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Part LXXXII

THE VERGE ESCAPEMENT USED IN WATCHES

One of the most important units of the watch is the escapement. It is this unit which transfers the power of the train to the balance wheel and hairspring, the timekeeping unit of the watch. In other words, the escapement changes the circular motion of the train to vibratory motion of the balance wheel and hairspring.

One of the earliest escapements used in watches was the verge escapement. Therefore, if one restores antique watches, it will be necessary to repair and adjust the verge escapement at some time or other.

The verge escapement is a "frictional rest" escapement. There is no pallet fork; therefore, the escape wheel teeth are always resting on the pallets which are attached to the balance staff, except during the drops.

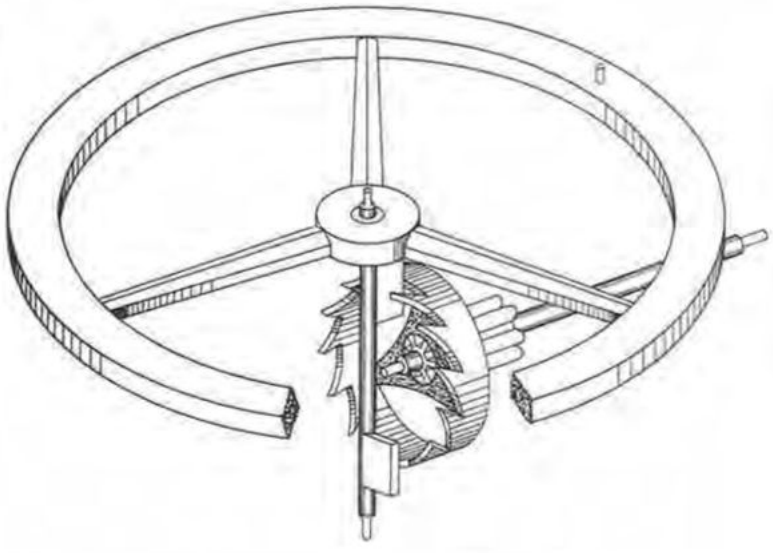
Figure 1 shows a watch verge escapement. The balance staff, which is the axis for the balance wheel, is called a verge staff. The verge staff has two pallets for the verge escape wheel teeth to work against alternately. The pallet next to the balance wheel is the upper pallet and the other one is the lower pallet. The locking faces of the two pallets are situated on the staff 100 degrees apart as one views them from the end of the staff. The escape wheel is of contrate wheel design; that is, the teeth extend up from the plane of the wheel instead of out with the plane of the wheel as in the case of a regular train wheel. The axis of the escape wheel is set at right angles to the verge staff. The verge staff runs in a vertical position and the escape wheel pinion runs in a horizontal position.

Figure 1 shows a tooth of the escape wheel locked on the upper pallet of the verge staff. The escape wheel must have an odd number of teeth for the escapement to function. When one tooth is locked on a pallet, there must be an empty space between two teeth to clear the other pallet. The escape wheel can have 11, 13, 15, 17, or more teeth as long as the number is uneven. The verge staff is centered with the escape wheel.

The balance wheel has a banking pin extending up from its rim to limit the motion of the balance wheel. This pin banks against each side of the balance cock if the motion becomes too much. On some verge watches, the banking pin extends down from the bottom of the balance wheel rim and banks against the ends of the regulator cover on the upper plate. Another method sometimes used is to bank the upper pallet against the end of a small pin that has been set into the edge of the hole in the upper plate which the verge staff goes through.

The hairspring is situated underneath the balance. The hair-

FIGURE 1



spring collet frictions onto the balance wheel hub. (The hub is not shown.)

THE ENGLISH VERGE ESCAPEMENT

Figure 2 shows how the escape wheel is held in position in an English verge watch. View A shows the escape wheel with its pinion. The potence is shown in View B and the counter potence is shown in View C. The potence and counter potence are fastened onto the underside of the upper plate. The potence is held to the upper plate with a screw and steady pins, whereas the counter potence is fastened to the plate by riveting.

The potence B carries the upper escape wheel pivot as well as the lower end of the verge staff shown at F. The lower verge staff pivot rests in a hole in the plug shown in View "c". The upper escape wheel pivot works in a hole in the dovetailed bar shown in View "a". This bar can be shifted in its dovetailed slot for equalizing the drops on the escapement.

The counter potence has an adjustable plug shown at D which is used to adjust the endshake on the escape wheel. This plug is called a follower. The rounded section on the follower is slightly tapered so it will fit friction tight in the hole in the counter potence. View E, Figure 2 shows the reversed end of the follower. The hole for the escape wheel pivot is shown at "d", Figure 2.

When the follower is shifted inward in the counter potence, the endshake on the escape wheel is decreased and the lock of the escape wheel teeth on the pallets is increased. When the follower is shifted outward in its hole in the counter potence, the endshake is increased and the lock is decreased on the escapement. Note: Adjustments to the English verge escapement should be done while the balance and escape wheel is assembled to the upper plate before the watch has been assembled.

FIGURE 2

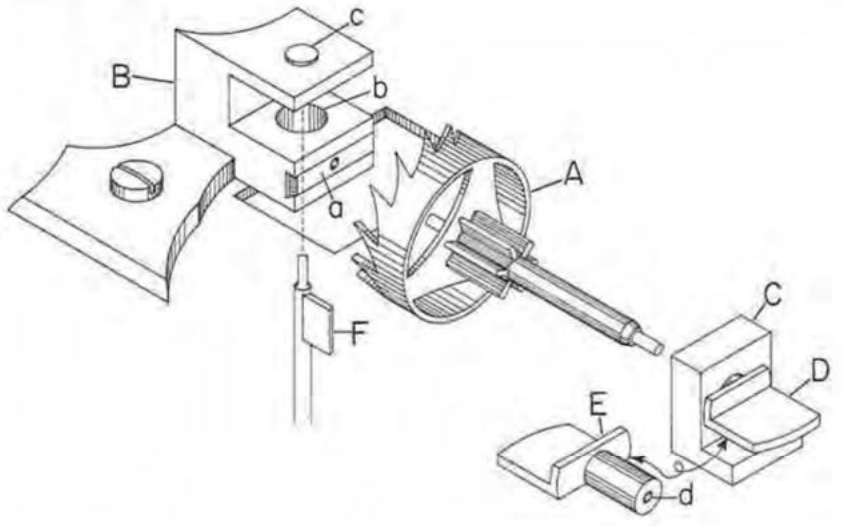
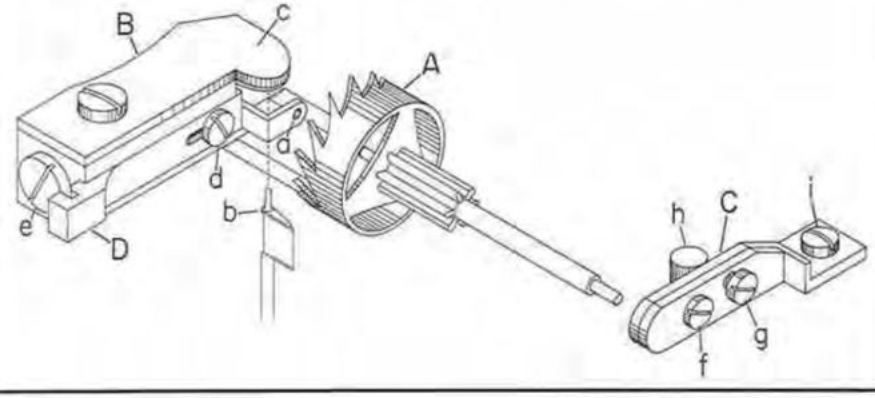


FIGURE 3



THE FRENCH VERGE ESCAPEMENT

Figure 3 shows the French verge escapement. The French method of adjustment is more precise than the English method. The escapement adjustments can usually be done with the watch assembled on French watches. This is due to their design. The escape wheel and pinion is shown at A. View B shows the potence and View C shows the counter potence. The upper pivot of the escape wheel fits into its hole "a" near the end of slide D. The lower pivot of the escape wheel fits into its hole in the counter potence. The lower pivot "b" of the verge staff fits into its hole in the potence B. Plate "c" on top of the potence serves as a cap for the lower verge staff pivot.

EQUALIZING THE DROP

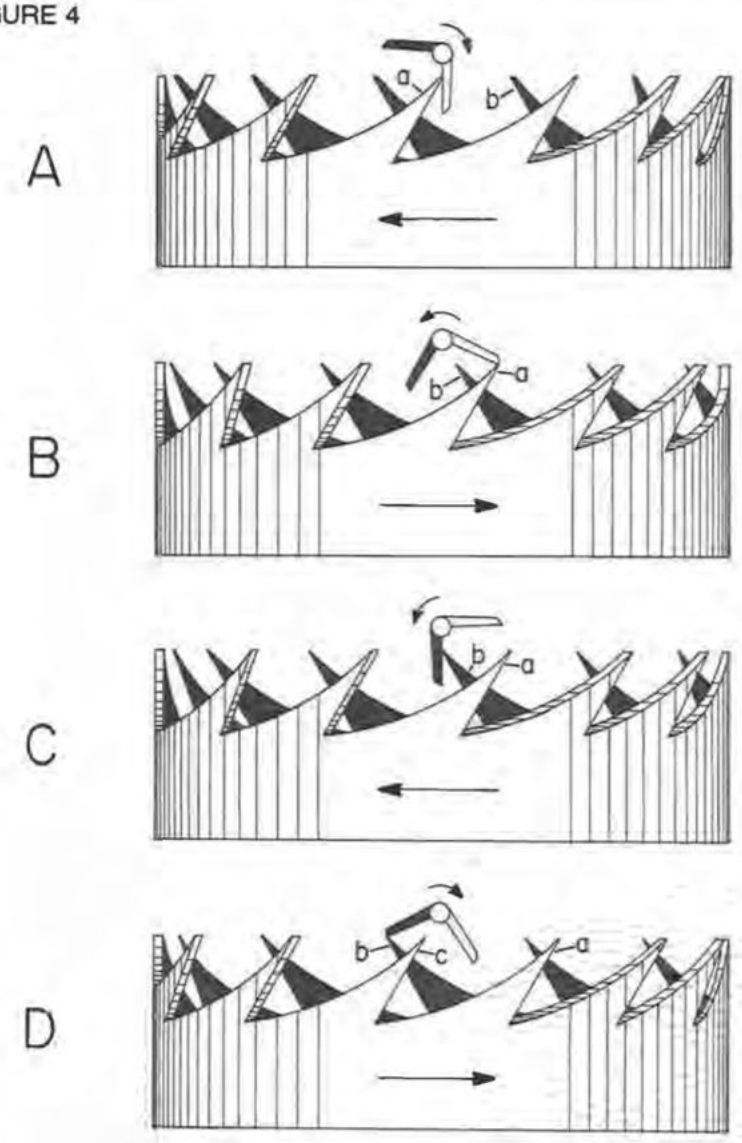
To equalize the drop on the escapement, one would move slide D back or forth in its slot on the side of the potence. Two screws are used to control the slide. Screw "d" is used to lock the slide into position and screw "e" is used to move the slide back and forth in its slot. Note that the edge of the head of screw "e" works in a slot in the slide to move the slide back and forth in its slot. To equalize the drop, one would loosen slightly screw "d". Then screw "e" is turned clockwise to advance the slide and one would turn the screw "e" counterclockwise to retract the slide. After the drops have been equalized, the locking screw "d" is tightened to maintain the position of the slide.

