# V4 TELEPHONE REPEATERS
# INITIAL LINE-UP

CONTENTS PAGE

1. GENERAL . . . . . 1
2. SETTING UP THE BASIC V4 REPEATER . . 2
3. SETTING UP THE 24V4 REPEATER . . . 4
4. SETTING UP THE 44V4 REPEATER . . . 5
5. APPARATUS FOR LINING UP REPEATER . 7
6. LINING UP THE 227-TYPE AMPLIFIER . . 8
7. LINING UP THE 849-TYPE NETWORK . . 10
8. EQUALIZATION . . . . . 10

## 1. GENERAL

1.01 This section describes the initial line-up of various types of V4 telephone repeaters, including touch-up of transmission equalization at the request of the control office. It does not cover the over-all tests required before the circuit is placed in service. These latter tests include a check of stability and measurement of over-all net loss.

1.02 If a plug-in unit proves to be defective as a result of tests covered herein, it should be replaced with another unit. Defective units should not be repaired in the field.

1.03 The circuit-layout record information includes: (a) the codes of the apparatus to be plugged into the various sockets of the repeaters (socket designations are stamped near the outer edge of each shelf); (b) the loss of the 89-type resistor to be plugged into each 849-type network or 1C, 1D, or 1G terminating set; (c) screw settings of plug-in units that are provided with screw-type switches, when prescription design is employed; and (d) the required 1000-cps gain of each amplifier as measured with its equalizer adjusted as specified. Note that the gain between the IN and OUT jacks of an amplifier includes the effect of the associated loaded-cable equalizer.

1.04 "Prescription design" is the preselection of plug-in units and their settings, by the circuit-layout forces. A complete prescription design specifies the type of terminating set, amplifier, network (with 89-type resistor), or equalizer to be inserted in each socket; the settings of all screw-type switches on the plug-in units; and the gain or loss to which each amplifier or network is to be adjusted.

1.05 ***EACH PLUG-IN UNIT INCLUDES, AT THE PLUG END, ONE OR MORE RUGGED PINS. THESE PINS SERVE AS GUIDES FOR PROPER AIMING AND SEATING OF THE PLUG-IN UNITS. TAKE EXTREME CAUTION NOT TO BEND THE CONNECTION PINS WHEN PUSHING A UNIT INTO ITS SOCKET. PLACE THE UNIT IN ITS ASSIGNED POSITION ON THE SHELF AND PUSH IT IN GENTLY UNTIL THE PLUG TOUCHES THE SOCKET. STILL PUSHING GENTLY, SHIFT THE PLUG SLIGHTLY FROM SIDE TO SIDE UNTIL THE GUIDE PIN OR PINS ENGAGE THEIR SOCKETS. THEN, SLOWLY BUT FIRMLY, PUSH THE UNIT FULLY INTO THE SOCKET. WHEN INSERTING AMPLIFIERS, DO NOT PUSH ON THE GAIN-CONTROL DISK. NO UNIT WILL FIT INTO A SOCKET***

***DESIGNED FOR A UNIT OF ANOTHER TYPE, OR INTO ITS OWN SOCKET WRONG SIDE UP.***

**1.06** For simplicity in measuring gains and losses during repeater line-ups, all such measurements are made between 600-ohm impedances. The service order, circuit-layout record or similar information includes the gains and losses that are to be measured in this way; no corrections are necessary. These specified gains and losses, however, do not necessarily represent the true effects of amplifiers and networks in their circuits.

**1.07** The test procedure is designed to avoid power levels greater than 1 milliwatt at any point, from the output of the oscillator to output of the amplifier or network.

**1.08** Adjacent to every screw-type switch on the plug-in units is a designation consisting of letters or numerals or both. Some of these designations express the resistance or capacitance under control of the switches; others indicate the function of the switch in the circuit. These designations are illustrated in the descriptive sections of practices on the V4 repeaters.

**1.09** The circuit-layout record information generally includes instructions for setting the screw-type switches, either down (contacts closed) or up (contacts open). For this purpose, it is desirable to designate each screw-type switch by a concise, but unmistakable, designation. Three systems of designations are described below. Depending upon local preference, any one of these or a still different system may be used. Whatever the system, it must be thoroughly understood by everyone using it as a guide for setting screw-type switches.

***System 1*** consists of the designations described in Par. 1.08. Each screw thus identified is to be turned (or left) down; all others are to be turned (or left) up.

***System 2*** designates the columns of switches by the letters A, B, C, D, etc, from left to right, omitting I, O, and Q, while designating the horizontal rows by the numerals 1, 2, 3, 4, etc, from top to bottom. Every switch may thus be identified by a letter and a numeral such as B3, C4, D1. To designate more than one switch in the same column, the column need be shown only once. For example, "B134" indicates that the 1st, 3rd, and 4th switches from the top of the second column from the left are to be turned (or left) down, and that all others in Column B are to be turned (or left) up. Fig. 1 shows how the columns and rows are designated in this system. ***The column letters and row numerals do not appear on the plug-in units. They are simply convenient aids in locating columns and rows.*** Note that some terminating sets have three rows of switches instead of two as shown in Fig. 1a.

