TYPE N AND ON CARRIER SYSTEMS

240-TYPE FLAT-GAIN AMPLIFIERS

AND ASSOCIATED NETWORKS

DESCRIPTION

CONTENTS PAGE

1. GENERAL

A. Scope

1.01 This section describes the 240-type flat-gain amplifier for application to N and ON carrier telephone systems. This amplifier is to be used for the improvement of signal-to-noise ratios in N carrier line sections in order that the channels may meet Bell System requirements for data transmission. The amplifier also may be used to improve regulation on long repeater spans by raising the average carrier level to the center of its regulation range at the input of a repeater or terminal.

1.02 This section is revised to include the 240A2, B2, and C2 amplifier units. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

B. 240-Type Amplifier

1.03 Initially three models of the 240-type amplifier were manufactured; and they were designated 240A, B, or C. Each of these models provides 20 db of gain. These three models have been superseded by the 240A2, B2, and C2, respectively (see Fig. 1 through 3). Each of these amplifiers provides gain step adjustments of 12, 16, and 20 db by means of strapping arrangements on the printed wiring board. Aside from differences in powering arrangements, the 240 A, B, and C are identical in amplification circuitry and transmission characteristics. Similarly, except for differences in powering arrangements, the 240A2, B2, and C2 are identical in amplification circuitry and transmission characteristics. In order that two amplifiers may be powered in series between a positive and a negative cable pair, the power circuitry of the 240A or A2 and 240B or B2 amplifiers complement each other. With two amplifiers in series, a considerable reduction in total power dissipation is realized. The third amplifier, 240C or C2 permits in-service replacement of either the 240A

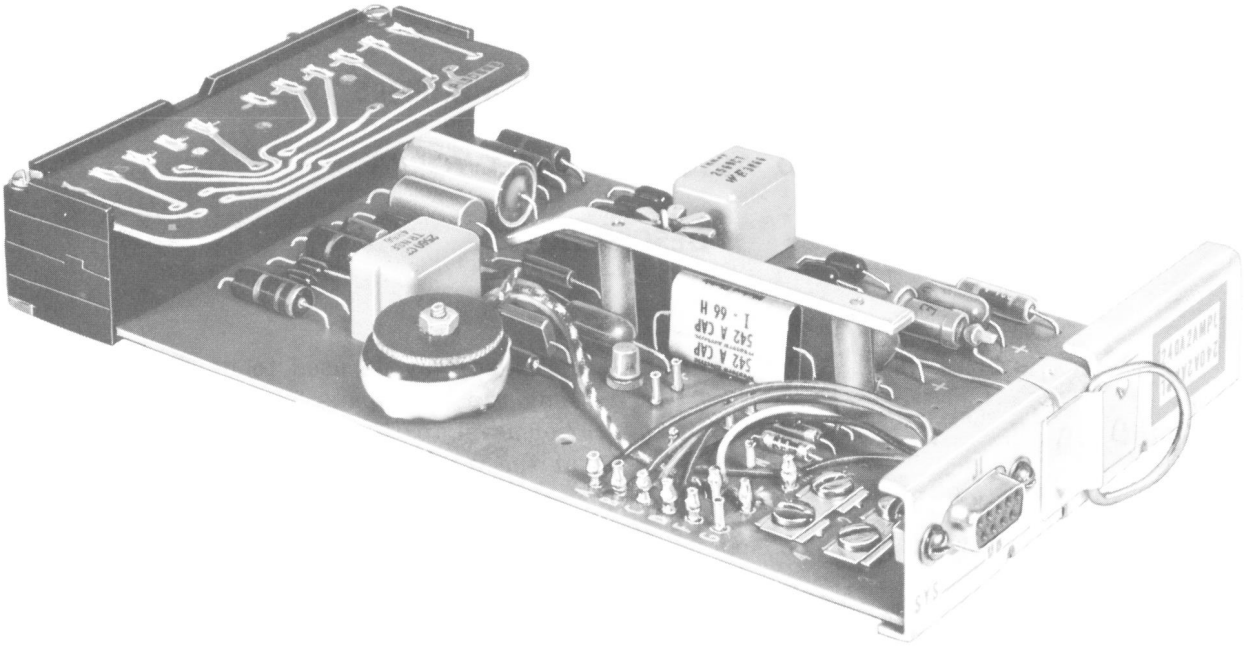


Fig. 1 — 240A2 Amplifier

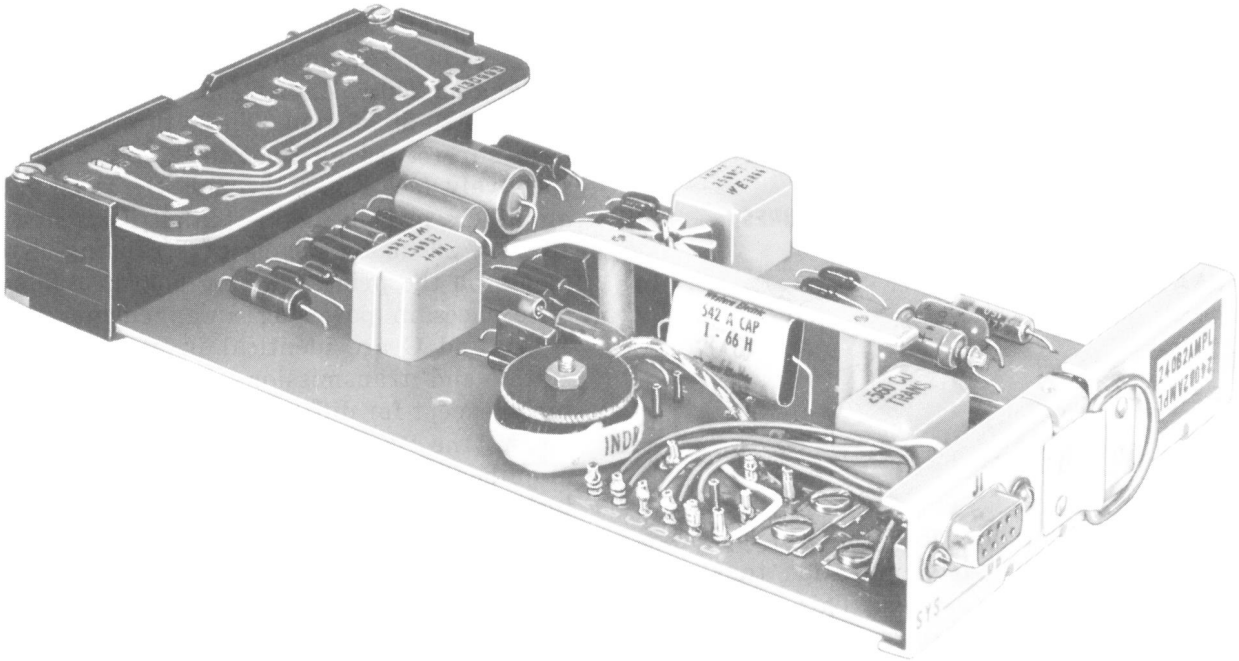


Fig. 2 — 240B2 Amplifier

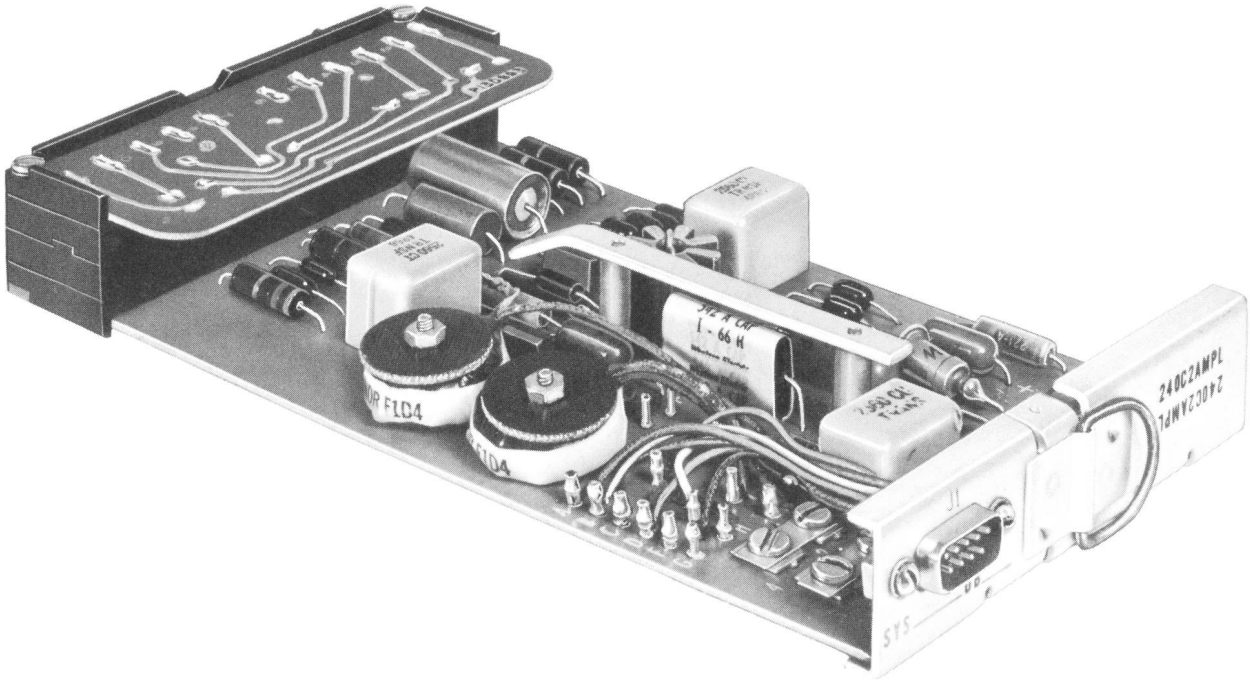


Fig. 3 — 240C2 Amplifier

or A2 or 240B or B2 amplifier during maintenance procedures. The power circuitry of the 240C or C2 will complement either the 240A or A2 or 240B or B2 amplifier.

