

MODEL TTS-4A TRANSMISSION TEST SET
(Northeast Electronics Corporation)

1. GENERAL

- 1.01** This section provides information on the operation and maintenance of the Model TTS-4A- Transmission Test Set.
- 1.02** The section consists of an instruction manual for this test set prepared by the Northeast Electronics Company, Concord, New Hampshire.
- 1.03** Accuracy checks and repair service for the TTS-4A are available at Western Electric Distributing House locations under the "Red Ball" program.

Attached:

**Instruction Manual for
TTS-4A Transmission Test Set**



OPERATING INSTRUCTIONS

MODEL TTS 4A

TRANSMISSION TEST SET

NORTHEAST ELECTRONICS CORPORATION

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NORTHEAST ELECTRONICS CORPORATION
MODEL TTS 4A TRANSMISSION TEST SET

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NORTHEAST ELECTRONICS CORPORATION
Concord, New Hampshire

TRANSMISSION TESTING
MODEL TTS 4A TRANSMISSION TEST SET

1. GENERAL DESCRIPTION

1.1 The Model TTS 4A Transmission Test Set was designed to permit transmission measurements over a wide variety of telephone circuits. The set contains low resistance holding coils and can therefore be used on circuits which carry DC, such as local exchange or PBX circuits, as well as on toll and program circuits. In addition to the self-powered, transistorized, transmission measuring circuits and their associated switching provisions, the set contains a talking circuit, hookswitch control, a neon bulb indicating incoming ringing in the "on hook" condition, and a talk battery. A connector is provided for connecting external frequency determining networks available in accessory covers, which include frequencies used for testing program lines or FAA voice frequency remote control circuits. The meter scale includes red and green arcs for VU measurements. Jacks are provided to accept a 52A or equivalent headset and a dial. With accessories the set duplicates the functions of a subscriber dial set. The block diagram and overall wiring diagram of the set are shown in Figs. 1 and 2. The set is contained in a grey finished aluminum case 8" wide by 11" long by 7" deep, with a detachable hinged cover. It weighs 17 1/2 pounds. All batteries required for operation are contained within the case.

1.2 The test set operates in the audio frequency range and covers levels down to -50 dbm. A 4 1/2" mirror scale meter with a knife edge pointer and a scale graduated in 0.2 db steps over the range of +3 to -3 db is centrally located on the panel. Additional 1 db scale markings are provided on the scale from -3 to -10 db, at -20 db, and at meter zero. All connections to the test set are made through standard telephone type jacks arranged along the lower edge of the front panel. The sleeve circuits of the jacks are arranged for external connection to suit cord circuit applications.

1.3 A set which will give +10 dbm output can be supplied on special order. This is designated as Model TTS 4AH. If higher output levels are desired, the Model TTS 4A may be used in conjunction with the Northeast Electronics Corporation's Model TA-3 transistorized program amplifier, which will give outputs up to +24 dbm.

A. Oscillator

1.4 The oscillator portion provides for sending individual tone frequencies of 300, 500, 1000, 1500, 2000, 2500, 3000 and 3500 cycles, selected by operation of the SEND FREQ switch. An additional position, marked EXT on the SEND FREQ switch, transfers the frequency determining circuits in the oscillator to a front panel plug marked EXT FREQ. Adapter units contained in special removable covers may be connected to this plug to provide additional frequencies for testing of program circuits, FAA voice control circuits, etc. Output levels

of 0, -5, -10, -16, -20, -30, and -40 dbm, selected by operation of the SEND LEVEL switch, are sent at either 600 or 900 ohms impedance, selected by operation of the SEND IMP switch. In the third position of this switch (marked 600P) the hold coil is removed from the 600 ohm output circuit and an additional condenser is added in the transformer center tap, thus extending the frequency range downward to 35 cps for use on program circuit measurements.

1.5 The maximum level variation, when switching the self-contained SEND frequencies, is less than 0.1 db, thus permitting a change of frequency without necessitating recalibration of the output level for each new frequency. The output of the oscillator is available at jacks designated LINE and SEND.

1.6 The CAL SEND potentiometer is provided to calibrate the sending portion of the set.

B. Amplifier and Level Meter

1.7 The receiving portion of the test set covers a range of levels from -50 dbm to +18 dbm. A step attenuator, REC LEVEL, with steps of -40, -35, -30, -25, -20, -15, -10, -5, 0, +7, and +15 db is used in conjunction with a meter scale graduated every 0.2 db between +3 and -3 db to obtain a range of -43 to +18 dbm in 0.2 db steps. By using the meter calibration points from -3 to -10 db useful measurements may be made by interpolating between -43 and -50 dbm. Access to the receiving portion is accomplished by connection to jacks designated LINE, REC, and REC DIR. Input impedances of 600, 900, or 6000 ohms are available by operation of the REC IMP key. The REC DIR jack has 600 ohm impedance only and should not be used on circuits carrying DC voltages.

1.8 The CAL REC adjustment is provided to calibrate the receiving amplifier.

C. Talk, Monitor, Calibration Circuits

1.9 The test set contains an induction coil and internal talk batteries. TEL SET jacks are provided for insertion of a 52A or equivalent headset, thus permitting test personnel to send, receive, or talk on any line connected to the LINE jack, by moving the LINE key to the desired position. A key designated LINE/MONITOR provides a means to open the DC line circuit, thus creating the "on hook" condition for the talk circuit. In this position a neon bulb, in series with a condenser, is connected across the line to indicate incoming ringing signals. The LINE/MONITOR key has a third position which provides a transfer of the telephone set receiver to amplifier output circuit to monitor the connection being measured. Operation of this key will not affect the meter indication. Two series connected LINE jacks are provided. The line under test is connected to one of these; a dial may be plugged into the second, unused jack.

1.10 The FUNCTION switch provides two positions for calibrating the oscillator and the level measuring section, and a third position for making transmission tests.

1.11 The POWER key turns the set off and on. A bracket located in the cover will operate the key to OFF before the cover is fully closed. The cover also provides space for storing cords. The cover can be removed and another cover, for instance one providing additional frequencies, can be substituted.

D. Jack Strips and Pin Jacks

1.12 A number of jacks are located at the bottom of the front panel; all but two pin jacks marked SL are contained in a jack strip.

SL A pin jack to the left of the jack strip provides a connection to the sleeves of both SEND jacks.

SEND Two cut-off type jacks in tandem, one accepting a 309 and the other a 310 plug, provide direct access to the LINE side of the balanced, DC blocked, output transformer. A holding coil with 125 ohms resistance is connected across the SEND jacks for the 600 and 900 ohm positions of the SEND IMP key switch. In the 600P position on this key switch the hold coil is removed to provide extended low frequency response for measurements on program lines.

TEL SET A twin jack to accept the plug of a 52A or equivalent headset connects to the talk circuits in the set.

CALL A recessed neon bulb serves as an incoming ringing indicator when the LINE/MONITOR key is in the LINE OPEN position.

LINE Two jacks in series, one accepting a 309 and the other a 310 plug, provide the following: A 125 ohm DC resistance holding coil is connected across this circuit when the LINE/MONITOR key is in the HOLD or MONITOR position. In the SEND or REC position impedances of 600 or 900 ohms are selected by operation of the SEND IMP and REC IMP keys; in the REC position an additional 6000 ohm input impedance is available. A telephone dial may be connected to the unused LINE jack to permit dialing test calls through the test set.

REC A jack to accept a 310 plug provides direct access to the LINE side of the balanced, DC blocked input transformer of the RECEIVE amplifier. The impedance at this jack is 600, 900, or 6000 ohms as selected by the REC IMP key switch.

REC DIR A jack to accept a 310 plug provides direct access to the amplifier input attenuator. Using this jack the input transformer is bypassed to take advantage of the full frequency response of the RECEIVE amplifier. To avoid the need for recalibration, a pad equivalent to the transformer insertion loss is automatically inserted in the REC amplifier when this jack is used. DC voltages must NOT be applied to this jack.

SL A pin jack to the right of the jack strip provides a connection to the sleeves of the LINE, REC, and REC DIR jacks.

2. TRANSMISSION MEASURING PERFORMANCE

A. Oscillator

2.1 After a warm-up period of 2 minutes the output level of the oscillator will hold ± 1 db over the temperature range of 60° to 80° F when changing to any of the self-contained SEND frequencies. If the test set is transported to an area in which the temperature varies from the above range, it should be recalibrated by means of the CAL SEND and CAL REC control. In temperatures approaching freezing, the efficiency of the batteries drops rapidly, and frequent recalibration is recommended to retain accuracy. Table 1 gives a summary of the oscillator performance.

TABLE I OSCILLATOR PERFORMANCE

Frequency: Controlled by multi-position switch: 300, 500, 1000, 1500, 2000, 2500, 3000, 3500 cps. Two extra frequencies can be supplied on special order.

External Frequency Control: A connector is provided on the panel for connecting external frequency determining networks.

Frequency Accuracy: Better than 1% from 50° to 100° F. Better than 2% from 30° to 120° F (factory adjustment 1/2% for 1000 cps).

Distortion: Less than 1% at any harmonic component.

Output Levels: Initial 0 dbm calibration by CAL SEND control with FUNCTION switch in SEND position and attenuators in CAL position. Fixed send levels are: 0, -5, -10, -16, -20, and -40 dbm. Additional level adjustment between +3.0 and -3.0 db available through the calibration control.

Attenuator Accuracy: Better than 0.10 db, wirewound resistors.

Level Variation with Frequency: Less than 0.10 db.

Output Impedance: 600 ohms, $\pm 5\%$, $\pm 5^{\circ}$ from 300-3500 cps. 900 ohms, $\pm 5\%$, $\pm 5^{\circ}$ from 300-3500 cps. Impedance selected by switch. Balanced output transformer with DC blocking. 600P switch position: 600 ohms, $\pm 5\%$, $\pm 5^{\circ}$ from 35-8000 cps, $\pm 5\%$, $\pm 5^{\circ}$ from 8000-15,000 cps.

Holding Coil: 125 ohms (274J or equivalent) on 600 and 900 ohm position; no hold coil on 600P position.

Output Connections: On either 309 or 310 LINE jack when talk switch is in SEND position. On either 309 or 310 SEND jack irrespective of LINE switch position.

B. Amplifier and Level Meter

2.2 The amplifier level meter combination will read signals to -43 dbm in 0.2 db divisions. Markings in 1 db steps from -6 to -10 dbm and a mark at -20 dbm make it possible to measure lower signal levels at reduced accuracy. The dynamic characteristics of the meter are identical to those of a VU meter, therefore the Model TTS 4A can be used for VU measurements. In addition, a red arc covering levels below -6 db and a green arc covering levels above 0 db are provided for this application. With a 52A headset plugged into the jacks marked TEL SET, operation of the LINE/MONITOR key to the MON position makes it possible to monitor the amplifier output without upsetting the meter reading. Table II gives a summary of the amplifier and level meter performance.

