

WAR DEPARTMENT TECHNICAL MANUAL

TM 11-377

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BOEHME AUTOMATIC  
KEYING AND RECORDING  
EQUIPMENT

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WAR DEPARTMENT

4 JULY 1944

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*United States Government Printing Office  
Washington • 1944*

WAR DEPARTMENT,  
WASHINGTON 25, D. C., 4 July 1944

TM 11-377, War Department Technical Manual, Boehme Automatic Keying and Recording Equipment, is published for the information and guidance of all concerned.

[A. G. 300.7 (25 April 1944).]

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IC 11 (5): T/O 11-107, 11-127, 11-187, 11-237; T/O & E 11-287, 11-587, 11-597, 11-617,

IC 11 (2): T/O & E 11-500, Sig Sv Organization, Radio Automatic Operation Augmentation Team (ED), Radio Rep Sec (EG), Radio Telegraph Fixed Sta, 1 Position (EH), Radio Telegraph Fixed Sta, 2 Position (EI), Radio Telegraph Fixed Sta, 3 Position (EJ), Multichannel Single Side Band Radio Sec (EL), Receiving and Transmitter Sec (HD), Boehme Instal Sec (HE)

For explanation of symbols, see FM 21-6.

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## DESTRUCTION NOTICE

**WHY** — To prevent the enemy from using or salvaging this equipment for his benefit.

**WHEN** — When ordered by your commander.

**HOW** — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools, large rocks.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

### USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

**WHAT** — 1. Smash — *a. Keying equipment:* Keying head drive base casting, motor housing and armature, gear box, relays, switches, capacitors, all resistors, pilot lamp. Keying head.

*b. Recording equipment:* Recorder driving unit front panel and base, tubes, transformers, chokes, all capacitors and resistors, meters, knobs, dials, switches, tube sockets. Tape puller base casting, gear box, motor housing and armature, filter, rewinder reel attachment and magnetic release attachment. Ink recorder signal coil assembly, field coil and pot.

*c. Auxiliary equipment:* Tape reel housing and stand. Tape bridge and supports.

2. Cut — All wiring, cables, motor field coils, and armature windings.

3. Burn — Technical manuals, cables, paper tape, and oil. Throw the smashed parts on the fire.

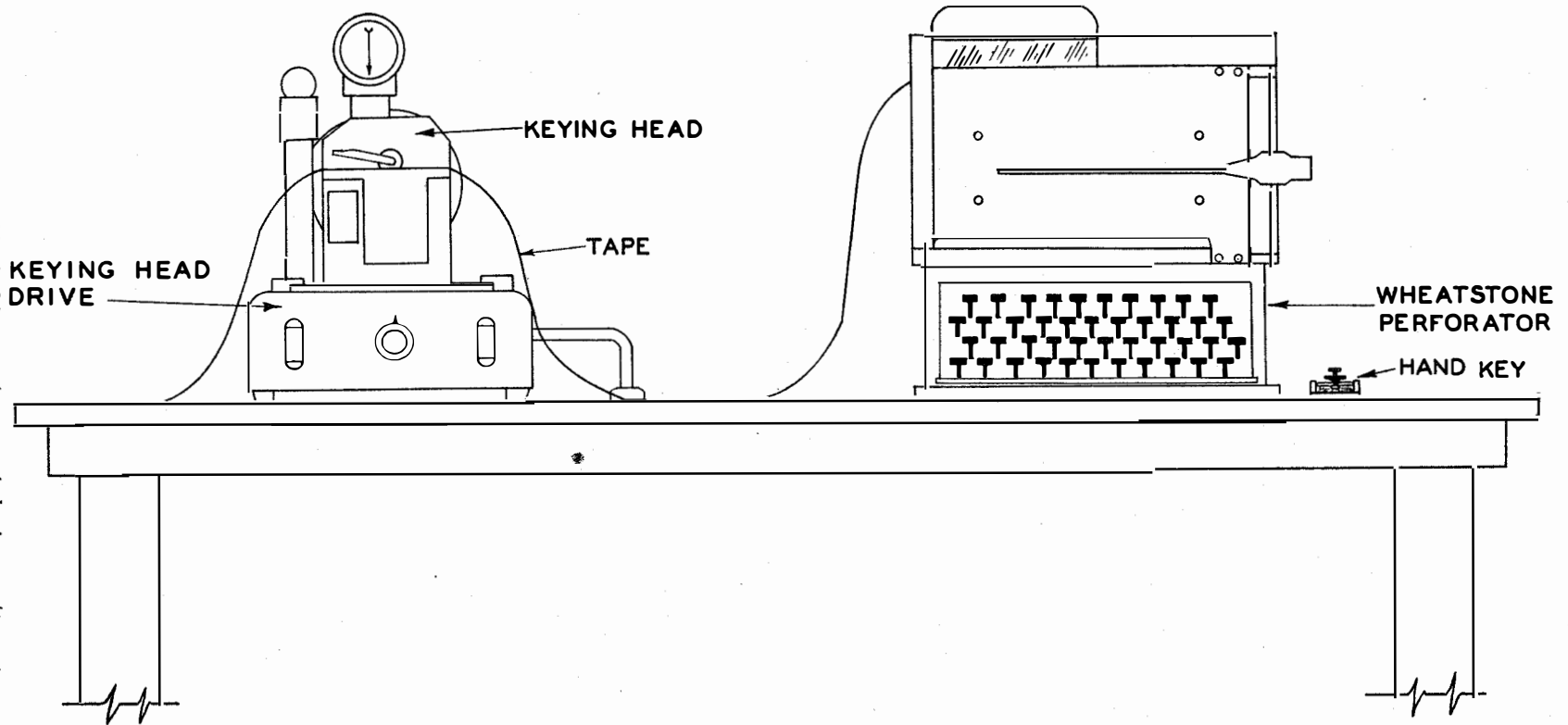
4. Bury or scatter — Any or all of the above pieces after smashing, cutting, breaking, and/or burning.

\*

## SAFETY NOTICE

SEVERE SHOCK MAY RESULT FROM CONTACT WITH CURRENT-CARRYING PARTS OF THIS EQUIPMENT. BE SURE THAT THE POWER IS OFF BEFORE MAKING ADJUSTMENTS WITHIN THE EQUIPMENT. HANDLE THE LINE WIRES CAREFULLY.

Figure 1. Typical layout of automatic keying equipment.



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# PART ONE

## AUTOMATIC KEYING EQUIPMENT

### SECTION I

#### DESCRIPTION

#### 1. PURPOSE.

Boehme automatic keying equipment is designed for the high-speed automatic transmission of radio-telegraph signals in International Morse Code. The two main components of the automatic keying equipment are a keying head and a keying head drive. Figure 1 shows a layout

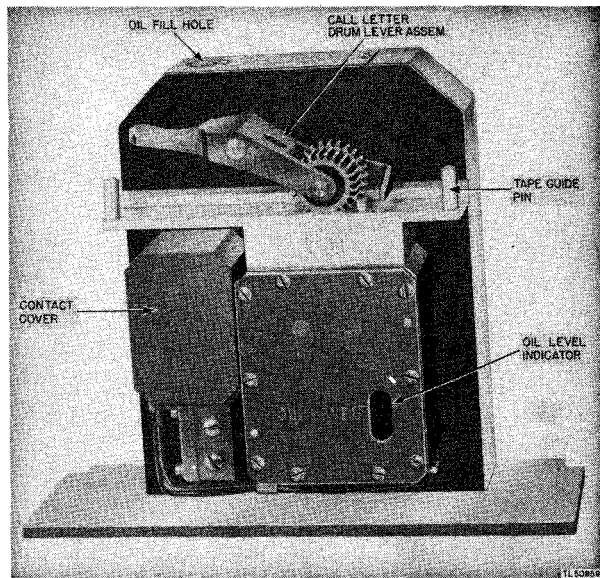


Figure 2. Keying head, type 4-E, series B, front view.

of a typical operating arrangement. A wiring diagram of a typical operator's transmitting table is shown in figure 44.

#### 2. KEYING HEAD.

The keying head, type 4-E, series B (figs. 2 and 3), controlled by a perforated tape, is used to automatically key an external radio-telegraph circuit at any desired speed within the range of from approximately 15 to approximately 400 words per minute. The keying head is connected electrically and mechanically to the keying head drive (figs. 13 and 14). Mechanical power is transmitted from the keying head to the keying head drive through a saw-tooth coupling (figs. 3, 4, and 13). Elec-

trical connection between the keying head and the external circuit is made by three brass contact pins on the keying head (fig. 3) and three corresponding brass contact points on a block mounted on the keying head drive (fig. 4). Figure 13 shows these mechanical and electrical connections in detail.

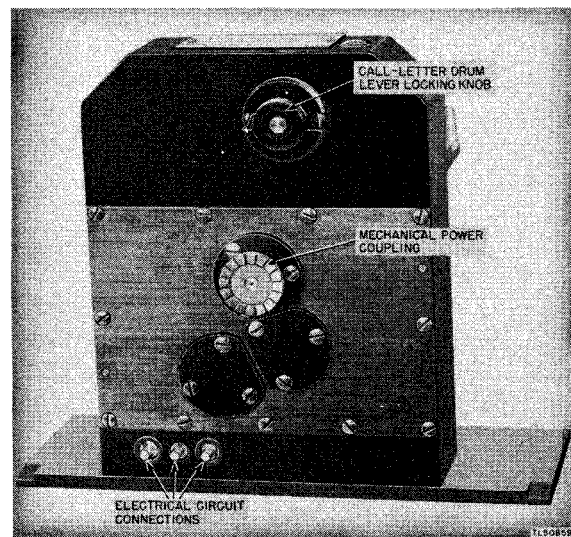


Figure 3. Keying head, type 4-E, series B, rear view.

#### 3. KEYING HEAD DRIVE.

The keying head drive, type 4-D, series E (figs. 4, 5, and 14), drives the keying head through its entire speed range. The keying head drive is connected directly to the external circuit, and is connected mechanically and electrically to the keying head. The circuit of the drive, which is equipped for both local and remote hand keying, is arranged so that if the hand key (figs. 4 and 5) is operated while the keying head is transmitting, a system of relays in the drive disconnects the keying head from the circuit and connects the hand key. Operation of the keying head drive is from a 110-volt, d-c source of power.

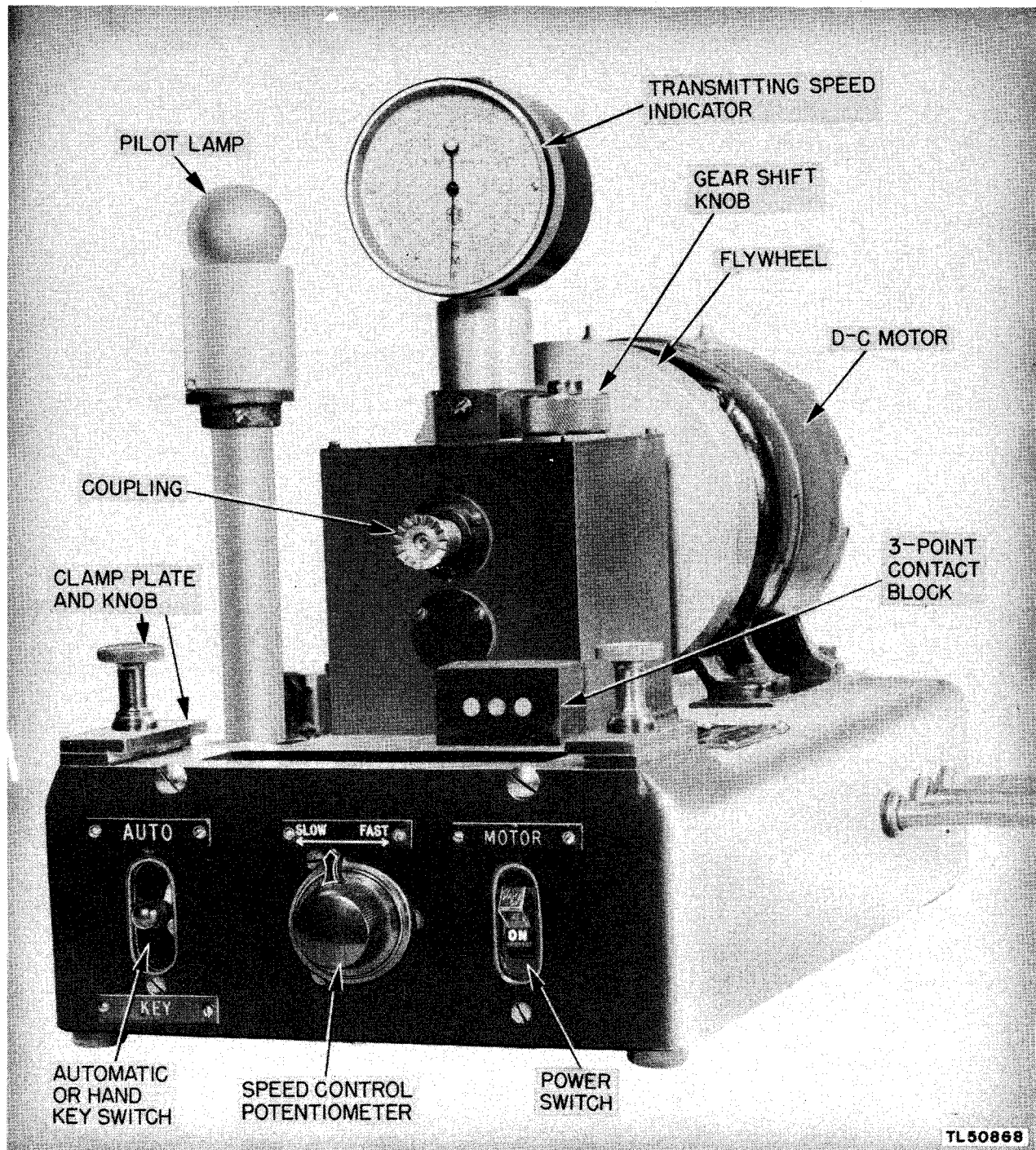
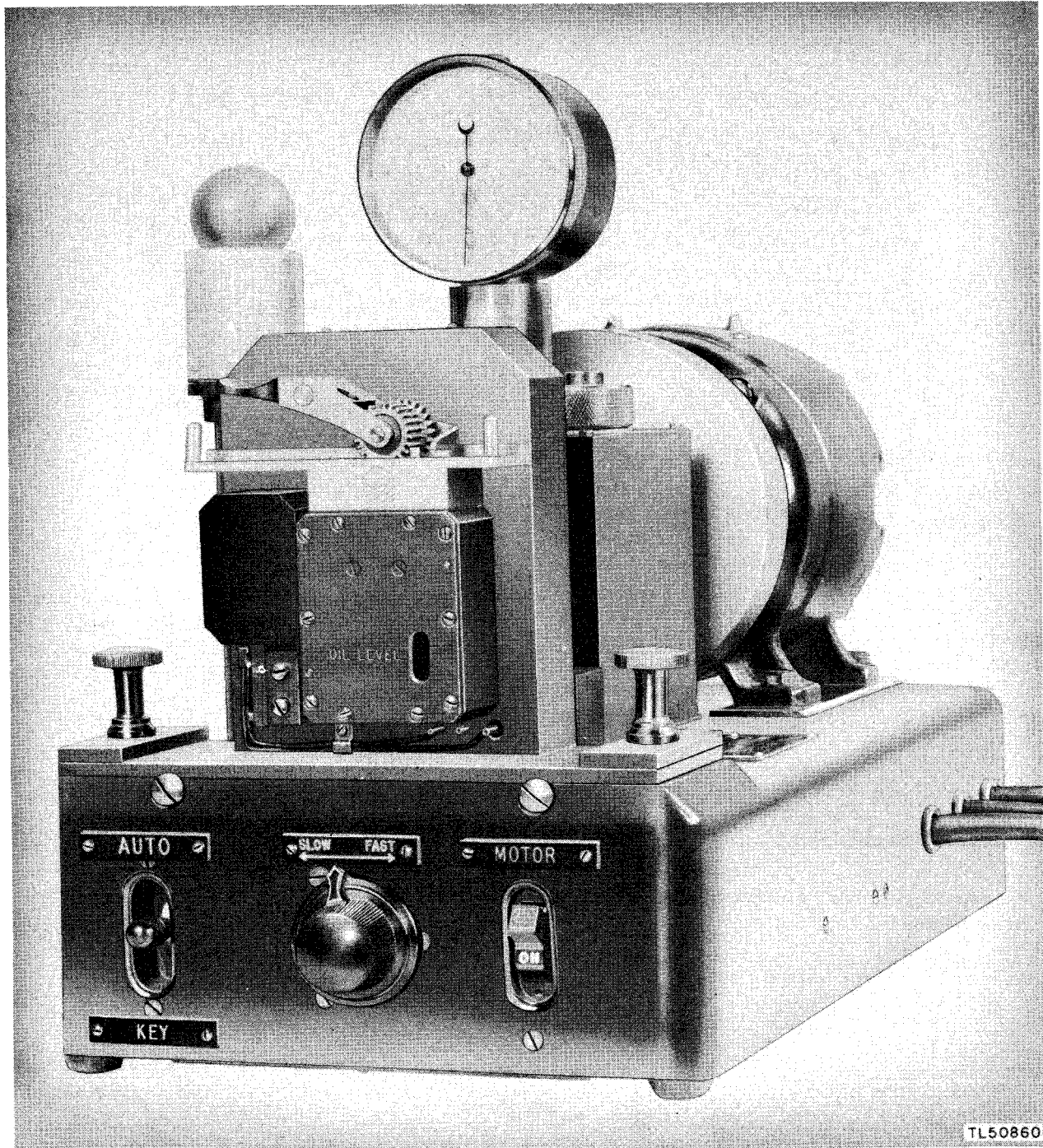


Figure 4. Keying head drive, type 4-D, series E.

#### 4. TRANSMISSION.

a. For automatic transmission, the equivalent of dots and dashes are first perforated in an oiled paper tape (15/32 inch wide) by a Wheatstone perforator which has a typewriter keyboard (fig. 6) or by other means of perforating tape.

b. The perforated paper tape is run through the keying head. The keying head, actuated by the coded perforations of the tape, causes a radio transmitter to send groups of corresponding dots and dashes. Figure 7 illustrates the arrangement of the perforations on a section of transmitting tape.



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Figure 5. Keying head mounted on keying head drive, front view.

## 5. DIMENSIONS AND WEIGHTS.

### a. Keying Head.

- (1) Over-all dimensions: 4 inches deep, 8½ inches wide, and 7 inches high.
- (2) Packing dimensions: 12 by 8 by 12 inches.
- (3) Net weight: 8 pounds.
- (4) Shipping weight: 24 pounds.

### b. Keying Head Drive.

- (1) Over-all dimensions: 11 inches wide, 18 inches deep, and 13 inches high.
- (2) Base dimensions: 9 by 15½ inches.
- (3) Packing dimensions: 24 by 20 by 22 inches.
- (4) Net weight: 50 pounds.
- (5) Shipping weight: approximately 120 pounds.

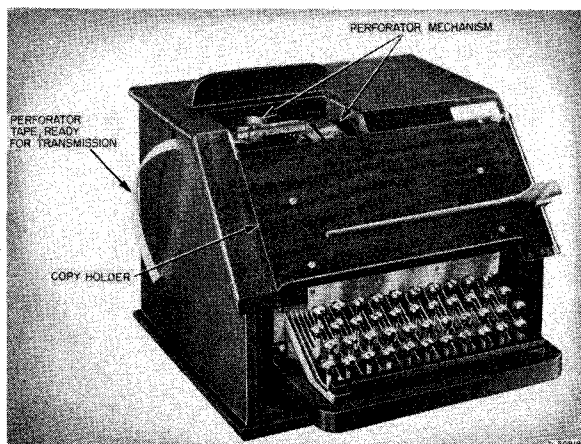


Figure 6. Typical tape perforator.

**6. KEYING HEAD CONTACT LEVER AND CONTACT.**

The motion of the contact lever, which carries the moving contact in the keying head between the fixed contacts, thereby sending mark and space signals, is imparted through gears and levers operating from the main shaft (figs. 8, 9, 19, and 22) and does not depend upon springs. The contact lever is mechanically polarized; therefore, no external polarized relays are necessary. The floating type marking and spacing contact (fig. 9) permits a very small contact clearance and also permits the longest contact time. The contacts are designed to carry a continuous signal current of not more than 75 milliamperes. To allow for various operating conditions, a biasing adjustment (fig. 8) is provided to permit the operator to vary the length of the alternate marking and spacing contacts.

**7. KEYING HEAD STATION IDENTIFICATION ATTACHMENT.**

The keying head is equipped with a blank call-letter drum which is mounted on the call-letter drum lever

assembly (figs. 2 and 5). This drum can be replaced by a special call-letter drum having depressions in its teeth for station identification. These depressions cause the keying head to transmit the station identification signal when the drum is placed in station identification position. With such a call-letter drum, a fixed signal can be transmitted automatically without the use of a looped perforated tape. Figure 10 shows a typical station-identification call-letter drum. The maximum signal that can be placed on the drum is the equivalent of 24 center holes in standard perforated tape.

**8. KEYING HEAD DRIVE MOTOR.**

The keying head drive is powered by a 1/12-horsepower, 1,140 rpm, ball-bearing compound motor (fig. 14) which operates from a 110-volt, d-c power supply. The motor has a flywheel for stability. Power consumption is approximately 150 watts.

**9. KEYING HEAD DRIVE GEAR BOX.**

The keying head drive gear box contains a three-speed gear shift, coupled at one end to the flywheel on the motor by a mechanical safety clutch. The other end is fitted with a saw-tooth coupling for engaging the saw-tooth coupling on the keying head. Figure 11 is a sketch of the gear train in the gear box. A brass knob on top of the gear box (figs. 4 and 16) is provided for shifting the gears in the gear train from one speed range to another. These speed ranges are designated by the letters S (slow), M (medium), and F (fast), which are engraved in the gear box cover near the pointer of the gear shift knob.

**10. KEYING HEAD DRIVE TRANSMITTING SPEED INDICATOR.**

The transmitting speed indicator (figs. 4 and 15), mounted on top of the gear box, covers the three speed ranges and is calibrated in words per minute.

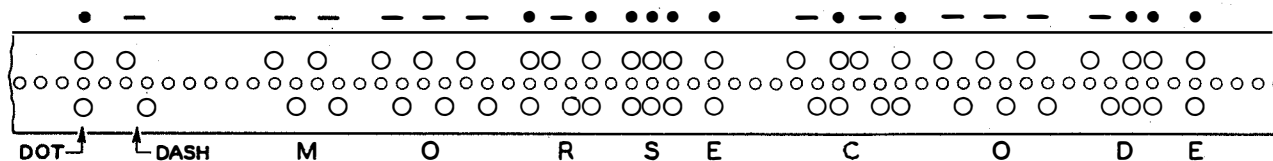


Figure 7. Typical message punched in transmitting tape by perforator.

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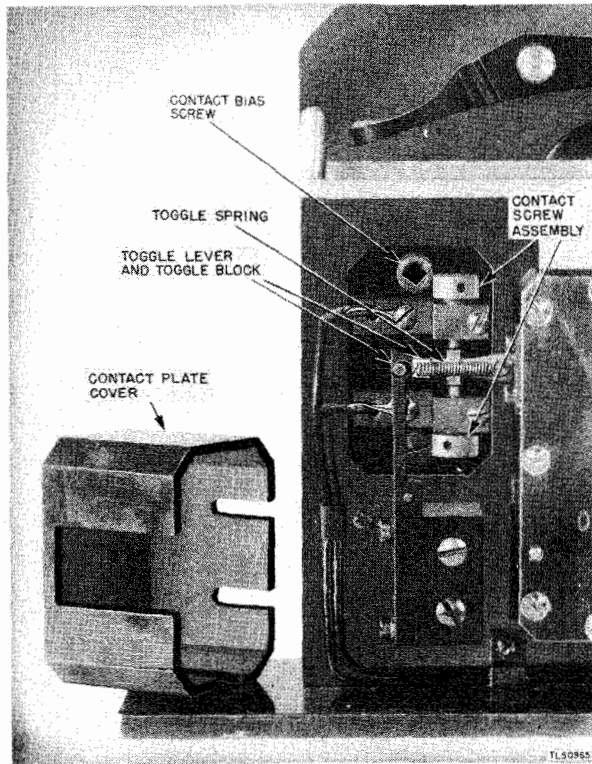


Figure 8. Contact mechanism of keying head.

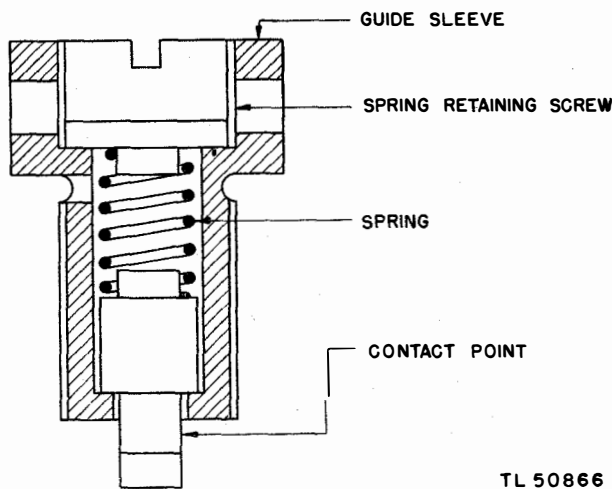


Figure 9. Cross-section of floating type keying head contact screw assembly.

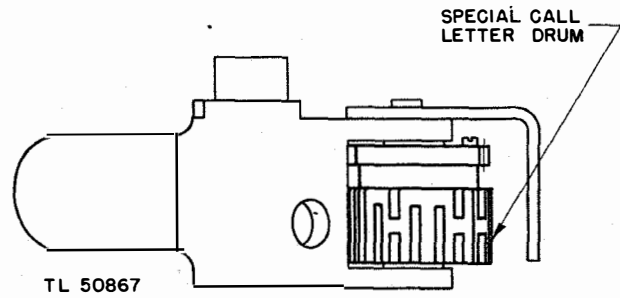


Figure 10. Typical call-letter drum for station identification.

11. KEYING HEAD DRIVE BASE.

a. The keying head drive motor and the gear box are mounted on top of a cast base. This base (fig. 12) contains the wiring of the unit, a potentiometer for controlling motor speed, a power switch, three cords and plugs for connection to the external circuits, an automatic or hand key switch, a hand keying relay (Boehme relay), a vibrating reed relay, a slow release relay, and various resistors.

b. The electrical circuits of the keying head drive are provided with filters to suppress radio interference created by the motor and keying head contacts.

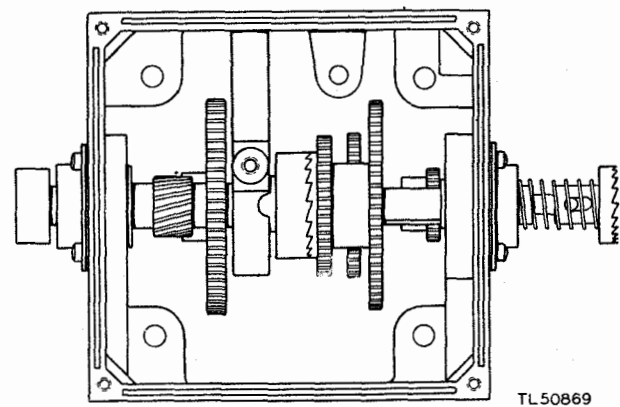
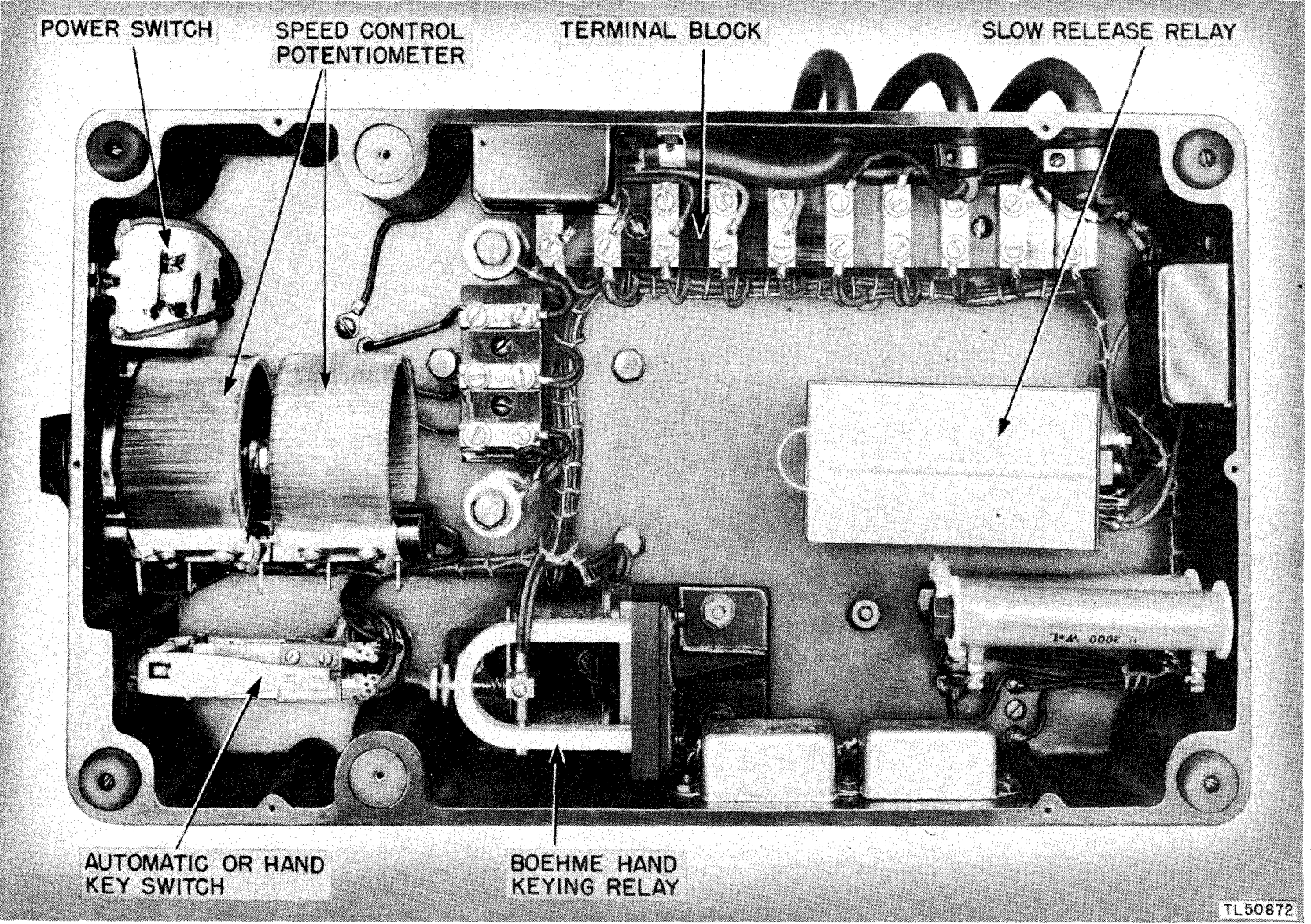


Figure 11. Sketch of gear train in keying head drive gear box.



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Figure 12. Keying head drive base, bottom view.



## SECTION II

### INSTALLATION AND OPERATION

#### 12. PROCEDURE BEFORE INSTALLING KEYING HEAD.

a. The keying head is shipped from the manufacturer without oil. Before using the keying head, fill it with two ounces of the oil supplied (or Oil, Engine SAE 10, U. S. Army Specification 2-104B). To do so, remove the OIL FILL screw (fig. 2) and pour the oil into the unit through the hole left by removal of the screw. The hole is marked OIL FILL. With the keying head standing upright, pour in oil until the oil level reaches the mark on the OIL LEVEL indicator which is on the front plate (figs. 2 and 5).

**CAUTION:** AFTER THE UNIT IS PROPERLY FILLED WITH OIL, KEEP IT IN A VERTICAL POSITION TO PREVENT THE OIL FROM RUNNING OUT OF THE CONTACT LEVER AND THE SELECTOR PIN SLOTS. THE KEYING HEAD MUST BE CORRECTLY LUBRICATED AT ALL TIMES. CHECK THE OIL LEVEL FREQUENTLY.

Replace the OIL FILL screw. Put a few drops of the same oil on the front and back edges of the call-letter drum (figs. 2 and 10), on the selector pins (fig. 19), and on the toggle block (fig. 8). Do this at frequent intervals during operation.

b. Drain all oil from the keying head before packing for reshipment.

#### 13. INSTALLATION OF KEYING HEAD.

a. Loosen the clamp plate knobs (fig. 4) on the keying head drive.

b. Slide the keying head under the clamp plates (fig. 5).

c. Push the keying head back until the front edge of its base is behind the two keying head stop screws on the front of the keying head drive.

d. Line up the saw-tooth coupling on the keying head with the one on the keying head drive (figs. 13 and 14).

e. Tighten the clamp plate knobs.

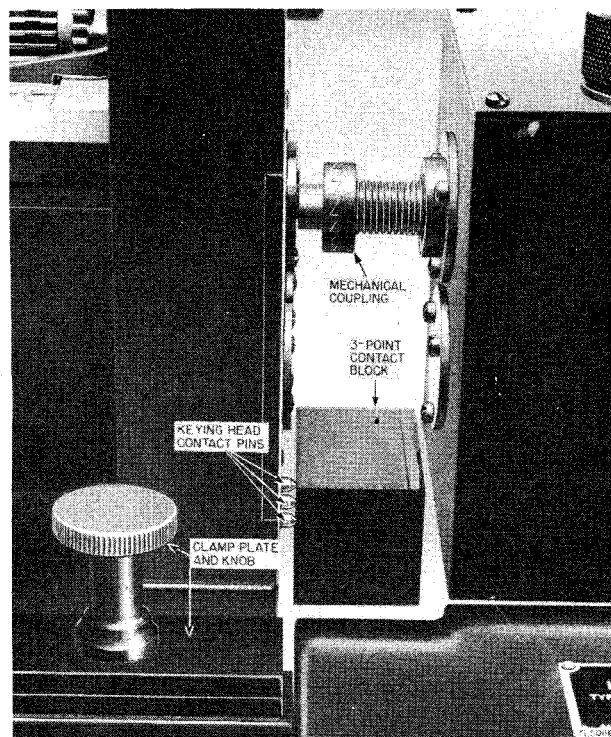


Figure 13. Electrical and mechanical connections between keying head and keying head drive.

#### 14. INSTALLATION OF KEYING HEAD DRIVE (figs. 4, 5, and 14).

a. The keying head drive is shipped from the manufacturer with oil in the gear box, ready for operation. Before installing a new keying head drive for the first time, or if there is evidence of oil leakage during transportation of a keying head drive that has been in service, remove the five screws securing the gear box cover plate to the gear box.

(1) Remove the gear box cover plate and the gasket, being careful not to damage the gasket or bend the cover plate.

(2) If the gear box is dry, pour in 6 ounces of Oil, Engine, SAE 50, U. S. Army Specification 2-104B.

(3) If little or no oil is found in the gear box when it is checked for oil leakage, turn the keying head drive upside down and drain out any remaining old oil. Then pour in 6 ounces of new Oil, Engine, SAE 50, U. S. Army Specification 2-104B.

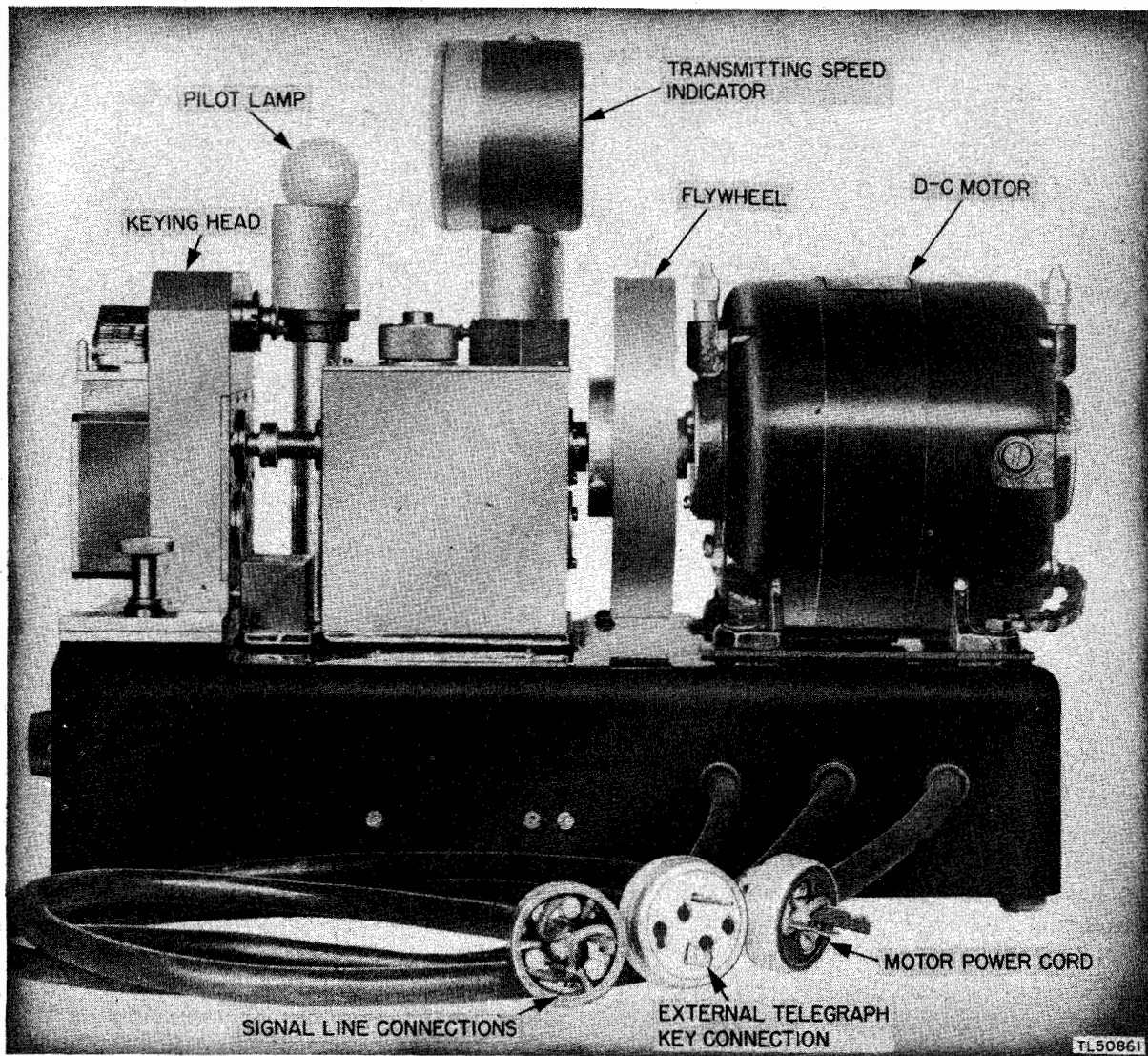


Figure 14. Keying head mounted on keying head drive, side view.

(4) Replace the gasket and the cover plate and tighten the five cover plate screws.

(5) Check the keying head to see that it has been installed in accordance with paragraph 13.

b. Connect the three-prong plug to the external marking, spacing, and neutral signal circuits.

**CAUTION: THE CURRENT THROUGH THE SIGNAL CIRCUIT FOR THE KEYING HEAD AND THE KEYING HEAD DRIVE MUST NOT EXCEED 75 MILLIAMPERES!**

c. Connect the polarized two-prong plug (center cord and plug) to the hand key circuit.

d. Connect the standard two-prong plug (front cord and plug) to the 110-volt, d-c power source (two-prong polarized plugs are used on the motor cord in some instances).

#### 15. OPERATION OF KEYING HEAD.

**CAUTION: EXCESSIVE WEARING OF SELECTOR PINS AND CALL-LETTER DRUM OCCURS WHEN KEYING HEAD IS OPERATED WITHOUT TAPE. DO NOT OPERATE KEYING HEAD AT HIGH SPEEDS WITHOUT TAPE.**

**a. Insertion and Removal of Tape.** Insert the perforated transmitting tape into the keying head either by placing the end of the tape under the right-hand side of the call-letter drum, or by pressing down on the call-letter drum lever, thereby raising the drum, and placing the tape under it (figs. 2 and 5). Always insert the tape with the spacing holes nearest to the operator and with the signals reading from left to right. The spacing holes are the bottom row of holes as shown in figure 7. Note that the diagonal rows of holes forming the dashes run from upper left to lower right when the spacing holes are at the bottom as shown in the illustration. To remove or pull the tape back at any point, press down on the call-letter drum lever to lift the call-letter drum. The drum returns to the operating position when pressure on the lever is removed.

**CAUTION: DO NOT LET THE CALL-LETTER DRUM LEVER ASSEMBLY SNAP DOWN ON THE SELECTOR PINS. THE PINS ARE BRITTLE AND WILL BREAK OFF.**

**b. Transmitting from Perforated Tape.** The tape-transmitting position of the call-letter drum lever assembly (figs. 2 and 5) is with the lever pushed in all the way against the housing. It is held in this position by the call-letter drum lever locking knob on the back of the keying head (fig. 3).

**c. Transmitting Fixed Signal.** (1) The keying head is fitted with a second operating position of the call-letter drum lever assembly which is used *only* when the regular blank call-letter drum has been replaced by a special call-letter drum.

(2) If the fixed signal (usually the station identification) on the special call-letter drum is to be transmitted, press down on the call-letter drum lever, pull the call-letter drum lever assembly forward, and release it. It is locked in this second position by a locking knob (fig. 3).

**CAUTION: DO NOT LET THE CALL-LETTER DRUM LEVER ASSEMBLY SNAP DOWN ON THE SELECTOR PINS.**

(3) To return the call-letter drum to the normal (tape-transmitting) position, press down on the call-letter drum lever, push it in all the way against the housing, and release it.

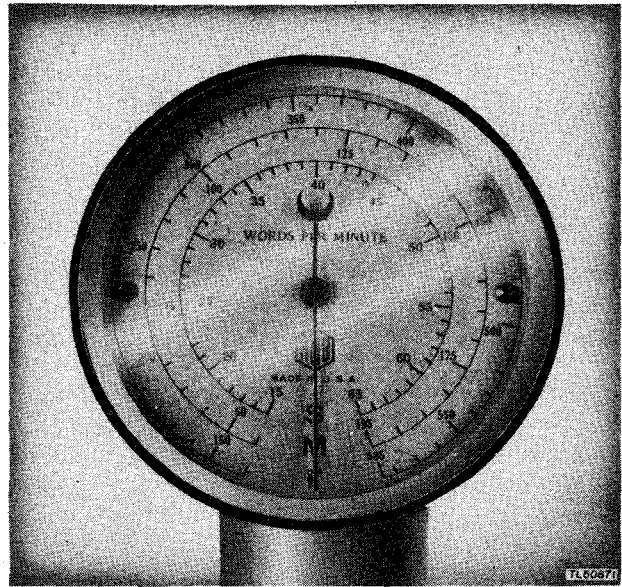


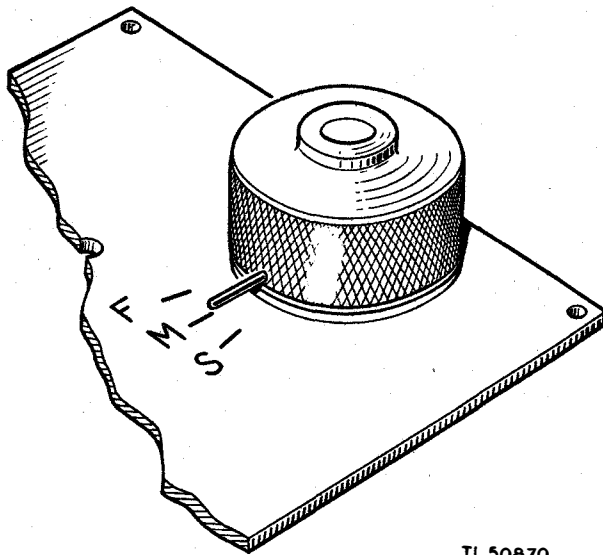
Figure 15. Transmitting speed indicator showing speed ranges in words per minute.

## 16. OPERATION OF KEYING HEAD DRIVE.

**a.** Start the motor by snapping the MOTOR-ON-OFF switch (figs. 4 and 5) to ON.

**b.** The transmitting speed indicator, mounted on top of the gear box (figs. 4, 5, and 15), shows transmitting speed in words per minute. When reading the keying head transmission speed, be sure to read the scale on the dial of the indicator which corresponds to the speed range being used. Any one of three speed ranges can be selected by the gear shift knob on top of the gear box (figs. 4 and 16). The three ranges are designated by the letters S (slow), M (medium), and F (fast) stamped in the top of the gear box near the pointer on the gear shift knob.

**c.** If the keying speed is too slow or too fast, change it by turning the speed control potentiometer to SLOW or FAST (figs. 4 and 5) to decrease or increase the motor speed. If the desired speed is not within the range of the speed control potentiometer marked SLOW-FAST, change the gear ratio by turning the gear shift knob. Before shifting gears from one speed range to another, turn the motor off and allow the motor and gears to slow down. Shift the gears just before the motor stops coasting. To slow down the motor more rapidly, carefully press the hand against the flywheel.



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Figure 16. Keying head drive gear shift knob.

d. The Boehme relay, which has two pairs of contacts, connects the signal line to the marking and spacing battery (fig. 17) when the hand telegraph key is operated. The automatic or hand key switch marked AUTO-KEY (figs. 4 and 5) connects the center leg (line) either to the keying head for automatic keying or to the Boehme relay for hand keying.

e. For automatic keying, push the AUTO-KEY switch to AUTO.

f. When the hand key is operated, the red pilot lamp (fig. 14) lights, indicating that the automatic keying head is no longer connected to the external signal circuit. The motor need not be stopped when hand keying. However, remove the perforated tape from the keying head during hand keying, because the message on the tape passing through the keying head during hand keying is not being transmitted. A few moments after the completion of hand keying, the red pilot lamp goes out, showing that the keying head is again connected to the external signal circuit. Reinsert the perforated transmitting tape into the keying head at a point approximately 12 inches before the point at which automatic transmission was interrupted. The repeated portion of the message permits the receiving operator to pick up the continuity of the text.

g. If the keying head drive is not equipped with the automatic hand key break-in feature, the pilot lamp, slow-release relay and vibrating reed relay are omitted. Therefore, it is necessary to push and hold the AUTO-KEY switch to KEY. When the hand key is operated, the motor need not be stopped, but the transmitting tape should be removed from the keying head, as with the automatic hand key break-in. The red pilot lamp is not furnished to indicate when the keying head is disconnected from the signal circuit. Reinsert the transmitting tape into the keying head, as with the automatic hand key break-in.

## SECTION III

### FUNCTIONING OF PARTS

#### 17. ELECTRICAL FUNCTIONS OF KEYING HEAD.

The keying head, type 4-E, is designed to key a radio transmitter or other external signal circuit by either of two methods: In a single-current (neutral) circuit (fig. 17A) only one battery is used, and the keying head makes and breaks one circuit. In a double-current (polar) circuit (fig. 17B) two batteries are used; the positive terminal of one battery is connected to the marking contact of the keying head, and the negative terminal of the second battery is connected to the spacing contact. The remaining terminals of both batteries are connected to ground. In a double-current circuit, the keying head connects the signal line to either the marking battery or the spacing battery, according to the code perforated in the transmitting tape.

has been chosen, all other characters, words, phrases, etc., can be considered in terms of a total of all the separate bauds. The standard commercial test word, PARIS (fig. 18), contains 50 bauds and corresponds to 25 center feed holes in the transmitting tape. The call-letter drum has 24 teeth which match the feed holes. Therefore, the call-letter drum is equivalent to 48 bauds or 2 bauds less than one standard test word. The number of revolutions per minute of the call-letter drum is approximately equal to the transmitting speed of the keying head in words per minute. The transmitting speed indicator mounted on the gear box of the keying head drive is calibrated on the basis of 50 bauds per word. The number of times per minute that the test word PARIS passes through the keying head checks very closely with

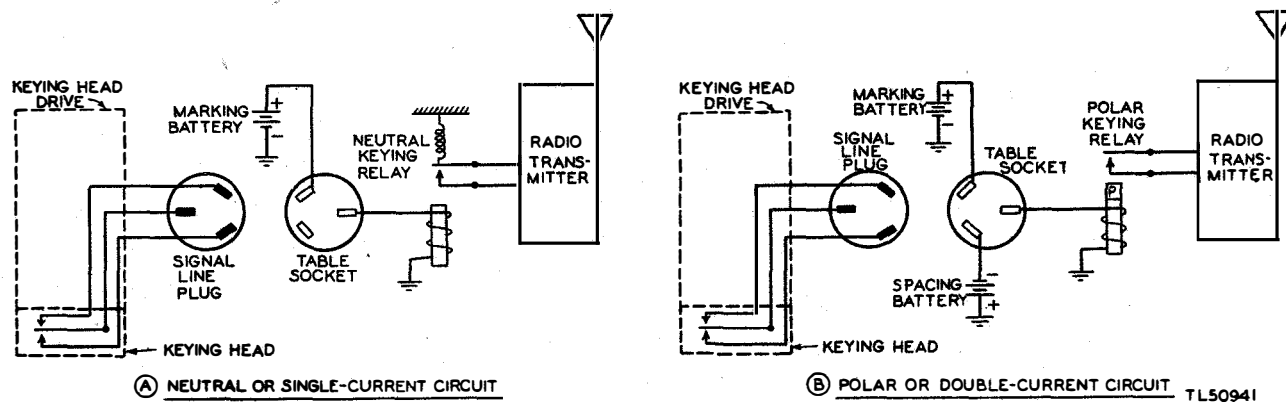


Figure 17. Typical single- and double-current circuits connecting automatic keying head and radio transmitter.