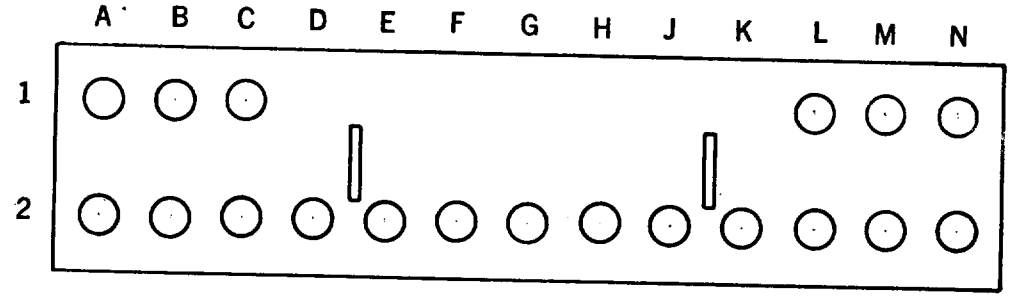
***System 3*** is diagrammatic and uses a simplified front view of the plug-in unit. It shows as a black disk (●) each screw that is to be turned (or left) down, and as a circle (O) each screw that is to be turned (or left) up. Illustrations are shown in Figs. 2b through 6b.

## 2. SETTING UP THE BASIC V4 REPEATER

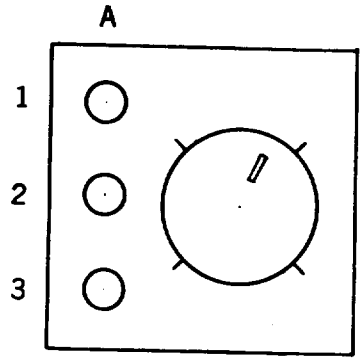
**2.01** Use the plug-in units specified on the circuit-layout record. Plug them into the corresponding sockets of the amplifier shelves assigned, and make the screw adjustments as shown in the circuit-layout record information.

**2.02** Adjust amplifier gains as covered in Part 6.

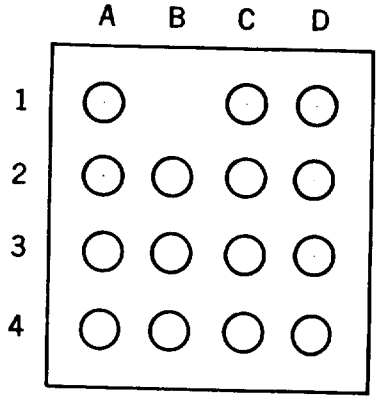
**2.03** ***IN CLOSING SCREW CONTACTS, AVOID SHEARING OFF THE SCREW HEADS. FINGER-GRIP OF THE SCREWDRIVER IS RECOMMENDED INSTEAD OF FIST-GRIP. IN OPENING SCREW CONTACTS, MAKE TWO FULL TURNS OF THE SCREWDRIVER. ADJUSTING SCREWS ARE NOT "CAPTIVE". IF A SCREW IS DAMAGED, IT MAY BE COMPLETELY REMOVED AND REPLACED WITH A GOOD ONE.***



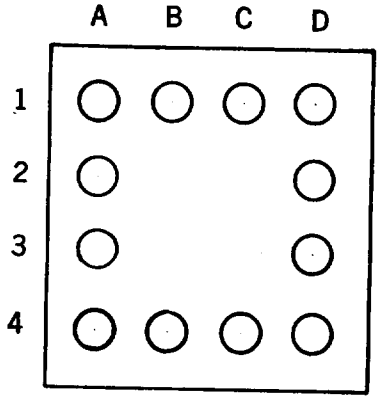

1a - 1A TERMINATING SET




1b - 227-TYPE AMPLIFIER




359A or D EQUALIZER




359G or H EQUALIZER

1c

**Fig. 1 – Screw Arrangement — Plug-In Units**

**2.04** ***Example — Basic V4 Repeater***

Fig. 2a shows how the coding system is used to designate gain settings for a specific circuit. For Amplifier 1, screw A2 is to be turned down, and the potentiometer is to be turned so that 13.0 db gain is measured. For Amplifier 2, screw A3 is to be turned down, and the potentiometer is to be adjusted so that 22.3 db gain is measured. Fig. 2b shows how the same information is conveyed by diagram.

| | | |
|---|---|---|
| AMPL 1 | A2 | 13.0 db GN |
| AMPL 2 | A3 | 22.3 db GN |

**Fig. 2a – Gain Setting**

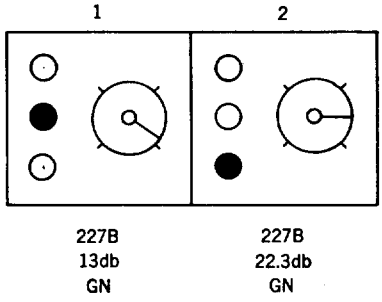



**Fig. 2b – Gain Setting**

Measurements at test jacks for any amplifier include only the loss or gain of equipment in that amplifier socket.

## 3. SETTING UP THE 24V4 REPEATER

**3.01** Select the plug-in units shown in the circuit-layout record information. Plug them in the corresponding sockets of the 24V4 shelf assigned, and make the screw adjustments specified.

**3.02** Adjust amplifier gains as covered in Part 6.

**3.03** ***Example — 24V4 Repeater***

Fig. 3a shows the coded adjustments for a specific circuit including the screws that are to be turned down.

Fig. 3b shows the same information in diagram form.

| | | |
|---|---|---|
| TERM SET | 1A | A12, J2, K2, L1, M2 |
| T AMPL | 227A | A2 7.5 db GN |
| R AMPL | 227A | A2 8.0 db GN |
| EQL | 359A | A1234, B23, C234, D12 |

