# Instructions

## AUDIO CONSOLE

### MODEL 4BC21A1, REVISION B

EBI—2179A

GENERAL ELECTRIC

*INSTRUCTIONS*

# AUDIO CONSOLE

## MODEL 4BC21A1, REVISION B

**EBI—2179A**

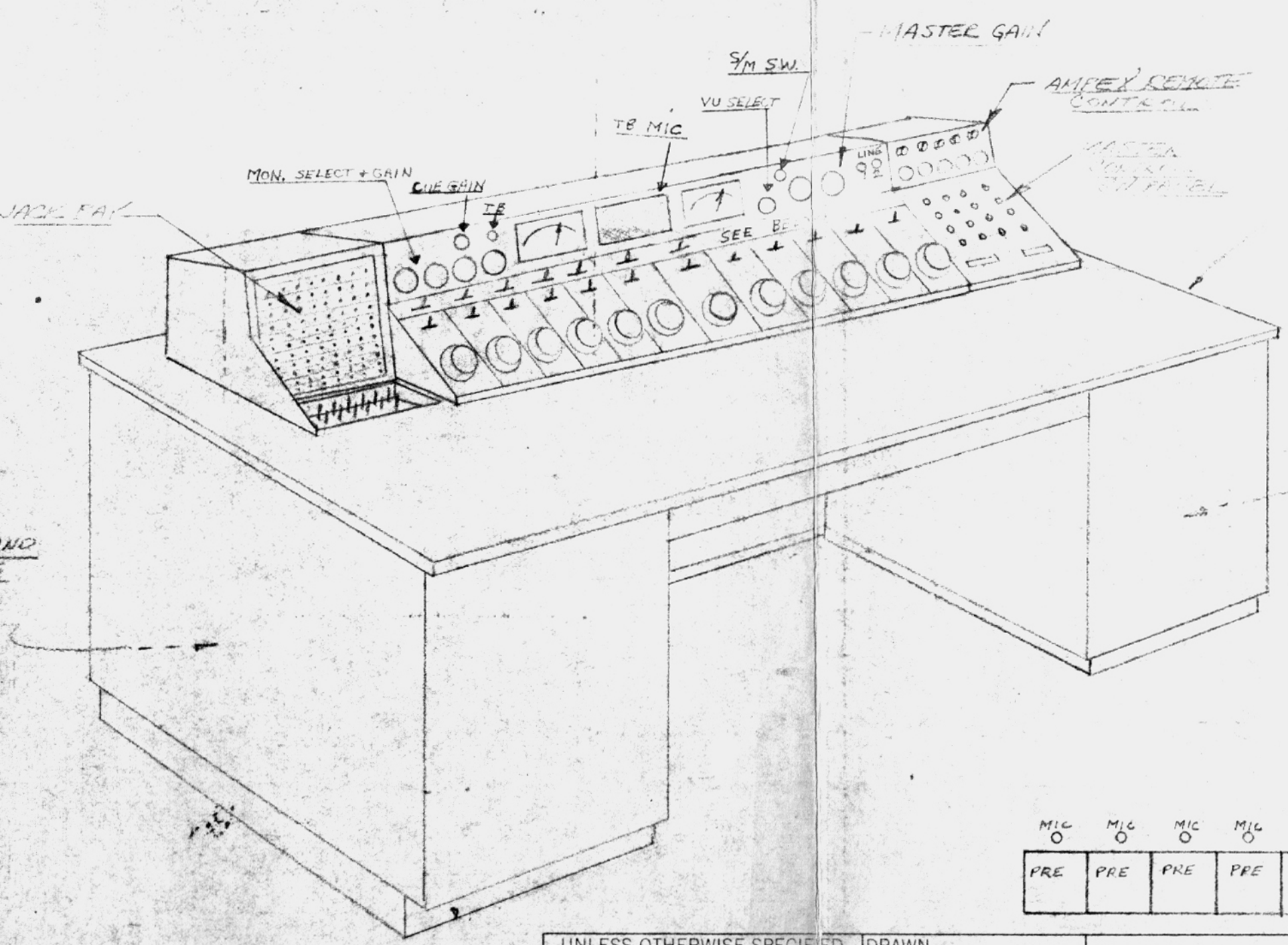
DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

PRINTED IN U.S.A.

2/61 (400)




| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS ± DECIMALS ± ANGLES ± | DRAWN N.T. |
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## SAFETY NOTICE

### WARNING

VOLTAGES USED FOR THE OPERATION OF THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE.

This instruction manual is written for the general guidance of maintenance and service personnel who are familiar with and aware of the dangers of handling electric and electronic circuits. It does not purport to include a complete statement of the safety precautions which should be observed in servicing this or other electronic equipment. The servicing of this equipment by inadequately trained or inexperienced personnel involves risks to such personnel and to the equipment for which the manufacturer can not accept responsibility. Personnel servicing this equipment should familiarize themselves with first-aid treatment for electrical burns and electrical shock.

## PRODUCTION CHANGES

From time to time it becomes necessary to make changes in the equipment described in this book. Such changes are made to improve performance or meet component shortages and are identified by a revision letter following the model number stamped on the nameplate. The changes in the equipment as they affect the instruction book are listed on a Production Change Sheet included in the book. If no Production Change Sheet is included, no changes have been made. The revision letter appearing on the title page indicates the equipment revision to which the book corresponds.

This information is provided as a servicing aid; it should not be used to modify earlier equipments to incorporate later revisions except under specific instructions. Please mention the revision letter in any correspondence.

## REPLACEMENT PARTS

The parts list contained in this book includes all principal replacement parts. The symbol numbers are the same as those appearing on elementary and other drawings. Whenever possible, replacement parts should be obtained from a local electronics supply dealer. If it is necessary to order a part (other than a tube or transistor) from the General Electric Company, please include the symbol number, description, and drawing number of the part and model number of the unit. Orders may be sent to the nearest Electronics Division office appearing on the list at the end of the book or the General Electric Company, Technical Products Operation, Electronics Park, Syracuse, N.Y.

## REPLACEMENT TUBES AND TRANSISTORS

In all cases replacements must be ordered from a local distributor.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TECHNICAL PRODUCTS OPERATION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

EBI-17C 1/63 (10M)

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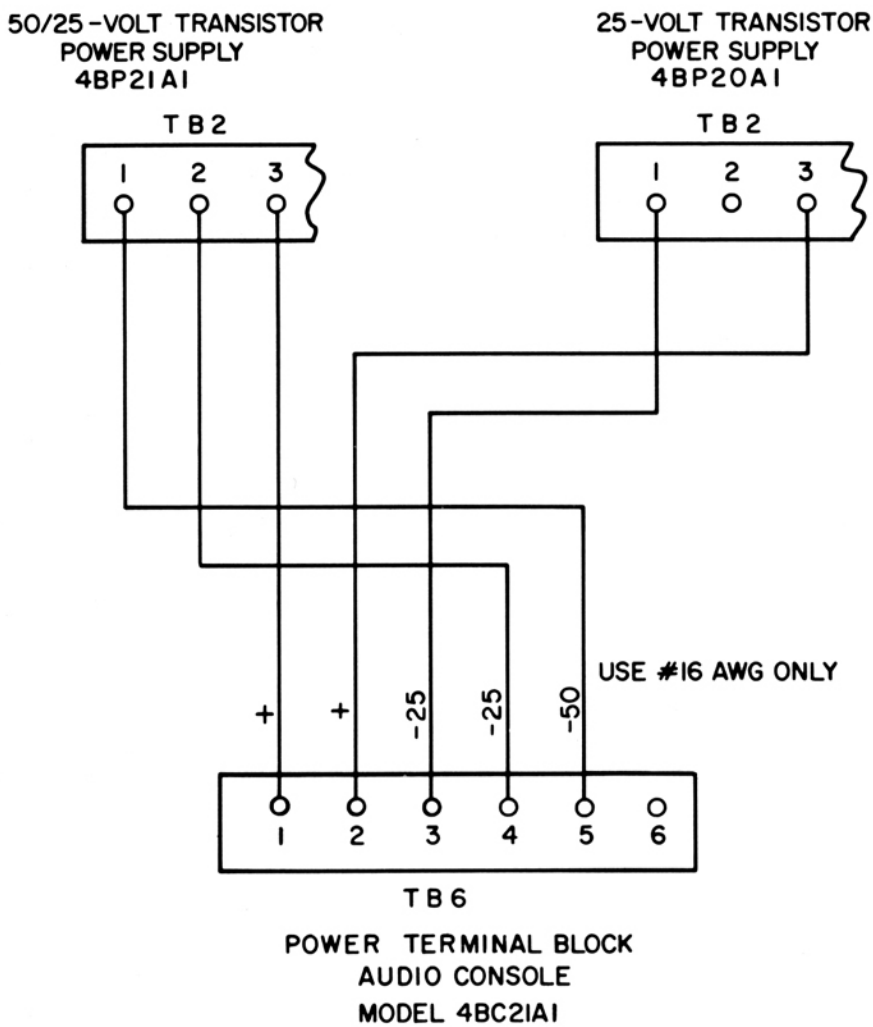
## WARRANTY

The General Electric Company (hereinafter called the Company) warrants to the Purchaser that the equipment will be free from defects in material, workmanship, and title, and will be of the kind and quality designated or described in the contract. The foregoing warranty is exclusive of all other warranties whether written, oral, or implied (including any warranty of merchantability or fitness for purpose). If it appears within one year from the date of shipment by the Company that the equipment described in this instruction book does not meet the warranties specified above and the Purchaser notifies the Company promptly, the Company shall thereupon correct any defect, including non-conformance with the specifications, at its option, either by repairing any defective part or parts or by making available at the Company's plant, a repaired or replacement part. In lieu of the foregoing, the standard published tube warrranties in effect on the date hereof shall apply to new electronic tubes. If the equipment is installed, or its installation supervised, by the Company, said one year shall run from the completion of installation provided same is not unreasonably delayed the Purchaser. The conditions of any test shall be mutually agreed upon and the Company shall be notified of and may be represented at all tests that may be made. The liability of the Company to the Purchaser (except as to title) arising out of the supplying of the said equipment, or its use, whether on warranty, contract or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of said one year, all such liability shall terminate. The foregoing warranty does not apply to any used equipment supplied under contract or any equipment supplied under contract which bears a trademark of a manufacturer other than that of the Company. Because of the more restrictive warranties expressed by other manufacturers, the Company under contract can only make available to the Purchaser the warranty of the manufacturer on all such equipment. The Company will secure for the Purchaser at his request copies of the manufacturer's standard published warranty applicable to all such equipment. Used equipment is sold as is without warranty unless otherwise specifically provided in writing in the sales contract. The foregoing shall constitute the sole remedy of the Purchaser and the sole liability of the Company.

# ADDENDUM

## AUDIO CONSOLE
## MODEL 4BC21A1

When interconnecting the 50/25-Volt Transistor Power Supply, Model 4BP21A1, and the 25-Volt Transistor Power Supply, Model 4BP20A1, to the Audio Console, refer to the following Power Supply Installation Wiring Diagram for the proper connections.




Power Supply Installation Wiring Diagram

# PRODUCTION CHANGE SHEET

## AUDIO CONSOLE
## MODEL 4BC21A1

## REVISION A

This revision replaces the printed circuit board which mounts connectors J1 through J5 with chassis mounted connectors.

### Elementary Diagram

Printed circuit board C-7777480 has been removed and is replaced with one metal chassis, C-7776758.

Remove the reference to TB3 on the Elementary Diagram (EE-7354329). This now becomes a 9-pin board.

## REVISION B

The Monitor Amplifier, Model 4BA24A1 (EBI-2181), has been changed to Model 4BA24A2 (EBI-2192).

## INTRODUCTION

The General Electric Audio Console, Model 4BC21A1 (see Figs. 1 and 2), is designed to provide a flexible and efficient means for performing the controlling functions of radio and television studio audio systems. These functions include switching, mixing, and amplifying the outputs of microphones, turntables, tape mechanisms, remote and network lines, and other audio sources. In addition, the Console supplies facilities for auditioning, cueing, monitoring remote lines, and cue and talkback circuits to studio and remote lines.

## EQUIPMENT FURNISHED

The Audio Console includes the following major subassemblies:

| Quantity | Description | Type Number | Instruction Book Number |
|---|---|---|---|
| 4 | Pre-Amplifier | BA-21-A | EBI-2185 |
| 1 | Program Amplifier | BA-22-A | EBI-2180 |
| 1 | Monitor Amplifier | BA-24-A | EBI-2192 |
| 1 | Cue/Talkback Amplifier | BA-28-A | EBI-2182 |
| 1 | 25-Volt Power Supply | BP-20-A | EBI-2183 |
| 1 | 50/25-Volt Power Supply | BP-21-A | EBI-2184 |

## TECHNICAL SUMMARY

### Electrical

PROGRAM CIRCUITS

| | |
|---|---|
| Frequency Response: | ± 2 db, 50 to 15,000 cps. |
| Gain: | 105 db ± 2 db. |
| Noise: | 65 db below +18 dbm out (with controls set at 68 db of gain). |
| Crosstalk (Nominal): | At least 50 db down, 50-15,000 cps.<br>At least 80 db down, at 1000 cps. |
| Distortion: | 1% or less at +18 dbm (after 6 db pad). |

MONITOR CIRCUITS

| | |
|---|---|
| Frequency Response: | ± 1 db, 50 to 15,000 cps. |
| Distortion: | $1\frac{1}{2}$% at +33 dbm. |

POWER REQUIREMENTS

110/117/125 volts, 50/60 cycle, single phase, a-c, 90 watts (45 watts each power supply).

25 volts d-c at 1 amp for the Monitor Amplifier and control relays, from the Type BP-20-A Power Supply.

50 volts d-c at 500 ma for Program Amplifier and Cue/Talkback Amplifier as well as 25 volts d-c at 40 ma for the pre-amplifiers from the Type BP-21-A Power Supply.

## SIGNAL INPUTS

### Impedances

| | |
|---|---|
| Microphones: | Ten - 30 / 150 / 250 / 600 ohms, balanced or unbalanced. |
| Turntables: | Three - 600 ohms, balanced or unbalanced. |
| Network or Remote Lines: | Three - 600/150 ohms, balanced or unbalanced. |
| Tape/Projectors: | Two - 600 ohms, balanced or unbalanced. |
| External Monitor: | Three - 20,000 ohms, balanced, bridging. |
| External VU: | One - 7500 ohms, balanced, bridging. |

### Levels

| | |
|---|---|
| Low Level Inputs: | Microphone level to -25 dbm. |
| High Level Inputs: | -10 to +18 dbm. |

## SIGNAL OUTPUTS

### Impedances

| | |
|---|---|
| Program Lines (Regular): | Two - 600 ohms, balanced. |
| Monitor Channel: | One - 600/150/8 ohms, balanced. |
| Remote Cue (Into NEMO Line): | Three - bridging, balanced. |

### Levels

| | |
|---|---|
| Program Output Level: | +18 dbm. |
| Monitor Output Level: | +33 dbm (2 watts). |

## Mechanical

| | |
|---|---|
| Height: | 11 inches |
| Width: | 38 inches |
| Depth: | 17 inches |
| Weight: | 74 pounds |

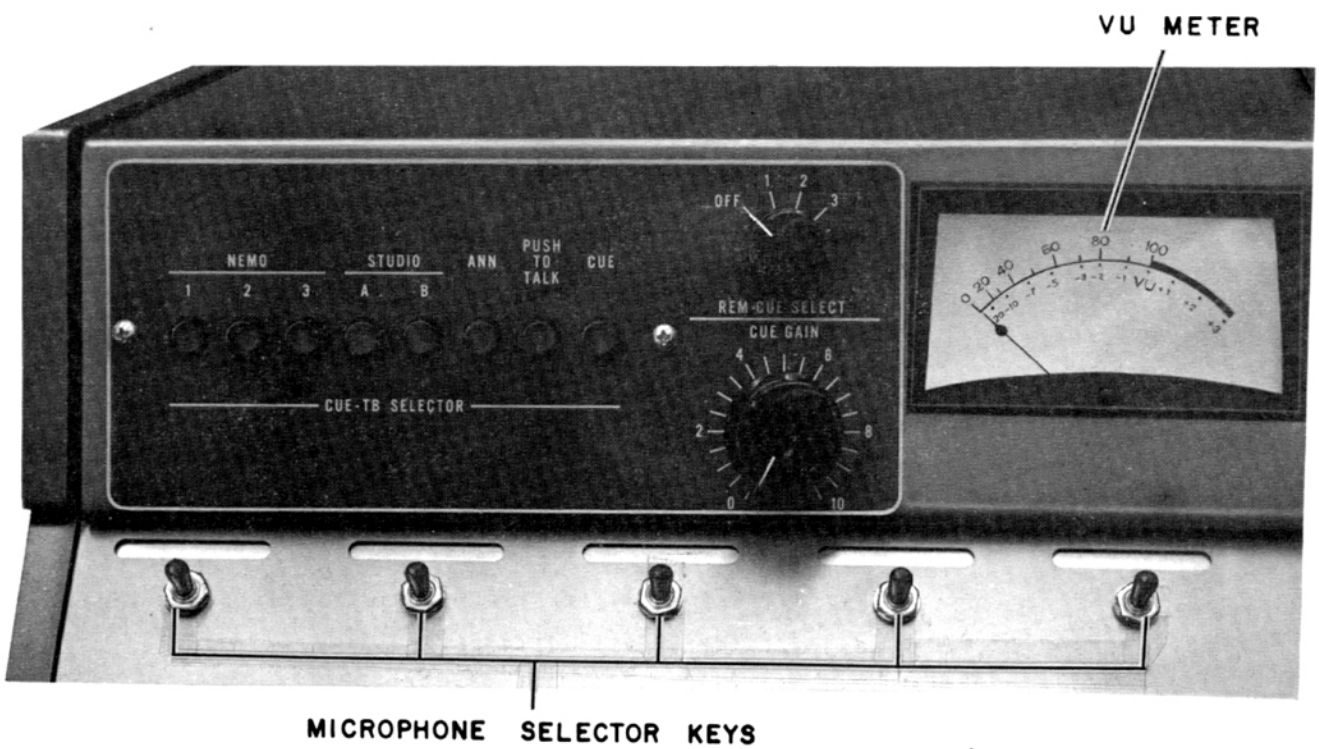



Fig. 1 Left Front View of Audio Console (9-1156)

## DESCRIPTION

Complete transistorization and modular design both contribute to the flexibility, reliability, and compactness of the Audio Console. It is constructed in two main sections. The upper section is hinged across the back and when opened, exposes the internal portions of both sections to facilitate wiring, cleaning, and servicing.

The units listed under EQUIPMENT FURNISHED are plug-in modules (with the exception of both power supplies) and are to be placed in their appropriate locations in the Console proper as explained in the INSTALLATION section under Plug-in Module Installation.

Depending on the number of Pre-Amplifiers installed, the Console will provide for a maximum of ten low-level (microphone) inputs and eight high-level inputs. As shipped, it is connected for single program channel operation plus an audition channel. Dual program channel operation may be readily attained by the installation of a second plug-in Program Amplifier, a second VU Meter, and a few simple wiring changes as explained in the INSTALLATION section under Dual Channel Conversion.

When used as a single channel Audio Console, the Monitor Amplifier will provide emergency program operation by placing the line keys in the second channel position.

Two regulated power supplies are furnished with each Console. The Type BP-20-A, 25-volt d-c supply provides power for the Monitor Amplifier and the relay control system. The second power supply, Type BP-21-A, 50/25-volt d-c supply, provides 50-volt power for the Program Amplifier and Cue/TB Amplifier. The 25-volt section provides power for the Pre-Amplifiers.

## INSTALLATION

### General

The installation of the Audio Console depends largely upon the individual studio requirements but it is recommended that the procedures listed below be performed in the order given.

The installation procedure is covered in five sections: unpacking, mounting, connections (including normal wiring connections, network connections, and dual channel conversion), preliminary power check, and plug-in module installation.

