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OVER LING OF MECHAN ECK CLOCKS

BUREAU OF SHIPS NAVY DEPARTMENT April 1953

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

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U.S. NAVY CLOCKS—CHELSEA TYPE

This publication will be known as: "Manual for Overhaul, Repair, and Handling of U. S. Navy Mechanical, Boat and Deck Clocks, Chelsea Type, with Parts Catalog."

This manual, prepared with the assistance and cooperation of certain U. S. Navy repair activities and Chelsea Clock Company, Boston, Massachusetts, is promulgated for the information and guidance of all personnel in the Naval Establishment engaged in the servicing, repair, and testing of clocks.

This manual is available for public sale through the Superintendent of Documents, Washington 25, D. C.

H. N. Wallin,
Chief, Bureau of Ships

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Figure 1. Chelsea 8-1/2" Type B Mechanical Clock in Phenolic Case

(above)

Figure 2. Chelsea 6" Type A Mechanical Clock in Phenolic Case

(right)

SECTION I

INTRODUCTION

PURPOSE AND PLAN OF REPAIR MANUALS FOR NAVIGATIONAL INSTRUMENTS

Each of these manuals on the repair of navigational instruments has several purposes:

1. To make an adequate record of know-how at the time the information was prepared.
2. To establish standard practice for the particular instrument.
3. To provide a manpower training tool for newcomers to the field, especially in cases of national emergency, when working forces must be expanded rapidly.
4. To form a foundation or base from which the quality of repair may be constantly improved, and the cost of repair reduced.

This standard repair practice manual will provide the groundwork for establishing standard allowable repair times by which performance may be judged.

Methods Employed

Prior to the preparation of this manual, an engineering survey of repair methods was conducted in Naval shipyards and in the plants of manufacturers. Consequently, the methods selected as standard repair practice are an integration of the best and most modern in Naval repair activities and those used by instrument manufacturers.

Methods Improvement

This handbook, as you see it, is by no means the final word. It is hoped that it will be subject to continuous change.

The Navy wishes each one working with navigational instrument repair to become "methods-conscious." It would like you to contribute ideas for further improvements to standard practice. Your suggestions should be cleared with your foreman and he will then submit them to the Beneficial Suggestions Committee. The Committee will forward each suggestion to the navigational instruments authority of the Bureau of Ships. There, it will be properly evaluated and, if adopted, you will be given credit and the appropriate portion of this manual will be changed.

Why is this opportunity being offered? Because everyone wants to do his or her share in improving methods and reducing repair costs. After this standard practice has first been put into effect, nobody but a person using it is in the best position to recommend improvement. You are the expert, so put your ideas to work. Take advantage of this chance to better your own position and, at the same time, increase the efficiency of instrument repair.

In this manual are included instructions for the maintenance, repair and overhaul of Chelsea Mechanical, Boat and Deck Clocks, containing Chelsea Model No. 12E and No. 17E movements. Certain sections of this book give separate specific instructions relating to each individual movement, as is required in Disassembly Procedure, Reassembly Procedure and the Maintenance Parts Catalog. Other sections give instructions which are equally applicable to both movements, as is true in Parts Inspection, Repair and Cleaning; in Test, Adjustment and Final Inspection; and in Special Service Tools and Testing Devices.

Model 12E U. S. Navy Mechanical Clocks are constructed in accordance with U. S. Navy Department Specification 18-C-11c. They consist basically of an eight-day movement enclosed in a black phenolic case with a hinged bezel of the same material. See Figs. 1 and 2. Each type has a sweep second hand provided with a slip clutch for resetting. All have black finished dials with non-luminous hands and figures, and all are wound and regulated through the dial. They are intended for general shipboard use, for all applications other than those requiring Deck or Boat Clocks. The various type designations are listed in the table which follows. See the parts lists in Section VII for the stock number of each type listed.

MODEL 12E	DIAL		NET WEIGHT
Type	Hrs.	Dia. in Inches	Pounds (approx.)
A	24	6	3
A	24	8-1/2	5
B	12	6	3
B	12	8-1/2	5

Figure 3. Chelsea Boat Clock in Phenolic Case

Figure 4. Chelsea Deck Clock in Phenolic Case

Each Model 12E dial is marked as follows:

CHELSEA CLOCK CO.
BOSTON
U. S. NAVY

Ser. No. _____

Model 17E Boat and Deck Clocks (Mark 1) are constructed in accordance with U. S. Navy Department Specifications 18-C-5d and 18-C-13. They consist basically of an eight-day movement enclosed in a chromium-plated brass or a black phenolic case. See Figs. 3 and 4. The case is dustproof, moisture-proof and equipped with a cushioned bulkhead mounting plate. Both types have a lusterless black 12-hour dial with luminous hands and dots over the numerals. Each has an eccentric second hand. The Boat and Deck Clocks are designed to be wound, set and regulated through a dust cover in the back of the case. The two type designations may be described as follows:

MODEL 17E	DIAL		NET WEIGHT
Type	Hrs.	Dia. in Inches	Pounds (approx.)
Boat	12	3-1/2	4-1/4
Deck	12	6	7

Each Model 17E dial is marked as follows:

MARK I (BOAT OR DECK) CLOCK
U. S. NAVY

(N) (Serial Number) (Year)

The allowance of Mechanical, Boat and Deck Clocks to the vessels and ships of the Navy are indicated on the ships' allowance lists.

Preparation for Repair

Clocks awaiting overhaul should be sorted by model and type into lots of similar instruments to be processed through the different phases of repair work at one time—the larger the lots, the more efficient the repair operation.

At the clock repair activity, the regular pre-disassembly inspection accurately determines whether or not each clock is worth repairing. If it is decided that the clock is worth repairing, this inspection locates any defects in the movement (as far as this is possible before disassembly). As a part of the pre-disassembly inspection, a route ticket, listing these defects, is made out for each clock and accompanies the clock throughout the overhaul process. The purpose of the route ticket is to assure that these defects will be examined and corrected during the regular overhaul and repair process as described in this manual. Statistical data is also gathered as a result of this inspection.

Once it has been determined that a clock is worth repairing, all clocks go through the same overhaul procedure regardless of the nature of the repairs required. It is in the nature of timepieces that they should be completely overhauled and cleaned at intervals of from one to two years; therefore, all clocks should be completely overhauled no matter what specific repair is required.

A general knowledge of Chelsea Clocks and the points which are of special importance in repair work may be obtained from the descriptive material in Section II. All repair personnel should be thoroughly familiar with the information contained in that section.

OUTLINE OF REPAIR PROCEDURE

The repair work itself is divided into the following main classes of activity:

(1) Disassembly (Section III)
(2) Escapement Disassembly (Section III-A)
(3) Parts Inspection, Repair and Cleaning (Section IV)
(4) Escapement Operations (Section IV-A)
(5) Reassembly (Section V)
(6) Test, Adjustment and Final Inspection (Section VI)

Supplementing the preceding sections are the parts catalogs in Section VII and the index of tools and testing devices in Section VIII. The material in Section II on "Performance Requirements" contains necessary information for all repair personnel.

A separate manual, the Bureau of Ships Navigational Instrument Control Manual, contains information on cleaning, lubrication, and final repair inspection standards. Where reference is made to that volume, it will be called the "Control Manual." Such references will usually include a title from the Control Manual index. Use the index for all material pertinent to the particular references in the repair text.

The repair instructions in any of the major operation sections of this handbook may be carried out by one or more persons. For example, it will be noted that disassembly work is arranged to permit several persons to aid in taking apart a single instrument, if desired. After the work covered in one section of the manual is finished, the clock (or its component parts) may be returned to the proper place in the Instrument Control Center. The Instrument Control Center is the clearing house for all work and, also, acts to level off the flow of work through the repair facility. Its personnel receive and sort the instruments into lots for processing through the repair operations. All repair personnel draw their work (whole instruments or a parts tray containing a single instrument)

from the Instrument Control Center and return it to the Center upon completion of the operations they perform. After final inspection, the completed instrument is returned to the Center for storage or shipment.

If the volume of work warrants—that is, if the lots are of sufficient size—work may flow directly from the operations of one section to the next without returning the clock parts tray to the Instrument Control Center. This decision is discretionary with the supervisor.

Disassembly

After the movement is removed from the case and the hands and dial are removed, all as per instructions given in this handbook, a pre-disassembly inspection is performed. This inspection determines whether or not the clock is worth repairing and, if so, what defects are found which warrant special attention during the regular overhaul process. These defects are noted on a route ticket which accompanies the clock through the entire overhaul process. All personnel who work on the instrument will sign the route ticket. Performance and usage data is collected by the inspector and this information will serve the Bureau of Ships as a guide for re-design and development.

After being given the pre-disassembly inspection, each movement to be overhauled is broken down, as per step-by-step instructions, and the parts put into their proper compartments in the cleaning trays. Special hand tools and fixtures are used to facilitate disassembly. When all disassembly operations are completed, the parts in their cleaning trays are returned to the Instrument Control Center.

Inspection and Repair

After the parts have been cleaned properly, they are inspected to determine which parts are defective and whether they should be repaired or scrapped. The general policy is to scrap defective movement parts and to perform certain restricted repair operations on the escapement parts. It is the intention that highly skilled watchmakers do not spend their time repairing parts which can be more economically replaced with new parts drawn from stock. Instead, these highly skilled men may better employ their talents by putting the escapement into proper adjustment. As a result of this policy, inspection and repair is broken up into "Movement Inspection and Replacement" (Section IV) and "Escapement Operations" (Section IV-A). Skilled watchmakers will concern themselves only with "Escapement Operations."

Reassembly

Following step-by-step instructions, the clock is completely reassembled, oiled and adjusted. The overhauled escapement from "Escapement Operations" is inserted. During the process of reassembly, several tests and adjustments must be made to assure a proper fit of the various train wheels and related parts. In addition, all of the pivots, with the exception of those already lubricated in the escapement operations, must be oiled. The clock is not put into its case until after it has been properly timed and tested as described in "Test, Adjustment and Final Inspection" (Section VI). The semi-completed clock is returned to the Instrument Control Center.

TABLE I—CIVILIAN PERSONNEL SKILL REQUIREMENTS

SECTION	CIVILIAN PERSONNEL
Disassembly Procedure	
Pre-disassembly Inspection Operations	Watchmaker, Senior Grade
Disassembly Operations	Mechanical Instrument Assembler, Junior Grade
Movement Parts Inspection	Mechanical Instrument Assembler, Senior Grade
Escapement Inspection and Repair	Watchmaker, Junior Grade Watchmaker, Senior Grade (supervisor)
Reassembly Procedure	Mechanical Instrument Assembler, Senior Grade
Test, Adjustment and Final Inspection	Mechanical Instrument Assembler, Senior Grade

Test and Adjustment

The clocks are timed and tested to make them meet the standards prescribed by Navy Specifications. See "Performance Requirements," Section II. After each clock has met the test requirements, it is forwarded to an instrument inspector who gives it a final check. If it passes the final inspection, the inspector codes the clock in accordance with the "Coding" procedure described in the Control Manual. The instrument is then cleared through the Instrument Control Center and packaged for shipment or storage according to specifications in the Control Manual.

The repair procedure, as described in the foregoing outline, is intended to raise repair standards and to keep all clocks at the highest authorized performance and serviceability levels. The procedure also is designed to permit the planning of the flow of work and the utilization of the best in methods and techniques so as to lower repair costs.

PERSONNEL REQUIREMENTS

At the beginning of each repair section in this handbook, the required level of personnel skill is noted. This indicates the economic level of skill that is commensurate with the technicalities involved. In Table I, the personnel skills are listed that can be used successfully without interim instruction, for each operation in the repair of Chelsea Mechanical, Boat and Deck Clocks. See Table I on Page 4.

The foregoing list is a general guide. Where higher levels of skill are required or where lower levels can be used for a particular operation, the manual points out specifically the proper skill rating.

Under instruction, others may work at the class of operations indicated. In particular, the development of an escapement specialist rating will promote the economy of centralized escapement repair. An escapement specialist is a Mechanical Instrument Assembler, Senior Grade, who is specially trained in one particular phase of clock escapement operations. Some of these specialties are: Jewel inspection and replacement, balance wheel truing and poising, endshake and sideshake inspection and adjustment. After an escapement specialist has become proficient in all the different specialties, he should be capable of performing the duties of Watchmaker, Junior Grade and should be so rated.

An outlined training path appears in the following tabulation, Table II.

TABLE II

TRAINING STEPS	CIVILIAN PERSONNEL ADVANCEMENT	
	From	To
Disassembly Operations	Mechanical Instrument Assembler, Trainee	Mechanical Instrument Assembler, Junior Grade
Movement Inspection and Replacement Operations	Mechanical Instrument Assembler, Junior Grade	Mechanical Instrument Assembler, Senior Grade
Reassembly Operations	Mechanical Instrument Assembler, Junior Grade	Mechanical Instrument Assembler, Senior Grade
Test and Adjustment Operations	Mechanical Instrument Assembler, Junior Grade	Mechanical Instrument Assembler, Senior Grade
Escapement Operations	Mechanical Instrument Assembler, Senior Grade	Escapement Repair Specialist
	Escapement Repair Specialist	Watchmaker, Junior Grade
	Watchmaker, Junior Grade	Watchmaker, Senior Grade
Pre-disassembly Inspection and Supervision	Watchmaker, Junior Grade	Watchmaker, Senior Grade

The training program should be in force continuously to provide a pool of "key" personnel as the basis for rapid expansion of clock repair staffs in times of national emergency.

All repair personnel, and especially trainees at the beginning of their training period, should study the information contained in Section II. It covers HOW a clock works, WHAT performance requirements a clock must meet, WHY a clock must be overhauled regularly and WHAT to look out for in the overhaul and repair of clocks.

SECTION II

DESCRIPTION

This section provides information about the construction of Chelsea Mechanical, Boat and Deck Clocks and the requirements which a properly overhauled clock must be made to meet. It tells what you, as a repairman, should know about the purpose of each component in the clock. A good understanding of the construction and operation of a clock will help you do a better repair job.

The Chelsea Clocks considered in this manual fall into two main classifications— the Chelsea Model 12E Mechanical Clocks and the Chelsea Model 17E Boat and Deck Clocks. The case and dial variations of these two types are described in Section I and illustrated in Figs. 1 to 4 in that section.

The 12E movement is characterized by a sweep second hand and provisions for winding and regulating through openings in the dial. The 17E movement has an eccentric second hand and the operations of winding, setting, regulating and stopping the second hand take place through cutouts in a dust cover mounted on the back of the case.

FUNCTIONAL DESCRIPTION OF THE 12E AND 17E MOVEMENTS

General

The Chelsea Model No. 12E and No. 17E movements contain all of the components usually found in high grade clocks and watches. The front plate is the foundation of the movement. The other plates and bridges which support moving parts are fastened to the front plate by pillars. There are three major groups of parts which work together to drive the clock hands and keep the correct time—the power assembly, the train and the escapement.

The power assembly contains the mainspring and all the parts necessary to wind it and to allow it to run down in the proper direction. The train is a set of toothed wheels which transmit the power of the mainspring to the escapement. The escapement is the "brain" of the clock—it controls (through the train) the speed at which the mainspring unwinds, and it therefore controls the speed at which the hands are driven.

Plates and Bridges

The 12E movement has three plates and one bridge. As shown in Fig. 5, the train plate and the back plate are mounted off the front plate by means of pillars and the fourth upper bridge is mounted off the train plate by means of pillars. The train plate has provisions for mounting the escapement and contains the pivot holes for the intermediate and center wheels, and the back plate contains the upper pivot hole for the mainspring barrel. Due to the fact that this movement has a sweep second hand, a fourth upper bridge is used to contain the upper pivots for the third and fourth wheels.

From Fig. 6, it will be noted that the 17E movement does not have a fourth upper bridge since this movement is designed with an eccentric second hand. This permits the upper pivots for the intermediate, the center, the third and the fourth wheels to be included in train plate which also has provisions for mounting the escapement. Like the 12E movement, the back plate of the 17E movement contains the upper pivot hole for the mainspring barrel. In addition, the 17E back plate has provisions for mounting certain components which are not a part of the 12E movement. These components, mounted on the 17E back plate, are: a start and stop knob, a setting shaft and four pillars for holding on the dust cover. The 17E regulator adjusting components are mounted on the back plate rather than on the front plate as is the case in the 12E movement.

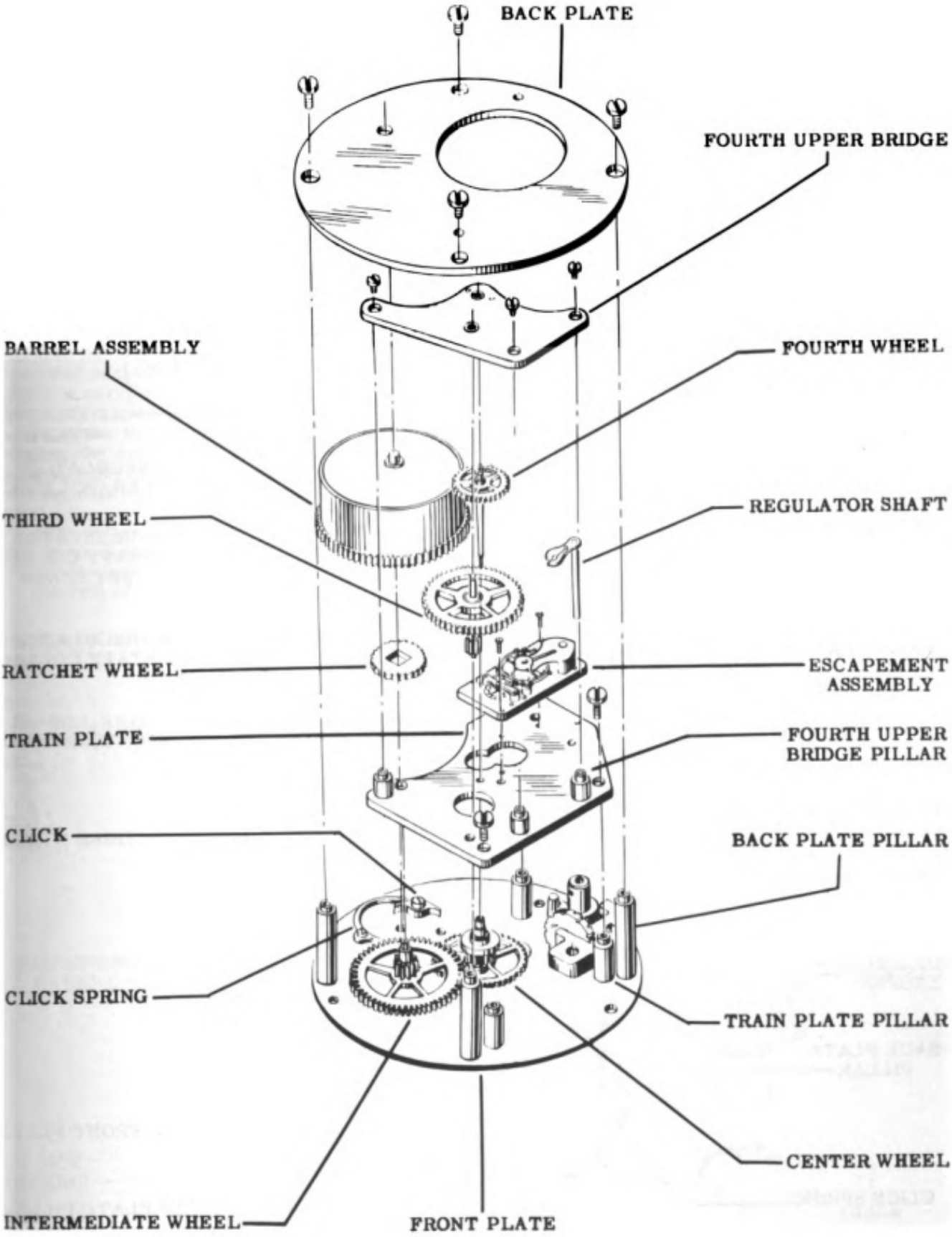


Figure 5—12E Movement

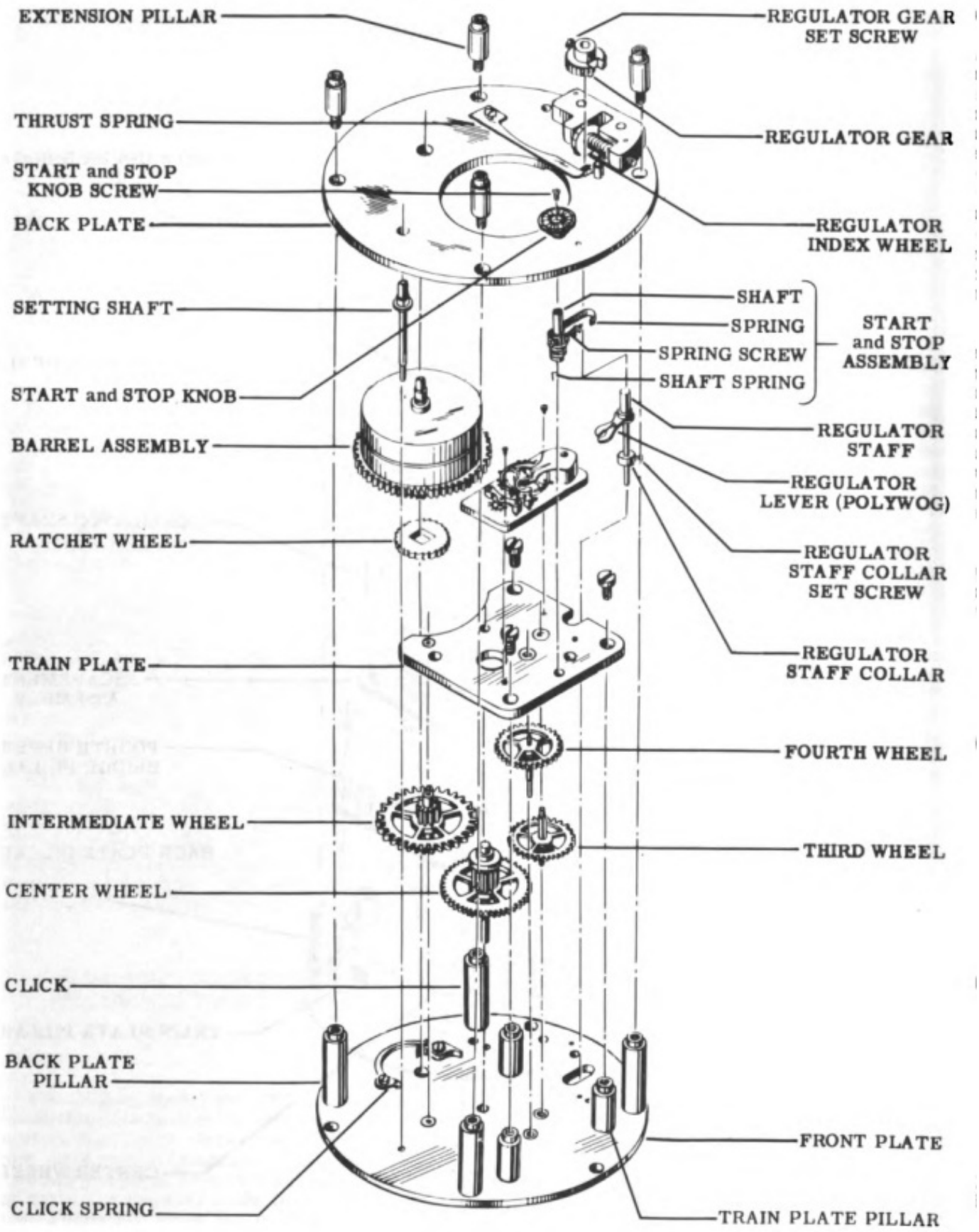


Figure 6—17E Movement

Power Source

As with conventional clock and watch movements, the mainspring is contained in a barrel. See Figs. 7 and 8. The inner end of the mainspring is attached by a hook to the barrel arbor, around which the mainspring is wound, and the outer end is attached by a hook to the inside of the barrel. In the 12E movement, the barrel arbor is positioned so that the mainspring can be wound through the dial attached to the front plate. See Figs. 7 and 5. In the 17E movement, the barrel arbor is turned around and the mainspring is wound through the dust cover attached to the back plate. See Figs. 8 and 6.

The mainspring is wound by placing a key over the squared end of the barrel arbor and turning the key clockwise. A ratchet wheel mounted on the barrel arbor just behind the front plate is engaged by a click which is held in position by a click spring. See Figs. 5 to 10. The click locks the teeth of the ratchet wheel, allowing the arbor to turn in the winding direction but preventing the arbor from unwinding the mainspring.

The entire arrangement of the power assembly is so designed that the mainspring can unwind only by turning the barrel, which is geared to the rest of the train.

The Train

The train, shown in Figs. 9 and 10, consists of the teeth on the mainspring barrel and the intermediate, the center, the third and the fourth wheels. The power from the mainspring is delivered to the escapement through the wheels in the order mentioned. The center wheel has a long arbor which projects through the front plate, and mounts a cannon pinion.

NOTE

The wheel driven by the barrel is named the "intermediate wheel" by the Chelsea Clock Company. In the parlance of certain other manufacturers, the wheel driven by the barrel is named the "second wheel." Due to this varying terminology, a discrepancy will be noticed between the names of functionally similar wheels in clocks coming from different sources. In Bu-Ships manuals, the original terms of the manufacturer concerned are preserved in order to avoid confusion when ordering parts.

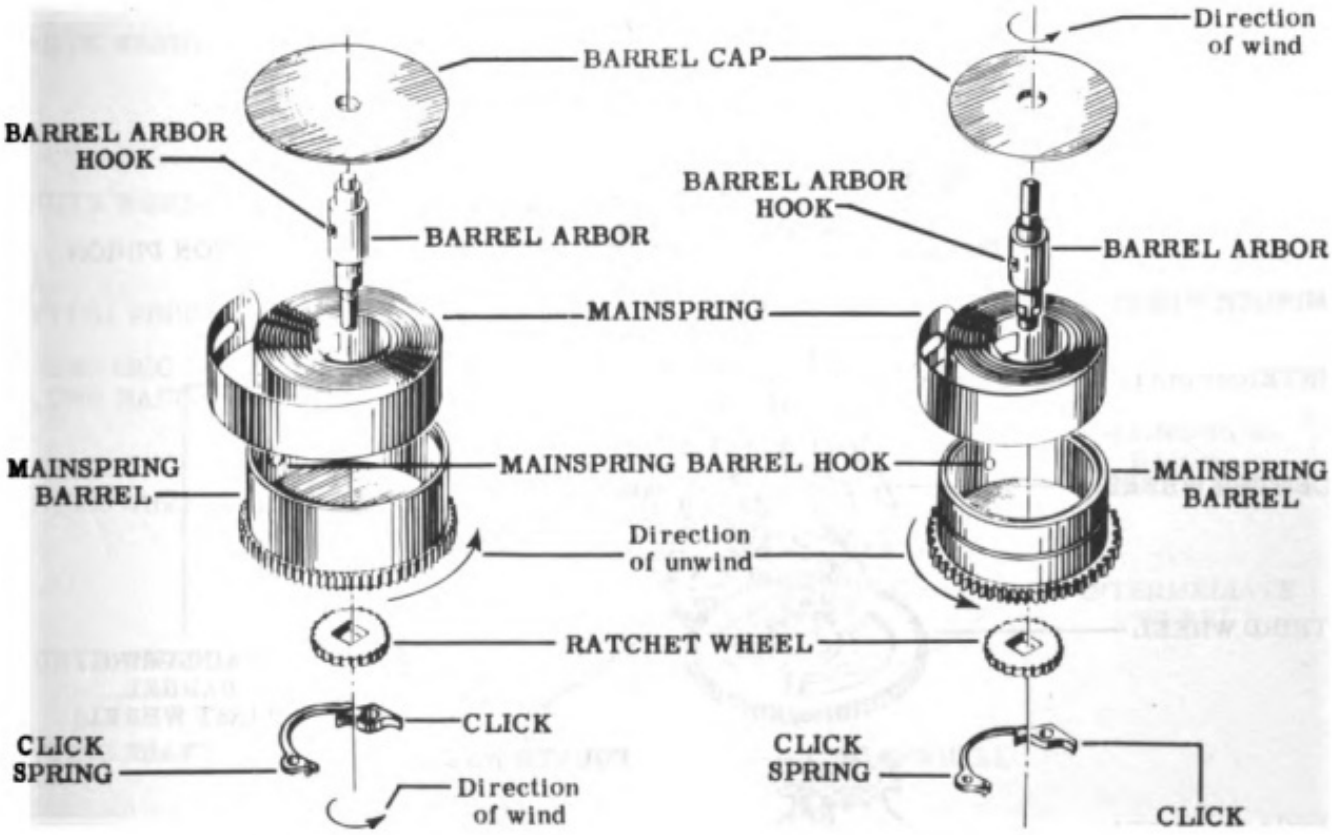


Figure 7—12E Power Source Components

Figure 8—17E Power Source Components

A minute hand is attached to the end of the cannon pinion. The cannon pinion drives a minute wheel which drives an hour wheel, freely riding around the shaft of the cannon pinion. It is to the shaft of the hour wheel that the hour hand is attached. This combination of the cannon pinion, the minute wheel and the hour wheel is known as the dial train.

In the 12E movement (see Fig. 9), the fourth wheel has a long staff which projects down through the center wheel arbor. It is to the end of the fourth wheel staff that the sweep second hand is attached. In the 17E movement (see Fig. 10), the long staff of the fourth wheel projects through the front plate and the dial to receive the eccentric second hand.

Construction of the Escapement

The escapements of both the 12E and 17E movements are completely detachable from the train plate and both operate in a manner similar to the conventional watch escapement. The escapement consists of an escape wheel, a pallet and a balance wheel assembly. See Figs. 11 and 12. An escapement plate forms the foundation for the entire escapement and it contains the lower jewel bearings for the escape wheel, the pallet and the balance wheel assembly. The upper jewel bearings of the escape wheel and the pallet are contained in an escape bridge and a pallet bridge. The upper jewel bearings of the balance wheel assembly are contained in the balance clock.

The only difference between the escapements of the two movements is that the escape wheel lower jewel bearing is mounted in the escapement plate in the case of the 12E movement (see Fig. 11), and in an extension (named "potance") to the escapement plate in the case of the 17E movement. See Fig. 12.

The purpose of the escapement is to control the unwinding of the mainspring so that the second, minute and hour hands will travel around the dial at proper speed. The escapement oper-

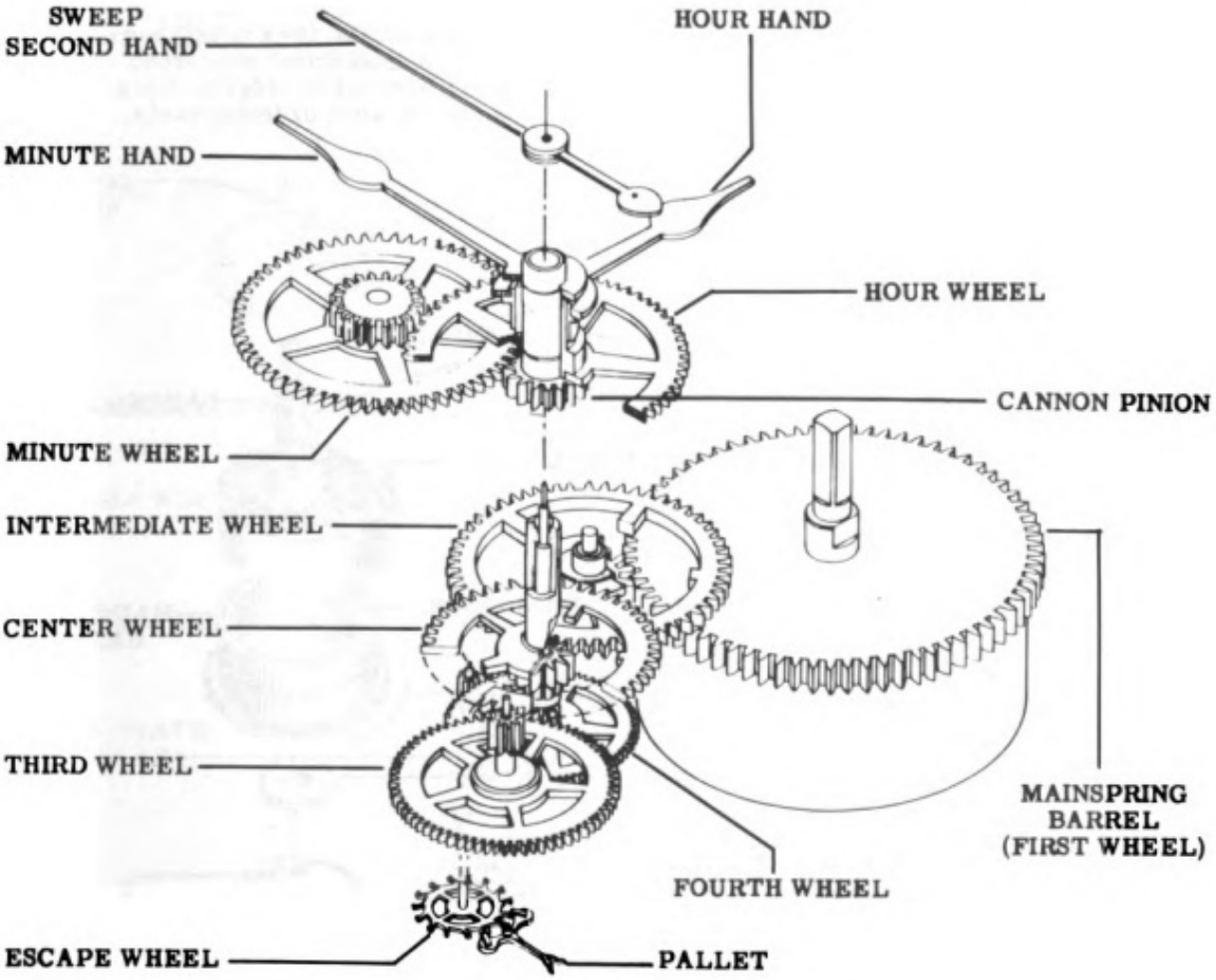


Figure 9—12E Mechanical Clock Train

ates in such a manner that each tooth of the escape wheel passes one of the locking jewels of the pallet at a regulated interval. As each escape wheel tooth goes by, it delivers an impulse to a pallet jewel and the impulse is transmitted through the pallet and delivered to the balance wheel. The back-and-forth rotation of the balance wheel moves the pallet back and forth, thereby regulating the speed at which the escape wheel teeth are released.

The balance wheel rotates first in one direction, and then the other, under the impulse which it receives from the pallet. The rotation of the balance wheel is controlled by the hairspring. The inner end of the hairspring is pinned to the collet fixed to the balance staff, and the outer end is pinned to a stud which is held firmly in place on the balance cock by means of a stud screw The balance wheel oscillations are controlled by the resistance of the hairspring (first it is wound and then unwound). The time required for each oscillation, therefore, depends upon the weight in the balance wheel rim and the tension of the hairspring. Due to the fact that the weight on the balance wheel rim is well counterbalanced by the hairspring tension, and due to the fact that the balance pivots are set in jewel bearings, very little impulse from the escape wheel through the pallet is required to keep up the oscillations.

On the balance staff, just under the balance wheel, is mounted a roller in which is set a jewel pin. It is this jewel pin which receives the impulse from the pallet fork, and it is the jewel pin which strikes the pallet fork to release each escape tooth.

Operation of the Escapement

The operation of the lever escapement is well understood by all watch and clockmakers. Since only these persons will have reason to exercise judgment with respect to the escapement, no discussion of the theory of escapement operation is necessary for the purpose of this manual. For other persons who wish to learn the principles of escapement operation, such information may be obtained from many sources.

Jeweling

There are eleven jewels in the Chelsea 12E and 17E escapements: One hole jewel and one cap jewel at each end of the balance staff, one hole jewel at each end of the escape wheel and pallet staffs, a balance roller jewel pin and two pallet jewels.

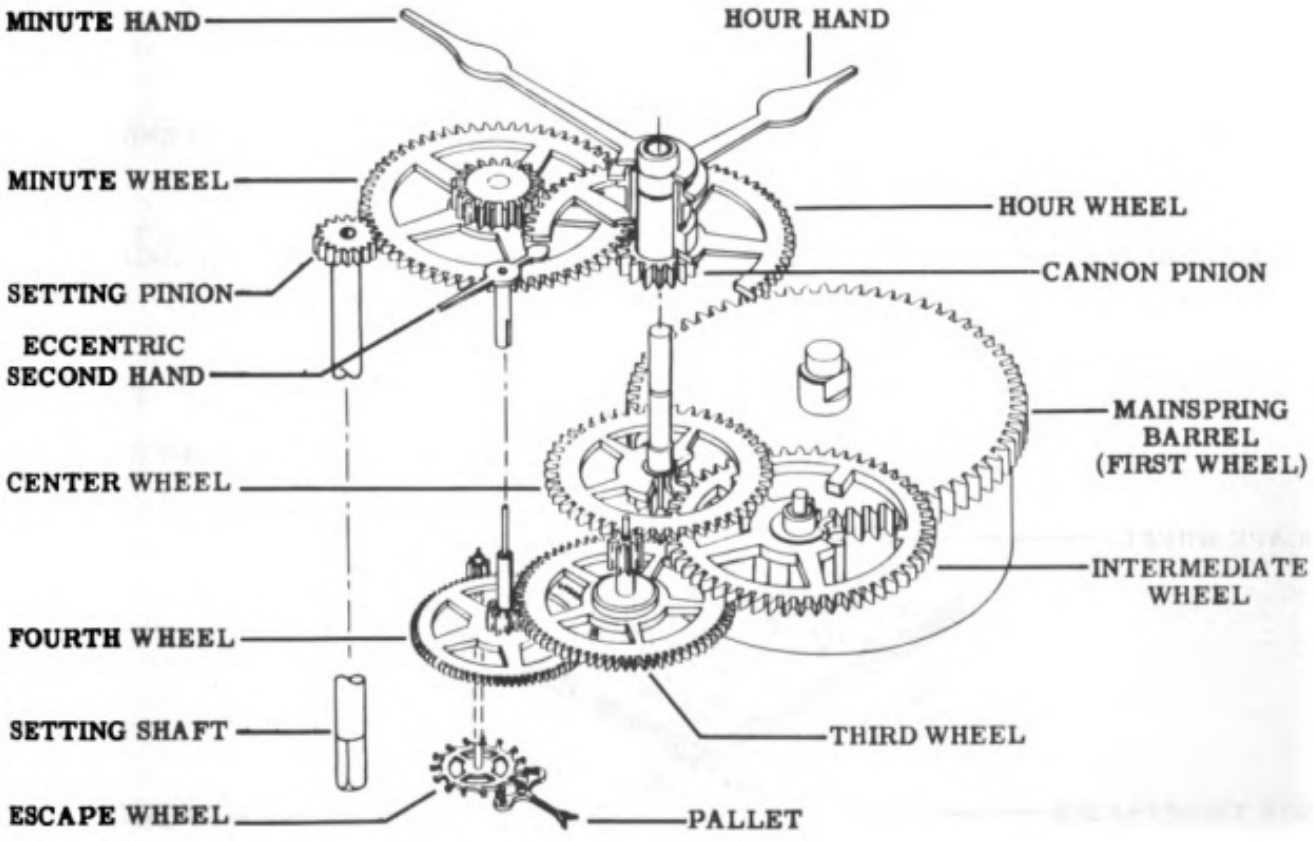


Figure 10—17E Boat and Deck Clock Train

Special Devices

Both the Chelsea 12E and 17E movements contain a power source, a train, a dial train and an escapement described in the previous paragraphs. In addition, the 17E movement has two devices not included in the 12E—a setting shaft and a start and stop mechanism.

The setting shaft, included in the 17E but not the 12E movement, (see Fig. 6) has a squared end which projects through the back plate. The arbor extends right through the front plate, where a setting pinion is attached to its end. The setting pinion engages the teeth of the minute wheel. When the squared end of the setting shaft is turned by the winding key, the setting pinion turns the minute wheel which turns both the cannon pinion and the hour wheel. This allows the minute hand and hour hand to be set in any desired position without actually touching them.

The start and stop mechanism, included in the 17E but not the 12E movement, (see Fig. 6)

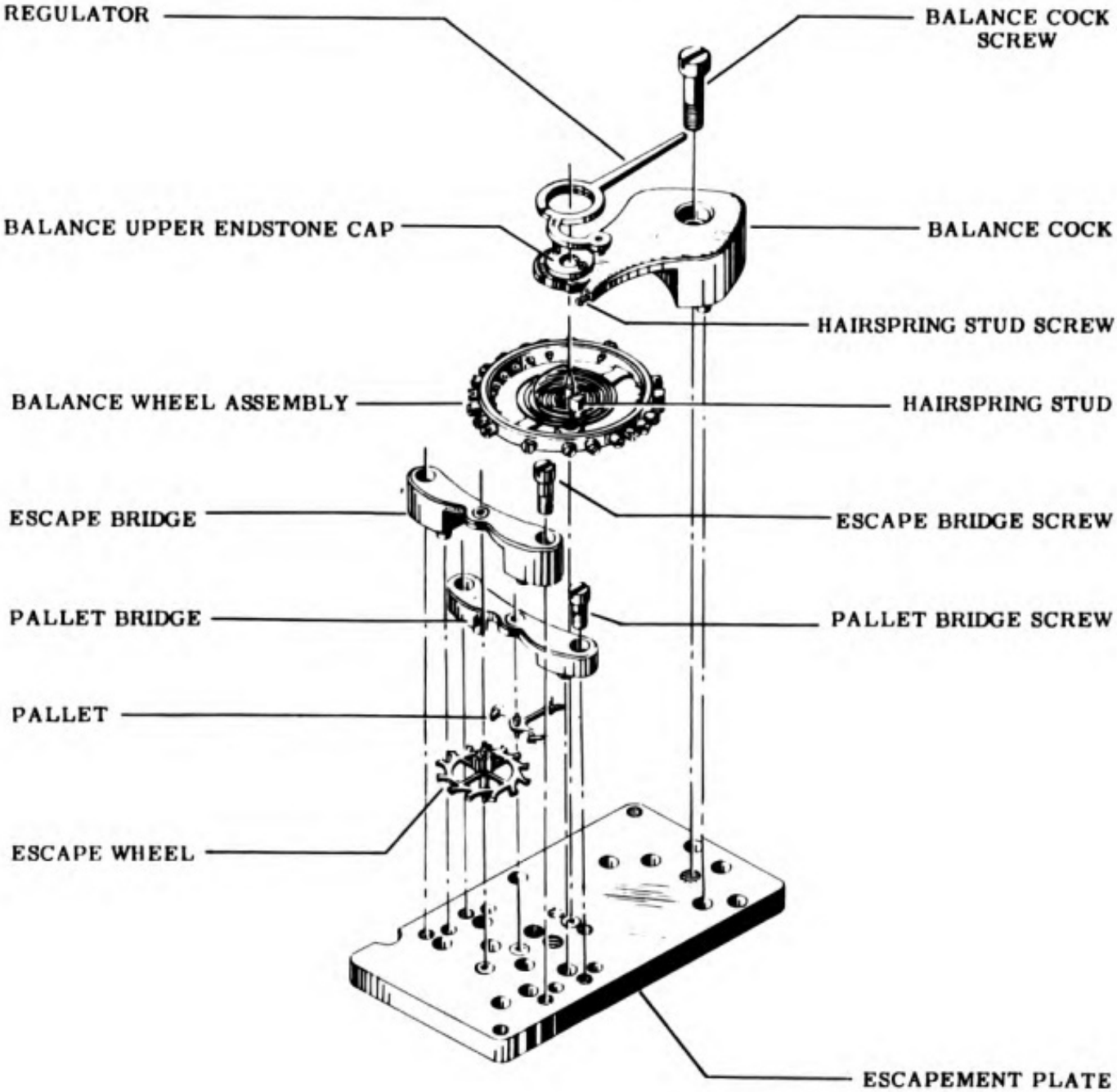


Figure 11—12E Mechanical Clock Escapement

is a simple device consisting of a start and stop knob mounted on the back plate, a shaft, coiled shaft spring, a flat start and stop spring and a screw for the flat spring. When the start and stop knob is turned, the shaft turns against the resistance of the coiled spring. The flat spring turns until its rounded end touches the balance wheel, stopping its motion—thus effectively stopping the second hand in any desired position (usually 60). When the standard time signal matches the setting of the second hand, the start and stop knob is released. The spring coiled around the arbor starts moving the arbor back toward its original position, releasing the balance wheel and allowing the second hand to begin turning once more. The shaft continues to turn until the start and stop screw is in contact with a stud in the back plate, stopping the shaft at its place of rest.

PERFORMANCE REQUIREMENTS

When clocks come in for repair, every operator is expected to be extremely careful in performing his work on these instruments. Then,

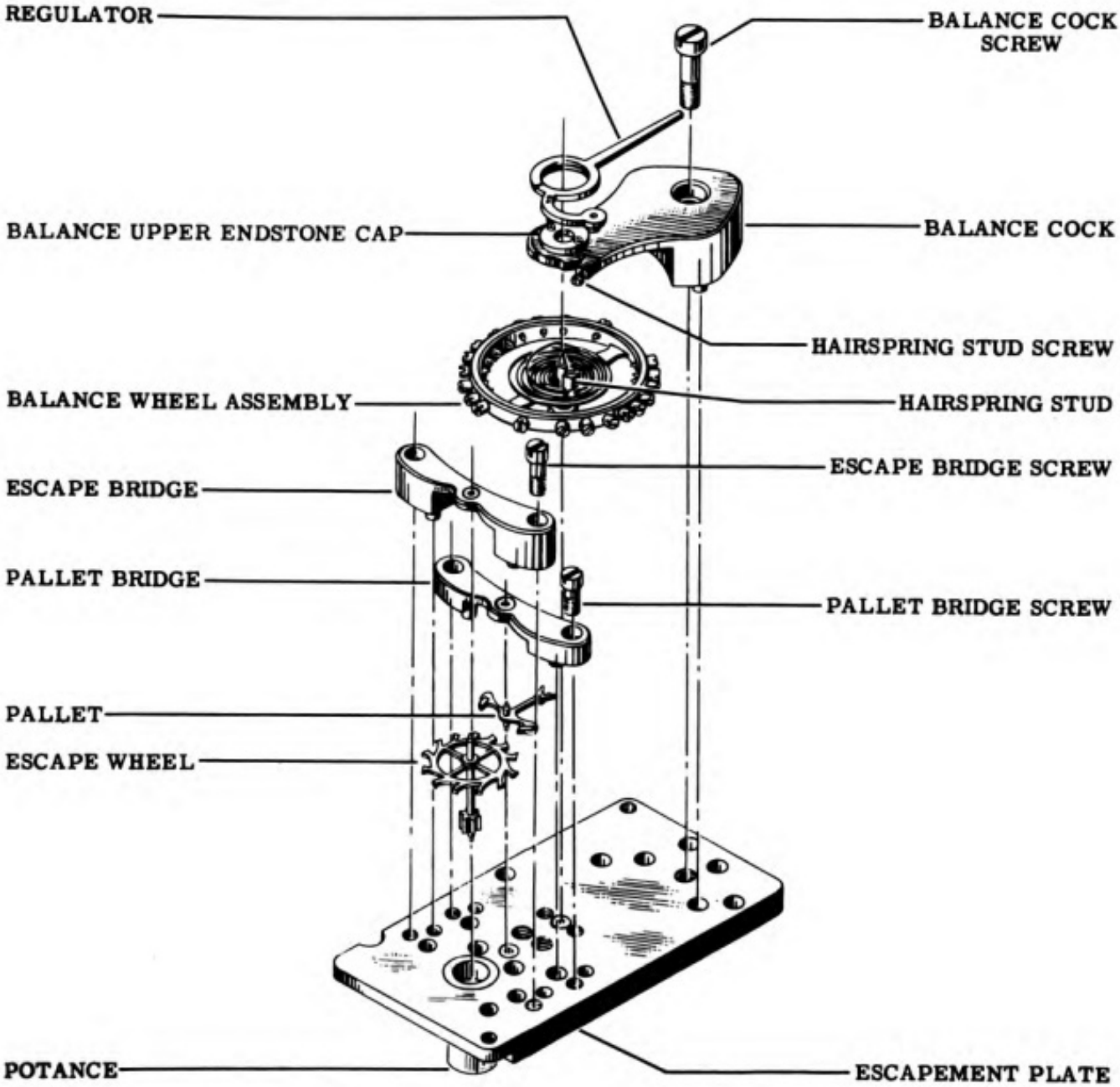


Figure 12—17E Boat and Deck Clock Escapement

351155 O - 52 - 2

after each overhauled clock leaves the repair shop, it will do the job it was designed to do out in the Fleet.