**Fig. 3a – Example of 24V4 Coded Settings**

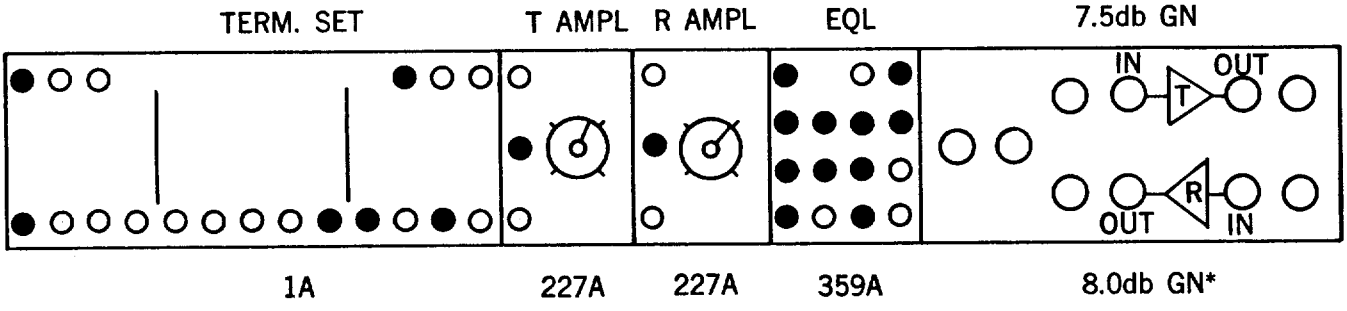



**Fig. 3b – Example of 24V4 Settings**

*** This specified measured gain is less than the true gain of the R AMPL itself because of equalizer loss included in the measurement, and also because of reflection loss at the junction of the measuring equipment and the amplifier. In this example, the measured gain of the T AMPL is less than the true gain because of reflection loss alone. In every case, however, adjust the gain to the amount specified in the circuit-layout record information.**

## 4. SETTING UP THE 44V4 REPEATER

### 44V4A Repeater

**4.01** Select the plug-in units shown on the circuit-layout record information. Plug them into the corresponding sockets of the 44V4A shelf assigned (gray jack mounting) and make the screw adjustments furnished.

**4.02** Adjust amplifier gains as covered in Part 6.

**4.03** ***IN CLOSING SCREW CONTACTS, AVOID SHEARING OFF THE SCREW HEADS. FINGER-GRIP OF THE SCREWDRIVER IS RECOMMENDED INSTEAD OF FIST-GRIP. IN OPENING SCREW CONTACTS, MAKE TWO FULL TURNS OF THE SCREWDRIVER. ADJUSTING SCREWS ARE NOT "CAPTIVE." IF A SCREW IS DAMAGED, IT MAY BE COMPLETELY REMOVED AND REPLACED WITH A GOOD ONE.***

**4.04** ***Examples — 44V4A Repeater***

Fig. 4a shows the coded adjustments for a specific circuit with amplifiers including the screws that are to be turned down.

| | | | |
|---|---|---|---|
| AMPL 1 | 227A | A2 | 10.0 db GN |
| EQL 1 | 359B | — | |
| AMPL 2 | 227A | A3 | 9.0 db GN |
| EQL 2 | 359A | A123, B24, C3, D34 | |

**Fig. 4a – Example of 44V4 Coded Settings**

Fig. 4b shows the same information in diagram form.

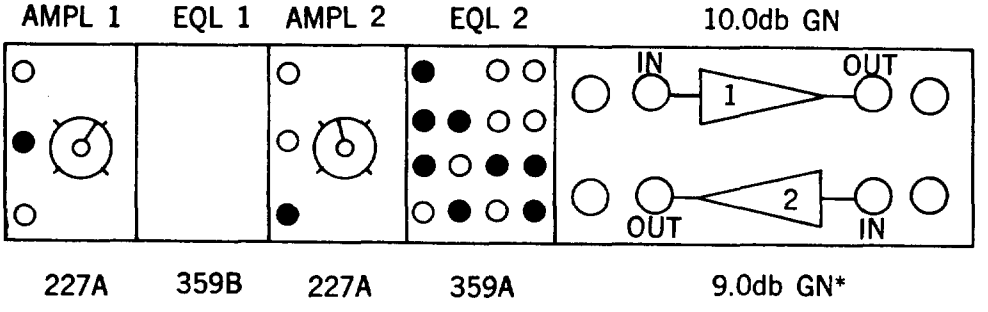



**Fig. 4b – Example of 44V4 Settings**

*** This specified gain is less than the true gain of the AMPL 2 itself because of equalizer loss included in the measurement, and also because of reflection loss at the junction of the measuring equipment and the amplifier. In this example the measured gain of AMPL 1 is less than the true gain because of reflection loss alone. In every case, however, adjust the gain to the amount specified in the circuit-layout record information.**

Fig. 5a shows the coded adjustments for a specific circuit with 849-type networks, including the screws that are to be turned down on the 359D equalizer.

| | | | |
|---|---|---|---|
| AMPL 1 | 849A | 1.50 89G | 2.9 db LOSS |
| EQL 1 | 359C | | |
| AMPL 2 | 849B | 7.00 89AJ | 9.8 db LOSS |
| EQL 2 | 359D | A123, B24, D1234 | |

**Fig. 5a – Example of 44V4 with Networks Instead of Amplifiers**

Fig. 5b shows the same information in diagram form.

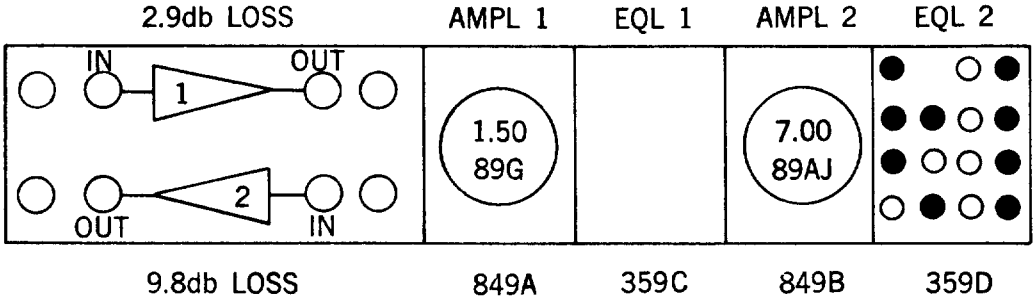



**Fig. 5b – Example of 44V4 with Networks Instead of Amplifiers**

**4.05** The loss measured at the jacks includes not only the loss marked on the 89-type resistor, but also transformer and/or equalizer losses.