### Unpacking

Unpack each container carefully and check the contents with the shipping list to assure

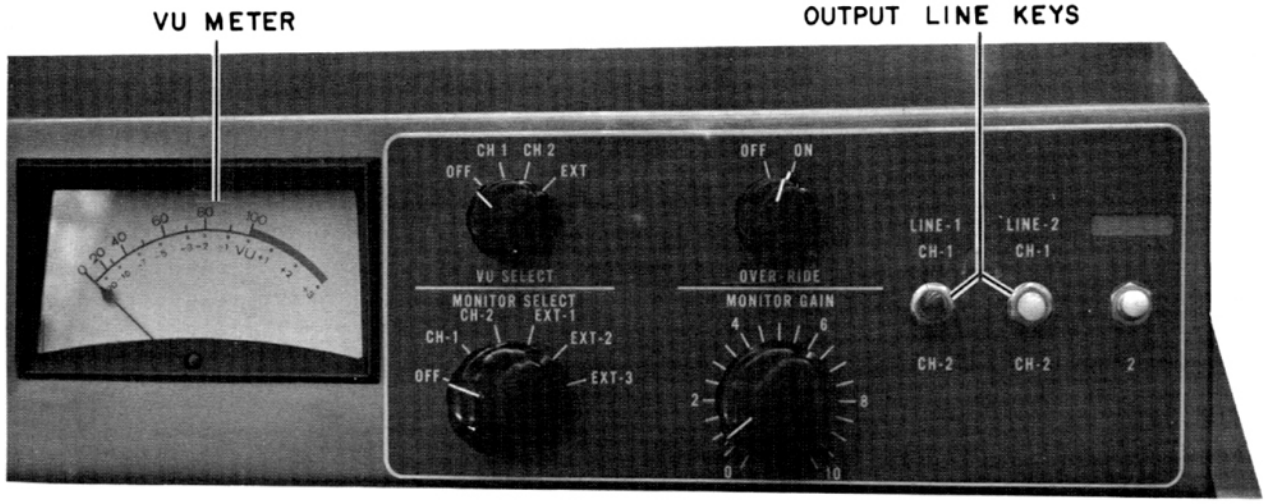



Fig. 2 Right Front View of Audio Console (9-1155)

that all equipment has been received and in good condition. If anything is damaged, notify the shipping company immediately.

## Mounting

The Audio Console Cabinet may be mounted on two Type PR-16-B/C Base Cabinets or any available desk of sufficient size. The power supplies may be mounted in one of the base cabinets or any standard EIA rack, such as the G-E Type PR-1-A Cabinet Rack.

## Connections

NORMAL CONNECTIONS

1. General

Refer to the Elementary Diagram, Fig. 8, and the Control Circuits Diagram, Fig. 7, when wiring the input, output, and power connections of the Console. The following paragraphs interpret and supplement the information given on these Diagrams.

Viewed from the front, all low-level and high-level audio source wiring is brought into the rear left-hand corner of the Console. Holes have been provided to bring the wiring either up through the bottom or through the back panel. Output, relay control circuits, and power wiring are made in the right-hand rear section of the Console.

It is recommended that shielded audio wire such as the General Electric Type FA-19-M (solid) or FA-19-R (stranded), be used for all input and output audio circuits of the Console.

2. Microphone Inputs

A maximum of ten microphones may be wired into the Console. The incoming microphone lines are connected to terminals located on TB1 which is directly behind the microphone selector keys, S1 through S5. Bring the wiring in from the back of the Console, through and along the wiring ducts, to the associated tie points. Convenient ground points (G) have been provided on TB1 for terminating the microphone cable shields.

Specific microphone input connections are given in the table on page 5.

3. High-Level Inputs

Eight, assorted, high-level input sources of 600-ohm impedance may be connected into the Console. The first five positions on the high-level switch panel are connected for local studio sources such as turntables, tape audio, projector audio, etc. The wiring for these may be routed through the wiring duct and connected to the receptacle mounted in back of the center switching section. Connect as follows:

Position #1 - connect to J15-1 and -2.
Position #2 - connect to J15-4 and -5.
Position #3 - connect to J15-7 and -8.
Position #4 - connect to J15-10 and -11.
Position #5 - connect to J15-13 and -14.
Connect shields to bus bar looped around J15.

Positions 6, 7, and 8 are for connection of remote line and network line inputs. The connections are made at the terminal board mounted on line coils T1, T2, and T3 located in back of the Pre-Amplifier section of the Audio Console. Connect as follows:

Position #6 - connect to TB2-3 and -4.
Position #7 - connect to TB2-7 and -8.
Position #8 - connect to TB2-11 and-12.
Connect the shields to points marked G.

As wired at the factory, input positions 6, 7, and 8 are provided with one-to-one isolation coils and 10 db, fixed, H pads in the input side of the line coils. The coils and pads are wired for 600-ohm lines. If it is desired to connect 150-ohm lines into these positions, reconnect the coils for 150-ohm inputs and change the pads to the appropriate values for 150-ohm lines. For example, if it is desired to change position #6 to 150-ohm operation, perform the following steps:

a. Remove the connections between T1-2 and -3.
b. Connect T1-2 to T1-4 and T1-1 to T1-3.
c. Change R34 to 100 ohms.
d. Change R30, R31, R32, and R33 to 39 ohms.

4. Output Line Connections

Two program lines, controlled by separate switches, may be connected to the

| Switch | Position | TB1 Input Terminals | Shield |
|---|---|---|---|
| *1 | A (up) | 1 and 2 | G |
| *1 | B (down) | 3 and 4 | G |
| 2 | A (up) | 5 and 6 | G |
| 2 | B (down) | 7 and 8 | G |
| 3 | A (up) | 9 and 10 | G |
| 3 | B (down) | 11 and 12 | G |
| 4 | A (up) | 13 and 14 | G |
| 4 | B (down | 15 and 16 | G |
| **5 | A (up) | 17 and 18 | G |
| **5 | B (down) | 19 and 20 | G |

Console at terminal strip TB5. The terminal strip is located on the Console base plate and connections are to be made as follows:

Line #1 Output - connect to TB5-11 and -12.

Line #2 Output - connect to TB5-13 and -14.

5. External Monitor Inputs

Three external audio sources for monitoring purposes may be connected to the Console and are selected by use of the MONITOR SELECT switch, S10. The level of these inputs should not exceed +8 VU. The connections are made as follows:

External Line #1 - connect to TB5-3 and -4.

External Line #2 - connect to TB5-5 and -6.

External Line #3 - connect to TB5-7 and -8.

6. External Input to VU Meter

The Console is provided with a means for connecting the VU Meter to an external line of a +8 VU level. Connections to the circuit are made at TB5-1 and -2.

To make use of this facility the VU SELECT switch must be place in the EXT position.

7. Monitor Speaker Connections

The monitor output of the Console is for use with remote speakers of 600-ohm impedance, consequently the speakers should be provided with line-to-voice coil transformers such as the G-E Type FA-42-A. Connections are made to SPKR terminals located on the relay module terminal board, TB4 (see the Control Circuit Diagram, Fig. 7), as listed below:

a. Control Room Speaker - connect to SPKR terminals adjacent to J19.

b. Announce Booth Speaker - connect to SPKR terminals adjacent to J18.

c. Studio "B" Speaker - connect to SPKR terminals adjacent to J17.

d. Studio "A" Speaker - connect to SPKR terminals adjacent to J16.

8. Audition and "On Air" Light Connections

Control circuitry for the operation of AUDITION and ON AIR lights is incorporated in the Console. Light control circuits for two studios, an announce booth, and a control room are provided.

External light control relays should have 24-volt d-c coils with a nominal resistance of 400 ohms.

All control circuits operate on 24 volts d-c with the positive side grounded.

## CAUTION

DO NOT GROUND ANY POINT IN MAKING EXTERNAL RELAY CONNECTIONS.

*Do not connect to terminals of switch #1 unless the fifth Pre-Amplifier (AR-1) has been added to the Audio Console. If it has been installed, remove resistors R27 and R28 which are mounted across J1-6 and -7 and J1-4 and -5 on the rear of mixer board TB3.

**For normal use of announce booth microphone on position "A" and control room microphone on position "B."

The external connections for light control circuits are to be made as follows:

a. Connect one side of the external relays to terminal Z on TB4.

b. Make all other connections to TB4 as shown on the Elementary Diagram, Fig. 8.

9. Power Supply Connections

It is recommended that AWG #16 wire be used for making all interconnections between the Audio Console and its associated power supplies. General Electric Type FA-19-J shielded power cable is well suited for this application.

All power connections for the Console are shown on the Elementary Diagram, Fig. 8.

## CAUTION

OBSERVE CORRECT POLARITY IN MAKING POWER CONNECTIONS TO THE CONSOLE TO AVOID TRANSISTOR AND DIODE DAMAGE.

SPECIAL NETWORK CONNECTIONS

When a network program source is to be connected to the Audio Console through positions 6, 7, or 8 of the HI-LEVEL SELECTOR switch (S11), the talkback and remote program cue facilities of the Console must be disconnected from the audio input circuit.

A study of the Elementary Diagram, Fig. 8, in particular the facilities of the CUE/TB SELECTOR switch, S9, and the REMOTE CUE SELECT switch, S15, will show the necessity of such a step to assure that no outgoing signal can be impressed upon the incoming network line. Remove these connections as follows:

1. If the network is connected through T1 to input #6, disconnect and separately tape the audio pair connected to J15-21 and -24.

2. If the network source is connected through T2 to input #7, disconnect and separately tape the audio pair connected to J15-27 and -30.

3. If the network source is connected through T3 to input #8, disconnect and separately tape the audio pair connected to J15-32 and -33.

DUAL CHANNEL CONVERSION

The Audio Console may be converted from a single program channel Console (as shipped) to a dual program channel Console by following the procedure outlined below:

1. Necessary Additional Equipment

1 Type BA-22-A Program Amplifier
1 VU Meter, B-7492839-P1.
1 Master Gain Control Module, G-E Drawing A-7164636-G1.
1 VU Meter Attenuator, G-E Drawing M-7477541-P4.

2. Meter Installation

a. Remove the existing meter attenuator board, TB7, from the VU Meter.

b. Loosen the existing Meter mounting screws, slip the calibration ring off of the Meter back, and remove the Meter from the panel.

c. Remove the dummy escutcheon from the opening on the right-hand side of the existing meter.

d. Re-install the VU Meter in this right-hand opening, making sure to place the calibration ring back on the Meter before mounting attenuator board TB7.

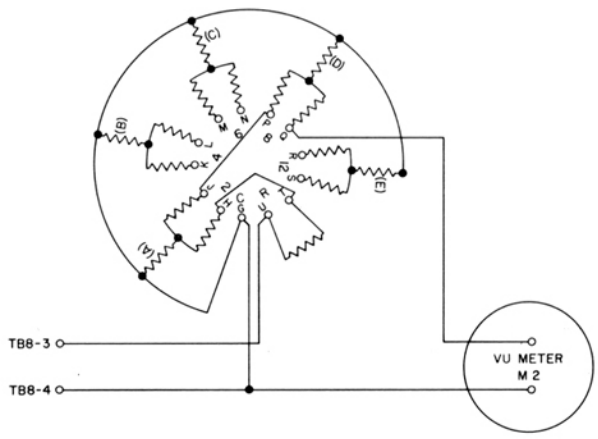



Fig. 3 Meter Attenuator Connection Diagram (M-7477541-P4, Rev. 8)

e. Remove the pilot lamp holding screw and allow the lamps to hang down out of the way.

f. Remove the Cue/TB speaker assembly and relocate it in the center opening.

g. Mount the new VU Meter in the left-hand opening.

h. Mount the VU Meter Attenuator at some convenient point and connect the Attenuator as shown on the Meter Attenuator Connection Diagram, Fig. 3.

i. Remount the pilot lamps, one to each meter. If additional illumination is required, two lamps may be mounted at each meter location. In this case, connect each group of two lamps in series and then connect the two lamp groups in parallel. Use only G-E 1819 or 1829, 28-volt lamps since they are connected across the 50-volt supply.

Upon completion of the meter installation, the left-hand meter is always connected to the CH-1 output. The right-hand meter becomes a utility meter which reads the line selected by the VU SELECT switch.

3. Program Amplifier Installation

Before installing the Type BA-22-A Program Amplifier, make the following wiring changes:

a. Remove R67 from TB8-23 and -24.

b. Remove R68 from TB8-7 and -23.

c. Remove R69 from TB8-8 and -24.

d. Remove the audio pair (marked with a yellow sleeve) from TB8-35 and -36 and reconnect them to TB8-33 and -34.

e. Connect a jumper between TB8-10 and -12.

f. Connect a jumper between TB8-11 and -13.

g. Remove the jumper between J9-8 and J10-8 (located on the back of the Master Gain Control receptacles).

## Marking Tabs

Card slots above the HI-LEVEL SELECTOR switches and the microphone selector switches can be used for identification marking of the various inputs. Typical marking tabs, which can be cut out and inserted into the slots according to the requirements of the individual application, are provided on page 21 with an acetate sheet to be cut and slipped in front of the tab to protect it. Fig. 4 shows these tabs in reduced form.

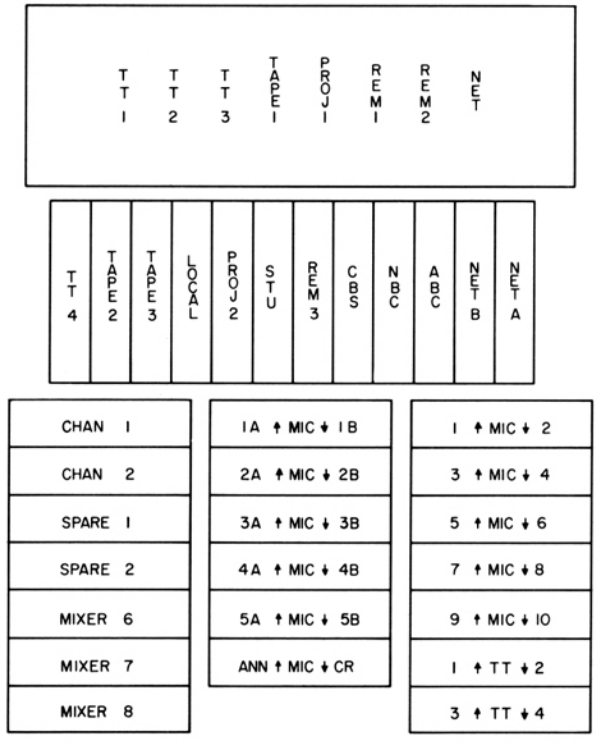



Fig. 4 Audio Console Marking Tabs

## Preliminary Power Check

After completing the installation connections, it is recommended that d-c voltages be checked before placing the Console in operation. Make the test with all amplifiers removed from the Console. Turn the power supplies on and check the following voltages:

| (+) Positive Meter Lead | (-) Negative Meter Lead | Voltage Reading |
|---|---|---|
| TB6-2 | TB6-3 | 25 volts |
| TB6-1 | TB6-5 | 50 volts |
| TB6-1 | TB6-4 | 40 volts |

Upon conclusion of the voltage check, turn the power off and install the amplifiers.

The input and output impedances of the plug-in amplifiers, as they are shipped from the

| Type | Name | Input Impedance | Output Impedance |
|---|---|---|---|
| BA-21-A | Pre-Amplifier | 150 | 600 (unbalanced) |
| BA-22-A | Program Amplifier | 150 | 600 |
| *BA-24-A | Monitor Amplifier | 150 | 600 |
| BA-28-A | Cue/TB Amplifier | 150 | 600 |

facory, are listed above. For impedance requirements other than these, consult the individual amplifier instruction books for the proper connections.

## Plug-in Module Installation

It is recommended that the individual module instructions, included in this book, be read before proceeding with the module installation.

CUE/TB AMPLIFIER, TYPE BA-28-A (AR9)

The Cue/TB Amplifier mounts in the cover section of the Console at the extreme back, left-hand side, and plugs into connector J13. Loosen the four mounting screws on the Console frame, and place the Amplifier down over the screws. Align the Amplifier plug with socket J13 and move it into the socket. Tighten the four screws to complete the installation.

PROGRAM AMPLIFIER(S), TYPE BA-22-A (AR6)

The Program Amplifier mounts in the same manner as the Cue/TB Amplifier but is inserted into J11, located in the center portion of the Audio Console cover. If the Console is used for dual channel operation, the second Program Amplifier is mounted in the extreme right-hand side of the Console cover and plugs into J12.

*The Monitor Amplifier is shipped connected for 600-ohm output impedances. For application in this Audio Console, reconnect the output transformer (T2) for 150-ohm output by clipping the jumper between T2-5 and -6 and connecting jumpers between T2-3 and -6 and between T2-5 and -8. See EBI-2192.

MONITOR AMPLIFIER, TYPE BA-24-A(AR8)

The Monitor Amplifier mounts in the same manner as the Cue/TB Amplifier but is to be located in the right-hand corner of the Console base and inserted into J14.

PRE-AMPLIFIERS, TYPE BA-21-A (AR1), AR2, AR3, AR4, AND AR5)

The Pre-Amplifier modules mount into the left-hand, sloping portion of the Audio Console front. Starting with AR5 (located directly to the left-hand side of the centrally located push-button selector switches) insert it through the Console front making sure to align the Pre-Amplifier board connector with connector socket J5. A group of lock-in handles are located at the lower rear section of the mixer board (TB3). Rotate the handle behind J5 until the slot of the bullet is aligned with the pin in the Pre-Amplifier module. Push the Pre-Amplifier in with one hand and rotate the lock-in handle until the Pre-Amplifier is drawn in and locked into position. DO NOT USE UNDUE FORCE.

Install the remaining Pre-Amplifiers, AR2, AR3, and AR4, in the same manner. If a fifth Pre-Amplifier is being used (AR1), remove the dummy module and install the Pre-Amplifier in its place.

HIGH-LEVEL CONTROL MODULES

Three high-level control modules mount in the sloping front section of the Audio Console in the first three positions to the right of the center switches. Each position is stamped with a color on the base of the Console. Observe the color of the lever switch on each module and place it in the position of its corresponding color marking. Mount the modules in the same manner as the Pre-Amplifiers, using the lock-in handles in the rear.

MASTER GAIN CONTROL

The master gain control module mounts in the same manner as the high-level control modules. It is placed in the fourth position to the right of the center switches. If the Console is being used for dual channel operation, two master gain control modules are used. Remove the dummy module from the extreme right-hand side and place the second master gain control module in this position.

PLUG-IN RELAY MODULES

Install the relay modules into TB-4 in the base of the Audio Console. Remove the relay cover and plug the modules into J16, J17, and J18. These modules are all of the same type. The relay module for the control room speaker and warning lights contains only one relay and plugs into J19.

# OPERATION

## General

The purpose of this section is to provide operating personnel with the information necessary to understand the function of the Audio Console controls and to supply the basic instructions necessary for its operation. This is discussed in two parts (1) Control Functions and Location, and (2) Operational Procedure.

## Control Functions and Location

Figs. 1, 2, 5, and 6 show the location of the following controls.

MICROPHONE SELECTOR KEYS

Five microphone selector keys are located in the left-hand center strip of the Console and above each Pre-Amplifier module. The keys operate in a vertical direction and are used to select and connect either of two microphones into an associated Pre-Amplifier input.

MIXER BUS KEYS

Each Pre-Amplifier module and high-level module is provided with a mixer key which permits placing the output of the associated

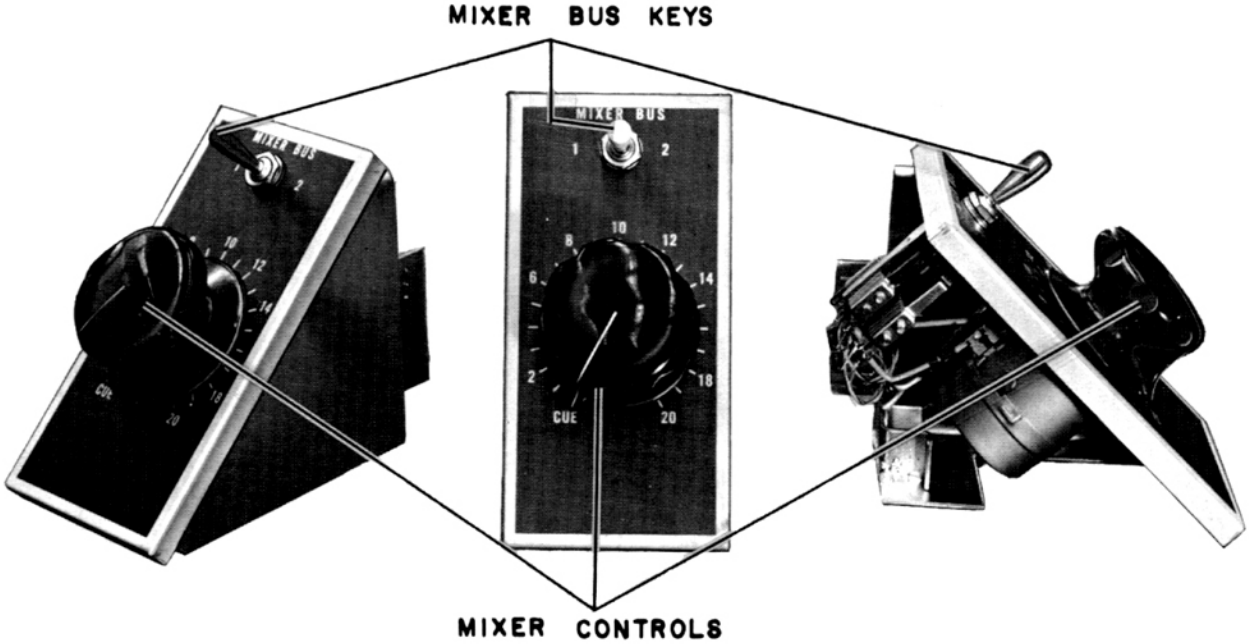



Fig. 5 Audio Console Modules (9-1165)

module on either the channel #1 (program) or channel #2 (audition) bus. The keys operate in a horizontal direction, the center is the OFF position.