The actual performance requirements for Mechanical, Boat and Deck Clocks are subject to variation. See Performance Requirements, as indexed in the Control Manual, for the complete and up-to-date specifications. The following requirements are traditional in Navy procurement as of the time this manual was first prepared.

1. Operating Standards

   A. Length of run—All clocks shall run at least 8 days on one winding.

   B. Timekeeping—The average weekly error shall be within ± 2 minutes for Mechanical Clocks, and ± 2 minutes 30 seconds for Boat and Deck Clocks. All daily errors shall be within ± 10 seconds for Mechanical Clocks, and ± 15 seconds for Boat and Deck Clocks, of the average daily error for at least one week during the final test.

   C. Final Testing—Each clock shall undergo a final test of approximately four-weeks duration. During this final test, each clock shall meet the timekeeping requirements indicated in "B."

2. Assembly Adjustments

   A. Hand Clearance—The hands shall not interfere with each other or rub on the glass or dial at any time.

   B. Setting—The hands shall be set either manually or by setting mechanism without injuring the escapement or movement in any way.

3. Workmanship

   The workmanship shall be first class in every respect.

4. Final Case Inspection

   A. Cases—The cases shall be free from warpage, chips, blisters, burrs, ridges and unsightly finishes.

   B. Glasses—The glasses shall be clear, free from blemishes and securely locked and sealed to the bezel to exclude dust and moisture under usual variations in temperature.

   C. Stamping—Before packing, each clock shall be rubber-stamped on the back, at the bottom, with the date and repair activity code.

In order to meet these requirements, there are certain essentials to be borne in mind. The overhaul procedure is normally broken down into disassembly, cleaning, escapement overhaul, reassembly, and test and adjustment. Unless each procedure is carried out in the recommended manner, there is no guarantee that the clock will continue to operate properly once it is returned to the Fleet. The requirements necessary for continued proper operation are brought together here in order to call to your attention how important your particular job is in the entire overhaul procedure. When you read the following paragraphs, you will see how your job ties in with all the other jobs that go into overhauling a clock and putting it into first class condition.

The Reason for Overhaul

A clock must be completely overhauled whenever it receives physical damage, whenever it will not run, whenever it shows a tendency to stop or whenever it fails to keep good time. These symptoms indicate that there is something mechanically wrong within the clock and that the condition must be corrected in order to prevent further damage. In addition, a clock must be completely overhauled every one to two years, whether or not it is in apparent perfect working condition.

Nobody would operate an automobile without keeping the crankcase filled with oil and without having the oil changed periodically. The balance wheel within a clock turns many times more than the engine in any automobile. It swings 300 times each minute, day in and day out, month in and month out and year in and year out. The other wheels also must continue in operation all this time without stopping. It should be obvious that unless any damage is repaired, dirt removed and oil renewed, a tremendous amount of wear can take place.

Proper Disassembly

Once the pre-disassembly inspection is complete, the entire purpose of disassembly is to break down the movement to an extent sufficient that it can be properly cleaned and inspected. If the disassembly instructions are not carefully carried out, it is quite possible that damage will result to the parts. This will cause additional expense for replacement parts

and, in addition, will cause extra difficulties in the inspection department.

If the movement is not broken down to the recommended degree, the result will be improper cleaning and incomplete inspection. On the other hand, if the movement is broken down further than recommended, unnecessary work will fall upon the cleaning, inspection and reassembly departments. From this, it is obvious that proper and careful disassembly is a very important part of clock overhaul.

Cleanliness

Clocks must be clean to assure continued accuracy. Whenever dust enters the movement or whenever oil dries, causing the pivots to become gummy, the result is wear and lack of power in the train. This causes the movement to show an erratic gain and loss of time which cannot be corrected by the regulator. The condition becomes worse and worse until the movement stops functioning.

In addition, a clock movement must be perfectly clean before it can be properly oiled. The slightest film or deposit causes oil to spread, leaving dry the pivot where its presence is essential and, very likely, causing difficulty elsewhere. Thus, satisfactory service after overhaul is entirely dependent upon the care and attention given to cleaning.

Careful Inspection

The purpose of movement inspection is to cause replacement of any worn or damaged parts with perfect new ones. It is the responsibility of the inspector to check each cleaned part to see that it is functionally perfect. If a worn or defective part were to pass the inspector, it would eventually cause trouble when put into a movement with other perfect parts. The net result of careless inspection is to cancel all of the careful work that is put into the overhaul of a clock and require that the clock be put through another overhaul in a short time. Proper inspection will assure that all reassembly, test and adjustment work will be done with functionally perfect parts and that the clock will have a good chance to complete its scheduled service period without developing any defects.

Proper Escapement Repair and Adjustment

The inspection, repair, reassembly, oiling and adjustment of the escapement are critical points in the overhaul procedure. Since the escapement is the "brain" of the clock, only persons who are skilled in the applicable portions of the watchmaker's trade should attempt to do any work on it. From the brief description of escapement construction and operation, it should be clear that considerable knowledge and manual dexterity are needed to perform the necessary repairs and adjustments that are normally required. Without a properly repaired and adjusted escapement, there would be no point in all of the careful work done by the other operators.

Any qualified watchmaker fully understands, without further explanation, just how much this work determines the final accuracy and performance of the overhauled clock.

Careful Reassembly

The purpose of reassembly is to make up a clock movement from clean and mechanically perfect parts and from the fully adjusted escapement passed by the watchmaker.

During the process of reassembly, all the train wheels will have to be tested for proper fit in their pivot holes. All train wheels must have sufficient endshake and sideshake to assure that the pivots will not bind in their pivot holes, and yet the endshake and sideshake must not be so great as to cause a sloppy fit which would result in excessive wear, erratic operation and possible slipping of the interlocking teeth. The reassembly operator will be responsible for certain tests and adjustments which will keep the endshakes and sideshakes within tolerances of a few thousandths of an inch.

To perform these operations properly requires a certain sensitivity of touch and knowledge of how to handle the necessary tools.

In addition, the reassembly operator has the responsibility of properly oiling all of the various pivots not included in the escapement. This requires a reasonable amount of knowledge and skill—too little oil causes excessive wear and too much oil causes a rapid gumming-up of the movement.

The reassembly operation is the next to the last process in the overhaul of the clock and its importance in the successful overhaul process is self-evident.

Careful Timing Operations

A properly overhauled Chelsea movement may be put on a timing machine and adjusted so that it will show neither a gain nor a loss of time on the timing machine. When so adjusted and wound each week, a Chelsea movement on test will easily meet the "Timekeeping" requirements listed under "Performance Requirements —1.B." included earlier in this section.

It is the job of the timing-machine operator to perform the necessary adjustments to the timing screws on the balance wheel to bring the clock to perfect time.

These adjustments also require that whatever is done to one timing screw be done in exactly the same manner to the opposite timing screw. Whenever adjustments in weight are made on other balance screws, it is again important that the same adjustment be performed on the opposite screw. If symmetry of weight distribution on the balance wheel is not kept perfect, the result will be an erratic gain or loss of time and failure of the clock to pass its performance test.

The timing operator should realize that his is the last operation in the overhaul procedure and that it is his responsibility to see that the work of all the other operators is not in vain. If the perfect poise of the balance wheel is lost, the escapement unit will have to be returned to the watchmaker for repoising before the clock will be able to pass its performance test. See "Timing Operations" on Page 64.

Conclusion for Performance Requirements

It should be clear to each person involved in the clock overhaul process that he is a member of a team and that all the other members depend upon him to do his work properly. When proper coordination takes place, clocks in all stages of damage and wear will flow smoothly through the overhaul process and will come out in perfect working condition.

Read the instructions as given in the remainder of this manual, understand what you have to do, do your job well and you will have the satisfaction of being an efficient member of the team.

Having familiarized yourself with the "Functional Description" and "Performance Requirements," you are now ready to proceed with the actual disassembly operations, Section III.

SECTION III

DISASSEMBLY PROCEDURE

Skill Levels: Disassembly Operations—Mechanical Instrument Assembler, Junior Grade

Pre-disassembly Inspection Operations—Watchmaker, Senior Grade

This section contains instructions covering the recommended procedure for disassembling Chelsea Mechanical, Boat and Deck Clocks. The reason for disassembly, as described, is to permit proper cleaning and inspection for purposes of overhaul and repair. Chelsea clocks have proved rugged and dependable in the service of the U. S. Navy, but it must be stressed that they may easily be damaged in the hands of those unskilled in the care of fine clocks. For this reason all disassembly operations should be performed only by qualified personnel and by following only the described procedures.

Because of certain differences in the Chelsea 12E and 17E clocks, the disassembly of each clock is described separately to avoid any possible confusion.

The disassembly procedure for each clock is broken down into three main steps:

1. Pre-disassembly Inspection Operations
2. Preliminary Disassembly Operations
3. Movement Disassembly Operations

Since escapement disassembly is the same for both 12E and 17E clocks, it is described in detail in "Escapement Disassembly," Section III-A.

Observe that in the arrangement of this section "Pre-disassembly Inspection Operations" is treated before the preliminary disassembly operations which must precede it. This is done in order that the disassembly procedure shall be presented to disassembly personnel as a continuous process without being interrupted by material which is directed only to a Watchmaker, Senior Grade.

Pre-disassembly Inspection

A pre-disassembly inspection is provided in the text. This inspection is to be performed after the movement has been removed from the case and after the hands and dial have been removed from the movement. The purpose of this inspection is to determine whether the movement is worth overhauling and to locate the troubles within the movement. Location of specific troubles is for the purpose of assuring that they will be found and remedied during subsequent inspection and reassembly. All clocks worth overhauling are to go through the entire overhaul process as described in this instruction manual—pre-disassembly inspection provides a double check that any existing trouble will be remedied. It also affords opportunity to record statistics of component performance which are valuable for design and development purposes.

As a part of the pre-disassembly inspection a route ticket, listing these defects, is made out for each clock and accompanies the clock throughout the overhaul process. The purpose of the route ticket is to assure that these defects will be examined and corrected during the regular overhaul and repair process as described in this manual.

Before beginning the actual work of disassembly, turn to Section VII, "Maintenance Parts Catalog," and study the group assembly parts lists and the associated exploded views to familiarize yourself with the names, appearance and relative positions of all the assemblies and parts. Also, read Section II, "Description," if

you have not already done so, to learn the functions of the various components of the clock. The knowledge of this information will give you an appreciation of the disassembly procedure and make your job easier.

Disassembly Inspection

During disassembly there is no inspection procedure particularly recommended for the purposes of repair. Aside from setting aside parts obviously damaged, such inspection may best be reserved until after cleaning and, therefore, it is described in Section IV, "Parts Inspection, Repair and Cleaning."

Tools

Most of the tools required are those included in every watchmaker's kit. They are mentioned in the text when necessary. Where special service tools are needed, or tools are employed for purposes which are not immediately obvious, they are explicitly designated by number in the text. Also, they are further identified in Section VIII of this book, "Special Service Tools and Testing Devices."

NOTE

The description of the pre-disassembly inspection operations which follows is directed only to Watchmakers, Senior Grade. All other personnel may skip this portion of the text and go on to "Disassembly Procedure Chelsea Model No. 12E."

PRE-DISASSEMBLY INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

The Need for Pre-disassembly Inspection Procedure

Before a clock is put through the overhaul process, valuable information can be gained as to just what is wrong with it. Every clock that comes in for overhaul has been carefully adjusted by the manufacturer and by any Navy repair shop to which it has been previously sent for overhaul. Therefore, special repairs and adjustments will be usually required only when the clock has met with some accident.

The first inspection is made after the removal of the movement from the case and after the removal of the hands and dial but before the movement is disassembled. Such an inspection can locate some types of defects much more rapidly than an inspection of the cleaned parts after disassembly.

All clocks coming in for overhaul must go through the entire process of Disassembly, Cleaning, Inspection, etc. as described in this manual. The findings of the pre-disassembly inspection are intended to assist the overhaul process as described and they should not eliminate any of the standard procedures.

For purposes of the first inspection, clocks coming in for overhaul may be divided into three classes:

1. Clocks that are in operating order and are sent in for a routine cleaning, oiling and regulation. These clocks can go right through the overhaul process and generally the only repairs will be to replace any worn parts.

2. Clocks that are not in operating order but have not met with any accident. These clocks will have functional disorders such as gummed oil, excessive wear or mechanical failure. By locating the trouble before disassembly, it will be assured that this fault will be corrected during the process of cleaning, inspection and reassembly.

3. Clocks that have met with an accident. Clocks of this type will require a double check after cleaning because the damage may easily be more extensive than is immediately visible. A report of this nature will assure that the inspection and reassembly operations will correct the trouble.

The person performing the first inspection should be thoroughly acquainted with the "Clock Movement Assembly Adjustment Standards" and "Clock Escapement Assembly Adjustment Standards" indicated in the index of the Control Manual. He should also be thoroughly acquainted with all phases of the overhaul process as described in this manual. It is the duty of the pre-disassembly inspector to fill out the route ticket which will accompany each clock and each escapement. This will assure that any such defects will be located and corrected as described in Sections IV and IV-A of this manual and that further checks and adjustments will be made as described in Section V of this instruction manual.

The persons doing the various inspection and reassembly operations will initial the route

ticket for each movement and escapement to indicate that they have done their part in correcting the original trouble.

Pre-disassembly Inspection Procedure

The first inspection will take place after the movement has been removed from the case and after the hands and dials have been removed.

The procedure for the pre-disassembly inspection is as follows:

1. Check the general condition of the movement with regard to corrosion, oil gumming and any obvious physical damage.
2. Make all the checks listed under "Clock Movement Final Inspection Operations" as listed in Section V of this manual.
3. From the results of the inspection, determine whether the clock will be overhauled or surveyed and salvaged. The "Survey and Salvage Standards," as set forth in the Control Manual, is the basis for this decision. Indicate the disposition on the route ticket. If the instrument is to be surveyed, also indicate on the route ticket the salvaging to be performed. Serviceable parts should be turned in to the Instrument Control Center for stock as available replacements.
4. On the route ticket for the movement, indicate any recommendations for replacement during parts inspection or readjustment during movement reassembly. On the route ticket, enter the specific parts or fits to be checked.
5. On the route ticket for the escapement, indicate any recommendations for replacement, repair or readjustment during "Escapement Operations" as described in Section IV-A. On the route ticket, enter the specific parts or fits to be checked.
6. On the route ticket, indicate the appearance standards that shall be met by the overhauled clock—see "Appearance Standards" under "Pre-disassembly Inspection Standards" as indexed in the Control Manual.
7. Place the route tickets in the parts tray for delivery to the movement disassembler.

The inspected clock with its route ticket, on which you have recorded all defects to be checked, or on which you have entered directions to survey and salvage, should be returned to the Instrument Control Center.

DISASSEMBLY PROCEDURE CHELSEA MODEL NO. 12E

PRELIMINARY DISASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Junior Grade

The purpose of the preliminary disassembly operations is to remove the movement from the case and to remove the hands and dial components from the movement. These operations permit the movement to be inspected so that the pre-disassembly inspection previously described may be carried out.

1. With the fingers, loosen the case knob on the side of the bezel until the bezel can be swung open. The bezel need not be removed—it should just be turned completely out of the way of the dial. Fig. 13 shows the relative positions of the parts involved.
2. Unscrew the three reflector screws which hold the reflector on to the dial and which hold the dialed movement in the case. See Fig. 13.
3. Place a winding key, or a mainspring letdown key (Tool No. 5A), through the dial winding hole (see Fig. 13) and over the squared end of the barrel arbor. With a tilting and lifting motion on the key, lift up one edge of the dial so that it can be grasped with the fingers.
4. Lift the dialed movement out of the case and rest it, dial side up, on the movement work block (Tool No. 1A) in the position shown in Fig. 14.
5. Using a pair of hand removers with felt pads (Tool No. 2A) as shown in Fig. 14, pry off the sweep second hand, then the minute hand and finally the hour hand. The purpose of the felt pads on the heels of the hand removers is to put a cushion between the bearing surface of the hand removers and the dial to prevent the dial from being scratched.
6. Tilt the dial and movement so that you can see the "grasshoppers" holding the dial

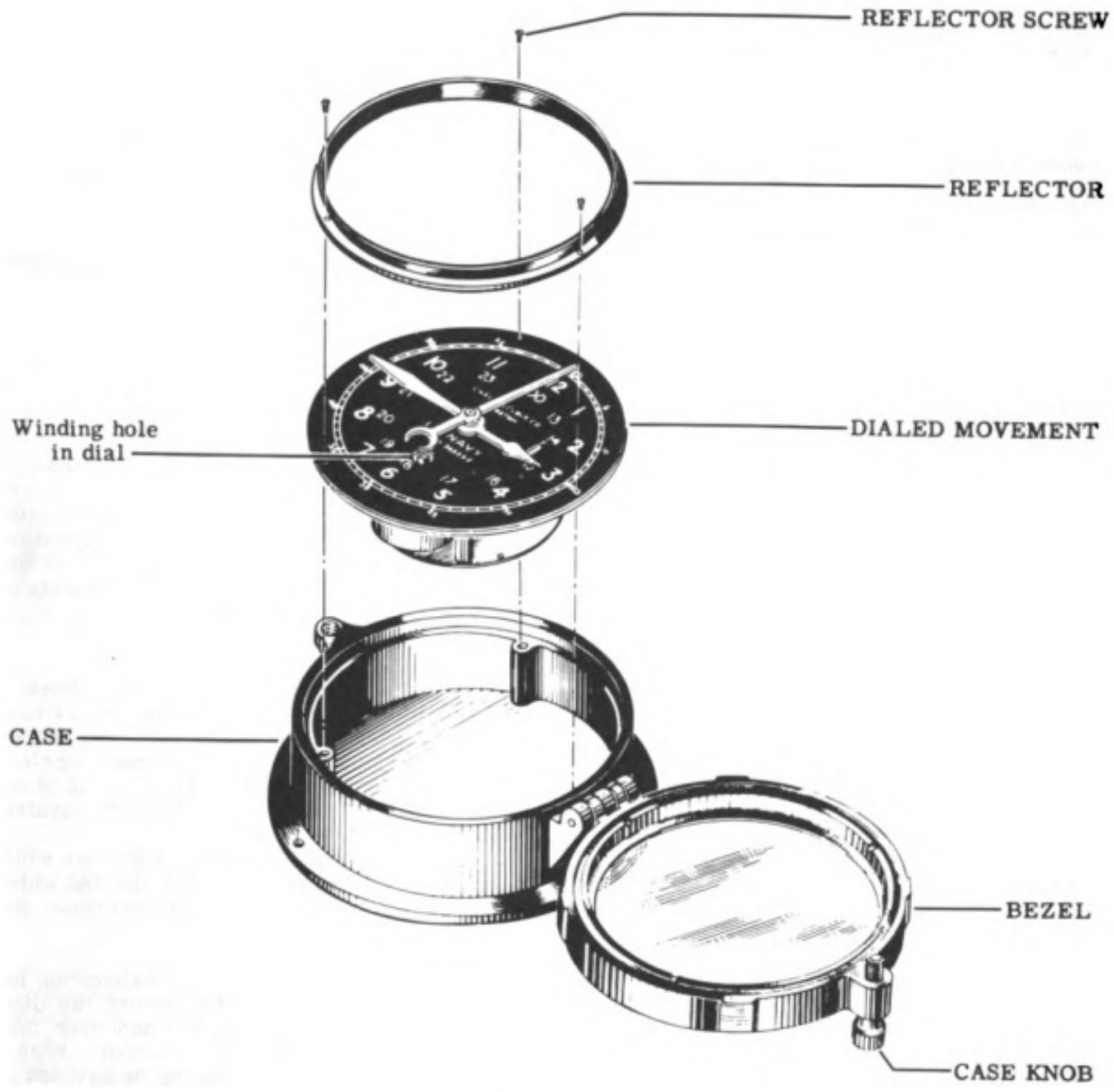


Figure 13

ring feet to the front plate of the movement. With a pair of needle nose pliers, turn each grasshopper so that the head points away from the center of the dial and pull the grasshoppers completely off each of the three dial feet. Refer to Fig. 15.

7. Lift off the dial with the attached dial ring. See Fig. 15 for the relative positions of the parts involved. For purposes of repair, the dial may be separated from the dial ring by removing the three dial screws—otherwise the two parts are not ordinarily disassembled for purpose of cleaning.

8. Place the case, the dial, the hands and the movement in the parts tray for delivery to the pre-disassembly inspector.

PRE-DISASSEMBLY INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

Perform the inspection previously described in this section under the above heading.

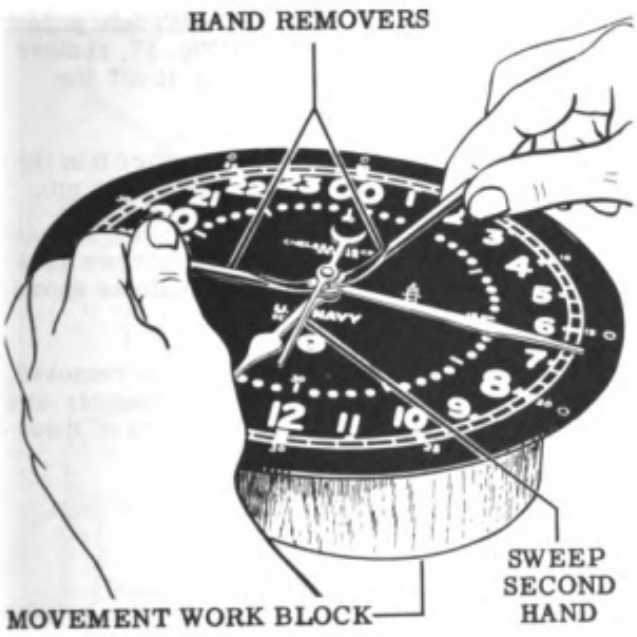


Figure 14

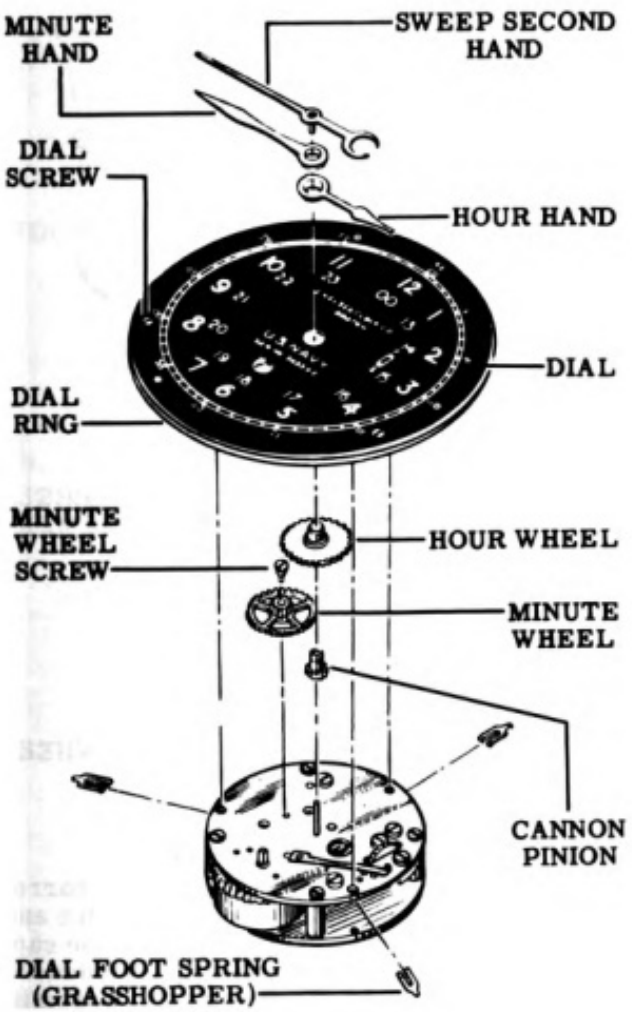


Figure 15.

MOVEMENT DISASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Junior Grade

During the disassembly of the movement, the parts should be put in the cleaning trays as soon as they are taken out of the movement. The arrangement of the parts in the cleaning trays is shown in "Cleaning"—see the Control Manual index.

1. Before any disassembly work is done on the movement, it is necessary to let down the mainspring. Since the hour wheel is loose on the cannon pinion, first lift off the hour wheel. See Fig. 15.

CAUTION

In Operation 1, use only a letdown key (with no projecting wings) similar to Tool No. 5A, as listed in Section VIII. Use of a winding key may result in serious injury to the fingers should they slip while holding the key against the force of the mainspring. If a letdown key is not available, have the shop make up one for you by fitting a smooth round handle to a winding key.

To let down the mainspring, stand the movement on its side in the movement work block (Tool No. 1A) in the position shown in Fig. 16. Place the mainspring letdown key (Tool No. 5A), not a winding key, over the squared end of the barrel arbor and hold it firmly with the fingers. With a small screwdriver, disengage the click from the ratchet wheel on the barrel arbor (as shown in Fig. 16). The click will not disengage from the ratchet wheel when you press on the click end. To do this you must turn the winding key a very small amount (less than 1/8 of a turn) in a clockwise direction. When you do this, you will feel the click disengage from the ratchet wheel and the force of the mainspring will be felt in the hand holding the winding key. Allow the letdown key to spin slowly in the fingers until the mainspring is completely run down.

2. With the movement in the work block, dial side up, unscrew the minute wheel screw and remove the minute wheel. See Fig. 15.

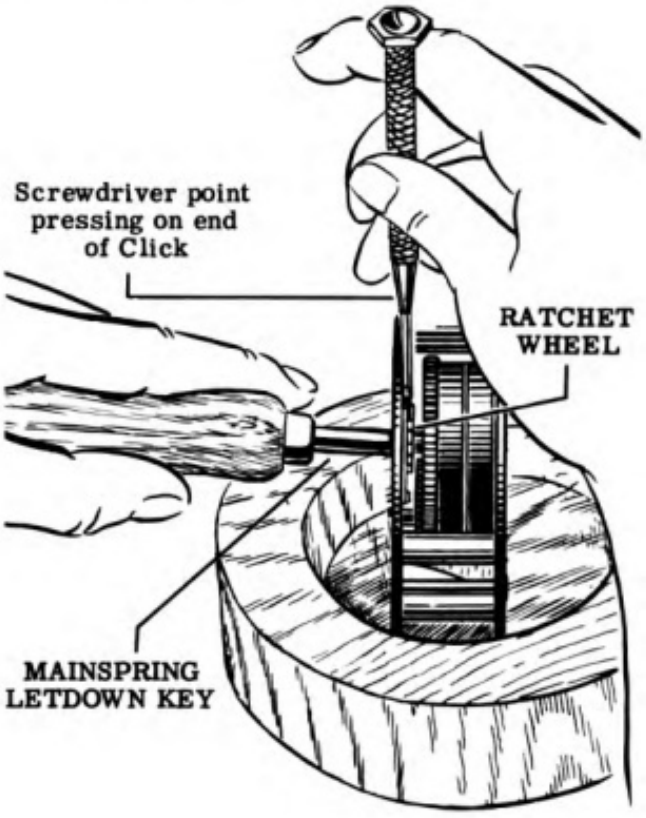


Figure 16

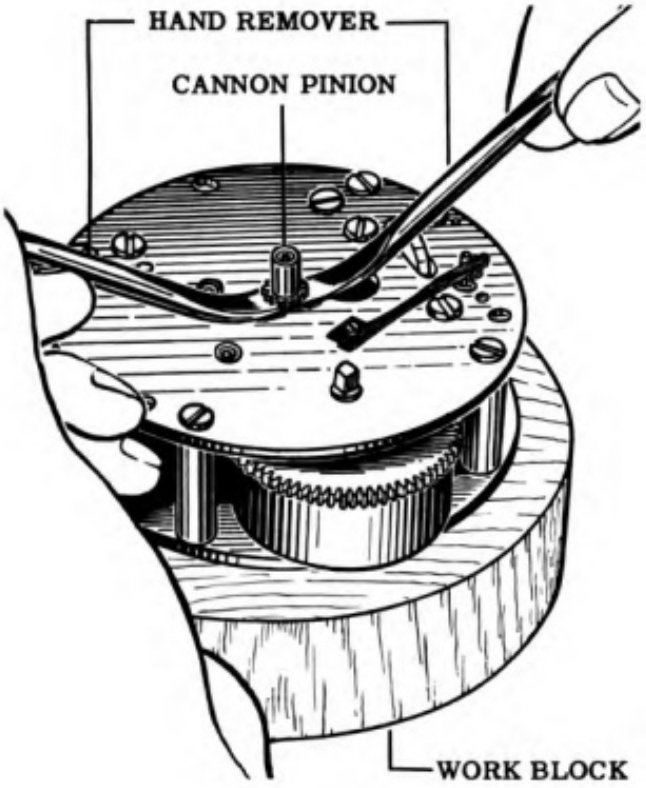


Figure 17

3. Using the hand removers with felt pads (Tool No. 2A) as shown in Fig. 17, remove the cannon pinion by prying it off the center arbor.

4. Turn the movement over and place it in the work block, train side up (back plate up).

5. Unscrew the four back plate screws (see Fig. 18) and lift off the back plate as shown in Fig. 19.

6. As soon as the back plate has been removed, lift out the mainspring barrel assembly and the ratchet wheel. The positions of these parts are shown in Fig. 18.

CAUTION

Do not use a steel-headed hammer in Operation 7. It will deform the end of the barrel arbor.

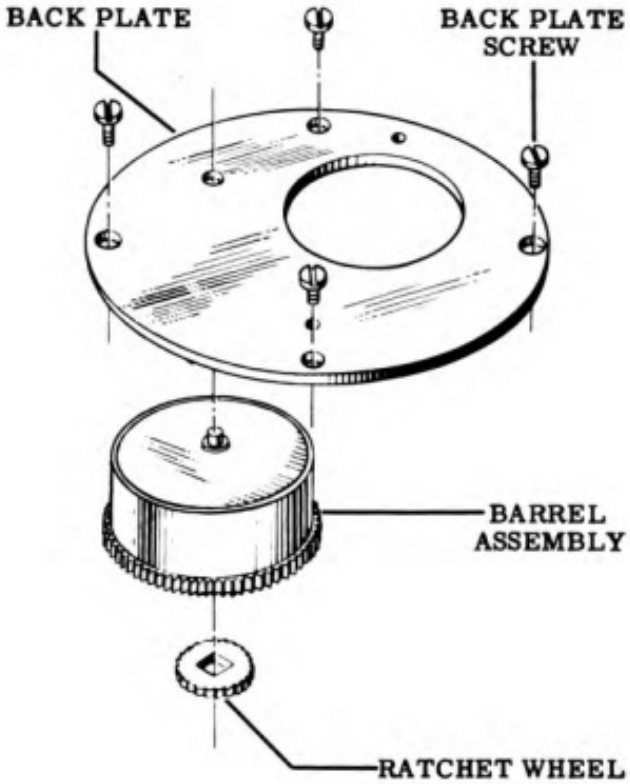


Figure 18

7. To remove the barrel cap, hold the barrel tightly in one hand and strongly hit the end of the barrel arbor farthest from the cap with a plastic- or wood-headed hammer. The shoulder on the arbor will transmit this force directly to the inside of the cap and force it out. The manner in which the

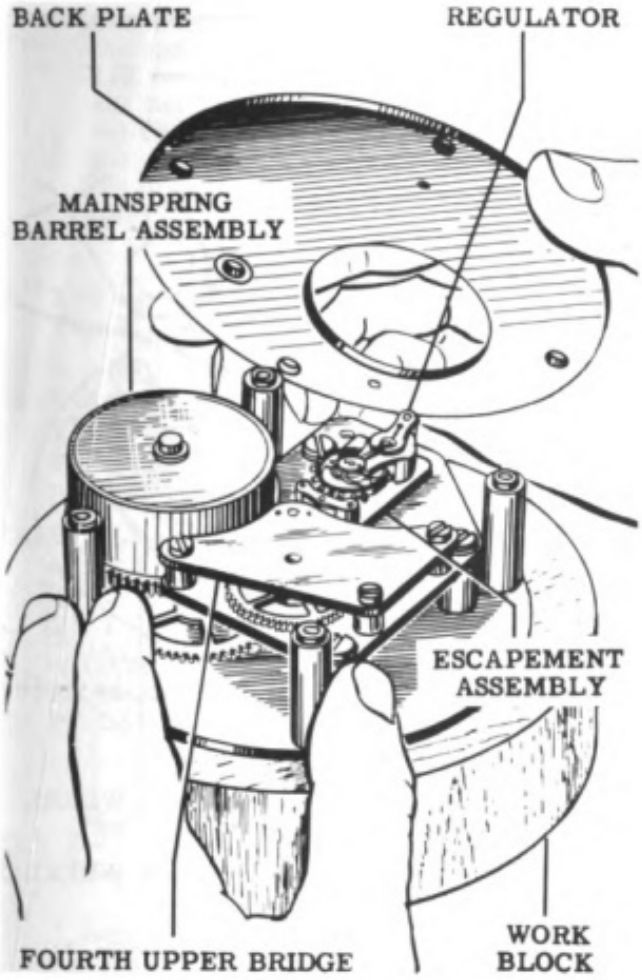


Figure 19

barrel components fit together is shown in Fig. 20.

8. Unhook the barrel arbor from the mainspring and remove the arbor. See Fig. 20.

CAUTION

The only safe method of performing Operation 9 (removing the mainspring from the barrel) is to use the mainspring winding tool (Tool No. 9A) in the manner described. Methods of hand removal, although simple, always involve serious danger to the hands and face should the fingers slip in their grip on the oily mainspring. No hand removal method is recommended.

9. To remove the mainspring, place the barrel on the mainspring winder (Tool No. 9A) so that the inner end of the mainspring is engaged by the hook on the turning shaft of the winder. Wind the spring onto the winder shaft just enough to form enough space inside the barrel so that you may insert into the barrel the portion of the winder which holds the outer turn of the mainspring. When the mainspring is securely held by the winder, turn the barrel back and forth to disengage the outer end of the mainspring from the barrel hook. Pull off the barrel, leaving the mainspring on the winder. Hold the winding handle firmly and release the click preventing the mainspring from unwinding. Slowly turn the handle so as to unwind the mainspring. Pull on the outer end of the mainspring while unwinding, so as to draw it out of the winder.

Discard the mainspring since a new one will be used upon reassembly.

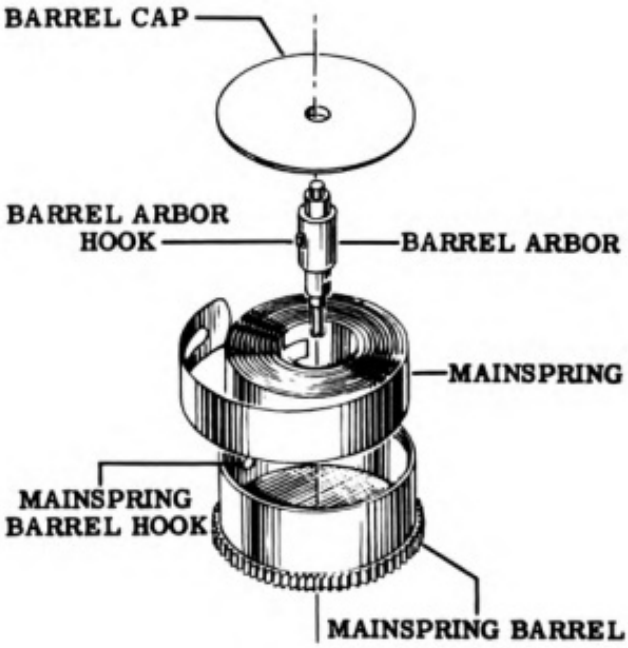


Figure 20

10. Unscrew the three fourth upper bridge screws (see Fig. 21) and lift off the fourth upper bridge as shown in Fig. 22.

11. Unscrew the regulator gear set screw just enough to release its hold on the regulator staff assembly. Lift out the regulator staff, complete, and slip out the regulator gear from the side. See Fig. 21. If the regulator gear does not come out easily, allow it to remain in place until Operation 15.

12. Unscrew the two escapement mounting screws with the screwdriver inserted

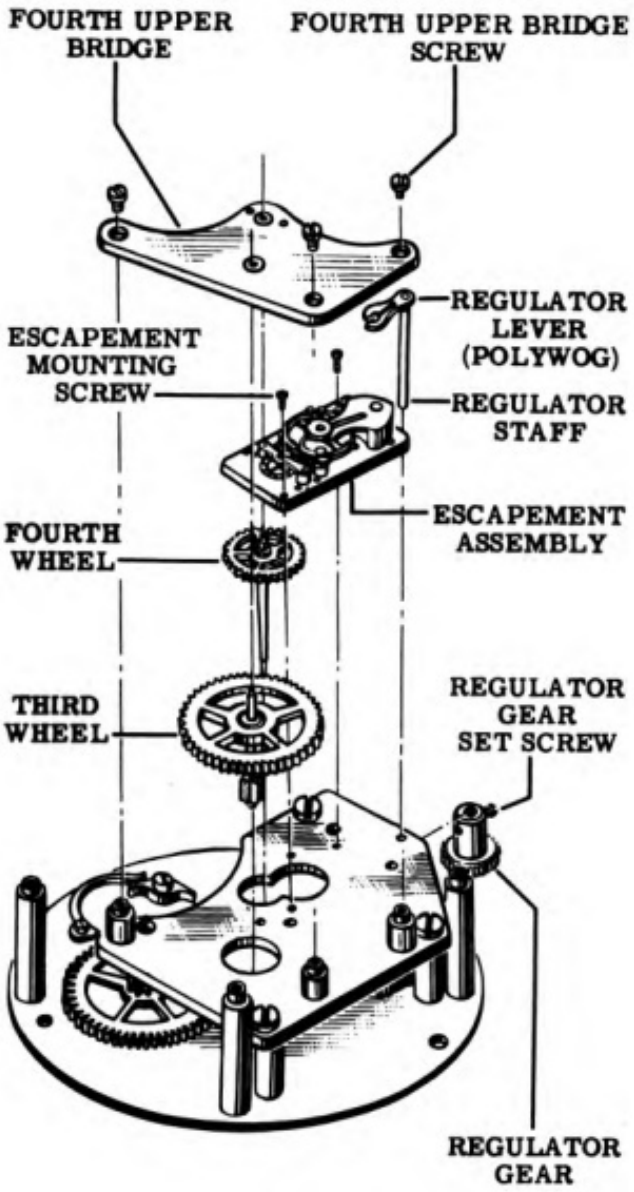


Figure 21

through the work holes in the front plate, as shown in Fig. 23. Remove the escapement and set it aside for separate disassembly.

NOTE

Disassembly of the escapement is simple enough to be performed by any Mechanical Instrument Assembler, Junior Grade, who has seen the process demonstrated by a skilled operator. More manual dexterity is required than for the test of the movement, but it has been well demonstrated that escapement disassembly may be efficiently carried out by this skill level.

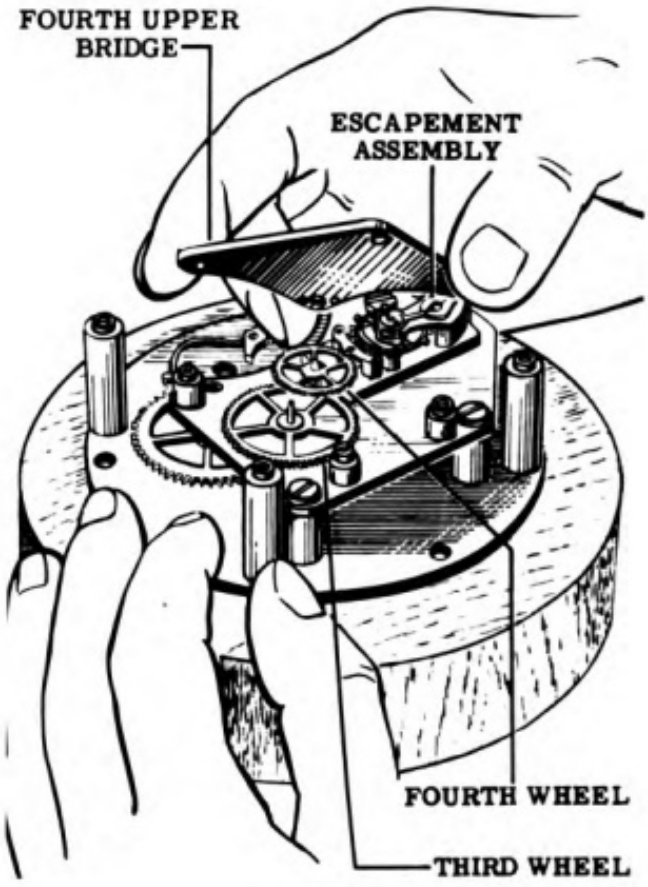


Figure 22

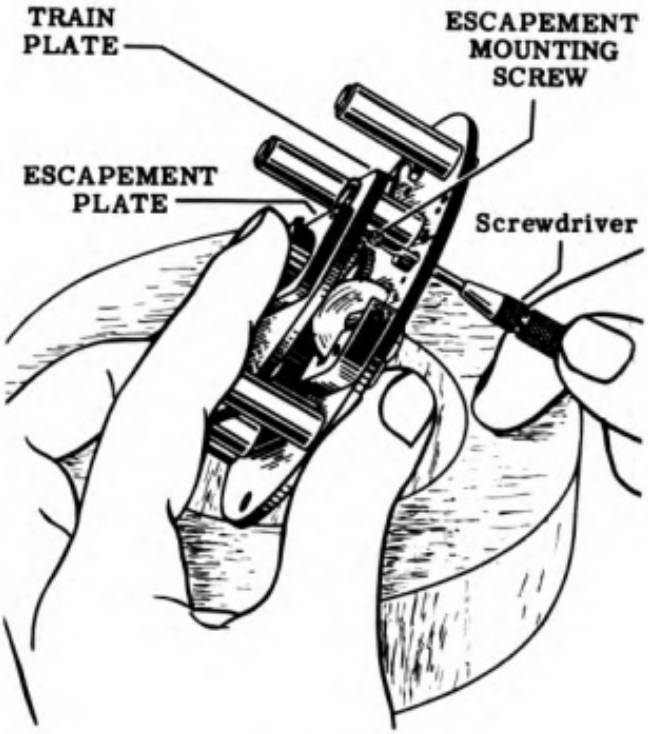


Figure 23

Since escapement disassembly is the same for both the Chelsea 12E and 17E clocks, it will be described in "Escapement Disassembly" (Section III-A), which will be found immediately after the disassembly procedure for the 17E movement.