TABLE II AMPLIFIER AND LEVEL METER PERFORMANCE

AMPLIFIER

Input Circuits:

- (1) On either 309 or 310 LINE jack when TALK switch is in REC position. In this circuit a 125 ohm holding coil (274J or equivalent) is provided.
- (2) On the 310 REC jack; no hold coil is provided in this connection. A DC blocked, balanced transformer is provided in (1) and (2).
- (3) On the 310 REC DIR jack, direct access to "floating" amplifier through the amplifier input attenuator and a fixed pad matching the input transformer insertion loss. Note that this input must NOT be used in circuits carrying DC voltages.

Level Accuracy: Built-in calibration feature eliminates errors from amplifier gain variations.

Frequency response: Variations from 1000 cps at 70°F.

(1) Through balanced transformer:

- a) LINE jack
With hold coil, 600 or 900 ohms
Variation: $\begin{matrix} \text{V} \\ \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.1 db from 300 to 8000 cps
 $\begin{matrix} \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.2 db from 50 to 10,000 cps
- b) REC jack
Without hold coil, 600 or 900 ohms
Variation: $\begin{matrix} \text{V} \\ \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.1 db from 100 to 8000 cps
 $\begin{matrix} \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.2 db from 35 to 15,000 cps
- c) REC jack
Bridging, 600 ohms
Variation: $\begin{matrix} \text{V} \\ \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.1 db from 150 to 5,000 cps
 $\begin{matrix} \text{||} \\ \text{||} \\ \text{||} \end{matrix}$ 0.2 db from 75, to 10,000 cps

Note: There is a 20 db reduction in sensitivity in the bridging position.

- (2) Direct input through REC DIR jack, 600 ohms.
Variation: \approx 0.2 db from 20 to 20,000 cps. Amplifier frequency response is virtually independent of temperature.

Input Impedance: Selected by switch, impedance 600, 900, 6000 ohms. Impedance is 600 or 900 ohms, $\pm 5\%$, $\pm 5^\circ$ over frequency range specified under frequency response, except for the LINE input, where the hold coil causes a 7° phase angle at 300 cps.

Receive Levels: +15, +7, 0, -5, -10, -15, -20, -25, -30, -35, and -40 for 0 dbm reading on meter scale. Levels to -60 dbm may be read. For 6000 ohm input impedance the sensitivity is reduced by 20 db. An accessory amplifier can be supplied to eliminate this loss.

Attenuator Accuracy: Better than 0.10 db, wirewound resistors.

METER

Range: -20 to +3 dbm.

Scale: Mirror scale, marked in 0.20 db steps from -3.0 to +3.0 dbm; 1 db steps from -3.0 to -10 dbm; additional mark at -20. Marks above 0 dbm are colored red. For VU measurements an extra arc colored green between 0 and +3 db, and an extra arc colored red from -6 dbm to the meter zero are provided. These arcs can be deleted on special order.

Accuracy: Better than ± 0.15 db from -3.0 to +3.0 db from 60° to 90°F .
Better than ± 0.25 db from -3.0 to +3.0 db from 30° to 120°F .
Representative production sets show accuracies of ± 0.05 db or better over the range of -3.0 to +3.0 db.

Variation With Frequency: None up to 20 KC (error is -0.15 db at 50 KC).

Dynamic Characteristics: Identical to VU meter.

C. Batteries

2.3 The oscillator uses two 9 volt (Burgess P6M or equivalent) batteries connected in series for 18 volts. The buffer amplifier uses one 9 volt (Burgess P6M or equivalent) battery. The talk circuit uses three 1.5 volt D cells (Eveready 950 or equivalent). The amplifier circuit uses two 9 volt (Burgess P6M or equivalent) batteries in parallel. Battery life (excluding the talk circuit) should readily exceed 75 hours. Note that battery output voltage drops materially at temperatures below approximately 45°F . As a result, although the circuits operate properly at temperatures down to 30°F and below, the overall set performance will be affected in prolonged use at low temperatures; for this type of service special batteries are required.

3. CIRCUIT DESCRIPTIONS

A. Amplifier (Fig. 3)

3.1 The amplifier uses two stages of common emitter amplification followed by an emitter follower. An overall negative feedback circuit, providing approximately 15 db of negative feedback, and consisting of resistors R9 (fixed, 3.3 K) and R31 (variable, 500 ohm), is inserted between the first and last emitter. Resistor R31 is used to center the range of the CAL REC variable attenuator consisting of variable resistors R30 (dual potentiometer) and fixed resistors R36 and R34. This is a factory adjustment and does not require readjustment. R36 is a fixed resistor which equals the input impedance of the amplifier in parallel with the fixed resistor R34. The value of R8 determines the output impedance of the amplifier. This in turn controls the accuracy with which the meter indications follow input level variations above and below the 0 dbm indication. To suit the impedance characteristics of different groups of meters, slightly different values of R8 may be used during the process of factory adjustment. A thermistor from the base of Q2 to ground provides the correct bias for this stage over a wide temperature range. The input impedance to the amplifier can be adjusted to exactly 600 ohms for optimum accuracy. The output level can be varied over at least a ± 1.0 db range by the adjustment of the CAL REC control R30.

B. Oscillator and Buffer Amplifier (Fig. 4)

3.2 The bridged-T oscillator uses three transistor stages. The first two are direct coupled from the collector of Q1 to the base of Q2. The positive feedback path is completed from the emitter of Q2 back through a tungsten bulb used for level stabilization to the emitter of Q1. The emitter resistor of Q1 is variable for setting the correct amount of positive feedback necessary for stable operation. A negative feedback which is greater than the positive feedback is supplied to the base of Q1 through a null selective network and an emitter follower. The selective bridged-T null network decreases the negative feedback sufficiently to permit oscillation to occur at the desired frequency, which is determined by the values in the bridged-T circuit. This frequency determining network consists of two padded capacitances, C19, C23, and C20, C22, and two resistors selected by the frequency selector switch S9.

3.3 The buffer amplifier is a single transistor in a common emitter circuit. The oscillator voltage obtained at the emitter of Q4 is connected from the base of Q3 to R20, a 1 K resistor, to ground. This arrangement permits a fine adjustment over a range of about 6 db at the output. The collector load is coupled through a large value of capacitance to the output circuit, which consists of the wirewound step attenuator and the output transformer.

4. CALIBRATION (Figs. 1 and 2)

4.1 The calibration procedure is simple and can be performed by following instructions printed on the front panel. Both attenuators

should be placed in the 0 db position; this position is marked (CAL).

4.11 With the FUNCTION switch in the CAL SEND position the meter is connected directly to the 600 ohm tap on the balanced transformer in the oscillator section, irrespective of the position of the SEND IMP switch; the hold coil is eliminated in this circuit. The CAL SEND control in the oscillator is adjusted until the meter reads 0 dbm. The oscillator section will now deliver an accurate 0 dbm level into any 600 ohm load connected to the 600 ohm output taps.

4.12 With the FUNCTION switch in the CAL REC position the 0 dbm, 600 ohm oscillator output is connected directly to the 600 ohm taps of the input transformer of the amplifier level meter section. This 600 ohm connection again eliminates the hold coil and is independent of the position of the SEND IMP and the REC IMP switches. The CAL REC control is now adjusted until the meter reads 0 dbm. The gain of the amplifier is now normalized.

5. OPERATION

5.1 For procedures to be followed in the operation of the TTS 4A Transmission Test Set refer to pages 1 through 5 of the Appendix. Procedures for using the external accessories, which are included in detachable covers for the Model TTS 4A, are described on pages 6 and 7 of the Appendix.

6. MAINTENANCE

A. Field Maintenance

6.1 Battery Replacement (See page 12 for voltage check).

6.11 All of the 9 volt batteries should be replaced when either of the following is observed:

a) During CAL SEND the maximum level on the meter is below + .75 db.

b) During CAL REC the maximum level on the meter is + .30 db or less.

6.12 With a 52A headset plugged into the TEL SET jacks, power ON, LINE switch in TALK position, LINE/MONITOR switch on HOLD, blow lightly into the mouthpiece; if the sound is not heard distinctly in the earphones, replace the three D cells.

6.13 All batteries can be replaced by loosening the four captive screws and lifting the test set out of the case (Appendix, page 1).

6.2 Cleaning Jack and Switch Contacts

6.21 If the reading on the meter fluctuates continually at any time in operation, turn the FUNCTION switch first to the CAL SEND

and then to the CAL REC position. If the reading still fluctuates in these positions, check for weak batteries. If the batteries are normal, proceed as follows:

- a) Remove the test set from its case and set it carefully upside down.

6.3 Any other maintenance work should be done by qualified personnel only.

B. Shop Maintenance

The general location of the major parts in the TTS 4A are shown in Figs. 5, 6, and 7. Data on the wiring of the switches used in this set are given in Figs. 8, 9, and 10.

6.4 Oscillator

6.41 No output or fluctuating output at the SEND jacks

6.411 Check batteries if this has not already been done (see Section 6.1) and DC voltages shown in Table III on page 11.

6.412 Connect a milliammeter in series with one of the leads to the 18-volt supply in the oscillator section. Normal current for this section is 9 ma $\pm 20\%$. (If the current is outside these limits, turn the power off and locate the trouble.) Refer to Fig. 7 of this manual and connect the high side of a VTVM to point A and the low side of point C of the printed circuit board. The voltage should be 1.6 volts RMS at these points. If it is not, adjust R41 for this level. Turning R41 with a screwdriver counter clockwise increases the positive feedback and therefore increases the output level at points A and C. The fluctuation in the output level should cease when the output level at points A and C is 1.60 volts RMS.

6.413 If there is no level at points A and C (with R41 in maximum counter clockwise position), remove the tungsten bulb and check the filaments for continuity. Replace if faulty. If the bulb is good, reinstall, and replace transistors, starting with Q1 and ending with Q3, until the oscillator is operative. When installing a new bulb, age it first by operating it at 115 volts for one hour.

6.42 Distortion

6.421 Adjust R41 for 1.60 volts at A and C and measure the harmonic distortion at the SEND jack. Any harmonic of the fundamental frequency should not exceed 1% (down 40 db) of the fundamental level. If the distortion exceeds this requirement, trace and replace the transistor causing this condition.

6.43 Frequency Accuracy

6.431 Frequencies should be within $\pm 1\%$ of their indicated values. Measure all frequencies and note whether they are either all high or low. If they are all high, increase the capacitance equally at C19-23 and C20-22. If all frequencies are low, decrease in equal amounts the capacitance of C19-23 and C20-22. Normally, only small amounts of capacitance changes are involved (30 to 100 mmf) if frequencies are found to be in error. Note: It is important that equal amounts of capacitance be added or removed at C19-23 and C20-22. If only one or two frequencies are found to be in error, the resistor or resistors involved should be replaced. After correcting any frequency problem, be sure to check the level stability. The level should not change more than ± 0.10 db with changes in frequency.

