16 Size watch

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OPERATION, SERVICE AND OVERHAUL INSTRUCTIONS

WITH

PARTS CATALOG

FOR

MASTER NAVIGATION WATCH TYPE AN5740 NAVY STOCK NO. R88-W-510 (HAMILTON)

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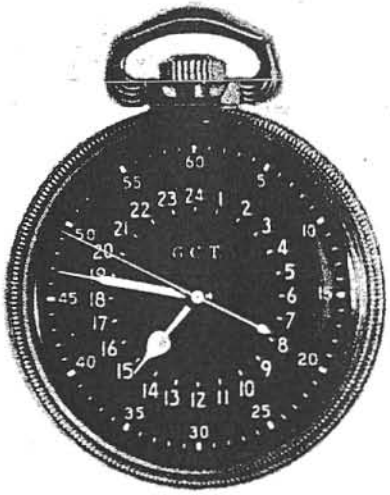


Figure 1 — Front and Rear Views of Hamilton Master Navigation Watch AN5740

SECTION I
INTRODUCTION

1. GENERAL.

a. This handbook contains complete descriptive data and detailed instruction for the operation, maintenance, repair, and overhaul of the 16 size Hamilton Master Navigation Watch AN5740, manufactured to Army-Navy Aeronautical Specification AN-GG-W-108. The Navy Stock Number is R88-W-510. The watch was designed and is manufactured by the Hamilton Watch Company, Lancaster, Pa., U.S.A. The manufacturer's assembly part number is 33106. The watch formerly was known as Hamilton Model 4992B.

b. The master navigation watch is a 16 size pocket watch with a 24-hour dial and dial train, a continuous-running center seconds hand, and a seconds setting mechanism that locks the balance wheel when the crown is pulled outward from the case. The seconds setting mechanism permits the watch hands to be set to agree with a standard time source. All of the conventional detailed procedures of fine watch repairing and adjusting are entirely applicable to the repair, overhaul, and maintenance of the master navigation watch.

CAUTION

Adjustment, repair, or assembly of this watch should be undertaken by qualified, experienced personnel only.

2. DEFINITIONS.

a. The front of the watch and movement is the visible side carrying the dial and hands. This side is commonly known as the dial side.

b. The rear or back of the watch movement is the side opposite the dial. This side is commonly known as the train side.

c. The terms top, bottom, right, and left are used in reference to the watch as viewed from the front with the dial numeral 24 directly above the numeral 12.

SECTION II
DESCRIPTION

1. GENERAL. *(See figure 1.)*

a. Essentially, the Master Navigation Watch AN5740 is a 16 size 24-hour pocket watch designed to be used as a master time indicator in airplanes. It is intended to be set to Greenwich Civil Time as the reference timepiece for navigational purposes. The movement is enclosed in a chromium-plated nickel silver case which may be carried in the pocket. It is sometimes mounted face up in a box made of soft iron, to shield it from possible magnetization by fields set up by stray electric currents within the airplane. This shielding case has a 1⅞-inch round opening through which the dial of the watch can be seen. The watch is not fastened in position because of the necessity for removing it from the box for daily winding and for periodic setting to a master time source. The iron shield is not furnished with the watch. In Navy applications the Hamilton master navigation watch is enclosed in a hardwood box and shock-mounted within it. An aperture in the top of the box enables the watch to be read without removal from the box. Navy stock number of the box is R88-B-860.

b. In most respects the master navigation watch is just like the normal 16 size man's pocket watch. In the watch movement are 22 jewels located to minimize friction and wear at points where such action would affect its accuracy.

c. The dial is divided into 24 equal and numbered sectors, in place of the 12 usually found in a watch of this size, and the hour hand makes one revolution each 24 hours, instead of one revolution each 12 hours as in conventional watches.

d. All hands, the hour and minute markings, and the letters G.C.T. (Greenwich Civil Time) are finished in durable white paint. The background of the dial has a black finish.

Time is indicated on two orbits. The inner orbit is graduated from 1 to 24 and designates the hours; the outer one is divided into 60 equal sectors numbered at 5 and multiples thereof to 60 and designates hours and minutes.

An hour hand of the railroad, or spade, type completes the circuit of the dial once each 24 hours and is read against the inner orbit.

A minute hand of the straight type circles the dial once every hour and is read against the outer orbit.

Figure 2—Three-quarter Cutaway View of Hamilton Master Navigation Watch

The center seconds, or sweep second, hand circles the dial once every minute and is also read against the outer orbit.

e. The case bezel and back have knurled edges and are screwed to the case ring, forming dust and moisture protection for the movement. The watch is not immersion-proof and should be protected from the elements.

f. The crystal is of the extra heavy, mi-empire shape. It is held in a shallow recess in the front of the bezel, into which it snaps under slight but firm pressure.

g. The back of the watch is engraved with the following information:

Part No. AN5740
Manufacturer's part number
Contract number
Serial number
Manufacturer's name

h. A special feature in which the master navigation watch differs from a conventional 16 size watch is the incorporation of a seconds setting device which depresses a spring finger into light contact with the rim of the balance wheel when the winding stem is pulled out, stopping the watch instantly. With a little practice the center seconds hand can be stopped at any predetermined second, and the hour and minute hands can then be set at any time indication on the dial. When the crown is pushed in (returned to its normal position) the watch will start. Thus the watch can be set in exact agreement with an official time source.

2. DETAILED. *(See figures 2 and 3.)*

a. CASE.—The master navigation watch is enclosed in a chromium-plated nickel silver case. Two case screws hold the movement in place, and a screw back and screw bezel complete the case. The bezel holds the crystal, which is of the mi-empire shape. The case bow and stem are of the conventional type, except that the stem recess in the case has a dustproof assembly to prevent the entry of foreign matter through the stem opening. The dustproof seal consists of a sleeve, helical spring, and seat, held in place by a seal plug.

b. DIAL AND HANDS.—The dial has a black background with graduations, numerals, and the letters G.C.T. (Greenwich Civil Time) printed in white. Graduations are in two orbits. The inner, or hour orbit is graduated from 1 to 24 hours; the outer, or minute orbit is graduated in 60 even divisions, numbered at each fifth division from 5 to 60 to indicate seconds.

The spade type hour hand is read against the inner orbit, while the straight minute hand and sweep second hand are read over the minute orbit. All hands run continuously except when the watch movement is stopped by the action of the seconds setting mechanism.

c. MOVEMENT.

(1) GENERAL.—The following description of the various parts of the movement is essentially functional and follows the action from the application of power through the train, escapement, and balance mechanisms.

The movement is supported between the pillar plate, which acts as the chassis of the watch, and the barrel bridge, train bridge, and balance cock. This type of construction enables portions of the watch to be disassembled when necessary without taking down the entire watch.

(2) POWER ASSEMBLY.—The power assembly in the master navigation watch consists of the mainspring, the mainspring barrel, the barrel arbor, and the barrel cap. When wound, the mainspring furnishes the power for operation of the watch. The mainspring is a narrow ribbon of steel coiled around the barrel arbor within the mainspring barrel. One end of the mainspring has a small hole which engages in a hook on the barrel arbor. The other end is equipped with a brace with two protruding ears, one of which is anchored in a cut-out slot in the base of the barrel close to its outer periphery, the other in a similar slot in the barrel cap. By unwinding, the mainspring forces the barrel, which is integral with the first wheel of the train, to revolve, thus supplying motive power for the watch.

The mainspring barrel is supported by its arbor between the pillar plate and the barrel bridge. The upper end of the barrel arbor, where it extends through the barrel bridge, is squared and fits into a square hole on the ratchet wheel which is above the barrel bridge. A ratchet device, called a click, meshes with the ratchet wheel and prevents it from turning backward while permitting it to rotate forward under the action of the winding pinion and stem for winding the watch. Thus, winding the watch is accomplished by rotating the barrel arbor with the ratchet wheel, and running is accomplished by holding the barrel arbor steady and allowing the mainspring barrel to rotate around it as the spring unwinds.

(3) TRAIN.—The train consists of a set of wheels and pinions which step up the rotation of the gear on the mainspring barrel and deliver the motion to the escapement. The train consists of a center wheel and pinion, a third wheel and pinion, a fourth wheel and pinion, an escape pinion, and a center seconds wheel and pinion. The center, third, and fourth wheels and their pinions are integral, while the center seconds wheel and center seconds pinion are on different arbors. The center seconds wheel is above the barrel bridge on an extension of the third wheel arbor, while the center seconds pinion is on an arbor that extends through the hollow center wheel arbor.

Meshing of the gears is always from wheel to pinion; that is, the teeth on the mainspring barrel mesh with the center pinion (so-called because of its position in the watch); the center wheel meshes with the third wheel pinion, the third wheel meshes with the fourth wheel pinion, and the fourth wheel meshes with the escape pinion. The center wheel is supported between the pillar plate and the barrel bridge. It projects through the pillar plate and above the dial to receive the cannon

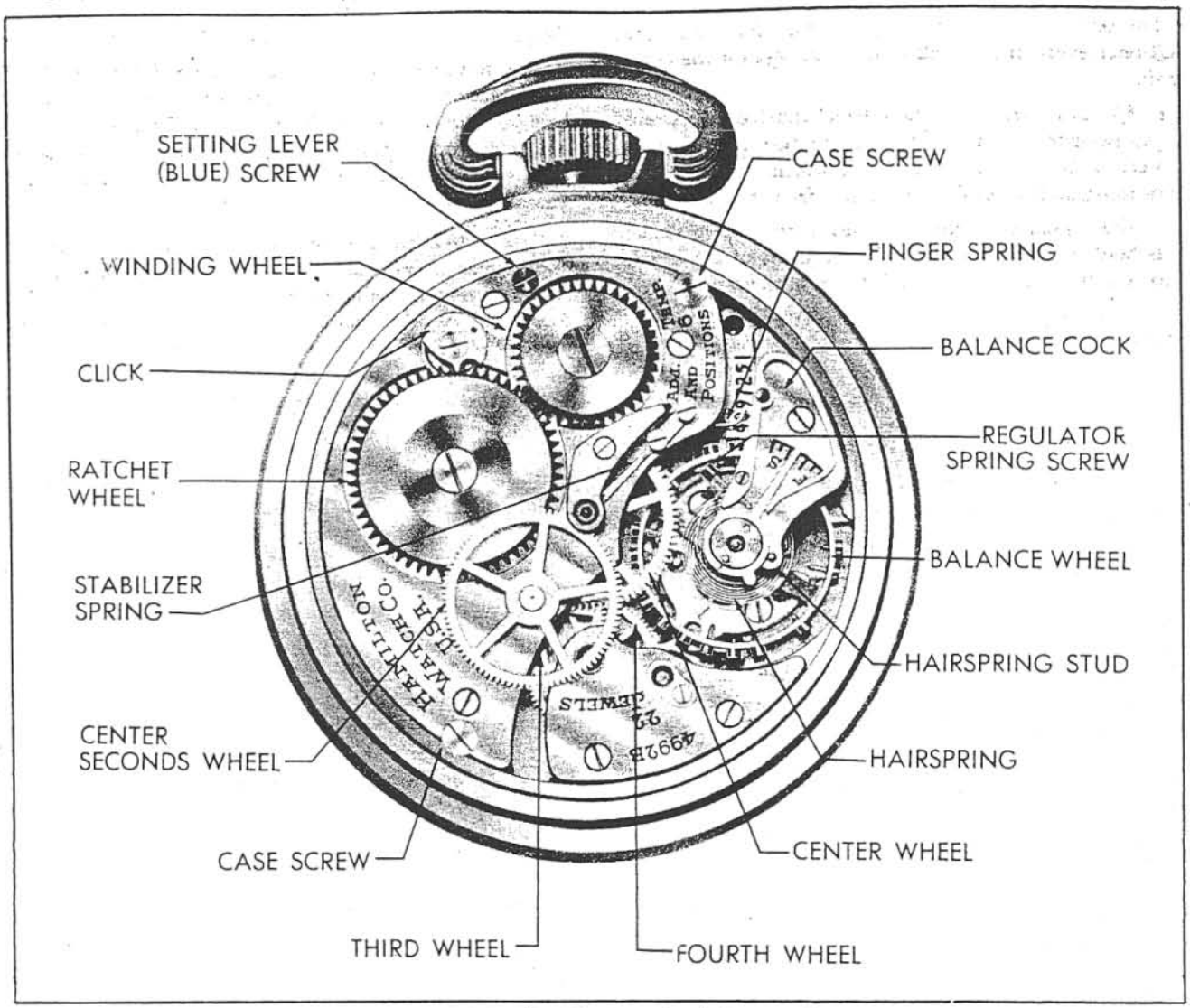


Figure 3—Watch with Case Back Removed

pinion and the hour wheel. The cannon pinion is friction fit on the center wheel arbor, which is hollow. The third wheel is also supported between the pillar plate and the barrel bridge. The upper end of its arbor projects through the bridge and supports the center seconds wheel above the barrel bridge. This meshes with the center seconds pinion whose arbor passes through the hollow center wheel arbor and supports the center seconds hand. An auxiliary bridge called the center seconds bridge is mounted on the barrel bridge to support the other end of the center seconds pinion arbor in a jewel. A fork-shaped stabilizer spring is screwed to the barrel bridge and serves to hold the center seconds pinion against its bridge. The fourth and escape wheels are supported between the pillar plate and the train bridge.

(4) ESCAPEMENT. — The escapement is the mechanical link between the train and balance assembly. That is, it meters out the power of the mainspring. Without the escapement the train would run continuously under the action of the mainspring. This would result in the watch running down in a few minutes. The escape wheel, one of the principal components of the escape, is so designed as to permit the passage of equally spaced increments of power through the pallet, the mechanical link between the escapement and the balance. The escapement is composed of the escape wheel and the pallet assembly.

(a) ESCAPE WHEEL.—The escape wheel with its pinion is the last wheel of the train and connects the train with the escapement. The escape wheel has club-shaped teeth between which the pallet jewels move in and out under the influence of the balance and hairspring, allowing one tooth to advance or escape at a time.

(b) PALLET.—The pallet is a pivoted lever of the general shape of the letter T and functions as the

mechanical connecting link between the train and the balance. The part which approximates the crosspiece of the letter T is fitted with two rectangular-shaped jewels; the other end of the pallet is fork-shaped. The pallet is mounted on an arbor and is pivoted between jewels in the pillar plate and jewels in the horseshoe-shaped pallet bridge. In its normal position in the watch the pallet is located between more or less conventional banking pins fitted into the pillar plate; they serve to restrict the movement of the pallet.

(5) BALANCE AND HAIRSPRING ASSEMBLY. —The balance and hairspring assembly is supported between the pillar plate and the balance cock. It consists of the balance wheel, a balance staff on which are mounted a safety roller, a roller table, and the hairspring assembly. A roller jewel pin is rigidly friction-fit in the roller table. Rotation of the balance wheel is controlled by the hairspring, the inner end of which is pinned to a collet which is a friction fit on the balance staff. The hairspring is of the Breguet type with a stud pinned to its overcoil end. The hairspring stud is anchored in the opening provided for it in the balance cock. The overcoil of the hairspring is positioned between two pins of the regulator. Movement of the regulator shortens or lengthens the effective length of the hairspring controlling oscillation of the balance, and thus regulates the timing of the watch.

Around the periphery of the balance wheel are weight screws which serve to balance the wheel. Four meantime screws provide a means of varying the inertia of the wheel for accuracy of timing. The roller table and its jewel pin engage the fork in the end of the pallet, as previously described, to drive the pallet at proper intervals to enable measured amounts of power to be received through the train. The safety roller prevents the pallet from moving except under the action of the balance wheel. The balance and hairspring assembly is designed to oscillate at the rate of 18,000 beats per hour.

(6) WINDING AND SETTING.—The winding and setting mechanism consists of the crown, stem, winding pinion, clutch, setting wheel, intermediate setting wheel, setting lever, clutch lever, setting spring, upper and lower winding wheels, and ratchet wheel. With the crown and stem in the normal position—that is, with the stem pushed in—the clutch lever holds the clutch in the winding position. When the stem is turned clockwise, the winding pinion turns the lower winding wheel under the barrel bridge and this turns the upper winding wheel, on top of the barrel bridge, to which it is connected. The upper winding wheel turns the ratchet wheel to wind the mainspring as previously described. The clutch allows the stem to be turned counterclockwise without affecting the movement.

Pulling the stem and crown outward pushes the setting lever against the clutch lever, and engages the clutch with the setting wheel. Turning the crown in either direction causes the setting wheel and the intermediate setting wheel to revolve. The latter wheel is in constant mesh with the minute wheel, which is also in mesh with the cannon pinion. In addition, the minute wheel pinion is in mesh with the hour wheel; therefore, turning the crown and stem turns the hour wheel and the cannon pinion, thereby positioning the hands to any desired time setting. The setting wheel, intermediate setting wheel, and minute wheel are supported, and revolve, on posts on the dial side of the pillar plate. With the clutch disengaged, the winding pinion is not driven by rotation of the stem and crown, the pinion merely remaining stationary since it is in mesh with the lower winding wheel.

(7) MISCELLANEOUS.

