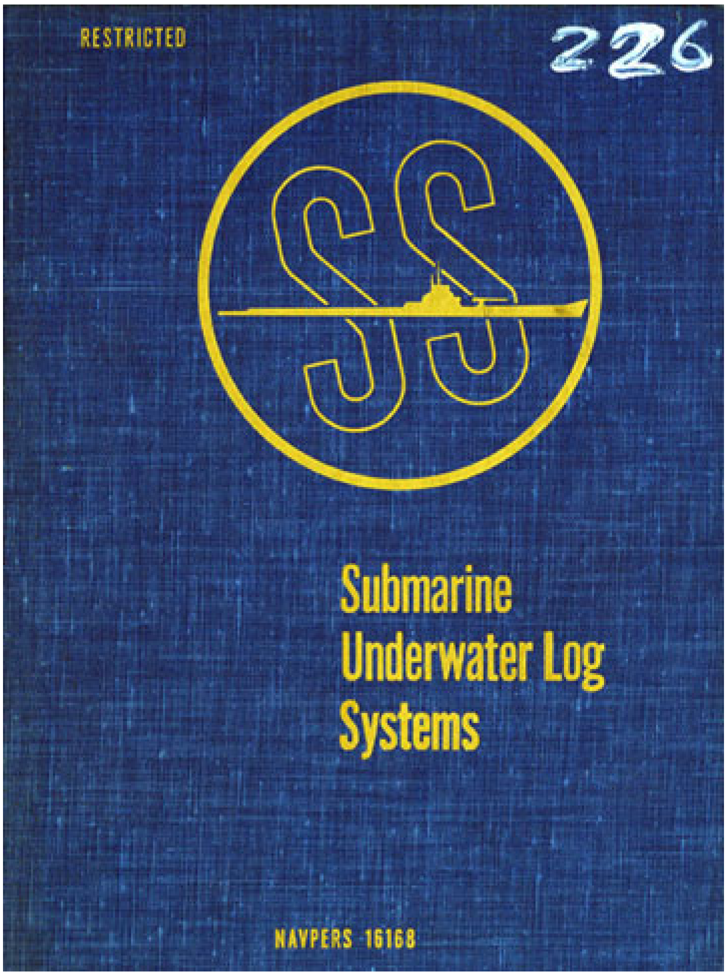
The Fleet Type Submarine Online Submarine Underwater Log Systems



Folks,

Submarine Underwater Log Systems, Navpers 16168, is one of a series of submarine training manuals that was completed just after WW II. The series describes the peak of WW II US submarine technology.

In this online version of the manual we have attempted to keep the flavor of the original layout while taking advantage of the Web's universal accessibility. Different browsers and fonts will cause the text to move, but the text will remain roughly where it is in the original manual. In addition to errors we have attempted to preserve from the original (for example, it was H.L. Hunley, not CS Huntley), this text was captured by optical character recognition. This process creates

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Standards and Curriculum Division,
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SUBMARINE

UNDERWATER LOG SYSTEMS

June 1946

~~RESTRICTED~~

This is one of a series of Submarine Training Manuals. The series includes:

1.	The Fleet Type Submarine	NavPers 16160
2.	Submarine Main Propulsion Diesels	NavPers 16161
3.	Submarine Electrical Installations	NavPers 16162
4.	Submarine Refrigerating and Air-Conditioning Systems	NavPers 16163
5.	Submarine Distilling Systems	Navpers 16163A
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7.	Submarine Periscope Manual	NavPers 16165
8.	Submarine Trim and Drain Systems	NavPers 16166
9.	Submarine Sonar Operator's Manual	NavPers 16167
10.	Submarine Underwater Log Systems	NavPers 16168
11.	Submarine Hydraulic Systems	NavPers 16169
12.	Torpedo Tubes, 21-Inch submerged, Mks 32 to 39	O.P. 1085

PREFACE

A submarine must operate below the surface a great part of the time while in enemy-controlled waters. She is therefore denied the opportunity to establish her position by means of sights of the sun; and weather conditions often make it impossible to obtain sights of the stars when surfaced at night. Accurate knowledge of her position is vital to the submarine, not only to enable her to avoid the ordinary hazards of navigation, but to assist in her primary mission of locating and destroying the enemy. In order to know her position with accuracy, the submarine must have a means of determining her own speed.

The accurate solution of the torpedo fire-control problem, in order to destroy the enemy, is dependent in large measure upon precise knowledge of the enemy's speed. The determination of this factor is in turn dependent upon knowledge of the submarine's speed. The submarine underwater log system is the means provided for determining enemy speed.

The purpose of this manual is to explain in full detail all phases of the theory, operation, adjustment and calibration, assembly and disassembly, and maintenance of the various underwater log systems installed in fleet submarines. It is intended as a complete service and reference manual for operating forces as well as an -instructional textbook for personnel receiving advanced training in the maintenance of the log systems.

The Submarine School, Submarine Base, New London, Connecticut, and other activities of Submarines, Atlantic Fleet, have collaborated in the preparation of this manual. Its entire contents have been checked by engineers in the employ of the separate manufacturers who furnish underwater log systems to the Navy.

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Version 1.14, 5 July 07

1
INTRODUCTION

A. GENERAL DESCRIPTION OF THE LOG SYSTEM

1A1. General. The submarine underwater log system is a device for indicating, in knots, the speed of the ship as it travels through the water, and for recording in nautical miles the distance traveled. The principal components of the system are located in the forward torpedo room, below the light draft water line of the ship.

Figure 1-1. Underwater log in position in submarine extended down below the forward torpedo room.

B. PRINCIPLES OF OPERATION

1B1. Principles. The underwater forward, the movement creates

log system operates on the principle of hydraulic pressure actuating electrical and mechanical units. These units are so calibrated that hydraulic pressure is translated into terms of speed and distance. The hydraulic pressure acts through the rodmeter. This part of the underwater log system extends through the hull of the ship into the water. There are two passages in the rodmeter. When the ship is at rest, the hydraulic pressure is equal in both passages, and is due only to the weight of the water above the system. This pressure is known as static pressure. As the ship moves additional pressure in the forward passage of the rodmeter. This added pressure is known as dynamic pressure, and is the actuating force which operates the system.

The dynamic pressure developed in the forward passage in the rodmeter can be determined by creating a force of known value and using it to equalize the dynamic pressure. The amount of force required to equalize the dynamic pressure is converted into units of speed. These units are registered on indicators calibrated to read in knots, and in distance traveled.

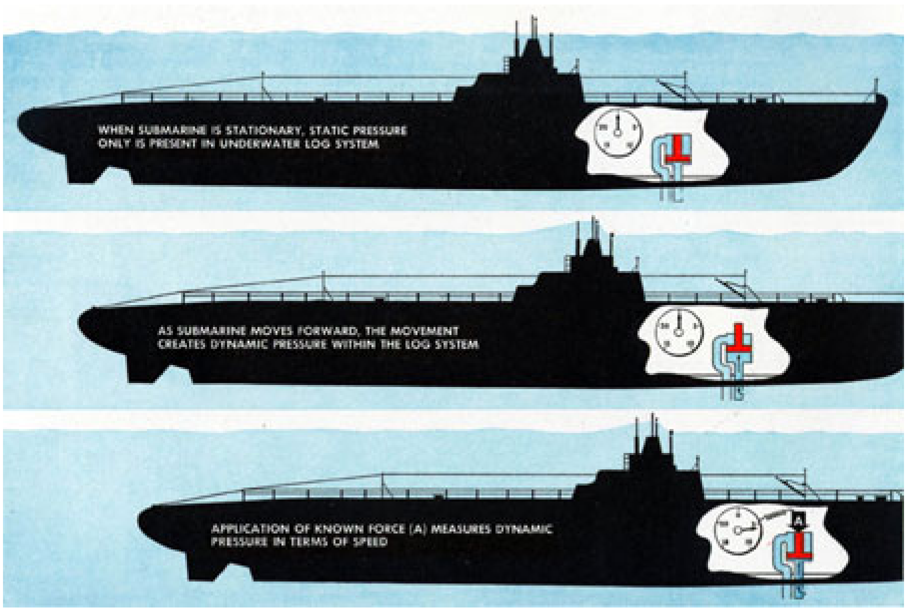


Figure 1-2. Elementary diagram showing fundamental principle of operation.
Top: When submarine is stationary, static pressure only is present in the underwater log system.
Middle: As submarine moves forward, the movement creates dynamic pressure within the log system.
Bottom: Application of known force (A) measures dynamic pressure in terms of speed.

Version 1.10, 22 Oct 04

PART I

PITOMETER UNDERWATER LOG-ROTARY BALANCE TYPE

2
DESCRIPTION

A. GENERAL DESCRIPTION

2A1. General. The Pitometer underwater log, rotary balance type, is made by the Pitometer Log Corporation, New York, New York. This system, illustrated in Figure 2-1, consists of five major components. Each instrument is watertight, and is designed for either panel or bulkhead mounting.

2A2. Rodmeter. The rodmeter, commonly called the sword, is located in the forward torpedo room below the light draft water line. It projects through the hull of the ship, into the water, and is the unit in which static and dynamic pressures are produced and transmitted to the other units of the system. When in use, the rodmeter extends into the water for a distance of about 3 feet. Being located in the forward part of the ship, the rodmeter contacts water that is least affected by the movement of the ship or by the turbulence of the water created by the action of the propellers.

2A3. Sea valve. The sea valve forms a support for the rodmeter and provides a means of closing bellows enclosed in a watertight housing, and a set of electrical contacts. The inside of the bellows is hydraulically connected to the pump of the rotary distance transmitter, while the outside of the bellows is connected to the static orifice of the rodmeter. The electrical contacts control the supply of current to the rotary distance transmitter pump drive motor.

2A5. Rotary distance transmitter. The rotary distance transmitter is located in the forward torpedo room, below the light draft water line. It is the unit that develops the force applied to equalize the dynamic pressure produced within the rodmeter. It consists of an electrically driven transtat assembly, an electric motor which drives a centrifugal-type pump, and a distance transmitting unit. By means of these components, rotary motion is transmitted to the master speed indicator, and to the speed and distance indicator.

2A6. Master speed indicator. The master speed indicator (Figure 2-3) is mounted on a panel near the control room steering station.

the opening through which the rodmeter passes when the rodmeter is withdrawn, or fully housed. It is located in a well below the deck in the forward torpedo room, and is bolted to the inner hull below the light draft water line. A tube extends from the underside of the inner hull to the outer hull where it is welded to a flange and guide bushing. The guide bushing forms the lower support for the rodmeter. When the rodmeter is withdrawn, closing of the sea valve prevents sea water from flooding the forward torpedo room.

2A4. Control unit. The control unit is mounted in the forward torpedo room and is suspended on a gimbal bracket which tends to keep the unit in an upright position regardless of the pitching or rolling of the ship. This unit provides a means of automatically controlling the operation of the rotary distance transmitter. It consists of a sensitive

Revolutions, the number of which are proportional to the distance traveled, are received by this unit from one of the self-synchronous transmitters in the rotary distance transmitter. These revolutions are registered on a counter and, by means of a time element, are converted into a speed indication in knots. This indication is transmitted to the speed and distance indicator.

2A7. Speed and distance indicator. The speed and distance indicator, commonly called the repeater, is mounted in the conning tower. It repeats the speed and distance readings of the master speed indicator.

2A8. Constant frequency supply unit. Some installations of the Pitometer underwater log system include another unit known as the constant frequency supply unit. This unit is designed to supply a constant 60-cycle current at 115 volts to the system.

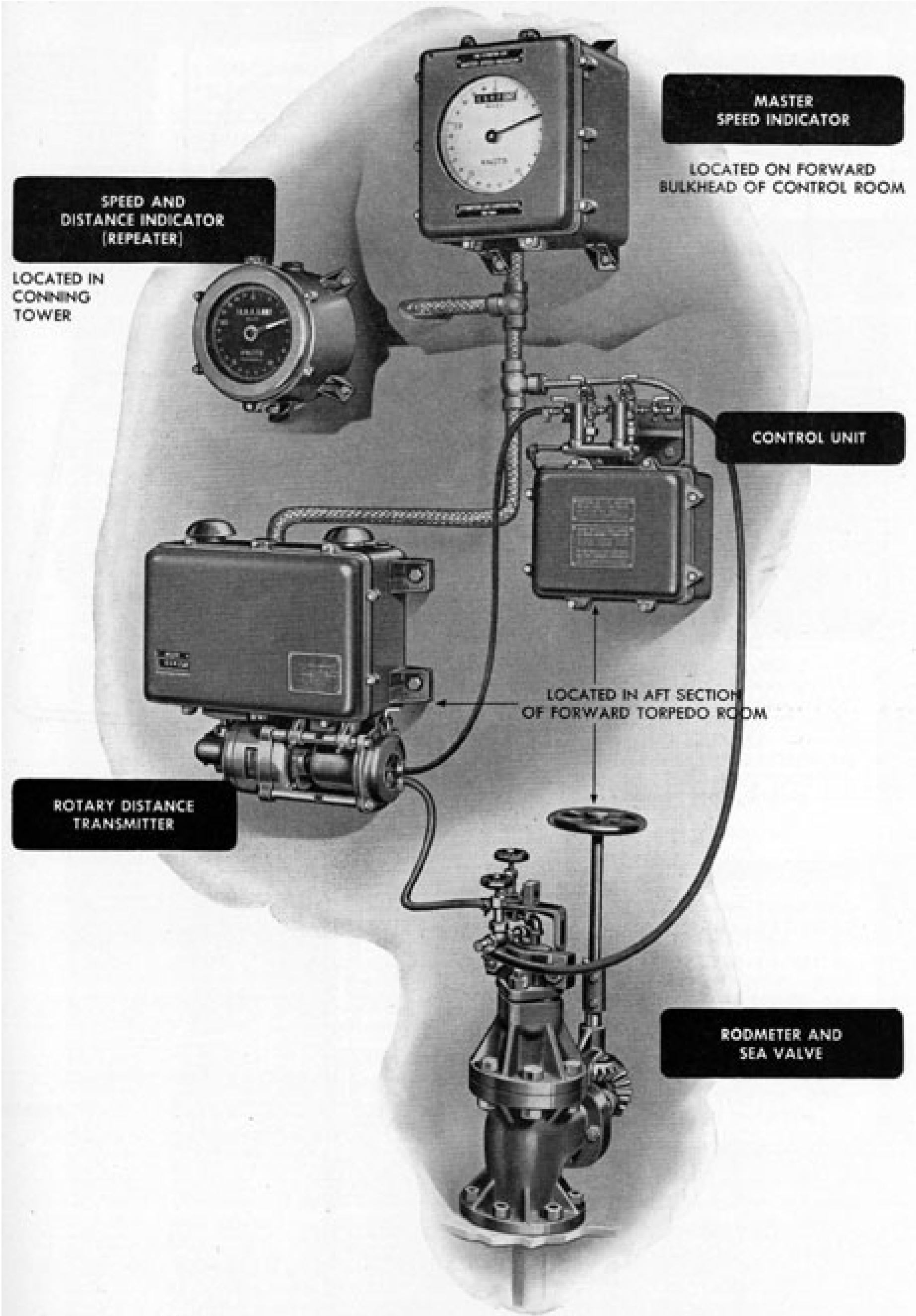


Figure 2-1. Components of Pitometer underwater log-rotary balance type.

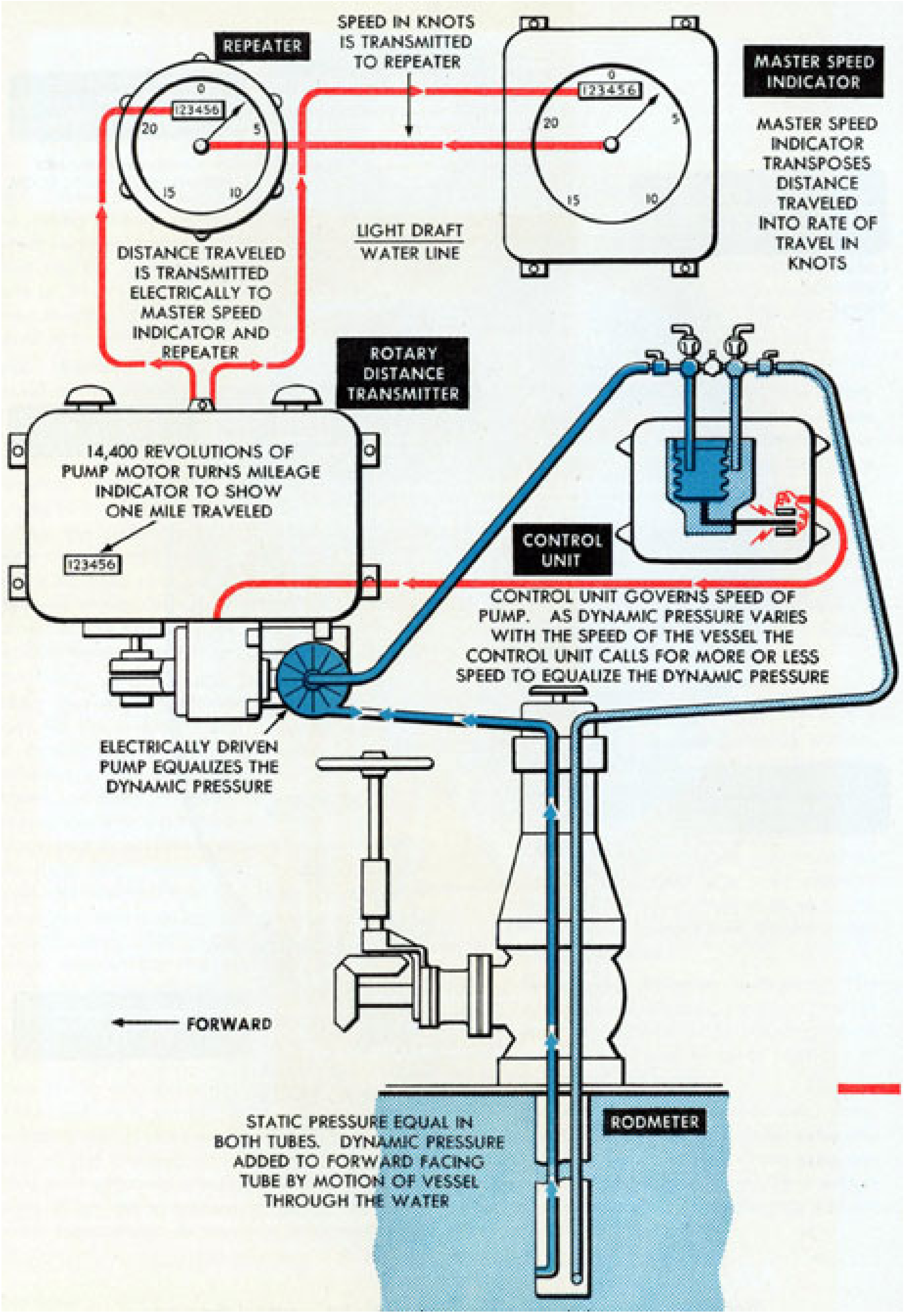


Figure 2-2. Operation of Pitometer rotary balance system.

Figure 2-3. OPERATION OF THE MASTER SPEED INDICATOR

B. DESCRIPTION OF OPERATION

2B1. Sea valve and rodmeter. While the ship is stationary, the water pressure in the rodmeter is static and the log system is in balance. As soon as the ship is underway, the forward motion creates additional pressure through the dynamic orifice in the rodmeter, while the pressure breaking the flow of current through the contact points. The pump continues to operate at a constant speed until a variation in the speed of the ship causes a variation in the pressure inside the bellows. The pump motor is geared to a distance counter, and is so designed that for every

through the static orifice remains the same. This creates an unbalanced condition in the control unit, and causes it to operate. (See Figure 2-2.)

2B2. Control unit. As the dynamic pressure increases, it is transmitted through the pump of the rotary distance transmitter to the inside of the bellows in the control unit. The pressure on the outside of the bellows (static pressure) has not changed, and because of this, the increased pressure inside the bellows causes it to expand. Movement of the bellows actuates the external contact arm, forming an electrical contact through the contact points at the outer end of the arm. Current then flows to the follow-up motor in the rotary distance transmitter.

2B3. Rotary distance transmitter. The follow-up motor operates the transtat, an electric transformer which supplies current to the pump drive motor. As the pump drive motor operates, the pressure produced by the pump opposes the dynamic pressure created in the rodmeter, reducing the pressure inside the bellows in the control unit. The bellows then contracts, returning to its former position. The contracting movement of the bellows draws the external contact arm upward, 14,400 revolutions of the pump, 1 mile is recorded on the distance counter, regardless of the speed at which that mile is covered. The distance reading is electrically transmitted to the master speed indicator and to the repeater.

2B4. Master speed indicator. The master speed indicator (Figure 2-3) receives the distance reading from the rotary distance transmitter, and registers it on a counter. This reading is of distance traveled, and bears no relation to the rate of speed. Through suitable gearing that connects the mechanism recording the known revolutions per mile with a mechanism that is operating at a known number of revolutions per minute, speed in knots is computed and registered on the dial of the master speed indicator. This reading is electrically transmitted to the speed and distance indicator, or repeater, in the conning tower.

2B5. Speed and distance indicator (repeater). The speed reading of the master speed indicator, and the distance reading of the rotary distance transmitter are transmitted electrically to the mechanism in the speed and distance indicator, and are registered on the dial and counter of that unit.

C. RODMETER AND SEA VALVE

2C1. Rodmeter. The rodmeter is made of manganese bronze, and is 8 feet 3 inches long this length is necessary because the rodmeter projects through the when the ship is submerged to a depth greater than 200 feet, to prevent damage to the sensitive bellows in the control unit (Figure 2-5). The lower end of the forward

inner and outer hulls of the submarine. It is of oval, cross-section construction, with a fiat tip at its lower end. Two water passages are formed in the rodmeter (Figure 2-4). The upper ends of these passages terminate in nipples to which a rubber hose is attached by means of a clamp. Some types of rodmeter are equipped with valves so that these passages can be closed passage in the rodmeter terminates in an opening or orifice in the forward edge, and is known as the dynamic tube and orifice. The lower end of the after passage terminates in two openings (one on either side of the tip), which are known as the static tube and orifices. These two orifices are not placed diametrically opposite each other, and therefore, cross pressures

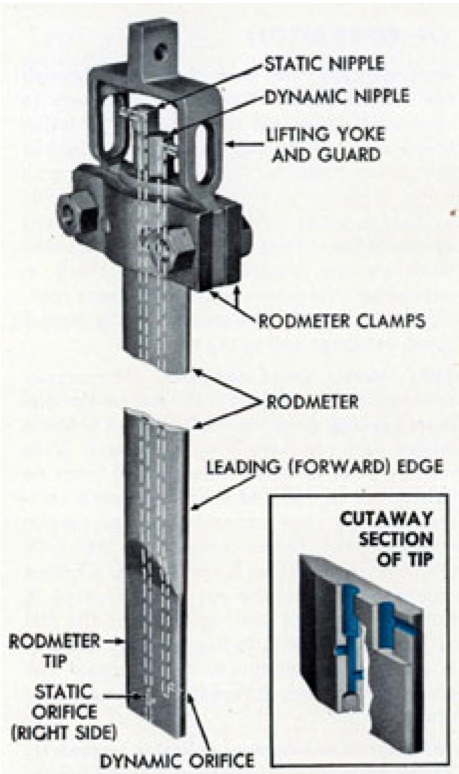


Figure 2-4. Cutaway view of rodmeter.

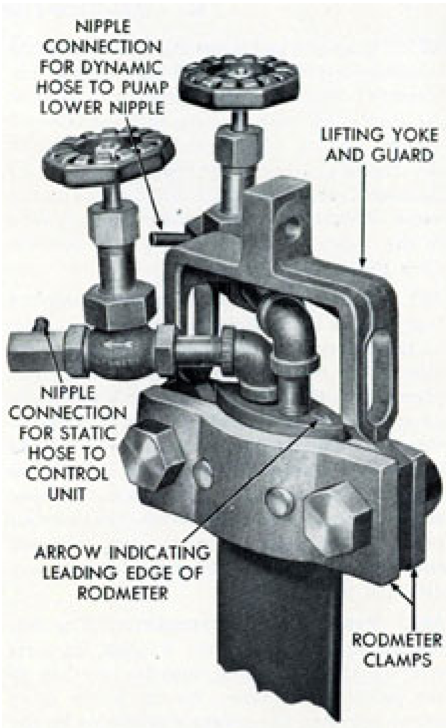


Figure 2-5. Radmeter with valves attached.

which would affect the accurate operation of the system do not develop. A lifting yoke and guard are attached to the upper end of the rodmeter by clamps, serving as a means of raising or lowering the rodmeter, and also forming a protection for the nipples. When lowered, the rodmeter projects about 3 feet through the hull into the water. A lifting device is provided in the ship for raising prevents water from entering the ship when the rodmeter is removed. The valve is a 3inch gate type, operated by means of a handwheel on an operating rod which in turn is bevel-geared to the valve stem. The sea valve is bolted to the inner hull of the ship. A 5inch valve extension with a packing land is mounted on the top flange of the valve. This extension provides an upper support when the rodmeter is

and lowering the rodmeter, and for replacing it in the event of damage. The rodmeter must always be raised, or housed, when the submarine docks or when, for tactical reasons, the submarine is allowed to rest on the ocean floor.

2C2. Sea valve. The sea valve is the mechanism that supports the rodmeter when the rodmeter is extended into the sea and that projected into the sea, and also provides a leakproof joint around the rodmeter.

2C3. Rodmeter hoist. Submarines are equipped with either one of two types of rodmeter hoist (Figure 2-7) for raising and lowering the rodmeter. One type consists of a double sprocket and roller chain arrangement, and the other type is a single chain and

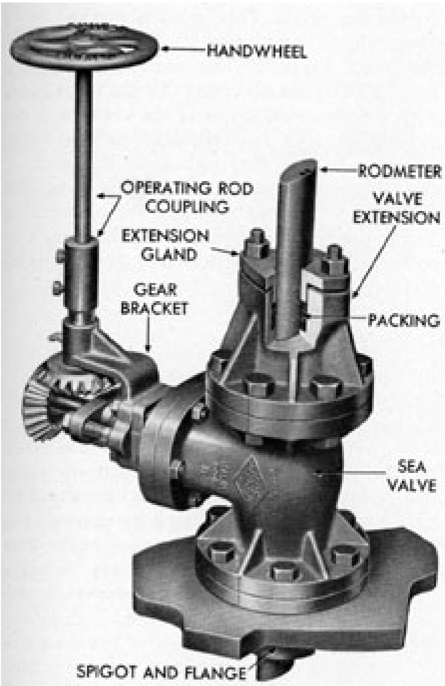


Figure 2-6. Sea valve.

single sprocket assembly. The upper sprockets are mounted either on the side of the hull or on a suitable panel near the installed rodmeter. The lower sprockets are mounted in the sea valve and rodmeter well. Sprockets are connected by roller chains. Operation is by means of a hand crank through a worm gear drive. In the single chain hoist assembly, the chain is connected to the clamp and guard assembly of the rodmeter by means of a connecting link

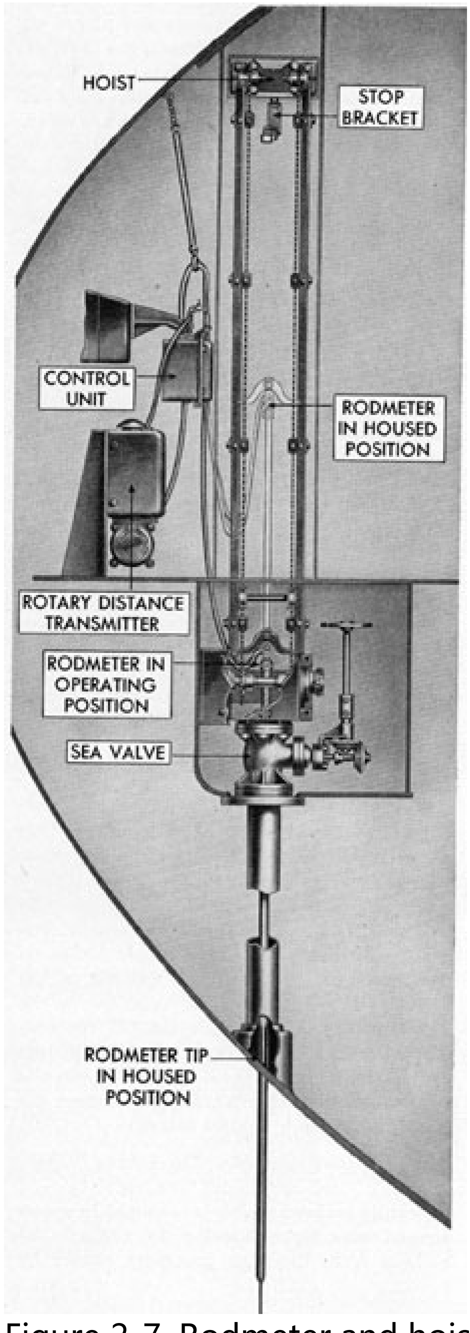


Figure 2-7. Rodmeter and hoist installed.

which is pinned to the chain and to the clamp and guard assembly. In the double sprocket and double roller chain type of hoist, the chains are connected to a lifting bar which in turn is pinned to the lifting yoke and guard of the rodmeter. As the hand crank is operated, the chains rotate around the sprockets, thereby raising or lowering the rodmeter. The hoist crank normally is stowed in brackets in the rodmeter and sea valve well. To operate the hoist, a deck plate is first raised and the

crank is lifted off its brackets and placed on the hoist operating rod. When in the lowered, or operating, position, the clamp and guard on the upper end of the rodmeter are flush with the top of the extension on the sea valve. Approximately 32 turns of the crank are required to raise the rodmeter to the normal housed position. The normal housed position of the rodmeter is defined as the position that will permit the tip to just clear the outer hull; In this position, approximately half of the length of the rodmeter is above the extension on the sea valve. This point is marked by a plate which is mounted on the hull side of the hoist bracket. The rodmeter is fully housed when the tip clears the sea valve gate. Approximately 82 turns of the crank are required to raise the rodmeter to the fully housed position. Approximately 90 turns of the crank are required to raise the rodmeter to its extreme raised position for inspection. The sea valve should be closed whenever the rodmeter is raised to the fully housed position.

D. CONTROL UNIT

2D1. Control unit case. The control unit case (Figure 2-8) is mounted on a gimbal bracket, and is suspended above the rotary distance transmitter in the forward torpedo room. Tapped openings which contain pipe plugs are located on the upper and lower sides of the case to submersion. The primer bellows is mechanically, connected to an external contact arm which actuates electrical circuits through a lever. The upper end of the bellows is secured to the bellows housing by a bellows ring. The lower end of the bellows is connected to a seal bellows

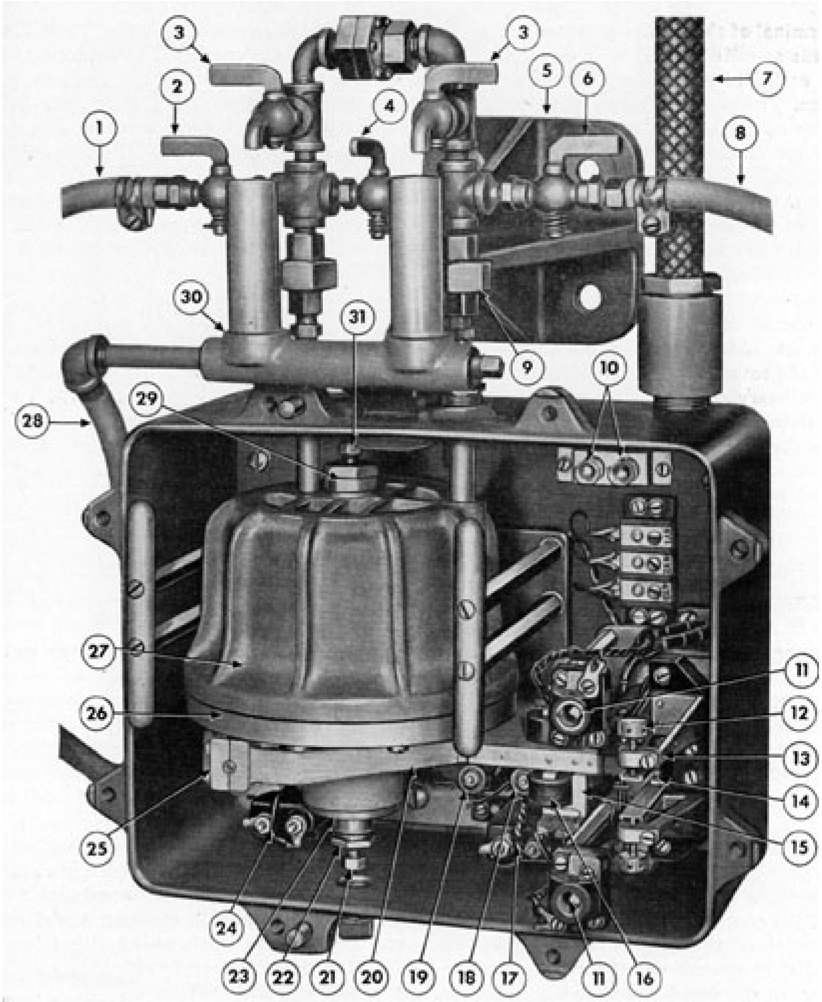
permit access to the upper and lower adjustable stop rods. A third opening is provided in one end of the case to permit access to the inner contact arm clamp. The case cover, equipped with a rubber seal, is doweled in position on the case and secured to the case with cap screws.

2D2. Valve and pipe assembly. A valve and pipe assembly is mounted above the control unit case to permit venting, or bleeding, of air from the hydraulic system. Two vent cocks are provided to vent the bellows chamber; one vent cock is connected to the piping that terminates inside the bellows; the other vent cock is connected to piping that terminates in the bellows housing outside the bellows. The inside of the bellows is hydraulically connected to the nipple fitting on the center of the pump; the outside of the bellows is connected hydraulically to the nipple fitting on the static tube of the rodmeter. A control valve is mounted at the control unit end of each of these hydraulic lines. A bypass valve is mounted between the static and dynamic control valves.

2D3. Bellows assembly. The primer bellows assembly used on submarines consists of a hydraulic bellows which is mounted in a cast bronze watertight housing to protect the bellows from the high pressures caused by mounting stud by means of a cap screw and bellows extension post. The seal bellows mounting stud passes through the bellows housing and is secured to the contact lever shaft by a bellows shoulder screw. A water seal is provided between the bellows mounting stud and the pressure bellows housing by a seal bellows. The seal bellows is attached to the pressure bellows housing by means of a bellows seal cap and gasket. The contact lever shaft is supported in ball bearings which in turn are mounted in a pillow block.

A Y-shaped external contact arm is mounted on the ends of the contact lever shaft by adjustable clamps. Upper and lower adjustable stop rods are provided to limit the motion of the bellows, thereby preventing damage to the interior parts at times of excessive pressure differences in the bellows. As the ship moves forward, the dynamic pressure in the bellows causes the bellows and its attached linkage to move downward, establishing electrical contact at the lower end of the external contact arm.

2D4. Electrical contacts. Upper and lower platinum contacts are attached to springs on an extension of the external contact arm. A pigtail wire connects the inner arm of the external contact arm with the right-hand



1. DYNAMIC HOSE (FROM PUMP)
2. DYNAMIC PRESSURE VALVE
3. VENT COCK
4. BYPASS VALVE
5. GIMBAL BRACKET
6. STATIC PRESSURE VALVE
7. ELECTRIC CABLE (FLEXIBLE)
8. STATIC HOSE (FROM RODOMETER)
9. UNION
10. TEST LAMPS
11. LAMP SOCKETS
12. ADJUSTABLE THUMB SCREW
13. CONTACT BRACKET
14. CONTACT SCREW
15. MAGNET CORE
16. MAGNET SPOOL
17. CONDENSER 0.5 MICROFARAD 18. 1000-OHM RESISTOR
19. 100-OHM RESISTOR
20. EXTERNAL CONTACT ARM
21. LOWER ADJUSTABLE STOP SCREW (SHORT)
22. GLAND NUT
23. HOUSING END CAP
24. CONDENSER 0.5 MICROFARAD
25. OUTER CONTACT ARM CLAMP
26. BELLOWS HOUSING COVER
27. BELLOWS HOUSING
28. DRIP TUBE DRAIN HOSE
29. BELLOWS HOUSING CAP
30. DRIP TUBE FITTING AND GIMBAL SUPPORT
31. UPPER ADJUSTABLE STOP SCREW (LONG)

Figure 2-8. Control unit, cover removed.

terminal of the auxiliary center contact block. This so-called pigtail wire is a light wire and is coiled to prevent any drag on the contact arm. The pigtail is connected from the auxiliary center contact block through a resistor to the center terminal of the terminal block located in the upper right side of the control unit. Upper and lower stationary contact points are mounted in brackets in the control unit, and mate with the contact points on the end of the external contact arm. The upper stationary contact is connected to the upper terminal of the terminal block, and thence to one shading coil of the follow-up motor in the rotary distance transmitter. The lower stationary contact is connected to the lower terminal of the terminal block and thence to the other shading coil of the follow-up motor. Magnetic coils mounted one above and one below the external contact arm are known as antihunting coils. Their function is to assist the operation of the contact by causing a rapid break of the contacts when the bellows pressures are equalized. When the ship begins to move forward, or to increase speed, the bellows and its attached linkage move downward. The contact arm also moves downward, establishing contact between the arm and the lower stationary contact. Current then passes to the transmitter mechanism in the rotary distance transmitter, actuating the pump to equalize the pressure in the bellows. Conversely, when the ship slows down or stops, the contact arm moves upward to make contact with the upper stationary contact. Current then flows through the transmitter mechanism in the rotary distance transmitter, and causes the pump to slow down to a point at which the pressures in the bellows are equalized.

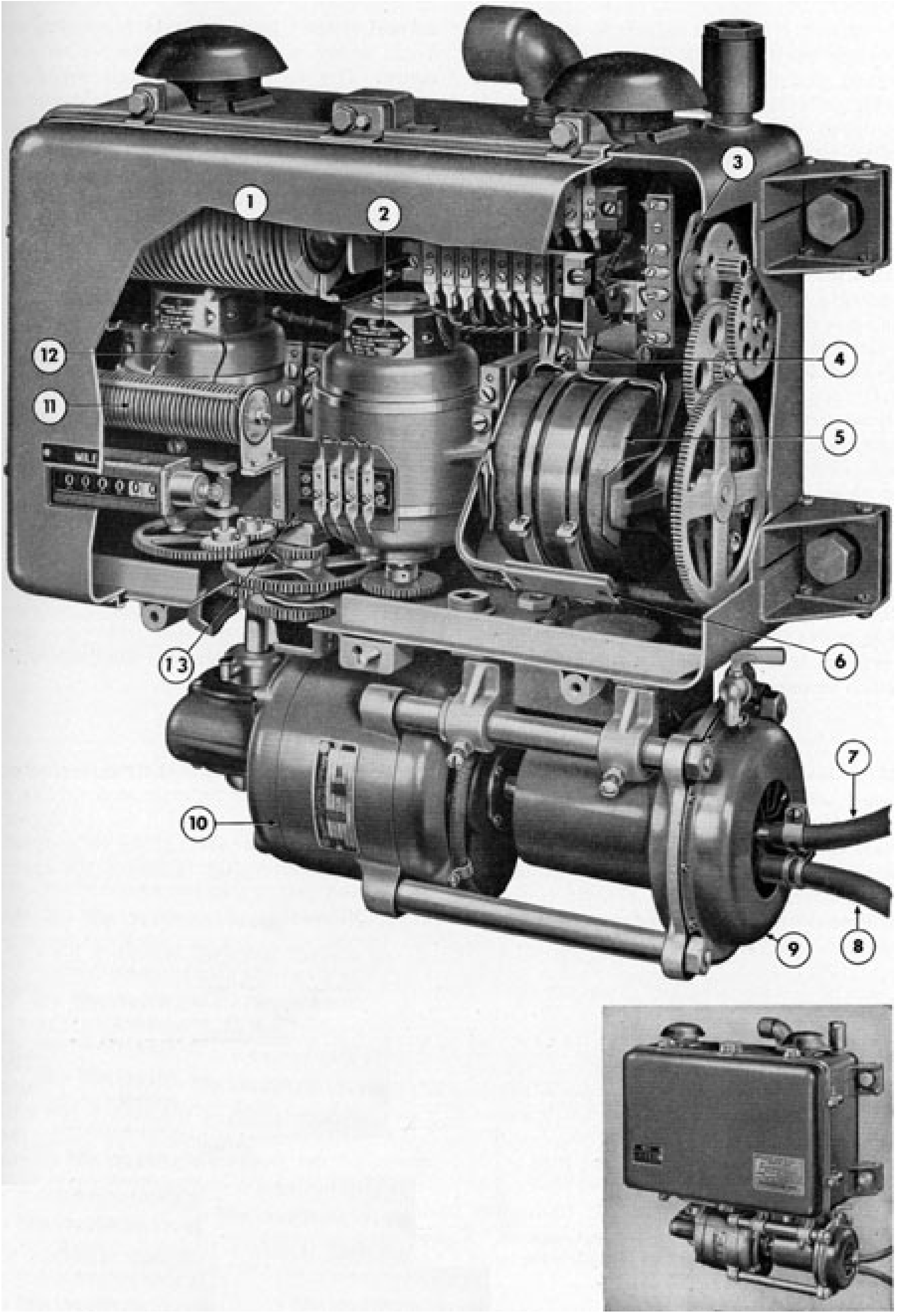
E. ROTARY DISTANCE TRANSMITTER

2E1. Rotary distance transmitter. The rotary distance transmitter (Figure 2-9) consists of four major units: the pump, the pump drive motor, the distance transmitting unit, and the motor-driven transtat assembly. The pump and the pump drive motor are mounted beneath the rotary distance transmitter case. The case contains the motor-driven transtat assembly, rectifiers, two electrical transmitters, a counter, and a gear train which connects the transmitters with the pump drive motor. The functions of the direction. This motor, through a gear train at the right side of the transtat assembly, then moves the rotating brush arm of the transtat toward its high voltage end. Alternating current starts flowing through the rectifiers, which change the current to d.c., and on to the pump drive motor armature. When the current becomes approximately 15 volts, the pump starts to turn over slowly, gradually increasing in speed until the pump pressure equalizes the pressures in the bellows, at which time the contact arm centers and shuts off the flow

rotary distance transmitter are to control the speed of the pump, to equalize the pressures in the bellows of the control unit, and to transmit the rotary motion of the pump (14,400 revolutions per mile) to a counter in the master speed indicator, to the speed and distance indicator, and to the dead reckoning analyzer.

2E2. Motor driven transtat. The transtat assembly derives its name from the fact that it functions as a combination transformer and rheostat. Electric current from the control unit, actuated by the control unit external contact arm, flows through a shading coil of the follow-up motor in the rotary distance transmitter, and causes this motor to operate. When the contact arm moves downward, the follow-up motor runs in a counterclockwise of current to the follow up motor. The pump continues to operate at a substantially constant speed until such time as the ship's speed either increases or decreases. When the ship decreases its speed, the opposite action occurs. The opposite shading coil of the follow-up motor is energized, causing the motor to turn in a clockwise direction. The transtat brush arm moves toward its low voltage end, and the pump slows down until the pressures in the bellows are again equalized.

2E3. Pump. Figure 2-10 shows a centrifugal-type pump. The pump shaft is coupled to a pump-driven motor shaft, which drives a radially bladed impeller. Hydraulic pressure developed by the pump is used to oppose



1. ARMATURE RECTIFIER
2. SELF-SYNCHRONOUS TRANSMITTER TO DRT SYSTEM (360 R.P. MILE)
3. FOLLOW-UP SWITCHES
4. LIMIT SWITCHES
5. TRANSTAT
6. TRANSTAT ARM
7. PRESSURE HOSE TO CONTROL UNIT
8. DYNAMIC PRESSURE HOSE FROM RODMETER
9. PUMP
10. PUMP MOTOR
11. FIELD RECTIFIER
12. SELF-SYNCHRONOUS TRANSMITTER TO MASTER SPEED INDICATOR (60 R.P. MILE)
13. COUNTER MOUNTING PLATE WITH MOTOR TERMINAL BLOCK.

Figure 2-9. Cutaway view of rotary distance transmitter.

the dynamic pressure which is transmitted through the rodmeter. The pump is so current is used because speed regulation of a d.c. motor is superior to that of an a.c. motor.

designed that it turns 14,400 revolutions for every mile the ship travels. The pump is equipped with two hydraulic nipples. The outer nipple is hydraulically connected to the dynamic nipple of the rodmeter. The center nipple is hydraulically connected to the left-hand nipple of the control unit. When the ship moves forward, the pump drive motor drives the pump impeller, producing a pressure at the outer nipple which opposes the dynamic pressure from the rodmeter. When the pump impeller reaches a speed sufficient to produce a balance between these opposing forces, the external and internal pressures of the bellows in the control unit are" equal. The contact arm in the control unit is in its central position, the transtat brush arm maintains its approximate position with a slight hunting, motion, and the pump drive motor drives the pump at an approximately steady speed until the ship's speed increases or decreases.

2E4. Pump drive motor. The electric motor that drives the pump receives its power from rectifiers in the rotary distance transmitter, which change the a.c. supply to d.c. Direct The field rectifier (small rectifier) supplies a voltage to the motor field which is constant regardless of motor speed. The armature rectifiers (large rectifiers) supply a variable voltage to the motor armature. This voltage is controlled by the position of the transtat brush arm. With the field voltage constant, the motor will not operate until the armature voltage reaches approximately 15 volts. Above 15 volts, the greater the armature voltage, the greater will be the pump motor speed. The motor also drives a shaft and a slow speed gear train which is connected to a counter and two self-synchronous transmitters. The gear train is so designed that for every 14,400 turns of the pump drive motor shaft, one mile is registered on the counter. The left-hand transmitter turns at the rate of 60 revolutions per nautical mile. These revolutions are transmitted to the master speed indicator and to the speed and distance indicator. A second transmitter located in the left center of the case is turned at the rate of 360 revolutions per nautical mile and transmits these revolutions to the dead reckoning analyzer.

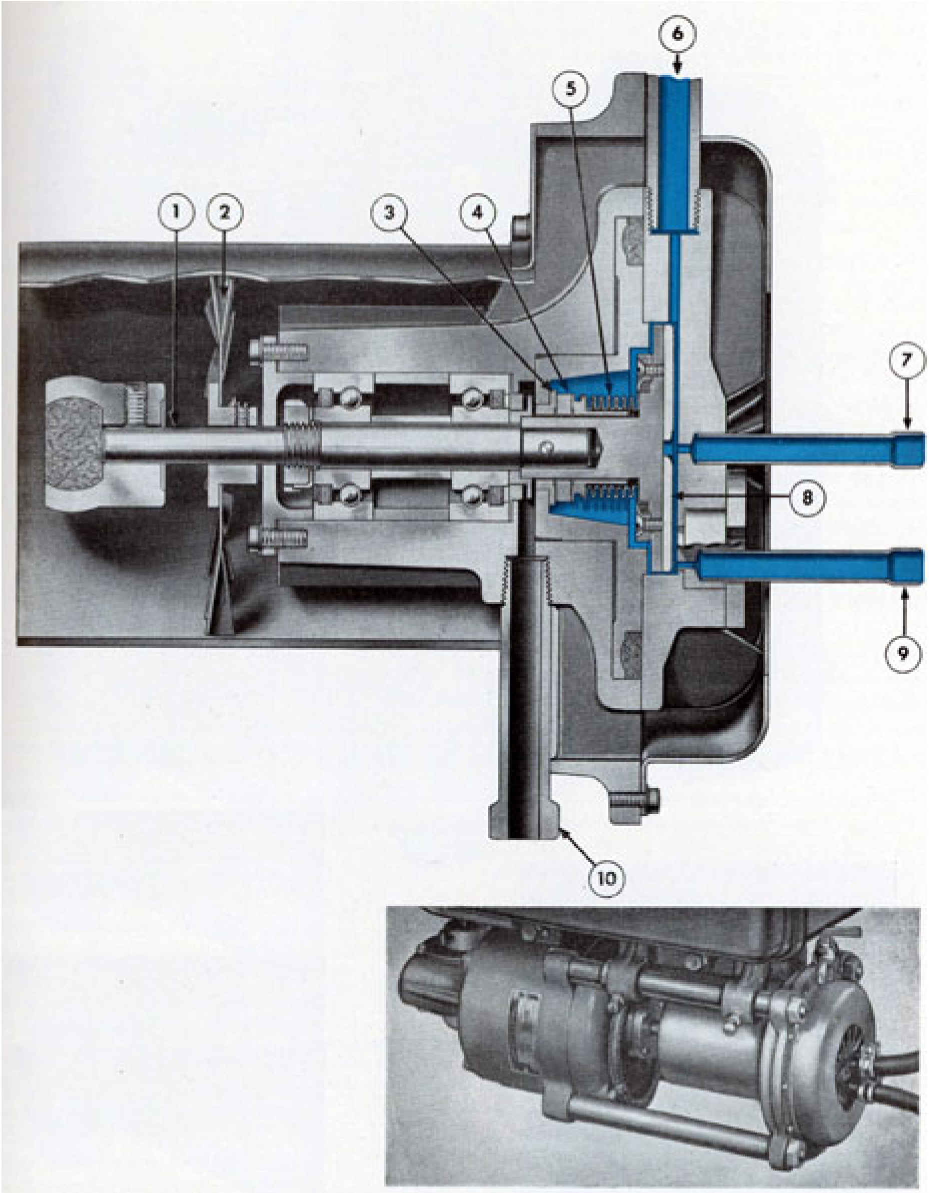
F. MASTER SPEED INDICATOR

2F1. Master speed indicator. The master speed indicator (Figures 2-3 and 2-11), located near the control room steering station, consists of the following components: self-synchronous repeater, self-synchronous transmitter, slip ring and contact the distance traveled. The shaft extension of the self-synchronous repeater also carries a spiral gear which meshes with the spiral gear fastened to the upper shaft of the differential. When the repeater shaft is turned, the upper differential gear is also turned.

assembly, differential assembly, lead screw drive motor, counter, roller and disk assembly, and a constant speed (synchronous) motor. These components are mounted on a main mounting plate in such a manner that the whole assembly can be removed from the case as a unit for inspection and tests.

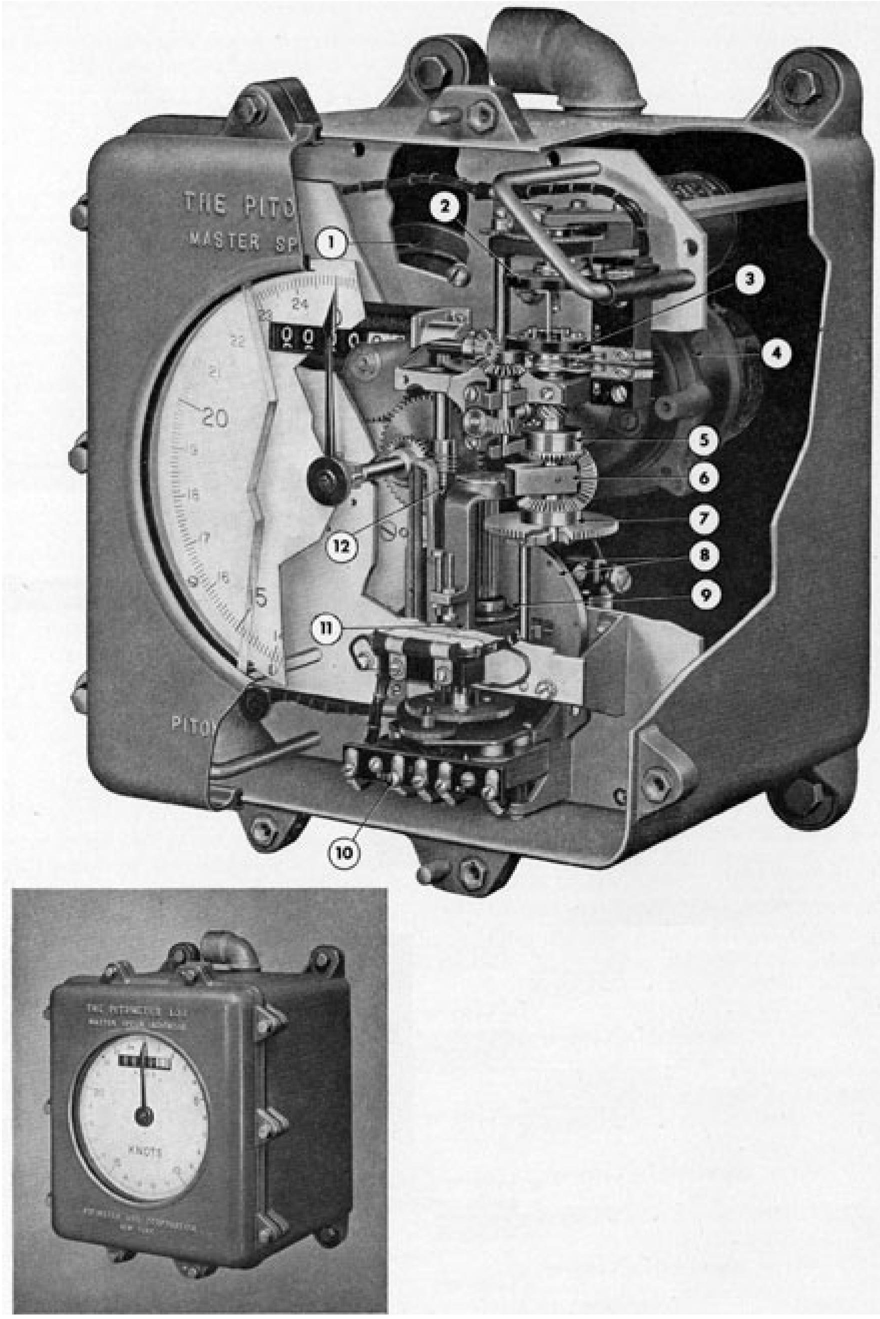
2F2. Self-synchronous repeater. The self-synchronous repeater receives rotary motion at the rate of 60 revolutions per nautical mile from the self-synchronous transmitter in the rotary distance transmitter. This rotary motion of the repeater shaft is transmitted through a worm and worm gear to a counter in the master speed indicator which registers

2F3. Differential. The upper end of the differential shaft is connected to the slip ring and contact assembly. The lower differential gear is meshed through a spur gear with the roller shaft and pinion of the lead screw assembly. The upper differential gear is free to rotate on the differential shaft. The small differential pinion gear is free to rotate on the differential spider, and is in mesh with both differential bevel face gears. If the speeds of the two bevel face gears are not equal, the spider, which is rigidly attached to the differential shaft, will rotate in a direction corresponding to that of the faster running gear. This turns the slip ring and contact



1. IMPELLER SHAFT
2. PUMP FAN
3. ROTARY SEAL INSERT
4. SEAL RING
5. ROTARY SEAL BELLOWS
6. VENTING COCK
7. HOSE CONNECTING NIPPLE, TO CONTROL UNIT
8. PUMP IMPELLER
9. HOSE CONNECTING NIPPLE, TO RODOMETER
10. DRIP FITTING

Figure 2-10. Cutaway view of rotary pump.



1. SELF-SYNCHRONOUS TRANSMITTER
2. FOLLOW-UP CONTACT ASSEMBLY
3. SLIP RING AND CONTACT ASSEMBLY
4. SELF-SYNCHRONOUS REPEATER
5. UPPER DIFFERENTIAL GEAR
6. DIFFERENTIAL SPIDER
7. LOWER DIFFERENTIAL GEAR
8. CONSTANT SPEED MOTOR AND DISK
9. FRICTION ROLLER AND PINION
10. LEAD SCREW DRIVING MOTOR
11. YOKE
12. LEAD SCREW

Figure 2-11. Cutaway view of master speed indicator.

assembly which is mounted on an increasing speed. Its

the differential shaft.

2F4. Slip ring and contact assembly. The slip ring and contact assembly turns with the spider and the differential shaft. This causes one of the contact points to push up against one side of the contact of the follow-up contact assembly, which is frictionally mounted on the follow-up shaft. Closing this contact shorts out one of the shading coils of the lead screw driving motor, causing the motor to run in one of two directions, depending on which shading coil is shorted out.

2F5. Lead screw driving motor. The lead screw driving motor is geared to the lead screw. As the motor turns the lead screw, the yoke assembly which is meshed with the lead screw, moves upward or downward on the lead screw, depending on which way the screw is turning. The friction roller and roller shaft and pinion which are mounted in the lead screw yoke also move with the yoke.

2F6. Constant speed motor and friction disk. The constant speed (synchronous) motor is energized, by a 60-cycle controlled frequency a.c. The current is obtained from the constant frequency supply unit in the ship. Through gearing, this motor operates a slow speed shaft on which a spider and disk assembly is mounted. The disk turns at 100 rpm. A spring arrangement keeps the disk in positive contact with the friction roller. When the roller is at the center of the disk it will not revolve, because of its central revolutions are transmitted through the roller shaft and pinion to a spur gear which carries the lower differential gear. When the speed of the lower differential gear equals the speed of the upper differential gear, the spider stops revolving. This causes the follow-up contact to open, and the lead screw driving motor stops. The roller stays in one position on the disk until a change occurs in the ship's speed.

2F7. Anti-hunting mechanism. When the two differential gears are revolving at the same speed, and the differential spider and shaft stop moving, the contacts are still closed lightly. This would cause the lead screw motor to move the roller beyond the desired point, and hunting of the pointer would result due to the contact arm hitting first one contact point and then the other. To control this, a gear driven by a pinion at the extreme top end of the lead screw, drives the center contact very slowly in the same direction as the differential shaft. This will open the contacts just before the differential: shaft stops moving, allowing final adjustment to the exact balance point.

2F8. Speed transmission. A full revolution of the pointer measures the speed of the ship from 0 to 25 knots. As the lead screw turns, the worm at the upper end of the lead screw turns a worm gear which moves the pointer to indicate-speed in knots. The rear end of the pointer shaft is connected to a self-synchronous transmitter which electrically transmits the speed in knots to the speed and distance indicator, the torpedo data

position. As the roller is moved away from the center of the disk by the action of the lead screw, it rotates at computer, and the gyrocompass speed corrector.

G. SPEED AND DISTANCE INDICATOR

2G1. Speed and distance indicator. The speed and distance indicator (Figure 2-12) is located in the conning tower. The unit consists of two self-synchronous repeaters, a counter, a dial and pointer. Speed is received from the master speed indicator self-synchronous transmitter, and distance is received from the transmitter in the rotary distance transmitter. The shaft of the large repeater self-synchronous motor carries the speed-indicating pointer. The function of the counter is to repeat the number of nautical miles traveled. The indicator dial is illuminated by three Navy type TF 53 lamps, which are rheostat-controlled by an exterior knob. The complete mechanism can be removed from the case as a unit.

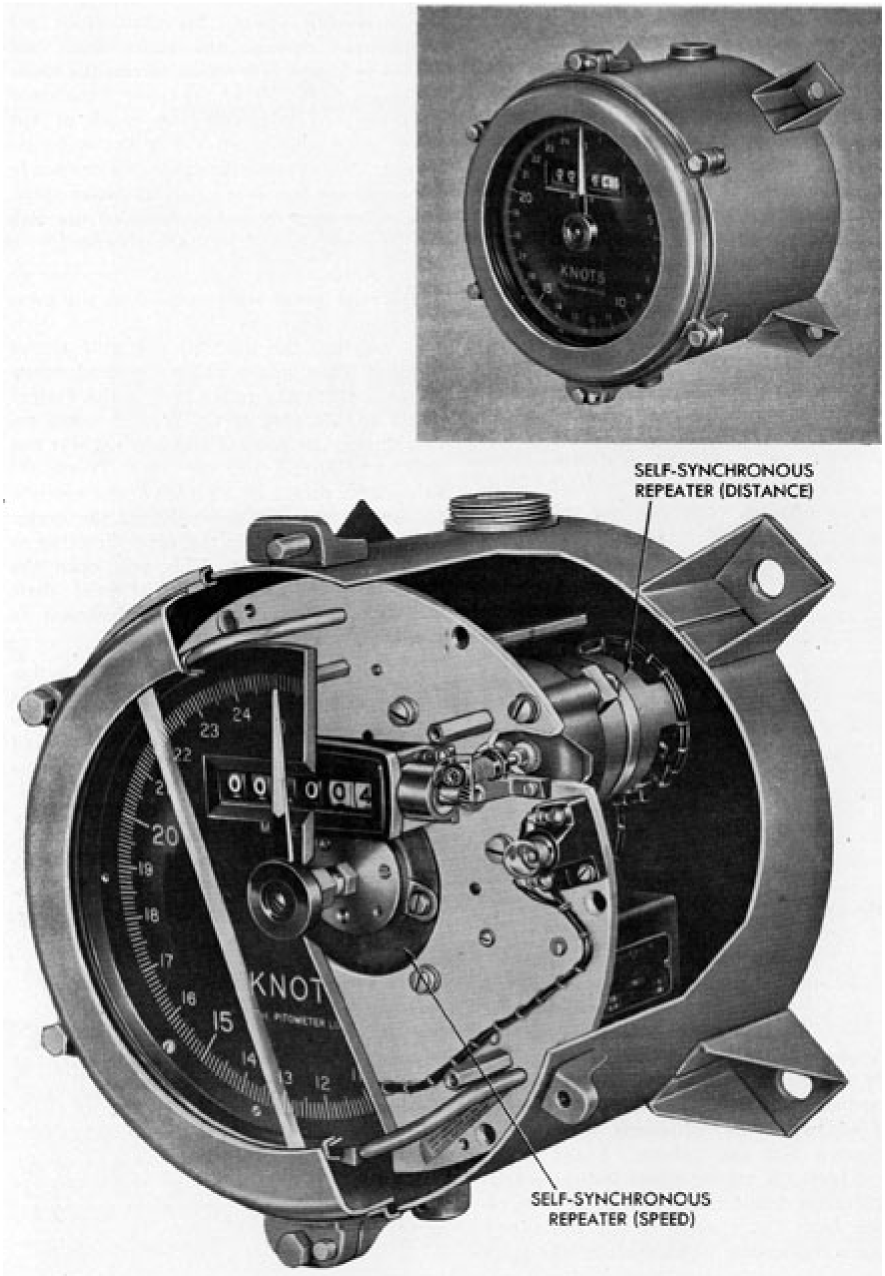


Figure 2-12. Cutaway view of speed and distance indicator.

H. CONSTANT FREQUENCY CONTROL UNIT

2H1. Constant frequency supply unit. Older type submarines are equipped with a constant frequency supply unit (Figure 2-13). Recently commissioned submarines derive their constant frequency supply from the ship's regular a.c. supply. The Pitometer rotary balance unit is composed of two parts: the converter which changes d.c. to a.c. of a constant

2H5. Rotor (stroboscope). A neon light is mounted beneath the rotor in the phonic wheel motor. This light flashes each time the tuning fork vibrates. Visual inspection of the rotor, when operating, should show the white marks on the rotor clearly and distinctly. This indicates that the impulses from the tuning fork are being amplified correctly and that the rotor is rotating in frequency with the fork frequency.

frequency of 60 cycles per second at 115 volts, and the control unit which controls the output of the converter to maintain a constant frequency. Constant frequency voltage is supplied to the constant speed motor which drives the friction disk assembly in the master speed indicator, and to the shaft revolution indicator.

2H2. Converter. The converter consists of an armature having its d.c. and a.c. windings in the same slots of the armature core. The d.c. windings connect to the commutator on one end of the armature, and the a.c. windings connect to two collector rings on the opposite end of the armature. The converter is prevented from rotating more than 1750 rpm until speed control is taken over by the control unit by a speed regulator assembly. This speed regulator consists of a rotating disk on which are mounted two electrical contacts. When the disk tends to rotate more than 1750 rpm, the contacts are opened by centrifugal force, and the converter slows down. When the converter begins to drop slightly below 1750 rpm, the contacts close. This action tends to keep the converter operating at a substantially constant speed. When the control unit takes over control of the speed of the rotary converter, it holds it at 1800 rpm.

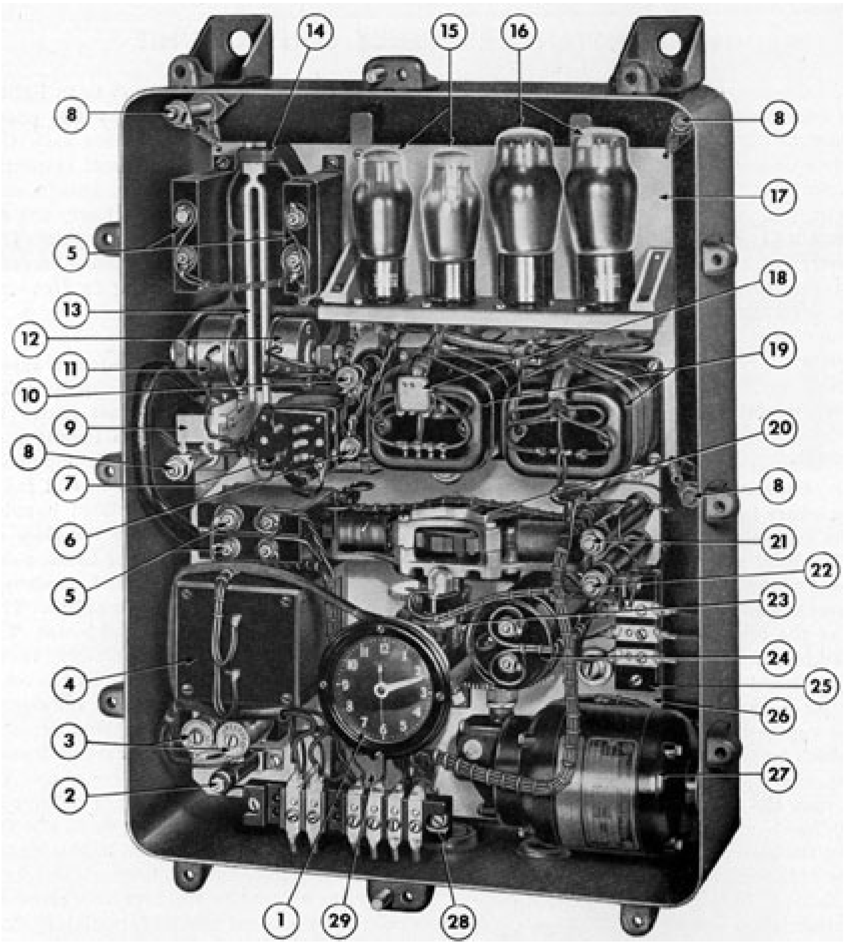
2H3. Control unit. The control unit consists of an electrically driven tuning fork, an amplifier circuit to amplify the tuning fork frequency, a phonic wheel motor assembly which is driven at a constant speed by the tuning

2H6. Operation of constant frequency supply. When the constant frequency supply unit is energized, the starting magnet starts the tuning fork vibrating. These impulses are amplified and picked up by the pick-up phone, where they are further amplified and fed to the driver phone. These amplified impulses keep the fork vibrating. The impulses are also picked up by the amplifier tubes, power tubes, transformers, chokes, and condensers which further amplify the impulses. They are then fed to the phonic wheel motor. This motor is attached through gearing to the upper differential gear, which is free to rotate: on the differential shaft. Two differential pinion gears attached to the spider are meshed with the upper and lower differential gears, and are free to rotate with these gears. The spider is rigidly attached to the differential shaft. The lower differential gear is also free to rotate on the differential shaft, and is driven by a synchronous motor which rotates at the same speed as the converter armature. The lower end of the differential shaft is connected through spur gears to a rheostat shaft. The rheostat shaft controls the rheostat contact arm, which in turn regulates the converter field current, increasing or decreasing the speed of the converter armature, and thereby the output frequency of the converter. If the frequency of the controlled 60-cycle a.c. supplied by the converter should drop, the speed of the synchronous motor driving the lower differential gear would also drop. The upper and lower differential gears would not be rotating at the same speed.

fork impulses, a differential gear assembly, a rheostat, a synchronous motor, and an electric clock.

2H4. Electric clock. The clock operates on 60-cycle a.c. supplied by the converter, and is a means of checking frequency.

Consequently the spider and shaft would turn in the direction of the faster moving gear. The rheostat



1. CLOCK
2. 50,000-0HM RESISTOR
3. RECTIFIERS
4. CHOKE
5. CONDENSER 2-MICROFARADS
6. 1000-OHM RESISTOR
7. GRID TRANSFORMER
8. SPRINT POST, ASSEMBLY
9. STARTING MAGNET, ASSEMBLY
10. 2250-OHM RESISTOR
11. PICK-UP PHONE UNIT
12. DRIVER PHONE UNIT
13. TUNING FORK
16. POWER TUBES, NO. 25B6G
17. SUSPENDED PLATE
18. CONDENSER, 0.005-MICROFARAD
19. TRANSFORMERS
20. PHONIC WHEEL MOTOR, ASSEMBLY
21. 190-OHM RESISTOR
22. 2000-OHM RESISTOR
23. DIFFERENTIAL, ASSMEBLY
24. STARTING CONDENSER
25. CONSTANT SPEED (SYNCHRONOUS) MOTOR TERMINAL BLOCK

14. TUNING FORK BASE
15. AMPLIFIER TUBES, NO. 6J5G
26. MAIN MOUNTING PLATE
27. CONSTANT SPEED (SYNCHRONOUS) MOTOR
28. TERMINAL BLOCK
29. RHEOSTAT, 450-OHMS

Figure 2-13. Constant frequency control unit, cover removed.

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arm is turned so as to insert more resistance in the converter field circuit, thereby increasing the speed of the converter and of the synchronous motor. When the lower differential gear is rotating at the same speed as the upper differential gear, the spider and shaft stop turning; the rheostat arm remains stationary until further change in frequency occurs. When the upper and lower differential gears are rotating at the same speed, the output frequency of the converter is exactly 60 cycles.

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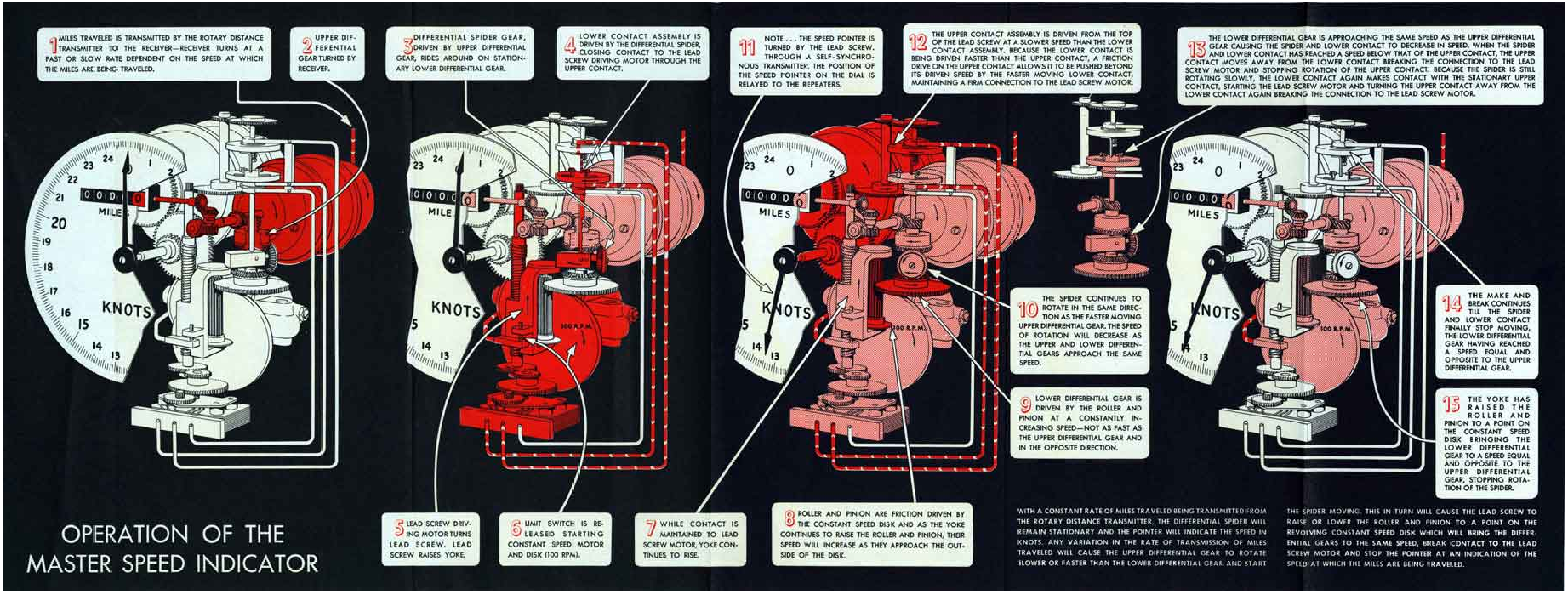
Next chapter

Figure 2-3. OPERATION OF THE MASTER SPEED INDICATOR

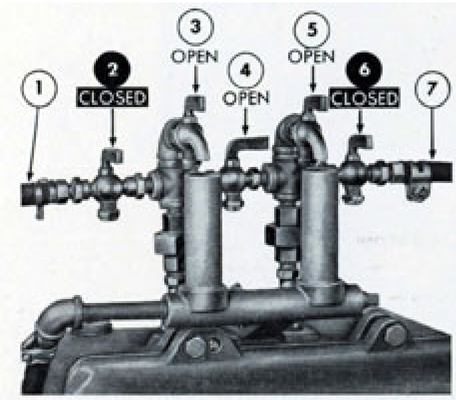
Sub Log
Home Page



3
OPERATING THE LOG

A. OPERATING INSTRUCTIONS

3A1. Energizing the system. Turn the electrical switches controlling the 1Y, 2Y, and 3Y circuits on the interior communication (I.C.) board, and the conning tower repeater switch on the action cutout (A.C.O.) board to their ON positions.



1. DYNAMIC HOSE (FROM PUMP)
2. DYNAMIC PRESSURE VALVE
3. VENT COCK
4. BYPASS VALVE
5. VENT COCK
6. STATIC PRESSURE VALVE
7. STATIC HOSE (FROM RODMETER)

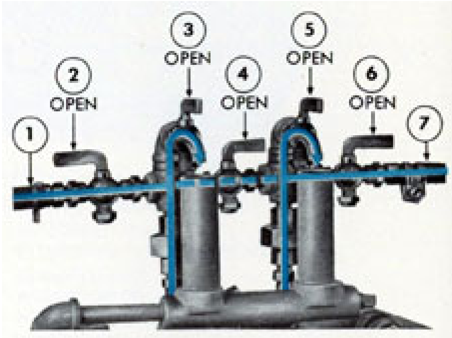
Figure 3-1. Valves and vent cocks in secured position.

3A2. Opening the sea valve. Raise the deck plate above the sea valve. Turn the sea valve handwheel in a counterclockwise direction as far as possible to fully open the sea valve gate.

simultaneously so as to keep the pressures on both sides of the bellows equal. The described procedure may also be used for surface venting.

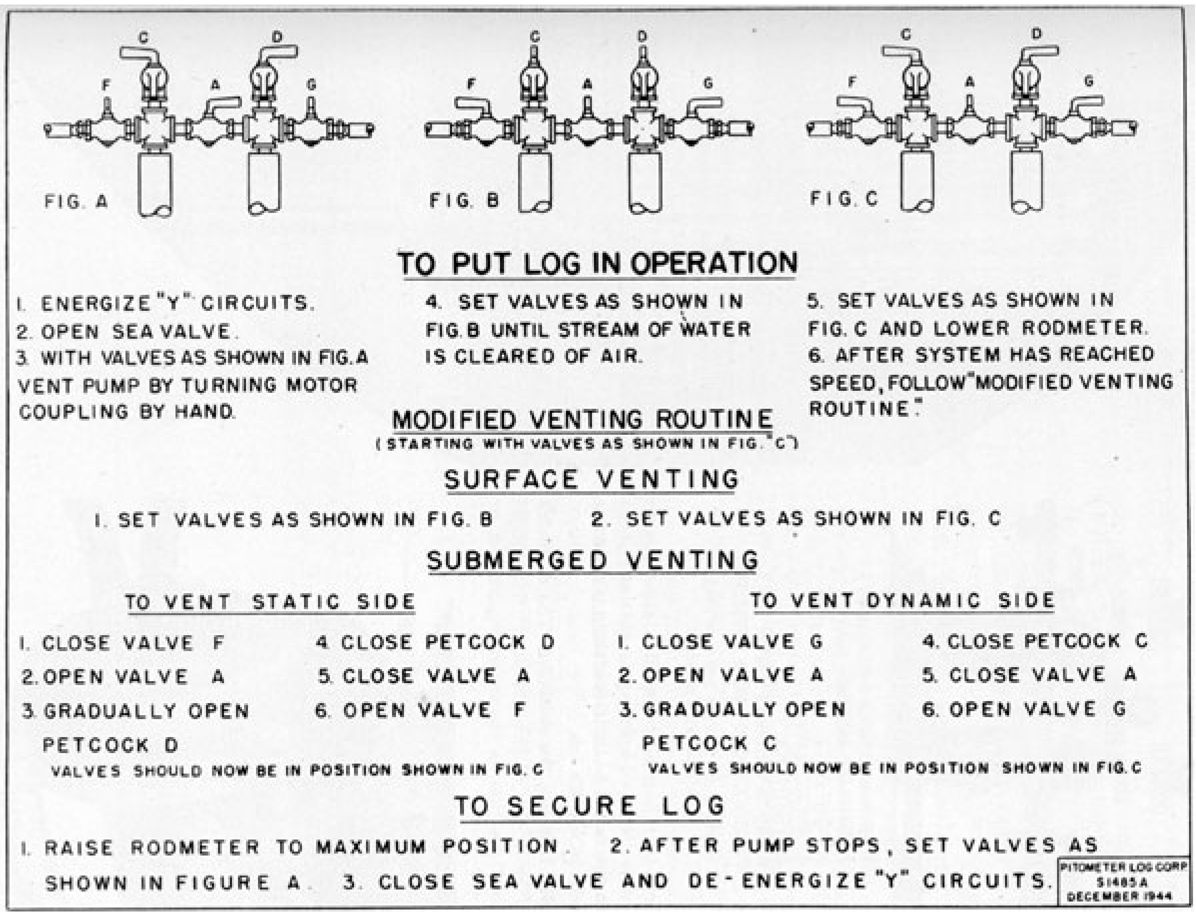
b. When surfaced. For best results the system should be vented when the submarine is stationary. The purpose of venting the hydraulic system is to remove any air that may be trapped in the system. The following venting routine includes venting the pump. When the ship is once underway it is not necessary, to include the operation of venting the pump. However, the rest of the venting routine that applies to the valves located above the control unit should be carried out daily. Vent the pump by opening the vent cock located on the pump until a clear stream of water, free of spitting, is obtained; then close the pump vent cock (Figure 3-5). Turn the valves located above the control unit from their secured position as shown in Figure 3-1 to the venting position as shown in Figure 3-2. Keep the

3A3. Venting the system. a. While submerged. When venting the underwater log system while submerged, the instructions given in Figure 3-3 should be followed. Improper venting procedure will crush the bellows mechanism or throw it out of calibration. With other procedures than that described in Figure 3-3, it is practically impossible to open or close the dynamic and static pressure valves



1. DYNAMIC HOSE (FROM PUMP)
2. DYNAMIC PRESSURE VALVE
3. VENT COCK
4. BYPASS VALVE
5. VENT COCK
6. STATIC PRESSURE VALVE
7. STATIC HOSE (FROM RODMETER)

Figure 3-2. Valves and vent cocks in surface venting position.



TO PUT LOG IN OPERATION

1. ENERGIZE "Y" CIRCUITS.
2. OPEN SEA VALVE.
3. WITH VALVES AS SHOWN IN FIG. A VENT PUMP BY TURNING MOTOR COUPLING BY HAND.
4. SET VALVES AS SHOWN IN FIG. B UNTIL STREAM OF WATER IS CLEARED OF AIR.
5. SET VALVES AS SHOWN IN FIG. C AND LOWER RODMETER.
6. AFTER SYSTEM HAS REACHED SPEED, FOLLOW "MODIFIED VENTING ROUTINE."

MODIFIED VENTING ROUTINE
(STARTING WITH VALVES AS SHOWN IN FIG. "C")

SURFACE VENTING

1. SET VALVES AS SHOWN IN FIG. B
2. SET VALVES AS SHOWN IN FIG. C

SUBMERGED VENTING

TO VENT STATIC SIDE

1. CLOSE VALVE F
2. OPEN VALVE A
3. GRADUALLY OPEN PETCOCK D
4. CLOSE PETCOCK D
5. CLOSE VALVE A
6. OPEN VALVE F

VALVES SHOULD NOW BE IN POSITION SHOWN IN FIG. C

TO VENT DYNAMIC SIDE

1. CLOSE VALVE G
2. OPEN VALVE A
3. GRADUALLY OPEN PETCOCK C
4. CLOSE PETCOCK C
5. CLOSE VALVE A
6. OPEN VALVE G

VALVES SHOULD NOW BE IN POSITION SHOWN IN FIG. C

TO SECURE LOG

1. RAISE RODMETER TO MAXIMUM POSITION. 2. AFTER PUMP STOPS, SET VALVES AS SHOWN IN FIGURE A. 3. CLOSE SEA VALVE AND DE-ENERGIZE "Y" CIRCUITS.

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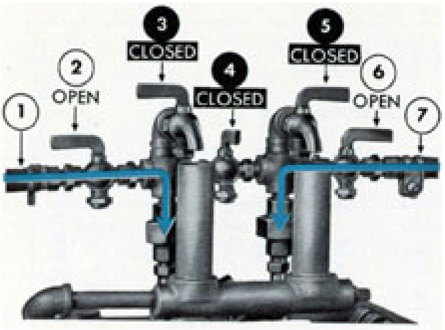
Figure 3-3. Surface and submerged venting routines.



1. DYNAMIC HOSE (FROM PUMP)
2. DYNAMIC PRESSURE VALVE
3. VENT COCK
4. BYPASS VALVE
5. VENT COCK
6. STATIC PRESSURE VALVE
7. STATIC HOSE (FROM RODMETER)

Figure 3-4. Valves and vent cocks in operating position.

valves in this position until a clear stream of water, free of spitting is obtained; then turn the valves to their operating position as shown in Figure 3-4.

3A4. Lowering the rodmeter. The rodmeter will be in one of two positions: the normal housed position as shown in Figure 2-6, or

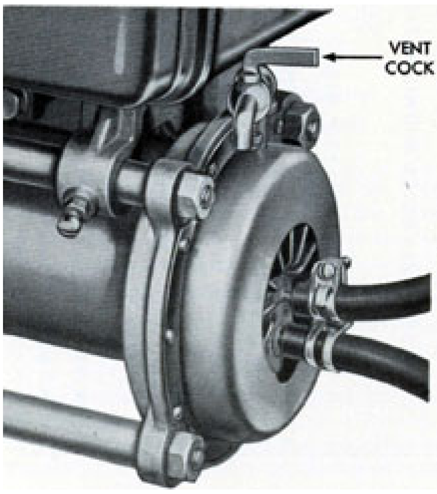


Figure 3-5. Pump vent cock.

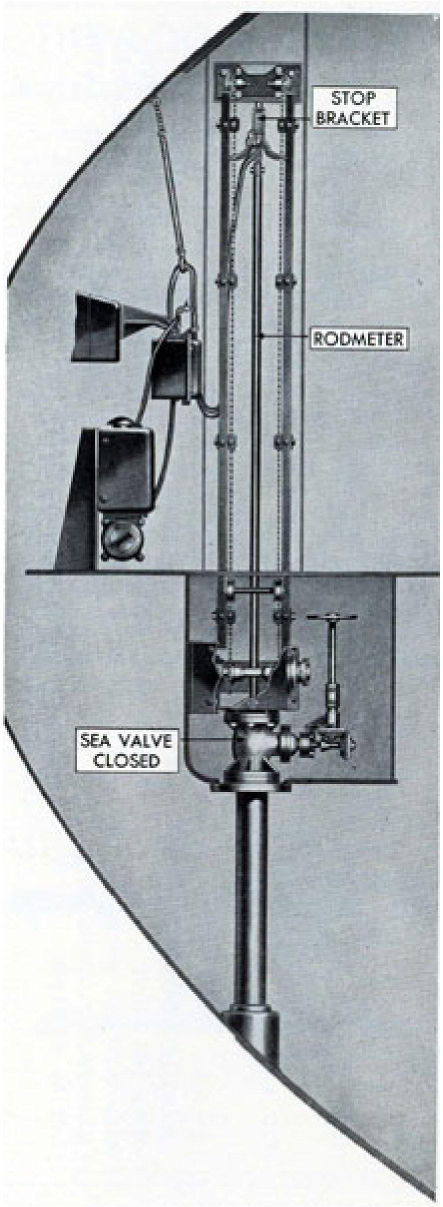
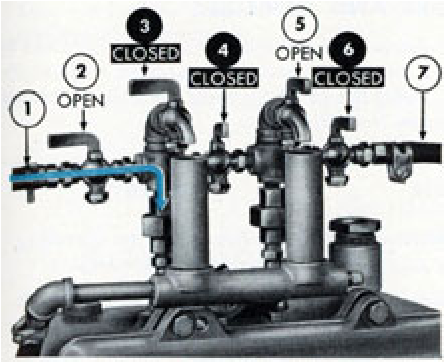


Figure 3-6. Rodmeter in secured position

the fully housed position as approximately 5 inches below its

shown in Figure 3-6. To lower the rodmeter, turn the hoist crank counterclockwise until the rodmeter is



1. DYNAMIC HOSE (FROM PUMP)
2. DYNAMIC PRESSURE VALVE
3. VENT COCK
4. BYPASS VALVE
5. VENT COCK
6. STATIC PRESSURE VALVE
7. STATIC HOSE (FROM RODMETER)

Figure 3-7. Valves and vent cocks operating on static head.

normal housed position. Keep the rodmeter in this position until the pump motor and pump are operating; then lower the rodmeter to its operating, or fully extended, position. Keep the hoses clear of projections or chain links. The rodmeter is in its operating position when the clamp and guard assembly at the top of the rodmeter is flush with the top of the sea valve extension.

3A5. Securing the log. Whenever the ship enters port, the log system is secured. Secure the system in the following manner: Turn the hoist crank in a clockwise direction until the top of the rodmeter is level with the marker plate, indicating that the tip of the rod is clear of the hull. Keep the hose clear of projections as the rodmeter is raised. The rodmeter may be raised to its fully housed, or secured, position, by turning the crank until the top of the rodmeter hits the stop at the top of the hoist. Turn the valves above the control unit to their secured position as shown in Figure 3-7. Turn the 1Y, 2Y, and 3Y switches on the I.C. board, and the conning tower repeater switch on the A.C.O. board to their OFF positions. Do not turn off the switches until the log has stopped operating.

4
TROUBLE SHOOTING

A. TROUBLES, CAUSES AND REMEDIES

4A1. General. This section contains troubleshooting information and tests which will be helpful in determining the causes of some of the troubles that may develop in the log system. Each trouble symptom is followed by a list of the possible causes of the trouble, and a list of the possible remedies to correct the trouble.

TROUBLE	CAUSE	REMEDY
1. Log does not start when rodmeter is lowered while ship is underway.	1a. Valve positions incorrect. 1b. 2Y circuit open. 1c. Follow-up motor in rotary distance transmitter does not operate. 1d. Rodmeter, hose, control unit piping, or pump is clogged. 1e. Control unit or stop rods off adjustment. 1f. Hose lines reversed. Rodmeter reversed. 1g. Pump shaft is frozen tight.	1a. Set valves to operating position (Figure 3-4). 1b. Close 2Y switch. Check fuses and circuits. 1c. Check wiring and limit switches. Replace motor. (See Sections 5G1 through 5G4.) 1d. Blow out rodmeter. Clean out hose, control unit piping, or pump. 1e. Reset contacts and stop rods. (See Sections 5K3, 5K4, 5K9, and 5K10.) 1f. Install hose correctly. Reverse rodmeter (Figures 2-1 and 2-4). 1g. Disassemble pump and make necessary repairs. (See Sections 5D3 through 5D27.)
2. Speed pointer indicates approximately 6 1/2 knots regardless of	2a. Constant frequency supply (3Y) not reaching synchronous motor	2a. Close 3Y switch. Check fuses and constant frequency supply switch. If constant frequency control unit is not

changes of ship's speed.	in master speed indicator. 2b. Starting condenser open or shorted. 2c. Synchronous motor stalled or burned out.	running, throw switch to ship's a.c. 2b. Replace condenser. 2c. Attempt to start motor. Replace motor. (See Sections 5M26 and 5M31.)

TROUBLE	CAUSE	REMEDY
3. Speed pointer is sluggish, does not respond readily to changes of ship's speed.	3a. Clogged rodmeter hose, control unit piping, or pump. 3b. Control unit contacts dirty or off adjustment. 3c. Control unit contact arm rubbing on bearing plates. 3d. Bad leak in control unit bellows or gasket. 3e. Friction in bellows linkage, in shaft seals, or bearings of control unit. 3f. Sticky follow-up motor in rotary distance transmitter. 3g. Contacts in master speed indicator are dirty, burned, or too far apart.	3a. Blow out rodmeter. Clean out any other obstructions. (See Sections 5B1, 5B2, and 5B3.) 3b. Clean contacts. Readjust contacts and reset stop rods. (See Sections 5K1, 5K3, 5K4, 5K9, and 5K10.) 3c. Shift contact arm to provide clearance. 3d. Test and replace bellows and gasket. (See Sections 5K12 through 5K25.) 3e. Disassemble bellows housing, reduce friction in linkage or shaft assembly. (See Sections SK12 through 5K25.) 3f. Lubricate motor. Replace if necessary. (See Sections 5G1, 5G2, 5G3, and 5G4.) 3g. Clean and reset contacts. Clean brushes and slip rings. (See Sections 5M9, 5M14, 5M15 and 5M35.) 3h. Clean and lubricate motor, lead screw, and gears. Replace motor if necessary. (See Sections 5M4, 5M5, and 5M6.)

	3h. Friction in lead screw drive motor, or in lead screw gears.	
4. Speed pointer "hunts" over several knots on dial, especially at speeds below 10 knots.	4a. Pump seal too tight. (Shaft binds when ship is submerged.) 4b. Control unit contacts incorrectly set. 4c. Friction in jackshaft or follow-up gearing in master speed indicator.	4a. Disassemble pump. Change tension of seal bellows. (See Sections 5D3, 5D4, 5D9, and 5D27.) 4b. Reset control unit contacts. Reset stop rods. (See Sections 5K3, 5K4, 5K9, and 5K10.) 4c. Lubricate jackshaft and gearing.

TROUBLE	CAUSE	REMEDY
	4d. Friction in self-synchronous repeater or associated gearing in either master speed indicator or speed and distance indicator. 4e. Spiral take-up spring broken. Follow-up tension spring loose in master speed indicator.	4d. Clean and lubricate bearings of repeaters. Clean and lubricate connecting gears and bearings. 4e. Replace spiral spring. Tighten tension spring. (See Sections 5M10 and 5M33.)
5. Log components operate correctly but excessive error of speed and distance indications at all speeds is noted.	5a. Air in pump or control unit. 5b. Clogged rodmeter. 5c. Bent rodmeter. 5d. Pump orifice plug set incorrectly. 5e. Pump motor coupling slipping on shaft.	5a. Vent pump and control unit-on surface only. (See Section 3A3.) 5b. Blow out rodmeter. Clear hose pump, and control unit piping of obstructions. (See Sections 5B1, 5B2, and 5B3.) 5c. If possible, pull up rodmeter, examine

		for bent tip. Replace with spare. (See Sections 5C1 through 5C7.) 5d. Check setting of plug (Chapters 6 and 7). 5e. Tighten coupling and transmitter drive gears.
6. Log components operate correctly, but excessive speed and distance error below 10 knots is noted.	6a. Control unit contacts incorrectly set. 6b. Pump leaking excessively.	6a. Reset control unit contacts. Reset control unit stop rods. (See Sections 5K3, 5K4, 5K9, and ,5K10.) 6b. Repair pump seal. (See Section 5D11.)
7. Speed pointer does not return to zero when rodmeter is housed. Pump continues to operate.	7a. Control unit contacts dirty or off adjustment. 7b. Air in pump and control unit. 7c. Control unit contact arm rubbing on bearing plates.	7a. Clean and reset control unit contacts. Reset stop rods. (See Sections 5K1, 5K3, 5K4, 5K9, and 5K10.) 7b. Vent pump and control unit. (See Section 3A3.) 7c. Shift contact arm to provide clearance.

	7d. Friction in bellows linkage, or in shaft seals and bearings of control unit. 7e. Sticky follow-up motor in rotary distance transmitter.	7d. Disassemble bellows housing. Reduce friction in linkage and shaft assembly. (See Sections 5K12 through 5K25.) 7e. Lubricate motor replace if necessary. (See Sections 5G1, 5G2, 5G3 and 5G4.)
8. Rodmeter cannot be	8. Rodmeter is bent.	8. Replace with spare rodmeter. Salvage bent one and restraighten if possible.

raised with chain hoist.		(See Sections 5C1 through 5C7.)
9. Rodmeter gland leaks excessively.	9. Packing Gland loose or worn.	9. Tighten packing gland nuts. Repack if needed.
10. Pump leaks at drip fitting, more than 3 drops per minute.	10. Pump seal assembly worn or corroded.	10. Disassemble pump. Repair or replace seal components. (See Sections 5D3 through 5D27.)
11. Pump is excessively noisy.	11a. Pump motor coupling incorrectly installed. 11b. Loose pump fan. 11c. Worn pump bearings. 11d. No clearance between end cap and pump housing.	11a. Check spacing of coupling halves. Check rubber block. 11b. Tighten fan. Replace if blades are broken. 11c. Disassemble pump, replace bearings. (See Sections 5D3, 5D4, 5D16 through 5D27.) 11d. Check end cap and spacers. Add shims if needed.
12. Noisy pump drive motor.	12a. Worn ball bearings. 12b. Slow speed shaft worm and gears worn.	12a. Replace ball bearings. Check armature end play. (See Sections 5D3, 5D4, 5D16 through 5D27.) 12b. Remove reduction gear housing. Clean or replace gear.

