J68338A IF SWITCHING AMPLIFIER

J68338B IF DISTRIBUTING AMPLIFIER

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1. GENERAL

1.01 This section pertains to the J68338A IF Switching Amplifier and the J68338B IF Distribution Amplifier. These amplifiers are used for program and maintenance switching and distribution at IF frequency in the repeater and terminal locations of the TD-2 Radio System. Detailed circuit information and equipment features are covered and transmission characteristics are outlined. Related photographs, simplified schematics and references are included as a part of this section.

1.02 The J68338A IF Switching Amplifier is an intermediate frequency amplifier with two inputs and a single output. By means of a DC control voltage, a transmission path from either input to the common output may be selected. The working gain from either input to the common output is unity for most applications. If the controlled voltage is not applied, there is no transmission from either input.

1.03 The J68338B IF Distributing Amplifier is a wide band intermediate frequency amplifier with a single input and three outputs. Transmission is continuous to each output.

2. IF SWITCHING AMPLIFIER

(A) Equipment Features

2.01 The IF Switching Amplifier is designed to present minimum front panel area so that several amplifiers may be arranged to form a patching field. The amplifier has a front panel 3-1/2" wide x 5-1/4" high on which are located the input, output, and monitoring jacks, the gain adjusting controls, and two indicating lamps whose function is to show which input path is transmitting to the output circuit. The amplifier is constructed on a vertical chassis extending 8-1/2" behind the front panel. Connectors are provided at the rear of the chassis for power and tube testing functions.

2.02 The mounting framework for the amplifier is 5-1/4" high, is designed for use on duct-type bays, and provides space for five amplifiers which may be any combination of switching and distributing amplifiers. Each amplifier is located in the framework by means of guide bars at the top and bottom which engage channels provided on the amplifier chassis. The amplifiers are a plug-in type and when they are pushed in place the power connections are made through a plug and jack arrangement. The plug is mounted on the amplifier chassis and the power jack is mounted on the framework. The rear of the framework also mounts a filament dropping resistor and a jack both of which are required for filament activity tests. The wiring at the power jack and the value of the filament dropping resistor is different for switching and distributing amplifiers. Arrangements are made according to job engineering requirements. A jack strip may be attached to the top or bottom of the framework to terminate IF trunks and to mount control switches for the line switching amplifiers.

2.03 All of the vacuum tubes required for the switching amplifier are provided installed in their sockets. The tube compliment is two 404A vacuum tubes. Two G.E. type NE 51 neon lamps are used as indicators.

2.04 Power is supplied to the IF Switching Amplifier from the 130V and 12V supplies. The current drain from 130V is 0.03A and from 12V is 0.6A.

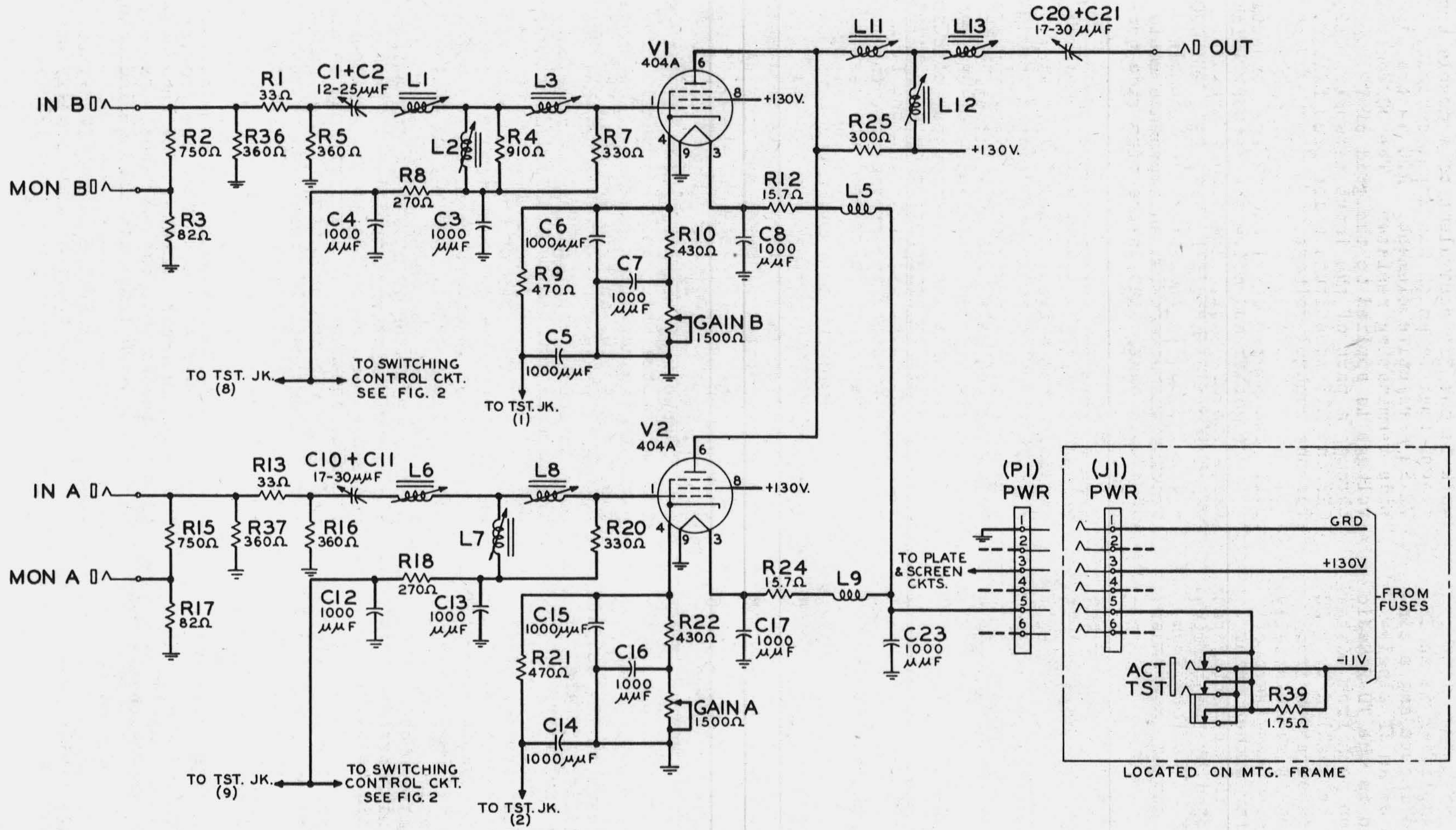


Fig. 1 - IF Switching Amplifier Simplified Schematic of Transmission and Power Circuits

(B) Circuit Description

2.05 The IF Switching Amplifier is an IF amplifier with two inputs and a single output. It is used as an IF single-pole double-throw switch in the TD-2 Radio System. The transmission path from either input to the output may be enabled by a DC control voltage. The transmission from either input to the output is substantially flat from 60-80 mc. The working gain of the amplifier is unity for either path. The transmission through the operating path is substantially unaffected by the termination at the unused input. The loss from the unused input to the output is greater than 55 db.

