TM 11-2208

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TEST SETS

TS-2/TG TS-2A/TG TS-2B/TG

(TELETYPEWRITER SIGNAL DISTORTION)

DEPARTMENT OF THE ARMY • JANUARY 1957

AGO 3686A—Jan

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 115-volt motor circuit.

DON'T TAKE CHANCES!

TECHNICAL MANUAL
No. 11–2208

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *29 January 1957*

TEST SETS TS–2/TG, TS–2A/TG, AND TS–2B/TG

* This manual supersedes TM 11–2208, 3 March 1948, including C 1, 7 February 1950, and C 2, 6 August 1952.

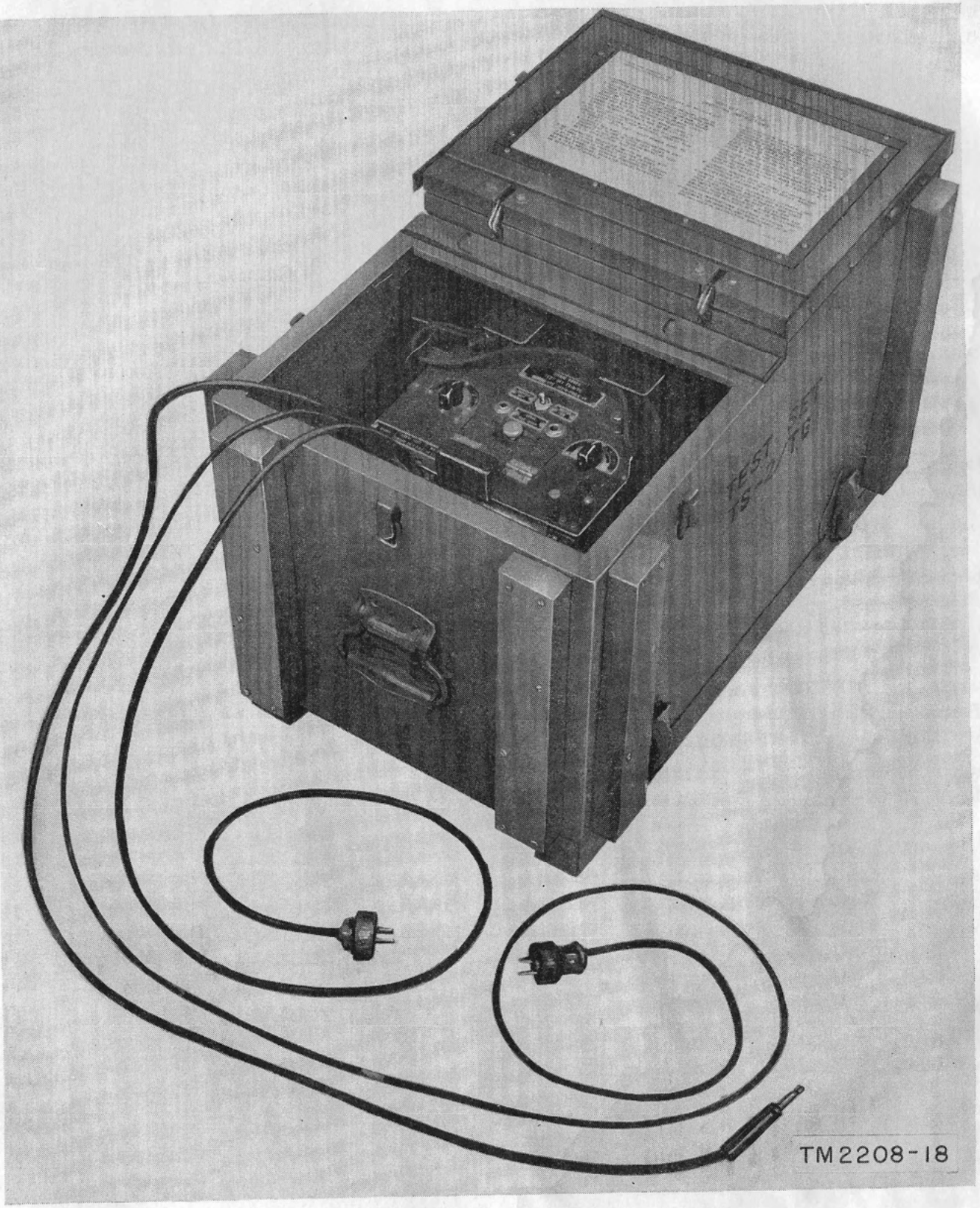

Figure 1. Test Set TS–2/TG.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual covers the installation, operation, theory, maintenance, and repair of Test Sets TS–2(*)/TG (fig. 1).

b. Basic nomenclature followed by (*) is used to indicate all models of the equipment covered herein. Thus, Test Set TS–2(*)/TG refers to Test Sets TS–2/TG, TS–2A/TG, and TS–2B/TG.

c. Forward comments on this publication directly to the Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, N.J.

2. Forms and Records

a. Unsatisfactory Equipment Reports. Fill out and forward DA Form 468 (Unsatisfactory Report) to Commanding Officer, Signal Equipment Support Agency, Fort Monmouth, N.J., as prescribed in AR 700–38.

b. Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

c. Preventive Maintenance Forms.

(1) Prepare DA Form 11–252 (fig. 9) (Operator First Echelon Maintenance Check List for Signal Corps Equipment—Teletypewriter) in accordance with instructions on the back of the form.

(2) Prepare DA Form 11–253 (fig. 10) (Second and Third Echelon Maintenance Check List for Signal Corps Equipment—Teletypewriter) in accordance with instructions on the back of the form.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Test Sets TS–2(*)/TG are teletypewriter signal distortion test sets that are capable of sending normal or distorted signals for testing teletypewriter circuits and equipment. They are used to determine operating margins of start-stop teletypewriter mechanisms and to test the efficiency of the selecting mechanisms in teletypewriter selector units. These test sets are also used to test and calibrate the bias meters of Line Units BE–77–A, BE–77–B, and BE–77–C, and Switchboards BD–100 and BD–100–A. They may also be used with Allied (British) teletypewriter equipment operating at a speed of 404 operations per minute (opm).

4. Technical Characteristics

Type of installation	Tactical or fixed station; send only; direct wire.
Signaling code	Five-unit, start-stop; stop impulse length equals start impulse length multiplied by 1.42.
Types of signal	Neutral (60 milliampere).
Speed	368.1, 404, 460, or 600 opm.
Power demand	Aprx 100 watts.
Motor type	Series-governed.
Motor speed	2,100 revolutions per minute.
Motor power requirements.	110 to 120 volts, 50- to 60-cycle, single phase alternating current.
Signal bias	0 to 50 percent, adjustable, marking or spacing bias.
End distortion	0 to 50 percent, adjustable, marking or spacing end distortion.
Suppression of interference with radio reception.	Does not interfere with radio reception at frequencies between .15 and 1,000 megacycles when located 2 feet or more from radio antenna.
Weight	70 pounds.

5. Description

(figs. 1 and 2)

a. General. Test Set TS–2(*)/TG is a self-contained unit, 23 inches long, 17 inches high, and 14 inches deep overall. It weighs 70 pounds. The test set is mounted on a base casting which is attached to a reinforced wooden base. A strongly reinforced wooden cover with two carrying handles houses the test set and fastens to the wooden base with four trunk-type latches. One half of the top of the wooden cover consists of a hinged lid. When this lid is open, it exposes the control panel, which is equipped with control switches and local test jacks, and permits the test set to be operated without removing the wooden cover from the wooden base. Both the wooden cover and the wooden base are painted olive drab.

b. Controls. The control switches and jacks, with the exception of the target light and the radio filter cut-out switches, are mounted on the control panel which is located above the motor. A small door on the control panel permits access to the target light switch. The radio filter cut-out switch is mounted in the base casting of the test set.

c. Motor. The motor is an alternating current (ac) governed series motor which may be adjusted for use at 368.2 or 404 opm.

d. Cords. The test set is equipped with all necessary signal and power cords.

e. Spare Parts. A small wooden box containing a spare target light, two spare fuses, sandpaper, two small brushes, and two large brushes, is mounted on the wooden base at the motor end of the test set.

6. Differences in Models

In external appearance, the several models of the test sets vary slightly. The later models have been modified to improve operational features. The differences between the models of the test sets are given in the following table.

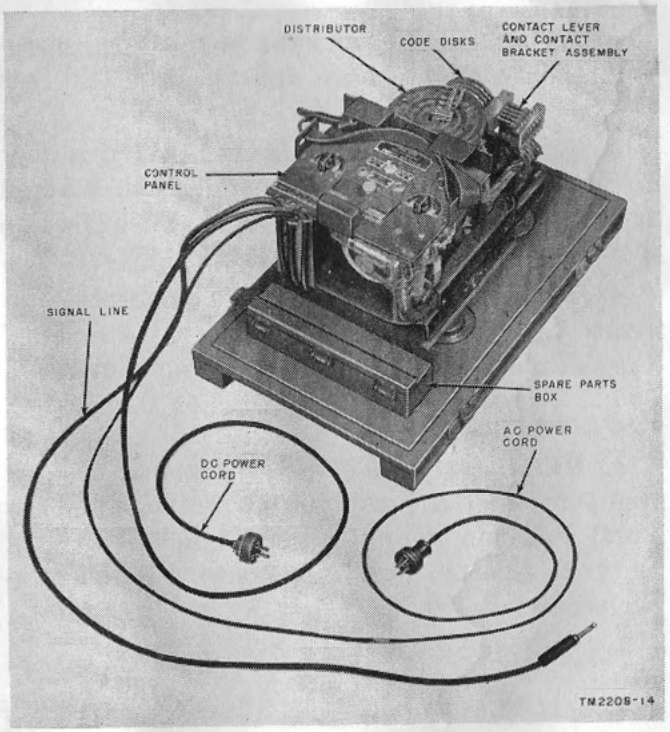

Figure 2. Test Set TS–2/TG, wooden cover removed.

Item	TS–2/TG	TS–2A/TG	TS–2B/TG	TS–2B/TG Orders No. 25796–Phila–54, No. 31154–Phila–55, and No. 15598–Phila–55
Pointer and calibration scale.	Calibration scale is fixed, pointer is adjustable.	Same as TS–2/TG	Same as TS–2/TG	Calibration scale is adjustable with respect to a fixed pointer. Lateral movement of the calibration scale is made possible by providing elongated calibration scale mounting holes.
Resistor (motor speed control).	2,500-ohm resistors	Same as TS–2/TG	Same as TS–2/TG	The two 500-ohm resistors are replaced by a single 250-ohm resistor.
Motor pinion guard	Mounted on the base casting	Same as TS–2/TG	Same as TS–2/TG	The motor pinion guard is mounted on the motor hub.
Resistor bracket assembly.	Mounted on the motor	Same as TS–2/TG	Same as TS–2/TG	The resistor bracket assembly previously mounted on the motor is not used. A capacitor and resistor bracket assembly has been designed to accommodate this resistor.
Governor housing	Three-piece assembly; a governor shell, a front cover, and a target ring.	Same as TS–2/TG	Same as TS–2/TG	The governor housing is made up of a rear cover, a governor shell, and a front cover. The target markings are placed directly on the front cover instead of on a separate target.
Capacitor and resistor bracket assembly.	Capacitor bracket assembly extends between the top surface of the base casting and the under surface of the control panel. It is turned so that the capacitor is facing inward, toward the motor.	Same as TS–2/TG	Same as TS–2/TG	The capacitor and resistor bracket assembly extend between the top surface of the base casting and the under surface of the control panel. It is turned so that these components are facing outward, making them easily accessible for maintenance.
Control panel	Metal nameplates are used for panel markings.	Same as TS–2/TG	Same as TS–2/TG	Metal nameplates for the control panel are not used. The markings are not changed and are applied directly to the panel.
Motor bearings	Open face bearings. Require periodic lubrication.	Factory greased and sealed. Will require no further lubrication.	Same as TS–2A/TG	Same as TS–2A/TG.
Governor contact filter assembly.	Mounted inside the base casting	Mounted on the base casting.	Same as TS–2A/TG	Same as TS–2A/TG.
Base casting	Cast iron	Same as TS–2/TG	Aluminum.	Same as TS–2B/TG.

CHAPTER 2
INSTALLATION

Section I. SERVICE ON RECEIPT OF EQUIPMENT

7. Siting

Place the test set on a convenient workbench or table, or on the floor, near enough to the equipment to be tested so that connections can be made to the test set. Locate the test set so that the cords do not interfere with exposed wiring and cabling. When the equipment to be tested is located in a tent or temporary building, select a site for the test set that will be as free from moisture and dust as possible. In cases where a ground connection must be provided at the test site, locate the equipment as near as possible to a source of good ground.

8. Unpacking
(fig. 3)

a. Packaging Data. When packaged for export shipment, these test sets are packed with a dehydrating agent. The test set is blocked and braced by plywood sheets or pads of corrugated fiberboard. The fiberboard box is sealed in a moisture-vaporproof barrier, which, in turn, is inclosed in a nailed wooden shipping case, reinforced with steel straps. Crated for shipment, the test set weighs approximately 160 pounds and has a volume of approximately 3.5 cubic feet.

b. Removing Contents. Be careful when unpacking equipment. Do not thrust tools into the interior of the shipping container; this procedure may damage the equipment. Follow the steps given below.

(1) Place the packing case as near the operating position as possible and cut the steel straps.

(2) Remove the nails, using a nail puller, and remove the sides and top of the packing case. Do not pry the sides and top off. This procedure may damage the equipment.

(3) Remove the moistureproof barrier.

(4) Slit the taped seams of the outer corrugated carton.

(5) Remove the moisture-vaporproof barrier covering the inner corrugated carton.

(6) Slit the taped seams of the inner corrugated carton, remove the corrugated filler and remove the test set.

9. Checking

a. Check the contents with the packing slip.

b. Examine the equipment carefully for possible damage during shipment.

c. Report damaged equipment in accordance with instructions contained in paragraph 2*b*.

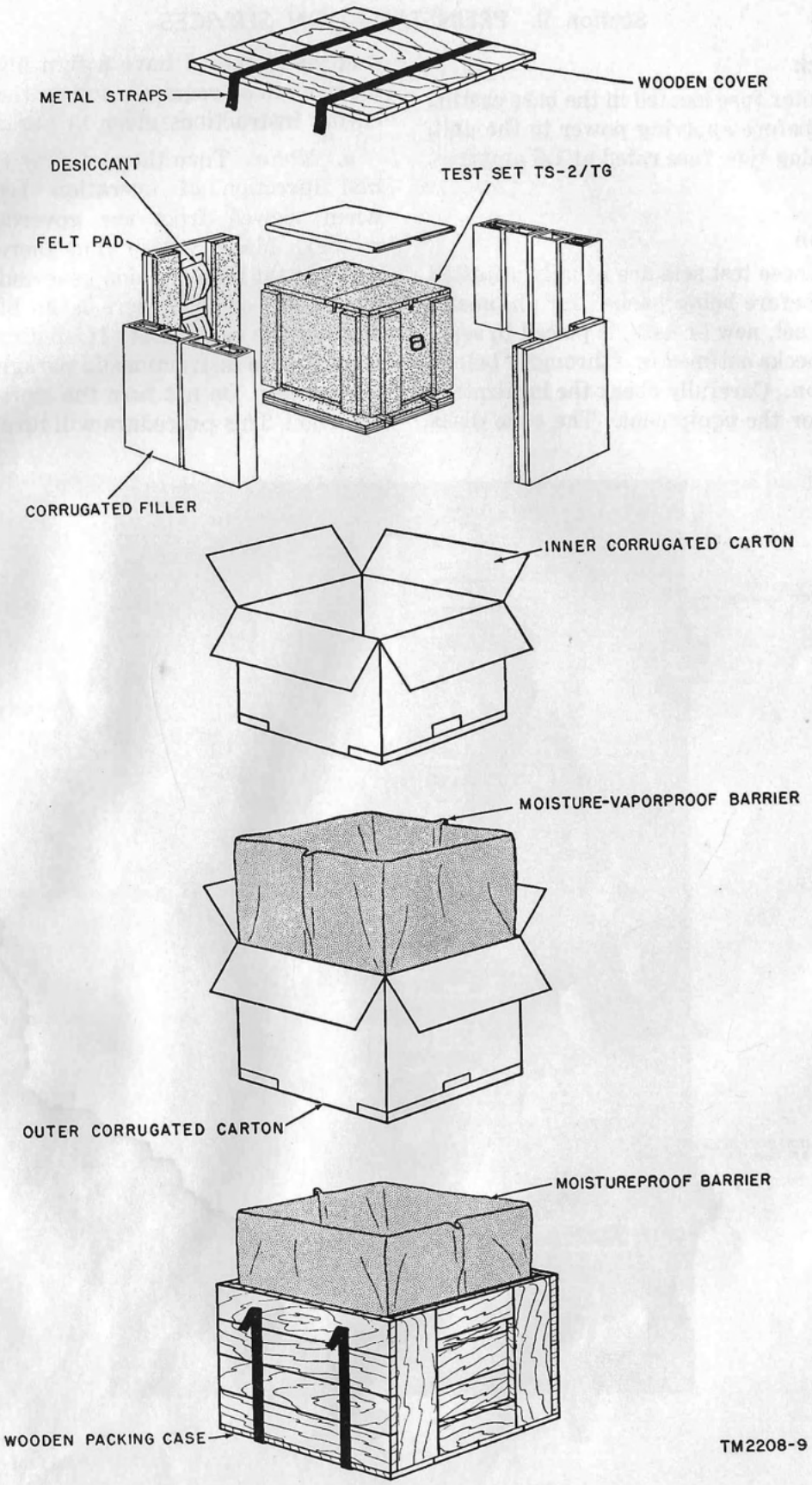

Figure 3. Test Set TS–2/TG, packaged for oversea shipment.

Section II. PREINSTALLATION SERVICES

10. Fuse Check

Check the motor fuse located in the base casting of the test set before applying power to the unit. This fuse is a plug type fuse rated at 1.6 amperes, 125 volts.

11. Preparation

a. General. These test sets are usually adjusted at the factory before being packed for shipment. Before any test set, new or used, is placed in service, make the checks outlined in *b* through *f* below.

b. Lubrication. Carefully check the lubrication requirements for the equipment. The code disks and gears should have a thin film of grease. If lubrication is required, follow the detailed lubricating instructions given in paragraph 100.

c. Motor. Turn the motor by hand in the normal direction of operation (counterclockwise when viewed from the governor end of the motor). Make certain that there is no binding between the motor pinion gear and the main shaft fiber gear, or that there is no binding in other parts of the equipment. If binding occurs, adjust according to instructions in paragraph 37.

Caution: Do not turn the motor in the wrong direction. This procedure will turn the distributor

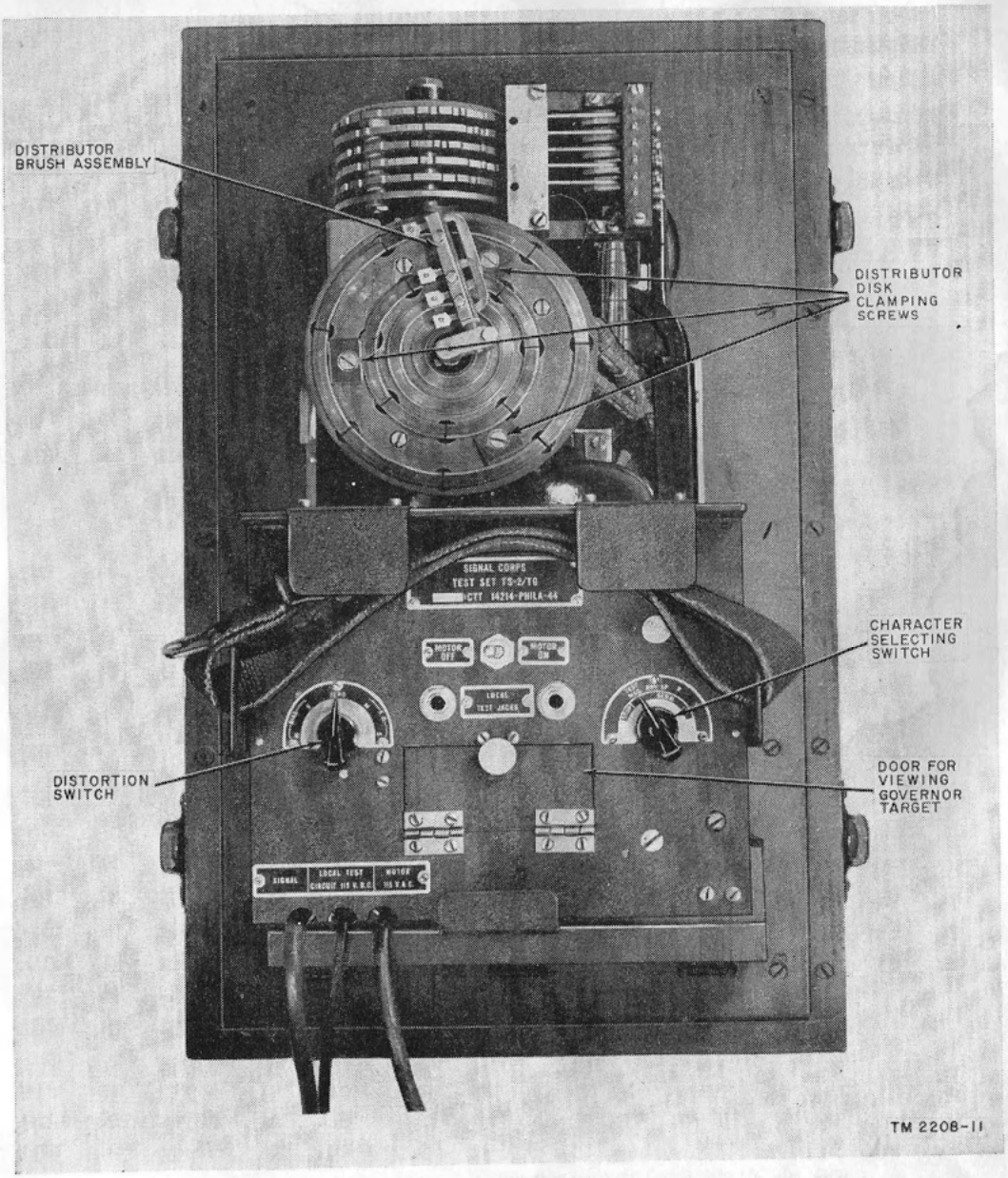

Figure 4. Test Set TS–2/TG, top view.

brushes backward and cause damage to the brush holders because the brushes may catch on the edges of the commutator segments.

d. Distributor Brushes. The distributor brushes should make contact with the commutator segments. They should have the proper tension and position (pars. 49 and 50).

e. Code Disk Transmitter. All contact tongues and contact springs should be undamaged.

f. Control Switches. Operate the switches to check freedom of action. Check the contacts for damage, dirt, and loose connections.

12. Motor Speed

a. Plug the ac power (MOTOR) cord into a source of 110- to 115-volt, 50- to 60-cycle ac.

b. Turn the motor switch to MOTOR ON and allow the motor to run a few minutes.

c. Open the door on the control panel (fig. 4) to expose the governor target, turn on the target lamp and adjust the motor speed as follows:

(1) Strike an 87.6 vibrations-per-second (vps) (for 368.2 opm) or a 96.1 vps (for 404 opm) tuning fork against the palm of your hand to cause the tuning fork to vibrate. Do not strike the tuning fork against a metal or solid object or the fork may become damaged.

(2) View the white target spots at the end of the motor governor through the vibrating shutters of the tuning fork. If the motor is operating at the correct speed, the target markings will appear stationary when viewed through the vibrating shutters of the tuning fork. If the motor is turning too fast, the target markings will appear to be moving in the direction of rotation. If the motor is turning too slow, the target markings will appear to be moving in the opposite direction.

(3) If the motor speed is too fast, stop the motor and, if necessary, rotate the governor until the speed adjusting wheel is in its highest position above the armature shaft. Then turn the speed adjusting wheel counterclockwise about one-fourth turn. Start the motor and recheck the speed. Repeat the adjustment if necessary.

(4) If the motor speed is too slow, follow the procedure given in (3) above, except that the speed adjusting wheel should be turned clockwise about one-fourth turn. Start the motor and recheck the speed. Repeat the adjustment if necessary.

13. Distortion Settings (Percentages)

For most tests, the adjustable distributor disk is set for 35 percent bias or end distortion; however, it may be set for any percentage, from 0 to 50. To set the percentage of distortion, first make the local test, preliminary checks and adjustments as instructed in paragraph 15*a*. Then loosen the adjustable distributor disk clamping screws (fig. 4) and rotate the disk counterclockwise until the printer is set for the desired (35) percent of bias or end distortion on the calibration scale. Tighten the three clamping screws.

Section III. SIGNAL CONNECTIONS

14. General

The test sets may be installed to meet several operational requirements. This variety is achieved by varying the connections of the signal lines to the test sets.

15. Power Connections (fig. 4)

a. Local Test, Preliminary Checks and Adjustments.

(1) Set the motor switch to the MOTOR OFF position.

(2) Plug the ac power (MOTOR) cord into a source of 110- to 115-volt, 50- to 60-cycle ac.

(3) Plug the direct current (dc) power (LOCAL TEST) cord into a source of 115-volt dc.

(4) Plug the signal line (SIGNAL) cord into one of the LOCAL TEST JACKS.

(5) Plug a milliammeter capable of measuring .060 ampere of current (accurately) into the other LOCAL TEST JACK.