TROUBLE	CAUSE	REMEDY
13. Hum in transmitters in rotary distance transmitter.	13a. Excessive hum is due to shorts in circuits to master speed indicator or speed and distance indicator, or to binding of gears, bearings, or distance counters. 13b. Slight hum is due to excessive end play in transmitter shafts.	13a. Check circuits. Check load on repeaters. 13b. Add shims as required.
14. Control unit contact arm tends	14a. Air in control unit.	14a. Vent control unit. (See Section 3A3.)

to rest on lower contact although rodmeter is housed and bypass valve is open.	14b. Contact arm loose on contact arm shaft. 14c. Seal bellows stud not secured to primer bellows extension post. 14d. Stop rods too far apart, causing arm to shift under unequal pressures. 14e. Bellows has been stretched due to excessively unequal pressures.	14b. Recenter and reclamp arm. Reset contacts and stop rods. (See Sections 5K2, 5K3, 5K4, 5K9, and 5K10.) 14c. Remove cover from bellows housing. Tighten capscrew. Recenter contact arm. Reset contacts and stop rods. (See Sections 5K2, 5K3, 5K4, 5K9, and 5K10.) 14d. Recenter contact arm. Reset contacts and stop rods. (See Sections 5K2, 5K3, 5K4, 5K9, and 5K10.) 14e. Recenter contact arm. Reset contacts and stop rods. Replace bellows if stretched too afar. (See Sections 5K2, 5K3, 5K4, 5K9, 5K10, and 5K18.)
15. Water appears at control unit cover over and above the quantity to be expected from sweating.	15a. Gaskets broken, eaten away, or misaligned. 15b. Punctured seal bellows.	15a. Remove housing cover and shaft seal bellows. (See Section 5K15.) 15b. Remove seal bellows and inspect. (See Sections 5K15 and 5K17.)

TROUBLE	CAUSE	REMEDY
16. Excessive friction in control unit contact arm. Arm does not return to exactly same spot when moved.	16a. Control unit contact arm rubbing on bearing plates. 16b. Contact arm shaft bearing corroded.	16a. Shift contact arm to provide clearance. 16b. Disassemble bellows housing. Replace bearings. Repair shaft seal assembly. (See

		Sections 5K13 through 5K25.)
17. Control unit stop rods cannot be set correctly.	17a. Threads stripped on rods. 17b. Rods do not contact bellows when in all the way. Bellows distorted or stretched.	17a. Remove rods and replace. 17b. Replace bellows if necessary. (See Sections 5K13 through 5K25.)
18. Time check on distance indication disagrees with speed indication.	18a. Master speed indicator not correctly calibrated. 18b. Constant frequency not exactly 60 cycles.	18a. Recalibrate master speed indicator. (See Sections 5M51 and 5M52.) 18b. Check operation of constant frequency unit. (See Sections 5N15, 5N16, 5N17, and 5N18.)
19. Conning tower speed indication disagrees with speed indication of master speed indicator.	19a. Speed transmitter drive gear incorrectly set. 19b. Speed transmitter drive gear hub has slipped on transmitter shaft. 19c. Repeater not on electrical zero.	19a. Reset adjustment to make pointers agree. (See Sections 5M46, 5M51, and 5M52.) 19b. Tighten hub screws and reset adjustment. (See Sections 5M51 and 5M52.) 19c. Set on electrical zero. Readjust transmitter drive gear. See Sections 5M51 and 5M52.)
20. Log components operate correctly, but speed and distance readings disagree with navigator's figures.	20. If error exists after proper allowance has been made for effect of bottom fouling, for wind, and for currents, the pump orifice may not be set at proper correction.	20. Set to percent correction determined by navigator. (See Chapter 6 for the method of calibration on measured courses.)

5
MAINTENANCE

A. PRELIMINARY INSTRUCTIONS

5A1. General. Extreme vigilance and care should be practiced in the inspection, cleaning, and repair of parts. Personnel performing repair work should use common sense in judging whether or not a part should be put back into service or discarded. If there is any doubt regarding this, replace the part. With the exception of bearings and electrical equipment, corrosion should be removed from parts by washing them in clean fresh water. Dry the parts thoroughly, and apply a light film of gyro oil to prevent rusting or corrosion. Use Navy-approved cleaning fluid to clean grease and oil from the parts. Keep bearings oiled and clean by wrapping them in wax paper, or cloth, until needed for assembly. The area in which the repair work is being performed should be kept in an absolutely clean condition in order to prevent any dust and dirt from getting on the parts.

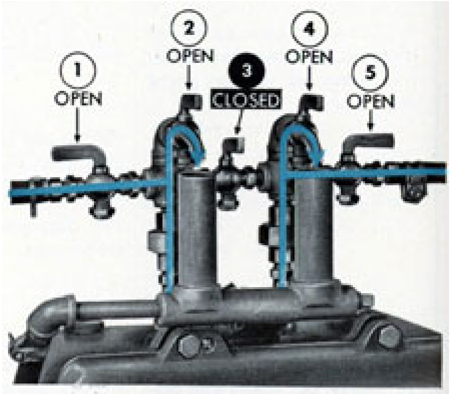
5A2. Operating the system on a static head. This operation is a means of checking the operation of the log system and other equipment connected to the log system while the ship is at rest on the surface. By shutting off the pressure on one side of the bellows, unequal pressure is obtained on the bellows, and the system will operate at one speed in the same manner as if the ship were underway. This permits the checking and inspection of the system under operating conditions. Operate on the static head as follows: Turn the valves from the secured position as shown in Figure 3-2 to the static head operating position as shown in Figure 3-7. The system will now operate at approximately 5 knots. After inspection, turn the valves to their secured position as shown in Figure 3-2. The pump motor should then stop turning and the speed pointers should beat zero.

B. MAINTENANCE OF RODMETER

5B1. Testing for obstruction in the rodmeter. The rodmeter may become clogged with jellyfish, mud, seaweed, or other foreign matter. Consequently the pressure difference will not be normal, and the mechanism will

not register correctly. The following test must be performed when the ship is on the surface: Position the vent cocks and valves as shown in Figure 5-1. If a full stream of water does not flow from both vent cocks, it is an indication that the particular line not flowing is clogged.

5B2. Blowing out the rodmeter. This operation should be performed with the rodmeter in its extended, or operating, position. It is good practice to blow out both lines even if the tests for obstruction indicate that only one line is clogged, as foreign matter has undoubtedly entered both passages. Blow out the rodmeter in the following manner: Disconnect the hose from the static pressure valve nipple on the control unit. Pinch the



1. DYNAMIC PRESSURE VALVE
2. VENT COCK
3. BYPASS VALVE
4. VENT COCK
5. STATIC PRESSURE VALVE

Figure 5-1. Vent cocks positioned to check clogged rodmeter.

end of the hose to prevent leakage of water. If the line is completely clogged, water will not leak from the hose. Connect the low-pressure air line of the ship to the static hose, and blow the obstruction out of the hose and rodmeter into the water outside of the ship. Do not apply the low-pressure air hose to the lines that enter the control unit, as air pressure will damage the sensitive mechanism. When a full stream of water is obtained from the static hose, install the end of the hose over the nipple on the static pressure valve and install the hose clamp to secure the hose in position. Blow out the upper sprockets. Using a soft brass wire, dig out the obstructions from the orifices (openings) at the lower end of the rodmeter.

Do not use steel wire or a drill to clean the orifices as they may score the orifices or break off in the openings.

Blow out the rodmeter as described in Section 5B2 with the exception that the rodmeter need not be extended into the sea. Have one crew member hold his hand near the orifices to detect the flow of air which indicates that the orifice and tubing are clear. Repeat the operation until all passages are clear. Align the lower end of the

dynamic line in the same manner.

5B3. Removing solid obstructions from the rodmeter. If obstructions are not removed by blowing out the rodmeter with compressed air, the following operations will be necessary:

Raise the rodmeter to its fully housed position (Figure 5-2). Close the sea valve. Unlatch the stop bracket at the top of the hoist assembly by opening and removing the lock which secures the bracket in position above the rodmeter, and swing it to one side out of the way (Figure 5-2). Remove the lower end of the rodmeter from the sea valve extension by raising the rodmeter to the rodmeter with the opening in the sea valve extension and lower the rodmeter to its fully housed position (Figure 5-2).

At this point the tip of the rodmeter is approximately 1 inch above the sea valve gate. Open the sea valve. Swing the stop bracket to its normal position above the rodmeter and secure in place with the lock. It is important that the stop bracket be in position above the rodmeter at all times except during the above operation, or when the rodmeter is being replaced. Lower the rodmeter to its normal housed position or to its fully extended position as desired. Place the hoist crank in the brackets provided, and replace the deck plate over the sea valve.

C. REPLACING DAMAGED RODMETER

5C1. General instructions. If the rodmeter is bent so that it cannot be drawn up into the ship, it will be necessary to install a spare rodmeter. Do not attempt to force the damaged rodmeter up into the ship, as the hoist mechanism may be damaged. The removal and installation operations should be carried out only when the ship is surfaced. If the damaged rodmeter is to be salvaged, it may be accomplished if a diver is available. Lower the diver over the side of the ship so that he can rig a line around the damaged rodmeter. Secure the other end of the line to the ship so that the rodmeter may be pulled out of the water after it is pushed out of the sea valve. The rodmeter (see Figure 5-3), instead of the conventional nipple installation as shown in Figure 5-4. This necessitates a different procedure for removing and installing the clamp and guard assembly. These two procedures will be covered in the following operations.

5C2. Breaking out the spare rodmeter. Break out the spare rodmeter and place it alongside of the hoist mechanism so that it will be immediately available when needed.

5C3. Rumoring the clamp and guard assembly (nipple installation). (See Figure 5-4.) Loosen the hose clamps and remove the two lengths of hose from the nipples on the upper end

rodometers of all submarines are equipped with two valve assemblies mounted on the upper end openings of the rodmeter. Unscrew the longest nipple (after nipple) and plug the hole in the rodmeter with a wooden plug. Remove the

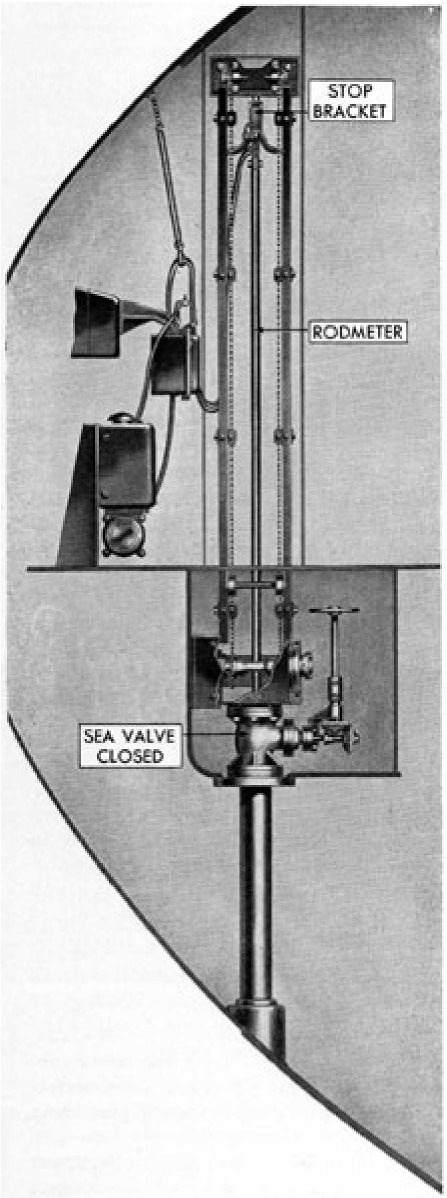


Figure 5-2. Rodmeter in secured position.

forward nipple in the same manner. Remove the two nuts and bolts that secure the clamps, and guard to the rodmeter and remove the clamp and guard assembly. Raise the guard, by means of the hoist, up against the stop bracket above the rodmeter (Figure 5-2).

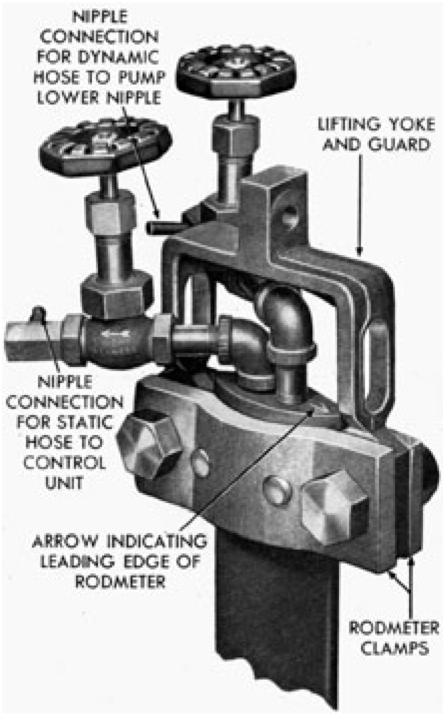


Figure 5-3. Rodmeter with valves installed.

5C4. Removing the clamp and guard assembly (valve installation). Loosen the two hose clamps (one on each hose) that secure the ends of the hose to the nipples provided on the valve assemblies at the upper end of the rodmeter (Figure 5-3). Remove the hose and clamps. Remove the two bronze nuts and bolts that secure the two clamps and the guard to the top of the rodmeter, and remove the clamps. Raise the

guard and yoke assembly up against the stop bracket by means of the hoist provided for raising the rodmeter.

It may be necessary to remove one or both valve handles from the valve stems in order to get enough clearance to raise the guard.

This is accomplished by removing the two nuts (one on each handle) that secure the valve handles to the valve stems, and by removing the handles. Make a rough sketch of the position of the valve assemblies so that they can be installed in their original position on assembly. Spread the two valve assemblies apart so that one of them can be unscrewed without interference from the other valve assembly. Unscrew and remove the lower valve assembly from the elbow which connects this valve assembly with the opening in the top of the rodmeter. Plug the elbow opening with a wooden plug. Unscrew the complete valve assembly from the other opening on top of the rodmeter, and plug this opening in the rodmeter with a wooden plug. Unscrew and remove the elbow of the lower valve assembly from the top of the rodmeter, and plug the opening in the top of the rodmeter with a wooden plug.

5C5. Installing the valve assemblies in the top of the rodmeter. (See Figure 5-3.) The spare rodmeter is equipped with nipples and a clamp and guard

5. Install the valve assembly in this elbow, tightening the valve until secure. Be sure that the valve stem is facing upward.

6. Disassemble the second valve assembly by unscrewing the horizontal nipple and valve assembly from the elbow and nipple assembly. Also remove the valve bottom and stem assembly from the valve body. This disassembly is necessary in order to obtain the proper clearances while installing the second valve assembly in the rodmeter.

7. Install the elbow and nipple in the forward (dynamic) opening on top of the rodmeter. Tighten until the elbow is in its original position. Refer to the sketch made previously for the position of the elbow.

8. Install the valve body and nipple into the elbow.

9. Install the valve bottom and stem assembly into the valve body, making certain that the valve stem is facing upward.

5C6. Installing the clamp and guard assembly. (See Figure 5-4.) The two clamps and the guard are stamped at their ends. These numbers should be adjacent to one another when these pieces are assembled on the rodmeter. Place the two clamps around the upper end of the spare rodmeter in such a manner that the clamps are over

assembly. For those ships which have valve assemblies installed instead of the conventional rodmeter nipples, the following procedure is necessary to install the valve assemblies in the spare rodmeter:

1. Remove the clamp and guard assembly from the spare rodmeter by removing the two bronze nuts and two bolts that secure the clamps and guard in position at the upper end of the rodmeter, and remove the clamps and guard.

2. Unscrew and remove the two nipples from the top of the rodmeter.

3. Apply a coating of white lead compound to the threads of the valve assemblies to be installed.

4. Install the elbow of the lower valve assembly (previously removed from the damaged rodmeter) in the after (static) opening in the top of the rodmeter. Refer to the sketch previously made at disassembly, and tighten this elbow to its original position.

the knock-out pins provided at the top of the rodmeter. Place the guard between the clamps. Align the mounting holes in the three pieces, and install the two bronze bolts and nuts that secure the clamp and guard assembly to the rodmeter. Tighten the nuts securely.

5C7. Installing the spare rodmeter. (See Figure 5-4.) The following procedure should be used in installing the rodmeter:

1. If the damaged rodmeter is partially raised, push it downward until the knock-out pin rests on top of the packing gland in the sea valve extension. It may be necessary to use a heavy hammer and wooden block to start the rodmeter downward.

2. Place the tip of the spare rodmeter on top of the damaged rodmeter, being sure that the dynamic orifice in its leading edge is facing forward. Note the arrows stamped on the

rodmeter for facing the rodmeter in the proper direction.

3. Remove the cotter pin and the clevis pin which secure the old guard to the lifting bar on the hoist chain, and remove the old guard. Align the opening in the lifting bar with the opening provided in the guard on the spare rodmeter, and install the clevis pin and cotter pin which

secure the lifting bar to the guard assembly.

4. Place the loose end of the dynamic hose over the nipple provided on the dynamic fitting on top of the rodmeter. The opposite end of this hose is attached to the pump. Secure the hose to the nipple by tightening the hose clamp on the end of the hose. Place the end of the static hose on the nipple provided on the fitting on top of the rodmeter. The opposite end of the static hose is attached to the control unit. Secure the hose to the nipple by tightening the hose clamp on the end of the hose.

5. Remove the knock-out pin from the damaged rodmeter. Push downward on the spare rodmeter to drive the damaged rodmeter downward and out of the ship.

6. Vent the system in accordance with the instructions in Section 3A3.

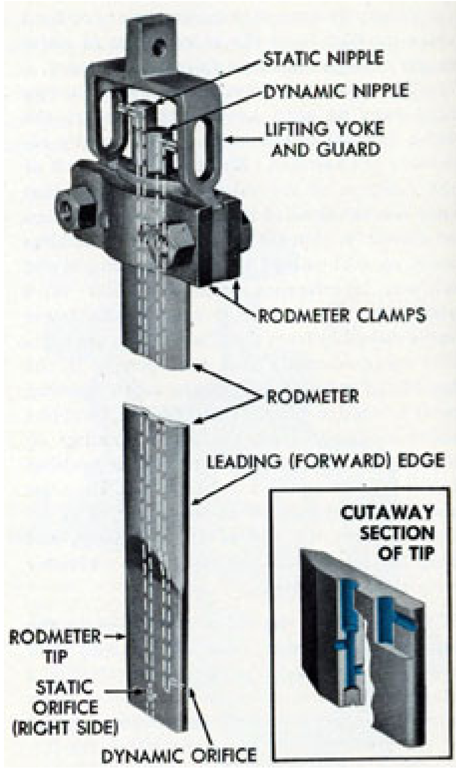


Figure 5-4. Cutaway view of Pitometer rodmeter.

D. MAINTENANCE OF PUMP

5D1. General. The pump is removed, disassembled, inspected, cleaned, repaired, adjusted, and lubricated whenever the leakage from the pump exceeds three drops per minute; or whenever the pump becomes noisy due to worn bearings or because the impeller blades are hitting on the cover.

5D2. Period of overhaul. If possible, the pump assembly should be removed, disassembled, cleaned, inspected, lubricated, adjusted, or longer interval of overhaul is left to the discretion of the commanding officer.

5D3. Removing the pump. (See Figure 5-5.) Have the rodmeter in its secured position with the sea valve closed. Disconnect the two lengths of hose from the pump by loosening the two hose clamps (one on each hose) that secure the hose to the nipples on the pump, and remove the hose and clamps. Remove the four nuts that secure the pump to the spacer (mounting) rods, and remove the

and/or repaired, if necessary, every 45 days. If the tactical situation does not warrant servicing the pump at 45-day intervals, it should be overhauled after every patrol to keep the pump operating correctly. A shorter

pump assembly from the spacer rods.

5D4. Disassembly of the pump assembly. (See Figure 5-7.) Following is the procedure for disassembling the pump assembly.

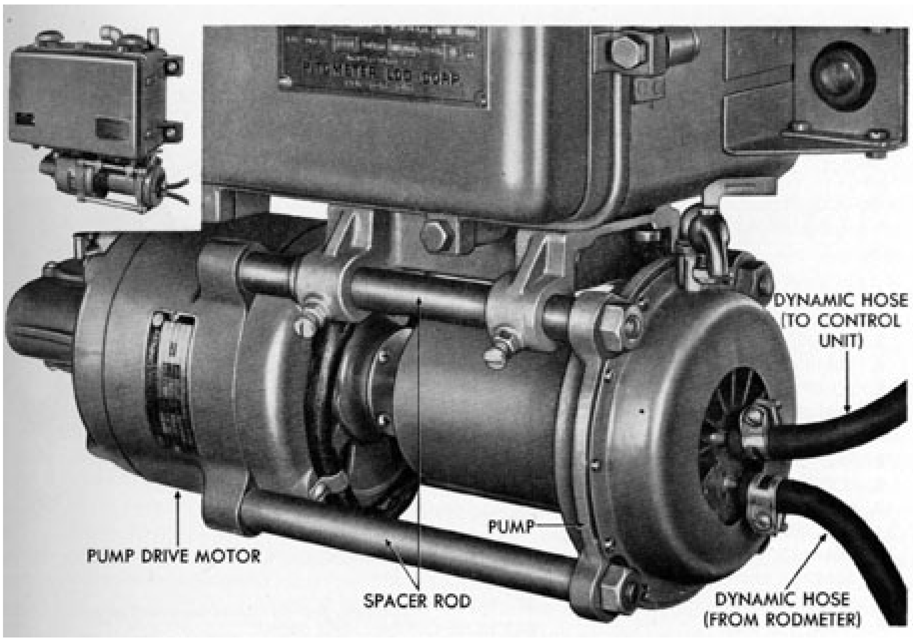


Figure 5-5. Pump installed.

1. Remove the 11 screws that secure the pump cover jacket to the pump housing, and remove the cover jacket. Do not remove the marked orifice plate.

2. Remove the 12 screws that secure the housing cover to the housing, and remove the housing cover. Lift the rubber gasket off the housing. Turn the pump assembly over so that the impeller blades are facing downward, and rest the pump assembly on the cover jacket with the impeller blades in the opening in the cover jacket. Do not rest the impeller blades on an uneven surface as they will be damaged.

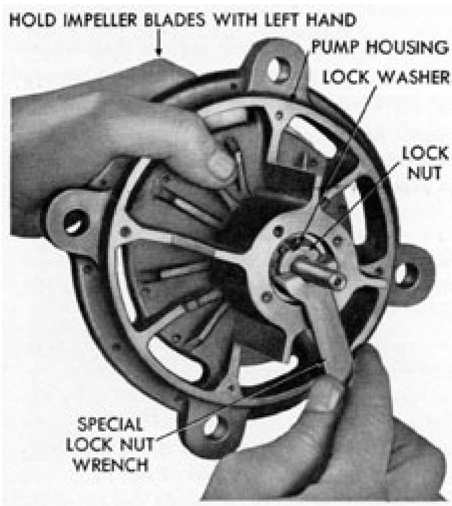
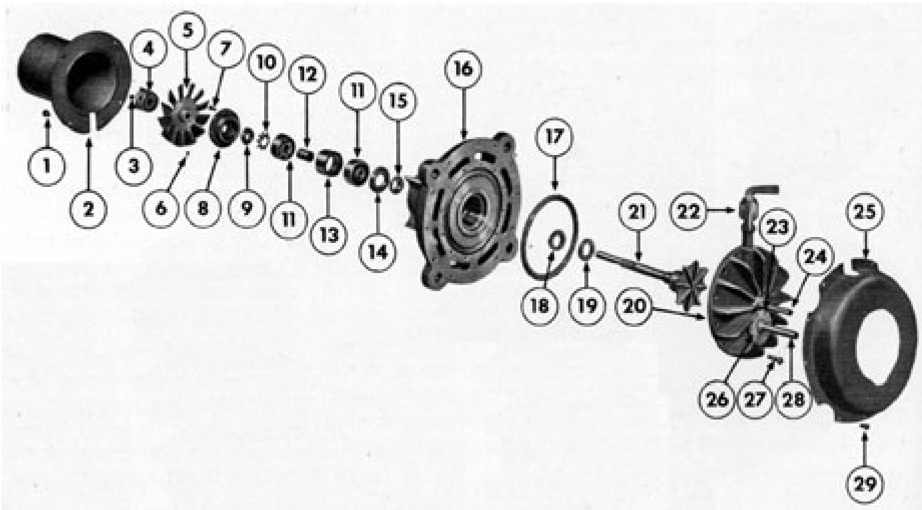


Figure 5-6. Removing impeller shaft lock nut.

3. Remove the four screws that secure the housing jacket to the pump housing, and remove the housing jacket.

4. Loosen the two setscrews (one on each piece) that secure the coupling and the fan on the impeller shaft, and remove the coupling and fan.



1. HOUSING JACKET SCREW
2. PUMP HOUSING JACKET
3. COUPLING SET SCREW
4. PUMP COUPLING
5. PUMP FAN
6. FAN SETSCREW
7. END CAP SCREW
8. END CAP
9. LOCK NUT
10. LOCK WASHER
11. BALL BEARING
12. BEARING INNER RACE SPACER
13. BEARING OUTER RACE SPACER
14. SHIELD WASHER
15. THROWER DISK
16. PUMP HOUSING
17. GASKET
18. ROTARY SEAL INSERT
19. SEAL RING
20. PUMP HOUSING COVER
21. PUMP IMPELLER, ASSEMBLY
22. VENT COCK
23. ORIFICE PLATE SCREW
24. HOSE CONNECTING NIPPLE TO CONTROL UNIT
25. PUMP COVER JACKET
26. ORIFICE PLATE
27. HOUSING COVER SCREW
28. HOSE CONNECTING NIPPLE TO RODMETER (DYNAMIC)
29. COVER JACKET SCREW

Figure 5-7. Pump disassembled.

5. Remove the four screws that secure the end cap to the pump housing, and remove the pump end cap.

5D5. Disassembly of the impeller assembly. (See Figure 5-8.) The impeller assembly is disassembled as follows:

6. Bend down the lug of the external toothed lock washer that secures the lock nut in position. Using the special lock nut wrench (Figure 5-6), remove the lock nut from the end of the impeller shaft. Do not place the impeller blades in a vise. Lift off the lock washer. Pull the impeller assembly out of the pump housing.

7. Insert a brass or fiber rod V inch in diameter into the pump housing from the impeller end of the pump housing and push out the two ball bearings, two spacers, thrower disk, and shield washer from the pump housing. Do not use a steel rod as the parts will become burred, and the bearings will not align properly at assembly.

1. The rotary seal bellows is disassembled from the impeller assembly when visual inspection reveals the fade of the bellows to be grooved, burred, or badly corroded.

2. Remove the eight screws that secure the impeller gasket ring to the impeller, and remove the gasket ring. Remove the gasket from the ring or from the impeller if the gasket is sticking to the impeller. Carefully pull the rotary seal bellows from the impeller and off the impeller shaft.

3. Place the impeller shaft in a soft-jawed vise in such a manner that the pin that secures the shaft to the impeller is parallel to the jaws of the vise. Using a pin punch, drive out the pin from the impeller and the, impeller

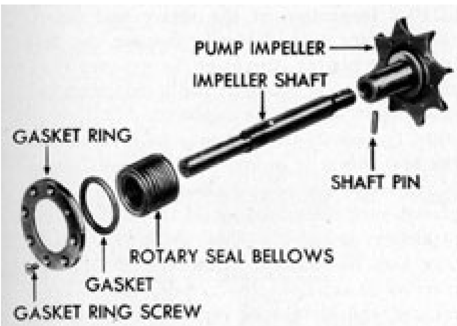


Figure 5-8. Impeller disassembled.

shaft. The impeller shaft is disassembled from the impeller only if a gap between the shaft and the impeller indicates that the pin that secures the shaft to the impeller has been distorted, or sheared off due to the application of too much pressure on the lock nut which secures the bearings and spacers to the impeller at a previous assembly operation.

an indication that the pin that secures the shaft to the impeller has been distorted, or sheared off at a previous assembly. If the shaft is not straight, or the pin has been distorted or sheared off, remove the pin from the shaft and impeller. Press a new shaft into the impeller, and install a new, 3/32-inch monel pin which secures the shaft to the impeller. A bronze pin may be substituted for the monel pin if the latter is not available, but do not use steel or stainless steel pins as they will corrode and fail prematurely. If the threads are damaged, touch them up on a lathe. The diameter of the screws is 0.391 inch (10 mm), 32 threads per inch.

5D6. Inspection and repair of impeller shaft. (See Figure 5-8.) Inspect the impeller shaft for straightness. Inspect the shaft for security of mounting in the impeller. The impeller shaft should be securely mounted in the impeller, and the pin that secures the shaft to the impeller should be in place. A gap between the impeller shaft and the impeller is

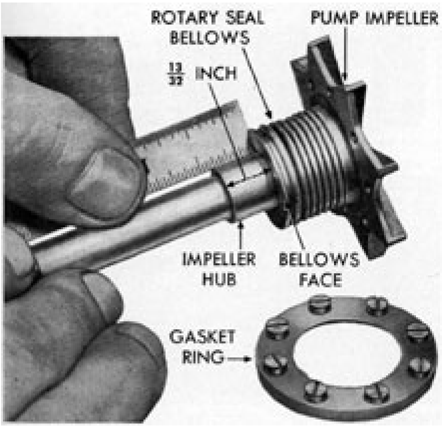


Figure 5-9. Checking length of rotary seal bellows

5D7. Inspection of the impeller blades. (See Figure 5-8.) Inspect the impeller blades for straightness and depth. The blades should be straight. The depth of the impeller blades on a new, impeller is 0.189 inch. If the impeller blades are worn more than 0.002 inch below the depth of the blades of a new impeller, that is, the depth of blades is less than 0.187 inch, the impeller should be replaced, or the calibration of the system will be incorrect.

5D8. Inspection of the rotary seal bellows. (See Figure 5-8.) Visually inspect the face of the rotary seal bellows. If worn, pitted; or corroded, replace the bellows and gasket. Use KR monel bellows for replacement, if available. Use monel or bronze screws on the gasket ring. Do not use stainless steel screws on the gasket ring as the steel screws corrode badly when used with monel. Check the

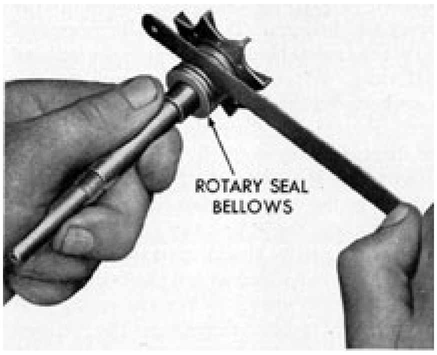


Figure 5-10. Stretching rotary seal bellows.

5D10. Inspection of the rotary seal insert. (See Figure 5-7.) Visually inspect the seal insert for pitting, corrosion, or grooves indicating wear. If pitted or badly corroded, the seal insert should be replaced. If lightly worn (grooved) the seal may be refaced. If the seal

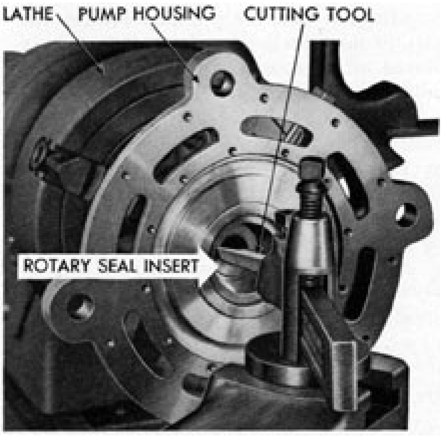


Figure 5-11. Refacing rotary seal insert.

dimension from the impeller hub to the bellows face (Figure 5-9). This dimension is very critical and should be exactly 13/32-inch. If the bellows is too short (dimension more than 13/32-inch), the pump may leak excessively. If the bellows is too long (dimension less than 13/32-inch), the seal faces will wear rapidly, and may make the pump too tight. This latter fault will cause the pump to bind at low speeds.

5D9. Adjusting-the rotary seal bellows. (See Figure 5-10.) If the bellows are found to be too short, as described in Section 5D8, they may be stretched as follows: Place a thin strip of metal, such as the smooth edge of a hacksaw blade, between the folds of the rotary seal bellows. Turn the bellows around so that the metal blade will stretch the bellows uniformly. After each turn, measure the distance between the impeller hub to the bellows face. Repeat the spreading operation until the dimension between the impeller hub and bellows face is exactly 13/32-inch. When the bellows is too long, as described in Section 5D8, compress the bellows by hand (while installed on impeller

insert is bronze, and a monel insert is available, the bronze insert should be replaced with the monel insert. If a monel replacement is not available, the bronze insert may also be refaced. However, the bronze insert will continue to corrode even though refaced and should be replaced by a monel insert at the first opportunity.

5D11. Refacing the old seal insert. (See Figure 5-11.) Place the pump housing in a lathe. Align the housing up to 0.0005 inch, using a dial indicator on the monel liner face. Take light cuts across the seal insert face until score marks are removed. Undercut the inner face at the inside diameter of the insert 0.010 inch below the face of the seal insert. Occasionally when an old seal insert is refaced, enough metal is removed so that the

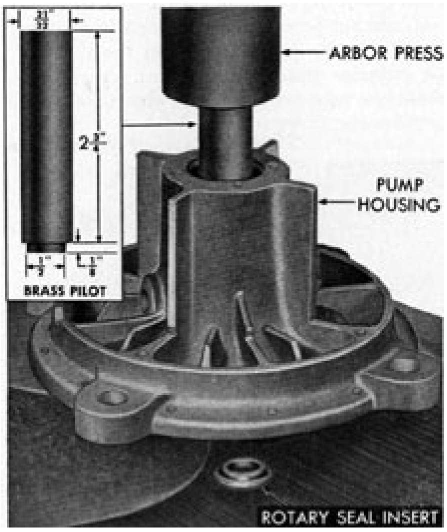


Figure 5-12. Pressing out rotary seal insert.

shaft) until the dimension between the impeller hub and the bellows face is exactly 13/32-inch. When the rotary seal bellows is at proper dimension, the bellows face must move freely inward and outward along the shaft.

pump will leak when installed, due to a looseness between the insert, micarta ring, and the bellows. This may be remedied by disassembling the pump and stretching the bellows to take up the space between the bellows and the seal insert.

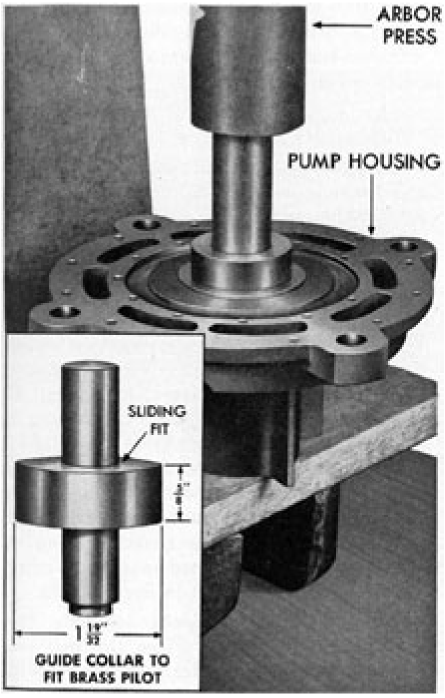


Figure 5-13. Installing rotary seal insert.

5D12. Replacing the seal insert. (See Figures 5-12 and 5-13.) Place the pump housing on the bed of an arbor press with the large end of the housing downward. Using a special rod as shown in Figure 5-12, press out the seal insert. To install a new seal insert, place the housing on the bed of an arbor press with of the seal downward. Using a special seal installing tool as shown in Figure 5-13, press the seal insert into housing.

5D13. Refacing the new seal insert. (See Figure 5-11.) At manufacture, the dimensions of the seal insert are such that it may be faced to allow for removal of burrs or score marks from the seal surface after the pressing operation. This precaution is also taken to allow

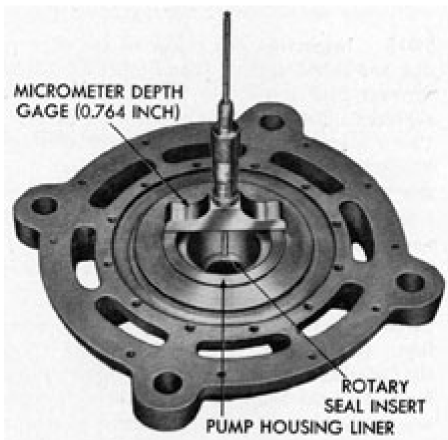


Figure 5-14. Checking rotary seal insert.

for facing the seal in the event it is not pressed true in the housing. Reface a new seal insert as follows: Place the pump housing in a lathe. Align the housing up to 0.0005 inch, using a dial indicator on the monel liner face. Take light cuts across the seal insert face until the proper dimension of 0.764 inch is reached and the face of the seal

the small end of the housing downward. Put a moderate amount of pipe compound on the outer surface of the shoulder of the insert and on the inner surface of the opening through the housing liner. Place the new seal insert in the housing with the shouldered end

insert is smooth. This dimension is the distance from the monel liner face of the housing to the face of the seal insert, and is determined with a depth gage as shown in Figure 5-14.

5D14. Inspection of the seal ring. (See Figure 5-7.) Visually inspect the seal ring. The ring must be perfectly flat, or it should be 0.0005 inch thicker at its outer edge. If it is worn on either side, the ring should be replaced. The seal ring should always be

replaced if the rotary seal bellows or the seal insert surfaces have been changed. Some pump assemblies are still equipped with the carbon ring. Replace the carbon ring with a micarta ring. In emergencies when micarta seal rings are not available, a ring turned from lignum vitae would be satisfactory. Cut across the grain of the wood to the approximate size; soak in water for a day, and while it is moist, turn it to the exact thickness and flatness. This ring must be kept wet thereafter or it will warp out of shape, making it worthless.

5D15. Inspection and repair of the thrower disk and shield washer. (See Figure 5-7.) The thrower disk and shield washer need not be replaced unless they are badly worn or bent. Using a straightedge, inspect the pieces for flatness. Visually inspect the thrower disk and shield washer for burrs. Remove nicks from the inner surfaces of the thrower disk and shield washer with a

5D17. Cleaning and inspection of the bearing spacers. (See Figure 5-7.) Thoroughly clean and dry the two bearing spacers. Examine them for pitting, cracks, or scored end surfaces. Spacers with ends that are not smooth should be replaced. Measure the length of the spacers. The inner bearing spacer should be from 0.029 to 0.033 inch longer than the outer spacer in order that the bearings seat properly when assembled on the impeller shaft. The outer spacer should be 0.625 inch long.

5D18. Assembling the shaft and impeller. (See Figure 5-8.) Place the impeller shaft in the impeller hub. Align the hole in the shaft and the hole in the impeller hub, and install the pin that secures the shaft to the impeller hub. Be sure that the ends of the pin are flush with the impeller hub, and that the surfaces at the ends of the pin are smooth.

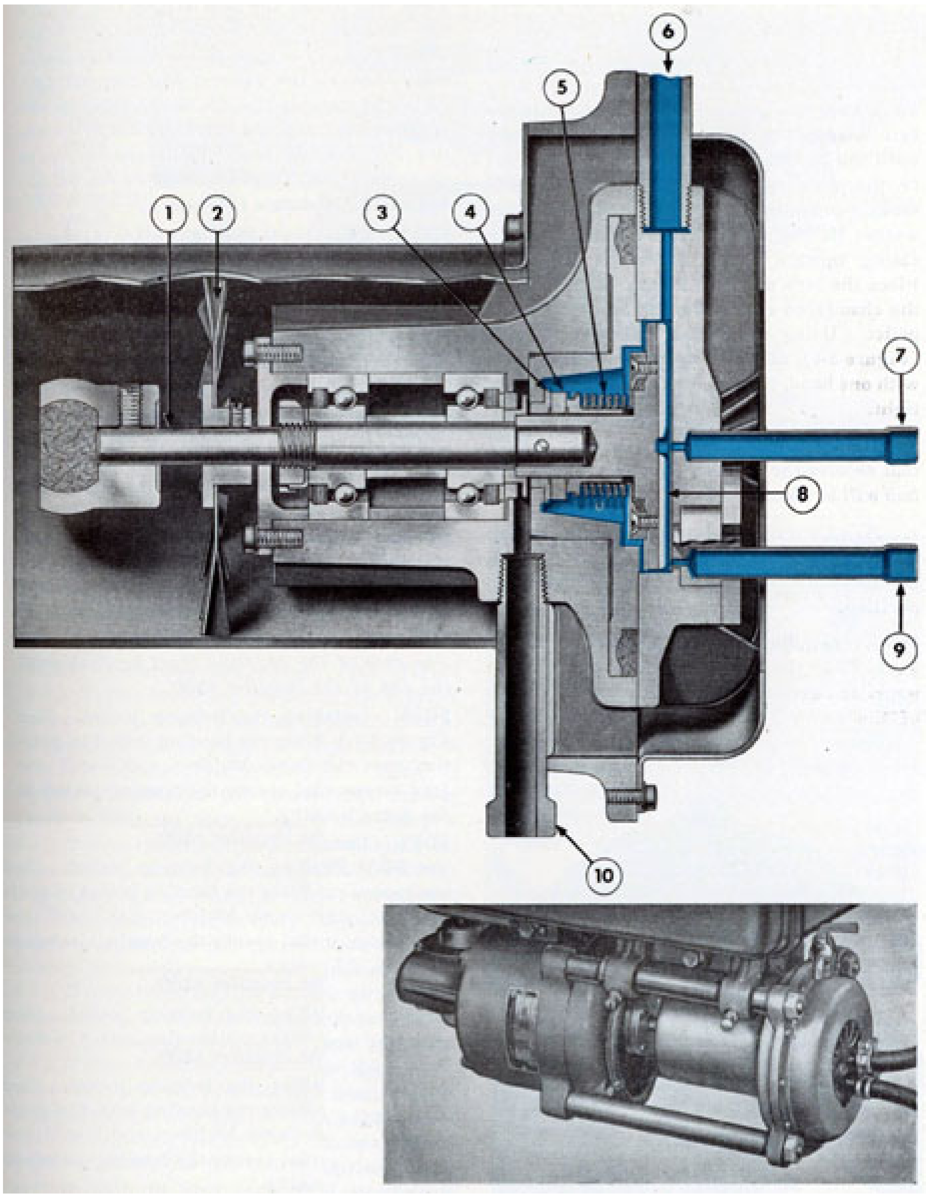
5D19. Installing the rotary seal bellows. (See Figure 5-8.) Place the rotary seal bellows on the

bearing scraper. Remove score marks from surfaces with a finecut file.

5D16. Cleaning and inspection of the bearings. (See Figure 5-7.) Thoroughly clean the bearings with Navy-approved cleaning fluid. Dry the bearings thoroughly. In cases where the grease has become hardened within the bearing, the bearing should be allowed to soak in the cleaning fluid until the grease has softened, and then swished back and forth in the cleaning fluid until all grease and dirt are removed from the bearing. Visually inspect the bearings for pitting resulting from corrosion, and if they are pitted, replace the bearings. The bearings should be smooth and operate freely. Turn the bearing by hand, and note any clicking noise which indicates a cracked ball, or a piece of metal or dirt within the bearing. If the bearing is thoroughly clean, and clicking or binding exists when the bearing is rotated by hand, the bearing should be replaced: If the bearing is worn so that there is excessive side play, or excessive end play between races, it should be replaced. After cleaning and inspection, oil the bearings with light oil, and pack the bearings with grease, Navy, Symbol 14L3. Wrap the bearings in waxed paper until they are to be assembled.

impeller shaft with the recessed end of the bellows toward the impeller. Install the rubber gasket over the seal bellows and up against the impeller (not inside the bellows). Place the gasket ring over the bellows. Align the mounting holes in the gasket ring and the holes in the impeller, and install the eight screws which secure the gasket ring to the impeller. Check the dimensions of the rotary seal bellows as described in Section 5D8.

5D20. Installing the impeller assembly. (See Figures 5-7 and 5-15) Place the seal ring (micarta ring if available) over the impeller shaft and up against the face of the rotary seal bellows. Place the pump housing over the impeller shaft with the large end of the pump housing toward the impeller. Place the thrower disk on the impeller shaft with the large flat surface of the ring toward the impeller. Install the shield washer on the impeller shaft with the flat surface of the washer facing away from the impeller. Install the inner ball bearing on the impeller shaft with the shield end of the bearing toward the impeller. Place the inner and outer bearing spacers on the shaft so that they are adjacent to the inner ball bearing just installed. Fill the bearing spacers one-half full with grease, Navy Symbol 14L3.



1. IMPELLER SHAFT
2. PUMP FAN
3. ROTARY SEAL INSERT
4. SEAL RING
5. ROTARY SEAL BELLOWS
6. VENTING COCK
7. HOSE CONNECTING NIPPLE, TO CONTROL UNIT
8. PUMP IMPELLER
9. HOSE CONNECTING NIPPLE, TO RODMETER
10. DRIP FITTING

Figure 5-15. Cutaway view of rotary pump.

Do not fill the spacers more than one-half full with grease.

Install the outer bearing on the impeller shaft with the shield end of the bearing facing away from the impeller. Carefully press the ball bearing on the impeller shaft by hand until the bearing is aligned with, and adjacent to, the inner and outer bearing- spacers holes, and install the four screws that secure the end cap to the pump housing. There should be a gap of approximately 0.002 inch or more between the housing and the end cap. This end cap clamps the outer race of the outer ball bearing and therefore holds the entire ball bearing and impeller assembly in proper position. Do

previously installed. Place the toothed lock washer on the impeller shaft with the teeth facing upward (away from the impeller). Place the lock nut on the impeller shaft with the chamfered end of the nut toward the impeller. Using the special lock nut wrench (Figure 5-6), and holding the impeller blades with one hand, tighten the lock nut reasonably tight.

Do not force-tighten this nut, or the pin that secures the impeller shaft to the impeller hub will be sheared off.

Align one of the slots in the lock nut with one of the teeth in the lock washer, and bend the tooth upward to secure the lock nut in position.

5D21. Installing the end cap. (See Figure 5-7.) Place the end cap over the end of the impeller shaft and up against the small end of the pump housing. Align the mounting

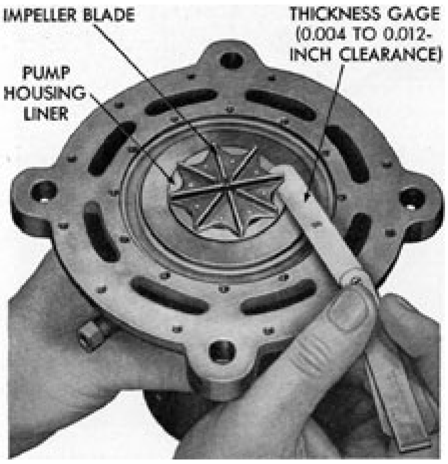


Figure 5-16. Checking impeller clearance.

not file off or cutoff the end cap to eliminate this gap.

5D22. Checking the impeller blade clearance. (See Figure 5-16.) Using a thickness gage, check the clearance between the housing end of the impeller blades, and the monel liner of the pump housing as shown in Figure 5-16.

5D23. Installing the fan and coupling. (See Figure 5-7.) Place the fan on the impeller shaft with the hub of the fan toward the impeller. Align the setscrew in the fan hub with the flat side of the impeller shaft, and tighten the setscrew to secure the fan on the shaft. Place the half-coupling on the end of the impeller shaft with the lugs of the coupling facing away from the impeller. Carefully align the end of the coupling with the end of the impeller shaft and tighten the setscrew that secures the coupling to the impeller shaft. The face of the coupling must be flush with the end of the impeller shaft.

5D24. Installing the housing jacket. (See Figure 5-7.) Place the housing jacket in position over the pump housing, and install the four screws that secure the housing jacket to the pump housing.

5D25. Installing the pump cover. (See Figure 5-7.) Place the rubber cover gasket in the groove provided in the impeller end of the pump housing. Place the finned pump cover in position on the impeller end of the pump housing. Align the cover so that the vent cock is directly opposite the drip fitting on the pump housing. Install the 12 screws that secure the cover to the pump housing.

The vent cock should be repaired at this time. Inspect and clean the vent cock as follows: Remove the nut or cotter pin that secures the spring and valve assembly in the vent cock body. Lift the valve assembly from the vent cock body. Clean corrosion from all parts of the vent cock, and lubricate with a small amount of waterproof grease.

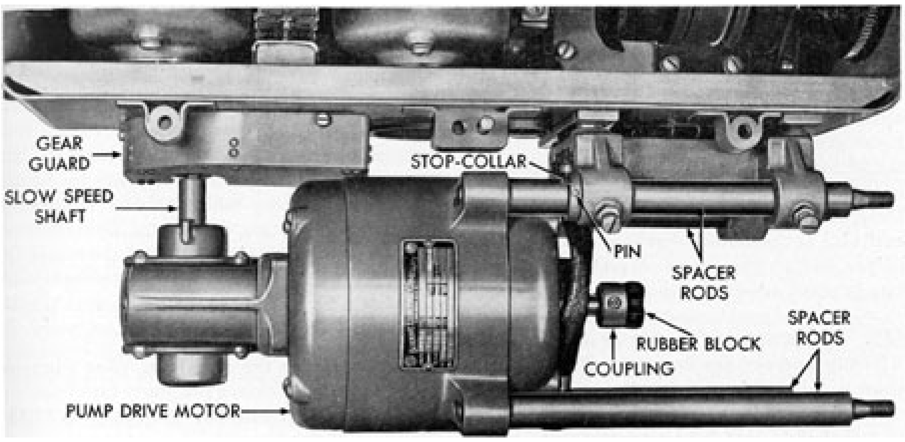


Figure 5-17. Pump drive motor installed.

5D26. Installing the cover jacket. (See Figure 5-7.) Place the cover jacket in position on the pump housing, and secure it with the brass or bronze screws provided.

5D27. Installing the pump. (See Figure 5-5.) Before installing the pump, test it under pressures up to 200 pounds per square inch at a speed as low as 1 knot in accordance with the instructions given in Chapter 7. Slide the pump assembly on the spacer rods, making certain that the went cock on the pump is facing upward. Be sure that the coupling on the pump drive motor shaft is flush with the end of the drive shaft. Place the rubber block in one half of the pump coupling. Move the pump

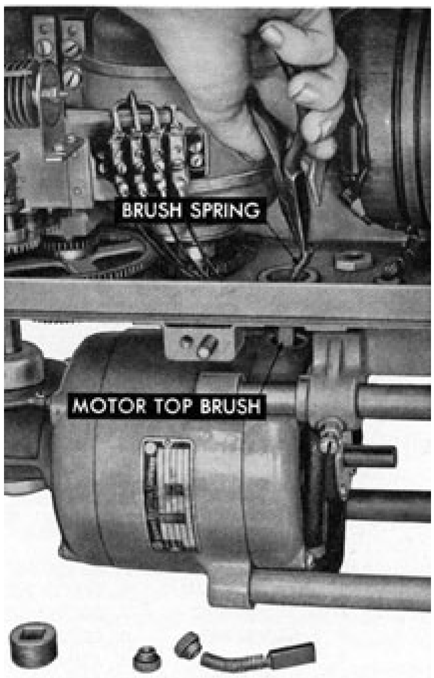


Figure 5-18. Removing upper brush.

to the left until the two halves of the coupling are properly engaged; then install the four nuts that secure the pump assembly on the spacer rods. Install the dynamic hose from the control unit on the upper nipple on the pump, and tighten the hose clamp to secure the hose to the nipple. Install the dynamic hose from the rodmeter on the lower pump nipple, and tighten the hose clamp to secure the hose on the nipple. Vent the system in accordance with the instructions given in Section 3A3.

E. MAINTENANCE OF PUMP DRIVE MOTOR

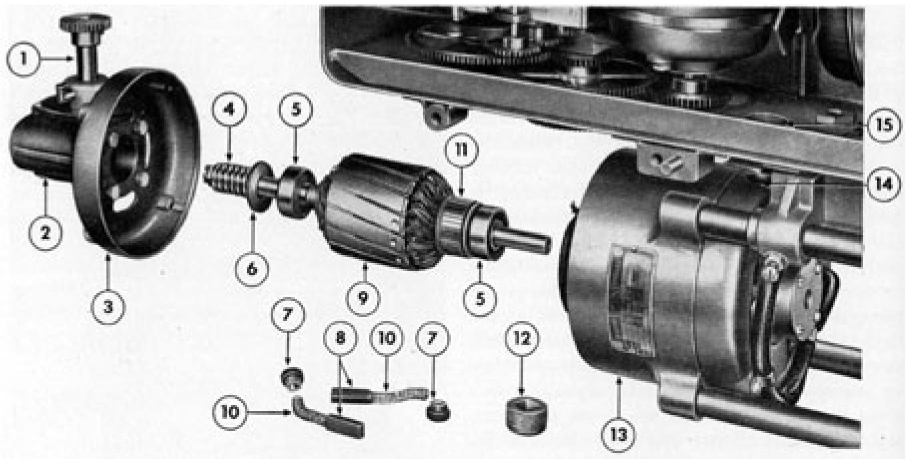
5E1. Removing the brushes. See Figures 5-17 and 5-18.) Remove the 10 screws that secure the cover on the rotary distance transmitter case and remove the cover. This is necessary in order to make the upper brush accessible. Remove the pipe plug from the bottom of the rotary distance transmitter case. Unscrew and remove the two caps (one on each side of the motor) that secure the brushes in position in the motor. Carefully lift the two brushes out of the motor.

5E2. Inspection and repair of the brushes. Visually inspect the brushes. They should show a polished surface on the end that contacts the commutator. The brushes should not be less than 3/8-inch long from the contact end to the shoulder where the brush spring is attached. Brushes showing wear nearing the 3/8- rubbed across the surface without affecting the curvature of the face.

5E3. Installing the brushes. (See Figures 5-17 and 5-18.) Place the lower brush in the hole provided in the lower side of the motor. Compress the brush tension spring by hand, and install the cap which secures the lower brush in the motor. Install the upper brush in the hole provided in the top of the motor in the same manner. Install the pipe plug in the hole in the bottom of the rotary distance transmitter case. Install the case cover.

5E4. Removing the armature. (See Figures 5-17 and 5-19.) Remove the pump (see Section 5D3.) Remove the brushes (see Section 5E1). Remove the two screws that secure the gear guard to the rotary transmitter case and remove the gear guard. Loosen the socket head setscrew that

inch dimension should be replaced. If the brush contact surface is pitted, smooth off the surface, using fine sandpaper wrapped around a cylindrical object. The brushes can be secures the drive motor coupling on the motor shaft, and remove the coupling and rubber spacer. Remove the four screws that secure the back end shield on the motor



1. SLOW SPEED SHAFT
2. GEAR HOUSING
3. BACK END SHIELD
4. WORM
5. BALL BEARING
6. SPACER WASHER
7. BRUSH HOLDER CAPS
8. BRUSHES
9. ARMATURE CORE AND SHAFT
10. BRUSH SPRINGS
11. COMMUTATOR
12. PIPE PLUG
13. MOTOR FRAME
14. TOP BRUSH HOLDER
15. PIPE PLUG HOLE

Figure 5-19. Pump drive motor partially disassembled.

field ring, and remove the back end shield and armature assembly :from the pump motor. The armature assembly can then be carefully pulled out of the back end shield for inspection of bearings.

5E5. Inspection of the bearings. (See Figure 5-19.) Visually inspect the two bearings on the armature shaft for evidence of pitting due to corrosion. Turn the bearings by hand. They should turn easily and freely. A clicking noise indicates that one or more of the balls is cracked, and the bearing must be replaced. A damaged bearing is removed by

terminal block on the bottom of the rotary distance transmitter case by removing the four screws from the terminal block and carefully lifting off the wire terminals with the blade of a screwdriver. Remove the gear guard. Loosen the two stop screws that secure the spacer rod in the motor mounting bracket, and pull the pump drive motor assembly to the left and off the rotary, distance transmitter case.

5E8. Installing the pump drive motor. (See Figures 5-17 and 2-8.) Align the two upper spacer rods with the motor mounting bracket, and slide the motor assembly to

using a bearing puller. Press the replacement bearing onto the shaft in place of the damaged bearing.

5E6. Assembly of the armature. (See Figures 5-17 and 5-19.) Align the worm, spacers, and bearing on the end of the armature shaft with the opening in the back end shield, and carefully push the armature assembly into the back end shield. Place the armature inside the motor, being careful when inserting the shaft through the opening in the front end shield. Align the mounting holes in the back end shield with the holes in the field ring, and install the four screws that secure the back end shield to the field ring of the motor. Turn the pump drive shaft by hand to be sure that the armature and gears are turning freely. Install the gear guard. Install the two brushes (see Section 5E3). Install the coupling on the armature shaft and secure with the setscrew provided. Install the rubber spacer. Install the pump (see Section 5D27).

5E7. Removing the pump drive motor as a unit. See Figure 2-8.) Disconnect the hose and remove the pump (see Section 5D3). Disconnect the armature and field wires from the the right as far as the stop on the spacer rod will allow. Make sure that the gears at the left end of the motor are properly meshed and that the spacer rod is against the motor mounting bracket. There should be a slight amount of backlash between the two external gears. If the gears do not mesh properly when the stop is against the motor mounting bracket, it will be necessary to relocate the stop. This is accomplished as follows: Drill out the pin that secures the stop on the spacer rod. Slide the motor assembly to the right until the gears at the left end of the motor are properly meshed. Slide the stop over against the motor mounting bracket and locate the pinhole. Drill a hole through the spacer rod. Install a new pin through the stop and the spacer rod. Install the gear guard. Connect the two armature and the two field wires to the terminal block on the counter mounting plate inside the rotary distance transmitter case. The terminal block and terminals on the wires are marked for the location of wires. The corresponding terminals are marked as follows A+, A-, F+, and F-. Install the pump (see Section 5D27).

F. TRANSTAT ASSEMBLY

5F1. Removing the transtat assembly. (See Figure 5-20.) The transtat assembly is removed as a unit as follows: Remove the four screws and toothed lock washers that secure the transtat mounting base to the plate back the assembly to make the wire connections more accessible. Remove the nuts and flat washers that secure the wire terminals to the posts on the transtat assembly. Mark the wires for ready identification at assembly. Loosen

of the rotary distance transmitter. Carefully lift the defective unit from the plate, and turn the setscrew that secures the gear on the right side of the transtat assembly and

remove the gear. Place the gear on the new or rebuilt transtat assembly to be installed and tighten the setscrew to secure the gear on the shaft.

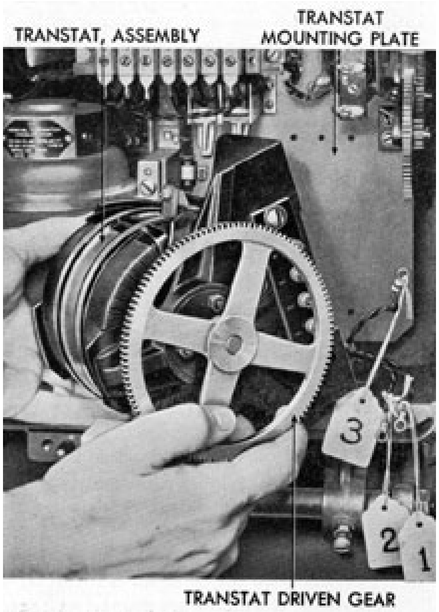


Figure 5-20. Removing transtat.

5F2. Installing the transtat assembly. (See Figure 5-20.) Place the new transtat assembly with its assembled gear in position in front of the rotary distance transmitter in such a manner that the wires can be connected. Place the three wires, previously marked, on their corresponding marked posts, and secure each terminal with a flat washer and nut. Place the transtat assembly in position on the mounting plate provided on the back of the rotary distance transmitter case, making certain that the gears are meshed, and install the four screws and toothed lock washers that secure the transtat assembly in the case. Rotate the transtat gearing by hand over its entire range and note the position of the center brush of the transtat at the instant the upper and lower limit switches are operated. The brush must still be on the transtat winding. Do not force the gearing beyond the point where the switches are actuated. If the brush is not on the winding at each position, loosen the three clamp screws passing through the core; shift the core radially to the proper position, and tighten the screws. Recheck for proper operation.

G. MAINTENANCE OF FOLLOW-UP MOTOR

5G1. Testing the follow-up screws and the toothed lock

motor. (See Figure 5-21.) Test the operation of the follow-up motor in the following manner: Remove the cover from the rotary distance transmitter case. Disconnect the wire lead from the center terminal on the motor terminal block. This terminal is marked C. Move the transtat brush arm well away from its limit switch. Using a screwdriver, alternately short-circuit the terminals marked CW and CCW with the center terminal. The motor will run first clockwise and then counterclockwise if it is operating properly. If the motor is binding, or inoperative, replace it.

5G2. Removing the follow-up motor. (See Figure 5-21.) Disconnect the wires from the terminal block on the motor. Tag the wires for ready identification. Remove the three washers that secure the motor assembly to the mounting plate, and remove the motor.

5G3. Exchanging the pinion and spur gear assembly. The replacement of the spur gear on the follow-up motor follows exactly the same procedure as that described in Section 5M5 for the gear replacement of the lead screw drive motor.

5G4. Installing the follow-up motor. (See Figure 5-21.) Place the follow-up motor assembly in position on the mounting plate. Install the three screws and toothed lock washers that secure the motor to the mounting plate. Connect the wires to the terminal block on the motor. Tighten the terminal screws. Install the cover on the case.

H. REMOVAL AND INSTALLATION OF ARMATURE RECTIFIERS

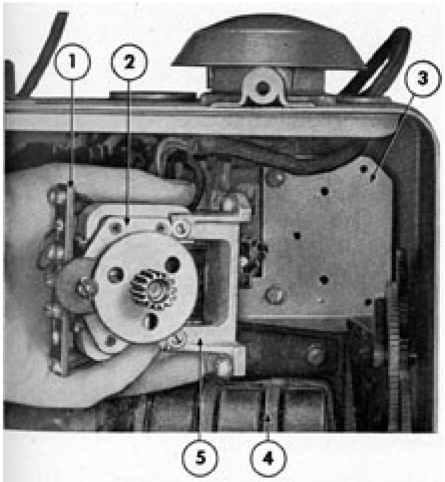
5H1. Removing the armature rectifiers. (See Figure 5-22.) Burned-out rectifiers are detected by the presence of deposits of molten metal on the bottom of the rectifier disks. This metal has the appearance of melted solder. Remove the rectifiers in the following manner: Remove the case cover. Unsolder the lead wires to each armature rectifier and tag each wire to make certain that it is installed in the same position on the new rectifiers. Remove the four screws and toothed lock washers that secure the rectifier assembly, on the studs of the new rectifiers in the same position as previously installed.

This is important in order that the same space between the mounting brackets will be maintained.

Place the two rectifiers in the mounting brackets in the same position as the previously removed rectifiers, making certain that the name plates are facing in the same direction, and install the four lock washers and nuts (two at each end) that secure the brackets to the rectifier studs. If the

brackets to the mounting plate and remove both rectifiers as a unit.

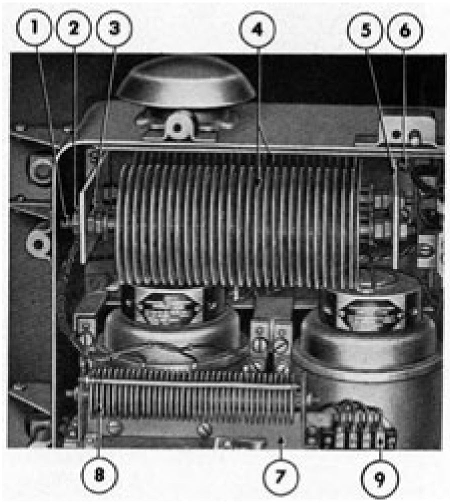
5H2. Replacing the rectifier stacks in the rectifier assembly. (See Figure 5-22.) Remove the four nuts (two at each end) that secure the brackets to the rectifier studs, and remove the brackets. Save any spacer washers that may be installed on the rectifier studs for replacement on the new rectifiers. Place the spacer washers, if used on the old rectifier



1. TERMINAL BLOCK
2. FOLLOW-UP MOTOR
3. TRANSTAT MOUNTING PLATE
4. TRANSTAT, ASSEMBLY
5. MOTOR BRACKET

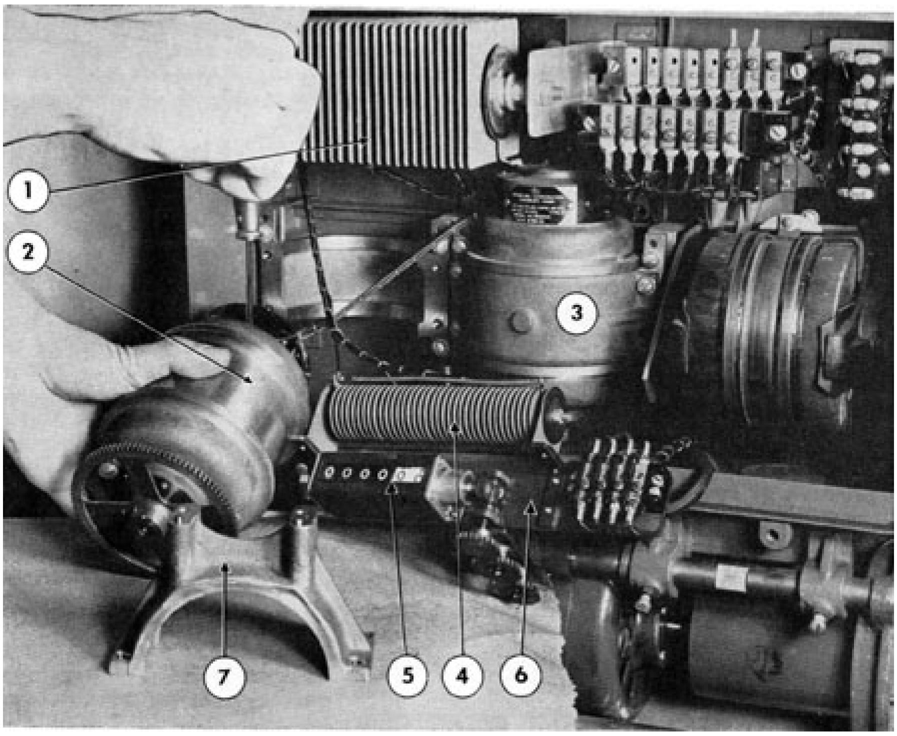
Figure 5-21. Removing follow-up motor.

replacement rectifiers have square plates (slightly higher current capacity) be sure that the bakelite spacer, furnished with this type, is properly installed between the two stacks. The spacer prevents the stacks from touching if they should become loose during operation. The angle brackets provided are held between the inside face of the mounting brackets and the adjacent nuts. Two spacer washers may be



1. RECTIFIER STUD
2. NUT
3. LOCK NUT
4. ARMATURE RECTIFIERS
5. MOUNTING BRACKET
6. BRACKET SCREW
7. COUNTER MOUNTING PLATE
8. FIELD RECTIFIER
9. COUNTER MOUNTING PLATE WITH MOTOR TERMINAL BLOCK

Figure 5-22. Rectifiers installed.



1. ARMATURE RECTIFIER
2. SELF-SYNCHRONOUS TRANSMITTER (60 REVOLUTIONS PER MILE)
3. SELF-SYNCHRONOUS TRANSMITTER (360 REVOLUTIONS PER MILE)
4. FIELD RECTIFIER
5. DISTANCE COUNTER
6. COUNTER MOUNTNG PLATE WITH MOTOR TERMINAL BLOCK
7. MOUNTING STRAP

Figure 5-23. Removing self-synchronous transmitter.

removed to compensate for the thickness of the two angle brackets.

Be sure to hold the lock nut adjacent to the inside of the bracket while tightening the outer nut to prevent the distortion of the plates.

5H3. Installing the armature rectifier. (See Figure 5-22.) Place the rectifier assembly in position on the mounting plate and secure with the four screws and toothed lock washer provided. Connect the wires to the terminals with solder.

I. REMOVAL AND INSTALLATION OF FIELD RECTIFIER

5I1. Removing the field rectifier. (See Figure 5-22.) Evidence of a burned-out field rectifier is the presence of deposits of molten metal on the bottom of the plates. Remove the field rectifier as follows:

5I2. Installing the field rectifier. (See Figure 5-22.) The new rectifier and brackets are replaced as a unit. Place the rectifier assembly in position on the counter mounting plate. Install the four screws and toothed lock washers that secure

Unsolder the lead wires from the rectifier terminals. Tag the wires for location. Remove the four screws and toothed lock washers that secure the rectifier assembly to the counter mounting plate, and remove the rectifier. the rectifier assembly to the counter mounting plate. Connect the lead wires to the rectifier terminals with solder.

J. REMOVAL AND INSTALLATION OF SELF-SYNCHRONOUS TRANSMITTER

5J1. Removing the distance transmitter. (See Figure 5-23.) Remove the cover from the case. Remove the two screws and toothed lock washers that secure the counter mounting plate to the transmitter mounting strap, and swing the counter assembly to one side out of the way. Remove the four screws and toothed lock washers that secure the transmitter mounting strap to the mounting cradle, and remove the strap. Pull the motor out of the cradle as far as the wires will allow, and disconnect the two wires from one of the brush blocks, and three wires from the opposite brush base. Tag the wires for identification. Lift the transmitter from the case. The other transmitter is removed in the same manner.

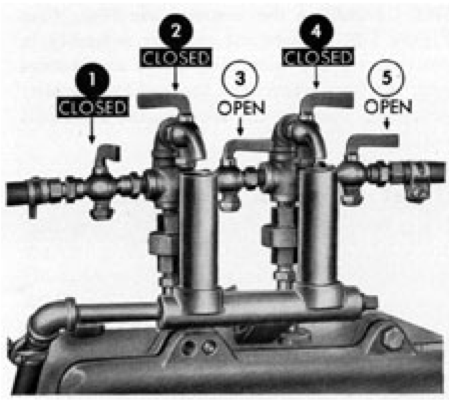
5J2. Installing the distance transmitter. (See Figure 5-23.) Place the transmitter on the forward edge of the case so that the wires may be connected. Connect the three wires to the terminals in the rear brush block. Connect the two wires to the front brush base. Place the transmitter in position in the cradle with the gear on the shaft properly meshed with the slow speed gear train in the case. Place the mounting strap in position and install the four screws and toothed lock washers that secure the strap to the cradle. Place the counter mounting plate with the counter in position on the transmitter mounting strap, making certain that the dowel holes in the plates are properly aligned with the dowel pins on the strap. Install the two screws and toothed lock washers that secure counter mounting plate to the transmitter mounting strap. The other transmitter is installed in the same manner. Install the case cover.

K. MAINTENANCE OF CONTROL UNIT

5K1. Checking and cleaning the contact points. (See Figure 2-7.) Remove the cover from the control unit case and place the top of the cover on the lower dowel pin of the case in such a manner that the dowel pin hole in the top edge of the cover is position with one screw. This causes the unit to hang level in the gimbal bracket. It is apparent that the control unit contact points are not properly adjusted if the pump motor does not stop running when the rodmeter is secured, and

engaged in the bottom dowel pin in the case. Secure in this

the bypass valve on the control unit is open.

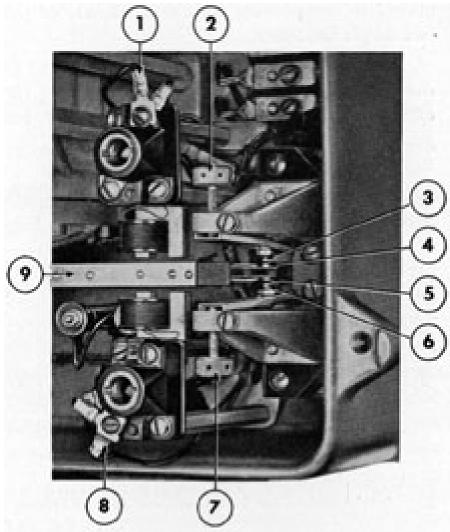


1. DYNAMIC PRESSURE VALVE
2. VENT COCK
3. BYPASS VALVE
4. VENT COCK
5. STATIC PRESSURE VALVE

Figure 5-24. Valves in position for adjusting contacts.

Clean the contact points in the following manner: Insert a piece of ordinary note paper between the contact points. Manually press the contact arm against the paper and adjacent contact point, and drag the paper across the points. This will usually remove any film of oil or dirt which may be present on the points. If this does not stop arcing between the points, clean the contact points with fine crocus paper or with a jeweler's file. Operate the system on the static head to determine whether this procedure has remedied the trouble.

5K2. Checking the position of the contact arm. (See Figure 5-25.) Remove the cover from the control unit case and hang it on the lower dowel pin. Place the valves in position for adjusting the contacts (Figure 5-24.) This places the static pressure only on

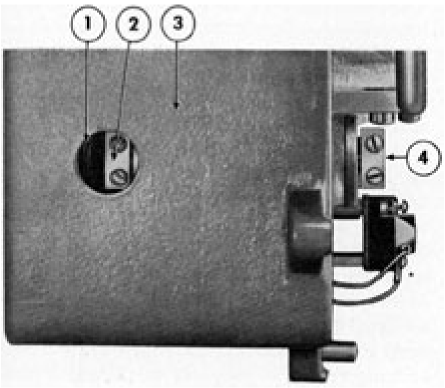


1. TERMINAL LUG A
2. ADJUSTABLE THUMB SCREW A
3. CONTACT SCREW A
4. CONTACT POINT A
5. CONTACT POINT B
6. CONTACT SCREW B
7. ADJUSTABLE THUMB SCREW B
8. TERMINAL LUG B
9. EXTERNAL CONTACT ARM

Figure 5-25. External contact arm in center position.

the stationary contact levers are completely open. Check to see that arm No. 9 is centered between stationary contact points No. 3 and No. 6. Manually move arm No. 9 upward and downward to see that it works freely and returns to the center position. If it is in good order, adjust the contact points as described in Sections 5K3 and 5K4. If the contact arm does not move freely or if it cannot be moved to each side of its center position because the internal lever strikes a stop rod, the interfering stop rod will have to be backed off slightly in the manner described in Sections 5K9 and 5K10. If the stop rods do not

both sides of the bellows, insuring that it is in the neutral, or center, position. Unless otherwise specified, all adjustments on the control unit are made with the valves in this position. Adjustments can be made while the ship is underway on the surface, but not while submerged. Back off screws No. 2 and No. 7 until interfere and the arm still does not return to the center position, it will be necessary to attempt to position the contact arm by adjusting the



1. PIPE PLUG OPENING
2. INNER CONTACT ARM CLAMP
3. CONTROL UNIT CASE
4. OUTER CONTACT ARM CLAMP

Figure 5-26. End view of contact arm clamps.

contact arm clamps. This is performed in the following manner: position.Remove the pipe plug from the end of the case to make the inner clamp accessible, as shown in Figure 5-26. Slightly loosen the inner clamp screws. Slightly loosen the clamp screws from the outer clamp. Carefully hold the arm in the center position with one hand, and tighten the outer clamp screws so that an equal space is maintained between the clamp and the end of the arm. Then carefully tighten the inner clamp screws in the same manner. Clamp screws must be securely tightened, and equal

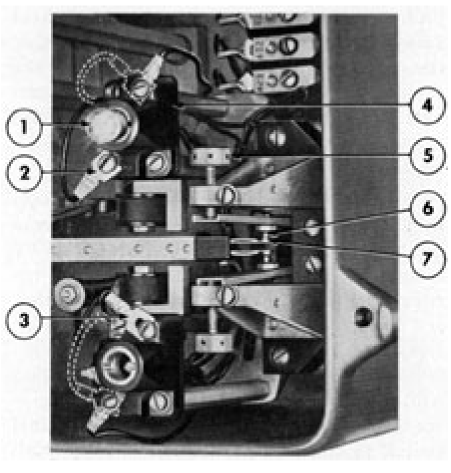
5K3. Adjusting the upper contact without using the lamp. (See Figure 5-27.) Adjusting the contacts without using a test lamp is the regular procedure used. However, an alternate method of adjusting the contacts with the use of a test lamp is also employed. Both methods are explained.

Set the valves and vent cocks as shown in Figure 5-24. This insures equal pressure on the bellows. Deenergize or turn off the 2Y circuit on the control board. Remove the cover from the rotary distance transmitter, and disconnect either the $2Y^1$ or the $2YY^1$ wire from the left end of the terminal block. This is done to prevent the pump from operating while adjustments are being made. Energize the 2Y circuit by turning the control panel switch to the ON position. Manually push down the external contact arm until the transtat brush arm in the rotary distance transmitter travels approximately one-third of its distance from the lower limit switch. This allows sufficient movement of the brush arm while making adjustments. Turn down screw No. 5 until the follow-up motor in the rotary distance

space must be maintained between the inner surfaces of the contact arm and the bearing plate at the bellows housing. If the arm continues to bind, it is an indication of corrosion or damaged inner parts of the bellows assembly or faulty bellows linkage installation. If this is the case, disassemble the bellows as described in Sections 5K12 through 5K16. Inspect, clean, and repair parts if necessary, as described in Section 5K17. Assemble the bellows as described in Sections 5K18 through 5K29. Adjust the contacts as described in Sections 5K3 and 5K4. Reset the stop rods as described in Section 5K8, 5K9, and 5K10.

transmitter starts running smoothly. When the upper contacts first touch, the follow-up motor will operate unevenly. Continue to turn down screw No. 5 slowly, three-quarters of the distance between the holes in the head of the screw (approximately 15 to 18 degrees). Secure screw No. 5 in this position by means of the lock screw in front of the contact mounting bracket.

5K4. Adjusting the lower contact without using the lamp. (See Figure 5-2$.) Break the electrical contact on the upper lamp socket by loosening the terminal screw and removing one wire from the terminal. This is done so that the transtat motor will operate when both contacts are touching. Normally the transtat motor will not operate when both contacts are touching the: contact arm. Turn up screw No. 6 until the follow-up motor in the rotary distance transmitter just starts operating, then back off screw No. 6 slowly, three-quarters of the distance between the holes in the screwhead (approximately 15 to 18 degrees). Secure screw No. 6 in this position by means of the lock screw in front of



Remove the cover from the rotary distance transmitter. Disconnect either the $2Y^{1}$ or the $2YY^{1}$ wire from the left end of the terminal block in the rotary distance transmitter. This is done to prevent the pump from operating while adjustments are being made. Energize the 2Y circuit from the control panel. Manually push down on the contact arm until the

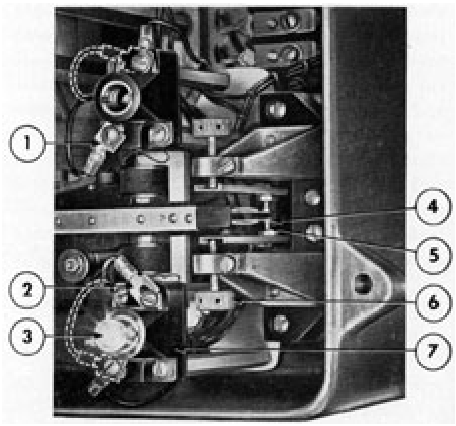
1. LAMP
2. TERMINAL LUG A
3. TERMINAL LUG B
4. UPPER LAMP SOCKET
5. ADJUSTABLE THUMB SCREW A
6. CONTACT SCREW A
7. CONTACT POINT A

Figure 5-27. Adjusting upper contacts by the lamp method

the contact mounting bracket. Reinstall the wire terminal on the terminal of the upper lamp socket. This is necessary in order that the follow-up motor will run down. The follow-up motor should then run down until the transtat brush arm hits its lower limit switch. If the brush arm does not hit the lower limit switch and the follow-up motor does not stop, it is an indication that the contact points were not set properly. Personnel will have to reset the contact points, being very careful to slowly turn the contact adjusting screws the proper amount as discussed above.

5K5. Preparing the system before adjusting contacts with the test lamp. This is an alternate method of adjusting the contact points. Two lamps are provided to make this adjustment. These lamps are mounted in a bracket in the upper right side of the control mounting plate. Use only one lamp when making this adjustment. The other lamp is a spare only. Set the valves and vent cocks as shown in Figure 5-24, in order to insure equal pressure on the bellows. Deenergize, or turn off the 2Y circuit switch on the control panel. transtat brush arm travels approximately one-third of its total distance from the lower limit switch. This allows sufficient movement of the brush arm while making adjustments. Move the wire from the upper terminal to the lower terminal of the upper lamp socket as shown in Figure 5-27. The lower lamp socket is prepared in the same manner as shown in Figure 5-28.

5K6. Adjusting the upper contact using the lamp method. (See Figure 5-27.) Remove one of the lamps from the bracket in the rear of the case. Install the lamp in the upper socket. Turn down screw No. 5 until the lamp burns without flickering. Then slowly continue to turn down screw No. 5 for three-quarters of the distance between the holes on the screwhead



1. TERMINAL LUG A
2. TERMINAL LUG B
3. LAMP
4. CONTACT POINT
5. CONTACT SCREW B
6. ADJUSTABLE THUMB SCREW B
7. LOWER LAMP SOCKET

Figure 5-28. Adjusting lower contacts by the lamp method.

(approximately 15 to 18 degrees). Secure screw No. 5 in this position by means of the lock screw on the upper contact bracket.

5K7. Adjusting the lower contacts, using the lamp method. (See Figure 5-28.) Remove the test lamp from the upper socket and install it in the lower lamp socket. This breaks the contact in the upper socket, and permits proper adjustment of, the lower contact. Turn screw No. 6 slowly upward until the lamp glows; then slowly back off screw No. 6 until the lamp does not glow. Continue to back off screw No. 6 slowly for three-quarters of the distance between the holes in the screwhead (approximately 15 to 18 degrees). Secure the screw in this position by means of the lock screw in front of the mounting bracket. Remove the lamp from the socket and install it in the carrying bracket back of the control mounting plate. Remove the wires from the upper and lower lamp socket terminals and install them in their original position on the sockets as shown in Figures 5-27 and 5-28. If the follow-up motor in the rotary distance transmitter does not drive the transtat brush arm to the lower limit switch, it is an indication that the contacts are not properly adjusted, and that the operation of the adjusting contact points will have to be repeated. Check the setting of the upper and lower stop rods and reset if necessary (see

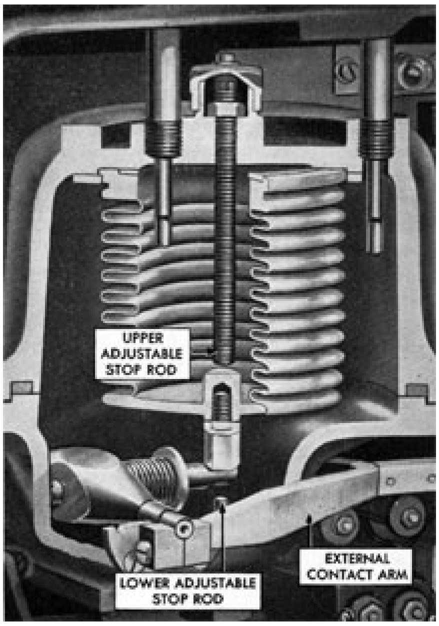


Figure 5-29. Adjustable stop rods installed.

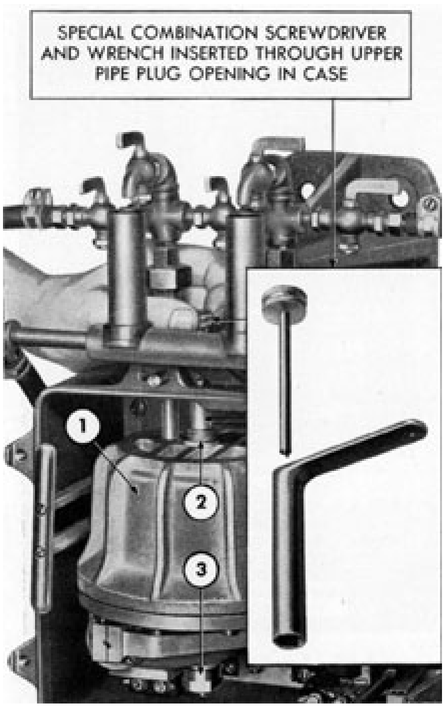
type rods become damaged or stripped, the complete bellows assembly must be disassembled to remove them. In the newer type of bellows assembly, the stop rods are threaded throughout the entire length and may be removed without dismantling the bellows housing.

5K9. Setting the lower adjustable stop rod. (See Figures 5-29, 5-30, and 5-3l.) Remove the cover from the control unit case. Unscrew and remove the lower cap to make the lower stop rod accessible. Remove the pipe plug from the dower side of the case. Using the socket wrench, loosen the lock nut that secures the stop rod in position. Place a finger on the contact arm and hold the arm slightly downward. Turn the lower stop rod inward (clockwise) until the stop rod contacts the bellows stud and starts to push the contact arm upward. Continue to turn the stop rod until the gap between the

Sections 5K8, 5K9, and 5K10) before operating the log. The contact setting made may be thrown off adjustment if the stops are incorrectly set.

5K8. Adjustable stop rods. (See Figure 529.) Two adjustable stop rods are provided in the bellows assembly to limit the upward and downward motion of the bellows, thus preventing possible damage to the interior parts of the bellows housing, and to the contact mechanism at times of excessive pressure differences. These pressure differences often cause the bellows to stretch slightly from the newly installed position and consequently necessitate adjustment of the stops as well as of the contact points. Older type bellows assemblies are equipped with stop rods that are only partly threaded throughout the length of the rod. In the event that these old

upper contact points is reduced to approximately 1/32-inch.



1. BELLOWS HOUSING

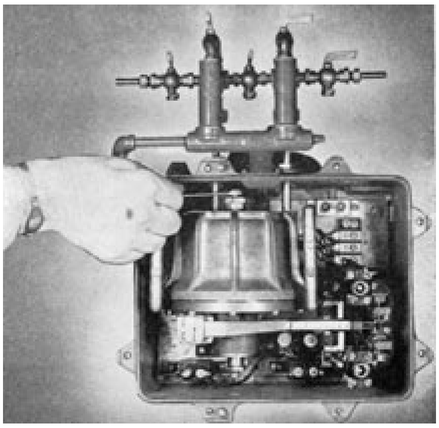


Figure 5-31. Setting upper adjustable stop rod, new installation.

the bellows housing. Using the socket wrench as illustrated in Figure 5-31, loosen the lock nut on the stop rod. Turn the stop rod

2. UPPER TOP CAP REMOVED
3. LOWER STOP CAP REMOVED
Figure 5-30. Setting upper adjustable stop rod, old installation.

Tighten the lock nut to secure the stop rod in this position. Set the valves and vent cocks as shown in Figure 5-42 (Position 7). This causes the water to force the bellows downward. The upper contacts should be open approximately 1/32-inch. If the points are not open this amount, reset the lower stop rod. Make certain that the lock nut on the lower stop rod is tight. Install the lower cap. Turn the valves and cocks to the desired position.

5K10. Setting the upper adjustable stop rod. (See Figure 5-31.) Remove the pipe plug from the upper end of the case to make the stop rod accessible. Remove the cap from the top of downward (clockwise) while holding the contact arm up against the upper contact screw until the stop rod contacts the inside of the bellows head. Continue to turn the stop rod until the gap between the lower contacts is reduced to approximately 1/32-inch; then tighten the lock nut on the stop rod. Set the vent cocks and valves as shown in Figure 5-42 (Position 3). Water pressure will now force the, contact arm upward. The lower contacts should be open approximately 1/32-inch. If the contacts are not open this amount, reset the upper stop rod. Make certain that the lock nut on the stop rod is tight. Install the cap on the bellows housing. Turn the valves and vent cocks to the desired position. Check the operation of the system by operating it on the static head as described in Section 5A2.

5K11. Checking the control unit after adjustment. Check the control unit, after adjusting the contact point and setting the stop rods, in order to make certain that the unit is operating properly. Perform the following operations: Deenergize the 2Y circuit by turning the switch on the control panel to the OFF position. Reconnect the $2Y^1$ or $2YY^1$

circuit, whichever was previously disconnected, in the rotary distance transmitter. Energize the 2Y circuit. Operate the system on the static head as described in Section 5A2. The system should operate and register approximately 5 to 10

Break the piping unions and remove the two hexagonal nipples. Disconnect the three wire leads that connect the outside current source with the terminal block and pull the wires to one side out of the way. Remove the three screws and toothed lock washers that

knots, depending on the waterline above the unit. The transtat brush arm should oscillate or hunt slightly. Turn the valves and vent cocks to position (Figure 5-24). The transtat arm should drive down until the pump and motor stop, and should then continue to drive down until the follow-up motor is stopped by the limit switch. If satisfactory, turn the valves and vent cocks to the secured position or the operating position, whichever is desired.

5K12. Removing the control unit from its case. (See Figure 5-32.) Remove the cover retaining screws and the cover. Remove the static and dynamic hose from the nipples. secure the mounting plate to the case, and lift the plate and the assembled control unit out of the case by means of the handles provided.

5K13. Removing the bellows assembly from the plate. (See Figure 5-33.) Disconnect the pigtail wire from the terminal on the auxiliary center contact block. Remove the handle screws and the two handles. Unscrew and remove the handle studs that secure the bellows housing to the mounting plate, and remove the studs and complete bellows assembly. Be careful that the contacts on the external contact arm are not damaged.

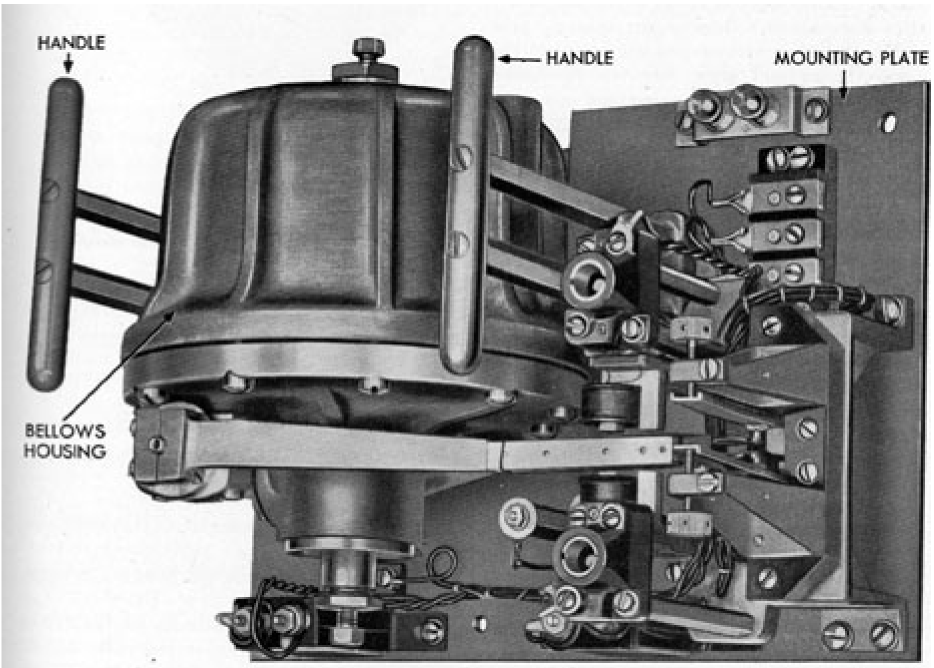


Figure 5-32. Control unit removed from case.

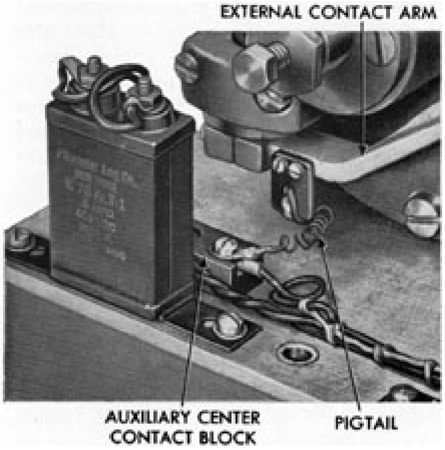
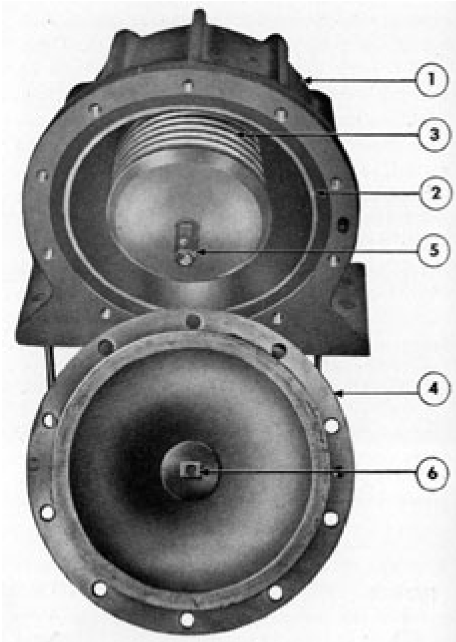


Figure 5-33. Pigtail wiring connection.

5K14. Removing the bellows housing corer. (See Figure 5-34.) Remove the external arm clamp retaining screws and clamps, and remove the contact arm. Remove the three screws that secure the housing and cap with the lower adjustable stop screw to the housing cover. Drain the water from the bellows. Remove the cap screw from the bellows extension post, and the ten housing cover screws and lift the housing cover from the assembly.

5K15. Disassembly of housing cover. (See Figure 5-38.) Remove the shoulder screw that secures the shaft seal bellows to the contact lever shaft. Detach the two pillow blocks and bearing assemblies from the housing cover after removing the shoulder screws. (The external contact arm was removed previously.) It may be necessary to tap the end of the contact arm shaft lightly with a soft hammer or wooden block to loosen the bearings and sockets. Remove the contact lever shaft. Detach the bellows seal cap after removing the three seal cap screws. Remove the shaft seal



1. BELLOWS HOUSING COVER
2. GASKET
3. SEAL BELLOWS ASSEMBLY
4. CAP (BELLOWS SEAL)
5. CONTACT LEVER SHAFT
6. BELLOWS SHOULDER SCREW

Figure 5-34. Bellows housing, cover removed.

the bellows gasket from the housing. Unscrew and remove the cap, gland liner, packing, and stop rod from the top of the housing.

5K17. Inspection and repair. Examine the gaskets for cracks and torn edges. Replace any damaged gaskets. Examine the contact arm shaft for score marks. Remove any scoring with an oilstone or crocus paper. Examine the threads of the adjustable stop rods. I the threads are slightly damaged, chase them with a stock and die. Replace badly damaged stop rods. Carefully examine the pressure bellows and shaft seal for cracks or pin holes. Fill the bellows with kerosene and note any evidence of seepage, which indicates cracks or holes. Replace damaged bellows. If the bellows does not leak, thoroughly clean the kerosene from

bellows, bellows stud, and gasket.