C. Passive Networks

1.04 The 240-type amplifiers are associated with the 4038A and 4038B networks which perform passive functions. These networks are constructed on the same type printed wiring board as the amplifiers, and the physical dimensions are identical (see Fig. 4 and 5). The 4038A network provides the power circuitry to simulate the dc load of the 240B or B2 amplifier in locations where the 240B or B2 amplifier is not required. It is also used when it is desired to power each amplifier separately on lightly loaded routes and for service protection. In this case, care should be taken to ensure that the stub cable to the 469A apparatus case is spliced corectly for this type of operation. (See Section 632-520-210.) The 4038B network provides circuitry for making through connections of noncarrier pairs that are brought into the 469A apparatus case. These pairs are generally brought into a partially filled cabinet at the the time of installation in anticipation of future needs.

D. APPARATUS CASE

1.05 Housing for the 240A-type amplifiers is provided by the 469A apparatus case. The apparatus case is a hermetically sealed cabinet which is approximately 39 inches long and 12 inches in diameter. When in service, the cabinet is maintained at about the same pressure as the cable. Mounting brackets are provided for mounting the case horizontally on a manhole wall or vertically on a pole. The interior of the case contains a framework to accommodate twenty-four plug-in amplifiers or networks and a twenty-fifth position for the 240C or C2 switching amplifier (see Fig. 6).

1.06 Power control may be exercised through a group of potentiometers (4039A network) which are part of the 469A apparatus case and allow for adjusting the dc current to the amplifiers at the time of installation. Test points are provided to measure the dc current during adjustment. As a second but important function, the 4039A network acts as a heat reflector in order to maintain the temperature inside the case at a tolerable level.