(a) MICROMETRIC REGULATOR. — Regulation of the watch is accomplished by movement of the regulator which can be controlled accurately by means of a fine screw. Turning the screw in a clockwise direction moves the regulator towards F, causing the effective length of the hairspring to be decreased, and making the watch run faster. Turning the regulator screw counterclockwise reverses the direction of movement of the regulator, making the watch run slower.

(b) SECONDS SETTING MECHANISM.—The master navigation watch is provided with a seconds setting mechanism which serves automatically to stop the watch while setting it and thus enable it to be set accurately. The seconds setting mechanism consists of a lever, a spring finger, and a seconds setting spring. The spring finger is supported on a post on the sickle-shaped seconds setting lever, the short end of which butts up against the end of the stem. When the stem is pulled out to the setting position, the end of the stem is pulled away from the seconds setting lever, and the seconds setting lever spring forces the spring finger against the rim of the balance wheel, stopping its motion and the running of the watch. Pressing the stem in reverses the action described, releases the balance which immediately begins to oscillate, and the watch begins to run.

(c) JEWELS.—The twenty-two jewels in the Hamilton master navigation watch are located as follows: one hole and one cap jewel at each end of the balance staff; one hole and one cap jewel at each end of the escape wheel staff; one hole jewel at each end of the center wheel staff; one hole and one cap jewel at each end of the pallet arbor; one hole jewel at each end of the fourth wheel staff; one hole jewel at each end of the third wheel staff; two pallet jewels; one roller jewel; and one hole jewel at the end of the center seconds pinion staff.

SECTION III
PREPARATION FOR USE

1. PROTECTION.

It is advisable to maintain the master navigation watch in a dial-up position in a soft iron case or wooden box situated at a point in the airplane where it will be readily accessible for reference or winding. The soft iron box is used sometimes and serves to shield the watch from any magnetic fields generated by stray electric currents from generators or other electrical equipment of the airplane. Where this factor is not important a wooden box with shockproof mounts is used. An opening in the cover enables the watch face to be seen.

2. WINDING.

Winding the watch is accomplished in the conventional manner. To assure best performance the watch should be wound once each 24 hours at approximately the same time of day.

SECTION IV
OPERATION

1. PRINCIPLES OF OPERATION.

The master navigation watch has four main assemblies identical in principle to all watch movements employing the lever escapement; namely, winding, time train, escapement and balance, and dial train assemblies. These have previously been described in detail in section II herein. So far as operation is concerned, these assemblies are employed in the watch for three purposes: winding, running, and setting. The first, winding, is the means for storing power in the watch movement. The second, running, is the means by which the stored power is expended, directed, and controlled to tell time and make it known to the user. The third, setting, enables the user to set the watch to agree with any desired time source. The following discussion of the principles of operation will describe these three functions.

a. WINDING.—What occurs in the watch during the winding operation is shown in the schematic diagram, figure 4. The winding pinion is in mesh with the lower winding wheel at all times. With the stem and crown in the winding (and running) position, the clutch teeth at the bottom of the winding pinion are engaged with similar teeth at the top of the clutch. The winding pinion and clutch are both located on the stem. The pinion is free to rotate on the stem but the clutch has a square hole that mates with a square on the stem; thus, while it is free to slide on the stem, it is forced to rotate with it.

If the crown and stem are turned clockwise the clutch is forced to turn, and from the construction of the mating teeth the winding pinion is also turned. As the winding pinion turns it rotates the lower winding wheel, which in turn rotates the upper winding wheel to which it is pinned. The upper winding wheel turns counterclockwise, as shown in the diagram, and causes the ratchet wheel to turn clockwise. Since the ratchet wheel is held on a square end of the barrel arbor where it extends through the barrel bridge, rotation of the wheel causes corresponding rotation of the arbor. The inner end of the mainspring is held on the barrel arbor by a hook with the result that the mainspring is coiled tightly around the arbor and stores energy for operating the watch movement. Backward rotation of the arbor is prevented by the click which engages the ratchet wheel and allows it to rotate clockwise but forbids backward movement. The outer end of the mainspring is hooked to the barrel and since the spring cannot uncoil by turning the arbor backward it can do so only by rotating the barrel clockwise. As a result of the actions described above, energy is stored in the mainspring and causes rotation of the barrel.

Rotating the stem and crown in a counterclockwise direction causes the clutch to turn in the same direction, but the winding pinion cannot do so since it is restrained by the action of the click. Instead, the action of the ratchet teeth of the clutch, sliding upon and over those of the winding pinion, produces the characteristic back-ratchet sound.

b. RUNNING. *(See figures 5 and 6.)*—The teeth on the mainspring barrel engage and turn the center wheel pinion as the barrel turns under the action of the uncoiling mainspring. The center wheel makes one revolution per hour under the control of the balance mechanism.

(1) The arbor of the center wheel projects through the pillar plate to the dial side where it is a friction fit in the cannon pinion. (See figure 6.) On the cannon pinion, where it projects through the center of the dial, is mounted the minute hand which thus makes one revolution of the dial each hour.

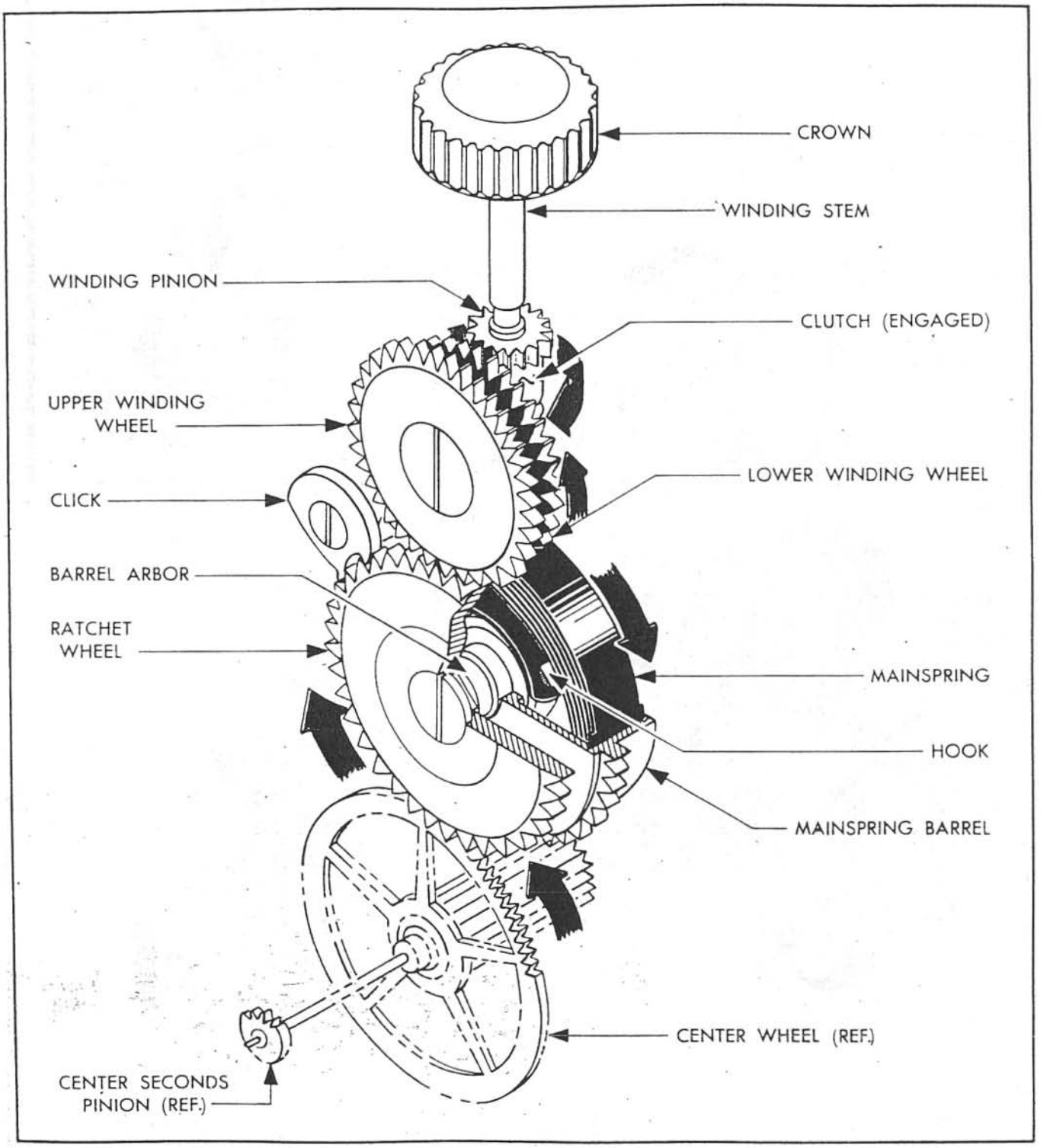


Figure 4—Schematic of Events During Winding

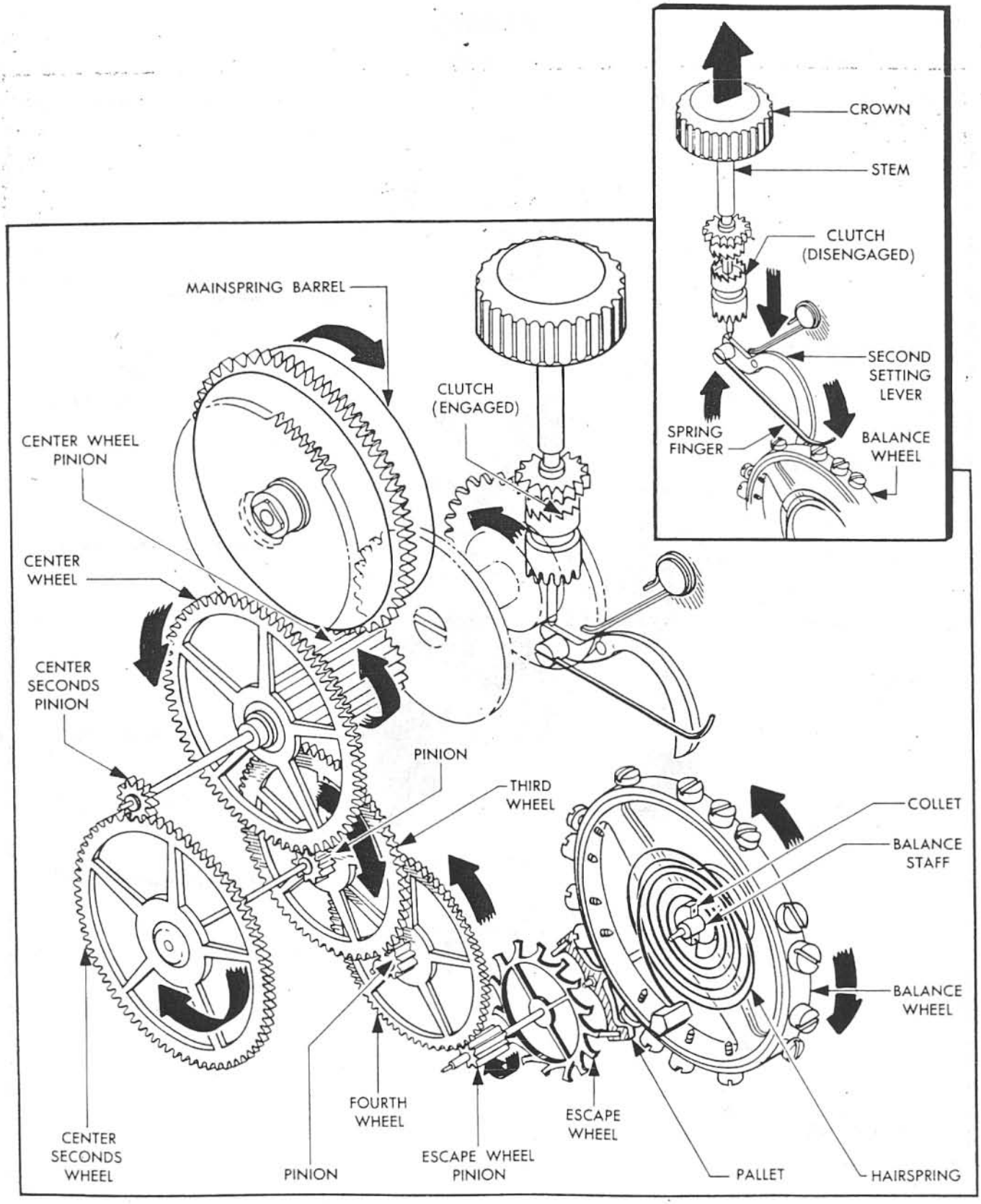


Figure 5—Schematic of Events During Running

(2) The hour wheel fits over the cannon pinion and runs freely on it while supporting the hour hand. Gearing from the cannon pinion is through the minute wheel and minute wheel pinion to the hour wheel. The gear ratio is such that the cannon pinion turns at 24 times the speed of the hour wheel. The time required for the hour hand to complete its circuit of the dial is thus 24 hours.

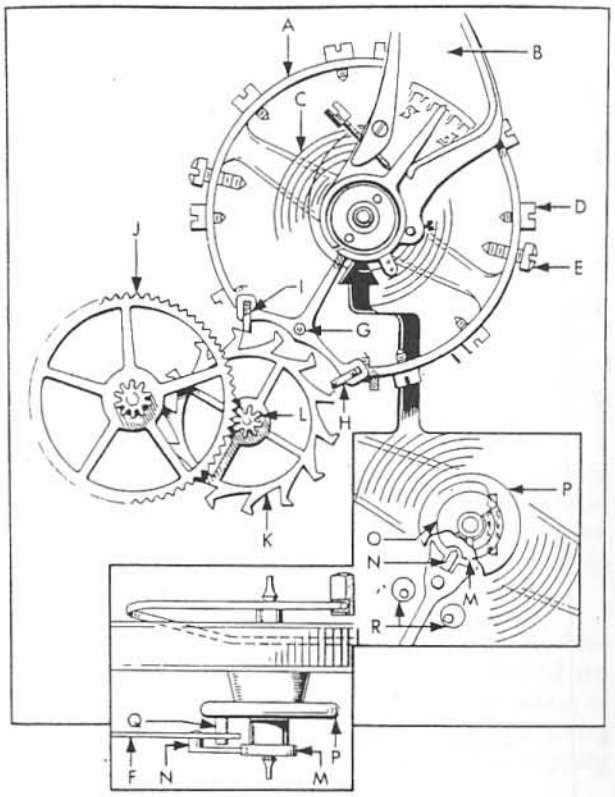
(3) The center wheel turns the third wheel pinion as shown in figure 5. The arbor of the third wheel projects through the barrel bridge and supports the center seconds wheel. The center seconds wheel in turn meshes with the center seconds pinion whose arbor extends through the hollow arbor of the center wheel and supports the center seconds hand. Gear ratios are such that the center seconds hand makes one revolution of the dial each minute.

(4) Mesh of the third wheel with the fourth wheel pinion causes the latter to rotate in a counterclockwise direction. In turn, the fourth wheel drives the escape wheel pinion in a clockwise direction. The escape wheel is properly part of the escapement mechanism since its interaction with the pallet is the means of controlling the rate at which the mainspring is allowed to unwind. Thus, the escape wheel acts as a transmitter, allowing measured amounts of mainspring power to be released, or to escape, through the pallet to the balance assembly where it is dissipated, and at which point it is controlled and/or regulated.

(5) Before the watch is wound, when no power from the mainspring is being exerted on the escape wheel, the roller pin jewel on the balance assembly is at rest in the slot in the end of the pallet, the pallet is halfway between the two banking pins, and the impulse face of the right pallet jewel is engaged with the impulse face of one of the club-shaped escape wheel teeth.

When the mainspring is wound and power is applied to the train, the escape wheel moves in a clockwise direction. The force exerted by the escape wheel tooth as it slides on the right pallet jewel causes the pallet to turn counterclockwise on its arbor. The pallet transmits the power impulse to the balance assembly by pushing the roller pin jewel to the left. This causes the balance assembly to rotate in a clockwise direction about three-fourths of a turn, at which point the tension of the hairspring overcomes its momentum. During this action, the left pallet jewel intercepts a tooth on the escape wheel, causing the wheel to stop momentarily, and the pallet comes to rest against the left banking pin. This locked position accounts for the intermittent rotation of the escape and train wheels.

After the balance wheel has come to rest, the opposing force of the hairspring causes it to rotate back in a counter-clockwise direction to its original position, where the roller pin jewel reenters the slot of the pallet with a force great enough to move the pallet clockwise away from the banking pin. This causes the left pallet jewel to move out of the path of the escape wheel tooth. This is known as "unlocking."