(6) Turn the character selecting switch to the Y position.

(7) Loosen the adjustable distributor disk

clamping screws and rotate the disk clockwise until the pointer is off the calibration scale (fig. 22).

(8) Move the distortion switch to the ED M position and turn the motor by hand slowly in the normal direction of rotation (counterclockwise when viewed from the governor end of the motor) until the brush arm approaches the beginning of the No. 5 segment of the stationary disk. Continue to turn the motor slowly until the milliammeter just registers current. Observe the caution notice given in paragraph 11*c*.

(9) Allow the brush arm to remain in this position and turn the distortion switch to the BIAS S position. The milliammeter should now register no current.

(10) Rotate the adjustable distributor disk ring slowly counterclockwise until the milliammeter again just registers current. Tighten the adjustable distributor disk clamping screws.

(11) Adjust the position of the pointer by loosening the mounting screws and moving the pointer to 0 on the calibration scale. Tighten the pointer mounting screws. On Test Sets TS–2B/TG bearing Orders No. 25796–Phila–54, No. 31154–Phila–55, and No. 15598–Phila–55 the pointer and calibration scale has been modified by making the calibration scale adjustable with respect to a fixed pointer. Lateral movement of the calibration scale is made possible by providing elongated calibration scale mounting holes. After the adjustable disk ring has been clamped in position, loosen the calibration scale mounting screws and move the calibration scale so that the pointer registers 0 on the calibration scale. Tighten the mounting screws.

b. Teletypewriter Connections with Test Set Supplying Signal Current.

(1) Set the motor switches of the test set and the teletypewriter to the MOTOR OFF position.

(2) Plug the signal line cord into one of the LOCAL TEST JACKS (fig. 5).

(3) Plug the dc power cord into a source of 115-volt dc.

(4) Plug the receiving cord of the teletypewriter into the other LOCAL TEST JACK.

(5) Plug the ac power cords of the test set and the teletypewriter into a 110- to 115-volt 50- to 60-cycle ac source.

(6) Set the character selecting and the distortion switches to the positions desired.

(7) Turn the motor switches to the MOTOR ON position and perform the required tests (par. 20*a* and *b*).

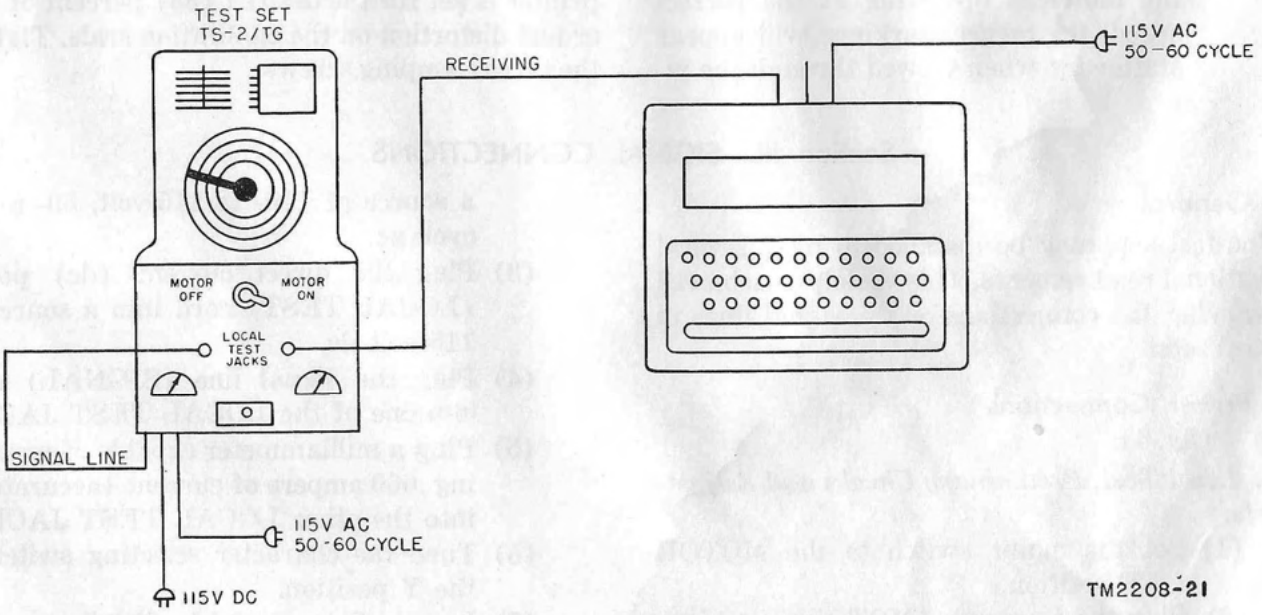

Figure 5. Connections for supplying signal current from the test set.

c. Teletypewriter Connections with Teletypewriter (Line Unit) Supplying Signal Current.

(1) Set the motor switches of the test set and the teletypewriter to the MOTOR OFF position.

(2) Set the character selecting switch to the STOP position.

(3) Set the LOCAL–DISTANT CURRENT SUPPLY switch of the line unit to the LOCAL CURRENT SUPPLY position.

(4) Set the RELAY IN–OUT OF CIRCUIT switch of the line unit to the RELAY OUT OF CIRCUIT position.

(5) Place a strap (short) between the LINE and GND binding posts of the line unit.

(6) Plug the signal line cord of the test set into the BLK jack of the line unit (fig. 6).

(7) Plug the red (receive) shell plug of the teletypewriter into the RED jack of the line unit. (The black shell (send) plug of the teletypewriter is not used for this installation.)

(8) Plug the ac power cord of the test set into a suitable source of ac. (The dc power cord is not used for this installation.)

(9) Plug the dc power cord of the line unit into a source of 115-volt dc.

(10) Plug the ac power cord of the teletypewriter into a suitable source of ac.

(11) Turn the rectifier (or other source of dc) on to supply dc. If a vacuum tube rectifier is used, allow sufficient time for the unit to warm up. Adjust the LINE RHEOSTAT of the line unit to obtain a 60 milliampere reading on the meter.

(12) Set the character selecting and the distortion switches to the positions desired.

(13) Turn the motor switches of the test set and teletypewriter to the MOTOR ON position and perform the required tests (par. 20*a* and *b*).

d. Bias Meter Test Connections for Line Units BE–77–A, BE–77–B, and BE–77–C. It is not necessary to remove the bias meter from the line unit for testing and calibration.

(1) Remove any plugs or teletypewriter connections from the line unit.

(2) Place a strap (short) between the LINE and GND binding posts of the line unit.

(3) Remove the line unit relay.

(4) Remove the plug from the signal line cord of the test set.

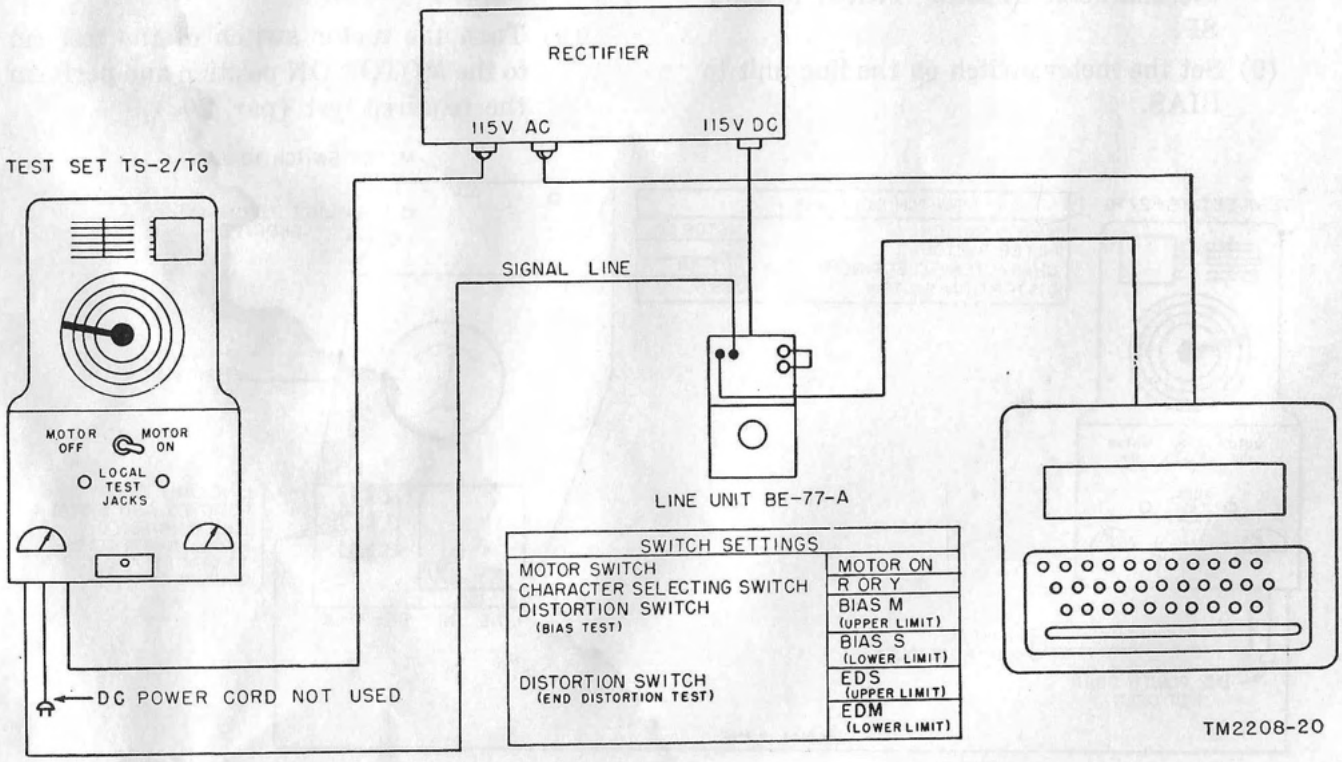

Figure 6. Connections for supplying signal current from the teletypewriter (line unit).

(5) Using suitable alligator clips, attach one wire of the signal line cord to the center terminal of the relay mounting block and attach the remaining wire from the signal line cord to the top center terminal of the relay mounting block (fig. 7). If extensive tests of this nature are to be made, use a salvaged 41–C relay to make an adapter for these connections. Completely remove all parts of the relay such as coils, magnets, springs, contact points, and adjusting knob. Utilize the hole in the top of the plastic cover (after removing the white adjusting knob) to mount a jack. Wire the jack to the proper terminals of the salvaged relay so as to make connections with the specified terminals (center and top center) of the relay base within the line unit. This will eliminate the necessity of removing the plug from the signal line cord for this test.

(6) Plug the dc power cord of the line unit into a source of 115-volt dc.

(7) Turn the filter switch on the test set to the FILTER OUT position.

(8) Set the distortion switch to ZERO and the character selecting switch to RPT SP.

(9) Set the meter switch on the line unit to BIAS.

(10) Plug the ac power cord of the test set into a suitable source of ac. (The dc power cord is not used for this test.)

(11) Turn the motor switch to the MOTOR ON position and perform the required test (par. 20*c*).

e. Bias Meter Test Connections for Switchboard BD–100 and BD–100–A. It is not necessary to remove the bias meter from the switchboard for testing and calibration, or to remove the switchboard from service.

(1) Plug the signal line cord of the test set into the BIAS METER jack of the switchboard. The switchboard must be connected to its regular source of dc (fig. 8).

(2) Plug the ac power cord of the test set into a suitable source of ac. (The dc power cord is not used for this test.)

(3) Turn the filter switch on the test set to FILTER OUT position.

(4) Set the distortion switch to ZERO and the character selecting switch to RPT SP.

(5) Set the switchboard METER key to the BIAS position.

(6) Turn the motor switch of the test set to the MOTOR ON position and perform the required test (par. 20*d*).

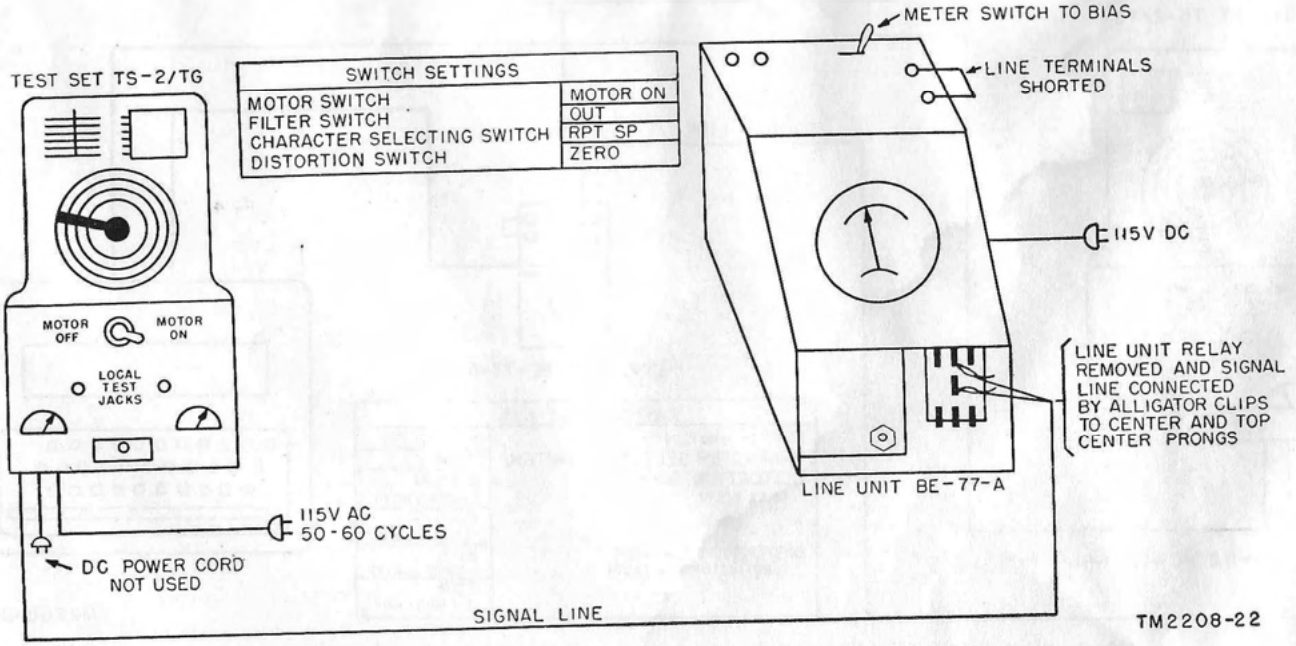

Figure 7. Connections for calibrating bias meter in line units.

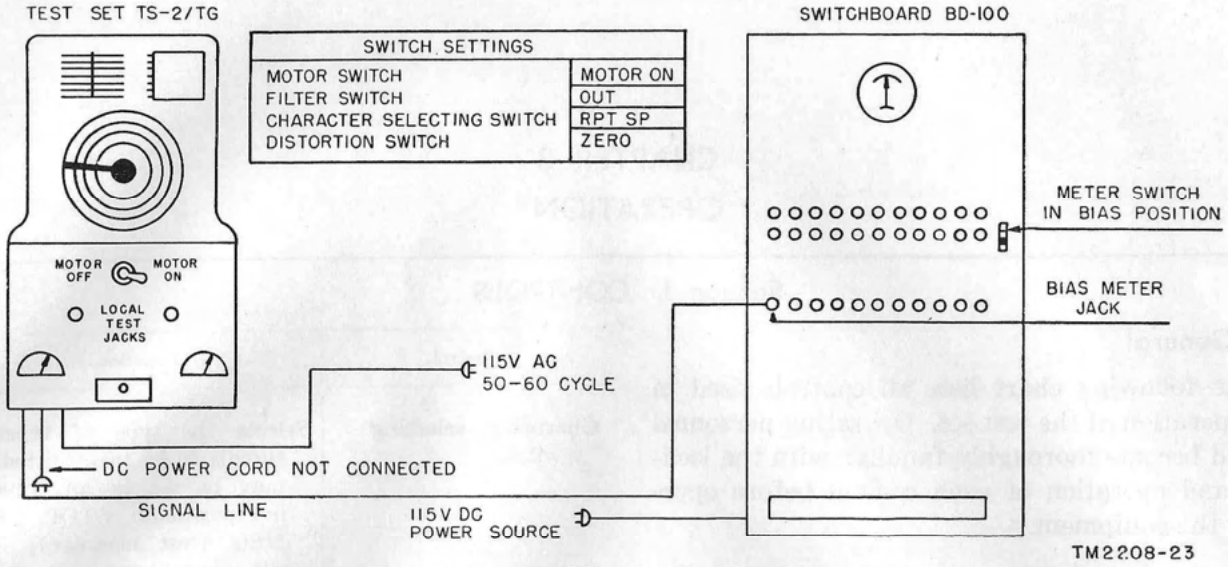

Figure 8. Connections for calibrating bias meter in switchboards.

16. Changing Operating Speed

Test Sets TS–2(*)/TG are shipped from the manufacturer ready for use on 60 words per minute (wpm) equipment. However, these test sets are capable of testing teletypewriter equipment utilizing either 75 or 100 wpm operation by replacing the existing drive gears with gears of a different ratio. These (motor pinion and main shaft) gears may be procured through regular supply channels when required.

CHAPTER 3
OPERATION

Section I. CONTROLS

17. General

The following chart lists all controls used in the operation of the test set. Operating personnel should become thoroughly familiar with the location and operation of each control before operating the equipment.

18. Controls

Control	Function
MOTOR ON MOTOR OFF switch.	Turns the motor on or off.
Distortion switch	Selects the type of distortion required. It may be set in any one of five positions: BIAS M (bias marking), BIAS S (bias spacing), ZERO (no distortion), ED M (end distortion marking), and ED S (end distortion spacing).
Character selecting switch.	Selects the type of repeated signals to be transmitted. It may be set in any one of five positions: STOP, TEST MSG (test message), RPT SP (repeat space), R, and Y.
FILTER OUT FILTER IN switch.	Disconnects the radio filter from the signal line.
Target light toggle switch.	Turns the target lamp on or off.
Adjustable distributor disk.	Regulates the amount of distortion desired.
LOCAL TEST JACKS	Connects teletypewriter equipment to the test set.
Calibration scale and pointer or indicator.	Indicates the amount of distortion being transmitted.

Section II. OPERATION UNDER NORMAL CONDITIONS

19. Preliminary Starting Procedures

a. Plug the ac power cord into a source of 110- to 115-volt, 50- to 60-cycle ac.

b. Turn the motor switch to MOTOR ON and allow the motor to run for a few minutes.

c. Turn on the target lamp and adjust the motor speed as directed in paragraph 12.

d. Calibrate the distortion setting as directed in paragraph 15*a*.

e. Loosen the adjustable distributor disk clamping screws and rotate the disk counterclockwise until the pointer is set for 35 percent bias or end distortion on the calibration scale. Tighten the adjustable distributor disk clamping screws. For most tests, the disk is set for 35 percent bias or end distortion; however, it may be set for any percentage from 0 to 50.

20. Types of Operation

The type of operation of the test set is determined by the distortion switch position. The positioning of the character selecting switch determines what letter or series of letters (R, Y, RPT SP or TEST MSG) will be sent out on the signal line. The percentage of distortion, if any, is determined by the position of the adjustable distributor disk and is indicated on the calibration scale. The detailed switch settings for each condition are given in *a* through *d* below.

a. Bias Test of Teletypewriter Selector Unit.

(1) Make the connections as directed in paragraph 15*b* when the test set is to supply current, or as directed in paragraph 15*c* if the teletypewriter is to supply current.

(2) If the test set or the teletypewriter is equipped with governed motors, adjust the motor speeds as directed in paragraph 12.

(3) Set the character selecting switch of the test set to either R or Y.

(4) Set the distortion switch to BIAS M, which controls the transmission of signals with marking bias.

(5) Check the range of the teletype machine to determine the upper limit of the range.

(6) Set the distortion switch to BIAS S, which controls the transmission of signals with spacing bias.

(7) Check the range of the teletype machine to determine the lower limit of the range.

(8) Midway between these two settings is the point where the teletypewriter will tolerate the maximum bias. Determine the maximum amount of bias by use of the following formula:

$$\text{Maximum bias} = 35 + \frac{\text{Upper limit BIAS } M - \text{Lower limit BIAS } S}{2}$$

b. End Distortion Test.

(1) Make the connections as directed in paragraph 15*b* when the test set is to supply current, or as directed in paragraph 15*c* if the teletypewriter is to supply current.

(2) If the test set or the teletypewriter is equipped with governed motors, adjust the motor speeds as directed in paragraph 12.

(3) Set the character selecting switch of the test set to either R or Y.

(4) Set the distortion switch to ED M, which controls the transmission of signals with marking end distortion.

(5) Check the range of the machine to determine the lower limit of the range.

(6) Set the distortion switch to ED S, which controls the transmission of signals with spacing end distortion.

(7) Check the range of the machine to determine the upper limit of the range.

(8) The maximum amount of end distortion the teletypewriter will tolerate can be determined from the following formula:

$$\text{Maximum end distortion} = 35 + \frac{\text{Upper limit } ED\ S - \text{Lower limit } ED\ M}{2}$$

c. Calibration of Line Units BE–77–A, BE–77–B, and BE–77–C Bias Meter. It is not necessary to remove the bias meter from the line unit for testing and calibration.

(1) Install the test set and line unit as directed in paragraph 15*d*.

(2) With the test set transmitting undistorted signals, the bias meter should indicate 0.

(3) If it does not, adjust the small rheostat in the front of the line unit by first removing the nut which forms a cap covering and turning the adjusting screw with a screwdriver until the meter shows zero bias.

(4) Tighten the cap on the rheostat securely to prevent accidental turning of the adjusting screw.

d. Calibration of Switchboard BD–100, BD–100–A Bias Meter. It is not necessary to remove the bias meter from the switchboard for testing and calibration, or to remove the switchboard from service.

(1) Install the test set as directed in paragraph 15*e*.

(2) With the test set transmitting undistorted signals, the bias meter should indicate 0.

(3) If the meter does not indicate 0, adjust the rheostat, located at the bottom of the switchboard, until zero bias is obtained.

21. Stopping Procedure

a. Turn the character selecting switch to the STOP position.

b. Turn the distortion switch to the ZERO BIAS position.

c. Turn the motor switch to the MOTOR OFF position.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

22. General

a. Operation and maintenance of these test sets in arctic, tropical, or desert regions creates a number of problems peculiar to those regions. Moisture condensation due to extreme humidity causes short circuits and cross fire. Deterioration of parts due to rust and corrosion often results in a complete breakdown of the equipment. Dust,

dirt, or sand encountered in desert regions will affect operation and may cause equipment failure.

b. To prevent corrosion, keep the equipment as dry as possible. In cold regions, heat the shelter in which the test set is installed whenever possible. Use all possible measures to prevent quick changes in room temperature which might cause moisture condensation.

23. Operation in Arctic Climates

a. Provide a reliable source of heat whenever possible. A temperature of at least 40° F. should be maintained in the room containing operating test equipment.

b. The standard lubricants specified in paragraph 96 provide the proper lubrication for low temperature operation.

c. Allow the motor to run for a warm-up period of approximately 15 minutes.

24. Operation in Tropical Climates

Heat and humidity are the major climatic problems which must be overcome to permit reliable operation of this equipment in tropical areas.

a. High humidity may cause condensation of moisture on the equipment whenever the temperature of the equipment is lower than that of the surrounding area. Equipment corrosion and the presence of fungi are inevitable results of this condition unless preventive measures are taken. A continuously lighted bulb placed within the equipment at the operating site can minimize corrosion and growth of fungus.

b. The disadvantages of excessive heat may be partially or wholly overcome by providing as much ventilation as possible around the test set, particularly around the motor. Increased friction caused by lack of lubrication and dirty mechanisms also results in unnecessary heat.

25. Operation in Desert Climates

Operational problems in desert areas are much the same as those in tropical areas, except for the lack of humidity. Dryness may require more frequent lubrication. Dirt and dust can damage bearings and moving parts of mechanisms. Apply measures similar to those given for operation under tropical conditions to insure efficient operation of the equipment.

a. Protect the equipment against dust, dirt, and sand. Dustproof the shelter in which the equipment is installed. If necessary cover the inside walls with heavy paper.

b. Provide adequate ventilation to prevent overheating.

c. See that proper lubricants are used to protect the equipment.

d. Make frequent preventive maintenance checks.

CHAPTER 4
ORGANIZATIONAL MAINTENANCE

Section I. FIRST ECHELON (OPERATOR) MAINTENANCE

26. Scope

This section contains information on maintenance to be performed by the operator. This is accomplished by routine inspections, cleaning and visual checking of the test set.

27. Materials

The materials necessary to maintain the equipment at this level are as follows:

a. Cheesecloth or other lint free cloth.

b. Cleaning Compound, liquid form (Federal stock No. 7930–395–9542).

28. Preventive Maintenance

a. Inspections. The test sets require regular inspections to detect and correct deficiencies caused by continuous use, as follows:

(1) *Daily*: Check presence of running spares. Check all screws, bolts, and nuts on the chest. Check all electrical connections for firmness of seating and proper contact.

(2) *Weekly*: Inspect the chest for cracks, missing or broken screws, damaged or worn load mountings; all wiring and cabling for cracks, rotting insulation, frayed, cut or gouged jacketing. Check operation of the test set for smoothness of operation, signs of wear, or evidence of the motor overheating.

b. Deficiencies. All deficiencies should be noted on DA Form 11–252 and brought to the attention of the technician at the next higher echelon of maintenance for correction.

29. Visual Inspection

a. Wooden Cover.