## MIXER CONTROLS

Each Pre-Amplifier module and high-level module contains a step-type attenuator (large black knob) which permits controlling the level of the individual Pre-Amplifier or high-level audio source. In addition, the high-level module controls are equipped with a CUE position (full counterclockwise). The high-level signal at the input of the attenuator is fed to a common cue bus when the control is rotated fully counterclockwise (until switch click is felt).

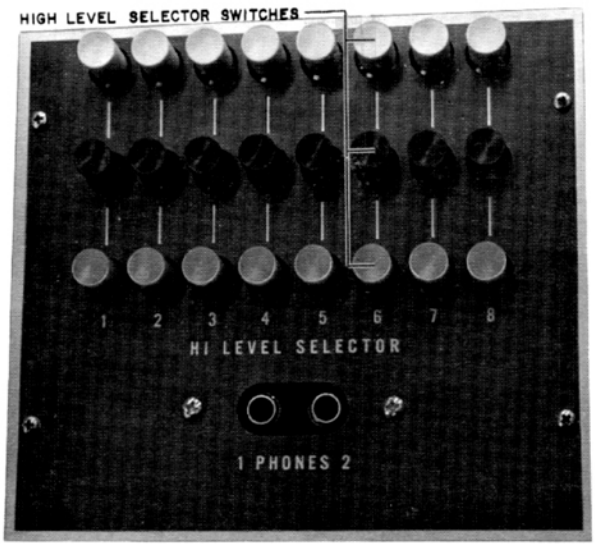



Fig. 6 High Level Selector Panel (9-1157)

## HI-LEVEL SELECTOR PANEL

The HI-LEVEL SELECTOR panel is located in the center of the sloping front section of the Audio Console. Three colored rows of eight push buttons provide a means of selecting and connecting any one of eight audio sources to the associated high-level mixer control. Color coding of the push-button rows and mixer bus keys of the high-level modules serves to identify which group of buttons feed the mixer position of the corresponding color.

The push buttons in each horizontal row are mechanically interlocked. Pressing any button will release any previously pressed button in that row. If it is desired to release all the buttons in a given row, it is only necessary to depress, halfway, any button in that row.

Switch positions one through five, in each row, are fed from a common source. The program sources (network or remote) are connected to positions six, seven, and eight of each row. These last three positions of each row are electrically interlocked with the corresponding position of the other rows. The order of priority ranges from bottom to top. For example, if position eight of the bottom row is locked down, the audio source associated with position eight of the middle or top row will not be available. Likewise, if position number eight of the top row was depressed first, it will be disconnected by depressing position eight of the middle or bottom row.

## MASTER GAIN CONTROL

The master gain control is located on the module at the lower right-hand end of the Audio Console. In the case of two-channel operation there will be two master gain controls placed adjacent to each other. Each module is equipped with a red indicator light which lights when the output line key has been placed in the corresponding position.

## OUTPUT LINE KEYS

Two output line keys (LINE-1 and LINE-2) are provided and are located in the upper right-hand section of the Audio Console. Each key makes it possible to connect a line to the output of channel #1 or channel #2 of a two-channel equipped Console. In the case of the standard or single channel Console, when the output line key is placed in the CH-2 position, the Monitor Amplifier output is connected to the outgoing line and emergency operation for the audition channel is made possible.

## MONITOR SELECTOR SWITCH

The MONITOR SELECTor switch is also located in the upper right-hand portion of

the Console and provides five positions for connecting the input of the Monitor Amplifier to channel #1, channel #2, or to any of three external audio sources.

MONITOR GAIN CONTROL

The MONITOR GAIN control is located in the upper right-hand portion of the Audio Console cover and is used to control the level of the Monitor Amplifier. In the case of emergency operation, the MONITOR GAIN control also serves as a master gain control.

OVER-RIDE SWITCH

The OVER-RIDE switch is a two-position rotary switch located in the upper right-hand section of the Audio Console. When placed in the ON position, it connects incoming remote lines to the Monitor Amplifier in order to attract the operator's attention to remote line sources.

REMOTE CUE SELECT SWITCH

The REMote CUE SELECT switch is located on the upper left-hand section of the Audio Console and is used to select and connect program material for cue purposes to any one of three remote lines. When placed in one of the three line positions, the switch disconnects that line from the over-ride monitor circuits.

CUE/TALKBACK GAIN CONTROL

The CUE/talkback GAIN control is located in the upper left-hand corner of the Audio Console and is used to control the level of the Cue/Talkback Amplifier.

CUE/TALKBACK SELECTOR SWITCH

The CUE/TalkBack SELECTOR switch is an eight-position, push-button type located on the upper left-hand section of the Audio Console. It is used to select and control intercommunications with three remote lines, two studios, an announce booth, and a cue bus. When the eighth position (CUE) is depressed, the Cue/TB Amplifier is connected to the Console cue bus. The audio output from the Cue/TB Amplifier is heard from the four-inch speaker mounted in the Console cover. To use the communication facility it is only necessary to select the desired circuit by depressing one of the first six buttons and then using the seventh (red) button as a push-to-talk switch. When the nonlocking red button is depressed, the Console speaker serves as a microphone.

VU SELECT SWITCH

The VU SELECT switch is used to connect the VU Meter to either channel #1, channel #2, or a remote source for measuring purposes. The extreme counterclockwise position is OFF and disconnects the VU Meter from any input.

## Operational Procedure

SINGLE CHANNEL OPERATION

As shipped, the Audio Console is normally connected for single channel operation.

Placing any MIXER BUS key in position number one connects the output of the associated module to the program bus. Placing the keys in position number two connects the outputs to the audition bus.

The output LINE keys make it possible to connect either of two program lines or both lines simultaneously to the output of the Program Amplifier. Placing the LINE keys in the CH-1 (up) position connects the program lines to the Program Amplifier. In the event of Program Amplifier failure, an emergency output can be obtained by placing the LINE keys in the CH-2 (down) position. This connects the program lines to the Monitor Amplifier through a loss pad. Under such conditions the output line level is determined by the MONITOR GAIN control.

Under normal conditions the LINE keys will be placed in the CH-1 position and the output level is determined by the MASTER GAIN control. The average setting for this control is between 10 and 12 as read on the dial.

AUDITIONING

All microphone and high-level input sources may be used for audition purposes by

placing the MIXER BUS key of the associated module in the number 2 (audition) position and the MONITOR SELECT switch in the CH-2 position. For normal auditioning operation the MONITOR GAIN control determines the output level and should be set at a dial reading of approximately 4.

1. Microphone Auditioning

a. Select the desired microphone input by placing the proper microphone selector key in either an up or down position.

b. Turn the fader control of the associated Pre-Amplifier to the OFF position.

c. Place the MIXER BUS key in position 2 and adjust the fader control to the desired level.

2. High-Level Auditioning

a. Determine which of the three high-level modules are free for use and turn the fader control of this module counterclockwise up to but not into the CUE position.

b. Place the colored MIXER BUS key in position 2.

c. Select the input to be auditioned by depressing the proper button in the colored row of the HI-LEVEL SELECTOR switch panel which corresponds to the color of the MIXER BUS key of the high-level module.

d. Adjust the fader control of the high-level module to the desired level.

## CUEING HIGH-LEVEL INPUTS

All high-level inputs may be switched to the cue bus, amplified by the Cue/TB Amplifier and reproduced by the Console speaker by:

1. depressing the CUE button of the CUE/TB SELECTOR switch,
2. determining which high-level control module is to be used and turning its fader knob fully counterclockwise to the CUE position,
3. selecting the desired input by depressing the proper button in the colored row of the HI-LEVEL SELECTOR switch which corresponds to the color of the MIXER BUS key on the high-level control module, and
4. adjusting the CUE GAIN control to the desired level.

## AUDITION LIGHTS AND SPEAKER OPERATION

During an audition operation it is possible to connect the Console monitor output into a studio speaker, provided that none of the microphone selector keys associated with the studio are in an ON (up or down) position, and that neither LINE key is in the CH-2 position. At this time, intercommunications may be carried on with a studio or announce booth by means of the Cue/TB facilities of the Console. The talkback operation is accomplished by depressing the STUDIO A, B, or ANN button on the CUE/TB SELECTOR panel. Use the red, non-locking, push-button for listen/talk operation.

## ON-AIR OPERATION

The same operational procedures and facilities that apply to auditioning operation also apply to the ON-AIR operation except the LINE keys are used to place the Console in an ON-AIR status. However, place them in the off (center) position before placing a program on an outgoing line so that the microphone selector keys and all mixer keys may be preset to the desired position. Under this condition the studio warning lights will indicate an AUDITION status.

Placing a LINE key in the CH-1 or ON-AIR position will turn out the studio AUDITION light and turn on the studio ON-AIR light and the ON-AIR light on the master gain control module of the Console.

The cueing facilities of the Console may be used at any time whether in an ON-AIR or AUDITION status.

## FEEDING PROGRAM CUE TO REMOTE LINES

The REM CUE SELECT switch makes it possible to feed program cueing to any one of three remote lines.

Assume that an incoming remote line is connected to position #7 of the HI-LEVEL SELECTOR switch. The remote line will be connected to the CUE/TB SELECTOR switch and the REM CUE SELECT switch when all three push buttons in the #7 position of the HI-LEVEL SELECTOR switch are off (out).

To connect program cue to this line, place the REM CUE SELECT switch in the #2 position. This connects the CH-1 output of the Console to the remote line through an isolation pad.

When the NEMO #2 push button of the CUE/TB SELECTOR switch is depressed for intercommunication purposes, the program cue facilities will be cut off.

The cue and talkback functions will continue to operate until a #7 push button on the HI-LEVEL SELECTOR switch is depressed. This connects the remote line to a mixer position and disconnects the cue and cue/talkback circuits. That is, intercommunications can be maintained with a remote station until it is put in an ON-AIR status.

OVER-RIDE FACILITY

When placed in the ON position, the OVER-RIDE switch connects all incoming remote lines to the Monitor Amplifier. However, when a remote line is selected on the CUE/TB SELECTOR switch or the REM CUE SELECT switch, the remote line is disconnected from the over-ride circuit of the Console.

## MAINTENANCE

### Preventive

To assure continuous satisfactory operation of the Audio Console, establish a routine cleaning schedule. Opening the Console cover exposes the inside of both the top and bottom sections making cleaning with a soft brush or air hose a simple task.

Standard studio maintenance techniques can be applied to the cleaning of attenuators, switches, and relay contacts. The removal of some of these items is necessary to facilitate routine maintenance and is explained below:

RELAY MODULES

The relay modules may be removed by gripping the mounting board by the edges and pulling upward. DO NOT APPLY FORCE TO THE RELAYS.

ATTENUATORS

The Daven attenuators used on the Pre-Amplifier modules, high-level modules, and master gain control module are accessible for routine maintenance. Remove the individual modules from the Console by releasing the locking handles in back and pulling the module forward. The attenuator cover can then be removed by depressing the tab and turning the cover in a counter-clockwise direction. In some cases it may be necessary to rotate the attenuator knob, as close tolerances inside may tend to bind the cover.

HIGH-LEVEL SELECTOR SWITCH PANEL

To perform any routine maintenance on the high-level selector switch panel, remove it from the Console using the following procedure:

1. Remove the Pre-Amplifier adjacent to the switch panel.
2. Loosen the two screws holding the angle bracket to the side wall of the switch housing (viewed from Pre-Amplifier opening).
3. Remove the four mounting screws on the face of the switch panel.
4. Gently pull the switch panel forward while slightly tipping up taking care not to snag the spring contacts of the switches in the top row.
5. When clear of the frame, move the panel sideways until a hand will fit underneath the panel to remove the cable assembly.
6. After performing the required maintenance, reverse the above procedure to re-install the panel.

CLEANING

Keep the equipment as clean and dry as possible. An air blower or a brush with long soft bristles makes a very good dust remover. When a high pressure air hose is used for cleaning, care should be taken not to disturb components or wiring.

## COMPONENT REPLACEMENT

Before installing the replacement part, check the circuit for the cause of the component failure. When replacing components, select the proper replacement part from the Parts List. All components are listed by symbol number and have their G-E Drawing number and a complete description given.

## Corrective

Some special precautions are necessary when servicing this equipment to avoid damaging the transistorized and printed circuits.

1. Do not remove transistors from an Amplifier when the power is on.
2. Do not use soldering irons of a rating higher than 30 watts when servicing the printed wiring boards as excessive heat will damage the boards.
3. In the event of diode removal or replacement, grasp the diode lead, being soldered, with a long-nose pliers. The pliers will act as a heat sink to protect the diode from damage by helping to dissipate excess heat which is conducted through the lead.

Specific servicing information on the various modules and power supplies is explained in the individual instructions which are included as part of this book.

## PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | PLUG-IN-UNITS | |
| AR2 thru AR5 | Pre-Amplifier. See EBI-2185. | 4BA21A1 |
| AR6 | Program Amplifier. See EBI-2180. | 4BA22A1 |
| AR8 | Monitor Amplifier. See EBI-2192. | 4BA24A2 |
| AR9 | Cue/TB Amplifier. See EBI-2182. | 4BA28A1 |
| | ATTENUATORS | |
| AT1 | Potentiometer, composition: 150 ohms ± 20%, 1.13 w, modified log taper. Allen Bradley Type J. | M-2R74-P3 |
| AT2 | Potentiometer, composition: 500,000 ohms ± 20%, 1.13 w, modified log taper. Allen Bradley Type J. | M-2R74-P24 |
| | CAPACITORS | |
| C1 and C2 | Electrolytic, polarized twist prong base; 2000 mfd +250% -10%, 50 v d-c w. | C-7776308-P106 |
| C3 | Ceramic Hi-K disk, 0.02 mfd +100% -0%, 500 v d-c w. | C-7774750-P15 |
| C4 | Mylar, dielectric; 0.047 mfd ± 20%, 100 v d-c w. Goodall Electric Co. Type 663-UW. | B-7491930-P8 |
| | GERMANIUM DIODES | |
| CR1 thru CR6 | Type 1N91. | A-7164424-P14 |
| | INDICATOR LIGHTS | |
| I1 and I2 | G-E Type 1819. | A-7164423-P16 |
| | CONNECTORS | |
| J1 thru J5 | Mica filled phenolic, 13 contacts. Elco Part #PVC2-13-F-3-1/16-0. | C-7777466-P2 |
| J6 thru J14 | Mica filled phenolic, 9 contacts. Elco Part #PCV2-9-A-3-1/16-0. | C-7777466-P3 |
| J15 | 33 female contacts. HB Jones Cat. #S-333-EB. | P-7772322-P14 |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CONNECTORS (CONTINUED) | |
| J16 thru J19 | Mica filled phenolic, 13 contacts. Elco Part #PCV2-13-F-3-1/16-0. | C-7777466-P2 |
| J20 and J21 | 3-conductor jacks to accommodate phone plug Type PL-68 and all standard 3-conductor plugs. | A-7109613-P5 |
| | SPEAKER | |
| LS1 | Dynamic speaker, permanent magnet, 4" size; voice coil impedance 3.2 ohms ± 10%, speaker resonance 200 to 275 cps, voice coil d-c resistance 3.2 ohms ± 5%. G-E Type S400C22. | B-7485089-P1 |
| | METER | |
| M1 | VU Meter. Assembly Products Inc. Model 561, meter scale Type B. | B-7492839-P1 |
| | PLUG | |
| P15 | 33 pin male. HB Jones Cat. #P-333-CCT. | P-7767680-P56 |
| | RESISTORS (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R1 thru R20 | 0.15 megohm ± 10%. | C-3R77-P154K |
| R21 thru R26 | 150 ohms ± 10%. | C-3R77-P151K |
| R27 and R28 | 1200 ohms. | C-3R77-P122J |
| R30 thru R33 | 160 ohms. | C-3R77-P161J |
| R34 | 430 ohms. | C-3R77-P431J |
| R36 thru R39 | 160 ohms. | C-3R77-P161J |
| R40 | 430 ohms. | C-3R77-P431J |
| R41 thru R44 | 160 ohms. | C-3R77-P161J |