A BALANCE WHEEL	J FOURTH WHEEL
B BALANCE COCK	K ESCAPE WHEEL
C HAIRSPRING	L ESCAPE WHEEL PINION
D WEIGHT SCREW	M SMALL ROLLER
E MEANTIME SCREW	N PALLET GUARD PIN
F PALLET	O HAIRSPRING COLLET
G PALLET ARBOR	P LARGE ROLLER
H LET-OFF PALLET JEWEL	Q ROLLER JEWEL
I RECEIVING PALLET JEWEL	R BANKING SCREWS (2)

Figure 6—Action of Escapement and Balance

As the left pallet jewel releases the escape wheel tooth, the escape wheel, driven by the force of the mainspring, is free to revolve again in the clockwise direction. As it turns, the tooth slides on the impulse face of the left pallet jewel, and the pallet imparts a further counterclockwise impulse to the roller pin jewel. This causes the balance wheel to continue in the counterclockwise direction about three-fourths of a turn until the tension of the hairspring overcomes its momentum again. During this action the right pallet jewel intercepts the next tooth on the escape wheel, causing the wheel to stop again for an instant, and the pallet comes to rest against the right banking pin.

After the balance wheel has come to rest again, the tension of the hairspring causes it to rotate back in the clockwise direction to its original position, where it receives a further clockwise impulse from the pallet as the escape wheel tooth slides on the right pallet jewel again, and the cycle is repeated.

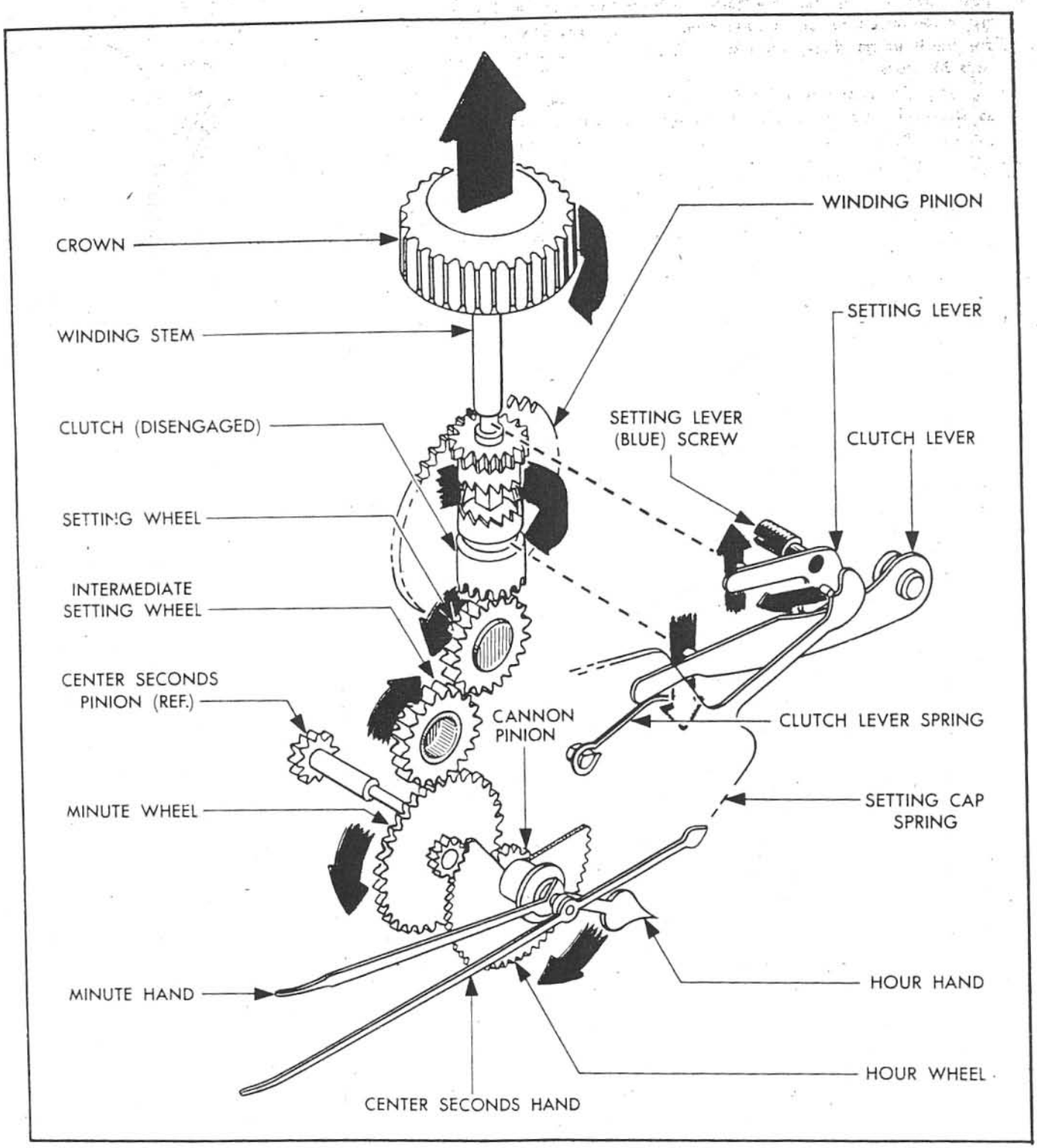


Figure 7—Sequence of Events During Setting

The delicate balance between the torque of the hairspring and the inertia of the balance wheel determines the frequency with which these actions take place. Decreasing the effective length of the hairspring or the inertia of the balance wheel will result in the watch running faster. Increasing the hairspring length or the balance wheel inertia will slow the watch. Changing either one of the factors mentioned above will cause a change in the watch's timekeeping. Usually the watch is brought to time by adjusting opposite meantime screws equally, with the regulator in mid-position, to adjust the inertia of the wheel. Exact adjustment is then achieved by moving the regulator. This moves the regulator pins, between which the hairspring vibrates, to shorten or lengthen the effective portion of the hairspring.

c. SETTING. *(See figure 7.)*—The sequence of events that occurs when the watch is set is much like that in a typical pocket watch except for the action of the seconds setting mechanism which is separately described in the subparagraph below. To set the watch the crown and stem are pulled out. A pin on the setting lever rests in a groove in the stem. Pulling the stem out rotates the setting lever about the setting lever (blue) screw. A pin on the opposite side of the setting lever rests in a groove in the end of the setting cap spring and, as the setting lever turns, the pin rides to the tip of the groove and holds the setting lever and stem in the setting position. In addition to these actions the rotation of the setting lever pushes the clutch lever downward by cam action. A pin in the clutch lever engages a groove in the clutch, which is free to slide up and down the square portion of the stem. As the end of the clutch lever rotates downward this pin disengages the clutch from the winding pinion and engages it with the setting wheel beneath.

While the clutch is free to slide on the stem it must turn with it; in figure 7 clockwise rotation of the crown and stem is assumed; rotation in the opposite direction will cause the same sequence of events but in the opposite direction. Turning the crown clockwise will cause the clutch to turn and turn the setting wheel. The setting wheel and intermediate setting wheel turn counterclockwise and clockwise respectively on studs on the dial side of the movement. The intermediate setting wheel is in mesh with the minute wheel and turns it counterclockwise. The cannon pinion is also in mesh with the minute wheel and thus rotates and moves the minute hand which the minute wheel supports. Meanwhile the minute wheel pinion engages and turns the hour wheel which supports the hour hand.

Note that no provision is made for setting the center seconds hand.

Turning the crown and stem has no effect on the winding pinion because it is free on the stem and engaged with the lower winding wheel, which is held stationary by the action of the click.

When the crown and stem are returned to the normal, or running, position the setting lever is rotated downward, the clutch lever is pushed upward by the clutch lever spring, and the clutch lever pin moves the clutch upward into engagement with the winding pinion and disengages it from the setting wheel. The pin on the setting lever slides back into the groove in the setting cap spring which serves to hold the crown and stem in whichever position they are set.

d. SECONDS SETTING MECHANISM. *(See insert in figure 5.)*—The seconds setting mechanism of the master nagivation watch is a special feature not normally found in pocket watches and it is therefore treated separately here. Action of this mechanism is associated with both the running of the watch and the setting mechanism.

When the crown and stem are in the running position the end of the stem bears against the end of the sickle-shaped second setting lever, holding it upward against the second setting lever spring and holding the spring finger free of the balance wheel.

Pulling the stem and crown into the setting position draws the end of the stem away from the second setting lever, allowing the lever to rotate under action of the second setting lever spring. This pushes the spring finger against the rim of the balance wheel, stopping the movement during the setting operation.

2. OPERATION INSTRUCTIONS.

a. WINDING.—To wind the watch, rotate the crown clockwise until full wind is reached. The design of the winding mechanism is conventional, and the fingers need not be released from the crown when they have gone as far clockwise as convenient. The crown may be rotated in a counterclockwise direction without danger to the movement. When this is done, the characteristic clicking sound of the clutch is produced. In winding the watch, approach the full wind slowly to avoid injury to the mainspring or winding mechanism. For best performance, the watch should be wound daily at approximately the same hour.

Note

Take care not to pull the stem and crown into the setting position while winding, or the movement will be stopped and the watch will require resetting.

b. SETTING.—To set the hour and minute hands, pull out the crown and rotate it in either direction until the desired setting is reached. Note that the center seconds hand stops when the crown is pulled out. It is usually best to stop the watch when the center seconds hand is at 60, particularly if it is to be synchronized with a master time source. If the hour hand is then set to the proper hour, and the minute hand set to the next or anticipated minute, accurate synchronization with the

master time source is achieved by simply pressing the crown to return it to its normal position. In this manner, it is possible to set the watch to correct time within very close limits.

c. REGULATING.—If the movement requires regulating, the watch should be sent to an instrument shop or overhaul depot for regulation and examination to discover the cause of the improper time keeping.

SECTION V

SERVICE INSPECTION, MAINTENANCE, AND LUBRICATION

1. SERVICE TOOLS REQUIRED.

No service tools are issued with this watch. It is recommended that no adjustments or repairs of any sort be undertaken by any but qualified personnel at an instrument shop or overhaul depot.

2. SERVICE INSPECTION.

DAILY.—At the time of daily winding inspect for a broken or loose crystal and set the watch to correct time.

SEMI-ANNUALLY.—Send the watch to an overhaul depot for complete inspection and overhaul, cleaning, and repair if necessary.

3. MAINTENANCE.

a. SETTING.—Whenever necessary reset the watch to agree with the master time source.

b. REGULATING.—If the time rate is excessive, send the watch to an instrument shop or overhaul depot for regulating by authorized personnel.

CAUTION

Do not move the regulator to regulate the watch. This adjustment should be made only by qualified personnel. Never unscrew the bezel or back from the case ring. All maintenance on the watch, beyond winding daily and setting to a master time source, should be done by qualified personnel at the overhaul depot.

To regulate the watch it is necessary to unscrew the case back. Turning the regulator screw (figure 2) clockwise will make the watch run faster; turning it counterclockwise will make the watch run slower. This watch is equipped with what is known as a micrometric regulator which allows very close regulation.

After regulation the time rate should be checked for 3 days on the bench against a master time source, or immediately by means of a rate recorder if available.

c. ADJUSTING, REPAIRING, AND CLEANING.—Any irregularity in the rate of the watch is an indication that it is in need of cleaning and adjusting or repair. Send the watch to an overhaul depot where all adjusting and cleaning will be done, and repairs made by qualified personnel.

CAUTION

Electrical timing machines should not be used as inspection tools to determine the cause of service irregularities of watches turned in for repair or overhaul. Only the conventional visual and mechanical inspection techniques are recommended.

If, after cleaning and overhaul, the range of regulator adjustment is not sufficient to enable the watch to be brought to time it will be necessary to remove the balance cock as specified in section VI, paragraph 2 *c* (2), and make adjustments on the balance wheel screws. The balance in the watch is designed to beat 18,000 times per hour. If the rate is fast the four meantime screws on the rim can be turned counterclockwise; if too slow the screws can be turned clockwise. Adjustment of all screws must be equal. A one-quarter turn of all four meantime screws will produce a change of rate of approximately 48 seconds per day. Final adjustment is then accomplished with the regulator. A one-quarter turn of the regulator screw will cause the watch to run approximately 4 seconds a day slow or fast depending upon the direction in which the screw is turned.

The foregoing procedure assumes that the balance wheel was in correct static poise before adjustment. Poise is obtained by using balance screws of equal weight opposite each other on the rim until the wheel is balanced as to weight distribution.

Thus, the sequence of events to bring a watch to time is, first, to bring it to static poise with the balance screws at a beat of approximately 18,000 per hour, then to adjust for exact beat with the meantime screws, after which final adjustment is accomplished with the regulator.

d. REPLACING CRYSTAL.—A cracked crystal should be replaced only in the instrument shop, where the bezel can be removed and the crystal replaced without exposing the movement to moisture or dust. If the crystal has been shattered, be careful to remove any broken glass. Examine the movement for other damage.

If any damage is noted, or if the movement of the watch has been exposed to moisture or dust because of the broken crystal, it should be cleaned and adjusted.

4. LUBRICATION.

Lubrication should be performed only at time of overhaul, as specified in section VI.

5. SERVICE TROUBLES AND REMEDIES.

TROUBLE	*PROBABLE CAUSE*	*REMEDY*
WATCH OFF TIME	Incorrectly set.	Reset.
	Bent balance pivot resulting from severe jar.	Send to depot for complete overhaul.
	Loose balance screw caused by excessive vibration.	Send to depot for balance screw replacement, retiming, and rerating.
	Worn balance pivots caused by depleted lubrication.	Send to depot for complete overhaul.
	Pitted endstone caused by poor lubrication or presence of dirt in jewel bearing.	Send to depot for correction.
WATCH STOPS	Broken balance staff pivot resulting from severe jar or accident.	Send to depot for balance staff replacement, retiming, and rerating.
	Broken mainspring.	Send to depot for mainspring replacement, lubrication and retiming.
	Dirt or lint lodged in mechanism.	Send to depot for cleaning and complete overhaul.
BROKEN CRYSTAL	Severe jar or blow.	Send to shop for crystal replacement; inspect movement for other damage and for the presence of shards and glass.
CROWN UNSCREWS	Stripped threads on stem or crown.	Replace defective parts.
	Stem rusted.	
	Binding of clutch or winding pinion.	
	Tight or binding cannon pinion.	
STEM PULLS OUT	Loose setting lever screw or stripped threads.	Replace worn or broken parts.
	Wear, or stripped threads on setting lever.	
	Loose or bent bridge.	
WATCH CAN BE WOUND BUT NOT SET	Improperly engaged clutch; broken clutch teeth; broken or worn setting lever.	Replace worn or broken parts.
	Minute wheel slipping out of mesh with setting wheel or cannon pinion; teeth sheared off hour or minute wheel.	Straighten minute wheel post.
	Cannon pinion broken or loose.	Replace or tighten.
WATCH CAN BE SET BUT NOT WOUND	Broken mainspring, clutch lever spring, click or click spring.	Replace worn or broken parts.
	Sheared or stripped teeth on ratchet wheel, winding pinion, or winding wheel.	
	Loose barrel cap, worn brace, or barrel arbor broken.	
WATCH CANNOT BE WOUND TIGHT	Broken clutch lever.	Replace worn, broken, or rusty parts.
	Broken clutch lever spring.	
	Stem broken below bottom shoulder.	
WATCH CANNOT BE WOUND OR SET	Mainspring off arbor hook.	Inspect to see that mainspring is hooked at both ends.
	Broken mainspring, or arbor hook.	Replace broken parts.

SECTION VI

DISASSEMBLY, INSPECTION, REPAIR, AND REASSEMBLY

1. OVERHAUL TOOLS REQUIRED.

a. No special tools are required for the overhaul of the watch. A set of watch screwdrivers, running from a blade size of 0.025 to a blade size of 0.100, two hand removers, a 16 size movement block to support the movement when working from the top side, and assorted sizes of tweezers, pegwood sticks, oilers, and the like are all that are necessary.

b. Other than a cleaning basket and the usual watch repairman's kit, which should include a staking tool and a mainspring winder, no special cleaning or repair tools are required.

CAUTION

Disassembly, cleaning, repair, and reassembly are to be performed only by authorized, experienced personnel. It is advisable to have available several small cardboard or wood boxes for the purpose of keeping together the various parts of the several assembly groups. These boxes will facilitate the reassembly of the watch. All screws should be kept with the parts they are designed to hold.

2. DISASSEMBLY.

a. PRECAUTIONS.—Extreme care should be used in disassembling the watch. Bear in mind the following three points:

(1) Always have the requisite tools at hand.

(2) Keep all parts covered except when they are actually being worked upon.

(3) Handle all parts except the dial with tweezers. After cleaning and during reassembly do not let the bare fingers touch any portion of the movement.

b. PREPARATION.—Removing the watch movement from the case for disassembly requires removal of the following:

(1) BEZEL.—Removal of the bezel which is screwed to the case ring is accomplished by turning the edge counterclockwise with the tips of the fingers. The crystal is a snap fit in the bezel and if its removal is required it can be pushed out with the fingers.

(2) BACK.—Removal of the back is accomplished by unscrewing in the same way as the bezel.

(3) HANDS.—Place the watch movement in a support, in a dial-up position. Use the hand removers (figure 8) to pry off the center seconds hand, the minute hand, and the hour hand from their supports. Insert under the hour hand and around the center stem a piece of paper or used photographic film that has a V opening cut to fit. This will protect the face of the dial from being chipped or marred by the hand removers. If the watch is running, pull the stem out to the setting position to stop the hands before removing them.