5K16. Disassembly of the bellows housing. (See Figure 5-43.) Remove the screws that secure the bellows holding ring to the housing, and remove the ring. Lift the bellows and

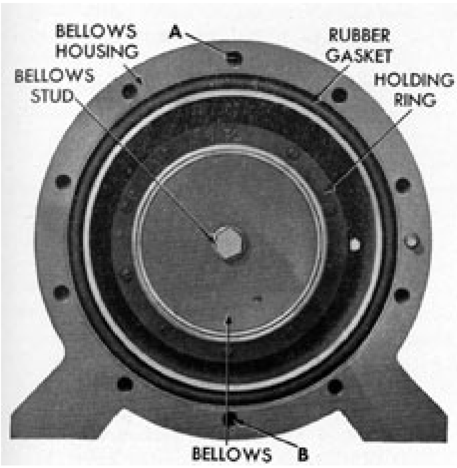
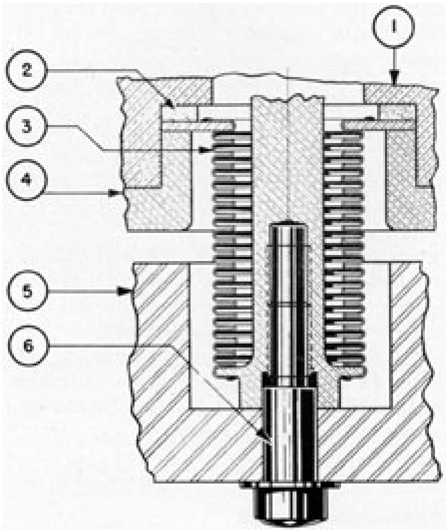


Figure 5-35. Bellows installed on housing.

the bellows to prevent damage to any rubber parts. Carefully examine the bearings; Turn the bearings slowly by hand. They should turn freely. A clicking noise and binding indicate cracked balls.

5K18. Installing the pressure bellows in bellows housing. (See Figure 5-35.) Place the bellows gasket in the recess provided in the bellows housing. Carefully place the bellows on the top of the gasket so that the bellows flange is properly seated over the gasket. Place the bellows holding the ring over the bellows. Align the mounting holes and install the ten screws that secure the ring to the housing. Check the length of the pressure bellows with the



1. BELLOWS HOUSING COVER
2. GASKET
3. SEAL BELLOWS ASSEMBLY
4. CAP (BELLOWS SEAL)
5. CONTACT LEVER SHAFT
6. BELLOWS SHOULDER SCREW
Figure 5-36. Cutaway view of seal bellows assembly.

to the bellows extension post. Tighten the seal bellows cap retaining screw.

2. Assemble the ball bearing in the pillow blocks (one to each block) and install the ball bearing retainers on the pillow blocks. Assemble the pillow blocks on the ends of the contact lever shaft (one at each end), then place the contact lever shaft in position over the seal bellows and adjacent to the bellows housing cover with the side of the shaft marked TOP toward the cover. Secure the

bellows extension post installed. Adjust the free length of the bellows so that the top of the extension post projects 31/32-inch outside of the outer (machined) surface of the bellows housing.

5K19. Assembling and installing the bellows housing cover. (See Figures 5-37, 5-38, and 5-39.) Mount the seal bellows and stud with a gasket in the housing cover. Place the cover with a rubber gasket on the bellows housing. Then carry out the following procedure:

1. Align the seal bellows stud with the bellows extension post, and loosely install the cap screw that secures the seal bellows stud pillow blocks to the cover with four screws (two to each block).

3. Install the seal bellows shoulder screw through the hole in the contact lever shaft, and tighten the screw securely.

4. Tighten the cap screw that secures the seal bellows stud to the bellows extension post.

5. Assemble the lower adjustable stop screw in the following manner: Install the

short screw into the gland nut. Slide the gland liner on the stop screw with the concave surface of the liner facing away from the head of the stop screw. Place sufficient packing against the concave surface of the liner; then screw the stop-screw assembly into the housing end cap. In replacing the packing, do not use more than necessary, as too much will prevent the proper adjustment of the stop screw. Be sure that the stop screw is well backed out. Place the stop screw assembly in position on the bellows housing cover, being sure that the gasket is in place, and secure with the three screws provided. Tighten securely.

6. Assemble the upper adjustable stop screw in the housing cap in contact arm and clamps on the contact arm shaft. Move the contact arm upward and downward. If the arm operates stiffly in one direction, unscrew the adjustable stop rod on the stiff side of the arm. Set a small tool or block at the outer end of the external contact arm to act as a marker. Manually move the contact arm first in one direction and then in the opposite direction, approximately 1/32-inch each way. The arm should return to its original position if the bellows components were properly installed. If the bellows contact arm does not return to its original position, the bellows should be disassembled, and the cause of the binding determined and eliminated. Remove the contact arm and clamps from the bellows

the same manner as the lower stop screw. Be sure that the stop screw is well backed out of the cap. Install the housing cap with its assembled stop screw on top of the bellows housing.

5K20. Checking the bellows assembly for friction. Temporarily install the external cover. Install the balance of the cover screws. Place the bellows subcover and its gasket in position on the housing cover, and secure with the six screws provided.

5K21. Installing external contact arm. (Figures 5-40 and 5-41.) Place the external contact

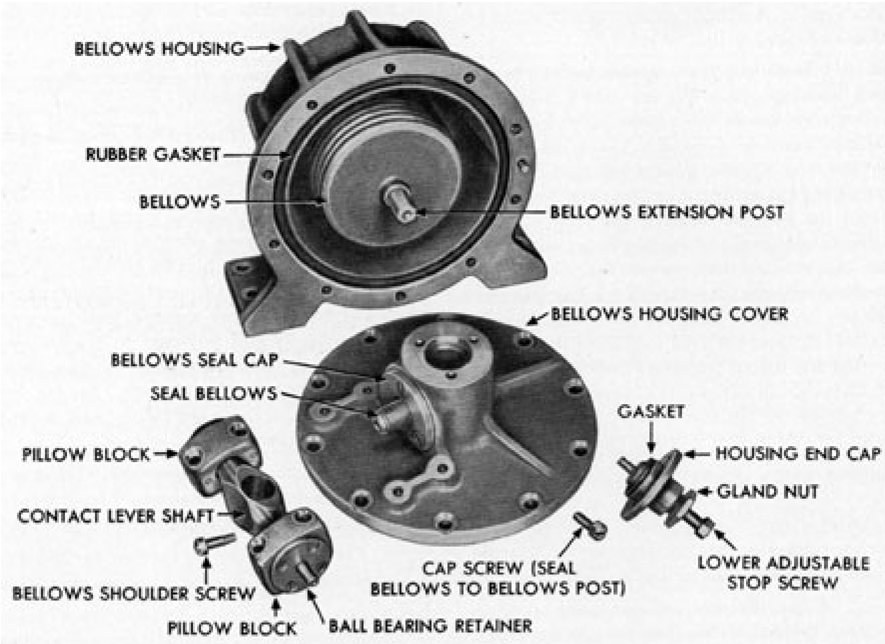


Figure 5-37. Bellows housing assembly, old installation.

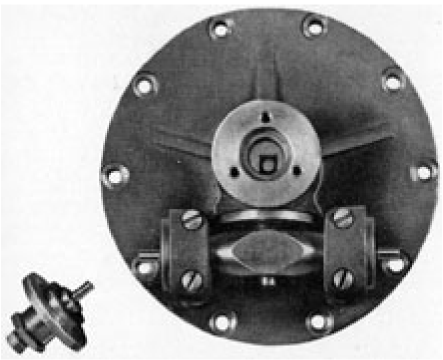


Figure 5-38. Bellows housing cover with housing end cap and stop rod removed, new installation.

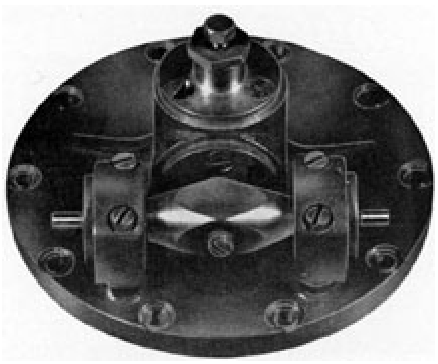
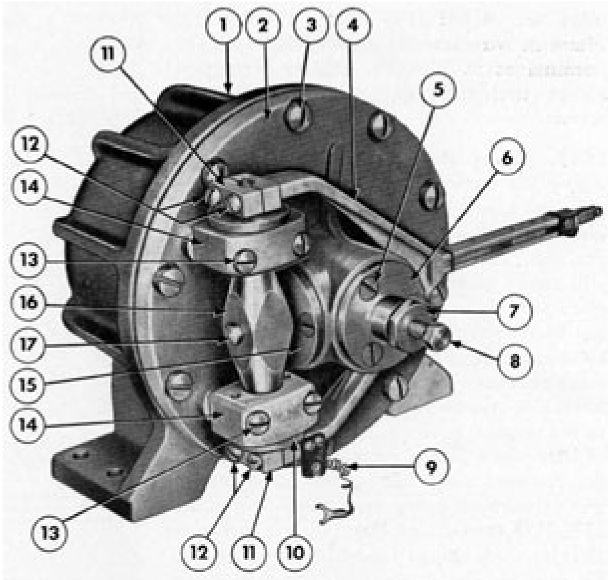


Figure 5-39. Bellows housing cover assembled, new installation.

arm in position on the contact lever shaft. Install the contact, arm clamps, making certain that the assembly marks on the clamps correspond with those on the arm. Install the four zinc- clearance between each clamp and the adjacent ball bearing retainer.

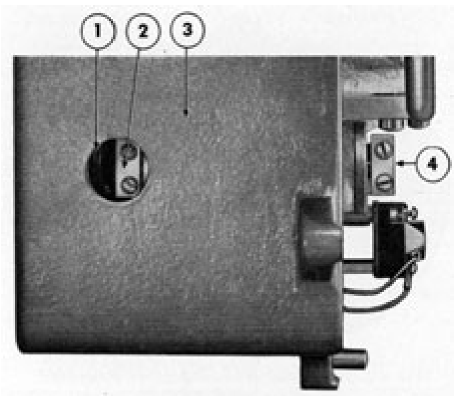
5K22. Installing the bellows assembly on the mounting plate. (See Figures 5-32 and 5-33.) Carefully place the bellows

plated steel screws (two to each clamp) that secure the arm clamps to the external contact arm. Be sure that there is housing on the mounting plate. Align the mounting holes



1. BELLOWS HOUSING
2. BELLOWS HOUSING COVER
3. BELLOWS HOUSING COVER SCREW
4. EXTERNAL CONTACT ARM
5. HOUSING END CAP SCREW
6. HOUSING END CAP
7. GLAND NUT
8. LOWER ADJUSTABLE STOP SCREW (SHORT)
9. PIGTAIL
10. BALL BEARING RETAINER
11. EXTERNAL CONTACT ARM CLAMP
12. CONTACT ARM CLAMP SCREW
13. PILLOW BLOCK RETAINING SCREW
14. PILLOW BLOCK
15. BELLOWS SEAL CAP
16. CONTACT LEVER SHAFT
17. BELLOWS SHOULDER SCREW

Figure 5-40. Bellows housing assembly.



1. PIPE PLUG OPENING
2. INNER CONTACT ARM CLAMP
3. CONTROL UNIT CASE
4. OUTER CONTACT ARM CLAMP

Figure 5-41. End view of contact arm clamps.

and install the four handle studs that secure the housing to the plate. Remove the terminal screw from the right side of the auxiliary center contact block. Lift of f the wire, and place the pigtail connection on the block. Place the wire over the pigtail and install the terminal screw. Place the handles in position on the studs, and install the handle retaining screws.

5K23. Aging the bellows.
(Figure 5-42.) Aging the control unit bellows is necessary any time a new bellows is installed, or if the old bellows has been bent out of its normal position. The bellows, like any metal spring, will return to a certain position when an applied pressure is released, unless the pressure has been sufficient to bend it and cause the bellows to set in a new position. If there are stresses retained in the metal from bending or stretching, the bellows will not return at once to the original position, but may creep slowly to that point. To be certain that all stresses are removed from the bellows it should be put through an aging operation. The aging operation consists of impressing a pressure first on the inside of the bellows and then on the outside, while gradually reducing the impressed pressure to zero.

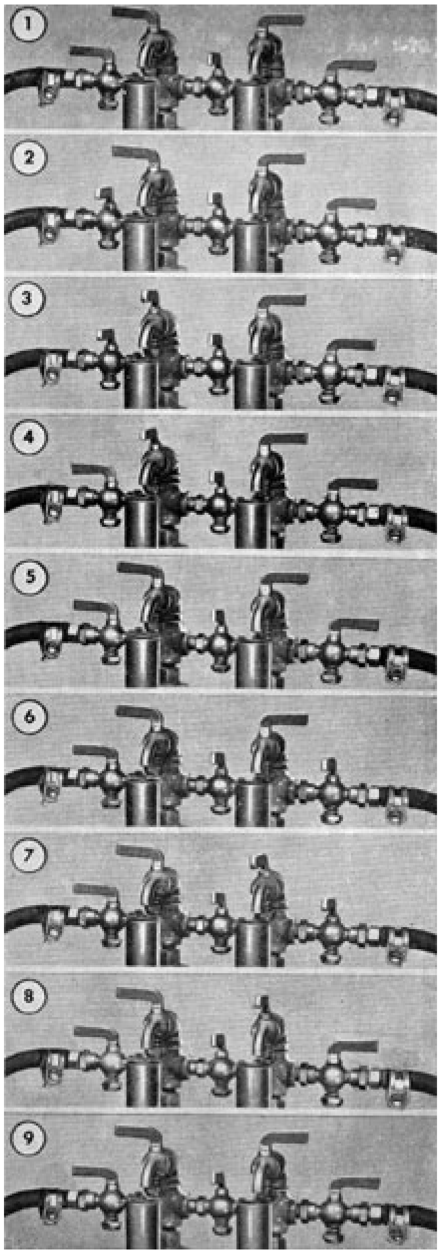
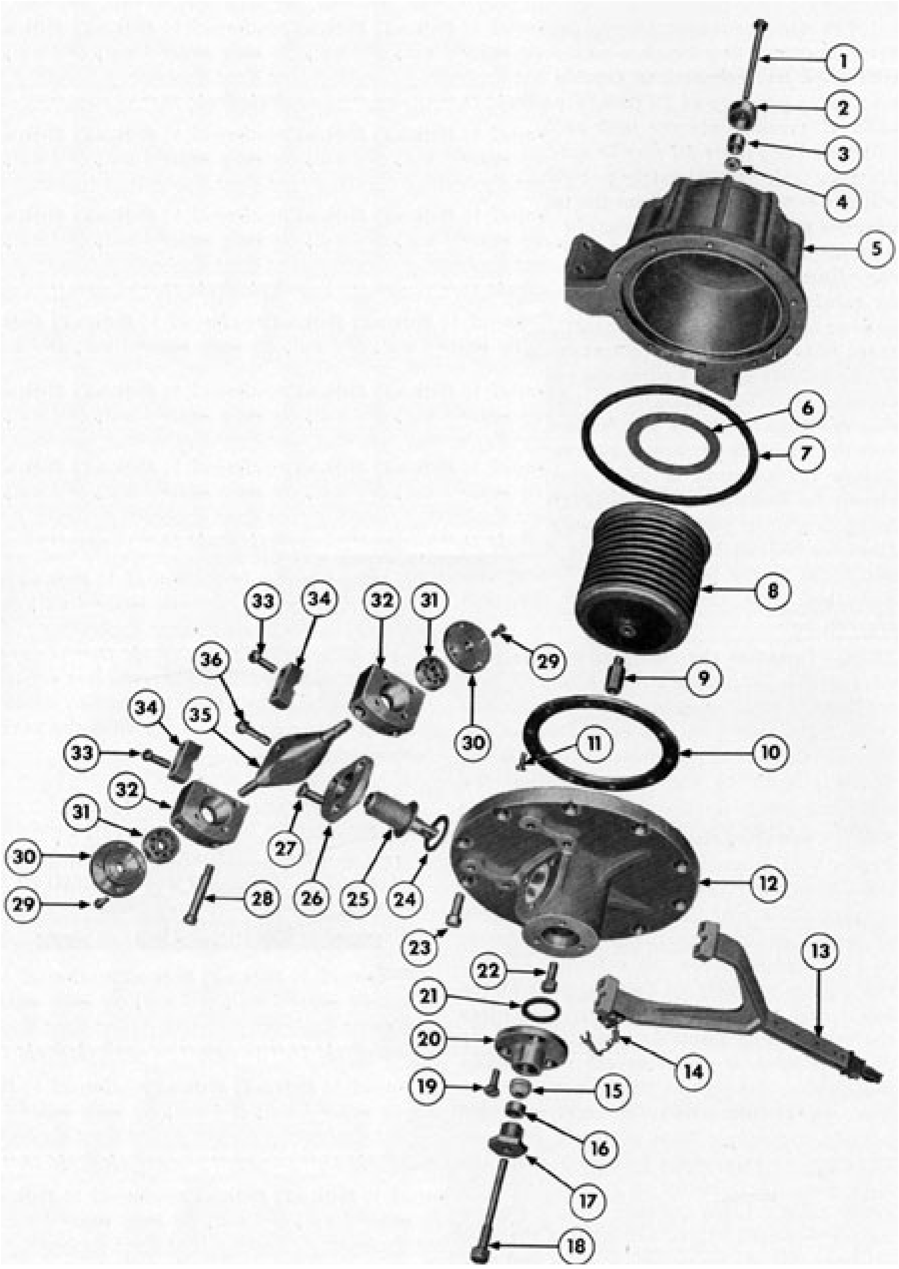


Figure 5-42. Valve positions for aging the bellows.



*1. UPPER ADJUSTABLE STOP SCREW (LONG).
*2. BELLOWS CAP.
*3. GLAND LINER
*4. PACKING
5. BELLOWS HOUSING.
6. BELLOWS GASKET.
7. RUBBER GASKET.
8. BELLOWS.
*9. BELLOWS EXTENSION POST.
10. BELLOWS HOLDING RING.
11. HOLDING RING SCREW.
*12. BELLOWS HOUSING COVER.
13. EXTERNAL CONTACT ARM.
14. PIGTAIL
*15. PACKING
*16. GLAND LINER.
*17. GLAND NUT.
*18. LOWER ADJUSTABLE STOP
*22. CAP SCREW (SEAL BELLOWS TO BELLOWS POST).
23. BELLOWS HOUSING COVER SCREW.
*24. GASKET.
*25. SEAL BELLOWS.
*26. BELLOWS SEAL CAP.
*27. SEAL CAP SCREW (BRONZE 10-32 X 1/2 FLAT HEAD).
*28. PILLOW BLOCK RETAINING SCREW.
*29. BALL BEARING RETAINER SCREW (BRONZE 4-36 X 3/8 FLAT HEAD).
*30. BALL BEARING RETAINER.
*31. BALL BEARING.
*32. PILLOW BLOCK.
33. CLAMP RETAINING SCREW.
34. EXTERNAL CONTACT ARM

SCREW (SHORT).
*19. HOUSING END CAP SCREW (BRONZE 10-32 X 1/2 FLAT HEAD).
*20. HOUSING END CAP.
*21. GASKET.
CLAMP.
*35. CONTACT LEVER SHAFT.
*36. BELLOWS SHOULDER SCREW.

* Indicates replacement parts necessary to modify old bellows.
Figure 5-43. Exploded view of bellows assembly.

The equipment necessary to perform the aging operation is a 2-gallon tank with pressure gage, and connections capable of withstanding a pressure of 20 pounds per square inch. A pressure storage tank such as that illustrated in Figure 7-1 may be used. Fill the pressure tank approximately one-half full of water. Connect the line from the tank to the dynamic and static connections of the control unit. Vent the control unit. Make certain that the adjustable stop rods have been positioned by turning in each rod until it touches the bellows and then backing off exactly two full turns so as to have the movement on each side of the bellows equal. Loosen the contact arm clamps. With valves and vent cocks in position as shown in Figure 5-24, build up a pressure of 20 pounds per square inch in the tank. Follow the sequence of valve operations as shown in Positions 1 to 9 (Figure 5-42), being careful to permit all the water to flow from the bellows before changing the valves and cocks to the next position. Repeat this operation until the pressure in the tank reaches zero.

5K24. Installing the control unit in its case. (See Figure 2-7.) Lift

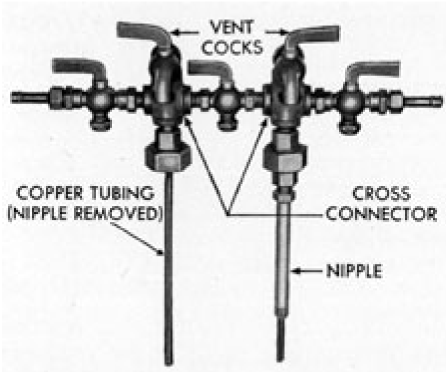


Figure 5-44. Piping assembly, old installation.

it as described in Section 3A3. Center the contact arm, adjust the contact points and stop screws (see Sections 5K2, 5K3, 5K4, 5K9, and 5K10). In this case, the top contact adjusting screw is advanced only 1/2-hole, and the bottom screw is backed off 1/2-hole. The stop screws in the modified control unit are adjusted in the same manner as the stop rods in the older installation, except that the special stop rod wrench and screwdriver are not needed. Place the cover in position on the control unit case and secure with the cover retaining screws.

the control unit into the control unit case, and secure with the three screws and lock washers. Connect the lugs on the ends of the electrical leads to the terminal block on the upper right of the mounting plate.

5K25. Installing the piping assembly. (See Figure 2-7.) Loosen the gland nuts on top of the control unit case; and place the nipples through the top of the case and into the top of the bellows housing, using a small amount of pipe compound on the threads. Tighten the nipples securely so that the tops of the lower half of the unions are parallel. Place the valve piping assembly in position on top of the nipples, with the copper tubes inside the nipples, and tighten the unions securely. Test the complete unit for leaks with 300 pounds per square inch of water pressure. (The bypass valve must be open.) Place the hose- from the rodmeter on the static nipple (right-hand). Place the hose from the pump on the left-hand nipple and tighten the hose clamps. Fill the system with water and vent

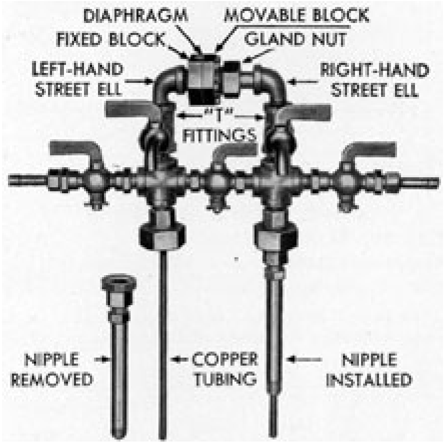


Figure 5-45. Piping assembly, new installation.

L. CONTROL UNIT PIPING

5L1. Description of modified control unit piping assembly. Most submarine control units are equipped with the conventional type of piping assembly as shown in Figure 5-44. Some, however, are equipped with a modified piping assembly that contains a safety pressure relief

4. Install the vent cocks in the T-fittings. Use pipe compound.

5. Assemble the left-hand street ell, nipple, and fixed block, and install the left-hand street ell in the left-hand T-fitting. Use pipe compound.

assembly as shown in Figure 5-45. This is a safety feature which protects the bellows when the pressure difference across the bellows exceeds approximately 25 pounds per square inch. Such a difference will occur if a hose should blow off, or if the unit is vented incorrectly when submerged. When the pressure difference exceeds 25 pounds per square inch, the diaphragm will rupture,

6. Assemble the pipe fitting into the right-hand street ell, using pipe compound.

7. Slide the gland nut, bakelite washer, rubber slip joint washer, and movable block onto the pipe nipple.

8. Align the fixed and movable blocks, and loosely install the four lower movable block screws.

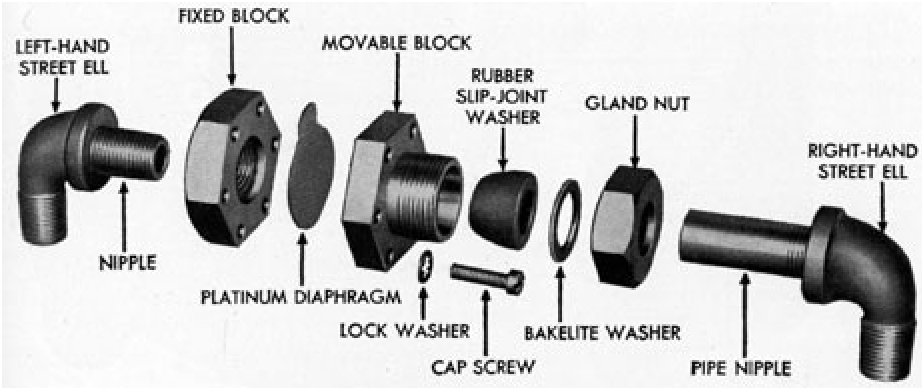


Figure 5-46. Pressure relief assembly disassembled.

thereby equalizing the pressures on both sides of the bellows and protecting the bellows from distortion.

5L2. Modifying the control unit piping assembly. (See Figures 5-45 and 5-46.) Modify the control unit piping assembly as described in the following steps:

1. Unscrew and remove the vent cocks.

2. Remove the elbows, but leave the elbow nipples installed in the cross-connector.

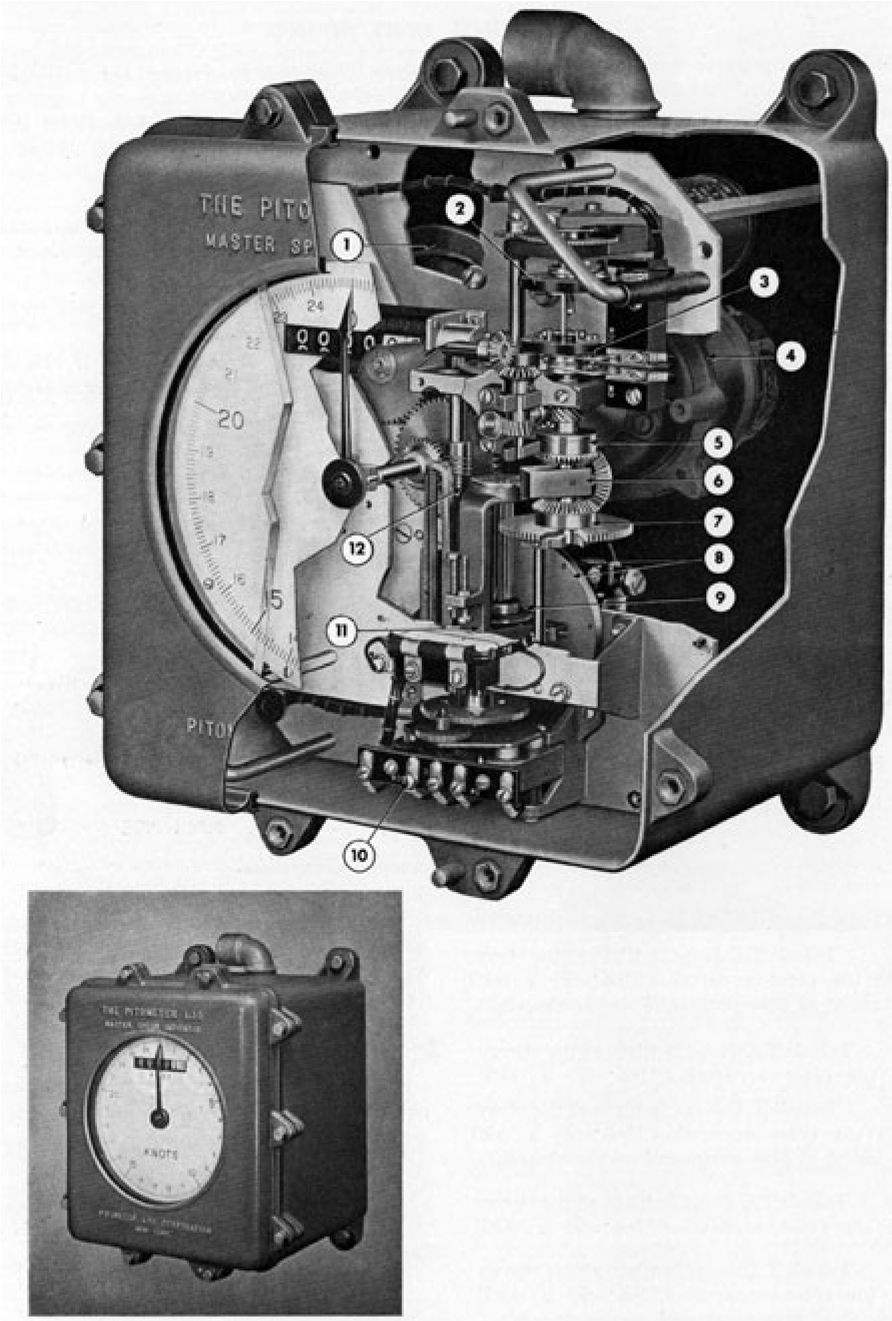
3. Install T-fittings in place of the elbows in the cross-connector. Use only a small amount of pipe compound on the threads.

9. Insert the platinum diaphragm into the gap between the blocks. Make certain that the diaphragm is properly aligned within the blocks to prevent damage to the diaphragm when the remainder of the screws are installed in the blocks.

10. Install the remainder of the block retaining screws and tighten all screws.

11. Hold the blocks with a wrench and tighten the gland nut securely.

12. Test the complete unit for leaks with 300 pounds per square inch of water pressure. The bypass valve must be open.



1. SELF-SYNCHRONOUS TRANSMITTER
2. FOLLOW-UP CONTACT ASSEMBLY
3. SLIP RING AND CONTACT ASSEMBLY
4. SELF-SYNCHRONOUS REPEATER
5. UPPER DIFFERENTIAL GEAR
6. DIFFERENTIAL SPIDER
7. LOWER DIFFERENTIAL GEAR
8. CONSTANT SPEED MOTOR AND DISK
9. FRICTION ROLLER AND PINION
10. LEAD SCREW DRIVING MOTOR
11. YOKE
12. LEAD SCREW

Figure 5-47 Cutaway view of master speed indicator.

5L3. Testing for leaky or punctured diaphragm. Operate the system on the static head as described in Section 5A2. If water drips continuously out of the open vent cock, it is an indication that the diaphragm is punctured.

5L4. Replacing a damaged diaphragm. (See Figure 5-45.) Hold the movable and fixed blocks with a wrench, and loosen the gland nut. Remove the two top screws from the movable block, and loosen the remainder of the block screws. Separate the movable block from the fixed block sufficiently to remove the damaged diaphragm. Remove the damaged diaphragm. Insert the new diaphragm between the blocks, making certain that it is aligned properly within the blocks. The diaphragm must be 0.0008 inch thick (Pitometer Log Corporation S1452B). Install the two top movable block retaining screws, and tighten all screws securely. Test for a leaky diaphragm as described in Section 5L10.

M. MAINTENANCE OF MASTER SPEED INDICATOR

5M1. General information. Provision has been made for removal of the complete unit from the case for purposes of inspection and test of the master speed indicator. Subassemblies of the unit are constructed so that they may be replaced as units. Whenever any of the components are removed, it is necessary that the instrument be recalibrated.

5M2. Replacing the pointer and dial. (See Figure 5-47.) Remove the cover retaining screws, and remove the case cover. Remove the hub cap from the pointer hub. Remove the screw that secures the pointer hub to the, speed transmitter shaft and remove the pointer assembly. Remove the six screws that secure the dial to the mounting studs and remove the dial. To install the dial, position it on the mounting studs and install the dial retaining screws. Place the pointer on the shaft of the

will run first clockwise and then counterclockwise, if it is operating properly. If the motor is binding, or inoperative, replace it.

5M4. Removing the lead screw drive motor. (See Figure 5-48.) Remove the cover from the case. Disconnect the wires from the motor terminal, and tag the wires for ready identification. Remove the three screws and toothed lock washers that secure the motor bracket to the main mounting plate, and remove the motor assembly.

5M5. Replacing the lead screw drive motor. (See Figure 5-49.) Remove the lead screw drive motor (see Section 5M4). Remove the two fillister head screws that position the

transmitter shaft, and secured it with the screw provided. Set the pointer to exact zero, if necessary, as described in Sections 5M51 and 5M52. Install the pointer hub cap. Place the cover in position on the case and install the cover retaining screws.

5M3. Testing the lead screw drive motor. (See Figure 5-48.) Test the operation of the lead screw drive motor in the following manner: Remove the cover from the case. Disconnect the lead from the center terminal of the motor. This terminal is marked C. Rotate the gear by hand until the pointer reads several knots. Using a screwdriver, alternately short circuit the terminals marked CW and CCW with the center terminal. The motor

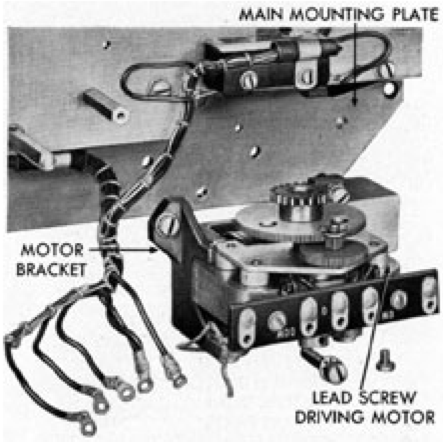
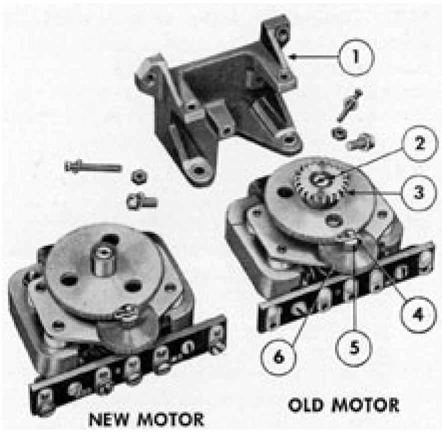


Figure 5-48. Lead screw drive motor removed.

motor in its bracket. Remove the two screws, lock washers, and nuts, and remove the motor from its mounting bracket as shown in Figure 5-50. Remove the reduction gear stud nut. Remove the retaining pin and washer from the old motor as shown in Figure 5-50, and remove the gears from the motor. Remove the stud nut from the new motor. Remove the retaining



1. MOTOR BRACKET
2. REDUCTION GEAR STUD NUT
3. REDUCTION GEAR
4. RETAINING PIN
5. WASHER
6. MICARTA REDUCTION GEAR AND PINION

Figure 5-50. Replacing lead screw drive motor, Step 2.

Place the new motor with its assembled reduction gear as

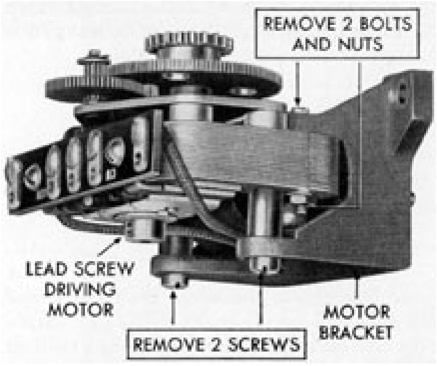


Figure 5-49. Replacing lead screw drive motor, Step 1.

pin and washer from the micarta gear son the new motor, as the washer interferes with the installation of the reduction gear assembly. Place the reduction gear assembly from the old motor on the shaft of the new motor, and install the stud nut. Install the washer and retaining pin on the micarta gear shaft.

shown in Figure 5-51 in position in the motor mounting bracket. Install the two fillister head screws that position the motor in its bracket. Install the two screws, lock washers, and nuts that secure the motor (Figure 5-49).

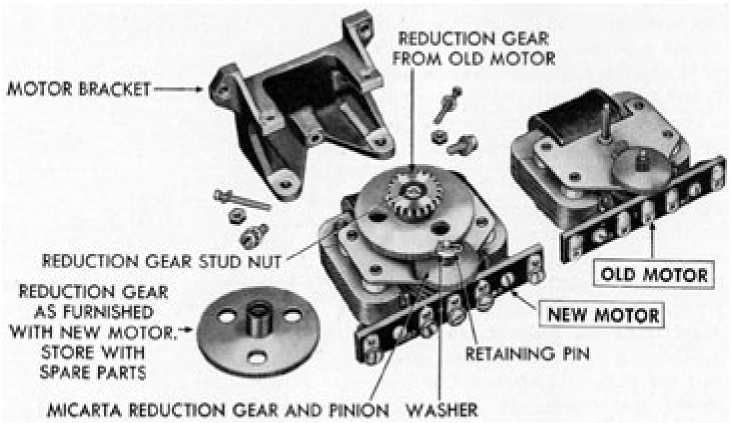
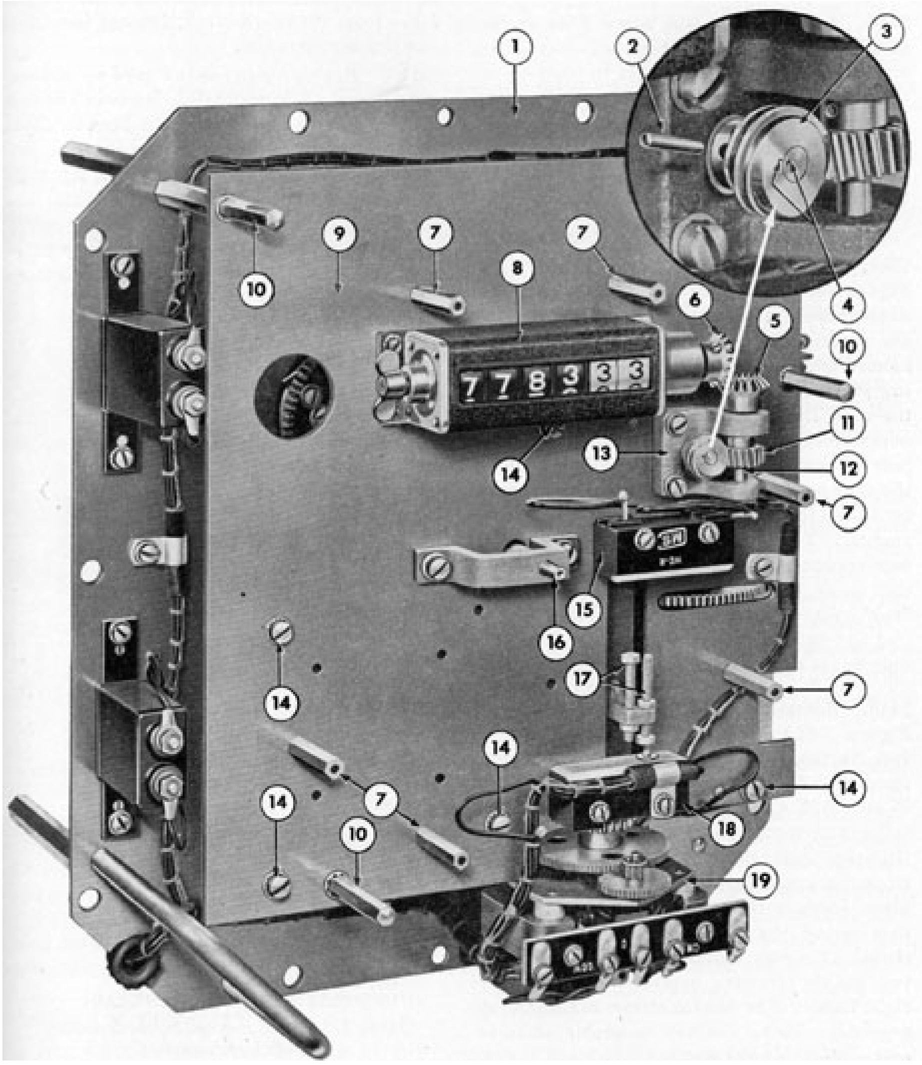


Figure 5-51. Replacing lead screw drive motor Step 3.



1. MAIN MOUNTING PLATE
2. TAPERED PIN
3. COUNTER DRIVING WORM
4. LOCATING DOTS
5. COUNTER DRIVE SHAFT MITER GEAR
6. COUNTER DRIVE MITER GEAR
7. DIAL STUDS
8. MILEAGE COUNTER
9. TOP MOUNTING PLATE
10. TOP SUPPORT STUD
11. COUNTER DRIVE HELICAL GEAR (L.H.)
12. COUNTER DRIVE SHAFT
13. COUNTER DRIVE SHAFT BRACKET
14. TOP MOUNTING PLATE MOUNTING SCREWS
15. LEAD SCREW DRIVING MOTOR LIMIT SWITCH
16. POINTER SHAFT
17. LIMIT SWITCH OPERATING SCREWS
18. CONSTANT SPEED MOTOR LIMIT SWITCH
19. LEAD SCREW DRIVING MOTOR

Figure 5-52. Master speed indicator, dial removed.

5M6. Installing the lead screw drive motor. (See Figure 5-48.) Place the lead screw drive motor and its attached bracket in position on the main mounting

wires from the brush block, and tag them for ready identification.

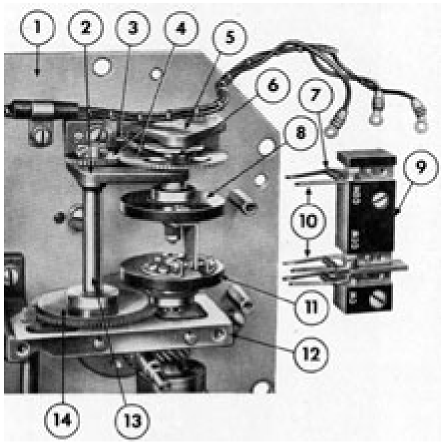
5M10. Replacing the spiral take-up spring. (See Figures 5-53 and

plate and install the three screws and toothed lock washers that secure the motor assembly to the mounting plate. Connect the wires to the terminal on the motor. Test the operation of the motor as described in Section 5M3.

5M7. Replacing the mileage counter. (See Figure 5-52.) Turn the operating shaft of the dimmer rheostat so that its forked end clears the rheostat shaft extension. Remove the 10 mounting screws that secure the main mounting plate to the case, and lift the unit out of the case. Disconnect the outside source lead wires from the terminal block. Remove the pointer and dial (see Section 5M2). Remove the four screws that secure the mileage counter to the top mounting plate, and remove the counter. Transfer the counter gear to the new counter. Place the new counter in position on the top mounting plate, and install the four counter retaining screws. Install the dial and pointer (see Section 5M2). Place the unit in its case (see Section 5M50).

5M8. Removing the top mounting plate. (See Figure 5-52.) Remove the mileage counter (see Section 5M8). Remove the tapered pin from the counter driving worm as shown in Figure 5-52, and remove the worm from the self-synchronous repeater shaft extension. Unscrew and remove the top support stud from the upper left corner of the mounting plate. Remove the screws and lock washers that secure the top mounting plate to the studs on the main mounting

5-54.) Remove the top mounting plate as described in Section 5M8. Unscrew and remove the pin screw from the second follow-up driving gear at the left side of the spring. Loosen the setscrew that secures this second follow-up driving gear to the jackshaft. Hold the large follow-up driving gear while lifting the small follow-up



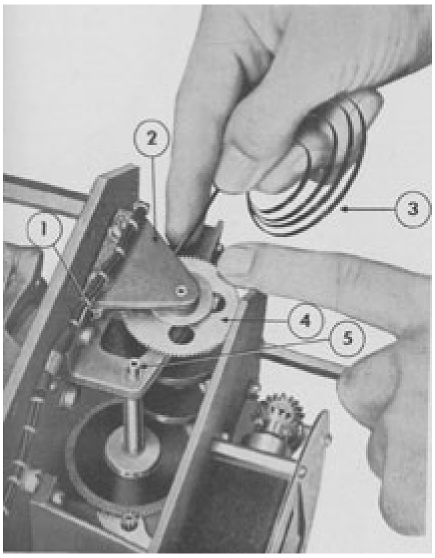
1. MAIN MOUNTING PLATE
2. TOP BRACKET
3. TAKE-UP SPRING HOOK
4. SECOND FOLLOW-UP GEARS
5. BEARING PLATE
6. SPIRAL TAKE-UP SPRING
7. BRUSH SPRING
8. FOLLOW-UP CONTACT ASSEMBLY
9. BRUSH BLOCK
10. BRUSHES
11. SLIP RING AND CONTACT ASSEMBLY
12. DIFFERENTIAL TOP BRACKET
13. JACKSHAFT
14. FIRST FOLLOW-UP DRIVEN GEAR

Figure 5-53. Slip ring and contact assembly, brush block removed.

gear from the jackshaft to prevent the spring from unwinding too rapidly. Gradually release the large gear to permit the spiral takeup spring to unwind gradually. Disengage the end of the spring from the hooks provided on the top mounting bracket and on the

plate. Remove the two handle retaining screws from the upper right handle. The handle screws are staked at assembly. Swing the top mounting plate to one side out of the way.

5M9. Removing the brush block assembly. (See Figure 5-53.) Remove the top mounting plate (see Section 5M8). Remove the two screws that secure the brush block as to the studs on the main mounting plate, and carefully remove the brush block to disengage the brushes from the slip rings of the slip ring and contact assembly. Disconnect the hub of the large second follow-up driving gear. Install the new spring in the following manner:



1. SPRING HOOK
2. BEARING PLATE
3. SPRIAL TAKE-UP SPRING
4. LARGE SECOND FOLLOW-UP DRIVEN GEAR
5. JACKSHAFT (SMALL SECOND FOLLOW-UP DRIVING GEAR REMOVED)

Figure 5-54. Installing spiral take-up spring.

Engage the hole in one end of the spring in the hook on the hub of the large second follow-up driving gear as shown in the spiral take-up spring (see Section 5M10). Remove the starting condenser from the back of the main mounting plate as described in Section 5M47. This makes the top bracket mounting screws accessible. Remove the two top bracket retaining screws and lock washers. Loosen the mounting screws on the differential top bracket, differential bottom bracket, and the main mounting bracket, so that the brackets can be slightly lifted to allow for the clearance of the dowel pins on the top bracket. Lift all the brackets away from the main mounting plate and remove the top bracket with its assembled follow-up contact assembly as shown in Figure 5-55. Remove the lock nut, tension spring, washer, and the follow-up contact assembly from the follow-up shaft.

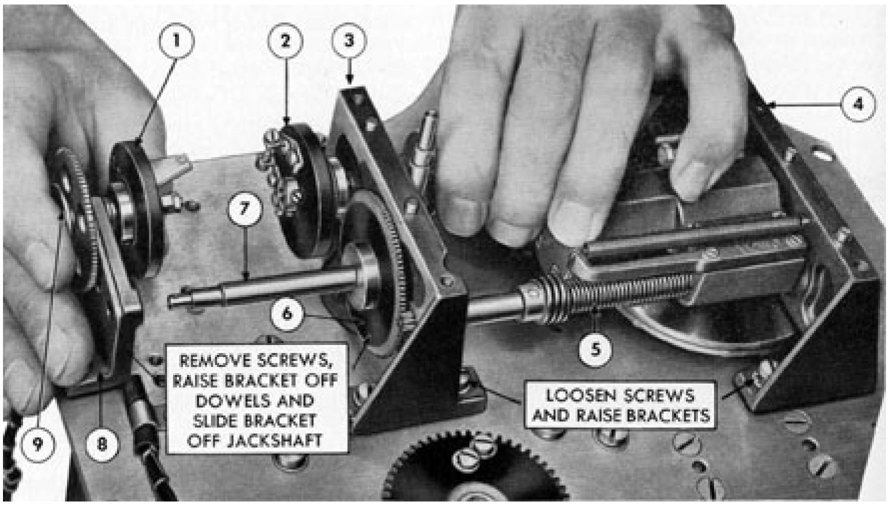
5M12. Removing the slip ring and contact assembly. (See Figure 5-55.) Remove the follow-

Figure 554. Turn the large gear by hand to wind up the spring on the gear hub. Hook the loose end of the spring on the hook provided on the top mounting bracket as shown in Figure 5-54. Turn the gear until the spring is tightly wound, and then back off the gear three-quarters of a turn to give the spring the proper tension. Hold the large gear and spring in this position while installing the small second follow-up driving gear on top of the jackshaft. Align the pin screw hole and install the pin screw and setscrew to secure the small gear on the jackshaft.

5M11. Removing the follow-up contact assembly. (See Figure 5-55.) Remove the brush block assembly (see Section 5M9). Remove up contact assembly as described in Section 5M11, in order to get proper clearance for the removal of the slip ring and contact assembly. Remove the pin screw and loosen the setscrew that secures the slip ring and contact assembly to the differential shaft. The slip ring and contact assembly is removed as a unit (see Figure 5-57).

5M13. Repairing the follow-up contact assembly. (See Figure 5-56.) Under ordinary circumstances the follow-up contact assembly is replaced as a unit. However in an emergency the follow-up contact can be replaced as follows: Remove the screws from the bakelite disk, and unsolder the lead wire from the contact arm. Place the new contact arm in position on the bakelite disk, and secure with the screws provided. Solder the lead wire to the contact.

5M14. Repairing and adjusting the slip ring and contact assembly. (See Figure 5-57.) Smooth the contact points with a jeweler's file, and remove fine particles; oil, or grease with clean cloth or paper. If .the contact points are badly worn, or pitted, unscrew the contact screws from their mounting brackets, and install new contact screws. At assembly there should be a space of 1/32-inch between the contact screw point and the follow-up



1. FOLLOW-UP CONTACT, ASSEMBLY
2. SLIP RING AND CONTACT, ASSEMBLY
3. DIFFERENTIAL TOP BRACKET
4. MAIN MOUNTING BRACKET
5. LEAD SCREW, ASSEMBLY
6. FIRST FOLLOW-UP DRIVEN GEARS
7. JACKSHAFT
8. TOP BRACKET
9. SPRING SHIELD

Figure 5-55. Removing follow-up contact assembly and top bracket.

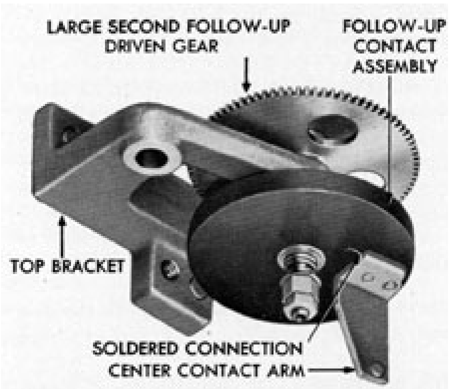


Figure 5-56. Follow-up contact assembly removed.

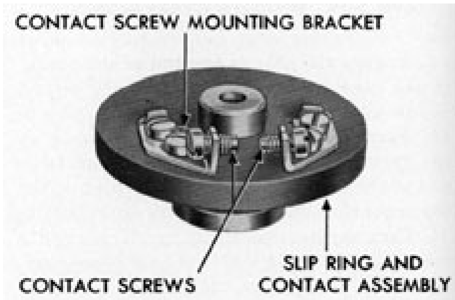


Figure 5-57. Slip ring and contact assembly removed.

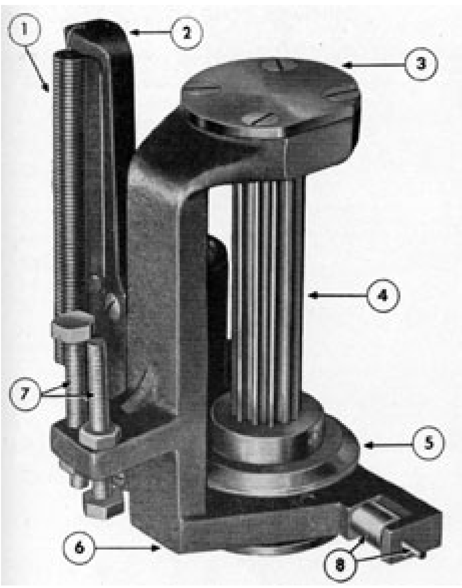
contact when one of the contact points is touching the contact arm. Adjust for this clearance by turning the contact screws inward or outward until the desired clearance is obtained. Clean the slip rings with crocus paper.

5M15. Cleaning and repairing brushes. (See Figure 5-53.) The brushes on the brush block should be cleaned with crocus paper. The

brushes should move freely on their mounting studs without binding and should contact both sides of the slip ring. If they do screw assembly out of the differential top bracket. Carefully lift off the differential top bracket, differential bottom bracket, and

not contact the slip ring properly, replace the brush springs.

5M16. Removing the differential and lead screw assemblies. (See Figures 5-59 and 5-60.) Since all mounting brackets on the forward face of the main mounting plate are doweled, it is necessary to raise all the brackets simultaneously to clear the dowel pins without distorting the connecting parts. Remove the follow-up contact assembly (see Section 5M11). Remove the slip ring and contact assembly (see Section 5M12). Remove the lead screw drive motor (see Section 5M4). Remove all the bracket mounting screws. Lift the jack



1. TAKE-UP SPRING
2. OIL WELL COVER AND SPRING SUPPORT
3. END PLATE
4. ROLLER SHAFT AND PINION
5. FRICTION ROLLER
6. LEAD SCREW YOKE
7. LIMIT SWITCH OPERATING SCREWS
8. ROLLER AND PIVOT

Figure 5-58. Lead screw yoke assembly removed.

the main mounting bracket in such a manner that the connecting parts will not be distorted or sprung. Loosen the setscrew that secures the guide rod in the differential bottom bracket, and pull the guide rod out of its brackets. Remove the differential from the top and bottom mounting brackets. Remove the pin screw and loosen the setscrew that secures the lead screw driven gear to the bottom of the lead screw, and remove the gear. Pull the lead screw assembly out of the main mounting bracket.

5M17. Disassembly of the lead screw assembly. (See Figures 5-58 and 5-61.) Unscrew and remove the lead screw and follow-up pinion from the lead screw yoke. Remove the end plate retaining screws, end plate, thrust spring washer, and ball bearing from the upper end of yoke. Push the roller and pinion upward as shown in Figure 5-61, and remove them from the yoke. The ball bearing on the opposite end of the yoke is removed by removing the end plate and thrust spring washer.

5M18. Cleaning and repairing the lead screw assembly. Do not attempt to remove the friction roller from the roller shaft and pinion. Replace this assembly as a unit. Thoroughly clean all parts in Navy-approved cleaning fluid. Examine the friction roller and guide rod roller for flat spots. The diameter of the friction roller should be 1.2505 inches maximum and 1.2480 inches minimum. If the roller is smaller than 1.2480 inches, replace the complete roller shaft and pinion assembly.

5M19. Assembling the lead screw assembly. (See Figures 5-58 and 5-61.) Install the lower end plate on the yoke. Place the ball bearing in the yoke with the open face of the bearing upward. Place the friction roller shaft and the pinion assembly in position in the yoke. Install the upper ball bearing in the yoke with the open end of the bearing toward the roller shaft. Place the thrust spring washer on the bearing with the protruding section of the washer away from the bearing. Install the end plate and the end plate retaining screws.

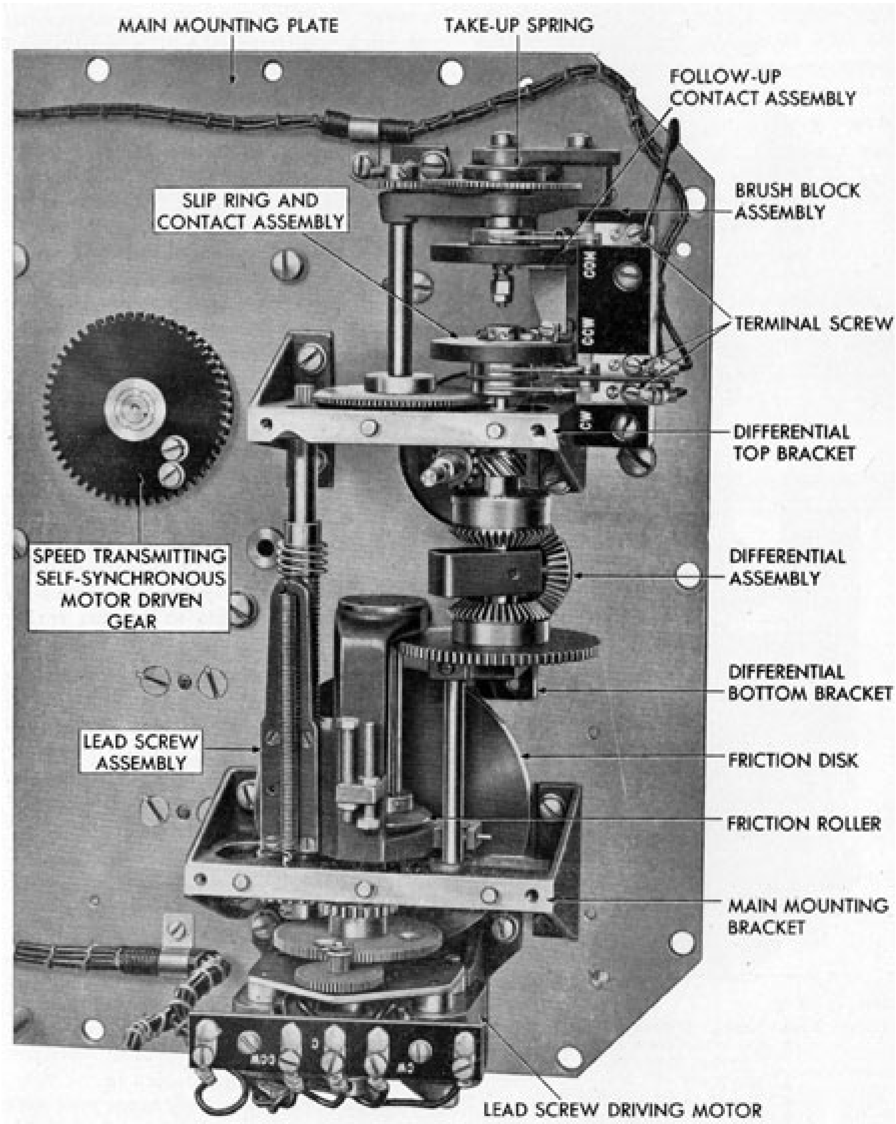
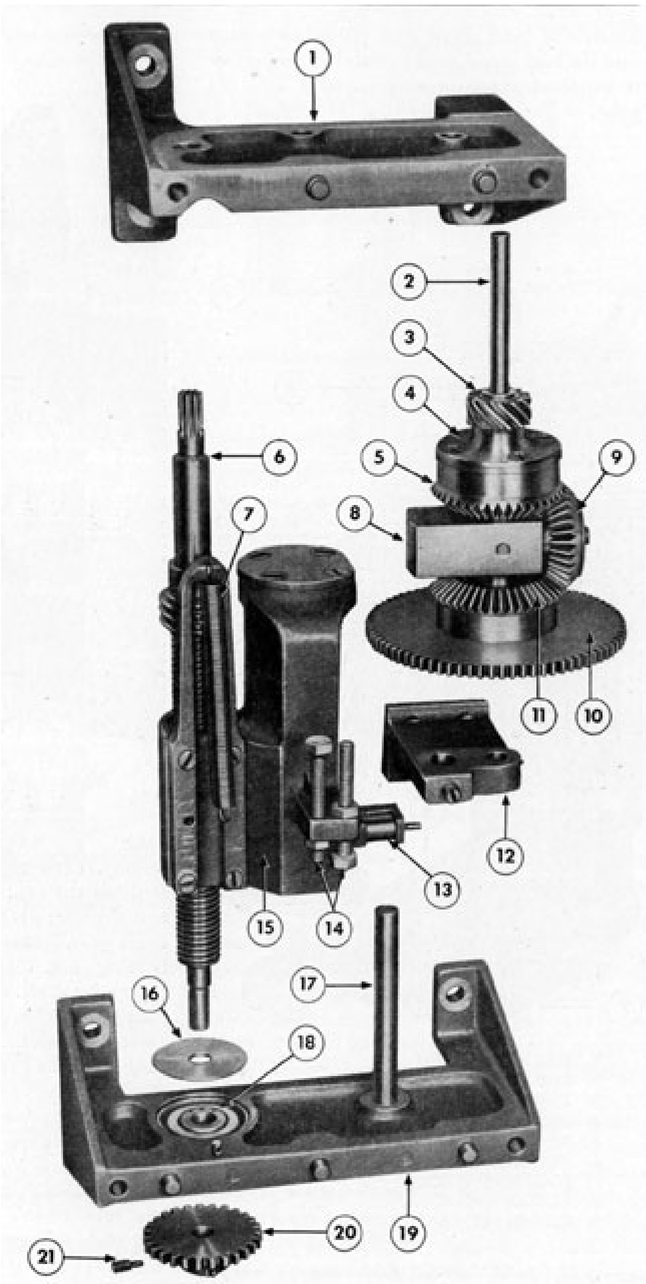


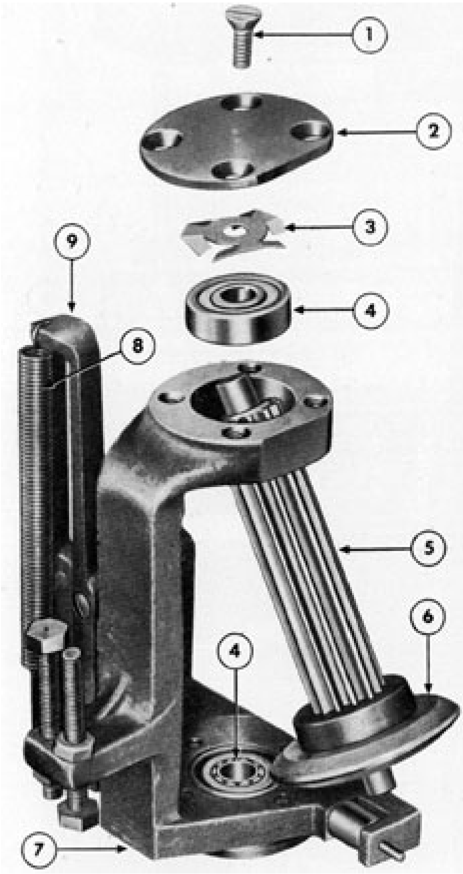
Figure 5-59. Master speed indicator, top mounting plate removed.



1. DIFFERENTIAL TOP BRACKET
2. DIFFERENTIAL SHAFT
3. DRIVEN SPRIAL GEAR
4. DIFFERENTIAL END PLATE AND GEAR HUB
5. UPPER DIFFERENTIAL FACE BEVEL GEAR
6. LEAD SCREW AND FOLLOW-UP PINION
7. TAKE-UP SPRING
8. SPIDER
9. DIFFERENTIAL BEVEL PINION
10. SPUR GEAR (STANDARD SPEED)
11. LOWER DIFFERENTIAL FACE BEVEL GEAR
12. DIFFERENTIAL BOTTOM BRACKET
13. ROLLER AND PIVOT
14. LIMIT SWITCH OPERATING SCREWS
15. LEAD SCREW YOKE
16. DUST WASHER
17. GUIDE ROD
18. BALL BEARING
19. MAIN MOUNTING BRACKET
20. LEAD SCREW DRIVEN GEAR
21. PIN SCREW

Figure 5-60. Lead screw and differential partially disassembled.

Screw the lead screw and follow-up pinion into the lead screw yoke so that the lead screw is installed approximately halfway into the yoke.



1. END PLATE SCREW
2. END PLATE
3. THRUST SPRING WASHER
4. BALL BEARING
5. ROLLER SHAFT AND PINION
6. FRICTION ROLLER
7. LEAD SCREW YOKE
8. TAKE-UP SPRING
9. OIL WELL COVER AND SPRING SUPPORT

Figure 5-61. Roller shaft and pinion removed from yoke.

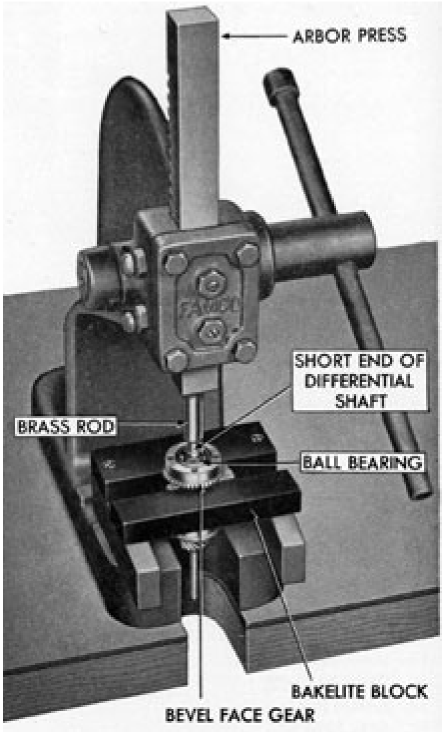


Figure 5-62. Pressing out short end of differential shaft.

5M20. Disassembly of the differential assembly. (See Figures 5-60, 5-62, and 5-63.) Remove the four spur gear retaining screws, and the spur gear from the lower differential bevel gear. Remove the screw, retaining plate, bearing, and differential bevel pinion from the spider shaft. Support the differential bevel face gear which is mounted on the short differential shaft on bakelite or other soft blocks to protect the gear teeth. Do not use brass or steel blocks. Using a brass rod as shown in Figure 5-62, press out the shaft from the bearing. Remove the bearing from the gear. The bearings are a light press fit on the shaft, and a hand press fit in the gear housing. Remove the four screws that secure the differential end plate and gear hub to the upper differential bevel face gear, and lift off the plate and

gear hub with the assembled driven spiral gear. Place the special pilot over the long end of the differential shaft as shown in Figure 5-63. Support the gear teeth on the bakelite blocks on the bed of an arbor press. Press the shaft out of the bearings. Remove the bearing from the gear housing.

5M21. Cleaning, inspection, and repair of the differential assembly. (See Figure 5-60.) Thoroughly clean all parts of the differential assembly with Navy-approved cleaning fluid. Dry all parts thoroughly. Replace all bent, broken, or heavily scored parts. If the differential shaft is lightly scored, remove the score marks with an oilstone, and polish with crocus paper. Visually inspect the bearings, and replace any cracked or otherwise damaged bearings. Remove light nicks from the gear teeth with a knife-edge file. Gears with cracked or chipped teeth should be replaced.

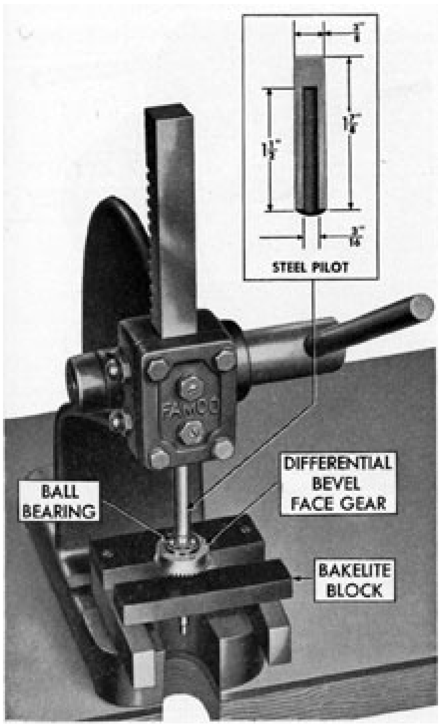


Figure 5-63. Pressing out long end of differential shaft.

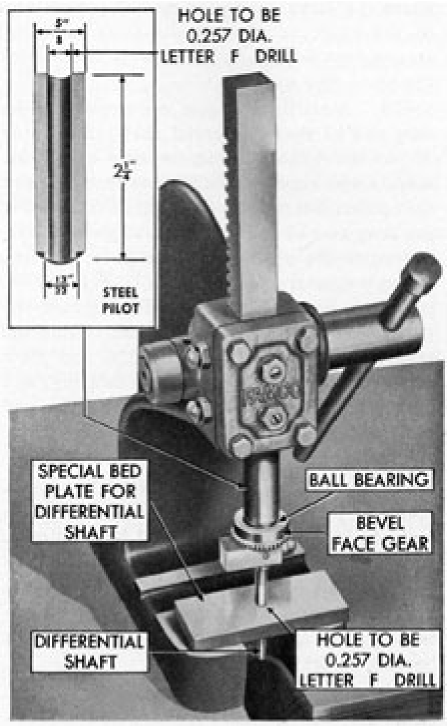


Figure 5-64. Installing bearing on short end of differential shaft.

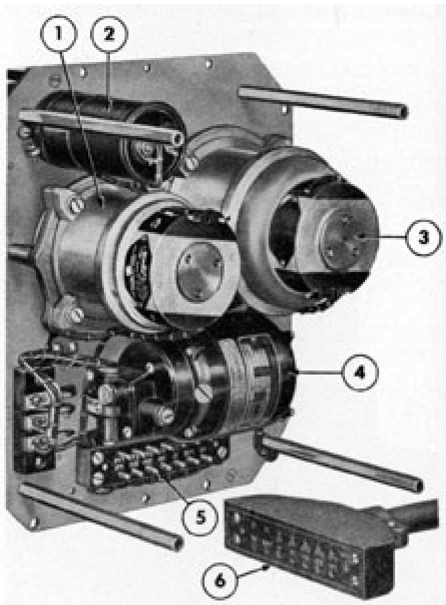
5M22. Installing the gear and bearing on the short end of the differential shaft. (See Figure 5-64.) Support the shoulder on the long end of the differential shaft in a special bed plate on an arbor press as shown in Figure 5-64. This is necessary in order to prevent bending the shaft. Place one of the differential bevel face gears over the short end of the shaft with the gear teeth facing the spider. Place one of the two identical ball bearings over the short end of the shaft, and align the bearing with the opening in the gear housing. Using a special pilot as shown in Figure 5-64, press the bearing into the gear housing. Remove the assembly from the arbor press.

Place the large spur gear over the short end of the shaft and install the four retaining screws that hold the spur gear to the hub of the bevel face gear.

5M23. Installing the gear and bearing on the long end of the differential shaft. Place the second bevel face gear on the long end of the differential shaft with the gear teeth toward the spider. Place the second ball bearing over the long end of the shaft and align the bearing with the opening in the gear housing. Using a special pilot as shown in Figure 5-64, press the bearing on the shaft and into the gear housing. Remove the assembly from the arbor press. Place the differential end plate and gear hub assembly over the bearing, and install the four screws that secure the end plate and gear hub assembly to the bevel face gear.

5M24. Installing the differential bevel pinion. (See Figure 5-60.) Place the bevel pinion ball bearing in the differential bevel pinion. Place the gear and bearing on the shaft of the spider with the gear teeth meshed with those of the two bevel faced gears. Install the retaining plate and screw to secure the gear and bearing to the spider shaft.

5M25. Installing the lead screw and differential assemblies. (See Figures 5-59 and 5-60.) When installing the lead screw assembly and/or the differential assembly on the main mounting plate, it is necessary that the brackets be placed in their dowel pin holes without being fastened bracket with the spur gear in mesh with the friction roller shaft and pinion. Place the differential top bracket over the long differential shaft and over the lead screw pinion. Loosely set the dowel pins of the top bracket in the mounting plate dowel pin holes. Place the jackshaft and gear in position in the differential top bracket with the first follow-up gear on the jackshaft in mesh with the lead screw pinion. Install the slip ring and contact assembly (see Section 5M32). Install the follow-up contact assembly as explained in Sections 5M33 and 5M34. Install the bracket retaining screws loosely. Do not tighten the bracket screws at this time, as the brackets will have to be lifted slightly in order to install the top mounting bracket.



1. SELF-SYNCHRONOUS REPEATER (60 R.P. MILE)
2. STARING CONDENSER FOR CONSTANT SPEED MOTOR
3. SELF-SYNCHRONOUS TRANSMITTER (SPEED)
4. CONSTANT SPEED (SYNCHRONOUS) MOTOR
5. PLUG-JACK CONNECTION
6. PLUG-JACK CORD (SPARE PARTS BOX)

down to the plate. The close fits of the brackets and shafts make it necessary to lift the brackets slightly as the shafts are installed to allow clearance for the various dowel pins. Place the lead screw ball bearing in the main mounting bracket. Place the dust washer over the lower end of the lead screw, and insert the lead screw through the bearing and mounting bracket. Place the lead screw driven gear on the lower end of the screw and secure with the pin screw and the setscrew. Slide the guide rod through the opening in the main mounting bracket and into the opening in the differential bottom bracket. Secure the guide rod in the differential bottom bracket with a setscrew. Place the lower end of the differential shaft into the bottom

Figure 5-65. Rear view of master speed indicator showing jack plug connections.

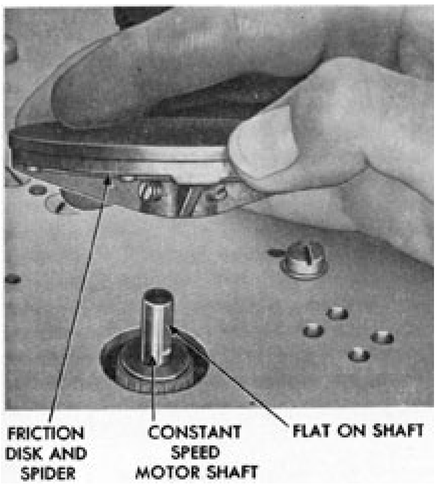


Figure 5-66. Removing friction disk and spider.

5M26. Removing the constant speed motor. (See Figures 5-65, 5-66, and 5-67.) Remove the lead screw and differential assemblies from the main mounting plate as explained in Section 5M16. Loosen the two setscrews that secure the friction disk and

the pin screw and loosen the setscrew that secures the worm gear on the shaft. Carefully pull the slow speed shaft from its housing, and lift out the worm gear, spacer washer, and spacer.

5M28. Cleaning, inspection, and repair of the reduction gear assembly. (See Figure 5-69.) Thoroughly clean all parts with Navy-approved cleaning fluid. Visually inspect the felt and fiber washers for torn edges or other damage. Replace the damaged washers. Examine the worm gear for chipped or broken teeth, and replace the damaged worm gear. Examine the slow speed shaft for score marks. Remove light score marks with an oilstone, and polish with crocus paper.

spider to the motor shaft and lift off the spider and disk assembly. Do not attempt to turn the disk on the motor shaft as the teeth on the micarta worm gear will be stripped. Disconnect the three electrical leads from the terminal block on the back of the mounting plate. These wires and terminals are marked W1, S1, and S2. Remove the four screws that secure the motor to the mounting plate from the front of the mounting plate, and remove the motor.

5M27. Removal and disassembly of the reduction gear housing. (See Figures 5-68 and 5-69.) Remove the three screws that secure the reduction gear housing assembly to the motor, and remove the housing. Remove the packing nut and felt washer from the housing. Remove the adjusting screw and nut, fiber washer, felt washer, spring, and ball from the opposite end of the high speed shaft. Remove

5M29. Replacing the shaft bearings. (See Figure 5-68.) Bearings are replaced if they become pitted due to corrosion, or if they are damaged. Remove the shaft bearings in the following manner: Remove the worm gear housing (see Section 5M27). Remove the four screws, two felt retainers, and felt washer

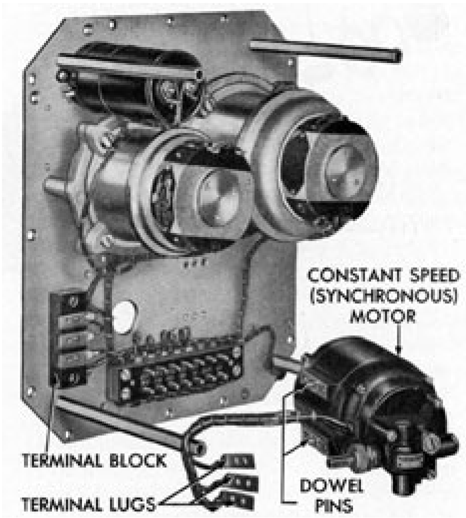
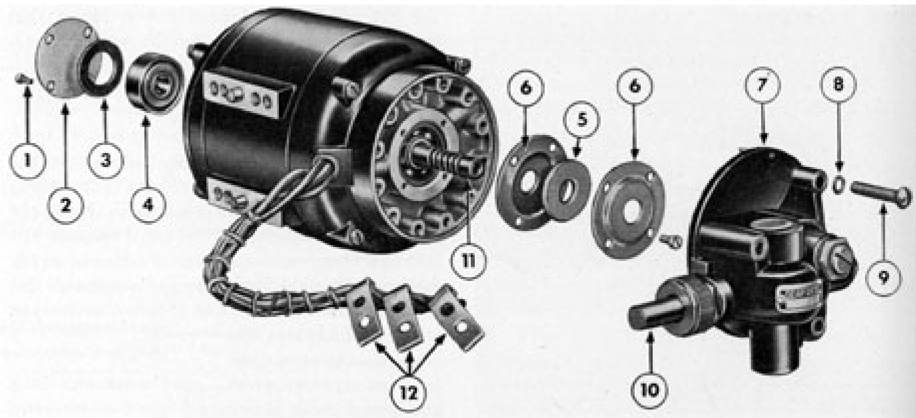


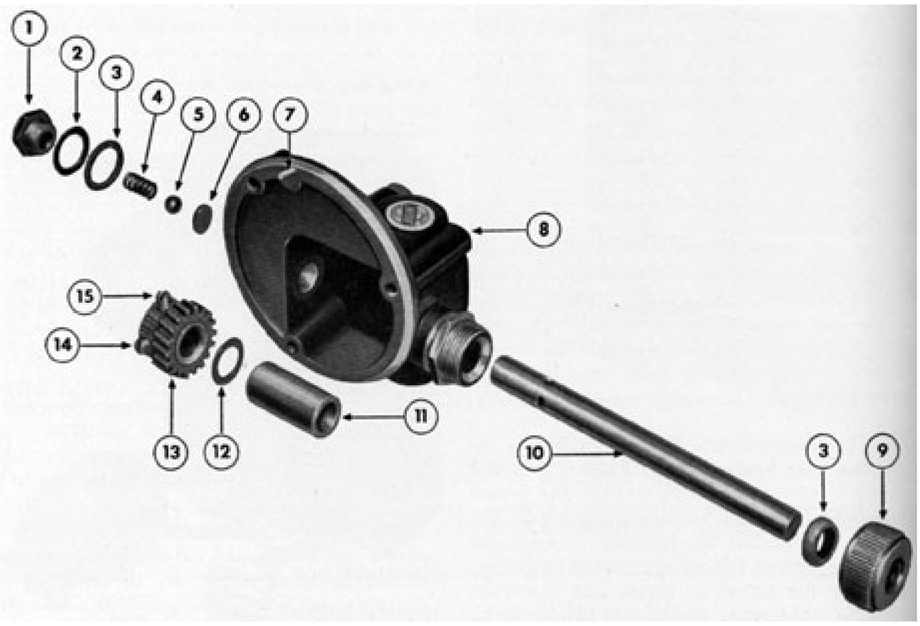
Figure 5-67. Constant speed motor removed.



1. END PLATE SCREW
2. END PLATE
3. SHIM
4. BALL BEARING
5. FELT WASHER
6. FELT RETAINERS

7. REDUCTION GEAR HOUSING
8. LOCK NUT
9. SCREW
10. SHAFT FOR FRICTION DISK AND SPIDER
11. WORM ON MOTOR SHAFT
12. TERMINAL LUGS

Figure 5-68. Constant speed motor partially disassembled.



1. ADJUSTING SCREW AND NUT
2. WASHER
3. FELT WASHER
4. SPRING
5. BALL
6. THRUST PLATE
7. LOCATING PIN
8. GEAR HOUSING
9. PACKING NUT
10. SLOW SPED SHAFT
11. SPACER
12. SPACING WASHER
13. HELICAL GEAR
14. SET SCRW
15. PIN SCREW

Figure 5-69. Worm gear housing assembly disassembled.

from the reduction gear end of the shaft. Remove the four screws, end plate, and shun from the opposite end of the shaft. In the event that the bearings will not come off the shaft by

end. The wires are tagged for identification, and the lugs are installed in the same manner as an old motor wiring. Install the friction disk and spider on the motor shaft, and secure with the

tapping, it will be necessary to remove the armature assembly as follows: Remove the motor back and shield, and pull the armature assembly from the motor frame. Remove the bearings from the shaft with a bearing puller. Press the new bearings into position on the shaft. Install the armature assembly into the motor frame, and install the back end shield. Install the shim and end plate. Install the felt washer and two felt retainers on the reduction gear end of the motor. Install the worm gear housing (see Section 5M30).

5M30. Assembly and installation of the gear housing. (See Figures 5-68 and 5-69.) Install the felt washer in the packing nut, and install the packing nut on the gear housing. Place the spacer, spacer washer, and worm gear in approximate position in the gear housing. Insert the slow speed shaft into the housing, through the reduction gear, spacers, and packing nut. Align the pin hole in the shaft and gear, and install the pin screw and setscrew to secure the reduction gear to the shaft. Install the thrust plate, ball, spring, felt washer, fiber washer, and adjusting screw and nut on the opposite end of the gear housing. Place the reduction gear housing in position on the motor, being sure to carefully engage the teeth of the worm and reduction gear. Secure with the three screws and toothed lock washers.

5M31. Installing the constant speed motor. (See Figures 5-65, 5-66, and 5-67.) Place the two setscrews provided. Install the lead screw and differential assemblies as explained in Section 5M25.

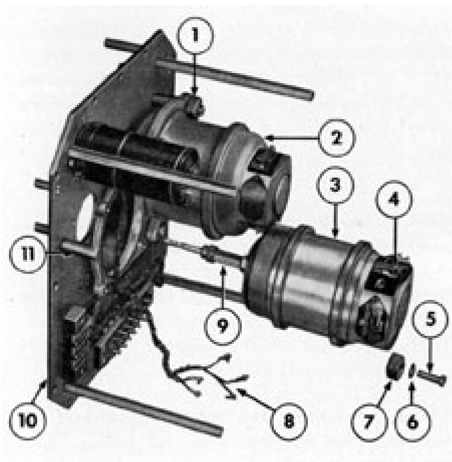
5M32. Installing the slip ring and contact assembly. (See Figures 5-55 and 5-57.) Place the slip ring and contact assembly on the upper end of the differential shaft. Align the pin screw holes and install the pin screw. Install the setscrew that secures the assembly on the differential shaft.

5M33. Installing the follow-up contact assembly. (See Figures 5-55 and 5-56.) Place the follow-up contact assembly on the follow-up shaft with the contact arm located between the contact points of the slip ring and the contact assembly. Install the tension spring, washer, nut, and lock nut on the follow-up shaft in such a manner that approximately three threads of the contact shaft will be visible when the lock nut is installed. This will put the proper tension on the spring.

5M34. Installing the top mounting bracket. (See Figure 5-55.) Place the top mounting bracket with its assembled follow-up contact assembly in position on the main mounting plate by inserting the dowel pins of the bracket into the dowel pin holes provided in the main mounting plate. Secure the bracket to the plate with the two screws and lock washers provided. Install the starting condenser on the back of the main mounting plate. The starting condenser was removed to make the bracket mounting screws accessible. Tighten all the bracket mounting screws which were left loosely installed in order

constant speed motor in position on the back of the main mounting plate, with the dowel pins on the motor base inserted into the dowel pin holes in the mounting plate. Install the four screws from the front of the plate which secure the motor to the plate. Connect the three wire terminals to the terminal block on the block on the rear of the mounting plate. Terminals are marked W2, S2, and S1. When a new motor is to be installed, the motor is received without terminal lugs on the wire to position the top bracket dowels. Install the spiral take-up spring as described in Section 5M10. Adjust the contact points as described in Section 5M14.

5M35. Installing the brush block assembly. (See Figures 5-53 and 5-59.) Place the brush block assembly in position on its mounting studs, being careful to align the brushes properly on the slip rings of the follow-up contact



1. MOUNTING CLAMP INSTALLED
2. SELF-SYNCHRONOUS TRANSMITTER (SPEED)
3. SELF-SYNCHRONOUS REPEATER (60 R.P. MILE)
4. BAKELITE BRUSH BASE
5. SCREW
6. LOCK WASHER
7. MOUNTING CLAMP
8. WIRES DISCONNECTED FROM UPPER AND LOWER BRUSH BASES
9. SHAFT EXTENSION
10. MAIN MOUNTING PLATE
11. MOUNTING BASE

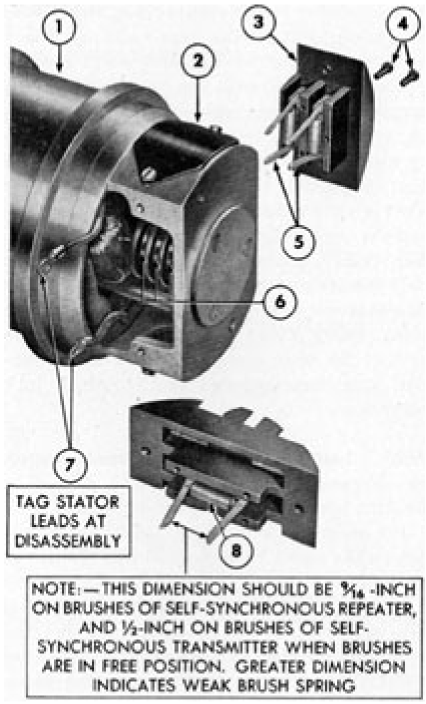
Figure 5-70. Distance repeating self-synchronous motor removed.

the repeater to the bracket on the back of the main mounting plate, and carefully lift the repeater from the plate.

5M37. Inspection and removal of the brushes. (See Figure 5-71.) The brushes may be removed while the repeater is mounted to the main mounting plate. Remove the brush inspection plate and name plate. Inspect the brushes and slip rings. Disconnect the wires from the brush bases and tag the wires for

assembly and the slip ring and contact assembly. Install the two screws that secure the brush block to the mounting studs on the main mounting plate. Connect the lead wires to the brush block.

5M36. Removing the self-synchronous distance repeater. (See Figures 5-52 and 5-70.) Remove the master speed indicator unit from the case (see Section 5M7). Remove the pointer and dial (see Section 5M2). Remove the tapered pin that secures the counter driving worm on the repeater shaft extension, and remove the worm. Disconnect the lead wires from the two bakelite brush bases, and tag the wires for ready identification. Remove the four screws and mounting clamps that secure



1. SELF-SYNCHRONOUS REPEATER OR TRANSMITTER
2. SLIP RING AND BRUSH INSPECTION PLATE
3. BAKELITE BRUSH BLOCK
4. BRUSH BLOCK RETAINING SCREWS
5. SILVER BRUSHES
6. SLIP RINGS
7. STATOR LEAD WIRES
8. BRUSH SPIRNG

Figure 5-71. Self: synchronous repeater, brushes removed.

ready identification. Remove the four screw; (two on each brush base) and lift off the two molded brush bases.

5M38. Maintenance of the brushes. (See Figure 5-71.) Clean the silver brushes and split rings thoroughly with crocus paper. The in. side surfaces at the ends of the brushes should be 9/16-inch apart when the brush is in the free position. Greater spacing than this is an indication of a weak brush spring. The brushes

extension by holding the shaft nut with one wrench and unscrewing the shaft lock nut with a second wrench. Remove the front plate retaining screws and the front plate. Remove the two studs and lock washers that secure the end frames to the motor shell, and remove the front end frame. Remove the shims and bearings from the front end frame. Slide the damper flywheel off the shaft. Remove the damper spring. The bearing on the slip ring end is removed after removing the back plate.

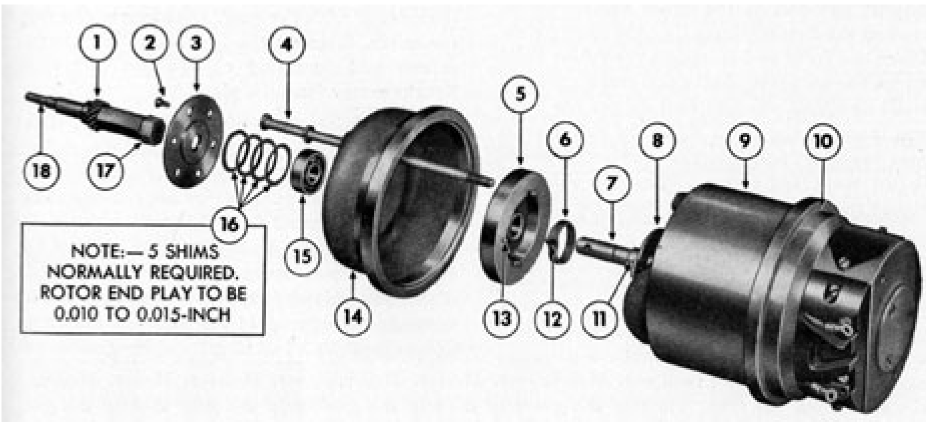
must be free on their mounting studs without excessive binding.

5M39. Installing the brushes. (See Figure 5-71.) Carefully install the brushes and brush bases on the repeater. Be sure to align the brushes carefully with the slip rings to prevent bending of the brushes. The brush bases are of a different size to prevent error in positioning them. Install the four brush base retaining screws (two on each base). Install the brush inspection plate and name plate.

5M40. Removing the bearings and damper assembly. (See Figure 5-72.) Remove the brushes (see Section 5M37). Remove the shaft

5M41. Inspection of the self-synchronous repeater bearings. (See Figure 5-72.) Clean the bearings with Navy-approved cleaning fluid. Replace damaged bearings. Turn the bearings slowly by hand and note the smoothness of operation. A clicking noise, or binding, indicates chipped or cracked balls. Replace damaged bearings. Lubricate the bearings with gyro oil.

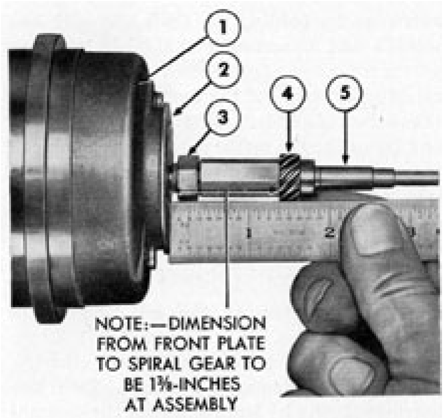
5M42. Installing the bearings and damper. (See Figure 5-72). Place the damper spring on the damper collar with the spring ends engaged on the stud of the collar. Install the



1. DIFFERENTIAL DRIVING SPIRAL GEAR
2. FLATHEAD SCREW
3. FRONT PLATE
4. STUD AND LOCK WASHER
5. STUD AND LOCK WASHER
6. DAMPER SPRING
7. MOTOR SHAFT
8. DAMPER COLLAR
9. SHELL
10. BACK END FRAME
11. DAMPLER SPRING STUD ON COLLAR
12. SPRING ENDS
13. DAMPER SPRING STUD
14. FRONT END FRAME
15. BALL BEARING
16. SHIMS
17. SHAFT LOCK NUT
18. SHAFT EXTENSION

Figure 5-72. Self-synchronous repeater, damper assembly removed.

5M43. Installing the distance self-synchronous repeater. See Figures 5-52 and 5-70.) Place the



1. SELF-SYNCHRONOUS REPEATER
2. FRONT PLATE
3. SHAFT LOCK NUT
4. DIFFERENTIAL DRIVING SPIRAL GEAR
5. SHAFT EXTENSION

Figure 5-73. Checking shaft extension installation.

damper flywheel on the motor shaft with the stud on the flywheel engaging the spring ends. Place the front end frame on the motor shell. Align the mounting holes and install the two studs and lock washers that secure the front end frame to the shell. Slide the ball bearing over the shaft and into the opening provided in the front end frame. Place the shims on top of the bearing and push downward on the shims until the outer shim is flush with the end of the frame. Install the front plate on the frame. The bearing on the slip ring end is placed in position in the frame and secured by the back plate. Place the shaft extension over the end of the motor shaft, and temporarily tighten the shaft lock nut. Measure the distance from the front plate to the gear on the extension as shown in Figure 5-73. This distance should be 1sg inches at assembly. Tighten the lock nut securely while holding the shaft nut. Turn the shaft by repeater in position on the back of the main mounting plate. Install the four clamps and clamp retaining screws loosely. Hold the wires in the approximate position on the brush base, and turn the motor until the wires reach the terminals. Install the lead wires in the brush bases (three wires to the upper base, and two wires to the lower base). Tighten the mounting clamps securely. Place the counter driving worm on the end of the shaft extension; align the locating dots on the gear and the gear shaft as shown in Figure 5-52, and install the taper pin. Install the dial and pointer (see Section 5M2). Install the master speed indicator in the case (see Section 5M50).

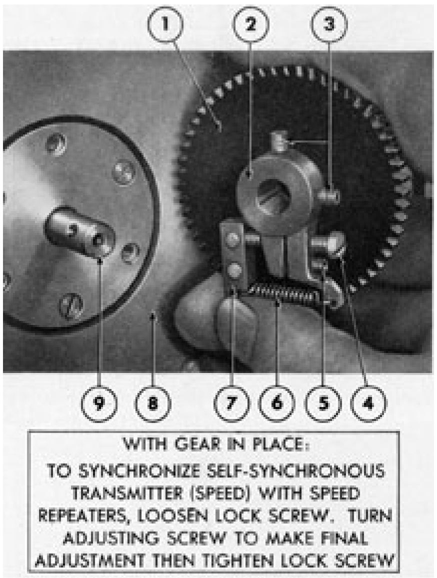
5M44. Removing the self-synchronous speed transmitter. (See Figures 5-65 and 5-74.) Remove the top mounting plate (see Section 5M8). Loosen the two socket head setscrews that secure the driven gear hub to the speed transmitter shaft, and carefully remove the gear assembly (Figure 5-74). The adjusting mechanism mounted on the rear of the gear is removed with the gear. Disconnect and tag the wires. Remove the four mounting clamp screws and mounting clamps and carefully lift the motor from the plate.

5M45. Maintenance of the transmitter. The transmitter self-synchronous motors differ from the repeaters in that they do not have a damper mechanism. Brushes are removed, inspected, and installed in the same manner as explained in Sections 5M37, 5M38, and 5M39. Bearings are removed by removing the end plates and shims. Inspect the bearings as described in Section

hand to see that the repeater operates freely. The rotor end play should be between 0.010 and 0.015 inch. Add or remove shims as necessary to obtain the required end play (Figure 5-72).

5M41. Install the bearings in the frames. Install the shims and end plates.

5M46. Installing the speed transmitter. (See Figures 5-65 and 5-74.) Place the transmitter in position on its bracket on the rear of the main mounting plate. Loosely install the mounting clamps. Hold one set of wires in their approximate position, and turn the motor until the wires are correctly placed in relation to the brush base. Tighten the mounting clamps. Connect the wires to the brush bases.



1. SELF-SYNCHRONOUS TRANSMITTER (SPEED) DRIVEN GEAR
2. ADJUSTABLE HUB
3. SETSCREWS
4. ADJUSTING SCREW
5. LOCK SCREW
6. TENSION SPRING
7. ANCHOR BLOCK
8. FORNT OF MAIN MOUNTING PLATE
9. SELF-SYNCHRONOUS TRANSMITTER (SPEED) SHAFT

Figure 5-74. Speed transmitter driven gear removed.

