# Master WATCHMAKING

## SHOP TRAINING JOB GUIDES

# LESSON 5

Mainsprings in Watches

—

Sections 125 - 162

**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**

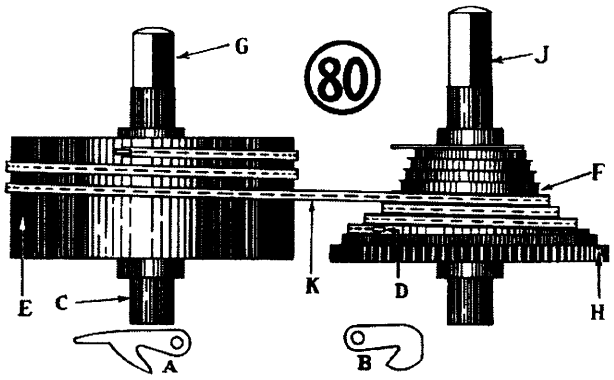
**Lesson 5**

**Sections 125 to 162**


## *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.

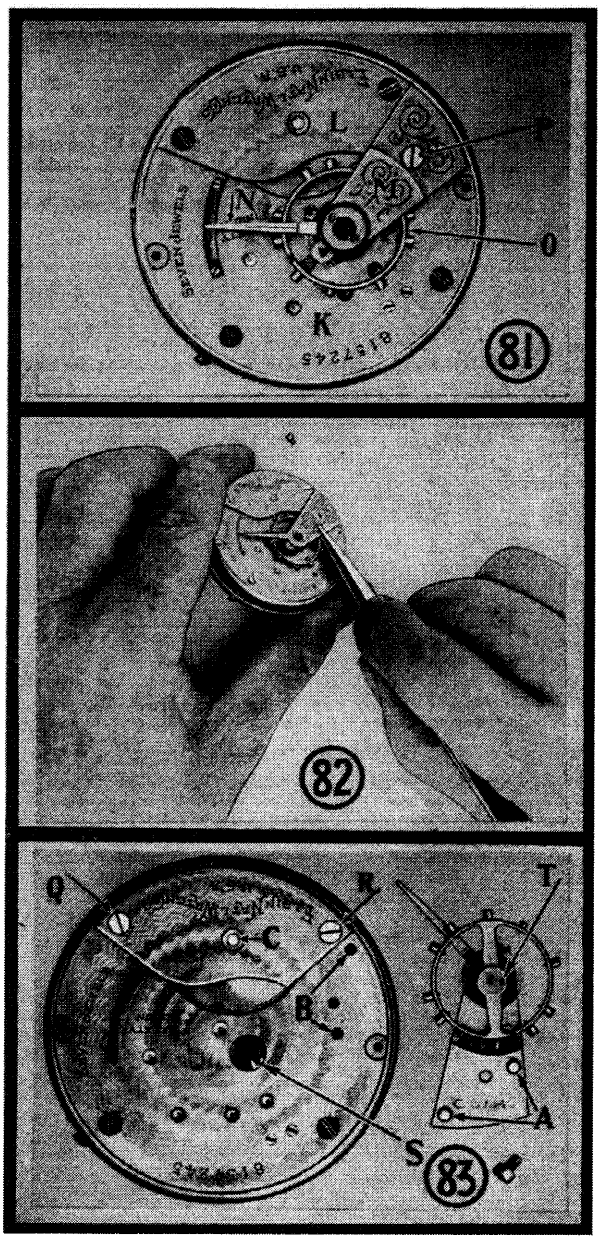
### *Sec. 130 — The Going Barrel*

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.