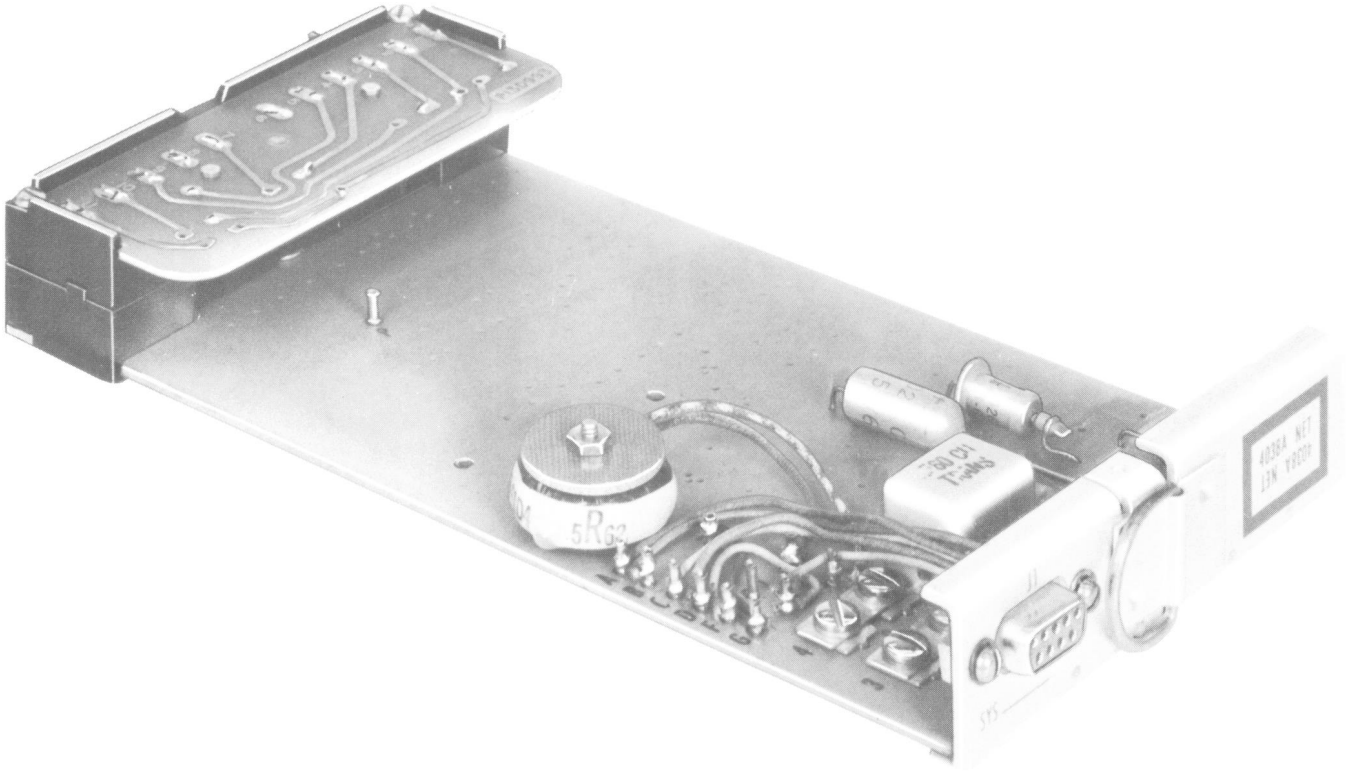


Fig. 4 — 4038A Network

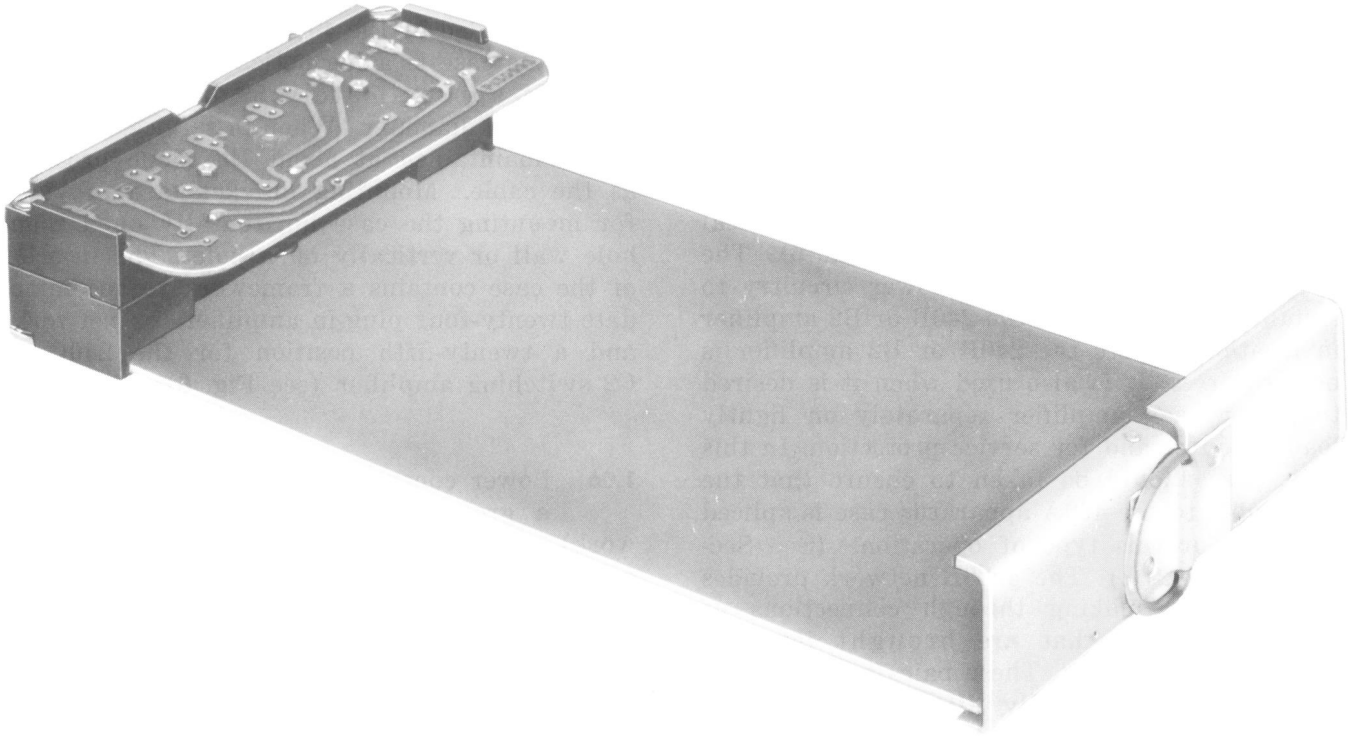


Fig. 5 — 4038B Network

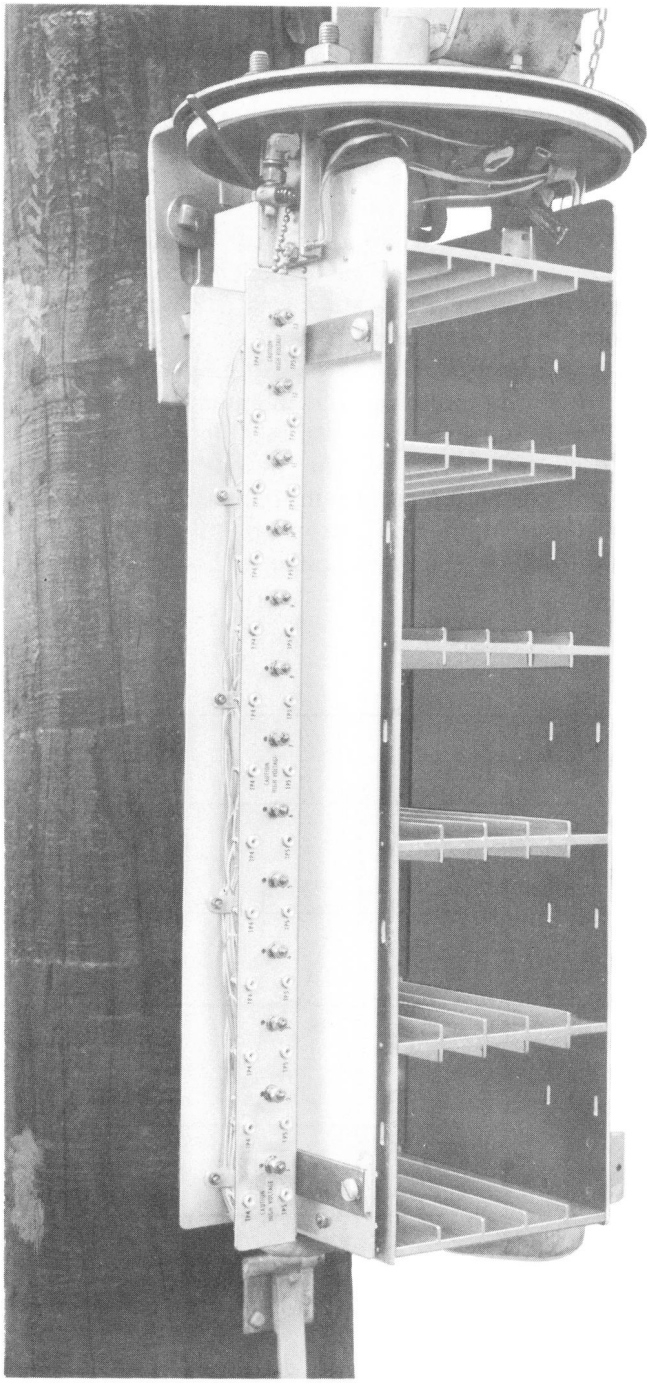


Fig. 6 — Interior of 469A Apparatus Case

2. EQUIPMENT DESCRIPTION

2.01 The 240-type amplifiers are constructed on printed wiring boards which are approximately 4 inches wide and 8 inches long. The components and front panel extend up to 1 inch above the base of the board, and the entire assembly slips into a protective metal case. For switching purposes during maintenance procedures, the 240A or A2 and B or B2 amplifiers each have a 9-pin female receptacle mounted on the front panel and the 240C or C2 amplifier is equipped with a 9-pin male plug.

2.02 Associated with the 240-type amplifiers and 4038 networks are the P9E switching cord and the P4AP adapter cord. The P9E cord has a jack on one end which mates with the 240C or C2 amplifier and a plug on the other end which mates with the 240A or A2 or B or B2 amplifiers or the 4038A network. The P9E cord together with the 240C or C2 amplifier is used for in-service switching. The P4AP adapter cord is used to provide connections between the amplifiers and either the 2J repeater test set or the KS-15538 carrier frequency voltmeter. A photograph of the P9E switching cord and P4AP adapter cord is shown in Fig. 7.

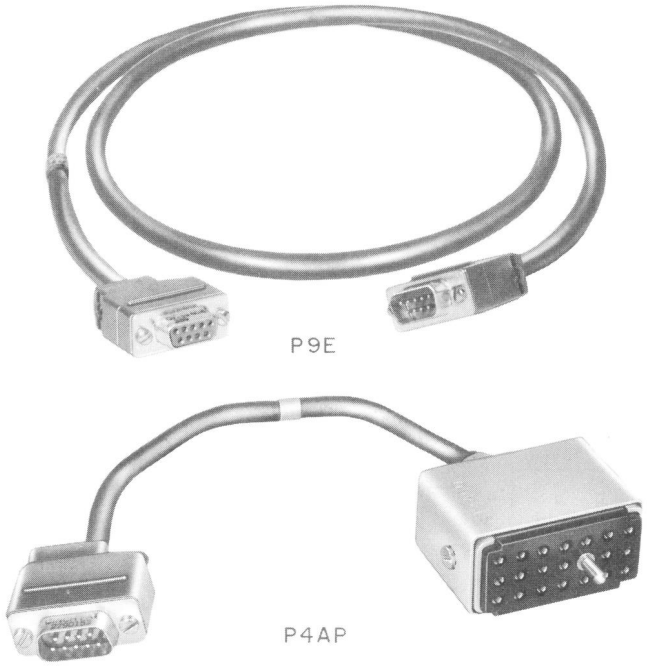


Fig. 7 — P9E Switching Cord and P4AP Adapter Cord

3. CIRCUIT DESCRIPTION

A. General

3.01 The 240-type amplifier is installed in the line to raise the carrier level or to improve the signal-to-impulse noise ratio. In other cases, the 240-type amplifier may be installed before the line repeater to minimize noise and/or to raise the carrier level, as determined by the existing field condition. With the 240-type amplifier installed in the cable pair, a dc bypass around the amplifier is necessary to provide power to the following repeater. This dc bypass connection provides a convenient pick-off point for the dc power required by the amplifier.

3.02 Normally the 240A or A2 amplifier is installed in a cable pair connected to a −130 volt supply and the 240B or B2 is connected to the +130 volt pair. However, power options are provided on each amplifier or 4038A network through the use of strapping arrangements which allow either amplifier to be installed in either a positive or negative cable pair.

3.03 Provisions are also made on each 240-type amplifier for installation as a one-direction device in a system or as a 2-way device in both directions within the same system (see Fig. 8 and 9). This is possible through the use of different splicing arrangements between the 469A apparatus case stub cable and the main cable. Turnover of the second amplifier for 2-way operation is accomplished by transposing both the input and output pairs of the second amplifier at the stub splice. This is illustrated in Fig. 10.

