TM 11-2045

WAR DEPARTMENT TECHNICAL MANUAL

DECIBEL METER TS-399/U, 13A (SPL)

TRANSMISSION MEASURING SET

PER D-165655 (MOISTURE-RESISTANT)

This is a reprint of TM 11–2045, 26 September 1944, Preliminary Instructions 13A (SPL) Transmission Measuring Set Per D-165655 (Moisture-Resistant). No initial distribution will be made to personnel possessing copies of the original publication.

WAR DEPARTMENT *SEPTEMBER 1944*

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TM 11–2045, Decibel Meter TS–399/U, 13A (SPL), Transmission Measuring Set Per D–165655 (Moisture-Resistant), is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
J. A. ULIO
Major General
The Adjutant General

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X-Specification	Technical Manual	Title
X-61806	TM 11-2046	Instructions 67B and 67B(SPL) Test Sets per D-173231 Test Receiver with External Resistance
X-63641	TM 11-2021	Instructions Voice-Frequency Ringer Packaged Equipment
X-63653	TM 11-2029	Preliminary Instructions Voice-Frequency Carrier Telegraph Packaged Equipment
X-66038	TM 11-2034	Preliminary Instructions D-C Telegraph Repeater Packaged Equipment
X-66147	TM 11-2024	Preliminary Supplemental Instructions for the Installation of Voice-Frequency Carrier Telegraph Packaged Equipment
X-66150	TM 11-2031	Instructions for Line Terminating and Composite Panel and Type C Carrier Transfer Panel Packaged Equipment
X-66226	TM 11-2048	Instructions 32A(SPL) Transmission Measuring Set per X-66065A (Moisture-Resistant)
X-66227	TM 11-2040	Instructions 51A(SPL) Oscillator per X-66065B (Moisture-Resistant)
X-66228	TM 11-2026	Type C Carrier Telephone Packaged Equipment
X-66229	TM 11-2023	Preliminary Supplemental Instructions for the Installation of Type C Carrier Telephone Packaged Equipment (Moisture-Resistant)
X-66230	TM 11-2028	Preliminary Instructions Voice-Frequency Telephone Repeaters Packaged Equipment (Moisture-Resistant)
X-66231	TM 11-2027	Preliminary Supplemental Instructions for the Installation of Voice-Frequency Telephone Repeater Packaged Equipment (Moisture-Resistant)
X-66232	TM 11-2039	Preliminary Instructions 19C(SPL) Oscillator per D-166636 (Moisture-Resistant)
X-66233	TM 11-2045	Preliminary Instructions 13A(SPL) Transmission Measuring Set per D-165655 (Moisture-Resistant)
X-66234	TM 11-2044	Preliminary Instructions 5A(SPL) Attenuator per D-165654 (Moisture-Resistant)
X-66247	TM 11-2020	Preliminary Instructions Line Terminating and Simplex Panel Packaged Equipment
X-66251	TM 11-2033	Preliminary Instructions 2A(SPL) Test Unit
X-66259	TM 11-2030	Preliminary Instructions Test and Control Board Packaged Equipment
X-66260	TM 11-2042	Preliminary Instructions Volt-ohm-milliammeter per D-166852 Moisture-Resistant
X-66307	TM 11-2041	Description and Use of Tools, Gauges, and Materials for Installation and Maintenance of Packaged Equipment Offices
X-66464	TM 11-2047	Preliminary Instructions Hickok Model 560(SPL) Tube Tester per KS-9237 (Moisture-Resistant)

SAFETY NOTICE

ALWAYS REMOVE THE PLUG FROM THE RECEPTACLE AND THROW THE OFF-ON SWITCH LEVER TO THE OFF POSITION BEFORE REMOVING THE CHASSIS FROM THE BOX. WITH DOOR SWITCH D1 CLOSED AND THE POWER TURNED ON, THE CHASSIS AND ALL METAL PARTS CONNECTED TO IT, MAY BE AT LINE POTENTIAL. PROPER PRECAUTIONS SHOULD, THEREFORE, BE TAKEN TO AVOID ELECTRICAL SHOCK.

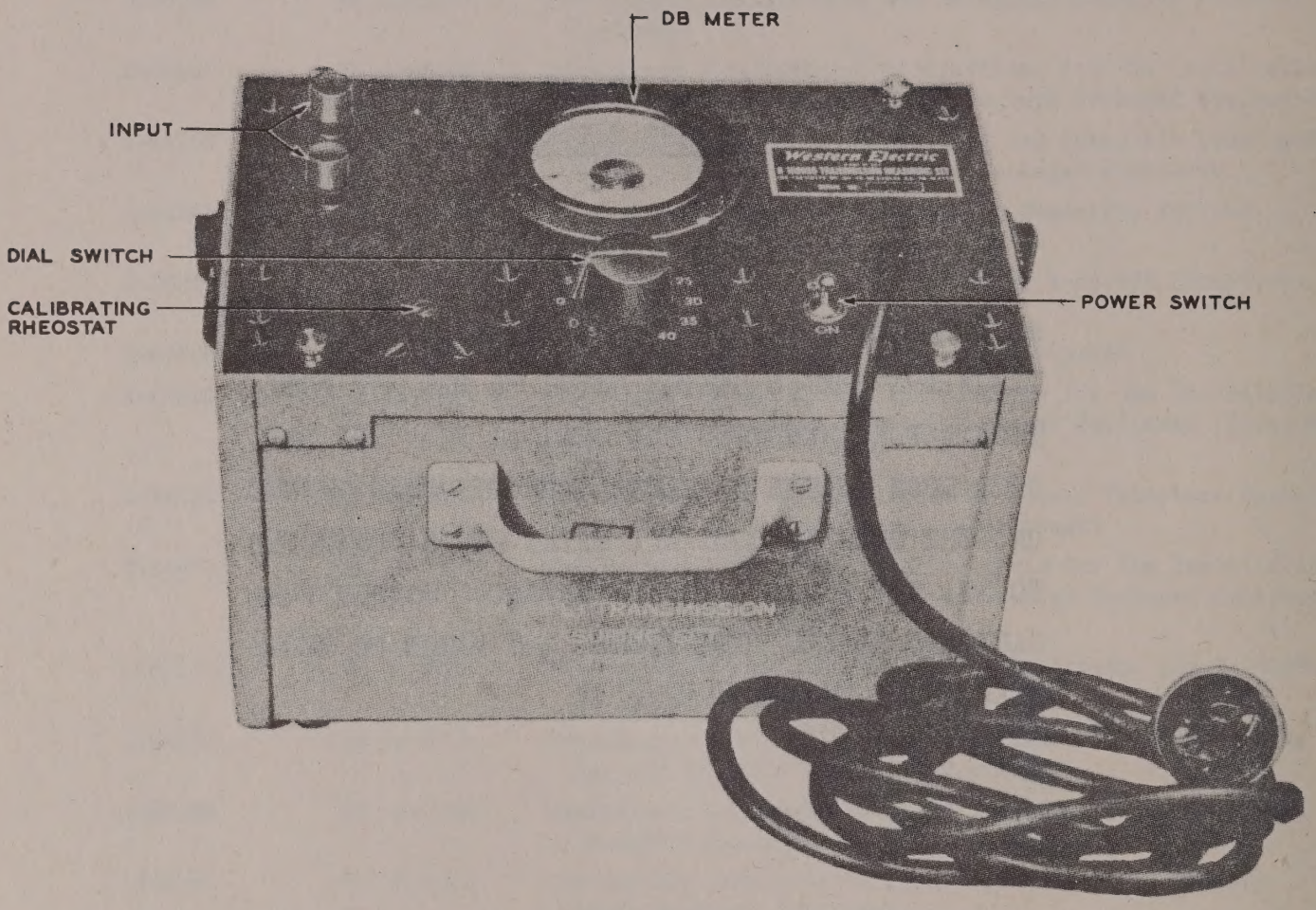


Figure 1 - 13A (SPL) Transmission Measuring Set, in Operating Position

SECTION I
DESCRIPTION

1. PURPOSE.

a. The 13A (SPL) Transmission Measuring Set is designed for use in making transmission measurements where portable apparatus is required to measure received testing power.

b. The 13A (SPL) Transmission Measuring Set has component parts specially treated with moisture-resistant materials for use under tropical conditions and differs in this respect from the 13A Transmission Measuring Set. The circuit and operating features, however, are the same for both the 13A and 13A (SPL) sets. The 13A (SPL) Transmission Measuring Set is manufactured as the D-165655 set.

2. RANGE.

This set has an input impedance of approximately 600 ohms and is capable of measuring received power from -45 dbm (45 db below a milliwatt into 600 ohms) to +10 dbm (10 db above a milliwatt into 600 ohms) over a frequency range from 30 cycles to 15 kilocycles. An external source of standard testing power of 1 MW (one milliwatt) is required for gain or loss measurements.

3. SIZE AND WEIGHT.

The 13A (SPL) Transmission Measuring Set is provided in portable form equipped with a power-supply cord and removable cover. It is approximately 11 inches long, 6-1/2 inches wide, and 8-1/2 inches high, weighing about 14 pounds.

4. POWER.

The power required for operation is a source of 105 to 125 volts which may be obtained from either direct current or 25- to 60-cycles alternating current, consuming about 50 watts.

5. EQUIPMENT ASSEMBLY.

The meter, binding posts, and adjustable features of the set, consisting of a dial switch, a calibrating rheostat, and a toggle switch in the power-supply circuit are assembled on the panel as shown in figure 1. Figure 2 shows the equipment removed from its case. The chassis is fastened to the case by means of four knurled thumb screws, one near each corner of the panel. The wiring side of the equipment is shown in figure 3.