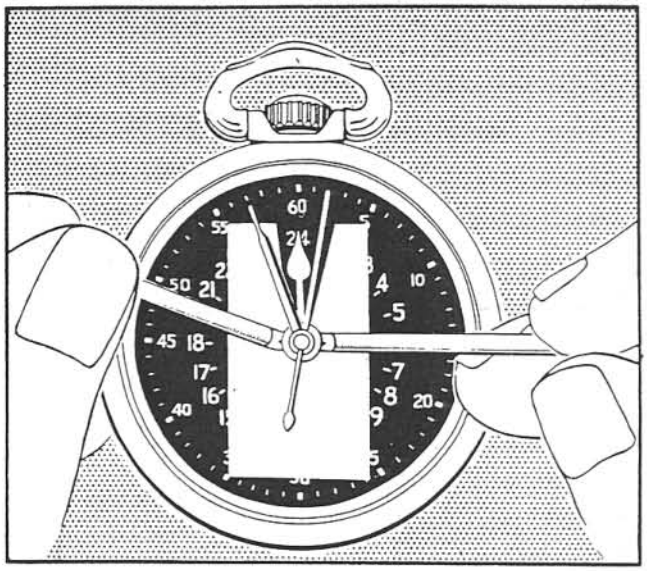


Figure 8—Removing Hands

(4) LETTING DOWN MAINSPRING. *(See figure 9.)*—Hold the crown between the thumb and index finger of the right hand. Turn the crown slightly as

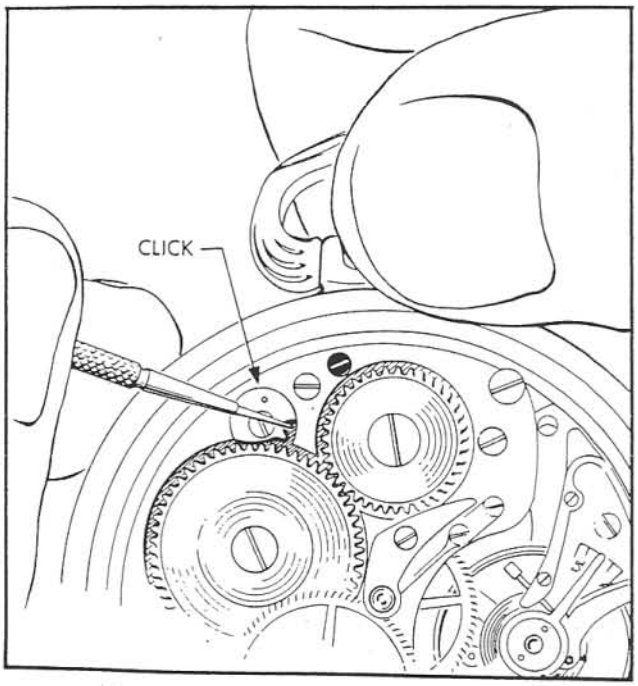


Figure 9—Letting Down Mainspring

when winding the watch. Release the click with a small pointed tool held in the left hand. Allow the crown to turn slowly, against the restraint of the fingers until it is completely let down.

(5) STEM AND CROWN.—Place the watch dial side down in the movement block and loosen, but do not remove the setting lever (blue) screw (see figure 2), sufficiently to allow the stem and crown to be withdrawn. Maintain downward pressure on the screw while withdrawing the stem and crown.

(6) MOVEMENT.—Remove the two case screws and lift the case ring from the movement.

(7) CASE RING.—After removal of the movement from the case ring, the stem dust-seal assembly can be removed from the case ring if necessary. To do this, unscrew the seal plug as shown in figure 10 from the stem hole in the ring. The seal sleeve, helical ring and spring seat ring will then drop out.

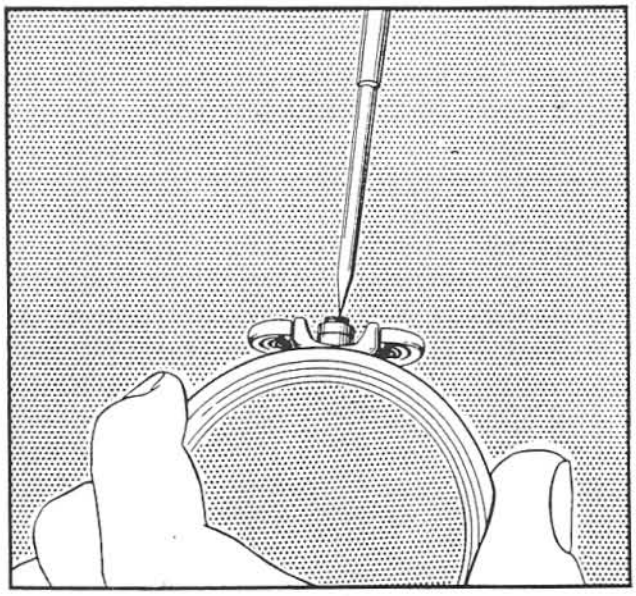


Figure 10—Removing Seal Plug

c. MOVEMENT DISASSEMBLY.—To disassemble the movement proceed as follows:

(1) DIAL.—Remove the three dial foot screws located around the edge of the pillar plate (figure 11). This will allow the dial to be lifted off with the fingers. Then remove the hour wheel and cannon pinion underneath.

(2) BALANCE COCK AND BALANCE WHEEL.—Turn the watch train side up in the movement block. Loosen the small hairspring stud screw at the side of the balance cock and push the stud out of the cock. Immediately retighten the hairspring stud screw so that it will not be lost. Unscrew the balance cock screw. Lift the balance cock from the pillar plate and lift out the balance and hairspring assembly. Then remove the regulator spring from the balance cock by unscrewing its two screws; then unscrew the two upper endstone cap screws

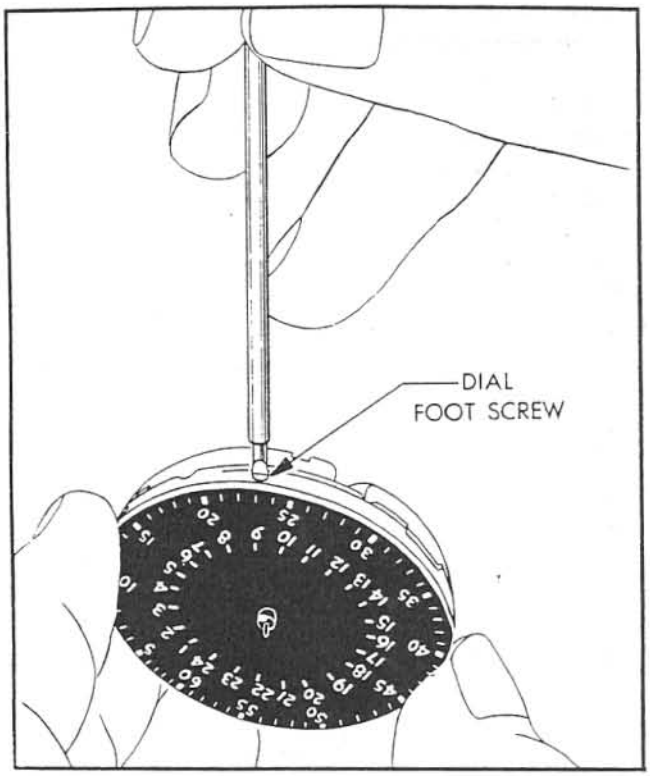


Figure 11—Removing Dial Foot Screws

that lie underneath the cock and remove the upper endstone cap and regulator. The parts removed in this procedure are shown in figure 12.

Remove the balance wheel and attached hairspring. Insert a square tapered rod, as shown in figure 13, in the slot in the hairspring collet, and twist it to open the collet. The collet and hairspring can then be lifted off the staff. Inspect the balance assembly to see whether the

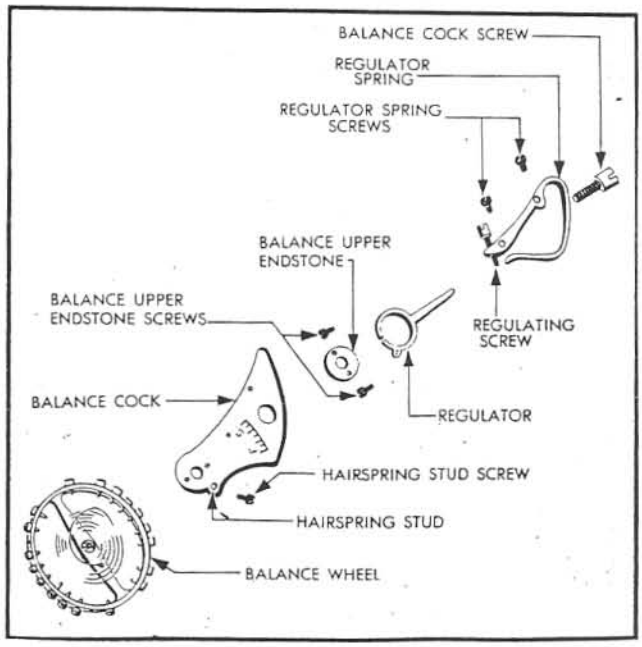


Figure 12—Disassembly of Balance Cock

staff pivots are bent or worn, the large roller table is loose, or whether the roller jewel pin is chipped, loose, or improperly positioned.

(3) CENTER SECONDS BRIDGE.—Loosen and remove the single screw holding the center seconds bridge. Lift off the bridge.

(4) CENTER SECONDS PINION AND STABILIZER SPRING. *(See figure 15.)*—Withdraw the

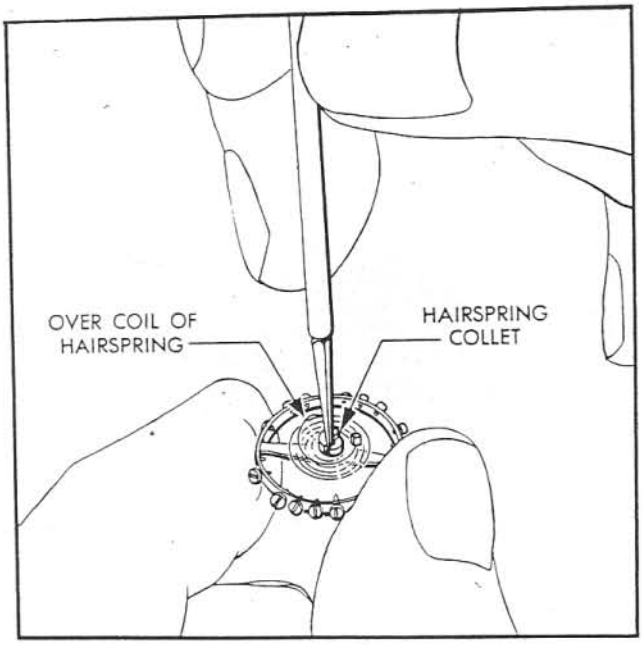


Figure 13—Removing Hairspring from Balance Wheel

center seconds pinion which passes through the hollow center of the center wheel pinion. Remove the two screws holding the stabilizer spring and lift off the spring.

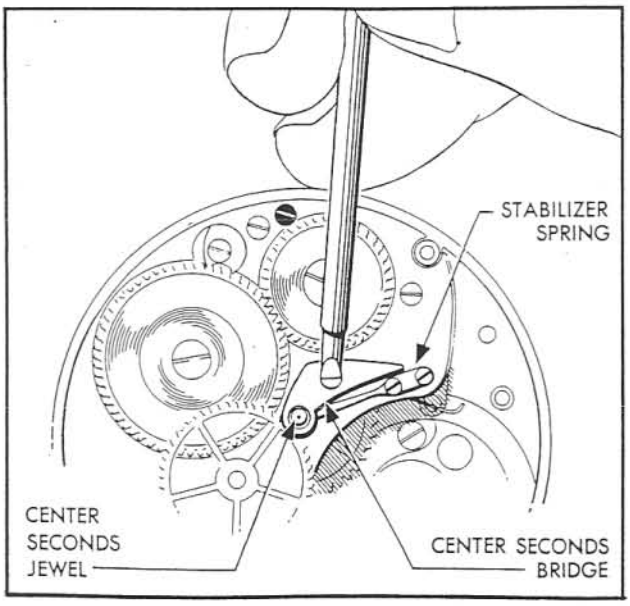


Figure 14—Removing Center Seconds Bridge

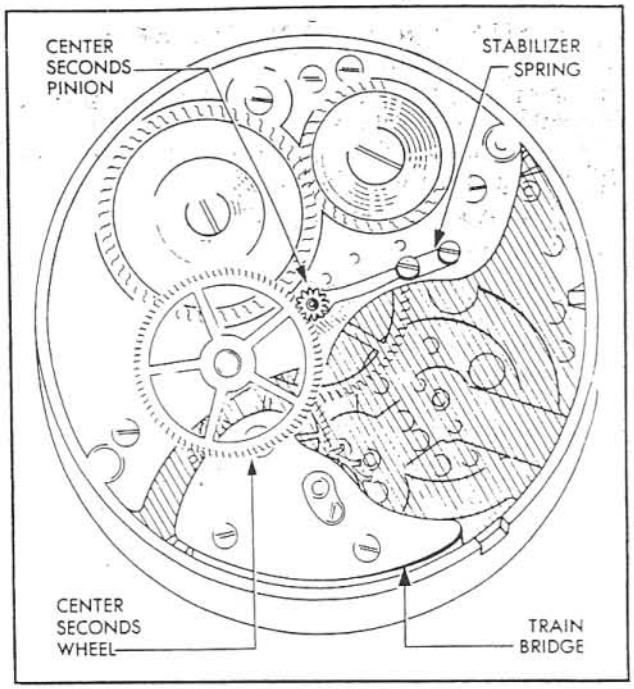


Figure 15—Location of Center Seconds Pinion and Stabilizer Spring

(5) CENTER SECONDS WHEEL.—Using a wheel remover, as shown in figure 16, gently pry off the center seconds wheel.

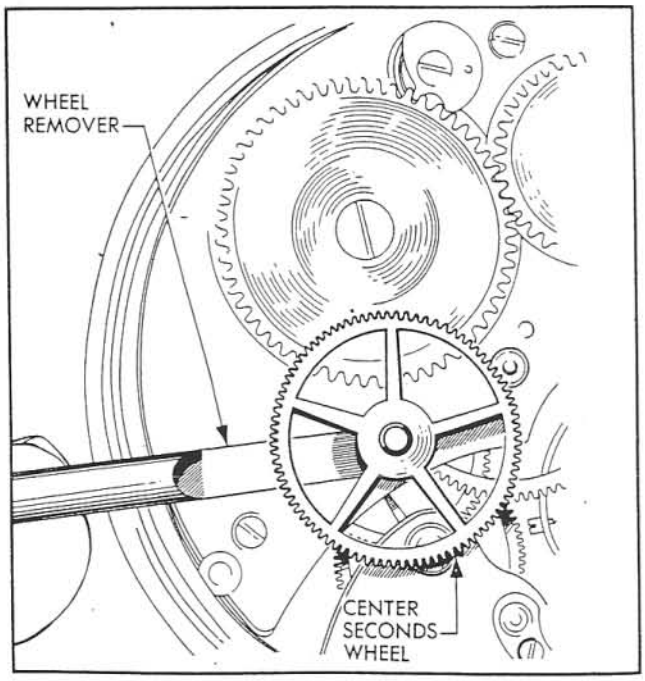


Figure 16—Removing Center Seconds Wheel

(6) PALLET BRIDGE AND PALLET.—Remove the two screws holding the pallet bridge, as shown in figure 17, and lift out the bridge and then, the pallet. Removal of one screw allows the pallet upper endstone cap to be taken off the bridge.

(7) TRAIN BRIDGE. *(See figure 19.)*—Remove the two train bridge screws and lift the bridge from the pillar plate. Then lift out the escape and fourth wheels. Removal of the escape upper endstone cap screw allows separation of the escape upper endstone cap from the bridge.

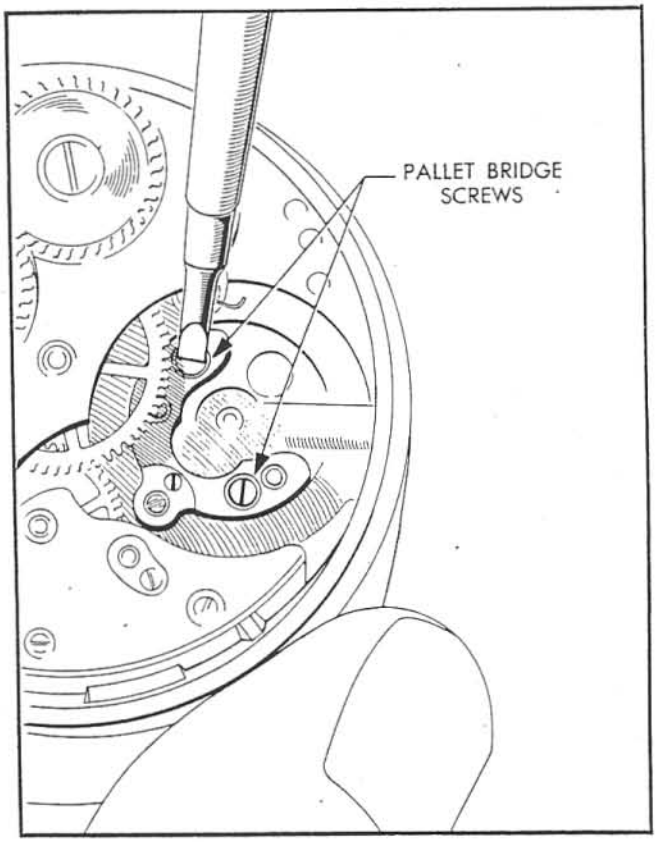


Figure 17—Pallet Bridge

(8) BARREL BRIDGE.—To remove the barrel bridge, take off the ratchet wheel (see figure 18) and the upper winding wheel by removing their screws.