**44V4B Repeater**

**4.06** Select the plug-in units shown on the circuit-layout record information. Plug them into the corresponding sockets of the 44V4B shelf assigned (light-brown jack mounting) and make the screw adjustments furnished.

**4.07** ***IN CLOSING SCREW CONTACTS, AVOID SHEARING OFF THE SCREW HEADS. FINGER-GRIP OF THE SCREWDRIVER IS RECOMMENDED INSTEAD OF FIST-GRIP. IN OPENING SCREW CONTACTS, MAKE TWO FULL TURNS OF THE SCREWDRIVER. ADJUSTING SCREWS ARE NOT "CAPTIVE." IF A SCREW IS DAMAGED, IT MAY BE COMPLETELY REMOVED AND REPLACED WITH A GOOD ONE.***

**4.08** ***Example — 44V4B Repeater***

Fig. 6a shows the coded adjustments for a specific WADS circuit, including the screws to be turned down.

| | | |
|---|---|---|
| AMPL 1 | 849C | 2.00 89J 2.0 db LOSS |
| EQL 1 | 359G | A14, B1, C1, D24 |
| AMPL 2 | 227A | A13, 4.5 db GN |
| EQL 2 | 359H | A12, D1234 |

**Fig. 6a – Example of 44V4 with WADS Equalizers**

Fig. 6b shows the same information in diagram form.

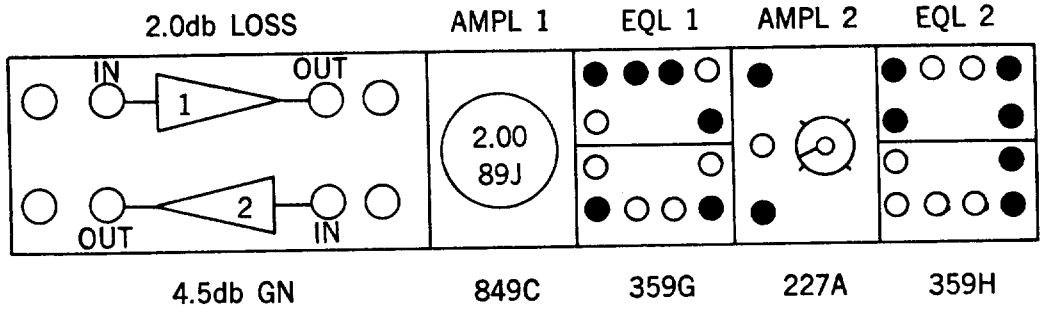



**Fig. 6b – Example of 44V4 with WADS Equalizers**

**Measurements made at AMPL 1 jacks include only the loss or gain of the equipment in the AMPL 1 socket but EQL 2 must be plugged in for continuity. Measurements made at AMPL 2 jacks include effects of equipment in EQL 1 socket as well as that in AMPL 2 and EQL 2 sockets.**

## 5. APPARATUS FOR LINING UP REPEATER

**5.01** Two methods are given for lining up repeaters. Method 1 is the simpler, but is applicable only where the test power output is continuously adjustable. Method 2 must be used where the test power output is adjustable in steps only. For either method, use only sources and measuring equipment that have been calibrated at standard intervals.

*Note 1:* The adjusted gain measured as outlined above is not necessarily the true amplifier gain but may include the effects of equalizers and impedance mismatches. These effects have been taken into account in specifying the measured gain to which the amplifier is to be adjusted.

*Note 2:* Table 1 shows the screw switch settings for each of the three ranges of true amplifier gain.

**TABLE I**

| SCREW SWITCH | RANGE — DB | | |
|---|---|---|---|
| | 0-13 | 10-24 | 21-36 |
| TOP | OPEN | OPEN | CLOSED |
| MIDDLE | CLOSED | OPEN | OPEN |
| BOTTOM | OPEN | CLOSED | CLOSED |

*Note 3:* The marks outside the gain-adjusting disk are roughly, but not exactly, 1 db apart. Do not attempt to set the gain by means of these marks, without making measurements. The marks and figures are intended to be rough guides only.

**5.02** *Apparatus*

For Method 1:

One 21A transmission measuring set; or a combination of one KS-19353 or KS-19260 oscillator and one 23A transmission measuring set.

For Method 2:

Standard 1-kc tone at several levels, appearing at 600-ohm jacks in the repeater bays, and one 23A transmission measuring set; or one Northeast Electronics 4A Transmission Test Set.

**5.03** *Accessories*

1 Cord equipped with a 310 plug at one end and a plug suitable for connection to the source of test power at the other end.

1 Cord equipped with a 310 plug at one end and a plug suitable for connection to the detector at the other end.

1 Cord equipped with a plug for connection to the source at one end, and to the detector at the other end.

2 258C, D, or E plugs (dummy plugs)

1 602C tool (for removing plug-in units from repeater shelf).

1 KS-14418 high-impedance headset equipped with a 310-type plug or 354A plug.

2 386A plugs (600 ohms ± 1%)

**5.04** In order to avoid confusion in making measurements, all test power is sent from 600-ohm ports of oscillators and received at 600-ohm ports of detectors. No attempt is made to match impedance of test gear to that of apparatus. This simplification of measurements entails no sacrifice of accuracy; measurements made with unmatched test gear are just as predictable as those made with matched test gear. Suppose a "loaded" type of equalizer is chosen for a 24V4 repeater. This equalizer automatically selects the 1200-ohm amplifier ports for connection to the loaded cable by way of the test jacks on the line side. For amplifier gain measurements, however, 600-ohm oscillator and detector ports are connected to these jacks. Reflection losses are taken into account in specifying the ***gain measurement*** required.