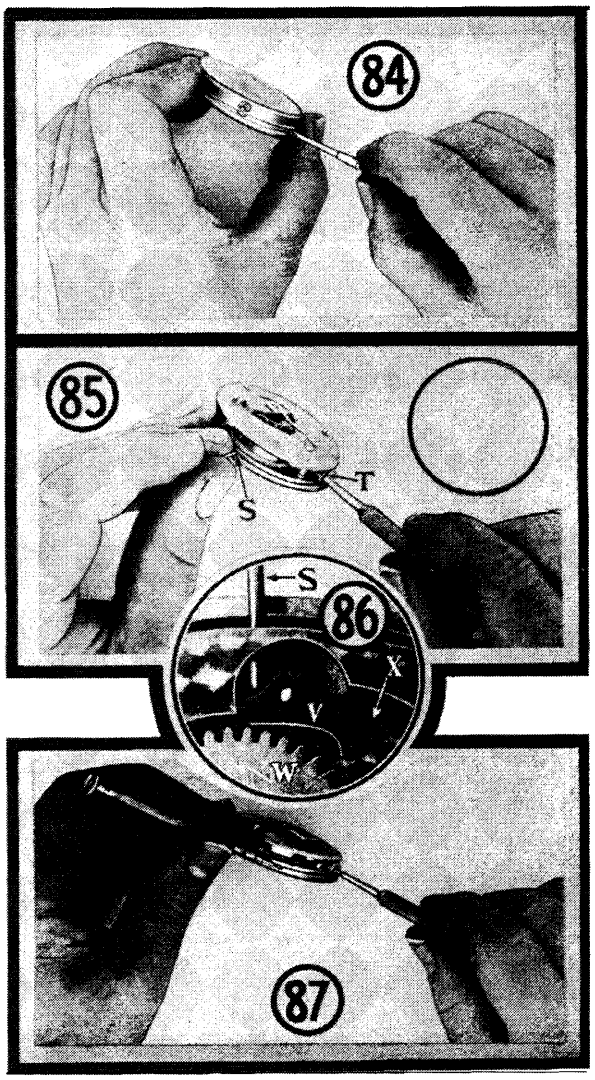
At figure 86 is shown (much as it appears when viewed through an eye glass) how the wire S extends through the hole in the edge of the pillar plate and presses against the end of the click V raising the other end away from the teeth of the ratchet wheel at W so that this wheel may turn backwards in letting 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*

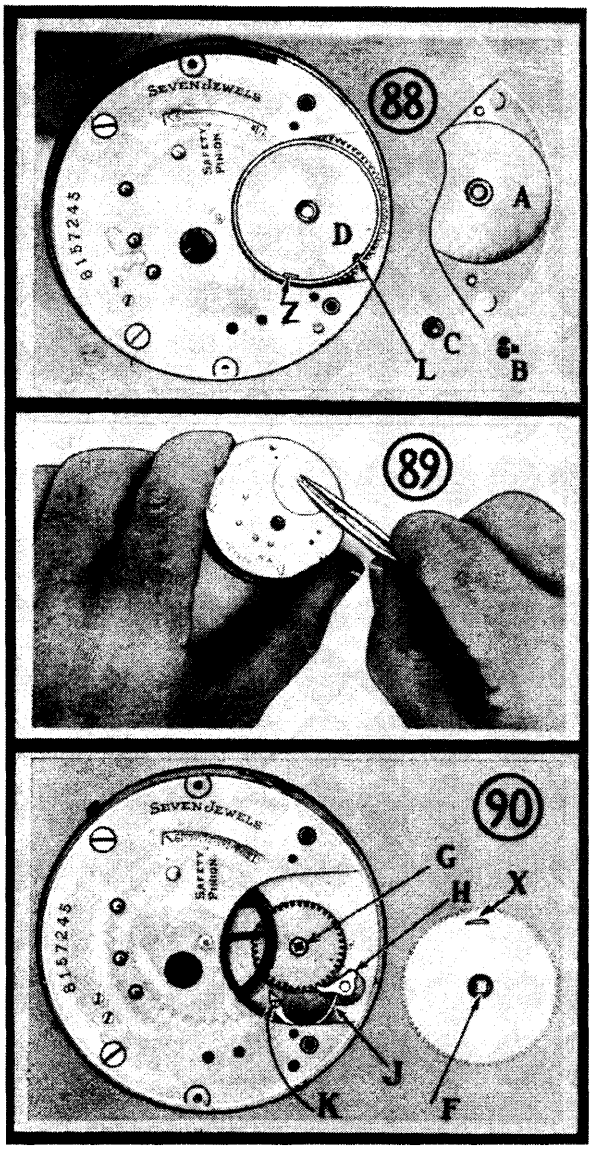
Though a mainspring may be broken it is well to see if there is any power left in the barrel by going through the same procedure as just outlined. If the mainspring is broken near the outer end, there still might be enough power to cause damage when you lift out the barrel without having "let down" the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