Note

Use a piece of pegwood to hold the teeth of the wheels so that they will not turn while the screws are being loosened.

Remove the three bridge screws from the barrel bridge and lift off the barrel bridge. Lift out the center wheel and third wheel and barrel assembly. Also, from the barrel bridge, remove the click screw and lift off the click, underneath which is the click spring. This is quite small. Take care not to lose it. Then remove the lower winding wheel by lifting it from its recess in the bridge.

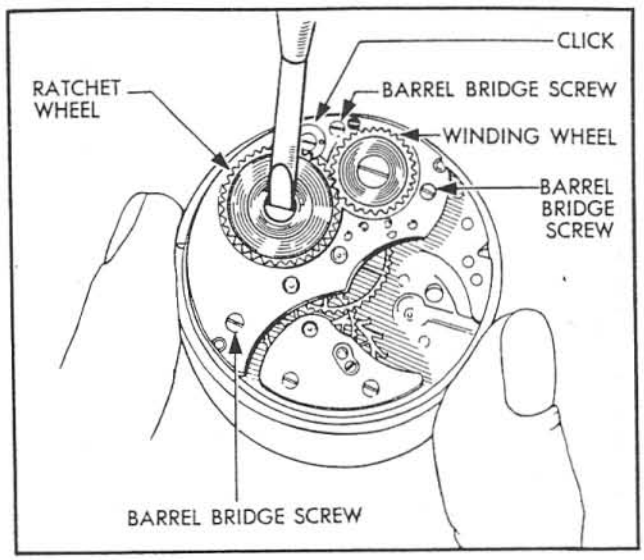


Figure 18—Removing Ratchet Wheel Screws

Disassemble the barrel by prying off the barrel cap with a small screwdriver inserted in the smaller slot in the cap, and carefully withdraw the barrel arbor and mainspring from the barrel. Do not touch the mainspring with bare fingers; use watch repairman's tissue.

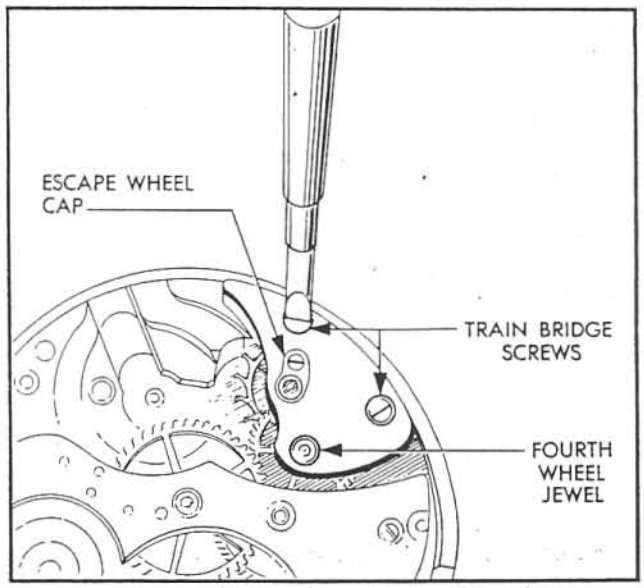


Figure 19—Removing Train Bridge

(9) SECONDS SETTING MECHANISM. *(See figure 20.)*—Remove the two screws from the seconds setting cap, which holds the seconds setting mechanism to the pillar plate. Then lift out the seconds setting cap, the seconds setting lever with its attached spring finger, and the seconds setting lever spring which is underneath. Be sure to lift out the cap screws before raising the seconds setting mechanism because the spring will jar the mechanism and might cause the screws to be lost.

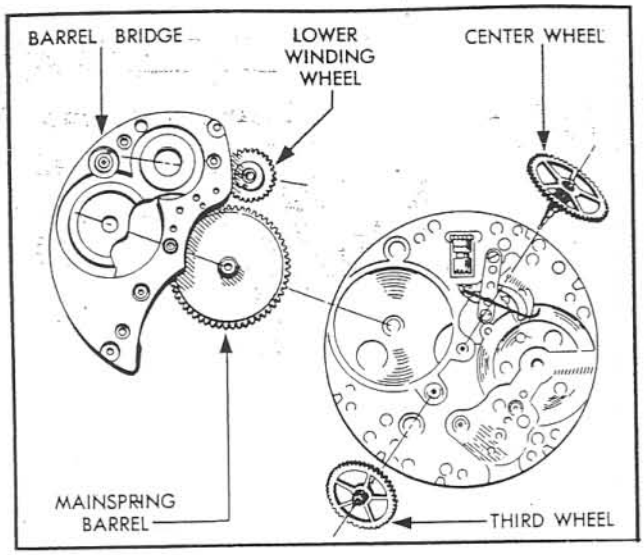


Figure 20—Barrel Bridge Disassembly

(10) WINDING PINION AND CLUTCH. *(See figure 21).*—Remove the winding pinion and the clutch from their recess in the pillar plate. At this point remove the setting lever (blue) screw previously loosened.

(11) DIAL TRAIN.—Now turn the movement over with the dial side up. Remove the slipper-shaped setting cap spring by removing two screws. Remove the minute wheel, intermediate setting wheel, and the setting wheel in that order. Then remove the clutch lever, clutch lever spring and setting lever.

(12) PILLAR PLATE.—To complete the disassembly of the pillar plate, unscrew the two balance lower endstone cap screws and remove the cap. Next remove the escapement lower endstone cap screws and cap. This completes the disassembly of the watch. While the banking pins normally should not be disturbed, if their removal is necessary because of breakage, they can be unscrewed at this time. The screws can be readily recognized since each is cross slotted.

3. CLEANING, INSPECTION, TESTING, AND REPAIR.

a. CLEANING.—The cleaning procedure described herein is the method, and employs the materials, recommended for the machine cleaning technique. Manual methods may be employed, and any of the commonly accepted cleaning materials available to the watch repairman will prove satisfactory if thorough manual procedures are employed.

If the oil has thickened in the jeweled bearings (if it adheres to the jewels or pivot holes) or appears to be gummy, carefully remove it with a pointed pegwood stick before the cleaning operation.

(1) GENERAL.—Exercising care to see that no part is in contact with another, place all the disassembled pieces, except the pallet, the balance wheel, the hairspring, the mainspring, the dial, and the hands, in separate compartments of the cleaning basket. Adhering strictly to the sequence given below, immerse the baskets and parts in the following solutions:

(a) Degreasing agents, preferably carbon tetrachloride (U.S. Army Specification 4-503-110B) or benzine. The latter should be used only in a well-ventilated room, as the vapors are explosive.

(b) Water-free denatured alcohol (Specification AN-O-A-391).

(c) Soap solution. If obtainable, use castile soap. As a substitute, ivory soap may be employed.

(d) Tap water.

(e) Distilled water.

(f) Denatured alcohol.

(g) Denatured alcohol.

If any of the watch parts are excessively dirty, brush each with a medium stiff watch brush dipped in the degreasing agent before immersing it in the first denatured alcohol solution. While the cleaning baskets are immersed in each of the solutions mentioned above, rotate them so that the cleaning fluid will come in contact with every part of the watch movement. Allow the baskets to come to rest two or three times while in each solution so that entrapped air may escape. After withdrawing a basket from a solution, rotate it rapidly for a few seconds to spin off any adhering liquid. After the last denatured alcohol rinse, twirl the baskets rapidly for several minutes so that the last trace of alcohol may evaporate and the parts become completely dry.

(2) BALANCE.—Suspend the balance wheel and the hairspring on fine wire hooks and dip them separately in the order specified in the cleaning solutions mentioned above.

(3) MAINSPRING.—Wipe the mainspring with a soft rag or with tissue, being careful not to distort its shape while cleaning and not to touch it with the bare fingers.

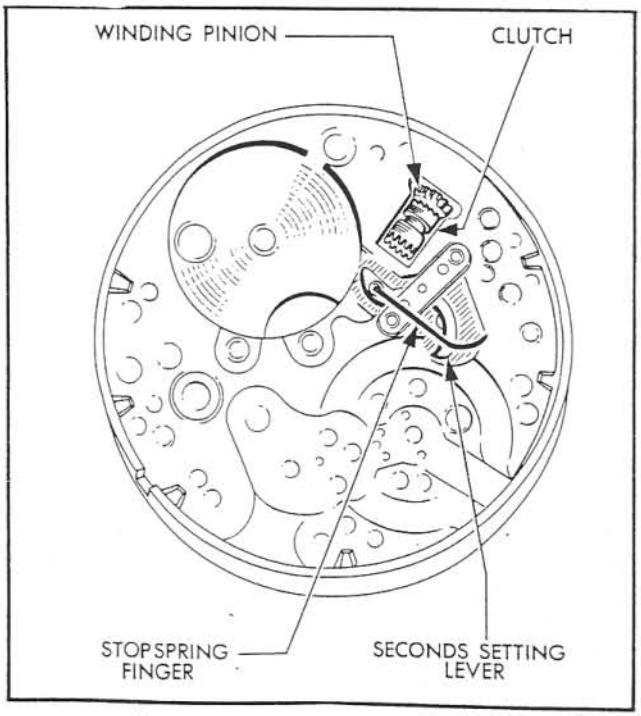


Figure 21—Removing Seconds Setting Mechanism

(4) DIAL AND HANDS.—The dial and hands should be cleaned with a soft, dry, camel's hair brush. Take care that they do not come in contact with any liquid.

(5) PALLET.—Clean the pallet by removing any gum or old oil with pegwood and dipping in benzine.

CAUTION

Be extremely careful not to touch any of the jewels or pivots with the fingers after cleaning. Finger marks can be avoided by manipulating all pieces with the tweezers only. Be certain that all pieces are perfectly dry, and that they are free of any foreign matter before they are reassembled.

b. INSPECTION.—After cleaning, all parts should be examined to be sure that they have been thoroughly cleaned. Then all parts should be inspected for worn, bent, or broken pivots; cracked, pitted, or broken jewels; cracked, bent, or damaged springs; and broken or damaged wheels and pinions. Complete all repairs or replacements at this time.

c. TESTING.—After reassembly of the watch it should be tested as specified in section VII.

d. REPAIR.—If at all possible, broken or damaged parts be replaced. Repair or reworking of damaged parts is not recommended.

4. REASSEMBLY.

a. LUBRICATION INSTRUCTIONS.—Oiling of the movement must take place during, and just after, reassembly. Jewels and other parts must be oiled as specified as they are assembled. The entire procedure is given here to prevent confusion.

(1) JEWELS.—Before reassembling the movement be sure that all jewels are clean, and make sure that no lint or dust remains on them. A jet of air under moderate pressure will generally suffice to remove any foreign matter.

To oil a capped jewel, place a conventional size drop of oil (Navy Specification M-537) in the bar or olive hole. The oil should not be permitted to remain in the hole. Use a piece of fine pointed wire to lead the oil into the space between the two jewels. The oil that has been led between the jewels will then spread away from the central axis. Proper oiling is indicated when the outer edge of the drop has spread about half-way from the center to the circumference. Too little oil may cause undue wear of the pivot, while too much will result in its draining away to near-by parts where oil is not necessary. If the drop of oil which has been urged to enter the space between the jewels does not assume a truly circular form, a lack of parallelism probably exists between the two jewels. This should be corrected.

Place a small drop of oil in each of the train bar hole jewels after the movement is assembled. This should be just large enough to create a film of oil between the jewel and the shoulder of the pivot, with a small surplus remaining in the depression. Too much oil is likely to spread to adjacent parts and is undesirable. When oiling a train jewel, the fine pointed wire, used as an oiler, should make contact with the pivot at the point where it touches the jewel hole. In withdrawing the wire, take care that it does not leave a track of oil on the top surface of the jewel. Such a track would tend to draw or drain the oil from the jewel hole. When oiling the center lower bar hole jewel, place a small quantity of oil on the center staff, where it enters the cannon pinion, to lubricate the cannon pinion.

(2) MAINSPRING.—After cleaning and winding the mainspring, place a sufficient amount of oil in the barrel to lubricate the entire surface of the spring, but not such an amount as would result in oil being forced from the barrel when the spring is completely wound.

(3) OTHER PARTS.—Apply petroleum jelly or a similar and suitable grease sparingly to the winding stem—particularly on the square portion under the clutch—on the pins of the setting lever, and on other obvious points of friction, excepting, of course, the dial train wheels. Dip the end of a fine pointed wire in oil and touch it to each of the impulse faces of the two pallet stones, being careful that no oil spreads to the metal portions of the pallet.

(4) EFFECTS OF FAULTY CLEANING AND OILING.—Although the synthetic sapphire of which all watch jewels are made is of extreme hardness and uniformity, any abrasive dust will ultimately cause *wear*. Since it is easy for dust to become mixed with lubricants, it is important to keep all containers holding lubricants clean and covered at all times.

b. REASSEMBLY OF PILLAR PLATE.

CAUTION

Never force parts together. If parts do not fit together easily they are being assembled improperly.

(1) SETTING MECHANISM.—Reassembly of the watch starts with the pillar plate. First replace the dial foot screws in order not to lose them. Next install the balance lower endstone cap and the escapement lower endstone cap in their recesses on the dial side of the pillar plate as shown in figure 22. The balance cap has two screws and the escapement cap has three. Turn the pillar plate over and put the setting lever (blue) screw in its hole in the pillar plate. Then install the setting lever on the dial side, so that the lower end of the blue screw holds it loosely against the dial side of the pillar plate.

With the dial side up, install the clutch lever and the clutch lever spring. The lower pin on the clutch lever should engage the groove in the clutch, and the clutch lever spring should bear against the end of the clutch lever as shown in figure 22.

Re-install the setting wheel, the intermediate setting wheel, and the minute wheel over the posts on the dial side of the pillar plate (figure 22). Replace the setting cap spring and its two screws. The recess in the long end of the setting cap spring should be under the pin of the setting lever.

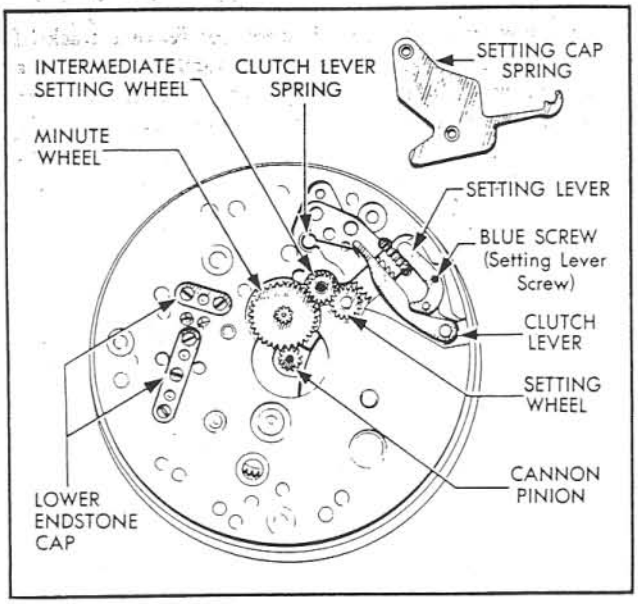


Figure 22—Pillar Plate Assembly, Dial Side

Now install the clutch and the winding pinion in the recess in the pillar plate and hold them in place by installing the stem and crown. The end of the setting lever previously installed should drop in the groove in the stem. Tighten the setting lever (blue) screw sufficiently to keep the stem from falling out. This completes the assembly of the setting mechanism which should be checked by pulling the stem into the setting position several times and noting the action.

(2) SECONDS SETTING MECHANISM.—Turn the movement over on the train side and install the seconds setting lever spring on its post. Then install the seconds setting lever, complete with spring finger, on its post in the recess in the pillar plate. Next put the seconds setting cap over the seconds setting lever and under the spring finger and into its recess. Install the two seconds setting cap screws.

(3) COILING MAINSPRING. *(See figure 23.)*—To wind the mainspring in the mainspring barrel, fasten the mainspring winder firmly in a bench vise. Wind the mainspring slowly into the barrel-like recess of the winder. Place the mainspring barrel over the coiled mainspring and set the hook of the brace into the slot in the barrel. Press the mainspring winder plunger to transfer the wound mainspring into the barrel. Install the barrel arbor so that its hook engages the hole in the inner end of the mainspring. Then snap the barrel cap into its recess, with the larger slot in the cap engaging the other hook on the mainspring brace. These parts are shown in figure 24.