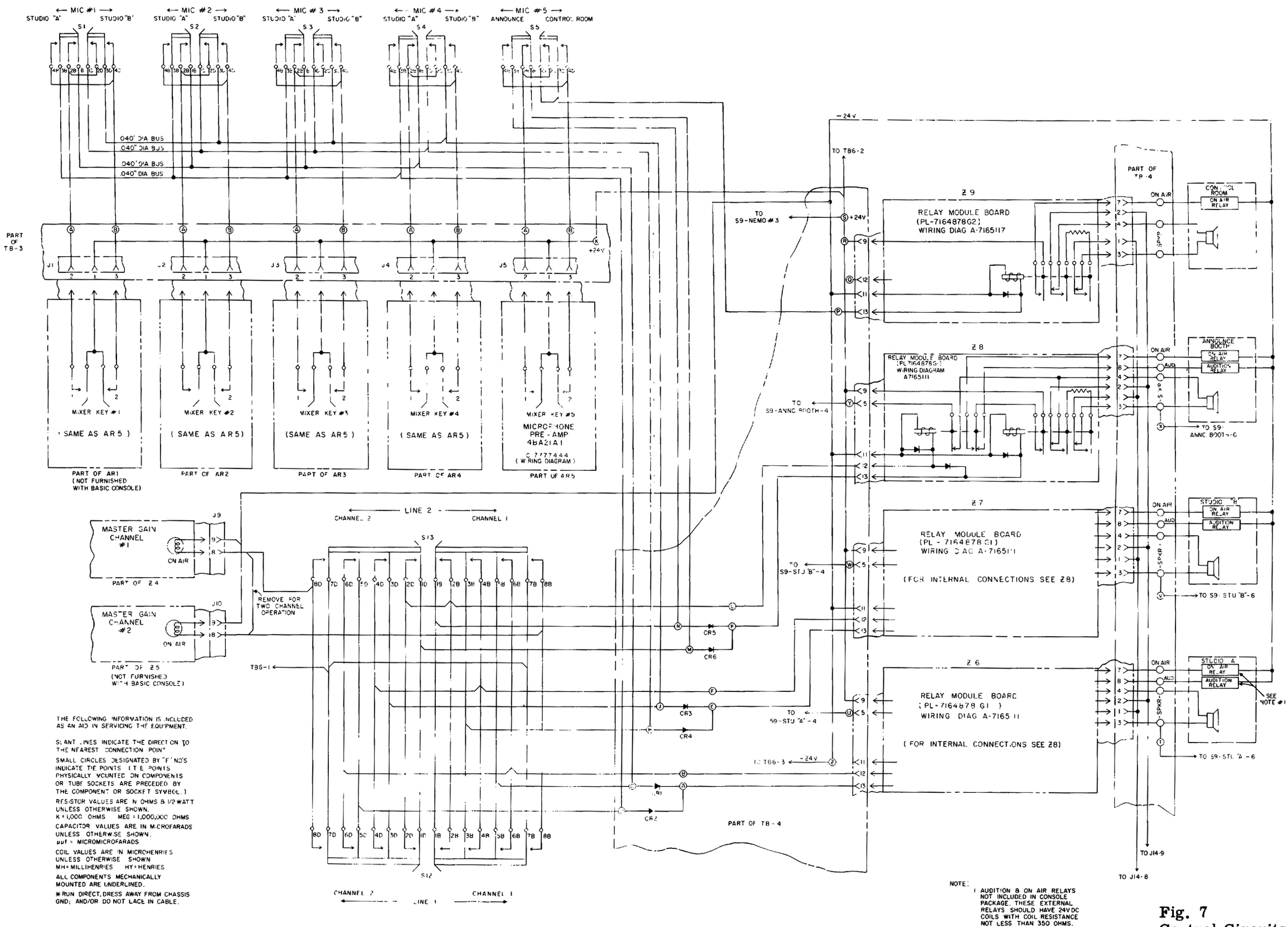



**Fig. 7 Control Circuits Diagram (E-7354581, Rev. 2)**

**Fig. 7**
**Control Circuits**

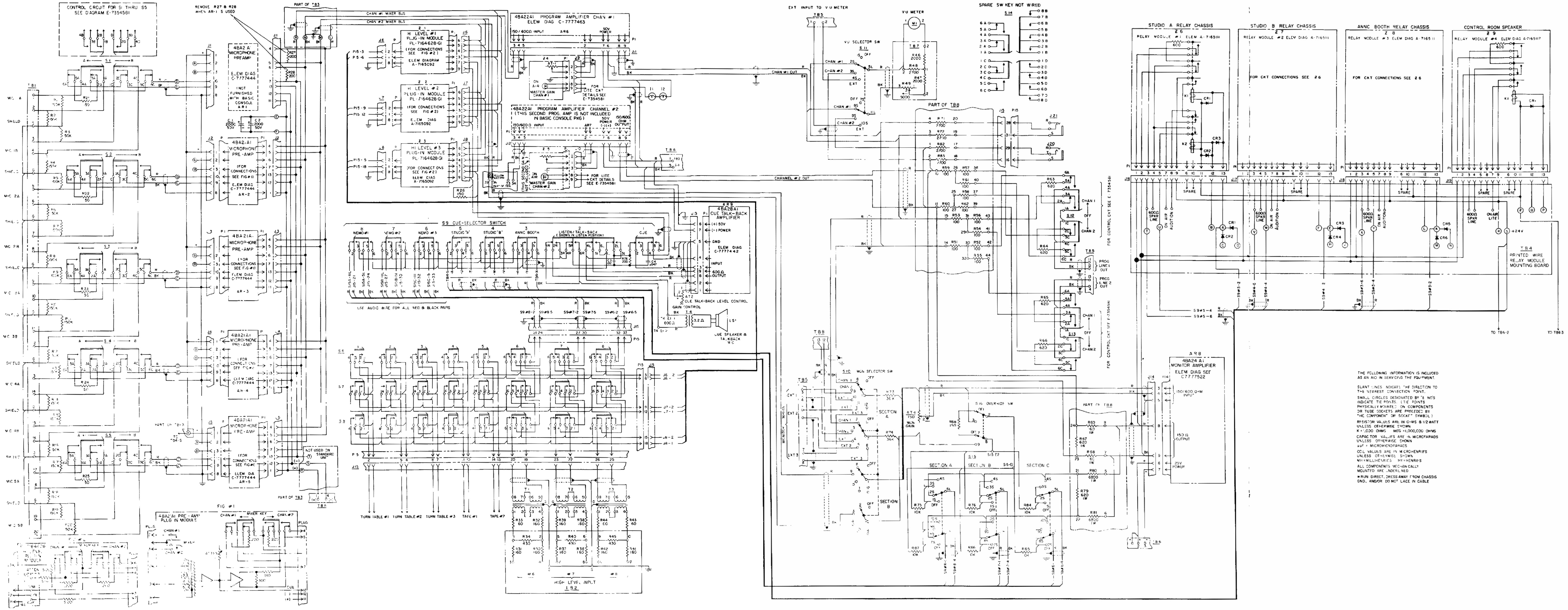
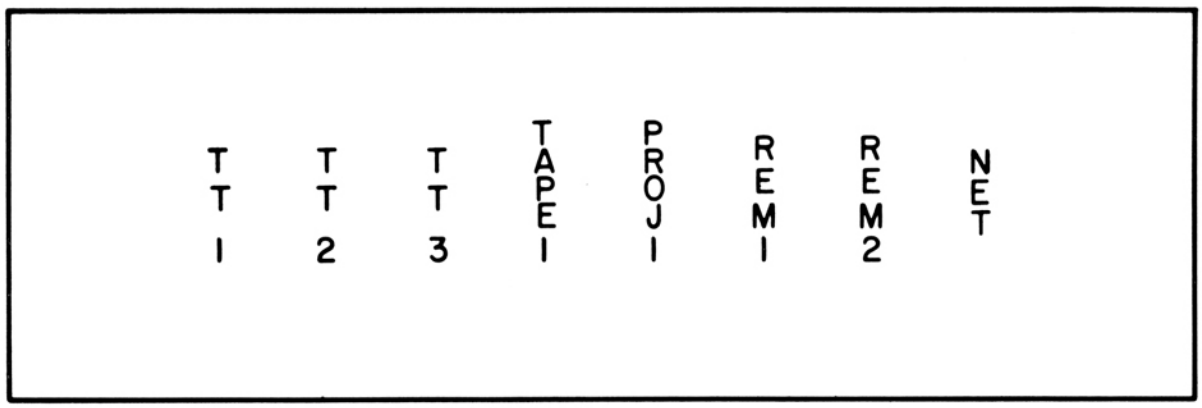
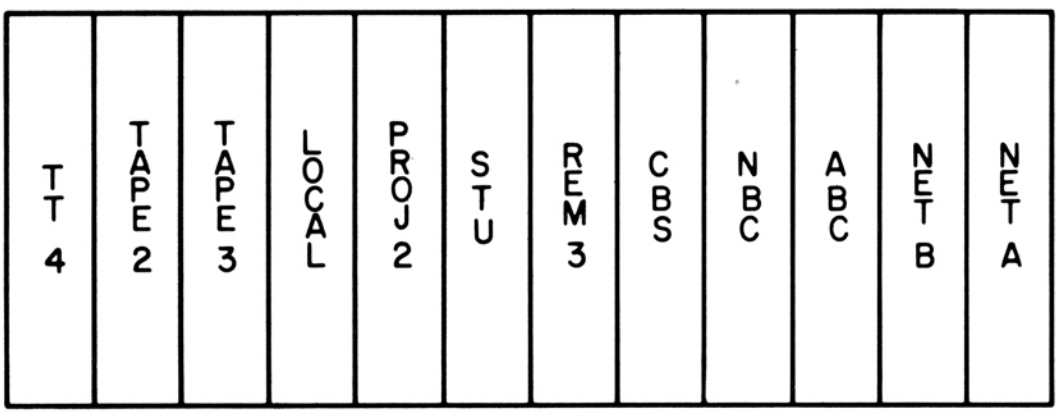
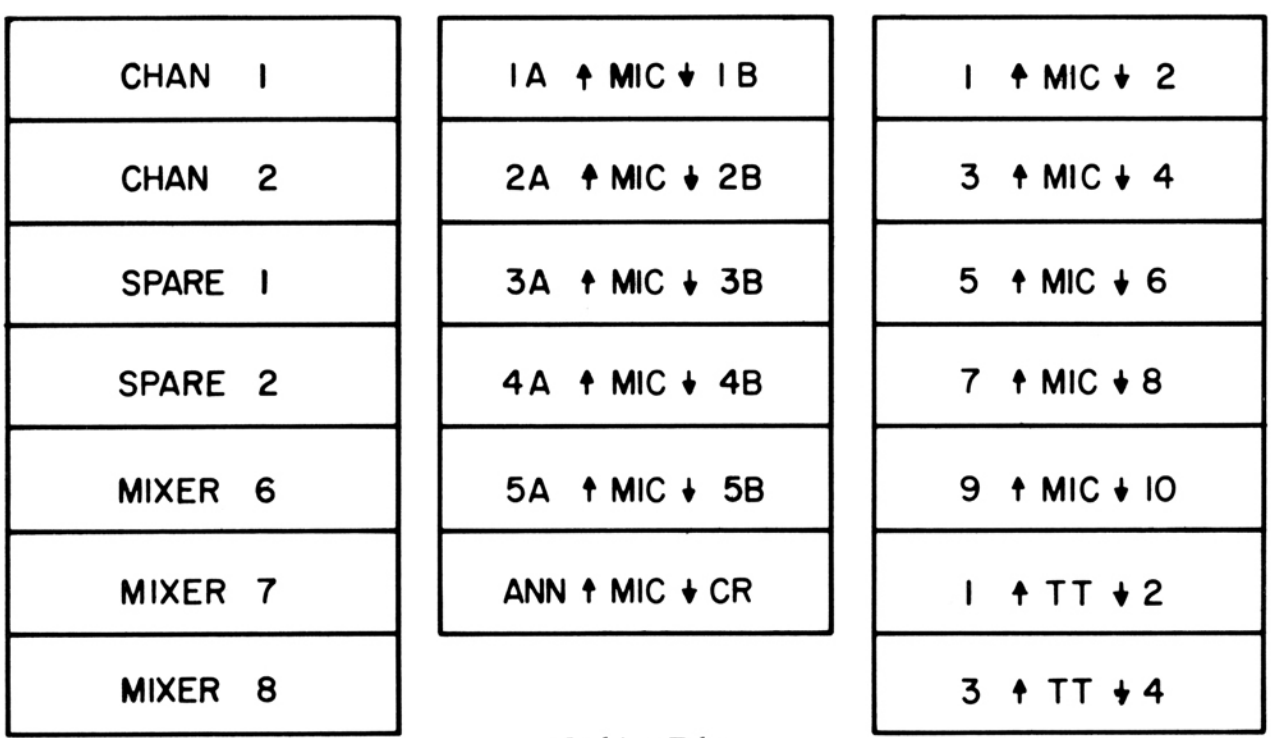


Fig. 8 Elementary Diagram, Audio Console, Model 4BC21A1 (EE-7354329, Rev. 2)




Marking Tabs

*INSTRUCTIONS*

# PRE-AMPLIFIER
## MODEL 4BA21A1, REVISION A

**EBI—2185B**

DEFENSE ELECTRONICS DIVISION
GENERAL ELECTRIC
ELECTRONICS PARK, SYRACUSE, N. Y.

5/61 (600)

PRINTED IN U.S.A.

## CONTENTS



## ILLUSTRATIONS

# PRODUCTION CHANGE SHEET

## PRE-AMPLIFIER
## MODEL 4BA21A1

## REVISION A

### Parts List and Elementary Diagram, Fig. 5

| Symbol | Was | Changed To |
|---|---|---|
| C6 | 20 mfd +100% -15%, 50 v d-c w.<br>Sprague Cat. #30D198A1.<br>G-E Drawing B-7489483-P11. | 50 mfd +100% -10%, 50 v d-c w.<br>Sprague Cat. #30D200A1.<br>G-E Drawing B-7489483-P25. |

## INTRODUCTION

The General Electric Model 4BA21A1 Pre-Amplifier is a high-fidelity, plug-in amplifier assembly designed to raise the level of microphone outputs for broadcast applications. See Figs. 1 and 2. The use of printed wiring and complete transistorization makes the unit very compact and easy to install and maintain.

The Pre-Amplifier is designed for use in the Type BC-21-A Audio Console or other custom console systems employing transistor amplifiers Type BA-22-A, BA-24-A, or BA-28-A.

Power for the operation of five Pre-Amplifiers may be obtained from the Type BP-21-A Transistor Power Supply or from another well filtered 25-volt d-c supply.


Fig. 1 Pre-Amplifier, Front Oblique View (9-1980)

## EQUIPMENT

The equipment furnished is comprised of a plug-in amplifier board, a mounting frame, a 2-db per step Daven Attenuator, an output mixer bus key, and one set of transistors.

## ACCESSORIES

Additional equipment recommended for use with the Model 4BA21A1 Pre-Amplifier is listed below and must be ordered separately:

### Transformer, Type FA-47-A

Transformer, Type FA-47-A, is recommended for providing either a 150- or 600-ohm balanced output from the Model 4BA21A1 Pre-Amplifier. It must be mounted external to the Pre-Amplifier, and for best results, adjacent to it. The transformer is provided with mounting holes in both top and bottom for ease of installation. The connections to be made to the transformer for either 150- or 600-ohm balanced outputs are shown in Fig. 3.

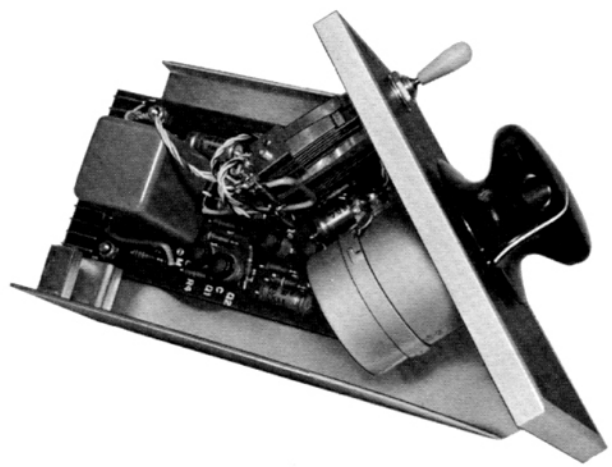


Fig. 2 Pre-Amplifier, Left Side View (9-1983)

## Connector

When the Pre-Amplifier is mounted in equipment other than a Type BC-21-A Audio Console, a receptacle (G-E Drawing C-7777466P1) is required for making all connections to it.

## Bridging Volume Control, Type FA-35-G

For variable bridging service, the Bridging Volume Control, Type FA-35-G, is recommended for use with the Pre-Amplifier. See Bridging Input Operation, page 4, and EBI-2147.

# TECHNICAL SUMMARY

## Electrical

POWER INPUT

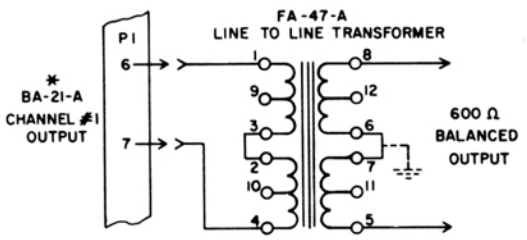
8 ma at 25 volts d-c.

SOURCE IMPEDANCE

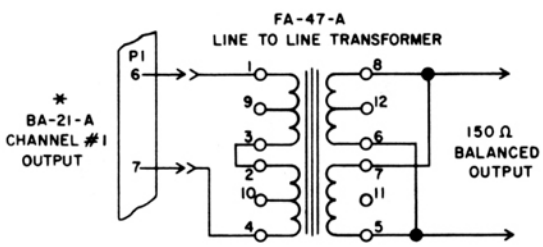
30/150/250/600 ohms (balanced or unbalanced).

INPUT IMPEDANCE

Unloaded transformer.




A CONNECTIONS FOR 600 OHM BALANCED OUTPUT




B CONNECTIONS FOR 150 OHM BALANCED OUTPUT

* FOR CHANNEL #2 OUTPUT CONNECT TO P1-4 & P1-5

Fig. 3 Connection Diagram, Line-to-Line Transformer, Type FA-47-A (A-7165757)

MAXIMUM INPUT LEVEL

-35 db with amplifier connected for 50 db of gain.
-25 db with amplifier connected for 40 db of gain.

OUTPUT LOAD IMPEDANCE

300-1000 ohms (nominally 600 ohms) unbalanced.

OUTPUT LEVEL AND DISTORTION
(50-15,000 cps)

-10 dbm with $\frac{1}{2}$% or less of distortion.

OUTPUT NOISE

-70 dbm (60 db below -10 dbm program level).

FREQUENCY RESPONSE

± 1 db, 50-15,000 cps.

GAIN

40 or 50 db (shipped connected for 50 db gain).

## Transistor Complement

3 Type G-E 4JX1A547/2N508 (Q1, Q2, Q3)
1 Type G-E 2N320 (Q4)

## Mechanical

| | |
|---|---|
| Length: | $9\frac{1}{2}$ inches |
| Width: | 3 inches |
| Height: | 4-7/16 inches |
| Weight: | 1-3/4 pounds |
| Front Panel Slope: | 45 degrees |

### Maximum Operating Temperatures

Maximum room ambient temperature (continuous): 95 F (35 C)

Maximum room ambient temperature (5% of time): 113 F (45 C)

## DESCRIPTION

The General Electric Model 4BA21A1 Pre-Amplifier is a complete, plug-in, transistor amplifier assembly which includes in addition to the amplifier, a mounting frame, an etched front panel, a Daven Step Attenuator, and a three-position output lever switch.

The Pre-Amplifier is constructed on a printed circuit board with input, output, and power connections made to it by means of a 13-pin connector assembly which is staked and soldered to the printed circuit board.

The mounting frame is plated steel with a flat base. An etched aluminum front panel, which overlaps the frame, slopes at a 45-degree angle from vertical. An access hole in the frame makes it an easy matter to change the input transformer connections when input impedances other than the factory connected 150 ohms are necessary.

## INSTALLATION

### Mounting

The mounting frame of the Pre-Amplifier is designed to fit the frame of the Type BC-21-A Audio Console. The 13-pin connector of the Pre-Amplifier is merely inserted into the corresponding receptacle in the Audio Console. The Accessory Connector, G-E Drawing C-7777466P1, is required if the Pre-Amplifier is to be mounted in any other type of installation.

### Connections

The Elementary Diagram, Fig. 5, shows the proper pins on plug P1 for connection of power, audio-input, and audio-output leads. The following paragraphs interpret and supplement the information given on the Elementary Diagram.

AUDIO-INPUT CONNECTIONS

The types of operation (unloaded input transformer, matching, and bridging input) are defined in the DISCUSSION OF GAIN RATINGS section of these instructions, and their application is discussed in the OPERATION section.

1. Unloaded Input Transformer Operation

The Pre-Amplifier as shipped is connected to operate from a 150-ohm source connected to pins 9 and 10 of P1. Terminal T1-3 may be grounded at P1-11 for balance to ground operation. The 150-ohm input may be used for 250-ohm sources with excellent results.

Changes for operation from a 600-, 250-, or 30-ohm source may be made at the input transformer (T1) terminals.

For operation from a 600-ohm source instead of a 150-ohm source, disconnect the wire between P1-9 and T1-2 at T1-2 and reconnect it to T1-1. Disconnect the wire between P1-10 and T1-4 at T1-4 and reconnect it to T1-5. Terminal T1-3, may be grounded at P1-11 for balance to ground operation.

For operation from a 250-ohm source instead of a 150-ohm source, disconnect the wire between P1-10 and T1-4 at T1-4 and reconnect it to T1-5. A balance to ground may be provided by connecting two 2500-ohm resistors in series between T1-2 and T1-5 and grounding their center tap to P1-11.

For operation from a 30-ohm source instead of a 150-ohm source, disconnect the wire between P1-9 and T1-2 and reconnect it to T1-5. A balance to ground may be provided by connecting two 300-ohm resistors in series between terminals T1-4 and T1-5 and grounding their center tap to P1-11.

2. Matching Input Operation

For matching operation from a 600-ohm source, disconnect the wire between P1-9 and T1-2 at T1-2 and reconnect it to T1-1; disconnect the wire between P1-10 and T1-4 at T1-4 and reconnect it to T1-5. Terminal T1-3 may be grounded to P1-11 for balance to ground operation. Then connect a 600-ohm resistor across terminals P1-9 and P1-10 to match the source.

For matching operation from a 150-ohm source, leave the connections to T1-2 and T1-4 as they were shipped from the factory. Terminal T1-3 may be grounded to P1-11 for balance to ground operation. Then connect a 150-ohm resistor across terminals P1-9 and P1-10 to match the source.

3. Bridging Input Operation

For fixed resistor bridging, connect a 600-ohm external terminating resistor across the input and use series bridging resistors that total at least ten times the input impedance value. Bridging may be easily varied by changing the bridging resistors.

For variable bridging with a 600-ohm input, the G-E Type FA-35-G Bridging Volume Control consists of a high quality log-taper dual potentiometer and two fixed resistors. Its shaft is slotted for screwdriver control, yet long enough to use a knob. The input impedance is 10,000 ohms and the output impedance is 600-ohms. The FA-35-G is intended for use with balanced circuits. The mimimum insertion loss is 30 db when working into an amplifier with its input transformer unloaded (no termination). Thus, the BA-21-A Pre-Amplifier when used with an FA-35-G Control has a maximum bridging gain of 20 db when bridging a 600-ohm line. The Bridging Volume Control must be mounted external to the Pre-Amplifier.

4. Recommended Type of Wire

Since the input circuit is operated at a low level, the input wiring should be of shielded-pair construction, and the shield grounded at a ground lug on the shelf. Covered wire is recommended since it permits grounding of the shield at the Amplifier only. G-E Type FA-19-R (flex) or FA-19-M (solid) wire is recommended for this purpose.