Unequal drop is usually caused by the center of the escape wheel being off center with the verge staff. To correct this condition, one must shift the escape wheel back on center with the verge staff by shifting the slide that supports the upper escape wheel pivot. The escape wheel is shifted toward the pallet which has the greatest drop onto the pallet face.

ADJUSTING THE DEPTH OF THE ESCAPE WHEEL

To adjust the depthing of the escape wheel teeth into the verge, one would manipulate the device on the counter potence which is intended for this purpose. Figure 3, View C shows the French counter potence. The following is a description of its use. Screw "f" is used to hold the cap to the potence. Screw "g" is used as a depthing screw for changing the endshake of the escape wheel. The end of this screw goes against post "h" which is frictioned into the upper plate. Screw "i" holds the counter potence tightly into position on the upper plate. A steady pin is placed in the base of the counter potence between screw "i" and the end of the base. This gives a pivot point so the base can be swung back and forth to make adjustments for endshake on the escape wheel. The hole in the base of the counter potence for screw "i" is enlarged enough to allow for the potence to be swung for the adjustments.

FIGURE 4



INCREASING THE LOCK

To increase the lock on the escape wheel, one would first loosen screw "i" slightly to allow the counter potence to be moved. Then screw "g" is backed up slightly by turning it counterclockwise. Next the counter potence is held so the end of screw "g" is against post "h". Then the base screw "i" is tightened so the counter potence is locked into position. This procedure is repeated if necessary to obtain the correct amount of lock. Note: As the lock is increased, the endshake on the escape wheel is decreased.

DECREASING THE LOCK

To decrease the lock, one would use the same procedure except, in this case, screw "g" is advanced by turning it clockwise. As this is done, the counter potence will be backed away from the post through the action of the end of screw "g" against the post. The endshake on the escape wheel is increased by this action and the lock is made less.

When the lock is increased, the drops are at the same time decreased; and when the lock is decreased, the drops are increased.

THE ACTION OF THE VERGE ESCAPEMENT

Figure 4 shows the sequential action of the verge escapement. View A shows tooth "a" of the escape wheel locked on the face of the upper pallet. This is at a point during recoil. The verge staff is turning clockwise and the escape wheel is backing up against the force of the train as is shown by the arrow on the escape wheel. This is an undesirable action, but it is a characteristic of the verge escapement. At the end of the recoil, the balance wheel reverses in the opposite direction which allows the escape wheel tooth "a" to slide down the pallet to give impulse to the balance wheel. This impulse is referred to as lift. This is

shown in View B. Note that the black tooth "b" has advanced toward the lower pallet shown in black. As soon as tooth "a" drops off of the white pallet, then tooth "b" drops onto the black pallet. The escape wheel is turning in the direction of the arrow. The balance wheel and its staff are turning in the direction of the small arrow during this action. View C shows the recoil taking place on the black pallet. Then the balance wheel reverses after recoil which allows the escape wheel to reverse and the black tooth "b" to slide down the pallet giving impulse or lift to the balance. This is shown in View D. At the end of impulse, the white tooth "c" will drop onto the white pallet and the escape wheel will recoil before tooth "c" impulses the balance wheel. This is a complete cycle of the escapement's action.

SPECIFICATIONS OF A VERGE ESCAPEMENT

Specifications of a verge escapement are as follows:

A. Opening of the pallets should be 100 degrees.

B. Lift -- Total lifting arc should be 40 degrees.

C. Escape wheel teeth should be undercut 30 degrees.

D. Maximum complete oscillation of balance -- 180 degrees.

E. Width of each pallet should equal slightly more than one-half of the space between the points of two escape wheel teeth.

F. Escape wheel teeth should overlap pallets approximately two-thirds of the width of the pallets for the correct amount of lock. This is measured from the center of the verge staff to the edge of the pallet.

Figure 5 shows layout drawings of the verge escapement showing the correct amount of lock, lift, and pallet opening. View A shows the correct amount of overlap of a tooth on a pallet at the center line of the escapement. This overlap or lock is two-thirds of the distance between the edge of the pallet and the center of the verge staff.

View B, Figure 5 shows a correctly laid out verge escapement. The escapement has 40 degrees of lift or impulse and a pallet span of 100 degrees. The width of the pallets is slightly more than one-half the distance between the points of two escape wheel teeth. These conditions cause the correct amount of lock and drop to be present. The drop is shown between the tip of tooth "b" and the black pallet.

EXCESSIVE LOCK

Figure 6 shows the effect of too much lock. View A shows a verge escapement which has too much lock. Tooth "a" lock is so deep that its tip is almost touching the body of the verge staff. This condition could cause the tip of the tooth to catch on the verge staff, as well as causing the escapement to set due to the lack of leverage. This condition causes more pressure directly against the pivots of the verge staff. This causes more friction on the staff which causes the pivot holes to wear more quickly.

Other conditions are created when the lock is too heavy also. This is shown in View B, Figure 6. These conditions are too much lift on the escapement and too little drop. In this particular case, the lift is 60 degrees instead of the 40 degrees needed. Note how small the drop is by observing the distance between the tip of tooth "b" and the black pallet. If the escape wheel should have uneven teeth, some teeth could hang up causing the watch to stop. Too much lock can cause the balance to overmotion and slow the rate of the watch.

INSUFFICIENT LOCK

Figure 7 shows a verge escapement which has too little lock. View A shows the lock at the center line. The tooth overlaps only one-half of the width of the pallet. The results of this condition are shown in View B, Figure 7. This light lock causes too little lift on the escapement. In this particular case, the lift is only 19 degrees when it should be 40 degrees. This condition also causes too much drop on the escapement. This is shown between the tooth "b" and the black pallet. This amount of drop is very excessive. Too much drop causes wasted power and excessive wear on the pallets, escape wheel teeth, pivots, and pivot holes. Also, the motion of the balance will be decreased, making the watch run fast.

FIGURE 5

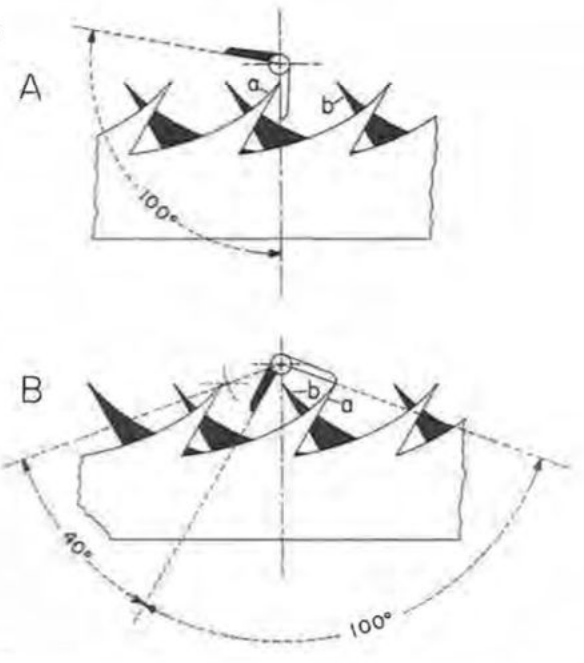


FIGURE 6

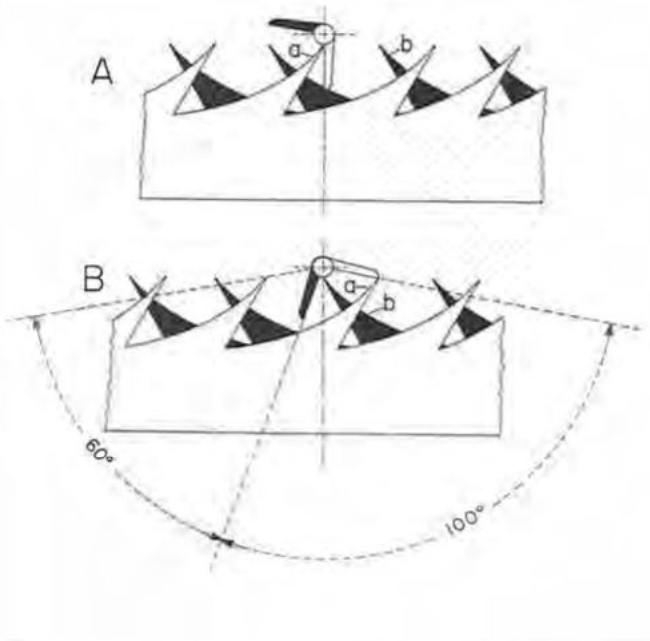
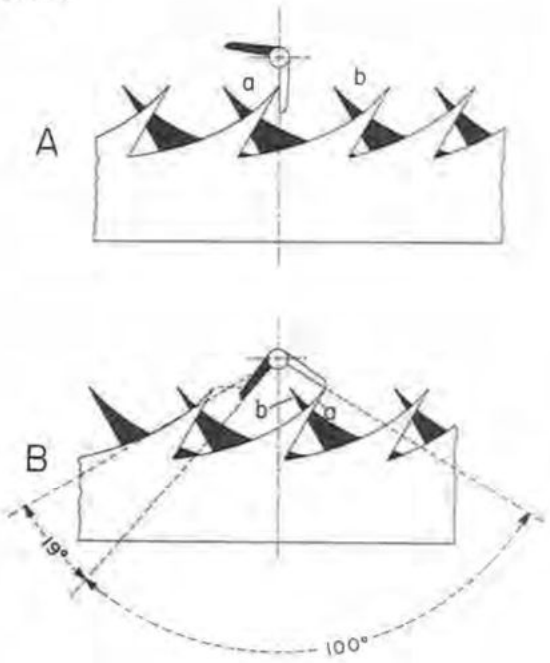


FIGURE 7



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Part LXXXIII

MAKING A VERGE ESCAPE WHEEL

One of the most common problems in the verge escapement is a damaged escape wheel. The teeth of the escape wheel are so delicate that they easily become damaged. It is common to find an escape wheel which has become damaged and has been repaired by someone. An attempt has been made to straighten the bent teeth, file all of the teeth to the same length, and use a file to repoint the teeth. In most cases, this destroys the accuracy of the escape wheel, making it useless. When this problem is encountered, there is nothing else to do but to make a new escape wheel.