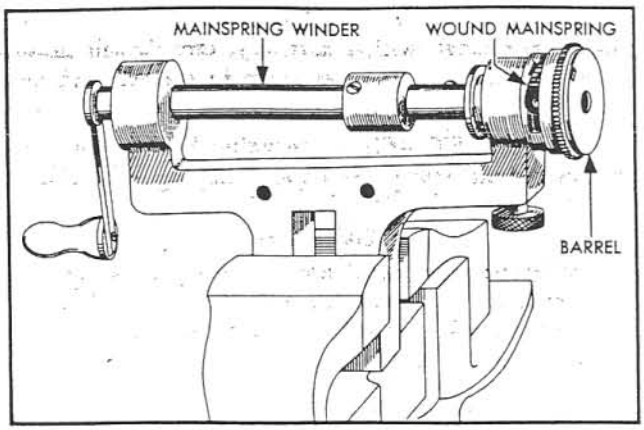


Figure 23—Winding Mainspring

(4) BARREL BRIDGE.

(a) Put the lower winding wheel on the under side of the barrel bridge and fasten the upper winding wheel to it on top of the bridge with its screw making certain that the lower winding wheel dowel pin enters the hole in the face of the upper winding wheel. Place the click spring in the hole at the bottom of the click recess on the upper side of the pillar plate. Turn the bridge over and set the click so that the bent-up end of the click spring enters the hole in the click. Then insert and tighten the click screw.

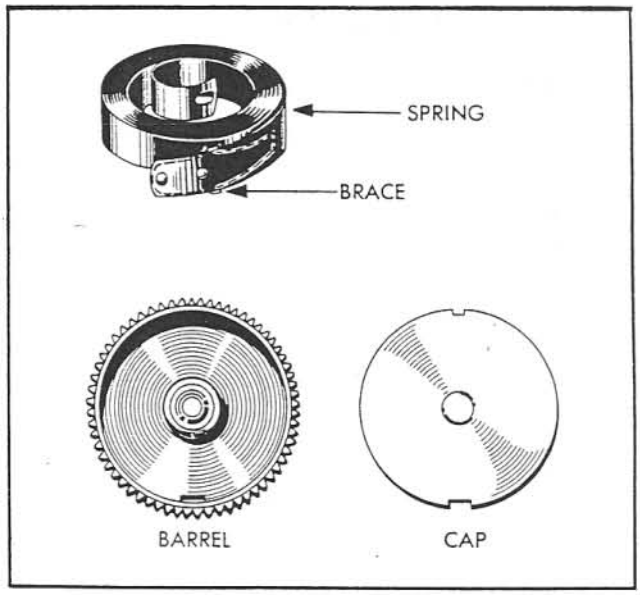


Figure 24—Mainspring, Barrel, and Cap

(b) With the pillar plate train side up, set the barrel, into which the mainspring has been wound as previously described, in position. Then place the third and center wheels in their respective jewels in the pillar plate (figure 25).

(c) Place the subassembled barrel bridge over the square end of the barrel arbor, making certain that the center and third wheels mesh and that their arbors are free in their jewels. Install and tighten the three barrel bridge screws.

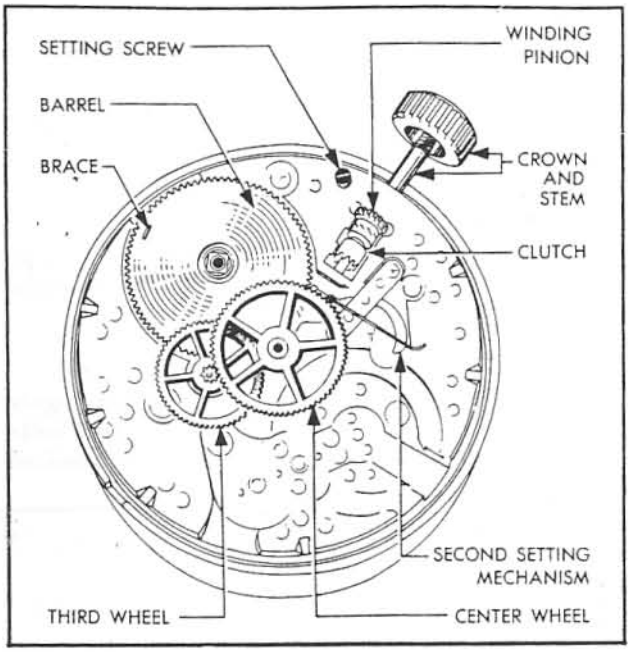


Figure 25—Installing Barrel and Third and Center Wheels

(d) Place the ratchet wheel on the square end of the barrel arbor where it protrudes through the barrel bridge, seeing that its teeth mesh with the winding wheel and the click (figure 26).

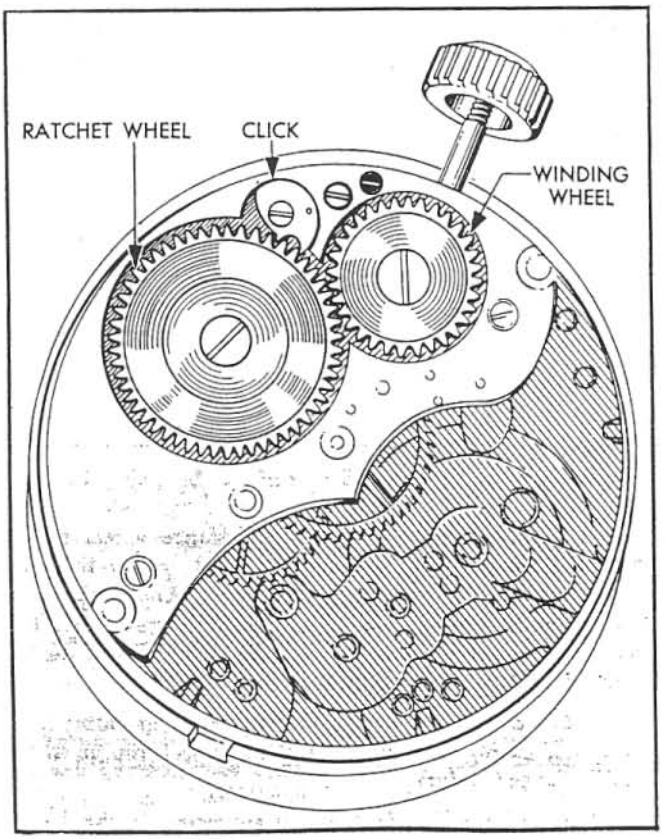


Figure 26—Installing Ratchet Wheel and Click

(5) TRAIN BRIDGE. *(See figure 27.)*—Assemble the escape upper endstone cap to the train bridge with its screw. Place the fourth and escape wheels in their jewels in the pillar plate and set the train bridge in place being sure that both the fourth wheel and the escape wheel are properly seated in their upper jewels in the bridge. Fasten it with the two bridge screws. Then wind the watch slightly and observe the action of the train to be assured that it operates freely and smoothly.

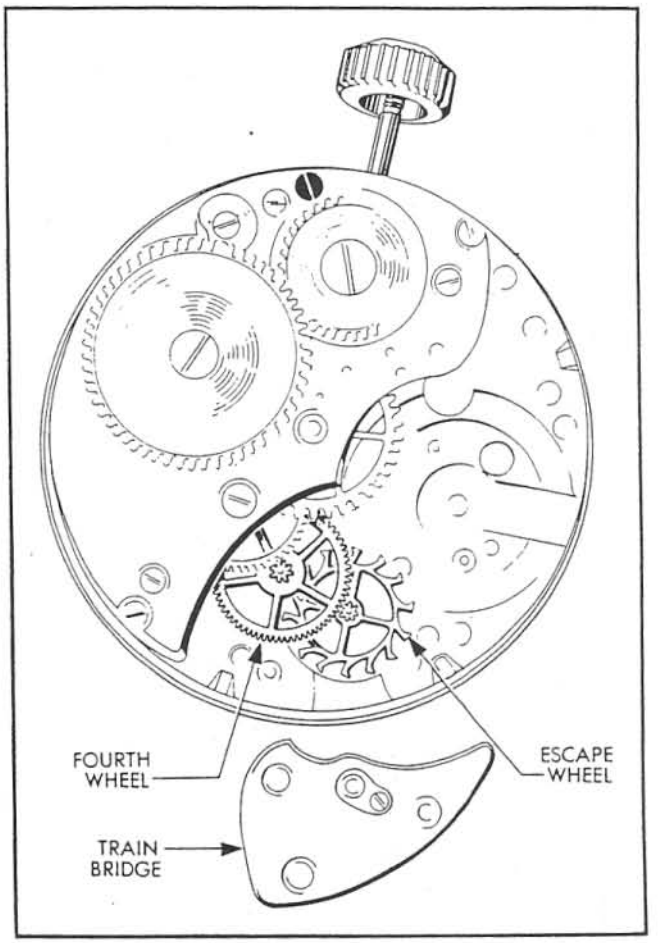


Figure 27—Installing Train Bridge

(6) CENTER SECONDS PINION.

(a) Place the stabilizer spring on the barrel bridge, fastening it with the two stabilizer spring screws, and replace the center seconds wheel on the third wheel pinion which extends above the barrel bridge.

(b) Insert the center seconds pinion through the hollow stem of the center wheel pinion, seeing that it meshes properly with the center seconds wheel.

(c) Replace the center seconds bridge on the barrel bridge making sure that the pivot of the center seconds pinion enters its jewel. Tighten down the center seconds bridge screw. Again try the free running of the train.

(7) PALLET AND PALLET BRIDGE.—Fasten the pallet upper endstone cap to the pallet bridge (figure 28). Set the pallet assembly in position in the pallet lower jewel with the pallet arm between the banking

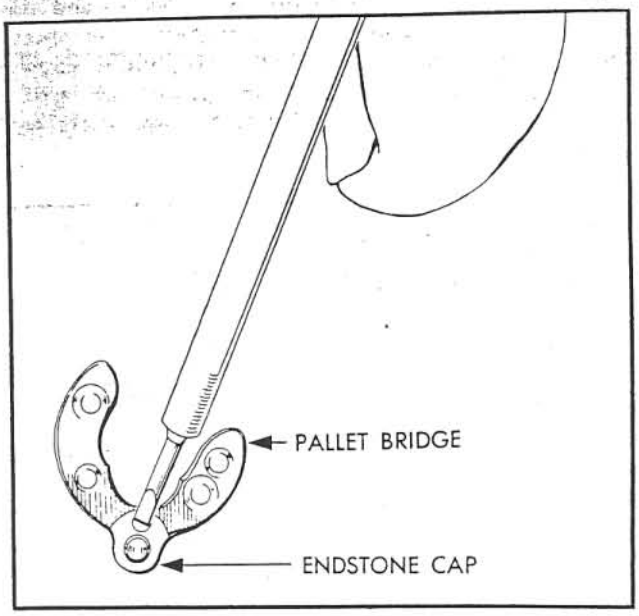


Figure 28—Installing Pallet Endstone Cap

pins. Install the pallet bridge (figure 29). Install and tighten the two pallet bridge screws.

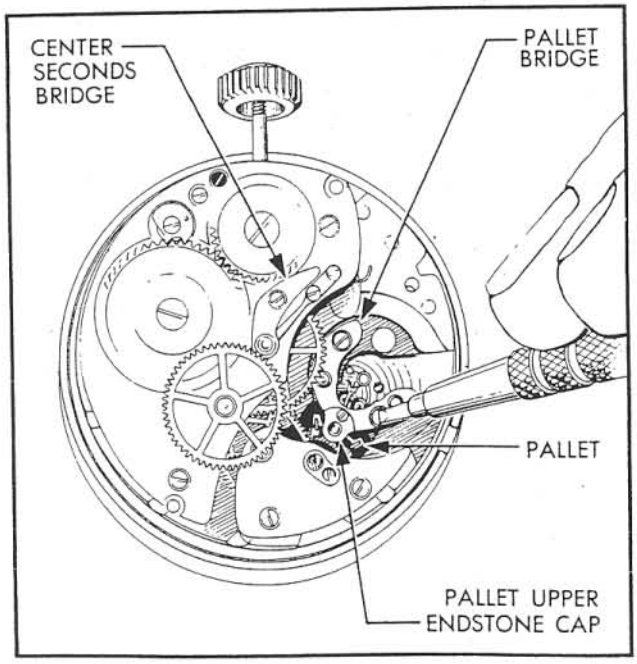


Figure 29—Installing Pallet Bridge

(8) BALANCE WHEEL. *(See figure 30.)*

(a) Assemble the balance wheel in the following order: Place the balance wheel in the staking tool resting on its safety roller. Assemble the hairspring to the balance by placing the hairspring collet over the upper end of the balance staff, and pressing it home with the hollow spindle of the staking tool. Remove the balance wheel and hairspring from the staking tool and examine the roller jewel pin and safety roller. The roller jewel pin should be perpendicular to the arm of the balance wheel and exactly centered in the crescent of the safety roller. The hairspring should be located so that its stud is approximately 10 degrees counterclockwise from the balance wheel arm.

CAUTION

It is absolutely essential that a proper angular relationship of roller pin jewel, small roller crescent, and balance wheel spokes be obtained.

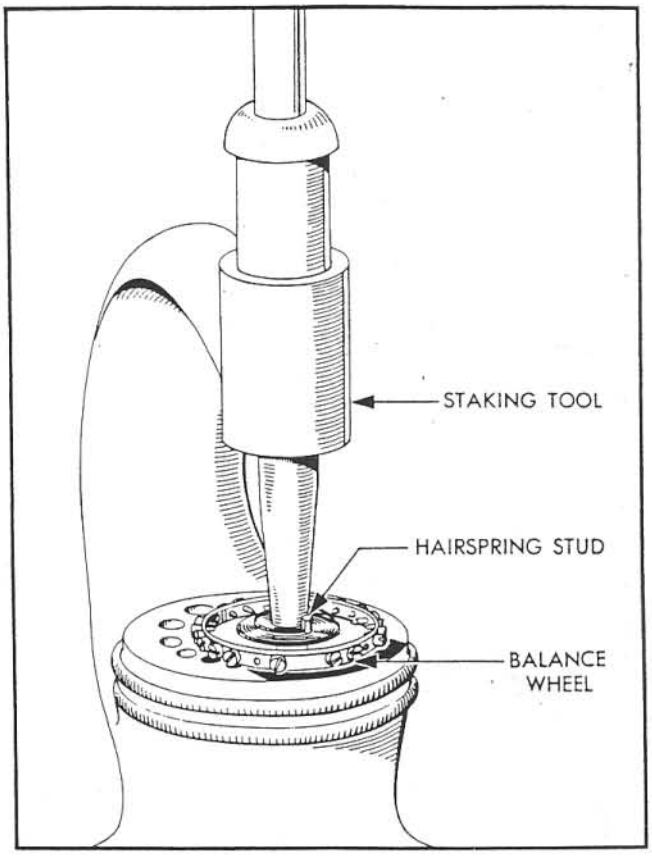


Figure 30—Assembling Hairspring to Balance Wheel

(b) Place the subassembled balance wheel in a pair of truing calipers (figure 31), and spin it to test the hairspring for trueness and flatness. Any faults revealed by this test should be corrected immediately. If necessary, a new balance wheel subassembly or a new hairspring should be installed.

(c) Set the balance and hairspring assembly in its jewel, taking care to engage the jewel pin in the slot of the pallet fork.

(9) BALANCE COCK.—To subassemble the balance cock set the balance upper endstone cap upside

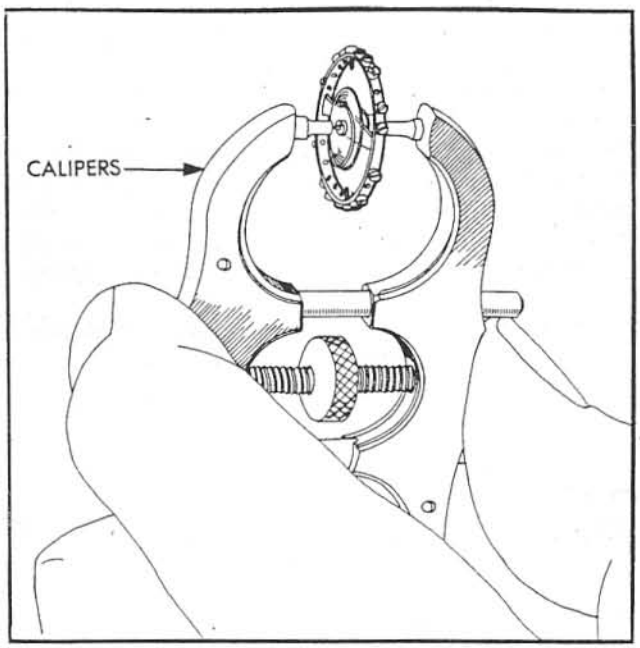


Figure 31—Truing Balance Wheel

down on a level surface. Place the regulator over the cap; lay the balance cock over the two parts, and install and tighten the balance upper endstone cap screws. These screws pass through the balance cock from beneath and into the cap (see figure 12).