2.06 The switching amplifier includes two pentode amplifier tubes whose plates are connected to a single output transformer which drives the output circuit. The amplifier tubes are enabled or disabled by varying their DC grid potentials. Gain controls are provided so that the transmission through each path may be adjusted to unity. The control will cover a gain variation of 5-6 db and in certain cases gain settings other than unity gain are used.

2.07 Switching control is provided by a key located in the adjacent jack strip or by a remote control circuit. Indicator lamps on the front panel indicate which transmission path is operating. Monitor jacks are provided at the input so that the signal applied to the disabled path may be monitored before a switch is made.

2.08 A simplified schematic of the transmission and power circuits of the IF switching amplifier is given in Fig. 1. The inputs for the switching amplifier are applied to the IN A and IN B jacks which are designed to connect with 75 ohm unbalanced circuits. Input monitor jacks MON A and MON B are bridged to the input circuits through R2 and R15, R3 and R17 provide terminations for the monitor circuits. When the monitor jacks are connected to a 75-ohm circuit, the signal delivered to the monitor circuit is 26 db below the signal in the transmission path.

2.09 The IN B jack drives a resistance pad (R36, R1 and R5) which in turn feeds the input network which includes C1 + C2, L1, L2, L3 and R7. This network is the "T" equivalent of a double-tuned transformer in which the input capacity of V1 is used as a reactive element. R7 forms the high side termination for this equivalent transformer. The DC control voltage is applied to the grid of V1 through a part of the input network. C3, C4 and R8 comprises a low pass filter for the control voltage.

2.10 The IN A jack drives a resistance pad (R37, R13 and R16) which in turn feeds the input network which includes C10 + C11, L6, L7, L8, and R20. This network is the "T" equivalent of a double tuned transformer in which the input capacity of V2 is a reactive element. R20 is the high side terminating resistor. The DC control voltage is applied to the grid of V2 through a part of the input network. C12, C13 and R18 constitute a low pass filter for the control voltage.

2.11 The plates of V1 and V2 are connected together and drive the network which feeds the OUT jack. The output network, which includes R25, L11, L12, L13, and C20 + C21, is the "T" equivalent of a double tuned transformer with an impedance ratio of 300:75 ohms. R25 is the high side termination.

2.12 When a transmission path is enabled, the control grid of the tube in question is positioned at +9 volts with respect to ground. When a transmission path is to be disabled the -11 volt filament supply voltage is applied to the control grid. The +9 volts which is applied to the control grid in the operating condition requires a high value of cathode resistance to avoid excessive plate and screen currents. This method of operation gives a high negative feedback at DC, which tends to stabilize the amplifier gain against tube variations.

2.13 If V1 is conducting, its cathode current flows to ground through R10 and the GAIN B rheostat. These resistors provide DC feedback and fix the operating bias of the tube. The GAIN B rheostat appears on the front panel and is used to adjust the gain of V1 when it is conducting. R10 is a fixed resistance which determines the tube bias when the gain control is set for maximum gain. Similarly, the cathode circuit of V2 includes a fixed resistor R22 and the GAIN A rheostat. The cathode resistors are bypassed by condensers C6, C7, C15 and C16.

2.14 Fig. 2 is a simplified schematic of the switching control circuits of the amplifier. The function of the circuit is to apply a positive voltage to a resistance voltage divider so that a nominal +9V is supplied to the control grid of the tube in the enabled path. In the absence of this voltage -11V appears at the grid and the tube is disabled. The resistance voltage divider includes R26, R30, and R33 + R35 for V2 and R27, R28 and R33 + R35 for V1.

2.15 A pair of neon lamps are used to indicate the operation of the switching amplifier. These lamps, IA and IB, are connected to the resistance voltage divider so that the potential across a lamp is -11 volts when the

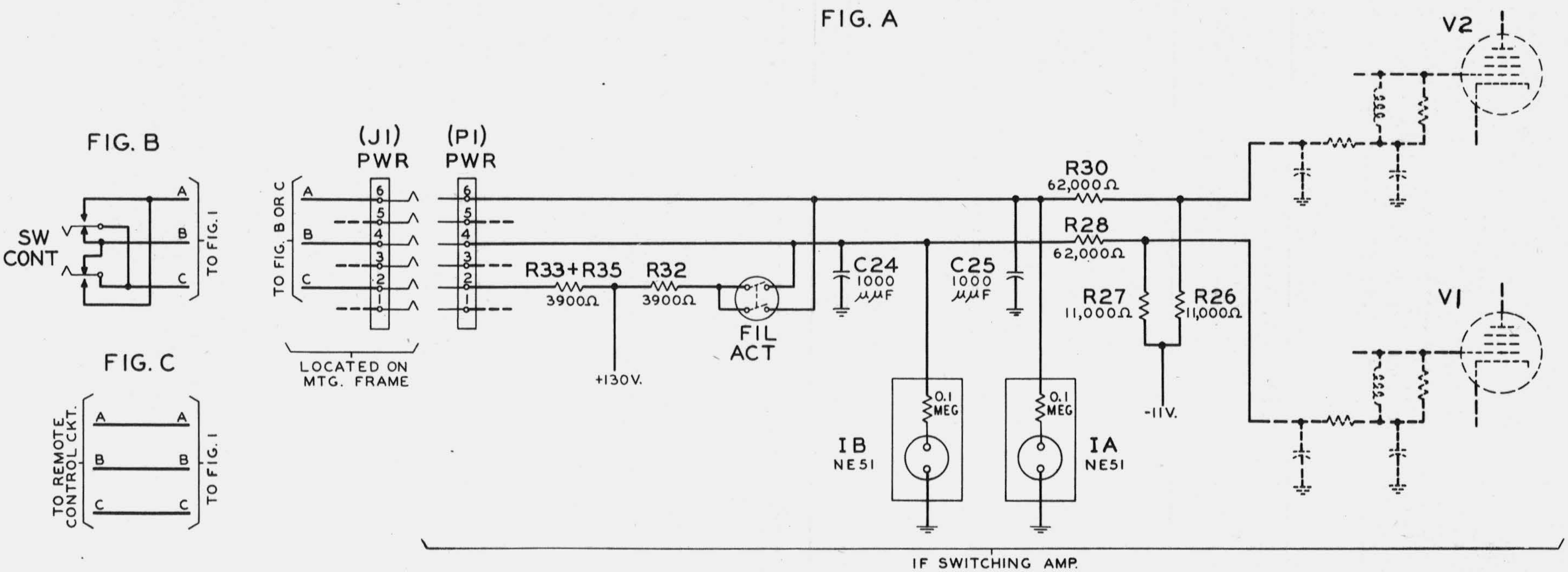


Fig. 2 - IF Switching Amplifier Simplified Schematic of Switching Control Circuits

corresponding amplifier tube is disabled and +120 volts when the amplifier tube is enabled. 0.1 megohm protective resistors are built into the indicating lamp sockets.