(1) Inspect the wooden cover thoroughly. Look for cracks, marred painted surfaces, loose or missing screws, and faulty hinges. See that the latches are in good condition.

(2) Clean the outer surfaces of the cover with a piece of cheesecloth slightly moistened with water. To remove oil, grease, or gummy stains on the outer surface of the wooden cover, slightly moisten the cloth with cleaning compound.

Warning: Prolonged breathing of cleaning compound fumes is dangerous. Make certain that adequate ventilation is provided. Cleaning compound is flammable; do not use near a flame.

b. Test Set.

(1) Inspect the test set control panel for marred painted surfaces, missing or loose screws, dust and dirt.

(2) Clean the outer or painted surfaces of the test set by using cheesecloth moistened with water or cleaning compound.

(3) Check each switch knob to be sure that it is fastened securely to the switch.

(4) Check all visible wiring for cracked or deteriorated insulation, frayed or cut insulation at connecting or supporting points, kinks, and strain caused by improper placement. Make certain that the outer insulating cover on cords and cables is wiped clean. Do not use oil or cleaning compound on rubber insulation.

c. Miscellaneous. Perform all additional maintenance checks listed in DA Form 11–252.

30. Use of Operators Preventive Maintenance Form (fig. 9)

a. DA Form 11–252 (fig. 9) is a preventive maintenance checklist to be used by the operator as directed by his commander.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
TELETYPEWRITER

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
TEST SET TS-2/TG	38

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	INSPECT UNIT FOR PRESENCE OF ~~TOOLS,~~ ACCESSORIES, AND RUNNING SPARES. PAR. 5e	✓	✓	✓				
2	~~TIGHTEN ALL LOOSE SCREWS, BOLTS, AND NUTS ON CHESTS, TELETYPEWRITER COVER, COMPONENT PANEL.~~							
3	CLEAN INSIDE AND OUTSIDE OF CHESTS ~~AND TELETYPEWRITER COVER~~ OF DIRT, GRIME, GREASE, RUST, OIL, GUMMY DEPOSIT. PAR. 29a	✓	✓	✓				
4	~~INSPECT THE COVER OF THE TELETYPEWRITER FOR CRACKED OR BROKEN GLASS, LOOSE SCREWS, BROKEN OR DAMAGED HINGES, DAMAGED COPYHOLDER, SCRATCHES.~~							
5	INSPECT ALL ELECTRICAL CONNECTIONS FOR FIRMNESS OF SEATING AND PROPER CONTACT, CORROSION, GREASE, OIL. PAR. 29b	✓	✓	✓				
6	~~TIGHTEN ALL LOOSE ELECTRICAL CONNECTIONS.~~							
7	~~TIGHTEN ALL LOOSE SCREWS, LUGS, MOUNTING BOLTS ON TERMINAL BLOCKS, AND SLIP CONNECTORS.~~							
8	CLEAN EXTERIOR OF ~~KEYS,~~ SWITCHES, ~~AND TERMINAL BLOCKS~~ OF DIRT, GREASE, GRIME, MOISTURE. PAR. 29b	✓	✓	✓				
9	INSPECT EACH ~~KEY OR~~ SWITCH FOR PROPER MECHANICAL ACTION; FREEDOM OF MOVEMENT, POSITIVE ACTION, SPRING TENSION. ~~LOOK FOR BROKEN, MISSING OR ILLEGIBLE KEY TOPS.~~ PAR. 29b	✓	✓	(X)				

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
10	INSPECT CHESTS FOR DIRT, CRACKS, MISSING OR BROKEN SCREWS, RUST, DAMAGE, WORN LORD MOUNTINGS. PAR. 29b		12	~~INSPECT TERMINAL BLOCKS FOR CRACKS, BREAKS, DIRT, LOOSE CONNECTIONS, LOOSE SCREWS AND MOUNTINGS.~~	
11	INSPECT ALL WIRING AND CABLING FOR CRACKS, ROTTING INSULATION, FRAYED, CUT, OR GOUGED JACKETING, KINKS, PROPER SUPPORT WHERE REQUIRED, LOOSE TERMINATIONS, BROKEN CONDUCTORS. PAR. 29b		13	~~OPERATE THE TELETYPEWRITER AND CHECK FOR SMOOTH OPERATION, CLEAR PRINTING, SIGNS OF WEAR, EVIDENCE OF MOTOR OVERHEATING.~~	

14 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-252 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

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Figure 9. DA Form 11–252.

b. Items not applicable to these test sets are lined out on figure 9. References in the item block in the figure are to paragraphs in this manual which contain additional maintenance information pertinent to the particular item.

Section II. SECOND ECHELON MAINTENANCE

31. Scope

This section contains information on the maintenance to be performed by the organizational maintenance (second echelon) technician. This maintenance consists of some removal and replacement, disassembly and reassembly, adjustments, isolation of faults, and repairing cordage and wiring.

32. Tools, Materials, and Test Equipment

a. Tool Equipment TE–50–B contains all tools necessary to maintain Test Sets TS–2(*)/TG.

b. Cleaning Compound (liquid form) which is necessary to maintain the test set is not contained in the TE–50–B.

c. Multimeter TS–297/U (part of TE–50–B) is used to check the circuits of the test set.

33. Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair in that its object is to prevent certain troubles from occurring. The technician at this level of maintenance should, in addition to performing all tasks assigned to the operator, check, remove, replace, repair, and adjust those items on DA Form 11–253 not crossed out (with the exception of item 29), and for which he is authorized replaceable parts.

34. Use of Second Echelon Preventive Maintenance Form (fig. 10)

a. DA Form 11–253 is a preventive maintenance checklist to be used by second echelon repairman as directed by his Commander.

b. Items not applicable to Test Set TS–2(*)/TG are lined out on figure 10. References in the ITEM block in the figure are to paragraphs in this manual which contain additional maintenance information pertinent to the particular item. Item 29, lubrication, although not crossed out on this form, will not be performed at this echelon of maintenance.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
TELETYPEWRITER

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE: TEST SET TS-2/TG

EQUIPMENT SERIAL NO.: 382

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION
1	INSPECT UNIT FOR PRESENCE OF ~~TOOLS~~, ACCESSORIES, AND RUNNING SPARES. PAR 5 e	✓
2	~~TIGHTEN ALL LOOSE SCREWS, BOLTS, AND NUTS ON CHESTS, TELETYPEWRITER COVER, COMPONENT PANEL.~~	
3	CLEAN INSIDE AND OUTSIDE OF CHESTS ~~AND TELETYPEWRITER COVER OF DIRT, GRIME, GREASE, RUST, OIL, GUMMY DEPOSIT.~~ PAR. 29a	✓
4	~~INSPECT THE COVER OF THE TELETYPEWRITER FOR CRACKED OR BROKEN GLASS, LOOSE SCREWS, BROKEN OR DAMAGED HINGES, DAMAGED COPYHOLDER, SCRATCHES.~~	
5	INSPECT ALL ELECTRICAL CONNECTIONS FOR FIRMNESS OF SEATING AND PROPER CONTACT, CORROSION, GREASE, OIL. PAR. 29b	✓
6	TIGHTEN ALL LOOSE ELECTRICAL CONNECTIONS. PAR. 29b	✓
7	TIGHTEN ALL LOOSE SCREWS, LUGS, MOUNTING BOLTS ON TERMINAL BLOCKS, AND SLIP CONNECTORS. PAR. 29b	✓
8	CLEAN EXTERIOR OF ~~KEYS,~~ SWITCHES, ~~AND TERMINAL BLOCKS~~ OF DIRT, GREASE, GRIME, MOISTURE. PAR. 29b	✓
9	INSPECT EACH ~~KEY OR~~ SWITCH FOR PROPER MECHANICAL ACTION; FREEDOM OF MOVEMENT, POSITIVE ACTION, SPRING TENSION; ~~LOOK FOR BROKEN, MISSING OR ILLEGIBLE KEY TOPS.~~ PAR. 29b	✓
10	INSPECT CHESTS FOR DIRT, CRACKS, MISSING OR BROKEN SCREWS, RUST, DAMAGE, WORN LORD MOUNTINGS. PAR. 29b	✓
11	INSPECT ALL WIRING AND CABLING FOR CRACKS, ROTTING INSULATION, FRAYED, CUT, OR GOUGED JACKETING, KINKS, PROPER SUPPORT WHERE REQUIRED, LOOSE TERMINATIONS, BROKEN CONDUCTORS. PAR. 29b	✓
12	~~INSPECT TERMINAL BLOCKS FOR CRACKS, BREAKS, DIRT, LOOSE CONNECTIONS, LOOSE SCREWS AND MOUNTINGS.~~	
13	~~OPERATE THE TELETYPEWRITER AND CHECK FOR SMOOTH OPERATION, CLEAR PRINTING, SIGNS OF WEAR, EVIDENCE OF MOTOR OVERHEATING.~~	
14	SOLDER ANY LOOSE OR BROKEN SOLDER CONNECTIONS. PAR. 29b	✓
15	INSPECT THE CONTACTS OF SWITCHES ~~AND KEYS~~ FOR PITTING, CORROSION AND WEAR. PAR. 95	✓
16	ADJUST SPRING TENSION OF CONTACT SPRINGS, ~~KEY~~ AND SWITCH CONTACTS WHERE NECESSARY. PAR. 57	✓
17	CLEAN CONTACTS OF SWITCHES ~~AND KEYS~~ OF DIRT, GREASE, DUST, CORROSION. PAR. 73	✓
18	~~CLEAN THE TYPING UNIT AND TYPE BAR CARRIAGE VERY CAREFULLY OF GREASE, DUST, DIRT, OIL; (care should be exercised to prevent dirt from getting into the bearings).~~	
19	~~INSPECT THE TYPING UNIT FRAME CASTING, TYPE BAR CARRIAGE FRAME CASTING, KEYBOARD CASTING, MOTOR BASE FOR CRACKS, LOOSE OR MISSING SCREWS, OTHER DAMAGE.~~	
20	~~INSPECT THE TYPING UNIT, TYPE BAR CARRIAGE, KEYBOARD, FOR LOOSE OR MISSING SCREWS, FREE MOVEMENT OF ALL MOVING PARTS, DENT, BROKEN, DISTORTED, OR WORN SHAFTS, GEARS, SPRINGS, BEARINGS, CAMS, CLUTCHES.~~	
21	~~ADJUST ANY ITEMS ON TYPING UNIT WHICH REQUIRE ADJUSTMENT.~~	
22	~~INSPECT EACH BELL CRANK, CODE BAR, TYPE BAR, TO DETERMINE THAT ALL PARTS MOVE FREELY AND ARE NOT BENT OR BROKEN, THERE ARE NO MISSING OR DAMAGED PALLETS.~~	
23	INSPECT GEARS, SHAFTS, BEARINGS ~~OF TYPE BAR CARRIAGE~~ FOR SIGNS OF EXCESSIVE WEAR, LOOSE PARTS, DAMAGE. PAR. 29b	✓
24	ADJUST ANY UNITS ~~ON THE TYPE BAR CARRIAGE~~ THAT REQUIRE ADJUSTMENT. PAR. 35 THROUGH 57	✓
25	INSPECT THE MOTOR FOR SIGNS OF OVERHEATING, WORN BRUSHES, PROPER BRUSH SPRING TENSION. PAR. 80 AND 81	✓
26	CLEAN THE MOTOR AND GOVERNOR ASSEMBLY OF DIRT, GREASE, FOREIGN MATTER. PAR. 77	✓
27	CLEAN OIL, GREASE, DUST, DIRT FROM ~~KEYBOARD, KEY TOPS, KEY LEVERS, AND AROUND~~ THE TRANSMITTING MECHANISM. PAR. 95	✓
28	~~INSPECT THE MOISTURE AND FUNGUS PROOFING.~~	
29	INSPECT GENERAL CONDITION OF LUBRICATION AND LUBRICATE AS REQUIRED ACCORDING TO LATEST DEPARTMENT OF THE ARMY LUBRICATION ORDER. PAR. 100	✓

30 · IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-253 (*Formerly DA AGO*) REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

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Figure 10. DA Form 11–253.

Section III. ADJUSTMENT PROCEDURES

35. General

This section presents the requirements and adjustment procedures for the test set. Perform adjustments described in paragraphs 36 through 57 in the order presented.

36. Main Shaft Position
(fig. 11)

a. Requirement. The center of the main shaft fiber gear should line up with the center of the motor pinion gear.

b. Adjustment. Loosen the upper and lower bearing bracket mounting screws. Position the main shaft to meet the requirement. Tighten the upper and lower bearing bracket mounting screws.

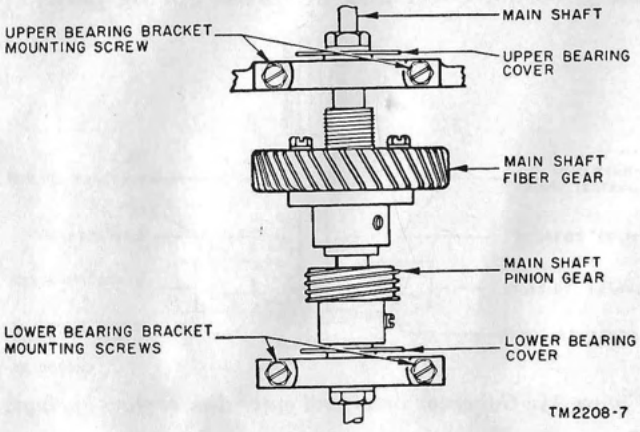


Figure 11. Main shaft assembly.

37. Motor Position

a. Requirement. There should be a minimum amount of backlash between the motor pinion gear and the main shaft fiber gear throughout a complete revolution of the main shaft.

b. Adjustment. Loosen the motor mounting screws and position the motor to meet the requirement. Tighten the motor mounting screws.

38. Governor Shell
(figs. 12 and 13)

a. Preparation. Remove the brush spring plate and governor cover (fig. 12). Remove the speed adjusting spring (fig. 13).

b. Requirements.

(1) The governor contacts should meet squarely and there should be at least .010-inch clearance between the governor spring bracket and the rim of the governor shell.

(2) There should be a gap of .015 to .040 inch between the governor contacts when they are open.

c. Adjustments.

(1) Remove the governor shell from the armature shaft. Loosen the governor spring bracket mounting screws. Position the governor spring bracket to meet the requirement. Tighten the governor spring bracket mounting screws.

(2) Bend the governor contact spring to meet the requirement. Replace the governor shell on the armature shaft. Replace the speed adjusting spring, the governor cover and the brush spring plate.

39. Governor Speed Adjusting Wheel Friction Washer
(figs. 12 and 13)

a. Preparation. Remove the brush spring plate and governor cover (fig. 12). Hook a 32-ounce

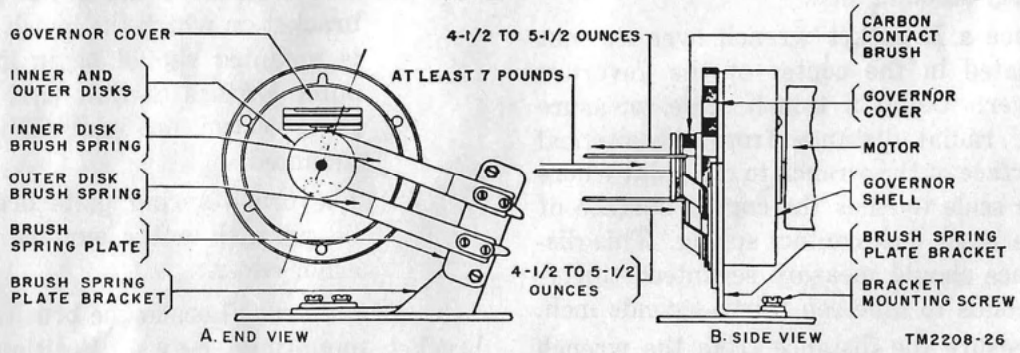


Figure 12. Governor assembly.

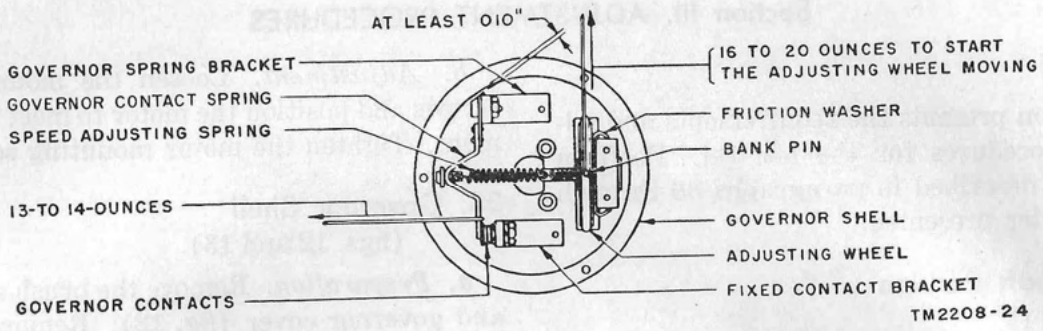


Figure 13. Governor shell, governor cover removed.

scale over the governor contact spring arm near the governor contacts and pull in line with the speed adjusting spring (fig. 13). Turn the speed adjusting wheel to the right or left until a pull of 13 to 14 ounces just separates the governor contacts.

b. Requirement. Hook a 32-ounce scale over a bank pin inserted radially in the leather of the speed adjusting wheel and pull at right angles to the radius of the wheel. A pull of 16 to 20 ounces should be required to start the wheel moving.

c. Adjustment. Remove the governor shell from the armature shaft. Remove the friction washer and bend the large projections to meet the requirement. Replace the friction washer, governor shell, governor cover, and the brush spring plate.

40. Governor Inner and Outer Disk Contact Springs
(fig. 14)

a. Preparation. Remove the brush spring plate and governor cover.

b. Requirements.

(1) The distance from the inner surface of the governor cover to the highest point on the contact springs should be twenty-five thirty-seconds to twenty-seven thirty-seconds inch.

(2) Place a D socket wrench over the nut located in the center of the governor cover. Using a 6-inch scale, measure the radial distance from the vertical surface of the wrench to the point where the scale touches the curved surface of the inner disk contact spring. This distance should measure seventeen thirty-seconds to nineteen thirty-seconds inch.

(3) Measure the distance from the wrench to a point of contact on the outer disk contact spring in the same manner as described in (2) above. This distance should measure seven-sixteenths to one-half inch.

c. Adjustments. Bend the inner and outer disk contact springs to meet the requirements. Avoid sharp bends or the springs may break. Replace the governor cover and the brush spring plate.

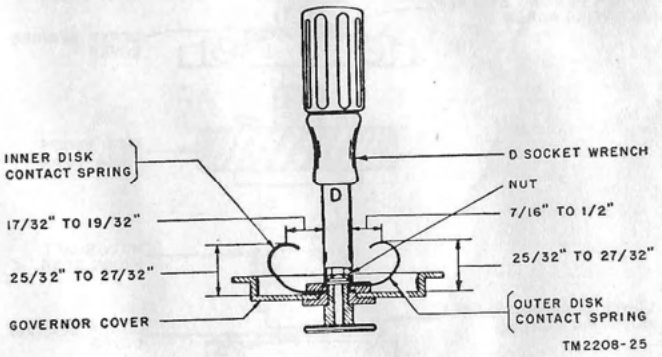


Figure 14. Governor inner and outer disk contact springs.

41. Governor Brush Spring Plate Bracket
(fig. 12)

a. Requirements.

(1) A line through the center of the outer disk should pass through the center of each carbon contact brush.

(2) The surface of the brush spring plate bracket on which the brush spring plate is mounted should be in line with the outer surface of that part of the governor cover on which the target is mounted.

(3) The brush spring plate bracket should be parallel to the surface of the governor cover.

b. Adjustment. Loosen the brush spring plate bracket mounting screws. Position the brush spring plate bracket to meet the requirements.

Tighten the brush spring plate bracket mounting screws.

42. Governor Brush Spring Pressure (fig. 12)

a. Requirements.

(1) Apply an 8-ounce scale to the brush spring near each carbon brush and pull (inner disk brush spring) or push (outer disk brush spring) horizontally in line with the armature shaft. A pull or push of 4½ to 5½ ounces should be required to start each brush moving away from its associated disk.

(2) Both carbon brushes should lie flat against their associated disks, and the outer edges of the brushes should be flush with or not more than three sixty-fourths inch inside the outer edges of the disks.

b. Adjustments. Loosen the two brush spring clamping screws and slip out the brush springs. Bend the springs to meet the requirements. Remount the springs and position them properly. Tighten the clamping screws.

43. Code Disk Shaft End Play (fig. 15)

a. Requirement. The code disk shaft should have some end play, but not more than .006 inch.

b. Adjustment. Loosen the code disk assembly mounting screw. Position the code disk assembly on its shaft to meet the requirement. Tighten the code disk assembly mounting screw.

44. Intermediate Shaft End Play (fig. 15)

a. Preparation. Remove the intermediate shaft gear guard.

b. Requirement. The intermediate shaft should have some end play, not more than .003 inch.

c. Adjustment. Unscrew the intermediate shaft collar setscrew and position the collar to meet the requirement. Tighten the setscrew.

45. Intermediate Shaft Bakelite Gear (fig. 15)

a. Requirements. The center of the intermediate shaft bakelite gear should be in line with the center of the main shaft pinion gear, and the play between the gears should be a minimum without binding throughout a complete revolution of the intermediate shaft bakelite gear.

b. Adjustments.

(1) Loosen the intermediate shaft gear clamping screw and position the gear. Tighten the intermediate shaft gear clamping screw.

(2) Loosen the four mounting screws that fasten the code disk assembly subbase to the distributor base and position the assembly to meet the requirement. Tighten the four mounting screws. Recheck adjustment in (1) above.

46. Code Disk Shaft Gear (fig. 15)

a. Requirements. The code disk shaft gear should line up with the driving gear on the intermediate shaft, and the play between the gears should be a minimum without binding throughout a complete revolution of the code disk shaft gear.

b. Adjustment. Loosen the code disk bracket mounting screws. Position the code disk bracket to meet the requirement. Tighten the code disk bracket mounting screws.

47. Contact Bracket Assembly (fig. 16)

Note. To check these adjustments, it will be necessary to remake them in accordance with the following instructions.

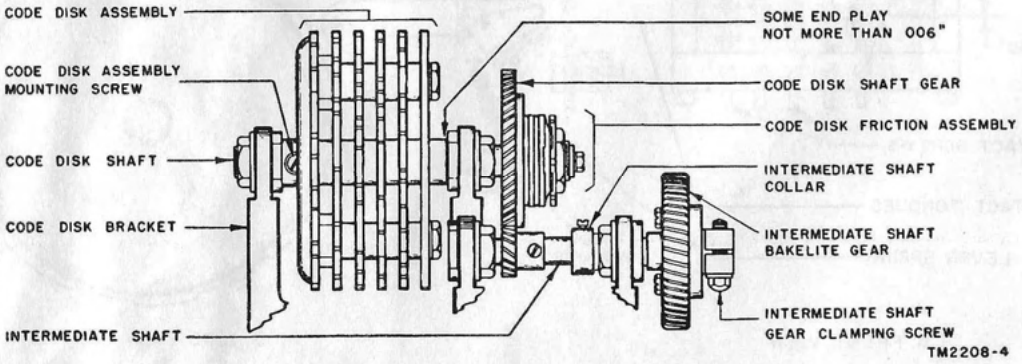


Figure 15. Code disk and intermediate shaft assemblies.

a. Contact Lever Bracket Position.

(1) *Preparation.* Loosen the contact setscrews and back off the upper and lower contact screws all the way. Rotate the motor manually until the No. 1 and No. 5 contact levers rest on a high part of their respective code disks.

(2) *Requirement.* There should be .002- to .030-inch clearance between the No. 1 and No. 5 upper contacts and their respective contact tongues.

(3) *Adjustment.* Loosen the bridge bracket mounting screws. Position the bridge bracket to meet the requirement. Tighten the bridge bracket mounting screws.

b. Contact Tongues.

(1) *Preparation.* Rotate the motor manually until all the contact levers rest on the low part of their respective code disks.

(2) *Requirements.* Contact tongues Nos. 2, 3, and 4 should line up with contact tongues No. 1 and 5 with a variation not to exceed .030 inch.

(3) *Adjustment.* Bend the contact tongues as required.

c. Contact Screws.

(1) *Preparation.* Rotate the motor manually until the No. 1 contact lever rests on the high part of its code disk.

(2) *Requirements and Adjustments.* Turn in the No. 1 upper contact screws so that it just makes contact with the No. 1 contact tongue. Then advance the screw 2½ additional turns and tighten its set screw. Adjust the No. 1 lower contact screw until there is a gap of .006 to .010 inch between the tongue and the lower contact. Tighten the setscrew. Adjust Nos. 2, 3, 4, and 5 upper and lower contact screws in the same manner.

48. Contact Levers Spring Tension (fig. 16)

a. Preparation. Rotate the motor manually until the No. 1 contact lever rests on the low part of its code disk.

b. Requirement. Hook an 8-ounce scale under the horizontal portion of the contact lever (the scale rod just clearing the contact tongue pivotal mounting) and pull up in a vertical line. A pull of 3 to 3¾ ounces should be required to separate the contacts.

c. Adjustment. Loosen the spring anchor clamping screw. Position the spring anchor to meet the requirement. Tighten the spring anchor clamping screw. Adjust Nos. 2, 3, 4, and 5 contact lever springs in the same manner.