5M48). Install the dial and counter (see Section 5M2). Recalibrate the instrument (see Sections 5M51 and 5M52).

5M47. Replacing the starting condenser. (See Figure 5-65.) Remove the unit from the case (see Section 5M7). Remove the two nuts from the terminal studs, and remove the wires. Remove the two screws that secure the condenser to the main mounting plate, and remove the condenser. Place the new condenser in position on the rear of the main mounting plate, and secure it with the two screws provided. Place the wire terminals over the terminal studs, and install the terminal nuts. Install the unit in the case (see Section 5M50).

5M48. Installing the top mounting plate. (See Figure 5-56.) Place the top mounting plate in position on the mounting studs provided on the main mounting plate. Install the six screws and

Install the transmitter driven gear assembly as follows: Have one crew member remove the cover from the speed and distance indicator in the conning tower. Energize the speed circuit. Hold the conning tower pointer on zero while positioning the transmitter driven gear assembly on the transmitter shaft. Then tighten the two setscrews that secure the gear hub to the shaft. This operation eliminates major movement of the driven gear on the transmitter shaft when recalibrating the instrument. Deenergize the circuit. Install the top mounting plate (see Section toothed lock washers that secure the top mounting plate to the mounting studs. Install the top support stud in the upper left corner of the top mounting plate.

5M49. Installing the counter driving worm. (See Figure 5-52.) Place the counter driving worm on the shaft extension of the distance repeating self-synchronous motor. Align the pinhole in the worm with the pinhole in the shaft in such a manner that the locating dots on the worm and shaft are adjacent to one another. This is important, as the pinhole is tapered to take a tapered pin. Install the tapered pin through the worm and shaft with the large end of the pin toward the locating dots. Place the handle in position on the upper right-hand side of the main mounting plate. Install and stake the two screws which secure the handle to the main mounting plate. Install the dial and pointer (see Section 5M2). Recalibrate the instrument (see Sections 5M51 and 5M52).

5M50. Installing the unit in its case. (See Figure 5-47.) Turn the operating shaft of the dimmer rheostat so that its forked end clears the rheostat shaft extension. Place the unit in its case, being careful not to damage the wiring. Install the 10 screws that secure the mounting plate to the case. Place the cover in position and install the cover retaining screws.

5M51. Setting the lower limit switch. (See Figure 5-52.) Whenever the subassemblies of the master speed indicator are removed for purposes of on the hub, and set the pointer to zero. Tighten the screws to lock the pointer in the zero position, and install the hub cap. Turn up the lower limit switch operating

cleaning, replacement, or repair, the unit must be recalibrated. The following operations are performed; Reassemble the instrument with the exception of the dial and pointer. Back off the lower lead screw limit switch, operating the screw several turns. With the instrument electrically connected to the rotary distance transmitter by means of the plug-jack cord, energize the electrical circuits, and allow the lead screw driving motor to adjust the position of the friction roller to the zero position. The friction disk should be rotating, and the roller should be stationary at its center position on the disk. Install the dial, pointer, and pointer hub. Do not install the hub cap at this time. Loosen the screws securing the pointer in position screw so that it will open the circuit of the constant speed (synchronous) motor when the pointer reading is 0.075 knots.

5M52. Aligning the speed repeaters with the master speed indicator. (See Figure 5-74.) The transmitter driven gear of the master speed indicator is temporarily set to the zero position as described in Section 5M46. Have a crew member hold the pointer of the speed and distance indicator on zero, as described in Section 5M46. Loosen the locking screw (Figure 5-74), and turn the adjusting screw until the speed pointer is set to the exact corresponding reading of the pointer in the master speed indicator. Tighten the locking screw.

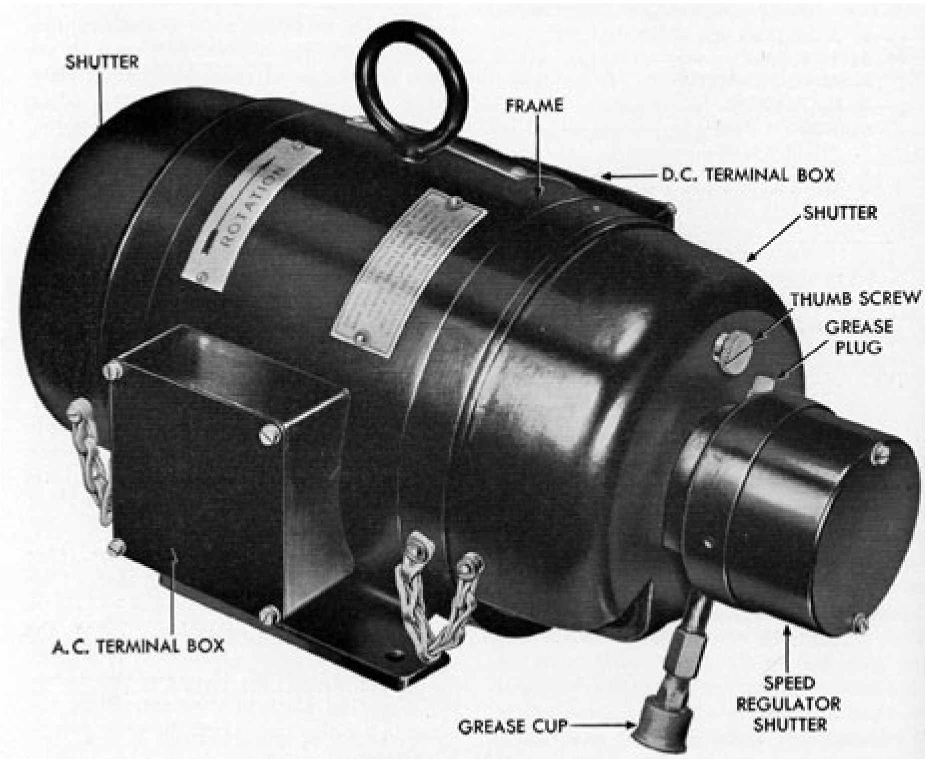


Figure 5-75. Rotary converter.

N. MAINTENANCE OF CONSTANT FREQUENCY SUPPLY UNIT

5N1. Periodic inspection and repair of the converter. Every six months, remove the grease plugs located opposite the grease cup and tube assembly. While the unit is operating, screw down the grease cups until clean grease comes out of the grease plug openings. Refill the grease cups and repeat the operation if necessary. Do not use too much grease, as some may get into the speed regulator assembly. Shut down the unit and remove the commutator and slip ring shutters. Remove the commutator brushes (see Section 5N2) and collector ring brushes (see Section 5N5). Inspect the commutator and slip rings. If the commutator and/or slip ring are pitted, or show uneven wear, dress them down with fine sandpaper or a commutator stone while the unit is operating. Do not use emery cloth as

Figure 5-76. Rotary converter, commutator shutter removed.

particles from the cloth will cause serious trouble. Install the commutator brushes (see Section 5N4) and collector rings (see Section 5N7). Check all brushes to be sure that they are free in their brush holders and making positive contact with the commutator and slip rings. Install the shutters.

5N2. Removing the commutator brushes. (See Figure 5-76.) Loosen the thumbscrew and remove the commutator shutter. Disconnect the brush lead wire from the brush terminal. Lift the clip spring upward and remove the brush from the holder. The other commutator brush is removed in the same manner.

5N3. Cleaning, inspection and repair of the commutator brushes. Inspect the contact surface of the brushes for oil, grease, or a pitted condition. Clean the brush surfaces. Smooth out the pitted surfaces with sandpaper and polish with crocus paper.

5N4. Installing the commutator brushes. (See Figure 5-76.) Lift up the clip spring and insert the brush in the holder. Brushes should be free in their holders, and make positive contact with the commutator. Connect the brush lead wire to the terminal. Place the commutator shutter in position on the frame, and secure it with a thumbscrew.

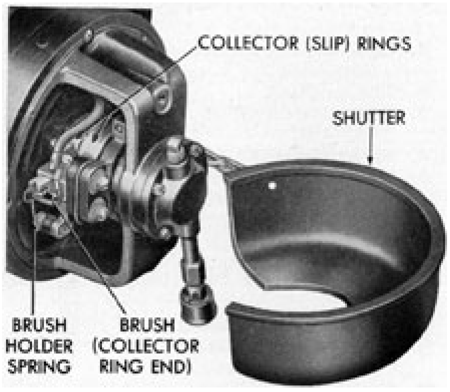


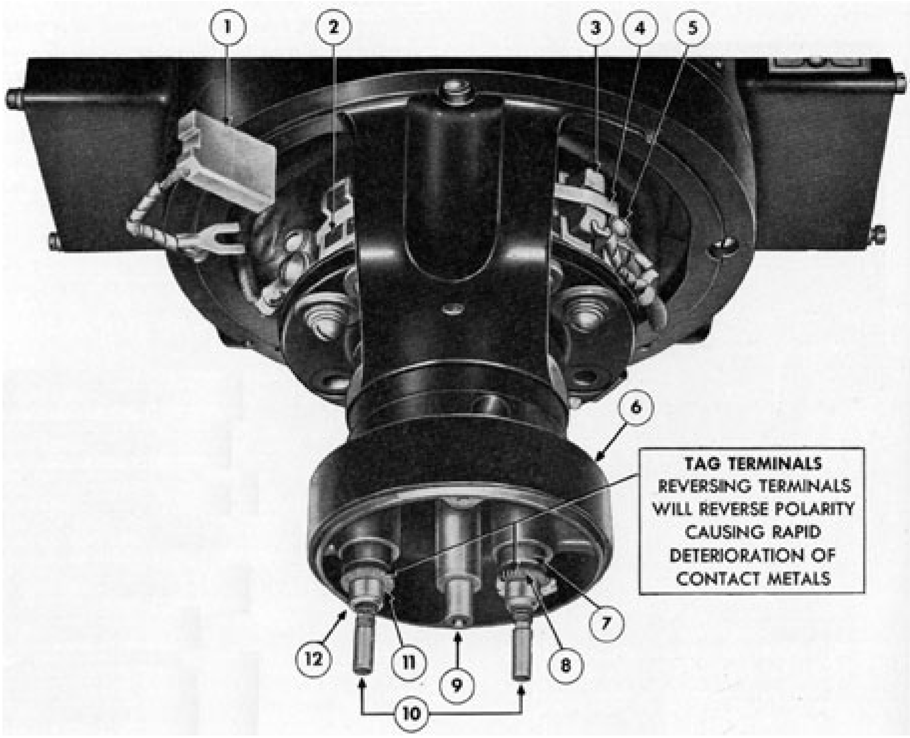
Figure 5-77. Rotary converter, collector ring shutter removed.

5N5. Removing the collector ring brushes. (See Figure 5-77.) Loosen the shutter retaining thumbscrew, and remove the collector ring shutter. Disconnect the brush terminal by loosening the terminal screw and pulling the wire lug from the terminal. Lift up the brush holder spring, and remove the brush from its holder. The other collector ring brush is removed in the same manner.

5N6. Cleaning, inspection and repair of the brushes. Inspect the contact surface of the brushes for oil, grease, and a pitted condition. Clean the brushes thoroughly. Dress the contact surfaces with fine sandpaper.

5N7. Installing the collector ring brushes. (See Figure 5-77.) Lift up the brush holder spring and place the brush in its holder. Connect the wire lug to the terminal and tighten the terminal screw. The other collector ring brush is installed in the same manner. Place the collector ring shutter in position, and secure it by tightening the thumbscrew.

5N8. Removing the speed regulator assembly. (See Figures 5-78 and 5-80.) Remove the two speed regulator shutter screws and the speed regulator shutter. Loosen the two setscrews that secure the speed regulator on the armature shaft and slowly remove the speed regulator. It is necessary to remove the speed regulator slowly from the armature shaft as the spring tension on the brushes that are behind the regulator assembly may cause them to spring out of their brush boxes and become lost. Lift the brushes from their brush boxes.



1. COMMUTATOR BRUSH (REMOVED)
2. BRUSH HOLDER
3. COMMUTATOR BRUSH (INSTALLED)
4. BRUSH HOLDING SPRING
5. BRUSH TERMINAL SCREW
6. SPEED REGULATOR HOUSING
7. BRUSH BOX INSULATOR
8. INNER SPRING TERMINAL (POSITIVE TERMINAL)
9. ARMATURE SHAFT
10. SPEED REGULATOR BRUSHES AND SPRINGS
11. OUTER SPRING TERMINAL (NEGATIVE TERMINAL)
12. BRUSH BOX

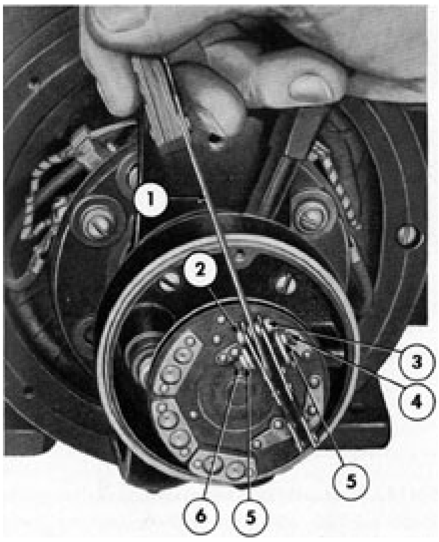
Figure 5-78. Rotary converter, speed regulator and one commutator brush removed.

5N9. Cleaning, inspection, and repair of the speed regulator. Clean the parts in Navy-approved cleaning fluid. Examine the speed regulator brush and spring assemblies. If the brush or its attached spring is damaged, replace the complete brush and spring assembly. If the contact surfaces of the brushes are pitted, smooth them off with fine sandpaper. Examine the speed regulator contact points (Figure 5-79). Clean the pitted points with a jeweler's file. If the contact points are badly worn or burned,

5N11. Installing the speed regulator assembly. (See Figures 5-78 and 5-79.) Carefully place the spring ends of the brush assemblies in their brush boxes. Place the metal surface of the speed regulator against the brushes, and gently compress the brush springs and brushes into the brush boxes by moving the speed regulator on the armature shaft. When the regulator is against the shoulder of the shaft, tighten the two setscrews that secure the regulator to the armature shaft. Place the speed regulator shutter in position on the speed regulator

replace the complete speed regulator assembly.

5N10. Adjusting the speed regulator contact points. (See Figure 5-79.) Check the gap between the speed regulator contact points with a thickness gage. The points should be open 0.020 inch. Adjust the gap to 0.020 inch by means of the outer and inner contact adjusting screws. The gage should slide freely between the contact points without binding.



1. THICKNESS GAGE (SET CONTACT POINTS 0.020-INCH SPACE
2. SILVER CONTACT (POSITIVE)
3. TUNGSTEN CONTACT (NEGATIVE)
4. OUTER CONTACT ADJUSTING SCREW
5. LOCK NUT
6. INNER CONTACT ADJUSTING SCREW

Figure 5-79. Checking speed regulator contact point gap.

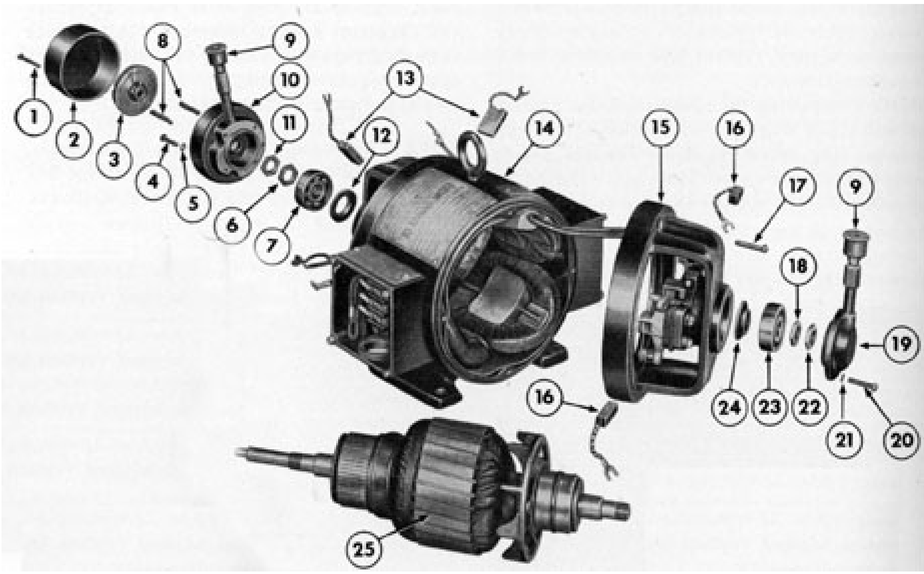
housing, and install the two speed regulator shutter screws.

5N12. Removing the armature assembly. (See Figure 5-80.) Remove the terminal box cover from the a.c. and d.c. terminal boxes, and disconnect the wires leading to outside sources. Tag the wires for ready identification. Remove the commutator shutter (see Section 5N2). Remove the collector ring shutter (see Section 5N5). Remove the speed regulator (see Section 5N8). Remove the commutator brushes (see Section 5N2). Remove the collector ring brushes (see Section 5N5). Carefully remove the spring terminals from the brush boxes in the speed regulator (Figure 5-78). Be sure to tag these wires for ready identification as they must not be reversed at assembly. Remove the four screws that secure the speed regulator housing to the armature cover, and remove the speed regulator housing. Remove the screws that secure the grease cap to the collector ring cover, and remove the grease cap. Remove the shaft nut and lock nut from each end of the shaft. Remove the screws that secure the collector ring cover to the frame and move the cover to one side out of the way. It is not necessary to disconnect the wires connecting the cover and the windings in the converter frame. Tap the end of the armature shaft lightly with a soft hammer or wooden block to loosen the armature assembly. Remove the armature assembly from the frame. Remove the ball bearing and grease from the collector ring cover and armature cover.

5N13. Cleaning, inspection, and repair of the converter. (See Figure 5-80.) Thoroughly clean all parts in Navy-approved cleaning

fluid. Do not saturate electrical wiring with the cleaning fluid. Inspect the bearings for a pitted condition resulting from corrosion. Carefully turn the bearings by hand. A clicking noise or binding indicates chipped or cracked balls. Replace damaged bearings. Undamaged, or new bearings should be lubricated with ball and roller bearing grease, Navy symbol 14L3.

heavily damaged threads should be trued up with a stock and die. Inspect the commutator and collector rings. If they are pitted or show uneven wear, true them up in a lathe. The commutator of a new armature is 2 3/8 inches in diameter. Commutator bars have a wearing depth of 3/16-inch. If the commutator has worn to a diameter of less than 2 inches, replace the armature assembly.



1. SPEED REGULATOR SHUTTER SCREW
2. SPEED REGULATOR SHUTTER
3. SPEED REGULATOR AND SET SCREWS
4. SPEED REGULATOR HOUSING SCREW
5. TOOTHED LOCK WASHER
6. SHAFT NUT
7. BALL BEARING
8. SPEED REGULATOR BRUSHES AND BRUSH SPRINGS
9. GREASE CUP AND TUBE
10. SPEED REGULATOR HOUSING
13. COMMUTATOR BRUSHES
14. FRAME
15. COLLECTOR RIGN COVER
16. COLLECTOR RIGN BRUSHES
17. COLLECTOR RIGN COVER SCREW
18. SHAFT NUT
19. GREASE CUP
20. GREASE CAP SCREW
21. TOOTHED LOCK WASHER
22. LOCK NUT
23. BALL BEARING
24. LEATHER GREASE SEAL
25. ARMATURE ASSEMBLY

11. LOCK NUT
12. LEATHER GREASE SEAL

Figure 5-80. Rotary converter partially disassembled.

Wrap the bearings in wax paper or cloth if they are not needed immediately for assembly. Inspect the grease seals. Replace torn or otherwise damaged seals. Inspect both ends of the armature shaft for burrs or rough spots. Remove the burrs or rough spots with a fine-cut file and polish the shaft with crocus cloth. The threads on the shaft should be clean and true. Remove light burrs from the threads with a knife-edge file. More

5N14. Assembling the rotary converter. (See Figure 5-80.) Place the grease seal and ball bearing in the opening provided in the armature cover. Place the armature assembly in position in the converter frame. Place the collector ring cover on the frame. Install the grease seal and ball bearing in the opening provided in the collector ring cover. If necessary, tap the outer race of the bearing lightly with a soft hammer to properly seat the bearing.

Install the shaft nut and lock nut on each end of the armature shaft. Allow a shaft end play of 0.010 inch when installing the shaft nuts.

Place a coating of ball bearing grease around the seal in the speed regulator assembly. Hold the housing in its approximate position near the end of armature shaft and insert the two wire leads through the opening in the lower part of the housing, while carefully sliding the housing on the armature shaft. Install the four screws to secure the housing to the armature cover. Connect the wires to the terminals on the brush holders by slipping the spring terminals over the brush holders (Figure 5-78). Be sure to install the wires on their correct terminals, as reversing the terminals will cause reverse polarization with consequent

action. The phone units should not be tampered with or adjusted unless absolutely necessary. After adjustment be sure to tighten the unit securely in its new position.

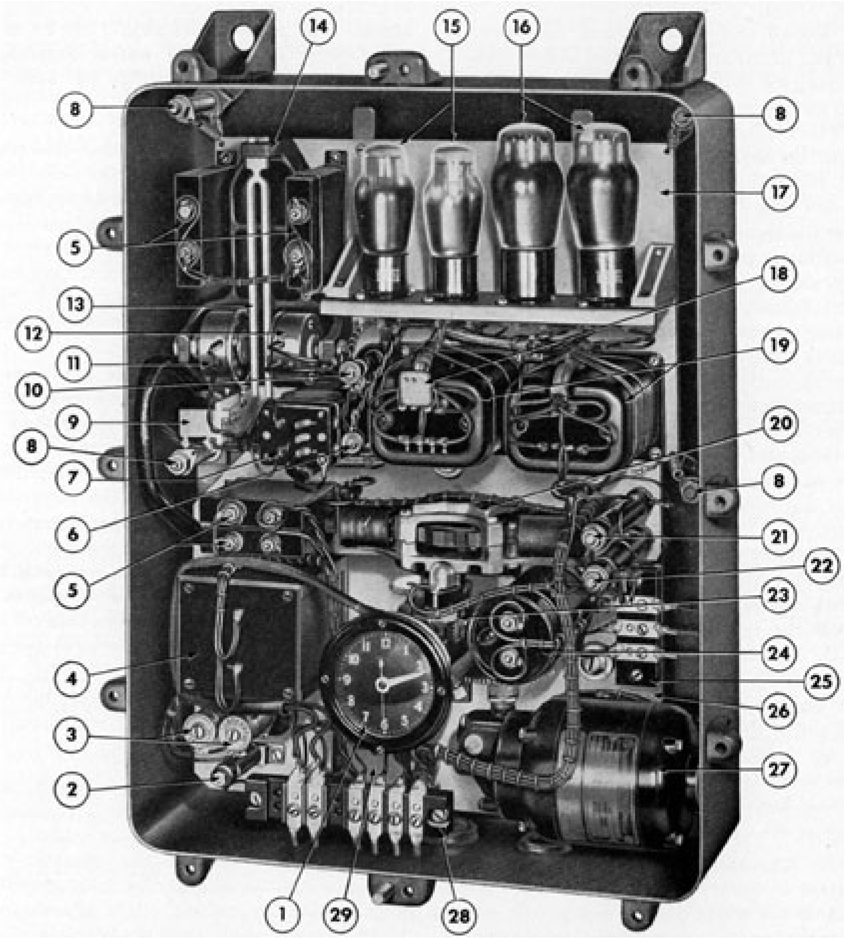
5N16. Checking speed of the converter. (See Figures 5-79 and 5-81.) If the white lines of the phonic wheel motor rotor do not appear stationary when viewed through the cover window, check the speed of the converter as follows: Remove the cover from the constant frequency control unit. Connect a jumper wire between the 10K and 10K1 terminals. This shorts out the rheostat. Energize the 10K circuit. Using a reliable stop watch, check the accuracy of the clock over a period of 5 minutes. If the clock is slower than 1.5 seconds per minute, deenergize the 10K circuit, remove the shutter of the speed regulator assembly, and back off the top adjustable contact screw

rapid deterioration of the metal contacts and early failure of the converter.

Place the grease cap assembly on the collector ring cover, and secure it with the four screws and toothed lock washers provided. Install the regulator assembly (see Section 5N11). Install the collector ring brushes (see Section 5N7). Install the commutator brushes (see Section 5N4). Install the shutters on each end of the converter and secure the shutters by tightening thumbscrew. Connect the wires to the terminal blocks in the a.c. and d.c. terminal boxes. Install the covers on the terminal boxes.

5N15. Checking operation of the clock in the constant frequency control unit. (See Figure 5-81.) If the white lines of the phonic wheel motor appear stationary when viewed through the cover window, check the accuracy of the clock as follows: Allow approximately half an hour for the unit to warm up. Using a reliable stop watch, check the clock over a period of at least 2 hours. The clock should of show an error greater than 5 seconds per hour. Slight changes in the tuning fork frequency, and hence in the controlled frequency and speed of the clock, may be made by moving the driver (right-hand) phone unit by means of its adjusting nuts. Moving the unit toward the fork slows the clock action; moving the unit away from the fork speeds the clock (Figure 5-79) approximately a one-eighth turn, and recheck the clock. Repeat this adjustment, if necessary, until the desired accuracy is obtained. If the clock is faster than 0.5 second per minute, back off the inner adjustable contact screw until the required accuracy is obtained. Replace the speed regulator shutter. Deenergize the 10K circuit, and remove the jumper wire from the 10K and 10K1 terminals.

5N17. Visual check of the control unit. (See Figure 5-81.) When the unit is regulating properly, the rheostat slider should be away from the end of the rheostat and should be hunting slightly, an indication that it is continually making slight adjustments. If the rheostat slider does not regulate as described above, deenergize the 10K circuit, and allow the rotor of the phonic wheel motor to come to rest. See that all the shafts and gears are free to operate properly. Observe the tuning fork while the circuit switch is being closed. The clapper of the starting magnet should strike the fork and start it vibrating. Within a few minutes the neon light below the phonic wheel motor should glow. If the neon lamp fails to glow, visibly check the tubes to see whether or not they are incandescent. If the tubes are in good condition, and the fork still does not sustain vibration,



1. CLOCK
2. 50,000-OHM RESISITOR
3. RECTIFIERS
4. CHOKE
5. CONDENSER, 2-MICROFARADS
6. 100-OHM RESISTOR
7. GRID TRANSFORMER
8. SPRING POST, ASSEMBLY
9. STARTING MAGNET, ASSEMBLY
10. 2250-OHM RESISTOR
11. PICK-UP PHONE UNIT
12. DRIVER PHONE UNIT
13. TUNING FORK
14. TUNING FORK BASE
15. AMPLIFIER TUBES, NO. 6J5G
16. POWER TUBES, NO. 25B6G
17. SUSPENDED PLATE
18. CONDENSER, 0.005-MICROFARAD
19. TRANSFORMERS
20. PHONIC WHEEL MOTOR, ASSEMBLY
21. 190-OHM RESISTOR
22. 2000-OHM RESISTOR
23. DIFFERENTIAL, ASSEMBLY
24. STARTING CONDENSER
25. CONSTANT SPEED (SYNCHRONOUS) MOTOR TERMINAL BLOCK
26. MAIN MOUNTING PLATE
27. CONSTANT SPEED (SYNCHRONOUS) MOTOR
28. TERMINAL BLOCK
29. RHEOSTAT, 450-OHMS

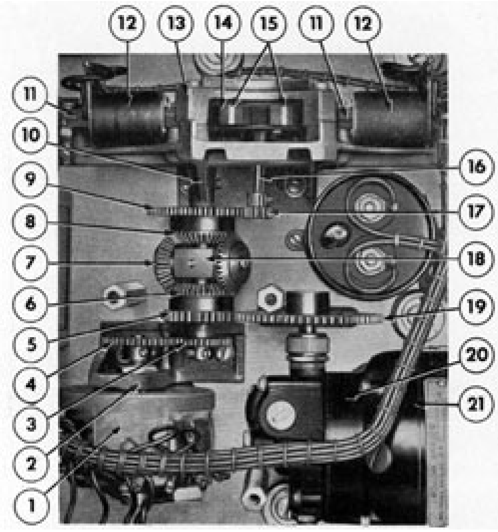
Figure 5-81. Constant frequency control unit, cover removed.

check the transformers, coils, resistors, and condensers for open circuits or grounds.

Using a meter of different sensitivity gives different voltage values. With a line voltage of 120 volts d.c., normal voltages should

5N18. Checking the control unit with a voltmeter. (See Figure 5-81.) Use a 1,000-ohms per-volt voltmeter. be as follows when checked between the two points listed below:

MEASURED BETWEEN	DESIRED VOLTAGE	INDICATION
Upper terminals of right-hand transformer	130 - 150 a.c.	Voltage output of amplifier to copper oxide rectifier
Inner terminals of phonic wheel motor coils	110 - 125 a.c.	Voltage being supplied to coils
Outside upper terminals, secondary of left-hand transformer	20 - 30 a.c. (150 V. range)	A.C. signal applied to grid of output tube
Outside lower terminals, primary of left-hand transformer	5 - 7 d.c. (7.5 V. range)	Primary transformer and amplifier tube in good condition
No. 2 terminal of choke, and 10KK terminal	95 - 100 d.c.	Proper amount of plate voltage, choke in good condition
Ends of 190-ohm resistor	60 - 65 d.c.	Heater circuit operating correctly/td>
Tap of 2,000-ohm resistor, and 10KK terminal	9 - 12 d.c. (15 V. range)	Grid bias on 25B6 tube
End of 1,000-ohm resistor	3.5 - 5.0 d.c. (7.5 V. range)	Grid bias on first amplifier tube (second from left side of case)
Tap of 2,250-ohm resistor, and 10KK terminal	5 - 6 d.c. (7.5 V. range)	Grid bias on driver tube (first from left side of case)
Terminals of synchronous motor starting condenser	250 a.c.	Condenser and one winding of motor in good condition
The current in the driver (right-hand) phone should be as follows: When the tuning fork is held so that it cannot vibrate, the reading should be from 0.25 to 0.5 milliamperes a.c. When the tuning fork is vibrating, the reading should be from 3.5 to 4.0 milliamperes d.c.		



1. RHEOSTAT	12. PHONIC WHEEL MOTOR COIL
2. RHEOSTAT BRACKET	13. PHONIC WHEEL MOTOR TOP BRACKET
3. DIFFERENTIAL SHAFT GEAR	14. ROTOR
4. RHEOSTAT SHAFT GEAR	15. WHITE MARKS ON ROTOR
5. LOWER DIFFERENTIAL SPUR GEAR	16. PHONIC WHEEL MOTOR SHAFT
6. LOWER DIFFERENTIAL BEVEL GEAR	17. PHONIC WHEEL MOTOR SHAFT PINION
7. DIFFERENTIAL BEVEL PINION	18. DIFFERENTIAL SPIDER
8. UPPER DIFFERENTIAL BEVEL GEAR	19. CONSTANT SPEED (SYNCHRONOUS) MOTOR SLOW SPEED SHAFT GEAR
9. UPPER DIFFERENTIAL SPUR GEAR	20. GEAR HOUSING
10. PHONIC WHEEL MOTOR BASE	21. CONSTAT SPEED (SYNCHRONOUUS) MOTOR
11. PHONIC WHEEL MOTOR FIELD CORE	

Figure 5-82. Phonic wheel motor and differential assembly installed.

5N19. Final checking of control unit. (See Figure 5-81). If the tubes are in good condition and there are no defective transformers, coils, resistors or condensers, but the fork still will not sustain vibration, run in the pick-up (left-hand) phone unit slightly. Recheck the operation of the unit. After the above adjustment has been made so that the fork will sustain vibration, check the accuracy of the clock (see Section 5N15). It may be necessary to make slight adjustments of the driver (right-hand) phone unit as described in Section 5N5. If the synchronous motor and clock do not operate, the terminal block to the block mounting studs, and place the terminal block to one side. Unsolder and tag the wire connections from the rheostat terminals. Loosen the two setscrews on the spur gear hub; then remove the gear from the rheostat shaft. Remove the clamping nut from the rheostat shaft, and remove the rheostat from its mounting bracket.

5N21. Installing the rheostat. (See Figure 5-82.) Place the rheostat in position in the bracket and install the clamping nut-on the rheostat shaft. Place the spur gear on the end of the shaft. Mesh the gear teeth with the adjoining

check the wiring, brushes, and windings of the converter. If the synchronous motor alone does not operate, but the clock does operate, check the motor wiring (Figure 5-86) and also check the starting condenser. Replace the part as a unit if it is defective.

5N20. Removing the rheostat. (See Figure 5-82.) Remove the case cover. Loosen the screws that secure the clock to the support studs. Lift the clock off the studs and place it to one side. Remove the two screws that secure gear and tighten the two setscrews that secure the gear on the rheostat shaft. Solder the wire connections to the rheostat terminals. Place the terminal block in position on the mounting studs, and install the two block retaining screws. Place the clock in position on the clock support studs, and tighten the thumbscrews that secure the clock on its studs. Install the case cover.

5N22. Removing the differential assembly. (See Figure 5-82.) Remove the rheostat (see

Section 5N20). Loosen two setscrews from the gear hub on the lower end of the differential shaft, and remove the spur gear. Remove the two rheostat bracket mounting screws. Loosen the screws securing the phonic wheel motor base to the mounting plate. Carefully raise the rheostat bracket from the base to clear the dowel pins; then remove the bracket from the differential lower shaft. Remove the differential assembly from the phonic wheel motor base. The disassembly, inspection, repair, and assembly of this differential are performed in the same manner as on the differential assembly of the master speed indicator.

5N23. Installing the differential assembly. (See Figure 5-82.) Place the differential upper shaft in position in the phonic wheel motor base. Place the rheostat bracket on the differential lower shaft. Carefully align the dowels in the plate, and position the bracket on the mounting plate. Secure the bracket with the two screws and toothed lock washers provided. Tighten the phonic wheel motor base screws. Install the spur gear on the lower end

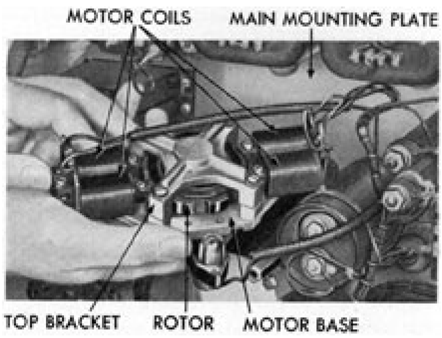
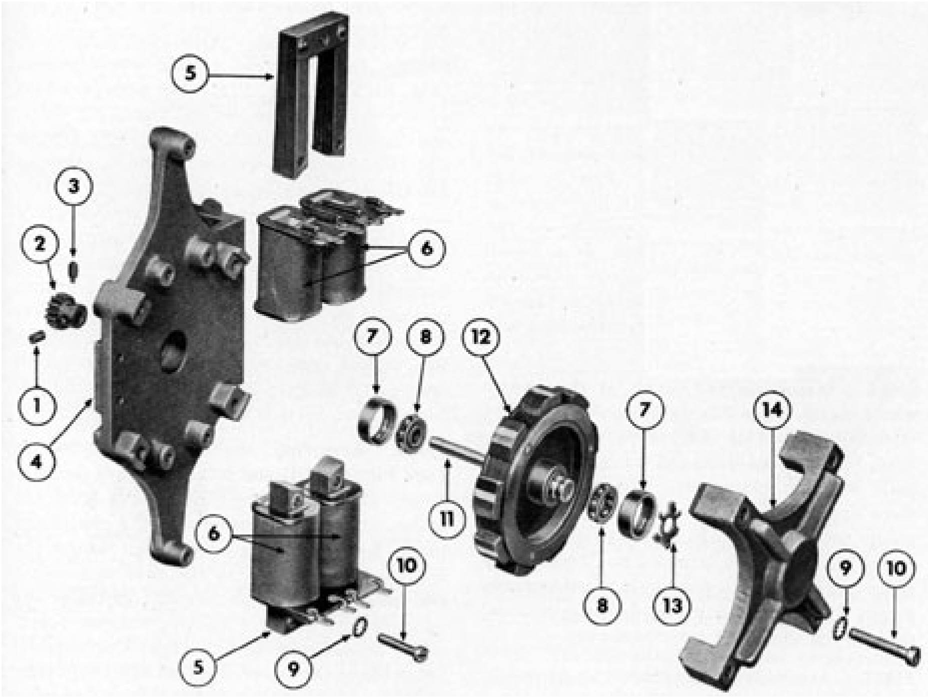


Figure 5-83. Removing phonic wheel motor.

on the rheostat bracket with the
holes



1. SET SCREW	8. BALL BEARING
2. ROTOR PINION	9. TOOTHED LOCK WASHER
3. PIN SCREW	10. SCREW
4. MOTOR BASE	11. MOTOR SHAFT
5. LAMINATED CORE	12. ROTOR
6. COILS	13. THRUST SPRING WASHER
7. OUTER RACE	14. TOP BRACKET

Figure 5-84. Phonic wheel motor disassembled.

of the differential shaft, and tighten the two gear retaining setscrews. Install the rheostat (see Section 5N21).

5N24. Removing the phonic wheel motor assembly. (See Figure 5-83.) Remove the differential assembly. (see Section 5N22). Remove the two screws and toothed lock washers that secure the phonic wheel motor base to the mounting plate, and pull the motor assembly forward away from the base. Remove the two screws that secure the neon lamp and bracket to the phonic wheel motor base, and remove the

in the outer race, and place the bearing assembly in the motor base. Carefully insert the motor shaft through the bearing and place the shaft and rotor in position in the motor base. Assemble the second bearing in its outer race, and place the bearing and race on top of the motor shaft. Place the thrust spring washer on the upper bearing with the center protruding section of the washer away from the bearing. Place the top bracket in its original position on the motor base. The original position is indicated by a scribed line marked at disassembly. Install the four screws and toothed lock washers that

lamp and bracket. Unsolder the wire leads from the cores, and tag the wires for ready identification. Lay the motor assembly aside.

5N25. Disassembly of the phonic wheel motor. (See Figure 5-84.) Remove the three screws from each coil and core assembly and remove the coils and cores from the motor base. Remove the pin screw and loosen the setscrew which secures the pinion gear on the lower end of the motor shaft, and remove the pinion. Scribe a line on the motor base and on the motor top bracket so that they may be reassembled in their original position. Remove the four screws that secure the top bracket to the motor base, and remove the top bracket from the base. The bearings may be removed from the shaft, but occasionally they stick in the base and in the top bracket. Tap the top bracket on a bench to remove the ball bearing, outer race, and thrust spring washer. Tap the motor base on a bench to remove the bearing, outer race, and bakelite washer.

5N26. Inspection and repair of the phonic wheel motor. (See Figure 5-84.) Thoroughly clean all parts with Navy-approved cleaning fluid. Replace all damaged parts. Check the coils with an ohmmeter. The coils should show approximately 350 ohms per pair. Examine the ball bearings to see that the balls rotate freely in their inner races. Remove any score marks from the motor shaft with crocus paper. If the shaft is pitted due

secure the top bracket to the motor base. Place the pinion gear on the lower end of the motor shaft. Align the pin screw holes, install the pin screw, and tighten the setscrew to secure the pinion gear on the shaft. Place the coils in position on their cores. Align the cores with the mounting base, and install the three screws that secure the cores and coils to the motor base.

5N28. Installing the phonic wheel motor. (See Figure 5-83.) Place the phonic wheel assembly in position on the mounting plate, and loosely install the two mounting screws and toothed lock washers provided. Do not install the mounting screws tightly at this time as the motor base must be raised slightly in order to get the proper clearance of the dowel pins when the differential assembly is installed. Solder the wires to the terminals on the cores. Place the neon lamp and bracket in position on the motor base, and install the two screws that secure the lamp bracket to the motor base. Install the differential assembly (see Section 5N23).

5N29. Removing the synchronous motor. (See Figures 5-81 and 5-85.) Remove the case cover. Disconnect the ground wire from the upper right-hand corner of the mounting plate. Loosen the six screws that secure the main mounting plate to the case, and swing the mounting plate to the left to make the synchronous motor mounting screws accessible. Disconnect the wires from the terminal block above the motor. Tag the wires for ready identification. Remove the four

to corrosion, replace the shaft and rotor assembly.

5N27. Assembly of the phonic wheel motor. (See Figure 5-84.) Place the bakelite washer in the motor base. Assemble the ball bearing

mounting screws and toothed lock washers from the

rear of the main mounting plate, and remove the motor. The synchronous motor is the same type of motor as the constant speed motor used in the master speed indicator. Therefore, the disassembly, inspection, repair, and assembly operations are identical with those of the constant speed motor. However, the spring tension on the slow speed shaft of the motor as used in the control unit can be reduced to a minimum.

on the mounting plate screws. Place the mounting plate in position in the case and tighten the six mounting plate retaining screws. Connect the ground wire to the upper right-hand corner of the mounting plate. Install the case cover.

5N31. Removing the tuning fork condensers. (See Figure 5-81.) These two condensers are mounted to the tuning fork base. Disconnect the wires from the terminals on, the

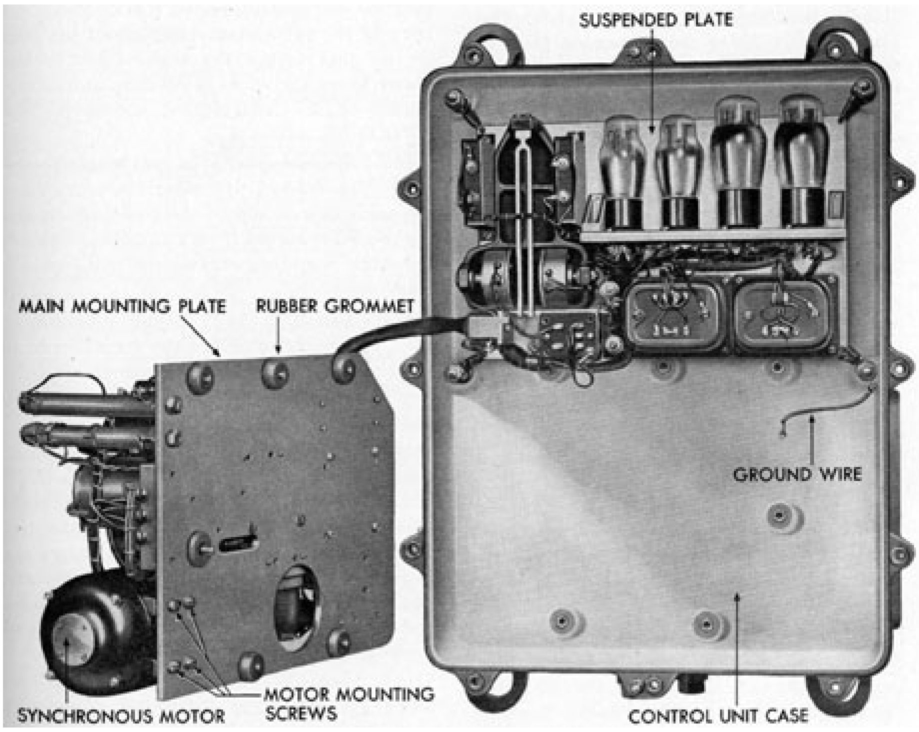


Figure 5-85. Constant frequency control unit, main mounting plate removed.

5N30. Installing the synchronous motor. (See Figures 5-81, and 5-85.) Place the motor in position on the

condensers. Tag the wires for ready identification. Remove the four screws (two to each condenser) that secure the

front of the main mounting plate. Install the four motor mounting screws and toothed lock washers from the rear side of the mounting plate. Connect the lead wires to the terminal block above the motor. Make certain that the rubber grommets are installed condensers to the tuning fork base, and remove the condensers.

5N32. Installing the tuning fork condensers. (See Figure 5-81.) Place the condenser in position on the tuning fork base, and install the two screws that secure the condenser to

the base. Place the wires on the terminals of the condenser and secure them with the terminal nuts provided. The other condenser is installed in the same manner.

5N33. Removing the suspended plate. (See Figure 5-81.) Remove the four nuts (one at each corner) that secure the suspended plate spring assemblies to the mounting studs. Lift the plate and spring assemblies from the case.

5N34. Installing the suspended plate. (See Figure 5-81.) Place the suspended plate assembly in approximate position in the case. Hook the shock-absorbing springs over the spacers on the four mounting studs, and install the four nuts that secure the springs to the mounting studs.

5N35. Removing the starting magnet. (See Figure 5-81.) Unsolder the wires from the terminals on the starting magnet. Tag the wires for ready identification. Remove the suspended plate to make the mounting screws accessible (see Section 5N33). Remove the three screws and toothed lock washers from the magnet mounting studs, and remove the magnet.

5N39. Removing the grid transformer. (See Figure 5-81.) Unsolder the wires from the terminals of the grid transformer, and tag the wires for ready identification. Remove the suspended plate (see Section 5N33.) From the back of the suspended plate, remove the four screws that secure the grid transformer to the plate, and remove the transformer.

5N40. Installing the grid transformer. (See Figure 5-81.) Place the grid transformer in position on the suspended plate. From the back of the suspended plate, install the four screws that secure the transformer to the plate. Place the wires in position on the terminals of the transformer, and solder the wires to the terminals.

5N41. Removing the output transformer. (See Figure 5-81.) Unsolder the wires from the terminals on top of the transformer, and tag the wires for ready identification. Remove the four mounting screws and lift out the transformer.

5N42. Installing the output transformer. (See Figure 5-81.) Place the transformer in position on the mounting plate. Install the

5N36. Installing the starting magnet. (See Figure 5-81.) Place the starting magnet in position on the front of the suspended plate. Install the three screws and toothed lock washers from the rear of the suspended plate to secure the magnet to the plate. Install the suspended plate in the case (see Section 5N34). Solder the wires to the magnet terminals.

5N37. Removing the phone units. (See Figure 5-81.) Remove the two screws that secure the wire identification. Remove the clamping nut that secures the phone unit to the mounting bracket, and remove the phone. The other phone unit is removed in the same manner.

5N38. Installing the phone units. (See Figure 5-81.) Place the phone unit in position in its mounting bracket and secure it with a clamping nut. Place the wires in the sockets provided in the phone unit. Secure the wires in position with the two screws provided (one for each wire). The other phone unit is installed in the same manner.

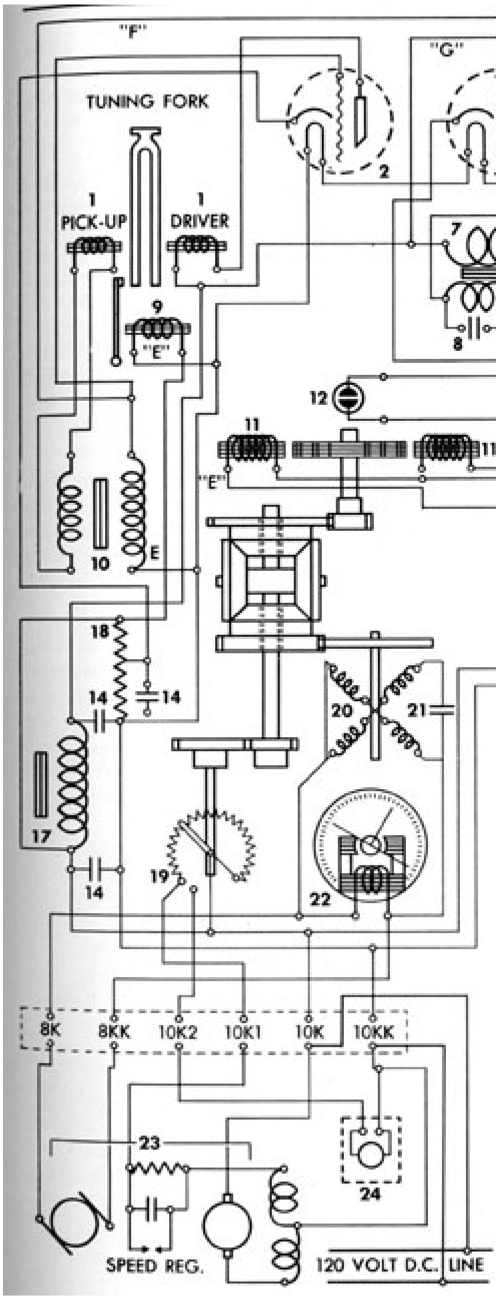
four mounting screws. Solder the wires to the terminals.

5N43. Removing the resistors from the suspended plate. (See Figure 5-81.) The 2250- and 1000-ohm resistors are located to the right of the driver phone unit. Remove the two screws (one on each resistor) that secure the resistors to the studs on the suspended plate, and lift them away from the plate. Unsolder and tag the wires for ready identification, and remove the resistors.

5N44. Installing the resistors. (See Figure 5-81.) Place the 2250- and 1000-ohm resistors in position on the suspended plate. Install the two nuts (one on each resistor) that secure the resistors to the plate. Solder the wires to the terminals on the resistors.

5N45. Removing the tuning fork. (See Figure 5-81.) The tuning fork is removed only if it is damaged. Remove the two screws that secure the tuning fork to the tuning fork base and remove the tuning fork.

5N46. Installing the tuning fork. (See Figure 5-81.) Place the new tuning fork in position



1. PHONE UNIT
2. AMPLIFIER TUBE 6J5 (G)
3. POWER TUBE, 25B6 (G) OR 25L6 (G)
4. TRANSFORMER, NO. 23882
5. RESISTOR, 50,000-OHM, 25-WATT
6. RECTIFIER
7. TRANSFORMER, NO. D21
8. CONDENSER, 0.005 MFD. OR 0.01 MFD. NOTE: 0.01 MFD. USED IN CONJUNCTION WITH POWER TUBE 25L6 (G) ONLY
9. STARTING MAGNET
10. GRID TRANSFORMER, NO. 26978
11. PHONIC WHEEL MOTOR COIL
12. LAMP
13. RESISTOR, 200-OHM, 40-WATT
14. CONDENSER, 2 MFD., 600V. D.C., 200 DEG. F.
15. RESISTOR, 100-OHM, 10 WATT
16. RESISTOR, 190-OHM, 50 WATT
17. CHOKE, NO. 23534
18. RESISTOR, 2250-OHM, 10 WATT
19. RHEOSTAT
20. SYNCHRONOUS MOTOR
21. STARTING CONDENSER, 2-2.4 MFD.
22. CLOCK, 60-CYCLE, NO HOURS HAND
23. INVERTED ROTARY

CONVERTER, 75-WATT
24. TROUBLE INDICATOR ON I.C. BOARD

Figure 5-86. Constant frequency control unit wiring diagram.

in the tuning fork base with the stamped number on the fork upward. Install the two screws that secure the fork in the tuning fork base. Instructions for calibrating the fork are furnished with each new fork.

5N47. Removing the choke. (See Figure 5-81.) Unsolder the wires from the terminals on the choke. Tag the wires for ready identification. Loosen the ground wire. Remove the plate to make the choke mounting screws accessible (see Section 5N29). Remove the choke mounting screws from the back of the suspended plate.

5N48. Installing the choke. (See Figure 5-81.) Place the choke in position on the front of the suspended plate. Install the choke mounting screws from the back of the plate. Install the main mounting plate in the case (see Section 5N30). Solder the wires to the terminals. Install the ground wire.

5N49. Removing the variable resistors. (See Figure 5-81) The two variable resistors are located on the right side of the main mounting plate above the synchronous motor. Remove the nuts from the resistor mounting, studs. Mark the position of the resistor clamps on the resistors. Unsolder the wires and tag them mounting studs. Place the resistor clamps in their original position. Solder the wires to the terminals on the resistors. Install the two nuts (one on each stud) that secure the resistors to the studs.

5N51. Removing the rectifier. (See Figure 5-81.) Unsolder the wires from the terminals of the rectifier and tag the wires for ready identification. Remove the two screws that secure the rectifier unit to the main mounting plate and remove, the rectifier.

5N52. Installing the rectifier. (See Figure 5-81.) Place the rectifier in position on the mounting plate. Install the two mounting screws. Solder the wires to the terminals on the rectifier.

5N53. Removing the 50,000-ohm resistor. (See Figure 5-81.) Mark the position of the variable resistor clamp on the resistor. Unsolder the Wires from the resistor terminals. Remove the two screws that secure the resistor mounting bracket to the plate, and remove the resistor.

5N54. Installing the 50,000-ohm resistor. (See Figure 5-81.) Place the resistor in position on the mounting plate, and install the two mounting screws. Place the variable resistor clamp in the position marked on removal. Solder the wires to the terminals on the resistor.

for ready identification. Remove the resistors from the studs.

5N50. Installing the variable resistors. (See Figure 5-81.) Place the resistors on their

6
MEASURED MILE CALIBRATION

A. CALIBRATION OF LOG ON MEASURED MILE

6A1. Purpose of calibrating log. Each complete log system is calibrated at the factory with a standard U-tube mercury manometer, having a scale graduated in knots. This scale is based on a constant determined by towing-tank experiments on a standard rodmeter. The rodmeter used with each log system has physical dimensions identical with that used in towing-tank experiments. Thus it is possible to calibrate each log system by means of the standard manometer mentioned above. The pump unit contains an orifice plug as shown in Figure 6-1, the position of which determines the calibration of the log. During factory tests this orifice plug is rotated to a position that will cause the log to indicate a speed equal to that indicated by the standard mercury manometer. The centerline on the orifice plug is then extended to the orifice plate and marked as reference point O. While maintaining the mercury deflection at a steady value, the orifice plug is rotated to either side of O for the purpose of making calibration lines at 2, 4, and 6 percent, plus and minus. The equipment is shipped from the factory with the pump setting at 0 percent. When the equipment is installed in a ship, a factory representative checks the operation of the entire system and set the pump orifice at a value that was determined during the measured mile trials of a ship of the same class. When the correction for a particular type or class of ship is unknown, the setting is left at 0 percent. No changes in speed calibration settings should be made on the shaft rpm knot data alone. The data upon which the rpm-knot table, or curve, are based were in most cases determined during the measured mile trials of the ship, or on another ship of the same class. Trial conditions can rarely, be duplicated; and even with suitable corrections for foul bottom, variations in displacement and trim, and effect of wind and sea, speed indications thus derived are worthless for calibrating the log system. Similarly, checking distance indications by comparison of log readings with distances traveled between ports cannot be used for recalibration

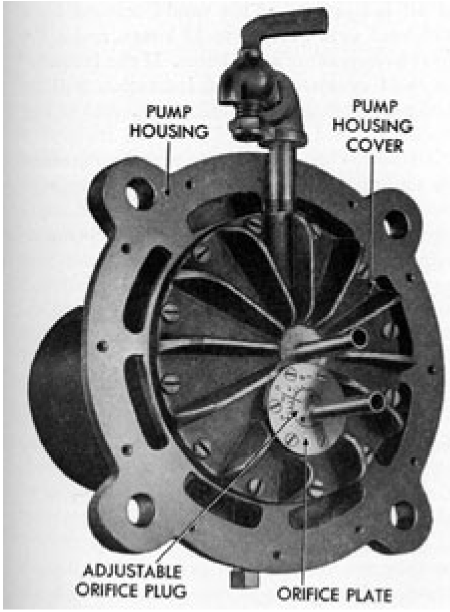


Figure 6-1. Pump orifice plate.

purposes since the current effect cannot be determined with the degree of accuracy required. Thus the most accurate and suitable method of checking the calibration of a log under actual operating conditions is to run the ship over a measured course 1 mile in length (Figure 6-2).

6A2. Preparations for checking log. If the ship is not near a standard measured mile course, it is possible to use fixed points one mile apart as shown in Figure 6-2. If possible, a location should be chosen in which the current effect is small and having a direction parallel to the axis of the ship's course. The depth of water should be at least 20 fathoms. Shallower water will prevent the ship from

developing proper speed for a given propeller shaft rpm, and the log will tend to read high when checked in shallow water because of wave systems established by the ship. Before making the runs over the measured mile, the log system should be checked for proper operation as follows:

The hydraulic system should be entirely free of air. The system should be vented as described in Section 3A3. All hose connections must be tight. Leakage at the drip fitting on the pump must not exceed three drops per minute. If leakage is in excess of this amount, the pump must be disassembled and the rotary seal inspected and replaced if required. The 3Y circuit of the master speed indicator must receive controlled 60-cycle a.c. from the constant

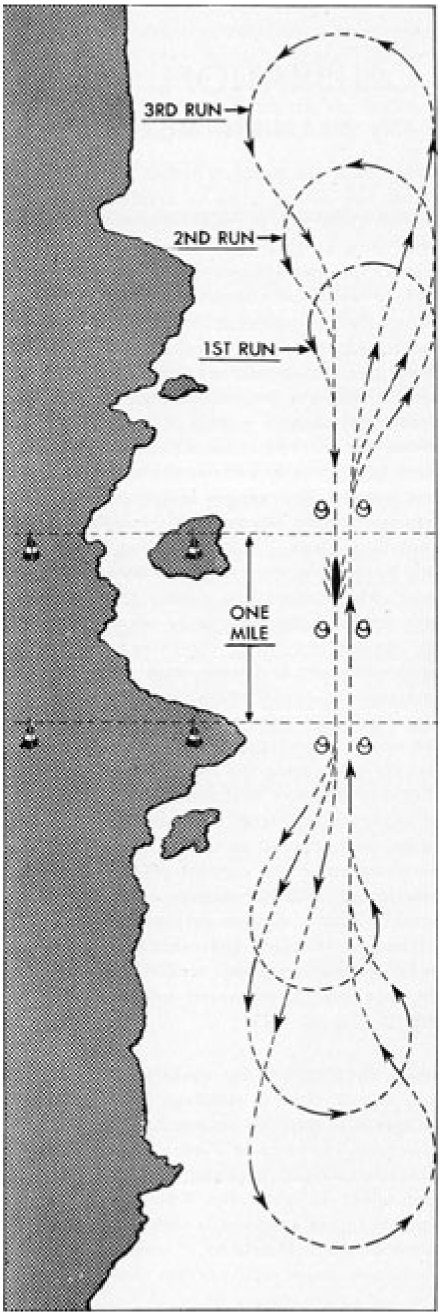


Figure 6-2. Measured mile course.

frequency supply. A frequency greater than 60 cycles will result in a proportional negative error in speed reading. A frequency less than 60 cycles will result in a proportional positive error in speed reading. For example, if the frequency is 59 cycles instead of 60 cycles, the speed indication will be 1 division high in 60, or 1.66 percent high at all indications. This would amount to a 0.25 knot over-reading at 15 knots, and a 0.4 knot over-reading at 25 knots. If the frequency is 61 cycles, the speed indication will be 1.66 percent low at all indications. As the log distance is not affected by the 3Y frequency variations, this speed error may be detected by aiming, with a reliable stop watch the registering of 1 mile on the master speed indicator distance counter while the ship is maintaining a steady speed. (This particular test need not be made on a measured mile course.) Readings should be taken of the log speed indicator during this test. The average speed calculated from the stop watch reading should check with the average of the pointer reading within 1 percent.

6A3. Operation and calculation. The ship should make three runs at each speed selected. One run should be made in each direction over the measured course, and then the first run should be repeated. As many speeds should be selected as time will permit. In general, three typical speeds - low, medium, and high - are the minimum for proper log calibration. A signal system should be used to permit observers to read and record simultaneous readings

at the propeller shaft revolution indicators, and the master speed indicator. The crew members stationed at the propeller shaft revolution indicators will read and record indications on each revolution counter at the beginning and end of each run. They should also read and record indications on the rpm pointer every 15 seconds throughout the run.

compensate for this error. Let us assume that the log averages 1.0 percent high at all speeds. Adjust the orifice plug by loosening the six screws in the orifice plate, and rotating the orifice plug clockwise, to subtract a value of 1.0 from the original setting. In the example given, the orifice plug would be moved from 0 percent to a point halfway

Calibration of Pitometer Underwater Lag on a Measured Mile

U.S.S................
Displacement: 1300 tons
Condition of Bottom: Clean (1 month out of dock)
Setting of Pump Orifice: 0%
Projection of Rodmeter: 36 inches
Relation of Underwater Sound Projector to Rodmeter: Rodmeter 3 ft. to Stbd. of Stbd. Sound Ball

Date: April 14, 1941
Place: Provincetown, Mass.
Length of Course: 1 mile
Depth of Water: 20 fathoms
Wind Direction: 180 degrees (T)
Wind Intensity: 5 knots
Direction of Sea: 180 degrees (T)
State of Sea: 1

Record and Average Data as follows:

Run No.	Ship's Course	Elapsed Time Min. Sec.	Knots Over Ground	Log Knots	Log Distance	Average rpm
1	311	3:54.0	15.39	15.20	1.01	200.0
2	131	4:06.0	14.63	15.17	.99	201.0
3	311	3:52.7	15.47	15.19	1.01	200.5

Average = Average of Run No. 1, No. 2,
No. 3 and No. 2

Average:
15.03 Knots over ground
15.18 Log knots
1.00 Log distance
200.5 Average rpm

Log Percent Error = (15.18 -15.03)/15.03 X 100 = (+) 1.0%

Crew members stationed at the master speed indicator should read and record the indications of the distance counter at the

between 0 and (-) 2.0 percent. This would be a setting of (-) 1.0 percent. Tighten the orifice plate screws securely. The orifice plug is

beginning and end of each run. They should read and record the speed pointer every 15 seconds throughout the run. The data shown above should be summarized and entered in the machinery history.

If, after measured course trials are held, the recorded data positively indicate that the log has a definite error, the orifice plug in the pump unit (Figure 6-1) may be adjusted to not to be adjusted each time the log appears to be in error. Once a setting has been properly made there should be no further occasion for changing it unless some structural alteration is made in the ship's hull forward of or near the rodmeter. A structural change may affect the pressures at the rodmeter, thus necessitating a new correction.

7
SHOP CALIBRATION

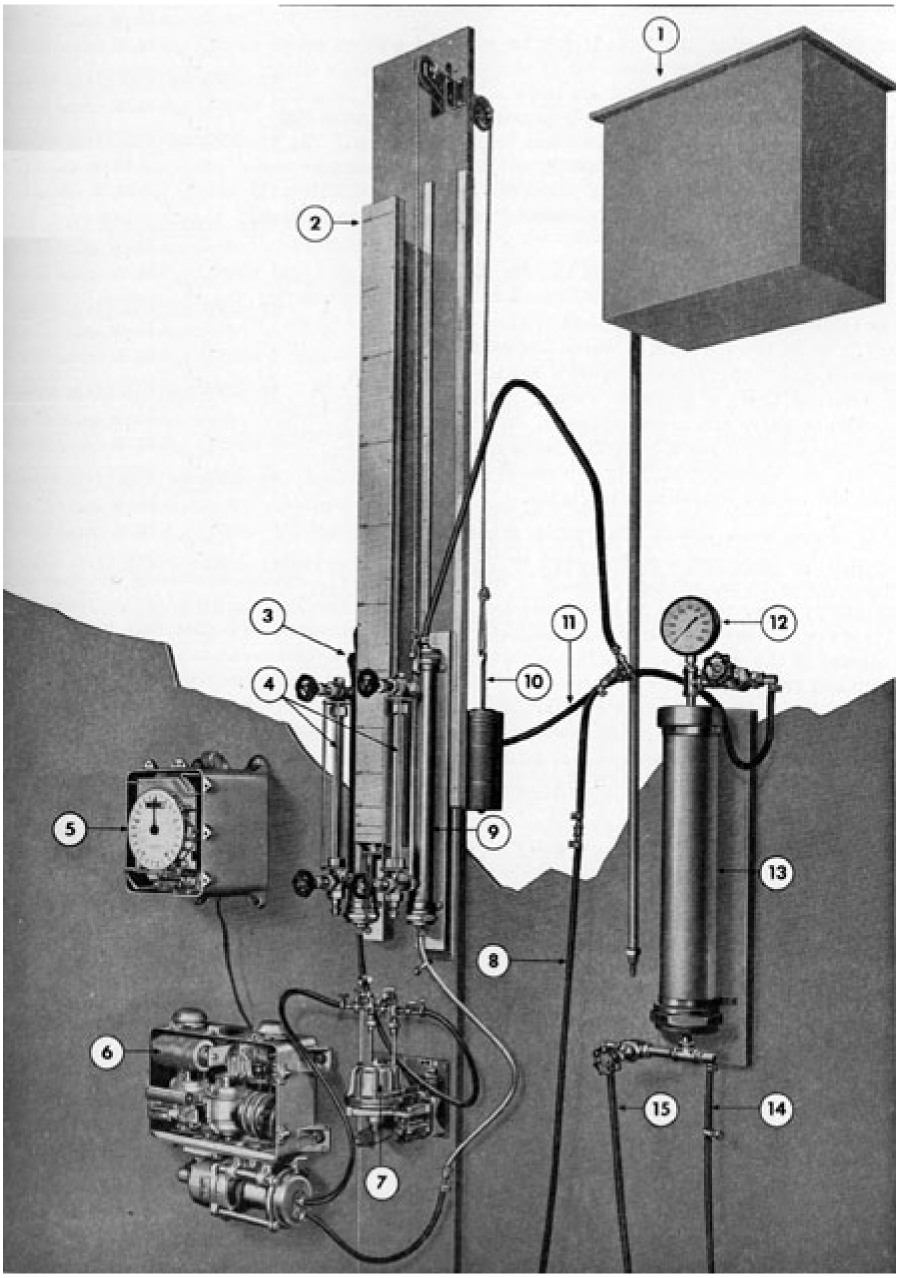
A. TEST AND CALIBRATION IN SHOP

7A1. General. The components of the pitometer underwater log that are most likely to need overhauling are the rotary pump on the rotary distance transmitter, and the control unit. The procedure generally followed is to remove these two units from the ship and overhaul them in a tender or base shop, in the manner described previously. The most practical means of checking the units before installation in the ship is to operate them in the shop under the same conditions as those encountered in service. This entails speeds up to 10 knots, under water pressures up to 200 psi. The pump should be tested for leakage at pressures up to 200 psi, and for freeness of operation, at speeds as low as 1 knot. This means that the pump should be tight enough not to leak, yet free enough to operate at low speeds. The control unit contact arm must be centered, the contacts and stop rods properly set, and the unit operated in conjunction with the pump, so that it will regulate the pump speed down to 1 knot under static pressures up to 200 psi. Any leakage or binding of the seal assembly will be evident during this operation.

7A2. Equipment required. The log equipment listed below is the minimum required:

Number of Units	Equipment	Pit. Log No.
1	Pump drive motor, complete	45-3
4	Spacer rods	S645-3
1	Motor mounting bracket (optional)	S686B
1	Motor pump coupling	No number
1	Terminal block	S1144M-1
1	Transtat assembly, complete	21-0
1	Limit switch assembly, 2 switches	S1133-1
1	Follow-up motor with driving pinion	37A
1	Follow-up motor base	K40A-1
1	Transtat mounting plate	S1140-1
1	Gear, 60 T, 24 P	S1134
2	Pinions, 16 T, 24 P	S1135
1	Gear, 72 T, 24 P	S1136

1	Transtat gear, 12 T, 24 P	S1137-1
1	Gear bracket	S1138-1
2	Pivots	S1139
1	Set (2 stacks) armature rectifier	No number
2	Rectifier brackets	S1141
1	Field rectifier	No number



1. WATER STORAGE TANK
2. KNOT SCALE
3. STATIC PRESSURE TANK
4. WATER LEVEL GAGES
5. MASTER SPEED INDICATOR
6. ROTARY DISTANCE TRANSMITTER
7. CONTROL UNIT
8. AIR COMPRESSOR LINE (OPTIONAL)
9. DYNAMIC PRESSURE TANK
10. COUNTERWEIGHT
11. AIR LINE TO STATIC PRESSURE TANK
12. PRESSURE GAGE
13. PRESSURE STORAGE TANK

14. VENT LINE
15. HAND PUMP PRESSURE LINE

Figure 7-1. Shop calibration equipment.

for properly testing the log. It can be assembled and installed by personnel of tender and base shops from readily available material. Because the entire rotary distance transmitter rarely needs to be removed from the ship for overhaul, for shop use it will be necessary to provide a duplicate pump drive motor with the speed control connected to operate from the control unit.

Any or all of the above parts may be ordered from the Pitometer Log Corporation. The following hydraulic equipment is necessary: a water storage tank, or water line with connection, a static pressure tank, a dynamic pressure tank, a pressure storage tank, a pressure gage, and air compressor, water level gages, a knot scale, hydraulic hoses, and fittings and connections. This equipment is described in the following paragraphs.

7A3. Pump drive motor. The pump drive motor is the same model as that used on the ship. It may be mounted on a bench so that the pumps under test can be easily attached. If it is desired that the master speed indicator be tested in the shop in conjunction with the pump and control unit, the slow speed end of the motor may be geared in a 6 to 1 ratio to a self-synchronous transmitter, while the mileage counter shaft is geared in a ratio

be verified before using this equipment. However, with a correct scale, this equipment may be used on other types of logs operating on the principle of pressure differences from a rodmeter. The scale should be mounted so that it can be shifted up and own approximately 6 inches. The distances to be marked above zero, and the corresponding knot speeds are as follows:

Knot Speed	Distance Above Zero
1	0.58 in.
2	2.32 in.
3	5.22 in.
4	9.29 in.
5	14.52 in.
6	20.88 in.
7	28.42 in.
8	39.17 in.
9	46.98 in.
10	58.00 in.

In any case: distance (inches) equals 0.58 x (knots)^2.

7A6. Pressure tanks. (See Figure 7-1.) Two pressure tanks are mounted one on each side of the knot scale. The tank on the right side supplies dynamic water pressure. The left-hand tank supplies static water pressure. Provision is made for raising and lowering the right-hand (dynamic) tank, while the left-hand (static) tank is stationary. When the

of 36 to 1 from the slow speed shaft of the pump drive motor.

7A4. Transtat and rectifiers. The transtat assembly and rectifiers may be mounted in an out-of-the-way place with the three wires brought out for connection to the control unit. Power is obtained from 115-volt, 60-cycle a.c. and is connected to terminals 1 and 3 of the transtat.

7A5. Knot scale. (See Figure 7-1.) The knot scale is laid off from the values listed below and is preferably made of metal. The marks are cut with a milling machine so that the distances from the zero line can be measured accurately. This scale is suitable only for use with fresh water in tanks and system, and should be used only for units using the Pitometer rodmeter. Pressure values from rodometers of other manufacturers may differ from the pressures prescribed here and should

dynamic tank is elevated above the static tank, the head, or difference of level of water, creates a pressure difference which is equal to dynamic pressure at some known speed. Water level gages are mounted in front of the pressure tanks and show the exact level of water in each tank. The knot scale mounted between these pressure tanks is calibrated in knots, and enables the water level to be read closely, even at low speeds. The tanks are made of 3- or 4-inch heavy-duty pipe, approximately 18 inches long with heavy threaded caps at each end. The glass tubing and gage fittings should be able to withstand a pressure of 400 psi for safety. Shut-off cocks should be mounted on the lower ends, ahead of the nipples. Nipples only are required at the top. When mounted as shown in Figure 7-1, the left-hand (static) tank is connected to the

static line. The right-hand (dynamic) tank is suspended on a chain, or cord, that is connected to a counterweight so that it may be moved up or down. The tanks should be mounted so that the zero water level is at least 3 feet above the control unit bellows and the rotary pump. However, the shop ceiling may be the determining factor, and may not permit raising the dynamic tank to the 10-knot mark on the scale. In this case the distance of the zero water level above the bellows will have to be less than 3 feet.

this may make it necessary to reset the contacts later.

7A9. Testing equipment at surface pressure. (See Figures 7-2 and 7-3.) To operate the units at normal surface pressure, set the valves and vent cocks of the control unit to the operating position as shown in Figure 3-3. Vent both the static and dynamic tanks to the same level at the zero point on the knot scale. The top connections of the tanks are open to the atmosphere. Energize the pump motor power supply. Raise the dynamic tank to the knot mark

7A7. Water and air connections. (See Figure 7-1.) The hose connecting the dynamic tank to the lower nipple of the pump must be long enough to permit the dynamic tank to be raised to the extreme upper position of 10 knots. The nipples on the upper ends of the tanks are connected together, and the hoses are so arranged that they can be connected to a water supply line, or to a water storage tank, mounted from 8 to 12 feet above the tanks. It should also be possible to connect these hoses to a pressure line capable of delivering a pressure of at least 100 pounds per square inch. A pressure storage tank mounted as shown in Figure 7-1 permits the use of higher pressures which are developed in the top of the tank when water is pumped up into it from below by a hand pump, or when air is pumped into the top of it from an air compressor. An air pressure gage should be mounted on either the dynamic or static tanks, on the common air line, or on the pressure storage tank. Connect the left-hand nipple of the control unit to the center nipple on the pump; the outer pump nipple to the bottom of the dynamic tank, and the right-hand nipple of the control unit to the bottom of the static tank.

7A8. Preparing equipment prior to testing; Fill both tanks nearly to the top and vent the control unit and pump thoroughly as described in Section 3A3. Close the left-hand valve of the control unit, open the bypass valve, and proceed to center the external contact arm, set contacts, and desired. If adjusted properly, the control unit should control the pump speed and cause the transtat arm to regulate, even at speeds of 1 and 2 knots. Lowering the dynamic tank to the zero mark should cause the pump to stop, and the transtat arm to return to the zero voltage position.

7A10. Testing equipment, submerged condition. (See Figure 7-1.) Connect the common pressure hose at the top of the tanks to a controllable supply of air pressure, preferably from the pressure storage tank (Figure

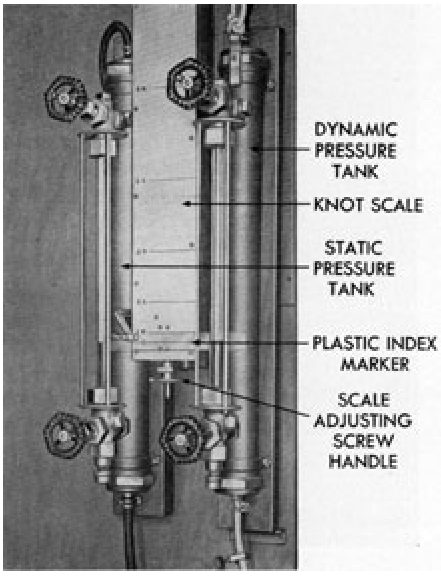


Figure 7-2. Pressure tanks at zero position.

set the stop rods as described in Chapter 5. It is advisable to have at least 3 feet of water above the control unit while making adjustments. Less head than

7-1). Apply air slowly, and test at steps of 50 psi. Because of hose expansion with pressure, the water level in the tanks may change and the zero of the scale may have to be slightly lowered. Raise the dynamic tank to the desired knot mark on the scale and note the operation of the units. Pressures beyond 200 psi are unnecessary if the parts operate satisfactorily up to this pressure. The pump seal bellows should tighten and not leak at 200 psi, while no leakage should be evident at any part of the control unit. The pump should not be so tight that it stalls at 1 or 2 knots, but should be turning over smoothly at 3/4 of a knot without excess hunting of the transtat arm. If the test under pressure (submerged condition) is satisfactory, release the air pressure from the top of the tanks. Do not release the air by opening the vent cocks on the control unit. Again test the equipment with only atmospheric pressure on the water in the tanks. The units should start and stop freely as before. However, if the bellows has not been properly aged as described in Section 5K23, it may be necessary to reset the contacts and stops, and perhaps to recenter the contact arm. If this has to be done, recheck for proper operation. When the performance is satisfactory, the equipment under test may be installed in a ship. It should not be necessary to make any further adjustments on the ship.

7A11. Additional tests. An operation test under at least 100 psi, at 4 or 5 knots, should be run for 10 to 15 hours if possible. The dynamic tank should be lowered and raised at intervals during this run to determine whether the units stop and start correctly. When the pump alone is being repaired, it can be run at various speeds under pressure to determine whether or not it leaks. However, it will not be possible to determine whether it is sufficiently free at very low speeds, and it is recommended that it be run in conjunction with the control unit at these speeds whenever possible. A static test of 100 to 200 psi of water pressure may be placed on the control unit alone to test for leaks; but this shows up

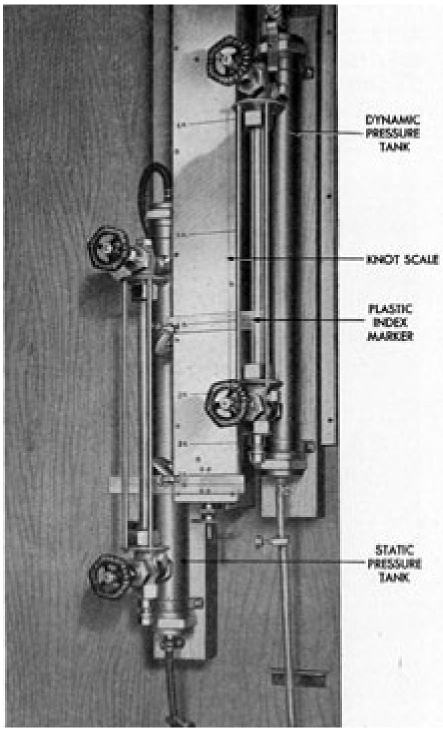


Figure 7-3. Dynamic pressure tank of 4-knot position.

leaks only, it will not test for proper operation under pressure.

7A12. Preparation for pump calibration. The procedure outlined previously for testing the control unit and pump together, with a water column as a standard can also be used to check the accuracy of the log speed and distance indications. If the control unit contacts have been adjusted as previously outlined, and the pump impeller clearances maintained, the accuracy of the log should not be changed from the previous calibration. However, there are times when an over-all check for accuracy is desirable. This is particularly true when a new impeller and shaft or a new thrower disk have been installed in the pump, causing a possible change in clearances between the impeller blades and the pump cover. The incorrect setting of contacts on the control unit will cause considerable error at low speeds. If the pump only,

but not the entire rotary distance transmitter, is removed from the ship at this time, it will be necessary to gear the slow speed end of the pump drive motor with a 6 to 1 ratio to a self-synchronous transmitter, to transmit rotary distance to the master speed indicator. The interior unit of the master speed indicator is removed from the ship and connected to the previously mentioned transmitter. The 115-volt supply connected to the 3Y terminals must be of exactly 60 cycles frequency.

agree within 0.1 knot, it should be first checked as described in Section 5M52, before an attempt is made to change the pointer setting. Using the average speed indication from above as the standard reference point, shift the orifice plug to the other marks, plus and minus 2, 4, and 6 percent. Tighten the orifice plate each time before making a test. It will not be necessary to time each setting if the master pointer is read carefully. For example: The speed reading may be 10.05 when the orifice is on zero, and should be 10.25 for +2 percent, and 10.45 for

7A13. Pump calibration. The system is thoroughly vented and is run at speeds of 2, 5, and 10 knots, with atmospheric pressure on the water in the pressure tanks. There is no need to check calibration under pressure. To make a check at 10 knots, for example, the following operations are performed: Note the position of the pump orifice plug (Figure 61). Loosen the orifice plate and set it on the zero percent mark, and tighten the plate retaining screws. Using an accurate stop watch, time the mileage counter on the master speed indicator for exactly 1 mile, noting the reading of the speed pointer every 30 seconds. The time should be close to 360 seconds. Calculate the percentage of error from the following formula:

(Seconds deviation from 360 x 100)/360 = percent of error

If the time is less than 360 seconds, the pump is high, or fast. If the time is more than 360 seconds, the pump is low, or slow. The true speed reading is more or less than 10 knots by the percentage calculated. Average the speed readings taken above. They should indicate the same percentage deviation, if any, from 10 knots as was calculated for the pump. At 10 knots, 0.05 knot is 0.5 percent, 0.1 knot is 1 percent. If the master speed indicator indications do not agree with the calculated speed, the error is either due to the 3Y constant frequency supply not being exactly 60 cycles, or to the master speed indicator not being in exact calibration. This test is +4 percent, and 10.65 for +6 percent. Shift the orifice plug to the original setting as found on the ship when the above tests are completed. The error at zero pump setting should be within plus or minus 1/2 percent, and within 3/4 percent at the other points.

If the error is greater than this, it maybe necessary to re-mark the orifice plate. To remark the place, first file off, or cut off, the old lines. With the static water level carefully set at zero knots and the dynamic water level at 10 knots, shift the orifice plug to get a timed accuracy of plus or minus 2 percent. Be certain that the orifice plate screws are tight. This setting will be the new "zero" point, and a thin line should be described on the plate opposite the index line of the plug. Shift the plug to obtain plus and minus marks of 2, 4, and 6 percent from indications of the master speed indicator.

Unless the pump error has been found to be considerable, it will be evident that it is unnecessary to recalibrate the pump. The correct registration of speed and distance by the instrument as installed in the ship and in actual service is the criterion of the log accuracy. Because so many factors other than the pump calibration affect the over-all accuracy, it is preferable to attempt to calibrate the log on a measured mile course as described in Chapter 6, rather than spend considerable time on the equipment in the shop. If the pump and control unit have met the requirements mentioned previously in this chapter, little trouble may be expected from the log in actual service.

made primarily to check the
pump accuracy and if the master
does not

Previous Chapter Sub Log Home Page Next chapter

8
ELECTRICAL CIRCUITS

A. LOG ELECTRICAL CIRCUITS

8A1. Types of circuits. (See Figure 8-1.) All electrical circuits that connect to the underwater log are known as Y circuits. All underwater logs, regardless of the manufacturer or type have circuits as follows:

1Y - Speed transmission circuit
2Y - Distance transmission circuit
3Y -Constant frequency supply
2Y100 - Distance transmission to dead reckoning analyzer

8A2. 1Y circuit. (See Figure 8-1.) The speed pointer shaft of the master speed indicator drives the transmitter motor for the 1Y circuit. The movement of the pointer shaft positions the rotor of the transmitter in a corresponding angle, and thus positions the repeater motor which rotates to the same angle. The R^1 and R^3 internal connections in the speed and distance indicator speed repeater are reversed because the transmitter is actually rotated in a reverse direction to the pointer in the master speed indicator. The transmitter also feeds into the speed corrector in the gyrocompass, and the speed master speed indicator, and one in the speed and distance indicator. The circuit from the rotary distance transmitter to the speed and distance indicator passes through the repeater switch on the A.C.O. board. In addition, this circuit supplies power to the pump drive motor (through the transtat, armature rectifiers, and field rectifiers). Connection to the motor circuit is made through two jumpers to terminals 2Y1 and 2YY1.

8A4. 3Y circuit. (See Figure 8-1.) The 115 volt 60 cycle a.c. supply driving the synchronous motor in the master speed indicator is the 3Y circuit. As the entire speed calibration of the log depends on the operation of this motor at constant speed, the 3Y frequency must be held to 60 cycles. To permit the operation of the log if the constant frequency control unit should fail, a selective switch is usually provided that permits the 3Y circuit to operate from the ship's a.c. supply. On some of the latest submarines the ship's a.c. supply is considered accurate enough, and no constant frequency control unit is provided.

8A5. 2Y100 circuit. The right-hand self-synchronous motor in the rotary distance transmitter transmits rotary distance at the

input in the torpedo data computer.

8A3. 2Y circuit. (See Figure 8-1.) The 2Y circuit is the basic circuit in the Pitometer log, as rotary distance is first obtained in the rotary distance transmitter and is later changed to a speed indication in the master speed indicator.

The 2Y circuit supplies 110-115 volts a.c. to the distance transmitting motor in the rotary distance transmitter, and its associated repeating motors, one of which is in the rate of 360 revolutions per mile into the 2Y100 circuit. This is connected only to the distance input repeater motor in the dead reckoning analyzer, and not to the tracer of the tracking table. This circuit switch is generally located on the gyro control board, rather than on the I. C. board.

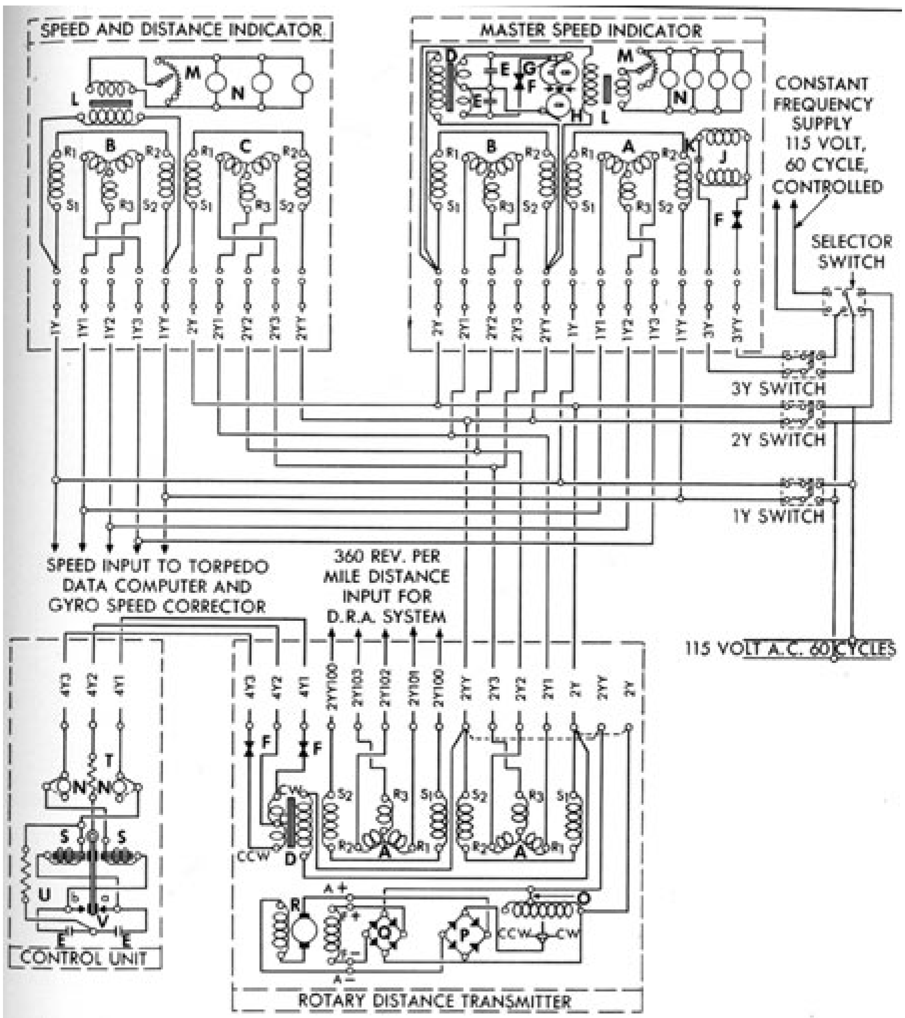


Figure 8-1. Log wiring circuit diagram.

A- SELF-SYNCHRONOUS TRANSMITTER, TYPE B&C
B- SELF-SYNCHRONOUS

M- RHEOSTAT, 25-WATT, 30 OHM
N- LAMPS, NAVY TYPE

REPEATER, TYPE M
C- SELF-SYNCHRONOUS REPEATER, TYPE N
D- FOLLOW-UP MOTOR (BARCOL)
E- CONDENSER, .5 MFD.
F- LIMIT SWTICH, NORMALLY CLOSED
G- SLIP RING AND CONTACT ASSEMBLY
J- SYNCHRONOUS MOTOR (BODINE) 1800 R P M
K- STARTING CONDENSER, 2-2.4 MFD.
L- TRANSFORMER, 5 VA.
O- TRANSTAT ASSEMBLY
P- ARMATURE RECTIFIER
Q- FIELD RECTIFIER
R- PUMP DRIVE MOTOR
S- ANTI-HUNTING COIL
T- RESISTOR, 100-OHM
U- RESISTOR, 1000-OHM
V- CONTACTS

9
LUBRICATION

A. LUBRICATION OF PITOMETER UNDERWATER LOG SYSTEM

9A1. Purpose. The following illustrations show the various points of the log system that require lubrication. The type of lubricant, approximate amount, and the service interval is also listed with each illustration. Proper lubrication service will increase the operational efficiency of the equipment, and prevent premature failure of the parts due to wear.

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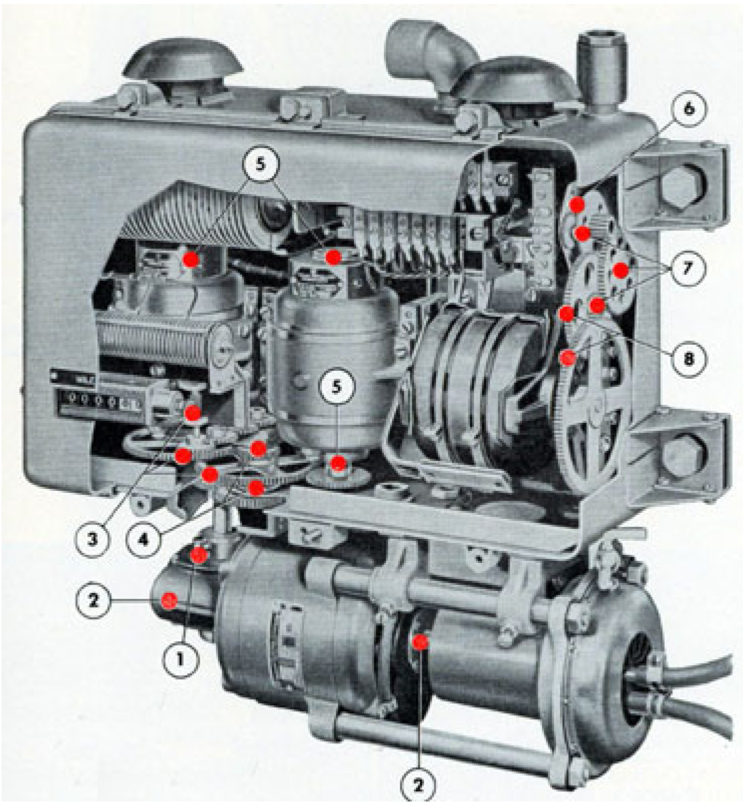


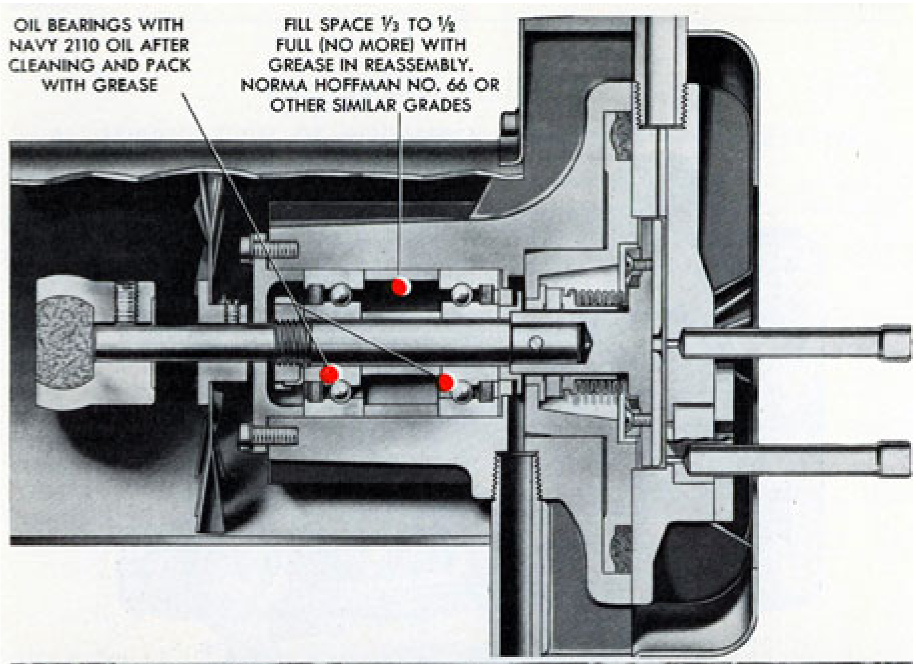
1. 8 OR 10 DROPS OF OIL (NAVY 3050) IN OIL CUP, EVERY 6 MONTHS
2. REPACK MOTOR BALL BEARINGS, AND REFILL REDUCTION GEAR CASE WITH NORMA-HOFFMAN GREASE NO. 66, OR SIMILAR GRADES WHENEVER MOTOR IS DISASSEMBLED
5. 2 OR 3 DROPS PURE SPERM OIL OR NAVY 2110 OIL IN TRANSMITTER BEARINGS, EVERY 12 MONTHS
6. 2 DROPS OF OIL IN MOTOR BEARINGS (NAVY 2110) EVERY 6 MONTHS
7. 2 DROPS OF OIL (NAVY 2110) BETWEEN WASHERS AND GEAR, EVERY 6 MONTHS

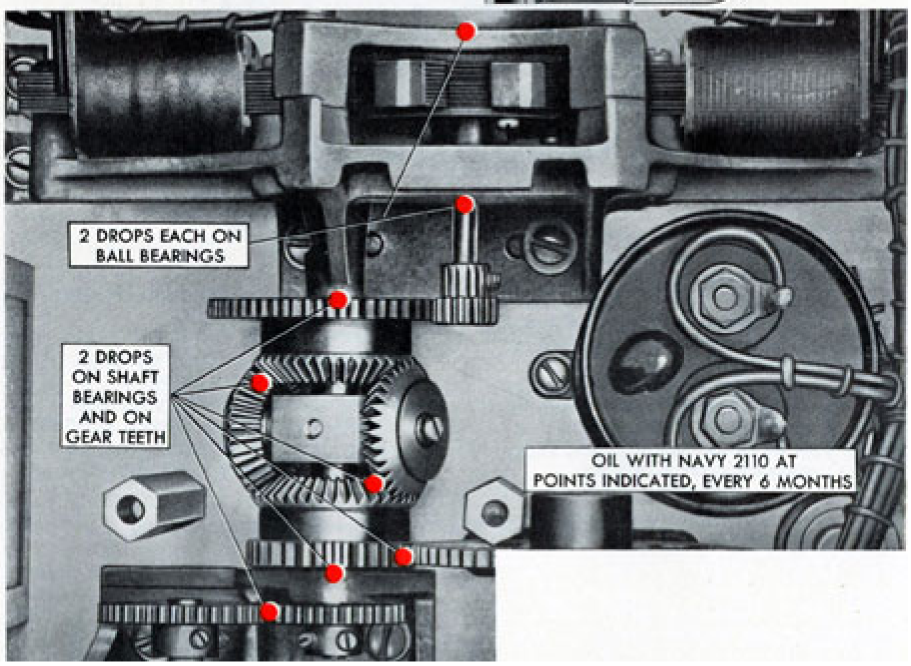
3. 2 OR 3 DROPS OF OIL (NAVY 2110) ON GEARS, COUNTER WORM SHAFT AND BEARINGS, EVERY 6 MONTHS

4. 3 DROPS OF OIL (NAVY 2110) IN EACH BEARING, EVERY 6 MONTHS

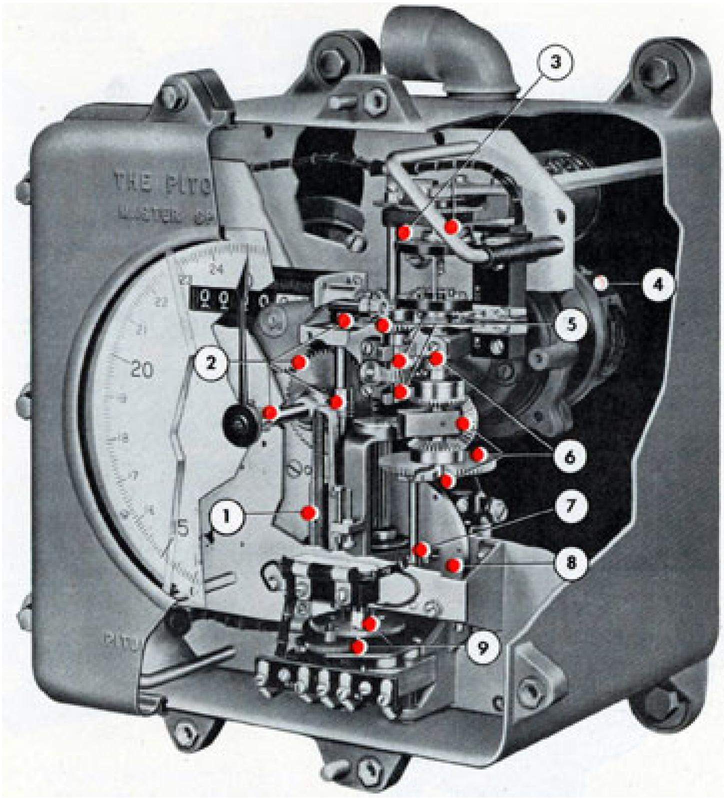
8. 2 OR 3 DROPS OF OIL (NAVY 2110 ON GEAR TEETH, EVERY 6 MONTHS

Figure 9-1. Lubrication points, rotary distance transmitter





Top-Figure 9-2. Lubrication points, rotary pump.
Bottom-Figure 9-3. Lubrication paints, constant frequency control unit.