6.5 Buffer Amplifier (See Circuit Diagram in Fig. 4)

6.51 Oscillator operative but no output at SEND jacks

6.511 Connect a 600 ohm load to the SEND jacks and set the SEND IMP switch at 600 ohms. Insert a milliammeter in series with a lead going to the buffer amplifier circuit. The current should be approximately 6 ma $\pm 30\%$. Connect the high side of a VTVM to point B and the low side of point C. The level should be approximately 1.4 volts RMS with the CAL SEND ADJ in its extreme clockwise position. Replace Q4 if it is not within 20% of 1.4 volts RMS. The harmonic distortion should be under 1% at any frequency. Measuring points are indicated in Fig. 7. Replacement of Q4 in the buffer amplifier requires checking of the output impedances at the SEND jacks. The SEND IMP switch should be in the 600 ohm position and the SEND LEVEL in the 0 (CAL) position. Disable the oscillator by disconnecting one of the leads to the 18 volt battery supply and turn the power ON. The output impedance can be varied with adjustment of R42. The output impedance should be 600 ohms $\pm 5\%$ with not more than 5° phase shift over the range indicated in Table I.

6.6 Amplifier and Level Meter

6.61 No meter indication when on CAL REC, or when a known level is applied to the REC jack

6.611 Check batteries if this has not been done (see Section 6.1), and DC voltages shown in Table III, page 11.

6.612 Connect a milliammeter in series with one of the leads to the 9 volt supply in the amplifier section. Normal current flow for this section is 9.5 ma $\pm 20\%$. (If the current is outside these limits, turn power off and locate trouble.) Refer to Fig. 7 of the Manual and connect the high side of a VTVM to the terminal (red lead) at the top left side of the printed circuit board. Connect the low side of the VTVM to the terminal next to it (black lead). Turn REC LEVEL to 0 (CAL). Apply a 0 dbm, 1 KC signal from a 600 ohm generator to the REC jack. The level at the VTVM should read -40 db. If it does not, refer to the overall schematic (Fig. 4) and locate the trouble by the following method. Disconnect the VTVM from the printed

circuit board and use it to test progressively from the REC jack to the printed circuit board, and locate the point where the signal is lost. Re-establishing the -40 db level to the printed circuit board should make the amplifier operative. If the VTVM at the amplifier input measures -40 dbm, trace through the amplifier to locate the defective transistor or component.

6.62 Input Impedance

6.621 The input impedance can be checked by the substitution method at the REC jack. Turn power ON and the REC LEVEL to -40 db. R32 can be adjusted if necessary to give exactly 600 ohms input. When it is desirable to measure impedance and phase angle over the frequency range of 100 cps to 8 KC, this can be done with the REC LEVEL at 0 (CAL) and the power off.

6.63 Meter Tracking With Level Changes

6.631 Connect a precision, 600 ohm, unbalanced attenuator (with steps of 1.0 db and an accuracy of $\leq .05$ db) between a 600 ohm oscillator (1 KC) and the REC jack of the test set. Complete the calibration of the test set per page 1 of the Appendix. Adjust the level of the 1 KC generator for exactly 0 db on the level meter in the test set. Now vary the precision attenuator in 1.0 db steps from a meter reading of 0 db to -3 db and then to +3 db. The meter should track, within $\pm .05$ db, db for db with the precision attenuator. If the meter does not track, replace transistor Q6. If this does not provide proper tracking, replace resistor R8 with any value in the 0 to 120 ohm range, which will produce proper tracking. If transistors have been replaced, the frequency response of the amplifier should be remeasured to be sure that the changing of the transistors has not adversely affected the frequency characteristics of the amplifier.

7. DC VOLTAGES IN TTS 4A

7.1 These voltages should be approximately as shown in Table III.

TABLE III CHART OF REPRESENTATIVE DC VOLTAGES

		<u>Emitter</u>	<u>Base</u>	<u>Collector</u>
OSC	Q1	1.12	1.10	11.0
	Q2	11.0	11.0	18.0
	Q3	9.60	7.60	18.0
	Q4	1.10	1.20	5.20
AMP	Q5	.08	.18	2.75
	Q6	.06	.15	4.60
	Q7	4.50	4.60	9.0

7.11 The voltages listed above were measured after the set was operating for five minutes at room temperature (70°F), and with new batteries operating at rated voltages.

7.2 Minimum Battery Operating Voltages

7.21 Batteries should be replaced if their voltage underload at room temperature (70°F) falls below the minimums specified below, or as stipulated under Section 6.1, page 8.

TABLE IV BATTERY VOLTAGES

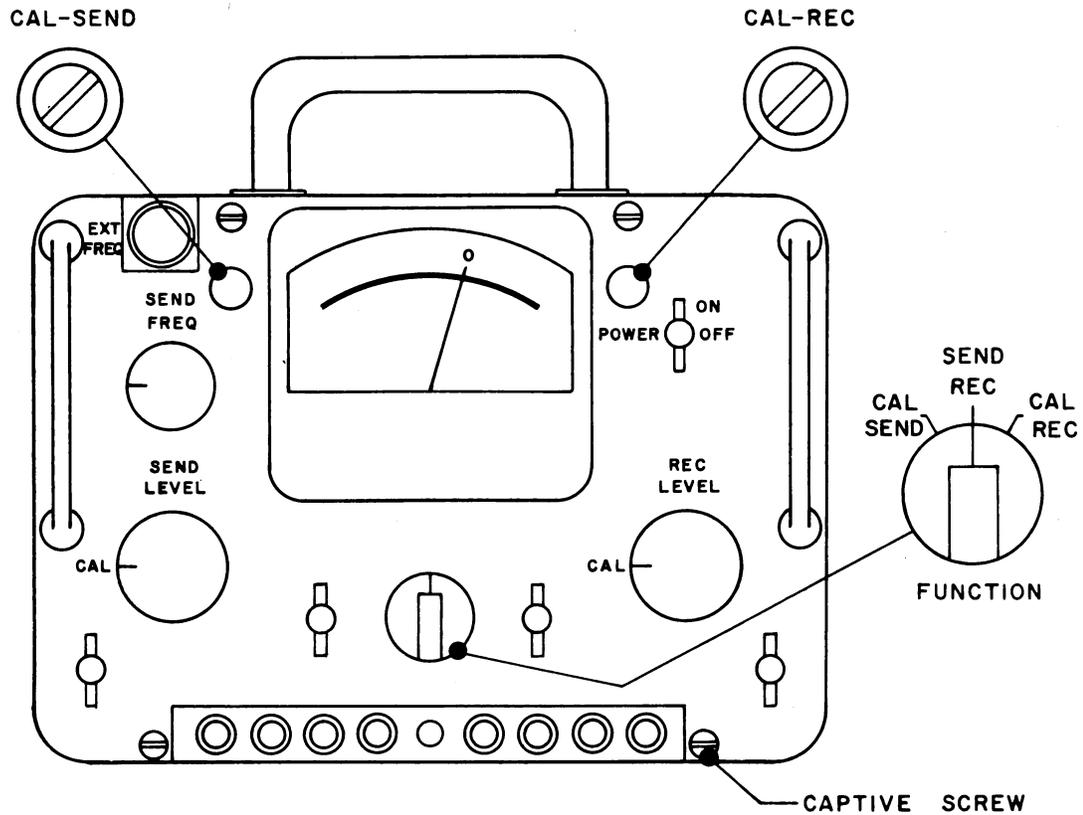
<u>Circuit</u>	<u>Minimum Operating Voltage</u>	<u>New</u>
Amplifiers	7.5 volts	9.0 volts
Oscillator	10.0 volts	18.0 volts
Buffer	5.5 volts	9.0 volts
Talk Circuit	3.0 volts	4.5 volts

7.22 If the battery voltages fall below the minimums specified above, the various circuits will not operate properly.

MODEL 4A TRANSMISSION TEST SET

OPERATION—GENERAL

(A) PREPARATION

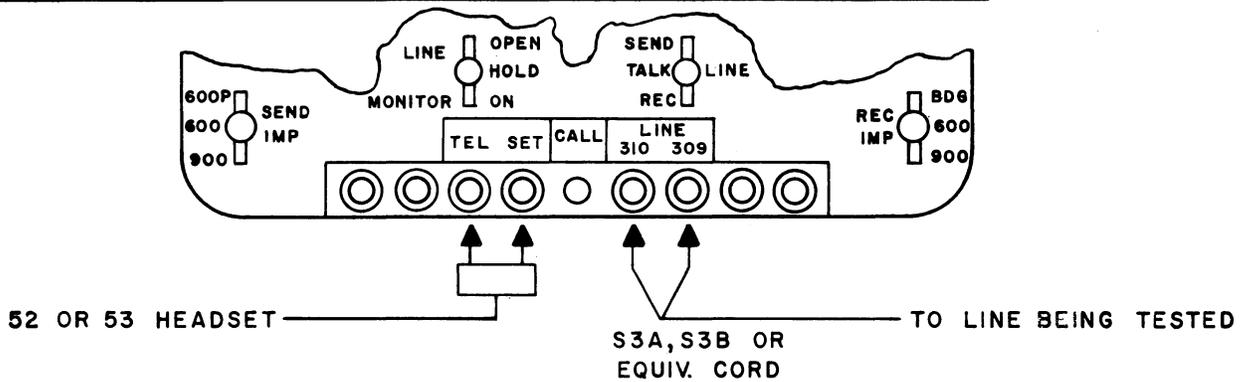


STEP

PROCEDURE

- 1 Open lid. (May be removed by moving cover to the left.)
- 2 Turn POWER switch ON.
- 3 Wait 90 seconds for warm up.
- 4 Set SEND LEVEL and REC LEVEL to 0 (CAL).
- 5 Set FUNCTION to CAL SEND.
- 6 Adjust CAL SEND for 0 dbm on meter.
- 7 Set FUNCTION to CAL REC.
- 8 Adjust CAL REC for 0 dbm on meter.
- 9 Set FUNCTION to SEND REC.

(B) GENERAL OPERATION USING LINE JACK



STEP

PROCEDURE

- 1 Complete all steps under (A) PREPARATION
- (a) TO TALK
- 2 Connect line to be tested to LINE 310 or LINE 309 jack depending on type of plug available.
 - 3 Connect 52 or 53 type telephone set to TEL SET jack.
 - 4 Operate LINE key to TALK. This connects the telephone set to line.
- (b) TO SEND TONE
- 2 Set SEND FREQ to desired frequency.
 - 3 Set SEND LEVEL to desired level.
 - 4 Set SEND IMP to desired sending impedance.
 - 5 Operate LINE key to SEND. This connects the output of the oscillator to the line.
 - 6 After a predetermined length of time, restore the LINE key to TALK.
- (c) TO MEASURE TONE
- 2 Set REC IMP to desired impedance.
 - 3 Request tone to be sent.
 - 4 When tone is heard in the telephone set, operate LINE key to REC.
 - 5 Turn REC LEVEL switch to obtain a convenient reading on the meter (between the -3 and +3 marks, if possible).