49. Distributor Brush (fig. 17)

Note. If either of the brushes that ride on the two segmented rings is readjusted or replaced, the calibration adjustment described in paragraph 15*a* should be made.

a. Preparation. Rotate the motor manually un-

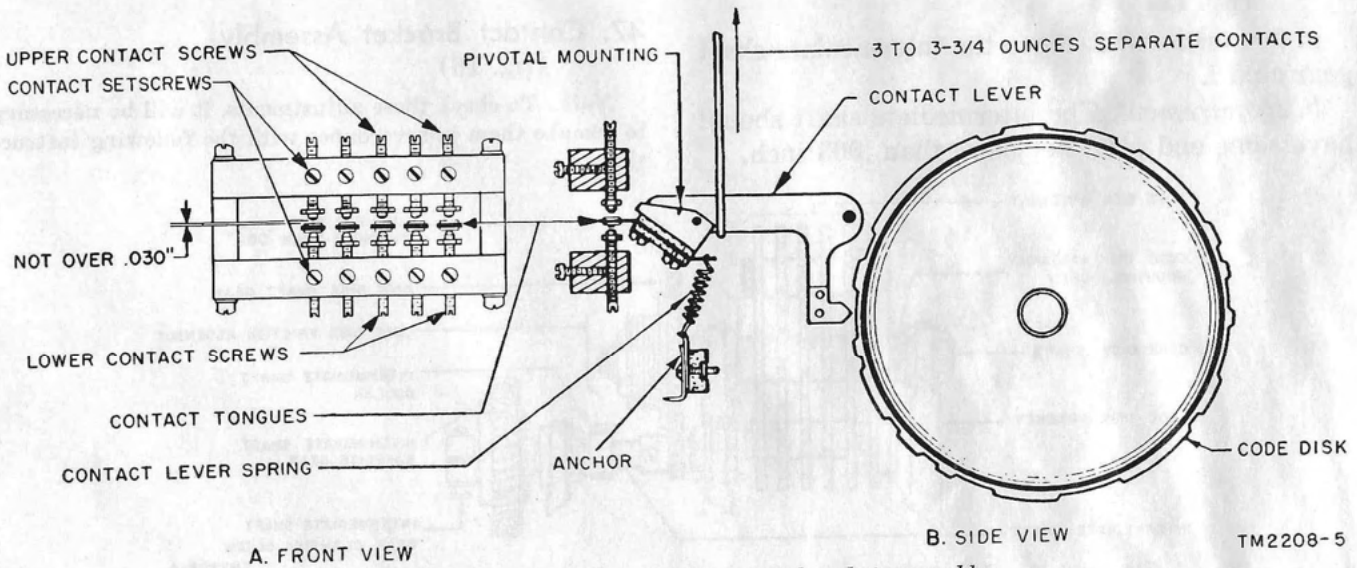


Figure 16. Contact lever and contact bracket assembly.

til the brush arm is parallel to the inscribed line on the commutator disk.

b. Requirement. The trailing edge of the inner segment brush should make contact with its associated ring at a point in line (within .020 in.) with the inscribed line on the stationary disk. All brushes should be centrally located with respect to their associated commutator rings.

c. Adjustment. Loosen the brush spring clamping screws. Position the distributor brushes to meet the requirements. Tighten the brush spring clamping screws.

50. Distributor Brush Spring Tension (fig. 17)

Caution: Replace brush springs that are kinked or have sharp bends.

a. Requirement. Hook an 8-ounce scale under the end of each distributor brush spring and pull upward at right angles to the end of the brush spring. A pull of 2½ to 3½ ounces should be required to lift the brush from its commutator ring.

b. Adjustment. Loosen the brush holder clamp screw until the brush holder is frictiontight. Rotate the brush holder clockwise until the brushes rest against the segments with a pressure of 2½ to 3½ ounces. Tighten the brush holder clamping screw.

c. Resurfacing Brushes. If it is necessary to readjust the brush holder to obtain the proper spring tension, the brushes should be resurfaced. Place a piece of No. 0000 sandpaper (approx 1-in. wide) face up on the distributor disk so that the brushes will pass over the sandpaper. Draw

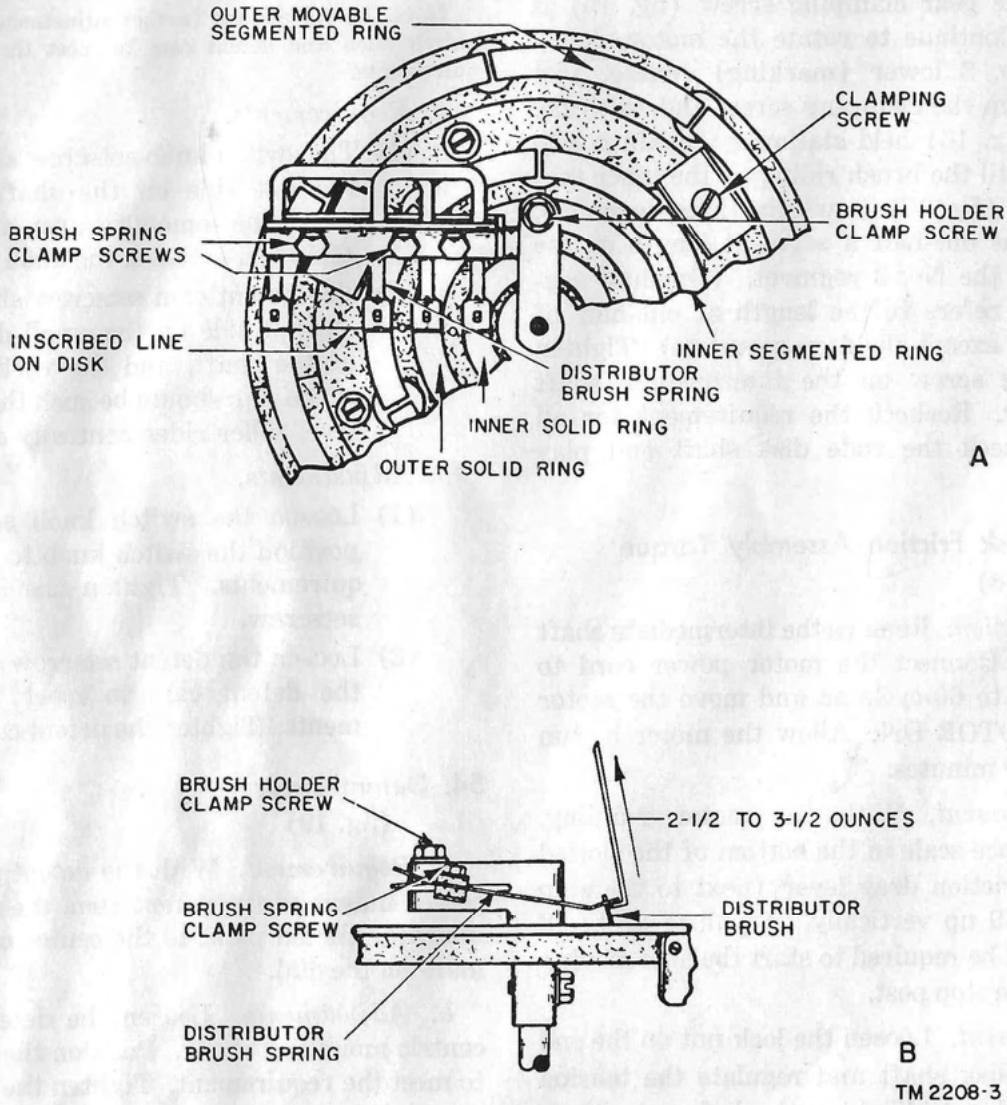


Figure 17. Distributor brush and brush spring.

the brushes across the sandpaper two or three times or until the bottoms of the brushes are parallel to the surface of the segments. Recheck the spring tension of each brush and readjust if requirements are not met.

51. Code Disk Position

a. Requirement. Each contact tongue should close with the lower (marking) contact before the distributor brush is within two segment lengths of the associated distributor segment and should remain closed until the brush has passed beyond the associated segment by two segment lengths. Use the inner segmented ring when checking these requirements. Refer to figures 15, 16, and 17 for location of parts.

b. Adjustment. Rotate the motor in its normal direction slowly by hand until the intermediate shaft bakelite gear clamping screw (fig. 15) is accessible. Continue to rotate the motor slowly until the No. 3 lower (marking) contact just closes. Loosen the clamping screw and, with the code disk (fig. 16) held stationary, again rotate the motor until the brush riding on the inner segmented ring (fig. 17) is within three segments, plus or minus one-half a segment length of the front end of the No. 3 segment. (One-half segment length refers to the length of one-half of any segment except the stop segment.) Tighten the clamping screw on the intermediate shaft bakelite gear. Recheck the requirement for all contacts. Check the code disk shaft end play (par. 43).

52. Code Disk Friction Assembly Torque (fig. 18)

a. Preparation. Remove the intermediate shaft gear guard. Connect the motor power cord to 115-volt, 50- to 60-cycle ac and move the motor switch to MOTOR ON. Allow the motor to run for at least 10 minutes.

b. Requirement. With the motor running, hook a 32-ounce scale in the bottom of the slotted end of the friction drag lever (next to the stop post) and pull up vertically. A pull of 20 to 32 ounces should be required to start the arm moving away from the stop post.

c. Adjustment. Loosen the lock nut on the end of the code disk shaft and regulate the tension by the slotted nut. Tighten the lock nut. Move the motor switch to MOTOR OFF. Replace the intermediate shaft gear guard.

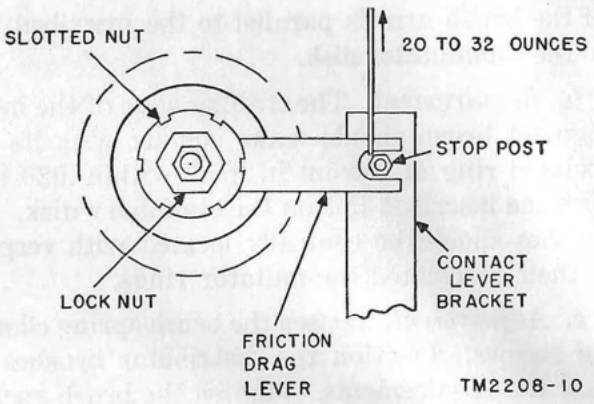


Figure 18. Code disk friction assembly.

53. Distortion Switch and Detent Cam (fig. 19)

Note. Before making further adjustments, position the switch knob and detent cam to meet the following requirements.

a. Requirements.

(1) The switch knob setscrew should engage the flat side on the shaft, and there should be some clearance, not to exceed .025 inch, between the knob and the dial.

(2) The detent cam setscrew should engage the flat side on the small diameter end of the shaft, and the vertical position of the cam should be such that the detent level roller rides centrally on the cam.

b. Adjustments.

(1) Loosen the switch knob setscrew and position the switch knob to meet the requirements. Tighten the switch knob setscrew.

(2) Loosen the detent setscrew and position the detent cam to meet the requirements. Tighten the detent cam setscrew.

54. Detent Lever (fig. 19)

a. Requirement. With the detent roller in the center indent of the detent cam, the switch knob indicator should point to the center of the ZERO mark on the dial.

b. Adjustments. Loosen the detent lever eccentric mounting screw. Position the detent lever to meet the requirement. Tighten the detent lever eccentric mounting screw.

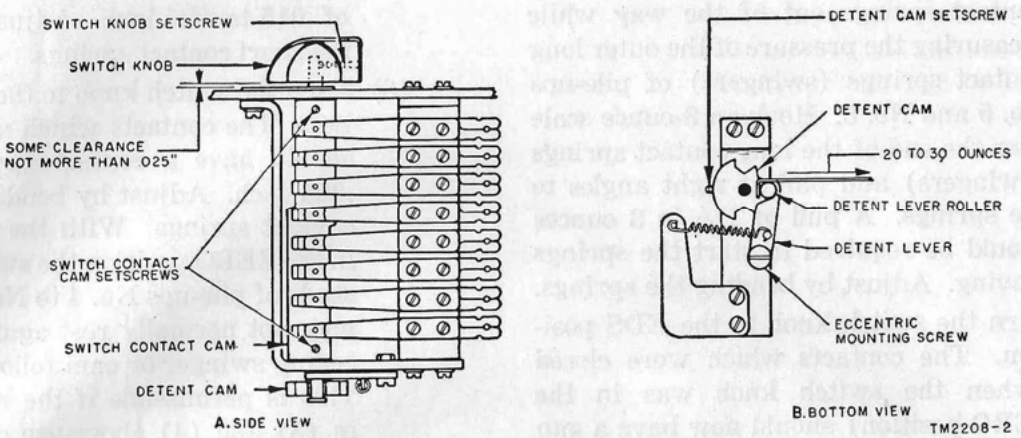


Figure 19. Distortion switch assembly.

55. Distortion Switch Contact Cam (fig. 19)

a. Preparation. Move the switch knob to the ZERO position.

b. Requirements. The setscrews of the switch contact cam should be at right angles to the switch knob pointer and the heads of the setscrews should be toward the left side of the unit.

c. Adjustments. Loosen the switch contact cam setscrews. Position the switch contact cam to meet the requirement. Tighten the switch contact cam setscrews.

56. Switch Detent Lever Spring Tension (fig. 19)

a. Requirement. With the detent lever roller in an indent on the detent cam, hook a 32-ounce scale over the detent lever roller and pull horizontally and at right angles to the detent lever. A pull of 22 to 30 ounces should be required to start the detent lever roller moving away from the detent cam.

b. Adjustment. If the requirement is not met, replace with a new spring.

57. Distortion Switch Contact Assembly (fig. 20)

a. Preparation. Move the switch knob to the ZERO position.

b. Requirements and Adjustments.

(1) The contact pile-ups (numbered 1 to 8, from top to bottom) should be as follows:

No. 1—All open.
No. 2—All open.
No. 3—Open.
No. 4—Back closed, front open.
No. 5—Back closed, front open.
No. 6—Back closed, front open.
No. 7—Back closed, front open.
No. 8—Open.

(2) With the switch knob at the ZERO position, the eight cam follower springs should bear against the cam. While holding the long contact springs (swingers) out of the way, hook an 8-ounce scale over the end of each cam follower spring at the cam and pull at right angles to the spring. A pull of not more than 1 ounce should be required to start each spring moving away from the cam. Adjust by bending the springs.

(3) Turn the switch knob to the EDM position. The cam follower spring of the pile-ups No. 3 to No. 8 inclusive should assume the same position (within .010 in.) as in the ZERO position. If necessary, refine the switch contact cam adjustment (par. 55). Turn the switch knob to the BIAS S position and check the cam follower springs of contacts No. 1 and No. 2 for the same requirements.

(4) With the switch knob in the ZERO position, the long contact springs (swingers) should bear against the cam follower spring or the next inner long contact spring (swinger). Hold the short contact springs and the outer long contact springs (swingers) out of the way while measuring the pressure of the inner long contact springs. Hold the short

contact springs out of the way while measuring the pressure of the outer long contact springs (swingers) of pile-ups No. 5 and No. 6. Hook an 8-ounce scale over the end of the long contact springs (swingers) and pull at right angles to the springs. A pull of 1½ to 3 ounces should be required to start the springs moving. Adjust by bending the springs.

(5) Turn the switch knob to the EDS position. The contacts which were closed (when the switch knob was in the ZERO position) should now have a gap of .015 to .025 inch. Adjust by bending the short contact springs.

(6) Turn the switch knob to the ZERO position. The contacts which are now open should have a contact gap of .015 to .025 inch. Adjust by bending the short contact springs. With the switch knob in the ZERO position the swinger spring studs of pile-ups No. 4 to No. 7 inclusive may not normally rest against the preceding swinger or cam follower springs. This is permissible if the requirements in (3) and (4) above are met.

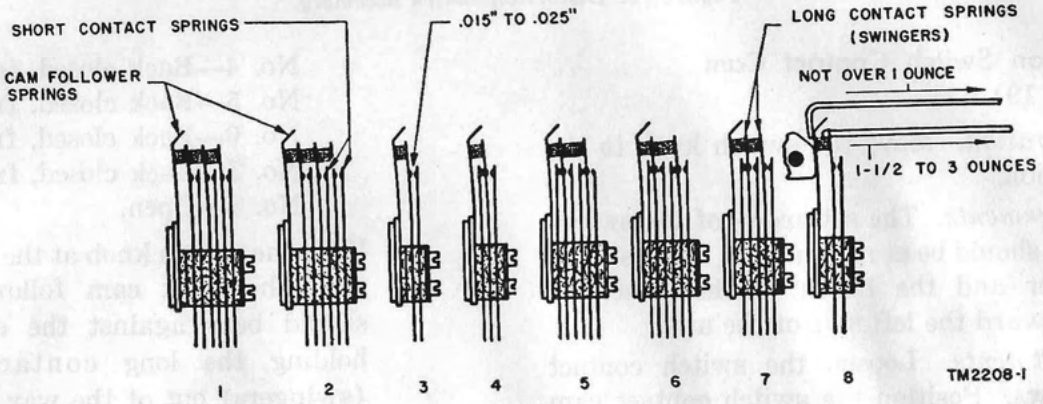


Figure 20. Distortion switch contact assembly.

CHAPTER 5
THEORY

Section I. THEORY OF TEST SETS

58. General

This chapter contains a complete explanation of the theory of operation of Test Sets TS–2(*)/TG. The first section covers the overall fundamentals of the test sets and the second section explains the overall theory of operation of the various control mechanisms.

59. The Distributor

a. The distributor face is equipped with four concentric rings. The two outer rings are segmented and the two inner rings are solid conductor rings. The outer segmented ring is movable so that it can be adjusted with respect to the inner segmented ring to send any amount of distortion from 0 to 50 percent. The amount of distortion is indicated on the scale at the side of the distributor disk. An overall view of the distributor is shown in figure 21.

b. Attached to the main shaft assembly is a brush holder assembly (fig. 21). The brush holder assembly mounts two sets of brushes which are drawn, in a clockwise direction, across the concentric distributor rings. One pair of brushes makes contact with the outer (movable) segmented ring and the outer solid ring. When undistorted signals are transmitted, these brushes are the only ones involved. The other pair of brushes makes contact with the inner segmented ring and the inner solid ring. Both sets of brushes and rings are used to transmit distorted signals by connecting the corresponding segments of the movable ring and the stationary ring electrically, either in series or in parallel.

c. The distributor rings are electrically connected, through the transmitting contacts and the character selecting switch, to the signal line. This provides a means of transmitting the signals at the correct speed and sequence to the equipment under test.

d. The segmented rings correspond to the impulses of the teletypewriter code; that is, a *start* segment for the start impulse, five *code* segments for the intelligence impulses, and a *stop* segment for the stop impulse. The distributor brushes make one complete revolution to transmit the code combination for each character or function. When a brush passes over the start segment, a *spacing* impulse is always transmitted. When a brush passes over the stop segment, a *marking* impulse is always transmitted. These two impulses keep the distributor and the receiving teletypewriter equipment in step or synchronism. A detailed explanation of the selection of character impulses is given in paragraph 61.

e. Distortion is introduced into the signal by positioning the outer movable segmented ring and by connecting these rings in either series or parallel by means of the distortion switch before completion of the electrical path to the signal line. Exact details of this procedure are discussed in paragraph 62.

60. Code Disk Transmitter Assembly

a. The code disk transmitter assembly (fig. 22) consists principally of five code disks, five contact levers, five contact tongues, and ten contacts. The code disks are driven by an intermediate shaft assembly which, in turn, is driven by the main shaft through a gear arrangement.

b. The five contact levers pivot about a shaft in the contact lever bearing. At the outer end of the contact levers are pivotal mountings. Attached to these mountings, but insulated from them by fiber insulators, are contact tongues which ride between the upper (spacing) and lower (marking) contacts. Springs are connected between the contact tongues and a terminal block. These springs serve a dual purpose. They hold the contact tongues on the lower contacts until

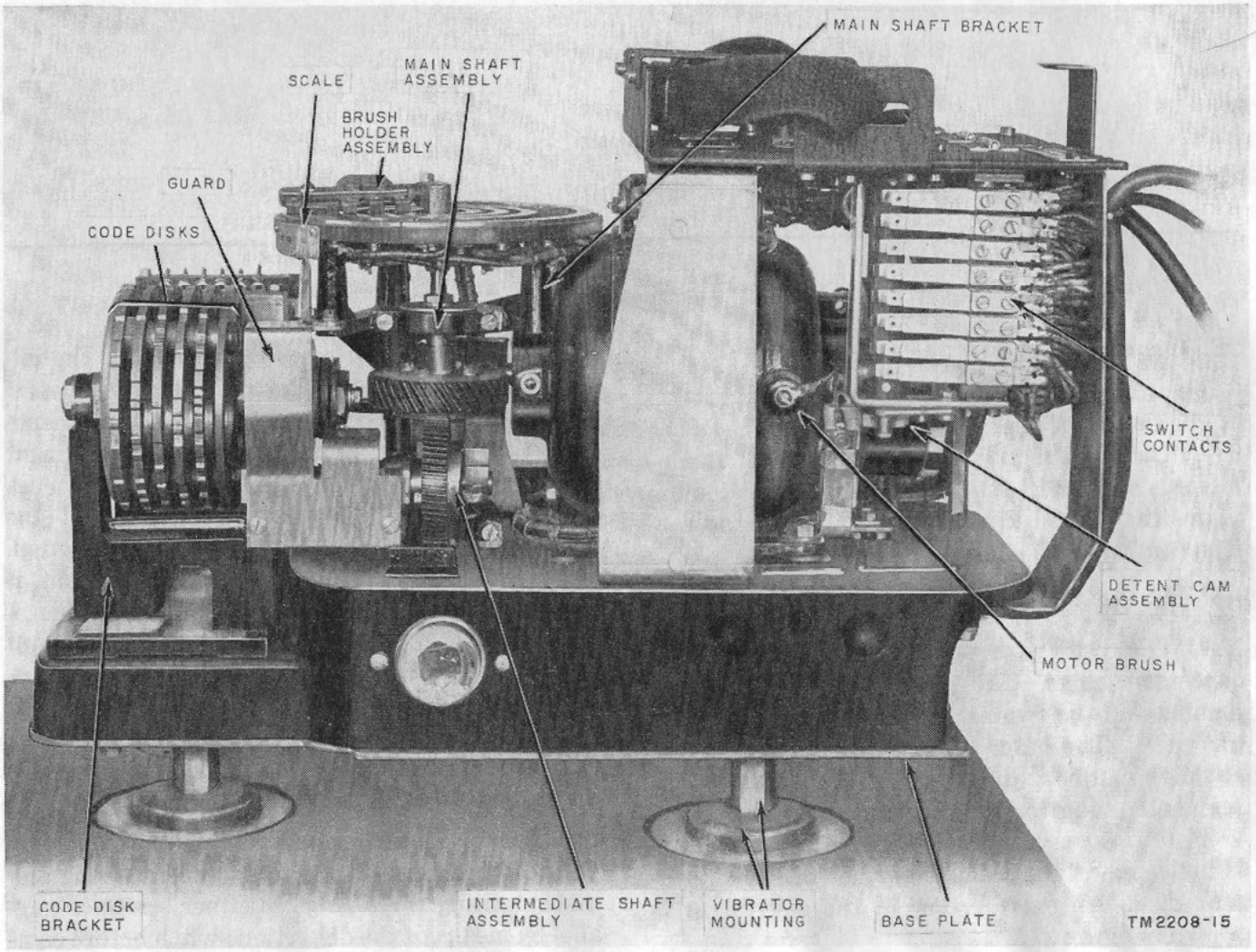


Figure 21. Distributor and main shaft assemblies.

the tongues are forced up by the code disks, and they afford an electrical connection between the terminal block and the contact tongues. Thus, when the tongues are in the lower position, an electrical connection exists from the terminal block, through the contact tongues, and through the lower contacts to the character selecting switch.

c. The five code disks (fig. 22) contain cams of various lengths spaced around their outer rims. The disks are bolted together and rotate with a fixed relationship to the rotation of the distributor brush arm. A friction assembly, located at the end of the code disk cam assembly, applies a drag on the shaft and prevents backlash. The five contact levers have pointed arms which press against the coded disks. As a contact lever rides up on a raised cam, it is forced to pivot about the contact lever bearing shaft, raising the contact tongue against the upper (spacing) contact and thus transmitting a space (no current) impulse. When the contact lever rides into a low position of the coded disk, the contact tongue is pulled down to the lower (marking) contact, transmitting a mark (current) impulse. The coded disks are so arranged that at any one position, the five contact levers hold the contact tongues in the positions necessary to transmit marking and spacing impulses in the correct sequence to form a complete character or function in accordance with the teletypewriter 5-unit start-stop code. One complete revolution of the code disks on Test Sets TS–2/TG and TS–2A/TG transmits the test message THE QUICK BROWN FOX JUMPED OVER A LAZY DOG'S BACK 1234567890 TESTING, followed by one carriage return and two line feed combinations. One complete revolu-

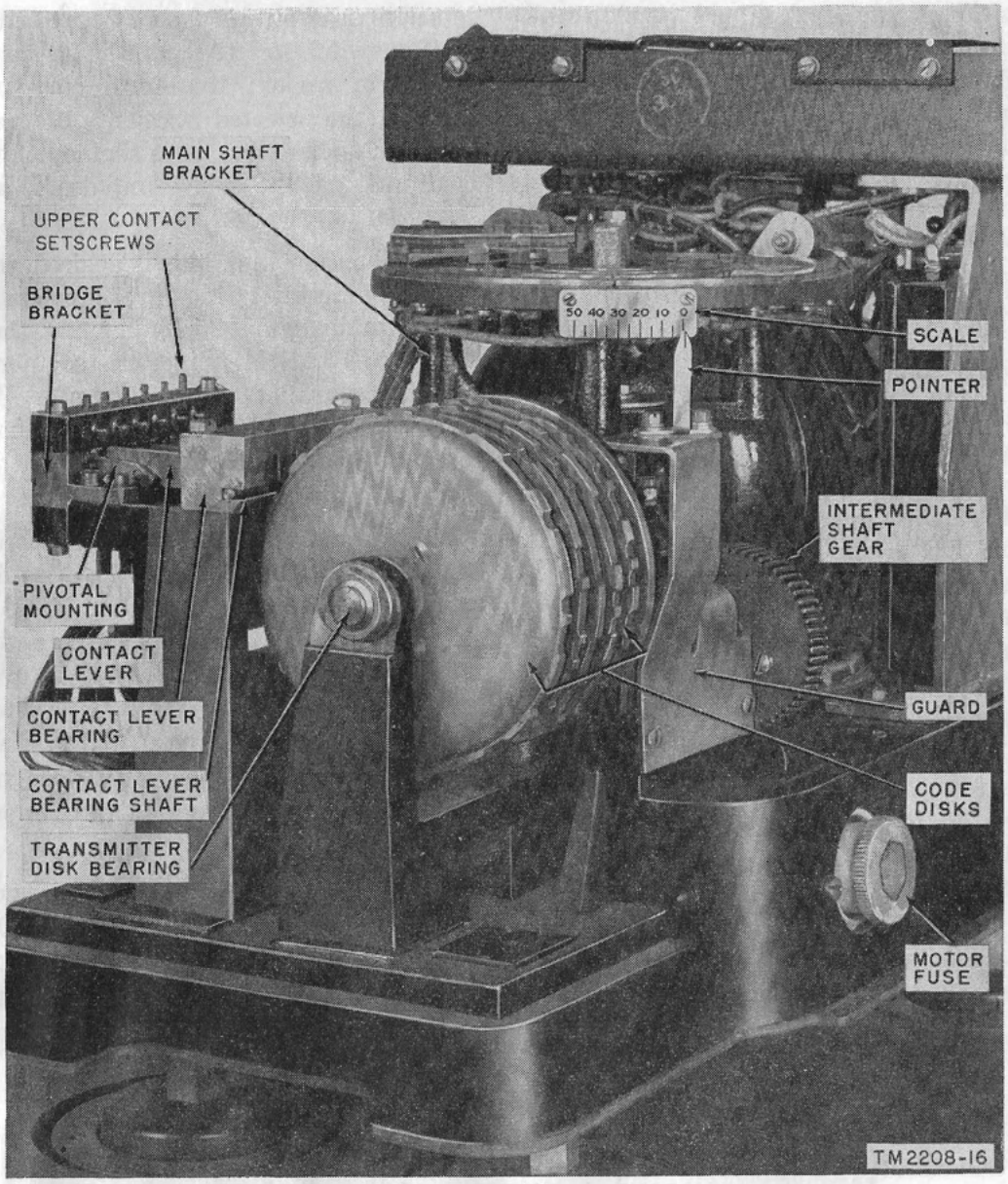


Figure 22. Code disk and contact lever assemblies.

tion of the code disks on Test Sets TS–2B/TG transmits the same test message followed by four letters combinations, two carriage return combinations, one line feed combination and one letters combination.

d. The electrical circuit from the distributor through the transmitting contacts to the signal line is completed by setting the character selecting switch in the TEST MSG position. When the character selecting switch is in any other position, the transmitting contacts are open and the test message is not transmitted to the signal line.