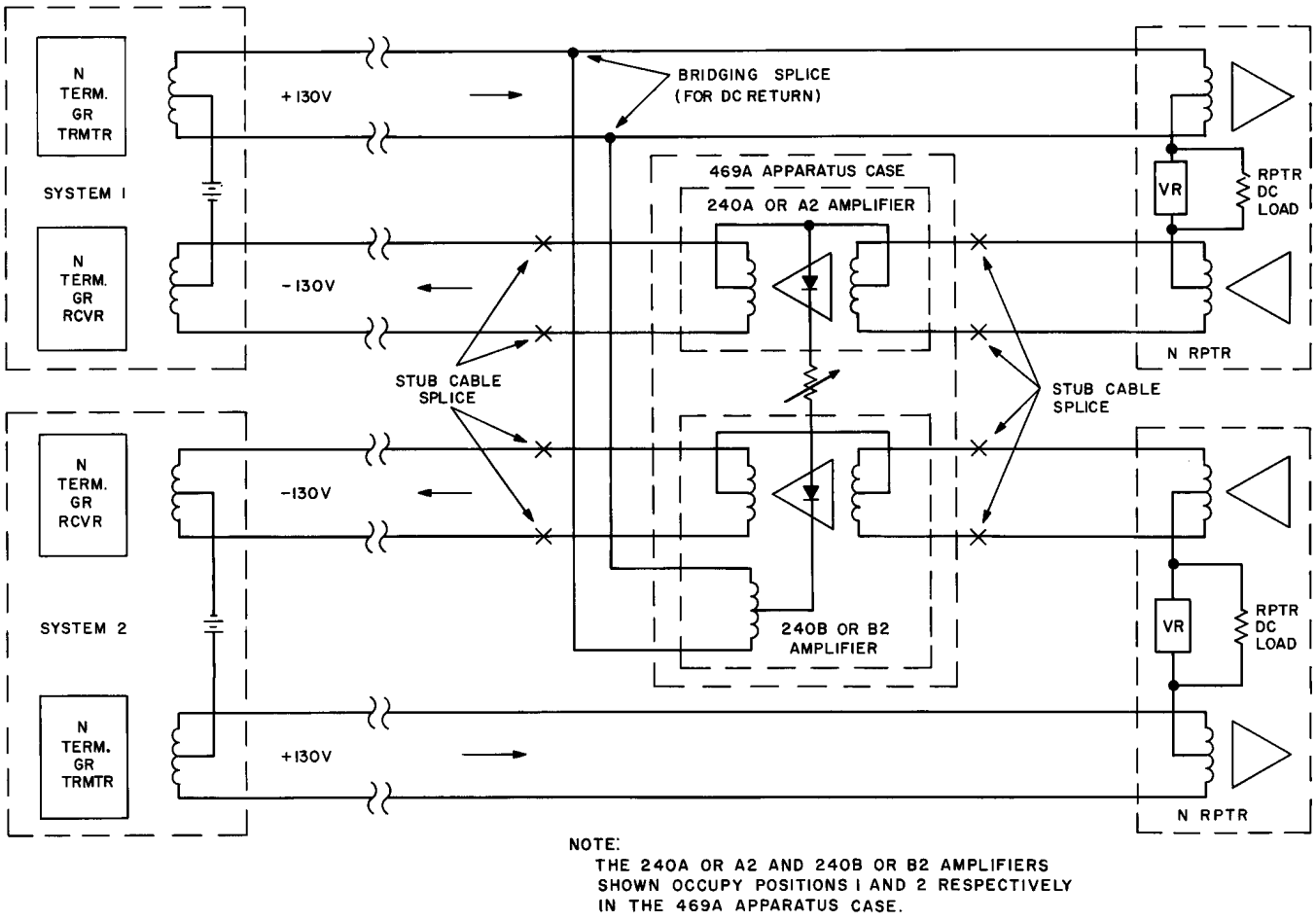


Fig. 8 — 240-Type Amplifiers Connected for One-Way Operation

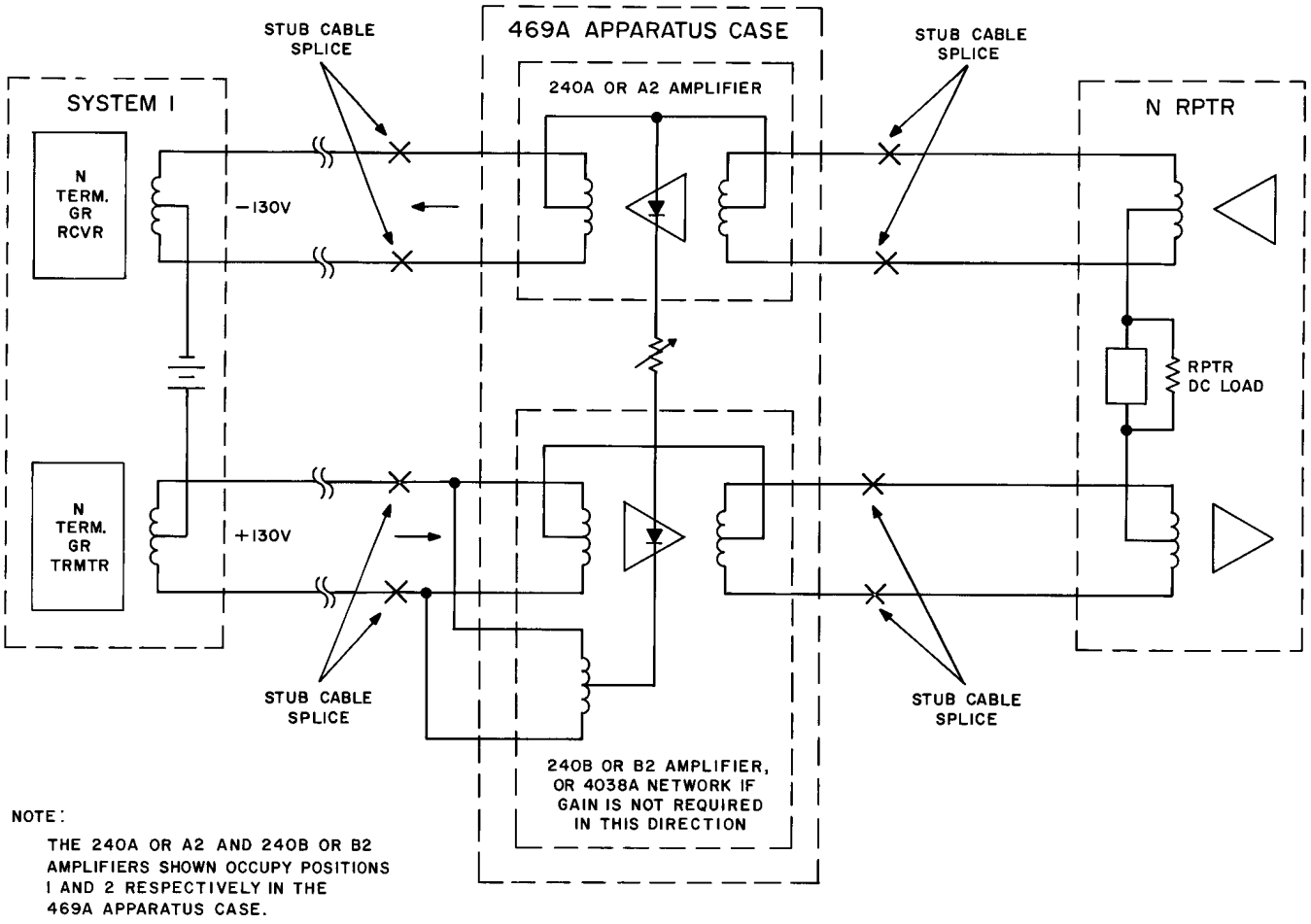


Fig. 9 — 240-Type Amplifiers Connected for 2-Way Operation

B. Amplifier Circuit

3.04 The 240-type amplifier consists of two common-emitter stages utilizing both local and bridged loop feedback. (Schematics of the 240A2, 240B2, and 240C2 amplifiers are shown in Fig. 11 through 13.) Local feedback is used to reduce the total amount of loop feedback needed to obtain the required stability and modulation performance. With feedback, the amplifier has a gain of 12, 16, or 20 db with a virtually flat response over the operating range of 36 to 268 kc.

3.05 The input signal is applied to terminals 1 and 2 through current limiting resistors R1 and R2 (see Fig. 11). These resistors limit the current to approximately 50 ma, providing protection for the varistors should one side of the line become grounded because of unbalanced carbon block action. Secondary protection of the amplifier input is also provided by varistors RV1 and RV2 connected between the input terminals. The signal is then coupled through transformer T1 to the base of transistor Q1. Transformer T1 matches the cable impedance of 125 ohms to the input impedance of the transistor, which is approximately 700 ohms. The dc bypass is connected between the center tap of T1 and the center tap of T2.

3.06 Resistor and capacitor network R3 and C1 across the highside winding of transformer T1, in conjunction with capacitor C6 across T2 and shunt capacitor C4, provide high-frequency shaping for stability purposes.