13. Lift out the fourth and third wheels. See Fig. 21.

14. Unscrew the three train plate screws (see Fig. 24) and lift off the train plate as shown in Fig. 25.

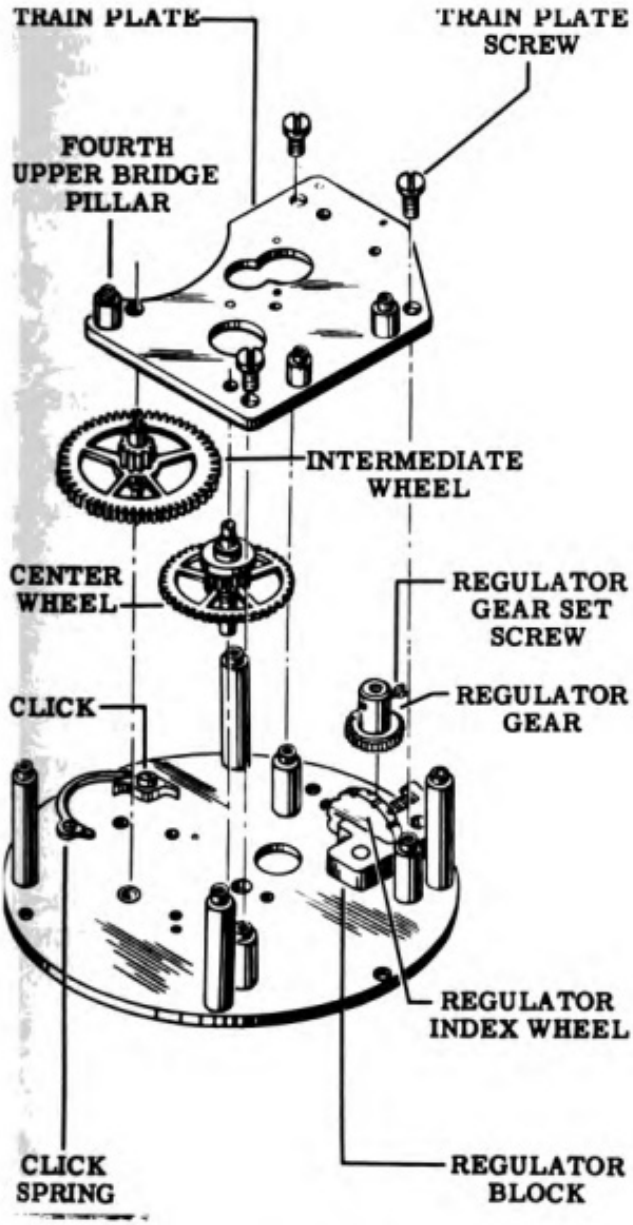


Figure 24

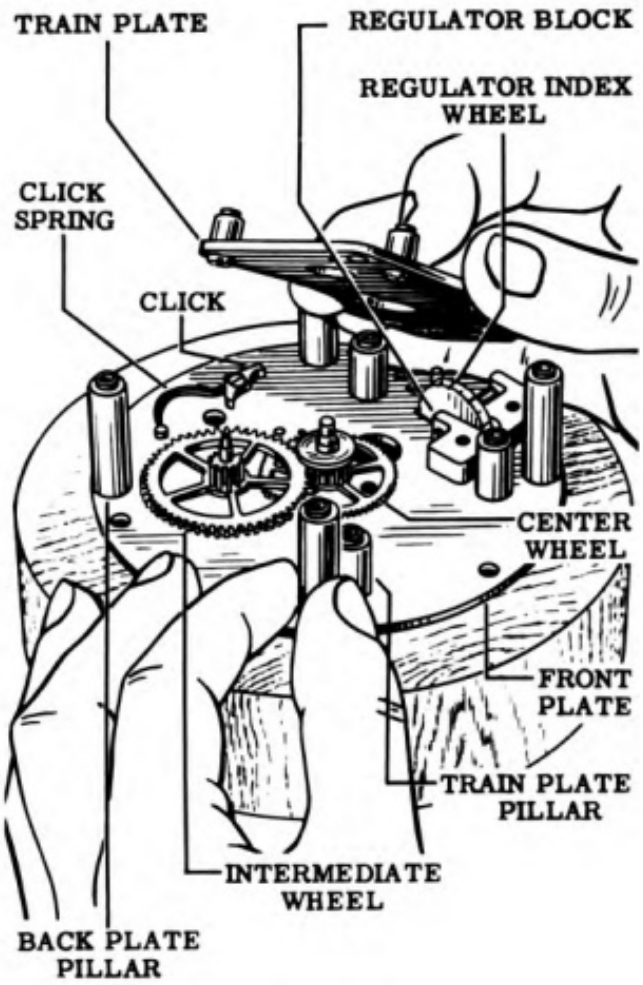


Figure 25

15. Lift out the intermediate and the center wheels. Remove the regulator gear if it was not removed in Step 11. See Fig. 24 for the relative positions of these parts.

16. For purposes of cleaning, no further disassembly is required. The train and back plate pillars, the click and click spring and the regulator block and index wheel remain attached to the front plate. To provide for more efficient cleaning, the click should be turned in a clockwise direction until the curved end of the click spring is locked against the flat end of the click.

All the case components, the dial and the hands should be in the parts tray. All parts of the movement, with the exception of the escapement, should now be in the cleaning tray. After the escapement is disassembled and placed in its individual cleaning tray, place the cleaning trays in the parts tray with the case components, the dial and the hands and return to the Instrument Control Center.

DISASSEMBLY PROCEDURE
CHELSEA MODEL NO. 17E

PRELIMINARY DISASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Junior Grade

The purpose of the preliminary disassembly operations is to remove the movement from the case and to remove the hand and dial components from the movement. These operations permit the movement to be inspected so that the pre-disassembly inspection, previously described, may be carried out.

1. With the fingers, loosen the case knob on the side of the case until the case is free to swing away from the back plate. Refer to Fig. 26 for identification of all parts in Operations 1 through 6.

2. In the Deck Clock, the case should be disengaged from the hinge pin to separate the case from the base plate. In the Boat Clock, the screw-type hinge pin must first be unscrewed. See Fig. 26.

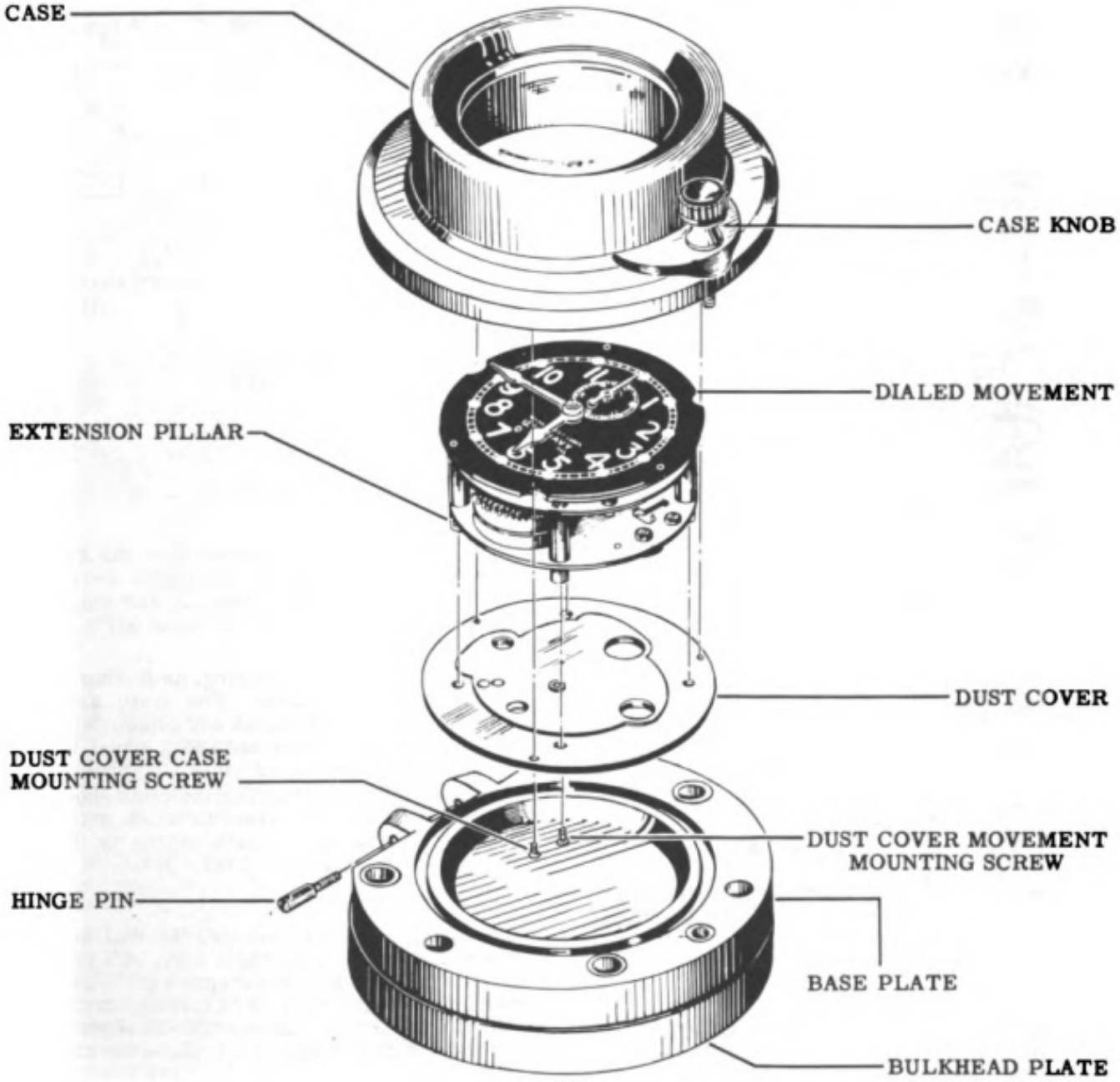


Figure 26

3. Put the case on the work bench, dial down. Remove the three dust cover case mounting screws which hold the dialed movement and the dust cover inside the case. See Fig. 26.

4. In order to remove the dialed movement from the case, place one hand over the dust cover. Turn the entire case over so that the dialed movement and dust cover are supported by one hand. Lift the case off with the free hand and place the movement dial down on the movement work block (Tool No. 1A).

5. Remove the four dust cover movement mounting screws which hold the dust cover to the back plate of the movement, and lift off the dust cover.

6. Place the dialed movement on the work block (Tool No. 1A), dial side up so that it rests on the four extension pillars in the position shown in Fig. 27.

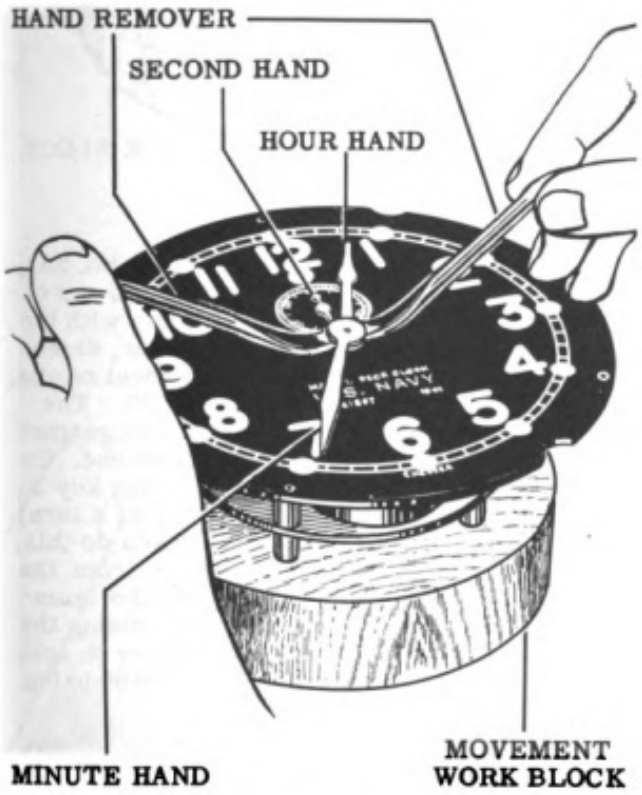


Figure 27

7. Using tweezers and a small screwdriver, remove the hand washer screw and the hand washer. See Fig. 28.

8. Using a pair of the special hand removers with felt pads (Tool No. 2A), as shown in Fig. 27, pry off the minute, the hour and the second hands one by one. The purpose of the felt pads on the heels of the hand removers is to put a cushion between the bearing surface of the hand removers and the dial to prevent the dial from being scratched.

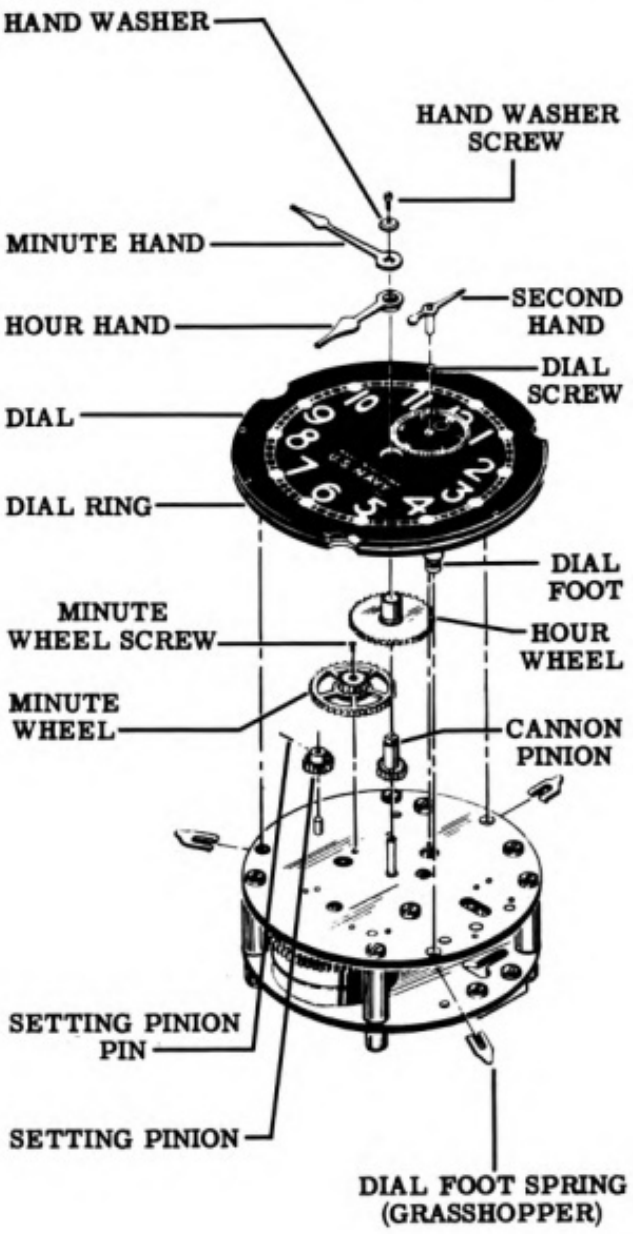


Figure 28

9. Tilt the dial and movement so that you can see the "grasshoppers" holding the dial ring feet to the front plate of the movement. With a pair of needle nose pliers, turn each "grasshopper" so that the head points away from the center of the dial and pull the "grasshoppers" completely off each of the three dial feet. Refer to Fig. 28 to identify the parts properly.

10. Lift off the dial with the attached dial ring. For purposes of repair, the dial may be

separated from the dial ring by removing the three dial screws—otherwise these two parts are not ordinarily disassembled.

11. Place the case, the dial, the hands and the movement in the parts tray for delivery to the pre-disassembly inspector.

PRE-DISASSEMBLY INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

Perform the inspection described at the beginning of this section under the above heading, as indicated in the Control Manual index. After the inspection is complete, have the parts tray delivered to the movement disassembler.

MOVEMENT DISASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Junior Grade

During the disassembly of the movement, the parts should be put in the cleaning trays as soon as they are taken out of the movement. The arrangement of the parts in the cleaning trays is shown in the "Cleaning" section (see the Control Manual).

1. Before any disassembly work is done on the movement, it is necessary to let down the mainspring. Since the hour wheel is loose on the cannon pinion, first lift off the hour wheel. See Fig. 28.

CAUTION

In Operation 1 use only a letdown key (with no projecting wings) similar to Tool No. 5A, as listed in Section VIII. Use of a winding key may result in serious injury to the fingers should they slip while holding the key against the force of the mainspring. If a letdown key is not available, have the shop make up one for you by fitting a smooth round handle to a winding key.

To let down the mainspring, stand the movement on its side in the work block (Tool No. 1A) in the position shown in Fig. 29.

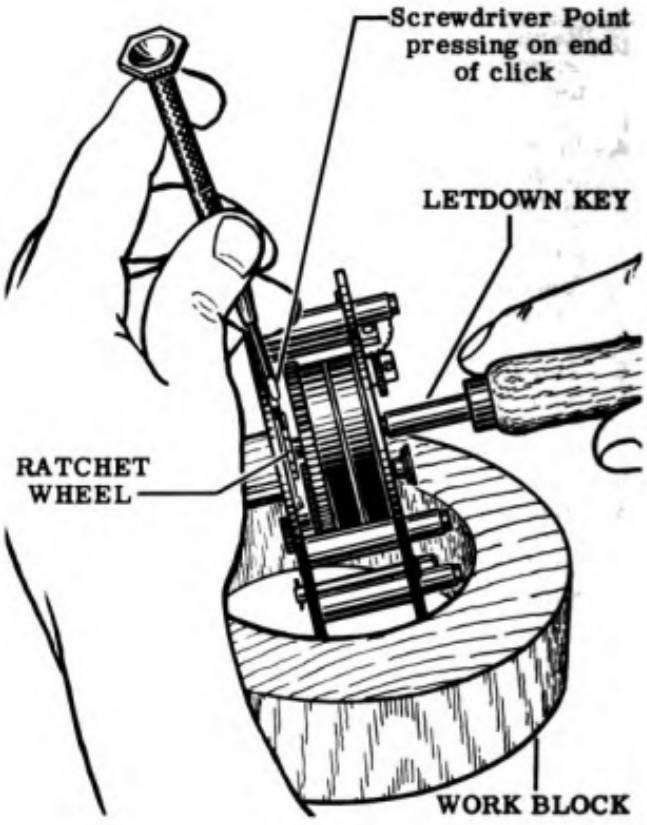


Figure 29

Place the special letdown key (Tool No. 5A), not a winding key, over the squared end of the barrel arbor and hold it firmly with the fingers. With a small screwdriver, disengage the click from the ratchet wheel on the barrel arbor as shown in Fig. 29. The click will not disengage from the ratchet wheel when you press on the click end. To do this, you must turn the winding key a very small amount (less than 1/8 of a turn) in a clockwise direction. When you do this, you will feel the click disengage from the ratchet wheel and the force of the mainspring will be felt in the hand holding the winding key. Allow the letdown key to spin slowly in the fingers until the mainspring is completely run down.

2. With the movement in the work block, dial side up, unscrew the minute wheel screw and remove the minute wheel, the relative positions of which are shown in Fig. 28.

3. Using the special hand removers with felt pads (Tool No. 2A) as shown in Fig. 30, remove the cannon pinion by prying it off the center arbor.

4. With needle nose pliers, pull out the setting pinion pin. Pry the setting pinion loose from the setting shaft with the hand removers and remove the setting pinion.

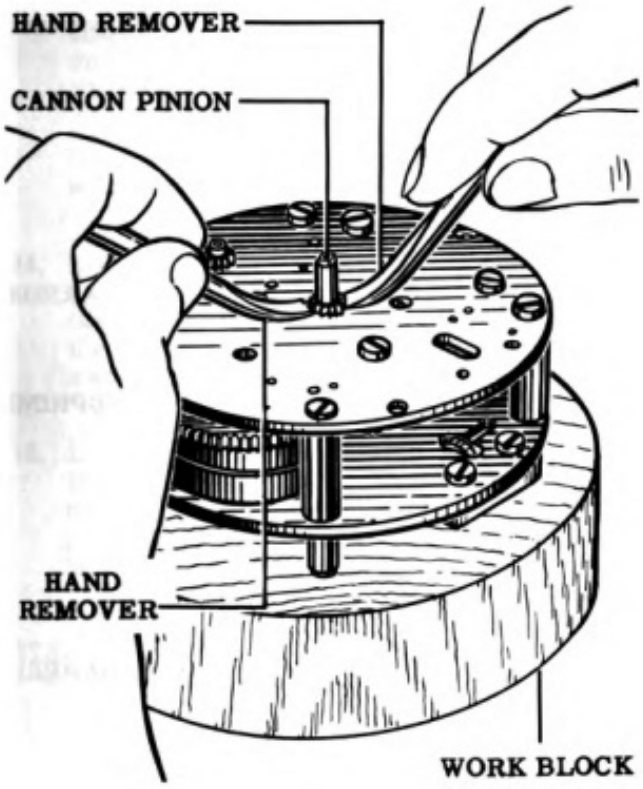


Figure 30

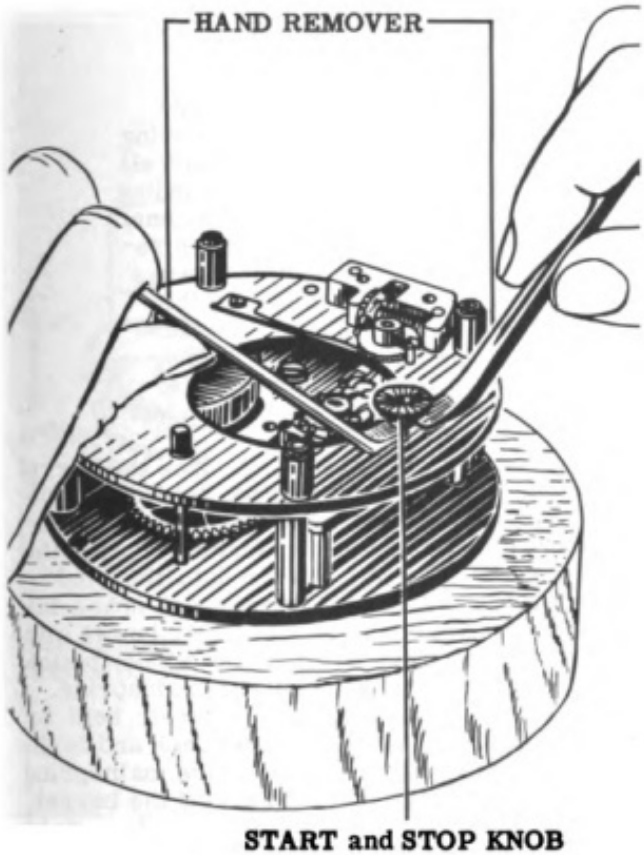


Figure 31

5. Turn the movement over and place it in the work block, train side up (back plate up), in the position shown in Fig. 31.

6. Unscrew the start and stop knob screw and lift off the knob, using the hand removers with felt pads (Tool No. 2A) shown in Fig. 31.

7. Unscrew the regulator gear set screw and remove the regulator gear, using the hand removers, Tool No. 2A (refer to Fig. 33).

8. Using the special pillar pliers (Tool No. 6A), remove the four extension pillars which hold on the back plate (refer to Fig. 33). Remove the back plate as shown in Fig. 32.

9. For purposes of cleaning, the thrust spring and the regulator block and index wheel need not be removed. They remain assem-

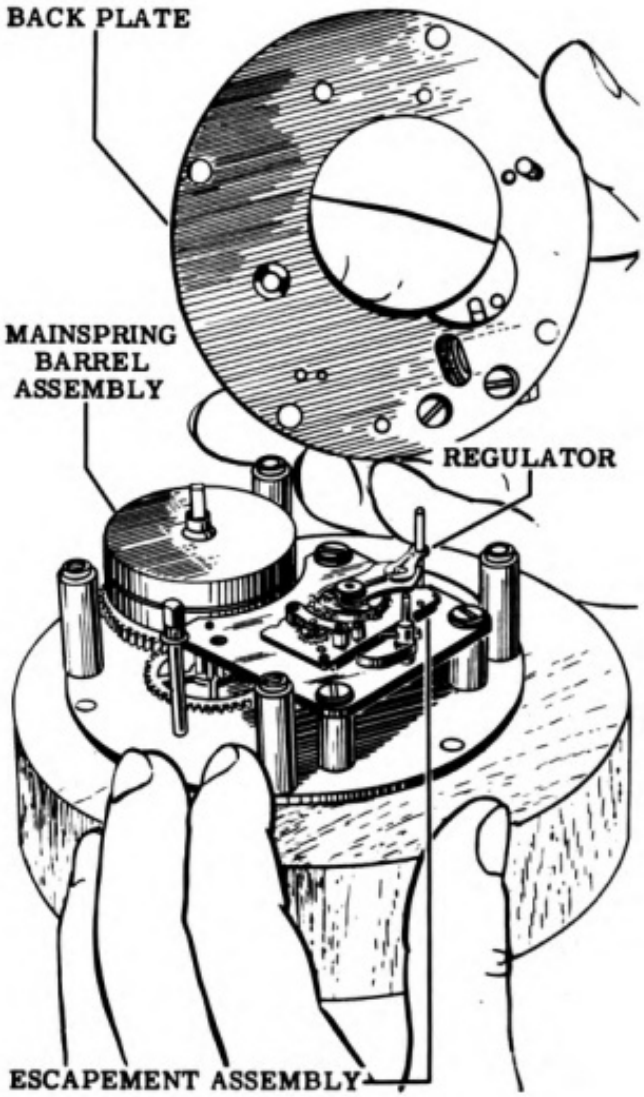


Figure 32

bled on the back plate unless further disassembly is required for repairs. See Fig. 33.

10. As soon as the back plate has been removed, lift out the setting shaft, the mainspring barrel assembly and the ratchet wheel. The positions of these parts are shown in Fig. 33.

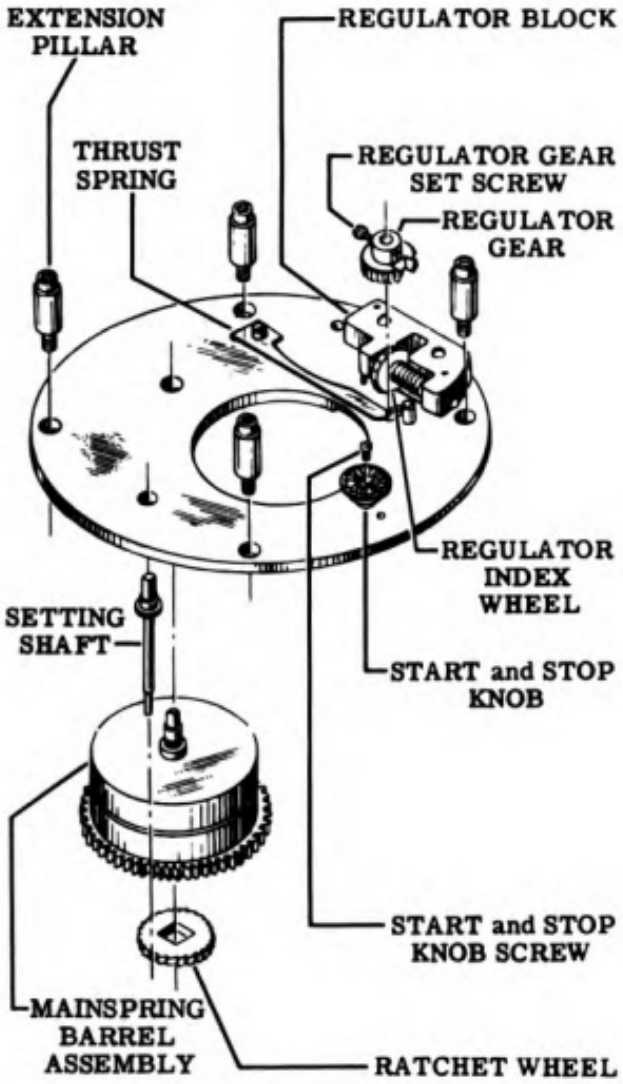


Figure 33

CAUTION

Do not use a steel-headed hammer in Operation 11. It will deform the end of the barrel arbor.

11. To remove the barrel cap, hold the barrel tightly in one hand and strongly hit the end of the barrel arbor farthest from the cap with a plastic- or wood-headed hammer. The shoulder on the arbor will transmit this force directly to the inside of the cap and force it out. See Fig. 34 for identification of the mainspring barrel components.

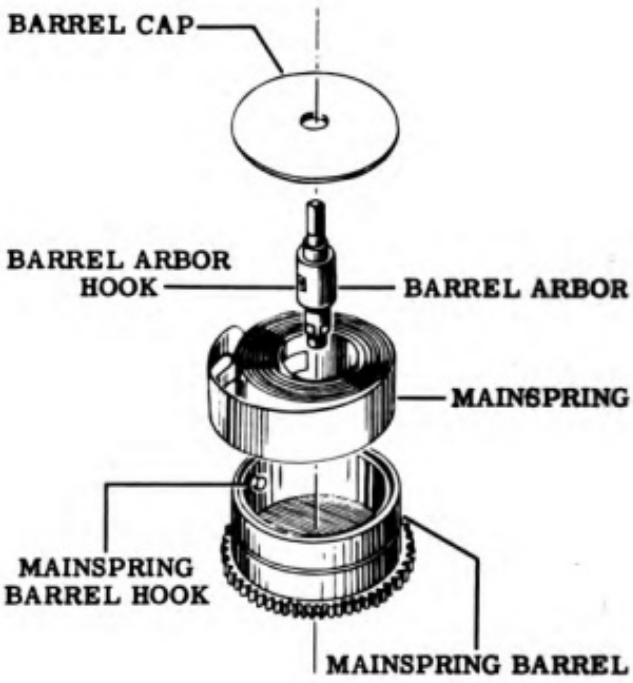


Figure 34

12. Unhook the barrel arbor from the mainspring and remove the arbor.

CAUTION

The only safe method of performing Operation 13 (removing the mainspring from the barrel) is to use the mainspring winding tool (Tool No. 9A) in the manner described. Methods of hand removal, although simple, always involve serious danger to the hands and face should the fingers slip in their grip on the oily mainspring. No hand removal method is recommended.

13. To remove the mainspring, place the barrel on the mainspring winder (Tool No. 9A) so that the inner end of the mainspring is engaged by the hook on the turning shaft of the winder. Wind the spring onto the winder shaft just enough to form enough space inside the barrel so that you may insert into the barrel the portion of the winder which holds the outer turn of the mainspring. When the mainspring is securely held by the winder, turn the barrel back and forth to disengage the outer end of the mainspring from the barrel hook. Pull off the barrel, leaving the mainspring on the winder. Hold the winding handle firmly and release the click preventing the mainspring from unwinding. Slowly turn the handle so as to

unwind the mainspring. Pull on the outer end of the mainspring while unwinding so as to draw it out of the winder.

Discard the mainspring since a new one will be used upon reassembly.

14. Lift out the start and stop assembly. Disassembly of this unit is not required for the purposes of cleaning unless some of the parts are damaged and require replacement. See Fig. 35.

15. Lift out the regulator staff with its collar. Disassembly of this unit is not required for the purposes of cleaning unless some of the parts are damaged and require replacement. See Fig. 35.

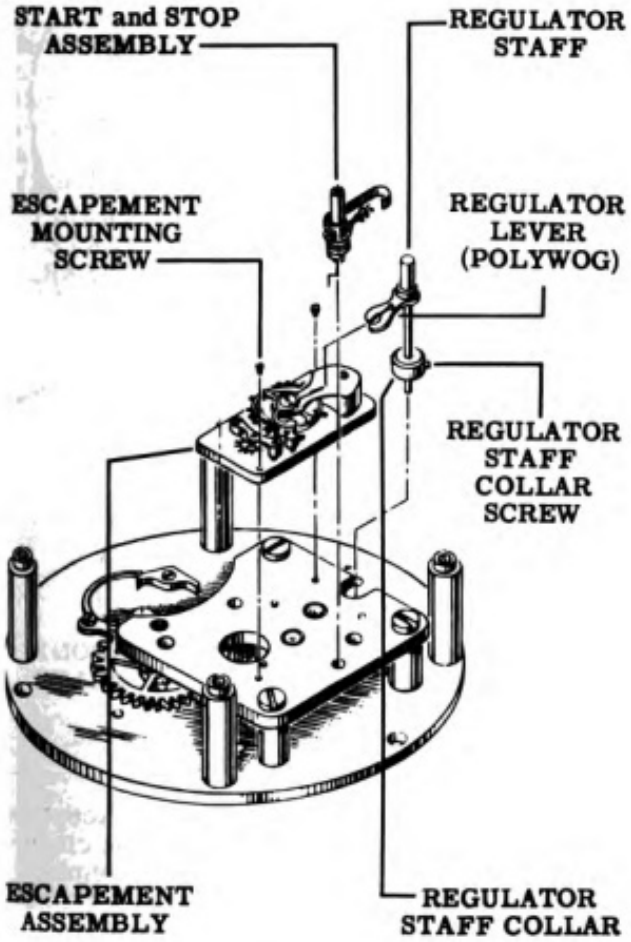


Figure 35

16. Unscrew the two escapement mounting screws and lift off the escapement as shown in Fig. 36. Set the escapement aside for separate disassembly.

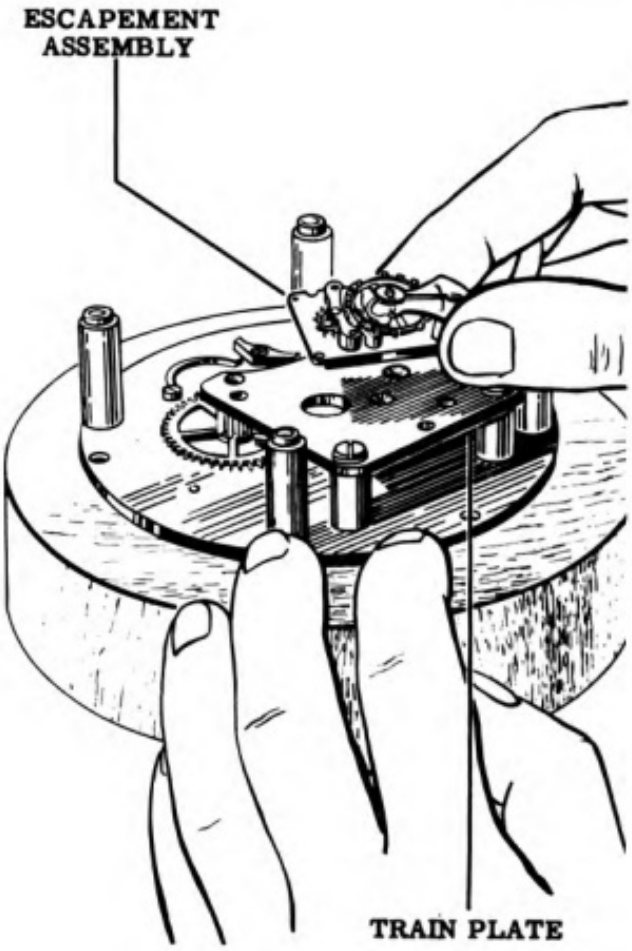


Figure 36

NOTE

Disassembly of the escapement is simple enough to be performed by any Mechanical Instrument Assembler, Junior Grade, who has seen the process demonstrated by a skilled operator. More manual dexterity is required than with the rest of the movement, but it has been well demonstrated that escapement disassembly may be efficiently carried out by this skill level.

Since escapement disassembly is the same for both the Chelsea 12E and 17E, it will be described in "Escapement Disassembly" (Section III-A), which will be found immediately after this disassembly procedure.

17. Unscrew the three train plate screws (see Fig. 37) and remove the train plate as shown in Fig. 38.

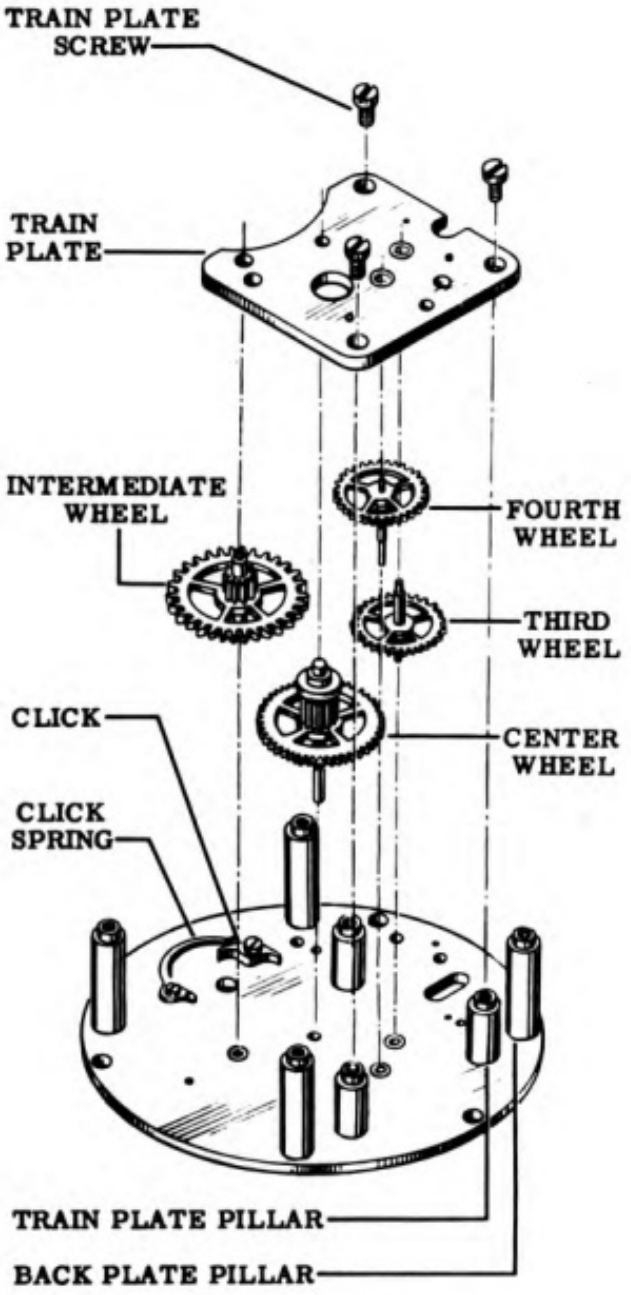


Figure 37

18. Lift out the fourth, third, intermediate and center wheels. Refer to Figs. 37 and 38.

19. For purposes of cleaning, no further disassembly is required. The train plate and back plate pillars, the click and the click spring remain attached to the front plate. To provide for more efficient cleaning, the click should be turned in a clockwise direction until the flat end of the click spring is locked against the flat end of the click.

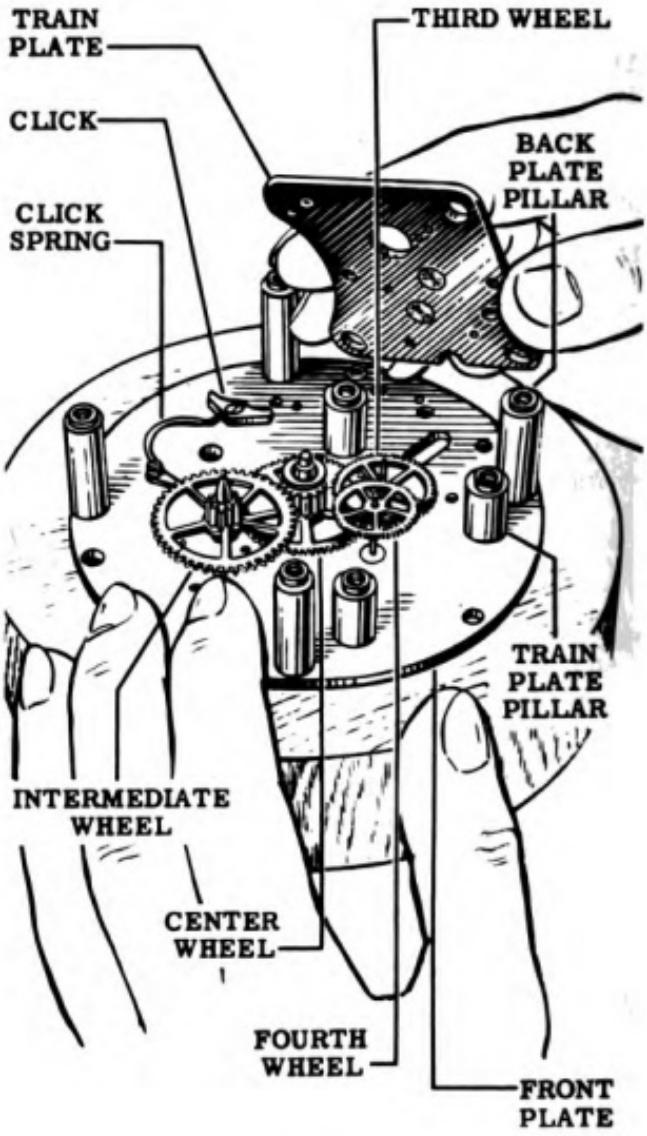


Figure 38

All parts of the movement, with the exception of the escapement, should now be in the cleaning tray. After the escapement is disassembled and placed in its individual cleaning tray, return the trays to the Instrument Control Center.

SECTION III-A

ESCAPEMENT DISASSEMBLY

Skill Level: Mechanical Instrument Assembler, Junior Grade

It is recommended that the proper manual techniques of escapement disassembly be demonstrated by a skilled operator. These operations may readily be performed by any Mechanical Instrument Assembler, Junior Grade, after one or two demonstrations of the manual techniques involved.

1. Place the escapement upon the escapement work block, Tool No. 7A. In the case of the No. 17E Escapement, which has a potance, the potance should be placed down in the hole in the escapement work block so that the escapement rests level in the position shown in Fig. 39.

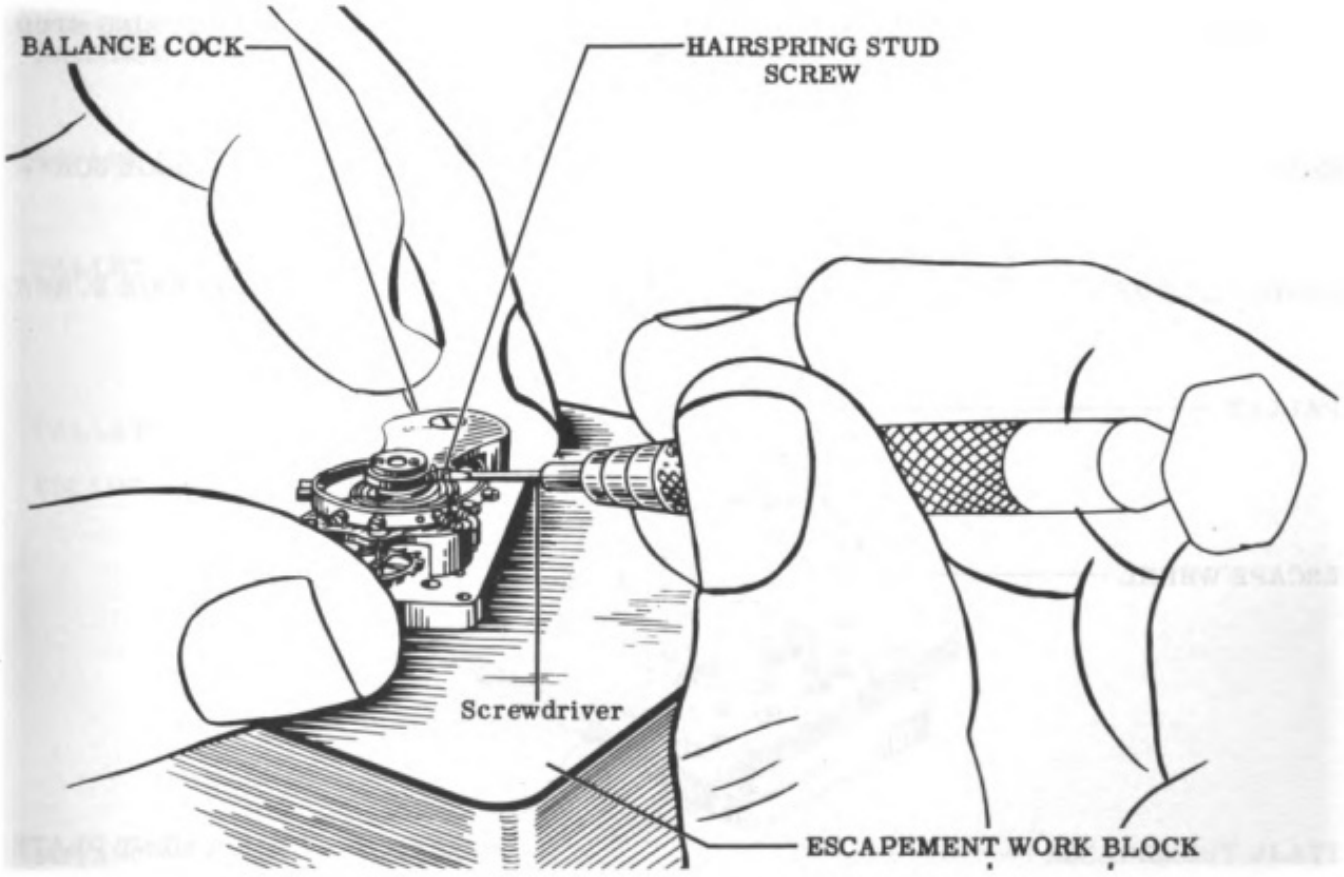


Figure 39

Refer to Figs. 40 and 41 to see the relative positions of all escapement parts to be disassembled in Operations 2 through 7.

2. With a small screwdriver, pry off the regulator, leaving the balance upper endstone cap in place. As you remove each part, place it in its proper compartment in the cleaning tray. See "Cleaning" in the Control Manual index.

3. Loosen the hairspring stud screw several turns to release the hairspring stud from its notch in the balance cock. See Fig. 39. Using a pair of fine tweezers, slide the stud down out of the notch. Retighten the stud screw into the balance cock.

CAUTION

In Operation 4 (removing the balance cock), be sure to lift the free

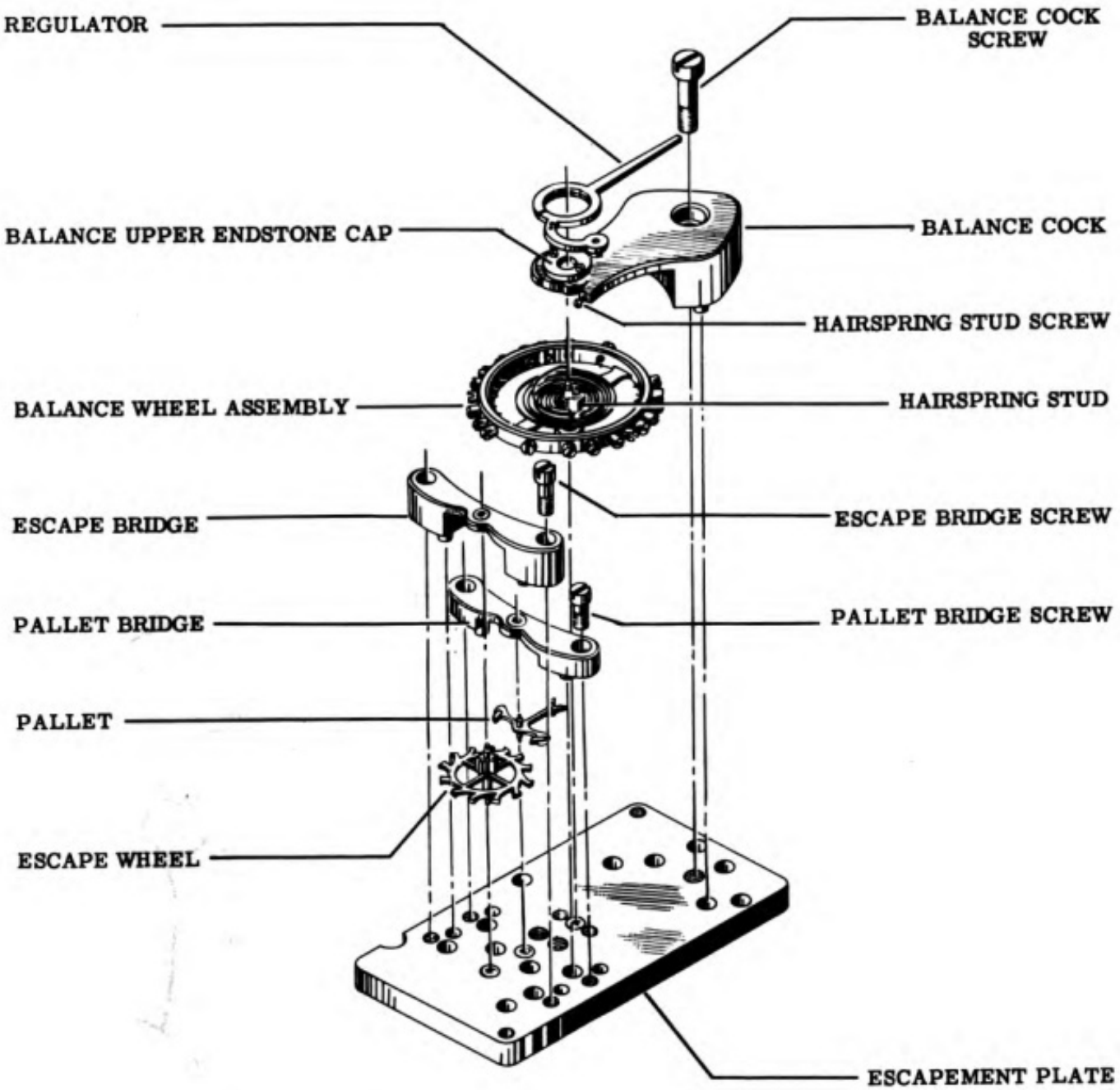


Figure 40—12E Mechanical Clock Escapement Assembly, No. 26

end of the balance cock with tweezers while prying the base loose from the escapement plate. If the free end of the balance cock is not lifted, the prying may put a downward force on the free end of the balance cock—resulting in damage to the balance staff pivots or jewels.