MAKING THE ESCAPE WHEEL BLANK

Figure 1 shows some of the preliminary steps in making a verge escape wheel blank. The blank should be made from a piece of hard brass turning rod. The diameter of the rod should be slightly larger than the diameter of the escape wheel. The rod is chucked true in the lathe headstock as shown in View A, Figure 1. Then a sharp cutter is used in the slide rest to turn down the diameter of the rod so it is about .05 mm larger than the diameter of the escape wheel being reproduced. This operation trues up the rod so it is round and almost to diameter. Next, a small sharp cutter is used in the slide rest to bore out the end of the rod to form the inside shape of

FIGURE 1

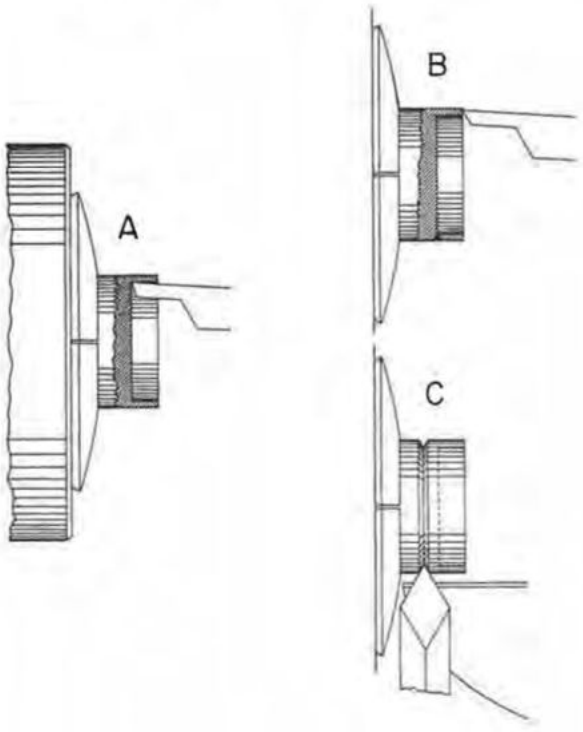
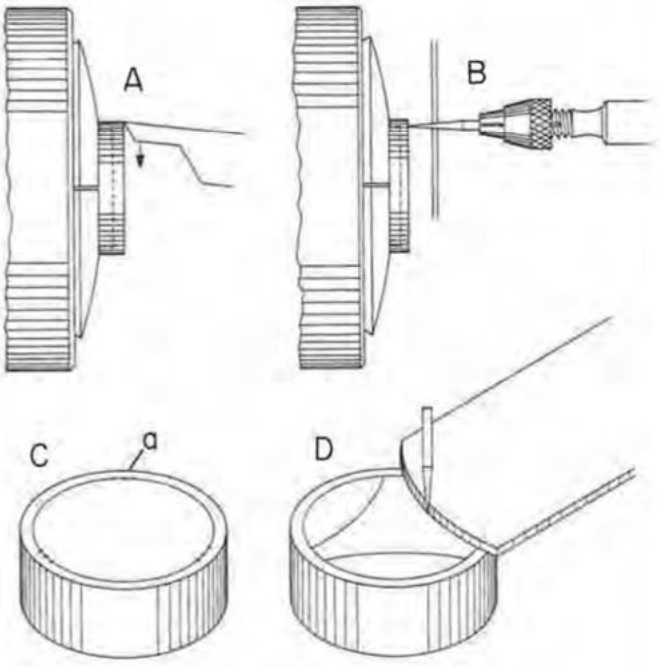


FIGURE 2



the blank as shown in View A, Figure 1. Note: The same cutter used to bore out the hole could also be used to turn down the diameter of the rod. The hole should be bored slightly deeper than is needed to allow for facing the end of the wall after the hole has been bored. The facing off is shown being done in View B, Figure 1. After the rod has been bored and faced, a sharp graver is used to cut a groove in the rod so the blank can be sawed off of the rod with a jewelers saw. This is shown in View C, Figure 1. Another method of removing the blank from the rod is to use a cut-off graver instead of the saw. The blank should be left slightly too long to allow for facing the bottom of the blank after it is removed from the rod.

View A, Figure 2 shows the bottom of the blank being faced flat after the blank has been reversed in the chuck. The blank must be running true before the facing is done.

CROSSING OUT THE WHEEL BLANK

The next operation in making the wheel blank is to cross out the spokes. This type of wheel universally has three spokes. The main reasons for crossing out this wheel are to lighten the wheel and to give a better view of the escapement action. The first step in crossing out the wheel blank is to scribe the outer circle of the spokes. This can be done by one of two methods. One method is to use a fine needle scriber over the T-rest while the blank is still chucked true after the bottom has been faced. This is shown in View B, Figure 2. This circle should not be very deep because it must be removed after the spokes have been made. The other method that can be used to scribe the circle is to spot a small center with a sharp graver after the bottom of the blank has been faced. Then use a small pair of dividers to scribe the circle.

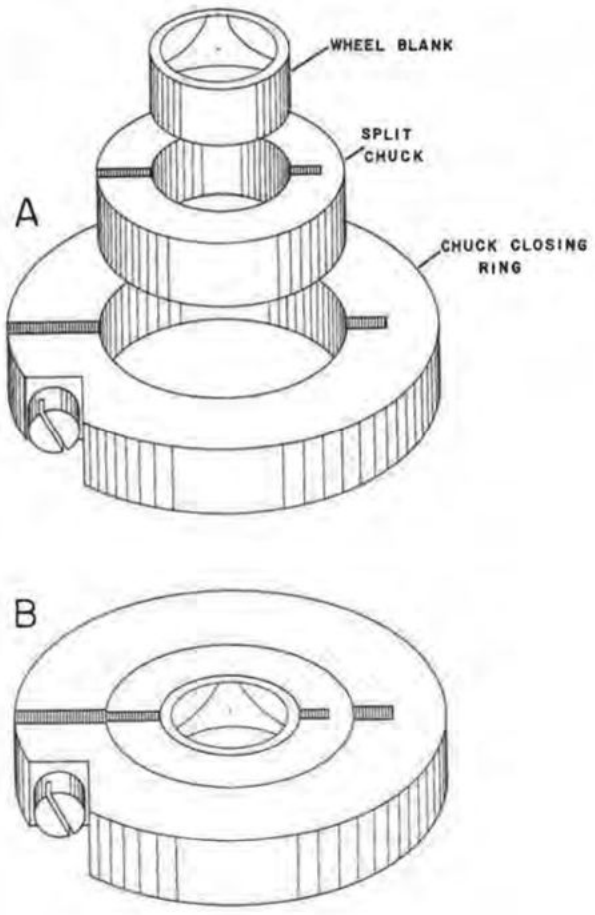
LAYING OUT AND SCRIBING THE SPOKES

The next step in making the blank is to lay out the spokes. This is done with a small pair of dividers. The dividers are used to divide the circle scribed previously into three equal parts. Marks are made across the circle at these points. These points will be the center of the end of each spoke of the wheel. Next lay off the width of the end of each spoke by making a mark on each side of the center mark for each spoke. This is shown at "a", View C, Figure 2. Now the spokes are scribed out as shown in View D, Figure 2. A radius gauge is being used as a pattern and a fine needle-pointed scriber is being used to scribe spokes.

HOLDING THE BLANK FOR MAKING THE SPOKES

Holding the wheel blank while making the spokes is very difficult since the blank is so small. A special holding device can be made up for holding verge escape wheel blanks. This holder is shown in Figure 3. The device has a split chuck to fit the diameter of the wheel blank and this chuck is closed with a chuck closing ring. View A, Figure 3 shows an exploded view of the device. One would make different size chucks as needed for different diameter escape wheel blanks but only one closing ring would be needed. The diameter of the chucks should be based on a standard size rod so they would be easier to produce. The chuck closing ring should be bored to fit the rod from which the chucks are made. View B, Figure 3 shows an escape wheel blank chucked in the device. This holding device would safely allow one to cross out the wheel after the teeth

FIGURE 3



have been cut. The teeth would be protected by this device during the layout, drilling, sawing, and filing of the spokes.

DRILLING THE HOLES FOR SAWING OUT THE SPOKES

Figure 4 shows the holes being drilled in the wheel blank for the saw blade when sawing out the spokes. The wheel holding device is supported on a drill pad which is held in the tailstock spindle. The drill is held in a chuck in the lathe headstock. The holes could also be drilled on a sensitive drill press. In this case, the wheel holding device would rest on the drill press table for the drilling operation.

SAWING OUT THE SPOKES

Figure 5 shows the spokes being sawed out. The wheel-holding device is rested on a sawing board as the three sections are sawed out to form the spokes. It is recommended that an 8/0 saw blade be used for this job. The saw blade must be kept absolutely vertical during the sawing process especially around the scribed circle. This is to avoid sawing into the wheel's rim. Very little pressure should be applied on the blade and very light uniform strokes should be taken with the saw. One should saw just inside the scribed lines, always leaving the line just visible.

FILING THE SPOKES

After the spokes have been sawed out, the spokes are filed just to the scribed line. The wheel blank is held in the wheel-holding device when the filing is done. The files used for this purpose should be Number 6 cut escapement files. One should file the spoke and the rim of the wheel to match the original wheel. To obtain a good finish to the filed surface, a small scraper can be used to scrape the surfaces smooth.

MAKING THE CUTTER FOR THE WHEEL

Figure 6 shows the main steps used in making the fly cutter for cutting the teeth of the verge escape wheel. The diameter of the drill rod for the cutter need not be larger than 1/8 inch. One would need an arbor chuck with a slightly off-center cross hole to fit the drill rod.

The first step in forming the cutter is to file or grind away about one half of the thickness of the rod at one end of the rod as shown in View A, Figure 6. This flat surface will form the front face of the cutter. Next, one should remove material from the back side of the cutter as shown in View B, Figure 6. Now the blank is hardened and tempered before the cutter is finally shaped by grinding.

