TRAINING UNIT
NUMBER 8

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OVERCOILING

BULOVA SCHOOL of WATCHMAKING

OVERCOILING

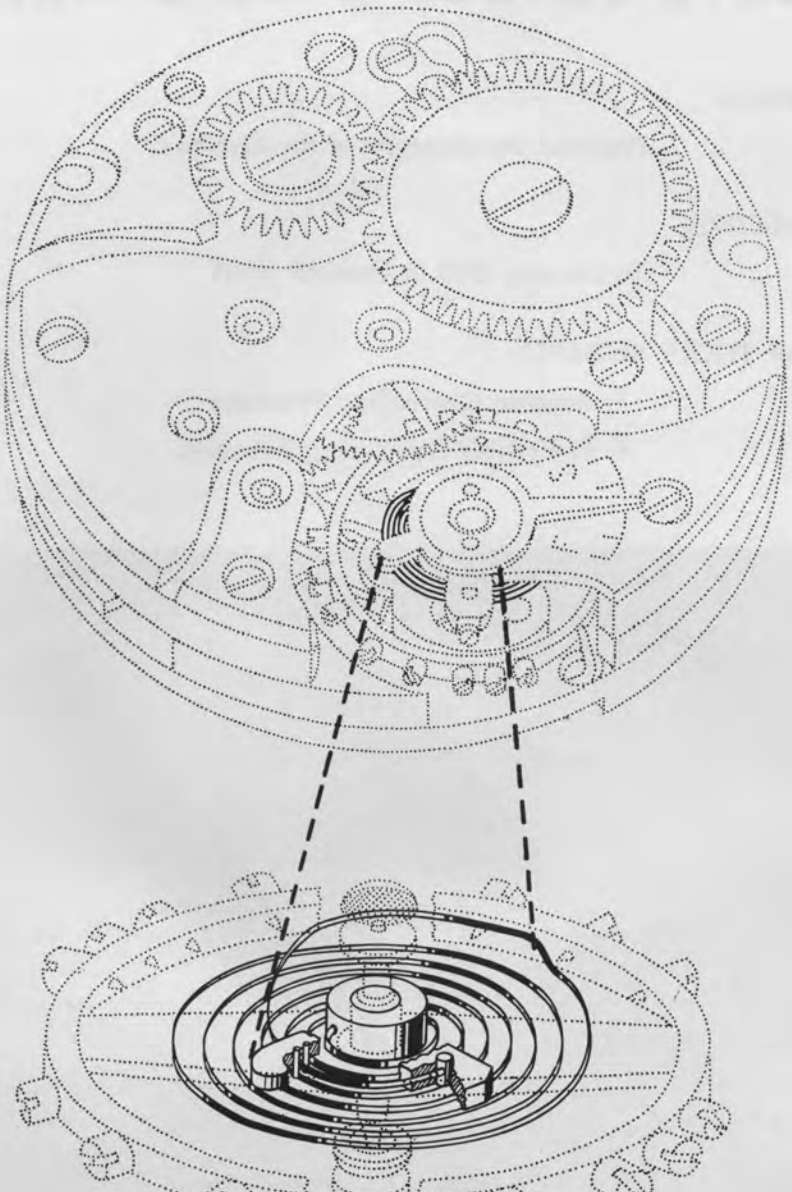
Overcoiling is a manipulative operation whereby the outer coil of a hairspring is so formed that when it is operating in a watch, the following conditions will be present:

1. The center of gravity of the spring will consistently tend to coincide with the axis of the balance staff.

2. As the spring winds and unwinds, its coils will remain concentric with the axis of the balance staff and its elastic force will increase and decrease in proportion to the angle of rotation of the balance wheel from the line of centers.

3. The spring will not cause the balance pivots at any point in their angular movement to exert a side thrust or pressure against their jeweled bearings.

4. The balance unit will make each swing or vibration in the same amount of time regardless of whether an impulse causes it to travel through a small or a large arc.