4. Unscrew the balance cock screw. The balance cock will remain in position, being held by its steady pins. Grasp the free end of the balance cock with tweezers and apply a slight upward force. Pry loose the balance cock with a small screwdriver, making use of the two prying holes in the escapement plate. Lift off the balance cock as shown in Fig. 42.

   No further disassembly of the balance cock is to take place before cleaning.

5. Lift out the entire balance wheel assembly as shown in Fig. 43, and put it in the cleaning tray without any further disassembly.

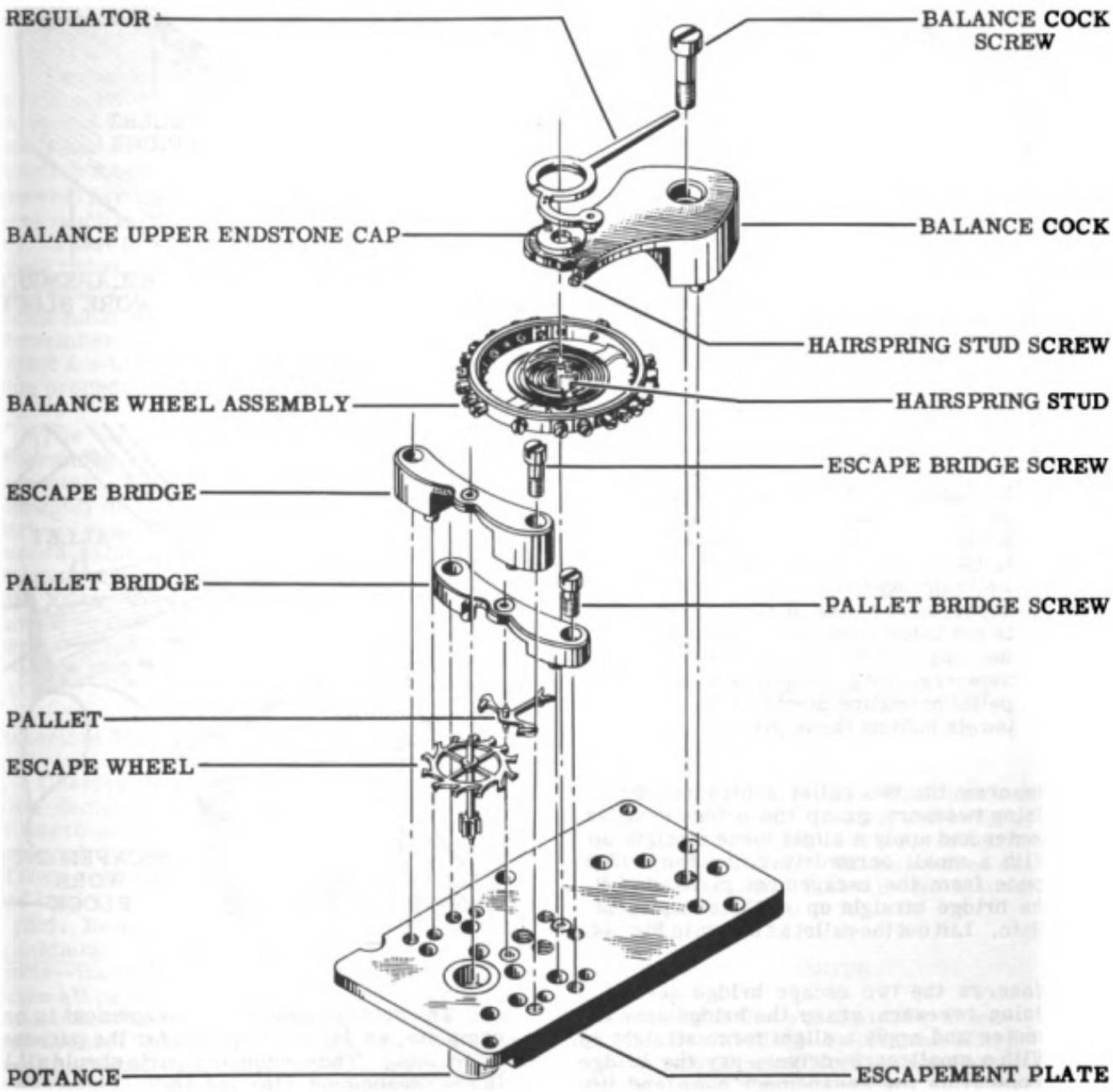


Figure 41—17E Boat and Deck Clock Escapement Assembly, No. 22

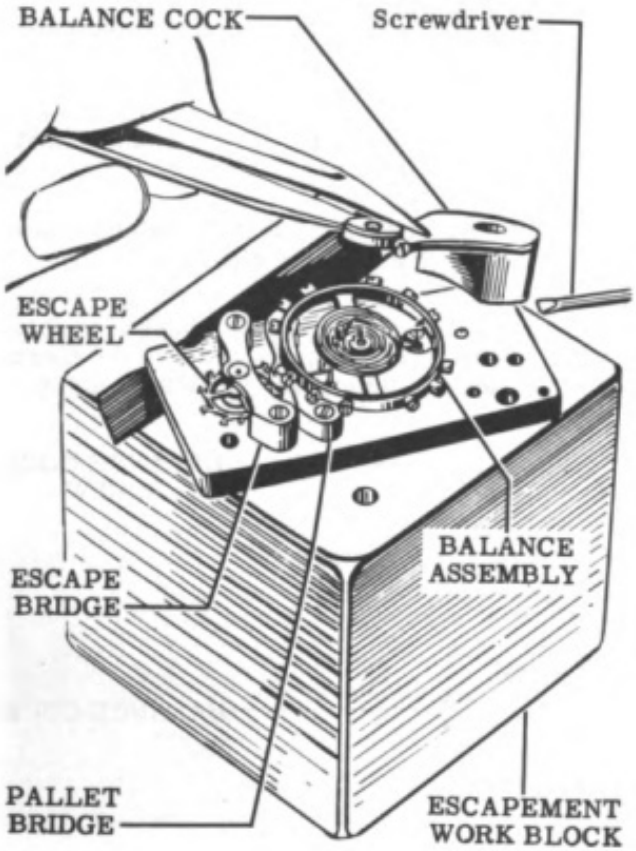


Figure 42

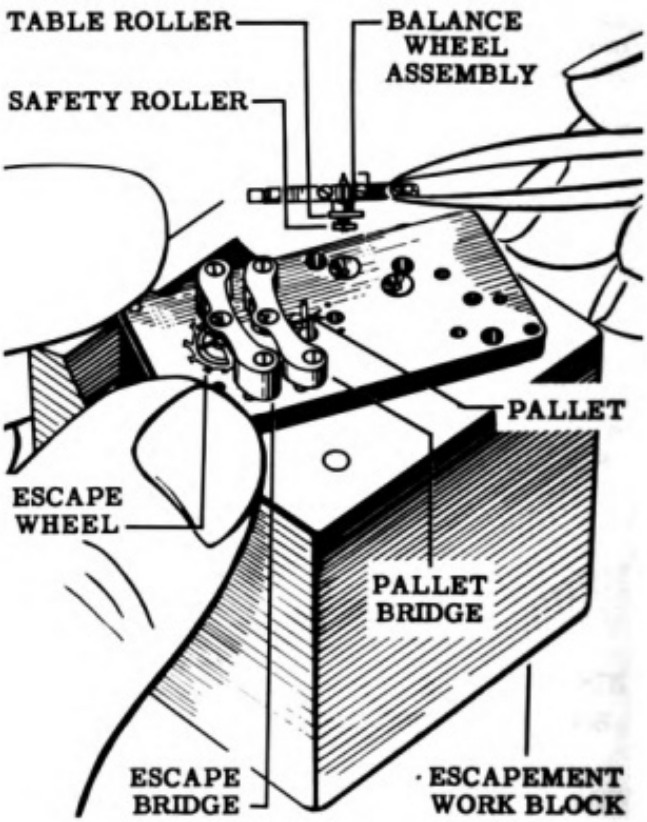


Figure 43

CAUTION

In Operations 6 and 7 (removing the pallet bridge and the escape bridge), be sure to use tweezers to lift the bridge straight up while prying the bridge from the escapement plate. If the bridge is not lifted straight up, the prying may turn the bridge to the side—resulting in damage to the pallet or escape pivots or the jewels holding these pivots.

6. Unscrew the two pallet bridge screws. Using tweezers, grasp the bridge near its center and apply a slight force straight up. With a small screwdriver, pry the bridge loose from the escapement plate and lift the bridge straight up off the escapement plate. Lift out the pallet as shown in Fig. 44.

7. Unscrew the two escape bridge screws. Using tweezers, grasp the bridge near its center and apply a slight force straight up. With a small screwdriver, pry the bridge loose from the escapement plate and lift the bridge straight up off the escapement plate. Lift out the escape wheel.

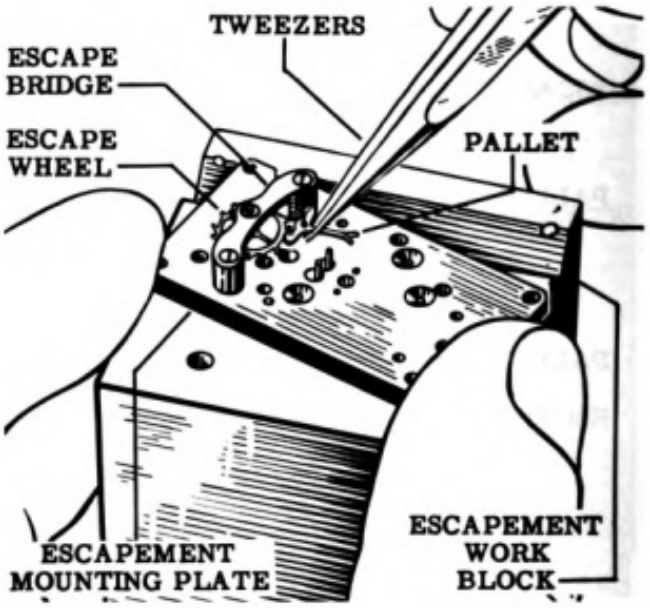


Figure 44

The disassembly of the escapement is now complete, as far as required for the purposes of cleaning. The escapement parts should all be in the escapement cleaning tray. Place the escapement cleaning tray into the parts tray and deliver to the Instrument Control Center.

SECTION IV

PARTS INSPECTION, REPAIR AND CLEANING

Skill Levels: Cleaning Operations—Cleaner

Inspection Operations—Mechanical Instrument Assembler, Senior Grade

The purpose of the procedures included within this section is to prepare a complete set of clean and serviceable parts that will reassemble easily and efficiently. The pre-disassembly inspection determined what parts were defective and what particular fits were not within tolerance —as much as this was possible before disassembly. These functional defects were noted on the route ticket, and all parts listed or parts concerned in any defective fits listed on the route ticket must be double-checked for defects. Remember that the defects noted on the route ticket are to be checked in addition to the inspection procedures in this section.

The economy of clock overhaul is largely determined by the skill and efficiency of the inspector. Time and money invested in the reassembly of a clock will be wasted if a defective part is included. A defective part which has passed inspection will either cause a clock to fail in passing its performance test or, which is still more undesirable, it will cause a clock to have an early breakdown when it is placed in service in the Fleet. The responsibility is yours —learn your job and apply yourself to it.

Inspection Standards

Chelsea Mechanical, Boat and Deck Clocks were designed and manufactured on the basis of interchangeable parts, and every part can be replaced without causing any special problems of fitting or matching. Repairs are expensive and tend to destroy the standard dimensions of a part. Do not perform any repairs that involve machining. This is to be the policy with all parts—including those in the escapement. Replace all parts which have functional defects or structural weakness—not merely for the sake of appearance. Refinishing of the clock case and bezel is the only true repair which is permissible. Further discussion of this policy will be included in the specific inspection instructions which are set forth later in this section.

Performance and Usage Data

The Navigational Instruments Section of the Bureau of Ships needs to be informed as to how various clock parts are holding up in service. It is only with complete recorded facts that design improvements can be made to bring about desirable changes. Therefore, from time to time, you will be requested to report on certain conditions of performance; this is a very important function of inspection, so don't pass it off lightly. In addition, since you are the "eyes and ears" of the Bureau of Ships, you should take it upon yourself to bring attention to certain of your own observations which you consider important. Remember that the Navy is one of the largest individual users of clocks in the world and, as a result, you will gather a tremendous amount of information on the performance of all clock parts. It is only from the experience data you supply that the Bureau can be kept up to date on developments in the field. Your efforts in this connection will be very much appreciated.

CLEANING OPERATIONS

Skill Level: Cleaner

Clean all parts—case, dial, movement and escapement parts. The standard techniques and materials to be used are fully described in "Timepiece Cleaning" as referenced in the index of the Control Manual. No instructions are given here.

NOTE

Parts that are obviously defective need not be cleaned. They should be replaced with new parts in the cleaning baskets so that clean new parts will be available for reassembly.

INSPECTION OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

The exploded views and parts lists in the Maintenance Parts Catalog (Section VII) will provide a means for identifying parts and obtaining stock numbers for requisitioning replacements. The parts lists also indicate those parts which should be replaced as a subassembly and not individually.

NOTE

All inspection and repair work on the escapement other than preliminary disassembly and cleaning is to be done only by Watchmakers, Junior Grade, under the supervision of a Watchmaker, Senior Grade. For this reason, inspection and repair is divided into two parts: One part for the case, dial and movement less the escapement (Section IV) and one part for the escapement operations alone (Section IV-A).

Inspection of the Case, Dial and Movement—Less Escapement

After the disassembled parts are perfectly cleaned, the parts tray will be delivered to the inspector—less the escapement parts which will go to the Escapement Repair Group. The check list which follows tells you the defects for which you should look. Worn, damaged or badly corroded parts are to be replaced. The check list mentions particular checks that are required, although various other reasons may be found for replacing a part. It should be noted that no repairs should be attempted other than those indicated. The basic reason for this is that it is usually more economical to replace a defective part with a new one rather than to repair it. Repairs are expensive and often cause a changing of the dimensions of parts which results in complications during reassembly.

CAUTION

The parts you receive will be clean—keep them that way. Keep handling to a minimum and use tweezers whenever possible. Fingerprints hold dust, promote corrosion and interfere with proper oiling. Pivots and bushings are specially critical points—never touch them with the fingers.

NOTE

Because case, dial and hand inspection and refinishing may involve the use of paints and buffing equipment, it is recommended that these operations be performed by a different inspector and away from the movement inspection position. Such procedure will minimize the likelihood of dirtying the movement parts.

INSPECTION CHECK LIST

Before proceeding to make any of the checks on the following list, first refer to the "route ticket" accompanying the clock parts. This route ticket may bear notations which are to be considered in addition to the check list which follows. As you carry on in accord with each notation, initial it to indicate that the work has been done. The appearance standards called for in these instructions are essentially for "like new" final appearance. Refer to the route ticket to check whether any other appearance standards are specifically called for.

Case and Dial Components

1. Check cases and bezels for cracks, breaks, chips, warpage or damaged hinge lugs which prevent proper closing of the case or permit the entry of dust or moisture. If any such condition exists, the part must be replaced with a new one.

2. Check cases, bezels, back plates and bulkhead plates for superficial scratches, chips and damage to the finish. These defects are not a cause for replacement unless they cannot be removed and seriously affect the appearance of the clock.

   Scarred hinge pins and case knobs may be replaced. Finish damage may be removed by careful use of a very fine wire wheel or sandpaper, followed by buffing to a polish that will match the rest of the case. When the black finish has worn off metal inserts which are used for hinging and locking the case, the exposed portion should be wire-brushed clean and carefully touched up with matching paint—see "Paints" as referred to in the index of the Control Manual.

3. In the case of Mechanical Clocks, inspect the glass set into the bezel and temporarily remove the locking wire in order to inspect the waterproof cement seal of the glass to the bezel. If the glass is broken, cracked or badly scratched, it should be replaced with a new one and resealed to the bezel with waterproof cement—see "Waterproofing" as indexed in the Control Manual. If

the waterproof seal is not in perfect condition, the glass should be resealed to the bezel with waterproof cement.

4. In the case of Boat and Deck Clocks, the permoseal crystal is not replaceable—the entire case must be replaced. Carefully inspect the permoseal crystal for any breaks or cracks which might permit the entry of dust or moisture. If such a condition exists, the case must be replaced. Do not replace the case because of superficial scratches on the crystal. Only scratches which prevent proper reading of the dial would warrant replacement in such case.

5. Inspect cork and rubber gaskets used to seal the case and rubber discs used for shock mounting. Check these parts for cracks, breaks and brittleness that indicate that the material is aged and dried out. If this condition is found, replace the part with a new one.

6. Inspect the dial and dial ring for any deformity or breakage. In these cases, replace the defective part. See that the numerals and markings on the dial are bright and clear. Superficial dial scratches are not to be the cause for replacement. Minor chips in the numerals and other dial markings may be retouched with matching paint. See "Paints" in the index of the Control Manual. However, do not attempt any refinishing which involves more than a few minor scratches or chips—in that event, replace the dial with a new one.

7. Check the hour, minute and second hands for bending, cracks or other physical deformities. If these are noted, replace the hand with a new one. If the finish of any of the hands is chipped or flaked, replace it with a new part.

8. Recheck the route ticket as it applies to the case, dial and hand inspection to make sure you have initialed and attended to each of the recommendations.

After the inspection and repair work is complete on the case components, the dial, and the hands, place the parts in the parts tray for delivery to the movement inspector.

Movement Inspection

CAUTION

Replacement parts procured from stock should be clean and in sealed containers. If the parts are not sealed or if preserving material has been put on them, have the parts cleaned before placing them in with the movement being inspected.

1. Check the pivots of all the train wheels. If the pivots are worn, scored, bent or broken, replace with a new wheel.

2. Check the teeth of all the train wheels and their pinions. If the teeth appear corroded, bent, worn or broken, replace with a new wheel.

3. Check each staff and the fit of each wheel on its staff. Replace any wheel which has a bent staff or which has loosened in its fastening to the staff.

4. Check the teeth on the barrel, the ratchet wheel, the cannon pinion, the minute wheel and the hour wheel. Also check the teeth on the regulator gear and the threads on the regulator index wheel worm screw. In the case of the Boat and Deck Clock movement, also check the teeth on the setting pinion. If any teeth or threads show any corrosion, bending, wear or breakage, replace the part.

5. Check barrel hook for looseness. If hook is loose, be especially careful in checking for bent teeth. If a bent tooth is found, replace the entire barrel. If hook is loose but no teeth are bent, the hook may be tightened by peening over the rivet.

6. In the case of the Boat and Deck Clock movement, check the start and stop spring and the start and stop shaft spring for any corrosion, deformity or breakage. If such is found, replace the spring with a new one.

7. Check each plate and bridge for any bending, cracks or corrosion which would affect the fit of any of the movement parts. Any of these conditions required replacement with a new plate or bridge.

8. In regard to all other miscellaneous pillars, screws, arbors, etc., the rule is as follows: If any part has corrosion, wear, bending or breakage which interferes with its function in the movement, it must be replaced.

When the case, dial, and movement parts have gone through inspection, they should be put back in the parts tray.

9. Recheck the route ticket to see that all the recommendations referring to movement inspection have been initialed to indicate that the work has been done. Return the parts tray to the Instrument Control Center.

SECTION IV-A

ESCAPEMENT OPERATIONS PROCEDURE

Skill Levels: All Escapement Operations Except Matching—Watchmaker, Junior Grade

Escapement Matching Operations, Bench Inspection and Supervision —Watchmaker, Senior Grade

The larger part of the operations described in this section are intended for Watchmakers, Junior Grade, who are under the supervision of a Watchmaker, Senior Grade. When the skill of a Watchmaker, Senior Grade is required for certain critical adjustments, special note is made.

As mentioned in Section I, Mechanical Instrument Assemblers, Senior Grade, may be trained to do work as "Escapement Specialists." It has been demonstrated in commercial practice that these Escapement Specialists can readily be trained to perform efficiently any one of such specialized jobs as jewel inspection and replacement, balance wheel truing and poising, balance wheel repairs, hairspring repairs, endshake and sideshake adjustment, etc. Utilization of this specialist rating can be used to expedite the establishment of centralized escapement overhaul and repair.

The escapement repairs described in this section apply equally to the escapements for both the Chelsea No. 12E and No. 17E movements. Since the escapement operations of inspection, repair, oiling, reassembly and adjustment are all normally and necessarily done by persons under the immediate supervision of a Watchmaker, Senior Grade, they are all included in this section. For that reason, the entire sequence is described as it would normally be performed on a flow-line basis. The number of persons required in such a flow line depends basically upon the number of escapements to be overhauled and, therefore, the subdivision of the overhaul process is left to the discretion of the supervisor.

Escapement operations begin when the cleaned escapement parts are delivered to the watchmaker along with the inspection report. Escapement operations end when the escapement is completely overhauled and adjusted and ready for insertion into the main movement.

Descriptions of proper oiling techniques and materials are included in "Timepiece Lubrication" as listed in the Control Manual index. It is to this heading that reference is made when the "Control Manual" is mentioned in connection with escapement lubrication.

Repairs to parts, and any adjustments for which specific directions are not given in this text, are accomplished in the same manner and by the same methods with which the watchmaker is thoroughly accustomed by his work on other timepieces. In all cases, the basic tools of the watchmaker will be found to be completely adequate for escapement operations although a few special fixtures are recommended for convenience.

NOTE

Certain adjustment and repair operations which are standard procedures, which require special explanation or which involve more than one or two operations, are described under "Special Timepiece Repair and Adjustment Operations"—see the Control Manual index. This plan is followed in order to avoid breaking up the text in this section, which describes the normal sequence of events. When "Special Operations" are mentioned, locate the operation in question by referring to "Special Timepiece Repair and Adjustment

Operations" in the Control Manual index.

Inspection Standards

Chelsea escapements were designed and manufactured for parts to be interchangeable and every part can be replaced without causing any special problems of fitting or matching. Repairs are expensive and tend to destroy the standard dimensions of a part. Do not perform any repairs that involve machining. The intent is that the watchmaker devote his skills to making the necessary tests and adjustments indicated in this section, and not spend any time correcting badly bent hairsprings, repairing scored or bent pivots and performing other repairs which are best corrected by replacement.

Any questions you have on what you should repair and what you should replace are answered in this section and in the parts list. The exploded views of the escapements and their parts lists in the Maintenance Parts Catalog (Section VII) will provide a means for identifying parts and obtaining stock numbers for requisitioning replacements. The parts lists also indicate which parts are not recommended for replacement—in which case the part should be replaced by the next higher assembly.

Performance and Usage Data

The Navigational Instruments Section of the Bureau of Ships needs to be informed as to how various escapement parts are holding up in service. It is only with complete recorded facts that design improvements can be made intelligently. Keep a daily record of the number of escapements handled. On this record keep columns for parts replaced, parts repaired, and parts requiring unreasonably difficult adjustment. Identify each part by name and part number. Keep a comment column for noting exactly what was wrong with each part. You can expect to be requested to report on this from time to time. The keeping of repair, replacement and adjustment records is a very important part of your job as a watchmaker, so don't pass it off lightly. In addition, since you are the "eyes and ears" of the Bureau of Ships, you should take it upon yourself to bring attention to any special problems that you consider important. Since the Navy is one of the largest individual users of clocks in the world, you will have the opportunity of gathering a tremendous amount of information on performance which will be very useful to the Bureau.

ESCAPEMENT OPERATIONS

Skill Levels: Operations 1 through 25 and 30 through 41—Watchmaker, Junior Grade

Operations 26 through 29 plus supervision—Watchmaker, Senior Grade

Before proceeding with the escapement operations, first refer to the route ticket accompanying the escapement parts. This route ticket will make recommendations which are to be considered in addition to the procedure which is outlined in the following paragraphs. As each recommendation is followed, initial it to indicate that the work has been done.

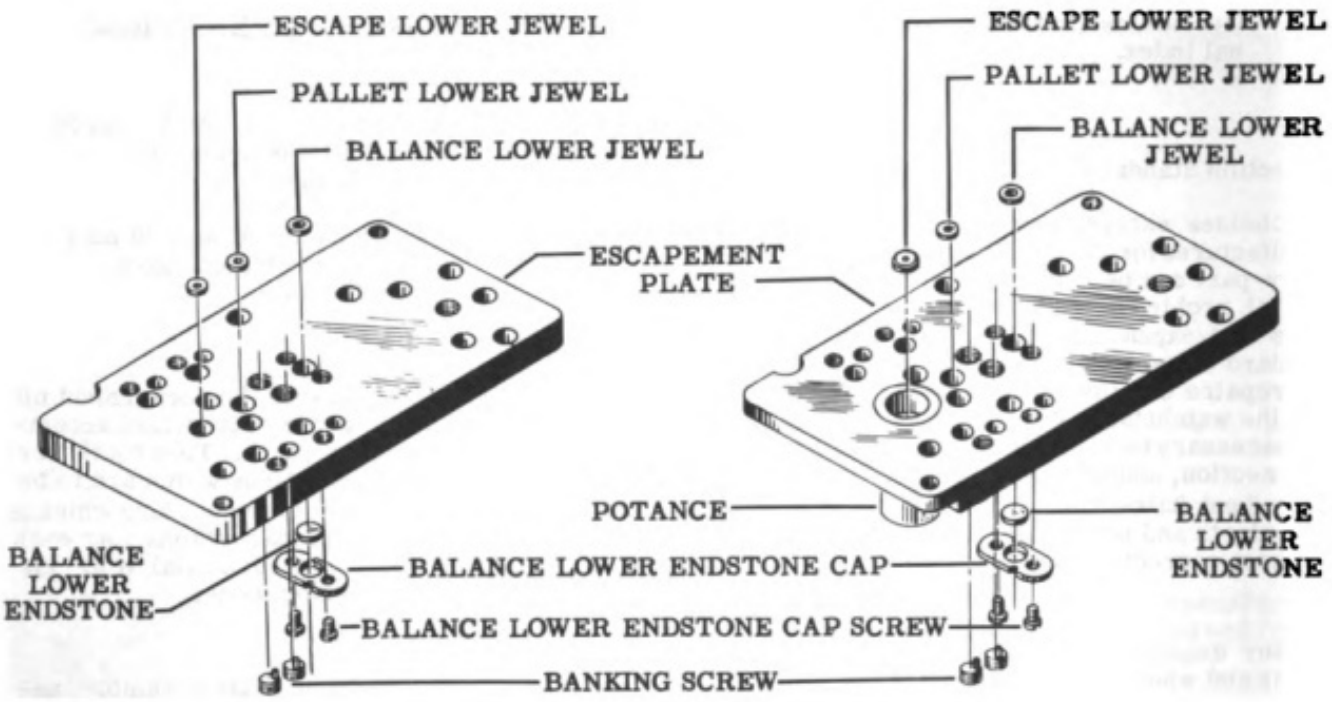
1. From the escapement plate assembly, unscrew the two balance lower endstone cap screws and remove the balance lower endstone cap. Refer to Fig. 45 for the positions of these parts.

2. Clean off the endstone with a buff stick dampened with the cleaner specified in "Timepiece Cleaning" as indexed in the Control Manual and examine it for pits, chips, cracks or breakage. If the endstone is defective, it should be replaced as described in "Special Operations." See the Control Manual index.

3. Clean off the escapement plate with a buff stick. See "Timepiece Cleaning" in the Control Manual in order to check the recommended technique.

4. Peg out the balance lower, escape lower and pallet lower jewels from both sides with clean, soft pegwood. See "Timepiece Cleaning" in the Control Manual to check the recommended technique. See Fig. 45 for the locations of these parts. Blow out the holes with an air blast. Check the hole jewels for chips, cracks, breakage or possible wear. Chipped or worn hole jewels will usually be noticeably out-of-round. If any of the hole jewels are defective, they should be replaced as described in "Special Operations." See the Control Manual.

5. Check the banking screws with tweezers to see that they are not loose. If they are loose, remove, spread the slot and replace.



12E MOVEMENT ESCAPEMENT **17E MOVEMENT ESCAPEMENT**

Figure 45

6. Replace the balance lower endstone cap and lubricate—see "Timepiece Lubrication" as referenced in the Control Manual index.

7. Place the escapement plate on the work block. If there is a potance, as in the escapement for the Chelsea No. 17E movement, see that it extends over the side or down into a hole in the work block.

8. Examine the escape wheel with a high-powered eyeglass, checking for bent or scored pivots and worn escape teeth. If any defect is noted, discard the escape wheel and replace with a new one.

9. Put the escape wheel in place and mount the escape bridge with the two escape bridge screws. See Fig. 46 for the positions of the parts.

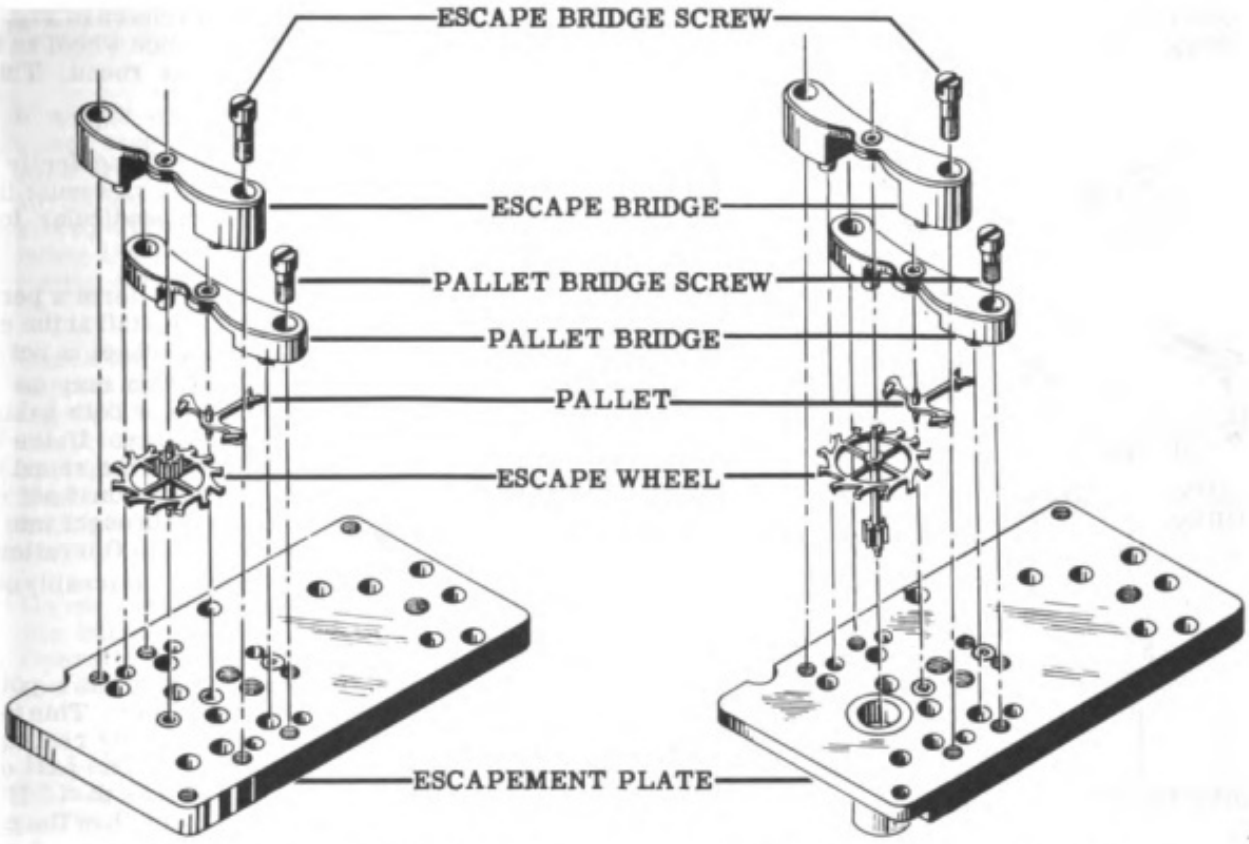
10. Check the sideshake and endshake of the escape wheel with reference to "Clock Escapement Assembly Adjustment Standards." See the Control Manual index. To make any sideshake or endshake adjustments, refer to "Special Operations" in the Control Manual.

11. Examine the pallet for chipped, loose or out-of-line stones. Check the pallet pivots for scoring or bending. Check the guard pin for proper fit and alignment. Loose or chipped stones may be properly re-set or replaced by the use of pallet warmers and thread shellac. See Fig. 47. Defective pivots should be corrected by driving out the pallet arbor and replacing it with a new one.

    No other repairs to the pallet are recommended—if they are required, the entire pallet assembly should be replaced.

12. Put the pallet in position and mount the pallet bridge with the two pallet bridge screws. See Fig. 46 for the position of these parts. Check the sideshake and endshake, using the standards listed in "Clock Escapement Assembly Adjustment Standards" as referenced in the Control Manual index. To make any sideshake or endshake adjustments, refer to "Special Clock Escapement Repair Operations" in the Control Manual.

13. Remove the hairspring assembly from the balance assembly by using the special hairspring removing tool (Tool No. 21A) to pry under and pull off the collet. For details see Fig. 48 and "Special Operations." See



12E MOVEMENT ESCAPEMENT 17E MOVEMENT ESCAPEMENT

Figure 46

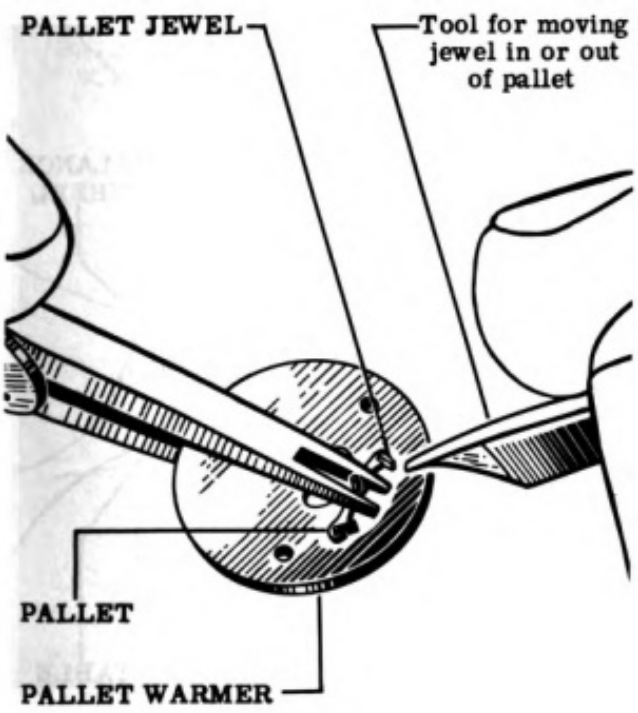


Figure 47

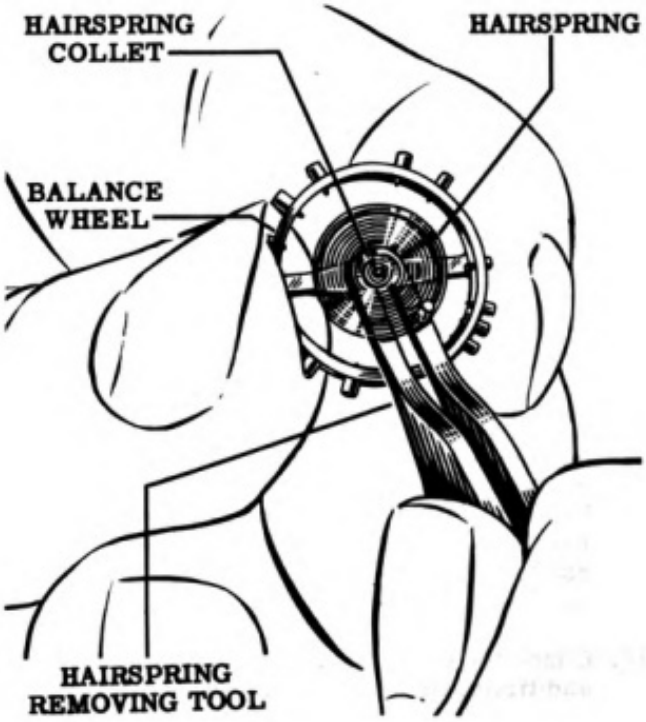


Figure 48

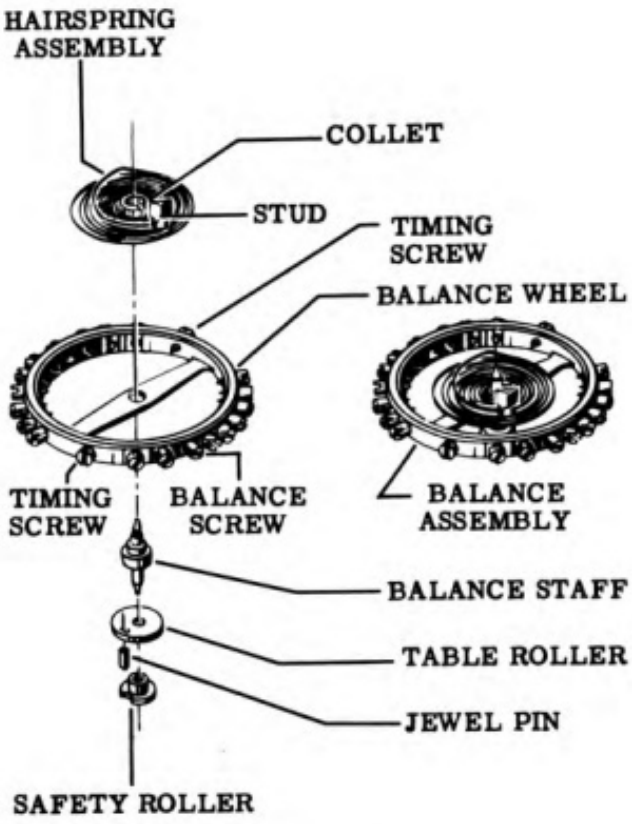


Figure 49

Fig. 49 for identification of the various balance components.

14. Check the jewel pin on the table roller for cracks, chips, breakage, tightness and proper alignment. Check the safety roller to see that it is tight. If either the roller or roller table is loose, replace the loose roller with a new one. Remove and replace the rollers, using standard watchmaker's tools. For details refer to "Special Operations." It is not recommended that the roller hole be closed and reamed out for a tight fit since there is extremely little tolerance for eccentricity.

15. Check the balance pivots for scoring or bending out of line. If this condition exists, replace the balance staff as described in "Special Operations." See the Control Manual index. Do not attempt to repair a damaged pivot. Instead replace the balance staff.

16. Check the tightness of the balance screws and timing screws. If a screw is damaged, try a new screw. If the threads are stripped in the balance wheel, replace the entire balance wheel.

17. Using a truing caliper as shown in Fig. 50, check to see that the balance wheel is true in the flat and true in the round. This means that:

    A. The balance rim must be perfectly flat, and all portions of the rim must lie in a plane which is perpendicular to the balance staff.

    B. The balance rim must form a perfect circle with the balance staff at the exact center. If the balance wheel is not true in the flat, this condition may be corrected by bending one or both balance arms the required amount. If the balance wheel is not true in the round by a slight amount, this condition is not serious if the wheel can be brought into perfect poise as described in Operation 18. If the balance wheel is noticeably out of round, replace it.

18. Check the balance for poise on a poising stand or with a poising caliper. This means that, when the balance is freely resting on its pivots, it should show that no part of its rim is heavier than any other part. If any screw is apparently heavier than the opposite screw, carefully cut out the slot of the heavy screw with a saw or file or undercut

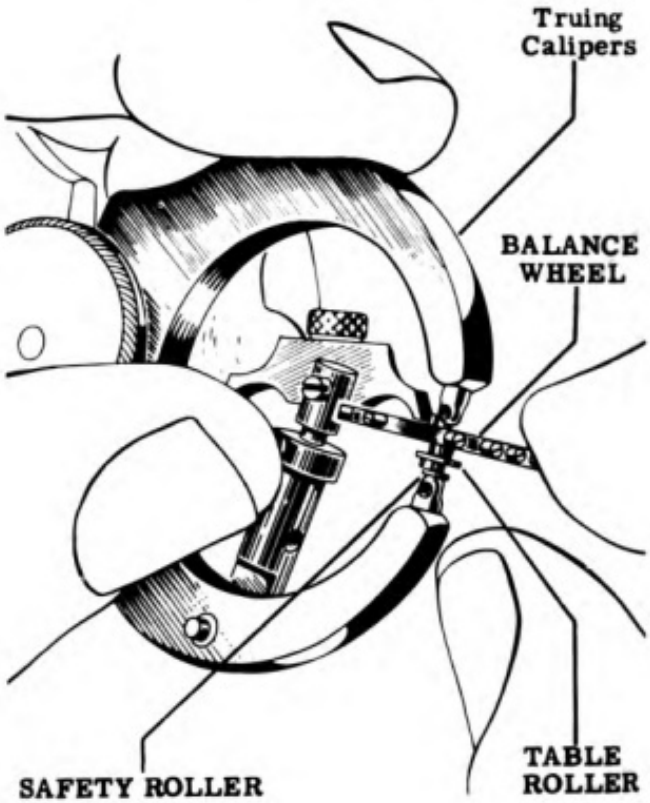


Figure 50

the screw head with an undercutter as shown in Fig. 51.

19. If weight must be added to the balance wheel, use a washer under the light balance screw. Radical change in weight of any of the balance screws is to be avoided, since, afterward, it may not be possible to bring the balance to proper time with the timing screw.

20. Check the shape of the hairspring. Minor corrections in shape may be made by bending with a pair of fine tweezers. Do not attempt to repair major distortions of the hairspring, and do not attempt to replace the stud or collet. If necessary, replace the entire hairspring assembly with a new one.

21. Do not replace the hairspring assembly on the balance wheel. This will be done in Operation 31 after the process of matching the escapement (Operations 26 through 29).

Figure 51

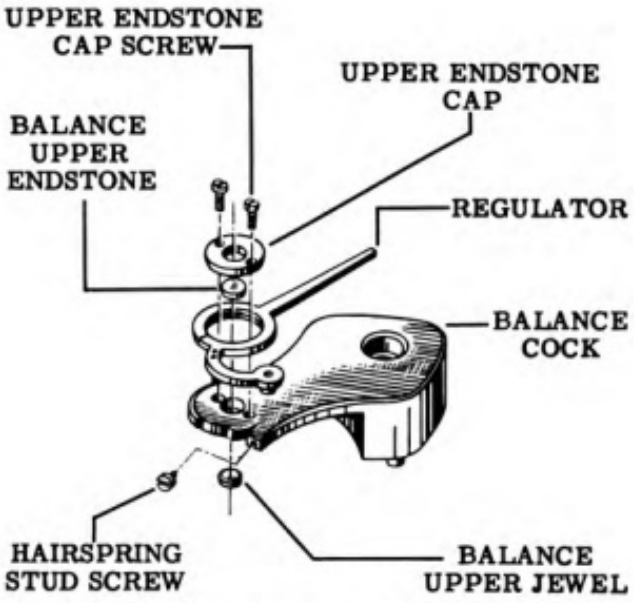


Figure 52

22. Remove the balance upper endstone cap from the balance cock by unscrewing the two cap screws. See Fig. 52. Peg out the balance hole jewel and check it for cracks, breakage or possible wear. Check the endstone. See "Special Operations" for details if it is necessary to replace the balance hole jewel. Replace the endstone cap and mount it in position with its two screws.

23. Place the balance wheel in position (without the hairspring) and mount the balance cock with the balance cock screw.

24. Check the sideshake and endshake of the balance staff. Refer to the standards listed in "Clock Escapement Assembly Adjustment Standards" as listed in the index of the Control Manual. To make any adjustments refer to "Special Clock Escapement Repair Operations." See the Control Manual index.

25. Check the position of the roller jewel pin. It should be perpendicular to the roller and centered in the crescent of the safety roller. In no position should the bottom of the jewel pin rub against anything.

NOTE

The following operations (Operations 26 through 29) involve checking and adjusting the matching of the various components of the escapement to each other. These checks and adjustments call for the knowledge and skill of a Watchmaker, Senior Grade, and

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should be made only by fully qualified personnel. Since these adjustments are very well understood by skilled watchmakers and since they are performed in a manner similar to that employed with any high grade watch, only a brief outline is presented here.

It is recommended that these adjustments be made with the escapement mounted on a movement in order to provide a power source, although some skilled craftsmen may very well make them without a power source.

MATCHING THE ESCAPEMENT

Skill Level: Watchmaker, Senior Grade

26. Before making any checks or adjustments, examine the operation of the escapement. Read the route ticket for the escapement to see what notations appear there. The predisassembly inspector may have made some recommendations concerning escapement banking and matching adjustments. Every escapement has been carefully banked and matched by the factory and by any previous repair activity, so readjustment is usually necessary only when the escapement has met with an accident or careless handling. Give consideration to these points before adjusting the escapement as outlined in Operations 27, 28 and 29.

27. Remove the balance cock and the balance wheel. Carefully move the pallet fork back and forth between the banking pins. Observe the action of the pallet stones in relation to the escape wheel teeth. Check the "lock," the "drop" and the positioning of the banking pins. Make any adjustments in the banking pins necessary to make the fork "Banked to the Drop."

28. Put the balance (without the hairspring) in position and mount the balance cock with its screw. With the finger, roll the balance wheel back and forth through an arc which enables the roller jewel pin to engage the slot in the pallet. In this manner, move the pallet from side to side so that the escape wheel is allowed to turn. Observe the operation of the escapement.

29. Check and adjust if necessary: (a) "Lock," (b) "Drop," (c) "Jewel Pin Shake" and (d) "Guard Pin Shake." Readjust the banking pins to allow the proper amount of "Slide." Specifications for these adjustments will be found in "Clock Escapement Adjustment Standards" as referenced in the Control Manual index. Remember that these standards are only for the purpose of guidance and that it is the responsibility of the operator to put the escapement in its best running condition. When the adjustments are completed, remove the escapement from the movement for the remaining operations.