HARDENING AND TEMPERING THE CUTTER BLANK

To harden the cutter blank, one should warm the blank in the torch flame before dipping the blank into a container of boric acid powder. This is done to prevent the surface of the blank from turning black in the hardening process. Next the cutter end of the blank is re-heated in the flame until it turns a medium cherry red. Then, at this point, the blank is quenched, cutter end first, into cold tap water. Note: When this is done, the cutter blank is held by the end opposite the cutting end with a pair of soldering tweezers. This prevents the body of the cutter from getting enough heat for it to harden when it is quenched. It is better for the body of the cutter to be soft so the arbor chuck set screw will hold the cutter tightly in the chuck. After the cutter has been heated and quenched, the cutter end should be checked with a file to see if it has been sufficiently hardened. If the file will not bite into the

FIGURE 4

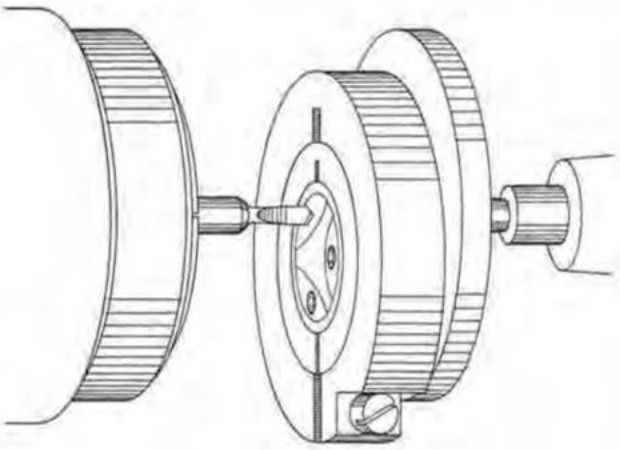
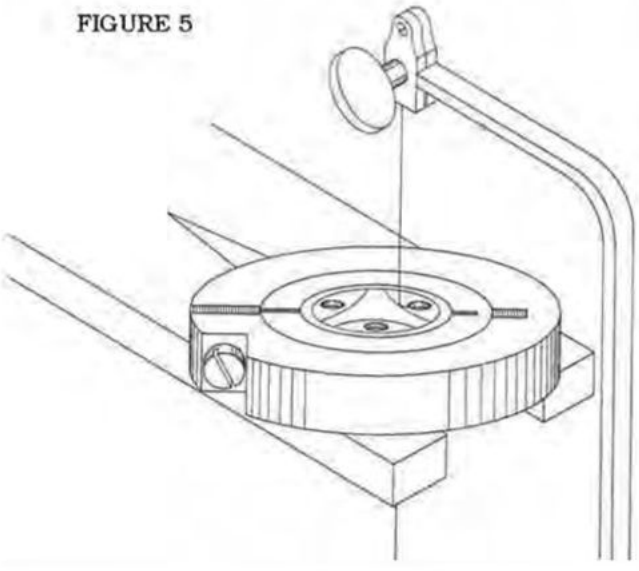


FIGURE 5



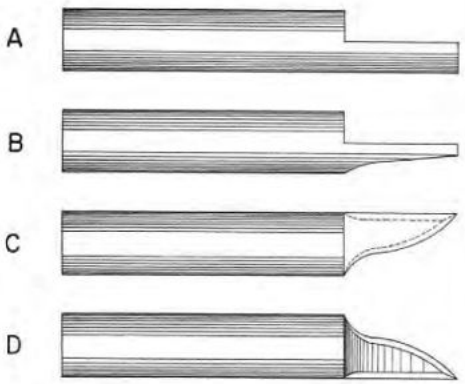
surface of the cutter, it has been hardened.

The cutter blank is now chucked up in the lathe and its surfaces cleaned off with emery paper to prepare it for tempering. Next the cutter blank is tempered to a light straw color. This is done on sand which is used in a metal tray or pan. The pan is heated over an alcohol lamp or burner. As soon as the cutter has reached the desired color, it is removed from the sand and placed on a piece of glass or sheet metal to let it cool slowly.

Now the shape of the cutter is completed by grinding on an emery wheel. A good grinding wheel for this purpose is a fine India wheel. The cutter blank can be held in a square chuck-holding device and used on top of a saw table.

The cutter is shaped to fit the space between two good teeth of the old escape wheel and, at the same time, the relief is ground on the cutter. This relief is shown in View C, Figure 6. The cutting face of the cutter is shown in this view. The dotted lines show the undercut which gives relief to the face of the cutter.

FIGURE 6



The back side of the cutter is shown in View D, Figure 6. The bevel around the edge of the cutter which gives relief to the cutting edge is shown in this view. The cutter is sharpened by grinding the front face of the cutter.

FIGURE 7

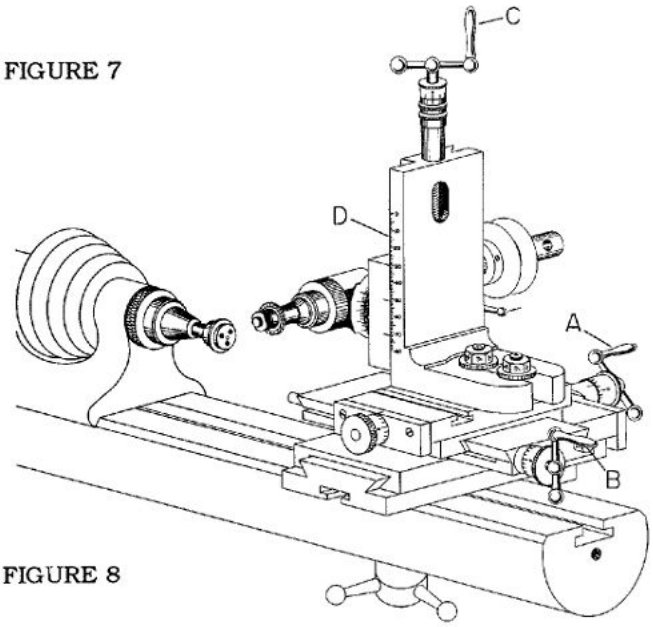
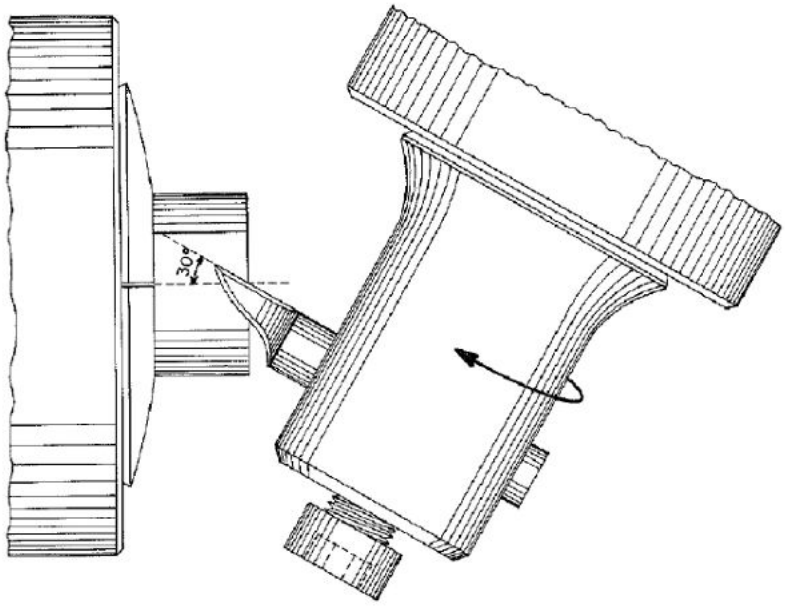


FIGURE 8



SETTING UP THE GEAR CUTTING EQUIPMENT

When cutting a verge escape wheel, one would need, in addition to the lathe, a slide rest and a gear cutting attachment to mount on top of the slide rest. One would also need an idler stand with pulleys to guide the belt to the gear cutting attachment. The slide rest should be placed on the lathe bed from the back side of the bed as shown in Figure 7. The gear cutting attachment should be fastened squarely and securely on the slide rest. The gear cutting attachment spindle should be set in a horizontal position as shown in Figure 7. The cutter arbor chuck is placed in the spindle of the gear cutting attachment. Then the cutter is fastened in the cutter arbor chuck. The front face of the cutter must be in line with the length of the arbor chuck. Now the top part of the slide rest is swiveled clockwise 30 degrees and locked in this position. This should

cause the spindle of the gear cutting attachment to have the same angular relationship to the lathe spindle as is shown in Figure 8. This is when they are viewed from the top of the lathe. Next a sharp center chuck is placed in the lathe spindle and, at the same time, the proper index plate is placed on the lathe spindle. Then the center chuck is tightened in the lathe spindle. The tip of the cutter is centered with the point of the center chuck. This is done by turning the crank (A) on the bottom slides. After the cutter is centered, one should not touch this crank. The crank shown at B which operates the top slides is used to set the depth of the cutter for length of tooth, and the crank shown at C on the gear cutting attachment is used each time a tooth is cut. The cutter is moved up and down when a tooth is cut. Now the center chuck is removed from the lathe spindle and the chuck holding the wheel blank is placed in the lathe spindle and tightened. Make sure that the wheel blank runs true in the round and flat.

SETTING THE CUTTER AND CUTTING THE TEETH

The cutter is set as shown in Figure 8 but not quite so deep into the blank to start with, then it is fed into the blank gradually to obtain the proper length tooth with the proper width tip to the tooth.

Note: One should start out with a practice wheel blank to first set the cutter, then the practice blank is replaced with the real blank and the teeth are cut. One can use a rod that has had a blank turned on its end for practice in setting the cutter.

Figures 9 and 10 show the cutter being used to cut the teeth on the verge escape wheel. View A, Figure 9 shows the cutter being fed through the wall of the blank. The cutter must never be fed completely through the wall as shown because, when this is done, the tips of the escape wheel teeth will come out with a triangular shape. This is shown at B, Figure 9.

Figure 10, View A shows the correct way to cut a verge escape wheel. The cutter should be lowered into the blank just far enough to make the tips of the teeth come out parallel as shown in View B, Figure 10. Note: The width of the tooth tips should be more narrow than is shown. The tips of the teeth should be .10 mm to .15 mm wide. One needs a stop on the vertical slide of the gear cutting attachment so the cutter will be lowered into the blank the correct amount and the same amount each time a tooth is cut. If the gear cutting attachment has a metric or inch scale on the edge of the slide as shown in View D, Figure 7, this can be used to indicate the distance that the cutter is lowered into the wheel blank.

When cutting the teeth on the escape wheel blank, it is a matter of engaging the index latch into the index plate, then lowering the cutter the proper amount into the blank, and then raising the cutter clear of the blank. Then index for the next tooth. This is repeated until all of the teeth are cut.

MOUNTING THE VERGE ESCAPE WHEEL

The seat on the pinion that the new escape wheel will be mounted on should be checked and re-cut if necessary. The rivet should be undercut so it is sharp. Then the new wheel is chucked true in the lathe with the teeth inside the chuck. Next the hole is drilled in the escape wheel. After this the hole is opened with a small boring tool so the pinion will just start into the hole. Then a staking tool is used to press the pinion into the wheel. After this the rivet is staked down onto the surface of the escape wheel. The wheel must run absolutely true on its pinion. After being staked, if the wheel should be slightly out of true in the flat, one would re-stake the rivet on the high side to bring the wheel true on the pinion.

