock on both stones. While it does not alter them exactly in the same proportion, yet the difference is trifling for ordinary alterations of this nature. In equi-distant center escapements, when the lock is equal as to angular measurement, it will be slightly greater in actual measurement on the receiving stone than on the discharger. This is due to the fact that the locking face of the receiving stone is farther from the center of the pallet than the locking face of the discharging stone. Judgment should be used when making an alteration for lock. Bear in mind what has been said in reference to the effect, in other particulars, of moving a stone.

SEC. 411—Slide

Slide—sometimes called run—is the distance from the point at which the wheel tooth strikes the locking face of a stone at the instant of drop to the point it reaches when the motion of the pallet is arrested by the fork coming in contact with the banking. The purpose of the slide is to allow proper freedom for the impulse pin to pass out of the fork slot; also, freedom between the guard pin and the edge of the roller. Its amount should be about the same as the lock. Figure 22-15 shows both lock and slide on the receiving stone as indicated by the lines radiating from the pallet center.

Lock and slide, in combination, are sometimes referred to as "total lock." This term seems confusing as it necessitates the use of the two terms "lock" and "total lock." It leads to a confusion of terms. Lock and slide are two distinct functions. Opening or closing a banking alters the slide but does not change the lock. A pallet stone must be moved to change the lock.

Referring back to figure 21-18, it will be seen that a wheel tooth is locked on the receiving stone, but the fork is not quite in contact with the left banking. Moving it into contact will make the slide on the stone. The slide is very easily changed by moving the banking, but should never be increased beyond an amount equaling the correct lock.

SEC. 412—Drop

Drop is the space that the escape wheel passes through during the interval between the release of one tooth by a pallet stone and the arrest of another tooth by the opposite stone. The drop is clearly shown in figure 22-15. At the point marked **A** the tooth has just been released by the discharging stone; at **B** a tooth has contacted the locking face of the receiving stone. The space intervening between the releasing corners of tooth and stone at **A** exactly equals the space between the locking corner of the tooth and its point of contact with the stone at **B** before it dropped. This is the drop and should be alike on both stones.

Drop may be altered by spreading the stones apart or closing them. The former increases the drop from the receiving stone to the discharger and decreases the drop from the discharger to the receiver. Closing the stones has the opposite effect; hence it is seen that a change made in this manner may affect a correction with a very slight movement, as its effect is always multiplied by two. Another way in which the drop may be altered is by moving a pallet stone in or out. Moving a pallet stone does not change the drop on that stone, but on the opposite one.

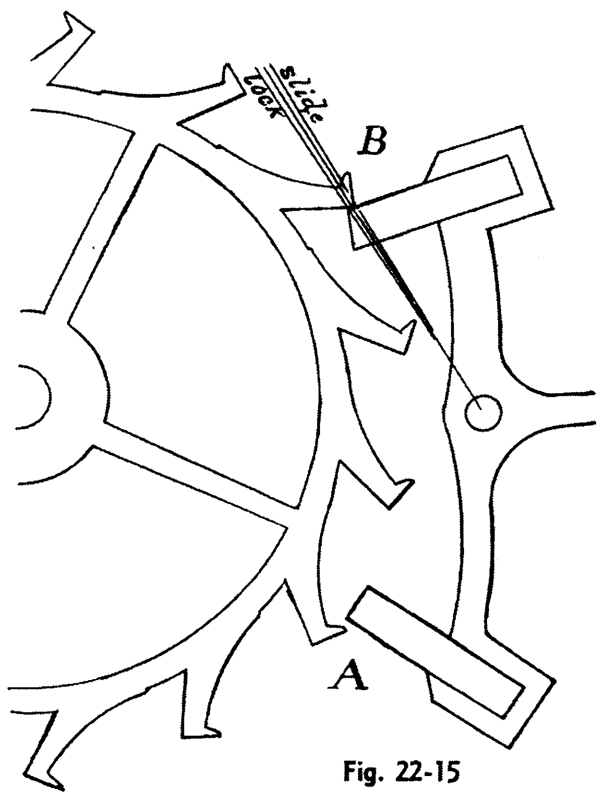


Fig. 22-15

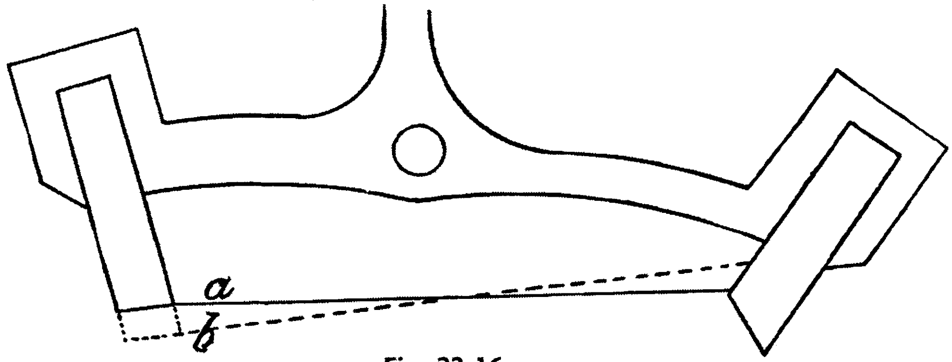


Fig. 22-16

Moving the receiver out increases the drop on the discharger; moving the discharger out increases it on the receiver; moving it in has the opposite effect.

Drop is sometimes termed inside and outside shake, meaning that when a tooth has been released by the discharging stone and another locked on the receiving, if the pallets are then swung so as to almost—not quite—lock, the wheel may be moved to and fro. The locking corner is arrested by the receiving stone and the releasing corner of another tooth is arrested by the discharging stone. This is called the outside shake. With a tooth just locked on the discharging stone there will be three teeth embraced by the stones and the play between them is called the inside shake.

Figure 22-13 will illustrate what is meant by inside and outside shake. In both **A** and **B** the escapement in full lines shows the outside shake; that in dotted lines the inside shake. At **A** the lock is equal and the inside and outside shakes are equal, while at **B** the locks are unequal, making the outside shake close. In speaking of shake as applied to pallets, it is technically termed "close inside" and "close outside," the former meaning that the drop is less on the discharging stone, the latter that it is less on the receiver.

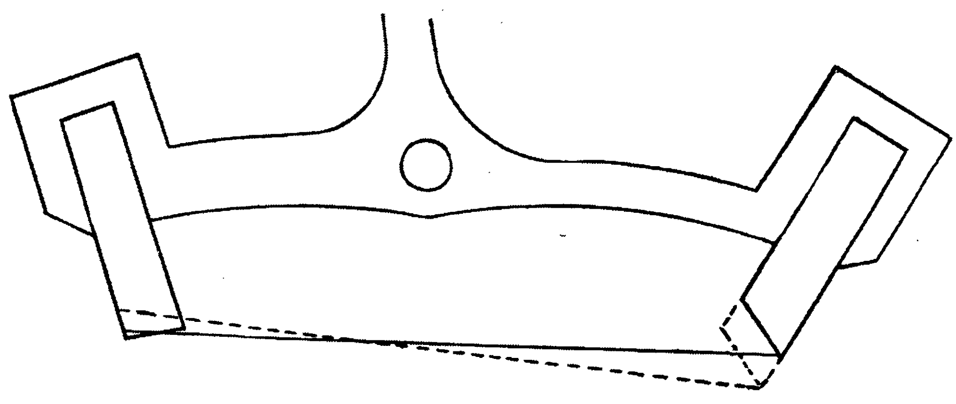
The effect upon the drop—shake—of moving a pallet stone is clearly demonstrated by figures 22-16 and 22-17. In figure 22-16 the full line **a** gives the distance that embraces three escape wheel teeth when the escapement is properly locked on the discharging stone. The broken line **b** gives the distance when the receiving stone has been drawn out to the position shown in dotted lines. This proves that drawing out the receiving stone increases the inside shake. Figure 22-17 shows the effect of drawing out the discharging stone, which decreases the outside shake, but not to so great an extent as the effect of moving the receiving stone.

SEC. 413—Equi-distant Locking and Equi-distant Center Escapement

It is well that the student should learn the precise meaning of the above terms and the different conditions they produce. They apply solely to the pallet.

Figure 22-18 shows both forms. At **A** is shown equi-distant locking. The locking corners of both stones are at equal distances from the center of the pallet as indicated by the full circular line. This feature gives the escapement its name. The releasing corner of the receiving stone is nearer the center by the distance be-

Fig. 22-17



tween the broken and full circle. The releasing corner of the discharging stone is farther from the center by the distance between the dotted and the full line circle; thus it will be seen that, while the locking corners are equi-distant, the releasing corners differ in distance by double the width of the stone.

At **B** is shown the equi-distant center escapement. In this drawing two full circular lines are drawn from the pallet center. The locking corner of the receiving stone and the releasing corner of the discharging stone are at equal distances from the pallet center. The same is the case with the locking corner of the discharging stone and the releasing corner of the receiving. This brings the centers of the impulse faces equi-distant from the pallet center, which gives this escapement its name.

As has been explained, the lift— the angular impulse—is measured from the pallet center. It is shown at **A** as indicated by lines embracing the angles **1** and **2**. It will be noticed that the impulse face of the discharging stone forms a greater angle with its locking face than the impulse face of the receiving stone does with its locking face. At **B** the angles **3** and **4**, determining the impulse angles of the stone, are the same as **1** and **2**, but in this case the impulse faces form equal angles with the locking faces.

Another feature in connection with these escapements is that in the equi-distant locking the discharging stone must embrace a greater angle than the receiving. This peculiar feature will be demonstrated in the latter part of this work when the subject of drafting an escapement is taken up.

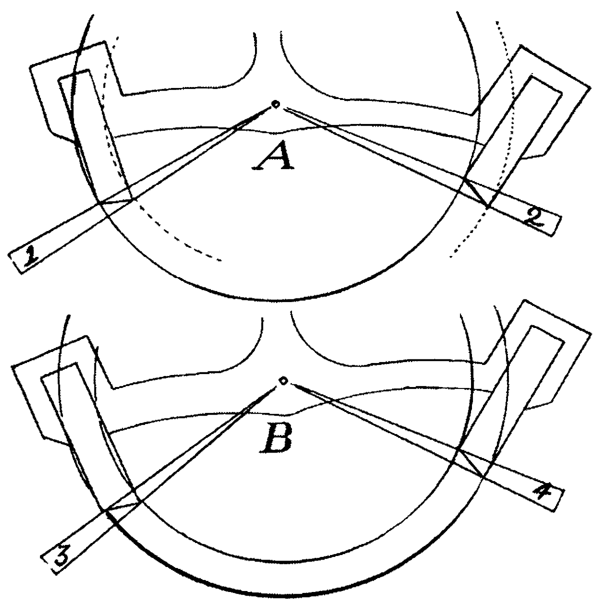


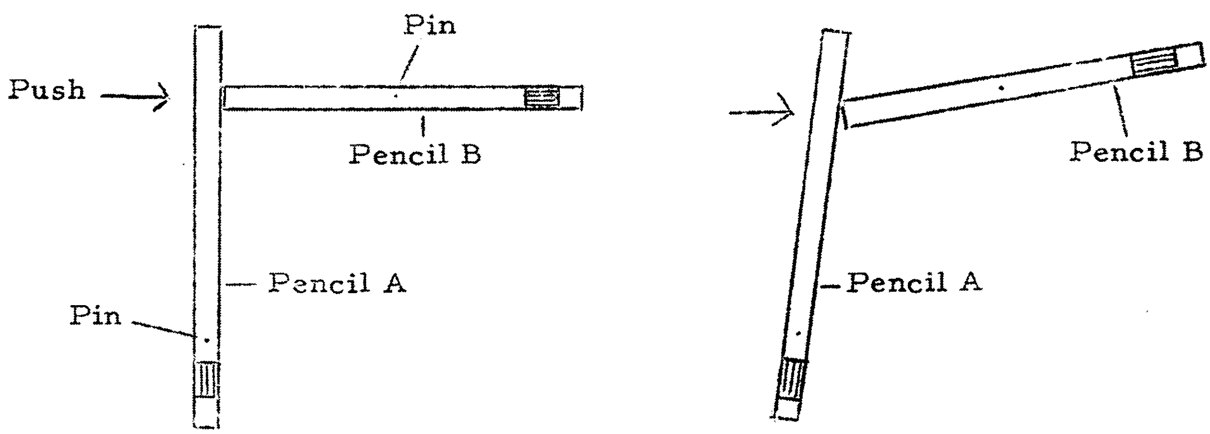
Fig. 22-18

(Insert in Lesson text 22)

Students frequently have trouble understanding what is meant by draft (or draw, as it is more commonly called nowadays) and how it differs from slide. Draw is a force which cannot be seen. It is created when the teeth of the escape wheel and the pallet stones are set at such an angle as to cause the tooth to pull (or draw) the fork against the banking.

The result of draw is slide (Sec. 411), which can be seen. A simple experiment can make this relationship clear:

You will need two unsharpened pencils and two pins (push pins preferred). Drill a small hole through the center of one pencil and just before the eraser cap of the other. Pin the two pencils at right angles on a piece of flat board or heavy cardboard as shown at left below:



If you now try to push Pencil A towards Pencil B, as indicated by the arrow, nothing happens, because the two opposing forces are equal and cancel each other.

If you now turn both pencils slightly, so they form less than a right angle as shown above and again put pressure on A, both pencils will move, with B sliding down A. What you have just seen is slide. The force which caused it is draw.

The angle which causes draw is determined by the manufacturer of the watch. The repairman is seldom justified in changing it and normally doesn't. However, in replacing a pallet stone, it must be fitted snugly in the fork slot without side-play in order to maintain the correct amount of draw.

Draw can be tested with the balance out of the movement by pushing the fork away from the banking with a piece of pointed pegwood but not to the point of unlocking. If the pegwood is now lifted, releasing the fork, it should return promptly to the banking pin.

With the balance in the movement, draw can be tested by turning the balance wheel so the roller jewel is outside the fork horns. While in this position, push the fork away from the banking with a pointed piece of pegwood or small broach until the guard dart contacts the roller. Now remove the pegwood. If draw is present, the fork will at once return to the banking.

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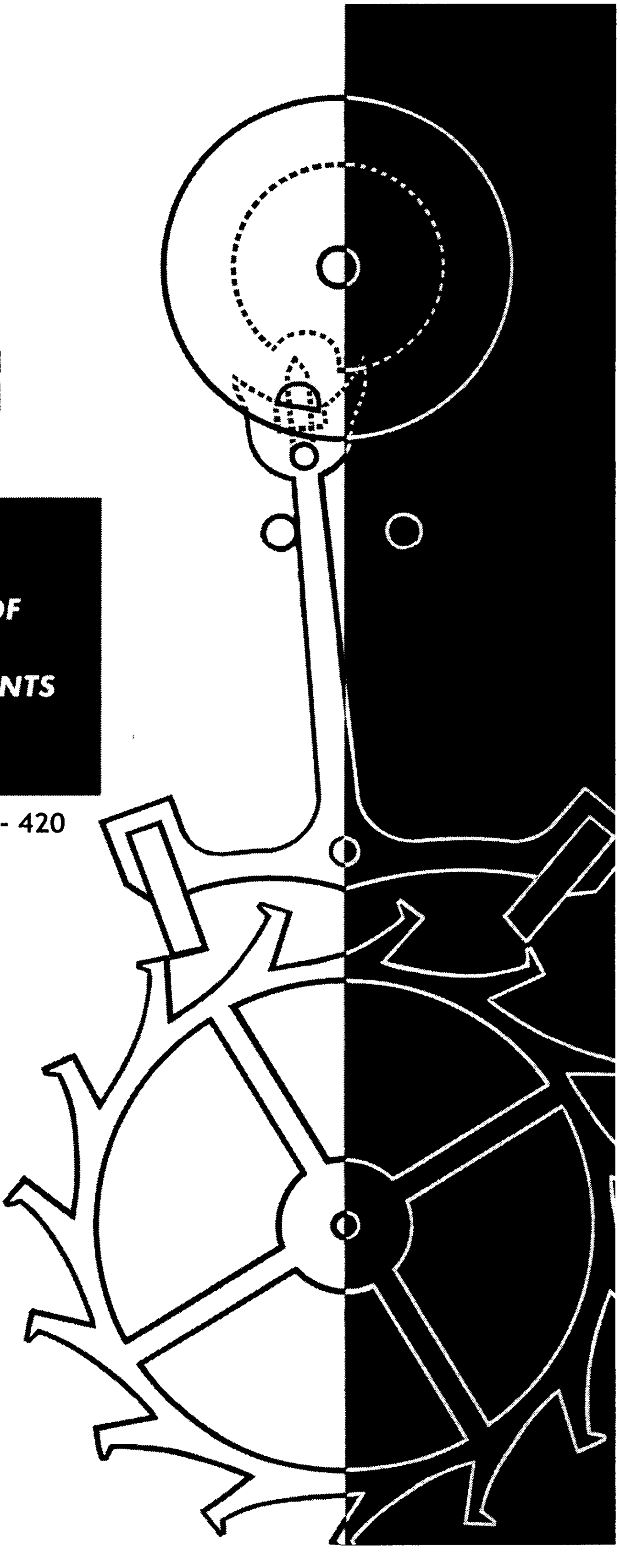
Master WATCHMAKING

LESSON 23

TYPES OF ESCAPEMENTS

Sections 414 - 420



CHICAGO SCHOOL OF WATCHMAKING

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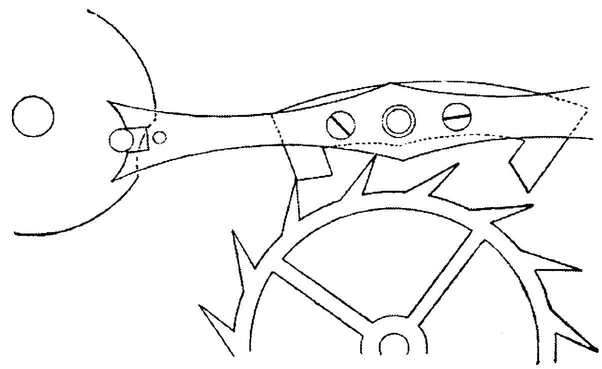


Fig. 23-1

SEC. 414—Other Forms of Lever Escapement

The form of escapement under consideration thus far has been the club tooth, short impulse. The short and the long impulse are generally designated as the short and the long fork. A long or a short fork can be constructed with either long or short impulse. When we come to consider the roller, however, the distance from its center to the roller jewel cannot be changed without altering the arc of impulse of the roller jewel.

The relative distance between the roller jewel and the balance center, as compared with the distance from the pallet arbor to the fork slot, is as four and one-half to one, whereas in in the short fork it is usually about three to one. The effect is that the roller jewel is in contact with the fork for a greater extent of the vibration of the balance in the long impulse—long fork—than in the short one. The short fork being usually about three times the length, it is in action with the roller jewel about 30 degrees —three times the arc of vibration of the fork.

In the first forms of detached lever escapements the active impulse was 10 or more degrees; sometimes as high as 12. This has been reduced from time to time until, in the modern escapement, it is usually found to be about eight and one-half. The roller impulse makes it more difficult to secure the safety action of the guard pin on the single roller, hence the general adoption of the double roller.

The detached lever escapement owes its superiority to the fact that the balance performs so great a portion of its vibration free from contact with any other part of the mechanism. As has been said, in modern forms the fork is only in contact for about 30 degrees. The shorter the duration of contact the better the rate secured. This, however, has its limit. We have been approaching the present form gradually and it would seem as though we had reached the limit. Further reduction would necessarily be secured only by a sacrifice of power, which, as already stated, is now very great.

SEC. 415—The Poised and Unpoised Fork

For many years it was considered to be an important advantage to have the fork and pallets perfectly poised. In order to secure this it became necessary to add considerable weight to these parts. The Swiss usually use the fleur-de-lis pattern for a counterpoise, but whatever is used the adding of weight increases the resistance of inertia which the balance must overcome in unlocking the escapement. This is not compensated for by the questionable advantage of a poised fork.

A fork without counterpoise requires a slight increase in the draft angle. A noted horologist and writer, Mr. Grossman, in his prize essay on the lever escapement, gives 12 degrees draft angle for each stone. Doubtless this would be enough for a poised fork, equi-distant locking, but it would not be safe for an unpoised fork, equi-distant center. This form of escapement should have 14 degrees for the discharging stone and 15 for the receiving stone.

One disadvantage of the unpoised fork is that the additional draft increases the resistance —especially when the watch is in a vertical position with the fork horizontal. This is quite true so far as the lowermost stone is concerned. Assuming the fork points to the right, the resistance on the discharging stone would be increased, but it should be remembered that the resistance on the receiving stone would be decreased in exactly the same amount. Thus the mean of the two resistances would exactly equal the resistance with the fork in a vertical position, either up or down.

Figure 23-1 illustrates the ratchet tooth escapement, which was the first form of detached lever to come into general use. This form of pallet is known as "close-pallet," as distinguished from "exposed pallet." In the "close-pallet" the pallet arm is slotted longitudinally with its plane, while in the "exposed pallet" it is slotted transversely. The "close pallet" method is a more secure way of fastening the stone, but does not permit of alteration as readily as the "exposed pallet." In the "close-pallet" the steel and the stone are finished flush on both locking and impulse faces which precludes the possibility of drawing out or pushing in either stone.

The escapement shown in figure 23-1 is what is known as the right angle escapement, which means that a line drawn from the center of the escape wheel to the center of the pallets and thence to the center of the balance forms a right angle. All the early forms of levers were almost universally laid out on this plan. The inconvenience of having to locate the pallet arbor and the escape wheel under the balance brought about the use of the straight line escapement, which is now the invariable form.

In the right angle-escapement, as shown in figure 23-1, the fork was attached to the pallets by two screws, the threads being in the pallet steel. The pallet arbor was fitted to the pallet steel, the hole in the fork through which it passed being a little larger. The holes in the fork for the screws permitted adjusting the fork with relation to the pallet, so that bending a fork was never necessary.

SEC. 416—Evolution of the Lever Escapement

The evolution of the detached lever escapement is a most interesting history. It is not quite two centuries ago that the idea of transferring the motion from the escape wheel to the balance by means of a lever was successfully applied.

Thomas Mudge, an English watchmaker, in 1765, was the first to produce a lever escapement. Figure 23-2 illustrates his invention.

The pallets were so formed that the locking faces gave no draft. Instead they were inclined in the opposite direction, thus pressing the end of the lever against the roller. The roller was provided with a notch **A** into which the point of the fork entered in delivering its impulse. No bankings were required in this escapement. Its great defect was the constant pressure of the fork against the edge of the roller. Reference to figure 23-2 will clearly illustrate this. The leverage exercised against the edge of the roller was of the same force as that to impart motion,

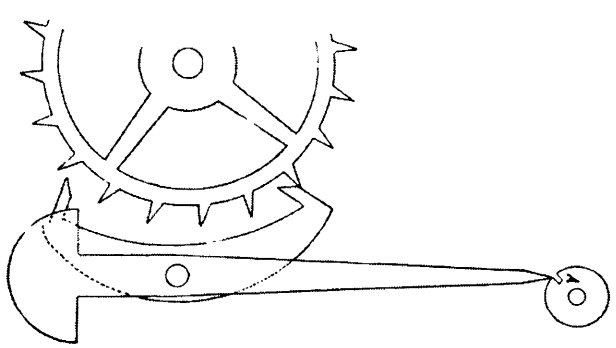


Fig. 23-2

and inasmuch as the pressure against the roller was at an acute angle with its periphery, the retarding effect was great. If the reader will picture in his mind the effect of a guard pin continually pressed against the edge of a roller, he can form an idea of this serious defect in the Mudge escapement. Increasing or decreasing the diameter of the roller in no way helped matters because decreasing the roller diameter decreased the resistance to the revolution of the balance, but it also decreased the force of impulse of the fork. Increasing the diameter of the roller increased the force of the impulse, but also increased the resistance to the motion of the balance. In consequence of this radical defect, Mudge's escapement did not come into use. In fact, he did not adopt it in watches of his own production, using the cylinder and the duplex instead.

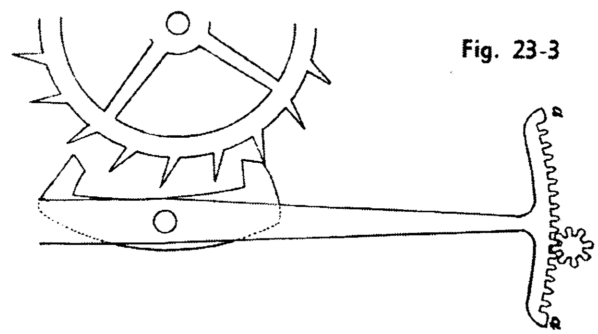


Fig. 23-3

The next important step in development was the rack and pinion lever shown in figure 23-3. In this form the lower part of the balance staff carried a small pinion into which was geared a circular rack on the end of the lever—the term fork was not then used. The pallets were what is technically termed "dead beat," that is, they produced no recoil to the escape wheel. The locking faces of both stones were arcs of circles, the center of which was the pallet arbor. The motion of the balance was limited by the toothless ends of the rack, **aa,** which acted as bankings. When the rack teeth and pinion leaves were properly proportioned and well finished, this escapement gave fairly good results and was in use many years. It was patented by Peter Litherland in 1791, but is said to have been invented by Abbe Hautefeuille half a century prior.

Another form of escapement that came out about the same time is shown in figure 23-4. This escapement was a "dead beat." The escape teeth stood perpendicularly to the plane of the wheel. The balance is not shown. The annular wheel **A** is a part that performs the function of the roller in the modern lever watch. The short segment **a** attached to the under side of one of the arms takes the place of the roller-pin. The projecting arms **bb** include a space that acts as a fork slot. **B** is the escape wheel, **C** the fork.

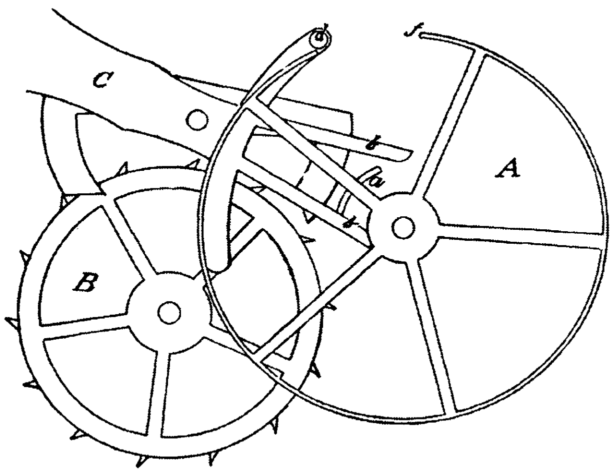


Fig. 23-4

The fork carries two circular arms in the end of one of which is a stud, **d**, which serves as a guard pin. This stud, in connection with the annular rim, **f**, provides the safety device. Bankings are provided but not shown. When the wheel is locked on the receiving pallet the guard pin is on the outside of the safety ring. When the impulse begins, as shown in figure 23-4, the guard pin is in position to enter the opening in the safety ring and pass to the inside thereof. Thus the pin **d** and rim **f** perform the function of the guard pin and safety roller. The fork and pallets required perfect poise, which accounts for the otherwise useless arm extending from the right side of the fork.

The locking faces of the pallets were so formed that they acted as a sort of break to prevent the movement of the fork while locked. The fork and pallets were perfectly poised. Despite this the guard pin must necessarily sometimes be thrown against the safety ring which is located so far from the center that the motion of the balance would be much retarded. It is surprising that draft was not given to the pallets in order to overcome the weakness just spoken of. This, however, is the exact condition of the escapement made, being drawn to scale from the original. This was probably the first attempt at making a detached lever escapement. As will be seen, it was exactly the reverse of the double roller. In the escapement shown in figure 23-4 the impulse was delivered nearer to the balance center than the safety action, while in the double roller the impulse is delivered farther from the center than the safety action.

Figure 23-5 shows a form of escapement suggested by Perron, a French watchmaker. This form is also a detached lever and was probably the first detached lever made. The pallets consisted of two pins, the impulse being entirely

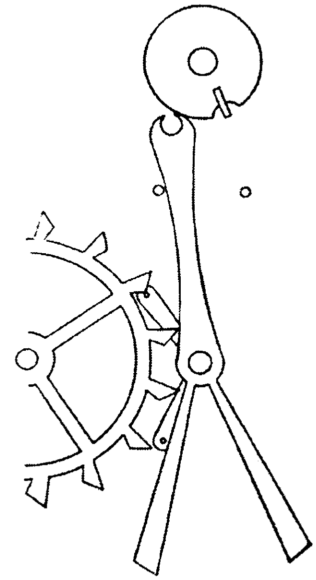


Fig. 23-5

on the teeth, a radical departure from anything heretofor done. Another novel feature was the inclination of the locking faces of the teeth to draw the fork against its bankings. The safety action is performed by the outside of the horns of the fork and the roller edge. The impulse is delivered by a pin projection radially from the roller. A passing hollow, the first device of the kind, permits the passage of the fork during the impulse.

Fig. 23-6

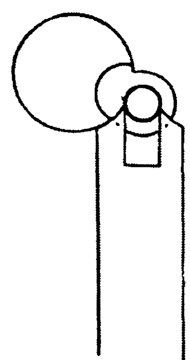


Figure 23-6 shows a form of fork and roller action called the crank lever, so called from its resemblance to the crank of an engine. This form succeeded the rack and pinion and was in use for a long period. It had the advantage over the rack lever of being more simple to manufacture and to adjust. Like the Perron, the safety action was effected between the horns of the fork and the roller edge. The pallets and fork required a vibration of about 25 degrees and the roller about 70.

It has been thought that this form of fork and roller action may have been suggested by the rack and pinion for the reason that a resemblance may be traced to that form. If in a rack and pinion we cut off all but one leaf and all but two rack teeth we shall have, virtually, a crank lever. However, it seems the semblance is more accidental than incidental.

The form of escapement shown in figure 23-1 was the standard for many years, being known as the detached lever. As other forms became popular other terms were added to distinguish them, such as exposed pallets, straight line, club tooth, double roller, anchor, equi-distant center, equi-distant lockings, poised fork, etc., many of which are no longer used.

A form of escapement that deserves special mention is shown in figure 23-7. It is the invention of a London watchmaker named Savage. Theoretically this escapement embraces ideal conditions, especially in the unlocking and impulse. The unlocking is performed at a shorter radius from the roller center than the impulse is delivered. The two pins **AA** perform the unlocking, taking no part in the impulse. The pin **B** which is in the end of the fork performs the double office of impulse pin and guard pin. This form simplifies the production of a non-setting escapement for the reason that both unlocking and impulse are performed under more favorable conditions than any other escapement. Its delicacy of adjustment, however, proved prohibitive to its general use.

SEC. 417—The Cylinder Escapement

The cylinder escapement was invented by George Graham in 1720. It met with little favor at first, being condemned by most of the celebrated watchmakers of that time, among whom was Berthoud who actually attempted to demonstrate that the verge escapement was much its superior.

It is a dead beat escapement which is, of course, a point in its favor. This point is more than offset by the fact that the escape tooth is in constant contact with the cylinder, and at a considerable distance from the center.

Figure 23-8 is a perspective view of the cylinder and its plugs. The letters indicate the names applied to the different parts: **a,** the arbors; **b,** the great or top plug; **c,** the small or bottom plug; **d,** the great shell; **e,** the small shell; **f,** the plug face; **g,** the receiving lip; **h,** the discharging lip; **i,** the banking slot; **j,** the half shell; **k,** the cylinder column.

Figure 23-9 is designed to show the action of the escape tooth on the cylinder. The names applied to the different parts of the teeth are: **a,** the top or flat of the tooth; **b,** the impulse face; **c,** the arm of the tooth; **d,** the locking point; **e,** the heel; **f,** the space. That part of the tooth connecting it with its arm is not shown. It is called the column.

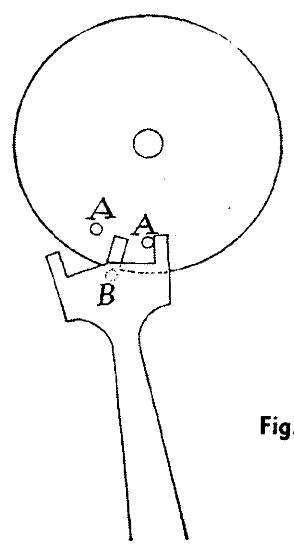


Fig. 23-7

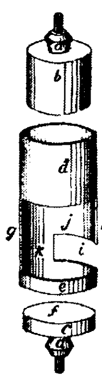


Fig. 23-8

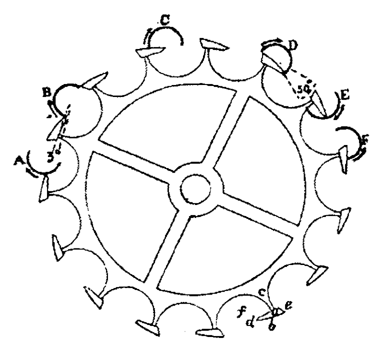


Fig. 23-9

Six positions of the cylinder in action are shown, the cylinder moving as indicated by arrows. At **A** the locking point of the tooth is in contact with the half-shell. At **B** the tooth is about to unlock. At **C** the face of the tooth is delivering an impulse on the receiving lip of the cylinder. At **D** the impulse has been delivered and the tooth is in contact at the locking point with the inside of the half-shell. At **E** the tooth is still in contact with the inside of the half-shell, the cylinder having revolved until the tooth arm has entered the banking slot. The purpose of this slot is to allow the balance a wider arc of vibration than if it were not introduced into the half-shell. At **F** the motion of the cylinder has reversed, the tooth has been released and is delivering an impulse to the discharging lip of the cylinder.

The impulse faces shown in the drawing are slightly curved, but they are more frequently formed of a straight plane. There is some difference of opinion as to the best form.

When a curve is used it can be so formed that equal proportions of its length cause the cylinder to rotate through equal arcs, or it may be so formed that an equal resistance to the changing force of the hairspring is offered throughout the entire impulse. The straight face, however, causes the balance to give the greatest arc of vibration.

A condition brought about by the action of the escapement is that the size of the balance as well as its weight, is confined to comparatively narrow limits. When the balance is heavier than those limits the watch loses with an increase of the motive force, and when the balance is too small it gains. This seems to conflict with mechanical laws but is nevertheless a fact.

There is no other escapement that requires more frequent cleaning. If this is not properly attended to, any approach to a steady rate is not to be expected. Owing to the peculiar shape of the teeth and their constant contact with the cylinder, dirt and thick oil will quickly accumulate on the parts, shortening the arcs of vibration of the balance.

The arc that the cylinder describes during the delivery of an impulse by an escape tooth is called "the lift." This is usually about 30 degrees, as shown at **D,** figure 23-9. The aperture in the cylinder shell is generally about 180 degrees. The thickness of the shell is about 1/16 the length of the impulse face of the tooth. The drop should be as small as possible, consistent with freedom. The smallest drop practical for a lever escapement is 1½ degrees. In the cylinder escapement it need not exceed 1 degree.

The amount of lock of the tooth on the cylinder shell should be 3 degrees, as shown at **B,** figure 23-9.

Le Toy says that in its progress the point of the tooth should pass through the axis of the cylinder. Berthoud says that the middle of the locking face should pass through the axis. The latter seems preferable but in other respects the rules laid down by Berthoud for the construction of the cylinder escapement are not to be recommended.

When this escapement was first introduced the escape wheels were of brass and, as might be expected, gave poor results. Later, when steel wheels were adopted and the parts were highly finished, the time-keeping qualities were much improved.

There has been a great diversity of opinion on the part of experts as to the proportions of the parts, forms of curves, extent of angles, etc. Tavan, Moinet, Wagner, Robert, Jodin, Lepaute, Berthoud and Jurgensen, all eminent watchmakers, differ widely on many points but inasmuch as no good purpose would be served by going minutely into details, particularly as the escapement is fast falling into disuse, their various opinions and arguments will not be discussed here.

There are two important matters to be observed in fitting a new cylinder. First, see that the depth between the cylinder and the escape wheel is so pitched that the center of the impulse face of the tooth passes through the axis of the cylinder. If the depth is too deep or too shallow the friction of the tooth on the cylinder is increased, also the drop will not be equal. Second, see that the drop is equal on the inside and the outside of the shell.

To sum up, the cylinder has in its time given good results and should be appreciated from the fact that it filled the gap in a most satisfactory manner between the old verge and the detached lever. Indeed, Mudge, the inventor of the lever, preferred the cylinder to it and used it in his own watches.

It must not be inferred that the cylinder in its best days made any approach in performance to the detached lever of today. Mudge's lever would hardly be recognized when compared with the modern lever escapement.

The cylinder escapement has degenerated into a poorly executed counterfeit of what it was in its day, when the shell was a ruby and the other parts beautifully executed. Add to this the fact that many of the escape wheels of cylinders as now made up have but six leaves and it will be readily understood why it has fallen into disrepute.

An improperly designed or executed cylinder escapement can only be improved to a limited extent. No amount of manipulation will make it perfect.

Watches having this escapement are usually provided with an adjustable potence which contains the lower jewels and carries the steady pin holes for the balance cock. This enables an adjustment to be made for the depth of the cylinder into the escape wheel teeth. Any other alteration is at best a makeshift.

The description already given will enable the repairer to know when a cylinder escapement is correct. To test its action, move the balance slowly in either direction until the drop takes place. Now reverse the motion a slight amount, just enough to insure a lock, and try the shake of the wheel on the cylinder. Repeat this on the other lip and again try the shake. It should be equal. If it is not it indicates that either the wheel tooth or the cylinder, or possibly both, are not of correct size. If the inside shake, the shake when the tooth is resting against the inside of the shell, is the greatest, it indicates that the cylinder is too large in diameter. If the outside is the greatest, it is too small. The correct way to remedy this is to put in a new cylinder of proper size.

In fitting a new cylinder, see that the shake is equal.

SEC. 418—The Verge Escapement

The verge escapement is so rarely found in use at the present day that only an exceedingly brief description of it is deemed necessary.

This escapement first came into use in clocks in the early part of the 14th century, not being applied to watches until some time later. It continued to be used in watches to a constantly diminishing extent until about a century ago, when it ceased altogether.

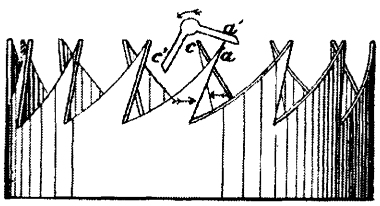


Fig. 23-10

Figure 23-10 illustrates the form and action of the verge escapement. Tooth **a** is delivering an impulse to the pallet, **a'** driving the balance in the direction indicated by an arrow. This tooth moves to the right, also indicated by an arrow. Tooth **c** is moving to the left as indicated. When tooth **a** is released, tooth **c** will drop on the pallet **c'** and deliver an impulse in the opposite direction.

It is evident that this escapement has an excessive amount of recoil, hence its unreliability. Even a slight variation in the power produces a material rate error so that under the most favorable conditions it is unreliable. The wearing of the parts, which in this escapement is always very great, soon causes the watch to gain on its rate, and as the balance, or rather verge, is seldom jeweled this wear soon makes itself manifest.

Another part of the escapement which soon becomes deranged is the escape wheel teetn. These not only wear away, but do so very unevenly, leaving them of varying lengths. In fact, this is one of the most common defects to be found in an old verge watch. It can be remedied by the process known as "topping and filing." The usual method is to fasten a screw collet to the escape staff and, using a Swiss Jacot lathe or an English pivot lathe and a fiddle-bow, true the teeth to length with a slip of bluestone or water of Ayr stone.

The stone should be held firmly against the T rest and brought carefully forward until the longest tooth touches it. Then proceed carefully until all the teeth are of an equal length. Using oil on the stone has the effect of cutting without throwing a burr. After this operation the teeth should be dressed upon the back with a small, fine, half-round file.

When the operation has been performed it will generally be found that the escape wheel does not engage deeply enough into the pallet, but in this escapement that trouble is easily corrected. The escape wheel in a verge watch usually has much more end shake than is necessary. It does no harm for the reason that the action of the escapement keeps the escape wheel constantly pressed away from the center of the verge. The outer pivot finds its bearing in what is called by the English "a follower," which is frictionally inserted into a hole and can be adjusted forward to bring the escape wheel teeth to the proper depth in the verge.

In Swiss watches the same alteration can be made by moving forward the piece called "the counter-potence" which contains the bearing in Swiss verges.

SEC. 419—The Duplex Escapement

This escapement made its appearance about the middle of the eighteenth century. It was the invention of an ingenious French watchmaker, Dutertre, but was perfected by LeRoy. It acquired its name from the fact that in its original form it had two escape wheels, hence the application of the Latin word, duplex—double.

The duplex escapement met with favor among the English watchmakers and was very popular for a considerable period. In this connection it is a remarkable fact that although a French invention it did not become popular in France, but the cylinder, an English invention, was extensively used there and but very little used in England.

Figure 23-11 illustrates the appearance and action of the duplex escapement.

A, the escape wheel.

a, the locking tooth; lying in the plane of the wheel.

a', the impulse tooth; standing at right angles with the plane of the tooth.

B, the impulse arm, carried by the balance staff.

b, the impulse pallet.

C, the roller, carried by the balance staff.

c, the releasing slot.

The impulse arm is located above the roller. The roller is generally of ruby or sapphire, but is sometimes omitted, a slot in the staff taking its place.

The action of the escapement will be made clear by referring to figure 23-11, the parts being represented as moving in the direction indicated by the arrow. **1** shows a locking tooth about to enter the releasing slot in the roller. As the roller moves forward the tooth passes into the slot and is in turn released, thus allowing an impulse tooth to drop on the impulse pallet as shown at **2.** When the impulse tooth has de-

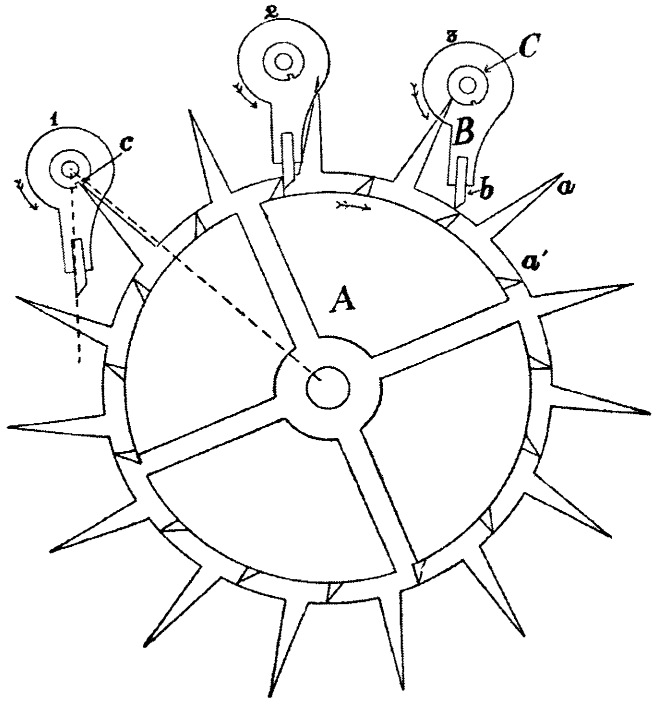


Fig. 23-11

livered its impulse it is released and a locking tooth drops upon the roller as shown at **3**.

On the return excursion the locking tooth again enters the roller slot which allows the tooth to drop forward a slight amount but not enough to release it, and it is immediately forced back to place against the outside of the roller. This exercises a slight retarding influence on the balance which is compensated for when the roller moves in the opposite direction—the direction indicate by the arrow. When it drops into the slot under this condition it delivers a slight impulse which is called "the lesser lift." The lift delivered by the impulse tooth is termed "the great lift."

The adjustment of the rollers to the proper angular relation to each other is of vital importance. The releasing slot must be so placed that it will release a tooth at exactly the right instant. If the tooth is released too soon the impulse tooth will not engage the pallet because the pallet will not have entered the path of the tooth, which will then go forward without delivering an impulse. If the tooth does not enter the slot soon enough and its release is too long delayed, the impulse will be shortened and a poor motion will result.

In the drawing the parts are shown in correct position, but are not strictly correct from a draftsman's point of view, which would require some of the lines to be shown broken.

The duplex escapement requires extreme delicacy in its manufacture and adjustment; a wide side-shake or other slight error being fatal to its proper action. There is comparatively little loss from drop, and it utilizes the movement of the wheel in delivering the impulse to fully as great an extent as in the lever. In the lever the balance revolves without any restraint (except that imposed by the hairspring) except during the brief period that the unlocking and impulse are taking place, whereas in the duplex escapement there is continual contact between the escape wheels and the rollers. For the greater portion of the time a tooth is pressed against the edge of the roller at an extremely unfavorable direction—74 degrees from a right angle, or its complement, 16 degrees from a tangent.

A high authority on horology refers to the duplex as possessing a rate equal to the lever. This might have been true at the time the comparison was made nearly a century ago—but it is far from being the case at the present time. Those who have had much experience with the duplex will agree. The duplex is not manufactured at the present time.

As in laying out the lever escapement, authorities differ to a certain extent as to the proportions that give the best results in the duplex. Saunier in his excellent work, giving for his authority Jurgensen, says:

"The diameter of the roller should be a third of the distance between two adjacent locking teeth of the escape wheel.

"The lifting action on the roller—the small life—extends over an arc of 20 degrees.

"The drop of the impulse tooth on the impulse pallet should be 10 degrees.

"The active impulse on the impulse pallet, measured from the center of the staff, should be 30 degrees."

He quotes many authorities, all of whom, with one exception, agree upon the arc of impulse; the exception referred to is M. Winnerl, who gives the greater lift as 60 degrees, 15 of which is drop, leaving 45 degrees for active impulse.

The lift is determined to some extent by the proportions between the roller, impulse pallet and diameter of the escape wheel.

SEC. 420—The Chronometer Escapement

Next in importance to the lever is the chronometer or detached detent escapement. Its chief value is its adaptability to navigation.

The instrument known as the marine chronometer is capable of close rating when it is kept in a horizontal position and is specially adjusted therefore. It is invariably hung in gimbals which maintain it in a horizontal position, face up.

Marine chronometers are not adjusted to other positions, and if placed in any other than the horizontal will vary in rate.

The fuzee is always used to equalize the power. This facilitates their adjustment and enhances their accuracy. They are frequently to be seen in jewelers' windows as standards of time for the public. The mistaken idea prevails to some extent that a ship's chronometer is a more accurate timepiece than a fine clock. As a matter of fact, a well constructed and adjusted clock with a well compensated seconds, mercurial pendulum, located so as to be free from jar or vibration, is much more reliable.

Many of the chronometers used in show windows are inferior instruments and are often sadly neglected, the owner fondly supposing that cleaning once a year is all that is necessary. Actually frequent cleaning is required. The main spring will have lost a portion of its energy, pivots may need polishing, a readjustment of the escapement may be called for and other things require attention.

When a chronometer receives its annual cleaning, the main spring should be tested with an adjusting rod. The adjusting rod is attached to the fuzee square and the chain is in place connecting the fuzee and barrel. The adjusting rod is provided with one or more sliding weights by which the rod may be balanced in a horizontal position by the force of the main spring. With the chain entirely on the barrel, the mainspring is wound to a certain extent by means of the ratchet on the barrel arbor, the amount of winding—setting up—being changed

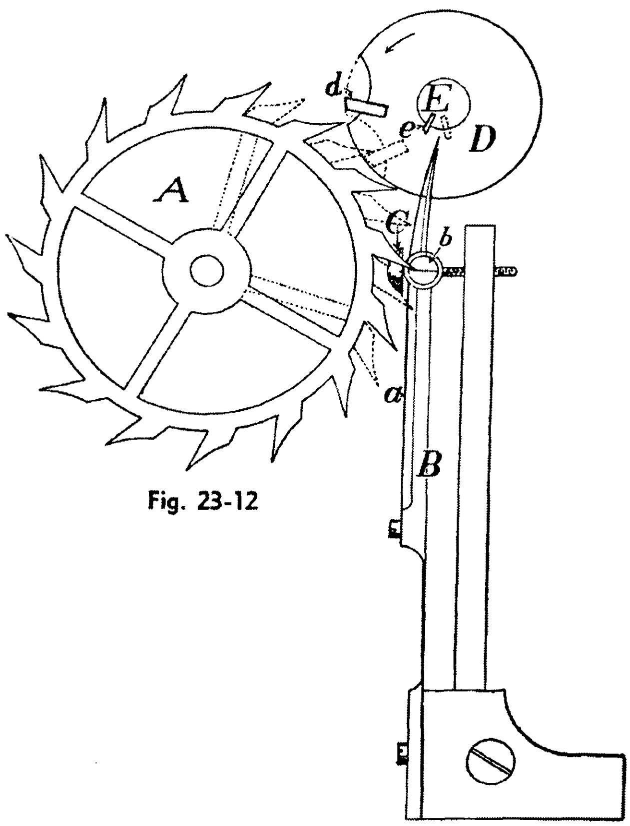


Fig. 23-12

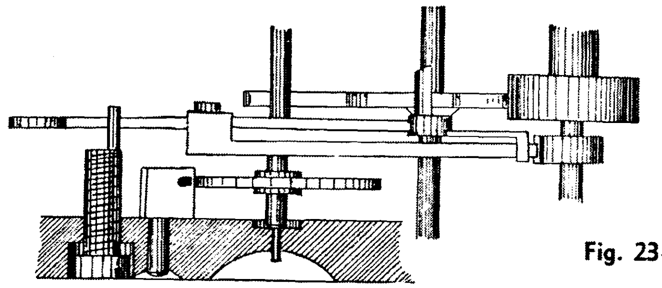
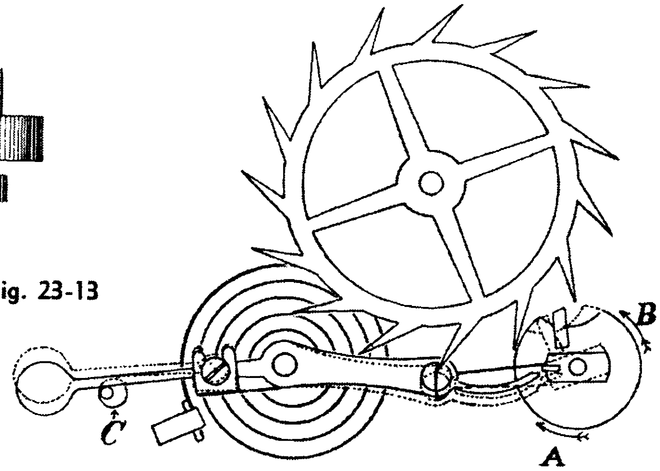


Fig. 23-13



until an approximation to a uniformity of power is attained. When the mainspring becomes set to any extent it is impossible to secure accuracy of rate. This invariably takes place in the course of time, and if the old spring is not replaced by a new one the rate of the instrument is impaired. The same is true to a greater extent of the balance spring. In view of these facts, it will be readily understood that although a chronometer be cleaned at proper intervals, the pivots polished, etc., yet it may become inaccurate and unreliable as a timepiece.

The parts of the chronometer escapement are, referring to figure 23-12:

A, the escape wheel.

B, the locking detent.

a, the unlocking spring, commonly called the gold spring, it being usually made of that metal.

b, the detent jewel.

C, the banking screw.

D, the impulse roller.

d, the impulse pallet.

E, the discharging or releasing roller.

e, the releasing pallet.

There are two principal forms of the chronometer escapement. That shown in figure 23-12 is called "the spring detent" and is generally used in marine instruments. The other, called "the bascule," meaning see-saw, is the form generally used in watches. In this form the detent is pivoted and a coiled spring, called the recovering spring, is colleted to the arbor carrying the detent, the outer end of the spring being secured in a stud attached to the watch plate. The office of the spring is to bring the detent against its banking **C,** figure 23-13.

The chronometer escapement gives impulse to the roller only in one direction, usually when the balance vibrates to the left. Figure 23-12 shows in broken lines the action when the balance, revolving to the left as indicated by the arrow, receives its impulse. In this action the releasing pallet comes in contact with the extreme end of the gold spring and forces the detent aside, releasing an escape wheel tooth. While this is taking place, the impulse pallet has moved into the path of another escape wheel tooth, and when the wheel is released that tooth drops on the impulse jewel thus communicating an impulse to the balance. On the return excursion of the balance the releasing jewel lifts the gold spring from the detent and is allowed to pass on its excursion to the right. The outer end of the impulse jewel is flush with the periphery of the roller and passes between two teeth without contact.

Figure 23-13 shows a plan view and an elevation of the bascule. It is shown in full lines with the balance revolving to the right as indicated by the arrow **A.** The releasing pallet is in contact with the gold spring, lifting it from the detent. The broken lines show the releasing pallet in contact with the other side of the gold spring, forcing the detent from its banking and carrying the detent jewel to a point where it is about to release the escape wheel for the delivery of an impulse. The roller is rotating as indicated by the arrow **B.**

The elevation is for the purpose of showing the position of the parts as in the watch. Note that the extreme ends of the detent, gold spring, releasing roller and releasing jewel, are all located beneath the impulse roller. The same condition prevails in the escapement depicted in figure 23-12.

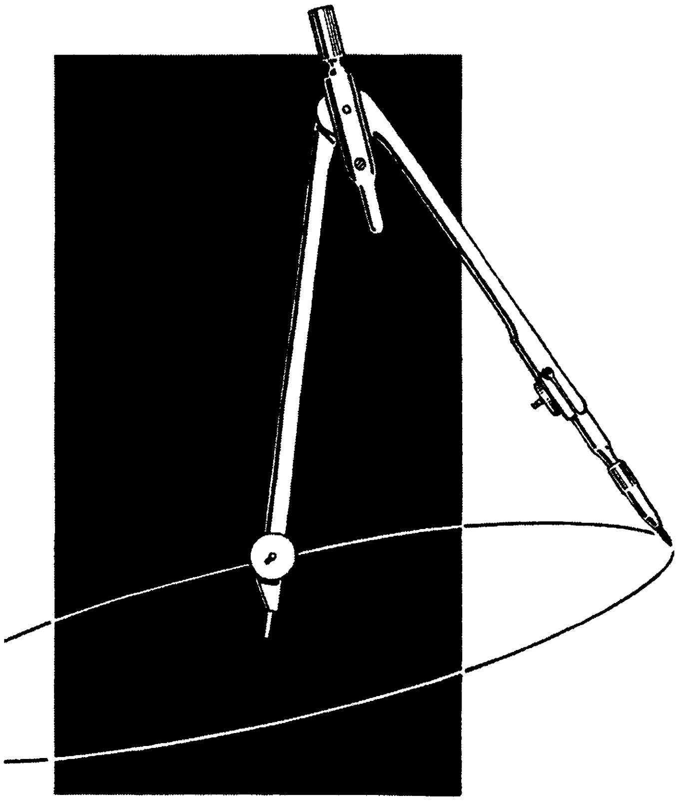
A close scruitiny of the chronometer escapement will disclose the fact that fully four-tenths of the power is lost in the drop of the wheel tooth on the impulse pallet. There is also a loss of power in forcing the detent aside to release the escape wheel, and in raising the gold spring from the detent to allow the releasing jewel to pass. It has been shown that there is a loss of one-third in the lever escapement. The loss in the chronometer is still greater.

Many modifications of the chronometer escapement have been made from time to time but the two forms shown are those found in general use.

LESSON 24 DRAWING THE LEVER ESCAPEMENT

Sections 421 - 434

CHICAGO SCHOOL OF WATCHMAKING
Founded 1908 by Thomas B. Sweazey



SEC. 421—Purpose of Mechanical Drawing

It should be the aim of every watchmaker to acquire a theoretical as well as a practical knowledge of the craft. He should not be content with the simple fact that making a certain alteration will produce a definite result, but should learn through what mechanical laws that result was brought about. With this knowledge he proceeds logically with his work. He applies the correct methods to remedy the defect; thus he accomplishes it in the shortest time and in the most workmanlike manner. Without this knowledge he works on the "cut and try" plan, and while he may eventually succeed in remedying the defect, it is often at the cost of valuable time wasted in futile attempts before success is achieved. This is particularly true of the lever escapement.

The ability to make and read drawings aids greatly in developing inventive and constructive powers, and when applied to the study of the mechanism of the watch, helps the student in mastering the principles of the various actions of trains and escapements. In preparation of these lessons, it has been assumed that the student has a knowledge of elementary mathematics and that he has some understanding of mechanics as applied to watches and clocks. No attempt has been made to give a treatise on drafting. Only such elementary principles of mechanical drawing are included as will enable one to work out the various projects which the author feels will prove most beneficial. If the student has had training in mechanical drawing, the projects to be studied offer few dificulties, but for those who have not had the benefit of such training, it is necessary to give a brief description of the instruments and methods used in making various plane figures before assembling them into the completed drawings. Study diligently the lessons that follow and make all the drawings in the order in which they are given. Only such problems are given as are needed in the lessons to follow and if these are mastered thoroughly, very little dificulty will be encountered in completing the advanced work.

The purpose of this lesson is to give such instruction as will enable a student, though he may not be a draftsman, to make these drawings.

SEC. 422—Drawing Instruments Required

The drawing instruments necessary for a beginner are:

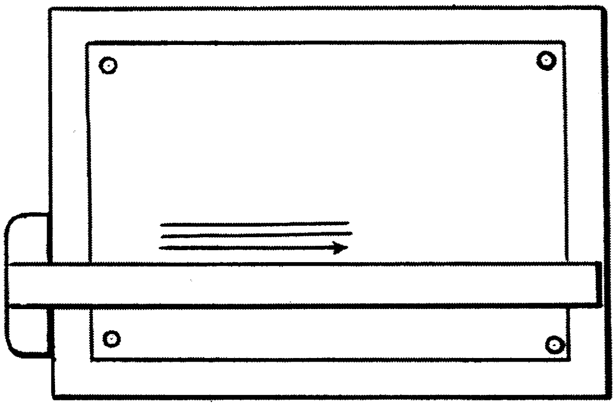
1 Drawing Board or Drafting Machine with Metric Scales
1 T Square
1 45° Triangle
1 30° Triangle
(These articles are not required if drafting machine is used.)
1 Metric Scale
1 Pair 6-inch Compasses with Pencil and Attachments
1 4½-inch Ruling Pen
1 Bottle Waterproof Drawing Ink
2 Hard Drawing Pencils (2H-4H)
1 Rubber Eraser
1 Art Gum Eraser
Drawing Paper
Drafting Tape (or Thumb Tacks)
1 Protractor

Sharpen pencils to fine point. In sharpening, use pencil sharpener or knife and shape lead on sand paper. KEEP YOUR PENCILS SHARP.

SEC. 423—Using the Drawing Board

A right-handed person uses the T square with the head of the T square against the left end of the board, figure 24-1. Let the pencil slant in the direction in which you are moving the hand and apply only enough pressure to make a distinct line. Draw lines as lightly as possible. The head of the T square is held against the left hand edge of the drawing board, moving parallel. In drawing horizontal lines, the upper edge of the T square is used as a straight edge. Vertical lines are drawn by means of a triangle resting against the T square, **A,** figure 24-2. **B,** figure 24-2, illustrates the method used to obtain a line making a given angle with the horizontal.

Fig. 24-1



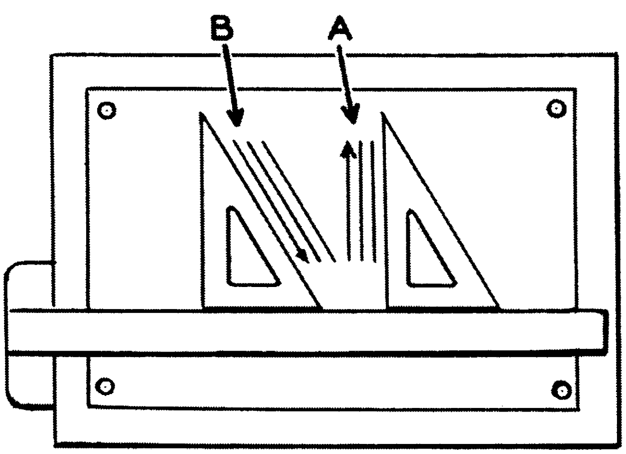
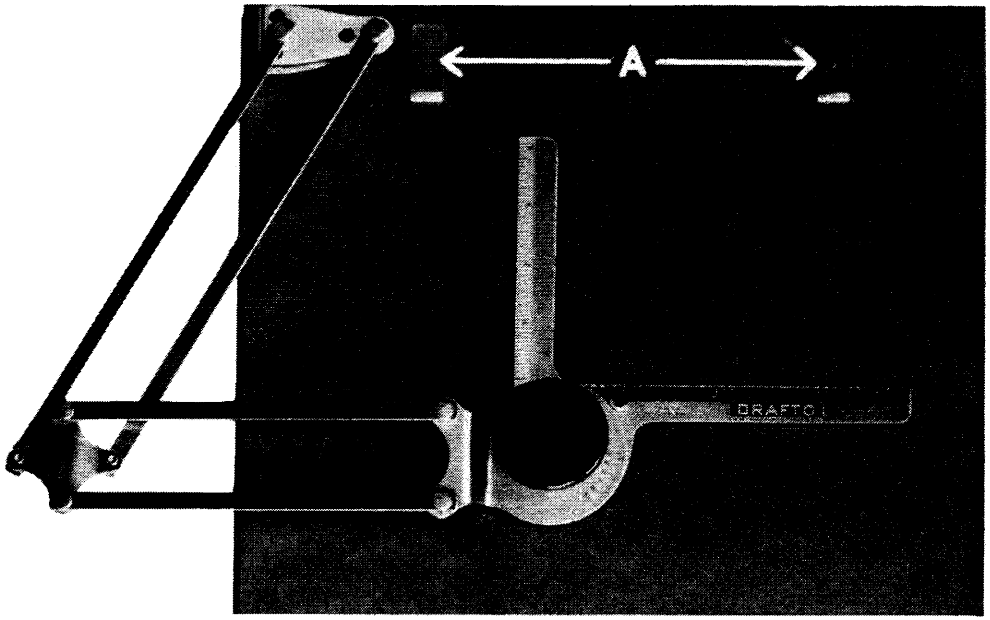


Fig. 24-2

Fig. 24-3



SEC. 424—Using the Portable Drawing Machine

The Portable Drawing Machine, figure 24-3, operates smoothly and easily and eliminates the use of triangles, thumb tacks and T square. The paper clamps, **A**, figure 24-3, hold securely one or more sheets of drawing paper. They are tightened underneath the board and do not interfere with the movement of the scales.

For our use the detachable metric scales with millimeters on one edge and half millimeters on the other are attached as in figure 24-4. The two fingers of the attaching clip are slipped over the ruling side of the integral scale. Then by pressing the two scales firmly together the detachable scale is locked rigidly and in accurate alignment. The detachable scale can be easily removed by applying slight pressure against the spring lock of the attaching clip. There are two clips on each scale permitting either edge to be used on the ruling side.

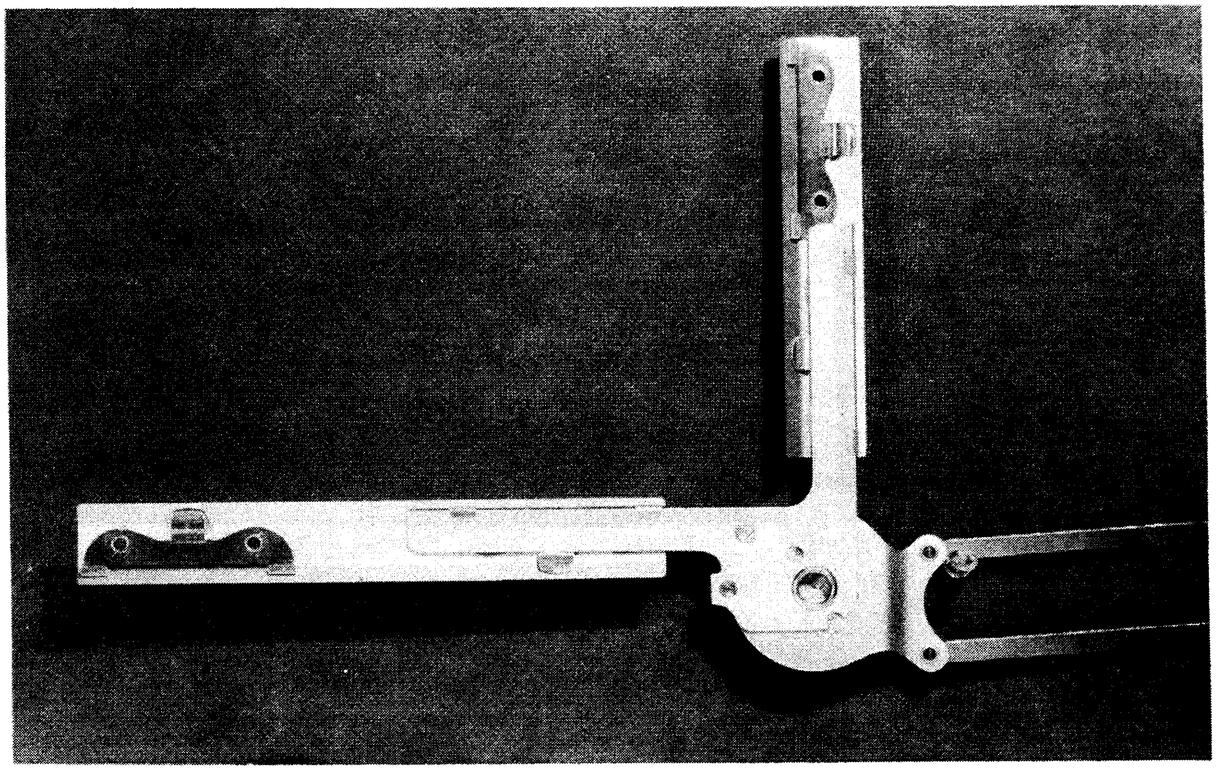


Fig. 24-4

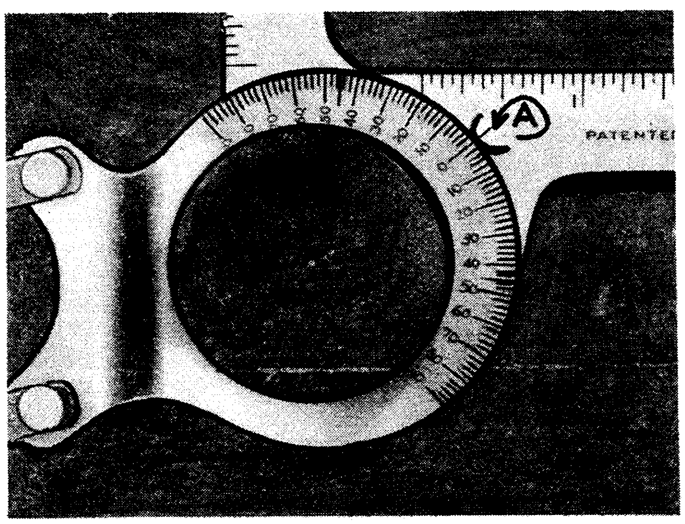


Fig. 24-5

The protractor feature, figure 24-5, is graduated to 2 degrees. To draw a horizontal line, the index on the scale **A**, figure 24-5, is set at zero. The vertical scale is used to draw vertical lines and these lines are always perpendicular to the horizontal scale.

Example: Set index **A** at **0** and draw horizontal line **AB**, figure 24-6. From point **A**, draw vertical line **AC**, using the vertical scale. Now move horizontal scale up until the index line is opposite the 30 degree marker and draw line **AD** from **A** - the angle **DAB** is an angle of 30 degrees. Using the vertical scale, draw line **AE** from **E** and the angle **EAC** is an angle of 30 degrees. When an angle of odd degrees is desired as 15 degrees, the index will have to be set midway between 14 and 16 as each graduation represents 2 degrees.

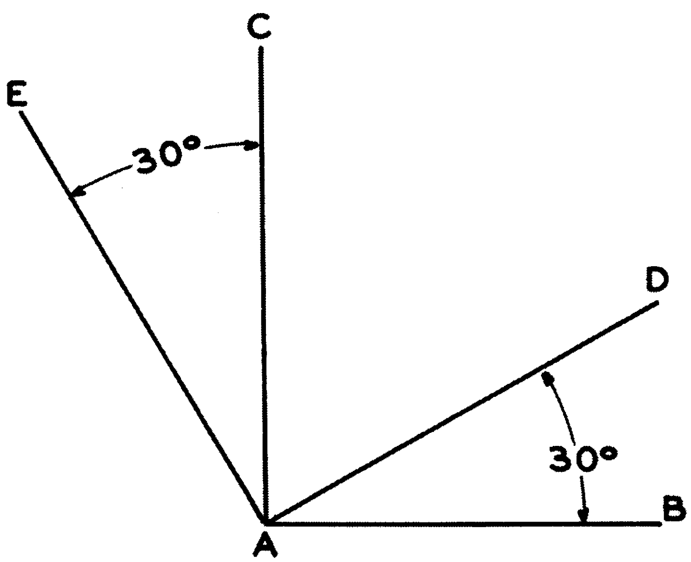
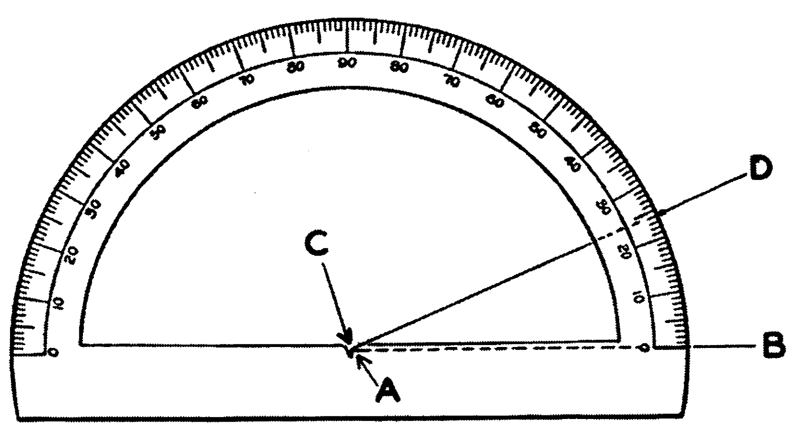


Fig. 24-6

Fig. 24-7



SEC. 425—The Protractor

Figure 24-7 illustrates a protractor used for measuring and laying out angles as follows:

Problem: With **A** as center, draw an angle of 24 degrees above line **AB.** Place the center of protractor **C,** figure 24-7, directly over point **A** and the zero on the right side of protractor directly over the line **AB.** With a sharp pointed pencil, mark a dot at the 24 degree mark on the protractor scale and draw line **AD.** The angle **DAB** is an angle of 24 degrees.

SEC. 426—Geometrical Constructions

Our first drawing will consist of a series of geometrical constructions as illustrated in figures 1 through 17 of Plate 24-8.

First draw in "trim lines". These lines are drawn inside the thumb tack holes of drafting tape, and after the drawing is completed these lines are cut away. For our purpose, the horizontal trim line will be 225mm and the vertical trim line 290mm. Inside of the trim lines draw the border lines; the horizontal border line to be 215mm and the vertical border line to be 280 mm. It is not necessary to ink in the trim line. Divide the drawing paper into 3 equal vertical columns, draw and letter each figure as close as possible to the illustrations in Plate 24-8.

PLATE 24-8

Fig. 1. A **point** is that which has position but no magnitude. It is represented by a dot.

Fig. 2. A **line** is that which has but one dimension - namely length.

Fig. 3. A **straight** or **right line** has the same direction throughout its length.

Fig. 4. A **curved line** or **curve** changes its direction at each succeeding point.

Fig. 5. A **vertical line** is perfectly erect—namely is parallel with a plumb line.

Fig. 6. A **horizontal line** is one that is level throughout its length.

Fig. 7. Parallel lines are those lines which lie in the same plane.

Fig. 8. A **perpendicular** is a straight line so meeting another that the two adjacent angles formed are equal. Each of these angles is called a right angle.

Fig. 9. A **right angle** is composed of 90 equal parts called degrees.

Fig. 10. A **circle** is a plane figure bounded by a curve, all points of which are equi-distant from the center of the circle.

Fig. 10. The boundary of a circle is called the **circumference.**

Fig. 11. Any part of the circumference is called an **arc.**

Fig. 11. Any Chord passing through the center is a **diameter.**

Fig. 11. Any straight line from the center to the circumference is called a **radius.**

Fig. 12. Any straight line having its ends in the circumference is called a **chord.**

Fig. 12. Any straight line which touches a circle at but one point is a **tangent** to the circle and it is always perpendicular to a radius drawn to that point.

A **plane** or **plane surface** is one in which the straight line connecting any two points will lie wholly within the surface. Example: The surface of a drawing board.

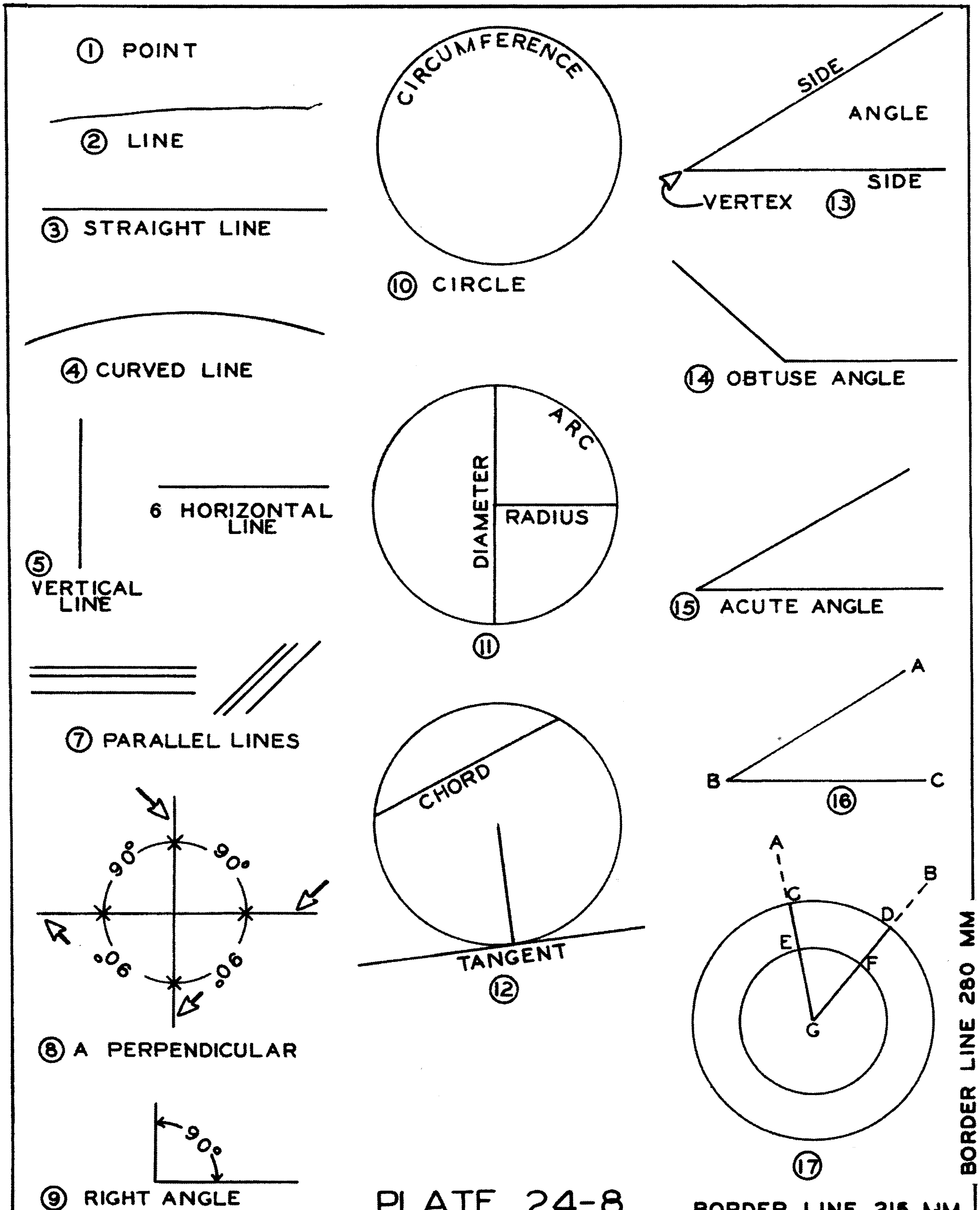
Fig. 13. When any two straight lines meet at a point the figure so formed is called an **angle.** The two lines are called the **sides** of the **angle.** The point of meeting of the sides is called the **vertex** of the **angle.** The **size** of the **angle** is the amount of its opening and doesn't depend on length of its sides.

Fig. 14. If the opening between the sides is greater than a right angle, the angle is an **obtuse angle.**

Fig. 15. If the opening is less than a right angle, the angle is an **acute angle.**

Fig. 16. In figure 16 is shown an **angle,** the two lines **BA** and **BC** being the sides and the point **B** the **vertex. Angles** in drawings are designated by three letters, the center letter indicating the vertex of the angle. Figure 16 would be described as the **angle ABC.**

If the circumference of a circle is divided into 360 equal parts, each one of these parts is called a **degree.** In other words, a degree is 1/360th of the circumference of a circle regardless of the diameter of that circle. For instance, a degree on the rim of a balance wheel from a man's size watch would be a very small amount if measured in inches, not to exceed 1/200th of an inch, being but 1/360th of the circumference of that wheel. If we were to take a degree on the rim of an automobile wheel, it would be larger, measured in inches rather than in hundredths of an inch. If we go still further and speak of a degree upon the circumference of the earth at the equator, it would measure about 69 miles. Hence a degree is not a **linear** measurement but an **angular** measurement, and while the angle as shown in the circle, figure 17, is 40 degrees, it would remain 40 degrees regardless of how far the lines **AG** and **BG** might be extended from the Center **G,** and also regardless of the size of any circle that might be described from the Center **G.** If we were to draw a circle as shown at **E** and another one at **C,** figure 17, using **G** as a center, the actual distance between the lines on these two arcs would vary greatly, but the angular measurements of **CGD** and **EGF** would still be the same, 40 degrees. Therefore, the size of the angle is the amount of its opening and does not depend upon the length of its sides.



① POINT
② LINE
③ STRAIGHT LINE
④ CURVED LINE
⑤ VERTICAL LINE
6 HORIZONTAL LINE
⑦ PARALLEL LINES
90°
90°
90°
90°
⑧ A PERPENDICULAR
90°
⑨ RIGHT ANGLE
CIRCUMFERENCE
⑩ CIRCLE
ARC
DIAMETER
RADIUS
⑪
CHORD
TANGENT
⑫
SIDE
ANGLE
SIDE
VERTEX
⑬
⑭ OBTUSE ANGLE
⑮ ACUTE ANGLE
A
B
C
⑯
A
B
C
D
E
F
G
⑰
BORDER LINE 280 MM
BORDER LINE 215 MM

PLATE 24-8

ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890

Fig. 24-9

SEC. 427—Lettering Your Drawing

In lettering your drawing, always draw horizontal and vertical guide lines as shown in figure 24-9 and sketch the letters or figures in pencil. In this way, any errors may be corrected before inking which is best done with a lettering pen and a good black drawing ink.

When you have completed the pencil drawings and lettering, proceed to ink the plate as follows:

1. Ink main center lines.
2. Ink small circles and arcs.
3. Ink large circles and arcs.
4. Ink irregular curves.
5. Ink horizontal lines.
6. Ink vertical lines.
7. Ink inclined lines.
8. Ink dotted lines.
9. Ink extension and dimension lines.
10. Ink arrow heads.
11. Letter.
12. Ink border lines.
13. Check drawing.
14. Clean with art gum and cut away trim lines.

SEC. 428—Drawing to Scale

PLATE 24-9

If you wish to show the purpose or function of certain mechanical actions, it should be possible to convey your ideas by means of free hand drawings, but if the different parts of such a drawing are to be of proper proportions and the work accurate, it is necessary to use drawing instruments and make the drawings **to scale.**

In making our drawing to scale, the actual measurements of our object can be increased or decreased in any proportion. Most of our drawings will be increased proportion because of the minuteness of the parts with which we work. This will enable the student to see clearly the proper shapes or mechanical principles involved in any part or combination of parts he desires.

Example: If we have a part such as a balance staff and we desire to draw it proportionately larger, it is necessary to predetermine the ratio. **Example:** Let 20mm. equal 1mm. Then if our staff measures 5:50mm, we would increase it twenty times and the length of the staff in our drawing would be 110mm, figure 18, Plate 24-9.

All of the figures referred to in the following text are contained in Plate 24-9.

Fig. 18 is a drawing of a balance staff which will be drawn to the scale of 1mm equals 20mm. All the necessary dimensions are given in millimeters. Keep your drawing in the upper left hand corner and inside the trim lines.

The following problems in Geometrical Constructions are essential because of their particular bearing on the work to follow. Solve these problems with great care and keep your drawings neat and accurate.

Fig. 19. To erect a perpendicular to a given line from a point on the line. Given point **A** on line **BC.** With **A** as a center and any convenient radius, describe arcs intersecting the line **BC** at points **1** and **2.** With points **1** and **2** as centers, and with a radius greater than half the distance between points **1** and **2,** describe arcs which intersect at **3.** Draw line **3-A,** which is the required perpendicular.

Fig. 20. To erect a perpendicular to a given line from a point outside the line. Given point **A** and line **BC.** With **A** as a center and any radius intersect the given line at points **1** and **2.** With points **1** and **2** as centers and any radius, describe arcs intersecting at **3.** Join **A** and **3. A-4** is the required perpendicular.

Fig. 21. To erect a perpendicular at the end of a given line. Given line **AB.** With **B as** a center and any radius describe an arc of a circle **1-2-3.** With **1** as a center and the same radius, cut the arc at **2.** With **2** as a center and the same radius, cut the same arc at **3.** With the same radius and with points **2** and **3** as centers, describe arcs which intersect at **4.** Draw **4B** the required perpendicular.

Fig. 22. To bisect an angle. Given angle **CAB.** With **A** as a center and any convenient radius describe an arc intersecting **AC** at **1,** and **AB** at **2.** With **1** & **2** as centers and any radius describe arcs intersecting at point **3.** Draw **A3** the bisector of the given angle.

Fig. 23. To draw a tangent to a circle at a given point in the circumference. Draw radius **BA** and extend beyond circumference. Erect a perpendicular **3-4** to the radius through point **A.** This is the required tangent.

Fig. 24. To draw a line tangent to a given circle thru a given point outside the circle. Assume any point outside the circle, as **C.** Draw a line from the point **C** to the center of the circle as **CB.** Bisect this line at point **3,** illustrated by line **1-2.** With **3** as a center and radius equal to **3B,** draw arcs intersecting the circumference at points **4** & **5.** These are the points of tangency for lines drawn from point **C** through points **4** & **5.**

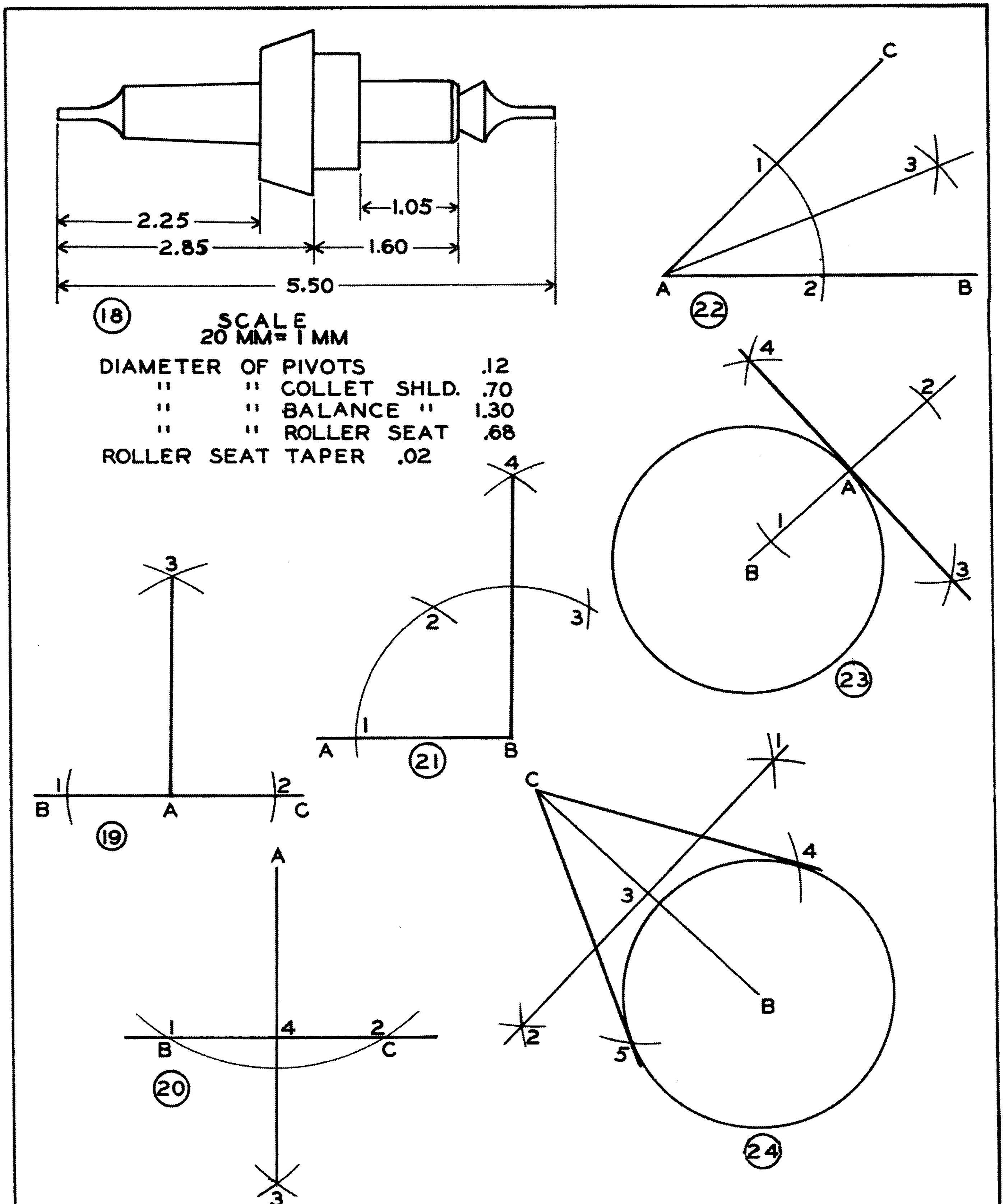

2.25
2.85
1.05
1.60
5.50
18
SCALE
20 MM = 1 MM
DIAMETER OF PIVOTS .12
" " COLLET SHLD. .70
" " BALANCE " 1.30
" " ROLLER SEAT .68
ROLLER SEAT TAPER .02
19
20
21
22
23
24

PLATE 24-9

SEC. 429—Working Lines

PLATE 24-10

Our next problem will be to draw an escape wheel containing 15 teeth. This type of escape wheel is used in most modern watches.

Many of the lines necessary in laying out an escapement are solely for the purpose of locating the several parts that constitute the finished drawing. They are called **working lines.**

In Plate 24-10 as in the preceding Plates, these lines are broken. This is done in order that they may be printed readily, but the student may use pencil lines, which he can erase when they have served their purpose. Such of these as he may desire to retain should be inked in red. The first step in drawing the escape wheel will be to draw in the border lines 280 mm and 215 mm respectively. Draw center line **AA** and divide it equally at **B.**

SEC. 430—Distance Between Escape and Pallet Center

The relative distances between the escape and the pallet centers and the pallets and balance centers may be taken at pleasure, provided it is within reasonable limits, say from escape center to pallet center, being anywhere between 30 per cent and 40 per cent of the entire distance between pallets and balance. These proportions are sometimes exceeded to accommodate other conditions, such as those existing in extra thin watches.

Decide upon the center distances between the escape and pallets and the pallets and balance. In the following instructions it will be understood that the measurements given are not from actual sizes.

Take 115 millimeters on the scale for the distance between the center of the escape wheel (point **B**) and the center of the pallets (point **C**) on center line **AA.**

SEC. 431—Relative Position of Parts

The escapement may be drawn with its parts in any relative position to each other that they assume during action. In this case, we will show them at the instant of locking on the receiving stone. In order to do this, we must find the exact point of contact of the locking corner of an escape tooth with the locking face of the receiving stone. Before we do this, however, it is well to decide what the circular impulse is to be and how it is to be proportioned between the wheel teeth and pallet stones.

SEC. 432—Locating The Arc Of Impulse

The arc through which an escape tooth passes at each impulse is called the arc of impulse, and in an escape wheel of **15 teeth** is **12** degrees. The reason that it must be **12** degrees is that each tooth delivers two impulses —one to the receiving stone and one to the discharging stone—during each revolution of the escape wheel. There being 15 teeth in the escape wheel, we divide the entire circle (360 degrees) by twice that number, which gives us 12 degrees. This 12 degrees is not entirely taken up by impulse. A part of it is required for drop. In this case, we will give 1½ degrees for drop. The remaining 10½ degrees is what is termed active circular impulse and is divided between a pallet stone and an escape wheel tooth. We will divide this active circular impulse by giving 4½ degrees to the tooth and 6 degrees to the stone.

SEC. 433—Number of Degrees Between Escape Teeth

When the tooth of the escape wheel is locked on the receiving stone, two teeth stand between it and the locking face of the discharging stone. From the locking corner of a tooth to that of the next adjacent tooth is 24 degrees, which is divided into 2 equal impulses of 12 degrees each. From the locking corner of the tooth that is locked on the receiving stone to the locking corner of the second tooth in advance is, therefore, 48 degrees. The third tooth, which has just been released by the discharging stone, is just one impulse — 12 degrees — in advance, making an arc of 60 degrees in all between the locking corners of the pallet stones when measured from the escape wheel center. In an equi-distant locking escapement, the locking corners embrace angles of 30 degrees at each side of the line of centers, but in an equidistant center escapement these 30-degree angles of measurement pass through the centers of the stones, or, to be exact, midway between where the paths of the locking and releasing corners intersect like paths of the escape teeth. This being the case, lines drawn from the escape center 30 degrees each side of the line of centers will pass through the centers of the stones; for this is to be an equi-distant center escapement.

The foregoing has been gone into minutely in order that the student may understand clearly why we use 30 degrees from each side of the line of centers to determine the location of the pallet stones. It must be understood, however, that this only applies to pallets spanning 2½ teeth of a 15-tooth escape wheel.

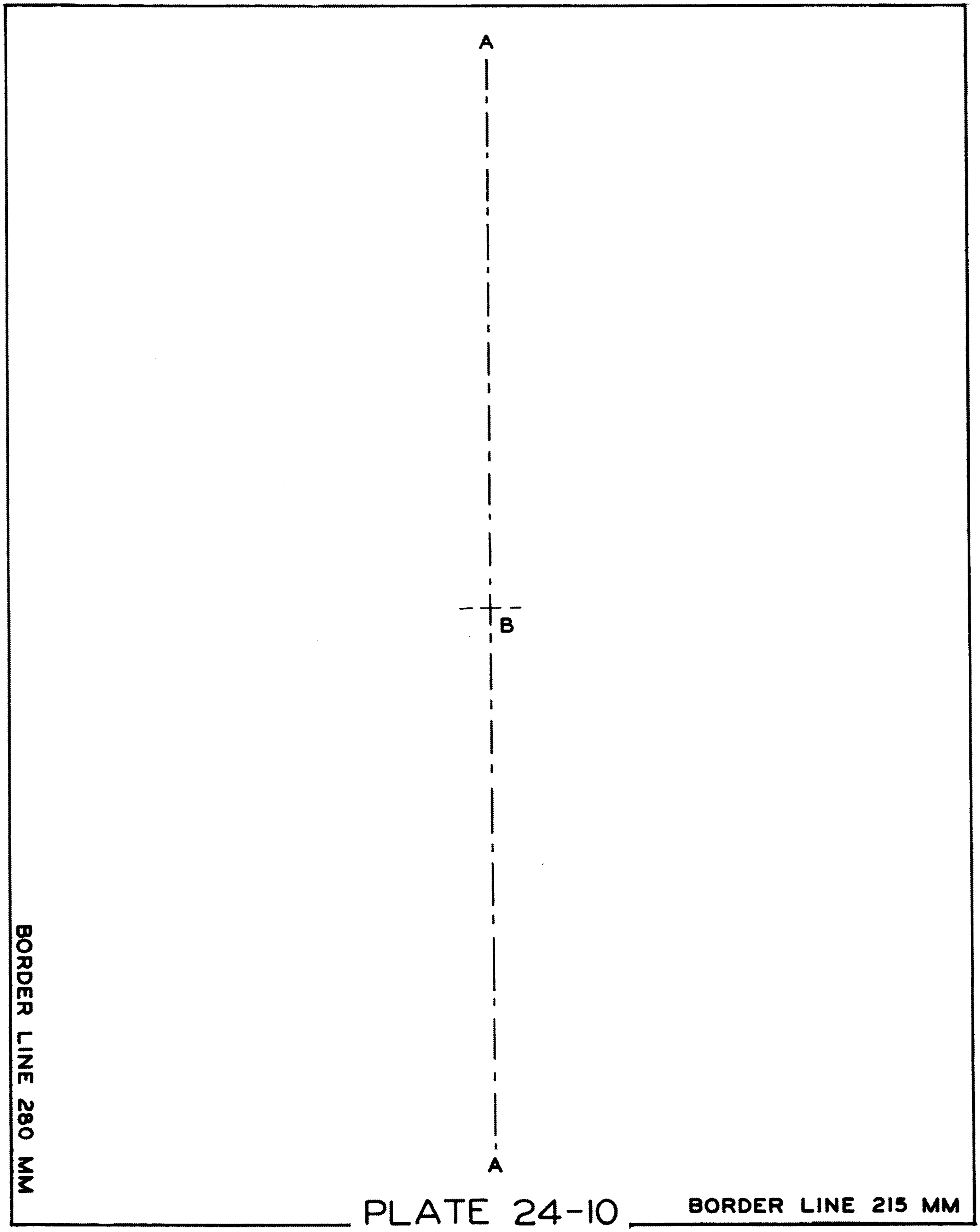
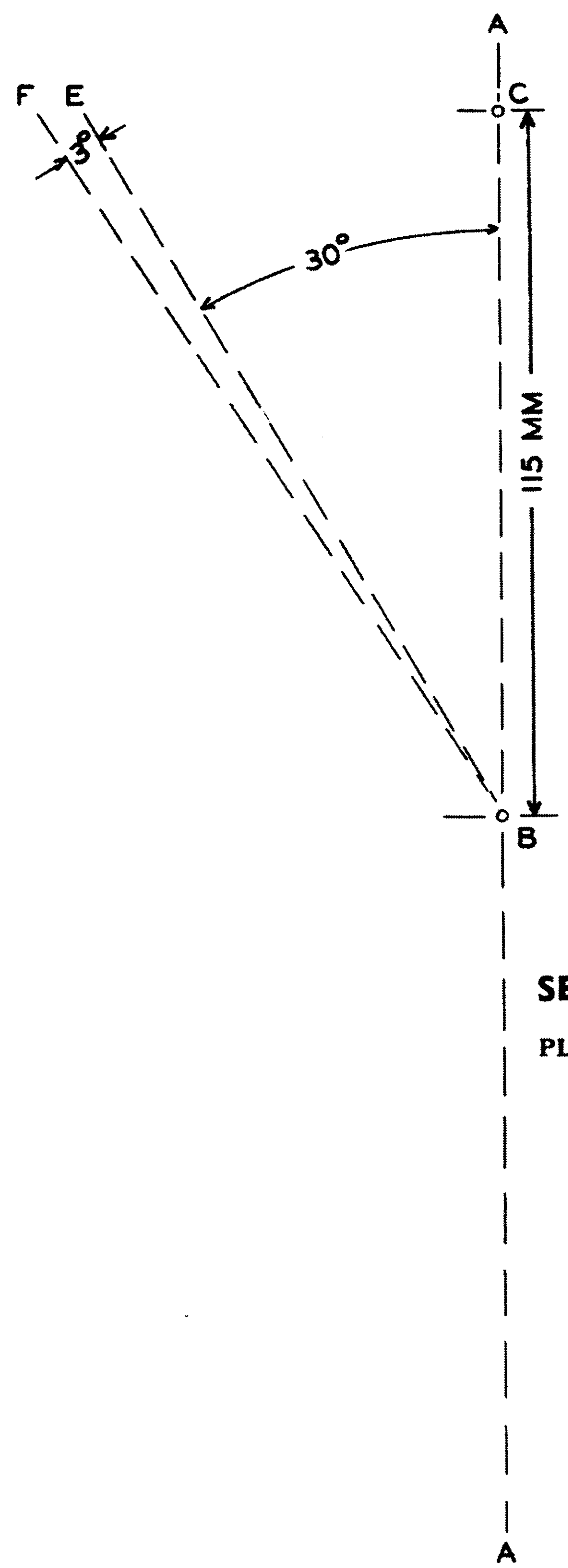


PLATE 24-10



SEC. 434—Drawing an Escape Wheel

PLATE 24-11. From **B** draw line **E,** 30 degrees to the left of the line of centers. Inasmuch as this line runs through the center of the stone, and that the locking corner is half the angle—6 degrees—to the left of this point, draw a line, **F,** 3 degrees to the left of **E.**

PLATE 24-11

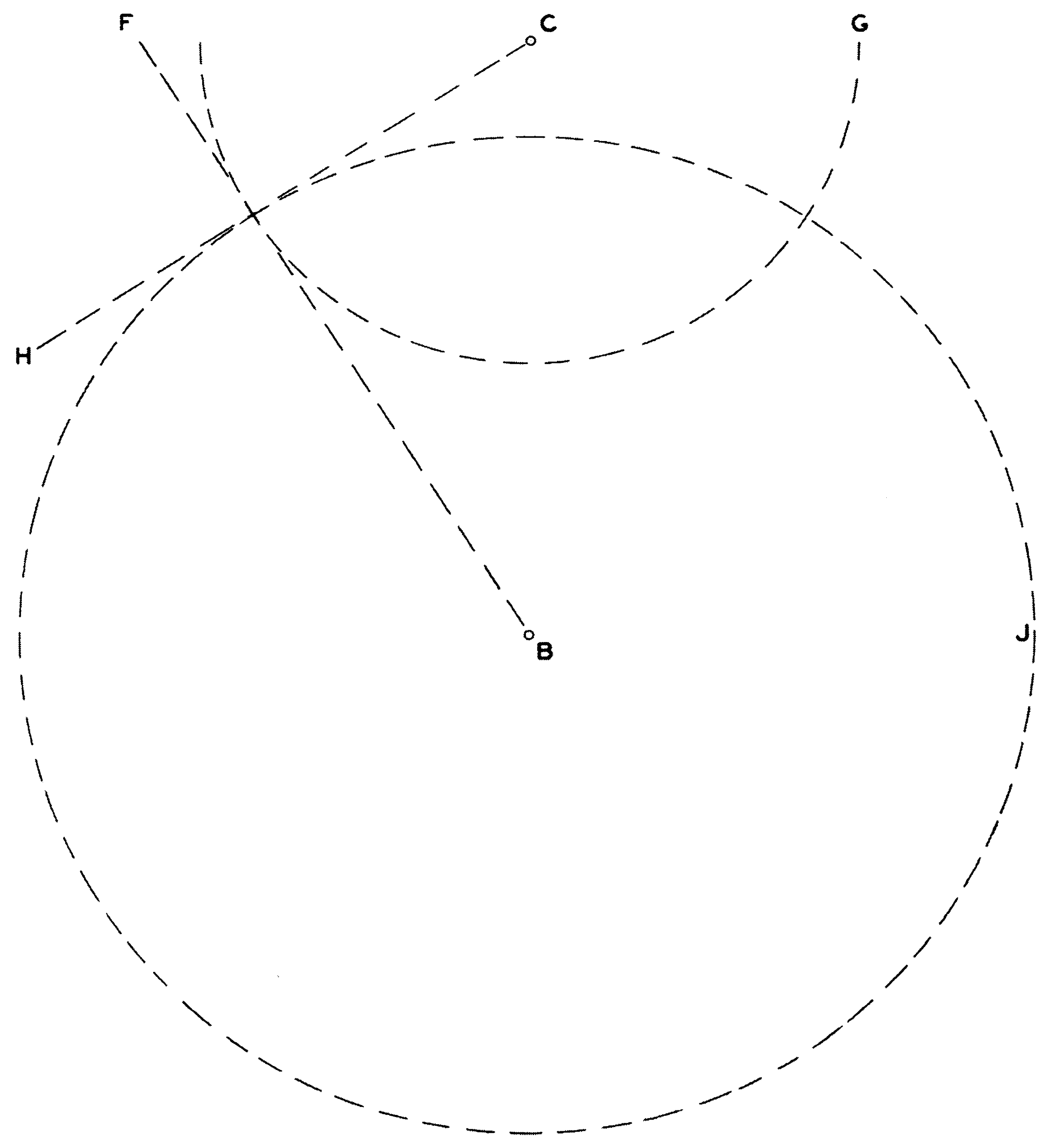


PLATE 24-12. The circular path of the receiving stone locking is tangent to this line. From **C** as a center draw an arc **G** tangent to line **FB.** At the intersection of arc **G** and line **F** from **C** draw line **H.** This line will form a right angle with line **F.** With **B** as a center describe the circle **J** thru the intersection of lines **H** and **F.** This circle is called the primitive diameter of the escape wheel, and would be its diameter if the wheel were trimmed down to the locking corners.

PLATE 24-12

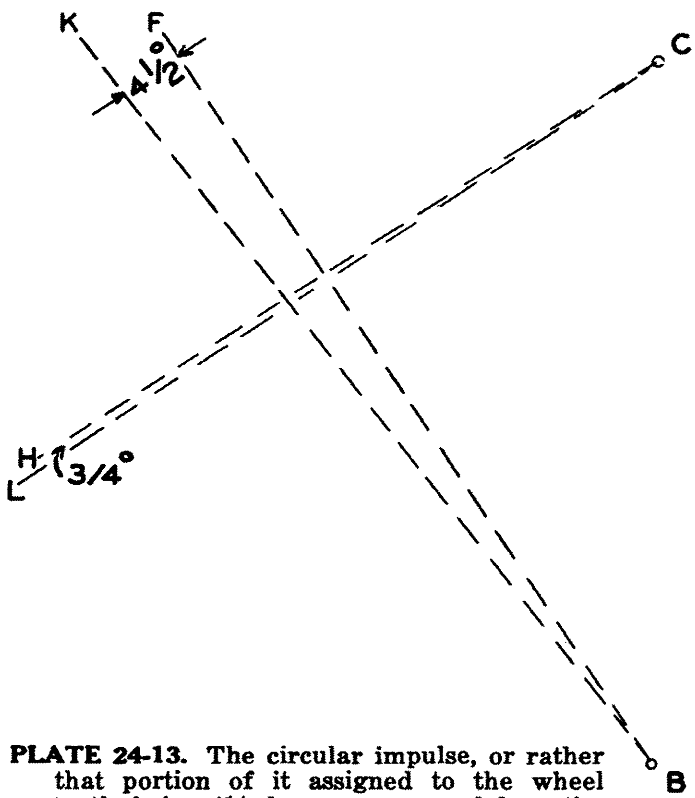


PLATE 24-13. The circular impulse, or rather that portion of it assigned to the wheel tooth, being 4½ degrees measured from the center **B**, draw line **K** that amount to the left of **F**. Upon this line will fall the releasing corner of the tooth. We will now decide upon the amount of lock, which should be as light as possible, consistent with safety, say ¾ degree. From **C** draw line **L**, ¾ degrees below **H**. Where this line intersects line **F** will mark the locking corner of the pallet stone.

PLATE 24-14. We may now decide upon the arc of vibration of the fork and pallets. Let it be 10 degrees. Of this, ¾ degree will be for slide, ¾ degree for lock, leaving 8½ for active impulse—sometimes called lift. This amount should be divided between the tooth and stone in about the same proportion as the circular impulses bear each other. We will give 5 degrees to the stone, 3½ degrees to the tooth. From **C**, 5 degrees below **L**, draw line **M** and from the same center, 3½ degrees above line **H**, draw line **N**. From **B**, draw line **O**, 6 degrees to the right of line **F** (or 3° from **E**.)

From **B** as a center, through the intersection of lines **N** and **G**, draw circle **P**. This circle will embrace the diameter of the escape wheel over points.

From **C** as a center through the intersection of circle **P** with line **O**, draw arc **Q**. This will be the path of the releasing corner of the stone.

The student cannot be too strongly urged to make himself familiar with the principles involved in locating these few lines, for they embody the fundamental principle of the lever escapement.

At this point it may be well to give a simple way whereby the true diameter of an escape wheel may be found. In spanning an escape wheel with a micrometer gauge we do not get its true measurement for the reason that the gauge must necessarily bridge two teeth, which leaves us short of its true measurement by the height of the arc between these teeth. The process of measuring this accurately is somewhat complicated but can be closely approximated by simple addition. To illustrate: Let us assume that the apparent diameter of the wheel is 7.55 mm. Write it this way and add:

$$\begin{array}{r} 7.55 \\ .0755 \\ .00755 \\ \hline 7.63305 \end{array}$$

Then 7 63 mm is the true diameter of the escape wheel.

PLATE 24-13

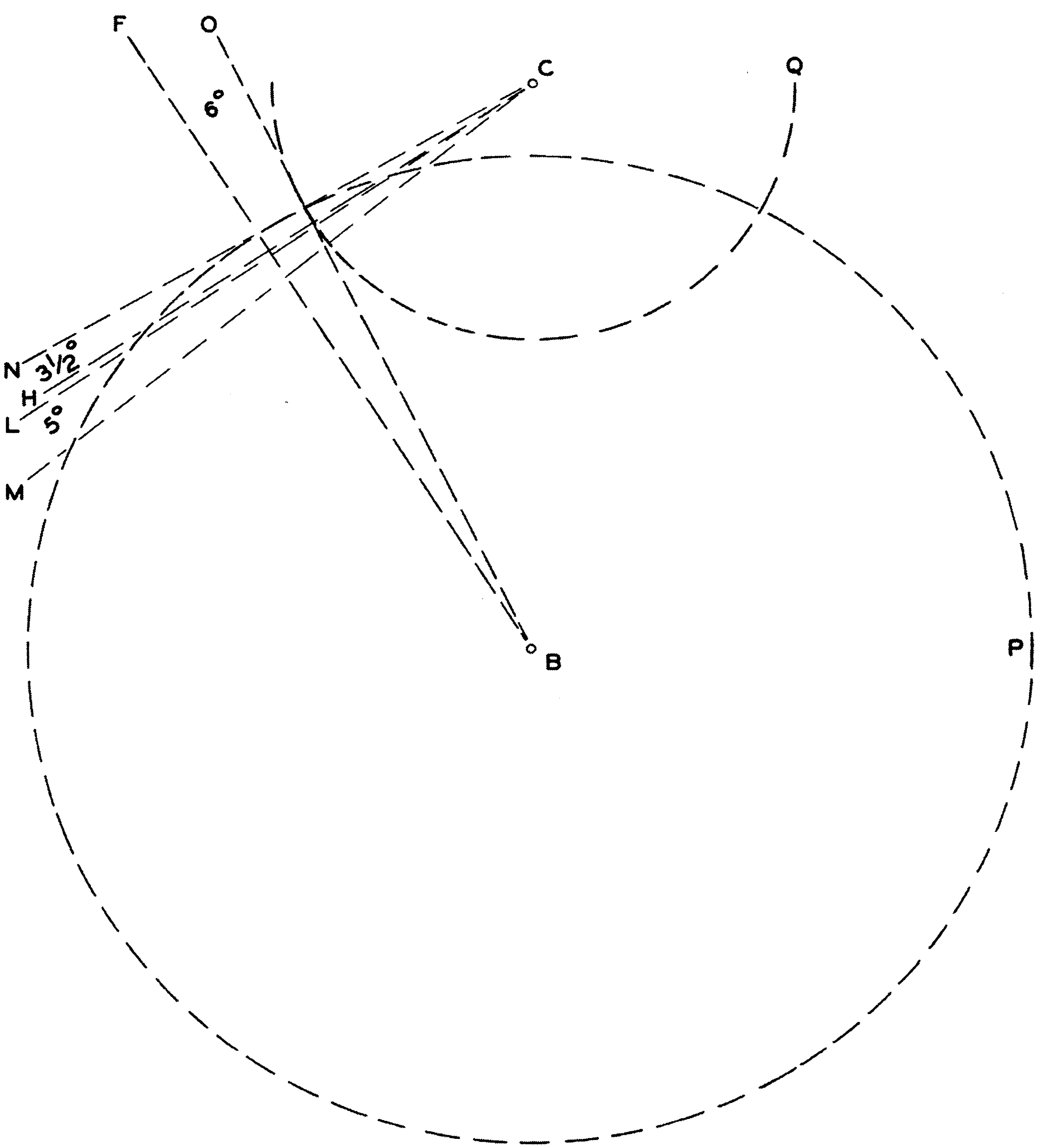


PLATE 24-14

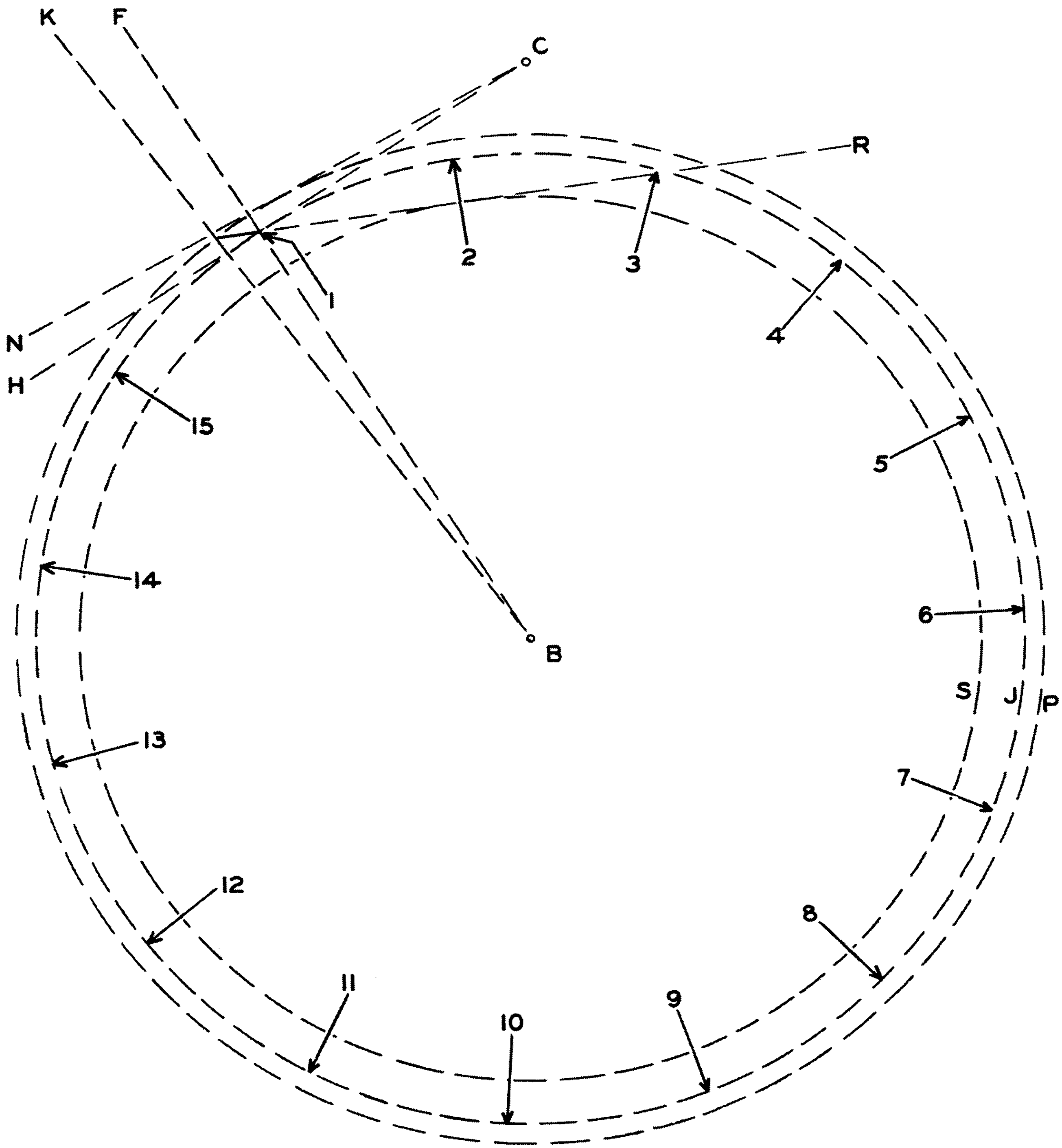


PLATE 24-15. The impulse face of a tooth is formed by drawing a full line from the intersection of lines **P** and **K** to the intersection of lines **H** and **F.** Extend this line to the right to **R.** Its use is to aid in drawing the impulse faces of the other teeth. From the locking corner of the impulse face just drawn in, mark off circle **J** into **15** equal spaces, **1, 2, 3, etc.** These will be the locking corners of the teeth.

To divide the circle **J** into 15 equal arcs from the intersection of line **F** with arc **J** with **B** as a center, mark point **2** 24 degrees below line **F.** With **B** as a center mark point **3** 24 degrees from point **2.** With **B** as a center mark point **4** 24 degrees from point **3** and so on until you have 15 equal arcs.

PLATE 24-15

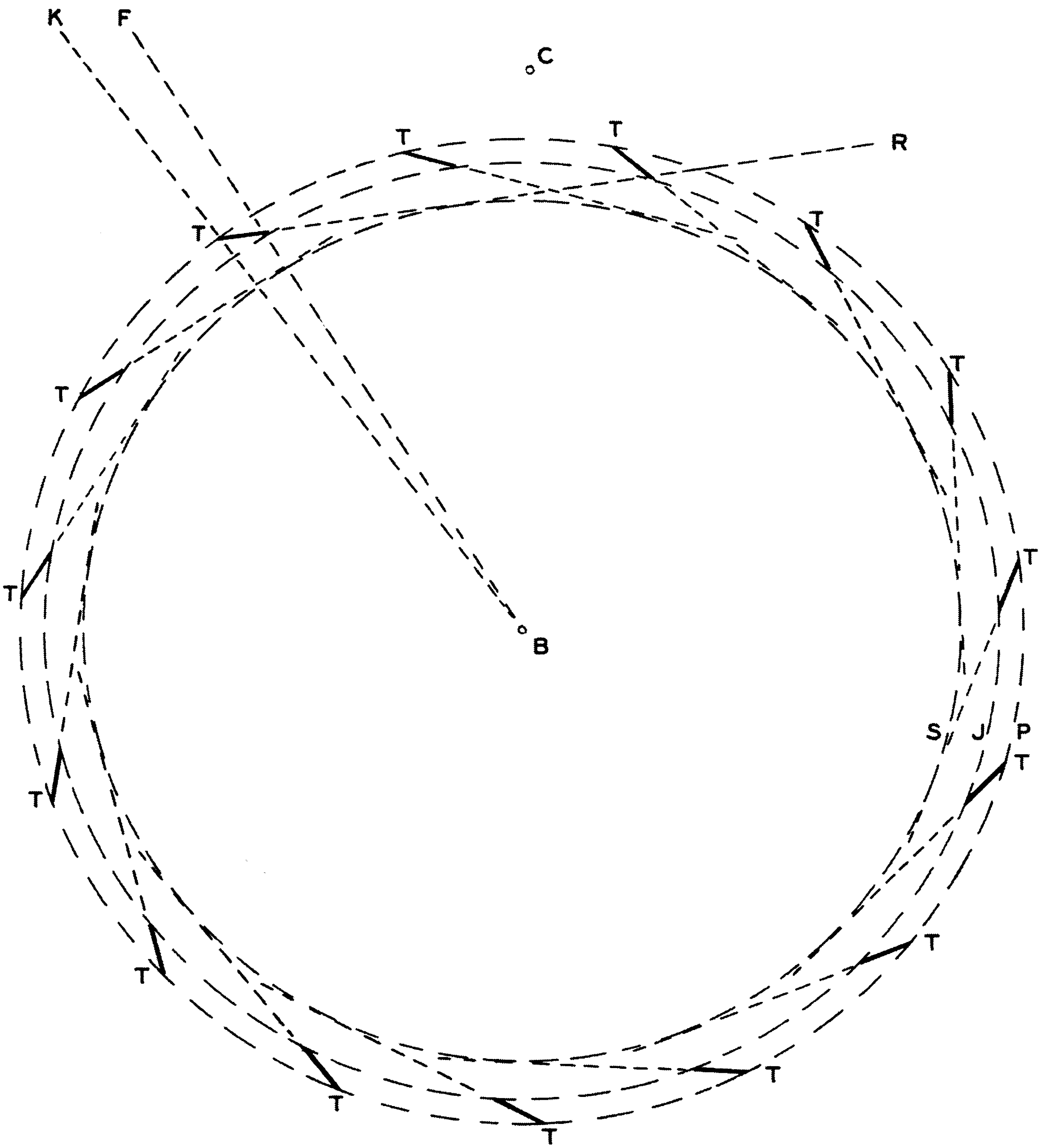


PLATE 24-16. From these points with dividers set to the length of the impulse face already drawn in, mark points **T, T, T,** etc., on circle **P.**
These points will embrace the length of the impulse for the other teeth, being guided by the tangential circle **S.**

PLATE 24-16

PLATE 24-17. We will now draw the hub, arms and rim of the escape wheel.
The dimensions of these are more or less a matter of taste.
Taking the full radius of the wheel (approx. 100 mm) as a basis, we will draw in the wheel to certain proportions, as follows:
For the hub 20%
For the inside rim 73%
For the outside rim 80%
For the thickness of the arms 8%
Setting the compass at **20 mm**, draw a circle for the wheel hub from center **B.**

Setting the compass at **73 mm,** draw a circle for the inside of the rim.
Setting the compass at **80 mm,** draw a circle for the outside of the wheel rim.
Setting the compass at **4 mm**, draw a circle to be used as a guide in drawing the arms of the wheel. Draw two lines parallel to each other and tangent to this circle.
At right angles to these lines and tangent to the same circle, draw two more parallel lines.
These will form the arms of the escape wheel.