AUDIO OUTPUT CONNECTIONS

As shipped, the Model 4BA21A1 Pre-Amplifier provides an unbalanced output nominally rated at 600 ohms. When used for this type of output operation, terminals P1-6 (channel 1) and P1-5 (channel 2) are at ground potential. A balanced output of 150 or 600 ohms may be obtained by using a G-E Type FA-47-A Line-to-Line Transformer as an output transformer. The proper connections for the transformer are shown in Fig. 3.

The output circuit of the Pre-Amplifier includes a building-out resistor (R14) of 910 ohms which, in conjunction with switch S1, is part of the Type BC-21-A Audio Console mixer base circuits. When the Pre-Amplifier is used in audio system applications other than in the Type BC-21-A Audio Console, strap out the building-out resistor.

The two-channel function of S1 may be used or discarded, depending on the installation requirements, without changing connections.

It is recommended that the same type of shielded audio wire used for the input connections be used in making the output connections.

POWER CONNECTIONS

When used with a Type BC-21-A Audio Console, the power input for the Pre-Amplifier is obtained from a 25-volt section of the Type BP-21-A Transistor Power Supply.

The Pre-Amplifier may be operated from other, well-filtered, 25-volt d-c sources, if necessary. It is required however, that the positive side of the source be grounded. In some cases additional filtering or decoupling between the power source and the Pre-Amplifier may be necessary.

**CAUTION**

IT IS NECESSARY THAT THE POWER INPUT CONNECTIONS BE OF THE CORRECT POLARITY TO PREVENT DAMAGE TO THE TRANSISTORS

The power connections to the Pre-Amplifier are:

| | |
|---|---|
| P1-11 | Positive connection (ground) |
| P1-12 | -25 volts |

OVER-ALL GAIN MODIFICATION

As shipped, the over-all gain of the Pre-Amplifier is 50 db (unloaded). If an over-all gain of 40 db is desired, remove capacitor C2.

## OPERATION

### Operation With Unloaded Input Transformer

With this type of operation the highest signal-to-noise ratio of a microphone pre-amplifier is obtained since its input does not load the source. Hence the full voltage generated by the source is applied to the amplifier. Unloaded input operation is commonly used in pre-amplifier applications.

### Operation With Matching Input

Under certain conditions it might be desirable to have the pre-amplifier match a source impedance. For example, the pre-amplifier might be fed from a device, such as a precision attenuator or sound effects filter, which requires a matching resistance load. To match the Type BA-21-A Pre-Amplifier to a source impedance, merely connect a resistor across the pre-amplifier input terminals equal to the source impedance. Thus, if a 600-ohm pad is to feed the pre-amplifier and be properly terminated, connect the pad to the 600-ohm input terminals of the pre-amplifier, and connect a 600-ohm resistor across the same terminals. In this way, the normal unloaded-input-transformer characteristic inherent in the pre-amplifier will be changed to that of a matching input, where the pre-amplifier input impedance matches the source impedance.

Operation with matching input is not used with microphones, except in special cases which are specified by the microphone manufacturer.

### Operation With Bridging Input

Bridging input is sometimes desirable in order to connect the Type BA-21-A Pre-Amplifier across a low-impedance line without affecting the operation of the line. In this way, the pre-amplifier may be used to monitor the line or feed other lines. Refer to Bridging Input Operation, page 4.

### Operational Checks and Adjustments

The Elementary Diagram, Fig. 5, gives typical a-c and d-c operating voltages. Use a meter having an internal resistance of 20,000 ohms-per-volt or higher to read these voltages.

## DISCUSSION OF GAIN RATINGS

### Unloaded Input Transformer (50 DB Gain)

When the full generated voltage of a microphone, turntable pickup, or similar device is applied to the input terminals of the pre-amplifier which it is feeding, the operating conditions are referred to as those of an unloaded input transformer. Under these conditions the highest signal-to-noise ratio of a microphone pre-amplifier combination is obtained because the pre-amplifier does not load the microphones.

Operating with an unloaded input transformer, as explained above, the pre-amplifier has a gain of 50 db. This gain is defined as the ratio of "power delivered to the load" to the "power which would be delivered to the load" if the pre-amplifier were replaced by an ideal transformer connected to match the load and source impedance. The gain is determined as follows (see Fig. 4).

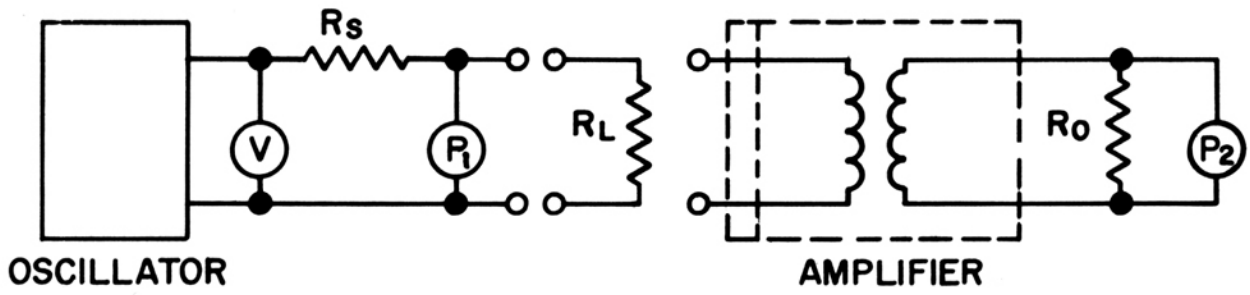



Fig. 4 Unloaded Input Transformer Circuit

A source resistance ($R_s$), fed by an oscillator, is connected to a load resistance ($R_L$) of equal value. The oscillator output is adjusted until the power dissipated in $R_L$ is -50 dbm, as indicated by the power measuring instrument, $P_1$. The output voltage of the oscillator, as indicated by voltmeter V, is recorded. $R_L$ is then disconnected from $R_s$ and the oscillator, and the pre-amplifier is connected in place of $R_L$. A tap on the input transformer of the pre-amplifier is used which is equal to the value of $R_s$ (250-ohm tap for 250-ohm $R_s$). The output of the oscillator, as indicated by voltmeter V, is held constant at the value previously recorded. The resulting output, as indicated by $P_2$, which the pre-amplifier will deliver to its proper load resistor $R_o$, is "0" dbm. Thus the gain of the amplifier is 50 db.

### Matching Input (44 DB Gain)

When the input circuit of a pre-amplifier constitutes a resistive load, equal in value to the impedance of the source feeding it, the pre-amplifier is said to have a matching input. Under these conditions, the voltage at the terminals of the input transformer of the pre-amplifier is only one-half the voltage generated by the source. This constitutes a 6-db drop in the voltage input to the pre-amplifier which effectively produces a 6-db decrease in pre-amplifier gain as compared with the gain obtained with unloaded-input-transformer operation. Thus, the gain of the pre-amplifier with matching input is 44 db.

### Bridging Input (Variable Gain)

When a pre-amplifier, or similar low-impedance device, is connected across a low-impedance line in such a way that only a small fraction of the energy in the line (insufficient to affect the operation of the line) is diverted into the pre-amplifier, the pre-amplifier is said to employ a bridging input. This is accomplished by stepping up the input impedance of the pre-amplifier either by fixed bridging resistors or by a variable bridging device such as the G-E Bridging Volume Control, Type FA-35-G. The FA-35-G is designed to provide a balanced 10,000-ohm bridging-input circuit for the pre-amplifier. It contains a continuously variable dual-potentiometer for the 600-ohm output portion of the resistive network, thereby offering a means for control of gain when desired. Since the Bridging Volume Control has a 30-db minimum insertion loss when used with the pre-amplifier, maximum gain is held to 20 db, bridging a 600-ohm line.

## MAINTENANCE

### General

When operated under normal studio conditions, the Model 4BA21A1 Pre-Amplifier will require very little maintenance other than periodic inspection and occasional cleaning of attenuator and switch contacts. If it should become necessary to trouble-shoot the Pre-Amplifier, the voltage readings shown on the Elementary Diagram, Figs. 5,

will be useful. If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first determining the cause of the failure.

## Transistor Selection

The present state of transistor technology sometimes necessitates transistor selection in order to meet the specified signal-to-noise ratio of an amplifier.

Performance specifications of the transistors permit a broad operational range for most types. Because of this broad range of characteristics, some transistors of a given type will not perform as well as others when used in the same circuit.

In any well designed transistor circuit, variations in the transistor performance will exhibit a minimum effect on the frequency response and distortion characteristics of an amplifier. The most noticeable effect of transistor variations will be in the noise characteristics.

In general, the random replacement of a defective transistor type, by another of the same type, will restore the amplifier to service. However, to realize the specified noise figure of a particular design it will sometimes be necessary to select or interchange like transistors in a given circuit to obtain the lowest noise figure.

When checking the noise in an amplifier, it is recommended that the two transistors in the Darlington Compound input circuit be interchanged to locate them for the best signal-to-noise ratio.

## Printed Wire Board Service Notes

### CAUTION

DO NOT USE LARGE SOLDERING IRONS TO SERVICE THE PRINTED WIRE BOARD.

The following steps will be of aid in replacing components on the board. Use only a 25- or 35-watt soldering iron to service the Pre-Amplifier as excessive heat can damage the printed wiring.

1. Grip the component to be removed at one end with a long-nose pliers, then apply a narrow-tip soldering iron to the component lead, barely touching the board wiring. Lightly pull away with the pliers, while the solder joint melts, until the lead can be pulled free of the board. Free the other lead in the same manner.

2. It is suggested that when a component has been removed, it be replaced by a new component of the same value. When installing a new component, observe the length and dress of the leads on the old component, then cut and bend the leads of the new component accordingly.

3. Try placing the leads in the holes. If residual solder prevents a lead from entering the hole, very gently ream out the solder with a sharply pointed, square tipped awl. Then place the leads in the holes so that the component is held in place by friction or slight spring tension of the leads.

4. Using a high-grade electrical solder, apply the soldering iron tip, then the solder to the junction of the hole so that a very small amount of solder flows around the lead and into the hole, thus bonding the lead to the board.

5. Examine the joint carefully. A good joint should withstand a light pull by the fingers. Clear away any loose solder, making sure that no solder scraps fall where they might cause a short.

6. In the unlikely event of a break in a printed wiring strip, the strip can be repaired by placing a short piece of tinned wire across the break and flowing solder over the length of the wire. Be careful that excess solder does not short adjacent strips.

# PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | ATTENUATOR | |
| AT1 | 20 steps (21 contacts) with "off" position at extreme CCW position; resistance elements to be ½ w composition resistors within ± 5% of value specified. | B-7492759-P1 |
| | CAPACITORS (Electrolytic, hermetically sealed) | |
| C1 and C2 | 50 mfd +100% -10%, 6 v d-c w. Sprague Cat. #30D133A1. | B-7489483-P4 |
| C3 and C4 | 5.0 mfd +100% -10%, 25 v d-c w. Sprague Cat. #30D179A1. | B-7489483-P6 |
| C5 | 35 mfd +100% -10%, 15 v d-c w. Sprague Cat. #30D169A1. | B-7489483-P10 |
| C6 | 50 mfd +100% -10%, 50 v d-c w. Sprague Cat. #30D200A1. | B-7489483-P25 |
| | TRANSISTORS | |
| Q1 thru Q3 | G-E Type 4JX1A547/2N508. | |
| Q4 | G-E Type 2N320. | |
| | RESISTORS (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R1 | 33,000 ohms. | C-3R77-P333J |
| R2 | 2000 ohms. | C-3R77-P202J |
| R3 | 4300 ohms. | C-3R77-P432J |
| R4 | 18,000 ohms. | C-3R77-P183J |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (CONTINUED) (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R5 | 510 ohms. | C-3R77-P511J |
| R6 | 1600 ohms. | C-3R77-P162J |
| R7 | 0.56 megohm. | C-3R77-P564J |
| R8 | 0.18 megohm. | C-3R77-P184J |
| R9 | 7500 ohms. | C-3R77-P752J |
| R10 | 2000 ohms. | C-3R77-P202J |
| R11 | 12,000 ohms. | C-3R77-P123J |
| R12 | 5100 ohms. | C-3R77-P512J |
| R13 | 300 ohms. | C-3R77-P301J |
| R14 | 910 ohms. | C-3R77-P911J |
| R15 and R16 | 1200 ohms. | C-3R77-P122J |
| | SWITCH | |
| S1 | Lever key type, 2 form A, 4 form D contacts, locking. D. Mossman Type 4900. | C-7777410-P2 |
| | TRANSFORMER | |
| T1 | Audio input. Pri imp: 600/150/30 ohms; sec imp: 2400 ohms. | A-7165301-P1 |
| | TRANSISTOR SOCKETS | |
| XQ1 thru XQ4 | Elco Cat. #3305. | B-5490277-P2 |

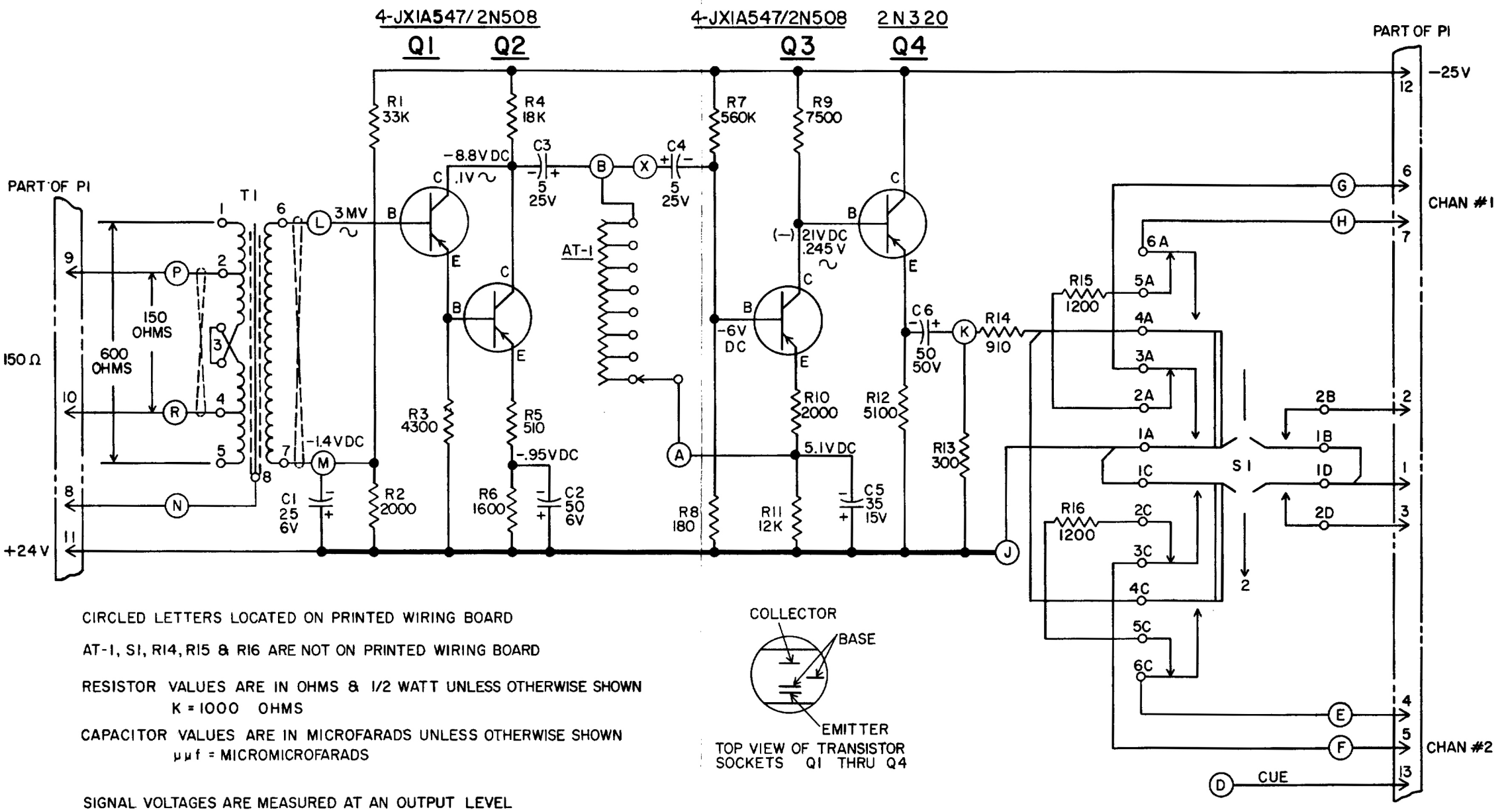



Fig. 5 Elementary Diagram, Pre-Amplifier, Model 4BA21A1 (C-7777444, Rev. A)

*INSTRUCTIONS*

# PROGRAM AMPLIFIER

## MODEL 4BA22A1

**EBI—2180B**

**DEFENSE ELECTRONICS DIVISION**

**GENERAL ELECTRIC**

**ELECTRONICS PARK, SYRACUSE, N. Y.**

4/61 (400)

PRINTED IN U.S.A.

## CONTENTS



## ILLUSTRATIONS

## INTRODUCTION

The General Electric Program Amplifier, Model 4BA22A1, is a high-fidelity, plug-in, transistor audio amplifier. See Figs. 1 and 2. It is designed for use in broadcast studio applications to amplify mixer-bus audio signals up to the program level necessary to feed telephone lines and broadcast transmitters. A completely transistorized audio system is made possible when the Amplifier is used with the Type BC-21-A Audio Console and the associated units.

## ACCESSORY EQUIPMENT

### Shelf, Type FA-48-A

The G-E Type FA-48-A Shelf will accommodate rack mounting for a maximum of four Program Amplifiers or a combination of four Type BA-22-A Program Amplifiers, Type BA-28-A Cue/TB Amplifiers, or Type BA-24-A Monitor Amplifiers. The Shelf is designed to standard EIA rack mounting dimensions occupying $5\frac{1}{4}$ inches of vertical rack space. Each Shelf includes a hinged front panel and four receptacles for mating with the Amplifier plugs.

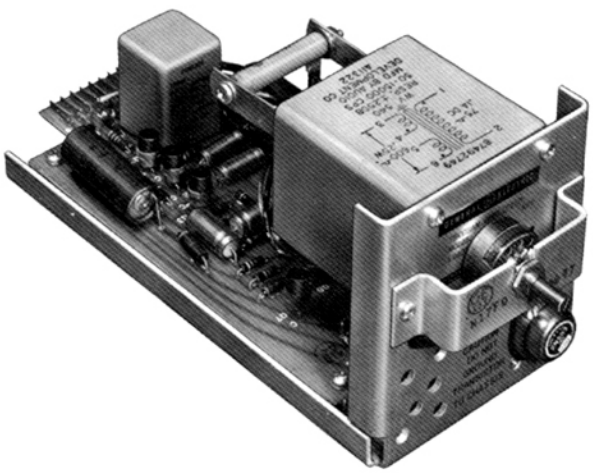


Fig. 1 Front View (S61-553)

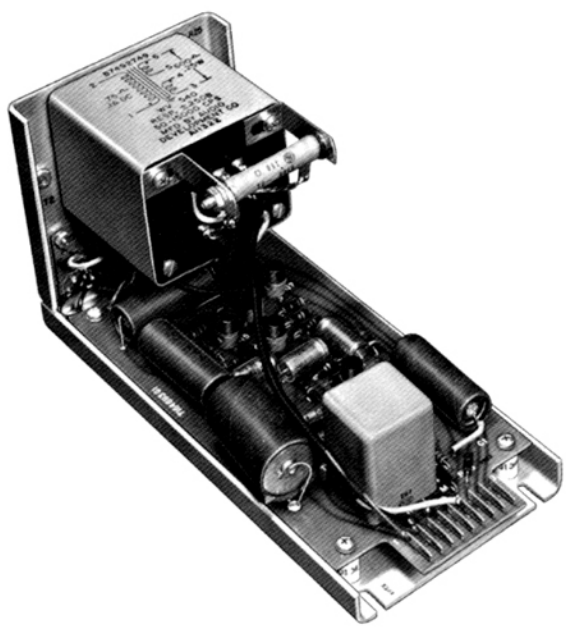


Fig. 2 Left Oblique View (S61-553)

### Connector

A Connector (G-E Drawing C-7777466-P3) may be used for making amplifier plug-in connections when it is desired to mount the Amplifier in other than the Audio Console or the Type FA-48-A Shelf.

### Volume Control

An interstage gain control may be mounted on the bracket across the end of the Program Amplifier chassis. Either a 500,000-ohm or 750,000-ohm log taper, carbon potentiometer may be used. A 750,000-ohm control suitable for this application may be ordered by G-E Drawing M-2R74-P25.