❑

FIGURE 9

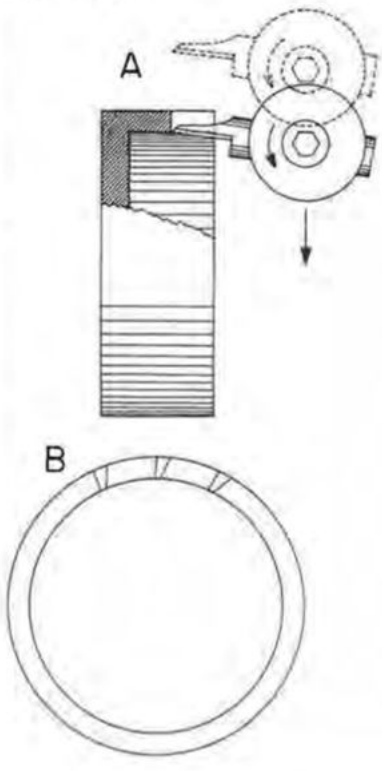
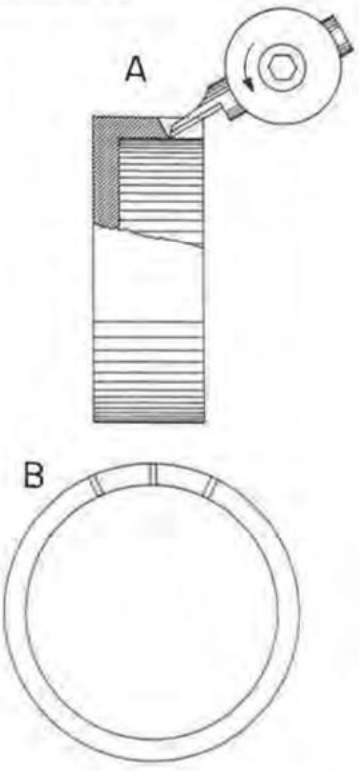


FIGURE 10



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Part LXXXIV

Making a Verge Staff

When there is a need to replace a verge staff, it most often needs to be made by the watchmaker to fit the particular watch. In the past, some verge staffs were available with brass hubs without the pivots being turned. These could be fitted without much work. Since these staffs do not seem to be available any more except maybe in some old watch materials bought in old tool sets, one must make the staff completely.

Construction of a Verge Balance Wheel Assembly

Figure 1 shows an exploded view of a verge watch balance wheel assembly. The following is a description of the assembly. View A shows the balance wheel. The balance wheel hub is shown in View B. The hairspring and its collet are shown at C, and the verge staff is shown at D. When assembled, the hub is riveted into the hole in the wheel. The hairspring collet frictions onto the wheel hub. The verge staff fits into the hole in the hub. There is usually a groove cut into the bottom of the hub for the end of the upper pallet to fit into. This keys the staff into a fixed position in the hub to prevent it from turning in the hub. Although some of these staffs are fitted friction tight into the hub, many of them were sweated into the hub with a small amount of soft solder.

Figure 1

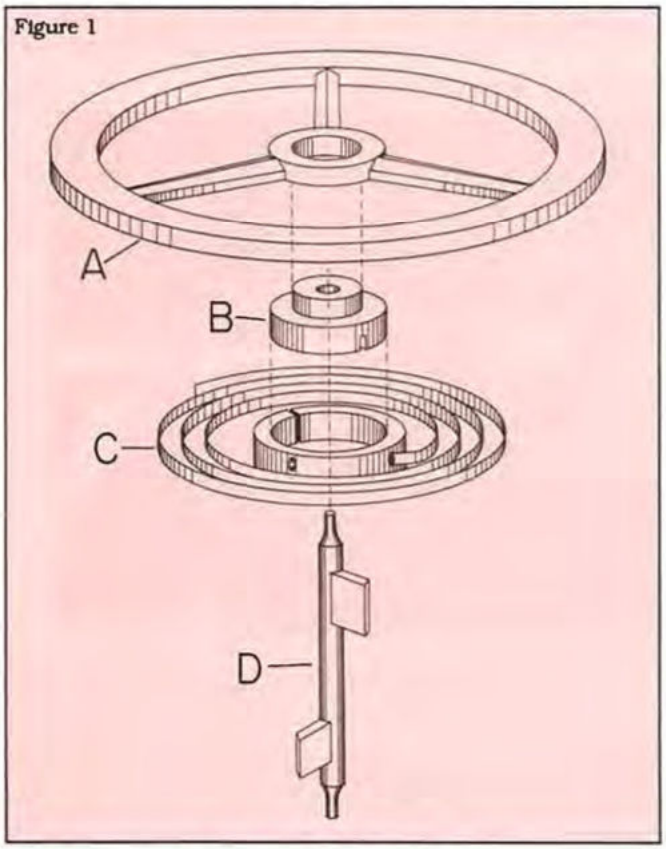
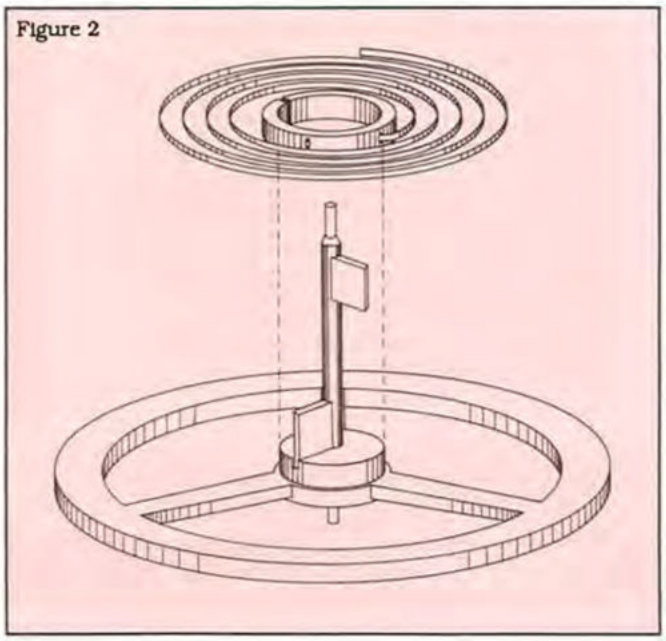


Figure 2 shows a verge balance with the staff already assembled into the balance wheel. The balance wheel is in an upside-down position. The hairspring collet fits around the balance wheel hub as shown by the dotted lines. This places the hairspring underneath the balance wheel when the wheel is in the watch and viewed from the top of the balance cock.

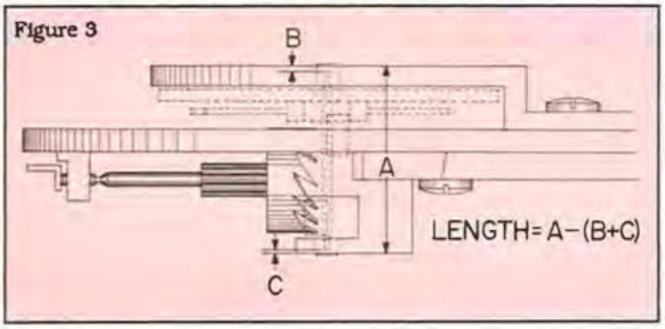
Figure 2



Taking Measurements
From the Watch

Sometimes the verge staff is broken and the lower part is missing. In this case, measurements must be taken from the watch in order to determine the dimensions for the new staff. Figure 3 shows an edge view of the verge escapement. The total length for the new verge staff can be determined by measuring with a micrometer from the outside of the balance cock to the bottom side of the potence as shown at A, Figure 3, then subtracting distance B plus distance C from measurement A. Distances B and C can be determined by measuring the depth of the pivot holes and subtracting these from the thickness of the balance cock and the section of the potence holding the pivot bushing. In Figure 3, the balance wheel, hairspring, and verge staff are shown in dotted lines. Note that teeth of the escape wheel run near the bottom of the opening in the potence. This means that the end of the lower pallet must be set close to the bottom of the opening of the potence; otherwise, the escape wheel teeth may miss the pallet. On the other hand, the end of the pallet must not rub on the potence. This condition leaves the lower end of the staff below the pallet shorter than the upper end of the staff above the upper pallet. All of this must be taken into consideration when making a new verge staff.

Figure 3



Selecting the Material
For a Verge Staff

The material selected for making a verge staff must be capable of being hardened. Usually sheet steel of the correct thickness is used for this purpose. If the proper high carbon water hardening steel cannot be obtained, one can use a piece of clock mainspring of adequate thickness. The steel should be slightly thicker than the diameter of the body of the verge staff being made. Figure 4 shows a piece of steel that has been selected for a verge staff. The dotted lines show the general outline of the shape that the verge staff will have and the location of the pallets in relation to the escape wheel. Enough material should be allowed at one end of the stock for going through the balance hub and for the upper pivot. The lower end of the verge staff is shorter than the upper end, but one must allow enough material for the pivot below the lower pallet.

The material for the verge staff should be in an annealed state when forming the shape of the staff. Then, after the staff has been formed, it is hardened, tempered, and finished.

Making the Verge Staff

Figure 5, View A shows how the material for the verge staff is filed for shaping the staff. The material is held in a specially made chuck in the headstock of the lathe and supported in the groove on top of a wood peg which fits the hand rest of the lathe.

The special chuck shown in View B, Figure 5 was made by the author. It has a small hole and wide slots. The hole is to accommodate the body of the verge staff while the stock fits in one of the slots of the chuck. In some cases, one may be able to use a standard wire chuck already in the chuck set, but in most cases, when one is found with the proper hole size, the slots are too narrow for the verge material. The wood peg supporting the verge material should be made of hard wood such as maple. The groove in the wood peg can be sawed or filed. For best results, the groove should be sawed with a circle saw in the milling attachment spindle while the plug is chucked in the headstock of the lathe. The purpose of the groove is to hold the verge material solid while the excess material is filed away.

The file used to remove the excess material when forming the verge should have a Number 6 cut and be of a width which will fit between the two pallets on the verge staff. Usually a needle file or an escapement file is used for this purpose.

The verge material should be filed until the section which will make up the body of the verge staff is square. Later, this square body is filed round.

Filing the Verge
Body Round

After the verge staff has been filed out, it is rechucked so the ends of the body can be pointed with a graver as shown in Figure 6. This is done so the end of the staff can be supported with the tailstock spindle while the body of the verge is filed round. After the ends have been pointed, the staff may be chucked between centers in the lathe if desired. One would use a work carrier on the verge staff and a pin on the center chuck to go against the work carrier to turn the staff. One may also chuck the staff as shown in Figure 7.

Figure 7, View A shows the verge staff being filed round. The end of the staff is supported with a female taper center in the lathe tailstock. The center of the staff is supported on a wood peg in the hand rest. The wood peg must be made narrow enough to go between the pallets on the staff as shown. The first step in filing the staff round is to file off each of the four sharp corners of the square staff. When this is done, the lathe headstock is turned by hand. After the sharp corners have been removed with the file, the lathe headstock can be turned slowly with the motor for filing the staff round. NOTE: The square staff must be turning true in the lathe before attempting to file it round. The staff is left slightly over-sized for the hardening and tempering process, then it is brought down to size after this.