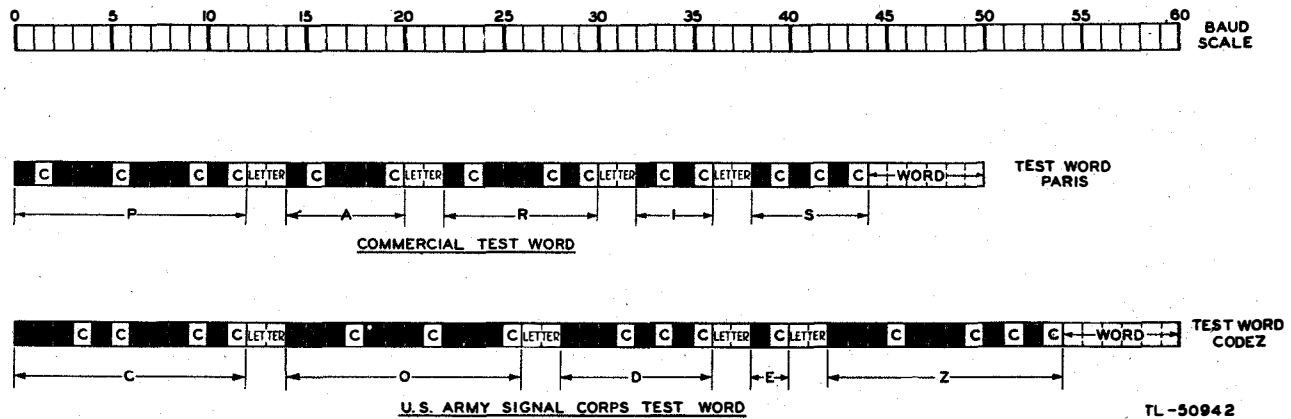
#### 18. EXPLANATION OF BAUD SYSTEM.

a. All of the characters punched in a transmitting tape by the Wheatstone perforator and transmitted by the keying head are based on the units of time required to transmit the characters. The term *baud*, derived from the name of the man<sup>1</sup> who invented the time unit system of recording telegraph messages, is the most common name for the arbitrary time interval chosen for a starting point. After the arbitrary time interval, or baud,





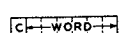





the speeds on the indicator dial.

b. The Signal Corps test word CODEZ contains 10 more bauds (total 60) than the commercial test word. A speed check of the keying head using the test word CODEZ gives the impression that the indicator reads too fast because the keying head must be speeded up to pass the longer tape in the same amount of time. The difference in speed is approximately 20 percent. Figure 18 shows a graphic representation of the baud system.

<sup>1</sup> J. M. E. Baudot (1845-1903), French inventor.



EXPLANATION

-  Space between characters = 1 baud = 1 dot.
-  Space between letters = 2 bauds (used only in computing total space between letters).
-  Total space between letters = 3 bauds = 1 baud of character space from preceding letter plus 2 bauds of letter space.
-  Space between words = 6 bauds (used only in computing total space between words).
-  Total space between words = 7 bauds = 1 baud of character space from preceding letter plus 6 bauds of word space.
-  1 feed hole = 2 bauds.
-  1 dot (not including following space) = 1 baud. (Every dot is followed by 1 baud of character space as shown above. Together they are equal to 1 feed hole in tape.)
-  1 dash (not including following space) = 3 bauds. (Every dash is followed by 1 baud of character space as shown above. Together they are equal to 2 feed holes in tape.)
-  6 dots and the 6 following character spaces = 12 bauds.
-  6 dashes and the 6 following character spaces = 24 bauds.

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Figure 18. Baud system.

### 19. MECHANICAL FUNCTIONS OF KEYING HEAD (fig. 19).

a. The drive ratio of the keying head is 4.8 revolutions of the saw-tooth coupling to one revolution of the call-letter drum. Therefore, 4.8 revolutions per minute of the saw-tooth coupling equals a transmitting speed of approximately one word per minute.

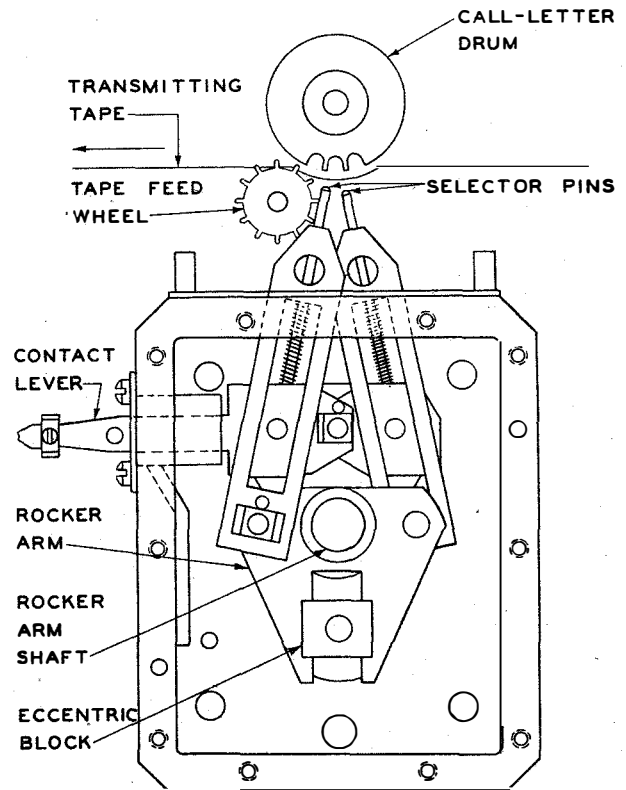
b. Two selector pins are moved alternately through two rows of holes in the tape (fig. 7) and engage the teeth on the revolving call-letter drum of the keying head. When the selector pins encounter unpunched portions of the tape, the selector pin springs are compressed; therefore, the pins do not engage the call-letter drum. As each pin passes through a hole and enters between two teeth, the pin is carried forward by the revolving drum in the direction of tape travel. The two levers attached to the selector pins are pivoted at the middle and linked at one end so that, as one pin is being carried forward, the other is returned to operating position. The contact lever is rigidly connected to one of these selector pin levers and has a mechanical toggle on its end. The mechanical toggle causes the contact lever to remain in either the marking or the spacing position until it is moved to the opposite contact by the selector pin levers. Thus, the contact lever cannot float between contacts.

c. When the keying head is operated without tape, the contact lever makes contact alternately on the marking and spacing contacts as the alternate selector pins are moved forward by the call-letter drum. When tape is inserted, the contact lever moves only when a hole in the tape is encountered by a selector pin. When a pin passes through a hole in the tape, it engages with and is moved forward by the call-letter drum. Thus, the contact lever is moved to marking or to spacing position, depending upon which selector pin is engaged by the drum.

**CAUTION: HIGH-SPEED OPERATION WITHOUT TAPE CAUSES EXCESSIVE WEAR.**

### 20. KEYING HEAD DRIVE AUTOMATIC HAND KEY BREAK-IN.

a. The automatic hand key break-in feature is used for remote hand keying of the transmitting circuit. If the remote hand key is operated while the keying head is transmitting, the keying head is disconnected from the circuit and the hand key is connected. A pilot lamp burns as long as the automatic keying head is disconnected during hand keying. Operation of the hand key

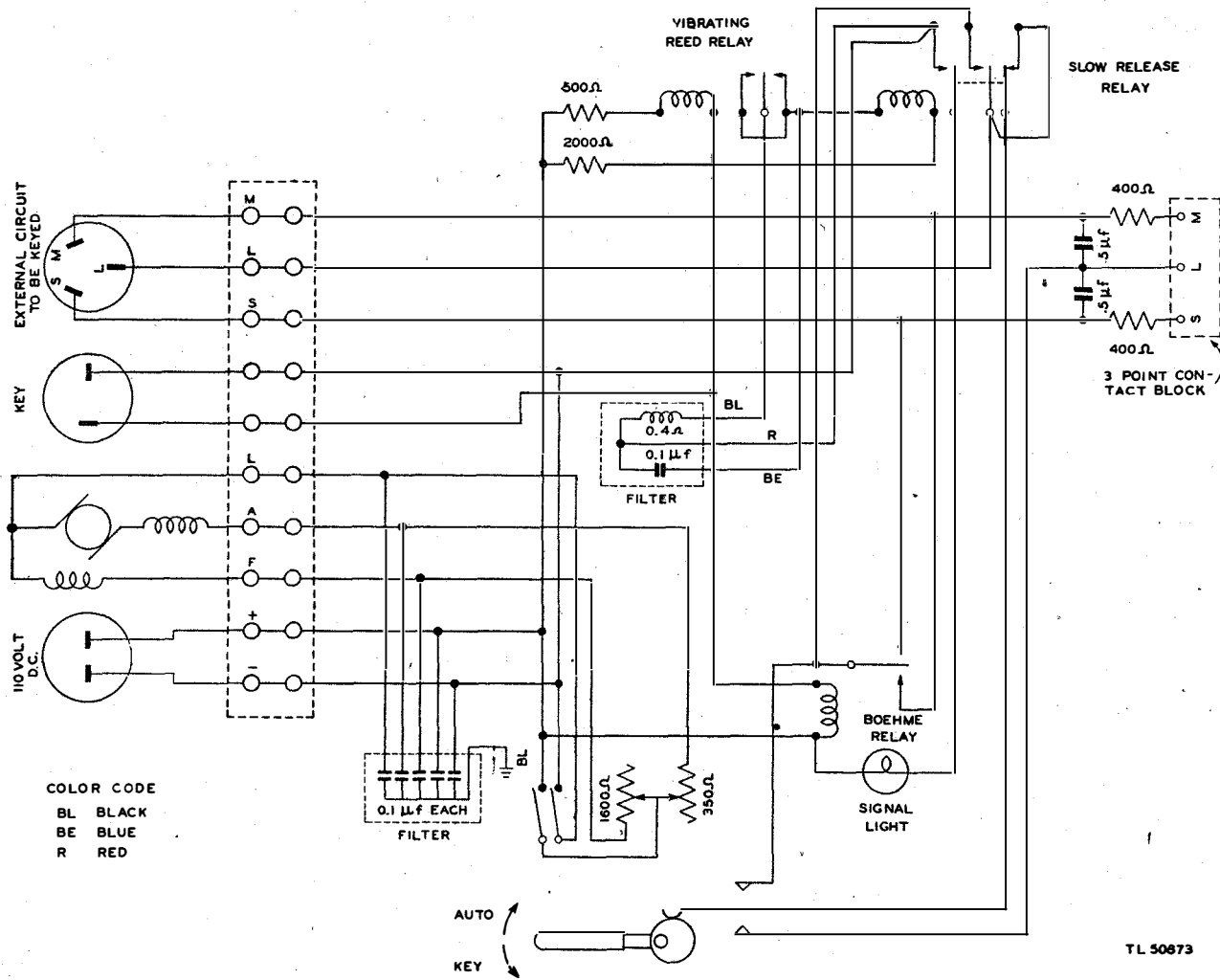


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Figure 19. Detailed sketch showing operation of keying head.

break-in is accomplished by means of three relays: One relay (Boehme) is a neutral keying type, one is a vibrating reed type, and the third is a slow-release type (fig. 20). When the hand key is operated, the key pulses cause the keying (Boehme) relay to repeat the key pulses, and at the same time cause the vibrating reed relay armature to oscillate. The oscillating armature of the vibrating reed relay makes contact alternately with the front and rear contact points which are paralleled. Small pulses of current from the vibrating reed relay flow through the coil of the slow-release relay, causing it to operate. Operation of the slow-release relay disconnects the keying head from the external signal circuit and connects the hand key. The slow-release relay remains in operation and the hand key remains connected to the external signal circuit because the time interval required by the vibrating reed relay armature to move from one contact to the other is shorter than the release time of the slow-release relay.

b. As soon as hand keying is stopped, the oscillations of the vibrating reed relay armature begin to die out. When the oscillations have died out to the extent that



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Figure 20. Wiring diagram of keying head drive.

the armature fails to make contact with either the front or rear contact points, the circuit through the coil of the slow-release relay is opened and the slow-release relay releases. Releasing of the slow-release relay disconnects the hand key from the external signal circuit and reconnects the automatic keying head. At the same time,

the pilot lamp goes out. The time between the cessation of manual keying and the reconnecting of the keying head can be adjusted over a narrow range by varying the distance between the contacts of the vibrating reed relay.



## SECTION IV MAINTENANCE

**NOTE: UNSATISFACTORY PERFORMANCE OF THIS EQUIPMENT WILL BE REPORTED IMMEDIATELY ON WD, AGO FORM NO. 468. IF FORM IS NOT AVAILABLE, SEE TM 38-250.**

### 21. CLEANING AND INSPECTION OF KEYING HEAD.

a. Inspect the keying head daily. Wipe the dust off the keying head and remove any paper lint that has gathered around the selector pins (56<sup>1</sup>, fig. 35) and the tape bridge (3, fig. 25).

b. Check the oil level daily. Correct oil level is shown on the OIL LEVEL indicator on the front of the unit.

c. Occasionally put a drop of Oil, Engine, SAE 10, U. S. Army Specification 2-104B, on the slots of the toggle block (6, fig. 25).

d. Frequently clean dirt and paper lint out of the slots of the call-letter drum (10, figs. 25 and 27).

### 22. ADJUSTMENTS OF KEYING HEAD.

a. **Tools.** A set of tools (fig. 21) is supplied with each keying head. The six tools are as follows:

- (1) Feeler gauge (4E-93) for contact gap adjustment.
- (2) Bias key (2E-95) for bias adjustments.
- (3) Contact wrench (4E-97) for removing tongue contact nut.
- (4) Punch (4E-98) for removing and replacing all pins and for timing of gears.
- (5) Tommy bar (4E-99) for contact adjustment.
- (6) Spring tension wrench (4E-100) for adjusting spring tension on the tape drum bracket.

<sup>1</sup> All numbers appearing in this section in connection with names of parts are reference numbers appearing in parts location figures of this section. The numbers of those parts which are maintenance parts appear also in the reference symbol column of the lists of maintenance parts.

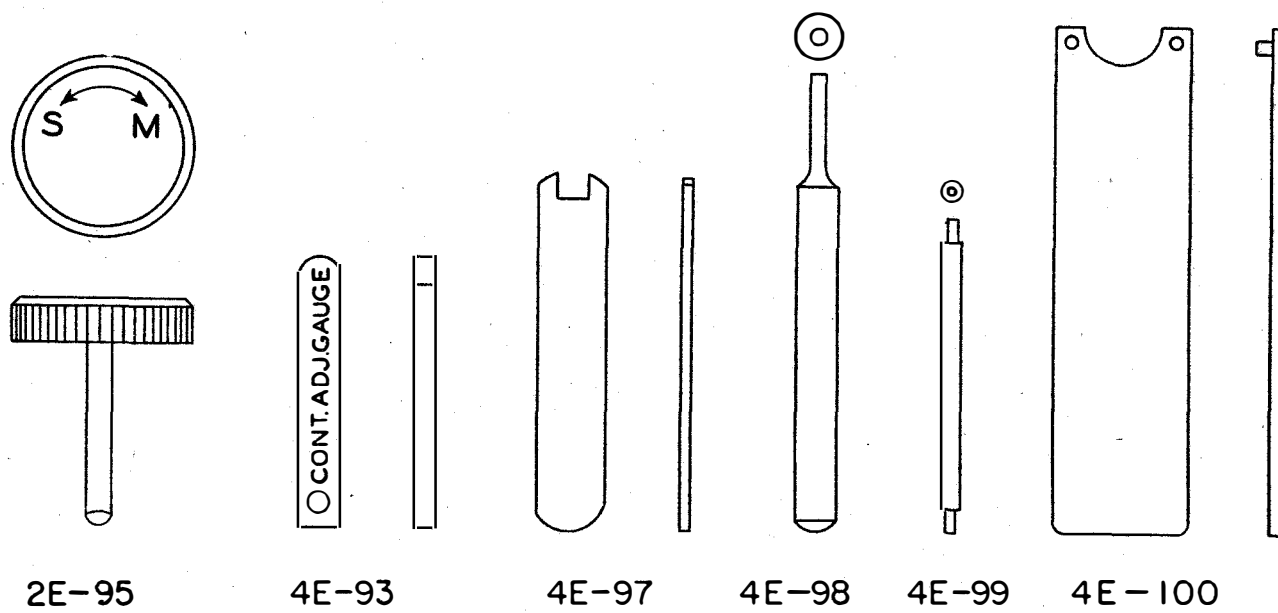


Figure 21. Set of tools for keying head.

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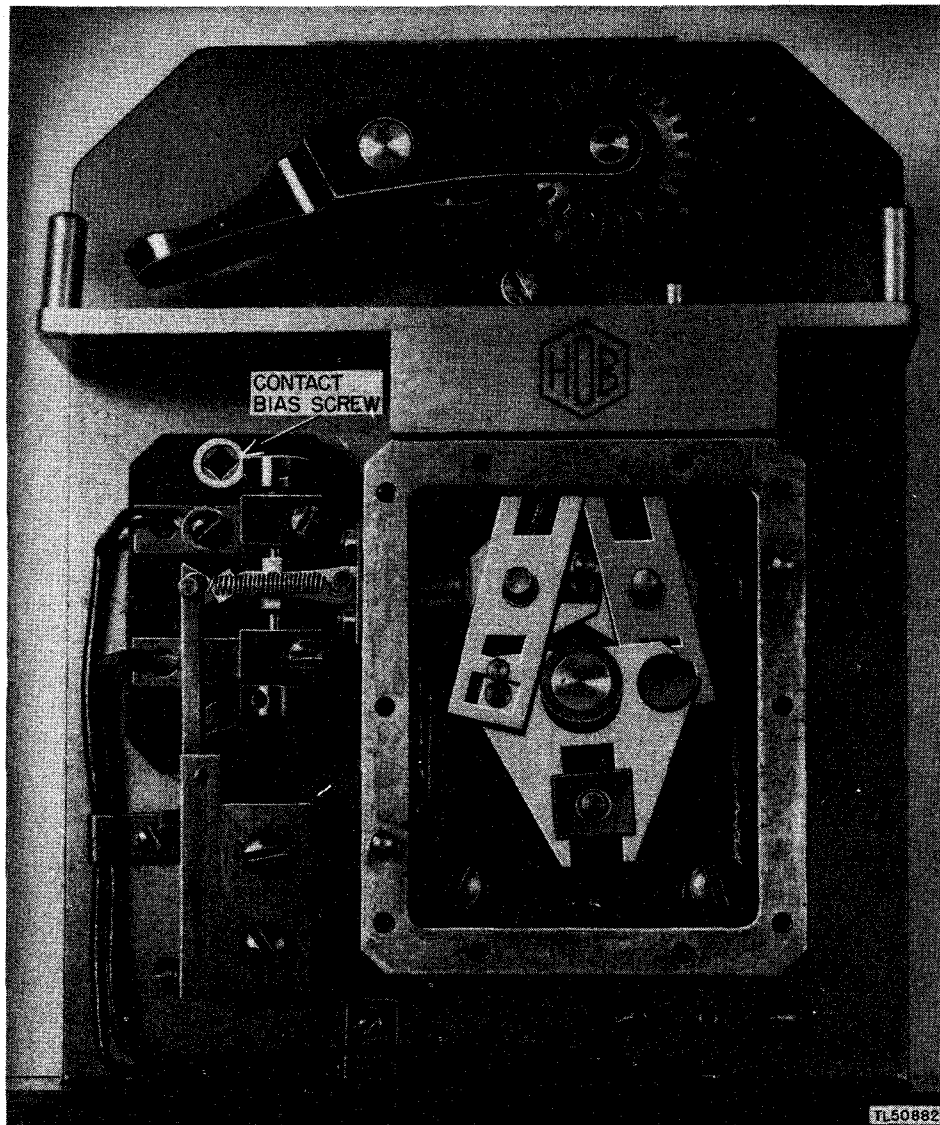


Figure 22. Detailed view of internal parts of keying head.

**b. Biasing of Contacts.** (1) A biasing adjustment makes it possible to vary the length of time that the alternate marking and spacing contacts are closed, thus permitting operation of the keying head under various signal line conditions. Before shipment, the keying head is adjusted for 50 percent marking and 50 percent spacing bias. To change the bias adjustment, remove the contact plate cover (9, fig. 25), insert the bias key (2E-95) into the square hole in the contact bias screw (fig. 22) and turn it in the desired direction as marked on the head of the biasing key (fig. 23). Turning the bias key clockwise (in the direction of the arrow pointing toward M) increases the length of the marking signal and decreases the length of the spacing signal. Turning

the key counterclockwise (in the direction of the arrow pointing toward S) decreases the length of the marking signal and increases the length of the spacing signal.

**CAUTION: BE SURE TO REMOVE THE BIAS KEY AFTER USE AND REPLACE THE CONTACT PLATE COVER.**

(2) To check the bias of the keying head contacts with a meter, follow the set-up and procedure shown in figure 24.

(3) Be sure that the current is balanced. Run the keying head at the speed to be checked. The meter needle should remain at zero at high speeds. At low speeds,

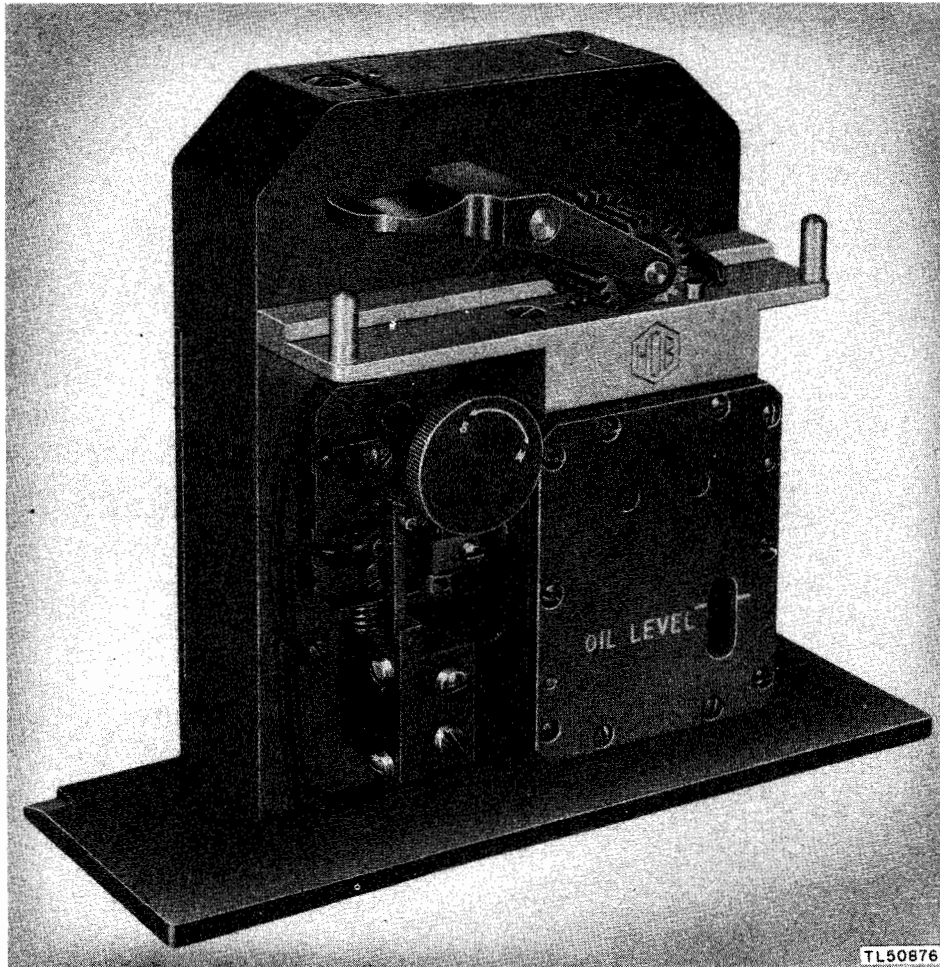


Figure 23. Bias key in position for changing contact bias of keying head.

the meter needle should fluctuate or jiggle equally to each side of zero. If the meter shows an unbalanced condition, readjust the bias screw to equalize the bias. If possible, use an oscilloscope instead of a meter. The lengths of the upper and lower horizontal traces should be equal.

c. **Removal, Cleaning, and Care of Contact Screw Assembly (fig. 25).** To remove the contact screw assembly (5), proceed as follows:

- (1) Remove the contact plate cover (9) by pulling the cover forward.
- (2) Unhook the two toggle springs (8) from the toggle spring pin (30) and swing the toggle lever (7) to the left to free the toggle block (6). Be careful not to lose the toggle block.
- (3) Remove the contact screw assembly by loosening the clamping screw (29) and unscrewing the assembly with the tommy bar (4E-99).

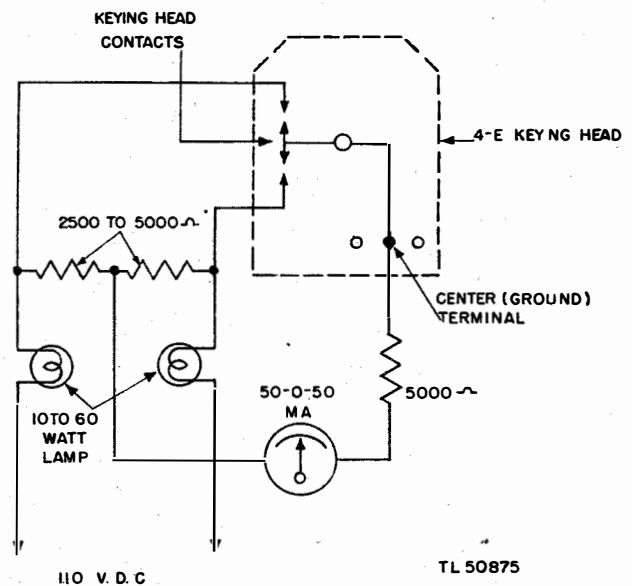
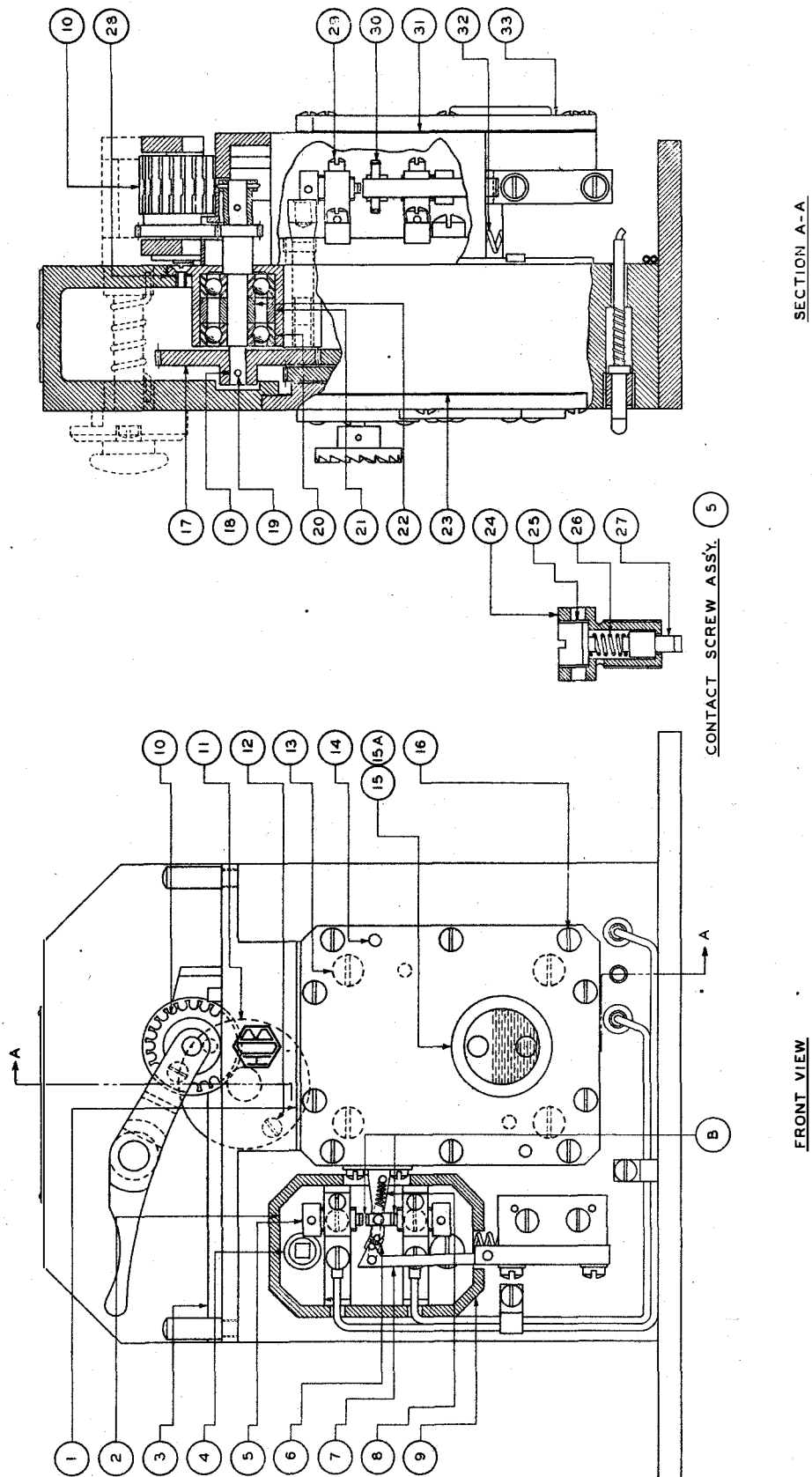


Figure 24. Bias checking circuit for keying head contacts.



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SECTION A-A

FRONT VIEW

Figure 25. Keying head, general assembly, showing front view and two cross-sections.

(4) Remove the contact point (27) from the contact screw assembly by taking out the contact spring retaining screw (25) and the contact spring (26) from the contact guide sleeve (24).

(5) Clean all parts of the contact screw assembly with carbon tetrachloride or dry cleaning solvent (Federal Specification P-S-661a). Before reassembly, dip the parts in any light oil such as Oil, Lubricating, preservative, special, Specification AXS-777, and wipe them to remove excess lubricant.

(6) To replace a contact, reverse the above procedure and adjust the contact as outlined in subparagraph e below.

(7) When one contact has been replaced, remove the other one, clean it, and make a complete readjustment.

**d. Removal, Cleaning, and Care of Tongue Contact (fig. 35).** Unscrew the tongue contact lock nut (67) using the contact wrench (4E-97). Remove the tongue contact screw first because the lock nut will hold the screw firmly and breakage will result.

**CAUTION: DO NOT ATTEMPT TO FILE OR POLISH THE CONTACT SURFACES. THE CONTACTS ARE MADE OF TUNGSTEN CARBIDE AND CAN BE GROUND ONLY WITH A SPECIAL GRINDING WHEEL.**

**e. Contact Adjustment.** Of the two contacts, the upper one is the *marking* and the lower one is the *spacing*. To adjust these two contacts, proceed as follows:

- (1) Insert the bias key (2E-95) in the bias screw (fig. 23) and turn it clockwise (in the direction of the arrow pointing toward M) as far as it will turn.
- (2) Turn the key counterclockwise two full turns to adjust the contact mounting plate (2, fig. 25) so that the marking and spacing bias is approximately equal when the contacts are set up.
- (3) Place the feeler gauge (4E-93) between either of the contact points (B, fig. 25) and the tongue contact. Screw down the contact screw assembly until the contact lever rests on the side of the contact lever stop plate (66, fig. 35) opposite the contact point which is being adjusted.
- (4) Remove the gauge and tighten the clamp screw (29, fig. 25).
- (5) To adjust the other contact point, proceed exactly as above. This adjustment gives the contacts 50 percent marking and 50 percent spacing bias.

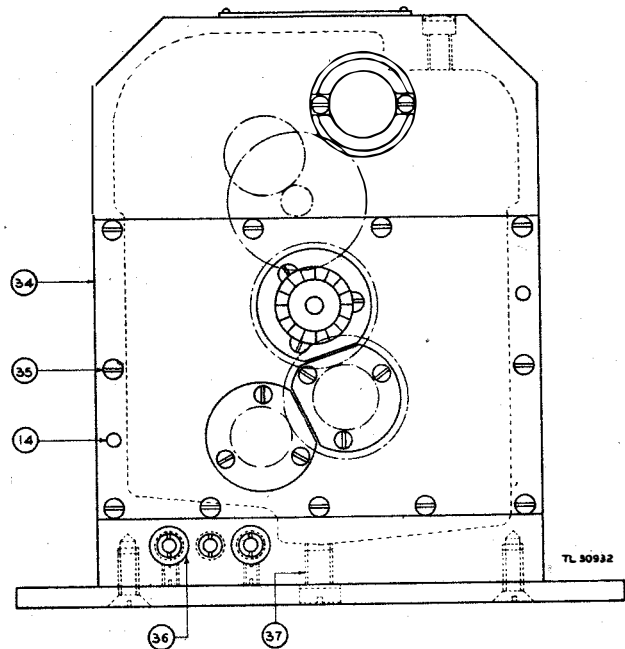


Figure 26. Keying head, general assembly, rear view.

**f. Timing Adjustment (figs. 27 and 28).** The gear train and call-letter drum are properly timed with relation to the selector pins when a tooth of the drum engages the selector pin at the top of the pin's stroke. If the selector pin butts against the edge of the tooth, the timing is out of adjustment. An external adjustment is provided for shifting the gear on the call-letter drum to compensate for normal wear. Make this adjustment as follows:

- (1) Press down on the call-letter drum lever and raise the call-letter drum (10) as high as it will go.
- (2) Loosen the small screw (41) on the back of the call-letter drum gear (42). Turn the gear with relation to the drum until the next higher number on the gear is in line with the beveled marker tooth on the drum.
- (3) Tighten the screw which holds the gear and the drum in line.
- (4) This adjustment can be made only three times. The call-letter drum gear (42) has four positions marked on it: 0, 1, 2, and 3. The gear, when new, is set on 0 and can be moved to positions 1, 2, and 3, in that order.
- (5) If the third adjustment has been made and the selector pins are again out of time with the call-letter drum, dismantle the keying head and inspect all parts for wear. Replace worn parts, and set the call-letter drum and gear back to the zero position.

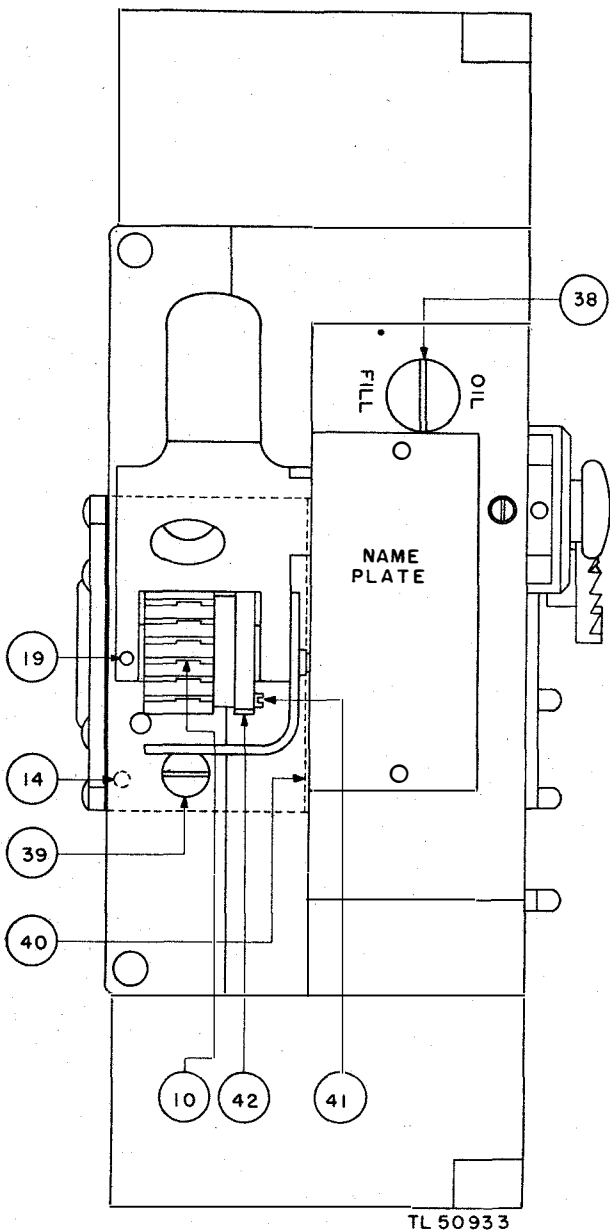


Figure 27. Keying head, general assembly, top view.

**23. DISASSEMBLY OF KEYING HEAD GEAR BRACKET.**

The gears in the gear bracket (fig. 29) synchronize the movement of the call-letter drum and the selector pins. The gears have timing marks close to the teeth for use in setting up proper timing between the eccentric drive shaft and the drum. This setting must be maintained at all times and is shown on the timing diagram (fig. 32). The punch (4E-98) is furnished for driving out and replacing all pins and for holding the gears in proper position when replacing the gear bracket on the keying head. When dismantling the keying head, be very careful not to damage the gaskets under the gear bracket

and bearing covers. Disassemble the gear bracket as follows:

- a. Drain the oil from the keying head by removing the drain screw (37, fig. 26).
- b. Remove the 11 screws (35, figs. 26 and 31) holding the bracket to the housing. Tap the edge of the bracket with some soft material, such as a piece of lead or a wooden block, to loosen it, and remove the entire bracket (fig. 29) by prying it off with a knife blade from all sides. Be careful not to bend the locating pins (14, fig. 31) or tear the gasket (23, fig. 25).
- c. Remove the covers from the ball bearings of the part to be removed. Remove the pin from the hub of the saw-tooth coupling (46, fig. 31). Be careful not to bend the shaft. Slide the coupling off the shaft.
- d. Drive the pin out of the gear which has the bearing cover removed.

**NOTE: REMOVAL OF THE PIN IS NOT NECESSARY FOR GEAR 52 BECAUSE ITS OUTSIDE DIAMETER IS LESS THAN THE BEARING BORE.**

- e. Drive out the shaft using a chunk of lead or babbitt, a brass block, or similar tool, driving it out in such a direction that the gear is driven against the wall of the bracket and *not* against an adjoining gear. This forces the shaft and the bearing out on the opposite side. The gear can now be slipped off the end of the

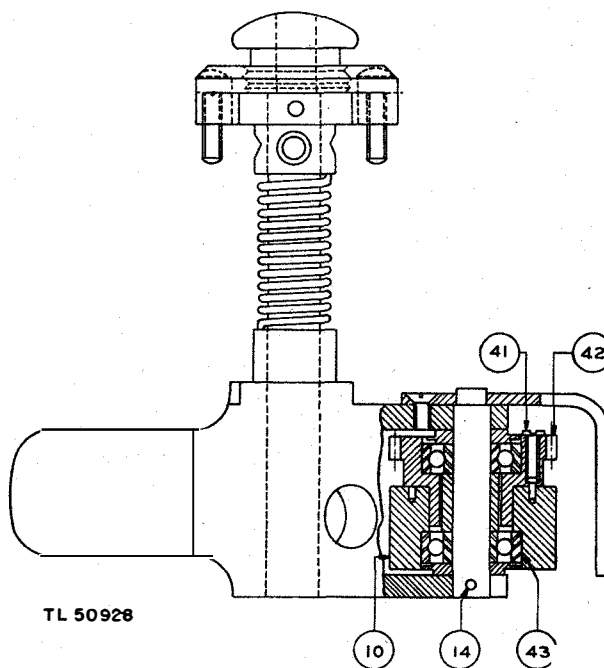


Figure 28. Keying head call-letter drum lever assembly.

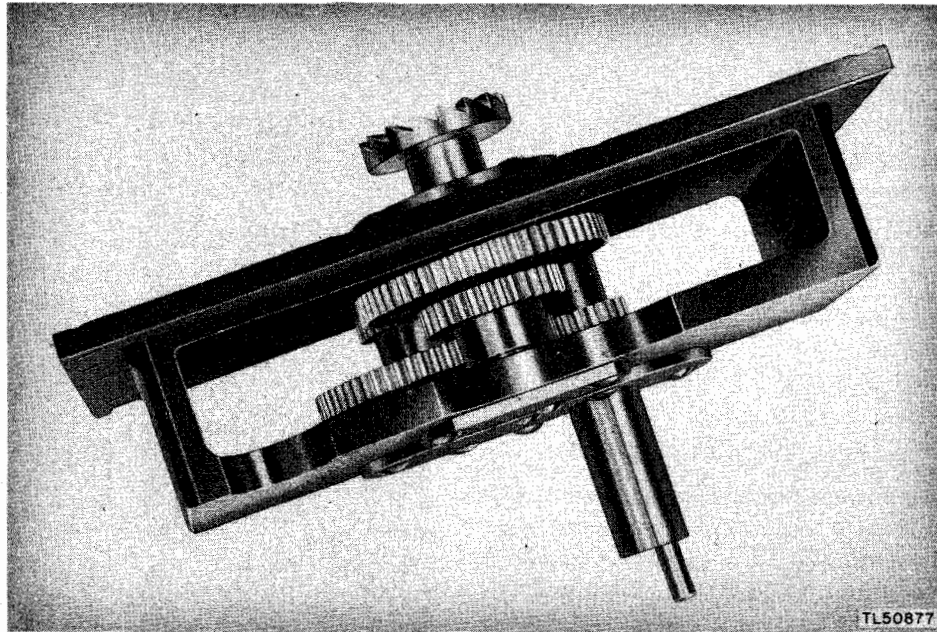


Figure 29. Internal view of gear train of keying head.

shaft. The other bearing can then be carefully pressed out if necessary.

#### 24. REMOVAL OF GEARS AND BEARINGS FROM MAIN HOUSING.

a. To remove gear 17 and bearings 20 (fig. 25) located in the main housing, remove the lever housing on the front of the keying head by removing the four screws (13) and pulling the lever housing forward.

b. Drive out the pin (19) holding the spur gear (17) to the tape feed wheel shaft (18). Remove the three screws (12) and pull the feed wheel shaft bearing housing (11) away from the main housing (fig. 25).

c. Tap the end of the feed wheel shaft (18) with a chunk of lead or babbitt, a wooden block, or similar soft object (*not* iron or steel) to loosen the bearings (20) and the bearing spacers (21 and 22) from the feed wheel shaft bearing housing. Tap the shaft on the opposite end to separate the shaft from the spacers and inner bearing.

d. Do not drive out the pin holding the tape feed wheel to the feed shaft and do not slide the feed wheel off the shaft unless it is necessary to install a new feed

wheel at the same time the bearings are examined or replaced. Be careful not to bend the feed shaft.

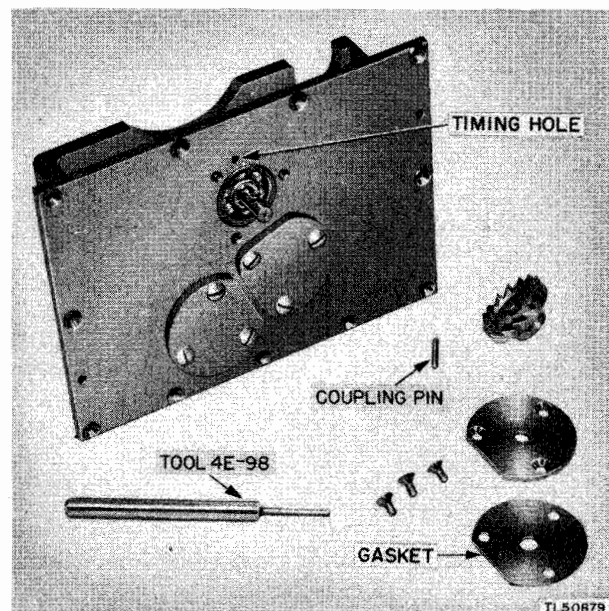


Figure 30. Disassembly of keying head gear train and mounting plate necessary for proper timing of keying head.

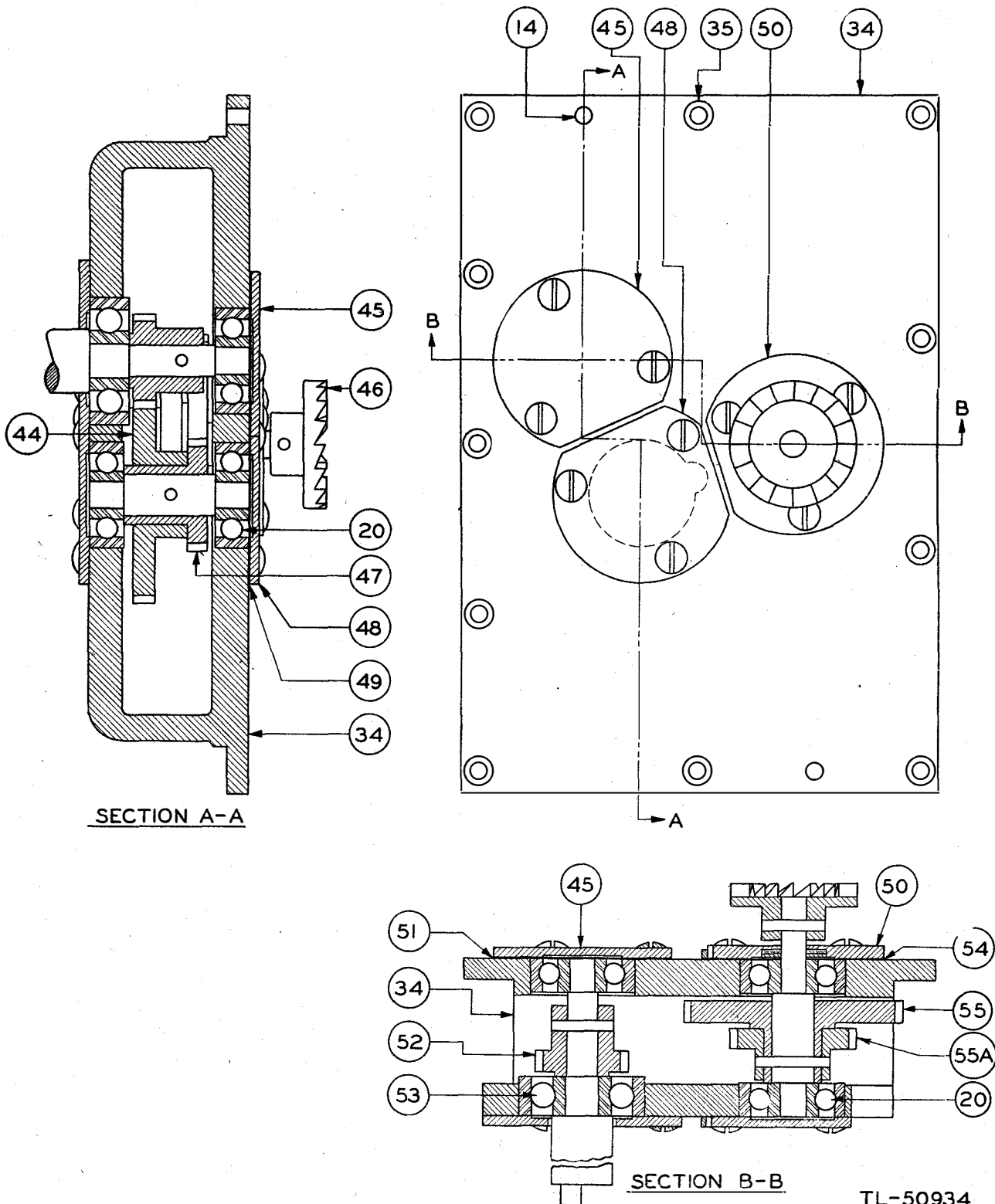


Figure 31. Keying head gear bracket assembly.