NOTE

The following operations may be performed by a Watchmaker, Junior Grade.

ESCAPEMENT OPERATIONS (continued)

Skill Level: Watchmaker, Junior Grade

30. Remove the balance cock by unscrewing the balance cock screw. Remove the balance wheel. Oil the balance upper and the balance lower jewels. See the Control Manual.

31. Replace the hairspring on the balance wheel, using a staking stand. For details see "Special Operations."

32. Place the balance wheel on the beat adjusting block (Tool No. 22A) and turn the collet with the beat adjusting tool (Tool No. 23A) so that the stud is directly over the right balance arm when the roller jewel is facing toward you. See Fig. 53.

33. Put the balance in place and mount the balance cock with the balance cock screw. See Fig. 54. Place the hairspring stud into the notch in the balance cock. Fasten down the stud with the hairspring stud screw as shown in Fig. 55.

34. Check to see that the escapement is in beat. This means that the collet should be in such a position that the balance roller jewel pin is on the center of the pallet when the balance is at rest. In other words, there should be a straight line from the center of the pallet pivot through the pallet center line, through the roller jewel pin and to the center of the balance pivot when there is no tension on the hairspring.

35. Make any necessary beat adjustments by moving the hairspring collet on the balance staff by means of a beat tool placed in the collet slot.

36. Oil the escape wheel and the pallet hole jewels and oil the pallet stones. See the Control Manual.

37. Check the condition of the regulator pins on the regulator. If they are badly bent or broken, they may be replaced by use of a staking stand.

38. Carefully slip the regulator into position so that the regulator pins straddle the hairspring overcoil.

39. Check the hairspring to see that it is level and centered. Corrections in level and centering are made by bending the first turn of the collet end of the hairspring. The overcoil should be made parallel to the hairspring by bending the hairspring between the

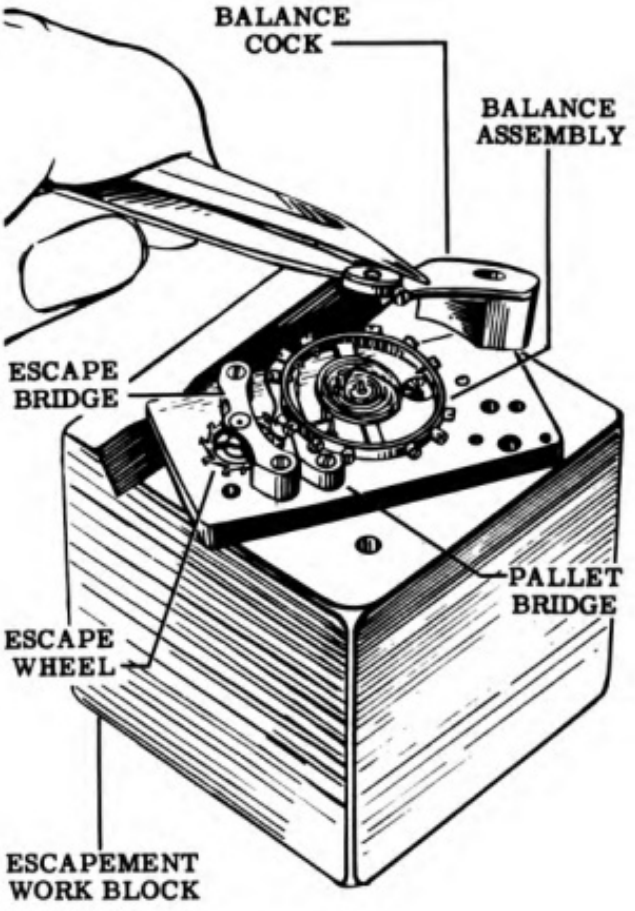

Figure 54

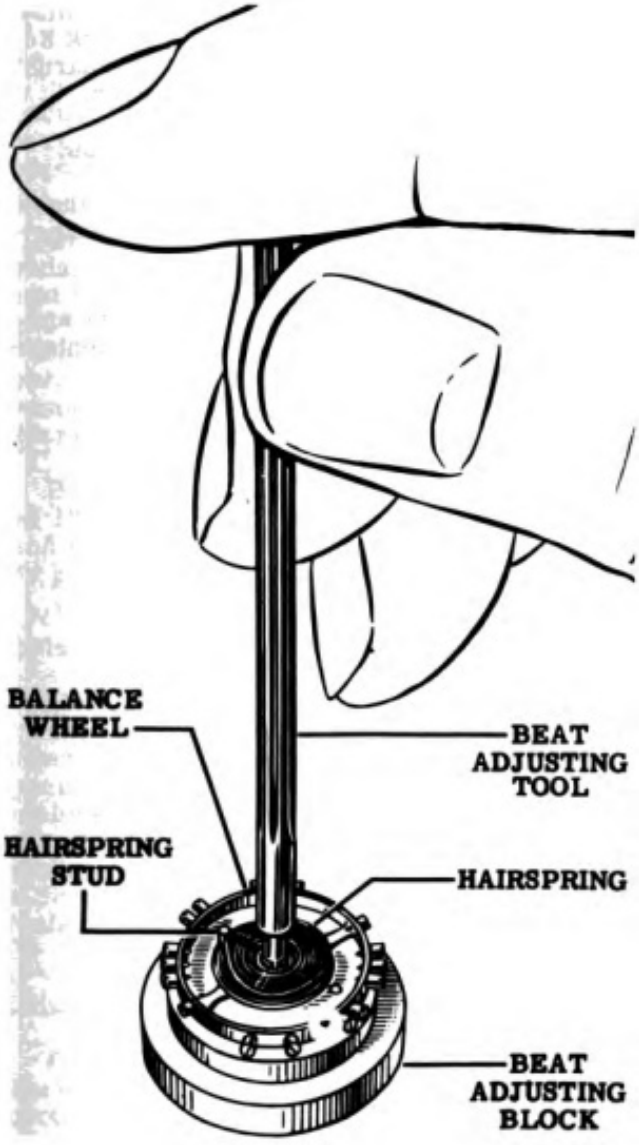

Figure 53.

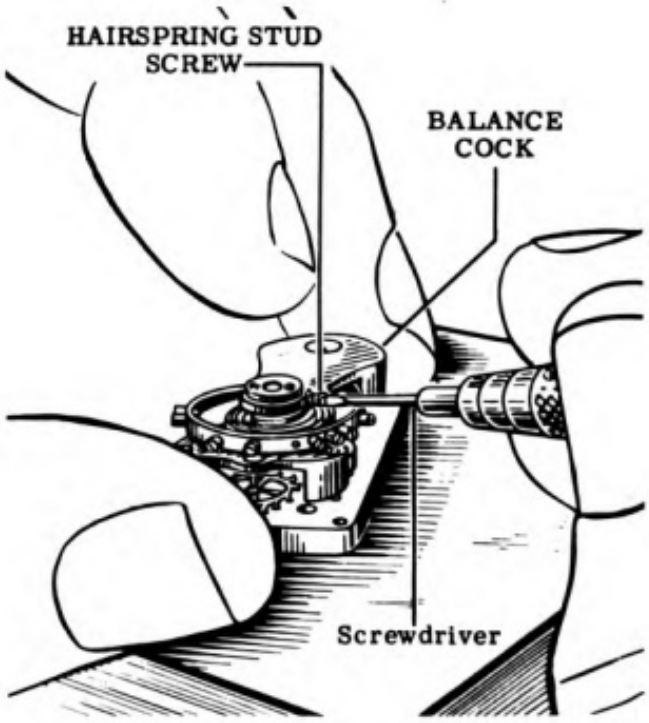

Figure 55

stud and the point where the regulator pins reach their closest point to the stud (extreme slow position).

40. Oscillate the balance wheel and observe the action of the hairspring between the regulator pins to check the circling. The regulator pins should be closed just enough so that they just barely touch the hairspring in all positions, slow or fast, and the touch should be equal on both regulator pins. When the balance wheel is at rest, the hairspring should not touch either regulator pin and should be centered between the regulator pins in all positions of the regulator. Correct the shape of the hairspring if necessary.

41. Recheck the route ticket to see that all the recommendations pertaining to escapement operations have been initialed to indicate that the work has been done. Pass the escapement on to the bench inspector.

BENCH INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

The purpose of the bench inspection is to assure that a mechanically perfect escapement is ready for installation into the movement for final adjustment and testing. It is the job of the bench inspector to locate any defects and have them corrected before the escapement is mounted onto the movement. Defective escapements cause clocks to fail in passing their final performance test or, much worse, cause an early failure in the Fleet.

1. Check to see that all screws are tight.

2. Check for clearance of all parts.

3. Check all endshakes and sideshakes listed in "Clock Escapement Assembly Adjustment Standards" as listed in the Control Manual index.

4. Check for oil on all bearings.

5. Place the escapement on a movement and check the overall operation of the escapement with special regard to the lock, slide, drop, etc. adjustments listed in "Clock Escapement Assembly Adjustment Standards" as listed in the Control Manual index.

6. Inspect the escapement for cleanliness.

7. Check the route ticket to see that all the recommendations with regard to the escapement have been carried out.

8. Place the escapement in its container and attach the route ticket. Return the container to the Instrument Control Center.

SECTION V

REASSEMBLY PROCEDURE

Skill Levels: Movement Reassembly, Dialing and Casing Operations—Mechanical Instrument Assembler, Senior Grade

Bench Inspection Operations—Watchmaker, Senior Grade

This section contains instructions covering the recommended procedure for reassembling Chelsea Mechanical, Boat and Deck Clocks. All parts used in reassembly have previously been cleaned, inspected and repaired or replaced and the result of reassembly, for all practical purposes, will be equivalent to a brand new movement.

Chelsea parts have proved rugged and dependable in the service of the U. S. Navy, but it must be stressed that they may easily be damaged in the hands of those unskilled in the care of fine clocks. For this reason, all reassembly operations are to be performed only by qualified personnel and only by following the procedure described in the text.

Because of certain differences in the Chelsea 12E and 17E movements, the reassembly of each movement is described separately to avoid any possible confusion.

Tools

Most of the tools required are those included in every watchmaker's repair kit and are mentioned in the text as they are required. Where special service tools are needed, or tools are employed for purposes which are not immediately obvious, they are explicitly designated by number in the text. They are further identified in Section VIII of this manual-"Special Service Tools and Testing Devices."

Endshakes and Sideshakes

During reassembly it will be necessary to check the endshake and sideshake of various pivots. The tolerances permissible are listed in "Clock Movement Assembly Adjustment Standards," which is the heading that appears in the Control Manual index. Procedures for correcting these endshakes and sideshakes, to bring them within the required limits, are described in "Special Timepiece Repair and Adjustment Operations" in the Control Manual. It is to these two headings that reference is made in this text when the "Control Manual" is mentioned in regard to endshakes and sideshakes.

Lubrication

The points to be lubricated are mentioned in the text, but specific instructions as to oiling techniques, precautions and the type of oil to be used are included in "Timepiece Lubrication" as referenced in the Control Manual index. It is to this heading that reference is made when the "Control Manual" is mentioned in regard to lubrication.

REASSEMBLY OPERATIONS CHELSEA MODEL NO. 12E

Skill Levels: Movement Reassembly, Dialing and Casing Operations—Mechanical Instrument Assembler, Senior Grade

Bench Inspection Operations—Watchmaker, Senior Grade

Before proceeding with the movement reassembly operations, first refer to the route ticket accompanying the movement parts. This route ticket will make recommendations concerning movement reassembly which are to be considered in addition to the procedures outlined in the following paragraphs. As each recommendation is followed, initial it to indicate that the work has been done.

MOVEMENT REASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

1. Place the front plate on the movement work block (Tool No. 1A) with the pillars facing up. Already mounted on the front plate should be the pillars, the thrust spring, the click, the click spring, the regulator block and the regulator index wheel, unless these parts have been removed for replacement. Replace any of these parts that are missing. Refer to Fig. 56 and also to Fig. 94 in Section VII, for the proper location of these parts.

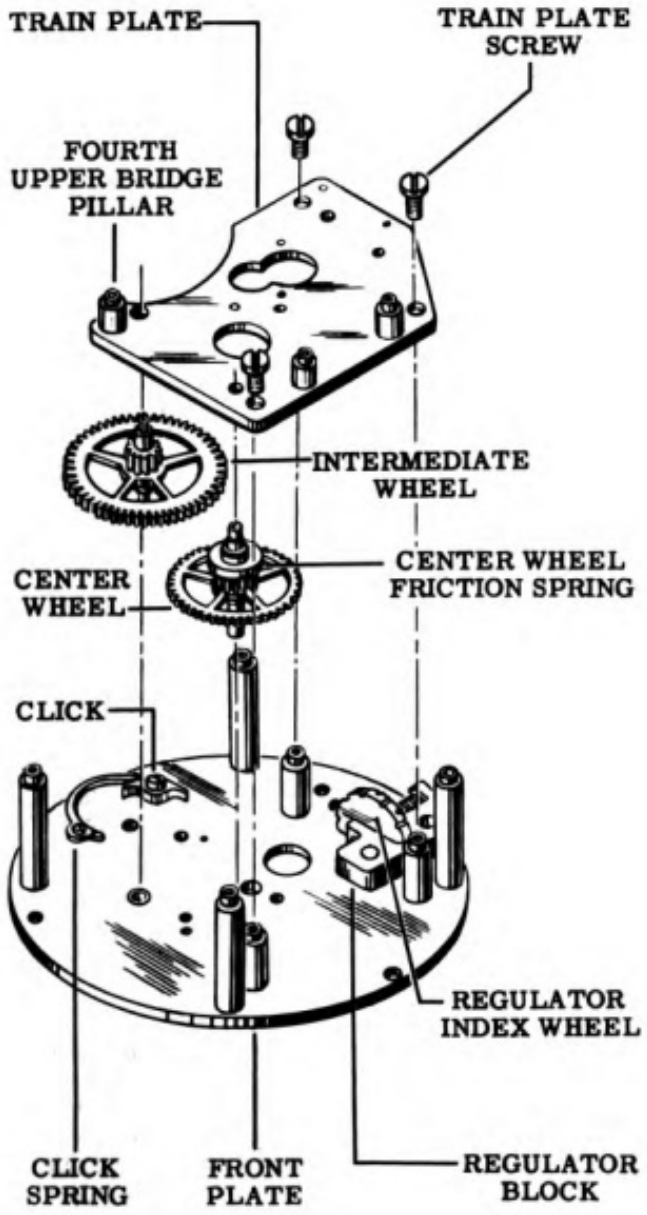

Figure 56

2. Check to see that the pillars are tight. Check the click spring for sufficient pressure on the click to insure a positive engagement between the click and the barrel ratchet wheel. If necessary, bend in the click spring to increase the force on the click.

3. Oil the corners of the center wheel friction spring. For the type of oil to be used, see "Timepiece Lubrication" as indexed in the Control Manual.

4. Check the center and intermediate wheels for uprightness in their pivot holes by testing them for equal tilt in four directions. Corrective procedures are given in "Special Timepiece Repair and Adjustment Operations." See the Control Manual index.

5. Put the center wheel and intermediate wheel in place. Put on the train plate (see Figs. 56 and 57) and fasten it down with the three train plate screws. Use the special collar (Tool No. 13A) on the end of an automatic

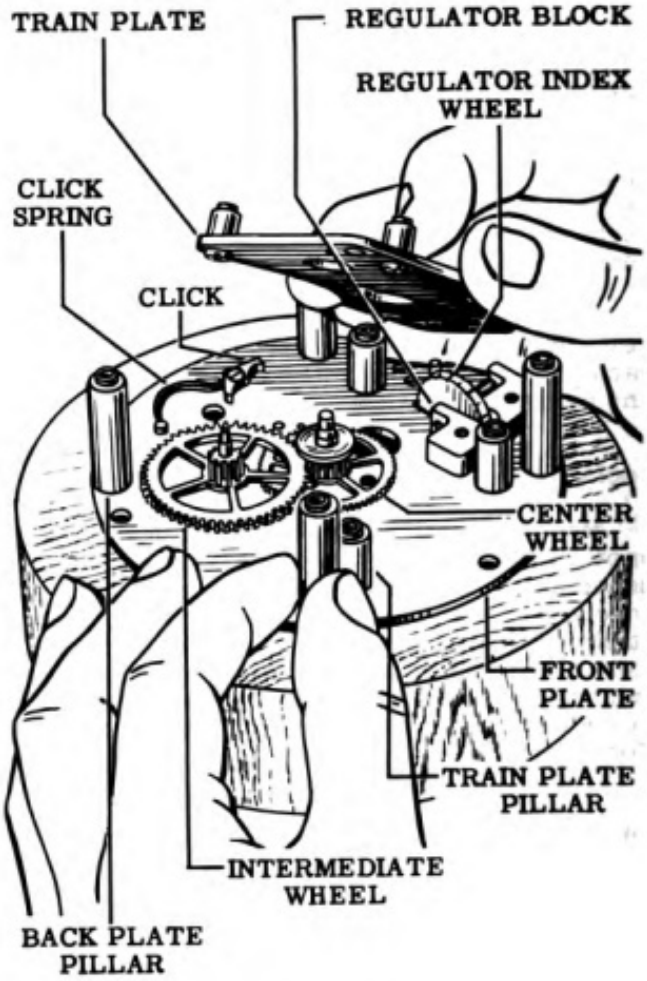

Figure 57

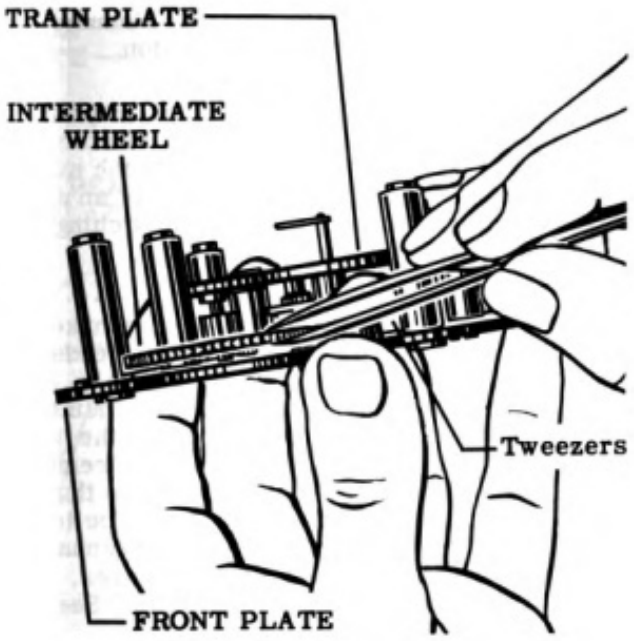

Figure 58

screwdriver to avoid scratching the plate and to speed up the work.

6. Check the freedom of the center and intermediate wheels in their pivot holes by spinning the intermediate wheel to see that there is no binding.

7. Check the endshake of the center and intermediate wheels. Fig. 58 shows the operation of checking the intermediate wheel endshake.

   Refer to "Clock Movement Assembly Adjustment Standards" as indexed in the Control Manual. If any adjustments are necessary, look up the procedures given in "Special Timepiece Repair and Adjustment Operations," also listed in the index of the Control Manual.

8. Oil the center wheel and the intermediate wheel upper pivots. See Fig. 59 and refer to "Clock Movement Lubrication" in the Control Manual.

9. Place the third wheel in position. See Fig. 60. Oil the staff of the fourth wheel (see

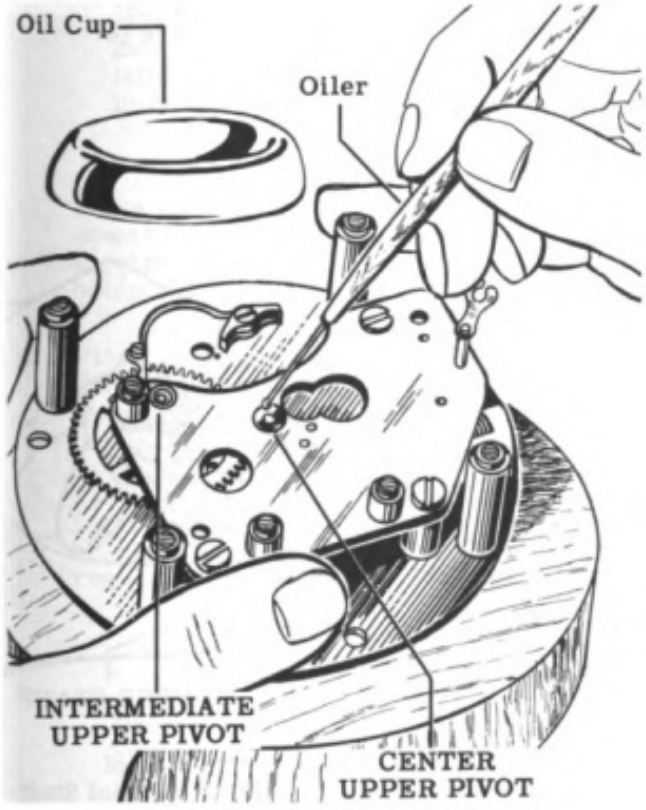

Figure 59

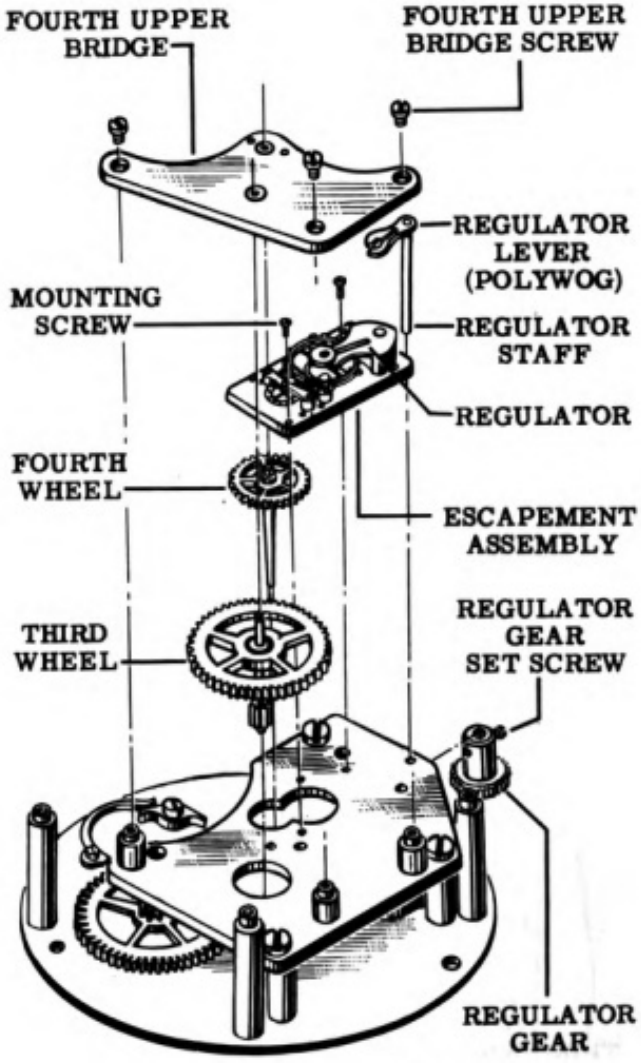

Figure 60

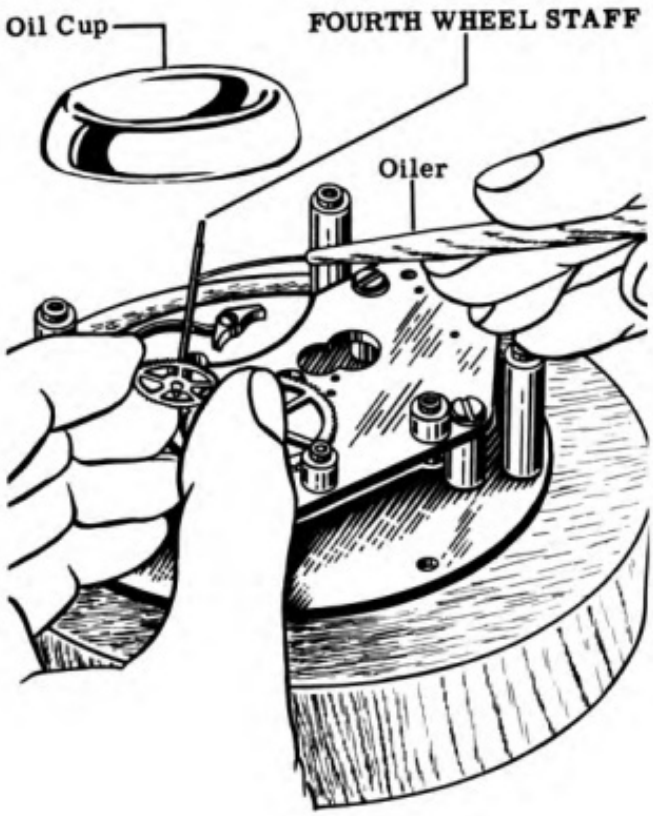

Figure 61

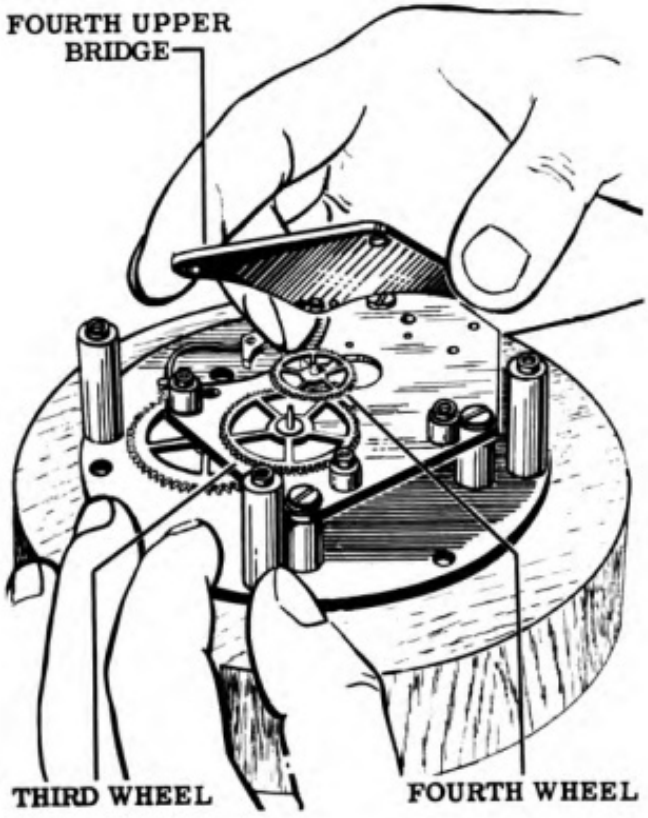

Figure 62

Fig. 61 and also the Control Manual) and place the fourth wheel in position.

10. Place the fourth upper bridge in position (see Fig. 62) and fasten it down with the three fourth upper bridge screws. Use the special collar (Tool No. 13A) on the end of an automatic screwdriver to avoid scratching the bridge and to speed up the work.

11. Check the endshakes and the sideshakes of the third and fourth wheels. The endshake of the fourth wheel must be taken by holding the center staff with the left thumbnail while testing the endshake with the right thumb, as shown in Fig. 63. This removes the endshake of the center wheel so that the endshake of the fourth wheel may be tested independently. See the Control Manual for standards and corrective measures. Oil the third and fourth upper pivots. See the Control Manual.

NOTE

At this time the escapement is mounted into the movement. However, due to the great ease of mounting this escapement, this step may be postponed until after the movement is completely assembled and oiled. This procedure may be required if there is

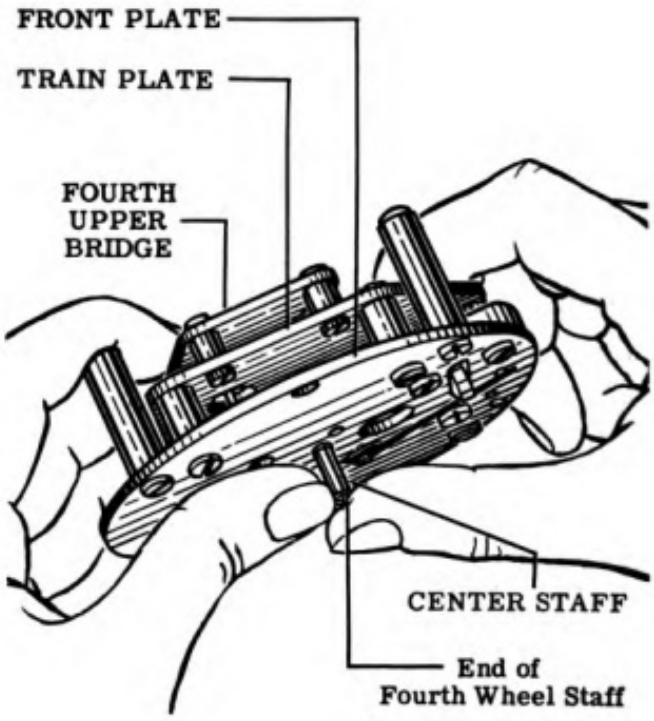

Figure 63

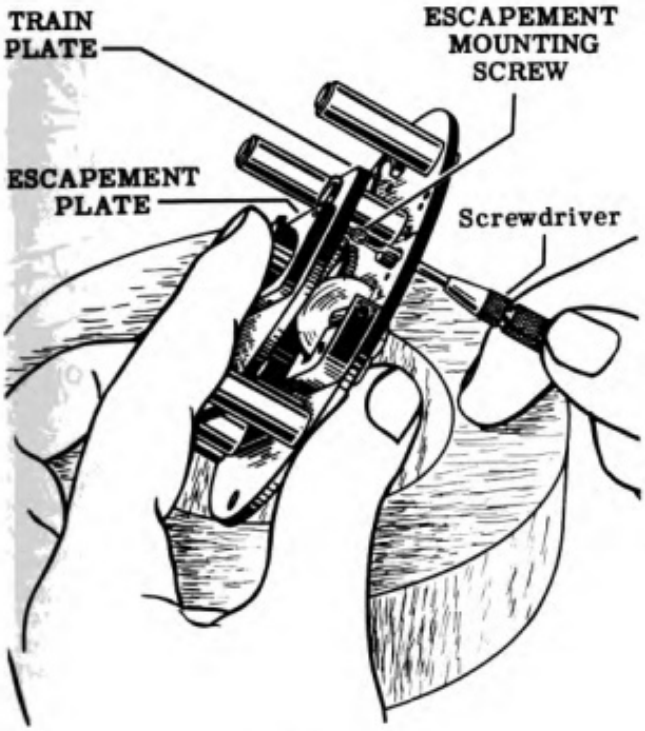

Figure 64

a great deal of escapement work to be done—in which case, movement assembly need not be delayed in waiting for the escapement. In either event, the regulator staff assembly must be put in before the back plate is mounted.

12. Place the escapement in position. Screw it down to the train plate with the two escapement mounting screws—working through the holes in the front plate as shown in Fig. 64.

13. Place the regulator gear in position with the stop stud exactly in the center of the slot. Place the regulator staff assembly in place through the regulator gear, and hold aside the thrust spring so that the staff end can go through its hole in the front plate. The polywog should grasp the regulator in its mid-position. Tighten the regulator gear set screw. Refer to Fig. 60.

NOTE

Operations 14 through 17 are not necessarily performed at this time. Mainspring barrels may be assembled by a person other than the movement assembler and at any time before Operation 18.

14. Take a new mainspring and shape the inside end so that it will match the shape of the barrel arbor for about one-half turn around the arbor. Use the special mainspring end shaping pliers, Tool No. 8A. With the same special pliers, put a slight bend in the extreme outside end of the mainspring so that it will engage the hook on the inside of the barrel.

15. Wind the mainspring into the barrel using the special mainspring winder, Tool No. 9A. Oil the mainspring. See the Control Manual. For the proper positions of the barrel components, see Fig. 65.

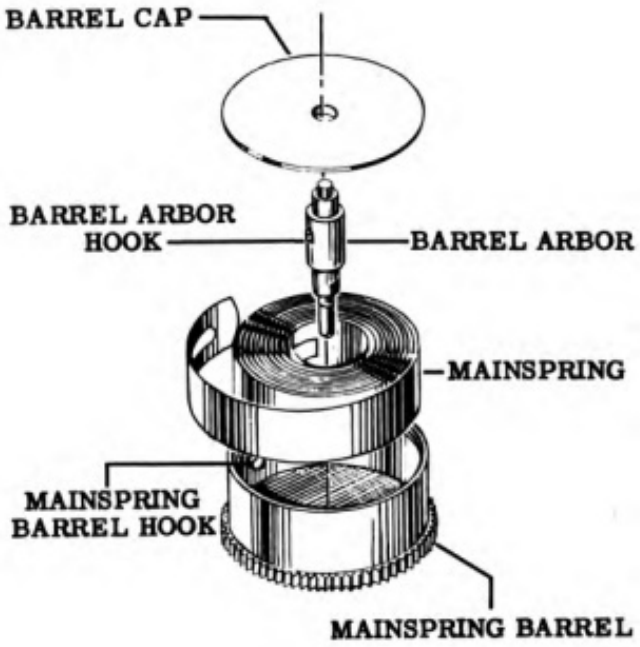

Figure 65

16. Insert the barrel arbor and engage it to the inside end of the mainspring. Place on the barrel cap and press it into position using the special barrel cap press, Tool No. 10A.

17. Check the endshake and the sideshake of the barrel arbor. Refer to the Control Manual.

18. Turn the barrel arbor several times to see that the barrel hook and arbor hook engage the mainspring inside the barrel. Oil both mainspring arbor bearings. See the Control Manual.

19. Place the ratchet wheel on the barrel arbor. Mount the barrel into its hole in the front plate. Check to see that the click properly engages the ratchet wheel.

20. Place the back plate in position (see Fig. 66) and fasten it down with the four back plate mounting screws. Use the special collar (Tool No. 13A) on the end of an automatic screwdriver to avoid scratching the plate and to speed up the work.

21. Oil the barrel upper pivot and the fourth upper pivot as shown in Fig. 67. See "Timepiece Lubrication" as indexed in the Control Manual.

22. Turn the movement over so it is dial side up in the work block. Oil the center lower, the barrel lower, the third lower and the intermediate lower pivots. These points are shown in Fig. 68. See the Control Manual.

23. Press on the cannon pinion with the special cannon pinion pusher (Tool No. 19A) as shown in Fig. 69 and indicated in the "Special Service Tools" section.

24. Place the minute wheel in position and fasten it down with the minute wheel screw.

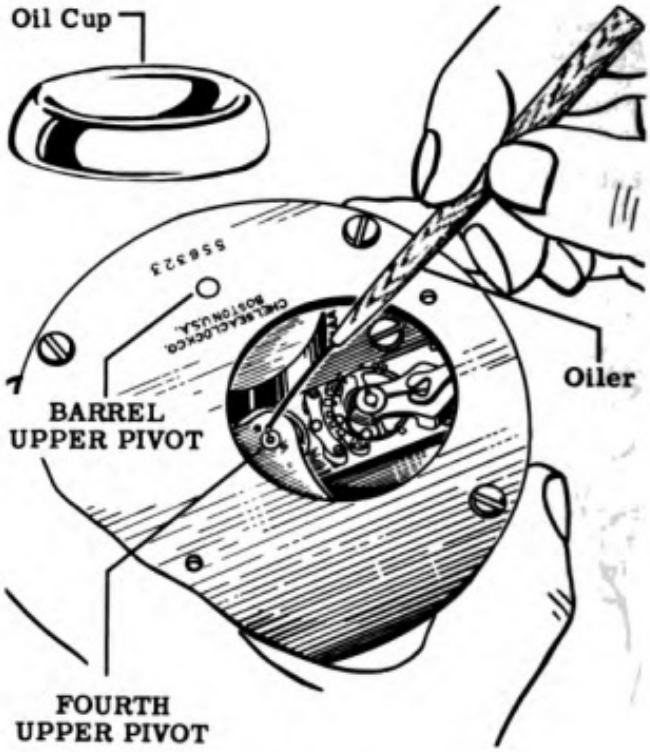

Figure 67

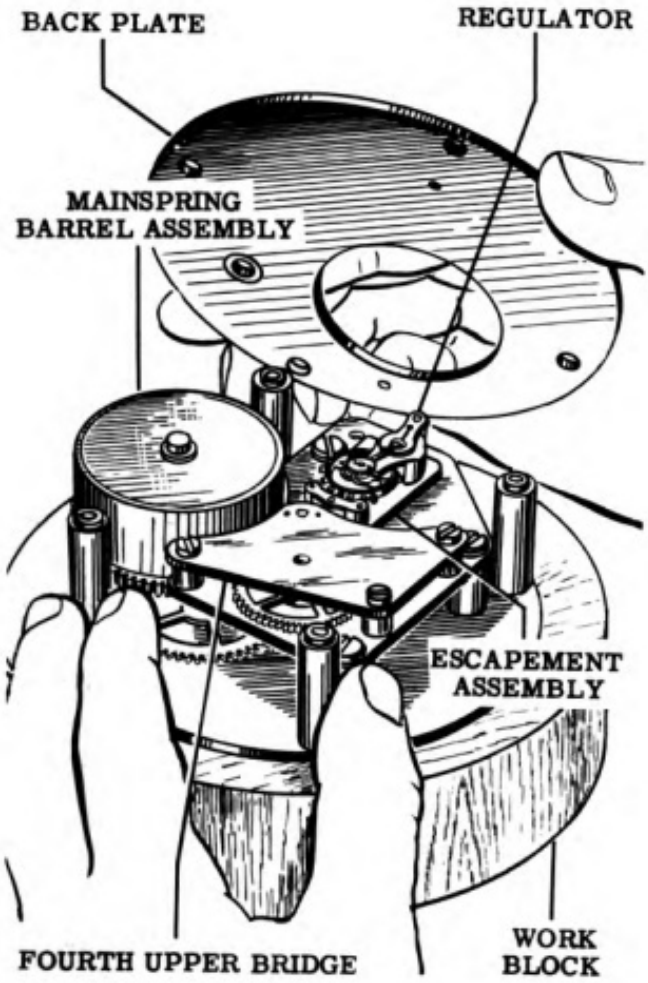

Figure 66

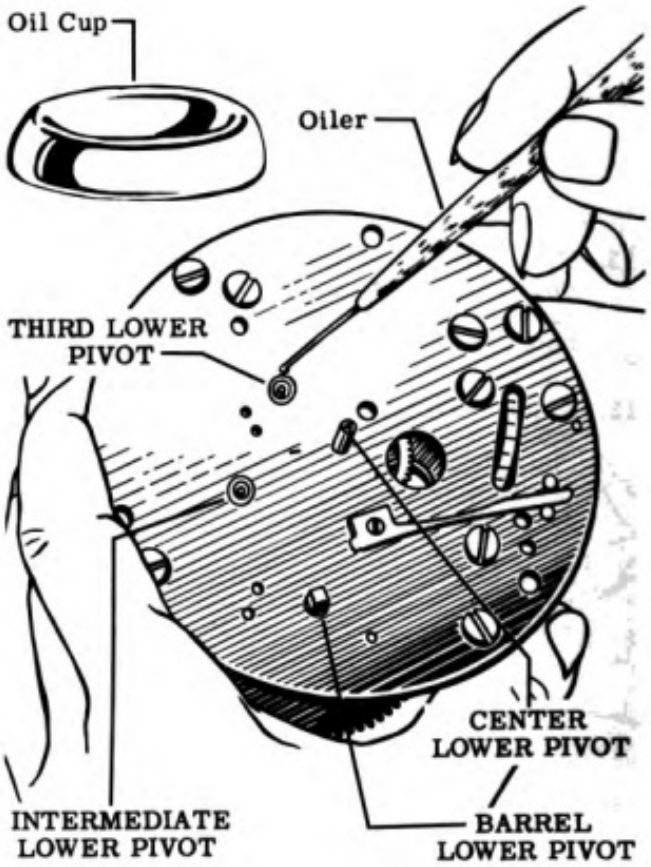

Figure 68

Put on the hour wheel. See Fig. 70 for the proper position of these parts.

25. Recheck the route ticket to see that all the recommendations pertaining to clock movement assembly have been initialed to indicate that the work has been done. Pass the movement on to the bench inspector.

BENCH INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

The purpose of the bench inspection is to assure that a mechanically perfect movement with a mechanically perfect escapement is ready for dialing, timing and performance testing. It is the job of the bench inspector to locate any defects and have them corrected before dialing, timing and performance testing. Defective movements cause clocks to fail in passing the performance test or, much worse, cause an early failure in the Fleet.

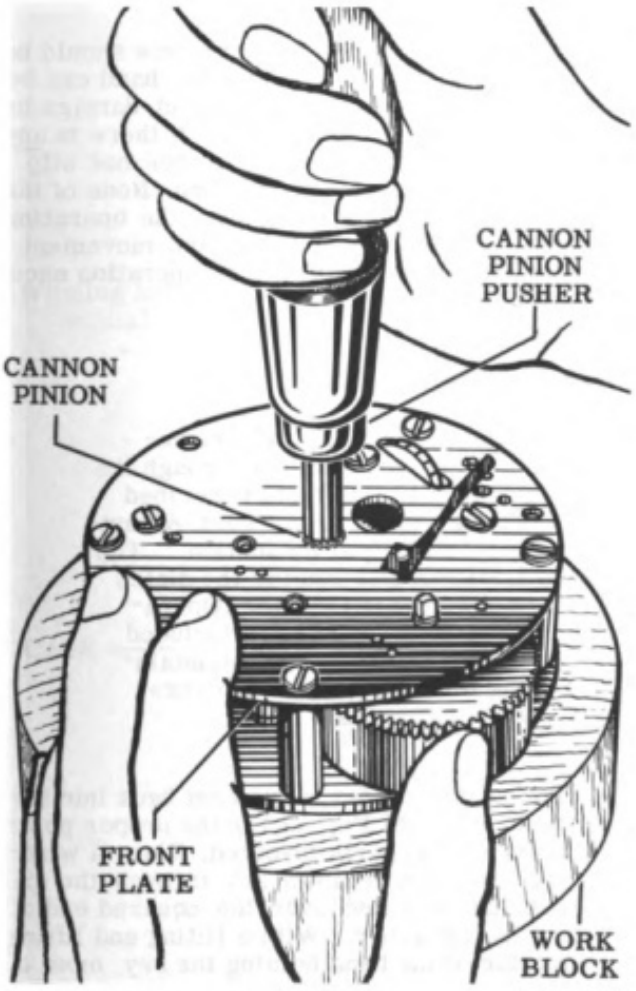

Figure 69

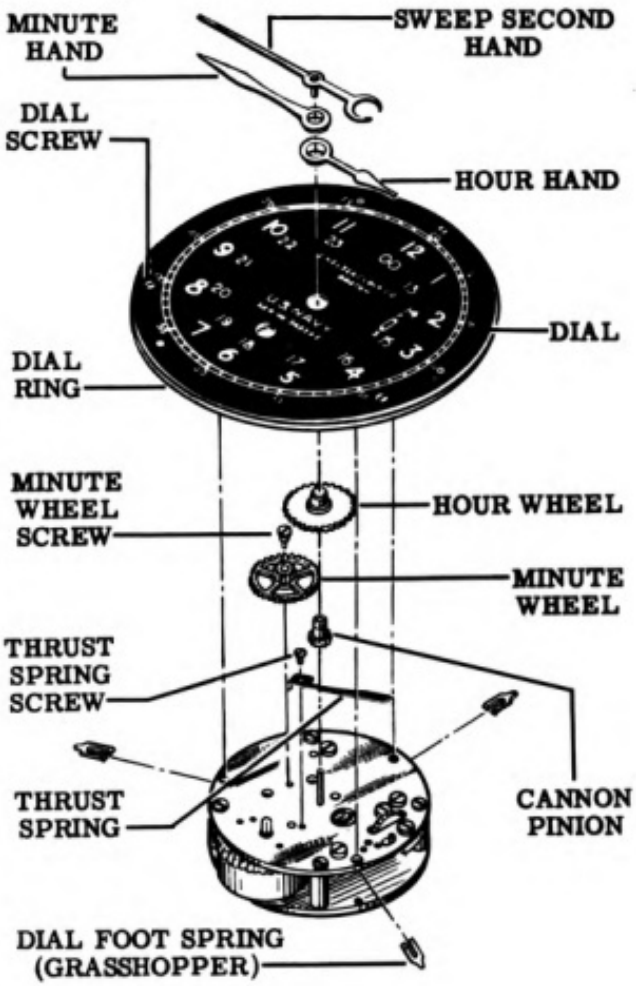

Figure 70

1. Check to see that all screws are tight.
2. Check for clearance of all parts.
3. Check all endshakes and sideshakes listed in "Clock Movement Assembly Adjustment Standards" as referenced in the Control Manual index.
4. Check for oil on all bearings.
5. Check for freedom of click.
6. Check for sufficient tension on click spring.
7. Check the operation of the regulating mechanism through its entire path by turning the regulator index wheel in both directions from stop to stop. There should be no backlash and no play of the regulator shaft in its slot. The regulator must not disengage from the regulator lever in any part of the cycle.

8. Check for clearance between the cannon pinion and the front plate.

9. With the mainspring full wound, the motion of the balance wheel should be at least 1-1/2 turns. With the mainspring wound 3-1/2 turns, the motion of the balance wheel should be at least 1-1/4 turns.

10. On Boat and Deck Clocks, check the operation of the mechanism for stopping and starting the balance wheel.

11. On Boat and Deck Clocks, check the operation of the hand setting mechanism.

12. Inspect the movement for cleanliness.

13. Check the route ticket to see that all the recommendations entered by the pre-disassembly inspector have been carried out.

14. Pass the checked movement on for dialing.

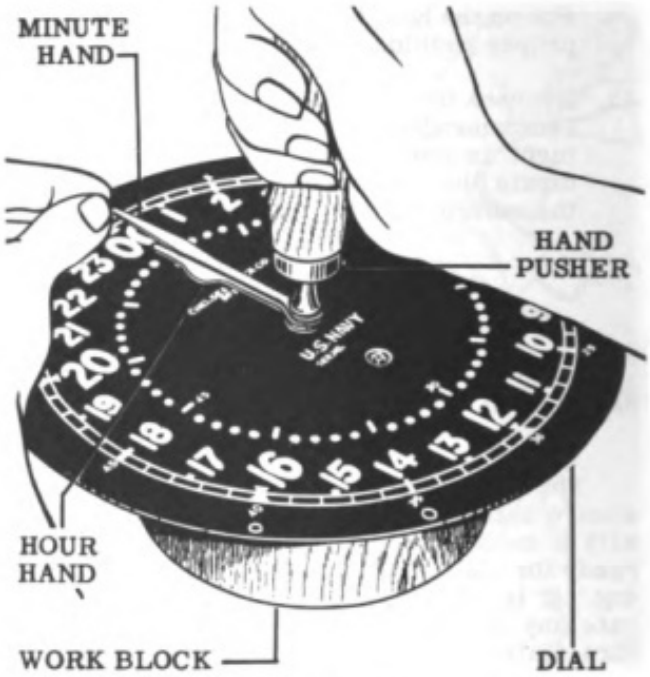

Figure 71

DIALING AND CASING OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

1. Place the assembled dial and dial ring in position so that the dial feet project downward through the holes in the front plate. Press a grasshopper onto each dial foot slot, keeping the grasshopper points facing away from the back of the front plate. Position the grasshoppers so that they firmly grasp the feet and no part of the grasshopper projects out from under the front plate. Refer to Fig. 70.