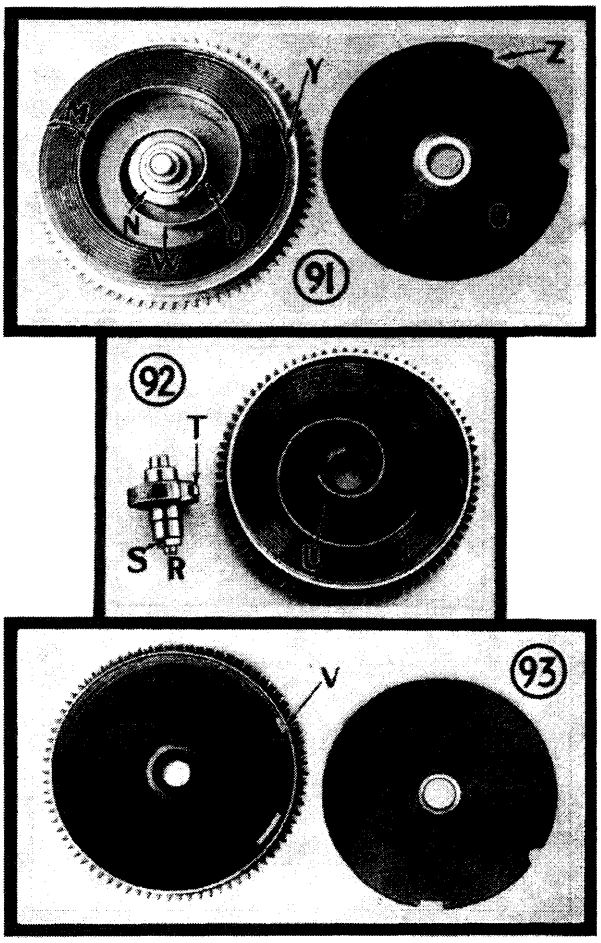
The cap fits in the barrel with a snap fit and may be removed by prying off with a screw driver or other lever like instrument. The cap has an opening at the edge in which to insert the screw driver at L figure 88. Of course, the cap is pried out after you have taken the barrel from the movement.

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.