After the staff has been filed round, the back

Figure 4

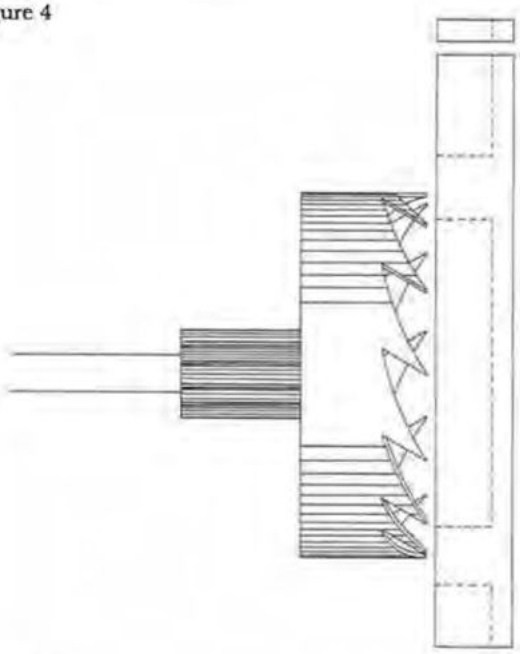


Figure 5

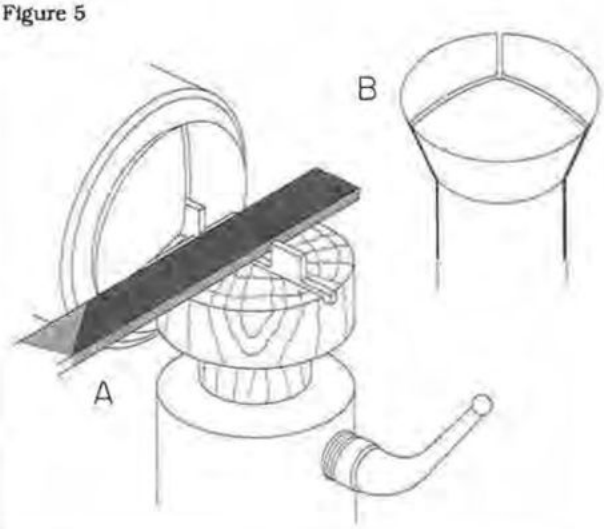


Figure 6

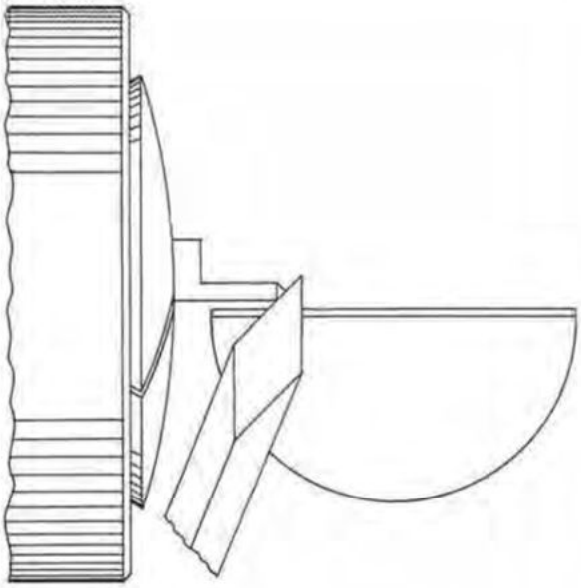
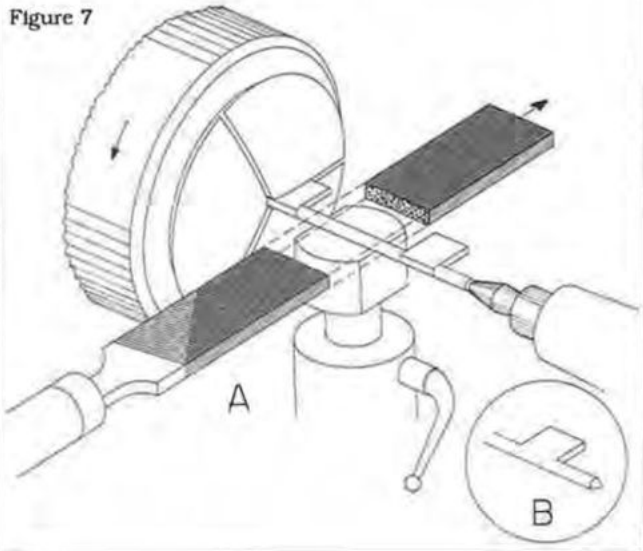


Figure 7



edge of each pallet is filed round and even with the staff as shown in View B, Figure 7.

Turning the Verge Body Round

The shaft part of the verge staff may be turned round instead of filing it round. This is shown being done in Figure 8. The staff is chucked the same as when it was filed except the wood support peg is not used when turning the staff. A right-hand shouldering graver is used for part of the turning and a left-hand shouldering graver is used for the other part of the turning. A cutoff graver could also be used for turning the staff round. The T-rest used to support the graver would need to be narrow enough so it could be placed as close to the work as possible. After the staff has been turned round, the back of each pallet would need to be filed off rounded to be even with the turned section of the staff.

Figure 8

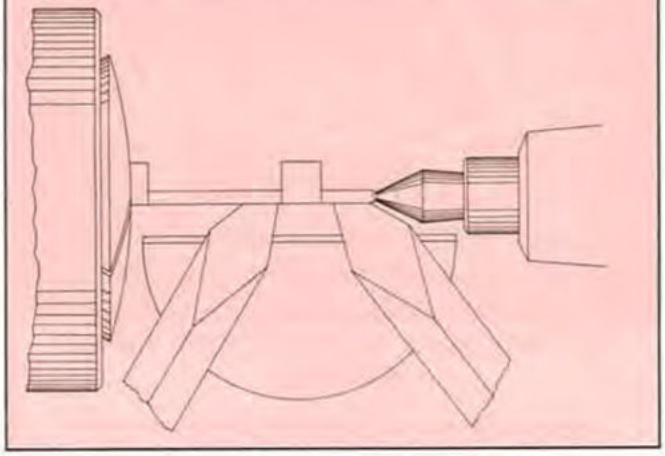


Figure 9

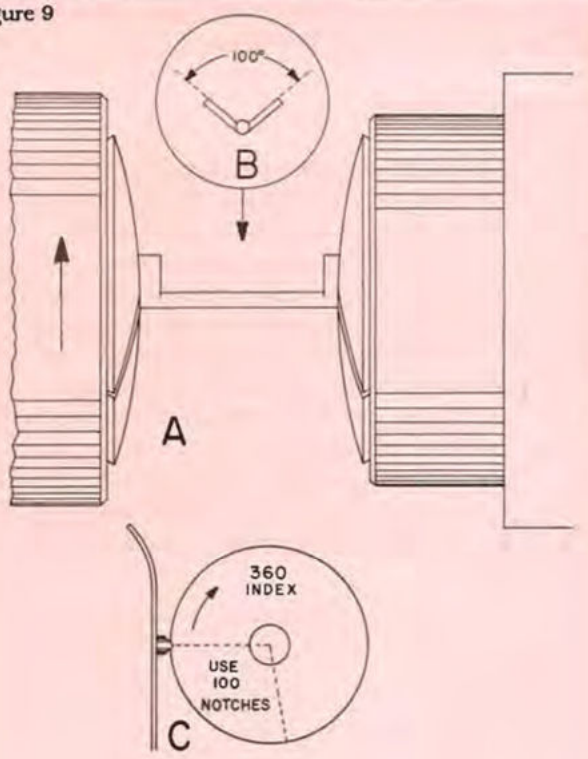
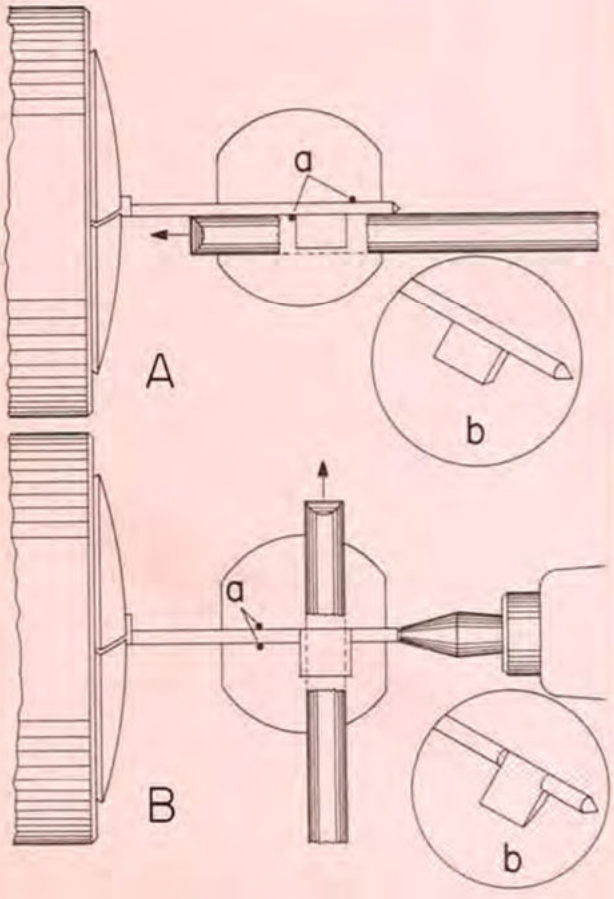


Figure 10



Twisting the Verge Staff

After the verge staff has been filed or turned round, it must be twisted to obtain the correct angle between the two pallets. The proper angle is 100 degrees. Although the pallet can be twisted by hand with pliers or pin vises, a more accurate and controlled method is shown in Figure 9.

View A, Figure 9 shows the verge staff being held on one end in a chuck in the lathe headstock. The other end of the staff is held in a chuck in the lathe tailstock. NOTE: If one does not have a lathe with a chuck holding tailstock, a chuck holder for the tailstock can be used in the tailstock spindle for holding the end of the verge staff. The tailstock spindle is locked solid and the headstock is turned 100 degrees clockwise when viewed from the chuck end. This spreads the pallets 100 degrees as shown in View B, Figure 9. The method used to measure this amount is to use a 360 notch index plate on the lathe headstock spindle and an index latch that fastens to the bed of the lathe to gauge the amount indexed. Since a complete circle has 360 degrees, each notch of a 360 index has a value of 1 degree; therefore, 100 notches equals 100 degrees. This is shown in View C, Figure 9.