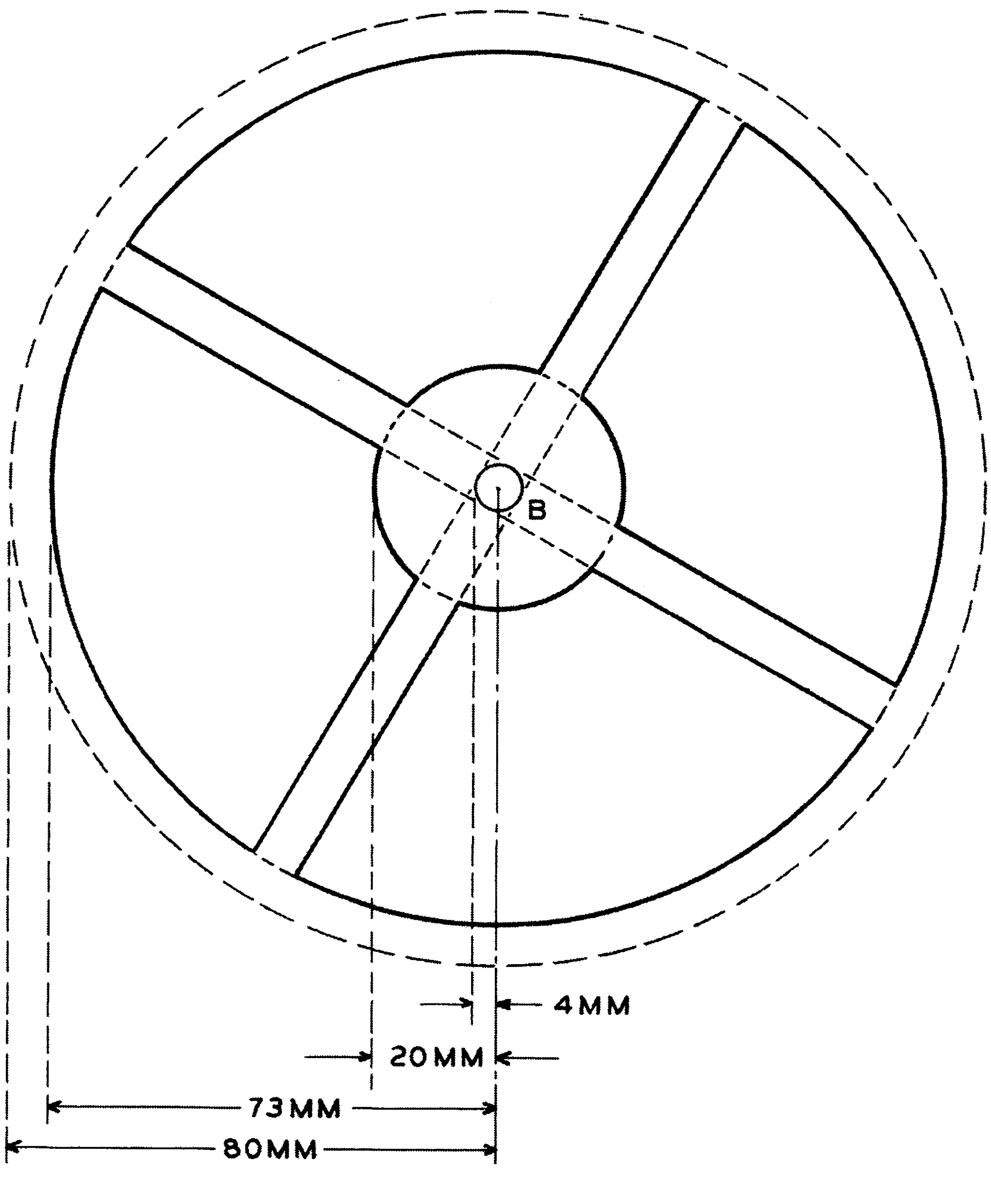


PLATE 24-17

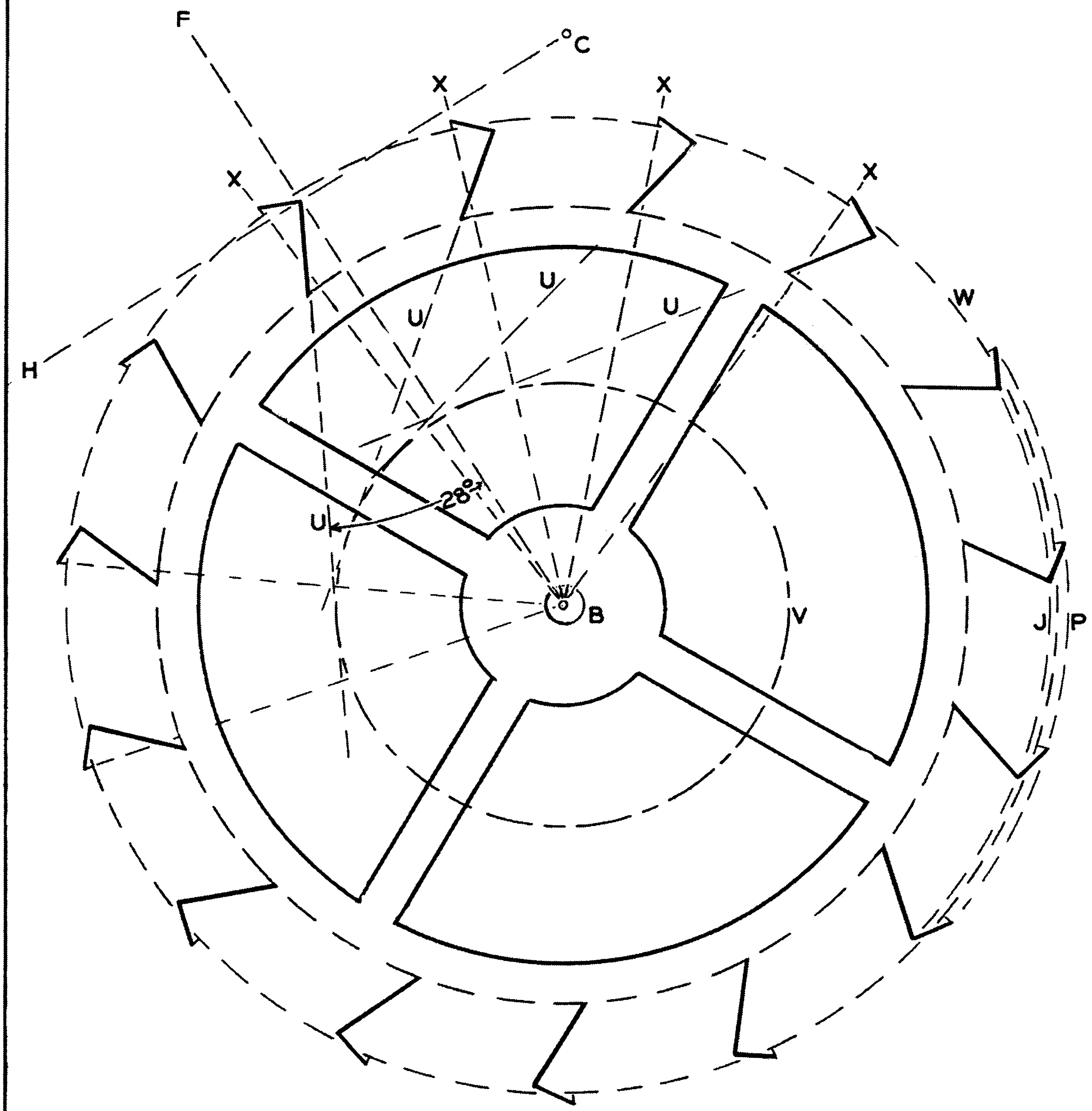


PLATE 24-18

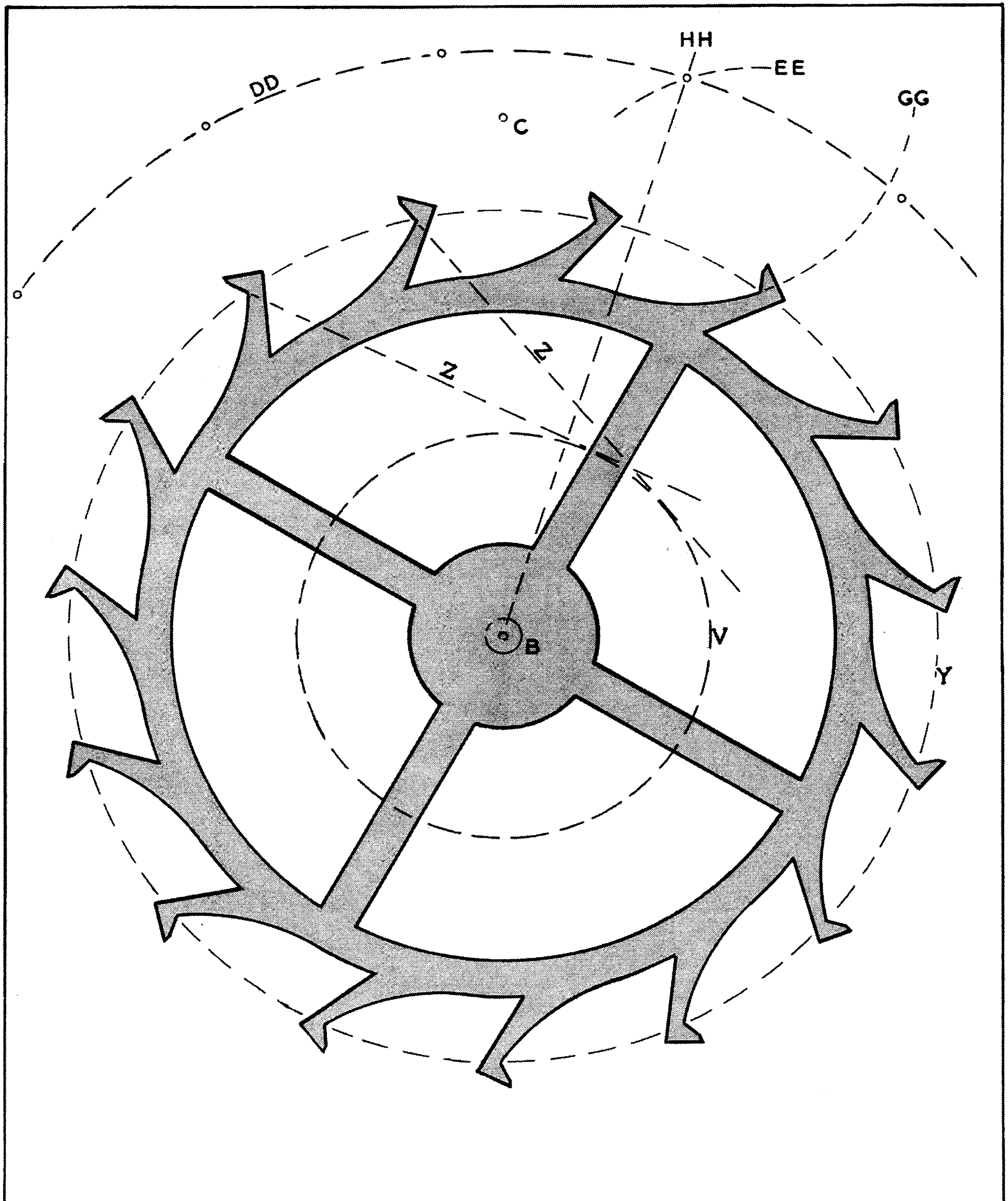


PLATE 24-19

PLATE 24-18. The angle at which the locking face of the tooth should be formed may now be determined. This angle is frequently placed at 24 degrees from a radial line to the center of the wheel but 28 degrees will be found better for the purpose, especially for an equi-distant center escapement. The reasons for this are that an unpoised fork requires increased draft for the pallet stones, and with this increased draft the locking face of the wheel tooth almost coincides with the locking face of the stone; furthermore, as the slide takes place on the discharging stone, the angle between the face decreases, with the result that when the oil becomes viscid, resistance is produced by adhesion.

On the receiving stone, the greater the slide the more the divergence, but on the discharging stone, the greater the slide the less the divergence.

With the intersection of the lines **HC** and **FB** as a center, draw line **U,** forming an angle of 28 degrees with **FB.**

This is the locking angle of the wheel tooth.

Draw circle **V** tangent to **U.** It will be a guide for forming the locking faces of the other teeth.

From the points marked **1, 2, 3,** etc. (Plate 24-15) draw lines tangent to circle **V.** These will be the locking faces of the teeth.

Draw circle **W** halfway between circles **J** and **P.**

From the points marked **T, T, T,** etc., (Plate 24-16) draw radial lines **X** to circle **W.** These form the toes of the teeth.

PLATE 24-19. From the points where these lines touch the circle **W,** draw lines in a direction that would make a tangent with circle **V,** as at **Z.** These form the under side of the club.

The next step is to form the backs of the teeth. In doing this, care should be taken that they are so shaped that when the train of the watch is reversed they will not contact the releasing corners of the pallet stones in such a manner as to wedge the guard pin against the roller.

Draw a circle **DD,** 1.3 the radius of the wheel, which will be approximately 130 mm.

Draw a circle 95% of the wheel radius, which will be 95 mm. (Circle **Y**).

With the dividers set at 50 mm, which is the difference between the radius of circle **DD** and the outside of the wheel rim, draw arc **EE** from the intersection of circle **Y** and line **Z.**

Using the same radius from the intersection of arc **EE** and circle **DD,** draw an arc **GG** from intersection of circle **Y** and line **Z** tangent to the outside of the wheel rim.

The point of tangency is located at the intersection of a line drawn from **HH** to center **B.** Draw similar arcs for the other teeth from similar points on circle **DD.** These arcs will form the backs of the teeth.

This completes the directions for drawing the escape wheel which may now be inked in as shown. Clean with art gum and print in ink your name and student number in lower right hand corner.

LESSON 25 DRAWING THE LEVER ESCAPEMENT

(cont'd)

Sections 435 - 442

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by Thomas B. Sweazey

SEC. 435—Drawing the Pallets

We will now proceed to draw the pallets, transferring lines as are needed in making Plate 25-1.

In order that we may keep our finished drawings of uniform size, we will show only four teeth of the escape wheel in the following drawing. Consequently, some of the working lines will be located outside of the border lines and will serve no purpose on the finished drawing. If the student desires to make a larger drawing in order to show a full escape wheel, it is permissible and desirable.

Locate Center **B** 55 mm, below the border line.

Locate Center **C** 115 mm, above **B** on center line **A**.

Transfer lines **E, F, K, O, H, L, M, N.**

Transfer circles **J** and **P.**

Transfer arcs **G** and **Q.**

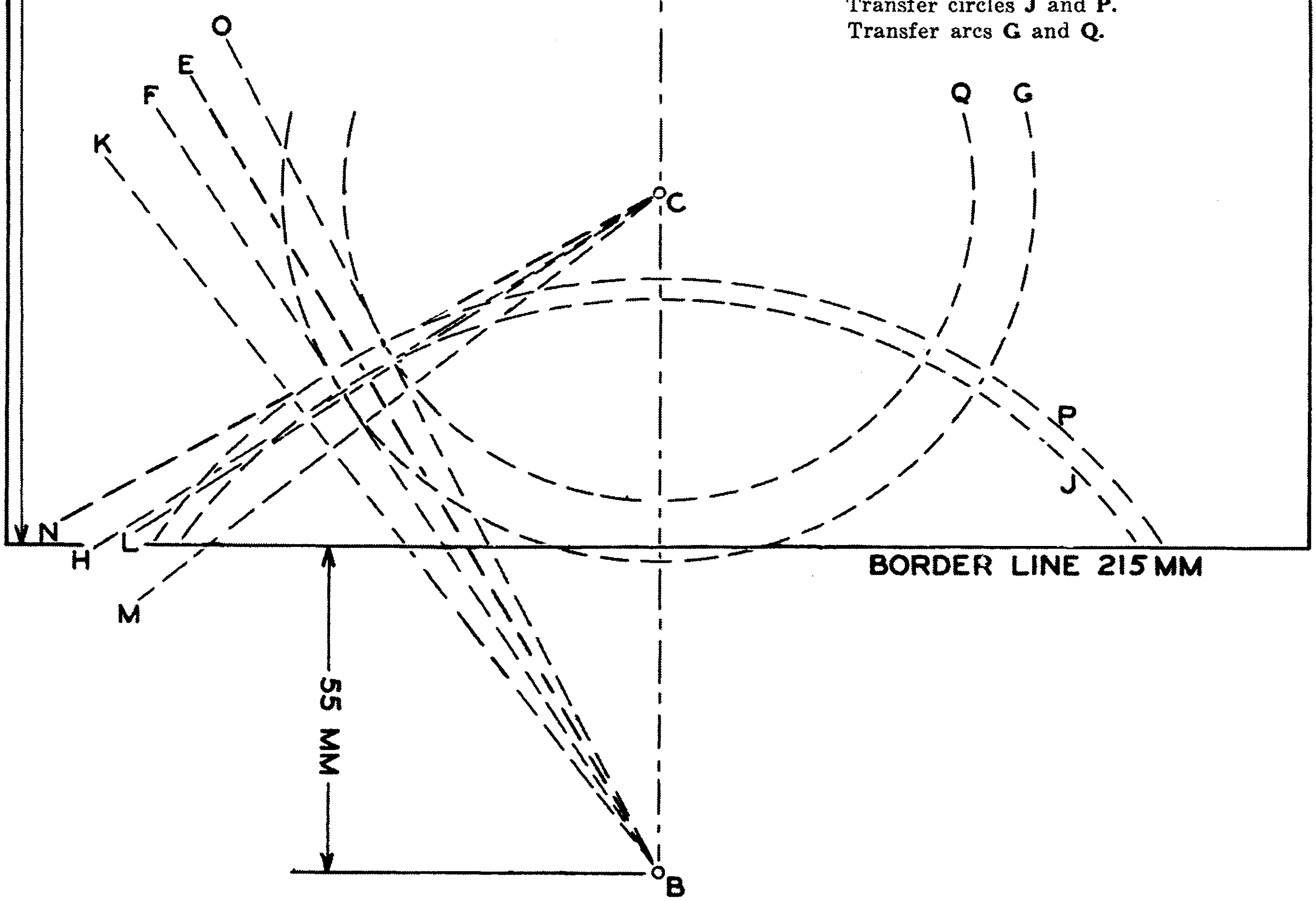


PLATE 25-1

SEC. 436—Circular Impulse and Lift

The circular impulse and lift combined must be the same on both the receiving and the discharging sides. The circular impulse of the teeth is always the same, regardless of the position of the wheel. The circular impulse of the stones and the lift of the teeth must be modified according to location. As has been stated, the lift must be the same on both sides, but the proportions between the lift of the wheel and that of the stone vary.

Extend arcs **G** and **Q.**

The points from which the circular impulse of the discharging stone is determined are the intersections of arc **Q** with circle **J** and of arc **G** with circle **P**; therefore, draw lines **1** and **2** from **B** through these points. These lines embrace an angle of 6 degrees, as do lines **F** and **O** on the receiving side, and are the circular impulses of the stone.

The lift of the tooth is determined on the discharging side from the same intersections; therefore, draw lines **3** and **4** from **C** through these points.

Compare the angle included between **H** and **N** with that between **3** and **4.**

The lift of the tooth at the discharging side is greater than at the receiving side. In order that the combined lift be alike on both sides, it follows that the lift of the stone must be less on the discharging side. At the discharging side the wheel lifts the pallets through an arc of 4½ degrees; the lifting angle of the discharging stone must be just enough to make up the difference between that amount and 8½ degrees, which is the entire lift. This amount will be 4 degrees.

From **C** draw line **5,** 4 degrees above line **4.**

Connect the two points of intersection: **Q** and **5** with **G** and **4.** This will give the impulse face of the discharging stone.

Connect the intersection of arc **G** with line **L** and arc **Q** with line **M.** This will give the impulse face of the receiving stone.

The student who desires to acquaint himself thoroughly with the principles involved in this type of escapement should carefully note the points referred to above. At the risk of repetition we will explain again.

The action of the escape wheel tooth in oscillating a pair of pallets drives them through an arc of a circle the angular extent of which is measured by radial lines from the pallet center. The angle formed by these lines is called the lift. The lift given in the drawing under consideration is 8½ degrees, exclusive of the lock —the lock being no part of the active impulse.

The lines that measure the lift of the pallets pass, one through the locking corner, the other through the releasing corner of each stone, the angles formed thereby being identical, regardless of the changing position of the pallet.

Radial lines from the pallet center also measure the lift of the wheel tooth. These lines pass, one through the locking corner, the other through the releasing corner of the wheel tooth. There is this difference, however, between the two conditions: The locking and releasing corners of the stones do not change their relation to the center from which the lift is measured, while the locking and releasing corners of the escape wheel teeth are constantly changing their relation to the center from which their lift is measured.

This being the case, the manner in which the lifting angle of a tooth is measured is to draw one line from the center of the pallets through the locking corner of an escape tooth at the point where the lift begins and another where the lift ends, the embraced angle being the lift of the wheel tooth.

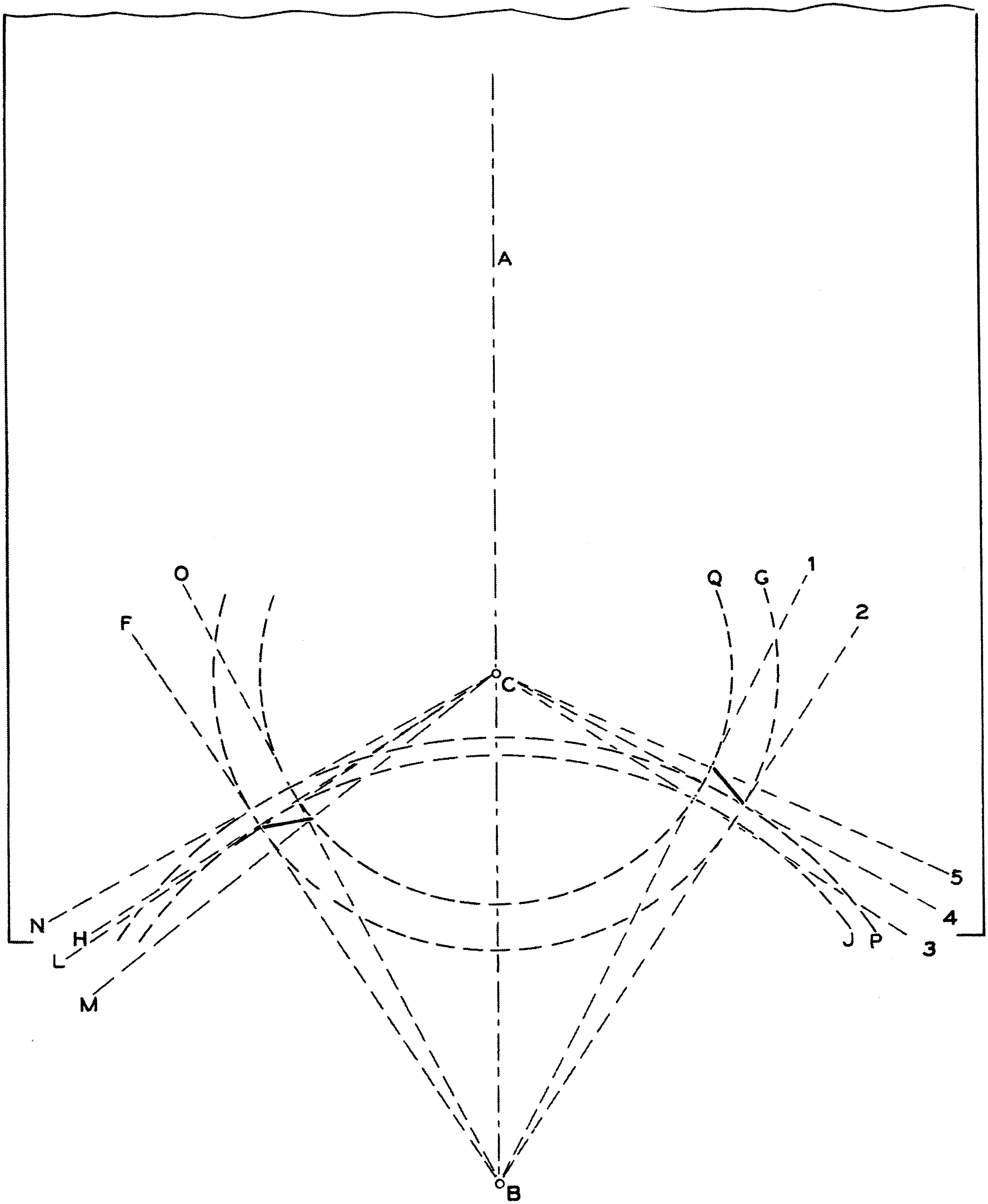


PLATE 25-2

SEC. 437—Angle at which Locking Faces Are Drawn

We will now determine the angle at which the locking faces of the stones should be drawn. They should be at such an inclination that the pressure of the wheel teeth will bring the fork to its bankings, holding it there until released by the action of the roller jewel. This is called the draft or draw. Its force is determined by the angle that the locking face forms with a line at right angles to a radial line from the pallet center to the locking corner of the stone. **L** is such a radial line, **6** is a line at right angle, and **7** is the line upon which the locking face of the stone should be drawn.

From the locking corner of the receiving stone draw line **6** at right angles with **L.** From the same point, draw line **7** at the right of, and **14** degrees from **6.** From the releasing corner draw line **8** parallel with **7.** This will give the form of the receiving stone.

Instead of drawing line **6** from which to take the angular measurement, it may be taken directly from line **L,** the angle being 76 degrees. The complement of an angle is the difference between that angle and **90** degrees. Now inasmuch as **6** forms an angle of 90 degrees with **L,** and we wish to draw a line 14 degrees less, if we draw it 76 degrees from **L** it will amount to the same thing.

From the locking corner of the discharging stone draw line **9** at right angles with **5.** From the same point, draw line **10** at the right of, and **14** degrees from **9.** From the releasing corner draw line **11** parallel with **10.** This will give the form of the discharging stone.

For our purpose, the length of the **R** stone measured from the locking corner will be **33** mm. The length of the **L** stone from locking corner is **34** mm.

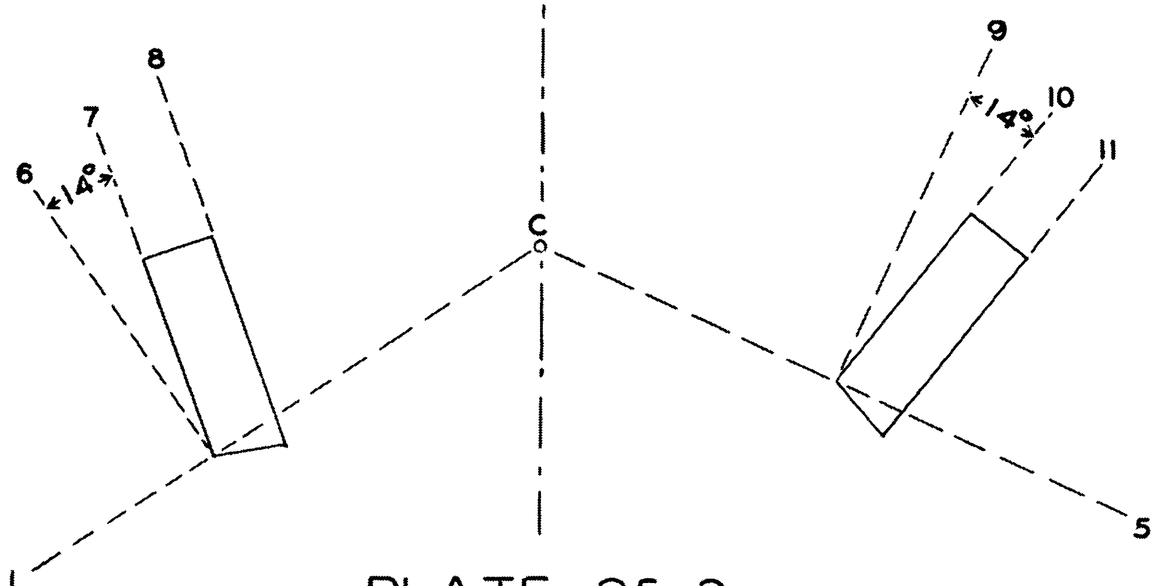


PLATE 25-3

SEC. 438—Form of Pallet Steels

The form of the pallet steels is to a large extent a matter of taste. Lightness of structure, however, is to be aimed at. Another condition that plays an important part is to have the arms of the pallets as near the wheel as possible in order that they may act, to some extent, as a counterpoise to the fork. The lower part of the fork only is represented in this drawing. It should be borne in mind that the fork as shown is at half its arc of vibration to the left of the line of centers; therefore, from the pallet center **C**, draw the line **12** at an angle of 4½ degrees from the line of centers. Draw two lines **13** and **14**, 6 mm at each side of and parallel with **12**.

The amount of steel surrounding the stones may be about 7 mm. The position of the lines forming the steels does not call for letting, but the means of locating them will be described. The arms being formed of arcs of circles, their centers must be located. For this purpose four centers, **JJ - MM - LL - KK** are found.

Locate center **JJ** 9.5 mm to the left of and 5.2 mm below the center **B.** Locate center **MM** 4.4 mm to the right of center **B.** Locate center **LL** 17.3 mm to the right of the center **B.** Locate center **KK** 29.2 mm to the right ofand 2 mm below the center **B.**

Arcs of 111 mm radius are drawn from **JJ** and **KK** to form the belly of the pallets. Arcs of 123 mm from **LL** and **MM** form the back of the pallet.

To form the circles that connect the pallets with the fork, two arcs of circles are drawn, each with a radius of 22 mm, from centers **NN** and **OO** and tangent to line **13** and arc **MM** and line **14** and arc **LL.** This completes the pallets.

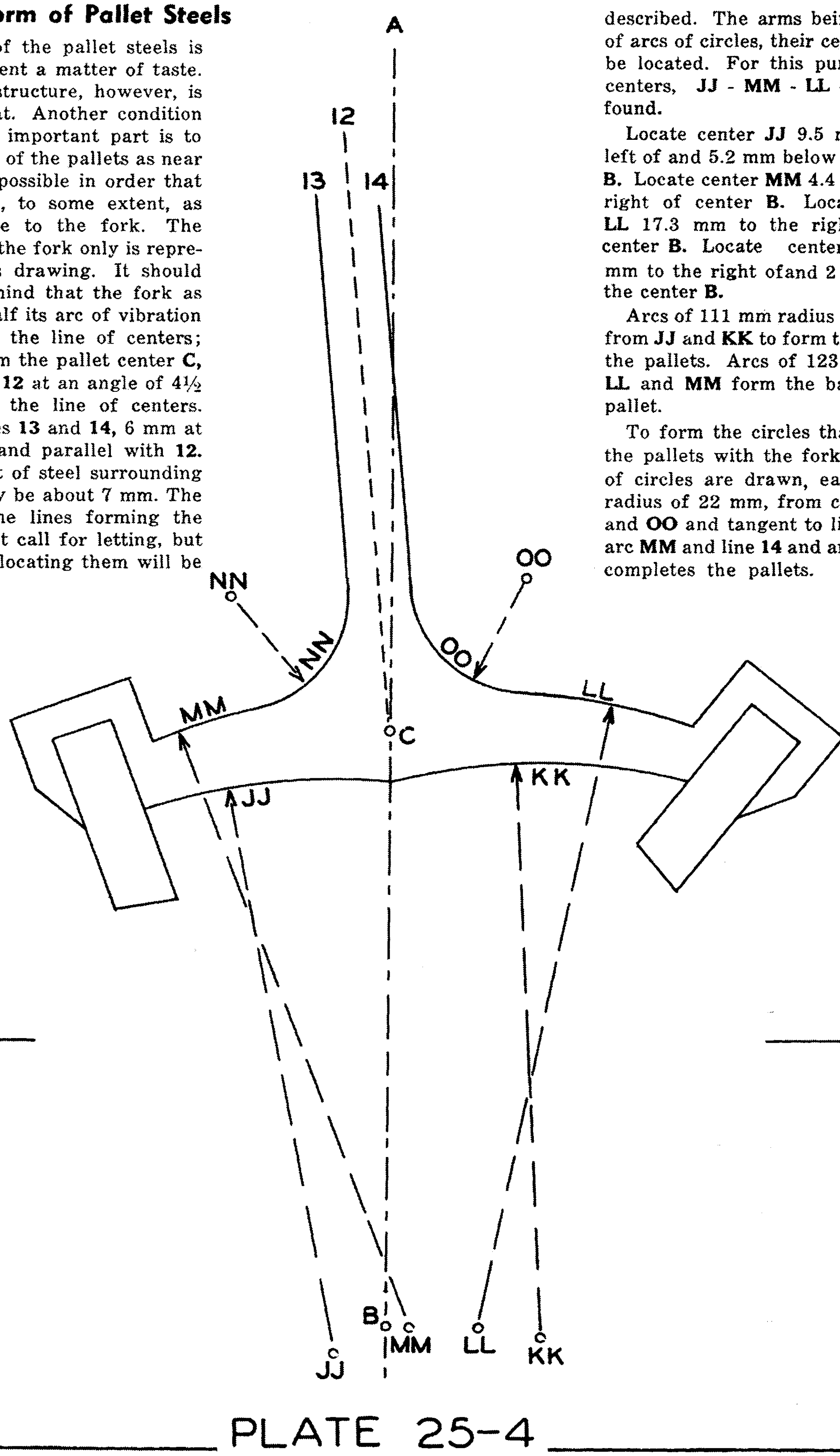


PLATE 25-4

SEC. 439—Laying Out the Fork and Roller

We will now proceed to lay out the fork and roller. Locate center **D**—170 mm above center **C** on line **A**. This will be the center of the balance and of the impulse and safety roller. With **C** as a center, extend line **12** at the left of center line **A**. The first point to be decided is the proportional distance of the roller jewel. On this will depend what is usually termed the freedom of the escapement. The proportional distances of the roller jewel and the fork slot from the centers upon which they vibrate is a highly important matter for consideration. The farther the roller jewel is from the center of the balance, the greater the force delivered by the fork, and the shorter the arc of contact; but as the force delivered by the fork to the roller jewel is increased by decreasing the length of the fork, the force delivered by the roller jewel in unlocking is decreased.

When a balance is stopped with the roller jewel on the line of centers and then released carefully, the watch should start even when the power is light—at the end of a 24 hour run. When a watch does not start under these conditions, it is said to "set on the impulse." A watch which is wound to the top but will not start when the balance is drawn to a position with the wheel tooth on the locking face, almost ready to unlock, is said to "set on the locking." This condition will be found when the fork is too short in proportion to the roller. An escapement that is free from these conditions is said to be a "free escapement." To avoid one or the other of these conditions it is necessary to have the distances properly proportioned to each other.

We will make them **3** to **1**; **3** for the fork, **1** for the roller jewel. With the dividers set at 42.5 mm, draw the arc of the circle **15** from **D** as a center. From **D** through the intersection of line **12** and arc **15**, which is the center of the roller jewel, draw line **16**. For the size of the roller jewel divide the total center distance 285 mm by **21**, which will give 13.6 mm. This is the diameter of the roller jewel. Setting the dividers at 7 mm, draw the circle **17** from the intersection of line **16** and arc **15**. This will be the roller jewel. The face of the roller jewel should now be drawn as follows: With the dividers set at 44.5 mm from center **D** draw the arc **18**. This arc will give the face of the roller jewel. Theoretically, the face of the roller jewel should be the arc of this circle instead of being flat, as is often seen. Draw the lines **19** and **20** parallel to **12** and tangent to circle **17**. These will give the sides of the fork slot. For the bottom of the fork slot draw the line **21**, 10 mm from the center of the roller jewel and at right angles to lines **19** and **20**.

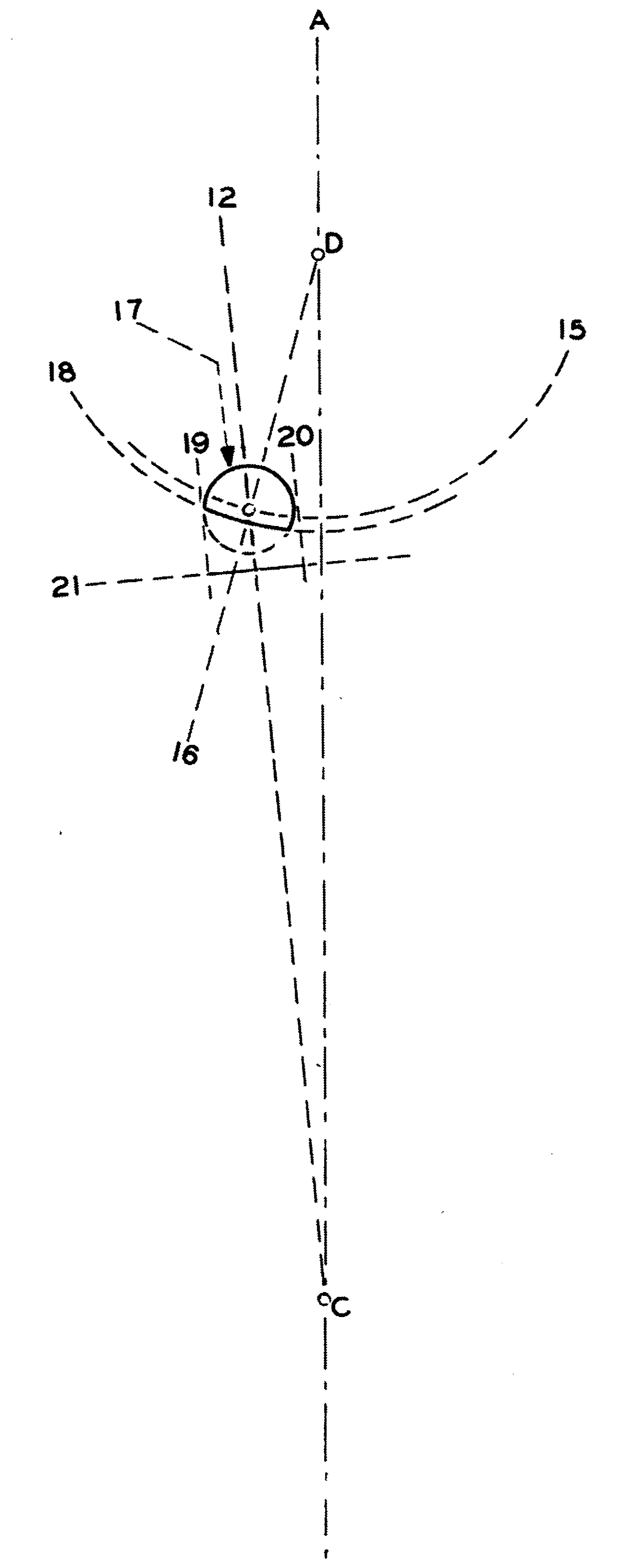


PLATE 25-5

SEC. 440—Fork Horns

The fork horns should extend at each side of the slot to a distance at least equalling its width. Setting the dividers at 22.5 mm, draw two short arcs, **22** and **23,** from the intersection of line **12** with arc **18.** The inside curves of the fork horn will end at these arcs.

The curves of the fork horns should be arcs of circles of the same radius, but not from the same center. In the position in which the fork is shown, the arc which forms the left horn is drawn from the roller center **D** and corresponds with arc **18.** To find the center for the curve of the right horn draw arc **24** from **C** as a center and through **D.** On this arc, to the left of its intersection with **12,** mark point **LL** at a distance equal to that from the intersection to **D.** From **LL** using the radius of arc **18,** draw an arc from Line **20** to arc **23.** This will be the right fork horn. From **LL** using the radius of arc **15,** draw arc **15A,** which will be used to locate center **MM** on plate 25-7.

The radius of the safety roller is usually two-thirds the distance from the roller center to the roller jewel center. With the dividers set at 28 mm, draw the circle **25.** This will be the safety roller.

The passing hollow may be of generous dimensions for the reason that the fork horns when made as directed provide additional safety against the fork going out of action. With the dividers set at 10.5 mm, draw arc **26** from a center at the intersection of line **16** with circle **25.** This will be the passing hollow.

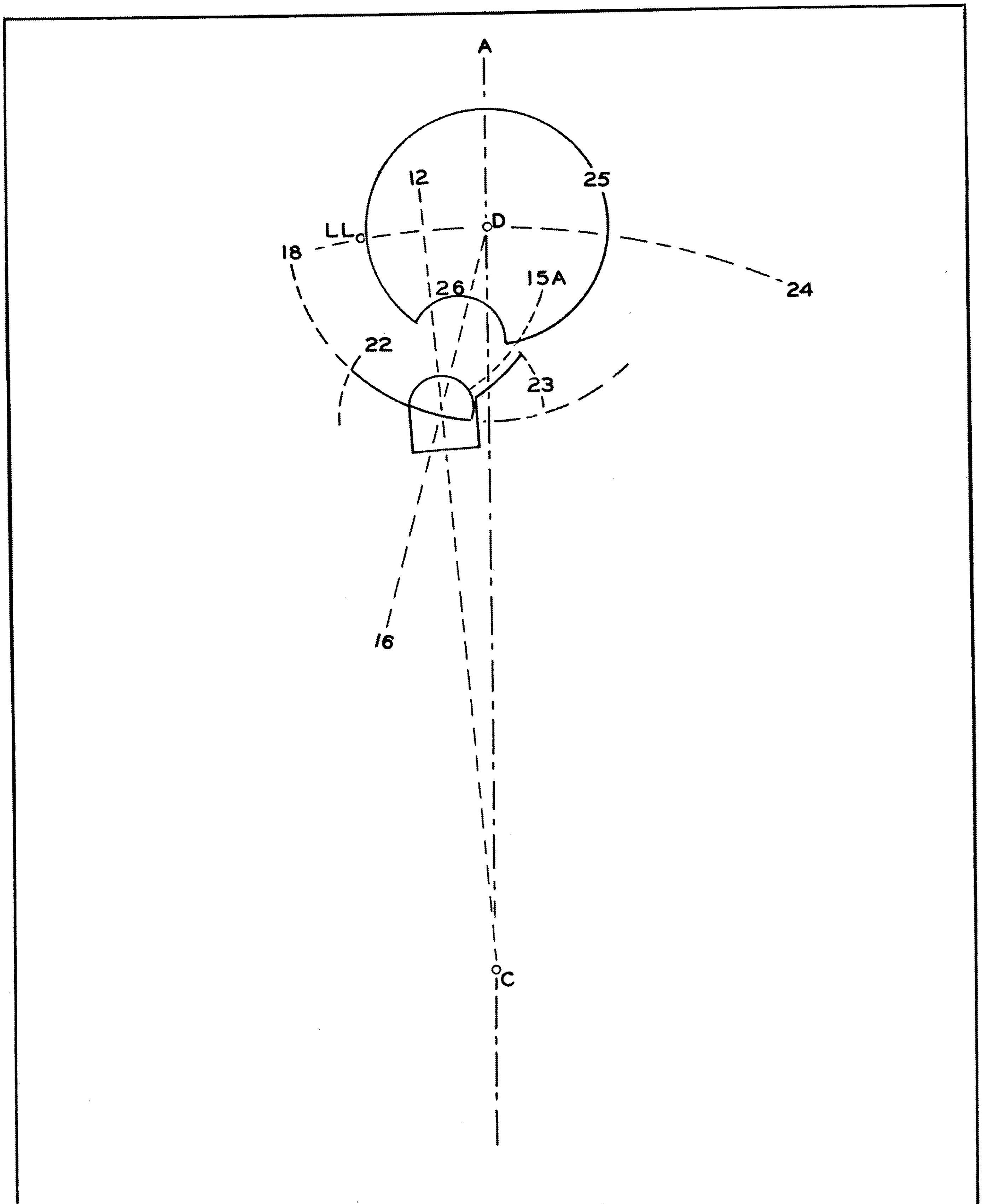


PLATE 25-6

SEC. 441—Guard Pin

The guard pin—sometimes called the dart—should be drawn with its point at the intersection of line **12** with circle 25. From this point draw lines **27** at each side of and 25 degrees from the line **12.** These will form the point of the guard pin. At each side of and parallel to the line **12** draw the lines **28.** These lines may be half the diameter of the roller jewel apart. They will form the sides of the guard pin.

The form of the fork is largely a matter of taste, lightness being a desirable feature.

Setting the dividers at 15 mm, mark the point **MM** on the arc **15** from center of roller jewel. Mark a similar point **MM** on arc **15A** to the right. From these points, with the dividers set at 7 mm, draw arcs of circles to form the ends of the horns as shown. These arcs are not lettered, but the student will have no difficulty in distinguishing them. From **C,** with the dividers set at 125 mm, draw the arc **29.** From the intersection of this arc with **12,** with the dividers set at 41 mm, mark the points **NN.** These points are the centers from which to draw arcs tangent to those forming the ends of the horns, thus forming the sides. With dividers set at 121 mm, from **C** locate center on line **12.** Draw arc from this center from sides of the horn to sides of fork (lines **13** & **14**). This completes the fork.

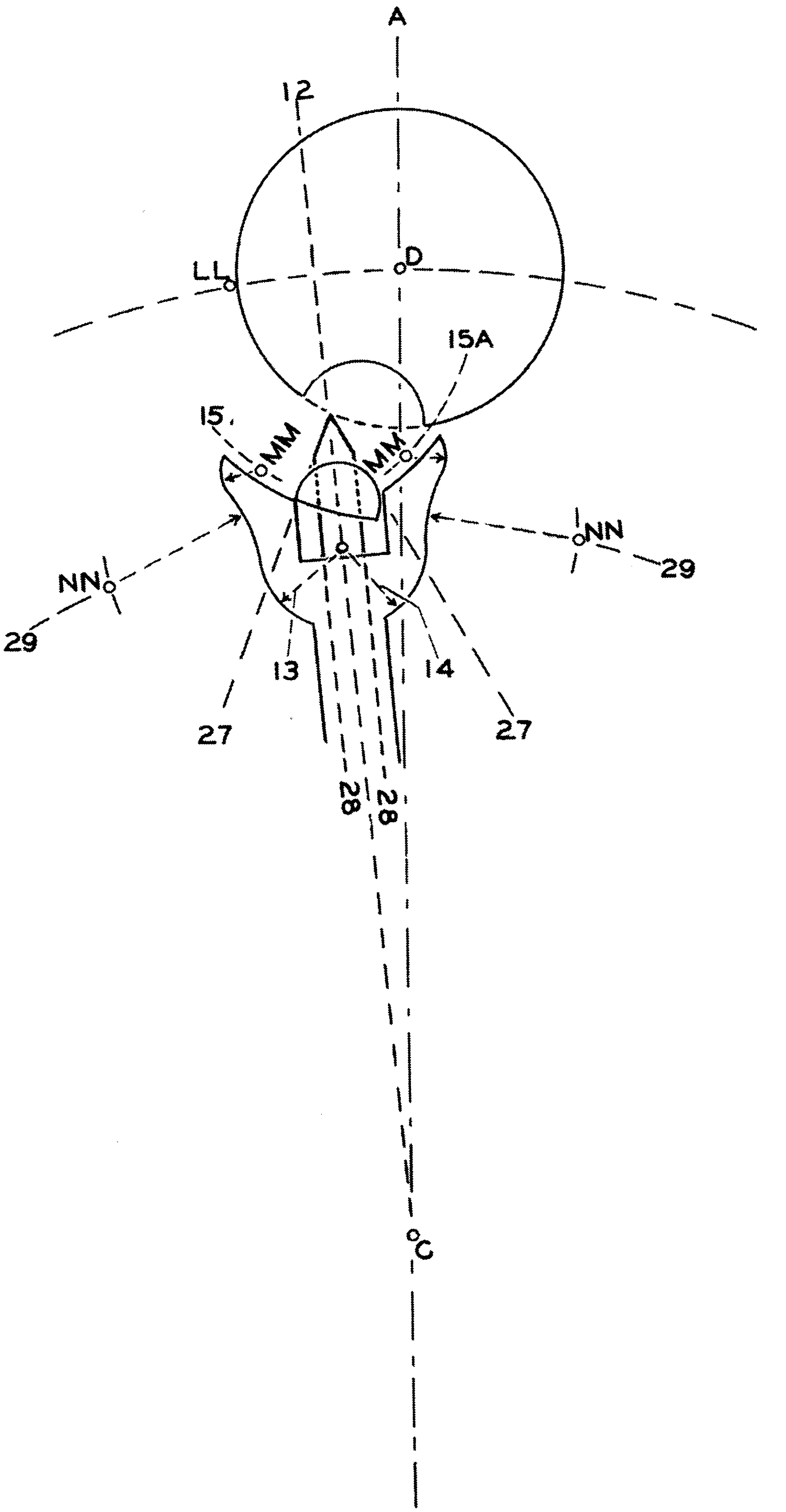


PLATE 25-7

SEC. 442—Banking Pins

The location of the banking pins, so far as their distance from the pallet center is concerned, is a matter of no vital importance. The best position would be the points which would arrest the fork by contacting it at its center of percussion. It is rarely, however, that circumstances will permit this. We shall locate them in about the usual place. With the dividers set at 95 mm, from **C** draw the arc **30.** Set the dividers at 20 mm, and mark the points **OO** from the intersection of the arc **30** with the line of centers **A.** These will be the centers of the bankings. In drawing the bankings, it should be borne in mind that the pallets as shown are at the locking point, the slide not having taken place; consequently, the fork should not be represented in contact with a banking; therefore, draw them as shown leaving a space between.

The piece which carried the impulse roller jewel pin is generally made in the form of a disc and is called the impulse roller. Setting the dividers at 52 mm from the center **D,** draw the circle **31** to form the impulse roller. This will complete the entire escapement.

If the student has used a sharp, hard pencil for the working lines and drawn them lightly, they may now be erased. In case it is desired to keep the drawing for use as a reference, the working lines may be drawn in red.

Plate 25-9 shows the escapement divested of the working lines. Coloring the drawing will greatly improve the appearance. For this purpose colored pencils or crayons are most suitable. Color the pallet stones and roller jewel red. Color the roller tables blue, using two shades—light blue for the impulse roller and a little darker blue for the safety roller. Color the banking pins and escape wheel yellow. This completes the drawing.

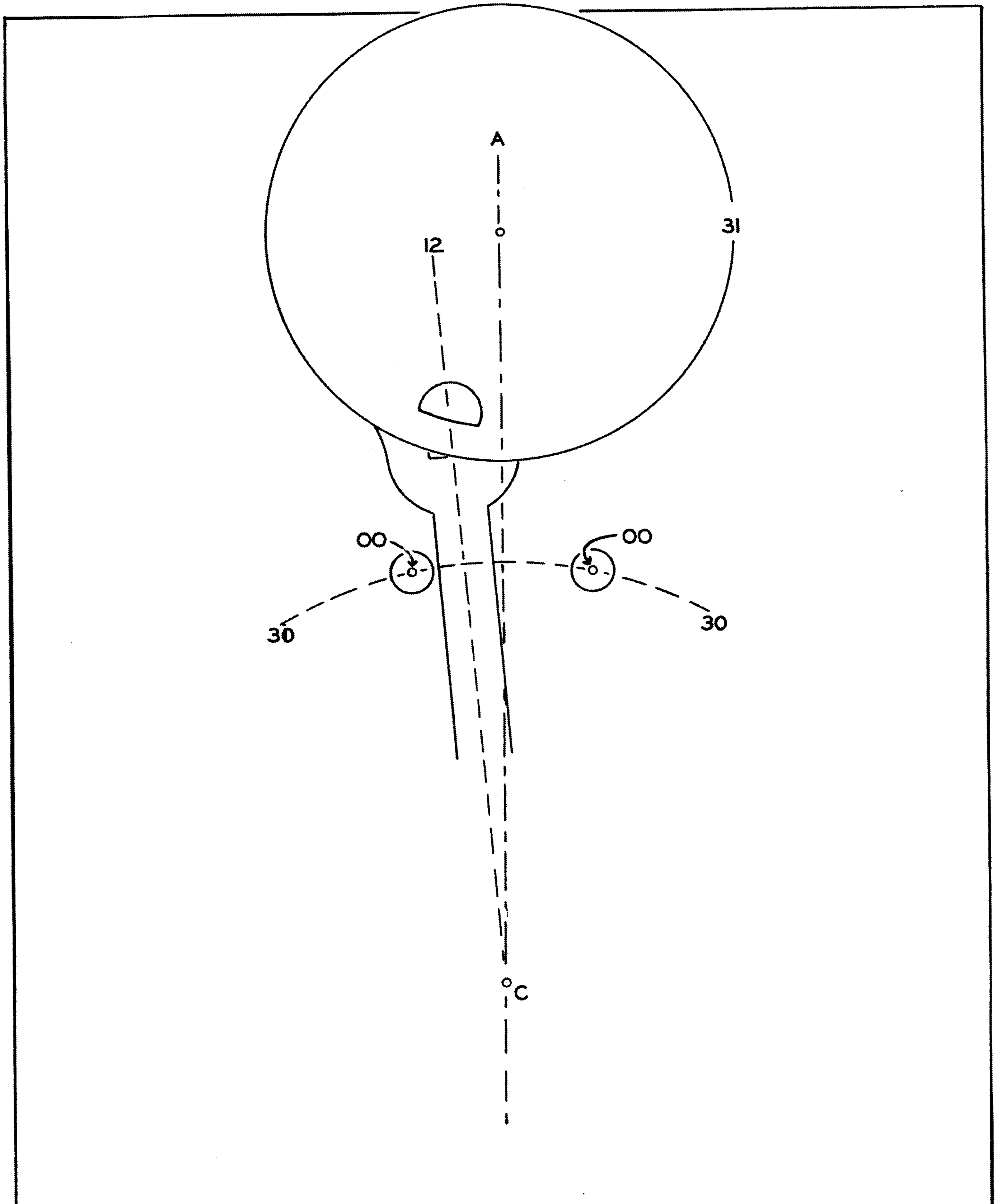


PLATE 25-8

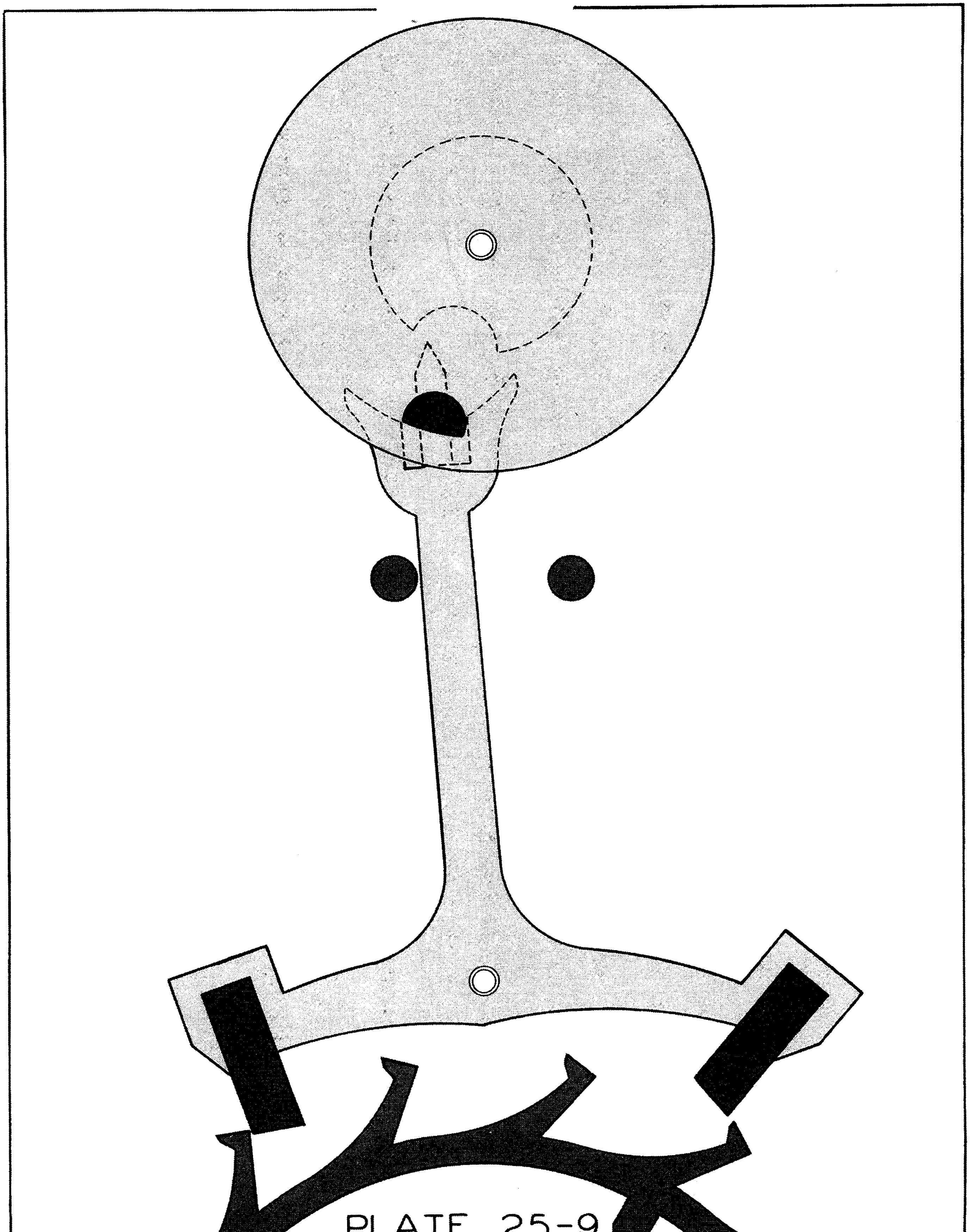


PLATE 25-9

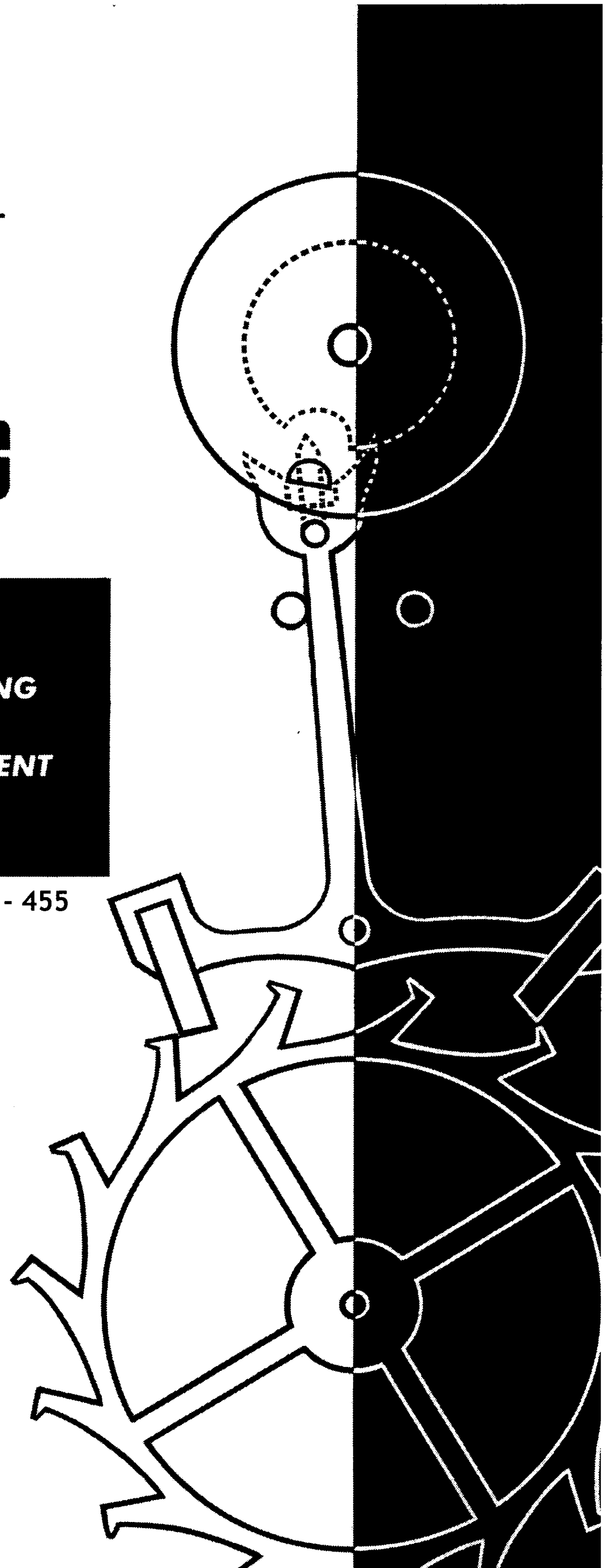
Master

WATCHMAKING

LESSON 26

MATCHING THE ESCAPEMENT

Sections 445 - 455



CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by THOMAS B. SWEAZEY

SEC. 445—Reasons for Loose Pallet Stones

You have completed an elementary treatise on the purpose, function, and theory of the lever escapement as applied to the vast majority of pocket and wrist watches in use today. Many books have been written about the lever escapement and although they are comprehensive and theoretically correct, it is practically impossible for the student to ascertain if the escapement in the average watch is good or bad. Right now you can assume they are all good. The escapement holds a horror for many so-called watchmakers because they do not understand it. In the average shop there is so little actual escapement work that one man could do all of it in a few hours out of each month. When a watch leaves the factory we must believe that the escapement is properly matched and satisfactory for that type and grade or it should not pass inspection. After the watch leaves the factory there is not much possibility of the escapement getting out of order except through improper handling. In most cases, a pallet stone becomes loose because the watch repair man has left the pallet fork in the cleaning or rinsing solution too long, or in replacing the fork in the movement, he did not place the stones between the teeth of the escape wheel. It is now time to put to practical use the knowledge gained from the preceding lessons on theory and drafting. Follow each step carefully and if it becomes confusing, start over.

SEC. 446—Checking The Movement

Before attempting to set the pallet jewels, a thorough check of the watch should be made as follows:

1. Check balance and cap jewels. They should be clean and freshly oiled in order that the balance may oscillate freely.
2. The pivots on the balance must be straight, polished and free from dust.
3. The staff must be riveted securely to the balance.
4. The roller table must be tight on the staff and the edge smooth and polished.
5. The roller jewel must be clean and set securely in the roller.
6. The train must be free.
7. The pivots on the pallet arbors must be straight and clean, and the jewels clean.

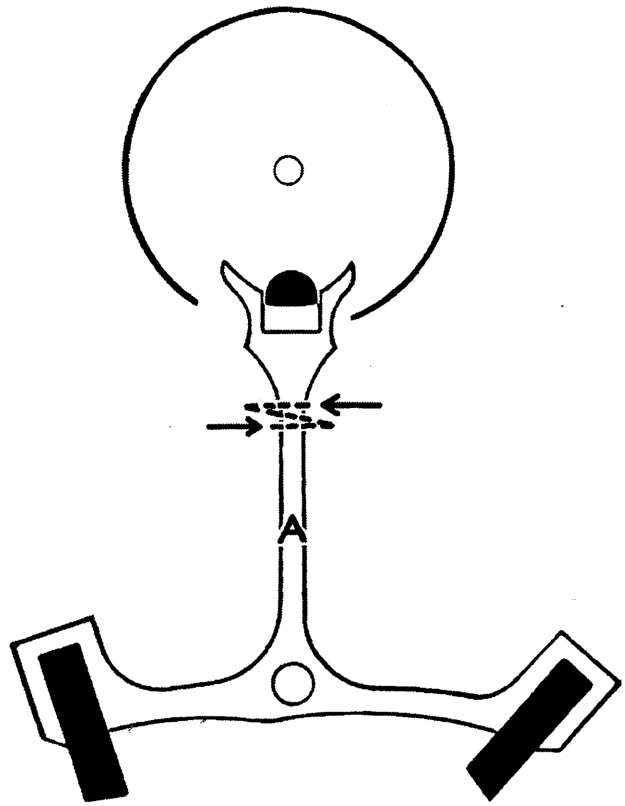


Fig. 26-1

SEC. 447—Matching an Escapement with Movable Bankings

In matching an escapement with movable banking pins, plan each step before making any alterations or moving the pallet stones.

1. Check the roller jewel for freedom in the fork slot. (Reference: Sec. 320, Lesson 13).
2. To check the freedom of the roller jewel in the fork slot with the balance in place, proceed as follows:

A. Let down the power.

B. Turn balance until the roller jewel is in line with the slot in the fork, figure 26-1.

C. Hold balance in this position with thumb or forefinger and grasp fork at **A** with pair of fine tweezers.

D. Carefully move back and forth in direction shown by arrows.

E. If roller jewel is of the correct width, you can "feel" this freedom.

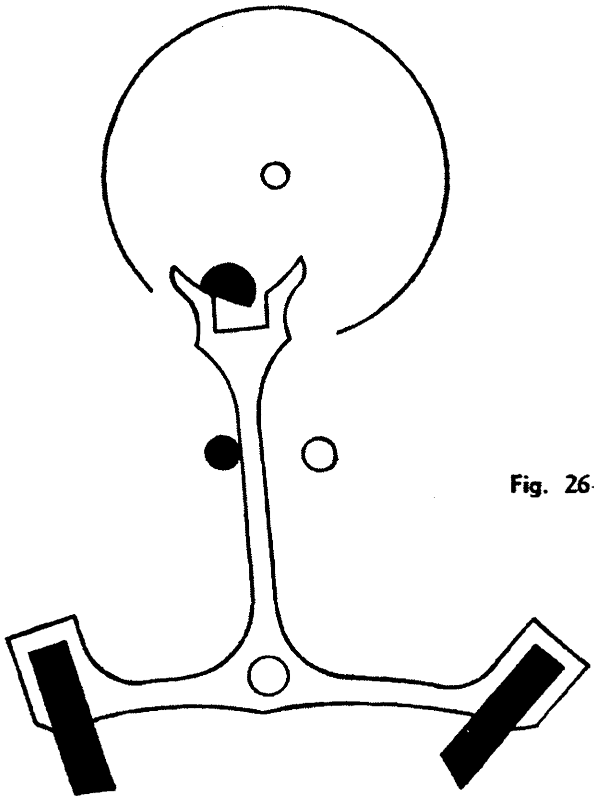


Fig. 26-2

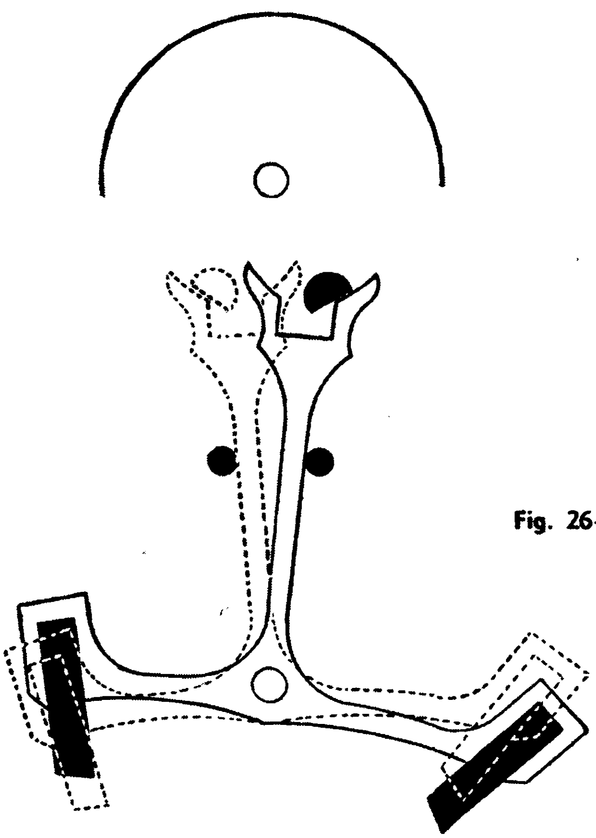


Fig. 26-3

3. Turn in one banking pin until the roller jewel will just pass through the horn of the fork and the corner of the fork slot, figure 26-2.

4. Turn in the opposite banking pin until the roller jewel will just pass by the opposite corner of the fork, figure 26-3.

The banking pins are left in this position until the stones have been set properly for lock, drop and draw and the safety action is found to be correct. Matching the escapement or making any safety action tests with the banking pins in this position is known as **banked to the drop.** When you are satisfied that the fork and roller action are correct, you may proceed to set the pallet stones.

SEC. 448—The Pallet Warmer

Setting a pallet stone is similar to setting a roller jewel—with the exception of the tool used to heat the shellac. Figure 26-4 shows a common type of pallet warmer. The pallet fork

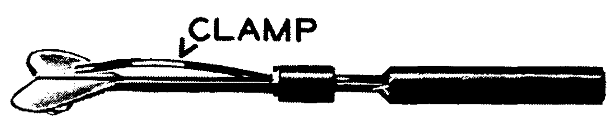


Fig. 26-4

is placed on the pallet warmer bottom side up with the upper pivot in the slot in the plate and then clamped in place. The cement is always placed on the under side of the pallet stones. The pallet stones are set flush with the top of the pallet fork and, in some cases, the lower side of the pallet stone will protrude a little on the underside. In case of a loose pallet stone, it is often possible to warm the pallet fork until the cement just melts in which case the pallet stone will again be set securely in place. However, it is best to remove the pallet stone and clean it. Place the stone between two pieces of pithwood which have been moistened with alcohol and rub the sides and face of the pallet stone until clean. Clean the slots in the pallet fork with pegwood and alcohol. In case there is an excess of cement on either the stone or the fork, use the tool described in Lesson 13, figure 13-20, to chip off the excess cement before cleaning.

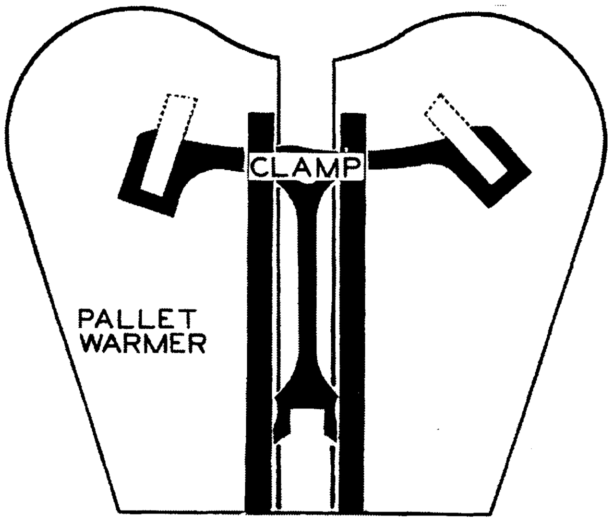


Fig. 26-5

SEC. 449—Setting the Stone

In setting pallet stones, be very careful as the stones are easily chipped or lost. Do not attempt to pick up a pallet stone except by the sides and then toward the back of the stone so that you will not injure the face or locking corner of the pallet stone. Figure 26-5 shows a diagram of the pallet fork clamped on a pallet warmer upside down. The dotted lines illustrate the correct position of the pallet stones with regard to the angles on the lifting faces.

In some watches you will find one stone has more lifting angle than the other. The one with the greater angle is the **L** stone and the one with the lesser angle is the **R** stone. In small watches the angles are the same.

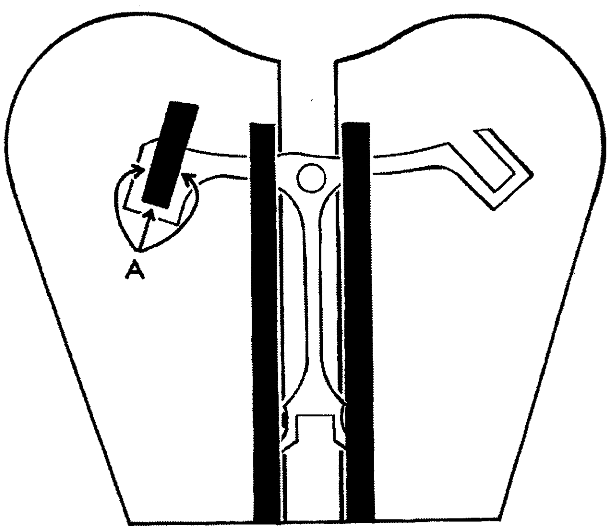


Fig. 26-6

Start with the **R** stone. After placing stone in position, push it to the bottom of the slot, figure 26-6. Use pegwood when moving a pallet stone. If the watch is one of excellent manufacture and has had careful handling, it is very possible that when the stone is pushed into the back of the slot, the amount of lock will be correct. Do not take this for granted, however. Warm slowly with alcohol lamp, heating one stone at a time. The pallet warmer is made so that one stone can be heated without danger of heating the other. Use shellac which has previously been drawn threadlike (Lesson 13, figure 13-21) and place on both sides and back of stone where it joins the pallet fork, arrows **A**, figure 26-6. Let cool before attempting to remove pallet from pallet warmer and remove any excess cement with the tool in figure 13-19, Lesson 13. Clean the lifting face and sides of the pallet stone with pithwood wet with alcohol. Now set **L** stone in place exactly the same as the **R** stone and as far back in the slot as possible, figure 26-7.

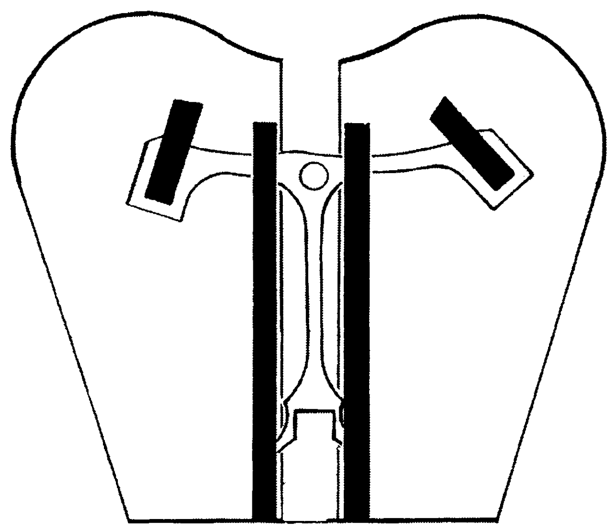


Fig. 26-7

Testing for lock and draw is always done with the power on. It is not necessary to wind the watch fully. The stones are adjusted until there is the correct amount of lock and drop. The fork should be arrested by the banking pin at the instant the drop takes place. When this occurs on the **R** stone and then the **L** stone, the escapement is banked to the drop. Each time it becomes necessary to move a pallet stone, the fork must be removed from the movement and reheated on the pallet warmer. Be careful not

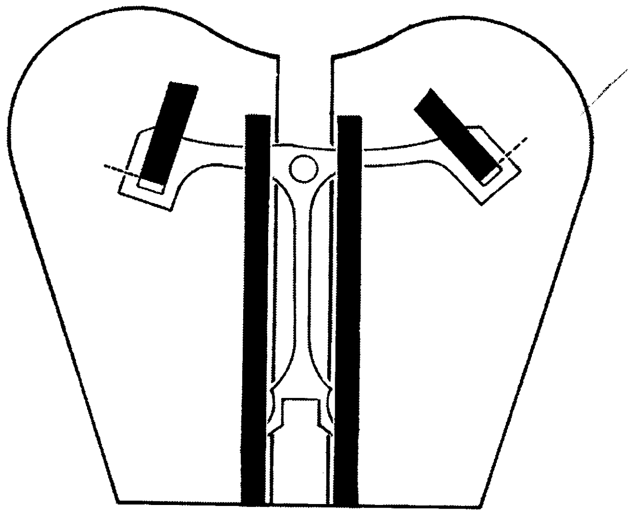


Fig. 26-8

to overheat or burn the shellac. If this should occur, it will be necessary to remove the stone and clean both it and the slot in the fork before applying new cement. Use pegwood when moving a pallet stone forward or backward. The distance you wish to move the stone can be carefully judged by the distance between the back of the pallet stone and the bottom of the slot, figure 26-8.

Figure 26-9 illustrates an **R** stone with too much lock. Moving the **R** stone in the direction of arrow **A** will decrease the amount of lock on the **R** stone but it will also decrease the lock on the **L** stone. Therefore, it would be necessary to move the **R** stone in and the **L** stone out until both locks are equal. This also holds true when there is too much lock on the **L** stone and not enough lock on the **R** stone.

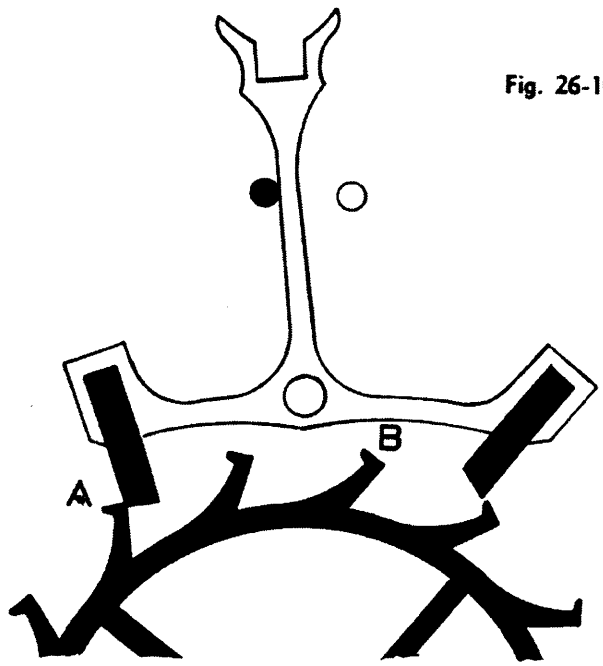


Fig. 26-10

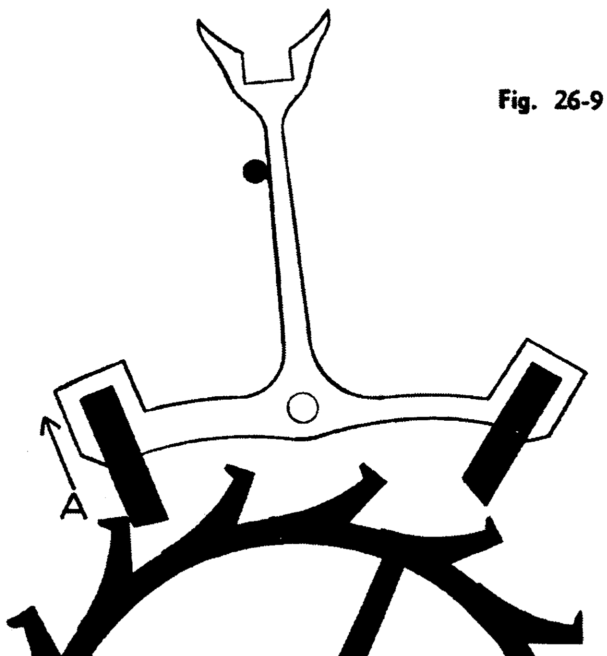


Fig. 26-9

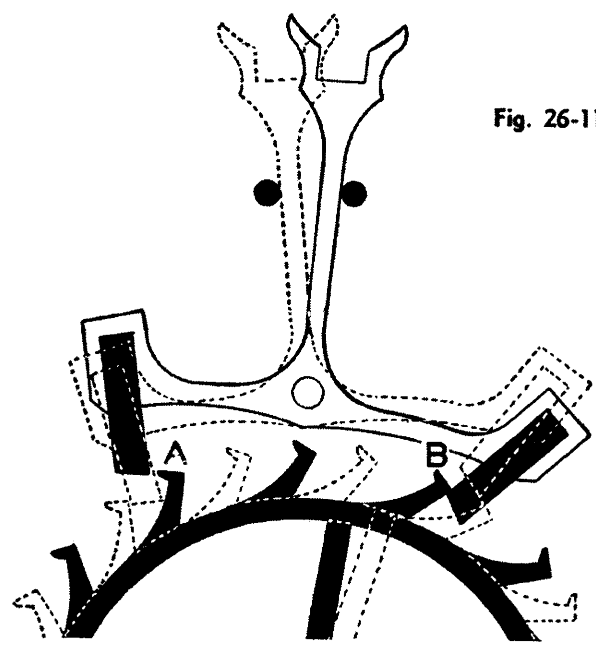


Fig. 26-11

Figure 26-10 illustrates the correct amount of lock on the **R** stone at the moment of drop. As the escape wheel tooth "lets off" from the **L** stone, the fork is against the banking pin and the **R** stone intercepts the escape wheel tooth **A**. When the fork is moved away from the banking pin far enough to allow the **R** stone to unlock, the escape wheel tooth **A** passes across the lifting face of the **R** stone and when the tooth has completed the lift, the fork will be against the opposite banking pin at the instant the escape wheel tooth **B** is arrested by the **L** stone, figure 26-11. The escapement is now banked to the drop. This can be seen readily by placing the escape wheel and fork in these positions and moving back and forth.

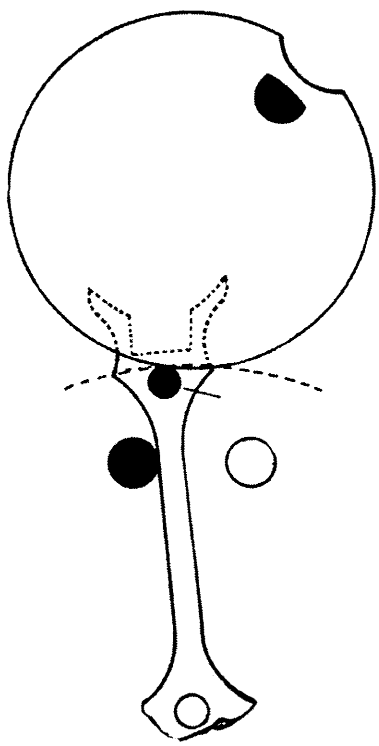


Fig. 26-12

SEC. 450—The Safety Action

When you have banked your escapement to the drop, adjust the safety action. Figure 26-12 illustrates the guard pin in a single roller escapement set as close as possible to the edge of the roller when the fork is against the banking pin. Test the safety action on both sides.

Figure 26-13 illustrates the guard dart set properly in the double roller escapement. Test action on both sides.

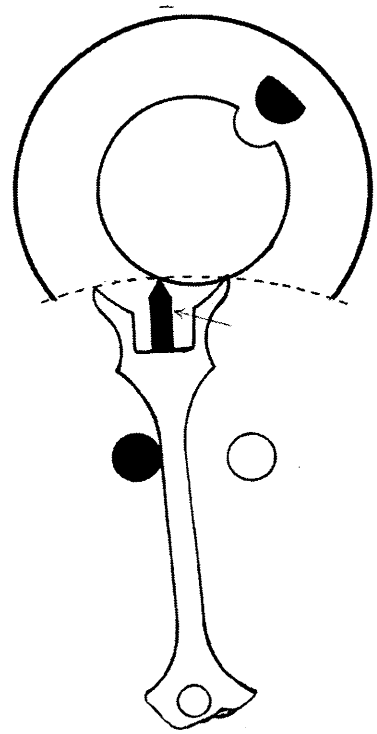


Fig. 26-13

Now open each banking pin slightly. This will allow the escape wheel tooth to slide on the face of the pallet stone, figure 26-14. The dotted lines illustrate the **R** stone after slide has taken place. Now the roller jewel will enter the horn in the fork without danger of it rubbing on the horn. There will be a small amount of clearance between the guard pin and the roller.

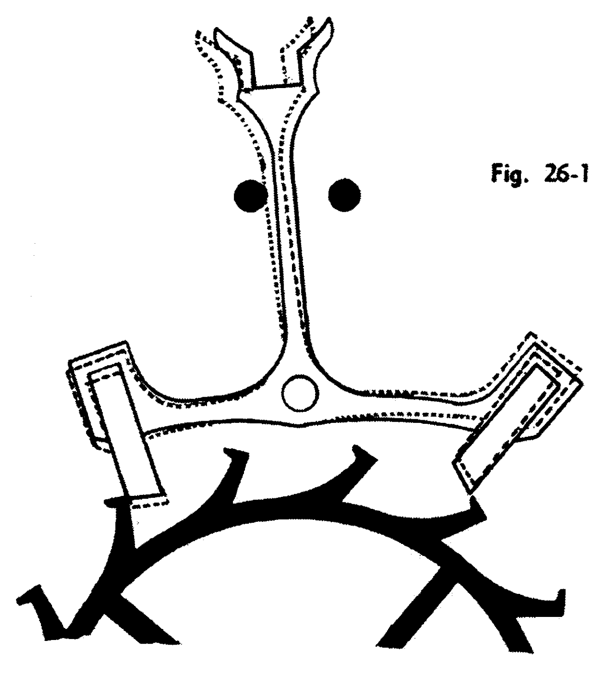


Fig. 26-14

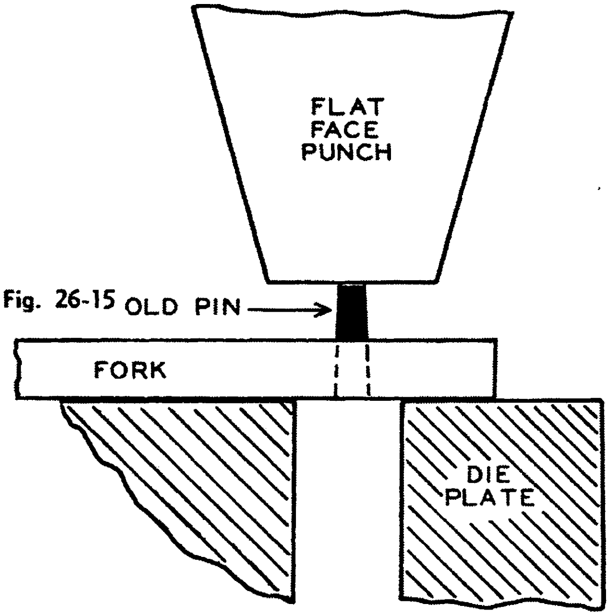


Fig. 26-15

SEC. 451—Replacing Guard Pin in a Single Roller Escapement

The old guard pin is usually inserted from the bottom. It can be removed by placing pallet fork over a hole in the bench block and pressing out with a flat face staking punch, figure 26-15. If the guard pin bends, cut it off about .5 mm above the fork and stone the end flat with a hard arkansas slip before attempting to push it out, figure 26-15. If the guard pin was put in from the top, turn the fork over and push out with a small pointed punch or needle.

It is desirable at times to have small punches such as the punch used for forcing out the guard pin. Such punches are not manufactured. Figure 26-16 illustrates a method whereby any number of small, specially shaped punches can be made from tempered steel wire and held in a hollow staking punch. **A**, figure 26-16, represents a cross section of a round face hollow punch. **B** represents a length of blued steel wire shaped in the form of a sub-punch and placed in the staking punch. It should fit as closely as possible without binding. Notice that the punch **B** rests at the bottom of the hole in the staking punch and extends beyond the face just enough to serve the purpose for which it is intended.

Replace the guard pin as follows:

1. Remove old guard pin.
2. Select a brass stud pin that will enter hole as in figure 26-17. If student desires to make a tapered brass pin, refer to Sec. 386 Lesson No. 19, figure 19-13.

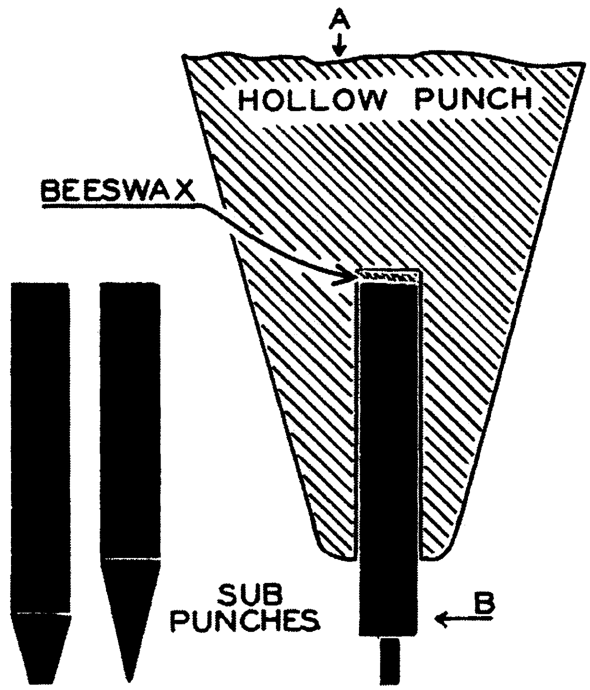


Fig. 26-16

3. Insert from the under side and press in until pin comes to a stop.
4. Cut off a little longer as illustrated and stone the end flat.
5. Press in until pin is flush with bottom of fork, figure 26-18.
6. Cut pin slightly longer than the top edge of roller table, figure 26-19, and stone flat with arkansas slip.
7. Adjust guard pin.

SEC. 452—Replacing Guard Dart in Double Roller Escapement

Replacing the guard dart in a double roller escapement is not a difficult job but great care must be used when removing an old dart. The dart in a double roller escapement is usually put in from the front. Consequently, if the guard dart in a double roller should become loose, it would seem to be too long. Replacing a guard dart of this type allows the thicker portion of the pin to form the safety action with the safety roller.

It is usually an easy matter to force out the old pin with a pair of heavy tweezers. Figure 26-20 illustrates the method used when a small section of the guard pin extends through the hole in the "boss."

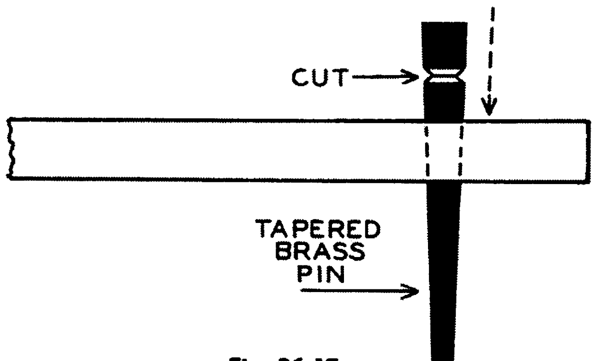


Fig. 26-17

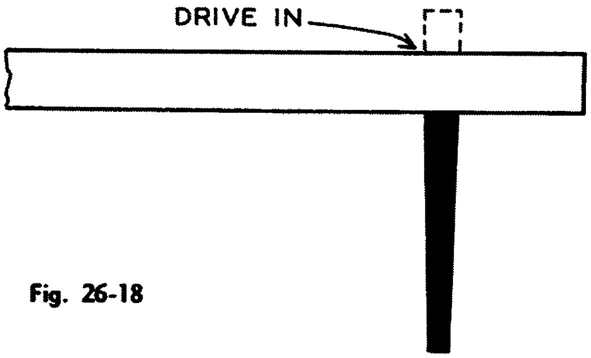


Fig. 26-18

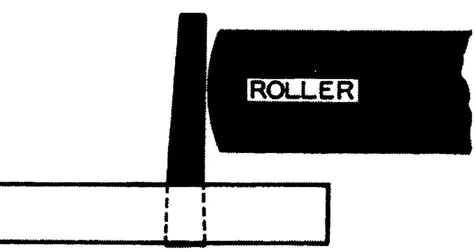


Fig. 26-19

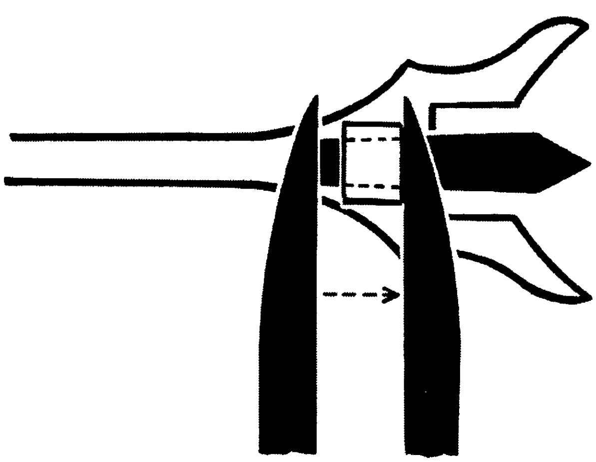


Fig. 26-20

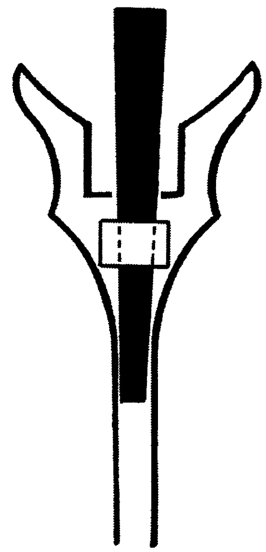
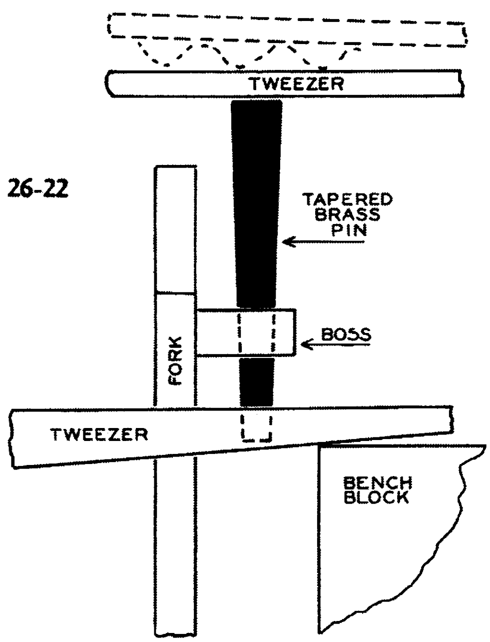


Fig. 26-21

In some forks the pin will be cut off flush with the "boss." Place the fork over a staking tool stump and force out the old pin with a sharp pointed punch or needle.

In replacing the guard dart, use a brass stud or taper pin and insert from the front, figure 26-21. Hold the fork with a heavy tweezer, the points of which can be rested on an anvil and tap in gently with the back of another pair of tweezers, figure 26-22. The pin must have very little taper in order to hold securely.

Fig. 26-22



Cut off pin a little longer than necessary with a pair of hairspring nippers and shape as in figure 26-23. This can be accomplished with a hard arkansas stone or needle file. In using either of these, place a piece of scotch tape over the side of stone or needle which comes in contact with the underside of the fork. This will prevent cutting or marring the under side of the fork. Cut each side a little at a time until shaped properly.

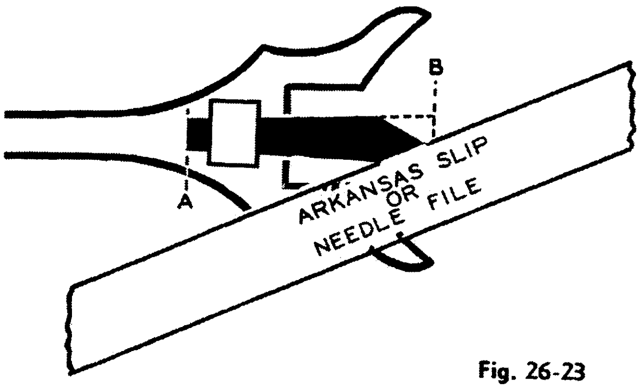


Fig. 26-23

SEC. 453—Matching an Escapement with Immovable Bankings

Most Swiss watches use the permanent type of banking pins. In the better grades the bankings are often milled out of the plate. In the common type of Swiss watches, the bankings are considered immovable and are merely pins driven through a hole in the plate. It is possible but seldom necessary to bend them slightly as these pins were adjusted properly at the factory.

The procedure used to match this type of an escapement is identical with the procedure described for typical American watches with movable bankings except that you must allow for slide at the time you make each test of fork and roller action and lock and drop.

Use the same procedure as described in Sec. 447:

1. Test roller jewel in fork slot.
2. Test fork and roller action as in figure 26-2 by placing the face of the roller jewel opposite the corner of the fork slot. In figure 26-2, the roller jewel has only enough freedom to pass the corner of the fork slot. Figure 26-24 shows the space between the roller jewel and the corner of the slot when the bankings are immovable. This space is determined by the amount of slide allowed which is the difference between the position of the permanent banking **B** and the position of the banking when banked to the drop and illustrated by dotted circle **C.**
3. Proceed to set pallet stones in the same

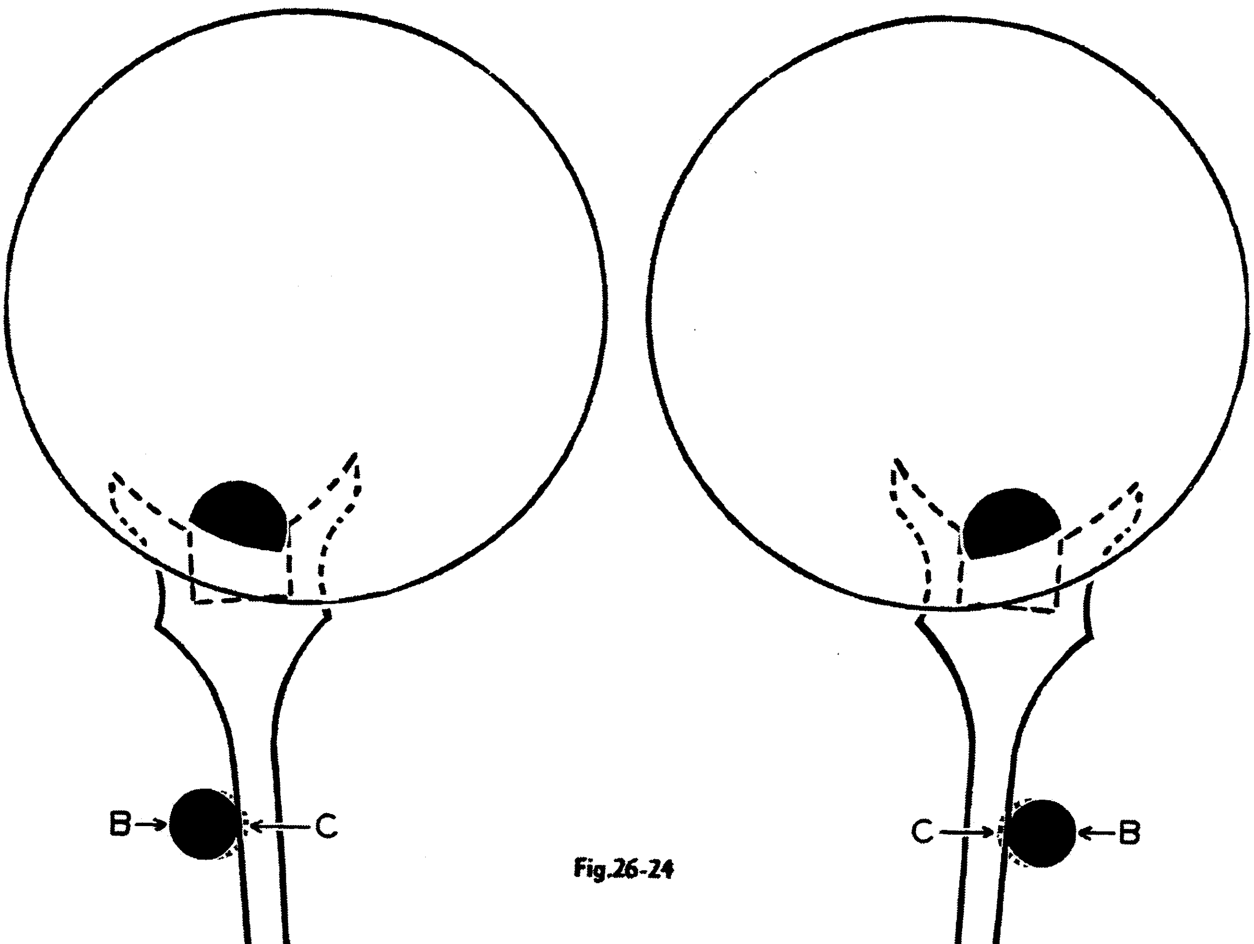


Fig.26-24

manner as described in Sec. 449. At this time remember that the lock is exactly the same as described in this section, and illustrated in figure 26-25. The fork is illustrated to show the locking corner of the escape wheel tooth locked on the locking corner of the pallet stone at the moment of drop. Notice, however, that this fork is **not** against the banking pin. The space between the fork and the banking pin is the amount left for slide. This space must be equal on both sides and the student must be certain that he has the proper amount of lock **before** the fork rests against the banking pin.

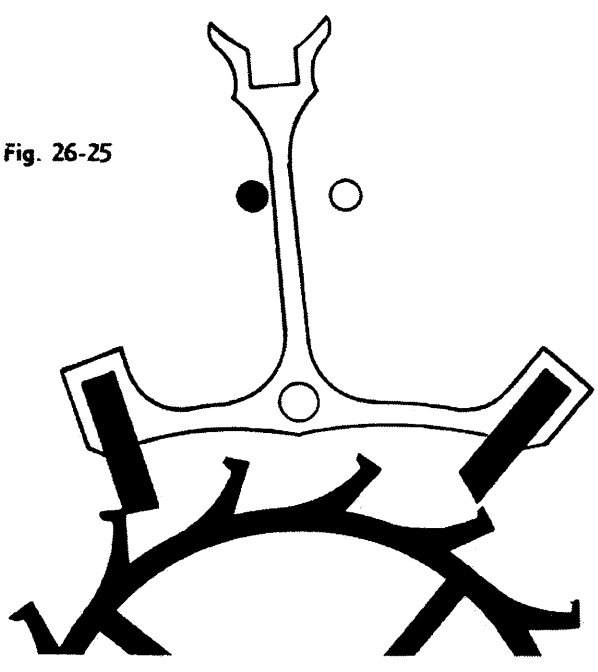
One of the most successful methods of holding the fork stationary at this instant is to insert a small piece of pithwood under the fork as shown in figure 26-26. It is very easy to observe the amount of lock and drop on each stone and the distance the fork is from the banking pin. After you are certain the stones are set correctly, remove pithwood and test the draw.

SEC. 454—Checking the Guard Action.

The guard action is tested next and this test is illustrated in figure 26-27. Notice that the guard dart is arrested by the safety roller when the fork is moved away from the banking but the escape wheel tooth is still **locked** on the corner of the receiving stone.

This then insures perfect safety action.

Fig. 26-25



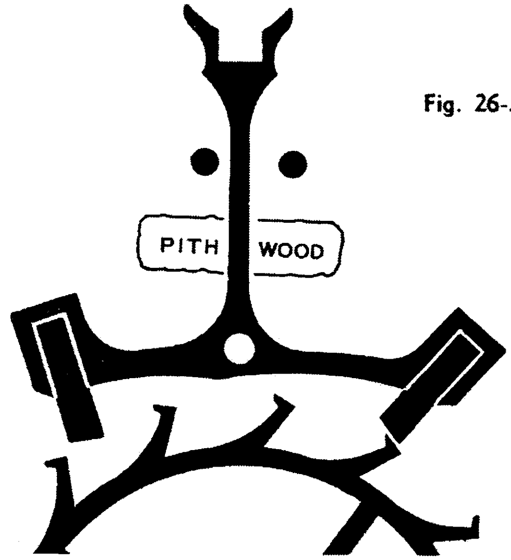


Fig. 26-26

This same action takes place between the guard pin and the edge of the roller table in the single roller escapement and is tested in the same manner. When the fork is arrested by either banking pin you should find:

1. A small amount of play between the corner of the fork slot and face of the roller jewel.
2. The proper amount of lock **and** slide.
3. Freedom between the safety roller and guard dart. There are very few watches in use today using immovable bankings with a single roller.

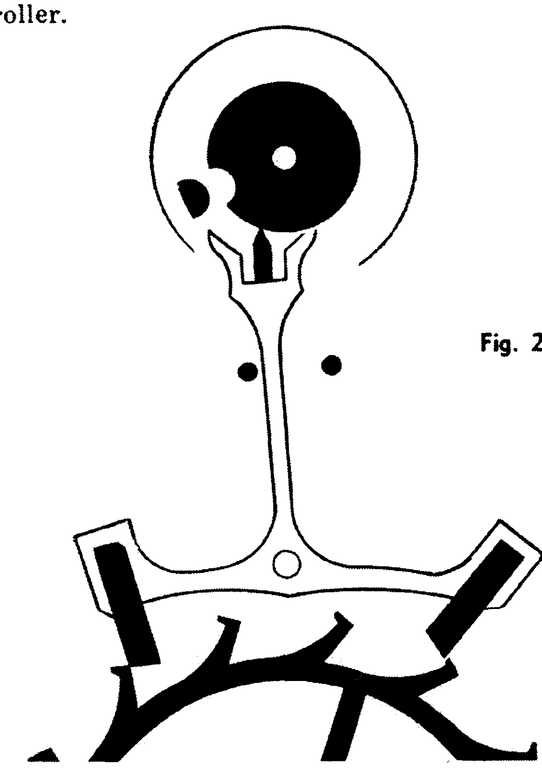


Fig. 26-27

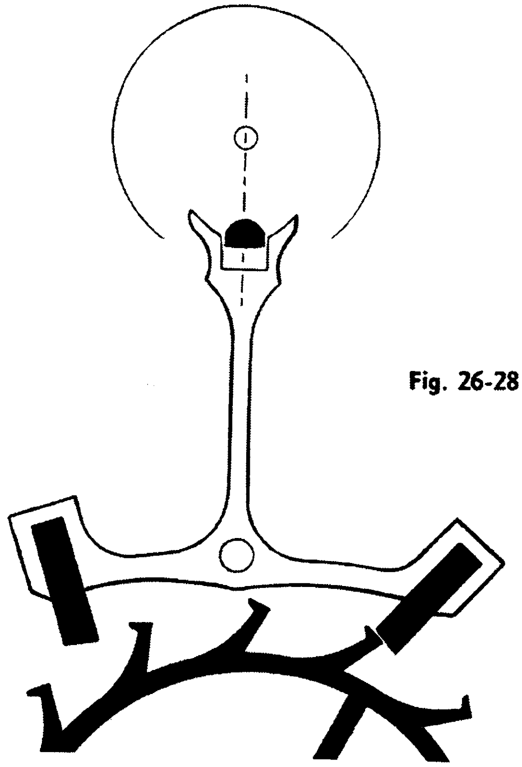


Fig. 26-28

SEC. 455—Putting in Beat

Theoretically, the watch is in beat when the center of the roller jewel is in line with the center of the pallet arbor and the center of the balance staff. Figure 26-28 illustrates this condition and shows the escape wheel tooth about half way across the face of the **L** stone. If you apply a **small** amount of power to the train so that a tooth of the escape wheel rests equally on the faces of both the **R** and **L** stones, your watch should be in beat. Figure 26-29 shows an escape tooth which has come to rest at the front of the **R** stone. Notice too that the roller jewel is not in line with the fork. Turning the roller jewel in the direction of the arrow **A** until the roller jewel is in line will allow the escape wheel tooth to come to rest at the approximate center of the **R** stone, figure 26-30, and this amount is equal to the amount shown in figure 26-28. In this case the hairspring collet would have to be moved in the direction of the arrow **B,** figure 26-29. This is one of the best methods by which to determine if a watch is in beat.

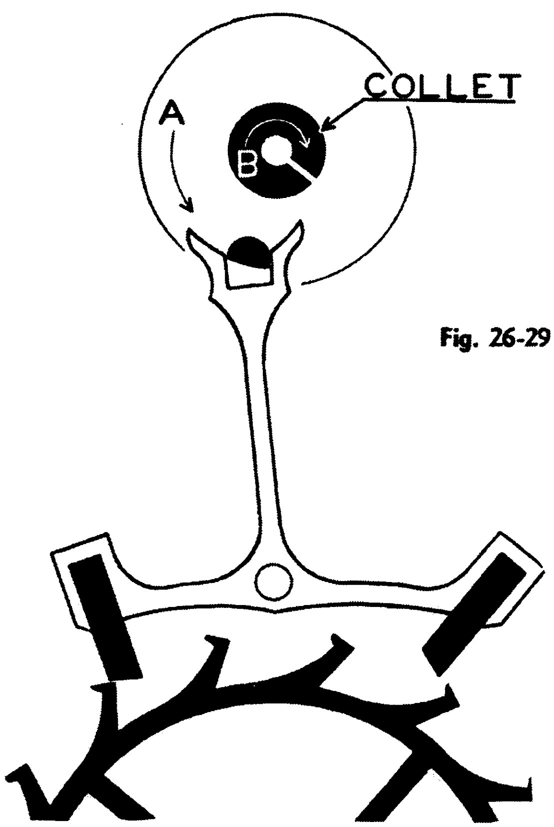


Fig. 26-29

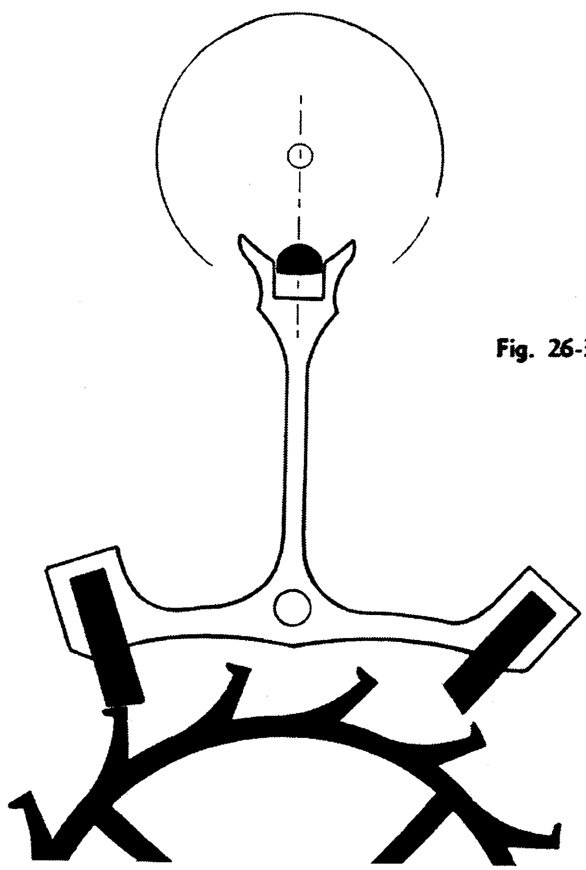


Fig. 26-30

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JOB SHEETS

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Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET

W26-J1

REPLACING PALLET STONE: "R" Stone (Receiving) in Swiss Watch

TOOLS, EQUIPMENT AND SUPPLIES:

Pallet Warmer - Shreaded Shellac - Alcohol Lamp

PROCEDURE	REFERENCE
HOW TO REPLACE "R" STONE IN SWISS WATCH	Les. 26
1. Remove damaged stone and old cement from pallet. NOTE: To remove stone place fork in pallet warmer, warm and push out stone.	Sec. 448
2. Select replacement "R" stone. NOTE: To determine correct width of stone, measure slot in pallet with roller jewel gauge and determine metric thickness of stone. Replacement should be a snug fit.	Les. 13
3. Place fork on pallet warmer, bottom side up.	Sec. 448
4. Insert stone in pallet with angled impulse face of stone in proper direction.	
5. Cement stone in place.	Sec. 449
6. Allow fork to cool, then remove from pallet warmer and clean.	Sec. 449
7. Place pallet fork in movement.	
8. Test lock, drop and slide. Each should be equal to opposite or "L" side of escapement.	Sec. 453 Sec. 454
9. If adjustment is necessary, place fork on pallet warmer and move stone with pointed pegwood as required.	
10. Continue testing and adjusting until you determine stone is in correct position.	

NOTE: Moving "R" stone outward in slot increases lock on both stones.

Moving "R" stone inward in slot decreases lock on both stones.

(3-57) W26-J1

UNIT	W7
LESSON	26

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W26-J2

REPLACING PALLET STONE: "L" Stone (Let Off) in Swiss Watch

TOOLS, EQUIPMENT AND SUPPLIES:

Pallet Warmer - Shreaded Shellac - Alcohol Lamp

PROCEDURE | REFERENCE Les. 26

HOW TO REPLACE "L" STONE IN SWISS WATCH

1. Remove damaged stone and old cement from pallet. — Sec. 448
   NOTE: To remove stone place fork in pallet warmer, warm and push out stone.

2. Select replacement "L" stone. — Les. 13
   NOTE: To determine correct width of stone, measure slot in pallet with roller jewel gauge and determine metric thickness of stone. Replacement should be a snug fit.

3. Place fork on pallet warmer, bottom side up. — Sec. 448

4. Insert stone in pallet with angled impulse face of stone in proper direction.

5. Cement stone in place. — Sec. 449

6. Allow fork to cool, then remove from pallet warmer and clean. — Sec. 449

7. Place pallet fork in movement.

8. Test lock, drop and slide. Each should be equal to opposite or "R" side of escapement. — Sec. 453, Sec. 454

9. If adjustment is necessary, place fork on pallet warmer and move stone with pointed pegwood as required.

10. Continue testing and adjusting until you determine stone is in correct position.

    NOTE: Moving "L" stone outward in slot increases lock on both sides.

    Moving "L" stone inward in slot decreases lock on both sides.

REPLACING PALLET STONE: "R" Stone (Receiving) in American Watch

TOOLS, EQUIPMENT AND SUPPLIES:

Pallet Warmer-Shreaded Shellac-Alcohol Lamp

PROCEDURE | REFERENCE Les. 26

HOW TO REPLACE "R" STONE IN AMERICAN WATCH

1. Remove damaged stone and old cement from pallet. — Sec. 448
   NOTE: To remove stone place fork in pallet warmer, warm and push out stone.

2. Select replacement "R" stone.
   NOTE: Pallet stones for American Watches are ordered for the particular make and model. When ordering the Make, Size and Model or Make, size and serial number of movement should be furnished.

3. Place fork on pallet warmer, bottom side up. — Sec. 448

4. Insert stone in pallet with angled impulse face of stone in proper direction.

5. Cement stone in place. — Sec. 449

6. Allow fork to cool, then remove from pallet warmer and clean. — Sec. 449

7. Place pallet fork in movement.

8. Test lock, drop, slide and guard action. Each should be equal to opposite "L" side of escapement. — Sec. 453 Sec. 454

9. If adjustment is necessary, place fork on pallet warmer and move stone with pointed pegwood as required.

10. Continue testing and adjusting until you determine stone is in correct position.

NOTE: Moving "R" stone outward in slot increases lock on <u>both</u> stones.

Moving "R" stone inward in slot decreases lock on <u>both</u> stones.

UNIT	W7
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Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

JOB SHEET
W26-J4

REPLACING PALLET STONE: "L" Stone (Let Off) in American Watch

TOOLS, EQUIPMENT AND SUPPLIES:

Pallet Warmer - Shreaded Shellac - Alcohol Lamp

PROCEDURE	REFERENCE
HOW TO REPLACE "L" STONE IN AMERICAN WATCH	Les. 26
1. Remove damaged stone and old cement from pallet. NOTE: To remove stone place fork in pallet warmer, warm and push out stone.	Sec. 448
2. Select replacement "L" stone. NOTE: Pallet stones for American Watches are ordered for the particular make or model. When ordering the Make, Size and Model or Make, size and serial number of movement should be furnished.	Les. 13
3. Place fork on pallet warmer, bottom side up.	Sec. 448
4. Insert stone in pallet with angled impulse face of stone in proper direction.	
5. Cement stone in place	Sec. 449
6. Allow fork to cool, then remove from pallet warmer and clean.	Sec. 449
7. Place pallet fork in movement.	
8. Test lock, drop, slide and guard action. Each should be equal to opposite or "R" side of escapement.	Sec. 453 Sec. 454
9. If adjustment is necessary, place fork on pallet warmer and move stone with pointed pegwood as required.	
10. Continue testing and adjusting until you determine stone is in correct position.	

NOTE: Moving "L" stone outward in slot increases lock on <u>both</u> stones.

Moving "L" stone inward in slot decreases lock on <u>both</u> stones.

GUARD PIN: In Single Roller Escapement

TOOLS, EQUIPMENT AND SUPPLIES:

Heavy Tweezers - Bench Block - Staking Tool - Stud Pins

PROCEDURE: REFERENCE

Les. 26

HOW TO REPLACE A GUARD PIN IN SINGLE ROLLER ESCAPEMENT.

1. Remove old guard pin. Sec. 451

2. Select tapered brass pin (stud pin) Fig. 26-17

3. Insert from underside of fork to snug fit, cut off pin.

4. Drive pin tight. Fig. 26-18

5. Adjust guard pin for proper guard action. Les. 21-22-26
   a. Pin should be long enough so it protrudes just slightly above the roller but not so long that it will hit arms of wheel.
   b. Check guard action with wheel and pallet fork in watch, without hairspring. Sec. 450
   c. With wheel held with roller jewel out of fork slot with slight pressure move the fork toward the balance, there should be slight freedom between guard pin and roller, freedom should be equal on both sides. Sec. 454

GUARD DART: In Double Roller Escapement.

TOOLS, EQUIPMENT AND SUPPLIES:

Heavy Tweezers - Bench Block - Staking Tool - Stud Pins.

PROCEDURE — REFERENCE Les. 26

HOW TO REPLACE GUARD DART IN DOUBLE ROLLER ESCAPEMENT

1. Remove old guard dart, take care to remove in proper direction. Sec. 452
   NOTE: Guard darts in American Watches are usually put in from the front of the boss, the thick end of the pin toward the roller - In Swiss Watches the thin end of pin is toward the roller.

2. Select tapered brass pin (Stud pin).

3. Insert in boss from proper direction, press in tight and cut off unused part of pin.

4. Cut off guard dart at a point slightly longer than fork horns.

5. Shape end with arkansas slip. Fig. 26-23 Les. 21-22-26

   NOTE: Reducing guard dart to proper length is a matter of repeated trial and adjustment until properly adjusted. Section 454.

   a. Check guard action with wheel and pallet fork in watch, without hairspring.

   b. Until you determine that there is freedom between guard dart and roller, the balance should be put in the watch with roller jewel in fork slot.

   c. Check freedom by carefully turning balance wheel to determine if roller jewel will swing free out of the slot in both directions. If wheel will not swing without undue pressure, it indicates the guard dart is too long, reduce length of guard dart a small amount at a time until desired clearance is achieved.

CHECKING ESCAPEMENT FOR PROPER FUNCTION

PROCEDURE:

1. Check roller jewel.
   The roller jewel should be approximately .02 mm less in width than the fork slot. It must be of correct length to extend through the fork slot but not so long it will touch guard dart. It must be firmly cemented in an upright position in the roller without tilt in either direction. This can best be checked with balance out of the watch.

2. Check guard action.
   Proper adjustment of guard pin or dart will give a very slight clearance between roller and guard pin at the instant a tooth drops off a pallet stone. This clearance would be equal on both sides. As more clearance is desired in a properly functioning escapement, the slide which pulls the fork against the bankings will give that clearance. Testing must be done by "feel" as this can not be observed. Move balance wheel slowly to cause a tooth to drop off one stone onto the other. Stop the balance at the instant it drops. Then, with a needle like instrument, apply slight movement to the fork in direction of the roller. The amount the fork travels to bring guard pin or dart in contact with the roller should be slight.

3. Check lock.
   Lock occurs at the instant the tooth of the escape wheel drops on the pallet stone. The correct amount of lock for a particular watch is determined by the manufacturer and may be as much as 1/5th the width of the impulse face of the pallet stone or as little as 1/10th the width of the impulse face. The amount of lock should be the same on both stones. Lock is checked by turning the balance wheel slowly and stopping wheel at the instant a tooth drops on a pallet stone. The amount of lock may now be seen. Reverse the direction of the balance wheel and check opposite side for equal lock.

4. Check drop.
   Drop is the distance the escape wheel travels after tooth leaves let off corner of one pallet stone to the lock on the opposite stone. The drop may be observed at the same time as checking for lock by observing distance between tooth and stone opposite the one which has just let off.

5. Check Slide.
   Slide is the action of the pallet stone sliding up the escape wheel tooth after locking. The slide should not exceed an amount equal to the lock or less than half the lock. This may be checked immediately after checking the lock. When checking lock, the movement of the balance is stopped at the instant the tooth drops on a stone. By moving the balance wheel farther, the fork will then rest against the banking pin. Amount of slide may now be observed. The slide may be changed by either opening or closing the distance between banking pins.

Master WATCHMAKING

Lesson 27

Tools –
Hardening and
Tempering

CHICAGO SCHOOL OF WATCHMAKING *Founded 1908 by* THOMAS B. SWEAZEY

SEC. 460—Reasons for Using Good Tools

In bygone years, it was necessary for the watchmaker to make a great many of his tools. Many watchmakers, especially old timers, consider tool making an essential part of an apprentice's or student's training. The student learned to file and shape tools from brass and steel, make screws, rivet parts, harden and temper wire from which to make staffs, pinions, setting parts, etc., thus becoming very proficient at tool and parts making. Most good watchmakers of this era could calculate a lost wheel and pinion; and if they had the proper equipment, make a wheel or pinion or any part of the watch including the jewels. In most cases, the tools made were not of exceptional quality due in part to a lack of machinery with which to make them. With the advent of modern machinery, the toolmaker became interested in making precision watchmakers' tools and the modern up-to-date teachings tend away from tool and parts making and are concentrated on watch repairing, using factory replacement parts and tools made by modern methods and machinery. It is an old adage that "any workman works better with good tools." Concentrate on obtaining the best tools, the proper materials for the proper movements, and then use these materials and tools, to do a better job. Quality work is the supreme achievement and it can be done better and faster with quality tools and materials.

There are times in every watchmaker's career when he may be called upon to devise a tool suitable for his own needs, or one that will do a job quicker than some tool already on the market. Such is the case of the collet removing tools mentioned in Lesson 15, Section 352. The three tools which you are required to make in order to complete this lesson are tools which are unobtainable. You will learn the types of files, the steel to use, how to file, how to harden and temper, etc.

SEC. 461—The Vise, Saw, Files, Etc.

The first requirement is a bench and a bench vise. The vise illustrated in figure 27-1 is a small bench vise suitable for the watchmaker which can be mounted on the extreme right hand corner of his bench. It is best, however, to mount the vise elsewhere as it is not used too often. When filing work which you

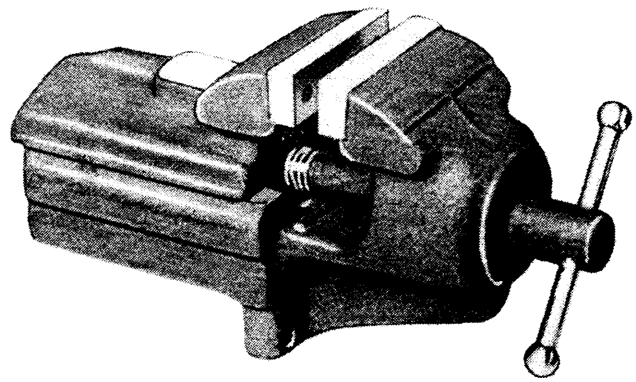


Fig. 27-1

do not wish to mar, it is advisable to form a pair of jaws out of copper similar to those in figure 27-2. These are placed over the jaws of the vise and the work is placed between the copper jaws. This will prevent marring of the work.

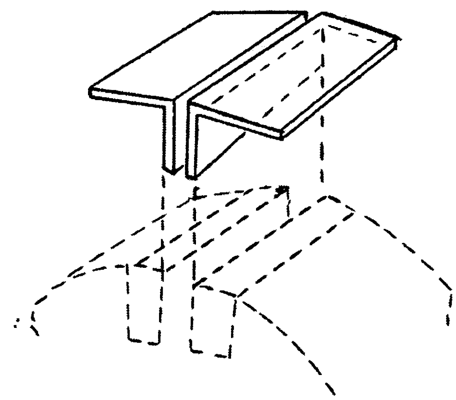


Fig. 27-2

Figure 27-3 illustrates a jeweler's saw frame which is a necessity for the watchmaker. It is much smaller than a hack saw. The small blades come in different cuts from 4 to 4/0, 4 being the coarsest and 4/0 the finest, figure 27-4. These blades are held in place by the clamps at **A**, figure 27-3, which are closed by means of the thumb screws **B**. The saw blade is inserted as follows: Place the head or top of the saw frame against the bench with the handle against your chest. Press against the handle, place saw blade in the lower clamp and tighten thumb screw. When pressure is released, the saw blade will be tight and have a high pitch when picked with your finger in the manner in which you would pick a string on a violin. The

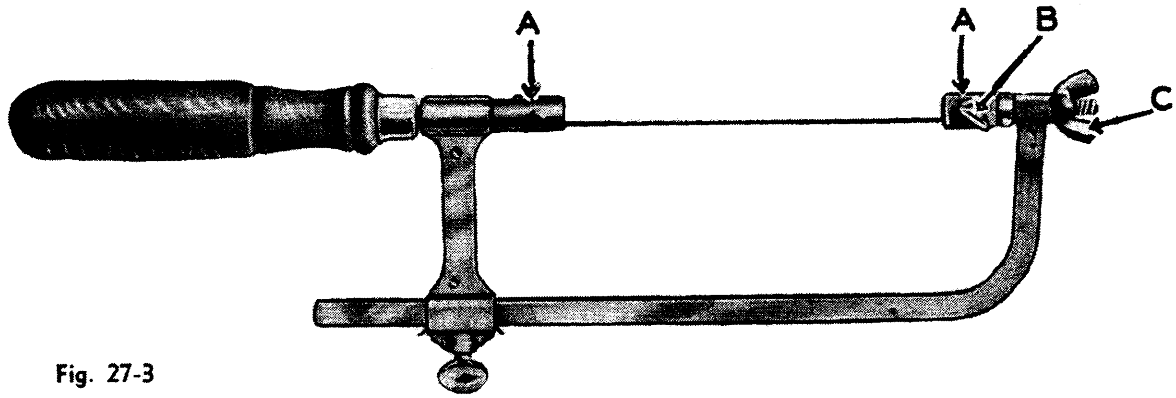


Fig. 27-3

teeth of the saw blade should **point toward the handle.** Further adjustment can be made by means of wing screw at **C.** These saws will cut soft steel, brass, nickel, gold, silver, etc. The work should be held securely in a bench or hand vise and the saw frame pulled down or toward you at which time a slight pressure is

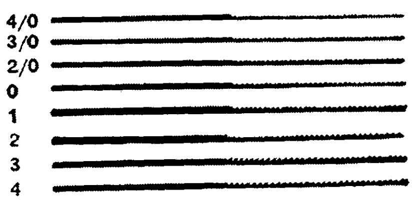


Fig. 27-4

exerted. When reversing the direction of the saw frame, the pressure is released until the downward motion is again started. In sawing flat pieces of steel or brass, etc. in which you wish to follow a line or pattern, the saw frame is held in a vertical position and the work should be held over a wood filing block, figure 27-5. After sawing, the work is usually finished with

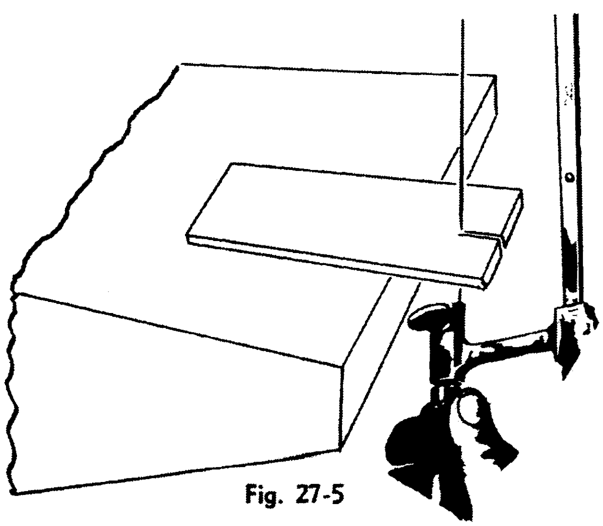


Fig. 27-5

a file and polished if necessary.