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**25. REASSEMBLY OF TAPE FEED SHAFT AND BEARINGS IN MAIN HOUSING.**

a. Press the inner feed shaft bearing and the larger of the bearing separators into the feed shaft bearing

housing. Insert the tape feed shaft through the bearing housing and through the inner bearing hub. Place the smaller bearing spacer on the feed shaft and press the outer bearing into the end of the housing. Place the



back of the bearing housing (mounting flange down) on two parallel blocks sufficiently high to prevent the tape feed wheel from hitting the bench or work table. Hold the feed wheel end of the tape feed shaft with one hand, and tap the other end very lightly until the end of the shaft is flush with the side of the outer bearing. Continue to hold the tape feed shaft to prevent it from completely dropping out, and tap the outer bearing hub until the outside edge of the bearing is flush with the outside of the bearing housing. A block of wood placed across the side of the bearing will prevent damage to the bearing. When the outer bearing has been tapped in flush with the housing, turn the entire housing and shaft over, and place them on the parallel wooden blocks. Separate the blocks just enough to let the feed shaft go between them. Tap the feed wheel end of the shaft until the offset in the shaft is flush against the hub of the inner bearing. Check to see that the outer bearing is still flush with the edge of the housing.

b. Insert the tape feed shaft bearing housing (11) part way into the main housing of the keying head. Place gear 17 inside the main housing and line up the hub with the feed shaft. Push the shaft through the hub until the pin holes line up; then tap the pin through the hub and shaft. Insert the bearing housing the rest of the way into the main housing and line up the screw holes. Insert and tighten the three retaining screws (12).

## 26. REASSEMBLY OF KEYING HEAD GEAR BRACKET.

a. If the bearings (20) on the inner side of the gear bracket have been removed, replace them. Mount the bearing covers and tighten the screws. Leave off the front bearing covers (45 and 48, fig. 31) and also the ball bearings under them, so that the timing marks on the gears may be seen when the gears are installed.

b. Hold gears 44 and 47 hub to hub. Push the hub of gear 47 through the hub of gear 44 until the pin holes line up.

c. Insert the aligned gears (44 and 47) into the gear bracket, and hold in their approximate position with one hand while the gear shaft is slipped through the gears and into the back bearing hub.

d. Hold the hub of gear 55 opposite the back of gear 55A. Press the gears together until the pin holes line up.

e. Insert the aligned gears (55 and 55A) into the gear bracket. Line up the timing mark on one of the gears being installed with the timing mark on the gear installed according to the procedure in subparagraph c

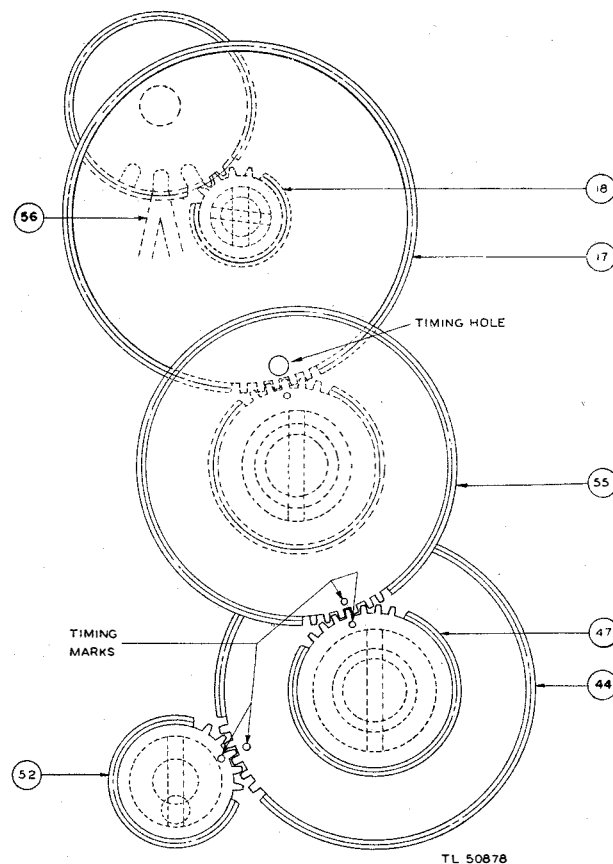


Figure 32. Keying head gear train timing diagram.

above. Hold the gears in mesh while the gear shaft is slipped through the gears and into the hub of the back bearing. Check to see that the timing marks are still in the proper relationship. If not, pull one of the gear shafts out just enough to clear the hub of the back bearing. Reposition the teeth and push the gear shaft back into the bearing hub. Recheck position of timing marks.

f. Insert the eccentric shaft complete with its bearing (53) and gear (52) into the gear bracket. Line up the timing marks on gears 44 and 52 before pressing the bearing (53) fully into place, thus bringing the gears into mesh. Check to see that the timing marks are still in the correct relationship. If not, slip the eccentric shaft back out of the gear bracket until the gears are out of mesh. Turn each gear as required to line up the timing marks; press the eccentric shaft and bearing all the way into position. Recheck the timing marks and mount the eccentric shaft back bearing cover.

g. Hold the gear train with one hand, and with the other turn each of the gear shafts until the pin hole in the shaft lines up with the hole in the gear hub. Insert the pins just enough to keep the holes aligned. Do NOT drive the pins in all the way at this time.

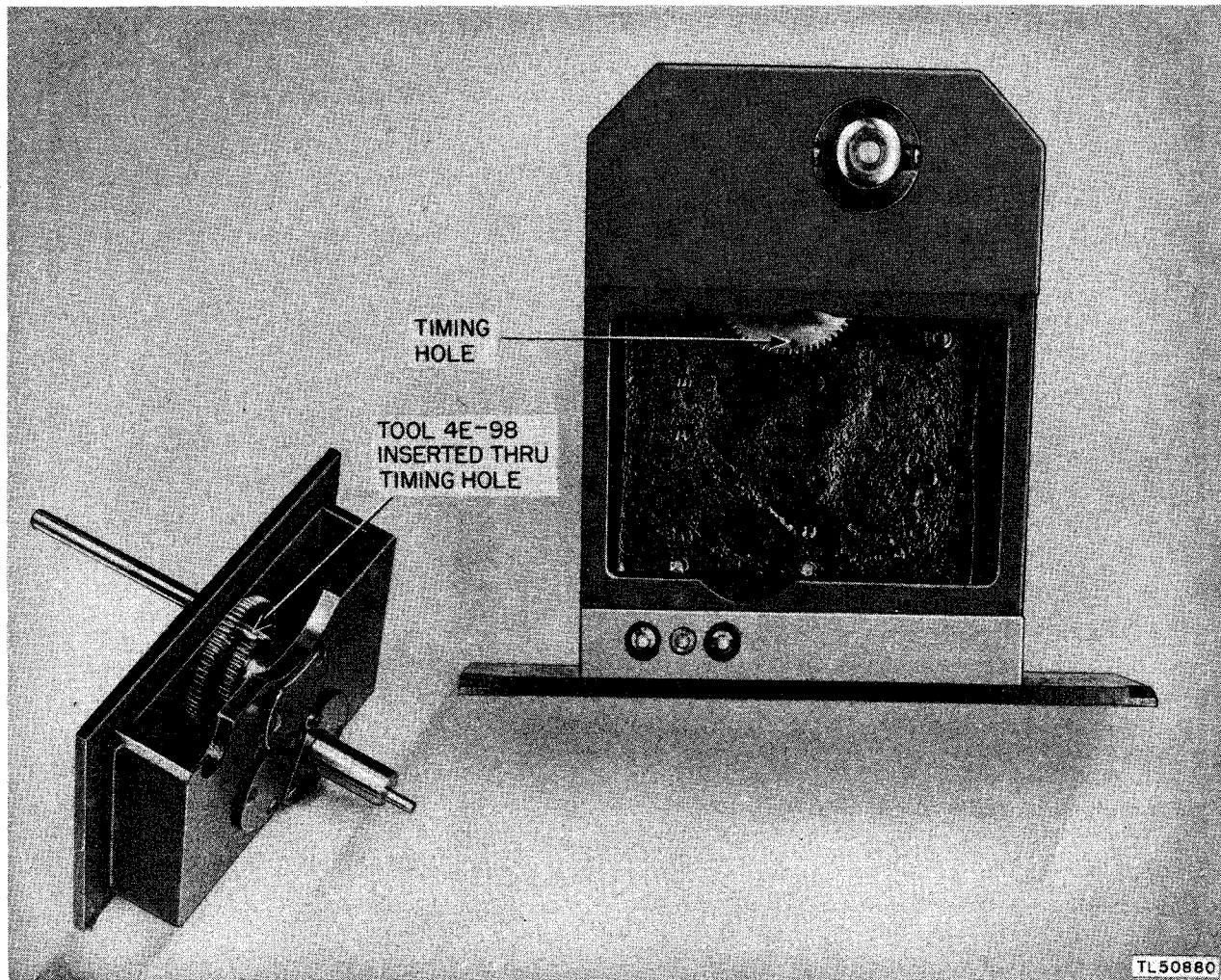


Figure 33. Use of punch (4E-98) in timing of keying head.

**CAUTION:** DRIVING PINS INTO THE GEAR HUBS AND SHAFTS BEFORE THE FRONT BEARINGS ARE IN PLACE MAY BEND THE GEAR SHAFTS.

*h.* Place the front ball bearings on all three gear shafts and press into place. Mount the two front bearing covers not having a center hole. Do *not* mount the cover (50) which has a center hole.

*i.* Drive the pins into the gear hubs to fasten the gears securely to the shafts.

#### 27. REMOUNTING GEAR BRACKET ON KEYING HEAD MAIN HOUSING.

*a.* Insert punch 4E-98 through the timing hole in the face of the gear bracket (fig. 30) and through the timing hole in gear 55. Turn gear 17 in the main housing with the fingers until its timing hole is centered in the opening.

*b.* If the front cover assembly has not been removed so that the eccentric block can be moved with the fingers as the eccentric shaft is passed through the housing, proceed as follows:

(1) Place the keying head housing face down on the bench or work table with the opening for the gear bracket *up*. Place a small block of wood under the top of the housing to level the housing.

(2) Insert a screwdriver through the hole in the housing wall and move the rocker arm until it is in its center position. Then move the eccentric block with the screwdriver until the top edge of the hole in the block coincides with a horizontal line through the center of the hole in the housing wall. Pick up the gear bracket with punch 4E-98 inserted through the timing hole. Very carefully lower the gear bracket into the main housing so as not to disturb the settings of the rocker arm and the eccentric block. If the hole in the eccentric block is

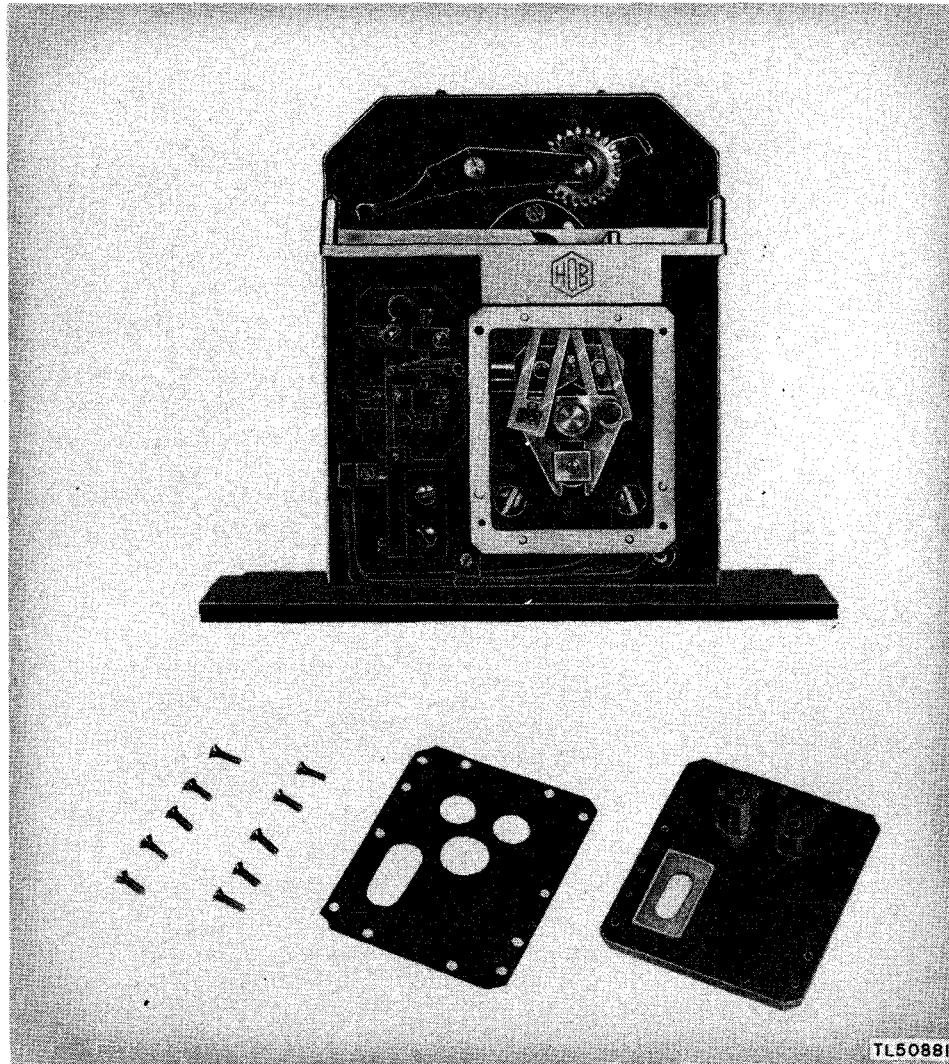


Figure 34. Disassembly of front section of keying head.

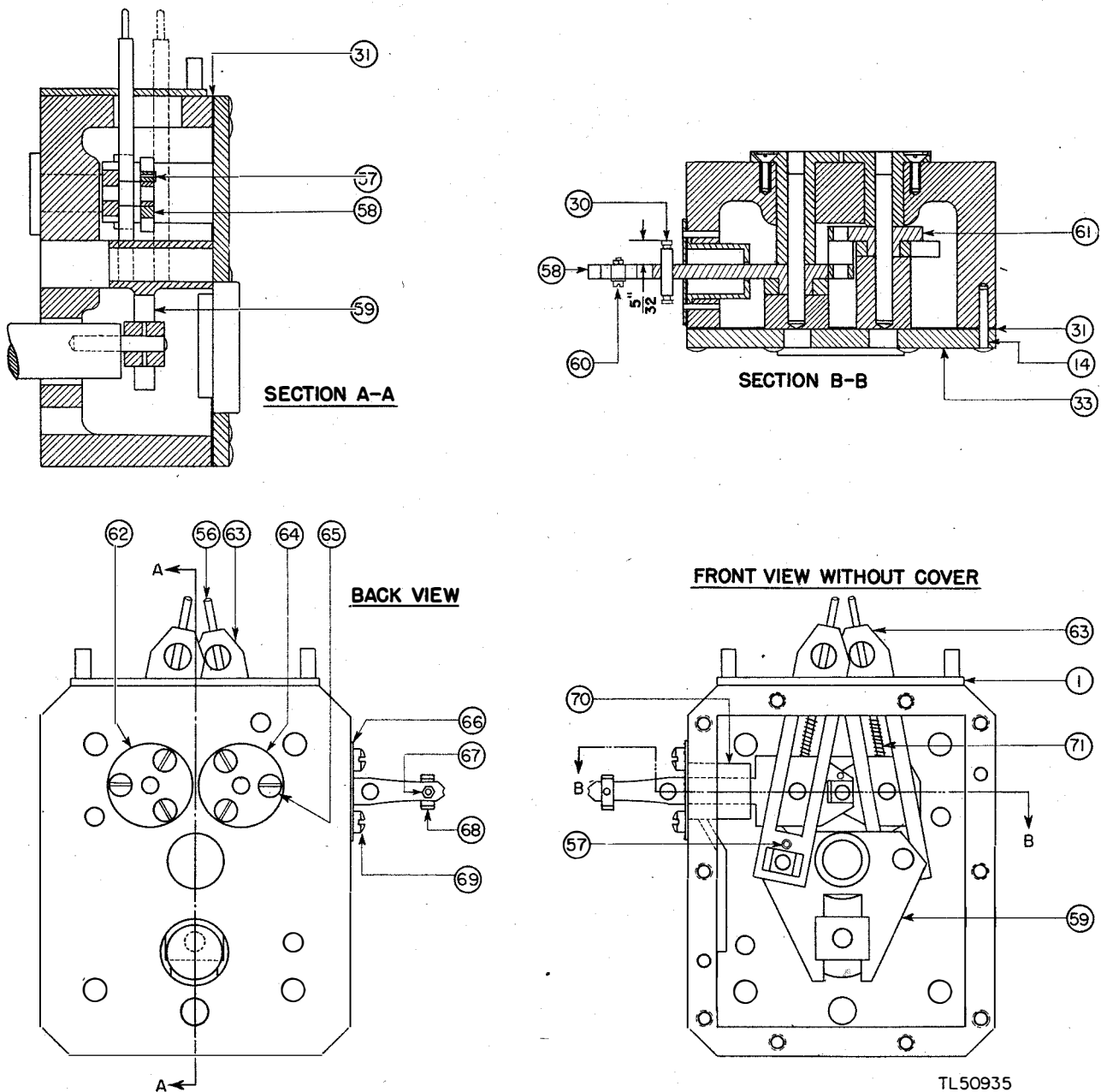
not exactly in line with the eccentric shaft, it will be necessary to wiggle the entire gear bracket very gently until the eccentric shaft enters the eccentric block.

**CAUTION:** EXCESSIVE WIGGLING OR SHAKING OF THE GEAR BRACKET MAY MOVE THE ECCENTRIC BLOCK SO FAR TOWARD THE TOP OR BOTTOM OF THE ROCKER ARM THAT THE ECCENTRIC SHAFT COMPLETELY MISSES THE HOLE IN THE ECCENTRIC BLOCK. THIS CONDITION WILL BE INDICATED BY THE FACT THAT THE GEAR TRAIN WILL NOT REVOLVE WHEN THE PUNCH (4E-98) IS REMOVED FROM THE TIMING HOLE. REMOVE GEAR BRACKET AND RELOCATE THE ECCENTRIC

BLOCK. REPEAT PROCEDURE GIVEN IN SUBPARAGRAPH *b* (2) ABOVE.

c. If the front cover assembly has been removed, the main housing need not be laid on its face and leveled, since the eccentric block can be moved with the fingers as the eccentric shaft is passed through the hole in the main housing. Insert the protruding end of the punch into the timing hole in gear 17, and push the gear bracket into place in the main housing. This procedure places the gears in the gear bracket in the proper relationship to the gears in the main housing (figs. 31 and 32). Figure 33 shows punch 4E-98 being used for lining up the gears.

d. After the gear bracket has been screwed in place, remove the locating punch. Replace the ball bearing cover, the gasket, and the saw-tooth coupling. Pin the coupling to the shaft.



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Figure 35. Keying head lever housing assembly.

**28. KEYING HEAD LEVER HOUSING** (figs. 25, 26, 27, and 35).

**a. Selector Pins.** To remove and replace the selector pins (56), proceed as follows:

- (1) Drain the oil from the keying head by removing the oil drain screw (37).
- (2) Take out the two screws (39) and remove the tape bridge (3) by lifting it straight up.

- (3) Remove the lever housing top plate (1) with extreme care to prevent bending the locating pins (14).
- (4) Remove the 10 screws (16) holding the front cover assembly (33). Tap the edge of the cover with a chunk of lead or babbitt, a brass block, or similar tool, to loosen it, and remove the cover by prying it off with a knife blade from all sides. Be careful not to bend the locating pins (14).

- (5) Turn the saw-tooth coupling to bring the spacing (front) selector pin lever (63) to its highest position.

Remove the complete lever by pulling it forward until it is clear of its support.

**CAUTION: BE CAREFUL TO CLEAR THE SPRING FROM THE HOLE IN THE CONTACT LEVER (58).**

(6) Remove the rocker arm (59) by pulling it forward. Remove the marking (rear) selector pin lever (63) by turning the saw-tooth coupling to bring the lever to its highest position and pulling the lever forward and down.

(7) The selector pins (56) can now be removed from the levers.

(8) To reassemble, reverse the steps in subparagraphs (1) to (7) above. Be careful when putting the levers back on their supports not to damage the springs (71).

**NOTE: NOTICE THAT THE RETAINING PIN (57) FACES THE BACK OF THE HOUSING ON THE REAR (INTERLINK) LEVER AND FACES THE FRONT ON THE FORWARD (CONTACT) LEVER.**

**b. Contact Lever and Interlink Lever.** To replace the contact lever (58) and the interlink lever (61), proceed as for replacing the selector pins. In addition, the lever housing must be taken off the main housing as follows:

(1) Remove the four screws (13) and pull the lever housing forward.

(2) Remove the tongue contact lock nut (67), the tongue contact screw (60), and the tongue contact (68) from the contact lever (58).

(3) Carefully push out the toggle lever spring pin (30).

(4) Remove the oil retainer (70) by taking out the four screws (69) and pushing the retainer from the inside of the lever housing. Slip the retainer off the contact lever.

(5) Remove the six screws (65) holding the stud bearings (62 and 64). Remove the two stud bearings from the rear of the lever housing.

(6) Remove the contact lever and the interlink lever.

(7) After installing new contact levers and interlink levers, replace the lever housing by reversing the steps in subparagraph (1) to (5) above.

## 29. LUBRICATION AND CLEANING OF KEYING HEAD.

After each 500 hours of operation, clean the keying head thoroughly, drain out the old oil, and refill with new oil. Proceed as follows:

**a.** Remove the tape bridge (3, fig. 25) and clean out any dust and paper lint which has accumulated under the bridge. Use carbon tetrachloride, gasoline, or naphtha for this purpose.

**CAUTION: DO NOT USE A CLEANER WHICH HAS AN ALCOHOL BASE.**

**b.** Remove the oil drain screw (37, fig. 26) from the bottom of the keying head and thoroughly flush out the keying head with gasoline or similar cleaner. Allow the keying head to dry out.

**c.** Replace the oil drain screw. Refill the keying head with 2 ounces of Oil, Engine, SAE 10, U. S. Army Specification 2-104B. If SAE 10 oil is too thin and leaks out excessively, use Oil, Engine, SAE 30, U. S. Army Specification 2-104B.

**d.** Put a few drops of the same oil on the front and back edges of the call-letter drum and on the selector pins before replacing the tape bridge.

## 30. ADJUSTMENT OF BOEHME RELAY IN KEYING HEAD DRIVE (fig. 36).

The total contact clearance of the Boehme (hand keying) relay (123) is set at approximately 0.020 inch before shipment. This setting is usually satisfactory and should not be changed unless unsatisfactory operation occurs. If any change in contact clearance is required, adjust as follows:

**a.** Loosen the rear relay contact adjusting screw lock nut (103) and unscrew the relay contact adjusting screw (102).

**b.** Push the center contact bar (105) as far as it can be moved toward the rear of the base, and hold it there.

**c.** Turn the rear contact adjusting screw until it barely touches the center contact. Then give the adjusting screw two or three more turns. As the contact adjusting screw presses against the center contact bar, the bar is moved slightly forward.

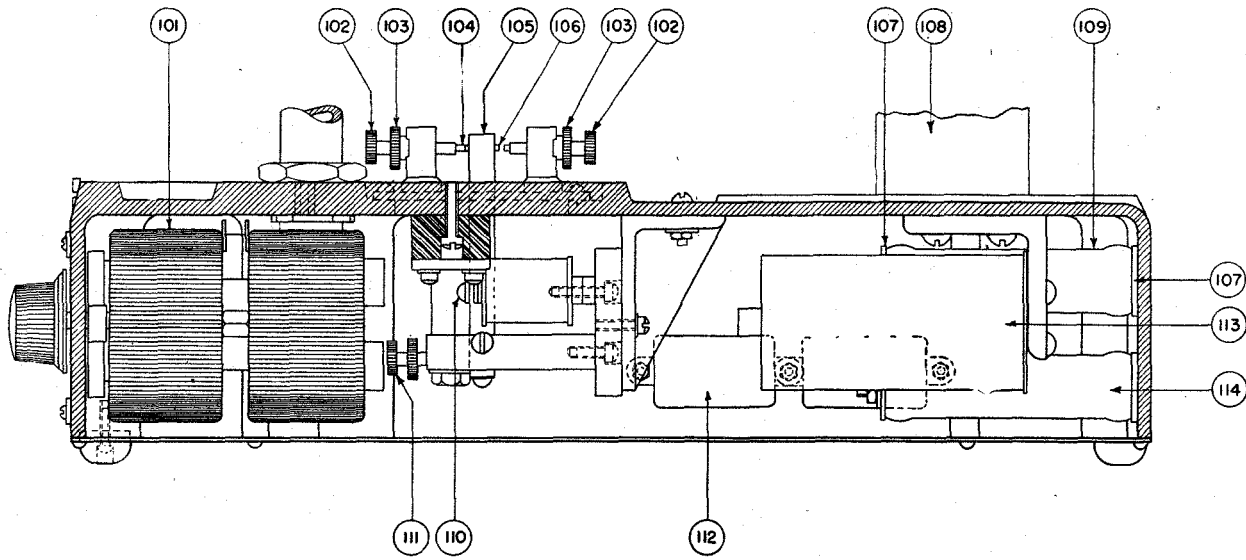
**d.** Tighten the rear adjusting screw lock nut.

**e.** Loosen the front relay contact adjusting screw lock nut (103).

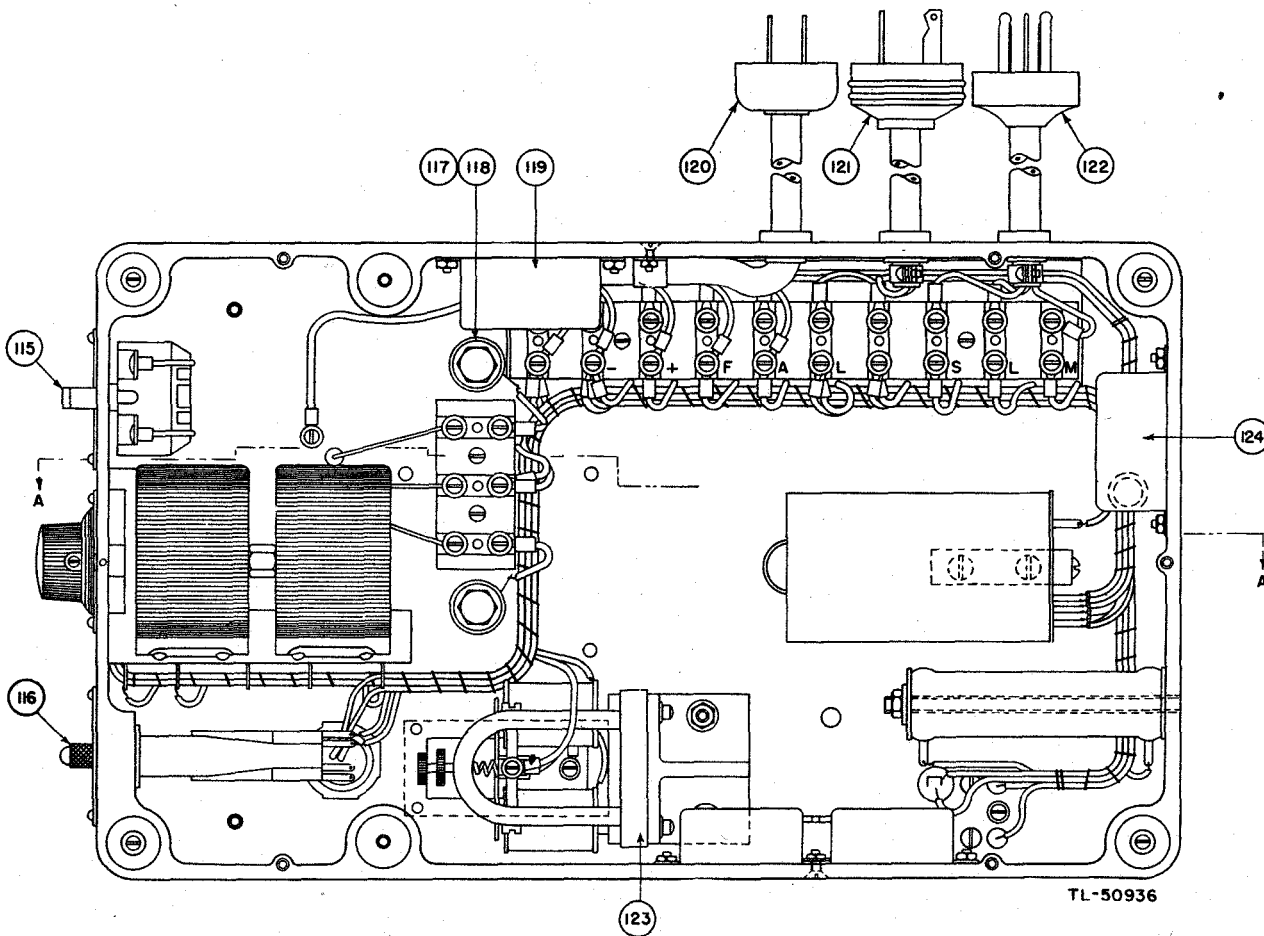
**f.** Turn the front relay contact adjusting screw so that the center contact bar is moved toward the rear contact until a gap of 0.015-0.020 inch is obtained.

**g.** Tighten the adjusting screw lock nut.

**h.** This contact setting gives the maximum spring tension for a given setting of the contact bar spring adjusting screw (111). To change the spring tension, loosen the center contact bar spring adjusting screw lock nut, turn the spring adjusting screw as required, and tighten the spring adjusting screw lock nut. If the desired tension cannot be obtained with the contact bar spring adjusting screw or if other clearance is desired, the contact setting should be shifted toward the front of the base by moving the rear relay throw adjusting screw seven or eight turns instead of two or three, and by resetting the contact clearance as described above.



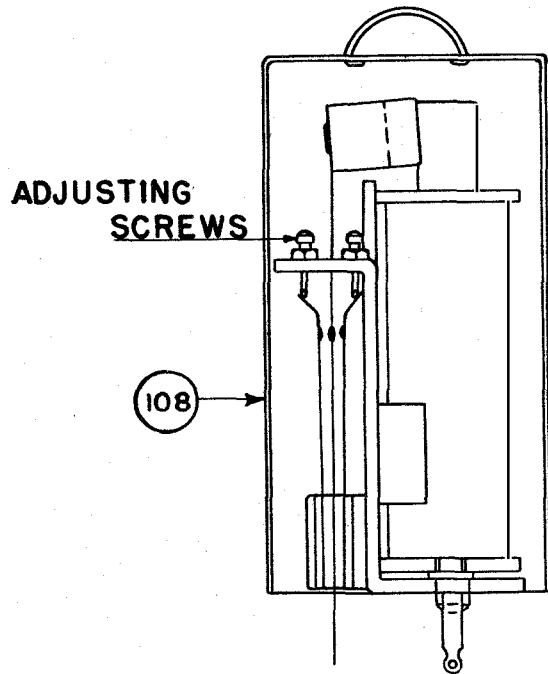
SECTION A-A



TL-50936

BOTTOM VIEW WITHOUT COVER

Figure 36. Keying head drive, base assembly.



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Figure 37. Vibrating reed relay, side of cover removed.

### 31. ADJUSTMENT OF KEYING HEAD DRIVE VIBRATING REED RELAY (fig. 37).

The vibrating reed relay (108) controls the transfer of the signal line from automatic keying to hand keying and vice versa. The time required to return the signal line to automatic keying at the end of hand keying depends upon contact separation. Wide contact separation provides quick return. Narrow contact separation provides slow return. The contact clearances are adjustable to secure an over-all time delay of between 2 and 15 seconds. The contact separation is set before shipment from the factory to provide 7 to 8 seconds delay. If a different setting is desired, adjust the contact separation as follows:

- a. Remove the relay dust cover by pulling it straight up.
- b. Loosen the two small brass nuts locking the two adjusting screws.
- c. Turn both adjusting screws clockwise to increase the contact separation and to reduce the time delay. Turn both adjusting screws counterclockwise to reduce the contact separation and to increase the time delay. Retighten the two lock nuts.
- d. Replace the dust cover.
- e. One or two adjustments may be necessary to get the required time delay.

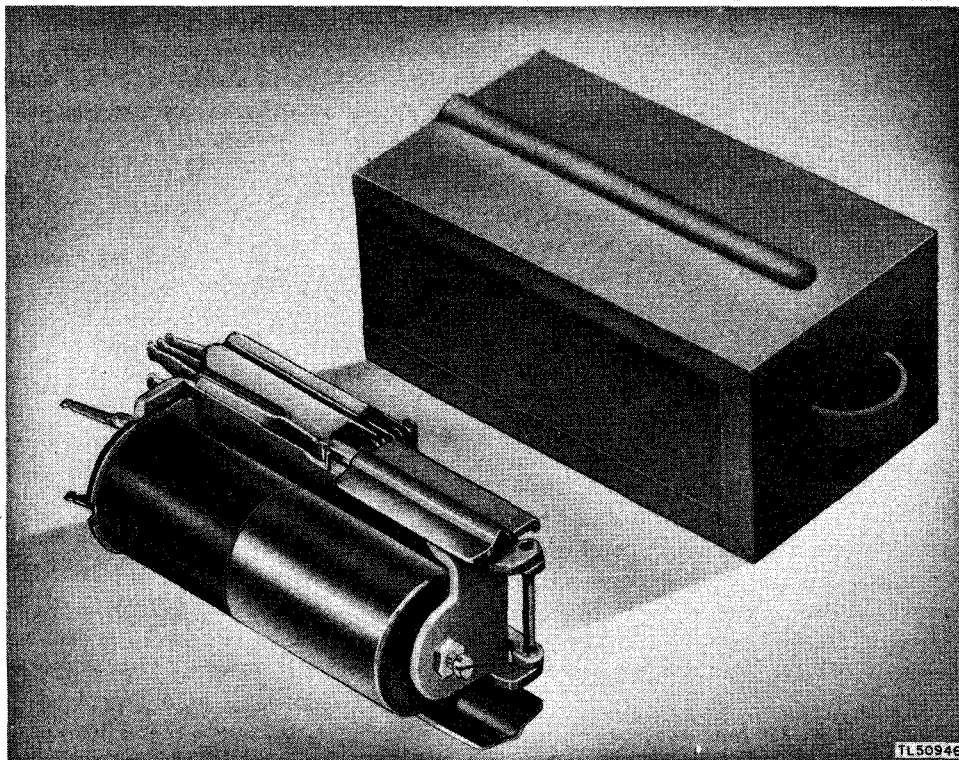


Figure 38. Slow-release relay, cover removed.

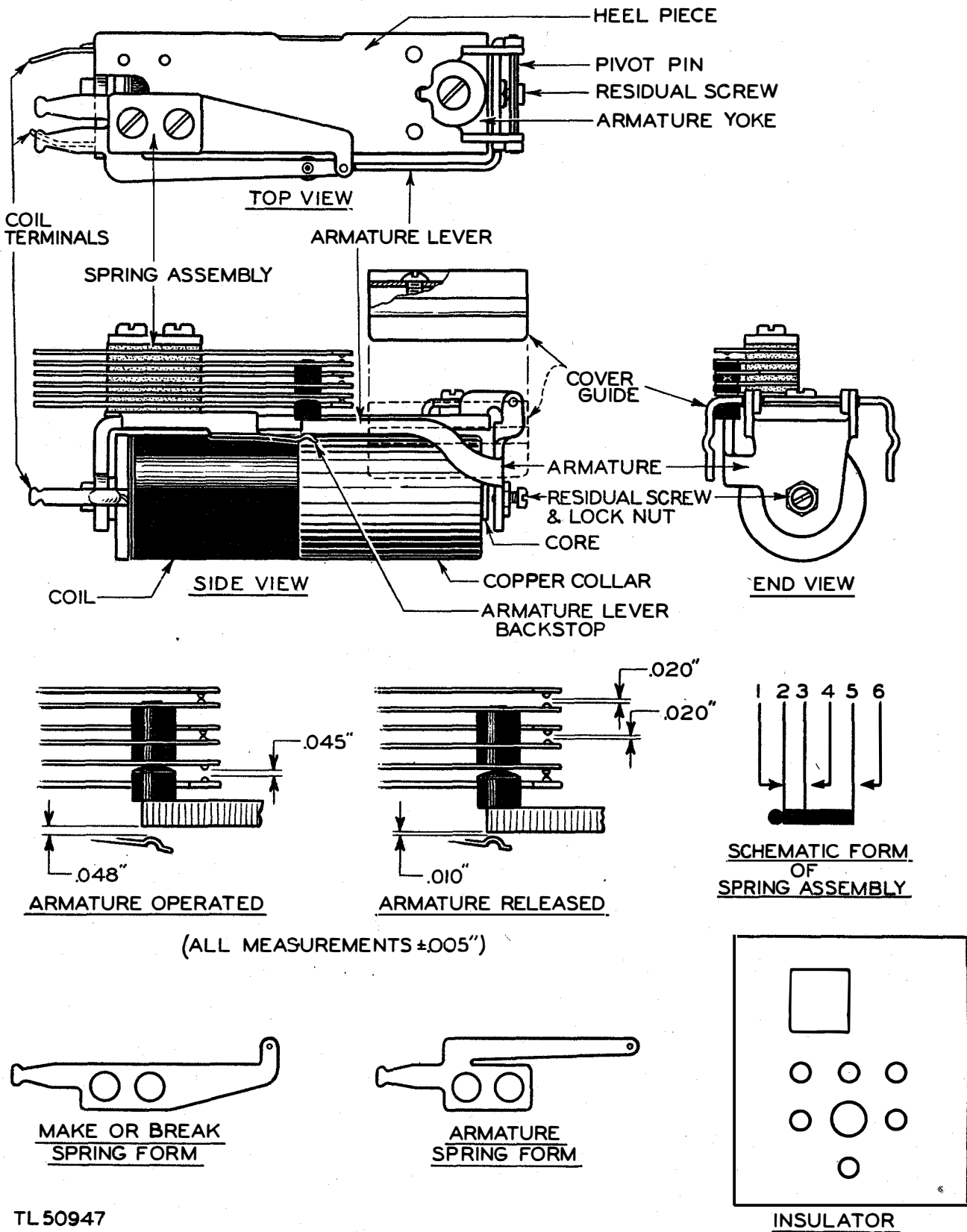


Figure 39. Mechanical requirements of slow-release relay.

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### 32. ADJUSTMENT OF SLOW-RELEASE RELAY OF KEYING HEAD DRIVE.

**a. General.** The slow-release relay (fig. 38) is adjusted prior to shipment from the factory. Generally, the slow-release relay requires very little maintenance to keep it in perfect operating condition.

**b. Requirements.** The residual screw (fig. 39) should be adjusted until the end of the screw is flush with the face of the armature nearest the core. Tighten the lock nut. The W. E. Co. number 48<sup>2</sup> switchboard tool, composed of a socket wrench and screwdriver, is designed for adjusting residual screws. The contact clearances for operated and nonoperated (released) conditions are as follows:

(1) OPERATED. With the residual screw adjusted as described in subparagraph *b* above, and with the armature fully operated, either electrically or by hand, the clearances shown in figure 39 should be obtained. Measure the clearances with a W. E. Co. number 74D<sup>3</sup> thickness gauge.

(2) NONOPERATED (RELEASED). With the armature in the nonoperated (released) position, the clearances shown in figure 39 should be obtained. Measure the clearances with a W. E. Co. number 74D<sup>3</sup> thickness gauge.

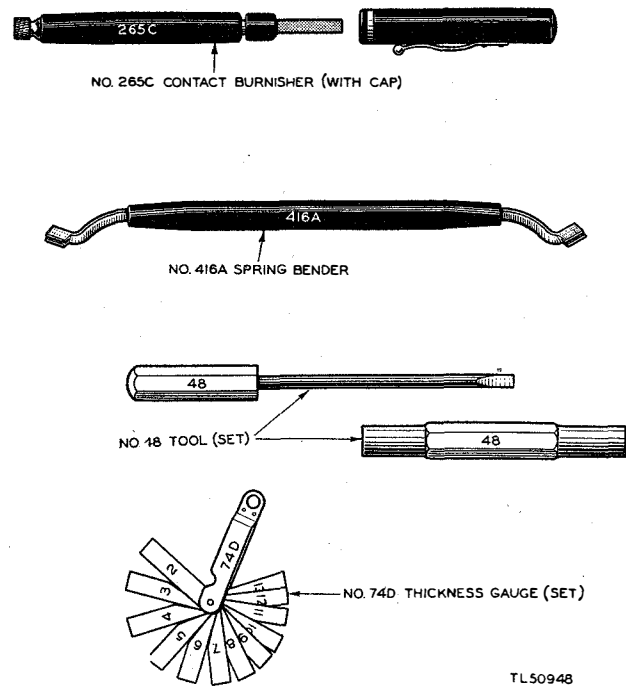
**c. Adjustments.** Bend the contact springs and armature stop as required, using a W. E. Co. number 416A spring bender<sup>4</sup>. Place the spring bender (fig. 40) on the spring to be adjusted, and slide the bender back against the spring pile-up. Avoid any sharp kinks or bends in the springs.

**d. Cleaning.** (1) Relay contacts become dirty or pitted as a result of arcing. Wash dirt from the contacts with carbon tetrachloride.

(2) Rinse the blade of the W. E. Co. number 265C burnishing tool<sup>5</sup> in carbon tetrachloride to remove any grease or dirt.

**CAUTION: DO NOT TOUCH THE CLEANED BLADE WITH THE FINGERS, BECAUSE OIL OR PERSPIRATION FROM THE HANDS WILL BE CARRIED ONTO THE RELAY CONTACTS.**

(3) Remove any contact pits by drawing the blade of the contact burnisher between the break contacts while the relay is in the nonoperated (released) position. Rinse contact burnisher in carbon tetrachloride each time it is drawn between the contacts. Operate the relay, either electrically or by hand, and draw the blade of the



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Figure 40. Tools for adjusting slow-release relay.

contact burnisher between the two make contacts. Repeat this operation if necessary.

**CAUTION: USE THE CONTACT BURNISHER ONLY WHEN ABSOLUTELY NECESSARY, BECAUSE EXCESSIVE USE SHORTENS THE LIFE OF THE RELAY.**

(4) Dust and gum frequently collect between the relay armature and the core. To clean, insert a small strip of high grade *bond* paper between the core and the armature. Hold the armature in the operated position with one hand, and draw out the strip of paper with the other hand. Examine the strip of paper, and if it is soiled, repeat with a clean strip until the paper comes out clean.

**e. Emergency Tools.** The tools described in subparagraphs *a*, *b*, *c*, and *d* above, or their equivalents, are the tools recommended for adjusting the slow-release relay. When an emergency adjustment must be made and these tools are *not* available, a pair of narrow, long-nosed pliers may be used to bend the contact springs. If a contact burnisher is not available, contacts may be cleaned with a small strip of *bond* paper. *Never use fibrous*

<sup>2</sup> Catalog nomenclature: TOOL, switchboard, W. E. Co. #48. Signal Corps stock numbers for parts are: Wrench, socket, 6R40848; screwdriver, 6R40848/1.

<sup>3</sup> Catalog nomenclature: TOOL, switchboard, W. E. Co. #74D, gauge set. Signal Corps stock number: 6R40874D.

<sup>4</sup> Catalog nomenclature: TOOL, switchboard, W. E. Co. #416A, spring bender. Signal Corps stock number: 6R41216A.

<sup>5</sup> Catalog nomenclature: TOOL, switchboard, W. E. Co. #265C, contact burnisher. Signal Corps stock number: 6R41065C.

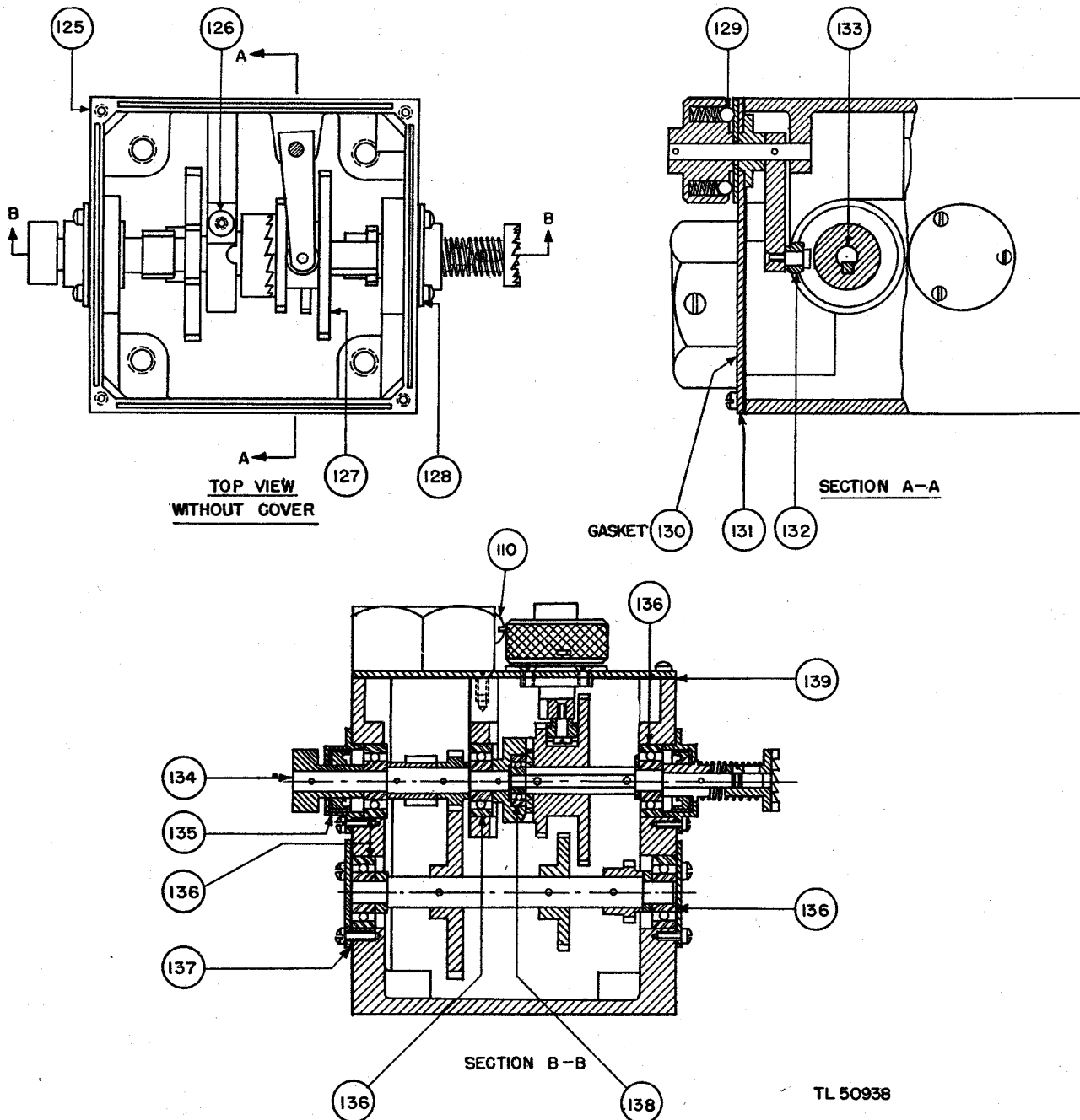


Figure 41. Gear box assembly of keying head drive.

*paper to clean relay contacts.* If contacts are cleaned with ordinary paper, the small paper fibers tend to stick to the contacts and cause them to become dirty again.

### 33. KEYING HEAD DRIVE GEAR BOX ADJUSTMENTS.

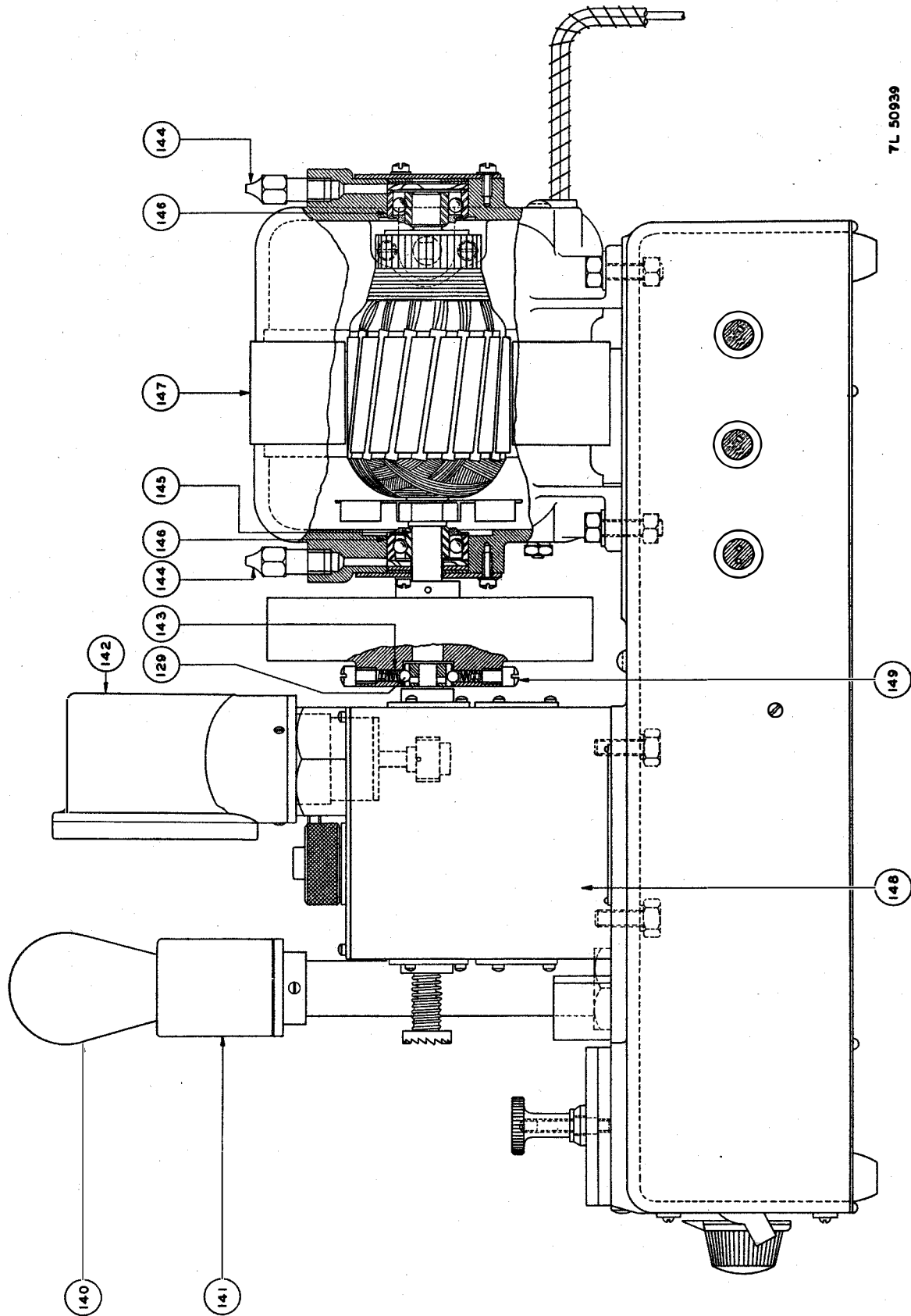
When removing or replacing any of the parts in the gear box (148), the following precautions must be taken:

- a. When removing gears, drive out all the pins on

the shaft that hold the gears. Be extremely careful not to bend the shaft.