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6. METER SCALES.

Measurements are indicated on a 5-db range meter scale which is marked in 0.1-db divisions. A dial switch operates a potentiometer circuit in steps of 5 db each with step designations which indicate the amount to be added to the meter scale. This provides an adjustment of the input of the amplifier-rectifier circuit so that any received power in the range of the set can be measured in reference to one milliwatt. With an input of one milliwatt and the dial switch at either zero position, the meter scale deflection will be zero on the meter scale corresponding to the dial switch setting. The dial steps designated in red are associated with the red or upper scale of the meter and indicate received power greater than one milliwatt. On the other steps, designated in white, the received power is less than one milliwatt and the black or lower meter scale is used.

7. CALIBRATING RHEOSTAT.

A calibrating rheostat operated by means of a screwdriver is provided for making an adjustment of the amplifier gain.

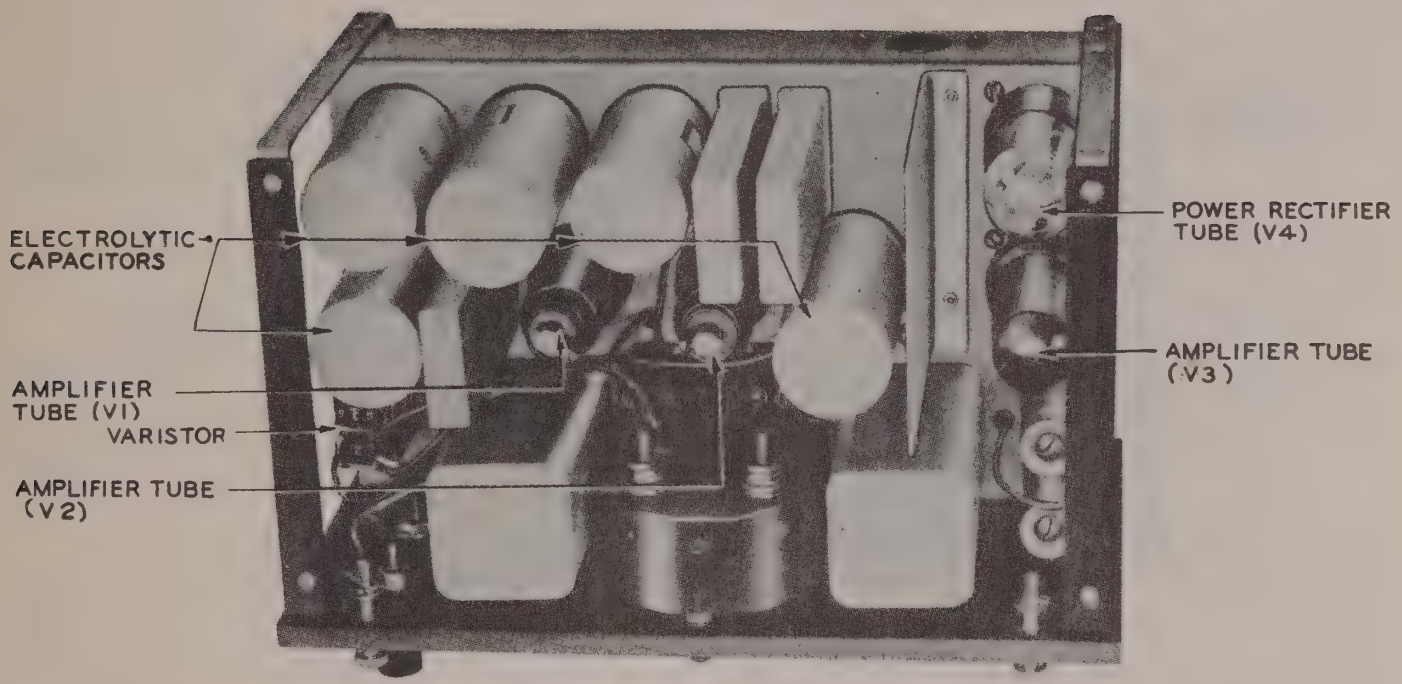


Figure 2 - 13A (SPL) Transmission Measuring Set, Terminal and Wiring Side of Chassis

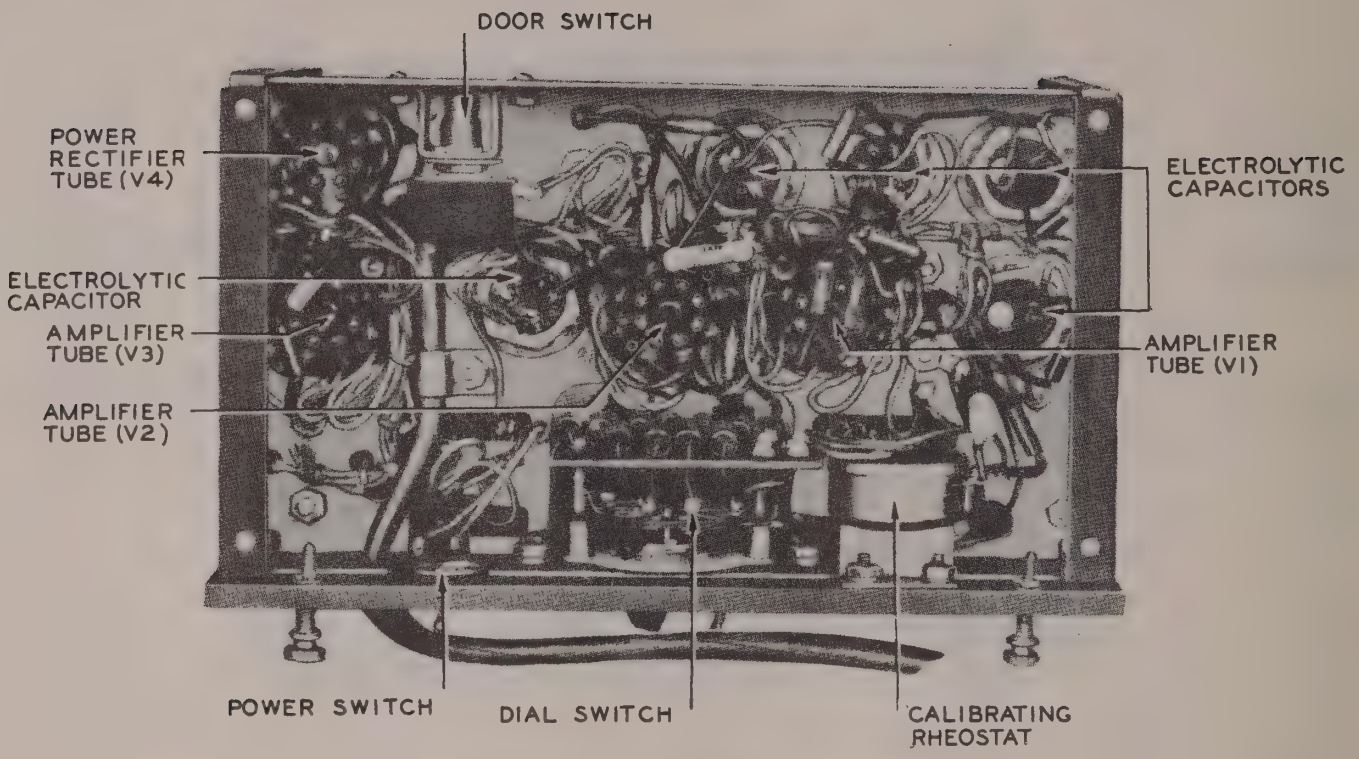


Figure 3 - 13A (SPL) Transmission Measuring Set, Terminal and Wiring Side of Chassis

SECTION II
EMPLOYMENT

8. GENERAL.

The 13A (SPL) Transmission Measuring Set should always be operated with the panel in a horizontal position in order to insure proper heat dissipation from the vacuum tubes and resistors and to assure correct readings on the meter.

9. INPUT LIMITS.

a. Do not connect the input of this set to any circuit having an output in excess of 10 db above one milliwatt. Where output levels of more than 10 db above a milliwatt are to be read an attenuator, such as the 5A (SPL) should be inserted between the output of the circuit under test and the input of the 13A (SPL) Transmission Measuring Set.

b. This set should not be connected to a circuit which would cause direct current to flow in the primary winding of the input transformer. If circuits having a d-c component in the transmission path are to be measured a 2-microfarad capacitor should be connected in series with each of the leads to the INPUT binding posts of the 13A (SPL) Transmission Measuring Set. Insertion of these capacitors will introduce a transmission loss which will vary with frequency. To correct for this transmission loss, first connect the oscillator to the 13A (SPL) Transmission Measuring Set through the series capacitors, and increase the oscillator output until the 13A (SPL) Transmission Measuring Set reads 0 db. Then read the oscillator output. The oscillator output reading will be greater than one milliwatt by the loss of the capacitors. Use this value of oscillator output instead of one milliwatt in making measurements. The 13A (SPL) Transmission Measuring Set will then read the loss or gain of the equipment directly as the loss of the capacitors will be corrected for by the increase in oscillator output. The oscillator output should be readjusted for each testing frequency because the capacitor loss varies with frequency.