Section II. CONTROL MECHANISMS

61. Character Selecting Switch

The character selecting switch is a 6-pole, 5-position switch. The positions are: R, Y, TEST MSG, RPT SP, and STOP. In the TEST MSG position, the character selecting switch connects the code disk transmitter to the signal line. In the R, Y, and RPT SP positions, the switch disconnects the code disk transmitter from the signal line and connects the distributor rings in the correct sequence to the signal line. With the switch

in the R position, segments 2, 4, and the stop segment are connected to the signal line. With the switch on Y, segments 1, 3, 5, and the stop segment are used. The switch, in any of the above positions, permits a continuous selected function to be transmitted. When the character selecting switch is in the STOP position, the signal line is shorted, preventing any signals from being transmitted but providing a closed circuit to the equipment under test.

62. Distortion Switch

a. The distortion switch is a system of make-break spring contacts which are ganged together and operated by a bakelite camshaft. The switch may be set for ZERO distortion, BIAS M, BIAS S, ED M, and ED S. The selections are defined by a detent roller and lever which presses against a detent cam mounted on the lower end of the bakelite camshaft.

b. When bias is provided by the test set, all *space-to-mark* transitions are advanced or retarded with regard to the beginning of the start impulse of a teletypewriter character. End distortion differs in that all *mark-to-space* transitions are advanced or retarded with regard to the beginning of the start impulse. Figure 23 shows examples of distorted signals.

c. When spacing bias is desired, the segments of the segmented commutator rings are connected in series as shown in figure 24 by setting the distortion switch to BIAS S. The segments are connected in series; therefore, current will flow through the selected segments of the two rings only during the time these segments overlap. The beginning of the mark impulse is retarded as shown in (a) figure 23.

d. When marking bias is desired, the segments of the commutator rings are connected in parallel as shown in figure 25 by turning the distortion switch to BIAS M. Since the segments are connected in parallel, current flows as illustrated in (b) figure 23. This shows the beginning of the mark impulse advanced with regard to the start impulse.

e. When spacing end distortion is desired, the segments are connected as shown in figure 26 by setting the distortion switch to ED S. Since the segments are again connected in series, current flows when the selected segments overlap, with the result shown in (c) figure 23. The end of the mark impulse is advanced. Note that the start and stop segments of the movable segmented ring are connected, resulting in a start impulse always equal to a unit length impulse.

f. When marking end distortion is desired, the segments are connected as shown in figure 27 by setting the distortion switch to ED M. Note that in this case, only one movable stop segment is used

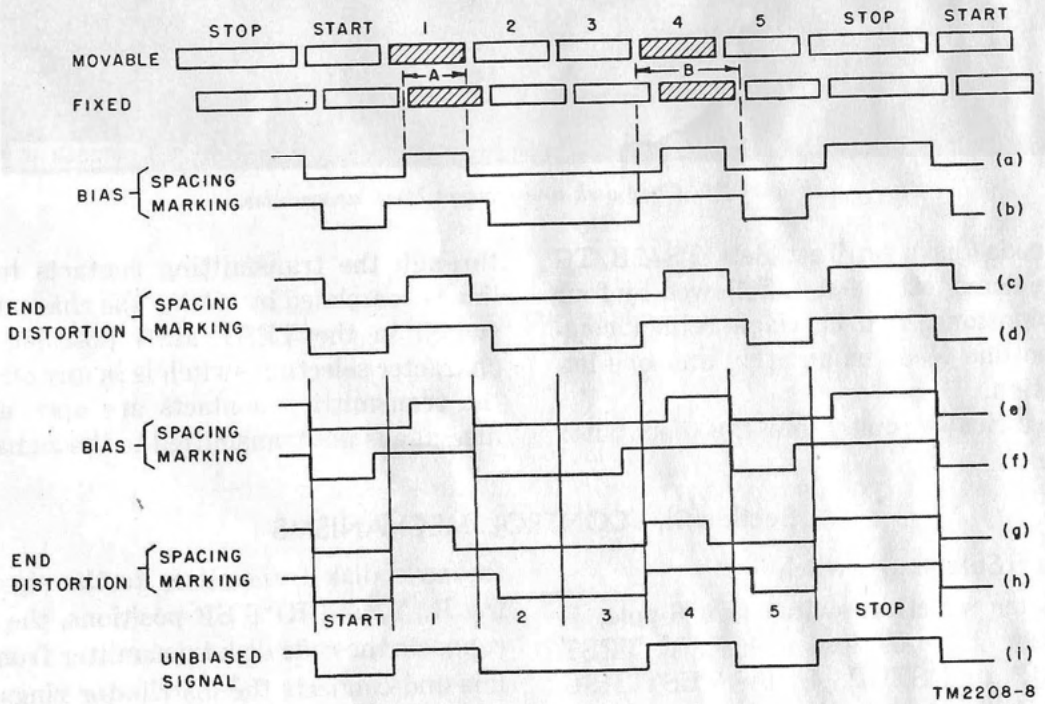


Figure 23. Examples of distorted signals.

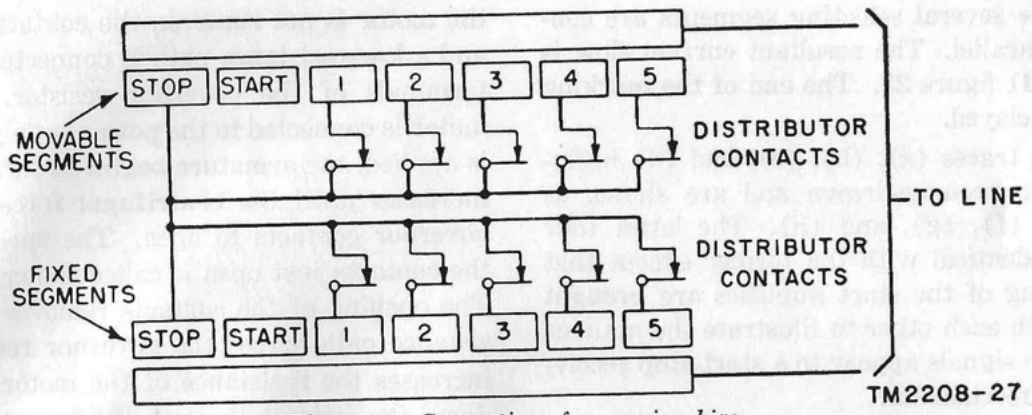


Figure 24. Connections for spacing bias.

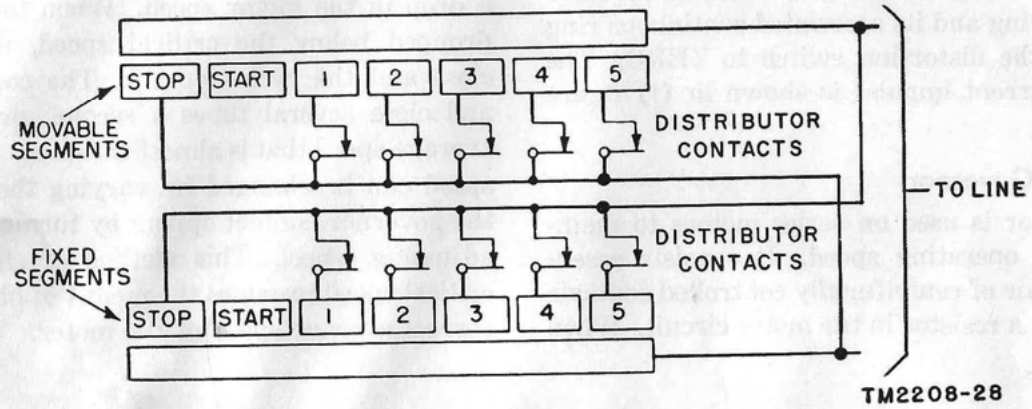


Figure 25. Connections for marking bias.

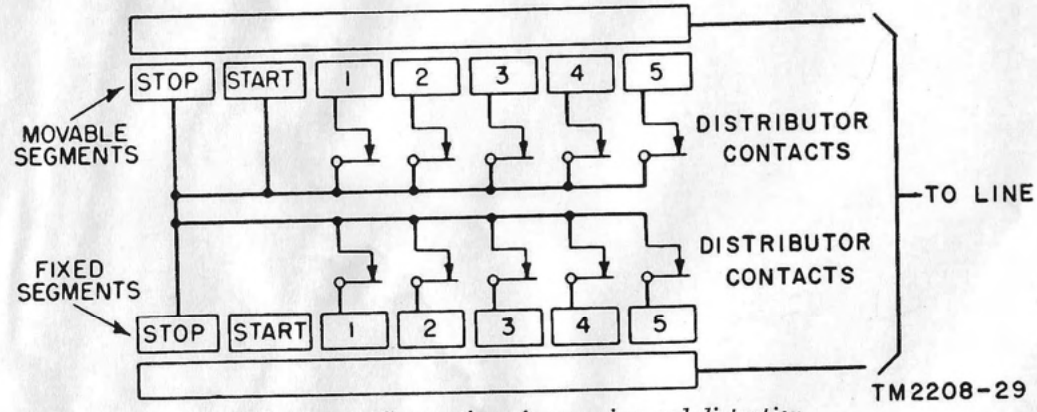


Figure 26. Connections for spacing end distortion.

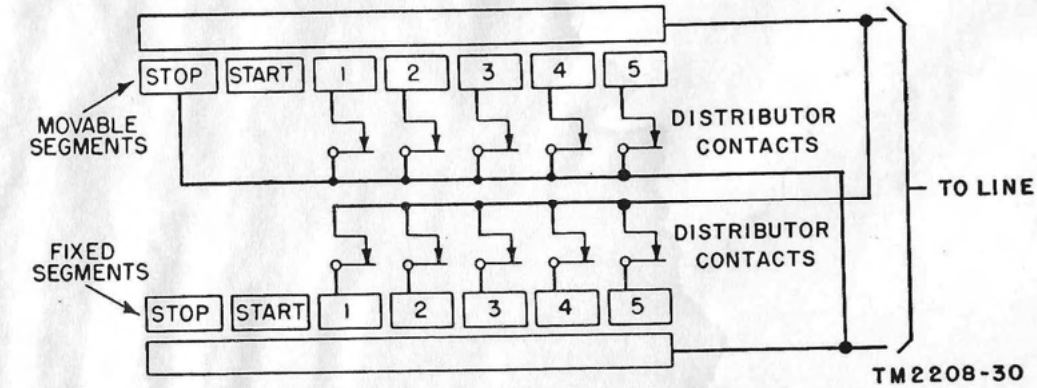


Figure 27. Connections for marking end distortion.

and that the several selecting segments are connected in parallel. The resultant current flow is shown in (d) figure 23. The end of the marking impulse is delayed.

g. Signal traces (a), (b), (c), and (d) in figure 23 have been re-drawn and are shown as traces (e), (f), (g), and (h). The latter four traces are identical with the former except that the beginning of the start impulses are brought into line with each other to illustrate the manner in which the signals appear to a start-stop receiving selector mechanism.

h. Unbiased signals are obtained from the fixed segmented ring and its associated continuous ring by setting the distortion switch to ZERO. The resultant current impulse is shown in (i) figure 23.

63. Motor Governor

A governor is used on series motors to maintain proper operating speed. It consists essentially of a pair of centrifugally controlled contacts which shunt a resistor in the motor circuit. When the motor is not running, the contacts are closed and a low-resistance path is connected across the terminals of the governor resistor. When the motor is connected to the power supply and power is applied, the armature begins to turn. Its speed increases until the centrifugal force causes the governor contacts to open. The speed at which the contacts just open is called the critical speed. The opening of the contacts removes the low-resistance path across the governor resistor. This increases the resistance of the motor circuit, reduces the current through the motor and causes a drop in the motor speed. When the speed has dropped below the critical speed, the contacts close and the cycle repeats. The contacts open and close several times a second, producing an average speed that is almost constant. The critical speed can be changed by varying the tension of the governor contact spring by turning the speed adjusting wheel. This method of changing the critical speed provides the means of obtaining the correct average speed of the motor.

CHAPTER 6
FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information pertinent to field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and the skill of the repairman.

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

64. General

a. A thorough knowledge of the functioning of each unit of the test set is of fundamental importance in analyzing trouble. The maintenance man must be able to determine quickly whether the trouble is due to a mechanical failure within a specific part of the equipment or whether the trouble is in some electrical circuit. The appearance of a particular operating failure may immediately indicate the exact location of the faulty adjustment or damage. If it does not, the maintenance man must determine exactly what parts are functioning properly and what parts fail to do so.

b. The isolation of trouble can usually be accomplished quickly by the process of elimination. If the test set, when connected into a circuit which was previously known to be in good operating condition, fails to give satisfactory service, the trouble is probably in the test set itself.

Caution: Do not take the test set apart or make readjustments until it is certain that the equipment is faulty.

c. When it has been reasonably established that the trouble is within the test set, the next step is to localize the trouble to a particular electrical circuit or mechanical element. The troubleshooting chart (par. 67) gives the most common troubles and the probable causes. Use this chart as a reference when locating trouble.

65. Localizing Electrical Troubles

All electrical circuits are wired to terminal blocks mounted on the under side of the base casting from where they are taken by cords and plugs to their external destination. The localization of trouble in the circuits is discussed in the following subparagraphs.

a. Code Disk Transmitter Circuit. The probability of trouble in the code disk transmitter circuit is always present, but it is a trouble which can be readily isolated. The code disk transmitter circuit operates only when the character selecting switch is in the TEST MSG position. Therefore, when trouble arises, the transmitter can be isolated by merely turning the character selecting switch to R or Y. If trouble persists, it is not in the code disk transmitter circuit.

(1) An open in any lead from the code disk transmitter causes the impulse to be transmitted as a spacing impulse, that is, a no-current impulse. This causes a partial garbing of the transmitted message.

(2) An open in the distortion control circuit may cause a no-current impulse to be sent out. It may also have the effect of sending out an undistorted signal when the distortion control switch is set for a distorted signal.

(3) A short in two leads from the code disk transmitter circuit causes a marking impulse to be transmitted at a point when one is not desired. It has the same result as though two segments of the distributor were shorted.

b. Control and Distributor Circuits. The various circuits are selected for operation by the character selecting switch. This switch changes the electrical circuit in such a manner as to select the desired signal for transmission.

(1) An open in any of the leads from the

character selecting switch causes a spacing impulse to be transmitted, thereby garbling the transmitted signal. In like manner, a short between any of the leads causes an erroneous marking impulse to be transmitted. This short can be localized by switching to the various signals.

(2) The most common electrical troubles caused by the distributor are excessive sparking and shorts between the brushes. Metal and carbon particles occasionally accumulate between the ends of the segments and between the concentric rings. If the accumulation becomes great enough to short the segments, false impulses are transmitted. If the concentric rings are shorted, a steady marking signal is transmitted. Excessive sparking of the distributor brushes usually is caused by brushes that are worn or improperly seated. Excessive sparking causes irregularities of the marking impulse.

c. Motor Circuit. Motor circuit troubles depend upon the type of motor used. The most common trouble is caused by worn or dirty motor brushes or by worn, burned, or shorted governor contacts.

66. Localizing Mechanical Troubles

Mechanical faults may develop in the test sets, but little trouble should be experienced in localizing them if the logical sequence of checks outlined in the following subparagraphs is followed.

a. Code Disk Transmitting Assembly. After the set has been running a few minutes, set the character selecting switch to TEST MSG. If the signal shows signs of garble or erroneous space impulses, turn the selecting switch to another character. If trouble no longer exists, the trouble probably lies somewhere in the code disk transmitting assembly. To correct the trouble, refer to paragraphs 47 and 48 for the proper adjustment of transmitter contact levers and tongues.

b. Distributor. If errors continue to be transmitted on all settings of the character selecting switch, a fault in the distributor is indicated. A poorly adjusted commutator brush or pits on the commutator caused by arcing will cause spasmodic errors in the transmitted signal. Consistent errors in all settings may indicate that the distributor is not properly adjusted to transmit ZERO distortion. Correct these errors by proper adjustment according to instructions given in paragraphs 49 and 50.

c. Controls.

(1) *Character selecting switch.* Turn the character selecting knob to the various signals. If characters other than those selected are transmitted, the character selecting switch is at fault. Excluding trouble in the electrical circuit, the fault is probably caused by open or dirty contacts or an improperly adjusted knob.

(2) *Distortion switch.* If distortion is present when the distortion knob is set at ZERO or if no distortion can be obtained by turning the distortion knob, the trouble is caused by dirty, pitted, or improperly adjusted contacts. The distortion switch should be adjusted in accordance with the requirements in paragraphs 53 through 57. The detent cam or distortion knob also may be out of adjustment.

d. Motor and Governor. If the test set seems to run too fast or too slow or if there is a marked fluctuation in the speed, the governor assembly requires adjustment. Check the adjustments with the requirements given in paragraphs 38 through 42. Weak or poorly adjusted governor springs or pitted or dirty contacts will cause this trouble. Make adjustments according to instructions in paragraph 40.

67. Troubleshooting Chart

The most common troubles that occur in these test sets, together with a listing of the probable causes and the corrective action, are given in the following chart. This list of troubles does not represent all the troubles that might occur or all the probable causes for each condition, but does include those which occur in the majority of cases. The probable causes or the items in which the causes may be found are listed under each heading. The references included after the corrective action furnish a cross-reference to paragraphs in other sections of this manual.

Condition	Probable trouble	Corrective action
Motor fails to start	Ac power cord not plugged in	Plug in ac power cord.
	Burned-out motor fuse	Replace fuse.
	Power switch inoperative	Clean or replace switch.
	Motor brushes dirty or inoperative	Clean or replace brushes (pars. 80 and 81).
	Open connection in power cord	Repair connection or replace cord.
Motor runs too fast or too slow. Governor cannot be adjusted.	Governor contacts dirty or inoperative.	Adjust contacts (pars. 38 and 39) or clean or replace (pars. 87–90).
	Governor brushes and contact disks dirty or inoperative.	Clean or adjust (pars. 40–42) brushes and disks.
Transmits garbled test message	Dirty or inoperative transmitting contacts.	Clean or adjust (pars. 47 and 48) contacts.
	Code disk phasing out of adjustment	Phase code disks (par. 51).
	Open in leads to transmitting contacts.	Repair open.
	Shorted leads to transmitting contacts.	Remove short.
Sends garbled signals in all positions of character selecting switch.	Distributor segments shorted	Remove short.
	Shorted wiring or leads from coding unit assembly.	Remove short.
	Improperly adjusted distributor brushes.	Adjust brushes (pars. 49 and 50).
Transmits characters other than those indicated by character selecting switch.	Character selecting knob positioned improperly on shaft.	Reposition knob.
	Short or open in wiring or leads from coding unit assembly.	Remove short or repair open.
	Improperly adjusted distributor brushes.	Adjust brushes (pars. 49 and 50).
Transmits garbled signals in one position of character selecting switch.	Open lead in circuit for that position	Repair open.
	Shorted lead in circuit for that position.	Remove short.
Transmits spasmodically erroneous marking impulses.	Distributor segments dirty or shorted	Clean segments (par. 75) or locate short and remove.
	Grounded lead in distributor circuit	Remove ground.
	Short in leads to distortion switch contacts.	Remove short.
Distortion cannot be obtained or is present at all times.	Distributor brushes shorted	Remove short.
	Improperly adjusted distributor brushes.	Adjust brushes (pars. 49 and 50).
	Transmitting commutator rings shorted.	Remove short.
	Short in leads to distortion switch contacts.	Remove short.
	Open in leads to distortion switch contacts.	Repair open.
	Distortion control switch improperly adjusted or worn.	Adjust switch (par. 53) or replace (par. 94).
	Weak or poorly adjusted springs in distortion switch.	Adjust springs (pars. 54–57) or replace switch (par. 94).
Amount of distortion cannot be increased or decreased.	Open or short in leads from distributor disk.	Repair open or remove short.
Runs properly but fails to transmit signals.	Open in line cord	Repair or replace cord.
	Open connection on terminal block	Resolder connection.
	Shorted capacitor in filter switch	Replace capacitor.
	Improperly adjusted distributor brushes.	Adjust brushes (pars. 49 and 50).
Local test circuit inoperative	Open in local test jack	Repair open.
	Short in local test jack	Remove short.
	Open resistor in test jack circuit	Repair open or replace resistor.
	Open in local test circuit cord	Repair or replace cord.

Section II. REMOVAL AND REPLACEMENT

68. General

Most assemblies of Test Set TS–2(*)/TG should be removed from the base before they are dismantled for repairs. This section describes the recommended procedure for removing, repairing and replacing defective parts of the test set. It does not duplicate information on preventive maintenance contained in chapter 4. Except in cases of extreme emergency, all repairs should be completed by personnel thoroughly trained in teletypewriter maintenance.

69. Removal and Replacement of Motor

a. Remove the motor from the base for all repairs except replacement of motor brushes.

(1) Remove the test set from the wooden chest base.

(2) Remove the motor pinion guard.

(3) Loosen and lay aside the control panel. Be careful not to crack or damage any insulation or pull apart any connections.

(4) Unscrew or untape any motor leads and clip any waxed string or other lacing which holds the wiring to the base. The governor and motor pinion gear need not be removed until the motor has been taken off the base.

(5) Carefully slide out the governor brush bracket assembly and motor governor filter assembly and lay them to one side.

(6) Remove the four motor mounting bolts and carefully work the motor from the base.

b. Replace the motor on the base by reversing the procedures outlined above.

70. Removal and Replacement of Main Shaft

a. Remove the main shaft as follows:

(1) Remove the brush holder assembly from the main shaft. The screw that holds the brush holder assembly on the main shaft is located on the shaft under the distributor disk.

(2) Loosen the clamping screw on the bakelite gear on the intermediate shaft and slide the gear off the end of the intermediate shaft.

(3) Remove the upper and lower bearing retaining caps.

(4) Lower the shaft so that it will clear the bottom of the distributor disk and swing the top end of the shaft clear of the disk.

(5) Ease the main shaft assembly out and upward.

b. Replace the main shaft by reversing the procedures outlined above. Adjust the intermediate shaft bakelite gear according to instructions in paragraph 45.