(CONTINUED)

(CONTINUED)

The level is the algebraic sum of the REC LEVEL switch and the meter reading.

Examples:

<u>REC LEVEL</u>	<u>METER READING</u>	<u>LEVEL</u>
+ 7	+ 2 (RED)	+ 9
+ 15	- 3 (BLACK)	+ 12
0	- 1.6 (BLACK)	- 1.6
- 10	+ 2.4 (RED)	- 7.6
- 15	- 0.6 (BLACK)	- 15.6

- 6 To monitor the tone being measured, turn MONITOR key to ON.
- 7 When tone is removed, operate MONITOR key to HOLD and LINE key to TALK.

(d) TO SEND TONE AT ANY LEVEL OTHER THAN 0 dbm

(This procedure applies for sending on either the LINE jack or the SEND jacks.)

- 1 Complete steps 1 thru 8 under (A) PREPARATION. (FUNCTION still on CAL REC)
- 2 Adjust SEND FREQ to desired frequency.
- 3 Adjust SEND LEVEL and REC LEVEL attenuators to the value nearest to the desired SEND level.
- 4 Adjust the CAL SEND for the desired level on the meter.

Examples:

- a. Send level of -12 dbm required.
SEND level and REC level are set for -10dbm.
Set CAL SEND to read -2.0dbm on meter.
 - b. Send level of -19 dbm required.
SEND level and REC level are set for -20 dbm.
Set CAL SEND to read + 1.0 dbm on meter.
- 5 Return REC level to 0 (CAL).
 - 6 Return FUNCTION to SEND REC.

(CONTINUED)

(CONTINUED)

7 Set SEND IMP to desired sending impedance.

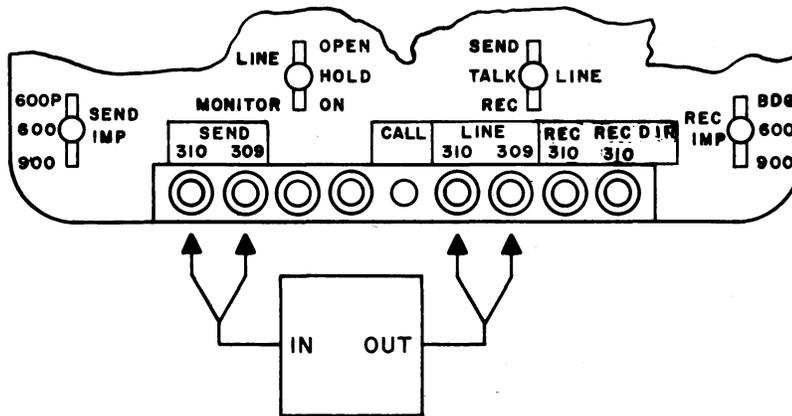
NOTE:

The calibration of the RECEIVE section of the test set has not been affected by the procedure described here and RECEIVE levels may be read in normal fashion.

(e) VU MEASUREMENTS

As the dynamic characteristics of the meter are identical to a VU meter the making of VU measurements follows the same steps described for the TONE-RECEIVE measurements.

(C) TO MAKE GAIN OR LOSS MEASUREMENTS



STEP

PROCEDURE

- 1 Complete all steps under (A) PREPARATION.
- 2 Set SEND FREQ, SEND LEVEL and SEND IMP switches as required.
- 3 Connect input of equipment to be measured to SEND 310 or SEND 309.
- 4 Connect output of equipment to be measured to LINE 310 or LINE 309.
- 5 Operate LINE key to REC.
- 6 Turn REC LEVEL switch to obtain convenient reading on meter.
- 7 Gain or loss is the difference between sending level and receiving level.

Example:

<u>SEND LEVEL</u>	<u>REC LEVEL</u>	<u>METER READING</u>	<u>GAIN (+) or LOSS (-)</u>
0	-5	-1.2	-6.2
0	+7	-.3	+6.7
-20	+15	-2.0	+33.0

INSTRUCTIONS FOR USE OF ACCESSORY COVERS FOR MODEL TTS 4A

Accessory covers are available for extending the scope of application of the Model TTS 4A Transmission Test Set. These covers are designed to replace the regular cover which is supplied with the basic unit; they can be purchased with the instrument or at a later date. Instructions for the use of the various covers are presented below.

Model TTS 4XB - Preamplifier Cover

This model provides impedance matching into the 600 ohm input to the TTS 4A for "bridging" measurements at full sensitivity. The input impedance exceeds 15,000 ohms.

The circuit to be measured is plugged into the input jack on the cover and the output jack is connected to the REC jack on the TTS 4A. The REC IMP switch is set at 600 ohms. Measurements may now be made as previously described; no loss is introduced in bridging measurements by using this cover.

Model TTS 4XD - Dial Adapter Cover

This model contains a dial, hookswitch, jacks for connecting to the Model TTS 4A, a jack and binding posts for external line connections, mounting holes and space for a ringer, and storage space for a headset, cords, and small tools.

The line to be used for talking and testing is connected to the binding posts or jack marked LINE. A connecting cord is then plugged into the jack marked TTS 4A, and into the jack on the TTS 4A marked LINE. A toggle switch on the panel serves as a hookswitch; it should be in the ON position when the unit is in use. A hookswitch is also included as part of the MONITOR/LINE switch on the TTS 4A.

Model TTS 4XMF - FAA Line Test Frequency Cover

This model contains a 27-position switch and the frequency determining networks for operating the oscillator in the TTS 4A at the frequencies required for testing FAA peripheral circuits. Frequencies from 300 cps to 2,900 cps inclusive are supplied in 100 cps increments. A storage compartment which contains the cable for connecting the cover switch to the TTS 4A is also provided.

The TTS 4XMF cover is used as follows:

1. Plug the connector at the end of the cable in the cover in the connector on the TTS 4A panel marked EXT FREQ.
2. Turn the SEND FREQ switch to EXT.

3. Set the cover switch to 1 KC and adjust the CAL SEND control to obtain 0 dbm on the meter in accordance with the calibration instructions previously described.
4. The unit is now ready for use.
5. If a frequency of 3000 cps is required for the FAA line tests, the SEND FREQ switch on the TTS 4A should be turned to 3000 and the calibration rechecked.

Model TTS 4XMP - Program Line Test Frequency Cover

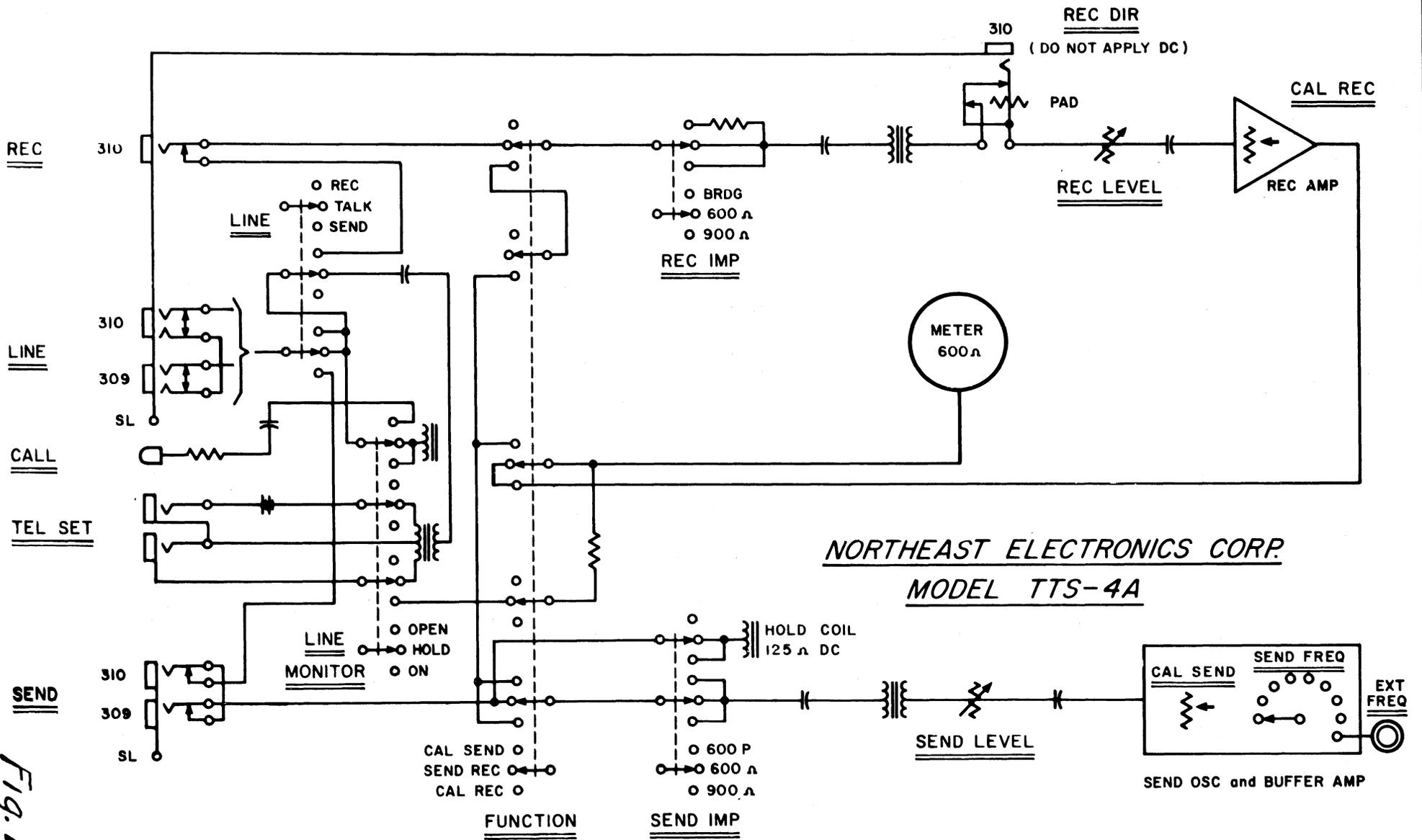
This model contains a 27-position switch and the frequency determining networks for operating the oscillator in the TTS 4A at the various frequencies required for testing program lines. Frequencies from 35 cps to 15,000 cps are supplied. A storage compartment which contains the cable for connecting the cover switch to the TTS 4A is also provided.

Instructions 1 to 4 provided for the use of the Model TTS 4XMF cover are to be used here also. In addition, it is necessary to switch the SEND IMP switch to 600P. This disconnects the hold coil and increases the size of the DC blocking capacitor.