- b. Remove the ball bearing covers and pull out the shaft. Be careful that the gears do not butt against any other part in the gear box hard enough to damage the gears.

- c. When replacing the gear box cover (131), be sure that the roller (132) rests in the groove of the transmission coupling gear (127).



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Figure 42. Keying head drive, general assembly, side view.

d. If the oil seals (135) for shafts 133 and 134 are removed, replace them with the hollow sides of the seals toward the inside of the gear box.

e. If the safety clutch (fig. 42) between the flywheel and the gear box refuses to hold under normal load, remove the flywheel screws (149), and the balls and springs (129 and 143), and examine the latter to see that they are in good condition. Replace with new balls and springs if necessary.

### 34. LUBRICATION OF KEYING HEAD DRIVE.

a. **Gear Box.** After every 6 months of continuous operation, clean the gear box and refill it with 6 ounces of Oil, Engine, SAE 50, U. S. Army Specification 2-104B. To do so, loosen screw 110 (fig. 41) and remove the transmitting speed indicator (142). Turn the keying head drive upside down and drain thoroughly. Rinse with gasoline or similar cleaner and let the gear box dry before filling it with new oil. If oil leaks occur, make the necessary repairs immediately and check the amount of oil remaining in the gear box. Refill if necessary, as explained above. When replacing the cover, be sure that the roller (132) rests in the groove of the transmission coupling gear (127).

b. **Motor.** Grease the motor bearings (145) after every 250 hours of continuous operation by inserting a light grease through the two *alemite* fittings (144) provided for this purpose. Either of two greases may be used: Grease, Lubricating, Special, Specification AXS-

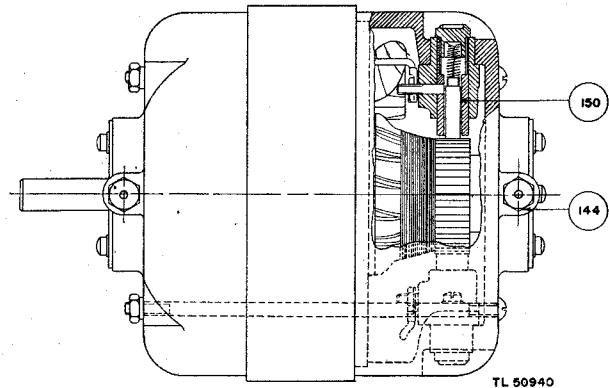


Figure 43. Keying head drive motor.

637; or Grease, Teletypewriter, KS-7471 (Signal Corps stock No. 6G-650, 1-pound container). In some localities Grease, Teletypewriter, KS-7471, is available in 4-ounce tubes (Signal Corps stock No. 4T97116).

**CAUTION: DO NOT USE OIL. DO NOT APPLY TOO MUCH GREASE, ESPECIALLY AT THE FLYWHEEL END OF THE MOTOR.**

### 35. MOISTUREPROOFING AND FUNGIPROOFING OF KEYING EQUIPMENT.

Instructions and a list of the materials for moistureproofing and fungiproofing Boehme automatic keying equipment will be furnished in the form of a technical bulletin as soon as the information is available.

## SECTION V SUPPLEMENTARY DATA

### 36. SPECIAL OPERATOR'S TABLE FOR KEYING EQUIPMENT.

Several forms of special tables for keying equipment are in use in various localities. Since these tables are pro-

cured separately to meet special requirements, they have been omitted from this technical manual. However, a wiring diagram of a typical operator's table for Boehme automatic keying equipment is shown in figure 44.

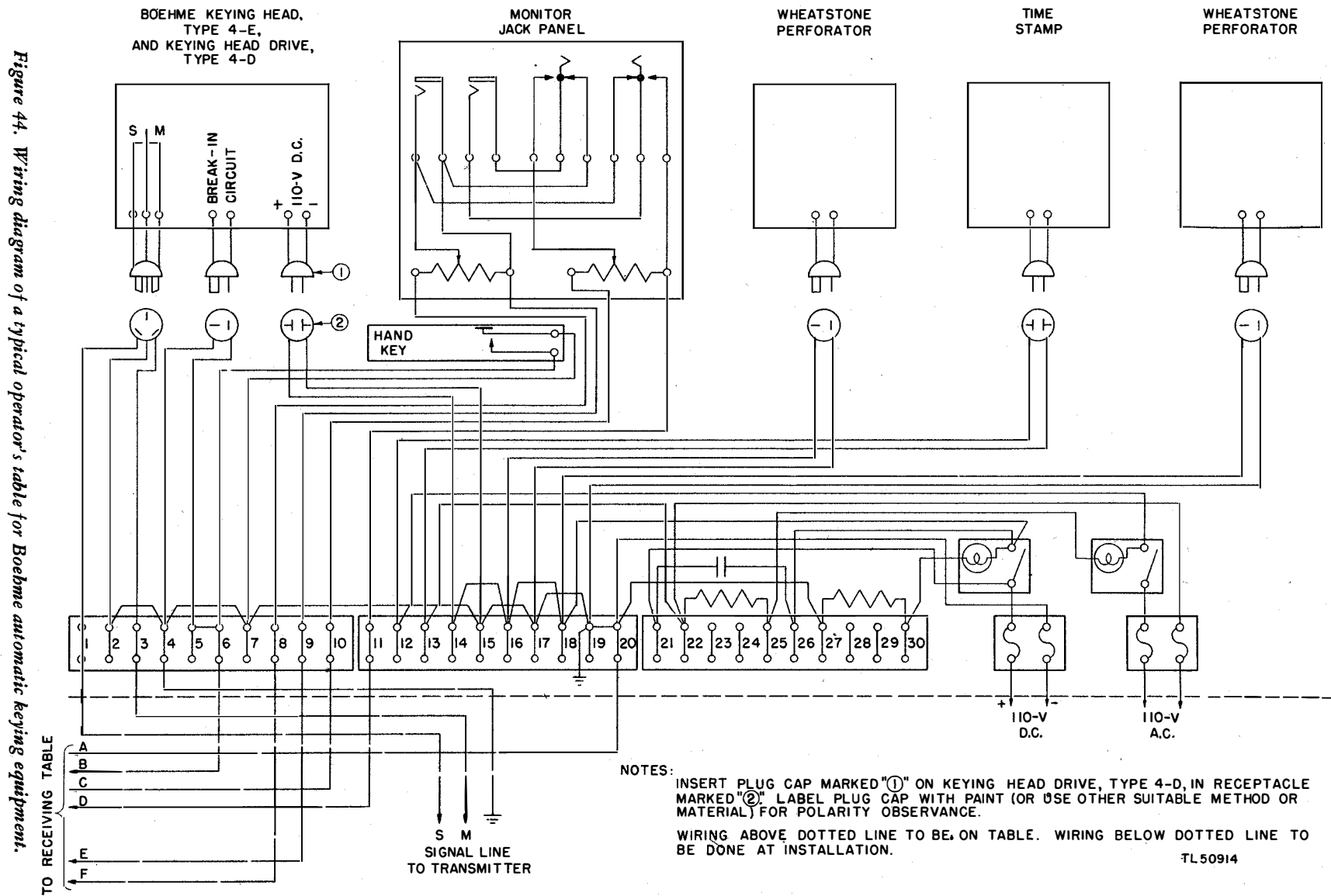


Figure 44. Wiring diagram of a typical operator's table for Boehme automatic keying equipment.

**37. MAINTENANCE PARTS LIST FOR  
KEYING HEAD, TYPE 4-E.**

The following list contains only those parts contained

in the maintenance list compiled by the Signal Corps Plant Engineering Agency. Parts referred to in the text but not included in the list are not stocked and should not be ordered.

**NOTE: ORDER MAINTENANCE PARTS BY STOCK NUMBER, NAME, AND DESCRIPTION.**

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A1245	KEYING HEAD: 4-E.	1		*
36	4A1245/D	BASE CONTACT: assembly; (Boehme #4E-D).	2		*
43	4A1245/124	BEARING: ball; (Boehme #4E-124; New Departure #F-3).	2	*	
20	4A1245/125	BEARING: ball; (Boehme #4E-125; Norma Hoffmann #C-94).	2	*	
53	4A1245/126	BEARING: ball; (Boehme #4E-126; New Departure #35; Norma Hoffman #C-95).	1	*	
27	4A1245/60	CONTACT POINT: for ref. 5, contact screw assembly; (Boehme #4E-60).	2	*	
5	4A1245/H	CONTACT SCREW: assembly; (Boehme #4E-H).	2		*
46	4A1245/14	COUPLING: saw-tooth; (Boehme #4E-14).	1		*
49	4A1245/90	GASKET: ball-bearing cover; vellumoid; (Boehme #4E-90).	1	*	
51	4A1245/91	GASKET: ball-bearing cover; vellumoid; (Boehme #4E-91).	1	*	
54	4A1245/92	GASKET: ball-bearing cover; vellumoid; (Boehme #4E-92).	1	*	
31	4A1245/84	GASKET: front cover; vellumoid; (Boehme #4E-84).	1	*	
23	4A1245/95	GASKET: gear bracket; vellumoid; (Boehme #4E-95).	1	*	
40	4A1245/96	GASKET: lever housing; vellumoid; (Boehme #4E-96).	1	*	
28	4A1245/94	GASKET: star wheel housing; vellumoid; (Boehme #4E-94).	1	*	
15	4A1245/76	INDICATOR: oil level; glass; square; (Boehme #4E-76).	1	*	
15A	4A1245/177	INDICATOR: oil level; glass; round; (Boehme #4E-177; Bijur #B-4900).	1	*	
78	4A1245/P1	PACKET: small parts, consisting of lock-washers & misc. screws.	1	*	
56	4A1245/42	PIN: selector; drill rod; (Boehme #4E-42).	2	*	
38	4A1245/135	SCREW: machine; fillister head, brass; #14-24 x 3/8"; (Boehme #4E-135).	1	*	
32	4A1242/36	SPRING: bias; plate contact; music wire; (Boehme #2E-36).	1	*	
71	4A1245/43	SPRING: selector pin; hard; music wire; (Boehme #4E-43).	2	*	
68	4A1245/49	TONGUE CONTACT: cold-rolled steel & tungsten carbide; (Boehme #4E-49).	1	*	
		TOOLS			
72	4A1242/95	BIAS KEY: (Boehme #2E-95).	1	*	
73	4A1245/93	GAUGE: feeler; (Boehme #4E-93).	1	*	
74	4A1245/98	PUNCH: (Boehme #4E-98).	1	*	
75	4A1245/99	TOMMY BAR: (Boehme #4E-99).	1	*	
76	4A1245/97	WRENCH: contact screw; (Boehme #4E-97).	1	*	
77	4A1245/100	WRENCH: spring tension; (Boehme #4E-100).	1	*	

\* Indicates maintenance part available in station or region stock.

**38. MAINTENANCE PARTS LIST FOR KEYING  
HEAD DRIVE, TYPE 4-D.**

The following list contains only those parts contained

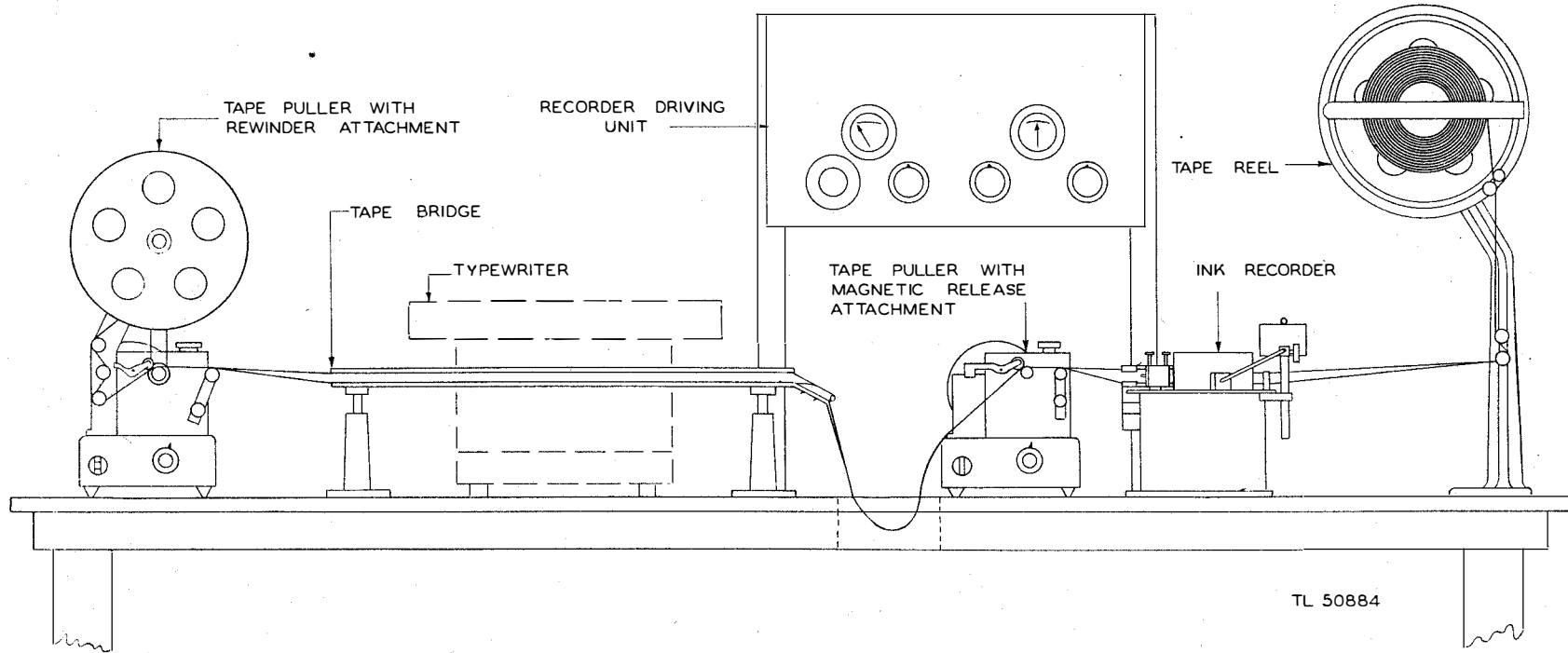
in the maintenance list compiled by the Signal Corps Plant Engineering Agency. Parts referred to in the text but not included in the list are not stocked and should not be ordered.

NOTE: ORDER MAINTENANCE PARTS BY STOCK NUMBER, NAME, AND DESCRIPTION.

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A564	KEYING HEAD DRIVE: includes base, driving motor, #4-DB automatic hand key break-in, and one spare set of motor brushes; (Boehme #4-D).	1		*
146	4A564/300G	ARMATURE: motor; (Boehme #4D-300G for G.E. motor model #5BC36A16).	1		*
136	4A564/147	BEARING: ball; (Boehme #4D-147; New Departure #37; Norma Hoffman #C97; SKF 37; Federal #9433).	5	*	
138	4A564/148	BEARING: ball; (Boehme #4D-148; New Departure #34; Norma Hoffman #94; SKF 34; Federal #9430).	1		*
145	4A564/310	BEARING: ball; (Boehme #4D-310; New Departure #8501).	2	*	
125	4A564/2	BOX: gear; (Boehme #4D-2, brass casting).	1		*
150	4A564.3/300D	BRUSH: motor; carbon; with spring; (Boehme #4D-300D).	2	*	
112	3DA500-97	CAPACITOR: paper; 0.5 $\mu$ f; 600-v dc (working); fixed; oil-filled; rectangular metal case; (Boehme #4D-158; Dubilier #DY-6050).	2	*	
119	4A564/162	FILTER ASSEMBLY: motor and line interference limiting; (Boehme #4D-162).	1		*
124	4A564/163	FILTER ASSEMBLY: spark suppressor; relay contact; (Boehme #4D-163).	1		*
137	4A564/119	GASKET: bearing cover; vellumoid; (Boehme #4D-119).	2	*	
128	4A564/120	GASKET: seal cover; vellumoid; (Boehme #4D-120).	2	*	
126	4A564/103	GASKET: vellumoid; (Boehme #4D-103).	1	*	
130	4A564/104	GASKET: collar; vellumoid; (Boehme #4D-104).	1	*	
139	4A2764/32	GASKET: cover; gear box; vellumoid; (Boehme #4F-32).	1	*	
116	4C5104.79K	KEY: switchboard; used as automatic or hand key switch; (Boehme #4D-97; W.E. #479K).	1		*
140	6Z6810-7.5	LAMP: red; 7½-w, 110-120-v; (Boehme #4D-167; Mazda #G-11).	1	*	
147	4A564/MA	MOTOR: keying head power; 1/12-hp; 1,140 rpm; 115-v dc; compound wound; (Boehme #4D-MA; G.E. model #5BC36A16).	1		*
151	4A564/P	PACKET: small parts, consisting of screws, nuts, pins, and washers.	1	*	
104	4A564/79	PIN: relay stationary contact; silver; (Boehme #4D-79).	2	*	
121	4A564/130	PLUG: polarized; 2-conductor; (Boehme #4D-130; Hubbell #5567).	1		*
120	4A564/131	PLUG: d-c power supply; (Boehme #4D-131; Hubbell #5965).	1		*
122	4A564/132	PLUG: signal; (Boehme #4D-132; Hubbell #6150).	1		*
101	4A564/129	POTENTIOMETER: field 1,600-ohm; armature 350-ohm; (Boehme #4D-124; De Jur Amsco Type HD).	1	*	
113	4A564/151	RELAY: slow-release; with cover; (Boehme #4D-151, Strowger #R-318-AZ).	1		*
108	4A564/152	RELAY: vibrating reed; with cover; (Boehme #4D-152).	1		*
118	3Z5200	RESISTOR: fixed; 400-ohm; 25-w; (Boehme #4D-157; W.L. Co. size A, 2").	2	*	
109	3Z5350.2	RESISTOR: fixed; 500-ohm, 40-w; (Boehme #4D-154; W.L. Co. size B, 3½").	1	*	
114	3Z5420.2	RESISTOR: fixed; 2,000-ohm, 40-w; (Boehme #4D-153; W.L. Co. size B, 3½").	1	*	
102	4A564/52	SCREW: adjusting; relay; brass, with coin silver contact; (Boehme #4D-52).	2		*
111	6L6632-11.8K	SCREW: relay contact bar spring adjusting; brass; (Boehme #4D-39).	1		*
149	6L7920-7.38	SCREW: flywheel; special iron; (Boehme #4D-101).	2	*	
135	4A564/126	SEAL: oil; ⅜" bore; (Boehme #4D-126; Sirvene Type H-80).	2	*	
141	4A564/160	SOCKET: porcelain; (Boehme #4D-160; Hubbell #854).	1		*
115	4A564/96	SWITCH: automatic or hand key; see Key; switchboard.	1	*	
106	4A564/78	SWITCH: tumbler; (Boehme #4D-96).	1	*	
107	6L35032-1	TIP: relay moving contact; coin silver; (Boehme #4D-78).	2	*	
107	6L35032-1	WASHER: asbestos; 1" OD; ⅛" ID; (Boehme #4D-113).	4	*	
117	6L35032	WASHER: asbestos; ¾" OD; ⅛" ID; (Boehme #4D-114).	4	*	

\* Indicates maintenance part available in station or region stock.

Figure 45. Typical layout of automatic recording equipment.



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# PART TWO

## AUTOMATIC RECORDING EQUIPMENT

### SECTION I

#### DESCRIPTION

#### 39. PURPOSE.

Boehme automatic recording equipment is designed for the automatic reception and recording of high-speed, radio-telegraph communications using International Morse Code. The principal components are: the ink recorder, type 4-G; the recorder driving unit, type 4-C; the tape puller, type 4-F, series E. The tape puller can be equipped with either the rewinder reel attachment, type 4-FA, or the magnetic release attachment, type 7-FA. Figure 45 shows a typical layout of the recording equipment. A wiring diagram of a typical receiving operator's table is shown in figure 86.

#### 40. INK RECORDER.

The ink recorder, type 4-G (fig. 46), is designed for

recording high-speed radio-telegraph signals in ink on  $\frac{3}{8}$ -inch wide standard paper recording tape.

a. Signals are recorded in ink on the paper tape by a fountain-type pen. The pen is attached to a movable signal coil which is mounted in a strong magnetic field. Electrical signals, composed of either single- (marking) current or double- (marking and spacing) current impulses, cause the signal coil to move up and down. Since the pen arm and pen are attached to the signal coil, they follow the up-and-down movement of the coil. However, the pen arm and pen are on the opposite side of the trunnion shaft from the coil; therefore, when the coil moves up, the pen moves down, and vice versa.

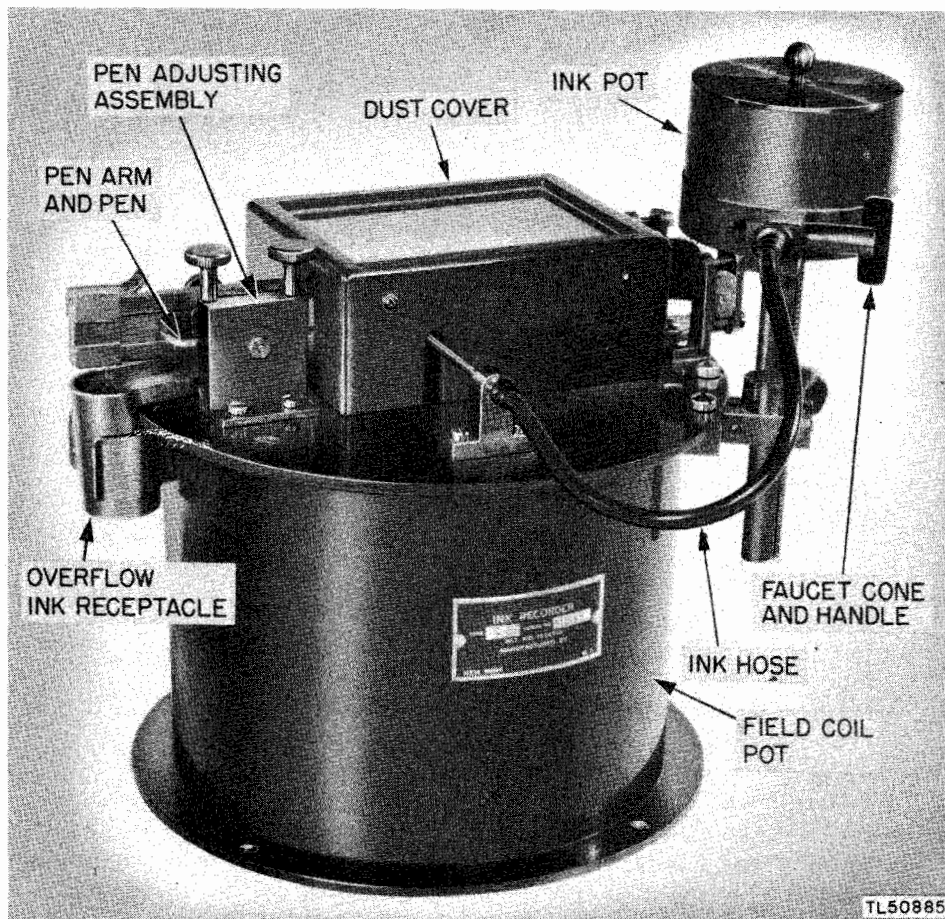


Figure 46. Ink recorder, type 4-G, front view.

b. As mentioned in subparagraph a above, the ink recorder may be operated on double-current (marking and spacing, also called polar) circuits. The circuit may be either a direct wire line (fig. 47A) or a radio channel.

pen snaps back to the lower stop and again draws a nearly vertical line. The upper (marking) lines form the dot and dash signals. The lower (spacing) lines form the spacings between dots and dashes, letters, and words.

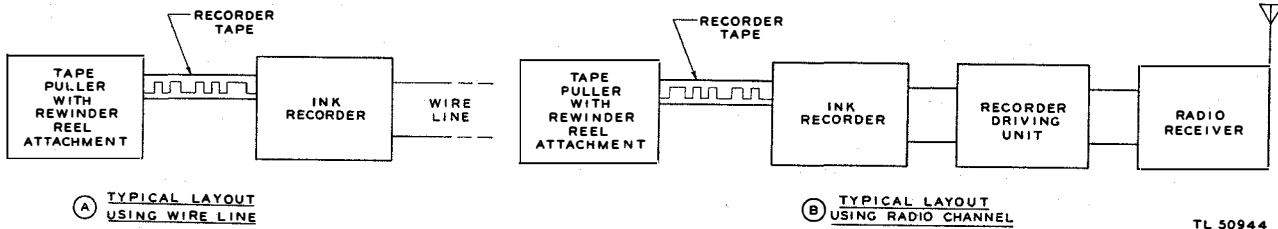


Figure 47. Block diagram of ink recorder connected to radio and wire circuits.

When a radio channel is used, the recorder driving unit (par. 41) is inserted in the circuit between the radio receiver and the ink recorder (fig. 47B).

Figure 48 shows a piece of recorder tape illustrating the irregular square waveform of the recorded signals.

c. In the double-current system, current flows in the circuit continuously; keying merely reverses the direction of current flow to correspond with the dots and dashes of the message being transmitted. The pen remains against the stop in one position (spacing) as long as the key is not closed. When the key is closed a marking signal is sent to the ink recorder and the pen snaps to the stop in the opposite (marking) position. When the key is released the pen snaps back to the first position.

e. For single-current operation the recorder driving unit is not used, and the ink recorder is connected directly to the transmitting equipment by wire lines. The pen is moved to the upper stop when current flows through the signal coil, and drops to the lower stop (the baseline) under tension of the signal coil restraining spring when no current flows.

f. The ink recorder has a top speed of approximately 400 words per minute when operated on double (marking and spacing) current. On single current the recorder has a top speed of approximately 300 words per minute.

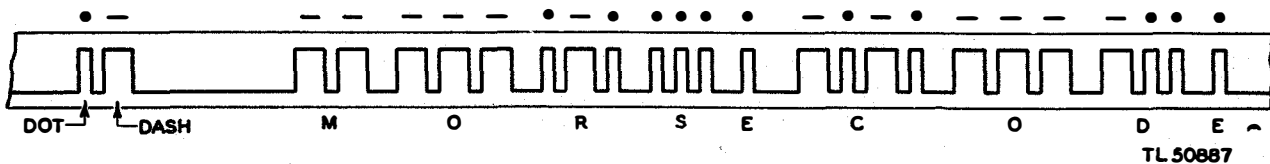


Figure 48. Typical message recorded on tape by ink recorder.

d. The tape is moved past the pen by the tape puller, type 4-F (par. 42). When a spacing signal is received by the signal coil, the pen draws a horizontal line on the lower part of the tape. When a marking signal is received, the pen snaps to the upper stop and draws an almost vertical line as it changes position. A second horizontal line is drawn along the upper part of the tape as long as the marking signal is being received by the signal coil. When a spacing signal is again received, the

**41. RECORDER DRIVING UNIT.**

The recorder driving unit, type 4-C (figs. 52 and 53), is used to convert 500- to 1500-cycle keyed signals, such as the output of a radio receiver or similar source, into double currents for high-speed operation of the signal coil of the ink recorder. The recorder driving unit has a self-contained power supply designed to operate from 110-volt, 60-cycle alternating current. Power consumption is approximately 175 watts.

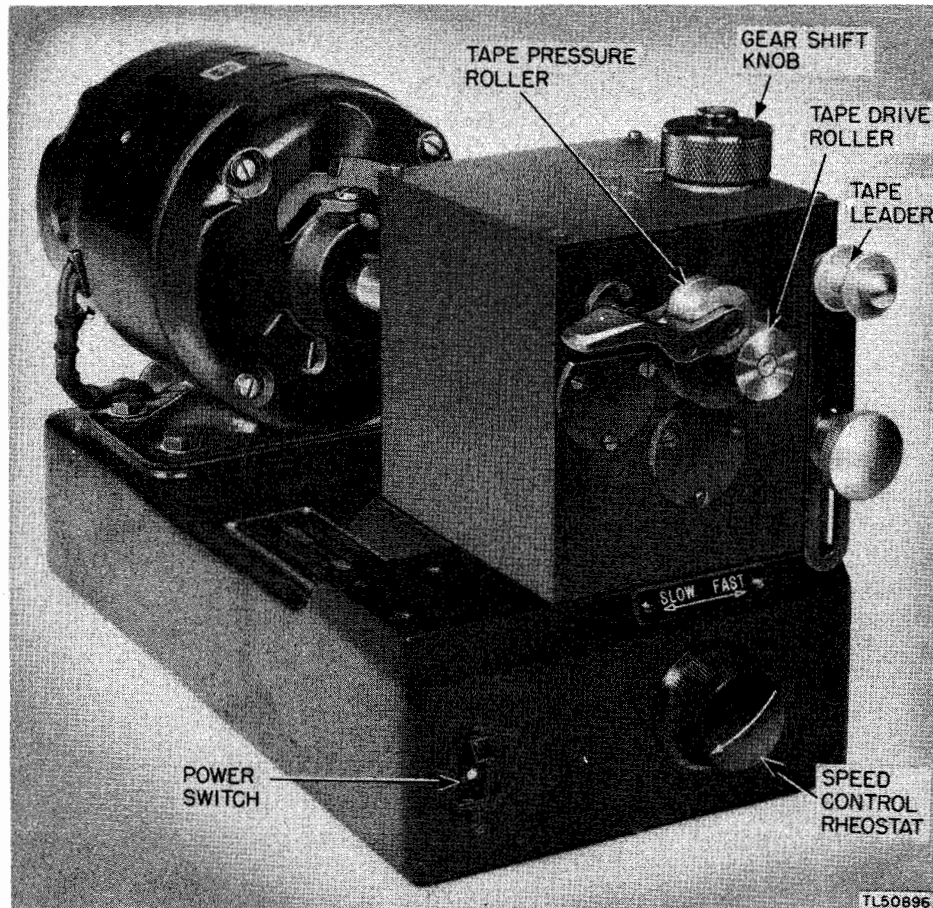


Figure 49. Tape puller, type 4-F, front view.

#### 42. TAPE PULLER.

a. The tape puller, type 4-F, series E (fig. 49), is used to pull the  $\frac{3}{8}$ -inch wide paper recording tape through the ink recorder or across the tape bridge, type 4-K (par. 90). A three-position gear shift and a motor-speed-control rheostat permit operation over a wide speed range.

b. The tape puller is equipped with either a rewinder reel attachment or a magnetic release attachment. The tape puller used with the ink recorder is equipped with the magnetic release attachment, type 7-FA (fig. 57), which permits the receiving operator to start or stop the movement of the tape from a remote point by controlling the movement of the pressure roller bracket assembly of the tape puller.

c. The tape puller used to pull the recorder tape across the tape bridge, type 4-K, is equipped with the rewinder reel attachment, type 4-FA (fig. 56), which mechanically rolls up the transcribed tape.

#### 43. DIMENSIONS AND WEIGHTS.

##### a. Ink Recorder.

- (1) Over-all dimensions: 10 inches deep, 9 inches wide, and 10 inches high.
- (2) Base dimensions: 7 inches in diameter.
- (3) Packing dimensions:  $18\frac{1}{2}$  by  $18\frac{1}{2}$  by 15 inches.
- (4) Net weight: 29 pounds.
- (5) Shipping weight: 88 pounds.

##### b. Recorder Driving Unit.

- (1) Over-all dimensions: 19 inches wide, 12 inches deep, and  $10\frac{1}{2}$  inches high.
- (2) Packing dimensions: 29 by 21 by 24 inches.
- (3) Net weight: 105 pounds.
- (4) Shipping weight: 165 pounds.

##### c. Tape Puller with Magnetic Release Attachment.

- (1) Over-all dimensions: 7 inches wide, 13 inches deep, and 8 inches high.
- (2) Packing dimensions: 18 by 14 by 16 inches.

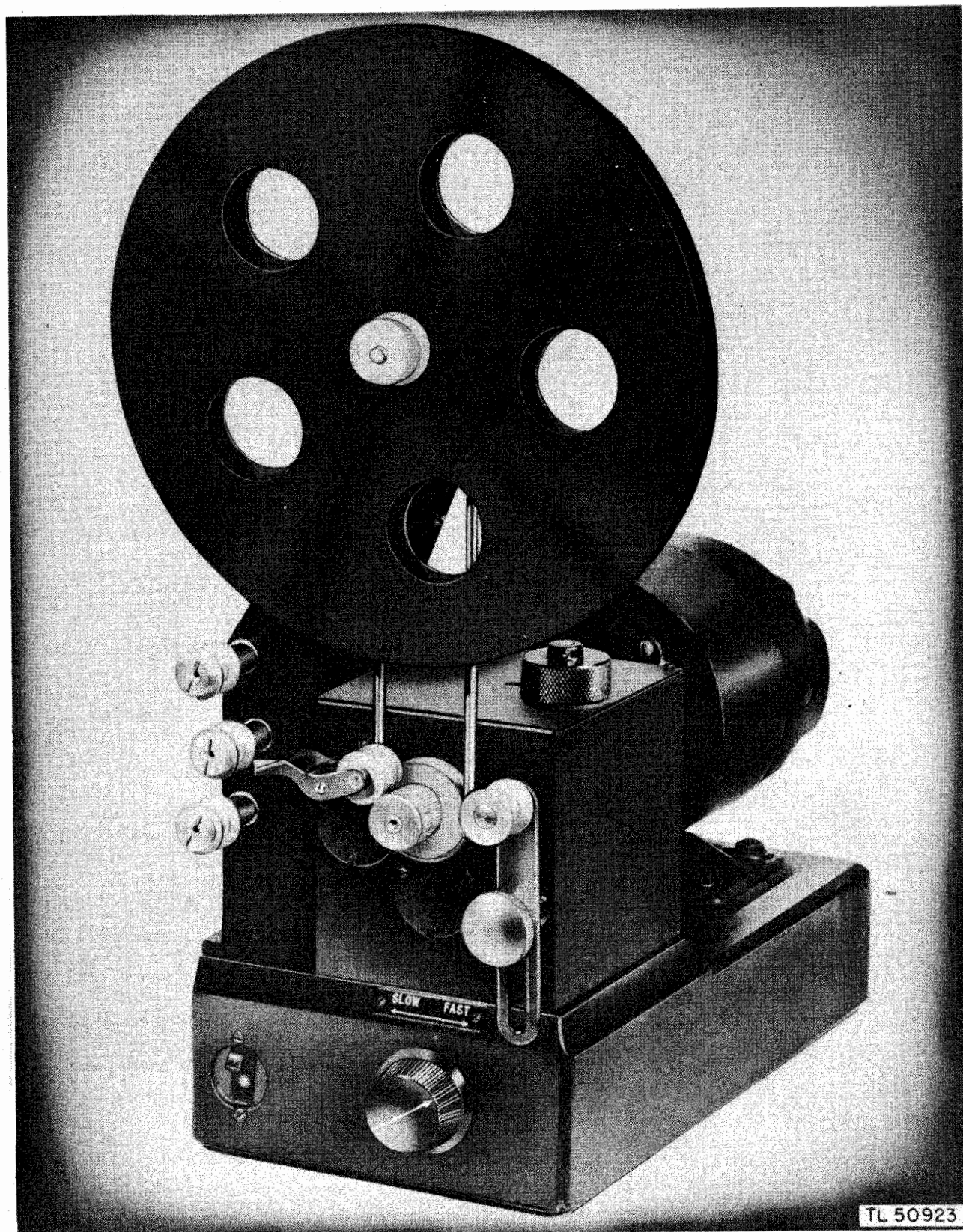


Figure 50. Tape puller, type 4-F, with rewinder reel attachment, type 4-FA.

- (3) Net weight: 20 pounds.
- (4) Shipping weight: 60 pounds.

**d. Tape Puller with Rewinder Reel Attachment.**

- (1) Over-all dimensions: 9 inches wide, 13 $\frac{1}{2}$  inches deep, and 16 $\frac{1}{2}$  inches high.
- (2) Packing dimensions: 18 by 14 by 21 inches.
- (3) Net weight: 22 pounds.
- (4) Shipping weight: 66 pounds.

**44. ELECTRICAL CHARACTERISTICS OF INK RECORDER.**

**a. Field Coil.** The field coil, which produces the magnetic field, requires approximately 35 watts of d-c power at 110 volts. Each of the two windings has a resistance of approximately 170 ohms. The windings are connected in series and have a total resistance of 340 ohms.

**b. Signal Coil.** The signal coil has a resistance of approximately 1,800 ohms, and, when operating at highest speed, requires a *maximum* current of 35 milliamperes, with lesser currents being required for slower speeds.

**45. MECHANICAL CHARACTERISTICS OF INK RECORDER.**

Mechanical features include the following:

- a.** An adjustable signal coil restraining spring for re-

turning the pen arm to the lower baseline for single-current operation (figs. 51 and 61).

**b.** Adjustable pen stops to control the relative position on the tape and the amplitude (distance between the upper and lower lines) of the recorded signals (figs. 46 and 51).

**c.** An adjustable tape bridge for maintaining the moving tape in proper relationship to the pen (figs. 51 and 61).

**d.** An ink pot which can be raised or lowered to vary the rate of ink flow through the ink hose to the pen (fig. 46).

**e.** A male plug with a nonreversible female receptacle for connection to the d-c supply for exciting the magnetic field and for connection to the signal current source (figs. 58 and 59).

**f.** A receptacle beneath the pen to catch any excessive flow of ink (fig. 46).

**g.** A pair of bristle brushes to remove lint from the paper tape (fig. 61).

**h.** A hinged, glass-top cover inclosing the entire signal system to protect it from dust and paper lint (fig. 46).

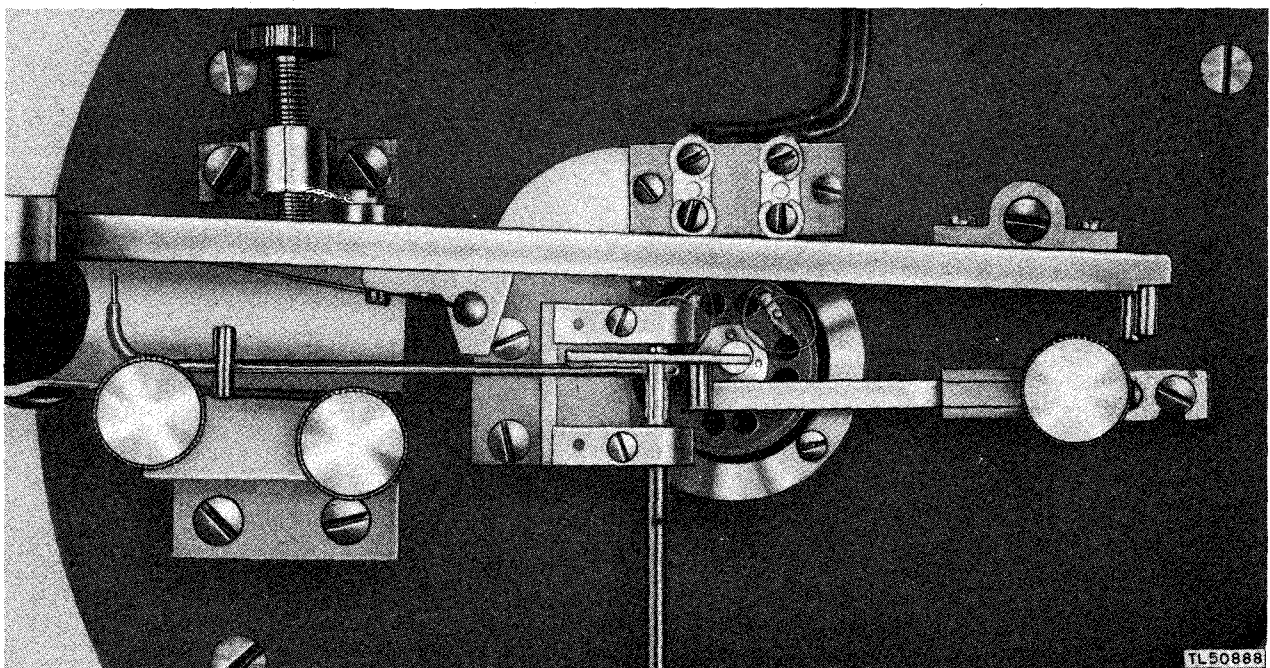
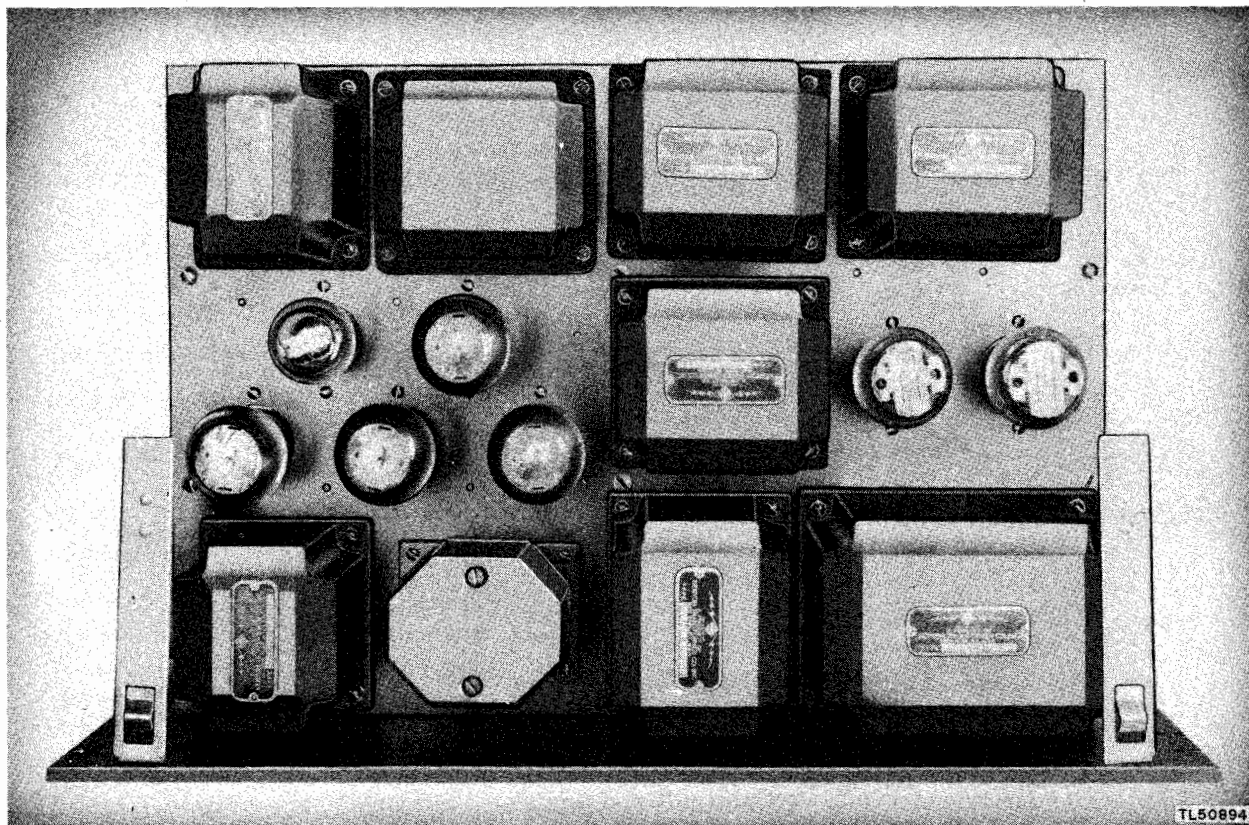
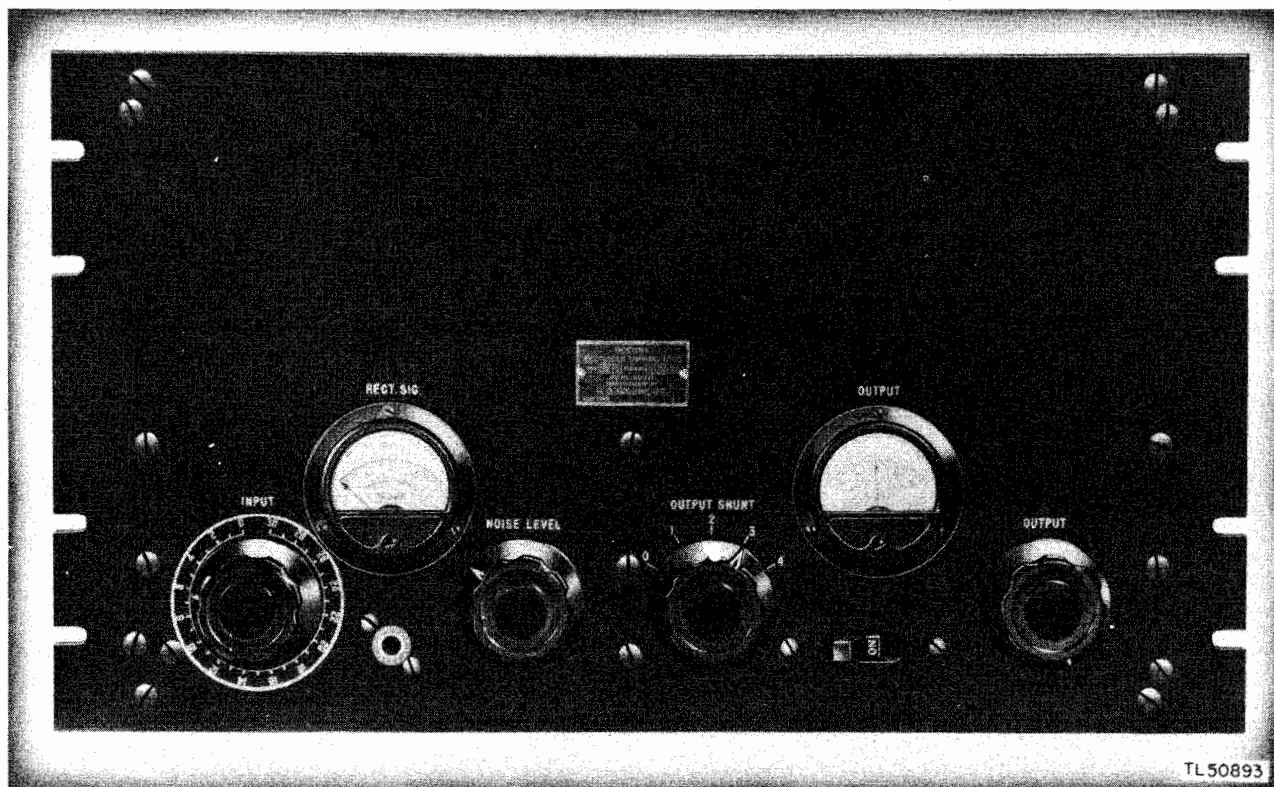


Figure 51. Detailed view of recording mechanism of ink recorder.



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Figure 52. Recorder driving unit, type 4-C, top view.



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Figure 53. Recorder driving unit, type 4-C, front view.

**46. OUTPUT OF RECORDER DRIVING UNIT.**

The recorder driving unit supplies at least 30 milliamperes of spacing and marking current with a minimum of -8 decibels signal level at the input terminals (zero decibel level being 6 milliwatts). The output of the recorder driving unit remains constant regardless of the input signal voltage, provided that the input signal level is at least -8 decibels above noise level.