71. Removal and Replacement of Contact Lever Bracket, Code Disk Bearing, and Intermediate Shaft Assemblies

a. The contact lever bracket and the code disk bearing assemblies are mounted on a base which forms a part of the intermediate shaft assembly. This base, in turn, is fastened to the base of the test set with four screws located on the underside of the test set base.

(1) Remove the bottom plate of the test set to get at the four screws which secure the intermediate shaft base to the base of the test set. Be careful not to break or put any strain on the wiring to the contact lever bracket assembly.

(2) Remove the four screws which fasten the contact lever bracket assembly and the code disk bearing assembly to the intermediate shaft base.

b. Replace the above assemblies by reversing the procedures outlined above.

72. Removal and Replacement of Character Selecting Switch

a. Remove the bakelite knob by loosening the setscrew which holds the knob in place.

b. Remove the mounting nut and gently work the switch out. Be careful not to damage any wiring.

c. Unsolder the leads and tag them to facilitate connecting the new switch.

d. Replace the switch, following in reverse order, the procedure for removal.

Section III. REPAIRS

73. Cleaning Procedure for Major Overhaul

a. General. Equipment that has been disassembled for major overhaul can be cleaned by immersing or brushing the mechanical parts in vats of appropriate cleaning material or by wiping the parts thoroughly with a cloth dampened with appropriate cleaning material.

Caution: Do not immerse, brush excessively, or dampen motor windings and armatures, equipment, wiring, capacitors, and resistors.

b. Materials.

(1) *Cleaning Compound, liquid form.* Use Cleaning Compound, liquid form (Federal stock No. 7930–395–9542) to remove oil, grease, gummy deposits, and small amounts of soluble materials such as dirt, dust, mud, paper, and lint. Do not use on rubber products. After using Cleaning Compound, wipe the equipment dry so that no film or residue is left when the Cleaning Compound dries.

(2) *Water.* Use water only to remove excessive amounts of mud, dirt, or other soluble foreign materials from the exterior of the chest.

Caution: Do not allow water to dampen the motor windings and armature, equipment wiring, capacitors, or resistors.

c. Drying.

(1) *Wiping.* Wipe smooth-surfaced parts with a clean, dry cloth until they are dry. Be sure that all crevices and corners are dry.

(2) *Oven.* If possible, dry all parts that have been washed or flushed with water in an oven or under heat lamps for 1 to 2 hours at 160° F.

(3) *Air blast.* Parts that have been washed with water or Cleaning Compound may be dried by using an air blast. Dry all parts thoroughly.

Warning: Be careful when drying parts with an air blast to prevent loss of parts or serious injury to personnel from flying parts.

74. Main Shaft Repairs

(fig. 11)

Repairs on the main shaft consist principally of replacement of parts. Before any repairs can be made on the main shaft it must be removed (par. 70) from the test set. The main shaft should be disassembled as follows:

a. Remove the upper and lower ball bearings by taking off the nut and lockwasher which hold them in place. Remove the bearing covers.

b. Remove the main shaft pinion gear by loosening the setscrew in the hub and slipping the pinion gear off.

c. Remove the main shaft gear by unscrewing the screws which hold it to the main shaft hub.

d. The main shaft hub is pressed on the shaft and secured by a pin. For most repairs the main shaft hub need not be removed.

e. Reassemble the main shaft by reversing the procedures outlined above.

75. Refinishing Distributor Disk

a. Loosen the brush holder arm retaining screw and remove the brush holder assembly. Wrap a piece of cheesecloth or other cloth around the main shaft and the code disk transmitter below the distributor disk to protect them from metal particles and grit.

b. Wrap a piece of No. 000 sandpaper around a block of soft wood with dimensions of about 2 by 5 by ¾ inches. Place the block on the distributor disk and press down with the fingers. Rotate the block about the axis of the main shaft, avoiding undue pressure on any one point. As soon as the segments are almost smooth, remove the No. 000 sandpaper and replace it with No. 0000 sandpaper. Repeat the finishing process until the segments are smooth and polished. Do not remove any more metal than is necessary. Remove any dust or metal particles which may have accumulated between the segments.

c. Carbon particles from carbon brushes become imbedded in the surface of the copper commutator segments, causing them to become dark. The discoloration is a form of case-hardening and greatly increases the life of the segments. Do not remove this discoloration unless the segments are deeply grooved.

d. After refinishing the distributor, trim off any burrs that may have formed on the ends of the segments. These burrs cause the carbon brushes to chip. Coat the ends of the segments with a coat of insulating varnish to prevent car-

bon dust or copper particles from shorting the segments.

76. Disassembly of Motor for Repairs

a. General. Remove the motor from the base as directed in paragraph 69. Unsolder any leads so that the motor will be totally disconnected from the set. Label the leads to facilitate reconnection.

b. Step-by-Step Disassembly of Motor in Test Set TS–2/TG.

(1) Remove the motor pinion gear and the governor. Be careful not to lose any of the shims that may be on the armature shaft between the governor and the end of the frame casting of the motor.

(2) Remove the brush holder caps and the brushes.

(3) Remove any external bearing retainer screws.

(4) Remove the motor bolts and take off the end bell by prying gently with the blade of a screwdriver. Lift out the armature. Be careful not to drop the armature or damage the windings. Do not lose any of the parts such as bearing retainers, springs, or washers.

(5) Remove the armature bearings with a suitable bearing puller.

c. Step-by-Step Disassembly of Motors in Test Sets TS–2A/TG and TS–2B/TG.

(1) Remove the motor pinion gear and the governor.

(2) Remove the brush holder caps and remove the brush and spring assemblies.

(3) Remove the two screws on the plain end of the motor. This will allow the motor to be pulled apart and the armature removed. Be careful not to drop the armature or damage the windings. Do not lose the tension washer located under the armature bearing.

(4) Remove the armature bearing with a suitable bearing puller.

Caution: Be careful when using a bearing puller on bearings which have built-in dust shields. Position the puller so that it presses on the outer bearing race *only*. Pressure exerted on the dust shield will crumple the shield and destroy the bearings. *Do not attempt to pull the bearings off with a screwdriver.*

77. Special Cleaning Instructions for Motor

The instructions given in this paragraph are for cleaning the internal parts of the motor.

a. Disassemble the motor (par. 76).

b. Remove all dust, paper lint, nonoily dirt, etc., from the armature and stator windings by brushing carefully with a clean, dry sash brush. *Do not damage the windings.*

c. Remove all oil, grease, or gummy deposits from the face of the armature and stator by wiping them with a piece of cheesecloth, dampened with Cleaning Compound. *Do not use too much Cleaning Compound.*

d. Clean the end frames, bearings, motor pinion gear, and any other metal parts by immersion in a container of the appropriate cleaning fluid. Be sure to dry and lubricate the parts as directed.

e. Remove all dust, dirt, oil, grease, gummy deposits, or other foreign matter from the commutator by rubbing it with a piece of cheesecloth dampened with Cleaning Compound. Be careful not to damage the windings. The copper segments of the commutator may become quite dark and discolored. *Do not* polish the commutator to remove this discoloration unless the commutator has become so deeply grooved, or unless it causes such excessive sparking at the brushes, as to require being turned down on a lathe. When the armature requires such action, it should be replaced and the old armature returned to supply or qualified armature repair personnel.

78. Replacement or Repair of Motor Armature

a. After long periods of operation, the commutators of series-wound motors become worn and grooved by brush wear, and they require resurfacing. If the surface of the commutator is not deeply grooved and has an even, smooth, grayish coating of oxide, resurfacing is not required unless there is excessive sparking at the brushes when the motor is under load.

b. If there is excessive sparking of brushes on a commutator that is not grooved or pitted, clean it with a cloth moistened with Cleaning Compound, turning the shaft over by hand after the

brushes are removed, as described in paragraph 80.

c. If there is still excessive sparking, remove the armature from the motor and clean the commutator by lightly applying No. 0000 sandpaper. To do this, wrap a piece of sandpaper around the commutator and rotate the armature, holding the sandpaper against the rotating commutator very lightly.

d. Inspect the commutator carefully to determine if it is necessary to undercut the separating insulators between the segments (par. 79). The top of the insulating material must be below the level of the commutator bars on either side. This is necessary to prevent small carbon particles from lodging in the separators and building up to a point where the adjoining commutator segments or bars will be short-circuited.

79. Undercutting Commutator Bar Separators (Insulators)

Tool equipments available at larger repair shops may include any one of several types of undercutting tools. Do not attempt to use such tools until the directions furnished with them have been carefully studied. If no standard undercutting tool is available, improvise a substitute from a piece of hacksaw blade, as follows:

a. Grind the sides of the cutting edge of the hacksaw blade until the total width of the teeth is a little less than the width of the slot between the commutator segments.

b. Fit a wooden handle to the unground portion of the blade to protect the fingers against injury.

c. Hold the improvised tool at an angle so that only one or two teeth are in contact with the separator material, which is usually mica. Draw the tool—in a direction away from the windings—and cut away a portion of the separator. Repeat the process until the surface of the separator material is a maximum of one sixty-fourth inch below the surface of the adjacent metal commutator segment bars, uniformly, along the entire slot. Repeat for all the separator slots in the commutator. *Be sure that there are no slivers of metal remaining in the slots after the cutting process.* Such slivers will short-circuit the commutator segments and burn out the windings when the motor is started.

80. Replacing Motor Brushes

a. When removing the brushes, mark the upper surface so that the brush may be replaced in the same holder with the same side uppermost. If the brush has a number stamped on the upper side of the carbon, this number may be used as a guide.

b. Inspect the brushes as follows:

(1) See that at least five-eighths inch of brush material remains.

(2) Be sure that at least one-third of the brush face bears upon the commutator surface.

(3) See that the brushes make contact across at least 75 percent of the long dimension of the brush face.

c. If the above requirements are not met, replace it with a new brush.

81. Surfacing and Instaling Motor Brushes

To shape the contact face of the brush to the curvature of the commutator, proceed as follows:

a. Wrap a piece of No. 0000 sandpaper around the commutator under the brush holder with the abrasive side away from the commutator face.

b. Insert the brush in the brush holder with the numbered or marked side uppermost, so that the brush bears against the sandpaper under the normal pressure of the brush spring.

c. Rotate the armature back and forth by hand, so that the sandpaper will wear a surface of proper curvature in the contact face of the brush. The last rotation of the armature should be in the direction in which it would turn during operation of the motor.

d. After the proper curvature has been cut in the brush face, remove the brush from the brush holder. Bevel the edges, slightly, with sandpaper.

e. Wipe the brush with a cloth moistened with Cleaning Compound.

f. Examine the brush spring to see that it is in good condition. See that the pigtail within the brush spring is intact and free from kinks, and that it will permit the spring to extend properly.

g. Clean out the brush holder with a piece of cloth moistened with Cleaning Compound wrapped around a stick, or an appropriately shaped tool such as a screwdriver. Be careful not to score the sides of the brush holder.

h. Reinsert old brushes in brush holders from which they were removed for resurfacing. See that the brush is restored in the same position that it occupied before removal.

i. Always insert a new brush that has just been resurfaced with the numbered side uppermost.

j. See that the brush moves freely in the brush holder. Check the pressure of the brush springs and see that they meet the specified requirements.

82. Replacing Armature Bearings

a. General. Install new bearings if those in use are burned, cracked, badly worn, or damaged in any way. Handle the bearings carefully. See that no dirt gets into the bearing races. Except on Test Sets TS–2A/TG and TS–2B/TG, lubricate all bearings including used bearings that are found to be in good condition when cleaned and inspected. Apply grease, Signal Corps stock No. 6G650, to new bearings before they are installed on the shaft. In addition to its lubricating properties, the grease prevents dirt from entering the bearings. Place a paper washer over the exposed side of the bearing to further prevent dirt or dust from entering. The motors in Test Sets TS–2A/TG and TS–2B/TG are equipped with factory-greased and sealed bearings and will not require further lubrication.

b. Installation of Bearings. The following procedure outlines a typical method of installing bearings on the armature shaft.

(1) *General.* Bearings fit tightly upon the armature shaft. Therefore, they must be pressed onto the shaft with an arbor press, vise, or similar tool. Such tools are normally available at field repair shops. It is important to see that the bearing is pressed onto each end of the shaft carefully, so that the pressure exerted by the press or vise will not bend the armature shaft or force the bearing on the shaft at an angle to the axis of the shaft.

(2) *Preparatory.* Prepare two blocks of hardwood, equal in length and about 1 inch longer than the armature shaft extension. Shape one end of each block so that it will not bear against the ball bearing or outer race of the bearing. Prepare another block (fig. 28) large enough to be used against the rear jaw of the press or vise. Slip a bearing onto each end of the shaft as far as it will go, fingertight. On Test Sets TS–2A/TG, slide the bearing onto the fan end of the armature shaft only. Be careful to see that the bearings are at right angles to the axis of the armature shaft.

(3) *Installing.*

(*a*) If the bearings have dust covers see that the dust cover of each bearing is nearest the winding. Place the two wooden blocks of equal length at either side of the armature shaft extension (fig. 28). Place the other block of wood against the rear jaw of the press or vise. See that the armature is set in the press or vise so that each end of the armature shaft is near the center of the face of each jaw. Tighten the tool very slowly until there is even pressure applied to *both* sides of the bearings. *Be careful not to bend the armature shaft.* Continue to slowly tighten the tool until the bearing is pressed onto the shaft and is against the armature shaft shoulder (fig. 28). Repeat the procedure to mount the bearing on the opposite end of the shaft. Some types of bearings can be taken apart. If possible, disassemble and assemble this type of bearing on the shaft. The inner race can then be removed and replaced on the shaft with less danger of damage to the other parts of the bearing.

(*b*) When a suitable press or vise is not available, bearings can be installed on the armature shaft, when authorized as a field expedient, by the following method:

1. Slide the bearings on the armature shaft as described in (2) above.

2. Prepare a piece of copper or brass pipe 1 inch longer than the shaft extension (fig. 29) with an inside diameter slightly larger than the diameter of the diameter of the armature shaft. If copper or brass pipe is not available, and iron pipe

can be substituted, provided a brass washer is used to protect the inner race of the bearing against the iron pipe. Slip the copper or brass pipe onto the shaft so that it bears against the inner bearing race.

3. Stand the armature on end with the pipe resting on the bench or work table.

4. Place a block of hardwood over the other end of the armature shaft. Drive the armature shaft down by pounding the upper end of the armature shaft (protected by the hardwood block) with a hammer (fig. 29). Use steady, even strokes of the hammer until the bearing is forced firmly against the shoulder of the shaft.

Caution: Make certain that the pipe bears against the inner bearing race. Do not bend or otherwise damage the armature shaft.

83. Reassembly of Motor

a. Preparation. Thoroughly clean and dry the motor before reassembling. Examine the bearings and parts, which should be free from dirt before beginning to reassemble the motor.

b. Step-by-Step Reassembly.

(1) Remove the brushes if they are still in the end frame section that fits over the commutator.

(2) Position the bearing retainer so that the holes match the positions of the retainer screws.

(3) Insert the armature into the stator so that the bearing on the shaft, opposite the commutator end, enters the end frame section. Do not use force because the bearing should fit easily into the end frame section.

(4) Place the end frame section on the commutator end of the shaft. Gently tap the end frames into position.

(5) Insert the motor frame bolts. Tighten the opposite ends at the same time to be sure that the end frame sections are mounted correctly and seated in the motor frame.

(6) Use a toothpick, piece of wire, or any other convenient means to move the bearing retainer ring into position so that the bearing retainer screws can be started. Tighten both retainer screws at the same time.

(7) Replace the motor pinion gear and the governor.

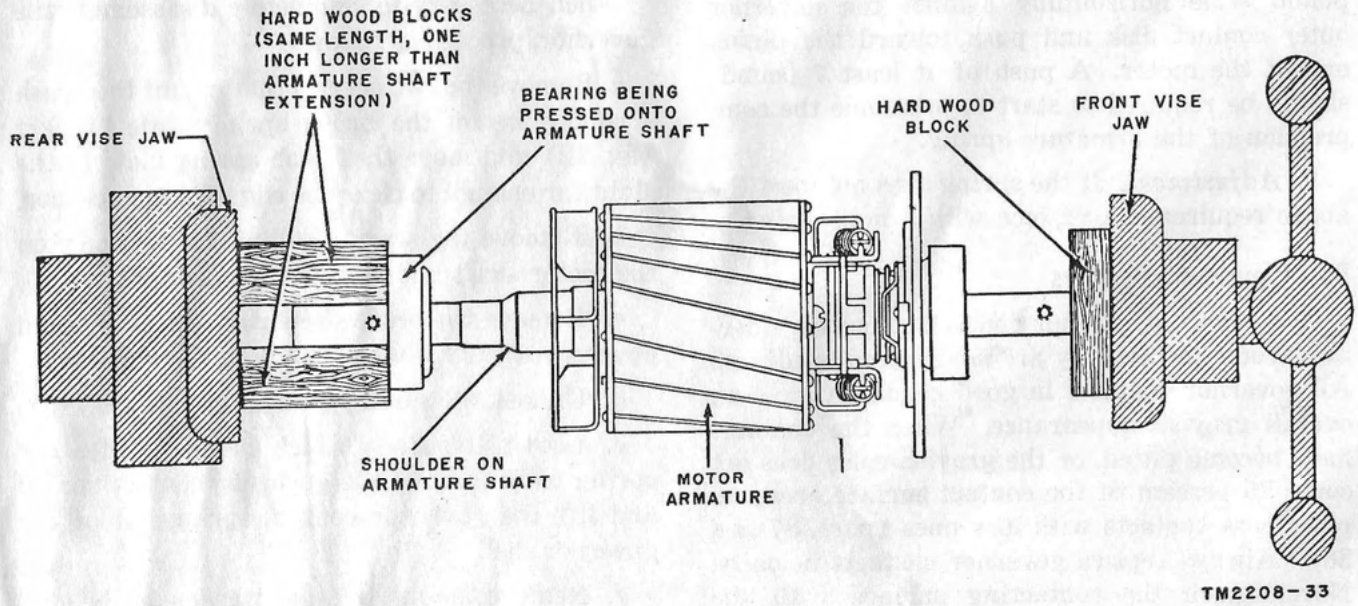


Figure 28. Pressing armature bearing onto its shaft by use of a vise.

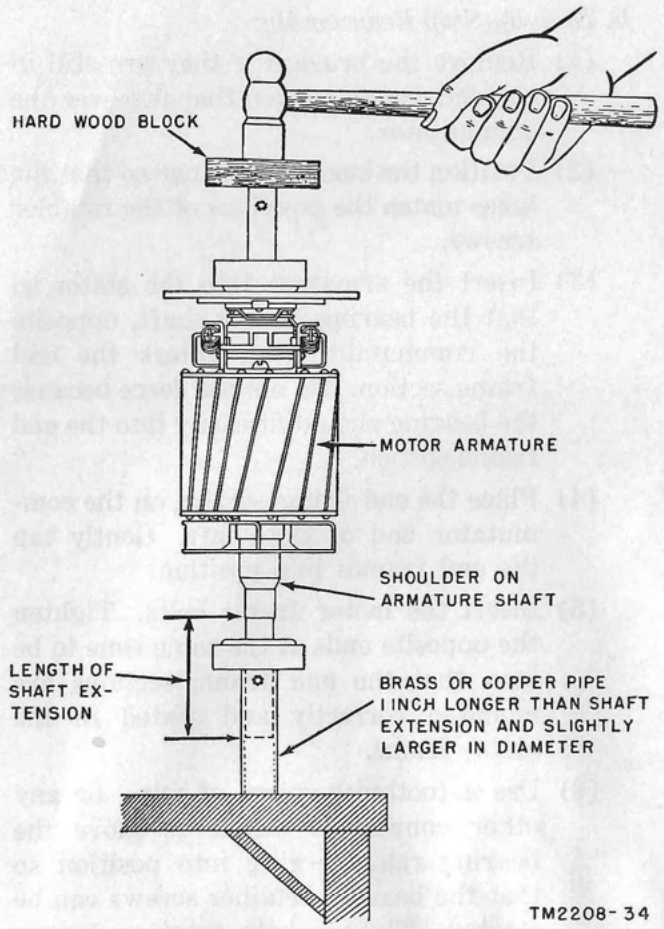


Figure 29. Mounting bearings on the armature shaft by use of hammer and soft metal pipe.

84. Motor Armature Thrust Spring Compression (fig. 12)

a. Requirement. Apply the push end of a 12-pound scale horizontally against the governor outer contact disk and push toward the pinion end of the motor. A push of at least 7 pounds should be required to start to overcome the compression of the armature spring.

b. Adjustment. If the spring does not meet the above requirement, replace with a new spring.

85. Governor Repairs

a. General. Governor contacts cause considerable trouble when they are not in good condition. All governor contacts in good condition have an overall grayish appearance. When the contacts have become pitted, or the grayish color does not cover 75 percent of the contact surface area, replace *both* contacts with new ones (pars. 87 and 88). Always replace governor contacts in pairs. Never touch the contacting surface with the fingers because even very small deposits of moisture or dirt will cause arcing and pitting.

b. Contacts in Satisfactory Condition. The ideal condition for governor contacts is when both contact surfaces are exactly parallel and the area of contact is a maximum (A, fig. 30). However, contacts may be satisfactory under the condition that one contact has build-ups and the other has corresponding craters, provided that the craters will accept the build-up (A, fig. 30), and thus maintain contact over an acceptable area. Contacts in this condition are considered to be good and need not be replaced unless there is trouble in obtaining and maintaining proper motor speed.

c. Common Causes of Contact Trouble.

(1) Trouble due to poor surface contact is frequently the result of a previous attempt to burnish or file contacts to produce better surfaces. In such cases the build-ups have been removed, with the result that the craters that still remain do not meet the renewed surface (B, fig. 30), thus reducing the amount of effective contact surface.

(2) If the contacts are rotated or shifted in position, as shown in C, figure 30, the build-ups and craters will not match. This condition results in extremely erratic motor speed because practically all of the contacting surface has been lost.

86. Disassembly of Governor

When necessary to completely disassemble the governor, proceed as follows:

a. Remove the two screws that mount the brush spring plate on the brush spring plate bracket (fig. 12) and move the brush spring plate to the right far enough to clear the edge of the governor.

b. Remove the screw holding the governor on the motor shaft and slip off the governor.

c. Remove the screws securing the target and governor cover. Remove the target and cover.

d. Unhook the speed adjusting spring (fig. 13).

e. Loosen the screw which clamps the feather spring to the end of the governor contact spring and lift the governor contact spring out of the governor shell.

f. Remove the nut and lockwasher on the contact screw mounted on the fixed contact bracket and lift out the contact screw.

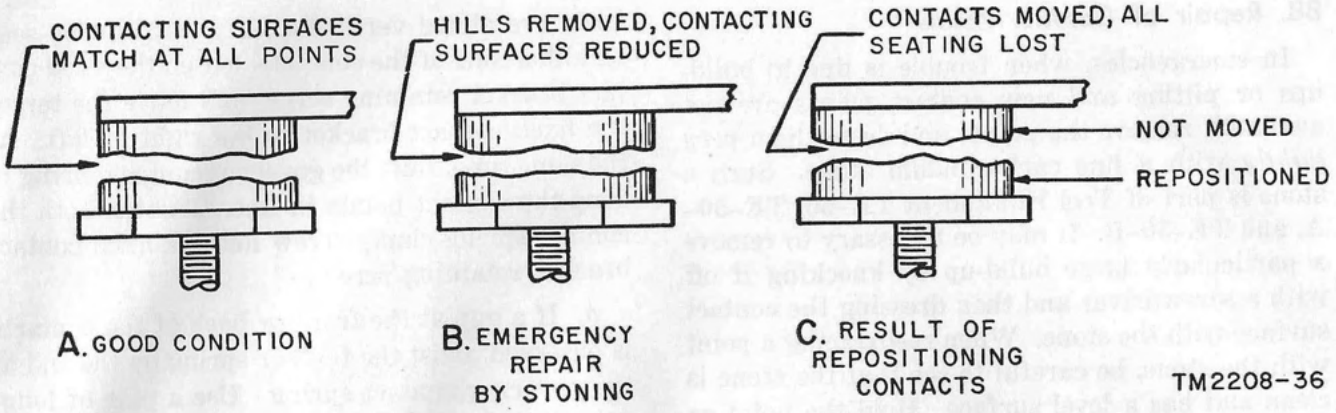


Figure 30. Governor contacts surfaces, enlarged diagrams.

87. Replacing Governor Contact Points

a. Contact points are made of tungsten. They are welded to the contact spring (upper contact) and to the contact screw (lower contact). When removing the old contact points, replace both the upper and lower points at the same time to avoid difficulties in seating them.

b. Replace the new points with their associated contact springs and contact screws. The new lower point with a contact screw is properly alined when the contact surface of the new point is perpendicular (or at right angles) to a line through the axis of the contact screw (A, fig. 31). The new upper point and contact spring is properly alined when there is no appreciable gap between any part of the contacting surface of the new point and a straightedge (B, fig. 31).

Note. Old style contact springs had contact points that screwed into the spring and were bonded in position by a drop of solder on the spring or were soldered directly to the contact springs. New style contacts are welded and require replacement of upper spring and lower screw with contacts.