BULOVA SCHOOL *of* WATCHMAKING

SUBJECT:

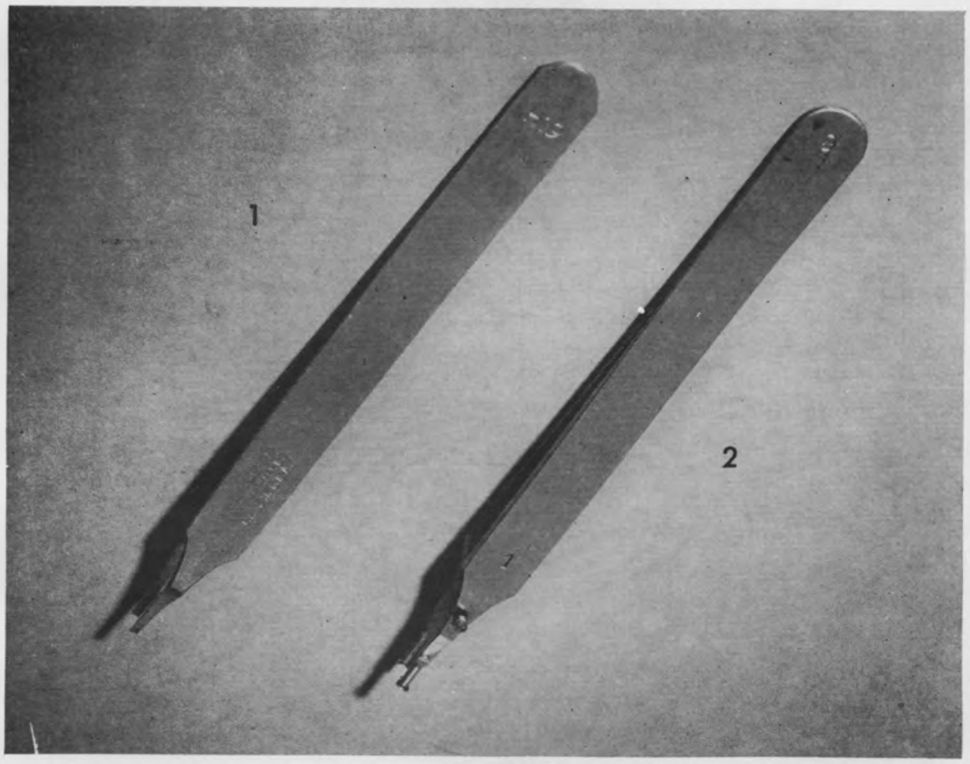
Practical Development of the Overcoil

OBJECTIVE:

To Develop Skill in Overcoil Work

NEW TOOLS REQUIRED:

1. Regular Overcoiling Tweezers
2. Knee Bend Overcoiling Tweezers



THE ISOCHRONAL HAIRSPRING

If a watch is in good working order and fully wound, the balance wheel may possibly swing in an arc as much as 270 degrees in a single vibration, Fig. 1. As the watch runs down, the swing gets less and less, Fig. 2. But regardless of this change in motion as time passes, it is required of the watch neither to lose nor gain. If this characteristic is present in a watch, then it may be said that it possesses an isochronal hairspring. An isochronal error exists in a hairspring if it causes the balance wheel to swing at a different rate in the high arcs than in the low arcs of motion.