For the watchmaker 6 emery buffs of 6 different grades of emery from 2 to 4/0 are generally used to polish steel, figure 27-6.

Fig. 27-6

Polishing any metal is the removing of surface roughness or scratches. When a piece of steel has been filed to the proper shape and we wish to polish it, we start with an emery buff No. 2. The work is carefully gone over with the No. 2 emery buff until all lines or marks left by the file have been removed. Clean the work carefully until all traces of scratches or marks left by emery buff No. 2 have been removed. Repeat the process with emery buffs Nos. 0, 1/0, 2/0, 3/0, and 4/0, being certain to clean the work each time another grade of emery is used. When you have finished with the No. 4/0 emery buff, you will have a piece of work with a high polish. This high polish is very necessary when we temper our work. The polishing of brass, nickel, gold, silver, etc., is not done with emery but with an electric polishing buff and tripoli to remove the scratches, and rouge to give it a high luster.

There are numerous types of files and hundreds of different shapes depending upon the type of work to be performed. There are files with a rough cut, bastard cut, 2nd cut and smooth cut in all sizes and shapes. For ordinary filing in brass and steel, a good flat file will serve our purpose, figure 27-7. For our work a 5-inch to 8-inch file with a 2nd or medium cut is preferred. The file is a cutting tool and should be used as such. To hold a file in the

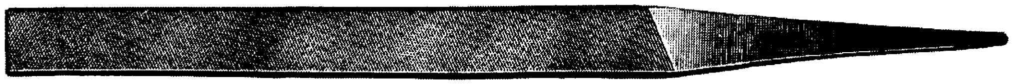


Fig. 27-7

proper position, grasp it firmly in the right hand with the end of the handle butting against the palm of the hand and the thumb resting along the top of the file. The left hand is used to guide the file when pushing it across your work and to regulate the pressure.

The stroke should not be straight across the work in flat filing but should be in a diagonal direction so that the file takes a shearing cut. After the completed forward stroke, the file should be lifted above the work and returned for the next forward stroke. Do not drag the file back across the work. Remember that the teeth of an ordinary file cut only when the file is moving forward. Keep your file clean with a file cleaning brush.

The watchmaker usually works in steel, brass, or nickel. Drill Rod or "Stubs" steel in rod or plates is high carbon steel which can be hardened. Low carbon steel cannot be hardened; consequently, it does not have much value to the watchmaker. Brass or nickel should be procured in the hard form as it is easily annealed.

SEC. 462—Making a Stripping and Seat Cutting Tool

In order to obtain practice in filing, polishing, hardening and tempering, we will make two jewelling tools. They are made from 3 mm square tool steel or drill rod approximately 100 mm in length, figure 27-8. Each step is accompanied by two illustrations. One gives the dimensions in millimeters or fraction thereof and the other is a projection illustrating each cut as it is made. For example: figure 27-8 illustrates a piece of square steel 100 mm long and 3 mm square. Figure 27-8P is a projection of the end to be worked upon. Figure 27-9 illustrates the same piece of steel with a section 20 mm long and 1 mm down from the front edge to be filed away. The projection, figure 27-9P, illustrates the piece of steel after this has been done. Follow each step carefully and work slowly.

1. Clamp the rod in vise allowing approximately 22 mm to extend beyond the jaws of the vise, figure 27-8 and 27-8P.

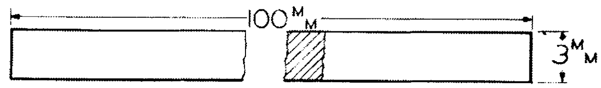


Fig. 27-8

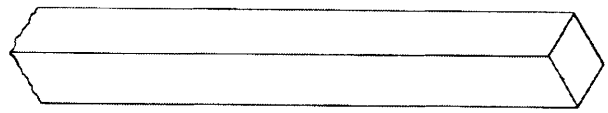


Fig. 27-8P

2. Scratch a line with the edge of the file approximately 20 mm from the end, figure 27-9.

3. Holding the file at an angle of about 18 degrees, file a bevel as in figure 27-9 and 27-9P. Figure 27-9P shows this section after it has been filed.

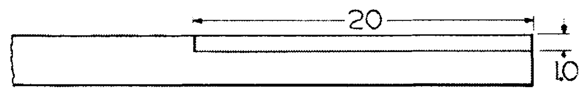


Fig. 27-9

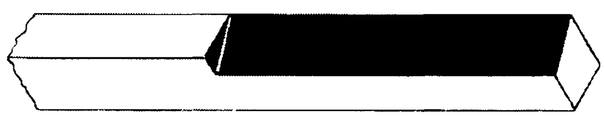


Fig. 27-9P

4. Turn rod over in vise and file the lower side off as in figure 27-10 and figure 27-10P leaving the end measurement at .6 mm thick and the taper about 30 mm back from the end.

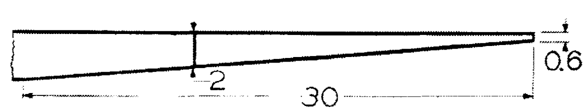


Fig. 27-10

Fig. 27-10P

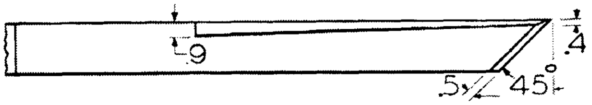


Fig. 27-11

Fig. 27-11P

5. File angle of approximately 45 degrees as shown in figure 27-11 which will remove section **B,** figure 27-11P.

6. File second cut as shown at **C,** figure 27-11P.

7. Reverse steel and file tang which fits into handle as shown in figure 27-12 and 27-12P. Polish all sides of the stripping tool with emery buffs as described in Section 461 until you have a very high polish. It is not necessary to polish the tang.

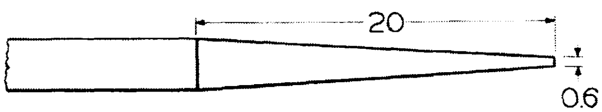


Fig. 27-12

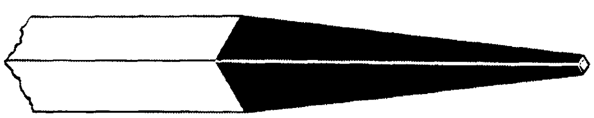


Fig. 27-12P

8. Take another rod of the same length and diameter and repeat steps 1, 2, 3, and 4. The rod should then appear as in figure 27-13 and 27-13P.

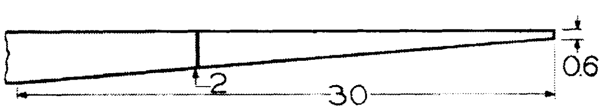


Fig. 27-13

Fig. 27-13P

9. File off the under side and tip as shown in figure 27-14 and figure 27-14P. This will be used as a seat cutting tool.

10. File tang on the other end as in figure 27-12 and 27-12P.

11. Polish as in step 7.

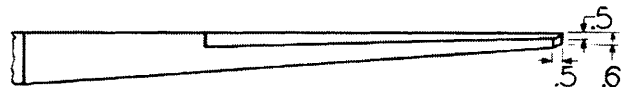


Fig. 27-14

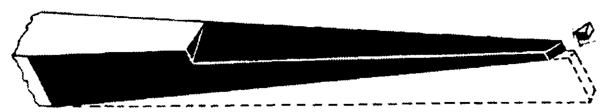


Fig. 27-14P

SEC. 463—Hardening

We are now ready to harden the tools. It is necessary to have some means of heat, preferably a bunsen burner, in order to obtain a red heat. Place a jar of cold water as close to the burner as possible. Wet the stripping tool with water and dip into powdered boric acid. The boric acid will form a glass-like covering over the steel and prevent "burning." In order to make the tool hard, heat it gradually until it is a bright cherry red and plunge it quickly and vertically into the water, holding it in the water until it is cool. A pair of heavy soldering tweezers is used to hold it. Remove from water and test with file. If it is hard, the file will not "bite" into the metal. If the file will bite, it is soft and it is necessary to repeat the process. Be careful when hardening tools such as the jewelling tools just made to apply heat to the bulkiest part of the stock first. Figure 27-15 illustrates a stripping tool. Apply heat at **A** until you are certain the stock is heated through thoroughly; then carefully let the flame heat toward the tapered end, first at **B** then back to **A,** back to **B,** down to **C,** back to **B** and **A,** and then reverse until section **D** of the tool from the end to **B** is cherry red. Quickly plunge into cold water and cool slowly. Test with a file.

When steel is hardened by the method just described, it is sometimes referred to as glass hard. The significance is that it is brittle and will break easily. Every piece that has been

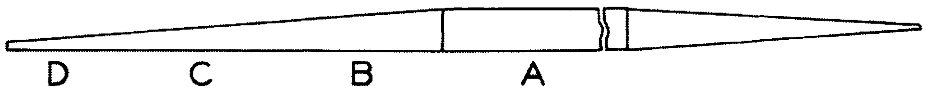


Fig. 27-15

hardened must be handled carefully. After your tools are hardened, they must be repolished using emery buffs 2/0, 3/0, and 4/0 in the order stated. Apply the buffs carefully in order not to break your tool.

SEC. 464—Annealing and Tempering

In order to toughen the tools, they must be annealed. This is known as tempering. Annealing brass, nickel, gold or silver is done by heating to a dull red and then plunging the stock into cold water. Annealing steel is done by heating the stock carefully and slowly and letting it cool gradually. Great care must be used to prevent overheating, and if you happen to overheat your work, it must be rehardened and repolished before attempting to temper it again. For the student, tempering is best done with an alcohol lamp, observing the colors which appear on the highly polished surface of the work.

Colors appearing when tempering	Degrees Fahrenheit (Average)	Tools
Light Yellow	430	Tools for cutting steel
Light Straw	460	Tools for cutting brass, nickel, gold and silver.
Medium Straw	470	
Dark Straw	480	
Reddish Purple	525	
Bluish Purple	550	
Blue	570	Click springs, set levers, balance staffs, pinions, arbors, screws etc.
Gray Blue	600	Soft

Fig. 27-16

The chart in figure 27-16 gives the temperature in Fahrenheit of the different tempers and the tempers to be used with the different tools and springs used by the watchmaker.

The first color to appear when annealing is a very light yellow which is barely visible. It is hard to differentiate between this light yellow and the succeeding light straw color. As you can ascertain by the chart in figure 27-16, the jewelling tools will be tempered to a medium or light straw. Figure 27-17 illustrates how this can be obtained when heated slowly over the

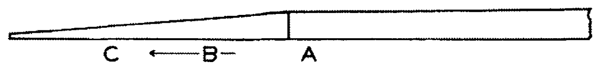


Fig. 27-17

flame of an alcohol lamp. Heat slowly the heaviest part first as at **A.** As the first color appears, move gradually in the direction of Arrow **B** until Section **C** is the desired color. The fact that from **B** to **A** may be a purple or blue is an advantage, as this part of your tool will be tougher. After the desired color is obtained, repolish and mount in small graver handle.

SEC. 465—Making an Iron Grinding Slip

For the purpose of grinding both square and cone shaped pivots, we will make an iron grinding slip as shown in figure 27-18. File straight edge **A** at an angle of approximately 15 degrees.

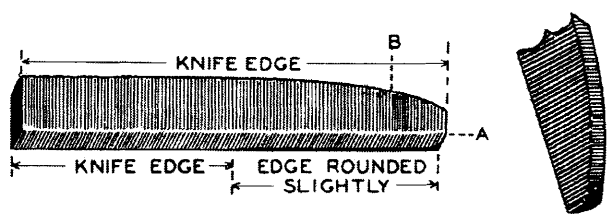


Fig. 27-18

File the other edge at the same angle but curved as shown at B. Finish carefully by leaving file marks at right angles to the horizontal edges on both top and bottom and also the edges.

SEC. 466—Hardening and Tempering Small Springs

Watchmakers can usually purchase all the necessary springs such as click springs, clutch, and lever springs, etc. It is also possible to ob-

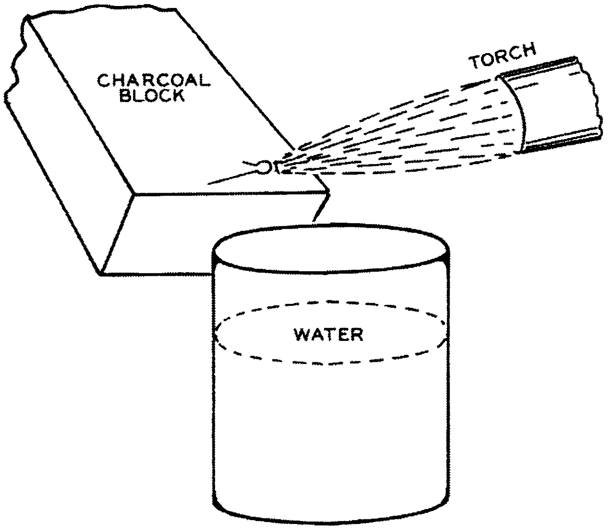


Fig. 27-19

tain click spring wire of assorted widths and diameters from which the watch repairman can shape his own springs. There are times when this is necessary, especially for old watches. At times it is necessary to alter the shape of the spring slightly in order to get the proper results. In order to reshape or form a new spring, proceed as follows:

1. Heat spring to a dull red and let cool slowly. This will anneal the spring.
2. Shape the spring to the desired form.

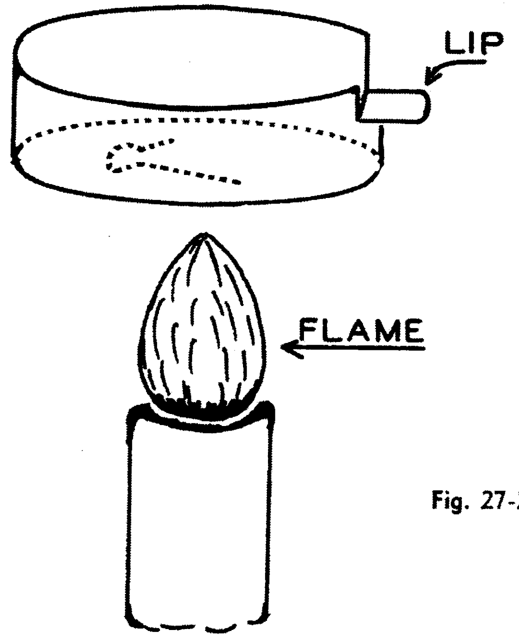


Fig. 27-20

3. Cover with soap and press lightly into a charcoal block, figure 27-19.
4. Heat spring to a bright cherry red with a blow-pipe or small torch.
5. Strike edge of charcoal block against the edge of a jar containing cold water. This will project the spring into the water and if properly executed, the spring will be "glass hard."
6. Remove and carefully polish the end of spring with your emery buffs.
7. Select a small material box and break the edge with a pair of flat nose pliers forming a small lip as in figure 27-20.
8. Place the spring in box and grasp lip with a pair of soldering tweezers and move box rapidly back and forth over the flame of an alcohol lamp.
9. Observe carefully until polished section turns blue and remove from the flame.

The above method can be used for annealing and tempering all small parts.

SEC. 467—Duplicating Broken Levers, Etc.

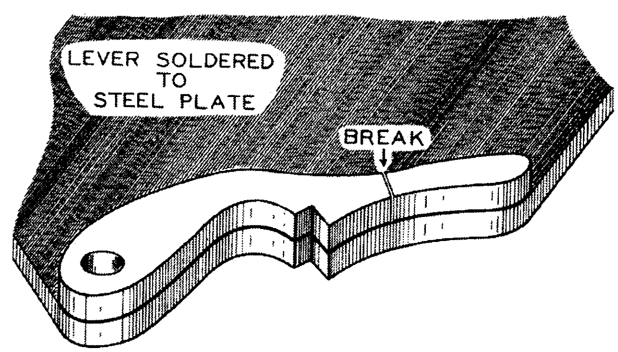


Fig. 27-21

Sometimes it is necessary for the watchmaker to make a small detent or lever. Figure 27-21 illustrates a broken clutch lever soft soldered to a piece of high grade steel. The two pieces can be matched perfectly in this manner and an outline made with a fine saw and finished carefully with small files of various shapes. The hole is also drilled at this time. After this much has been shaped, the process can be repeated on the back edge. Separate by heating over an alcohol lamp. Finish the top and bottom with emery and harden and temper to a blue. (Section 466).

SEC. 468—Soft Solder

Soft soldering is rarely used in watch repair work. Soft soldering a lever to a piece of steel as shown in figure 27-21 is permissible, however. To do the job properly, brighten the surfaces of the lever and the steel plate which come in contact with each other, using a fine file or emery. Cover each of the brightened parts with a soldering flux and a small amount of soft solder. Heat each part separately over an alcohol lamp until solder melts, and brush off the surplus solder while hot with a hard watch brush. This should leave each surface with a thin covering of solder. Put additional flux on steel plate, put lever in place, and reheat until solder turns bright. At this temperature the broken parts can be maneuvered into position. Set aside and let cool before proceeding with the shaping process.

SEC. 469—Soldering Bits in Enamel Dials

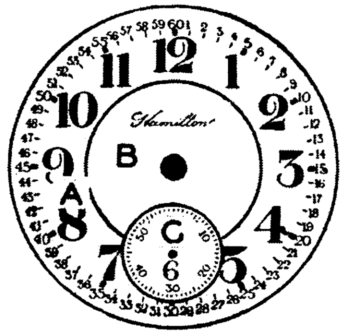


Fig. 27-22

The enamel dials used on high grade watches are usually made of two or three separate pieces which are soft soldered together. Such dials are known as **double sunk** dials. These different sections are shown in figure 27-22 at **A, B** and **C.** Figure 27-23 shows a single sunk dial with the two sections labeled **A** and **B.** The center bit and second bit are held in place with a special soft solder. This solder can be made of 3 parts of lead, 5 parts of tin, and 8 parts of bismuth. Figure 27-24 illustrates where the solder is placed. The copper center of the dial which is illustrated in the left half of the illustration is

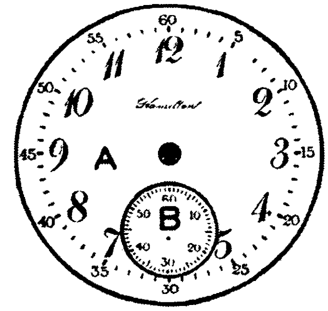


Fig. 27-23

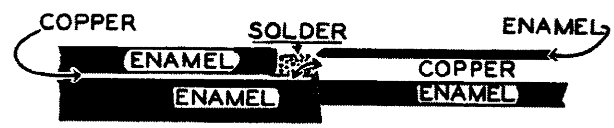


Fig. 27-24

represented by a thin white section extending beyond the upper section of enamel. The bit represented in the right half of the illustration shows the copper center of the bit in white. The edge of this bit must be brightened with a file as must the copper ledge of the dial. The solder is made to flow in the groove fusing the copper centers together as shown, which will hold the bit securely in place. Flux must be applied before soldering. The dial may be placed on a copper plate and warmed carefully until the solder starts to flow. Use a small brush and while the dial is warm, brush the solder around the groove as shown by Arrows **A** and **B,** figure 27-25. Be certain that the solder is below the enameled surface. Clean all soldering flux off with water and dry carefully with a clean, lintless cloth.

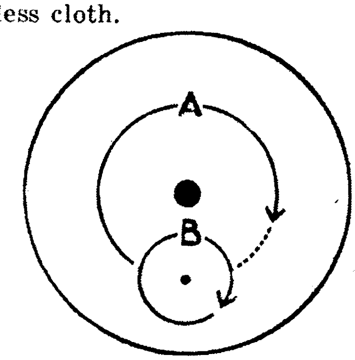
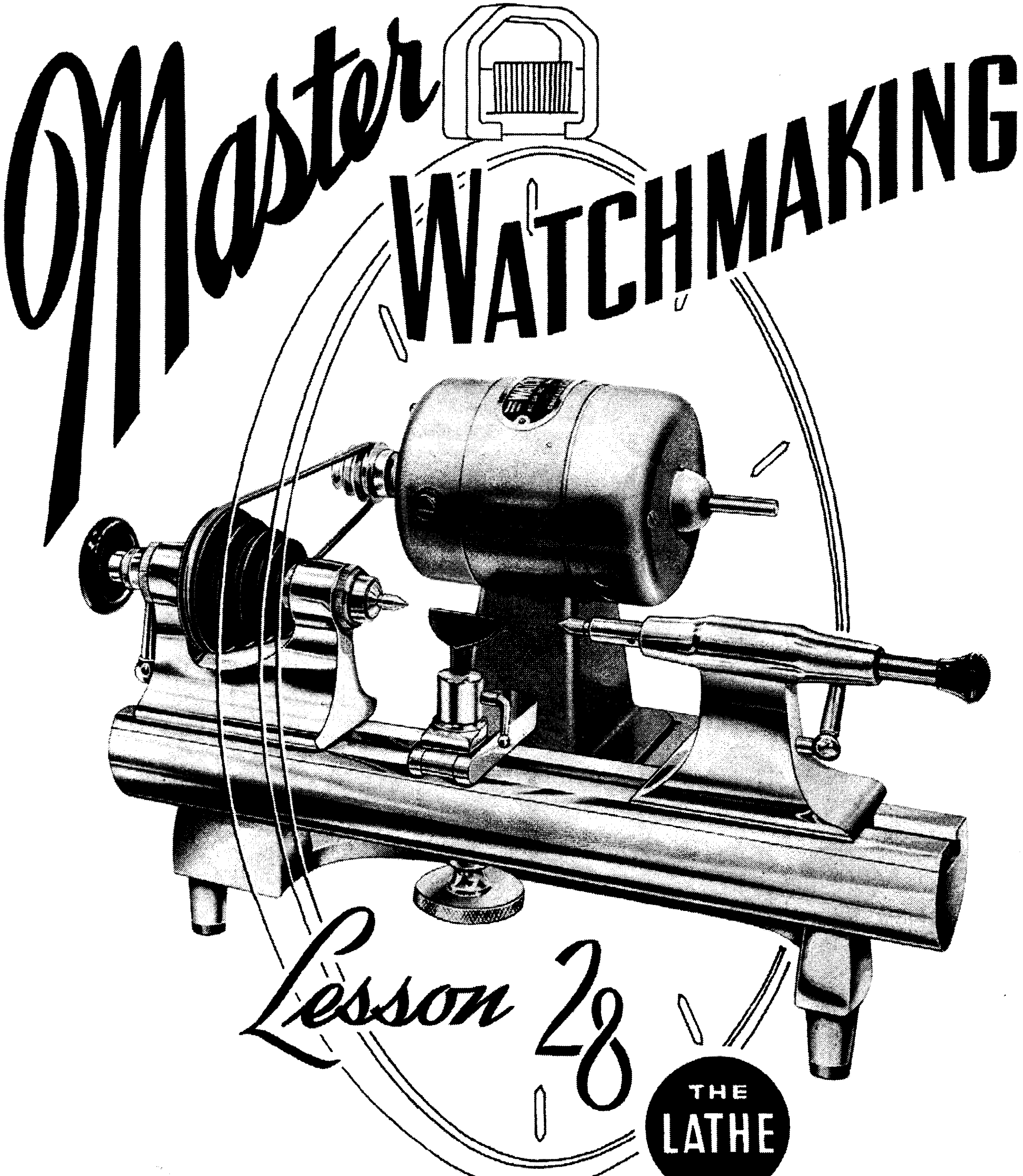


Fig. 27-25

note:

(No job sheets are associated with Lesson 27)



CHICAGO SCHOOL OF WATCHMAKING *Founded 1908 by* THOMAS B. SWEAZEY

SEC. 475 — The Watchmaker's Lathe

In the lessons so far you have been shown some of the practical work of watch repairing without the use of that very important part of the expert's equipment—the watchmaker's lathe.

Before proceeding with the more advanced problems in watch repairing, it is essential that you be able to cut square shoulders, polish pivots, reset jewels, turn down jewel settings, fit balance staffs and pinions, and do numerous other jobs that can only be accomplished on an accurately made lathe of proper size and with sufficient equipment.

Very few people outside the profession know the part which this tool plays in the delicate work of creating the timepieces of today. In its present perfection, the modern lathe combines a degree of accuracy and ease of operation undreamed of by the old masters who toiled long and laboriously to accomplish what today's Master Watchmaker is able to do in a few moments with the aid of his ever-ready lathe. Many do not realize that with a first class lathe and its attachments such as should be found on every Master Watchmaker's bench, the expert workman is able to make a complete watch capable of keeping the most accurate time. While the modern lathe will accomplish such work in skilled hands, the mastery of it cannot be acquired by merely studying from any text book. However, as in any other watchmaking projects, only by constant and consistent practice can the beginner hope to become expert.

Through abuse, a lathe may be easily thrown out of its fine adjustments or out of true as to be practically worthless for the fine work for which it is intended. For this reason, it is best for the beginner to secure a new lathe and attachments and thus have the pleasure of working upon one that is capable of doing the highest grade of work. When you purchase a second hand lathe, you have no means of telling how much it has been abused or how much it is out of true. Only an expert has the equipment and ability to make the proper tests necessary to insure you against trouble when purchasing such second hand equipment. A lathe that has been ruined by improper handling is a handicap to good work that is mighty hard to overcome.

With proper handling, a well made watchmaker's lathe is good for a lifetime of service. For this reason, you should treat your lathe with the care to which it is entitled, keeping it clean and oiled at all times and never allowing any person unskilled in its use to try it out or play with it.

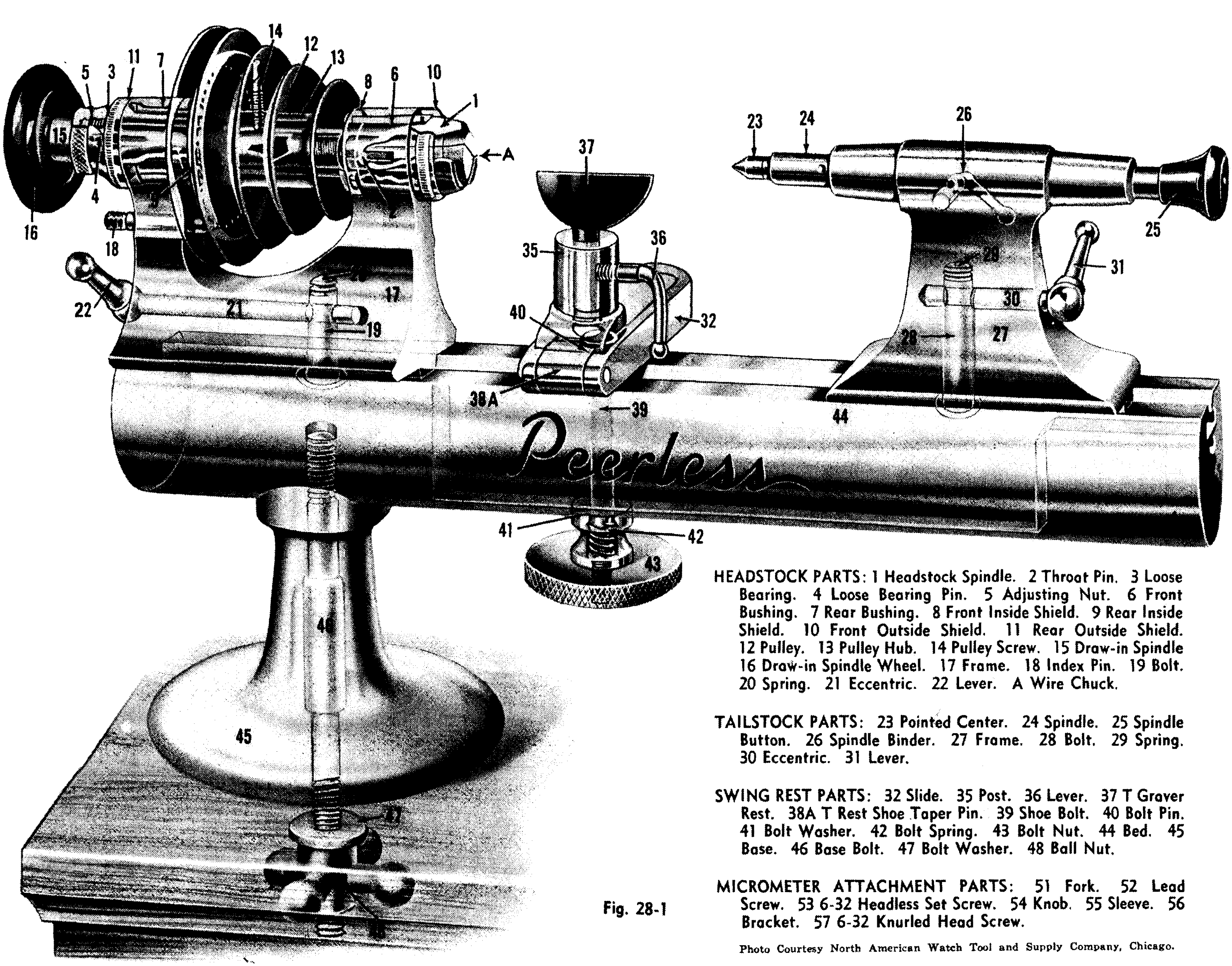


Fig. 28-1

HEADSTOCK PARTS: 1 Headstock Spindle. 2 Throat Pin. 3 Loose Bearing. 4 Loose Bearing Pin. 5 Adjusting Nut. 6 Front Bushing. 7 Rear Bushing. 8 Front Inside Shield. 9 Rear Inside Shield. 10 Front Outside Shield. 11 Rear Outside Shield. 12 Pulley. 13 Pulley Hub. 14 Pulley Screw. 15 Draw-in Spindle 16 Draw-in Spindle Wheel. 17 Frame. 18 Index Pin. 19 Bolt. 20 Spring. 21 Eccentric. 22 Lever. A Wire Chuck.

TAILSTOCK PARTS: 23 Pointed Center. 24 Spindle. 25 Spindle Button. 26 Spindle Binder. 27 Frame. 28 Bolt. 29 Spring. 30 Eccentric. 31 Lever.

SWING REST PARTS: 32 Slide. 35 Post. 36 Lever. 37 T Graver Rest. 38A T Rest Shoe Taper Pin. 39 Shoe Bolt. 40 Bolt Pin. 41 Bolt Washer. 42 Bolt Spring. 43 Bolt Nut. 44 Bed. 45 Base. 46 Base Bolt. 47 Bolt Washer. 48 Ball Nut.

MICROMETER ATTACHMENT PARTS: 51 Fork. 52 Lead Screw. 53 6-32 Headless Set Screw. 54 Knob. 55 Sleeve. 56 Bracket. 57 6-32 Knurled Head Screw.

Photo Courtesy North American Watch Tool and Supply Company, Chicago.

SEC. 476 — Lathe Nomenclature

The new lathe as it comes from the dealer may be already assembled or it may come "knocked down" for packing, in which case the different parts are assembled but not located in their places on the bed. Figure 28-1 shows a modern American-made lathe together with its nomenclature. The following lists the most common parts:

44 Lathe bed
17 Frame and headstock
A Chuck
15 Draw in spindle
16 Draw in spindle wheel
18 Index pin
12 Pulley
37 T Rest—tip-over style
39 Shoe bolt and bolt nut (43)
43 Bolt nut
27 Tail stock frame

On the bottom of the head stock at **19** is a bolt with **T** head which fits into the slot in the bed. This bolt is controlled by the locking lever **22.** Turn this locking lever until the head of the bolt is at its lowest point and then slide the headstock on the left side of the bed as shown, figure 28-1, the throat in which the chuck **A** fits being toward the right. The draw in spindle **15** is inserted in the left end of the lathe spindle. The index pin **18** fits in the hole found in the headstock but it is not necessary to have this in place at this time, but rather keep it in your chuck box.

Before attempting to assemble the bed plate, notice that the washer at **41** is counterbored to permit a coiled spring to be placed between this washer and the hand wheel nut **43.** It is essential that this spring be in place when these parts are assembled on the bed. The coiled spring keeps a tension on the bolt and prevents to a great extent the danger of the key getting out of its seat. The base of the T rest has a slot which fits over the head of the bolt projecting above the bed plate and the next step is to slip this into place. Loosen the nut enough so that by pressing up on the bolt to overcome the tension of the coil spring, it is possible to slip the T rest into place on the bed plate. Tightening the nut at the bottom permits you to secure the base of the T rest firmly in place on the bed plate and your assembly will appear as in figure 28-1. The tailstock is placed on the right side of the bed, securing in place with a locking lever as was done with the headstock, but it will not be necessary to use this tailstock at this time.

SEC. 477—The T Rest

On the older model lathes, the T rest was stationary and each time the watchmaker wished to check a measurement and the T rest interfered, it was necessary to loosen the hand nut and move the entire T rest, after which it was again adjusted to the proper position and secured in place by turning the hand nut. The modern tip-over T rest is a great timesaver when compared with the old model. After it is once adjusted to position, it is not necessary to disturb that adjustment. The T rest can be tipped back out of the way, the measurement or fitting tested and the T rest tipped back into its original position.

SEC. 478 — Mounting The Lathe

In mounting a lathe on your bench for use with a motor, drill a hole of proper size to receive the bolt which extends down from the foot of your lathe. This hole for the average size person should be about six inches in from the left side of the bench top and the same distance from the front edge. Secure the lathe in position by means of the hand nut, placing an iron washer between the nut and bench top. If you are going to have the motor connected with the lathe, set the motor on the bench about 8 inches back from the lathe. If the motor is too far from the lathe, the belt is inclined to vibrate too much. See that the cone pulley on the motor is so placed that its largest diameter is opposite the smallest part of the lathe pulley. Have the axis of the motor parallel to the edge of the bench top and fasten in place by means of screws.

The lathe is connected to the motor by means of 1/8" twisted leather belting which is preferable to solid round belting. The stopping and starting together with the speed of the motor is governed by means of a foot control which is placed on the floor of the bench in such a position that it is easily reached. When properly connected, pressure on the foot control will start the motor and the further it is pressed down, the faster the speed. When the pressure is released, the current is shut off and the motor stops.

To connect motor and lathe, thread a piece of 1/8 inch twisted leather belting through the pulley of the lathe and then over the pulley of the motor. Let the belting rest in the middle groove of each pulley, pull it up rather tight and cut off so the ends of the belting will just come together without lapping. Have the ends of the belt cut off square and punch a hole in each end to receive the fastener which you can make from a piece of brass wire about 1 millimeter in diameter. The hole should be about 3 millimeters from the end and can be made by means of a broach or even a larger needle, twisting it around in the leather until it is of the right size to receive the wire.

Take a piece of one millimeter wire and with a flat or snipe nose plier shape one end as shown in figure 28-2, the space at **A** being slightly smaller than the diameter of the belting. The end forming the hook should be approximately 3 mm long. Make the next bend at **B** and the wire will appear as in figure 28-3. Make a bend at **C**, figure 28-3, at approximately a 45 degree angle. The wire should then appear as in figure 28-4. Flatten the ends of the belting and start the long end of the wire **D**, figure 28-4, through the inner side of the belt and pull wire through. Thread the belt through the lathe pully and push the long end of the wire D through the hole in the other end of belt and slide belt in place.

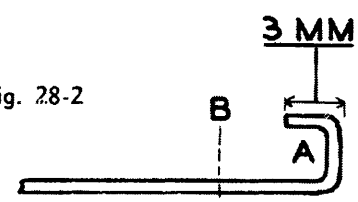
Before going further, slip belt over the two pulleys and see if you have the proper tension. If belt is too loose, it may be tightened by taking wire out of one end and then giving it a few twists, or untwist it a few turns to loosen it.

If tension is correct, bend the long end of the wire tight against the belt and cut off wire at **E**, figure 28-4. With the jaws of your flat pliers, press ends of clamps tight against the belt.

SEC. 479 — The Lathe Motor

Figure 28-5 shows a popular type of motor with foot control, which can be used in driving a lathe. These are usually universal motors, working on either AC or DC current with a voltage of from 110 to 130, and come already wired with separate types of plugs on the two free ends of the wire, one a standard plug which fits into the regular receptacle or base connec-

Fig. 28-2



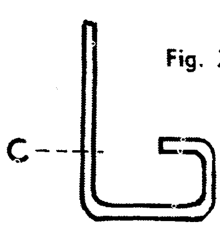


Fig. 28-3

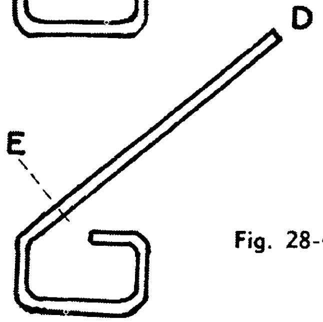


Fig. 28-4

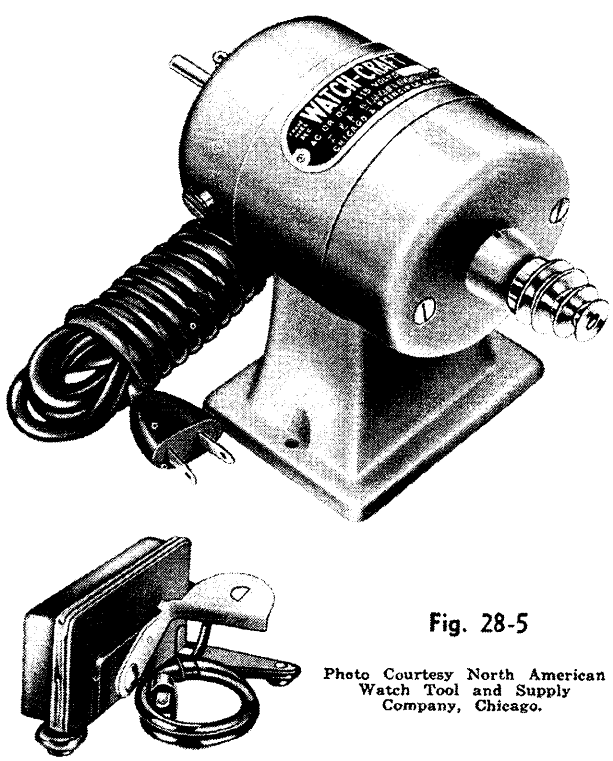


Fig. 28-5

Photo Courtesy North American Watch Tool and Supply Company, Chicago.

tion of the house or store current, the other a special plug which fits on the foot control or the connection to the motor, depending on style used. The stopping and starting together with the speed of the motor is governed by means of the foot control which is placed on the floor of the bench in such a position that it is easily reached. When properly connected, pressure on the foot control will start the motor and the further it is pressed down, the greater the speed. When the pressure is released, the current is shut off and the motor stops.

Sec. 480 — Oiling The Lathe

Now having set up your lathe and motor and tested the latter by making sure the electric current is on and properly connected and that the foot control is in working order, it is time to get a little better acquainted with the lathe. As the lathe comes from the factory, it generally is already oiled and greased to prevent rust but it does no harm to go over it again after wiping off all old grease and dust.

As stated before, a lathe as it comes from the factory is good for a great many years of every day service, provided it is properly cared for and never abused. One of the principal causes of lathe failures is a lack of oil and accumulation of dust and grit in the bearings of the head stock. You should always keep your lathe covered when not in use and once a day apply a light grade of oil on the bearings. It is better to apply too much oil than not enough. Push the dust caps at **10 and 11,** figure 28-1, far enough out to permit you to place several good sized drops from your oil can in the oil holes for the bearings. Have your lathe running at a moderate speed and apply oil until it forms a ring around the bearing. Let it continue to run for a half minute or so and then wipe off all surplus oil with a clean cloth. Press the dust caps firmly back in place and again wipe off any oil that may be on the surface.

On some lathes you will find a hole at the inside edge of the dust caps which can be turned until in line with the oil hole in the bearings, thus enabling you to oil the bearings without removing the cap. In others, the dust caps are split. In either of these types, be sure that the hole or the split portion is down to prevent as much as possible the entrance of dirt or grit into the bearings.

Apply a drop of oil on the draw in spindle at **15;** also a drop in the throat of the lathe spindle at **1,** figure 28-1.

SEC. 481 — Footwheels

If you are not convenient to a 115 or 120 volt AC or DC current, it is a very easy matter to arrange your lathe to be driven by a foot wheel. In fact, with a foot wheel driven lathe it is possible to do just as fine work as with a motor.

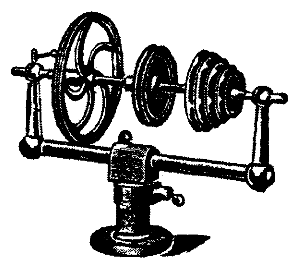


Fig. 28-6

In setting up a lathe with a foot wheel, it is better to use a counter shaft as shown in figure 28-6. The use of a counter shaft eliminates the moving belt that is right in front of you when you are working and also permits a variety of speed and the use of a speed wheel for special work which will be described further on in these lessons.

SEC. 482 — Chucks

Before the invention of the split chuck, any work which was to be turned in a lathe had to be held between centers or clamped on some form of face plate. The "fiddle bow" lathe, some of which are still in use, is an example of the dead center style of lathe. These lathes were generally small and held in a vise. The workman was compelled to use one hand to drive the lathe by means of the so-called fiddle bow, while with the other hand he manipulated the tool upon whatever piece he was working.

The modern watchmaker's lathe uses two general types of chucks for holding work—the hollow split chuck and solid chuck. Your first work will be with the split chuck, sometimes called wire chuck.

Figure 28-7 is an illustration of the conventional type of split chuck as used in the majority of watchmaker's lathes. It is split lengthwise at a trifle over half of its length, to form three

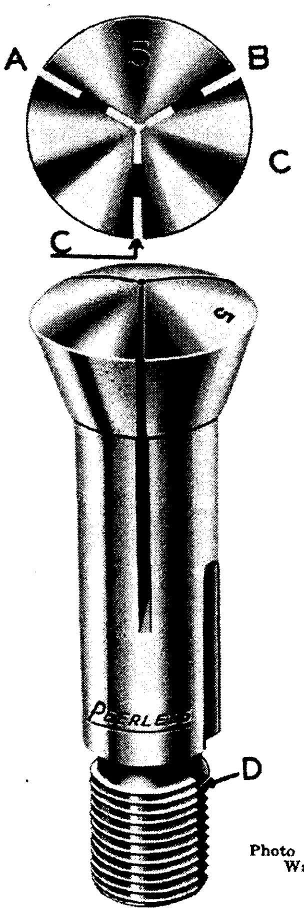


Fig. 28-7

Photo Courtesy North American Watch Tool and Supply Company, Chicago.

jaws at the face, these splits being shown at **A, B,** and **C.** This chuck fits into the spindle of the lathe and the object to be turned is held firmly in place by the compression of the three split portions. This is accomplished by means of the draw in spindle which fits on the threaded portion of the chuck at **D.** As the chuck is drawn into the throat of the lathe by means of the draw-in spindle, the jaws are forced toward the center and act as a clamp.

A properly made chuck is so tempered that the jaws will close equally when compressed by the draw-in spindle and care must be used to see that they are never sprung out of true.

On the face of each chuck is stamped its size, figure 28-8. This refers to the diameter of the opening in the jaws and this opening when received from the factory has been ground and lapped true and will remain in that condition if treated as it should be. For that reason, you should measure every piece which you wish to "chuck up" and select a chuck according to the measurement you find.

With some of the older lathes, the chucks were sized to match wire dimensions as found on a stubs gauge but this was not satisfactory to most watchmakers who were not accustomed to working with such a gauge and they found it somewhat confusing owing to the fact that the larger the number on a stubs gauge the smaller the size. Thus a wire that gauges 50 by stubs gauge measures about one and three-fourths millimeter while No. 20 wire would be a trifle over four millimeters in diameter.

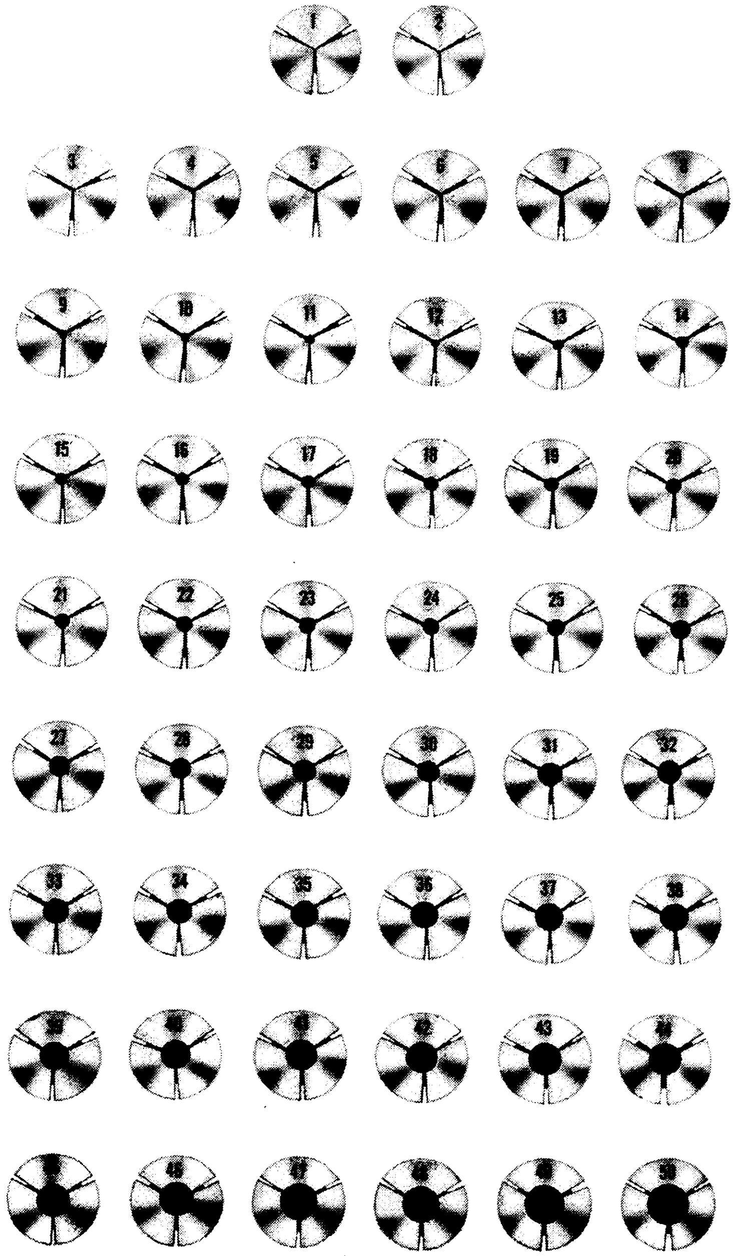
The universal standard for marking and gauging chucks at the present time is one tenth of a millimeter. If the chuck is stamped 20, it means that its opening in the jaws is twenty tenths of a millimeter or 2 mm, No. 8 equals 8/10 mm, 16 equals 1-6/10 or decimally 1.6 mm, etc. This makes it very easy for the workman to select the proper chuck by merely measuring the piece he wishes to hold in the chuck, provided he has a millimeter gauge and knows how to use it.

If a workman has but a small assortment of chucks, he may be tempted to use one that is too large or too small and thus spring the jaws to such an extent that it will never run true.

For this reason, it is well to secure as large an assortment of chucks as you can afford when purchasing a lathe. For your preliminary lathe work, you can get along very nicely with 10 chucks but when you are prepared to do all kinds of watch repairing, do not have less than 24 split chucks beside the taper chuck and cement chuck which come with the lathe.

For a complete set of split chucks, one each of the following numbers is recommended: 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 47, 48 and 50. This will insure your having a sufficient variety of split chucks for practically all ordinary watch work you may be called upon to do. Later you can add to these any which you may find necessary.

In the spindle of the lathe is a pin or key to match the slot or key seat shown at **2,** figure 28-1. It is necessary that the key seat in the chuck matches this key in the spindle when you place any chuck in the headstock of a lathe. Occasionally this key is worn or cut off by having a chuck forced into place but this can be avoided by anyone who will learn to seat each chuck properly.



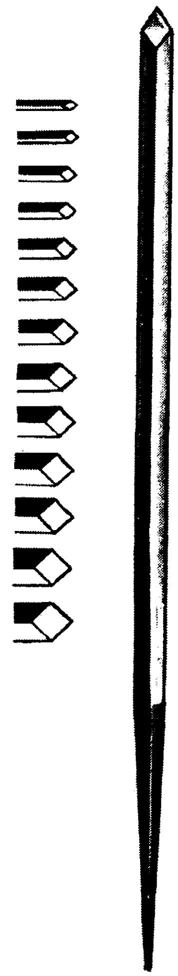


Fig. 28-9

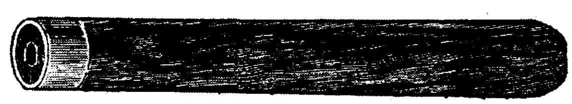


Fig. 28-10

Photo Courtesy North American Watch Tool and Supply Company, Chicago.

Fig. 28-8

SEC. 483 — Types of Gravers

There are two common shapes of gravers used in turning, the square and lozenge or diamond shape as indicated in figure 28-9.

The square graver is most commonly used and it is this form that you will use in your preliminary lathe work. It can be had in different sizes but the most practical for all around work should be from 2½ to 3 mm square. As it comes to you it is about 5½ inches long and should be mounted in a handle before using. The most practical type of handle is shown in figure 28-10, a pivot graver handle. This is somewhat on the order of a file handle though shorter and about ¼" in diameter. These handles generally are drilled ready to receive the graver. In mounting the graver, it is only necessary to clamp the graver in a vise with the tapered end out and drive the handle down firmly in the graver. Some prefer to "burn in" the handle in which case the end of the graver protruding above the vise is heated to a red heat by means of a blow torch or bunsen burner and the handle driven on as before while the graver end is red hot. Care must be used to see that the balance of the graver is not heated enough to draw the temper on the cutting edge. You will find, however, that it will prove satisfactory to merely drive the handle on with heating provided you do not drive it hard enough to split the handle. A series of sharp taps is better than attempting to drive it down with one or two hard blows.

The new graver will be found to have the end cut off at about the correct angle but the edges are liable to be rather round and your first step after mounting will be to sharpen it ready for turning. To do this, you should provide yourself with a combination oil stone of good quality, figure 28-11, one side of which is coarse for rapid cutting and the other much finer for finishing. Be sure to use plenty of oil

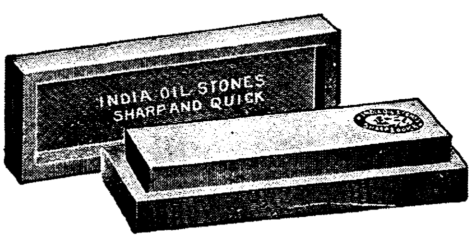


Fig. 28-11

on the stone when sharpening the graver in order to keep the surface in good cutting condition. If the stone is used dry, the small particles of steel ground off the tool will imbed themselves in the pores of the stone and in time the surface will become glazed and greatly hinder its use for sharpening. Plenty of the right type of oil will prevent this and keep the stone in first class condition. Never use a vegetable oil for this purpose, however. Ordinary kerosene will give very good results and it is well to have a bottle of this always at hand and keep the surface of your oil stone saturated with it whenever sharpening the tool. Thoroughly wipe off the stone when you are finished and thus have it clean and ready the next time it is used.

SEC. 484 — Sharpening the Graver

The angle of the cutting end of the graver should be about 45 degrees for the general run of lathe work as shown in figure 28-12. As received from the manufacturer, the graver is usually ground at about that angle but as stated

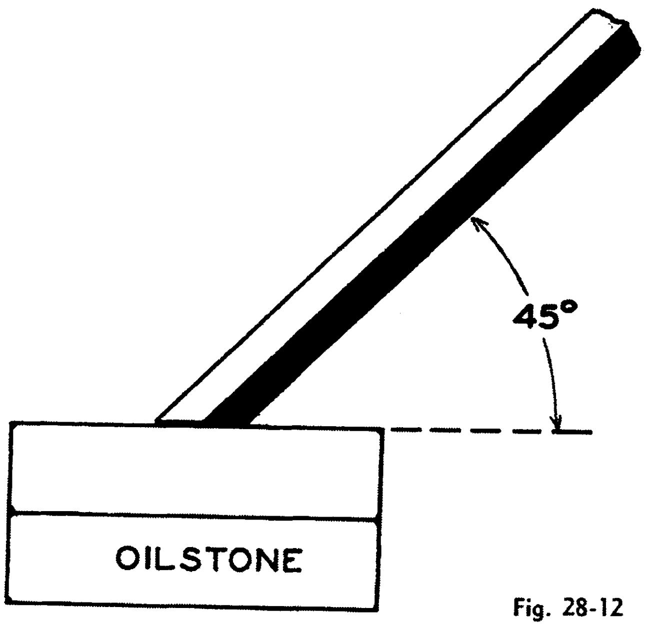


Fig. 28-12

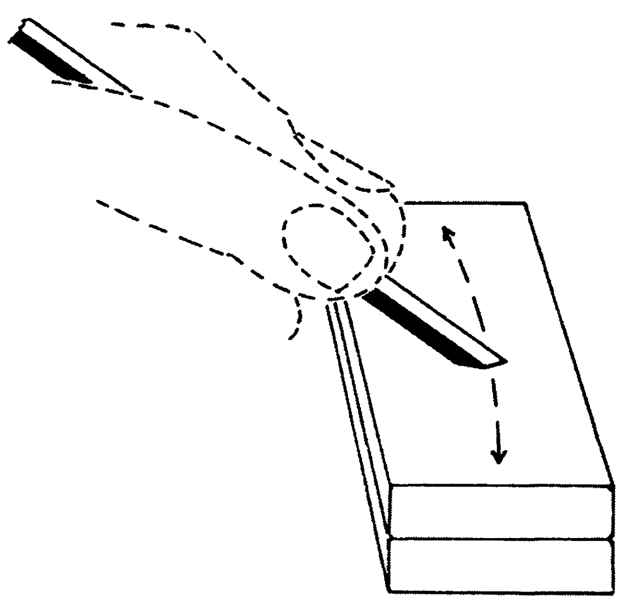


Fig. 28-13

before, it is too rough and should be resharpened on a fine oilstone. If you find this angle about correct, you need only smooth it upon the finer side of your combination oil stone. Place a liberal supply of oil on the stone and holding the graver as shown in figure 28-13, grind it by moving the hand steadily back and forth as indicated by the double headed arrow. The graver should be held so that an imaginary line down through the upper and lower angular corners of the tool will be at right angles with the surface of the stone. If the graver is twisted either to right or left, the result may appear as in figure 28-14. The beginner usually has a tendency to roll the handle slightly while moving it back and forth thus giving the face of the graver a convex surface instead of flat.

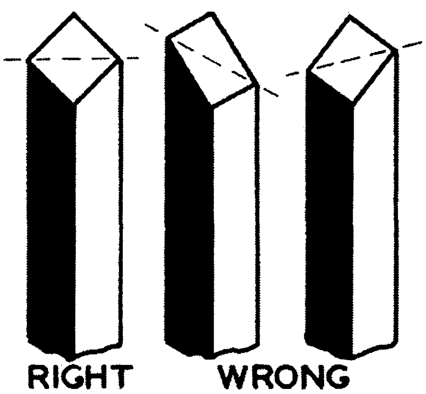


Fig. 28-14

The contact of the cutting edge and the moving piece generates heat, the degree being dependent upon the depth of cut and speed. To keep the tool as cool as possible some sort of crolant is applied to its edge to carry off this frictional heat. With the old type of carbon steel cutters, the speed had to be kept slow enough to prevent them from losing their cutting temper. With some of the new alloy cutting bits, the cutting edge is retained even though the cutter reaches a red heat.

The greater portion of turning in lathe work as done by watchmakers is accomplished by hand tools and high speed with heavy cuts is not so essential.

Before applying the graver to whatever you may be turning, it is well to test the point of your graver. This may be done on your thumb nail. If you rest the point of a properly sharpened graver on your nail as shown in figure 28-15 without exerting any downward pressure except the weight of the graver and while so holding it press lightly in the direction indicated by the arrow, the point will catch in the surface of the nail, while if the graver is dull the point will slip over the nail without catching. If the graver proves to be dull, proceed to sharpen it before attempting to cut anything.

It is essential that you as a student follow these instructions very closely. Do not attempt to proceed with the next lesson until you have satisfactorily sharpened your gravers.

SEC. 485 — Modern Lathe Mount

Figure 28-16 illustrrates a watchmaker's lathe and motor mounted on an aluminum base. With this arrangement the watchmaker can move his lathe to suit his purpose. It can be removed from the bench when not in use, thus allowing the watchmaker additional room.

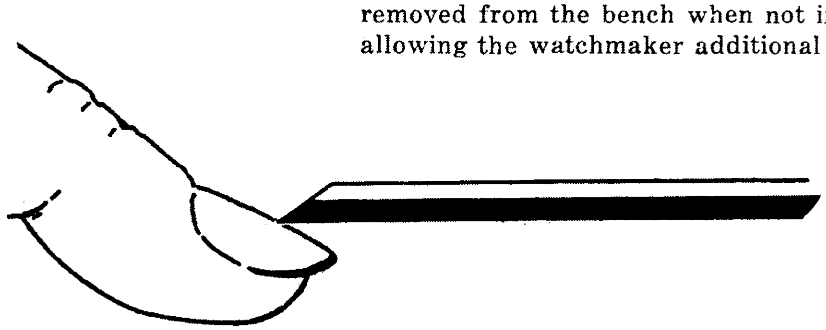


Fig. 28-15

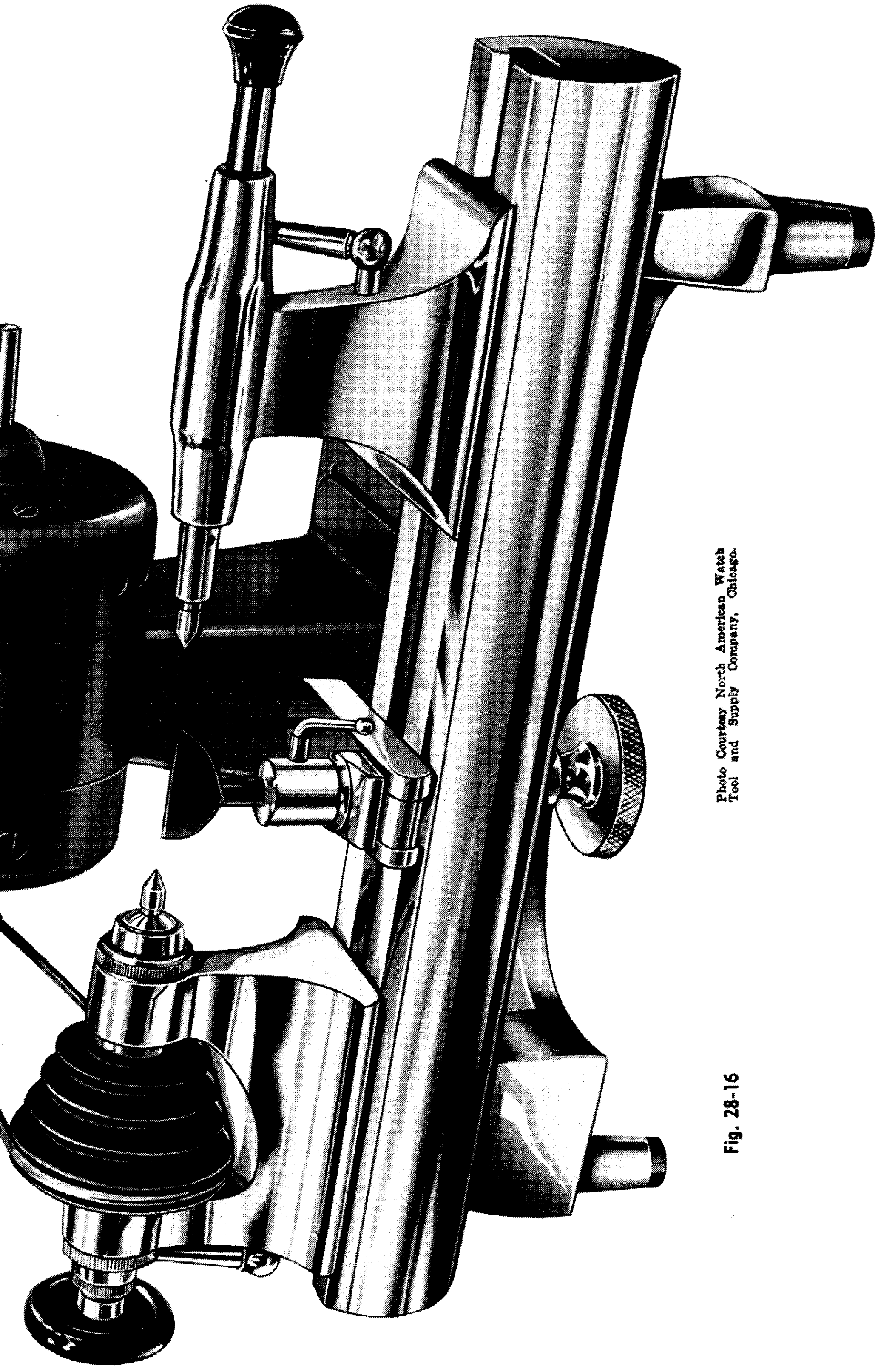
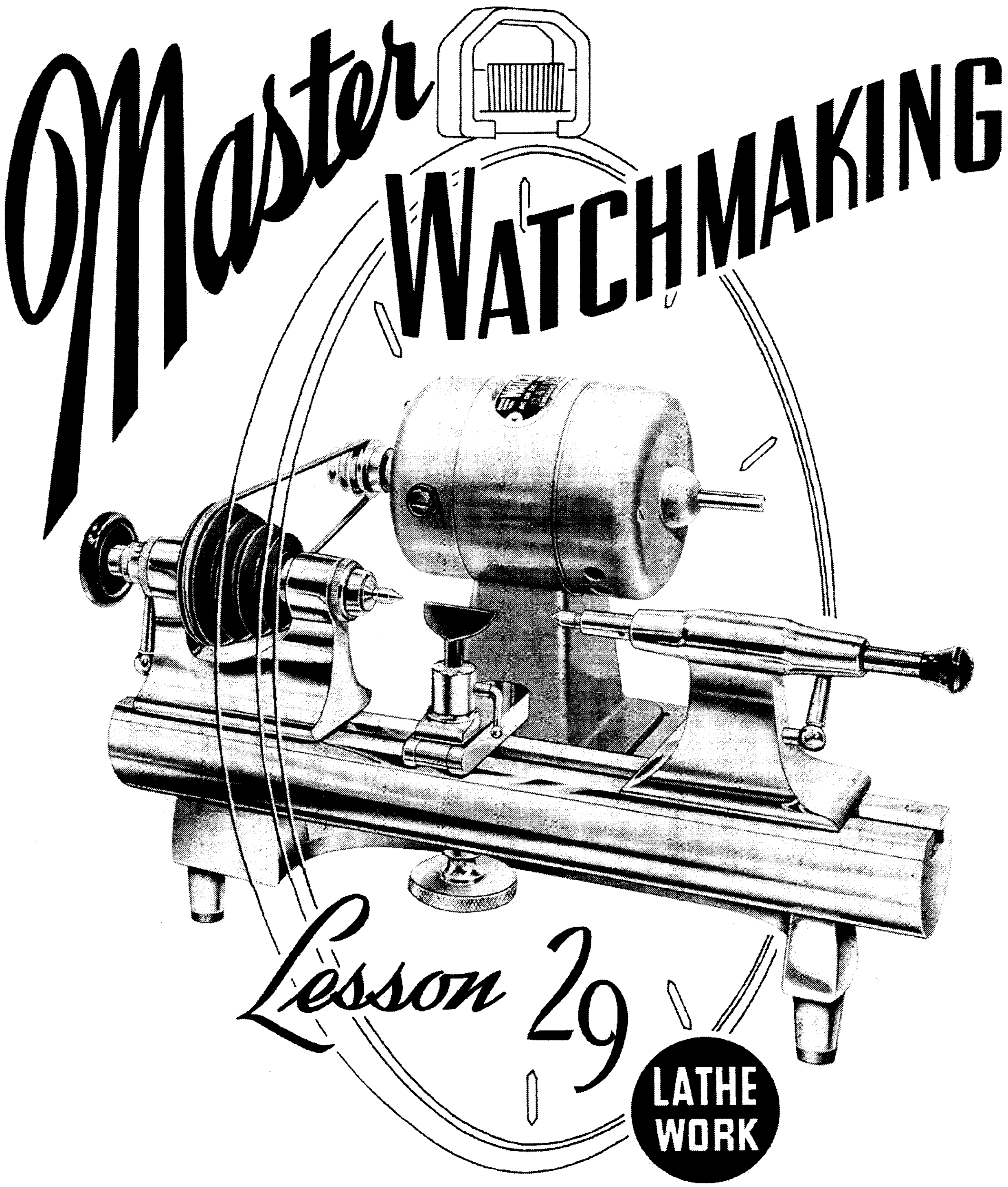


Fig. 28-16

Photo Courtesy North American Watch Tool and Supply Company, Chicago.

note:

(No job sheets are associated with Lesson 28)



CHICAGO SCHOOL OF WATCHMAKING *Founded 1908 by* THOMAS B. SWEAZEY

SEC. 490 -- The Importance of Lathe Instruction

By now you should be familiar with the principles and functions of the average watch movement. These principals and functions have been presented step by step in order that you may make the repairs necessary to qualify you as an expert. It should be obvious to you by now that it is much better to purchase good tools and the proper material for replacements in watch repairing than it is to endeavor to make such repair parts yourself. In years gone by, this was not always possible. The manufacturers of American watches endeavored to produce watches and materials with interchangeable parts. This was not true of imported watch movements and it was necessary for the watch repairman to be able to make a great many parts. Many times he had to make the tools to make these parts. In recent years the manufacturers of American watches have greatly improved the standardization system because they have been benefited by automatic machinery. The same is true of imported watches and today it is much more profitable for the watchmaker to purchase his replacement parts and devote the time he would spend making them to making repairs on other watches. However, the Master Watchmaker must be able to determine quickly if replacement parts will function properly when used. Many times he will find watches which have been botched by so-called repairmen and in order to make the repairs correctly, he will have to undo the botch work before he can proceed in a workmanlike manner.

For this reason it is necessary for the student to acquaint himself with the methods used in making certain parts. The satisfaction derived from doing a job better than the next man cannot be measured in dollars and cents, but is the main difference between the ordinary repairman and the one whose success is measured by the better things in life he seems to acquire.

The lessons on lathe work are made up of a series of explanations and illustrations covering the making of a few small tools and the principles of parts making. The student will gain much by practicing these problems and will, upon occasion, have to make repairs along these lines. He will become adept at handling the watchmaker's lathe without which no watchmaker can do a master job. Each problem is approached step by step. Read your instructions carefully and refer to the illustrations frequently.

SEC. 491 -- Turning Square Shoulders

Our first exercise will be the turning of square shoulders in brass. Take a piece of 4 mm brass rod and insert it in a 40 chuck, figure 29-1, extending it about 10 mm from the face of the chuck. Set the T rest parallel to the 4 mm brass rod as illustrated in figure 29-2. The height of our T rest should be about on the center line of our work, figure 29-3.

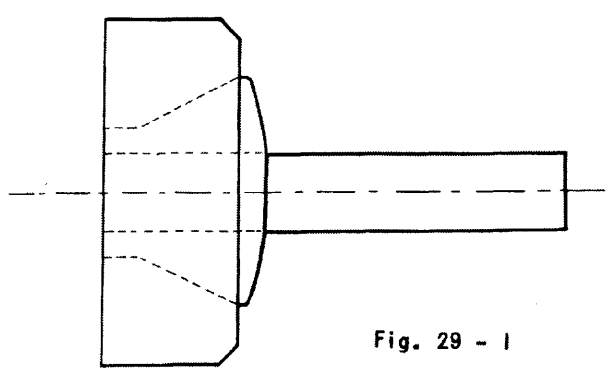


Fig. 29 - 1

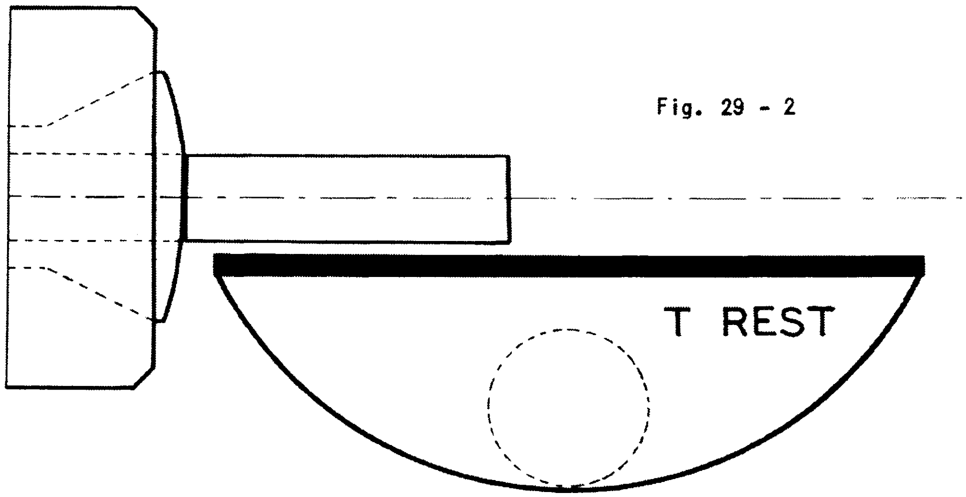


Fig. 29 - 2

Figure 29-4 illustrates the method of holding a square cutting graver. The forefinger of the right hand is placed along the edge of the graver as illustrated with the handle in the heel of the hand. The thumb and the rest of the fingers fall naturally in place. Figure 29-4 illustrates the graver held in position ready to make a cut. The forefinger of the left hand is placed on the side of the graver as illustrated. In this way, the graver can be moved to the right or left depending on which finger exerts the most pressure. Now running the lathe toward you in the direction of the arrow, figure 29-4,

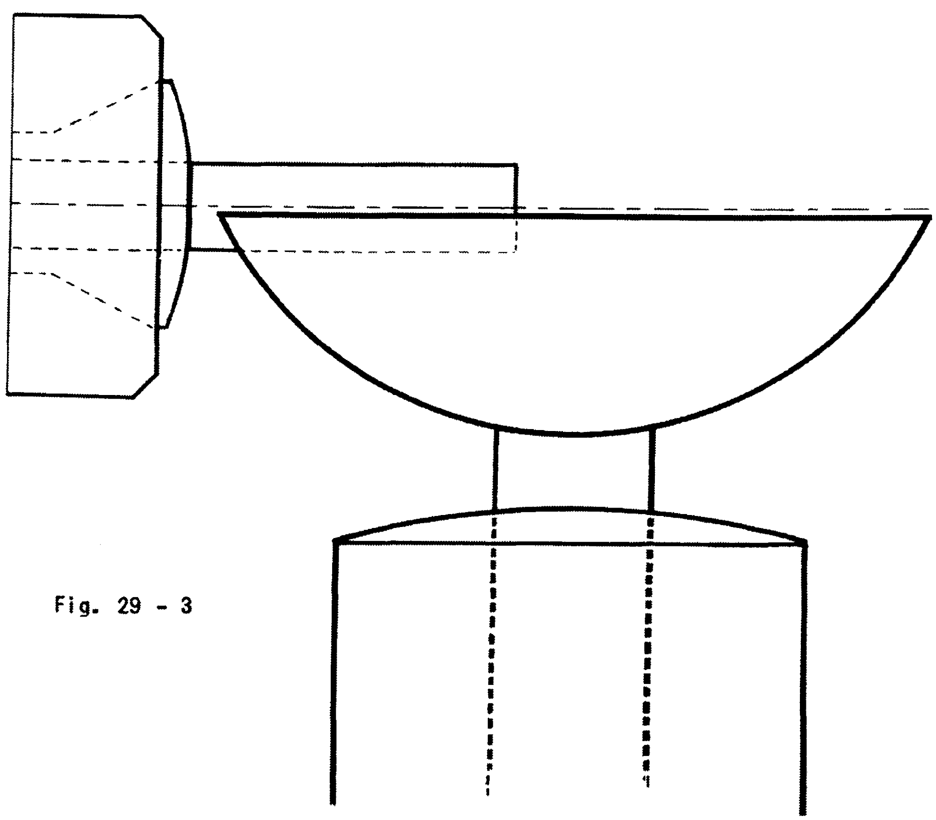


Fig. 29 - 3

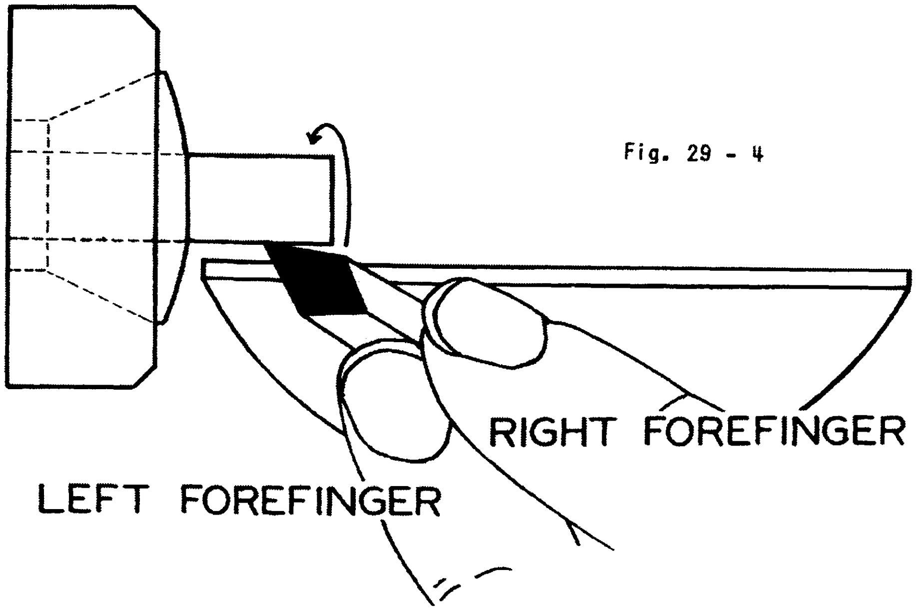


Fig. 29 - 4

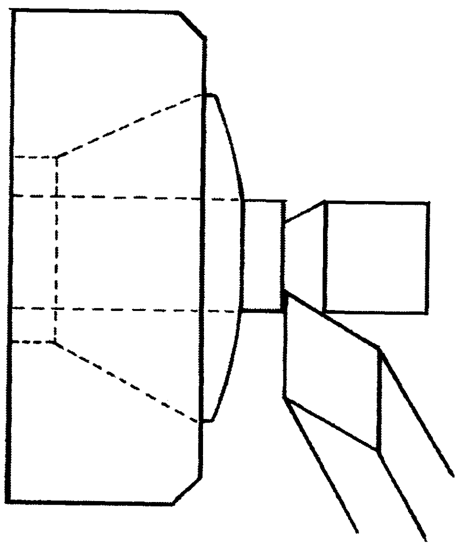


Fig. 29 - 5

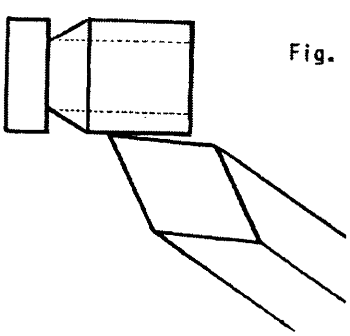


Fig. 29 - 6

move the graver against the brass rod until a small shaving appears. The position of the graver in figure 29-4 will produce this shaving if we have met all the conditions in figures 29-2 and 29-3. If your graver fails to produce shavings, it will be up to you to move your graver handle up or down or to either side until the cutting edge of the graver produces these shavings. Do not proceed any further until you can cut shavings rapidly, moving the graver either to the right or to the left.

Figure 29-5 illustrates the first cut necessary to produce a square shoulder. The point is carefully moved forward until we produce a small cut as shown in this figure. Do not go too deep with the first cut. Holding the graver in the position shown in figure 29-6, remove the section illustrated by the dotted line. Figure 29-7 shows the finished square shoulder. It is possible for us to make a square shoulder of any desired diameter and length.

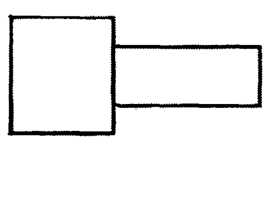


Fig. 29 - 7

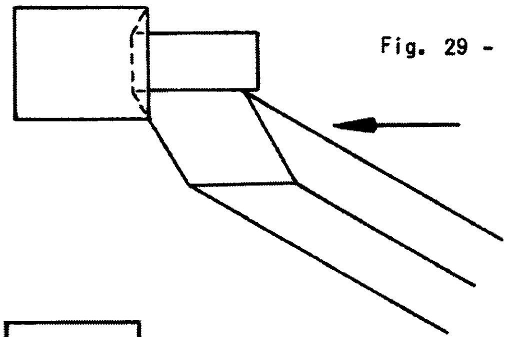


Fig. 29 - 8

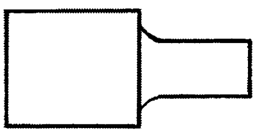
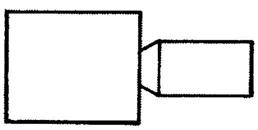


Fig. 29 - 9

Fig. 29 - 10



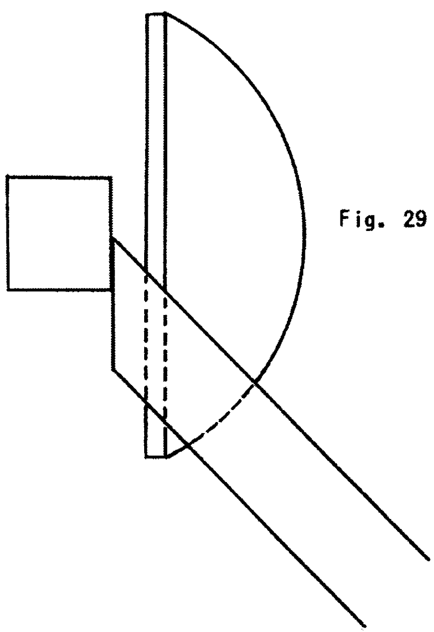


Fig. 29 - 11

Fig. 29 - 12

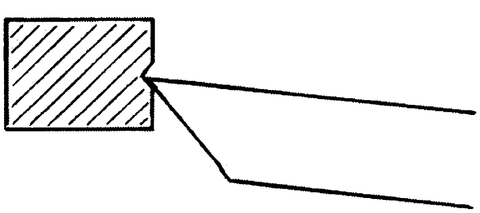


Figure 29-8 illustrates an under cut. It is done by starting the graver in the position shown and moving in the direction of the arrow. Figures 29-9 and 29-10 illustrate two types of incorrect square shoulders. In turning square shoulders in steel, the same method is followed but you will find steel will cut much more slowly and you will probably have to sharpen your gravers oftener.

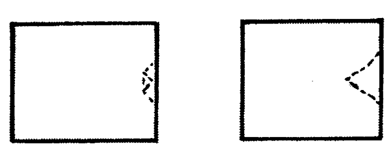
SEC. 492 -- Centering Stock

In order that we may drill brass or steel which is held in a lathe, it is necessary to locate the exact center of our material. Move the T rest parallel with the face of the rod as in figure 29-11 and face off material. Start cutting point of graver as close as possible to the center of the work until you have obtained the cut shown in figure 29-12.

This is the exact center of our work and can be tested by using an ordinary small needle held in the position shown in figure 29-13 with the lathe revolving. If the work is centered properly, the needle will stand still. If you have not obtained the exact center, the needle will wobble. If such is the case, it is because you have left in your center a little point which must be removed. Figure 29-14 illustrates incorrect centers.

Fig. 29 - 13

Fig. 29 - 14



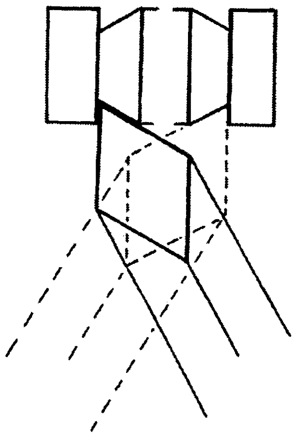
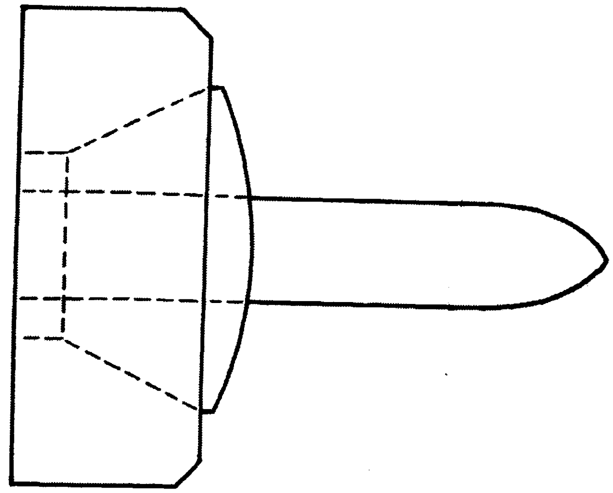


Fig. 29 - 15

Fig. 29 - 16



SEC. 493 -- Using A Saw with the Lathe

To cut off work held in a lathe, cut a groove in your work as shown in figure 29-15. Use a jeweler's saw with the teeth of the saw pointing toward the handle and place saw blade in groove while the lathe revolves backward.

Be careful not to use too much pressure when nearing the center of your work as your work is liable to jump away.

SEC. 494 -- Making a Hardened Steel Burnisher

When setting a jewel, it is necessary to burnish the metal over the edge of the jewel. For this purpose a hardened steel burnisher is required. It can be made from 3 mm round drill rod about 3 inches in length as follows:

1. Turn down the end as in figure 29-16. Do not get it too pointed or too round.
2. Polish with emery buffs in the following rotation: #2, #1, #0, #2/0, #3/0, and #4/0.
3. Harden. (Lesson 27 - Sec. 463.)
4. Temper to a very light straw at the tip. (Lesson 27 - Sec. 464.)
5. File Tang, figure 29-17, and repolish.
6. Mount in graver handle.

SEC. 495 -- Making Flat Drills

1. Determine the diameter of the drill and select a section of drill rod slightly larger than that diameter. It is best to have the shanks of all your drills of one size.

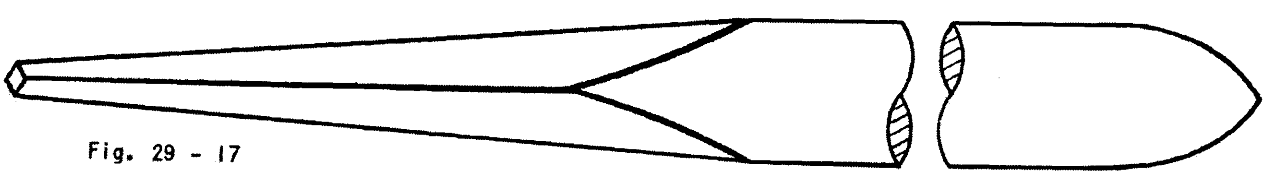


Fig. 29 - 17

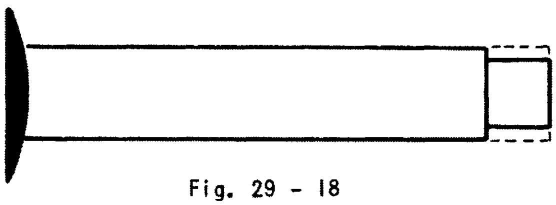


Fig. 29 - 18

2. Turn a square shoulder at the end of the rod to the diameter of your drill, figure 29-18. The length of the drill is then determined by this diameter, being usually about five times the diameter. (Example: The shank of a drill measuring .5 mm in diameter would be about 2.5 mm long.)

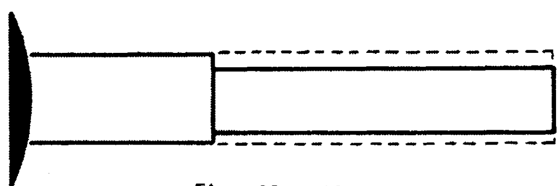


Fig. 29 - 19

3. Turn back shoulder as illustrated in figure 29-19 to the correct length.

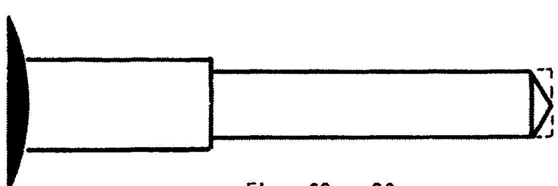


Fig. 29 - 20

4. Bevel end of rod at about 30 degrees, figure 29-20.

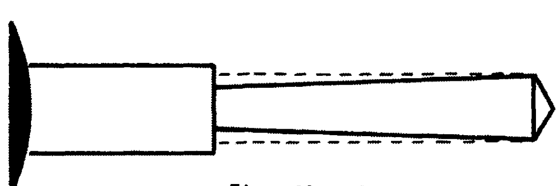


Fig. 29 - 21

5. Taper from the corner of bevel to back of drill as in figure 29-21.

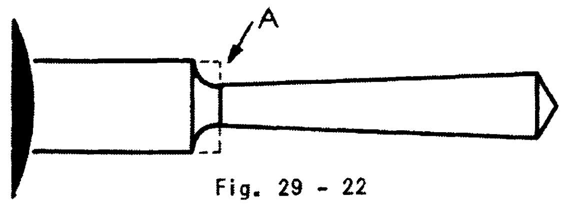


Fig. 29 - 22

6. From this point make a small curve at A, figure 29-22.

7. Reverse lathe motor and polish with emery buffs in the following rotation: #2, #1, #0, #2/0, #3/0, and #4/0. Hold your emery buffs on the underside and use the full length of the buff while moving it back and forth with the lathe running in reverse.

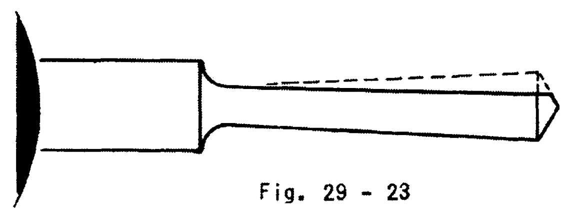


Fig. 29 - 23

8. Set index pin in hole zero and with a flat file, file top of drill as illustrated by dotted line, figure 29-23. The T rest can be used as a steady rest for your file.

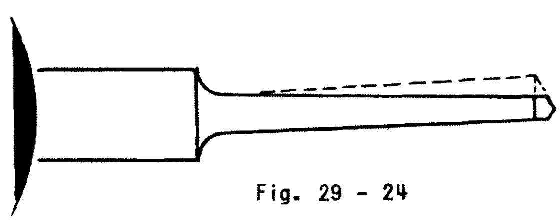


Fig. 29 - 24

9. Remove index pin and turn head of lathe 1/2 turn. Replace index pin in hole marked 30 and file this side exactly the same as in figure 29-24. The drill will now appear as in figure 29-25.

10. Polish the flat sides of the drill with emery buffs in the following rotation: #2, #1, #0, #2/0, #3/0, and #4/0.

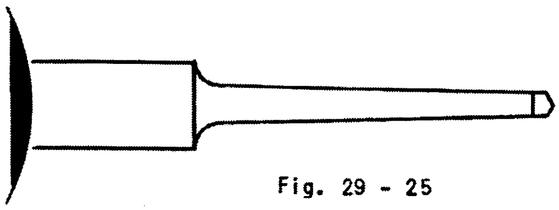


Fig. 29 - 25

11. Cover drill with soap or boric acid, heat to a cherry red and plunge into cold water. (Lesson 27 - Sec. 463.)

12. Repolish and temper to a light straw (Lesson 27 - Sec. 464) then polish off the color and polish shank.

Most drills purchased are marked in 10/1000ths of an inch. However, we will mark ours to correspond to the metric system.

1. Reverse drill in lathe, finish the end of stock with a graver, and polish with emery buffs. File a small notch as in figure 29-26.

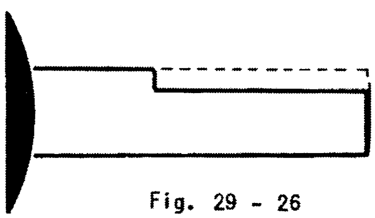


Fig. 29 - 26

2. With the edge of a file, mark the drill with Roman numerals to correspond with the metric measurement, figure 29-27.

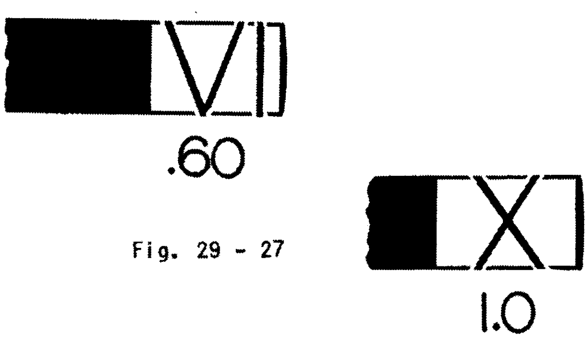
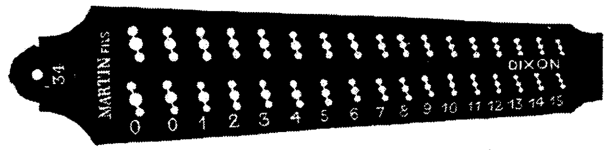


Fig. 29 - 27



Double Notched Screw Plate

Fig. 29 - 28

SEC. 496 -- Making Taps

In making taps use a Swiss Screw Plate as shown in figure 29-28 to cut the threads. There are different types of Screw Plates containing from 5 to 60 holes and having double or single notches. The screw plate illustrated in figure 29-28 is double notched and these notches allow the shavings to break clear. In this particular screw plate the die holes directly across from each other are of the same size.

To make a tap, use any size drill rod of suitable diameter and proceed as follows:

1. Determine the diameter of tap. If the finished tap is to be a #6, allow a difference of 2 numbers when ascertaining the diameter of the tap; in this case, it would be #4 hole.

2. Turn a square shoulder on the end of rod, figure 29-29, that will just enter hole #4 on the screw plate.

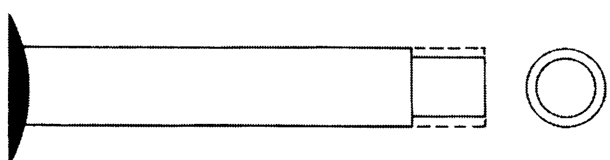


Fig. 29 - 29

3. Measure this diameter with millimeter gauge and multiply by 5. This will give the length of the tap.

4. Turn back shoulder to this length as shown in figure 29-30.

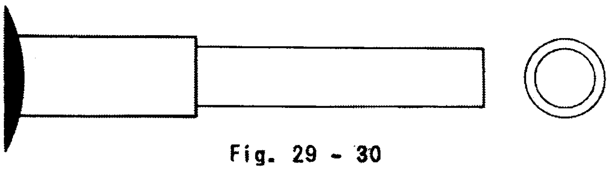


Fig. 29 - 30

5. Bevel the end at about a 60 degree angle, figure 29-31. Turn curve and cut back, figure 29-32.

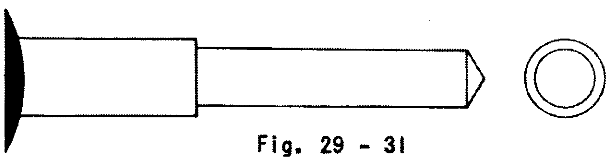


Fig. 29 - 31

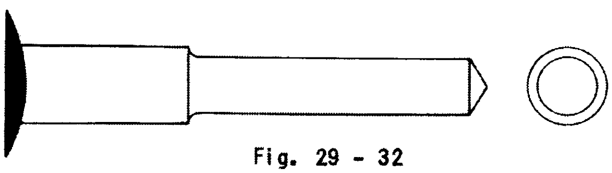


Fig. 29 - 32

6. Place screw plate on end of rod using hole one size larger than the finished tap, figure 29-33; in this case hole #5.

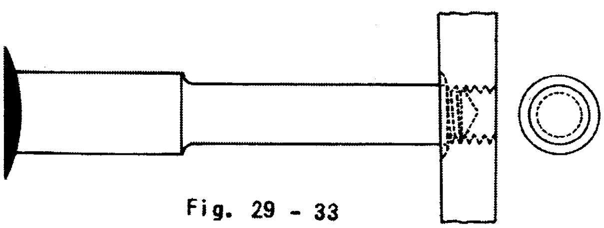


Fig. 29 - 33

7. Hold screw plate with right hand and with left hand on lathe pulley, turn pulley toward you about 1/2 turn. This should start the thread.

8. Place a little oil on the rod and continue turning lathe pulley another half turn. A good thread should now be started.

9. Now reverse motion of left hand, about 1/4 turn and then turn forward 1/2 turn. Each forward turn will chase a new section of thread and the reversing breaks out the excess metal, figure 29-34.

10. Repeat this forward and backward motion until tap is completely threaded, and then remove screw plate.

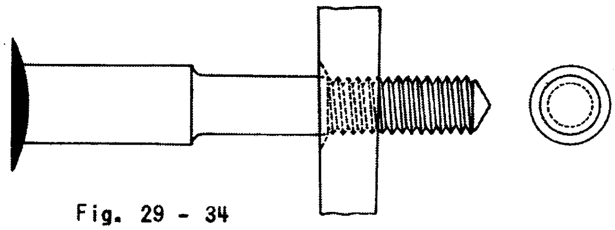


Fig. 29 - 34

11. Now place screw plate on rod using selected finished thread size, in this case #6, and repeat steps 7, 8, 9, and 10. Your finished work should appear as in figure 29-35.

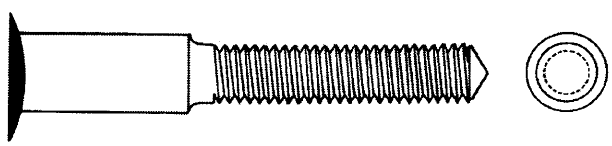


Fig. 29 - 35

12. Set index pin at zero and file across and through threads as shown in figure 29-36.

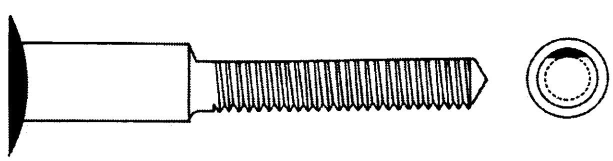


Fig. 29 - 36

13. Turn index 1/3 the way around and file through and across threads as shown in figure 29-37.

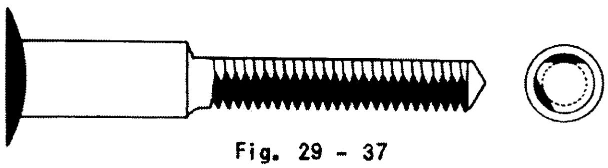


Fig. 29 - 37

14. Turn index 1/3 way around and repeat filing process. The tap will now appear as in figure 29-38 side and end view.

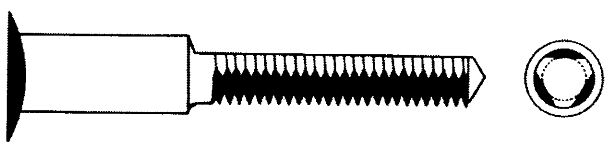


Fig. 29 - 38

15. Set index back at zero and then move backward 3 holes. With file held at an angle of about 10 degrees, cut away the back of the first few threads, figure 29-39. Do this on all three sides. This will allow your tap to start easily.

Fig. 29 - 39

16. Polish with emery buffs.
17. Harden. (Lesson 27 - Sec. 463.)
18. Temper to a light straw at the tip to a medium straw at the back. (Lesson 27 - Sec. 464.)

19. Taps are used the same as a screw plate, 1/2 turn forward and 1/4 turn backward. The hole to be tapped must first be drilled. Use a drill about 2 numbers smaller than the size of tap measured by holes in the screw plate. Taps can be marked the same as drills, figure 29-27.

SEC. 497 -- Making A Screw

1. Turn down drill rod to the proper diameter for the head of the screw, figure 29-40, and polish.

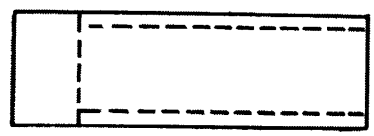


Fig. 29 - 40

2. Select thread size and follow procedure for making tap, figures 29-41, 29-42, 29-43, and 29-44.

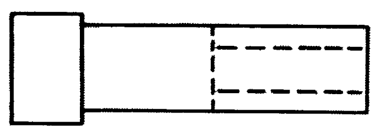
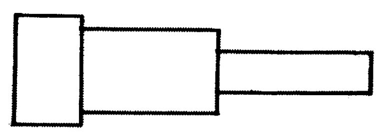


Fig. 29 - 41

Fig. 29 - 42



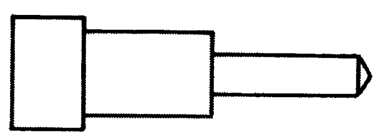
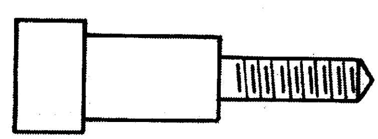


Fig. 29 - 43

Fig. 29 - 44



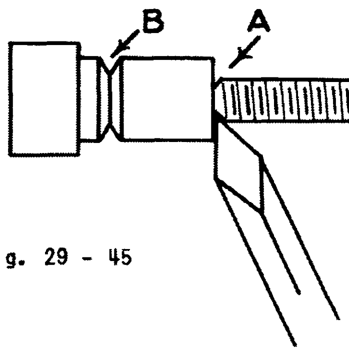


Fig. 29 - 45

3. Face off under side of screw leaving a small notch as shown at A, figure 29-45.

4. Cut notch as shown at B, figure 29-45, and saw off.

5. Reverse screw in lathe, face off the head of screw, and bevel the corner, figure 29-46.

6. With a screw headfile cut slot in head of screw, figure 29-47, using the T rest as a support.

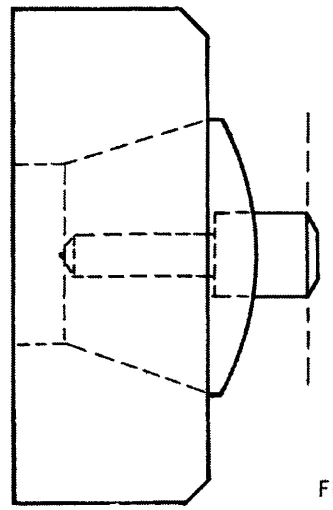
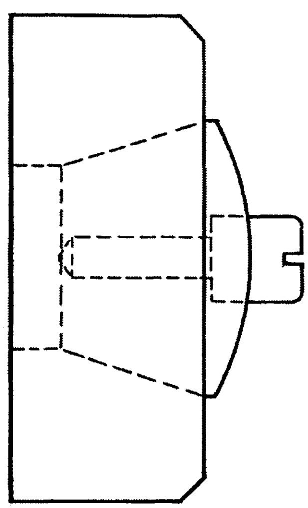


Fig. 29 - 46

7. Polish head of screw with emery and harden (Lesson 27 - Sec. 466) and temper to a blue (Lesson 27 - Sec. 466, figure 27-20).

8. Polish off the color or leave blue, whichever is preferred.

9. Figure 29-48 illustrates the screw held in a tripod device when a flat surface is desired.



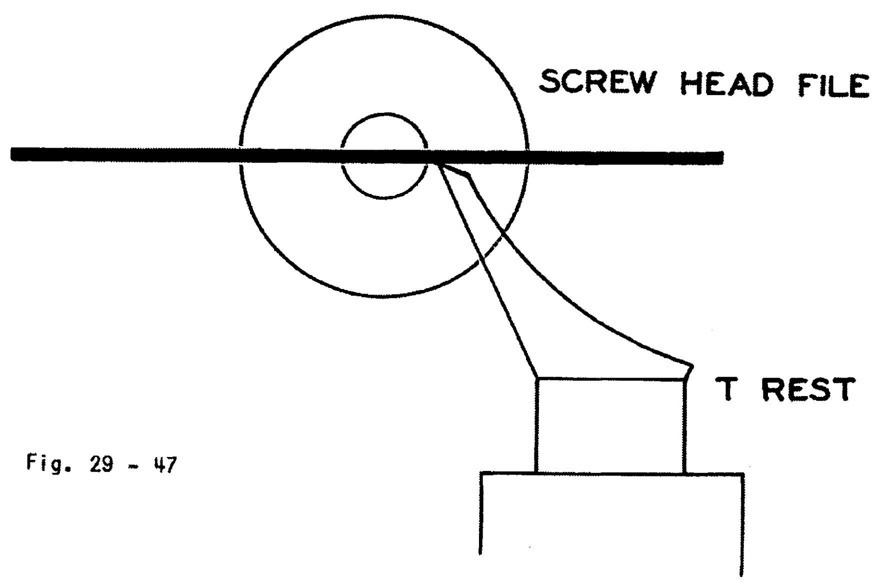


Fig. 29 - 47

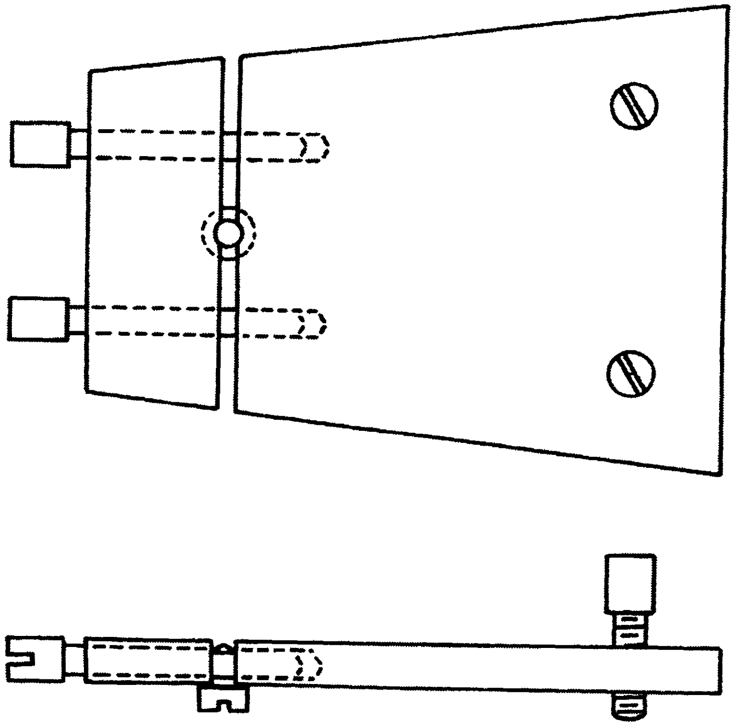


Fig. 29 - 48

SEC. 498 -- Making A Pipe for a Second Hand

1. Select a piece of brass wire of small diameter and place in chuck, figure 29-49.

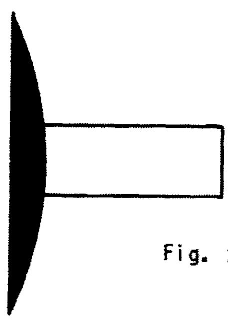


Fig. 29 - 49

2. Center, figure 29-50, and drill hole as illustrated in figure 29-51. This hole should be slightly smaller than the 4th wheel pinion pivot.

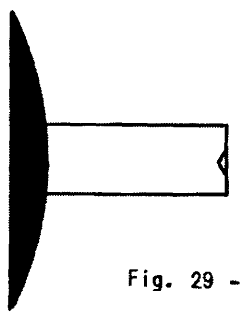


Fig. 29 - 50

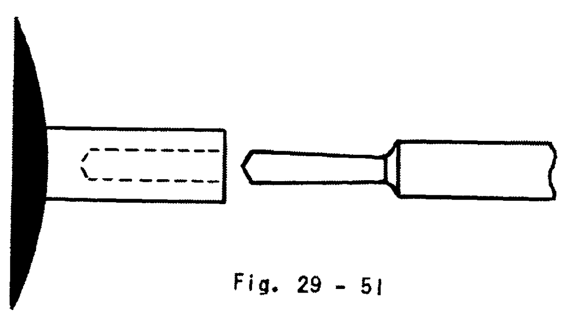


Fig. 29 - 51

3. Turn down outside diameter to desired measurement.

4. Turn square shoulder seat on which hole in second hand will fit snugly, figure 29-52.

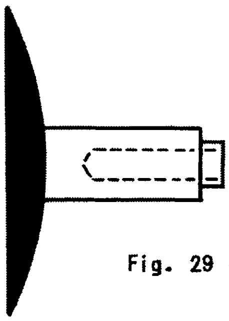


Fig. 29 - 52

5. Place second hand in place and burnish brass over second hand at A, figure 29-53.

6. Finish with stripping tool.

7. Cut notch in wire at desired length and saw through wire carefully, figure 29-54.

8. Broach hole in pipe from the under side with pivot broach. The second hand should fit friction tight.

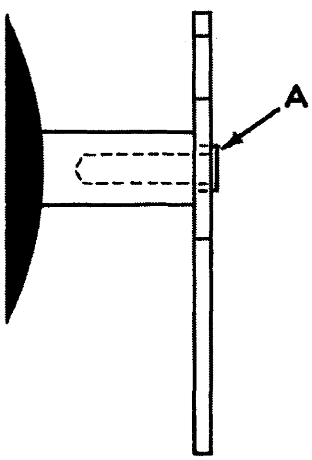


Fig. 29 - 53

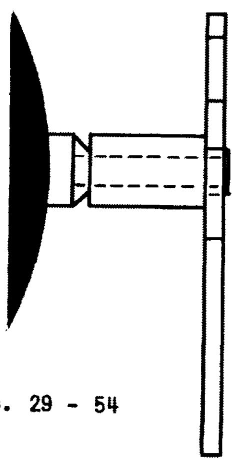


Fig. 29 - 54

SEC. 499 -- Replacing a Dial Foot

The following procedure of replacing a dial foot is for a hard enamel dial. Replacing a dial foot on a metal dial is not too practical as in most cases the dial must then be sent out to a dial painter to replace the figures, finish, and lacquer.

1. With a small carborundum wheel held in the lathe cut off old dial foot by grinding through a section of enamel until the copper center is exposed, figure 29-55.

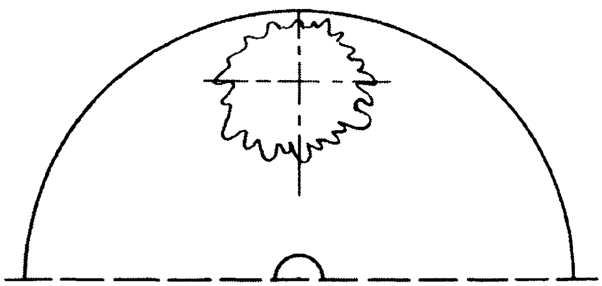


Fig. 29 - 55

2. With a sharp pointed scriber and steel straight edge draw two lines at right angles to each other through the center of the old dial foot, which usually can be distinguished even through the ground finish, figure 29-55. It is also possible to place dial in place over the pillar plate and with a small, sharp pointed scriber, locate the center of the proposed dial foot.

3. Place a piece of brass wire in lathe and turn down the end until it will enter hole in pillar plate, figure 29-56. Turn larger diameter for the base about three times the diameter of the small end.

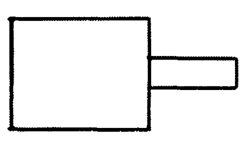


Fig. 29 - 56

4. Curve back corner slightly as shown in figure 29-57.

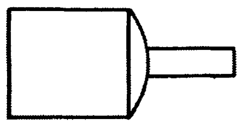


Fig. 29 - 57

5. Cut notch as shown in figure 29-58 and saw off.

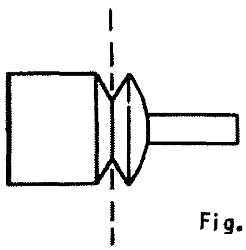


Fig. 29 - 58

6. Reverse in chuck, figure 29-59, and hollow slightly as shown in figure 29-60.

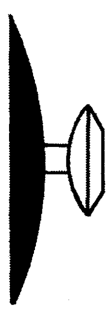


Fig. 29 - 59

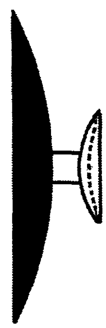


Fig. 29 - 60

7. Place dial foot in soldering tweezers, figure 29-61, with soldering flux and heat over alcohol lamp. Fill hollow with bismuth soft solder. (See Lesson 27 - Sec. 468.)

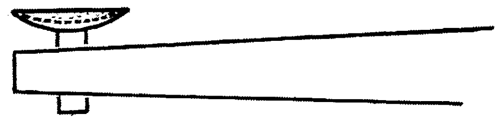


Fig. 29 - 61

8. Place dial on thin copper plate, cover ground section with soldering flux and place dial foot directly over center lines, figure 29-62.

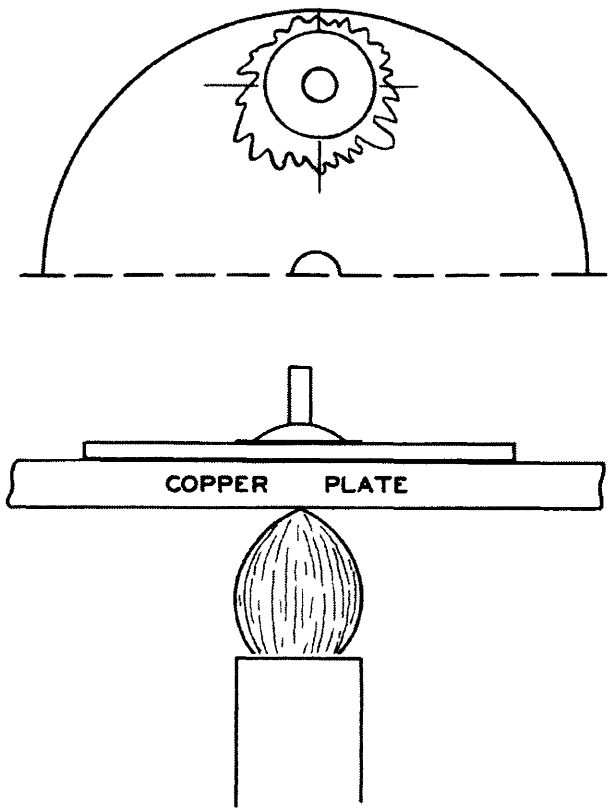
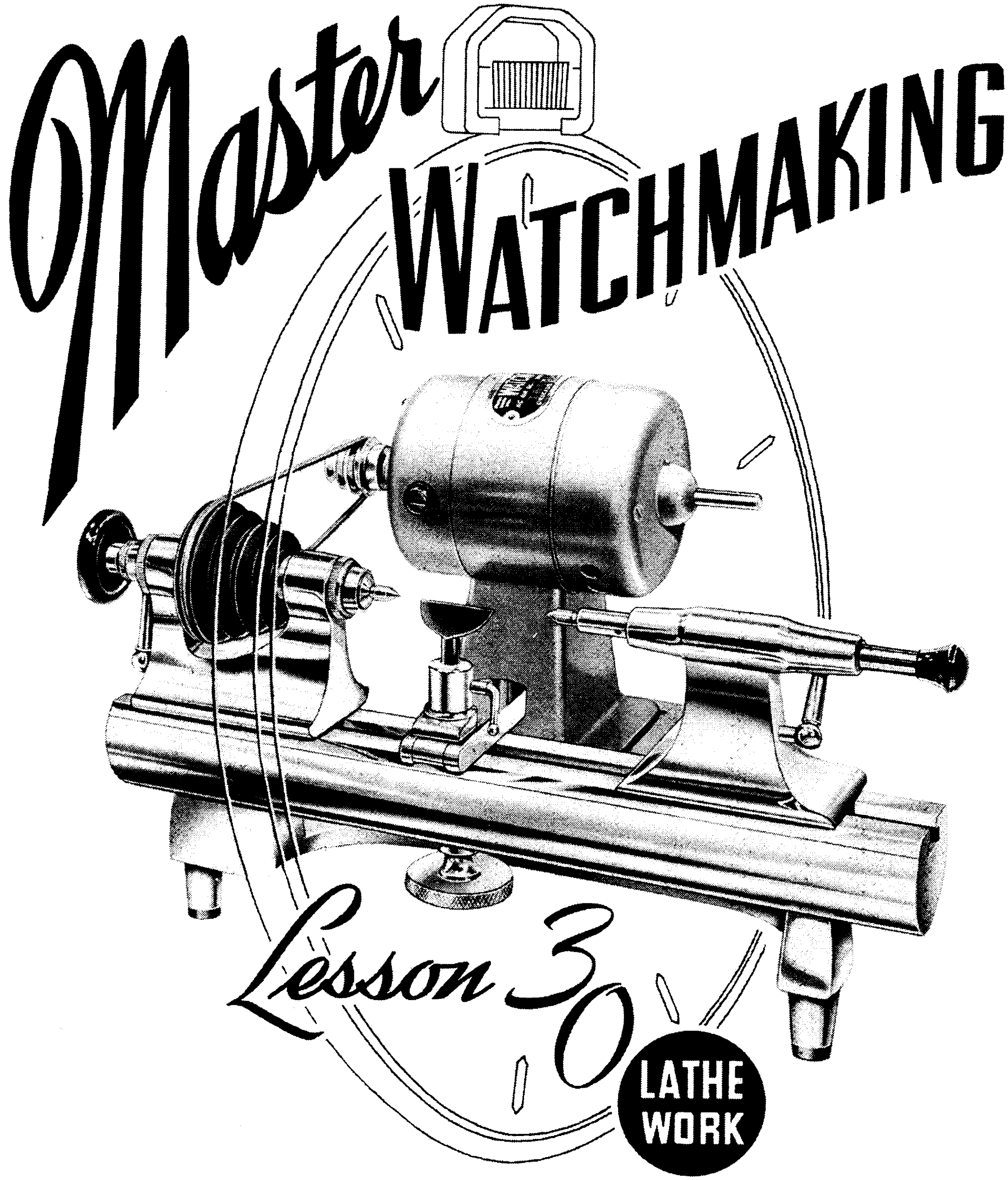


Fig. 29 - 62

9. Warm this copper plate over alcohol lamp until solder flows. Remove dial and let cool slowly. Wash thoroughly with water and dry carefully.

note:

(No job sheets are associated with Lesson 29)



CHICAGO SCHOOL OF WATCHMAKING *Founded 1908 by* THOMAS B. SWEAZEY

SEC. 500 -- Metals Used

This lesson deals with lathe work as concerned with base metals. The base metals used in watchmaking are brass and nickel and occasionally oreide, which has a high copper content. These metals are easy to work and if the student will keep the cutting edge of his graver polished, a smooth polished finish can be obtained. Polishing the graver is best done with a 4/0 emery buff.

SEC. 501 -- Steps in Setting a Train Jewel

1. Select train jewel to be set. Push a pointed piece of pegwood through the hole in jewel keeping the oil cup down, figure 30-1. Tap slightly on bench plate in order to flatten pointed end of pegwood. This will hold jewel securely and make it easy to handle.

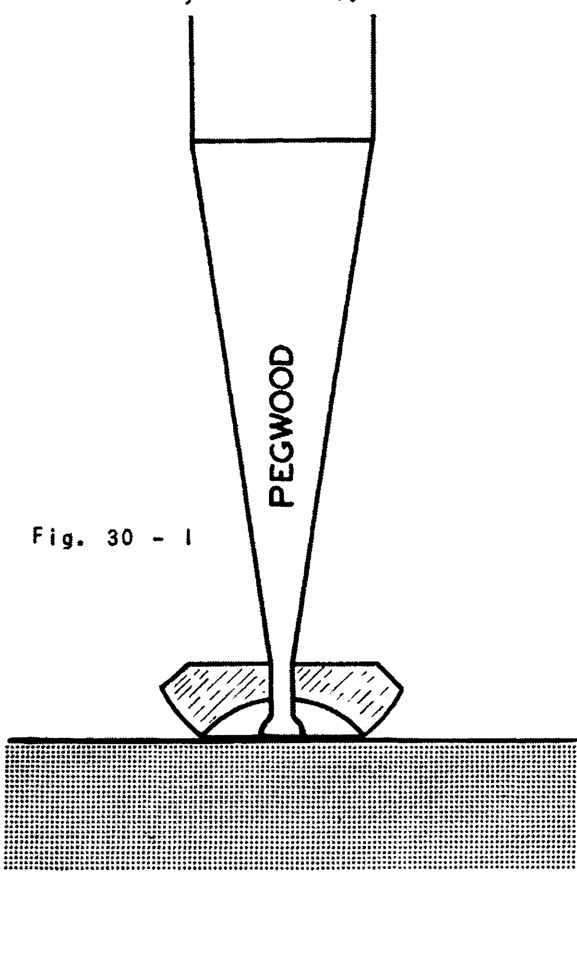


Fig. 30 - 1

2. Place brass, nickel or oreide rod in lathe chuck and center, figure 30-2.

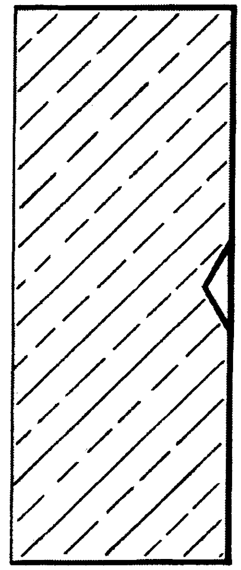


Fig. 30 - 2

3. Select a drill about 2/3 the diameter of the train jewel. Drill a hole fairly deep into the rod, figure 30-3.

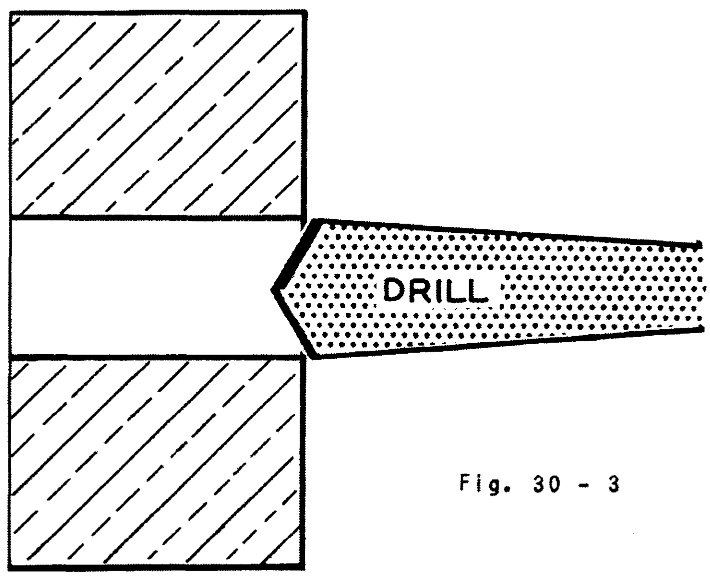


Fig. 30 - 3

4. Place seat cutting tool in position shown in figure 30-4, cut a seat by running lathe in reverse and moving seat cutting tool with left forefinger in the direction of Arrow A.