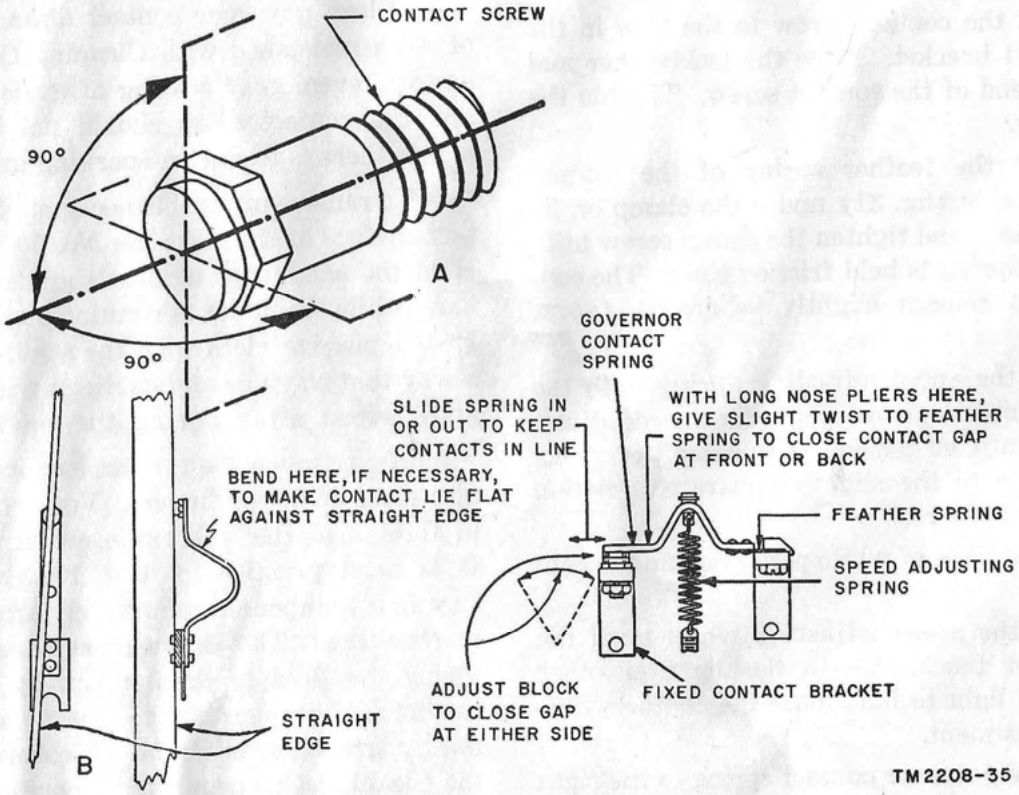


Figure 31. Alinement of new governor contact points.

88. Repair of Contact Points

In emergencies, when trouble is due to build-ups or pitting and new contact points are not available, remove the points and dress them *very lightly* with a fine carborundum stone. Such a stone is part of Tool Equipment TE–50, TE–50–A, and TE–50–B. It may be necessary to remove a particularly large build-up by knocking if off with a screwdriver and then dressing the contact surface with the stone. When resurfacing a point with the stone, be careful to see that the stone is clean and has a level surface. Hold the point as flat as possible against the surface of the stone. To be sure that the entire face of the point is dressed level, use a rotary motion when dressing the contact point. In this way all parts of the face of the point will be dressed. Do not use too much pressure. Examine the point after every rotation. Stop when the face of the point meets the requirements mentioned in paragraphs 85*b* and 87*b*. Clean the dressed points with Cleaning Compound. *Replace both points as soon as possible. This is necessary to avoid trouble from build-ups and pitting, which form quickly on resurfaced contacts.*

89. Reassembling Governor

a. Insert the contact screw in the hole in the fixed contact bracket. Place the lockwasher and nut on the end of the contact screw. Tighten the nut securely.

b. Insert the feather spring of the contact spring assembly (fig. 31) under the clamp on its mounting block and tighten the clamp screw until the contact spring is held friction tight. The contacts should remain slightly separated (aprx. .005 in.).

c. Hook the speed adjusting spring onto the governor contact spring. Turn the speed adjusting wheel until all tension is released. Contacts should return to the slightly separated position indicated in *b* above.

d. Insert a piece of white paper behind the contacts.

e. Turn the speed adjusting wheel until the contacts just touch. Use a flashlight or other small bright light to illuminate the contacts during this adjustment.

f. Slide the governor contact spring to the right or left until the sides of the upper and lower contacts are alined vertically. If a gap can be seen on either side of the contacts, loosen the fixed contact bracket retaining screw and move the top of the fixed contact bracket to the right or left. At the same time, shift the governor contact spring to keep the contact points in line. Tighten both the contact spring clamp screw and the fixed contact bracket retaining screw.

g. If a gap at the front or back of the contacts is observed, twist the feather spring on the end of the governor contact spring. Use a pair of long-nosed pliers for the purpose. Repeat the above adjustments until the contacts are correctly positioned.

h. Turn the speed adjusting wheel so that the tension of the spring is near the midpoint of its range.

i. Clean the points with Cleaning Compound applied with a toothpick or an orange stick. Reassemble the governor cover and the target to the governor, and remount the governor on the motor.

90. Inspection, Cleaning, and Repair of Governor Contact Disks

a. Clean governor contact disks with a piece of cloth moistened with Cleaning Compound. A smooth, even, gray coating of oxide is desirable, and the contact disks should not be disturbed unless there is excessive sparking at the brushes.

b. To remove pits or burned spots from the contact surface of the disks use No. 0000 sandpaper. Hold the sandpaper against the disk surface by hand while the motor is running at normal speed. Hold a piece of cloth with the sandpaper in such a way that cuttings and particles will be immediately wiped away during the sanding process.

c. Never touch the contact surface of the contact disks with the fingers. Very small deposits of foreign matter will cause arcing and pitting. It is good practice to flush the contacts with Cleaning Compound immediately after they have been polished. This can be done by repeatedly applying the fluid to the contact, by means of a toothpick or orange stick, to flush away all foreign matter, grease, or moisture. Be careful to prevent the Cleaning Compound from coming in contact with wire insulation or plastic parts.

91. Replacement of Inner and Outer Disk Contact Brushes

Replace the carbon contact brushes (fig. 12) on the inner and outer disk contact springs when the brushes are worn down to one-eighth inch. The carbon contact brushes and springs may be replaced as a unit or the carbon contact brushes may be replaced individually when it is not necessary to replace the entire brush assembly.

a. Replacing Carbon Contact Brushes and Springs as a Unit.

(1) Loosen the screws that secure the spring and insulator pile-ups to the brush spring plate. It is not necessary to unscrew them completely as the springs have slotted ends and can be slid free of the brush spring plate.

(2) Slide the new springs into the same position in the insulator pile-up. Adjust and position the new springs and carbon contact brushes according to instructions in paragraphs 41 and 42. Tighten the screws.

b. Replacing Carbon Contact Brushes.

(1) Remove the carbon contact brushes and springs as directed in *a*(1) above.

(2) Unsolder the old brush from the spring. Clean off any solder that remains in the mounting hole in the spring from which the brush is removed.

(3) Insert a new brush in the mounting hole and solder it securely in place. Clean the brush with Cleaning Compound applied with an orange stick or toothpick.

(4) Replace the springs as directed in *a*(2) above.

92. Testing Repaired Governors

a. After the governor is completely reassembled, seat the new contacts by running the motor on test for at least an hour. Check the speed every 15 minutes and immediately investigate any change in motor speed.

b. If the motor speed is erratic and the trouble cannot be traced to other parts of the motor, disassemble the governor and check the contacts for build-ups and alinement. If build-ups are found, replace the contacts. After the contacts have been properly realined, reassemble the governor and run the motor again for an hour.

c. Proper operation of the governor is indicated if the motor speed does not change appreciably during the hour test run.

93. Disassembly and Reassembly of Contact Lever Bracket

Note. After any parts on the contact lever bracket assembly have been replaced, make an overall adjustment of the test set.

The contact tongues and the upper and lower contacts may become pitted, broken, or otherwise damaged so that they require replacement.

a. Upper Contacts. To remove an upper contact, proceed as follows:

(1) Remove the two screws that secure the upper insulator bridge to the bridge bracket.

(2) Lift the insulator free and loosen the setscrew of the contact to be removed.

(3) Remove the contact screw using an open-end or socket wrench of the correct size. Do not use a screwdriver in the slotted end of the contact screw for any purpose other than final adjustment of the contact gap. If the slot in the contact screw has been spread, burred, or damaged, file off such portions before removing the screw from the insulator to prevent damage to the thread in the insulator.

(4) Reassemble in reverse procedure to disassembly. Adjust according to instructions in paragraph 47.

b. Lower Contacts. To remove a lower contact, proceed as follows:

(1) Remove the screws that secure the lower insulator bridge to the bridge bracket.

(2) While holding the insulator bridge clear of the bracket, loosen the setscrew and the terminal screw.

(3) To remove the contact screws refer to *a*(3) above.

(4) To reassemble the lower contact screws refer to *a*(4) above.

c. Contact Tongues. To remove a contact, proceed as follows:

(1) Remove the four screws that secure the contact screw bridge assembly to the contact lever bracket.

(2) Slide the bridge assembly clear of the contact lever bracket and the contact tongues.
(3) Unsolder and remove the helical spring from the contact tongue.
(4) Remove the two screws that secure the contact tongue and the insulators to the contact lever.
(5) Reassemble in reverse procedure to disassembly. Adjust according to instructions in paragraph 47.

d. Contact Levers. To remove a contact lever, proceed as follows:

(1) Remove the contact bridge assembly and the helical springs on the contact tongues.
(2) Remove the two screws that secure the contact lever bearing to the contact lever bracket.
(3) Remove the bearing with the contact levers from the contact lever bracket.
(4) Loosen the two setscrews that hold the contact lever shaft in the bearing and slide the shaft out.
(5) Remove the contact levers from the shaft.
(6) Reassemble in reverse procedure to disassembly. Adjust according to instructions in paragraphs 47 and 48.

94. Disassembly and Reassembly of Distortion Switch Assembly

The distortion switch is easily accessible and is built of units. The individual contact spring assemblies and the detent assembly can be removed without disturbing or removing other parts.

a. Detent Lever and Detent Cam.

(1) Remove the detent lever spring.
(2) Remove the nut on the detent lever cam screw. The detent lever and the cam screw will then drop free.
(3) Remove the setscrew in the detent cam and slide the cam off the shaft.
(4) Reverse the above procedure for reassembly. Adjust in accordance with instructions in paragraphs 53 and 54.

b. Contact Cam and Shaft.

(1) Remove the detent cam and loosen the setscrews in the bakelite cam sleeve. Pull the shaft out by the knob, and the bakelite cam will fall free.
(2) Reassemble, following the disassembly procedure in reverse order. Adjust according to instructions in paragraphs 53 and 55.

c. Contact Spring Assemblies.

(1) Remove the mounting screws that pass through the insulator pile-up. Note the position and order of the springs and insulators in the pile-up.
(2) Unsolder the leads and tag them to facilitate reconnection.
(3) Reassemble; follow in reverse order the procedure used for disassembly. Adjust according to instructions in paragraph 57.

95. Cleaning Transmitting and Distortion Switch Contacts

a. Cleaning Nonpitted Contacts.

(1) To clean nonpitted contacts, use a clean toothpick to flush the contacts with Cleaning Compound. Dip the flat end of the toothpick into the Cleaning Compound to a depth of about one-half inch, and deposit the liquid on the contacts without rubbing. Hold the contacts slightly separated during this operation.
(2) Dip the flat end of another toothpick into the Cleaning Compound and deposit it on the contact, without rubbing, to flush away the dirt that was loosened on the first application. Be careful to keep the Cleaning Compound away from the insulators.
(3) When the contacts are thoroughly dry, burnish them so that no deposit or residue from the solution or other foreign material remains on the contacts.

b. Burnishing Contacts.

(1) Clean the contact burnishers before using by wiping with a clean, dry cloth, and wipe frequently with a clean cloth moistened with Cleaning Compound.
(2) When burnishing normally open contacts, press the contacts together by hand to give a slight pressure on the blade of the burnisher. When contacts are normally closed the tension of the springs will usually furnish sufficient pressure against the burnisher.

(3) Rub the burnisher back and forth against the contacts two or three times. When contacts are pitted, additional strokes of the burnisher may be required. Do not use abrasives other than the burnisher blade.

(4) After cleaning and burnishing operations, check the adjustments of the contact springs.

Section IV. LUBRICATION

96. Recommended Lubricants

The only lubricants recommended for these test sets are:

a. Oil, lubricating, Signal Corps stock No. 6G-1325 (1 qt can).

b. Grease, Signal Corps stock No. 6G650 (1 lb container).

97. Recommended Lubrication Schedule

The lubrication instructions listed in paragraph 100 are based on normal operating conditions with the equipment in service for an average of 8 hours a day. Under these conditions, the lubrication interval should be every 30 days with the exception of the code disk cam surfaces, which should be lubricated weekly. When equipment is operated more than 8 hours a day, reduce the time interval proportionally. When equipment is operated in tropical climates, a further reduction in the interval is required. Do not lubricate the equipment while the motor is running. Complete all necessary cleaning and adjusting before lubricating the equipment. Do not apply oil or grease in excess of the quantities recommended. Wipe off any excess oil.

98. Preparation for Lubrication

To lubricate the test set thoroughly, remove it from service and partially disassemble it as outlined in *a* below.

a. Disassembly. Disassemble the test set as follows:

(1) Disconnect the ac and dc power cords and the signal line cord.

(2) Remove the wooden cover.

b. Old Lubricants. Remove all old grease and oil with a clean, dry, lint-free cloth. Wrap the cloth around the end of a screwdriver or an orange stick to remove old lubricants from hard-to-reach places.

99. General Lubrication Instructions

a. Methods of Applying Grease. Use the grease gun supplied with Tool Equipment TE–50–B to apply grease. To grease the gears, hold the nozzle of the grease gun against the gear teeth at an angle of about 45°. Operate the handle until enough grease is ejected and, at the same time, turn the gear or move the nozzle to form a continuous ribbon of grease.

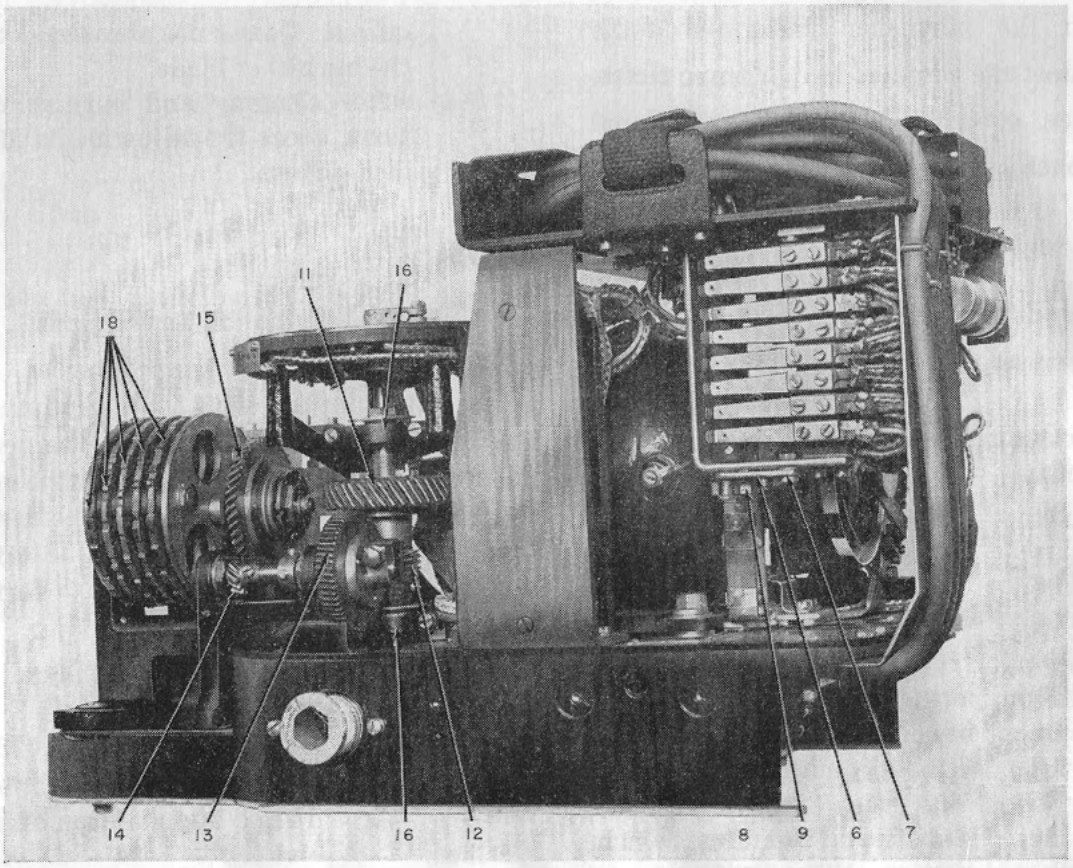
b. Methods of Applying Oil. Apply oil with the oiler furnished with Tool Equipment TE–50–B or with a piece of wire approximately .025 inch in diameter. Dip the wire one-half inch into the oil. Withdraw the wire and apply a drop of oil where specified.

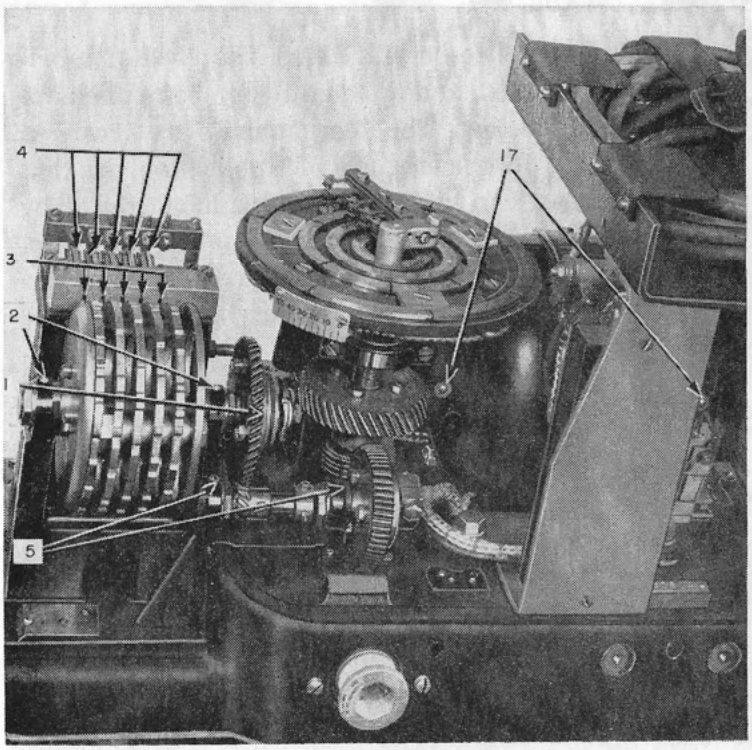
100. Detailed Lubrication Instructions (fig. 32)

The points to be lubricated, the type of lubricant to be used, and the quantity to be applied are listed in *b* below. The item numbers are arranged according to the method of application, so that the test set can be treated by one lubricant or by one method at a time in a systematic way. Item numbers shown in figure 32 correspond with the item numbers listed in the chart below.

a. Ball Bearings. To clean and lubricate ball bearing assemblies properly, it is necessary to remove them from the main shaft or the motor armature. Clean the bearing assemblies by brushing and flushing in Cleaning Compound. Thoroughly dry the assemblies and repack them with grease. Wipe off excess grease and reassemble the equipment. The motors in Test Sets TS–2A/TG and TS–2B/TG are equipped with sealed, factory-greased bearings and will not require further lubrication.

b. Gears. Wipe the old grease from the gears with a clean, dry, lint-free cloth. Apply fresh grease as follows:





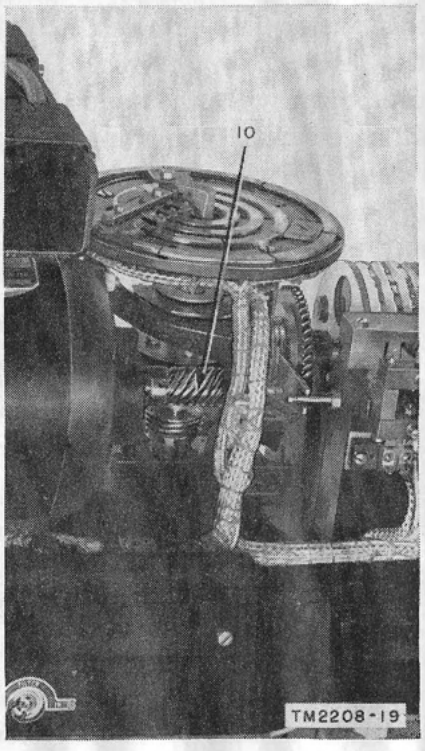


Figure 32. Location of lubricating points.

1 Felt washers, code disk friction assembly
2 Code disk shaft bearings
3 Contact lever bearings and slots
4 Contact lever pivot bearings
5 Intermediate shaft bearings
6 Detent lever spring
7 Detent lever bearing
8 Detent roller
9 Detent cam
10 Motor pinion gear
11 Main shaft gear
12 Main shaft pinion gear
13 Intermediate shaft gear
14 Intermediate shaft pinion
15 Code disk gear
16 Main shaft bearings
17 Motor bearings
18 Code disk cam surfaces

Figure 32—Continued.

Item No.	Name of part	Lubricant	Method and quantity
1	Felt washers, code disk friction assembly	Oil	Saturate.
2	Code disk shaft bearings (two) (on TS–2/TG and TS–2A/TG only).	Oil	1 to 2 drops in each oilhole.
3	Contact lever bearings and slots (five)	Oil	1 drop each slot and bearing.
4	Contact lever pivot bearings (five)	Oil	1 drop each pivot.
5	Intermediate shaft bearings (two) (on TS–2/TG and TS–2A/TG only).	Oil	1 to 2 drops in each oilhole.
6	Detent lever spring	Oil	1 drop to each loop.
7	Detent lever bearing	Oil	1 drop.
8	Detent roller	Grease	Thin film.
9	Detent cam	Grease	Thin film.
10	Motor pinion gear	Grease	Thin film.
11	Main shaft gear	Grease	Thin film.
12	Main shaft pinion gear	Grease	Thin film.
13	Intermediate shaft gear	Grease	Thin film.
14	Intermediate shaft pinion	Grease	Thin film.
15	Code disk gear	Grease	Thin film.
16	Main shaft bearings	Grease	Repack and wipe off excess grease.
17	Motor bearings	Grease	1 or 2 strokes of grease gun plunger to each oiler.
18	Code disk cam surfaces	Grease	Thin film.

Section V. WEATHERPROOFING

101. Weatherproofing Procedures

Test Sets TS–2(*)/TG have been moistureproofed and fungiproofed at the time of manufacture. Retreatment may be required after a period of use. During overhaul of the equipment, moistureproof and fungiproof the equipment in accordance with current directives.

102. Rustproofing and Painting

a. If the finish on painted portions of the test set or wooden cover is scratched or scarred, prevent rust and corrosion by painting the damaged surfaces. Use No. 00 or No. 000 sandpaper to clean the surfaces. Obtain a bright, smooth finish. Do not use steel wool when working on the test set because very small particles of steel wool may enter the electrical parts and cause internal shorting and grounding of circuits.

b. When retouching is necessary, apply the paint with a small brush. If numerous scars and scratches warrant complete repainting, remove the test set from service. Remove slight rust or corrosion from metal by cleaning with Cleaning Compound to soften the rust, then sandpaper to complete the preparation for painting. Place protective masking over areas that do not require paint or where paint may cause damage; then spray-paint the entire surface.

Section VI. FINAL TESTING

103. Purpose

Equipment that has been repaired must meet definite minimum performance standards before it is returned to service. The tests outlined in this section are designed to measure the performance capability of a repaired test set. Equipment that meets the minimum standards stated in the tests will furnish satisfactory operation.

104. Test Equipment Required for Final Testing

In addition to the test equipment listed in paragraph 32, Distortion Test Set TS–383/GG (fig. 33) is required for final testing.