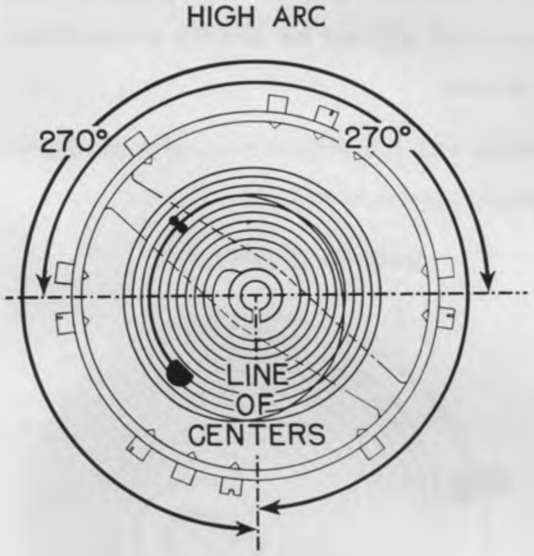


Fig. 1

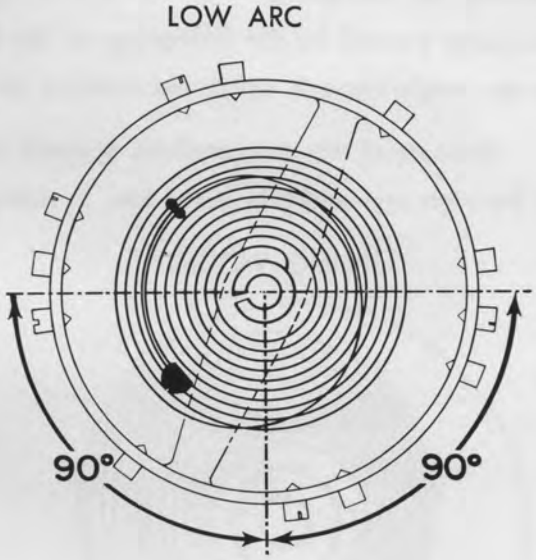


Fig. 2

THE FLAT HAIRSPRING

There is a characteristic present in a flat hairspring as it vibrates, i.e., winds and unwinds, that causes the coils to bunch together first on one side of the balance staff, then on the other. Fig. 3 and Fig. 4. Because of this action, it is apparent that a side thrust or pressure is brought to bear between the balance pivots and their jewel bearings. As the spring is wound up, the pressure is exerted in a direction away from the regulator pins. As the spring unwinds, the pressure is toward the regulator pins. This pressure causes an unequal turning action, or torque on the balance staff. The greater the swing of the balance, the greater will be the side thrust and the resulting friction. This means that the energy received by the jewel pin from the pallet does not all go into winding and unwinding the hairspring. Some of it is dissipated in overcoming friction. Because of this, the force exerted by the hairspring on the balance staff will not be directly proportional to the angle through which the balance staff is turned.

Because of this characteristic, a watch containing such a hairspring would tend to gain in the high arcs and lose in the low. In short, it would not be isochronal.

SPRING WOUND

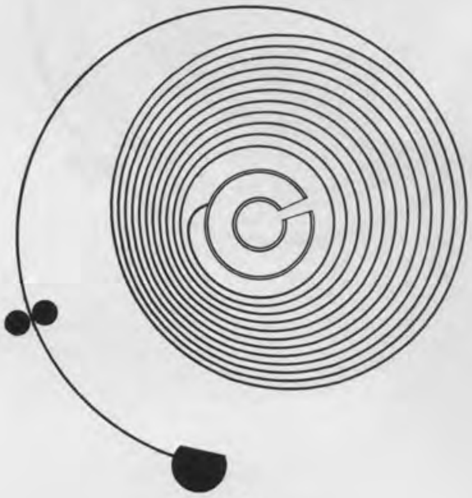


Fig. 3

SPRING UNWOUND

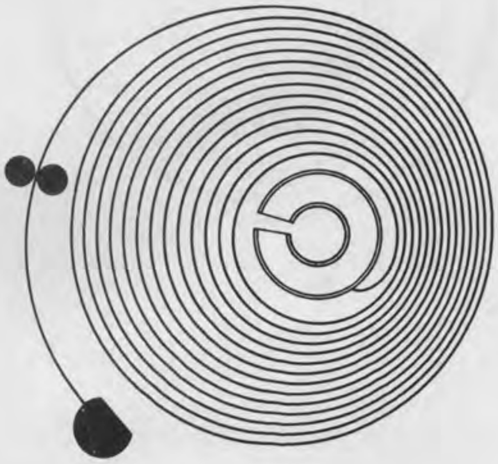


Fig. 4

THE BREGUET OR OVERCOIL HAIRSPRING

The idea for the overcoil came from the horologist Breguet who reasoned that if the outer coil of a flat hairspring was bent up and laid over the top of the main body of the spring, then the spring would wind and unwind more concentrically. As a result, the spring would not exert a side thrust and the force on the balance would be proportional to the angle through which it turned.

However, through experimentation, it was found that an isochronal error opposite to that produced by a flat hairspring was present when the overcoil was laid straight across the spring as shown in Fig. 5. The hairspring in this condition will produce a faster rate in the low arcs than in the high arcs. That is to say, a watch with such a spring will run slow when first wound and will gain as it runs down.

It is obvious that betweeen the two extremes just described, there must be a place to lay the overcoil which will cause the balance wheel to perform its vibrations in the same period of time regardless of whether it swings in a small or large arc of motion.

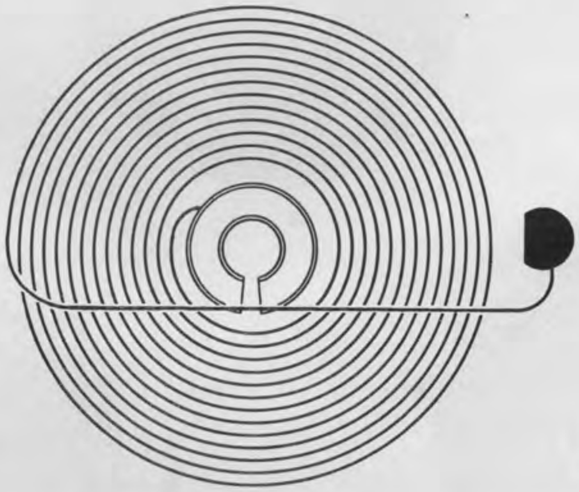


Fig. 5

In Fig. 6 are shown three basic types of overcoils that are in common use today. If any one of these types is selected for a given watch, then due consideration must be had for the location of portion AB of the overcoil relative to the balance staff. If AB should be located too close to the balance staff, the hairspring will cause the watch to have a gaining rate in the low arcs and a losing rate in the high arcs of motion. If AB should be located too far from the balance staff, then the hairspring will cause the watch to have a losing rate in the low arcs and a gaining rate in the high arcs of motion.