### Bridging Volume Control, Type FA-35-G

For variable bridging service, the Type FA-35-G Bridging Volume Control is recommended for use with the Program Amplifier. See Bridging Input Operation, pages 3 and 4, and EBI-2147.

### Transistor Power Supply, Type BP-21-A

Power for three Program Amplifiers or a combination of three Type BA-22-A Program Amplifiers and Type BA-28-A Cue/TB Amplifiers may be obtained from a Type BP-21-A Transistor Power Supply.

## TECHNICAL SUMMARY

### Electrical

SOURCE IMPEDANCE

150/600 ohms (factory connected for 150 ohms).

INPUT IMPEDANCE

Unloaded transformer.

MAXIMUM INPUT LEVEL

-21 dbm (matched input).

POWER INPUT

160 ma d-c at 50 volts (positive ground).

OUTPUT LOAD IMPEDANCE

150/600 ohm balanced or unbalanced (factory connected for 600 ohms).

OUTPUT LEVEL AND DISTORTION

+24 dbm output, $\frac{1}{2}$% or less of distortion from 50 to 15,000 cps.

FREQUENCY RESPONSE

± 1 db from 50 to 15,000 cps.

GAIN

75 db, ± 2 db with matching input.

NOISE

At least -35 dbm with a +24 dbm output.

### Mechanical

| | |
|---|---|
| Length: | 9-5/8 inches |
| Height: | $4\frac{1}{2}$ inches |
| Width: | $4\frac{1}{4}$ inches |
| Weight: | 2 pounds, 13 ounces |

### Transistor Complement

3 G-E Type 2N324/2N508 (Q1, Q2, Q3)
4 G-E Type 2N320 (Q4, Q5, Q6, Q7)
1 Delco Type 2N553 (Q8)

## DESCRIPTION

The Program Amplifier is of the plug-in design to facilitate replacement and maintenance. It is constructed on a printed wiring board which is mounted to an "L" shaped aluminum chassis. The output transistor, Q8, is mounted on the front of the chassis through an anodized aluminum washer allowing the chassis to serve as a heat sink for the output stage.

A bracket is mounted across the front end

of the chassis, above Q8, and provides a handle, transistor guard, and mounting for the local gain control, when one is required.

The size of the input transformer is small enough to allow mounting it to the wiring board. The larger and heavier output transformer is mounted directly on the vertical front section of the aluminum chassis.

The connecting plug, P1, is an extension of the printed wiring board and is located horizontally across the back of the unit.

# INSTALLATION

## Location

The Program Amplifier should not be mounted immediately above existing heat producing equipment when installed for applications other than the Type BC-21-A Audio Console.

## Mounting

The mounting frame of the Program Amplifier is designed to fit the frame of the Type BC-21-A Audio Console or the Type FA-48-A Shelf. The 9-pin connector at the back of the unit is merely inserted into the corresponding receptacle of the Console or Shelf and held in place by four #6-32 screws through the chassis base.

## Connections

The Elementary Diagram, Fig. 3, shows the proper pins on plug P1 for connection of power, audio input, and audio output leads. The following paragraphs interpret and supplement the information given on the Elementary Diagram.

AUDIO INPUT CONNECTIONS

1. Matching Input Transformer Operation

The Program Amplifier, as shipped, is connected to operate from a 150-ohm source. Input terminals P1-3 and P1-4 are connected to transformer terminals T1-2 and T1-4.

For matching operation from a 150-ohm source, connect a 150-ohm resistor across terminals P1-3 and P1-4 to match the source.

For matching operation from a 600-ohm source, disconnect the input wires from transformer terminals T1-2 and T1-4, and reconnect to transformer terminals T1-1 and T1-5. Then connect a 600-ohm resistor across terminals P1-3 and P1-4 to match the source. The center tap of T1 or either side may be grounded.

2. Bridging Input Operation

For fixed resistor bridging, connect the input for 600 ohms and then connect a 600-ohm external termination resistor across the input and use series bridging resistors that total at least ten times the input impedance value. Bridging gain may be easily varied by changing the bridging resistors.

For variable bridging with a 600-ohm input, the G-E Type FA-35-G Bridging Volume Control is suitable for use with the Program Amplifier. It consists of a high quality log-taper dual potentiometer and two fixed resistors. Its shaft is slotted for screwdriver control, yet long enough to use a knob. The input impedance is 10,000 ohms and the output impedance is 600 ohms. This Bridging Volume Control is intended for use with balanced circuits. The minimum insertion loss is 30 db when working into an amplifier with its input transformer unloaded (no termination). Thus the Program Amplifier when used with the Type FA-35-G Control has a maximum bridging gain of 45 db when bridging a 600-ohm line. The FA-35-G Control will not mount directly on the BA-22-A chassis. It should be mounted adjacent to the Amplifier, such as on the shelf door for convenience.

3. Recommended Type of Wire

Since the input circuit is operated at a low level, use input wiring of shielded-pair construction and ground the shield at

the grounding lug on the amplifier receptacle. Covered wire (G-E Type FA-19-R) is recommended since it permits grounding of the shield at the amplifier only.

AUDIO OUTPUT CONNECTIONS

1. 600/150-Ohm Operation

The Program Amplifier is shipped connected for operation into a 600-ohm load to be connected across terminals P1-8 and P1-9. It may be changed to operate into a 150-ohm load connected across these terminals by disconnecting the jumper between terminals T2-4 and T2-5 and reconnecting terminal T2-4 to T2-3 and T2-5 to T2-6. For operation into either a 600- or 150-ohm load, either terminal P1-8 or P1-9 may be grounded to P1-6.

2. Recommended Type of Wire

Connections to the audio-output terminals should also be of shielded pair construction such as G-E Type FA-19-R.

POWER INPUT CONNECTIONS

The Program Amplifier is designed for use with the G-E Type BP-21-A Power Supply; however, any equivalent well filtered 50-volt supply may be used.

1. Power Connections

Jumper P5 and P6 together on the amplifier socket. Connect the positive lead of the 50-volt input to terminal P1-6, and the negative lead to P1-7. DO NOT REVERSE POLARITY as serious damage to the transistors may result.

2. Recommended Type of Wire

The wire carrying the 50-volt d-c input should be of at least #16 AWG size. This wire does not have to be twisted or shielded but shielded wire such as G-E Type FA-19-J is recommended especially if RF fields are present.

## OPERATION

### Operation With Unloaded Transformer

When no resistance loading of the input transformer is used, the full generated voltage of the source is applied to the input terminals of the Amplifier. This is called unloaded transformer operation. Under these conditions the highest signal-to-noise ratio is obtained in the system.

### Operation With Matching Input

In many applications it will be desirable to have the Amplifier match a source impedance. For example, the amplifier may be fed from a pre-amplifier, a line, or a precision attenuator, which requires a matching resistance load. To match the Program Amplifier to a source impedance, merely connect a resistor across the amplifier input terminals equal to the source impedance. Thus if a 600-ohm pad is to feed the Amplifier and be properly terminated, connect the pad to the 600-ohm input terminals of the Amplifier, and connect a 600-ohm resistor across the same terminals. In this way, the normal unloaded input transformer characteristic inherent in the Amplifier will be changed to that of a matching input, where the Amplifier input impedance matches the source impedance. Under these conditions the voltage at the terminals of the Amplifier's input transformer is only one-half of the voltage generated by the source. With the transformer connected for matching input as described above, the gain is 75 db.

### Bridging Input Operation

When an amplifier is connected across a low-impedance line in such a way that only a small fraction of the energy in the line (insufficient to affect the operation of the line) is diverted into the amplifier, the amplifier is said to employ a bridging input. This is accomplished by stepping up the input impedance of the amplifier to about

10,000 ohms so that in connecting it across the low-impedance line (0 to 600 ohms), it has negligible effect.

Used as a bridging amplifier across a 600-ohm line the Program Amplifier with the Bridging Volume Control, Type FA-35-G, has a gain of 46 db, where the gain is defined as the ratio of the power ($P_1$) in the 600-ohm line terminating resistance ($R_L$) to the output power ($P_2$) of the amplifier; that is GAIN (db) equals 10 log $P_2$ divided by $P_1$.

Since the voltage across the terminating resistance of a 150-ohm line is one-half of the voltage across the terminating resistance of a 600-ohm line, the bridging gain of the amplifier when bridging a 150-ohm line will be essentially 6 db less that when bridging a 600-ohm line with fixed resistance bridging.

### Operational Checks and Adjustments

The Elementary Diagram, Fig. 3, gives typical operating voltages. Use a meter having an internal resistance of 20,000 ohms-per-volt or higher to read these voltages.

## THEORY AND CIRCUIT ANALYSIS

The Program Amplifier consists of eight transistor stages, an input transformer, and an output transformer. See Elementary Diagram, Fig. 3.

The first two amplifier stages, Q1 and Q2, are connected in a Darlington Compound configuration to provide the best signal-to-noise ratio. A pair of capacitors, C2 and C3, are series connected and used to couple the collector output of Q2 to the base of Q3. The junction point of the capacitors is brought out to terminal P1-2 to allow the connection of a gain control, if required. This control is connected as a rheostat between terminals P1-2 and P1-1 which is essentially the junction of R10 and R11. Both Q3 and Q4 are common emitter stages. C5 provides coupling between the collector output of Q3 and the base of Q4. The collector of Q4 is directly coupled to the base of emitter follower stage Q5, which in turn drives another common emitter stage, Q6. The output stages, Q7 and Q8, are also connected in a Darlington Compound configuration and are driven by Q6. The primary of output transformer T2 is connected in the emitter circuit of Q8 which operates as a Class A amplifier drawing approximately 160 ma of current during normal operation. The secondary of the transformer is connected to terminals 8 and 9 of P1 to provide a 150- or 600-ohm balanced line output. The Elementary Diagram, Fig. 3, shows the output connected for 600 ohms.

## MAINTENANCE

### General

When operated under normal studio conditions, the Model 4BA22A1 Program Amplifier will require very little maintenance other than periodic inspection and occasional cleaning. If it should become necessary to troubleshoot the Program Amplifier, the voltage readings shown on the Elementary Diagram will be useful. If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first determining the cause of failure.

### Transistor Selection

The present state of transistor technology sometimes necessitates transistor selection in order to meet the specified signal-to-noise ratio of an amplifier.

Performance specifications of the transistors permit a broad operational range for

most types. Because of this broad range of characteristics, some transistors of a given type will not perform as well as others when used in the same circuit.

In any well designed transistor circuit, variations in the transistor performance will exhibit a minimum effect on the frequency response and distortion characteristics of an amplifier. The most noticable effect of transistor variations will be in the noise characteristics.

In general, the random replacement of a defective transistor type, by another of the same type, will restore the amplifier to service. However, to realize the specified noise figure of a particular design it will sometimes be necessary to select or interchange like transistors in a given circuit to obtain the lowest noise figure.

When checking the noise in an amplifier, it is recommended that the two transistors in the Darlington Compound input circuit be interchanged to locate them for the best signal-to-noise ratio.

## Transistor Replacement

### CAUTION

DO NOT REMOVE TRANSISTORS FROM AN AMPLIFIER WHEN THE POWER IS ON.

Transistors Q1 through Q7 plug into sockets. These sockets are designed to accommodate both the old and new pin configurations found on small transistors. If it is necessary to replace a transistor, clip the leads of the new transistor to a 3/8-inch length and insert it into its proper socket.

Output transistor Q8 is a power transistor mounted to the chassis by means of insulated machine screws and an anodized washer. This washer acts as an electrical insulator between the chassis and the transistor case which is connected to the collector stud. To replace Q8, unplug the emitter-base connector (accessible from inside the chassis) and remove the nuts and associated hardware which secure Q8 to the chassis. Care should be taken to avoid losing the insulating washers and scratching the anodized washer. If the surface of the anodized washer is scored or seriously scratched, it will lose its usefulness as an insulator. To install the new power transistor, reverse the steps taken in its removal. Be sure that all insulated bushings, etc., are replaced properly.

After mounting the new transistor and before replacing the emitter-base connector, make a preliminary check with an ohmmeter to make sure that no short circuits exist between the collector stud and the chassis. Replacing the emitter-base connector completes the replacement.

## Transistor Testing

The use of an ohmmeter to test small signal type transistors such as 2N508, 2N320, etc., is not recommended. There are several transistor testers available which are specifically designed for this purpose. If necessary, check stages by substitution of another transistor of the same type number.

Power type transistors such as the Delco 2N553, 2N277, etc., may be given a non-conclusive good or bad test by means of an ohmmeter. To make such a test, turn the power off and remove the emitter-base connector from the transistor. Using the ohmmeter set on its RX1 scale, check the resistance between the collector stud and the emitter. Note the resistance value and reverse the ohmmeter leads. If the same resistance is noted, it can be assumed that the transistor is shorted out. A good transistor will give a high resistance reading in one direction depending on the polarity of the ohmmeter leads.

## Printed Wiring Board Service Notes

### CAUTION

DO NOT USE LARGE SOLDERING IRONS TO SERVICE THE PRINTED WIRE BOARD.

The following steps will be of aid in replacing components on the board. Use only

a 25- or 35-watt soldering iron to service the Program Amplifier as excessive heat can damage the printed wiring.

1. Grip the component to be removed at one end with a long nose pliers, then apply a narrow-tip soldering iron to the component lead, barely touching the board wiring. Lightly pull away with the pliers, while the solder joint melts, until the lead can be pulled free of the board. Free the other lead in the same manner.

2. It is suggested that when a component has been removed, it be replaced by a new component of the same value. When installing a new component, observe the length and dress of the leads on the old component, then cut and bend the leads of the new component accordingly.

3. Try placing the leads in the holes. If residual solder prevents a lead from entering the hole, very gently ream out the solder with a sharply pointed square-tipped awl. Then place the leads in the holes so that the component is held in place by friction or slight spring tension of the leads.

4. Using a high-grade electrical solder, apply the soldering iron tip, then the solder to the junction of the hole so that a very small amount of solder flows around the lead and into the hole, thus bonding the lead to the board.

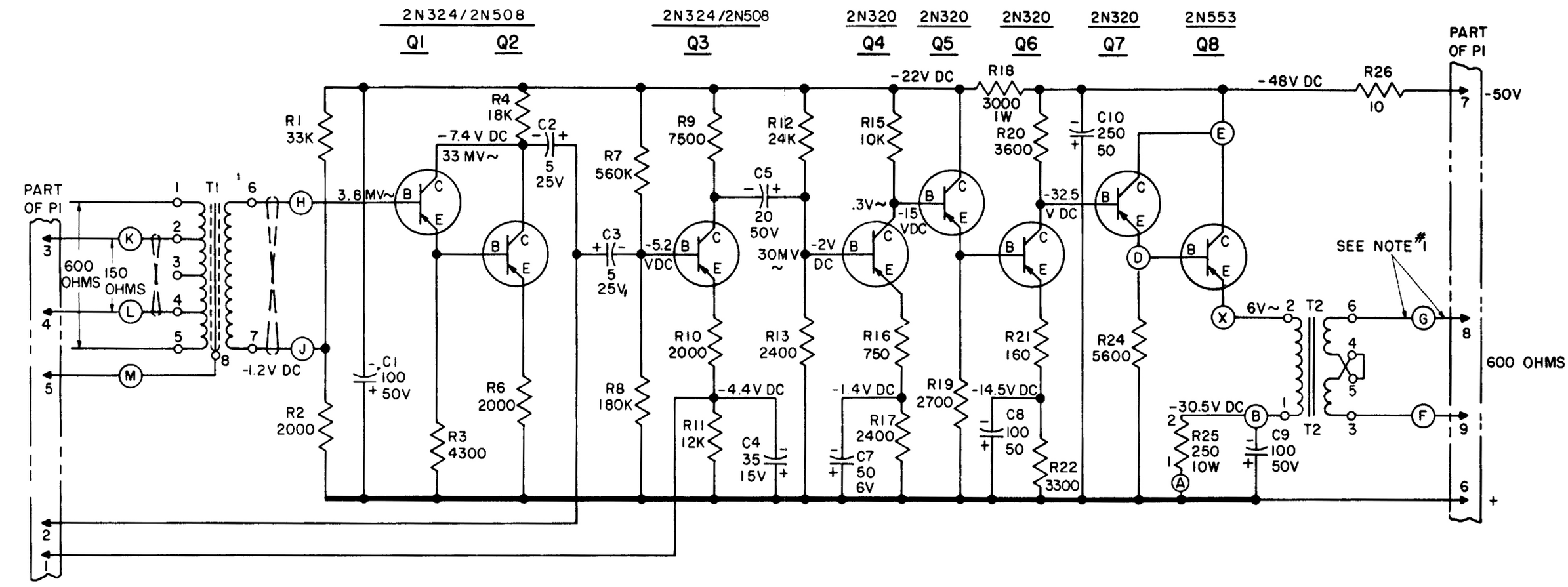
5. Examine the joint carefully. A good joint should withstand a light pull by the fingers. Clear away any loose solder, making sure that no solder scraps fall where they might cause a short.

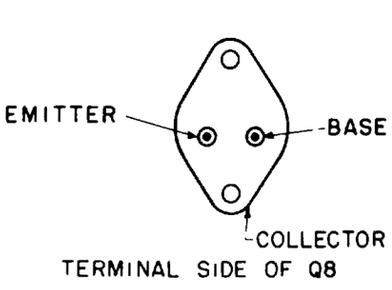
6. In the unlikely event of a break in a printed wiring strip, the strip can be repaired by placing a short piece of tinned wire across the break and flowing solder over the length of the wire. Be careful that excess solder does not short adjacent strips.

## PARTS LIST

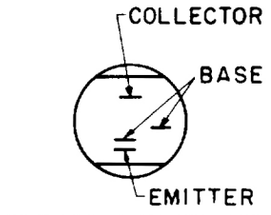
| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (Electrolytic) | |
| C1 | Polarized, insulated, tubular; 100 mfd +250% -10%, 50 v d-c w. Mallory Type TC-3501. | C-7775849-P6 |
| C2 and C3 | Hermetically sealed; 5.0 mfd +100% -15%, 25 v d-c w. Sprague Cat. #30D179A1. | B-7489483-P6 |
| C4 | Hermetically sealed; 35 mfd +100% -15%, 15 v d-c w. Sprague Cat. #30D169A1. | B-7489483-P10 |
| C5 | Hermetically sealed; 20 mfd +100% -15%, 50 v d-c w. Sprague Cat. #30D198A1. | B-7489483-P11 |
| C7 | Hermetically sealed; 50 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D133A1. | B-7489483-P4 |
| C8 and C9 | Polarized, insulated, tubular; 100 mfd +250% -10%, 50 v d-c w. Mallory Type TC-3501. | C-7775849-P6 |
| C10 | Polarized, insulated, tublar; 250 mfd +100% -10% 25 v d-c w. Sprague Type D18418. | C-7775849-P1 |
| | TRANSISTORS | |
| Q1 thru Q3 | G-E Type 2N324/4JX1A547/2N508. | |
| Q4 thru Q7 | G-E Type 2N320. | |
| Q8 | Delco Type 2N553. | A-7164451-P80 |
| | RESISTORS (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R1 | 33,000 ohms. | C-3R77-P333J |
| R2 | 2000 ohms. | C-3R77-P202J |
| R3 | 4300 ohms. | C-3R77-P432J |
| R4 | 18,000 ohms. | C-3R77-P183J |
| R6 | 2000 ohms. | C-3R77-P202J |
| R7 | 0.56 megohm. | C-3R77-P564J |
| R8 | 0.18 megohm. | C-3R77-P184J |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (CONTINUED) (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R9 | 7500 ohms. | C-3R77-P752J |
| R10 | 2000 ohms. | C-3R77-P202J |
| R11 | 12,000 ohms. | C-3R77-P123J |
| R12 | 24,000 ohms. | C-3R77-P243J |
| R13 | 2400 ohms. | C-3R77-P242J |
| R15 | 10,000 ohms. | C-3R77-P103J |
| R16 | 750 ohms. | C-3R77-P751J |
| R17 | 2400 ohms. | C-3R77-P242J |
| R18 | 3000 ohms, 1 w. | C-3R78-P302J |
| R19 | 2700 ohms. | C-3R77-P272J |
| R20 | 3600 ohms. | C-3R77-P362J |
| R21 | 160 ohms. | C-3R77-P161J |
| R22 | 3300 ohms. | C-3R77-P332J |
| R24 | 5600 ohms. | C-3R77-P562J |
| R25 | Wirewound, 250 ohms ± 5%, 10 w. Ward Leonard Cat. #10F250. | M-2R12-P125 |
| R26 | 10 ohms. | C-3R77-P100J |
| | TRANSFORMERS | |
| T1 | Audio input. Pri imp: 600/150/30 ohms; sec imp: 2400 ohms. | A-7165301-P1 |
| T2 | Audio output. Pri imp: 75 ohms. sec imp: 150/600 ohms. | B-7492749-P1 |
| | TRANSISTOR SOCKETS | |
| XQ1 thru XQ7 | Elco Cat. #3305. | B-5490277-P2 |




TERMINAL SIDE OF Q8




TOP VIEW OF TRANSISTOR SOCKETS Q1 THRU Q7

NOTE 1 ALL WIRE FROM T2 MUST BE #20 AWG

RESISTOR VALUES ARE IN OHMS & 1/2 WATT UNLESS OTHERWISE SHOWN

CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN. $\mu\mu$f = MICROMICROFARADS.