OIL AT POINTS SHOWN WITH NAVY 2110 OIL, EVERY SIX MONTHS, EXCEPTION IS THE BALL BEARINGS ON REPEATER AND TRANSMITTER, WHICH SHOULD BE OILED EVERY 12 MONTHS WITH PURE SPERM OIL.

1. 2 OR 3 DROPS IN LEAD SCREW YOKE OIL HOLE
2. 2 OR 3 DROPS

1 OR 2 DROPS AT ENDS OF JACKSHAFT AND FOLLOW-UP SHAFT. KEEP OIL AWAY FROM CONTACTS AND SLIP RINGS

4. 2 DROPS IN TRANSMITTER AND REPEATER BALL BEARINGS SEE INSTRUCTIONS.
5. 2 DROPS ON SHAFT BEARINGS AND ON GEAR TEETH
6. 2 DROPS IN DIFFERENTIAL BEARINGS, AND ON ALL GEAR TEETH
7. 2 DROPS ON ROLLER, PIVOT AND ROD
8. 5 DROPS SPREAD OVER DISK
9. 2 DROPS IN EACH MOTOR BEARING AND IN ALL GEARS

Figure 9-4. Lubrication points, master speed indicator.

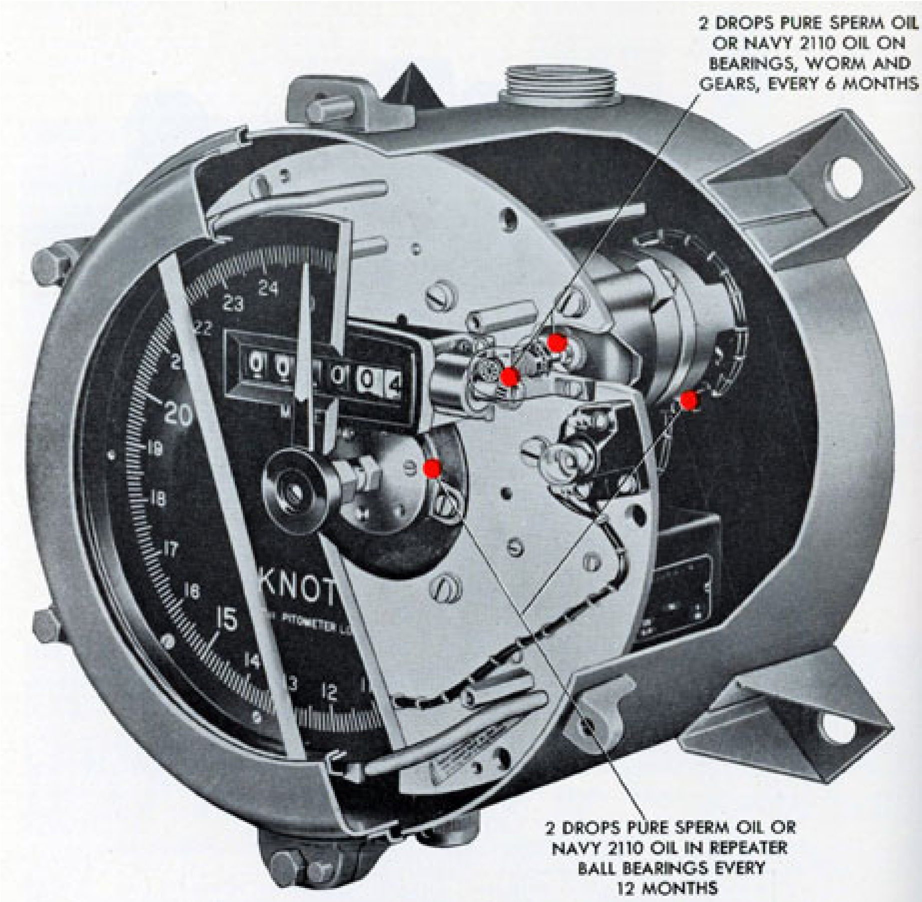


Figure 9-5. Lubrication points, speed and distance indicator.

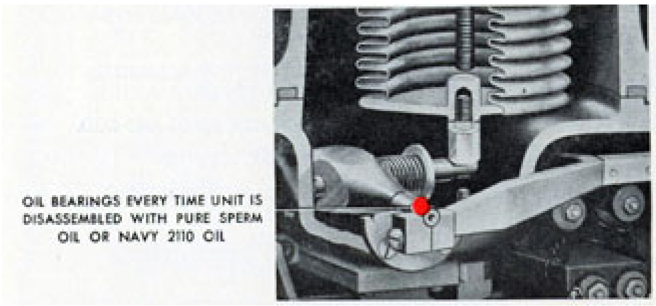


Figure 9-6. Lubrication points, control unit.

PART 2

BENDIX UNDERWATER LOG

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10 DESCRIPTION

A. GENERAL DESCRIPTION

10A1. General. The Bendix Underwater Log is made by the Bendix Aviation Corporation, Marine Division, Brooklyn, New York. This system (Figure 10-2) consists of four major components. Each instrument is watertight, and is designed for either panel or bulkhead mounting.

10A2. Rodmeter. The rodmeter (Figure 10-1), commonly called the sword, is located in the forward torpedo room below the light draft water line. It projects through the hull of the ship, into the water, and is the unit in which static and dynamic pressures are produced and transmitted to the other units of the system. When in use, the rodmeter extends about 3 feet into the water. Being located in the forward part of the ship, the rodmeter contacts water that is least affected by the movement of the ship or by the turbulence of the water created by the action of the propellers.

10A3. Sea valve. The sea valve and extension form a support for the rodmeter and provide a means of closing the opening through which the rodmeter passes when the rodmeter is withdrawn, or fully housed. It is located in a well below the deck in the forward torpedo room, and is bolted to the inner hull below the light draft water line. A tube extends from the underside of the inner hull to the outer hull where it is welded to a flange and guide bushing. The guide bushing forms the lower support for the rodmeter. When the rodmeter is withdrawn, the closing of the sea valve prevents sea water from flooding the forward torpedo room.

10A4. Master transmitter indicator. The master transmitter indicator (Figures 10-3 and 10-4) is mounted inside the ship in the forward torpedo room, 4 feet or more below the light draft water line of the ship. The instrument

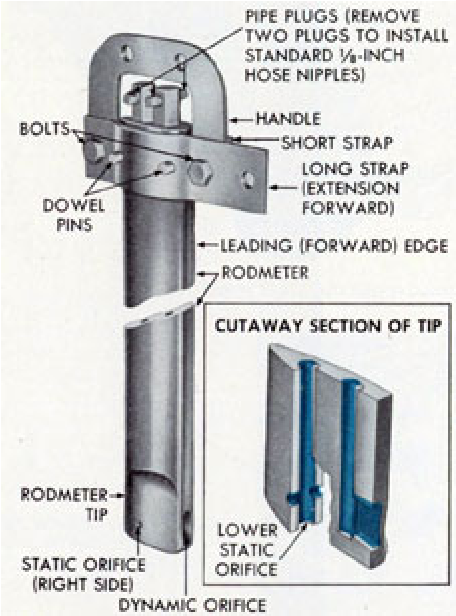


Figure 10-1. The Bendix rodmeter.

consists of electro-mechanical linkages, known as the log mechanism, mounted inside the case, and a bellows assembly mounted below the case. The bellows assembly is divided into chambers. The upper part of the bellows chamber is hydraulically connected to the static tube in the rodmeter by means of flexible hose and copper tubing. The lower part of the bellows chamber is connected to the dynamic tube in the rodmeter in the same manner. Flexible tubing permits lowering the bellows assembly from the case without disconnecting the tubing. The movement of the bellows rod, caused by dynamic pressure, actuates a spring-loaded balance arm mechanism which develops the force applied to equalize the dynamic pressure produced within the rodmeter. The movement of the balance arm operates electrical contacts which control a main drive

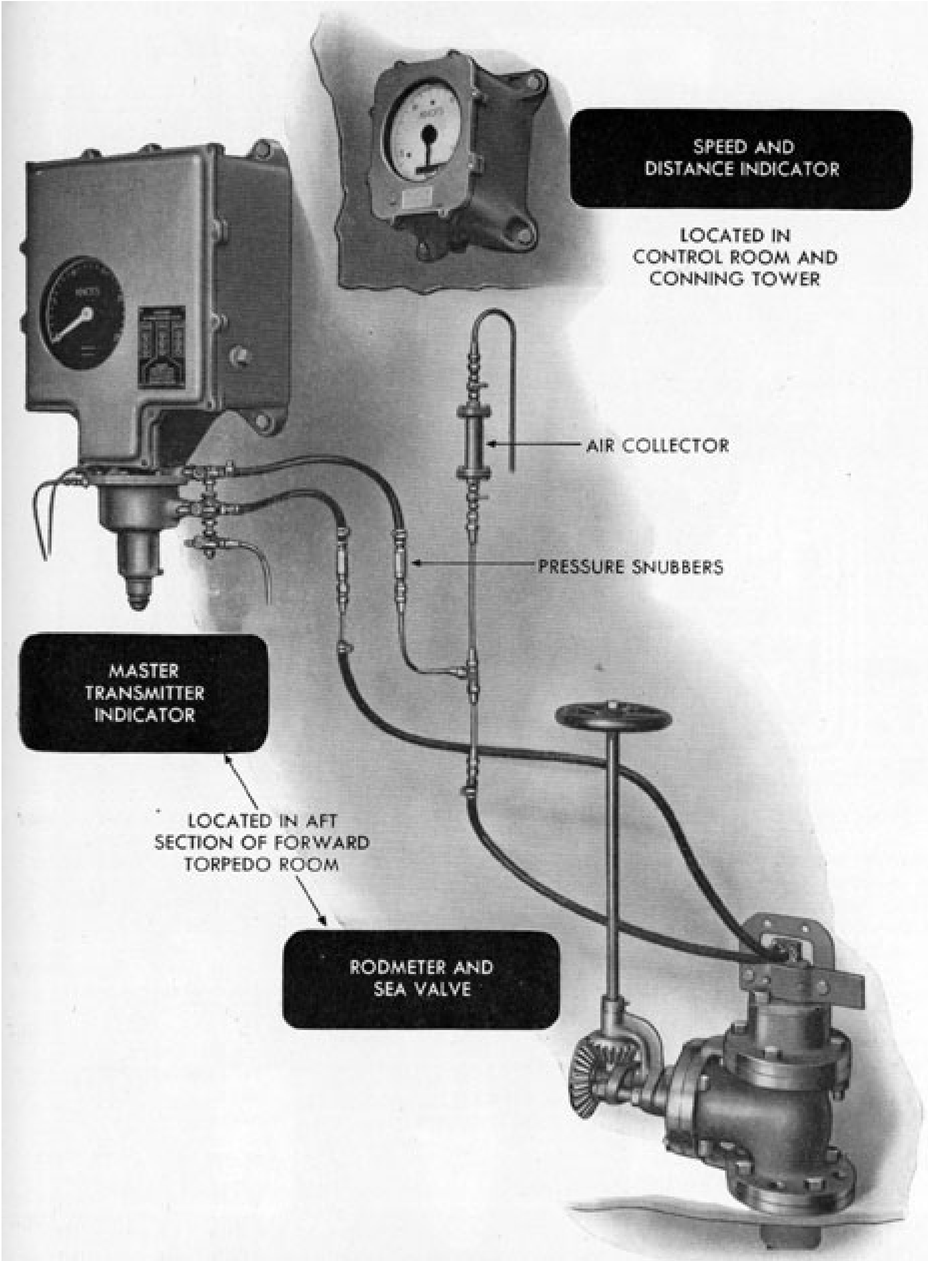
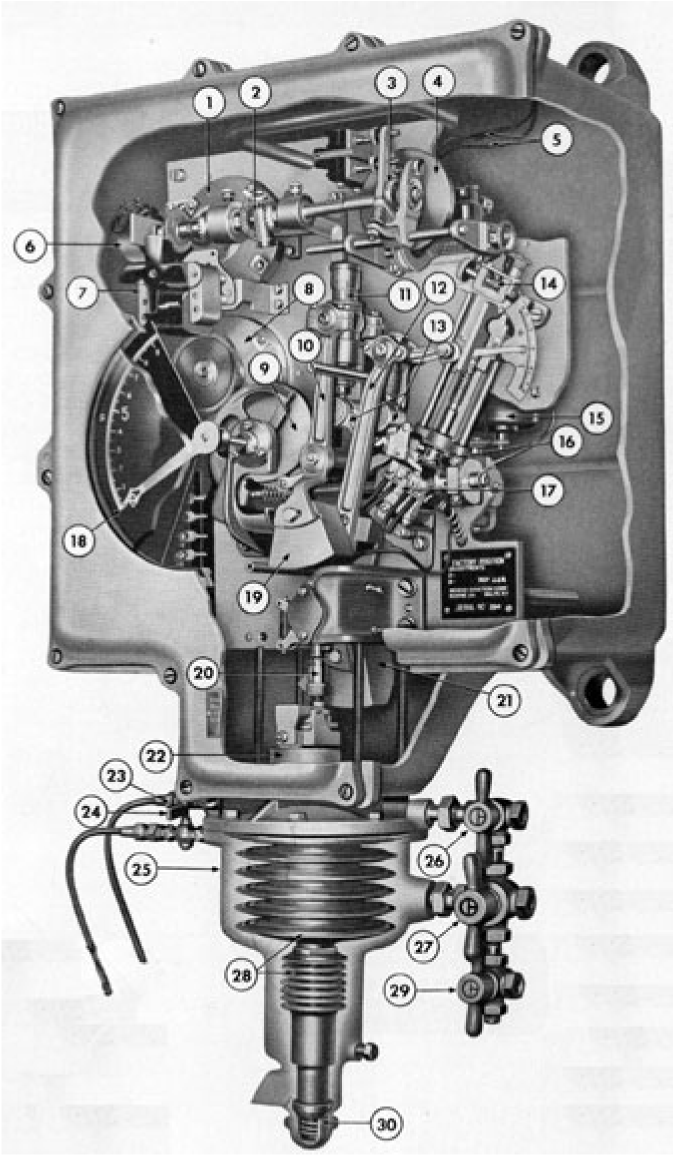


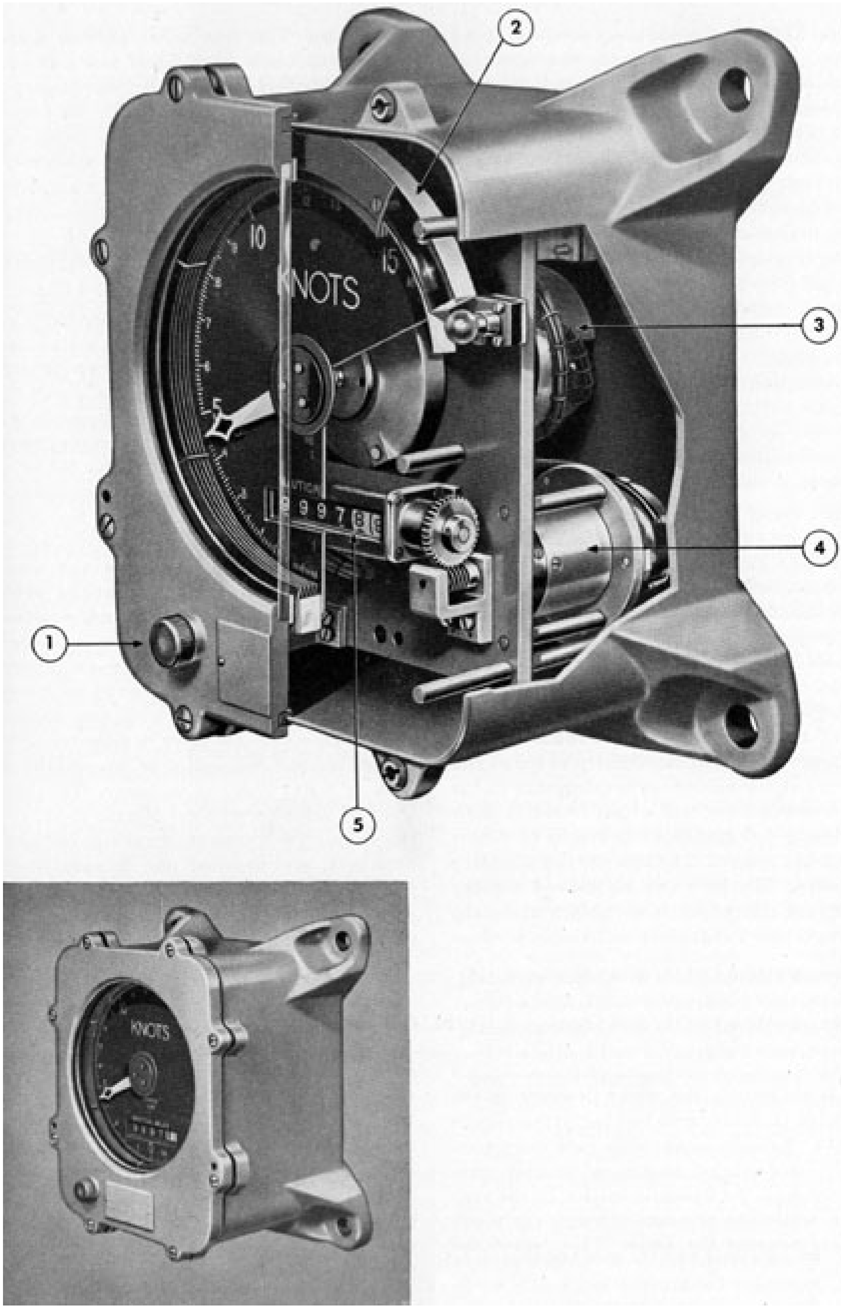
Figure 10-2. Components of Bendix underwater log system.



1. SELF-SYNCHRONOUS DISTANCE TRANSMITTER
2. DIFFERENTIAL ASSEMBLY
3. FOLLOWER
4. ROTATING DISK
5. LEADS TO CONSTANT SPEED MOTOR
6. RHEOSTAT
7. FOLLOW-UP MOTOR (TORQUE AMPLIFIER)
8. SELF-SYNCHRONOUS SPEED TRANSMITTER
9. CAM
10. MAIN FORCE ARM
11. A ADJUSTMENT ASSEMBLY
12. AUXILARY BALANCE ARM
13. MAIN BALANCE ARM
14. B ADJUSTMENT ASSEMBLY
15. POWER MOTOR
16. CONTACT ARM ASSEMBLY
17. CONTACT ASSEMBLY
18. POINTER
19. MAIN FORCE ARM COUTNERWEIGHT
20. C ADJUSTMENT ASSEMBLY
21. MAIN BALANCE ARM COUNTERWEIGHT
22. ROTATING CONTERWEIGHT
23. STATIC DRAIN COCK
24. DYNAMIC DRAIN COCK
25. BELLOWS CHAMBER
26. STATIC MANEUVERING COCK
27. DYNAMIC MANEUVERING COCK
28. BELLOWS
29. DRAIN MANEUVERING COCK
30. DIVE ERROR COMPENSATING ASSEMBLY

Figure 10-3. Master transmitter indicator.

Figure 10-4. OPERATION OF THE MASTER TRANSMITTER INDICATOR



1. ILLUMINATION INTENSITY CONTROL KNOB
2. RINGLIGHT SECTOR
3. SELF-SYNCHRONOUS SPEED REPEATER
4. SELF-SYNCHRONOUS DISTANCE REPEATER
5. DISTANCE COUNTER

Figure 10-5. Speed and distance indicator.

motor. Through mechanical linkage a speed pointer is turned to indicate the speed of the ship

miles. The four other number wheels are colored black with white numerals, and indicate

in knots. This speed indication is electrically transmitted to the speed and distance indicators, or repeaters. By means of a controlled time element, the motion of the mechanism is transposed from a speed indication to a distance indication, and this distance indication is electrically transmitted to the repeaters where it is registered on a six-place odometer, or counter. The log mechanism is mounted on a single brass plate which permits the removal of the entire mechanism from the case as a unit. The case and mounting plate are equipped with plug and jack units so that electrical connections need not be disturbed when removing the mechanism from the case. The complete instrument is rubber shock-mounted.

10A5. Speed and distance indicators. One of the two speed and distance indicators (repeaters) (Figure 10-5) is mounted in the control room and one in the conning tower. These units are housed in watertight cases equipped with glass windows through which the speed dials and the distance counters are visible. Each unit consists of a speed repeating self-synchronous motor, and a distance repeating self-synchronous motor which are connected electrically to speed and distance self-synchronous transmitters in the master transmitter indicator. Speed is indicated on a dial graduated in tenths of a knot from 0 to 25 knots. The counter is a six-place odometer. The first two right-hand number wheels are colored nautical miles. A transformer is mounted within the instrument to convert the 115-volt 60-cycle current to a lower voltage for the lighting circuit. A six-position tap switch is connected to the transformer and permits the selection of variable voltage to control the intensity of light for the instrument. Four lamps furnish illumination which is carried around the dial by a ringlight.

10A6. Sea water lines. The water lines system consists of copper tubing, flexible rubber tubing, an air collector, and two pressure snubbers. The fixed tubing consists of 3/8-inch seamless copper tubing connected with standard 3/8-inch flared-type screw connections that may be easily disconnected or replaced. Flexible rubber tubing is connected at the rodmeter nipples to permit the raising and lowering of the rodmeter. Flexible rubber tubing is also provided at the master transmitter end of the fixed lines to permit the lowering of the bellows assembly without disconnecting the lines. An air collector is mounted in the static line. The air collector consists of a glass tube protected by a metal casing, and is provided with two shut-off valves. One shut-off valve is mounted at the bottom of the air collector to control the flow of water into the collector. The upper shut-off valve permits the release of air from the lines. Two pressure snubbers, or shock absorbers, are mounted one in each line to protect the bellows from any sudden shock or increase in pressure due to an explosion or a sudden surge of water.

white with black numerals, and represent hundredths and tenths of nautical

B. DESCRIPTION OF OPERATION

10B1. Sea valve and rodmeter. While the ship is stationary, the water pressure in the rodmeter is static, and the log system is in balance. As soon as the ship gets underway, the forward motion creates additional pressure through the dynamic orifice in the rodmeter, while the pressure through the static orifices remains the same. This creates an unbalanced condition in the master transmitter indicator, and causes it to operate (Figure 10-4).

10B2. Operation of master transmitter indicator. a. Derivation of speed. As the ship begins to move forward, the bellows rod rises because of a pressure difference within the bellows. The rod movement is transmitted through the C-adjustment mechanism to a pivot on the main balance arm, causing the

main balance arm to rotate to the right. The contact arm mounted on the main balance arm first closes the slow speed contact and then the high speed contact, depending on whether the acceleration is small or great. When contact is made on the forward velocity side of the contact assembly, the power motor turns, and this action is transmitted through the gearing and the transmission shaft assembly to a helical gear on the cam and bracket assembly. The helical gear, cam, speed transmitter drive gear, and pointer are fixed to the same shaft so that when the helical gear is turned, the cam and pointer are also turned. As the cam turns, it moves the cam follower of the main force arm extension downward. This action moves the main force arm and

b. Derivation of distance. The lead screw in the component frame assembly is geared to the lead screw in the follower assembly. The follower assembly lead screw positions the follower radially across the rotating disk. The rotating disk, driven by the constant speed motor, is turning at a constant speed or 60 rpm. The position of the follower on the disk is dependent on the pointer indication, or speed indication. The follower is caused to turn by the rotation of the disk and, by its position on the disk, turns at the rate of 360 revolutions per nautical mile. The follower, through the universal joint, therefore, turns the right-hand side of the differential at 360 revolutions per nautical mile. Since the torque required to drive the distance transmitter is greater than the torque that can be obtained from the follower, a

causes the A-spring, attached at its upper end to the main force arm and at its lower end to the main balance arm, to stretch. When the load on this spring just overcomes the force of the bellows rod, the contact arm is returned to its central, or neutral, position and the power motor stops turning. When the power motor stops turning, the cam, pointer, and speed transmitter drive gear also stop turning, thereby maintaining this set position of the cam and pointer assembly until the ship changes speed. The speed transmitter drive gear is geared to the speed transmitter driven gear in such a relation that a 240-degree turn of the pointer in the master transmitter indicator will turn the pointers in the speed and distance indicators 360 degrees, thereby transmitting speed indications to the speed and distance indicators. In addition to driving the cam assembly, the power motor transmission shaft assembly also drives a lead screw in the component frame assembly which positions the B-adjustment slide downward from the zero position. When the B-adjustment pointer is turned away from zero on the scale, the motion of the slide moves the auxiliary balance arm which causes the B-spring to stretch between the auxiliary balance arm and the main balance arm. This B-spring aids the A-spring in overcoming the force of the bellows rod and in returning the contact arm to its neutral position.

torque amplifier is used. The torque amplifier (follow-up motor) consists of a shaded pole induction motor, rheostat, slipping clutch, differential, and suitable gearing. The shaded pole induction motor (follow-up motor) turns the distance transmitter and the left-hand side of the differential. If the left-hand and right-hand sides of the differential turn at different speeds, the spider rotates in the direction of the faster moving differential gear, and turns the rheostat brush arm through a slipping clutch. This action changes the voltage across the main field of the follow-up motor. The change in voltage changes the torque which the motor can supply, thereby changing its speed so that the distance transmitter rotates at the same speed as the follower and disk, that is, at 360 revolutions, per nautical mile. The self-synchronous distance transmitter transmits the distance indications to the speed and distance indicators.

10B3. Speed and distance indicators (repeaters). The speed and distance indications of the master transmitter indicator are electrically transmitted to the mechanism in the speed and distance indicators, and are registered on the dial and counters of those units.

C. RODMETER AND SEA VALVE

10C1. Rodmeter. The Bendix rodmeter (Figure 10-1) is made of manganese bronze, and is approximately 8 feet long. This length is necessary in order that the rodmeter may be projected through the inner and outer hulls of the submarine. It has a streamline cross-section, with a flat tip at its lower end. Two water passages are formed in the rodmeter; the upper ends of these passages terminate in tapped openings, protected by pipe plugs. Standard pipe fittings are installed in these tapped openings in order that the flexible hose may be attached to the rodmeter. The lower end of the forward passage in the rodmeter terminates in an opening in the forward edge, called the dynamic orifice. The lower end of the after passage terminates in three openings, one on each side of the tip and one in the bottom of the tip. The latter openings are called the static orifices. A handle and two straps are mounted at the top of the rodmeter to serve as a means of raising and lowering the rodmeter. When lowered, the rodmeter projects about 3 feet through the outer hull into the water. A lifting device is provided in the ship for raising and lowering the rodmeter and for replacing it in the event of damage. The rodmeter must always be raised, or housed, when the submarine docks or when, for tactical reasons, the submarine rests on the ocean floor.

lowering the rodmeter. One type consists of a single sprocket and chain arrangement, and the other type is a double sprocket and chain assembly. The upper sprocket is mounted either on the side of the hull or on a suitable panel near the rodmeter. The lower sprocket is mounted in the well containing the sea

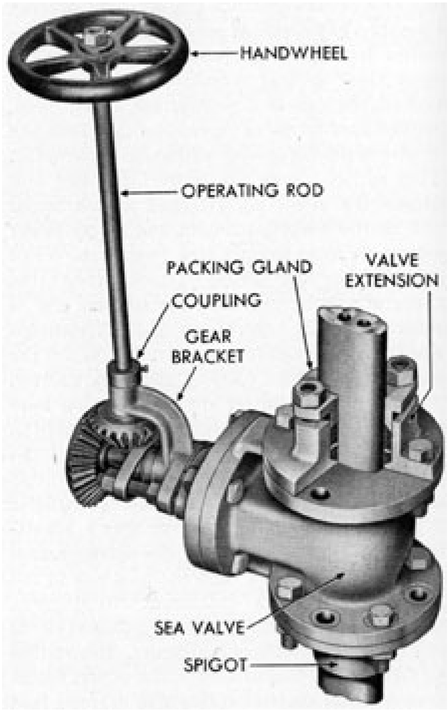


Figure 10-6. Sea valve.

valve. The sprockets are connected by a roller chain. Operation is by means of a hand crank through a worm gear drive. The roller chain is connected to the strap and handle assembly of the rodmeter by means of a connecting link which is pinned to the chain and to the strap and handle assembly. As the hand crank is operated, the chain rotates around the sprockets, thereby raising or lowering the rodmeter. The hoist crank normally is stowed in brackets near the sea valve. To operate

10C2. Sea valve. The sea valve assembly (Figure 10-6) supports the rodmeter when the rodmeter is projected into the sea, and prevents water from entering the ship when the rodmeter is removed. The valve is a 3-inch gate valve, operated by a handwheel on an operating rod which in turn is bevel-geared to the valve stem. The sea valve is bolted to the inner hull of the ship. A valve extension with packing gland is mounted to the top flange of the valve. This extension provides an upper support when the rodmeter is projected into the sea, and also provides a leakproof gland around the rodmeter.

10C3. Rodmeter hoist. Submarines are equipped with either one of two types of rodmeter hoists (Figure 10-7) for raising and

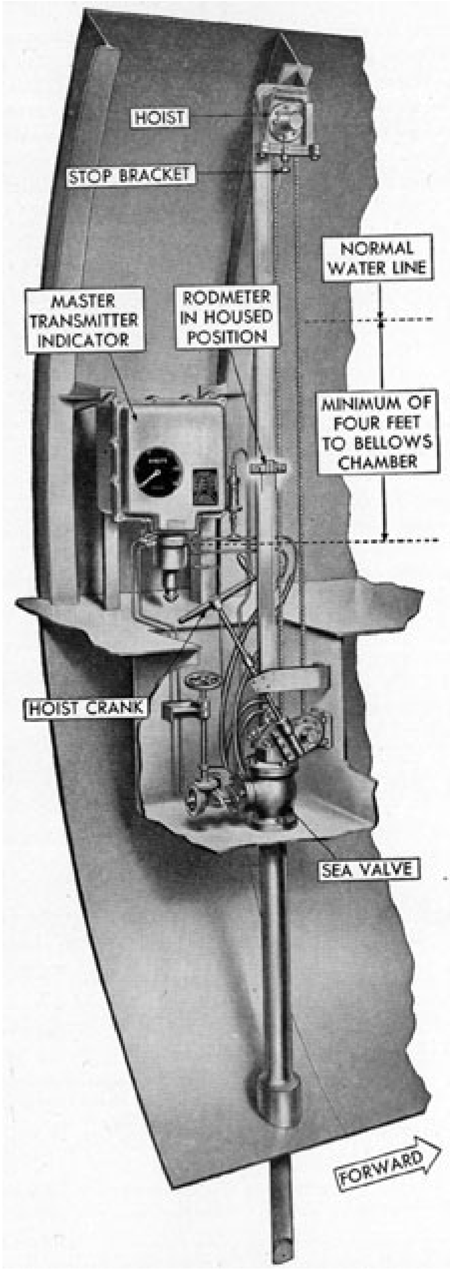


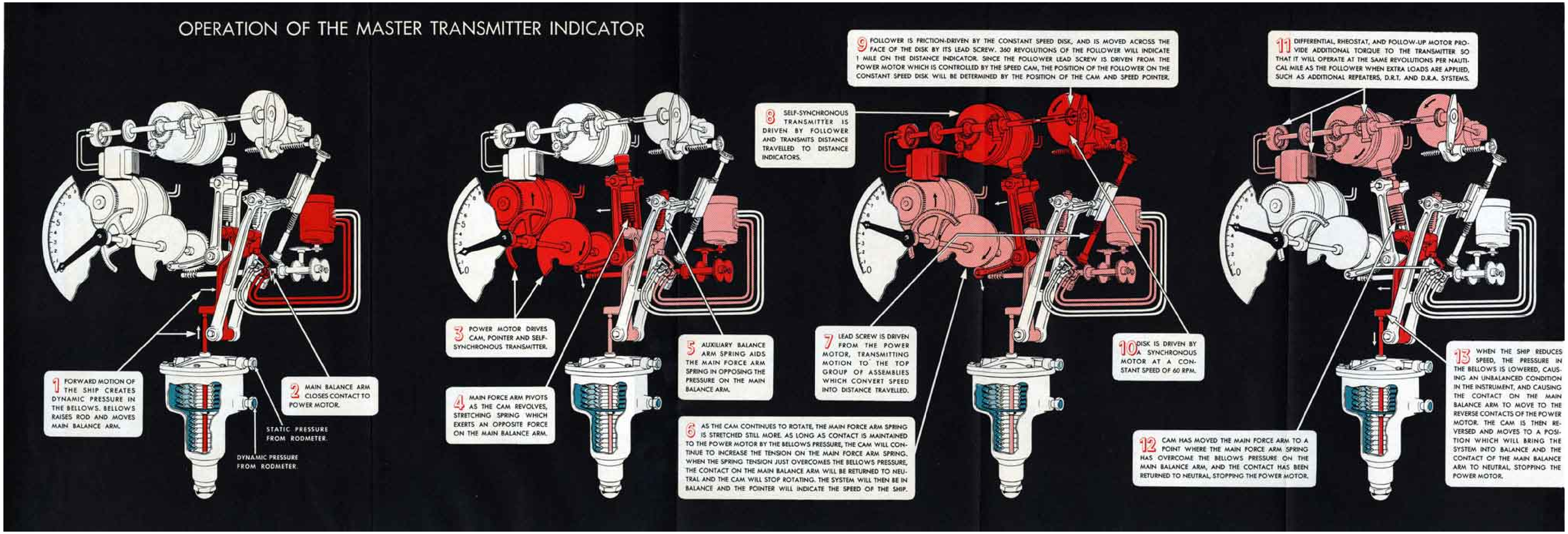
Figure 10-7. Rodmeter and hoist installed.

the hoist, a deck plate must be raised and the crank lifted off its brackets and placed on the hoist operating rod. When in the lowered or operating position, the straps on the upper end of the rodmeter are close to the top of the sea valve extension gland. Approximately 32 turns of the crank are required to raise the rodmeter to the normal housed position, that is, the position that permits the tip just to clear the outer hull. In this position, approximately half the length of marked by a plate mounted on the side of the hoist bracket. The rodmeter is fully housed when the tip clears the sea valve gate. Approximately 82 turns of the crank are required to raise the rodmeter to the fully housed position. The sea valve should then be closed. About eight additional turns are required to raise the rodmeter to its extreme secured position for inspection. Care should be exercised when lowering the rodmeter from this latter position to see that the

the rodmeter is above the sea valve extension. This point is usually packing is not pushed out of the gland.

Figure 10-4. OPERATION OF THE MASTER TRANSMITTER INDICATOR

Sub Log
Home Page



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11
OPERATING THE LOG

A. OPERATING INSTRUCTIONS

11A1. Position distance transmitter load switch. The distance transmitter load switch (Figure 11-1) is mounted in the upper right corner of the master transmitter indicator. This switch is set in the heavy load position when there are more than two repeaters operating, or when the dead reckoning tracer (DRT) and dead reckoning analyzer (DRA) are in operation. Otherwise, it is in the light load position at all times. This switch is used for making a rough adjustment to vary the

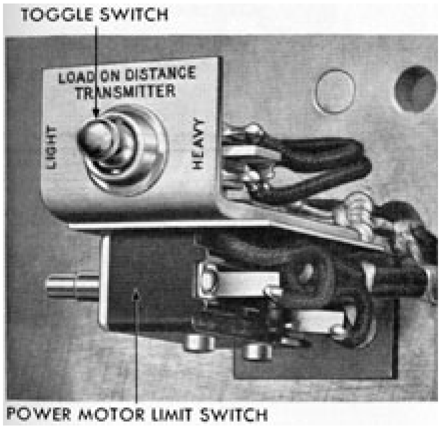


Figure 11-1. Distance transmitter load switch.

maximum torque output of the follow-up motor. The variable rheostat is employed for a fine adjustment of the output of the follow-up motor.

11A2. Energizing the system. Turn the electrical switches controlling the 1Y, 2Y, and 3Y

11A4. Lowering the rodmeter. (See Figure 10-7.) The rodmeter will be in one or two positions: the normally housed position as shown in Figure 10-7, or the fully housed position. To lower the rodmeter, turn the hoist crank counterclockwise until the rodmeter is in its extended, or operating position. Keep the hose clear of projections and chain links.

11A5. Venting the system. Do not vent the system when the ship is submerged. Such a practice will damage the bellows mechanism due to the fact that the pressure increases approximately 1/2 pound per square foot for each foot of submergence, and it is practically impossible to open or close the dynamic and static valves simultaneously so as to keep the pressures equal on both sides of the bellows.

For best results the ship should be stationary. The purpose of venting the hydraulic system is to remove any air that may be trapped in the system. Vent the hydraulic system in the following manner. Turn the

circuits on the interior communications (I.C.) switchboard and the conning tower repeater switch on the action cutout (A.C.O.) switchboard to their ON positions.

11A3. Opening the sea valve. Raise the deck plate above the sea valve. Turn the sea valve handwheel in a counterclockwise direction as far as possible to fully open the sea valve gate.

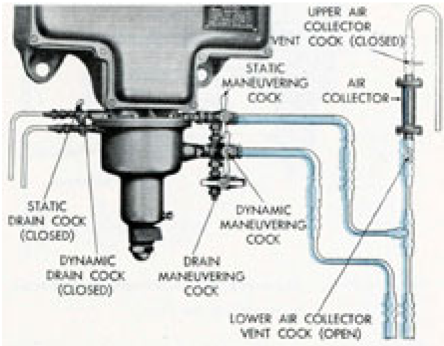
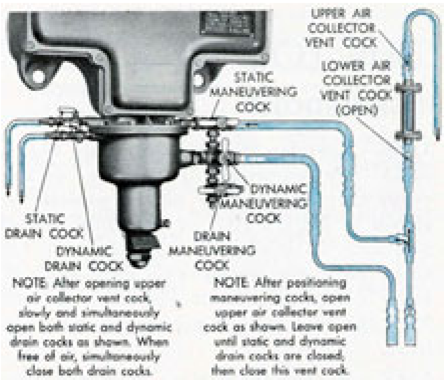


Figure 11-2. Maneuvering cocks and drain cocks in secured position.

maneuvering cocks and drain cocks from their secured position (Figure 11-2) to the venting position (Figure 11-3). Keep the valves in this position until a clear stream of water,



NOTE: After opening upper air collector vent cock slowly and simultaneously open both static and dynamic drain cocks as shown. When free of air, simultaneously close both drain cocks.
NOTE: After positioning maneuvering cocks, open upper air collector vent cock as shown. Leave open until static and dynamic drain cocks are closed; then close this vent cock.
Figure 11-3. Maneuvering cocks and drain cocks in venting position.

free of spitting is obtained; then turn the maneuvering cocks and secured, position by turning the crank until the top of the rodmeter hits the stop at the top of the hoist. Turn the valves to their secured position as shown in Figure 11-2. Turn the 1Y, 2Y, and 3Y switches on the I.C. switchboard, and the conning tower switch on the A.C.O. switchboard to their OFF positions.

11A7. Draining the hydraulic lines. If the ship is to be in port for an extended time, or

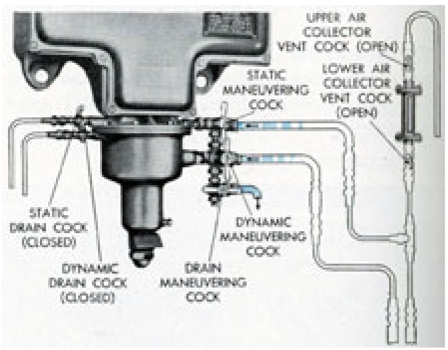


Figure 11-5. Maneuvering cocks and drain cocks in drain position.

if it becomes necessary to make repairs on the hydraulic lines, the

drain cocks to their operating positions (Figure 11-4). Turn the maneuvering cocks first in going to, and in going from, the venting position.

11A6. Securing the log. Whenever the ship enters port, the log system should be secured.

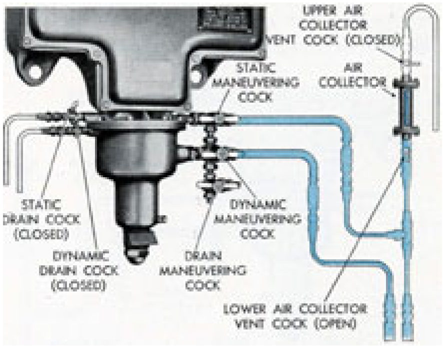


Figure 11-4. Maneuvering cocks and drain cocks in operating position.

This is done in the following manner: Turn the hoist crank in a clockwise direction until the top of the rodmeter is level with the marker plate, indicating that the tip of the rod is clear of the hull. Keep the hose clear of projections as the rodmeter is raised. The rodmeter may be raised to its fully housed, or fines are drained in the following manner: Raise the rodmeter to its fully housed, or secured, position. Position the valves and vent cocks as shown in Figure

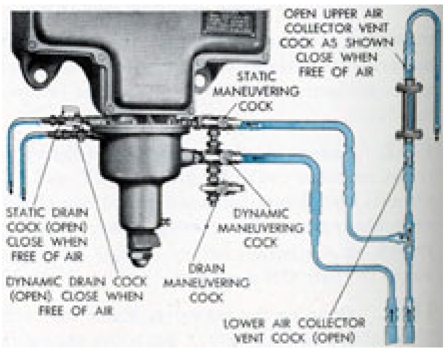


Figure 11-6. Maneuvering cocks and drain cocks positioned for filing hydraulic lines.

11-5. With the valves in this position, the water will drain from the lines through the drain maneuvering cock.

11A8. Filling the hydraulic system. If the ship is equipped with a new log installation, or if the hydraulic system has previously been drained, fill the hydraulic system in the following manner: Lower the rodmeter to its extended, or operating, position. Position the valves and vent cocks as shown in Figure 11-6. When a full stream of water, free of spitting is obtained from the upper air collector valve, close this valve. Tap the bellows housing to facilitate the removal of air from the bellows chamber, and when a full stream of water is obtained from the static and dynamic vent cocks, close these drain cocks. Vent the system thoroughly as

described in Section 11A5. Turn the valves to the desired position.

12
TROUBLE SHOOTING

A. TROUBLES, CAUSES, AND REMEDIES

12A1. General. This section contains trouble-shooting information and tests that can be made to help determine the causes of some of the troubles that may develop in the log system. Each symptom of trouble is followed by a list of the possible causes and a list of the possible remedies to correct the trouble.

TROUBLE	CAUSE	REMEDY
1. Log does not start when rodmeter is lowered while ship is underway.	1a. Valve positions incorrect. 1b. 2Y circuit open. 1c. Rodmeter, hose, or bellows piping clogged. 1d. Hose lines reversed.	1a. Set valves to operating position (Figure 11-5). 1b. Close 2Y switch. Check fuses and circuits. 1c. Blow out rodmeter and hose. (See Section 13B2.) Clean out bellows piping. 1d. Install hose correctly (Figure 10-2).
2. Log does not operate when main balance arm and contact arm are carefully moved to the right.	2a. Master transmitter is not energized. 2b. Log power motor is inoperative. 2c. Gearing is jammed.	2a. Close the 1Y, 2Y, and 3Y switches. Check fuses and circuits. 2b. Check wiring. Replace power motor. (See Sections 13G21 and 13G24.) 2c. Check for presence of foreign matter in gears. Manually turn power motor drive gear to note any binding of gears. Lubricate gears.

	2d. Bellows punctured, or broken.	2d. Replace bellows. (See Sections 13D2, 13D3, 13D4, and 13D5.)
3. Speed and distance readings low or nonexistent.	3a. Valve positions incorrect. 3b. Rodmeter, hose, or bellows piping clogged. 3c. Hose lines reversed. 3d. Large bellows leaks.	3a. Set valves to operating position (Figure 11-4). 3b. Blow out rodmeter and hose. (See Section 13B2.) Clean out bellows piping. 3c. Install hose correctly. 3d. Replace bellows assembly as a unit. (See Sections 13D2, 13D3, 13D4, and 13D5.)

TROUBLE	CAUSE	REMEDY
4. Speed and distance indications are sluggish when ship's speed changes.	4a. Clogged rodmeter, hose, bellows piping, or a clogged snubber. 4b. Contacts dirty. 4c. Gears binding.	4a. Clean out rodmeter, hose, bellows piping, and snubbers. 4b. Clean contacts. (See Section 13A1.) 4c. Clean, lubricate, and replace damaged gears.
5. Log components operate correctly but excessive error of speed and distance indications occurs at all speeds.	5a. Air in bellows. 5b. Clogged rodmeter. 5c. Bent rodmeter. 5d. Log improperly adjusted. 5e. Condition of hull has changed radically due to outboard installation of new	5a. Vent system. (See Section 11A5.) 5b. Blow out rodmeter. (See Section 13B2.) 5c. If possible, pull up rodmeter and examine for bent tip. Replace with spare rodmeter. (See Sections 13C1, 13C2, 13C3, and 13C4.) 5d. Check A1, A2, and B adjustments and record

	equipment near rodmeter.	figures on adjustment diagram. (See Section 14A10.) 5e. Recalibrate log over measured mile course. (See Section 13B.)
6. No distance indication.	6a. Distance transmitter burned out. 6b. Distance circuit not energized. 6c. Gears jammed. 6d. Synchronous motor (constant speed motor) burned out, and disk not rotating.	6a. Replace distance transmitter. (See Section 13G11.) 6b. Energize 2Y circuit. 6c. Clean and lubricate gears. Replace damaged gears. 6d. Replace synchronous motor. (See Sections 13G16, 13G17, and 13G18.)
7. Speed pointer does not return to zero when rodmeter is housed, or when cocks are set to zero position.	7a. Contacts are dirty. 7b. Excessive air in bellows. 7c. C adjustment is set incorrectly.	7a. Clean contacts. 7b. Vent system. (See Section 11A5.) 7c. Set C adjustment. (See Section 13A4.)

TROUBLE	CAUSE	REMEDY
8. Rodmeter cannot be raised with hoist.	8. Rodmeter is bent	8. Replace with spare rodmeter. Salvage bent one and straighten if possible. (See Section 13C.)
9. Rodmeter gland leaks excessively.	9. Packing gland loose or worn.	9. Tighten packing gland nuts. Repack if needed.
10. Hum in transmitters in master transmitter indicator.	10. Excessive hum is due to shorts in circuits to master transmitter indicator or speed and distance indicators; or to binding of gears, bearings, or distance counters.	10. Check circuits. Check load on repeaters.

11. Time check on distance indication disagrees with speed indication.	11a. Constant frequency not exactly 60 cycles. 11b. Slipping clutch does not operate properly. 11c. Tension spring holding follower against disk too tight or too loose. 11d. Dead reckoning tracer or dead reckoning analyzer may be upsetting system. 11e. Follower worn.	11a. Check operation of constant frequency supply. 11b. Adjust slipping clutch. (See Section 13G45.) 11c. Check spring tension. (See Section 13G48.) 11d. Time the counter with the dead reckoning tracer, and dead reckoning analyzer cut out of the system. 11e. Measure diameter of follower. Diameter should be 1.200 inch plus or minus 0.002 inch. If seriously worn, replace. (See Sections 13G37 and 13G38.)
12. Speed indication on one speed and distance indicator does not agree with another.	12. Repeater not set on electrical zero.	12. Set repeater on electrical zero. (See Section 13F30.)
13. Both speed indicators show same variation from master transmitter.	13. Transmitter not properly set in mounting plate.	13. Reset transmitter in mounting plate. (See Section 13G10.)
14. Speed indicators are out exactly 180 degrees.	14. The primary circuit of the self-synchronous repeaters is reversed.	14. Reset primary leads.

13 MAINTENANCE

A. PRELIMINARY INSTRUCTIONS

13A1. General. Extreme vigilance and care are necessary in the inspection, cleaning, and repair of parts. Personnel performing repair work should use common sense in judging whether or not a part should be put back into service or discarded. If there is any doubt, the part should be replaced. With the exception of the bearings and electrical equipment, corrosion should be removed from the parts by washing them in kerosene. Hydraulic equipment should be washed in clean fresh water. After cleaning, dry the parts thoroughly, and apply a light film of gyro oil to prevent rusting or corrosion of the parts. Use Navy-approved cleaning fluid to clean grease and oil from the parts. Keep the bearings oiled and clean by wrapping them in wax paper until they are needed for assembly. Clean the contacts and slip rings with ordinary paper to remove any film of oil or grease. Smooth off pitted contacts with a jeweler's file and polish with a burnishing tool. Do not use crocus cloth, crocus paper, or sandpaper on the contacts. Replace all cracked or broken parts. The area in which repair work is being done should be kept clean to prevent dust and dirt from getting on the parts.

the log system while the ship is at rest on the surface. By shutting off the pressure on one side of the bellows, unequal pressure is obtained on the bellows, and the system will operate at one speed in the same manner as if the ship were underway. This permits the checking and inspection of the system under operating conditions. The log is operated on the static head as follows: Turn the valves to the static head operating position as shown in Figure 13-1. The system will now operate at approximately 5 knots. After inspection, turn the valves to their secured position as shown in Figure 11-2. The transmitter indicator mechanism will then stop operating and the speed pointers should be at the zero position.

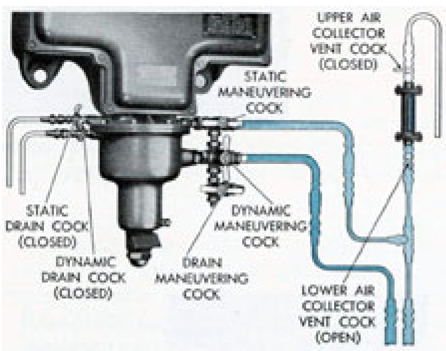


Figure 13-2. Maneuvering cocks and drain cocks in zero position.

13A3. Checking the operation of the system with a weight and arm. This operation is a means of checking the functioning of the system when the ship is either at

13A2. Operating the system on a static head. This is a means of checking the operation of

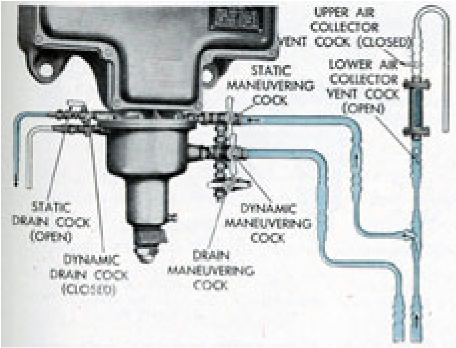


Figure 13-1. Maneuvering cocks and drain cocks positioned for operating on static head.

rest or underway, on the surface or submerged. It is described in detail in Section 14A10.

13A4. Setting the C-adjustment. (See Figures 13-2 and 13-3.) The C-adjustment mechanism consists of a micrometer assembly which connects the bellows rod with the main balance arm. This micrometer is a means of

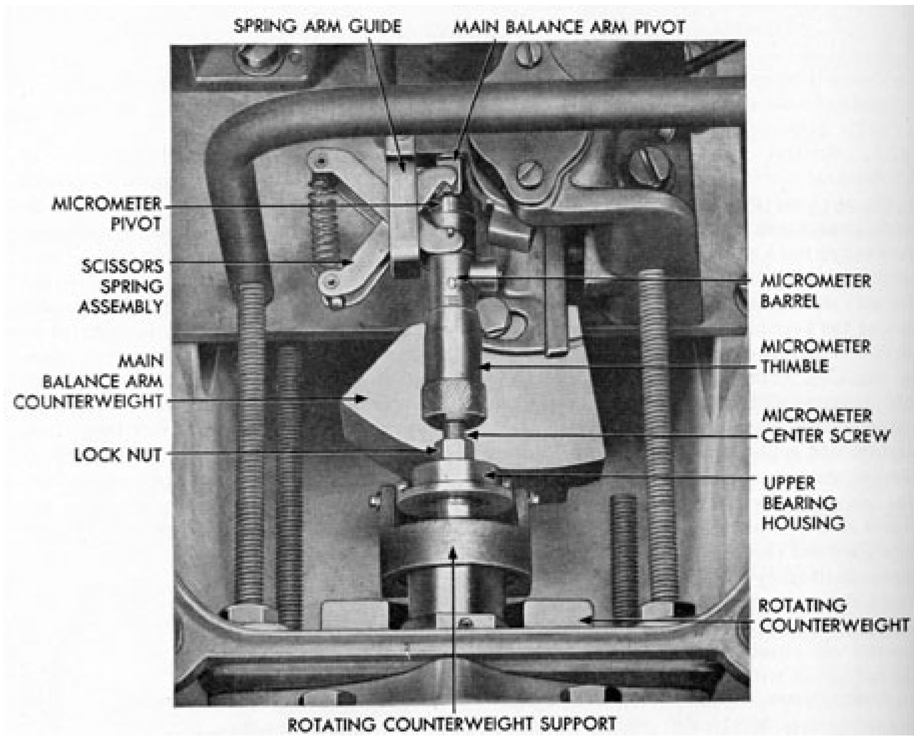


Figure 13-3. C-adjustment assembly.

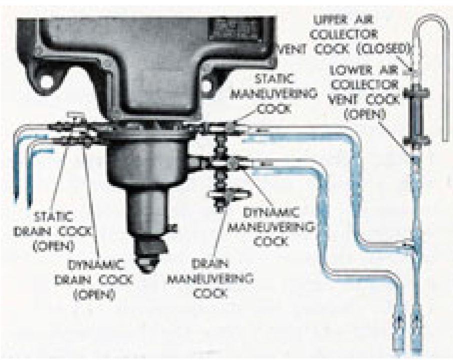


Figure 13-4. Maneuvering cocks and drain cocks positioned to check for clogged rodmeter.

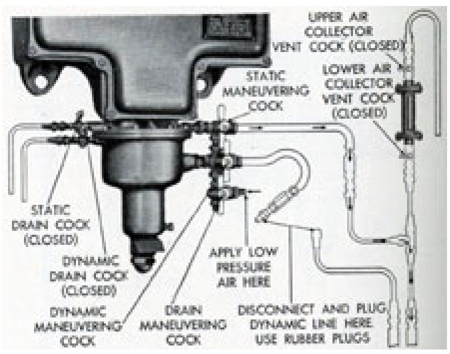


Figure 13-5. Maneuvering cocks and drain cocks positioned for blowing out static line.

adjusting the master transmitter indicator so that the speed pointer will point at exact zero on the dial. Setting the C-adjustment is accomplished in the following manner: Set the valves to the zero position as shown in Figure 13-2. Thoroughly vent the hydraulic system as described in Section 11A5. If the speed

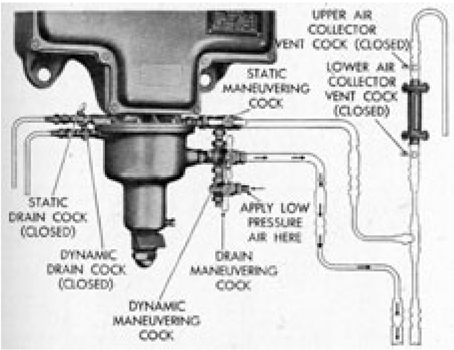


Figure 13-6. Maneuvering cocks and drain cocks positioned for blowing out dynamic line.

pointer is not at the zero position on the dial, turn the micrometer thimble (shown in Figure 13-3) until the pointer is at exact zero position on the dial. This adjustment is important because all other log adjustments are performed only after making certain that the C-adjustment is correct.

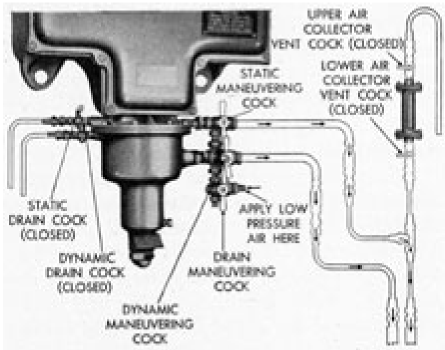


Figure 13-7. Maneuvering cocks and drain cocks positioned for blowing out both hydraulic lines.

B. MAINTENANCE OF RODMETER

13B1. Testing for obstruction in the rodmeter. The rodmeter may become clogged with jellyfish, mud, seaweed, or other foreign matter. Consequently the pressure difference will not be normal, and the mechanism will not register correctly. The following test must be performed when the ship is on the surface. Position the valves and vent cocks as shown in Figure 13-4. If a full stream of water does not flow from both drain cocks, it is an indication that the line not flowing is clogged.

13B2. Blowing out the rodmeter. This operation should rubber corks. Apply low-pressure air to the fitting at the drain maneuvering cock. After the static line is blown clear, remove the rubber corks and reconnect the dynamic line. Blow out the dynamic line as follows: Position the maneuvering cocks and drain cocks as shown in Figure 13-6. Apply low-pressure air to the fitting at the drain maneuvering cock. To blow out both the static and dynamic lines simultaneously, position the maneuvering cocks and drain cocks as shown in Figure 13-7. Apply low-pressure air to the fitting at the drain maneuvering cock. After blowing out the hydraulic lines, test for

be performed with the rodmeter in its extended, or operating, position. It is good practice to blow out both lines even if the tests for obstruction indicate that only one line is clogged, as foreign matter has probably entered both passages. Blow out the static line in the following manner: Position the maneuvering cocks and drain cocks as shown in Figure 13-5. Disconnect the dynamic line at the pressure snubber as shown in Figure 13-5 and plug the line openings with obstructions in the rodmeter as described in Section 13B1. Vent the hydraulic system thoroughly after blowing out the rodmeter as described in Section 11A5.

13B3. Removing solid obstructions from the rodmeter. (See Figure 13-8.) If obstructions cannot be removed by blowing out the rodmeter with compressed air, the following operations are necessary: Raise the rodmeter to its fully housed position. Close the sea

valve. Raise the rodmeter until its lower end is above the sea valve extension. Using a soft brass wire, dig out the obstructions from the openings on the lower end of the rodmeter. Do not use steel wire or a drill to clean out the openings as they may score the openings, or break off in the passages. Blow out the rodmeter as described in Section 13B2; in this case, however, the rodmeter need not be extended into the sea. Have a crew member hold his hand near the rodmeter openings to detect the flow of air which indicates that the opening and tubing are clear. Repeat this operation until all the passages are clear.

Align the lower end of the rodmeter with the opening in the sea valve extension, and carefully lower the rodmeter to its fully housed position. Care should be exercised in lowering the tip of the rodmeter through the packing gland so that the packing will not be pushed out

of the gland. At the fully housed position the tip of the rodmeter is approximately 1 inch above the sea valve gate. Open the sea valve. Place the hoist stop bracket in its original position above the rodmeter. It is important that the stop bracket be in position above the rodmeter at all times, except while performing the above operation, or when the rodmeter is being replaced. Lower the rodmeter either to its normally housed position or to its fully extended position. Place the hoist crank in the brackets provided, and replace the deck plate over the sea valve.

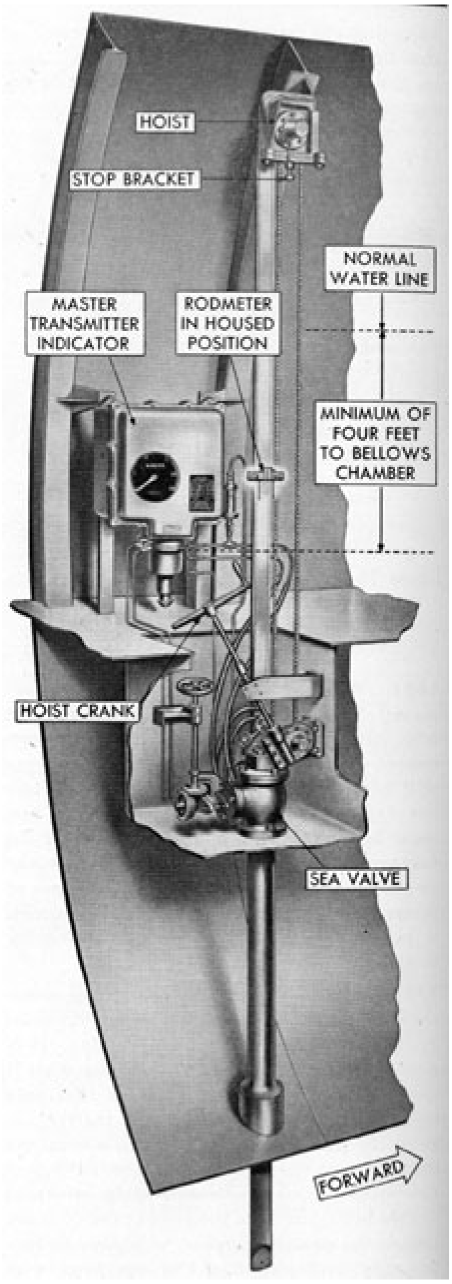


Figure 13-8. Rodmeter and hoist.

C. REPLACING DAMAGED RODMETER

13C1. General instructions. If the rodmeter is bent so that it cannot be drawn up into the ship, it will be necessary to install a spare rodmeter. Do not attempt to force the damaged rodmeter up into the ship, as the hoist mechanism may be damaged. The removal and installation operations should be carried out only when the ship is surfaced. If the damaged so that the rodmeter may be pulled out of the water after it is pushed out of the sea valve.

13C2. Breaking out the spare rodmeter. Break out the spare rodmeter and place it alongside of the hoist mechanism so that it will be immediately available when needed.

13C3. Removing the strap and handle assembly. (See Figure 13-

rodmeter is to be salvaged, it may be accomplished if a diver is available. Lower the diver over the side of the ship so that he can rig a line around the damaged rodmeter. Secure the opposite end of the line to the ship

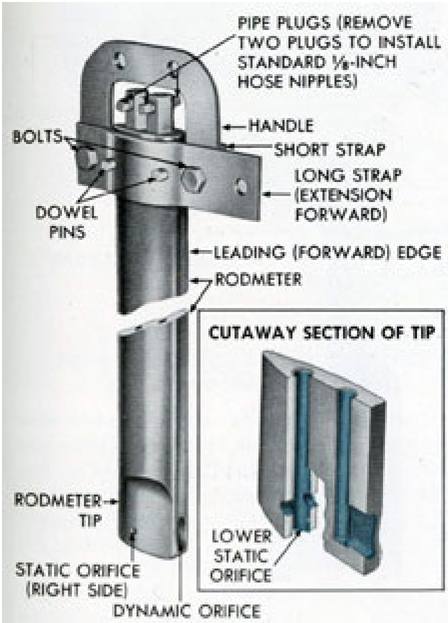


Figure 13-9. Bendix rodmeter.

9.) Loosen the hose clamps and remove the two lengths of hose from the nipples on the upper end of the rodmeter. Remove the nipples from the rodmeter and plug the tapped openings with wooden plugs or standard 1/8-inch pipe plugs. Disconnect the hoist chain link from the rodmeter. Remove the two nuts and bolts that secure the straps and handle to the rodmeter and remove the straps and handle. Raise the hoist chain until the connecting link is in its topmost position against the stop bracket above the rodmeter (Figure 13-8).

13C4. Installing the spare rodmeter. (See Figure 13-9.) The spare rodmeter is equipped with straps and handle. If the damaged rodmeter is partially raised, push it downward until the dowel pins rest on top of the packing gland on the sea valve extension. Remove the two pipe plugs from the spare rodmeter and install the hose fittings. Connect the hose to the spare rodmeter and tighten the hose clamps securely. Place the tip of the spare rodmeter on top of the damaged rodmeter. Drive out the dowel pins from the damaged rodmeter. Push downward on the spare rodmeter until it is completely free of the ship. Connect the link on the chain hoist to the rodmeter handle. Vent the hydraulic system in accordance with the instructions given in Section 11A5.

D. MAINTENANCE OF PRESSURE BELLOWS

13D1. General. The submarine bellows are matched as to spring-rate at the factory and should not be disassembled. The indicator cover retaining screws and cover. With the rodmeter in its housed position, turn the valves and maneuvering cocks to the

three sections of the bellows assembly (Figure 13-10) should be replaced as a unit.

13D2. Removing the bellows chamber. (See Figure 13-11.) Remove the master transmitter drain position (Figure 11-6). Spread the ends of the scissors spring to disengage the spring from the micrometer and pivot, and remove the scissors spring. Remove the snap rings from

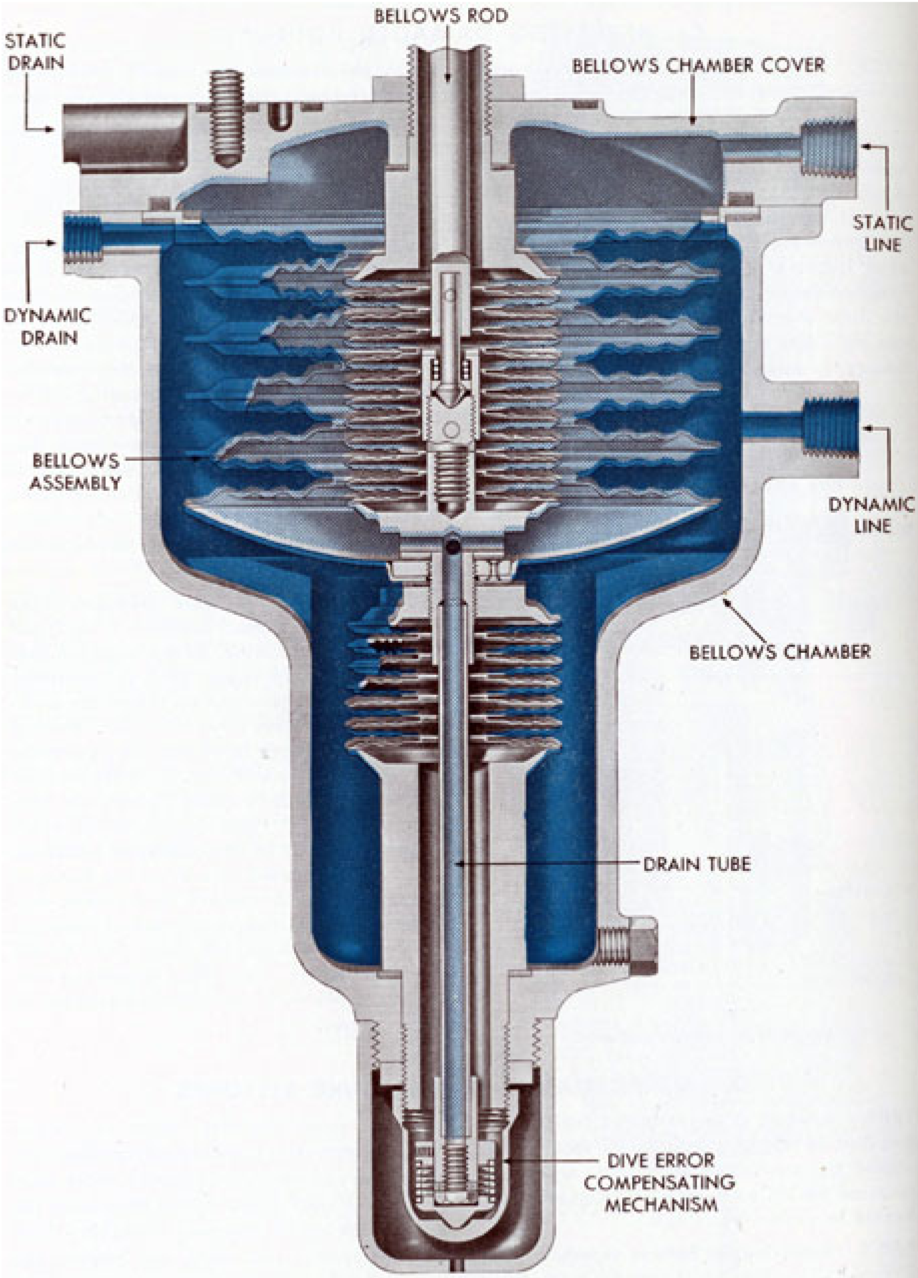
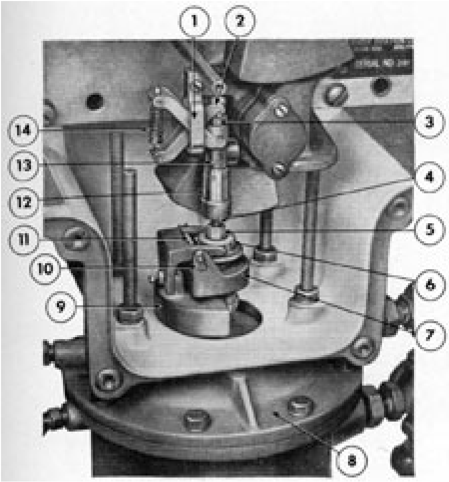


Figure 13-10. Cutaway of bellows assembly.

after the drain screw is removed. Remove the drain screw and gasket from the lower end of the drain tube. Loosen the three



1. SPRING ARM GUIDE
2. MAIN BALANCE ARM PIVOT
3. MICROMETER PIVOT
4. MICROMETER CENTER SCREW
5. LOCK NUT
6. UPPER BEARING HOUSING
7. COUNTERWEIGHT BRACKET
8. BELLOWS ASSEMBLY
9. ROTATING COUNTERWEIGHT
10. SNAP RING
11. COUNTERWEIGHT SHAFT
12. MICROMETER THIMBLE
13. MICROMETER BARREL
14. SCISSORS SPRING ASSEMBLY

Figure 13-11. Bellows installation on master transmitter case.

each end of the counterweight shaft, and remove the shaft. Lift out the counterweight and its bracket. Do not disturb, in any way, the counterweight mounted on the bottom of the main balance arm. Carefully block or hold the bellows chamber in place while removing the nuts from the bellows mounting studs. Carefully lower the bellows assembly from the master transmitter case.

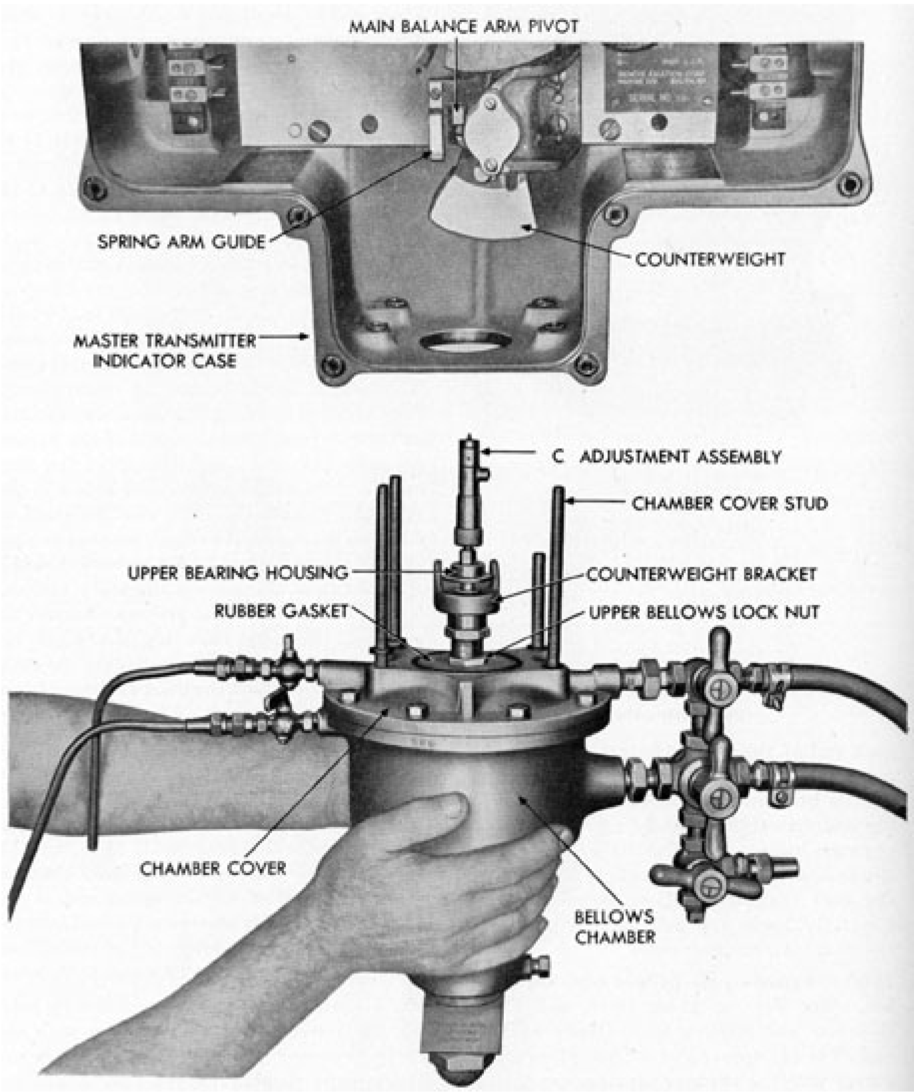
13D3. Removing the bellows from the chamber. (See Figures 13-12, 13-13, and 13-14.) Unscrew and remove the bellows chamber cap. The cap spacer and caution plate are removed with the chamber cap. Loosen the setscrews on the compensating spring bushing and remove the bushing from the drain tube. Using the special bellows wrench, which is stowed in the spare parts box, hold the lower end of the bellows as shown in Figure 13-13. Unscrew and remove the lock nut that secures the lower end of the bellows assembly to the bellows chamber. Unscrew the unions that secure the maneuvering cocks assembly to the bellows chamber and place the assembly to one side. Unscrew and remove the C-adjustment mechanism from the bellows rod by holding the rod with a wrench and unscrewing the micrometer center screw from the rod. The counterweight bearing is removed with the C-adjustment assembly. Remove the lock nut that secures the upper end of the bellows assembly to the chamber cover in the same manner that the bellows lower lock nut was removed. Loosen the three setscrews that secure the main counterweight support in position on the upper end of the bellows assembly and unscrew and remove the main counterweight support from the bellows. Remove the chamber cover by removing the eight cap screws and lock washers that secure the cover to the chamber. Lift the bellows assembly out of the bellows chamber. The bellows may be stuck in the chamber. If it is, the application of low-pressure air to the dynamic opening in the chamber will facilitate its removal.

13D4. Installing the bellows assembly in the chamber. (See Figures 13-12, 13-13, and 1314.) Make certain that the bellows chamber gasket is installed on the upper end of the chamber.

setscrew in the compensating spring holder and unscrew (counterclockwise) and remove the spring holder. Carefully remove the compensating spring assembly from the compensating spring bushing. The spring bushing is removed

Carefully insert the bellows into the chamber. Secure the lower end of the bellows to the chamber with the lock nut as follows

Tighten the lock nut in position by holding the lower end of the bellows with the special spanner wrench as shown in Figure 13-13, while turning up the nut. Place the bellows chamber cover gaskets in position on the chamber cover. Carefully place the chamber cover over the threaded end of the bellows so as not to burr the threads. Align the two large pipeline openings in the cover and in the



Figure, 13-12. Bellows assembly removed.

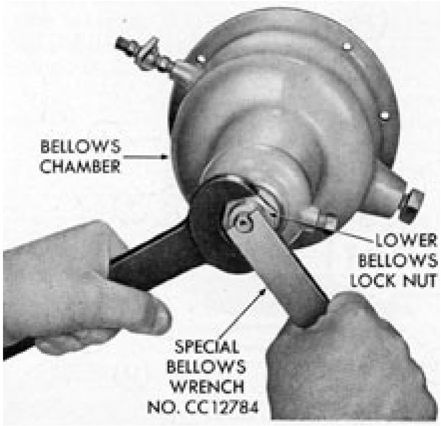


Figure 13-13. Removing bellows lower lock nut.

chamber so that the large openings are on the same side of the chamber. Align the mounting holes and install the eight cover retaining screws and lock washers. Install the lock nut that secures the upper end of the bellows to the chamber cover. Temporarily install the main counterweight bracket and bearing assembly on the upper end of the bellows assembly.

Do not tighten the setscrews in the counterweight bracket and bearing assembly at this time, as a final adjustment of the positioning of the assembly must be made when the bellows assembly is installed on the master transmitter indicator case.

Place the upper bearing housing assembly on top of the bellows rod with the large flange end of the bearing housing toward the top of the bellows rod. Temporarily install the C-adjustment mechanism in the top of the bellows rod by turning the micrometer center screw into the rod. Do not tighten the lock nut on the micrometer center screw or position the micrometer central position on the micrometer barrel. This is done so that the thimble can be moved in either direction when making the final zero adjustment. Make certain that the bellows stud gaskets are in good condition and are installed on the studs. Lift the bellows assembly into position on the bottom of the transmitter case. Hold the bellows assembly in this position while adjusting the micrometer screw in the top of the bellows rod so that the pivot on top of the micrometer will just clear the pivot recess in the main balance arm pivot when the rubber stud gaskets are compressed. Tighten the lock nuts on the bellows mounting studs so that the rubber stud gaskets are completely compressed and a metal-to-metal contact is obtained between the bellows chamber cover and the transmitter case. Secure the micrometer center screw in position by tightening the lock nut on the center screw up against the inner race of the counterweight bearing. Install the scissors spring assembly to hold the micrometer up against the main balance arm pivot. Apply a coating of white lead compound to the threads of the maneuvering and drain cocks. Install the two unions connecting the maneuvering cocks with the two large tapped openings, one in the chamber cover and one in the bellows chamber. Tighten the connections. Install the two drain cocks, one in the cover and the other in the chamber. Tighten the connections. Install the drain tubing in the drain cocks. Place the rotating counterweight in position

thimble at this time, as a final adjustment must be made when the complete bellows assembly is installed on the bottom of the master transmitter indicator case.

13D5. Installing the bellows assembly on the master transmitter case. (See Figure 13-11.) Position the micrometer thimble of the C-adjustment mechanism in its approximate on the counterweight support, and install the counterweight shaft and the two snap rings that secure the weight to the support. There should be approximately 1/32-inch clearance between the arms of the counterweight and the counterweight bearing. Check the clearance of the counterweight to see that it does not touch the case, the weight on the main balance arm, or any stud. Position the counterweight for proper clearance by screwing the counterweight support upward or downward as necessary. When the proper clearance is obtained, secure the counterweight support in position by tightening the setscrews provided in the support. The setscrew should not be made extremely tight, as the threads on the upper end of the

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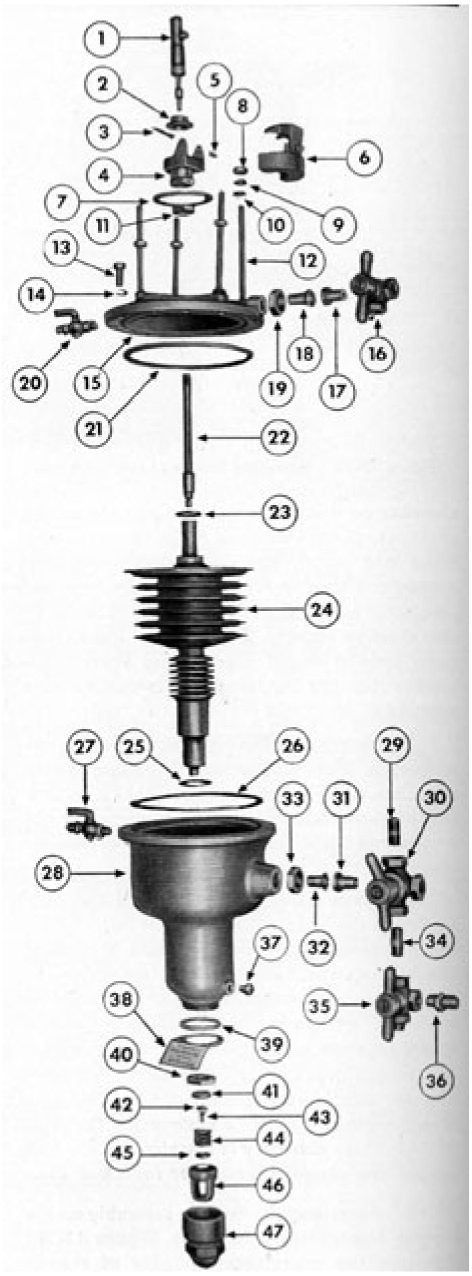
1. C ADJUSTMENT ASSEMBLY
2. UPPER BEARING HOUSING ASSEMBLY.
3. COUNTERWEIGHT SHAFT.
4. COUNTERWEIGHT BRACKET AND BEARING ASSEMBLY.
5. SNAP RING.
6. COUNTERWEIGHT AND BRACKET ASSEMBLY.
7. RUBBER GASKET.
8. STUD NUT.
9. LOCK WASHER.
10. STUD GASKET.
11. UPPER BELLOWS LOCKNUT.
12. CHAMBER COVER STUD.
13. CAP SCREW.
14. LOCK WASHER.
15. CHAMBER COVER.
16. THREE-WAY STATIC MANEUVERING COCK.
17. OUTER UNION.
18. INNER UNION.
19. COUPLING NUT.

20. STATIC DRAIN COCK.
21. NEOPRENE CHAMBER COVER GASKET.
22. BELLOWS ROD.
23. UPPER BELLOWS GASKET.
24. BELLOWS ASSEMBLY.
25. LOWER BELLOWS GASKET.
26. VELLUMOID GASKET.
27. DYNAMIC DRAIN COCK.
28. BELLOWS CHAMBER.
29. PIPE NIPPLE.
30. FOUR-WAY DYNAMIC MANEUVERING COCK.
31. OUTER UNION.
32. INNER UNION.
33. COUPLING NUT.
34. PIPE NIPPLE
35. THREE-WAY MANEUVERING DRAIN COCK.
36. COUPLING.
37. BELLOWS CHAMBER DRAIN PLUG.
38. CAUTION NAMEPLATE.
39. CAP SPACER.
40. LOWER BELLOWS LOCK NUT.
41. COMPENSATING SPRING BUSHING.
42. GASKET.
43. SCREW.
44. COMPENSATING SPRING.
45. COMPENSATING SPRING NOSE.
46. COMPENSATING SPRING HOLDER.
47. CHAMBER CAP.



bellows assembly will be damaged. There are three setscrews provided in the main counterweight support. It is necessary to tighten only the most accessible setscrew. Fill the hydraulic system with water. (See Section 11A8.) Vent the system thoroughly. (See Section 11A5.) Energize the system by turning on the switches in the control room. Make the C-adjustment by turning the micrometer thimble upward or downward until the pointer reads zero on the speed dial. (See Section 13A4.) Check the system for dive error. (See Section 13E2.)

E. COMPENSATION OF SUBMARINE BELLOWS FOR DIVE ERROR

13E1 General. The submarine bellows is carefully adjusted for dive error when the bellows assembly is made at the factory. This adjustment should not be tampered with unless the bellows has been damaged, and the replacement of the bellows assembly becomes necessary. **13E2. Checking the system for dive error.** The following operations are necessary in checking the system for dive error:

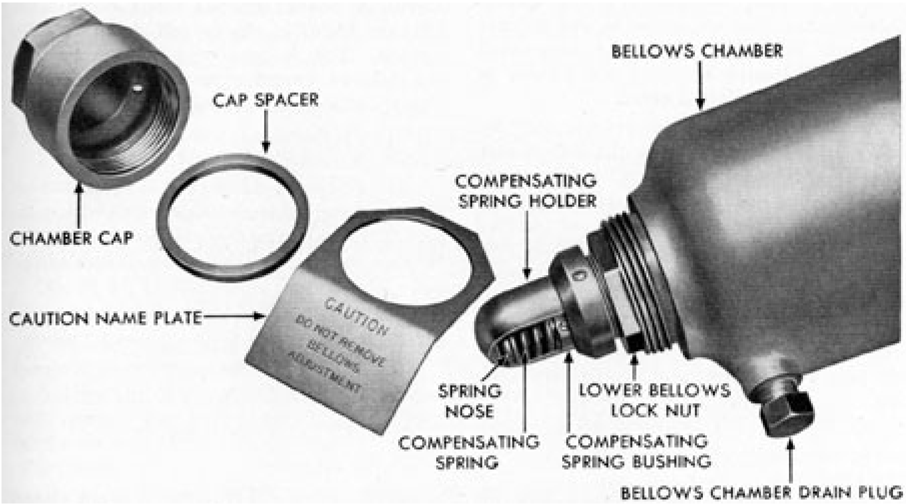
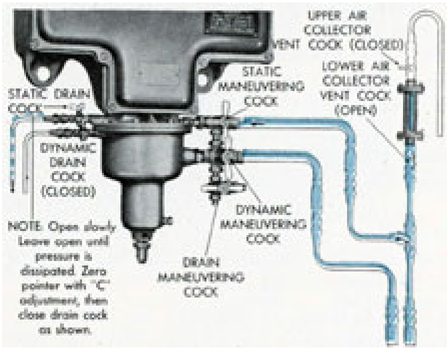


Figure 13-15. Dive error compensating mechanism.

a. The system is completely filled with water and bled of air.

b. The valves and vent cocks are set to the zero position.

c. The C-adjustment of the master transmitter indicator is set so that the speed pointer reads zero knots.



NOTE: Open slowly Leave open until pressure is dissipated. Zero point with "C" adjustment, then close drain cock as shown.
Figure 13-16. Maneuvering cocks and drain cocks positioned for dive error adjustment.

d. The submarine dives to approximately 300 feet. If the log still reads zero knots, there is no diving error and the system can be put into operation without further

adjustment. However, there usually is a positive error.

13E3. Adjusting for dive error. (See Figures 13-15 and 13-16.) When there is a positive dive pointer indicating zero knots, the submarine dives to 300 feet. If the pointer slowly rises and stops at 1 knot, the adjustment is made in the following manner:

error noted after performing the-operations outlined in Section 13E2, the following adjustment procedure is necessary:

a. Remove the chamber cap from the bottom of the bellows housing.

b. Loosen the setscrew on the compensating spring holder and screw up (clockwise) on the compensating spring holder, thus compressing the compensating spring. This will increase the error of the pointer indicator. The spring should be compressed until the indicated error of the pointer is about twice the original error.

c. Remove the static pressure in the following manner: Position the valves and vent the cocks as shown in Figure 13-16. Partially open the static drain cock as shown by the dotted outline in Figure 13-16. The static drain cock must be opened slowly so as to remove the pressure gradually. This is important as the sudden opening of the drain cock will damage the bellows. After the pressure has been dissipated, the speed pointer will drop but will not return to its zero position.

d. Set the speed pointer to the zero position by means of the C-adjustments. See Section 13A4.)

e. Position the valves and vent cocks to the zero position by turning the static maneuvering cock to the horizontal position as shown by the dotted lines in Figure 13-16. The above procedure may have to be repeated several times by alternately operating the static

a. Remove the chamber cap from the bottom of the bellows housing.

b. Loosen the setscrew securing the compensating spring holder.

c. Turn the screw holder clockwise (up), compressing the compensating spring until the log indicates 2 knots.

d. The static maneuvering cock (Figure 13-16) is closed and the static drain cock (Figure 13-16) is slowly and only partially opened. This reduces the pressure within the bellows chamber to the ship's atmosphere, and the pointer drops to 1.3 knots.

e. By means of the C-adjustment, the pointer is made to indicate zero knots.

f. The static drain cock is again closed, and the static maneuvering cock slowly opened. This increases the pressure within the bellows chamber to the water pressure of the sea. The pointer now rises to 0.6 knots.

g. The compensating spring is again compressed until the log indicates 1.2 knots.

h. The static maneuvering cock is closed and the static drain cock is slowly opened as before. The pointer drops to 0.7 knots. The pointer is made to read zero by means of the C-adjustment.

i. The static drain cock is again closed and the static maneuvering cock opened to the sea. The pointer rises to only 0.2 knots. If the cycle is repeated once more, the diving error, for all practical

maneuvering cock and the static drain cock until the correct spring pressure balances out the diving error. Then tighten the setscrew in the compensating spring holder.

f. Install the cap on the lower end of the bellows assembly. For an example of the method used in adjusting for dive error, refer to Section 13E4.

13E4. Example of adjusting for dire error. (See Figure 13-15 and 13-16.) With the maneuvering cocks in zero position, and the purposes, will have been eliminated.

j. If the log indications should become negative for increasing pressures, then the compensating spring is adjusted too tightly, and must be backed off.

k. After the spring holder has been set in the proper position, the setscrews are tightened, thus locking the spring holder against the dynamic bellows cap. Do not damage the threads by forcing the setscrews too tightly.

l. Replace the bellows chamber cap, being

sure to insert the caution plate and cap spacer between the cap and the bellows chamber.

13E5. Alternate method of adjusting for dive error. If a pressure pump is available, the bellows can be compensated when the ship is in port. The pump is connected to the static maneuvering cock. The maneuvering cocks are set in the zero position. The pressure should be checked by means of a pressure gage. A pressure of 150 pounds should be alternately applied and removed, while the adjustments described in Section 13E4 are being made.

F. MAINTENANCE OF SPEED AND DISTANCE INDICATOR

13F1. Removing the pointer and dial. (Figures 13-17, 13-18, and 13-19.) Remove the case cover retaining screws and cover. Remove the three screws and lock washers that secure the unit to the case, and lift the unit from the case. Remove the three screws and lock washers that secure the pointer hub cover and the pointer to the pointer hub, and remove the pointer. Remove the three screws and lock washers that secure the dial assembly to mounting studs, and carefully lift the dial assembly off the studs. The deflector

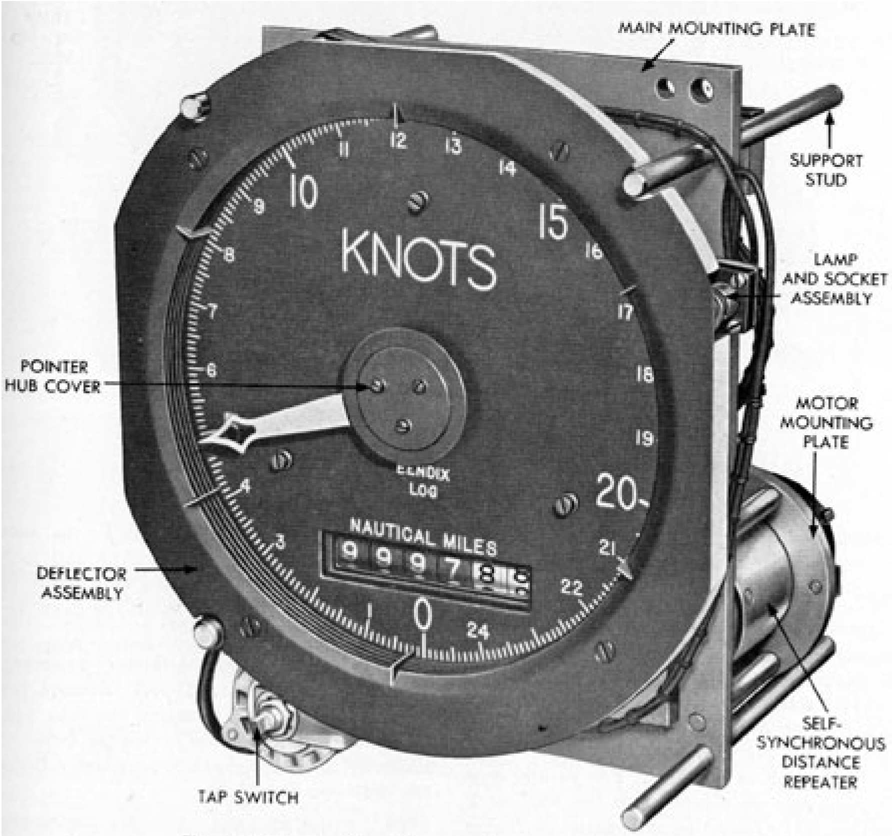


Figure 13-17. Speed and distance indicator removed from case.