In the watch, an efficient overcoil keeps the other coils of the hairspring concentric as they wind and unwind, thus removing side thrust which is a major contributing cause of isochronal errors.

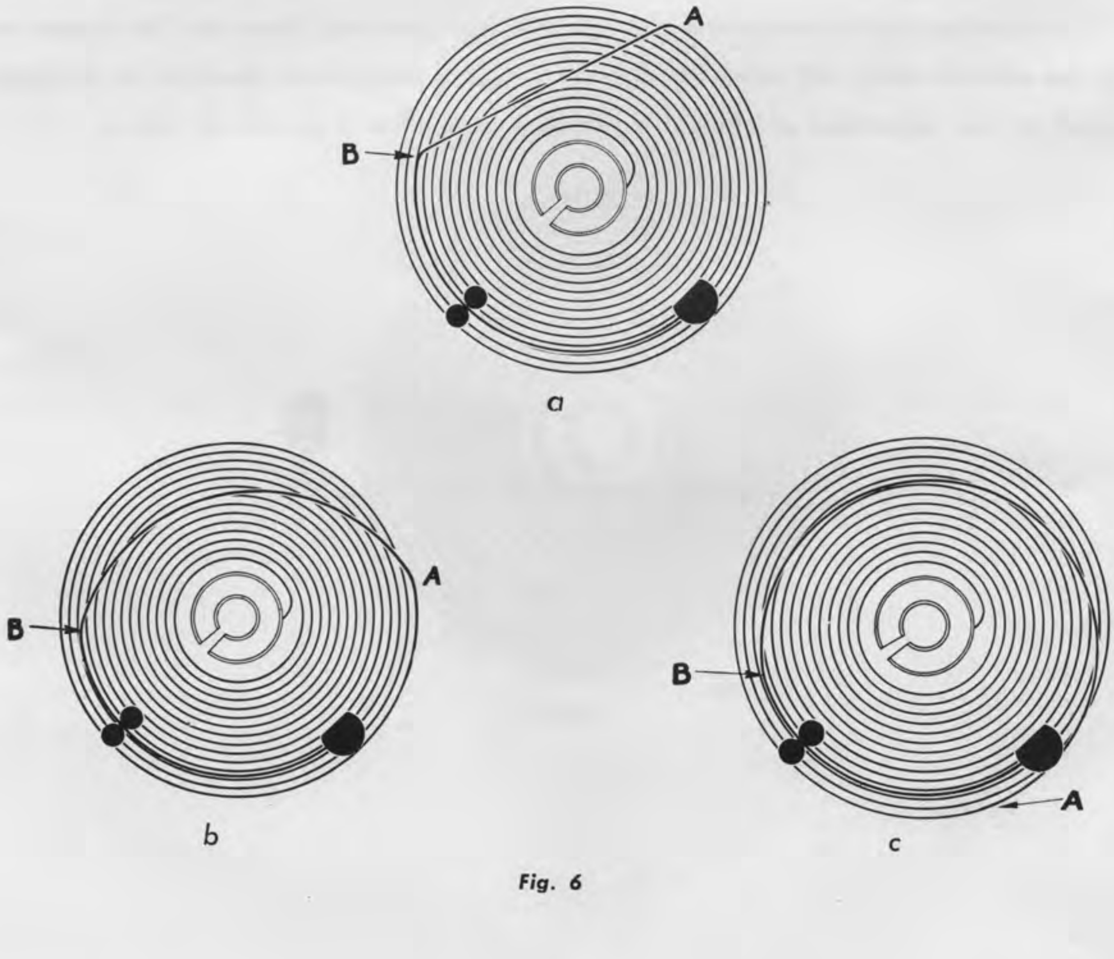
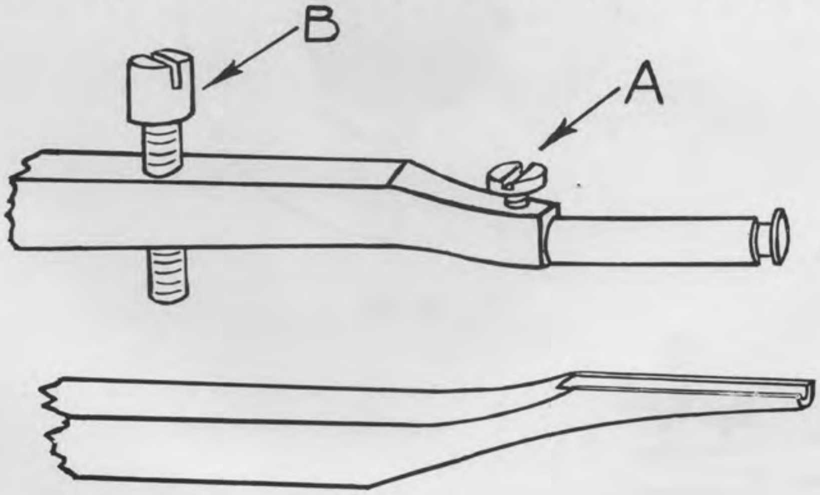