Shaping the Pallets

Figure 10, View A shows how a pallet on an English verge staff is filed to shape it so it will operate with the escape wheel. The staff is chucked in the lathe headstock while the pallet being filed is supported on the flat top of the wood peg in the hand rest. The headstock is locked solid with the pallet flat on top of the wood peg for this operation. The verge staff can be supported further by two brass pins, one on each side of the staff, as shown at points "a" in View A, Figure 10. These pins are pressed into the wood peg and then cut off about flush with the pallet and staff. It is very important that the hand rest be a solid non-tip-over type. The file used to file the pallet should be a Number 6 cut escapement file. The face of the pallet is filed almost to the center of the arbor or staff. When finished, the face of the pallet should be on center. This applies to both pallets. This is to allow for proper drop space on the pallet. Point "b," View A shows an end view of the pallet after it has been filed. Note that the outside edge of the pallet has been beveled away from the front face for escape wheel tooth clearance.

View B, Figure 10 shows how the pallets are filed on a French verge staff. In this case, the filing is done across the staff instead of with the length of the staff, as shown in View A. The end of the staff is supported by a taper center in the tailstock spindle. The pins shown at "a" are pressed into the wood peg to help support the center of the verge staff while filing and finishing the pallet. The pallet is filed until its face is almost to the center of the staff. Enough is allowed for finishing the face of the pallet after the staff has been hardened and tempered. The back side of each pallet is rounded as shown at point "b," View B. The finishing of the acting faces of the pallet can be done with grinding slips and fine grinding compound. The polishing is done with a boxwood slip and Linde A® or diamantine.

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Part LXXXV

HARDENING THE VERGE STAFF

After the verge staff has been made and the major shaping has been done, one would harden and temper the staff. Since the verge staff is so delicate, one must use special care in heating it during the hardening process. One must avoid heating the staff too hot or heating it unevenly. If the staff is heated too hot, the structure in the steel will become damaged and the staff could become warped. If the staff is heated unevenly, it could warp as well as having soft and hard spots throughout its structure. During the heating process, one should also try to avoid oxidizing the surface of the verge staff. Oxidation occurs when air gets to the surface of the article as it is being heated. This oxidation or discoloration is not always easy to remove, especially on something so delicate as a verge staff. The oxidation must be removed before the tempering is done in order to see the tempering colors. It is always best to take steps to prevent oxidation when hardening steel.

HEATING THE VERGE STAFF

Figure 1, View A shows a specially made box or tube that is excellent for use in heating small parts when they are being hardened. This box is made from a piece of steel rod. The rod has been drilled to form a chamber for the part. A cap to close the opening has been made to fit loosely in the hole in the end of the box. A groove has been turned at the opposite end of the box to accommodate a wire handle for one to hold onto during the process of using the box.

To use the box when heating the verge staff for hardening, one would use the following procedure. First, take some powdered wood charcoal and mix with some water to make a thick paste. The verge staff is then completely covered with the charcoal paste. Then some of the paste is placed in the bottom of the box before the verge staff is placed in the box. Next, more charcoal paste is placed in the box on top of the staff before the box is closed with its cover. This procedure serves two purposes. The charcoal keeps the air from getting to the surface of the staff while it is being heated, and the staff will absorb some carbon from the charcoal while it is red hot. This helps to enhance the carbon content of the steel from which the staff is made.

Next, the box with its contents is heated over a gas burner as shown in View B, Figure 1. The burner shown is a Fisher burner. The Bunsen burner may also be used, or even a gas torch can be used. The box is heated uniformly until it is a uniform medium cherry red and it is kept at this temperature for a minute or two. Then the cover is removed from the box and its contents are dumped quickly into a container of water which is at room temperature. Now the staff is removed from the water and dried off and

Figure 1

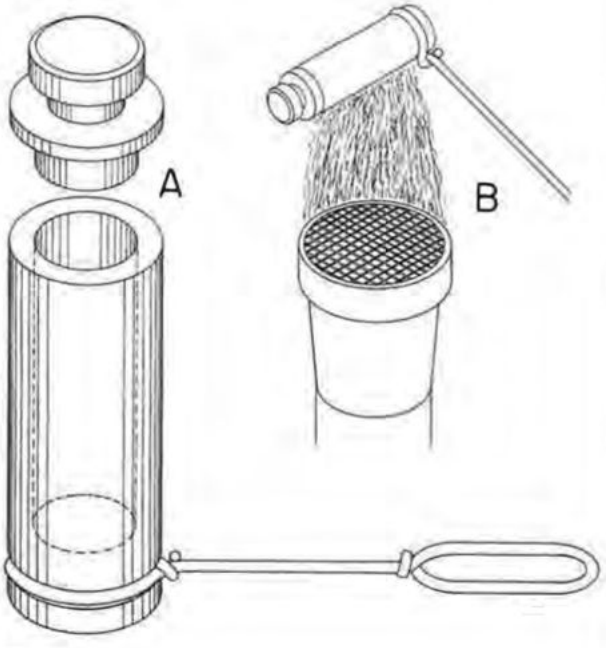
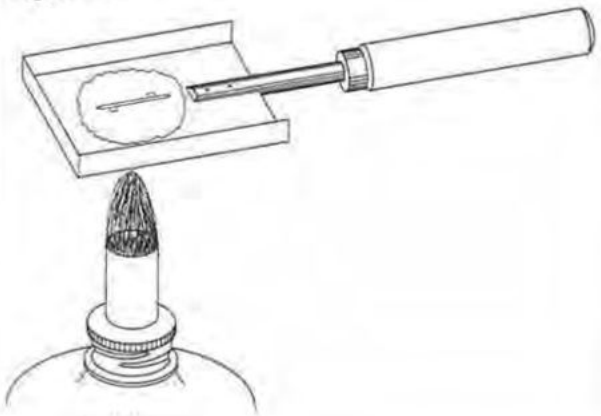


Figure 2



then checked with a fine file for hardness. If the file slides over the surface of the staff without biting into the surface, we can be assured that the staff did harden.

Note: If the previous instructions were followed, the staff should not have any discoloration on its surface. If the staff should come out of the heating process with discoloration, this must be polished off of the surface before tempering the staff. This can usually be done with fine emery paper or Diamantine on pegwood. Care must be used in polishing off the discoloration to avoid breaking the staff. Remember that the staff is very hard and brittle.

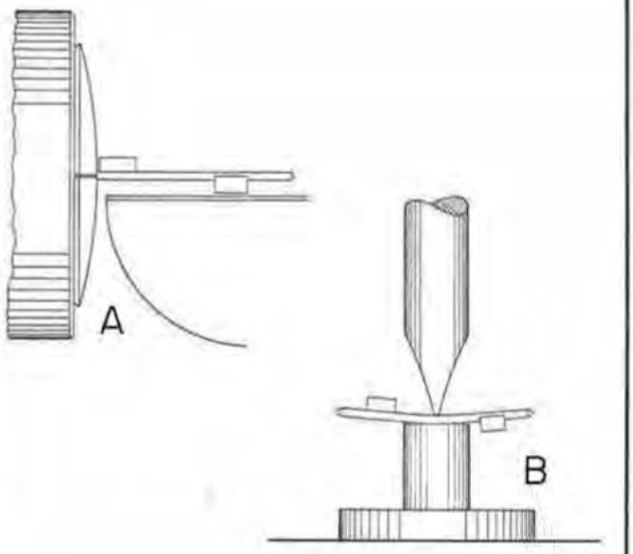
TEMPERING THE VERGE STAFF

The verge staff can be tempered as shown in Figure 2. A bluing pan is used for this purpose. Some clean fine sand is placed in the bluing pan. Then the staff is cleaned before being placed on top of the sand. The pan is heated slowly over the alcohol lamp until the staff turns dark blue which occurs just after the purple color. When the desired blue color is reached, the staff is removed from the sand and laid on a piece of glass or some metal to let it cool slowly. Note: When heating the pan, it should be kept moving back and forth over the alcohol flame. This is so the article will be heated more uniformly.

CHECKING THE STAFF FOR STRAIGHTNESS

Figure 3, View A shows how the staff is held in a chuck in the lathe to check it for being straight. The "T" rest is set as closely as possible to the staff, parallel to the staff and used as an indicator. The lathe is turned slowly for this test. If the staff shows to be warped, it is peened with a peening punch or a peening hammer as shown in View B, Figure 3. The peening is done on the hollow side of the staff which is the short side of the staff. This stretches the short side to straighten the staff. The peening should be done lightly at several places near the center of the bend, not all in one place. Any peening marks can be ground and polished out after the staff has been straightened.

Figure 3



FINISHING THE SURFACES OF THE VERGE STAFF

Figure 4 shows how the surfaces of the verge staff are finished. View A shows how grinding slips are used to grind and polish the body of a verge staff. Both edges of the grinding slip and polishing slips should be undercut as shown at "a", View A, Figure 4. This is to help prevent the pallets from getting caught on the slip during the finishing operations. A small narrow sapphire burnisher is excellent to use for grinding and lapping the body of a verge staff, or one

Figure 5

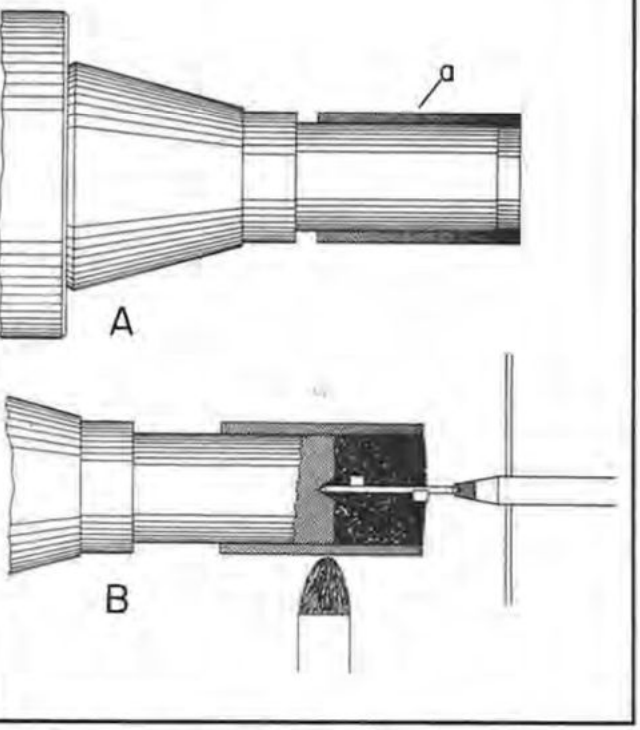
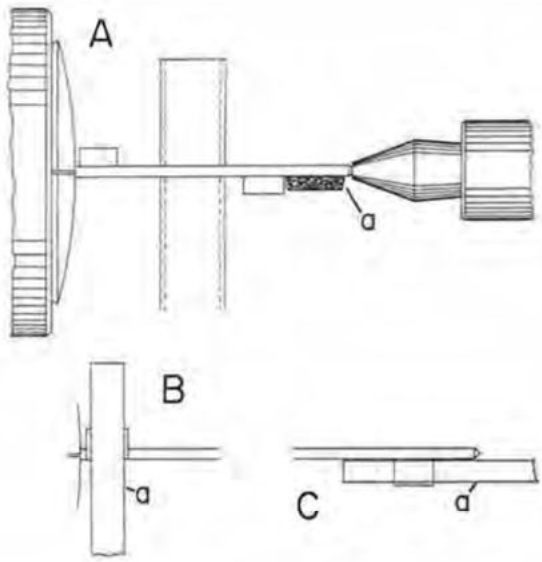


Figure 4



may use iron and bell metal slips instead. Oilstone paste is used on the iron slip and coarse Diamantine mixed with oil is used on the bell metal slip. The staff is finally polished with a boxwood slip and Linde A or fine Diamantine.