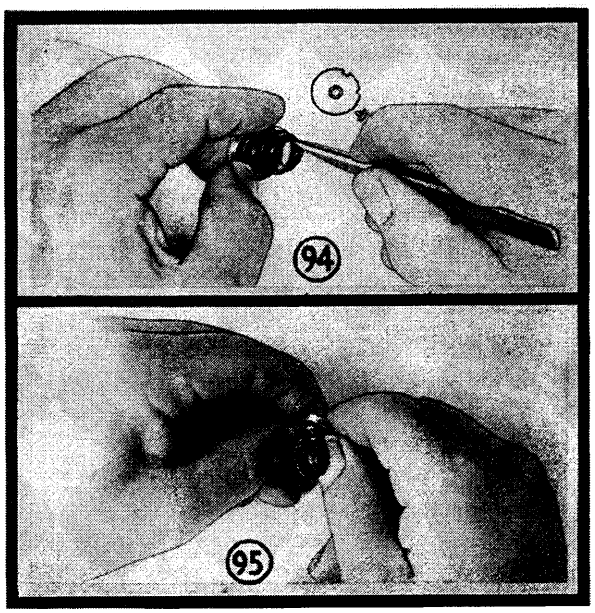
*Sec. 138 — Taking Out the Mainspring*

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*

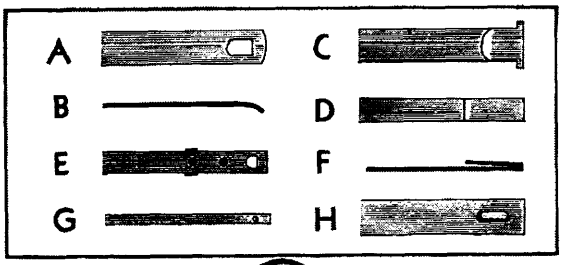
The outer end of a mainspring is commonly called the "tip" and its shape varies with the watch for which it is intended. There are several styles of tips on mainsprings but each is for the same purpose — to have some kind of an attachment to make the end of the mainspring hold securely on the inside 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)

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*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.

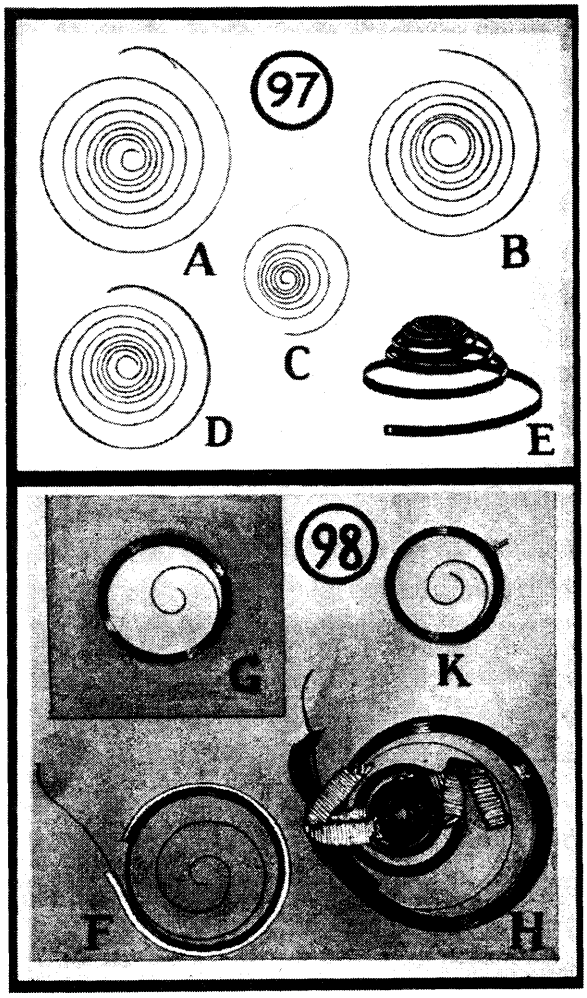
In removing the spring from its container hold the coils by the edge and let them expand slowly, never let them come out all at once.

*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.

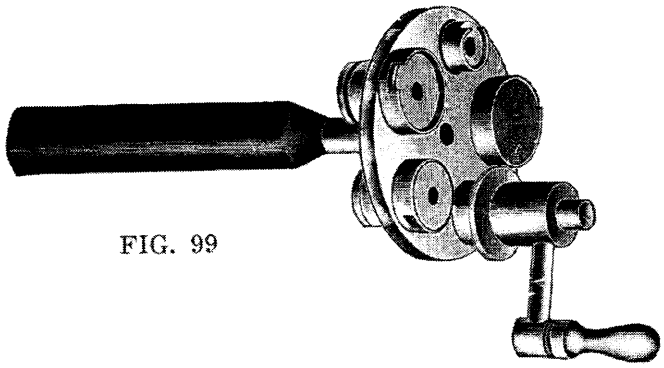


FIG. 99

*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.