## 6. LINING UP THE 227-TYPE AMPLIFIER
### METHOD 1

| STEP | PROCEDURE |
|---|---|
| 1 | Assemble the testing equipment shown in Fig. 7 and be sure the oscillator is set for minimum output before it is turned on. If impedances other than 600 ohms are provided as options in the oscillators and detectors, be sure both devices are set for 600 ohms. |
| 2 | Be sure that amplifiers and equalizers, where required, are ***fully inserted*** and that all adjusting screws are set as specified in the circuit-layout record information. In some setups, the amplifier outputs are connected to the test jacks via wiring in the equalizer units. In these cases, even when a "dummy" equalizer (359C, 359E) is specified, it must be fully inserted in the proper socket for all connections between jacks and amplifiers to be completed. In the ***basic V4 repeater,*** however, all jacks are connected directly to amplifier sockets. |
| 3 | Note the gain specified in the circuit-layout record information. Call it G. Now connect the oscillator directly to the detector, as shown by dotted line in Fig. 7, and adjust its output to −G dbm (G db ***below*** 0 dbm). |
| 4 | Disconnect the oscillator from the detector, and connect both units to the amplifier, as shown by solid lines in Fig. 7. Adjust the gain-control potentiometer to give a detector reading of 0 dbm ±0.1 db. If the potentiometer can not be adjusted to give 0 dbm without adjusting the gain-control screws, check all screw settings. If no error is found, try another amplifier (and equalizer, in turn, when one is specified). If 0 dbm output still can not be obtained, report the condition to your supervisor. |

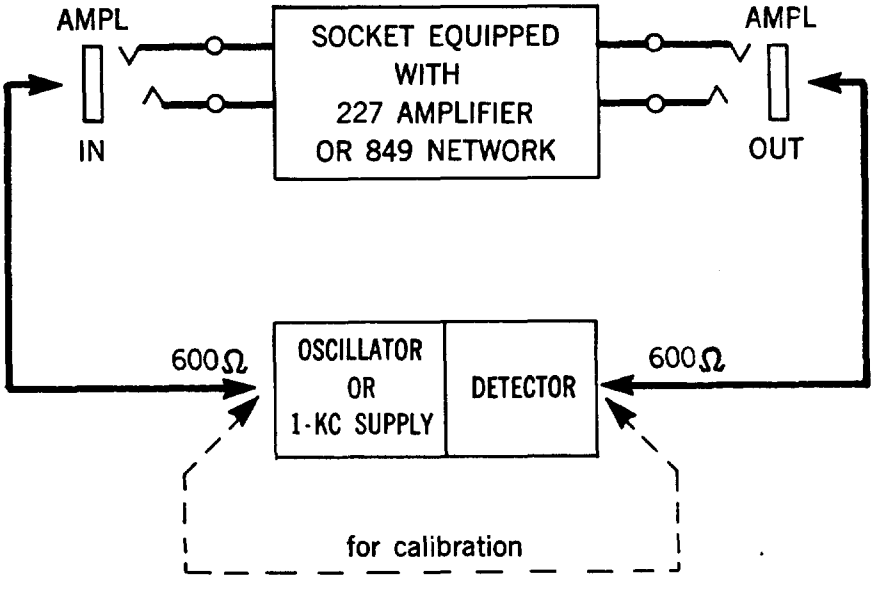



**Fig. 7 – Gain or Loss Measurement at Amplifier Socket**

*Example*

In Par. 3.03, 8.0 db measured gain is specified for the R AMPL. In accordance with the line-up procedure, Method 1, for the 227-type amplifier, the 600-ohm test oscillator is set to give −8.0 dbm output as measured directly into the 600-ohm detector. Then the oscillator is disconnected from the detector and connected to the IN jack of the R AMPL, while the detector is connected to the OUT jack of the R AMPL.

Finally, the gain-control potentiometer of the amplifier is rotated to such a position that the detector reads 0 dbm.

**LINING UP THE 227-TYPE AMPLIFIER**
**METHOD 2**

| STEP | PROCEDURE |
|---|---|
| 1 | Assemble the test equipment shown in Fig. 7. If impedances other than 600 ohms are provided as options at the test power supply and the detector, be sure to select the 600-ohm port in each device. |
| 2 | Be sure that amplifiers and equalizers, where required, are ***fully inserted*** and that all adjusting screws are set as specified in the circuit-layout record information. In some setups, the amplifier outputs are connected to the test jacks via wiring in the equalizer units. In these cases, even when a "dummy" equalizer (359C, 359E) is specified, it must be fully inserted in the proper socket for all connections between jacks and amplifiers to be completed. In the ***basic V4 repeater,*** however, all jacks are connected directly to amplifier sockets. |
| 3 | Note the gain specified in the circuit-layout record information. Call it G. Now select the highest 1-kc milliwatt output or the stepped oscillator output that does not exceed −G dbm. (If G were 8.5 db, and 0, −7, −10, −16 dbm outputs were available, the −10 dbm output would be chosen, because it is the highest available that does not exceed −8.5 dbm.) Connect the oscillator directly to the detector and read the output. Call it C. Add G and C algebraically, and call the result M. |
| 4 | Disconnect the test power source from the detector, and connect both units to the amplifier, as shown by the solid lines of Fig. 7. Adjust the gain-control potentiometer to give a detector reading of M dbm ±0.1 db. If the potentiometer can not be adjusted to give a reading of M dbm without adjusting the gain-control screws, check all screw settings. If no error is found, try another amplifier (and equalizer, in turn, when one is specified). If M dbm output still can not be obtained, report the condition to your supervisor. |

*Example*

Assume that 8.5 db gain (G) is specified for the R AMPL. In accordance with the line-up procedure, Method 2, for the 227-type amplifier, select the highest available 1-kc test power output that does not exceed −8.5 dbm. Suppose this output is marked −10 dbm, but measures −9.9 dbm (C) on the detector. Add −9.9 dbm and 8.5 db. The result, −1.4 dbm, is the detector reading (M) which the potentiometer dial should be adjusted to give. If −16 dbm test power had been available, and had measured −16.1 the potentiometer would have been adjusted to give −16.1 +8.5 or −7.6 dbm.