Figures B and C show how the pallets are ground and polished. Figure B shows how a French verge staff pallet is finished and View C shows an English verge pallet being finished. The same kinds of slips and compounds are used for this purpose as were used for the body of the staff.

MAKING THE PIVOTS ON A VERGE STAFF

After the surfaces of the staff have been finished, one would proceed to make and finish the pivots on the staff. When this is done, the staff should be cemented up true in a cement brass. This is shown in Figure 5. View A shows the type of cement brass that is needed for this operation. This cement brass has been turned down in diameter so it will fit closely inside a brass tube shown at "a", View A, Figure 5. This tube can be adjusted to accommodate any length of staff. The tube can be removed from the cement brass while the center is spotted for the end of the verge staff to fit into. The center need not be very deep since the tube can be adjusted outwardly to support the shellac and the verge staff. If one used a cement brass without the tube, the center would need to be cut so deeply to support the staff that it would be almost impossible to cut a good sharp center for the staff.

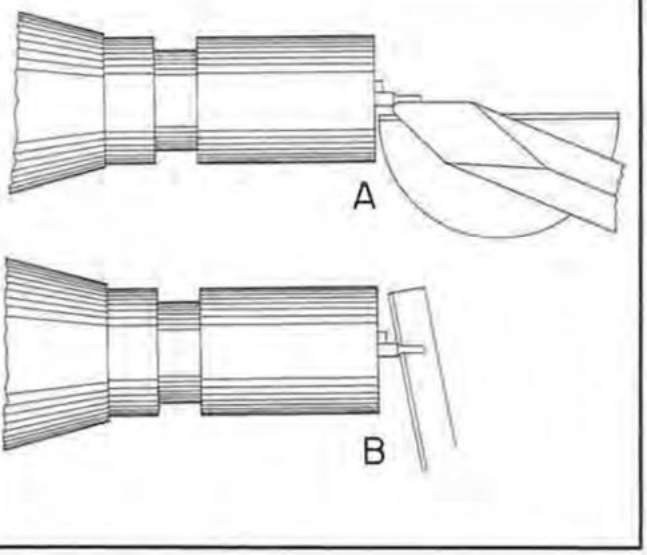
View B, Figure 5 shows a verge staff being cemented up in the cement brass. The tube on the cement brass has been adjusted to allow one end of the staff to protrude far enough past the end of the tube to allow the pivot to be made on the staff. An alcohol lamp is used to heat the cement brass and its tube while shellac is melted inside the tube as shown. While the shellac is melted, the end of the staff is inserted into the shellac until the pointed end of the staff is seated in the bottom of the center in the cement brass as shown. While the shellac is warm, a piece of pegwood is used over the "T" rest to keep the staff centered and running true until the shellac cools. The pegwood has a "V" center cut in its end to go over the pointed end of the staff. The lathe is turned slowly when the staff is being cemented up.

MAKING THE PIVOTS ON THE STAFF

Figure 6 shows how the lower pivot is made on the verge staff. View A shows how the pivot is turned almost to size. A round pointed graver is used for this purpose. View B, Figure 6 shows how grinding slips and burnishers are used to finish the pivot. The end of the pivot is also finished and any burr is removed from the corner of the pivot. The cement brass is reheated to remove the staff from the shellac. The shellac is removed from the staff by soaking it in denatured alcohol.

Next, the staff is cemented up for making the upper pivot and tapering the upper end of the staff so it can be frictioned into the hub in the balance wheel. See Figure 7, View A. After the upper pivot has been made and finished, the body of the staff back of the pivot is taper turned so it can be frictioned into the hub. An enlarged view "b" shows more clearly the

Figure 6



tapering operation. The amount of taper on the staff should match the taper on a broach used to broach the hole in the hub for the staff.

MAKING & STAKING THE BALANCE WHEEL HUB

Figure 8 shows how to make and stake the balance hub. View A shows the step in making the hub. A

Figure 7

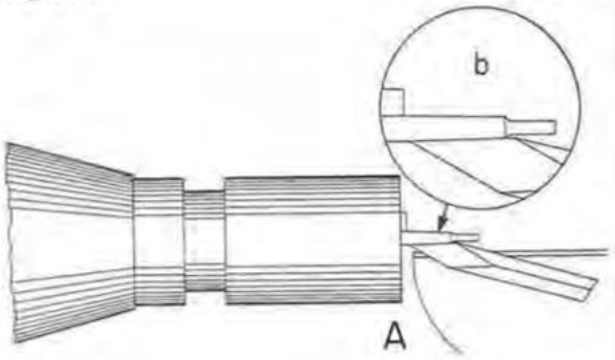


Figure 8

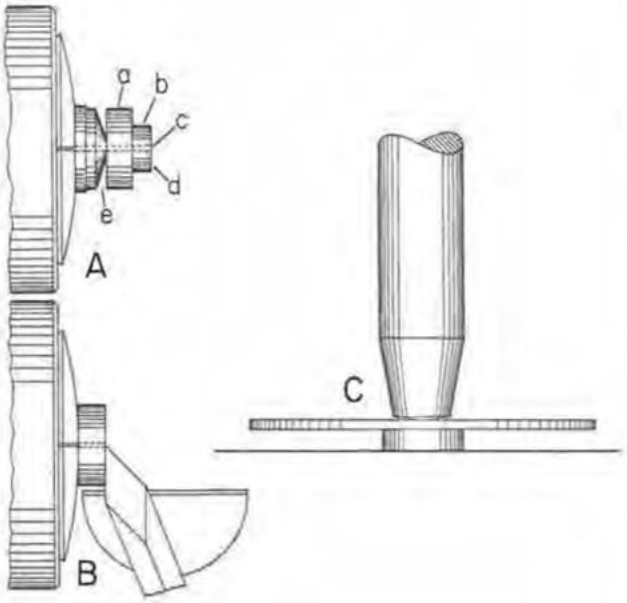
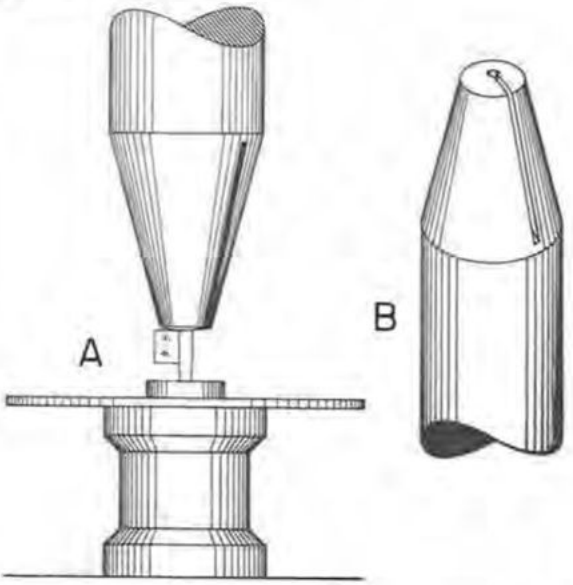


Figure 9



piece of brass rod is selected that is slightly larger than the hole in the hairspring collet. This is chucked up true in the lathe. Then diameter "a" is turned to fit the hairspring collet. Next, the diameter "b" is turned to fit the hole in the balance wheel. Now, a drill is selected which as slightly smaller than the tapered end of the verge staff. A center is spotted with the graver in the end of the rod for the drill to start into. Then hole "c" is drilled. After the hole has been drilled, the corner of the hole is beveled as shown at "d", View A. Then the hub is cut from the rod as shown at "e".

After the hub has been removed from the rod, it is chucked by the balance shoulder while the end is faced flat as shown in View B, Figure 8. View C, Figure 8 shows the finished hub being staked into the balance wheel. The hub is being supported on the die plate of the staking tool and a flat face solid punch is being used too flatten the rivet down onto the balance wheel.

STAKING THE VERGE STAFF INTO THE BALANCE HUB

Figure 9, View A shows the staff being staked into the balance wheel hub. A special punch is being used for this operation. The punch has a hole that just clears the diameter of the body of the staff. A slot has been sawed lengthwise of the punch which extends into the hole in the punch. This slot is a clearance slot for the lower pallet while the rounded end of the punch rests on the upper pallet as shown. View B, Figure 9 shows an end view of the construction of the punch. This view shows more clearly the design of the punch. Before staking the staff, the hole in the hub is broached from the bottom of the hub with a broach which has about the same taper as the taper on the staff. The staff is pressed in, or the punch may be tapped lightly with a small hammer until the upper pallet goes against the bottom of the hub. The reason that the end of the punch is rounded is so the punch will contact the pallet as closely as possible to the body of the staff. This causes the staking pressure to be more nearly on the center of the axis of the staff. Note: It is very important to note the position of the banking pin in the balance wheel when positioning the staff in the hub before staking in the staff. Make sure that the pallets are in the proper position in relation to the banking pin.

ALTERNATIVE METHOD USED TO MOUNT A VERGE STAFF

Another method that has been used to mount a verge staff into the hub is as follows. Instead of staking a verge staff into the hub, it may be sweated in with a little soft solder before or after the hub has been staked into the balance wheel. Some of the early watchmakers would saw or file a slot in the bottom of the balance wheel hub from the hole in the hub to the outside edge of the hub to accommodate the very end of the upper pallet. Then the verge staff was placed

into position in the hole in the hub with the end of the upper pallet in the slot. A small amount of soft solder was applied to the staff and the slot, then the hub was heated to melt the soft solder. Sometimes an unfinished brass hub was sweated to the verge staff. Then it was turned down later to fit the balance wheel and hairspring collet and then staked into the balance wheel. Regardless of the method used, the end results should be that the staff is tight in the hub and that the wheel runs true on the staff.

CHECKING THE VERGE STAFF IN THE WATCH

After the verge staff has been mounted into the balance wheel, the wheel is placed into the watch so the lock and drops can be checked. Any adjustments needed must be made.

TRUING & POISING THE BALANCE WHEEL

After the adjustments have been made, the balance wheel should be trued and poised. The balance wheel is placed in the truing caliper to check the truth only. The truing is done with the fingers when the wheel is out of the calipers. The poising is usually done by filing metal from the bottom inside corner of the wheel's rim. After the balance has been trued and poised, the hairspring and collet are staked onto the wheel's hub.

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