Model TTS 4XDMF and Model TTS 4XDMP Covers

These are combination covers which include the features of the TTX 4XD and the multi-frequency covers Models TTS 4XMF and TTS 4XMP. The cable for the frequency switch is stored under the hinged cover on which the dial assembly is mounted.

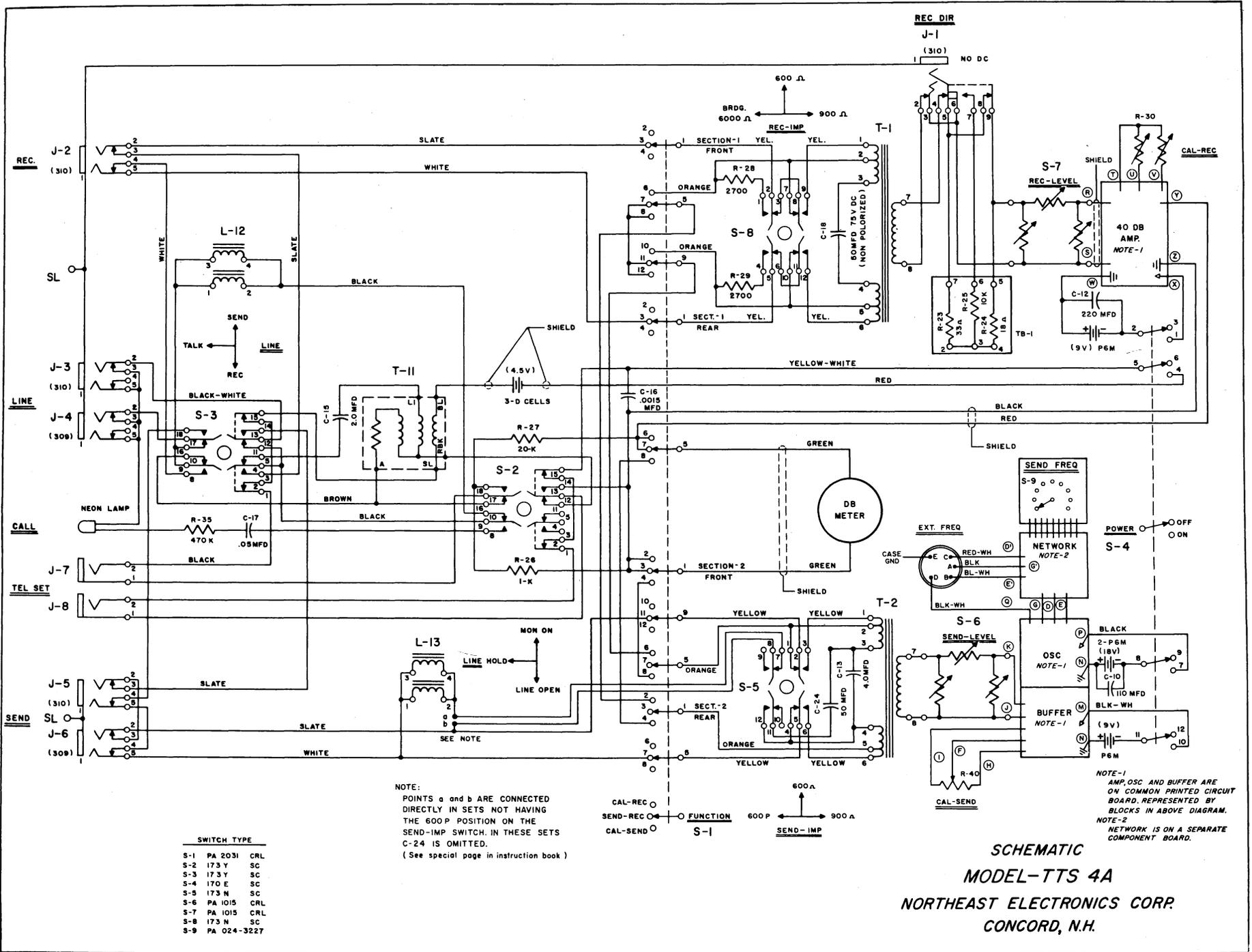
The instructions for using the dial and multi-frequency covers described above are applicable to the combination covers.

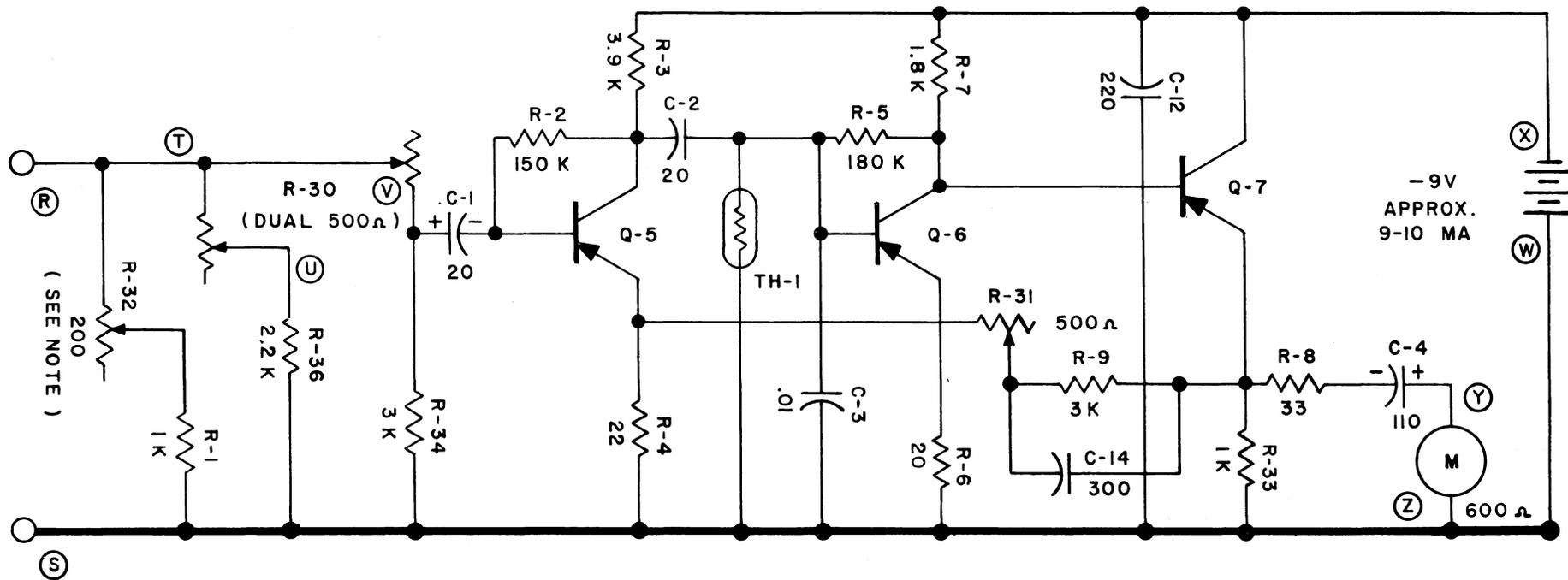


NORTHEAST ELECTRONICS CORP.
MODEL TTS-4A

Fig. 1

Fig. 2



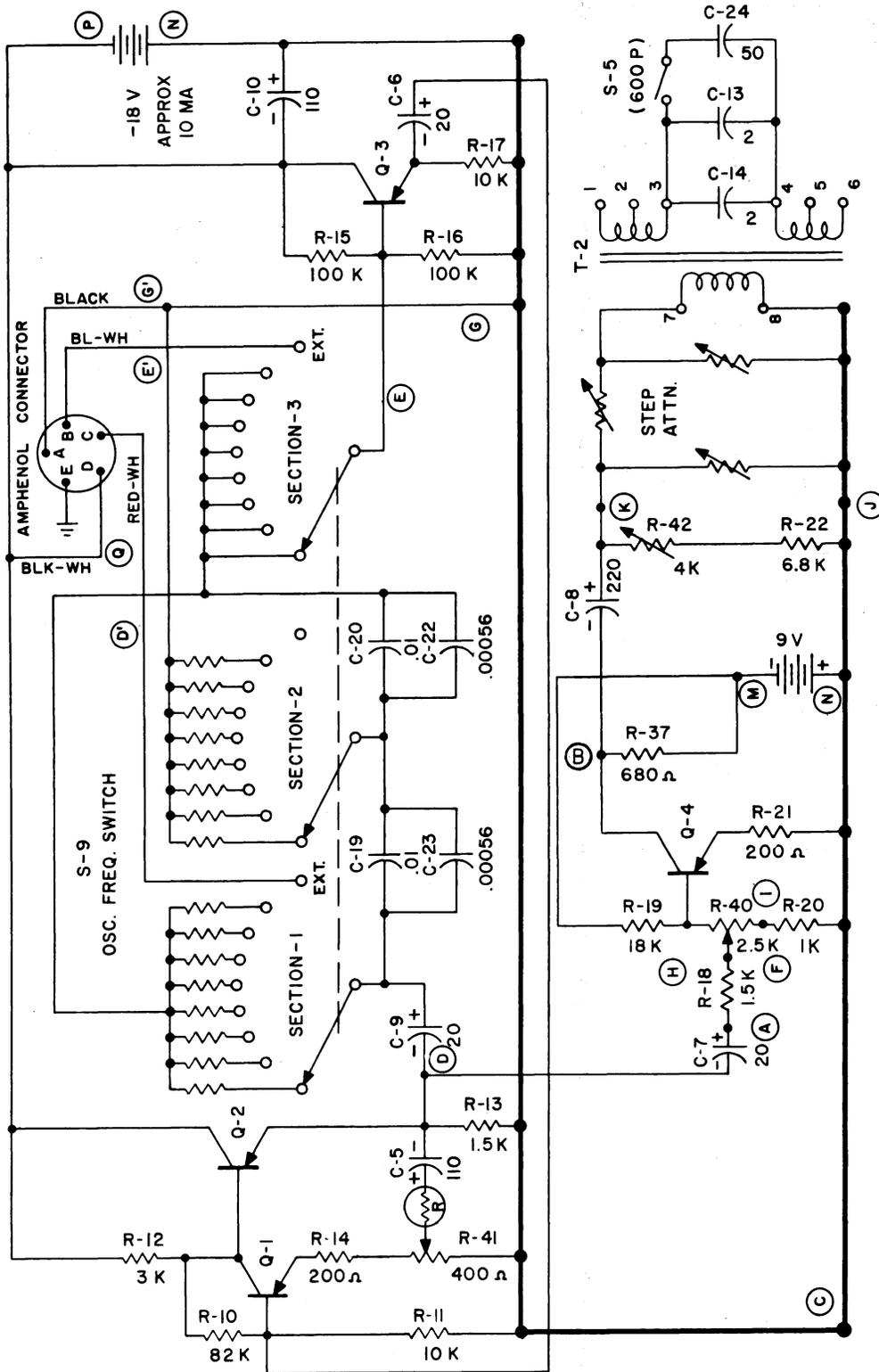


NOTE:
 ADJUST R-32 FOR A 600Ω INPUT
 BY THE SUBSTITUTION METHOD,
 WITH POWER ON AND REC-LEVEL
 ON 40 DB.