Fig. 6

FORMING THE OVERCOIL
Overcoil Raised with a Knee Bend Overcoil Tweeezers

The Overcoil will be developed according to the type shown in Fig. 6b. To accomplish a knee bend, a special tool shown in Fig. 7 is used. This is a knee bend overcoil tweezers. These tweezers will permit a variety of adjustments for use with many sizes of springs. Two adjustments must be made on the tweezers in order to prepare it for use. The width of the slot in the tweezers is adjusted by the slide and small set screw located at A, Fig. 7. The other adjustment is made with set screw B, Fig. 7. This screw regulates the distance apart the tweezer points will be when closed. The setting made in this latter adjustment determines the angle that the overcoil will rise from the main body of the spring.

Bear in mind that too sharp a bend will weaken or possibly fracture the spring. By experimenting with a discarded spring similar to the one to be overcoiled, the proper adjustments can be made accurately beforehand. An adjustment at B, Fig. 7, which will produce approximately a 25 degree rise from the main body of the spring, will be suitable.



KNEE BEND OVERCOILING TWEEZERS

Fig. 7

The first bend to be made in forming the overcoil is at A, Fig. 8, located about 270 degrees from the stud. (This angular measurement will vary with various sizes and types of balance units). The spring is suspended from a pair of ordinary tweezers held at T approximately 45 degrees to the right of A, Fig. 8. While in this condition, the hairspring is inserted into the slotted end of the overcoiling tweezers which are applied to the spring, with the slotted part above the concave part of the tweezers. The tweezers should be pressed together firmly until the set screw prevents further bending. When the spring is entirely released from the tweezers, it should have the appearance to that shown in Fig. 8C.

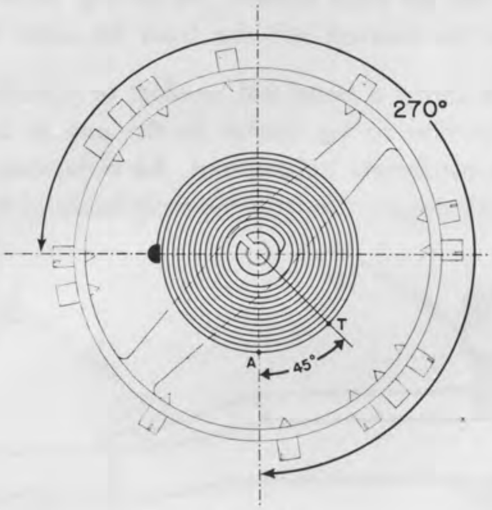


Fig. 8A

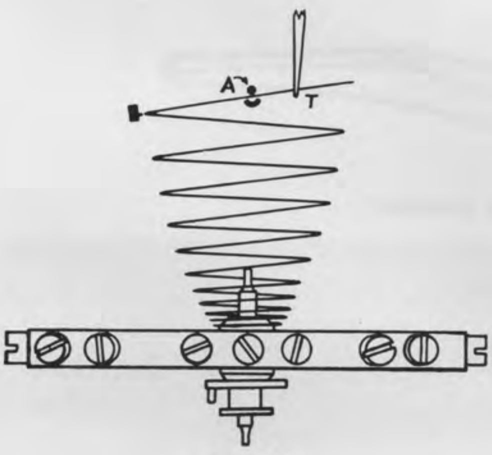


Fig. 8B

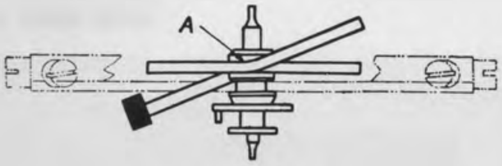


Fig. 8C

The second bend is at B, located to the right of A, Fig. 9. The purpose of this bend is to bring the overcoil into a plane parallel with the main body of the spring. The location of point B is determined by the desired height of the overcoil above the main body of the hairspring. For present purposes the height of the overcoil is to be about 2½ times the width of the hairspring itself. This bend is accomplished by suspending the balance and spring from a pair of ordinary tweezers held at point T, Fig. 9A approximately 45 degrees from point B. The knee bend overcoiling tweezers is applied in reverse from the way it was used to form bend A, i.e., with the concave part above the slotted part of the tweezers. As before, the spring is inserted into the slotted end of the tweezers and the tweezers are then pressed firmly together as far as they will go.