2. Replace the hour hand, the minute hand and the second hand, using hand pushers (Tool No. 20A) as shown in Fig. 71. Lift up on the hour hand to see that there is endshake between it and the minute hand. Also check to see that there is endshake between the second hand and the minute hand. If the hands are not completely free of each other, the movement will lose time or stop. Replace any defective hands or dial train parts which cause binding.

3. Set the clock to the correct time by moving the minute hand clockwise with the index finger. Check to see that the sweep second hand can be set clockwise or counterclockwise. This is done by rapidly but gently moving the end of the second hand in 10-second jumps all around the dial in both directions with the finger—there should be enough slip so that the second hand can be set in either direction without damage to the escapement in any way. If there is any sign that the second hand does not slip freely, use a new second hand. None of the hands should interfere with the operation of any of the others, and the movement should resume its normal operation once setting is completed.

NOTE

After Operation 3, the movement is normally put through the various timing tests described in the next section "Test, Adjustment and Final Inspection." The final steps of placing the dialed movement in the case (Operations 4 through 6) are included here for purposes of maintaining the continuity of the reassembly process.

4. To put the dialed movement back into the case, refer to Fig. 72 for the proper positions of the parts involved. Place a winding key or a letdown key through the dial winding hole and over the squared end of the barrel arbor. With a tilting and lifting motion of the hand holding the key, most of the weight of the dialed movement can be supported by the key. With the other hand supporting the rim of the dial, place the

dialed movement back into the case. Turn the dial so that the three dial mounting holes line up with the three mounting holes in the case rim.

5. Place the reflector ring in position on the dial so that the three holes around the reflector rim line up with the three holes around the outside of the dial. Screw down the reflector to the dial with the three reflector screws which also hold the dialed movement in the case.

6. Swing the bezel into position so that it covers up the dial and encloses the entire dialed movement inside the case. Tighten the case knob on the side of the bezel, sealing the case.

REASSEMBLY OPERATIONS CHELSEA MODEL NO. 17E

Skill Levels: Movement Reassembly, Dialing and Casing Operations—Mechanical Instrument Assembler, Senior Grade

Bench Inspection Operations—Watchmaker, Senior Grade

Before proceeding with the movement reassembly operations, first refer to the route ticket accompanying the movement parts. This route ticket will make recommendations concerning movement reassembly which are to be

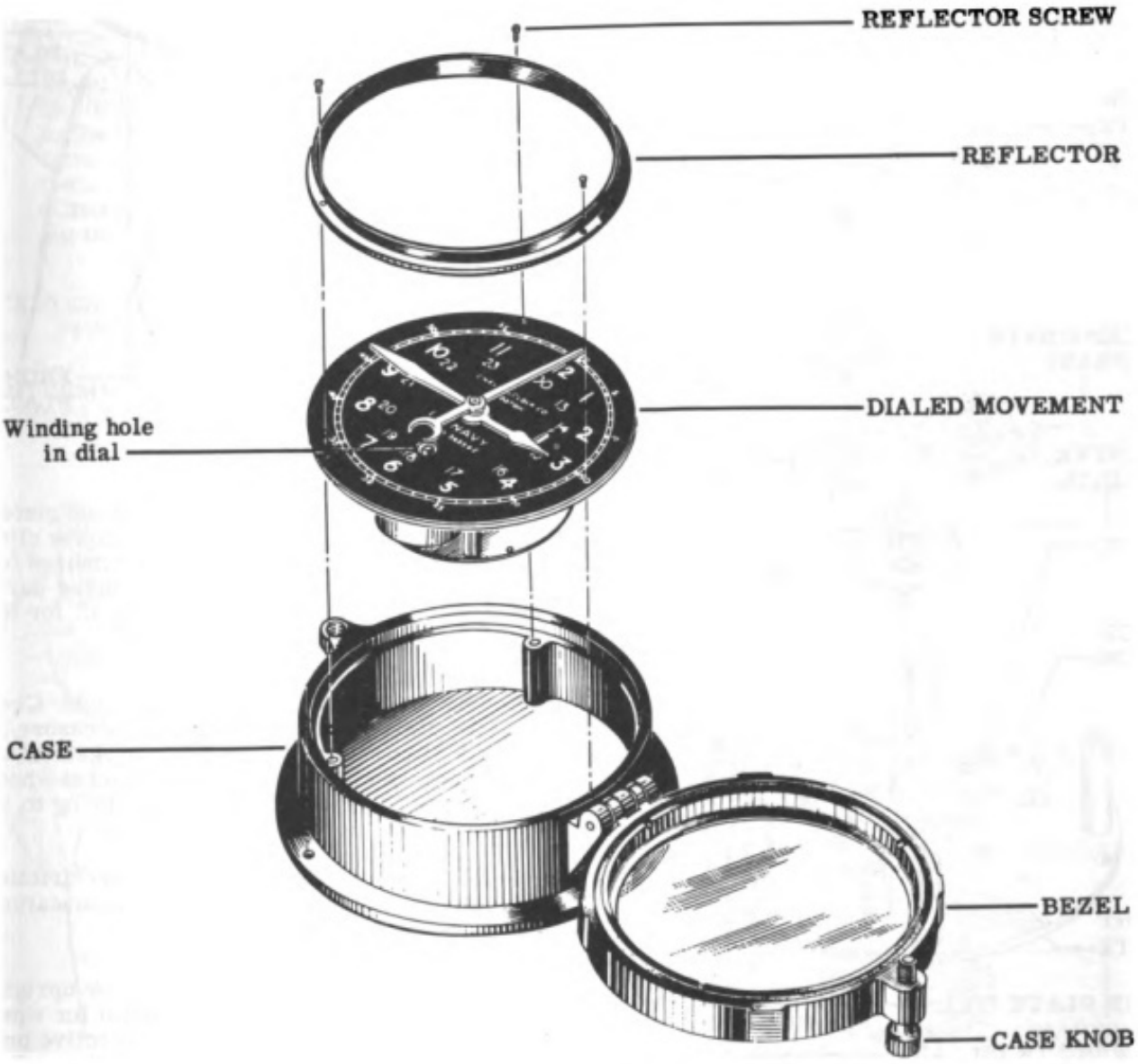

Figure 72

considered in addition to the procedures in the following paragraphs. As each recommendation is followed, initial it to indicate that the work has been done.

MOVEMENT REASSEMBLY OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

1. Place the front plate on the movement work block (Tool No. 1A) with the pillars facing up. Already mounted on the front plate should be the pillars, the click and the click spring, unless they have been removed for replacement. Replace any of these parts that are missing. Refer to Fig. 73 for the proper positions of these parts.

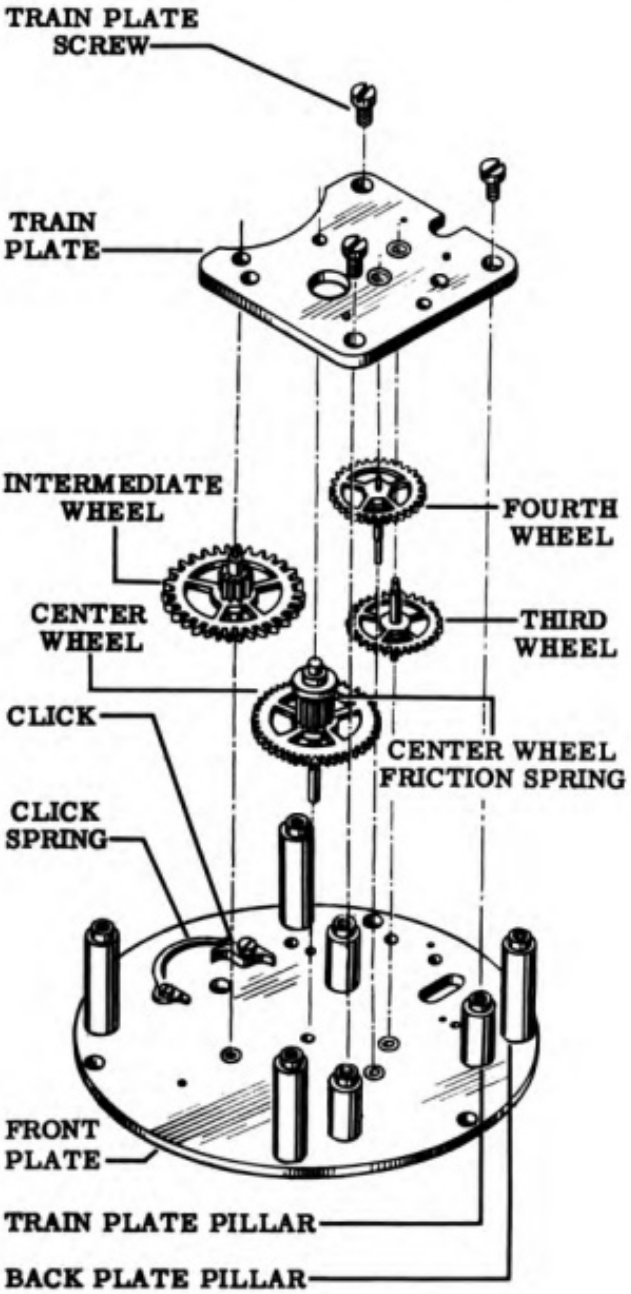

Figure 73

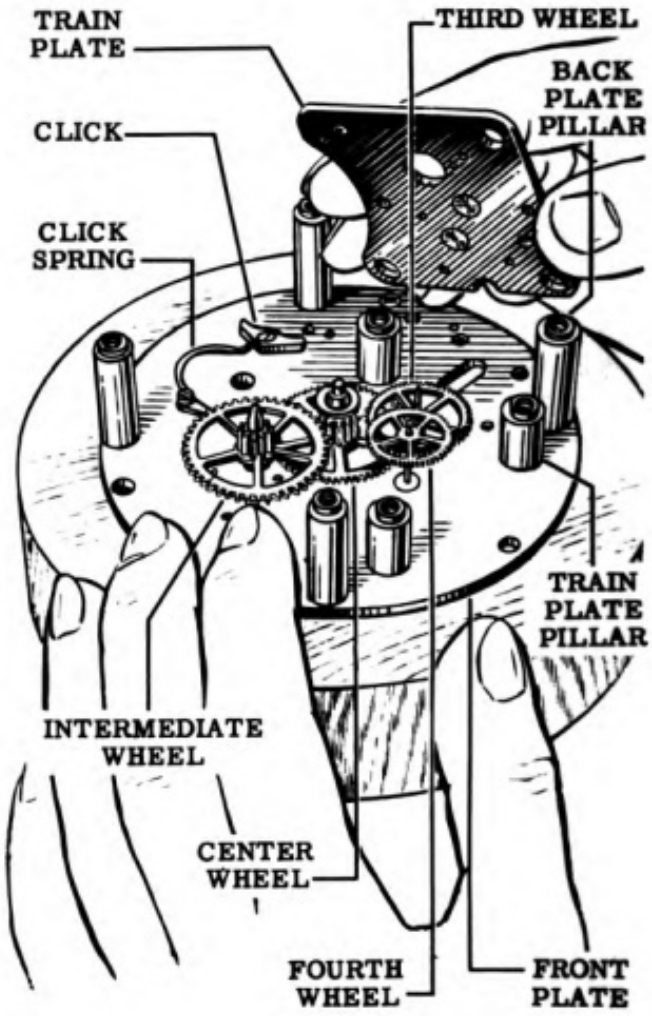

Figure 74

2. Check to see that the pillars are tight. Check the click spring for sufficient pressure on the click to insure a positive engagement between the click and the barrel ratchet wheel. If necessary, bend in the click spring to increase the force on the click.

3. Oil the corners of the center wheel friction spring. See "Clock Movement Lubrication" in the Control Manual.

4. Check each of the train wheels for uprightness in its pivot hole by testing it for equal tilt in four directions. For corrective procedures, refer to "Special Timepiece Repair and Adjustment Operations." See the Control Manual index.

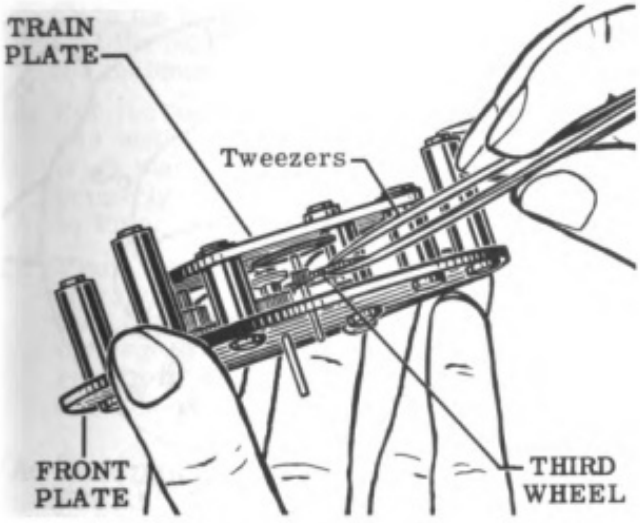

Figure 75

5. Put in the center wheel, the intermediate wheel, the third wheel and the fourth wheel. See Fig. 73 for the proper positions. Put on the train plate (see Fig. 74) and fasten it down with the three train plate screws. Use the special collar (Tool No. 13A) on the end of an automatic screwdriver to avoid scratching the plate and to speed up the work.

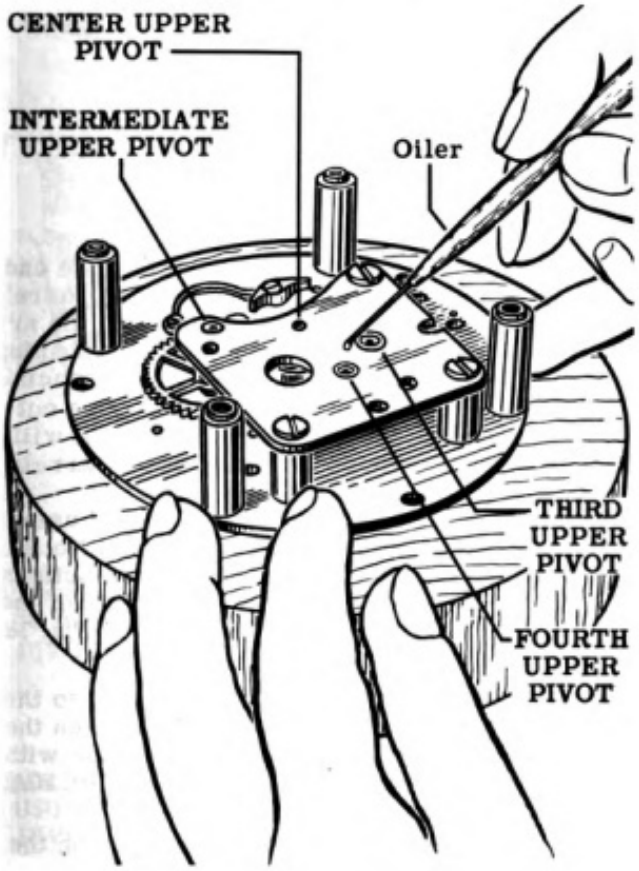

Figure 76

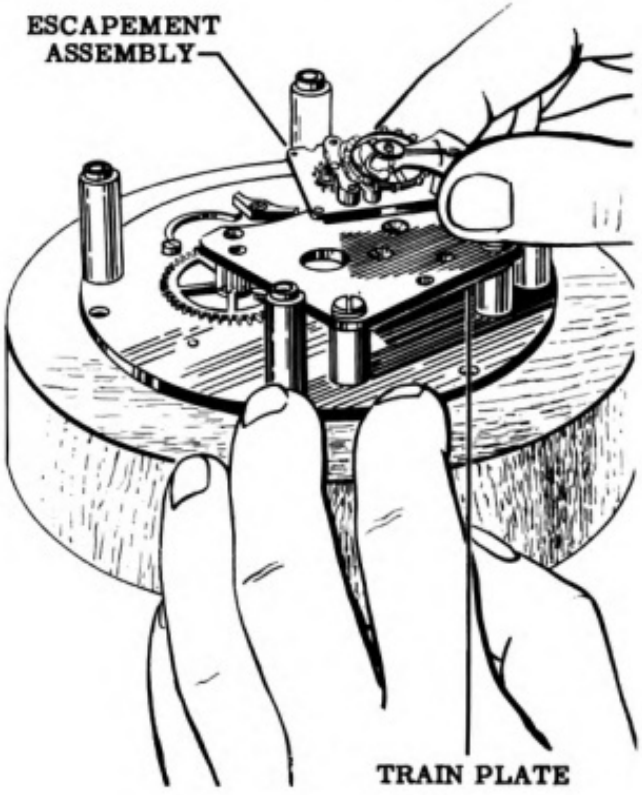

Figure 77

6. Check the freedom of the train by turning the intermediate wheel to see that none of the wheels bind.

7. Check the endshake of each of the train wheels and check the sideshake. Fig. 75 shows checking of the third wheel endshake.

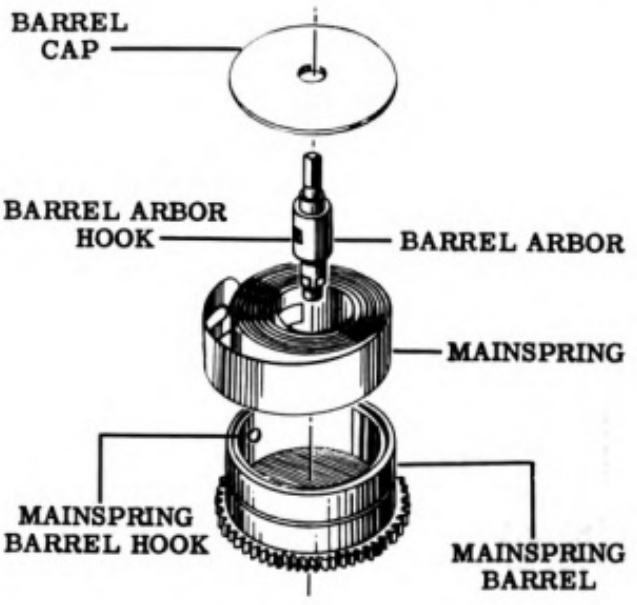

Figure 78

Tolerances for endshake and sideshake are listed in "Clock Movement Assembly Adjustment Standards" as indexed in the Control Manual. If any adjustments are necessary, refer to the procedures given in "Special Timepiece Repair and Adjustment Operations." See the Control Manual.

8. Oil the third and fourth upper pivots. See Fig. 76 and "Timepiece Lubrication" as indexed in the Control Manual.

9. Place the escapement in position on the train plate. See Fig. 77. Carefully mesh the escape pinion with the teeth of the fourth wheel. Fasten down the escapement with the two escapement mounting screws.

NOTE

Operations 10 through 14 are not necessarily done at this time.

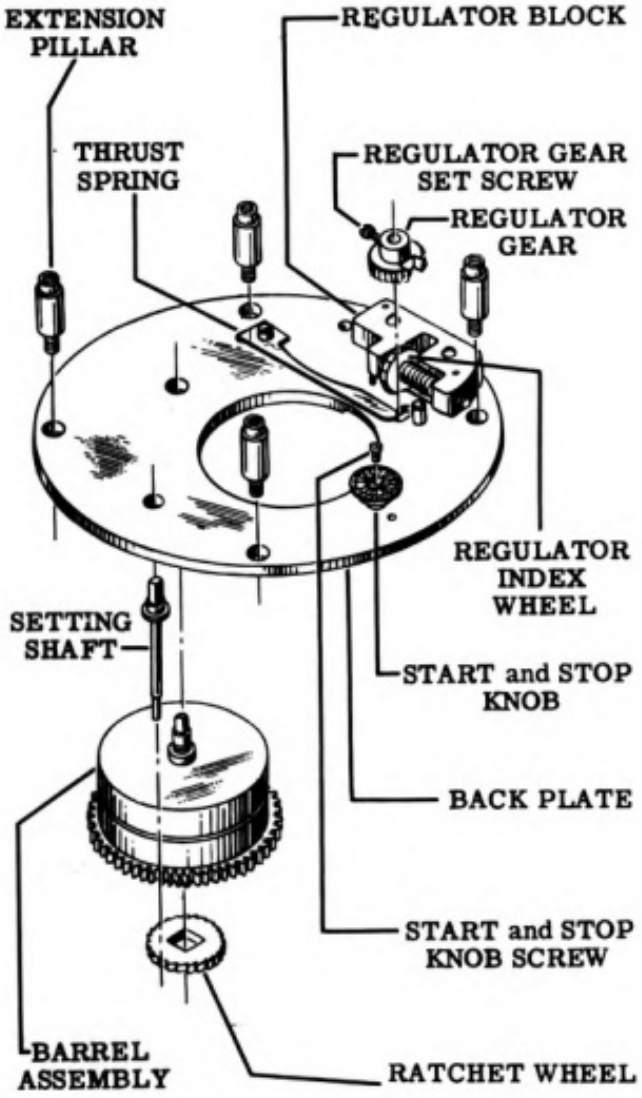

Figure 79

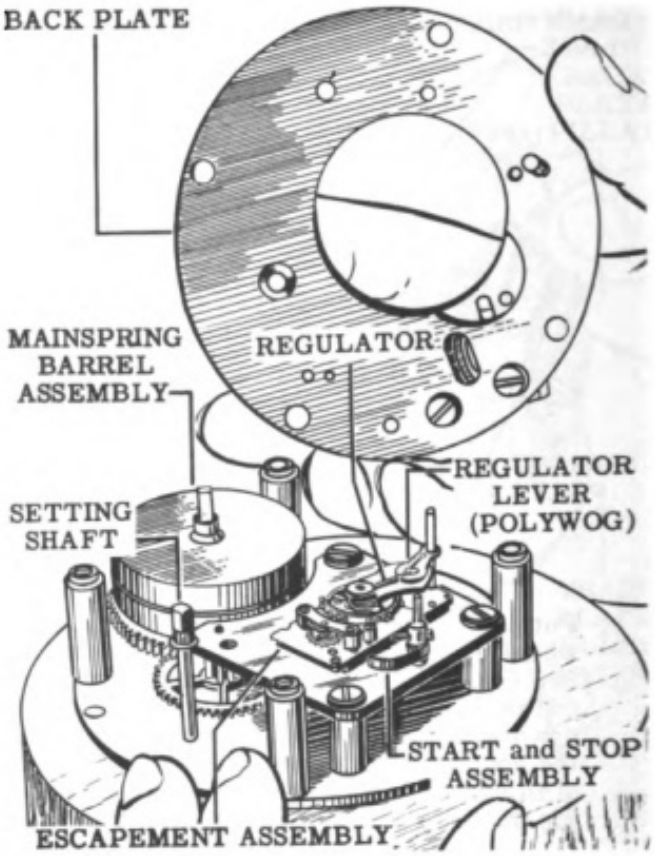

Figure 80

Mainspring barrels may be assembled by a person other than the movement assembler and at any time before Operation 15.

10. Take a new mainspring and shape one end so that it will match the shape of the barrel arbor for about one-half turn around the arbor. Use the special mainspring end shaping pliers, Tool No. 8A. With the same special pliers, put a slight bend in the extreme outside end of the mainspring so that it will engage the hook on the inside of the barrel.

11. Wind the mainspring into the barrel using the special mainspring winder, Tool No. 9A. Oil the mainspring according to instructions in the Control Manual. For positions of the mainspring barrel components, see Fig. 78.

12. Insert the barrel arbor and engage it to the inside end of the mainspring. Place on the barrel cap and press it into position with the special barrel cap press, Tool No. 10A.

13. Check the endshake and sideshake on the barrel arbor. Refer to the Control Manual for standards and corrective measures.

14. Turn the barrel arbor several times to see that the barrel hook and arbor hook engage the mainspring inside the barrel.

15. Put the ratchet wheel on the barrel arbor and mount the barrel into its hole in the front plate. Check to see that the click properly engages the ratchet wheel. Refer to Figs. 79 and 80.

16. Place the regulator staff assembly in position, making sure that the polywog engages the regulator in its center position. Tighten the regulator staff collar screw so that the regulator staff collar holds the polywog down on the regulator. Refer to Fig. 80.

17. Place the start and stop assembly in position on the train plate. See Fig. 80. Check to see that turning the start and stop shaft causes the start and stop spring to touch the rim of the balance wheel, and that the start and stop arbor spring causes a return of the arbor away from the balance wheel.

18. Place the setting shaft in position. See Fig. 80.

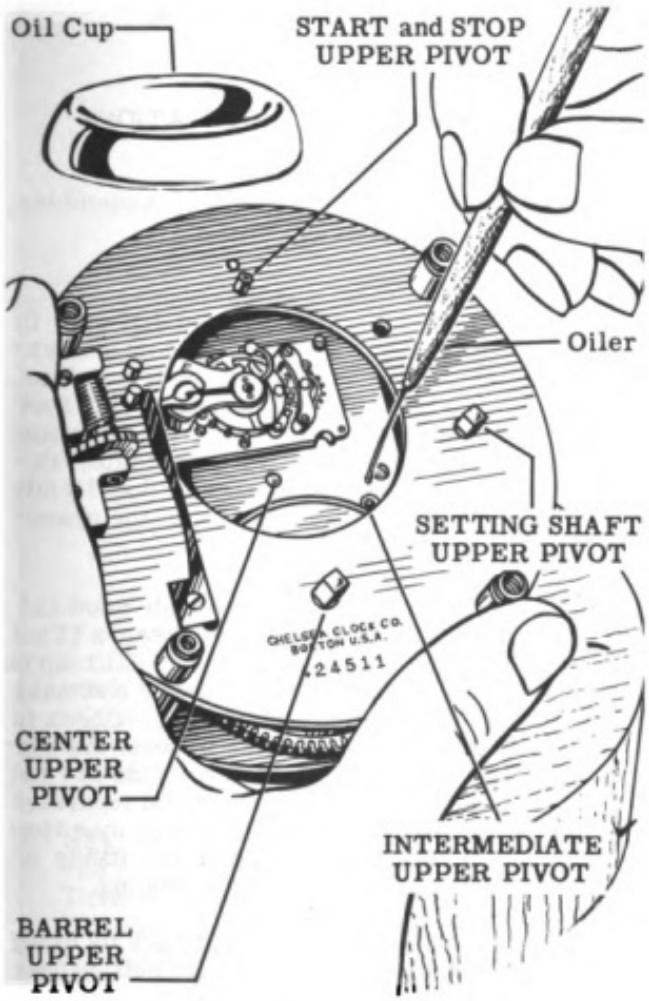

Figure 81

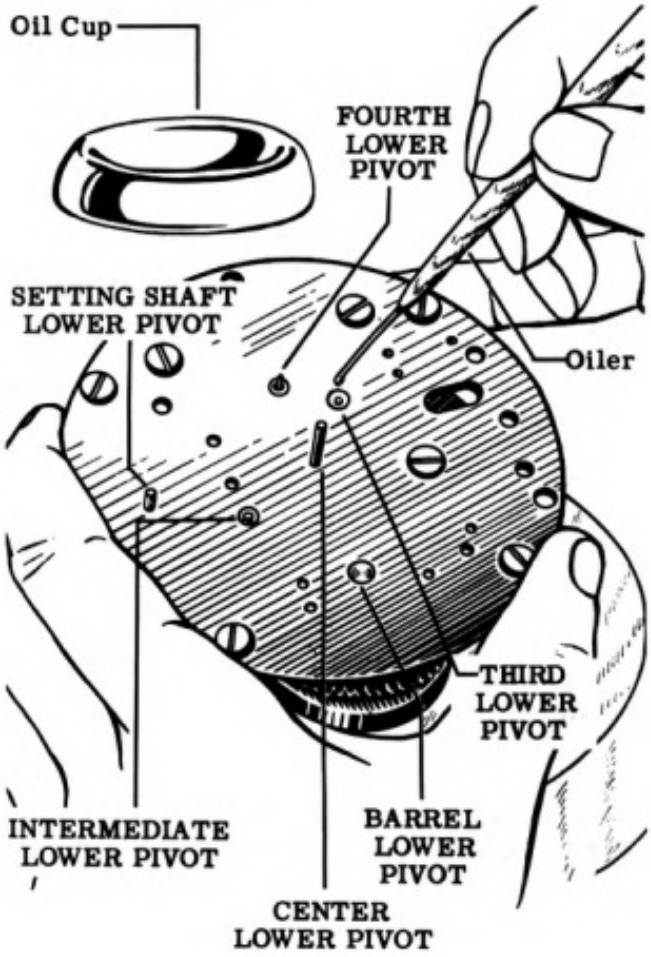

Figure 82

19. Put on the back plate with the assembled regulator assembly and thrust spring. See Fig. 80. While putting on the back plate, hold the start and stop spring screw aside so that it does not get on the wrong side of the start and stop stud in the back plate. With the stud in the proper position, the start and stop shaft can be turned in such a manner that the start and stop spring will touch the balance wheel. Fasten on the back plate with the four extension pillars and tighten with the special pillar pliers, Tool No. 6A. See Fig. 79.

20. Oil the upper pivots of the start and stop shaft, the barrel arbor, the setting shaft, the center wheel and the intermediate wheel. These points are shown in Fig. 81. See "Timepiece Lubrication" as listed in the index of the Control Manual.

21. Turn the movement over so that it is dial side up in the work block. Oil the lower pivots of the barrel arbor, the setting shaft, the center wheel, the intermediate wheel, the third and the fourth wheels. These points are shown on Fig. 82. See the Control Manual. Reach underneath the front

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plate and oil the lower pivot of the start and stop shaft on the dial side of the train plate. See the Control Manual.

22. Turn the movement over so that it is train side up in the work block. Fasten on the start and stop knob with the start and stop screw. See Fig. 79.

23. Place the regulator gear in position on the end of the regulator shaft. See Figs. 79 and 80. The regulator gear should be in center position and the polywog and the regulator on the balance cock also should be in center position. Hold aside the thrust spring and press the regulator gear down against the back plate. Release the thrust spring so that it presses against the regulator gear hub. Tighten the regulator gear screw.

24. Turn the movement over so that it is dial side up in the work ring. Press on the cannon pinion with the cannon pinion pusher (Tool No. 19B). Refer to Fig. 83.

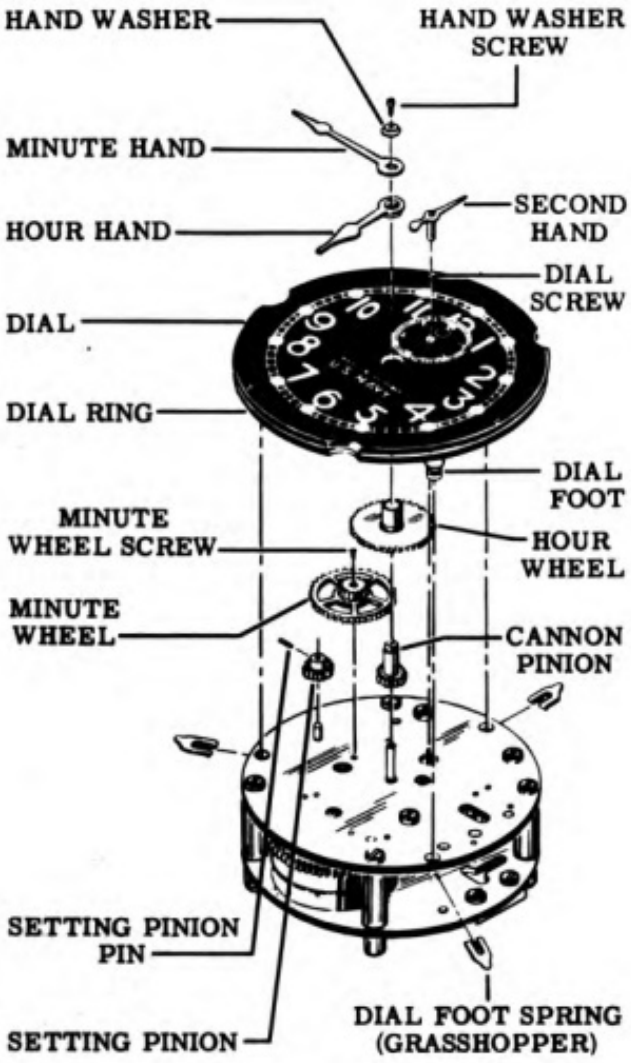

Figure 83

25. Mount the minute wheel with the minute wheel screw and try it to see that it is free.

26. Place the setting pinion on the setting shaft. Insert the setting pinion pin and squeeze it in place with a pair of pliers.

27. Put on the hour wheel.

28. Recheck the route ticket to see that all the recommendations pertaining to clock movement assembly have been initialed to indicate that the work has been done.

BENCH INSPECTION OPERATIONS

Skill Level: Watchmaker, Senior Grade

Perform the operations listed previously in this section under this same heading.

DIALING AND CASING OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

1. Place the assembled dial and dial ring in position so that the dial feet project downward through the holes in the front plate. Press a grasshopper onto each dial foot slot, keeping the grasshopper points facing away from the back of the front plate. Position the grasshoppers so that they firmly grasp the dial feet and no part of the grasshopper projects out.

2. Replace the second hand, the hour hand and the minute hand using hand pushers (Tool No. 20A) as shown in Fig. 84. Lift up on the hour hand to see that there is endshake between it and the minute hand. Check to see that there is clearance between the second hand and the dial. If the hands are not completely free of each other and separated from the dial, the movement will lose time or stop. Replace any defective hands or dial train parts which cause binding.

3. Set the clock to the correct time by using the setting mechanism. While setting, see that the hands do not interfere with each other. Once setting is completed, the movement should resume its normal operation.

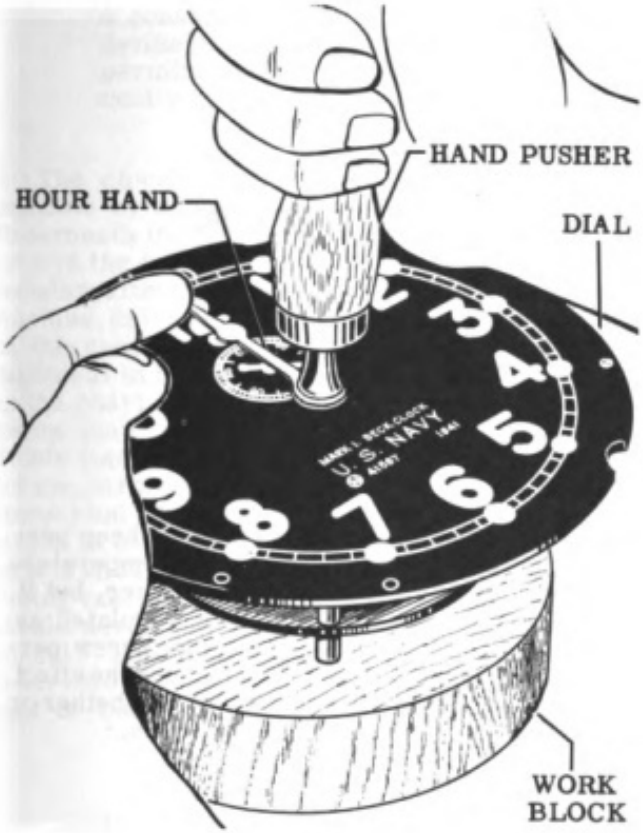

Figure 84

NOTE

After Operation 3, the movement is normally put through the various timing tests described in the next section "Test, Adjustment and Final Inspection." The final steps of placing the dialed movement in the case (Operations 4 through 7) are included here for purposes of maintaining the continuity of the reassembly process.

4. Refer to Fig. 85 for the relative positions of all parts involved in Operations 4 through 7. Turn the dialed movement over in the work block and position it so that no weight is placed on the hands. Fasten on the dust cover with the four dust cover movement mounting screws.

5. Hold the movement dial side up in one hand, and put the case over it with the other hand. Turn over the case and movement so that the dust cover is up. Turn the dust cover so that its three mounting holes line up with the three mounting holes in the case. Fasten the movement into the case by screwing in the three dust cover case mounting screws through the dust cover.

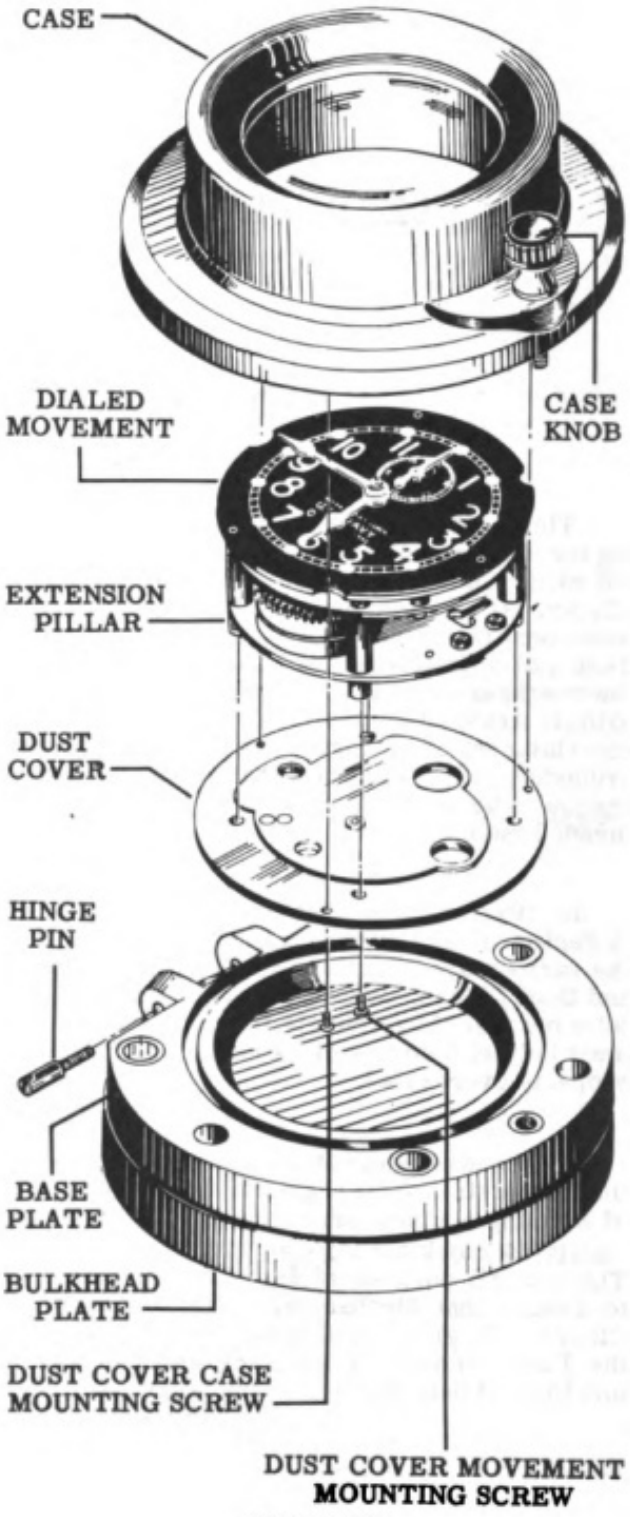

Figure 85

6. Place the case and movement in position on the back plate so that the hinges interlock. In the Boat Clock, the screw type hinge pin must be screwed back into place once the hinges are interlocked.

7. Tighten the case knob on the side of the case so that the case and back plate are firmly fastened together.

SECTION VI

TEST, ADJUSTMENT AND FINAL INSPECTION

Skill Level: Mechanical Instrument Assembler, Senior Grade

This section contains instructions covering the recommended procedure for testing and adjusting Chelsea Mechanical, Boat and Deck Clocks. At the beginning of this procedure the movement is completely assembled and dialed. Test and adjustment is the last procedure in the overhaul process before returning the clock to the Instrument Control Center to be packaged for shipment or storage. Because it is the last procedure, it is important that you understand the job to be done and perform it in the recommended manner.

In "Performance Requirements," included in Section II of this manual, there are included the various specifications for Mechanical, Boat and Deck Clocks. Read these requirements carefully because they indicate the standards that must be met before a clock can be considered properly overhauled.

Test and adjustment, as described in this section, consists in first regulating the clock by use of a timing machine and, second, in putting the regulated clock through a performance test. The overall purpose of test and adjustment is to assure that Mechanical, Boat and Deck Clocks will give satisfactory performance in the Fleet both as to accuracy and freedom of mechanical defects.

TIMING OPERATIONS

Skill Level: Mechanical Instrument Assembler, Senior Grade

The purpose of the timing operations is to adjust the balance wheel timing screws so as to secure a perfect rate on the timing machine. This does not mean that the clock will keep perfect time, because errors caused by temperature change and isocronism will take place, but it does mean that the clock will be regulated as perfectly as adjustment of the timing screw permits. The performance test will check the effect of the other errors and determine whether or not they are within satisfactory limits.

Regulating on the Timing Machine

The timing machine shown in Fig. 86 is one commonly used for the purpose, although any of the many similar commercially available types may be employed. Timing machines of this kind have a calibrated chart paper which is wrapped around a drum. As a drum turns, the recording mechanism produces a dot on the chart paper each time the clock "ticks." The completed chart consists of a sequence of these dots across the chart.

The usual timing machine of this type requires about 30 seconds to show the time deviation which would occur in a 24-hour run. Chart recordings which slope upward from left to right indicate a gaining rate, and recordings which slope downward from left to right indicate a losing rate. The chart paper is marked with ruled lines which indicate the number of seconds gained or lost in a 24-hour period.

NOTE

There are commercially available continuous tape timing machines which make a vertical row of dots on the paper tape when the clock is neither gaining nor losing time. If the row of dots slopes to the left, the clock is running slow; and if the row of dots slopes to the right, the clock is running fast.

A convenient angle measuring device mounted over the tape permits reading the error directly in seconds per day.

The clock is held in place in the timing machine by a spring clamp, Tool No. 26A. Underneath the clamp is a sensitive pickup which detects the impulse from the escapement. This impulse, after being amplified within the timing machine, drives a stylus that prints the impulse on the chart paper. A perfectly adjusted escapement in the clock will produce only one line on the chart paper. However, some clock movements may produce records consisting of a double line of dots and still be acceptable. It is not the purpose of this handbook to enter into a discussion of diagnosis of clock defects by means of a timing machine—first, because such information is usually furnished along with the timing machine and, second, because diagnosis should never be attempted by inexperienced personnel. The purpose of the timing operations described in this section is only to adjust the rate of the clock—if unusual chart recordings appear, the movement should be sent to the escapement repair activity for diagnosis.

Since Mechanical, Boat and Deck Clocks are intended to be used mounted in a vertical position with the 12 (or 24) mark straight up, they must be held in this position—the position of normal operation—while the timing machine is operating. Since the clamp on a timing machine is usually designed to hold a watch movement, a special spring clamp (Tool No. 26A) has been designed to hold dialed Mechanical, Boat and Deck Clocks in the proper upright position. This special clamp is held in place by the regular pickup clamp furnished with the timing machine and, once it is mounted, it need not be moved.

Timing Procedure

1. Set the regulator to the exact center position between "F" and "S."

2. Clamp the clock movement on to the timing machine as shown in Fig. 86. The movement should always be timed and tested in

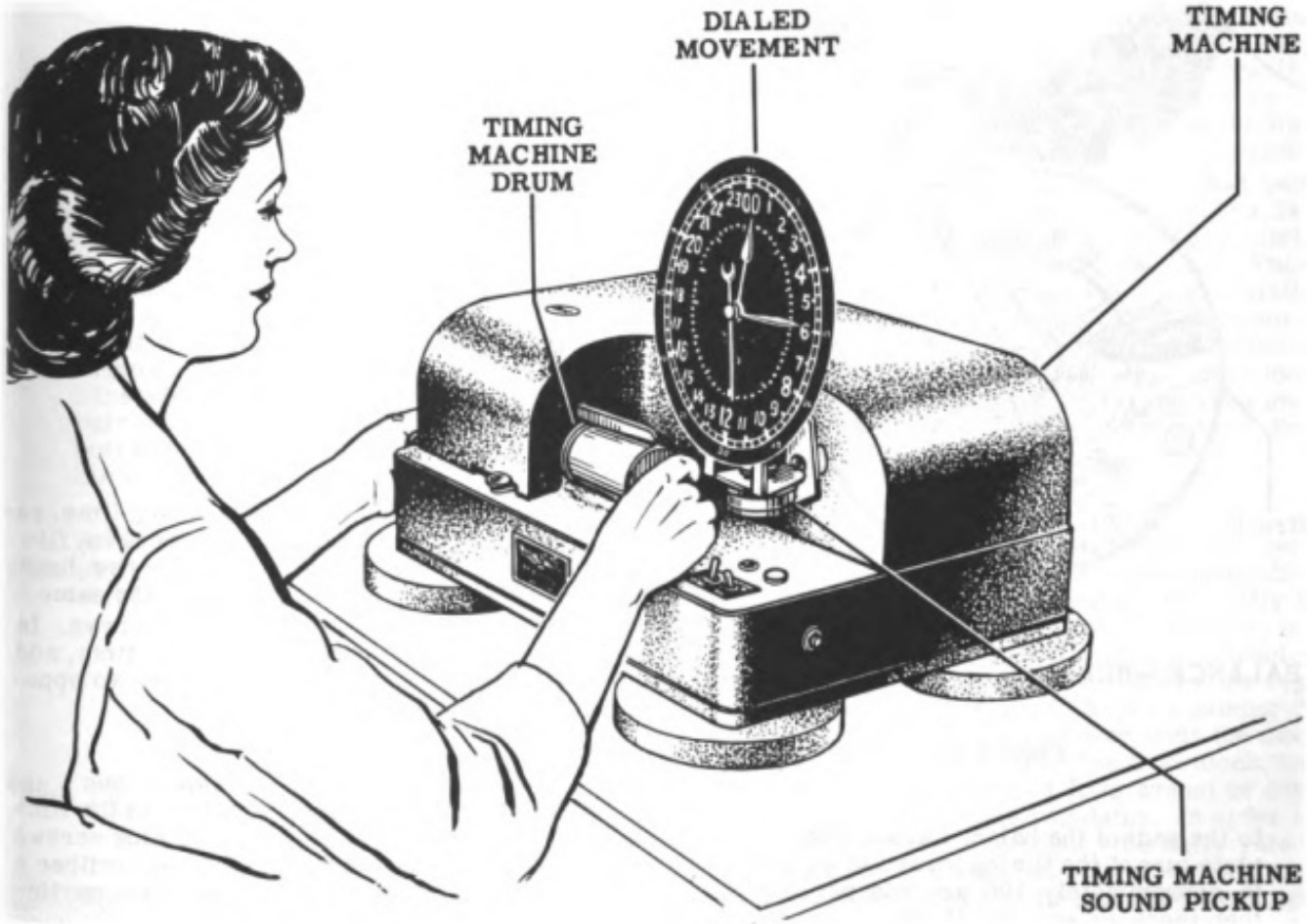

Figure 86

the position of its normal operation—in a vertical position with the 12 (or 24) mark up.