10. POWER SUPPLY.

a. Insert the plug of the power-supply cord into the receptacle of the 105- to 125-volt supply which may be either direct current or 25- to 60-cycles alternating current and throw the OFF-ON toggle switch to the ON position. With a-c supply either poling of the plug is normally satisfactory

but with d-c supply it is necessary to select the particular poling that results in a meter reading. This is discernible on the meter shortly after connecting the power supply, assuming there is sufficient input to obtain a meter deflection. It is desirable to allow a warming-up period of 5 minutes before proceeding with measurements. If the set is used without a warming-up period, its calibration should be checked occasionally until stable conditions are obtained.

b. With the type of power-supply circuit suitable for either alternating current or direct current, the chassis can be at line potential above ground. For this reason, the chassis and all exposed metal parts are insulated from the box and a door switch has been provided to automatically disconnect the power supply when the chassis is removed from the box. (See Safety Notice, page VII.)

11. CALIBRATION.

The amplifier of the 13A (SPL) Transmission Measuring Set, employing the negative feed-back principle, is stable and should not require frequent calibration. The calibration, however, should always be checked after the set has been shipped or a vacuum tube replaced. An occasional check against an accurate source of standard testing power, when available, should be adequate for general use. Calibration will be required if the calibrating potentiometer is tampered with or turned inadvertently. Do not turn this potentiometer except during a calibration adjustment.

12. CALIBRATION ADJUSTMENT.

a. Connect the binding posts IN of the 13A (SPL) Transmission Measuring Set to a source of 1000-cycle testing power having an output which has been accurately adjusted to one milliwatt into 600 ohms. The 19C (SPL) Oscillator can be used for this purpose. The output of the oscillator should be adjusted by means of the OUTPUT control knob so that the meter on the oscillator reads 0 db with the oscillator connected to the 13A (SPL) Transmission Measuring Set. The output of the oscillator will then be one milliwatt into 600 ohms.

b. Turn the dial switch to the white zero and note the meter scale indication. If the indicator is not within ±0.1 db of 0 db on the black (lower) scale of the meter, adjust the calibration potentiometer by means of a screwdriver until the meter reading is zero.

c. Turn the dial switch to the red zero. The meter should read within ±0.1 db of 0 db on the red (upper) scale. An excessive deviation is an indication of trouble in the set, in which case the chassis should be removed and the tubes, potentiometer, resistors, capacitors, etc. checked.

d. When frequencies other than 1000 cycles are available, repeat paragraphs 12a to 12c, omitting the readjustment of the calibrating rheostat. The indicated readings should be recorded and used as corrections to measurements when greater accuracy is desired. These corrections are greatest near the extremes of the frequency range (fig. 6).

13. MEASUREMENT OF RECEIVED POWER.

a. Connect the output of the circuit under test to the binding posts IN of the 13A (SPL) Transmission Measuring Set.

b. Turn the dial switch in a clockwise or counterclockwise direction as required to obtain a pointer deflection on the scale of the meter.

c. If the dial switch is at the red 0 or red 5, read the red (upper) scale on the meter.

(1) Example.—If the dial switch is on red 5 and the meter reading is 3.2 on the red scale, the output level being measured is 5 + 3.2 or 8.2 db above one milliwatt.

d. If the dial switch is at a white number, read the black (lower) scale on the meter.

(1) Example.—If the dial switch is at white 25 and the meter reads 4.2 on the black scale, the output level being measured is 25 + 4.2 or 29.2 db below one milliwatt.

e. If the output of the circuit under test is greater than +10 dbm, insert a 5A (SPL) Attenuator between the IN jacks of the 13A (SPL) Transmission Measuring Set and the circuit under test. Adjust the loss in the attenuator until a meter reading is obtained with the dial switch on the red 0. The power received is then equal to the meter reading plus the loss in the attenuator.

f. If the impedance of the circuit is not 600 ohms, a correction for reflection loss may be required as discussed in paragraph 16.

14. LOSS MEASUREMENTS.

a. Connect the output of an oscillator (whose output has been adjusted to one milliwatt or other value as specified) to the input of the circuit under test.

b. Connect the output of the circuit under test to the binding posts IN of the 13A (SPL) Transmission Measuring Set.

c. Measure the output power as outlined in paragraph 13.

d. The loss in the circuit under test is numerically equal to the output power in db below one milliwatt. If other than one milliwatt is specified as an input power, a correction should be made accordingly.

e. Losses up to 45 db may be measured by this method.

f. If the impedance of the circuit is not 600 ohms, a correction for reflection losses may be required as discussed in paragraph 16.

15. GAIN MEASUREMENTS.

a. Gain measurements in excess of 10 db require the use of a 600-ohm attenuator such as the 5A (SPL) Attenuator or a loss pad. The gain of an amplifier is usually measured with an attenuator or loss pad at the input of the amplifier to avoid any overloading effects as shown in figure 4.

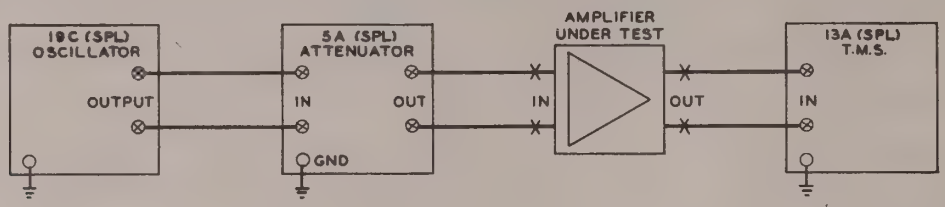


Figure 4 - Arrangement of Testing Equipment for Measuring Amplifier Gain

b. Connect the output of a 19C (SPL) Oscillator (adjusted for one milliwatt) to the input of a 5A (SPL) Attenuator. The attenuator loss should be set for a maximum.

c. Connect the output of the attenuator to the input of the amplifier under test.

d. Connect the output of the amplifier under test to the binding posts IN of the 13A (SPL) Transmission Measuring Set.

e. Set the dial switch in the 13A (SPL) Transmission Measuring Set to the red zero.

f. Decrease the attenuator settings until a reading is obtained on the red (upper) scale.

g. The reading of the meter plus the attenuator setting equals the gain of the amplifier. The output of the amplifier in this case will always be between 0 and 5 db above one milliwatt regardless of the amount of the gain.

h. If the impedance of the circuit is not 600 ohms, a correction for reflection losses may be required as discussed in paragraph 16.

16. REFLECTION LOSS.

If the impedance of the circuit to which the 13A (SPL) Transmission Measuring Set is connected is not 600 ohms, the power indicated by the set will be different from the power which the circuit will deliver if terminated in its own impedance. The difference will depend on the magnitude and angle

of the circuit impedance but, in general, will represent a loss. An additional reflection loss will occur if the oscillator used in making loss or gain measurements does not have the same impedance as the circuit under test. The following table gives the value of the reflection loss for circuits having impedances which are pure resistances.

REFLECTION LOSSES

Impedance* of Circuit - Ohms	Received Power Measurement - db	Gain or Loss Measurement With 19C (SPL) Oscillator - db
200	1.2	1.8
300	0.5	0.6
600	0	0
1200	0.5	1.4
1800	1.2	3.1

*Assumed to be a pure resistance.

In received power measurements, the actual power which the circuit will deliver into its own impedance will be greater than the measured power by the reflection loss. If the gain or loss of a circuit must be known between its own impedance terminations, instead of between 600-ohm terminations, the reflection losses should be added to the measured gain and subtracted from the measured loss. The figures in the last column of the table represent the total reflection loss when a 19C (SPL) Oscillator and 13A (SPL) Transmission Measuring Set are used for such measurements.

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SECTION III
FUNCTIONING OF PARTS

17. GENERAL.

a. The 13A (SPL) Transmission Measuring Set has been designed for measuring circuits of 600-ohm impedance in terms of the standard testing power of one milliwatt. The results are indicated in db above or below this power. When the impedance of the circuit is other than 600 ohms, it may be necessary to make corrections as discussed in paragraph 16. When making amplifier gain measurements, it will be necessary to provide loss pads in connection with the sending power and to make sending power corrections as explained in paragraph 15.

b. The performance information as given, assumes that good vacuum tubes are employed and that the power supply to the set has been turned on for about 5 minutes to allow for proper operation of the heater-type tubes. It also assumes that the power-supply voltage is within the range from 105 to 125 volts and that the set has been calibrated using precisely one milliwatt at 1000 cycles.

18. TYPE OF CONSTRUCTION.

This apparatus is of a panel-chassis type of construction and is contained in a perforated steel housing. The box is provided with a removable cover to protect the surface apparatus. The perforations in the housing assist in dissipating the heat generated, and the set should be exposed to freely circulating air while in operation. This is an important consideration in the use of the set due to its compactness and the effects of heat on the life of certain parts, particularly the electrolytic capacitors. The effects of temperature variations on the electrical performance have been minimized by the circuit design.

19. CIRCUIT DRAWINGS.

The principal circuit features of the 13A (SPL) Transmission Measuring Set are shown in figure 5. A more detailed copy of the schematic and circuit label as shown in figure 7 on page 24, is fastened in the cover of the set. Figure 8 on page 25 shows a wiring diagram of the terminal side of the chassis.

20. AMPLIFIER-RECTIFIER.

The received testing power is supplied through an input transformer and potentiometer circuit to a 3-stage amplifier and copper-oxide rectifier circuit from which the d-c output is supplied to the meter. The meter is a suppressed zero type and has a scale calibrated in db. The potentiometer controls the measuring range of the set in 5 db steps.