ALL TRANSISTORS 2N 525

SCHMATIC - AMPLIFIER
MODEL TTS-4A
NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.

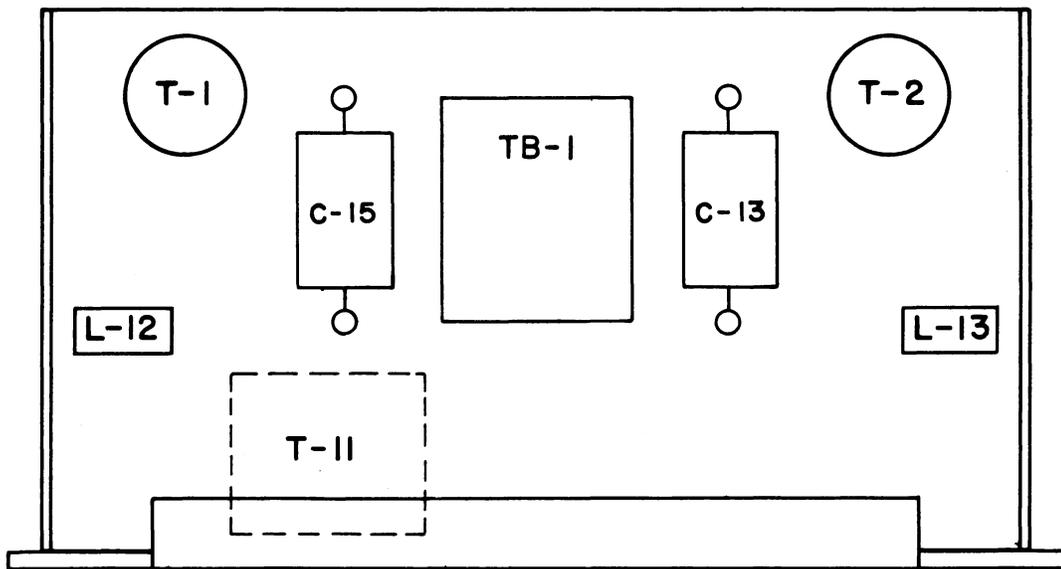
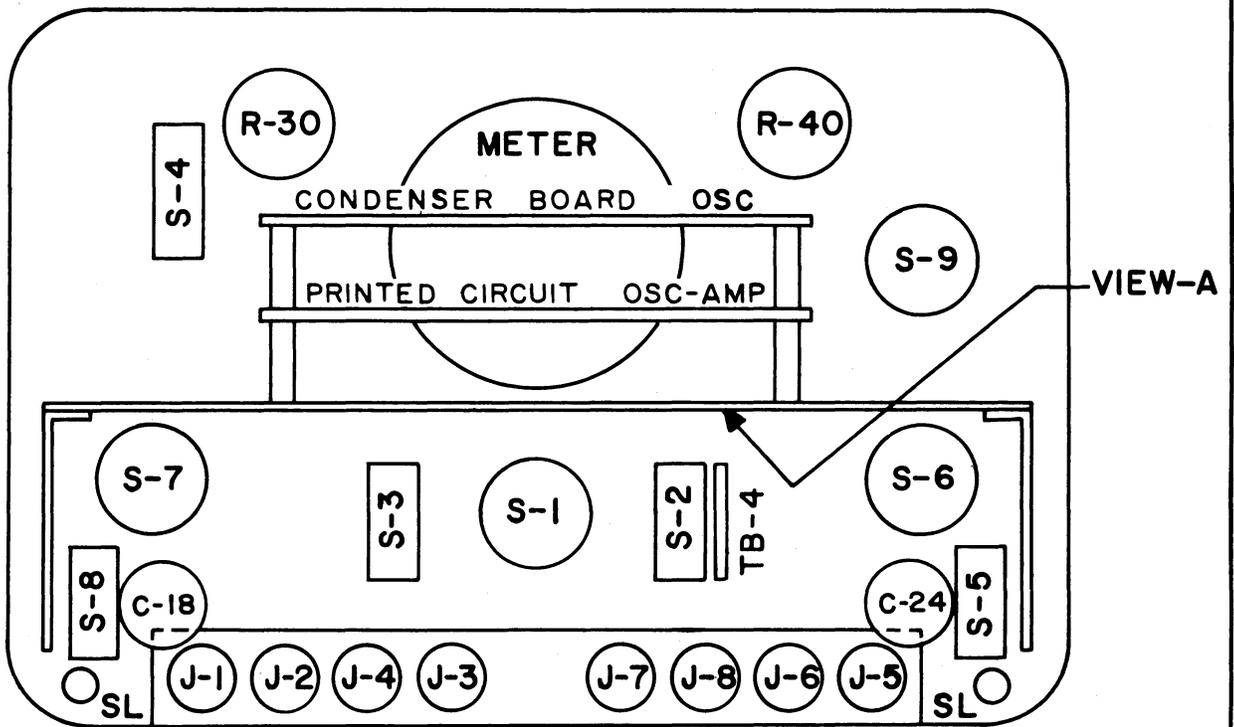
Fig. 3



ALL TRANSISTORS 2N 525

SCHEMATIC - BRIDGED-T OSC.
MODEL TTS-4A
NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.

Fig. 4



VIEW - A

NOTE: ALL VIEWS FROM WIRING SIDE.

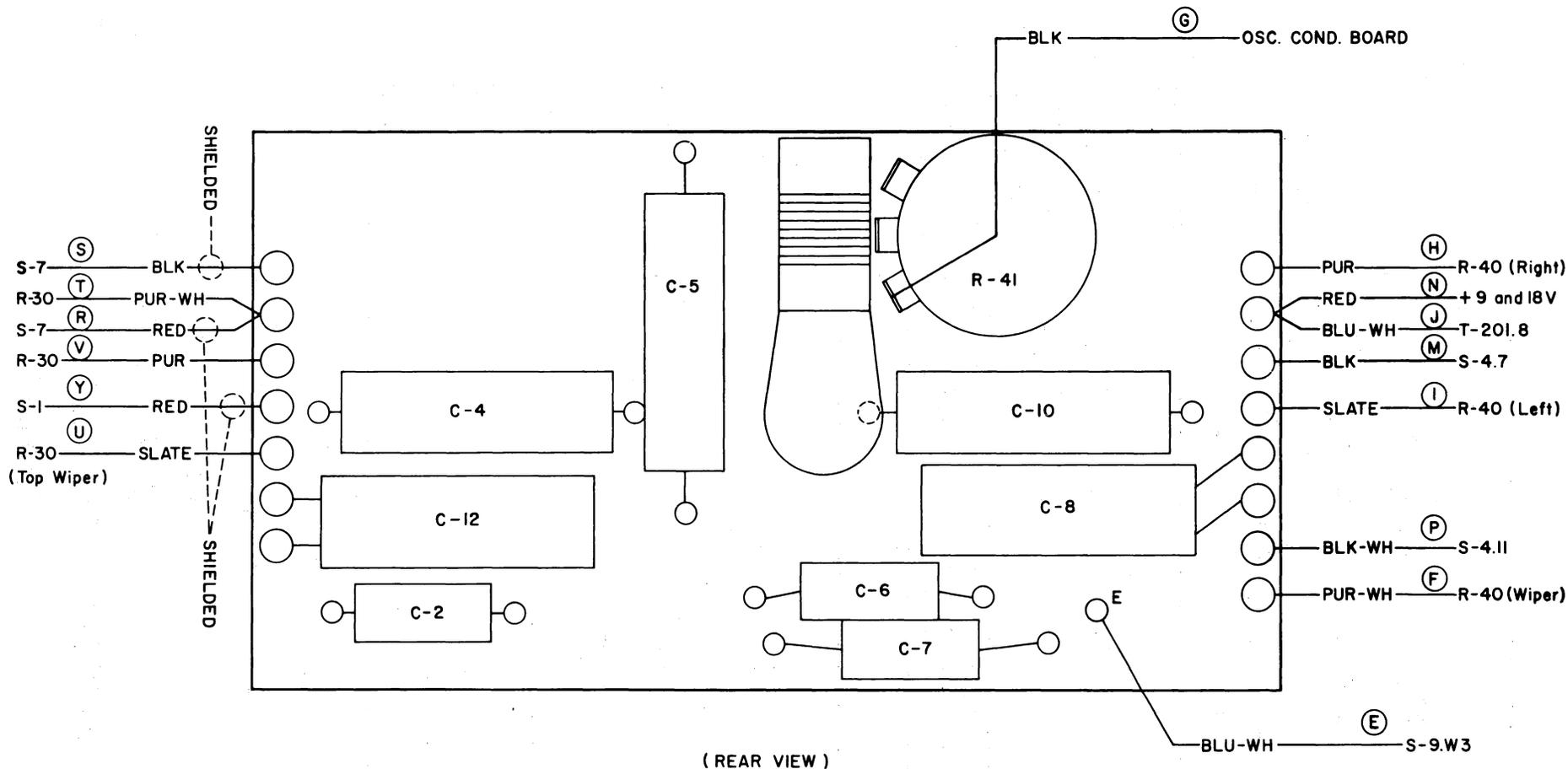
GENERAL LAYOUT

MODEL TTS-4A

NORTHEAST ELECTRONICS CORP.

CONCORD, N.H.