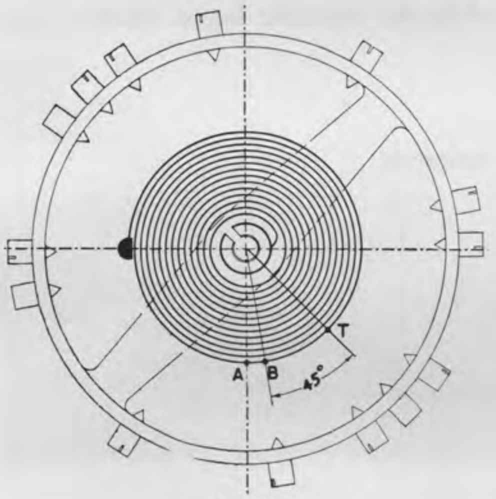


Fig. 9A

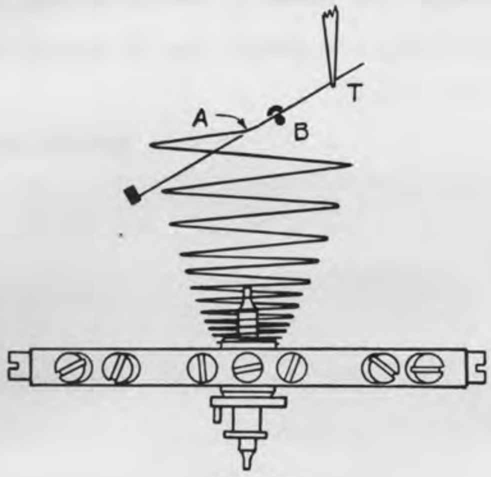


Fig. 9C

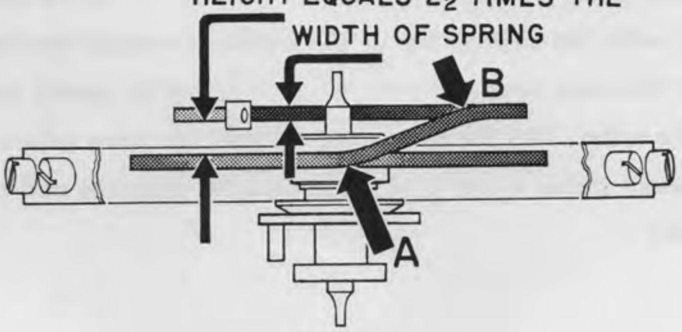


Fig. 9B

It will be found that, after bending the spring at B, the overcoil will not be exactly parallel with the main body of the spring. The point 180 degrees from B will be lower than it should be. A simple bend using two ordinary tweezers will provide the remedy. Grasp the spring a little to the left of bend B with a pair of tweezers held upright in the left hand. Then with the second tweezers held upright in the right hand, grasp the overcoil a trifle to the right of B. By simply swaying the right hand tweezer toward yourself, the overcoil can be brought to assume a perfect parallel position above the main body of the spring.

The next bend occurs at C, Fig. 11, using a pair of regular overcoiling tweezers, Fig. 10. This style of tweezers has its ends made in various widths for different sizes of springs. The inside of one of the legs is convex, while the opposite leg is concave and when they are closed, they fit closely together.