2.16 The switching control leads are carried through the PWR jack and may be energized by either the SW CONT key on a nearby jack strip or by a relay at some other location if remote control of the switching function is desired.

2.17 For filament activity testing, it is necessary to enable both amplifier tubes at the same time. This may be accomplished by a spring return switch designated FIL ACT, located on the rear of the amplifier chassis. Operation of this switch completes both voltage dividers and thereby enables both vacuum tubes. Both indicator lamps are lit when this switch is operated.

2.18 Heater power is supplied to each tube through a low pass filter which includes a series resistor. Because of this resistor tubes tend to operate at constant heater power despite tube-to-tube variations in heater resistance. This method of operation results in more uniform tube life. The series resistor is designed so that with an 11V filament battery supply 6.3V will appear across the heater of a normal tube. R12 and R24 are the series resistors for V1 and V2.

2.19 A voltage dropping resistor R39 is located on the amplifier mounting frame. This resistor is short circuited by the normally made contacts of the ACT TST jack which is also located on the mounting frame. When the plug associated with the filament activity test set is inserted in this jack, the short circuit is opened and the heater voltage is reduced for filament activity tests.

(C) Transmission Characteristics

2.20 Transmission characteristics of the IF switching amplifier are as follows:

Transmission-Frequency Characteristic	-0.1db to +0.2 db gain at 80 mc relative to 60 mc-linear slope between 60 and 80 mc.
Max. Gain IN A to OUT	At least 1.0 db
IN B to OUT	At least 1.0 db
Working Gain IN A to OUT	0.0 db
IN B to OUT	0.0 db
Loss from disabled input to output	>55 db
Input Impedance (IN A and IN B)	>27 db return loss referred to 75 ohms
Output Impedance	>25 db return loss referred to 75 ohms
Monitor Jack Impedance	>25 db return loss referred to 75 ohms
Working Input Level	+3 dbm max.
Working Output Level	+3 dbm max.

Note: For certain applications in low level patching circuits the gain may be set as required within the range of gain variation of the control.

3. IF DISTRIBUTION AMPLIFIER

(A) Equipment Features

3.01 The IF distribution amplifier is designed to present a minimum front panel area so that several amplifiers may be arranged to form a patching field. The amplifier has a front panel 3-1/2" wide and 5-1/4" high on which are located the input and output jacks and the gain controls for the three transmission paths. The amplifier is constructed on a vertical chassis extending 8-1/2" behind the front panel. Connectors are provided at the rear of the chassis for power supply and vacuum tube testing.

3.02 The mounting framework for the amplifier is 5-1/4" high, is designed for use on duct-type bays, and provides space for five amplifiers which may be any combination of switching and distributing amplifiers. Each amplifier is located in the framework by means of guide bars at the top and bottom which engage channels provided on the amplifier chassis. The amplifiers are a plug-in type and when they are pushed in place the power connections are made through a plug and jack arrangement. The plug is mounted on the amplifier chassis and the power jack is mounted on the framework. The rear of the framework also mounts a filament dropping resistor and a jack both of which are required for filament activity tests. The wiring at the power jack and the value of the filament dropping resistor is different for switching and distributing amplifiers. Arrangements are made according to job engineering requirements. A jack strip may be attached to the top or bottom of the framework. The inputs or outputs of the amplifier may be connected to jacks in this strip with short coaxial patch cords or a special patch plug.

3.03 All vacuum tubes required for the distribution amplifier are provided installed in their sockets. The tube complement is four 404A vacuum tubes.

3.04 Power is supplied to the IF Distributing Amplifier from the 130V and 12V supplies. The current drain from 130V is 0.07A and from 12V is 1.2A.

(B) Circuit Description

3.05 The IF distribution amplifier is an intermediate frequency amplifier with one input and three simultaneous outputs. The transmission from input to each output is substantially flat from 60 to 80 mc and the working gain is unity for each path. The normal operating level is +3 dbm. The transmission through any path is substantially independent of the termination of the other outputs.

3.06 The distribution amplifier includes an input amplifier stage which drives three output amplifier tubes whose control grids are connected in parallel and whose plates drive individual output transformers. Individual gain adjustments are provided for the three output stages so that the transmission through each path may be adjusted to unity.

3.07 A simplified schematic of the distribution amplifier is shown on Fig. 3. The IN jack feeds a resistive "T" pad which includes R1, R2, and R3. The shunt arm of the pad is paralleled by C47 which is adjusted for optimum input impedance. L1, L2, L3 and C1 + C2 form the "T" equivalent of a double-tuned input transformer with a ratio of 75:270 ohms. The input capacity of V1 is an element of the transformer. R4 provides the high-side termination.

3.08 The plate of V1 drives the parallel grids of the V2, V3, and V4 through the coupling network which includes L7, L8, L30, L10, L11, C13+C15, R12 and R36. This network is the electrical equivalent of two double-tuned transformers in tandem. The output capacity of V1 and the combined input capacity of V2, V3, and V4 are used as the capacitive elements of the input and output sections of the network. R12 and R36 are damping resistors. The DC potential at the plate of V1 is isolated from the grids of the output stages by coupling condenser C14. Resistors R14, R28, and R29 in the grid circuits of V2, V3, and V4 prevent parasitic HF oscillations.

3.09 The plate of V2 drives the OUT B jack through the equivalent of a doubled-tuned transformer which includes L15, L16, and C23+C24. R22 is the high-side termination for this transformer.

3.10 The plate of V3 drives the OUT C jack through the equivalent double tuned transformer which includes L21, L22, and C31+C32. R27 is the high-side termination of this network.

3.11 The plate of V4 drives the OUT A jack through the equivalent double tuned transformer which includes L27, L28, and C39+C40. R33 is the high-side termination of the network.

3.12 Although the three output stages should be identical, small differences in component values are required to compensate for the physical differences in the three output stages.

3.13 To reduce gain variations in the amplifier arising from tube to tube variations, DC feedback is provided on all of the amplifier tubes. The control grids are operated at +9 volts with respect to ground and large cathode resistors are used so that the space currents in the vacuum tubes are not excessive. The positive 9-volt bias is derived from the 130-volt plate battery supply through a voltage divider which includes R8 and R9. The positive bias is introduced on the control grid of V1 through a low-pass filter which includes R5 and C7 and to the output stages through the interstage network and a low-pass filter which includes R13 and C16.

3.14 The input stage operates with a small amount of IF feedback. This is provided by the un-bypassed cathode resistor R6. R7, which forms the major portion of the cathode resistance is bypassed by C9.

3.15 Each of the three output stages operates with a small amount of negative feedback at IF. The feedback is provided by un-bypassed cathode resistors R15, R23, and R30. The negative feedback minimizes changes in input impedance of V2, V3 and V4 as their gains are adjusted, thus tending to give a transmission-frequency characteristic which is independent of the setting of the gain controls. The remainder of the cathode circuits of the output stages consist of fixed resistors (R16, R24, and R31) in series with variable resistors which are used for gain control (Gain B, Gain C, and Gain A). Both the fixed and variable cathode resistors are bypassed.