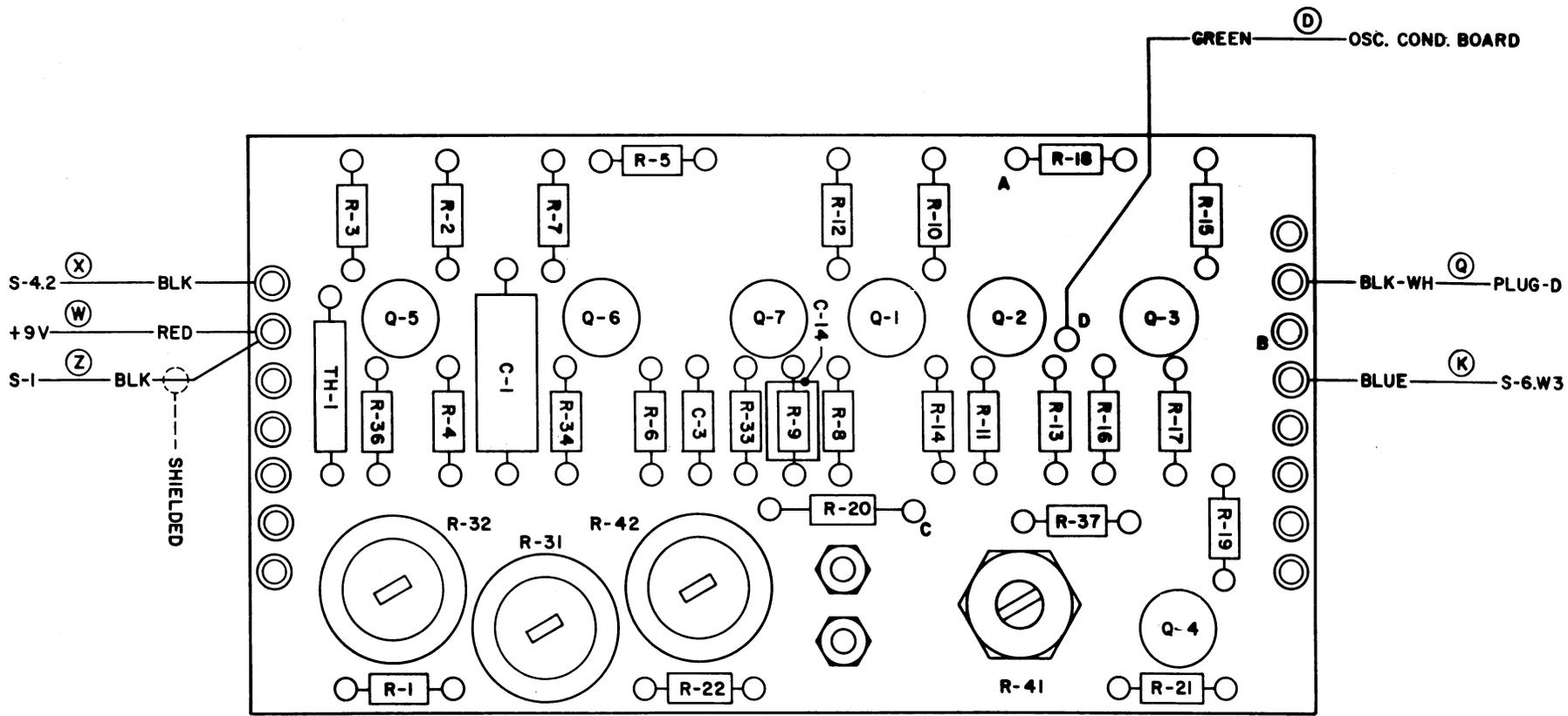
Fig. 5



GENERAL LAYOUT-PRINTED CIRCUIT BOARD
MODEL TTS-4A

NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.

Fig. 6

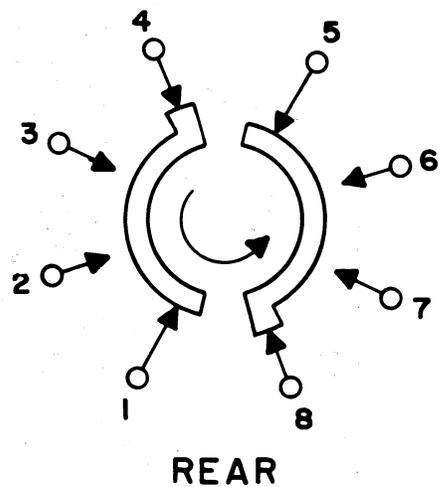
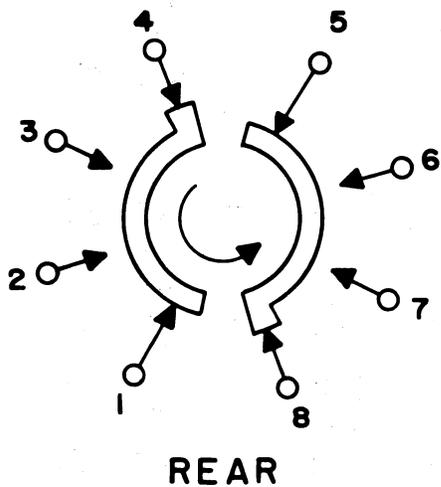
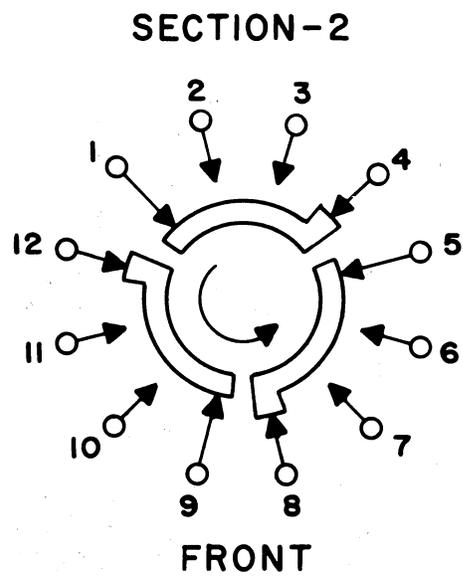
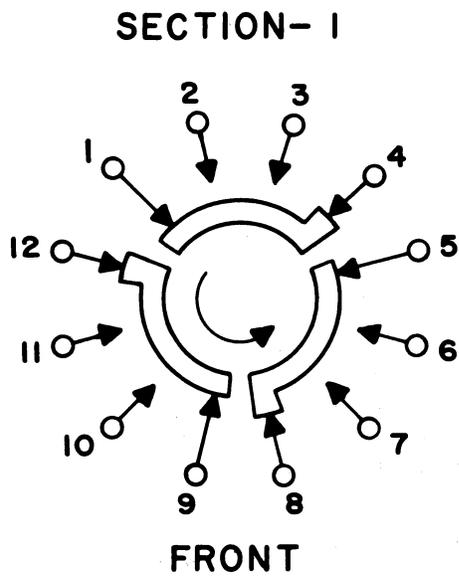


(TOP VIEW)

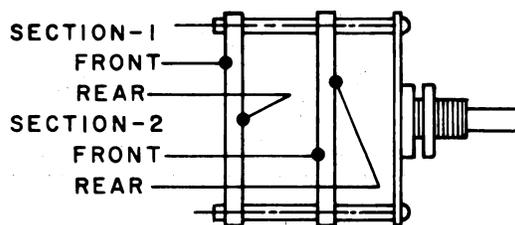
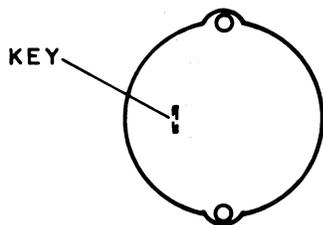
**GENERAL LAYOUT-PRINTED CIRCUIT BOARD
MODEL TTS-4A**

**NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.**

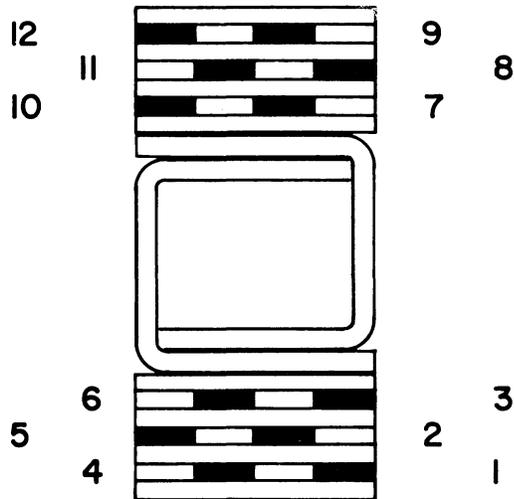
Fig. 7



NOTE: SWITCH VIEWED FROM WIRING SIDE, SHAFT IN EXTREME COUNTER CLOCK-WISE POSITION. TERMINAL NUMBERS FOR REFERENCE ONLY.

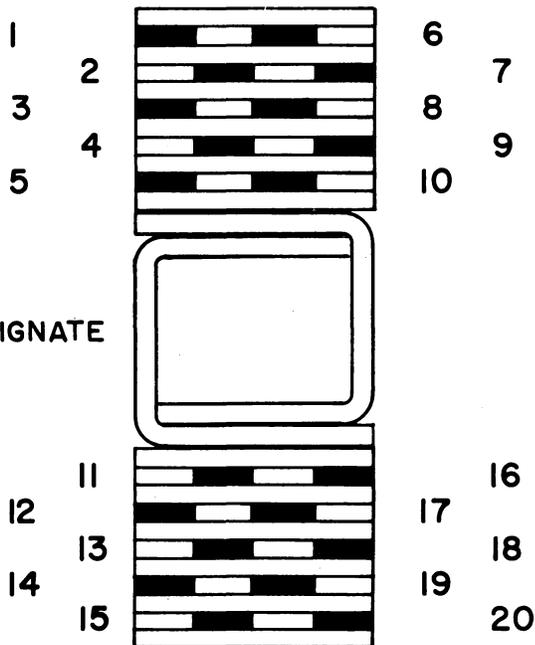


S-1 MODEL TTS-4A
NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.



S-4 S-5 S-8

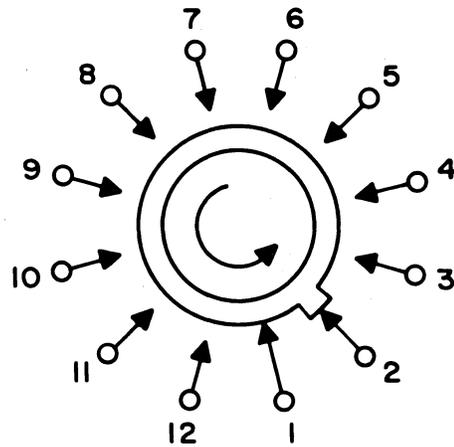
NOTE: SWITCH VIEWED FROM WIRING SIDE.
 TERMINAL NUMBERS FOR REFERENCE ONLY.



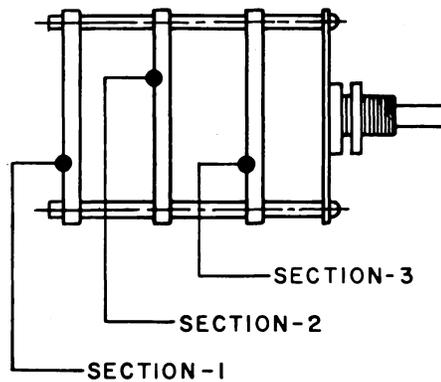
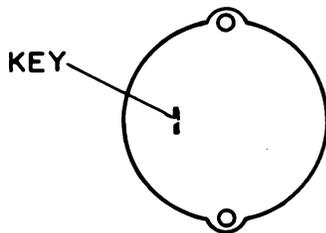
SHADED PORTIONS DESIGNATE
 SOLDER TERMINALS.

S-2 S-3

MODEL TTS-4A
 NORTHEAST ELECTRONICS CORP.
 CONCORD, N.H.