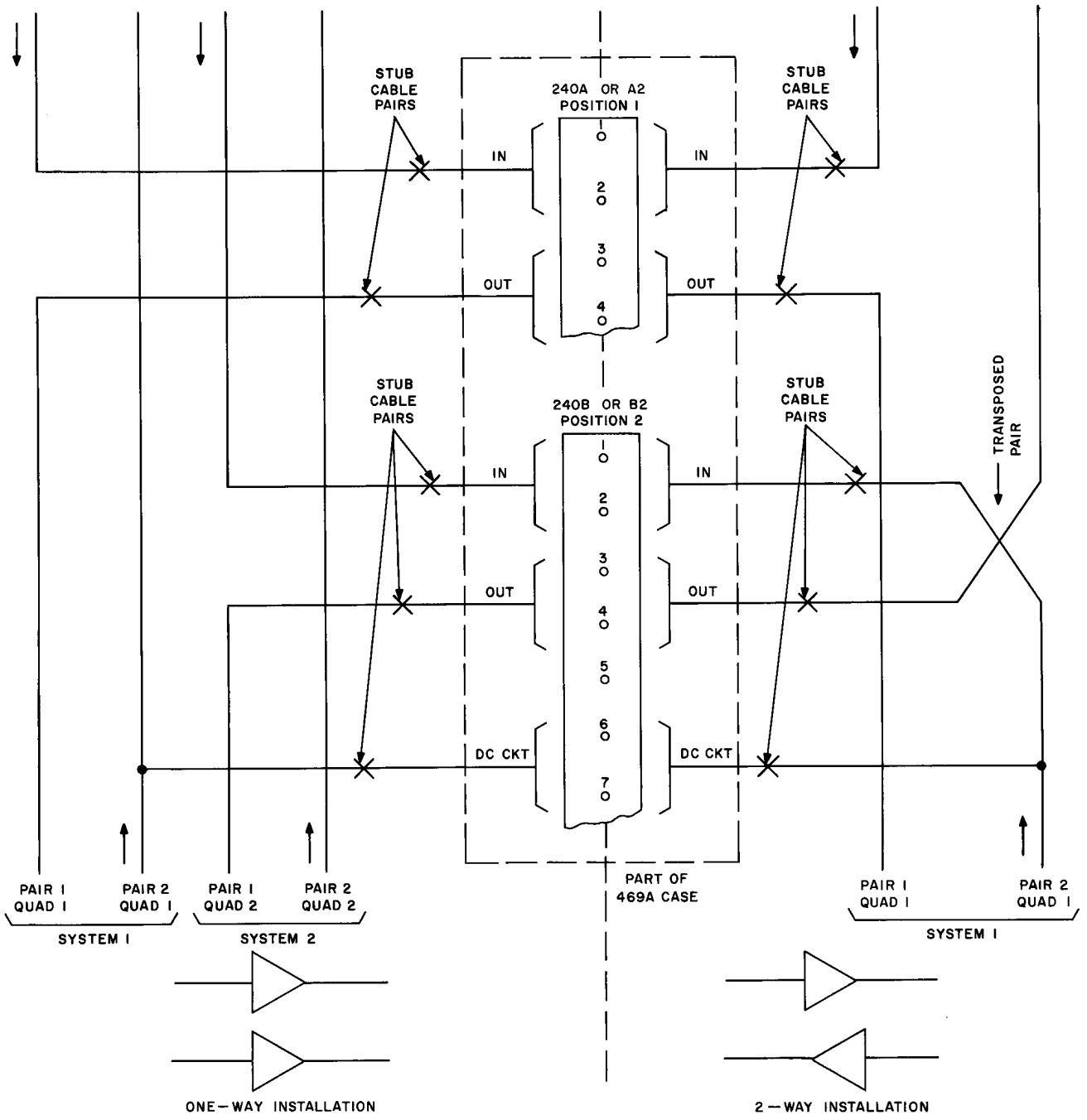


Fig. 10 — Stub Cable Connections for One- and 2-Way Operation

3.07 Transistor Q1 is biased by base resistor R10 and emitter resistor R4, with capacitor C2 serving as the emitter bypass. Capacitance coupling is used, with capacitor C3 coupling the output of Q1 to the input of the second stage. The base of Q2 is biased by resistor R6 and is returned to the same point on the voltage divider as the base resistor of Q1. Negative feedback from the output of Q2 to the input of Q1 is used to improve stability and modulation performance. The feedback path is from the low side of the primary winding of transformer T2 through series resistors R8 and R9 and capacitor C11, which shape the feedback voltage. Resistors R17 and R18 along with R9 are used to provide the gain adjustment for the

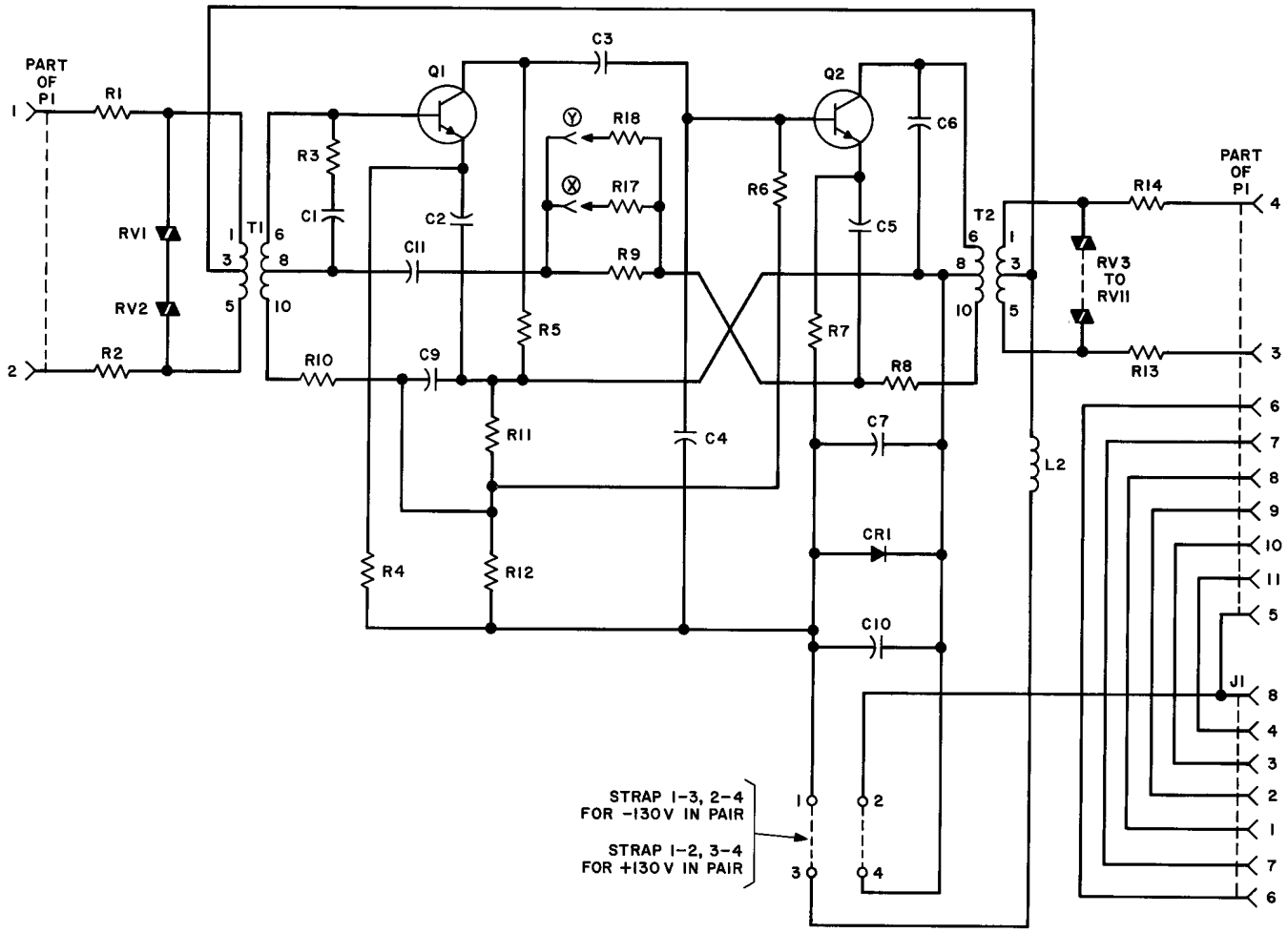


Fig. 11 — 240A2 Amplifier, Schematic

240A2, B2, and C2 amplifiers. These amplifiers are originally strapped for a 12-db gain when shipped from the factory (options X and Y). Only option X is provided for a 16-db gain. Neither option X nor Y is provided for a 20-db gain. Local feedback of the series type is also used on transistor Q2 and is provided by the unbypassed emitter resistor R7. The local feedback loop is from the output transformer to the emitter circuit through capacitor C5. Transformer T2 couples the output signal from Q2 to terminals 3 and 4 of terminal board P1. Nine varistors, RV3 through RV11, provide secondary protection on the output, and resistors R13 and R14 provide current limiting protection for the varistors.

C. Power

3.08 To conserve current and also to reduce the heat dissipated at the amplifier installation, the amplifiers are operated in series from one power source. Connecting two amplifiers in series reduces total power dissipation for a fully equipped case from 120 watts, if each amplifier is powered individually, to 58 watts.

3.09 Each amplifier requires 22 volts, or 44 volts is required for the two amplifiers in series. The current through each pair of amplifiers is set to 0.025 amperes during installation by the current adjusting potentiometers on

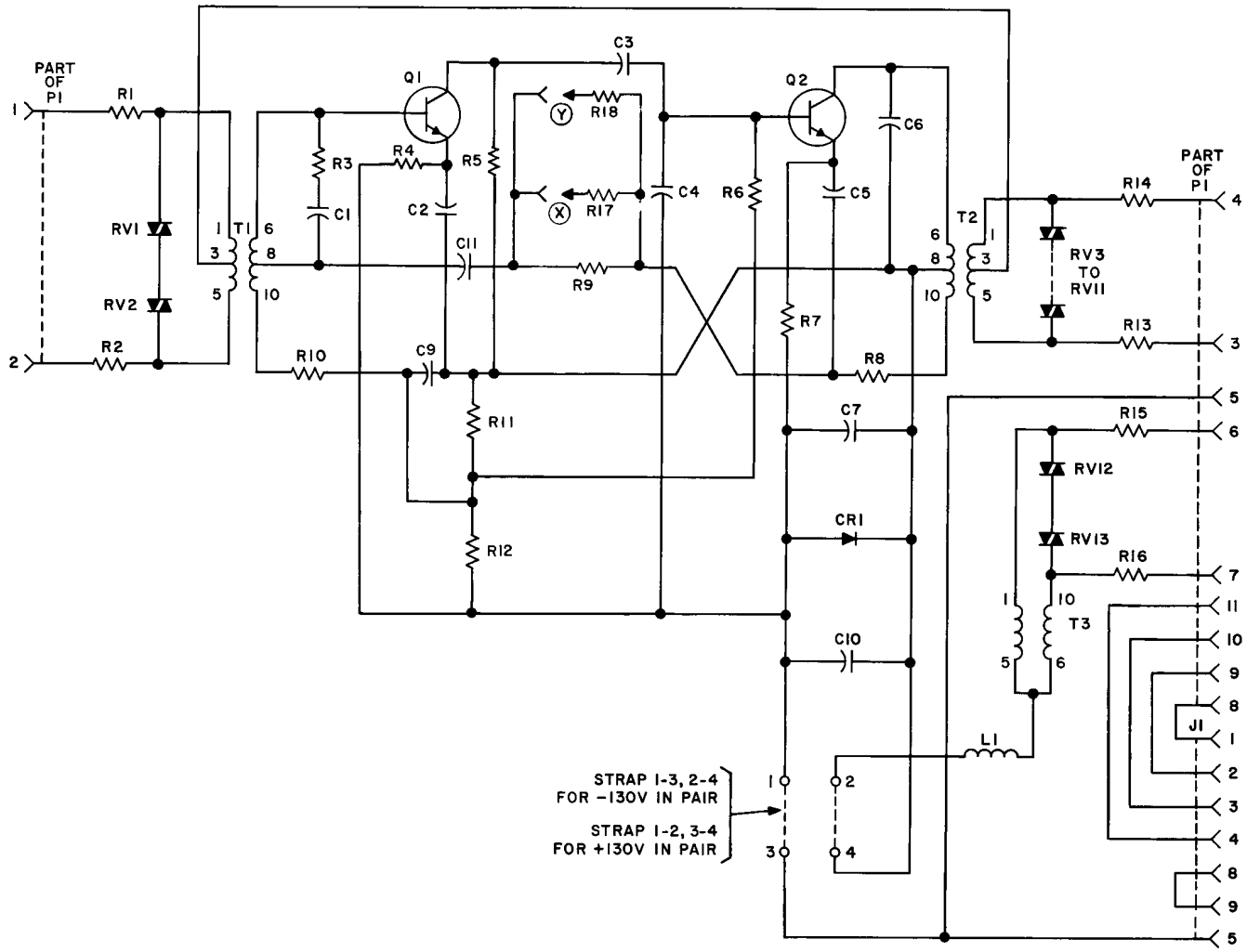


Fig. 12 — 240B2 Amplifier, Schematic

the 4039A network, which is part of the 469A apparatus case. This current is determined by reading the voltage across a 100-ohm resistor also located on the 4039A network (see Fig. 6).