3.16 Heater power is supplied to each vacuum tube through low-pass filter networks. Individual series resistors (R10, R21, R26, and R34) are used to stabilize the heater current. This circuit tends to operate the tubes at constant filament power regardless of manufacturing variations in their heater resistance. This method of operation results in more uniform tube life. The resistance values are chosen to give 6.3

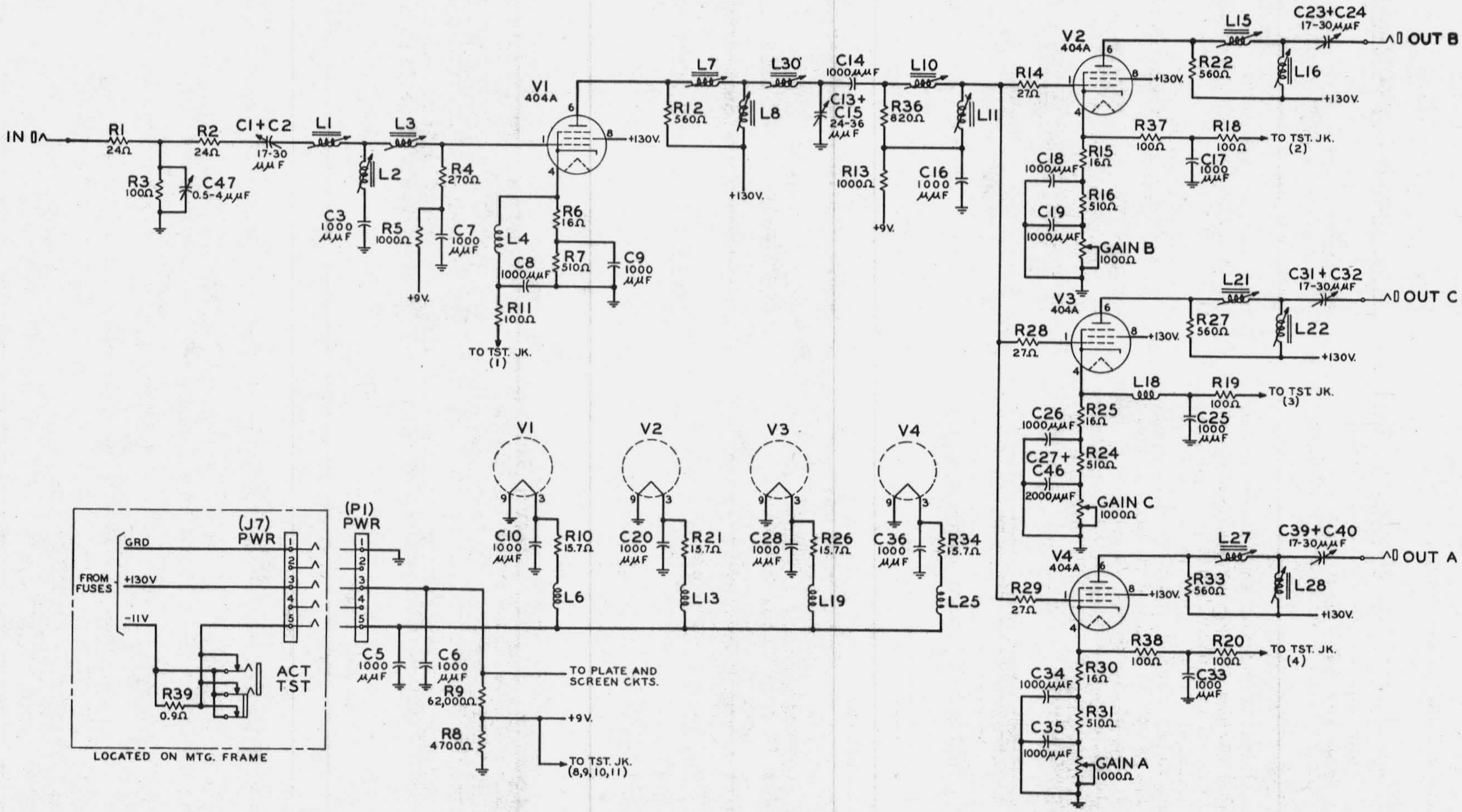


Fig. 3 - IF Distributing Amplifier Simplified Schematic

volts across the heaters with a supply voltage of 11.0 volts and a tube of nominal heater resistance.

3.17 The TST jack provides access to the grids and cathodes of the various tubes so that the operating bias may be measured and filament activity tests performed. The leads to the individual cathodes are filtered.

3.18 A heater voltage dropping resistor R39 is located on the mounting framework together with the ACT TST jack. This resistor is short circuited by the normally made contacts of the jack. When the plug from the filament activity test set is inserted in the ACT TST jack, the short circuit is opened and the heater voltage is reduced for activity tests.

(C) Transmission Characteristics

3.19 Transmission characteristics of the IF distributing amplifier are as follows:

Transmission-Frequency Characteristic	>0.1 db to +0.2 db - Linear Slope (60 - 80 mc)
Max Gain	
IN to OUT A	>1.0 db
IN to OUT B	>1.0 db
IN to OUT C	>1.0 db
Working Gain	
IN to OUT A	0.0 db
IN to OUT B	0.0 db
IN to OUT C	0.0 db
Input Impedance	>30 db return loss referred to 75 ohms
Output Impedance	
(OUT A, OUT B, OUT C)	>25 db return loss referred to 75 ohms
Working Input Level	+3.0 dbm max.
Working Output Level	+3.0 dbm max.

4. PHOTOGRAPH, DRAWING, AND REFERENCE LIST

(A) Photographs

4.01 The following photographs are attached:

Subject	Supplementary Page No.
IF Switching and Distributing Amplifiers - Front Panel	101
IF Switching Amplifier - Apparatus Side	102
IF Switching Amplifier - Wiring Side	103
IF Distributing Amplifier - Apparatus Side	104
IF Distributing Amplifier - Wiring Side	105