**47. CONSTRUCTION OF RECORDER DRIVING UNIT.**

All controls necessary for the operation of the recorder are mounted on the front panel (fig. 53) of the recorder driving unit. The recorder driving unit can be mounted on any standard 19-inch relay rack with 17-inch mounting centers. The unit has a dust cover which can be removed by pulling it straight back.

**48. COMPONENT PARTS OF RECORDER DRIVING UNIT (figs. 52 and 53).**

The recorder driving unit consists of the following component parts:

a. A single-stage audio-amplifier preceded by a 500-cycle high-pass filter and a 500-ohm adjustable attenuator.

b. A double-diode rectifier with a filter to smooth out the audio-frequency signal.

c. A phase shift tube and two output tubes; one output tube to supply spacing current and the other to supply marking current.

d. Two full-wave rectifier power supplies, each supplying approximately 50 milliamperes of direct current at approximately 220 volts. The positive terminal of one power supply is connected to the negative of the second to form the common terminal of the double-current circuit, approximately 220 volts marking and approximately 220 volts spacing.

e. A control marked INPUT for regulating the strength of the incoming signal.

f. A control marked NOISE LEVEL to bias out any noise which may be present, allowing only the signal above noise level to pass. Noise level is registered on

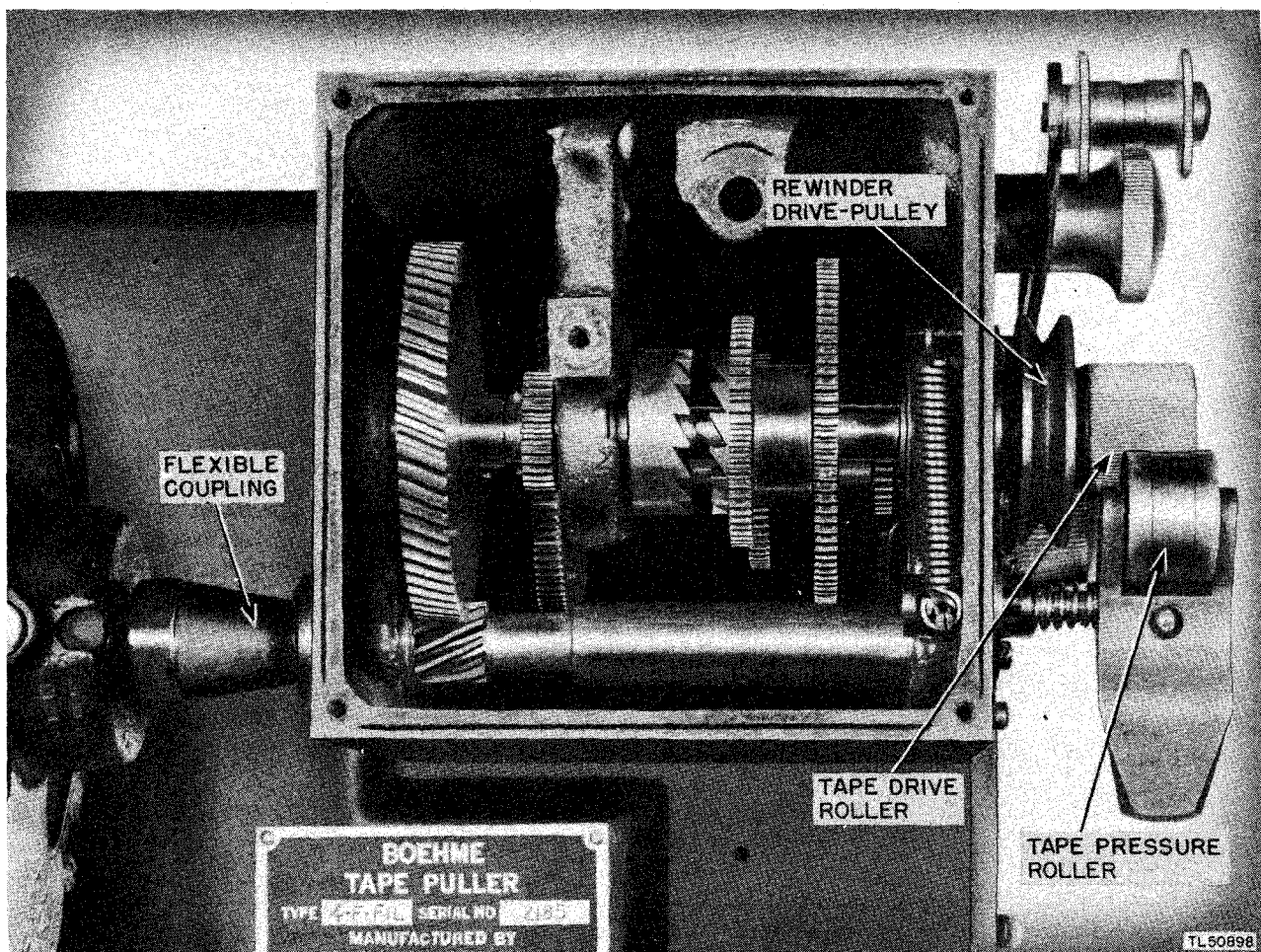


Figure 54. Internal view of tape puller gear box.

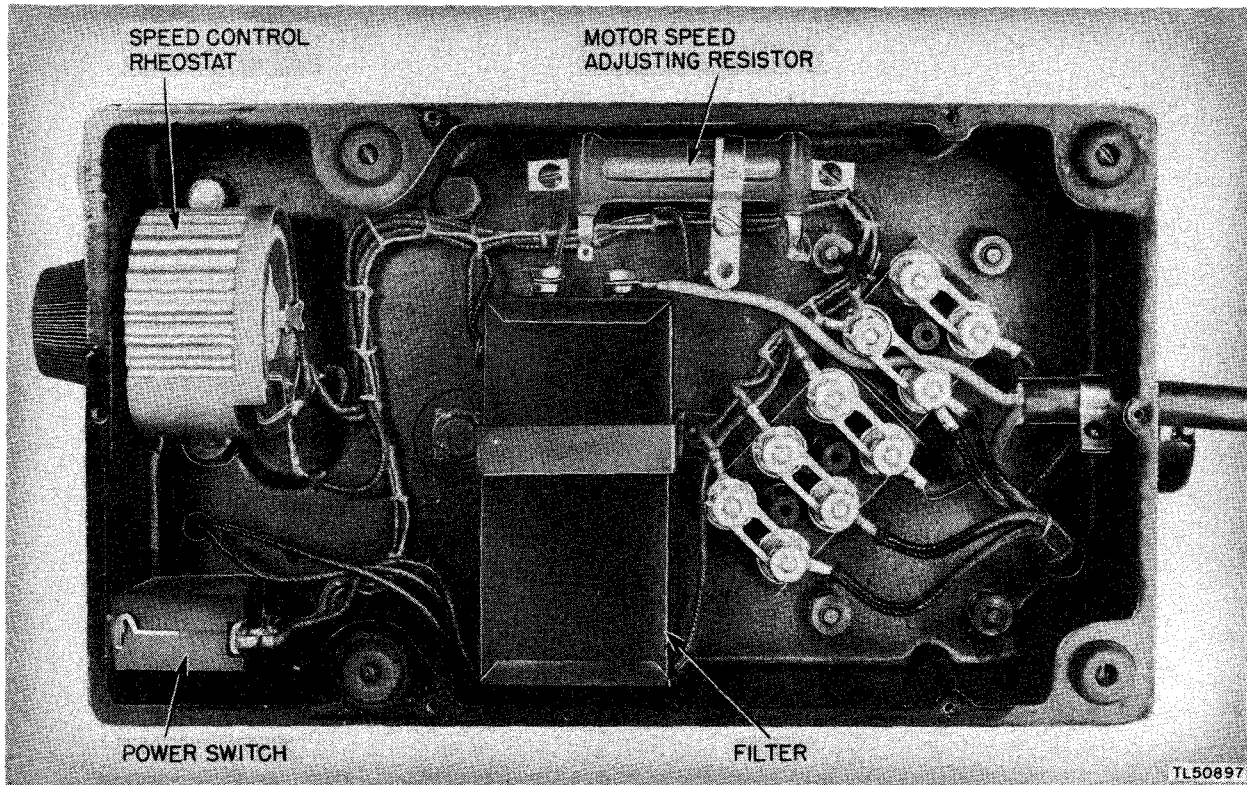


Figure 55. Tape puller, type 4-F, bottom view.

the meter marked RECT. SIG. when no signal is being received. The noise level can be lowered by turning the NOISE LEVEL control until the meter stops indicating. The RECT. SIG. meter also gives an indication of the strength of the incoming signals.

g. A four-position control marked OUTPUT SHUNT to insert capacitance across the output terminals to smooth ragged signals and high level peaked static.

h. A current control marked OUTPUT which varies the maximum marking and spacing current. A 50-0-50 milliammeter marked OUTPUT is mounted above the control to indicate the output current.

i. A phone jack in the input circuit to monitor the incoming signal.

j. The following vacuum tubes:

- (1) One tube, type 84 (V-84), signal rectifier.
- (2) Four tubes, type 42 (V-42), one each, amplifier, phase-shift, marking and spacing.
- (3) Two tubes, type 82 (V-82), full wave rectifiers.

k. A power ON-OFF switch to connect or disconnect the 110-volt a-c power supply.

#### 49. COMPONENT PARTS AND ATTACHMENTS FOR TAPE PULLER.

The tape puller (fig. 49) is a self-contained unit operat-

ing from a 110-volt, d-c circuit. The puller consists of the following component parts and attachments:

a. A 1/20 horse-power, 110-volt, d-c motor rated at 1,725 revolutions per minute.

b. A gear box (fig. 54) containing a three-speed gear shift coupled to the drive roller which moves the paper tape.

c. A cast base on which are mounted the motor and gear box and either the rewinder or the magnetic release attachment. The base (fig. 55) contains the wiring of the unit, a rheostat for the control of motor speed, the terminal block for making connections, a cable and plug to connect the motor to the d-c line, and a filter to eliminate any electrical disturbance created by the brushes of the tape puller motor.

d. A rewinder reel attachment (fig. 56), which is a tape reel fastened to a cast bracket. A steel spring belt turns the reel to rewind the tape. The reel holds an 8-inch roll of 3/8-inch wide recorder tape.

e. A magnetic release attachment (fig. 57) consisting of a pair of electromagnets and an armature mounted in a metal case. The armature extension operates the pressure roller bracket assembly on the tape puller, controlling the stopping and starting of the tape.



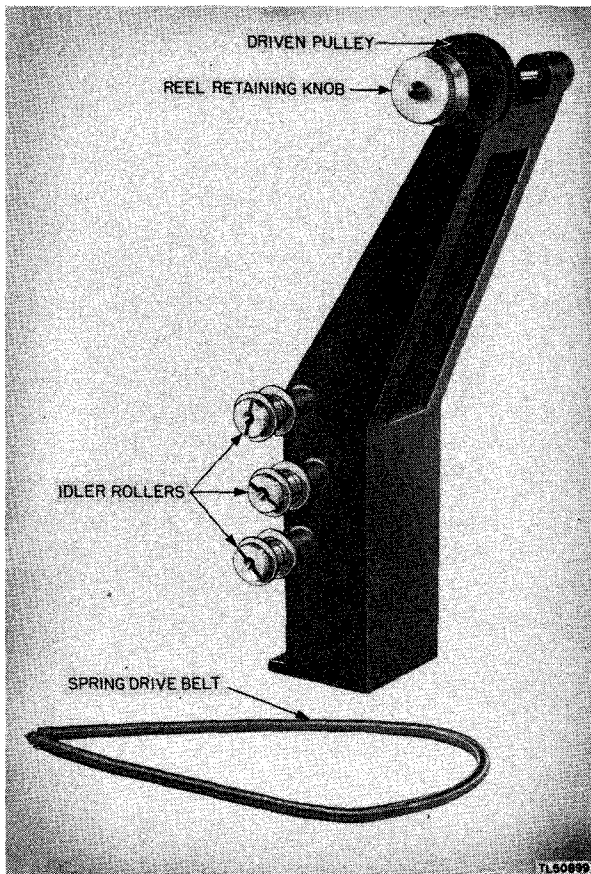


Figure 56. Rewinder reel attachment, type 4-FA.

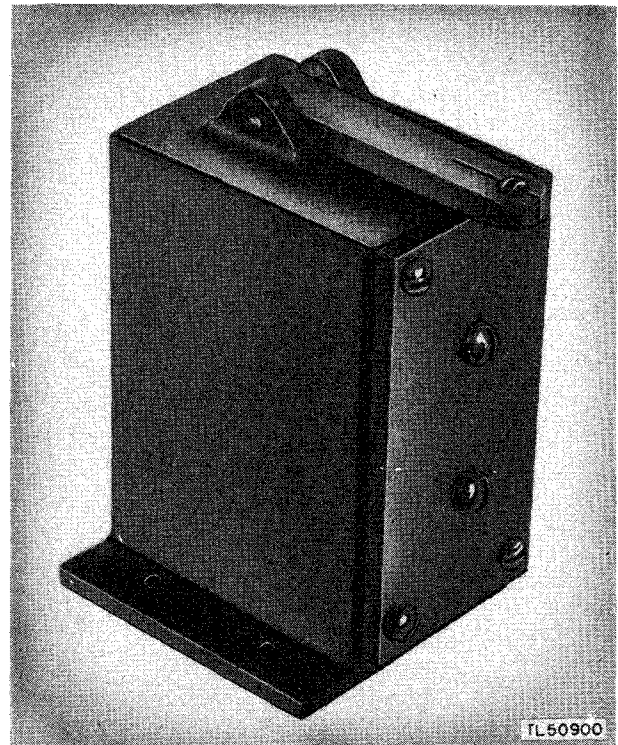


Figure 57. Magnetic release attachment, type 7-FA, front view.

## SECTION II

### INSTALLATION AND OPERATION

#### 50. INSTALLATION OF INK RECORDER.

The ink recorder, type 4-G, is shipped from the manufacturer complete and ready for installation. The recorder base has four mounting holes equally spaced on a  $6\frac{1}{2}$ -inch diameter circle. The holes will pass  $\frac{3}{16}$ -inch diameter screws for fastening the ink recorder to an operating table. Connect the blue and white leads of the nonreversible female receptacle (figs. 58 and 59) to the signal output terminals of the recorder driving unit. The blue lead is the positive side of the signal coil. Connect the red lead to the negative side and the black lead to the positive side of the d-c source for exciting the field. Connect the receptacle to the male plug on the back of the recorder.

#### 51. INSTALLATION OF RECORDER DRIVING UNIT.

a. The recorder driving unit is shipped from the manufacturer ready for installation. Tubes are packed separately. Unpack the tubes and place them in the proper tube sockets, which are plainly marked.

b. Make certain that there is at least a 24-inch clearance between the back of the relay rack and the nearest wall or other equipment so that the dust cover of the unit can be removed to permit servicing. Fasten the recorder driving unit securely to the relay rack.

c. Set all controls at zero. Throw the power switch to OFF.

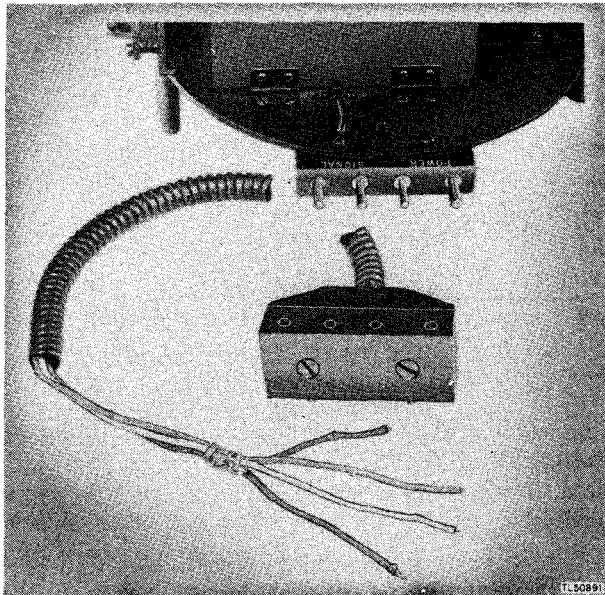


Figure 58. Power and signal connections to ink recorder.

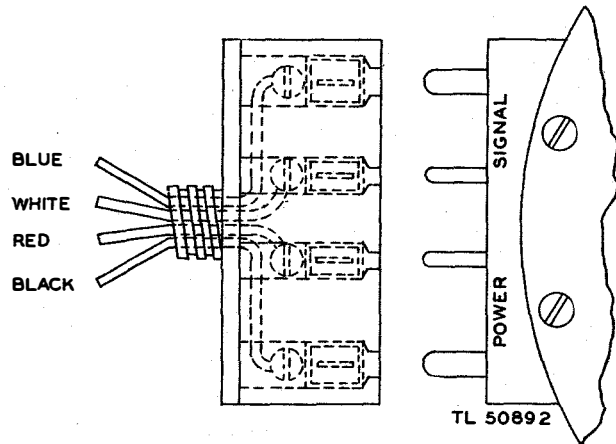


Figure 59. Detailed sketch of signal line and power plug.

d. All electrical connections to the recorder driving unit are made to the six-point terminal strip which is mounted on the bottom of the unit (fig. 60), on the left side as viewed from the panel. The terminals are marked INPUT, 110 VOLTS AC, and OUTPUT, and are for

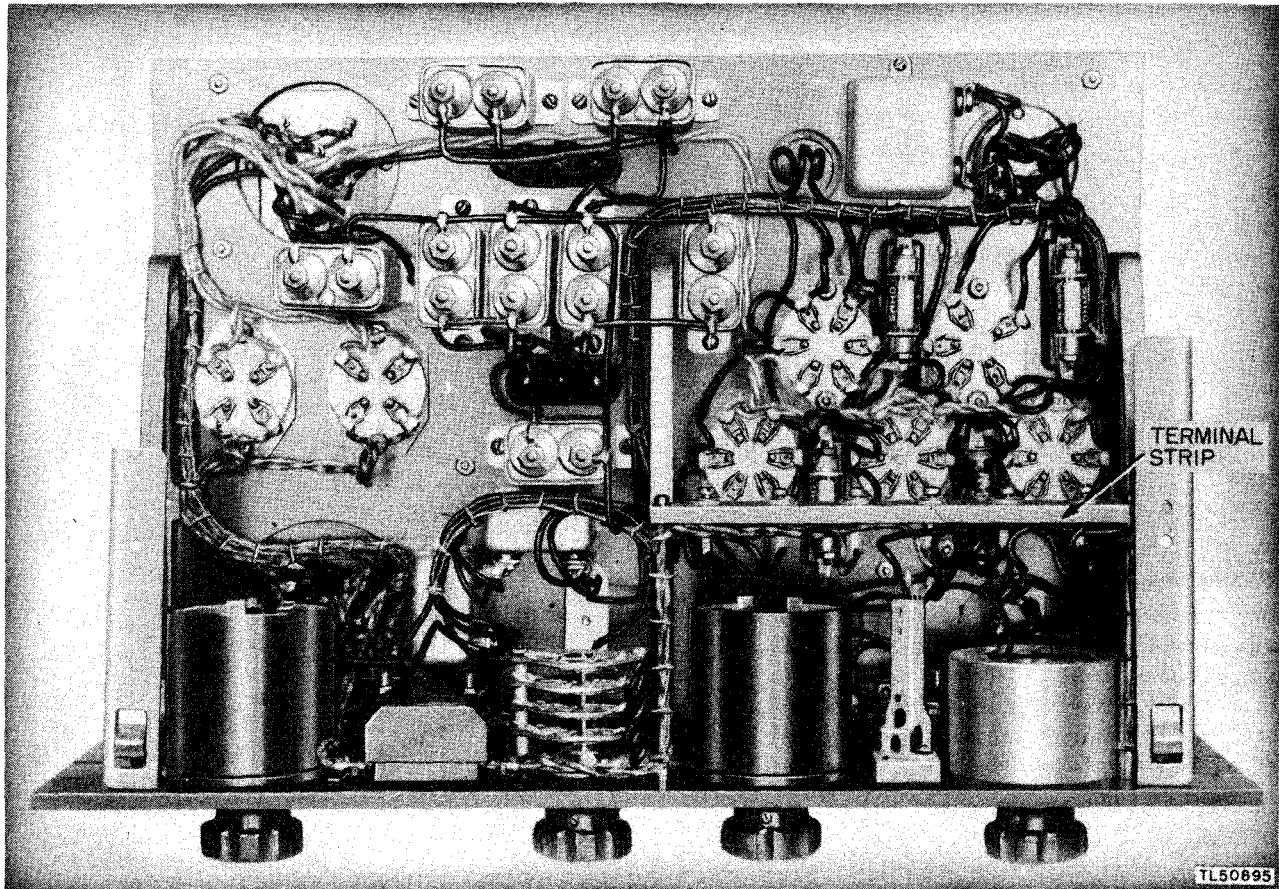


Figure 60. Recorder driving unit, type 4-C, bottom view.

the signal input from a radio receiver, the a-c power supply, and the output to the ink recorder signal coil, respectively.

## 52. INSTALLATION OF TAPE PULLER AND ATTACHMENTS.

a. The tape puller, type 4-F, is shipped from the manufacturer with oil in the gear box. However, before installing a new tape puller for the first time, or if there is evidence of oil leakage during transportation of a tape puller that has been in service, remove the five screws securing the gear box cover plate to the gear box.

(1) Remove the gear box cover plate and the gasket, being careful not to damage the gasket or bend the cover plate.

(2) If the gear box is dry, pour in 6 ounces of Oil, Engine, SAE 50, U. S. Army Specification 2-104B.

(3) If little or no oil is found in the gear box when it is checked for oil leakage, turn the tape puller upside down and drain out any remaining old oil. Then pour in 6 ounces of new Oil, Engine, SAE 50, U. S. Army Specification 2-104B.

(4) Replace the gasket and the cover plate and tighten the five cover plate screws.

b. Throw the power switch to OFF, and plug the power cable into a 110-volt, d-c power supply.

c. The tape puller used with the ink recorder should be located not less than 18 inches from the recorder when operating at high speed. Such a location allows time for the ink on the tape to dry before passing through the tape puller rollers.

## 53. PREPARATION OF RECORDER INK.

The special ink used by the ink recorder is supplied in powder form and is mixed with water as needed. This ink is suitable for slow and medium speed recording. For high speed recording, a quick-flowing, fast-drying ink is required. This is obtained by adding a special drying fluid to the ink.

a. *Ink Formula for Slow-Speed Recording.* For speeds of less than 200 words per minute, dissolve one capsule of ink powder in 1 quart of lukewarm water and stir well.

b. *Ink Formula for High-speed Recording.* For speeds greater than 200 words per minute, dissolve one capsule of the ink powder in 1 quart of lukewarm water. Add 1/2 pint (8 ounces) of quick-drying fluid and stir well. Experience may justify slight variations in this formula to suit individual requirements.

**CAUTION: USE DISTILLED WATER WHENEVER POSSIBLE.**

## 54. FILLING RECORDER WITH INK.

a. If the ink recorder has not been in operation for some time, fill the ink pot with warm water to see that the pen, pen arm, or ink hose are not clogged with dried ink. If the warm water does not pass through the pen, clean it as directed in paragraph 75.

b. Turn the faucet cone handle (fig. 46) to the off (vertical) position. Fill the ink pot about three-quarters full with the prepared ink.

c. To allow the ink to flow when starting the recorder for the first time, the air must be forced out of the ink hose. Open the faucet cone and squeeze the ink hose near the faucet cone with two fingers of one hand, sliding the fingers in the direction of the pen. At the same time, with the other hand, hold the ink hose tight over the nipple at the faucet cone to prevent it from being disconnected.

## 55. THREADING TAPE THROUGH INK RECORDER.

a. Slip the tape between the bristle brushes (fig. 61) and the two guide pins.

b. Draw the tape over and down between the tape guide spring and the tape bridge.

c. Lift the hinged tape guide (fig. 61) and draw the tape into the slot under it.

d. With the tape held flat against the tape bridge, lower the hinged tape guide into position, thereby preventing the tape from slipping out of the slot at the end of the tape bridge.

## 56. OPERATION OF INK RECORDER.

a. Adjust the tape bridge so that the tip of the pen *barely* touches the recording tape (figs. 51 and 61). *Do not* adjust the tape bridge so the pen actually *presses* against the tape, since too much pressure will scratch the tape and bend the pen. Also, so much signal current will be required to drive the binding pen that the signal coil will burn out.

**CAUTION: CHECK CAREFULLY FOR BINDING OF THE PEN AND OVERDRIVING OF THE SIGNAL COIL.**

b. When a lower baseline is used, the direction of the pen movement is *up* whenever single currents are passed through the signal coil. If the pen does not move up when single currents are passed through the signal coil, reverse the polarity of the d-c power supply to the field

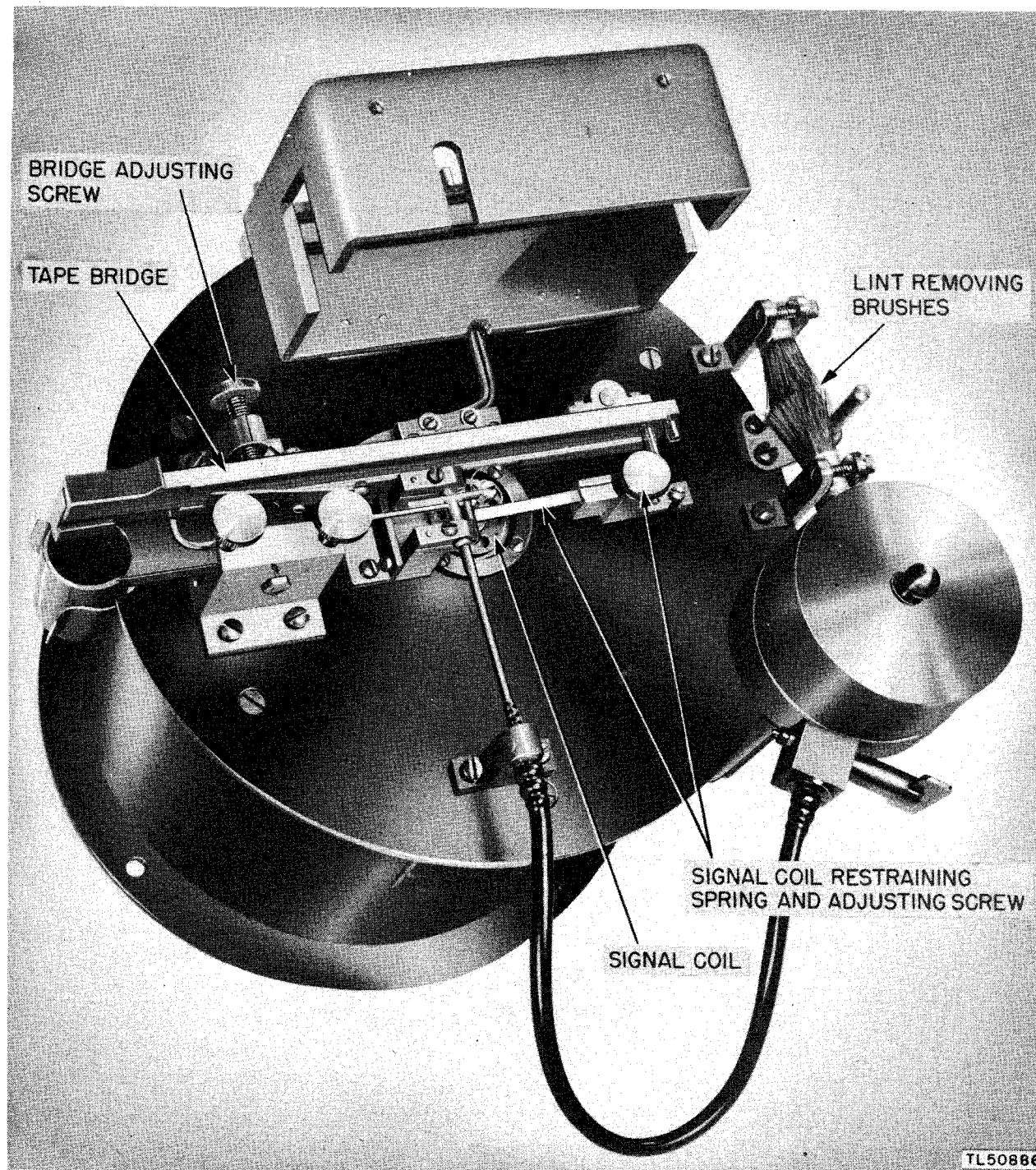


Figure 61. Ink recorder, type 4-G, top view.

coils. The tension of the signal coil restraining spring brings the pen back to the baseline (which is the bottom of the pen stroke) when the signal current stops flowing in the coil.

c. When marking and spacing currents are used, release the tension on the signal coil restraining spring by turning the adjusting screw until the coil floats freely,

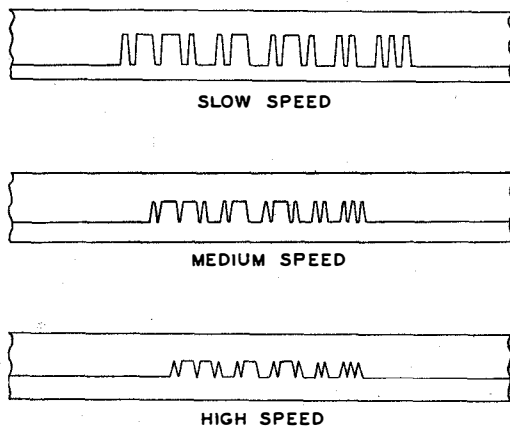
or until the weight of the coil is balanced. The coil is slightly heavier than the rest of the system. The movement of the pen should be *up* when marking current is applied and *down* when spacing current is applied. If these conditions are not met when the recorder is first connected, reverse the polarity of the d-c power supply to the field coils.

d. Adjust the signal current in relation to the recording speed. Signal current of a greater value than necessary causes the recorder pen to bounce, while too low a value results in an irregular record. Small, definite signals are essential for accurate recording at high speed. For a clear recorded signal at a speed of 400 words per minute, use a *maximum signal current of 35 milliamperes*. For slower speeds use smaller currents.

**CAUTION: NEVER OVERDRIVE THE PEN. MAINTAIN MINIMUM SIGNAL CURRENT FOR SATISFACTORY RECORDING AT WHATEVER SPEED IS BEING USED.**

e. Adjust the amplitude of the pen movement by turning the worm screws (fig. 46) for the upper and lower pen stops. Large amplitude of the recorder pen at high speeds produces great stress upon the recorder mechanism.

f. Figure 62 shows the approximate correct amplitude of recordings at slow, medium, and high speeds.



TL-50907

Figure 62. Comparison of messages received at low speed, medium speed, and high speed.

**CAUTION: BEFORE USING THE INK RECORDER, MAKE SURE THAT THERE ARE NO TWISTS IN THE SMALL INK HOSE ATTACHED TO THE PEN ARM: ANY TWISTS IN THIS HOSE INTERFERE WITH THE OPERATION OF THE RECORDING PEN.**

g. When recording, turn the faucet cone to the full *on* position and raise the ink pot to increase the ink pressure until a steady flow of ink in the proper amount is obtained. The best position of the ink pot must be determined by experience. The faucet cone handle should turn easily. If it sticks, obtain the services of a maintenance man, who will clean the ink hose and the valve with alcohol (par. 70 i).

h. When the recorder is not in use, leave a piece of paper tape in the tape bridge with the pen resting on it to prevent clogging of the pen with dried ink.

#### 57. OPERATION OF RECORDER DRIVING UNIT.

a. Throw the power switch (fig. 53) to ON. Allow a minute or so for the tubes to warm up.

b. Set the OUTPUT SHUNT control at zero.

c. Set the OUTPUT control so that 20 milliamperes is indicated on the OUTPUT meter (either space or mark).

d. Set the INPUT control to 4 on the dial.

e. Set the NOISE LEVEL control to the middle of its arc.

f. Connect the output of the radio receiver being used to the INPUT terminals of the recorder driving unit and adjust the receiver until the RECT. SIG. meter reads 1.5 milliamperes. The receiver output signal should be approximately a 1,000-cycle tone.

g. Reduce the noise level, if necessary, by turning the NOISE LEVEL control counterclockwise. Bring the reading of the RECT. SIG. meter back to 1.5 milliamperes with the INPUT control.

h. Add shunting capacitance with the OUTPUT SHUNT control for ragged signals, signal frequencies below 1,000 cycles, high-level peaked static, or high-frequency noise.

i. Set the OUTPUT control for the proper amount of current through the recorder signal coil as determined by the speed of recording.

j. Watch the operation of the ink recorder. If it is unsatisfactory, carefully readjust the controls.

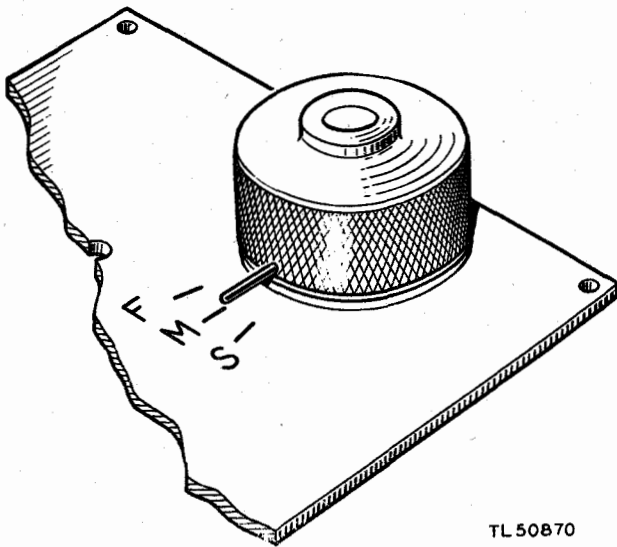
**CAUTION: DO NOT OVERDRIVE THE INK RECORDER PEN.**

#### 58. OPERATION OF TAPE PULLER.

a. Insert the tape between the knurled tape drive roller (fig. 49) and pressure roller. The pressure roller may be lifted from the drive roller by pressing down on the pressure roller bracket assembly. The pressure roller is held in this off position by a spring and a notch on the bracket shaft.

b. Release the pressure roller by pushing the bracket assembly toward the gear box. A second spring holds the pressure roller against the drive roller. The tape is pulled between the knurled tape drive roller and pressure roller when the tape puller is in operation.

c. Turn the gear shift knob on top of the gear box to select any one of the three speed ranges of the tape puller. The position of this knob at S, M, or F (fig. 63) indicates that the puller is geared for slow, medium, or fast speed, respectively. Changes in speed within a selected speed range are obtained by turning the motor speed control rheostat marked SLOW-FAST on the front



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Figure 63. Tape puller gear shift knob.

of the base. Before shifting gears from one speed range to another, turn the motor off and allow the motor and gears to slow down. Shift the gears just before the motor stops coasting.

d. Throw the power switch to the ON position to start the tape puller.

e. Start the tape pulling action by releasing the pressure roller bracket assembly. Press down on the pressure roller bracket assembly to lift the pressure roller and stop tape pulling.

**CAUTION: DO NOT ALLOW THE PRESSURE ROLLER TO RIDE ON THE TAPE DRIVE ROLLER WITHOUT TAPE. THIS ACTION WEARS THE KNURL OFF THE DRIVE ROLLER AND REDUCES PULLING POWER.**

f. Adjust the tape leader bracket (fig. 49) by loosening the clamp screw, placing the tape leader flange rings in the desired position, and tightening the clamp screw.

#### 59. OPERATION OF REWINDER REEL ATTACHMENT.

a. Remove the knob and the outer tape reel disk.

b. Feed the tape through the idler rollers as shown in figure 64. Insert the tape in a slot of the guide ring and wind several loops of the tape around the hub.

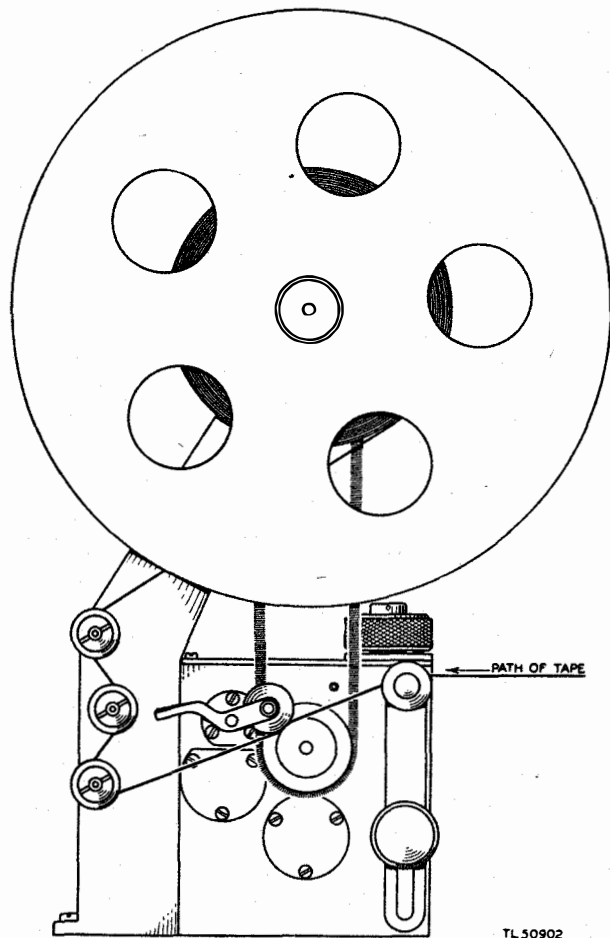
c. Replace the outer disk and knob. As the knob is screwed on, the guide ring expands, holding the tape tightly.

d. To remove a roll of tape from the reel, take off the knob and the outer tape reel disk.

**CAUTION: BE CAREFUL NOT TO STRETCH THE SPRING BELT.**

#### 60. OPERATION OF MAGNETIC RELEASE ATTACHMENT.

The magnetic release attachment (figs. 57 and 72) for starting and stopping the tape is controlled by a switch, which may be remotely located. Close the switch when tape is to be pulled. Open the switch to stop the tape-pulling action. The switch is usually located near the operator's typewriter so he can control the movement of tape through the ink recorder. The magnetic release attachment does not stop the tape puller motor, but merely holds the tape pressure roller off the drive roller when the switch is open. Usually the ink recorder records the tape faster than the receiving operator can transcribe it. The back log of tape accumulates in a tape bin under the operator's table after having passed through a slot



TL 50902

Figure 64. Sketch of tape puller with rewriter reel attachment showing threading of tape.

in the table. If there is any appreciable time delay between incoming messages, the operator can prevent waste of tape by operating the switch controlling the magnetic release attachment, thus stopping the movement of tape through the ink recorder. Probably more important than the saving of tape is the waste of time which oc-

curs when recorded messages are separated by long stretches of blank tape. Even though tape is not moving through the ink recorder, there is generally sufficient recorded tape in the tape bin to keep the operator busy and to make it unnecessary to stop the tape puller which has the rewinder reel attachment.

## SECTION III

### FUNCTIONING OF PARTS

#### 61. ELECTRICAL PARTS OF INK RECORDER.

a. **Field Coil (figs. 73 and 79).** The field coil consists of two coils of copper wire (265)<sup>1</sup> in the center of which is a steel core (262) fastened mechanically and magnetically to the bottom plate (266). The top of the steel core is level with the lower surface of the coil pot cover plate (209), which has a circular opening just above the core. The signal coil (280, fig. 61) moves up and down through this circular opening. The top of the steel core forms one magnetic pole. The base, sides, and top of the recorder case complete the magnetic circuit and bring the opposite magnetic pole within 3/32 inch of the core at the edge of the circular opening. Across this space is a very strong magnetic field, and a very small current through the signal coil causes a relatively large movement of the coil.

b. **Signal Coil (figs. 65, 66 and 74).** (1) The signal coil assembly consists of a pen and pen arm, a trunnion shaft, a signal coil, a pen arm lever, a coil lever arm, bearings, bearing brackets, and a coil connection block assembly.

(2) The signal coil is of the proper diameter to give a working clearance in the circular opening of the coil pot

cover plate of the recorder just above the steel core. The signal coil aluminum guide rod, which is riveted to the center of the coil, is slotted on both ends for hinging to the pen arm lever on the upper end and to the coil lever arm on the lower end. The lower end of the guide rod moves within a slot cut in the side of the steel core near the top; the coil lever arm extends out from the slot to the lower bearing. The pen arm lever with the pen and pen arm form a unit with a hollow trunnion shaft. The coil lever arm and solid trunnion shaft are also one unit. The two shafts are held in bearings; the bearings are held in the coil angle bracket that is fixed to the ink recorder cover plate. This construction makes the coil and pen arm a complete unit and limits the motion of the coil to a path parallel to the edge of the cover plate opening.

(3) Connection from the male plug on the back of the recorder to the coil connection block assembly is made by a pair of wires, the terminals of which are clamped under screws at the back of the coil connection block assembly.

<sup>1</sup>All numbers appearing in this section in connection with names of parts are reference numbers appearing in parts location illustrations of this section. The numbers of those parts which are maintenance parts appear also in the reference symbol column of the list of maintenance parts.

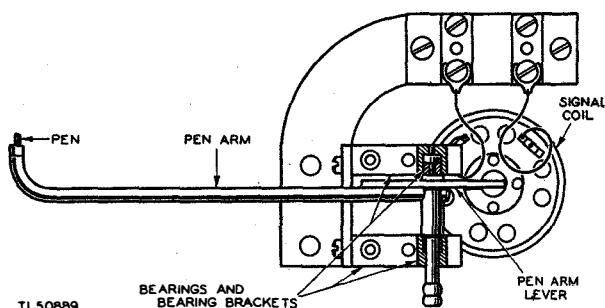


Figure 65. Sketch showing top view of pen and signal coil.

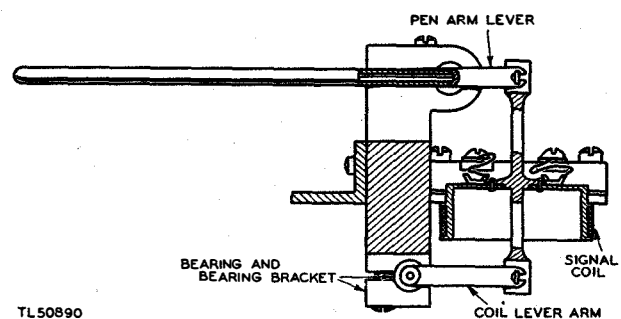


Figure 66. Sketch showing side view of pen and signal coil.

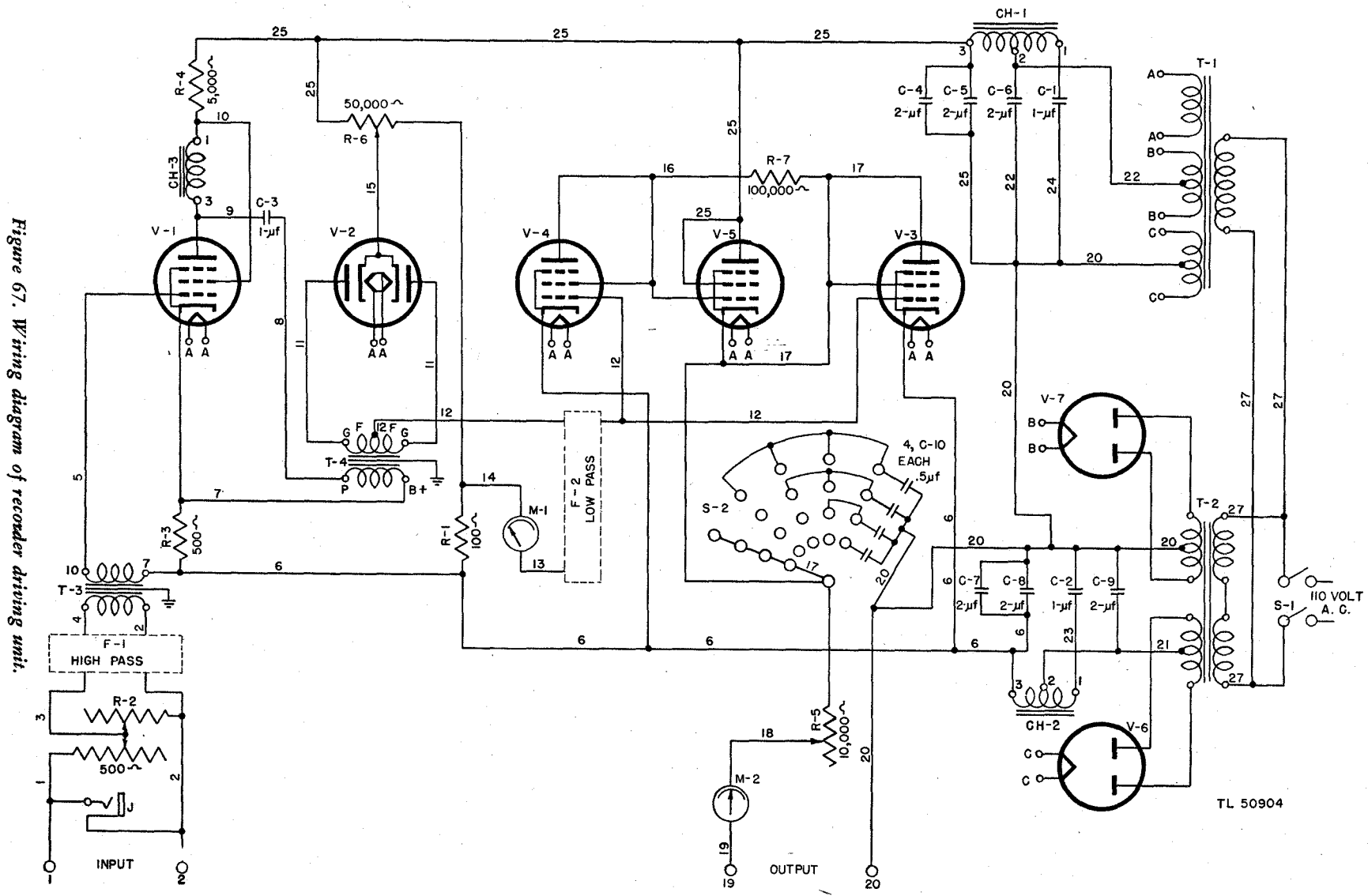
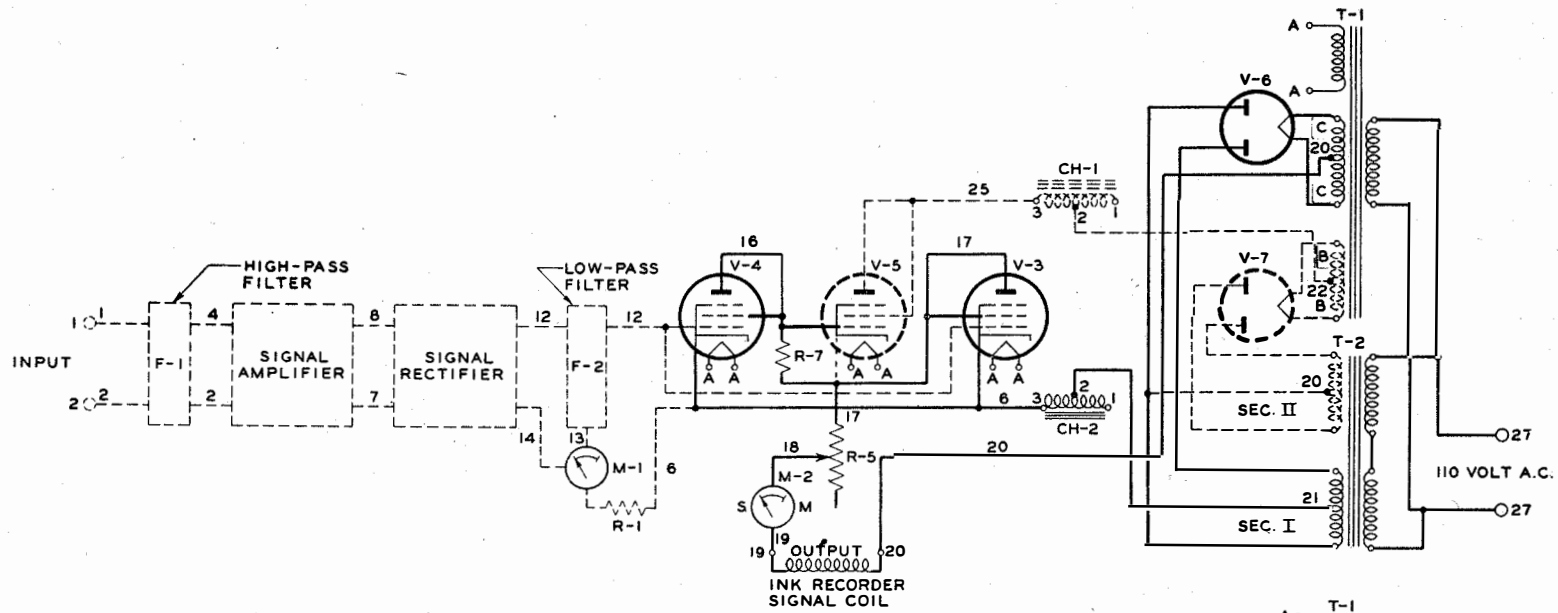


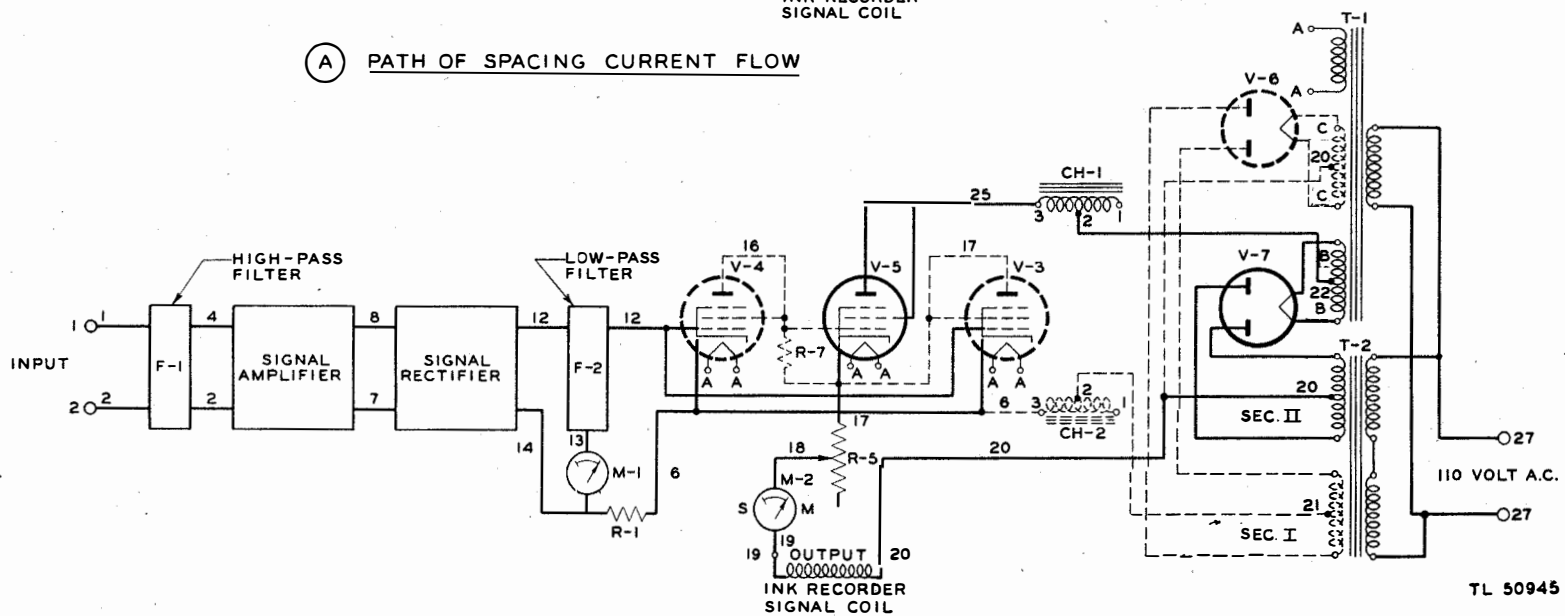
Figure 67. Wiring diagram of recorder driving unit.