3.10 ***240A or A2 Amplifier:*** Power is applied to the 240A or A2 amplifier through inductor L2 from the dc bypass connected to the center taps of transformers T1 and T2 (see Fig. 11). The inductor provides a high impedance to carrier frequencies. A strap option is provided on each amplifier by four terminals. With the 240A or A2 normally connected to a negative 130-volt transmission cable pair, terminal 1 is strapped to terminal 3 and terminal 2 to terminal 4 on the printed circuit board. Should the amplifier be connected in a positive 130-volt cable pair, terminal 1 should be strapped to terminal 2 and terminal 3 to terminal 4. In either case, the 22 volts applied across the reference diode CR1 will always be the same polarity. The diode is used as a voltage regulator.

The 22 volts also appears across bias capacitors C7, C9, and C10, and is applied to voltage divider R11 and R12. The base resistors for transistors Q1 and Q2 are returned to —14 volts on the voltage divider.

3.11 ***240B or B2 Amplifier:*** The 240B or B2 amplifier power circuitry is connected in series with that of the 240A or A2 amplifier and completes the dc return path to the line with the opposite polarity. Power is applied from the 240A or A2 amplifier through the 4039A potentiometer network on the apparatus case to pin 5 on terminal board P1 of the 240B or B2 amplifier (see Fig. 12). Strapping for the 240B or B2 should be identical to the 240A or A2, with terminals 1 and 3 and terminals 2 and 4 strapped for the normal —130 volt connection of the 240A or A2 amplifier. Bias arrangements for the amplifiers are the same. The dc return path for the two amplifiers is made through pins 6 and 7 from inductor L1, transformer T3, and the current limiting resistors R15 and R16. Transformer T3 is a 1 to 1 transformer with its windings connected in series. The transformer is used to provide a low dc impedance and a high ac bridging impedance on the cable pair.

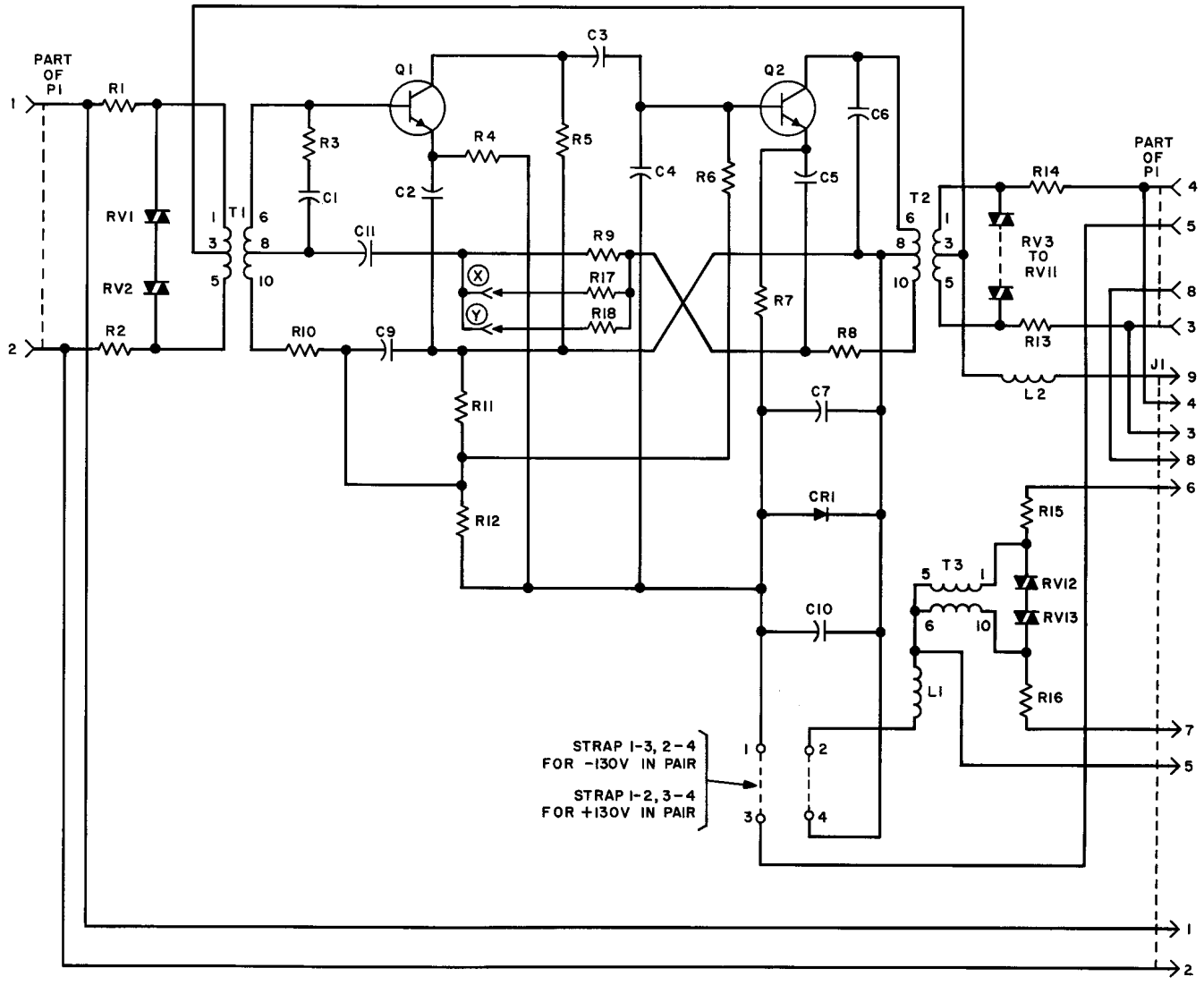


Fig. 13 — 240C2 Amplifier, Schematic

3.12 ***240C or C2 Amplifier:*** Powering arrangements for the 240C or C2 amplifier are the same as for the 240A or A2 and 240B or B2 amplifiers (see Fig. 13). However, the terminal connections are different in order that the amplifier may be connected to either the 240A or A2 or 240B or B2 during an in-service switching procedure. Connections are made via the P9E switching cord between the amplifier paired with the defective amplifier and the 240C or C2 amplifier. The questionable amplifier is then removed. Fig. 14 is a simplified schematic of the power connections with the 240A or A2 amplifier. Figure 15 shows the power connections with the 240C or C2 amplifier bridging the 240B or B2 amplifier. Actual terminal connections and apparatus case wiring for positions 1 and 2 are shown in Fig. 16, with the 240C or C2 connected to the front panel jack of the 240B or B2 amplifier via the P9E switching cord.

4. TRANSMISSION CHARACTERISTICS

4.01 ***Frequency Response:*** The frequency response of a 240-type amplifier is flat from approximately 40 to 268 kc, and down 0.1 db at 36 kc. This is shown in the gain versus frequency graph of Fig. 17.

4.02 ***Gain-Load Capability:*** The gain-load capability requirement is 15.0 dbm for a single-frequency tone. As shown in Fig. 18, a maximum output power of approximately +18 dbm for a single tone is obtained before gain fall-off occurs. Total carrier power output under normal circumstances is +3 dbm.

4.03 ***Temperature Versus Gain:*** The amplifier is relatively stable over a temperature range of −40° C to +70° C. A drop in gain of 0.08 db occurs at +70° C and may be attributed to an increase in copper loss in the transformers at the higher temperatures.

4.04 ***Modulation:*** Modulation measurements for a typical amplifier show that the 2F (second harmonic of the carrier) and 3F (third harmonic of the carrier) products are at least 55 db from the fundamental at the single-frequency output power point of +15.0 dbm. This compares with the same performance as the HL N1A repeater.