(B) Drawings

4.02 The following drawings are attached:

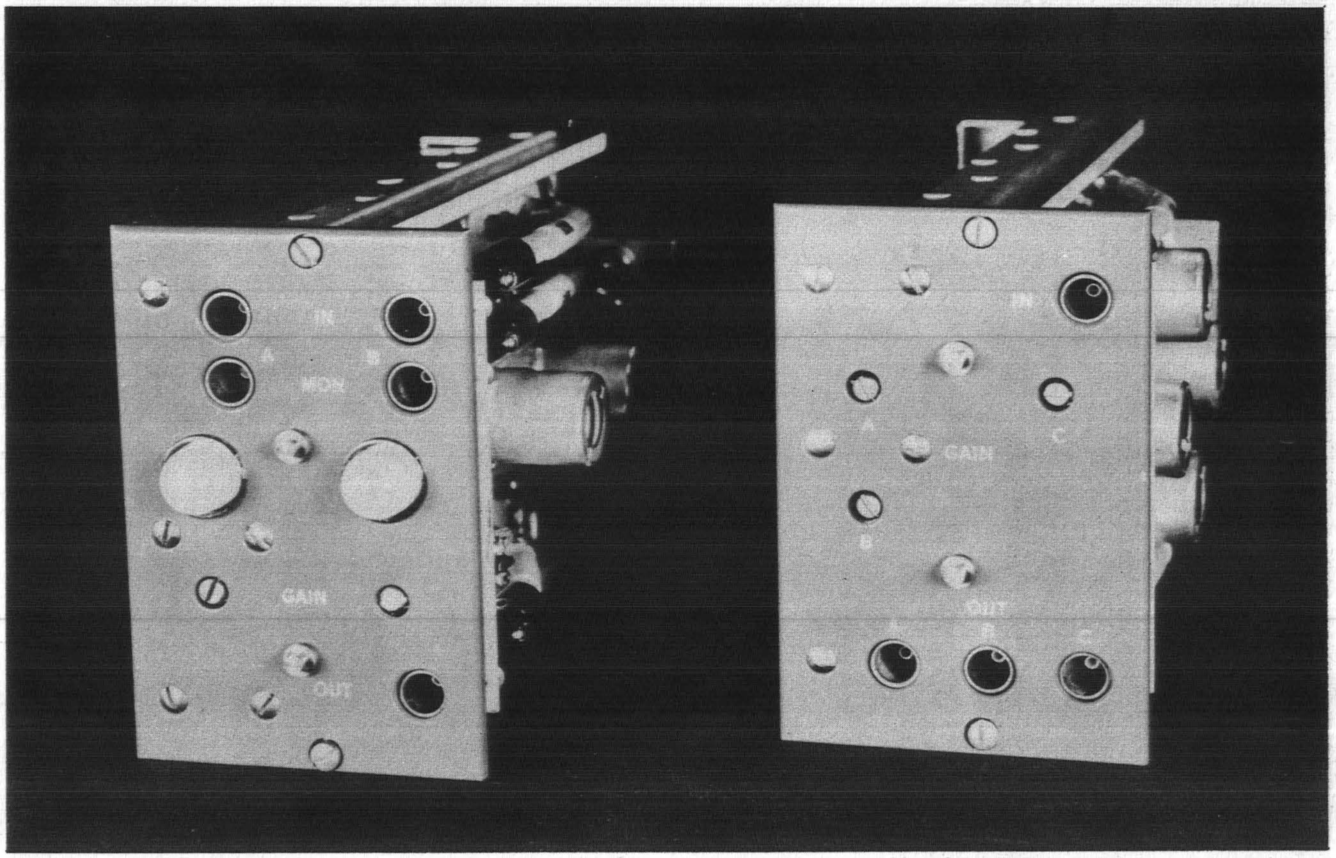
Designation	Subject	Supplementary Page No.
SD-59393-01	IF Switching Amplifier Circuit	106
SD-59394-01	IF Distributing Amplifier Circuit	107

(C) References

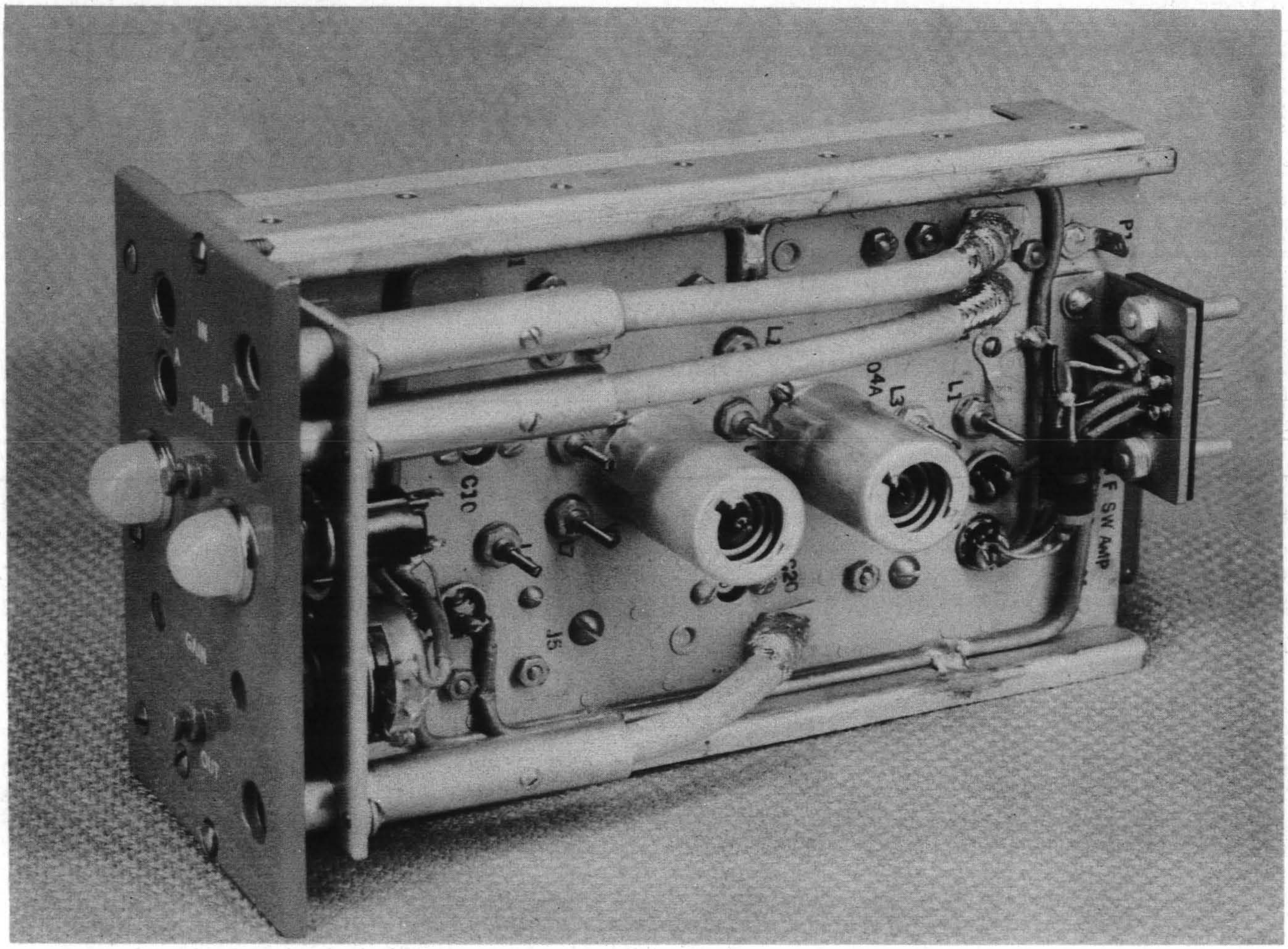
4.03 Reference is made to the following:

- R90.300 TD-2 Radio System
- R60.040 Patching and Monitoring Equipment
- R70.200 Test Bay (J68340A)
- R70.210 Test Bench (J68333A)
- R70.270 Tube Test Set (J64001AK)

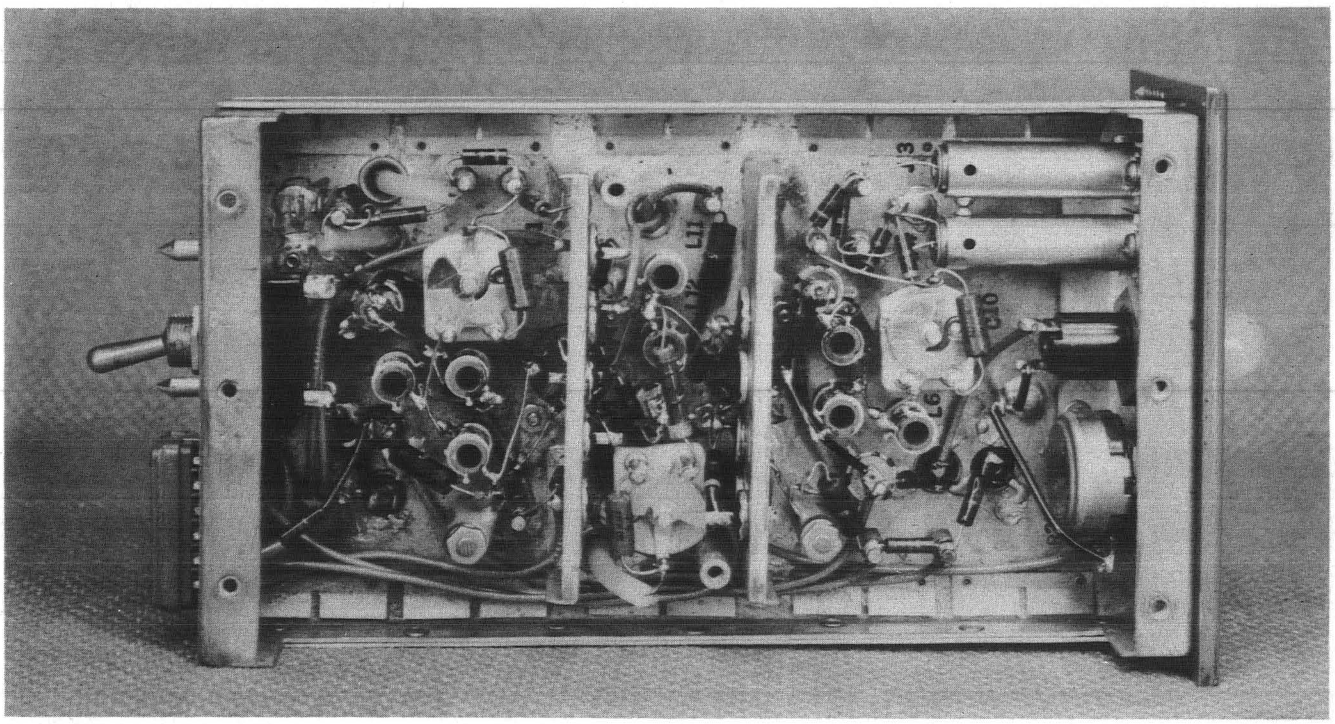
Bell Telephone Laboratories, Inc.



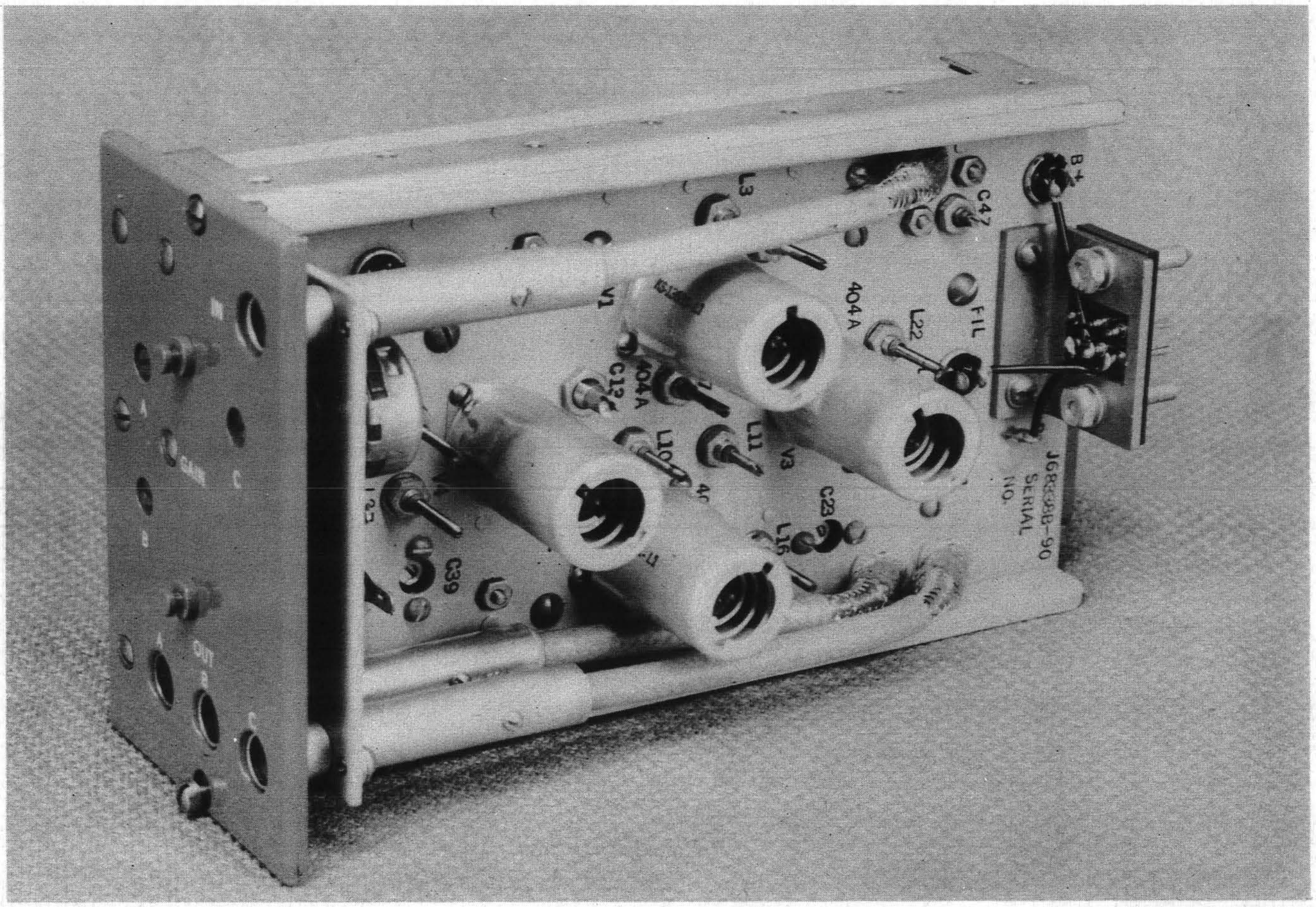
IF Switching and Distributing Amplifiers -
Front Panel