5. The train jewel is then tried into the seat, figure 30-5. The jewel should fit freely without side play and the face

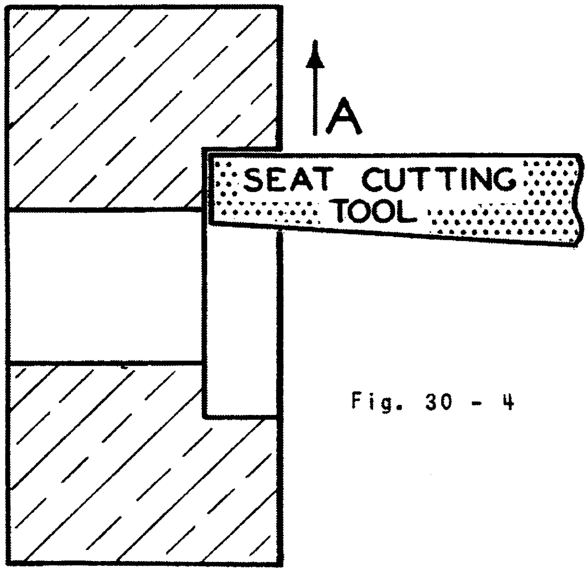


Fig. 30 - 4

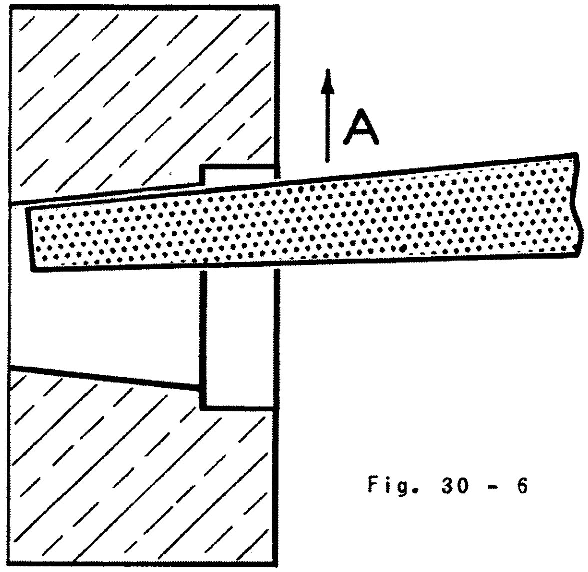


Fig. 30 - 6

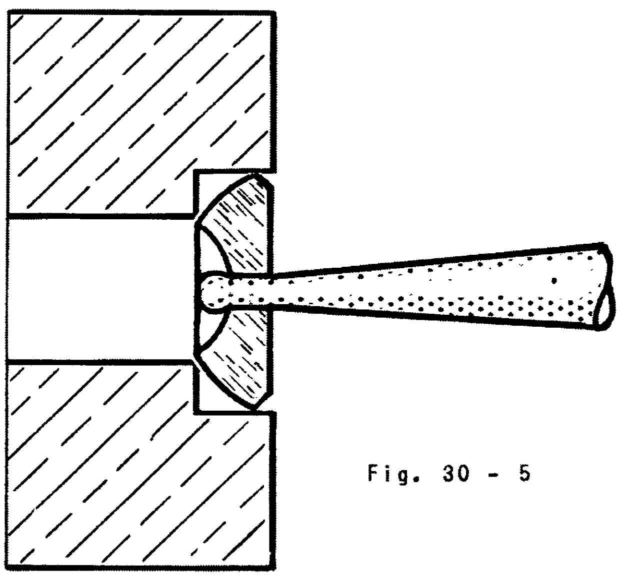


Fig. 30 - 5

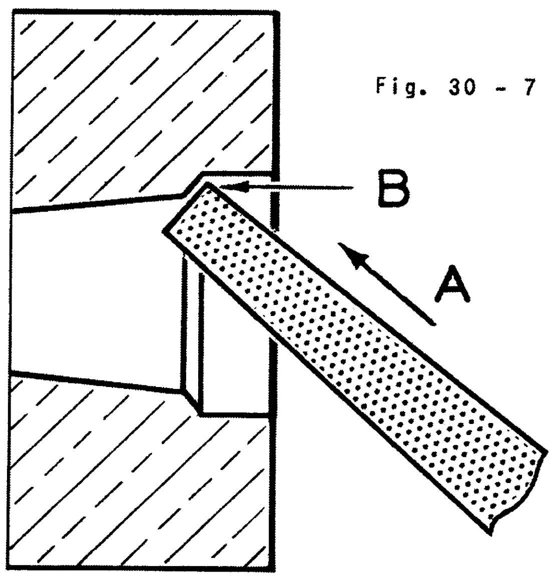


Fig. 30 - 7

of the jewel should be just below the surface.

6. Open the back of hole with seat cutting tool, running the lathe in reverse and moving the tool in direction of Arrow A, leaving a small shoulder, as shown in figure 30-6.

7. Bevel the corner of shoulder B with seat cutting tool, moving tool in direction of Arrow A, as illustrated in figure 30-7. This will allow the curved portion of train jewel on side of oil cup to rest securely in place. Face off rod until the jewel is just below the surface. It is now ready to be burnished in place.

8. With a square graver or a long pointed stripping tool, make a small cut to the edge of the hole as in figure 30-8. This is called the bezel.

9. Place train jewel in seat, place tweezer over face of train jewel and extract pegwood. A very small amount of beeswax applied to jewel before placing in hole will help keep jewel in place until burnished.

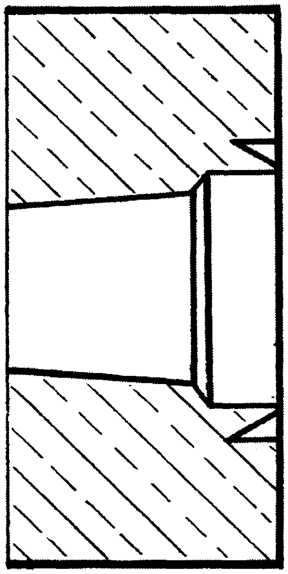


Fig. 30 - 8

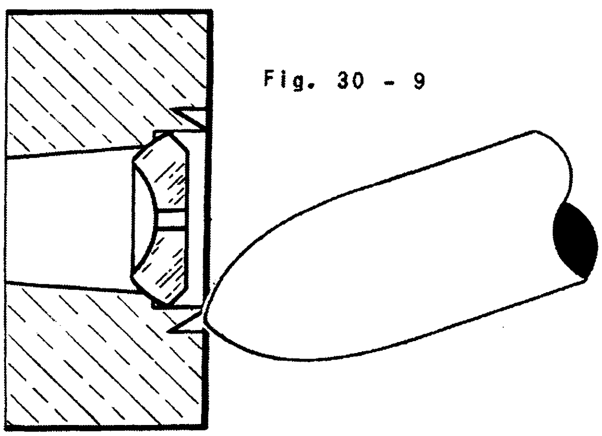


Fig. 30 - 9

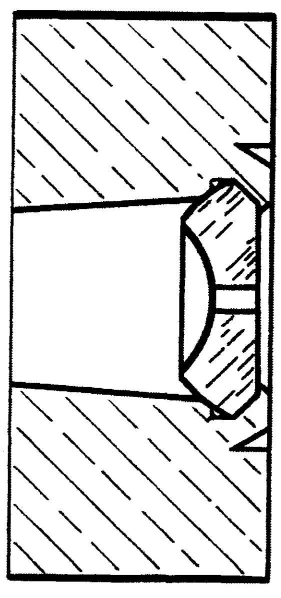


Fig. 30 - 10

10. Place burnisher in bezel, figure 30-9, and roll bezel over train jewel while running the lathe forward. Face off rod until jewel is slightly below surface and jewel will appear as in figure 30-10.

11. Figure 30-11 illustrates the train jewel in place and the burnisher held in position to burnish the edge of metal over the jewel without a cut bezel.

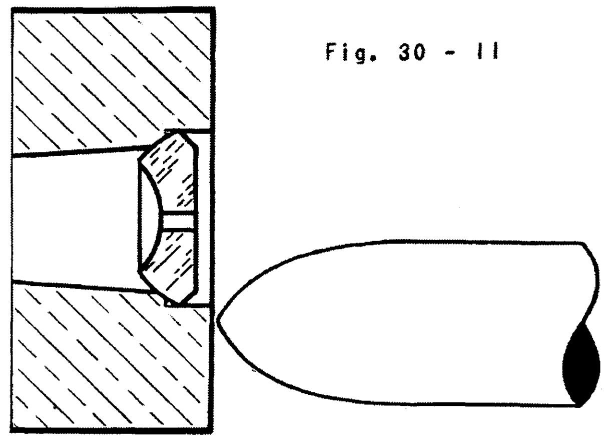
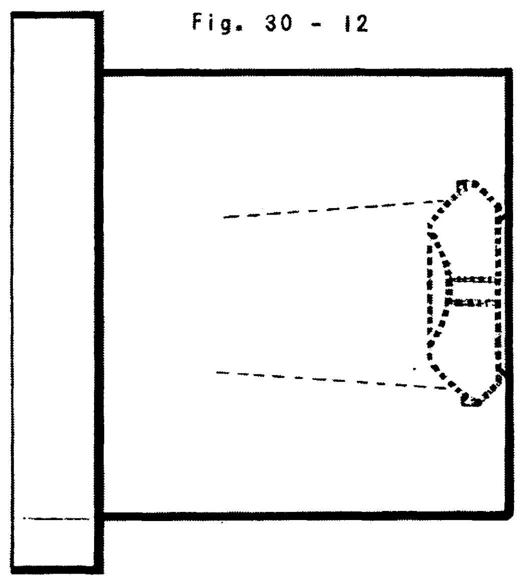


Fig. 30 - 11

12. Cut diameter of rod to preselected diameter, figure 30-12.

Fig. 30 - 12



13. Cut square shoulder on end of stock to correct depth and diameter as in figure 30-13.

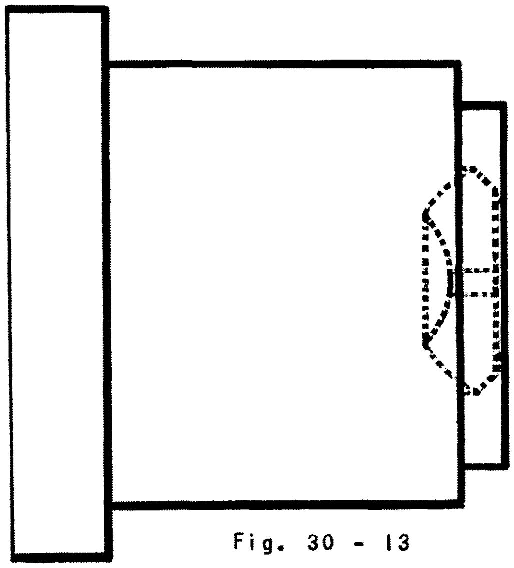
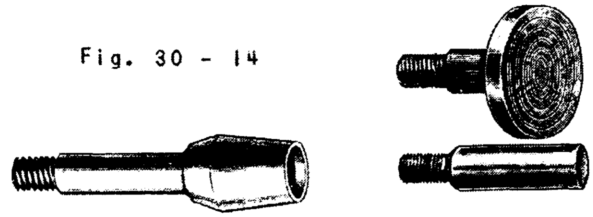


Fig. 30 - 13

Fig. 30 - 14



SCREW CHUCK CEMENT BRASSES

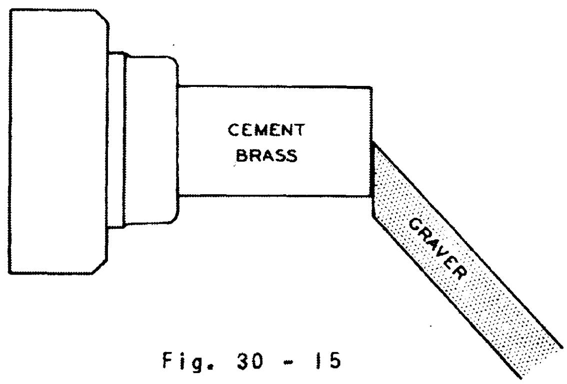


Fig. 30 - 15

SEC. 502 -- Steps in Stripping a Train Jewel Setting

Figure 30-14 illustrates a screw chuck. The screw chuck is made up of a steel chuck tapped to receive the threaded end of a cement brass. These come in assorted diameters. The face of the cement brass should be faced off. This will insure a true flat surface upon which to cement and center the jewel setting. The best cement to use is pure orange shellac in stick form. Be careful not to overheat or burn the shellac as it loses its adhesive qualities. In case this happens, remove burned cement and start over.

1. Figure 30-15 illustrates the method used to face off a cement brass prior to cementing a jewel. Be sure that the cement brass has been screwed securely into the chuck. Before proceeding any further, it might be well to make a little experiment. Heat the end of your stick shellac with the flame of an alcohol lamp and quickly press against the face of the cement chuck. It will be seen that the cement does not adhere to the cold metal, thus illustrating clearly that the metal must be heated to a temperature which will melt the cement before it will adhere properly.

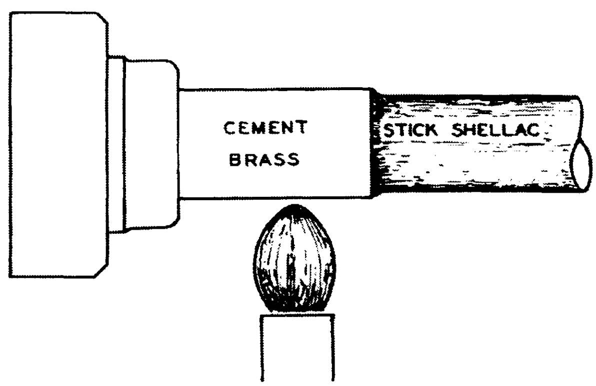


Fig. 30 - 16

2. In figure 30-16, the flame of the alcohol lamp is held directly beneath the cement brass. With the lathe turning, hold the stick shellac against the face of the cement brass until the cement melts and covers the face of the cement brass.

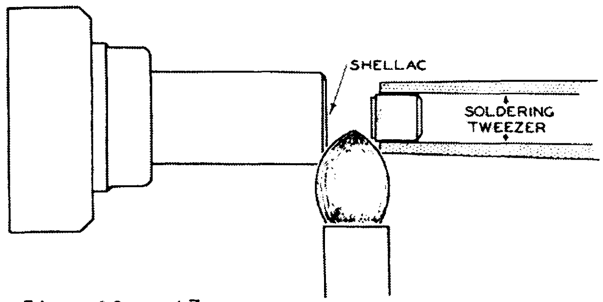


Fig. 30 - 17

3. Hold the jewel setting with a pair of soldering tweezers as illustrated in figure 30-17 and with the flame of the alcohol lamp placed in the position shown, keep the cement brass warm while heating the jewel setting. When the jewel setting has been heated, push it against the face of the cement brass and pull away. If the cement adheres to the face of the setting, the cement is of the proper temperature.

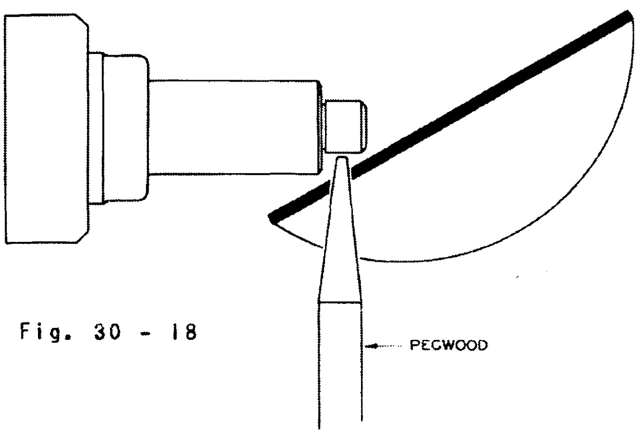


Fig. 30 - 18

4. Set jewel setting on cement chuck and set T Rest as close to the cement brass and setting as possible, as shown in figure 30-18. With a piece of pegwood in position shown, true the setting up by running the lathe forward and holding the pegwood lightly against the side of the jewel setting. If it does not adhere properly or run true, warm the cement brass again and repeat the truing process until your setting runs absolutely true. The setting should now appear on the face of the cement chuck as shown in figure 30-19. With a stripping tool, which has had the edge polished with a 4/0 emery buff, place in the position shown in this figure and face off the setting to the proper thickness.

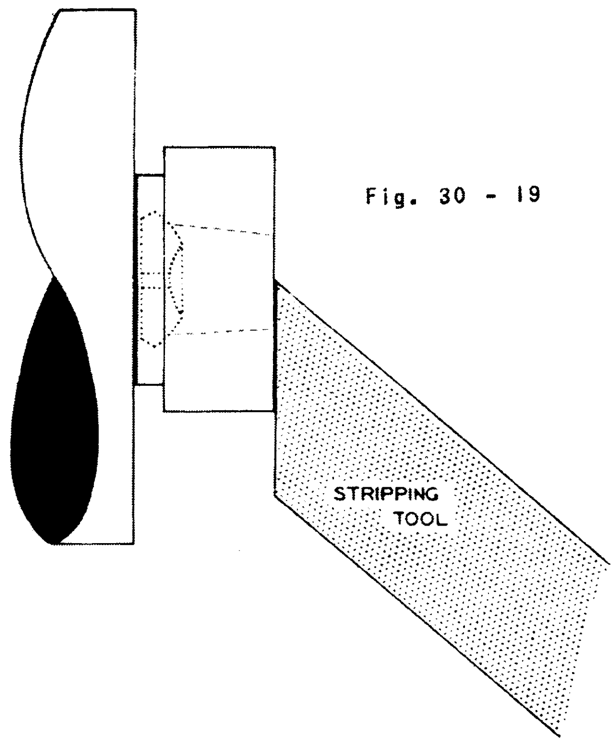


Fig. 30 - 19

5. Place the stripping tool in the position shown in figure 30-20 and open

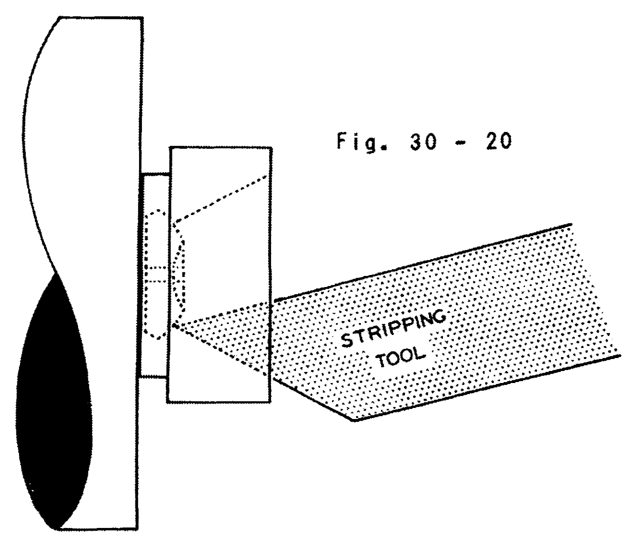


Fig. 30 - 20

up the hole leaving a small rim around the top of the setting. The finished setting should appear as shown in the cross section view in figure 30-21.

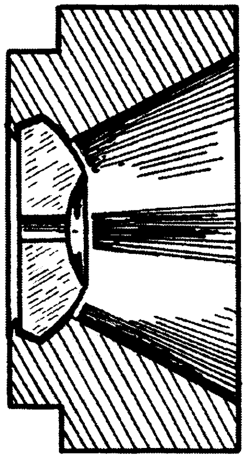


Fig. 30 - 21

SEC. 503 -- Cleaning Cement from Jewel Settings

Put the jewel or jewels to be cleaned in a small bottle about half full of alcohol. This bottle should have a screw cap, figure 30-22, through which a hole has been drilled. Place the bottle in a boiling pan about half full of water, and heat carefully over flame of alcohol lamp until alcohol has boiled violently for several minutes. It is not necessary for the water to boil. Remove setting from bottle and place between two pieces of pithwood which have been wet with alcohol, and twist pithwood back and forth. With a piece of pegwood wet in alcohol, clean hole in jewel.

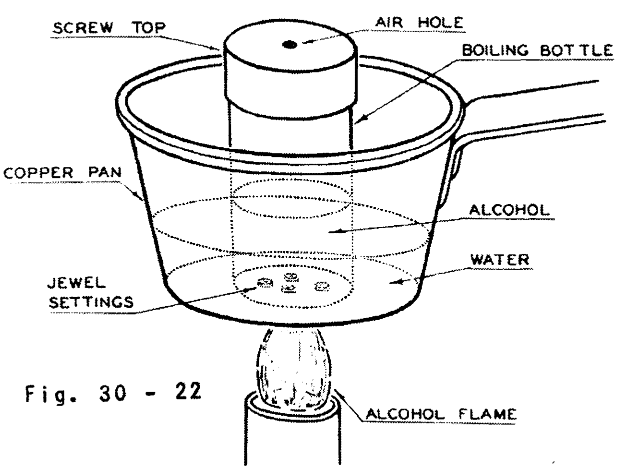
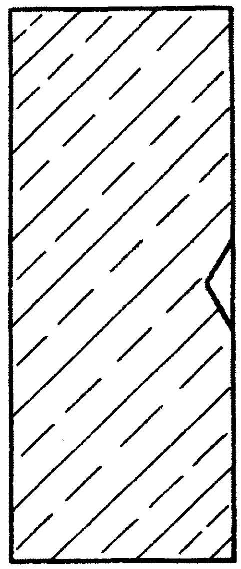


Fig. 30 - 22

SEC. 504 -- Steps in Setting a Balance Hole Jewel

1. Select balance hole jewel to be set. The balance hole jewel is held with pegwood as illustrated in figure 30-26.
2. Center stock as in figure 30-23.

Fig. 30 - 23



3. Select drill about 2/3 the diameter of the balance hole jewel and drill hole into rod as shown in figure 30-24.

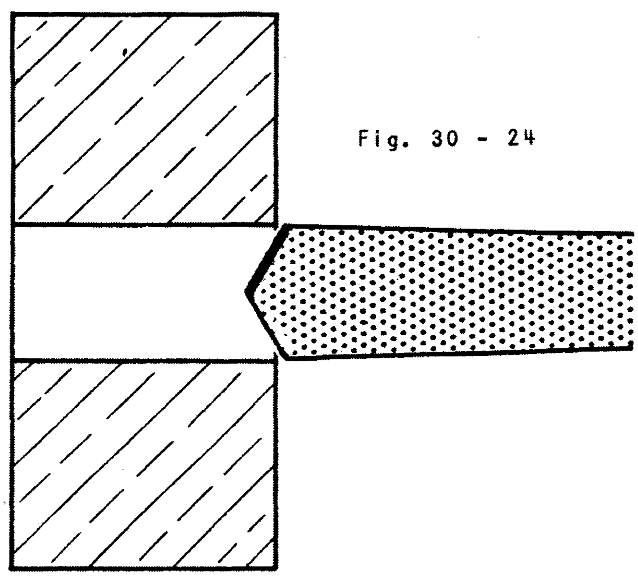


Fig. 30 - 24

4. Place seat setting tool in position as shown in figure 30-25. Cut seat for balance hole jewel.

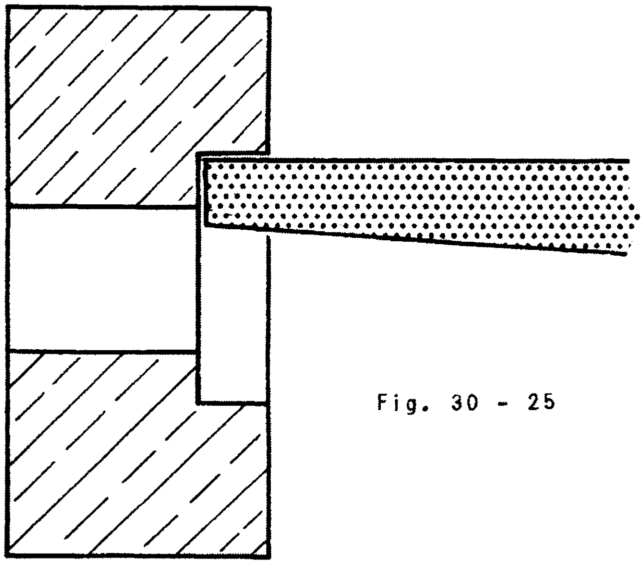


Fig. 30 - 25

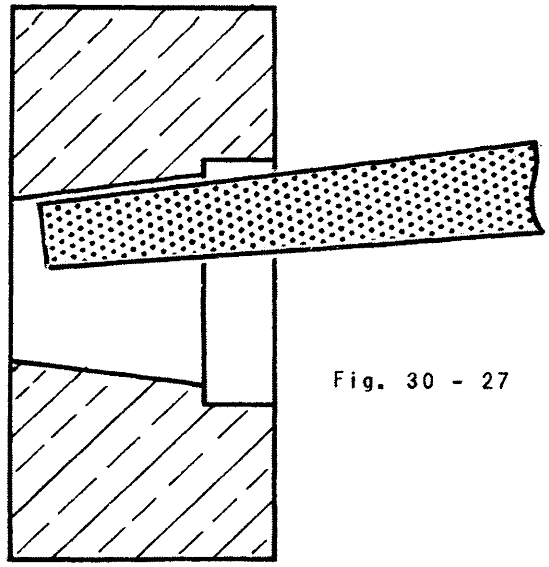


Fig. 30 - 27

5. The jewel should fit freely without side play and just below the surface of the rod as illustrated in figure 30-26.

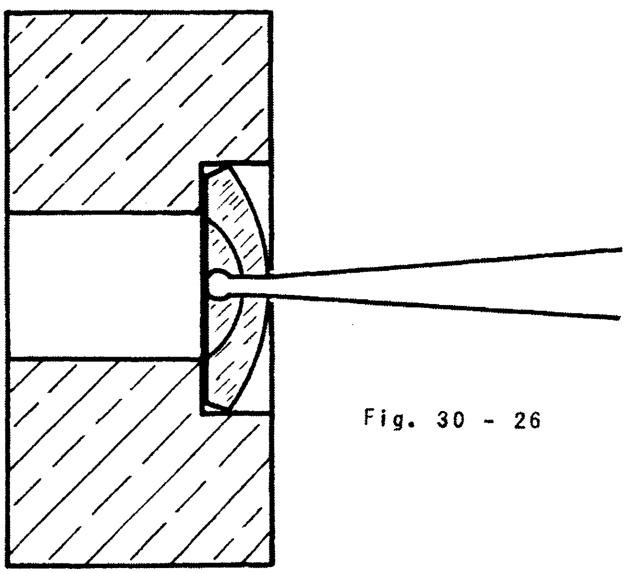


Fig. 30 - 26

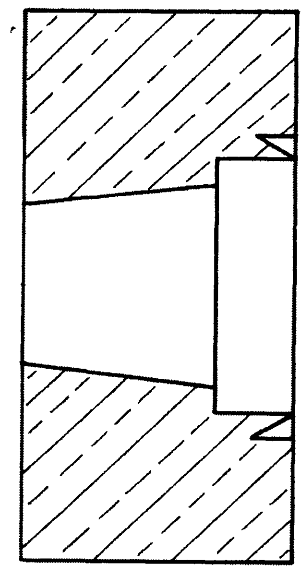


Fig. 30 - 28

6. Open the back of the hole with seat cutting tool as in figure 30-27, leaving a small shoulder as illustrated. Do not cut off the corner!

7. With a square graver or long pointed stripping tool, cut bezel as shown in figure 30-28.

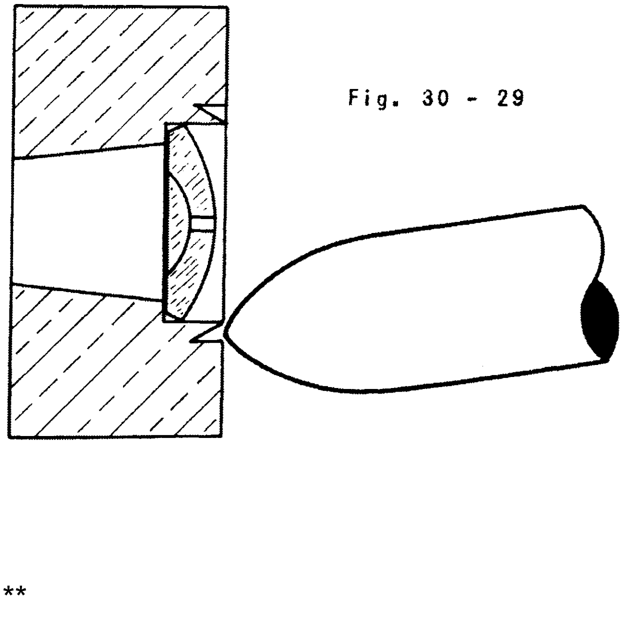
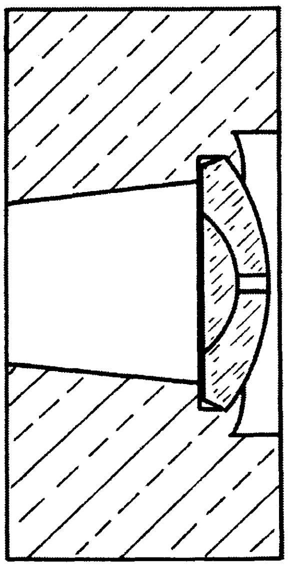


Fig. 30 - 29

8. Place balance hole jewel in position and holding tweezers over face of hole jewel, extract pegwood. Burnish bezel over face of balance hole jewel as shown in figure 30-29. The jewel should now appear as in figure 30-30.



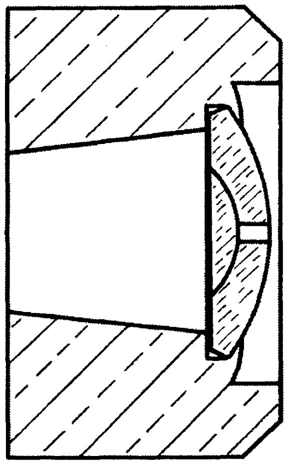


Fig. 30 - 31

Fig. 30 - 30

9. Face off rod until the face of the balance jewel sets just below the surface as shown in figure 30-31. Turn outside diameter to correct dimension.

10. Bevel corner of setting as shown in figure 30-31.

SEC. 505 -- Stripping a Balance Hole Jewel

The balance hole jewel is secured to cement chuck in the same manner as is a train jewel as explained in Sec. 502.

1. Face off setting to proper thickness, figure 30-32. With a square graver, cut shoulder on setting as shown in figure 30-33. In most cases there is not very much stripping on a balance hole jewel setting but it is accomplished by holding the stripping tool in position as shown in figure 30-33.

2. Figure 30-34 illustrates a cross section of a finished balance hole jewel setting. Notice that the corner has been beveled slightly at A. This makes for a finished job.

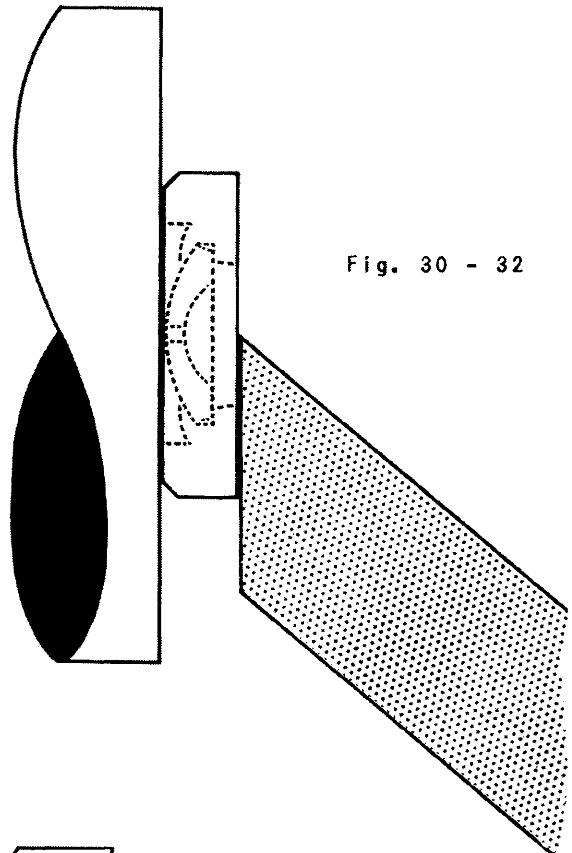


Fig. 30 - 32

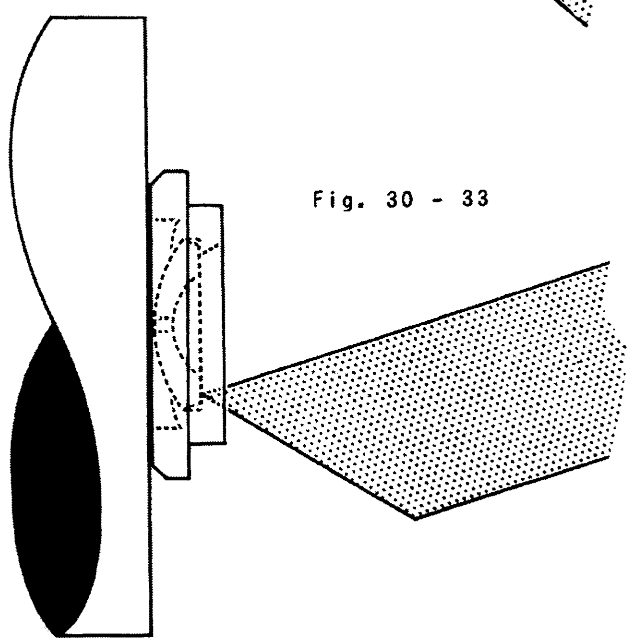


Fig. 30 - 33

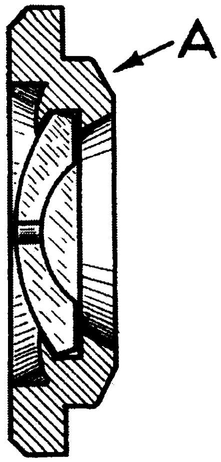


Fig. 30 - 34

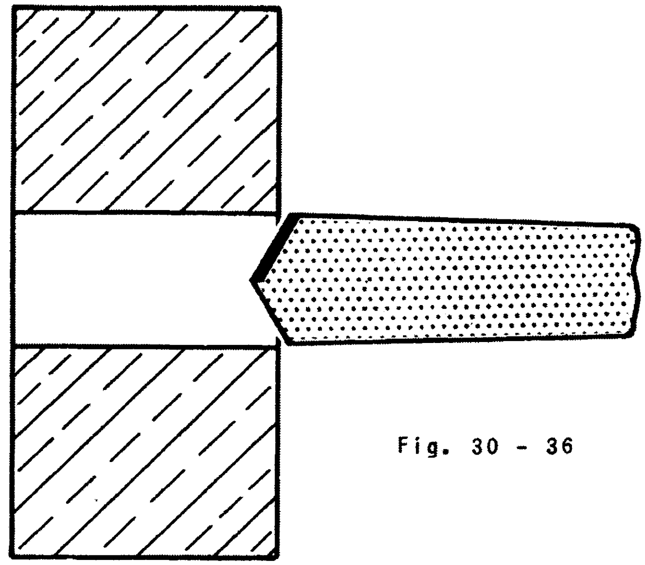


Fig. 30 - 36

SEC. 506 -- Steps in Setting a Cap Jewel

1. Select cap jewel to be set. Put a small amount of beeswax on a piece of pegwood and place against the flat side of cap jewel, figure 30-38. If the cap jewel has a curved surface, the procedure is identical to that for setting a train jewel. If the cap jewel is flat instead of being curved on the upper surface, it is set the same as a balance hole jewel.

2. Place stock in lathe chuck and center, figure 30-35. Select drill about 2/3 the diameter of the cap jewel and drill hole into stock as in figure 30-36.

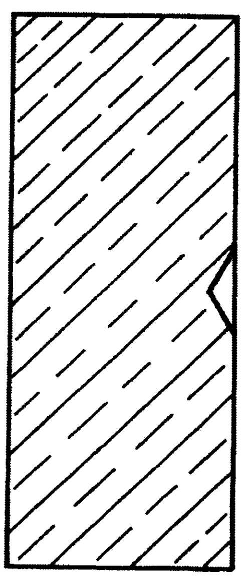


Fig. 30 - 35

3. Place seat cutting tool in position shown in figure 30-37 and cut seat while running the lathe in reverse.

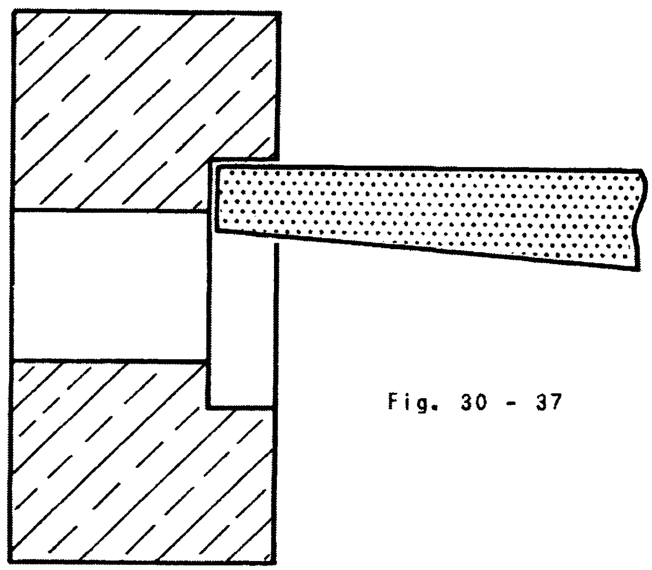


Fig. 30 - 37

4. The cap jewel can be tried as in figure 30-38. The jewel should fit freely without side play and the face of the cap jewel should be just below the surface.

5. Open the back of the hole with seat cutting tool as shown in figure 30-39.

6. Bevel corner as in figure 30-40.

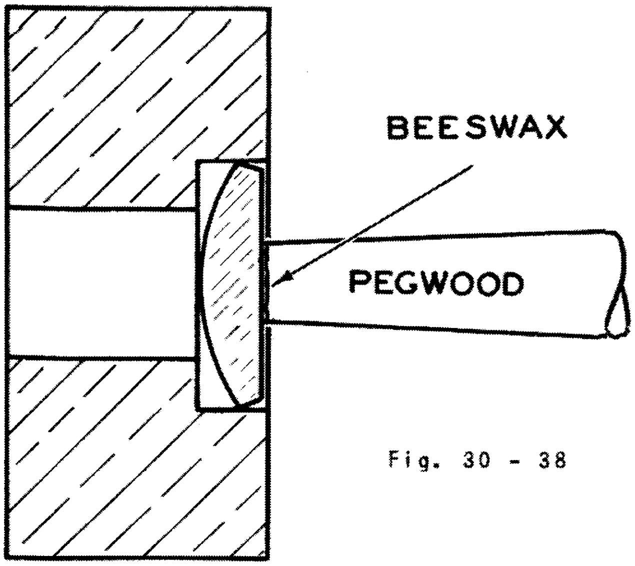


Fig. 30 - 38

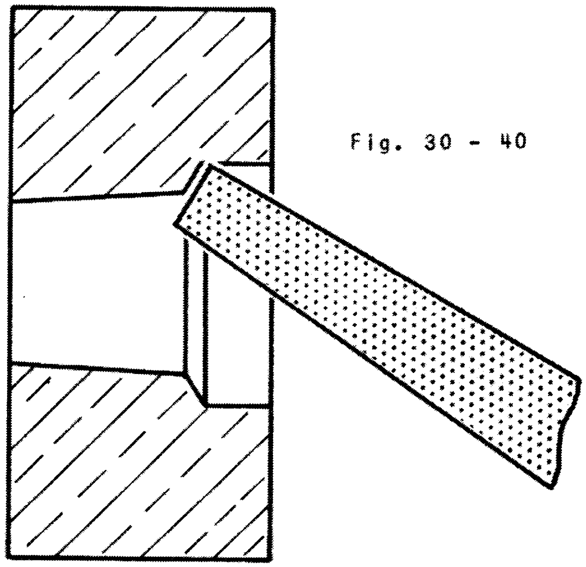


Fig. 30 - 40

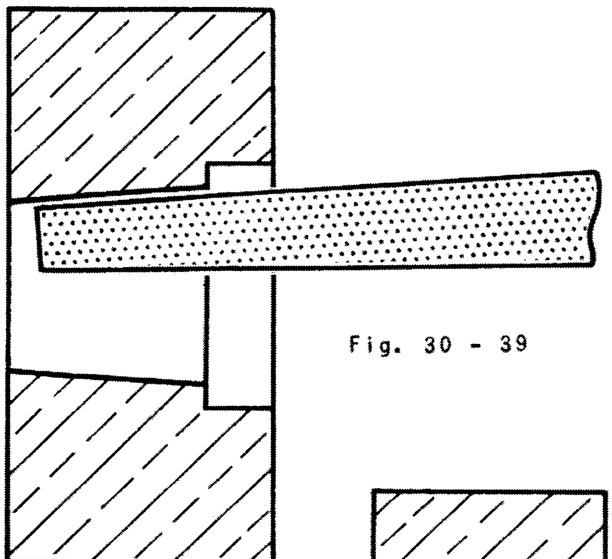


Fig. 30 - 39

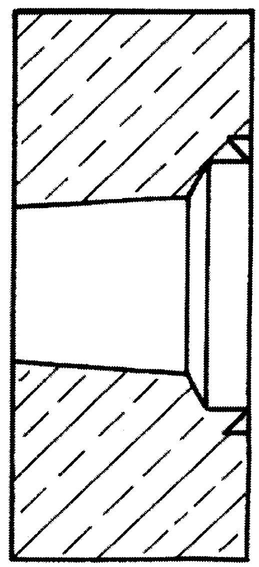


Fig. 30 - 41

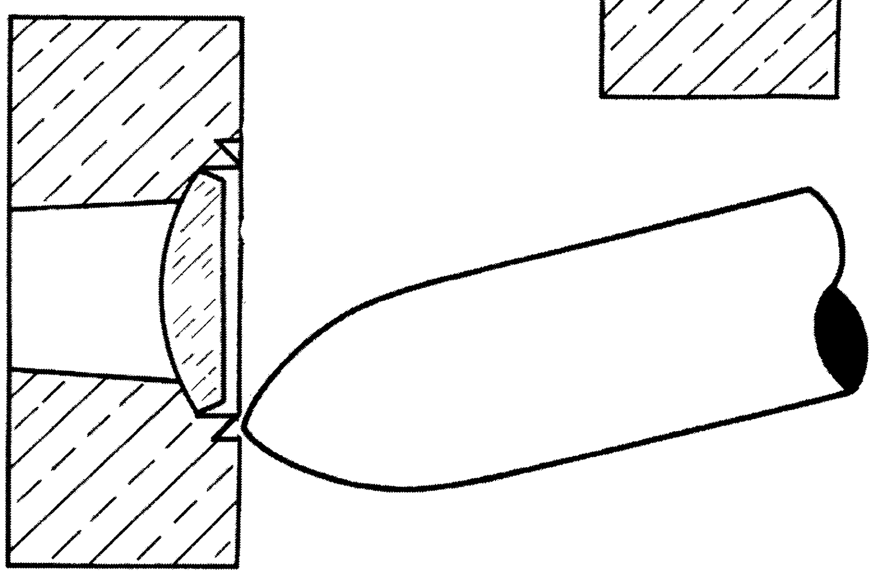


Fig. 30 - 42

7. Cut bezel as in figure 30-41.
8. With cap jewel in place as shown in figure 30-42, burnish bezel over cap jewel as shown in figure 30-43.

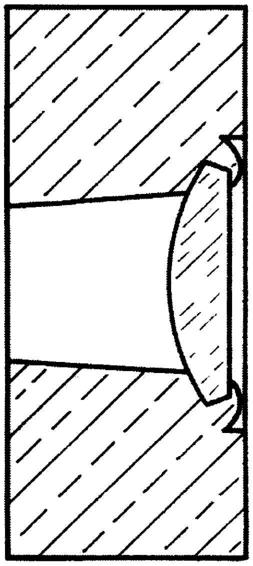


Fig. 30 - 43

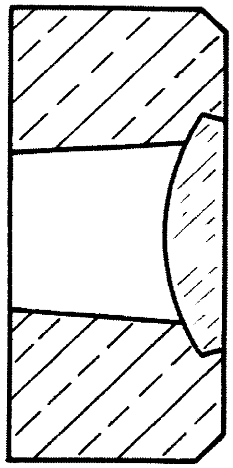


Fig. 30 - 44

9. Face off setting so that the face of cap setting is flush with rod as shown in figure 30-44.
10. Bevel corner of setting as shown in figure 30-44.

SEC. 507 -- Steps in Stripping a Cap Jewel

The cap jewel setting is cemented to a cement brass as previously explained and then faced off to the proper thickness as in figure 30-45. It is then stripped out as illustrated. Figure 30-46 illustrates a cross section view of a cap jewel in setting.

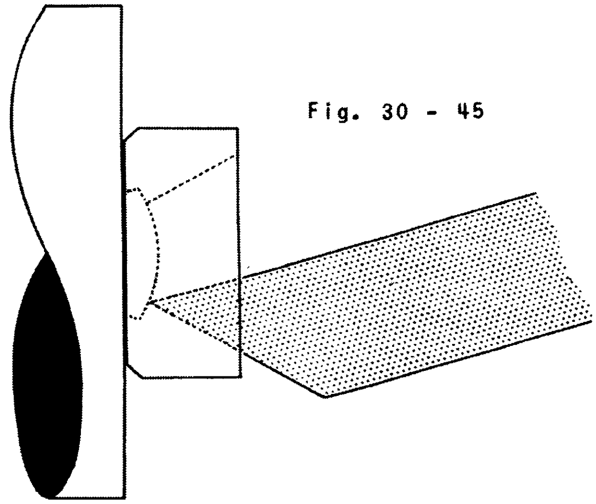


Fig. 30 - 45

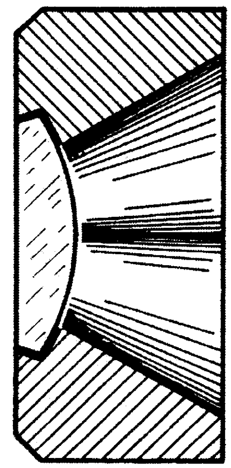


Fig. 30 - 46

SEC. 508 -- Setting Train Jewels in Watches

1. Measure pivot and select train jewel, allowing .02 mm for side shake.
2. Cut diameter of stock to fit plate or to the diameter of old setting.
3. Set train jewel (Steps 2, 3, 4, 5, 6, 7, 8, 9, and 10, of Sec. 501).
4. Cut shoulder to proper diameter and depth. As this depth determines the correct amount of end shake, it can be compared with the old setting as in figure 30-47.

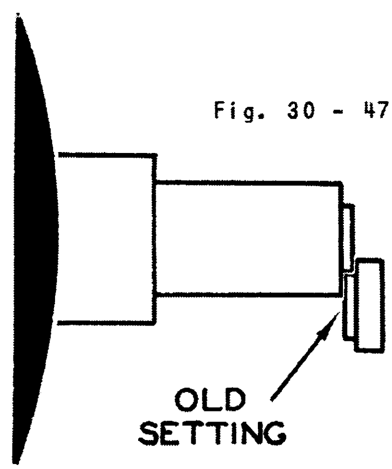


Fig. 30 - 47

5. Place bridge or plate on rod as far as it will go. With graver cut a notch which will end at the point of contact between the setting and the upper edge of bridge or plate, figure 30-48. Cut off setting.

6. Cement and face off to proper thickness. Strip as in Step 5 of Sec. 502.

7. Clean jewel setting in alcohol (Sec. 503).

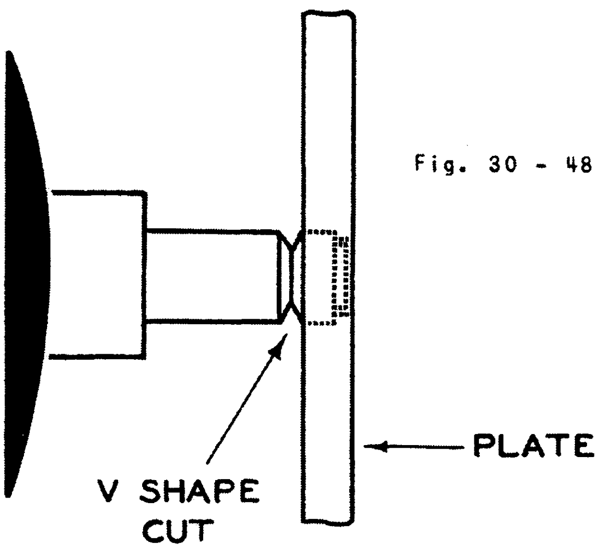


Fig. 30 - 48

SEC. 509 -- Countersinking Jewel Screw

Figure 30-49 is an illustration of a jewel screw countersink with a centering pivot. The centering pivot is used as a guide when countersinking the jewel setting as in figure 30-50. It is best to place one jewel screw in position as at

Fig. 30 - 49

JEWEL SCREW COUNTERSINK

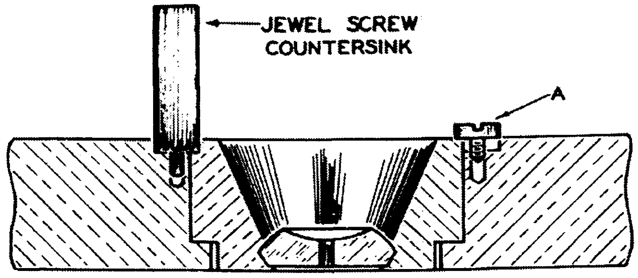


Fig. 30 - 50

A, figure 30-50, and countersink the opposite side. Then replace jewel screw in hole, which has just been countersunk, and countersink side at A. The jewel screws should be flush with the plate.

SEC. 510 -- Steps in Rebushing a Worn Pivot Hole

There are times when a pivot hole becomes worn so badly that it is impossible to close it satisfactorily or to locate the center in order to fit a friction jewel. This is a common occurrence in seven jewel watches. Figure 30-51 illustrates such a hole. The actual center

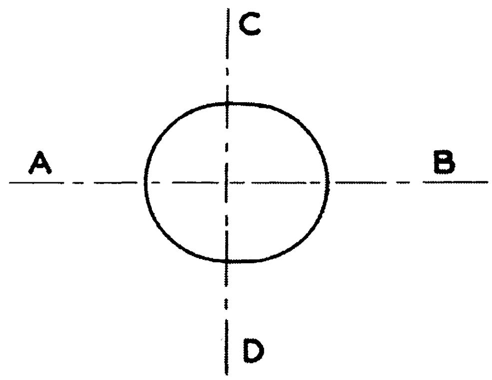


Fig. 30 - 51

is at the intersection of lines AB & CD. When a worn pivot hole has been uprighted and rebushed properly, the wheel and pinion will have the proper depthing and the pinion will be perpendicular to the hole in the bushing or jewel. For this purpose we use a face plate, figure 30-52. The face plate is made up of three moveable jaws secured to a circular plate

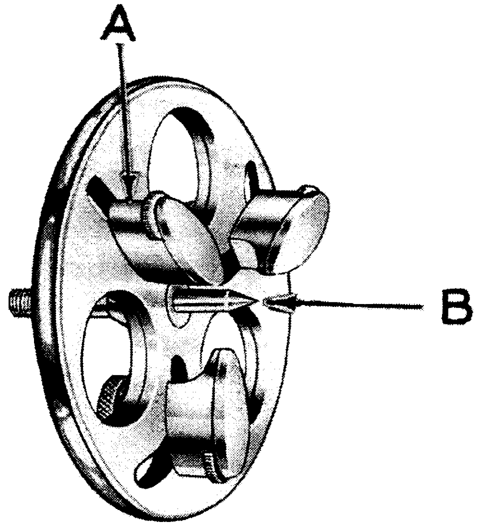


Fig. 30 - 52

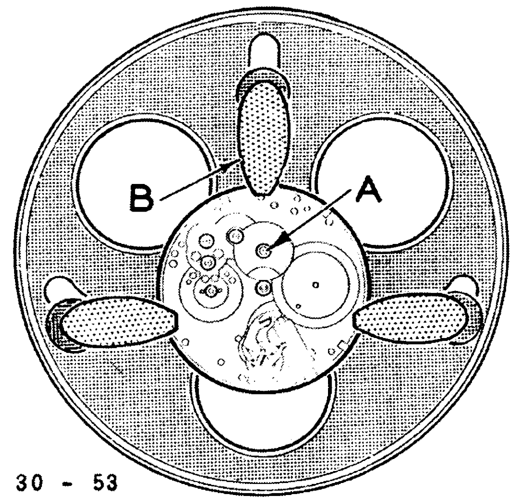


Fig. 30 - 53

and used in a watchmakers lathe. Notice that the jaw at A moves in a straight slot while the remaining two jaws move in curved slots. The pump center at B is used as a guide in locating the approximate center of the pivot hole which is to be uprighted. In uprighting a pivot hole in a bridge or upper plate of a watch, proceed as follows:

1. Place pillar plate with pivot hole A directly in line with center jaw B, figure 30-53, and place the other two jaws just over the edge of the pillar plate. The center of the pivot hole is located over the pump center, which is not visible in this view. Now remove pump center and tighten jaws with nuts A, figure 30-54, enough to hold plate in place. The knurled nuts at B are adjusted to keep the jaws parallel.

2. Figure 30-54 is a side view of the pillar plate held in position in the face plate with the T Rest set as close as possible and parallel to the face plate.

3. Place a long piece of pegwood as shown in figure 30-54 in pivot hole and rest on the T Rest. Now turn face plate slowly and pegwood will move up and down as illustrated by dotted pegwood. When the pegwood is at its lowest point A, figure 30-54, tap the top edge of pillar plate with a brass hammer. This will bring the pivot hole nearer to dead center. Continue turning the lathe and watching the low point of your pegwood while gently tapping the top edge of pillar plate until the end of the pegwood at

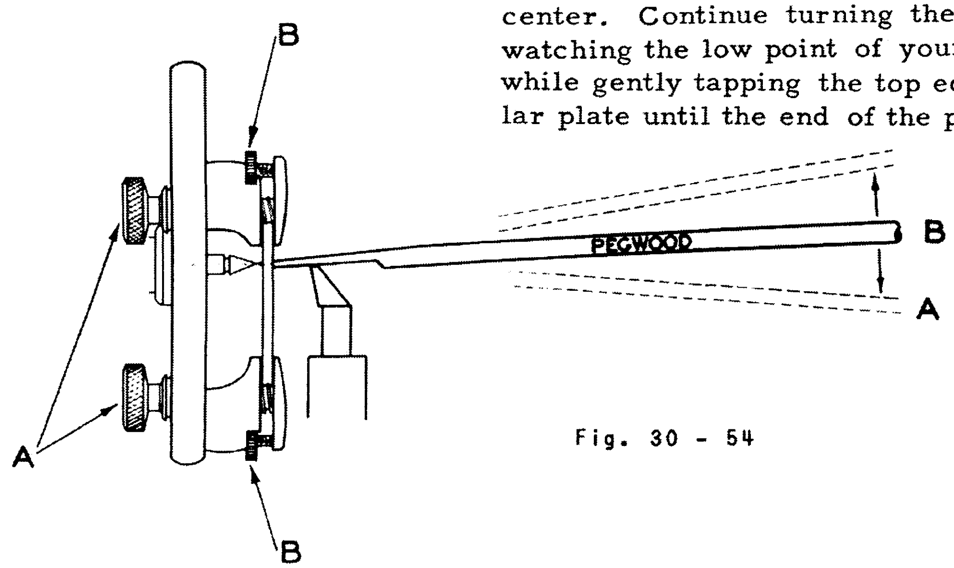


Fig. 30 - 54

B remains stationary. Tighten thumb nuts A. The pivot hole is then centered. Now screw the bridge in place on the pillar plate and bore out a hole for the new bushing. This hole can be of any convenient diameter. The bushing is made from a piece of brass rod turned to a diameter approximately 1/100 mm larger than the hole in the bridge. This bushing should be centered and the pivot hole made a trifle smaller than the diameter of the pivot for which it is intended. The bushing is then stripped out and pressed into position either with a friction jeweling tool or a staking tool. Broach pivot hole to fit pivot.

If the hole in the pillar plate was the one which needed to be rebushed, we would start off by uprighting the corresponding pivot hole in the upper bridge or plate; and after it was centered properly, remove the bridge and bore out a hole in the pillar plate and rebush as previously explained.

The most modern method today is to use a friction jewel instead of a bushing after a plate or bridge has been uprighted.

SEC. 511 -- Plugging Swiss Bridge

Although this method of replacing a jewel in a Swiss Bridge has been outmoded in favor of friction jeweling, there may be times in your career as a watchmaker when it is the most practical method to use.

1. Open bezel, using a cutting broach from the upperside of our bridge, as illustrated in figure 30-55. Do not cut any larger than necessary; just cut out old bezel.

2. Turn down a piece of rod on a very slight taper until bridge will just start over end of rod as in figure 30-56.

3. Select jewel to fit pivot. Set in rod and push bridge securely on rod, figure 30-57.

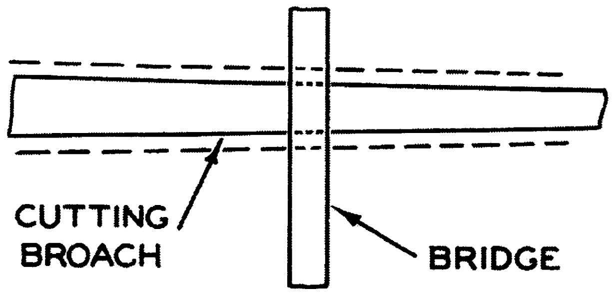


Fig. 30 - 55

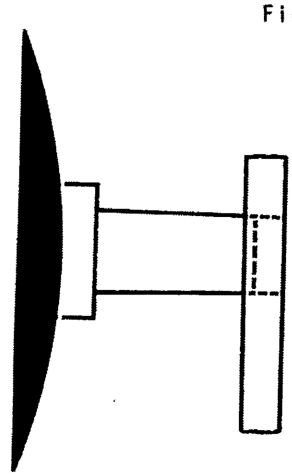


Fig. 30 - 56

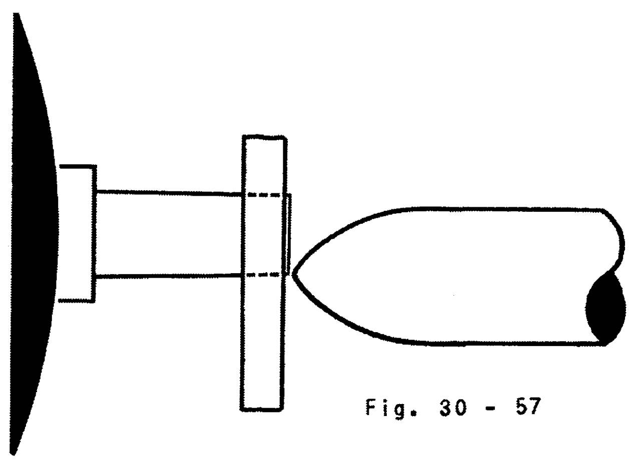


Fig. 30 - 57

4. Burnish edge of brass over setting and face off flush with bridge, figure 30-58. Cut a slot as at A, figure 30-59, and saw off. The jewel and setting are now burnished into the bridge. To finish, cement bridge to cement brass truing to hole in jewel as in figure 30-60, and strip along dotted lines, figure 30-60. Remove and clean with alcohol.

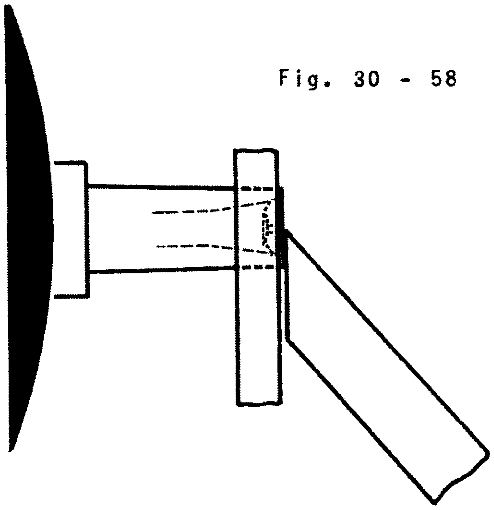


Fig. 30 - 58

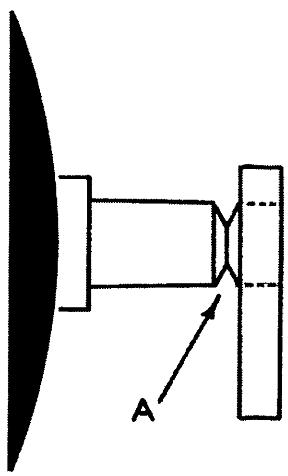


Fig. 30 - 59

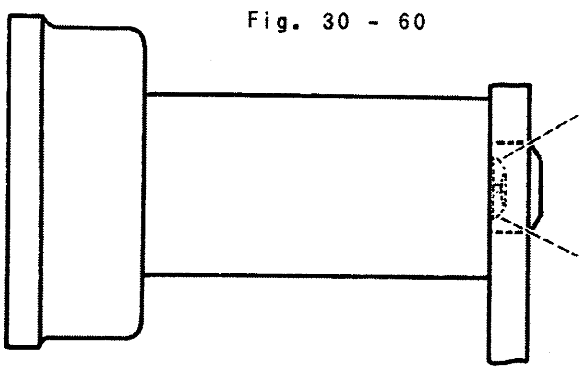


Fig. 30 - 60

SEC. 512 -- Setting Balance Jewels in Watches

1. Select balance hole jewel to be set allowing .01 mm for side shake. Always try the jewel on the pivot as you will frequently find a slight variation in the hole sizes. The balance pivot should extend through and above the top of the jewel approximately the thickness of the pivot as shown in figure 30-61. Pivots should always be polished, if necessary, before selecting the jewel to be set.

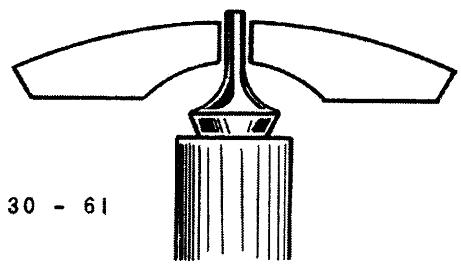


Fig. 30 - 61

2. Turn stock to the diameter of the old setting or until it fits hole in cock or plate snugly.
3. Set balance jewel (Steps 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10, Sec. 504).
4. Cut off setting, gauging the thickness by comparing with old setting.
5. Cement setting to cement chuck and face off to the proper thickness, using the old setting as a guide.
6. Cut square shoulder, using the old setting as a guide, figure 30-62. The thickness of the setting at A is very im-

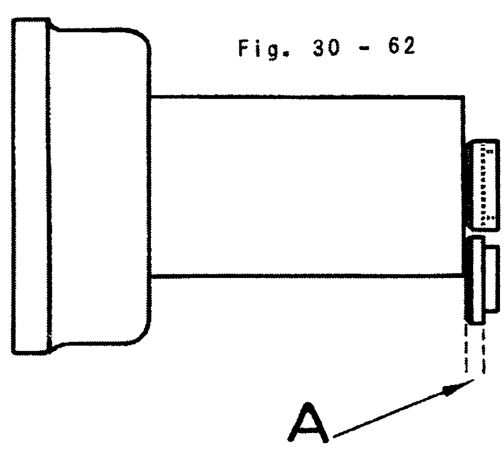


Fig. 30 - 62

portant and must be correct.

7. The diameter of the shoulder can be slightly smaller than the opening in the cock or plate and does not have to fit snugly.

8. Strip, remove and clean thoroughly.

SEC. 513 -- Setting Cap Jewels in Watches

1. Select cap jewel.
2. Cut diameter of stock to fit plate or to the diameter of the old setting.
3. Set cap jewel as in Sec. 506 and face off. Face setting flush with the face of cap jewel.
4. Cut off, using old setting as a guide for thickness.
5. Cement and face off to proper thickness, using old setting as a guide, and strip out setting.
6. Place cap and balance jewel in cock or plate and countersink jewel screws as in Sec. 509.

Figure 30-63 illustrates a cut away

CAP JEWEL IN SETTING

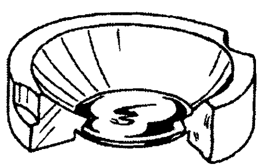
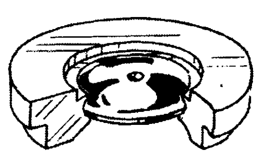
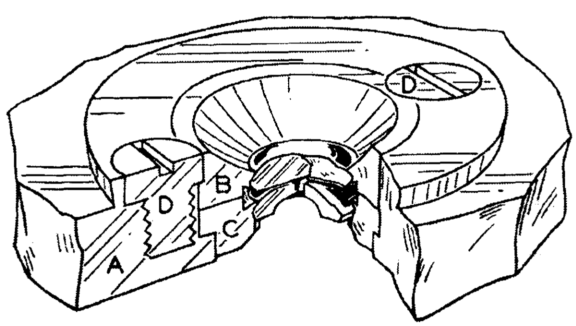


Fig. 30 - 63

BALANCE JEWEL IN SETTING





A - Balance Cock
B - Cap Jewel In Setting
C - Balance Jewel In Setting
D - Jewel Screws

view of the cap and balance jewels in settings and their relative position in the cock or plate.

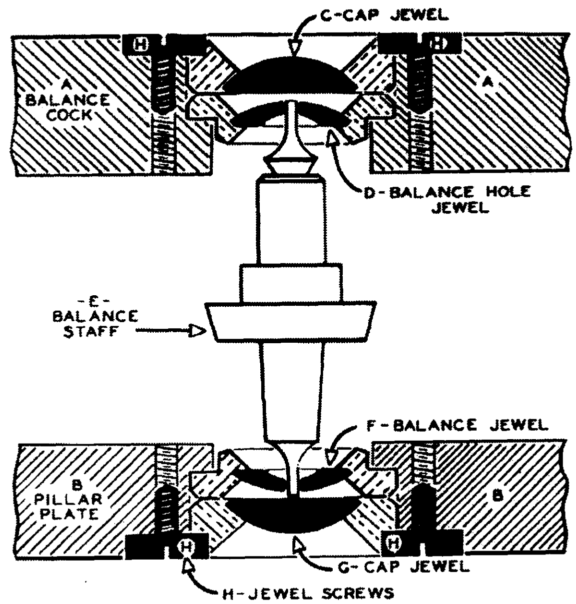


Fig. 30 - 64

Figure 30-64 is a cross section view of the balance cock and pillar plate with a balance staff placed in position. Notice that the lower pivot rests on the lower cap jewel and that the upper pivot is even with the top of the upper balance hole jewel. The space between the upper pivot and the upper cap jewel is the "end shake". This space is always determined by the fact that the balance hole jewel is set slightly below the surface of the balance jewel setting while the cap jewel is flush with the cap jewel setting.

SEC. 514 -- Raised Settings

Train jewel settings and cap jewel settings are found at times raised above the surface of the cock or plate. Figure 30-65 illustrates two types of raised settings. The one at A requires the countersinking of the jewel screws to the level of the bridge or cock. The one at B does not require countersinking but the bottom of the shoulder should be flush with but not below the level of the bridge or plate.

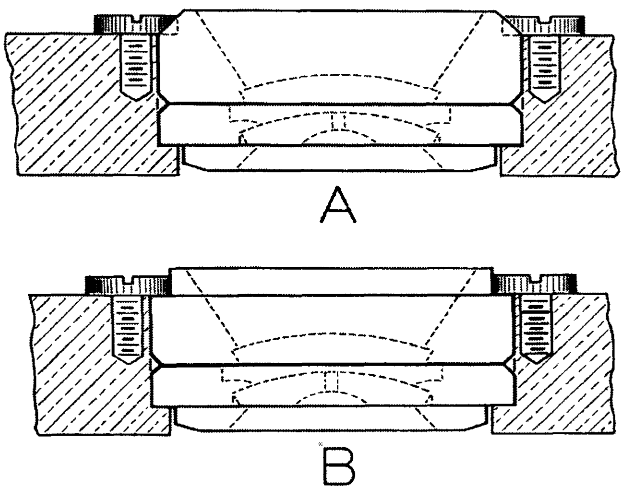


Fig. 30 - 65

SEC. 515 -- Replacing a Regulator Key, Swiss Style

1. Place in lathe a piece of brass rod which is thicker than the width of the regulator key at the thickest part, figure 30-66.

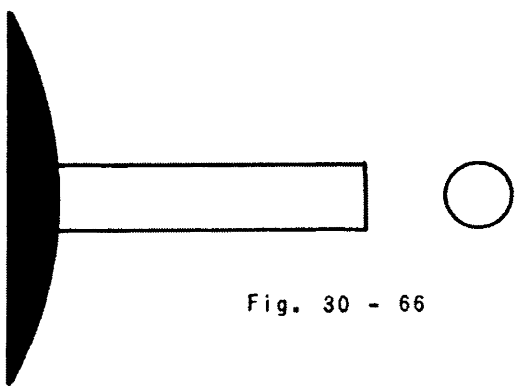
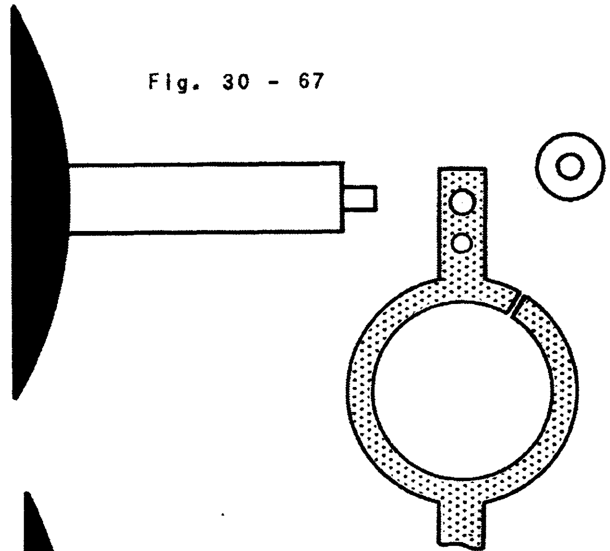


Fig. 30 - 66

2. Turn square shoulder to fit hole in regulator key, figure 30-67, the length to be slightly longer than the thickness of the regulator.

3. Turn another square shoulder, figure 30-68, the length of which is determined as shown in the drawing directly beneath it in which A represents the regulator and B the hairspring held in

Fig. 30 - 67



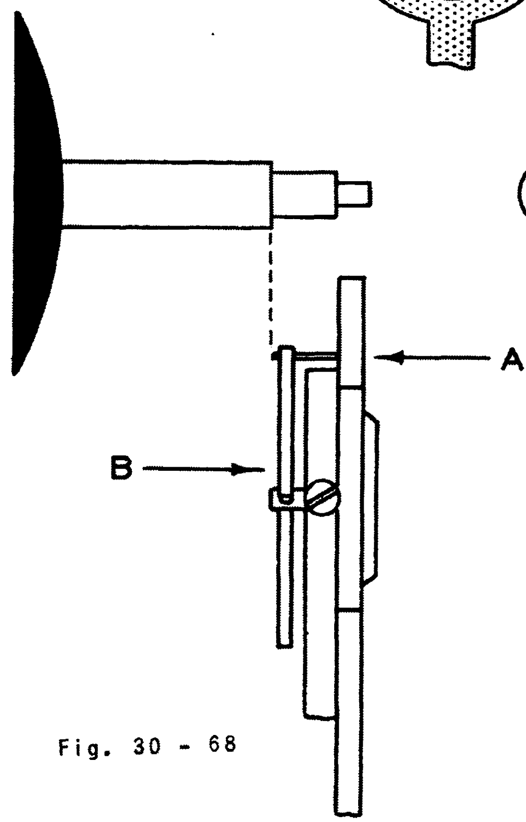


Fig. 30 - 68

place by the stud. Notice that this shoulder is slightly longer than the distance from the underside of the regulator to the underside of the hairspring.

4. File the sides flat, figure 30-69.

5. Cut off regulator key as in figure 30-70. Finish the end.

6. Rivet in place with staking tool punch, figure 30-71.

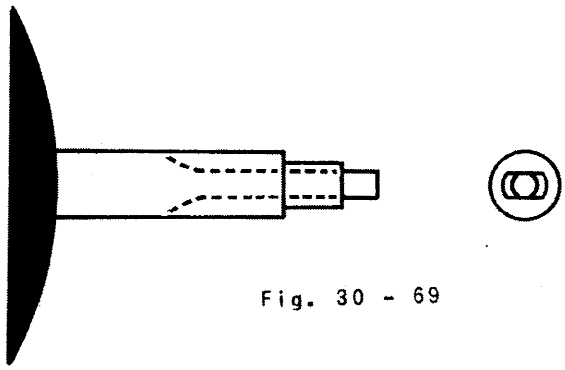


Fig. 30 - 69

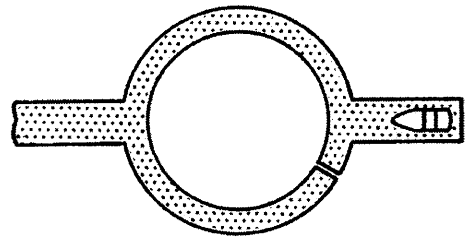


Fig. 30 - 72

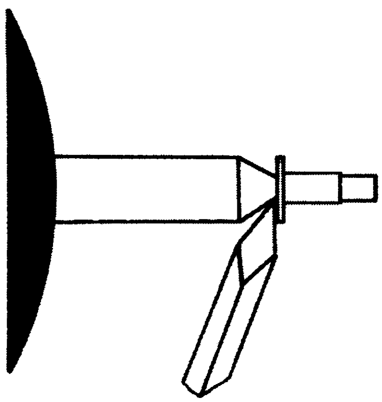


Fig. 30 - 70

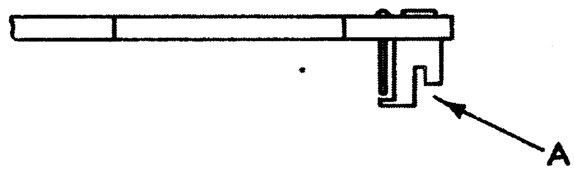
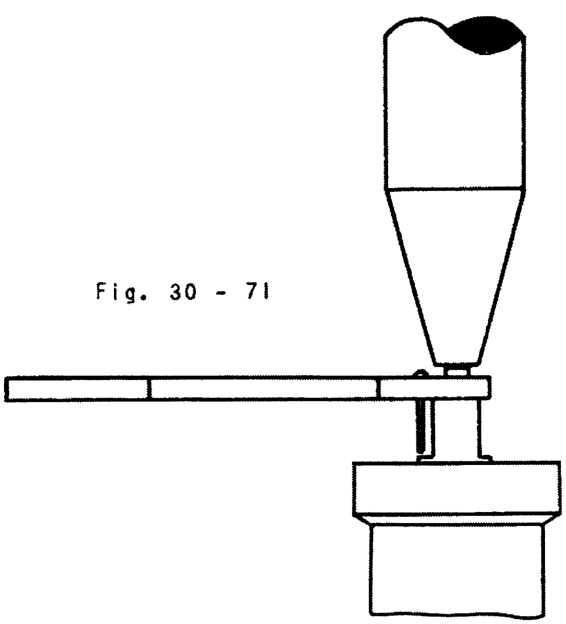


Fig. 30 - 73

Fig. 30 - 71



7. Shape key with file as in figure 30-72.

8. With screw head file, put slot in key at A, figure 30-73.

Although you may find variations from the methods described in these lessons, you can accept our methods as practical and correct. Each has been proved in practice.

On all watch work, do not, as said before, be content with doing a job once. In order to be proficient you should practice at every opportunity. Work Sheets are used with these lessons to give you this practice and the work laid out on these sheets should be reviewed from time to time. If you are working on staffs, make it a point to review your jewel setting work from time to time. If you are working on jewels, brush up on the escapement. Each time you review a lesson, you will be greatly benefited.

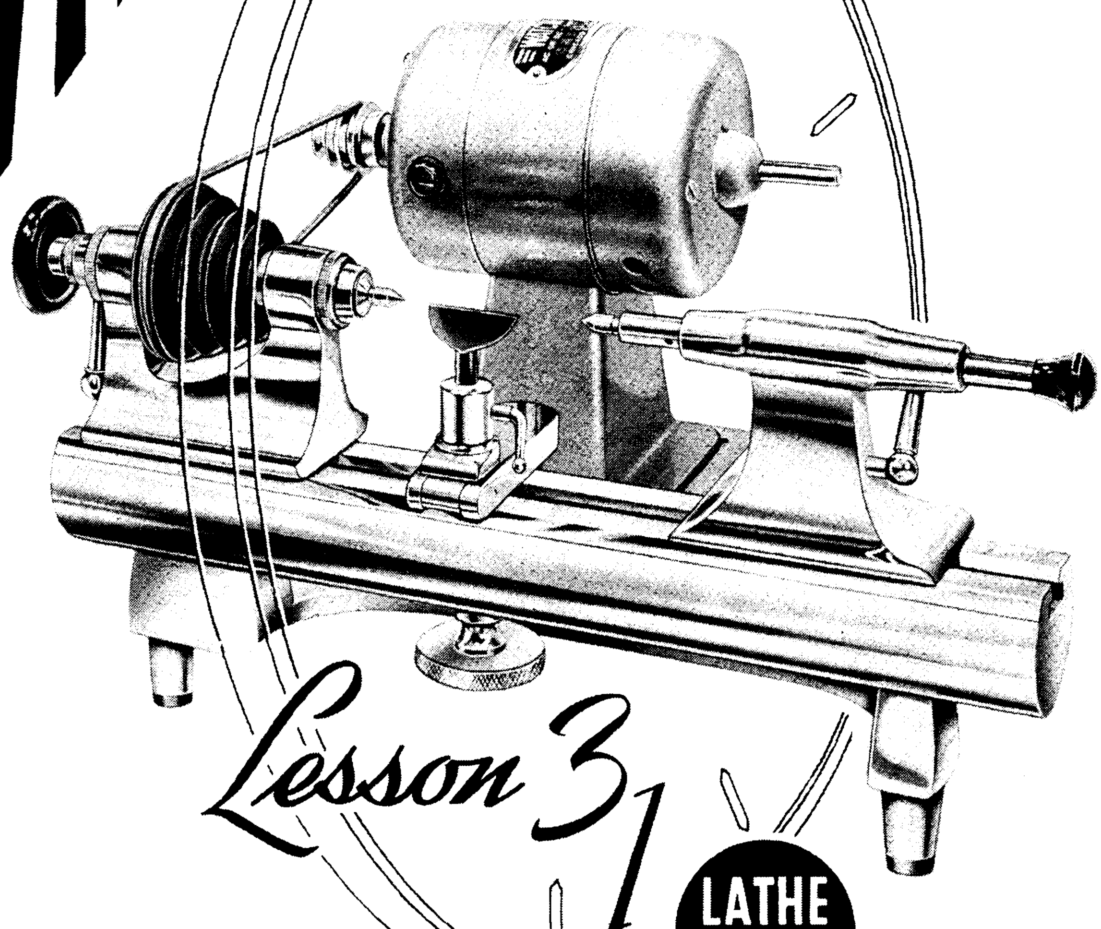
note:

(No job sheets are associated with Lesson 30)

Master Watchmaking

Lesson 31

LATHE WORK



CHICAGO SCHOOL OF WATCHMAKING *Founded 1908 by* THOMAS B. SWEAZEY

You may hear it said that today with interchangeable parts and the low cost of watch material it is a waste of time to make parts such as stems and balance staffs. But there are many old watches you will handle where it is impossible to obtain the correct material, and even on some newer watches not all repair parts fit perfectly. To justify the term Watchmaker, you must be able to repair all makes and models of watches, and your success as a Watchmaker depends upon your ability to make or alter the required parts for the watches you are repairing.

SEC. 520 -- Making a Square Shoulder Pivot

It is best to harden and temper your own material for practice. Select a piece of drill rod, harden, polish, and temper it to a deep blue. This is the color required for pivot and staff work.

1. Place hardened and tempered rod in chuck allowing it to extend approximately 6 mm. Grind the end with a Hard Arkansas slip, keeping it at right angles to the work and moving it rapidly back and forth as illustrated by arrows in figure 31-1.

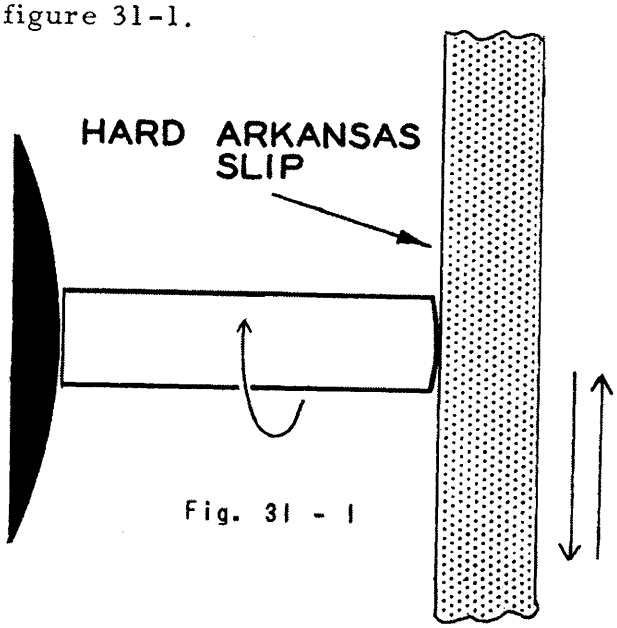


Fig. 31 - 1

2. Burnish end of rod with hardened steel pivot burnisher, figure 31-2.

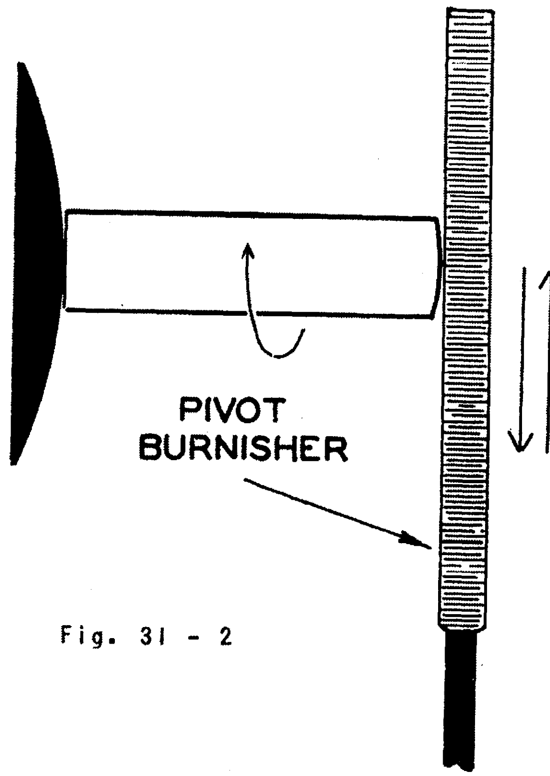


Fig. 31 - 2

3. Turn a square shoulder on end of rod approximately 4/100 mm larger than the diameter of the finished pivot, figure 31-3. This will allow for grinding and polishing.

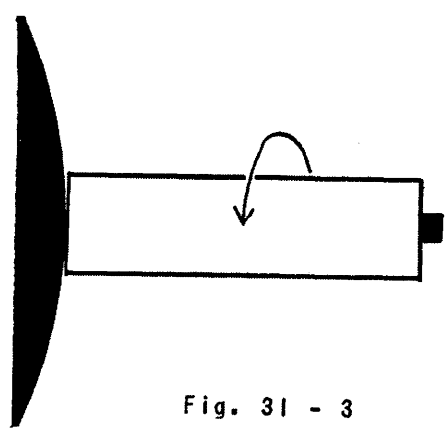


Fig. 31 - 3

4. Cut square shoulder back to a length of approximately 3 times the finished diameter of pivot figure 31-4.

Example: Diameter of finished pivot to be .3 mm.
.3 mm multiplied by 3 equals .9 mm, the length of the pivot.

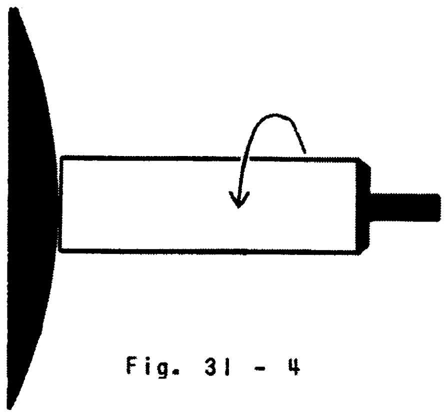


Fig. 31 - 4

5. Bevel corner, figure 31-4. This is a square shoulder pivot in the rough and it now must be ground and polished. Grinding the pivot will reduce its diameter slightly. Therefore, we allow about 3/100 of a millimeter for grinding and 1/100 millimeter for polishing, depending on the <u>finished diameter.</u> Not much grinding will be required if you are careful to cut a straight, smooth surface.

SEC. 521 -- Grinding and Polishing

There are several methods of grinding and polishing pivots. The method we will use is oilstone powder with the iron grinding slip, which we made in Lesson 27. For polishing we will use Diamantine with a boxwood slip.

1. Mix a small quantity of oilstone powder with oil until it is the consistency of thick cream. Place a little of this compound along the curved edge of the grinding slip and place slip on the underside of pivot as shown in figure 31-5. Run the lathe in reverse.

2. Move grinding slip rapidly backward and forward until pivot attains a

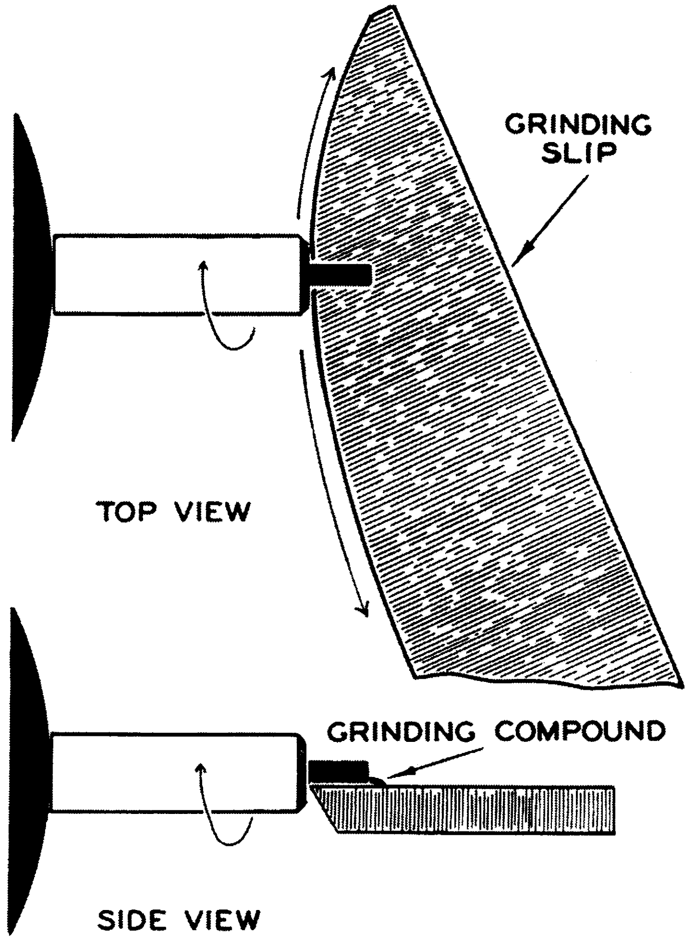


Fig. 31 - 5

dull gray finish. The grinding compound can be removed with pithwood in order to examine the work. Insufficient grinding will not leave a smooth surface. Excessive grinding will round the corner. Grind to within 1/100 mm of the finished diameter. This will allow for polishing.

3. Figure 31-6 illustrates a boxwood slip which has been impregnated along the top edge with Diamantine #2. Run your lathe at high speed when polishing and in the direction of arrow, figure 31-6, until you have a high polish.

4. Figure 31-7 illustrates the finished pivot.

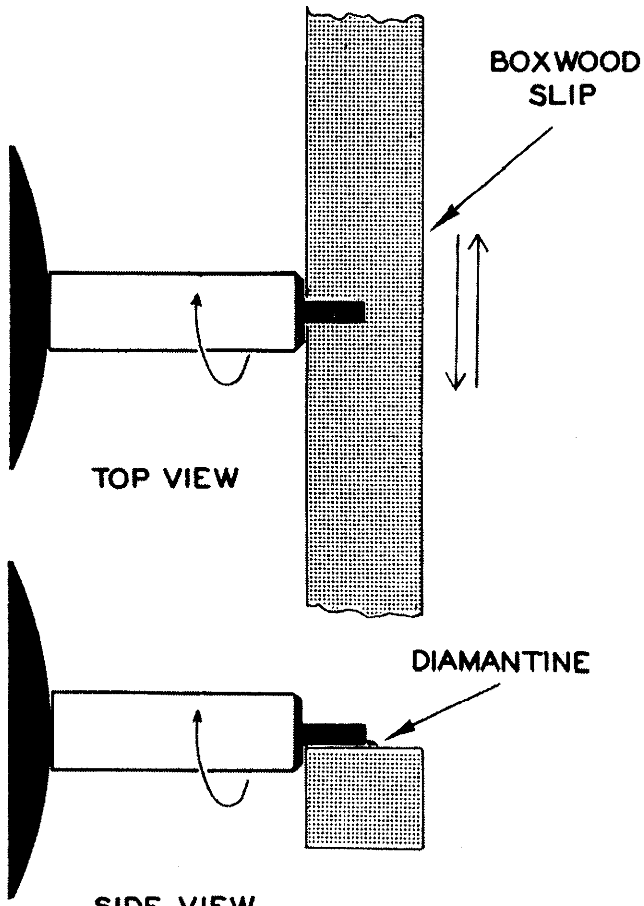


Fig. 31 - 6

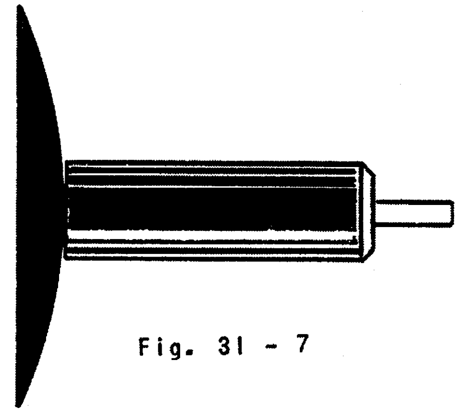


Fig. 31 - 7

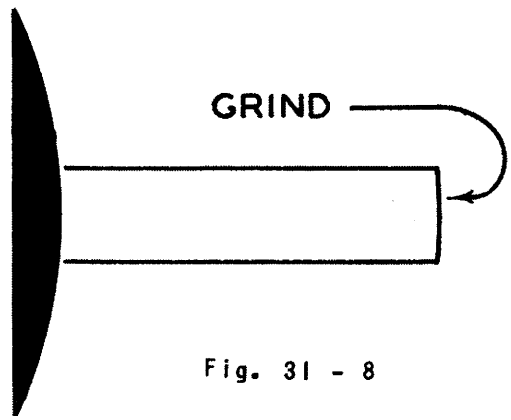


Fig. 31 - 8

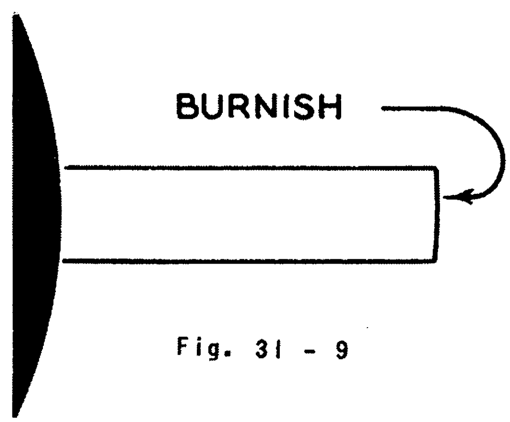


Fig. 31 - 9

You should be thoroughly familar with the function of the square shoulder pivot from your previous lessons, and as a good workman you should examine each square shoulder pivot in every watch you repair. Do this before cleaning the watch and if, under a double loupe, a pivot is found to be scratched or rough, it should be refinished in the manner described. Never overlook this fact and if in doubt, polish the pivot with Diamantine or pivot burnisher.

SEC. 522 -- Making a Cone Pivot

The first step in making a cone or balance pivot is to grind and burnish the end of the wire.

1. Grind end with an oilstone or Hard Arkansas slip, figure 31-8.

2. Burnish end with pivot burnisher, figure 31-9. The lathe is run at high speed and the burnisher held squarely against the metal.

3. Turn a square shoulder on the end of the rod approximately 3/100 millimeters larger than the finished diameter of pivot, figure 31-10.

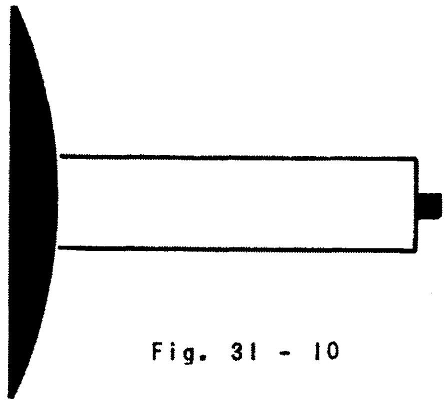


Fig. 31 - 10

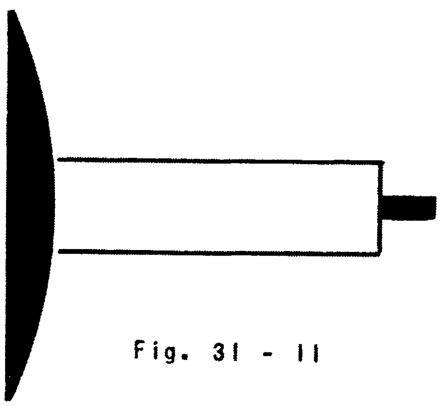


Fig. 31 - 11

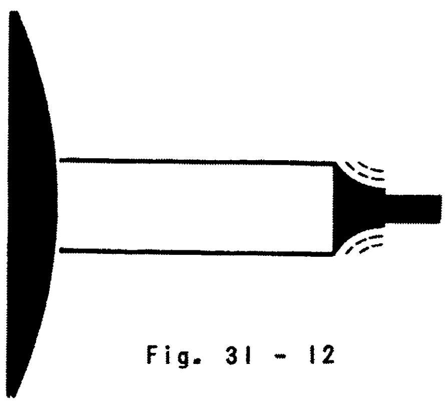


Fig. 31 - 12

4. Cut back and make a square shoulder pivot 2-1/2 times as long as the diameter of the finished pivot, figure 31-11.

Example: Diameter of finished pivot to be .12 mm
.12 mm multiplied by 2.5 equals .3 mm, the length of the pivot.

5. The cone of the balance pivot is cut after you have made a square shoulder pivot. Do not try to cut the pivot and cone at the same time. The dashed lines in figure 31-12 illustrate the shape of the cone as it is being formed. Some workmen use a round graver for this purpose. The length of the cone is left to the discretion of the watchmaker but is approximately the same length as the pivot.

6. The oil cut in figure 31-13 is left to the discretion of the watchmaker but keep it about the proportion shown. Bevel corner, figure 31-13.

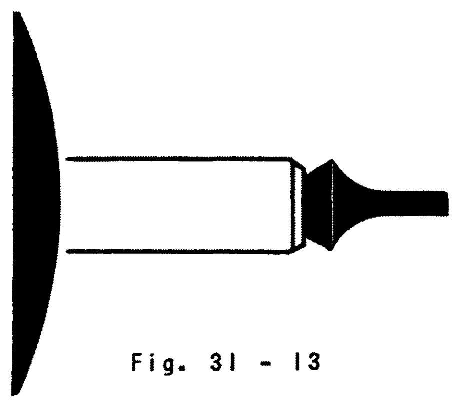


Fig. 31 - 13

7. Round the straight edge of the iron grinding slip slightly by draw filing at A, figure 31-14.

8. Place oilstone powder mixed with oil on grinding slip and while holding in position B, figure 31-15, run lathe in reverse moving grinding slip forward and backward rapidly. The cone is determined by the angle at which you hold the grinding slip. A, figure 31-15, illustrates the angle which will give a longer cone. B illustrates a shorter cone. It is only by practice that you will be able to grind the pivot and cone at the same time. If pivot is properly cut, it will not require much grinding.

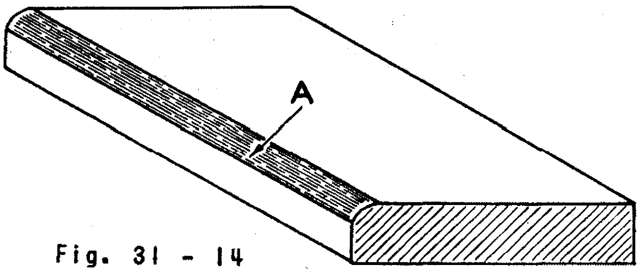


Fig. 31 - 14

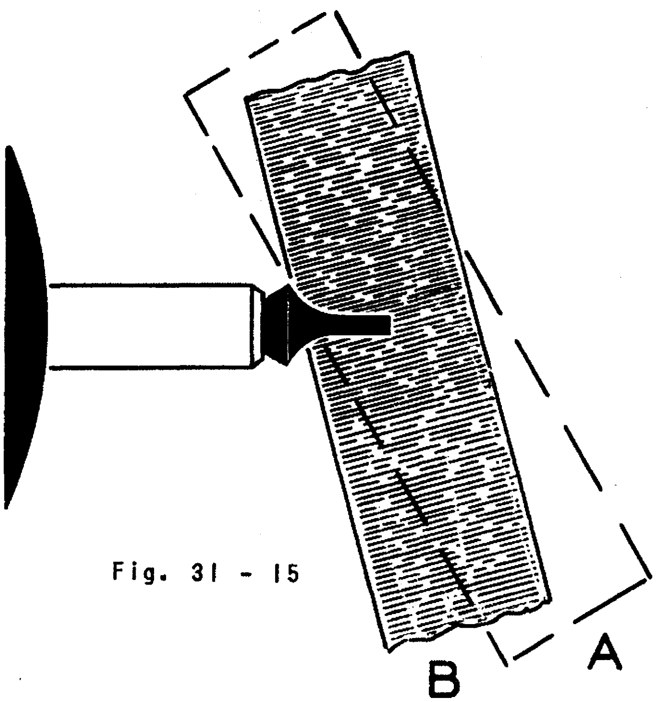


Fig. 31 - 15

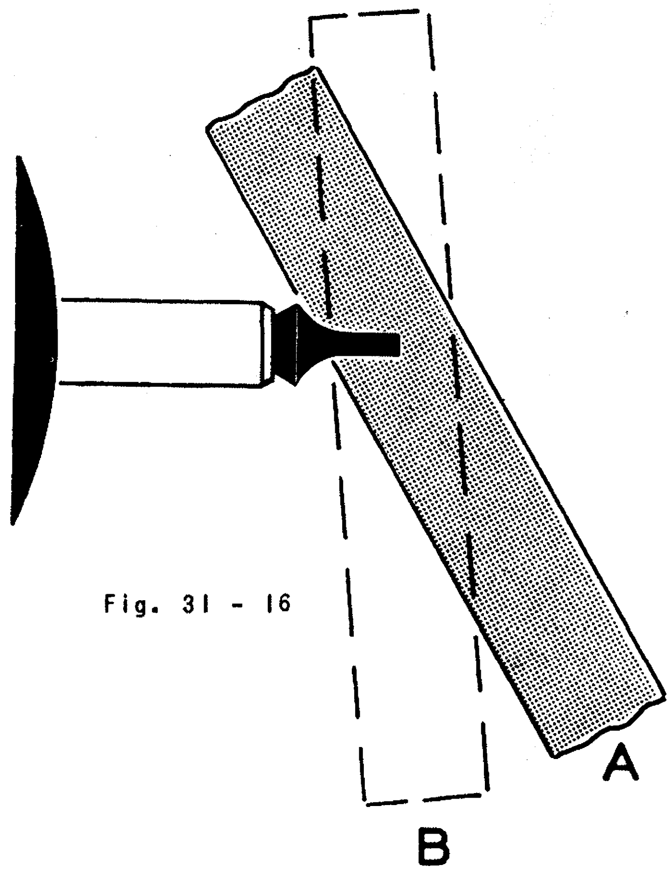


Fig. 31 - 16

9. Polishing is done with a boxwood slip impregnated with Diamantine to which a little rouge may be added, figure 31-16. Move boxwood slip rapidly back and forth as in figure 31-16. In order to polish the pivot and cone at the same time, shift the boxwood slip to different positions as at A & B, figure 31-16. This will give a high polish to the pivot.

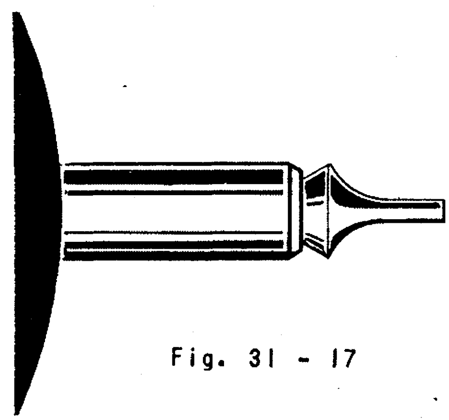


Fig. 31 - 17

Figure 31-17 illustrates the finished pivot.

Figure 31-18 illustrates a pivot which is too short.

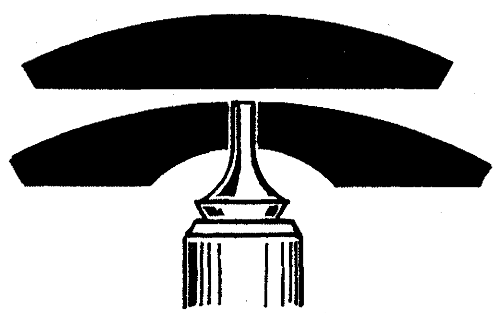


Fig. 31 - 18

Figure 31-19 illustrates a pivot with too short a cone.

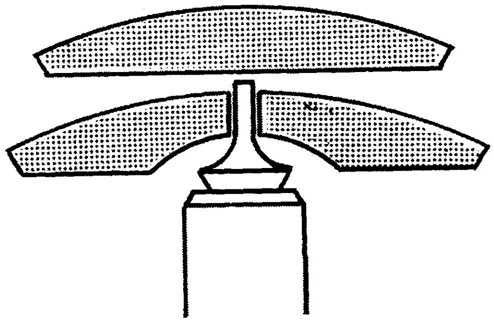


Fig. 31 - 19

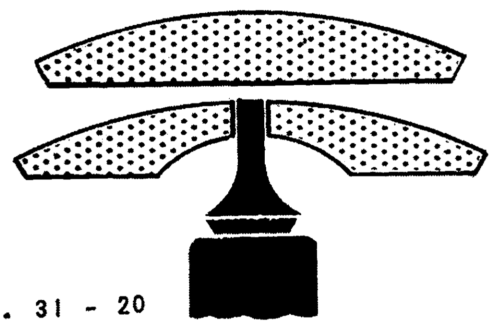


Fig. 31 - 20

Fig. 31 - 21

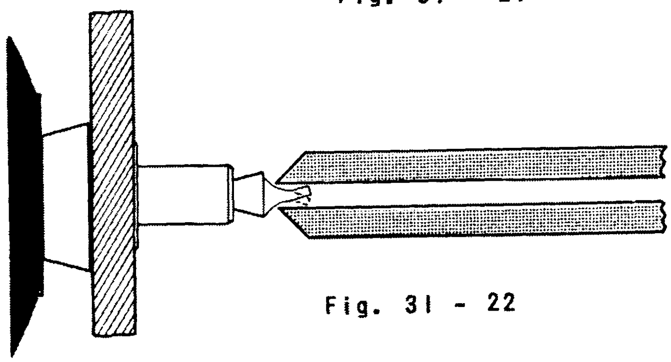


Fig. 31 - 22

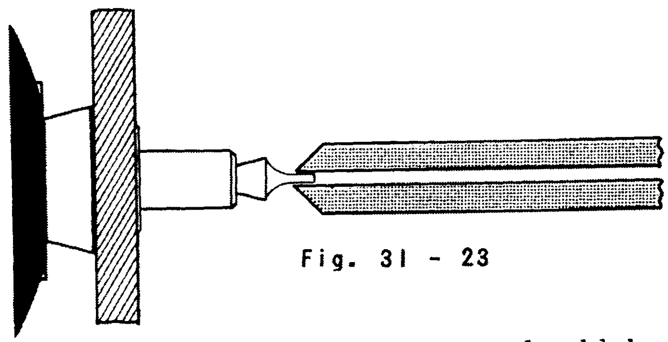


Fig. 31 - 23

Figure 31-20 illustrates a pivot which is too long.

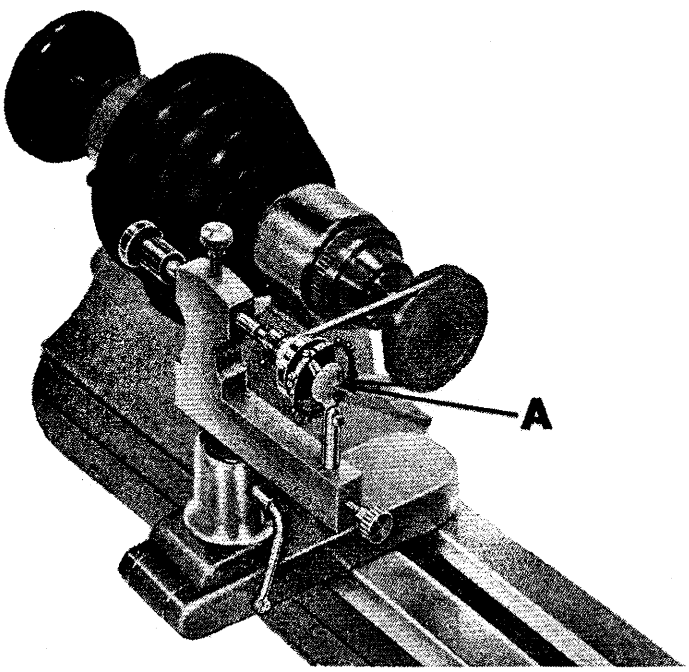
SEC. 523 - Straightening Pivots

In former years, a watchmaker took a great deal of pride in his work, especially when called upon to make a balance staff for a repair job. Factories seemed to delight in seeing which one could make the hardest balance staff, much to the dismay of a poorly trained workman. An exceptionally hard balance pivot broke more readily than a soft one. A soft one would bend in most cases before it would break. Balance staffs in modern watches are not generally as hard as the ones used formerly.

At times you will be able to straighten bent pivots, and if properly executed, straightened pivots will give good service. For this purpose, an old pair of tweezers ground to the shape shown in figure 31-21 will prove very satisfactory. The tweezers should be hardened and tempered to dark straw and the inside of the jaws highly polished. To be able to straighten balance pivots it is necessary to have a large selection of chucks. It is not always necessary to remove the roller table if the roller table has been fitted tightly. Figure 31-22 illustrates a pivot that is bent slightly. To straighten, place tweezers high upon the cone parallel with the balance staff, figure 31-22. Be sure the staff is running true. Reverse the lathe motor and run it at fairly high speed. Close jaws of tweezers until you reach the position shown in figure 31-23. If it straightens immediately, the chances of the pivot functioning properly are good. Do not feel badly if the pivot breaks as it will be a constant cause of trouble if the pivot does not run true. After straightening, the pivot must be burnished on the end and repolished. Train pivots are straightened in the same manner.

SEC. 524 - Reasons for Polishing Pivots

In the general repair of watches, cleaning, etc., it is good practice to burnish the ends and the sides of all balance pivots. The highly polished balance pivot decreases friction and, in most instances, the watch to be repaired will take a better motion. Most factory material is precision made and the majority of staff replacements can be made quickly and easily with genuine material. In replacing a factory balance staff, it is good practice to carefully check the pivots and be sure they are burnished and polished before replacing in the watch.



COURTESY OF THE NORTH AMERICAN WATCH TOOL AND SUPPLY CO., CHICAGO, ILLINOIS

Fig. 31 - 24

The pivot polisher illustrated in figure 31-24 is an excellent tool for burnishing and polishing cone shaped pivots. The T Rest has been removed and the pivot polisher inserted in its place. The drive pulley is mounted in a #50 wire chuck and a small rubber belt is used to connect the drive pulley and the pulley on pivot polisher. The small thin plate at A is one of several interchangeable plates required to accommodate different sized pivots. The plate is thin enough to allow the pivot to extend through the hole, the cone resting on the inner side of the plate. A small, hardened steel burnisher is used to finish the end and side of the pivot. Some watchmakers fasten the pivot polisher to the bench and operate it with a bow.

SEC. 525 - Making a Balance Staff

The ordering and replacing of a balance staff in a modern watch is done quickly and easily because of the standardization of watch material. At times you will find it necessary to make alterations on a new factory made staff. It may be that the balance shoulder, collet shoulder or roller post are too large. It is seldom that you will find a staff needing all of these corrections but in order to have the "know how", it is necessary to practice making balance staffs. There are times also when you will be called upon to make a balance staff for a watch, usually one for which no material is obtainable.

The difference between making a practice balance staff, a balance staff with a sample, and a balance staff without a sample varies only in the method in which the dimensions are obtained. Balance staffs are always made from high quality steel wire or drill rod, which has been hardened and tempered to a deep blue.

1. Place wire in chuck and let it extend a little more than the length of the finished staff.

2. Grind the end with a Hard Arkansas slip. Burnish end with hardened steel burnisher, figure 31-25.

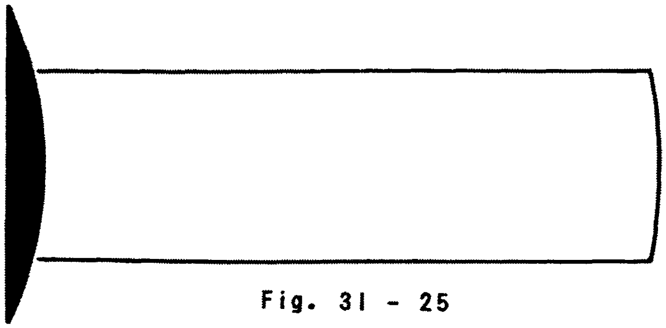


Fig. 31 - 25

3. Cut a square shoulder on the end of wire for the balance shoulder, figure 31-26. It is good practice to use the balance wheel for this diameter. As we must grind and polish each section of the balance staff, it is advisable to allow approximately 4/100 millimeters for this purpose (pivots excepted).

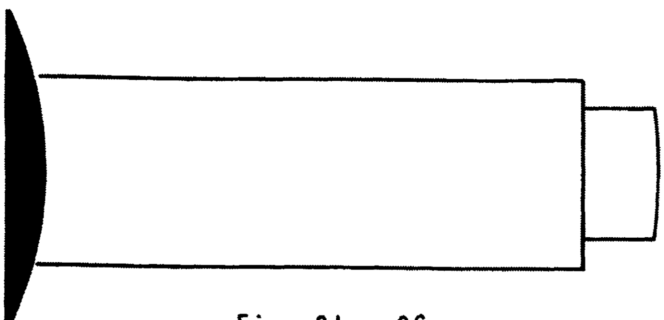


Fig. 31 - 26

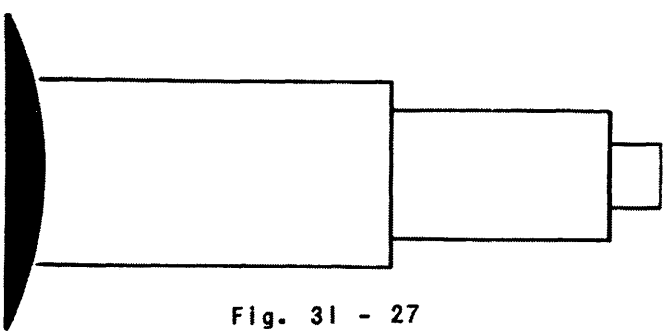


Fig. 31 - 27

4. Cut this shoulder back to proper length as in figure 31-27. This length and all lengths given in this section are obtained with a millimeter gauge from measurements given on your master work sheet.

5. Cut a square shoulder on end of wire for collet as in figure 31-27.

6. Cut collet shoulder back to proper length, figure 31-28. This length is actually determined by the thickness of the arm of the balance wheel, as there must be enough metal left up and above the arm of the balance wheel to allow for riveting as indicated by the dotted line in figure 31-28.

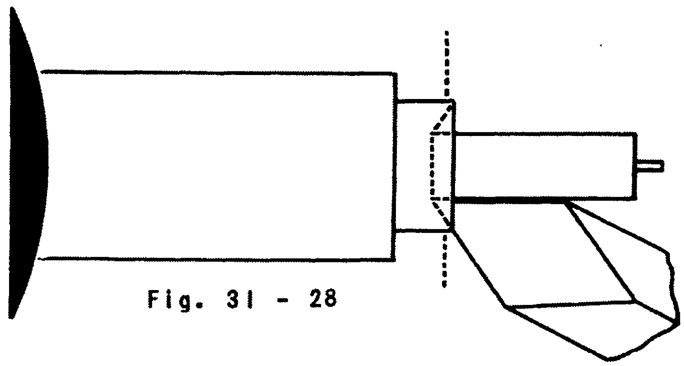


Fig. 31 - 28

7. The undercut is made, after the collet shoulder has been ground and polished, by holding the graver in position as shown in figure 31-28.

8. Cut a square shoulder pivot on end of wire, which is 2-1/2 times as long as the finished diameter of the pivot, in figure 31-28. Remember to allow approximately 2 or 3/100 mm for grinding and polishing.

9. Cut cone and oil cut and grind and polish pivot as shown in figure 31-29.

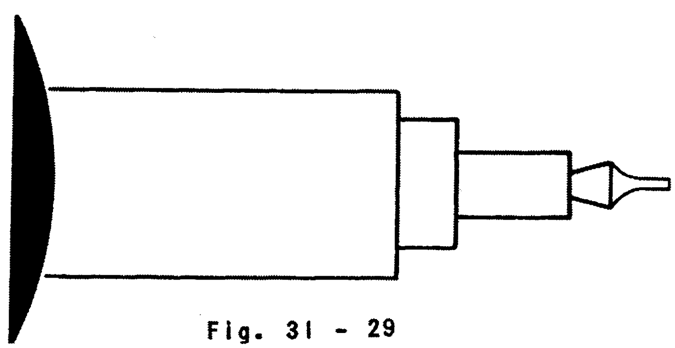


Fig. 31 - 29

10. Bevel corner of collet post as shown in figure 31-30.

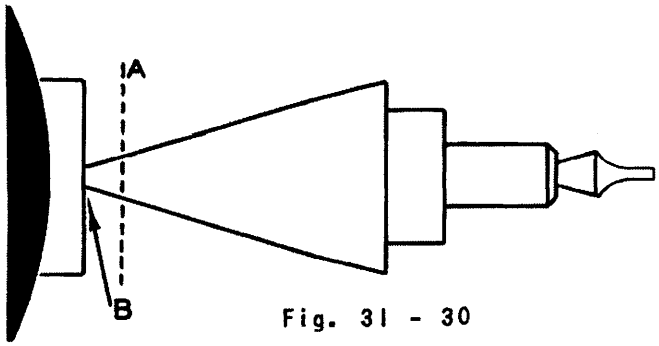
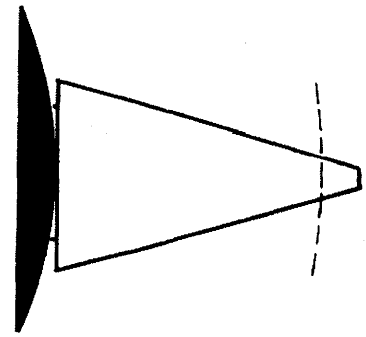


Fig. 31 - 30

Fig. 31 - 31



11. Make a tapered cut as shown in figure 31-30 so that we may break the staff off from the wire. The dotted line at A is the length of the finished staff measured from the end of the finished pivot. Notice that the cut extends beyond dotted line A, figure 31-30.

12. Break off unfinished staff at B, figure 31-30. The next step is to finish the end to the correct length of our balance staff. This method requires the workman to have a complete range of chuck sizes.

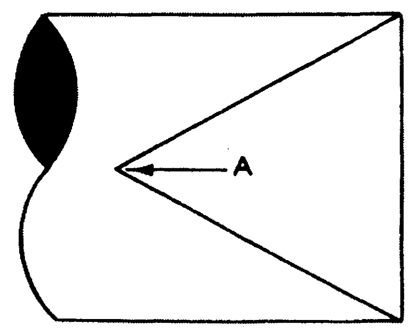
13. Catch the balance shoulder in the chuck of the proper size as in figure 31-31. Relieve the tension in the draw-in spindle of the lathe and while running the lathe in reverse hold the middle finger on a T rest and true the balance staff. Quickly grab the draw-in spindle with the left hand, which will tighten chuck on balance shoulder.

14. With a Hard Arkansas slip or oilstone, grind off the end of the unfinished staff to the proper length as illustrated by dotted line in figure 31-31. Burnish end. This may necessitate removing the staff from the chuck several times in order to measure the length with a micrometer.

It is impractical to use wire chucks to make this end of the balance staff because the staff will not run true. In order to have the staff run true, use a cement chuck which has been hollowed out.

15. Place cement chuck in lathe and make a deep cone shaped cut as in figure 31-32. The center of the cone indicated by Arrow A must be tested with a needle in order to insure this point being absolutely centered. Do not proceed until it is correct.

Fig. 31 - 32



16. Heat the cement chuck with an alcohol lamp and fill hollow with shellac. Then warm balance staff by placing it in warm shellac until the cement adheres to the balance staff, figure 31-33, the same way as it did the jewel settings in Lesson 30.

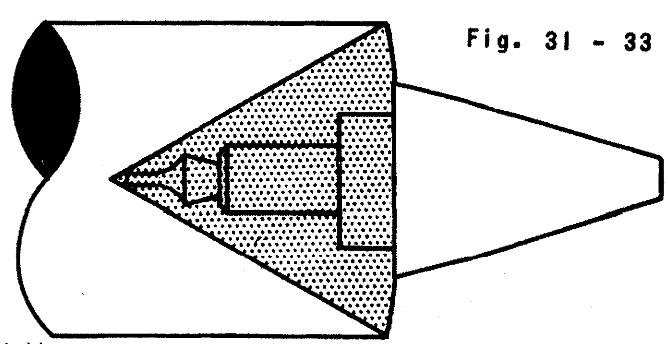


Fig. 31 - 33

17. Place T Rest as close as possible to balance staff and while cement chuck is still warm, true end of staff using pegwood or fingernail. Let cool.

18. Turn a square shoulder on end for roller post as illustrated in figure 31-34 and mark the length of roller post as illustrated by dotted line.

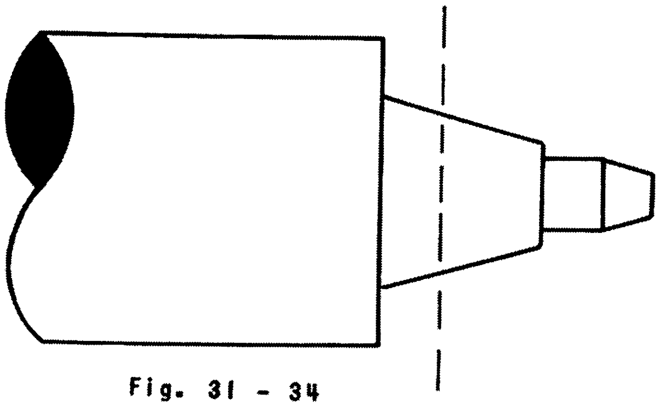


Fig. 31 - 34

19. Finish cutting roller post with a slight taper which should measure approximately 2/100 mm from front to back, figure 31-35. It is possible to use a micrometer if you know the exact measurement but in balance staff work, it is much better to try the roller table on the end of roller post and grind and polish the post until the roller table fits approximately one-half of the thickness of the roller table from the base of the hub as indicated by arrows in figure 31-36.

20. Grind and polish hub.

21. Cut square shoulder pivot on end of roller post 2-1/2 times the diameter of the finished pivot allowing approximately 2/100mm for grinding and polishing, figure 31-36.

22. Cut cone, grind and polish pivot as in figure 31-37.

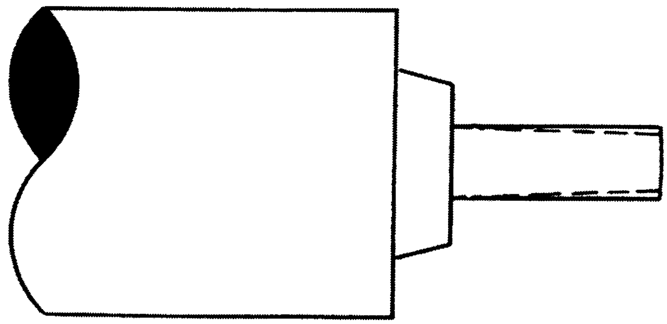


Fig. 31 - 35

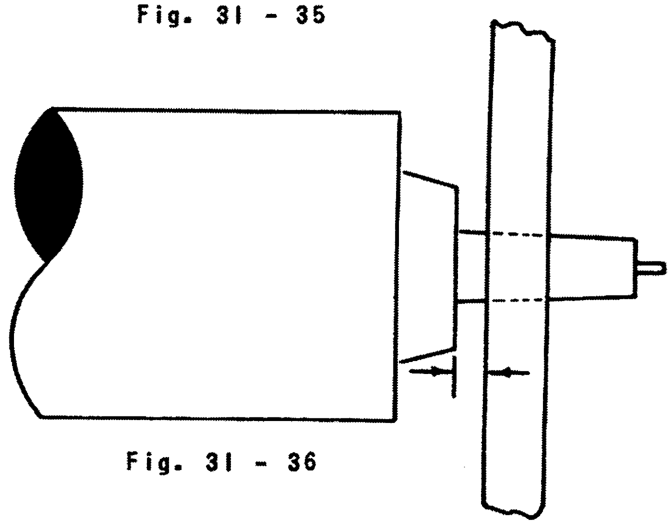


Fig. 31 - 36

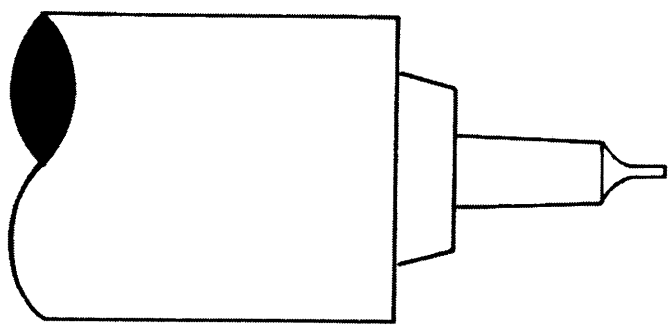


Fig. 31 - 37

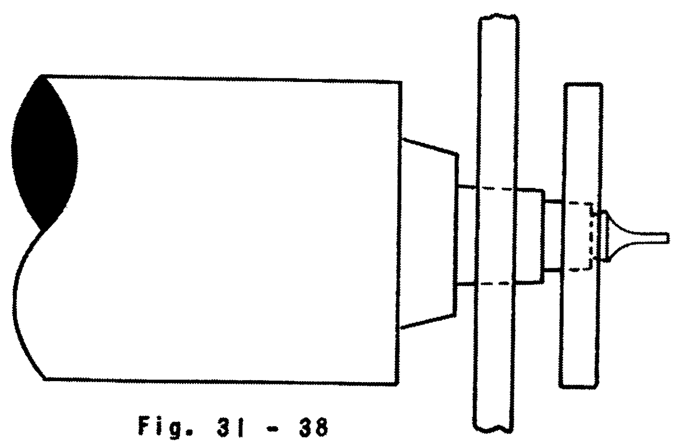


Fig. 31 - 38

23. Warm cement chuck with alcohol lamp, remove balance staff, and clean in alcohol. In fitting a combination roller, the same procedure is used as in figure 31-36- In fitting a two-piece double roller, two shoulders have to be cut as in figure 31-38 and both the impulse roller and the safety roller should fit to within one-half of the thickness of each roller from the shoulders, figure 31-38. The above instruction was given without mentioning any grinding or polishing except for the balance pivots. Remember it is necessary to grind and polish the balance shoulder, the collet shoulder, and the roller post. Therefore, you must allow approximately 3 or 4/100 mm for grinding and polishing.