Turn the balance cock over, move the regulator to the slow side (see figure 32) and install the regulator spring with its two screws. It is best to back out the regulator screw until it is flush with the face of the spring before installing the spring.

Assemble the balance cock to the pillar plate and fasten it with the balance cock screw. Make sure that the overcoil of the hairspring passes between the pins of the regulator and that the stud enters its hole in the cock. It may be necessary to back the stud screw

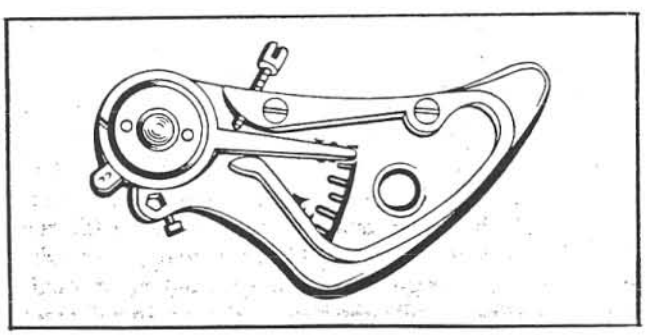


Figure 32—Assembled Balance Cock

(figure 32) out slightly if it has been previously tightened. Carefully level the hairspring by raising or lowering the stud, whichever is required. Then, when the hairspring has been leveled, tighten the hairspring stud screw.

(10) DIAL TRAIN.—Place the movement dial side up in a movement block and install the cannon pinion. This part is friction fit, and it should be pressed home. Over the cannon pinion install the hour wheel, checking to see that it meshes properly with the pinion on the minute wheel.

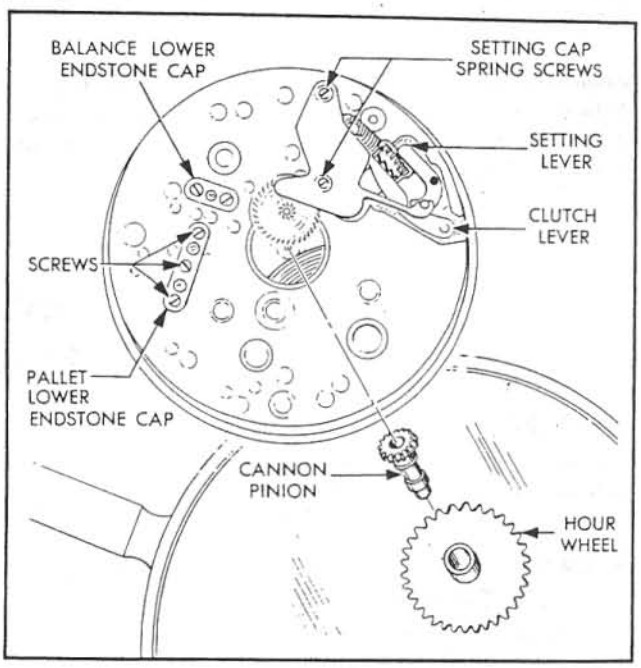


Figure 33—Assembly of Cannon Pinion and Hour Wheel

Wind the watch to check its action. Pull the stem out to the setting position and check the action of the dial train.

Figure 34—Installing Hour Hand

(11) DIAL AND HANDS.—Install the dial in place and tighten the dial foot screws which have been previously installed. Then put on the hands in the following order: the hour hand, minute hand, and second hand. See figure 34. Check to see that there is no interference between the hands at any point. The best instrument for replacing the hands is a hollow ivory or hardwood peg.

(12) CASE RING.—If the case ring has been disassembled, it should be reassembled by installing the helical spring and spring seal on the dustproof sleeve and dropping this assembly carefully in the stem hole. Install and tighten the dustproof seal plug.

(13) COMPLETION OF REASSEMBLY.—To reassemble the movement to the case ring it will first be necessary to loosen the setting lever (blue) screw sufficiently to allow the stem and crown to be removed. The case ring is then placed over the movement, and the case screws installed and tightened. The stem and crown are then reinstalled and the setting lever (blue) screw is retightened. This completes the assembly of the movement. It is then necessary only to screw on the case back and the bezel to complete final assembly.

The watch should be tested as specified in section VII and regulated as specified in section V.

SECTION VII
TEST PROCEDURE

1. GENERAL.

After complete overhaul, run the watch for one day before making tests to allow it to settle down. Wind fully once each 24 hours.

2. DAILY RATE TEST, ROOM TEMPERATURE, HORIZONTAL POSITION.

With the watch lying on its back (dial up), determine its daily rate for a period of 5 days with daily winding. During this 5-day test period, the average of the daily rate should not exceed 5 seconds. The average variation from the average daily rate should not exceed 2 seconds.

3. DAILY RATE TEST, ROOM TEMPERATURE, VERTICAL POSITION.

With the watch resting on its edges (bow up), determine its daily rate for a period of 5 days with daily winding. During the test period the average of the daily rate should not exceed 5 seconds, nor should the average variation from the average daily rate exceed 2 seconds. The difference in the average daily rate between this test and the one specified in paragraph 2 above should not exceed 5 seconds.

4. ISOCHRONISM.

The watch should be fully wound and the rate determined at the expiration of 12 hours, and again at the expiration of 24 hours. The difference between the rate for the first 12 hours and one-half the rate for the entire 24 hours should not exceed 1 second. This test should be conducted with the watch in the horizontal position, dial up, and in the vertical position with the numeral 24 up. The same requirements must be met in both positions.

Note

The tests specified in paragraphs 2 and 3 above may be combined with the tests made in paragraph 4.

5. TEMPERATURE TESTS.

a. Wind the watch fully and maintain it at a temperature of +35°C (+95°F) for a period of 24 hours. The watch should be in the horizontal, dial up, position. Determine the daily rate as specified in paragraph 2 above.

b. Wind the watch fully and subject it to a temperature of +5°C (+41°F) for a period of 24 hours in the horizontal, dial up, position and determine the daily rate. This daily rate of the watch should not differ from that determined in the daily rate test at +35°C (+95°F) by more than 10 seconds.

c. Maintain the fully wound watch at a temperature of −20°C (−4°F) for a period of 24 hours and determine the rate. The daily rate of the watch at −20°C (−4°F) should not differ from the daily rate at + 5°C (+41°F) by more than 16 seconds.

6. RATE RECOVERY.

Determine the daily rate of the watch for a period of 3 days with the watch lying in a horizontal position, dial up, with daily winding. The average of the daily rates during the test period should not exceed 5 seconds. The average variation from the average daily rate should not exceed 2 seconds. The average daily rate should not differ from the average daily rate determined from the room temperature rate test with the watch on its back (dial up) by more than 4 seconds. The room temperature for this test should be approximately the same as the temperature in the original room temperature test.

Note

The tests described above are the same as those specified for new watches at the factory. Specific rating specifications for repaired and/or overhauled watches can be established by the repairing facility.

PARTS CATALOG

SECTION VIII
INTRODUCTION

1. GENERAL.

The following parts catalog refers to the Master Navigation Watch AN5740, manufacturer's part No. 33106, manufactured by the Hamilton Watch Company, Lancaster, Pa., U.S.A.

2. GROUP ASSEMBLY PARTS LIST.

a. The Group Assembly Parts List indicates and describes each assembly and detail parts of the master navigation watch in the order of assembly. These are indented to indicate the relationship of each part to its next higher assembly. Each exploded view has a figure number and individual items on each figure have index numbers so that they can be easily located in the parts list.

b. Part numbers preceded by an asterisk (*) indicate parts that are not separately procurable.

3. NUMERICAL PARTS LIST.

The Numerical Parts List contains the numbers of all parts in their numerical sequence. A reference to the Group Assembly page number is given for each part to facilitate finding the description when only the part number is known.

4. STANDARD PARTS LIST.

No standard parts list is included since there are no service standard parts in the master navigation watch.

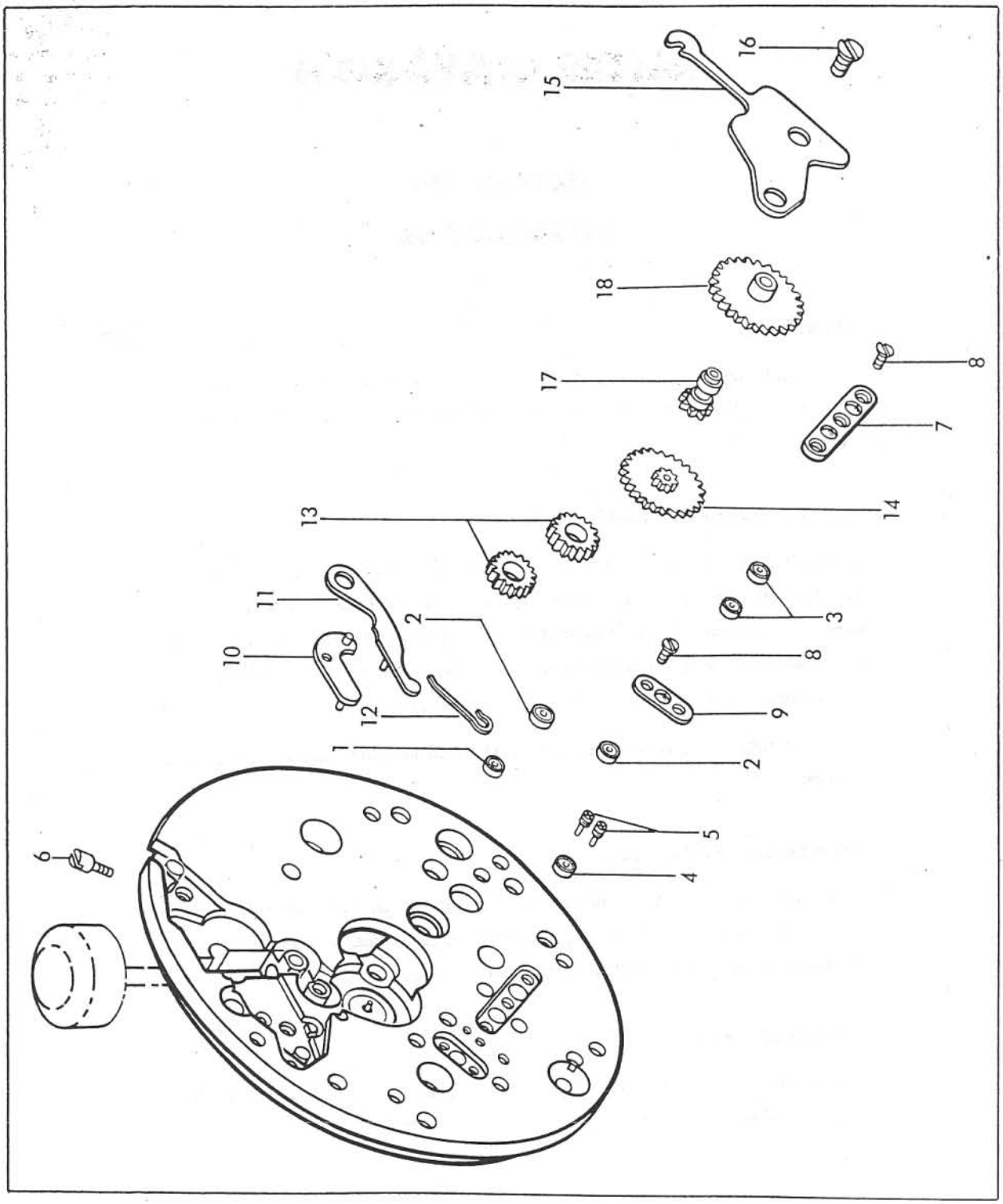


Figure 35 — Exploded View of Dial Side of Movement

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 NOMENCLATURE	UNITS PER ASSY.
	*33016A	Plate—Pillar complete with 9 jewels	1
	*33016	Plate—Pillar complete with pins and posts	1
	*35795	Pin—Pallet bridge steady	2
	*33029	Pin—Minute wheel	1
	*35013	Post—Clutch lever	1
	*35019	Post—Seconds setting lever	1
35- 1	215	Jewel—Bar hole center lower	1
2	35159	Setting—Third lower complete with jewel	1
	*35159-1	Setting—Third lower	1
	*213	Jewel—Bar hole	1
2	35159	Setting—Fourth lower complete with jewel	1
	*35159-1	Setting—Fourth lower	1
	*213	Jewel—Bar hole	1
3	33167	Setting—Escape lower complete with jewel	1
	*33167-1	Setting—Escape lower	1
	*224	Jewel—Olive hole	1
3	33167	Setting—Pallet lower complete with jewel	1
	*33167-1	Setting—Pallet lower	1
	*224	Jewel—Olive hole	1
4	35009	Setting—Balance lower complete with jewel	1
	*35009-1	Setting—Balance lower	1
	*222	Jewel—Olive hole	1
5	6765	Screw—Banking	2
6	35774	Screw—Dial Foot	3
7	33050	Cap—Escapement lower endstone complete with jewels	1
	*33050-1	Cap—Escape and pallet lower	1
	*231	Jewel—Endstone	2
8	20806	Screw—Escapement lower endstone cap	3
9	35195	Cap—Balance lower endstone complete with jewel	1
	*35195-1	Cap—Balance lower	1
	*231	Jewel—Endstone	1
8	20806	Screw—Balance lower endstone cap	2
10	35010	Lever—Setting complete with pin	1
	*35022	Pin—Setting lever	1
11	35011	Lever—Clutch	1
12	35603	Spring—Clutch lever	1
13	35246	Wheel—Setting	2
14	33030	Wheel—Minute complete with pinion	1
	*33032	Wheel—Minute	1
	*33031	Pinion—Minute wheel	1
15	35012	Spring—Setting cap	1
16	20853	Screw—Setting cap spring	2
36- 1	35232	Clutch	1
2	35014	Pinion—Winding	1
3	35785	Screw—Setting lever (blue)	1
4	35017	Lever—Seconds setting complete with spring finger	1
	*35021	Finger—Stop spring	1
	*35020	Pin—Seconds setting lever	1
5	35603	Spring—Seconds setting lever	1
6	35018	Cap—Seconds setting	1
7	20806	Screw—Seconds setting cap	2
	*35292	Barrel—Assembly	1
8	35213	Arbor—Barrel	1
9	35335	Barrel—Complete with cap	1
	*35211	Barrel	1
	*35340	Cap—Barrel	1
10	60061	Mainspring—Complete with brace (standard strength)	1
	*60061-1	Spring—Main	1
	*35085	Brace—Mainspring	1
		(Mainsprings are available in several strengths to provide more or less power when required following repair and overhaul)	
		#60060—.145-mm thick	
		60061—.150-mm thick	
		60062—.155-mm thick	
		60063—.160-mm thick	
		60064—.165-mm thick	
	*33017A	Bridge—Barrel complete with 2 jewels	1
11	33017	Bridge—Barrel	1
	*35794	Pin—Steady	2