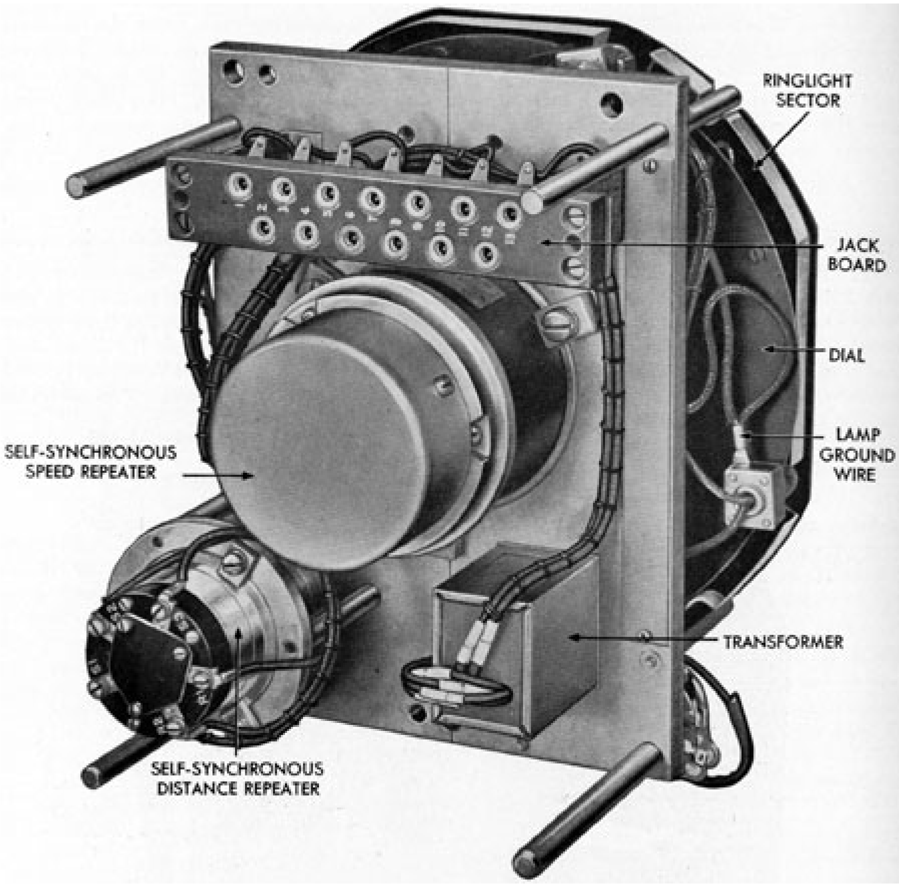


Figure 13-18. Rear view of speed and distance indicator.

assembly, ringlight sectors, and lamp sockets are removed with the dial.

location. Place the instrument in the case and secure with the three screws and lock washers provided.

13F2. Installing the dial and pointer. (See Figures 13-19 and 13-17.) Place the dial assembly in position on the dial mounting studs, and secure it with the three screws and lock washers provided. Place the pointer and pointer hub cover in position on the pointer hub, and secure with the three screws and lock washers provided. The pointer may be positioned in reference to the zero mark on the dial by loosening the pointer retaining screws and shifting the pointer to the desired

Place the case cover in position on the case and install the cover retaining screws.

13F3. Removing the deflector assembly. (See Figures 13-17 and 13-19.) Remove the cover from the case. Remove the four flathead machine screws that secure the deflector assembly to the ringlight sectors, and remove the deflector assembly.

13F4. Installing the deflector assembly. (See Figures 13-17 and 13-19.) Carefully

place the deflector assembly in position on the ringlight sectors, and secure with the four flathead machine screws provided. Install the case cover.

13F5. Replacing burned-out lamps. (See Figure 13-19.) Remove the deflector assembly. (See Section 13F3.) Replace the burned out lamps with new lamps. Install the deflector assembly. (See Section 13F4.)

13F6. Removing the ringlight sectors. (See Figure 13-19.) Remove the dial assembly from

13F4.) Install the dial assembly. (See Section 13F2.)

13F8. Removing the lamp sockets. (See Figure 13-19.) Remove the dial assembly. (See Section 13FL) Remove the lamps from the sockets. From the front of the dial remove the two screws that secure the lamp socket to the back of the dial. Remove the terminal screw from the ground wire. Push the center contact wire forward, unsolder the wire from the center contact, and remove the wires from

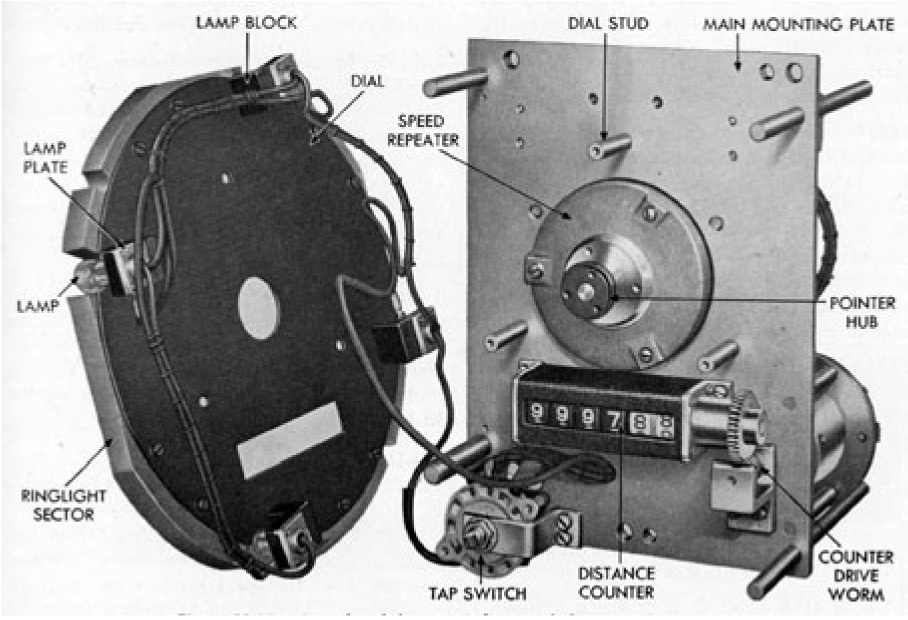


Figure 13-19. Speed and distance indicator, dial removed.

the dial mounting studs. (See Section 13F1.) Remove the deflector assembly. (See Section 13F3.) From the rear side of the dial remove the eight screws (two to each sector) that secure the sectors to the dial, and remove the sectors.

13F7. Installing the ringlight sectors. (See Figure 13-19.) Place one of the ringlight sectors in position on the back of the dial and secure with the two screws provided. The other sectors are installed in the same manner. Install the deflector assembly. (See Section

the socket. Remove the two screws that secure the lamp plate to the lamp bracket, and pull the socket out of the lamp block. The other three lamp sockets are removed in the same manner.

13F9. Installing the lamp sockets. (See Figure 13-19.) Place the socket in the lamp block. Position the lamp plate and secure it with the two screws provided. Push the lead wire into the rear end of the socket and solder this wire to the center contact. Connect the ground wire to the lamp plate. Place

the lamp socket in position and install the two screws that secure the socket to the dial. Install the lamp in the socket. The other three sockets are installed in the same manner. Install the dial assembly. (See Section 13F2.)

13F10. Removing the tap switch. (See Figure 13-19.) Remove the case cover. Remove the unit from the case. Remove

removed with the counter assembly. The worm gear is removed from the countershaft by loosening the setscrew, knocking out the tapered pin, and pulling the worm gear off the countershaft.

13F13. Installing the distance counter. (See Figure 13-19.) Place the worm gear on the countershaft and secure it with the setscrew

the two screws that secure the tap switch bracket to the mounting plate, and carefully pull the tap switch forward to make the wire connections accessible. Unsolder and tag the wires for ready identification. Remove the nut and toothed lock washer that secure the tap switch to the tap switch bracket.

13F11. Installing the tap switch. (See Figure 13-19.) Place the new tap switch in position in the tap switch bracket, and secure with the nut and toothed lock washer provided. Solder the wires to the terminals on the tap switch. Place the tap switch assembly in position on the mounting plate and secure it with the two screws provided. Install the unit in the case. Install the case cover.

13F12. Removing the distance counter. (See Figure 13-19.) Remove the dial assembly. (See Section 13F1.) Remove the four screws and lock washers that secure the counter to the front of the main mounting plate, and remove the counter. The worm gear is

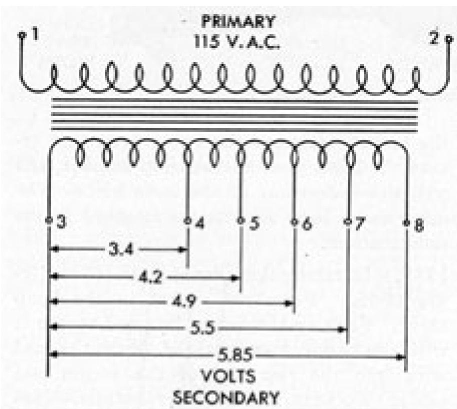


Figure 13-20. Transformer wiring diagram.

and tapered pin. Place the counter in position on the front of the mounting plate with the worm gear and worm properly meshed, and secure with the four screws provided. Install the dial assembly. (See Section 13F2.)

13F14. Removing the transformer. (See Figure 13-18.) Remove the dial assembly. (See Section 13F1.) From the front of the mounting plate remove the two screws that secure the transformer, to the mounting plate. Unsolder the primary leads from the jack connection. Unsolder the secondary leads from the tap switch. Tag the tap switch terminals for ready identification.

13F15. Testing the transformer. (See Figure 13-20.) Connect the two primary leads to the 115-volt a.c. line. Connect a voltmeter across the secondary leads as shown in Figure 13-20. Voltage readings should be taken as shown in Figure 13-20.

13F16. Installing the transformer. (See Figure 13-18.) Place the transformer in position on the back of the mounting plate, and secure it with the two screws provided, from the front of the mounting plate. Solder the two primary leads to the terminals on the jack connection. Solder the secondary leads to the terminals on the tap switch. Install the dial and pointer. (See Section 13F2.)

13F17. Removing the self-synchronous distance repeater. (See Figures 13-21 and 13-22.) Remove the unit from its case. Remove the terminal screws and washers that secure the lead wires to the distance repeater. Tag the

wires for ready identification. The terminals are marked S1, S2, S3, R1, and R2. Remove the three screws and lock washers that secure the distance repeater motor mounting clamps to the motor mounting plate, and remove the repeater from the mounting plate.

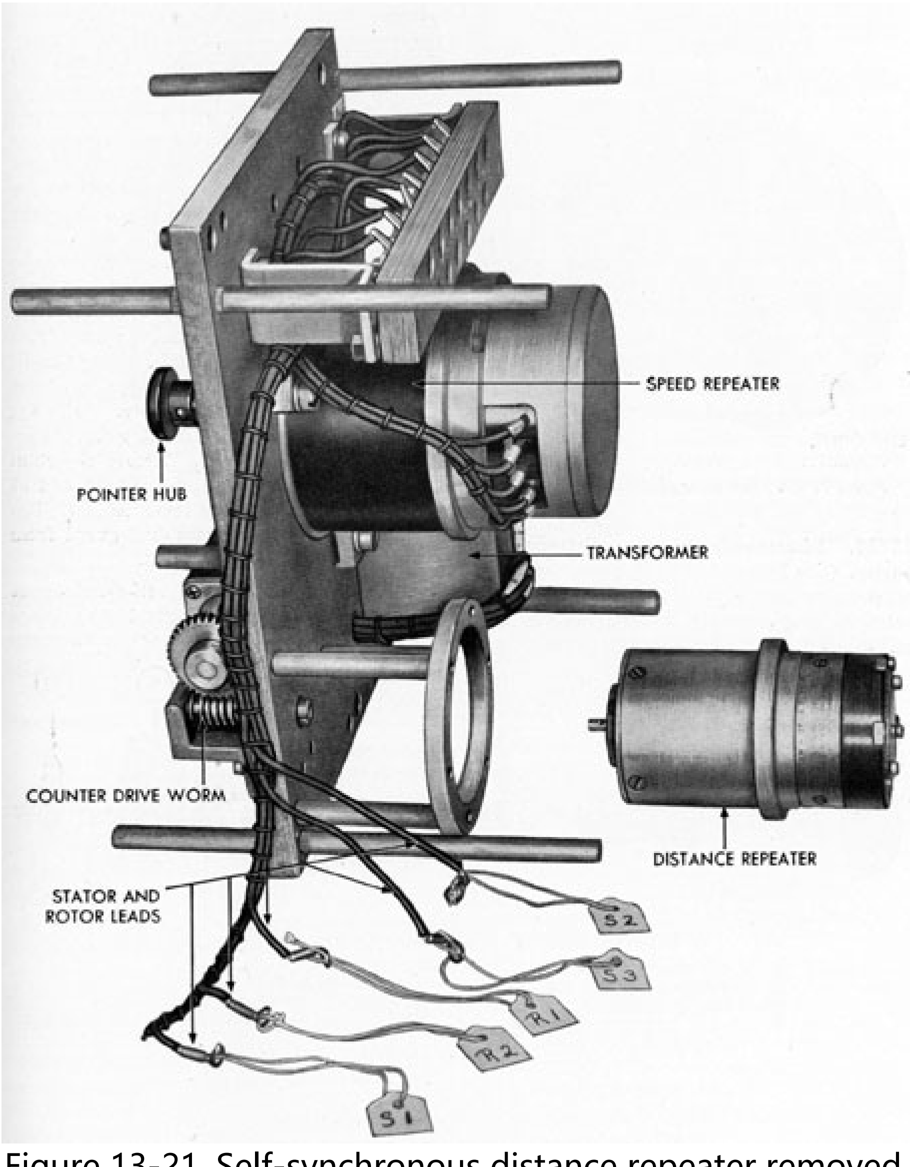


Figure 13-21. Self-synchronous distance repeater removed.

the terminal plates on the terminal ring assembly. Remove the three screws that secure the terminal ring assembly to the stator housing, and remove the ring assembly. The end and side

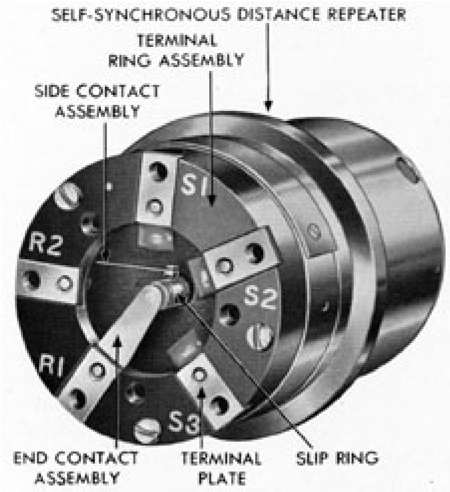
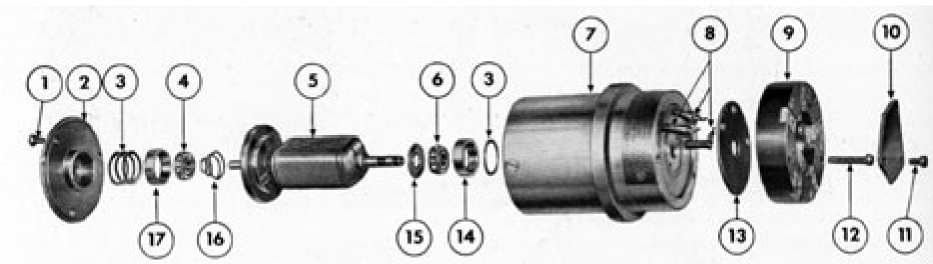


Figure 13-22. End view of distance repeater.

13F18. Disassembly of the distance repeater. (See Figure 13-23.) Remove the three screws that secure the terminal cover to the terminal ring assembly, and remove the terminal cover. Unsolder the stator leads from contact assemblies are secured in the terminal ring assembly with one screw. Slide the insulating plate off the wires. Remove the tapered pin from the front end of the rotor shaft. This pin engages the slot on the shaft extension of the worm shaft. Remove the three screws that secure the end cap assembly to the stator housing, and remove the end cap assembly. Pull the rotor and damper assembly from the stator housing. Remove the ball bearing and bearing spring from the front end of the rotor shaft. Using a small drive punch, drive out the outer race and shims from the end cap assembly. Holes are provided in the end cap assembly for the insertion of a drive punch. Remove the shim and bearing outer race from the back end of the stator housing in the same manner. Remove the bearing and brass dust guard from the rear end of the rotor shaft.

13F19. Assembly of the self-synchronous distance repeater. (See Figure 13-23.) Place the shim and bearing outer race in the back

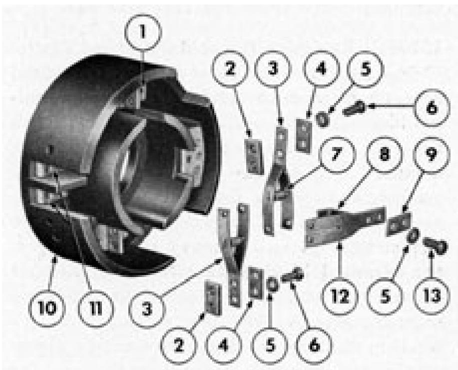


1. END CAP SCREW
2. END CAP
3. SHIMS
4. FRONT BEARING
5. ROTOR AND DAMPER, ASSEMBLY
6. REAR BEARING
7. STATOR HOUSING
8. STATOR LEADS
9. TERMINAL RING, ASSEMBLY
10. TERMINAL COVER
11. TERMINAL COVER SCREW
12. TERMINAL RING SCREW
13. INSULATING PLATE
14. REAR BEARING OUT RACE
15. DUST GUARD
16. BEARING SPRING
17. FRONT BEARING OUTER RACE

Figure 13-23. Distance repeater partially disassembled.

end of the stator housing, with the flange end of the race toward the end of the stator housing. Place the brass dust guard on the rear end of the rotor shaft, with the shoulder on the dust guard facing toward the end of the shaft. Place the ball bearing over the end of the rotor shaft and against the shoulder on the brass dust guard. Carefully insert the rotor and damper assembly into the stator housing, being careful to align the bearing in the outer race in the back end of the stator housing. Place the bearing spring over the front end of the rotor shaft, with the large diameter of the spring adjacent to the damper flywheel. Place the ball bearing over the front end of the rotor shaft and adjacent to the bearing spring. Place the shims and bearing outer race in the end cap assembly. Install the end cap assembly over the front end of the rotor shaft, and up against the stator housing. Secure the end cap with the three screws provided. Place the insulating plate over the stator leads, with the smooth side of the plate adjacent to the stator housing. Place the terminal ring assembly over the stator leads and up against the stator housing. Secure the ring with the three screws provided. Solder the stator leads to the terminals on the terminal plates. Install the terminal cover on the terminal ring with the three screws. If a new rotor assembly has been installed, it will be necessary to mounting plate. Secure the repeater with the three clamps and the three clamp screws provided. Install the unit in the case.

13F21. Removal of the self-synchronous speed repeater. (See Figure 13-18.) Remove the interior unit from the case. Remove the terminal block cover retaining screws and cover. The terminal block outer cover plate is removed with the terminal block cover. Cut the string that secures the lead wires together in order to fan out the lead wires near the terminals. Make a note of the position of the end contact terminal. This is the R1 lead terminal. Progressing in a counterclockwise direction, the other two brush terminals are identified as the R2 terminal and the R3 brush terminal. The wires are tagged with metal tags. The stator lead S2 is connected to the upper stator terminal, and the stator lead S1 is connected to the lower stator terminal. Remove the terminal screws that secure the leads to the terminal block, and



1. CONTACT PLATE
2. TAPPED SIDE CONTACT CLAMP PLATE
3. SIDE CONTACT SPRING
4. SIDE CONTACT CLAMP PLATE

drill a pin hole in the front end of the rotor shaft. Using the old rotor shaft as a guide, measure the distance from the center of the pin hole to the end of the rotor shaft in the same manner as shown for the speed repeater in Figure 13-26. Drill a transverse hole using a No. 55 drill for a 5/16-inch X 0.052 inch stainless steel pin. Press the pin into the hole in the rotor shaft. It is not necessary to set the distance repeater to electrical zero.

13F20. Installing. The self-synchronous distance repeater. (See Figure 13-21.) Connect the stator and rotor lead wires to the terminal ring of the distance repeater. Tighten the terminal screws securely. Align the pin on the front end of the rotor shaft with the slot provided in the worm shaft extension, and place the distance repeater in position on the

5. LOCK WASHER
6. SIDE CONTACT SCREW
7. CONTACT TENSION SPRING
8. CONTACT SPRING BRACKET
9. END CONTACT CLAMP PLATE
10. TERMINAL BLOCK
11. TERMINAL PLATE
12. END CONTACT SPRING
13. END CONTACT SCREW

Figure 13-24. Terminal block assembly partially disassembled.

remove the leads from the terminals. Cut off the terminal lugs from the ends of the rotor leads in order that these wires can be pulled out of the holes provided in the terminal block. Remove the three clamp screws and clamps that secure the speed repeater to the mounting plate, and remove the speed repeater.

13F22. Removing the contact assembly. The contact assembly can be removed from the speed repeater as a unit. Remove the terminal block cover retaining screw and the terminal block cover. Disconnect the rotor and

13F25. Installing the contacts. (See Figure 13-24.) Install one of the side contact assemblies in the following manner: Using tweezers, align one contact spring and the two contact clamp plates with the contact plate. Install the two screws and lock washers that secure the spring and clamp plates to the contact plate. The second side contact spring is installed in the same manner. Install the end contact assembly as follows: Align the contact spring bracket, contact spring, and contact clamp plate with the end spring contact plate, and install the two screws and lock washers that secure the end spring

stator lead wires from the terminal block as described in Section 13F21. Remove the two screws and lock washers that secure the terminal block to the rear end cap. Cut off the terminal lugs from the two stator leads that connect the stator with the contact plates. This is necessary in order that these two wires may be pulled through the holes provided in the terminal block. Remove the terminal block from the rear end cap.

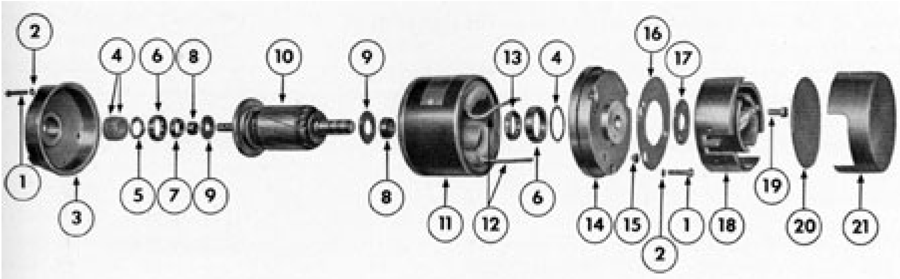
13F23. Removing the contacts. (See Figure 13-24.) Support the front end of the speed repeater on wooden blocks so that the terminal block is in an upright position. Remove the end contact assembly in the following manner: Remove the two screws and lock washers that secure the contact clamp plate, contact spring, and contact spring bracket to the contact plate. Remove the parts from the terminal block with tweezers. Remove the side contact assemblies in the following manner: Remove the two screws and lock washers that secure the side contact clamp plates and the side contact spring to the contact plate, and carefully remove the parts with tweezers. The second side contact assembly is removed in the same manner.

13F24. Cleaning the contacts and slip ring. Clean the contacts and the slip ring with a clean piece of note paper. Smooth the pitted contacts with a jeweler's file, and polish the surfaces with a burnishing tool. Do not; use emery cloth or crocus paper as fine particles from the cloth or contact in position on the contact plate.

13F26. Installing the contact assembly. (See Figure 13-25.) Insert the two stator wires through the holes provided in the terminal block. These are the two holes nearest the outer circumference of the terminal block. Be careful not to bend the contact springs. Secure the terminal block to the rear end cap with the two screws provided. Solder the terminal lugs on the ends of the two leads from the stator, and connect these wires to the contact plate with the screws and lock washers provided. Connect the S1 lead to the lower stator terminal, and the S2 lead to the upper stator terminal. Insert the R1 lead through the lower hole provided in the terminal block, the R2 lead through the upper hole, and the R3 lead through the center hole. Solder the terminal lugs on the ends of these rotor leads. Connect these rotor leads to the contact plates. Place the terminal block outer cover plate in position on the terminal block, and install the terminal block cover on the terminal block. Secure the cover with one screw. Install the unit in its case.

13F27. Removing the speed repeater rotor and bearings. (See Figure 13-25.) Remove the self-synchronous speed repeater. (See Section 13F21.) Remove the terminal block. (See Section 13F22.) Lift off the terminal block center cover plate and the terminal block inner cover plate. The two terminal lead insulating bushings are removed with the terminal block inner cover plate. Scribe a locating mark on the rear end cap and on the

paper will become imbedded in the soft metal of the contacts and slip ring.



1. END CAP SCREW
2. LOCK WASHER
3. FRONT END CAP
4. SHIMS
5. BEARING SPRING
6. BEARING OUTER RACE
7. FRONT BEARING
8. BEARING INNER RACE
9. DUST GUARD
10. ROTOR AND DAMPER ASSEMBLY
11. STATOR SHELL
12. STATOR LEADS
13. REAR BEARING
14. REAR END CAP
15. INSULATING BUSHING
16. TERMINAL BLOCK INNER COVER PLATE
17. TERMINAL BLOCK CENTER COVER PLATE
18. TERMINAL BLOCK ASSEMBLY
19. TERMINAL BLOCK SCREW
20. TERMINAL BLOCK OUTER COVER PLATE
21. TERMINAL BLOCK COVER

Figure 13-25. Speed repeater partially disassembled.

adjacent stator shell so that the end cap can be installed in the same relative position at assembly. Remove the three rear end cap retaining screws and lock washers, and remove the rear end cap. The rear bearing outer race and shim are removed with the rear end cap. Remove the setscrew that secures the pointer hub to the rotor shaft, and remove the pointer hub. Remove the three front end cap retaining screws and lock washers, and remove the front end cap. Be careful not to lose the bearing outer race, bearing spring, and shim from the front end cap. Remove the rotor and damper assembly from the stator

13F28. Assembling the self-synchronous speed repeater. (See Figure 13-25.) Place the rear bearing dust guard on the rear end of the rotor shaft, with the shoulder on the guard facing away from the rotor. Place the bearing inner race on the rear end of the rotor shaft adjacent to the dust guard. Place the shim and outer bearing race in the rear end cap with the flange of the race toward the cap. The race is a light press fit into the end cap. Place the rear ball bearing on the rear bearing inner race. Install the rear end cap on the stator shell with the locating scribed marks aligned. Secure the rear end cap with the three screws and lock washers

shell. Remove the bearing, bearing inner race, and dust guard from the front end of the rotor shaft. Remove the rear bearing, bearing inner race, and dust guard from the rear end of the rotor shaft. Remove the front bearing outer race, bearing spring, and shims from the front end cap. Remove the rear bearing outer race and shim from the rear end cap. The outer race and shim are removed from the rear end cap by inserting a small drive punch through holes in the rear end cap and driving out the shim and outer race.

provided. Carefully install the rotor and damper assembly into the stator shell, making certain that the rear end of the stator shaft is aligned with the opening in the rear end cover. Support the rear end cover and stator shell on wooden blocks in order to assemble the front end of the repeater. Place the front bearing dust guard over the front end of the rotor shaft, with the shoulder of the guard away from the rotor. Install the front bearing inner race adjacent to the front bearing dust guard. Place the ball bearing on the inner

race on the front end of the rotor shaft. Install the shims, bearing spring, and outer race in the opening provided in the front end cap. The lugs of the bearing spring should face the rotor, and the flange of the outer race should face the end cap. Install the front end cap on the stator shell, being careful when inserting the rotor shaft through the end cap not to damage the bearing. Secure the front end cap with the three screws and lock washers provided. Turn the rotor shaft by hand to make sure that the rotor rotates freely. Turn the repeater over so that the front end cap rests on wooden blocks on the bench. Place the two lead insulating bushings over the stator leads, with the flange end of the bushings away from the end cap. Insert the bushings into holes provided in the rear end cap. Install the terminal block inner cover plate on the rear end cap by inserting the stator leads through the

installed it will be necessary to drill a new pointer hub screw hole in the new shaft. Locate and drill the hole in the following manner: Measure the distance of the centerline of the hole from the front end of the old rotor shaft as shown in Figure 13-26. Mark the location of the hole and drill a hole in the new shaft, using a No. 32 drill. Tap a bole for a 6-40 screw. Install the pointer hub on the shaft and secure with the screw provided. Install the dial and pointer. (See Section 13F2.) Set the speed repeater to electrical zero. (See Section 13F30.)

13F30. Setting the speed repeater to electrical zero. (See Figure 13-27.) Set the speed

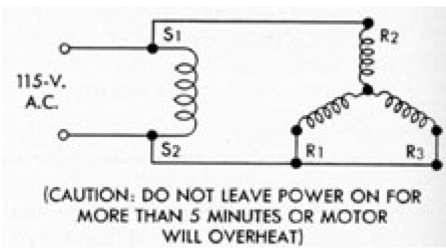


Figure 13-27. Wiring diagram

large holes in the inner cover. Place the terminal block center cover plate over the slip rings and against the rear end cap. Install the terminal block. (See Section 13F26.)

13F29. Installing the self-synchronous speed repeater. (See Figures 13-18, 13-25, and 13-26.) Align the scribe mark on the front end cap with the scribe line on the back of the mounting plate, and place the repeater in position on the back of the mounting plate. Secure in position with the three clamps and clamp screws provided. If a new rotor has been

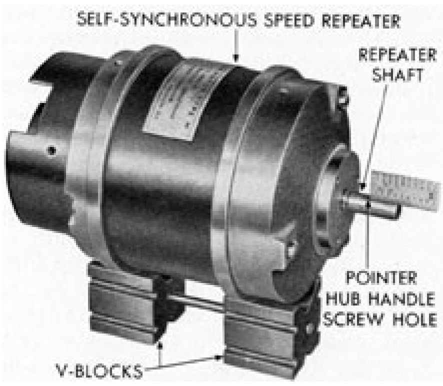


Figure 13-26. Locating position of pointer hub handle screw.

showing connections for setting speed repeater to electrical zero.

repeater to electrical zero as follows: Contact the terminals of the speed repeater S1 to R2 to one side of the line. Connect S2 to R1 and R3 to the other side of the line as shown in Figure 13-27. Energize the unit. Do not leave the power on for mote than 5 minutes, or the motor will overheat. When the unit is energized, the shaft will assume a definite position (zero position). Loosen the three screws that secure the pointer to the pointer hub, and shift the pointer to the zero position on the dial. Lock the pointer in this position by tightening the three pointer screws.

13F31. Disassembly of the counter drive worm assembly. (See Figure 13-28.) Remove the distance counter. (See Section 13F12.) Remove the two screws that secure the worm bracket to the mounting plate. Carefully pry the worm bracket from the mounting plate. The bracket is pinned to the mounting plate, and care should be exercised not to bend the

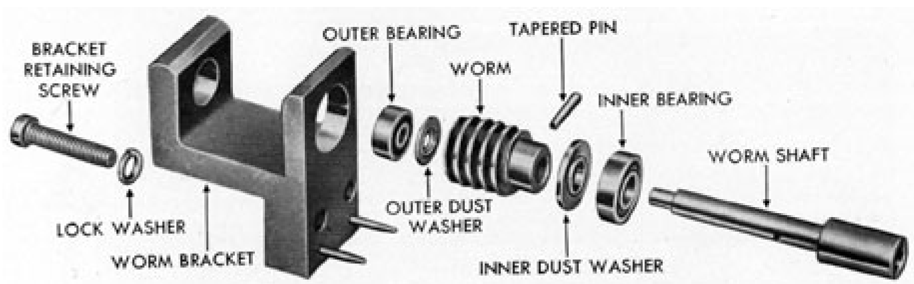


Figure 13-28. Counter drive worm assembly disassembled.

pins. Drive out the tapered pin that secures the worm on the shaft. Pull the worm assembly out of the worm bracket.

shoulder on the washer facing the inner race of the inner bearing. Place the worm on the shaft and install the tapered pin that secures

Remove the outer bearing, dust washer, worm, inner dust washer, and inner bearing from the worm shaft. It may be necessary to file off the burrs from the pin holes in order to remove the inner bearing.

13F32. Assembly of the counter drive worm assembly. (See Figure 13-28.) Place the inner bearing on the worm shaft, with the bearing shield toward the shaft extension. Install the inner dust washer on the shaft, with the the worm on the shaft. Install the outer dust washer on the shaft, with the shoulder on the washer facing the front end of the shaft. Place the worm and shaft assembly in the worm bracket. Align the dowel pin holes of the bracket with the holes provided in the mounting plate, and install the bracket on the mounting plate. Secure the bracket to the mounting plate with the two screws provided. Install the counter. (See Section 13F13.)

G. MAINTENANCE OF MASTER TRANSMITTER INDICATOR

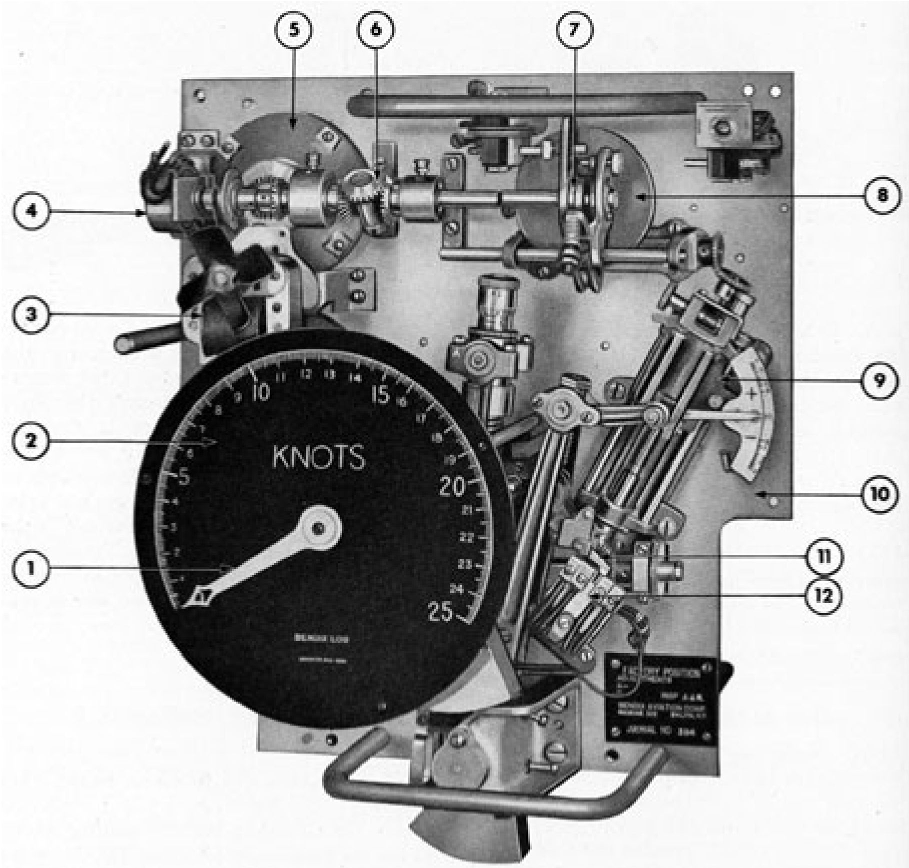
13G1. Removing the unit from the case. (See Figure 13-29.) Lower the bellows from the case so that the C-adjustment mechanism will clear the bottom of the main balance arm. (See Section 13D2.) Remove the screws that secure the main mounting plate to the case, and carefully lift the master transmitter log mechanism from its case. Place the log mechanism on a bench, or in an inspection stand.

13G2. Replacing the pointer and dial. (See Figure 13-29.) Remove the screw that secures the pointer and pointer washer to the pointer hub, and carefully lift the pointer off the pin of the pointer hub. Mark the back of the pointer so that it may be installed in the same relative position. Remove the three screws that secure the dial to the dial posts, and remove the dial. Place the new dial in position on the dial studs and secure with the three screws provided. Place and secure with the pointer screw provided.

13G3. Removing the follow-up motor. (See Figure 13-30.) Remove the four screws that secure the follow-up motor mounting clamp to the main mounting plate, and lift the motor to one side so that the lead wires are made accessible. Unsolder the wires from the motor terminals, and mark the wires for ready identification. Place the motor to one side.

13G4. Replacing the follow-up motor. (See Figures 13-31 and 13-32.) Remove the fan from the follow-up motor shaft by loosening the setscrew in the fan hub. Remove the motor mounting clamp from the old motor by removing the two screws, lock washers, and spacer washers that secure the clamp to the motor. Remove the gear assembly from the old motor by removing the snap ring and lifting the gear assembly from the gear mounting

the pointer and pointer washer in position on the pointer hub stud of the motor as shown in Figure 13-31. Place the gear assembly on the stud of



1. POINTER
2. DIAL
3. FOLLOW-UP MOTOR
4. 500-OHM RHEOSTAT
5. DISTANCE TRANSMITTER
6. DIFFERENTIAL ASSEMBLY
7. FOLLOWER
8. ROTATING DISK
9. COMPONENT FRAME ASSEMBLY
10. MAIN MOUNTING PLATE
11. CONTACT ARM
12. CONTACT ASSEMBLY

Figure 13-29. Master transmitter indicator removed from case.

the new motor and secure it with the snap ring as shown in Figure 13-32. Place the spacer washers in position on the new motor, and place the motor mounting bracket on the spacer washers. Secure the bracket to the motor with the two screws and lock washers

provided. Place the fan on the motor shaft, and tighten the setscrews in the fan hub.

13G5. Installing the follow-up motor. (See Figure 13-30.) Solder the motor lead wires to the terminals on the motor. Place the motor and mounting bracket in position on

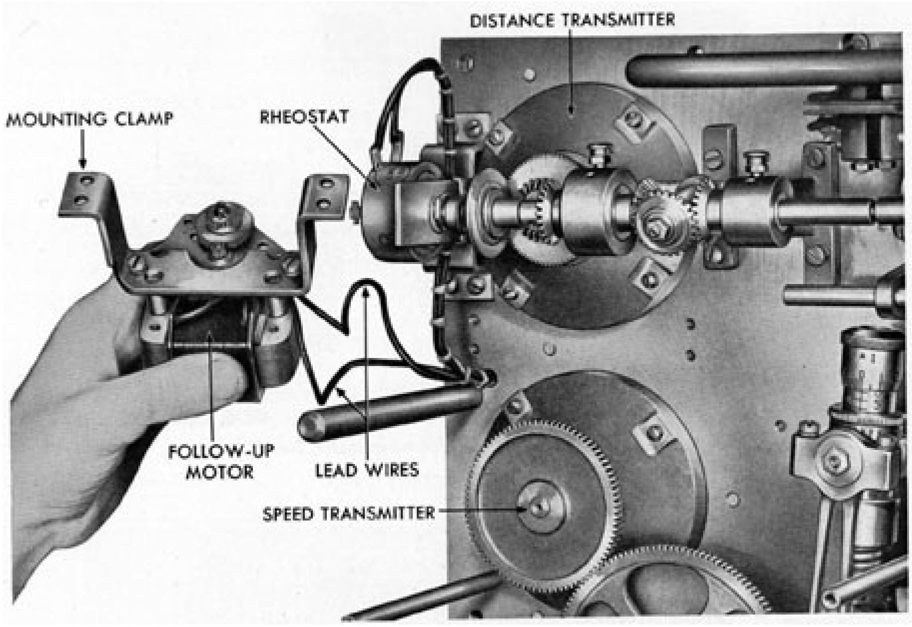


Figure 13-30. Removing follow-up motor.

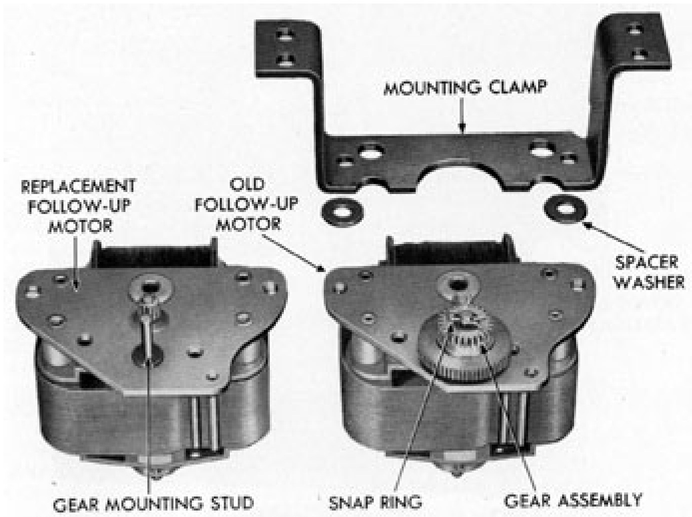


Figure 13-31. Replacing follow-up motor, Step 1.

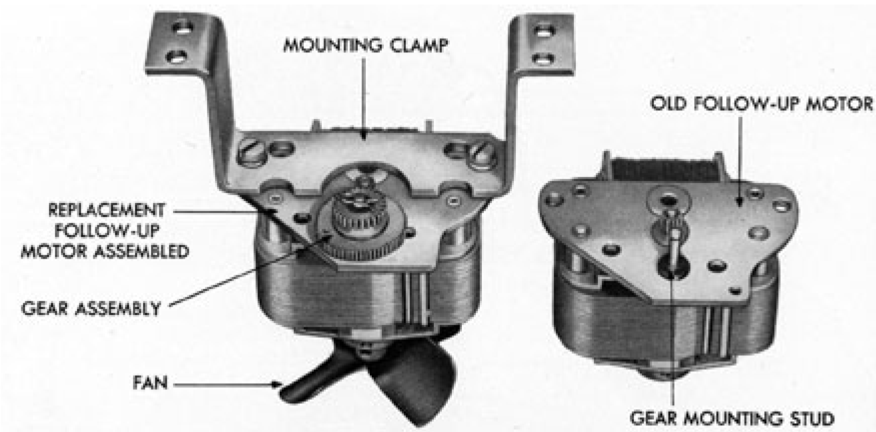


Figure 13-32. Replacing follow-up motor, Step 2.

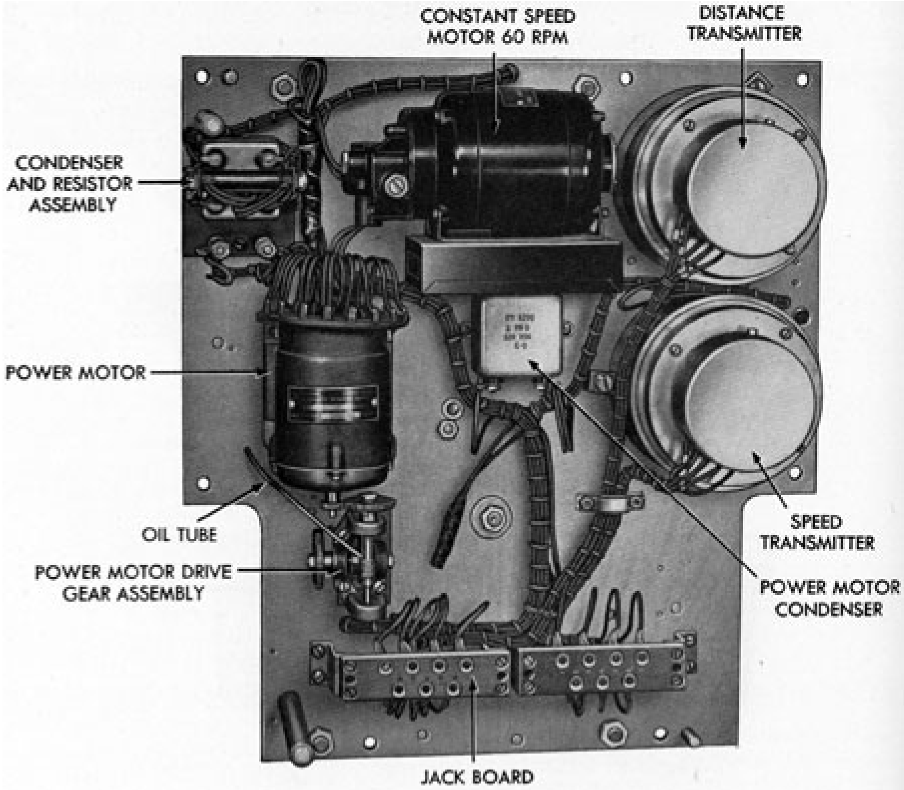


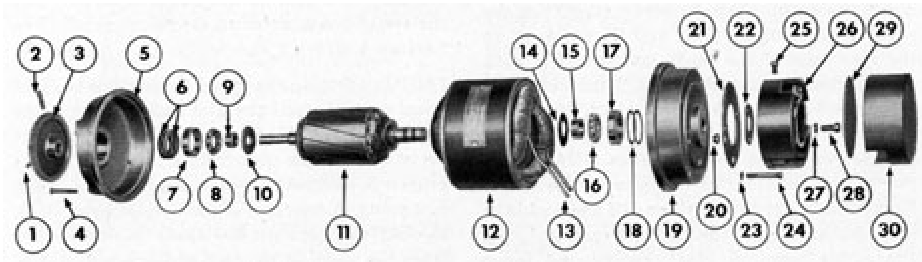
Figure 13-33. Rear view of master transmitter indicator.

the front of the main mounting plate, and secure it with the four screws provided.

13G6. Removing the self-synchronous speed transmitter. (See Figure 13-33.) Remove the master transmitter indicator mechanism from the case. Remove the terminal block cover retaining screw and the terminal block cover. The terminal block outer cover plate is removed with the terminal block cover. Disconnect the stator and rotor leads in the same manner as described for the disconnection of the leads of the speed repeater. (See Section 13F21.) Unsolder and remove the rotor lead terminal lugs. Pull the wires out of the terminal block. Turn the power motor shaft by hand so that the gear on the motor speed transmitter shaft will clear the main cam. Remove the three clamp screws and clamps that the front end of the rotor shaft by removing the handle screw and socket head setscrew that secure the gear to the shaft. Remove the front end cap retaining screws, and the front end cap. Carefully pull the rotor assembly out of the stator shell. Remove the front end bearing, bearing inner race, and front bearing dust guard from the front end of the rotor shaft. Remove the outer race and shims from the front end cap. Unsolder the terminal lugs from the stator inner leads. Remove the terminal block retaining screws and lock washers, and remove the terminal block. Remove the terminal block inner and center cover plates from the rotor shaft. Remove the terminal lead insulating bushings from the rear end cap. Remove the rear end cap retaining screws and lock washers, and remove the rear end cap from the stator shell. Remove the rear ball bearing, ball

secure the speed transmitter to the main mounting plate, and carefully remove the speed transmitter.

13G7. Disassembly of the speed transmitter. (See Figure 13-34.) Remove the gear from bearing inner race, and rear bearing dust guard from the rear end of the rotor shaft. Knock the rear bearing outer race and shims out of the rear end cap.



1. SETSCREW.
2. HANDLE SCREW.
3. SPEED TRANSMITTER DRIVEN GEAR.
4. FRONT END CAP SCREW.
5. FRONT END CAP.
6. SHIMS.
7. BEARING OUTER RACE.
8. FRONT BEARING.
9. BEARING INNER RACE.
10. DUST GUARD.
11. ROTOR ASSEMBLY.
12. STATOR SHELL.
13. STATOR LEADS.
14. DUST GUARD.
15. BEARING INNER RACE.
16. REAR BEARING.
17. BEARING OUTER RACE.
18. SHIMS.
19. REAR END CAP.
20. INSULATING BUSHING.
21. TERMINAL BLOCK INNER COVER PLATE.
22. TERMINAL BLOCK CENTER COVER PLATE.
23. LOCK WASHER.
24. REAR END CAP SCREW.
25. COVER RETAINING SCREW.
26. TERMINAL BLOCK.
27. LOCK WASHER.
28. TERMINAL BLOCK SCREW.
29. TERMINAL BLOCK OUTER COVER PLATE
30. TERMINAL BLOCK COVER.

Figure 13-34. Self-synchronous speed transmitter partially disassembled.

13G8. Assembly of the speed transmitter. (See Figure 13-34.) Place the shims and bearing outer race in the rear end cap, with the flange on the race toward the end cap. Install the rear end cap on the stator shell by inserting the stator leads through the end cap, and secure the end cap to the stator shell with the four screws provided. Place the speed transmitter in position on the main mounting plate, and temporarily install the clamps and clamp screws. Do not tighten the clamp screws at this time, as the motor will have to be shifted when setting it to electrical zero. Connect the rotor and stator leads to the terminal block in the same manner as described in Section 13F26. Set the speed

Place the rear bearing dust guard on the rear end of the rotor shaft with the shoulder of the guard toward the end of the shaft. Install the rear bearing inner race and rear bearing on the rotor shaft. Place the rotor assembly into the stator shell, being careful not to damage the bearing as the shaft is inserted through the rear end cap. Place the shims and front bearing outer race in the front end cap, with the flange of the race toward the end cap. Install the front bearing dust guard on the shaft, with the shoulder of the guard facing the end of the shaft. Install the bearing inner race and the front bearing on the rotor shaft. Install the front end cap on the stator shell and secure with the four screws and lock washers provided. Turn the rotor shaft to make sure that the shaft is rotating freely. Install the gear on the front end of the shaft, and secure it with the handle screw and socket head setscrew. If a new rotor has been installed, it will be necessary to drill and tap a hole in the shaft for the gear screw. (See Section 13G9.) Place the lead insulating bushings over the stator leads, and insert the small end of the bushings into the holes provided in the rear end cap. Place the terminal block center and inner cover plates on the rear end cap, with the stator leads inserted through the holes provided in the inner cover plate. Hold the terminal block in position near the rear end cap, and insert the stator leads through the two holes provided nearest the outer circumference of the terminal block. Carefully spread the side transmitter to electrical zero. (See Section 13G10.)

13G9. Drill and tap rotor shaft. When a new rotor is installed in the self-synchronous speed transmitter, it is necessary to drill and tap a hole in the shaft for installation of the motor-driven gear. This operation is performed in the following manner: Locate the position of this hole by measuring the distance from the end of the shaft to the centerline of the hole on the old rotor shaft as shown in Figure 13-26. Locate the position of the hole on the new rotor shaft. Using a No. 29 drill, drill a hole through the shaft. Tap this hole for an 8-36 screw. Place the gear on the rotor shaft and secure it with a handle screw and socket head setscrew. Set the speed transmitter to electrical zero. (See Section 13G10.)

13G10. Setting the speed transmitter to electrical zero. Install the dial and pointer. (See Section 13G2.) The speed pointer should be set at zero on the dial. While the speed transmitter is temporarily installed on the main mounting plate, move the transmitter back so that the gear on the shaft is disengaged from the gear on the cam and bracket assembly. Use one of the speed and distance indicators (repeaters) as a checking instrument. Energize the system. Manually turn the speed transmitter gear until the pointer on the speed and distance repeater is indicating zero. Carefully push the speed transmitter forward until the gears are properly meshed. Any slight shifting of the speed and distance repeater pointer is compensated for by a slight rotation of the

contacts while installing the terminal block so that the contact springs will not be bent. Secure the terminal block to the rear end cap with the two screws and lock washers provided. Solder the terminal lugs on the end of the stator inner leads, and connect the inner lead terminals to the terminal plate located between the stator leads. speed transmitter stator shell in the main mounting plate. When the pointer is at exact electrical zero, tighten the motor mounting clamps. Place the terminal block outer cover plate in position on the terminal block, and install the terminal block

cover. Secure the cover with the screw provided. Install the unit in the case.

13G11. Distance transmitter. The self-synchronous distance transmitter of the master transmitter indicator is removed, disassembled, and assembled in the same manner as the speed transmitter. (See Sections 13G6, 13G7, and 13G8.) It is not necessary to set the distance transmitter to electrical zero.

remove it from the differential shaft. The left-hand friction disk is removed with the friction disk holder. Remove the clutch plate, right-hand friction disk, and spring holder plate from the differential shaft. Drive out the pin that secures the slipping clutch compression spring in the spring adjuster, and remove the spring from the shaft. Loosen the spring adjuster socket head setscrew, and remove the spring adjuster. Loosen the

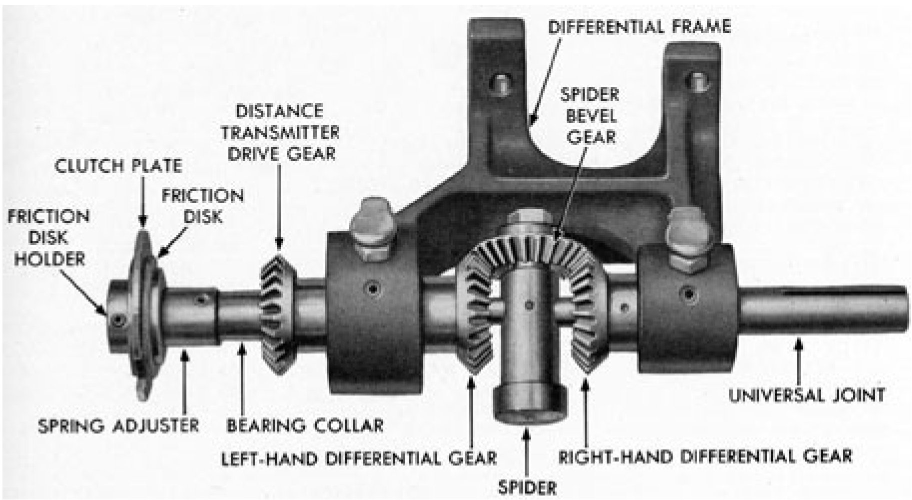


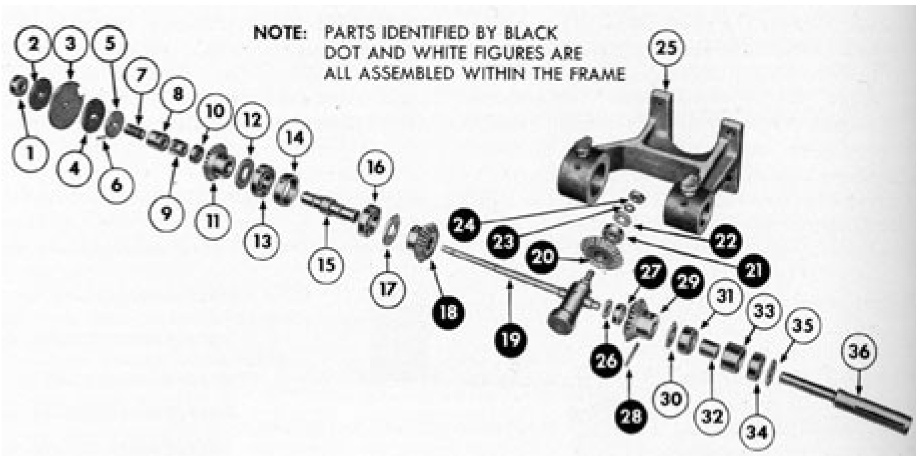
Figure 13-35. Differential assembly removed.

13G12. Removing the differential assembly. (See Figure 13-35.) Drive out the pin that secures the universal center in the universal joint. Move the universal center to the right and out of the universal joint. Remove the four screws that bearing collar setscrew, and remove the bearing collar. Loosen the distance transmitter drive gear setscrew, and remove the gear from the shaft. Remove the bearing from the distance transmitter drive gear. Remove the dust washer from the left-hand

secure the differential frame to the main mounting plate. Carefully remove the differential assembly from the main mounting plate. The differential frame is pinned to the mounting plate and must be carefully pried away from it. The differential assembly is usually replaced as a unit. In the event that it become necessary to clean and replace individual parts, the differential assembly must be disassembled, as described in Section 13G13.

13G13. Disassembling the differential assembly. (See Figure 13-36.) Loosen the friction disk holder socket head setscrew and side of the differential frame. Remove the nut, lock washer, dust washer, and spider bevel gear from the spider shaft. Remove the bearing from the spider bevel gear.

Loosen the two socket head setscrews in the differential frame. Push the differential shaft toward the left, and remove the bearing and bearing spacer from the left side of the differential frame. Loosen the setscrew in the differential right-hand gear; then pull the shaft toward the left in order to remove the bearing from the right-hand gear. Drive out the tapered pin from the differential



1 FRICTION DISK HOLDER.
2 LEFT HAND FRICTION DISK.
3 CLUTCH PLATE.
4 RIGHT HAND FRICTION DISK.
5 SPRING HOLDER PLATE.
6 COMPRESSION SPRING PIN.
7 SLIPPING CLUTCH COMPRESSION SPRING.
8 SPRING ADJUSTER.
9 BEARING COLLAR.
10 DRIVE GEAR BEARING.
11 DISTANCE TRANSMITTER DRIVE GEAR.
12 DUST WASHER.
13 BEARING.
20 SPIDER BEVEL GEAR.
21 BEARING.
22 DUST WASHER.
23 LOCK WASHER.
24 NUT.
25 DIFFERENTIAL FRAME.
26 DUST WASHER.
27 BEARING.
28 TAPERED PIN.
29 RIGHT HAND DIFFERENTIAL GEAR.
30 DUST WASHER.
31 BEARING.
32 BEARING INNER SPACER.
33 BEARING OUTER SPACER.

14 LEFT HAND BEARING SPACER.
15 HOLLOW SHAFT.
16 BEARING.
17 DUST WASHER.
18 LEFT HAND DIFFERENTIAL GEAR.
19 DIFFERENTIAL SHAFT AND SPIDER.

34 BEARING.
35 DUST WASHER.
36 UNIVERSAL JOINT.

Figure 13-36. Differential assembly disassembled.

right-hand gear, and remove this gear and the dust washer from the universal joint. Pull the universal joint assembly from the right side of the differential frame; then remove the bearing, bearing inner and outer spacers, second bearing, and dust washer from the universal joint. Loosen the differential left-hand bevel gear setscrew, and remove the gear from the hollow shaft. Push the hollow shaft assembly out of the left side of the differential frame. Remove the dust guard and bearing from the hollow shaft. Remove the differential right-hand bevel gear bearing and dust washer from the right end of the differential shaft. Remove the differential shaft and spider from the differential frame.

13G14. Assembly of the differential assembly. (See Figure 13-36.) Install the bearing and dust washer, with the shoulder facing the bearing race, on one end of the differential hollow shaft. Install the bearing spacer, second bearing, and dust washer on the opposite end of the hollow shaft in the same manner. Place the left-hand differential gear on the long end of the differential shaft, with the gear teeth facing the spider; then insert the long end of the shaft through the left-hand side of the differential frame, from right to left. Slide the hollow shaft assembly over the long end of shaft and into approximate position in the left-hand side of the differential frame.

Make certain that the long section of the hollow shaft is facing the spider, otherwise the hollow shaft assembly will not line up properly in the frame.

Install the dust washer on the left-hand side of the universal joint, with the shoulder on the dust washer facing away from the large section of the universal joint. Install the inner and outer bearing spacers; then

install the universal joint left-hand bearing adjacent to the inner and outer spacers. Install the bearing in the left-hand differential gear. Hold the left-hand differential gear in position the adjuster. Install the spring holder plate, with the slot in the plate aligned over the spring holder pin.

on the differential frame, and insert the universal joint assembly into the opening in the right side of the frame and into the left-hand differential gear. Place the dust washer on the short end of the differential shaft, with the shoulder of the washer away from the spider. Push the differential assembly toward the right while holding the universal joint assembly in position, to engage the differential shaft and universal joint. Install the bearing in the spider bevel gear; and place this gear in position on the spider, with the gear teeth meshing with the differential gears. Install the dust washer on the spider bevel gear, with shoulder of the washer toward the bearing race. Install the lock washer and nut that secure spider bevel gear in position on the spider.

Align the hole in the right-hand differential gear with the hole in the universal joint and install the tapered pin that secures the gear in position on the joint. Tighten the socket head setscrew in this gear hub. Install the bearing in the distance transmitter drive gear and install this gear on the left end of the hollow shaft, with the gear teeth facing away from the frame; then tighten the setscrew in the gear hub. Align the gears and shaft assembly in the differential frame and tighten the two socket head setscrews that secure the bearing spacers in the differential frame. Tighten the setscrew in the left-hand differential gear hub. Manually turn the spider and shaft by hand to be sure that the parts are rotating freely.

Install the right-hand friction disk, with the slot in the disk over the spring holder pin. Install the clutch plate, left-hand friction disk, and friction disk holder on the differential shaft, with the flat on shaft aligned with the setscrew in the friction disk holder hub; then tighten the hub setscrew.

13G15. Installing the differential assembly. (See Figure 13-35.) Place the differential assembly in approximate position on the main mounting plate so that the universal center is inserted within the universal joint. Use care in aligning the clutch plate with the rheostat assembly. Align the pin holes in the main mounting plate with the pins in the universal frame, and carefully place the universal assembly in exact position on the mounting plate. Install the four screws that secure the differential frame to the mounting plate. Install the pin that secures the universal center in the universal joint.

13G16. Removing the constant speed motor. (See Figure 13-37.) Remove the log mechanism from its case. Remove the differential assembly so that the motor mounting screws are accessible. (See Section 13612.) Loosen the two setscrews that secure the rotating disk to the motor shaft. Disconnect and tag the electrical leads. Remove the two screws and lock washers that secure the limit switch assembly to the mounting plate, and swing the switch assembly out of the way. From the front of the main mounting plate remove the four screws and lock washers that secure the constant speed motor to the mounting plate. One man holds the disk

Install the dust washer adjacent to the distance transmitter drive gear with the shoulder of the washer facing the bearing. Install the bearing collar on the left end of the shaft, and tighten the collar setscrew. Place the spring adjuster adjacent to the bearing collar, and tighten the adjuster setscrew. Install the slipping clutch compression spring in the spring adjuster. Compress the spring and install the pin that secures the spring in while a second man carefully pulls the motor shaft out of the friction disk. The motor shaft is sometimes burred because the setscrews have been forced too tightly. In such a case the motor will have to be turned clockwise and counterclockwise through approximately a 45-degree arc while pulling it away from the disk. Remove the friction disk. Cut the string that secures the lead wires to the main leads. Remove the tape from the ends of the leads,

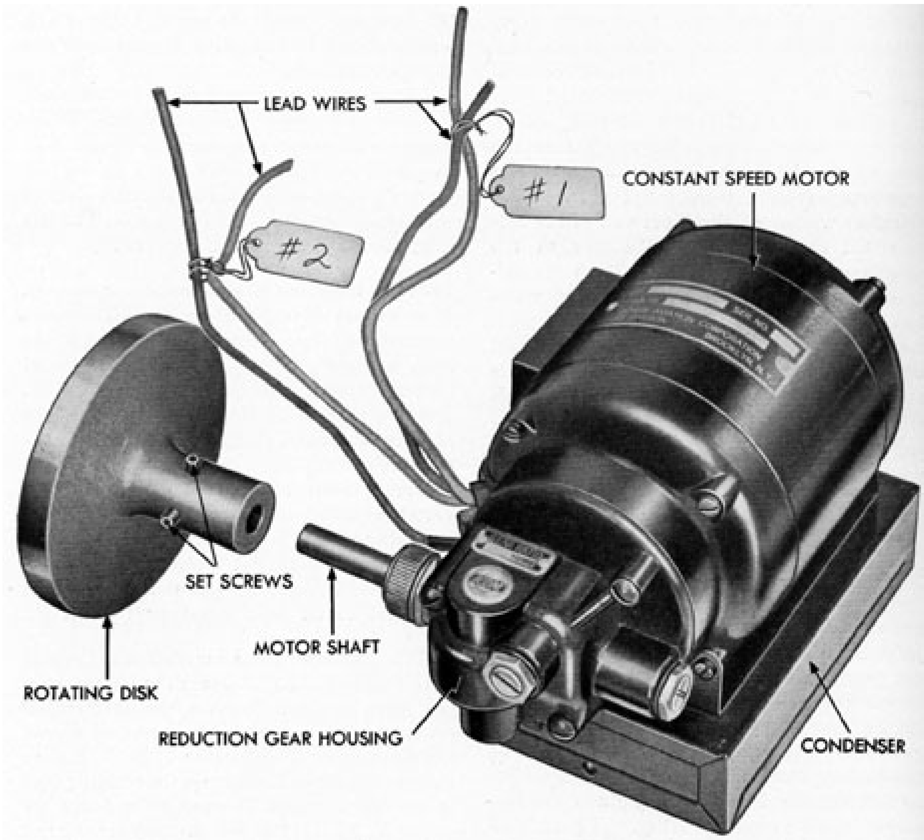


Figure 13-37. Constant speed motor removed.

and unsolder the lead connections. Tag the leads for ready identification. Place the motor to one side.

13G17. Disassembly of the constant speed motor. (See Figure 13-38.) Remove the three reduction gear housing screws, and remove the housing. Remove the four screws that of the rotor shaft. The bearing is a light press fit. Remove the bearing and shims from the back end cap.

13G18. Assembly of the constant speed motor. (See Figure 13-38.) If the felt retainers have been removed for any reason place a felt washer between the two felt retainers, and place the retainers in position or the back end cap.

secure the motor to the condenser, and lift the motor to one side of the condenser so that the end caps may be removed. Remove the four screws that secure the back end cap to the motor frame, and remove the end cap. Pull the rotor assembly from the motor frame. Remove the bearing from the worm gear end

Secure the retainers with the four screws provided. Place the bearing on the worm end of the rotor shaft, with the bearing shield toward the shaft end. Place the shims and bearing in the back end cap with the bearing shield toward the end, cap

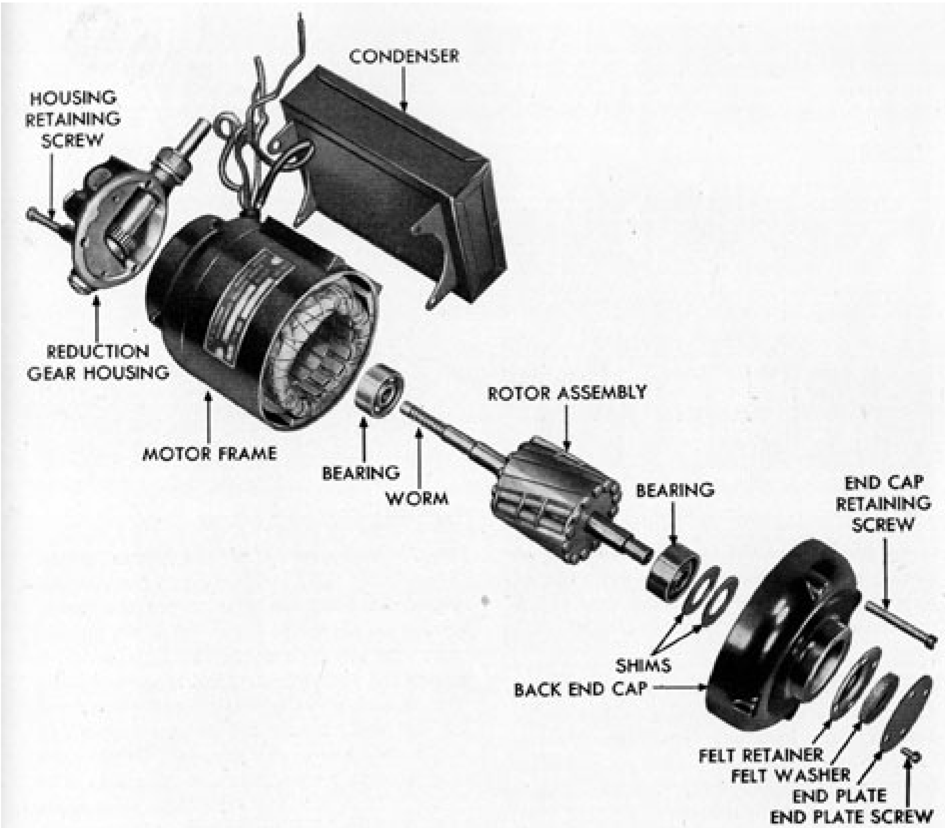


Figure 13-38. Constant speed motor partially disassembled.

Place the reduction gear housing in position on the front end of the motor, and secure with the three screws provided. Carefully insert the rotor into the frame with the worm on the shaft meshed with the gear on the reduction gear housing. Place the back end cap in position on the motor frame, being careful when aligning the rear end of the rotor shaft with the bearing in the back end cap. Secure the end cap with the four screws

switch assembly in position on the main mounting plate and secure it with the two screws and lock washers provided. Connect the electrical leads. Install the differential assembly. (See Section 13G15.)

13G19. Disassembly of the reduction gear housing. (See Figures 13-38 and 13-39.) Remove the reduction gear housing from the motor. (See Section 13G17.) Unscrew and remove the packing

provided. Place the constant speed motor in position on the rear of the main mounting plate, and secure it with the four screws and lock washers provided. Place the rotating disk on the motor shaft and secure it with the two setscrews provided. Place the limit nut and three felt washers from the gear housing. Loosen the two setscrews that secure the worm gear on the motor shaft, and pull the drive shaft out of the gear housing. Lift out the worm gear and spacing bushing from the gear housing.

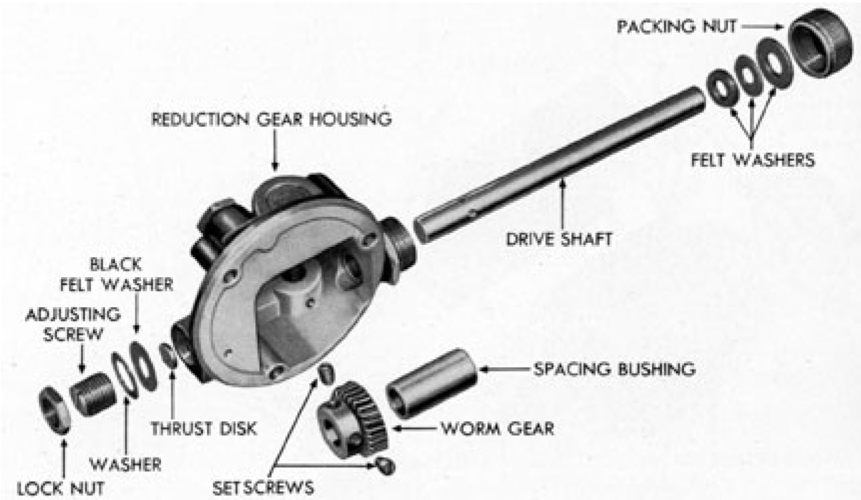


Figure 13-39. Reduction gear housing disassembled.

Unscrew and remove the lock nut from the adjusting screw. Unscrew and remove the adjusting screw, washer, black felt washer, and thrust disk from the gear housing.

13G20. Assembly of the reduction gear housing. (See Figures 13-38 and 13-39.) Insert the drive shaft into the packing gland in the reduction gear housing. Place the spacing bushing and worm gear on the shaft. Align the holes in the gear hub with the holes in the shaft, and install and tighten the two setscrews that secure the worm gear to the shaft. Install the thrust disk, adjusting screw, black felt washer, plain washer, adjusting screw, and adjusting screw lock nut on the opposite end of the gear housing. Place the three felt washers over the

13G22. Disassembly of the power motor. (See Figure 13-41.) Knock out the pin and loosen the setscrews that secure the power motor gear on the power motor shaft, and remove the gear. Remove the four end cap screws and lock washers, and remove the end cap. Knock out the bearing and shim from the end cap. Knock-out holes are provided in the end cap for this purpose. Remove the rotor assembly from the motor housing. The bearing on the opposite end of the rotor shaft will be removed with the rotor. Remove the dust guard from the lower end of the rotor shaft. Remove the bearing and dust guard from the opposite end of rotor shaft. Be careful not to lose the shims that are mounted behind the bearings in the end caps.

long end of the drive shaft, and slide the washers into the packing gland. Install the packing nut. Install the reduction gear housing on the motor. (See Section 13G18.)

13G21. Removing the power motor. (See Figure 13-40.) Tag the electrical leads to the motor for ready identification. Unsolder the leads from the motor terminal lugs. Remove the four screws that secure the motor to the rear side of the mounting plate, and remove the motor.

13G23. Assembly of the power motor. (See Figure 13-41.) Place the shim in the front end of the motor housing. Place the dust washer and bearing on the upper end of the rotor shaft, with the shoulder of the dust washer facing the bearing. Insert the rotor assembly into the motor housing. Install the dust washer and bearing on the lower end of the rotor shaft in the same manner as described above. Place the shim in the end cap. Place the end cap over the lower end

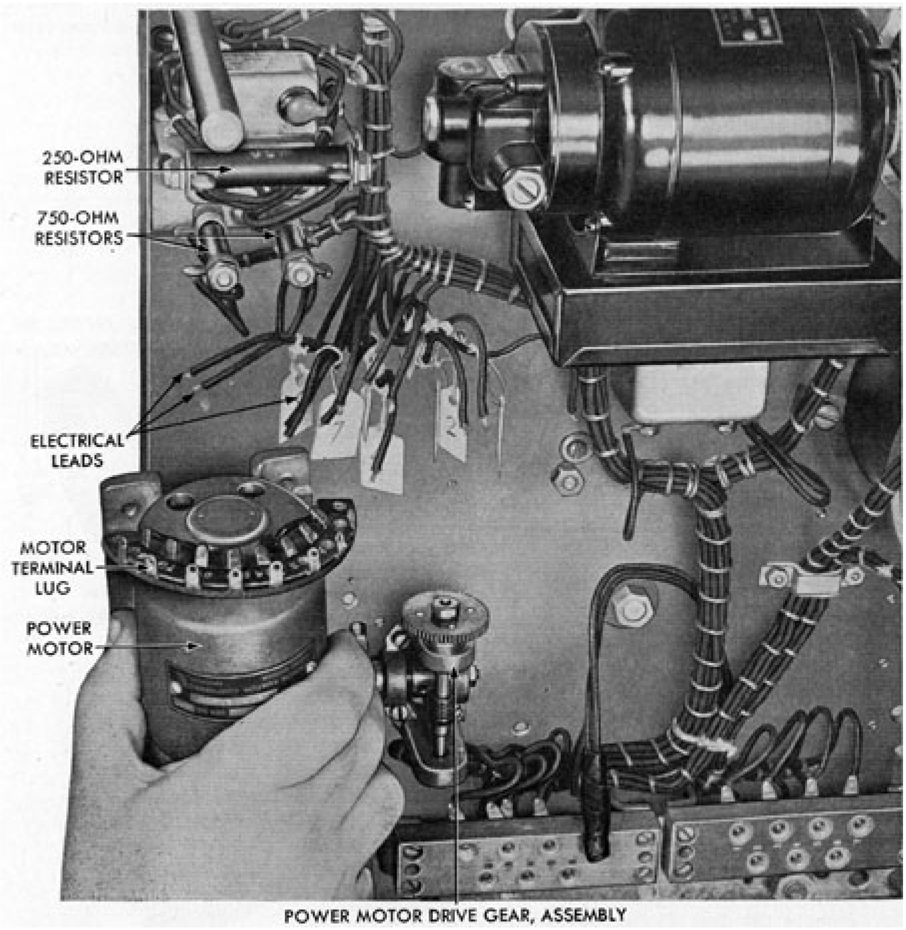


Figure 13-40. Removing power motor.

of the rotor shaft, and in position on the motor housing. Secure the end cap with the four screws and lock washers provided. Align the power motor gear on the end of the rotor shaft, and install the pin through the gear and meshing the gears. Secure the motor to the mounting plate with the four screws provided. Solder the electrical leads to the terminals on the motor.

shaft. Tighten the setscrew that secures the gear to the shaft.

13G24. Installing the power motor. (See Figure 13-39.) Place the power motor in position on the mounting plate, using care when

13G25. Removing the power motor drive gear assembly. (See Figure 13-42.) Remove the four screws and lock washers that secure the gear assembly to the back end of the mounting plate, and remove the gear assembly. There may be shims mounted between the gear box

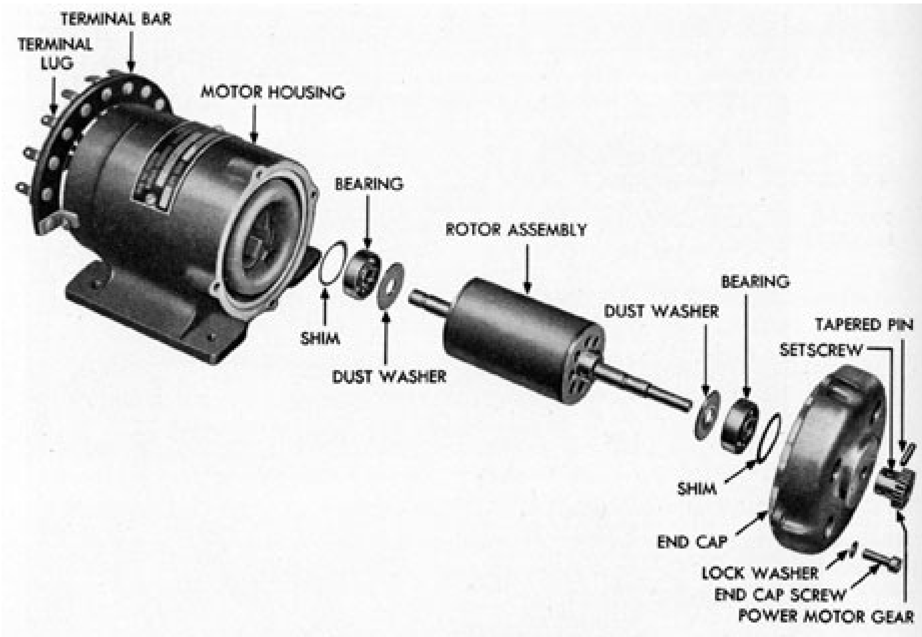


Figure 13-41. Power motor partially disassembled.

and mounting plate. Shims are to be installed in the same position at assembly.

13G26. Disassembly of the power motor drive gear assembly. (See Figure 13-43.) Remove the nut and washer from the driven gear end of the worm shaft. Drive out the tapered pin and loosen the setscrew securing the driven gear on the worm shaft; then remove the gear. Remove the dust washer, bearing, and shim from the driven gear end of the worm shaft. Remove the nut and lock washer, dust washer, and bearing from the lower end of the worm shaft. Pull the worm lock washer from the worm gear end of the shaft. Knock out the pin, and loosen the setscrew that secures the worm gear to the worm gear shaft. Drive the worm gear shaft out of the worm gear. Knock out the bearing outer races from the gear box.

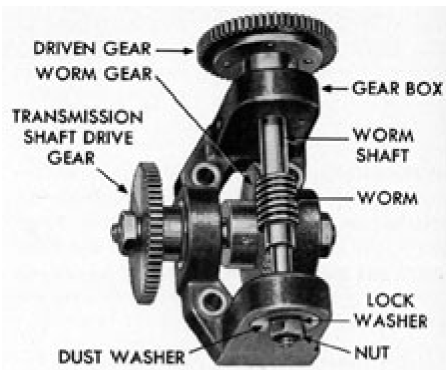
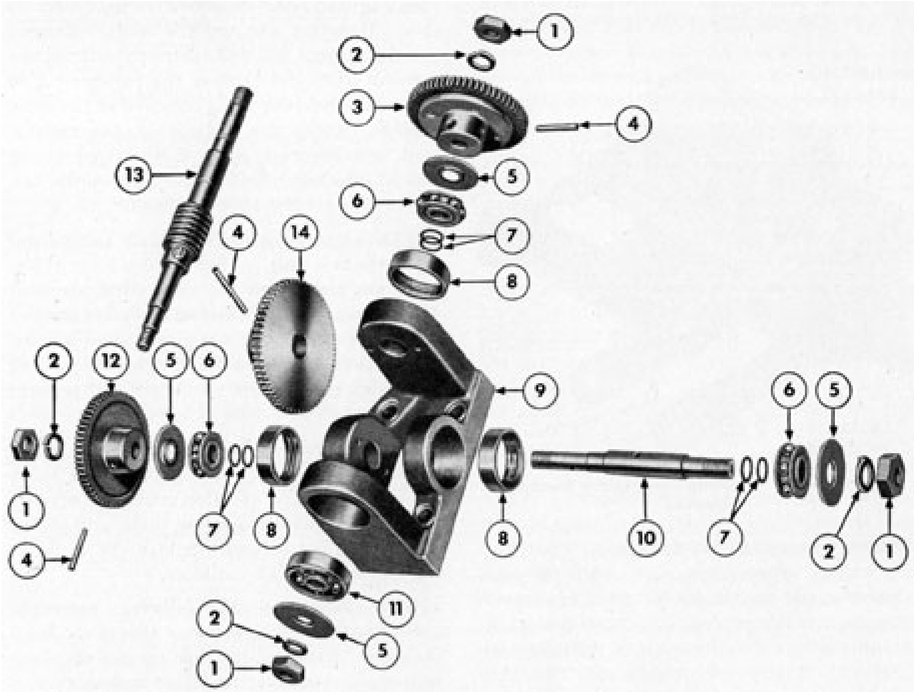


Figure 13-42. Power motor drive gear assembly removed.

shaft toward the top of the gear box; then tilt the worm shaft upward and remove it from the gear box. Remove the nut and lock washer from the driving gear end of the worm shaft. Knock out the pin, and loosen the setscrew that secures the driving gear on the worm gear shaft, and remove the driving gear. Remove the dust washer, and bearing from the driving gear end of the worm shaft. Remove the nut and

13G27. Assembly of the power motor drive gear assembly. (See Figure 13-43.) Install a bearing outer race in each of the two recesses in the sides of the gear box. Hold the worm gear in position within the gear box, with the gear hub toward the convex side of the gear box; then insert the worm gear shaft from right to left through the bearing recesses in the gear box, and through the worm gear hub. The long end of the worm gear shaft is toward the left side of the gear box. Align the hole in the shaft and worm gear hub, and install the tapered pin. Tighten the hub setscrew. Install the shims, bearing, dust washer, lock washer and nut on the worm gear end of the worm gear shaft. Install the shims, bearing, dust washer, and driving gear on the driving gear end of the worm gear shaft. Align the hole in the shaft and in the driving gear hub, and install the tapered pin. Install the lock washer and nut on the driving gear end of the shaft. Install the bearing outer race in the recess in the top of the gear box. Insert the long end of the worm shaft through the lower side of the upper section of the gear box. Move the shaft upward until the lower end of the shaft clears the lower section of the gear box, then insert the lower end of this shaft into the lower section of the gear box. Place the shims, bearing, dust washer, and



1. NUT
2. LOCK WASHER
3. DRIVEN GEAR
4. TAPERED PIN
5. DUST WASHER
6. BEARING
7. SHIMS
8. BEARING OUTER RACE
9. GEAR BOX
10. WORM GEAR SHAFT
11. BEARING
12. TRANSMISSION SHAFT DRIVE GEAR
13. WORM SHAFT
14. WORM GEAR

Figure 13-43. Power motor drive gear assembly disassembled.

driven gear on the upper end of the worm shaft. Align the hole in the shaft and in the driving gear hub, and install the tapered pin. Tighten the driven gear hub setscrew. Install the lock washer and nut on the driven gear end of the worm shaft. Install the shims, bearing, dust washer, lock washer, and nut on the lower end of the worm shaft. Turn the gears and shafts by hand to be sure that the parts operate freely.

13G28. Installing the power motor drive gear assembly. (See Figure 13-42.) Align the shims, if used previously, between the gear box, and the main mounting plate, and secure the gear box to the mounting

13G31. Removing the 250-ohm resistor. (See Figure 13-44.) Remove the unit from case. Unsolder and tag the leads. Remove one elastic stop nut and flat washer from one end of the resistor shaft, and pull the resistor from the shaft.

13G32. Installing the 250-ohm resistor. (See Figure 13-44.) lace the resistor in position on the resistor shaft in the mounting bracket, and install the flat washer and elastic stop nut securing the resistor to the bracket. Solder the leads to the resistor. Install the unit in its case.

13G33. Replacing the 750-ohm resistor. (See Figure 13-44.)

plate with the four screws and lock washers provided.

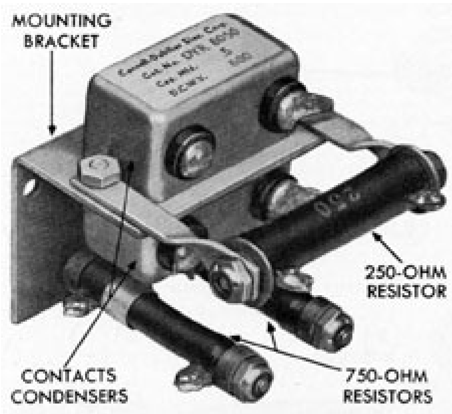


Figure 13-44. Condenser and resistor assembly removed.

13G29. Removing the condenser. (See Figure 13-44.) Remove the unit from the case. Unsolder and tag the leads at the condenser. Remove the two screws, nuts, and lock washers that secure the condenser to the mounting bracket, and remove the condenser. The other condenser is removed in the same manner.

13G30. Installing the condenser. (See Figure 13-44.) Place the condenser in position on the mounting bracket, and secure it with the two screws, lock washers, and nuts provided. Solder the leads to the condenser. Install the unit in the case.

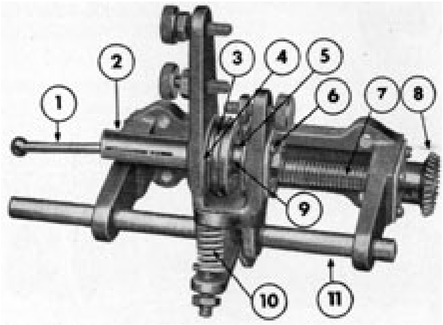
Remove the unit from its case. Unsolder and tag the leads. Remove the elastic stop nut and fiber spacer from the resistor stud, and remove the resistor. The other 750-ohm resistor is removed in the same manner. Place the resistor on the resistor stud, and secure it with a fiber spacer and elastic stop nut. Solder the lead to the terminal. Install the unit in its case.

13G34. Removing the condenser and resistor assembly as a unit. (See Figure 13-44.) Remove the unit from the case. Unsolder and tag the ten leads. Remove the three screws that secure the condenser and resistor mounting bracket to the back of the main mounting plate, and remove the condenser and resistor assembly.

13G35. Installing the condenser and resistor assembly as a unit. (See Figure 13-44.) Place the condenser and resistor mounting bracket in position on the mounting plate, and secure with the three screws. Solder the leads to the condensers and resistors.

13G36. Removing the follower assembly. (See Figure 13-45.) Remove the cover from the case. Remove the four screws and lock washers that secure the follower assembly to the main mounting plate, and carefully remove the follower assembly. The follower frame is pinned to the mounting plate, and must be removed carefully so as not to bend the pins.

13G37. Disassembling the follower. (See Figure 13-45.) Disassemble the follower as



1. UNIVERSAL CENTER
2. UNIVERSAL JOINT
3. FOLLOWER
4. FOLLOWER WASHER
5. PIN
6. BEARING CLAMP
7. LEAD SCREW
8. BEVEL GEAR
9. FOLLOWER HUB
10. FOLLOWER TENSION SPRING
11. FOLLOWER SLIDE ROD

Figure 13-45. Follower assembly removed.

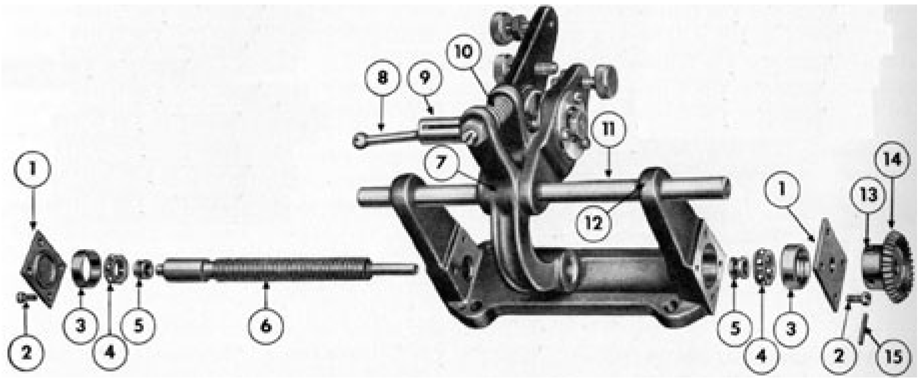
follows: Drive out the tapered pin from the follower hub. Remove the nut and lock washer from the right end of the universal joint. Remove the three screws that secure the bearing clamp to the right side of the follower frame, and remove the bearing clamp. Pull the universal joint out of the left side of the follower frame. Lift the follower assembly out of the frame. The inner bearing clamp is removed with the follower. Remove the three screws that secure the follower washer, follower, and follower hub together, and remove the follower. Remove the follower bearings as follows: Remove the outer dust washer, bearing, and inner dust washer from the right side of the follower frame. Remove the outer dust washer, bearing, inner dust washer, and shim from the left side of the frame.

joint, and partially insert the universal joint through the left side of the follower frame, being sure to align the bearing in the frame recess. Place the dust washer and shim adjacent to the ball bearing on the universal joint. Hold the follower and inner bearing clamp in position within the follower frame, and insert the universal joint through the follower and inner bearing clamp. Install the inner dust washer, bearing, and outer dust washer over the end of the universal joint and into position in the recess in the right side of the follower frame. Place the outer bearing clamp in position on the right side of the follower frame. Align the holes in the inner and outer bearing clamps and install the three screws that secure the clamps to the follower frame. Install the lock washer and nut on the end of the universal joint. Align the hole in the follower hub and hole in the universal joint, and install the tapered pin.

13G39. Removing the follower lead screw. (See Figure 13-46.) Remove the follower assembly from the mounting plate. (See Section 13G36.) Remove the tapered pin, loosen the setscrew that secures the bevel gear on the lead screw, and remove the bevel gear. Remove the four bearing clamp retaining screws, and the right bearing clamp. Remove the right bearing and bearing outer race. Remove the left bearing clamp, bearing, and outer race in the same manner. Unscrew and remove the follower lead screw from the follower slide frame.

13G38. Assembly of the follower. (See Figure 13-45.) Assemble the follower, follower hub, and follower washer, and secure them with the three screws provided. Place the dust washer, and bearing on the universal

13G40. Installing the follower lead screw. (See Figure 13-46.) Screw the follower lead screw into the follower slide frame. Move the follower slide frame clear of one bearing recess, and install the bearing outer race with the race flange facing outward; install the bearing and bearing clamp. Repeat this operation on the opposite end of the lead screw. Place the bevel gear on the right end of the follower lead screw. Align the hole in the gear with the hole in the lead screw, and install the tapered pin. Tighten the setscrew in the gear hub. Place the follower assembly in position on the main mounting plate and secure it with the four screws and lock washers provided.



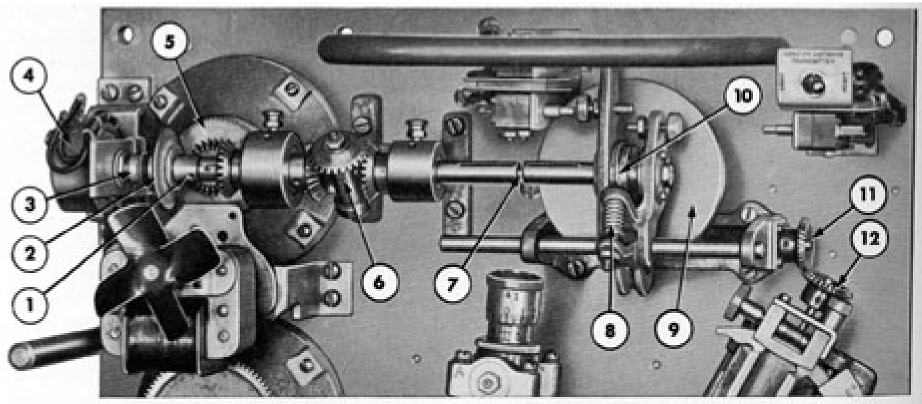
1. BEARING CLAMP
2. FILLISTER-HEAD SCREW
3. BEARING OUTER RACE
4. BEARING
5. BEARING INNER RACE
6. FOLLOWER LEAD SCREW
7. FOLLOWER SLIDE FRAME
8. UNIVERSAL CENTER
9. UNIVERSAL JOINT
10. FOLLOWER TENSION SPRING
11. FOLLOWER SLIDE ROD
12. COUNTER COMPONENT FRAME
13. SETSCREW
14. BEVEL GEAR
15. TAPERED PIN

Figure 13-46. Follower lend screw removed.

13G41. Removing the follower slide rod. (See Figure 13-45.) Remove the follower assembly from the mounting plate. (See

13G42. Installing the follower slide rod. (See Figure 13-45.) Place the slide rod in position in the follower slide frame, and install the

Section 13G36.) Remove the follower tension spring by removing the nut, tension screw, spring, and spring cap. Knock out the tapered pin that secures the slide rod in the follower slide frame, and pull out the slide rod. tapered pin that secures the rod in the frame. Install the spring cap, tension spring, tension screw, and tension screw nut. Place the follower assembly on the mounting plate, and secure it with the four screws and lock washers provided.



1. CLUTCH SPRING ADJUSTER
2. SLIPPING CLUTCH
3. DAMPER HUB
4. RHEOSTAT
5. DISTANCE TRANSMITTER DRIVEN GEAR
6. DIFFERENTIAL SPIDER
7. UNIVERSAL CENTER
8. FOLLOWER TENSION SPRING
9. ROTATING DISK
10. FOLLOWER
11. FOLLOWER LEAD SCREW BEVEL GEAR
12. COMPONENT FRAME UPPER BEVEL GEAR

Figure 13-47. Follower, differential, and rheostat assemblies installed.

13G43. Preparing the follower assembly for adjustment. (See Figure 13-47.) Prepare the follower assembly for adjustment after disassembly in the following manner: Adjust the follower tension spring so that there is a slight tension between the follower and the rotating disk. Unmesh the bevel gears by supporting the gear shaft of the component frame assembly and knocking out the tapered pin from the component frame upper bevel gear hub. Loosen the setscrew in the gear hub, and drop this gear from mesh with the follower lead screw gear. speed pointer to exactly 5 knots. Place a piece of paper between the contact arm and contacts so that a speed indication of exactly .5 knots is maintained. Measure the time required for the distance counter to register exactly V, mile on the speed and distance indicator. The time should be 6 minutes, plus or minus 3 seconds. If the error is greater than 10 seconds, it is an indication that the slipping clutch is not operating properly, or that the follower is off center position considerably. Test the slipping clutch for proper operation as described in Section 13G45. Adjust the follower to the

Remove the pin from the universal center so that the disk will rotate independently of the differential assembly.

13G44. Method of adjusting the follower to the center of the rotating disk. (See Figure 13-47.) Disengage the bevel gear on the component frame assembly from the lead screw bevel gear in the following manner: Manually move the main balance arm until the setscrew and tapered pin in the gear hub are accessible; then slip a piece of paper under the contact arm to maintain the position of the tapered pin and setscrew. Loosen the setscrew and drive out the tapered pin, and unmesh the gears. Be sure to support the shaft when driving out the tapered pin in order to prevent bending of the shaft. Move the lead screw gear until the follower runs in one direction; then turn the lead screw gear in the opposite direction until the follower just starts to run in the opposite direction. Manually move the lead screw first one way and then the opposite way until the follower will not rotate in either direction. This is an indication that the follower is in the center position of the rotating disk.

After positioning the follower in the center of the disk, carefully mesh the two beveled gears so that the lead screw gear is not moved from its position. Install the tapered pin and tighten the setscrew in the component frame upper gear. Connect the universal center by installing the pin in the universal joint and universal center. Energize the center of the rotating disk as described above.

13G45. Testing and adjusting the slipping clutch. (See Figure 13-47.) Place a finger on the distance transmitter driven gear and slow down the transmitter. The rheostat brush arm should rotate in a counterclockwise direction. Removing the finger from the transmitter driven gear should cause the rheostat brush arm to rotate to its original position. If the differential spider is turning and the slipping clutch is slipping, indicated by the rheostat brush arm not turning, tighten the clutch spring adjuster in the following manner: Loosen the setscrew in the clutch spring adjuster and move the spring adjuster to the left to tighten the adjustment on the slipping clutch. Repeat the operation until the rheostat brush arm turns with the differential spider.