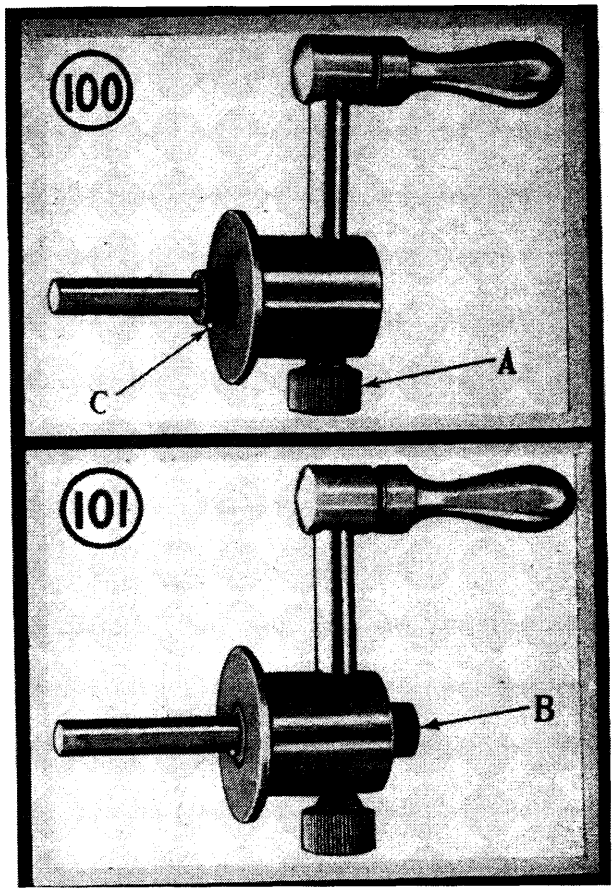
*Sec. 148 — A Satisfactory Mainspring Winder*

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.

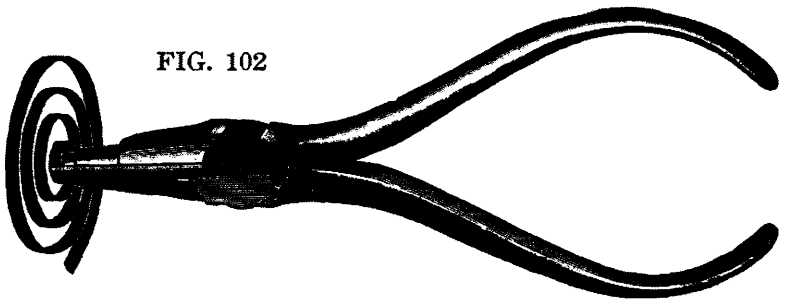



*Sec. 149 — Operating the Winder*

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*

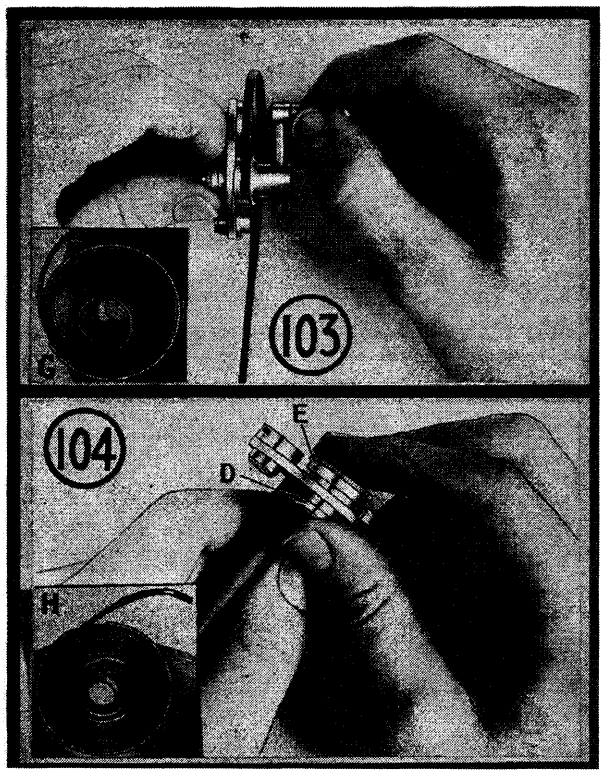
The coils of the mainsprings must now be oiled. The oil to use should be somewhat heavier than watch oil and of a quality that will easily spread. Most watchmakers use clock oil for this purpose but the type of so called *non-spreading* clock oil *should not* be used on the mainspring.