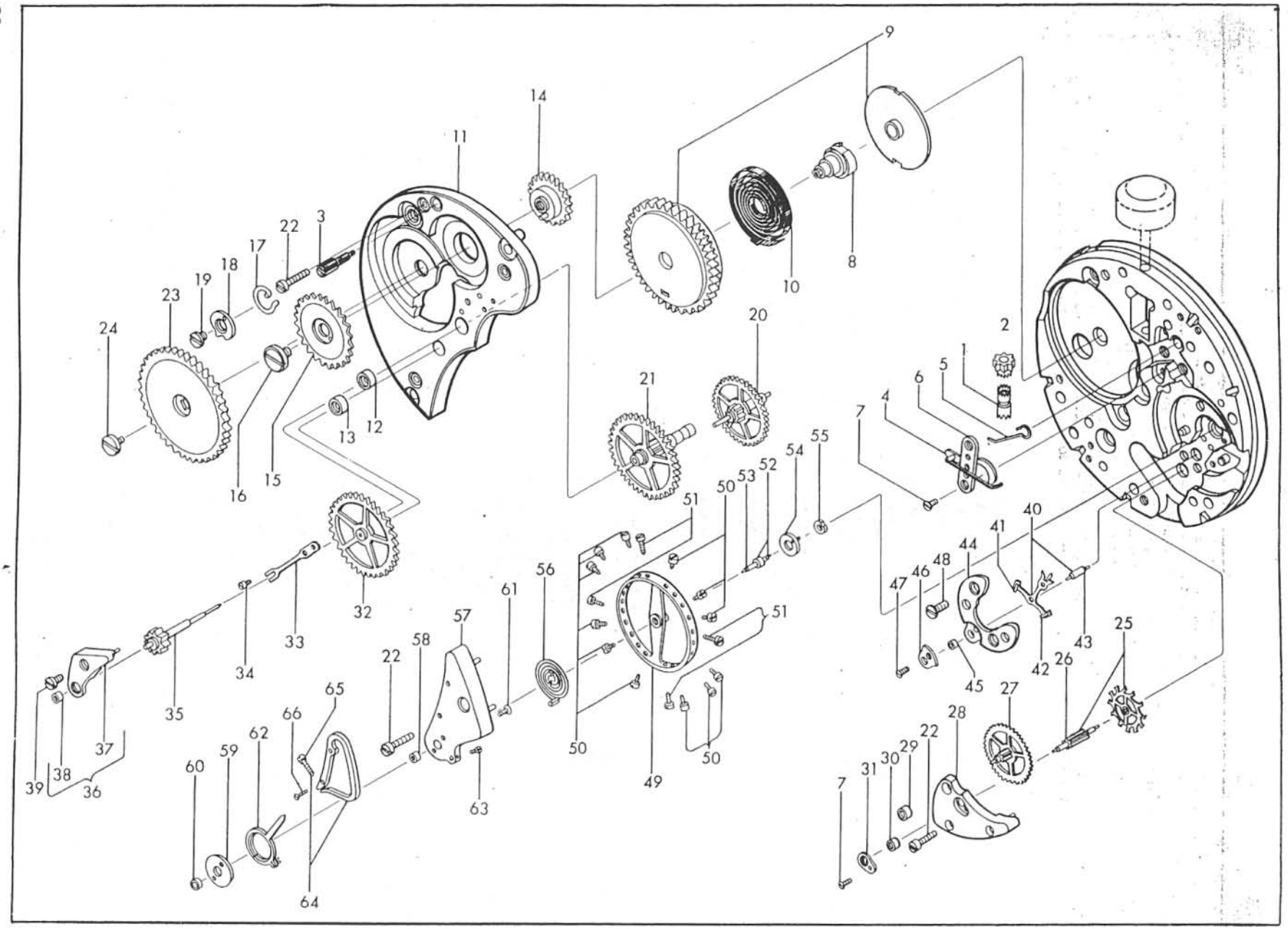


Figure 36 — Exploded View of Train Side

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 NOMENCLATURE	UNITS PER ASSY.
36-12	33156	Setting—Center upper complete with jewel	1
	*33156A	Setting—Center upper	1
	*215	Jewel—Bar hole	1
13	35159	Setting—Third upper complete with jewel	1
	*35159-1	Setting—Third upper	1
	*213	Jewel—Bar hole	1
14	35227	Wheel—Lower winding complete with pin	1
	*35227-1	Wheel—Lower winding	1
	*23632	Pin—Dowel	1
15	35229	Wheel—Winding	1
16	35779	Screw—Winding wheel	1
17	35601	Spring—Click	1
18	35600	Click	1
19	14766	Screw—Click	1
20	33022	Wheel—Third complete with pinion	1
	*35203	Wheel—Third	1
	*33023	Pinion—Third	1
21	33020	Wheel—Center complete with pinion	1
	*35200	Wheel—Center	1
	*33021	Pinion—Center	1
22	35760	Screw—Barrel bridge	3
23	35236	Wheel—Ratchet	1
24	35766	Screw—Ratchet wheel	1
25	33012	Wheel—Escape complete with pinion	1
	*33012-1	Wheel—Escape	1
	*6939	Hub—Escape wheel	1
26	33220	Pinion—Escape	1
27	33024	Wheel—Fourth complete with pinion	1
	*35206	Wheel—Fourth	1
	*33025	Pinion—Fourth	1
	*33018A	Bridge—Train complete with 3 jewels	1
28	33018	Bridge—Train	1
	*35794	Pin—Steady	2
29	35159	Setting—Fourth upper complete with jewel	1
	*35159-1	Setting—Fourth upper	1
	*213	Jewel—Bar hole	1
30	33167	Setting—Escape upper complete with jewel	1
	*33167-1	Setting—Escape upper	1
	*224	Jewel—Olive hole	1
31	33013	Cap—Escape upper endstone complete with jewel	1
	*33013-1	Cap—Escape upper	1
	*231	Jewel—Endstone	1
7	20806	Screw—Escape upper endstone cap	1
22	35760	Screw—Train Bridge	2
32	33026	Wheel—Center seconds complete with hub	1
	*33026-1	Wheel—Center seconds	1
	*33027	Hub—Center seconds wheel	1
33	39007	Spring—Stabilizer	1
34	20814	Screw—Stabilizer spring	2
35	33028	Pinion—Center seconds	1
36	33019A	Bridge—Center seconds complete with jewel	1
37	33019	Bridge—Center seconds	1
38	213	Jewel—Center seconds upper bar hole	1
	*7798	Pin—Steady	2
39	27759	Screw—Center seconds bridge	1
40	33132	Pallet—Escapement complete with arbor and jewels	1
	*33132-1	Pallet	1
41	35107	Jewel—"L" pallet stone	1
42	35108	Jewel—"R" pallet stone	1
	*35122	Pin—Pallet guard	1
43	33222	Arbor—Pallet	1
	*33510A	Bridge—Pallet complete with 2 jewels	1
44	33510	Bridge—Pallet	1
45	33171	Setting—Pallet upper complete with jewel	1
	*33171-1	Setting—Pallet upper	1
	*224	Jewel—Olive hole	1
46	33014	Cap—Pallet upper endstone complete with jewel	1
	*33014-1	Cap—Pallet upper	1
	*231	Jewel—Endstone	1

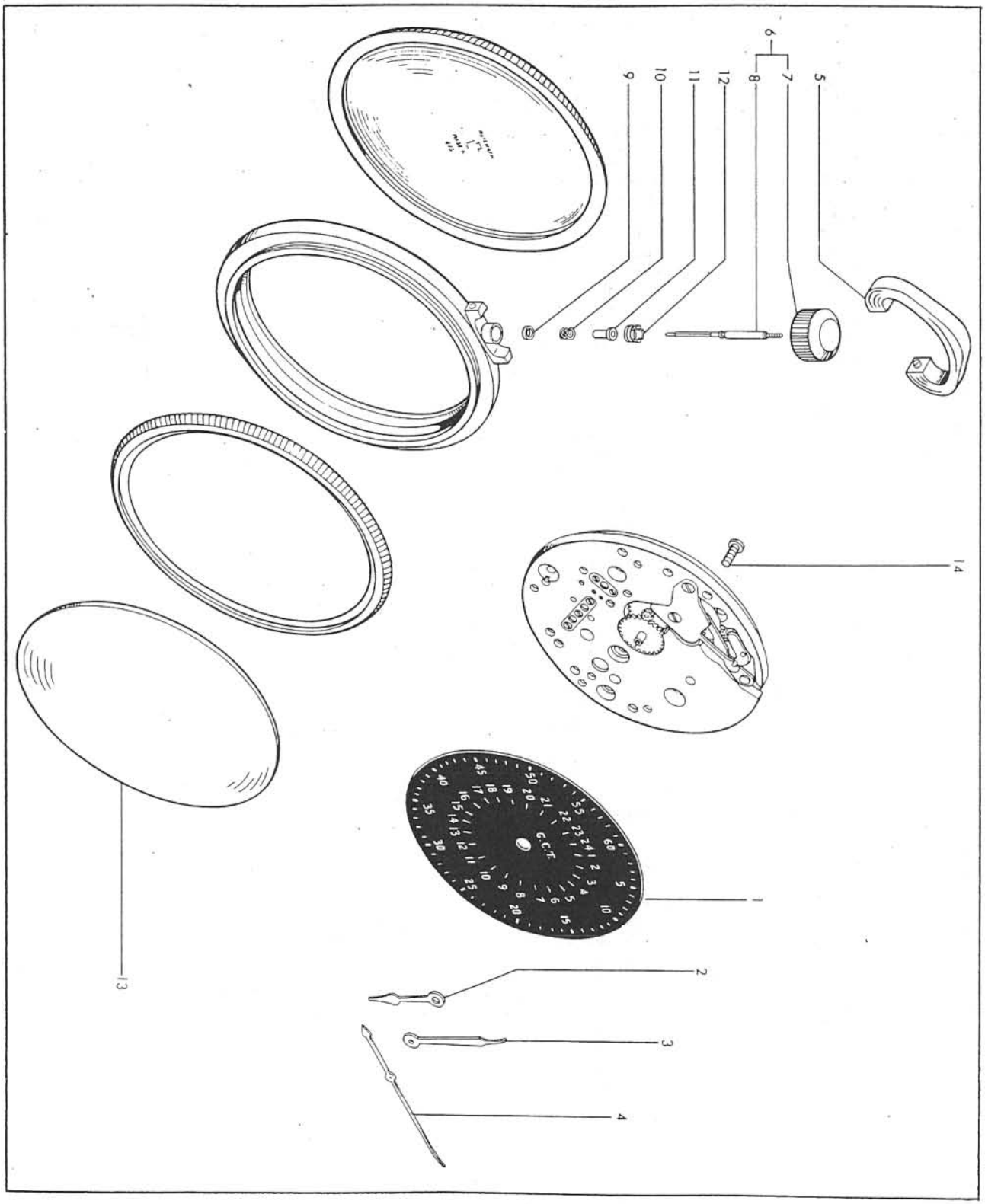


Figure 37 — Exploded View of Component Parts

FIGURE & INDEX NUMBER	PART NUMBER	1 2 3 4 5 6 7 NOMENCLATURE	UNITS PER ASSY.
36-47	2784	Screw—Pallet upper endstone cap	1
48	35768	Screw—Pallet bridge	2
	33000	Balance assembly—Complete	1
49	10003	Wheel—Balance subassembly	1
	*10149	Wheel—Balance	1
50	25748	Screw—Balance wheel, 8.00 mg weight	2
50	25754	Screw—Balance wheel, 9.00 mg weight	8
50	25759	Screw—Balance wheel, 10.75 mg weight	2
51	6751	Screw—Balance meantime regulating	4
52	35320	Hub—Balance wheel complete with staff	1
	*35320-1	Hub—Balance wheel	1
53	35224	Staff—Balance	1
54	4133	Roller—Large complete with jewel pin	1
	*4133-1	Roller—Large	1
	*25106	Pin—Jewel	1
55	35104	Roller—Small	1
56	33002	Spring—Hair complete	1
	*33002-1	Spring—Hair	1
	*35105	Collet—Hairspring	1
	*6121	Pin—Hairspring collet	1
	*20606	Stud—Hairspring	1
	*6121	Pin—Hairspring stud	1
	*33011A	Cock—Balance complete with 2 jewels	1
57	33011	Cock—Balance	1
	*35794	Pin—Steady	2
58	35009	Setting—Balance upper complete with jewel	1
	*35009-1	Setting—Balance upper	1
	*222	Jewel—Olive hole	1
59	35193	Cap—Balance upper endstone complete with jewel	1
	*35193-1	Cap—Balance upper	1
60	35575	Setting—Balance upper endstone complete with jewel	1
	*35575-1	Setting—Balance upper endstone	1
	*231	Jewel—Endstone	1
61	35814	Screw—Balance upper endstone cap	2
62	35339	Regulator—Complete with pins	1
	*35120	Pin—Regulator	2
63	1770	Screw—Hairspring stud	1
22	35760	Screw—Balance cock	1
64	35064	Spring—Regulator complete with regulating screw	1
65	6780	Screw—Regulating	1
66	35781	Screw—Regulator spring	2
35-17	35215	Pinion—Cannon	1
35-18	33033	Wheel—Hour	1
37- 1	50079	Dial—Complete with feet	1
	*6776	Foot—Dial	3
2	33042	Hand—Hour	1
3	33043	Hand—Minute	1
4	33044	Hand—Center seconds complete with pipe	1
	*7041	Pipe—Center seconds	1
	*33051	Case—Complete with crown and dustproof stem	1
	*33052	Ring—Case	1
5	218-E	Bow—Case (Keystone Watch Case No.) (Hamilton No. 33056)	1
6	33057A	Crown—Complete with stem	1
7	33057	Crown—Case	1
8	35231	Stem—Winding	1
9	33060	Ring—Spring seat	1
10	33061	Spring—Helical	1
11	33059	Sleeve—Seal dustproof	1
12	33058	Plug—Seal dustproof	1
	*33053	Back—Case	1
	*33054	Bezel—Case	1
13	MI-EMP 435-436-437-HT4	Crystal—Case (K-D Crystal Corp.) (Hamilton No. 33055)	1
14	35756	Screw—Case	2
	AN5740	Watch—Master Navigation (Hamilton No. 33106) (Former Model 4992B)	1

ARMY STATUS	PROPERTY CLASSIFICATION U.S. ARMY	U.S. NAVY	BRITISH	PART NO.	FIGURE AND INDEX NO.	TOTAL QTY
				MI-EMP 435-436-437-HT4	37-13	1
				10003	36-49	1
				*10149	36	1
				14766	36-19	1
				1770	36-63	1
				*20606	36	1
				20806	36-7	3
				20806	35-8	5
				20814	36-34	2
				20853	35-16	2
				213	36-38	1
				*213	35	2
				*213	36	2
				215	35-1	1
				*215	36	1
				218-E	37-5	1
				*222	35	1
				*222	36	1
				*224	35	2
				*224	36	2
				*231	35	3
				*231	36	4
				*23632	36	1
				*25106	36	1
				25748	36-50	2
				25754	36-50	8
				25759	36-50	2
				27759	36-39	1
				2784	36-47	1
				33000	36	1
				33002	36-56	1
				*33002-1	36	1
				33011	36-57	1
				*33011A	36	1
				33012	36-25	1
				*33012-1	36	1
				33013	36-31	1
				*33013-1	36	1
				33014	36-46	1
				*33014-1	36	1
				*33016	35	1
				*33016A	35	1
				33017	36-11	1
				*33017A	36	1
				33018	36-28	1
				*33018A	36	1
				33019	36-37	1
				33019A	36-36	1
				33020	36-21	1
				*33021	36	1
				33022	36-20	1
				*33023	36	1
				33024	36-27	1
				*33025	36	1
				33026	36-32	1
				*33026-1	36	1
				*33027	36	1
				33028	36-35	1
				*33029	35	1
				33030	35-14	1
				*33031	35	1
				*33032	35	1
				33033	35-18	1
				33042	37-2	1
				33043	37-3	1
				33044	37-4	1

ARMY STATUS	PROPERTY CLASSIFICATION U.S. ARMY	U.S. NAVY	BRITISH	PART NO.	FIGURE AND INDEX NO.	TOTAL QTY
				33050	35-7	1
				*33050-1	35	1
				*33051	37	1
				*33052	37	1
				*33053	37	1
				*33054	37	1
				33057	37-7	1
				33057A	37-6	1
				33058	37-12	1
				33059	37-11	1
				33060	37-9	1
				33061	37-10	1
				33132	36-40	1
				*33132-1	36	1
				33156	36-12	1
				*33156A	36	1
				33167	35-3	2
				33167	36-30	1
				*33167-1	35	2
				*33167-1	36	1
				33171	36-45	1
				*33171-1	36	1
				33220	36-26	1
				33222	36-43	1
				33510	36-44	1
				*33510A	36	1
				35009	35-4	1
				35009	36-58	1
				*35009-1	35	1
				*35009-1	36	1
				35010	35-10	1
				35011	35-11	1
				35012	35-15	1
				*35013	35	1
				35014	36-2	1
				35017	36-4	1
				35018	36-6	1
				*35019	35	1
				*35020	36	1
				*35021	36	1
				*35022	35	1
				35064	36-64	1
				*35085	36	1
				35104	36-55	1
				*35105	36	1
				35107	36-41	1
				35108	36-42	1
				*35120	36	2
				*35122	36	1
				35159	35-2	2
				35159	36-13, 29	2
				*35159-1	35	2
				*35159-1	36	2
				35193	36-59	1
				*35193-1	36	1
				35195	35-9	1
				*35195-1	35	1
				*35200	36	1
				*35203	36	1
				*35206	36	1
				*35211	36	1
				35213	36-8	1
				35215	35-17	1
				35224	36-53	1
				35227	36-14	1
				*35227-1	36	1

ARMY STATUS	PROPERTY CLASSIFICATION U.S. ARMY	U.S. NAVY	BRITISH	PART NO.	FIGURE AND INDEX NO.	TOTAL QTY
				35229	36-15	1
				35231	37-8	1
				35232	36-1	1
				35236	36-23	1
				35246	35-13	2
				35292	36	1
				35320	36-52	1
				*35320-1	36	1
				35335	36-9	1
				35339	36-62	1
				*35340	36	1
				35575	36-60	1
				*35575-1	36	1
				35600	36-18	1
				35601	36-17	1
				35603	35-12	1
				35603	36-5	1
				35756	37-14	2
				35760	36-22	6
				35766	36-24	1
				35768	36-48	2

ARMY STATUS	PROPERTY CLASSIFICATION U.S. ARMY	U.S. NAVY	BRITISH	PART NO.	FIGURE AND INDEX NO.	TOTAL QTY
				35774	35-6	3
				35779	36-16	1
				35781	36-66	2
				35785	36-3	1
				*35794	36	6
				*35795	35	2
				35814	36-61	2
				39007	36-33	1
				4133	36-54	1
				*4133-1	36	1
				50079	37-1	1
				60061	36-10	1
				*60061-1	36	1
				*6121	36	2
				6751	36-51	4
				6765	35-5	2
				*6776	37	3
				6780	36-65	1
				*6939	36	1
				*7041	37	1
				*7798	36	2