13G46. Adjusting the rheostat spring tension. (See Figure 13-47.) Another possible cause of a slipping clutch is that the spring in the rheostat is too tight. This causes the rheostat brush arm to stop turning when the differential spider is turning while the finger is slowing down the action of the transmitter driven gear. Adjust the rheostat spring tension as follows: Loosen the setscrew in the damper hub while holding the rheostat brush arm with the other hand. It is necessary to hold the left end of the rheostat shaft, while loosening the setscrew to prevent the spring from ejecting parts from within the rheostat. Carefully move the rheostat shaft assembly slightly to the left to loosen the spring

system, including at least one of the speed and distance indicators. Manually move the main balance arm to the right to raise the

tension, then tighten the setscrew in the damper hub. Repeat this operation until the desired rheostat spring tension is obtained.

13G47. Checking the spider operation. (See Figure 13-47.) If the differential spider does not turn when the transmitter driven gear is slowed down, it is an indication that the follower tension spring is not adjusted properly. Tighten the follower spring, and observe the operation of the differential spider.

13G48. Checking the follower tension. (See Figure 13-47.) After checking the slipping clutch tension, and the rheostat spring adjustment, check the follower spring tension as follows: Place a finger on the driven gear of the distance transmitter, and stall the distance transmitter. If the follower tension is correct, the follower will drive the differential spider, the spider will turn the rheostat brush arm to its limit of travel, and the clutch will slip,

13G49. Final checks of the follower, differential, and rheostat assemblies. (See Figure 13-47.) After checking the operation of the follower, slipping clutch, and rheostat as described above, check the timing on the distance counter for the 1/2-mile indication. Carefully mesh the bevel gears at the right of the follower assembly, and tighten the setscrew in the component frame upper gear. Do not install the tapered pin at this time. Move the main balance arm until the lead screws turn to make the large end of the tapered pin hole accessible, then loosen the setscrew and install the tapered pin through the gear hub and the lead screw. Tighten the setscrew after the tapered pin is installed. Make the distance check described in Section 13G44. Then set the speed pointer at 20 knots, and repeat the time and distance check. The time elapsed. should be 6 minutes plus or minus 3 seconds for 2 miles distance indicated on the distance counter.

13G50. Removing the rheostat. (See Figure 13-48.) The 500-ohm rheostat is replaced as a unit. Remove the four screws and lock washers that secure the rheostat bracket to the main mounting plate, and lift the rheostat away from the mounting plate. Unsolder and tag the electrical leads. Loosen the setscrew in the damper hub while holding the rheostat shaft in position in the rheostat. It is necessary to hold the shaft in position to prevent the rheostat spring from ejecting parts from the rheostat. Remove the damper hub, spring, and frame assembly from the rheostat shaft. Remove

of the speed and distance indicator as described in 13044. If the measured time exceeds the tolerance of plus or minus 3 seconds, it is a positive indication that the central position of the follower on the rotating disk is incorrect. Check the follower as follows: Remove the note paper from the contacts, and return the pointer to the zero position. Unmesh the component frame upper gear as follows: Manually move the main balance arm until the setscrew and tapered pin are accessible; then slip the note paper under the contact arm to maintain the position of the pin and setscrew. Be certain to support the shaft when driving out the taper pin in order to prevent bending of the shaft. Carefully turn the follower lead screw toward the person facing the instrument, one bevel gear tooth for each 3 seconds or less that the measured time exceeds the 6 minutes for 1/2-mile. Turn the lead screw in the opposite direction in the same manner for every 3 seconds or less below the measured 6 minutes the nut and toothed lock washer that secure the rheostat to the bracket, and remove the rheostat.

13G51. Installing the rheostat. (See Figure 13-48.) Carefully remove the lock washer from the shaft of the new rheostat while holding the shaft in position within the rheostat. This is necessary to prevent the internal parts from becoming lost when the washer is removed. Remove the nut and toothed lock washer from the replacement rheostat. Place the rheostat in its bracket and secure it with the toothed lock washer and nut provided. Align the damper hub of the damper spring and frame assembly with the flat-on end of the rheostat shaft, and tighten the setscrew in the damper hub. Place the rheostat and bracket in position on the main mounting plate, and secure them with the four screws

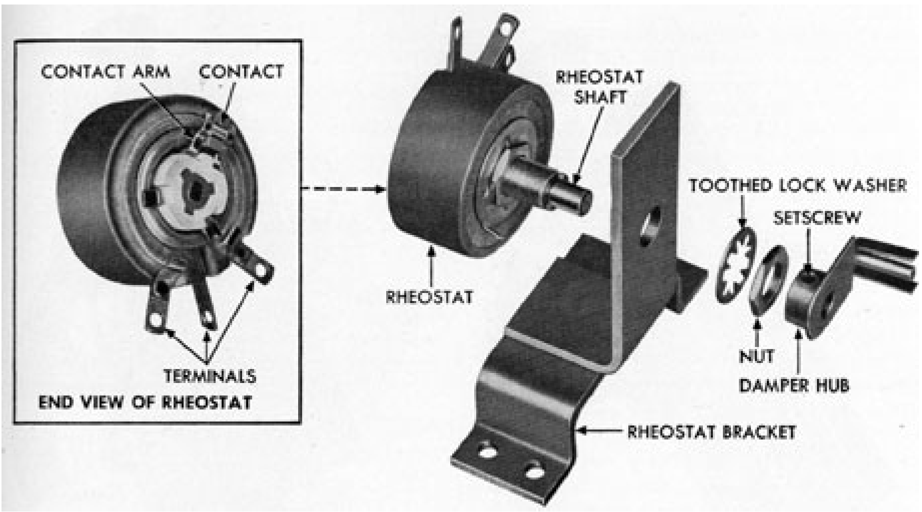


Figure 13-48. Rheostat removed.

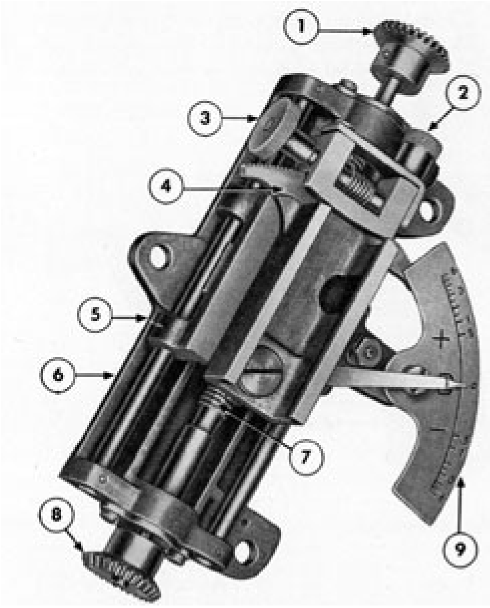
provided. Be careful to align the damper spring properly with the clutch plate. Solder the electrical leads to the terminal on the rheostat. Adjust the rheostat spring tension as described in Section 13G46.

13G52. Removing the component frame assembly. (See Figure 13-49.) Remove the log mechanism From its case. Place the mechanism on a bench, with the front of the log facing upward. Drive out the two locating pins as far as the main mounting plate so that the frame assembly will clear the force and balance arms. Remove the three screws that secure the component frame assembly to the mounting plate, and remove the frame assembly.

13G53. Replacing the bearings. (See Figure 13-50.) Scribe a locating mark on the component frame and the component slide so that the slide and frame can be held in the same relative position at assembly. Remove the tapered pin and loosen the setscrew from the component frame lead screw gear hub, and remove the gear. Remove the upper bearing clamp retaining screws and bearing clamp. Remove the shim, bearing, and bearing inner race from the recess in the component frame. The lower bearing is removed in the same manner. Install the bearing inner race in the recess in the component frame. Install the bearing and shim; then install the bearing clamp, and secure the clamp with the two screws provided. Place the component lead screw gear in position on the lead screw, align the hole in the gear hub and in the screw, install the tapered pin and tighten the setscrew in the hub. The bearing on the opposite end of the component frame is installed in the same manner.

13G54. Installing the component frame assembly. (See Figure 13-49.) Manually turn the gear on the component frame assembly until the scribe marks on the frame and slide are aligned. Place the component frame assembly in position on the front of the main mounting plate, and secure it with the three screws provided. Carefully drive in the locating pins from the back of the main mounting plate.

13G55. Removing the cam and bracket assembly. (See Figure 13-51.) Remove the case cover. Remove the pointer and dial. (See



1. UPPER BEVEL GEAR
2. GEAR LOCK KNOB
3. B ADJUSTMENT KNOB
4. B SECTOR
5. SCRIBE MARKS
6. COMPONENT FRAME
7. LEAD SCREW
8. LOWER BEVEL GEAR
9. B ADJUSTMENT SCALE

Figure 13-49. Component frame assembly removed.

Section 13G2.) Scribe a locating mark on the speed transmitter drive gear of the cam and bracket assembly, and the speed transmitter driven gear on the speed transmitter so that the gears may be meshed in the same relative position at assembly. Remove the two screws that secure the cam bracket assembly to the mounting plate, and remove the cam and bracket assembly.

13G56. Disassembly of the cam and bracket assembly. (See Figure 13-52.) Remove the handle screw from the pointer hub, and remove the pointer hub. Remove the three screws and lock washers that secure the bearing clamp to the cam bracket, and remove the bearing

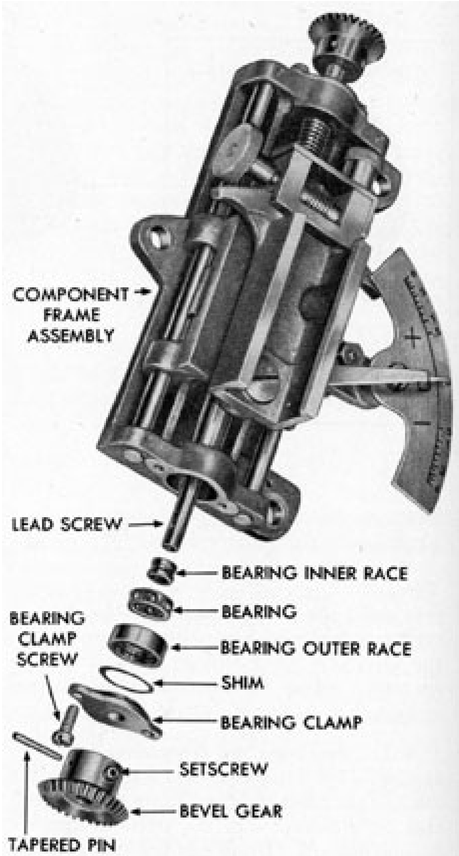


Figure 13-50. Component frame assembly partially disassembled.

Remove the bearing from the recess in the cam bracket. Remove the nut, lock washer, flat washer, and bearing from the rear end of the pointer shaft. Scribe a locating mark on the cam and on the adjacent hub of the speed transmitter drive gear so that the cam may be installed in the same relative position at assembly. Remove the setscrew between the cam and helical gear, and remove the helical gear and cam as a unit. Loosen the setscrew in the speed transmitter drive gear hub, and remove the drive gear from the pointer shaft. Remove the three screws and lock washers,

clamp. Knock out the tapered pin and loosen the setscrew on the bearing collar. Pull the collar off the pointer shaft.

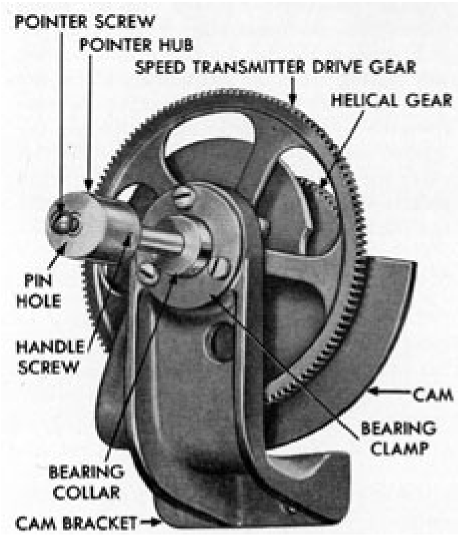
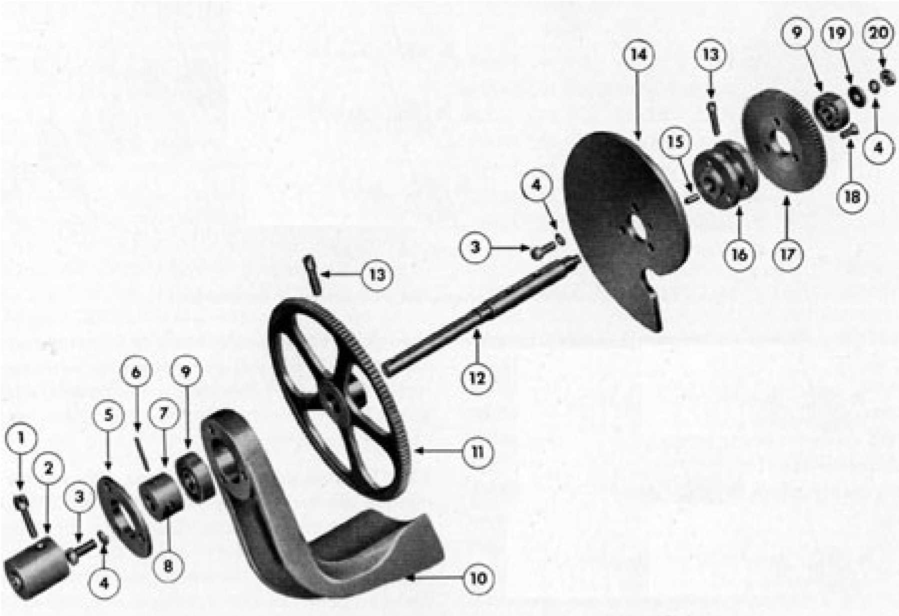


Figure 13-51. Cam and bracket assembly removed.

and knock out the pin that secures the cam to the cam hub, and remove the cam. Remove the three screws that secure the gear to the cam hub, and remove the gear.

13G57. Assembling the cam and bracket assembly. (See Figures 13-52 and 13-51.) Place the cam on the cam hub, using the scribe mark as a reference, and secure it with the three screws and pin provided. Install the helical gear on the cam hub, and secure it with the three screws provided. Place the speed transmitter drive gear on the pointer shaft, and install the handle screw. Place the bearing in the recess in the bracket, and install the bearing clamp. Place the pointer shaft in the bracket, install the cam and hub assembly on the pointer shaft, and install the handle screw. Install the bearing collar on the long end of the pointer shaft, and tighten the setscrew in the nearing collar. Install the pointer hub, and secure with the handle screw. Place the bearing on the threaded end of the pointer shaft, and install the flat washer, lock washer, and nut.



1. HANDLE SCREW
2. POINTER HUB
3. FILLISTER-HEAD SCREW
4. LOCK WASHER
5. BEARING CLAMP
6. TAPERED PIN
7. BEARING COLLAR
8. SOCKET HEAD SETSCREW
9. BEARING
10. CAM BRACKET
11. SPEED TRANSMITTER DRIVE GEAR
12. SHAFT
13. HANDLE SCREW
14. CAM
15. DOWEL PIN
16. HUB
17. HELICAL GEAR
18. FLAT HEAD MACHINE SCREW
19. FLAT WASHER
20. NUT

Figure 13-52. Cam and bracket assembly disassembled.

13G58. Installing the cam and bracket assembly. (See Figure 13-51.) Place the cam and bracket assembly in position on the main mounting plate with the transmitter drive and driven gears meshed according to the scribe marks made on the gears when they were removed. Install the two screws and dowel pin that secure the cam and bracket assembly to the main mounting plate. Install the dial and pointer.

13G60. Disassembling the power motor transmission shaft assembly. (See Figure 13-53.) Remove the bearing clamp, dust washer, and bearing from the left bearing block. Remove the nut, lock washer, and flat washer from the right end of the shaft. Remove the tapered pin and loosen the setscrew that secures the shaft driving gear to the shaft, and remove the gear. Remove the dust ring and bearing from the right bearing block. Remove

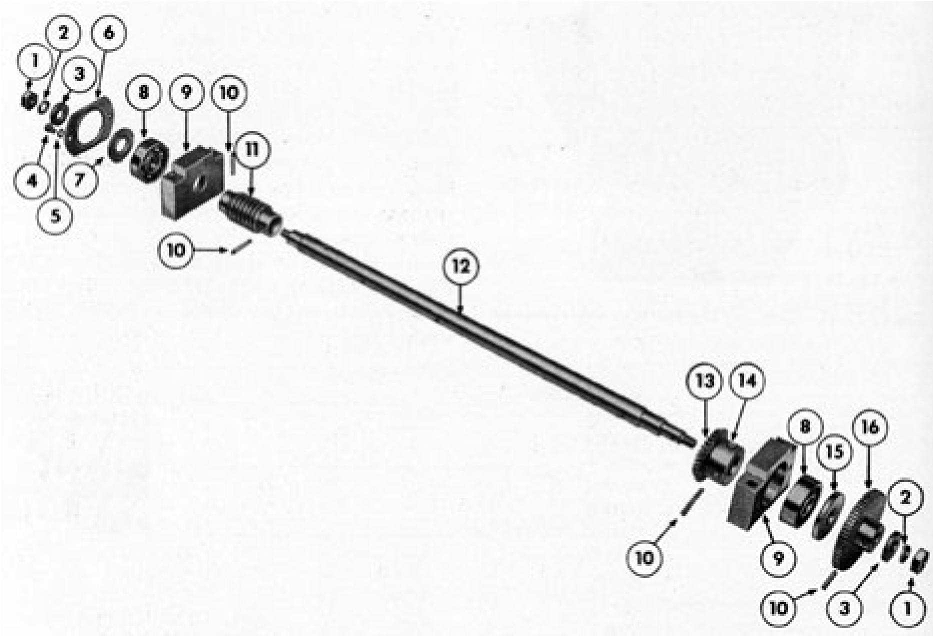


Figure 13-53. Power motor transmission shaft assembly disassembled.

13G59. Removing the power motor transmission shaft assembly. (See Figure 13-53.) Remove the cam and bracket assembly. (See Section 13G55:) Remove the nut, lock washer, and flat washer from the left end of the shaft. Remove the left bearing block from the mounting plate by removing the two block retaining screws. Remove the two screws from the right bearing block and pull the right bearing block and the shaft assembly to the right and away from the mounting plate.

the bevel gear from the shaft by knocking out the tapered pin and loosening the setscrew in the gear hub. Knock out the two tapered pins that secure the worm on the shaft, and remove the worm.

13G61. Assembling the power motor transmission shaft assembly. (See Figure 13-53.) Place the worm over the shaft, align the holes in the worm and shaft, and install the two tapered pins. Place the bevel gear on the right end of the shaft, with the gear teeth toward the worm, install the tapered pin and tighten

the setscrew in the gear hub. Place the bearing in the right bearing clamp. Insert the end of the shaft into the bearing and install the dust ring adjacent to the bearing. Place the drive gear on the shaft, with the gear hub facing the end of the shaft, and install the tapered pin. Install the flat washer, lock washer, and nut on the right end of the shaft. Install the bearing in the left bearing block. Install the dust

washer and bearing clamp in the left bearing block, and secure the clamp with the two screws provided. Insert the shaft assembly under the main balance arm and force arm assemblies, from right to left, and insert the end of the shaft into the left bearing block. Secure the bearing block to the mounting plate with the two screws provided. Align the right bearing block on the mounting plate and install the two screws that secure the bearing block to the mounting plate. Install the flat washer, lock washer, and nut on the left end of the shaft. Install the cam and bracket assembly. (See Section 13G58.)

13G62. Removing the main force arm. (See Figure 13-54.) Remove the log mechanism from the case. Remove the earn and bracket assembly. (See Section 13G55.) Unscrew and remove the spring thimble and adjusting screw assembly from the top of the spring barrel assembly of the A-adjustment mechanism. Insert the short screwdriver within the spring barrel, unscrew the connector screw that joins the A-mechanism with the rocker of the auxiliary balance arm, and remove the A-adjustment mechanism. From the back of the main mounting plate, remove the nut and flat washer that secure the main force arm shaft to the main mounting plate, and remove the main force arm. The force load spring is removed from the main force arm shaft when the assembly is lifted away from the mounting plate.

13G63. Disassembly of the main force arm. (See Figure 13-

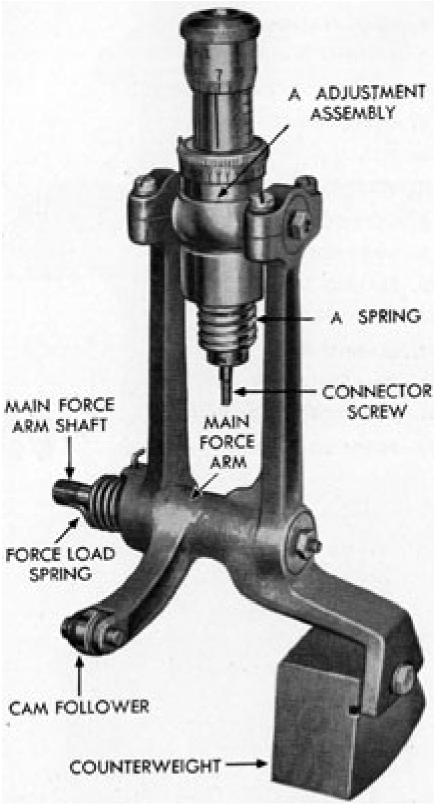
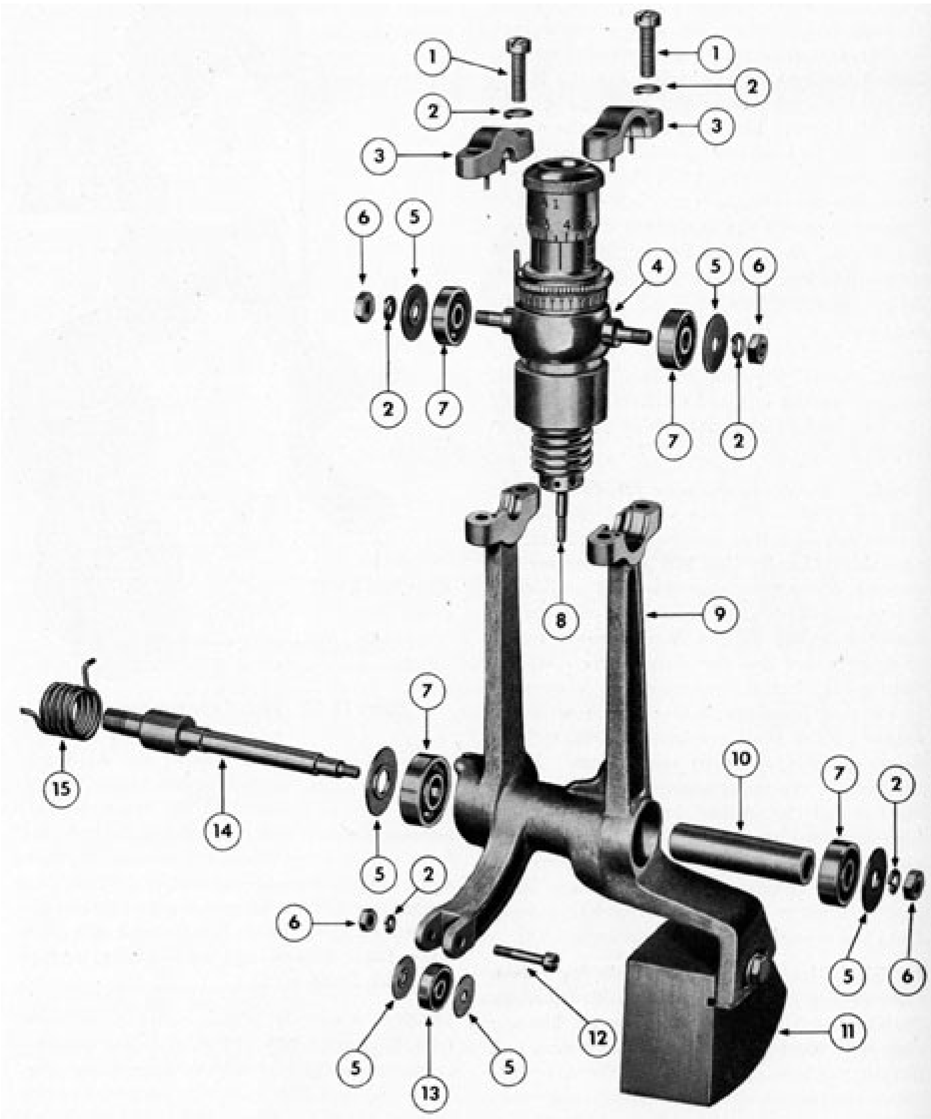


Figure 13-54. Main force arm removed.

and bearing from one side of the A-adjustment axle. The bearing on the opposite side of the axle is removed in the same manner. Remove the nut, lock washer, and dust washer from the front of the main force arm shaft, and pull the shaft to the rear and out of the main force arm. The rear dust washer is removed with the main force arm shaft. Remove the two bearings and bearing spacer from the force arm.

13G64. Assembly of the main force arm. (See Figure 13-55.) Place the rear bearing in the recess in back of the main force arm. Place the rear dust washer in position on the rear of the main force arm shaft. Hold the

55.) Remove the four screws (two on each side) that secure the bearing clamps to the top of the main force arm, and lift off the bearing clamps and the A-adjustment mechanism from the main force arm. Remove the nut, lock washer, dust washer,

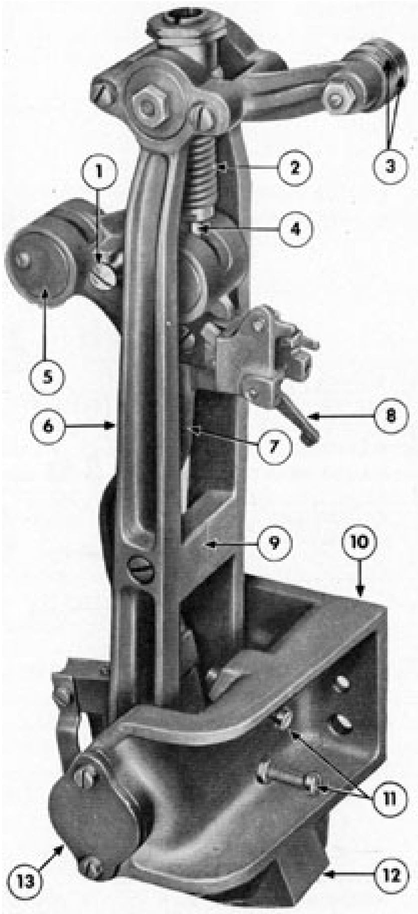


1. FILLISTER HEAD SCREW.
2. LOCK WASHER.
3. BEARING CLAMP.
4. A ADJUSTMENT ASSEMBLY.
5. DUST WASHER.
6. NUT.
7. BEARING.
8. CONNECTOR SCREW.
9. MAIN FORCE ARM.
10. BEARING SPACER.
11. COUNTERWEIGHT.
12. BEARING PIN.
13. CAM FOLLOWER.
14. MAIN FORCE ARM SHAFT.
15. FORCE LOAD SPRING.

Figure 13-55. Main force arm partially disassembled.

bearing spacer in position within

the force arm, and carefully insert the main force arm shaft from the rear of the arm, through the rear bearing and spacer to the front end of the arm. Install the front bearing, dust washer, lock washer, and nut on the front end of the main force arm shaft. Install the bearing, dust washer, lock washer, and nut on one side of the A-adjustment axle. The bearing on the opposite side of the axle is installed in the same manner. Place the A-adjustment mechanism in position on top of the main force arm, install the two bearing clamps, and secure each clamp with the two screws and lock washers provided.



1. INDEX SCREW
2. B SPRING
3. GUIDE BEARINGS
4. CONNECTOR SCREW
5. THRUST PLATE
6. FRONT SECTION AUXILIARY BALANCE ARM
7. MAIN BALANCE ARM
8. CONTACT ARM
9. AUXILIARY BALANCE ARM CENTER SUPPORT
10. MAIN FORCE BEARING, ASSEMBLY
11. MAIN BALANCE ARM ADJUSTING SCREWS
12. COUNTERWEIGHT
13. BEARING CLAMP

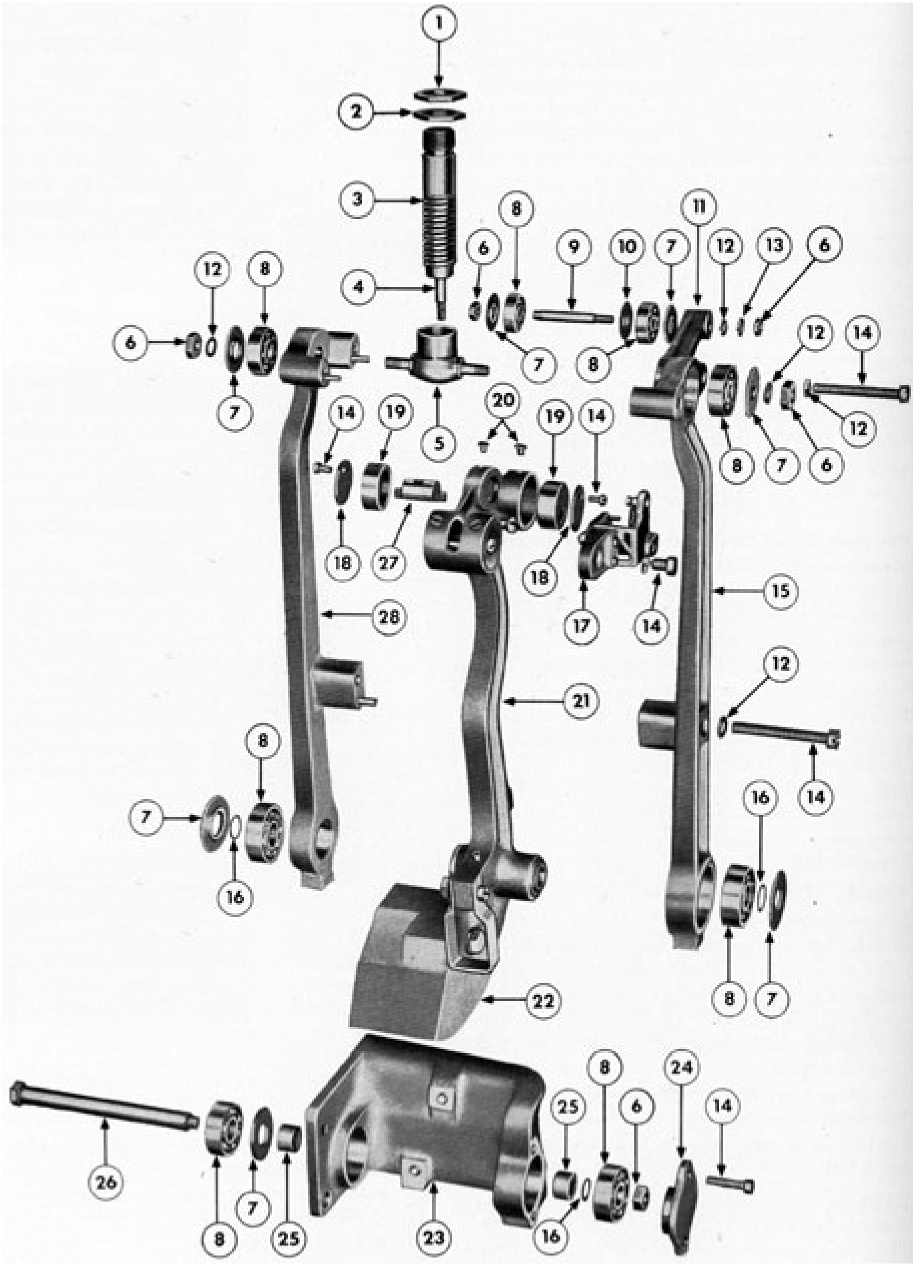
Figure 13-56. Auxiliary and main balance arm assembly removed.

13G65. Installing the main force arm. (See Figure 13-54.) Place the force load spring on the rear end of the main force arm shaft, with the offset in the spring engaged in the slot of the main force arm. Carefully place the main force arm in position on the main mounting plate, with the main force arm shaft inserted through the opening provided in the mounting plate and with the spring end also engaged in the hole provided in the mounting plate. Install the flat washer and nut that secure the main force arm shaft to the main mounting plate. Install the connector screw of the A-adjustment assembly into the rocker in the top of the auxiliary balance arm. Install the spring thimble and adjusting screw into the spring barrel of the A-adjustment mechanism. Calibrate the instrument. (See Chapter 15.)

13G66. Removing the auxiliary and main balance arms. (See

Figure 13-56.) Cut the string that secures the electrical lead to the main balance arm. Remove the three screws and lock washers that secure the auxiliary and main balance arm assembly to the main mounting plate. Lift the assembly upward, and turn it sideways to make the electrical lead to the contact arm accessible. Unsolder the electrical connection from the terminal on the contact arm, and remove the auxiliary and main balance arm assembly.

13G67. Disassembly of the auxiliary and main balance arm assembly. (See Figure 1357.) Remove the lock nut and thin nut from top of the B-spring, and disengage the spring



1. LOCK NUT
2. THIN NUT
3. B SPRING
4. CONNECTOR SCREW
5. SPRING FORCE HUB
6. NUT
7. DUST WASHER
8. BEARING
9. BEARING SHAFT
10. DOUBLE DUST WASHER
11. AUXILIARY ARM EXTENSION
12. LOCK WASHER
13. FLAT WASHER
14. FILLISTER-HEAD SCREW
15. FRONT SECTION OF AUXILIARY BALANCE ARM
16. SHIM
17. CONTACT ARM ASSEMBLY
18. THRUST PLATE
19. ROCKER BEARING
20. FLATHEAD MACHINE SCREW
21. MAIN BALANCE ARM
22. COUNTERWEIGHT
23. MAIN FORCE BEARING ASSEMBLY
24. BEARING CLAMP
25. SPACER
26. MAIN BALANCE SHAFT
27. ROCKER
28. REAR SECTION OF AUXILIARY BALANCE ARM

Figure 13-57. Auxiliary and main balance arm partially disassembled.

from the auxiliary balance arm. Unscrew and remove the B-spring connector screw from the rocker. Remove the two screws (one on each side) that secure the thrust plates to the rocker bearings and remove the thrust plates. Remove the two screws that secure the rocker bearings in the main balance arm, and remove the bearings and rocker from the top of the main balance arm. The other rocker and the bearings at the top of the main balance arm are removed in the same manner. Remove the two bearing clamp retaining screws and bearing clamp from the front of the main force bearing assembly. Remove the hexagonal nut from the front of the main balance shaft; then pull the main balance shaft to the rear and out of the: auxiliary and main balance arms. Remove the bearing, shim, and spacer from the front end of the balance shaft as the shaft is pulled to the rear. Lift the main force bearing assembly (bracket) away from the arm assembly. Remove the dust washer, spacer, second dust washer, shim, and bearing from the recess in back of the main force bearing. Remove the screw that secures the two sections of the auxiliary balance arm at the center support. Remove the two screws that secure the two sections of the auxiliary balance arm at the top of the arm. Remove the nut, lock washer, and dust washer from each end of the spring force hub. Carefully pull the two sections of the arm apart.

Mount the rocker assembly at the top of the main balance arm in the following manner: Install one rocker bearing in one side of the recess at top of the main balance arm. Place the rocker in approximate position in the installed rocker bearing. Place the second rocker bearing in approximate position on the opposite side of the main balance arm. Secure the rocker bearings to the main balance arm with the two screws provided (one on each bearing). Place the thrust plates in position on the outer sides of the rocker bearings (one on each bearing) and secure, with one screw for each thrust plate. The other rocker assembly is installed in the same manner.

Align the B-spring with the rocker, and tighten the connector screw in the rocker. Place both sections of the auxiliary balance arm in approximate position on each side of the main balance arm, and place the spring force hub between the upper sections of the auxiliary balance arm, with the long section. of the force hub upward. Align the pin holes and pins of the two sections of the auxiliary balance arm, and squeeze the two sections together into position on the main balance arm. Secure the auxiliary balance arm at its center support with one screw, and at the top of the arm with two screws. Install the bearing, dust washer, lock washer, and nut on each end of the spring force hub. Install a bearing in each of the two sections at the bottom of the auxiliary balance arm. Place the main force bearing assembly

The two sections of the auxiliary balance arm are pinned together, and the sections must be pulled straight away to prevent bending the pins.

Remove the bearings and spring force hub. Remove the nut and lock washer that secure the guide bearing assembly to the end of the auxiliary balance arm, and remove the bearing assembly. Remove the dust washer, bearing and double, dust washer from the bearing shaft. Remove the nut, rear dust washer, and second bearing from the other end of the bearing shaft. Remove the screw that secures the contact arm assembly to the main balance arm, and remove the contact assembly.

13G68. Assembly of the auxiliary and main balance arm assembly. (See Figure 13-57.)

(bracket) in position at the bottom of the auxiliary and main balance arms.

Assemble the bearing, dust washer, spacer, second dust washer, and shim, in that order, on the back of the balance shaft. Align all parts and carefully insert the balance shaft from the rear of the main force bearing through the auxiliary and main balance arms far enough to install the shim and outer dust washer on the front end of the balance shaft. Completely insert the balance shaft through the auxiliary and main balance arm assemblies. Install the spacer, shim, and bearing on the front end of the balance shaft. Install the hexagonal nut on the front end of the shaft. Install the bearing clamp on the forward side

of the main force bearing (bracket), and secure the bearing clamp with the two screws provided. Install the guide bearings as follows : Assemble the dust washer, and bearing on the short threaded end of the bearing pin. Assemble the double dust washer, second bearing, and dust washer from the other end of the bearing pin. Install the bearing pin, with its assembled bearings, through an opening in the arm extension at the top of the auxiliary balance arm, and secure it with a nut on the front end of the bearing pin. Place the B-spring assembly into the spring force hub, and install

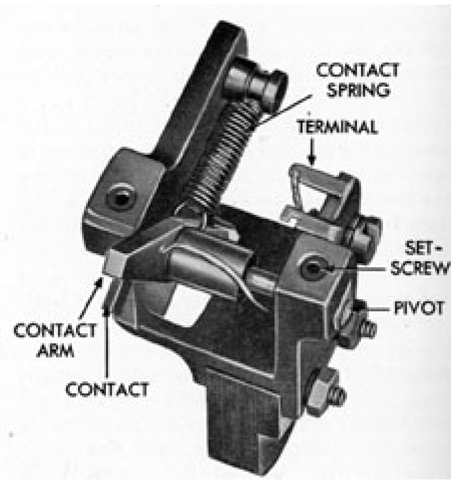


Figure 13-58. Contact arm assembly removed.

terminal. Remove the screw that secures the contact arm to the main balance arm, and remove the contact arm assembly. Unhook the contact spring from the contact

the thin nut and lock nut on top of the B-adjustment assembly. Install the contact arm assembly in position on the main balance arm, and secure it with one screw.

13G69. Installing the auxiliary and main balance arms. (See Figure 13-56.) Place the auxiliary and main balance arm assemblies in approximate position on the mounting plate. Solder the electrical lead to the terminal on the contact arm assembly. Install the three screws and lock washers that secure the auxiliary and main balance arm assemblies to the main mounting plate. Align the electrical lead along the main balance arm and secure it in position with string. Install the main force arm (see Section 13G65). Install the cam and bracket assembly (see Section 13G58). Calibrate the instrument as described in Chapter 15.

13G70. Replacing the contact arm. (See Figure 13-58.) The contact arm and contact are replaced as a unit. Remove the cover from the master transmitter indicator case. Unsolder the electrical lead from the contact arm arm. Remove the pigtail from the contact arm. Loosen the setscrews that secure the pivots in the contact arm bracket, loosen the pivots, and remove. the contact arm and shaft as a unit. Place the new contact arm in position, and tighten the pivots. Tighten the setscrews. Install the pigtail on the contact arm. Engage the contact spring on the end of the contact arm. Place the contact arm assembly in position on the main balance arm, and install the arm retaining screw. Solder the electrical lead to the terminal on the contact arm bracket.

14
MEASURED MILE CALIBRATION

A. CALIBRATION OF LOG ON MEASURED MILE

14A1. Purpose of calibrating log. Each complete log system is calibrated at the factory with a standard U-tube mercury manometer having a scale graduated in knots. The scale used is derived from the theoretical values obtained from the following equation:

$H=(V^2 X C) / 2g$

H=height of water
V=velocity
C=a factor determined by the specific gravity of sea water and the flow about the dynamic orifice
g=acceleration due to gravity

C is assumed to have a value of 1.02 considering only the specific gravity of sea water; g has a value of 32.16 feet per second. Since there has been no consideration of the flow of water about the rodmeter at factory calibration, it is necessary to calibrate, or adjust, the log for the particular ship on which it is installed. This calibration is performed during a trial run over a measured distance, usually 1 mile in length. Trial conditions can rarely be duplicated; and even with suitable corrections for foul bottom, variations in displacement and trim, and effect of wind and sea, speed indications derived from an ordinary cruise are worthless for calibrating the log system. Similarly, checking distance indications by comparison of the log readings with the distances traveled between ports cannot be used for recalibration purposes since the current effect cannot be determined with the degree of accuracy required. Thus the most accurate and suitable method of checking the calibration of a log under actual operating conditions is to run the ship over a measured course 1 mile in length (Figure 14-1). Since the conditions can rarely be duplicated, record the conditions under which any trial run is made in a table similar to the following:

U.S.S.	DATE ....
DISPLACEMENT	PLACE ....
PROJECTION OF	LENGTH OF COURSE ....

RODMETER ....

RELATION OF
UNDERWATER
SOUND GEAR
TO RODMETER ....

DEPTH
OF WATER ....

WIND DIRECTION ....

DIRECTION OF SEA ....

STATE OF SEA..........................

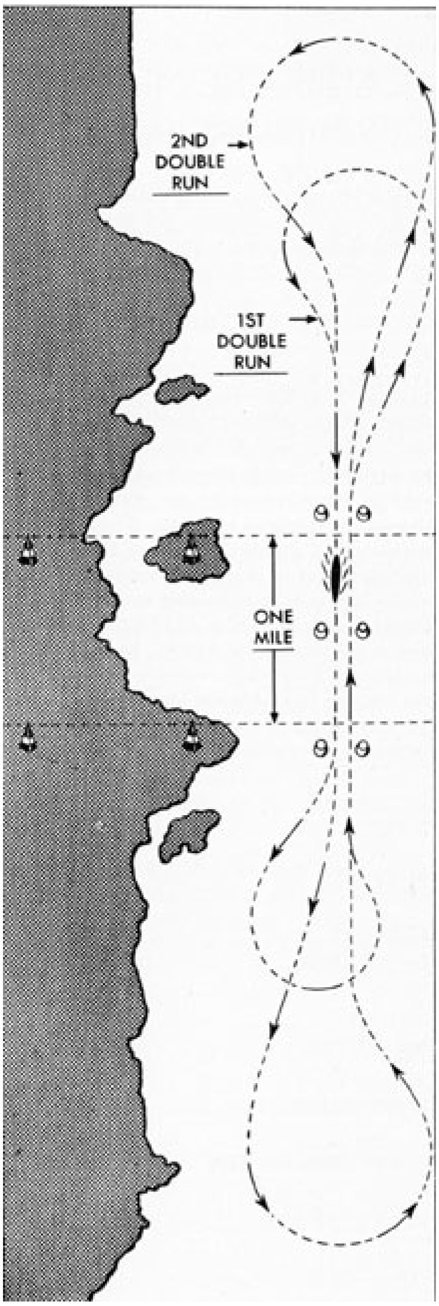


Figure 14-1. Measured mile course.

14A2. Preparations for checking the log. If the ship is not near a standard measured mile course, it is possible to use fixed points 1 mile apart as shown in Figure 14-1 If possible, a location should be chosen in which the current effect is small and which has a direction parallel to the axis of the ship's course. The depth of water should be, if possible, greater than 40 fathoms. Shallower water will prevent the ship from developing proper speed for a given propeller shaft rpm, and the log will tend to read high when checked in shallow water because of wave systems established by the ship and its screws. Before making the runs over the measured mile, the log system should be checked for proper operation as follows:

The hydraulic system should be entirely free of air. Vent the system as described in Section 11A5. All hose connections must be tight. The 3Y circuit of the master transmitter indicator must receive controlled 60-cycle alternating current from the constant frequency supply. A frequency less than 60 cycles will result in a proportional positive error in the distance reading. For example, if the frequency is 59 instead of 60 cycles, the distance indication will

be 1.66 percent low at all speeds. If the frequency is 61 cycles, the distance indication will be 1.66 percent high at all speeds. As the speed is not affected by the 3Y frequency variations, this distance error may be detected by timing with a reliable stop watch.

Check the operation of the instruments before operating on the measured course as follows: Run the speed indication on the master transmitter indicator up to 10 knots by manually moving the main balance arm to the right. When exactly 10 knots has been indicated, place a slip of clean note paper under the moving contact to maintain the speed indicator at 10 knots. At one of the distance counters, measure the time required to indicate 1 nautical mile. This time should be 6 minutes, plus or minus 3 seconds. If the time required exceeds the 3-second allowance, follow the method described in Section 13G49 for adjusting an error between the speed indicator in the master transmitter

indicator and the distance indicator of the speed and distance indicator. A member of the crew should be stationed at the speed and distance indicator (repeater) in the conning tower, and another man, usually the navigator, stationed where he can observe the entrance and exit from the measured mile course. Each man should be equipped with an accurate stop watch. Make certain that the A1, A2, and B adjustments are set to the same values as the factory stationed at the speed and distance indicator that the ship has entered the course. At this instant the man at the speed and distance indicator will also start his stop watch and measure the time required for the distance counter to indicate exactly 1 nautical mile. The navigator will measure the time required. to run the exact measured mile. In all probability, the two stop watch readings will not agree. Therefore, it is necessary that the ship continue on the same course and maintain

adjustment values listed for each particular log on the plate mounted in the lower right-hand corner of the main mounting plate.

14A3. Operation and calculation. The ship should make two double runs, one at a low speed (approximately 5 knots), and one at a high speed (approximately 15 knots). During a double run, the same shaft rpm should be maintained throughout. At the exact moment the ship enters the measured mile course, the navigator should start his stop watch, and simultaneously signal to the crew member the same propeller shaft rpm until both men complete their timing for each individual mile; that is, the true mile, and the log-indicated mile. Repeat the run on the measured mile course in the opposite direction in the same manner. Time indications of these runs should be noted and recorded. Repeat the double run at the higher speed, and record the time indications in the same manner as described at low speed. List the data as follows:

Observed					Calculated				
Run No.	Ship's Course	Length of Course Nautical Miles	Time to Travel Measured Mile Min.-Sec.	Time to Travel Indicated Mile Min.-Sec.	True Speed Knots	Log Indicated Speed Knots	Average True Speed	Average Log Indicated Speed Knots	Percent Error
1	311	1	11:30.2	11:03.4	5.22	5.43	5.29	5.49	+3.78
2	131	1	11:10.3	10:49.7	5.37	5.55			
3	311	1	4:10.6	3:56.5	14.93	15.23	14.95	15.29	+2.30
4	131	1	4:02.4	3:54.7	14.97	15.35			

The following equations are used for calculating the above data:

True speed = (3600 X distance in nautical miles) / (time in seconds to cover measured distance)

Time in seconds = (Minutes X 60) / seconds

Log indicated speed = (3600 X distance measured on counter) / (time in seconds to record log distance)

Average true speed = (Run No. 1 true speed + Run No. 2 true speed) / 2

Average log indicated speed = (Run No. 1 log speed + Run No. 2 log speed) /2

Per cent error = ((Average log indicated speed - Average true speed) X 100 %) / Average true speed

Note: The error is positive when the log speed is greater than the true speed.
The error is negative when the log speed is less than the true speed.

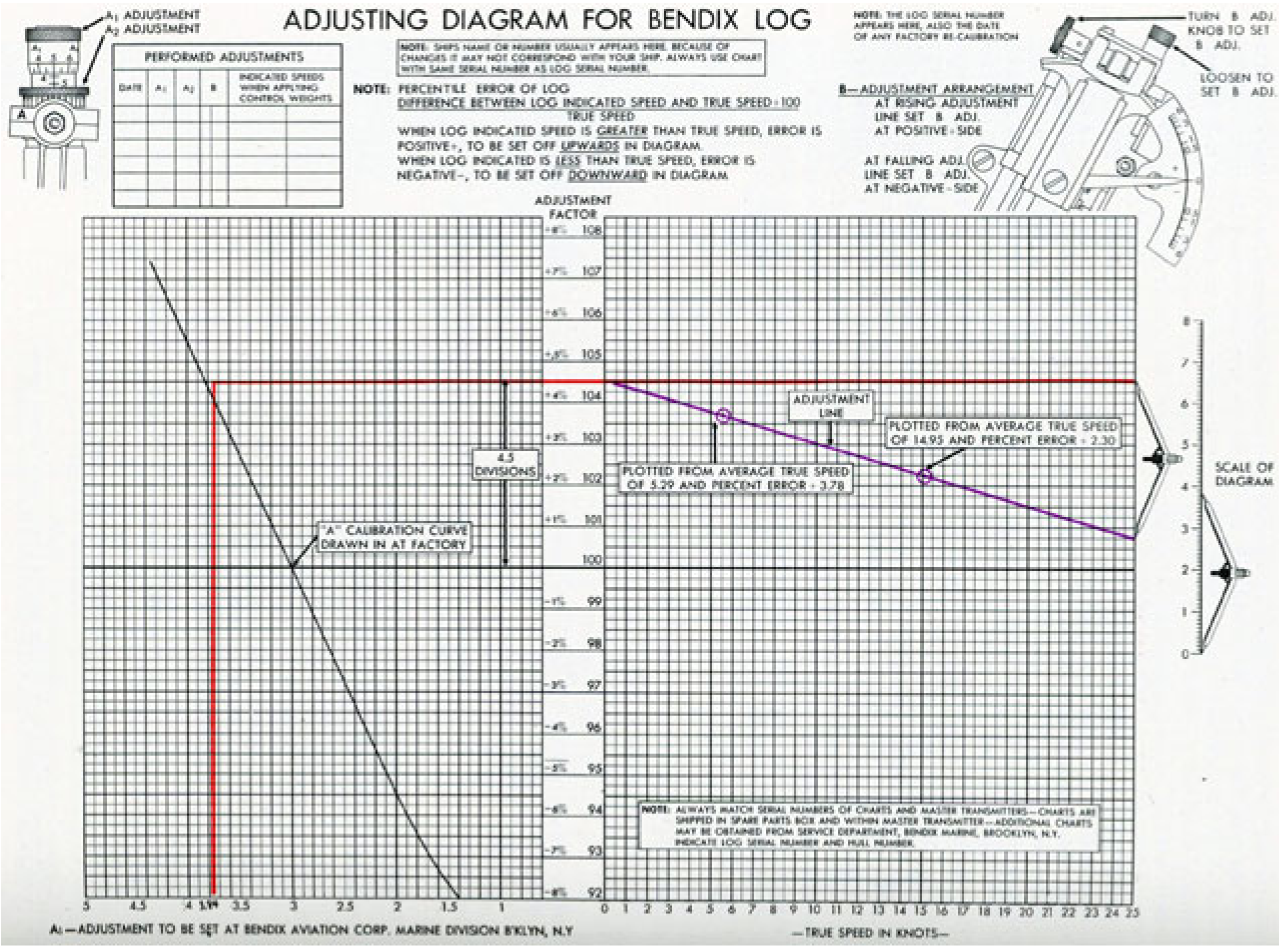
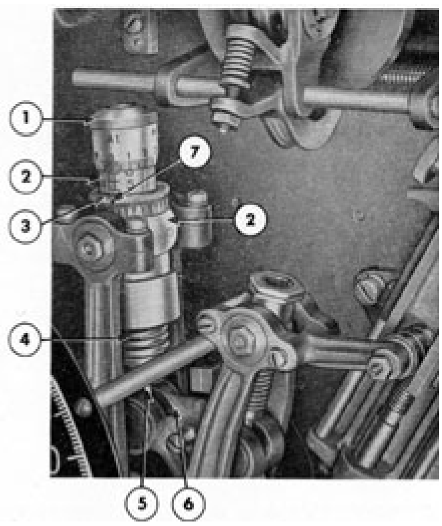


Figure 14-2. Adjusting diagram for calibrating the Bendix log.

14A4. General instructions for plotting adjustments. (See Figure 14-2.) Adjustment diagrams (calibration charts) for each particular Bendix underwater log are furnished with the log by the Bendix Aviation Corporation, Marine Division, Brooklyn, New York. The A-calibration line for each particular log is drawn on the diagram at the factory after the log mechanism has been tested and adjusted at the factory. Note the curved black line in Figure 14-2. Charts are shipped in the



1. A1 ADJUSTMENT KNOB
2. AXLE
3. A2 ADJUSTMENT RING
4. A SPRING (MAIN SPRING)

spare parts box, and within the master transmitter indicator. Additional charts may be obtained from the service department of the manufacturer. When ordering, always indicate the log's serial number and the hull number.

14A5. Plotting true speed in knots adjustment line. (See Figure 14-2.) Using the figures for the average true speed of the first double run (in this case 5.29), and the percent of error of the first double run (in this case +3.78), locate these points on the graph as shown in Figure 14-2. The figures in the vertical column in the center of the chart represent percent error in this manner: Each full division, that is, the distance between figures, represents 1 percent. Divisions above the 100 line represent positive error and divisions below the 100 line represent negative error. Figures in the horizontal line at the lower right side of the chart represent the true speed in knots. Plot the point on the graph for the high-speed double run as shown in Figure 14-2. Draw a line through these two plotted points on the graph as shown by the solid blue line in Figure 14-2.

14A6. Obtaining value for A1-adjustment. (See Figures 14-2 and 14-3.) Draw a horizontal line through the point where the adjustment line intersects the zero knot line from the A-calibration curve to the 25-knot line on the chart as shown by the solid red horizontal line in Figure 14-2. Draw a vertical line from the point of intersection of the horizontal line just drawn, and

5. CONNECTOR SCREW
6. MAIN BALANCE ARM
7. RED DOT
Figure 14-3. The A-adjustment assembly.

line (in this case 3.84) as shown in Figure 14-2. This is the value at which the A1-adjustment knob must be set. Turn the A1-adjustment knob to this value and note the direction in which the knob was turned.

14A7. Obtaining value for A2-adjustment. (See Figures 14-2 and 14-3.) Count vertically the number of major divisions at the zero knot line from the 100 line to the adjustment line. In this case it is 4 1/2 divisions as shown in Figure 14-2. This is the value at which the A2-adjustment must be set. Turn the A2-adjustment ring the number of divisions counted, in the same direction that the A1-adjustment knob was previously turned. We now have completed setting of the A1- and A2-adjustments. Observe the reference line shown on the axle in Figure 14-3. During factory calibration, a red dot is put above this

the A-calibration curve, downward to the base line as shown by the solid red vertical line in Figure 14-2. Read and record the figure at the point at which this vertical line intersects the base

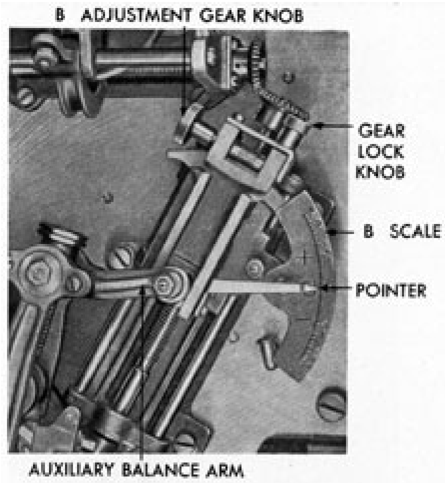
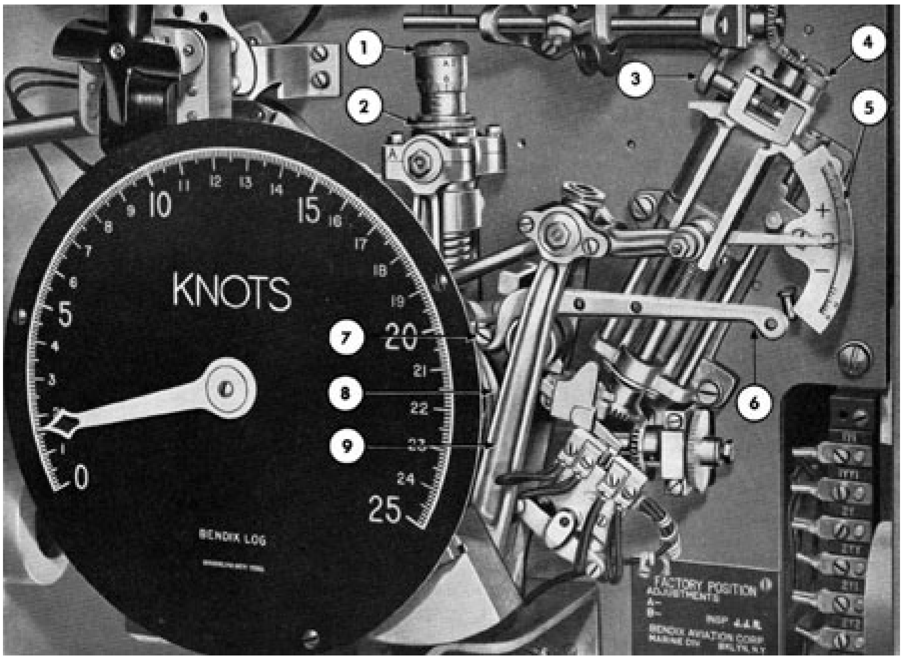


Figure 14-4. The B-adjustment assembly.

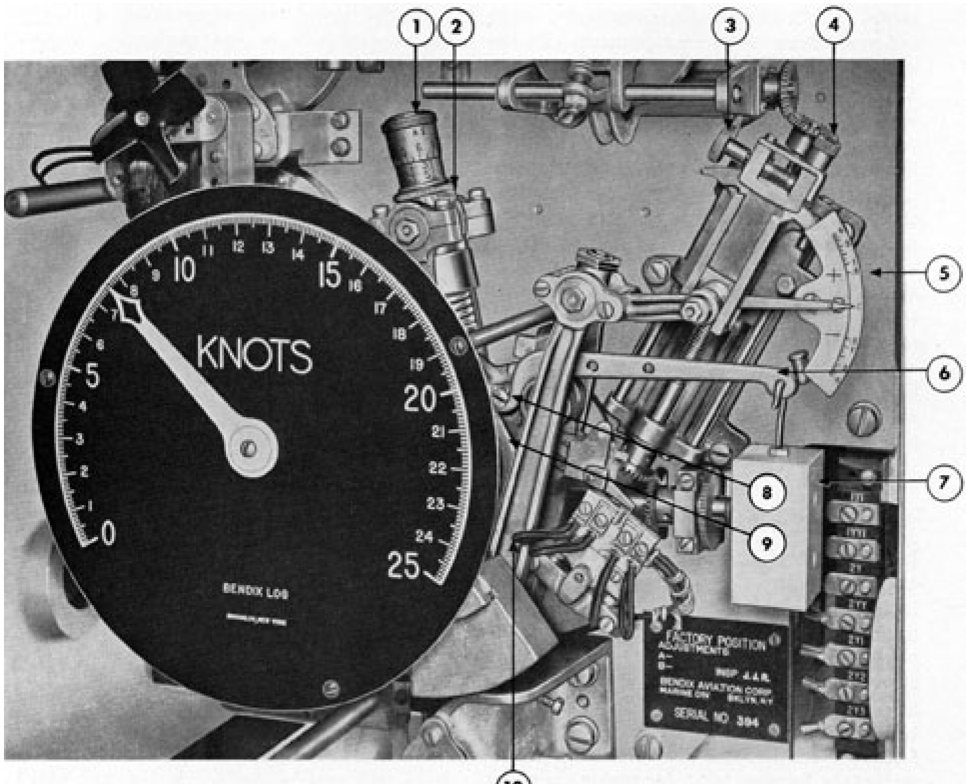
reference line on the A2-adjustment ring to indicate the zero setting of the A2-adjustment. Shipboard adjustments are made thereafter from this reference mark.

14A8. Obtaining value for B-adjustment. (See Figures 14-2 and 14-4.) Using dividers at the 25-knot line, measure the distance along this line which separates the adjustment line from the previously drawn horizontal line as shown in Figure 14-2. Transpose this distance by means of the dividers to the scale of diagram at the right side of the chart. This reading from the scale of diagram is the numerical value at which the B-adjustment must be set (in this case 3.85). If the adjustment line slopes downward to the right (as shown in the diagram), the B-adjustment is to be set on the negative side of the B-adjustment scale on the instrument. Conversely, if the adjustment line slopes upward to the right,



1. A1 ADJUSTMENT KNOB
2. A2 ADJUSTMENT RING
3. B ADJUSTMENT GEAR KNOB
4. GEAR LOCK KNOB
5. B SCALE
6. WEIGHT ARM
7. INDEX SCREW
8. MAIN BALANCE ARM
9. AUXILIARY BALANCE ARM

Figure 14-5. Weight arm attached to instrument.



1. A1 ADJUSTMENT KNOB
2. A2 ADJUSTMENT RING
3. B ADJUSTMENT GEAR KNOB
6. WEIGHT ARM
7. WEIGHT
8. INDEX SCREW

4. GEAR LOCK KNOB
5. B SCALE
9. MAIN BALANCE ARM
10. AUXILIARY BALANCE ARM

Figure 14-6. Weight arm attached to instrument.

the B-adjustment is to be set on the positive side of the B-adjustment scale in the instrument. Set the B-adjustment from the value determined above as follows: Loosen the gear lock knob. Turn the B-adjustment gear knob until the pointer is at the 3.85 position on the negative side of the B-scale. Tighten the gear lock knob.

14A9. Recording the A1-, A2-, and B-adjustments. After setting the A1-, A2-, and B-adjustments to the values obtained in Sections 14A6, 14A7, and 14A8, record the values obtained in the performed adjustments table in the upper left-hand corner of the adjustment diagram as shown in Figure 14-2.

14A10. Checking A1-, A2-, and B-adjustments with weight and arm. (See Figures 14-5 and 14-6.) After setting and recording the A1-, A2-, and B-adjustments as described in Section 14A9, check the recorded adjustment

values as follows: Set the maneuvering cocks and vent cocks to the zero position. Set the instrument to zero position by means of the C-adjustment as described in Section 13A4. Hang the weight arm only on the index screw of the main balance arm as shown in Figure 14-5. Note the speed indication obtained, and record it at the upper left-hand corner of the adjustment diagram. Repeat the operation using the weight arm and weight together, as shown in Figure 14-6. When the log is checked at some future time to see if the adjustments have changed due to temperature, spring tension or for some other reason, use the following procedure: Hang the weight arm alone, and then the weight arm and the weight together on the index screw as previously described. Compare the speed values obtained with the recorded values in the performed adjustments table. If the values are the same within 1/10 knot, the adjustments have not been changed. If the values have changed, check the instrument carefully. See that the contacts are clean, that all connections and screws are tight, that the adjustments have not been changed, and that the instrument generally is in good condition. If the above checks indicate that the instrument is in a satisfactory condition, it will be necessary to make a recalibration run at the earliest possible opportunity, unless the navigator is satisfied with the speed and distance indications obtained. See Section 1413 for information on recalibration.

B. RECALIBRATION OF THE MASTER TRANSMITTER INDICATOR

14B1. Purpose. The purpose of the recalibration run is to correct the log when it is in error. The log may be in error due to one or more of the following reasons: The condition of the hull has been radically changed; the previous run was not properly made, or the instrument and/or rodmeter has been changed in some way.

14B2. Preparation. The preparations described in Section 14A2 for making a measured mile run should be made in this case with the important exception that the A1-, A2-, and B-adjustments are to be set at the same values as last recorded in the performed adjustments table at the upper left-hand corner of the adjustment diagram (Figure 14-7).

14B3. Operation and calculation. (See Figure 14-7). Make the trial runs and calculations as described for the measured mile runs in Section 14A3. Make one additional set of calculations as follows: On the adjustment diagram there appears an adjustment line for the previous trial run. This dotted blue line on the sample diagram (Figure 14-7), is the line from which all plotting and calculations will now be made. At the true speed of 5.20 knots, and at the true speed of 15.40 knots, adjustment factors of 103.8 and 102.25 respectively are obtained. This will then give values which are to be recorded in the following additional table:

Average True Speed Knots	Percent Error	Adjustment Factor	Corrected Percent Error
5.20	2.2%	103.8	2.28%
15.40	3.4%	102.25	3.48%
Corrected percent error = (Percent error x adjustment factor) / 100			

14B4. Plotting the new adjustment line. (See Figure 14-7.) Plot the new adjustment line as follows: Add algebraically, the corrected percent errors to the adjustment factors at the true speeds obtained, and plot on the diagram as before (see Figure 14-7). In this example, the corrected percent error of 2.28 added to the adjustment factor of 103.8 equals 106.08, and the

14B7. Obtaining B-value. (See Figure 147.) Obtain the value at which the B-adjustment is to be set in the following manner: Using dividers, measure the distance between the intersection of the solid red horizontal line with the 25-knot line, and the intersection of the new adjustment line (solid blue) with the 25-knot line. Transpose this distance to the scale of diagram. This gives the

corrected percent error of 3.48 added to the adjustment factor of 102.25 equals 105.73. Draw the new adjustment line through the plotted points obtained as shown by the solid blue line in Figure 14-7.

14B5. Obtaining A1-value. (See Figure 14-7.) Obtain the new A1-adjustment value by drawing a straight line horizontally across the diagram through the point at which the new adjustment line intersects the zero knot line, and extending it to the A-calibration curve as shown by the solid red horizontal line. Draw a vertical line (solid red) downward from the point at which the previously drawn solid red horizontal line intersects the A curve, to the base line. The reading at this base line point is the value at which the A1-adjustment is to be set (in this case, 4.15).

14B6. Obtaining A2-value. (See Figure 147.) Obtain the A2-adjustment value by counting the .number of divisions between the points at which the old and new adjustment lines intersect the zero knot line on the diagram; in this case 1.5 divisions. That is, the A2-adjustment is to be turned 1.5 divisions from the previous setting in the same direction in which the A1-adjustment knob was turned.

percentage (value) that the B-adjustment is to be set away from the previous setting. In this case the B setting is minus 0.9. Therefore, the B-adjustment is to be set at minus 4.75.

14B8. Setting and recording new adjustments. Set the A1-adjustment knob to the value 4.15 obtained in Section 14135. Set the A2-adjustment away from the previously recorded setting by the value 1.5 divisions as determined in Section 14B6. Be sure to turn the A2-adjustment ring in the same direction that the A1-adjustment knob was turned. Set the B-adjustment away from the previously recorded adjustment value by the amount of the value obtained, in this case minus 4.75, as determined in Section 14B7. Record the new adjustment values in the table at the upper left-hand corner of the adjustment diagram as shown in Figure 14-7. Hang the weight arm, and then the weight arm and the weight on the index screw of the main balance arm as shown in Figures 14-5 and 14-6. Record these speed indications in the performed adjustments table in the upper left-hand corner of the adjustment diagram as shown in Figure 14-7.

C. CALIBRATION OF THE LOG WHEN PERCENTAGE ERROR EXCEEDS 8 PERCENT

14C1. Purpose. This method of calibration is to be used only when the log error, determined

14C3. Operation and calculation for setting B-adjustment. Set the maneuvering cocks and drain cocks to the zero position. Attach

during trial runs, exceeds plus or minus 8 percent.

14C2. Preparation. Trial runs have been made, and the percent error at certain true speeds determined. Carefully check all the data and calculations before proceeding with this method of calibration.

the weight arm, provided in the spare parts box, to the index screw on the main balance arm, as shown in Figure 14-5. Make and hang weights, preferably lead, on the arm so that the speed indications can be run up to the log indicated speeds obtained in the

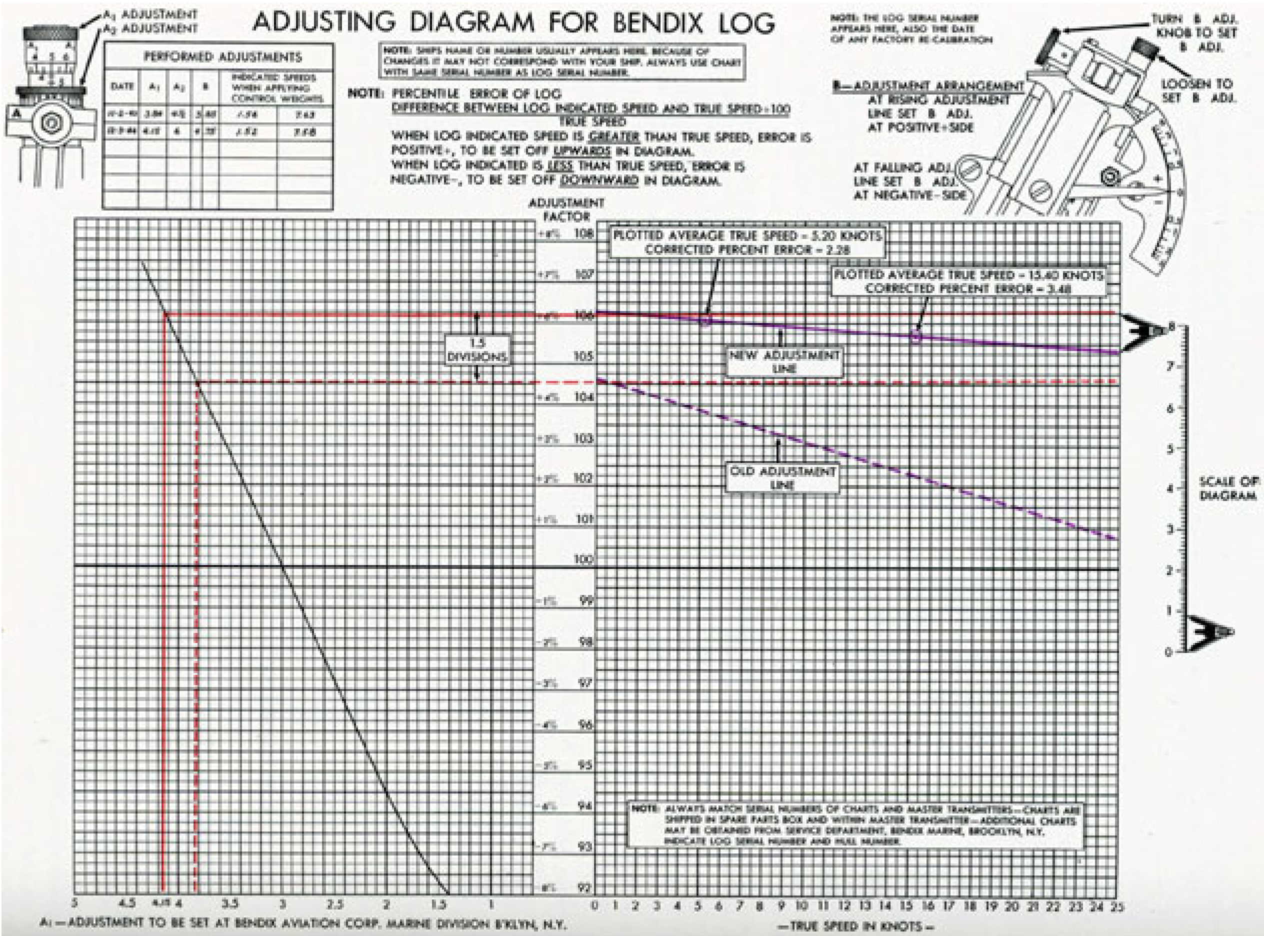


Figure 14-7. Adjusting diagram for recalibrating the Bendix log.

calculations for the trial runs. Mark each weight for ready identification. Subtract the percent error at a true speed of approximately 5 knots from the percent error at a true speed of approximately 15 knots, and divide this value by 0.4. Then set the B-adjustment to this value is high at 15 knots, turn the B-adjustment toward a positive, or more positive, reading on the B-scale and try adjusting again.

NOTE: When 5 and 15 knots are mentioned in the above text, they are used merely to indicate the low and high speed runs at which the trial runs were made.

on the plus side of the B-scale; if the percent error at 15 knots is greater than the percent error at 5 knots, in a positive direction. Set the B-adjustment on the negative side of the scale if the percent error at 15 knots is less than the percent error at 5 knots in a negative direction.

14C4. Operation and calculation for setting A1- and A2-adjustments. Hang a weight for a log indicated speed equivalent to a true speed of approximately 5 knots on the weight arm, and use the A2-adjustment ring to bring the pointer to the true speed at approximately 5 knots. Hang the weight equivalent to a true speed of approximately 15 knots on the same weight arm. Bring the pointer to a true speed of approximately 15 knots by adjusting the A1-adjustment knob. Repeat these operations using 5- and 15-knot weights in conjunction with the A2- and A1-adjustments until the reading of a low true speed, plus or minus 1/10 (0.10) knot, and a high true speed of plus or minus 15/100 (0.15) knots is obtained. If it seems to be impossible to obtain the proper readings at 5 and 15 knots, that is, if a reading is correct at 5 knots, and is low at 15 knots and cannot be changed, turn the B-adjustment toward a negative, or more negative reading on the B-scale, and try adjusting again. If it seems

14C5. Calibration when percent error exceeds 8 percent. The following is an example of calibration when the percent error is greater than 3 percent:

Average True Speed Knots	Average Log Indicated Speed Knots	Percent Error
5.20	4.65	-10.5%
15.12	13.87	- 8.3%

Weights are made that will make the log indicate 4.65 and 13.87 knots. The weights are marked for ready identification. Subtract the percent error at 5.20 knots from the percent error at 15.12 knots; that is (-8.3) minus (-10.5) equals plus 2.2. Divide 2.2 by 0.4 which equals plus 5.5 percent. The B adjustment is then set at plus 5.5 percent. Add a weight to make the pointer indicate 4.65 knots. The pointer will not indicate exactly 4.65 knots, as before, because the B setting has been changed. By means of the A2-adjustment ring, the instrument is made to indicate 5.20 knots. In this case the A2-ring is backed off. Then hang a weight required to make the log indicate 13.87 knots to the weight arm. Again the log will not, indicate exactly 13.87 knots because the B- and A2-adjustments have been changed. The log is made to indicate exactly 15.12 knots by turning the A1-adjustment. In this case the A1-adjustment is turned out (counterclockwise when looking downward on the knob), because the original percent error was low (negative). After the A1-adjustment has been made, remove the heavy weight and apply the weight required for the

impossible to obtain the proper readings at 5 and 15 knots, that is, if a reading is correct at 5 knots and low speed reading. The reading probably will be high

because of the previous change in the A1-setting. Therefore, the A2-ring must be turned downward (clockwise when looking downward on the ring) until a reading of exactly 5.20 knots is obtained. The reading is probably low, so again the A1-adjustment must be turned out. If the range of the A1-adjustment is exceeded, the plug on the bottom of the A-spring assembly must be turned as follows: Turn the plug a small part of a rotation (10 or 15 degrees). Turn the plug outward if the A1-adjustment has been turned all the way out. Conversely, turn the plug inward if the A1-adjustment has been turned all the way in.

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15
SHOP CALIBRATION

A. TEST AND CALIBRATION IN SHOP

15A1. General. When it becomes necessary to remove the main balance arm, auxiliary balance arm, main force arm, or the A-spring from the instrument, the procedure generally followed is to remove the instrument from the ship and overhaul it on a tender or in a shop. The most practical means of checking the instruments before installation in the ship is to operate them in the shop under the same conditions as encountered in service. After overhaul, the cam and pointer should be adjusted to the zero position (see Section 15A6), and the instrument should be balanced (see Section 15A7), and calibrated in the shop. The bellows should be tested, if necessary, under water pressure of 300 psi.

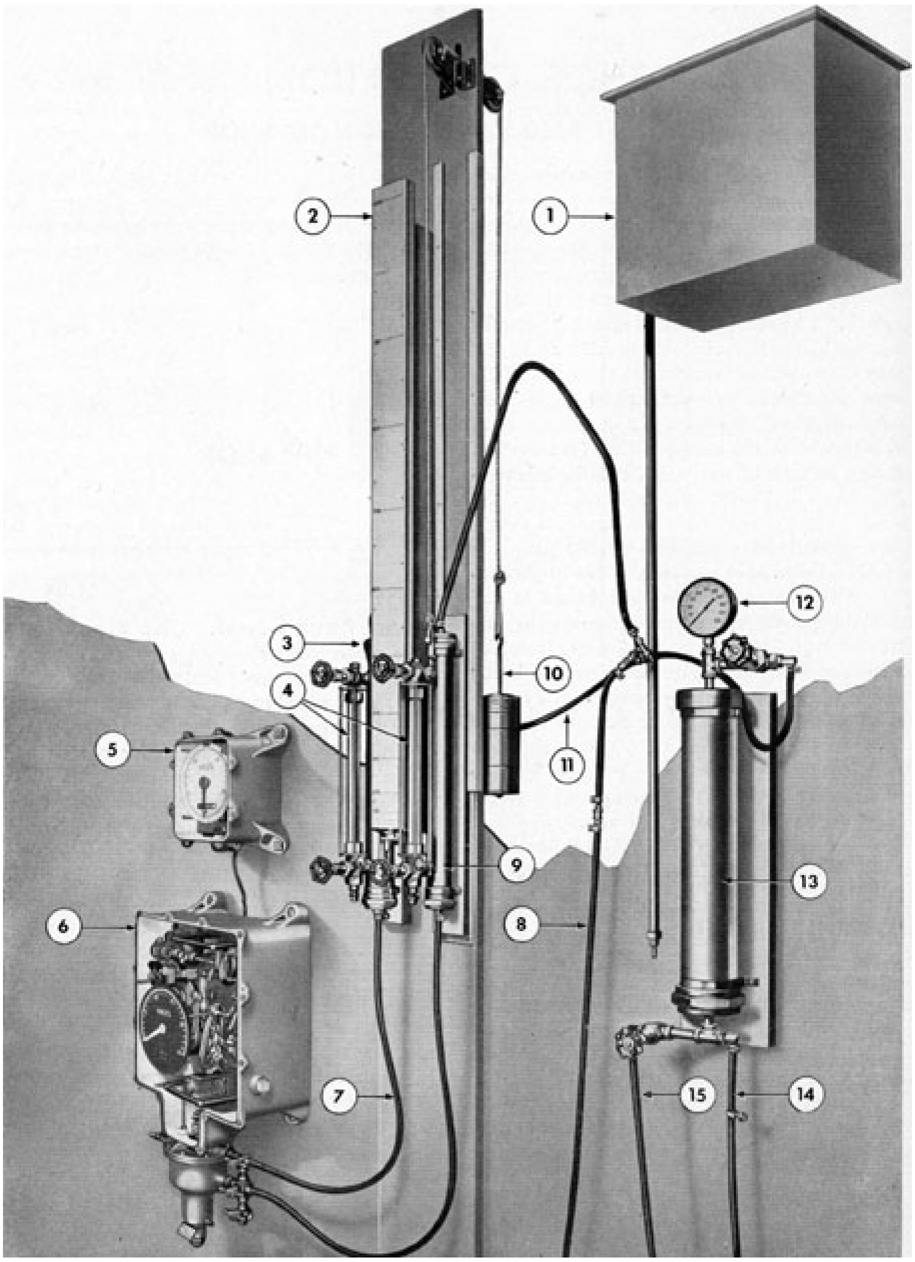
15A2. Equipment required. (See Figure 151.) The equipment described below is the minimum required for properly testing the Bendix log. It an be assembled and installed at a tender or base shop from readily available material. The following hydraulic equipment is necessary: a water storage tank, or water line with connection, static pressure tank, dynamic pressure tank, pressure storage tank, pressure gage, air compressor, water level gages, knot scale, hydraulic hose, and be mounted so that it can be shifted upward and downward approximately 6 inches, or else the left-hand static tank must be movable. The distances to be marked above zero, corresponding to knots are listed as follows:

Knots	Distance (in.) above zero
1	0.543
2	2.170
3	4.879
4	8.674
5	13.553
6	19.516
7	25.383
8	34.696
9	43.912
10	54.212

15A4. Pressure tanks. (See Figure 15-1.) Two pressure tanks are mounted, one on each side of the knot scale. The tank on the right side supplies dynamic water pressure. The left-hand tank supplies static water pressure. Provision is made for raising and lowering the right-hand (dynamic tank, while the left-hand (static) tank is stationary, unless the scale is stationary, in which case the latter tank must be movable, too. When the dynamic tank is elevated above the static tank, the head, or difference of level of water, creates

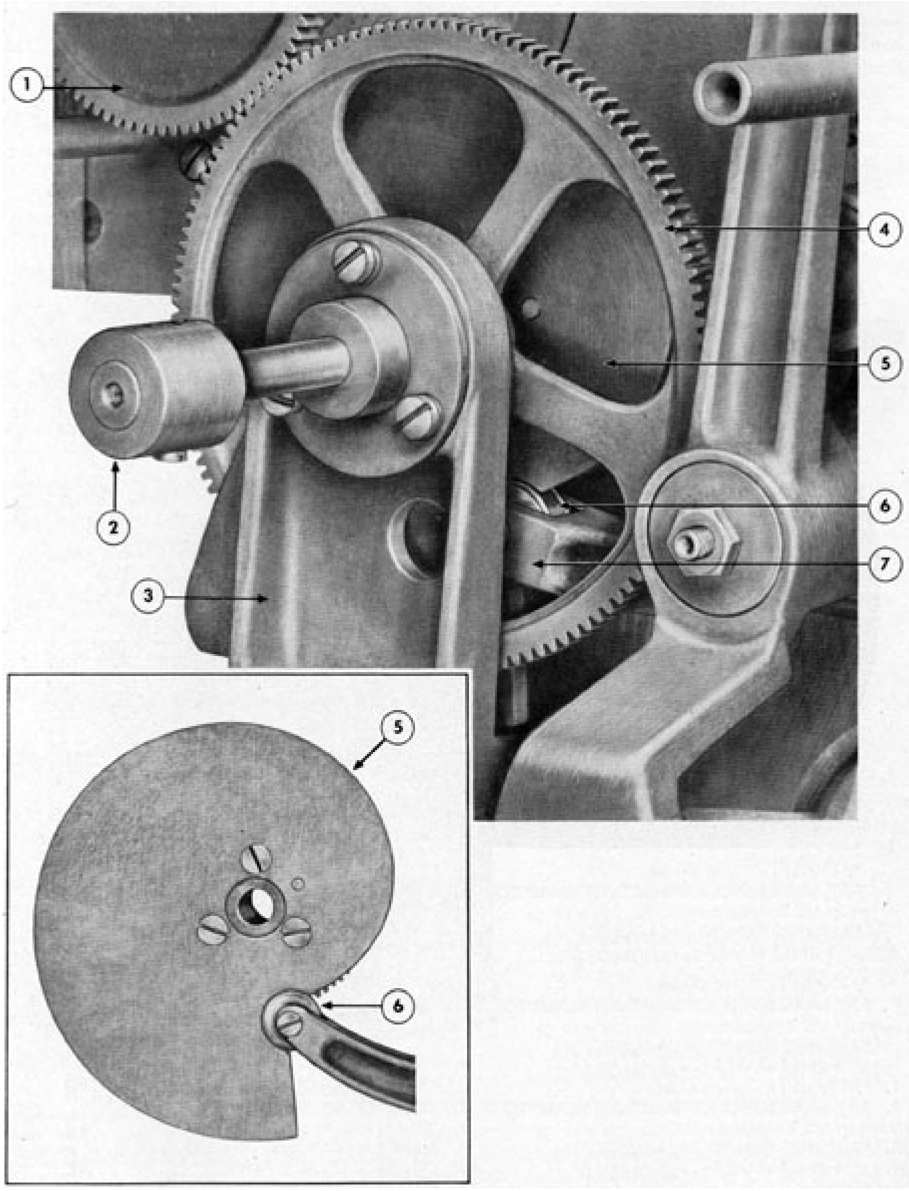
fittings and connections. This equipment is described in the following paragraphs.

15A3. Knot scale. (See Figure 15-1.) The knot scale is laid off from the values listed below, and is preferably made of metal. The lines are cut with a milling machine or jig borer, so that the distances from the zero line can be accurately measured. This scale is suitable for use only with fresh water in tanks and system, and is designed for calibrating Bendix log instruments only. Pressure values from rodometers of other manufacturers may differ from the pressure values indicated here, probably necessitating the use of a different scale. However, with a correct scale, this equipment may be used on other types of logs operating on the principle of pressure differences from a rodmeter. The scale should a pressure difference which is equal to the dynamic pressure at some known speed. Water level gages are mounted in front of the pressure tanks and show the exact level of water in each tank. The knot scale mounted between these pressure tanks is calibrated in knots and enables the water level to be read closely, even at low speeds. The tanks are made of 3- or 4-inch heavy-duty pipe, preferably brass, approximately 18 inches long, with heavy threaded caps at each end. The glass tubing and gage fittings should, be able to withstand a pressure of 400 psi for safety. Shut-off cocks should be mounted on the lower ends, ahead of the nipples. Shutoff



1. WATER STORAGE TANK
2. KNOT SCALE
3. STATIC PRESSURE TANK
4. WATER LEVEL GAGES
5. SPEED AND DISTANCE INDICATOR
6. MASTER TRANSMITTER INDICATOR
7. STATIC HOSE
8. AIR COMPRESSOR LINE (OPTIONAL)
9. DYNAMIC PRESSURE TANK
10. COUNTERWEIGHT
11. AIR LINE TO STATIC PRESSURE TANK
12. PRESSURE GAGE
13. PRESSURE STORAGE TANK
14. VENT LINE
15. HAND PUMP PRESSURE LINE

Figure 15-1. Shop calibration equipment.

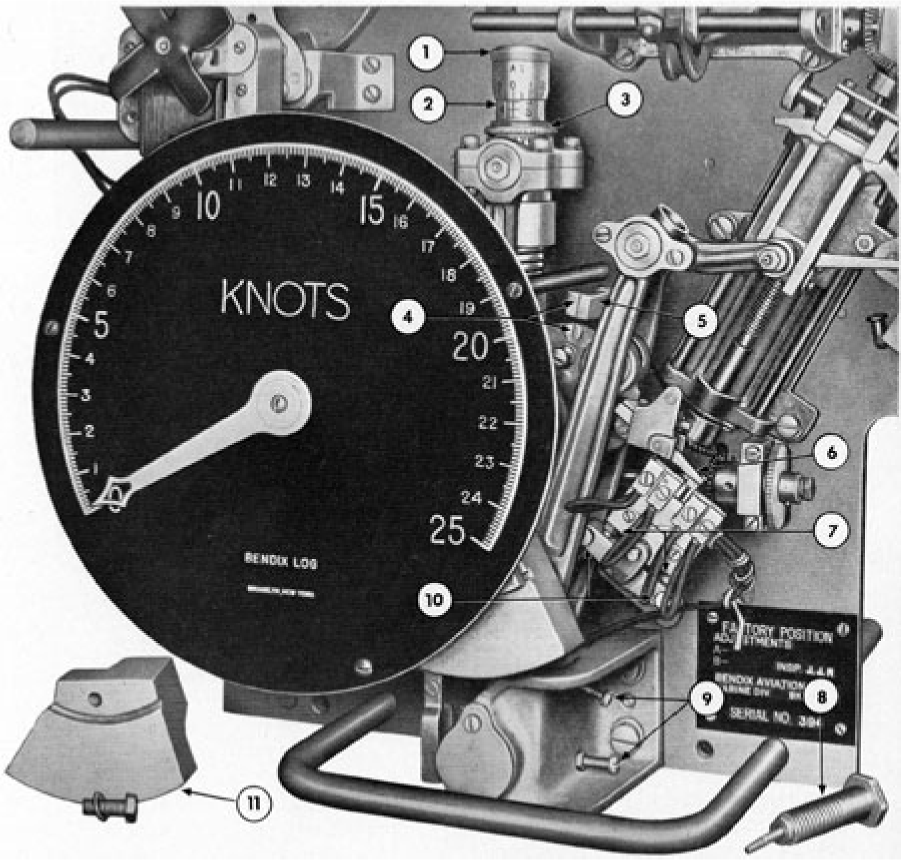


1. SPEED TRANSMITTER DRIVEN GEAR
2. POINTER HUB
3. CAM BRACKET
4. SPEED TRANSMITTER DRIVE GEAR
5. CAM
6. CAM FOLLOWER (BEARING)
7. MAIN FORCE ARM EXTENSION

Figure 15-2. Cam positioned prior to setting pointer to exact zero.

cocks are not required at the top. When mounted as shown in Figure 15-1, the left-hand (static) tank is connected to the static line. The right-hand (dynamic) tank is suspended on a chain, or cord, which is connected to a counterweight so that it may be moved upward or downward as water level is at least 4 feet above the bellows. However, the shop ceiling may be a determining factor, and may not permit raising the dynamic tank to the 10-knot mark on the scale. In this case the distance of the zero water level above the bellows will have to be less than 4 feet.

desired. The tanks should be mounted so that the zero

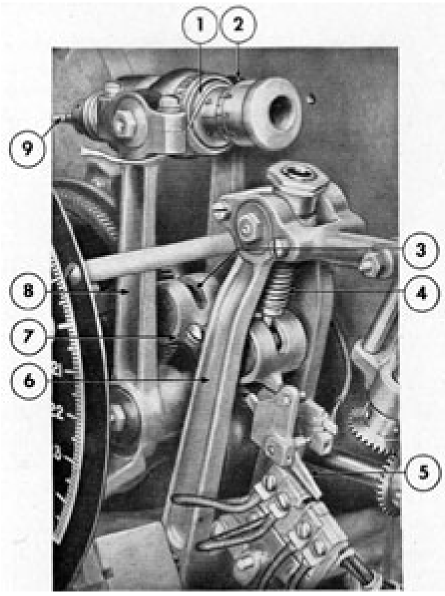


1. "A1" ADJUSTMENT KNOB
2. "A" ADJUSTMENT ASSEMBLY ATTACHED TO MAIN BALANCE ARM
3. "A2" RING TURNED ALL WAY DOWN
4. REFERENCE MARKS
5. REFERENCE POST
6. CONTACT ARM
7. CONTACT ADJUSTING SCREWS
8. "B" SPRING ASSEMBLY REMOVED
9. MAIN BALANCE ARM ADJUSTING SCREWS
10. CONTACT LOCK SCREWS
11. MAIN BALANCE ARM COUNTERWEIGHT REMOVED

Figure 15-3. Balancing master transmitter indicator, Step 1.

pressures which are developed in the top of the tank when water is pumped up into it from below by a hand pump. An air-pressure gage should be mounted on either the dynamic or static tanks, on the common air line, or on the pressure storage tank. Connect the upper bellows fitting to the static tank.

15A6. Aligning cam and pointer to exact zero position. (See



1. STRING
2. A ADJUSTMENT, ASSEMBLY
3. CONNECTOR SCREW CONNECTION
4. B SPRING
5. CONTACT ARM
6. AUXILIARY BALANCE ARM
7. MAIN BALANCE ARM
8. MAIN FORCE ARM
9. CONNECTOR SCREW

Figure 15-4. Balancing master transmitter indicator, Step 2.

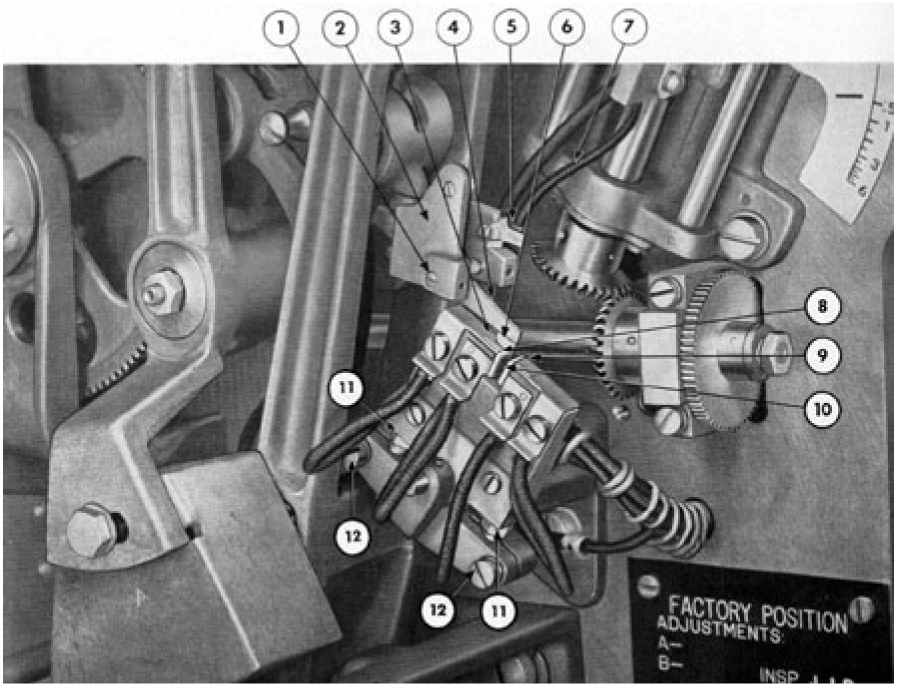
15A5. Water and air connections. (Figure 15-1.) The hose connecting the dynamic tank to the lower fitting of the bellows must be long enough to permit the dynamic tank to be raised to the extreme upper position of 10 knots. The nipples on the upper ends of the tanks are connected together, and the hoses are so arranged that they can be connected to either a water supply, or to a water storage tank, mounted from 8 to 12 feet above the tanks; and to an air pressure line capable of delivering a pressure of at least 100 psi. A pressure storage tank mounted as shown in the illustration permits the use of higher

Figure 15-2.) Remove the pointer and dial before calibrating the log; align the cam and pointer to the exact zero position as follows: Manually turn the driven gear on the power motor drive gear assembly until the bearing (follower) on the main force arm extension falls into the groove provided in the cam as shown in the illustration. Install the dial and pointer with the pointer set at zero position on the dial. Manually turn the power motor-driven gear until the pointer registers 1.2 knots on the dial. This is the exact zero setting of the pointer and cam. Loosen the pointer screw and move the pointer back to zero position on the dial. Tighten the pointer screw and pin the pointer to the pointer hub.