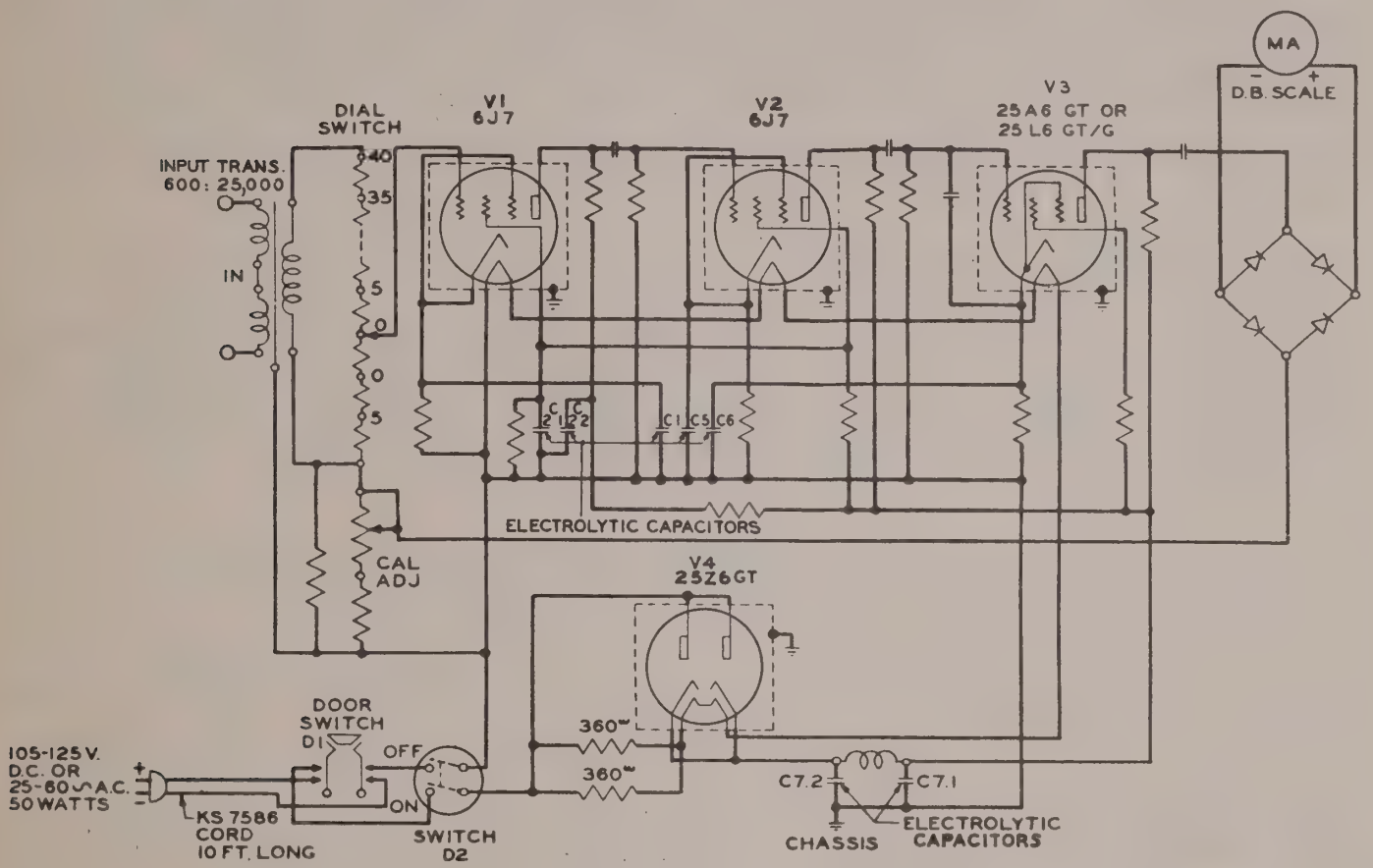


Figure 5 - Principal Circuit Features

21. AMPLIFIER.

The amplifier is of the negative feed-back type which results in greater stability and improved performance compared with the types which do not include this feature. As a result the amplification is substantially constant for the usual ranges of temperature and power-supply voltage variation and also with respect to the frequency of the testing power. The deviations from flatness in the low-frequency range is due largely to the input transformer and the potentiometer circuit and in the higher frequency range to the impedance of the copper-oxide rectifier. The amplifier circuit consists

principally of vacuum tubes, capacitors, and resistors, one of which is an adjustable resistor for setting the gain to the proper amount when one milliwatt of testing power is supplied to the input terminals. This resistor adjustment is made from the front of the set by means of a screwdriver. Need for changing this resistance setting should be rare.

22. RECTIFIER.

A rectifier-type vacuum tube is employed to adapt the power supply for the plate and grid circuits of the vacuum tubes. The rectified power is filtered by means of a retardation coil and electrolytic capacitor circuit to reduce the effect of power-supply variation and ripple. The current for the heaters of the tubes is obtained directly from the power mains without conversion.

23. ACCURACY OF MEASUREMENTS.

a. The best performance will be obtained when the 13A (SPL) Transmission Measuring Set is operated under normal temperature conditions. At temperatures outside this range the accuracy of the readings will vary due to the changing characteristics of the copper-oxide rectifier and the electrolytic capacitors.

b. The over-all accuracy of measurements under normal operating conditions is about ±0.3 db for any received power between 45 db below and 10 db above one milliwatt at frequencies between 50 and 6000 cycles. At the extremes of the range from 30 cycles to 15 kilocycles, the error may be as great as one db under adverse conditions.

c. The accuracy of the meter scale alone is usually better than ±0.1 db at any point in the scale range at normal temperatures. The accuracy of the 5-db steps on the dial switch is about ±0.1 db at any frequency in the range from 50 to 6000 cycles and ±0.25 db in the range from 30 to 15,000 cycles.

d. The error in the set due to the transmission-frequency characteristic of the input circuit varies with the dial step. This can be corrected by a recalibration at the particular frequency being used, provided the power used in calibration is such as to give zero db reading on the meter with the dial set on the step being checked.

24. FREQUENCY CHARACTERISTICS.

The frequency characteristics of the set on step 0 of the dial switch are as shown on the following page.

FREQUENCY-CYCLES	DEVIATION RELATIVE TO 1000 CYCLES
50 - 6,000	±0.1 db
40 - 10,000	±0.3 db
30 - 15,000	±0.7 db

On step 40 the above deviations may be as much as ±0.3 db greater. Figure 6 shows a representative frequency characteristic on step 0, based on a single calibration of one milliwatt at 1000 cycles.

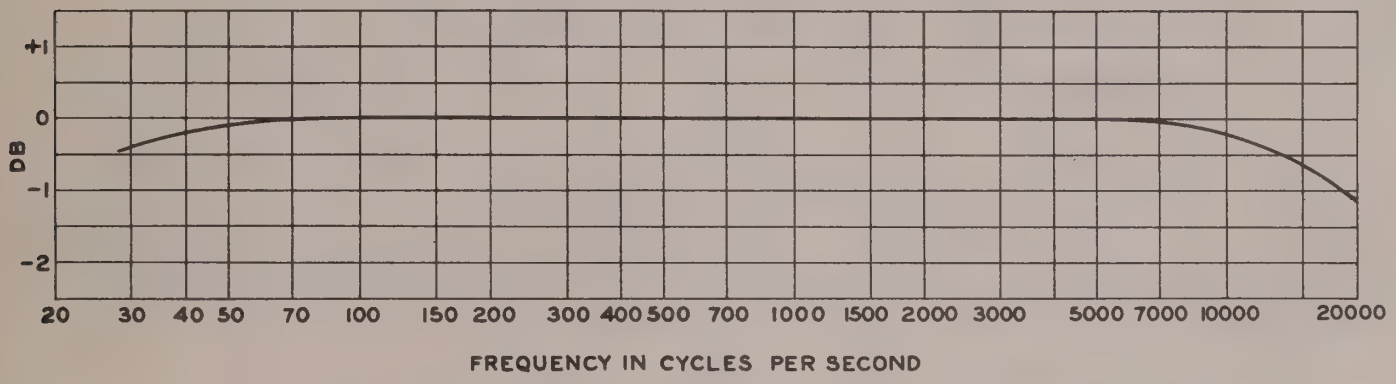


Figure 6 - Representative Frequency Characteristic

25. IMPEDANCE.

The impedance of the input circuit is substantially 600 ohms and is practically independent of the setting of the dial switch. It does vary with frequency, tending to decrease in both the low and the high-frequency ranges. The reflection coefficient with respect to 600 ohms is less than 5 per cent in the frequency range from 30 cycles to 10 kilocycles. The d-c resistance of the input circuit is approximately 26 ohms. If subjected to direct current greater than 150 milliamperes, the transformer may be damaged. A small direct current will affect the accuracy of measurement adversely.

SECTION IV
MAINTENANCE

26. GENERAL.

The periodic maintenance of the 13A (SPL) Transmission Measuring Set may be confined principally to a check of the vacuum tubes. Failure of the set to operate properly will necessitate removing the chassis from the box (see Safety Notice, page VII) and examining the equipment for a defective vacuum tube, electrolytic capacitor, or a broken wire.

27. VACUUM TUBES.

The vacuum tubes used in the set should be tested periodically and should be within the usual transconductance limits outlined in the vacuum tube Test Set I-171. The list of vacuum tubes together with the selector settings and transconductance values as outlined in the Test Set I-171 are as follows:

Tube No.	Average Mutual Conductance	Selectors A	B	Fil	Pots L	R	Test Conditions
V1, 6J7	1225 micromhos	1	9	6.3	48	18	Amplifier
V2, 6J7	1225 micromhos	1	9	6.3	48	18	Amplifier
V3, 25A6GT	2300 micromhos	8	5	25.0	62	35	Amplifier
or							
25L6GT/G	8000 micromhos	8	5	25.0	75	15	Amplifier
V4, 25Z6GT	-	7	2	25.0	40	0	Rectifier Standard
V4, 25Z6GT	-	7	5	25.0	40	0	Rectifier Standard

A full set of tubes is supplied with each set and should be inserted in sockets in accordance with the designations on the circuit label or on the chassis. A small bracket is provided at the side of each vacuum tube socket for clamping the tubes in place to reduce vibration. It is not necessary to remove the vacuum tubes from the sockets in transporting the oscillator when reasonable precautions are taken to prevent vibrations or jolts. When handling conditions are not controlled, the tubes should be removed and packed separately. The grid cap provided for the vacuum tubes V1 and V2, should be properly connected to their respective tubes. Looking down on the apparatus side of the chassis from the front, the grid cap directly to the right of V1 should be connected to V1 and the one to the rear of V2 should be connected to V2.