105. Test Setup

Distortion Test Set TS–383/GG is designed to receive and analyze distortion in the signals transmitted by teletypewriter equipment. When performing any tests on Test Sets TS–2(*)/TG, it is preferable to use synchronous motors on both test sets because an accurate check of the calibration adjustment cannot be made with the variation in speed caused by governed motors. Any speed variation will cause a wavering of the impulses as viewed on the stroboscope, making it difficult to measure accurately the impulse length.

a. Connect the ac motor power cord of the TS–383/GG into a suitable 110- to 115-volt, 50- to 60-cycle ac source.

b. Plug the stroboscope cord into one of the LOCAL TEST JACKS of the test set.

c. Plug the signal line cord of the TS–2(*)/TG into the other LOCAL TEST JACK. This provides a source of dc for the signal and for the stroboscope lamp.

d. Plug the ac power cord of the TS–2(*)/TG into a source of 110- to 115-volt, 50- to 60-cycle ac.

e. Plug the dc power cord of the TS–2(*)/TG into a source of 115-volt dc.

f. Place the radio filter cutout switch on the test set in the FILTER OUT position during the time that the test set is being checked.

g. Place the keys and switches on the TS–383/GG in the following positions:

MOTOR switch	ON
RUN–STOP switch	RUN
LINE–DIST key	LINE
BIAS–END DIST key	Neutral
VIEW–TRANSMIT key	TRANSMIT
MARK–ZERO–SPACE key	ZERO
Code selecting switch	R or Y
STOP PULSE switch	ON

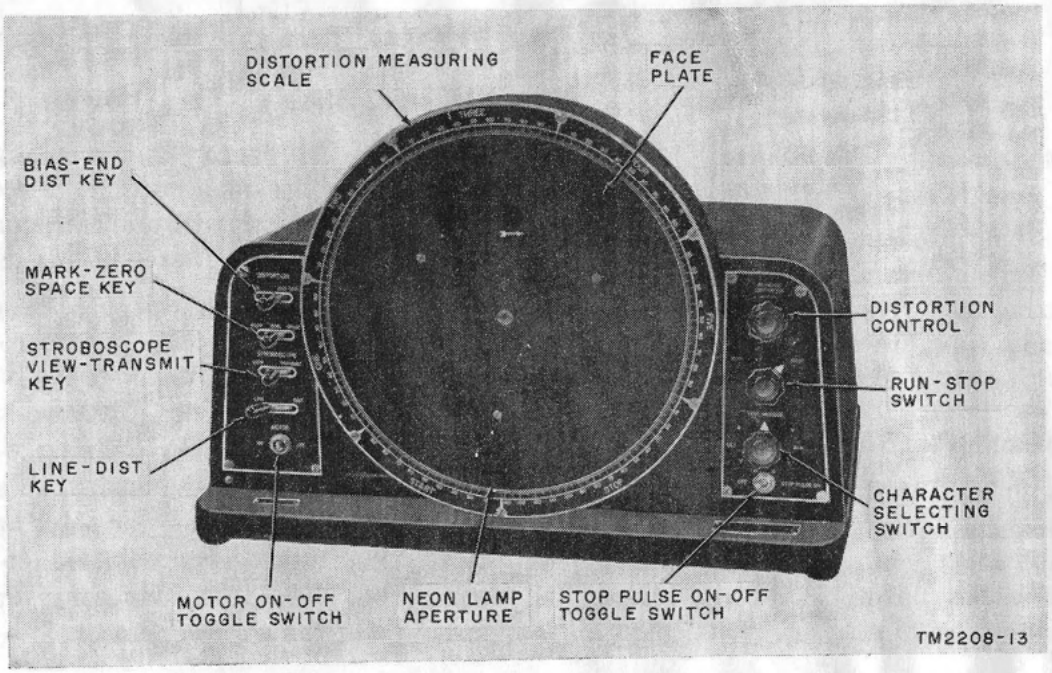


Figure 33. Distortion Test Set TS–383/GG.

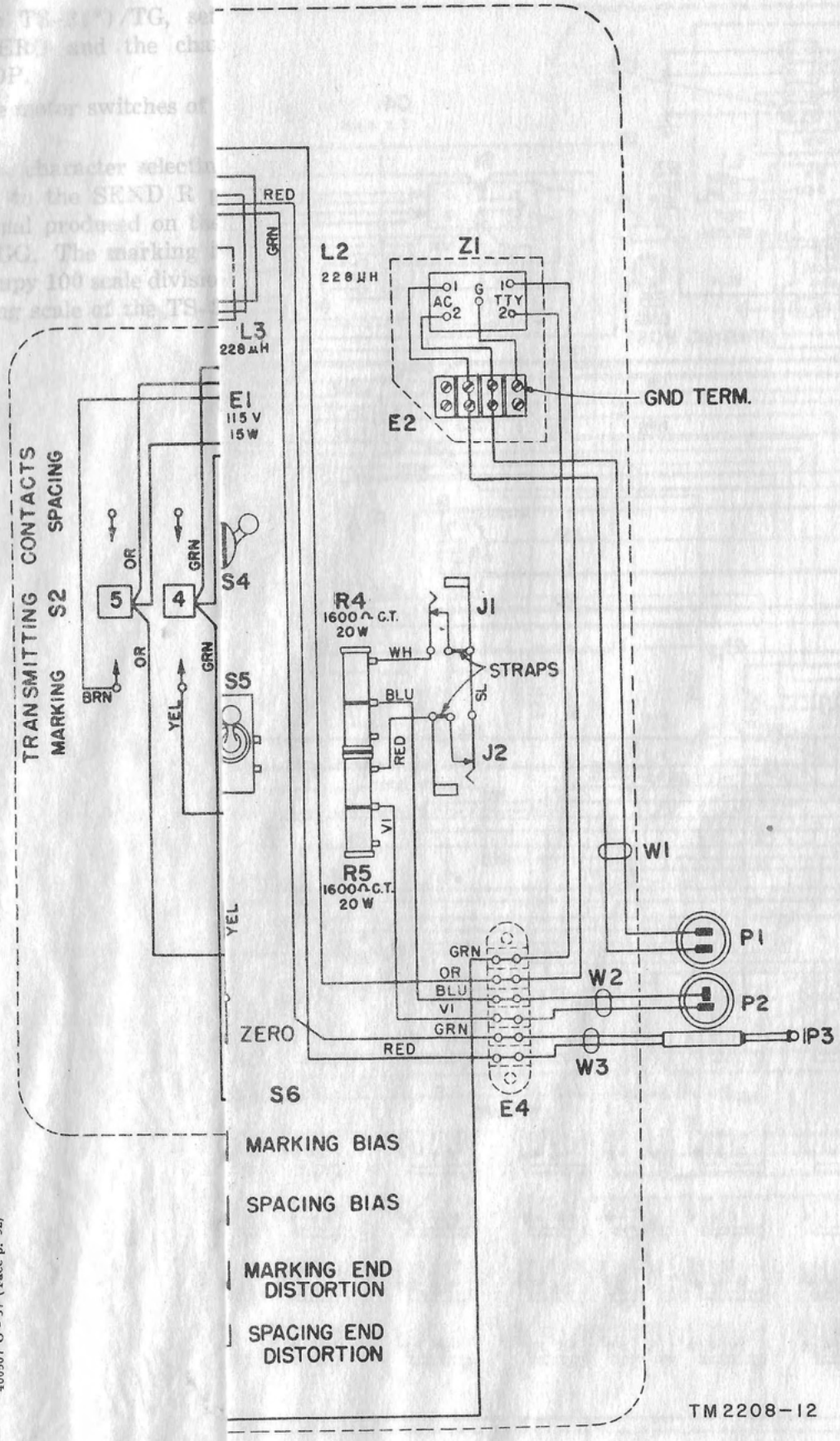
h. On the TS–2(*)/TG, set the distortion switch to ZERO and the character selecting switch to STOP.

i. Turn the motor switches of both test sets to MOTOR ON.

j. Move the character selecting switch on the TS–2(*)/TG to the SEND R position and observe the signal produced on the stroboscope of the TS–383/GG. The marking impulses (2 and 4) should occupy 100 scale divisions on the distortion measuring scale of the TS–383/GG.

k. Move the character selecting switch on the TS–2(*)/TG to the SEND Y position and observe the signal produced on the stroboscope of the TS–383/GG. The marking impulses (1, 3, and 5) should occupy 100 scale divisions on the distortion measuring scale of the TS–383/GG.

l. If the marking impulses observed in *j* and *k* above are more or less than 100 points in length recheck the motor speed adjustment (par. 12) the contact bracket assembly (par. 47) and the contact levers spring tension (par. 48).


RED
GRN
L2
228 μH
Z1
1
AC
2
G
10
TTY
20
L3
228 μH
E1
115 V
15 W
GND TERM.
E2
TRANSMITTING CONTACTS
MARKING S2 SPACING
OR
GRN
S4
5
4
R4
1600 Ω C.T.
20 W
J1
WH
STRAPS
SL
BLU
S5
BRN
YEL
RED
J2
VI
R5
1600 Ω C.T.
20 W
W1
P1
W2
P2
P3
W3
GRN
OR
BLU
VI
GRN
RED
ZERO
S6
E4
MARKING BIAS
SPACING BIAS
MARKING END DISTORTION
SPACING END DISTORTION
TM 2208-12

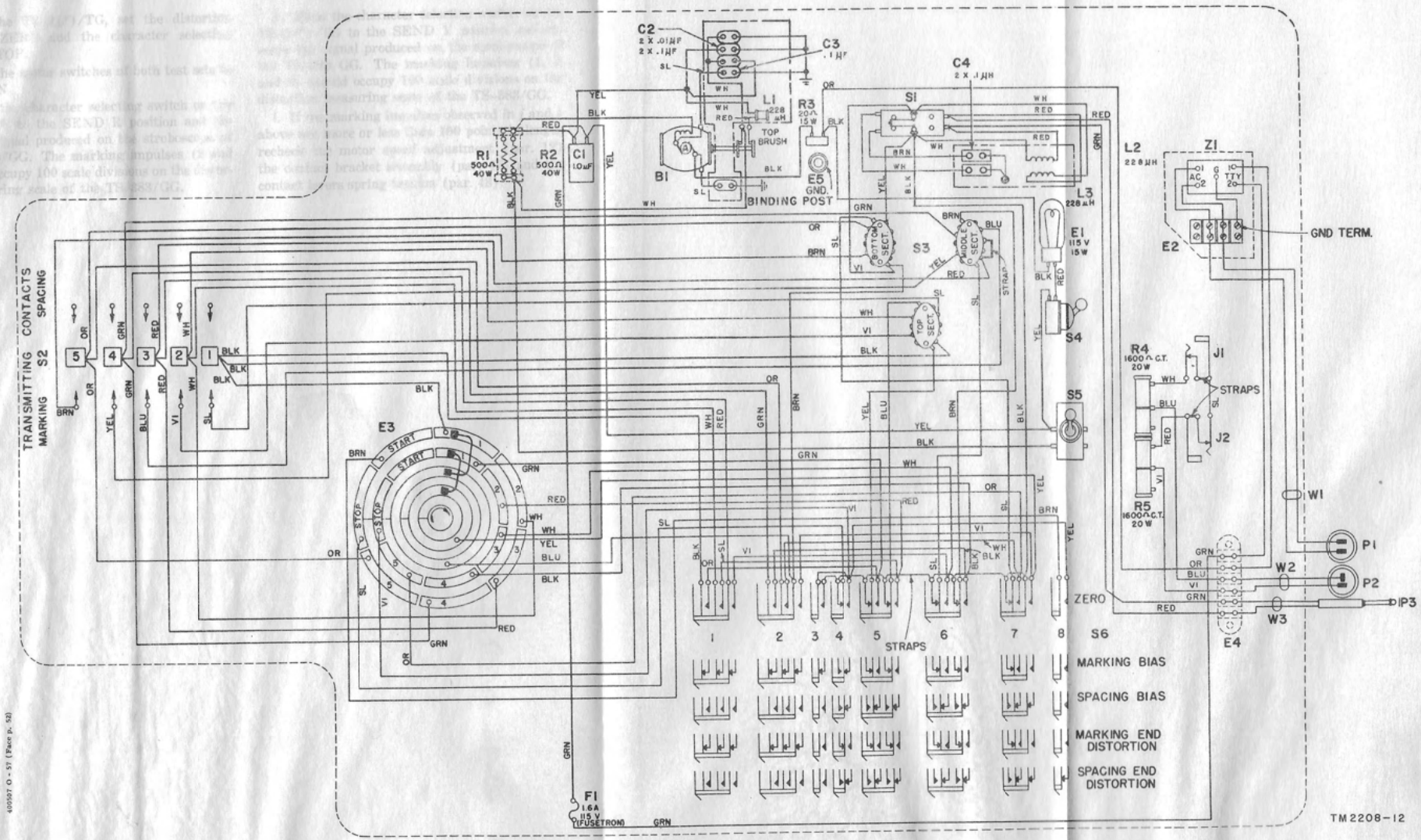


Figure 34. Test Sets TS-2/TG and TS-2A/TG, wiring diagram.

CHAPTER 7
SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

106. Disassembly

Prepare these test sets for storage as follows:

a. Disconnect the signal and power cords of the test set.

b. Coil the cords under the retaining brackets on the operating panel.

c. Close and latch the hinged lid.

d. Be sure that the cover is in place and is securely latched.

107. Repacking for Shipment and Limited Storage

a. If the original packing materials are on hand, use them and reverse the unpacking procedures given in paragraph 8. General repacking information is usually available at depots.

b. The prime requirement is to pack the equipment so as to prevent damage during transit or limited storage. Package the equipment securely and use sufficient wadding to minimize the effects of severe jolting. Make sure that the equipment is protected from rain or snow.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

108. General

Demolition of the equipment will be accomplished only upon the order of the commander. The demolition procedures outlined in paragraph 109 will be used to prevent the enemy from using or salvaging the equipment.

109. Demolition

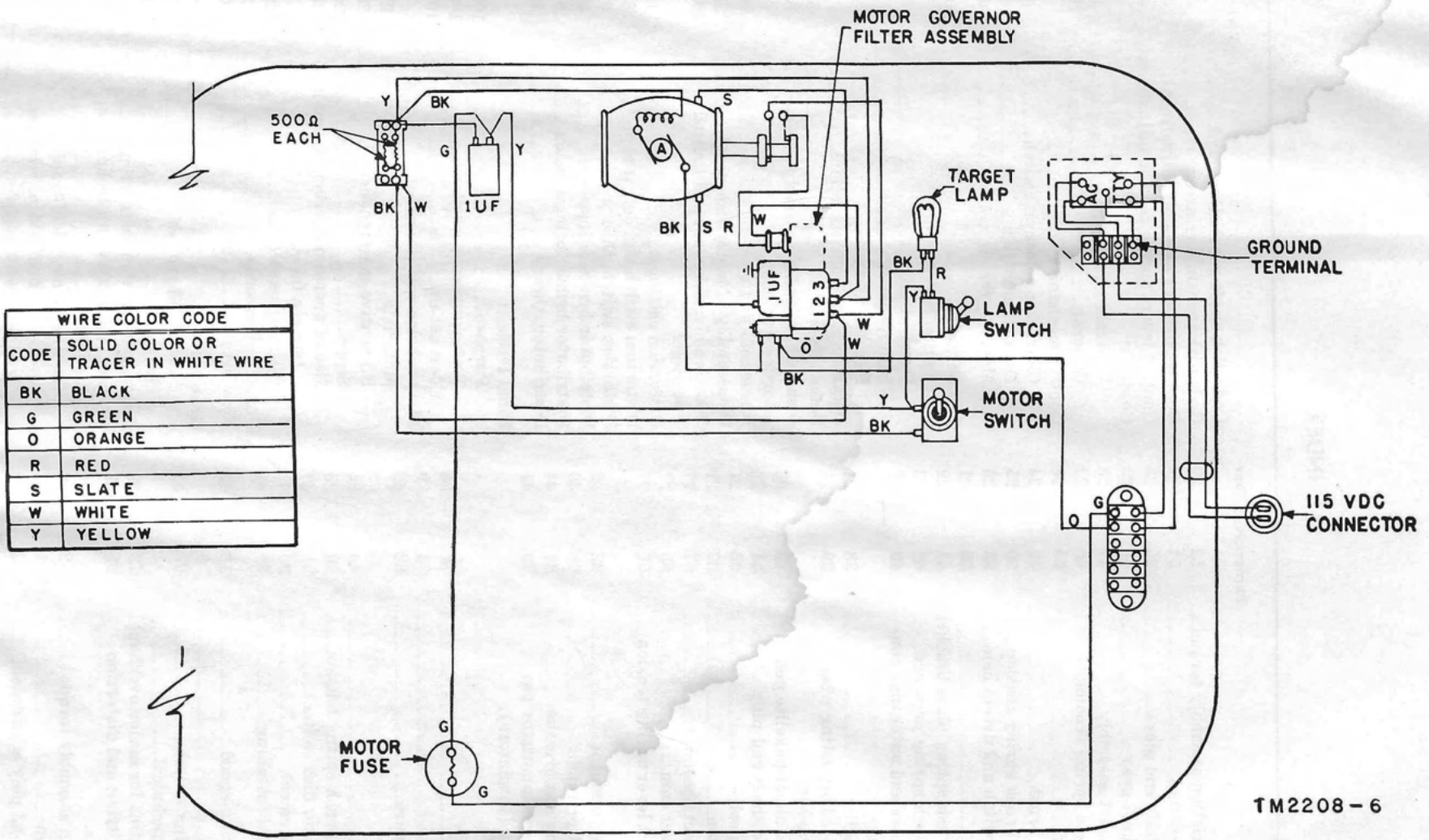
a. Smash. Smash the test set and all other parts; use sledges, crowbars, axes, handaxes, pickaxes, hammers, or heavy tools.

b. Cut. Cut all cords and wiring; use axes, handaxes, or machetes.

c. Burn. Burn technical manuals, circuit labels, other diagrams, resistors, coils, capacitors, cords, and wiring; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Explode. If explosives are necessary, use firearms, grenades, or TNT.

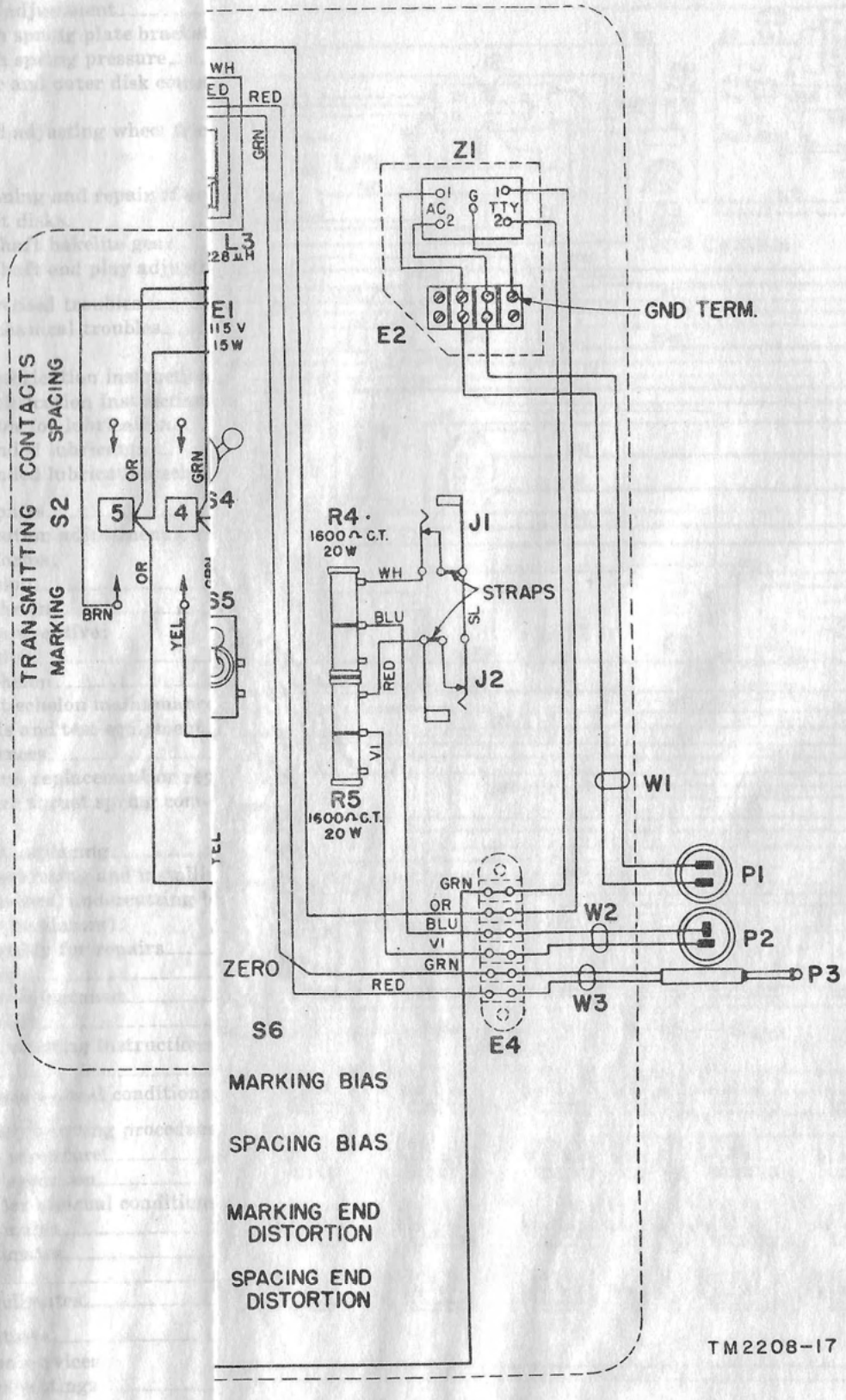
e. Dispose. Bury, scatter, and destroy parts in slit trenches, foxholes, or throw them in streams.



WIRE COLOR CODE	
CODE	SOLID COLOR OR TRACER IN WHITE WIRE
BK	BLACK
G	GREEN
O	ORANGE
R	RED
S	SLATE
W	WHITE
Y	YELLOW

Figure 35. Test Set TS–2A/TG, wiring diagram for motor connections.

INDEX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AC
G
TTY
GND TERM.
E2
E1
115 V
15W
L3
28 mH
TRANSMITTING CONTACTS
MARKING S2 SPACING
OR
GRN
BRN
YEL
S4
S5
R4
1600 Ω C.T.
20 W
J1
WH
STRAPS
BLU
SL
RED
J2
VI
R5
1600 Ω C.T.
20 W
W1
P1
GRN
OR
BLU
VI
GRN
W2
P2
P3
ZERO
RED
W3
E4
S6
MARKING BIAS
SPACING BIAS
MARKING END DISTORTION
SPACING END DISTORTION
TM2208-17

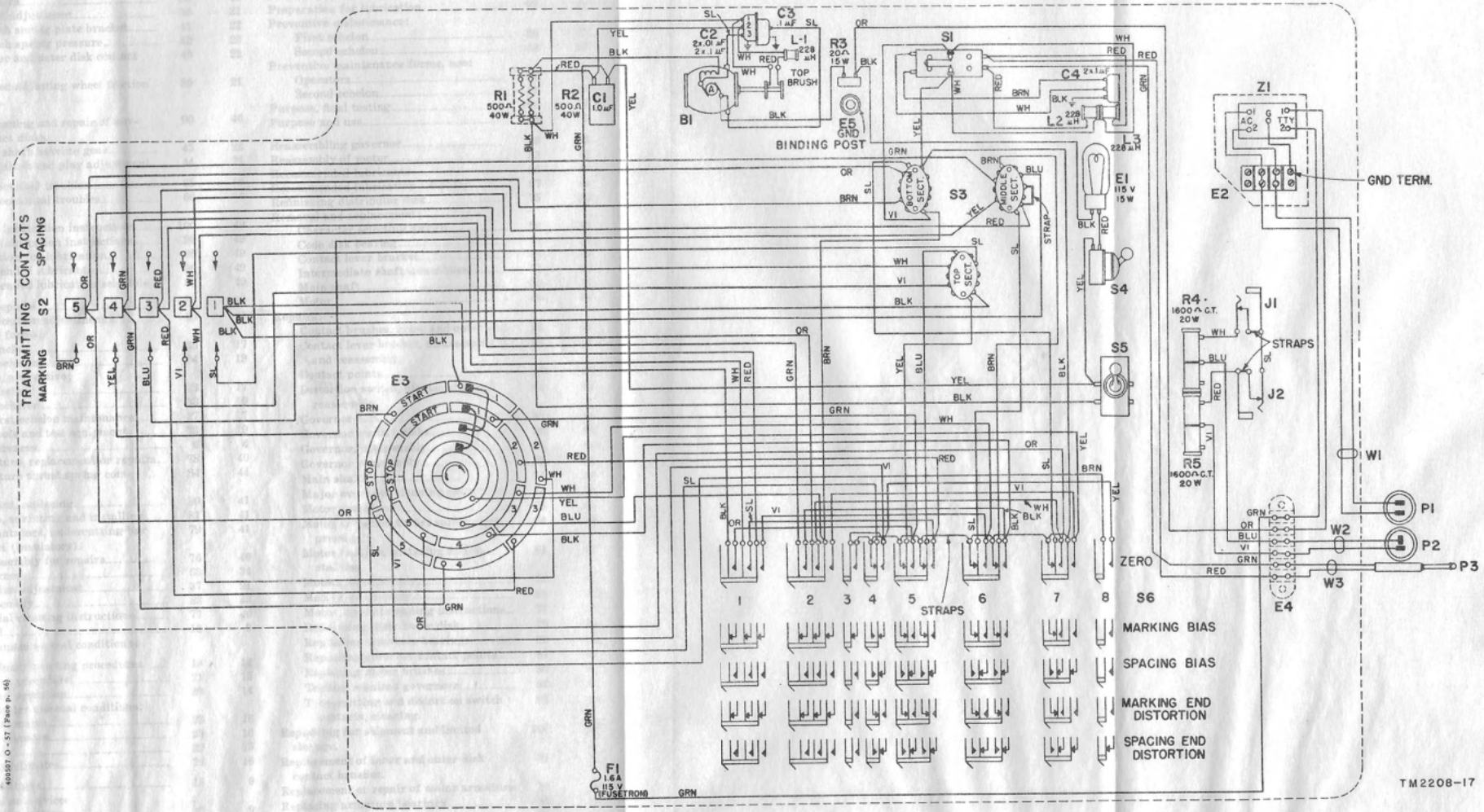

Figure 36. Test Set TS-2B/TG, wiring diagram.

[AG 413.6 (5 Dec 56)]

By Order of *Wilber M. Brucker*, Secretary of the Army:

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11–500R (2)
11–537R (2)
11–557C (2)
11–587R (2)
11–592R (2)
11–597R (2)
20–300R (2)
32–51R (2)
32–55R (2)
32–56R (2)
32–57R (2)
32–500R (2)

NG: State AG (6); units—same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

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