SIGNAL VOLTAGES ARE MEASURED AT AN OUTPUT LEVEL OF +24 DBM AT TERMINALS 8 & 9

Fig. 3 Elementary Diagram, Program Amplifier, Model 4BA22A1 (C-7777463, Rev. 3)

*INSTRUCTIONS*

# MONITOR AMPLIFIER

## MODEL 4BA24A2

EBI—2192A

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

6/62 (400)

PRINTED IN U.S.A.

## CONTENTS



## ILLUSTRATIONS

## INTRODUCTION

The General Electric Monitor Amplifier, Model 4BA24A2 (Figs. 1 and 2), is a high-fidelity, plug-in transistor audio amplifier designed for use in the Type BC-21-A Audio Console or similar broadcast audio systems. When used in conjunction with the Type BA-21-A Pre-Amplifier and the Type BA-22-A Program Amplifier, a completely transistorized audio system is made possible.

## ACCESSORIES

### Shelf, Type FA-48-A

The G-E Type FA-48-A Shelf will accommodate rack mounting for a maximum of four Monitor Amplifiers or a combination of four Type BA-24-A Monitor Amplifiers, Type BA-28-A Cue/TB Amplifiers, and Type BA-22-A Program Amplifiers. The Shelf is designed to standard EIA rack-mounting dimensions, occupying $5\frac{1}{4}$ inches of vertical rack space. Each Shelf includes a hinged front panel and four receptacles for mating with the amplifier plugs.


Fig. 1 Front View (S62-3995)

### Connector

A Connector (G-E Drawing C-7777466-P3) may be used for making Amplifier plug-in connections when it is desired to mount the Amplifier in other than the Type BC-21-A Audio Console or the Type FA-48-A Shelf.

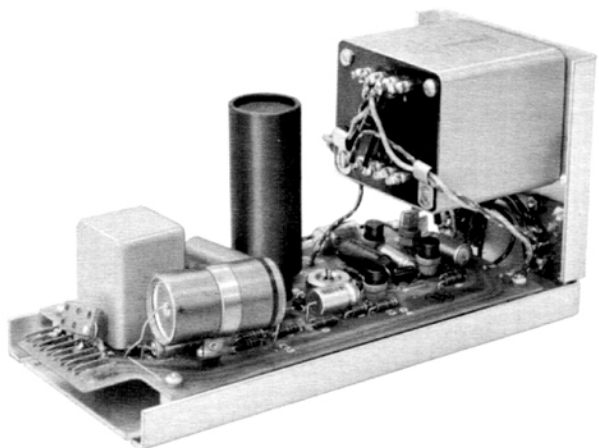


Fig. 2 Rear Oblique View (S62-4267)

### Volume Control

An interstage gain control may be mounted on the bracket across the front end of the Monitor Amplifier chassis. Either a 500,000-ohm or 750,000-ohm log taper, carbon potentiometer may be used. A 500,000-ohm control suitable for this application may be ordered on G-E Drawing M-2R74-P25.

### Bridging Volume Control, Type FA-35-G

For variable bridging service, the Bridging Volume Control, G-E Type FA-35-G, is recommended for use with the Monitor Amplifier. See Bridging Input Operation, pages 3 and 5, and EBI-2147.

### Transistor Power Supply, Type BP-20-A

Power for three Monitor Amplifiers or a combination of Monitor Amplifiers and 24-volt d-c relays of the Audio Console may be obtained from a Type BP-20-A 25-Volt Transistor Power Supply.

## TECHNICAL SUMMARY

### Electrical

SOURCE IMPEDANCE

150/600 ohms (factory connected for 150 ohms).

INPUT IMPEDANCE

Unloaded transformer.

MAXIMUM INPUT LEVEL

-20 dbm.

POWER INPUT (MAXIMUM FOR 2 WATTS OUTPUT)

360 ma d-c at 25 volts (positive ground).

OUTPUT LOAD IMPEDANCE

8/150/600 ohms balanced or unbalanced (factory connected for 600 ohms).

OUTPUT LEVEL AND DISTORTION

+33 dbm output, $1\frac{1}{2}\%$ or less of distortion from 50 to 15,000 cps.

FREQUENCY RESPONSE

$\pm \frac{1}{2}$ db from 50 to 15,000 cps.

GAIN

80 db, ± 2 db (with matched input).

NOISE

At least -33 dbm with an output of +33 dbm.

### Mechanical

DIMENSIONS

Length: 9-5/8 inches
Height: $4\frac{1}{2}$ inches
Width: $4\frac{1}{4}$ inches
Weight: $2\frac{1}{2}$ pounds

MAXIMUM OPERATING TEMPERATURES

Maximum room ambient temperature (continuous): 95 F (35 C).
Maximum room ambient temperature (5% of time): 113 F (45 C).

### Transistor Complement

4 G-E Type 2N324 (Q1, Q2, Q3, Q4)
1 G-E Type 2N527 (Q5)
1 G-E Type 2N525 (Q6)
2 Clevite Type CTP-1133 (Q7, Q9)
1 Sylvania Type 2N214 (Q8)

## DESCRIPTION

The Monitor Amplifier is of the plug-in design to facilitate replacement and maintenance. It is constructed on a printed wiring board and mounted on an "L" shaped aluminum chassis. The output transistors, Q7 and Q9, are mounted to the chassis through an anodized aluminum washer, allowing the chassis to serve as a heat sink for the output stages.

A bracket is mounted across the chassis

end, providing a handle, transistor guard, and a mounting for the local gain control when one is required.

The size of the input transformer is small enough to allow mounting it to the printed wiring board. The larger and heavier output transformer is mounted directly on the aluminum chassis.

Plug P1 is mounted on the back, extending out from the chassis.

# INSTALLATION

## Location

If used for applications other than in the Type BC-21-A Audio Console, the Monitor Amplifier should not be mounted directly above existing heat producing equipment.

## Mounting

The chassis of the Monitor Amplifier is designed to fit the frame of the Type BC-21-A Audio Console or the Type FA-48-A Shelf. To mount the Amplifier, merely insert the 9-pin connector, at the back of the unit, into its corresponding receptacle in the Audio Console or Shelf.

Since the chassis base is provided with four mounting holes for the use of #6-32 machine screws, the unit is also adaptable to other methods of mounting.

## Connections

Fig. 3 shows the proper pins on plug P1 for the connection of power, audio input, and audio output leads. The following paragraphs interpret and supplement the information given on the Elementary Diagram.

AUDIO INPUT CONNECTIONS

1. Matched Input Transformer Operation

The Monitor Amplifier, as shipped, is connected to operate from a 150-ohm source. Input terminals P1-3 and P1-4 are connected to transformer terminals T1-2 and T1-4.

For matching operation from a 150-ohm source, connect a 150-ohm resistor across terminals P1-3 and P1-4 to match the source.

For matching operation from a 600-ohm source, disconnect the input wires from transformer terminals T1-2 and T1-4 and reconnect to transformer terminals T1-1 and T1-5. Then connect a 600-ohm resistor across terminals P1-3 and P1-4 to match the source.

2. Installation of Interstage Gain Control

When required, an interstage gain control may be installed in the Amplifier circuit. A 750,000-ohm or 500,000-ohm carbon potentiometer, such as G-E Drawing M-2R74-P25, is recommended for this purpose and can be mounted on the Amplifier bracket. Connect the control as a rheostat with the arm (center connection) connected to P1-2 and the "off" end of the control connected to P1-5 (ground). Use a short length of shielded wire to make this connection.

3. Bridging Input Operation

For fixed resistor bridging, connect the input for 600 ohms and, with a 600-ohm external termination resistor connected across the input, use series bridging resistors that total at least ten times the input impedance value. Bridging gain may be easily varied by changing the bridging resistors.

For variable bridging with a 600-ohm input, the G-E Type FA-35-G Bridging Volume Control may be used with the Monitor Amplifier. It consists of a high-quality, log-taper dual potentiometer and two fixed resistors. Its shaft is slotted for screwdriver control, yet is long enough to allow the use of a knob. The input impedance is 10,000 ohms, and the output impedance 600 ohms. This Bridging Volume Control is intended for use with balanced circuits. The minimum insertion loss is 30 db when working into

an amplifier with its input transformer unloaded (no termination). Thus, when used with the Type FA-35-G Control, the Monitor Amplifier has a maximum bridging gain of 50 db when bridging a 600-ohm line. The Type FA-35-G Control will not mount directly on the Monitor Amplifier chassis, but for convenience should be mounted adjacent to it, such as on the Shelf door.

4. Recommended Type of Wire

Since the input circuit is operated at a low level, use shielded-pair construction for the input wiring and ground the shield at the grounding lug on the Amplifier receptacle. Covered wire, such as G-E Type FA-19-R, is recommended for this purpose, since it permits grounding of the shield at the Amplifier only.

AUDIO OUTPUT CONNECTIONS

1. 8/150/600-Ohm Operation

The Monitor Amplifier is shipped connected for operation into a 600-ohm load which is to be connected across terminals P1-8 and P1-9. It may be changed to operate into a 150-ohm load connected across these terminals by disconnecting the jumper between terminals T2-6 and T2-5 and reconnecting terminal T2-6 to T2-3 and T2-5 to T2-8. For operation into a 8-ohm load, connect the lead from P1-8 to T2-7 and the lead from P1-9 to T2-4.

2. Recommended Type of Wire

Use wire of shielded-pair construction such as G-E Type FA-19-R for connections to the audio output terminals.

POWER INPUT CONNECTIONS

The Monitor Amplifier is designed for use with the G-E Type BP-20-A Transistor Power Supply; however, any equivalent well-filtered 25-volt supply may be used.

1. Power Connections

Jumper P1-5 and P1-6 together on the Amplifier socket. Connect the positive lead of the 25-volt input to terminal P1-6 and the negative lead to P1-7. DO NOT REVERSE POLARITY SINCE SERIOUS DAMAGE TO THE TRANSISTORS MAY RESULT.

2. Recommended Type of Wire

Use wire at least #18 AWG size for the leads carrying the 25-volt d-c input. This wire does not have to be twisted or shielded, but shielded wire, such as G-E Type FA-18-J, is recommended if RF fields are present.

## OPERATION

### Operation With Unloaded Transformer

When no resistance loading of the input transformer is used, the full generated voltage of the source is applied to the input terminals of the Amplifier. This is called unloaded transformer operation. The highest signal-to-noise ratio is obtained in the system under these conditions.

### Operation With Matching Input

In many applications it will be desirable to have the Amplifier match a source impedance. For example, the Amplifier may be fed from a pre-amplifier, a line, or a precision attenuator, which require a matching resistance load. To match the Monitor Amplifier to a source impedance, merely connect a resistor across the Amplifier input terminals of a value equal to the source impedance. Thus, if a 600-ohm pad is to feed the Amplifier and be properly terminated, connect the pad to the 600-ohm input terminals of the Amplifier, and connect a 600-ohm resistor across the same terminals. In this way, the normal unloaded input transformer characteristic inherent in an amplifier will be changed to that of a matching

input, where the amplifier input impedance matches the source impedance. Under these conditions, the voltage at the terminals of the amplifier's input transformer is only one-half of the voltage generated by the source.

### Bridging Input Operation

When an amplifier is connected across a low-impedance line in such a way that only a small fraction of the energy in the line (insufficient to affect the operation of the line) is diverted into the amplifier, the amplifier is said to employ a bridging input. This is accomplished by stepping up the input impedance of the amplifier to about 10,000 ohms so that in connecting it across the low-impedance line (0 to 600 ohms), it has negligible effect.

Used as a bridging amplifier across a 600-ohm line, the Monitor Amplifier with the Bridging Volume Control, Type FA-35-G (mounted externally from the Amplifier chassis), has a gain of 50 db, where the gain is defined as the ratio of the power ($P_1$) in the 600-ohm line terminating resistance ($R_1$) to the output power ($P_2$) of the Amplifier; that is, GAIN (db) equals 10 log $P_2$ divided by $P_1$.

Since the voltage across the terminating resistance of a 150-ohm line is one-half of the voltage across the terminating resistance of a 600-ohm line, the bridging gain of the Amplifier when bridging a 150-ohm line will be essentially 6 db less that when bridging a 600-ohm line with fixed resistance bridging.

### Operational Checks and Adjustments

Fig. 3 shows typical operating voltages. Use a meter having an internal resistance of 20,000 ohms-per-volt or higher to read these voltages.

## THEORY AND CIRCUIT ANALYSIS

The Monitor Amplifier utilizes eight transistors of the PNP type and one transistor of the NPN type.

Input transformer T1 is shielded and provides a balanced input to the Amplifier with taps for impedances of 50, 150, and 600 ohms. The secondary of T1 is connected to the base of Q1, which is compound-connected (modified), with its emitter directly connected to the base of Q2. Capacitors C2 and C3 provide series-capacitive coupling between the collectors of Q1 and Q2. Either a 500,000-ohm or a 750,000-ohm rheostat may be inserted between ground and the connecting point of C1 and C2 to provide a means of controlling the gain of the Amplifier.

The output of Q2 is direct-coupled to the base input of emitter follower stage Q3, which in turn drives Q4. The collector of Q4 is direct-coupled to the base of common emitter stage Q5, which is the driver stage for the output section of the Amplifier. A bias adjusting potentiometer (R22) is connected in series with R23 between ground and the base of Q5. This control makes it possible to balance the driver and output stages in order to minimize distortion.

The output section consists of a self-inverting, compound-connected, Class B amplifier. One section is composed of Q6 and Q7 connected together in a Darlington Compound configuration. This conducts only on the negative half cycle of the signal and is biased near cutoff.

The other half of the output section consists of Q8 and Q9, also connected in a Darlington Compound configuration. Q8 is an NPN Type transistor and allows this half of the output section to conduct only on the positive half of the signal cycle.

The secondary of the output transformer is connected to terminals 8 and 9 of P1, with taps provided to allow an 8-, 150-, or 600-ohm balanced or unbalanced line output.

# MAINTENANCE

## General

When operated under normal studio conditions, the Monitor Amplifier will require very little maintenance other than periodic inspection and occasional cleaning. If it should become necessary to trouble-shoot the Monitor Amplifier, the voltage readings shown on the Elementary Diagram (Fig. 3) will be useful. If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first determining the cause of failure.

Following any transistor replacement or routine maintenance, it is recommended that R2 be readjusted to provide minimun distortion at 15 kc. Generally, it will be found that once the control has been adjusted at 15 kc, the output at lower frequencies will be within specifications.

## Transistor Replacement

### CAUTION

DO NOT REMOVE TRANSISTORS FROM AN AMPLIFIER WHEN THE POWER IS ON.

Transistors Q1 through Q6 and Q8 plug into sockets. These sockets are designed to accommodate both the old and new pin configurations found on small transistors. If it is necessary to replace a transistor, clip the leads of the new transistor to a 3/8-inch length and insert it into its proper socket.

Output transistors Q7 and Q9 are power transistors mounted to the chassis by means of insulated machine screws and anodized aluminum washers. The washer acts as an electrical insulator between the chassis and the transistor case which is connected to the collector stud. To replace either Q7 or Q9, unplug the emitter base connector and remove the nuts and associated hardware that bolt the particular transistor to the chassis. Care should be taken to avoid losing the insulating washers or scratching the anodized washers. If the surface of the anodized washer is scored or seriously scratched, it will lose its usefulness as an insulator. To install the new power transistor, reverse the steps taken for its removal. Be sure that all insulated bushings, etc., are replaced properly.

After mounting the new transistor and before replacing the emitter-base connector, make a preliminary check with an ohmmeter to make sure that no short circuits exist between the collector stud and the chassis. Replacing the emitter-base connector completes the replacement.

## Transistor Selection

The present state of transistor technology sometimes necessitates transistor selection in order to meet the specified signal-to-noise ratio of an amplifier.

Performance specifications of the transistors permit a broad operational range for most types. Because of this broad range of characteristics, some transistors of a given type will not perform as well as others when used in the same circuit.

In any well designed transistor circuit, variations in transistor performance will exhibit a minimum effect on the frequency response and distortion characteristics of an amplifier. The most noticeable effect of transistor variations will be in the noise characteristics.

In general, the random replacement of a defective transistor type by another of the same type will restore the amplifier to service. However, to realize the specified noise figure of a particular design it will sometimes be necessary to select or interchange like transistors in a given circuit to obtain the lowest noise figure.

When checking the noise in an amplifier, it is recommended that the two transistors in the Darlington Compound input circuit be interchanged to locate them for the best signal-to-noise ratio.

## Transistor Testing

The use of an ohmmeter to test small signal type transistors, such as 2N508,

2N525, etc., is not recommended. There are several transistor testers available which are specifically designed for this purpose. If necessary, check stages by substitution of another transistor of the same type number.

Power type transistors, such as the CTP-1133, may be given a nonconclusive good or bad test by means of an ohmmeter. To make such a test, turn the power off and remove the emitter-base connector from the transistor. Using the ohmmeter set on the RX1 scale, check the resistance between the collector stud and the emitter. Note the resistance value and reverse the ohmmeter leads. If the same resistance is noted, it can be assumed that the transistor is shorted out. A good transistor will give a high-resistance reading in one direction, depending on the polarity of the ohmmeter leads.

## Printed Wiring Board Service Notes

### CAUTION

DO NOT USE LARGE SOLDERING IRONS TO SERVICE THE PRINTED WIRING BOARD.

The following steps will be of aid in replacing components on the printed wiring board. Use only a 25- or 35-watt soldering iron to service the Monitor Amplifier, since excessive heat can damage the printed wiring.

1. Grip the component to be removed at one end with long-nose pliers and then apply a narrow-tip soldering iron to the component lead, barely touching the board wiring. Lightly pull away with the pliers, while the solder joint melts, until the lead can be pulled free of the board. Free the other lead in the same manner.

2. It is suggested that when a component has been removed, it be replaced by a new component of the same value. When installing a new component, observe the length and dress of the leads on the old component, then cut and bend the leads of the new component accordingly.

3. Try placing the leads in the holes. If residual solder prevents a lead from entering the hole, very gently ream out the solder with a sharply pointed square-tipped awl. Then place the leads in the holes so that the component is held in place by friction or slight spring tension of the leads.

4. Using a high-grade electrical solder, apply the soldering iron tip, then the solder to the junction of the hole so that a very small amount of solder flows around the lead and into the hole, thus bonding the lead to the board.

5. Examine the joint carefully. A good joint should withstand a light pull by the fingers. Clear away any loose solder, making sure that no solder scraps fall where they might cause a short.