Figure 68. Simplified version of wiring diagram showing paths of marking and spacing current flow.



(A) PATH OF SPACING CURRENT FLOW



(B) PATH OF MARKING CURRENT FLOW

TL 50945

## 62. MECHANICAL PARTS OF INK RECORDER.

**a. Ink Feeding.** The ink is fed by gravity from the ink pot (figs. 46 and 61) through the ink hose and through the hollow trunnion shaft and pen arm to the pen. The ink pot is mounted on top of a shaft which can be raised and lowered by means of a rack and pinion to vary the rate of ink flow. The faucet cone is used to shut off the ink supply.

**b. Tape Bridge.** (1) The tape bridge (figs. 51 and 61) has a long groove just large enough to permit the passage of  $\frac{3}{8}$ -inch paper recording tape, so placed that signals are in view as they are being recorded.

(2) The recorder tape bridge is supported at the right end by the tape bridge hinge pin, and is adjustable at the left end by means of the bridge adjusting screw, which permits the tape to set in proper position with respect to the pen.

(3) The tape guide spring holds the tape smooth as it passes the pen.

(4) Before entering the recorder tape bridge, the tape passes between two bristle brushes which remove lint from the tape to prevent clogging of the pen.

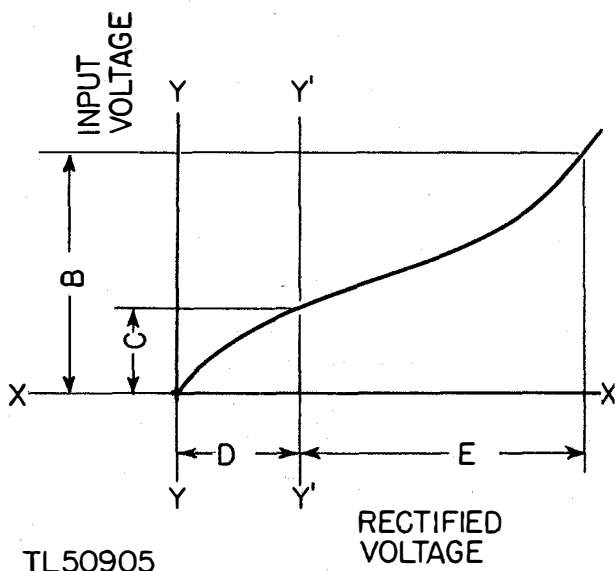


Figure 69. Rectified voltage diagram.

## 63. PRINCIPLE OF OPERATION OF RECORDER DRIVING UNIT (fig. 67).

**a. With No Signal at Input Terminals.** When there is no input signal, there can be no output signal from the audio amplifier; therefore, no rectified signal current passes through the low-pass filter (F-2) or through the rectified signal meter (M-1). Since no current flows through the low-pass filter, no voltage drop exists across the filter, and the grids of both the phase-shift

tube (V-4) and spacing tube (V-3) are *not* biased negatively. Each tube draws current: the spacing tube through the recorder signal coil circuit and the phase-shift tube through its 100,000-ohm plate resistor (R-7). The voltage drop across the phase-shift plate resistor is applied to the grid of the marking tube (V-5), biasing it to cut-off or beyond. Therefore, the output meter (M-2) indicates spacing current, and the recorder pen arm is forced to the lower (base) line.

**b. Circuit Run With No Signal Applied at Input Terminals.** With no signal applied at the input terminals, the spacing tube (V-3) conducts current (fig. 68A). Beginning at the plate of tube V-3, the circuit run is as follows: through conductor 17 to variable resistor R-5 (potentiometer used as rheostat); through conductor 18 to meter M-2 to output terminal 19; through signal coil of the ink recorder to output terminal 20; through conductor 20 to the center tap of the C section of the filament transformer for rectifier tube V-6; through tube V-6 to the center tap of the No. I section of the plate transformer for rectifier tube V-6; through conductor 21 to terminal 2 of choke CH-2; through conductor 6 from terminal 3 of choke CH-2 to the cathode of spacing tube V-3, thus completing the circuit.

**c. With 500- to 1,500-cycle Signal and More Than -8 Decibels at Input Terminals (fig. 67).** The signal input passes through the 500-ohm attenuator (R-2) and the 500-cycle high-pass filter (F-1). The signal input is then transformer-coupled to the audio amplifier tube (V-1) and is fed to the signal rectifier tube (V-2). The rectified signal feeds through the rectified signal meter into the low-pass filter, the negative side of which is connected to the grids of the phase-shift and spacing tubes. The rectified signal biases these tubes to cut-off or beyond, stopping the flow of current in both tubes. Since no current flows to the plate resistor of the phase-shift tube, no voltage is supplied to the grid of the marking tube (V-5). Therefore, current passes through the plate circuit of this tube and through the recorder signal coil circuit. This time, the direction of current in the recorder signal coil is opposite to that of the current which passes through the recorder coil under zero-signal conditions. The output meter indicates marking current, and the recorder pen arm is forced to the upper (marking) line.

**d. Circuit Run With a 500- to 1,500-cycle Signal at Input Terminals.** With a 500- to 1,500-cycle signal at the input terminals, the marking tube (V-5) conducts current (fig. 68B). Beginning at the plate of tube V-5, the circuit run is as follows: through conductor 25 to terminal 3 of choke CH-1; from terminal 2 of choke CH-1 through conductor 22 to the center tap of the B section of the filament transformer of rectifier tube

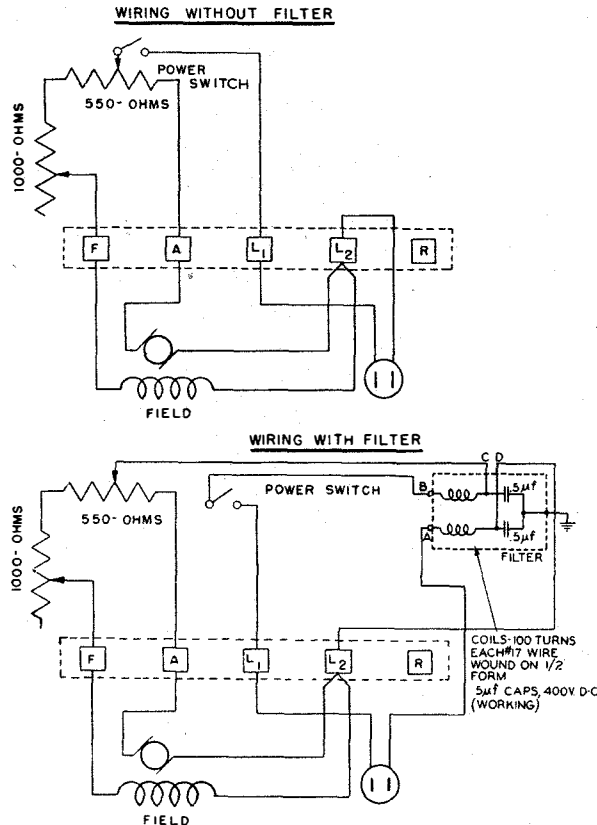
V-7; through rectifier tube V-7 to the center tap of the No. II section of the plate transformer for rectifier tube V-7; through conductor 20 to output terminal 20; through the signal coil of the ink recorder to output terminal 19; through conductor 19 to meter M-2; through conductor 18 to variable resistor R-5 (potentiometer used as rheostat); through conductor 17 to the cathode of the marking tube V-5, thus completing the circuit.

#### 64. THE FOUR CONTROLS OF RECORDER DRIVING UNIT (figs. 53 and 67).

The four controls on the front panel of the recorder driving unit are provided to make operation flexible. These controls are, from left to right:

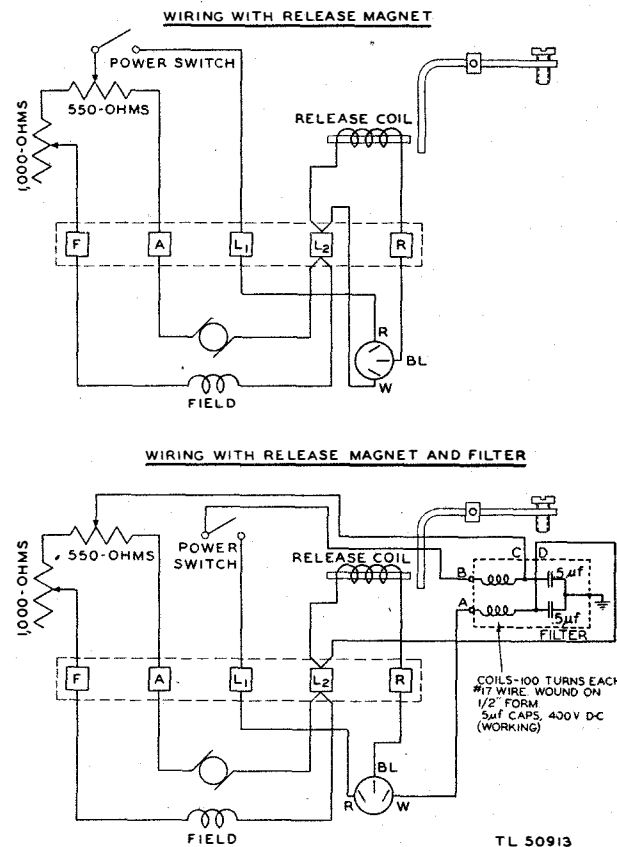
**a. The First and Second Controls.** (1) The attenuator control (R-2), marked INPUT, attenuates the incoming signal from 0 to 60 decibels, according to its position. This is range enough to keep the signal and noise within the range of the NOISE LEVEL control.

(2) The NOISE LEVEL control (R-6) is a potentiometer across the plate supply voltage. The potentiometer provides a variable bias voltage in the rectifier circuit to bias out a part of the rectified voltage equal to the noise level; this allows only the rectified signal



TL 50912

Figure 70. Wiring diagram of tape puller, type 4-F.



TL 50913

Figure 71. Wiring diagram of tape puller, type 4-F, equipped with magnetic release attachment, type 7-FA.

above noise to appear at the grid of the phase-shift tube and the spacing tube. A millimeter in series with the low-pass filter is used with this control. A description of the functioning of these first two controls follows:

(a) Consider a signal having a total input voltage, B, (fig. 69) of which a portion, C, is noise input. If this signal is fed into the rectifier, the noise, C, generates a voltage, D, at the grid of the phase-shift and spacing tubes. The noise component, D, of the rectified voltage must be biased out to obtain a portion, E, which is the rectified signal above the noise.

(b) The condition described in subparagraph (a) above is shown on the rectified voltage diagram (fig. 69) by a shift of the vertical axis, Y-Y, toward the right to Y'-Y'. The voltage to the left of the Y'-Y' axis is the bias voltage cancelling a like amount of rectified noise voltage. The voltage to the right of the Y'-Y' axis is the rectified signal above noise voltage. This rectified signal above noise voltage must be enough to bias the phase-shift and spacing grids at least to cut-off to obtain proper operation of the ink recorder.

(c) The rectified voltage diagram (fig. 69) shows that the bias voltage supplied by the NOISE LEVEL control

not only rejects the rectified noise but also rejects a like amount of rectified signal. The more the NOISE LEVEL control is turned counterclockwise, the greater is the loss of rectified signal. Increasing the input signal too much damages the unit. Therefore, the NOISE LEVEL control must be set to a point where noise is safely rejected, and where the signal input is limited so that the RECT. SIG. meter indicates 1.5 milliamperes.

**b. The Third Control.** (1) The third control, marked OUTPUT SHUNT, is a switch (S-2) which controls the number of capacitors (C-10) connected across the output to by-pass any audio-frequency which was not eliminated by the low-pass filter.

(2) For unmodulated input signals of 1,000 cycles or more, no output shunt capacitance is required. But, if the signals become ragged or if the frequency drops below 1,000 cycles, shunt capacitance must be cut in. This control is also effective in eliminating high-level peaked static and noise of a much higher frequency than the signal itself.

(3) The use of the OUTPUT SHUNT control is limited by the keying speed. At high keying speeds the time lag created by the shunt capacitance causes the vertical lines of the recorder signals to slope excessively. This slope is not noticeable at slow speeds.

**c. The Fourth Control.** The fourth control (R-5), marked OUTPUT, controls the output level and regulates the current passing through the recorder signal coil. This signal current should be kept as low as possible without giving a poor record on the tape.

#### 65. FUNCTIONING OF TAPE PULLER.

**a.** The tape puller, type 4-F (figs. 49, 54, and 55), pulls  $\frac{3}{8}$ -inch wide paper recorder tape at any desired speed within a wide range. When used with the ink recorder, the speed is set just fast enough to permit the recorder pen to leave a clear pattern in ink on the tape. Figures 70 and 71 show wiring diagrams of the tape puller with and without the magnetic release attachment, type 7-FA.

**b.** The gear box with its three speed ranges gives the over-all range of approximately 3 to 115 feet of tape per minute. In terms of words per minute, at the rate of 1 foot of tape for five words, its range is from approximately 15 to approximately 575 words per minute in the following steps:

- (1) Gear shift knob at position S: 15 to 65 words per minute.

- (2) Gear shift knob at position M: 45 to 200 words per minute.
- (3) Gear shift knob at position F: 175 to 575 words per minute.

#### 66. REWINDER REEL ATTACHMENT.

The rewinder reel attachment (fig. 56) rewinds the paper tape as fast as it is pulled by the tape puller. A steel spring belt on the rewinder allows for slippage due to the changing relation between the tape drive roller and the tape roll, which is constantly varying in diameter.

#### 67. MAGNETIC RELEASE ATTACHMENT.

This attachment (fig. 57) permits an operator to stop or restart the pulling of the tape from a remote position. The armature (fig. 72) operates the pressure roller bracket. When current flows through the coils, the armature extension moves away from the pressure roller bracket, permitting the spring to move the pressure roller against the drive roller in tape-pulling position. When current is not flowing through the coils, the release spring, acting through the armature and pressure roller bracket, lifts the pressure roller off the tape.

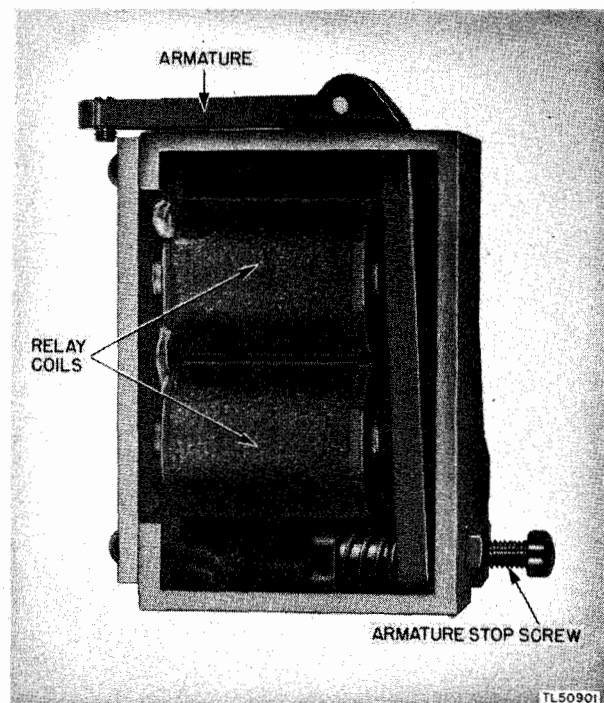


Figure 72. Magnetic release attachment, type 7-FA, internal view.

## SECTION IV

### MAINTENANCE

**NOTE:** UNSATISFACTORY PERFORMANCE OF THIS EQUIPMENT WILL BE REPORTED IMMEDIATELY ON WD, AGO FORM NO. 468. IF FORM IS NOT AVAILABLE, SEE TM 38-250.

#### 68. CLEANING AND INSPECTION OF INK RECORDER.

The ink recorder should be inspected and cleaned every day as follows:

a. Carefully brush off any dust that may have accumulated on top of the ink recorder. Be extremely careful not to sweep any dust or paper lint into the narrow gap around the signal coil.

**CAUTION:** NEVER BRING STEEL OR IRON TOOLS NEAR THE SIGNAL COIL WHEN THE 110-VOLT, D-C POWER IS ON. THE MAGNETIC ATTRACTION OF THE COIL FOR THE TOOL WILL SMASH THE TOOL AGAINST THE SIGNAL COIL OR THE PEN ARM HARD ENOUGH TO CAUSE SEVERE DAMAGE.

b. Make sure that there are no twists in the small ink hose (236).

c. Check the supply of ink in the ink pot.

d. Check the power and signal plug. See that all connections are secure.

#### 69. INSPECTION OF RECORDER DRIVING UNIT.

a. Make periodic inspections of the recorder driving unit. Examine cords and connections to associated equipment, making certain that all connections are secure.

b. Before removing the dust cover, be sure the power switch is in the OFF position. Remove any dust that may have collected. Be careful not to damage the wiring or break the tubes.

c. Inspect the recorder driving unit once a week for overheated transformers, which can be detected by the leaking of wax or filler compound. Adequate air circulation must be provided around the recorder driving unit to prevent overheating.

#### 70. LOCATING TROUBLE IN INK RECORDER.

Following are the remedies for recorder troubles which cause the pen to record only a straight line on the tape,

to make abnormal recording of signals, or to make no recording at all:

a. See that the recorder is getting a normal input signal.

b. Turn the adjusting screws (254) of the pen adjusting assembly to separate the pen arm stops so that the pen arm is not obstructed in either its upward or downward movement.

c. Make sure that the pen is not binding with the tape bridge (249). If the pen is pressing too hard against the tape in the tape bridge, move the bridge away from the pen. The pen should barely touch the tape.

d. Remove the power and signal receptacle from the ink recorder and move the pen arm up and down with the fingers to be sure that the signal coil system is moving freely. If it is not, check the bearings and signal coil alignment (pars. 71 and 72). Replace the receptacle.

e. Check to see that the two leads (272) from the signal coil have not become broken at the coil connection block.

f. Check to see that the field coil (265) is not open, and that field current is being supplied.

g. Blow dust and dirt from the circular coil aperture. If dust and dirt cannot be blown out, remove the signal coil as directed in paragraph 71 and clean the aperture. Replace the signal coil.

h. If the line drawn on the tape by the pen is too broad, the cause is paper lint sticking to the end of the pen. Remove such lint by dropping a little water on the point of the pen. If the line is too thin or is uneven, the cause may be too little paper pressure, a bent or loose pen, a clogged pen, or a dried-up ink hose. If the ink hose is dried up, replace it with a new hose. Clean the pen according to paragraph 75. Replace a bent or loose pen in accordance with paragraph 73.

i. If the faucet cone handle (224, fig. 73) sticks, empty the ink pot and remove the ink hose. Clean the ink hose and the valve with alcohol. Replace the ink hose and refill the ink pot with ink.

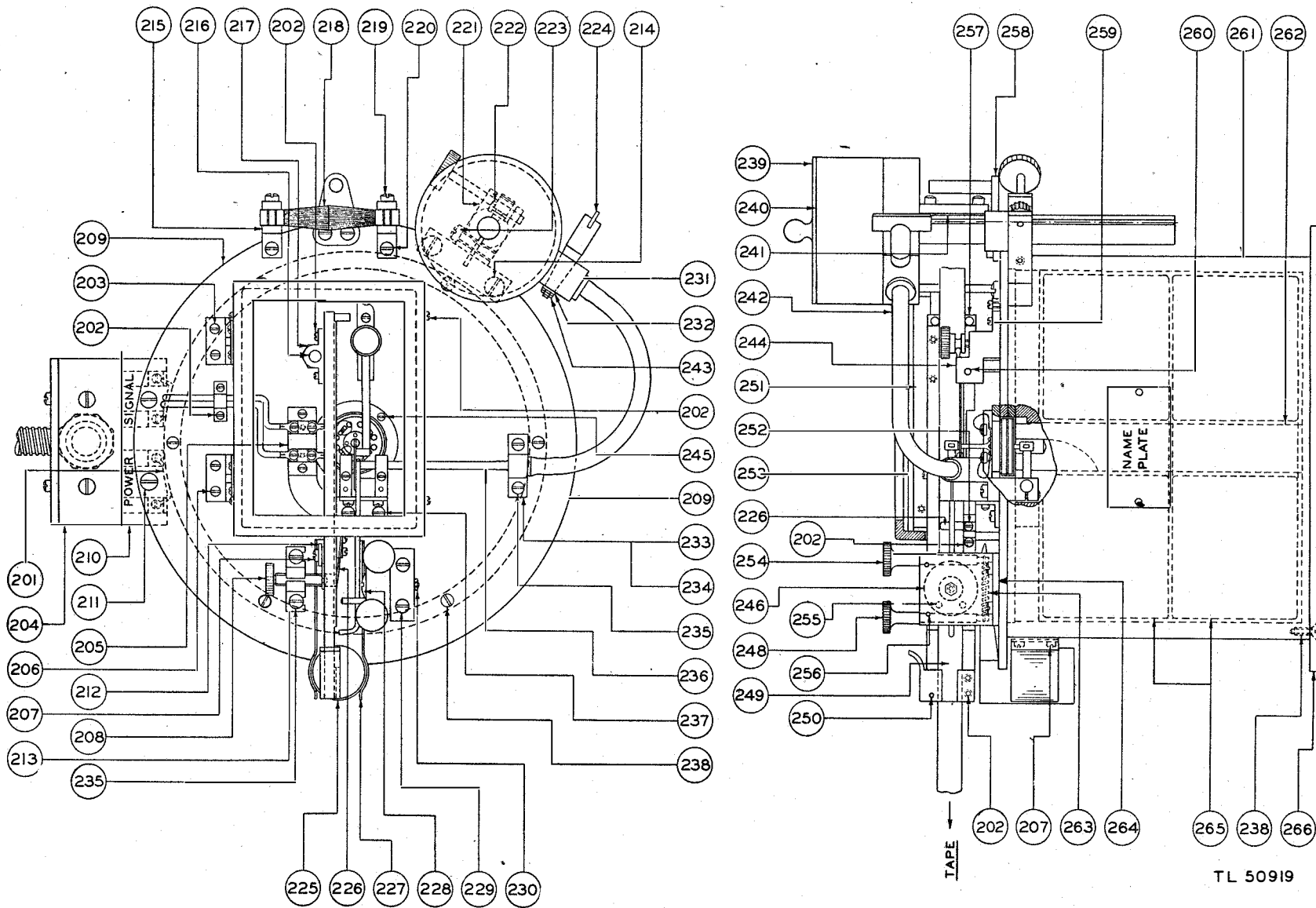
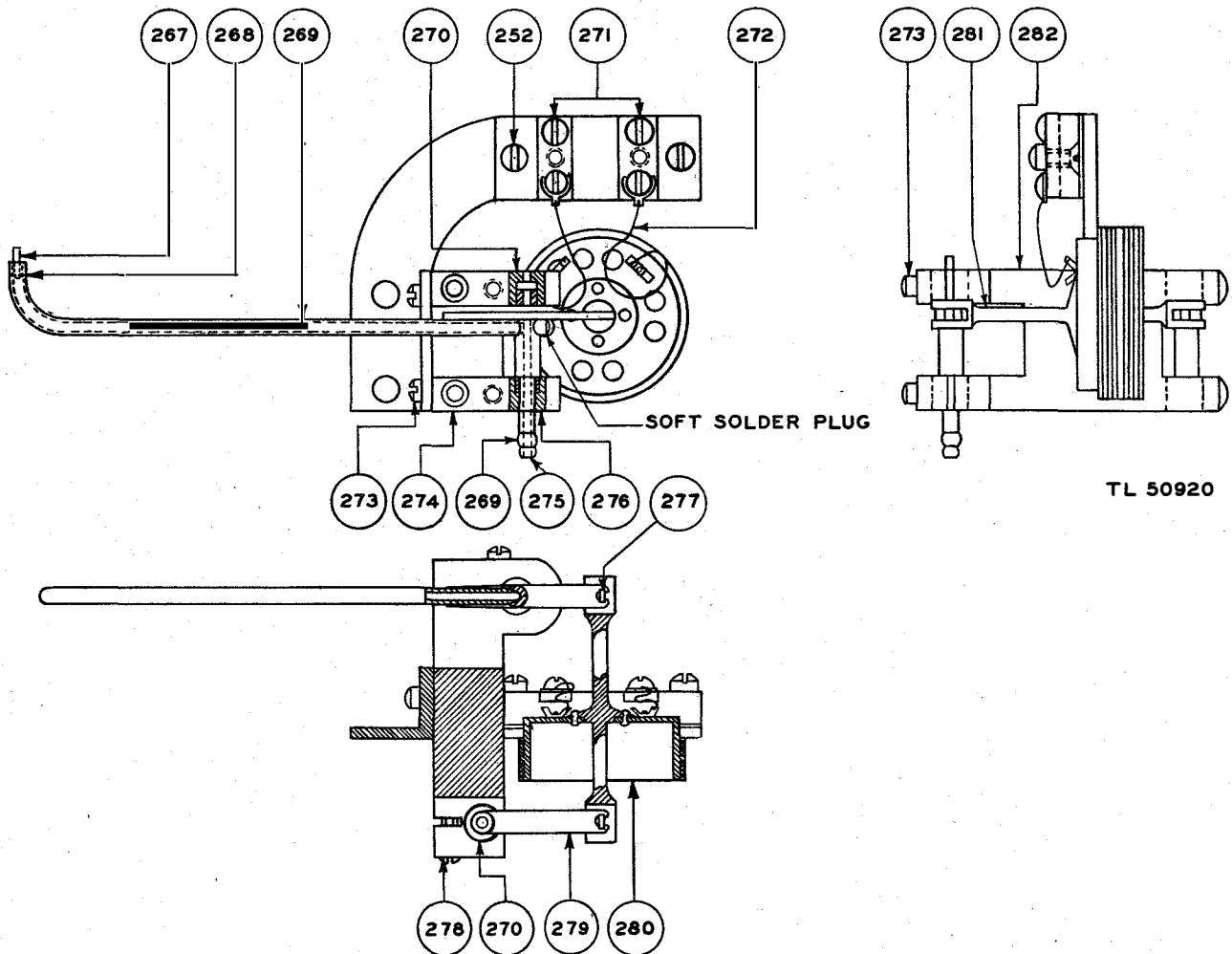


Figure 73. Ink recorder, general assembly.

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TL 50920

Figure 74. Signal coil assembly of ink recorder.

#### 71. REMOVING AND REPLACING SIGNAL COIL.

Figures 75 and 76 are step-by-step diagrams illustrating the proper operations for removal and replacement of the signal coil (280). These diagrams show how to remove the signal coil assembly (205) and how to unhinge the signal coil (280) from the assembly. To install a new coil or pen arm, reverse the steps in figures 75 and 76.

**CAUTION:** BE SURE TO TURN OFF THE POWER SUPPLY BEFORE MAKING REPAIRS OR ADJUSTMENTS.

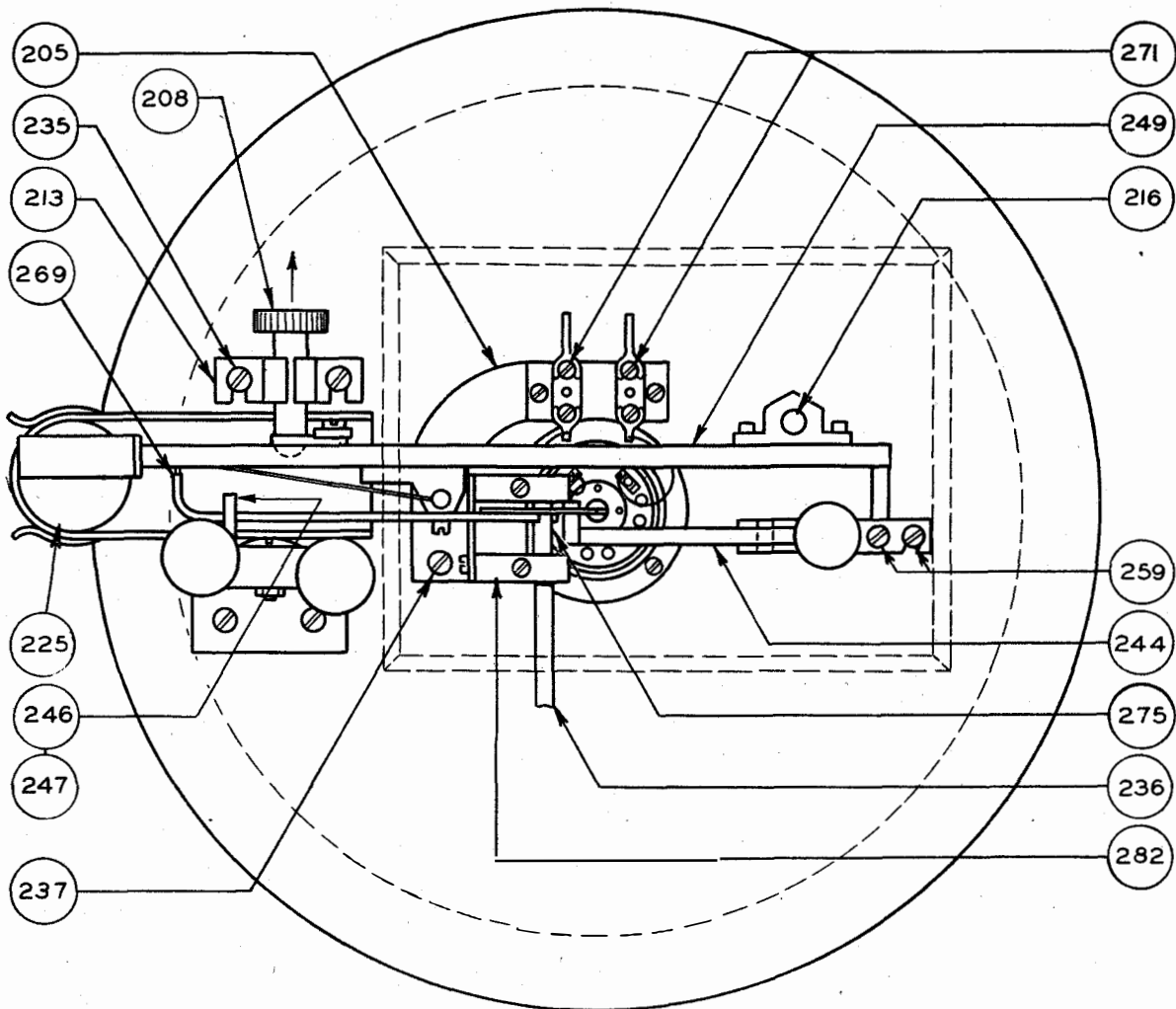
#### 72. REPLACING PEN ARM BEARINGS.

a. When replacing bearings 270 and 276, make sure that the rear bearing (270) is flush with the outside edge of the signal coil bracket; then clamp bearing 270

into position. Push the large bore bearing (276) in *lightly* until there is no side play in the trunnion shaft. The position of bearing 276 should permit the trunnion shaft to move freely when the bearing bracket has been tightened. Clamp the bearing into place. Coil the two connecting leads loosely enough to prevent interference with the free up-and-down movement of the coil.

b. Under conditions where it is not practicable to take the recorder out of service for any length of time, a complete signal coil assembly (205) should be kept on hand as a spare. This spare can be quickly set into place and the recorder can be put back in operation while the other signal coil assembly is being repaired.

c. After pen arm bearings have been replaced, position the tape bridge by turning the bridge adjusting screw (208) until the tape barely touches the end of the pen (267)



**STEPS**

- 1 REMOVE RUBBER HOSE (236) FROM END OF PEN ARM TRUNNION SHAFT (275) AND CLIP THE END WITH A PAPER CLIP OR OTHER MEANS TO PREVENT INK IN HOSE FROM RUNNING OUT. REMOVE RECEPTACLE (225) BY PULLING OUT FROM BETWEEN THE SPRING CLIPS.
- 2 LOOSEN SCREWS (235) AND PUSH BRACKET (213) BACK TO CLEAR SCREW HEADS.
- 3 REMOVE TAPE BRIDGE (249) BY GRASPING BRIDGE AT EACH END AND PULLING IT OFF GUIDE PIN (216) WHICH SHOULD BE OILED OCCASIONALLY.
- 4 LOOSEN SCREWS (259) AND SWING RESTRAINING SPRING (244) CLEAR OF PEN ARM LEVER ON PEN ARM ASSEMBLY (269)
- 5 LOOSEN SCREWS (271) HOLDING WIRES FROM PLUG ASSEMBLY (210) AND REMOVE TERMINALS.
- 6 REMOVE SCREWS (237) THEN REMOVE THE SIGNAL COIL ASSEMBLY (205) BY GRASPING BRACKET (282) AND LIFTING IT UPWARD, BEING CAREFUL NOT TO DAMAGE PEN ARM AGAINST ADJUSTABLE STOPS (246) AND (247)

**NOTE** - CLEAN DUST FROM COIL APERTURE BEFORE REPLACING ASSEMBLY.

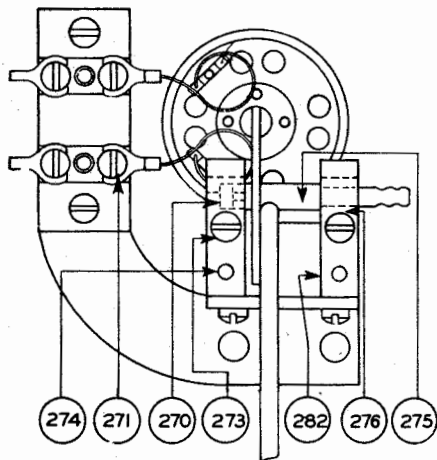
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Figure 75. Instructions for removing and replacing signal coil assembly (205) on ink recorder.

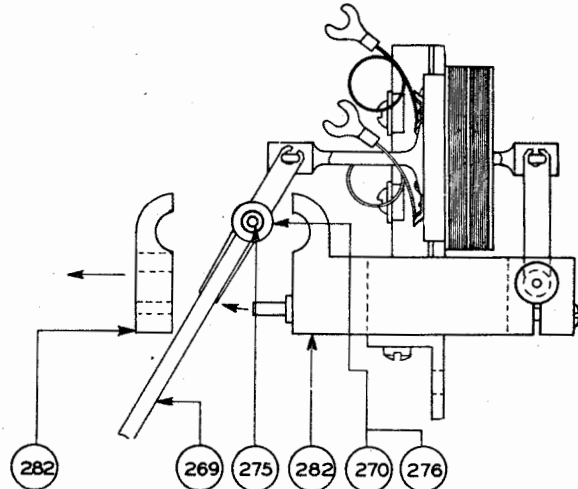


OPERATION NO. 1

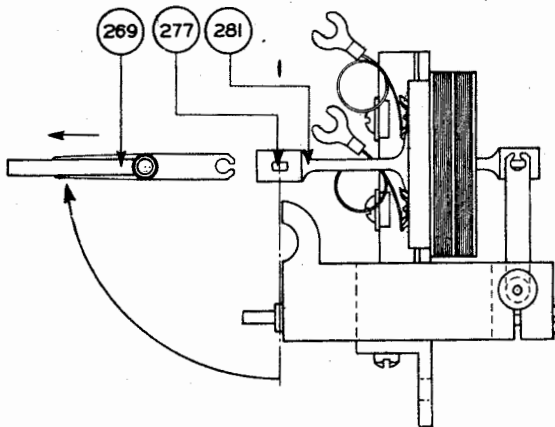
LOOSEN SCREWS (271) AND REMOVE TERMINALS FROM UNDER THEM. LOOSEN SCREW (273) AND REMOVE BEARING BRACKET (282) BEING CAREFUL NOT TO DAMAGE PIN (274).

OPERATION NO. 2

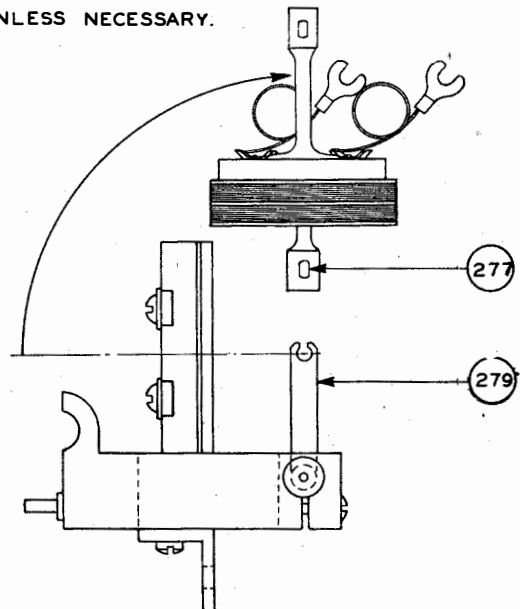
MOVE PEN ARM TRUNNION SHAFT (275) CLEAR OF BRACKET (282) BY PUSHING IN DIRECTION SHOWN BY ARROW AND REMOVE BEARING (270) AND (276) TO PREVENT ITS PARTS BEING LOST

OPERATION NO. 3

REMOVE PEN ARM ASSEMBLY (269) BY ROTATING IN DIRECTION SHOWN UNTIL IT IS IN LINE WITH GUIDE ROD (281) AND PULLING IT UPWARD REMOVE PIN (277) TO PREVENT LOSING IT BY PUSHING IT OUT FROM ONE SIDE.

OPERATION NO. 4

REMOVE SIGNAL COIL BY ROTATING IN DIRECTION SHOWN UNTIL IT IS IN LINE WITH COIL LEVER ARM (279) AND PULLING IT IN DIRECTION SHOWN REMOVE PIN (277) BUT DO NOT REMOVE LOWER BEARINGS OR COIL LEVER ARM UNLESS NECESSARY.



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Figure 76. Instructions for dismantling and reassembling signal coil assembly (205) on ink recorder.

### 73. REPLACING PEN (267).

a. Loosen the two screws (235) and push the tape bridge adjustment bracket (213) back to clear the screw heads.

b. Remove the tape bridge by grasping the bridge at each end and lifting it up off the tape bridge hinge pin (216).

c. Apply a light soldering iron to the pen arm at the end nearest the pen. *Be careful not to put enough pressure on the pen arm to bend it.*

**CAUTION: DO NOT HEAT THE REST OF THE PEN ARM ANY MORE THAN ABSOLUTELY NECESSARY.**

d. Remove the old pen from the bushing (268) with a pair of tweezers, being careful not to change the position of the bushing in the pen arm. Remove the bushing only when cleaning the pen arm.

**CAUTION: BE CAREFUL NOT TO LOSE THE BUSHING.**

e. With the soldering iron still in position, apply a spot of solder to the end of the pen arm. Do *not* overheat the pen arm.

f. Apply a small amount of flux to the middle of the new pen, and, with the soldering iron still on the tip of the pen arm, insert the new pen half-way through the bushing in the end of the pen arm.

g. Remove the soldering iron and run the pen cleaner tool (fig. 77) through the new pen to make sure the pen is clear.

### 74. REPLACING PEN ARM (269).

To remove the entire pen arm assembly, follow the same procedure used for removing the signal coil (par. 71).

### 75. CLEANING THE PEN.

a. When the pen becomes clogged, first remove the tape bridge as described in paragraphs 73a and b. Then carefully push the pen cleaner (4G-72) into the pen opening.

b. If the pen becomes severely clogged, remove the soft solder plug from the end of the pen arm where it extends through the trunnion shaft. Use a lightweight soldering iron for this operation. Clean out the pen arm tubing with a fine wire and alcohol.

**CAUTION: DO NOT OVERHEAT THE TRUNNION SHAFT OR THE ENTIRE PEN ARM ASSEMBLY MAY COME APART.**

c. To simplify cleaning the pen arm, first remove the pen and the bushing as described in paragraphs 73a, b, c, and d.

d. After cleaning the pen arm tubing, replace the soft solder plug to prevent ink leakage.

e. Ordinarily, stoppages of the ink flow can be remedied by squeezing the ink hose with two fingers of one hand near the ink pot and sliding them along the hose toward the pen arm. At the same time, with the other hand, hold the ink hose firmly over the nipple at the ink valve to prevent it from becoming disconnected.

### 76. REPLACING FIELD COILS (265).

The two field coil windings occupy the entire space within the coil pot (261) of the recorder (fig. 73). To replace them, proceed as follows:

**CAUTION: BE SURE TO TURN OFF THE POWER SUPPLY BEFORE MAKING REPAIRS OR ADJUSTMENTS.**

a. Disconnect the two wires connecting the field coils to the contact pins of the male power plug (210) after removing the two screws (211) and the plug block (291). Remove the four screws (288) and push the contact pins part way out of the block.

b. Loosen the screws (287) to disconnect the leads from the contact pins. Remove the screws (238) which hold the coil pot cover plate (209) to the coil pot. Lift off the cover plate without removing any of the other parts connected to it. Be careful not to damage the signal coil by bumping or striking it against the core.

c. Turn the coil pot upside down and shake out the defective coils. If the coils stick, warm the pot slightly.

d. To install a new set of field coils, arrange both coils so that the leads (201) extend from the upper side. Place one coil on top of the other. Connect the red wire of the bottom coil to the black wire of the top coil. Solder and tape the connection. Attach the two loose wires (one black and one red) to the male plug (210).

e. Insert the coils in the coil pot and lead the wires through the slot in the top of the pot. Replace the cover plate, being careful not to damage the signal coil or let the coil leads slip out of the slot and be cut in two when the cover is screwed down.

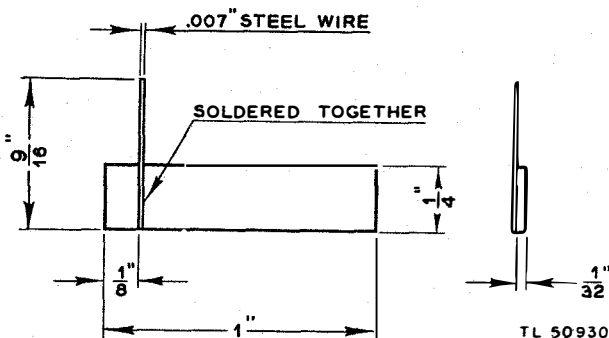


Figure 77. Pen cleaner (4G-72).

f. Connect the black wire to the large power contact pin (289) and connect the red wire to the small power contact pin (290). Push the contact pins back into posi-

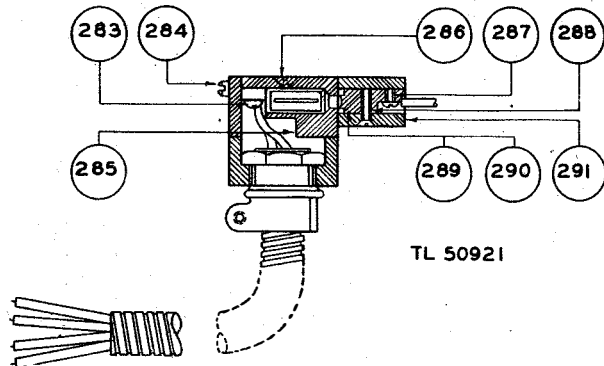


Figure 78. Section of plug and plug receptacle in ink recorder.

tion and replace the four screws (288). Then replace the male plug on the coil pot cover plate.

#### 77. TEMPORARY REPAIR OF FIELD COIL (265).

a. If only one of the two coils is damaged, remove both coils as described in paragraph 76. Unsolder the damaged coil from the good one, put the good coil back in the pot, and reconnect the power lead to the receptacle. With only half the normal resistance now in use with one coil, it is *absolutely necessary* that one of the following two things be done **BEFORE** putting the recorder back into service:

- (1) Place a 150- to 170-ohm resistance of at least 20-watt capacity in series with the good coil, or
- (2) Adjust the line voltage to 55-70 volts.

b. After this temporary repair has been made, the recorder works satisfactorily, but its top speed is reduced.

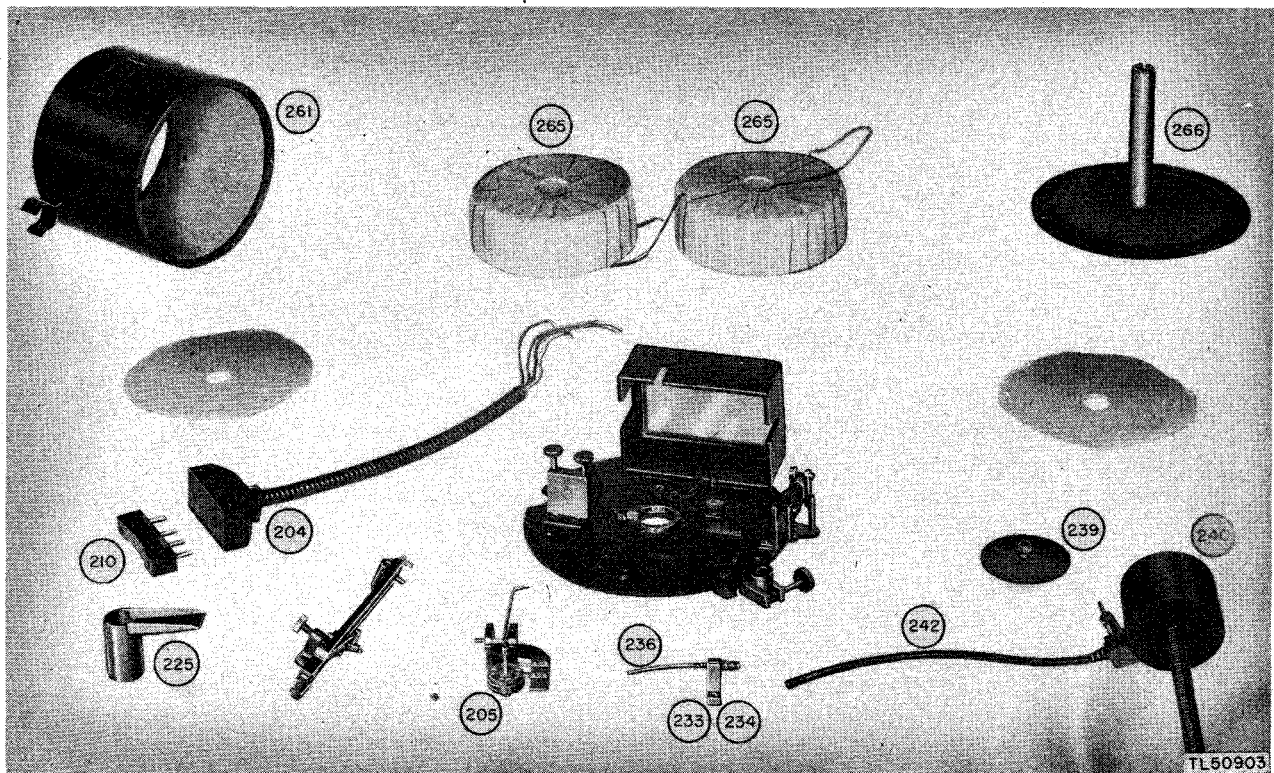


Figure 79. Ink recorder, disassembled view.