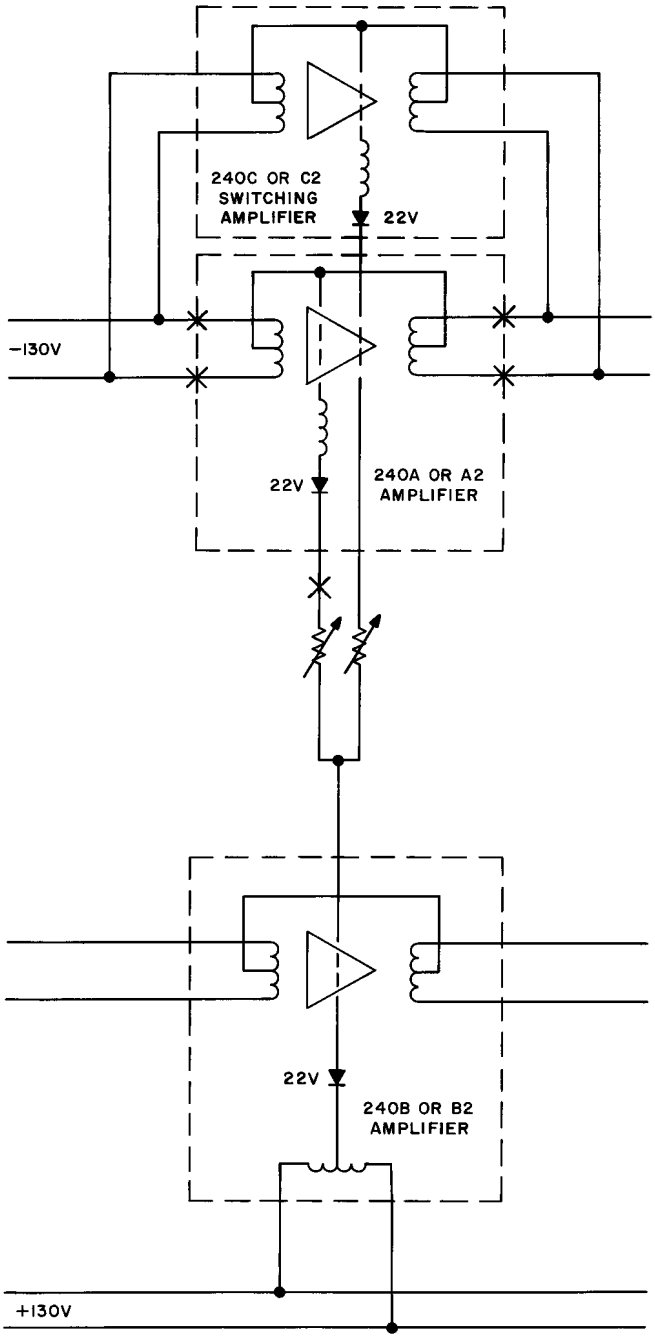
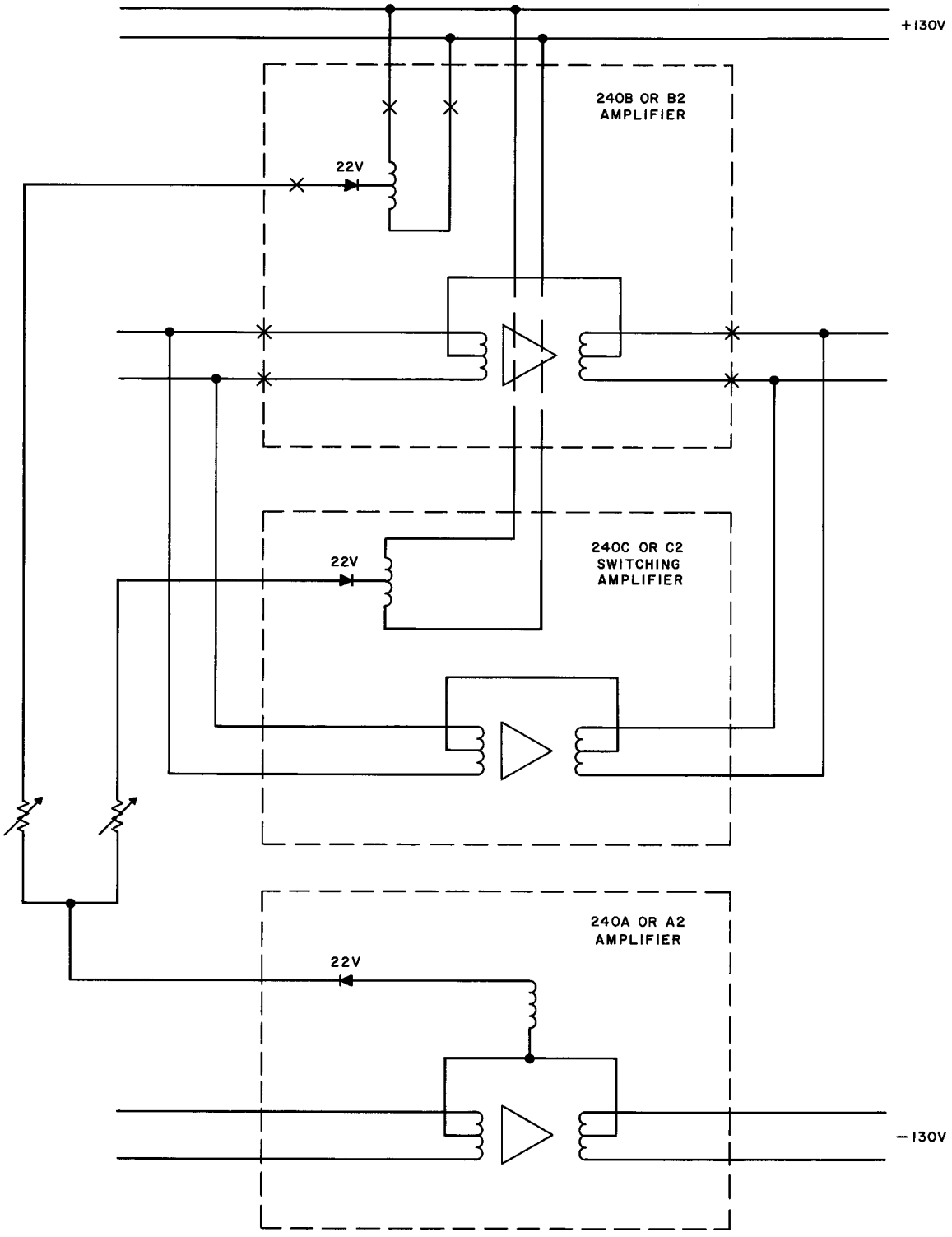


Fig. 14 — Bridging Condition Prior to Removal of 240A or A2



NOTE:
"X" REPRESENTS CONTACTS THAT ARE BROKEN WHEN 240B OR B2 AMPLIFIER IS REMOVED.

Fig. 15 — Bridging Condition Prior to Removal of 240B or B2

4.05 *Crosstalk:* Crosstalk coupling within the apparatus case has been measured. By sending a single frequency into an amplifier located in the center of a fully equipped apparatus case, a measured equal level coupling loss of better than 60 db is obtained. Coupling at this level will not be sufficient to cause intersystem interference.

5. TESTING AND MAINTENANCE FEATURES

5.01 In order that maintenance procedures may be performed on the 240A or A2 or 240B or B2 amplifier without interrupting normal service, either amplifier may be switched out of the circuit and a test amplifier substituted in its place. This is accomplished by paralleling all circuits on the amplifier to be removed from service with the 240C or C2 amplifier (see Fig. 19). With the circuits in parallel, the defective amplifier can be removed and replaced without disrupting either power or transmission within the assigned N system. This type of manual switching results in an initial 50- to 75-microsecond hit with a level of approximately 10 db. At the end of this interval, the hit will have decayed to 1 db. The bridging connection is made by the P9E cord from the J1 test connector on either the 240A or A2 or 240B or B2 amplifier to the J1 connector on the 240C or C2 amplifier. Also the J1 test connectors may be used for in-service measurements of the total average carrier output. A P4AP adapter cord is used to connect the amplifier to the 2J repeater test set or the KS-15538 carrier frequency voltmeter.