## 7. LINING UP THE 849-TYPE NETWORK

| STEP | PROCEDURE |
|---|---|
| 1 | Assemble the testing equipment shown in Fig. 7 and be sure the oscillator is set for minimum output before it is turned on. If impedances other than 600 ohms are provided as options in the oscillator and/or detector, be sure both devices are set for 600 ohms. |
| 2 | Be sure that 849-type networks, 89-type resistors, and 359-type equalizers are fully inserted and that all adjusting screws are set as specified. In some setups, the network outputs are connected to the test jacks via wiring in the equalizer units. In these cases, even when a "dummy" equalizer (359J) is specified, it must be fully inserted in the proper socket for all connections between jacks and amplifiers to be completed. In the basic V4 repeater, however, all jacks are connected directly to amplifier (or network) sockets. |
| 3 | Note the loss specified in the circuit-layout record information. Call it L. Now connect the oscillator directly to the detector and adjust its output to 0 dbm. |
| 4 | Disconnect the oscillator from the detector, and connect both units to the network, as shown in Fig. 7. The detector should read −L dbm (that is, L db below 0 dbm) ± 0.5 db. If it reads outside this range, check all screw settings. If no error is found, try another network (and equalizer, in turn, when one is specified). If 0 dbm ± 0.5 db output still can not be obtained, report the condition. |

*Example*

Refer to Fig. 5b, Amplifier-2 position. In accordance with the line-up procedure for measuring the loss of the 849-type networks, the test oscillator is adjusted to give 0-dbm output into a 600-ohm detector. The oscillator is then disconnected from the detector and connected to the IN jack of the AMPL 2 socket, while the detector is connected to the OUT jack of the AMPL 2 socket.

Finally, the detector reading is observed. It should lie within the range 9.3 to 10.3 db loss.

## 8. EQUALIZATION

**8.01** When the cable facilities throughout a repeater section are uniform, the circuit-layout record information may not include equalizer settings, but may call for standard equalization. In such cases, refer to Tables II through V for equalizer types and settings.

### Touching Up the Equalization

**8.02** If the control-office forces responsible for lining up the over-all circuit find that the prescribed settings of equalizers do not produce the required results across the frequency band, they may ask for changes in those settings. Ordinarily, they will say what changes they wish made in the screw-switches, but sometimes, especially for loaded circuits, they may say only what changes they want made in the transmission. Examples of this might be:

(a) "Raise (or lower) the gain at 3000 cycles."

(b) "Raise (or lower) the gain at 300 cycles."

The following paragraphs tell how to go about carrying out these requests.

### High-Frequency Adjustment

**8.03** The gain at 3000 cycles is increased, relative to that at 1000 cycles, by decreasing the resistance in the HF section of the 359A or 359D equalizer. This resistance consists of a string of six resistors in series: 75, 150, 300, 600,

1200 and 2400 ohms. Any resistor can be "shorted out" by closing the screw switch designated by its resistance figure. By choosing various combinations of screw switches to be shorted out, any total resistance from 0 to 4725 ohms can be set up, in steps of 75 ohms. A total of 600 ohms is about the minimum used in practice.

***Example — HF Touch-Up***

Assume that a total of 750 ohms has been set up on the HF section of the equalizer, by prescription. This means that the 75, 300, 1200 and 2400-ohm screw switches are closed. The over-all line-up shows too much loss at 3000 cycles, and the circuit-control point asks for more repeater gain at that frequency.

The first step is to decrease the resistance in the HF equalizer to 675 ohms. Do this by closing the 150-ohm screw switch and opening the 75-ohm screw switch. This increases the loss at frequencies below 3000 cycles, thereby raising the gain at 3000 relative to that at other frequencies.

The next step is to compensate for the increased loss by raising the gain of the amplifier. This is done simply by again adjusting the gain as covered in Part 6. It may sometimes be necessary to use a different gain range of the amplifier. This means readjusting screw switches on the amplifier. See Table I in Part 5.

The circuit control can now make overall measurements again to see whether or not the circuit meets requirements. If further change in the equalizer is needed, he will ask for it.

**Low-Frequency Adjustment**

**8.04** The gain at low frequencies is increased, relative to that at 1000 cycles, by increasing the capacitance in the LF section of the 359A or 359D equalizer. Basically, the LF equalization depends on both the resistance and the capacitance in the LF equalizer, but for touch-up adjustments, change only the capacitance. This capacitance consists of four capacitors: 0.25, 0.5, 1.0, and 2.0 $\mu$f,* in parallel. Any capacitor can be removed from the group by opening the screw switch marked with its capacitance value.

***Example — LF Touch-Up***

Assume that a total of 2.5 $\mu$f has been set up in the LF section of the equalizer, by prescription. This means that the 2.0 and the 0.5 $\mu$f switches are closed. The over-all line-up shows insufficient loss at 300 cycles, and the circuit control point asks for less gain at that frequency.