REGULAR OVERCOILING TWEEZERS

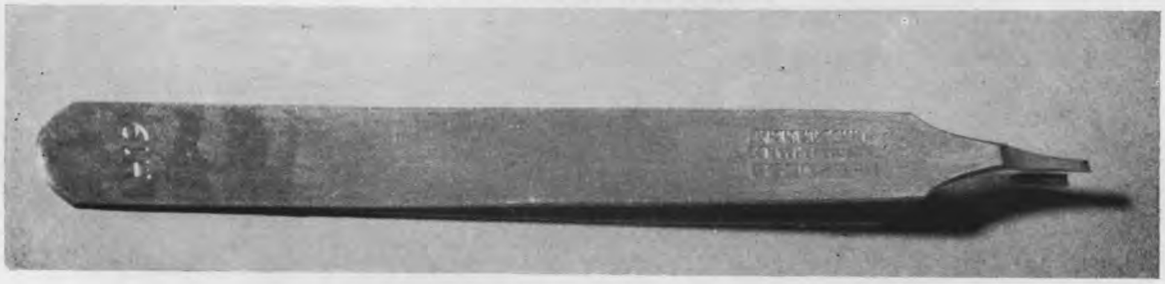


Fig. 10

Bend C is located about 45 degrees from bend A, Fig. 11 and is executed by grasping the spring at C with the convex leg of the tweezers nearest the balance staff and squeezing upon the tweezers until the overcoil at D moves to nearly halfway betweeen the outer coil and the collet. This position of the overcoil has been selected at random, the main purpose at present being to get practice in forming overcoils and not in developing an isochronal overcoil.

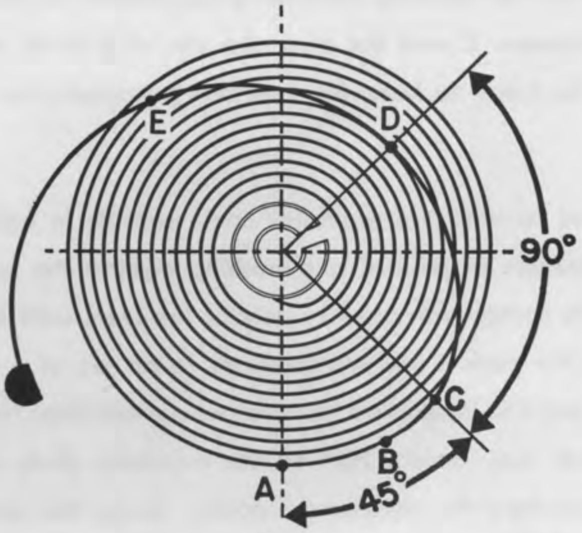


Fig. 11

The next bend is placed at E, Fig. 11 and is also performed with the regular overcoiling tweezers. Point E is arbitrarily selected where the overcoil crosses the 2nd coil counting from the outer coil. Since no attempt is being made to fit the hairspring to a given watch, this procedure will do. However in passing, note that for a given watch, the location of point E is determined by the distance from the hole jewel in the balance bridge to the regulator pins.

Forming the regulator circle is the final step in developing an overcoil. Since the regulator pins are mechanically held to a fixed distance from the hole jewel, they move in an arc of a circle. Because of this fact, it is necessary that the part of the overcoil that lies in the path of the regulator pins should be the perfect arc of a circle and should be free from any small kinks. If this should be otherwise, then proper regulation of the watch would be impossible.

The actual forming of the arc of a circle from point E to the stud may be performed in either of two ways. One way is to use the regular overcoiling tweezers. Grasp the overcoil at E, Fig. 12, and by carefully controlling the amount of pressure which is applied at successive points between E and the stud, the arc of a circle will result as shown in Fig. 12. Care should be taken to keep the tweezers perpendicular to the spring while it is being formed.

Another method of forming the regulator circle consists in holding the overcoil with a pair of ordinary tweezers at point E and pushing against the spring from the outside of the spring toward its center with another pair of tweezers until that part of the spring between E and where the push is applied conforms to an arc of a circle. Care should be taken not to select the point to be pushed too near where the other tweezers is grasping the overcoil because a kink may result. Part of the regulator circle is now formed. Next, observe where deviation from the circular arc occurs. Grasp the spring with the tweezers at this point, and with the other pair of tweezers, again push inward until another section of the overcoil conforms to the circular arc being formed. This procedure is continued all the way along the spring to the stud and if correctly done, a true circular arc will be produced.