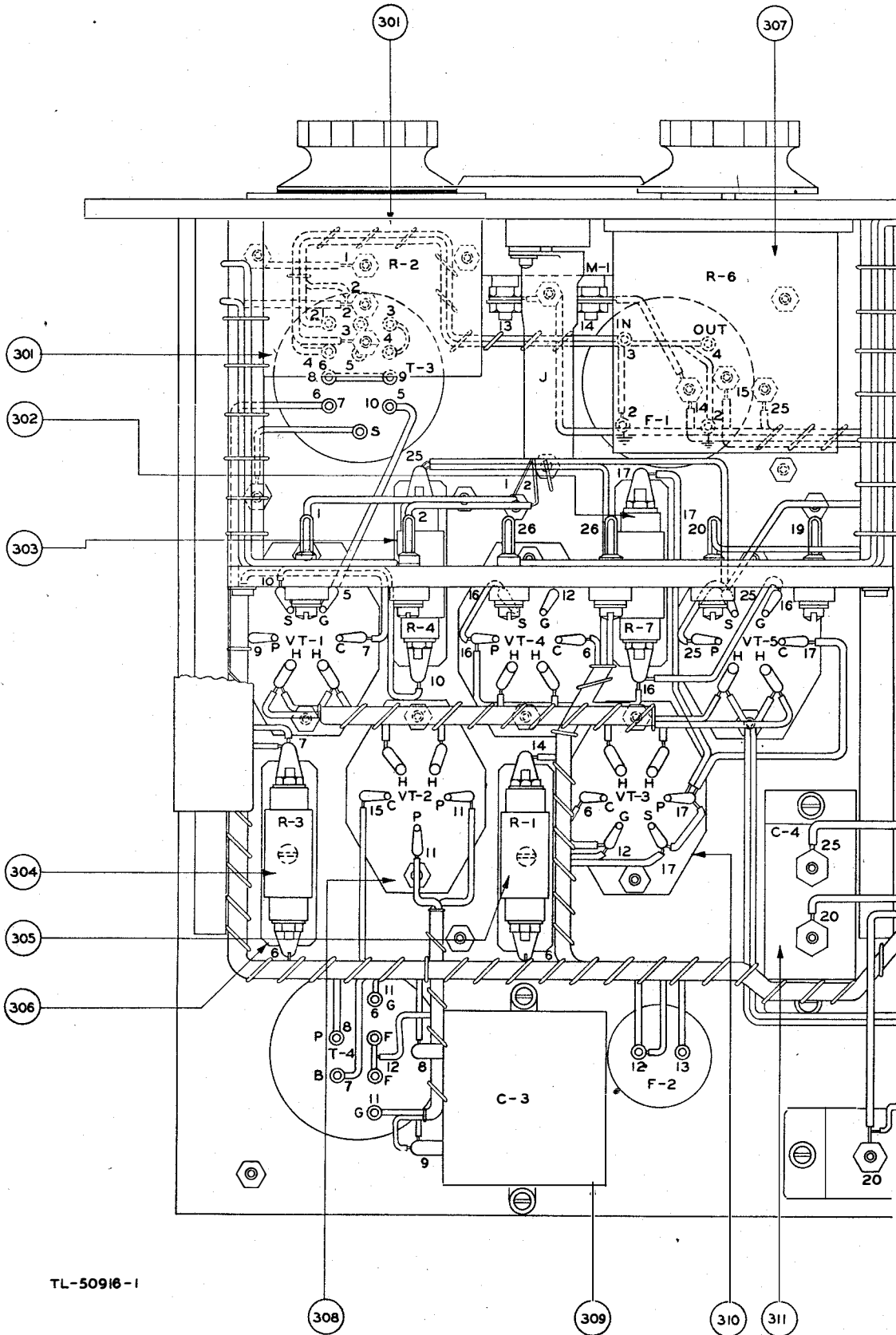
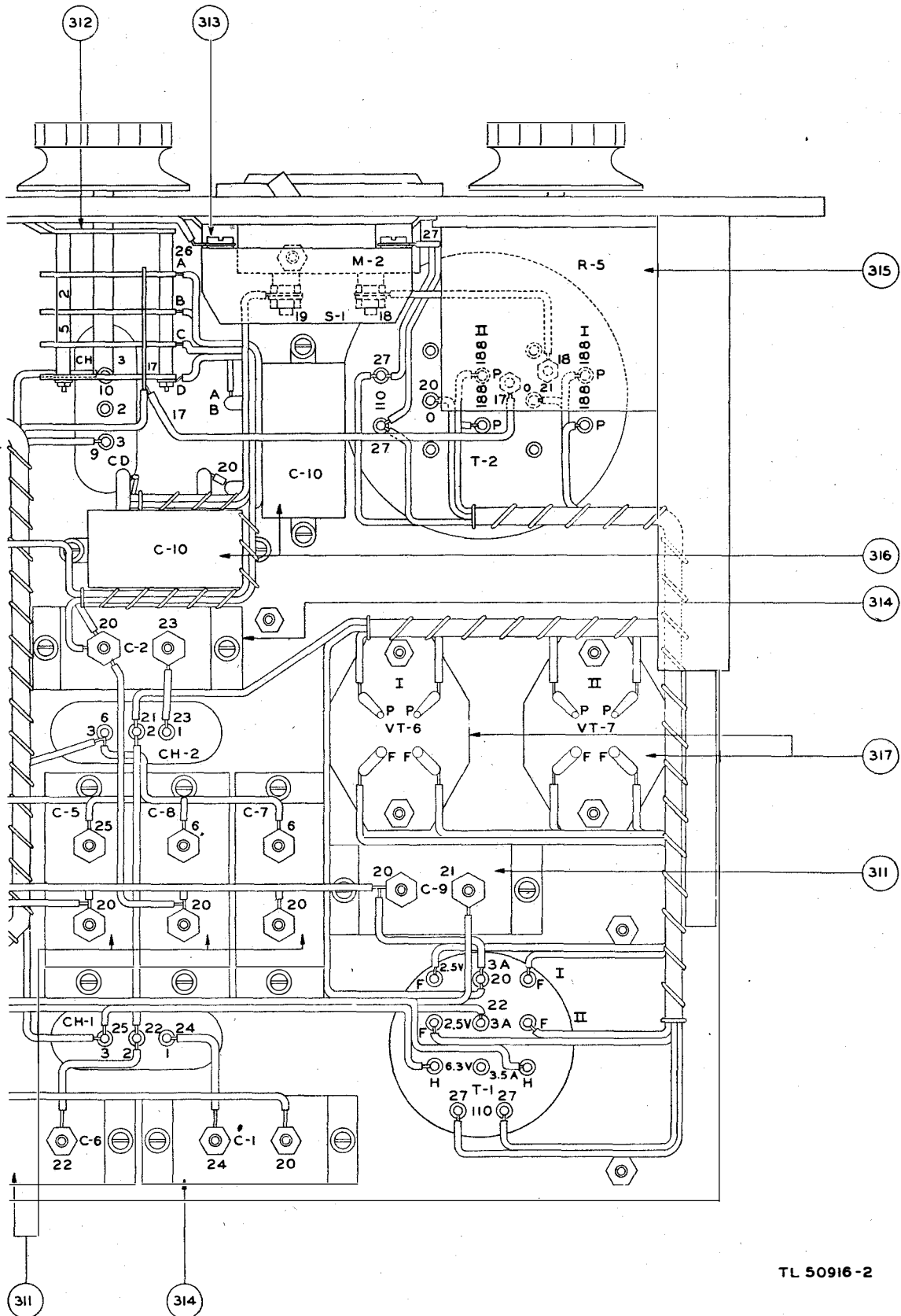


Figure 80. Recorder driving unit, bottom view.



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NOTE: NUMBERS IN CIRCLES ARE REFERENCE SYMBOLS FOR PARTS OR ASSEMBLIES WHICH ALSO APPEAR IN COLUMN 1 OF PARAGRAPH 87. MAINTENANCE PARTS LIST FOR RECORDER DRIVING UNIT, TYPE 4-C, OR WHICH ARE REFERRED TO IN TEXT. OTHER NUMBERS AND LETTERS REPRESENT CONNECTIONS AND TERMINALS SHOWN ON WIRING DIAGRAMS AND REFERRED TO IN TEXT.

## 78. LOCATING TROUBLE IN RECORDER

### DRIVING UNIT (figs. 80 and 81).

First check the d-c voltage across capacitors C-5 and C-8 to see that both power supplies are operating satisfactorily. The conditions stated in subparagraphs b and c below might be produced by shorted tubes. In either case, check tubes V-3, V-4, and V-5 for shorts and emission.

**NOTE: SEE PARAGRAPH 80 FOR VOLTAGE TABLE AND SETTINGS OF EQUIPMENT CONTROLS.**

**a. The Meter Marked RECT. SIG. Shows No Indication.** (1) Check the a-c voltage across terminals 7 and 10 of transformer T-3 with input signal applied. Lack of voltage indicates failure of one or more of the following parts: jack J, attenuator R-2, filter F-1, or transformer T-3.

(2) Check the a-c voltage across terminals G and G of transformer T-4 with input signal applied. Lack of voltage indicates failure in one or more of the following parts: tube V-1, choke CH-3, resistor R-3, resistor R-4, transformer T-4, or capacitor C-3.

(3) Check the d-c voltage across the terminals of filter F-2 with steady input signal applied. Lack of voltage indicates failure in one or more of the following parts: resistor R-1, meter M-1, potentiometer R-6, tube V-2, or filter F-2.

**b. The Meter Marked RECT. SIG. Indicates Satisfactory Signal through Filter F-2, but the Meter Marked OUTPUT Indicates Space Current Only.**

(1) Check the d-c voltage across resistor R-7 (see table I).

(2) Check the d-c voltage across the filter F-2 (see table I).

**c. The Meter Marked RECT. SIG. Indicates Satisfactory Signal through Filter F-2, but the Meter Marked OUTPUT Indicates Mark Current Only.** Check the d-c voltage across the filter F-2 (see table I).

**d. The Meter Marked RECT. SIG. Indicates Satisfactory Signal through Filter F-2, but the Meter Marked OUTPUT Fails to Indicate Anything.**

(1) Check resistance R-5 (see table II).

(2) Check meter M-2.

## 79. REPLACING PARTS.

To replace a recorder driving unit part, first remove the dust cover. If the part cannot then be reached, remove the recorder driving unit from its mounting rack. In soldering or unsoldering connections be very careful not to drop solder on the equipment. Drops of solder might short out a part.

**CAUTION: BE SURE TO TURN OFF THE POWER SUPPLY BEFORE MAKING REPAIRS OR ADJUSTMENTS.**

## 80. VOLTAGE AND RESISTANCE CHECKS.

**a.** Voltage and resistance measurements should check within 20 percent (voltmeter, 1,000 ohms per volt) except where total range is noted. Refer to tables I and II for point-to-point voltage and resistance values, respectively.

**b.** All ratings and measurements must be taken with the recorder driving unit set as follows:

(1) An 1,800- to 2,000-ohm load resistance (or a signal coil) across the OUTPUT control.

(2) OUTPUT control adjusted until meter indicates maximum output.

(3) OUTPUT SHUNT control set at zero.

(4) NOISE LEVEL control set at the middle of its arc.

(5) INPUT control set at zero.

(6) The signal source connected to the input should be capable of supplying 500 to 1,500 cycles at 0.75 volts into a 500-ohm load. Adjust the signal generator or radio receiver output until the RECT. SIG. meter indicates 2 milliamperes.

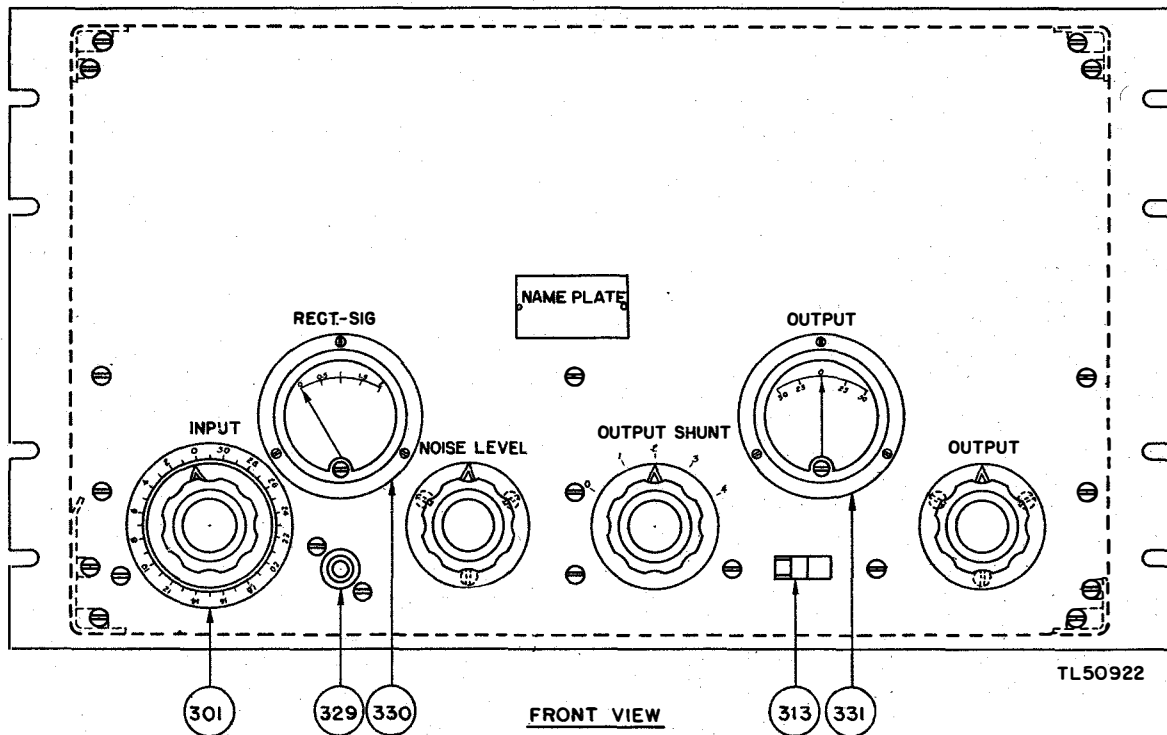
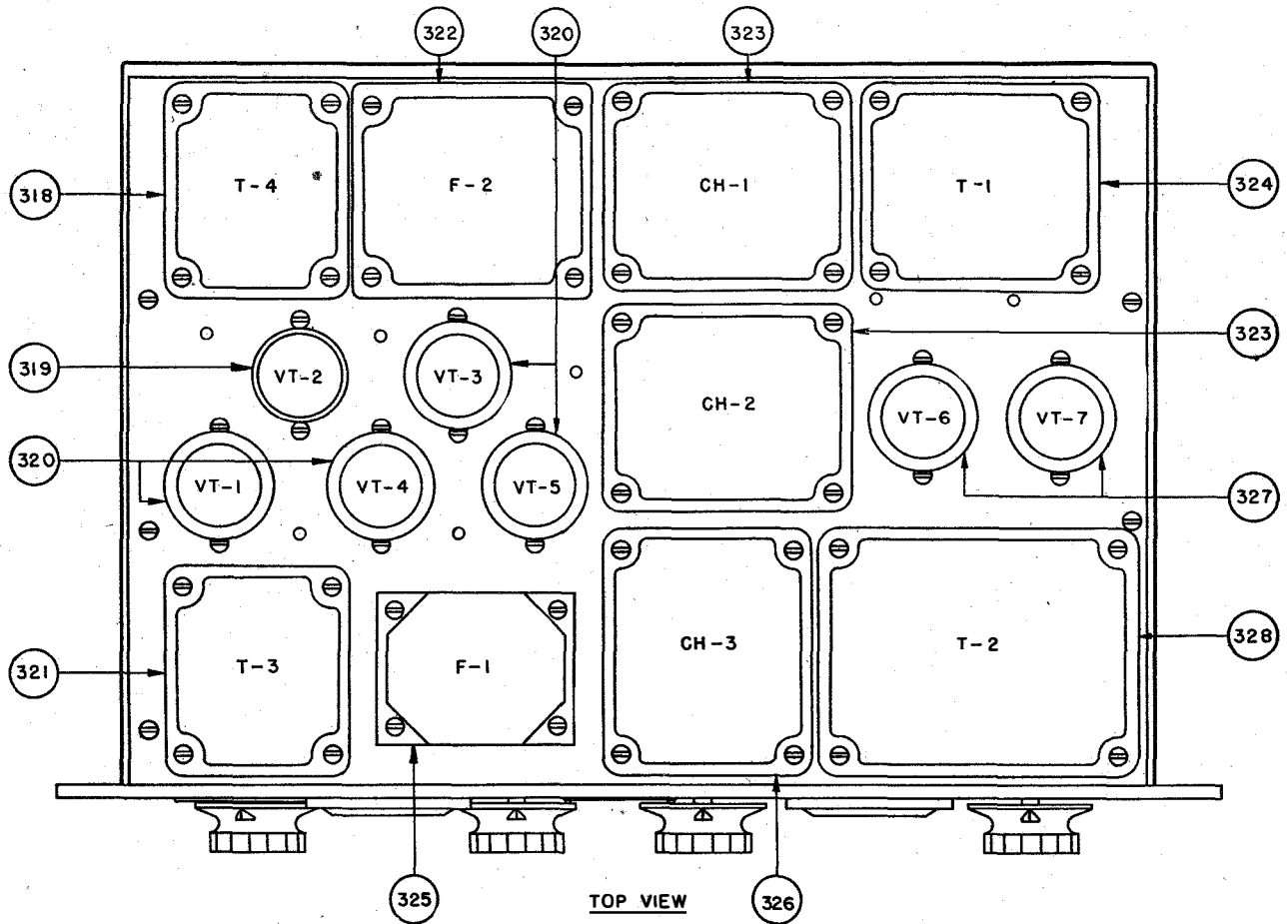


Figure 81. Recorder driving unit, general assembly.

**TABLE I**  
**POINT-TO-POINT VOLTAGES OF RECORDER DRIVING UNIT**

Part	Symbol	Terminals	D-C Volts*	
			Input signal OFF	Input signal ON
Tube	V-1	Cathode to screen grid.	270	270
"	V-1	Plate to cathode.	250	250
"	V-3	"	140	340
"	V-4	"	10	340
"	V-5	"	340	140
Capacitor	C-3	Across.	250	250
"	C-5	"	260	220
"	C-8	"	220	260
Resistor	R-1	Across.	0.5-1.5	0.5-1.5
"	R-3	"	18	18
"	R-4	"	195	195
"	R-7	"	130	0-15
Potentiometer	R-6	Across.	480	480
Filter	F-2	Across.	0	100-250

Part	Symbol	Terminals	A-C Volts*	
			Input signal OFF	Input signal ON
Transformer	T-4	B to P	0-15	0-100
"	T-4	G to G	0-100	600-1500
"	T-3	7 to 10	0	2-10

\* All voltages read on a 1,000-ohm-per-volt voltmeter.

**TABLE II**  
**POINT-TO-POINT RESISTANCES OF RECORDER DRIVING UNIT**

Part	Symbol	Terminals	Ohms
Resistor	R-1	Across.	100
"	R-3	"	500
"	R-4	"	5,000
"	R-7	"	100,000
Attenuator	R-2	Input.	300-600*
Variable resistor	R-5	Across.	10,000
Potentiometer	R-6	Across.	50,000
Filter	F-2	Across.	100,000
Transformer	T-3	1 to 6	100
"	T-4	B to P	1,600
"	T-4	G to G	11,000

\* Varies with attenuator rotation and is neither linear nor progressive.

**81. DISASSEMBLY AND REASSEMBLY OF  
TAPE PULLER GEAR BOX (fig. 83).**

When any of the parts in the tape puller gear box are being replaced, the following precautions must be taken:

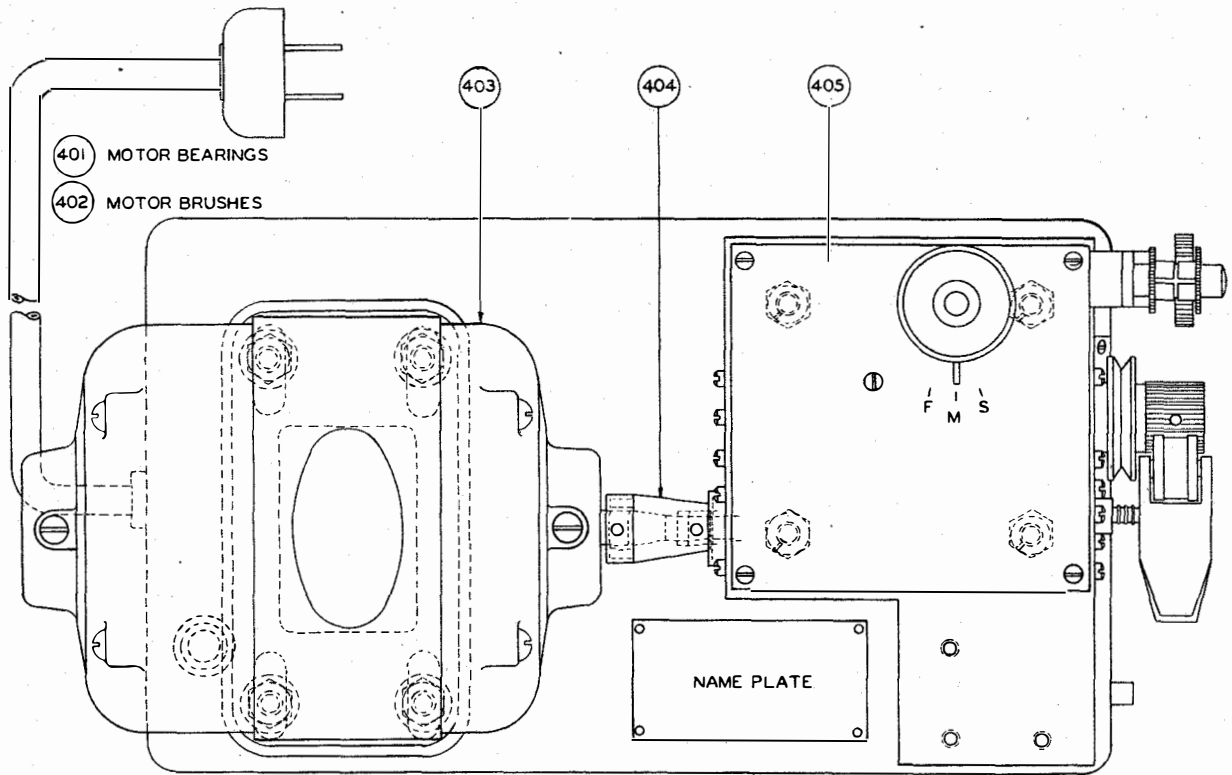
- a. When removing gears, first drive out all pins that hold the gears to the shafts, taking care not to bend the shafts.
- b. Remove the ball bearing covers. The shafts can

now be pulled out. Be careful that the gears do not butt against any other parts in the gear box hard enough to damage them.

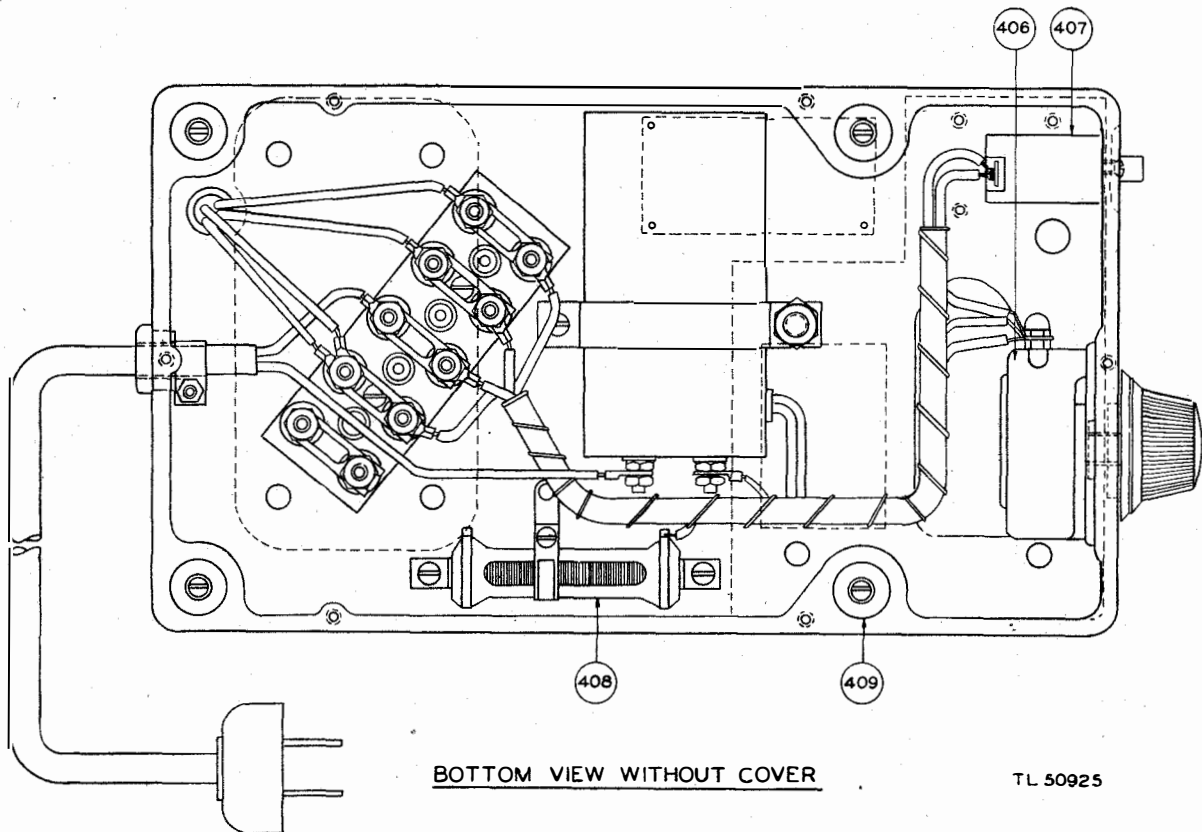
c. When replacing the gear box cover (422) and gasket (423), be sure that the lever roller (425) rests in the groove of the transmission coupling gear (412).

d. If the oil seals (420) for shafts 427 and 411 are removed, replace them with the hollow side of the seal toward the inside of the gear box.





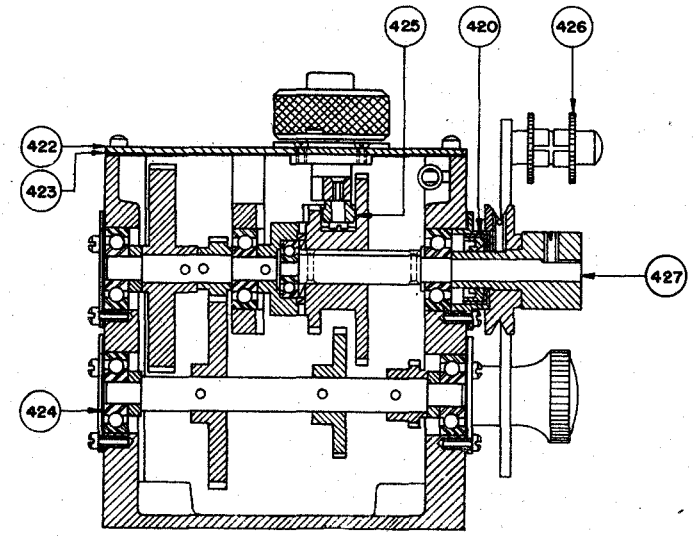
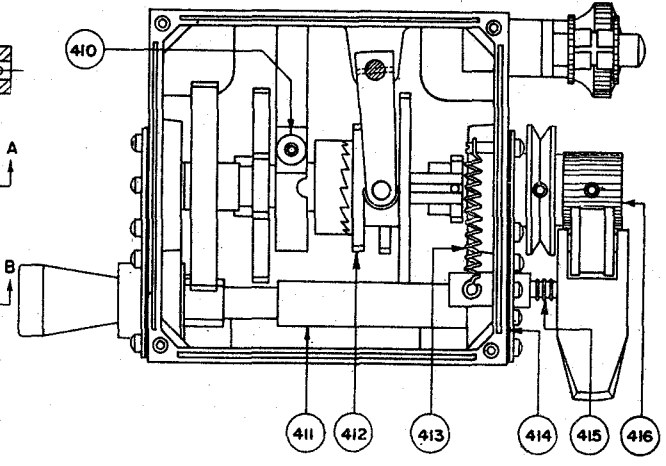
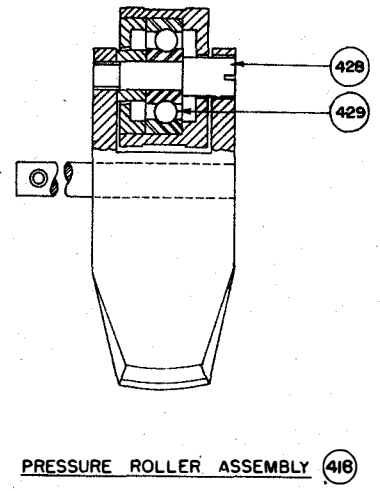
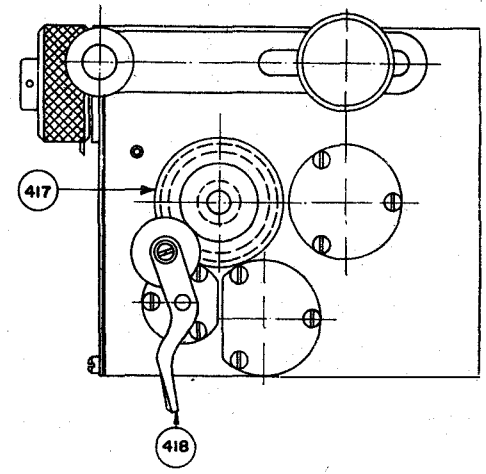
TOP VIEW



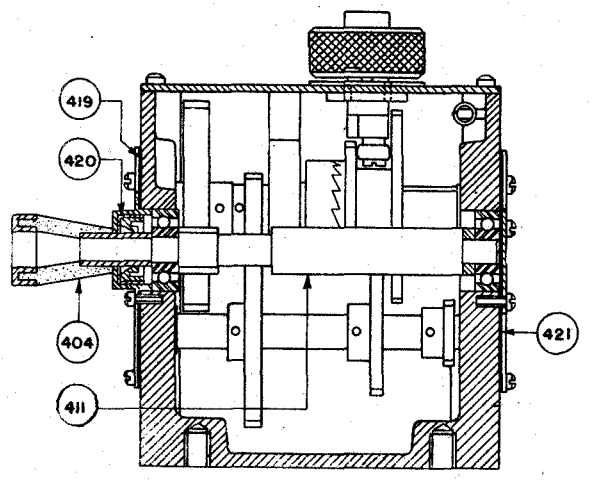
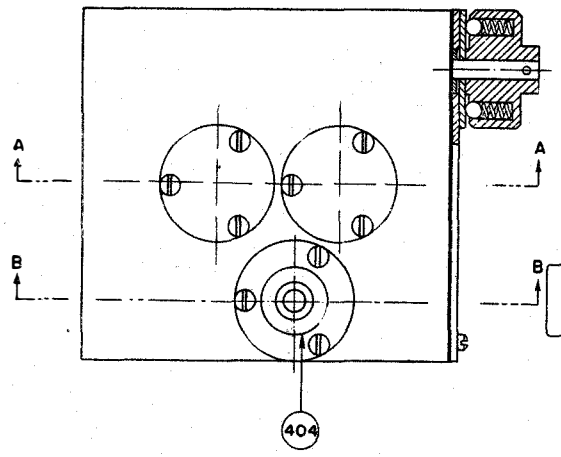
BOTTOM VIEW WITHOUT COVER

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Figure 82. Tape puller, general assembly, top and bottom views.



SECTION A-A



SECTION B-B

Figure 83. Tape puller gear box assembly.

## 82. LUBRICATION OF TAPE PULLER AND REWINDER REEL ATTACHMENT.

a. **Gear Box (fig. 83).** After every 6 months of continuous operation, clean and refill the gear box with 6 ounces of Oil, Engine, SAE 50, U. S. Army Specification 2-104B. To do so, remove the gear box cover and cover gasket (423) by removing the five screws that fasten the cover to the gear box. Turn the tape puller upside down and drain it thoroughly. Rinse with gasoline or similar cleaner and let the tape puller dry before filling it with new oil. When replacing the cover, be sure that the lever roller (425) is located in the proper groove (fig. 83). If oil leaks occur, make the necessary repairs immediately and check the amount of oil remaining in the gear box. Refill if necessary, as explained above.

b. **Motor.** After every 250 hours of continuous service, remove the screw at the top of each end of the motor housing and re-oil the ball bearings with Oil, Engine, SAE 50, U. S. Army Specification 2-104B.

c. **Pressure Roller (418).** Pack the pressure roller bearing (429) lightly with a non-fluid grease after every few weeks of continuous operation. Either Grease, Lubricating, Special, Specification AXS-637, or Grease, Teletypewriter, KS-7471, Signal Corps stock No. 6G-650, 1 pound container, may be used. In some localities Grease, Teletypewriter, KS-7471, is available in 4-ounce tubes (Signal Corps stock No. 4T97116). To reach this bearing, take out the pressure roller shaft (428), and remove the pressure roller. After packing the bearing with grease, replace the pressure roller and the shaft.

d. **Rewinder Reel Attachment, Type 4-FA (fig. 84)** Put an occasional drop of Oil, Engine, SAE 10, U. S. Army Specification 2-104B, in each oil hole of the two oilite bearings (430) at the top of the rewinder bracket.

## 83. ADJUSTMENT OF TAPE PULLER MAGNETIC RELEASE ATTACHMENT (figs. 83 and 85).

a. When the coils are energized, screw 437 must clear the lip of the pressure roller bracket assembly (436) enough to allow the pressure roller to press against the tape running over the drive roller.

b. When the coils are de-energized (current off), the armature should press on the pressure roller bracket assembly and lift the pressure roller off the drive roller (416). Adjust screw 438 so that when the coils are de-energized, the pressure roller (416) is lifted enough to prevent the pulling of the tape.

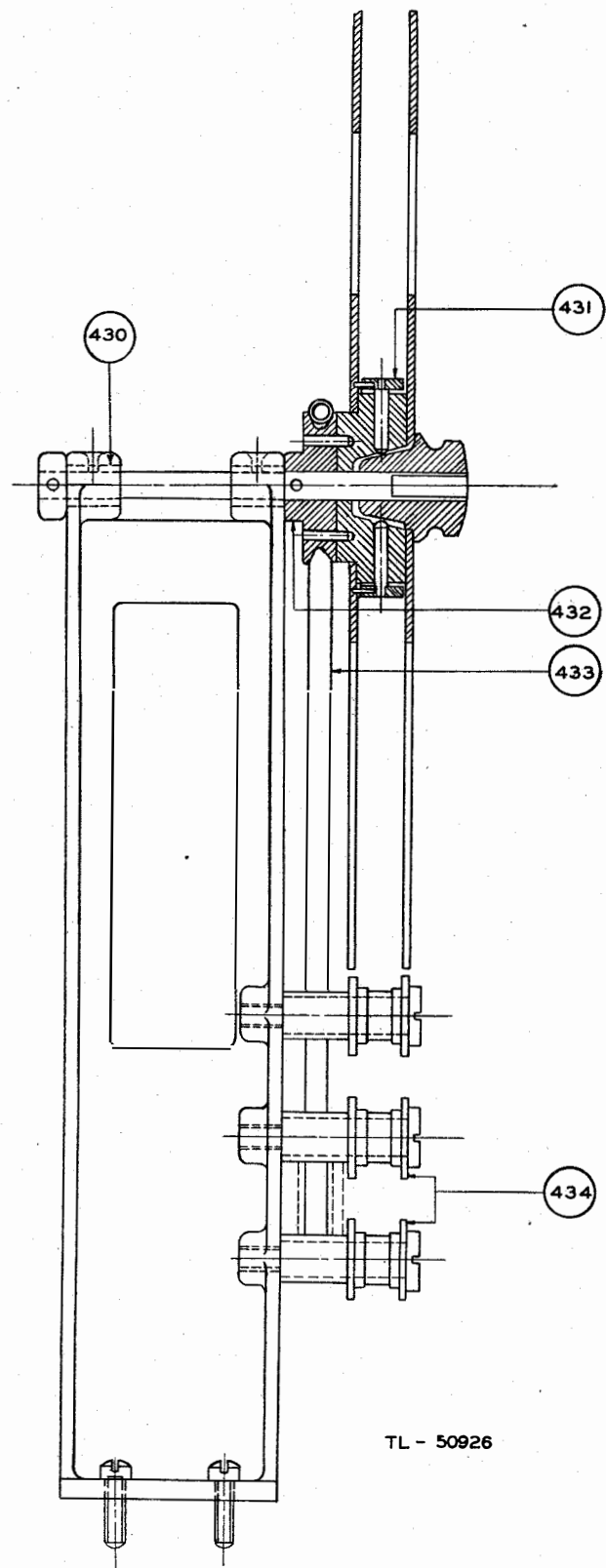


Figure 84. Tape puller rewinder reel attachment, side view.

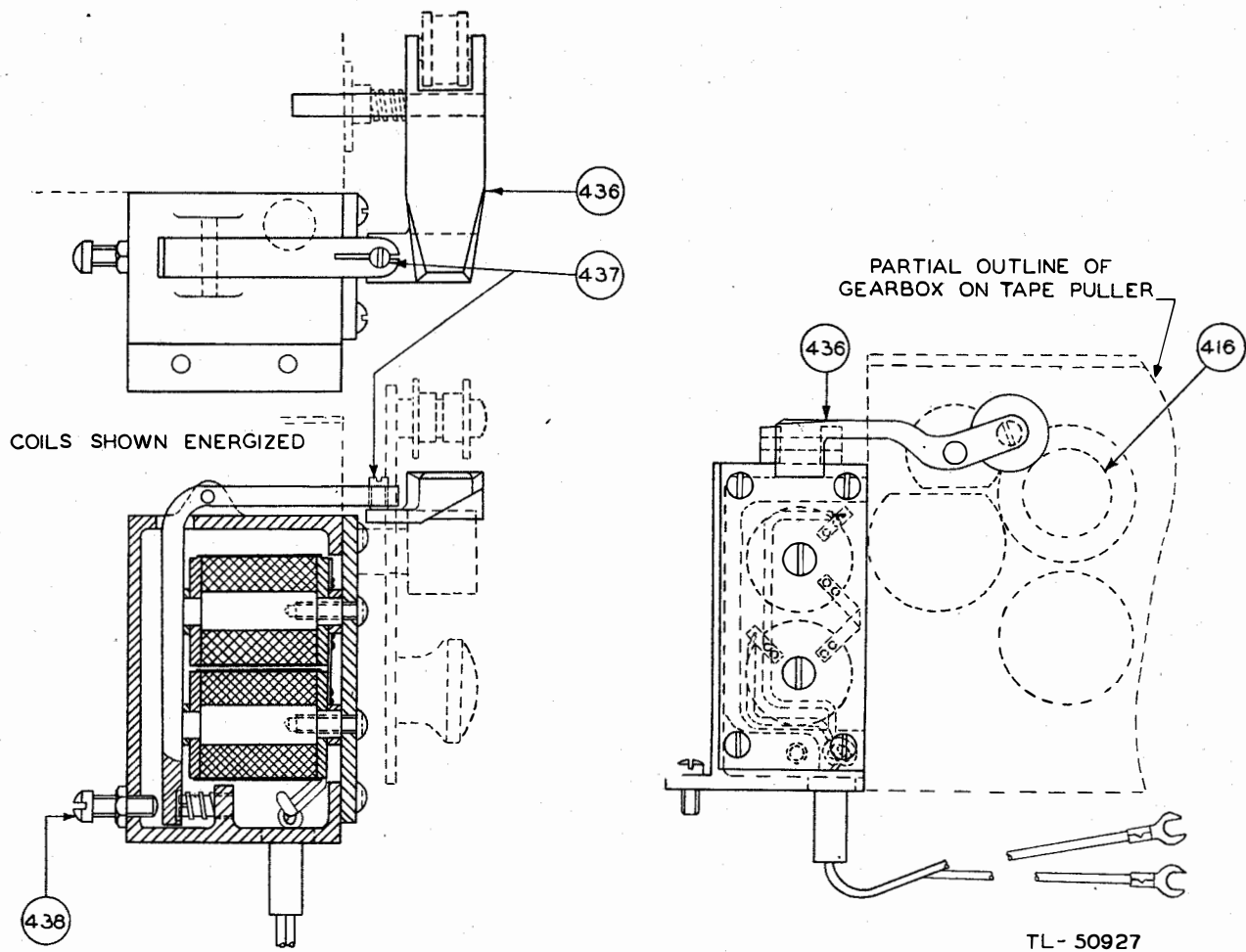


Figure 85. Tape puller magnetic release attachment.

**84. MOISTUREPROOFING AND FUNGIPROOFING OF RECORDING EQUIPMENT.**

Instructions and a list of materials for moistureproofing

and fungiproofing Boehme automatic recording equipment will be furnished in the form of a technical bulletin as soon as the information is available.

**SECTION V**

**SUPPLEMENTARY DATA**

**85. SPECIAL OPERATOR'S TABLE FOR RECORDING STATIONS.**

Several forms of special tables for recording equipment are in use in various localities. Since these tables are

procured separately to meet special requirements, they have been omitted from this technical manual. However, a wiring diagram of a typical operator's table for Boehme automatic recording equipment is shown in figure 86.

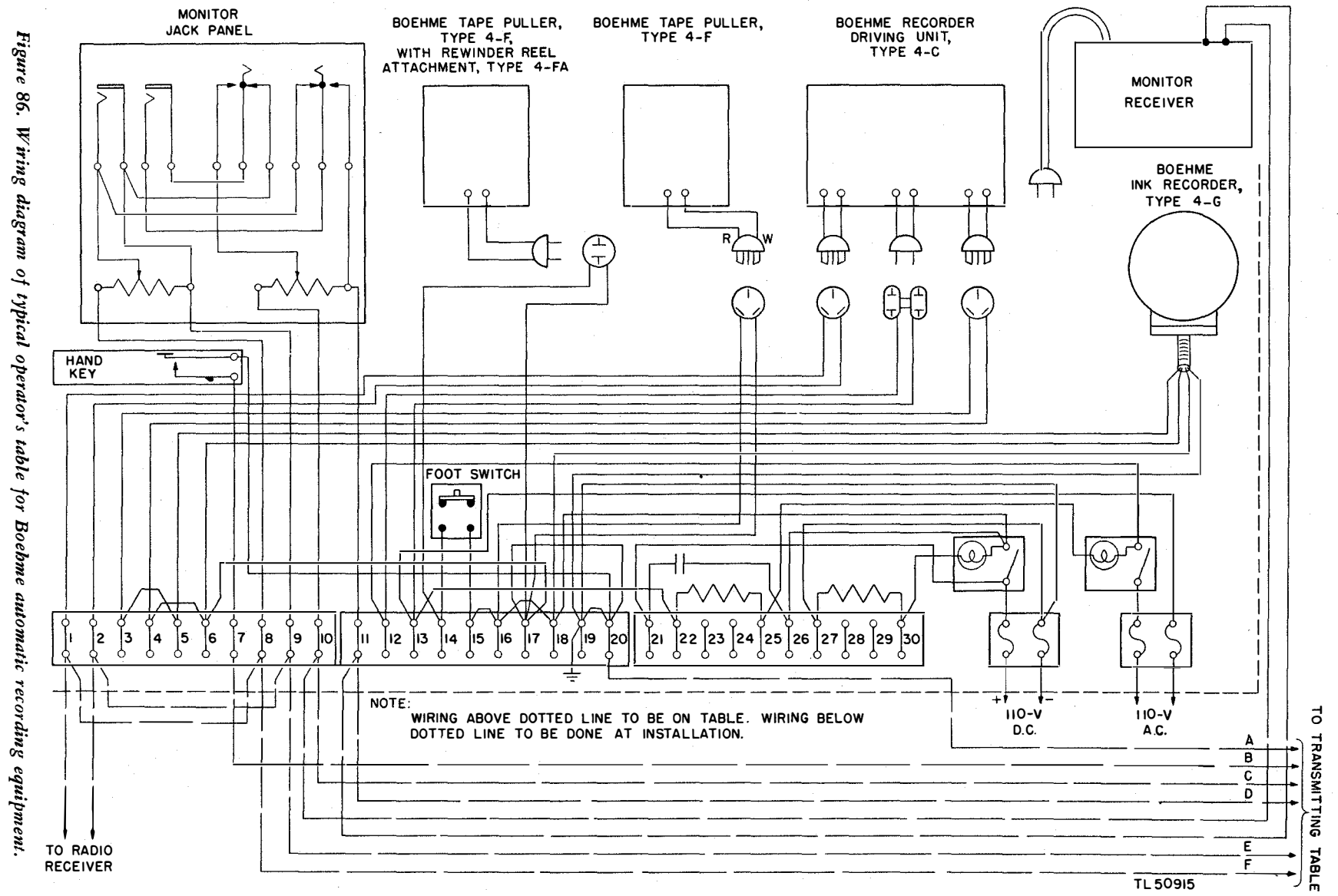


Figure 86. Wiring diagram of typical operator's table for Boehme automatic recording equipment.

**86. MAINTENANCE PARTS LIST FOR  
INK RECORDER, TYPE 4-G.**

in the maintenance list compiled by the Signal Corps Plant Engineering Agency. Parts referred to in the text but not included in the list are not stocked and should not be ordered.

The following list contains only those parts contained

**NOTE: ORDER MAINTENANCE PARTS BY STOCK NUMBER, NAME, AND DESCRIPTION.**

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A1954	BOEHME HIGH SPEED INK RECORDER #4-G.	1		*
279	4A1954/55	ARM: coil lever; dural; (Boehme #4G-55).	1	*	
270	4A1958A/98	BEARING: small bore; sapphire jewel; (Boehme #4G-61).	3	*	
276	4A1958A/99	BEARING: large bore; sapphire jewel; (Boehme #4G-62).	1	*	
291	4A1954/42	BLOCK: receptacle; black spauldite XXX; part of plug assembly 210; (Boehme #4G-42).	1		*
221	4A1954/9	BRACKET: ink pot guiding; brass; (Boehme #4G-9).	1		*
217	4A1954/15	BRACKET: hinge; brass; (Boehme #4G-15).	1		*
213	4A1954/19	BRACKET: bridge adjustment; (Boehme #4G-19).	1		*
215	4A1954/24	BRACKET: tape brush clamp; bronze; (Boehme #4G-24).	2		*
233	4A1954/32	BRACKET: ink hose connection; brass; (Boehme #4G-32).	1		*
264	4A1954/68	BRACKET: pen adjustment; brass; (Boehme #4G-68).	1		*
218	4A1954/160	BRUSH: lint-removing; hair; (Boehme #10G-49).	2	*	
268	4A1954/67	BUSHING: pen; nickel tube; (Boehme #4G-67).	1	*	
241	4A1954/23	CLAMP: tape brush; brass; (Boehme #4G-23).	2		*
227	4A1954/38	CLAMP: overflow receptacle; bronze; (Boehme #4G-38).	1		*
292	4A1954/41	CLAMP: ink hose, aluminum; used only in old models with rubber hose; (Boehme #4G-41).	1	*	
265	4A1954/D	COIL: field; complete; set of 2; (Boehme #4G-DA).	1		*
280	4A1954/K	COIL: signal; complete; (Boehme #4G-K).	1		*
239	4A1954/2	COVER: ink pot; brass casting; (Boehme #4G-2).	1		*
253	4A1954/36	COVER: glass; (Boehme #4G-36).	1	*	
224	4A1954/27	FAUCET CONE: with handle; phosphor-bronze; (Boehme #4G-27).	1		*
251	4A1954/35	HOLDER: glass cover; brass; (Boehme #4G-35).	2		*
242	4A1954/150	HOSE: plastic; 1/4" OD, 8" long; (Boehme #4G-150, Vynilite-200).	1	*	
236	4A1954/151	HOSE: plastic; 9/64" OD, 17/8" long; (Boehme #4G-151, Vynilite-200).	1	*	
240	4A1954/1	INK POT AND SHAFT ASSEMBLY: brass casting; (Boehme #4G-1).	1		*
272	4A1954/156	LEAD: with terminals; stranded-copper; (Boehme #4G-156).	2	*	
234	4A1954/33	NOZZLE: ink hose connecting; brass; (Boehme #4G-33).	1		*
231	4A1954/34	NOZZLE: ink pot; brass; (Boehme #4G-34).	1		*
243	4A1954/132	NUT: hex; brass; #3-48; (Boehme #4G-132).	2	*	
230	6L3104-40	NUT: hex; brass; #4-40; (Boehme #4G-139).	1	*	
269	4A1954/J	PEN ARM: complete; (Boehme #4G-J).	1		*
267	4A1954/65	PEN: nickel tube; (Boehme #4G-65).	1	*	
257	4A1954/26	PIN: tape guide; brass; (Boehme #4G-26).	1		*
216	4A1954/16	PIN: tape bridge hinge; brass; (Boehme #4G-16).	1		*
289	4A1954/43	PIN: contact; large; brass; (Boehme #4G-43).	2		*
290	4A1954/44	PIN: contact; small; brass; (Boehme #4G-44).	2		*
222	4A1954/131	PIN: drill rod; 1/32" x 3/16"; (Boehme #4G-131).	1		*
250	4A1954/134	PIN: drill rod; 1/16" x 3/16"; (Boehme #4G-134).	1		*
256	4A1954/135	PIN: drill rod; 0.040" x 5/16"; (Boehme #4G-135).	2		*

\* Indicates maintenance part available in station or region stock.