NOTE: SWITCH VIEWED FROM WIRING SIDE, SHAFT IN EXTREME
 COUNTER CLOCK-WISE POSITION.
 TERMINAL NUMBERS FOR REFERENCE ONLY.



S-9 MODEL TTS-4A
NORTHEAST ELECTRONICS CORP.
CONCORD, N.H.

Fig. 10

NORTHEAST ELECTRONICS CORPORATION
 MODEL TTS 4A TRANSMISSION TEST SET
 TABLE OF REPLACEABLE PARTS

<u>Circuit Ref</u>	<u>Description</u>	<u>Mfr* & Mfr's Designation</u>
C1	Capacitor: fixed, electrolytic, 20 mfd, 20 vdc	J, D20-C20A
C2	Capacitor: fixed, electrolytic, 20 mfd, 20 vdc	J, D20-C20A
C3	Capacitor: fixed, paper, .01 mfd, 200 vdc	A, P83Z
C4	Capacitor: fixed, electrolytic, 110 mfd, 20 vdc	J, K110-C20A
C5	Capacitor: fixed, electrolytic, 110 mfd, 20 vdc	J, K110-C20A
C6	Capacitor: fixed, electrolytic, 20 mfd, 20 vdc	J, D20-C20A
C7	Capacitor: fixed, electrolytic, 20 mfd, 20 vdc	J, D20-C20A
C8	Capacitor: fixed, electrolytic, 220 mfd, 20 vdc	J, A220-20ASRP-P
C9	Capacitor: fixed, electrolytic, 20 mfd, 20 vdc	J, D20-C20A
C10	Capacitor: fixed, electrolytic, 110 mfd, 20 vdc	J, K110-C20A
C12	Capacitor: fixed, electrolytic, 220 mfd, 20 vdc	J, A220-20ASRP-P
C13	Capacitor: fixed, paper, 4 mfd, 150 vdc	N, 121P40591R5S2
C14	Capacitor: fixed, silver mica, 500 vdc, 300 mmf ±5%	D, CM-15E-301J
C15	Capacitor: fixed, paper, 2 mfd, 150 vdc	N, 121P20591R5S2
C16	Capacitor: fixed, paper, .0015 mfd, 600 vdc	N, 6TM-D15
C17	Capacitor: fixed, paper, .05 mfd, 110 vdc	N, 2TM-S5
C18	Capacitor: fixed, non-polarized, 50 mfd, 75 vdc	N, DFP50M75
C19	Capacitor: fixed, paper, .01 mfd, 100 vdc	N, 194P10351
C20	Capacitor: fixed, paper, .01 mfd, 100 vdc	N, 194P10351
C22	Capacitor: fixed, silver mica, 560 mmf 500 vdc, ±5%	D, CM-20E-561J
C23	Capacitor: fixed, silver mica, 560 mmf 500 vdc, ±5%	D, CM-20E-561J
C24	Capacitor: fixed, non-polarized, 50 mfd, 75 vdc	N, DFP50M75

TABLE OF REPLACEABLE PARTS

<u>Circuit Ref</u>	<u>Description</u>	<u>Mfr* & Mfr's Designation</u>
R	Lamp: tungsten (used as resistor) 4 w, 120 vdc	I, T4-1/2
R1	Resistor: fixed, composition, 1 K, $\pm 5\%$, 1/2 w	B, EB1025
R2	Resistor: fixed, composition, 150 K, $\pm 5\%$, 1/2 w	B, EB1545
R3	Resistor: fixed, composition, 3.9 K, $\pm 5\%$, 1/2 w	B, EB3925
R4	Resistor: fixed, composition, 22 ohms, $\pm 5\%$, 1/2 w	B, EB2205
R5	Resistor: fixed, composition, 180 K, $\pm 5\%$, 1/2 w	B, EB1845
R6	Resistor: fixed, composition, 20 ohms, $\pm 5\%$, 1/2 w	B, EB2005
R7	Resistor: fixed, composition, 1.8 K, $\pm 5\%$, 1/2 w	B, EB1825
R8	Resistor: fixed, composition, 33 ohms, $\pm 5\%$, 1/2 w	B, EB3305
R9	Resistor: fixed, composition, 3.3 K, $\pm 5\%$, 1/2 w	B, EB3325
R10	Resistor: fixed, composition, 82 K, $\pm 5\%$, 1/2 w	B, EB8235
R11	Resistor: fixed, composition, 10 K, $\pm 5\%$, 1/2 w	B, EB1035
R12	Resistor: fixed, composition, 3 K, $\pm 5\%$, 1/2 w	B, EB3025
R13	Resistor: fixed, composition, 1.5 K, $\pm 5\%$, 1/2 w	B, EB1525
R14	Resistor: fixed, composition, 200 ohms, $\pm 5\%$, 1/2 w	B, EB2015
R15	Resistor: fixed, composition, 100 K, $\pm 5\%$, 1/2 w	B, EB1045
R16	Resistor: fixed, composition, 100 K, $\pm 5\%$, 1/2 w	B, EB1045
R17	Resistor: fixed, composition, 10 K, $\pm 5\%$, 1/2 w	B, EB1035
R18	Resistor: fixed, composition, 1.5 K, $\pm 5\%$, 1/2 w	B, EB1525
R19	Resistor: fixed, composition, 18 K, $\pm 5\%$, 1/2 w	B, EB1835
R20	Resistor: fixed, composition, 1 K, $\pm 5\%$, 1/2 w	B, EB1025
R21	Resistor: fixed, composition, 200 ohms, $\pm 5\%$, 1/2 w	B, EB2015
R22	Resistor: fixed, composition, 6.8K, $\pm 5\%$, 1/2 w	B, EB6821
R23	Resistor: fixed, composition, 33 ohms, $\pm 5\%$, 1/2 w	B, EB3305
R24	Resistor: fixed, composition, 18 ohms, $\pm 5\%$, 1/2 w	B, EB1805

TABLE OF REPLACEABLE PARTS

<u>Circuit Ref</u>	<u>Description</u>	<u>Mfr* & Mfr's Designation</u>
R25	Resistor: fixed, composition, 10 K, $\pm 5\%$, 1/2 w	B, EB1035
R26	Resistor: fixed, composition, 1 K, $\pm 5\%$, 1/2 w	B, EB1025
R27	Resistor: fixed, composition, 20 K, $\pm 5\%$, 1/2 w	B, EB2035
R28	Resistor: fixed, composition, 2.7 K, $\pm 5\%$, 1/2 w	B, EB2725
R29	Resistor: fixed, composition, 2.7 K, $\pm 5\%$, 1/2 w	B, EC2725
R30	Resistor: variable, dual, wirewound, 500 ohms each section	H, CM25722
R31	Resistor: variable, wirewound, 500 ohms	L, 2204
R32	Resistor: variable, wirewound, 200 ohms	L, 2204
R33	Resistor: fixed, composition, 1 K, $\pm 5\%$, 1/2 w	B, EB1025
R34	Resistor: fixed, composition, 3 K, $\pm 5\%$, 1/2 w	B, EB3025
R35	Resistor: fixed, composition, 100 K, $\pm 5\%$, 1/2 w	B, EB1045
R36	Resistor: fixed, composition, 2.2 K, $\pm 5\%$, 1/2 w	B, EB2225
R37	Resistor: fixed, composition, 680 ohms, $\pm 5\%$, 1/2 w	B, EB6815
R40	Resistor: variable, wirewound, 2.5 K	H, CM21616
R41	Resistor: variable, wirewound, 400 ohms	H, CM22425
R42	Resistor: variable, wirewound, 4 K	L, 2204
J1	Jack: telephone	T, 245C or P, CMT5J-1191
J2	Jack: telephone	T, 239C or P, MT334B
J3	Jack: telephone	T, 239C, or P, MT334B
J4	Jack: telephone	T, 248C or P, MT344B
J5	Jack: telephone	T, 239C or P, MT334B
J6	Jack: telephone	T, 248C or P, MT344B

TABLE OF REPLACEABLE PARTS

<u>Circuit Ref</u>	<u>Description</u>	<u>Mfr* & Mfr's Designation</u>
J7	Jack: telephone	T, 223A or P, MT331
J8	Jack: telephone	T, 223A or P, MT331
L12	Inductor: series, 3.17 henry	T, 274J or E, 2740J
L13	Inductor: series, 3.17 henry	T, 274J or E, 2740J
M	Meter: special	NEC, 1073-42258
S1	Switch: rotary, 3-position, 10-pole (FUNCTION)	G, PA2031
S2	Switch: key, telephone, 3-position (MONITOR)	O, Type 173Y 207249-000
S3	Switch: key, telephone, 3-position (LINE)	O, Type 173Y 207249-000
S4	Switch: key, telephone, 2-position (POWER)	O, Type 170E 206792-000
S5	Switch: key, telephone, 3-position (SEND IMP)	O, Type 173N 802621-000
S6	Attenuator: Send	NEC, 1073-S6
S7	Attenuator: Receive	NEC, 1073-S7
S8	Switch: key, telephone, 3-position (REC IMP)	O, Type 173N 802621-000
S9	Switch: special, rotary, 11-position, 3-pole, (OSC)	G, PA-024-3227
T1	Transformer: Receive, special	NEC, NES-918
T2	Transformer: Send, special	NEC, NES-918
T11	Inductor	T, 104A or equivalent
TH-1	Thermistor	S, 43R1
Q1-Q7	Transistors	R, 2N1375 or equivalent

TABLE OF REPLACEABLE PARTS

<u>Circuit Ref</u>	<u>Description</u>	<u>Mfr* & Mfr's Designation</u>
	Battery: 9-volt (5 per set)	F, P6M
	Battery: D-cell (3 per set) 1.5 volts	F, No. 2 or equivalent
	Knob: attenuator (2 per set)	K, S649-3L-BB
	Knob: for rotary switch S9	K, S648-3L-BB
	Knob: for rotary switch S1	M, 2250
P1	Plug: for EXT FREQ	C, 165-36

*See "List of Manufacturers" Code Letters for Replaceable Parts Table.

LIST OF MANUFACTURERS CODE LETTERS
FOR REPLACEABLE PARTS TABLE

<u>Code Letter</u>	<u>Manufacturer</u>
A	Aerovox Corporation
B	Allen-Bradley Company
C	Amphenol Electronics Corporation
D	Arco Electronics Inc.
E	Automatic Electric Company
F	Burgess Battery Company
G	Centralab
H	Clarostat Manufacturing Company
I	Herzog Miniature Lamp Works, Inc.
J	International Electrical Industries
K	Kurz-Kasch, Inc.
L	The Muter Company
M	H. H. Smith Company
N	Sprague Electric Company
NEC	Northeast Electronics Corporation
O	Stromberg-Carlson Company
P	Switchcraft, Inc.
R	Texas Instruments, Inc.
S	Victory Engineering
T	Western Electric Company, Inc.