SEC. 526 - Making Staff to Sample

Figure 31-39 illustrates the proper method of removing the balance staff from the balance wheel by cutting away the hub and then undercutting. Use this method on all watches which have riveted staffs in order not to mar the balance arm.

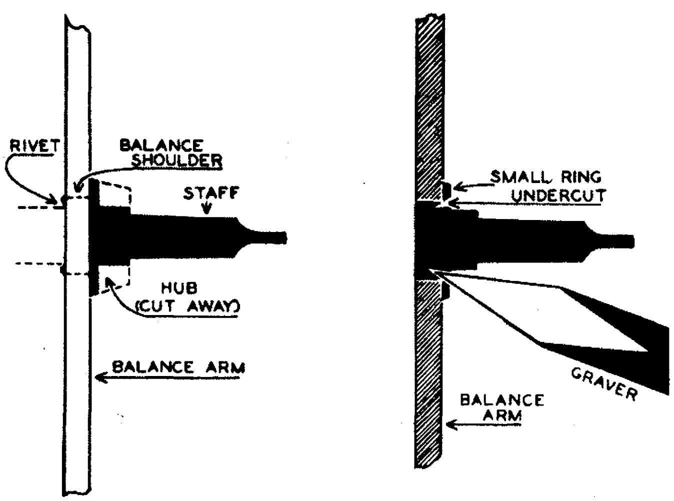
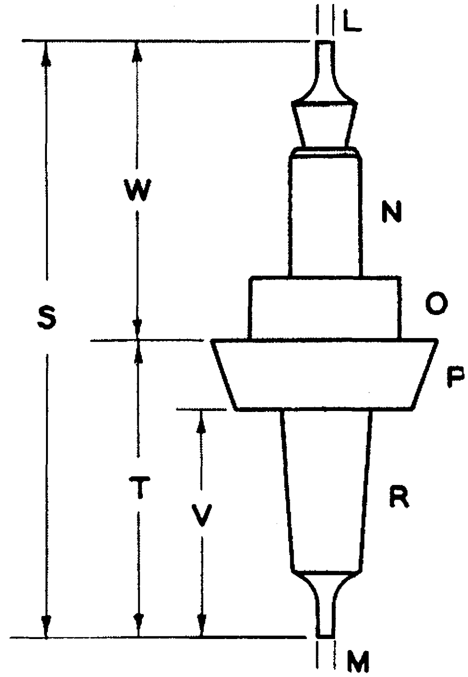


Fig. 31 - 39



L UPPER PIVOT _____MM
M LOWER " ______MM
N COLLET SEAT ______MM
O WHEEL " ______MM
P HUB ______MM
(The diameter of the hub should be less than the width of the balance arm)
R ROLLER SEAT ______MM
S LGTH. OVERALL______MM

Fig. 31 - 40

In making a balance staff to a sample, make a sketch as in figure 31-40 and fill in the dimensions of the pivots, balance shoulder, collet shoulder and roller post. To determine the correct length of balance staff with broken pivot, allow approximately 3/10 mm for each broken pivot. This will give you the total length overall.

1. Select wire, place in chuck, and proceed as in Section 525. Grind and burnish end of wire.

2. Hold sample balance staff in position shown in figure 31-41. The dotted line A represents the distance from the end of the pivot to the balance wheel shoulder.

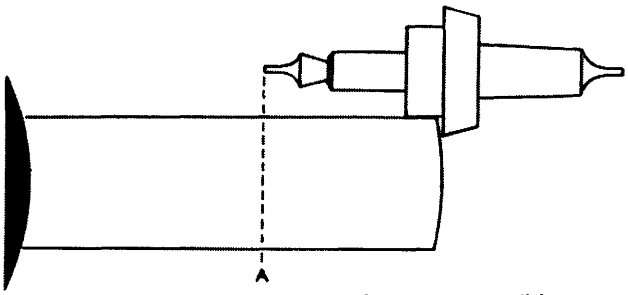


Fig. 31 - 41

3. Turn balance wheel shoulder. Grind and polish.

4. Turn collet shoulder allowing enough metal to extend through the arm of the balance wheel for riveting. Grind and polish.

5. Undercut balance shoulder.

6. Turn cone shape pivot and oil cut. Grind and polish.

7. Cut off staff as in Step 11, Sec. 525.

8. Grind to proper length, Step 14, Sec. 525.

9. Cement staff in cement chuck.

10. Hold sample balance staff in postiion shown in figure 31-42. The dotted line A represents the distance from the end of the pivot to the roller table shoulder.

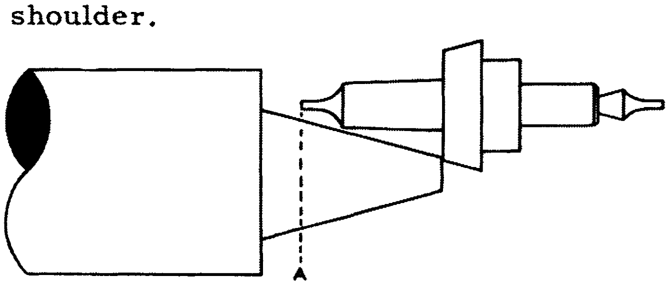


Fig. 31 - 42

11. Cut roller post. Grind and polish. Fit roller.

12. Grind and polish hub.

13. Cut pivot, grind, and polish.

14. Remove from cement chuck and clean in alcohol.

SEC. 527 - Making Balance Staff Without a Sample

Making a balance staff without a sample is an accomplishment enjoyed by all good watchmakers. The actual process of making a balance staff is the same as given in Sec. 525. It is advisable to make a sketch the same as in Figure 31-40 and fill in the dimensions as you obtain them. Before ascertaining the dimensions, make sure the upper and lower balance jewels and cap jewels are correct and the balance cock is not bent up or down but is parallel with the pillar plate.

To obtain the different dimensions proceed as follows:

Use a millimeter gauge or a degree gauge which measures in hundredths of a millimeter.

1. To get the overall length of a balance staff, measure from the outside of the upper cap jewel to the outside of the lower cap jewel A, figure 31-43. Subtract the thickness of both cap jewels, B and C, figure 31-43, which will give the over-all length of the balance staff exclusive of endshake, which can be adjusted later. This is written as LOA (Length Over-All). Mark the result on your sketch.

2. Measure the distance between the center wheel and the pallet bridge D, figure 31-43 (or the upper plate and balance bridge in case of a full plate

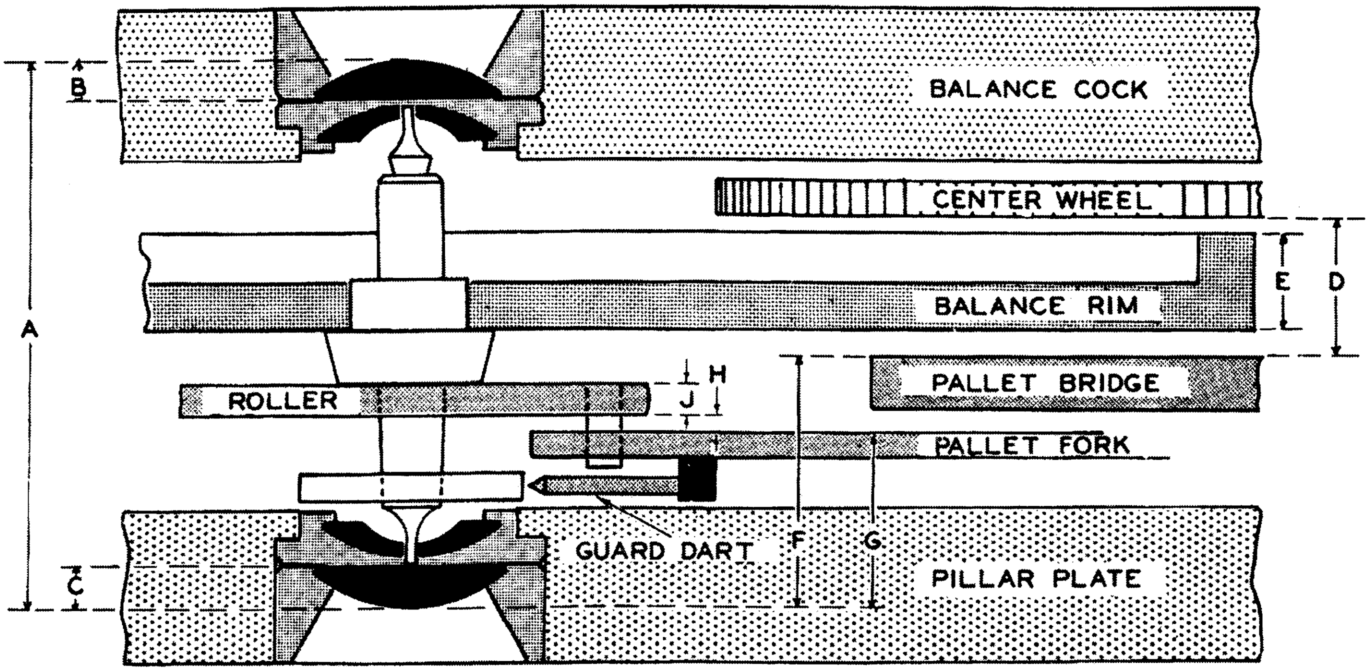


Fig. 31 - 43

movement). Measure the thickness of the balance rim E, figure 31-43. The difference between the measurements D & E divided by two will give the clearances between the lower edge of the balance rim and the top of the pallet bridge, and the top of the balance rim and center wheel, (or the lower edge of the balance rim and the upper plate, and the top of the balance rim and balance bridge in case of a full plate movement).

The remainder of the instructions will use, as an example, a three-quarter plate or bridge model movement, and measurements will be taken with the cap jewels in place.

3. Using the sketch you made of the balance staff, mark in the measurements as you determine them. From the outside of the lower cap jewel to the top of the pallet bridge, F, figure 31-43, plus one-half the difference between the thickness of the rim of the balance wheel and the space between the center wheel and the pallet bridge, (result of Step 2), minus the thickness of the lower cap jewel, C, figure 31-43, equals the length of the balance staff from the end of the lower pivot to the balance seat, T, figure 31-40.

4. From the outside of the lower cap jewel to the top of the pallet fork, G, figure 31-43, plus one-half the thickness of the impulse roller for clearance, H, figure 31-43, plus the thickness of the impulse roller, J, figure 31-43, minus the thickness of the lower cap jewel C, equals the length of the lower half of the balance staff from the end of the lower pivot to the underside of the balance hub, V, figure 31-40.

5. Subtract the result obtained in Step 3, T, figure 31-40. from the L O A of the balance staff, S, figure 31-40, and the result will be the length of the balance staff from the end of the upper pivot to the balance shoulder, W, figure 31-40.

6. The difference between W and V, figure 31-40, equals the thickness of the hub, P, figure 31-40.

7. Determine the diameters of pivots by measuring the jewel holes with a jewel hole gauge or balance pivots which fit correctly. Make the straight part of the pivot 2-1/2 times as long as the diameter, the cone the same length, and the back cut at your discretion. Back cut may be made extremely short if necessary to leave the collet seat long enough. Diameter of the back cut should be slightly less than the diameter of the collet seat.

8. Drop the collet on a tapered pin and mark the location, figure 31-44. Measure the diameter of pin at this point with a micrometer and multiply the result by the constant 1.05. This result will be the finished diameter of collet seat.

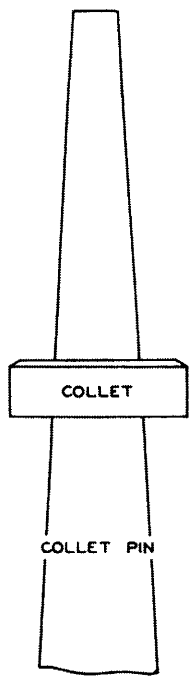


Fig. 31 - 44

9. The roller seat should have a slight taper (taper toward the lower pivot) and have a finished size that will permit the impulse roller to be pushed within half the thickness of the roller.

10. After all dimensions are obtained and entered on the sketch, proceed to make balance staff (Section 525).

SEC. 528 - Making Punches for Washer

At this time we will make punches to be used in poising balance wheels. As you proceed with watch repair work, make these punches to fit different size balance screws as you encounter them. The following dimensions are suitable for a 16 size Elgin Watch:

1. Turn down a square shoulder about 4/100ths mm larger than the threads of the balance screw, figure 31-45.

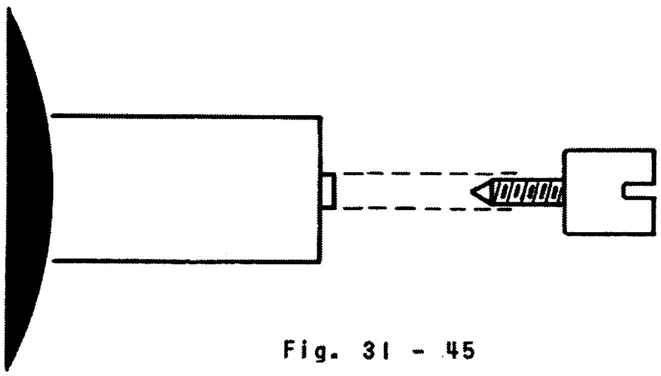


Fig. 31 - 45

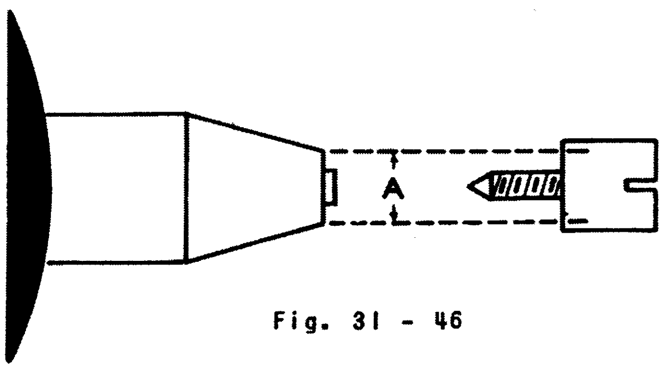


Fig. 31 - 46

2. Bevel corner of rod so that diameter illustrated at A is slightly smaller than the head of the balance screw. figure 31-46. Cut off pilot as shown in figure 31-47. Harden and temper to a straw. The shorter the pilot the less trouble you will have in removing the washers. Obtain a small lead block or melt some lead in a small material can. Punch washers from very thin material such as dial washers, figure 31-48.

Fig. 31 - 47

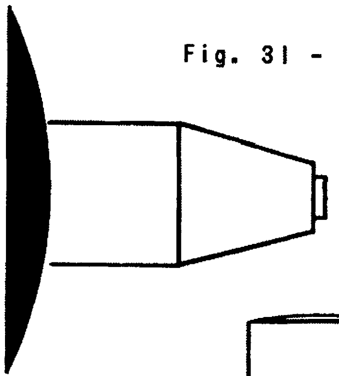
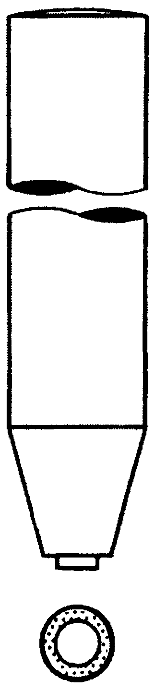


Fig. 31 - 48



These washers are slipped under the heads of the balance screws when poising wheel. At times, when we are under-cutting screws, it is a good policy to add washers to the opposite screws in order to keep the weight of the balance more equal, and you will not have to make as many adjustments when bringing the watch to time. These punches can be made in any size you desire and a work-man may make his own timing washers. In some cases where a pair of heavy washers is needed for a bracelet watch, thin gold or platinum can be used. Be-cause platinum is the heaviest metal known, washers made of this metal will have greater effect upon slowing up a watch. Keep these punches handy and use the washers when poising a balance wheel or regulating a watch.

SEC. 529 - Carboloy Gravers

Carboloy is the hardest metal made by man. It is a very useful tool for the watchmaker. A carboloy graver will cut the hardest of balance staffs or stems. It is extremely useful in removing a balance wheel by cutting away the old hub, figure 31-39. This method is with-out a doubt the safest and most practical way of removing the balance wheel from the staff. Before the advent of the carbo-loy graver, the watchmaker was con-fronted at times with a balance staff which was too hard to be cut with an ordinary graver. At times he would have the hub cut half way through and discover that in the cutting process the steel had become burnished making a great deal of extra work in sharpening the graver or drawing the temper in the staff. With the carboloy graver you can disregard the hardness. Keep your carboloy gravers sharp and use them only where it is impractical to use the ordinary graver. The carboloy graver illustrated in figure 31-49 has a removable handle. Carboloy gravers must be sharpened with a diamond charged lap or wheel. Remember that because of the extreme hardness of the carboloy graver the point will break quite easily. Therefore, do not force the graver when cutting.

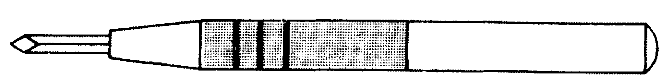


Fig. 31 - 49

SEC. 530 - Fitting Pinions to Watches

It should be an easy matter by now to replace a pinion in a watch. We are not often compelled to make a pinion from pinion wire as most pinions can be obtained in the finished form from a material house.

Although the average finished pinion ordered from a material house should fit there are times when the pivots have to be ground and polished to fit the bearings or jewels. Some pinions may have a square shoulder pivot on one end and a cone shape on the other. Figure 31-50 illustrates the end of a blank pinion. Blank pinions come with any number of leaves desired such as 6, 7, 8, 9, 10, and 12. The diameters are gauged by a Stubs Gauge.

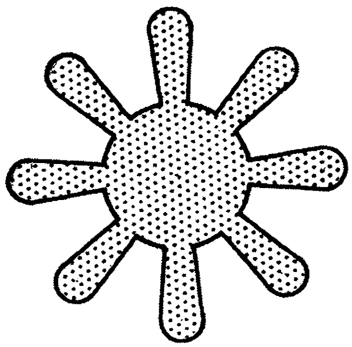


Fig. 31 - 50

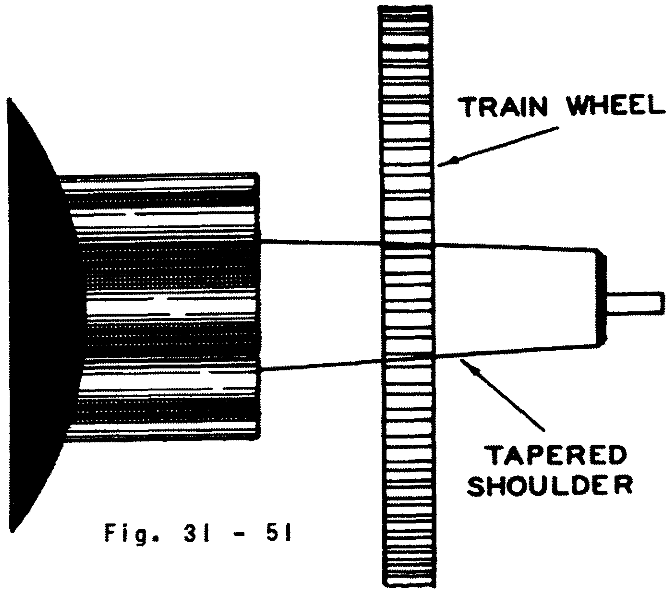


Fig. 31 - 51

Pinions to fit watches can be cut from pinion wire as follows:

1. Select a blank pinion with the same number of leaves as the sample and the same diameter as measured with a Stubs Gauge.

2. Obtain over-all length.

3. Obtain height of wheel shoulder.

4. Turn pinion wire to fit wheel.

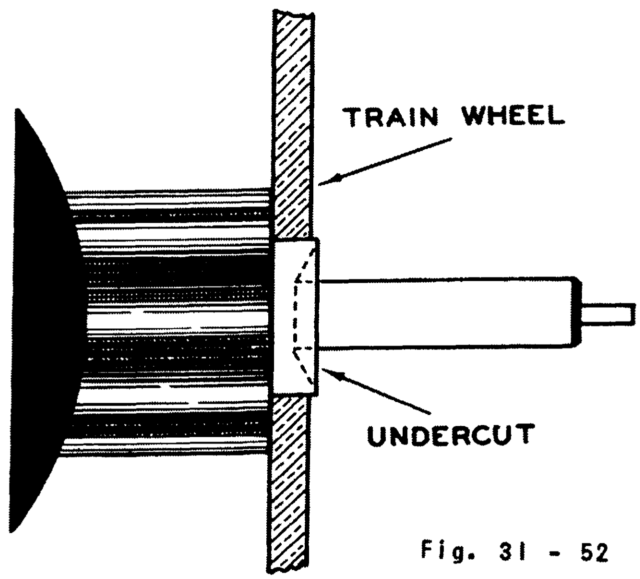


Fig. 31 - 52

Figure 31-51 illustrates the pinion leaves cut down to a tapered shoulder on which the train wheel is to be driven friction tight.

Figure 31-52 illustrates the pinion leaves cut down for a wheel which requires rivetting. The shoulder protrudes through the wheel enough to be rivetted after undercutting.

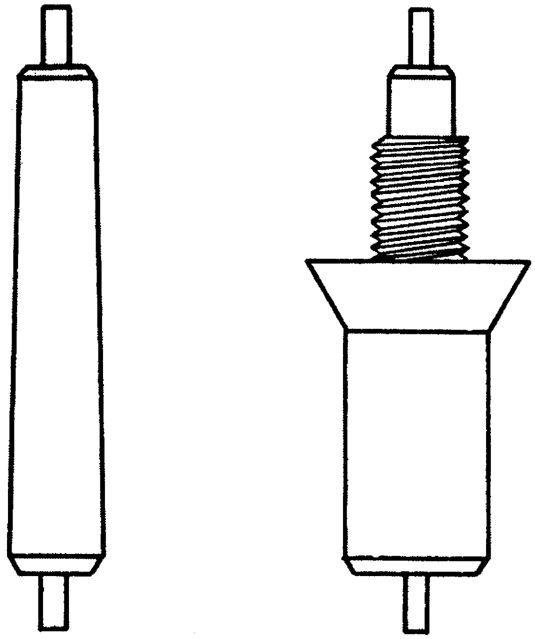
5. Cut through leaves to match length of sample pinion.

6. Cut, grind, and polish pivots.

7. Replace wheel.

SEC. 531 - Pallet Arbors

Figure 31-53 illustrates two types of pallet arbors. A is a friction type having a tapered shaft which is driven into pallet fork. B represents a screw type



A Fig. 31 - 53 B

pallet arbor. This is screwed into pallet fork and is easily removed by catching pallet arbor in a chuck and holding head of lathe with left hand, carefully turning pallet fork toward you. In replacing pallet arbors, it is necessary to ascertain the correct one to be used, using a micrometer. Any alterations of pallet arbor are made the same as for pinion or balance staffs using square and/or cone shaped pivots.

SEC. 532 - Making a Stem from a Sample

For stem work it is desirable to have a good slot cutting graver as illustrated in figure 31-54. This graver can be made from a regular graver #0, the tip to measure approximately .50 mm. It is also possible to make a graver from a piece of square drill rod. However, a carboloy graver is recommended in preference to all others.

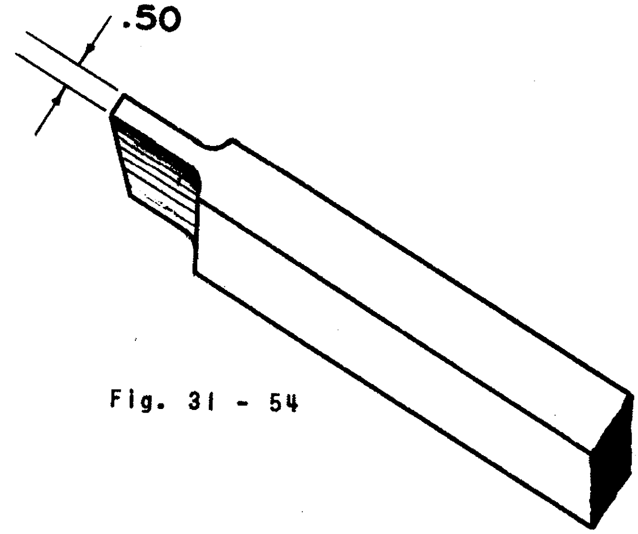


Fig. 31 - 54

1. Select a piece of drill rod slightly larger than the diameter of the finished hub of the sample stem.

2. Cut off as in figure 31-55, the length over-all to be slightly longer than the length of the finished stem.

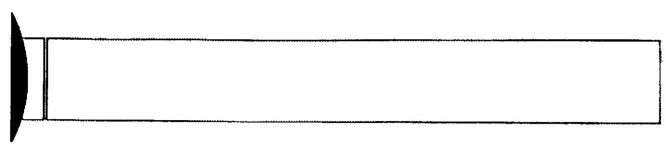


Fig. 31 - 55

3. Place in lathe and cut thread (Lesson 29, figure 29-34). This thread should be slightly longer than the sample, figure 31-56, and of the same tap size as crown to be used.

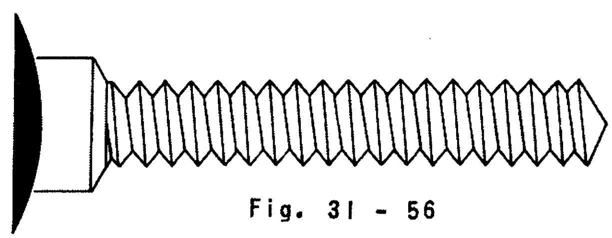


Fig. 31 - 56

4. Place threaded portion in lathe chuck and cut off to correct length using sample for length A, figure 31-57.

5. Remove, harden, and temper to a blue.

6. Place threaded portion in lathe chuck, figure 31-58, and turn outside diameter to the diameter of the hub.

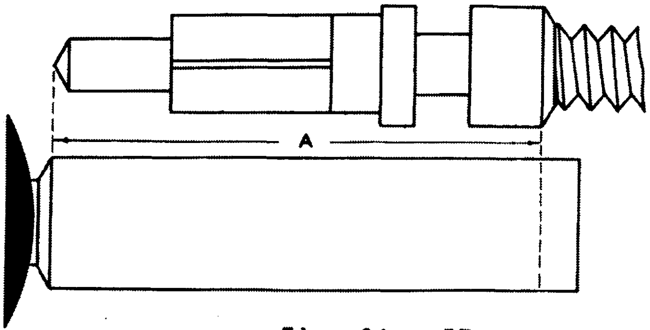


Fig. 31 - 57

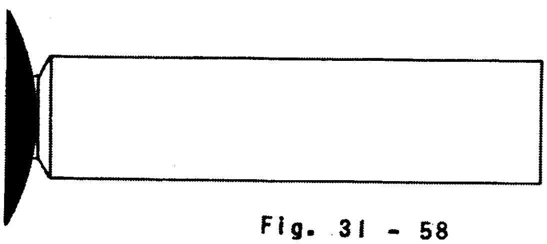


Fig. 31 - 58

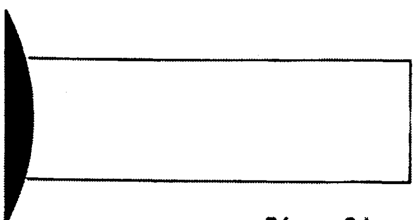


Fig. 31 - 59

7. Remove from lathe and place hub section in lathe chuck allowing the length required for the winding pinion shoulder to extend from chuck, figure 31-59.

8. Turn pilot, figure 31-60, using old stem pilot as guide for length.

9. Turn diameter for winding pinion using old stem as guide to length, figure 31-61.

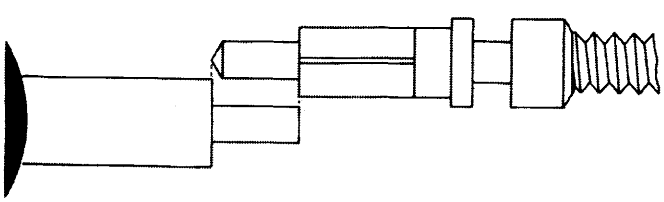


Fig. 31 - 60

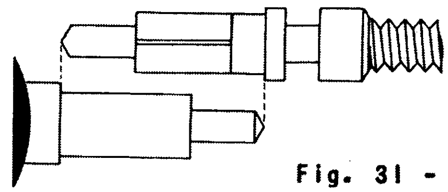


Fig. 31 - 61

10. Measure the width of the square on the old stem and multiply by the constant 1.39. The result is the diameter to turn for the winding square. This constant can be used for any size winding square. To find the exact diameter of a circle circumscribed about a given square, multiply the length of one side of the square by the constant 1.41. However, for our purpose, we use the constant 1.39 which will allow the corners of the square to be slightly rounded as in figure 31-62.

Example: Length of one side of square equals .95 mm. .95 multiplied by constant 1.39 equals 1.32 mm.

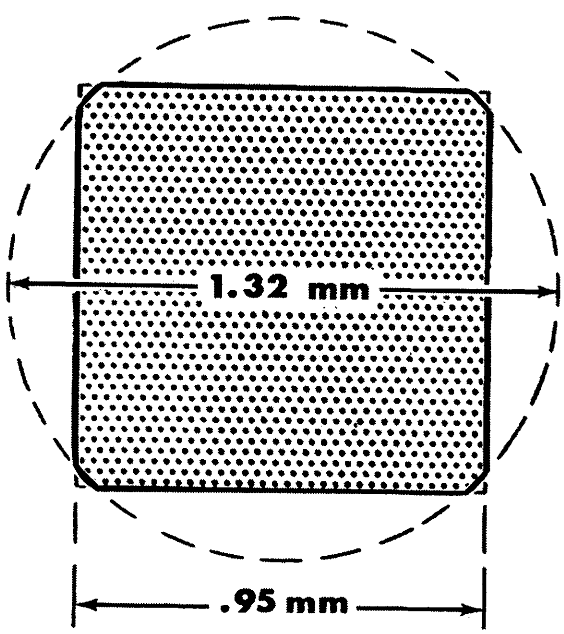


Fig. 31 - 62

11. Turn clutch shoulder to diameter using old stem as a guide for length, figure 31-63. Polish all surfaces finishing with 4/0 emery buff.

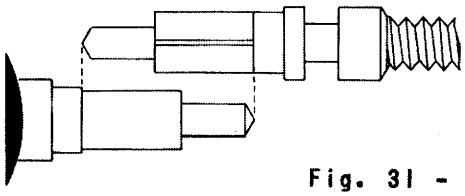


Fig. 31 - 63

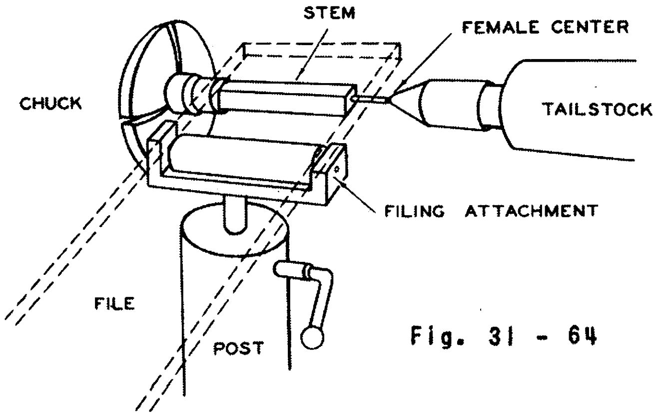


Fig. 31 - 64

12. File square on stem. This can be done using a file attachment as illustrated in figure 31-64. Figure 31-65 illustrates the four end positions of the stem as the square is turned using the index plate in the head of the lathe as a guide. The square can be measured with a micrometer and left several hundredths of a millimeter larger than the finished square. To finish draw file square to proper thickness. Remove from lathe, placing winding pinion shoulder in lathe chuck and cut slot, figure 31-66.

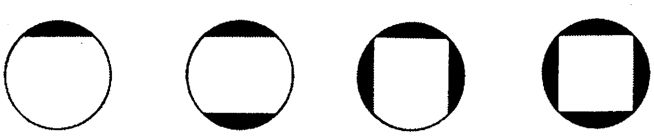


Fig. 31 - 65

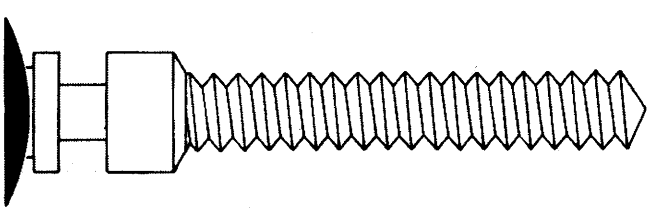


Fig. 31 - 66

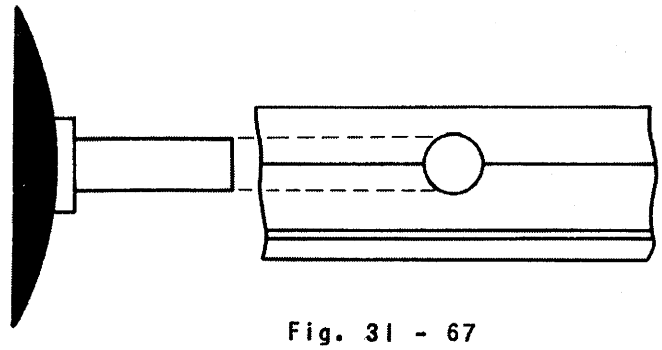


Fig. 31 - 67

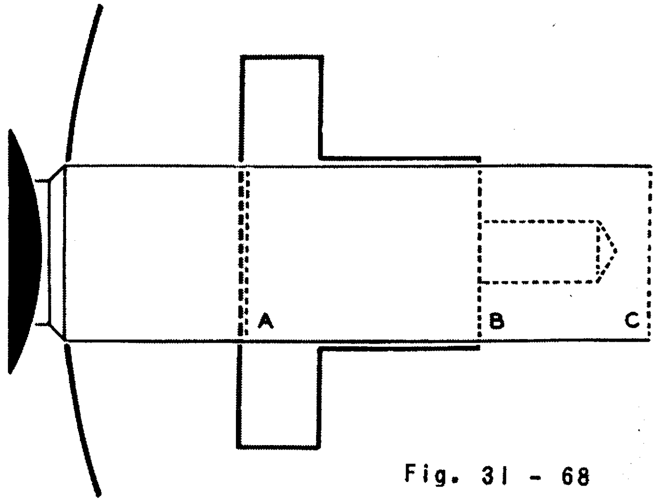


Fig. 31 - 68

SEC. 533 - How to Make a Stem Without a Sample

1. Turn down a metal plug until it just enters hole in plate, figure 31-67. At times it is necessary to round up the hole in the plate with a broach before making this plug.

2. Select a piece of drill rod slightly larger in diameter than the plug and of sufficient length for a complete stem.

3. Thread the end of stock the same tap size as the crown to be used and long enough to extend outside the watch case.

4. Remove from chuck and place threaded portion in a chuck of correct size. Hold pillar plate in position shown in figure 31-68 with the outer edge of pillar plate at the base of thread. Make

a mark with the point of your graver as indicated by dotted line A. This will be the winding pinion seat. Make a mark with the point of your graver as indicated by dotted line B. This will be the pilot seat. Allow sufficient length from this mark for the length of the pilot and cut off as at C, figure 31-68.

5. Remove, harden, and temper to a blue.

6. Place threaded portion in a chuck and turn the outside diameter to the diameter of the plug or until it fits the hole in plate snugly, figure 31-69.

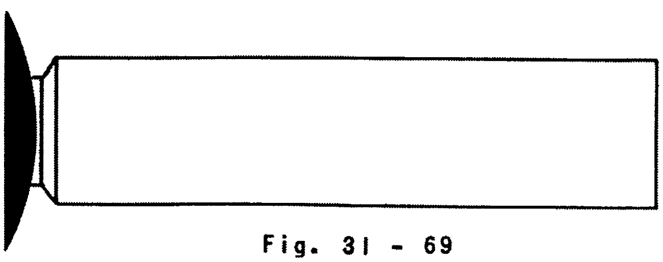


Fig. 31 - 69

7. Remove stem from lathe and catch up on full diameter of hub, figure 31-70.

8. Turn pilot to correct diameter and length, figure 31-70. If necessary, a plug can be made to ascertain the diameter of the hole in plate for pilot.

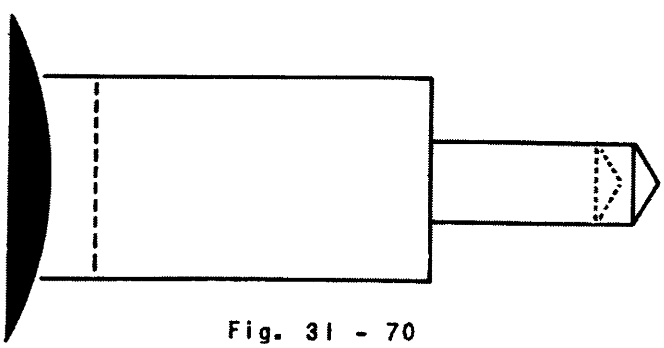


Fig. 31 - 70

9. Turn down winding pinion shoulder until winding pinion will just go on, figure 31-71.

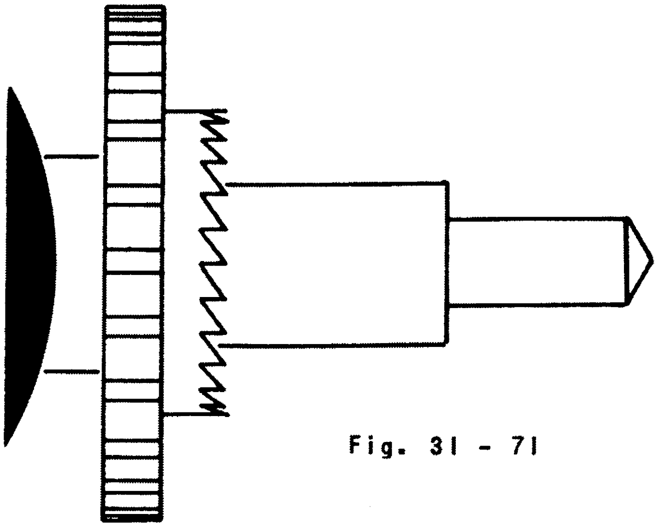


Fig. 31 - 71

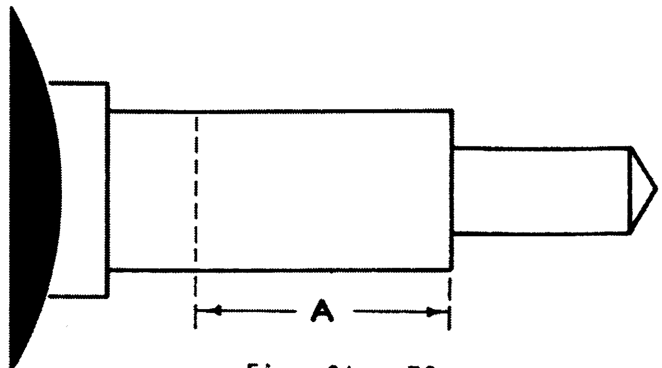


Fig. 31 - 72

10. Slide the clutch over a taper pin and measure the diameter with a micrometer at the point where the hole contacts the pin. Multiply this result by the constant 1.39. This result will give the diameter of section A, figure 31-72, from which the square is to be filed.

11. File square on stem.

12. Cut slot in stem. To locate slot insert stem into plate and with the winding and setting parts in place and in the winding position place a mark on either side of the point of contact between the setting lever pin and the unfinished stem. Be certain that the slot in stem is wide enough and deep enough to allow a minimum of play when set lever screw is tightened.

SEC. 534 - Repivoting

It is not often that we are called upon to repivot a pinion or a balance staff. This, however, was considered an accomplishment by the old master watchmaker but with today's standardized material it is more practical and profitable to purchase a new staff or pinion. At times you may find it profitable to repivot a pinion, especially in clock work.

1. Draw temper in pinion. Figure 31-73 illustrates the method by which a copper wire is crimped on to the pinion and heated until the pinion turns to a light blue.

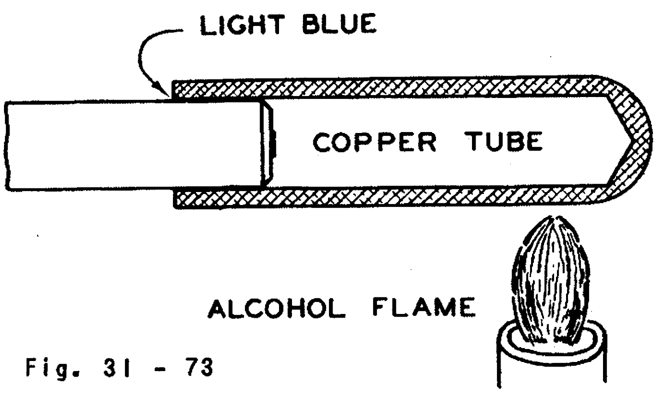


Fig. 31 - 73

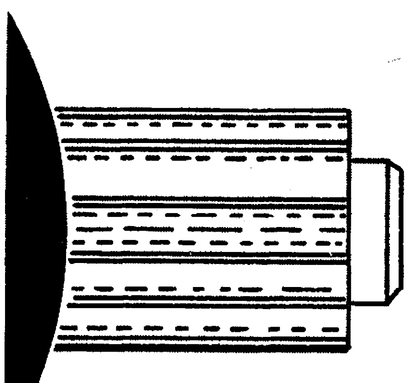


Fig. 31 - 74

2. Place pinion in lathe chuck and make certain it is running absolutely true, figure 31-74. If necessary, cement in a hollow cement chuck.

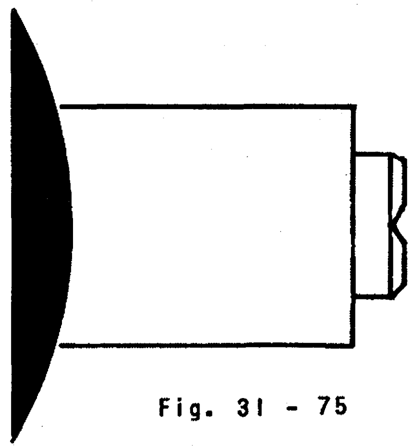


Fig. 31 - 75

3. Center, figure 31-75.

4. Drill hole slightly larger than the diameter of the finished pivot, figure 31-76.

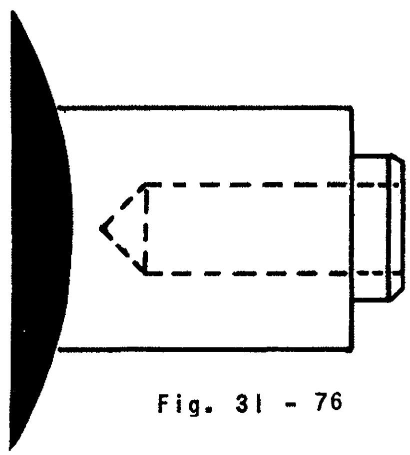


Fig. 31 - 76

5. Remove from lathe and take a blued pivot wire slightly larger than the finished pinion and chuck up the lathe. Turn down the diameter of this wire, figure 31-77, until it just starts into hole.

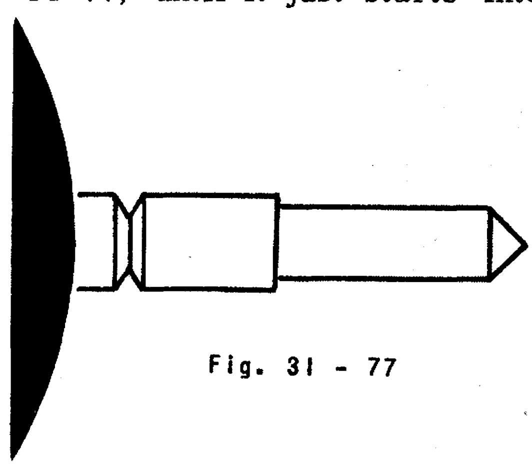


Fig. 31 - 77

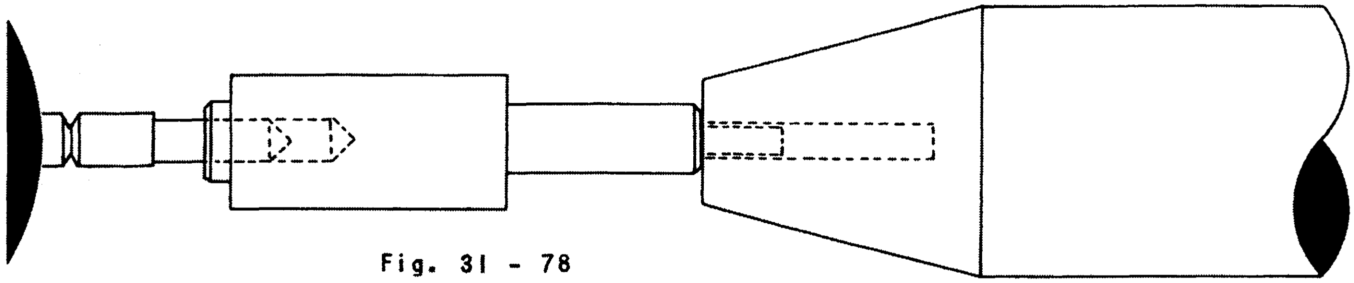


Fig. 31 - 78

6. Drive pinion into wire as in figure 31-78 using a flat face hollow staking tool punch. At times, it is necessary to reverse this process and drive the pivot wire in the pinion.

7. Remount pinion in lathe, figure 31-79, and finish pivot to the proper diameter and length, figure 31-80.

The same process is used to repivot a balance staff.

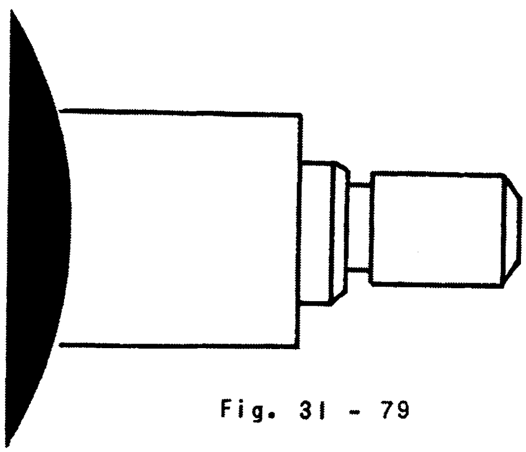


Fig. 31 - 79

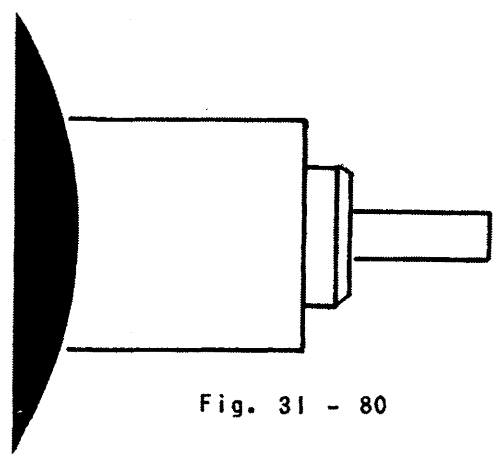


Fig. 31 - 80

SEC. 535 - Rebushing a Train Wheel

At times a train wheel which is out of true can be corrected with a rounding up tool and cutter. The rounding up tool which is used to round up the teeth in the wheel after the wheel is riveted to the pinion, is not used much by the watchmaker's craft here in the United States.

One of these tools is shown in figure 31-81. The wheel to be operated upon is placed upon a small table at A between two vertical runners with guard-pivot centers. The cutter is fixed at B to a suitable arbor chuck in a small head C, which is turned by hand-wheel D, a supplementary pulley E taking all strain off the axis. The three milled-headed nuts seen at F; G, and H are for adjusting; F for moving the lathe-head so that the cutter is in the same plane as the axis of the runners, a position which is determined by the pointer D; G for advancing the wheel against this cutter; and H for setting the plane of the wheel to pass through the axis of the lathe-head as indicated by the index K. The tool is accompanied by a number of cutters to suit the various sizes of teeth as well as of tables to support wheels of different dimensions.

An enlarged view of the mill cutter is shown in figure 31-82. Section A-B of the circumference is cut away and replaced by guide C-D made of spring steel and fixed to coincide with the edge

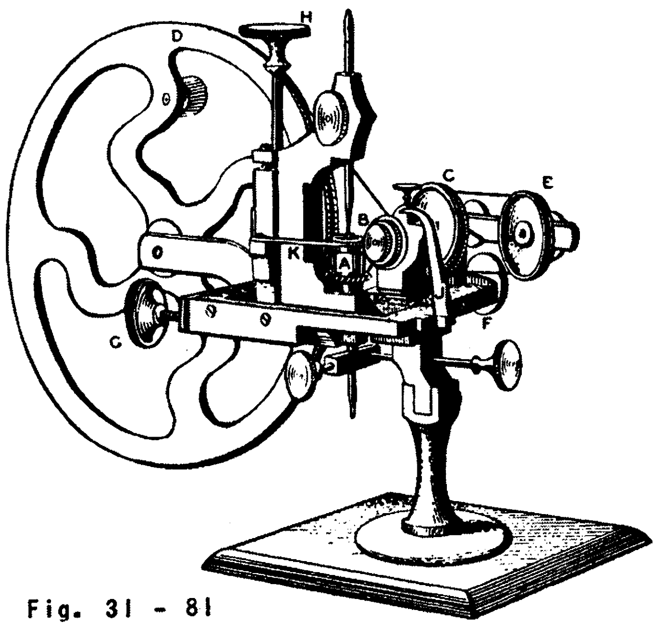


Fig. 31 - 81

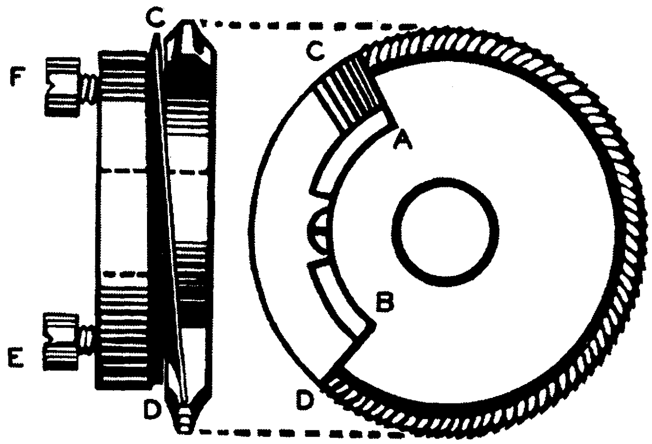


Fig. 31 - 82

of the cutter at D and inclined at C in order to compel the cutter to pass at each rotation into consecutive spaces of the wheel. Two screws are provided, E for setting the guide opposite the edge of the cutter, and F for placing the free end of the guide opposite to the space between teeth.

For the average watchmaker, it is possible to true up a train wheel in the following manner:

1. Remove train wheel from pinion.

2. Select a cement brass slightly larger than the diameter of the train wheel. Cut out a section as in figure 31-83 so that the train wheel will fit in without any side play.

3. Cement wheel in cement chuck, figure 31-84.

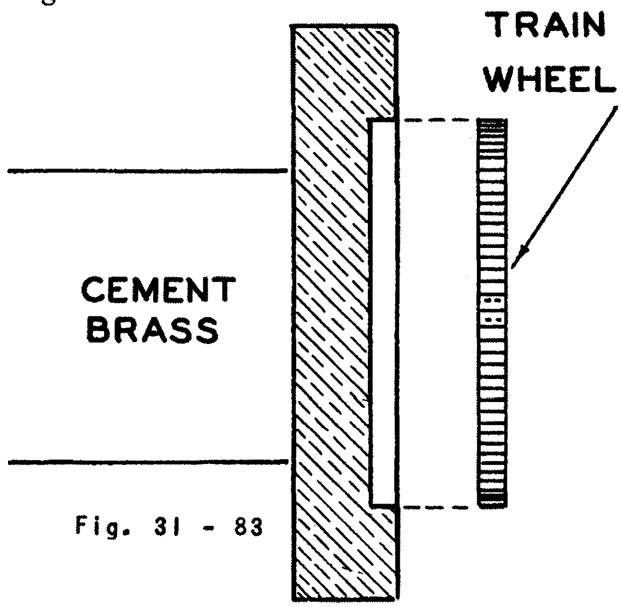


Fig. 31 - 83

4. Bore out center of wheel with boring tool, figure 31-84.

5. Remove wheel from cement chuck, boil and clean with alcohol.

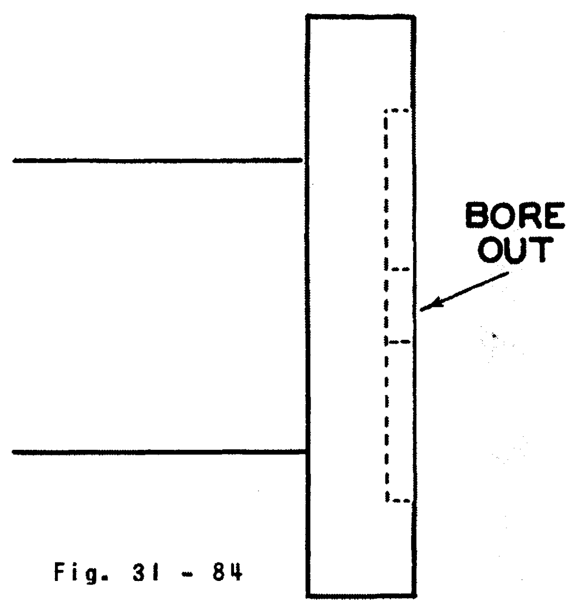


Fig. 31 - 84

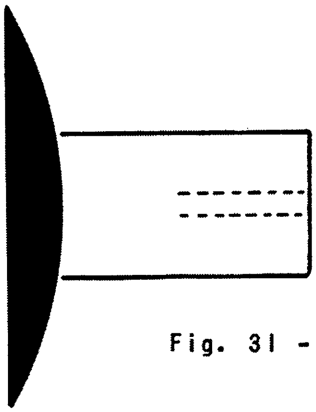


Fig. 31 - 85

6. Place a piece of brass wire in lathe, center and drill hole slightly smaller than the train pinion, figure 31-85. Turn shoulder until wheel just fits, leaving a small portion extending through wheel so that it can be riveted, figure 31-86.

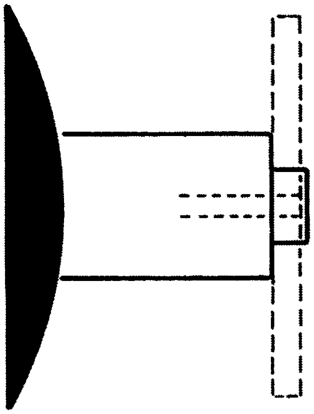


Fig. 31 - 86

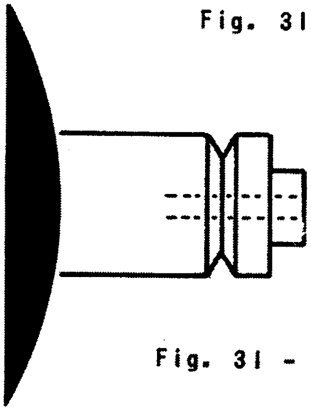


Fig. 31 - 87

Fig. 31 - 88

7. Cut a groove leaving a short hub as in figure 31-87. Saw off, reverse in chuck of proper size and face off hub as in figure 31-88.

8. A. Stake wheel to hub as in figure 31-89. The punch used for this operation will leave indentations as illustrated by A, figure 31-90.

B. Broach out hole in wheel and replace on pinion.

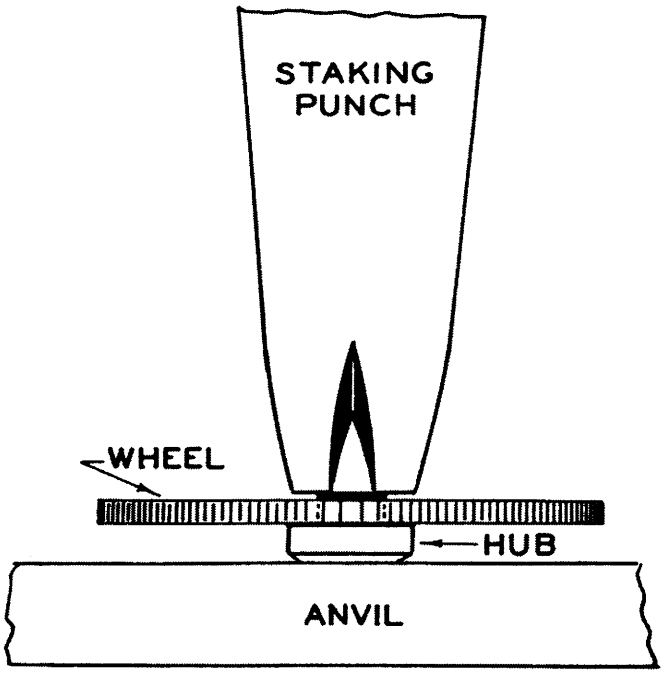


Fig. 31 - 89

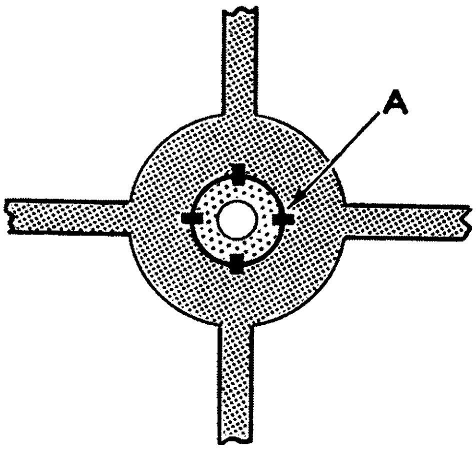


Fig. 31 - 90

SEC. 536 - Replacing a Hook in Barrel

When the hook in the barrel becomes broken or worn, the practical thing to do from the standpoint of time is to replace the barrel. At times this is impossible and it becomes necessary to replace the hook.

1. Locate center D, figure 31-91. This will be the center for the hook. It is found as follows:

$$\frac{A - B - C}{2} + B = D$$

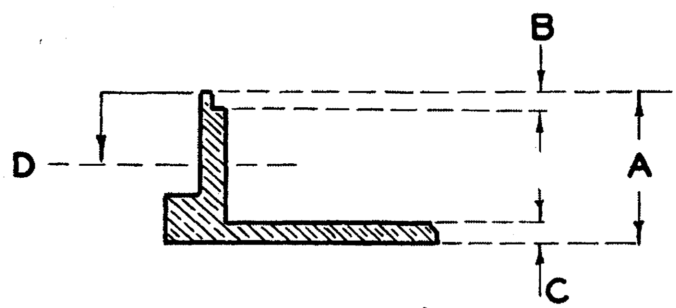


Fig. 31 - 91

2. Set a pair of dividers to this dimension and scribe a line on outside of barrel as shown at D, figure 31-92.

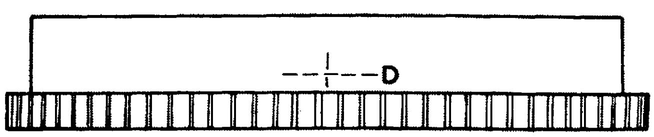


Fig. 31 - 92

3. Center punch barrel as in figure 31-93.

4. Select tap size, drill hole and tap barrel, figure 31-94.

5. Thread a piece of drill rod as in figure 31-95.

6. Turn diameter B, figure 31-95, slightly smaller than width A, figure 31-94.

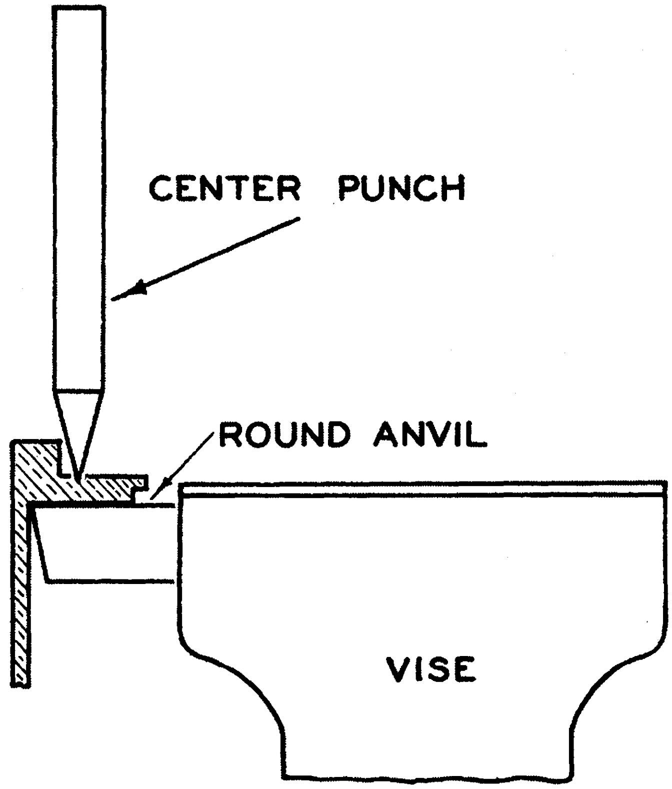


Fig. 31 - 93

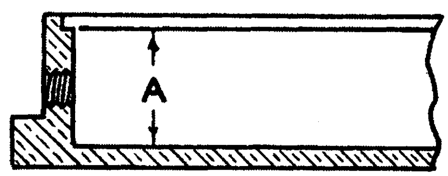


Fig. 31 - 94

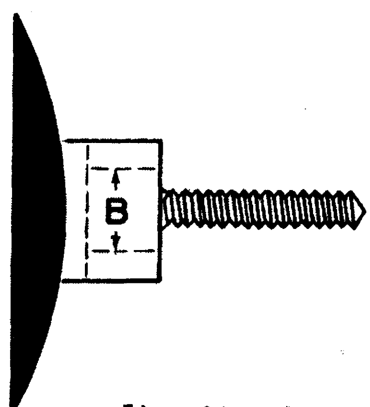


Fig. 31 - 95

7. Shape as in figure 31-96 to allow for the thickness of mainspring. The dashed lines illustrate the rim of barrel.

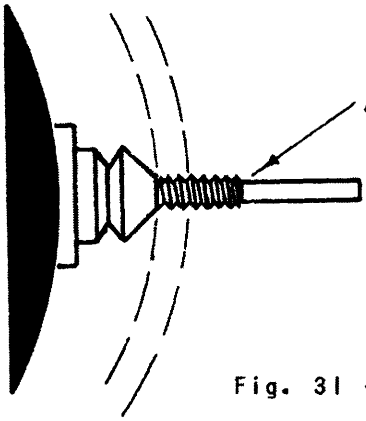


Fig. 31 - 96

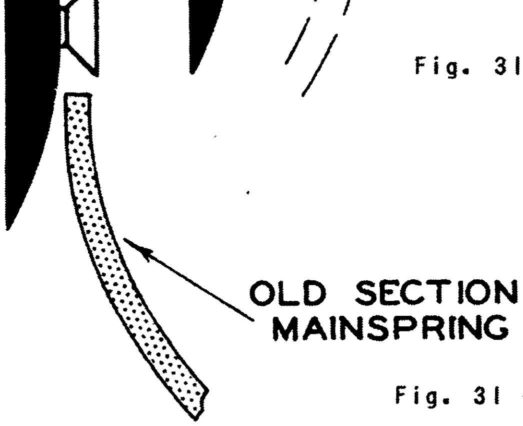


Fig. 31 - 97

8. Turn off thread as indicated at A, figure 31-96.

9. Cut groove, saw off end, reverse in chuck of correct size and finish end as in figure 31-97. The hook should now be slightly longer than the thickness of mainspring, figure 31-97.

10. Screw into barrel from the inside, figure 31-98.

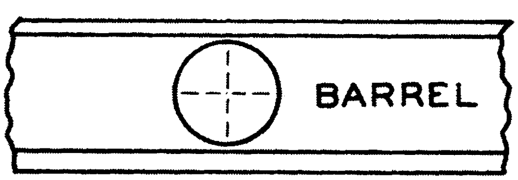


Fig. 31 - 98

11. Mark vertical and horizontal lines as in figure 31-98.

12. Remove and shape hook to fit hole in mainspring, figure 31-99.

13. Harden and temper to a blue.

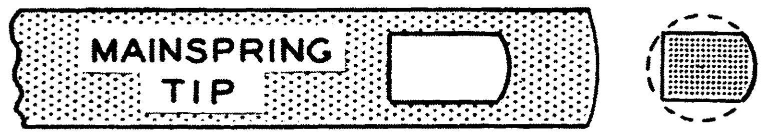


Fig. 31 - 99

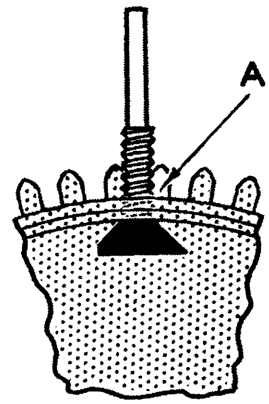


Fig. 31 - 100

14. Replace in barrel from inside. Screw in tightly and cut off excess at A, figure 31-100.

SEC. 537 - Calculating Lost Wheels and Pinions

To find the number of teeth for a center wheel. If the number of leaves in the fourth pinion goes into the number of teeth in the third wheel eight times without a remainder, the leaves of the third pinion multiplied by seven and a half will give the teeth for the center wheel.

If the leaves of the fourth pinion go into the third wheel seven and a half times without a remainder, the leaves of the third pinion multiplied by eight will give the center wheel teeth.

To calculate a missing third wheel and pinion. When the center wheel divides by eight without a remainder the quotient will be the number of leaves for the third pinion and number of leaves on the fourth pinion multiplied by seven and a half will be the number of teeth for the third wheel.

When the teeth in the center wheel divide by seven and a half without a remainder, the quotient will be the number of leaves for the third pinion, and eight times the leaves of the fourth pinion will be the number of teeth for the third wheel.

To calculate a missing fourth wheel and pinion. When the leaves of the third pinion go into teeth of the center wheel eight times without a remainder, dividing number of teeth in the third wheel by seven and a half will give the number of leaves for the fourth pinion.

When the leaves of the third pinion go into teeth of the center wheel seven and a half times without a remainder, dividing number of teeth in the third wheel by eight will give the number of leaves for the fourth pinion.

To find the number of teeth for the fourth wheel when the watch has an 18,000 train. This may be done by comparing the motion of the balance with that of another which is known to have an 18,000 train. The vibrations may be counted for half a minute or more.

An 18,000 train balance gives 300 vibrations a minute, or, if alternate vibrations are counted (which is more convenient), there will be 75 in half a minute.

When the watch is found to be an 18,000 train, multiplying the escape pinion by 10 gives the number of teeth for the fourth wheel.

To calculate a missing escape pinion. The teeth of the fourth wheel will always be divisible by either 8 or 9 without a remainder and the quotient will be the number of leaves for the escape pinion.

The number of teeth in the escape wheel will, of course, be fifteen in all modern watches.

It is seen that the calculations for the teeth and pinions in a modern watch train is a simple matter. For other trains that do not carry second hands the procedure is somewhat different.

SEC. 538 - Rule for Calculating Any Train of Wheels.

Trains are divided into two classes, simple and compound. Simple gearing consists of two or more wheels meshing directly into each other, each on its own bearings. Compound gearing consists of a series of wheels and pinions, two or more mounted on the same staff.

In simple gearing, the difference between the number of teeth in the first and last members of the train determines their respective revolutions, irrespective of the number of members or the number of teeth in the other wheels; the intermediate wheels simply transmit the motion from one to the other.

In compound gearing every member of the train enters into the calculations. To make these calculations three things are predetermined: The number of revolutions the last wheel in the train gives for one of the first; the number of members that constitute the train; the number of leaves to be given to each pinion.

Rule.--The prime factors of the product of each pinion and the number of revolutions of the last wheel, multiplied together and arranged in the number of groups corresponding with the number of wheels required, gives the number of teeth for those wheels.

For an example we will calculate the train, from the center wheel on, for an 18,000 train watch.

First operation: The number of teeth in the escape wheel is fixed at 15. Each tooth delivers two impulses to the balance; therefore, divide 18,000 by twice the number of escape teeth--30. Example:

```
30)18000(600
   180
```

The number of revolutions required of the escape pinion is, therefore, 600 per hour.

Second operation: We will select for the number of leaves in the pinions: 9 for the third; 8 for the fourth; 7 for the escape. The number 9 selected for the third is unusual. It is done for the purpose of demonstrating the adaptability of the rule to all cases.

Multiply the pinions and revolutions together:

```
     9
     8
    --
    72
     7
   ---
   504
   600
------
302400
```

Ascertain the prime factors of this number:

```
2)302400
2)151200
2)75600
2)37800
2)18900
2)9450
3)4725
3)1575
3)525
5)175
5)35
  7
```

This gives us as prime factors six 2s, three 3s, two 5s, and one 7.

We will take for our first group two 3s and three 2s:

```
 3
 3
--
 9
 2
--
18
 2
--
36
 2
--
72
```

This gives us 72 teeth for the center wheel.

We will take for the next group one 5, one 3 and two 2s, which multiplied together will give us 60 teeth for the third wheel.

We now have left one 7, one 5, and one 2, which multiplied together gives 70 teeth for the fourth wheel.

This completes the train, which it will be seen is correct for the purpose required. The center wheel has 72 teeth and as the third pinion has 9 leaves the center will give it 8 revolutions. The fourth pinion has 8 leaves and as the third wheel has 60 teeth, it will give to the fourth 7-1/2 revolutions. Seven and a half times 8 being 60, the center wheel will give the fourth pinion sixty revolutions, which is correct for carrying a second hand. The escape pinion having 7 leaves and the fourth wheel 70 teeth, the fourth will cause the escape to revolve ten times. The number of revolutions will, therefore, be 10 times 60, or 600.

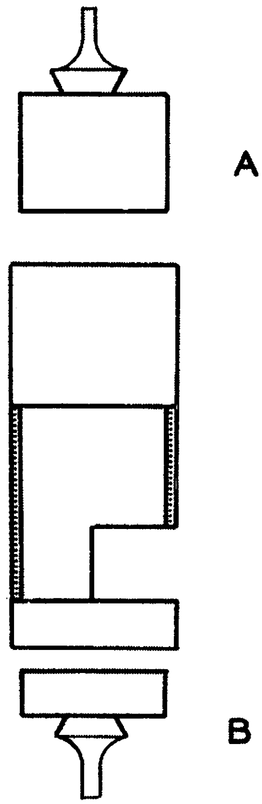


Fig. 31 - 101

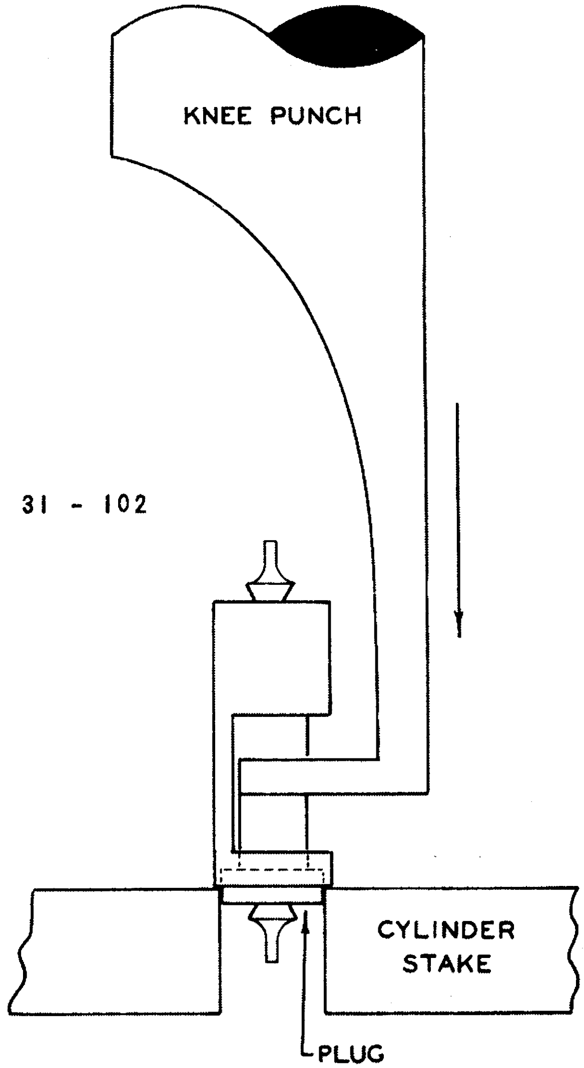


Fig. 31 - 102

SEC. 539 - Fitting New Cylinder Plugs

Figure 31-101 illustrates a Swiss Cylinder. The upper and lower pivots are made in the form of plugs A and B, which are fitted into the cylinder friction tight. The upper plug is the longer of the two and, in some cases, this plug may be driven out far enough to admit the turning of a new pivot. Cylinder plugs are driven out with a knee punch illustrated in figure 31.102. A cylinder stake or a hole in the die plate is used to hold the cylinder when removing the plug. The hole in the cylinder stake or die plate must be large enough to allow the entrance of the plug but not the cylinder. A few light taps of the knee punch is all that is necessary to drive out the old plug. The new plug must be made to fit friction tight without a taper. Use the micrometer to measure the old plug.

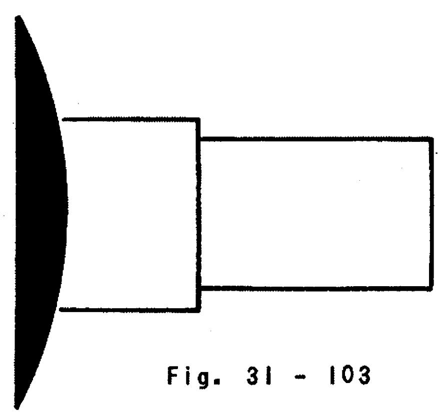


Fig. 31 - 103

1. Select a piece of blued drill rod slightly larger than the diameter of the plug.

2. Turn down outside diameter to proper dimension, figure 31-103.

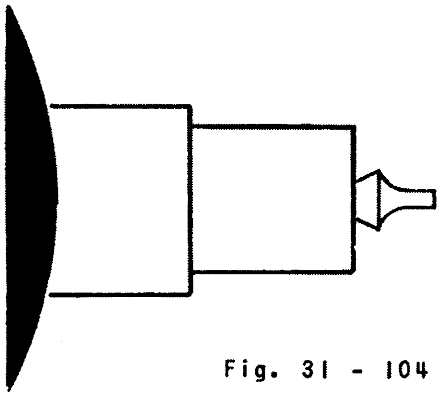


Fig. 31 - 104

3. Cut, grind, and polish a cone shape pivot on the end, figure 31-104.

4. Cut a square shoulder, the length to equal shoulder on old plug and cut off, figure 31-105.

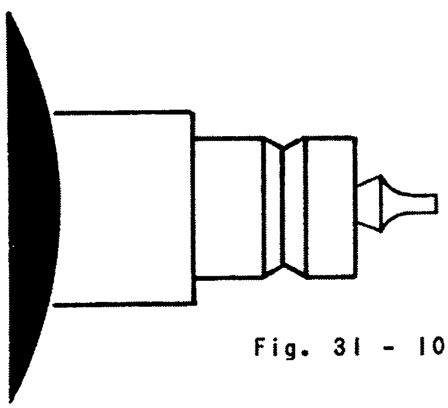


Fig. 31 - 105

5. Turn plug around in lathe and finish end, figure 31-106.

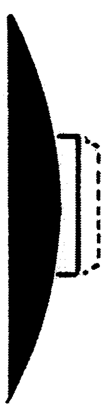


Fig. 31 - 106

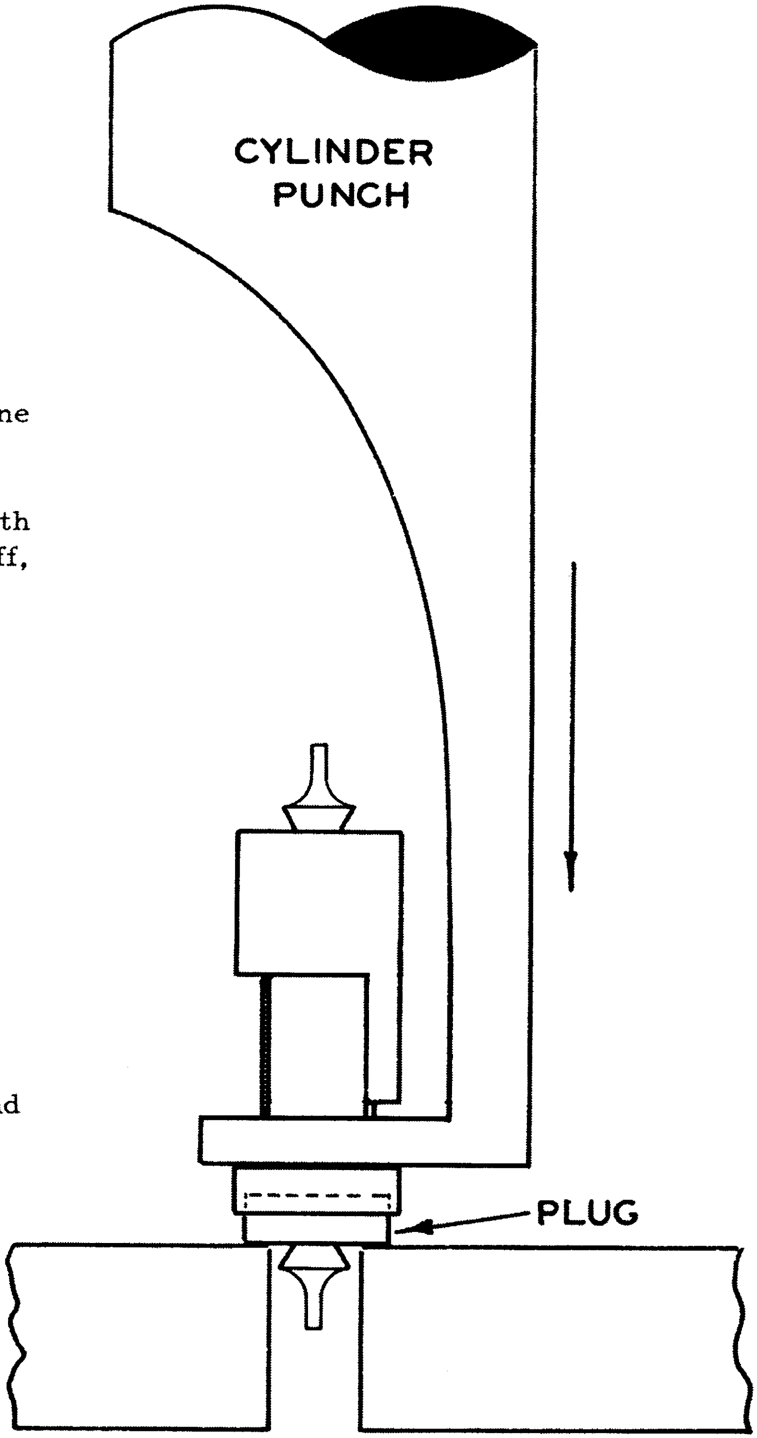


Fig. 31 - 107

6. Place plug in die plate of staking set or cylinder stake and with a punch shown in figure 31-107 placed across the inside walls of the cylinder, press plug into place.

SEC. 540 - Additional Tools

There are any number of additional tools used in watchmaking by men who have been at the bench a good many years. As you progress with your practical experience you too, will acquire additional tools. New tools will be developed and manufactured which will aid you in your work. You will become aware of other tools and material systems through the catalogues of the supply houses. Other watchmakers will recommend tools.

You should read magazine articles and acquire a good reference library of old and new books.

The following illustrations and descriptions are a few of many additional tools necessary at one time or another:

Figure 31-108 illustrates a balance chuck sometimes known as a "ballon" chuck. The pivot projects through convex face of chuck and a hardened steel burnisher can be used to finish end and sides of pivot.

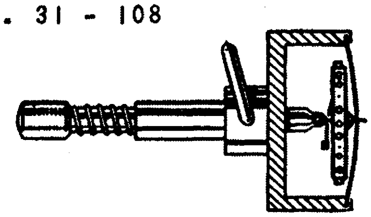


Fig. 31 - 108

Figure 31-109 illustrates a wheel chuck. These chucks are used to catch up wheels on their largest diameters and come in different sizes with graduated steps.

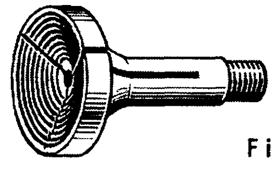


Fig. 31 - 109

Figure 31-110 illustrates a drill chuck for a watchmaker's lathe. It has a capacity up to 1/4".

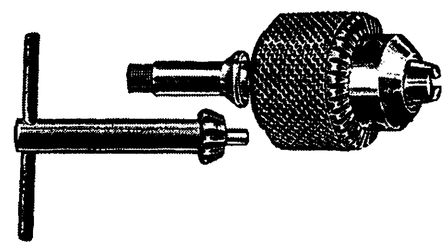


Fig. 31 - 110

Figure 31-111 illustrates a stepping device. It is used in the head stock of a lathe with a wire chuck. It affords a back seat in chuck for a jewel setting or other small pieces that lack thickness and require a shallow seat to set in.

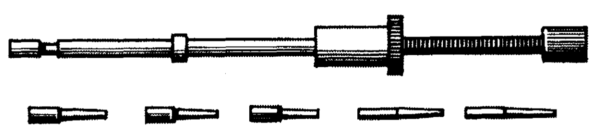


Fig. 31 - 111

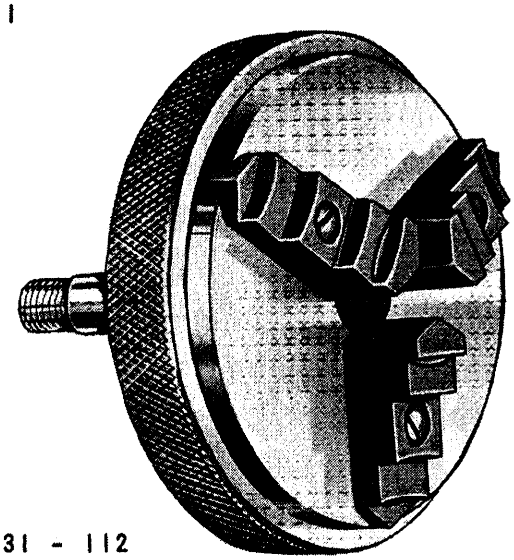


Fig. 31 - 112

Figure 31-112 illustrates a 3-Jawed Chuck with a self centering scroll movement. Jaws are reversible.

Figure 31-113 illustrates a slide rest with 3 slides. Top slide contains tool post. Dials are graduated in 1/100 mm.

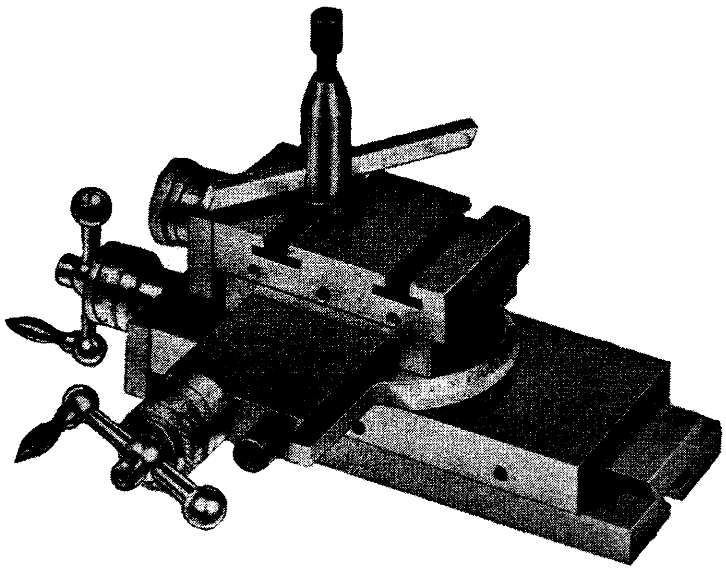


Fig. 31 - 113

Figure 31-114 illustrates a wheel cutting, grinding and drilling attachment.

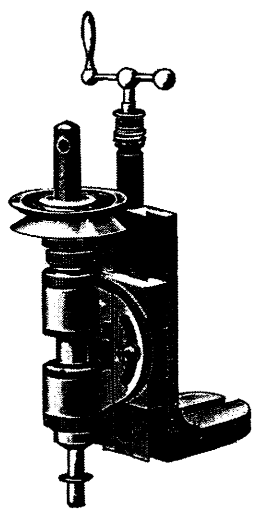


Fig. 31 - 114

Figure 31-115 illustrates the wheel cutting attachment bolted to a slide rest, adjustable to any conceivable position.

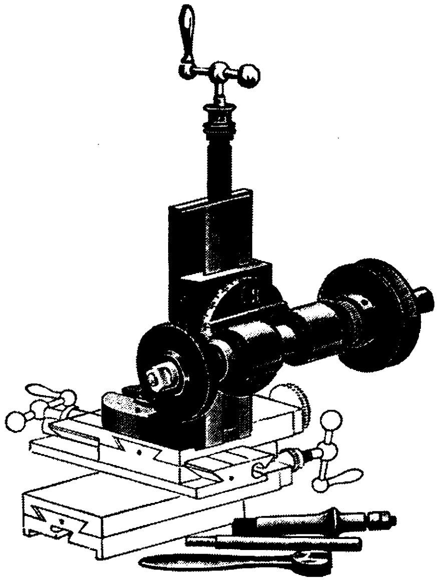


Fig. 31 - 115

Figure 31-116 illustrates an index for wheel cutter with index holes up to 360.

Fig. 31 - 116

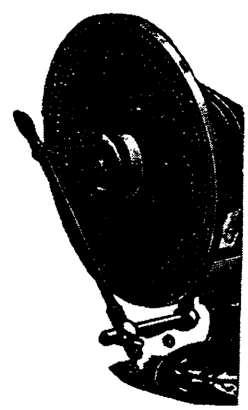


Figure 31-117 illustrates a tail stock chuck holder.

Figure 31-118 illustrates an arbor chuck for mounting wheels, saws, laps, etc.

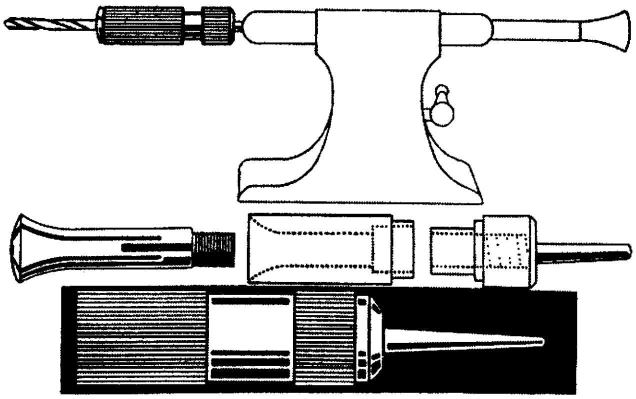


Fig. 31 - 117

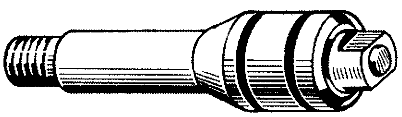


Fig. 31 - 118

Figure 31-119 illustrates a pivot drill chuck used with the regular taper chuck.

Fig. 31 - 119

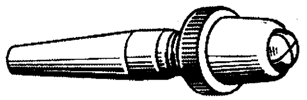


Fig. 31 - 120

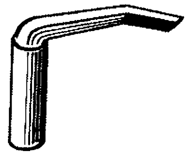


Figure 31-120 illustrates an "L" tool rest which is used in place of regular "T" rest with face plate or 3-Jawed Chuck.

These tools and many others will find their way into your shop as your work requires. Make it a practice to keep abreast with the times and endeavor to have the best tools possible in order to turn out the best work.

note:

(No job sheets are associated with Lesson 31)

Master Watchmaking

MODERN SHOP METHODS

LESSON

32 PART II

PRACTICAL JOB METHODS

CHICAGO SCHOOL OF WATCHMAKING
Founded 1908 by THOMAS B. SWEAZEY

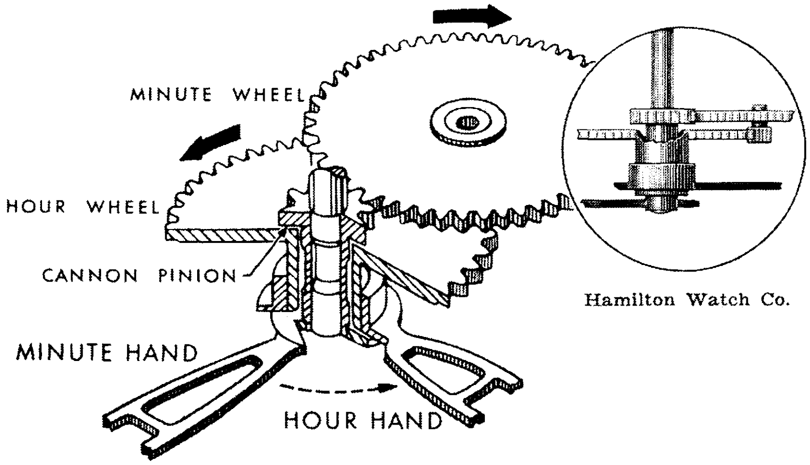
(This chart is for use with Modern Shop Methods Estimate and Check List)

In order to speed up the estimating of repairs necessary to put a watch in first class order the most common repairs are listed below, preceded by a number and followed by letters which designate special work. Estimate job carefully and enter by number or number and letter in space for estimate on check list. Example: Demagnetize-Mainspring (17 jewel)-Clean, Oil and Regulate would be entered 19, 23-B, 4.

1. PIVOTS
   - A. Polish
   - B. Straighten
2. HAIRSPRING
   - A. True in round
   - B. True in flat
   - C. Center
   - D. Level
   - E. Overcoil
3. BALANCE WHEEL
   - A. True
   - B. Poise
4. CLEAN, OIL, REGULATE
5. WATCH GLASS
   - A. Round
   - B. Fancy
   - C. Military Bend
6. NO-BREAK
   - A. Round
   - B. Fancy
7. SPECIAL CRYSTAL
   - A. Color
   - B. Extra Heavy
   - C. Special
8. BALANCE STAFF
9. DIAL
   - A. Refinish
   - B. Replace
10. SPRING BARS
11. CORD
12. STRAP
13. HAND
    - A. Plain
    - B. Luminous
    - C. Seconds
    - D. Sweep Seconds
14. HANDS - Pair
    - A. Plain
    - B. Luminous
15. CROWN
    - A. Regular
    - B. Waterproof
    - C. Snap
16. STEM
    - A. Regular
    - B. Oversize
    - C. Snap
17. SLEEVE
18. CROWN AND STEM
    - A. Regular
    - B. Special
19. DEMAGNETIZE
20. CASE
    - A. Joint
    - B. Catch
    - C. Lugs
21. REMOVE RUST
22. CLICK SPRING
23. MAINSPRING
    - A. 7 to 15 jewel
    - B. 17 to 19 jewel
    - C. 21 to 23 jewel
24. JEWELS
    - A. Cap
    - B. Balance
    - C. Roller
    - D. Train
    - E. Center
    - F. Pallet
25. WINDING PINION
26. MAINWHEEL
27. HAIRSPRING, New
    - A. Flat
    - B. Overcoil
28. SETTING SPRING
29. WHEELS
    - A. Center
    - B. 3rd
    - C. 4th
    - D. Escape
    - E. Balance
30. BOW
    - A. White
    - B. Yellow
31. CLUTCH
32. SHIPPER SPRING
33. SET LEVER SCREW
34. CANNON PINION

REVISED PRINTING 1955

SEC. 561 - Calculating Dial Trains



The cannon pinion, minute wheel, hour wheel, and minute wheel pinion are known as the dial train.

The center staff or arbor makes one revolution in one hour. The cannon pinion is attached by friction to the center arbor and likewise makes one revolution per hour.

The cannon pinion drives the minute wheel. The pinion attached to the minute wheel is known as the minute wheel pinion and drives the hour wheel.

The teeth of the hour wheel multiplied by the teeth in the minute wheel equals the number of leaves in the cannon pinion multiplied by the number of leaves in the minute wheel pinion multiplied by 12.

The following formula is used to prove the correctness of a 12 hour dial train:

$$\frac{\text{Teeth in minute wheel x teeth in hour wheel}}{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}} = 1$$

Substituting:

$$\frac{40 \text{x} 36}{10 \text{x} 12 \text{x} 12} = \frac{1440}{1440} = 1$$

If the dial train is correct, the result will always be 1

$$\frac{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}}{\text{Teeth in minute wheel}}$$ equals teeth in hour wheel

$$\frac{\text{Teeth in hour wheel x teeth in minute wheel}}{\text{Leaves in minute wheel pinion x 12}}$$ equals leaves in cannon pinion

$$\frac{\text{Teeth in hour wheel x teeth in minute wheel}}{\text{Leaves in cannon pinion x 12}}$$ equals leaves in minute wheel pinion

$$\frac{\text{Leaves in cannon pinion x leaves in minute wheel pinion x 12}}{\text{teeth in hour wheel}}$$ equals teeth in minute wheel

SEC. 562 - Practical Job Methods

The term "Watchmaker" has come down through the years to mean one who makes watches. But in the true sense of the word, the watchmaker of today is a repairman, one who has the ability to repair watches no matter who made them. He is judged by his customers on his ability to make their watches keep accurate time, the kind of time his customers can depend on.

A watchmaker can be considered a master only when he is able to make all of his watches keep time.

From now on, in your career in watch repairing, you know that you must not neglect any repairs necessary to put the train, the balance and hairspring, and the escapement in first class condition but you must also see that the watch keeps time.

In this lesson, we want to show you how to make your repairs in a systematic manner. System makes for better work and increased profits. The methods outlined here have been used profitably by many watchmakers. If you will follow them, you will shortly develop an efficient system of handling repairs that will become second nature.

SEC. 563 - Estimating

The first important step when you have taken in a watch for repair is to estimate what needs to be done. Try to have the customer leave the repair job in order that you can make an accurate estimate. When you estimate, you figure the material and the time it takes to make the necessary repairs. You base your charges upon your estimate. Therefore, it is very important that you check carefully each one of the following steps and make a note of the repairs required together with the material needed. Add to this the time it takes and you have an idea of how much to charge.

1. Check crystal. (Lesson #3)

2. Check crown, stem, sleeve, bow, etc. (Lesson #2)

3. Check hands. (Lessons #8 and #11)

4. Condition of dial. (Lesson #8)

5. Check cannon pinion. (Lessons #8 and #11)

6. Check hairspring. (Lessons #18, #19, #20 and #32)

7. Check balance staff. (Lesson #15)

8. Check roller jewel. (Lesson #13)

9. Check balance jewels. (Lesson #13)

10. Check pallets and escapement. (Lesson #26)

11. Check mainspring. (Lessons #5 and #6)

12. Check the train. (Lessons #8 and #10)

13. Observe general condition of oil, screws, etc. (Lesson #10)

SEC. 564 - Making Repairs

When making repairs on a watch, doesn't it seem wise to do your repairs first and then clean, assemble, oil and bring the watch to time? Don't get into the habit of cleaning the watch first and then taking it apart again to repair it.

The order of steps which follows has proven very practical when making repairs. In looking over the watch for mechanical troubles, follow these steps in the order given. Make your repairs as soon as you find the trouble. For example, if the watch is magnetized (step #5), demagnetize it right away. When you check the roller jewel (step #21) and find it loose, reset it properly at this time. As you use this sequence time after time, you'll find it develops speed in repairing and saves you doubling back to fix something you should have taken care of earlier.

1. Test winding and setting. (Lessons #2 and #9)

2. Remove watch from case. (Lesson #1)

3. Make all necessary repairs such as crowns, stems, sleeves, bows, and crystals. (Lessons #2 and #3)

4. Polish and clean case. Assemble and put to one side. (Lessons #1 and #10)

5. Check for magnetism. (Lessons #11)

6. Check loose cannon pinion with pegwood pushed against minute hand. (Lessons #8 and #11)

7. Remove hands and dial, and tighten dial screws. Replace screws if necessary. (Lessons #2 and #8)

8. Check dial and dial feet. (Lessons #8 and #29)

9. Fit new hands if necessary. (Lesson #11)

10. Check teeth in hour wheel. (Lessons #8, #10 and #11)

11. Remove cannon pinion - tighten if necessary. (Lessons #8 and #11)

12. Check hairspring for center. Place regulator in center of index. (Lesson #32)

13. Check hairspring for level. (Lesson #32)

14. Release stud screw. (Lesson #8)

15. Remove balance cock and separate balance from cock. (Lesson #8) Tighten stud screw.

16. Check regulator pins, adjust or replace. (Lessons #11 and #32)

17. Place balance in truing caliper and check hairspring in round and flat. (Lesson #18)

18. Remove hairspring. (Lesson #15)

19. Replace hairspring in balance cock and recheck for center and level. Check outside terminal coil to see if it is circled correctly. (Lessons #8 and #32)

20. Remove hairspring from bridge and tighten stud screw.

21. Check roller jewel. (Lesson #13)

22. Check for broken balance or cap jewels. Replace if necessary. (Lessons #13, #14 and #30)

23. Burnish and polish balance pivots. (Lesson #31) Fit new balance staff if necessary. (Lesson #15) When polishing the upper balance pivot, it is permissible to catch the balance up on impulse roller. Use a chuck of proper size and make certain the staff runs true before endeavoring to polish the pivot. If roller will not hold, remove

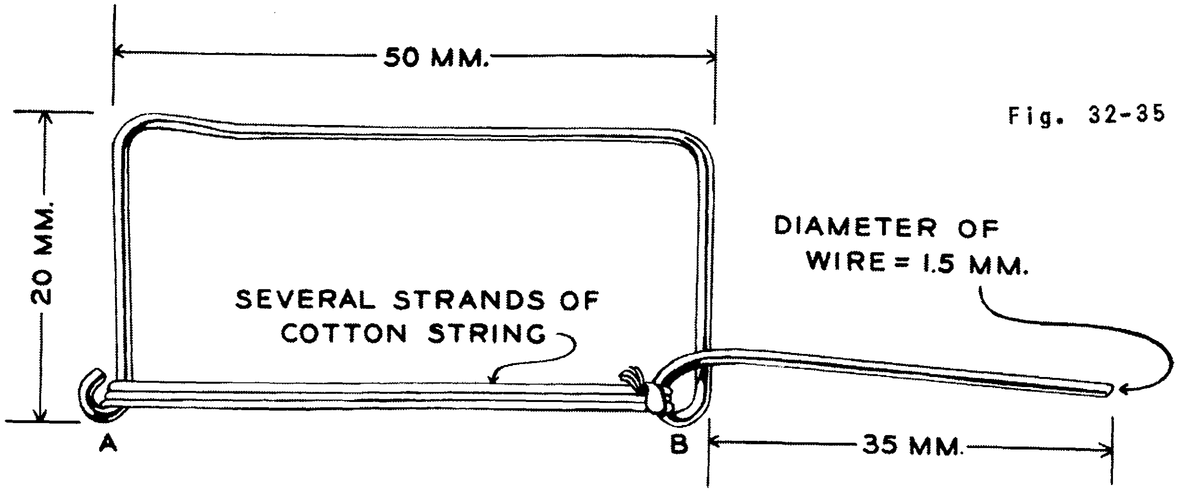


Fig. 32-35

roller (Lesson #15) and catch up on roller post. To polish lower pivot, catch up on collet post. In either case, if the pivots do not run true, it is best to use a pivot polisher as shown in figure 31-24, Lesson #31. Burnish end of every balance pivot lightly with smooth pivot burnisher, grind with grinding slip if necessary, and polish with boxwood slip and diamontine.

24. Replace balance, check endshake and sideshake. (Lesson #13)

25. Check guard action. (Lesson #26)

26. Remove cap jewels, replace balance jewels, and jewel screws. (Lesson #10)

27. Polish balance wheel rim if necessary. To polish between the screws of a balance wheel, make a small bow of brass wire. Approximate dimensions are given in figure 32-35. Wind two or three loops of cotton store string from A to B, keeping it taut. Wet the string with alcohol and rub across a stick of rouge. Balance screws and rim of wheel are then polished as in figure 32-36. Brush balance with cleaning solution to remove all rouge.

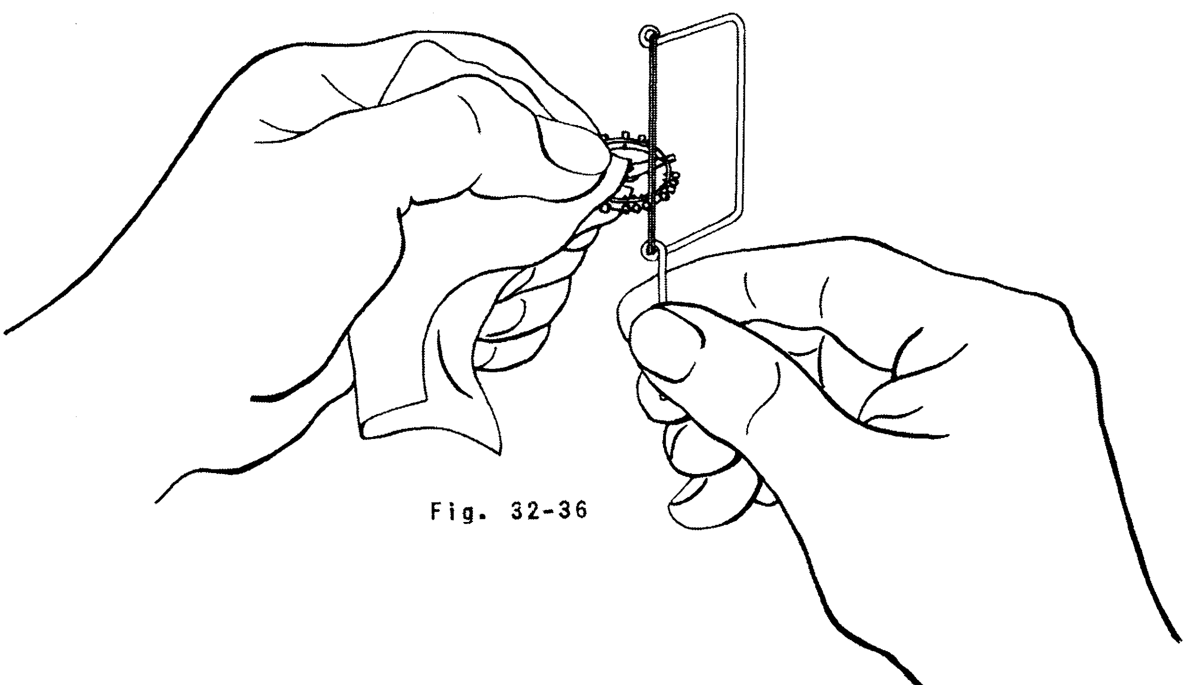


Fig. 32-36

28. True and poise balance wheel. (Lessons #16 and #17)

29. Check lock, drop and slide; also, sideshake of pallet arbor. (Lesson #26)

30. Let down power. (Lesson #5)

31. Remove fork and examine pallet stones and guard dart. (Lesson #26) Polish pallet arbor pivots if necessary. (Lesson #31) Make necessary escapement adjustments. (Lesson #26)

32. Check train wheels to see if they run true. Check lower 4th pivot for trueness.

33. Disassemble movement. (Lesson #8)

34. Dip each wheel and pinion in benzine or carbon tetrachloride and push leaves and pivots into pithwood.

35. Remove rust from pinion leaves. (Lesson #10)

36. Polish or burnish pivots if necessary. (Lesson #31) When polishing train pivots, place arbor or pinion leaves in chuck, making certain that the pivot runs true. If impossible to catch on arbor or pinion leaves, place wheel in a wheel chuck or cement to a flat face cement chuck, which has been hollowed out, making certain that the pivot runs true. Never place a pivot in a chuck as it will mar or distort the shape of the pivot. Lightly brush the ends of the pivot with a smooth pivot burnisher. Grind pivot with grinding slip, if necessary, and polish with boxwood slip and diamontine.

37. Check and peg out all pivot holes. Close holes if necessary. (Lesson #17) Replace broken jewels. (Lessons #12, #14 and #30)

38. Check endshake in barrel arbor. (Lesson #5)

39. Clean teeth in mainspring barrel using a stiff brush. (Lesson #10)

40. Remove mainspring, replace if necessary, check hook in barrel, and on barrel arbor. Polish bearing surfaces on arbor, barrel and cap if necessary. (Lessons #5 and #6)

41. Check and repair winding and setting parts. (Lesson #9)

42. Fit all new material. All repairs should have been completed by now.

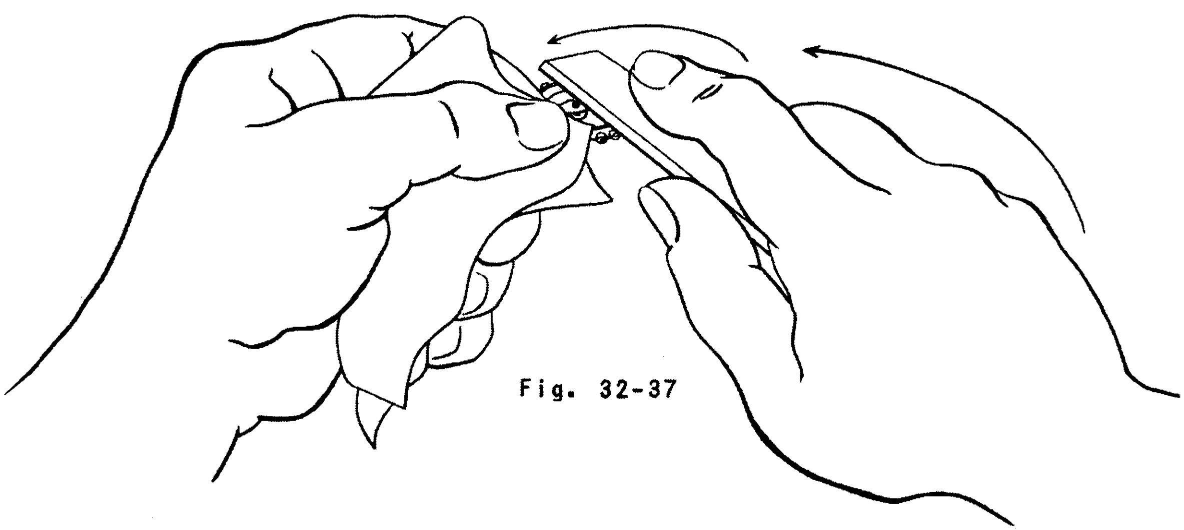


Fig. 32-37

43. Clean and dry all parts of watch. (Lesson #10) Repolish top of balance rim using small chamois buff and rouge. After the balance has been thoroughly cleaned and dried, polish the upper side of rim with a circular motion as in figure 32-37. The buff can be either chamois or leather and the wheel should be held between the fingers with watch paper. Do not use any pressure. Remove traces of rouge with soft dry brush.

SEC. 565 - Review of Cleaning Methods

A. Cyanide, soap, alcohol, and sawdust. (Lesson #10, Section 237)

B. Modern 7 Jar Method. (Lesson #10, Sections 238 through 247)

C. Machine Cleaning Methods:

The modern method is to use the 7 jar cleaning method as described in Lesson #10. Section 239. To use this method with the machine requires 7 jars plus the heat dryer unit. Label the jars from 1 to 7. A common type of cleaning basket is illustrated in figure 32-38. Put bridges, plates, and barrel into the largest Compartment C. Place all screws, levers, train wheels, etc. which you know will not slip through basket in Compartment B. Place pallet fork and balance in Compartment A.

Precaution: <u>Clean hairspring separately.</u>

Place cover on basket and place in cleaning machine. Run slowly in Solution #1 for approximately 60 seconds. Spin off surplus solution in upper half of jar #1. Rinse quickly in solution #2 and spin off surplus. Run very, very slowly in solution #3 for approximately 15 to 30 seconds. This solution is used to brighten parts so do not let it remain for over 30 seconds. Spin off surplus

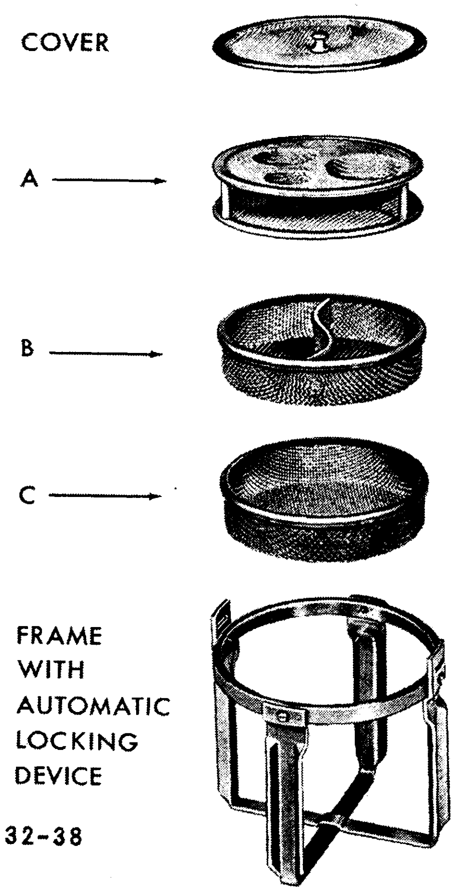


Fig. 32-38

Rinse quickly in solutions #4, #5, #6, and #7 and dry thoroughly over heater on cleaning machine.

3 Jar Cleaning Method: Although the 7 jar method is superior, there are a great many shops which use the 3 jar method with heater. This method of cleaning requires that all parts of a watch be brushed thoroughly with naphtha or benzine before putting in the cleaning machine. Assemble parts in cleaning basket as outlined in Lesson #10, Section 258, and run in solution #1, which is the cleaning solution, not to exceed 30 seconds. This will keep the parts from turning dull and it should not require any more time than this if the old oil has been thoroughly loosened before cleaning. Quickly rinse in solutions #2 and #3 and dry parts over heater.

<u>Clean the hairspring separately.</u> A small jar with an airtight screw top containing naphtha or benzine should be

kept handy for cleaning the hairspring. Dry with soft watch brush or blower. It is a good idea to warm the hairspring slightly to make certain that all the cleaning solution has been evaporated.

SEC. 566 - Assembling

1. Replace mainspring, oil barrel arbor and mainspring. (Lessons #5 and #6)

2. Replace winding and setting parts, and oil. (Lessons #9 and #10)

3. Replace and oil all balance hole and cap jewel combinations. (Lesson #10)

4. Replace train wheels and oil pivots. (Lessons #8 and #10)

5. Check the train carefully by winding the mainspring, and in most cases the train wheels will run down and the escape wheel will come to a stop and then reverse its direction. This is called train recoil and generally speaking, the train is in top notch condition if this recoil takes place. (Lesson #8)

6. Place balance in watch with pallet bridge in place and place movement dial down.

7. With a small brush or pointed piece of pegwood, test balance by flicking it with brush. Not fast. Carefully observe the reaction. The balance should revolve freely and slow down gradually!

8. Repeat this operation Dial Up position. When you are certain that the action is free in both positions, the balance is in good order.

9. Turn balance pendant up and test. In most cases, the balance will slow down more rapidly in this position than in the D U (Dial Up) or D D (Dial Down).

10. Replace pallet fork (remember to oil escape wheel teeth) and wind the stem 5 or 6 turns. Test lock, drop, draw, slide and endshake. (Lesson #26)

11. Replace balance without hairspring and check roller and safety action. (Lesson #26) Many of the high grade pocket watches will run on half time. When the balance (without a hairspring) continues to oscillate from impulses imparted to the roller jewel by the fork, it is referred to as running on "half time". A watch capable of running on "half time" in the Dial Down position should also run on "half time" in the Dial Up position or vice versa.

If all of the above conditions have been met, the watch can be adjudged to be in good condition.

12. Replace hairspring (Lesson #32) and put watch in beat (Lesson #26)

13. Check motion. (Lesson #11, Sec. 269)

14. Replace cannon pinion, hour wheel, dial and hands.

15. Check motion.

SEC. 567 - Timing and Regulation

Rating is the observation and comparison of the daily rate of a watch when it is being adjusted.

Timing is the operation required to bring a watch to time after it has been repaired and rated.

Regulation refers to the regulator adjustment of a watch to its owner's personal routine and habits.

This lesson could be extended into volumes if we were to consider all the theories advanced and operations required in temperature and position adjusting. In this lesson, we will consider three positions first as these three positions are most important in the majority of watches in use today. Facts, theories, and problems regarding temperature and position adjusting are contained in many good books and the student should endeavor to do a certain amount of study and practice from recommended books.

SEC. 568 - Limits of Accuracy

First, we, as watch repairmen, have to consider that the factory which made the watch has made the necessary adjustments regarding temperature and position errors and we, therefore, are only expected to repair the watch as well as it was when it left the factory. Consequently, we are primarily interested in:

1. Putting the watch in first class shape.

2. Making the watch keep accurate time within certain limits i.e., a railroad watch of 21 or 23 jewels must keep time within 30 seconds per week. This is the maximum error allowed by the watch Inspector. With careful regulation you should get greater accuracy. This is also possible with 7J, 15J, 17J and 19J watches in good order.

Average wrist watches should keep time within 90 seconds per week more or less. The principal factors to consider before endeavoring to adjust and time a watch are:

a. The train must be free, cleaned, and oiled properly.

b. The escapement must be free and have snap.

c. The balance must be in first class condition.

d. Hairspring - true and centered. Regulator pins adjusted properly.

e. Pivots polished.

f. Endshakes and sideshakes at a minimum.

g. Wheel true and poised.

If these conditions have been met, we should have good motion.

3. Dial Up and Dial Down the motion should be the same, 1-1/2 turns. (Lesson #11)

4. Pendant Up the motion should be about 1-1/4 plus turns. (Lesson #11)

In watches with a Breguet hairspring, the regulator pins should be parallel and be adjusted with a minimum amount of play. (Lesson #32) This is also true with flat hairsprings but the amount of clearance is greater in most cases than the Breguet Spring, (Lesson #32)

SEC. 569 - Rating and Timing Records

When all of the above conditions have been met, we will make three preliminary tests and keep a record of each test. Set the second hand of the watch you are timing with a regulator having a known rate. Of course, the best possible regulator is a short wave radio set which sends time signals on different wave lengths 24 hours per day. Other methods include regular radio tone beats, chronometers, clocks, etc.

Set the second hand on your watch to correspond exactly with the second hand on your regulator and place your watch in a Dial Up position. All rates are based on a 24 hour period. Wind the watch fully. It isn't necessary for us to let the watch run the full 24 hours before making further checks as that slows down the process of adjusting. For example: Let us say we let our watch run for 3 hours in the Dial Up position. At the end of this 3 hour period, calculate the loss or gain over a 24 hour period and make a note of it. Place watch in Dial Down position and calculate the loss or gain over a 24 hour period, and make a note of it. Now run watch in Pendant Up position and calculate the loss or gain over a 24 hour period and make a note of it. The Dial Up and Dial Down position should be the same. The Pendant Up may vary some but should be within a reasonable amount of loss or gain. When these calculations have been made and found to be correct, it is only a matter of adding weight to or subtracting weight from the balance wheel in order to bring the watch to time.

If we are timing a pocket watch, we will make the adjustment necessary to bring the watch to time in the Pendant UP position as this is the position in which the customer will carry his watch in the greater portion of time he will wear it. A wrist watch is brought to time in the Pendant Down position for the same reason.

It is better to have pocket watches gain from 5 to 10 seconds per day average and then have the customer return for regulating to his personal habits.

A wrist watch should have about 10 to 15 seconds per average day gain for the same reason.

For final check, compare rate a full 24 hours in each position. Regulating a watch when the rate is known can be accomplished by the meantime screws. (Lesson #11). Turning them in will cause the watch to gain: turning them out will cause the watch to lose. Adding timing washers will cause the watch to lose and removing washers or weight from balance wheel will cause it to gain.

SEC. 570 - Timing Machines

By now you should be able to put a watch in good running order and bring it to time properly. Of course, you may be slow, but speed comes only with practice.

At this point in his training, the average student becomes intrigued with the recently developed electronic timing devices. In his enthusiasm, he is often led to believe that the machine will make his repair analysis for him and is a "cure-all" for watch troubles. Actually, the machine is nothing more than a check on his craftsmanship and not a substitute for it.

Before the watch is placed in the machine, it must be in good running order. This means that all repairs have been made. By following the modern shop outline, the good craftsman locates and corrects the trouble as he checks each part. The machine does not make repairs nor is it a short cut to making repairs. It tests the job that has been done and shows up work that may have been slighted. If you have properly repaired the watch according to the Modern Shop outline, it is unlikely that the machine will ever indicate errors such as dirty balance jewels, magnetism, loose roller jewels, bent regulator pins, wheels out of poise and so forth. The good watchmaker will have already found and corrected these errors. He does not need a machine for this purpose.

The main advantage of an electronic timing machine is a saving in time for the watchmaker when rating, timing and adjusting. With it he can bring watches to time more quickly than without it. This means better service for his customer. But depending on the machine to show up errors in workmanship encourages slip-shod repair habits. There is then less saving as the repair work must be done over before the watch can be brought to time.

The average man uses a timing machine very briefly for rating or timing -- from 30 to 60 seconds with the watch half wound or fully wound. Some feel the rate they get from the machine tape is accurate for the entire 24 hour period. A true rate is possible only when the watch has run for a full 24-hour period in any one position. Many students have failed examinations because of this failure to test their watches over a 24 hour period.

Be a good watchmaker. This means to use all modern equipment available that will help you increase your income, save time and give greater service to your customers. But these devices must be used with understanding. The machine is only as good as the man who operates it.

WHAT IS A WATCH ???

"An ordinary sixteen-size watch of the present day is composed of about 217 parts. Making 18,000 beats or vibrations per hour, it has to make 432,000 per day, or 157,680,000 per year. The balance wheel travels 1.43 inches with each vibration which is equal to 9.75 miles in twenty-four hours; 292.50 miles in thirty days, or 3,558.75 miles in one year."

"Among the many who own and carry watches, how few ever stop to think of the amount of brain power that has been expended upon its construction or the repairs necessary to bring it back to its original factory condition. The number of its parts and the difficulties attendant upon the assembling of all these delicate parts into one harmonious whole so when completed it shall run continuously for a period of months at least, and always indicate the correct time without even a moment's rest."

-- Anonymous

note:

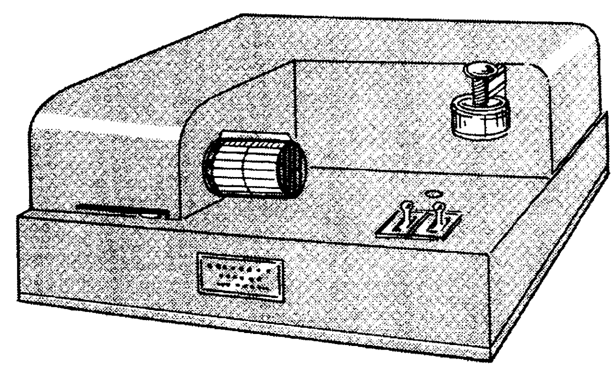
(No job sheets are associated with Lesson 32, Part 2)

Master Watchmaking

MODERN SHOP METHODS

LESSON

33



Electronic Timing Machines

(Watch-Master)

CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by THOMAS B. SWEAZEY

SEC. 575—Introduction

This lesson has been prepared for the purpose of assisting the student watchmaker in utilizing the WatchMaster Watch-Rate Recorder to its best advantage. The relationship between the record and the watch is explained in some detail as a means of simplifying the interpretation of unusual records. No attempt has been made to reproduce exact records which are entirely indicative of a specific watch but rather the principles of diagnosis are illustrated.

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SEC. 576—General Description

The WatchMaster Watch-Rate Recorder is a device which has been designed to record every tick of a watch or clock on calibrated chart paper in a manner which will give the maximum information in the shortest practical time. The calibration of the chart paper and the speed of its movement have been chosen to make an error of one second per twenty-four hour day, the minimum which can be distinguished in a period of thirty seconds, and at the same time, keep the recorded indication of instantaneous variations, due to watch irregularities, to a readable extent.

These principles take practical form in the WatchMaster by wrapping the chart paper around a drum which is rotated exactly five times per second by a motor controlled by a very accurate constant frequency. Since the escapement in a normal watch operates exactly five times per second when keeping correct time, a mark made on the chart paper every time the watch escapement operates would fall in exactly the same place for successive ticks. In order to distinguish between successive marks and hence successive ticks, the recording mechanism is advanced from left to right approximately the width of a mark every revolution of the drum. Therefore these conditions produce a line of marks on the paper which develop from left to right on the drum and exactly parallel to its axis when the rate of the escapement action and the rate at which the drum rotates are identical. A watch which is gaining produces marks which come slightly in advance of a complete revolution of the drum **between successive ticks** and hence produce a line of dots which slant in the direction of drum rotation as the recording is produced. This produces a line of dots which slopes upward from left to right as the record is viewed. Conversely, a watch which is losing produces marks which come slightly behind a complete revolution of the drum **between successive ticks** and hence produce a line of dots which slopes downward from left to right. The chart paper is calibrated directly in seconds error per twenty-four hour day, and the departure of the watch rate from correct time is read directly from the chart paper.