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.

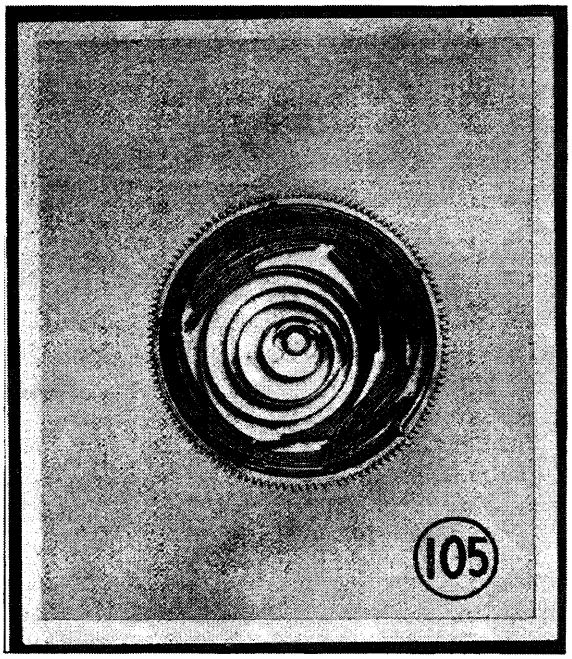
### *Sec. 159 — Preliminary Tests*

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.

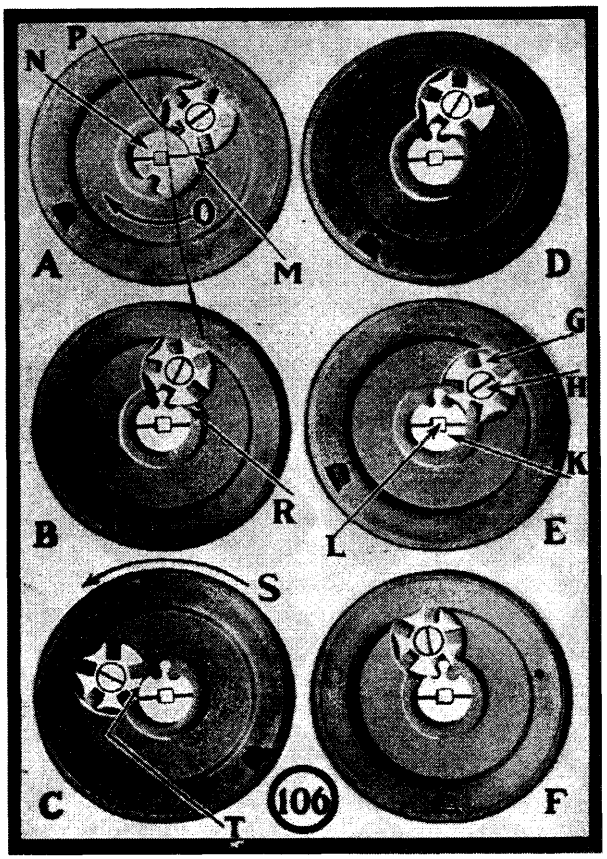
The mainspring should be kept well oiled at all times not only for its lubricating effect but also to help prevent rust.

*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.

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*Master Watchmaking*

CHICAGO SCHOOL OF WATCHMAKING

**JOB SHEET**

W5-J1

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.

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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. | |

| UNIT | II |
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| LESSON | 5 |

Master Watchmaking

CHICAGO SCHOOL OF WATCHMAKING

**JOB SHEET**

W5-J3

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. | |