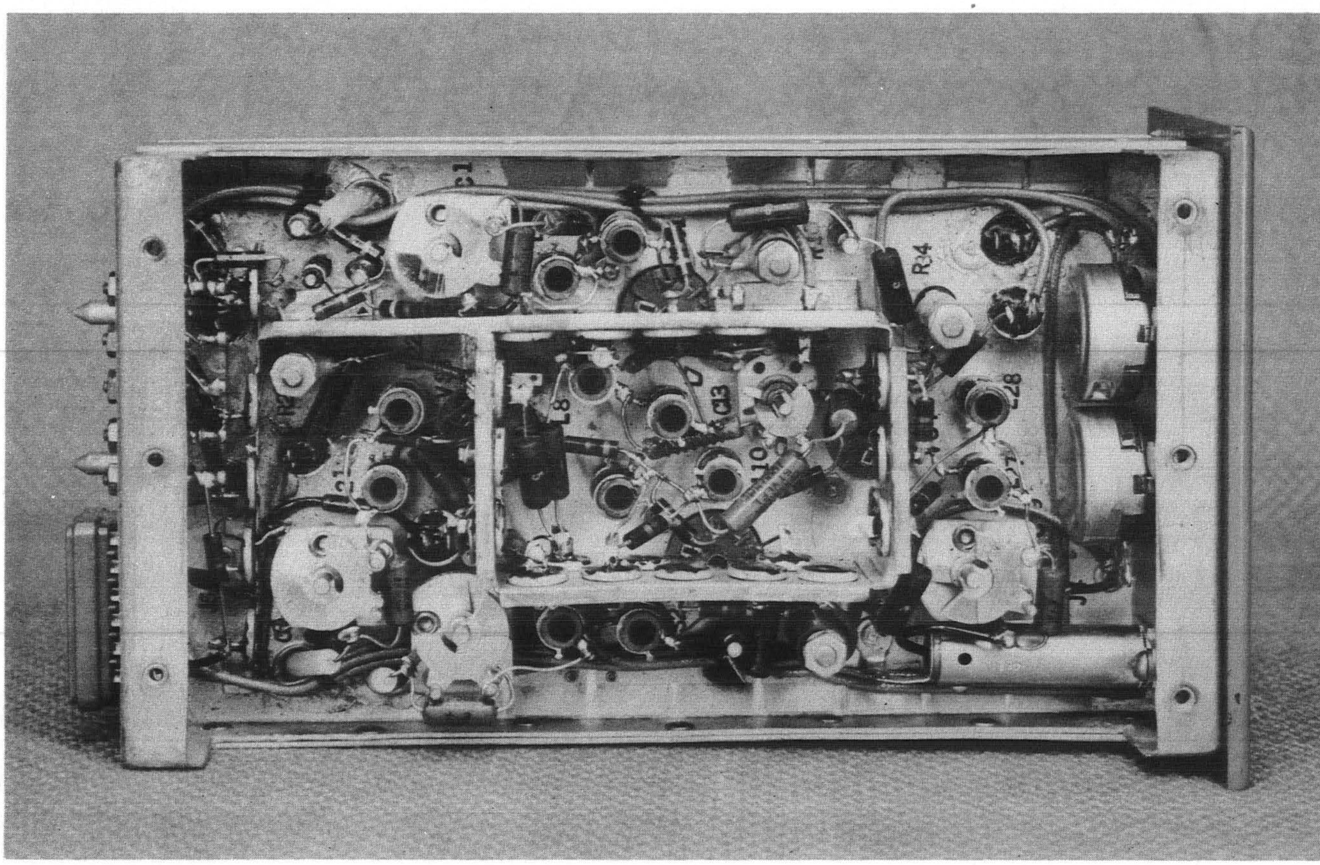
IF Switching Amplifier -
Apparatus Side



IF Switching Amplifier -
Wiring Side



IF Distributing Amplifier -
Apparatus Side

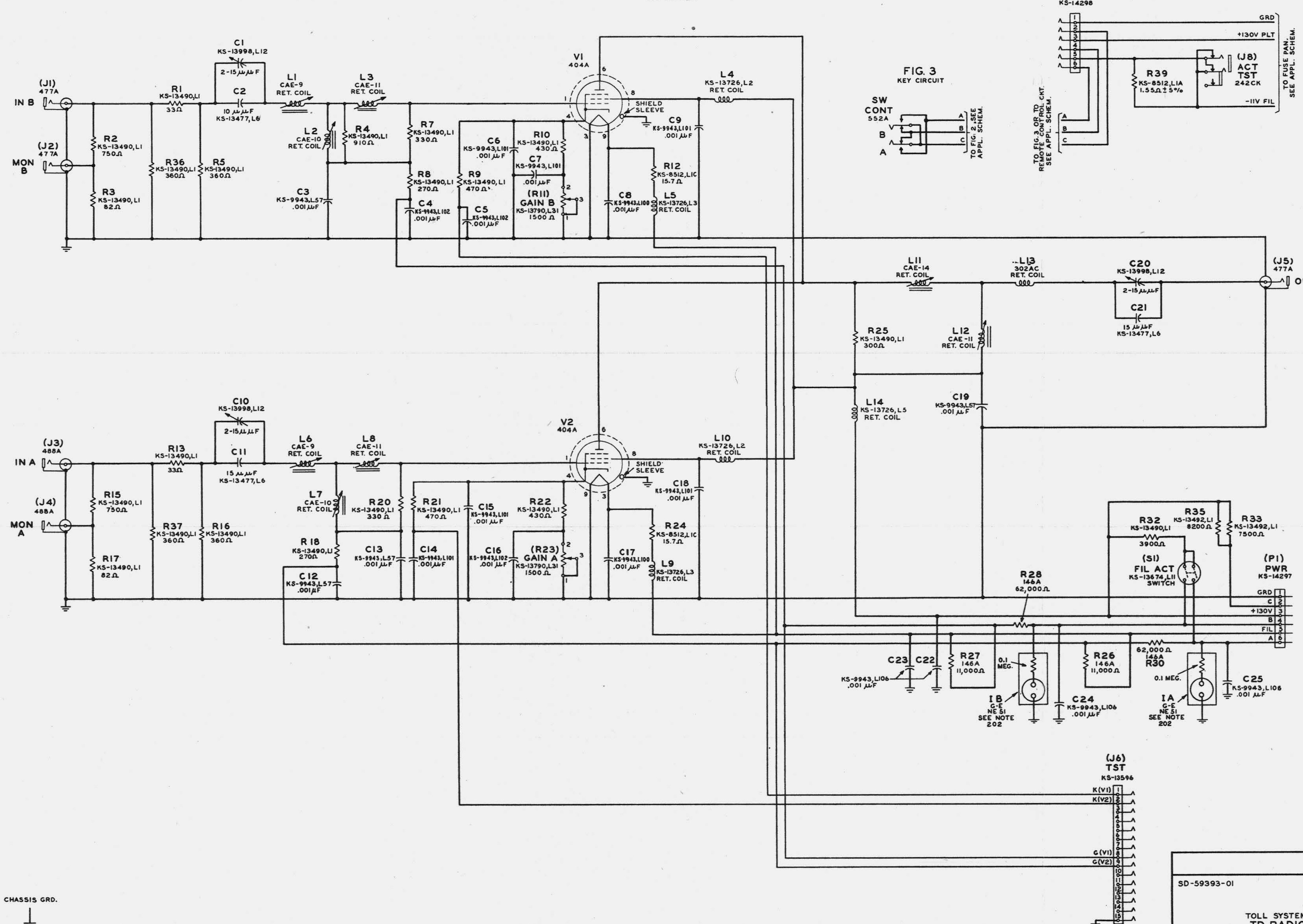


IF Distributing Amplifier -
Wiring Side

FIG. 1
IF SWITCHING AMPLIFIER
SEE NOTE 201

FIG. 2

FIG. 3
KEY CIRCUIT



EQUIPMENT NOTES:

201. THE PLACEMENT OF APPARATUS AND ARRANGEMENT OF WIRING MUST BE IN ACCORDANCE WITH EQUIPMENT REQUIREMENTS.

202. 0.1 MEG. RESISTANCES ARE PART OF PILOT LIGHT ASSEMBLY 95410-93-5 DIAL LIGHT CO. OF AMERICA.

LAST RES. AND COND. USED ON THIS DWG.	
R39	C25
R6, R14, R19, R29, R31, R34, AND R38 NOT USED.	

SW CONT 552A
A
B

CHASSIS GRD.

ISS.	EC OR CO ISSUE	DATE ISSUED	APPROVED
1	1	5-18-49	G.N.T.