3. Operate the timing machine following the directions given by its manufacturer.

4. Note the 24-hour error indicated on the chart recording.

5. Adjust the two timing screws to correct the error as shown in Fig. 87. These two screws are smaller in head size than the other balance screws and are located close

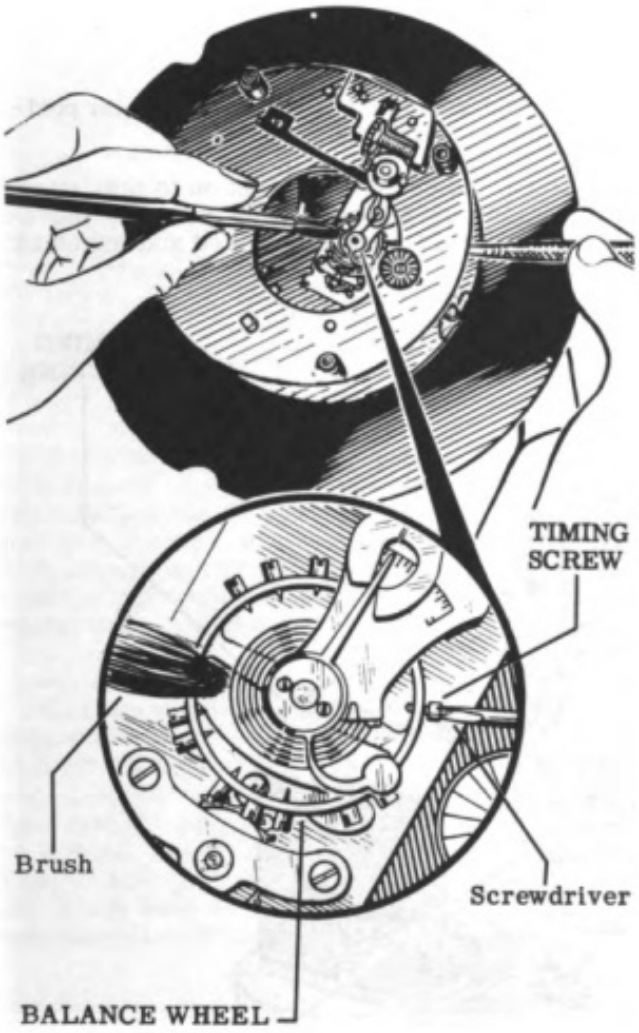

Figure 87

to the ends of the balance arms. Each complete turn of the timing screws is equivalent to approximately 100 seconds per day so that there is an overall adjustment of approximately 300 seconds per day by adjusting the timing screws in the Chelsea clocks.

If the chart recording shows that the clock is gaining time, turn the timing screws out; and, if the recording shows that the clock is losing time, turn the timing screws in. Both timing screws should be adjusted exactly the same amount in the same direction.

In the event that the clock cannot be brought to time by adjusting the timing screws, adjustments will have to be made to the balance weight.

CAUTION

In Operation 6 (adjusting the weight of the balance screws), it is very important to perform each detail very carefully. Any change to one balance screw must be made in exactly the same manner to the opposite balance screw. Failure to take sufficient care will result in completely ruining the poise of the balance wheel, resulting in excessive work by the Escapement Repair Activity in order to correct its poise.

If it is necessary to perform Operation 6, do it and then perform Operation 7. Once the clock has been brought to perfect time, send the movement back to the Escapement Repair Activity for checking and adjusting the poise of the balance wheel. Then go through the entire Timing Procedure once more.

6. In the event that the clock is losing time, remove any two opposite balance screws, file out the slots (or undercut the screw heads as shown in Fig. 88) by exactly the same amount and replace the balance screws. In the event that the clock is gaining time, add equal-weight timing washers to two opposite balance screws.

7. After the adjustments in Operations 5 and 6 are complete, place the clock in the timing machine and adjust the timing screws until the chart recording shows neither a gain nor a loss of time. This is not particularly difficult to do and requires only moderate skill in making time adjustments on the timing screws. If any adjustment was

Figure 88

made to the weight of the balance screws, send the movement back to Escapement Repair Activity for checking and adjusting the poise of the balance wheel. Then go through the entire timing procedure once more.

After the clock movement is brought to perfect time, it is ready for the performance test.

PERFORMANCE TESTING

Skill Level: Mechanical Instrument Assembler, Senior Grade

The purpose of the performance test is to prove that no mechanical defects appear in the clock movement, to make sure that the escapement adjustments were properly performed and to check the accuracy of the timing screw adjustment. During the performance test, the clock is wound every 168 hours (7 days) and maintained at ordinary room temperature (68 to 72 degrees F). The clock must be tested in a vertical position with the 12 or 24 mark on the dial straight up—thus simulating normal operating conditions. In order to determine whether or not the accuracy is up to standard, daily comparisons must be made between the clock dial reading and a master time source. The master time source may be a radio signal or a standard-frequency operated comparing clock. It is, therefore, very simple to arrive at the dial factor, which is the difference between the exact time and that indicated on the clock being tested. It is not necessary for one to be a highly experienced timer because it is sufficient for all comparisons to be correct only to the nearest second.

Determining the Daily Rate

As mentioned in the foregoing, during the course of the performance test each clock will be wound every 168 hours and rate (error) of each clock determined daily. The daily rate (daily error) is discovered by noting the difference between the dial errors of successive dial readings. If these dial errors are recorded daily, the rate is indicated by the time gained or lost per day. In the event that observations are unavoidably made more than one day apart, the rate should be reduced to a 24-hour basis by dividing the difference in dial errors by the number of days involved. This method of determining the daily rate can easily be understood from the sample "Performance Chart" included here. In the "Remarks" column as shown on the chart, any unusual conditions should be noted so that these may be taken into account when determining whether or not the clock has passed its performance test.

The daily rate or error is not the only important concern in proving the timekeeping abilities of a clock. A clock that gains exactly 15 seconds per day is an excellent timekeeper, because this type of error can easily be corrected by slightly slowing down the clock with the regulator. On the other hand, a clock gaining 5 seconds one day and losing 5 seconds the next day is not nearly as good as the first clock, because an erratic gain and loss cannot be corrected by means of the regulator. In order to take this factor into account, the daily rate (error) must be compared with the weekly error divided by 7 and a limit must be placed upon the allowable difference between the two. A study of the sample "Performance Chart" will make this clear. See Page 68.

PERFORMANCE CHART (SAMPLE)

1 DATE	2 DIAL ERROR + = Fast - = Slow	3 DAILY RATE (Daily Error)	4 AVERAGE (Daily Error)	5 DEVIATION OF DAILY ERROR (col 3-col 4)	REMARKS
	Min. Sec.	Sec.	Sec.	Sec.	
July 1951					
13	-0 03				Started and set 3 seconds slow
14	-0 10	-7	-10	+3	
15	-0 18	-8	-10	+2	
16	X X	X	X	X	Not checked
17	-0 37	*-10	-10	0	* Two-day average
18	-0 49	-12	-10	-2	
19	-1 1	-12	-10	-2	
20	-1 15	-14	-10	-4	

Weekly error Jul 14-20 = 1 min 15 sec -03 sec = 1 min 12 sec = 72 sec. Average daily error = 10-2/7 sec = 10 sec.

Performance Requirement Summary

The overall weekly dial error (last entry in col. 2 minus the first entry in col. 2) must be no more than 2 minutes for Mechanical Clocks and no more than 2 minutes 30 seconds for Boat and Deck Clocks during any of the 3 weeks of the Performance Test.

For at least one of the three weeks of the Performance Test, no deviation of daily error in col. 5 must be more than ± 10 seconds for Mechanical Clocks and more than ± 15 seconds for Boat and Deck Clocks.

THE PERFORMANCE TEST

Skill Level: Mechanical Instrument Assembler, Senior Grade

The overall performance test is made up of a series of individual tests which will determine whether or not the clock meets all parts of the specifications.

Testing Conditions

The testing conditions are prescribed as follows:

1. Temperature—The room temperature of the testing area shall be maintained between 68 degrees F and 72 degrees F at all times during testing.
2. Each overhauled clock shall pass the trial run and performance test before it can be released for use.
3. The requirements for the trial run and performance test shall be as described in the remainder of this section.

Trial Run

A trial run is to be made of each uncased movement—this test to last exactly eight days (192 hours). The movement is to be fully wound at the beginning of the trial run and a performance record kept. The purpose of this particular portion of the test is to bring to light any mechanical defects which may exist, to

determine that the clock will run at least eight days and to get information on whether or not the clock has a good chance to pass its performance test.

If the clock stops, determine whether it is due to the hands, the movement, or failure of the escapement. See that the hands are not interfering with each other. Check the endshakes and sideshakes in the train to see that there is no binding—correct any binding located. If the cause is not in the movement, but in the escapement, return the escapement to the escapement repair activity. After the condition is corrected, another trial run is required.

From the Performance Chart for the trial run you can get a good idea whether or not the clock has a good chance to pass its performance test. If a mechanical clock shows that it will gain or lose more than two minutes per week, or if a Boat or Deck Clock shows that it will gain or lose more than two minutes and thirty seconds per week, it is to be sent back to the timing machine. Smaller gains or losses are to be corrected by means of the regulator before the performance test is begun.

If the overall gain or loss is within limits, check for an erratic rate. If any of the deviations of daily errors (col. 5 of Performance Chart) are more than ± 10 seconds for the Mechanical Clock or more than ± 15 seconds for the Boat and Deck Clock, there is poor chance that the movement will pass the performance test. Unless unusual conditions exist, the trouble is improper adjustment of the escapement. In this case, the escapement is to be sent back to the escapement repair activity for readjustment, and the trial run performed over again.

Performance Test

Once the movement has passed its Trial Run, place it in its case, following the instructions given in "Reassembly Procedure," Section V. Make sure that the hands do not interfere with each other due to the pressure of the glass or the permoseal crystal. Rectify any such condition, if found. Set the clock to the correct time.

The Performance Test shall last three weeks. Wind the clock every 168 hours (7 days) and keep a daily record on the Performance Chart. Once the test has begun, neither the timing screws nor the regulator shall be adjusted without beginning the test over again. The performance requirements are as follows:

Requirement No. 1: Each weekly dial error shall be within ± 2 minutes for the Mechanical Clock and ± 2 minutes 30 seconds for the Boat or Deck Clock.

Requirement No. 2: During 1 week of the 3-week test the average daily error shall be determined by dividing the weekly error by 7. All daily errors shall be within ± 10 seconds (Mechanical Clock) or ± 15 seconds (Boat or Deck Clock) of the average so obtained.

Even though the performance requirements do not require this, it is important to keep a daily record on the Performance Chart—otherwise much time may be wasted. If the first week of the test shows that the clock is not meeting Requirements No. 1 and No. 2, there is no point in carrying out the balance of the test.

If the gain or loss is within 30 seconds of Requirement No. 1, correct the condition with the regulator and begin the test over again. If the gain or loss exceeds 30 seconds more than Requirement No. 1, send the clock back to the timing machine and begin the test over again. If the deviations of any of the daily errors (col. 5 on Performance Chart) are more than 1 or 2 seconds away from those listed in Requirement No. 2, it is unlikely that the clock will meet Requirement No. 2. In this case, send the escapement back to the escapement repair activity for readjustment and begin the test over again. Remember that any trouble of this nature, once the performance test has begun, is due to faulty interpretation of the Performance Chart during the Trial Run. The Trial Run is an important means of saving your time on the Performance Test.

By the end of the second week of the performance check, the clock should be well within Requirements No. 1 and No. 2. If it is, you can be sure that the clock will pass the test. If it is not, determine whether the cause is due to unusual conditions, such as failure to wind at proper intervals, excessive variations in room temperature, etc. In these cases, allow the test to continue but correct the condition causing it. If the cause is within the clock itself, you will have to decide whether the errors are of such a nature that Requirement No. 2 will be met during the third week or whether it will be more economical (as in the case of an erratic rate) to have the escapement readjusted.

Final Approval

Once the clock has passed the three-week Performance Test, it is in suitable condition to be issued for use in the Fleet. Return the clock to the Instrument Control Center, from which it may be drawn by the navigational instrument inspector for a complete inspection before packaging for shipment or storage. See the "Navigational Instrument Inspector's Final Inspection Standards and Procedure" in the Control Manual.

SECTION VII

MAINTENANCE PARTS CATALOG

INTRODUCTION

As a supplement to the repair sections of this manual for Chelsea Mechanical, Boat and Deck Clocks, the Maintenance Parts Catalog is included to provide a convenient source of stock numbers and complete identification for all maintenance parts and other components. Maintenance parts are under the cognizance of the Ship Parts Control Center, Mechanicsburg, Penna.

The Maintenance Parts Catalog consists of a Group Assembly Parts List detailing all main assemblies, subassemblies, component parts and attaching parts; also a series of exploded views illustrating the Group Assembly Parts List. These are described in the paragraphs which follow.

Group Assembly Parts List

The Group Assembly Parts List, together with its exploded views, lists and illustrates the complete disassembly of Chelsea Mechanical, Boat and Deck Clocks. This breakdown covers, in logical sequence, all operations in the disassembly procedure from the taking of the dialed movement out of its case to the removal of the bushings from the front plate, including some operations not ordinarily performed in clock overhaul. The arrangement provides an unabridged and methodical listing of maintenance parts and, in addition, serves as a reliable supplement to the sections on Disassembly Procedure, Section III, and Reassembly Procedure, Section V. Small distinctions of design and construction become glaring visual differences when reference is made to the exploded views in Section VII.

General Notes

In the Group Assembly Parts List, the "Part Name" column is indented to indicate the relationship of each component part to its next higher assembly. The attaching parts for each assembly are listed directly following that assembly, before the assembly is broken down. The part names were derived from the terms which are traditional among watch and clock makers, and these names are essentially functional and descriptive in origin. When ordering parts, refer to the Catalog of Navy Material No. 28001 for the standard stock names; these standard stock names must be used on all requisitions.

A footnote to some component parts reads, "Not recommended for stocking." This note is added for one of two reasons. One reason may be that the manufacturer recommends the purchase of some parts as assemblies rather than component parts, because assembling the parts may require special equipment not ordinarily found at repair stations. The other reason is that experience may show it is more economical to order a new assembly rather than to do a good job of replacing one of the components of that particular assembly.

Footnote references in the Parts List appear on the pages which list the particular referenced parts.

Those manufacturer's part and drawing numbers which are followed by a "-10(Z)," "-11(Z)," "-12(Z)," or higher numbers followed by (Z) are identified in that manner for two reasons.

a. Certain assemblies, subassemblies and parts had no manufacturer's part and drawing numbers at the time of publication of this manual. When part and drawing numbers are assigned, changes will be issued to this manual.

b. Certain assemblies, subassemblies and parts which, as such, are not procured as maintenance parts by the Ships Parts Control Center have been assigned numbers for purposes of inventory control, cost analysis, work control and handling of salvage. These assigned numbers will serve for purposes of identification at the repair facility, the Instrument Control Center and the navigational instrument control section of the Bureau of Ships.

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assembly 6" Size Type A 24 Hr.	6" Size Type B 12 Hr.	8-1/2" Size Type A 24 Hr.	8-1/2" Size Type B 12 Hr.
	*G18-C-1141			U.S. Navy Mechanical Clock, 6" size, type A (24 hr.)	1			
	*G18-C-1143			U.S. Navy Mechanical Clock, 6" size, type B (12 hr.)		1		
	*G18-C-1142			U.S. Navy Mechanical Clock, 8-1/2" size, type A (24 hr.)			1	
	*G18-C-1144			U.S. Navy Mechanical Clock, 8-1/2" size, type B (12 hr.)				1
89-1	H18-CHC0-10040	1500	1718-11(Z)	Key—Winding	1	1	1	1
		†15677	Z-6902-11(Z)	Case and Bezel Assembly, 7-9/16" O.D.	1	1		
		†15657	P-6521-11(Z)	Case and Bezel Assembly, 10-1/4" O.D.			1	1
89-2	H18-CHC0-10225	14062	Z-6902-12(Z)	Bezel Assembly, 6-9/16" O.D.	1	1		
89-2	H18-CHC0-10226	14069	P-6521-12(Z)	Bezel Assembly, 9-1/8" O.D.			1	1
89-3	H18-CHC0-10096	52033	8951	Knob—Case	1	1	1	1
89-4	H18-CHC0-10136	1179	1179	Pin—Case knob	1	1	1	1
89-5	H18-CHC0-10154	6913	6913	Screw—Case lock	1	1	1	1
89-6	H18-CHC0-10050	51033	8644	Glass—Bezel, 5.796" O.D.	1	1		
89-6	H18-CHC0-10051	50972	8645	Glass—Bezel, 8.312" O.D.			1	1
89-7	H18-CHC0-10026	52111	Z-6902-13(Z)	Wire—Glass	1	1		
89-7	H18-CHC0-10039	52110	P-6521-13(Z)	Wire—Glass			1	1
89-8	H18-CHC0-10065	51359	Z-6902-14(Z)	Gasket—Cork, 6" O.D. (approx.)	1	1		

* This is a stock number identified in the General Stores Section of the Catalog of Navy Material.

† Not recommended for stocking.

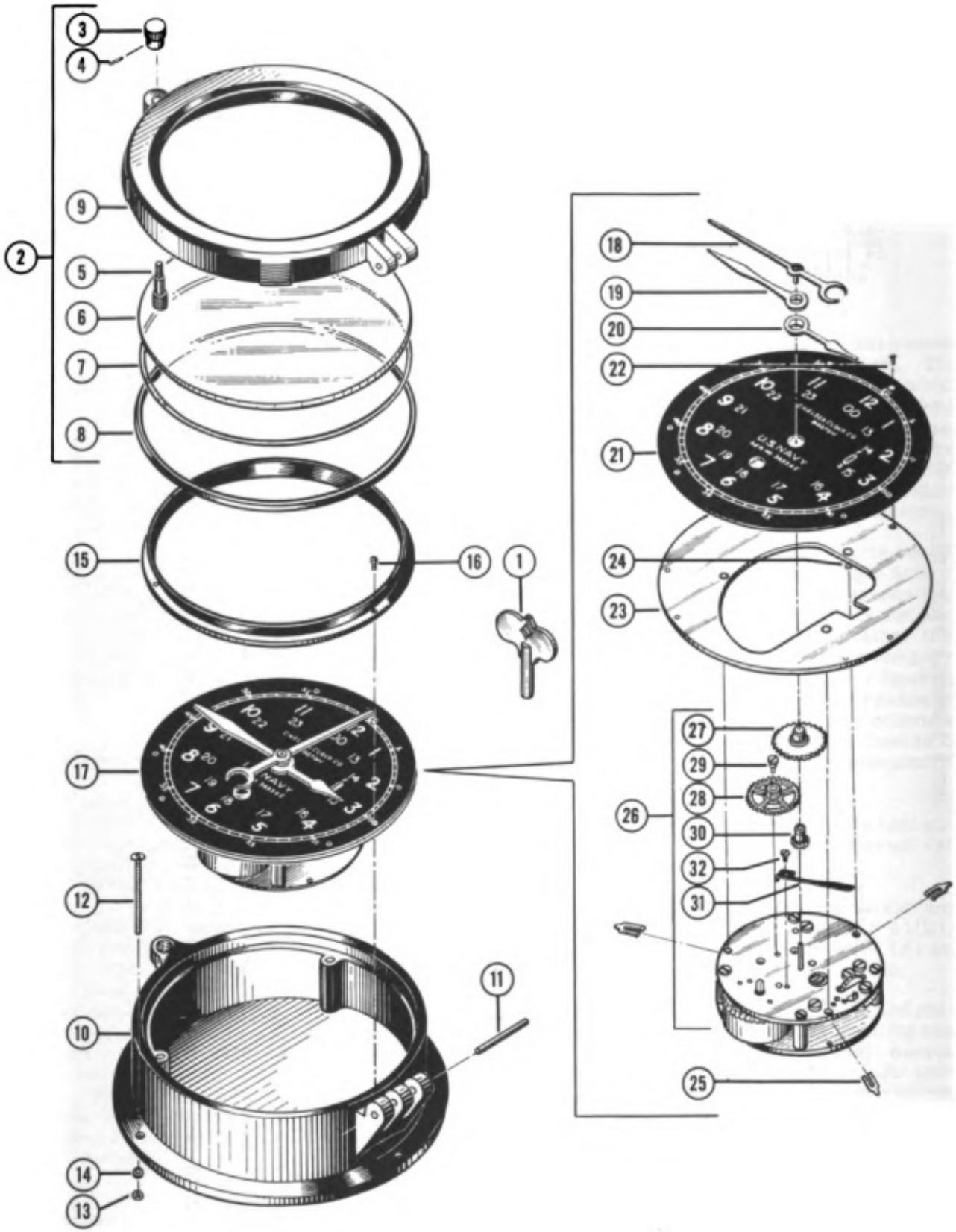

Figure 89—Chelsea No. 12E Mechanical Clocks, Main Assembly—Exploded View

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Type A 24 Hr.	6" Size Type B 12 Hr.	8-1/2" Size Type A 24 Hr.	8-1/2" Size Type B 12 Hr.
89-8	H18-CHCO-10064	51366	Z-6521-14(Z)	Gasket--Cork, 8-1/2" O.D. (approx.)			1	1
89-9		51358	Z-6902	Bezel, complete with insert, 6-9/16" O.D.	1	1		
89-9		51233	P-6521	Bezel, complete with insert, 9-1/8" O.D.			1	1
89-10	H18-CHCO-10037	51357	Z-6902	Case, complete with inserts, 7-9/16" O.D.	1	1		
89-10	H18-CHCO-10038	51213	P-6521	Case, complete with inserts, 10-1/4" O.D.			1	1
89-11	H18-CHCO-10134	6910	6910	Pin—Hinge, 1.500" long	1	1		
89-11	H18-CHCO-10135	6909	6909	Pin—Hinge, 2-1/16" long			1	1
89-12	H43-S-9415-1150	6945	6945-10(Z)	Screw—Case flange, rd. hd. machine, 10-32 x 2"	3	3	3	3
89-13		51471	51471-10(Z)	Nut—Case flange screw, hex. 10-32	3	3	3	3
89-14	43-W-6224-100	51472	51472-10(Z)	Washer—Lock, case flange, No. 8 split ring	3	3	3	3
89-15	H18-CHCO-10050	52082	D-8364	Reflector, 6" O.D.	1	1		
89-15	H18-CHCO-10100	52088	B-8864	Reflector, 8.52" O.D.			1	1
89-16	H43-S-9415-1120	6566	6566	Screw—Reflector	3	3	3	3
89-17		•15775	Z-6902-15(Z)	Movement Assembly—Dialed, 6" size, 24 hr. dial	1			
89-17		•15776	Z-6902-16(Z)	Movement Assembly—Dialed, 6" size, 12 hr. dial		1		

• Not recommended for stocking.

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Type A 24 Hr.	6" Size Type B 12 Hr.	8-1/2" Size Type A 24 Hr.	8-1/2" Size Type B 12 Hr.
89-17		*15778	P-6521-15(Z)	Movement Assembly—Dialed, 8-1/2" size, 24 hr. dial			1	
89-17		*15779	P-6521-16(Z)	Movement Assembly—Dialed, 8-1/2" size, 12 hr. dial				1
89-18	H18-CHC0-10089	7471	7471	Hand—Sweep second, complete with socket and washers	1	1	1	1
89-19	H18-CHC0-10085	7776	7776	Hand—Minute, complete with socket, 2-3/4" long (approx.)	1	1		
89-19	H18-CHC0-10086	7778	7778	Hand—Minute, complete with socket, 4" long (approx.)			1	1
89-20	H18-CHC0-10079	7777	7777	Hand—Hour, complete with socket, 2-1/8" long (approx.)	1	1		
89-20	H18-CHC0-10080	7779	7779	Hand—Hour, complete with socket, 2-7/8" long (approx.)			1	1
89-21	H18-CHC0-10060	†51484	D-7728	Dial—Brass, 6" O.D., 24 hr.	1			
89-21		†52038	D-7728	Dial—Phenolic, 6" O.D., 24 hr.	1			
89-21	H18-CHC0-10059	†51483	D-7727	Dial—Brass, 6" O.D., 12 hr.		1		
89-21		†52039	D-7727	Dial—Phenolic, 6" O.D., 12 hr.		1		
89-21	H18-CHC0-10057	†51485	B-7729	Dial—Brass, 8-1/2" O.D., 24 hr.			1	
89-21		†52040	B-7730	Dial—Phenolic, 8-1/2" O.D., 24 hr.			1	
89-21	H18-CHC0-10058	†51486	B-7730	Dial—Brass, 8-1/2" O.D., 12 hr.				1
89-21		†52041	B-7729	Dial—Phenolic, 8-1/2" O.D., 12 hr.				1
89-22	H18-CHC0-10156	3264	3264	Screw—Dial	3	3	3	3
89-23	H18-CHC0-10105	7370	D-7370	Ring—Dial, complete with feet, 6" O.D.	1	1		

* Not recommended for stocking.

† Dial may be either phenolic or brass.

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Type A 24 Hr.	6" Size Type B 12 Hr.	8-1/2" Size Type A 24 Hr.	8-1/2" Size Type B 12 Hr.
89-24		*7365		Foot—Dial ring	3	3		
89-23	H18-CHCO-10108	7470	7470	Ring—Dial, complete with feet, 8-1/2" O.D.			1	1
89-24		*7365A	7365	Foot—Dial ring			3	3
89-25		1378	1378	Spring—Dial foot, "grasshopper"	3	3	3	3
89-26		*7372	P-6521-17(Z)	Movement Assembly—Chelsea Model No. 12E	1	1	1	1
89-27	H18-CHCO-10174	7479	7479	Wheel--Hour (24 hr.), complete with tube, 1.305" O.D.	1		1	
89-27	H18-CHCO-10175	7356	7356	Wheel--Hour (12 hr.), complete with tube, 1.074" O.D.		1		1
89-28	H18-CHCO-10222	7480	7480	Wheel--Minute (24 hr.), complete with pinion, 1.241" O.D.	1		1	
89-28	H18-CHCO-10221	7354	7354	Wheel—Minute (12 hr.), complete with pinion, 1.011" O.D.		1		1
89-29	H18-CHCO-10167	1098	1098	Screw—Minute wheel	1	1	1	1
89-30	H18-CHCO-10071	7475	7475	Pinion—Cannon (24 hr.), 0.344" O.D,	1		1	
89-30	H18-CHCO-10072	7347	7347	Pinion—Cannon (12 hr.), 0.371" O.D.		1		1
89-31	H18-CHCO-10207	7734	7734	Spring—Thrust	1	1	1	1
89-32	H18-CHCO-10181	6862	6862	Screw—Thrust spring	1	1	1	1

* Not recommended for stocking.

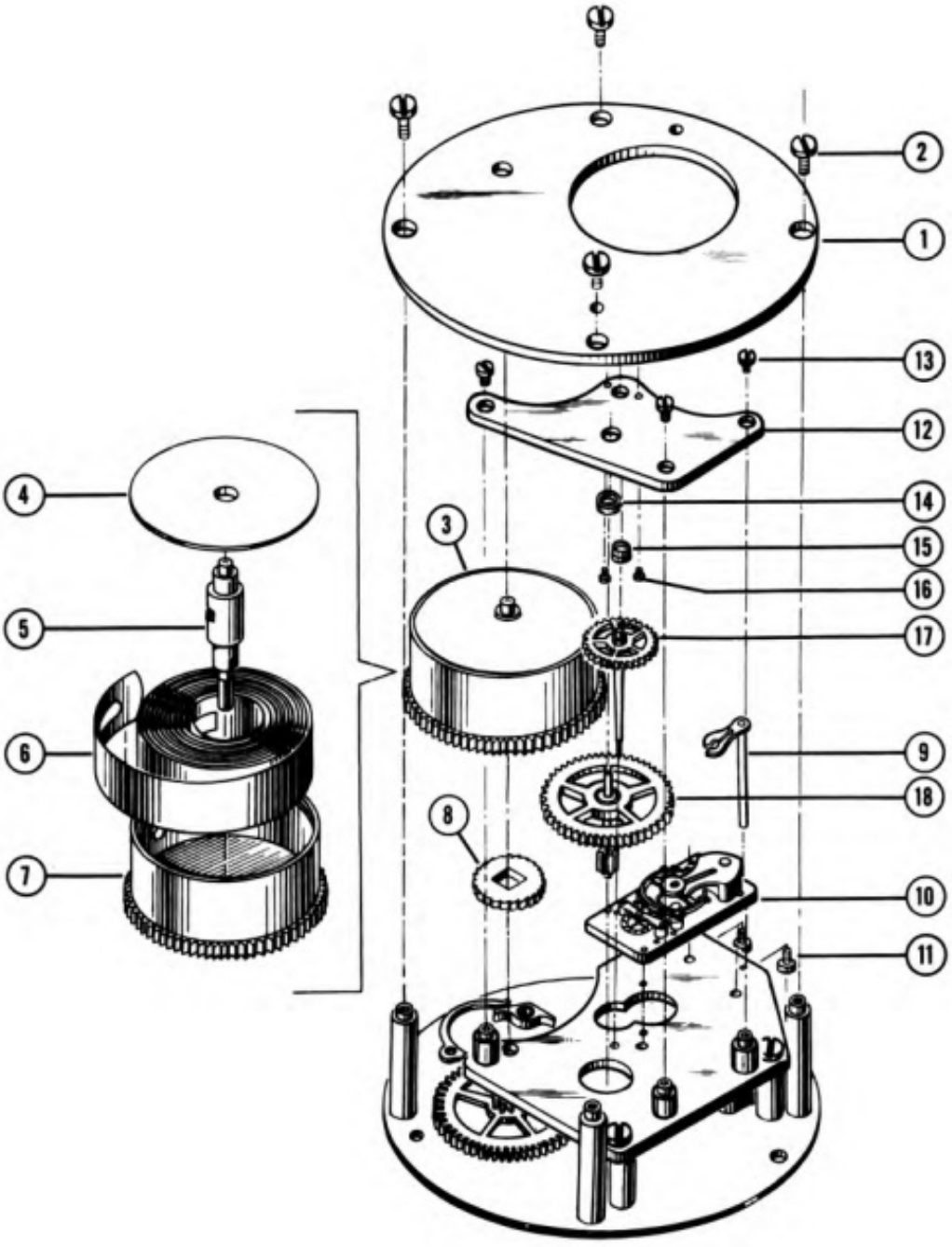

Figure 90—Chelsea No. 12E Mechanical Clock Components—Exploded View

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assy.
90-1	H18-CHCO-10125	8472	8472	Plate—Back	1
90-2	H18-CHCO-10182	633	633	Screw—Back plate	4
90-3		*431-10	431-10(Z)	Barrel Assembly—Mainspring	1
90-4	H18-CHCO-10034	8478	8478	Cap—Barrel, complete with hub	1
90-5	H18-CHCO-10001	7340	7340	Arbor—Barrel, complete with hook	1
90-6	H18-CHCO-10202	7374	7374	Mainspring—Clock	1
90-7	H18-CHCO-10014	431	431	Barrel—Mainspring, complete with hook	1
90-8	H18-CHCO-10185	745	745	Wheel—Ratchet	1
90-9	H18-CHCO-10009	7692	7692	Staff—Regulator, complete	1
90-10	H18-CHCO-10062	51505	51505	Escapement Assembly—No. 26	1
90-11	H18-CHCO-10159	712	712	Screw—Escapement mounting	2
90-12	H18-CHCO-10131	8471	8471	Bridge—Fourth upper, complete with bushing	1
90-13	H18-CHCO-10162	636	636	Screw—Fourth upper bridge	3
90-14	H18-CHCO-10024	8616	8616	Bushing—Third upper pivot	1
90-15	H18-CHCO-10020	†51481	51481	Jewel—Fourth upper	1
90-16	H18-CHCO-10161	960	960	Screw—Fourth upper jewel	2
90-17	H18-CHCO-10219	7361	7361	Wheel—Fourth, complete with hub, pinion and staff	1
90-18	H18-CHCO-10111	7376	7376	Wheel—Third, complete with hub and pinion	1

* Not recommended for stocking.

† Sapphire jewel, Part No. 51481, now furnished is interchangeable with substitute bronze jewel bearing formerly used.

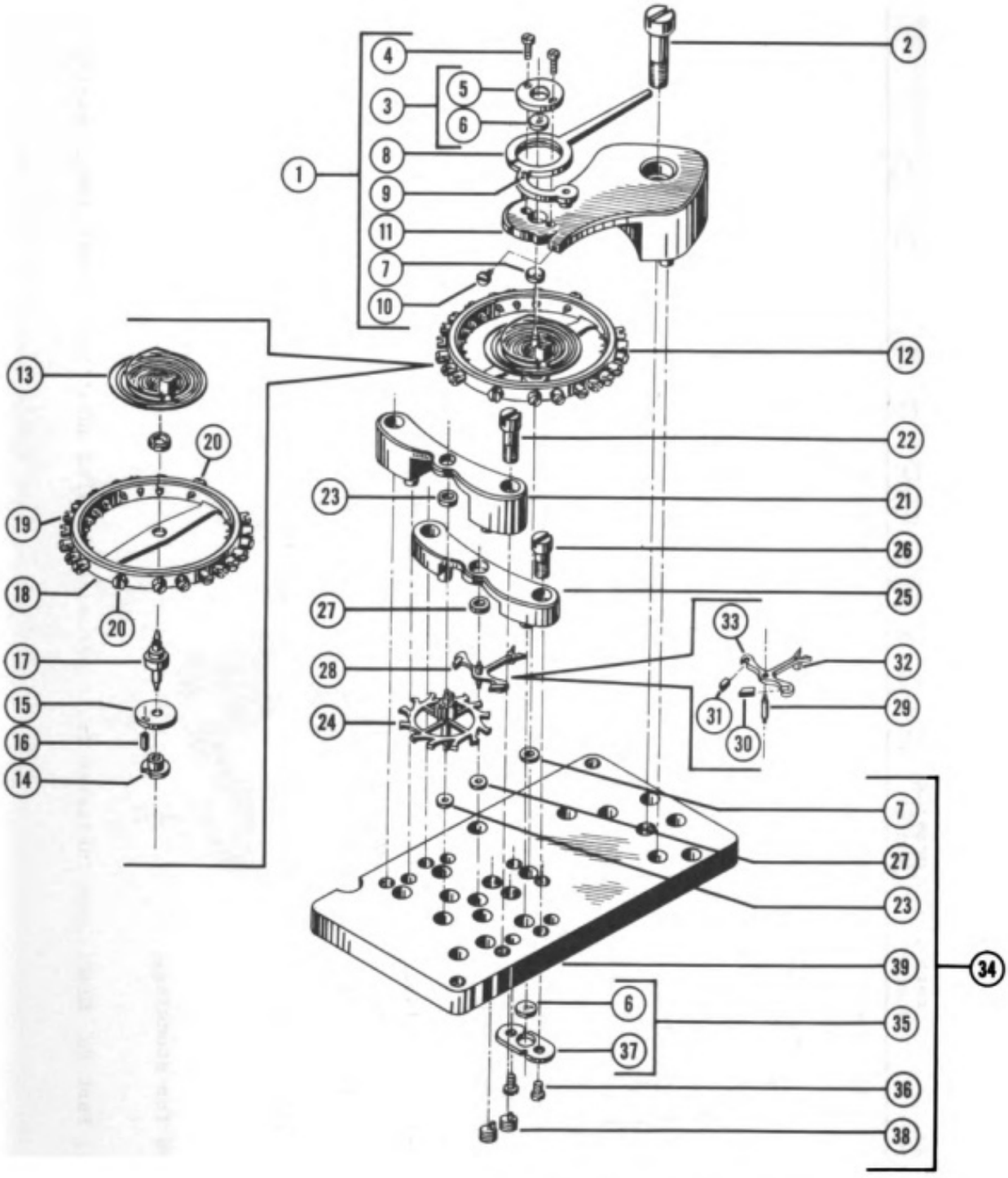

Figure 91—Chelsea No. 12E Mechanical Clock Escapement Assembly, No. 26—Exploded View

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assy.
90-10	H18-CHC0-10062	51505	51505	Escapement Assembly—No. 26	Ref.
91-1	H18-CHC0-10046	51709	3-0044-11(Z)	Cock Assembly—Balance	1
91-2	H18-CHC0-10150	51722	3-0121	Screw—Balance cock	1
91-3	H18-CHC0-10025	51712	3-0114	Cap Assembly—Balance upper endstone	1
91-4	H18-CHC0-10188	51714	3-0122	Screw—Balance upper endstone cap	2
91-5		*51713	3-0113	Cap—Balance upper endstone	1
91-6		*51715	3-0056	Endstone—Balance upper	1
91-7	H18-CHC0-10091	51716	3-0050	Jewel—Balance hole, upper	1
91-8	H18-CHC0-10000	51718	3-0049	Regulator, complete with pins	1
91-9		*51720	3-0066	Pin—Regulator	2
91-10	H18-CHC0-10163	51717	3-0117	Screw—Hairspring stud	1
91-11		*51710	3-0043	Cock—Balance, complete with steady pin	1
91-12	H18-CHC0-10012	51723	3-0086	Balance and Hairspring Assembly	1
91-13	H18-CHC0-10074	51728	3-0076	Hairspring Assembly—Complete	1
		*51729	3-0077	Hairspring	1
		*51730	3-0079	Collet—Hairspring	1
		*51720	3-0066	Pin—Hairspring collet	1
		*51732	3-0069	Stud--Hairspring	1
		*51720	3-0066	Pin—Hairspring stud	1
91-14	H18-CHC0-10147	51735	3-0088	Roller—Safety	1
91-15	H18-CHC0-10148	51736	3-0087	Roller—Table	1
91-16	H18-CHC0-10095	51734	3-0064	Pin—Jewel	1
91-17	H18-CHC0-10208	51727	3-0085	Staff—Balance	1

* Not recommended for stocking.

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assy.
91-18		*51724-11(Z)	3-0081-11(Z)	Wheel—Balance, complete with screws	1
91-19		*51725	3-0083	Screw—Balance wheel	AR
91-20		*51726	3-0082	Screw—Timing	2
91-21	H18-CHC0-10032	51737	3-0111	Bridge—Escape, complete with jewel and pins	1
91-22	H18-CHC0-10157	51741	3-0118	Screw—Escape bridge	2
91-23	H18-CHC0-10092	51740	3-0059	Jewel—Escape, upper	1
91-24	H18-CHC0-10216	51812	3-0099	Wheel—Escape, complete with pinion and hub	1
91-25	H18-CHC0-10033	51760	3-0155	Bridge—Pallet, complete with jewel and pins	1
91-26	H18-CHC0-10178	51763	3-0120	Screw—Pallet bridge	2
91-27	H18-CHC0-10093	51748	3-0057	Jewel—Pallet, upper	1
91-28	H18-CHC0-10115	51754	3-0091	Pallet Assembly	1
91-29	H18-CHC0-10004	51757	3-0096	Arbor—Pallet	1
91-30	H18-CHC0-10090	51758	3-0060	Stone—Pallet, left	1
91-31	H18-CHC0-10094	51759	3-0061	Stone—Pallet, right	1
91-32		*51755	3-0072	Pin—Guard	1
91-33		*51756	B-3-0090	Pallet	1
91-34		*51891	3-0020-11(Z)	Plate Assembly—Escapement	1
91-35	H18-CHC0-10022	51743	3-0116	Cap Assembly—Balance lower endstone	1
91-36	H18-CHC0-10165	51745	3-0119	Screw—Balance lower endstone cap	2
91-37		*51744	3-0115	Cap—Balance lower endstone	1
91-6		*51715	3-0056	Endstone—Balance lower	1
91-7	H18-CHC0-10091	51716	3-0051	Jewel—Balance hole, lower	1

* Not recommended for stocking.

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assy.
91-38	H18-CHC0-10177	51746	3-0070	Screw—Banking	2
91-23	H18-CHC0-10093	51740	3-0059	Jewel—Escape, lower	1
91-27	H18-CHC0-10093	51748	3-0057	Jewel—Pallet, lower	1
91-39		*51775	3-0020-12(Z)	Plate—Escapement	1
92-1	H18-CHC0-10129	8470	8470	Plate—Train, complete with bushing	1
92-2	H18-CHC0-10182	633	633	Screw—Train plate	3
92-3	H18-CHC0-10021	8473	8473	Bushing—Intermediate upper pivot	1
92-4	H18-CHC0-10120	7363	7363	Pillar—Fourth bridge	3
92-5	H18-CHC0-10162	636	636	Screw—Fourth bridge pillar	3
92-6	H18-CHC0-10209	7377	7377	Wheel—Intermediate, complete with pinion	1
92-7	H18-CHC0-10213	7463	7463	Wheel--Center, complete with arbor, pinion and friction spring	1
92-8	H18-CHC0-10170	† §7690	7690	Wheel—Regulator index, complete with worm screw	1
92-9		‡ §52029	52029	Screw—Worm bearing	2
92-10	H18-CHC0-10030	§8692	8692	Block—Regulator	1

* Not recommended for stocking.

† Regulator index wheel, Part No. 7690, is now furnished in black plastic with white index lines, and is interchangeable with the previous style using a brass index wheel.

§ Present regulator blocks, Part No. 8692, are furnished tapped with 4/48 holes, using Part No. 52029 worm bearing screws for mounting the regulator index wheel, Part No. 7690. Original regulator blocks were furnished tapped with 6/32 holes, using Part No. 50711 worm bearing screws. Only new style regulator blocks tapped with 4/48 holes will be furnished for replacement.

‡ The 4/48 screw, Part No. 52029, will be furnished unless old style 6/32 screw, Part No. 50711, is specifically ordered.

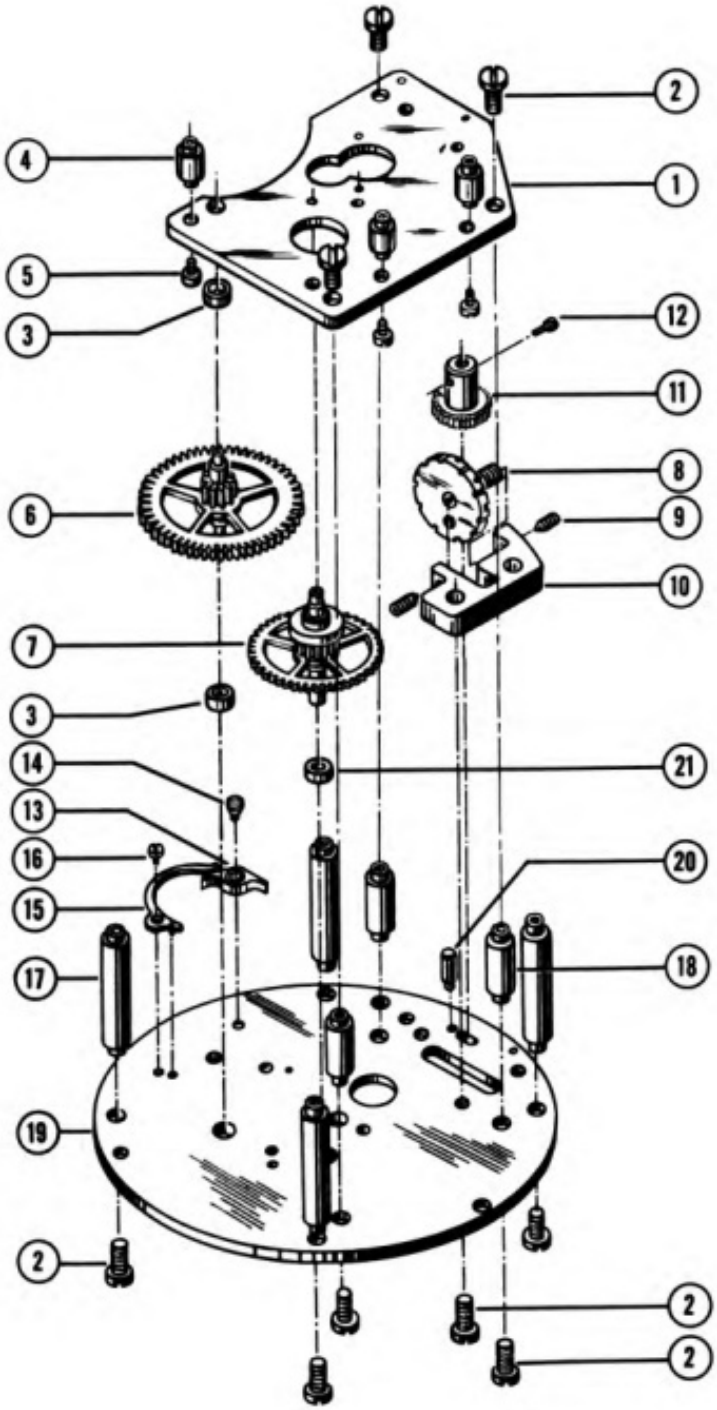

Figure 92—Chelsea No. 12E Mechanical Clock Components—Exploded View

CHELSEA MODEL NO. 12E MECHANICAL CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assy.
92-2	H18-CHCO-10182	633	633	Screw—Regulator block	2
92-11	H18-CHCO-10027	7662	7662	Gear—Regulator	1
92-12	H18-CHCO-10196	870	870	Screw—Regulator gear set	1
92-13	H18-CHCO-10117	10	10	Click	1
92-14	H18-CHCO-10179	52	52	Screw—Click	1
92-15	H18-CHCO-10200	1261	1261	Spring—Click, complete with pin	1
92-16	H18-CHCO-10181	6862	6862	Screw—Click spring	1
92-17	H18-CHCO-10122	7360	7360	Pillar—Backplate	4
92-2	H18-CHCO-10182	633	633	Screw—Backplate pillar	4
92-18	H18-CHCO-10133	7364	7364	Pillar—Train plate	3
92-2	H18-CHCO-10182	633	633	Screw—Train plate pillar	3
92-19	H18-CHCO-10127	8468	8468	Plate—Front, complete with bushings and stop pin	1
92-20		*7686	7686	Pin—Regulator gear stop	1
92-3	H18-CHCO-10021	8473	8473	Bushing—Intermediate lower pivot	1
92-21	H18-CHCO-10023	8474	8474	Bushing—Third lower pivot	1

* Not recommended for stocking.