28. METER.

This is a self-contained, moving coil, permanent magnet, suppressed zero-type meter housed in a flush-type bakelite case.

29. DEFECTIVE CAPACITORS.

The electrolytic capacitors should be replaced when found defective. This usually will be evidenced by instability of calibration. Unsatisfactory performance not due to vacuum tubes will probably be an indication of defective capacitors.

SECTION V

SUPPLEMENTARY DATA

30. REPLACEABLE PARTS.

a. The reference designations shown in the first column of the table in paragraph 30c correspond to the designations shown on the detailed schematic and circuit label shown in figure 7. These designations are also stamped on the equipment or on the mounting adjacent thereto.

b. List of Manufacturers.

Abbreviation in Paragraph 30c	Name	Address
Commercial	Any Standard Manufacturer	-
Eby	H. H. Eby, Inc.	Philadelphia, Pa.
H & H	Arrow-Hart and Hageman Electric Co.	Hartford, Conn.
RCA	R.C.A. Manufacturing Co.	Harrison, N. J.
Sylvania	Sylvania Electric Products Inc.	Emporium, Pa.
W. E. Co.	Western Electric Co.	New York, N. Y.
Zierick	Zierick Manufacturing Corp.	New York, N. Y.

Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	3F4270-2	SET, TRANSMISSION MEASURING: The set consists essentially of a 3-stage negative feed-back amplifier, a copper-oxide rectifier, and a d-c meter having a loss and gain scale. It is arranged to operate from a power supply of 105-125 volts d-c or 105-125 volts a-c, 50-60 cps or 105-125 volts a-c, 25 cps. The nominal input impedance is 600 ohms and the transmission loss range is 45 db and the transmission gain range is 10 db referred to one milliwatt over a frequency range from 30 to 15,000 cps. The amplifier response over this frequency range is flat within approximately 0.7 db. Measurements are made by means of the meter and a potentiometer adjustable in 5 db steps. A small slide wire rheostat is provided for calibration purposes and is arranged for screwdriver operation from the front of the panel. Apparatus is mounted in a panel-chassis structure, the panel being made of black phenol fabric and the chassis of sheet steel. The input binding posts, the controls, and the meter are mounted on the panel and the other apparatus on the chassis. The assembly is enclosed in a sheet steel box approximately 11" long, 8" wide, and 8-3/8" deep over-all with gray wrinkle finish. The box has a removable cover and a carrying handle and except for the cover and the side on which the handle is mounted, is made of perforated metal for ventilation. The set is equipped with a rubber-covered power cord which is brought out through the panel. The cord is equipped at the end with a plug. The box and all exposed metal parts are insulated from the chassis. The apparatus is moisture resistant for use in tropical climates.	To make transmission measurements where a portable instrument is required to measure received testing power.	W. E. Co.	D-165655
	3Z737-1	BINDING POST: Screw stem-type equipped with 1/2" high insulated cap and 5/8" diameter x 1/2" thick bakelite base, 3/32" wire hole in neck, stem 8-32" x 3/4" long.	In connections.	Eby	42 Commander P-3
	3F4270-2/B4	BOX ASSEMBLY: Steel, .0375" thick, gray wrinkle finish. Over-all dimensions approximately 7-3/16" high x 6-7/32" wide x 9-29/32" long, including detachable cover held in place by a flush hasp suitcase bolt at each end. Can be carried by means of a bar shaft lift on front of case. Bottom and rear are each equipped with four flat base rubber-insulated Domes of Silence. Side and bottom are perforated.	To house equipment of transmission measuring set.	W. E. Co.	ESL-639081 Det. 7
	3F4270-2/B1	BRACKET: Steel, .0625" x 3/4" x 1-3/4", zinc and chromate finish, U-shape 3/4" x 3/4" with two 1/2" long projecting mounting feet each having a .152" diameter hole. Horizontal spacing between holes 1-3/8". Base of U has a .5" diameter hole centrally located.	To support safety switch.	W. E. Co.	ESL-639081 Det. 3

Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	3F4270-2/B3	BRACKET: Steel, zinc plate and chromate finish, L-shape, .065" thick x 1/4" wide x 1/2" long x 3/8" high. Short leg has .1406" diameter hole 3/8" from end and 1/8" from sides.	Tube clamp.	W. E. Co.	ESL-639081 Det. 4
-	3F4270-2/B2	BRACKET: Steel, zinc and chromate finish, .0625" thick, 1-1/4" x 1" with L-shaped end, 19/32" high x 9/16" long. Horizontal leg of L has two .180" holes spaced 13/16" apart. Base of bracket has a .4062" hole 5/8" from sides and 1/2" from end.	To support potentiometer P2.	W. E. Co.	ESL-639081 Det. 5
-	4Z2797	BUSHING: Shoulder bushing, phenol fabric, 3/8" diameter.	To insulate screws on surface of panel.	W. E. Co.	ES-624438-1
-	2Z2635.8	CABLE CLAMP: Brass with gray lacquer finish, 1/32" thick, 1/2" wide, 7/16" long, one end bent into an inverted U-shape 1/4" high and 5/16" wide. Radius of U bend 9/64". Flat part of clamp .180" diameter hole 1/4" from sides and 3/16" from end.	To support power-supply cord.	W. E. Co.	ES-329115-10
-	3F4270-2/C1	CHASSIS ASSEMBLY: Over-all dimensions 5-7/16" x 5-9/16" x 9-1/2", assembly of steel details with zinc plate and chromate finish.	For mounting apparatus.	W. E. Co.	ESO-639080-2
-	6D16814-1	CIRCUIT LABEL: Circuit diagram, black on white paper, approximately 6" x 9".	For use in maintenance and understanding of circuit.	W. E. Co.	ESO-639078
C1		CAPACITOR: Electrolytic, 100 μf minimum, maximum effective series resistance 1.5Ω at 120 cps, 25 w-v d-c, 32F to 140F ambient temperature. Dry type, cylindrical, 1-3/8" diameter x 3-5/8" high including two terminals 7/16" long. Same as C5 and C6.	Cathode resistor by-pass.	W. E. Co.	KS-8676
C2		CAPACITOR: Electrolytic, dry type, two sections, minimum capacity of each section 14 μf, maximum series effective resistance 8Ω at 120 cps, both sections not exceeding 200 w-v d-c at 32F to 140F ambient temperature, cylindrical 1-3/8" diameter x 4-1/8" high including 3 lugs each 7/16" long. Same as C7.	By-pass.	W. E. Co.	KS-8677
C3	3DA400-3	CAPACITOR: 0.4 μf ±15%, 250 w-v d-c at 32F to 150F ambient temperature, 3-9/16" x 1-1/2" x 37/64" rectangular metal case, hermetically sealed, 31/32" rubber-insulated terminals, paper dielectric, single mounting stud 1/2" long, stud and terminals on same end of case. Moisture resistant W. E. Co. 230A. Same as C4.	Blocking capacitor for interstage coupling.	W. E. Co.	D-162242A
C4	3DA400-3	CAPACITOR: Same as C3.	Same as C3.	W. E. Co.	D-162242A
C5		CAPACITOR: Same as C1.	Cathode resistor by-pass.	W. E. Co.	KS-8676

Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
C6		CAPACITOR: Same as C1.	Cathode resistor by-pass.	W. E. Co.	KS-8676
C7		CAPACITOR: Same as C2.	Power-supply filter.	W. E. Co.	KS-8677
C8		CAPACITOR: 50 μμf ±5%, 500 w-v d-c at -40F to +212F ambient temperature, cylindrical 7/32" diameter x 7/16" long with two no. 20 axial wire leads 1-1/2" long, ceramic dielectric, moisture resistant.	Stabilizing capacitor.	W. E. Co.	KS-8150 50 μμf
C9	3DB1.884A	CAPACITOR: 1 μf minimum, 1.25 μf maximum, 200 w-v d-c at 32F to 120F ambient temperature, paper dielectric, rectangular metal case 15/32" x 1-1/2" x 3-7/16" not including two .164"-32 threaded mounting studs 1/2" long and 1" apart, two terminals 3/4" long.	Blocking capacitor for coupling from output tube to load.	W. E. Co.	D-161884A
-	3E4035-12.1	CORD: 2-conductor 18 AWG rubber-covered cord, 10'-0" long, nonpolarized plug cap.	Power-supply cord.	W. E. Co.	KS-7586
-	1B822.7	CORD: No. 22 AWG stranded CKR conductor, rubber-covered with outside covering of black cotton yarn, Length as required.	Grid leads.	W. E. Co.	D-161077 Black
-	6D974-4-20	COTTER PIN: 1/16" diameter x 5/16" long, steel.	To prevent panel screws from coming out of panel.	Commercial	-
-	3F4270-2/P1	ESCUTCHEON PIN: .049" x 1/4" long, steel with nickel silver finish.	To fasten nameplate to panel.	Commercial	-
-	2Z1609-2	GRID CAP: Tubular with wiring terminal.	For contact to screen element of vacuum tube.	Zierick	194
T1		INPUT TRANSFORMER: Direct capacitance of 30 μμf between (1-2) - (3-4) and (7-8) with case, core and shield grounded. Insulation resistance of 500 megohm between windings and between each winding and case, minimum voltage stepup (db) of 9.4 at 1000 cps, 9.0 db at 35 cps and 9.1 db at 10,000 cps, rectangular metal case 1-11/16" x 1-11/16" x 3-9/16" (not including seven 23/32" terminals).	Input transformer.	W. E. Co.	D-166463
M1	3F3307.10	MILLIAMMETER: Scale has 50 divisions, range 0-5 and 5-0 db. Accuracy ±2% of full scale, approximately 50Ω, calibrated for use on nonmagnetic panel. 3-1/2" flush type, bakelite case, self-contained, moving coil, permanent magnet, suppressed zero.	To indicate the gain or loss in transmission.	W. E. Co.	D-166279
		NAMEPLATE: Plastic with phenol fibre base, 1/16" x 1-1/8" x 2-1/2" with a .055" mounting hole at each corner, matte finish, engraved as follows, "Western Electric - MADE IN USA - D-165655 TRANSMISSION MEASURING SET - 105-125 VOLTS DC OR 50-60 CYCLES AC 50 WATTS - SERIAL NO." Characters and border are white on black background.	To show name of set, manufacturer, rating, and serial number.	W. E. Co.	ESP-652288

Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	3F4270-2/P2	PANEL: Phenol fabric, 1/4" x 6-3/16" x 9-7/8" mounts on chassis assembly per ES0-639080-2.	To mount ammeter, controls and binding posts.	W. E. Co.	ES0-624436-1
P1		POTENTIOMETER: D-c resistance at extreme counter-clockwise position is 24,000 ±1% between 1-2 and 2-3. Capable of withstanding 500v a-c insulation breakdown test, voltage divider type, 2-7/8" x 2-7/16" x 2-3/4" over-all including knob. Consists of a switch and a phenol fabric 3/32" mounting panel equipped with eleven resistances and three terminals wired to the switch. Mounting bushing 3/8"-32 thread, 1/2" long, suitable for 1/4" panel mounting. Extends approximately 1-5/8" from rear of mounting panel.	Input attenuator.	W. E. Co.	D-163157
P2	2Z7277.2	POTENTIOMETER: 30Ω ±10%, 5 watts in free air, 3 watts enclosed, wire wound, straight line taper, rotation 295 degrees, round metal case 1-17/32" diameter x 11/16" deep having three projecting terminals 15/32" long. Equipped with 3/8"-32 threaded mounting bushing 3/8" long and a 1/4" screwdriver-type operating shaft extending 1/2" beyond end of bushing.	For calibration adjustment.	W. E. Co.	KS-8680 30Ω
R1	3Z6610-7	RESISTOR: Metallized glass tube filament resistance element molded in phenol plastic, cylindrical, 5/8" x 3/16" diameter, 1-1/2" axial wire lead at each end. Resistance value +5% -10%, 1/2 watt.	Bleeder resistor. Screen supply voltage to tubes V1 and V2. Same as R2.	W. E. Co.	KS-8058B 10,000Ω
R2	3Z6640-1		Same as R1.	W. E. Co.	KS-8058B 40,000Ω
R3	3Z6300-2		Cathode bias resistor for tube V1.	W. E. Co.	KS-8058B 3000Ω
R4	3Z6700-6		Part of resistor capacitance for plate supply to tube V1.	W. E. Co.	KS-8058B .1 megohm
R5	3Z6630-9		Plate supply resistor for input tube V1.	W. E. Co.	KS-8058B 30,000Ω
R6	3Z6725-2		Grid leak resistor for vacuum tube V2.	W. E. Co.	KS-8058B .25 megohm
R7	3Z6725-2		Plate supply resistor for amplifier tube V2.	W. E. Co.	KS-8058B .25 megohm
R8	3Z6725-2		Grid leak resistor for vacuum tube V3.	W. E. Co.	KS-8058B .25 megohm
R9	3Z6300-2		Cathode bias resistor for tube V2.	W. E. Co.	KS-8058B 3,000Ω
R15	3Z6100-9		Part of calibration adjustment network.	W. E. Co.	KS-8058 1,000Ω
R14	3Z6630-9		Screen voltage dropping resistor when vacuum tube V3 is supplied per stock no. 2V25A6GT.	W. E. Co.	KS-8058B 30,000Ω
R14			Screen voltage dropping resistor when vacuum tube V3 is supplied per stock no. 2V25L6GT.	W. E. Co.	KS-8058B 100,000Ω

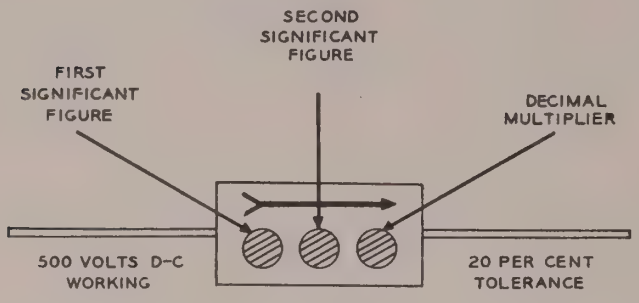
Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
R11	3Z6500-91	RESISTOR: Fixed resistance 5000 ω +5% -10%, 2 watts, metallized glass tube filament resistance element molded in phenol plastic, cylindrical, 1-3/4" x 5/16" diameter, 1-1/2" axial wire lead at each end.	Plate supply resistor for output tube V3.	W. E. Co.	KS-8060B 5000 ω
R10	3Z6060-42	RESISTOR: Fixed resistance 600 ω ±5%, 1/2 watt, inductive, cylindrical 5/16" diameter x 1", 2" radial lead at each end, single winding on ceramic core, lacquer coated. Moisture resistant 111A.	Cathode bias resistor for tube V3.	W. E. Co.	D-163158A 600 ω
R16	3Z6001-32	RESISTOR: Same as R10 except resistance value is 10 ω.	Part of calibration adjustment network.	W. E. Co.	D-163158A 10 ω
R12	3Z6036-1	RESISTOR: Fixed, 360 ω ±5%, 25 watts, wire wound, vitreous enameled, tubular, 27/32" diameter x 2" long, radial terminal .032" x 3/16" x 35/64" near each end, can be mounted by .406" diameter rod through center. Same as R13.	Filament voltage limiting resistance.	W. E. Co.	D-163528
R13	3Z6036-1	RESISTOR: Same as R12.	Filament voltage limiting resistance.	W. E. Co.	D-163528
L1	3C1987-83	RETARDATION COIL: D-c resistance at 68F of winding (terminals 1-6) is 200 ohms and minimum inductance at 200 cps with 45 milliamperes superimposed d-c is 5.0 henries. Insulation resistance between winding and case and winding and core is capable of withstanding 500v a-c. Shell type, silicon steel core, metal case 1-11/16" x 1-11/16" x 3-9/16" high, gray lacquer finish, two terminals on top of case 23/32" long.	Power-supply filter choke.	W. E. Co.	D-163883
D1	3Z9824-31.1	SWITCH: Push button, normally open, double pole, single throw, 3 amperes, 250 volts, switch mechanism enclosed in 5/8" x 9/16" x 1-1/8" bakelite housing with two 1/4" terminals at each end, bushing and push button mechanism 1-1/16" above housing, bushing 15/32"-32 thread, single hole mounting.	Disconnects 110-volt supply when chassis is removed from carrying case.	H & H	81069BD
D2	3Z9858-8.2	SWITCH: Toggle, double pole single throw, 3 amperes 250 volts, mechanism enclosed in 5/8" x 9/16" x 1-1/8" molded bakelite housing with two 1/4" terminals at each end, bushing and switch mechanism 7/8" above housing, bushing 15/32"-32 thread single hole mounting.	Manually operated switch to connect and disconnect the 110-volt power supply.	H & H	81009GB
	3Z12075-6	TERMINAL: Single brass terminal, bent 30 degrees, wire hole, 3/16" screw hole.	Binding post soldering terminals.	W. E. Co.	P-216277
		TERMINAL: Sheet brass with nickel dip finish, .0452" x 9/16" approximately 1" long with rounded ends. One end 1/8" radius bent 30 degrees from base has a .115 diameter wire hole. Other end 9/16" diameter has a .257 diameter screw hole centered 5/16" from bend.	Meter soldering terminals.	W. E. Co.	P-225678

Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
V1	2V6J7	VACUUM TUBE: Filament 6.3 volts, .3 ampere, triple grid detector-amplifier, plate 300 volts maximum, screen voltage 125 volts maximum, 3-1/8" long, 2-9/16" seated height, 1-5/16" diameter, coated unipotential cathode, heater type, metal shell, shell connected to pin no. 1, metal shell grid cap connection, 7 pins, octal socket. Same as V2.	Amplifier.	RCA or Sylvania	6J7
V2	2V6J7	VACUUM TUBE: Same as V1.	Amplifier.	RCA or Sylvania	6J7
V3	2V25A6GT	VACUUM TUBE: Power amplifier, maximum voltage of plate 160, screen 135, plate dissipation 5.3, screen dissipation 1.9, pin no. 1 connected to shell, no. 2 to heater, no. 3 to plate, no. 4 to screen, no. 5 to grid, no. 7 to heater, no. 8 to cathode grid no. 3, heater 25 volts, .3 ampere, 3-5/16" x 1-5/16" diameter, x 2-3/4" seated height, glass bulb, octal 7-pin base.	Power amplifier.	RCA or Sylvania	25A6GT
		or			
V3	2V25L6GT/G	VACUUM TUBE: Power amplifier, maximum voltage of plate 200, screen 117, plate dissipation 10, screen dissipation 1.25, pin no. 1 connected to shell, no. 2 to heater, no. 3 to plate, no. 4 to screen, no. 5 to grid, no. 7 to heater, no. 8 to cathode grid no. 3, heater 25 volts, .3 ampere, 3-5/16" x 1-5/16" diameter x 2-3/4" seated height, glass bulb, octal 7-pin base.	Power amplifier.	RCA or Sylvania	25L6GT/G
V4	2V25Z6GT	VACUUM TUBE: High vacuum rectifier, peak inverse plate voltage 700 maximum, peak plate current per plate 450 milliamperes maximum, d-c output current per plate 75 milliamperes maximum, d-c heater cathode potential 350 volts maximum, pin no. 1 connected to shell, no. 2 to heater, no. 3 to plate no. 2, no. 4 to cathode no. 2, no. 5 to plate no. 1, no. 7 to heater, no. 7 to cathode no. 1, heater 25v, .3 ampere, 3-5/16" long x 1-5/16" diameter x 2-3/4" seated height, glass bulb and octal 7-pin base.	Power-supply rectifier.	RCA or Sylvania	25Z6GT
VS1	2Z8678.30	VACUUM TUBE SOCKET: Phenol fibre, wafer type, metal mounting shell 1-7/16" wide x 1-7/8" long with .14" mounting hole near each end, spaced 1-1/2" apart, silver plated phosphor bronze contacts. Same as VS2, VS3, and VS4.	To hold vacuum tube V1.	W. E. Co.	KS-7862 39-1-E
VS2	2Z8678.30	VACUUM TUBE SOCKET: Same as VS1.	To hold vacuum tube V2.	W. E. Co.	KS-7862 39-1-E
VS3	2Z8678.30	VACUUM TUBE SOCKET: Same as VS1.	To hold vacuum tube V3.	W. E. Co.	KS-7862 39-1-E
VS4	2Z8678.30	VACUUM TUBE SOCKET: Same as VS1.	To hold vacuum tube V4.	W. E. Co.	KS-7862 39-1-E

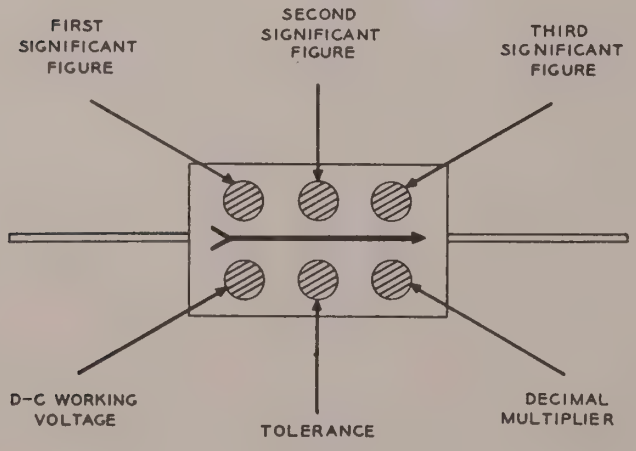
Reference Designation	Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
X1	3H4956-16	VARISTOR: Bridge-type rectifier, maximum input 4.5 volts rms, maximum continuous output 3.0 volts at 15 milliamperes d-c, maximum power output 0.024 watt, 3/4" x 1" x 1-1/4" rectangular metal case containing assembly of four 3/16" copper-oxide rectifier discs, 3/4" x 1-9/16" x 1-13/16" over-all including terminals and mounting lugs, two mounting lugs at right angles to each 3/4" side and flush with bottom of case and staggered so that mounting screws are on vertical and horizontal centers of 5/16" and 1-3/8", six 9/16" terminals.	Meter rectifier.	W. E. Co.	D-163139
	6D16814-2	WIRING DIAGRAM: Circuit diagram in envelope.	To aid in maintenance and understanding of set.	W. E. Co.	ES0-639079

d. RMA Standard Color Codes for Capacitors and Resistors.

RMA Color Codes for *Capacitors* (mmf)



Color	*Numeral*	*Volts*	*Multiplier*	*Tolerance*
Black	0		1	
Brown	1	100	10	1%
Red	2	200	100	2%
Orange	3	300	1,000	3%
Yellow	4	400	10,000	4%
Green	5	500	100,000	5%
Blue	6	600	1,000,000	6%
Violet	7	700	10,000,000	7%
Gray	8	800	100,000,000	8%
White	9	900	1,000,000,000	9%
Gold		1000	0.1	5%
Silver		2000	0.01	10%
No color		500		20%

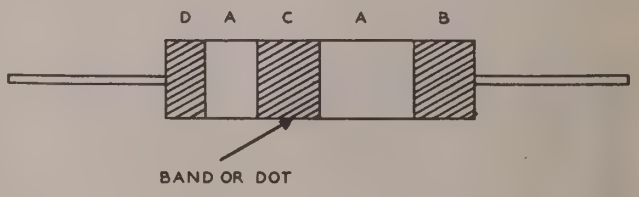


RMA Color Codes for *Resistors* (ohms)

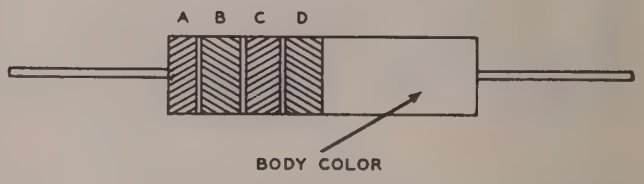
Color	*A* 1st Digit	*B* 2nd Digit	*C* Multiplier
Silver			0.01
Gold			0.1
Black		0	1.0
Brown	1	1	10
Red	2	2	100
Orange	3	3	1,000
Yellow	4	4	10,000
Green	5	5	100,000
Blue	6	6	1,000,000
Purple	7	7	10,000,000
Gray	8	8	100,000,000
White	9	9	

D—Tolerance Code:

Gold=5% Silver=10% No color=20%



Old Color Arrangement



New Color Arrangement

Body color (new color arrangement only) indicates type of resistor, as follows:

Black—composition, non-insulated
Tan, olive or white—composition, insulated
Dark brown—wire-wound, insulated