6. DRAWINGS

6.01 The following schematic drawings (not attached) provide additional information.

SD-97154-015 — Common Systems N and ON Carrier Telephone, Application Schematic for Flat-Gain (240-Type) Amplifier

SD-97272 — Repeater Power Application Schematic

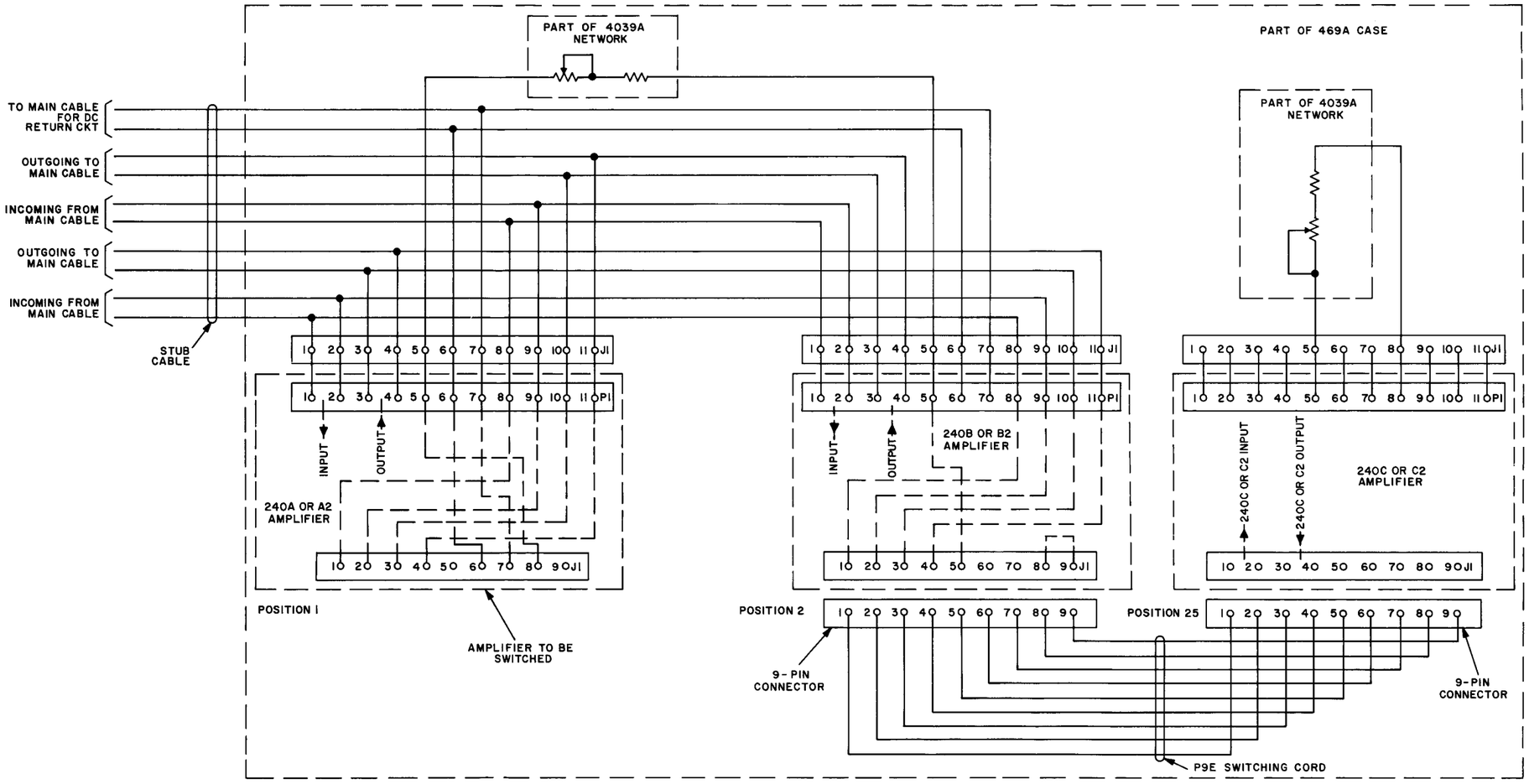


Fig. 16 — Terminal Connections in Switching a 240A or A2 Amplifier

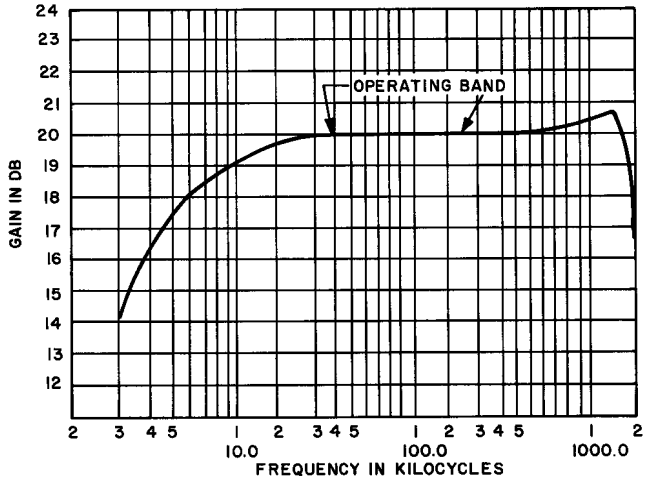


Fig. 17 — Typical Gain Versus Frequency Characteristic for 240-Type Amplifier (20-db gain)

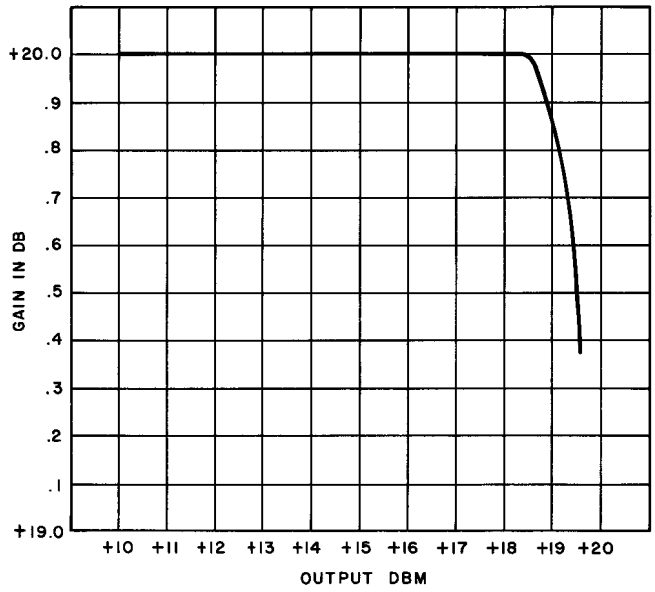


Fig. 18 — Typical Gain Versus Load Characteristic for 240-Type Amplifier (20-db gain)

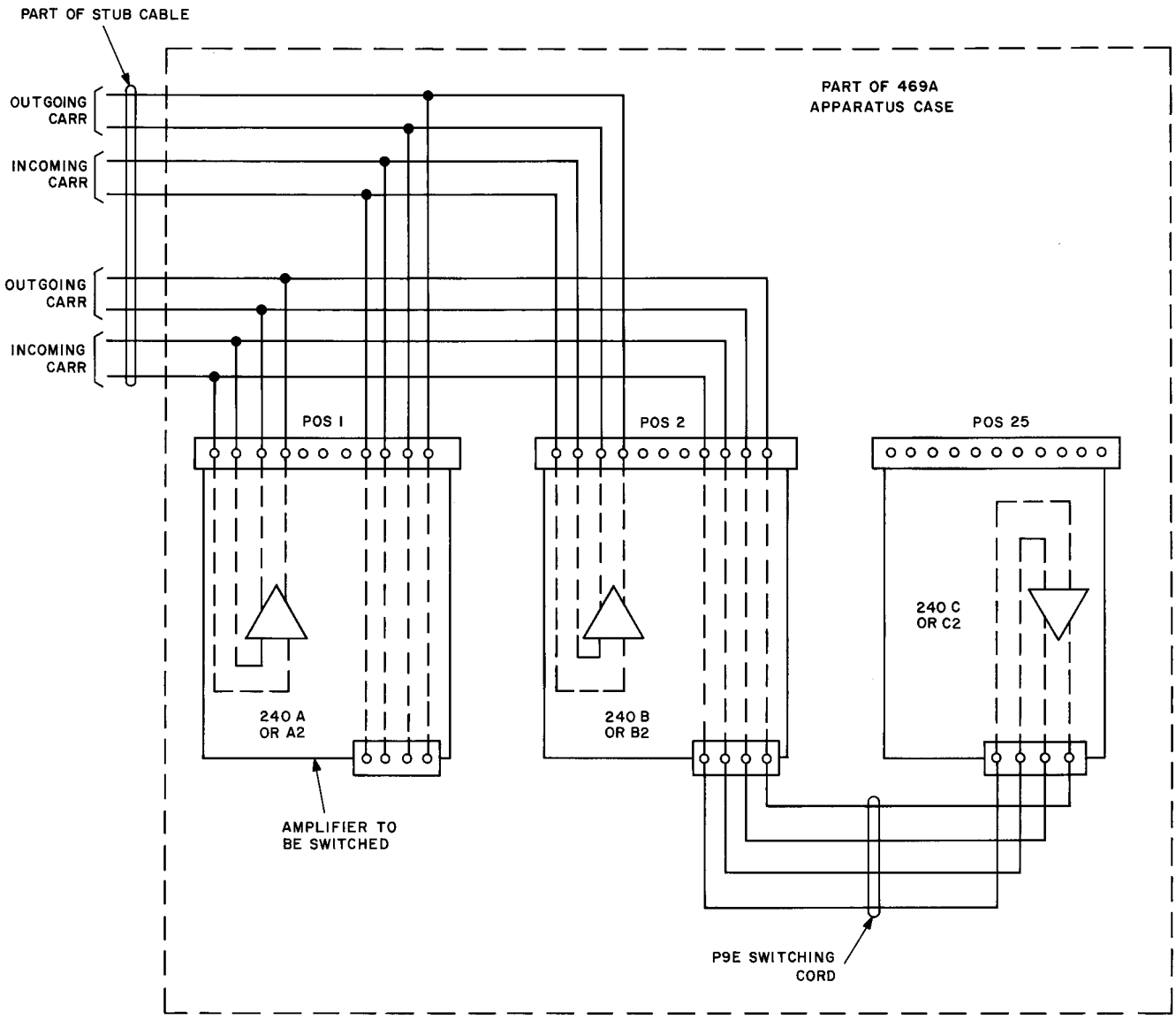


Fig. 19 — Switching a 240A or A2 Amplifier