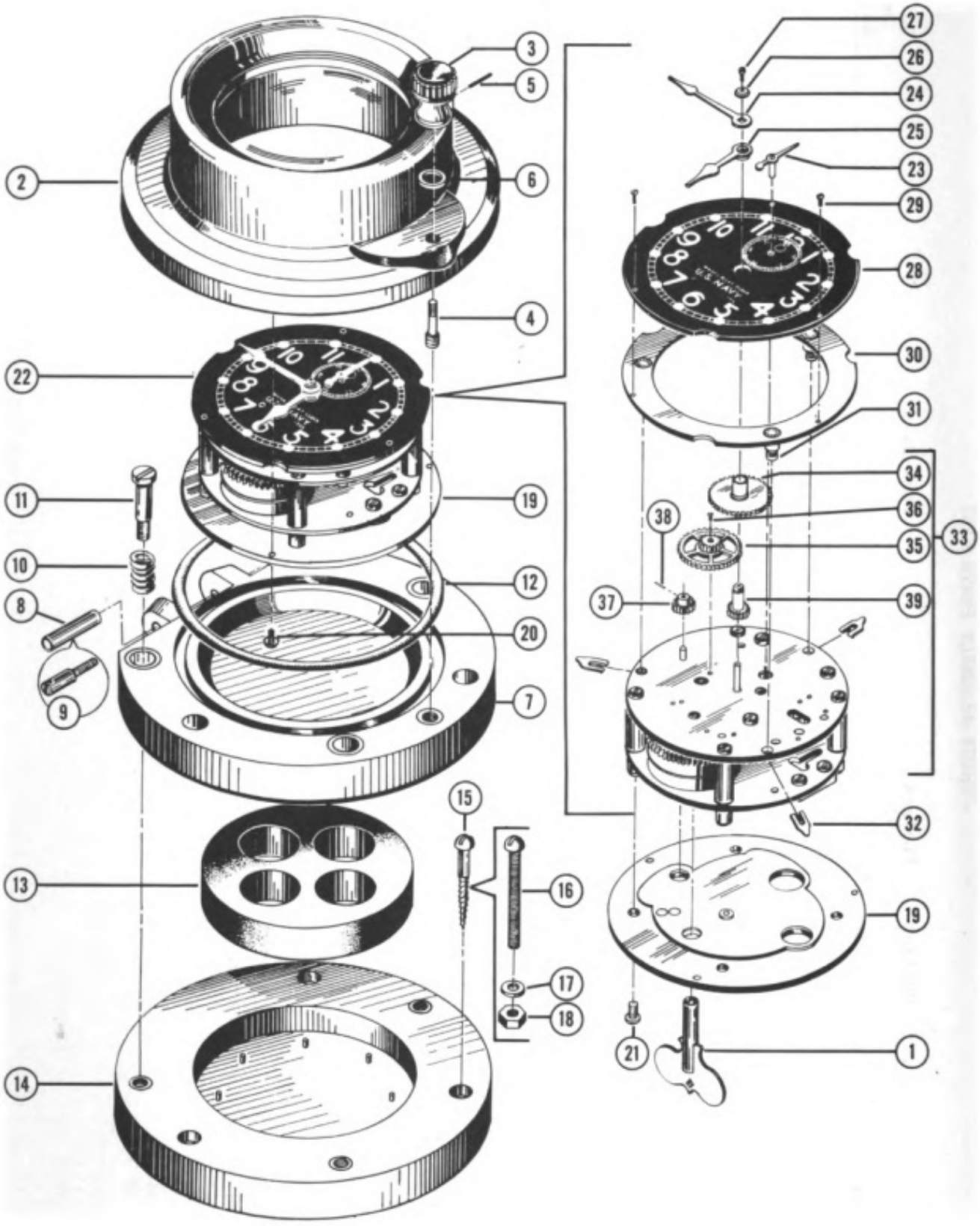

Figure 93—Chelsea No. 17E Boat and Deck Clocks, Main Assembly—Exploded View

CHELSEA MODEL NO. 17E BOAT AND DECK CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Deck Clock	Units Per Assembly 3-1/2" Size Boat Clock
	*G18-C-1048-100			U.S. Navy Deck Clock, 6" size (12 hr.)	1	
	*G18-C-992			U.S. Navy Boat Clock, 3-1/2" size (12 hr.)		1
93-1	H18-CHCO-10040	1500	1500	Key—Winding	1	1
93-2	H18-CHCO-10045	14060	C-8796-11(Z)	Case Assembly—Deck Clock, 8.382" O.D., complete with permoseal crystal and inserts	1	
93-2	H18-CHCO-10044	14074	L-8856-11(Z)	Case Assembly—Boat Clock, 6.400" O.D., complete with permoseal crystal and inserts		1
93-3	H18-CHCO-10098	52000	8861	Knob—Case, complete with screw and pin	1	1
93-4		†52000-11(Z)	8861-11(Z)	Screw—Case knob	1	1
93-5		†52000-12(Z)	8861-12(Z)	Pin—Case knob	1	1
93-6	H43-W-300	8964	8964	Washer—Case knob	1	1
93-7	H18-CHCO-10017	14059	14059-10(Z)	Plate—Base, complete with inserts	1	
93-7	H18-CHCO-10018	14076	14076-10(Z)	Plate—Base, complete with inserts		1
93-8	H18-CHCO-10138	12746	7751	Pin—Hinge	1	
93-9	H18-CHCO-10152	8898	8898	Pin—Hinge		1
93-10	H18-CHCO-10205	51986	8779	Spring—Back plate compression	3	3
93-11	H18-CHCO-10172	8748	8748	Screw—Back plate compression	3	3
93-12	H18-CHCO-10067	52091	52091-10(Z)	Gasket—Rubber	1	1
93-13	H18-CHCO-10053	51529	D-7604	Disc--Rubber, 6-1/4" O.D.	1	

* This is a stock number identified in the General Stores Section of the Catalog of Navy Material.

† Not recommended for stocking.

CHELSEA MODEL NO. 17E BOAT AND DECK CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Deck Clock	Units Per Assembly 3-1/2" Size Boat Clock
93-13	H18-CHCO-10052	51532	7549	Disc—Rubber, 4-1/4" O.D.		1
93-14	H18-CHCO-10143	14078	14078-10(Z)	Plate—Bulkhead, complete with inserts, 8.396" O.D.	1	
93-14	H18-CHCO-10145	14077	14077-10(Z)	Plate—Bulkhead, complete with inserts		1
93-15	43-S-11014	7890	7890	Screw—Case flange, rd. hd., wood	3	3
93-16	H43-S-23452-250	*7892	7892	Screw—Case flange, rd. hd., machine	3	3
93-17	43-W-6304	*51589	51589-10(Z)	Washer—Lock, mounting screw	3	3
93-18	H43-N-4737-50	*7893	7893	Nut—Mounting screw	3	3
93-19	H18-CHCO-10109	15764	D-8867	Cover Assembly—Dust, 6.5" O.D.	1	
93-19	H18-CHCO-10110	15777	8871	Cover Assembly—Dust, 4.5" O.D.		1
93-20	H43-S-11865-78	52002	8805	Screw—Dust cover case mounting	3	3
93-21	H18-CHCO-10160	51999	51999-10(Z)	Screw—Dust cover movement mounting	4	4
93-22		†51996-11(Z)	X-8883-11(Z)	Movement Assembly—Dialed	1	
93-22		†52027-12(Z)	X-8883-12(Z)	Movement Assembly—Dialed		1
93-23	H18-CHCO-10088	1308-A	1308	Hand—Second, complete with hub, 7/8" long approx.	1	1
93-24	H18-CHCO-10084	4786	4786	Hand—Minute, complete with socket, 2-3/4" long approx.	1	
93-24	H18-CHCO-10083	4593-B	4593	Hand--Minute, 1-3/4" long approx.		1
93-25	H18-CHCO-10078	4784	3899	Hand—Hour, 2-1/4" long approx.	1	
93-25	H18-CHCO-10077	4591-B	4591	Hand—Hour, 1-3/8" long approx.		1
93-26	H18-CHCO-10184	906	906	Washer—Hand	1	1

* Part Nos. 7892, 51589 and 7893 are alternates for Part No. 7890.

† Not recommended for stocking.

CHELSEA MODEL NO. 17E BOAT AND DECK CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assembly 6" Size Deck Clock	Units Per Assembly 3-1/2" Size Boat Clock
93-27	H18-CHCO-10164	1009	1009	Screw—Hand washer	1	1
93-28	H18-CHCO-10061	51996	D-8854	Dial, 6" O.D.	1	
93-28	H18-CHCO-10056	52027	8877	Dial, 4" O.D.		1
93-29	H18-CHCO-10156	3264	3264	Screw—Dial	3	3
93-30	H18-CHCO-10107	3937	D-3937	Ring—Dial, complete with feet, 6" O.D.	1	
93-30	H18-CHCO-10104	8880	8880	Ring—Dial, complete with feet, 4" O.D.		1
93-31		*391	391	Foot—Dial ring	3	3
93-32		1378	1378	Spring—Dial foot, "grasshopper"	3	3
93-33		*8826	X-8883	Movement Assembly--Chelsea Model 17E	1	1
93-34	H18-CHCO-10171	1713	1713	Wheel—Hour, complete with tube	1	1
93-35	H18-CHCO-10221	7354	7354	Wheel—Minute, complete with pinion	1	1
93-36	H18-CHCO-10167	1098	1098	Screw—Minute wheel	1	1
93-37	H18-CHCO-10069	8820	8820	Pinion—Setting	1	1
93-38	H18-CHCO-10141	5840	5840	Pin—Setting pinion	1	1
93-39	H18-CHCO-10073	909	909	Pinion—Cannon	1	1

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assy.
94-1	H18-CHCO-10097	7561	7561	Knob—Start and stop	1
94-2	H18-CHCO-10191	1361	1361	Screw—Start and stop knob	1
94-3	H18-CHCO-10112	8824	8824	Gear—Regulator	1
94-4	H18-CHCO-10196	870	870	Screw—Regulator gear	1
94-5	H18-CHCO-10207	7734	7734	Spring—Thrust	1
94-6	H18-CHCO-10181	6862	6862	Screw—Thrust spring	1
94-7		8795	8795	Plate—Back, complete with stud and pin	1

* Not recommended for stocking.

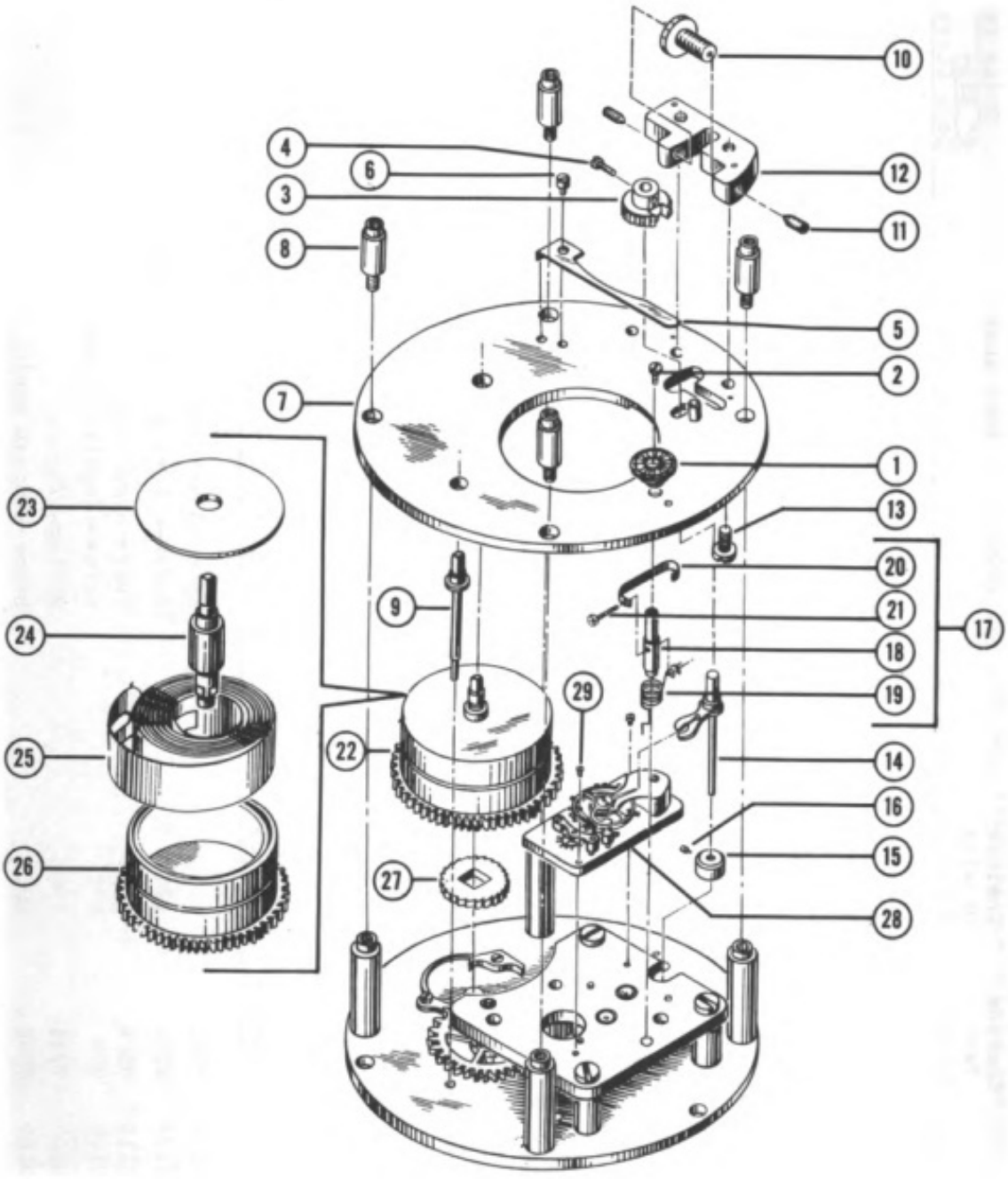

Figure 94—Chelsea No. 17E Boat and Deck Clock Components—Exploded View

GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assy.
94-8	H18-CHCO-10118	8855	8855	Pillar—Extension	4
94-9	H18-CHCO-18006	8819	8819	Shaft—Setting	1
94-10	H18-CHCO-10169	8818	8818	Wheel—Regulator index, complete with worm screw	1
94-11	H18-CHCO-10194	52029	52029	Screw--Worm bearing	2
94-12	H18-CHCO-10031	8821	8821	Block—Regulator	1
94-13	H18-CHCO-10182	633	633	Screw—Regulator block	2
94-14	H18-CHCO-10011	8814	8814	Staff—Regulator, complete with "polywog" regulator level	1
94-15	H18-CHCO-10047	8823	8823	Collar—Regulator staff	1
94-16	H18-CHCO-10195	773	773	Screw—Regulator staff collar	1
94-17		*8816-A	8816-A	Start and Stop Assembly	1
94-18	H18-CHCO-10008	8816	8816	Shaft—Start and stop	1
94-19	H18-CHCO-10189	192-A	192-A	Spring—Start and stop shaft	1
94-20	H18-CHCO-10206	8817	8817	Spring—Start and stop	1
94-21	H18-CHCO-10192	962-A	962-A	Screw—Start and stop spring	1
94-22		*8803-11(Z)	8803-11(Z)	Barrel Assembly—Mainspring	1
94-23	H18-CHCO-10035	8806	8806	Cap—Mainspring, complete with hub	1
94-24	H18-CHCO-10003	8808	8808	Arbor—Barrel, complete with hook	1
94-25	H18-CHCO-10203	8832	8832	Mainspring—Clock	1
94-26	H18-CHCO-10015	8803	8803	Barrel—Mainspring, complete with hook	1
94-27	H18-CHCO-10185	745	745	Wheel—Ratchet	1
94-28	H18-CHCO-10063	51502-A	51502-A	Escapement Assembly—Chelsea No. 22	1
94-29	H18-CHCO-10158	962	962	Screw--Escapement mounting	2

* Not recommended for stocking.

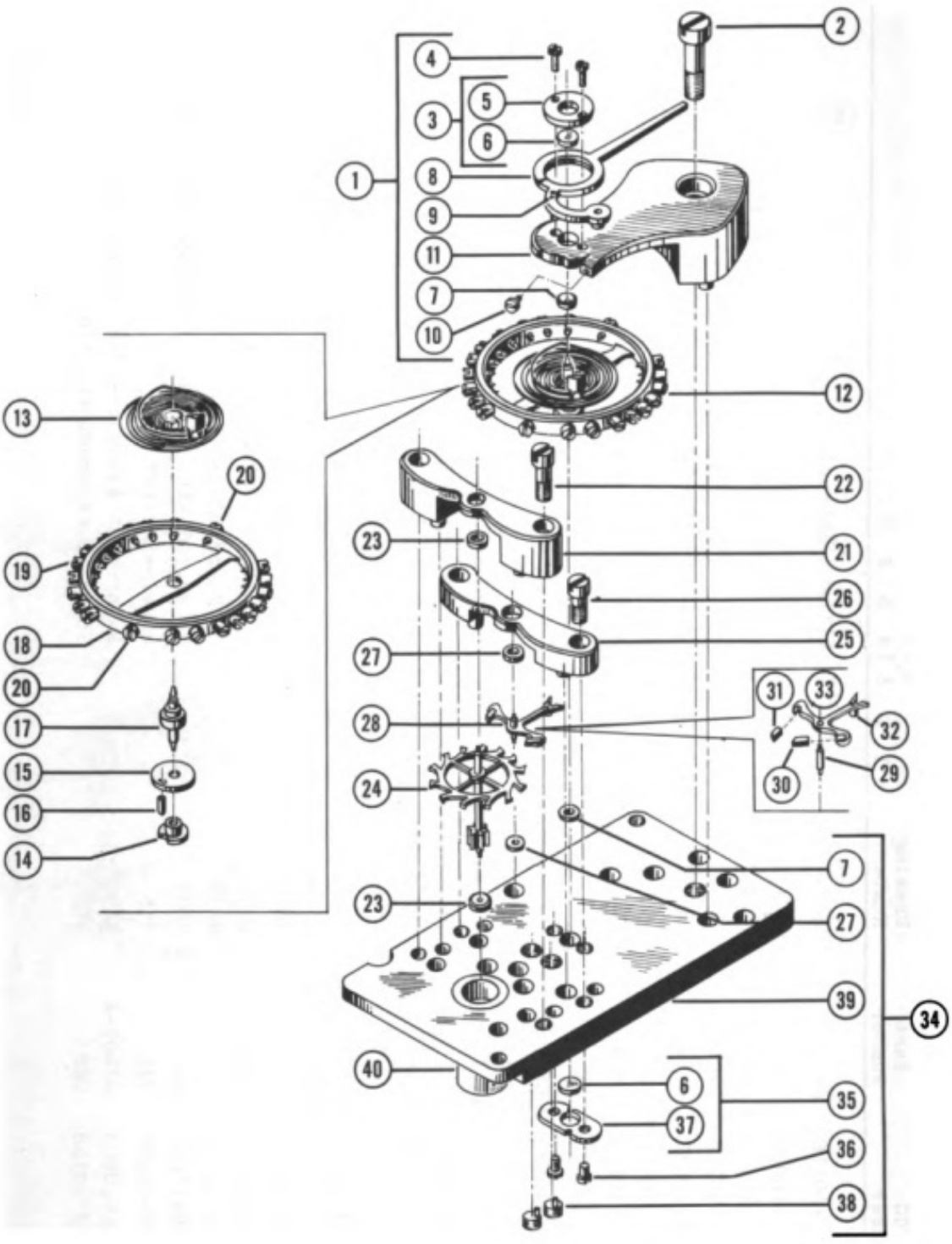

Figure 95—Chelsea No. 17E Boat and Deck Clock Escapement Assembly, No. 22—Exploded View

CHELSEA MODEL NO. 17E BOAT AND DECK CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assy.
94-28	H18-CHCO-10063	51502-A	51502-A	Escapement Assembly—Chelsea No. 22	Ref.
95-1	H18-CHCO-10046	51709	3-0044-11(Z)	Cock Assembly—Balance	1
95-2	H18-CHCO-10150	51722	3-0121	Screw--Balance cock	1
95-3	H18-CHCO-10025	51712	3-0114	Cap Assembly—Balance upper endstone	1
95-4	H18-CHCO-10188	51714	3-0122	Screw—Balance upper endstone cap	2
95-5		*51713	3-0113	Cap—Balance upper endstone	1
95-6		*51715	3-0056	Endstone—Balance upper	1
95-7	H18-CHCO-10091	51716	3-0050	Jewel—Balance hole, upper	1
95-8	H18-CHCO-10000	51718	3-0049	Regulator, complete with pins	1
95-9		*51720	3-0066	Pin—Regulator	2
95-10	H18-CHCO-10163	51717	3-0117	Screw—Hairspring stud	1
95-11		*51710	3-0043	Cock—Balance, complete with steady pin	1
95-12	H18-CHCO-10012	51723	3-0086	Balance and Hairspring Assembly, complete	1
95-13	H18-CHCO-10074	51728	3-0076	Hairspring Assembly, complete	1
		*51729	3-0077	Hairspring	1
		*51730	3-0079	Collet—Hairspring	1
		*51731	3-0066	Pin—Hairspring collet	1
		*51732	3-0069	Stud—Hairspring	1
		*51731	3-0066	Pin—Hairspring stud	1
95-14	H18-CHCO-10147	51735	3-0088	Roller—Safety	1
95-15	H18-CHCO-10148	51736	3-0087	Roller—Table	1
95-16	H18-CHCO-10095	51734	3-0064	Pin—Jewel	1
95-17	H18-CHCO-10208	51727	3-0085	Staff—Balance	1

* Not recommended for stocking.

CHELSEA MODEL NO. 17E BOAT AND DECK CLOCKS
GROUP ASSEMBLY PARTS LIST

Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name 1 2 3 4 5 6 7	Units Per Assy.
95-18		*51724-11(Z)	3-0081-11(Z)	Wheel—Balance, complete with screws	1
95-19		*51725	3-0083	Screw—Balance wheel	AR
95-20		*51726	3-0082	Screw—Timing	2
95-21	H18-CHC0-10032	51737	3-0111	Bridge—Escape, complete with jewel and pins	1
95-22	H18-CHC0-10157	51741	3-0118	Screw—Escape bridge	2
95-23	H18-CHC0-10092	51740	3-0059	Jewel—Escape, upper	1
95-24	H18-CHC0-10215	51750	3-0123	Wheel--Escape, complete with pinion and hub	1
95-25	H18-CHC0-10033	51760	3-0155	Bridge—Pallet, complete with jewel and pins	1
95-26	H18-CHC0-10178	51763	3-0120	Screw—Pallet bridge	2
95-27	H18-CHC0-10093	51748	3-0057	Jewel—Pallet, upper	1
95-28	H18-CHC0-10115	51754	3-0091	Pallet Assembly	1
95-29	H18-CHC0-10004	51757	3-0096	Arbor—Pallet	1
95-30	H18-CHC0-10090	51758	3-0060	Stone—Pallet, left	1
95-31	H18-CHC0-10094	51759	3-0061	Stone--Pallet, right	1
95-32		*51755	3-0072	Pin—Guard	1
95-33		*51756	B-3-0090	Pallet	1
95-34		*51742	3-0018-11(Z)	Plate Assembly—Escapement	1
95-35	H18-CHC0-10022	51743	3-0116	Cap Assembly—Balance lower endstone	1
95-36	H18-CHC0-10165	51745	3-0119	Screw—Balance lower endstone cap	2
95-37		*51744	3-0115	Cap—Balance lower endstone	1
95-6		*51715	3-0056	Endstone—Balance lower	1
95-7	H18-CHC0-10091	51716	3-0051	Jewel—Balance hole, lower	1

* Not recommended for stocking.

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Fig. & Index Number	SPCC Number	Chelsea Part Number	Chelsea Drawing Number	Part Name	Units Per Assy.
95-38	H18-CHC0-10177	51746	3-0070	Screw—Banking	2
95-23	H18-CHC0-10092	51740	3-0059	Jewel—Escape, lower	1
95-27	H18-CHC0-10093	51748	3-0057	Jewel—Pallet, lower	1
95-39		*51747	3-0018-12(Z)	Plate—Escapement	1
95-40		*51749	3-0022	Potance	1
96-1		8797	8797	Plate—Train, complete with bushings	1
96-2	H18-CHC0-10024	8616	8616	Bushing—Third and fourth pivot	2
96-3	H18-CHC0-10182	633	633	Screw—Train plate	3
96-4	H18-CHC0-10218	7947	7947	Wheel—Fourth, complete with pinion and hub	1
96-5	H18-CHC0-10224	2255	2255	Wheel—Third, complete with pinion and hub	1
96-6	H18-CHC0-10210	1213	1213	Wheel—Intermediate, complete with pinion	1
96-7	H18-CHC0-10214	8811	8811	Wheel—Center, complete with arbor, pinion and friction spring	1
96-8	H18-CHC0-10117	10	10	Click	1
96-9	H18-CHC0-10179	52	52	Screw—Click	1
96-10	H18-CHC0-10200	1261	1261	Spring—Click, complete with pin	1
96-11	H18-CHC0-10181	6862	6862	Screw—Click spring	1
96-12	H18-CHC0-10123	8804	8804	Pillar—Back plate	4
96-3	H18-CHC0-10182	633	633	Screw—Back plate pillar	4
96-13	H18-CHC0-10133	7364	7364	Pillar—Train plate	3
96-3	H18-CHC0-10182	633	633	Screw—Train plate pillar	3
96-14		8792	8792	Plate—Front, complete with bushings	1
96-15	H18-CHC0-10023	8474	8474	Bushing—Third and fourth pivot	2
96-16	H18-CHC0-10021	8473	8473	Bushing—Intermediate pivot	1

* Not recommended for stocking.

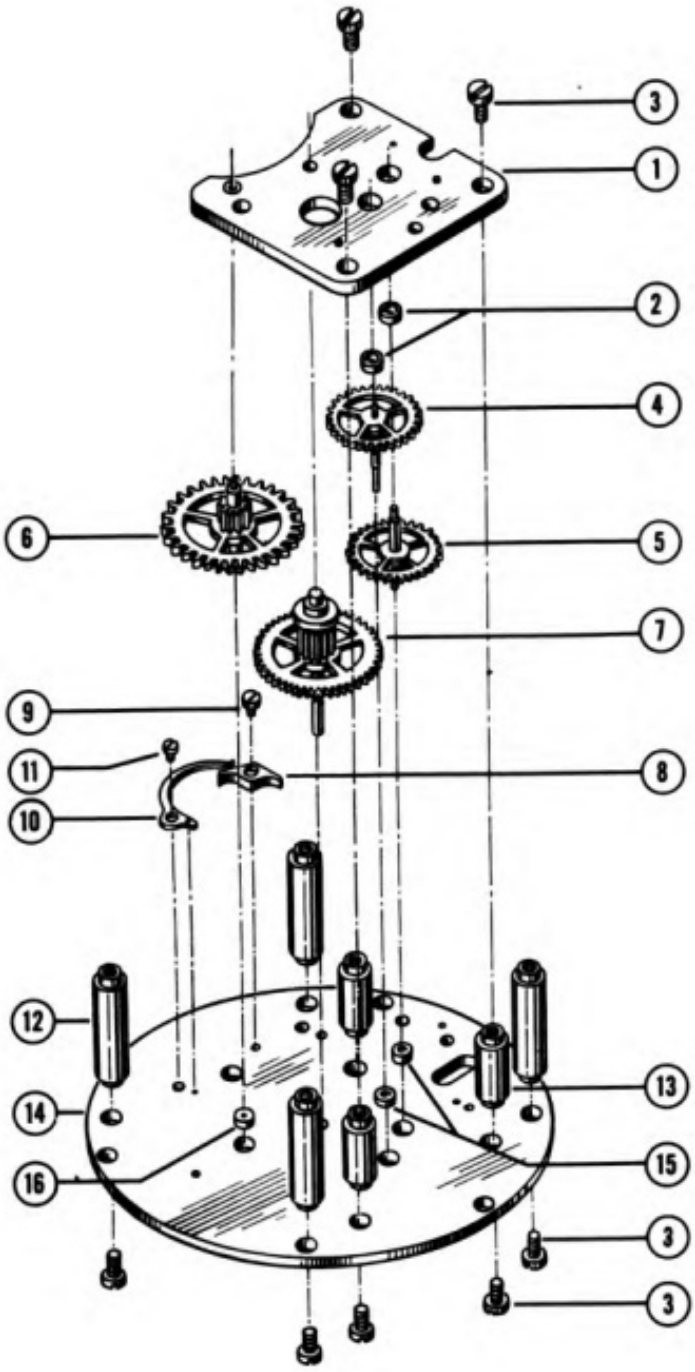

Figure 96—Chelsea No. 17E Boat and Deck Clock Components—Exploded View

SECTION VIII

SPECIAL SERVICE TOOLS AND TESTING DEVICES

INTRODUCTION

The standard practice for the repair of Chelsea clocks, as set forth in this manual, is an integration of the best and latest methods employed by both instrument manufacturers and Naval repair facilities. This section catalogs the special service tools, fixtures and test apparatus which were selected to:

a. Implement standard practice.

b. Reduce skill levels to that of the personnel ratings indicated.

c. Prevent damage to parts during repair operations.

The tools and testing devices are listed numerically in the Special Service Tool List by their tool numbers. The name assigned to each tool was selected on a functional basis to suggest the use of the tool.

Hand tools and test fixtures that can be readily fabricated in a small machine shop are illustrated by isometric drawings. Where such tools appear in the tool list, they are referenced to the illustrations.

As we have indicated, the special service tools and test apparatus, recommended for use in repairing a Chelsea clock are intended to increase the efficiency of the repair work; they should save time, reduce costs, help prevent damage to parts and make your job easier. However, these tools are hardly the last word; there is always room for improvement of existing tools and for new tools.

You are in an excellent position to use the benefits of your experience, in actually doing the work, toward improving the existing tools. The Beneficial Suggestion Program in shipyards was devised to encourage new ideas by rewarding those who make acceptable suggestions. Enlisted personnel aboard repair ships are also invited to submit their suggestions.

Become methods-conscious and constantly analyze your job and the tools you are using. See what improvements you can suggest. If you get an idea that requires time and material to develop, ask your supervisor for permission to work on it. Clear all suggestions through your supervisor and Beneficial Suggestion Committee for transmittal to the navigational instrument authority of the Bureau of Ships.

Any effort by you on behalf of the Navy will be appreciated. If your suggestions are accepted, future revisions of the Special Service Tool List will include your suggested tool for the benefit of all repair facilities.

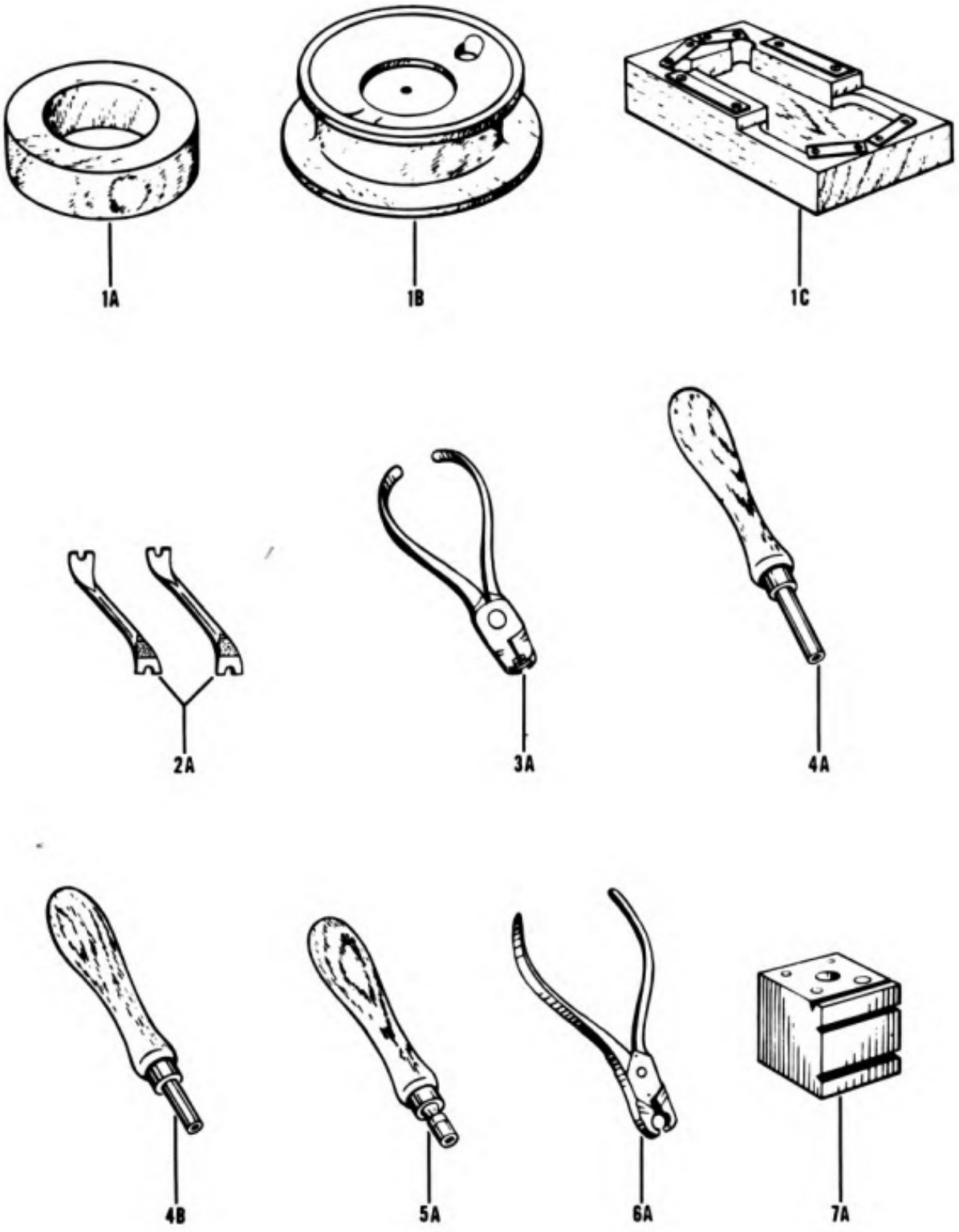

Figure 97—U.S. Navy Clock Special Tools and Fixtures

COMBINED SPECIAL TOOL AND FIXTURE LIST FOR U.S. NAVY MECHANICAL, BOAT AND DECK CLOCKS (CHELSEA AND SETH THOMAS TYPES)

Fig. & Index No.	Tool Type	Tool No.	Tool Name	Where Used
97-1	1		Block—Movement work	
		1A		Chelsea 12E and 17E
		1B		Seth Thomas Boat and Deck Clocks, 5165 Mechanical Clocks
		1C		Seth Thomas 5160 Mechanical Clocks
97-2	2		Remover—Hand (also called "lifters") (with felt heel pad)	
		2A		Chelsea and Seth Thomas Mechanical, Boat and Deck Clocks
97-3	3		*Pliers—Hand nut, round (with hard rubber insert)	
		3A		Seth Thomas Mechanical Clocks
97-4	4		Wrench—Socket, hand nut, hex	
		4A		Seth Thomas Boat and Deck Clocks. Large hex. nuts
		4B		Seth Thomas Boat and Deck Clocks. Small hex. nuts
97-5	5		Key—Mainspring letdown	
		5A		Chelsea and Seth Thomas Mechanical, Boat and Deck Clocks
97-6	6		Pliers—Pillar	
		6A		Chelsea and Seth Thomas Mechanical, Boat and Deck Clocks
97-7	7		Block—Escapement work	
		7A		Chelsea escapements
98-7		7B		Seth Thomas escapements
		7C		Elgin escapement
98-8	8		Pliers—Mainspring end shaping	
		8A		Chelsea and Seth Thomas Mechanical, Boat and Deck Clocks
98-9	9		Winder—Mainspring	
		9A		Chelsea and Seth Thomas barrels
98-10	10		Press—Barrel cap	
		10A		Chelsea barrels
98-11	11		Tool—Barrel cap staking	
		11A		Seth Thomas barrels

* The pliers for the round hand nut are to be replaced with a hexagonal socket wrench as soon as the round hand nut is replaced with a hexagonal hand nut.

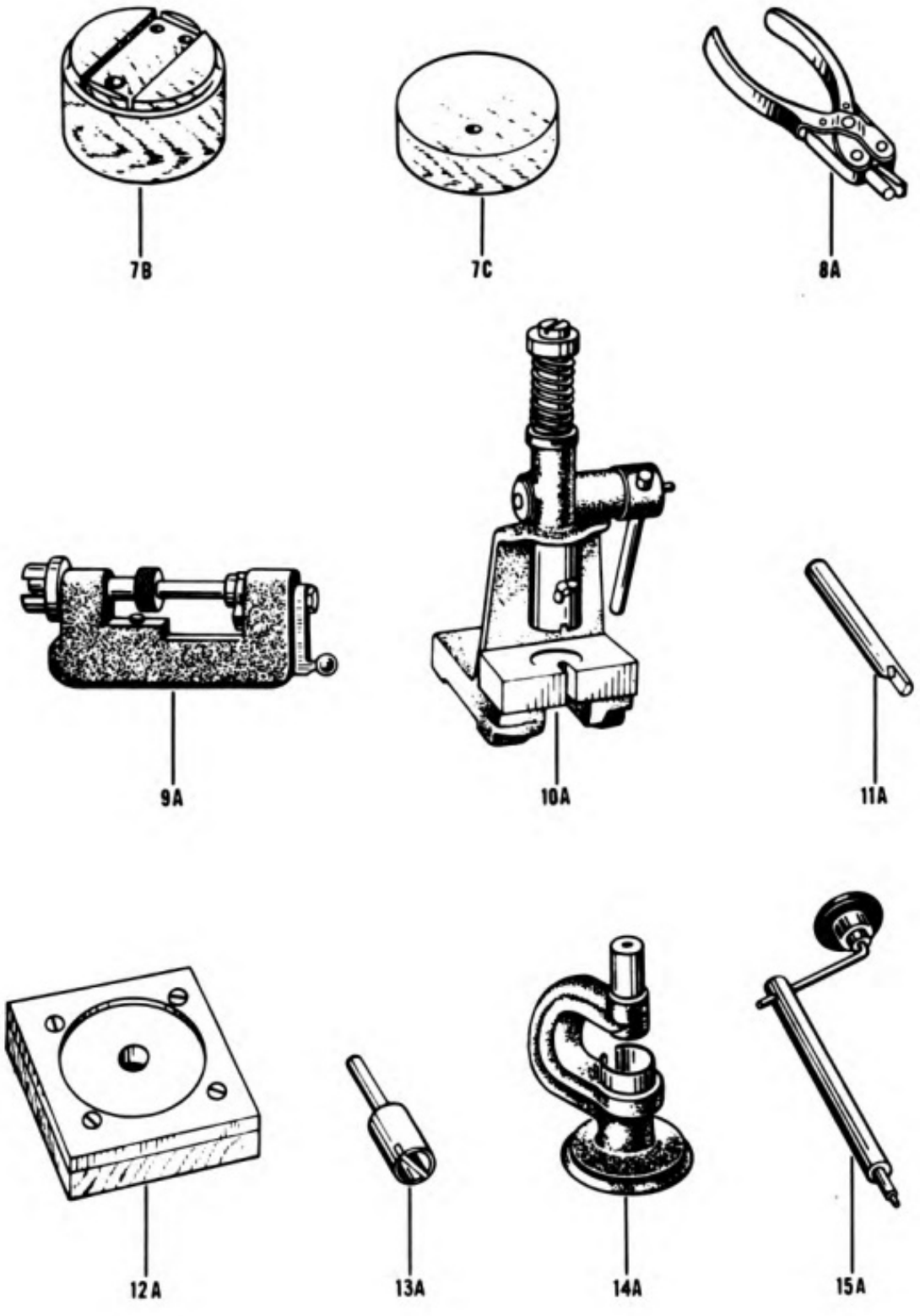

Figure 98—U.S. Navy Clock Special Tools and Fixtures

SPECIAL TOOL AND FIXTURE LIST

Fig. & Index No.	Tool Type	Tool No.	Tool Name	Where Used
98-12	12		Block—Barrel cap staking	
		12A		Seth Thomas barrels
98-13	13		Collar—Automatic screw-driver tip	
		13A		All pillar screws
98-14	14		Stand—Milling and broaching tool	
		14A		Endshaking and sideshaking all movement pivots
98-15	15		Holder—Milling and broaching tool	
		15A		Endshaking and sideshaking all movement pivots
99-16	16		Tool—Milling, assorted sizes	
		16A		Endshaking all movement pivots
99-17	17		Tool—Broaching, assorted sizes	
		17A		Sideshaking all movement pivots
99-18	18		Tool—Cannon pinion friction adjusting	
		18A		Seth Thomas large diameter cannon pinion
		18B		Seth Thomas small diameter cannon pinion
99-19	19		Pusher—Cannon pinion	
		19A		Large diameter cannon pinions
		19B		Small diameter cannon pinions
99-20	20		Pusher—Hand	
		20A		All hands
99-21	21		Tool—Hairspring removing	
		21A		All hairsprings
99-22	22		Block—Beat adjusting	
		22A		All balance wheels
99-23	23		Tool—Beat adjusting	
		23A		All balance wheels
99-24	24		Block—Balance cock bumping	
		24A		All balance cocks
99-25	25		Tool—Balance cock bumping	
		25A		All balance cocks
99-26	26		Clamp—Movement to timing machine	
		26A		All movements

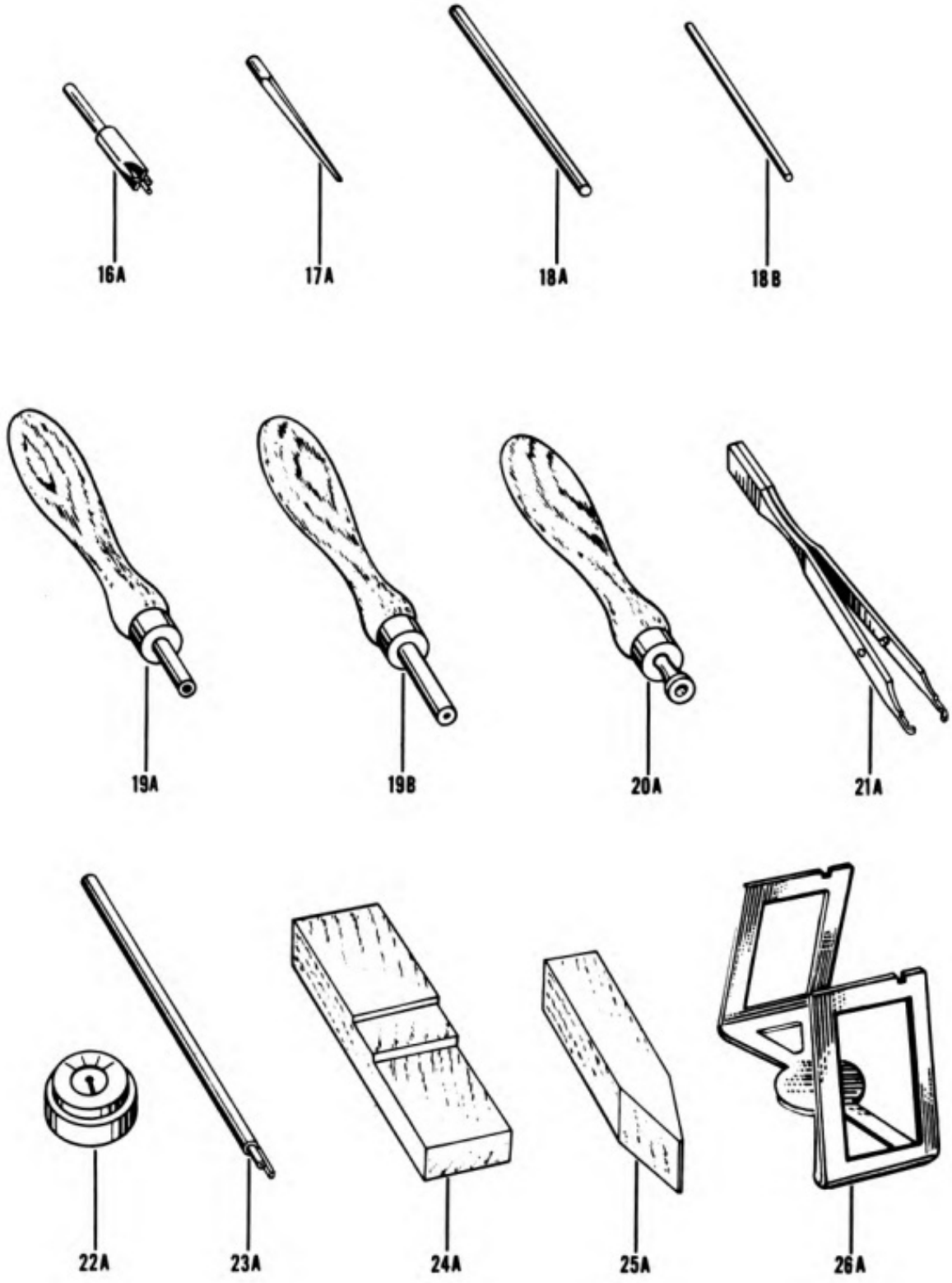

Figure 99—U.S. Navy Clock Special Tools and Fixtures

SECTION IX

CHELSEA CLOCKS SPECIAL SERVICE BULLETINS

INTRODUCTION

This section is provided for the manual as a place to incorporate the various clock service bulletins as they are issued by the Bureau of Ships. It is contemplated that such bulletins will be the medium by which navigational instrument repair facilities are informed of changes and developments in the overhaul and repair procedures of these instruments. Hence, it is important that all such information peculiar to the repair of clocks be placed immediately in this section of the manual. Changes affecting general navigational instrument standard repair procedures and techniques, inspection standards, etc. will be issued as supplementary service bulletins to the Bureau of Ships Navigational Instrument Control Manual.

All repair personnel should appreciate the importance of keeping up to date on all such changes. Good work can come only from well-informed personnel who are experienced in performing their duties.

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DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
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U.S. NAVY CLOCKS—CHELSEA TYPE

This publication will be known as: "Manual for Overhaul, Repair, and Handling of U. S. Navy Mechanical, Boat and Deck Clocks, Chelsea Type, with Parts Catalog."

This manual, prepared with the assistance and cooperation of certain U. S. Navy repair activities and Chelsea Clock Company, Boston, Massachusetts, is promulgated for the information and guidance of all personnel in the Naval Establishment engaged in the servicing, repair, and testing of clocks.

This manual is available for public sale through the Superintendent of Documents, Washington 25, D. C.

H. N. Wallin,
Chief, Bureau of Ships