SEC. 577—The Record and How to Read It

The size of the recorded marks has been chosen to be approximately the minimum which can be readily seen by the unaided eye and still be positive in its production. A line of such marks immediately adjacent to each other requires about thirty seconds of recording time to be dependably readable to one second in twenty-four hours when the instantaneous errors which exist in many watches are to be recorded.

The chart is ruled horizontally with parallel lines which are the equivalent of five seconds in twenty-four hours apart when the full width of the two inch recording represents a twenty-four hour day. When the record slopes the distance of one space between any two of these lines while covering the full two inch width of the paper, the watch is indicated to be five seconds in twenty-fours hours off time. When the record slopes the distance between two divisions, the error is indicated to be ten seconds in twenty-four hours, and so on in units of five seconds for each space covered. When the watch is very nearly correct, errors of one second can readily be distinguished.

For convenience in reading large errors, every sixth line has been made of double width and the distance between the double width lines is hence read as an error of thirty seconds or one half minute per twenty-four hour day. For further assistance in reading large errors, the chart is also ruled lengthwise to divide it in two equal parts. This divides the observation time by two and errors observed in either half represent the twelve-hour performance and must be doubled to obtain the twenty-four hour rate.

Figure 33-1 shows samples of typical records illustrating the method of reading charts. Record **A** represents a watch which is in exact agreement within the frequency standard. The record is exactly parallel with the lines on the chart. Record **B** represents a watch which is gaining at the rate of twenty seconds in twenty-four hours. Four five-second spaces are covered in the full width of the chart. Record **C** repre-

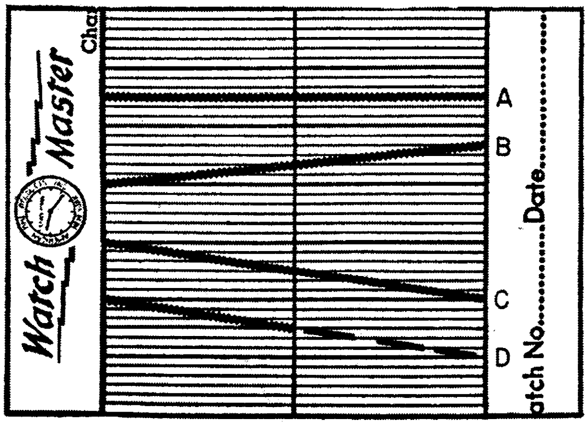


Fig. 33-1

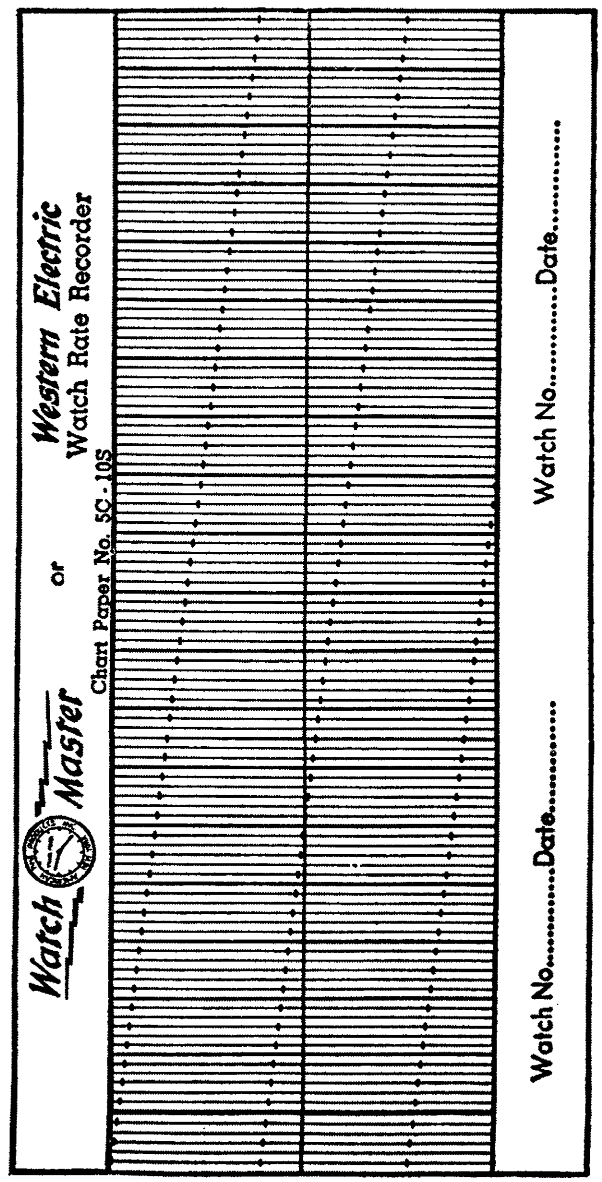
sents a watch which is losing at the rate of thirty seconds in twenty-four hours. Six five-second spaces, or the space between two heavy lines, are covered in the full width of the chart. Record **D** represents the use of the length-wise ruling. The left half of the chart covers three five-second spaces but since the half chart is a twelve hour indication, the error must be doubled making this error thirty seconds in twenty-four hours. By extending this record to the full chart width as indicated by the dashed line, the similarity with Record **C** is shown. The errors indicated by records **C** and **D** are identical.

Watches will occasionally be found which are running very fast or very slow in one or more positions. Records which indicate such rates may make one or more complete spirals around the drum. The size of the drum has been chosen to include exactly one hundred twenty five-second spaces, hence a record which made one complete spiral in the full width of the chart would indicate an error of ten minutes per day. Two spirals would represent twenty minutes per day and so on. Any incomplete spirals are read on the basis of five seconds for each division in the usual way and added to the error represented by the number of complete spirals in the record. For example, figure 33-2 represents a watch which is gaining at the rate of twenty-six minutes per day. The record makes two complete spirals plus twelve large (or seventy-two small) divisions.

There are also many watches made which do not operate five times per second when keeping correct time. Many inexpensive watches and most clocks operate only four times per second while many small ladies' watches operate up to six times per second. While the WatchMaster is primarily designed to record the action of watches which operate five times per second, it will produce usable records from these other so-called "odd beat" movements as well.

For example, a watch or clock which operates only four times per second will make only four marks for every five complete revolutions of the drum. This means that one and one-quarter revolutions of the drum occurs between succesive ticks. Hence, the first, fifth, ninth, thirteenth, etc., ticks will produce marks at the same position on the drum. The second, sixth, tenth, etc., ticks will produce marks in the same position and one-quarter revolution behind the first. The third, seventh, eleventh, etc., will produce marks on the other side of the drum and the fourth, eighth, twelfth, etc., will be three-quarters of a revolution behind the first. The effect of this condition will be to record four separate lines of dots on the drum. They will all be parallel and any one

Fig. 33-2



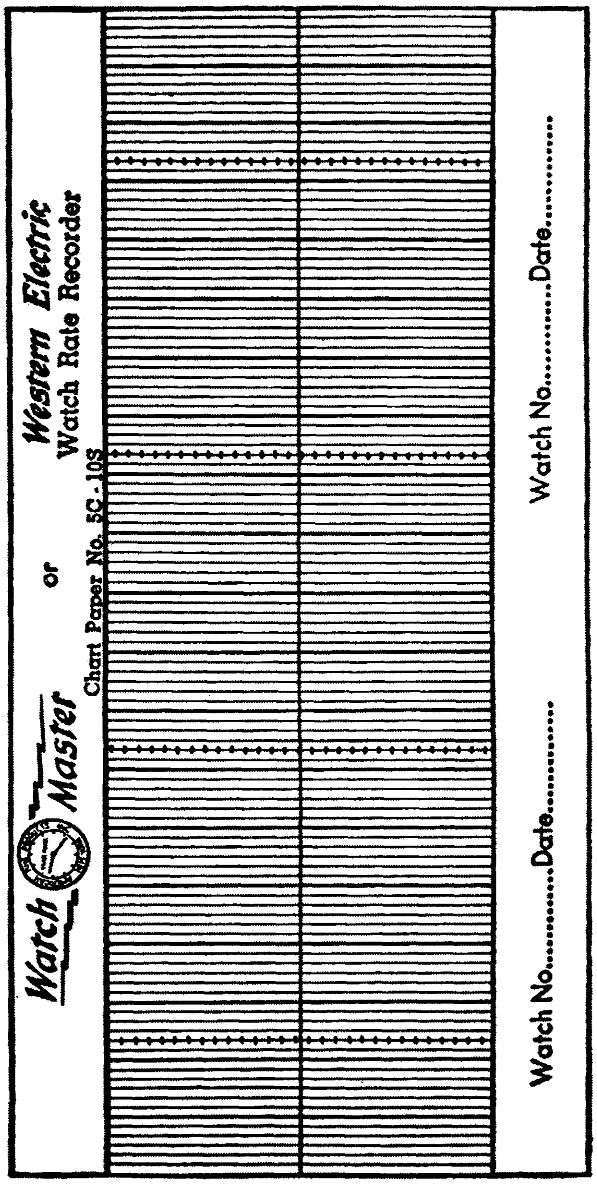


Fig. 33-3

of them may be used to read the rate in the same manner as the complete line is used for five-beat watches. Figure 33-3 represents a four-beat movement which is keeping correct time.

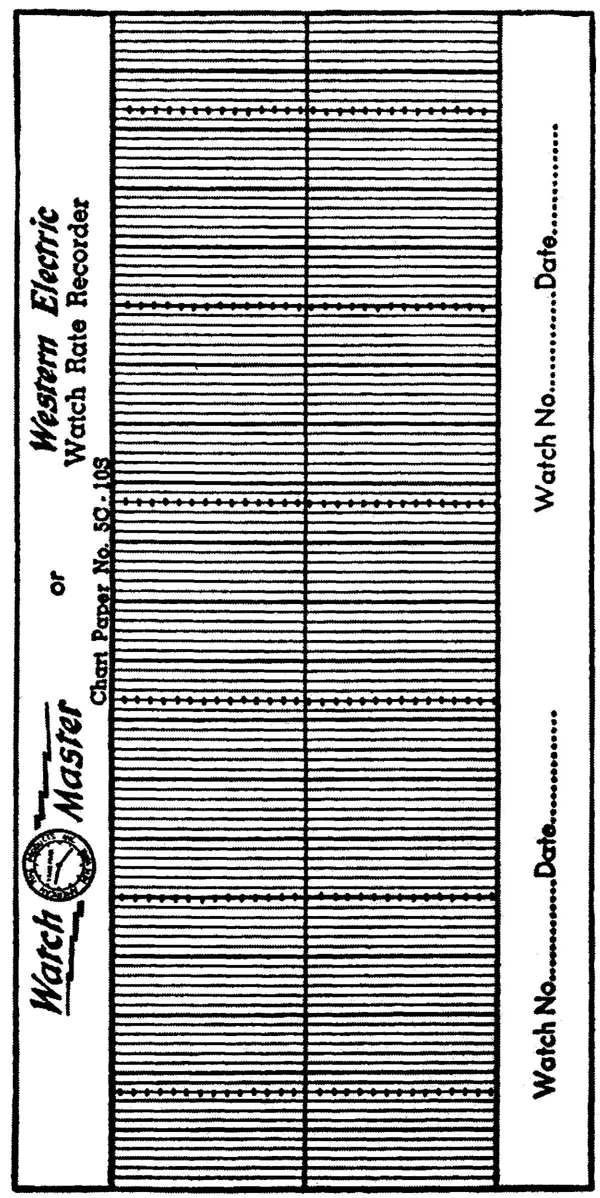
The manner in which the record from a six-beat movement is produced is similar except that six marks are produced for every five revolutions of the drum. In this case five sixths of a revolution occurs between successive ticks. This results in six separate lines of dots any one of which is usable in the regular manner. Figure 33-4 represents a six beat movement which is keeping correct time.

There are a number of other odd beats frequently encountered. Records from these movements are produced in a similar manner and all are usable in the same way. Typical records for most of the odd beat movements are shown at the rear of this lesson, together with a list of most common makes and sizes using each beat.

SEC. 578—Wrist Watches

When the WatchMaster is used for timing wrist watches of average commercial grade, it is generally unnecessary to make the complete 30-second record in each position. This is due to the fact that very few wrist watches will repeat their instantaneous rates exactly from one minute to the next and the average rate must be used. The dial-up and crown-down positions control the performance of a wrist watch when worn and the average between the rates in these

Fig. 33-4



positions is a satisfactory basis for wrist watch timing. Tnis two-position average is obtained by placing the watch in the holder with the dial up and the crown either to right or left.

The WatchMaster is started in the usual manner and when the record reaches the longitudinal dividing line, the watch is turned to the crown-down position without stopping the instrument. Each half of the record represents the twelve-hour rate in the respective positions used and when the chart is read for its full width, the twenty-four hour average is obtained. Record **A**, figure 33-5, shows a wrist watch which has been timed in this manner. The dial-up rate is 10 seconds per day slow and the crown-down rate 80 seconds per day slow. The twenty-four hour average is read as 45 seconds per day slow.

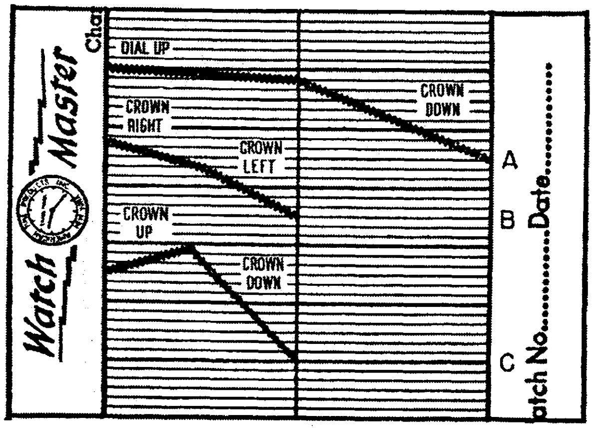


Fig. 33-5

In order to make certain that a serious rate error does not exist in one of the other positions, it is desirable to quickly check the crown-right and crown-left positions before bringing the watch to time. Record **B**, figure 33-5, shows the crown-right-and-left rates for same watch and illustrates the method used in making these quick checks. The rates are similar to the crown-down rate indicating a satisfactory condition. Record **C**, figure 33-5, shows a similar watch in which the balance is out of poise in a manner which does not affect the crown-down rate. This watch could not be expected to keep good time when worn and the error must be corrected before bringing to time.

The watch represented by Records **A** and **B** of figure 33-5 is in satisfactory adjustment for timing and the dial-up, crown-down average rate is 45 seconds per day slow. Since wrist watches generally run slightly slower when worn than they do when perfectly stationary, this watch should be adjusted somewhat more than 45 seconds per day faster. One position only is necessary for this operation although quick position checks are desirable to make certain that other errors have not been introduced by the timing operation.

Figure 33-6 shows the steps followed in regulating the watch and the use of short records to obtain an indication of the extent of the adjustment. Record **A** shows the result of the first attempt. This record represents a rate

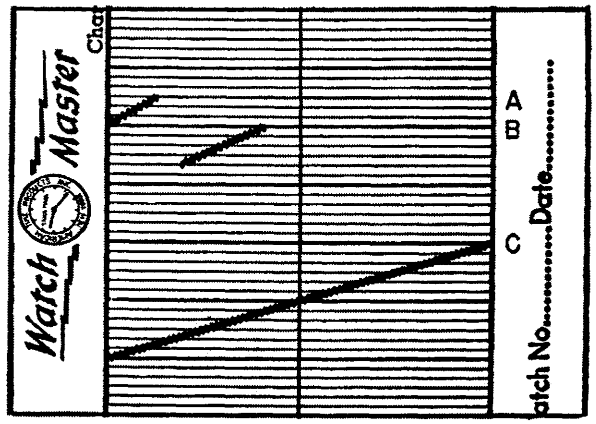


Fig. 33-6

approximately two minutes fast. Record **B** represents the next attempt—about 90 seconds fast. After a further adjustment the full record is made and the watch found to be one minute fast in the dial-up position. This should be about right for this particular watch as the average would then be about 30 seconds fast which allows for the amount the watch will run slow when worn and still have it gain slightly. This is the desirable condition to achieve as a slightly slow watch is unsatisfactory.

All of the records shown up to this point are representative of watches in good mechanical adjustment where the time from "tick" to "tock" is exactly the same as the time from "tock" to "tick" and hence are in perfect beat. Any departure from this time relationship is evidenced by a double line of dots as shown in figure 33-7. The separation between the two lines is a direct measure of this "time" difference and hence the amount the watch is out of beat dynamically (when it is running).

When the watch has been placed in beat statically, by visual inspection of the roller jewel with respect to the line of centers of the balance staff, pallet, and escape wheel arbors, there are at least two more factors which contribute to the dynamic beat condition. The first of these is the relative amount of angular travel the pallet makes on either side of center, (pallet travel is determined by the banking pin adjustment), and should be exactly the same on both sides of center in order that the time of balance swing on each side should be the same. The second contributing factor is the relationship between the hairspring and the regulator pins. It is vitally important that the spring be centered between the pins at rest and that both pins have the same restricting value on the spring at all motions normally encountered.

When all of these conditions have been met, the balance and hairspring combination are in the best condition to oscillate freely and be least affected by variable mechanical influences. The existence of this state of adjustment is evidenced by a single line record which is clean and does not show changes of time between succeeding ticks or ticks and tocks. In wrist watches of ordinary commercial grade, it may be impractical to attain this true state of dynamic beat due to the miscellaneous mechanical imperfections normally present. With watches of this type a compromise adjustment which will produce a double line record with a clear separation not to exceed one small chart division may be assumed to be acceptable. Record **B**, figure 33-7, is representative of such a compromise which may be assumed to be satisfactory although obviously not perfect.

Most watches have balance and hairspring assemblies which are out of true dynamic poise even though the balance wheel itself has been carefully poised before adding the spring. Part of this effect is due simply to lack of symmetry of the collet and inner spring termination and it can be reduced by counterpoise. A further contribution to the apparent out-of-poise condition is made by the tendency of the spring to sag when improperly supported.

SEC. 579—Out of Poise

In a carefully designed watch, the hairspring pinning points have been chosen to provide the most support to the spring in the positions which are most important. Most support is given in the pendant-up position and the least in the pendant-down. A sagging spring has the same general effect as an out-of-poise balance and the position which is affected the most is located in the same manner. When all other conditions are normal, this will generally be found in the pendant-down position. A slight movement of the inner regulator pin in the direction of the spring body away from the stud will be found effective in affording more support in the pendant-down position with a slight improvement in the pendant-right and left rates.

The principles involved in locating the effective heavy side are as follows:

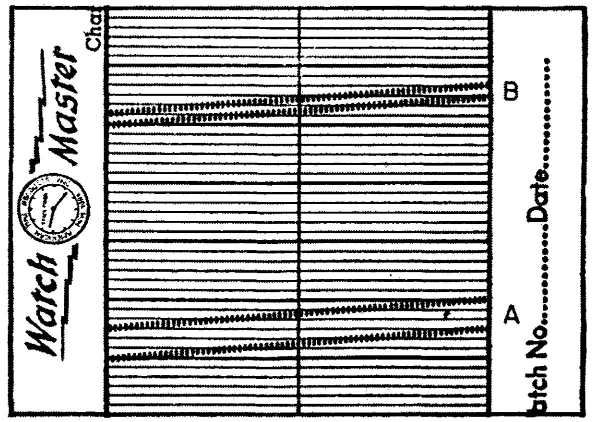


Fig. 33-7

Figure 33-8 shows the rates in one horizontal and four vertical positions in a watch which has the balance somewhat out-of-poise but is otherwise in good condition. The heavy spot on this balance is directly down with the pendant-up and the balance at rest in dead center. This is the position with respect to the out-of-poise condition of the balance which produces the fastest rate and the slowest rate is found directly opposite, in this case with the pendant-down. The pendant-right and left positions are not appreciably affected by this out-of-poise condition and remain close to the rate of the watch in the horizontal position.

Figure 33-9 shows the rate of the same watch in the same positions as in figure 33-8 with the heavy spot on the balance moved half

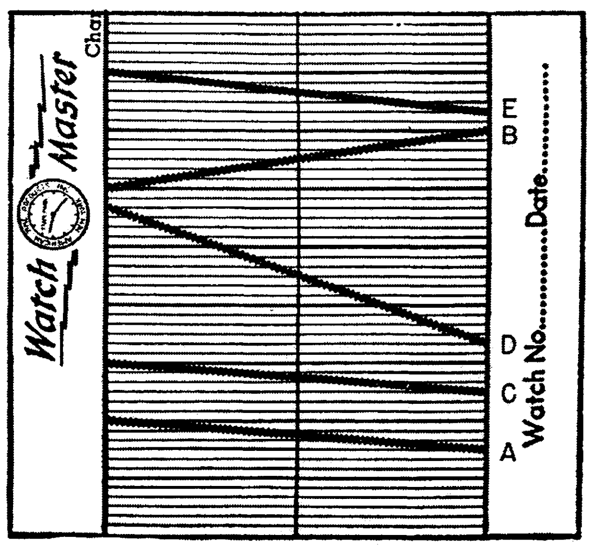


Fig. 33-8

E Pendant right
B Pendant up
D Pendant down
C Pendant left
A Dial up

way between the six and the nine on the dial with the pendant-up and the pendant-left rates are now fast and the pendant-right and pen-

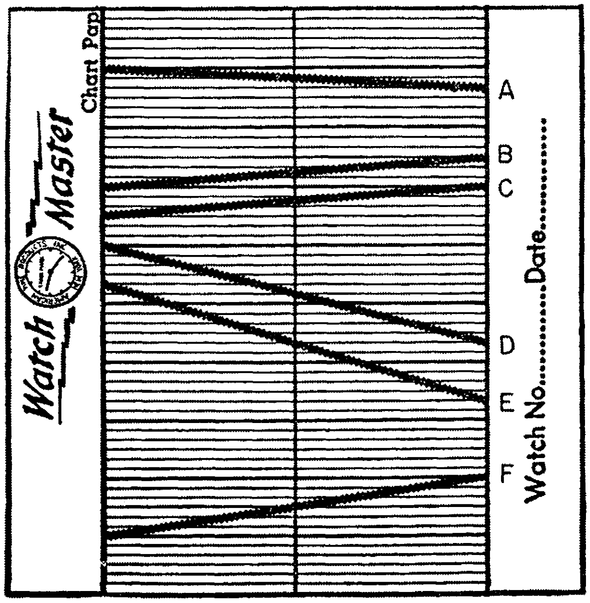


Fig. 33-9

A Dial up	D Pendant down
B Pendant up	E Pendant right
C Pendant left	F Pend. Half left

dant-down rates are slow, the errors in each case being less than the maximum errors indicated in Figure 33-8.

A comparison between figure 33-8 and 33-9 indicates that the fastest rate on the watch in the condition of figure 33-9 would be expected with the pendant moved half-way left, (in other words, the position corresponding to the 1½ on the dial uppermost). Figure 33-9, Record **F**, shows the rate in this position and this rate checks exactly with the pendant-up rate with the watch in the condition as shown in figure 33-8.

Figures 33-8 and 33-9 indicate the method to be followed in determining the balance poise error in any watch and offer a ready means of making a correction which will bring the watch within acceptable limits for its particular grade in a minimum of time. For example, the watch used in obtaining Records in figures 33-8 and 33-9 has its balance arbitrarily thrown out of poise by the addition of a single timing washer under one balance screw.

The effects of lack of poise are the same regardless of the cause. When the obvious mechanical conditions of wheel poise and collet center poise and pin support have been fulfilled and an out-of--poise condition is still apparent, the trouble will generally be found in the manner in which the spring develops. This is corrected by slightly altering the spring so that it develops in a direction away from the apparent heavy spot as located above.

Many watches, particularly of the cheaper grades, will be found with the regulator pins spread too far apart in order to correct the horizontal rate while leaving the regulator in the center of its scale. The most serious error caused by this manipulation appears to be the increased position error encountered.

Most of the error encountered through this condition is truly isochronous in that a difference in rate accompanies a change in motion. In this case the effect of the pins is reduced as the motion falls off in the vertical position, thereby making the full length of the spring to the stud effective for a greater part of the time and thus making the watch very much slower at the reduced motion encountered in the vertical positions.

Figure 33-10, Records **A, B and C,** show three positions of a watch having regulator pins excessively far apart. The horizontal rate is approximately correct, the pendant-down-and-up rates are very slow.

Figure 33-10, Records **A'**, **B'** and **C'**, show the same three positions after the regulator pins had

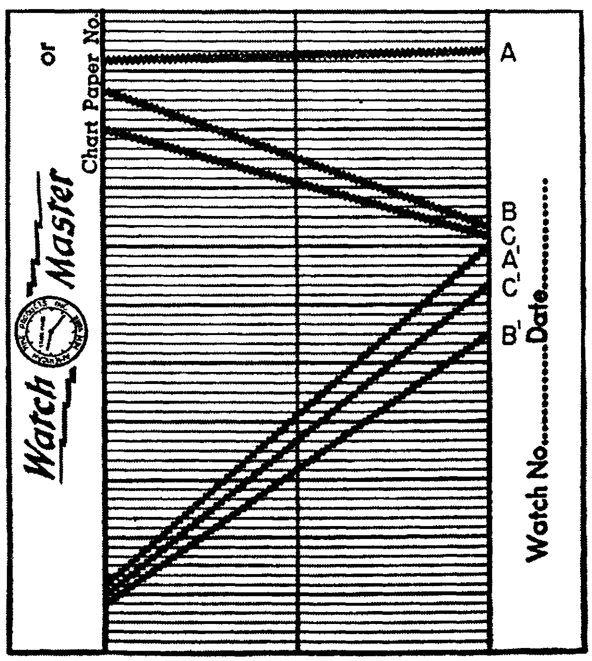


Fig. 33-10

A *Dial up*
B *Pendant up*
C *Pendant down*
A¹ *Dial up*
C¹ *Pendant down*
B¹ *Pendant up*

been closed to the point where the action of the hair-spring between them was proper. This, of course, has the effect of making the watch run faster in all positions but the change in the vertical position rates is greater than the change in the horizontal rate. This has had the effect of bringing the position error for this watch within acceptable limits.

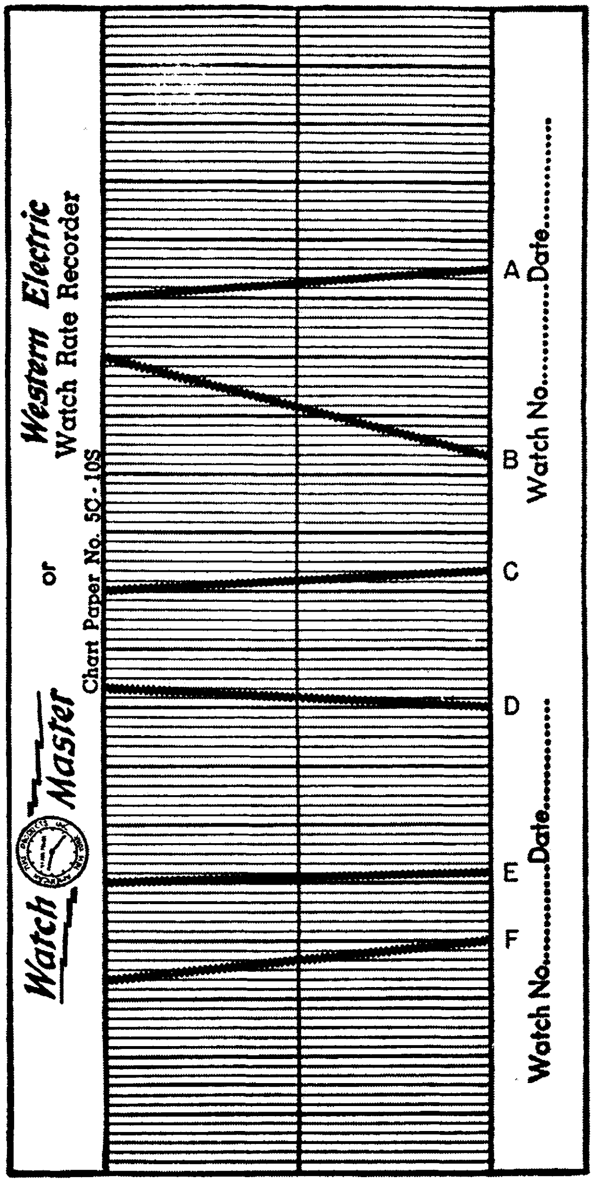


Fig. 33-11

A Dial up—full wound
B Dial up—24 hrs down
C Dial up—full wound
D Dial up—24 hrs down
E Dial up—full wound
F Dial up—24 hrs down

SEC. 580—Isochronism

Isochronism in a watch may be roughly defined as the relationship between the rate and the arc of balance motion in any position. The isochronous error may then be defined as the difference between the rate of the watch full wound and the rate at the end of the normal period between windings. This is generally 24 hours. This is most easily measured by taking the rate with the main-spring wound an amount equivalent to that after 24 hours of running and then measuring the rate in the same position with the mainspring fully wound. The difference between these two rates is the isochronous error of a watch in the position tested.

Figure 33-11, Records **A** and **B,** shows the full-wound and 24-hour down rates of a watch with a flat hairspring which, of course, has no isochronal correction and always runs slower as the motion decreases. Figure 33-11, Record **C** and **D,** shows a comparable watch having a hair-spring with an over-coil which does not fully compensate the rate with decreased motion and figure 33-11, Records **E** and **F,** shows another watch in this same classification in which the over-coil over-compensates for decreased motion, thereby making the watch run faster as it runs down.

From an inspection of these three records, a quick method for correcting excessive isochonal errors in watches having over-coils suggests itself, which may be also used advantageously in bringing the horizontal and vertical rates closer together without resorting to the undesirable method of altering the shape of the balance pivots. For example, a watch having a hairspring with an over-coil runs somewhat slower in all of the vertical positions than it does in the horizontal positions. It may be assumed to have an excessive isochronal error which should, of course, be roughly checked in the manner explained above.

When the wound-down rate is found to be considerably slower than the full-wound rate, the correction is made by re-shaping the over-coil slightly to have the straight part in the center section of the coil slightly closer to the staff. If this correction is over-done the watch will run faster as the motion decreases. However, a position for this over-coil section is easily reached where the isochronous error of the watch is reduced to a tolerable value, in which case a watch in good condition will have vertical rates extremely close to the horizontal rate.

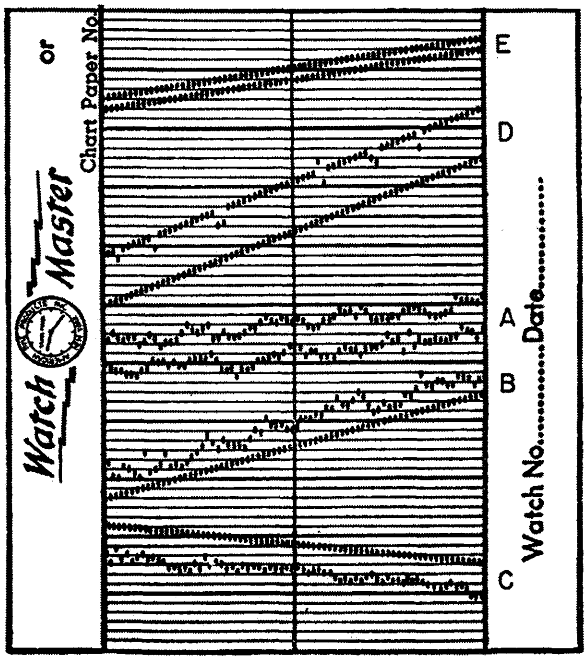


Fig. 33-12

SEC. 581—The Hairspring

The adjustment of the hairspring in the watch is the greatest single factor which contributes to the watch performance. Faulty adjustment of the hairspring and its relationship to the regulator pins can be the source of most of the erratic time-keeping which a watch in otherwise excellent mechanical condition will exhibit. Variations in rate in the vertical positions may occur when the spring is improperly centered or when it is given insufficient support in one position, thus allowing it to sag and producing an apparent out-of-poise condition. Variations in rate between dial-up and dial-down may occur when the regulator pins are not parallel. Variations in rate between the horizontal and vertical positions may occur when the over-coil is improperly formed or when the regulator pins are too far apart. Generally erratic behavior may be experienced when the spring is not centered between the regulator pins so that the restrictive effect of the two pins is unequal. Record **E**, figure 33-12, is indicative of this condition ,when the watch is in perfect beat statically. The effect is further exaggerated by bending one of the pins away from the spring at an angle. In addition to indicating a greater departure from perfect beat, one line of the record exhibits a slightly ragged tendency, due to spring hitting the pin at an angle and sliding an unequal amount on succesive oscillations. Record **D** is indicative of this condition which can also be caused by lack of parallelism between the pins in the direction of the staff.

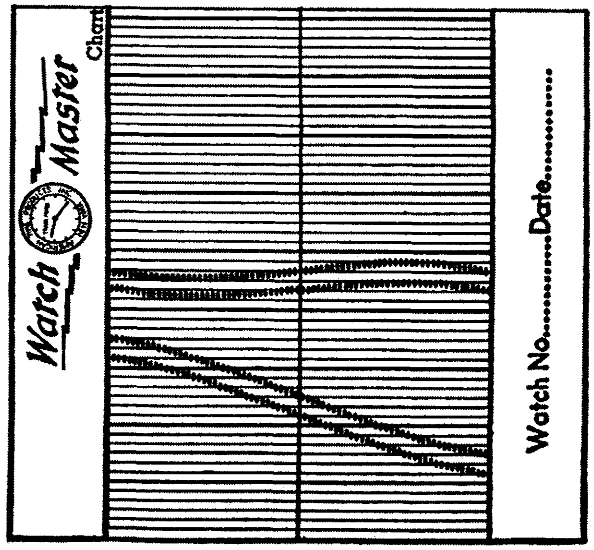


Fig. 33-13

Record **A** is representative of a hairspring which is not flat. This causes the flat sides of the spring to hit the pins at an angle and produces a tendency for it to slide on the pins unevenly and also causes the spring to move unevenly in the direction perpendicular to its plane. Records **B** and **C** are very common types and are indicative of trouble at only one pin. In general, a ragged upper line may be traced to the outer pin and a ragged lower line to the inner pin. None of these should be tolerated as they all are indicative of faults which make an otherwise good watch a poor timekeeper.

SEC. 582—Mechanical Faults

Many of the common mechanical faults produce characteristic records on the Watch-Master. Some of these are occasioned by the fact that most watches have some isochronal error and hence the rate changes as the power delivered to the balance changes. For instance, figure 33-13 shows two consecutive records for a watch having a defective fourth wheel. The fourth wheel revolves once per minute and as a consequence, when it is out of round, or has a bent arbor, the power delivered to the escape wheel will vary over the period of one minute and will be accompanied by a rate change as the power varies. A second hand which binds or drags on the dial on one side and not on the other is a common cause of this trouble.

Similarly, an escape wheel which is out-of-round or has any mar or bur on its pinion will cause a change ten times per minute (15-tooth escape wheel). Figure 33-14, Records **A, B** and **C,** shows the typical records for these conditions. When the wheel, itself, is out-of-round or not

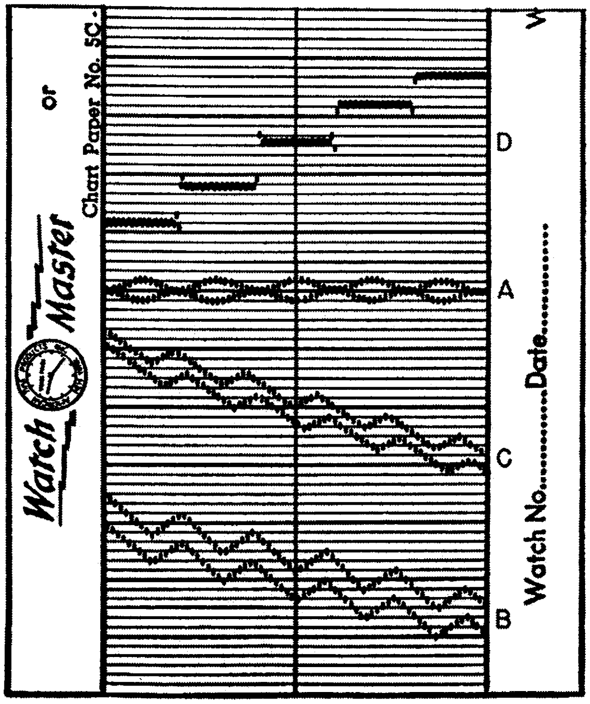


Fig. 33-14

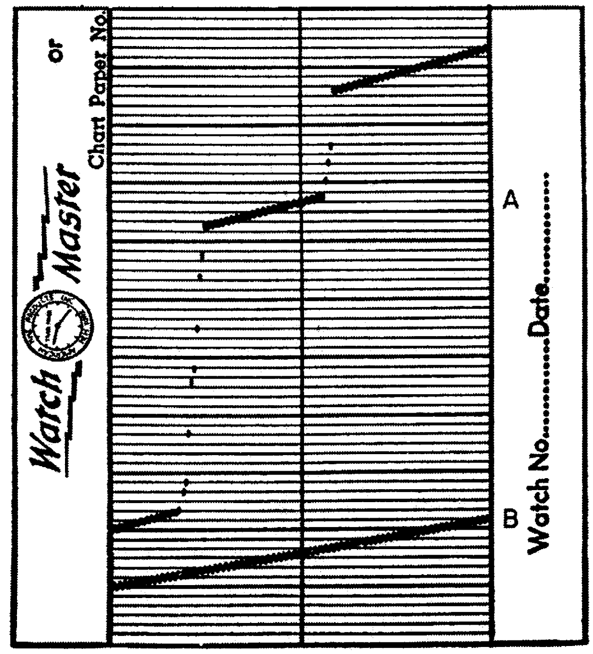


Fig. 33-15

exactly centered on the arbor, the locking of the escapement will vary as the wheel rotates and, while there may be slight changes in rate, the characteristic pattern consists of a periodic widening and narrowing of the space between the two recorded lines. This may also take the form of a single line which widens to a double line and returns to the single line at the rate of ten times per minute or five full cycles in the full 30 seconds of the WatchMaster Record. Figure 33-14, Record **A,** shows this condition.

When the pinion alone is defective, the power changes as the wheel rotates but the escapement is not affected. The record then shows a change of rate without change of pattern. Figure 33-14, Record **B,** shows this condition. When the pivot or arbor is at fault, the power transmitted usually varies and the escapement locking changes as the wheel rotates. This condition produces a record which changes rate and pattern both as shown on Figure 33-14, Record **C.**

In addition to these escape wheel faults, occasionally watches are found with a mutilated escape wheel tooth. This may result in the failure of the escapement to lock on one or both sides as this tooth presents itself to the pallet. Figure 33-14, Record **D,** shows the effect of this condition in a watch which is well adjusted in all other respects.

Occasionally, watches will produce records which indicate one or more of these escape wheel faults and upon examination, the fault cannot be found. This trouble will then be generally traced to a magnetized escape wheel. This is particularly true of a so-called non-magnetic watch which nevertheless has a steel escape wheel. When this condition exists the magnetism exerts a variable influence on the hairspring and the watch records a pattern which is similar to the escape wheel fault records of Figure 33-14.

Figure 33-15A is representative of watches in which the balance motion is excessive. This usually occurs after the watch has been put in first-class condition with the majority of its errors eliminated or greatly reduced. The trouble is ordinarily called "over-banking" and is caused by the roller jewel unlocking the escapement by hitting the pallet on its back side. The proper correction for this trouble consists in reducing the strength of the mainspring rather than by increasing the friction, by flattening the balance pivot ends. Figure 33-15B shows the same watch after the mainspring had been replaced.

Watches which have low motion of the balance wheel are generally unsatisfactory timepieces and are apt to be very troublesome in service. While the eye is a fairly good judge of the extent of the balance arc, the WatchMaster record gives a definite indication of the effect of the particular motion in question on the performance of the watch. In general, low motion which affects watch performance produces records which are unsteady in direction and are very characteristic of this condition. Figure 33-16 shows a record of this type. Watches which produce records having these characteristics are almost certain to be troublesome and should never be delivered until the condition is corrected.

All of the foregoing charts are indicative of watch faults which are correctable by adjustment and manipulation. These corrections are part of the finishing and timing procedure after the watch has been repaired.

There are, however, a certain number of specific faults which might be overlooked in the repairing process which produce records indicative of their existence. Such things as loose or cracked jewels, loose banking pins and loose or improperly set roller jewels produce ragged records which in some cases are similar to records produced by certain types of hairspring faults, but in general they will not vary between positions as the hairspring records do. In any event ragged, double records represent watch faults which should not be tolerated and the records furnish a clue to their correction although more than one part may contribute to the fault.

In addition to these specific faults excessive slide in the escapement has the effect of producing a ragged record when it begins to cause trouble in the watch. This may exist in one or both lines of the record and is an indication of which side to reduce the slide on. In many older watches in which the balance pivots have become slightly worn the separation between the lines vary as the watch is moved through the vertical positions. The lines will be closest together, in general, in that position where the balance is over the pallet and escape wheel, and the separation will be greatest in the position directly opposite that point with the records in the horizontal positions somewhere in between. When this condition exists, it is well to make all adjustments to the escapement in the position which brings the lines on the chart closest together. It is then likely that all other positions will be satisfactory.

In order to compensate for the wear existing in the balance pivots, it is sometimes possible to reduce the slide on one side of the escapement and increase it on the other and thus arrive at a compromise which will produce a satisfactory operating condition in all positions without interference. Figure 33-17, Records **B** and **A**, represents pendant-up and pendant-down for a watch having somewhat worn balance pivots and which has been adjusted to have a good escapement action in a horizontal position. It is noted that interference is encountered in the pendant-up position which makes an extremely erratic record and in the pendant-down position the lines have separated considerably.

The slide in this watch was then adjusted in the pendant-up position until it was optimum, and the results are shown in figure 33-18. Note that the records for the various positions have been brought very close to the same separation and the action is extremely good in all positions. This is accomplished without the necessity of replacing the staff and possibly the jewels in the watch.

Fig. 33-16

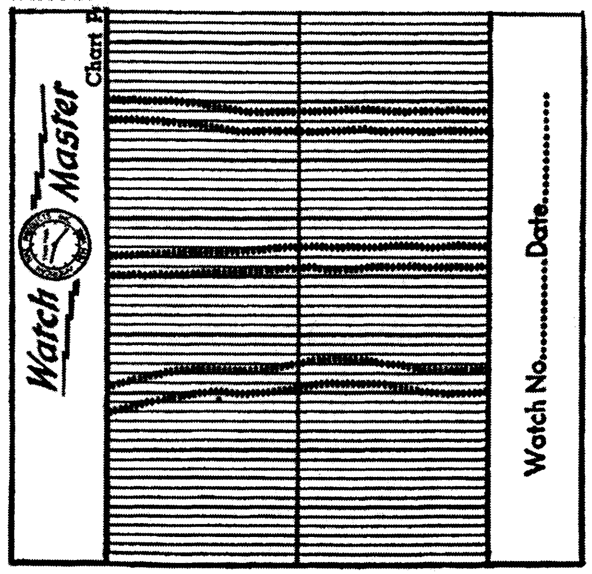


Fig. 33-17

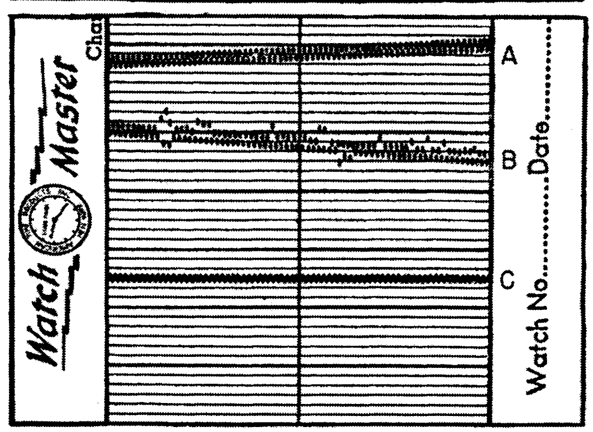
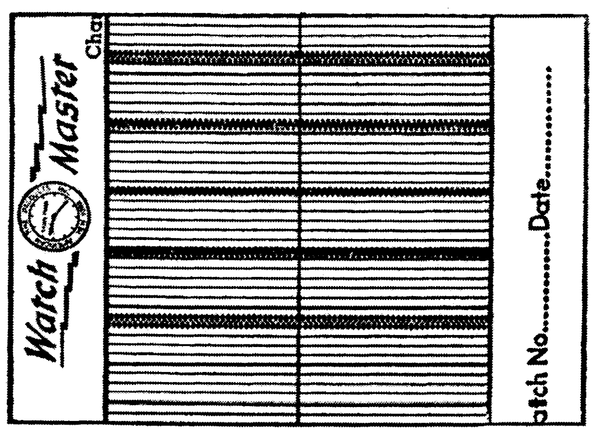


Fig. 33-18



SEC. 583—Odd Beat Movements

The WatchMaster is primarily designed to record the action of watches having 18000 beat per hour trains. This means that the drum turns at exactly 18000 revolutions per hour and the comparison between the watch rate and the machine rate is read directly from the chart. However, the very nature of the WatchMaster design insures an adequately readable record for any other beat up to at least double the normal rate, or 36000 per hour. Most of these so-called odd beats record multiple line records around the drum, any of which are usable in the regular manner. This condition exists for all beat rates that are reducible to a small common fraction of the drum speed. For example, a watch which beats only four times per second will make four dots in five revolutions of the drum. This means that one and one quarter revolutions of the drum will be made between beats and every fifth beat will record at the same position on the drum. The intervening beats will record at evenly spaced intervals around the drum, one-quarter revolution apart. Thus, a four beat movement will record a pattern of four lines all equally spaced and parallel to the drum when on time. From this fact, it may be shown that any beat which bears a common fraction relationship to the rate of the drum with a difference of one between the numerator and denominator will record a multiple record parallel to the drum. The following table lists these odd beats which will produce lines parallel to the drum when on time.

Beat	Ratio to 18000	Lines	Ratio to 18000	Beat
14400	4/5	4	4/3	24000
15000	5/6	5	5/4	22500
15428	6/7	6	6/5	21600
15750	7/8	7	7/6	21000
16000	8/9	8	8/7	20571
16200	9/10	9	9/8	20250
16363	10/11	10	10/9	20000
16500	11/12	11	11/10	19800
16615	12/13	12	12/11	19636
16714	13/14	13	13/12	19500
16800	14/15	14	14/13	19384
16875	15/16	15	15/14	19285
16941	16/17	16	16/15	19200
17000	17/18	17	17/16	19125
17052	18/19	18	18/17	19058
17100	19/20	19	19/18	19000

The maximum number of lines which can be read is nineteen. Any beat which is closer to 18000 than the beats which produce nineteen lines is read as one line with an off-time slope. Any beats which are other than the exact ones shown on the above chart produce the number of lines shown for the nearest exact beat but will have a slope which is representative of the difference between the beat of the watch and the nearest beat shown. The amount of this slope is determined by subtracting the value of the nearest beat shown from the beat of the watch, dividing this difference by the exact beat shown and multiplying by 86400, the number of seconds in one day. This product will represent the slope of the record for the beat in question when keeping correct time. The sign of the answer will determine whether the indicated record is gaining or losing. Plus represents a gain and minus a loss. For example, 20222 is a relatively common beat for medium small size Swiss ladies' watches. The nearest exact beat shown is 20250, which produces nine lines. The correct time slope is determined as follows:

$$\frac{\text{Beat of watch under test (20222)} - \text{Nearest exact beat (20250)}}{\text{Nearest exact beat (20250)}} \times \begin{array}{c}\text{No. of}\\ \text{second per}\\ \text{day}\end{array}$$

$$\frac{20222 - 20250 \times 86400}{20250} = \frac{28}{20250} \times 86400 = -120 \text{ seconds per day}$$

The correct record for a watch which is designed to beat at the rate of 20222 per hour is therefore nine lines evenly spaced around the drum at a slope of 120 seconds or 2 minutes per day slow.

SEC. 584—Typical Odd-Beat Charts

The following charts have been included to show the on-time record for most of the common types of odd beat movements. In reading a watch rate of this type only one line is used and the watch is fast or slow by the amount the record departs from the on-time record shown. Any watches having beats other than those shown may be checked by referring to the method outlined above.

Perfect Record — 14,400 Beats Per Hour

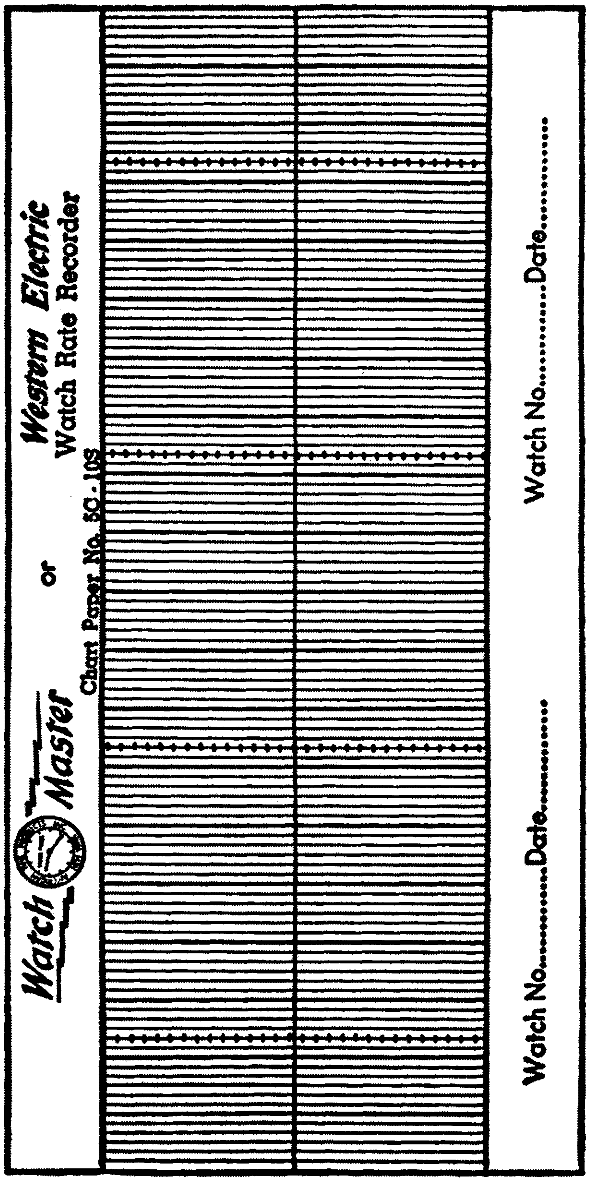


Fig. 33-19

4 lines — Horizontal

The rate can be easily determined in the manner described in the introduction to this section.

This beat is common in cheaper watches and alarm clocks.

Perfect Record — 19,800 Beats Per Hour

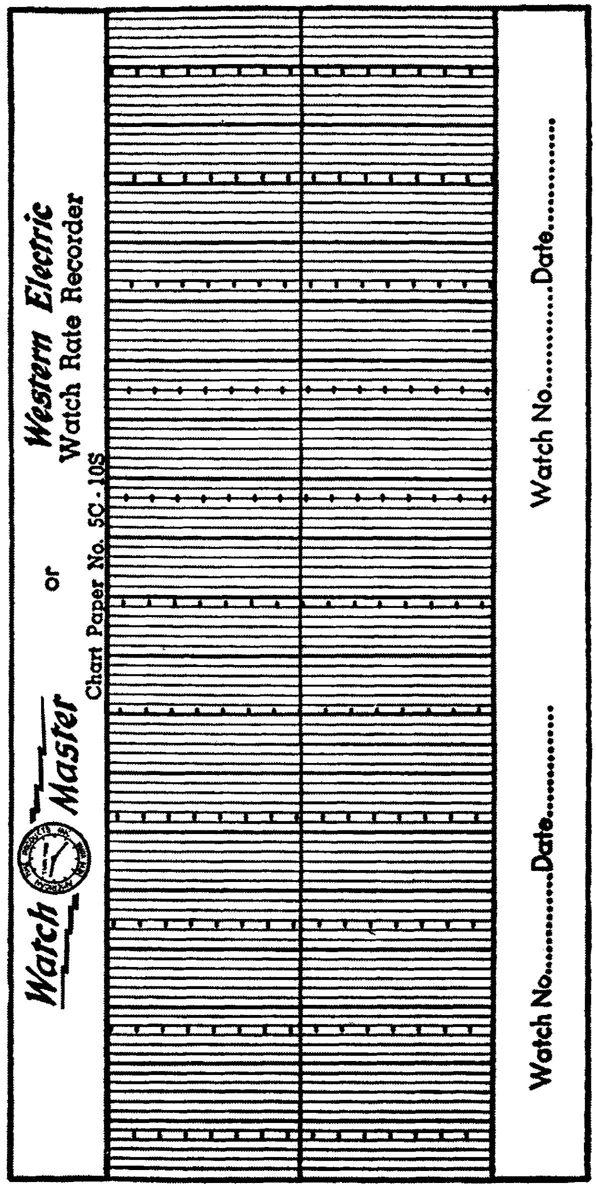


Fig. 33-20

11 lines — horizontal — indicates a correct rate.

If the lines slope upward, the rate is fast—if the slope is downward the rate is slow. (The same as for 18,000 beat per hour movements.)

Manufacturer	Model or Size
Elgin	Baguette
Omega	5½ ligne oval
Concord	5¼, 7¾ ligne and "R. Cart"

Perfect Record — 20,222 Beats Per Hour

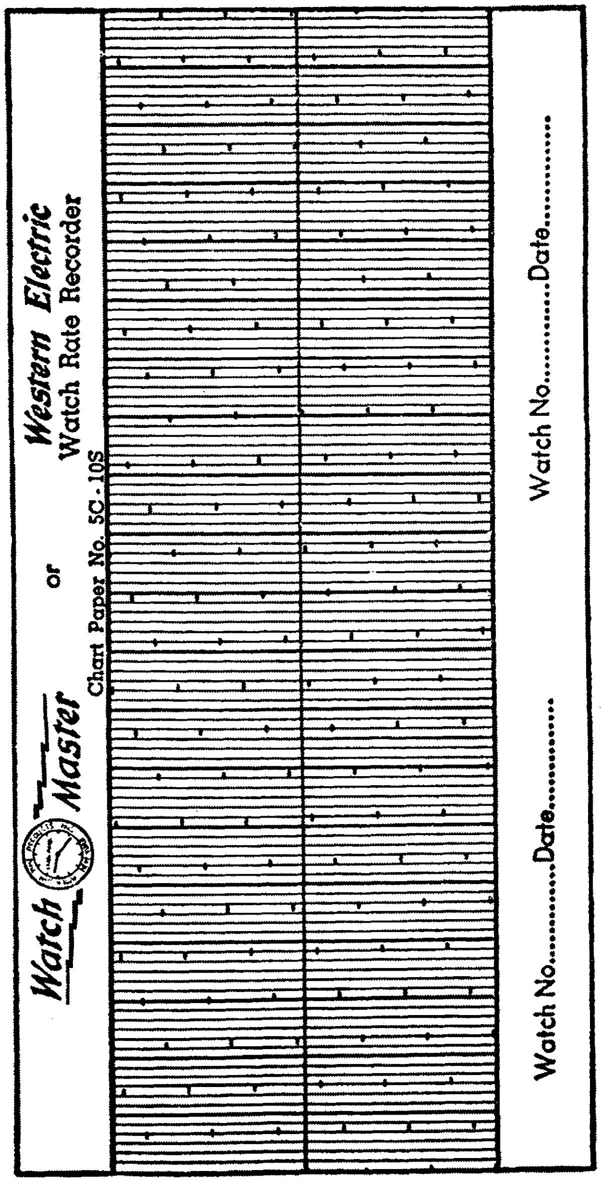


Fig. 33-21

9 lines— 6 min. 24 sec. "SLOW" — indicates a correct rate.

If the lines do not slope downward as much as this, or if they slope upward, the rate is fast—also if the slope downward is more than this, the rate is slow.

The rate can be easily determined in the manner described in the introduction to this section.

Manufacturer	Model or Size
Huguenin	$5\frac{1}{2}$ ligne
Gruen	Most small Models

Perfect Record — 20,160 Beats Per Hour

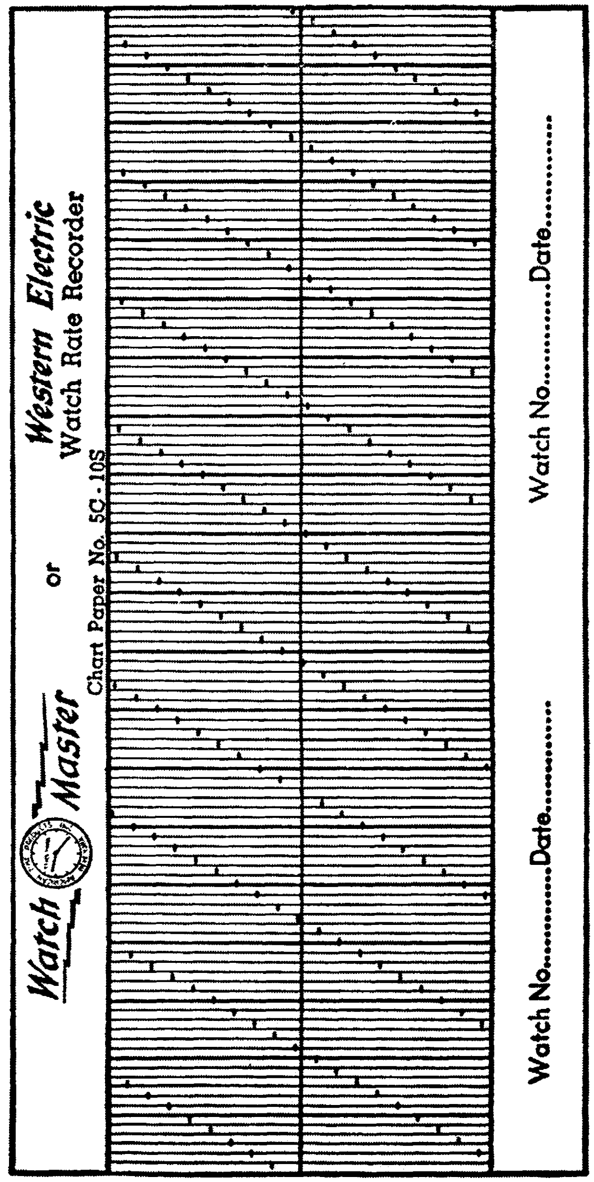


Fig. 33-22

9 lines — 2 min. "SLOW" — indicates a correct rate.

If the lines do not slope downward as much as this, or if they slope upward, the rate is fast—also if the slope downward is more than this, the rate is slow.

The rate can be easily determined in the manner described in the introduction to this section.

Manufacturer	Model or Size
Agassiz	8 ligne (8PCV)
Meylan	7 and 8 ligne
Hass	8 ligne round
Gruen (old)	105, 840, 845

Perfect Record — 20,944 Beats Per Hour

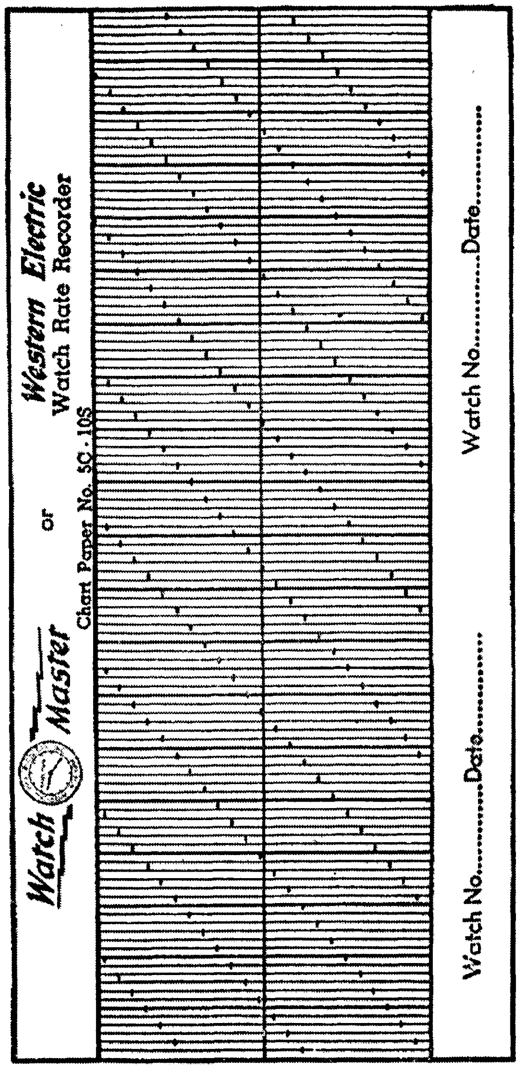


Fig. 33-23

7 lines — 3 min. 50 sec. "SLOW" indicates a correct rate.

If the lines do not slope downward as much as this, or if they slope upward, the rate is fast—also if the slope downward is more than this. the rate is slow.

Manufacturer	Model or Size
Vacheron and Constantine	7 ligne oval
Agassiz	7 ligne (PCV, AO, Z)
Meylan	7 and 8 ligne
Nardin	7 ligne round
Merrimont	7 ligne oval
Gruen (old)	839, 847

Perfect Record — 18,000 Beats Per Hour

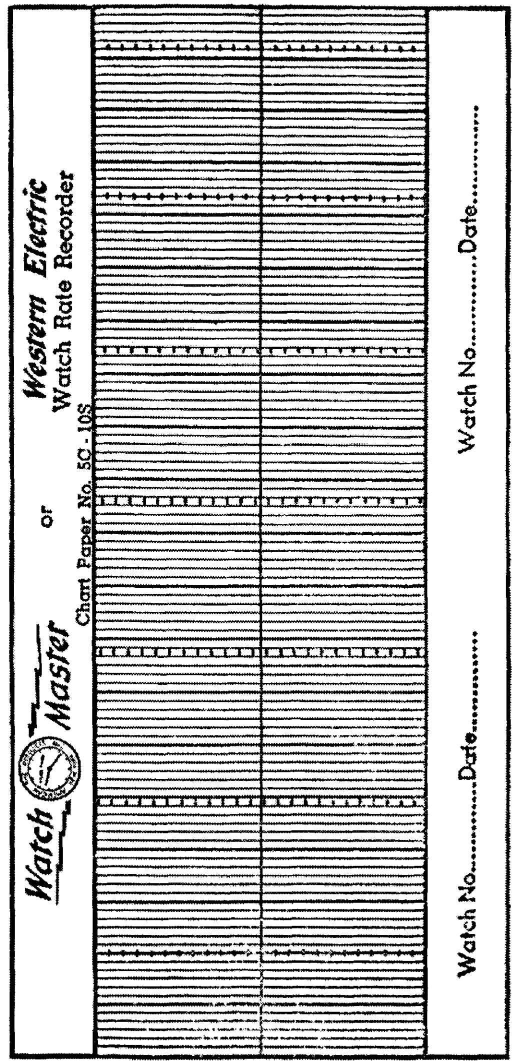


Fig. 33-24

7 lines — horizontal — indicates a correct rate.

If the lines slope upward the rate is fast—if the slope is downward the rate is slow. (The same as for 18,000 beat per hour movements.)

Manufacturer	Model or Size
Touchon	4 ligne Rect.
Patek Phillipe	Baguette
Audemars Piquet	8 ligne Rect.
Omega	Baguette
Cartier	Some Models

Perfect Record — 21,600 Beats Per Hour

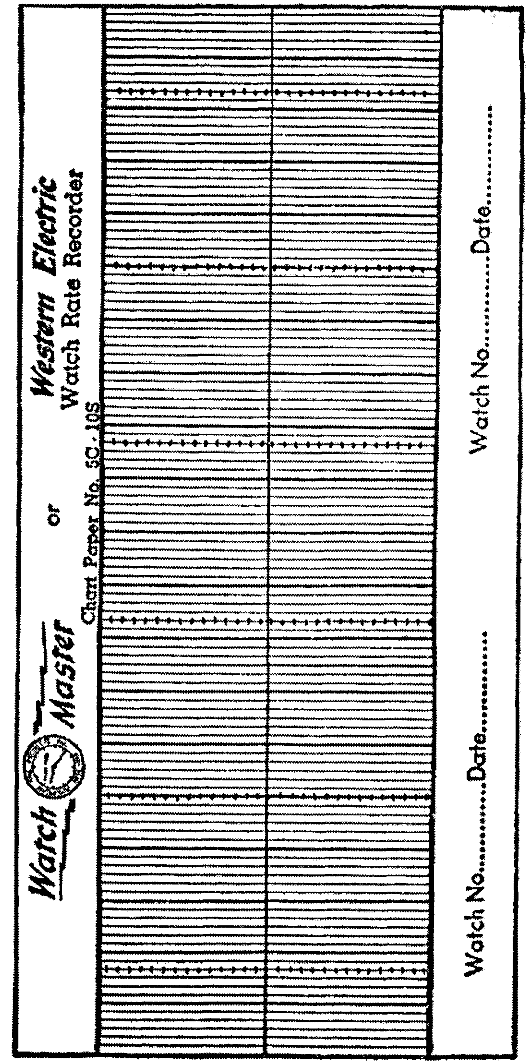


Fig. 33-25

6 lines — horizontal — indicates a correct rate.

If lines slope upward the rate is fast—if the slope is downward the rate is slow. (The same as for 18,000 beat per hour movements.)

Manufacturer	Model or Size
Agassiz	8 ligne (8AC)
Waltham	Baguette (400)
Cartier	Some Models

note:

(No job sheets are associated with Lesson 32, Part 2)

Master Watchmaking

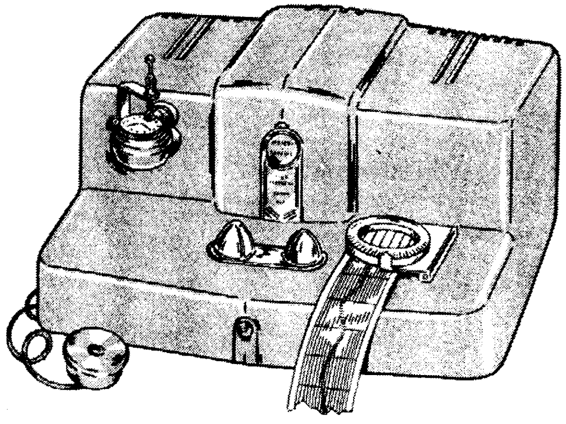
MODERN SHOP METHODS

LESSON

34

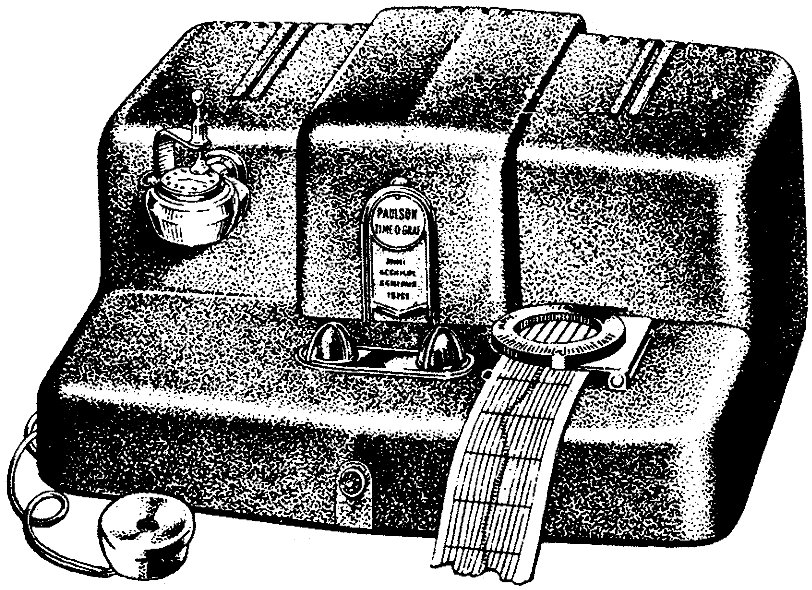
Electronic Timing Machines

(Time-O-Graph)



CHICAGO SCHOOL OF WATCHMAKING

Founded 1908 by THOMAS B. SWEAZEY



SEC. 585—Introduction

Every watchmaker, whether he be engaged in repair or manufacture, can do his work better and more efficiently if he has proper tools and uses them intelligently. The PAULSON TIME-O-GRAF is an electronic instrument which can be used to print on a paper tape a record of the performance of a watch; this record may be used to determine such factors as: rate, position errors, isochronal errors and faulty actions of the movement. TIME-O-GRAF cannot be used as a substitute for the skill and knowledge of watchmaking, but it can give a clear, accurate and rapidly obtained record of the actions of the watch under test and upon which watchmaker's skill and knowledge may apply.

In making this expertly designed machine only the finest of workmanship and materials have been used. Everything possible has been done to make it easy and convenient to set up and operate. But it is important to remember that this is a precision instrument and to take full advantage of its potentialities, you should know as much as possible about the machine.

You are urged, therefore, not only to make a thorough study of this lesson but to refer to it often.

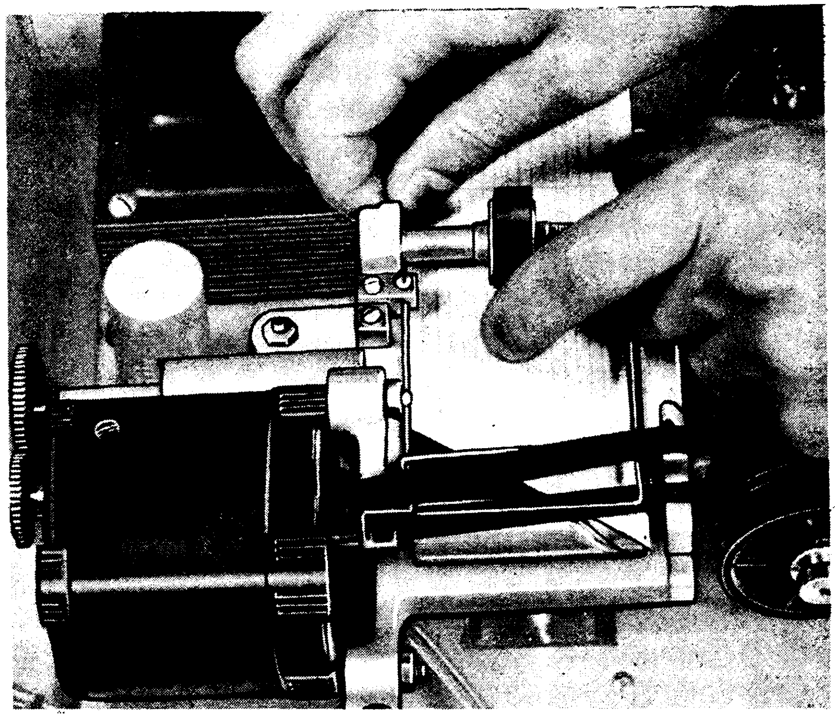


Fig. 34-1

SEC. 586—Threading the Printer Tape

Figure 34-1 shows the threading of the printer tape. Cut the end of the paper tape to about a 45 degree angle; place the roll on its roller in position and thread the end of the tape between the 3/32" diameter rod and the top surface of the cast aluminum printer frame.

DO NOT LIFT UP ON THE PRINTER BAR when threading the paper tape beneath the inked ribbon.

Connect the rubber covered cord to a source of 110-120 volt, 50-60 cycle alternating current and turn the right hand knob to the "ON" position and let the machine warm up for at least 30 seconds. Then, turn the knob to the "RECORD" position. As the machine then starts you will start the paper tape forward in between the rubber roller and the knurled driving roller. Let the motor feed it on through, and with a piece of pegwood guide the tip of the tape under the inked ribbon and over the spiral roller.

Let the machine run until the tip of the paper tape just extends beyond the inked ribbon, then turn the knob back to the "ON" position.

Remove the knob from its post and lower the cover of the machine into place.

Place both knobs on their respective posts.

Then, turn the right hand knob to the "RECORD" position, and as the paper tape feeds through, use a piece of pegwood and guide it through the window in the case and under the paper cutter bar.

Place a watch under the clamp of the microphone with the watch crystal making contact with the metal button in the center of the microphone and with the right hand knob in the "Record" position, the printer tape should start to emerge. Turn the volume control about 2/3 of the way on and then the printer bar should pull down with an easily heard click with each tick of the watch.

SEC. 587—Construction and Theory

The TIME-O-GRAF is a time differentiating watch rate recorder. Its basic principle is the comparison of the rate of the watch under test with an accurately measured interval of time and the printing of this comparison on a paper tape so that the rate may be ascertained therefrom or may be obtained by reference to a calibrated dial.

IMPORTANT: It must be clearly understood by every watchmaker that any watch rate recorder will indicate the rate of the watch during the period of the test only, hence it is impossible to predict the full 24 hour rate of

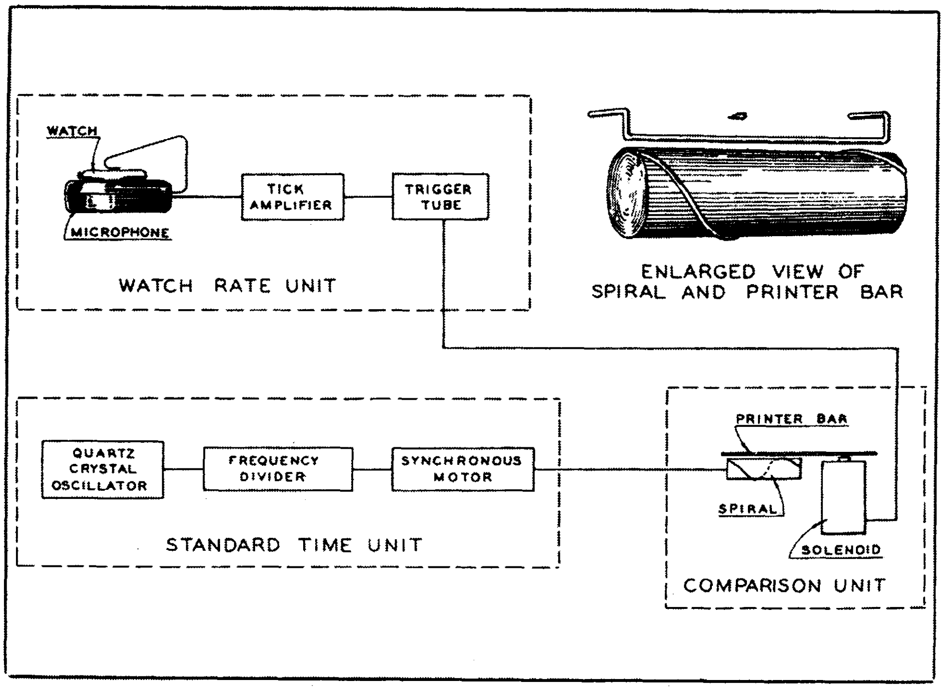


Fig. 34-2

a watch from any test covering less than that amount.

The method by which the TIME-O-GRAF makes the comparison between the rate of the watch on test and the standard time is shown in Figure 34-2. The unit which furnishes the source of standard time consists of a quartz crystal controlled oscillator which generates a high-frequency voltage of exceptional stability and a frequency divider which divides this frequency to a value which permits it to be used to drive the synchronous motor of the comparison unit. The armature shaft of this motor, running at a speed of 2700 revolutions per minute or 45 revolutions per second, carries a metal drum which has a raised spiral on its surface.

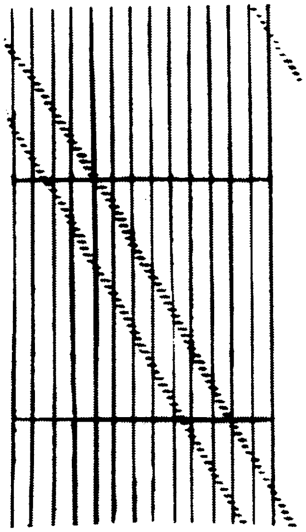
The watch rate unit consists of a microphone which picks up the tick of the watch under test, an amplifier which amplifies this tick, and a trigger tube which operates or "fires" once for each tick of the watch and energizes a solenoid in the comparison unit. This solenoid pulls a printer bar downward against an inked ribbon and a paper tape which rest lightly on the spiral previously mentioned. Inasmuch as the printer bar can strike the spiral at only one point, each stroke produces a dot on the tape, the location of the dot depending on which part of the spiral is under the printer bar at the moment of contact.

It can be seen that if the spiral is made to rotate at a constant rate of speed, the point at which the spiral and the printer bar make contact will move at a uniform rate across the tape. In the TIME-O-GRAF the spiral, which has a lead of two inches, is made to rotate at 45 revolutions per second which causes the point of contact to move from right to left across the tape at a rate of 90 inches per second. If each tick of the watch occurs EXACTLY one-fifth of a second later than the preceding one, the spiral will make exactly nine revolutions between ticks and each dot on the tape will fall on top of the last one. If, however, the watch is running slow, the spiral will turn slightly more than nine revolutions between ticks and each dot will fall to the left of the one preceding it. If the watch has a losing rate of 43 seconds per day, each tick will occur one ten-thousandth of a second later than it should, and consequently each dot on the tape will fall nine-thousandths of an inch to the left of the preceeding one. If provision is now made to advance the tape at a uniform rate, the dots will also progress along the long axis of the tape, forming a line thereon. In the TIME-O-GRAF this motion of the tape, which amounts to six inches per minute, is obtained by a reduction gear and friction roller driven by the same synchronous motor which drives the printed spiral.

Note that this line of dots may fall anywhere from the right side to the left side of the paper. Where it occurs depends entirely upon the time relationship between the motor spiral and the balance wheel in the watch. Thus, the location of the line (to the right or left side of the paper) is no indication of the rate of the watch.

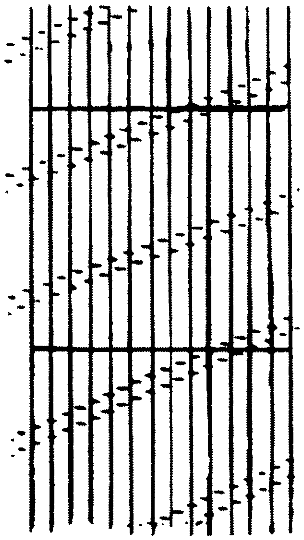
The rates of the watch and the actions of the escapement are determined by the slopes and variations in the line.

Hence, from the above, we see that if the watch is running slow the line of dots will slope to the left, as in figure 34-3, and if the watch is running fast the line of dots will slope to the right, as in figure 34-4.



Losing about 52" per day

Fig. 34-3



Gaining nearly 4' per day

Fig. 34-4

If one desires to calculate the rate of a watch directly from the line of dots on the tape, without using the Rotary Precision Dial, one may proceed as follows:—

Using the printed tape we find reference lines are printed on this tape, figure 34-5—one set spaced 1½ inches apart and the other set spaced ⅛ inch apart. The physical constants of the TIME-O-GRAF are so chosen that a rate of error of one second per day will cause the printed record to travel ⅛ inch across the tape while traveling 12 inches along the tape. Thus a record which travels ⅛ inch across the tape while traveling 1½ inches along the tape indicates an error of 8 seconds per day. The rate may be calculated by the following formula:

$$R = \frac{A \times 96}{B}$$

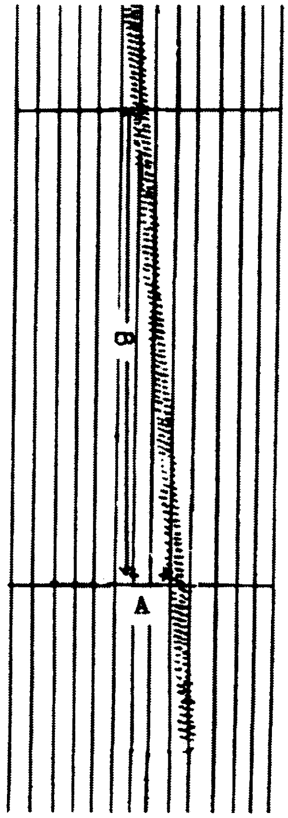


Fig. 34-5

Where **R** is the rate of the watch in seconds per day, **A** is the distance in inches which the record has travelled across the tape, while **B** is the distance in inches which the record has travelled along the tape.

SEC. 588—Crystal Control Assures Accuracy

Crystal Control: Nothing in the wide world has the accuracy of the quartz crystal control, your absolutely accurate, dependable time comparison. To depend upon anything but accurate time comparison is time wasted.

The U. S. Government uses crystal control for accuracy. The U. S. Bureau of Standards can tell you of the accuracy of crystal control. The world renowned clock at Greenwich, London, England, universally famous for continued accuracy, is under Crystal Control.

The Crystal Control is "natures own," scientifically ground and set; natures vibrations "like natures own" keeps in step with the stars for accuracy.

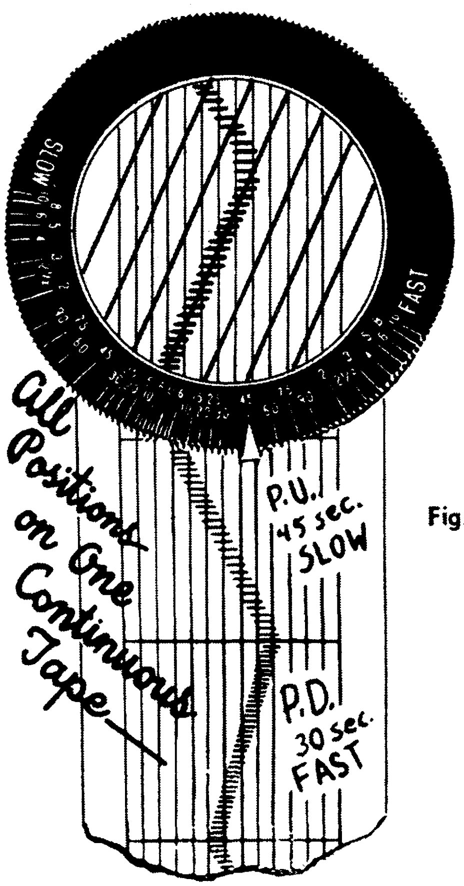


Fig. 34-6

SEC. 589—Instant Reading of Rates

The ROTARY PRECISION DIAL, under which the tape moves is calibrated in seconds per day, gain or loss, and enables the user to read the rate directly instead of having to measure the angle of the printed line and calculate the rate.

The rotary precision dial on the TIME-O-GRAF is illustrated in figure 34-6. It consists of seven parallel lines and is turned so that these parallel lines become parallel to the angle made by the line of dots issuing from the machine. Then the second marks on the dial show instantly the exact number of seconds per day, gain or loss. When using the rotary dial exclusively to ascertain the rates, it is not necessary to use the calibrated paper tape inasmuch as ordinary adding machine paper tape will suffice for the printed record under these circumstances.

SEC. 590—Operation

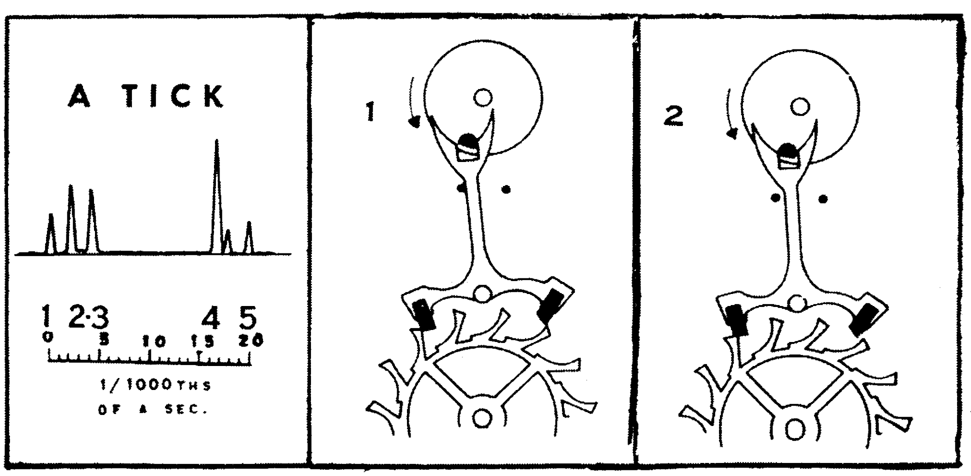
To use the TIME-O-GRAF intelligently it is first necessary to understand the sequence of sounds produced by the escapement in a watch. We know that the sounds in a watch which we call the "tick" and the "tock" occur as the result of the escapement action. These sounds are caused by the parts of the escapement striking or rubbing one another. An analysis of the escapement action will clearly show that not one but several sound impulses occur each time the escapement action ("tick" or "tock") occurs.

A watch "TICK" consists primarily of five major sounds. These sounds all occur within about 1/200th of a second. Figure 34-7 is a graph showing the sequence of these sounds, the height of the curve showing their comparative volumes.

The first sound, though not the loudest one, occurs when the roller jewel comes around and strikes the fork slot as in figure 34-7, No. 1.

The next sounds we hear are Nos. 2 & 3. When we have an escapement model and move the parts slowly, apparently the escape wheel tooth begins pushing on the pallet stone face

Fig. 34-7



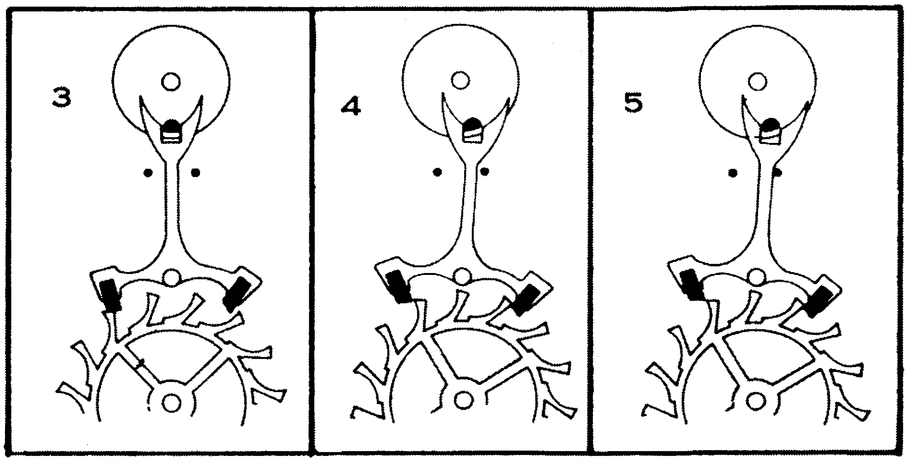


Fig. 34-7 (Cont.)

immediately after the unlocking action causing the fork slot to strike the roller jewel and push on it. But in actual practice it does not work that way because the pallet stone, having a certain amount of draw, forces the escape wheel to move backward a slight amount when it is withdrawn from the locking face of the tooth, and, inasmuch as the pallet stone is practically jerked out of that position (due to the speed at which the roller jewel is traveling at the time), it throws the escape wheel backwards slightly. Then, by the time the escape wheel overcomes its inertia and starts forward again the toe of the tooth may strike the pallet stone perhaps a third of the way down its impulse face, the impulse action actually beginning at that instant. The loudest sound is depicted in No. 4 when the escape wheel tooth drops onto the locking face of the other pallet stone. There is a slight rebound to that which is followed by the last sound as depicted in No. 5 when the lever falls against the banking pin.

For an accurate watch rate record it is necessary for the printed dot to come from a clearly defined part of the "Tick." The most exact point on a watch "Tick" and the most clearly defined point is the point designated in No. 1.

The trigger tube selects the part of the tick from which the dot is printed. The exact part of the tick that fires the trigger tube depends upon the loudness of the tick. If the trigger tube does not fire with the first (No. 1) part of the tick, then it will fire with the next part that is sufficiently loud to operate the tube. Since the ticks of different watches vary in loudness, it becomes necessary to adjust the volume control on the machine so that it will pick up the No. 1 sound at all times yet not have the volume on full enough to pick up unnecessary sounds as the picking up of unnecessary sounds only serves to confuse the action of the trigger tube, likewise the printed record. Therefore, if the machine is to be used for diagnostic purposes, the picking up of the No. 1 sound will give a continuous record from which a quite complete diagnosis may be made.

We then take this continuous record and by analysing the position of the dots, the lines they form, etc., consecutively and relatively, we are able to determine the condition of the escapement in detail and the rate of the watch throughout as long a run as we may desire.

SEC. 591—Diagnosis of the Printed Record

The methods of determining the overall rates of the watch under test have been described in Section 587 and Section 589.

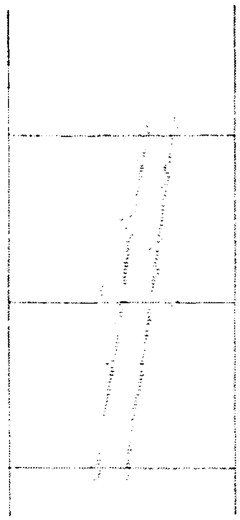
Now we present a few notations on the readings and diagnoses of irregularities found in the dots on the tape.

SEC. 592—Examples of Records

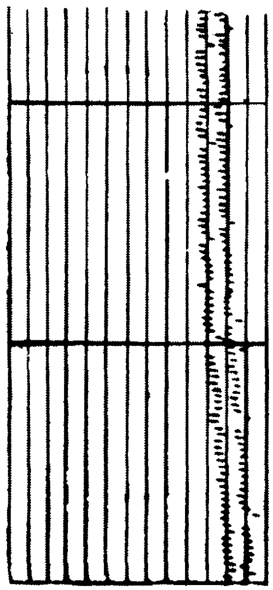
Before submitting any watch to the timing machine for analysis, the watchmaker should have made certain that the watch is in good mechanical order throughout.

Many defects may be heard in the ear phone and such should be corrected before any attempt is made to obtain a good printed record.

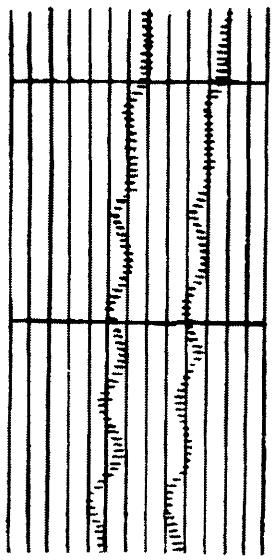
Pivots should be in good condition and jewels fitted correctly, otherwise the printed pattern will be irregular. The end-shake of the balance especially must be correct in the smaller wrist watches and the escapement



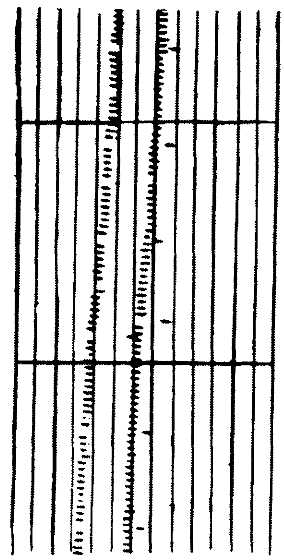
Loose Roller Jewel
Fig. 34-8



Loose Pallet Stones
Fig. 34-9



Escape Wheel Out of Round
Fig. 34-10



Bent Tooth in Escape Wheel
Fig. 34-11

PROPERLY oiled in order to obtain a readable record.

A loose roller jewel may be detected by visual inspection, but at times one may be so slightly loose as to have escaped notice.

Figure 34-8 is the record made by a 11¼ ligne watch with a roller jewel very slightly loose.

Loose pallet stones may also usually be detected by a visual inspection, yet one often finds that pallet stones which are apparently tight (visually) will show to be loose, giving a record similar to figure 34-9. A small amount of stone cement is the remedy.

Quite often we will find watches about 6¾ ligne in size that apparently keep time, but which refuse to make a legible record on the TIME-O-GRAF. An examination of many of these will disclose a hairspring which is out of flat and a balance staff which has too much endshake. The out of flat hairspring causes the balance staff to dance up and down or endwise in its pivot holes and the timing machine will pick up the sounds of that in preference to the sound of the roller jewel striking the fork slot (as in figure 34-7, No. 1). The obvious remedy is to true the hairspring and eliminate the surplus end-shake in the balance staff.

The left hand line of dots is usually the record of the action caused by the receiving pallet stone—likewise the right hand line of dots is usually the record of the action caused by the discharging pallet stone.

The escape wheel in the ordinary 18,000 beat watch makes one revolution in six seconds, or ten revolutions per minute. Hence, errors in the escape wheel may be easily recognized by the fact that they should repeat themselves every six seconds, or ten times per minute (ten times per six inches of paper travel). The line caused by an escape wheel which is out of round due to its either being bent itself or having a bent pivot will be curved, a complete cycle showing every six seconds. (Figure 34-10) A bent or damaged tooth in an escape wheel will show a single displaced marked similar to that shown in Figure 34-11, occurring every six seconds. A damaged leaf in the escape pinion will make a record showing an error of much longer duration, the duration of the error being nearly one second in length, and it also repeating every six seconds.

A bent fourth wheel or a fourth wheel out of round will show as an error every 60 seconds or every minute. This can be found only on a machine that runs for a full minute or more, such as the TIME-O-GRAF.

Presume now that we have a defect that occurs once in every 60 seconds. If it be curved, similar to that in figure 34-12, we would assume that the fourth wheel or one of its pivots was bent, as the record clearly shows it to be out of round. If, instead of the record showing a clearly cut curve, it shows defects of moderate time duration, spaced at intervals of 60 seconds apart, we may then examine further. When

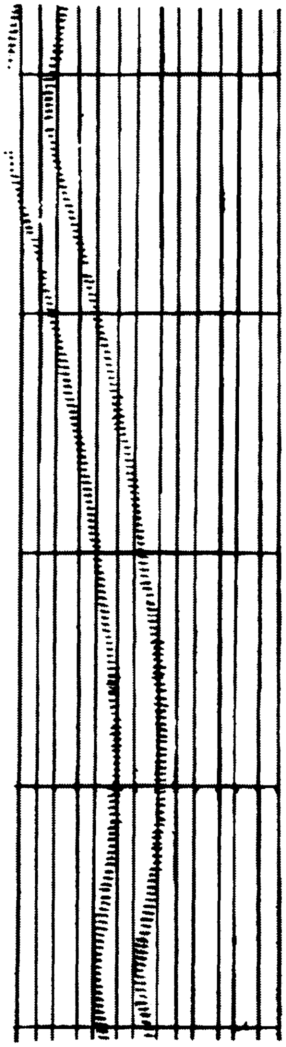


Fig. 34-12

Train Wheel Out of Round

the length of the record of the defect in a fourth wheel is about ½ inch of paper travel, we could assume that it was a defective tooth in the fourth wheel. If the length of the defect consumed about 10 seconds of travel of the paper, we would say that it was a defective leaf in the fourth wheel pinion. That is easily understood as the pinion leaf requires a longer time to pass than does a single wheel tooth.

Likewise, defects in the center seconds mechanism of chronographs are easily located with the TIME-O-GRAF. For example, we may take a chronograph and with the center seconds hand in its neutral or zero position, bring the watch movement to time. We then push the plunger which starts the center seconds hand into action and observe if the watch records any variation in rate. If so, we know there is some defect in the action of the center seconds hand mechanism when it is in action. We then may push the plunger which stops the center seconds hand, and any change in the rate of the watch at this point indicates a defect in the braking or locking mechanism of the center seconds hand.

MAGNETISM never affects two watches in the same manner. Hence, we cannot present any "typical" record showing magnetism. Watchmakers are supposed to look for magnetism in a watch with their compass.

PRESSURE applied to the movement, or to the train bridges of many of these thin watches will cause a noticeable variation in the rate of the watch.

We presume that the watchmaker has properly cleaned and oiled the mainspring, replacing it if necessary; but if he has not, he cannot be assured of a good rating of the watch. A dry mainspring will seize, then release, giving an uneven delivery of power to the train wheels. (See figure 34-13). CAUTION: A mainspring that is slightly too wide for the barrel will rub the barrel or the cap, and cause an irregular rating of the watch.

If the movement of the watch shows a record as keeping time, and the hands of the watch

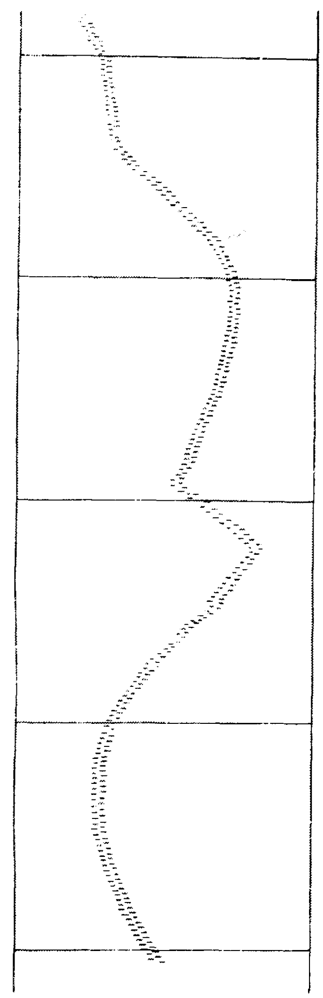


Fig. 34-13

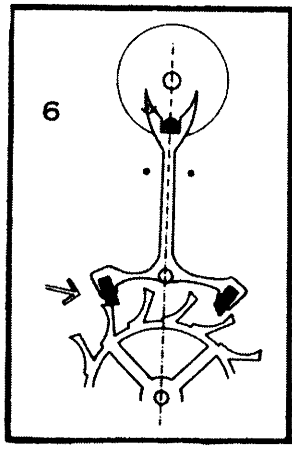
Uneven Power Caused By a Dry Mainspring

indicate a loss of time,—look well to the canon pinion friction, and see that the setting bridges do not bind on either the minute wheel or other dial wheels. Also see that the minute hand does not bind onto the hour hand, and the pipes do not rub the holes in the dial in any position.

SEC. 593—Putting an Escapement in "Beat"

The general rule for putting an escapement "in beat" is to so place the hairspring collet that when the escapement is at rest, the roller jewel lies on the line of centers. See figures 34-14 and 34-15.

To be sure that we have it in beat, we release the power from the train, even to the extent of removing the ratchet wheel. Then we carefully adjust the position of the hairspring collet so that when the escape wheel is moved forward, the toe of the escape wheel tooth will drop onto the receiving pallet stone about the center of its impulse face, (See figure 34-14), and likewise, the toe of the escape wheel tooth will drop onto the discharging pallet about the center of its impulse face or a little beyond. See figure 34-15. When that condition exists the escapement may be said to be very closely "in beat." Thus, when the hairspring collet is adjusted to that position, if we "bank the escapement to drop," (the escapement being otherwise in mechanically good order), we will find that the TIME-O-GRAF will give us a record composed of apparently almost one line, the two lines being practically superimposed upon each other. See figure 34-16.



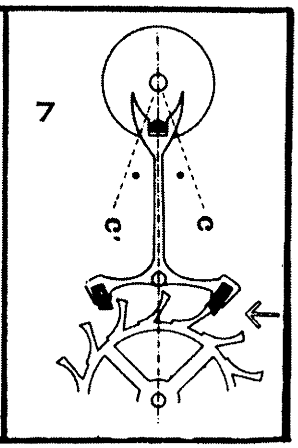
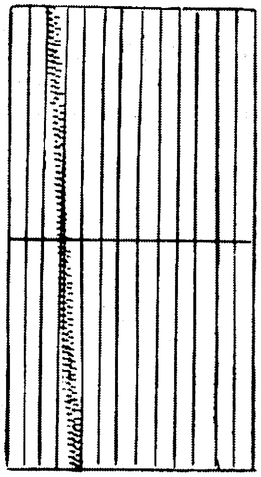


Fig. 34-14 Fig. 34-15

Fig. 34-16



SEC. 594—The "Double" Line

PLEASE NOTE: In practically all small Swiss watches and in many other watches due to variations in escapement design, it is practically impossible to obtain a reading of a "single line" as in figure 34-16.

The workman must be his own judge as to when the watch is in "passable" condition.

A double line on the record may be caused by numerous things, including the improper setting of a pallet stone, loosely fitting pivots in the members of the escapment, as well as the improper setting of the hairspring collet.

However in an escapement wherein the pallets are properly set, the roller jewel properly set and the escapement otherwise in good order, a double line indicates that the roller jewel is striking the fork slot on one side at a greater distance from the line of centers than on the other side. Turn to Escapement drawing No. 1, figure 34-7. If we move a banking pin out a little for example, the one on the left hand side of the figure, it will allow the lever to lay over a little farther to the left which means that the roller jewel will strike the fork slot on that side, which in this case is the receiving side, a little sooner or if you please, a little farther from the line of centers on that side which causes the machine to record the No. 1 sound on that side in a new position or sooner as shown by the appearance of the line of dots a bit away from their previous position. Following is an example of how this may apply:—

In figure 34-17 we have the record of a 16 size Elgin first with the escapement properly adjusted. At "A" we opened the banking pin which controls the slide on the receiving stone.

Here you will note the immediate appearance of the line of dots made by the receiving side moving over to a new position. Coincident with this you will note that the increment of the slide on the receiving stone of an escapement tends to slow down the rate of a watch slightly. Returning the banking pin to its proper position at "B," the line of dots produced by the receiving side return to their former position, and the watch resumes its former rate. Likewise, we may open the banking pin which controls the slide on the discharging pallet stone. This will cause the line of dots made by the discharging stone to assume a new position as at "C." Here we note that giving the discharge stone more slide, we tend to speed the rate of the watch slightly. Returning this banking pin again to its proper position, the line of dots controlled by the discharging side return to their former position, and the rate of the watch again returns to its former rate as at "D."

It is desirable to bring the two lines as closely together as possible with the slide adjusted to a minimum with safety on both sides.

SEC. 595—Poising and Adjusting

Much has been written in the past years on the matter of poising the balance wheel in a watch, and great theories have been expounded on the subject.

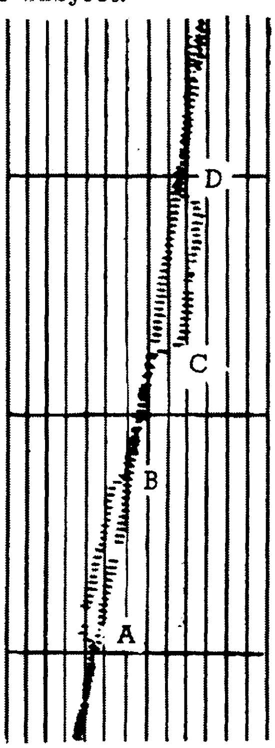


Fig. 34-17

The great majority of these are well founded, but one notable fact becomes increasingly evident: many textbooks, yes, even instructors in watchmaking, do not agree on even the fundamentals of hairspring work.

Not until the advent of the TIME-O-GRAF with its continuous tape with instant reading have we been able to solve these problems in a practical manner.

The RATE of a balance can only be changed by some force which gives an impulse tending to turn or retard its turning one way or the other.

When the balance is at rest and the hairspring idle, we may say that it is in the NEUTRAL POSITION.

The FUNDAMENTAL RULE on rates is: A push toward the neutral point speeds it up; a push away from the neutral point slows it down. This is true for either direction of the balance swing.

Let us see how this fundamental rule shows the effects of a balance which is out of poise. (See figure 34-18). If the heavy part of the balance is at the bottom in the neutral position, and the motion is less than one turn, the push of the heavy point is always toward the neutral point making the watch gain. Conversely, if the heavy part of the balance is at the top in a neutral position, and the motion is less than one turn, the push of the heavy point is always from the neutral point making the watch lose.

If the heavy point is at the side, the amount of gain and the amount of loss may counteract each other.

In figure 34-18 the balance is making a swing of over one full turn. The heavy point in going up from Z to the top on either side causes a gain, but in going beyond the top to X or Y the push of the weight is away from the neutral point and causes a loss. One might think that as in the figure, as the upswing from Z to the top of greater length than the swing from the top to either X or Y, the gain would be greater than the loss. It does not work out that way, for the travel from the top to either X or Y is nearer the end of the swing and errors which show that near the end of a swing of a balance are far more effective than errors near the middle of the swing. Mathematicians have shown that if the arc from the top to X and from the top to Y are each 40 degrees, and the heavy point being at Z, the loss from the top to X will offset the gain from Z to the top. Hence, for a swing of

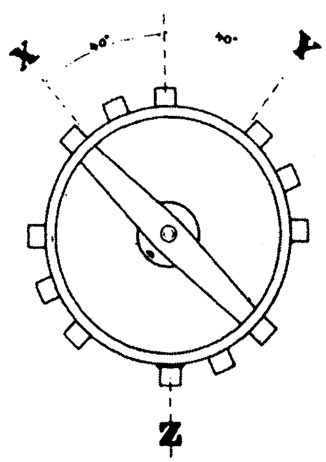


Fig. 34-18

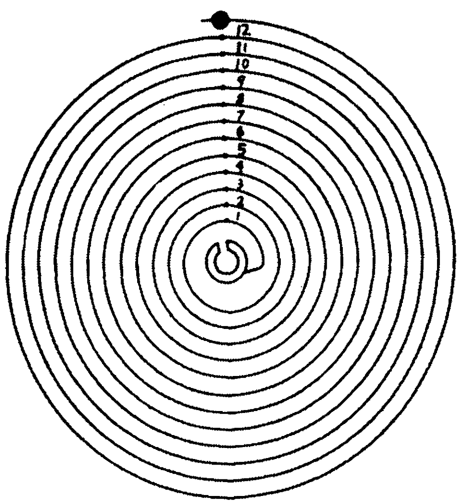


Fig. 34-19

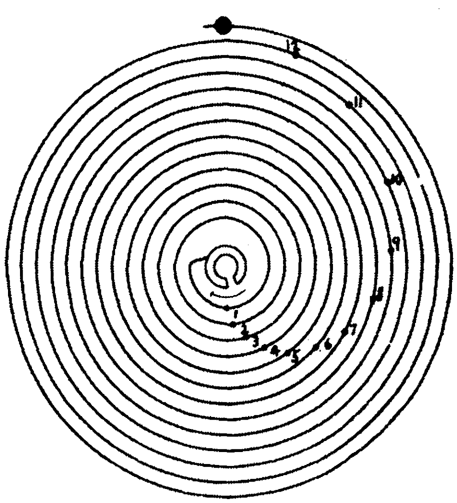


Fig. 34-20

220 degrees on a side, a poise error in the spot indicated will not affect the rate. However, should the arc of swing vary, either more or less, the poise error will show itself causing the rate to vary in turn.

Many watchmakers accept the statement that all watches, even those with an overcoil hairspring, have what they call a "natural error" of losing some 20 seconds per day, in some one of the vertical positions, which one it may be depends on the position of the pinning point of the hairspring to the collet.

There is nothing mysterious or occult about the workings of a watch or adjusting it. There is no such thing as an inexplainable "Natural Error." There is a definite reason for any and all errors and combinations of errors.

We may poise a balance wheel as carefully as we please on the poising tool and oft times we put it in the watch and the watch behaves as though it were out of poise. True, the fact that we have poised the wheel only, does not mean that we have poised the wheel with all its accessories, some of which move in whole or in part with the balance in the watch. We all know that we poise the wheel, and after that we apply the hairspring to it. In figure 34-19 we have a hairspring at rest with 12 little dots on the coils. Notice the dots are in a straight line. When that hairspring collet is turned a half turn, as it must when the balance carries it, notice the new position of the dots, and suppose the collet is turned a half turn in the opposite direction, the dots would arrange themselves in a similar pattern on the opposite side.

What occurs there, as you will notice, is that an unpoised mass, namely about half of the inner terminal of the hairspring plus certain portions of the succeeding hairspring coils, has been added to that balance staff. In other words, we have introduced and added to that balance an unpoised mass of material which is simply, as the balance moves to and fro, waggling back and forth.

In connection with this, please bear in mind that your hairspring must be true in the round and in the flat. The least error in the inner coil of the hairspring throws the entire timing of a watch into a condition where it is almost impossible to adjust. The hairspring must be

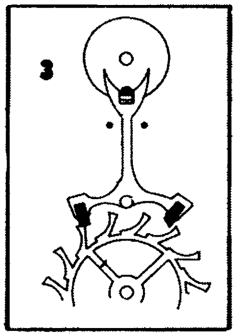


Fig. 34-21

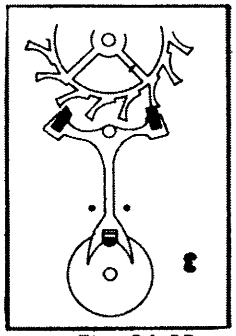


Fig. 34-22

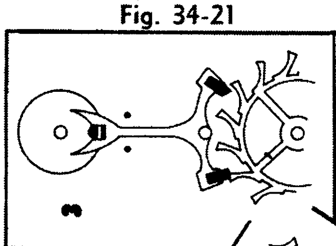


Fig. 34-23

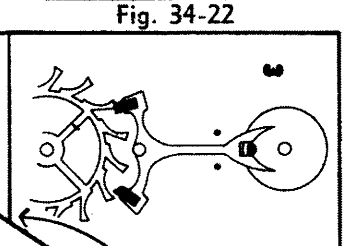


Fig. 34-24

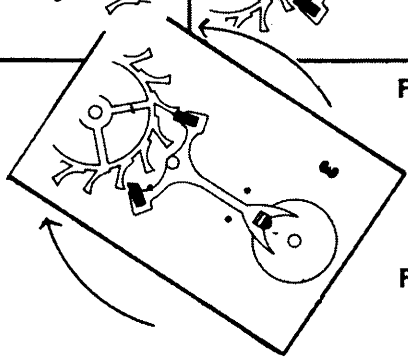


Fig. 34-25

true. Yes, the rates of a watch can be altered by tampering with the outer coil of the hairspring before or after it passes through the regulator pins, but inasmuch as the watch factories themselves do not agree on the proper shape for an overcoil, we shall not set forth any definite form that it should take. You can raise or lower the outer coil of a hairspring with the point of a tweezer, screw driver, tooth pick or anything else, call that operation anything you please, but if you adjust the outer coil of the hairspring in accordance with the well known rules of isochronism, it cannot be improved upon by any new tricks or methods.

Also theorists will tell us that the center of gravity of the hairspring shifts from side to side, up and down, or through any intervening angle, depending upon the position of the watch, and the shift of that center of gravity will affect the timekeeping, True, but it does so in an infinitesimal manner. Likewise the "sag" of a hairspring has but a very slight practical affect on the timekeeping. Even the unpoised pallet fork may introduce a slight position error.

The pallet fork may be considered as being practically "in poise" when the assembly finds itself in the positions depicted in figures 34-21 and 34-22. It is definitely out of poise in the positions depicted in figures 34-23 and 34-24. In the position shown in figure 34-23 the weight of the lever adds to or detracts from the power delivered to the roller jewel, depending on whether it is moving upwards (against the force of gravity) or downwards (being accelerated by the force of gravity). NOTE that when the watch is turned 180 degrees, so that we find the lever in the position as depicted in figure 34-24, the conditions described in figure 34-23, as to power delivered are exactly reversed. Concurrently, we must bear in mind that in practical usage, the lever finds itself in every conceivable angular position (figure 34-25) between the above described positions, hence, the "out of poise" element contributed by it, has every conceivable variation with positions.

Sometimes these small variations or errors will tend to offset each other, and sometimes they compound.

Thus we see that poising a balance wheel on the poising tool, while quite necessary, only suffices to place that one unit of the escapement in a condition which may be described as "static poise." That is quite insufficient—as it is imperative, for good timekeeping, that we consider the cumulative effects of the additional elements of the escapement. In other words, we must bring this entire "mobile unit," and by "mobile unit" we mean the completely assembled and running escapement, with its accumulated plus and minus errors—we must bring this entire "mobile unit" into a condition that shows it to be in poise WHILE RUNNING.

We can do this only with the use of the TIME-O-GRAF, as on it we can observe the entire accumulation, summation or whatever you wish to call it, continuously from one position to another, of all these infinitesimal errors, and correct them in one simple gesture.

First, we know that if we have a balance with a good motion, a motion with an arc of (See figure 34-18) over 220 degrees on a side, it will be very easy to detect the heavy side of the balance by locating the position of the watch when it has the greatest loss of time. We place the watch in the microphone of the TIME-O-GRAF pendant up, and rotate the watch slowly while the machine is running. The TIME-O-

GRAF immediately tells us on the continuous tape which position that watch is in when it has the slowest rate. We know that in that position, were the balance to be at rest, the heavy side of the balance assembly would be down. Your attention is called to the fact that when you rotate that running watch in the microphone of the timing machine, you have found the heavy side of the entire mobile unit, that is, of the balance, hairspring, all the other cumulative errors, some of which are very slight. However, you have absolutely and correctly located the heavy side of the mobile unit simply, effectively and without delay. This is the only method available today for the watchmaker to make a poise test on a running watch so that he may know at once where to make the necessary adjustments. Suggestion: If the watch has an over all losing rate, remove a little from the heavy side of the balance, or if it has an over all gaining rate, weight may be added to the lighter side. By these means in a very short time you can take a watch that is in good mechanical order and bring all of your vertical positions up to within a variation of less than 3 seconds in 24 hours in a good grade of pocket watch.

To summarize: The rates of a watch in the vertical positions can be adjusted very closely and rapidly by making use of the TIME-O-GRAF to determine the poise errors.

SEC. 596—Tapes from Odd Beat Movements

The watchmaker will occasionally encounter a watch beating other than 18,000 beats per hour (five beats per second).

Herewith is a list giving the beat of some of the currently found odd beat watches.

BEATS PER HOUR

Agassiz, 8PCV	20,222
Agassiz, PCV, AO, Z	20,944
Agassiz, 8AC	21,600
Audemars, 8'''	21,000
Concord 5½''', 7¾''', and "R. Cart"	19,800
Elgin, "Slow Train"	16,200
Elgin, 26/0	19,800
Gruen, some of the 124, 125, 176, 177	19,440
Gruen, 151	19,332
Gruen, 455, 457, 459, 465, 467, 469	19,800
Gruen, 106, 107, 109, 130, 133, 137, 139, 155, 159, 161, 169, 181, 183, 306, 307, 327, 328, 329, 331, 520	20,160
Gruen, 105, 333, 840, 841, 845, 857	20,222
Gruen, 305, 837, 839, 847, 863	20,940
Haas, 8''' round	20,222
Huguenin, 5½'''	20,160
Meylan, 7''' and 8'''	20,944
Meylan, 8'''	20,222
Nardin, 7'''	20,944
Omega, 11.5	21,300
Omega, 13.5 and 17.8	21,600
Omega, 30.10	19,800
Patek-Phillippe, 4'''	21,000
Touchon, 4'''	21,000
Vacheron & Constantin, 7''' oval	20,944
Waltham, 18 size, old models	14,400
Waltham, 18 and 16 and 14 size, "Slow Train"	16,200
Waltham, "400"	21,600

All of these odd beat watches can be rated on the TIME-O-GRAF, although in most cases the record for a watch with a zero rate will not consist of a single line, nor will it run straight down the tape.

In determining the pattern made by any odd beat watch, two constants of the machine must be known. These are the scanning speed and the rate of paper feed. The motor in the TIME-O-GRAF runs at EXACTLY 2700 revolutions per minute or, 45 revolutions per second. The lead on the printing spiral is exactly 2 inches. Thus, the scanning speed is exactly 45 r.p.sec. x 2" which equals 90 inches per second. The paper speed is exactly 6" per minute.

Some of the very early Roxbury made Walthams were 14,400 beats per hour, or 4 beats per second.

In this case the revolutions of the spiral per beat are 45/4, or 11¼ revolutions.

As ¼ revolution of the spiral equals one half an inch of scanning speed, this watch when running on time will print four lines of dots one half an inch apart, straight down the tape. Figure 34-26.

If the escapement is slightly out of beat, the record will appear somewhat like figure 34-27, the lines being "paired off."

Some of the early "Slow Train" Elgins and Walthams employed a 63 tooth fourth wheel and a 7 leaf escape wheel pinion, giving these watches a beat of 16,200 per hour, or 4½ beats per second.

In this case the revolutions of the spiral per beat are 45/4½, or 10 revolutions.

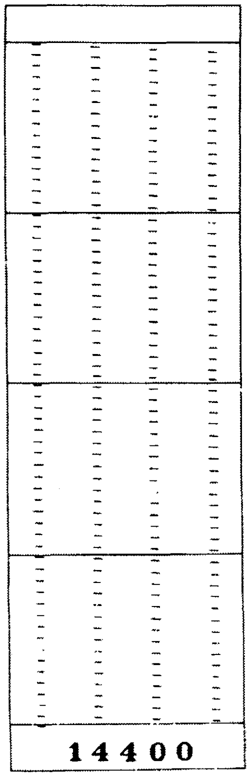


Fig. 34-26
A 14,400 Beat

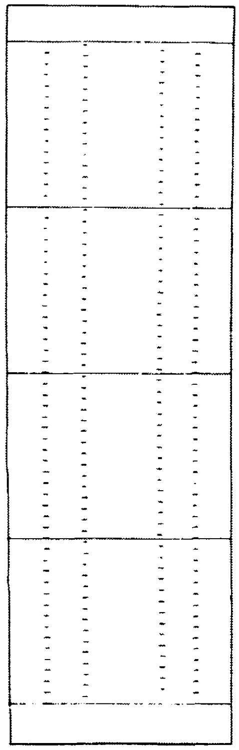
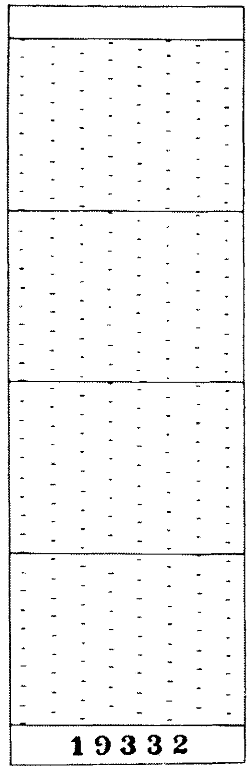
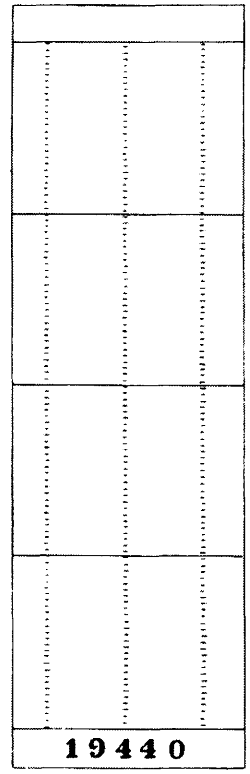


Fig. 34-27
A 14,000 Beat, when "Out of Beat"



A 19,332 Beat
Fig. 34-28



A 19,440 Beat
Fig. 34-29

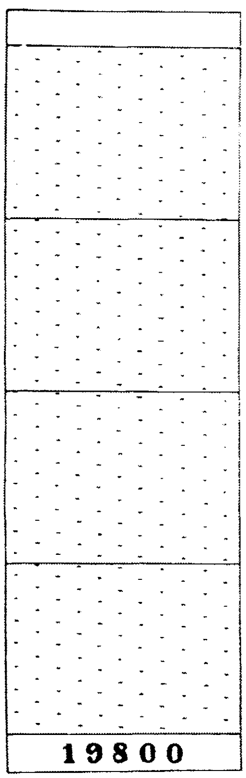


Fig. 34-30
A 19,800 Beat

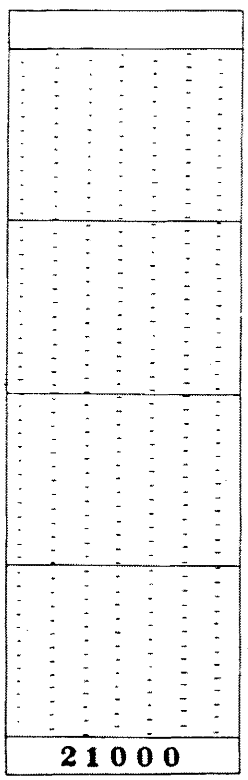


Fig. 34-31
A 21,000 Beat

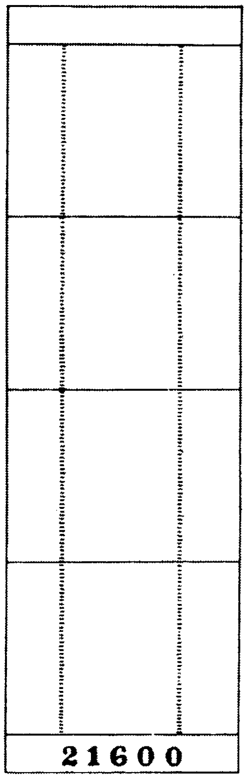
Thus, this 16,200 beat watch when running on time will print exactly in line straight down the tape very similar to the line made by an 18,000 beat.

Similarly, we find that the watches having 19,332 beats per hour, allow the spiral to make 8⅜ revolutions per beat, thus, these 19,332 beat watches when running on time will print 8 lines of dots straight down the tape, the lines being ¼ inch apart, figure 34-28.

The 19,440 beat watches allow the spiral to make 8-1/3 turns per beat, thus, the 19,440 beat watches when running on time will print three lines of dots straight down the tape 2/3 of an inch apart, figure 34-29.

The 19,800 beat watch will allow the spiral to make 8-2/11 turns per beat, thus the 19,800 beat watches when running on time will print 11 lines straight down the tape 2/11 of an inch apart, but it is rather difficult, on account of the scattered position of the dots comprising these lines, to arrive at a quick diagnosis of the watch, unless the watch is almost on time. The appearance of the correct record made by one of these watches is shown in figure 34-30.

The 21,000 beat watches, similarly, when running on time, will make a record of 7 lines straight down the tape, figure 34-31.