The first step is to decrease the capacitance by 0.25 $\mu$f. Do this by opening the 0.5 $\mu$f screw switch and closing the 0.25 $\mu$f screw switch. This leaves a total of 2.25 $\mu$f in the group, and results in more loss at 300 cycles. Ordinarily, the effect of this change at 1000 cycles is trivial, and no adjustment of the gain potentiometer is needed.

The circuit control can now make overall measurements again to see whether or not the circuit meets requirements. If further change in the equalizer is needed, he will ask for it.

*$\mu$f = abbreviation for microfarads.

**19H88**

## TABLE II
## PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF 359A AND 359D EQUALIZERS FOR CABLE END SECTIONS 1500 TO 4500 FEET

| 19H88 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CABLE LENGTH IN KILOFEET* → | | ZERO TO 42 | 60 | 78 | 96 | 108 | 114 | 150 | |
| | | ** | | | | | | | |
| CABLE LENGTH IN MILES* → | | ZERO TO 8.0 | 11.4 | 14.8 | 18.2 | 20.5 | 21.6 | 28.4 | |
| SCREW CODE | | | | | | | | | SCREW DESIG-NATION |
| HF | A1 | ○ | ● | ● | ● | ● | ● | ● | IN |
| | A2 | ○ | ● | ● | ● | ● | ● | ○ | 75 |
| | A3 | ○ | ● | ● | ○ | ● | ○ | ● | 150 |
| | A4 | ○ | ○ | ● | ○ | ○ | ● | ● | 300 |
| | B1 | · | · | · | · | · | · | · | |
| | B2 | ○ | ● | ● | ○ | ○ | ○ | ○ | 600 |
| | B3 | ○ | ○ | ○ | ● | ● | ● | ● | 1200 |
| | B4 | ○ | ● | ● | ● | ● | ● | ● | 2400 |
| LF | C1 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | .25 |
| | C2 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | .50 |
| | C3 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 1.0 |
| | C4 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | 2.0 |
| | D1 | ● | ● | ● | ● | ● | ● | ● | 250 |
| | D2 | ● | ● | ● | ● | ● | ● | ● | 500 |
| | D3 | ● | ● | ● | ● | ● | ● | ● | 1000 |
| | D4 | ● | ● | ● | ● | ● | ● | ● | 2000 |
| 1200-OHM INSERTION LOSS (db) OF CABLE AT I KC | | 0 | 3.4 | 4.8 | 6.3 | 7.7 | 8.7 | 9.2 | 12.1 |
| LOSS OF EQUALIZER (db) AT I KC | 359D | 0 | 1.4 | 1.8 | 2.1 | 2.3 | 2.8 | 3.0 | |
| | 359A | 6.2 | 7.6 | 8.0 | 8.3 | 8.5 | 9.0 | 9.2 | |
| HF TOTAL RES. (OHMS) | | ∞ | 1500 | 1200 | 1050 | 900 | 750 | 675 | |
| LF TOTAL CAP. (UF) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| LF TOTAL RES. (OHMS) | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

* For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.
Example: For 60 kilofeet, use the adjustment for the range 42–60 kilofeet.

** Preferably use dummy equalizer (359E or 359J), which has no adjustments and no loss.

○ indicates "screw up" (3 full turns).

● indicates "screw down".

· indicates "no screw".

## 22H88

TABLE III
PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF
359A AND 359D EQUALIZERS FOR CABLE END SECTIONS 1500 TO 4500 FEET

| 22H88 | | | | | | | |
|---|---|---|---|---|---|---|---|
| CABLE LENGTH IN KILOFEET* → | | ZERO TO 18 | 24 | 60 | 90 | 108 | |
| | | ** | | | | | |
| CABLE LENGTH IN MILES* → | | ZERO TO 3.4 | 4.5 | 11.4 | 17.0 | 20.5 | |
| SCREW CODE | | | | | | | SCREW DESIG-NATION |
| HF | A1 | ○ | ● | ● | ● | ● | IN |
| | A2 | ○ | ● | ● | ● | ● | 75 |
| | A3 | ○ | ● | ● | ● | ○ | 150 |
| | A4 | ○ | ● | ● | ○ | ○ | 300 |
| | B1 | · | · | · | · | · | |
| | B2 | ○ | ● | ● | ● | ○ | 600 |
| | B3 | ○ | ○ | ● | ○ | ● | 1200 |
| | B4 | ○ | ○ | ○ | ● | ● | 2400 |
| LF | C1 | ○ | ● | ○ | ○ | ● | .25 |
| | C2 | ○ | ● | ● | ○ | ○ | .50 |
| | C3 | ○ | ● | ● | ○ | ● | 1.0 |
| | C4 | ○ | ● | ● | ● | ○ | 2.0 |
| | D1 | ● | ● | ● | ● | ● | 250 |
| | D2 | ● | ● | ● | ● | ● | 500 |
| | D3 | ● | ○ | ○ | ○ | ● | 1000 |
| | D4 | ● | ○ | ○ | ○ | ○ | 2000 |
| 1200-OHM INSERTION LOSS (db) OF CABLE AT 1 KC | | 0 | 2.7 | 3.6 | 9.0 | 13.4 | 16.1 |
| LOSS OF EQUALIZER (db) AT 1 KC | 359D | 0 | 0.6 | 0.9 | 1.4 | 2.1 | |
| | 359A | 6.2 | 6.8 | 7.1 | 7.6 | 8.3 | |
| HF TOTAL RES. (OHMS) | | ∞ | 3600 | 2400 | 1500 | 1050 | |
| LF TOTAL CAP. (UF) | | 0 | 3.75 | 3.5 | 2.0 | 1.25 | |
| LF TOTAL RES. (OHMS) | | 0 | 3000 | 3000 | 3000 | 2000 | |

*For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.
Example: For 60 kilofeet, use the adjustment for the range 24–60 kilofeet.