15A7. Balancing master transmitter indicator. (See Figures 15-3, 15-4, and 15-5.)

a. Whenever the A-adjustment assembly is replaced, or whenever the arms are removed, it is necessary to balance the log mechanism before calibration. The first steps in balancing the master transmitter indicator are accomplished as follows: Remove the counterweight from the bottom of the main balance arm by removing the screw and lock washer that secure the counterweight to the arm. Turn the A2-adjustment ring in a clockwise direction as far as possible. This will stretch the A-spring. Remove the B-spring by unscrewing the B-spring connector screw from the rocker on the top right side of the main balance arm. Energize the power motor. Position the contact block so that the contact arm is in a neutral

position when the pointer reads zero by loosening the two lock screws at the bottom of the contact block, and then turning the contact block adjusting screws until the contact arm is positioned in a neutral position. Align the



1. PIVOT SCREW
2. CONTACT ARM SUPPORT
3. HIGH-SPEED REVERSE CONTACT
4. CONTACT ARM
5. TERMINAL
6. CONTACT ARM CONTACT
7. PIGTAIL
8. SLOW-SPEED REVERSE CONTACT
9. HIGH-SPEED FORWARD CONTACT
10. SLOWSPEED FORWARD CONTACT
11. CONTACT ADJUSTING SCREWS
12. CONTACT LOCK SCREWS

Figure 15-5. Contact arm and contacts installed.

reference marks on the reference post and on the main balance arm by loosening the lock nut on the rear of the main mounting plate and turning the reference post until the reference marks are aligned (Figure 15-3). Deenergize the power motor. Turn the main balance arm adjusting screws on the main tighten the lock nut on each adjusting screw.

b. The second step in balancing the master transmitter indicator is accomplished as follows: Disconnect the connector screw on the A-spring from the rocker on the left side of the main balance arm. Tilt the A-adjustment

force bearing so that the contact arm will move through an are sufficient to position the arm contact on the exact center of each high-speed contact, then

assembly to a horizontal position, and tie it in this position so that it will clear the rest of the mechanism as shown in Figure 15-4. Place the B-spring in the spring

force hub at the top of the auxiliary balance arm, and install the B-spring connector screw that secures the spring to the rocker in the right side of the main balance arm. Install the adjusting nut and thin lock nut at the top of the B-spring so that there is no tension and no slack in the B-spring. Install the counterweight on the bottom of the main balance arm and secure it with a screw and lock washer. Shift the position of the counterweight on the main balance arm until the reference mark on the reference post is aligned with the reference mark on the main balance arm (Figure 15-3) when the arm is freely balanced. When the reference marks are aligned, pin the main balance counterweight in position. It is not always possible to pin through the old pin hole. In such cases, a new hole should be drilled and a pin installed through it. Be careful not to get chips in any part of the instrument. Remove the string from the A-adjustment assembly and connect the A-adjustment assembly connector screw to the rocker at the left side of the main balance arm. Tighten the connector screw.

15A8. Preparing shop equipment prior to testing. Fill both the static and dynamic pressure tanks nearly to the top

cause the master unit to return to a zero indication of the pointer.

15A10. Testing equipment (submerged condition). Connect the common pressure hose at the top of the tanks to a controllable supply of air, preferably from the pressure storage tank. Apply air slowly, and test at steps of 50 psi. Because of hose expansion with pressure increase, the water level in the tanks may change and the zero of the scale may have to be lowered slightly. Pressure beyond 200 psi is not necessary if the parts operate satisfactorily up to this pressure. No part of the bellows assembly should leak. If the test under pressure (submerged condition) is satisfactory, release the air pressure from the top of the tanks. Do not release the pressure by opening the vent cocks on the bellows. Adjust the equipment for dive error as described in Section 13E5.

15A11. Calibration of Bendix log in shop. Shop calibration of the Bendix underwater log is accomplished in the following manner:

a. Set the B-adjustment to zero and the A1-adjustment to the factory adjustment setting as indicated on the plate which is mounted on the lower right-hand corner of the main mounting plate.

b. Energize the instrument.

with fresh water and vent the hydraulic system as described in Section 11A5.

15A9. Testing equipment at surface pressure. (See Figures 7-2 and 7-3.) To operate the unit at normal surface pressure, set the valves of the bellows to the operating position. Vent both the static and dynamic tanks to the same level at the zero point on the knot scale. The top connections of the tanks are open to the atmosphere. Energize the master transmitter indicator. Set the instrument to zero by means of the C-adjustment as described in Section 13A4. Raise the dynamic pressure tank to the desired knot mark on the scale as illustrated in Figure 7-3. If adjusted properly, the pointer of the master transmitter indicator will indicate the same speed. Lowering the dynamic tank to the zero mark as shown in Figure 7-2 should

c. With the water levels at the zero knot line of the knot scale and valves and vent cocks at the operating (speed) position, set the pointer at zero by means of the C-adjustment as described in Section 13A4.

d. Raise the water level in the dynamic pressure tank to 5 knots and make the pointer indicate 5 knots, plus or minus 0.10 knot, by turning the A2 adjustment ring. The red marks on the ring should line up with the scribe marks on the axle.

e. Raise the water level to 10 knots and observe the speed pointer. If it reads more than 10.1 knots, turn the plug at the bottom of the A spring until the pointer indicates 9.9 knots.

f. Lower the dynamic water level to 5 knots on the scale and repeat the operations outlined in Section 15A11d.

g. Raise the dynamic water level to 10 knots on the scale and repeat the operations outlined in Section 15A11e.

h. Repeat the operations outlined in Sections 15A11f and 15A11g until the speed indications of 5 knots plus or minus 0.10 knots, and 10 knots plus or minus 0.10 knots are obtained. If, when raising the dynamic water level to 10 knots on the scale, a speed indication of less than 9.9 knots is obtained on the speed dial, turn the plug below the A-spring outward until a speed indication of 10.1 knots is obtained.

16
ELECTRICAL CIRCUITS

A. LOG ELECTRICAL CIRCUITS

16A1. Types of circuits. (See Figure 16-1.) All electrical circuits that connect the underwater log are known as Y circuits. The Bendix underwater log is equipped with the following circuits:

1Y-Speed transmission circuit
2Y-Distance transmission circuit
3Y-Constant frequency supply

16A2. 1Y circuit. The 1Y circuit is the basic circuit in the Bendix underwater log system since a speed indication is first obtained in the master transmitter indicator, and then the distance is obtained by integrating the speed by means of the follower and rotating disk in the same instrument. The 1Y circuit includes the 1Y1 circuit which is shown separately, since it supplies 115-volt alternating current to the log power motor which positions the main force arm and gives a speed indication. The balance of the 1Y circuit is used to transmit speed indications to the repeaters, torpedo data computer, and into the speed corrector of the gyro compass through switches on the interior communication board. Note that the R1 and R3 leads are reversed in the wiring of the repeater, since the repeater and transmitter rotate in opposite directions.

16A3. 2Y circuit. The 2Y circuit supplies 115-volt alternating current to the follow-up motor in the master transmitter indicator. The follow-up motor supplies the torque required to drive the distance transmitter. In addition, the 2Y circuit is used to transmit, by means of self-synchronous motors, distance readings to the repeaters and the dead reckoning tracer. Control switches for the 2Y circuit are mounted on the interior communication board.

16A4. 3Y circuit. The 115-volt 60-cycle alternating current supply driving the constant speed motor in the master transmitter indicator is the 3Y circuit. As this current is used for timing, its frequency must be held to 60 cycles. For this reason a constant frequency control unit is generally supplied, with an alternative position on the circuit switch which connects to the ship's alternating current supply. On some of the latest submarines the frequency of the ship's alternating current is accurate enough, and no constant frequency control unit is required.

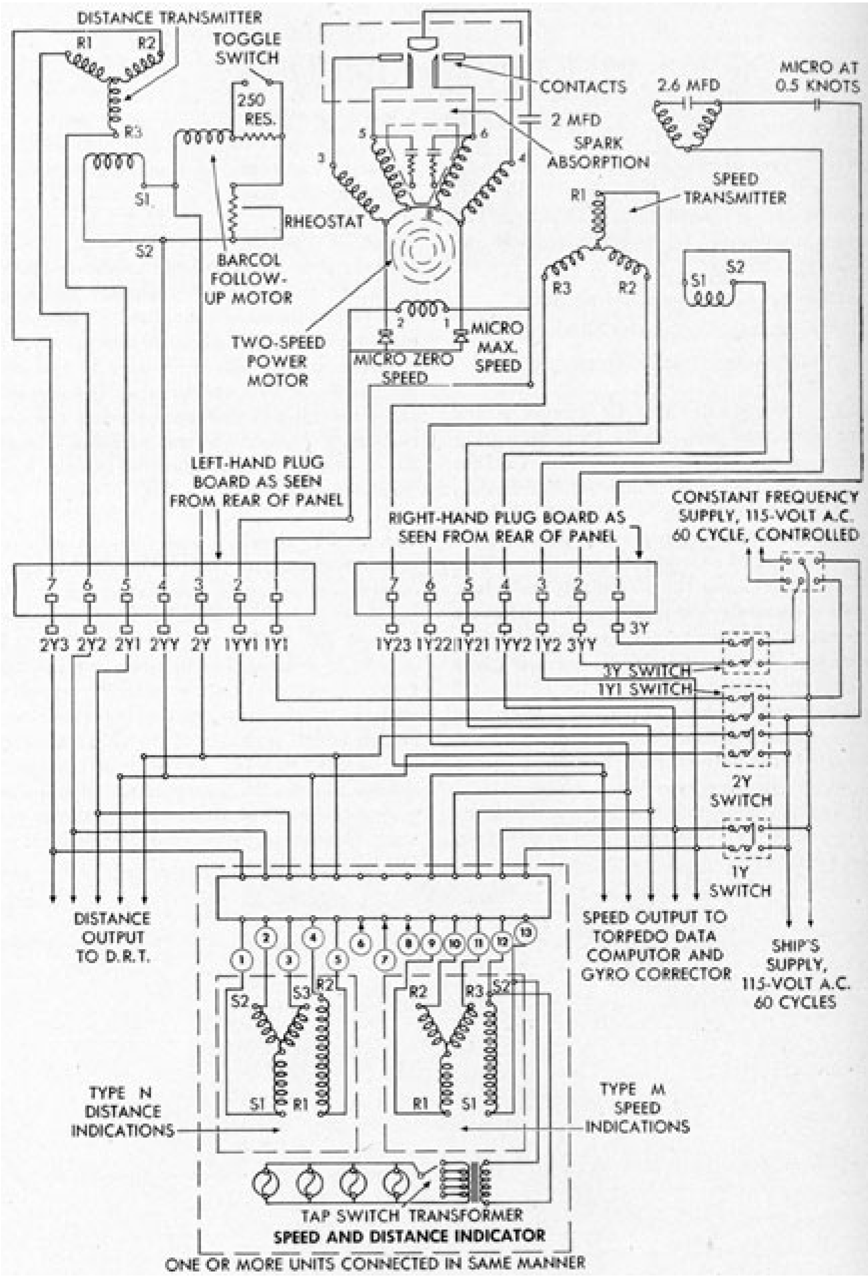


Figure 16-1. Bendix log wiring diagram.

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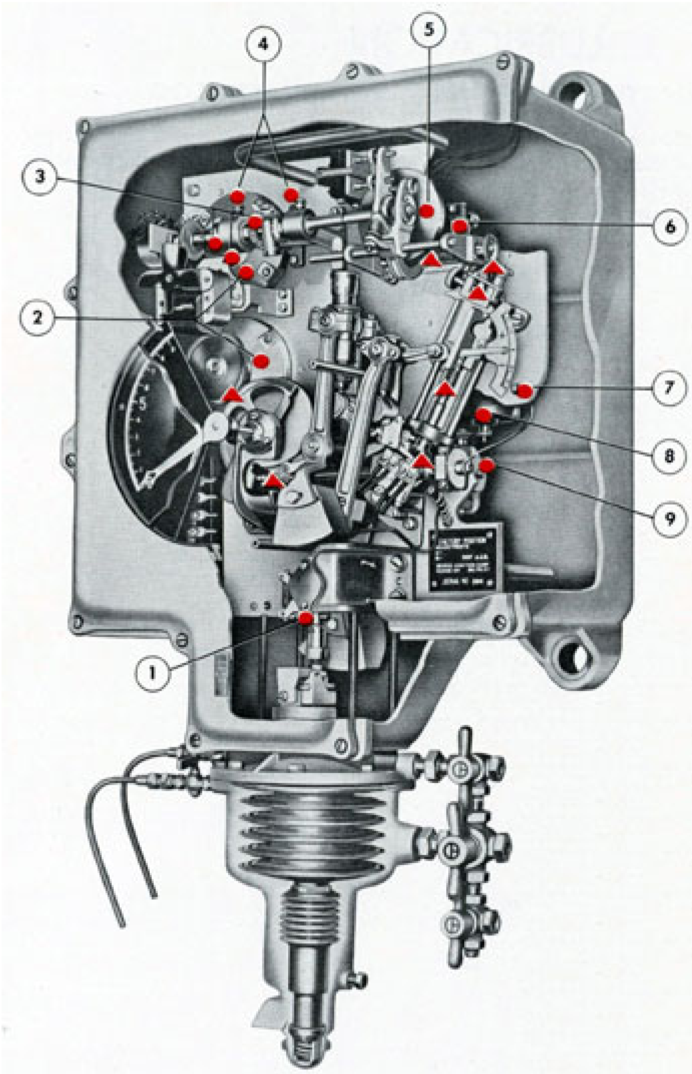
17
LUBRICATION

A. LUBRICATION Of BENDIX UNDERWATER LOG

17A1. Purpose. The following illustrations show the various points of the Bendix underwater log which require lubrication. The type of lubricant, and the lubrication service interval are listed with each illustration. Proper lubrication service will increase the operating efficiency of the equipment, and premature failure of the parts due to wear.



1. PIVOT, GYRO OIL OR UNIVIS NO. 48 EVERY MONTH
2. BEARINGS IN TRANSMITTERS, GYRO OIL OR UNIVIS NO. 48 EVERY 2 YEARS
3. MOBILGREASE ZERO EVERY MONTH

4. GYRO OIL OR UNIVIS NO. 48 EVERY MONTH
5. MOBILGREASE ZERO EVERY 3 MONTHS ON DISK
6. REDUCTION GEARS, HAUGHTON NO. 100 OR EQUIVALENT EVERY 2 YEARS
7. GYRO OIL OR UNIVIS NO. 48 EVERY MONTH
8. POWER MOTOR BEARINGS, GYRO OIL OR UNIVIS NO. 48 EVERY 2 YEARS
9. POWER MOTOR DRIVE GEAR ASSEMBLY, MOBILGREASE ZERO EVERY YEAR

Figure 17-1. Lubrication paints, master transmitter indicator.

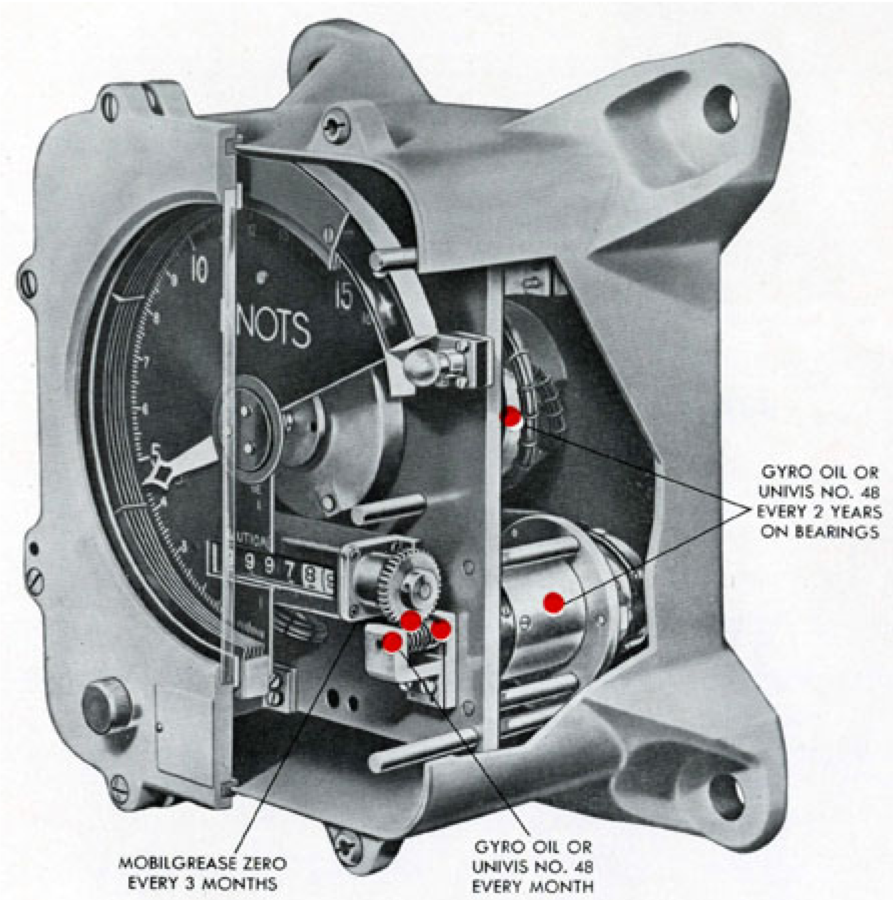


Figure 17-2. Lubrication points, speed and distance indicator.

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PART 3

MERCURY DIFFERENTIAL MANOMETER AND ELECTRONIC LOGS

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18 DESCRIPTION

A. GENERAL DESCRIPTION

18A1. General. The mercury differential manometer underwater log (Figure 18-1) is made by the Pitometer Log Corporation, New York, New York. This type of underwater log derives its name from the fact that hydraulic pressures actuate a column of mercury in a mercury manometer. The movement of the column of mercury, caused by dynamic pressure from the rodmeter, is the actuating force that operates the system. This system consists of the following components: rodmeter, sea valve, manometer, transmitter, master speed repeater, speed and distance repeater, and a mileage indicator.

18A2. Rodmeter. (See Figure 18-1.) The rodmeter, commonly called the sword, is located in the forward torpedo room or in the pump room below the light draft water line. This rodmeter is identical with the rodmeter used with the Pitometer rotary balance type log. It projects through the hull of the ship into the water and is the unit in which gland is mounted on the valve extension to provide a leakproof seal between the rodmeter and the sea valve.

18A4. Mercury differential manometer. (See Figure 18-1.) The mercury differential manometer is a U-tube of special design, containing mercury. It is mounted in gimbals so that the assembly will tend to remain in a vertical position regardless of the roll and pitch of the ship. The two larger outer tubes of the manometer are connected at their base. A small central tube connects this base with a float chamber in which the mercury rises and falls with changes in the ship's speed. The top of the float chamber opens into a gear chamber which is connected to, the upper or static line from the rodmeter. Dynamic pressure from the rodmeter is hydraulically transmitted to the lower nipple of the manometer which is connected through piping to both side tubes. A hard rubber float filled with mercury supports a bronze gear rack which is meshed with a gear on the shaft in the

static and dynamic pressures are produced and transmitted to the mercury differential manometer. When in use, the rodmeter extends outside the hull for a distance of approximately 2 feet. Being located in the forward part of the ship, the rodmeter contacts water least disturbed by the movement of the ship.

18A3. Sea valve. (See Figure 18-1.) The sea valve provides a means of closing the opening through which the rodmeter passes when it is withdrawn or raised to its fully secured position. The sea valve is located in the forward torpedo room beneath the deck. In some of the earlier ships, it is located in the forward part of the pump room. A tube connects the spigot and flange on the underside of the sea valve assembly with the outer hull, where it is welded to, a flange and guide bushing. The guide bushing forms the lower support for the rodmeter. A valve extension is mounted on top of the sea valve and forms an upper support for the rodmeter. A packing gear chamber. The shaft extension extends out of the gear chamber cover through a grease seal gland. Hose nipples, vent cocks, a bypass valve, and shutoff cocks are mounted in the hydraulic lines connecting the rodmeter with the mercury columns.

18A5. Transmitter. (See Figure 18-1.) The transmitter is mounted in an aluminum case which is secured to the manometer gear chamber. A distance integrator cam and the speed dial are mounted as a unit on the mainshaft, which is coupled to the shaft extension of the manometer. The speed dial is positioned directly by the mercury in the float chamber, and will indicate the ship's speed in knots without electrical connections. This speed indication is transmitted to the master speed repeater, or in some cases to speed repeaters only, by a self-synchronous transmitter. Distance is obtained from the speed element by means of a time-controlled mechanical

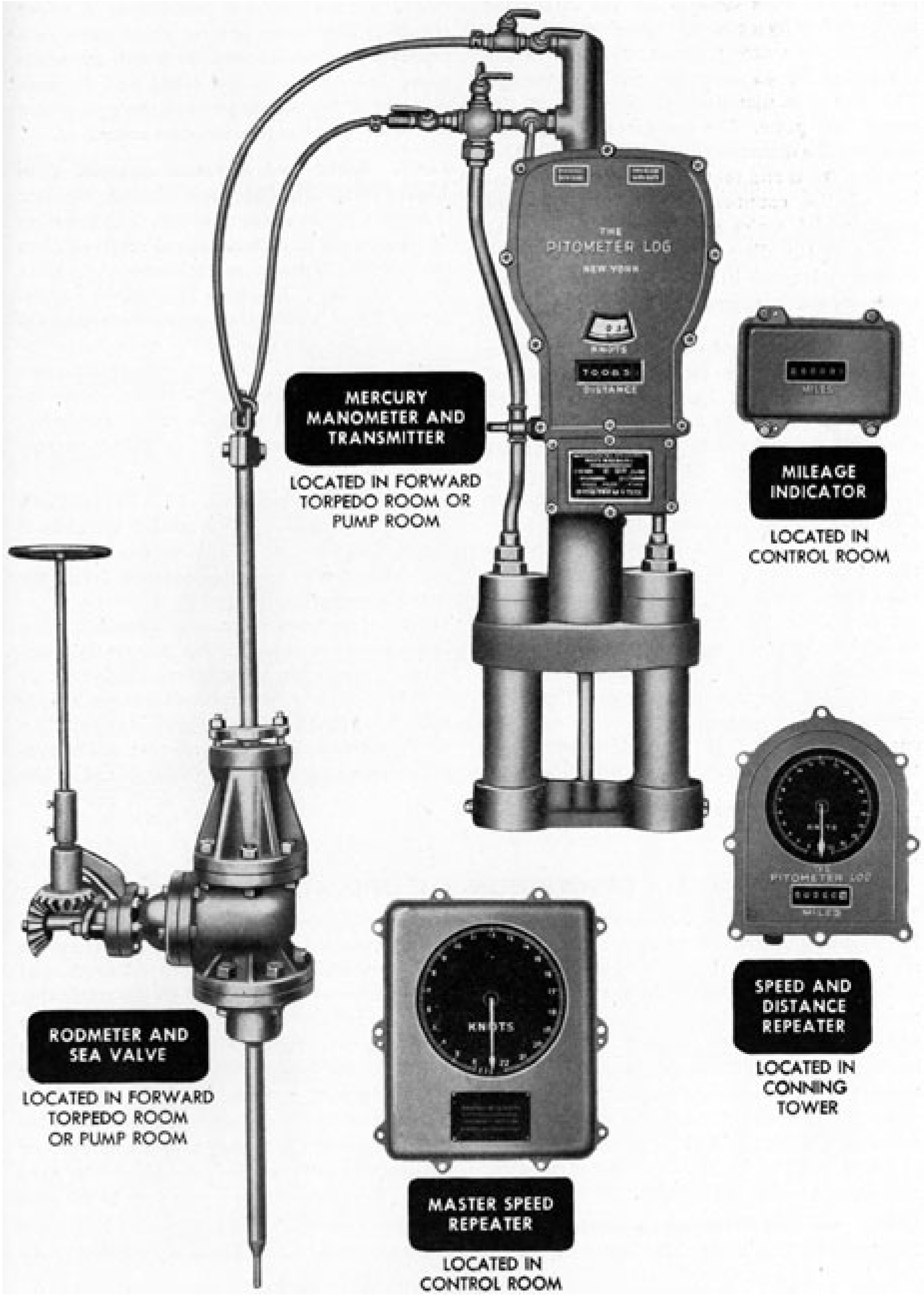


Figure 18-1. Components of mercury differential manometer underwater log system.

integrator. The time element for the integrator is introduced by a constant speed synchronous motor, or by a direct current motor which is controlled by an accurate clock movement. The motor is mounted on the back of the motor base plate. The integrator mechanism operates the distance counter which registers nautical miles and tenths of a mile. The turning of the countershaft operates contact points which make and drives a cam, thereby positioning a speed pointer. The speed pointer shaft actuates a self-synchronous transmitter which transmits speed indications to the speed and distance repeater in the conning tower, the gyro speed corrector, and the torpedo data computer.

18A7. Speed and distance repeater. (See Figure 18-1.) The speed and distance repeater is located in the conning tower. The function of this unit is to indicate

break the electrical circuit to the distance repeaters (magnetic counters) located in the speed and distance repeater, and in the mileage indicator.

18A6. Master speed repeater. (See Figure 18-1.) The master speed repeater is located in the control room. Its functions are: (1) to receive speed indications from the self-synchronous transmitter in the transmitter; (2) to convert these indications from the irregularly spaced speed dial of the transmitter (Figure 18-4) to a uniformly spaced dial (Figure 18-9); (3) to transmit these speed indications to the speed and distance repeater, the gyro speed corrector, and the torpedo data computer. The interior mechanism is mounted on a plate which is removable from the case so that the complete unit may be removed for purposes of inspection and tests. The self-synchronous repeater in this unit receives speed indications from the self-synchronous transmitter in the transmitter case. The self-synchronous repeater in the master speed repeater actuates a follow-up motor which speed received from the self-synchronous transmitter of the master speed repeater. Distance indications are received by an alternating current electromagnet from the impulses of the contacts in the transmitter case. This electromagnet operates a distance counter which records distance indications in units of 1/10 mile. In earlier ships the electromagnet is direct-current operated.

18A8. Mileage indicator. (See Figure 18-1.) The mileage indicator is located in the control room. The function of this unit is to receive and record distance indications from the transmitter mechanism.

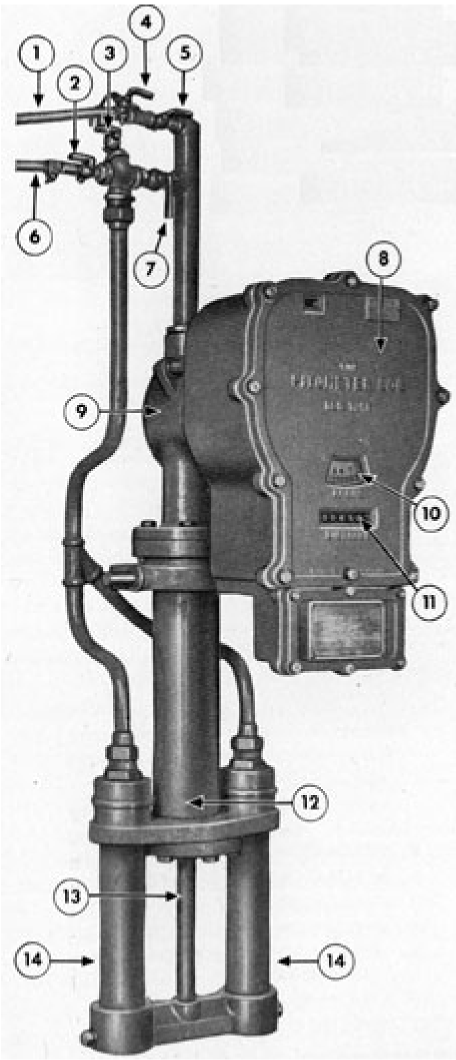
18A9. Constant frequency supply. Some installations of the mercury differential manometer underwater log system include another unit known as the constant frequency supply unit. The function of this unit is to supply a constant 60-cycle 115-volt current to the synchronous motor in the transmitter, and to the synchronous motors in the shaft revolution indicators.

B. DESCRIPTION OF OPERATION

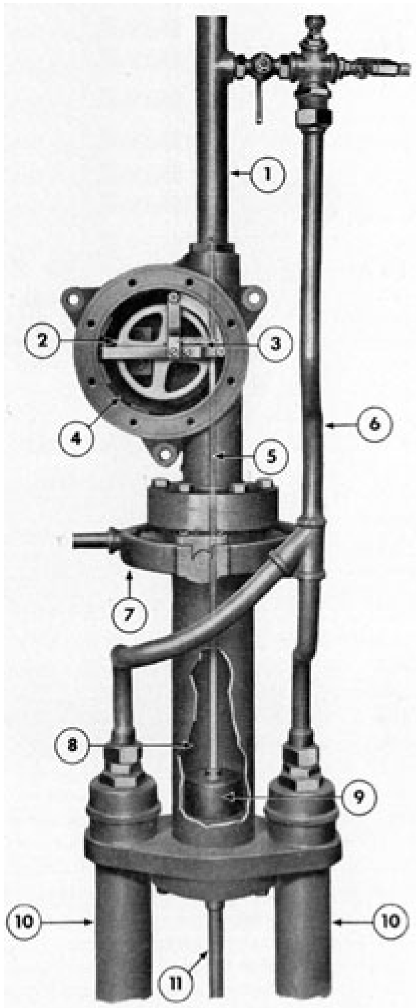
18B1. Hydraulic pressures. While the ship is stationary, the water pressures in the rodmeter tubes are equal (static pressure only), and the mercury columns in the manometer are at equal heights. As soon as the ship gets underway or increases speed, the forward motion creates additional pressure through the dynamic (forward) orifice in the the mercury manometer piping is hydraulically connected to the dynamic line from the rodmeter, while the upper central section of the manometer is connected to the static line from the rodmeter. The static pressure on top of the center mercury column remains the same. As the dynamic pressure increases, due to the forward movement of the ship, it is

rodmeter, while the pressure through the static orifices remains the same. This causes the center mercury column in the manometer to rise, thereby operating the system.

18B2. Mercury differential manometer. (See Figures 18-2 and 18-3.) The lower nipple of transmitted to the side mercury columns. This extra pressure (dynamic) causes the mercury column to rise in the float chamber. The hard rubber float supporting a gear rack in the gear chamber rises with the mercury and actuates the transmitter mechanism. A few ships have



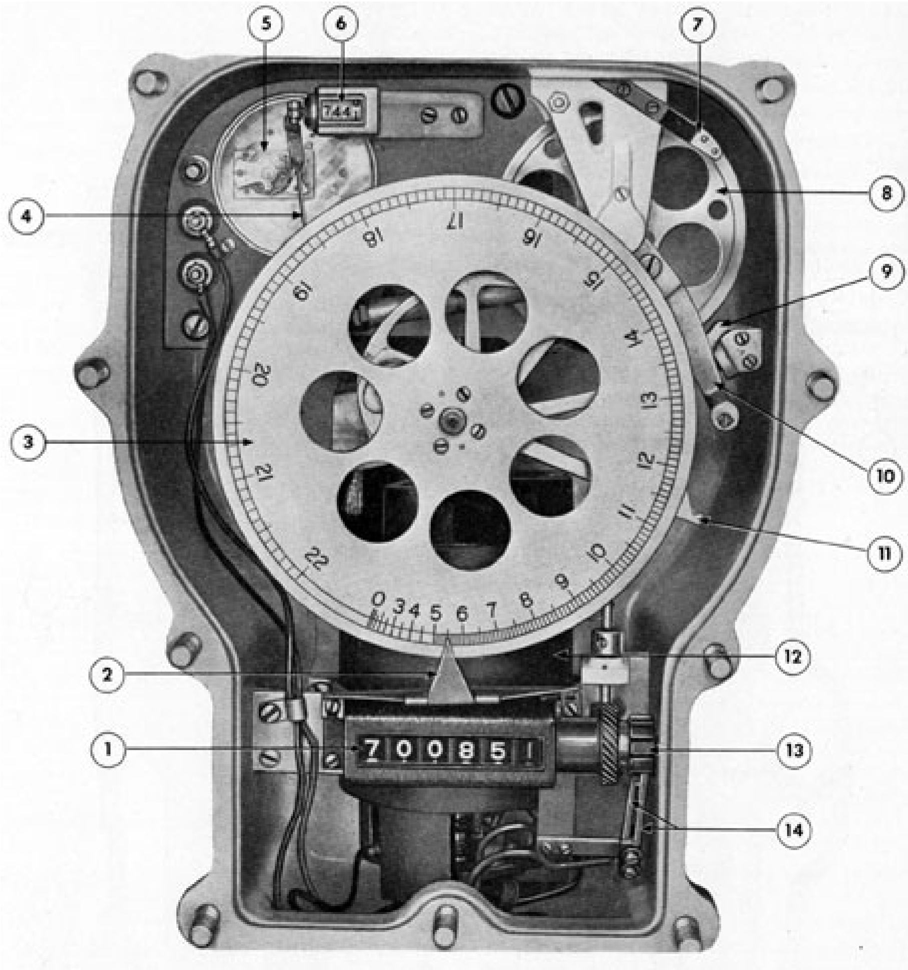
1. STATIC LINE
2. DYNAMIC SHUT-OFF VALVE
3. DYNAMIC VENT COCK
4. STATIC VENT COCK
5. STATIC SHUT-OFF VALVE
6. DYNAMIC LINE
7. BY-PASS VALVE
8. TRANSMITTER CASE
9. GEAR CHAMBER
10. SPEED DIAL
11. DISTANCE COUNTER



1. STATIC LINE
2. DRIVEN GEAR
3. ROLLER ARM SPRING
4. GEAR CHAMBER
5. GEAR RACK
6. DYNAMIC LINE
7. GIMBAL RING
8. FLOAT CHAMBER
9. FLOAT
10. MANOMETER SIDE TUBES
11. MANOMETER CENTER TUBE

12. FLOAT CHAMBER
13. MANOMETER CENTER TUBE
14. MANOMETER SIDE TUBES
Figure 18-2. Front view of manometer and transmitter.

Figure 18-3. Installation of float and gear rack.



1. DISTANCE COUNTER
2. POINTER
3. SQUARE FUNCTION SPEED DIAL
4. OPERATING ARM FOR TIMING COUNTER
5. ESCAPEMENT
6. TIMING COUNTER
7. INTEGRATOR WHEEL BRAKE
8. INTEGRATOR WHEEL
9. INTEGRATOR DRIVING PAWL
10. INTEGRATOR ARM
11. INTEGRATOR CAM
12. SELF-SYNCHRONOUS SPEED TRANSMITTER
13. STAR WHEEL
14. REPEATER CONTACTS

Figure 18-4. Transmitter, cover removed.

a spiral gear assembly instead of the conventional circular gear. The spiral gear is designed to an operating cam through an arc of approximately 20 degrees every 15 seconds, or 240 strokes per hour. A timing counter (Figure 18-

spread the dial graduations at the low-speed end of the dial.

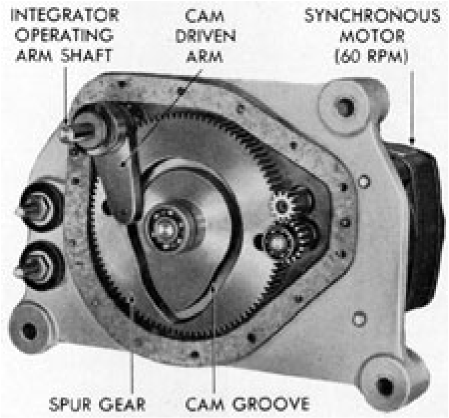
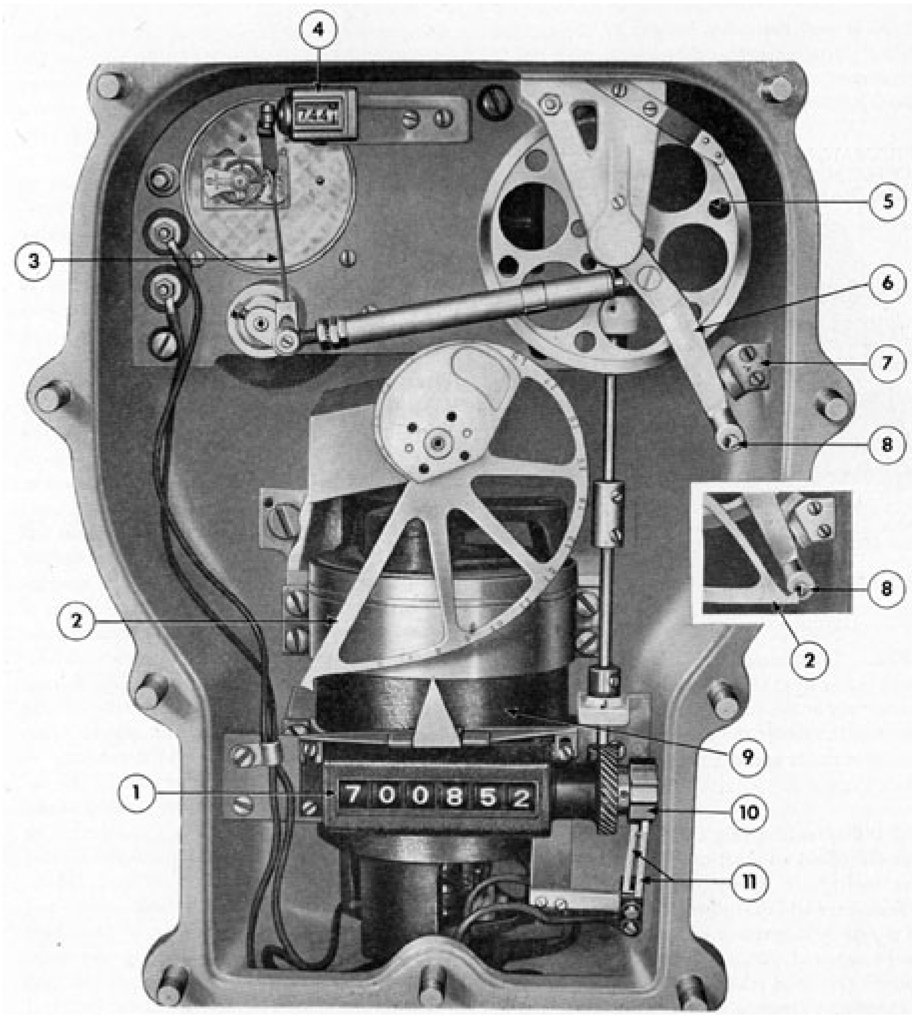


Figure 18-5. Sixty-cycle alternating current integrator timing assembly, cover removed.

18B3. Transmitter. The movement of the float in the float chamber is transmitted to the mainshaft of the transmitter mechanism. This mainshaft carries the distance integrator cam and the master speed dial assembly. The speed dial (Figure 18-4) is positioned directly by the movement of the mercury in the float chamber and indicates the ship's speed in knots without electrical connections. Through gearing, the mainshaft operates a self-synchronous transmitter which transmits speed indications to a self-synchronous repeater in the master speed repeater. On ships not having a master speed repeater, the speed indications are transmitted directly to the speed indicator in the speed and distance repeater. Distance is obtained from the speed element by a mechanical integrator in the following manner: A synchronous motor operating on controlled 60-cycle, 115-volt alternating current, turns a shaft at a speed of 60 revolutions per minute. This shaft is geared, in a ratio of 15 to 6) registers the number of strokes of the operating arm, and provides a means of checking the operation of the integrator unit. The operating arm is mechanically connected to the integrator arm by a spring-loaded integrator link. The lower end of the integrator arm carries a knife-edge which strikes the distance integrator cam when the arm is pulled over by the action of the operating arm and link. The distance integrator cam is so designed that the angle through which the integrator arm moves to strike the cam every 15 seconds is directly proportional to the speed of the ship. For example, the faster the speed of the ship, the longer the sweep of the integrator arm will be every 15 seconds, while at zero knots the knife-edge just clears the tip of the cam, and cannot swing at all (see inset, Figure 18-6). A tension spring inside the integrator link allows the operating arm to move when the integrator arm is restrained by the cam. A pawl mounted on the integrator arm drives the integrator wheel in a clockwise direction (Figure 18-7). A stop pawl mounted at the upper left side of the integrator wheel prevents the wheel from turning in a counterclockwise direction. A brake engages the upper right side of the integrator wheel to keep it from jumping ahead when the knife-edge strikes the cam. The integrator wheel drives a shaft which operates the master distance counter (Figure 18-8). This counter registers nautical miles and tenths; one complete revolution of the shaft of the counter being equivalent to one mile. A ten-tooth star wheel, mounted on the end of the shaft

1, to a spur gear under the clock plate cover. The spur gear (Figure 18-5) has a cam groove cut in its face, and a roller in this groove swings of the counter, operates electrical contacts. One contact is made and broken each tenth of a mile, and the resulting electrical impulse is transmitted to the electromagnet-operated counters in the speed and distance repeaters, and in the mileage indicator.

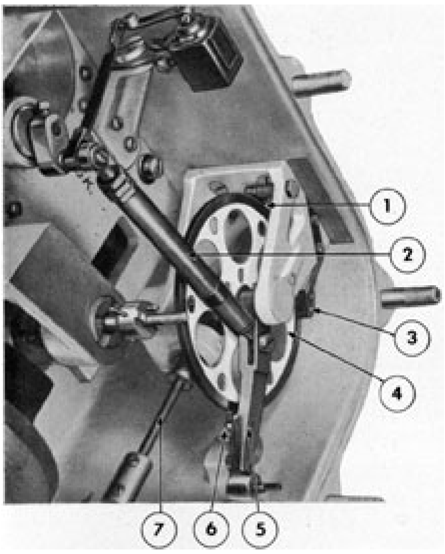
18B4. Master speed repeater. (See Figure 18-9.) The shaft of the self-synchronous repeater in the master speed repeater is



1. DISTANCE COUNTER
2. INTEGRATOR CAM
3. OPERATING ARM
4. TIMING COUNTER
5. INTEGRATOR WHEEL
6. INTEGRATOR ARM
7. STOP BRACKET
8. INTEGRATOR ARM KNIFE-EDGE
9. SELF-SYNCHRONOUS SPEED TRANSMITTER

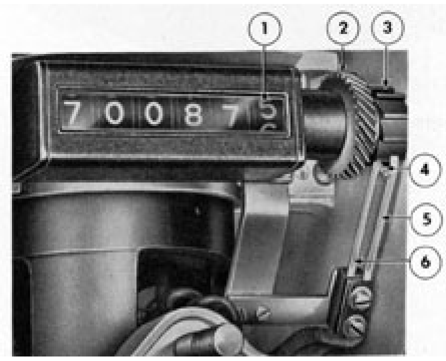
10. STAR WHEEL
11. REPEATER CONTACTS

Figure 18-6. Integrator cam at 15-knot and zero-knot positions.



1. STOP PAWL
2. INTEGRATOR LINK ASSEMBLY
3. WHEEL BRAKE
4. INTEGRATOR WHEEL
5. INTEGRATOR ARM
6. WHEEL DRIVING PAWL
7. COUNTERSHAFT

Figure 18-7. Integrator wheel control mechanism.



1. DISTANCE COUNTER
2. DRIVEN SPIRAL GEAR
3. STAR WHEEL
4. CONTACT POINTS
5. UPPER CONTACT SPRING
6. LOWER CONTACT SPRING

Figure 18-8. Distance repeater contacts installed.

electrically positioned by the self-synchronous transmitter in the transmitter mechanism. A heart-shaped cam assembly (Figure 18-10) is mounted on the repeater shaft extension, and actuates a pivoted arm which in turn operates electrical contacts. A roller which normally rides in the lowest part of this cam (Figure 18-11) is mounted on one end of a pivoted arm which has the center contact assembly mounted on the other end of the arm. A spring holds the roller in contact with the heart cam at all times. For normal changes in speed, the roller will maintain its position in the low spot of the cam as shown at the top center of Figure 18-11. For sudden abnormal changes in speed, the roller may be momentarily forced out of its normal position as shown at the left in Figure 18-11, but the spring will return the roller to the low point when the follow-up motor drives the follow-up contact assembly, and with it, the center contact assembly, to the proper position.

The follow-up contact assembly is driven through the same number of degrees as the heart cam without imposing any appreciable load on the self-synchronous repeater. Likewise, the use of the heart cam prevents the excessive load on the self-synchronous repeater which would result if the repeater armature were restrained

from following the speed transmitter during abnormal speed changes.

The center contact assembly normally stands with both spring contacts touching the contact screws of the follow-up contact assembly (Figure 18-12). As the center contact moves, it opens one of the two contacts that control the shading coil circuits of the follow-up motor through slip ring and brush assembly. This motor will run in either direction, depending on which contact is opened by the action of the heart cam. When the heart cam is stationary, both shading coils are energized, holding the motor stationary.

The follow-up motor drives a worm gear (Figure 18-11) which carries the follow-up contact assembly. The worm gear is mounted on a shaft, the other end of which carries a pointer cam which raises and lowers a carriage

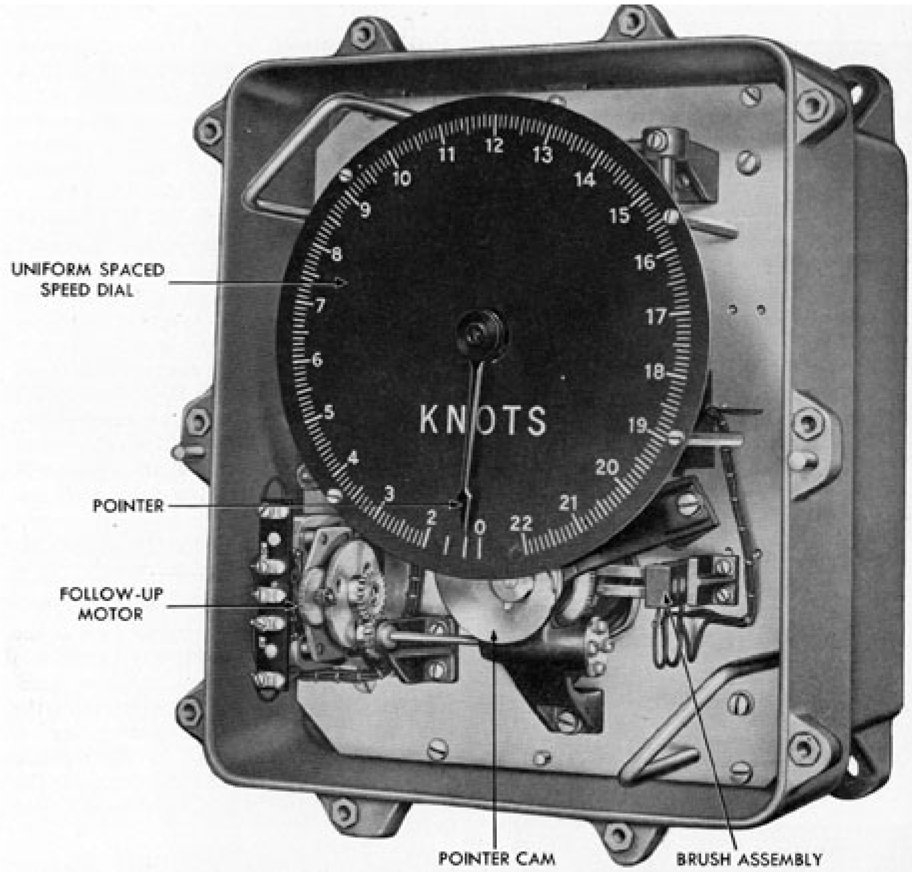
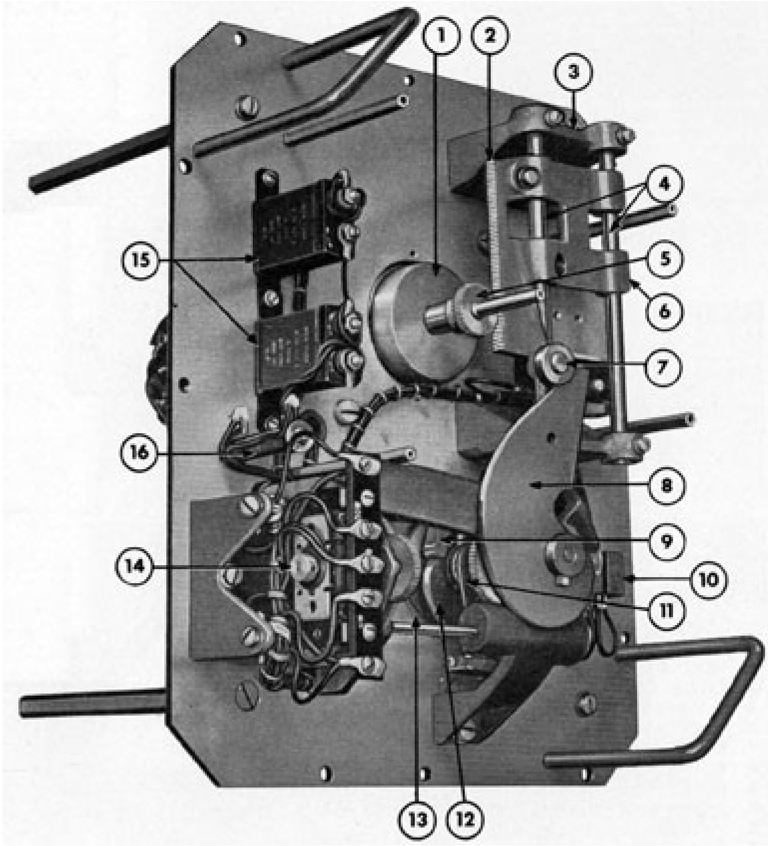


Figure 18-9. Master speed repeater, cover removed.

slide. This carriage slide has a gear rack on one side which engages the pointer shaft gear (Figure 18-10).

The pointer shaft gear is mounted on the pointer shaft extension of the self-synchronous transmitter. The pointer cam will always turn through the same number of degrees as the heart cam (and hence the same number of degrees as the square low-speed dial of the transmitter mechanism) for a given speed change. However, the pointer cam is so designed that the carriage slide will move with a linear function as the cam rotates with its square low function. As the pointer cam moves the carriage slide upward or downward, the pointer shaft extension of the self-synchronous transmitter is turned, the pointer is positioned to indicate speed in knots on the linear dial and the linear speed indications are electrically transmitted to the speed and distance repeater.

18B5. Speed and distance repeater. (See Figure 18-13.) The self-synchronous repeater in the speed and distance repeater is electrically



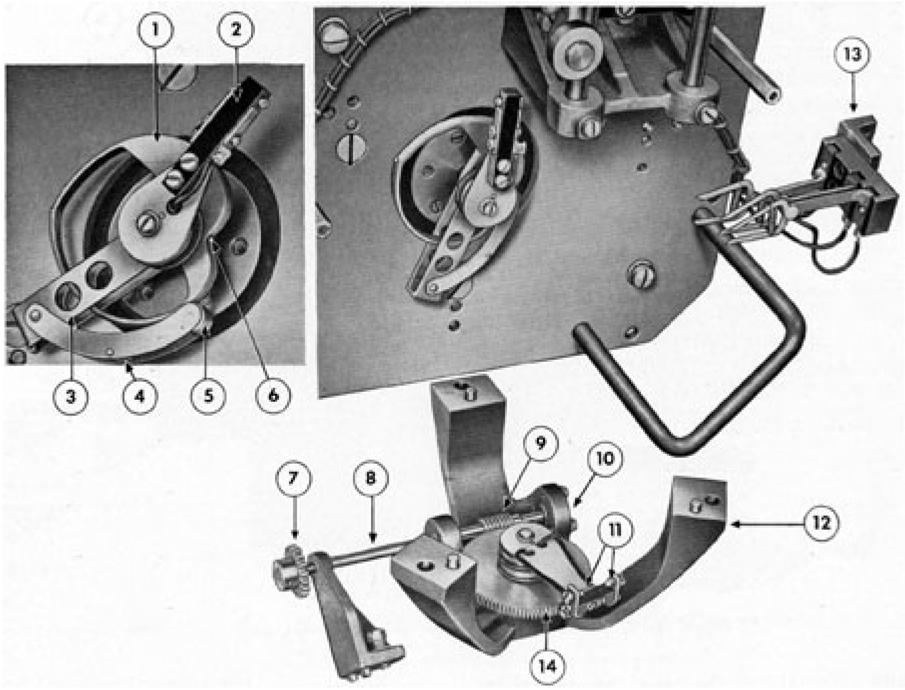
1. SELF-SYNCHRONOUS SPEED TRANSMITTER
2. GEAR RACK
3. CARRIAGE GUIDE ROD BRACKET
4. CARRIAGE GUIDE RODS
5. POINTER SHAFT GEAR
6. CAM ROLLER CARRIAGE
7. CAM ROLLER
8. POINTER CAM
9. ROLLER ARM ASSEMBLY
10. BRUSH ASSEMBLY
11. FOLLOW-UP CONTACT ASSEMBLY
12. HEART CAM
13. SELF-SYNCHRONOUS SPEED REPEATER
14. FOLLOW-UP MOTOR
15. CONDENSERS 0.5-MICROFARAD
16. RESISTOR, 100-OHM

Figure 18-10. Master speed repeater, pointer and dial removed.

connected to the speed transmitter in the master speed repeater, and repeats speed indications of this transmitter. The distance counter is electrically operated by an a.c. electromagnet which receives its electrical impulses from the contact assembly in the transmitter case. Some ships have d.c. electromagnets operating the distance counter. In some ships the speed repeater has a square function (unevenly spaced) dial (Figure 18-4), and is controlled by the self- a uniformly spaced dial for use with the torpedo data computer.

18B6. Mileage indicator. The mileage indicator electrically repeats the distance indications of the transmitter mechanism. A six-figure, reset-type counter indicates units of 1/10 nautical mile. The counter is operated by an a.c. electromagnet which receives an impulse every 1/10-mile from the contact assembly in the transmitter case in the same manner as distance is registered

synchronous transmitter in the transmitter case. Some of these ships have a master speed repeater which was later installed in order to provide on the speed and distance repeater.



1. HEART CAM
2. CENTER CONTACT ASSEMBLY
3. PIVOTED ARM
4. ROLLER SPRING
5. ROLLER
6. HEART CAM NOTCH
7. WORM SHAFT GEAR
8. WORM SHAFT
9. CAM DRIVING WORM
10. FOLLOW-UP CONTACT ASSEMBLY
11. SIDE CONTACTS
12. CAM SUPPORT BRACKET
13. BRUSH ASSEMBLY
14. WORM GEAR

Figure 18-11. Heart cam, with roller in normal and abnormal positions.

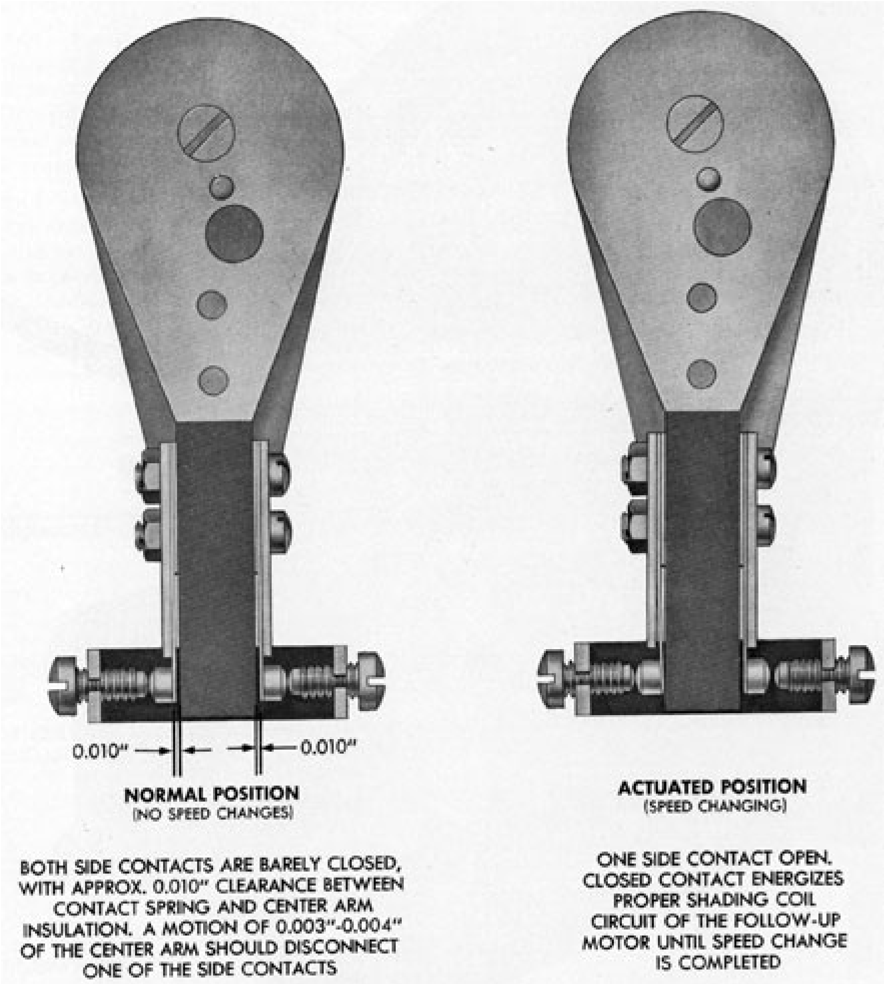


Figure 18-12. Follow-up contact assembly operating positions.

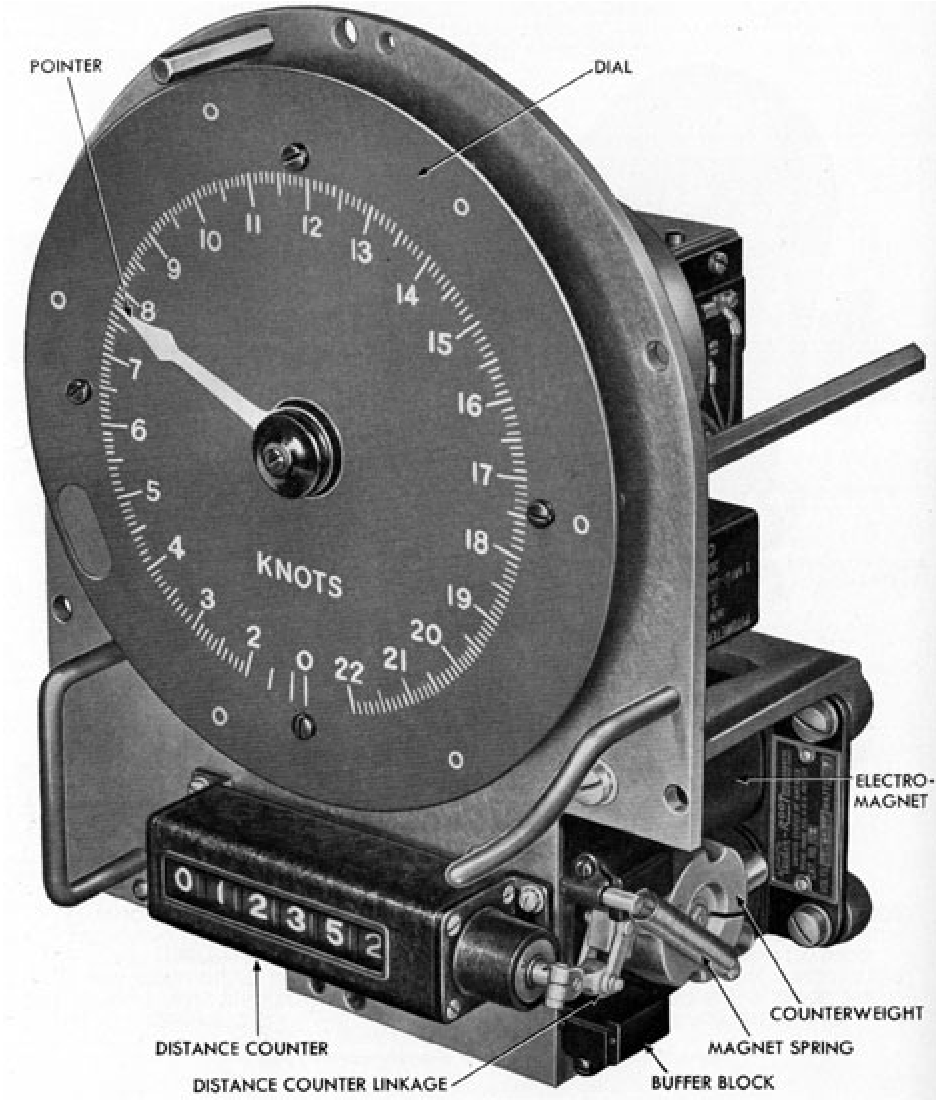


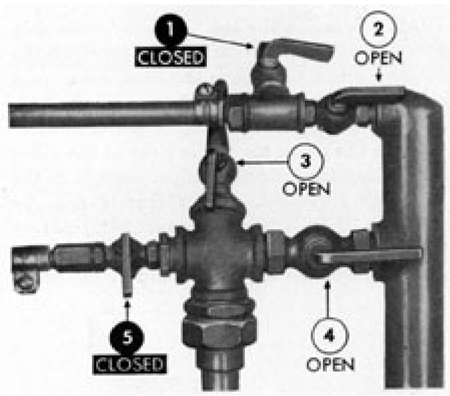
Figure 18-13. Speed and distance repeater removed from case.

19
OPERATING THE LOG

A. OPERATING INSTRUCTIONS

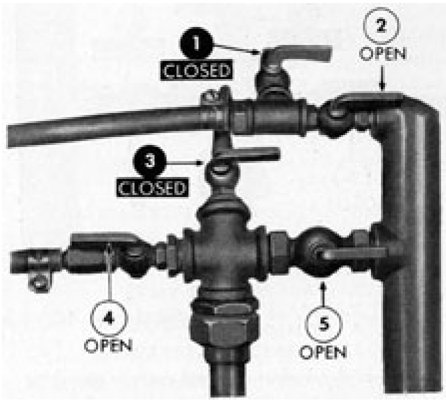
19A1. Energizing the system. Turn the electrical switches controlling the 1Y, 2Y, and 3Y circuits on the I.C. (interior communication) switchboard, and the conning tower repeater switch on the A.C.O. (action cutout) switchboard to their ON positions.

19A2. Opening the sea valve. Raise the deck plate above the sea valve. Turn the sea valve handwheel in a counterclockwise direction as far as possible to fully open the sea valve gate. On some of the older ships the valve handwheel is turned clockwise to open the sea valve. Inspect the marking on the handwheel before operating the valve.



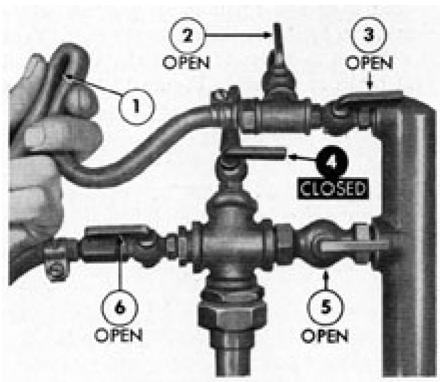
1. STATIC VENT COCK
2. STATIC SHUT-OFF VALVE
3. DYNAMIC VENT COCK
4. BYPASS VALVE
5. DYNAMIC SHUT-OFF VALVE

Figure 19-1. Venting routine, Step 1.



1. STATIC VENT COCK
2. STATIC SHUT-OFF VALVE
3. DYNAMIC VENT COCK
4. DYNAMIC SHUTOFF VALVE
5. BYPASS VALVE

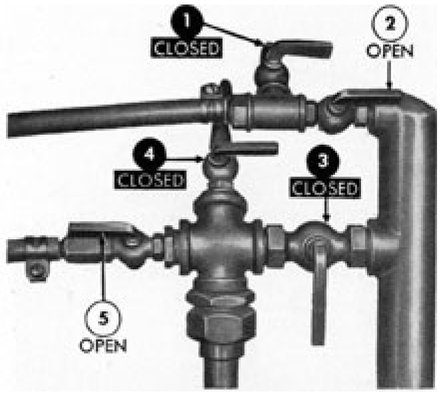
Figure 19-2. Venting routine, Step 2.



1. PINCH STATIC HOSE
2. STATIC VENT COCK
3. STATIC SHUT-OFF VALVE
4. DYNAMIC VENT COCK
5. BYPASS VALVE
6. DYNAMIC SHUT-OFF VALVE

Figure 19-3. Venting routine, Step 3.

19A3. Venting the system. Do not vent the system when the ship is submerged, as the pressures increase approximately 1/2 pound per square inch for each foot of submergence, and the mercury will be blown out of the manometer.



1. STATIC VENT COCK
2. STATIC SHUT-OFF VALVE
3. BYPASS VALVE
4. DYNAMIC VENT COCK
5. DYNAMIC SHUT-OFF VALVE

Figure 19-4. Valves and vent cocks in operating positions.

For best results the ship should be stationary. The purpose of venting the system is to remove any air that may be trapped in the lines. The venting routine should be carried out daily. The manometer should be gently rocked back and forth in its gimbals while venting to facilitate the removal of air. Vent the system as follows: Turn the valves and vent cocks as shown in Figure 19-1. When a full stream of water, free from spitting, is obtained from the dynamic vent cock, turn the valves and vent cocks as shown in Figure 19-2. This is a transition step in the venting routine. Turn the valves and vent cocks to the positions shown in Figure 19-3. When a full stream of water, free of spitting is obtained from the static vent cock, close the static vent cock. The system is now vented, and should be free of air. Turn the valves and vent cocks to the operating position as shown in Figure 19-4.

19A4. Lowering the rodmeter. To lower the rodmeter, turn the hoist crank counterclockwise until the rodmeter is lowered to its operating position. Keep the hose clear of projections and chain links. The rodmeter is in its operating position when the clamp and guard assembly at the top of the rodmeter is close to the sea valve extension.

19A5. Securing the log. Whenever the ship enters port the log system is secured in the following manner: Turn the hoist crank in a clockwise direction until the top of the rodmeter is level with the marker plate, indicating that the tip of the rod is clear of the outer hull. Keep the hose clear of projections as the rodmeter is

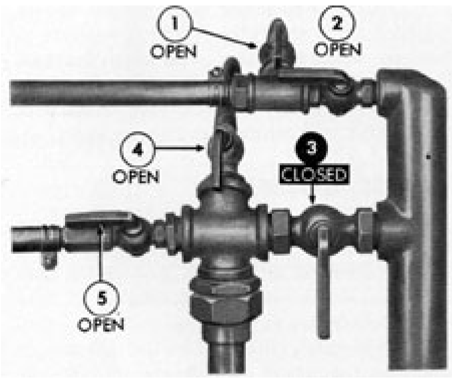
raised. The rodmeter may be raised to its fully housed, or secured, position by turning the crank until the top of the rodmeter strikes the stop at the top of the hoist.

20
MAINTENANCE

A. PRELIMINARY INSTRUCTIONS

20A1. General. Extreme vigilance and care should be practiced in the inspection, cleaning, and repair of parts. Personnel performing repair work should use common sense when judging whether or not a part should be put back into service or discarded. If there is any doubt, the part should be replaced. With the exception of bearings and electrical equipment, corrosion should be removed from arts by washing them in clean, fresh water. Dry the parts thoroughly, and apply a light film of gyro oil to prevent rusting or corrosion. Use Navy-approved cleaning fluid to clean grease and oil from the parts. Keep the bearings oiled and clean by wrapping them in wax paper until needed for assembly. The area in which the repair work is being performed should be kept in a clean condition in order to prevent dust from getting on the parts.

B. MAINTENANCE Of RODMETER



1. STATIC VENT COCK
2. STATIC SHUT-OFF VALVE
3. BYPASS VALVE
4. DYNAMIC VENT COCK
5. DYNAMIC SHUT-OFF VALVE

Figure 20-1. Valves and vent cocks in position to check for clogged rodmeter.

20B1. Testing for obstruction in the rodmeter. The rodmeter shown in Figure 20-1. If a full stream of water does not flow from both vent cocks, it is an indication that the line not flowing is clogged.

20B2. Blowing out the rodmeter. This operation should be performed with the rodmeter in its extended, or operating, position. It is a good practice to blow out both lines even if the tests for obstruction indicate only one line clogged, as foreign matter has possibly entered both passages. Blow out the rodmeter in the following manner: Disconnect the static hose from the static pressure pipe nipple at the top of the manometer piping. Pinch the end of the hose to prevent leakage of

may become clogged with jellyfish, mud, seaweed, or other foreign matter. Consequently the pressure difference will not be normal, and the mechanism will not register correctly. The following test must be performed when the ship is on the surface. Position the valves and vent cocks as water. If the line is completely clogged, water will not leak from the hose. Connect the low-pressure air line of the ship to the static hose, and blow the obstruction out of the hose and rodmeter into the water outside the ship. Do not apply the low-pressure air hose to the piping that enters the manometer as the air pressure will blow out the mercury. When a full stream of water is obtained from the static hose, place the end of the static hose over the end of the hose fitting at the upper end of the static piping of the manometer, and install the hose clamp securely. Blow out the dynamic line of the rodmeter in the same manner. Go through the venting routine after connecting the hoses to the manometer. (See Section 19A3.)

20B3. Removing solid obstructions from the rodmeter. If obstructions cannot be removed by blowing out the rodmeter with compressed air, the following operations are necessary. Raise the rodmeter to its fully housed position. Close the sea valve. Unlatch the stop bracket at the top of the hoist assembly by opening and removing the lock that secures the bracket in position above the rodmeter, and swing it to one side. Remove the lower end of the rodmeter from the sea valve extension by raising the rodmeter to the upper sprockets. Using a soft brass wire, dig out the obstructions from the orifices (openings) on the lower end of rodmeter. clear. Align the lower end of the rodmeter with the opening in the sea valve extension and carefully lower the rodmeter to its fully housed position.

Use care in placing the tip of the rodmeter in the packing gland so as not to roughen or remove the packing.

At this point the tip of the rodmeter is approximately 1-inch above the sea valve gate. Connect the tubing from the rodmeter to the manometer. Open the sea valve. Swing the stop bracket to its normal position above the rodmeter and secure it in place with the lock.

Do not use steel wire or a drill to clean out the orifices as they may score the orifices or break off in the openings.

Blow out the rodmeter (as described in Section 20B2) while out of the valve extension. Have one crew member hold his hand near the orifices to detect the flow of air which indicates that the orifice and tubing are clear. Repeat the operation until all passages are

It is important that the stop bracket be in position above the rodmeter at all times except during the above operation, or when the rodmeter is being replaced.

Lower the rodmeter to its normal housed position or to the fully extended position as desired. Place the hoist crank in the brackets provided, and replace the deck plate over the sea valve. Vent the system in accordance with the instructions outlined in Section 19A3.

C. REPLACING A DAMAGED RODMETER

20C1. General instructions. If the rodmeter is bent so that it cannot be drawn up into the ship, it is necessary to install a spare rodmeter. Do not attempt to force the damaged rodmeter up into the ship, as the hoist mechanism may be damaged. The removal and installation operations should be carried out only when the ship is surfaced. If the damaged rodmeter is to, be salvaged, it may be accomplished if a diver is available. Lower the diver over the side of the ship so that he can rig a line around the damaged rodmeter. Secure the other end of the line to the ship so that the rodmeter can be pulled out of the water after it is pushed out of the sea valve.

20C2. Breaking out spare rodmeter. (See Figure 20-2.) Break out the spare rodmeter and place it alongside the hoist mechanism so that it will be immediately available when needed.

diameter dowel pin stock, make up two tapered wooden plugs 1-inch long tapering to 3/8-inch diameter at one end. Loosen the hose clamps and remove the two lengths of hose from the nipples on the upper end of the rodmeter. Unscrew the longest (after) nipple and plug the hole in the rodmeter with a plug. Remove the forward nipple in the same manner, and plug the hole. Remove the two nuts and bolts that secure the clamps and guard to the rodmeter, and remove the clamp and guard assembly. Raise the guard by means of the hoist up against the stop bracket above the rodmeter. Knock out one of the stop pins in the rodmeter.

20C4. Installing the clamp and guard assembly. (See Figure 20-2.) The two clamps and the guard are marked to facilitate reassembly. These marks should be adjacent to one another when the pieces are assembled on the rodmeter. Place the two clamps

20C3. Removing the clamp and guard assembly. (See Figure 20-2.) From 1/2-inch

around the upper end of the spare rodmeter so that

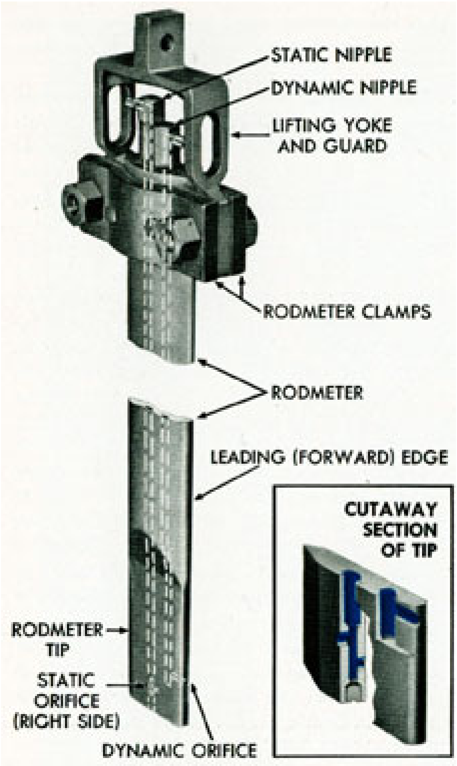


Figure 20-2. Rodmeter.

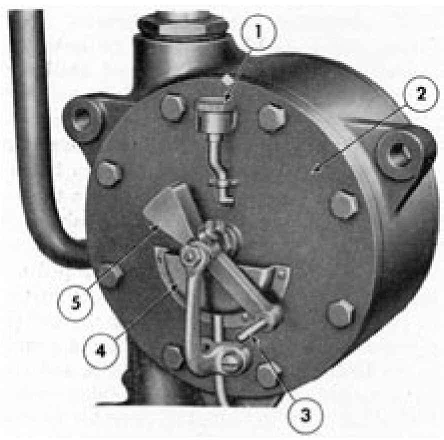
the clamps are over the stop pins provided at the top of the rodmeter. Place the guard between the clamps. Align the mounting holes in the three pieces, and install the two bronze bolts and nuts that secure the clamp and guard assembly to the rodmeter. Tighten the nuts securely.

20C5. Installing the spare rodmeter. (See Figure 20-2.) If the damaged rodmeter is partially raised, push it downward until the remaining stop pin rests on top of the packing gland in the sea valve extension. It may sometimes be necessary to drive the rodmeter downward with a sledge and wooden block. Place the tip of the spare rodmeter on top of the damaged rodmeter, making certain that the dynamic orifice in its leading edge is facing forward. Note the arrow stamped on the rodmeter for facing the spare rodmeter in the proper direction. Remove the cotter pin and clevis pin that secure the old guard to the lifting bar on the hoist chain, and remove the old guard. Align the opening in the lifting bar with the opening provided in the guard on the spare rodmeter, and install the clevis pin and cotter pin that secure the lifting bar to the guard assembly. Place the loose end of the dynamic hose over the nipple provided on the dynamic (short) nipple on the top of the rodmeter. The opposite end of this hose is attached to the lower pipe at the top of the manometer. Secure the hose to the nipple with a hose clamp. Place the end of the static hose on the long nipple on the top of the rodmeter. The opposite end of the static hose is attached to the top pipe fitting at the top of the manometer. Secure the hose to the nipple with a hose clamp. It is a good practice to wire the two hose clamps together with soft

brass wire to prevent the hoses from slipping off the nipples at deep submergence pressures. Knock out the pin from the damaged rodmeter and push downward on the spare rodmeter to drive the damaged rodmeter downward and out of the ship. Vent the system in accordance with the instructions given in Sections 19A3.

D. MAINTENANCE OF MANOMETER

20D1. General instructions. Valves and vent cocks should be kept clean and lubricated with a good grade of waterproof grease. Keep the hose securely clamped to the nipples of the piping of the manometer. The gland on the manometer shaft in the gear chamber is not adjustable and should be kept clean and well greased by tightening the grease cup on the front of the gear chamber (Figure 20-3). Friction in this shaft is usually due to hardened deposits of salt and grease in the gland. Remove the hardened grease, and clear the gear, roller, and float rack. Fill the gland with fresh grease.



1. GREASE CUP AND TUBE
2. GEAR CHAMBER
3. DRIVING ARM PIN
4. DRAIN SHIELD AND TUBE
5. GEAR SHAFT DRIVING ARM

Figure 20-3. Front view of gear chamber.

20D2. Testing for loss of mercury. With the bypass valve open, it should be possible to

that the mercury level is low, and that the float is hitting the bottom of the float chamber.

20D3. Adding mercury to the float chamber. Add mercury to the float chamber in the-following manner. Close the static and dynamic shut-off valves. Disconnect the three connections on the manometer Y-pressure piping, and remove the piping. Remove the back plate from the gear chamber. Siphon off all the water from the center and side tubes of the manometer. Add mercury to one of the side tubes until the float rises approximately 1/2-inch from the bottom of the float chamber. This is determined by manually pushing the rack and float downward until the float

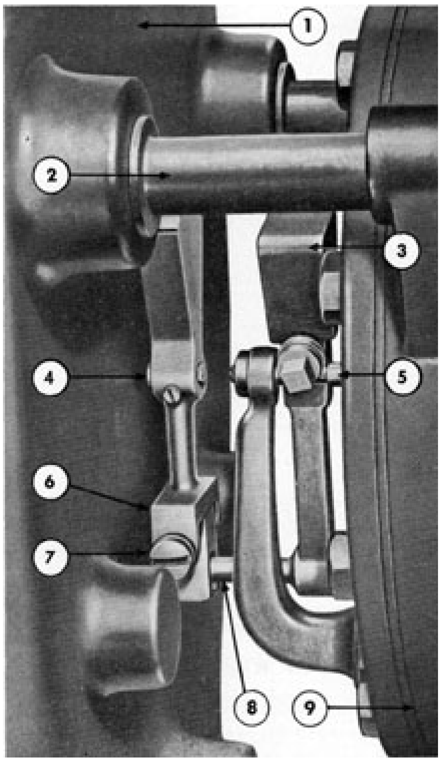
turn the transmitter speed dial approximately 1/4-inch beyond the zero mark on the dial, and when the dial is released it should read zero. If it does not return to zero, it is an indication

strikes the bottom of the float chamber, then releasing it and noting its rise. When measuring the float rise in this manner be sure that the float hits the bottom of the float chamber, and is not prevented from doing so by the driving arm pin (Figure 20-3) striking the front bracket of the gear chamber. It will be necessary to loosen the drawing arm clamping screw if the pin hits the bracket. Connect the piping to the manometer. Replace the gear chamber cover. Vent the system until all the air is removed from the hydraulic system as described in Section 19A3. Reset the speed dial to zero. (See Section 20E1.)

E. MAINTENANCE OF TRANSMITTER

20E1 Setting the speed dial to the zero position. Thoroughly vent the hydraulic system, (See Section 19A3.) House the rodmeter. Open the bypass valve. If the driving arm pin has been loosened (see Section 20D3), tighten it while holding the transmitter speed dial on zero. Be sure that the driving arm is so located on the gear wheel shaft that it will not rub on the front bracket, or on the front cover of the gear chamber. Slightly rotate the transmitter speed dial backward and forward from the zero position, pushing the adjusting fork (Figure 20-4). The dial should return to the zero position. If not, set the dial to zero by means of the adjusting screw on the adjusting fork (Figure 20-4).

20E2. Checking integrator timer. There are two types of integrator timing mechanisms used with the mercury manometer log. They are the synchronous motor integrator timer (known as the a.c. clock type), illustrated in Figure 18-5, and the d.c. clock integrator timer, known as the d.c. clock type (Figure 20-5). In the 18- and 20-knot logs, the d.c. clock is used and the integrator operating arm makes 180 strokes per hour. In the 22-knot logs, some having d.c. clocks and some having a.c. clocks, the operating arm makes 240 strokes per hour. The number of strokes per hour for each particular unit is indicated on a marker plate which is mounted over the



1. TRANSMITTER CASE
2. CASE MOUNTING STUD
3. GEAR SHAFT DRIVING ARM
4. MAINSHAFT
5. GEAR WHEEL SHAFT
6. ADJUSTING FORK
7. ADJUSTING SCREW
8. DRIVING ARM PIN
9. GEAR CHAMBER

Figure 20-4. Adjusting fork.

timing counter window. Check the integrator timer in the following manner:

Using an accurate stop watch, start the watch and record the indication on the timing counter when the counter number begins to change. Stop the watch and record the counter reading at the exact termination of 1-hour. The timing counter should read the number of strokes indicated on the marker

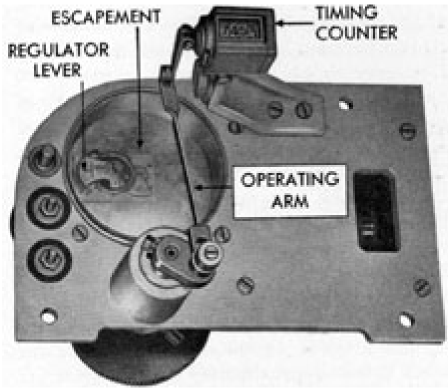


Figure 20-5. Direct current clock integrator timer.

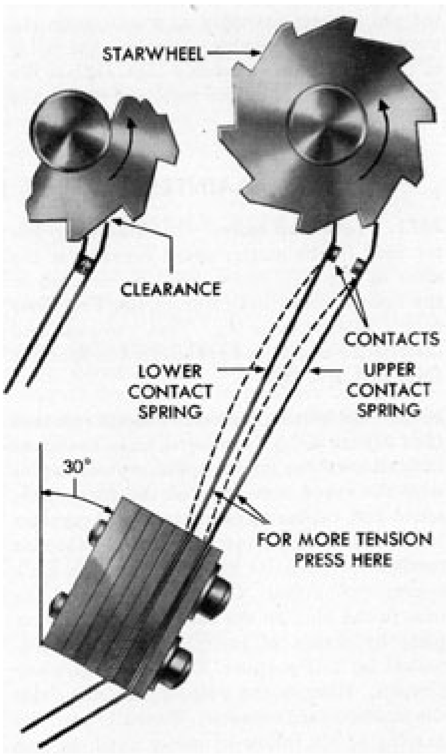


Figure 20-6. Distance repeater contacts adjustment.

plate for that particular unit. If the timing of the a.c. unit indicates that the number of

new assembly on the bracket with the holding screws. Center the contact springs on the star wheel,

strokes per hour is in error, check the constant frequency supply to be sure it is exactly 60 cycles. Also check the gearing for deposits of grease which may prevent the constant speed motor from running at synchronous speed. Clean and lubricate the gear mechanism. On the d.c. clock integrator timer, any error in the clock may be corrected by means of the regulator lever on the escapement (Figure 20-5). Moving the lever down one division on the scale will cause the clock to gain about half a minute per day. Moving the regulator up one division on the scale will cause the clock to lose approximately half a minute per day.

20E3. Installing and adjusting distance repeater contacts. (See Figure 20-6.) Remove the old contact assembly as a unit from the transmitter case bracket. Resolder the wires to the new contact assembly lugs, replace the insulating sleeves on the lugs, and mount the and tighten the holding screws. If either contact spring does not press against the star wheel in the open position, increase its tension by bending the spring as shown in Figure 20-6. Heavy spring tension is more desirable than light tension. Rotate the star wheel until the upper (longer) contact spring just drops clear of the tooth. At this instant the upper contact should rest squarely on the lower contact, but the upper contact spring should not touch the star wheel until the lower contact spring drops to the next tooth. This is important for proper, quick, make and break operation. If necessary, bend the tip of the upper contact spring to provide the correct clearance as shown in Figure 20-6. When the contacts are clean and properly adjusted, there should never be excessive sparking. The tungsten contacts must be absolutely free of oil or grease. If the contacts are pitted, they may be cleaned with fine sandpaper or a contact stone. Do not oil the star wheel.

F. MAINTENANCE OF MASTER SPEED REPEATER

20F1. Follow-up motor. The follow-up motor used in the master speed repeater is the same as the lead screw drive motor used in the master speed indicator of the Pitometer rotary balance type log. Test, removal, and installation operations are covered in Sections 5M3, 5M4, and 5M6.

20F2. Calibrating the master speed repeater. (See Figure 20-7.) In order to make the speed inch of seating in the hollow of the pointer cam as shown in Figure 20-7. Use care in turning the gears as excess motion may bend the supporting arm of the cam roller.

At this point, the limit switch which prevents over-travel of the follow-up motor should operate. If necessary, reset the limit switch operating screw. Replace the dial and pointer without the pointer hub cap, and set the pointer at exactly 22 knots by loosening the

indication of the master speed repeater agree with the speed indication of the transmitter speed dial, calibrate the master speed repeater in the following manner: Remove the interior mechanism from its case and place it on a convenient surface. Connect the jack of the case to the plug on the back of the mounting plate by means of the plug-jack cord furnished for this purpose. Do not energize any circuits. Remove the pointer and dial from the master speed repeater. Manually turn the gearing of the follow-up motor until the cam and roller are within approximately 0.005 three screws clamping the pointer to the hub; then replace the pointer hub cap. The speed pointer is now in correct relation to the cam (Figure 20-7). Now rotate the followup gearing by hand until the master speed repeater indicates about 5 knots. Energize the 1Y circuit. If the master speed repeater speed indications do not agree with those of the transmitter, it will be necessary to align the self-synchronous repeater with the self-synchronous transmitter.

This is accomplished in the following

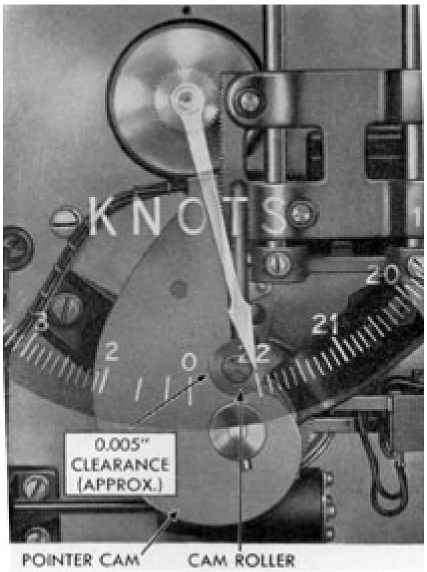


Figure 20-7. Cam positioned for setting pointer at 22 knots.

manner: Close the dynamic and static shutoff valves and open the bypass valve. Loosen the clamping screw of the gear shaft driving arm (Figure 20-4). Slowly turn the dial in the transmitter to 15 knots and secure the dial in this position to the fixed pointer with a small C-clamp. Loosen the clamps that secure the self-synchronous repeater to the mounting plate of the master speed repeater, and shift this repeater until the speed pointer reads 15 knots as indicated on the master speed repeater dial. Tighten the clamps to secure the repeater in this position on the mounting plate. Remove the C-clamp from the transmitter dial. Slowly turn the speed dial of the transmitter back to the exact zero. If the master speed repeater does not indicate zero, or approximately zero, clamp the transmitter dial at zero and make further very slight adjustments of the self-synchronous repeater in the

master speed repeater. Tighten the clamping screw of the driving arm (Figure 20-4), and remove the C-clamp.

G. SYNCHRONIZING SPEED AND DISTANCE REPEATER

20G1. Resetting the speed pointer of the speed and distance repeater. If the speed indications of the speed and distance repeater do not agree with the speed indications of the master speed repeater, shift the repeater of the former in the following manner: Remove the speed and distance interior mechanism from its case. Connect the plug jack cord to the case and interior mechanism. Loosen the clamps that secure the repeater to the mounting plate. Shift the repeater from until the speed indications agree with those of the master speed repeater, then tighten the clamps to secure the repeater in position. Install the speed and distance interior mechanism in its case.

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21
TROUBLE SHOOTING

A. TROUBLES, CAUSES, AND REMEDIES

21A1. General. This chapter contains trouble shooting information and tests which can be made to help determine the causes of some of the troubles that may develop in the log system. Each symptom of trouble is followed by a list of the possible causes, and a list of the possible remedies to correct the trouble.

TROUBLE	CAUSE	REMEDY
1. Speed pointer is sluggish, does not readily respond to changes of ship's speed; or speed indication is in error.	1a. Clogged rodmeter, clogged hose, or clogged pipe fittings of manometer. 1b. Friction in manometer shaft at gland, rack teeth, or rack roller. 1c. Friction in transmitter shaft bearings, gearing, or self-synchronous transmitter bearings. 1d. Transmitter dial not on zero when bypass valve is opened. 1e. Friction in master speed repeater, self-synchronous repeater,	1a. Blow out rodmeter. (See Section 20B2.) Vent thoroughly after reinstalling hose. (See Section 19A3.) 1b. Work grease into gland by turning down grease cup while rotating the shaft slightly. Open gear chamber, and clean shaft, gland, gearing, and roller. 1c. Clean and oil bearings where required. See that miter gears run true, and do not bind. 1d. Set the dial to zero with the bypass valve open. (See Section 20E1.) 1e. Clean and lubricate bearings and gearing. With pointer of master speed repeater at about 20 knots, lift cam roller carriage carefully by hand to check it for free operation on guide rods. Do not allow carriage to drop on the pointer cam. 1f. Clean and oil repeater bearings. 1g. Clean and adjust contacts. See Figure 18-12 for contact clearance.

	follow-up motor, or in cam roller carriage. 1f. Friction in self-synchronous speed repeater. 1g. Master speed repeater contacts dirty or out of adjustment.	

TROUBLE	CAUSE	REMEDY
2. Log does not indicate speed when rodmeter is lowered with ship underway.	2a. Valve positions incorrect. (Transmitter dial will not indicate.) 2b. 1Y circuit open. (Transmitter dial will indicate speed; but speed repeater will not indicate.)	2a. Set valves to operating position (Figure 19-4). 2b. Close 1Y circuit. Check fuses and circuit.
3. Transmitter does not record distance when rodmeter is lowered with ship underway.	3. Integrator timer not operating.	3. Check circuit supplying motor. If a.c. unit, check synchronous motor and starting condenser, or internal gearing. If d.c. unit, press starting button until unit picks up cycle of operation. Replace entire d.c. clock unit if feasible, returning defective unit to manufacturer for repair.
4. Speed reading correct but transmitter distance is in error; checked by	4a. Sweep of integrator operating arm not timed	4a. For a.c. units, check constant frequency supply (must be 60 cycles). Clean and oil gearing and cam. Oil motor bearings. For d.c. units, clean and reset, or replace

securing transmitter dial at a fixed reading and allowing integrator to operate for a fixed time.	correctly. Timing counter showing incorrect number of strokes per hour. 4b. Integrator mechanism binding (causes under-reading), or too free (causes over-reading). 4c. Transmitter distance counter defective.	motor contacts. Check escapement and replace if necessary. (See Section 20E2.) 4b. Clean smooth faces of integrator wheel. Clean friction brake and rear brake block by slipping paper between brakes and wheel. Brake tension should be 5 ounces measured at notch of brake spring. Clean pawls. Do not oil pawls or brake surfaces. Replace worn pawls. Check shafts, gears, and bearing surfaces for proper operation. 4c. Replace counter.

TROUBLE	CAUSE	REMEDY
5. Distance repeater counters do not record distance properly, although transmitter is recording distance correctly.	5a. Distance repeater circuit open. 5b. Distance contacts in transmitter, dirty, off adjustment, or burned. 5c. Star wheel worn, or loose on countershaft. 5d. Counter magnet armature or linkage sticking.	5a. Check switches and fuses. 5b. Clean contacts. Readjust, or replace if necessary. (See Section 20E3.) Keep oil away from contacts. 5c. Tighten or replace star wheel. 5d. Remove cause of sticking. Check magnet circuit.

	Counter circuit open.	
6. Integrator mechanism operating, although ship has stopped.	6. Transmitter dial not on zero, integrator arm can move slightly registering distance on counter.	6. Set transmitter dial on zero with by-pass valve open. (See Section 20EL)
7. Rodmeter cannot be raised with chain hoist.	7. Rodmeter is bent.	7. Replace with spare rodmeter. (See Section 2005.) Salvage bent rodmeter, and straighten if possible.
8. Rodmeter gland leaks excessively.	8. Packing gland loose or worn.	8. Tighten packing gland nuts. Repack if necessary.
9. Manometer shaft gland leaks excessively.	9a. Insufficient grease in shaft seal. 9b. Shaft worn.	9a. Refill grease cup and force grease into seal. 9b. Replace shaft. Use oversize shaft if necessary.
10. Erratic speed indications on transmitter dial.	10a. Grease in shaft gland hardened. Salt crust on rack and pinion teeth. 10b. Rack roller binding. Roller worn flat.	10a. Clean shaft, gland, gears, and rack. 10bb. Clean roller and pivot. Replace roller.
11. Transmitter speed dial cannot be moved below zero, with by-pass valve opened.	11. Float is hitting float chamber bottom due to insufficient mercury in chamber.	11. Add enough mercury to manometer to allow dial to be turned 1/4-inch below zero. Mercury should then raise float until dial reads zero. (See section 20D3.) Reset zero by means of fork adjustment if necessary.

TROUBLE	CAUSE	REMEDY
12. Master speed repeater speed indication does not agree with	12a. Master speed repeater not correctly calibrated.	12a. Recalibrate master speed repeater. (See Section 20F2.)

transmitter speed indication.	12b. Follow-up contacts dirty, or set too far apart. 12c. Cam roller carriage binding. Cam roller sticking.	12b. Clean and adjust followup contacts. (See Figure 18-12.) 12c. Clean carriage rods and bearings.
13. Speed and distance indicator speed does not agree with transmitter and master speed repeater indications.	13. Self-synchronous speed repeaters not lined up with self-synchronous repeater in master speed repeater.	13. Check repeaters for electrical zero. Reset pointer or shift repeater frame to make speed readings agree.
14. Master speed repeater rotates in wrong direction.	14. Roller has slipped over 180-degree mark (point) of heart-shaped cam causing reverse operation of follow-up motor.	14. Deenergize 1Y circuit. Turn transmitter dial by hand until its reading agrees with master speed repeater pointer. Energize 1Y circuit, and gradually allow transmitter dial to assume its proper position.

22
ELECTRONIC LOGS

A. ALLIS-CHALMERS UNDERWATER LOG

22A1. General description. At the time this book was written, a new type of underwater log was in process of development. This log is known as the All s-Chalmers underwater log, and is manufactured by the Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin. The rodmeter element of the system consists of a small propeller, in the hub of which is placed an a.c. generator. The propeller head is secured to a bronze tube with provision for inserting and removing through a 3-inch sea valve. Leads from the generator are brought up through the rodmeter tube to an electronic amplifier which in turn drives a small synchronous motor. A mechanism interprets the synchronous motor revolutions in terms of knots and nautical miles. Remote indicating stations are driven by the usual synchromotor system. Preliminary tests of these electronic logs give promise of extremely high accuracy even at low speeds.