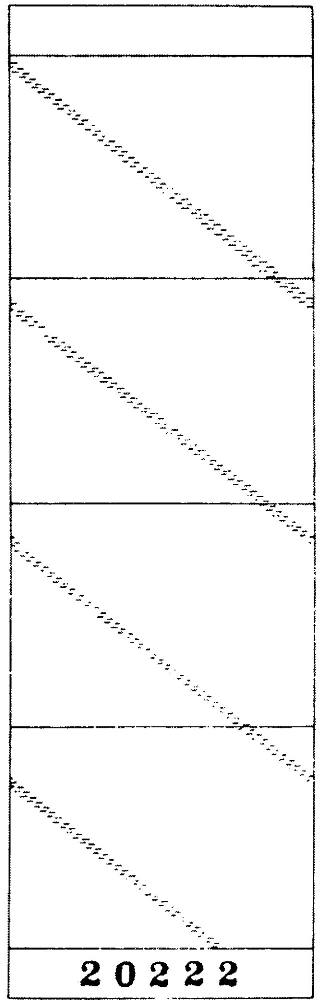


A 21,600 Beat

Fig. 34-32

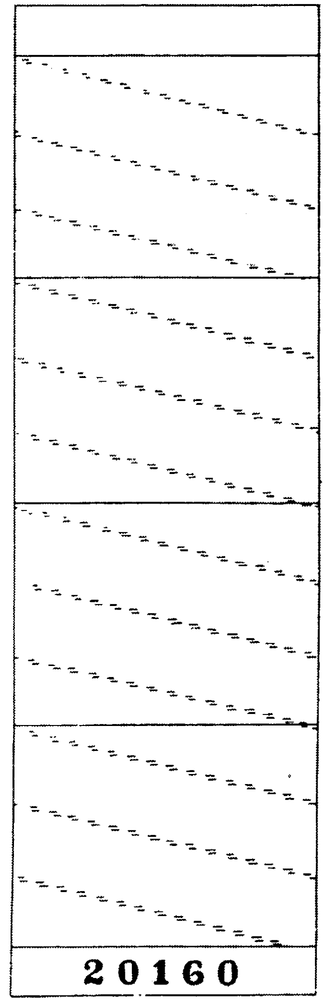
The 21,600 beat watches, similarly, when running on time, will make a record of two lines one inch apart, straight down the tape, figure 34-32.

Now, for those who like mathematics, let us look at a watch having 20,222 beats per hour, which is 5.61720555 per second. We see immediately that this watch will not print a straight line. $\frac{45}{5.61720555}$ equals approximately 8 and 1/100 revolutions of the spiral per tick. Now we can see that this one will print like a normal 5 beat watch **except** that since the spiral will make slightly more than an even number of turns between ticks, the line will slope to the left. Let us determine to what extent the line slopes. The time between ticks is 3600/20222 or .178024 seconds. Then .178024 x 90" per second (the speed of the spiral) equals a travel of 16.02216" per tick. As 8 turns equals 16" scanning, then 16.02216 minus 16 equals 0.02216" that each dot is displaced to the left of the previous dot. So, dividing the 2" of travel by this .02216 we get 90.25 ticks for the printed line to travel once across the 2" width of the paper. In time, this is equal to 90.25 x .178024 which equals 16.06666 seconds.



A 20,222 Beat

Fig. 34-33



A 20,160 Beat

Fig. 34-34

And $\frac{16.06666 \times 6''}{60 \text{ (sec.)}}$ equals 1.606" of paper travel while the dots move two inches to the left. We take a piece of paper and with a scale measure carefully 2" across the paper from a point and then up the paper 1.6" and make another point, then draw a line connecting these two points, giving us a pattern of what the record of this 20,222 watch should look like when the watch is running on time, figure 34-33.

With the paper travel of 1.6" while the line of dots crosses the 2" width of the paper, we may also lay out the position of the line by obtaining its angle by trigonometric functions.

The 20,160 beat watches, when running on time will make a record resembling that in figure 34-34.

note:

(No job sheets are associated with Lesson 32, Part 2)

Master Watchmaking

MODERN SHOP METHODS

LESSON

35

Problems and Solutions

Questions and Answers Illustrated

CHICAGO SCHOOL OF WATCHMAKING

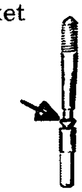
Founded 1908 by THOMAS B. SWEAZEY

WHEN IS A MAN A WATCHMAKER?

Time and time again we read or hear the definition of a watchmaker. It is said by some that a man must have years of experience behind him. Some states require a watchmaker to pass an examination, and upon meeting their requirements, will issue a certificate to that effect. Certain associations have set up a standard by which the aspiring watchmaker can take an examination and upon paying a fee be issued a certificate stating in large captions that he is a watchmaker. Schools issue diplomas stating that the recipient has completed his course in a satisfactory manner. Men who learned their trade in the old country declare that the best watchmakers come from the particular country in which they were apprenticed. Some state that a good watchmaker must have an electric timing device and only then can he be a good watchmaker. There are always those who will condemn something or other whether or not they are qualified to do so. Many so-called eminent watchmakers who a few years back condemned watch cleaning machines now regard them as a valuable asset to their shops.

Without much doubt it can be said that because of lack of educational facilities, watchmaking or watch repairing has not progressed as rapidly as it should have. The watchmaker must meet the problems of the future as soon as they are presented. He must be alive to new ideas. He must be on the lookout for new tools that will help him do a better job. He must not become "old fashioned." He must strive to do better work -- not strive to see how much he can "get away with." He should put himself in his customers' place and treat them accordingly. He should do everything possible to elevate himself and his associates. His pay should rank with that of the highest tradesmen. In short, a watchmaker is one who can conscientiously turn out a first class job with a personal feeling of a job well done. His success will depend upon his desire to be of service to his customers and an asset to his community.

To meet the conditions which prevail in some states and for those who are desirous of taking an outside horology examination, this review of your elementary training in watchmaking is put in the form of questions and answers. One of the best ways to cram for an examination is to write out each question several times and then write the answer several more times. This is the most effective method for the majority of the students. The majority of the following questions are similar to those given by state boards and other associations which have written test questions. Although some of the answers given may conflict with the opinions of others, they are, in most cases, generally accepted for written examinations.

QUESTION	ANSWER
1. To avoid fingerprints on the movement or dial we ...... ?	1-A. Handle the movement by the edge of the pillar plate and use watch paper.
2. Is it necessary to oil the stem on a pocket watch case and, if so, at what point? 	2-A. It is advisable to oil the stem at the point of contact with the sleeve.
3. What is the difference between an open face movement and a hunting movement?	3-A. An open face winds at 12; a hunting winds at 3.
4. Give the name used in horology which describes the series of gears and which transmits the power from the mainspring to the pallets.	4-A. Train.
5. What material are pinions made from?	5-A. Steel.
6. What controls the rate of a timepiece through the regularity of its oscillations?	6-A. The balance assembly.
7. How many revolutions does the center wheel and pinion make in an hour?	7-A. One.

8. How many revolutions does the fourth wheel and pinion make in one hour?

8-A. Sixty.

9. What is the minimum number of steady pins found on each bridge?

9-A. Two.

10. How many hours should an average watch run with one winding?

10-A. 32 to 36.

11. Is the metric or the Dennison Gauge the more accurate for measuring the width and strength of a mainspring?

11-A. The metric.

12. To get the best results of the area between the outside of the arbor and the inside shell of the barrel how much of the area should be occupied by a mainspring with 11 coils?

12-A. One half.

13. How much should be occupied by one with 13 coils?

13-A. One half.

14. The Metric Micrometer gives us readings in..?

14-A. 1/100 of a millimeter.

15. What is the purpose of the clutch lever?

15-A. To move the clutch from winding to setting.

16. Will a 7 Jewel and a 21 Jewel watch of the same size and model require mainsprings of different strength?

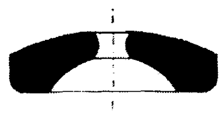
16-A. Yes.

17. Name the jewels in a 17 Jewel Watch which are not used as bearings for a wheel and pinion?

17-A. R. Stone (Receiving Stone)
L. Stone (Let-Off Stone)
Roller Jewel

18. What is the advantage of an olive hole jewel?

18-A. It has a smaller bearing surface.

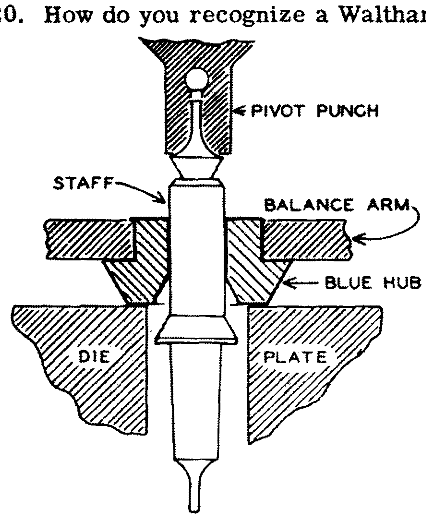


19. What does the term "genuine" watch material mean?

19-A. The material was made by the factory that made the watch.

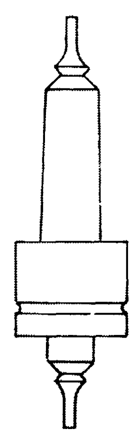
20. How do you recognize a Waltham friction staff?

20-A. By the blued hub on the balance wheel.



21. Some Hamilton watches use another type of friction balance staff which may be recognized by ...... ?

21-A. A groove cut in the staff.



22. The main purpose of truing and poising the balance wheel is ...... ?

22-A. To be able to properly adjust and bring the watch to time.

23. The balance screws in a compensating balance wheel have been placed in their respective positions by the factory for ...... ?

23-A. Temperature adjustment.

24. What is the general cause of a balance wheel which seems to run true in the caliper but not in the watch?

24-A. Most likely the pivots are bent.

25. In poising a balance wheel, would you generally remove or add weight if the regulator was as far toward the "fast" as possible?

25-A. More weight is removed than added.

26. Is it practical to do watch repairing without a lathe?

26-A. No.

27. The word Isochronism means?

27-A. Equality of time.

28. How many impulses does the pallet receive from an escape wheel with 15 teeth in 1 revolution?

28-A. 30.

29. What is the proper way to put a mainspring in a barrel?

29-A. With a mainspring winder.

30. How much space should a mainspring occupy in the barrel?

30-A. One half the remaining area with the barrel arbor in place.

31. Name the three kinds of barrels used in watches.

31-A. Motor Barrel; Going Barrel; Fuzee Barrel.

32. If a barrel has 80 teeth and the Center Pinion has 10 leaves, how many revolutions does the barrel make in 24 hours?

32-A. Three revolutions.

SOLUTION:

Teeth in barrel divided by leaves in center pinion equals time for 1 turn of barrel.

Substituting, $\frac{80}{10}$ equals 8

Hours watch runs divided by time for 1 turn of barrel equals number of turns of barrel.

Substituting, $\frac{24}{8}$ equals 3

33. What is the effect of putting a mainspring in a watch that is:
A. Too thick?
B. Too thin?
C. Too wide?
D. Too narrow?

33-A.
A. It will exert an excess of power.
B. It will not have enough power.
C. It will cause friction between the barrel cap and the bottom of the barrel.
D. It may cause buckling and will lack power.

E. Too short?

E. It would not run a sufficient length of time.

F. Too long?

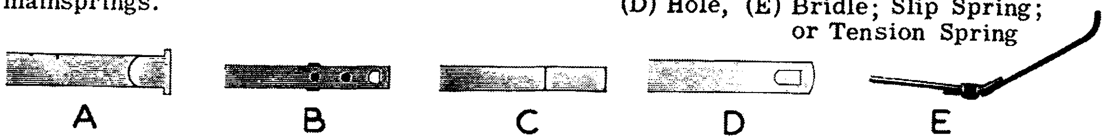
F. It would not run a sufficient length of time.

34. How many coils would you ordinarily find in the barrel if the mainspring is the proper length and strength?

34-A. Twelve.

35. Name the different kinds of end fastenings found on mainsprings.

35-A. (A) T-End, (B) Double Brace, (C) Tongue, (D) Hole, (E) Bridle; Slip Spring; or Tension Spring



36. What is a Motor Barrel?

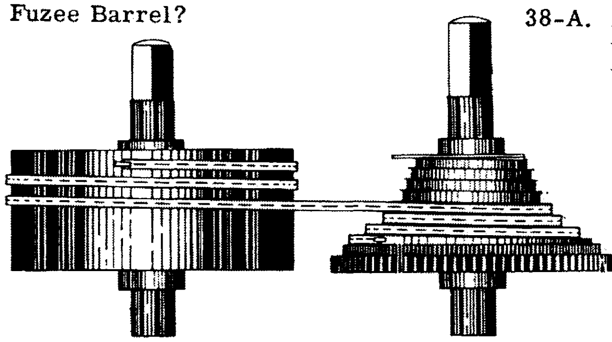
36-A. A Motor Barrel remains stationary. Its only purpose is to confine the mainspring. The great wheel, or first wheel, revolves independent of the barrel.

37. What is a Going Barrel?

36-A. The Going Barrel contains the teeth of the great wheel or first wheel and revolves as it drives the train.

38. What is a Fuzee Barrel?

38-A. A barrel which contains the mainspring and upon which the fuzee chain winds as the watch runs down.

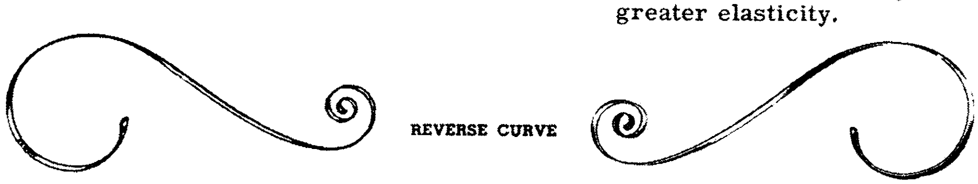


39. What is a Suspended Barrel?

39-A. A Suspended Barrel is one which is supported only from the upper plate.

40. What is a reversed curve mainspring?

40-A. A spring which is reversed to the direction which it is wound. It does not have a tendency to set as quickly and it possesses greater elasticity.



41. What is a cross curve mainspring?

41-A. One with a concave surface.

42. If a barrel head is loose, how do you tighten it?

42-A. With a barrel contractor.

43. What are the safeguards used when winding in a mainspring?

43-A. Clean the new mainspring thoroughly to dissolve the protective coating. Dry carefully. Oil lightly by passing spring through tissue with small amount of oil. Wind spring in with a mainspring winder. Use an arbor of the proper size, make certain that the pin on the winding arbor isn't any longer than the thickness of the mainspring. Insert mainspring in barrel and oil with watch or clock oil.

44. How would you fit a new hook in a barrel Explain.

44-A. Locate center from barrel head shoulder to bottom of barrel on the outside of barrel. Drill hole proper size and tap. Then take piece of brass wire slightly tapered and thread with same size die from which tap was made. Screw into barrel the proper amount after which cut off on the outside and finish flush with barrel. File slot on the proper side of the hook.

45. What risks would you take by not removing the mainspring every time you clean a watch?

45-A. The cleaning fluid would probably ruin the mainspring. The cleaning fluid would also ruin the lubricating properties of the oil.

46. How do you determine the strength of a mainspring?

46-A. The strength of the mainspring may be determined by dividing the inside diameter of the barrel by 100. For very small watches add 1/100th of a millimeter.

47. What is the ratio of the center wheel to the third pinion?

47-A. 8 to 1.

SOLUTION:

$$\frac{\text{Number of teeth in 3rd wheel}}{\text{Number of leaves in 4th pinion}}$$

Substituting: $\frac{80}{10}$ equals 8 Ratio is 8 to 1

48. What is the ratio of the 3rd wheel to the 4th pinion?

48-A. 7-1/2 to 1

SOLUTION:

$$\frac{\text{Number of teeth in 3rd wheel}}{\text{Number of leaves in 4th pinion}}$$

Substituting: $\frac{60}{8}$ equals 7-1/2 Ratio is 7-1/2 to 1

49. What is the ratio of the center wheel to the 4th pinion?

49-A. 60 to 1.

SOLUTION:

$$\frac{\text{Number of teeth in center wheel X number teeth in 3rd wheel}}{\text{Number of leaves in 3rd pinion X number of leaves in 4th pinion}}$$

Substituting: $\frac{80 \times 60}{10 \times 8}$ equals 60 Ratio is 60 to 1

50. What is the time of one revolution of the third wheel?

50-A. 7-1/2 minutes.

SOLUTION:

$$\frac{\text{Number teeth 3rd wheel}}{\text{Number leaves 4th pinion}} \text{ X Number turns 4th pinion makes in 1 minute}$$

51. Name five different kinds of trains.

51-A.

Slow	14,400	vibrations per hour
Medium	16,200	" " "
Fast	18,000	" " "
Quick	19,800	" " "
Extra Quick	21,600	" " "

52. How do you calculate the number of vibrations a watch with a second hand makes in one minute?

52-A. The number of teeth in the 4th wheel multiplied by twice the number of teeth in the escape wheel, divided by the number of leaves in the escape pinion.

EXAMPLE:

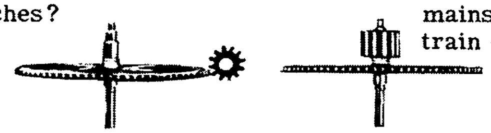
$$\frac{60 \text{ X } 30}{6} \text{ equals 300 vibrations per minute}$$

53. What is usually meant by a quick train watch?

53-A. Two Common Quick Train Watches are 19,800 vibrations and 21,600 vibrations per hour.

54. What is the purpose of a safety pinion on the center staff of some watches?

54-A. The Safety Pinion will unscrew when the mainspring breaks, thereby relieving the train of the excess strain.



55. What is the center staff?

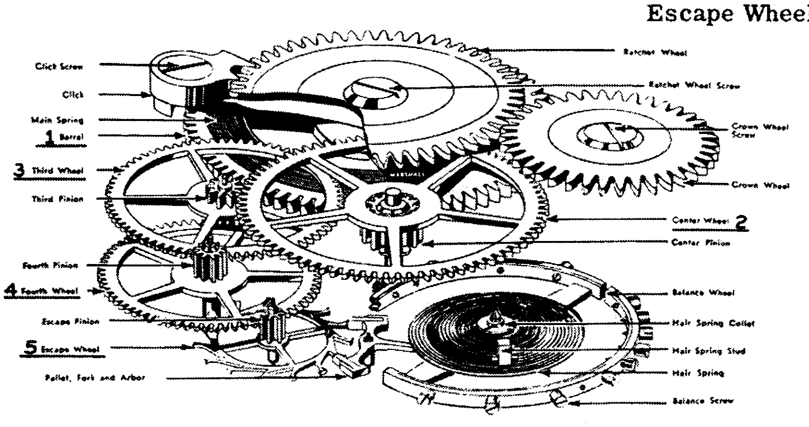
55-A. The arbor attached to the center wheel, which carries the minute hand.

56. If you had a train wheel that was out of round, how could you correct it?

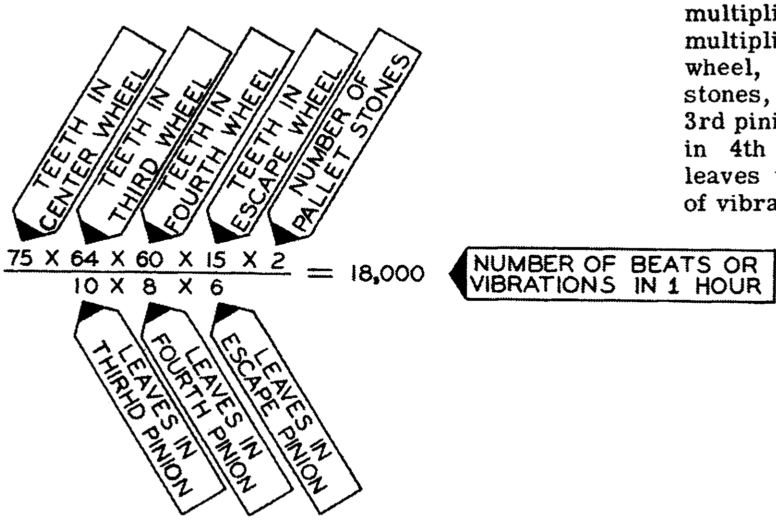
56-A. The wheel must be recentered usually by cementing to a cement chuck and then rebushed, or it may be corrected with a rounding up tool.

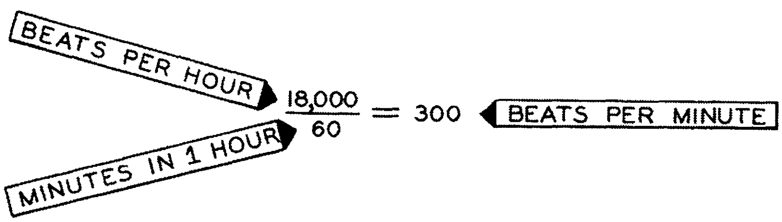
57. Name the wheels in a watch train.

57-A. Barrel, No. 1; Center Wheel, No. 2; Third Wheel, No. 3; Fourth Wheel, No. 4; and Escape Wheel, No. 5.



58. How do you calculate the train of a watch?





58-A. The number of teeth in the center wheel, multiplied by number of teeth in 3rd wheel, multiplied by number of teeth in 4th wheel, multiplied by number of teeth in escape wheel, multiplied by number of pallet stones, DIVIDED BY number of leaves in 3rd pinion, multiplied by number of leaves in 4th pinion, multiplied by number of leaves in 5th pinion, EQUALS the number of vibrations or beats per hour.

59. How do you figure a Quick Train?

59-A. All trains are calculated in the manner shown in the answer and question #58. Because of the different ratio between the center wheel and 4th wheel the number of vibrations can be other than 300 vibrations per minute.

EXAMPLE:

$$\frac{64 \times 66 \times 60 \times 15 \times 2}{8 \times 8 \times 6} \text{ equals } 19{,}8000$$

60. How do you figure on Extra Quick Train?

60-A. At times you will find a watch train with an additional train wheel and pinion. Do not let this confuse you but in figuring the number of vibrations place the number of teeth in the extra wheel and the number of leaves in the pinion in proper sequence.

EXAMPLE:

$$\frac{42 \times 42 \times 35 \times 35 \times 12 \times 2}{7 \times 7 \times 7 \times 7} \text{ equals } 21{,}600$$

61. How do you tighten the cannon pinion friction on a watch with a Center Pin?

61-A. By driving the cannon pinion against the end of the center pinion pivot.

62. What causes an ordinary Cannon Pinion to stay in place?

62-A. Usually a small depression in center staff, into which the center punch mark or spring snaps in place.

63. Do you oil a Cannon Pinion?

63-A. Yes, sparingly.

64. How much friction is considered necessary for the Cannon Pinion?

64-A. Sufficient to carry the hands safely.

65. If a Cannon Pinion works up slightly when setting a watch, what can you do?

65-A. Set center punch mark up higher on the cannon pinion.

66. What direction do you turn the dial screws when releasing most Swiss Dials?

66-A. To the right.

67. What is the proper way to center a dial if the holes do not center with cannon pinion and second bit?
Should the balance be taken out?

67-A. Place a piece of wood against the edge of the dial and tap the edge.

The balance should be taken out.

68. If a watch continues to run and the hands do not move, what might be the trouble and how would you remedy same?

68-A. The trouble might be a loose cannon pinion. Tighten the Cannon Pinion.

69. Name the Dial Train.

69-A. Hour wheel, minute wheel, cannon pinion, minute pinion.

70. How do you tighten a loose cannon pinion?

70-A. Use a Cannon Pinion tightener, or insert tapered brass wire into cannon pinion and use center punch.

71. What is the Hour Wheel?

71-A. The Hour Wheel is the wheel which turns on the cannon pinion once every 12 hours and carries the hour hand.

72. What is a Minute Wheel?

72-A. A wheel and pinion used to give the ratio 12 to 1 between the cannon pinion and the hour wheel.

73. What is the purpose of a dial washer?

73-A. The purpose of a dial washer is to hold the hour wheel in the proper position.

74. If a watch stops every 12 hours, where would you look for the trouble?

74-A. Examine the Hour Wheel.

75. How many revolutions does the ordinary escape wheel make per minute?

75-A. Ten.

EXAMPLE:

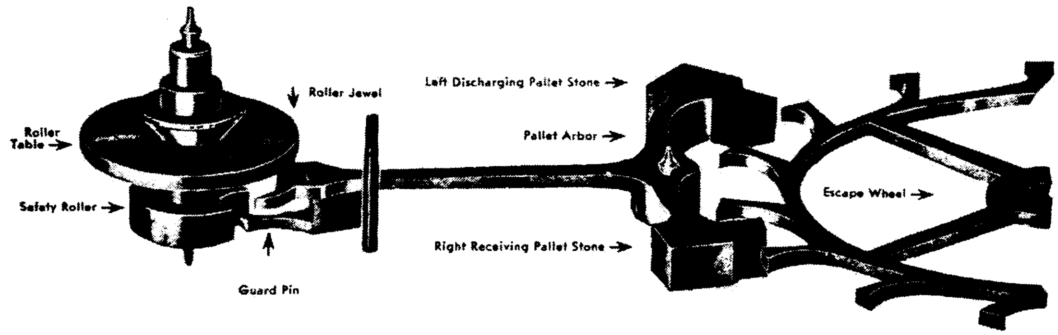
$$\frac{\text{Teeth in 4th Wheel}}{\text{Leaves in 5th Pinion}} \text{ X turns 4th wheel makes in 1 minute}$$

SUBSTITUTING:

$$\frac{60 \text{ X } 1}{6} \text{ equals } 10$$

76. Name the main group of parts of which the escapement consists.

76-A. Escape wheel and pinion; pallets; fork; roller; roller jewel.



77. How do you put an Escapement in beat?

77-A. By turning the hairspring collet until the balance escapes with equal ease on both sides or assuming that the watch is in line, bring the roller jewel to the line of center and then place hairspring in the proper position.

78. Why are the locking faces of the pallet stones placed at an angle?

78-A. To produce draw.

79. If an escapement has too much lock and slide, how do you correct it?

79-A. By pushing the pallet stone in and closing the banking pins.

80. What is meant by lock and slide?

80-A. Lock is the distance from the locking corner that the tooth drops on the pallet stone. Slide is the movement of the pallets after the lock.

81. For what purpose are the bankings in a watch?

81-A. To regulate the amount of angular motion to the Lever.

82. Name the pallet stones in a watch.

82-A. R meaning the Receiving and L the Let-Off.

83. What is meant by Corner Clearance?

83-A. The freedom between the horn of the fork at the fork slot and the face of the roller jewel.

84. Are the locking faces of the pallet stones at equal distance from the pallet center in the circular escapement?

84-A. No, but they are in an equidistant escapement.

85. What is meant by a watch rebanking? What may be the cause?

85-A. The balance takes an excessive motion, and the roller jewel hits the outside of the horns.
Caused by too strong a mainspring.

86. What would be the effect on the escapement if the let-off corner was broken off the L stone?

86-A. It would reduce or eliminate the Lock on the R. Stone due to insufficient lift.

87. In your opinion, what is the best way to test a watch for perfect beat?

87-A. By testing the let-off to see that it lets off of both pallets with equal ease with a small amount of power.

88. Name the various escapements that have been in common use for the past fifty years.

88-A. Lever, chronometer, cylinder, and duplex.

89. How many teeth does the average escape wheel have?

89-A. Fifteen.

90. When is an escapement overbanked or out of action?

90-A. When the roller jewel is out of fork slot.

91. What is meant by a Dead-Beat Escapement?

91-A. An escapement without recoil.

92. What is the recoil escapement?

92-A. One where the escape wheel moves backwards in the unlocking.

93. How many degrees lift in a lever escapement?

93-A. Average 8-1/2 degrees.

94. When does the lift occur?

94-A. Immediately after the unlocking.

95. What gives the lift?

95-A. Escape tooth passing across the impulse face of the pallet stone.

96. What is the object of the lift?

96-A. To give impulse to the roller jewel.

97. What is understood by impulse face of a pallet?

97-A. The lifting angle on a pallet stone.

98. How do you tell when impulse face is correct?

98-A. When the locking is equal.

99. How is this lift distributed in club and pointed tooth?

99-A. In club tooth it is divided between teeth and stone. In pointed tooth, it is all on stone.

100. How do you tell when pallets have right impulse face on pointed tooth?

100-A. See if it has equal lock.

101. How would you prove which pallet stone was incorrectly set on pointed tooth?

101-A. Go by the angular motion to see whether you increase one or decrease the other.

102. What would you do in case of unequal lift in pointed tooth?

102-A. Change the angle of the impulse face of one or the other stone.

103. How much drop in the lever escapement?

103-A. Approximately 1-1/2 degrees.

104. What is meant by the drop?

104-A. Space between the left off corners of tooth and stone.

105. When does the drop occur?

105-A. After the impulse.

106. What is the cause of too much or too little drop?

106-A. Pallet Stones are too thick or too thin; or escape wheel teeth are too wide or too narrow.

107. What is the object of the drop?

107-A. To give clearance.

108. Is there any bad effect in having too much drop?

108-A. Yes. It can cause wear and loss of power.

109. What is the cause of an unequal drop?

109-A. Pallet Stones are too wide apart, or too close together.

110. When is a lever watch banked to drop?

110-A. When the banking pins are moved to such a position that the tooth of the escape wheel just drops off the stone at the instant the pallet fork is arrested by the bankings.

111. What is the object of banking to drop?

111-A. To test the watch for lock and alignment.

112. Should a watch with a lever escapement be banked to drop to give good results?

112-A. No. There would be no clearance.

113. Can we have unequal drop when pallets are proper thickness and proper distance apart?

113-A. No.

114. How many degrees lock in a lever escapement?

114-A. 1-1/2 average.

115. When does the lock occur?

115-A. At the instant the escape tooth drops on the stone.

116. What is meant by locking face of pallets?

116-A. The face upon which the escape tooth drops.

117. What is the lock for?

117-A. To arrest the escape wheel while the balance performs its arc of vibration.

118. What effect would it have on the locking if the pallets were set too far from the escape wheel?

118-A. Reduce the lock.

119. What is one cause of an unequal lock?

119-A. Improper setting of pallet stones.

120. What would you do in the case of unequal lock?

120-A. Adjust one or both of the pallet stones.

121. How many degrees opening to pallets?

121-A. Sixty degrees.

122. What is understood by opening of pallets?

122-A. Angle from center of escape wheel to locking corners.

123. What is understood by equidistant lockings?

123-A. Locking faces on both stones are same distance from center of pallet.

124. What is a circular pallet?

124-A. Where the center of pallet stones is equal distance from the center of the pallets.

125. What is meant by slide?

125-A. Amount the tooth slides on the pallet.

126. Is it necessary to have slide?

126-A. Yes.

127. How much slide?

127-A. Approximately half as much as the lock.

128. When does slide take place?

128-A. Following the lock.

129. What decreases or increases slide?

129-A. Opening or closing the banking pins.

130. Can you have slide without draw?

130-A. No.

131. Would the effect be good or bad in a light locking to open the bankings a little?

131-A. Good.

132. What is meant by draw?

132-A. The angle of the locking faces of the pallets in a lever escapement.

133. How many degrees draw to the pallets?

133-A. 12 to 15.

134. When does the draw take effect?

134-A. As soon as it locks.

135. Where is the draw laid off from?

135-A. Locking Corner.

136. Would the effect of a strong draw be good or bad, and why?

136-A. Bad. Causes too much resistance to unlocking.

137. What is the object of the draw and what do you understand by the term?

137-A. Object is to hold lever against the banking to allow the balance freedom of motion.

138. When is an escapement out of line?

138-A. When the angular motion is not equal.

139. How do you test a lever watch to see if it is in line?

139-A. Bank to drop and test angular motion. Test guard freedom.

140. Name three ways of putting a watch in line.

140-A. Moving pallet stones; moving fork on two piece pallet; bending fork.

141. If the escapement was out of line and the jewel pin came to a line of centers when at rest, what effect, if any, would it have on the watch being in beat?

141-A. It would be out of beat.

142. Should the fork let off equal distance on either side of a line of centers?

142-A. Yes, if it is in line.

143. What is the ordinary length of fork as compared with diameter of escape wheel?

143-A. 2/3/ to 3/5.

144. What is the general rule for the length of fork and roller to match?

144-A. 3-1/2 to 1; or 4 to 1.

145. How do you tell when the roller is of proper size?

145-A. If the safety action is correct, the roller would be the proper size.

146. How much shake do you allow for jewel pin in fork?

146-A. Approximately 2/100 of a millimeter.

147. How do you find out when jewel pin is too far back?

147-A. Corner clearance test.

148. When should roller jewel leave the fork?

148-A. The instant before the fork is arrested by the bankings.

149. What portion of a jewel pin should be taken off or flattened when drawing an escapement?

149-A. 2/5.

150. What advantage, if any, in a double roller?

150-A. Greater safety action. Decreases friction of guard pin on roller.

151. What do you understand by double roller in lever escapement?

151-A. Large or impulse roller carries roller jewel. Small or safety roller carries the passing hollow and performs the safety action.

152. How many degrees angular motion to the lever? What gives the angular motion?

152-A. 10 degrees. The 8-1/2 degree lift and 1-1/2 degree lock gives the angular motion.

153. What is a Cylinder Escapement?

153-A. A frictional dead-beat escapement.

154. What is the advantage of a steel escape wheel over a brass?

154-A. Lighter, strong and has better wearing qualities.

155. What is a double roller escapement?

155-A. The lever escapement in which a separate roller is employed for the guard action.

156. What is a guard pin?

156-A. A pin which prevents the watch from going out of action or overbanking.

157. Explain all that you would do in putting in a pallet stone to replace one which is lost.

157-A. If an American watch, select a stone of proper make and size and test for lock. If Swiss watch, select a stone to fit the slot and test for lock and lift.

158. What is the Impulse Pin or Roller Jewel?

158-A. The impulse pin or roller jewel is the ruby or sapphire pin of the lever escapement which, entering the notch of the lever, unlocks the escape wheel and then receives the impulse from the lever and passes out of the opposite side.

159. What is the purpose of an escapement?

159-A. The escapement is that part of the watch which changes the circular force of the escape wheel into the vibratory motion of the balance.

160. What is the straight line escapement?

160-A. A straight line escapement is one in which the pallets, lever and balance are all in a straight line.

161. What is the right angle escapement?

161-A. In a right angle escapement, we find the line of centers of the pallet and balance crossed at right angles by the line of the escape wheel.

162. What is a semi-tangental escapement?

162-A. In a semi-tangental escapement location of the pallets is a compromise between the circular and equidistant escapement.

163. What is the purpose of the horns?

163-A. Horns on the lever have no definite purpose in single roller, except that they act as a safety in case of a jar to carry the jewel pin safely across from one side of the roller to the other. In the double roller they provide the safety action after the guard pin has entered the passing hollow.

164. What is meant by the term "long fork"?

164-A. If the roller jewel will not pass out of the fork slot when the escapement is banked to drop, it is called a long fork.

165. What is meant by the term "short fork"?

165-A. If the roller jewel shake is so great as to allow the pallet stone to unlock when an escapement is banked to drop, it is called a short fork.

166. In an ordinary watch, what do you call the fifth wheel?

166-A. Escape wheel.

167. In adjusting an escapement, name the procedure.

167-A. Check your bank to drop; lock; slide; drop; draw; guard freedom.

168. What is meant by a detached lever escapement?

168-A. It is an escapement in which the balance is free from the escapement and solely under the influence of the hairspring, except when unlocking and receiving the impulse.

169. What is a poised fork?

169-A. A poised fork is a fork which has an extension on the side opposite the horns to balance or counterpoise it.

170. How many vibrations per minute does the balance make in the three different trains in American bracelet watches?

170-A. Fast Train.............300
Quick Train............330
Extra Quick Train....360

171. How would you remove a broken screw from the rim of a balance?

171-A. Drill through the screw with drill slightly smaller then the thread of the screw, then broach the remainder.

172. What would you say is the proper amount of space between the balance and cap jewels?

172-A. 2/100 of a millimeter.

173. What do you consider the proper thickness of a balance jewel in comparison with the size of the hole?

173-A. Approximately one-half the size of the hole.

174. How long should a balance pivot be compared to its diameter?

174-A. 2 to 2-1/2 times as long as the diameter.

175. In your opinion, what is the proper amount of end shake on a balance staff for a pocket watch?

175-A. 2/100 of a millimeter.

176. What is meant by an olive balance hole jewel and what is its purpose?

176-A. The hole in an olive balance hole jewel is rounded on the inside instead of being straight. The purpose is to reduce friction.

177. What is the purpose of a compensating balance?

177-A. To compensate for loss or gain in heat or cold.

178. If the end of a balance pivot is flat and you make it slightly round, will it cause a slower or faster rate on that pivot?

178-A. Slower.

179. Name two kinds of hairsprings and explain the difference.

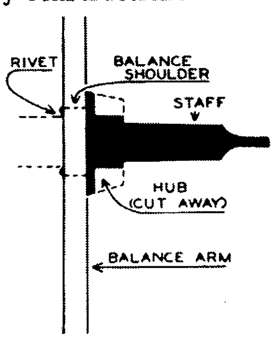
179-A. Breguet or overcoil and flat.

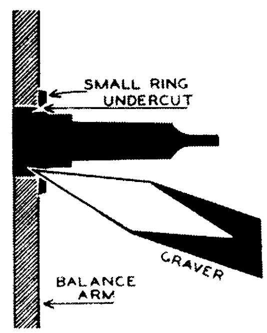
180. If, in putting in new balance staff, your nearest selection has pivots a trifle too large, explain fully how you reduce their diameter.

180-A. Grind with oilstone powder or crocus and polish with diamantine.

181. How do you remove a balance staff from a balance wheel of ordinary construction?

181-A. Chuck it up in the lathe and undercut the rivet, or turn away the hub.





182. Why are some balances made of two metals and cut?

182-A. To compensate for changes in temperature.

183. Why are two metals used in a compensating balance?

183-A. Because of their difference in expansion and contraction.

184. Why are steel and brass used?

184-A. Brass has a greater coefficient of expansion than steel.

185. What do you understand by a composition balance?

185-A. A balance made of alloyed metal.

186. How do you true a balance?

186-A. With a good truing caliper. First level the arms, then raise the lower segments until true in the flat. In the round, check to see that the arms are both the same length, then bring the rim in or out to conform with the edge of rim at end of arm, until both sections are true in the round.

187. How much of an arc should the balance make when the watch is in good condition?

187-A. 1-1/2 arcs or 540 degrees.

188. How do you select a balance staff?

188-A. You select a balance staff for the make of watch, size, length of staff, diameter of pivots, proper diameter of collet and roller shoulders.

189. Explain how you fasten a balance staff to a balance wheel of ordinary construction.

189-A. By first staking with a round face hollow and a flat face hollow staking punch.

190. Name the two other kinds of staffs and explain the difference.

190-A. Waltham Friction Taper Shoulder Staff, and Hamilton two-piece Friction Staff. The part which is the hub is staked into the balance arm permanently. The broken staff may be driven out and the new one driven in friction tight.

191. What is a compensating balance?

191-A. A compensating balance is a bimetallic balance consisting of approximately 2/5 steel and 3/5 brass.

192. What is the usual time value of a pair of balance screws?

192-A. A pair of regular sized screws added or removed from the balance of a pocket watch will vary the time approximately one hour per day. Some factories make screws known as heavy, medium, and light. Other companies make a line of timing screws for their watches, each pair having a specifically stated time value.

193. What is the purpose of the balance?

193-A. The vibratory wheel of a watch which in conjunction with the mainspring controls the progress of the hands.

194. Name the different kinds of screws that may be found on a balance.

194-A. Full head balance screws; timing screws; meantime screws.

195. Why are threads on some balance screws longer than others?

195-A. Those with long threads are fitted friction tight, and are called meantime screws. Moving a pair in will cause the watch to run faster.

196. What is Invar?

196-A. Nickel steel alloy containing approximately 36% nickel.

197. What is the most important property of Invar?

197-A. The expansion in the ordinary temperature range is negligible.

198. Explain how you take the staff measurements on a watch.

198-A. Overall length from outside of balance jewel settings. Then from outside of lower balance jewel setting to top of pallet bridge, and from outside of lower balance jewel setting to top of fork. The balance of the measurements may be computed from these three measurements.

199. If the hairspring of an 18,000 beat train was vibrated one count per minute fast, how much would the watch gain in 24 hours?

199-A. 9 minutes and 36 seconds.

SOLUTION:

1 Beat per minute equals 2/5 sec.
2/5 sec. x 60 minutes equals 24 (the number of seconds fast in 1 hour)
24 sec. x 24 hrs. equals 576 (the number of seconds fast in 24 hours)
576 divided by 60 (the number of seconds in one minute) equals 9.6

SUBSTITUTING:

$\frac{.4 \times 60 \times 24}{60}$ equals 9.6

200. Name two springs used in a hunting case.

200-A. Lift and lock.

201. What are the principal parts of an open face pocket watch case?

201-A. Frame or center, bezel, back, pendant, crown, bow.

202. What is the difference between an Open Face Watch and a Hunting Case Watch?

202-A. An open face watch has no cover or back. A hunting case watch has a cover protecting the glass. This cover is referred to as the front back.

203. What is the probable trouble with an American Pendant Set Watch when you pull the stem out to the setting position and it neither winds nor sets?

203-A. The sleeve may be in too far.

204. If the stem pulls out easily on an American Pendant Set Watch so that it occasionally gets in the setting position itself, what is usually wrong?

204-A. Usually a worn or broken sleeve.

205. What is a stem of a watch?

205-A. The stem is also known as the winding arbor.

206. What is the clutch?

206-A. A sliding pinion which shifts from winding to setting, or vice versa.

207. What is meant by Maintaining Power?

207-A. A mechanism for driving a watch or clock while being wound.

208. How do you take the excess shake out of a stem?

208-A. The shake in stem is generally due to the hole in between the plates being worn. In order to overcome excess shake in stem caused by wear, fit new stem with oversized hub.

209. What is the purpose of the balance spring?

209-A. To regulate the time of vibrations of the balance.

210. Why is the Breguet Spring superior to a flat one?

210-A. The action is more concentric and more susceptible to adjustment for Isochronism.

211. Is a cylindrical spring superior to all others?

211-A. Yes.

212. What do you understand by the word curb pins?

212-A. Regulator pins.

213. Should the hairspring vibrate between the curb pins?

213-A. On a flat spring, yes.
On a overcoil spring, no.

214. What is the proper distance between the curb pins?

214-A. Approximately twice the thickness of the spring.

215. In vibrating a flat hairspring, where should the point of vibration be placed?

215-A. About half way between stud and regulator pins.

216. About how many coils should a Breguet spring have?

216-A. Fourteen or fifteen.

217. Which way do you insert pin in collet and is it best to have pin flattened slightly?

217-A. Insert same direction as spring enters collet. No, it is not best to flatten pin.

218. About how many coils should a flat spring have?

218-A. Fourteen or fifteen.

219. If you were fitting a hairspring to a watch and you found it necessary, where would you add or take off weight?

219-A. You make your change on the balance within 1/3 from the solid end.

220. What is the hairspring?

220-A. It is frequently termed balance spring, and is a small coiled spring which vibrates the balance.

221. What is Elinvar?

221-A. Elinvar is the same as Invar with 12% chromium added, replacing a like amount of iron.

222. What is the most important property of Elinvar?

222-A. The elastic strength does not change in the ordinary temperature range.

223. What is known as a free spring?

223-A. A balance spring with no provision for regulating by curb pins. Marine Chronometers, and occasionally very fine watches, have no curb pin regulator in them. Regulation is effected by meantime screws in the balance rim.

224. What is the effect in increasing the weight of a pendulum bob?

224-A. No effect, except if increased too much, it will stop. As long as impulse will throw it, no effect.

225. How many millimeters are there in an inch?

225-A. 25.4.

226. How many millimeters are there in a Ligne?

226-A. 2.26.

227. Name materials used for making watch jewels.

227-A. Garnet, ruby, sapphire, and sometimes a diamond.

228. What is the difference between regulating a watch and adjusting a watch?

228-A. Regulating a watch is timing it so it doesn't gain or lose.
Adjusting a watch is manipulating it so that it will keep equal time in different positions and temperatures.

229. How do you remove the hands from a watch with a metal dial so as not to mar the dial?

229-A. With a hand remover and a dial protector.

230. If a watch should suddenly gain considerable time, name all the causes you can think of that might be the trouble.

230-A. Balance screw lost; balance out of true; oil on the hairspring; hairspring tangled.

231. What are each of the following:
a. Chronograph Watch?
b. Repeater Watch?
c. Calendar Watch?

231-A.
a. A Chronograph Watch is a recording time piece.
b. A Repeater Watch is one that strikes the time.
c. A Calendar Watch is one that records the date.

232. What is a:
a. Bezel?
b. Pendant?
c. Bridge?
d. Crown?
e. Click?

232-A.
a. A bezel is a grooved rim into which the watch glass or crystal is fitted.
b. A pendant is that part to which a bow is attached.
c. A bridge is the standard secured to the plate by means of screws and in which a pivot works.
d. A crown is the part you grasp when winding a watch.
e. A click is a dog or pawl which falls into a ratchet wheel and prevents it from turning backwards.

233. How often should the ordinary pocket watch be cleaned?

233-A. Every 12 to 18 months.

234. If you were fitting a second hand and found the hole in the socket too large, how would you close the hole to fit pivot?

234-A. Close hole in socket by placing in chuck and tightening draw in spindle.

235. In an 18,000 beat train, what fraction of a second does the second hand advance with each beat of the balance wheel?

235-A. 1/5 of a second.

236. To what temper do you draw stem wind wheels?

236-A. Dark Blue.

237. How do you put the alarm hand on an alarm clock so as to have the clock ring at the time indicated?

237-A. Turn hands until cam drops, then put alarm hand on at the time hour and minute hands indicate.

238. Name at least two causes for a watch winding hard after being put together.

238-A. Lack of oil under crown wheel, or not aligned with stem in case.

239. How do you regulate a pendulum bob?

239-A. By raising or lowering.

240. What clock will keep the best time, one driven by mainspring power or one driven by weight?

240-A. The one driven by weight keeps the best time because the power is more constant.

241. How may you prevent steel from being oxidized when hardening?

241-A. Cover with powdered boracic acid or soap.

242. Explain the advantage of a recoil click.

242-A. The recoil click prevents winding the mainspring too tightly.

243. When a watch varies in the pendant positions, what may be some of the troubles?

243-A. Balance out of poise; hairspring out of true or out of center; curb pins open.

244. If you had to enlarge the hole in a porcelain dial, how would you do so without chipping ?

244-A. Use a tapered broach charged with diamond powder.

245. What are the chief causes of variations in different temperatures?

245-A. Expansion and contraction of balance wheel; lengthening and shortening of the hairspring.

246. What are the most important qualities required for good watch oil?

246-A. Must remain liquid when exposed to intense cold.
Must evaporate slowly under intense heat.
Must not corrode on metal.
It must not become gummy.
It must not creep.

247. What time of day would it be when a ship or marine clock strikes eight bells?
Five bells?
One bell?

248-A. When it strikes eight bells, it is 12, 4 or 8 o'clock.
When it strikes five bells, it is 2:30, 6:30 or 10:30.
When it strikes one bell, it is 12:30, 4:30 or 8:30.

EXAMPLES:

1 Bell	12:30	4:30	8:30
2 Bells	1:00	5:00	9:00
3 Bells	1:30	5:30	9:30
4 Bells	2:00	6:00	10:00
5 Bells	2:30	6:30	10:30
6 Bells	3:00	7:00	11:00
7 Bells	3:30	7:30	11:30
8 Bells	4:00	8:00	12:00

248. What parts of a watch do you oil?

248-A. The winding wheels, the mainspring, all pivots, the center post, the escape wheel teeth; in other words, where there is friction. Do not oil roller or hour and minute wheels.

249. What is meant by adjustment of a watch?

249-A. Manipulating the balance, its spring and staff for the purpose of improving the time keeping qualities of the watch. Adjusting to position, isochronism and temperature.

250. What is meant by position adjustment?

250-A. The manipulation of the hairspring, curb pins, and balance so that the movement keeps time in the different positions.

251. What is meant by adjusting to Isochronism?

251-A. The manipulation of the hairspring so that the long and short arcs of the balance are performed in the same time.

252. What is meant by adjusting a watch to temperature?

252-A. Manipulation of the balance screws to cause a watch to rate the same in heat and cold.

253. How do you test a watch for magnetism?

253-A. By the use of a small compass, preferably with the magnetism removed.

254. What is the effect of magnetism on a watch?

254-A. It causes the watch to run erratically.

255. Define the following parts; dial; bob of a clock; cannon pinion.

255-A. A Dial is a graduated face of a time piece.
Bob of a clock is the metal weight at the bottom of a pendulum.
Cannon Pinion is the pinion to which a minute hand is attached.

256. What is a Marine Chronometer?

256-A. A chronometer hung in gimbals for use at sea.

257. What is a potance?

257-A. A lower bridge, or hang down bracket fastened on the under side of the upper plate of an 18 size watch.

258. What is a Demagnetizer?

258-A. A device used to remove magnetism from parts of watches.

259. Name the jewels in a 21 jewel watch.

259-A. 2 Balance hole jewels
6 Cap jewels
2 Pallet jewels
1 Roller jewel
2 Pallet arbor hole jewels
2 Escape pinion hole jewels
2 Third pinion hole jewels
2 Center pinion hole jewels
2 Fourth pinion hole jewels

260. When cleaning a watch, do you remove the mainspring from the barrel?

260-A. Yes.

261. What is a regulator of a watch?

261-A. The part to which the curb pins are attached.

262. How do you remove a broken screw from a plate?

262-A. Dissolve screw out in solution of alum water, or one part of sulphuric acid to 9 parts of water. If plate should discolor in either of these solutions, immerse in cyanide solution to restore finish.

263. What is Solar Time?

263-A. Sun time.

264. After placing a staff in a watch, and you find that the watch runs 2 or 3 minutes fast, explain how you would bring that watch to time.

264-A. If watch was running fast, turn the meantime screws out. If watch is running slow, turn the meantime screws in. If watch was running slow, in absence of meantime screws, reduce weight of balance by undercutting screws. If watch was running fast in absence of meantime screws, add weight in form of timing washers.

265. What are meantime screws?

265-A. Screws usually placed at quarters. Often called quarter screws. Threaded friction tight so they can be moved in or out. The purpose of meantime screws is to bring the watch to time without the use of the regulator.

266. How do you make a Swiss stem?

266-A. Select a piece of steel as large as the hole through the plate. Turn pivot, locate slot, fit winding pinion and clutch. Cut off proper length and thread for crown. Harden and temper to a blue.

267. If you flatten the ends of the balance pivots, what effect would it have in regard to rate?

267-A. By flattening the ends of the balance pivots, you would increase the friction, which would reduce the arc of the balance, and thereby increase the rate in the dial up and dial down positions.

268. Name the most important steps when taking a watch apart for cleaning and oiling and reassembling.

268-A.
1. Remove hands, dial and dial train.
2. Remove balance and bridge, being very careful with the hairspring.
3. Press back click and release the power slowly with the stem or bench key.
4. Remove pallet bridge and fork.
5. Remove winding wheels.
6. Remove bridges, barrel and train.
7. After cleaning all parts thoroughly, put mainspring and arbor in the barrel and oil.
8. Assemble balance hole jewels and cap jewels and oil.
9. Assemble barrel, train and pallet in watch oil, commencing at center.
10. Place balance in watch.
11. Check to see that hairspring is true in the round and flat and centered.
12. Oil center staff and replace cannon pinion.
13. Complete oiling at all points of friction including three of four teeth of escape wheel.
14. Complete assembly by replacing dial and hands.

269. What is a full plate watch?

269-A. In a full plate watch the balance and balance bridge are above the plate.

270. What is a 3/4 plate watch?

270-A. A 3/4 plate watch is where the balance is in the movement or below the surface of the plate.

271. Name the different kinds of crystals used in open faced watches.

271-A. Mi-concave; lentile; lentile chevee.

272. What is the name of the crystal used in hunting case watches?

272-A. Geneva.

273. How often should bracelet watches be cleaned?

273-A. Bracelet watches should be cleaned every 9 to 12 months. Very small watches should be cleaned every 6 to 9 months.

274. How would you transfer oil from your bottle to the oil cup and why?

274-A. Use a clean glass rod so that you do not contaminate your oil supply, or keep your oil in a hypodermic needle.

275. What is a floating or self centering stud?

275-A. It is the type of stud which when free allows the spring to seek its centered position, and which is held firmly in place with a small plate, which is held in position by two screws.

276. Name or illustrate eight kinds of jewels.

276-A. Regular cap; balance; plate; friction cap; friction balance; friction plate; roller jewel; pallet jewels; barrel arbor jewels.

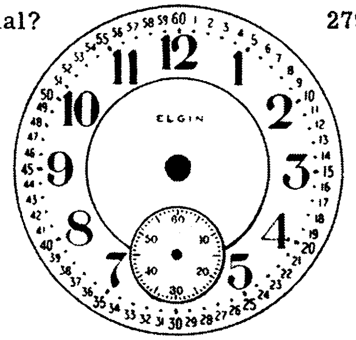
277. What is a patent regulator?

277-A. It is a type of regulator which makes possible a micro-meter adjustment.

278. What is a double sunk dial?

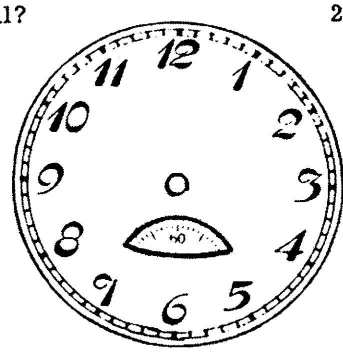
278-A. A dial which is in three parts before being assembled, each portion at a different level.

279. What is a Montgomery dial?



279-A. It is a dial showing numbers 1 to 60 on the margin, indicating minutes.

280. What is a Secometer Dial?



280-A. A secometer dial has an aperture through which the rotating second dial may be seen.

281. Where would you look for the trouble if a watch stops every five minutes?

281-A. The trouble may be caused by the cannon pinion if 12 leaf, or by the center pinion if 12 leaf.

282. What is Epilame process?

282-A. Pivots or plates are dipped in a liquid solution which prevents oil from creeping away.

283. Where are conical pivots found other than on the balance staff?

284-A. Conical pivots are found wherever the hole jewel is capped.

284. Where is the stop works found in a watch?

284-A. The stop work mechanism is usually found on the under side of the mainspring barrel.

285. What two different systems of measurements are used for Mainsprings?

285-A. Metric and Dennison.

286. Does Re-Banking mean the same as Over-Banking?

286-A. Re-Banking is caused by excessive motion. Over-Banking, providing the watch is correct in every other way, is caused by faulty guard pin, which action means the guard pin is too far away from the roller or too short.

287. What do you consider good timing qualities for a high grade watch? What should be the limit of error per week?

287-A. Within thirty seconds per week.

288. What is a depthing?

288-A. Distance between centers. It is the amount which a wheel will engage into a pinion.

289. In what way may a depthing be defective, and how is this to be remedied?

289-A. A depthing could be remedied by uprighting. Faulty depthing is usually corrected with a rounding up tool.

290. What is the length of the pendulum on a second beat clock?

290-A. 39 and a fraction inches.

291. What allowance is made between diameter of the reamer and the diameter of a friction jewel to obtain a friction fit?

291-A. 1/100 millimeter.

292. Name the different temper colors.

292-A. Light straw, yellow straw, light brown, dark brown, purple, dark blue, light blue, gray.

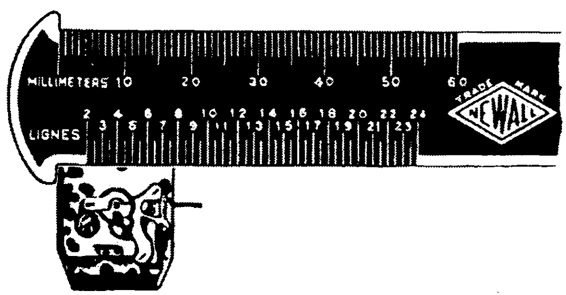
293. Name the three different lengths of running time on watches with one winding.

293-A. The ordinary watch should run 36 to 40 hours, 60 hours, or eight days.

294. How do you clean dials?

294-A. Cyanide Potassium solution is an excellent tarnish remover. Rinse in cool water.

295. How do you measure a watch for size?



295-A. Use watch gauge, or a millimeter gauge, and measure diameter of pillar plate on the dial side.

296. What is a simple train?

296-A. Where the teeth of one wheel engage the teeth on another wheel.

297. What is a compound train?

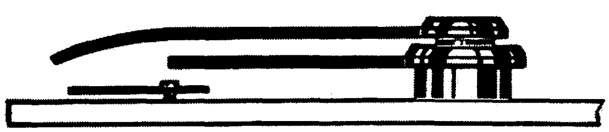
297-A. Where wheels depth into pinions.

298. What is meant by friction jeweling?

298-A. Jewels are placed into the proper position in a watch friction tight. The proper friction is obtained by pressing the jewel into a hole in the plate or bridge, and the hole is approximately 1/100 of a millimeter smaller in diameter than the jewel.

299. How do you adjust the hands on a watch?

299-A. The hands should be parallel with the dial.



300. What is required to attain a good regulation?

300-A. The barrel must be free from faults. The mainspring must be of the right dimensions, the train free, the escapement properly adjusted, proper fit of balance pivots and proper end shake, balance true and poised, hairspring true, flat and centered, and the curb pins in the proper position.

301. What is the purpose of a Rounding Up Tool?

301-A. A rounding up tool is used for touching up the teeth of a wheel or reducing the diameter very slightly.

302. What is a Depthing Tool?

302-A. An adjustable tool used to determine the distance between centers.

303. How do you close the socket in an hour hand?

303-A. The socket of an hour hand is closed with a taper mouth punch used in the staking tool.

304. How do you close the hole in a minute hand?

304-A. The hole in a minute hand may be closed by using a round edge punch which is slightly larger than the hole, which when tapped lightly with a hammer, will reduce the diameter of the opening.

305. How do you close the pipe or tube on a second hand?

305-A. By placing it in a chuck in a watchmaker's lathe and tightening the Draw-In Spindle, which closes it the entire length.

306. How may the moving parts in a watch movement be classified?

306-A. Winding parts; motive parts; transmitting parts; distributing parts; regulating parts; setting parts; time showing parts.

307. What is the use of jewels in a watch movement?

307-A. To reduce wear and friction of the moving parts to a minimum. Oil sinks in the jewels provide for adequate storage of oil.

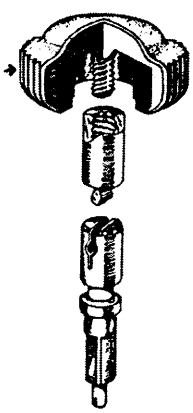
308. What is the difference between Sport Timers and Chronographs?

308-A. Sport Timers do not tell time.

309. On what type watches are snap-in crowns and slotted stems used?

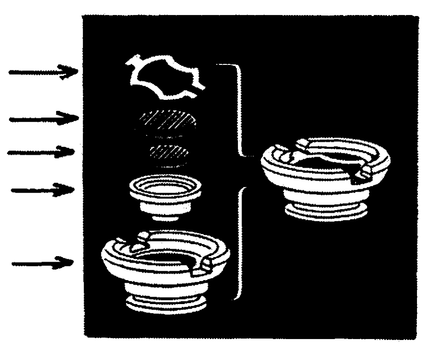
309-A. On waterproof watches.

WATER PROOF CROWN and SNAP-IN STEM



310. What do you understand by Incabloc assembly?

310-A. The assembly consists of the balance jewel cap jewel and spring, the purpose being to absorb shock when the watch receives a blow or is dropped.



311. When replacing a strap on a strap watch case, is the buckle end placed at 12 or 6?

311-A. 12.

312. Explain your method of cleaning and oiling a watch correctly.

312-A. The two methods of cleaning a watch are known as hand method and cleaning by machine method. Both methods require the use of a cleaning fluid which will remove the dirt and old oil and brighten the watch parts, after which all parts are thoroughly rinsed before drying. Regardless of the method used, all pivot holes should be thoroughly pegged before the watch is assembled.

313. If a watch was handed to you for repair, how would you go about examining it?

313-A. First examine to see if the case is tight, after which test the winding and setting. Then remove the movement from case, remove hands and dial and balance from the watch. Examine carefully and proceed to estimate the necessary repairs.

314. What is the difference between Static Poise and Dynamic Poise?

314-A. A balance is static poised on a poising tool. When the balance is in perfect static poise, it must come to rest and remain at rest in any position it may be placed.
Dynamic poise refers to conditions which arise when the balance of the watch is in motion, which in turn effects the rate of a watch.

315. When is a watch adjusted to temperature?

315-A. When proper adjustments have been made on balance for heat and cold.

316. If a watch gains in heat, what is the action and which way would you move the screws?

316-A. Balance expands in heat, and for that reason screws must be brought nearer arm, away from cut end.

317. Why are gold and platinum screws sometimes used?

317-A. For appearance and weight.

318. What is the first thing to be done in adjusting to heat and cold?

318-A. Get difference in rate between heat and cold.

319. What are the extreme temperatures used when adjusting to heat and cold?

319-A. 45 to 90 degrees.

320. Should a watch always remain in one position while being adjusted to temperature and why?

320-A. Yes, so as to eliminate position error.

321. How is temperature adjustment obtained?

321-A. When a watch is adjusted to temperature, it is run 24 hours dial up in a temperature of 90 degrees F, and its rate compared with a standard. It is then run 24 hours dial up in a temperature of 40 degrees F. If it then shows a gain in the 40 degrees temperature as compared with the running in the 90 degree, it is said to be under compensated. This is remedied by moving screws nearer the free ends of the rim.

322. What effect in timing to position would it have if the balance was out of poise?

322-A. Make vertical positions variable.

323. What is plus action and what is minus action?

323-A. Plus means gain; minus means a loss; although some writers reverse the signs.

324. Is the balance ever put out of poise in timing to position?

324-A. Sometimes done. Not recommended.

325. What effect does a thick hole jewel have on the rate of timing?

325-A. You would make vertical position slow.

326. Should the pivot be made flat on the end to equalize the friction?

326-A. No.

327. When is a watch in Isochronal condition?

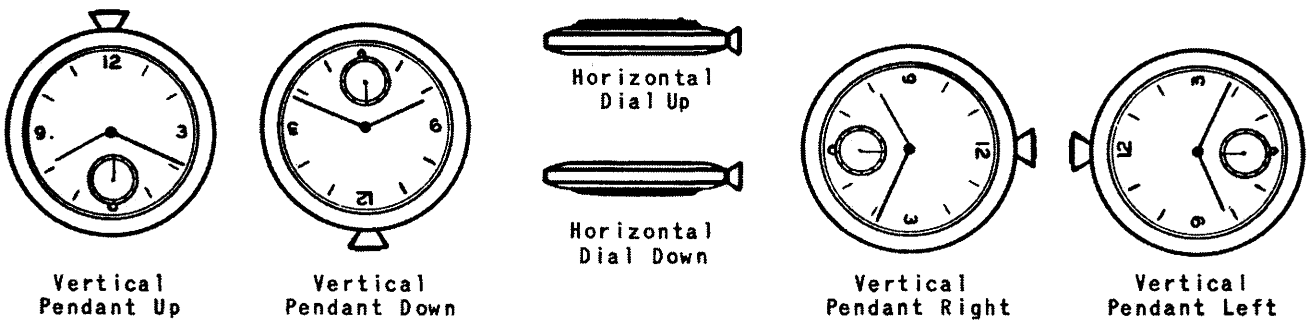
327-A. A watch is Isochronal when the short arcs of the balance have the same time value as the long arcs.

328. Is the pinning of a hairspring to a collet usually above or below the line of centers and why?

328-A. Usually above. It is pinned below when seeking a slower rate in pendant up position.

329. Name the 6 different positions to which a watch is commonly adjusted.

329-A. Dial up; Dial down; Pendant up; Pendant down; Pendant right; Pendant left.



330. What do the letters P F & A stand for?

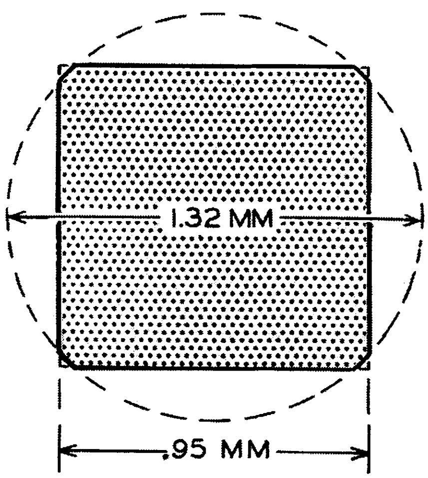
330-A. Pallet Fork and Arbor.

331. How do you determine the diameter of the round section from which you will mill or file the square for the winding clutch?

331-A. Multiply one side of the square by the constant 1.39.

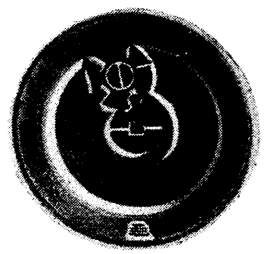
Example:

.95 MM Multiplied by 1.39 equals 1.32 MM



332. What is the purpose of the Stop Works?

332-A. The Stop Works prevent the mainspring from being wound up completely and also prevents it from running down entirely. It utilizes that portion of the mainspring which is most uniform in its delivery of power.



333. Many books containing tables of American Watch sizes list the measurement of an 18 size pillar plate at 44.87 mm. This is not correct. What is the correct diameter?

Solution:

Measure one.

333-A. 45.7 mm.

The following chart is a standard of points for grading repairs made. It is included here to give the student the point values placed on practical repairs to make a perfect grade.

1.	Function of winding	4	Points
2.	Function of setting	2	"
3.	Clearance and fit of hands	5	"
4.	Condition of jewel settings and screws	5	"
5.	Motion - dial up	4	"
6.	Motion - dial down	4	"
7.	Motion - Pendant down	4	"
8.	Freedom of train	3	"
9.	Condition of lock, drop and slide	10	"
10.	Jewel Pin Shake	4	"
11.	Guard Pin Shake	4	"
12.	Endshake of balance staff	4	"
13.	Sideshake of balance staff	4	"
14.	Trueness of balance wheel	7	"
15.	Condition of balance pivots	5	"
16.	Centering and condition of hairsprings	5	"
17.	Flatness and trueness of collet	5	"
18.	Condition of overcoil	5	"
19.	Condition of regulator pins	2	"
20.	Condition of cleaning	4	"
21.	Condition of oil	4	"
22.	Condition of all steel parts	4	"
23.	General appearance	2	"
Total		100	Points

Sizes of American Watches

One Inch = 25.4 MM.

SIZE	MM	SIZE	MM
18	45.7	6/0	25.4
16	43.1	8/0	23.7
14	41.5	10/0	22.0
12	39.8	12/0	20.31
10	38.1	14/0	18.6
8	36.4	15/0	17.8
6	34.7	16/0	16.9
4	33.0	18/0	15.2
0	29.6	20/0	13.5
3/0	27.9	21/0	12.7
4/0	27.09	22/0	11.8
5/0	26.2	26/0	8.5

Sizes of Swiss Watches

One Ligne = 2.258 MM.

LIGNES	MM	LIGNES	MM
3	6.77	11¾	26.51
3¼	7.38	12	27.07
3½	7.87	12¼	27.63
3¾	8.42	12½	28.20
4	9.03	12¾	28.79
4¼	9.59	13	29.33
4½	10.15	13¼	29.89
4¾	10.72	13½	30.45
5	11.28	13¾	31.02
5¼	11.84	14	31.58
5½	12.40	14¼	32.15
5¾	12.97	14½	32.71
6	13.53	14¾	33.27
6¼	14.10	15	33.84
6½	14.66	15¼	34.40
6¾	15.23	15½	34.98
7	15.79	15¾	35.53
7¼	16.35	16	36.09
7½	16.92	16¼	36.66
7¾	17.48	16½	37.22
8	18.05	16¾	37.78
8¼	18.61	17	38.35
8½	19.17	17¼	38.91
8¾	19.74	17½	39.48
9	20.30	17¾	40.04
9¼	20.87	18	40.60
9½	21.43	18¼	41.17
9¾	21.99	18½	41.73
10	22.56	18¾	42.30
10¼	23.14	19	42.86
10½	23.69	19¼	43.42
10¾	24.45	19½	43.99
11	24.81	19¾	44.55
11¼	25.38	20	45.12
11½	25.94		

Master Watchmaking

TOOLS and MATERIALS of the Trade

By

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1952

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FOREWORD

This text was prepared with two thoughts in mind: One, to give you in brief form an understanding of the common tools used in watchmaking, particularly those used with Lessons in Master Watchmaking. Second, to assist you in the oftimes difficult task of ordering materials. Lack of knowledge about proper tools and right ways to order materials can be serious stumbling blocks for newcomers to watch repair. I hope this text will remove these barriers to learning and enable you to concentrate your full attention on mastery of watch repair itself.

These pages may come as a revelation to those who have the impression that the only tools needed for watch repair are a loupe, screwdrivers, and a pair of pliers. Watch repair is precision work and demands precision tools. Skill and knowledge alone are not enough, especially if you intend to work for profit.

In the old days, watchmakers made most of their tools. Some still do. There is less need to do so now, since most tools are generally available at moderate prices. Indeed, dollar-wise watchmakers realize it is better to spend their time today in profitable watch repair than at arduous and unnecessary toolmaking. Moreover, it is possible to buy a first rate set of tools for a very modest sum if you buy wisely. You should look upon tools as an investment rather than an expense, because they will repay their initial cost many times over in their long years of service.

The tools described herein include the basic tools most likely to be acquired as well as some others you should know about. Not every tool can be covered in the limited space. Those described should be considered only as representative. No attempt has been made to compare the merits of one manufacturer's item against another's. All that is intended is to give you an understanding of what a tool should do. Knowing this, you can more ably judge the advantages claimed for any particular make.

Even so, the task of selecting tools is not easy. Manufacturer's catalogs present a tempting -- but bewildering -- array. The ever-present question is "Which tools should I buy first?" A few suggestions may help determine the answer.

First, consider your aim in watchmaking. Hobby? Or career? Obviously the needs for both are not the same. The professional ordinarily requires more tools than the amateur. This is not only because he handles a greater variety of work, but he must do it fast and economically if he expects to make a profit.

Next, consider how often you will use a tool. If you are going to have frequent use for it, and can do better work with it than without it, you probably should buy it. By limiting your first purchases to the tools you will habitually use, you avoid tying up money in special purpose or limited-use tools. These will come later when you see the need for more speed or more convenience.

A third consideration is what you can afford. It is sound advice to buy the best tools, if you can. This may not be possible in your situation. Students, especially, must often economize. If this is true of you, you should have a good understanding of what tools are used for. You can then more readily decide where you can hold off buying a tool, or can use a less expensive one, and where it would be a false economy to buy a cheap tool. For instance, it is no particular disadvantage to use an inexpensive set of screw drivers while learning. You can buy a better set later at no great cost. But it would be folly to buy a cheap truing caliper or similar tool where accuracy demands a precision tool of high quality.

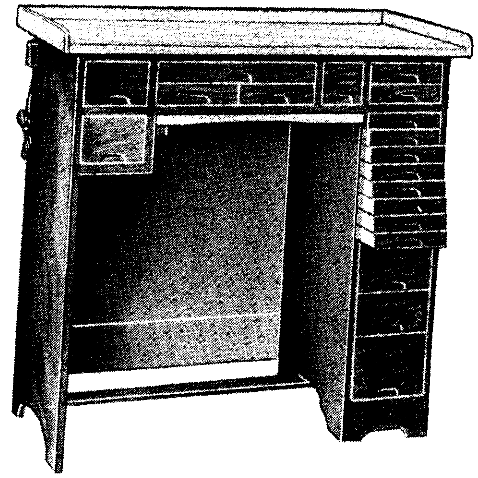
As a further help for those who must economize while learning, this text suggests some substitutes for certain tools, enabling you to postpone their purchase until you can afford them. These substitutes make use of other tools you are likely to have or other methods for doing the work. Such makeshifts are usually adequate for training, but should be replaced with the genuine article the first chance you have. In any event, don't force any tool beyond the limits for which it was intended.

When it comes to ordering materials, you should find these pages of considerable help. Typical methods for ordering and the type of information required are included to guide you in getting the exact material you want. Vague orders are a great expense, both for you and your supply house. They can mean extra correspondence, time lost and dissatisfied customers. If you realize this, you will understand the importance of this training and the value of this section of the text.

It ordinarily takes some years of practical experience to acquire the information that is presented so compactly here. I hope, therefore, that you will use these pages to advantage in speeding your progress.

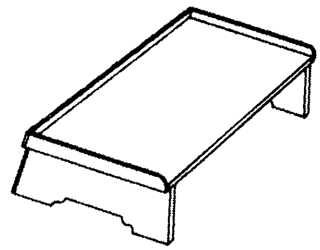
B. G. S.

WATCHMAKER'S BENCH



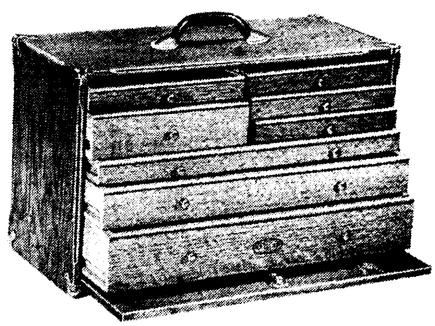
Watchmaker's benches are generally made of wood. They come in different finishes such as mahogany, oak and walnut. The bench contains small drawers and compartments in which the watchmaker can place his tools and materials. Average height is about 38 inches, width 22 inches and length 42 inches.

AUXILIARY BENCH



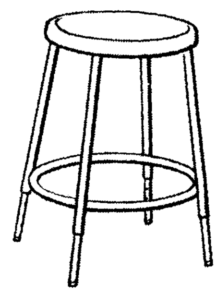
The beginner can improvise a working surface such as a table or drawing board. In order to raise the height of a table to 42 inches, it is advisable to make an auxiliary bench which can be set on an ordinary table and be readily removed and stored when not in use.

TOOL CHEST



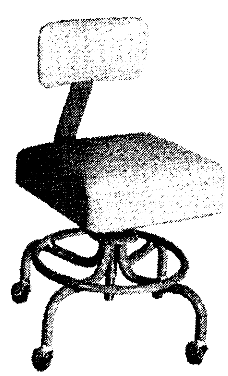
This portable cabinet is convenient for holding tools and materials if a regular bench is not available. It measures about 20 inches long by 9 inches wide by 12 inches high.

STOOL



A small stool is the most common form of seat used by the watchmaker. It should be adjusted to a height which allows the workman to rest his arms on the bench, at the same time keeping his shoulders back. This allows him to work without tiring as the bench supports the arms and proper breathing results. The beginner can use an ordinary chair.

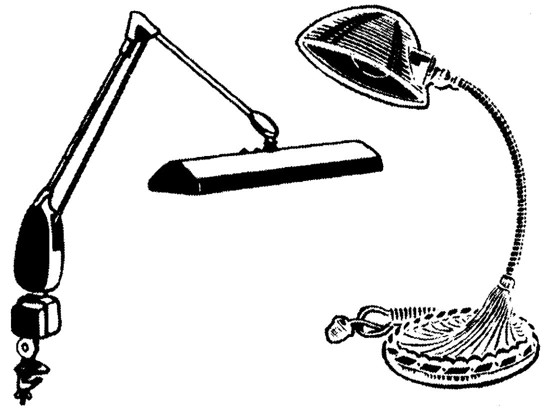
POSTURE CHAIR



The posture chair illustrated is becoming more and more accepted among watchmakers as a welcome addition to their equipment in making working conditions better. The better shops use this type of equipment, not only for watchmakers, but for all persons who sit down to do their work. It can be readily adjusted to fit the individual's requirements.

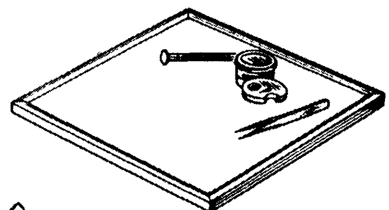
BENCH LAMPS

Good light is important. The watchmaker's bench should be placed as near to natural light as possible. North light is the most ideal. It is usually necessary to supplement the natural light with artificial light and there are many types of lamps for this purpose. A common gooseneck lamp with a round or oval reflector using about a 60 watt bulb is ideal. Another type is the fluorescent lamp which has been power corrected for watchmakers and is generally cooler.



BENCH PLATE

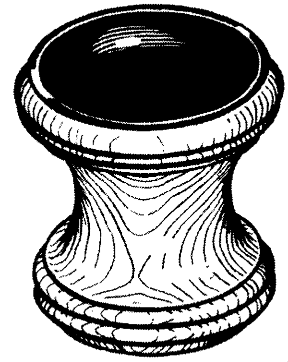
An auxiliary working surface of some sort of white material is recommended. A surface of hard enamel is not recommended. The beginner can use a piece of Bristol board or any white paper which will lie flat.



CASE OPENERS

A - Case openers are used to pry open the front and back of snap type cases. They come in many shapes and styles. They can be made from a piece of flat steel which has a curved edge and ground to a dull knife edge. It should be hardened and tempered. The beginner can use the blade of a small knife.

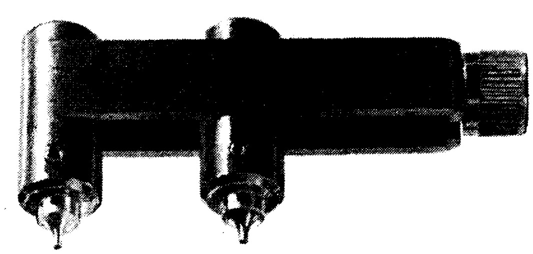
A



B

B - A rubber suction grip type of case opener can be used to remove the back and bezel on screw type cases of pocket size. The beginner may substitute a piece of rubber such as a small piece of inner tube.

C - A waterproof case opener is usually a type of wrench used to remove screw-back waterproof cases. There are many types of backs, requiring a variety of wrenches. The illustrated opener has reversible tips, which will open most types of screw backs.



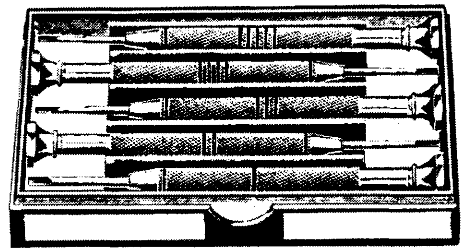
C

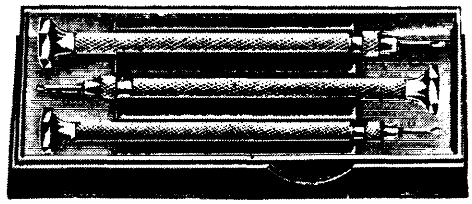
DOUBLE POLISHING CLOTH

This type of polishing cloth is comprised of an outer cloth, which keeps the hands clean when polishing metal, and an inner cloth which has been impregnated with rouge. It can be used to brighten all types of gold and silver jewelry, including the family silverware.

SCREWDRIVERS

The blades of watchmaker's screwdrivers are made of hardened and tempered steel. The head of the screwdriver remains stationary against the finger which is placed upon it, while the stem and blade revolves freely when in use. Screwdrivers are made in a variety of blade widths to fit the wide variety of screw head diameters. It is necessary to select a screwdriver of a width slightly smaller than the screw head so as not to damage the screw head or the plate.

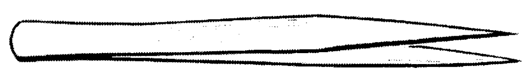




The smaller screwdrivers, used to remove jewel screws, range in size from .60 mm to .85 mm.

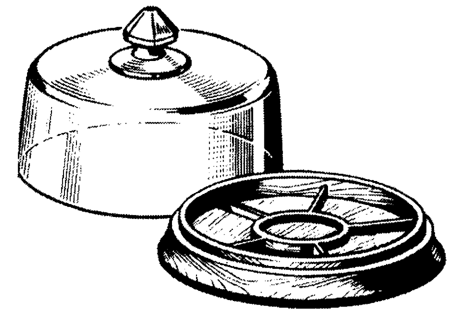
ASSEMBLY TWEEZERS

There are many types of watchmaker's tweezers. The assembly tweezer is a general purpose tweezer used for assembly work and handling watch material. The type illustrated is an excellent tweezer for general work but there are many other different styles and shapes of points.



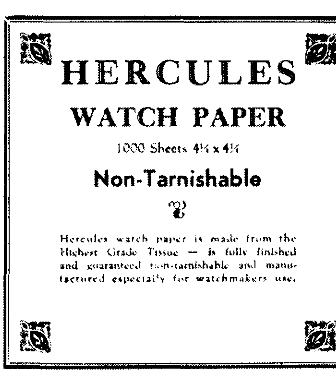
MATERIAL TRAY AND COVER

Most material trays are divided into sections in which to place the parts of a watch as it is disassembled. For example, train wheels in one section, balance and escapement in another, and so on. Most trays are covered in order to keep the parts free of dust and moisture. The beginner may use a clean porcelain dish, such as a saucer with an inverted glass.

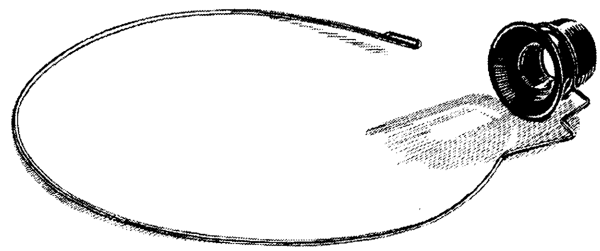


WATCH PAPER

Watch paper is used when handling parts of watches or watch movements. It is made from high grade, tarnish-proof tissue and usually comes in sizes about 2-1/4 x 2-1/4 and 4-1/4 x 4-1/4 inches. The tissue is placed between the fingers and the movement or parts when handling. The beginner can substitute a good grade of tissue which has been cut to either of the dimensions given. Watch paper is also used to wrap parts of watches and materials when sending samples to the supply house.

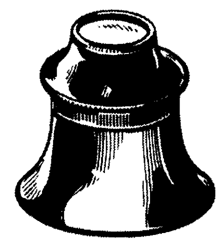


LOUPE OR EYEGLASS



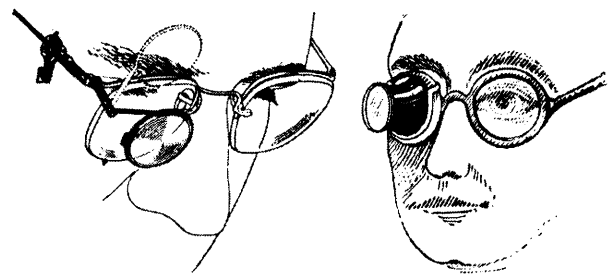
For the person who is not required to wear glasses a single eyeloupe is recommended for all general purposes. It can be held in place by using a head wire. The loupe should be approximately a 3 inch focus. This is comparable to a magnification of 3.3 times.

DOUBLE LOUPE



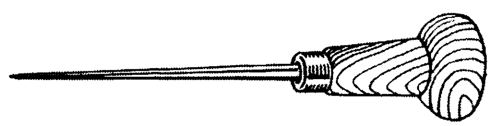
A two lens loupe used for close work and more magnification. The outer lens can be removed, thus reverting to a single loupe. Double loupes are available in many different powers and focus. The ideal double loupe for general work should magnify approximately 7-1/2 times.

SPECTACLE LOUPE



For the person who must wear glasses to correct vision, this type of spectacle loupe is preferred. It is quickly attached and detached. A 3 inch focus is recommended for general bench work. For those wearing bone rim glasses, a loupe similar to this is made to fit the frame. A loupe holder may also be used to attach the regular loupe to the glass frame.

AWL

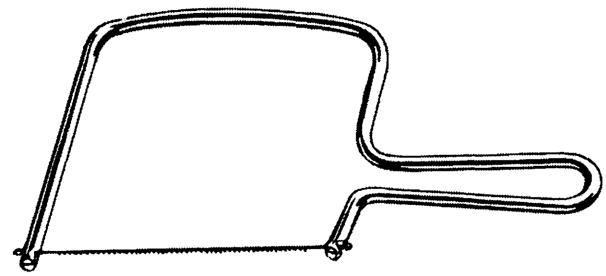


An ordinary awl is extremely handy around the watchmaker's bench. It can be used for punching holes in leather, opening clasps on bands and marking outlines in plastic etc. Any sharp pointed instrument may be substituted.

SOLDERING TWEEZERS

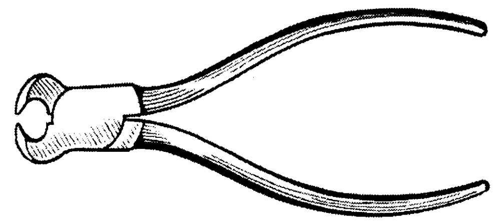
These tweezers are used to hold materials when heating, hardening and soldering. Some tweezers have a clamp as an added feature.

COPING SAW



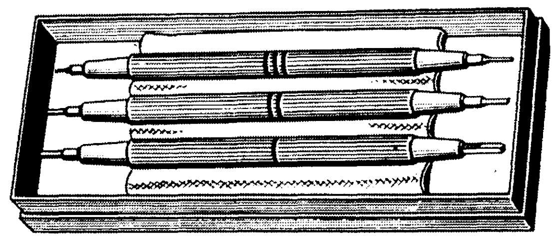
A small inexpensive coping saw is useful for cutting wood and plastic. It can be obtained at most hardware stores.

END CUTTING PLIERS



An end cutting plier of the type illustrated is another of the common type of watchmaker's pliers. It is made to cut soft steel, brass, nickel, and other materials.

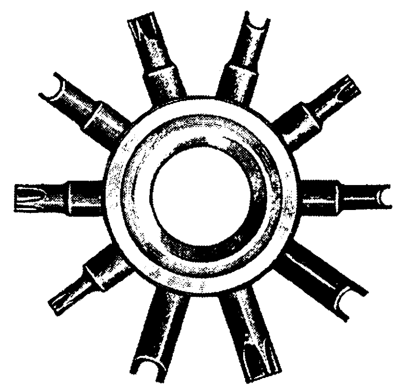
BENCH KEYS



These usually come in sets of three with double end and are used for winding and setting watches after removal from the case. They are seldom applicable to watches of Swiss manufacture, which use a different type of winding and setting arrangement. The beginner can readily make a set of bench keys from steel rod. After the pieces have been shaped to the proper size squares they should be hardened and tempered to a blue color. They can then be mounted in handles of metal or wood. The following dimensions are the most common:

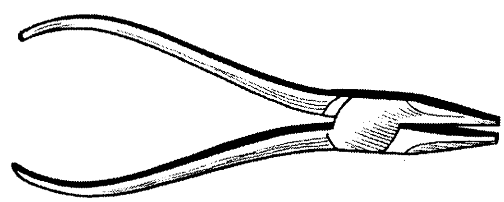
Length of square	Thickness of square
.6 mm	1.5 mm
5.5 mm	1.3 mm
4.5 mm	1.1 mm
4.5 mm	1.0 mm
3.3 mm	.8 mm
3.3 mm	.6 mm

SLEEVE WRENCH



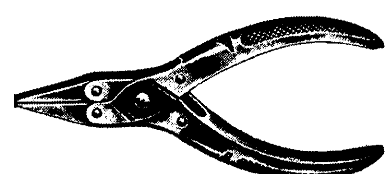
Sleeve wrenches have 3, 6 or 10 prongs. The prongs are of varied shapes and sizes and are used to remove or adjust sleeves, generally in pocket watch cases.

FLAT PLIERS



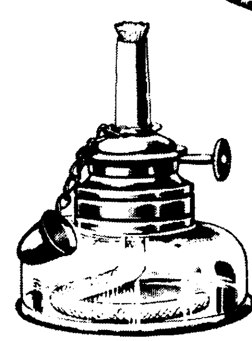
Flat pliers have a variety of uses to the watchmaker and jeweler. A flat plier of good quality, approximately 4-1/2 inches long, is ordinarily used. The beginner may use any type of plier by taking precaution not to mar the surface of the parts being worked on.

PARALLEL JAW PLIERS



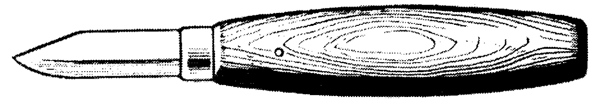
Used to hold small objects more securely. They differ from the conventional flat nose pliers in that the jaws remain parallel whether open or closed.

ALCOHOL LAMP



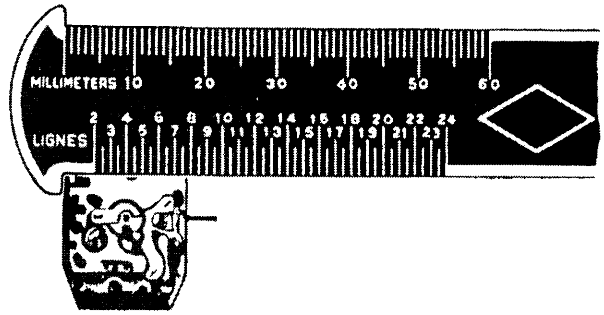
A small alcohol lamp similar to the one shown is a necessary piece of equipment for the watchmaker's bench. The fuel for these lamps is usually obtainable in a drug or paint store and is a denatured alcohol suitable for burning.

BENCH KNIFE



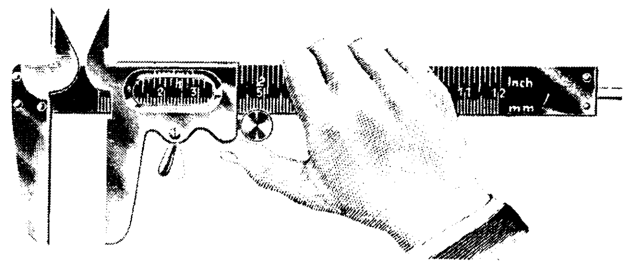
A small sharp knife used to sharpen peg wood. Any small pocket knife will suffice as a substitute.

LIGNE GAUGE



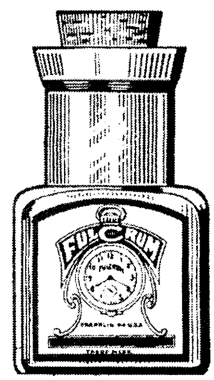
A small ligne gauge is usually obtainable from your supply house. It is handy to measure the diameter of movements to determine the size; however, it is not generally as accurate as the millimeter gauge.

MILLIMETER GAUGE



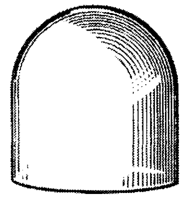
The gauge illustrated is a common type of millimeter gauge with a vernier for subdividing the millimeters into tenths. It is used for measuring the length and outside diameter depth in millimeters. MM is the abbreviation for millimeter. Later a description will be given of the micrometer, which measures to one/one-hundredth of a millimeter.

CLOCK OIL



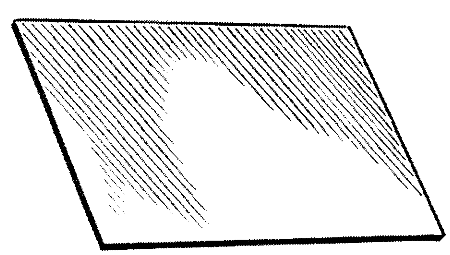
Clock oil, while principally used for oiling pivots on a clock, is used by the watchmaker to oil mainsprings and the winding and setting parts of the watch. It should be kept covered at all times and in a dark place. It should be removed from the bottle several drops at a time and placed in an oil cup. This assures the watchmaker of having clean, fresh oil at all times. Do not add fresh oil to the oil cup without first disposing of any remaining old oil.

CRYSTAL FORMER



For the beginner, any half round object of glass or metal and about 4 inches across will serve. A smaller size is desirable for small crystals. The crystal is shaped over the former and should be formed high enough to let the hands of the watch rotate without rubbing.

CRYSTAL MATERIAL

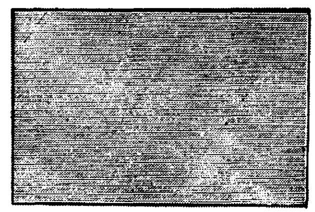


Crystal material for making and forming fancy shape watch crystals is usually of plastic, the most common of which is known by the trade name PLEXIGLASS. It can be formed and polished with a minimum of effort.

POLISHING PASTE

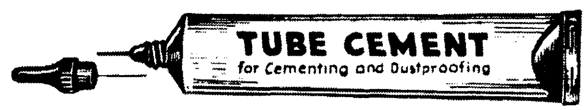
A good silver polishing paste can be used to polish the edges of a crystal after the rough edges have been smoothed with crocus paper. This polish can also be used to polish silverware and jewelry.

CROCUS PAPER



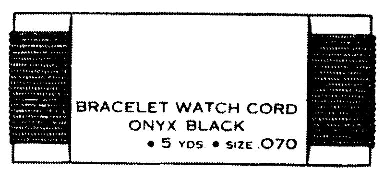
This is an abrasive material which is glued to smooth paper. It is used to remove scratches from metals and plastic. The student may use it to smooth the edge of non-breakable watch crystals.

CRYSTAL CEMENT



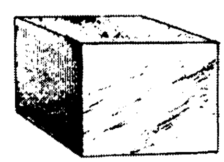
Crystal cement generally comes in tubes. These tubes are made with a needle cap which allows the cement to flow freely. Replacing the cap will keep the cement clean and liquid. It is used primarily as a sealer between the bezel and the crystal to keep dust from entering and not to hold the crystal in place.

BRACELET CORD



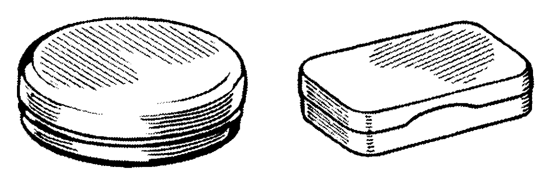
Replacement cords for ladies watch bands come in different diameters. The principal color is black. The old cord is used as a guide when replacing the cord. After the new cord has been cut to length, the ends should be dipped in hot wax.

PARAFFIN WAX



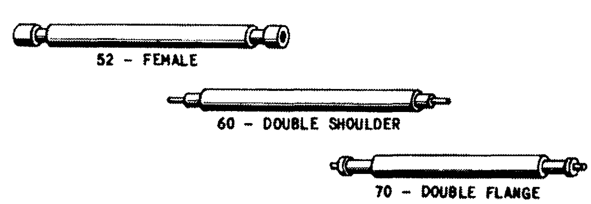
A small piece of paraffin wax is ideal for tipping the ends of the cord bands used on ladies' watches. The wax can be heated in a small material can.

MATERIAL CAN



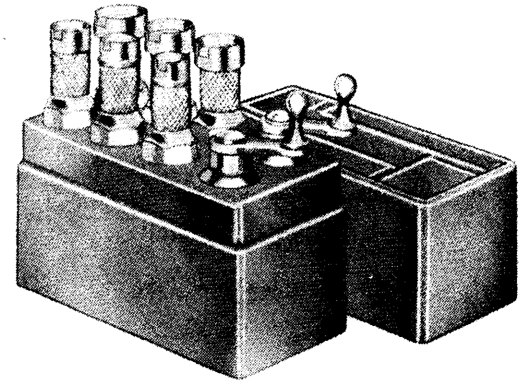
Small metal containers of varying shapes are known in the trade as material cans. They are usually furnished by the supply houses to hold watch material in mailing.

SPRING BARS



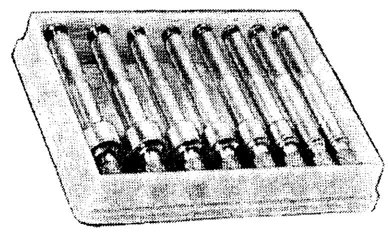
A small assortment of spring bars should be kept handy at all times. They come in assorted lengths in either regular or thin diameters.

MAINSPRING WINDER for Pocket Watches



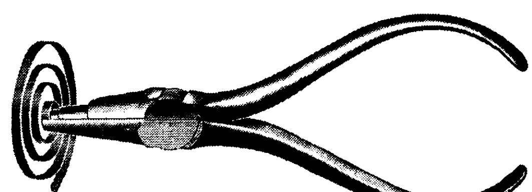
The mainspring winder is an indispensable tool used to insert the mainspring in the barrel. The winder illustrated has six loading barrels, the smallest being 8.8 mm, and is graduated up to 16.0 mm. It comes with two sizes of winding arbor. This winder is used on pocket size watches.

MAINSPRING WINDER for Bracelet Watches



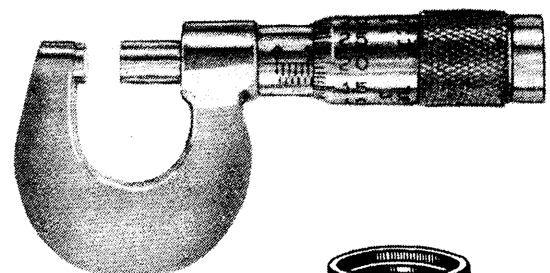
This set of 8 mainspring winders for bracelet watches ranges in size from 5 mm to 10 mm. They are a necessity for the watchmaker who works on small watches. There is no practical substitute for a mainspring winder.

MAINSPRING COILING PLIERS



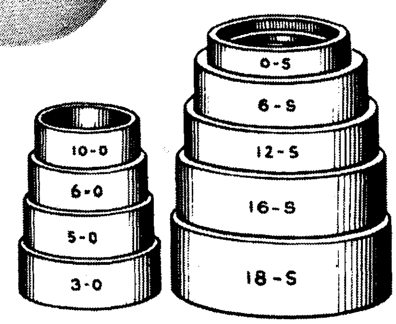
These pliers, with a specially designed end, are used to adjust the inner coil of a mainspring to fit the arbor. Slight alterations can be made with a pair of heavy tweezers if care is used not to snap off the end.

MICROMETER



The illustrated metric micrometer is graduated in 1/100 of a millimeter. This is a must item for the beginner as well as the professional. Practically all working parts of a watch are gauged in hundredths of a millimeter.

ASSEMBLY BLOCKS



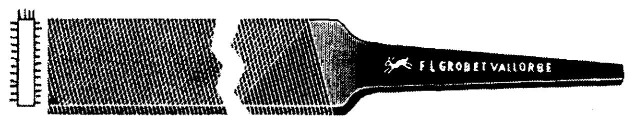
The assembly block is a cylinder used to hold the movement while working on it. The illustrated set is of plastic and ranges in size from 7-3/4 lignes to 18 size.

HAND REMOVER

This tool is designed to remove the hands of a watch without damage to the dial. Some of the old time watchmakers use two small screw drivers to pry up the hands while protecting the dial with either celluloid or watch paper.

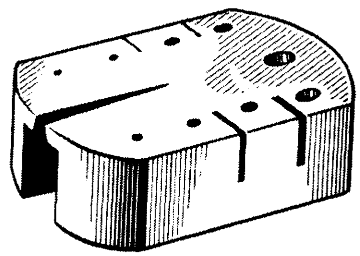
FLAT FILE

An ordinary file is in order around the watchmaker's bench. As a general rule, watchmakers have a variety of small files, but the reference here is to a flat file from six to ten inches long and with a medium cut.



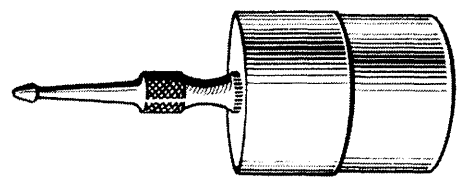
BENCH BLOCK OR ANVIL

This steel block has various size holes and slots to support different parts of the watch on which work is being done.



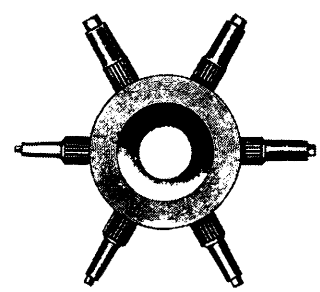
BLOWER

Used to blow off particles of lint or for drying certain parts of the watch, such as the balance and pallet fork. Not an essential item for the beginner, but a must for the professional. The beginner may substitute a small rubber syringe which can be purchased in a drug store.



JEWEL PUSHER

This tool is used to push out jewel settings such as a cap and balance jewel in setting. The tool has several size pushers to match different size settings. The beginner may use pegwood cut to the required size.

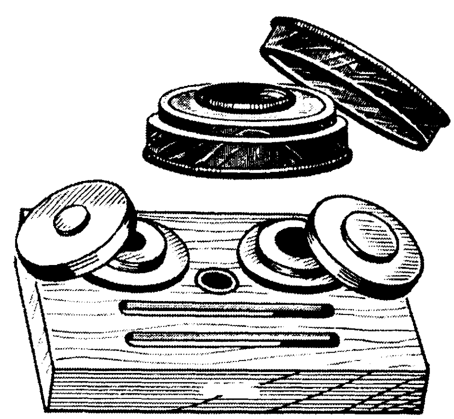


OIL CUP

Watchmakers use a small covered receptacle to hold oil. Only a little oil should be kept in the cup at a time and the cup should be cleaned frequently. The watchmaker should have at least three oil cups:

1 for clock oil
1 for regular watch oil
1 for bracelet watch oil

The beginner may be able to obtain small glass salt cups for this purpose.



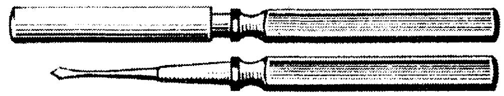
HARD WATCH BRUSH

This brush is used in the hand method of cleaning watches to scrub plates and other parts. It is made of materials that will not set up a chemical reaction in the solutions, which might cause corrosion.

SOFT WATCH BRUSH

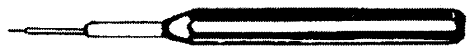
Used to remove any particles of dust or lint that may settle on the parts of the movement after cleaning. This brush should not be used after the movement has been assembled due to the presence of oil and the possibility of smearing it.

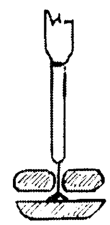
WATCH OILERS



Used to oil the parts of the watch. They are usually made of steel or nickel ground to a diamond-shaped tip. They are available in a variety of sizes, the smallest being used to oil those parts requiring the smallest amount of oil, and so on. The beginner may make his own oilers from needles. The illustration shows the shape of the tip.

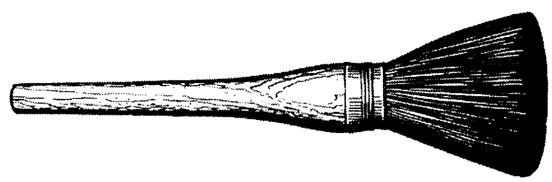
OIL INSERTER





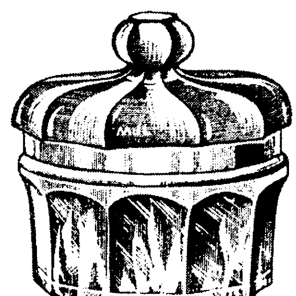
This tool is used to induce oil through the balance hole jewel onto the cap jewel. The beginner may make one by reducing a fine piece of steel such as a needle to a very fine point, approximately 5/100 mm.

DIAL BRUSH



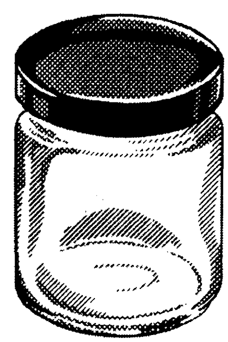
Used to brush off the dial after the movement has been assembled as well as to remove any dust or lint before casing the movement.

ALCOHOL CUP



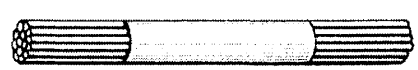
Used by the watchmaker as a container for alcohol, benzine, naptha, and so forth. These are solutions used in cleaning. The alcohol cup is usually fitted with a ground glass top, which retards evaporation. The beginner may use any small glass jar.

GLASS JARS



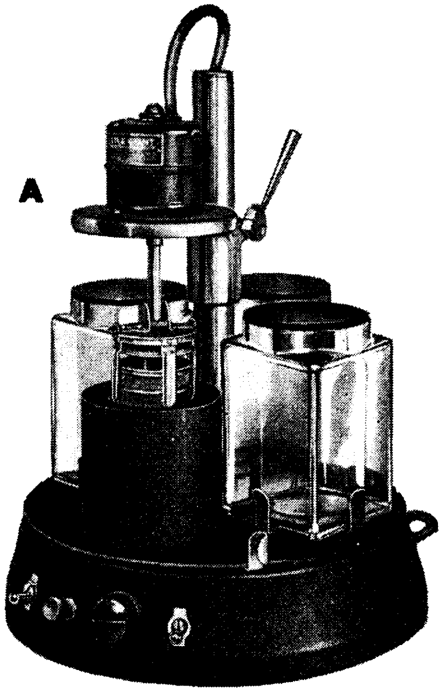
These pint jars hold cleaning solutions. The beginner may use mason jars or any other good substitute so long as there is not a rubber seal on the jar. Cleaning solutions will cause rubber to dissolve and contaminate the solution.

BRASS WIRE



Used to string parts for hand cleaning. Also used in lathe work.

A



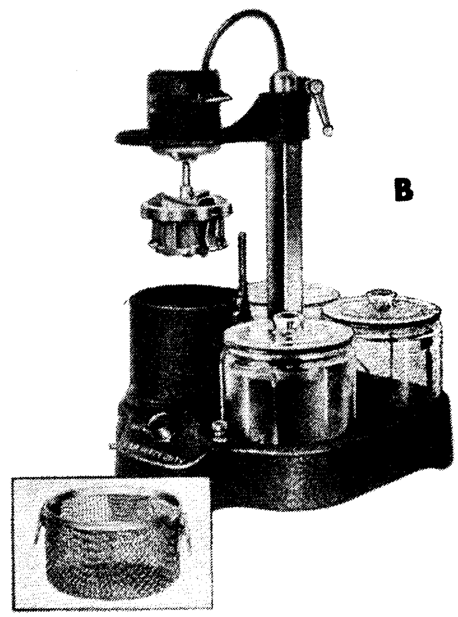
CLEANING MACHINES

Cleaning machines are a modern, time-saving device used to clean watch parts. They are generally found in the best shops; and, when properly used, have increased the profits of the repair department.

When first introduced, there were some claims that the watch need not be taken apart for cleaning. This brought quick condemnation from expert watchmakers and, for a while, the machine was not accepted in the trade. Nonetheless, as with everything that has merit, it was gradually adopted by watchmakers who began to use it properly and found it produced excellent results. It remains a fact, however, that any machine in the hands of an indifferent workman will not produce the best results.

There are many good machines on the market. They are all similar in that the watch must be completely disassembled, the parts placed in a basket which is attached to the machine, run through a series of cleaning and rinsing solutions, and then dried.

Some machines have a built-in electric dryer. They differ in the amount of automatic operation. Some have automatic reversing in which the basket moves automatically from one solution to another, and will clean as many as three watches at a time. The choice of a machine and solutions will depend on the needs of the individual.



B

C

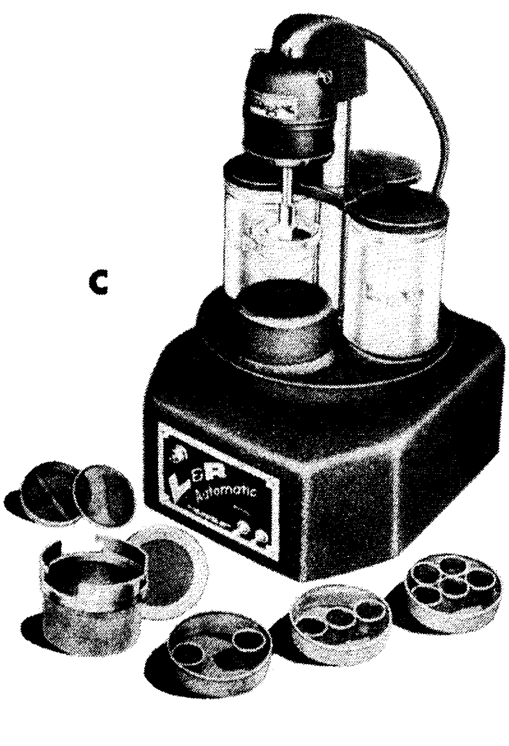


Figure A is a general all-purpose cleaning machine electrically-driven, with a revolving base. It illustrates the four-section wire basket in place. This type of machine is generally recommended for the average watchmaker.

Figure B is a heavy duty machine, used in production work. It will clean three separate movements at one time. It also features a basket for clocks.

Figure C is a fully automatic watch cleaning machine. After the basket has been placed in the machine and the machine started, it automatically takes the parts through the cleaning and rinsing solutions and dryer.

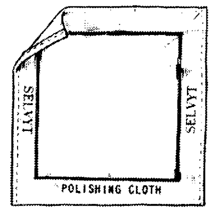
WATCH OIL

A fine grade animal or fish oil is used to lubricate the moving parts of a watch.

OILSTONE POWDER

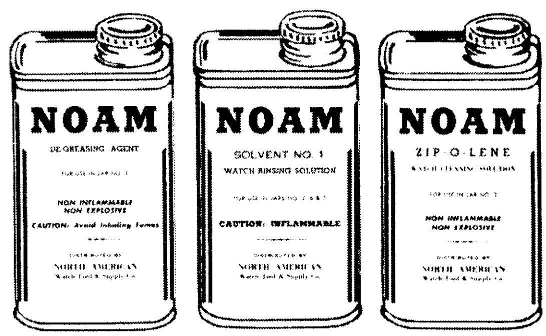
This abrasive powder is used in finishing metal. It is mixed with oil into a paste. When applied to a grinding slip, it may be used to grind pivots or other steel surfaces.

SELVYT CLOTH



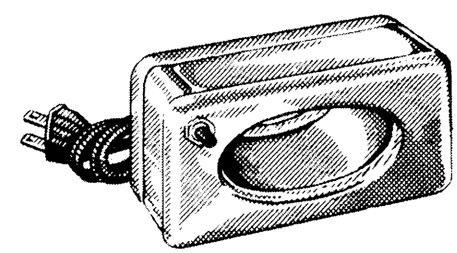
This type of cloth is used by watchmakers and jewelers in handling watches and jewelry to keep it free from finger marks. It is a lint-free, washable cloth.

CLEANING AND RINSING SOLUTIONS



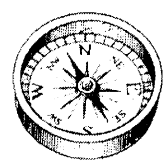
There are many commercially prepared cleaning and rinsing solutions in use. They are alike in this respect: they remove the old oil, clean and brighten the parts, and dry without leaving any sediment. Many watchmakers prepare their own solutions, using formulas that have been found to give satisfactory results.

DEMAGNETIZER



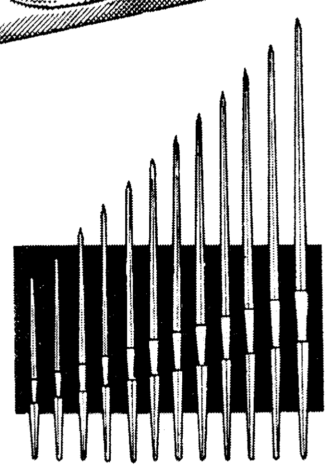
This is an electrical device used to remove magnetism from a watch movement. It is a desirable piece of equipment, for there is no other convenient method of demagnetizing.

COMPASS



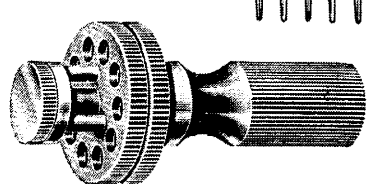
A small magnetic compass is used to detect magnetism in a watch.

LARGE BROACHES



These are tapered cutting tools designed to enlarge holes. They are usually made up in assortments of different sizes. They are used in fitting hands to movements and similar jobs.

HAND BROACHING DEVICE

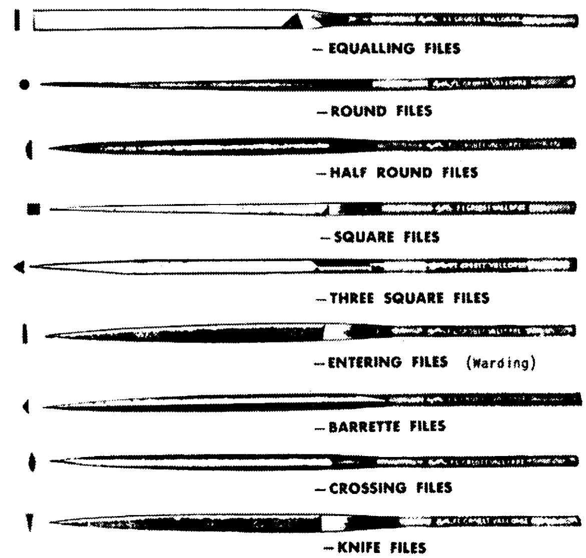


This vise-like device is used to hold hands while they are being broached.

NEEDLE FILES

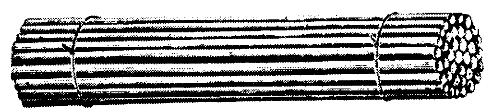
These are small, fine-cutting files that come in a variety of shapes. They are used on many jobs requiring fine work, such as fitting and shaping of regulator pins.

The first five files illustrated are the ones most commonly used by the watchmaker.



PEGWOOD

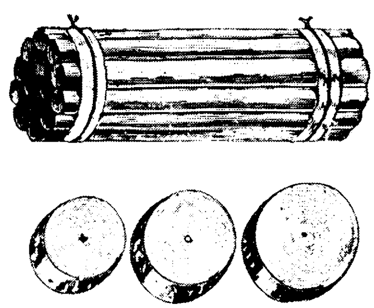
These are round sticks of Dogwood used for cleaning purposes. They are usually obtained from France. Pegwood comes in three sizes: small, medium and large. The last is usually called "clock pegwood" because its main use is for clock work. The medium size is more commonly used by the watchmaker. The smallest size is handy for tiny bracelet watches.



Pegwood can be sharpened to a point like a pencil. It is used in cleaning to reach hard-to-get-at places, such as pinion leaves. It can also be wet with naptha and used to peg out pivot or jewel holes. Cut to size, it can serve the beginner as a jewel pusher.

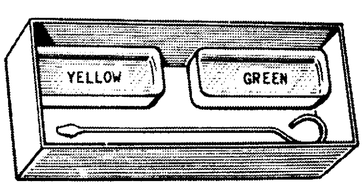
PITHWOOD

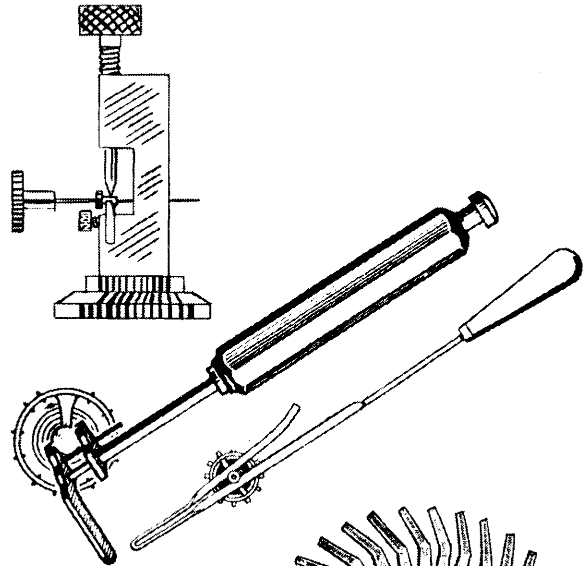
A soft, sap-free wood from the center of Elder tree branches. The watchmaker finds many uses for it. The sponge-like nature of the wood allows delicate parts to be pushed into it without damage. One use, therefore, is to clean oil from pivots before inspection. Another is to hold wheels, pinions and staffs while they are being measured or examined. Fine pointed tools, watch hands, and so forth can also be stuck into pithwood for safekeeping.



LUMINOUS PAINT KIT

A compound which may be used to refinish luminous hands. The mixture has a wax base and comes in a paste form. It is applied to the hands with a metal applicator, which has been warmed and dipped into the pan of paint. The heat causes a small amount of paint to stick to the applicator and melts the paint enough to flow it onto the hand while still warm. If the result is uneven, it may be trimmed with a knife blade.



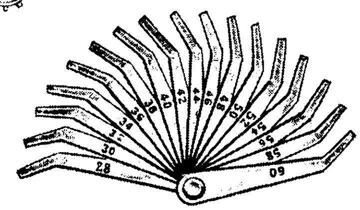


CANNON PINION TOOL

Used to tighten a cannon pinion. There are other methods used to close or fit a cannon pinion but the cannon pinion tool is considered the most practical and safest method.

ROLLER JEWEL SETTER

Used to hold and conduct heat to the roller table in order to set or make adjustments to the roller jewel.



ROLLER JEWEL GAUGE

A feeler gauge used to measure the pallet fork slot to determine the proper size of roller jewel.

TIMING WASHERS

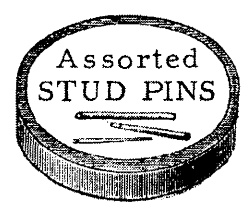
These are small brass washers used in poising balance wheels and timing of watches. They come in assortments, and are segregated in sizes and weights to fit the different sizes of watches. The weight is designated by a listing of the approximate amount of time it will alter a watch, such as 1 minute, 2 minutes, etc. This listing refers to a pair of washers placed on opposite screws near the neutral point on the balance wheel rim.

GENUINE AUNES
For American and Swiss Watches

COMPLETE ASSORTMENT No. 5
TIMING WASHERS
From 3¾ Ligne to 18 Size

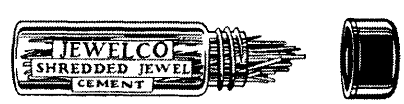
Bottle	Ligne	Min.	Bottle	Size	Min.
47	3¾	2	57	10/0	1
48	4¼	1	58	10/0	2
49	4¾	2	59	0	1
50	5¼	1	60	0	2
51	6	2	61	6	1
52	6½	1	62	6	2
53	7		63	12	1
54	8		64	12	2
55	9		65	16	1
56	10		66	16	2
			67	18	1
			68	18	2

STUD PINS



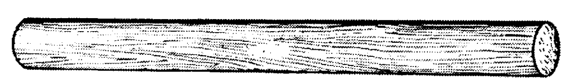
Small tapered brass pins used in studding hairsprings. May also be used in replacing regulator pins etc.

SHREDDED SHELLAC



This shellac is used in cementing roller jewels.

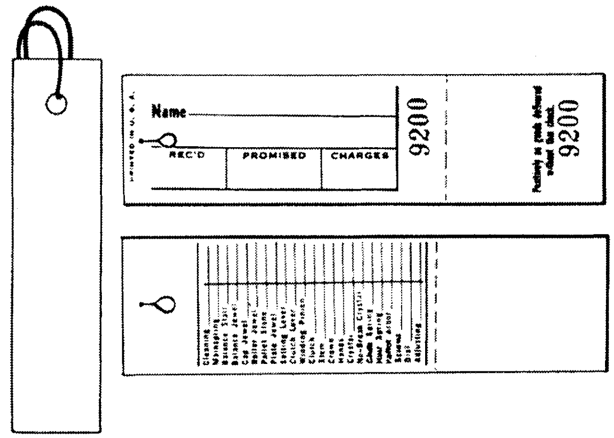
STICK SHELLAC



Used with the lathe in cementing jewel settings, staffs, etc. This cement may also be used for setting roller jewels if you have no shredded shellac.

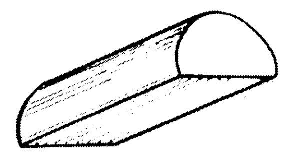
WATCH TAGS

Tags are used by a watchmaker to identify a customer's watch during repair. These tags may be plain, in which case you will fill in the desired information, such as name, date, charge, and so forth. More elaborate tags include a tag number, space for explanation of work performed, and the like. Tags are excellent for the beginner to use in recording repairs made in his practice work.



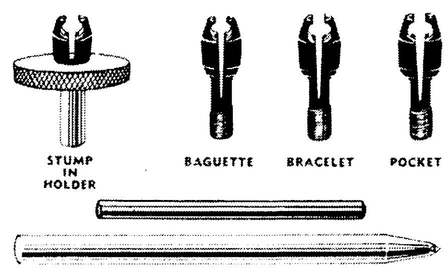
ROLLER JEWELS

When doing repair work it is desirable to have an assortment of roller jewels in a complete range of sizes, including both short and long jewels to fit both single and double rollers. The "D"-shape jewels are the most commonly used. They are gauged in 1/100 mm.



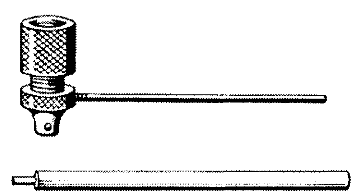
ROLLER REMOVER

This tool is used to remove roller tables and is designed for use with a bench block or staking tool. See page 22.



STAFF REMOVER

This tool is designed for use with the staking tool and is used for removal of riveted balance staffs. See page 22.

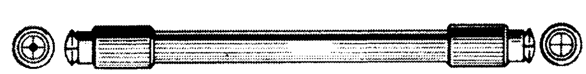


PIVOT ROUNDER

This small tool is fitted with a sapphire end which is placed over the bent pivot. Revolving the rounder between the fingers forces the pivot back to its original position. It also removes burrs and polishes the pivot.

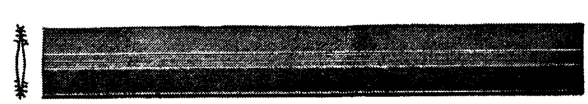
PIN VISE

A small hand vise is used to hold small objects, such as a stem, needle, and similar items.



SCREW HEAD FILE

A very fine-cutting, knife-edge file used to cut the screw driver slot in the head of a screw. It is also used to shape regulator pins and the like.



FRICTION JEWELING TOOLS

This tool is used to ream, press in and make adjustments to friction jewels. If the jewel to be replaced is a friction jewel, you need only press out the cracked or otherwise damaged jewel, determine the size of the hole (if the hole is not damaged), press in a friction jewel of the proper diameter and pivot hole size and adjust for proper end-shake. If the hole has been damaged, you should ream it with the next size reamer and then press in the proper size jewel.

In replacing other types of jewels with friction jewels, a more thorough knowledge of jewels and jewel settings is needed. This additional information can be found in Lessons in Master Watchmaking 12, 13 and 14.