2-A	2-A	6-21-49	G.N.T.
3-A	3-A	9-19-49	G.N.T.
4-A	4-A	11-23-49	G.N.T.
5-AR	4-A APPEAR	11-23-49	G.N.T.

ED-63523-01
EQUIPMENT INFO.

SD-59393-01

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TD RADIO
IF SWITCHING AMPLIFIER CKT.

(SW AMP)

AT&T CO
STANDARD

SD-59393-01

BELL TELEPHONE LABORATORIES, INC.

R2

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SD-59393-01

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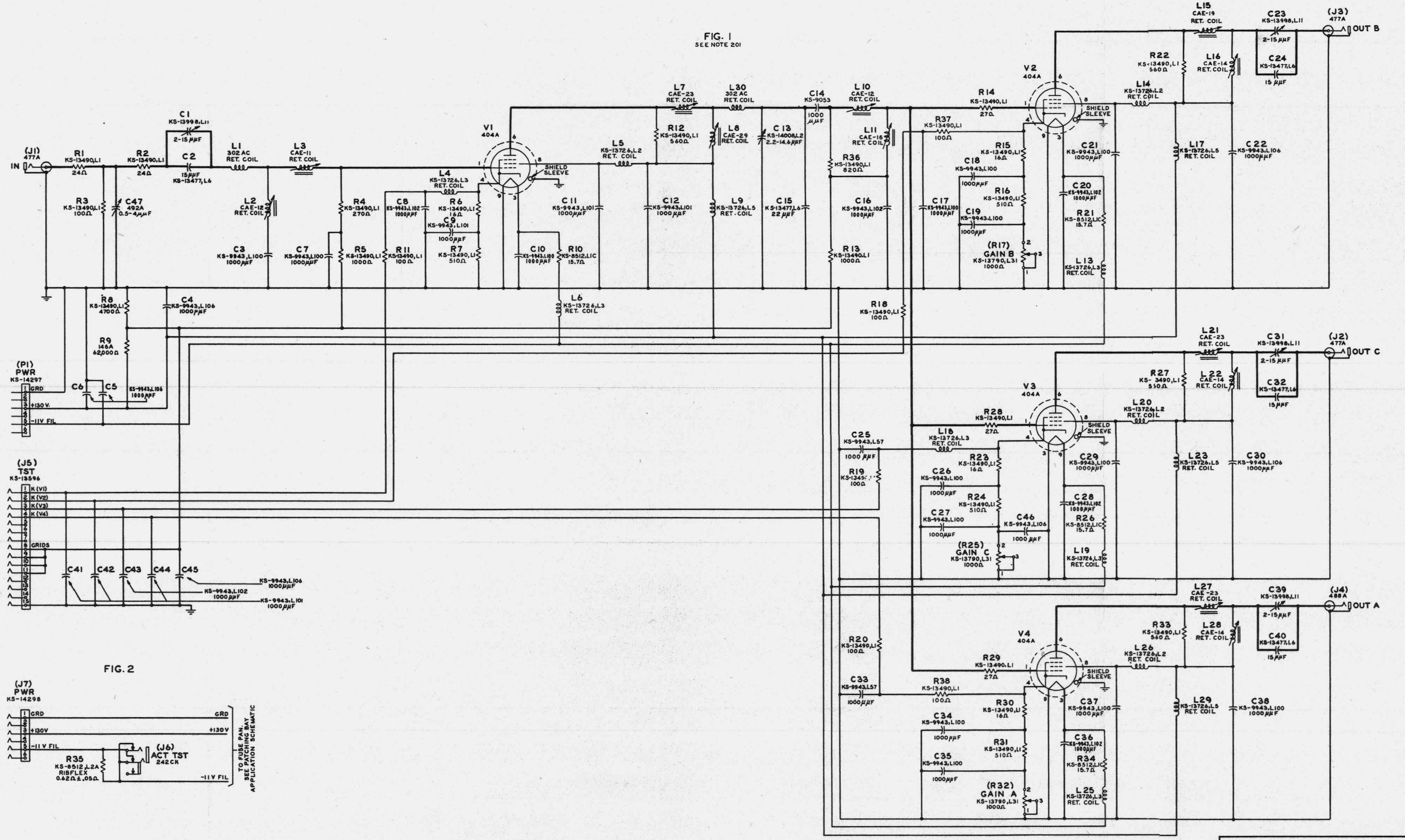

LAST RES. AND COND. USED ON THIS DWG.	
R38	C47

CHASSIS GROUND

ED-63524-01 EQUIPMENT INFO.

SD-59394-01

TOLL SYSTEMS
TD RADIO
IF DISTRIBUTION AMPLIFIER CKT.

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R2

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