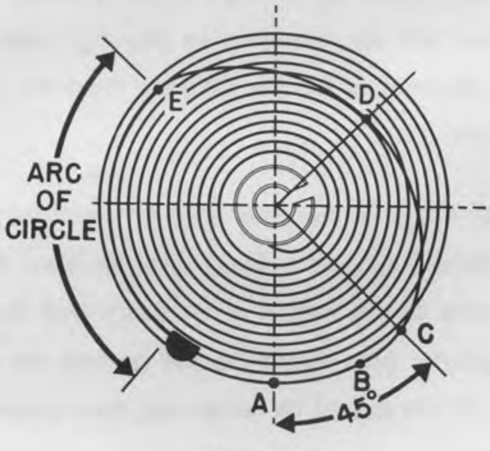


Fig. 12

OVERCOIL RAISED WITH THE GRADUAL BEND METHOD

The first bend upward is made at point A, which is located about 350 degrees from the stud. Fig. 13. As in the knee bend procedure, this measurement will also vary, depending on the requirements of the individual type of balance unit. This bend is made by using two pairs of ordinary tweezers. The spring is not staked to the balance staff which makes it easier to manipulate the gradual bend. The coil is firmly grasped at point A with one of the tweezers held vertically against the bench surface in the left hand. With the second tweezers held vertically in the right hand, grasp the coil about a millimeter to the right of the first tweezers. Hold the left hand tweezers steady and tilt the top of the right hand tweezer toward yourself. This will bend the spring in such a way that point B, 180 degrees away, will be the highest point. A sufficient bend is put in the spring at A until point B rises 2½ times the width of the spring.

For convenience, turn the entire spring clockwise until point B, Fig. 14, is nearest yourself. Then grasp the spring at B with a pair of tweezers held in the right hand and against the bench surface. About one millimeter to the left, grasp the spring with the other pair of tweezers held in the left hand. Be sure that the inner surfaces of the tweezers are in the same plane with that portion of the hairspring to be bent. Hold the left hand steady and tilt the right hand tweezer so that the top of it comes toward yourself. This manipulation bends that part of the overcoil between B and the stud upward, and enough of a bend should be put in the overcoil at B to bring it into a plane parallel to the main body of the spring.

The first bend inward occurs at point C which is located 90 degrees from point A. It is made with the regular overcoiling tweezers. Put sufficient pressure on the tweezers so that point B moves to almost halfway between the collet and the outer coil, Fig. 14. The next bend is placed at D where the overcoil crosses over the second coil. The regular overcoiling tweezer is used here as before.

The procedure of forming the regular circle from point D to the stud may be carried out using either of the two methods described when making a knee bend overcoil. When finished, the spring with overcoil will look like that shown in Fig. 15.

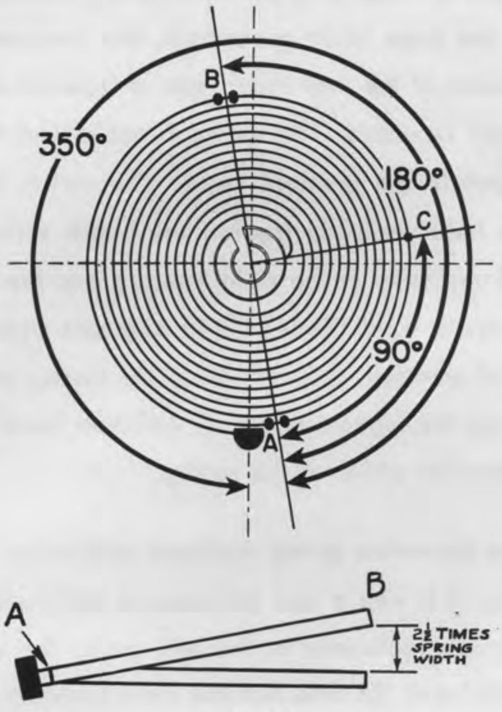


Fig. 13

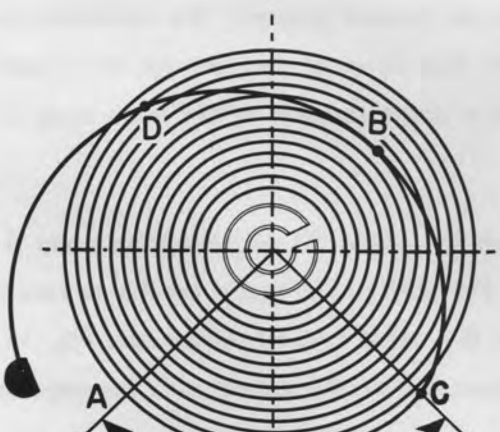


Fig. 14

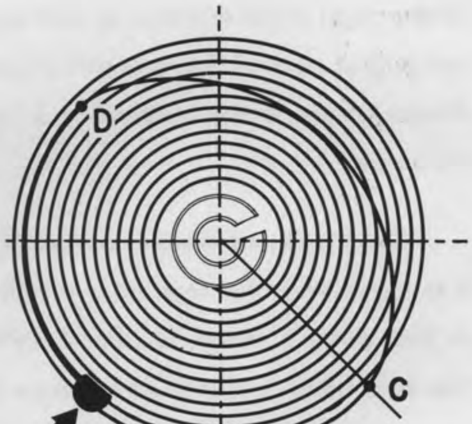


Fig. 15