**Preferably use dummy equalizer (359E or 359J), which has no adjustments and no loss.

○ indicates "screw up" (3 full turns).

● indicates "screw down."

· indicates "no screw."

**24H88**

TABLE IV
PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF
359A AND 359D EQUALIZERS FOR CABLE END SECTIONS 1500 TO 4500 FEET

| 24H88 | | | | | | | |
|---|---|---|---|---|---|---|---|
| CABLE LENGTH IN KILOFEET* → | | ZERO TO 18 | 30 | 42 | 60 | 72 | |
| | | ** | | | | | |
| CABLE LENGTH IN MILES* → | | ZERO TO 3.4 | 5.7 | 8.0 | 11.4 | 13.6 | |
| SCREW CODE | | | | | | | SCREW DESIG-NATION |
| HF | A1 | ○ | ● | ● | ● | ● | IN |
| | A2 | ○ | ● | ● | ● | ● | 75 |
| | A3 | ○ | ● | ● | ● | ● | 150 |
| | A4 | ○ | ● | ● | ○ | ● | 300 |
| | B1 | · | · | · | · | · | |
| | B2 | ○ | ○ | ● | ● | ● | 600 |
| | B3 | ○ | ○ | ● | ○ | ○ | 1200 |
| | B4 | ○ | ○ | ○ | ● | ● | 2400 |
| LF | C1 | ○ | ○ | ○ | ○ | ● | .25 |
| | C2 | ○ | ● | ● | ○ | ● | .50 |
| | C3 | ○ | ● | ● | ● | ○ | 1.0 |
| | C4 | ○ | ○ | ○ | ○ | ○ | 2.0 |
| | D1 | ● | ○ | ● | ○ | ● | 250 |
| | D2 | ● | ● | ○ | ○ | ● | 500 |
| | D3 | ● | ● | ● | ● | ○ | 1000 |
| | D4 | ● | ● | ● | ● | ● | 2000 |
| 1200-OHM INSERTION LOSS (db) OF CABLE AT 1 KC | | 0 | 4.0 | 6.8 | 9.5 | 13.7 | 16.4 |
| LOSS OF EQUALIZER (db) AT 1 KC | 359D | 0 | 0.5 | 0.9 | 1.4 | 1.8 | |
| | 359A | 6.2 | 6.7 | 7.1 | 7.6 | 8.0 | |
| HF TOTAL RES. (OHMS) | | ∞ | 4200 | 2400 | 1500 | 1200 | |
| LF TOTAL CAP. (UF) | | 0 | 1.5 | 1.5 | 1.0 | 0.75 | |
| LF TOTAL RES. (OHMS) | | 0 | 250 | 500 | 750 | 1000 | |

*For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths
Example: For 42 kilofeet, use the adjustment for the range 30–42 kilofeet.

**Preferably use dummy equalizer (359E or 359J), which has no adjustments and no loss.

○ indicates "screw up" (3 full turns).

● indicates "screw down."

· indicates "no screw."

## 26H88

### TABLE V
### PRESCRIPTION ADJUSTMENTS AND COMPONENT VALUES OF 359A AND 359D EQUALIZERS FOR CABLE END SECTIONS 1500 TO 4500 FEET

| 26H88 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CABLE LENGTH IN KILOFEET* → | | ZERO TO 12 | 18 | 24 | 30 | 36 | 42 | |
| | | ** | | | | | | |
| CABLE LENGTH IN MILES* → | | ZERO TO 2.3 | 3.4 | 4.5 | 5.7 | 6.8 | 8.0 | |
| SCREW CODE | | | | | | | | SCREW DESIG-NATION |
| HF | A1 | O | ● | ● | ● | ● | ● | IN |
| | A2 | O | O | O | O | O | O | 75 |
| | A3 | O | O | O | O | O | O | 150 |
| | A4 | O | O | O | O | O | O | 300 |
| | B1 | • | • | • | • | • | • | |
| | B2 | O | O | O | O | O | O | 600 |
| | B3 | O | O | O | O | O | O | 1200 |
| | B4 | O | O | O | O | O | O | 2400 |
| LF | C1 | O | ● | ● | ● | O | O | .25 |
| | C2 | O | ● | ● | ● | ● | ● | .50 |
| | C3 | O | O | O | O | O | O | 1.0 |
| | C4 | O | O | O | O | O | O | 2.0 |
| | D1 | ● | O | ● | O | O | ● | 250 |
| | D2 | ● | ● | O | O | ● | ● | 500 |
| | D3 | ● | ● | ● | ● | O | ● | 1000 |
| | D4 | ● | ● | ● | ● | ● | O | 2000 |
| 1200-OHM INSERTION LOSS (db) OF CABLE AT 1KC | | 0 | 3.7 | 5.8 | 7.9 | 9.9 | 11.9 | 14.0 |
| LOSS OF EQUALIZER (db) AT 1 KC | 359D | 0 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| | 359A | 6.2 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | |
| HF TOTAL RES. (OHMS) | | ∞ | 4725 | 4725 | 4725 | 4725 | 4725 | |
| LF TOTAL CAP. (UF) | | 0 | 0.75 | 0.75 | 0.75 | 0.5 | 0.5 | |
| LF TOTAL RES. (OHMS) | | 0 | 250 | 500 | 750 | 1250 | 2000 | |

*For an exact cable length shown at the top of the table, use the adjustment for the shorter lengths.
Example: For 30 kilofeet, use the adjustment for the range 24–30 kilofeet.

**Preferably use dummy equalizer (359E or 359J), which has no adjustments and no loss.

O indicates "screw up" (3 full turns).

● indicates "screw down."

• indicates "no screw."