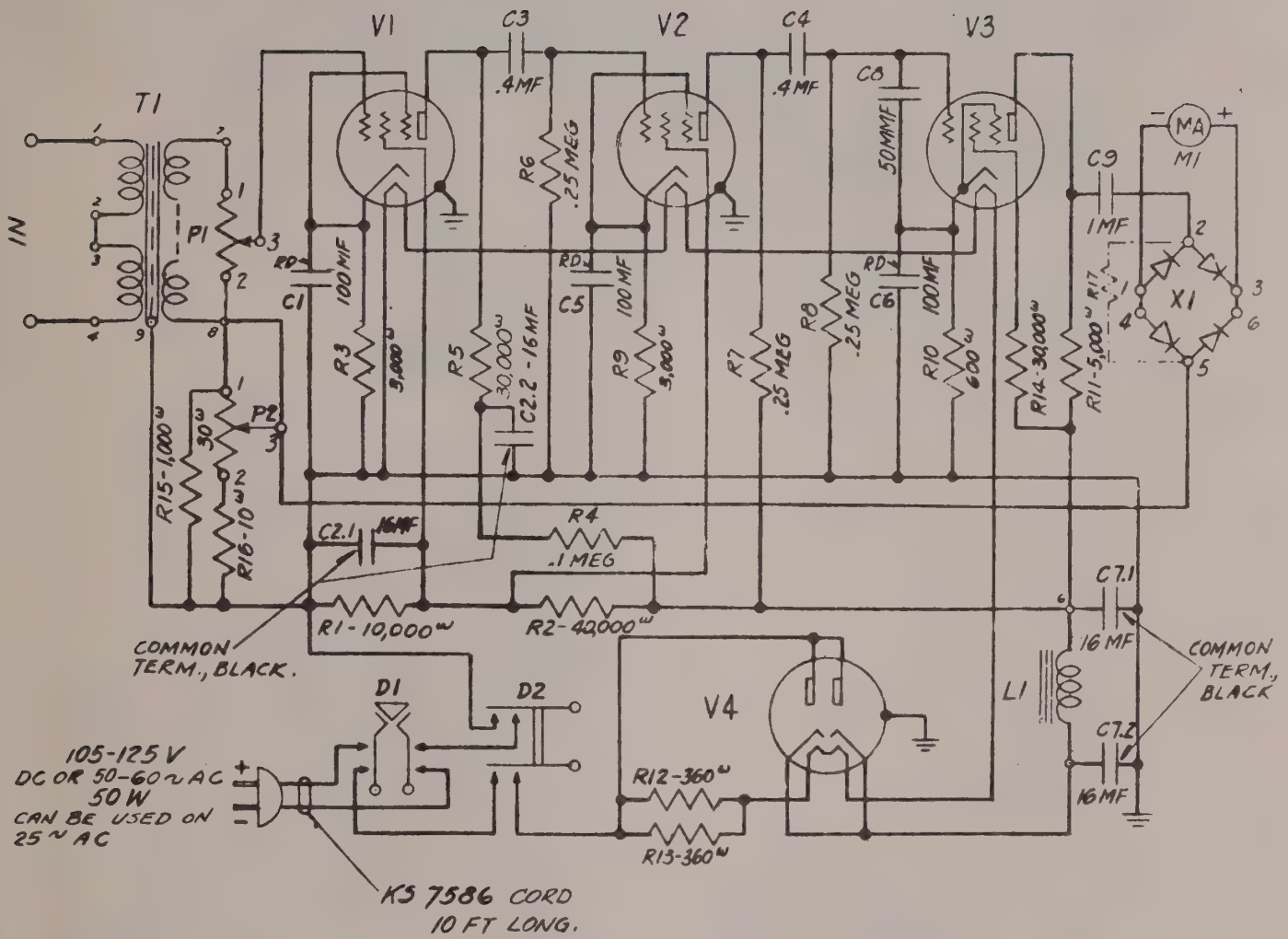


Figure 7 - Schematic and Circuit Label

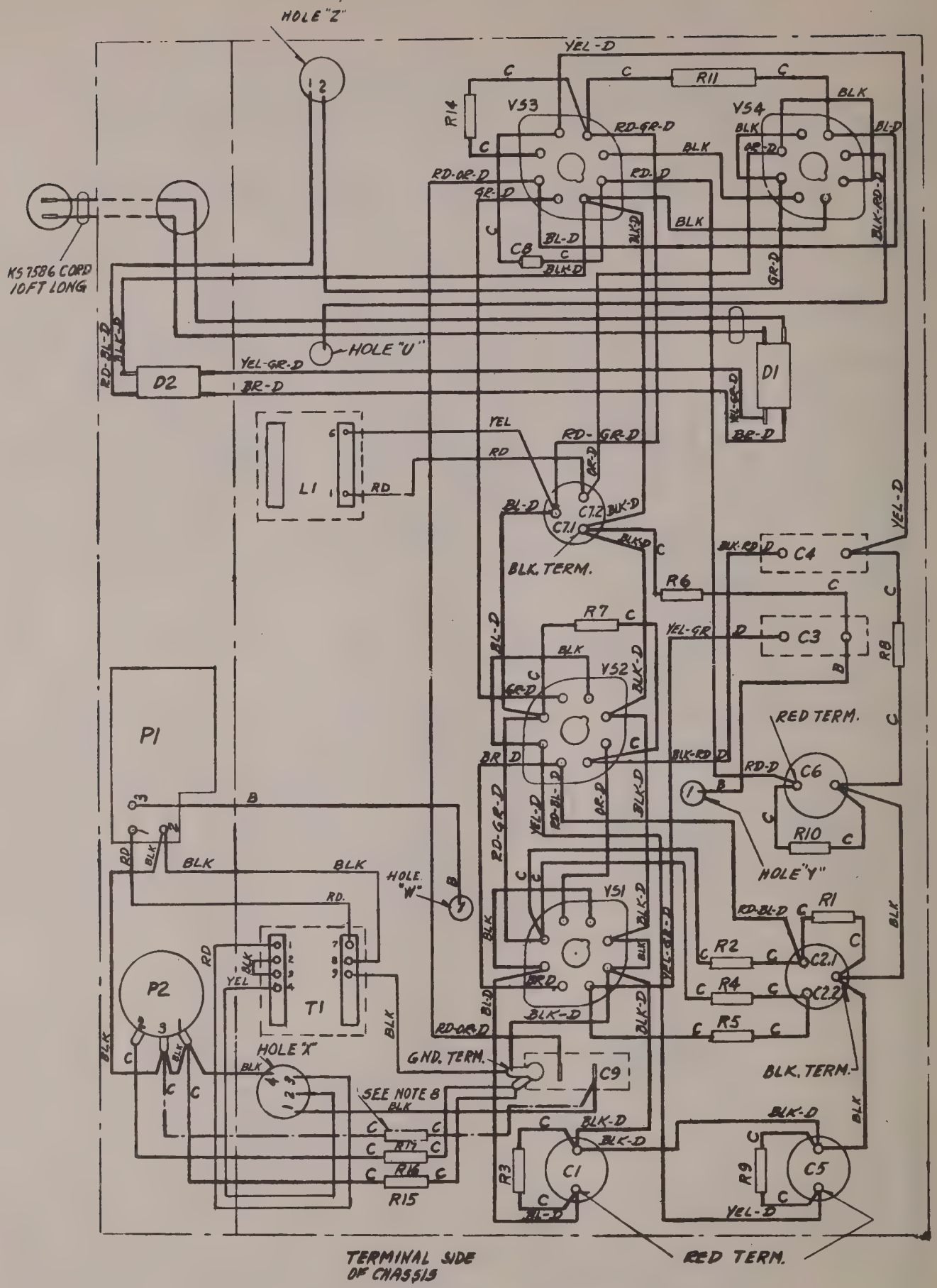
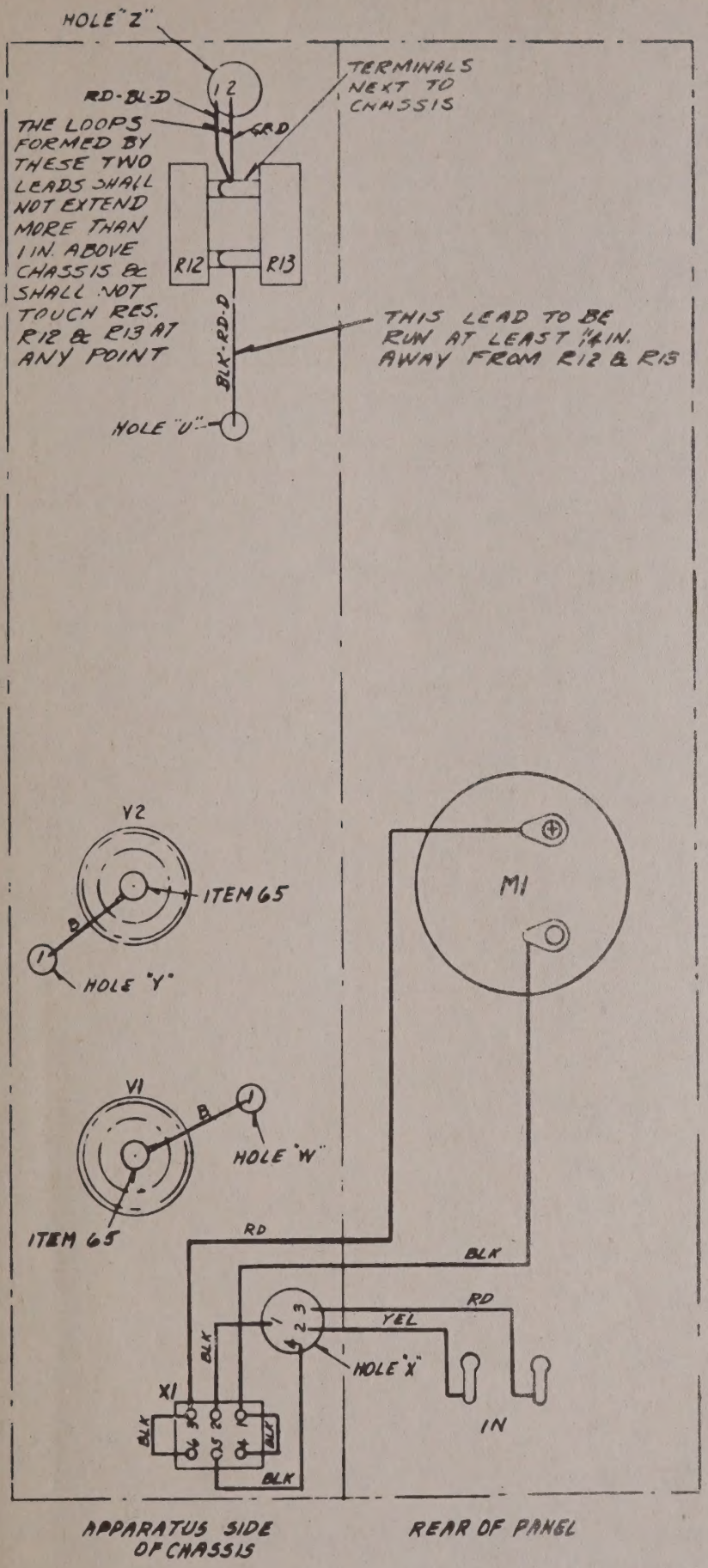


Figure 8 - Wiring Diagram



NOTES

1. ALL WIRES ARE AM WIRE 20 U SINGLE, ITEM 74, UNLESS OTHERWISE SPECIFIED. COLORS AS INDICATED.
2. WIRES MARKED "B" ARE #22 GA C KNITTED RCB PER D-161077 BLK., ITEM 72. THESE WIRES SHALL BE AS SHORT AND DIRECT AS POSSIBLE.
3. WIRES MARKED "C" ARE LEADS OF THE APPARATUS, INSULATED WITH VARNISHED TUBING, ITEM 70.
4. WIRES SHALL BE RUN IN SUCH A MANNER THAT MOUNTING NUTS FOR CONDENSERS C1, C2, C5, C6, AND C7 ARE ACCESSIBLE.
5. ALL SOLDERING SHALL BE DONE PER KS 512, METHOD "C".
6. WIRES ENDING AT A HOLE THUS —(1)— HOLE "X" ARE CONTINUED ON THE OTHER VIEW AT THE CORRESPONDING HOLE AND WIRE.
7. WIRES MARKED "D" ARE AM WIRE 20 GA AND ARE RUN IN CABLE.
8. THE RESISTANCE VALUE OF R17 (IF THIS RESISTANCE IS REQUIRED) IS DETERMINED AT TIME OF TESTING.

Figure 8 - Wiring Diagram

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