BASIC SET

The basic set will usually consist of the following:

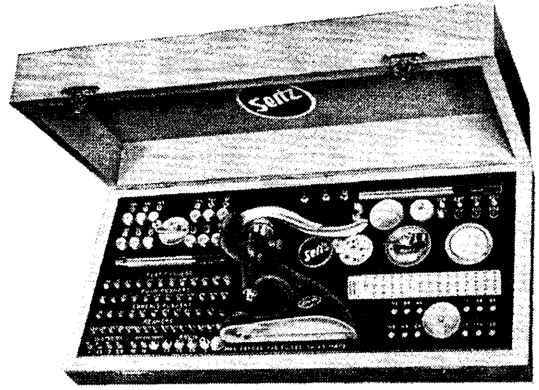
- Friction jeweling tool (with micrometer adjustment to control depth)
- Reamer holder
- Reamers (12 to 15)
- Pusher holder
- Pushers (12)
- Anvils (5)

COMPLETE SET

The complete set will usually include in addition to the basic parts:

- Concave pushers
- Pump pushers
- Hole reducing punches
- Set of tools for setting friction pallet arbors.

DELUXE SET



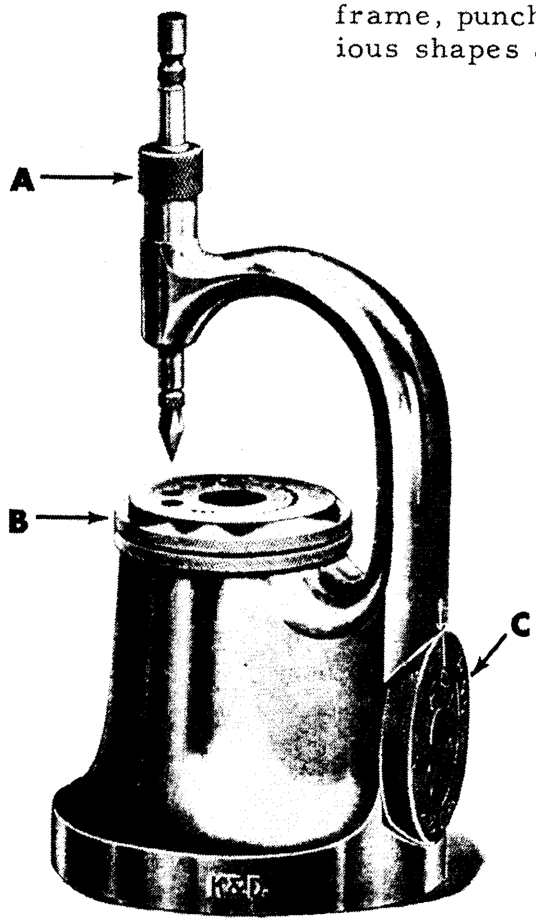
The deluxe set will usually include in addition to the parts listed above:

- Grinding stone (for refacing pushers)
- Holder for jewel settings
- Face plate with additional clamps
- Set of centering points
- Set of pushers and anvils for setting hands.
- Handle with set of chucks
- Tool for straightening pivots
- Pivot gauge
- Uprighting pump tool

THE STAKING TOOL

The staking tool is a tool of many uses, such as, removing and replacing a balance staff, closing pivot holes, removing or replacing pinions, replacing hands, replacing a hairspring, etc. With a few exceptions the following information will apply to all staking tools.

The staking tool consists of the following parts: the staking frame, punches in various shapes and sizes, and stumps in various shapes and sizes.



STAKING FRAME

STAKING FRAME

The punch guide A is aligned with the die plate B so that the punches will always be perpendicular to the die plate. The die plate may be turned so that any hole may be aligned with the punch. Turning the knurled wheel at C will lock the die plate in any desired position. The holes in the die plate are gauged and centered and give you the right spread of sizes from small to large.

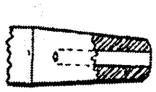
STAKING PUNCHES

Practically all work on the staking tool will require that the proper hole in the die plate be aligned with the punch. The centering punch serves this purpose.

CENTERING PUNCH

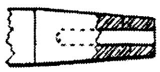
First determine the hole in the die plate to be used. Then insert the centering punch through the punch guide into the hole in the die plate and lock the die plate in position before removing the punch.

ROUND FACED HOLLOW PUNCH



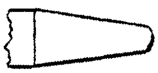
Its most common use is in staking balance staffs. After the die plate has been centered, the staff with wheel in place is placed in the die plate, and a round faced hollow punch of a size just slightly larger than the collet seat is used to spread the rivet on the staff.

FLAT FACED HOLLOW PUNCH



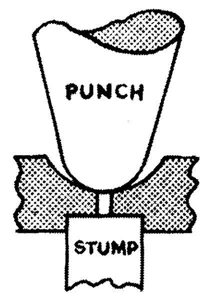
Used for finishing the riveting of balance staffs. After using a round faced hollow punch to spread the rivet, a flat faced hollow punch of the same size hole is used to finish off the top of the rivet. This punch has many other uses, such as pressing the hair-spring collet on the staff, hands on watches, and the like.

ROUND FACED SOLID PUNCH



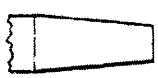
Generally used for closing pivot holes etc. The proper size of punch to use is determined by the size of the oil cup and should fit as shown in illustration A. The bottom of the plate should be properly supported with a stump or inverted punch and if there is a recess as shown in illustration B, the stump should be of a size which will fit the recess. This punch has a variety of other uses such as closing the hole in a minute hand, closing the hole on a single roller, and so forth.

A



B

FLAT FACED SOLID PUNCH

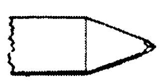


Generally used as an inverted stump.

HOLLOW TAPER MOUTH PUNCH

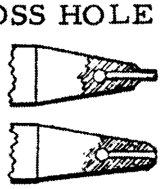
Used for closing holes, such as hour hand, and for closing collets, etc. Use care in selecting the proper size of punch.

STAR PUNCH



Sometimes known as the triangular point punch. It is used to close the hole in rollers by raising small burrs equidistant around the edge of the hole.

CROSS HOLE PUNCHES



Used in removing and replacing Waltham friction staffs. These punches are designed to fit over the pivot and rest on the cone rather than against a shoulder.

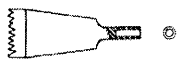
ROLLER DRIVING PUNCH

This punch was designed to replace single rollers. It is a flat face hollow punch with a slot cut in the edge to accomodate the roller jewel. Modern methods of replacing a roller do not require the use of this punch.

SCREW KNOCKING PUNCH

This punch is designed to drive out a screw which has been broken off in the plate. This is practical only if you have an oversize screw available and also a tap of the proper size to cut new threads, as the old threads will be stripped. The more practical method of removing a broken screw is to use an acid solution which will dissolve the steel screw and leave the brass or nickel threads intact.

INCABLOC ROLLER PUNCH

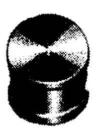


This punch is designed for use in replacing an incabloc roller. The incabloc roller has a raised edge on the bottom. This punch fits within this edge and so minimizes the possibility of damage to the roller.

STUMPS

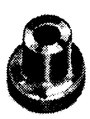
The manufacturers have done little to modernize their assortment of stumps. In most staking sets may be found stumps no longer in common use, as more modern tools and methods have been devised. Using the inverted style of tool, any of the punches can be turned over and used as stumps.

FLAT FACE SOLID STUMP



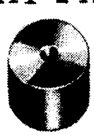
This type of stump has a variety of uses. Most staking sets have several of these stumps in different sizes. They may be used any time a flat solid surface is desired.

FLAT FACE HOLLOW STUMPS



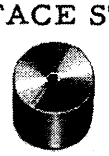
Most staking sets are equipped with these stumps in a variety of sizes. They may be used to support a plate when drilling, broaching, etc.

FLAT FACE TAPERED HOLLOW STUMPS



Used to support the hub on a Waltham friction type balance when the staff is being removed.

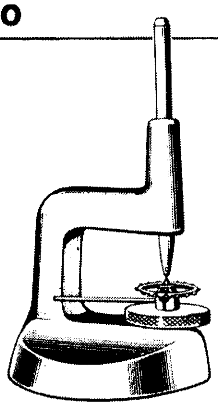
FLAT FACE STRAIGHT HOLE STUMP



Used to support a Waltham friction staff while the wheel is being staked on.

ROLLER REMOVING STUMPS

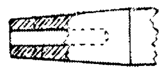
These stumps were designed for use in removing roller tables. More modern tools and methods have been devised to remove rollers.



A PRACTICAL STAKING SET for Beginners

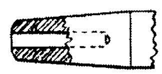
This set consists of a small, solid base frame, ten punches, five stumps, plus a reamer holder, reamer, and jewel pusher for friction jeweling. The various pieces are all standard size and may be used in other staking sets. Additional punches, stumps or attachments, such as a roller remover (illustrated), can be added.

FLAT FACED HOLLOW PUNCHES



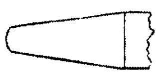
This type of punch is used to replace wheels on pinions, and to finish the riveting on balance staffs. It is a very versatile punch.

ROUND FACED HOLLOW PUNCHES



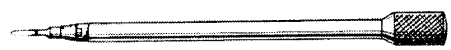
Round faced hollow punches are most commonly used to rivet over the countersinks on balance staffs and pinions.

ROUND FACED SOLID PUNCHES

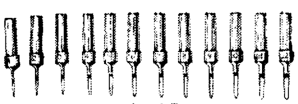


This type of punch is used for peening (flattening or spreading metal) and for closing holes in plates or bushings.

REAMER HOLDER AND REAMER



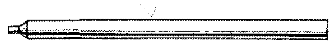
The reamer holder and reamer are used in friction jeweling. They will fit all standard staking frames. Reamers for this holder are available in the following sizes (millimeter measurement):



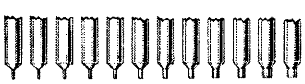
12 Fine Steel Reamers

.69	.99	1.39	1.79
.79	1.09	1.49	1.99
.89	1.19	1 59	2.29

FRICTION JEWEL PUSHER



This pusher is made with end sizes as listed below, which enables the watchmaker to remove, replace and adjust friction jewels and bushings, or to remove and replace balance hole and cap jewels in settings. Pushers can be made from 3/16 inch (4.7 mm) round steel stock, which should be hardened and tempered to a blue. These end measurements are in millimeters.



12 Polished Steel Pushers

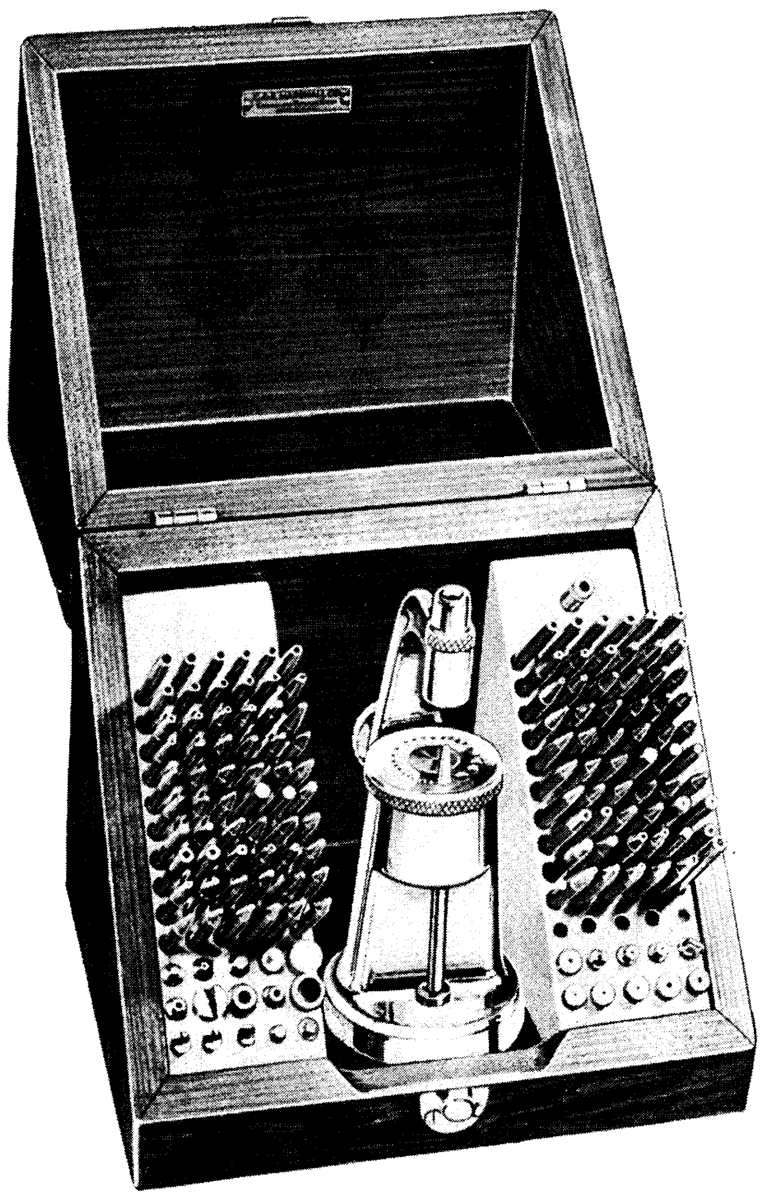
.55	.85	1.30	1.85
.65	.95	1.50	2.10
.75	1.05	1.60	2.65

STUMPS

Stumps are useful when milled or recessed surfaces are to be worked on. The base of the frame is drilled to accomodate the stumps, as well as other attachments, such as a roller remover, which also can be used on the frame.

WATCHMAKER'S STAKING SETS

The professional watchmaker's staking set usually contains from 80 to 120 punches and 20 stumps. More punches allow a greater variety of sizes to be handled. This is important to the watchmaker who has to work on many different makes of watches. Having the proper size punch readily available will speed up the work. For the beginner who intends to follow up watchmaking as a career, this investment should be carefully considered. The set illustrated here has 120 punches and 25 stumps and can be equipped with a friction jeweling attachment. The punches can be inverted as illustrated. As shown in the table below, it is also possible to start with a smaller set and add other punches as necessary or as you can afford them. A staking set will last a lifetime, if given average care.



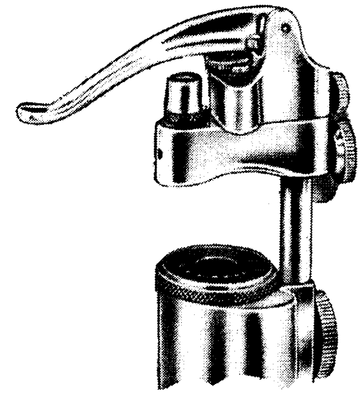
Staking tool sets can be purchased in different combinations, the most common of which are listed below:

	133	punches	25	stumps
	120	"	20	"
*	100	"	20	"
*	80	"	20	"
	60	"	12	"
**	48	"	8	"
**	36	"	6	"
**	24	"	4	"

* These sets come in boxes drilled for 120 punches and 30 stumps. Thus, you can add punches and stumps to these sets at any time.

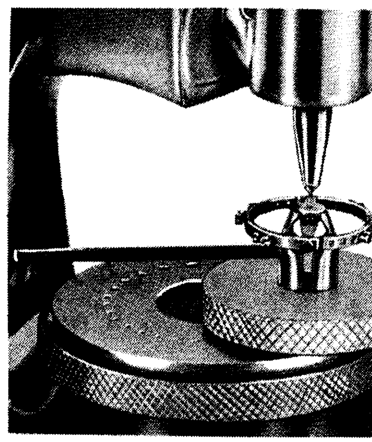
** These sets come in boxes drilled for 60 punches and 15 stumps, enabling you to add punches and stumps to these sets at any time. They are useful starter sets.

FRICTION JEWELING ATTACHMENT



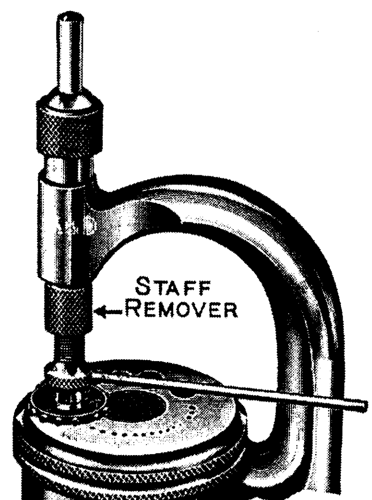
Many manufacturers of staking sets also make a friction jeweling attachment to fit the staking frame. It is more desirable to have a separate friction jeweling tool, but for those doing watch repair as a hobby or side line, this attachment will take care of most needs. With the attachment are included reamers, reamer holder and pushers. This attachment may be permanently attached to the staking frame without interfering with normal use of the tool.

ROLLER REMOVER



This tool, used in the removal of single or double rollers, is designed for use with the staking tool. The illustrated tool has three adjustable stumps in different sizes which allows the tool to be used to remove rollers in practically any size watch.

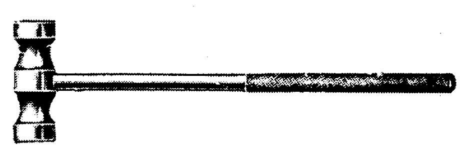
STAFF REMOVER



This tool, also designed for use with the staking tool, is used in the removal of riveted balance staffs. The staff and wheel are placed on the die plate in a hole just large enough to accommodate the hub of the staff. Using the screw adjustment on the staff remover, the arms of the wheel are pressed down firmly against the die plate, thus preventing the arms from bending when the staff is driven out.

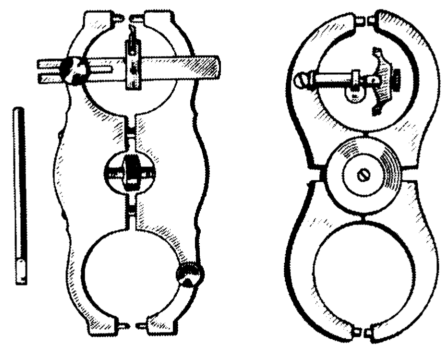
(A more desirable method than this of removing a balance staff, is to place it in a lathe and cut away the hub. This method minimizes the chance of damage to the wheel.)

BRASS HAMMER



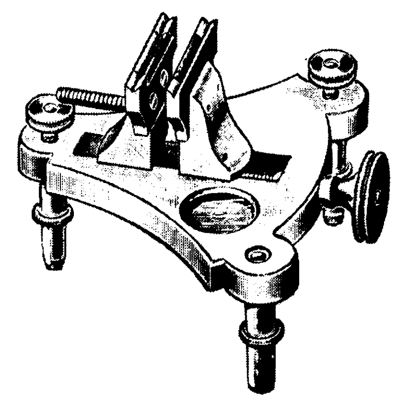
This brass hammer is used with the staking tool. A steel hammer should never be used as it will damage the punches. About 3 oz. weight is the proper size hammer.

TRUING CALIPERS



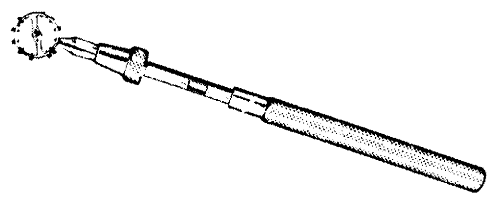
A tool in which to place a balance wheel to check for truth in round and flat and make the necessary adjustments. Two types of calipers are illustrated; one with a screw adjustment to open and close, and the other which works with hand pressure. Each tool has a moveable indicator and a wrench to make adjustments of the arms of the balance.

POISING TOOL



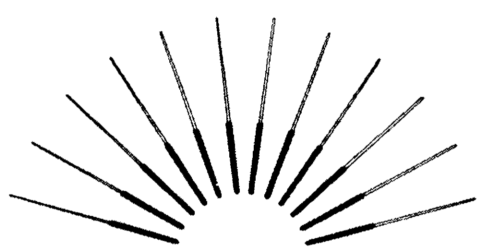
This tool is used in checking the poise of a balance wheel. The one shown has three legs. Two of these are adjustable so as to level on your working surface. The jaws are of highly polished sapphire or ruby jewels. With general use and care, these jaws will never need refinishing. The adjustable jaws make it possible to use this tool for any size of balance. Poising tools also come equipped with highly polished steel jaws and this type is equally serviceable if the jaws are kept highly polished.

BALANCE SCREW HOLDER



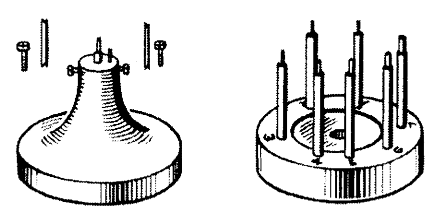
This tool is used to hold and remove a balance screw after it has been loosened with a screw driver. Undercutting to remove weight can be done after removing the screw from the holder while timing washers may be added without removing the screw from the holder.

PIVOT BROACHES



These come usually in assortments of twelve and are available in sizes to correspond with the smallest pivots. They are used to broach or clean pivot holes in train bushings or plates.

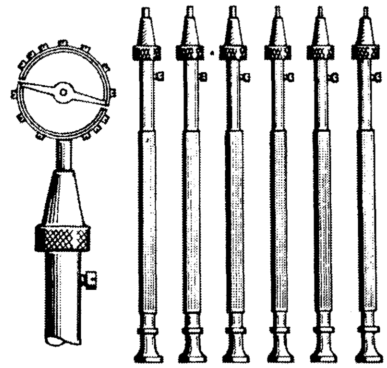
UNDERCUTTERS



Used to remove weight from a balance screw by cutting from the under side of the screw head. A set ordinarily has the variety of sizes necessary to undercut the different size balance screws.

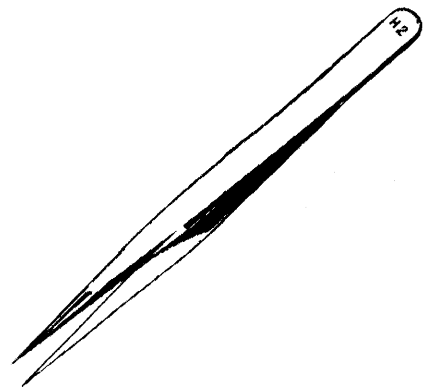
BALANCE SCREW CUTTERS

This is a Swiss type balance screw cutter used to remove weight from the balance wheel. It cuts a cone in the head of the screw without taking the screw from the wheel. The preferred method is to undercut with the lathe or the undercutting tool; however, many Swiss manufacturers use this type of cone cutter.



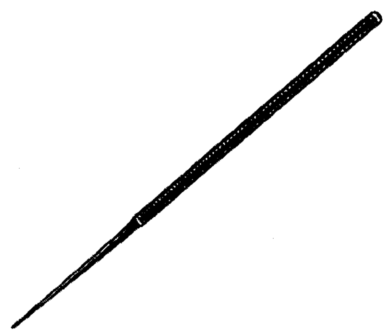
HAIRSPRING TWEEZERS

These are fine-pointed tweezers used only on hairsprings. Due to the delicate points it is not recommended that you use these tweezers for any other work. The tips are graded from very fine to coarse. Each manufacturer has a different system for designating the fineness of the tips. Usually the largest number will designate the finest tip. The beginner should start with a medium-fine tip and then add others as the need arises.



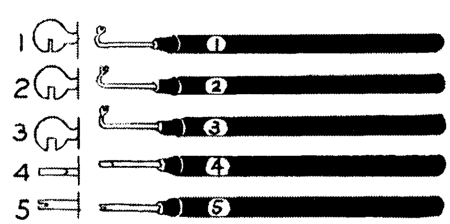
TAPER PIN

A steel pin used in working on hairsprings. It is mainly used as a holding tool for the collet and hairspring. It is tapered to a size that will accomodate all sizes of collets. You may substitute a broach or other tapered steel rod.



HAIRSPRING LEVELER SET

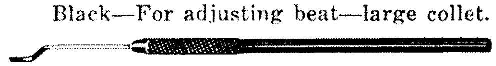
This set of five tools is designed to make adjustments to the hairspring while in the watch. It has three sizes of hairspring leveler tools, one tool for centering and one tool to adjust the regulator pins. These tools are not necessary for the beginner.



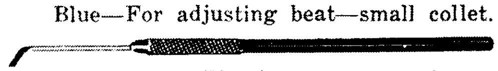
HAIRSPRING 'PIX'

This set of five tools is used in the manipulation of the hairspring. The illustration explains the use of each tool.

Black—For adjusting beat—large collet.

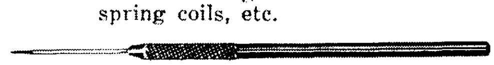


Blue—For adjusting beat—small collet.



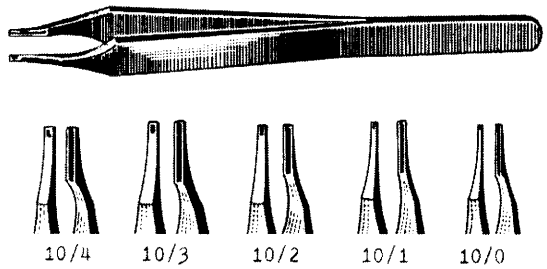
Green—For adjusting regulator pins.

Red—For needling overcoil and hairspring coils, etc.



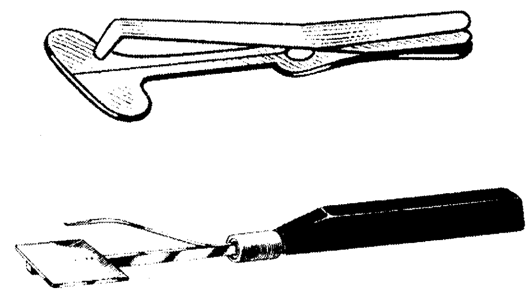
Yellow—For removing stud pins, curb pins, etc.

OVERCOILING TWEEZERS



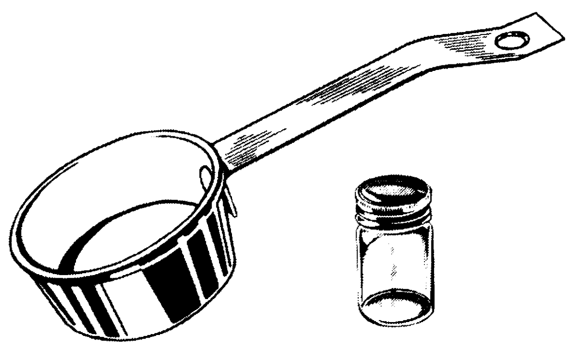
These tweezers are used to form the over-coil of a hairspring over the body of the spring. The illustrations show the different sizes of curved tips. 10/0 or 10/1 are recommended for general use. This tool is not essential for the beginner as the overcoil may be formed by using a pair of hairspring tweezers and a taper pin.

PALLET WARMER



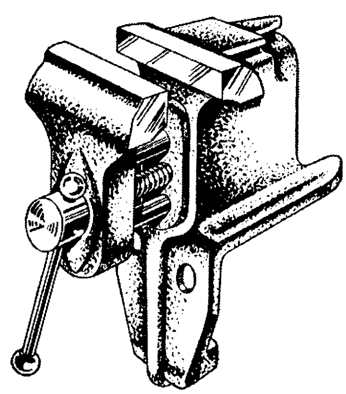
This tool is used to hold and apply heat to a pallet fork. The pallet stones are cemented into the fork with shellac. This cement will melt when heat is applied. Therefore, this becomes an essential tool whenever a pallet stone has to be adjusted or replaced. Heat should never be applied directly to the pallet fork, as direct heat will draw the temper from the steel fork and arbor. The part of this tool which holds the pallet fork is split to allow each pallet to be heated separately.

BOILING CUP AND BOTTLE



When ever it is found necessary to remove shellac from any part of a watch, such as the pallet fork, roller, etc., the recommended method is to boil the part in alcohol. The illustrated bottle with hole cut in cap is used to contain the part and alcohol (half full will be sufficient). A small amount of water is placed in the boiling pan, the bottle placed in the pan and heat applied until the alcohol boils sufficiently to dissolve the shellac. A low flame, such as an alcohol lamp, should be used to minimize the chance of igniting the alcohol fumes. Alcohol is highly inflammable.

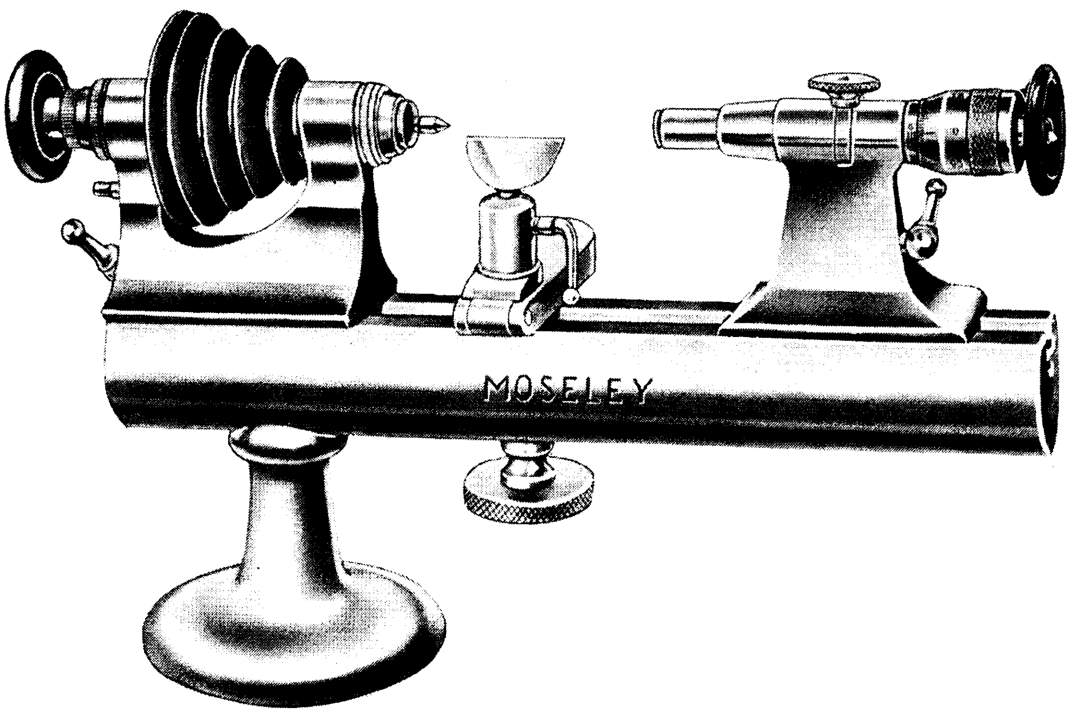
BENCH VISE



The bench vise has always been part of the watchmaker's equipment. It is used in the making or refinishing of tools and other small watch parts. The beginner will find it necessary to make certain tools which cannot be purchased, and so a bench vise should be a part of his equipment.

THE WATCHMAKER'S LATHE

The watchmaker's lathe is the most versatile tool at his command. With the lathe and its attachments, all manner of work can be done, from delicate, precision fitting of parts to making a complete watch, if need be. It enables the watchmaker to handle repairs he might ordinarily have to send out. And many jobs can be done in minutes with a lathe that would take hours to do by hand.



No simpler or more effective machine has yet been devised to do the multitude of jobs that the lathe can handle. Wheel cutting, jeweling, polishing, grinding pallet jewels, making balance staffs, opening wheels and jewel holes, uprighting, tapping screw holes, pivoting staffs -- these are but a few of the tasks that can be done efficiently on a lathe. Even though it is possible today to buy practically any part for any watch, many of these will need alteration to make a perfect fit. Alterations like changing the diameter of the roller seat, the collet seat, or the wheel seat on a balance staff can be done properly only on a lathe. As a result, the lathe is an investment that is well worth while. Even if used but a few minutes a day, it will repay its purchase price many times over. Properly used and maintained, the lathe will last a lifetime. It is considered a "must" tool for the professional.

THINGS TO LOOK FOR IN SELECTING A LATHE:

Choosing a lathe is largely a matter of personal choice and available budget, for today it is possible to find good lathes in almost every price range. However, price alone should not be the deciding factor, as accessories and minor features, such as finish, somewhat control the price. There are more basic things to look for:

The lathe bed should be of firm construction and preferably formed from a single casting. The head stock should be movable on the lathe bed, so the pulley can be aligned with the pulley on the motor. The pulley should be a step pulley to permit adjustment of speed and power desired. It should also turn freely, bearings should be fitted, and no end shake or side shake should be apparent. It should be possible to adjust the bearings.

The spindle should take standard size chucks and have a key way to assure each chuck fitting in the same position. Both lathe and chucks should run perfectly true.

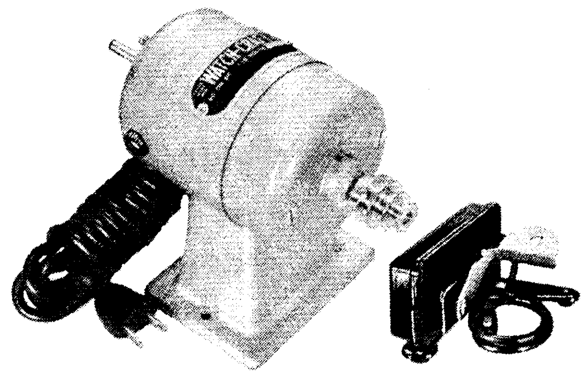
An index should be affixed to the pulley. An index is a circular plate with evenly spaced holes into which an index pin may be placed to lock the moving parts in any desired position. The lathe also should have a hinged or tip-over T-rest.

The tailstock is less used than formerly when the individual watchmaker had to make most of his parts himself. The beginner can postpone purchase of a tailstock. The professional usually acquires one in time.

There are many accessories that can be had for use with the lathe. A few are described in the following pages, but these are by no means all that are available. Some are necessities. Others are simply an added convenience on certain jobs and can be considered special-purpose tools in nature. The type of work habitually done as well as available funds will largely determine the worth of an accessory to the individual watchmaker. The beginner is advised to start with just the basic items and add others only as a need is felt for them.

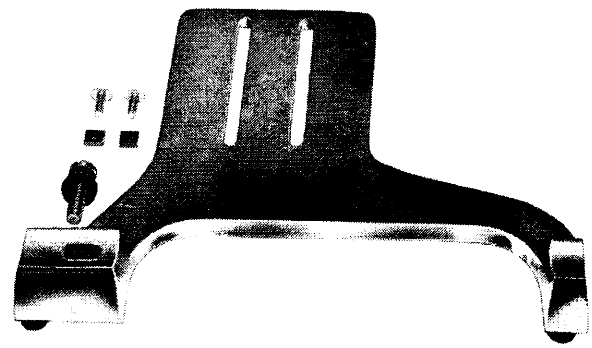
Space here permits but a hint on the selection and usefulness of the lathe and its accessories. For detailed information on its possibilities, we refer you to Ward Goodrich's authoritative book on the subject: "The Watchmaker's Lathe."

LATHE MOTOR



In years past the lathe was powered by a foot wheel. This may still be used in areas of the world where there is no electric power available. The modern method is to use a small, electric, reversible motor, about 1/10 horsepower, equipped with a foot rheostat to control the speed of the motor. It is best to select a motor designed for use with the lathe. The paint, enamel or chrome finish on the motor casing may somewhat control the price.

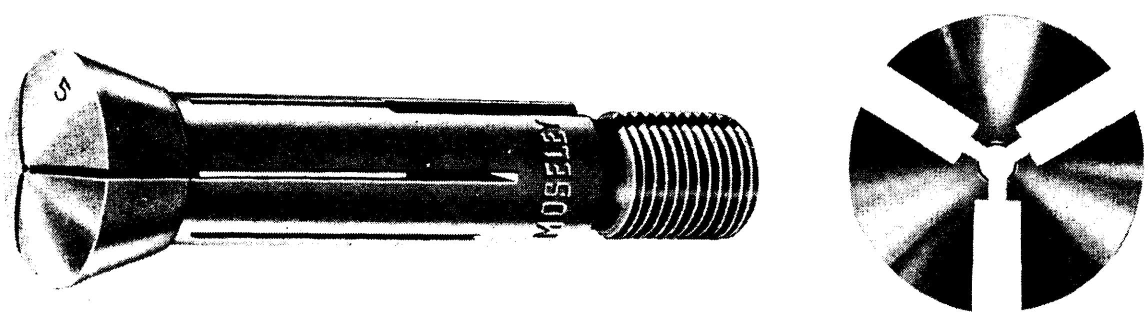
LATHE MOUNT



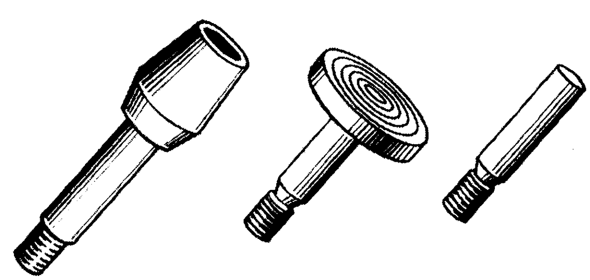
A portable lathe mount on which the lathe and motor are fastened is recommended for those who have no permanent working surface or who do not wish to mount the lathe and motor directly on the bench.

CHUCKS

Chucks are gauged in tenths of a millimeter. A number 20 chuck is twenty-tenths (20/10) of a millimeter. A No. 7 chuck is seven-tenths (7/10) mm., and so on. A beginner should have Nos. 16, 20, 32, and 40 chucks, plus a chuck for holding a cement brass. Other chucks may be added as the need arises. A chuck should be used only with metal stock of the same size, as spreading or compressing the jaws of a chuck will cause damage to the gripping surface and also cause the chuck to be off center.

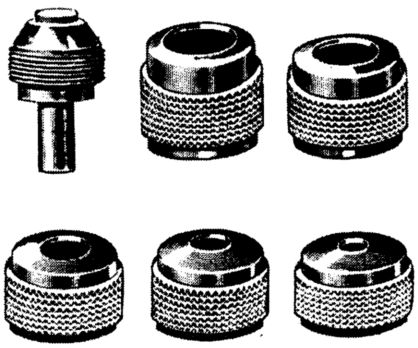


SCREW CHUCK WITH CEMENT BRASSES



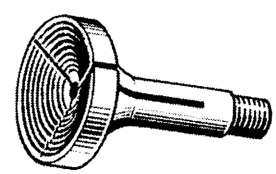
The cement brass is used on the lathe as a working surface for small parts that cannot be held in an ordinary wire chuck. The part, such as a jewel setting, is cemented and spun true on the cement brass.

CROWN CHUCKS



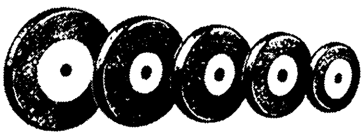
These chucks are used to hold crowns which have to be opened on the under side to fit over the pipe on the pendant of a case. They are designed primarily for crowns for pocket size watches. In lieu of this type chuck, as well as for smaller sizes, the crown may be cemented to a cement brass and the opening enlarged with a graver.

WHEEL CHUCK



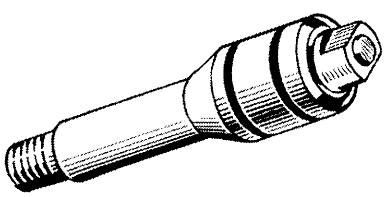
This chuck is used to hold a train wheel in the lathe when polishing pivots, and so forth. The chuck will hold more than one size wheel. This chuck grips the ends of the teeth and so care should be taken to use the proper size chuck and not apply too much pressure or the teeth will be damaged. This chuck need be used only when too little of the pinion extends past the wheel to be gripped with a wire chuck. Another method of setting up this wheel would be to cement it to a cement brass.

CARBORUNDUM WHEELS



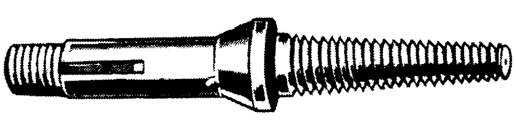
Small carborundum wheels can be mounted on an arbor chuck for grinding small steel work. When using these wheels on the lathe, take care to keep particles of carborundum from the bearings. Clean the lathe carefully after using carborundum.

ARBOR CHUCK



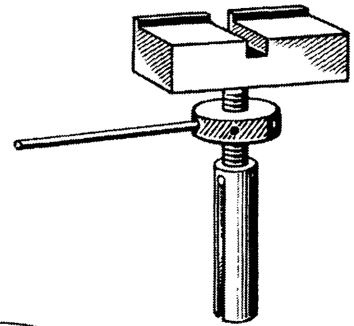
This chuck has a solid body and can be used to carry circular saws, wheel cutters, and the smaller size carborundum wheels.

BUFF CHUCK



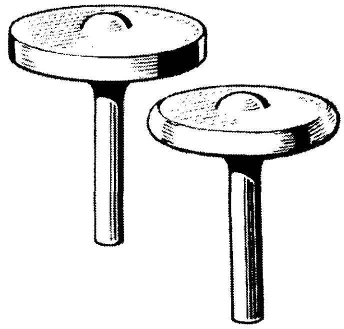
This solid body chuck has a tapered screw on which to mount polishing buffs. Buffing should be confined to small jobs and the same care should be taken of the lathe as when carborundum is used.

FILING FIXTURE



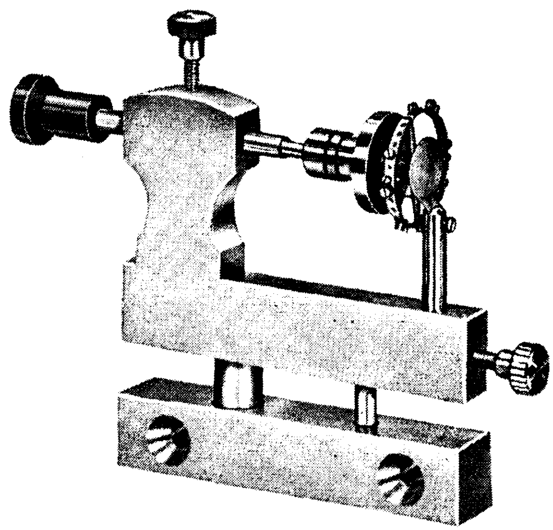
This fixture replaces the rest on your T-rest. It is used when filing across work held in the lathe, as when filing the square on a stem.

CARBORUNDUM WHEEL WITH ARBOR



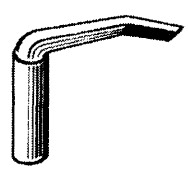
This type wheel comes in several shapes and grades. It can be had in hard Arkansas stone and Aloxite for grinding watch crystals. However, as mentioned before, it is not advisable to use grinding wheels to excess in your lathe.

PIVOT POLISHER



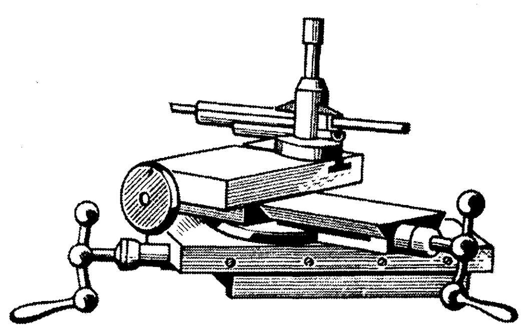
This attachment is mounted on the lathe and is used to hold pivots while they are being straightened, burnished, ground, or polished. It is adjustable to fit all balance staffs. The pivot to be worked on extends all the way through the end bearing plate.

"L" TOOL REST



This tool rest is used with the face plate. Its design will allow close adjustment to the plate.

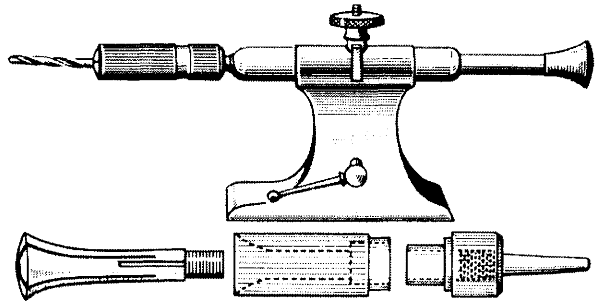
SLIDE REST



This lathe attachment is of little use to the average watchmaker of today. It has various uses for the watchmaker who specializes in making watch parts. It is also used by model makers.

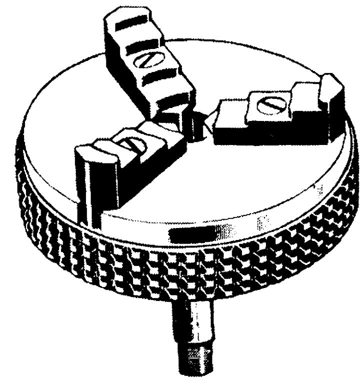
TAIL STOCK CHUCK HOLDER

This device is used to hold regular wire chucks in the tail stock. This is desirable when drilling so as to hold the drill in direct line with the work.



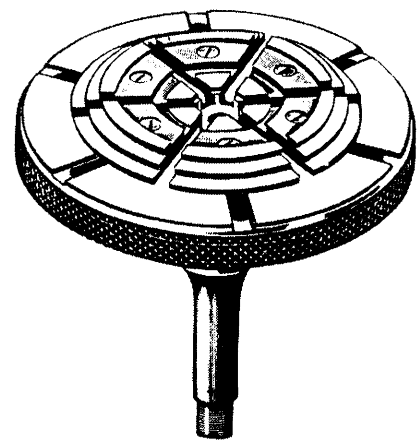
THREE JAW CHUCK

This chuck is used for heavier kinds of work. The jaws are adjustable and reversible. This chuck can be used for holding clock barrels and work by model makers.



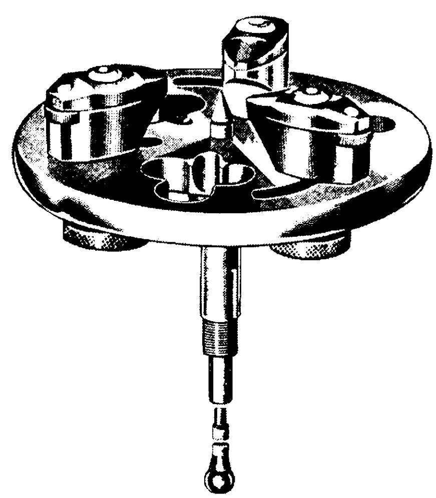
BEZEL CHUCK

This is a special chuck used primarily for holding bezels, either by the inner or outer edge.



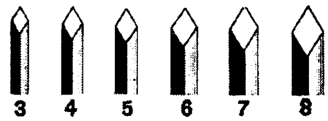
FACE PLATE

This lathe attachment is used to mount watch parts, such as plates, for uprighting a pivot hole. The jaws are adjustable, which allows free movement of the plate to any desired center.

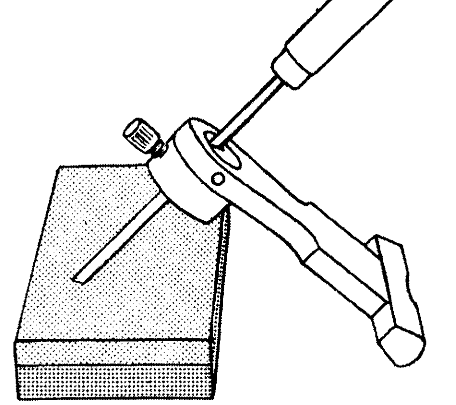


GRAVERS

The tools used for cutting on the lathe are known as gravers. They come in many shapes and sizes. The gravers most commonly used are the #4 or #6 square. It is essential that gravers be kept sharp.

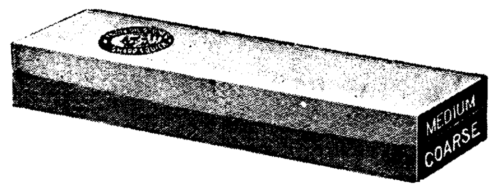


GRAVER SHARPENER



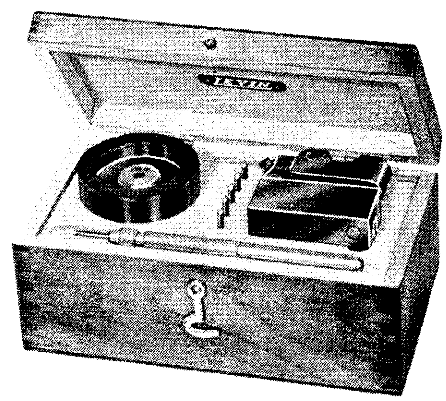
Gravers may be sharpened by hand, but it takes considerable experience to get the right result. An easier and more convenient method is to use a graver sharpener, which holds the graver in a fixed position during the sharpening process. The tool may also be used to shape the tip on a new graver or to reshape a broken tip. Engravers may likewise use this tool.

OILSTONE



For sharpening gravers, a combination oilstone with coarse and fine sides is reccommended. Kerosene or light machine oil should be used on the stone at all times.

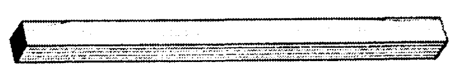
CARBOLOY GRAVER SET



This carboloy steel graver set is used on hardened or tempered steel, as when cutting out balance staffs from the balance wheel. When the gravers need sharpening, they must be ground on a special diamond-impregnated wheel. A set usually includes blades, handle, lap wheel, and compound.

BOXWOOD SLIP

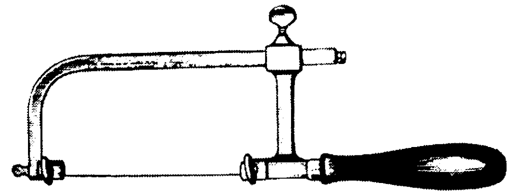
This slip is a hard, almost grainless wood used to polish pivots. Polishing compound, such as diamantine or rouge, is applied to the slip. Full explanation of the use of the boxwood slip will be found in Lesson 31, Master Watchmaking.



PIVOT BURNISHER

This tool is used to burnish a pivot, remove burrs and so forth. It is a very hard steel with a slightly rough surface. No grinding or polishing compound is ever used on this tool. When used as illustrated and described in Lesson 31, Master Watchmaking, it will compress, harden and close the pores in steel, thus giving it a smooth, hard and polished surface.

JEWELER'S SAW FRAME

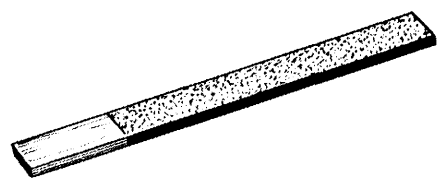


A saw frame designed to hold saw blades that are used to cut metal.

JEWELER'S SAW BLADES

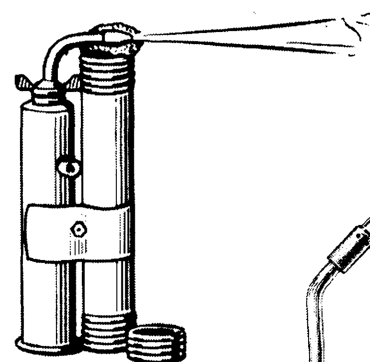
For use in jeweler's saw frame. They are made of narrow, tempered, flexible steel wire into which teeth have been cut. The teeth in a jeweler's saw should point toward the handle of the saw frame. The sizes are 5-4-3-2-1-1/0-2/0-3/0-4/0-5/0-6/0-7/0-8/0. The most useful size to the watchmaker is No. 2.

EMERY BUFFS



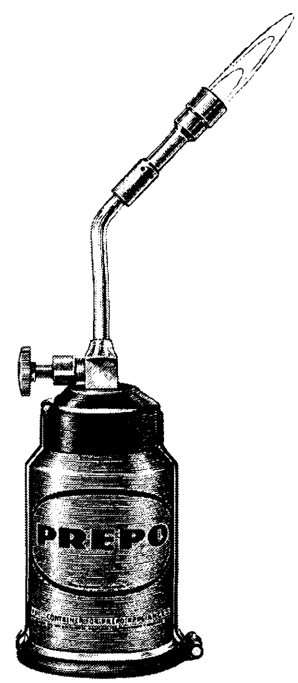
These are small strips of wood covered with abrasive cloth or paper. They are graded from coarse to fine grit: 2, 1, 0 2/0, 3/0, 4/0. They are used to polish steel surfaces by starting with the coarse buff and working to the fine ones.

ALCOHOL TORCH



All watchmakers will at some time need to harden and temper a piece of steel. The beginner will find it advisable to practice hardening and tempering steel to make pivots, etc. A small torch will usually supply enough heat to harden properly. The beginner may use any gas flame that will give sufficient heat.

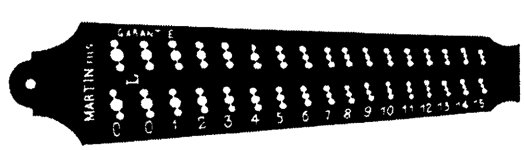
"PREPO" TORCH



This torch is ideal for use by the watchmaker or jeweler. It will produce a minimum heat of 2200 degrees F. It is equipped with a "throw-away" type of container which holds a liquid gas under high pressure. Ordinarily the container should last a minimum of four hours of continuous use. The empty container is easily removed and replaced with a new one.

SCREW PLATE

A threaded die plate with graduated hole sizes used in threading screws or making taps.



ORDERING MATERIAL

It is possible to get nearly any part for almost any watch now being manufactured as well as for many obsolete watches. Watch parts made by the maker of the watch are known as genuine parts, but other companies make replacement parts which have proven satisfactory in general. However, it is best to use genuine parts whenever they are available because they usually require less alteration.

Parts such as balance staffs, stems, crowns, mainsprings, roller jewels, friction jewels, friction bushings, and the like, may be purchased in assortments or singly. The advantage in having assortments is that you will have the part needed when you need it. You'll have no delay in completing the repair job and can give your customer faster service. The cost per part in assortments is usually less than the single part price, so there is some saving of money as well as time. You may make up your own assortments by ordering in 1/4 or 1/2 dozen lots as the need arises.

Before ordering a part for a watch, you must identify the watch by make, size, and model. To order a part for an American watch, it is advisable to include the manufacturer's name, size, number of jewels, and serial and/or movement number, which is stamped on the bridge of the watch. Some late model American watches have a model or grade number stamped on the bridge. Include this number also. When ordering staffs or wheels, list the pivot diameter size. In ordering jewels, list the hole size of the jewel or the diameter of the pivot on which the jewel is to fit.

The identification of a Swiss watch is a little more involved. The name on the dial means little in establishing the manufacturer of a Swiss-made movement. Bulova watches are usually identified by a model or caliber number stamped on the bridge, such as 7ap, 6am, 6ak, and so on. This is the only identification needed. Gruen watches usually have a model or caliber number stamped on the pillar plate and which can be seen between the barrel and train bridges or under the balance wheel. If no identification can be made on this side of the movement, remove the dial. You may then find a model or caliber number such as AS 976 or ETA 735. This listing will identify the maker and the model number.

You may find only a symbol to identify the maker. Most material catalogs list all well-known symbols and manufacturers who use them. If you find only a symbol, you still must identify the watch by model or caliber number. You can do this by means of the setting parts; that is, the set bridge, set lever and clutch lever. Manufacturers make their models with setting parts slightly different in size and shape. Material catalogs show these setting parts according to their size and shape and list their identifying model number. Close comparison of the setting parts in the watch at hand with these listings should enable you to identify the watch. If you are not familiar with this method of identification, a few minutes' study of a material catalog will make it clear to you.

Occasionally, you may have some trouble identifying a movement due to improper listing. If you are not able to positively identify a movement, you should send it to your material jobber for identification. Be sure, however, to wrap it carefully so it will not be damaged in transit.

Besides the identification, it is well to include the part you want replaced as a sample for comparison. Always package sample parts in a material can or similar container to insure safe arrival.

When ordering a balance staff for a Swiss watch, you should designate the type of balance jewels; that is, regular, Incabloc or Shock-resist. When ordering a regulator, you should indicate the type of hairspring; that is, flat or overcoil. When ordering a cannon pinion, you should furnish the exact length, if no sample is available, as cannon pinions for some Swiss watches come in as many as nine different lengths.

The following pages will guide you further in ordering specific parts. If you always include all the information shown in the samples, you should experience little trouble in getting exactly what you want.

When ordering material for a watch, the following information should be furnished:

Make:
Size:
Model or Grade (if known):
Serial Number (American only):
Number of jewels:
Description of part (Include factory number, if known):

SAMPLE ORDER (American)

FROM Your Name
Your Address City State

QUANTITY	ARTICLE	PRICE
1 only	Train jewel in setting, upper 4th wheel.	
	Pivot hole size .28 mm. Factory part	
	No. 6492. (Sample enclosed)	
	For Elgin, 12/s, 17J, No. 2304978.	

VIBRATE HAIRSPRING	CRYSTAL	DIAL
☐ Flat	☐ Waterproof ☐ Cylinder	☐ As is
☐ Breguet	☐ Regular ☐ Flat Top	☐ Change finish to:
	☐ Unbreakable ☐ Heavy	☐ Change figures to:
	☐ Other	

WATCH TOOL & SUPPLY CO.

SAMPLE ORDER (Swiss)

FROM Your Name
Your Address City State

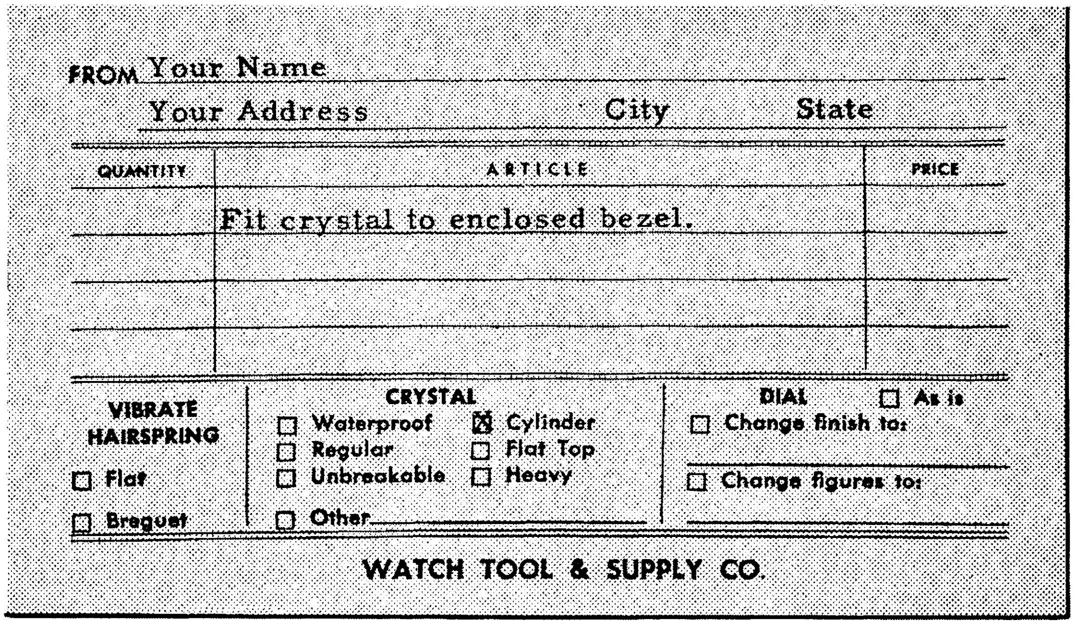
QUANTITY	ARTICLE	PRICE
1 only	Set bridge for Eta 735,	
	Ebauche part No. 445.	
1/4 doz.	Stems for Bulova 7AP.	
	Newall series No. 729-3/4. (Samples enclosed)	

VIBRATE HAIRSPRING	CRYSTAL	DIAL
☐ Flat	☐ Waterproof ☐ Cylinder	☐ As is
☐ Breguet	☐ Regular ☐ Flat Top	☐ Change finish to:
	☐ Unbreakable ☐ Heavy	☐ Change figures to:
	☐ Other	

WATCH TOOL & SUPPLY CO.

CRYSTALS

Crystal jobs can be sent out to be fitted. Your material jobber will handle this for you. Be sure to indicate the type of crystal desired.



FROM Your Name
Your Address City State

QUANTITY	ARTICLE	PRICE
	Fit crystal to enclosed bezel.	

VIBRATE HAIRSPRING
☐ Flat
☐ Breguet

CRYSTAL
☐ Waterproof ☒ Cylinder
☐ Regular ☐ Flat Top
☐ Unbreakable ☐ Heavy
☐ Other

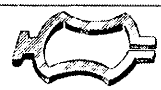
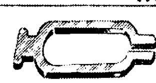
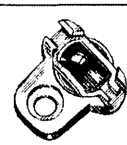
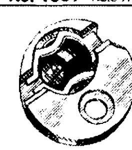
DIAL ☐ As is
☐ Change finish to:
☐ Change figures to:

WATCH TOOL & SUPPLY CO.

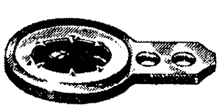
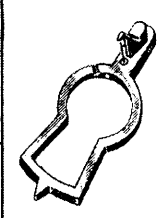
INCABLOC AND SHOCK-RESIST JEWELS

Replacement parts may be purchased from your jobber. You may also obtain assortments. When ordering parts, always include a sample.

INCABLOC

			
UPPER AND LOWER CAP JEWEL HOLDER SPRING No. 1000	LOWER CAP JEWEL HOLDER SPRING No. 1001	LOWER CAP JEWEL HOLDER SPRING No. 1002	UPPER ASSEMBLY LOCK No. 1003
			
UPPER CAP JEWEL .25 M/M Thick No. 1004	LOWER CAP JEWEL .16 M/M Thick No. 1005	UPPER AND LOWER BALANCE JEWEL IN SETTING No. 1006 -Hole .08 No. 1007 -Hole .09 No. 1008 -Hole .10 No. 1009 -Hole .11	SCREW FOR LOWER ASSEMBLY No. 1010
			
COMPLETE UPPER ASSEMBLY No. 1011—2.75 M/M Dia. No. 1012—2.95 M/M Dia. No. 1013—3.10 M/M Dia.	COMPLETE LOWER ASSEMBLY No. 1014	COMPLETE LOWER ASSEMBLY No. 1015	COMPLETE LOWER ASSEMBLY No. 1016

SHOCK-RESIST

				
UPPER BALANCE CAP JEWEL ASSEMBLY No. 1050—2.65 M/M Dia. No. 1051—2.80 M/M Dia. No. 1052—3.00 M/M Dia. No. 1053—3.10 M/M Dia.	LOWER BALANCE CAP JEWEL ASSEMBLY No. 1054—2.10 M/M Dia. No. 1055—2.45 M/M Dia.	UPPER AND LOWER BALANCE JEWEL WITH COIL No. 1062—Dia. 1.60—Hole .09 No. 1063—Dia. 1.60—Hole .10 No. 1064—Dia. 1.60—Hole .11 No. 1065—Dia. 1.80—Hole .09 No. 1066—Dia. 1.80—Hole .10 No. 1067—Dia. 1.80—Hole .11 No. 1068—Dia. 2.10—Hole .09 No. 1069—Dia. 2.10—Hole .10 No. 1070—Dia. 2.10—Hole .11	UPPER AND LOWER BALANCE JEWEL ASSEMBLY No. 1056—Dia. 1.90—Hole .09 No. 1057—Dia. 1.90—Hole .10 No. 1058—Dia. 1.90—Hole .11 No. 1059—Dia. 2.10—Hole .09 No. 1060—Dia. 2.10—Hole .10 No. 1061—Dia. 2.10—Hole .11	REGULATOR No. 1071

TRAIN WHEELS

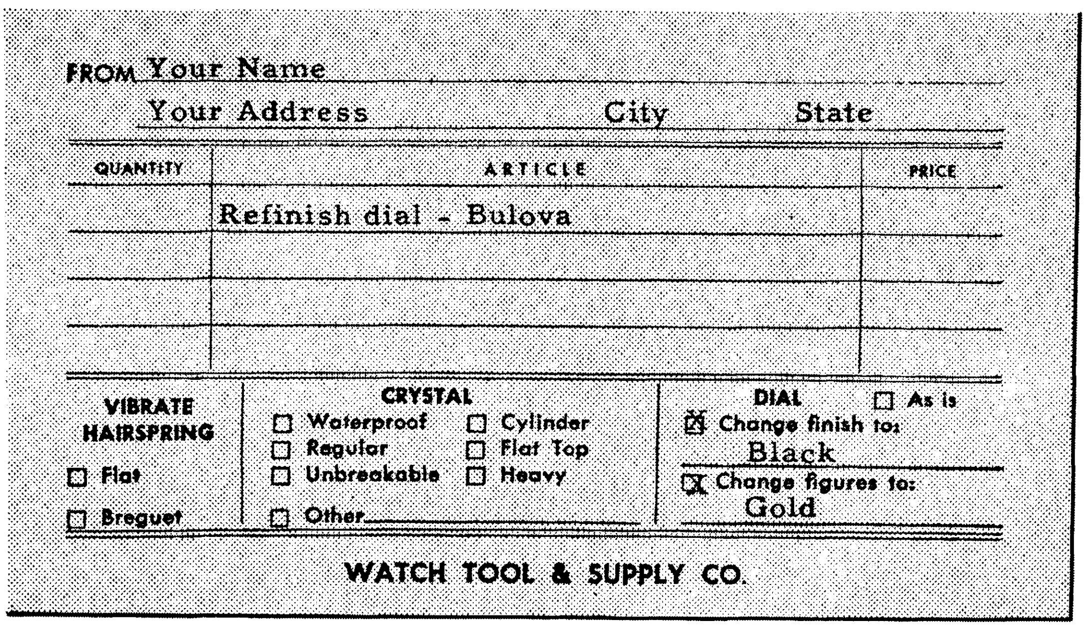
In addition to identifying the watch, when ordering train wheels, you should furnish the pivot size and indicate if the pivots are square shoulder or conical. Always enclose sample.

SCREWS

When ordering plate screws, jewel screws and the like, indicate if the screw should be regular or oversize. Damaged threads in the plates may sometimes be corrected by replacing with an oversize screw. It is helpful to buy assortments of screws from which you can usually select the one you need.

DIAL REFINISH

Dial refinishing is usually sent out to a specialist in that line. Your material jobber will handle this for you. On the material envelope you should give the name you want printed on the dial and the finish of dial and figures. If you want the dial refinished as it was originally, indicate "As Is". If a change is desired, indicate the change.


FROM Your Name

Your Address City State

QUANTITY	ARTICLE	PRICE
	Refinish dial - Bulova	

VIBRATE HAIRSPRING	CRYSTAL	DIAL ☐ As is
☐ Flat ☐ Breguet	☐ Waterproof ☐ Cylinder ☐ Regular ☐ Flat Top ☐ Unbreakable ☐ Heavy ☐ Other	☒ Change finish to: Black ☒ Change figures to: Gold

WATCH TOOL & SUPPLY CO.

SPRING BARS AND BANDS

Spring bars come in assortments of sizes and styles or may be purchased individually. It is good practice to keep an assortment on hand for necessary replacements. It is also good to have on hand a few leather bands for mens' watches as well as replacement cord for ladies' watches. Your material jobber can inform you on available assortments of these items.

FROM Your Name

Your Address City State

QUANTITY	ARTICLE	PRICE
1 only	Balance staff. Pivot size .08 mm.	
	Hamilton 14/0 size. Model 980.	
	(Sample enclosed)	

VIBRATE HAIRSPRING	CRYSTAL	DIAL ☐ As Is
☐ Flat	☐ Waterproof ☐ Cylinder	☐ Change finish to:
☐ Breguet	☐ Regular ☐ Flat Top	☐ Change figures to:
	☐ Unbreakable ☐ Heavy	
	☐ Other	

WATCH TOOL & SUPPLY CO.

NOTE: When ordering a balance staff, give the pivot size. If both pivots are broken, send the upper and lower jewels so that a proper staff can be fitted. Always enclose sample staff (removed from the wheel) for comparison.

Swiss staffs are ordered in the same manner.

BALANCE HOLE JEWELS AND CAP JEWELS

Furnish the hole size of the jewel. In many American watches, the cock (balance bridge) jewel setting is of a different size, so you should mention whether cock or foot jewel is needed. Enclose sample.

Upper and lower cap jewel settings in both American and Swiss movements are usually different in size. Also, Swiss balance hole jewels are usually either friction-fit or burnished in the plate. They should be replaced with friction jewels.

ROLLER

In addition to identifying the movement, you should indicate if the roller is single, combination, two-piece, Incabloc or Shock-resist.

BALANCE COMPLETE

This includes a balance wheel, staff, roller and hairspring which has been colleted, vibrated and fitted to the wheel. In ordering, you should identify the movement and designate whether the hairspring is flat or breguet (overcoil).

FROM Your Name
Your Address City State

QUANTITY	ARTICLE	PRICE
	Furnish and vibrate hairspring.	
	Balance wheel and balance bridge	
	enclosed. FF120.	

VIBRATE HAIRSPRING	CRYSTAL	DIAL ☐ As is
☒ Flat	☐ Waterproof ☐ Cylinder	☐ Change finish to:
☐ Breguet	☐ Regular ☐ Flat Top	☐ Change figures to:
	☐ Unbreakable ☐ Heavy	
	☐ Other	

WATCH TOOL & SUPPLY CO.

HAIRSPRINGS

New hairsprings can be sent out to a specialist to be vibrated and fitted to the wheel and bridge. Your material jobber will handle this for you. When ordering a new hairspring for either an American or Swiss watch, you should identify the watch and include the following parts:

a. Balance wheel with staff and roller. It must be true in the round and flat and in poise. Pivots must not be bent or broken.
b. The collet and stud.
c. Balance bridge with regulator. Balance and cap jewels should be clean and in place on the bridge.

Wrap and package all parts carefully to prevent damage.

NOTE: A hairspring fitted in this manner may need some further adjustment when fitted to the watch.

FROM Your Name
Your Address City State

QUANTITY	ARTICLE	PRICE
1/4 doz.	Mainsprings AS 1194. Tongue end.	
	1.60 x 10 x 10-1/2.	

VIBRATE HAIRSPRING	CRYSTAL	DIAL ☐ As is
☐ Flat	☐ Waterproof ☐ Cylinder	☐ Change finish to:
☐ Breguet	☐ Regular ☐ Flat Top	☐ Change figures to:
	☐ Unbreakable ☐ Heavy	
	☐ Other	

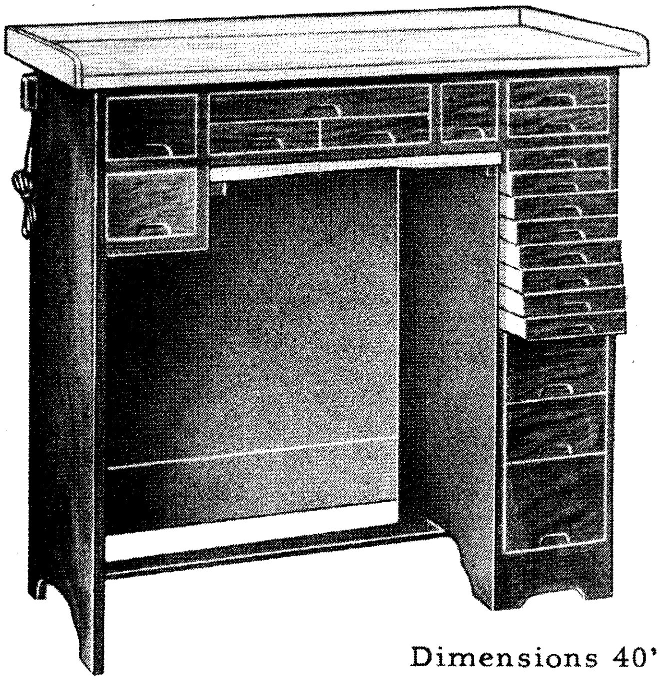
WATCH TOOL & SUPPLY CO.

WATCHMAKER'S EQUIPMENT

Benches • Lathes • Motors • Staking Tools
Friction Jeweling Tools • Cleaning Machines

CATALOG NO. 524

No. 25 WATCHMAKER'S BENCH has 19 drawers of various sizes; an apron slide; replaceable working top; foot rest and two chuck and staking tool blocks.



Bench is made of kiln-dried cabinet hardwood and laminated plywood. All work is tenon and mortise joints, all in accordance with the most approved cabinetmakers' methods.

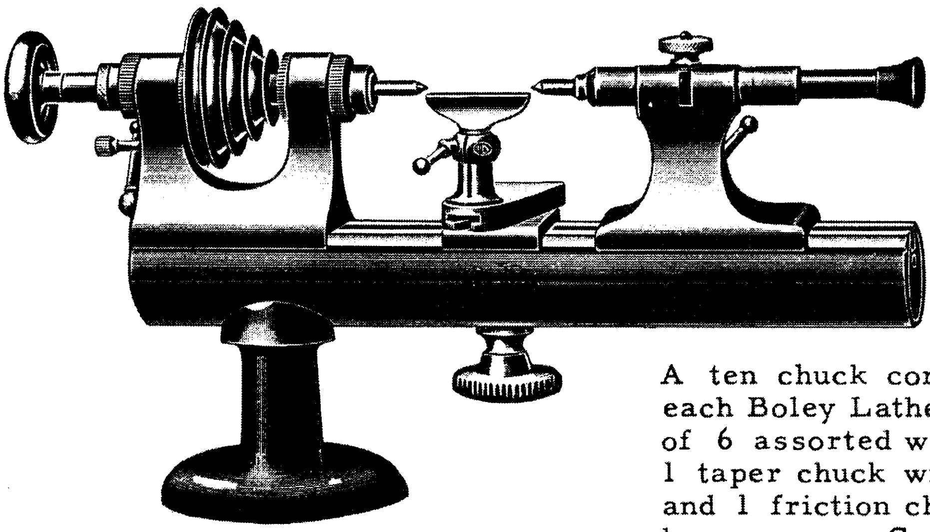
The drawers are tenon and groove with bottoms of 1/8" strong, noise absorbing "DURON."

The sides of the drawers extend 3'' beyond the back. Metal runners are used as slides, except where construction prevents their use. Depressed front acts as pulls.

Finishes: Ebony Black, Oak, Mahogany and Walnut. Highly lacquered and moisture resistant.

Dimensions 40'' x 20'' x 38'' high to working surface.

The BOLEY LATHE ..... one of the all time great names in precision lathes. This fine, German-made lathe is mechanically accurate and accurate alignment of all parts is guaranteed.



GENUINE BOLEY

LATHE

No. 800

A ten chuck combination is furnished with each Boley Lathe. The combination consists of 6 assorted wire chucks, 2 wheel chucks, 1 taper chuck with male and female tapers, and 1 friction chuck with 8 assorted cement brasses. Complete with wood chuck box.

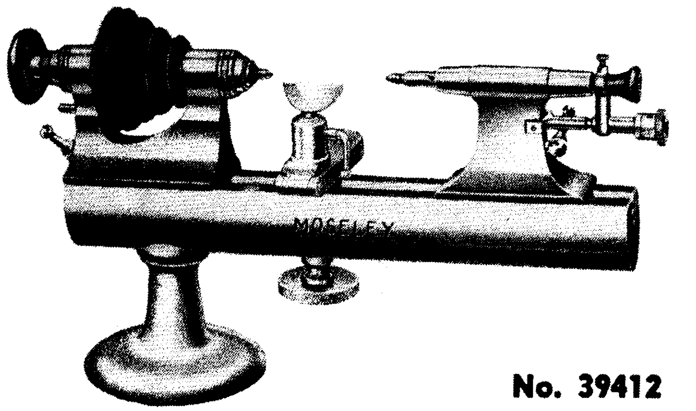
TELEPHONE:
Dickens 2-6464

North American Watch Tool & Supply Co.

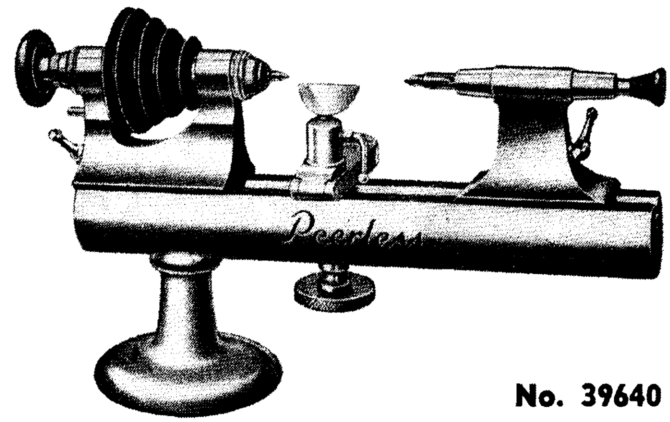
2320 Milwaukee Avenue • Chicago 47, Illinois

WATCHMAKER'S PRECISION LATHES

MOSELEY | **PEERLESS**



No. 39412



No. 39640

Length of Bed . . . 12" | **Distance, Center to Bed . . . 2"** | **Swing . . . 4"** | **CHROME PLATED**

Hardened and Ground STEEL BEARINGS Individually Lapped

10 CHUCK COMBINATION AND MICROMETER SCREW TAIL FEED

No. 39412. MOSELEY LATHE complete with Micrometer Tail Feed and tip-over "T" Rest, including taper chuck with center, screw chuck, six ¼" cement brasses, 8 wire chucks, belting and chuck box with hinged cover and block for chucks.

No. 39640. PEERLESS LATHE with tip-over "T" Rest and 10 chuck combination . . . 8 wire chucks, 1 taper chuck with taper, 1 screw chuck with 6¼ inch cement brasses. Complete with chuck box and leather belting.

LATHE BED

Made of cast Meehanite, the finest close grained cast iron made. Cast only by licensed foundries under rigid laboratory control. Seasoned to eliminate strain in the metal and prevent any distortion. After seasoning, the bed is machined to shape and ground on all surfaces to a micro finish, insuring perfect alignment of headstock and tailstock. The bed is then polished and given 3 coats of plating; copper, nickel and then chromium, insuring perfect protection for long service.

HEADSTOCK AND TAILSTOCK

Cast Meehanite, same quality as lathe bed. Machined, seasoned, polished and plated same as lathe bed. Hand scraped so they will fit the bed at any position and remain in perfect alignment.

SPINDLE BEARINGS

Highest grade tool steel . . . not bronze (See note below). Machined and hardened to 62 plus Rockwell, then ground on all surfaces to a ZERO TOLERANCE. Then fitted to the lathe headstock for lapping to the spindle, which is of double cone construction for accuracy and strength.

MAIN OR LIVE SPINDLES

Highest grade tool steel, machined and hardened same as bearings, ground on all surfaces to a ZERO TOLERANCE. Spindle then lapped into bearings to a mirror finish . . . no possibility of side shake or end shake. Inside angles of spindle that support the chuck and the draw-in-spindle are then ground and polished while the spindle is running in the headstock IN ITS OWN BEARINGS. A lock nut is provided to take up any end shake in the live spindle, if that ever becomes necessary. Experience has proved that under ordinary conditions, and if the lathe is not taken apart, no adjustments are necessary for at least 25 years.

CONE PULLEY

Molded Bakelite on heavy flanged metal hub. Pulley is balanced perfectly to eliminate vibration. Flanged end of hub is drilled with 60 holes for indexing.

TAILSTOCK SPINDLE

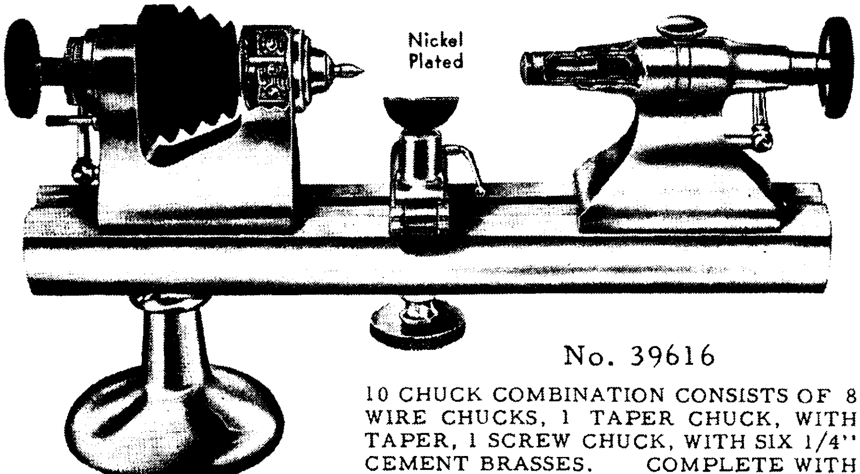
Highest grade tool steel hardened and ground, fitted after tailstock bearings are honed. Honing and lapping of bearings produces the velvety smoothness of operation. And with the protective coating of oil, the spindle actually floats.

T-REST

No shoe required for fitting. Made of oil hardened tool steel, hardened and polished and locked securely by positive locking lever that will hold "T" secure at any height within its range.

PEERLESS AND MOSELEY LATHES

have been in constant manufacture for 89 years and have always had hardened and ground steel bearings and spindles. **And the makers have never resorted to bronze or composition bearings which can be fitted without grinding or lapping because of their softness.**



Ball Bearing Lathe

With Chuck Holding Tailstock

No. 39616

10 CHUCK COMBINATION CONSISTS OF 8 WIRE CHUCKS, 1 TAPER CHUCK, WITH TAPER, 1 SCREW CHUCK, WITH SIX 1/4" CEMENT BRASSES. COMPLETE WITH CHUCK BOX.................. No. 39616

Pre-loaded Ball Bearings are sealed in oil for life. No oiling necessary. Their scientific design eliminates side or end shake in spindle.

There is no need to obtain special attachments as all WW Style Chucks and attachments are interchangeble on this lathe.

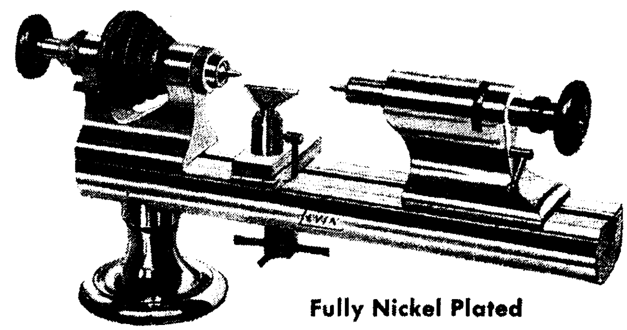
LEVIN CONE BEARING LATHES

Both models are identical except for the spindle bearings. In the model B they are of bronze, while in the model H they are made of hardened steel, ground and lapped to fit the spindle.

Standard accessories supplied with either lathe are tip-over "T"-rest, 2 taper chucks with hard centers, 2 brass cement chucks, ¼" diameter, 1 brass cement chuck ½" diameter.

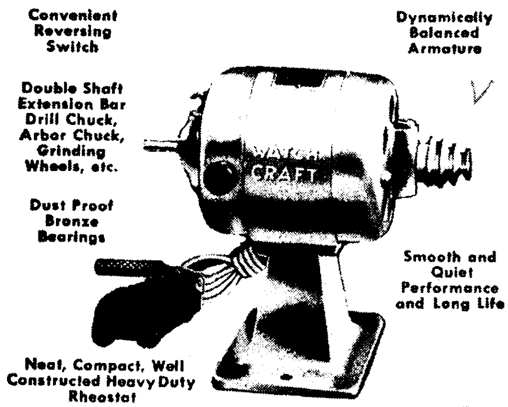
MODEL B
Bronze Bearings

MODEL H
Hard Steel Bearings



Fully Nickel Plated

WATCH-CRAFT LATHE MOTOR



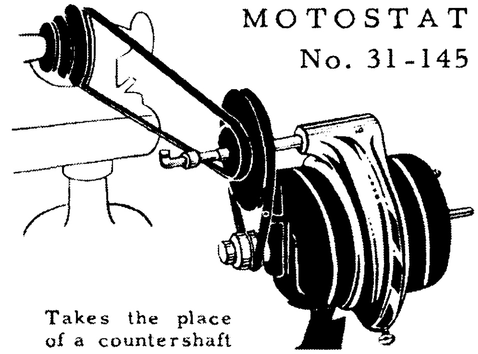
Variable Speed, Reversible, Foot Control Rheostat

1/10 H P. reversible motor. Six-speed rheostat for 110-120 volt A.C.-D.C. Full speed 6,000 R.P.M. under load. 3-step cone pulley, extended shaft on opposite end, cord and plug. Compressed composition bronze sleeve bearings require oiling only about six times a year. Height 6", base 3" x 3".

No. 39920

MOTOSTAT

No. 31-145

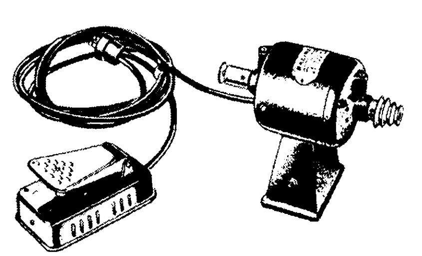


Takes the place of a countershaft and gives you more power at low speed. Heavy face plates etc. can be turned slowly for the most accurate work, yet the motor will have its full power and will not stall.

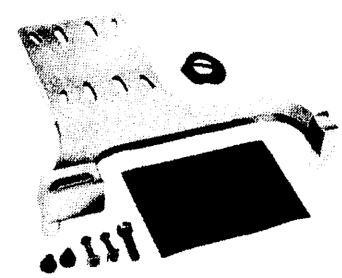
RACINE UNIVERSAL MOTOR

1/12 H.P. reversible motor provides reliable power. Dynamically balanced armature assures smooth. quiet operation. Foot control rheostat gradually steps up speed to 13.000 R.P.M. without load—6,000 R.P.M. under full load.

No. 1360 . . . Black Finish
No. 1360A Chrome Finish



LATHE MOUNT No. 1258



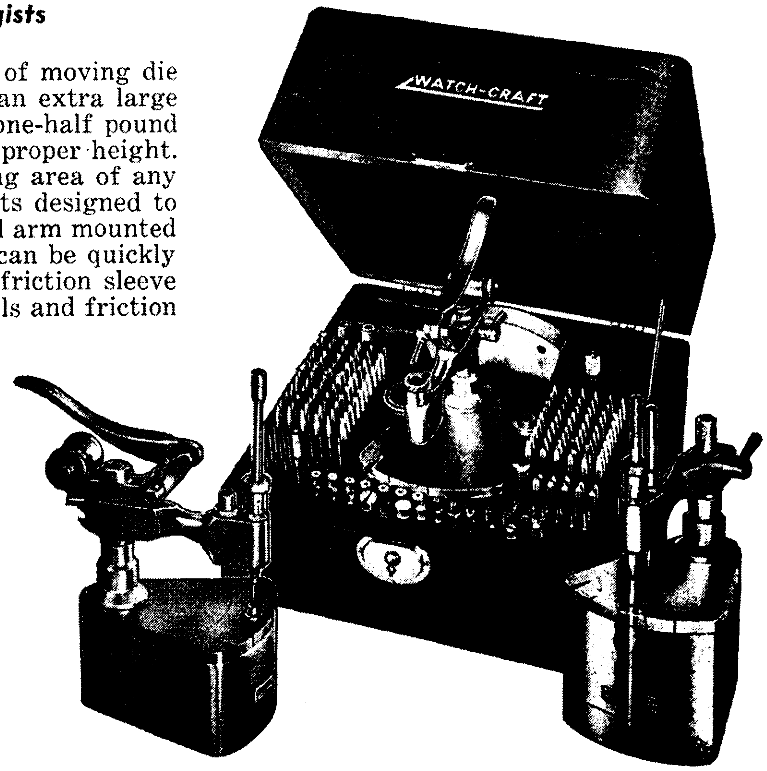
Portable lathe mount for mounting watchmakers lathe and motor.

WATCH-CRAFT REG. U.S. PATENT OFFICE No. 348436

TRI-DUTY OUTFIT

Finest, Most Complete Tool of It's Kind . . . Built and Priced to Lead in Quality and Value!

Tested and Approved by Leading Horologists



A superior quality chrome plated staking tool. Instead of moving die plate which has to be set each time it is used, it has an extra large accurate solid die plate fastened securely to a six and one-half pound base—a solid foundation for riveting work and just the proper height. The die plate is extra large with four times the riveting area of any other staking tool. Has two rows of holes and four slots designed to take care of all special and regular work. A special radial arm mounted on a heavy solid steel base swings to any position and can be quickly centered and locked over any hole. It is provided with friction sleeve guide for punches, also extra guide to accommodate drills and friction jeweling reamers and punches.

Punches are reversible and can be inverted in the base and used as stumps, which makes possible a very wide range of work. Each one is individually turned out by hand, hand finished, lapped and polished on the face to a mirror finish.

The Watch-Craft Tri-Duty tool is equipped completely for Friction Jeweling; all reamers, punches, stumps, etc., are supplied. The tool has an accurate micrometer adjustment so that the jewel can be set at just the proper depth in plate or setting for proper end shake.

The drilling attachment every watchmaker will appreciate. Pivot drilling, holes in plates, removing broken screws, attaching dials, etc., can be done with more accuracy and precision than in a lathe. Twenty-four finest quality Magic pivot drills are supplied with this outfit.

The Greatest ADVANCEMENT in the History of STAKING TOOLS!

Outfit Includes:

3 Complete Outfits In 1!

1. Staking Tool

133 Punches
25 Stumps
Punches Can Be Inverted in Frame and Used as Stumps.

2. Complete Friction Jeweling Equipment

12 Reamers 12 Pushers
7 Friction Jeweling Stumps
Reamer Holder—Pusher Holder—Micrometer Depthing Adjustment—Built-in Direct Pressure Lever

3. Precision Drill Press

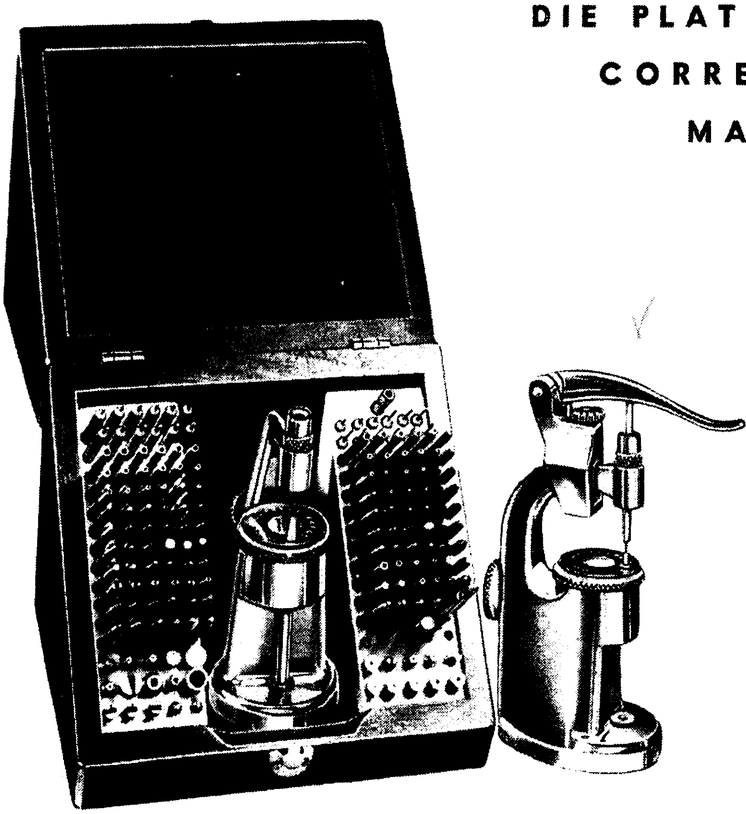
24 Magic Pivot Drills
2 Drill Holders
Spring Wire Belting, Pulleys and Full Equipment for Operating With Power from Lathe

No. 42694 Watch-Craft Tri-Duty Precision Staking tool, Friction Jeweling tool and Drill Press, combined as one convenient compact unit. Includes 133 Punches, 25 Special Stumps, 24 High-Grade Magic Pivot Drills and complete set of reamers, pushers and stumps for Friction Jeweling, all in a heavy solid walnut cabinet. A combination outfit that is beyond a doubt the finest precision watchmaking tool of its kind ever built.

BUILT and PRICED TO LEAD THE WORLD IN QUALITY and VALUE!

MOSELEY STAKING TOOL

With Attachment, Also a Friction Jeweling Tool



DIE PLATE OF TOUGHEST ALLOY STEEL CORRECTLY HARDENED TO GIVE MANY YEARS OF SERVICE

Die plate is easily locked into position with the knurled screw shown on illustration. After centering the die plate with the centering punch, included as standard equipment, you simply twist the screw to lock the die plate securely in the right position for staking. The die plate is made of the toughest alloy steel known to science and correctly hardened to give many years of service. Every die plate is surface ground for accuracy and drilled by hand on super-sensitive drill presses. The die plate has 26 holes which means the right size hole for any modern watch from smallest to largest. Holes are properly gauged and centered and give you the right spread of sizes from small to large.

STAKING TOOL PUNCHES

All punches supplied with MOSELEY Staking Tools are correctly gauged and graduated . . . you are assured of the right punch in the right combinations. Punches are uniformly cut from steel rod by our Swiss Type Automatic Screw Machines. Then they go through a series of hand operations which insure exactness and precision . . . including lapping and polishing punch faces to a mirror finish. Hole punches are drilled dead center, an operation that will not vary from one punch to the next. With Moseley, as with our other staking tools, any punch found defective in workmanship will be replaced free of charge. However, the best of punches can be broken occasionally . . . so be sure to use the right size punches for all work. And always use a brass hammer for staking so you will not flatten the head of the punch, as you might with a steel hammer.

ALL PUNCHES NUMBERED

All punches supplied with Moseley are numbered for quick identification. For instance, if a punch number B22, a round faced hole punch, is used to spread the shoulder of the balance staff, the companion punch for riveting the same staff is number A22, a flat faced punch, found in the same relative position on the opposite side of the case. This system, found only in WATCHCRAFT and MOSELEY Staking Tools, eliminates tedious searching for the right punch each time.

ACCURACY — STURDY CONSTRUCTION

The Moseley Staking Tool is completely chromium plated, giving the tool an attractive appearance, the first thing you look for in your staking tool. It is designed so punches can be reversed, inserted in frame and used as stumps. The frame is cast in one piece, giving you a rugged, sturdy tool that will stand up under continuous usage. This is very important, since a staking tool is a long time investment. You want it to last . . . sturdy construction is as important as accuracy. And both are emphasized in the Moseley Staking Tool. The frame is relieved so punches can be easily inserted and removed . . . so any watch parts driven out through die plate drop clear of frame. The punch guide is equipped with a friction sleeve which holds punches in any position. All Moseley Staking Tools are drilled for 120 punches and 30 stumps. Thus you can add punches and stumps to the smaller sets at any time.

6 PUNCH AND STUMP COMBINATIONS

No. 42717—Moseley Staking Tool, consisting of 120 punches, 25 stumps and fitted with friction jeweling attachment complete.

No. 42716—Moseley Staking Tool, consisting of 100 punches, 25 stumps and fitted with friction jeweling attachment complete.

No. 42715—Moseley Staking Tool, consisting of 80 punches, 20 stumps and fitted with friction jeweling attachment complete.

No. 42714—Moseley Staking Tool with 120 punches and 25 stumps.

No. 42713—Moseley Staking Tool with 100 punches and 25 stumps.

No. 42712—Moseley Staking Tool with 80 punches and 20 stumps.

No. 42718—Friction Jeweling Attachment only, for above tools, consisting of:

ATTACHMENT........12 Reamers

12 Pushers................1 Reamer Holder................1 Cone Miller

LITTLE GIANT

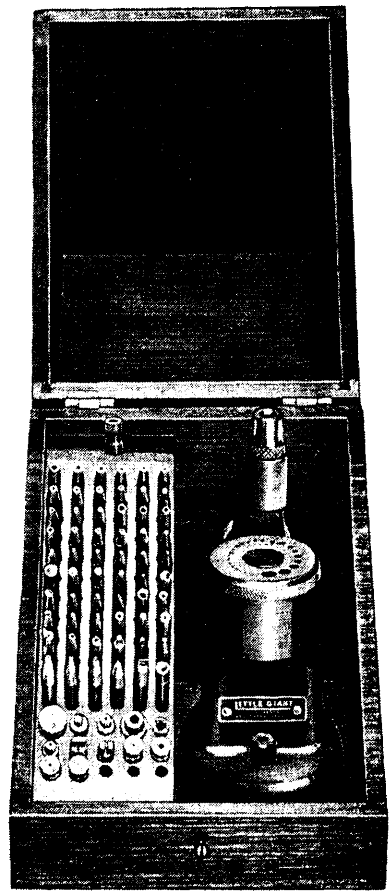
REG. U.S. PATENT OFFICE NO. 349883

STAKING TOOL

A High Quality Tool At Low Cost

The Little Giant Staking Tool is like the famed Moseley in general appearance and construction. It has the same frame and die plate, but has a lower cost . . . baked enamel . . . gunmetal finish. The tool comes in a smaller wood case with one insert . . . holding a maximum of 60 punches and 15 stumps. It has the same punches as the Moseley, but a smaller number of punches. The economies in this tool are confined to quantity, not quality.

The Little Giant comes in 4 different combinations of punches and stumps, with each insert drilled to hold a maximum of 60 punches and 15 stumps. You can add punches and stumps to the smaller sets at any time.



LITTLE GIANT STAKING TOOL PUNCHES

Little Giant Staking Tool punches are made from carefully selected high grade steel . . . the same as for Moseley and Watch-Craft punches. You are always assured of getting the right punches in the right combination regardless of the set you buy. Punches are uniformly and correctly hardened on a special machine . . . there is no guesswork about how hard they should be. That means they will give you satisfactory service for many years if they are properly used. Faces of punches are lapped and polished to a smooth finish . . . not sand blasted or acid finished. Punches are numbered for quick selection of the right punch. And they are inserted at an angle in the plastic holder so you can see the right punch without stretching or standing. Punches can be reversed, inserted in frame and used as stumps.

The frame is cast in one piece, giving you all the advantages of a solid piece of metal. Frame is relieved so punches can be easily inserted and removed . . . so any watch parts driven out through the die plate drop clear of frame. The punch guide has a friction sleeve which holds punches in any position.

THE LITTLE GIANT IS THE IDEAL STAKING TOOL FOR YOU WHOSE WORK DOES NOT REQUIRE THE MORE COMPLETE WATCH-CRAFT OR MOSELY

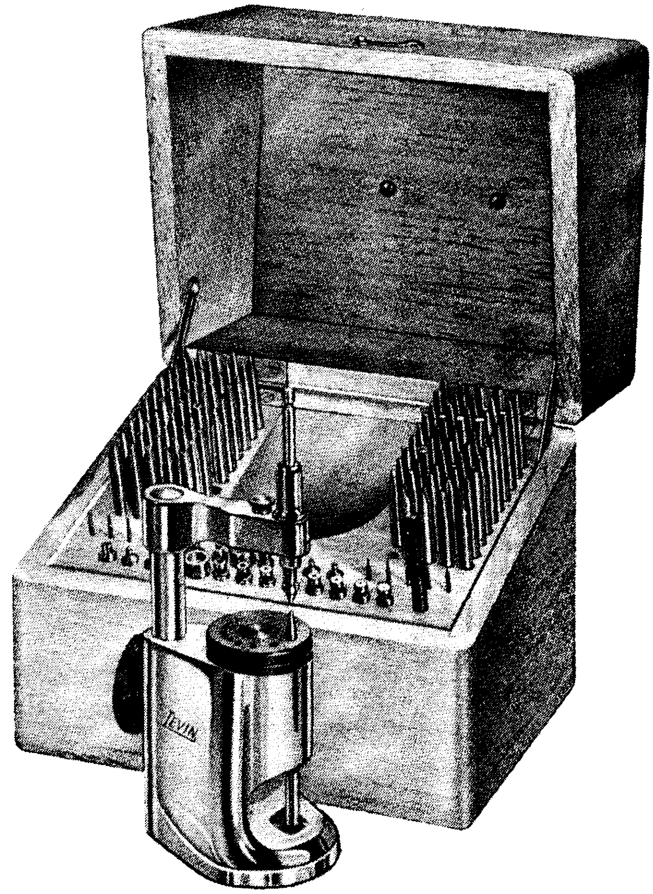
4 COMBINATIONS OF PUNCHES AND STUMPS

Number	Punches	Stumps
42720	60	12
42721	48	8
42722	36	6
42723	24	4

HEAVY DIE PLATE

The heavy die plate is easily locked into position with the knurled screw shown on illustration. It is made of the toughest alloy steel known to science and correctly hardened to give many years of service. The die plate is also surface ground to exactly the right flatness and depth for accuracy. It has 26 holes which gives you the right size hole for any modern watch from smallest to largest. The holes are properly centered and gauged to give you the right spread of sizes from small to large.

LEVIN STAKING TOOL



Since its introduction some years ago, the Levin staking tool has been universally recognized for its high quality. The frame is made of Meehanite with a stainless steel column. The arm contains a simple on and off friction device which cannot get out of order. The die plate is made of the finest tool steel 5/16" thick and lapped to a polish. Punches may be inverted so they can be used as stumps. The inclined block in the case contains 120 holes for punches, allowing room for additions to the regular set.

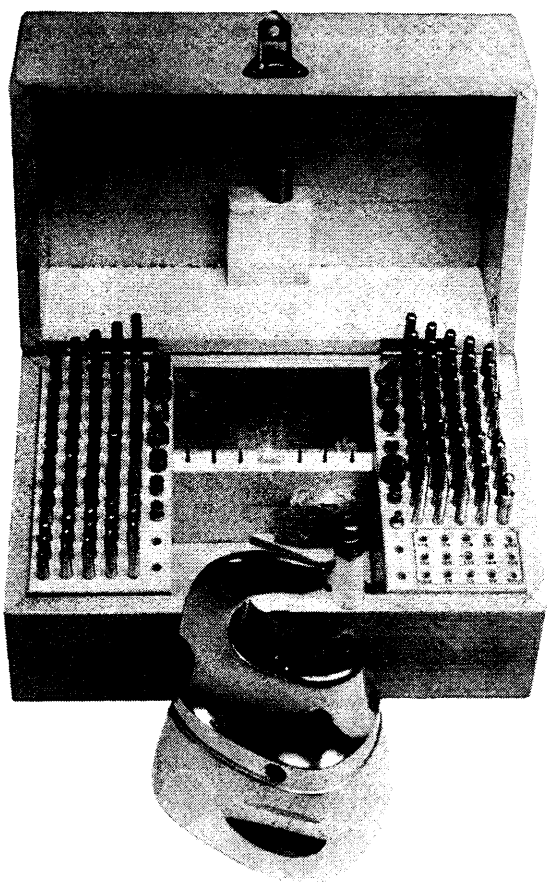
The same box is used with both sets.

100 punches, 20 stumps, 10 sub punches and punch pick-up....................Cat. No. STIM

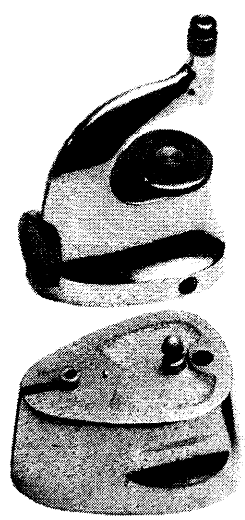
80 punches, 20 stumps, 10 sub punches and punch pick-up..................Cat. No. ABBE

BOLEY STAKING TOOL

(Imported)



The Superior staking tool. Punches can be inverted when auxiliary base is used. Frame is easily removed from auxiliary base when desired. Extra die plate fits on auxiliary base for use as a bench block.



Contains 114 punches and 14 stumps. Put up complete in finely finished, sturdy wood box.

No. 805 Without Jewelling Attachment.

No. 810 With Jewelling Attachment.

THE INVERTO "DELUXE" NO. 18R

Containing:

... 100 specially selected punches for modern watches

... 20 selected stumps

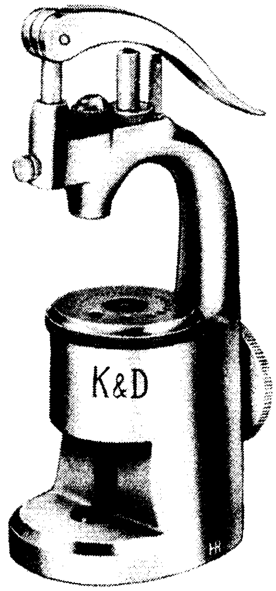
... complete Friction Jeweling Attachment including 18 reamers and holder, 7 sub punches and holder, 6 graduated flat face hollow stumps

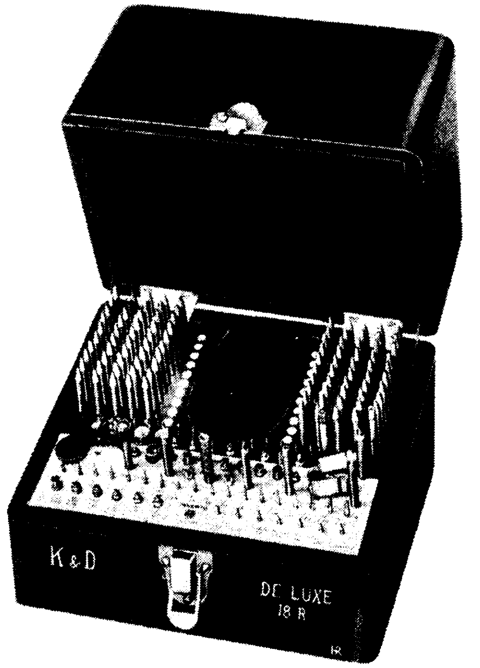
... two balance staff removers for large and small watches

... two adjustable roller remover stumps

... two sets cannon pinion closing punches and stumps

... 10 sub punches and holder for driving out screws and similar work

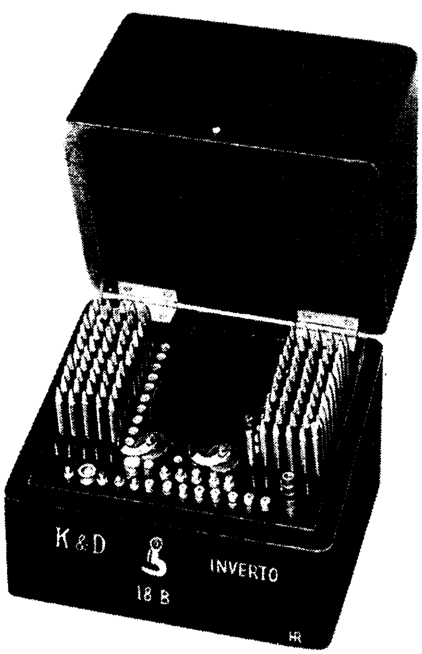


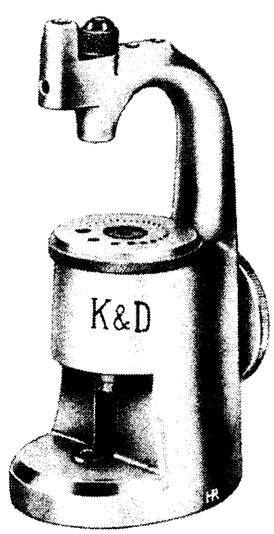


No. 43-018R.

K & D

NEW INVERTO STAKING TOOL NO. 18B





containing:

... 100 specially selected punches for modern watches.

... 20 selected stumps.

... two adjustable roller remover stumps.

... 10 sub punches and holder for driving out screws and similar work.

Provision has been made on the new 18B frame to facilitate the addition of K & D Friction Jeweling Attachment. It is not necessary to send these new models to the factory to have this work done.

No. 43-018B.

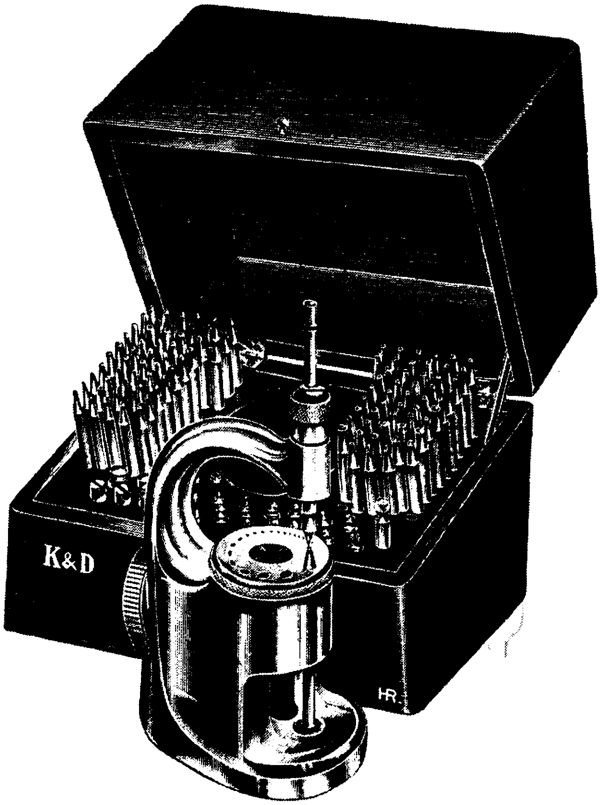
K & D

JUNIOR INVERTO
STAKING TOOL NO. 600 SERIES

This tool has all the features of the regular Inverto, but is lighter and has a smaller die plate.

No.	Punches	Stumps
600	60	20
601	80	20
602	100	20
**610	120	20

** is furnished in 18B Inverto Box.



NEW "R" SERIES

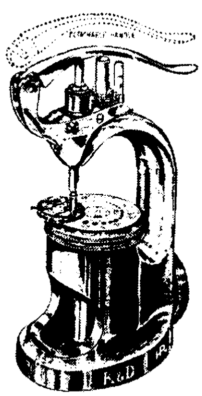
Furnished with Complete Friction Jeweling Attachments, 2 Balance Staff Removers, 2 Adjustable Roller Remover Stumps, 2 sets Cannon Pinion Closing Punches and Stumps, and De Luxe Box as shown with 18R De Luxe on Page 1.

No.	Punches	Stumps
601R	80	20
602R	100	20
610R	120	20

When ordering, specify above factory numbers preceded by 43.
Example: #601 Staking Tool becomes **No. 43-601.**

K & D

FRICTION JEWELING ATTACHMENTS



No. 43-540R FRICTION JEWELING ATTACHMENT. Lever type Friction Jeweling Attachment with micrometer stop for the new 18B frame as illustrated under 18B Staking Tool. Can be easily fitted by the watchmaker.

No. 43-018X COMBINATION SET. This combination converts your K & D Staking Tool to Friction Jeweling and consists of:

... large Deluxe box

... 540 or 540R Friction Jeweling Attachment

... 322B set of 18 Reamers

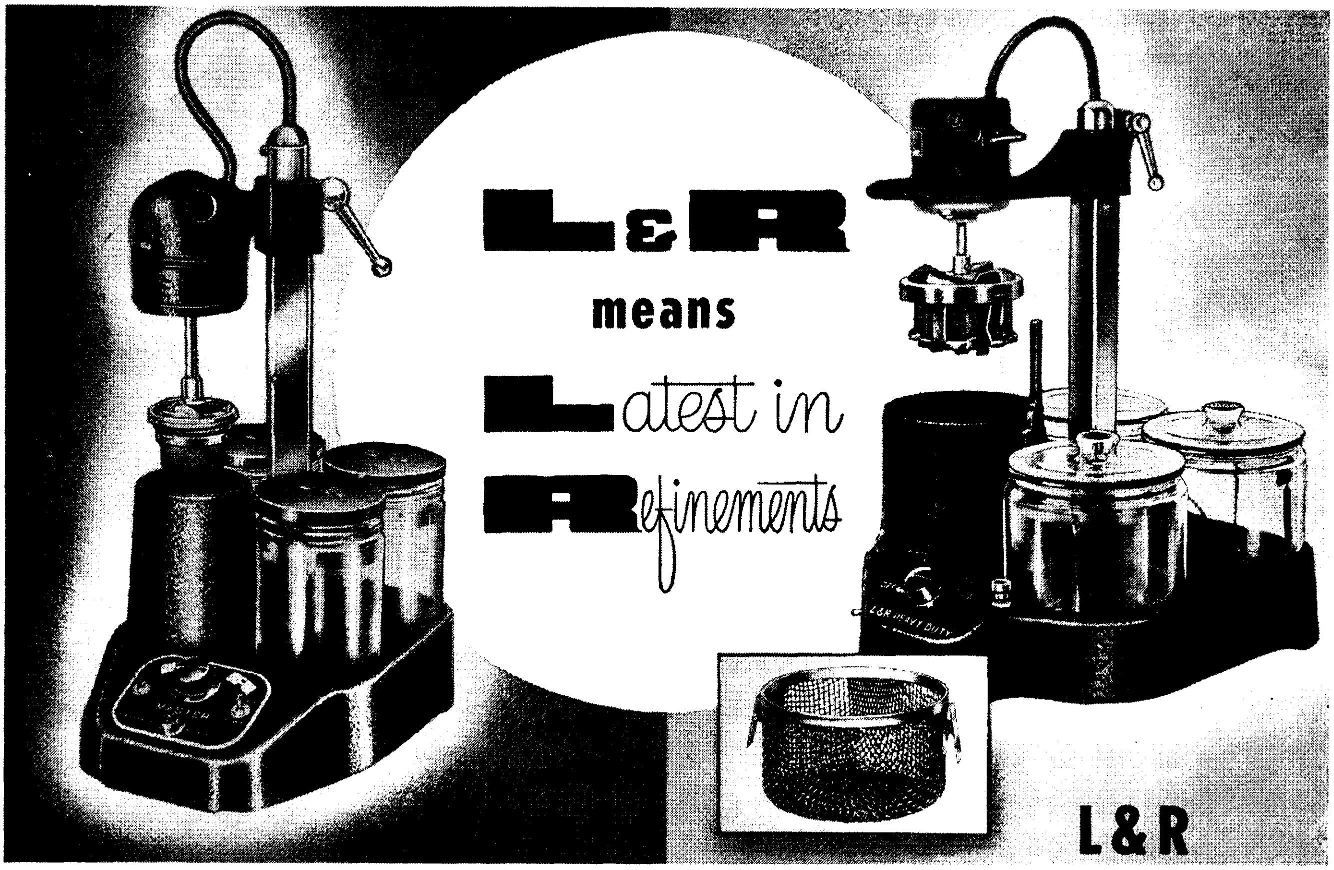
... 321 set 7 sub punches and holder

... 324 set of 6 hollow stumps

we fit 540 attachments to your old frame

No. 43-540 FRICTION JEWELING ATTACHMENT. Lever type Friction Jeweling Attachment with a micrometer stop that reads to 1/100 m.m. Can be fitted to all K & D frames except the smaller types such as 5B and 504, and the new 18B frame.

Full directions for attaching are included with the tool, but we strongly recommend sending in your frame to have this done.



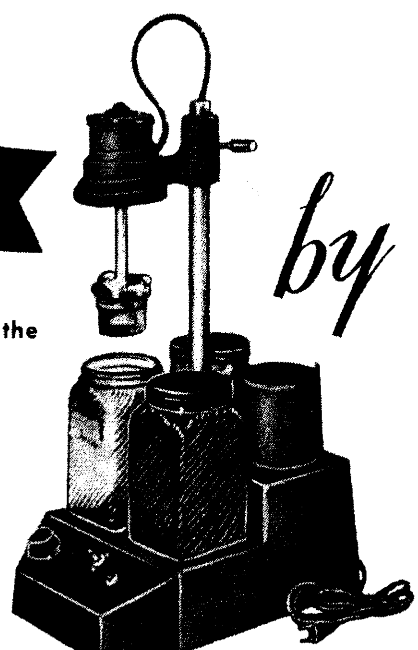
L & R Master Watch Cleaning Machine

Trimmer, more efficient, with all controls on new front panel. The most popular watch cleaning machine ever made will now, more than ever, lead the field. Powered by L & R's own motor.

Heavy Duty Watch Cleaning Machine

A true production unit now made even better with the new clock basket ----- double the capacity of former basket. Ingenious clips permit one hand attaching and removing. Fits all Heavy Duty Shafts ----- new or old.

LEADER



by Zenith

Watch Cleaning Machine

The *finest* budget-priced Machine on the Market!

Compare!

1. Powerful, precision-built Overhead Motor
2. 3 Square Jars
3. Drying Chamber
4. Speed Control
5. Fully Guaranteed

Quality —

Satisfaction —

Dependability —

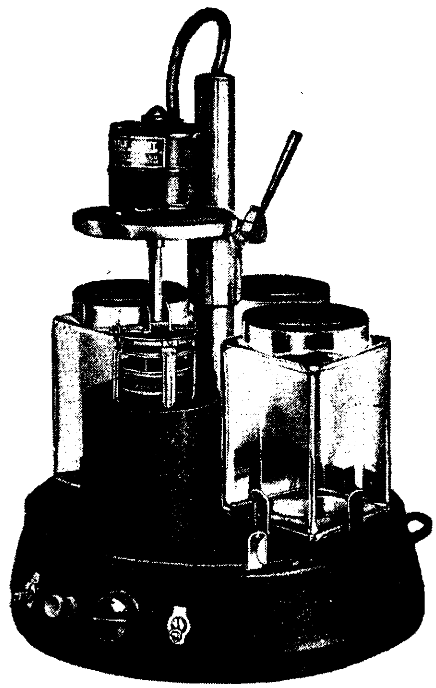
and the same superior workmanship of other ZENITH Watch Cleaning Machines!

LITTLE GIANT

WATCH CLEANING MACHINE

Featuring the Reversing Operation

The Little Giant is the choice of watchmakers who demand efficiency, satisfactory performance and economy . . . the best machine in its field.



INDEX TURNTABLE KEEPS WORK ALWAYS IN FRONT

BALL BEARING MOTOR

Wound for both forward and reverse operation.

FINGER-TIP LOCKING DEVICE

Designed to lock the motor at any position on the column. It affords the utmost convenience, for there are no knobs to turn or screws to tighten. Simply release pressure of your fingers on the locking device and it locks automatically.

PUSH BUTTON REVERSING

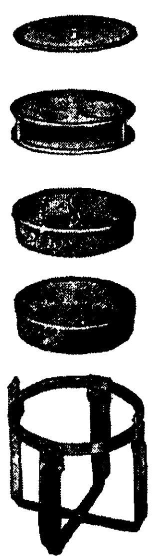
To make the basket turn in reverse to its normal operation, you simply press a button. The reverse operation will give a greater flow of solution over and through the basket, insuring perfect cleaning of all parts.

SQUARE JARS

Rest on an open turntable which is easily cleaned. The jars are held rigidly so there is no rattling while the machine is operating. They are extra high to permit the lower half for solution and the upper half for throwoff.

BAKELITE JAR COVERS

Made of fine grade Bakelite, they are durable and add to the appearance of your machine. Machine has chromium and black wrinkle finish.



STAINLESS STEEL BASKET

Made of stainless steel or Monel metal, the basket is constructed to the various sections fit together in one frame. Thus the solution passes through only one thickness of mesh straight to the parts to be cleaned.

METAL SHIELDED HEATING UNIT

An exposed heating coil will oxidize and wear out much sooner than this, which is covered. The purpose of this shield is twofold, being also designed to give uniform heat to the watch parts.

No. 36119

SEITZ FRICTION JEWELING TOOLS

Set consisting of:

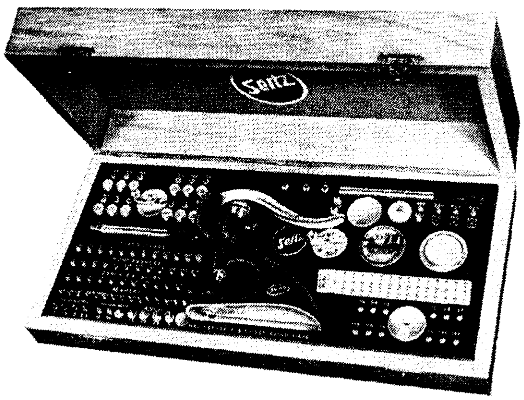
Friction Jeweling Stake
15 Reamers with Holder
12 Flat Jewel Pushers
5 Stumps
1 set Micrometrical Anvil, Pusher and Bushnut.
1 leatherette, felt-lined Case.

No. 28-020...Set

Set consisting of:

Friction Jeweling Stake
15 Reamers with Holder
12 Flat Jewel Pushers
12 Pump Pushers
11 Concave Jewel Pushers
5 Stumps
1 set Micrometrical Anvil, Pusher and Bushnut.
4 Hole Closing Punches
Set x3 of Pallet Arbor Setting Tools.
1 leatherette, felt-lined Case.

No. 28-026. (as illustrated)



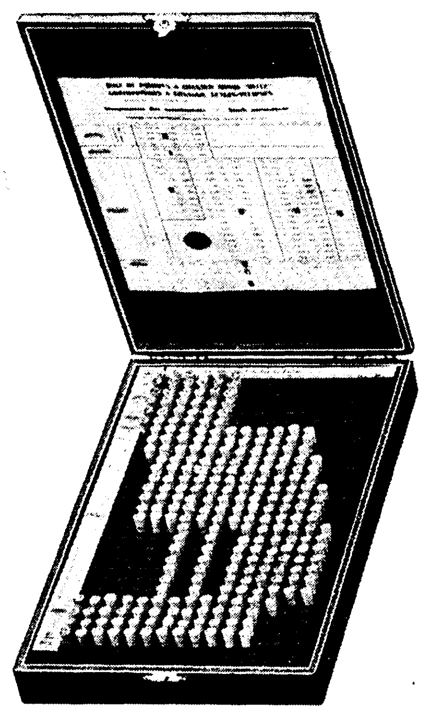
SEITZ FRICTION JEWELING TOOL

Complete set consisting of:

...All parts in Set No. 28-026
...Set No. 28-101. Hand Setting Tools
...Set No. 28-103. Face Plates x 3
...Set No. 28-105. Holder for Brass Settings
...Set No. 28-106. Chuck Holder with 3 Chucks
...Set No. 28-109. Self centering Points x 12
...Set No. 28-113. Grinding Stone
...Set No. 28-114. Pivot Straightening Tool

No. 28-035. (as illustrated).......Set

JEWELS



No. 702A. SEITZ BALANCE, PLATE AND CAP JEWELS. 2 Jewels in each bottle, total 100 Balance, 196 Plate and 30 Cap Jewels in wood cabinet.

No. 711. SEITZ BALANCE, PLATE AND CAP JEWELS. 1 Jewel ea. of 67 Balance, 138 Plate and 3 ea. of 15 Cap Jewels in wood cabinet.

No. 721. SEITZ CENTER JEWELS. 1 ea. of 100 numbers in wood cabinet.

No. 731. SEITZ BALANCE JEWELS. 1 ea. of 108 numbers in wood cabinet.