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
260	4A1954/138	PIN: hinge; drill rod; 3/32" x 9/32"; (Boehme #4G-138).	1		*
258	4A1954/25	PIN PLATE: tape guide; with pin; brass; (Boehme #4G-25).	1		*
210	4A1954/G	PLUG: power and signal; male; assembly; (Boehme #4G-G).	1		*
225	4A1954/13	RECEPTACLE: overflow; ink; brass; (Boehme #4G-13).	1		*
204	4A1954/A	RECEPTACLE: power and signal; female; assembly; (Boehme #4G-A).	1		*
208	4A1954/20	SCREW: bridge-adjusting; brass; (Boehme #4G-20).	1	*	
223	6L6832-6.3	SCREW: machine; fillister head; brass; #8-32 x 5/8"; (Boehme #4G-106).	1	*	
229	6L6632-5.3	SCREW: machine; fillister head; brass; #6-32 x 5/16"; (Boehme #4G-107).	2	*	
235	6L6632-6.3	SCREW: machine; fillister head; brass; #6-32 x 3/8"; (Boehme #4G-109).	4	*	
214	6L7032-8.3	SCREW: machine; fillister head; brass; #10-32 x 1/2"; (Boehme #4G-110).	2	*	
220	6L6632-4.3	SCREW: machine; fillister head; brass; #6-32 x 1/4"; (Boehme #4G-111).	4	*	
211	6L6832-8.3	SCREW: machine; fillister head; brass; #8-32 x 1/2"; (Boehme #4G-112).	2	*	
252	6L6256-3.3	SCREW: machine; fillister head; brass; #2-56 x 3/16"; (Boehme #4G-113).	3	*	
237	6L6540-5.4C	SCREW: machine; fillister head; brass; #5-40 x 5/16"; (Boehme #4G-114).	2	*	
202	6L6256-4.3	SCREW: machine; fillister head; brass; #2-56 x 1/4"; (Boehme #4G-117).	10	*	
207	6L6440-4.3	SCREW: machine; fillister head; brass; #4-40 x 1/4"; (Boehme #4G-118).	3	*	
219	6L6632-8.3	SCREW: machine; fillister head; brass; #6-32 x 1/2"; (Boehme #4G-121).	4	*	
259	6L6256-5.3	SCREW: machine; fillister head; brass; #2-56 x 5/16"; (Boehme #4G-122).	2	*	
273	6L6338-5.3	SCREW: machine; fillister head; brass; #3-48 x 5/16"; (Boehme #4G-125).	4	*	
278	6L6348-4.3	SCREW: machine; fillister head; brass; #3-48 x 1/4"; (Boehme #4G-126).	2	*	
284	6L6440-5.3	SCREW: machine; fillister head; brass; #4-40 x 5/16"; (Boehme #4G-222).	2	*	
288	6L6348-5	SCREW: machine; flathead; brass; #3-48 x 5/16"; (Boehme #4G-123).	4	*	
294	6L6256-3	SCREW: machine; flathead; brass; #2-56 x 3/16"; (Boehme #4G-127).	2	*	
286	6L6832-16	SCREW: machine; flathead; brass; #8-32 x 1"; (Boehme #4G-220).	2	*	
238	6L6540-6	SCREW: machine; flathead; iron; #5-40 x 3/8"; (Boehme #4G-108).	12	*	
245	6L6256-5.2	SCREW: machine; oval head; brass; #2-56 x 5/16"; (Boehme #4G-115).	4	*	
206	6L6256-4.2	SCREW: machine; oval head; brass; #2-56 x 1/4"; (Boehme #4G-116).	3	*	
203	6L6256-2.2	SCREW: machine; oval head; brass; #2-56 x 1/8"; (Boehme #4G-128).	1	*	
293	6L6256-4.1	SCREW: machine; round head; brass; #2-56 x 1/4"; (Boehme #4G-119).	4	*	
287	6L6348-2.1	SCREW: machine; round head; brass; #3-48 x 1/8"; (Boehme #4G-120).	4	*	
271	6L6256-2.1	SCREW: machine; round head; brass; #2-56 x 1/8"; (Boehme #4G-124).	4	*	
283	6L6348-2.1	SCREW: machine; round head; brass; #3-48 x 1/8"; (Boehme #4G-221).	2	*	

\* Indicates maintenance part available in station or region stock.

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
254	4A1954/71	SCREW: worm; brass; (Boehme #4G-71).	2	*	
205	4A1954/B	SIGNAL COIL ASSEMBLY: complete; (Boehme #4G-B).	1		*
244	4A1954/H	SPRING ATTACHMENT: single-current; complete; (Boehme #4G-H).	1		*
226	4A1954/18	SPRING: tape guide; phosphor-bronze; (Boehme #4G-18).	1		*
263	4A1954/74	SPRING: worm screw; music wire; (Boehme #4G-74).	1	*	
228	4A1954/70	STUD: worm wheel; cold-rolled steel; (Boehme #4G-70).	1		*
249	4A1954/8	TAPE BRIDGE: brass; (Boehme #4G-8).	1		*
212	6L50014	WASHER: tape bridge link; brass; (Boehme #4G-22).	1		*
232	6L50003	WASHER: brass; #3; (Boehme #4G-133).	1		*
246	4A1954/C69.1	WHEEL: worm; adjusting; with pin; without slot; (Boehme #4G-69a).	1	*	
247	4A1954/C69	WHEEL: worm; adjusting; with pin; with slot; (Boehme #4G-69b).	1	*	
TOOLS					
295	4A1954/72	PEN CLEANER: for ink recorder; (Boehme #4G-72).	1	*	

\* Indicates maintenance part available in station or region stock.

**87. MAINTENANCE PARTS LIST FOR RECORDER DRIVING UNIT, TYPE 4-C.**

in the maintenance list compiled by the Signal Corps Plant Engineering Agency. Parts referred to in the text but not included in this list are not stocked and should not be ordered.

The following list contains only those parts contained

**NOTE: ORDER MAINTENANCE PARTS BY STOCK NUMBER, NAME, AND DESCRIPTION.**

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
301 (R-2)	4A1213 2Z395.13	RECORDER DRIVING UNIT, TYPE 4-C ATTENUATOR: 30-500-ohm; 60 db; 1.5-w; (Boehme #4C-65).	1		*
316 (C-10)	3DA500-97	CAPACITOR: fixed; paper; oil; 0.5- $\mu$ f, 600-v dc (working); rectangular metal case; (Boehme #4C-74; Dubilier #DY6050).	1	*	
309 (C-3)	3DB1.6100A	CAPACITOR: fixed; paper; oil; 1- $\mu$ f, 600-v dc (working); rectangular metal case; (Boehme #4C-75; Dubilier #DY6100).	4		*
314 (C-1 and C-2)	3DB1.6010-3	CAPACITOR: fixed; paper; oil; 1- $\mu$ f, 600-v dc (working); rectangular metal case; ceramic insulated leads; (Boehme #4C-76; Dubilier #TD6010).	1	*	
311 (C-4, C-5, C-6, C-7, C-8, and C-9)	3D328	CAPACITOR CA-328; fixed; paper; oil; 2- $\mu$ f, 600-v dc (working); rectangular metal case; ceramic insulated leads; (Boehme #4C-77; Dubilier #TJ-6020, replacing and interchangeable with Dubilier #TD-7020).	2	*	
326 (CH-3)	4A1213/61	CHOKE: audio; 40-h; 60-ma, 500-ohm d-c resistance; (Boehme #4C-61; Kenyon #KC-40-60).	6	*	
323 (CH-1 and CH-2)	4A1213/62	CHOKE: filter; 15-h; 120-ma, 220-ohm d-c resistance; (Boehme #4C-62; Kenyon #KC-15-120).	1		*
325 (F-1)	4A1213/63	FILTER: audio; high-pass; special; (Boehme #4C-63).	2		*
322 (F-2)	4A1213/B	FILTER: audio; low-pass; special; (Boehme #4C-B).	1		*
329	2Z5524	JACK JK-24: telephone; open circuit; (Boehme #4C-79; W.E. Co. #218-A).	1		*
330	3F892	METER: d-c; 0-2-ma; (Boehme #4C-71; Triplett type #0221-T; De Jur Amsco type #210).	1		*

\* Indicates maintenance part available in station or region stock.



Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
331	3F905-5	METER: d-c; 50-0-50-ma; (Boehme #4C-72; Weston #506).	1		*
306	3Z3907	MOUNT: grid leak; (Boehme #4C-73; Aerovox #1049).	4		†
307 (R-6)	4A1213/66	POTENTIOMETER: 50,000-ohm, 12-w; (Boehme #4C-66; General Radio #471-A).	1	*	
315 (R-5)	4A1213/67	POTENTIOMETER: 10,000-ohm, 12-w; (Boehme #4C-67; General Radio #471-A).	1	*	
303 (R-4)	3Z6500-14	RESISTOR: fixed; 5,000-ohm, 10-w; (Boehme #4C-64).	1		*
305 (R-1)	3Z6010-13	RESISTOR: fixed; 100-ohm, 1-w; (Boehme #4C-68; Shallcross #100).	1		*
302 (R-7)	3Z6700-13	RESISTOR: fixed; 100,000-ohm, 1-w; (Boehme #4C-69; Shallcross #100).	1		*
304 (R-3)	3Z6050-5	RESISTOR: fixed; 500-ohm; 1-w (Boehme #4C-70; Shallcross #190).	1		*
332 (R-8)	3Z6720-8	RESISTOR: fixed; 200,000-ohm, $\pm 5\%$ ; 1-w; (Boehme #4C-98; IRC #BT-1).	1		*
333 (R-9)	3Z6620-11	RESISTOR: fixed; 20,000-ohm; $\pm 5\%$ ; 1-w; (Boehme #4C-99; IRC #BT-1).	1		*
310	2Z8676.28	SOCKET: tube; 6-prong; medium; isolantite; (Boehme #4C-51; Nat'l Co. #XC-6).	4		*
317	2Z8674.50	SOCKET: tube; 4-prong; medium; isolantite; (Boehme #4C-52; Nat'l Co. #XC-4).	2		*
308	2Z8764.8	SOCKET: tube; 5-prong; small; isolantite; (Boehme #4C-53; Nat'l Co. #XC-5).	1		*
312 (S-2)	3Z9826-4.1	SWITCH: drum-type; rotary; 5-position; 4-section; (Boehme #4C-78; Yaxley type #1346-L).	1		*
313 (S-1)	3Z9857.3	SWITCH: toggle; double-pole, single throw; flush; (Boehme #4C-83; Hubbell #9806).	1		*
321 (T-3)	4A1213/57	TRANSFORMER; input; audio; primary multiple line; secondary 80,000-ohm; (Boehme #4C-57; Kenyon #KLGA; Langevin #L-540).	1		*
318 (T-4)	4A1213/58	TRANSFORMER: interstage; audio; primary 15,000-ohm; secondary 200,000-ohm; (Boehme #4C-58; Kenyon #PPK-12-A; Langevin #L-541).	1		*
328 (T-2)	4A1213/59A	TRANSFORMER: plate; primary 110-v ac, 60-cps; secondary #1-400-v ct @ 100-ma, #2-375-v ct @ 100-ma; (Boehme #4C-59; Kenyon #S-2417; Red Arrow #307).	1		*
"	2Z9612.59	TRANSFORMER: plate; same as 4A1213/59A except 25-cps; (Kenyon #S-2419).	1		*
324 (T-1)	4A1213/60A	TRANSFORMER: filament; primary 110-v ac, 60-cps; secondary #1-6.3-v ct @ 3.5 amp; #2-2.5-v ct @ 3 amp; #3-2.5-v ct @ 3 amp; case #2; (Boehme #4C-60; Kenyon #S-1237; Red Arrow #309).	1		*
"	2Z9611.125	TRANSFORMER: filament; same as 4A1213/60A except 25-cps and case #3; (Kenyon #S-2420).	1		*
319 (V-2)	2V84	TUBE: rectifier; signal; type 84; (Boehme #4C-54).	1	*	
327 (V-6 and V-7)	2V82	TUBE: rectifier; power; type 82 (Boehme #4C-56).	2	*	
320 (V-1, V-3, V-4, and V-5)	2V42	TUBE: amplifier; type 42; (Boehme #4C-56).	4	*	

\* Indicates maintenance part available in station or region stock.

† Indicates maintenance part available in depot stock only.

**88. MAINTENANCE PARTS LIST FOR TAPE PULLER, TYPE 4-F, WITH REWINDER REEL ATTACHMENT, TYPE 4-FA.**

The following list contains only those parts contained

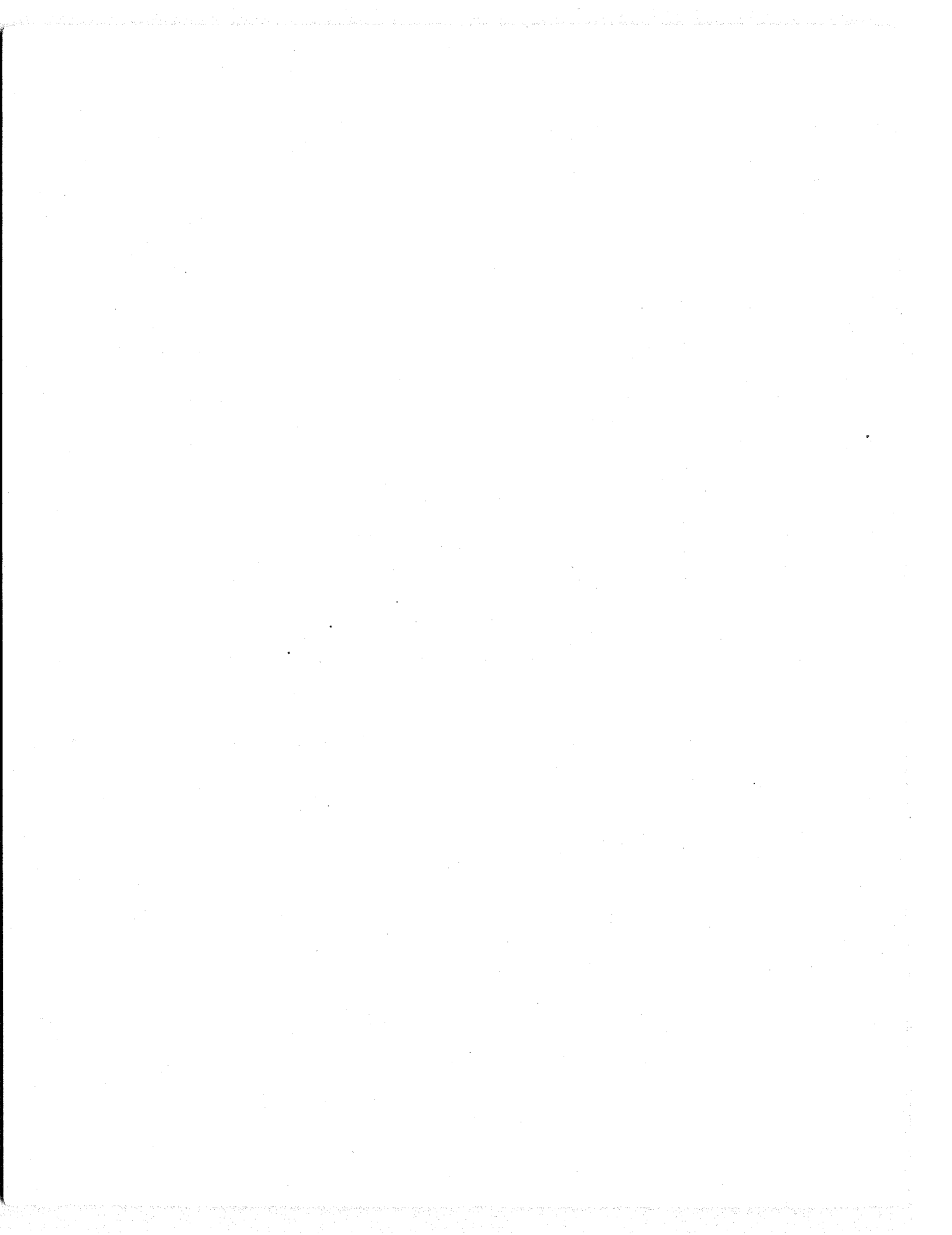
in the maintenance list compiled by the Signal Corps Plant Engineering Agency. Parts referred to in the text but not included in this list are not stocked and should not be ordered.

**NOTE: ORDER MAINTENANCE PARTS BY STOCK NUMBER, NAME, AND DESCRIPTION.**

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A2764.1	TAPE PULLER and MAGNETIC RELEASE ATTACHMENT ASSEMBLY: (1 each Boehme #4-F and #7-FA assembly).	1		*
	4A2764.2	TAPE PULLER and REWINDER REEL ATTACHMENT ASSEMBLY: (1 each Boehme #4-F and #4-FA assembly).	1		*
401	3H2337/4	BEARING: ball; for G.E. motor #5-BC26AC30; (N.D. #3200; Boehme #4F-200B).	2		†
430	4A2764/57	BEARING: oilite; (Boehme #4F-57).	1		*
433	4A2764/50	BELT: spring drive; music wire; (Boehme #4F-50).	1	*	
402	3H3100 A05-2/B1	BRUSH: motor; for G.E. motor #5-BC26AC30, carbon, 1/4" square by 3/4" long, complete with spring; 1/4" OD x 1 1/4" long, and pigtail; (Boehme #4F-200A).	2	*	
404	4A2764/33	COUPLING: flexible; steel and rubber; (Boehme #4F-33).	1		*
426	4A2764/31	FLANGE: tape guide; (Boehme #4F-31).	1		†
410	4A2764/89	GASKET: (Boehme #4F-89).	1	*	
421	4A2764/92	GASKET: bearing cover; (Boehme #4F-92).	1	*	
424	4A564/119	GASKET: bearing cover; (Boehme #4F-93).	3	*	
414	4A2764/95	GASKET: bearing cover; (Boehme #4F-95).	1	*	
423	4A2764/32	GASKET: cover; (Boehme #4F-32).	1	*	
419	4A564/120	GASKET: cover seal; (Boehme #4F-94).	2	*	
405	4A2764/C	GEAR BOX ASSEMBLY: complete; (Boehme #4F-C).	1		*
409	4A2764/215	LEG: rubber; (Boehme #4F-215).	4		*
403	3H3100A05-2	MOTOR: complete; G.E. #5-BC26AC30, 1/20-hp, 1725 rpm, 115-v dc modified; (Boehme #4F-200).	1		†
435	4A2764/P	PARTS: small; (packet consisting of miscellaneous assortment of small screws and pins for tape puller 4-F).	1	*	
418	4A2764/D	PRESSURE ROLLER ASSEMBLY: (Boehme #4F-D).	1		*
432	4A2764/81.1	PULLEY: driven; with pins #4F-82; (Boehme #4F-81).	1		†
417	4A2764/42	PULLEY: driving; (Boehme #4F-42).	1		†
408	3Z6100-147	RESISTOR: 1,000-ohm, 25-w IRC type DHA with brackets; (Boehme #4F-204).	1		*
406	4A2764/201	RHEOSTAT: 550-ohm, 50-w; Hardwick-Hindle type B-50; (Boehme #4F-201).	1		*
431	4A2764/51	RING: guide; 2 halves with pins #4F-52; (Boehme #4F-51).	1		†
416	4A2764/11	ROLLER: tape drive; (Boehme #4F-11).	1		†
434	4A2764/44	ROLLER: tape guide; (Boehme #4F-44).	3		†
420	4A2764/214	SEAL: oil; (Boehme #4F-214).	2	*	
415	4A2764/22	SPRING: release; (Boehme #4F-22).	1		*
413	4A2764/21	SPRING: stop; (Boehme #4F-21).	1		†
407	3Z9862-2.2	SWITCH: tumbler; single-pole, single-throw; flush; (G.E. #1299; Boehme #4F-203).	1		*

\* Indicates maintenance part available in station or region stock.

† Indicates maintenance part available in depot stock only.



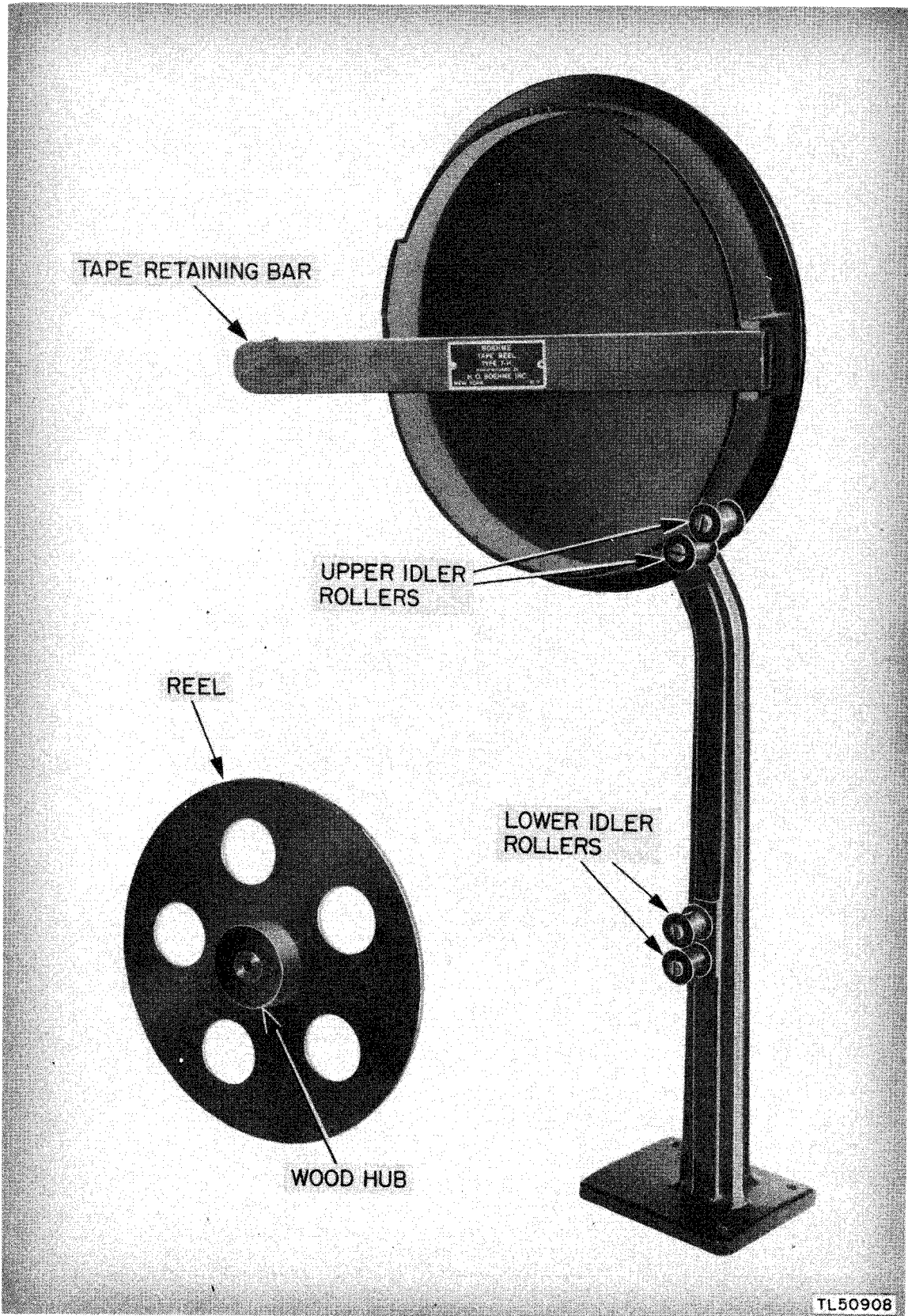


Figure 87. Tape reel, type 7-H.

# PART THREE

## AUXILIARY EQUIPMENT

### SECTION I

#### DESCRIPTION

#### 89. TAPE REEL.

**a. Description.** The tape reel, type 7-H (fig. 87), is designed to hold and feed paper recording tape  $\frac{3}{8}$ -inch wide into the ink recorder. The tape reel consists of two principal parts: the stand and the reel. The reel consists of a wooden core or hub of proper size to fit rolls of paper tape, and a stamped metal disk to which the hub is attached. The stand is cast metal with a circular tape-retaining shell to accommodate  $\frac{3}{8}$ -inch wide paper tape in rolls which may be up to 8 inches in diameter. A hinged retaining bar across the front of the shell keeps the tape securely in place. At the same time, the tape-retaining bar allows rapid loading and acts as a spring to prevent the tape from overrunning. The vertical arrangement of the tape reel makes the reel readily visible, and permits it to be placed close to the ink recorder, thereby conserving table space.

**b. Dimensions and Weights.** (1) Base only:  $3\frac{3}{4}$  inches wide by  $3\frac{1}{4}$  inches deep.

(2) Overall dimension:  $10\frac{1}{2}$  inches wide by  $3\frac{1}{2}$  inches deep by 23 inches high.

(3) Packing dimensions: 12 by 5 by 26 inches.

(4) Net weight: 5 pounds.

(5) Shipping weight: 20 pounds.

#### 90. TAPE BRIDGE.

**a. Description.** A tape bridge, such as shown in figure 88, is used to guide the moving paper tape upon which is recorded the incoming message over the keyboard of a typewriter. An operator can then transcribe the message from the tape as it passes in front of him. The tape bridge, type 4-K, consists of two cast metal supports attached to a metal bridge. The distance between the

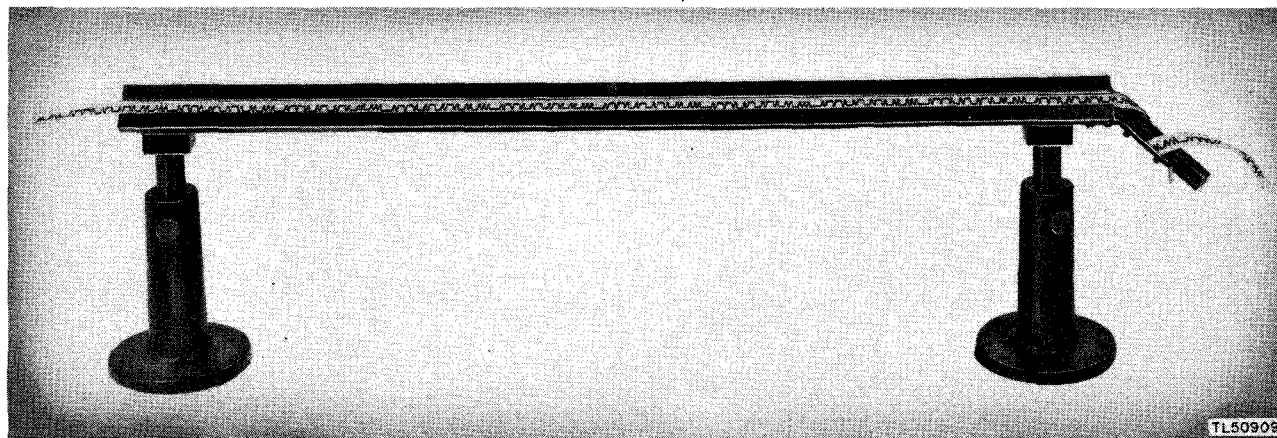


Figure 88. Tape bridge, type 4-K.

mounting centers of the supports is 19 inches, which is enough to permit placing the bridge over the keyboard of any typewriter. The height of the tape bridge is adjustable to suit the individual requirements of the operator. In the lowest position, the tape bridge is  $4\frac{3}{4}$  inches from the table top to the center of the tape; in the highest position,  $7\frac{3}{4}$  inches. A tape guide mounted on the right-hand end of the tape bridge creates a slight drag

on the tape as it is pulled across the bridge.

**b. Dimensions and Weights.** (1) Over-all dimensions: 23 inches wide by  $8\frac{1}{4}$  inches high.

(2) Packing dimensions: 6 by 7 by 30 inches.

(3) Net weight: 5 pounds.

(4) Shipping weight: 20 pounds.

## SECTION II INSTALLATION AND OPERATION

### 91. INSTALLATION OF TAPE REEL.

Mount the tape reel with its base parallel to the edge of the table and with the center of the roller surfaces of the lower idler rollers in line with the entering guide pins on the ink recorder. Fasten the reel stand to the operating table with screws or bolts through the four holes provided in the base. These holes provide clearance for screws or bolts of  $3/16$ -inch diameter.

### 92. INSTALLATION OF TAPE BRIDGE.

The base of each tape bridge support is approximately 3 inches in diameter, and has three mounting holes equally spaced on a  $2\frac{1}{2}$ -inch diameter circle. Fasten the tape bridge to the operating table with bolts or screws. The holes provide clearance for bolts or screws of  $3/16$ -inch diameter. Adjust the tape bridge to the correct height by loosening the two locking screws near the top of the supports and moving the bridge as required. Tighten the locking screws to hold the bridge in place.

### 93. OPERATION OF TAPE REEL.

a. To insert a roll of tape, open the hinged tape-retaining bar and place the roll of tape over the hub of the reel so that it rotates clockwise (the top turning to the right) when being unwound. Snap the tape-retaining bar back into place to retain the roll. Thread the tape between the idler rollers as shown in figure 89.

b. A new roll of tape can be inserted while the recording equipment is in operation without losing a single character. Proceed as follows:

(1) Remove the almost empty reel of tape from the tape reel and unwind the remaining tape.

(2) Place the new roll of tape on the tape reel hub.

(3) Make certain that there are no twists in the old tape or the new tape on the reel. Paste the old tape *over* the new tape as shown in figure 90 so that the pen will not catch on the edge of the new tape as the joint passes. Lap the tape about  $1\frac{1}{2}$  inches. Remove excess paste.

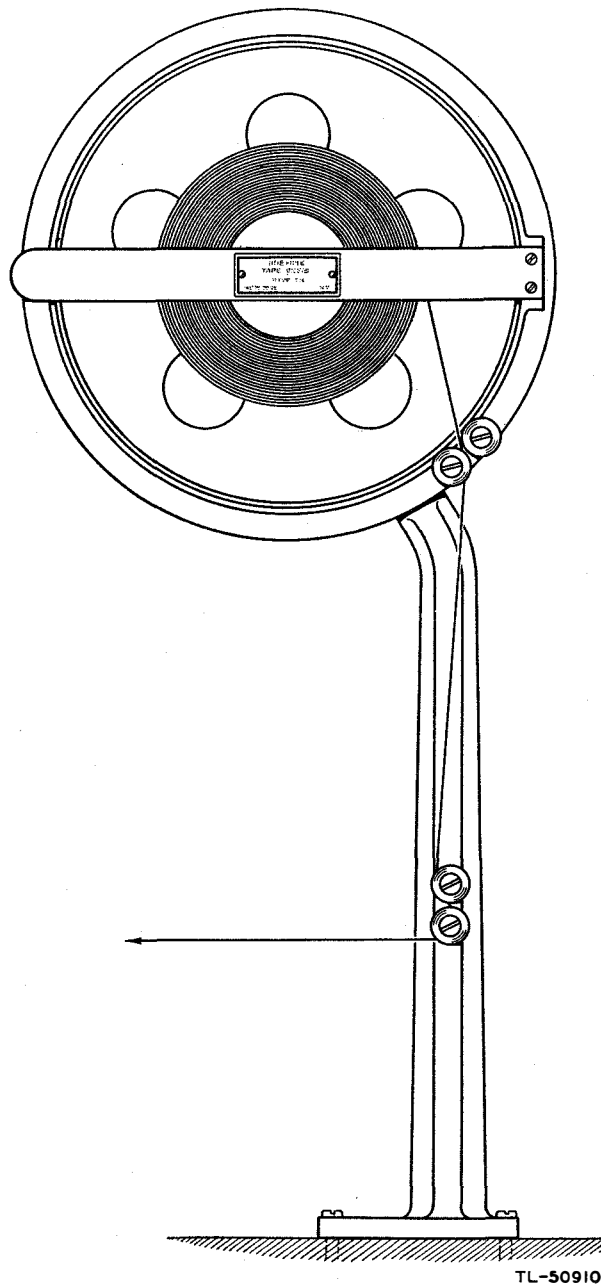


Figure 89. Installation of tape in tape reel.

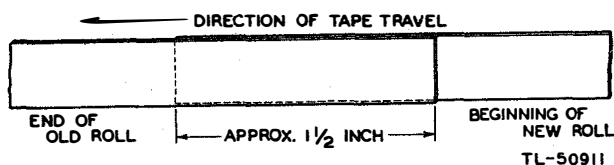


Figure 90. Splicing of recorder tape.

(4) Place the new reel of tape within the tape reel and snap the retaining bar shut. Thread the tape over the idler rollers as shown in figure 89. Check for twists. Resplice if necessary.

(5) With the new tape behind the old tape, avoid bouncing of the pen, as the joint passes, by a slight pressure of the forefinger on the tape to help guide it past the pen.

**CAUTION: DO NOT LEAN AGAINST THE TAPE REEL STAND. THE STAND IS MADE OF CAST METAL AND MIGHT BREAK UNDER STRAIN.**

#### 94. OPERATION OF TAPE BRIDGE.

a. To insert the tape in the groove of the tape bridge, place the tape on the bridge and force the tape into the groove by running the fingers of the right hand over the tape while pulling the tape with the left hand.

b. When the incoming tape is pulled from a loose pile of tape, or when the recorder is not directly in line with the groove in the bridge, the tape guide rod (fig. 88) should be used. Loop the tape around the guide rod and under the spring clip. When the tape enters the bridge directly in line with the groove, it is not necessary to use the tape guide rod.

## SECTION III

### FUNCTIONING OF PARTS

#### 95. TAPE REEL.

The metal disk of the tape reel forms a rigid metal back for the rolls of paper tape. This metal back prevents loosely wound rolls of tape from collapsing when the tape is being placed in the tape-retaining shell of the tape reel. The idler rollers straighten the tape and put a slight tension on it.

#### 96. TAPE BRIDGE.

The paper tape bearing the recorded message is pulled through the groove in the tape bridge. The groove keeps the tape in an upright position under tension, permitting the operator to read the tape as it passes in front of him. The tape guide puts a slight tension on the tape as it enters the bridge. The tape guide also permits tape to enter the tape bridge from equipment or storage bins which are not in line with the bridge.

## SECTION IV

### MAINTENANCE

**NOTE: UNSATISFACTORY PERFORMANCE OF THIS EQUIPMENT WILL BE REPORTED IMMEDIATELY ON WD, AGO FORM NO. 468. IF FORM IS NOT AVAILABLE, SEE TM 38-250.**

#### 97. TAPE REEL.

Oil the tape reel hub stud and the idler roller stud oil holes once a week with one or two drops of Oil, Engine, SAE 10, U. S. Army Specification 2-104B. Remove all

excess oil after spinning the tape reel and the idler rollers several times to work the oil over the bearing surfaces. Dust the tape reel.

**98. TAPE BRIDGE.**

Remove dust and accumulation of dried ink and paper lint from the tape guide and groove of the bridge. See that the height adjusting screws are tight and that the bridge is at the correct operating level.

and the tape bridge, type 4-K, will, if necessary, be included in the technical bulletin covering the moisture-proofing and fungiproofing of Boehme automatic keying and recording equipment. This technical bulletin will be published as soon as moistureproofing and fungiproofing information is available.

**99. MOISTUREPROOFING AND FUNGIPROOFING OF AUXILIARY EQUIPMENT.**

Instructions and a list of the materials for moisture-proofing and fungiproofing the tape reel, type 7-H,

**SECTION V**

**SUPPLEMENTARY DATA**

**100. MAINTENANCE PARTS LIST FOR TAPE REEL, TYPE 7-H.**

A list of maintenance parts for the tape reel, type 7-H, is not available and parts for it are not stocked. There-

fore, although various parts are described in the text, they should not be ordered. The complete tape reel, type 7-H, is listed below and can be ordered by stock number and name.

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A2787H	TAPE REEL: (Boehme #7-H).	1		*

Indicates part available in region stock.

**101. MAINTENANCE PARTS LIST FOR TAPE BRIDGE, TYPE 4-K.**

A list of maintenance parts for the tape bridge, type 4-K, is not available and parts for it are not stocked.

Therefore, although various parts are described in the text, they should not be ordered. The complete tape bridge, type 4-K, is listed below and can be ordered by stock number and name.

Ref. symbol	Signal Corps stock No.	Name of part and description	Quan. per major unit	Lowest maint. echelon	
				Station stock	Region stock
	4A2744K	TAPE BRIDGE: (Boehme #4-K).	1		*

\* Indicates part available in region stock.



## APPENDIX

### 1. MODIFICATION OF RECORDER DRIVING UNIT.

The type 42 radio tubes being manufactured under wartime restrictions are held very close to the minimum engineering specifications. Hence, the tubes do not have the characteristics of the pre-war type 42 tubes and cannot always be operated under the same conditions. Reports indicate that the recorder driving unit, type 4-C, may fail to operate properly when the wartime type 42 tubes are used as the phase-shift tube (V-4) because of a different cutoff characteristic of the new tubes. A pair of resistors (R-8 and R-9, which should have a ratio of approximately 10 to 1) may be added to the circuit to decrease the positive potential of the screen grid of the phase-shift tube as shown in figure 92. The recommended value for R-8 (332) is 200,000 ohms (0.2 meg.) and for R-9 (333) is 20,000 ohms. These resistors are stock items and can be ordered under the Signal Corps stock numbers given in the maintenance parts list for the recorder driving unit (part two, section V, par. 87).

### 2. INSTALLATION OF NEW RESISTORS.

The addition of resistors R-8 and R-9 constitutes a minor change that can be made by any radio repairman, and permits the recorder driving unit to be operated with any type 42 tubes. These resistors are being added to the new units during manufacture to avoid this problem in the field. To make the modification on old models, proceed as follows:

a. Remove the wire connecting the screen grid and plate of the phase-shift tube (V-4, figs. 67 and 80).

b. Connect one terminal of a 200,000-ohm (0.2-meg.) resistor (R-8) to that terminal of resistor R-7 which is connected to the plate of tube V-3.

c. Connect one terminal of a 20,000-ohm resistor (R-9) to the cathode of tube V-4.

d. Join the other two ends of resistors R-8 and R-9, and connect this common connection of the two resistors to the screen grid of tube V-4.

### 3. COLOR CODE.

Because of manufacturing difficulties, it has been found advisable to use a wiring harness instead of running each wire individually and then lacing the final job. The use of a wiring harness made it necessary to use color-coded wire so that the loose ends could be easily recognized during installation of the harness into the base of the recorder driving unit. The color code shown below is used to identify wiring in models being manufactured. Figure 91 shows the new wire arrangement and the color code designations. Other parts of the recorder driving unit are unchanged except for the addition of the two resistors, R-8 and R-9, explained in paragraphs 1 and 2 above.

## COLOR CODE

<i>Symbol</i>	<i>Body</i>	<i>Tracer</i>	<i>Symbol</i>	<i>Body</i>	<i>Tracer</i>
R	Red	None	BR-W	Brown	White
Y	Yellow	None	G-BR	Green	Brown
BE	Blue	None	G-R	Green	Red
VI	Violet	None	G-W	Green	White
BE-R	Blue	Red	O-BL	Orange	Black
BE-Y	Blue	Yellow	O-R	Orange	Red
BL-G	Black	Green	W-BE	White	Blue
BL-R	Black	Red	VI-W	Violet	White
BL-W	Black	White	Y-G	Yellow	Green
BR-G	Brown	Green	Y-R	Yellow	Red

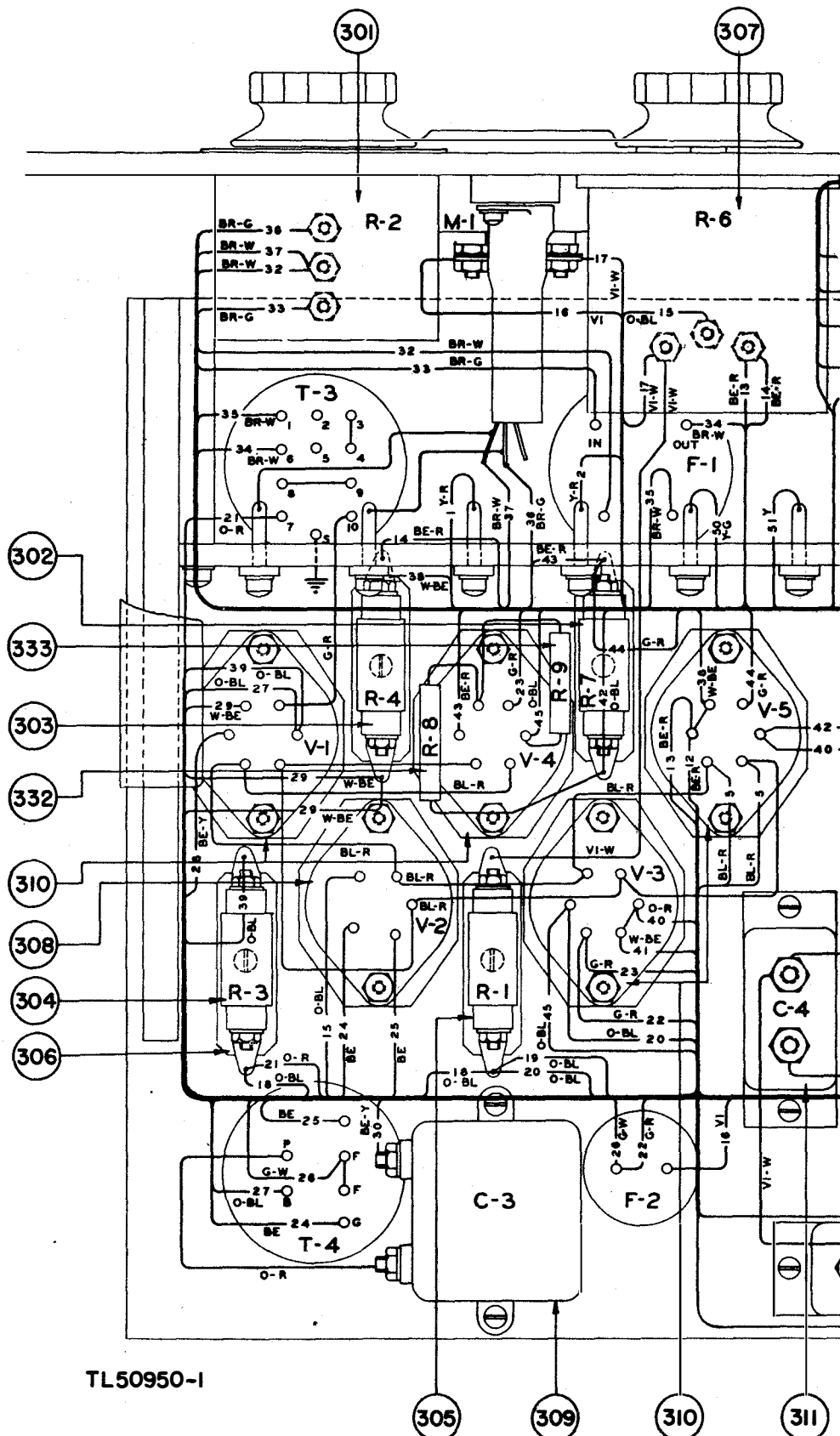
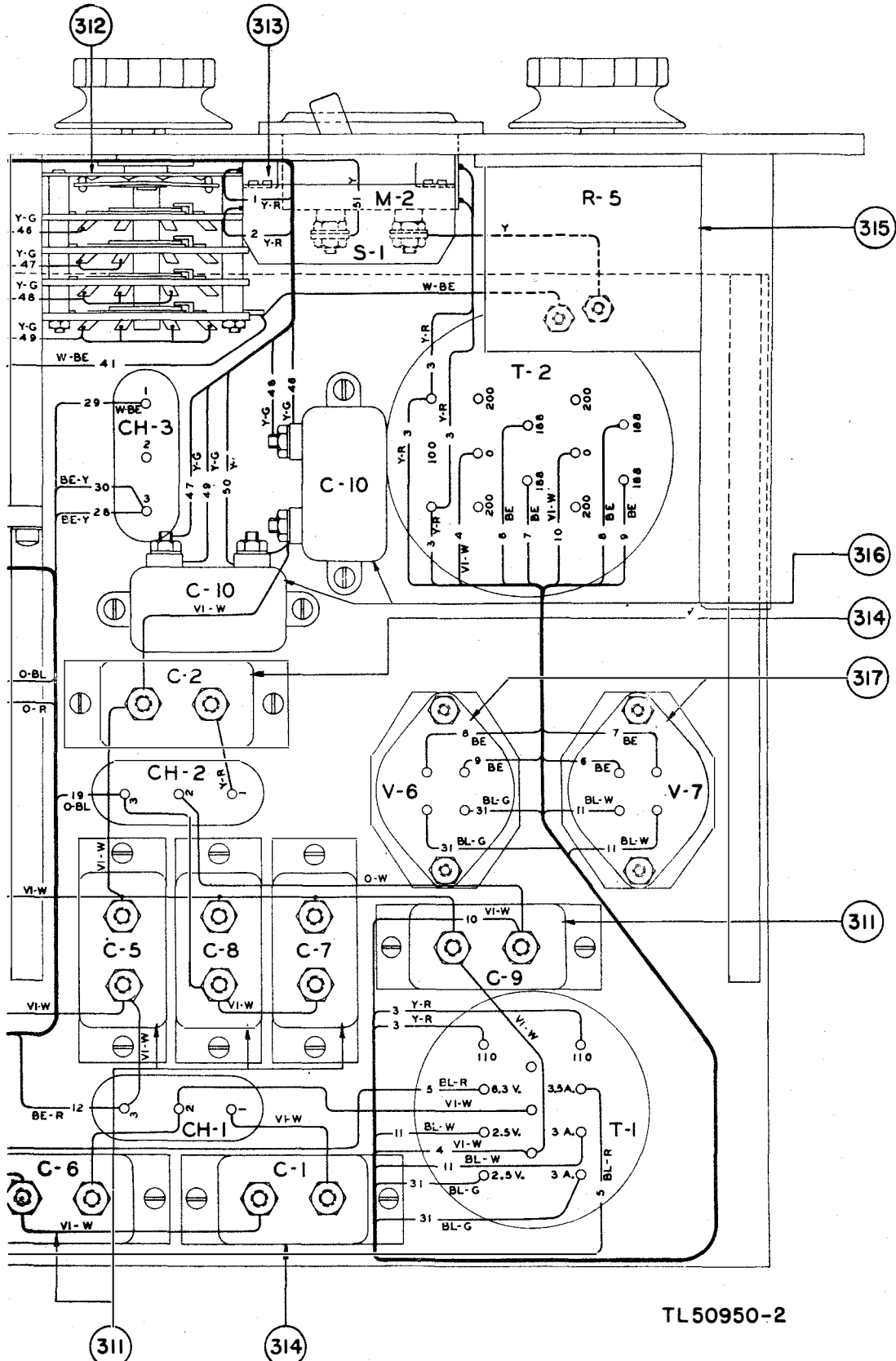


Figure 91. Bottom view of recorder driving unit, showing new style wiring harness and added resistors.



NOTE: NUMBERS IN CIRCLES ARE REFERENCE SYMBOLS FOR PARTS OR ASSEMBLIES WHICH ALSO APPEAR IN COLUMN 1 OF PARAGRAPH 87. MAINTENANCE PARTS LIST FOR RECORDER DRIVING UNIT, TYPE 4-C, OR WHICH ARE REFERRED TO IN TEXT. OTHER NUMBERS AND LETTERS REPRESENT CONNECTIONS AND TERMINALS SHOWN ON WIRING DIAGRAMS AND REFERRED TO IN TEXT.