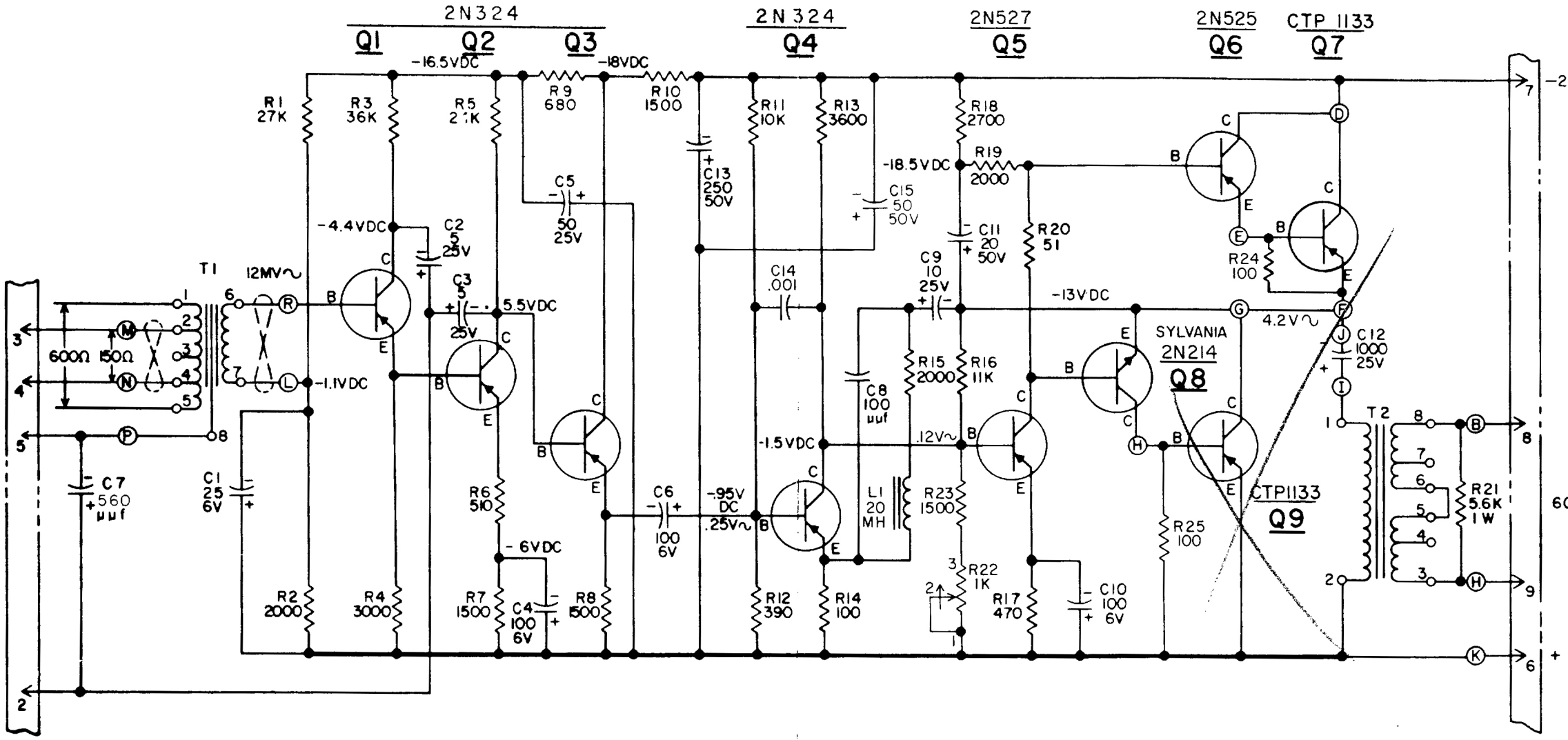
6. In the unlikely event of a break in a printed wiring strip, the strip can be repaired by placing a short piece of tinned wire across the break and flowing solder over the length of the wire. Be careful that excess solder does not short adjacent strips.

## PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (Electrolytic, unless otherwise specified) | |
| C1 | Hermetically sealed; 25 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D131A1. | B-7489483-P3 |
| C2 and C3 | Hermetically sealed; 5.0 mfd +100% -15%, 25 v d-c w. Sprague Cat. #30D179A1. | B-7489483-P6 |
| C4 | Hermetically sealed; 100 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D135A1. | B-7489483-P9 |
| C5 | Tubular, insulated; 50 mfd +250% -10%, 25 v d-c w. | C-7774786-P3 |
| C6 | Hermetically sealed; 100 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D135A1. | B-7489483-P9 |
| C7 | Silver mica, epoxy dipped; 560 mmfd ± 5%, 500 v d-c w. Electromotive Type DM20. | A-7147203-P2 |
| C8 | Silver mica, epoxy dipped, 100 mmfd ± 5%, 500 v d-c w. Electromotive Type DM15. | B-7489162-P27 |
| | CAPACITORS (CONTINUED) (Electrolytic, unless otherwise specified) | |
| C9 | Hermetically sealed; 10 mfd +100% -15%, 25 v d-c w. Sprague Cat. #30D182A1. | B-7489483-P7 |
| C10 | Hermetically sealed; 100 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D135A1. | B-7489483-P9 |
| C11 | Hermetically sealed; 20 mfd +100% -15%, 50 v d-c w. Sprague Cat. #30D198A1. | B-7489483-P11 |
| C12 | Polarized solder prong base; 1000 mfd +250% -10%, 25 v d-c w. | C-7776240-P110 |
| C13 | Polarized, tubular; 250 mfd +250% -10%, 50 v d-c w. Sprague Cat. #TVA-1312. | C-7775849-P60 |
| C14 | Ceramic, Hi-K disk; 0.001 mfd +100% -0%, 500 v d-c w. | C-7774750-P4 |
| C15 | Electrolytic, 50 mfd +100% -10%, 50 v d-c w. Sprague Cat. #30D200A1. | B-7489483-P25 |

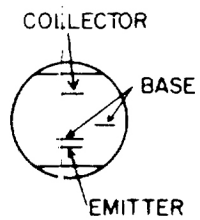
| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | INDUCTOR | |
| L1 | Inductance 20,000 uh min, d-c resistance 30 ohms. | B-7492281-P2 |
| | RESISTORS (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R1 | 27,000 ohms. | C-3R77-P273J |
| R2 | 2000 ohms. | C-3R77-P202J |
| R3 | 36,000 ohms. | C-3R77-P363J |
| R4 | 3000 ohms. | C-3R77-P302J |
| R5 | 24,000 ohms. | C-3R77-P243J |
| R6 | 510 ohms. | C-3R77-P511J |
| R7 and R8 | 1500 ohms. | C-3R77-P152J |
| R9 | 680 ohms. | C-3R77-P681J |
| R10 | 1500 ohms. | C-3R77-P152J |
| R11 | 10,000 ohms. | C-3R77-P103J |
| R12 | 390 ohms. | C-3R77-P391J |
| R13 | 3600 ohms. | C-3R77-P362J |
| R14 | 100 ohms. | C-3R77-P101J |
| R15 | 2000 ohms. | C-3R77-P202J |
| R16 | 11,000 ohms. | C-3R77-P113J |
| R17 | 470 ohms. | C-3R77-P471J |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (CONTINUED) (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R18 | 2700 ohms. | C-3R77-P272J |
| R19 | 2000 ohms. | C-3R77-P202J |
| R20 | 51 ohms. | C-3R77-P510J |
| R21 | 5600 ohms, 1 w. | C-3R78-P562J |
| R22 | Potentiometer, carbon film, 1000 ohms ± 20%, 0.15 w, linear taper. Chicago Telephone and Supply Type UPE-70. | B-7491365-P1 |
| R23 | 1500 ohms. | C-3R77-P152J |
| R24 and R25 | 100 ohms. | C-3R77-P101J |
| | TRANSFORMERS | |
| T1 | Audio input. Pri imp: 600/150/30 ohms; sec imp: 2400 ohms. | A-7165301-P1 |
| T2 | Audio output. Pri imp: 8 ohms; sec imp: 600 ohms. | A-7165300-P1 |
| | TRANSISTOR SOCKETS | |
| XQ1 thru XQ6 | Elco Cat. #3305. | B-7495897-P2 |
| XQ8 | Elco Cat. #3305. | B-7495897-P2 |

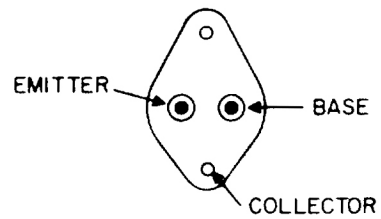



NOTE:

1. RESISTOR VALUES ARE IN OHMS & 1/2 WATT UNLESS OTHERWISE SHOWN.
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN. μμf = MICROMICROFARADS.
3. MH = MILLIHENRIES.
4. VOLTAGES MEASURED AT +33dbm OUTPUT LEVEL WITH VTVM. SIGNAL VOLTAGES ARE RMS VALUES.
5. R24 & R25 TO BE MOUNTED ON Q7 & Q9 SOCKETS.
6. CUSTOMER MAY SUBSTITUTE 2N508 OR 2N527 IN PLACE OF 2N324 FOR Q1, Q2, Q3, Q4.




TOP VIEW OF TRANSISTOR SOCKETS Q1 THRU Q6 & Q8




TERMINAL SIDE OF Q7 & Q9

Fig. 3 Elementary Diagram, Monitor Amplifier, Model 4BA24A2 (C-7778020, Rev. B)

*INSTRUCTIONS*

# CUE/TALK BACK AMPLIFIER

## MODEL 4BA28A1

FBI—2182A

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

10/61

PRINTED IN U.S.A.

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## ILLUSTRATIONS

## INTRODUCTION

The General Electric Cue/Talk Back Amplifier, Model 4BA28A1, is a high-gain, plug-in, transistor audio amplifier. See Figs. 1 and 2. It is designed for use in broadcast studio applications to amplify audio signals of a mixer bus level to a level sufficient for cueing and talk back service. A completely transistorized audio system is made possible when the Amplifier is used with the Type BC-21-A Audio Console and its associated units.

## ACCESSORY EQUIPMENT

### Shelf, Type FA-48-A

The G-E Type FA-48-A Shelf will accommodate rack mounting for a maximum of four Cue/TB Amplifiers or a combination of four Type BA-28-A Cue/TB Amplifiers, Type BA-24-A Monitor Amplifiers and BA-22-A Program Amplifiers. The Shelf is designed to standard EIA rack mounting dimensions occupying $5\frac{1}{4}$ inches of vertical rack space. Each Shelf includes a hinged front panel and four receptacles for mating with the amplifier plugs.

### Connector

A Connector (G-E Drawing C-7777466-P3) may be used for making amplifier plug-in connections when it is desired to mount the Amplifier on other than the Audio Console or the Type FA-48-A Shelf.

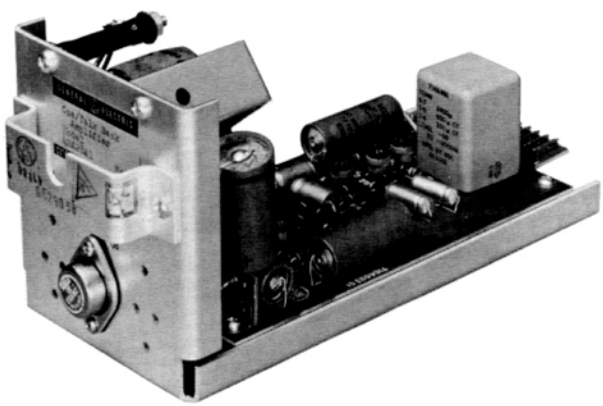


Fig. 1 Front Oblique View (S60-185)

### Volume Control

An interstage gain control may be mounted on the bracket across the end of the Cue/TB Amplifier chassis. Either a 500,000-ohm or 750,000-ohm log taper, carbon potentiometer may be used. A 750,000-ohm Control suitable for this application may be ordered on G-E Drawing M-2R74-P25.

### Bridging Volume Control, Type FA-35-G

For variable bridging service, the Bridging Volume Control, G-E Type FA-35-G, is recommended for use with the Cue/TB Amplifier. See Bridging Input Operation, pages 3 and 4, and EBI-2147.

### Transistor Power Supply, Type BP-21-A

Power for three Cue/TB Amplifiers, or a combination of three Type BA-28-A Cue/TB Amplifiers and Type BA-22-A Program Amplifiers may be obtained from a Type BP-21-A Transistor Power Supply.

# TECHNICAL SUMMARY

## Electrical

SOURCE IMPEDANCE

150/600 ohms (factory connected for 150 ohms).

INPUT IMPEDANCE

Unloaded transformer.

MAXIMUM INPUT LEVEL

-20 dbm.

POWER INPUT

160 ma d-c at 50 volts (positive ground).

OUTPUT LOAD IMPEDANCE

600-ohm balanced or unbalanced.

OUTPUT LEVEL AND DISTORTION

27 dbm output, 2% or less of distortion from 100 to 10,000 cps.

FREQUENCY RESPONSE

± 1 db from 100 to 10,000 cps.

GAIN

75 db, ± 2 db with terminated input.

NOISE

At least -35 dbm with a +24 dbm output.

## Mechanical

| | |
|---|---|
| Length: | 9-5/8 inches |
| Height: | $4\frac{1}{2}$ inches |
| Width: | $4\frac{1}{4}$ inches |
| Weight: | $2\frac{1}{2}$ pounds |

MAXIMUM OPERATING TEMPERATURES

Maximum room ambient temperature (continuous): 95 F (35 C).
Maximum room ambient temperature (5% of time): 113 F (45 C).

## Transistor Complement

3 G-E Type 2N324/4JX1A547/2N508 (Q1, Q2, Q3)
4 G-E Type 2N320 (Q4, Q5, Q6, Q7)
1 Delco 2N553 (Q8)

# DESCRIPTION

The Cue/TB Amplifier is of the plug-in design to facilitate replacement and maintenance. It is constructed on a printed wiring board which is mounted to an "L" shaped aluminum chassis. The output transistor, Q8, is mounted on the front of the chassis through an anodized aluminum washer allowing the chassis to serve as a heat sink for the output stage.

A bracket is mounted across the front end of the chassis, above Q8, and provides a handle, transistor guard, and mounting for the local gain control when one is required.

The size of the input transformer is small enough to allow mounting it to the printed wiring board. The larger and heavier output transformer is mounted directly on the

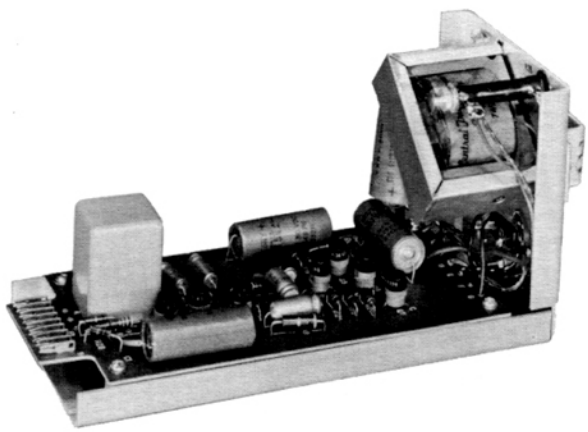


Fig. 2 Right Side View (S60-184)

aluminum chassis.

Plug P1 is an extension of the printed wiring board and located horizontally across the back of the Amplifier.

# INSTALLATION

## Location

The Cue/TB Amplifier must not be mounted immediately above existing heat producing equipment when installed for applications other than the Type BC-21-A Audio Console.

## Mounting

The mounting frame of the Cue/TB Amplifier is designed to fit the frame of the Type BC-21-A Audio Console or the Type FA-48-A Shelf. The 9-pin connector at the back of the unit is merely inserted into its corresponding receptacle and held in place by four #6-32 screws through the chassis base.

## Connections

The Elementary Diagram, Fig. 3, shows the proper pins on plug P1 for connection of power, audio input, and audio output leads. The following paragraphs interpret and supplement the information given on the Elementary Diagram.

AUDIO INPUT CONNECTIONS

1. Matching Input Operation

The Cue/TB Amplifier as shipped is connected to operate from a 150-ohm source. Input terminals P1-3 and P1-4 are connected to transformer terminals T1-2 and T1-4. Connect a 150-ohm resistor across terminals P1-3 and P1-4 to match the source.

For matching operation from a 600-ohm source, disconnect the input wires from transformer terminals T1-2 and T1-4, and reconnect to transformer terminals T1-1 and T1-5. Then connect a 600-ohm resistor across terminals P1-3 and P1-4 to match the source. The center tap of T1 or either side may be grounded.

2. Bridging Input Operation

For fixed resistor bridging, connect the input for 600 ohms and then connect a 600-ohm external termination resistor across the input and use series bridging resistors that total at least ten times the input impedance value. Bridging gain may be easily varied by changing the bridging resistors.

For variable bridging with a 600-ohm input, the G-E Type FA-35-G Bridging Volume Control is suitable for use with the Cue/TB Amplifier. It consists of a high quality log-taper dual potentiometer and two fixed resistors. Its shaft is slotted for screwdriver control, yet long enough to use a knob. The input impedance is 10,000 ohms and the output impedance is 600 ohms. This Bridging Volume Control is intended for use with balanced circuits. The minimum insertion loss is 30 db when working into an amplifier with its input transformer unloaded (no termination). Thus the Cue/TB Amplifier when used with the Type FA-35-G Control has a maximum bridging gain of 45 db when bridging a 600-ohm line. The FA-35-G Control will not mount directly on the Type BA-28-A chassis. For convenience it is recommended that it be mounted adjacent to the Amplifier, such as on the shelf door.

3. Recommended Type of Wire

Since the input circuit is operated at a low level, use shielded-pair construction for the input wiring and ground the shield at the grounding lug on the amplifier. Covered wire (G-E Type FA-19-R) is recommended since it permits grounding of the shield at the amplifier only.

AUDIO OUTPUT CONNECTIONS

1. 600-Ohm Operation

The Cue/TB Amplifier is designed for operation into a 600-ohm load to be connected

across terminals P1-8 and P1-9. For operation into an unbalanced load either terminal P1-8 or P1-9 may be grounded to P1-6.

2. Recommended Type of Wire

Shielded-pair construction, such as G-E Type FA-19-R, is recommended for audio output connections.

POWER INPUT CONNECTIONS

The Cue/TB Amplifier is designed for use with the G-E Type BP-21-A Power Supply; however, any equivalent well filtered 50-volt supply may be used.

1. Power Connections

Jumper P1-5 and P1-6 together on the amplifier socket. Connect the positive lead of the 50-volt input to terminal P1-6 and the negative lead to P1-7. DO NOT REVERSE POLARITY as serious damage to the transistors may result.

2. Recommended Type of Wire

Use #16 AWG size or larger for the wire carrying the 50-volt d-c input. This wire does not have to be twisted or shielded but shielded wire such as G-E Type FA-19-J is recommended especially if RF fields are present.

## OPERATION

### Operation With Unloaded Transformer

When no resistance loading of the input transformer is used, the full generated voltage of the source is applied to the input terminals of the amplifier. This is called unloaded transformer operation. Under these conditions the highest signal-to-noise ratio is obtained in the system.

### Operation With Matching Input

In many applications it will be desirable to have the amplifier match a source impedance. For example, the amplifier may be fed from a pre-amplifier, a line, or a precision attenuator, which requires a matching resistance load. To match the Cue/TB Amplifier to a source impedance, merely connect a resistor across the amplifier input terminals equal to the source impedance. Thus if a 600-ohm pad is to feed the amplifier and be properly terminated, connect the pad to the 600-ohm input terminals of the amplifier, and connect a 600-ohm resistor across the same terminals. In this way, the normal unloaded input transformer characteristic inherent in the amplifier will be changed to that of a matching input, where the amplifier input impedance matches the source impedance. Under these conditions the voltage at the terminals of the amplifier's input transformer is only one-half of the voltage generated by the source. With the transformer connected for matching input as described above, the gain is 75 db.

### Bridging Input Operation

When an amplifier is connected across a low-impedance line in such a way that only a small fraction of the energy in the line (insufficient to affect the operation of the line) is diverted into the amplifier, the amplifier is said to employ a bridging input. This is accomplished by stepping up the input impedance of the amplifier to about 10,000 ohms so that in connecting it across the low-impedance line (0 to 600 ohms), it has negligible effect.

Used as a bridging amplifier across a 600-ohm line, the Cue/TB Amplifier with the Bridging Volume Control, Type FA-35-G, has a gain of 46 db, where the gain is defined as the ratio of the power ($P_1$) in the 600-ohm line terminating resistance ($R_L$) to the output power ($P_2$) of the amplifier; that is GAIN (db) equals 10 log $P_2$ divided by $P_1$.

Since the voltage across the terminating resistance of a 150-ohm line is one-half of

the voltage across the terminating resistance of a 600-ohm line, the bridging gain of the amplifier when bridging a 150-ohm line will be essentially 6 db less that when bridging a 600-ohm line with fixed resistance bridging.

### Operational Checks and Adjustments

The Elementary Diagram, Fig. 3, gives typical operating voltages. Use a meter having an internal resistance of 20,000 ohms-per-volt or higher to read these voltages.

## THEORY AND CIRCUIT ANALYSIS

The Cue/TB Amplifier consists of eight transistor stages, an input transformer, and an output transformer. See the Elementary Diagram, Fig. 3.

The first two amplifier stages, Q1 and Q2, are connected in a Darlington Compound configuration to provide the best signal-to-noise ratio. A pair of capacitors, C2 and C3, are series connected and used to couple the collector output of Q2 to the base of Q3. The junction point of the capacitors is brought out to terminal P1-2 to allow the connection of a gain control, if required. This control is connected as a rheostat between terminals P1-2 and P1-1 which is essentially the junction of R10 and R11. Both Q3 and Q4 are common emitter stages. C5 provides coupling between the collector output of Q3 and the base of Q4. The collector of Q4 is directly coupled to the base of emitter follower stage Q5 which in turn drives another common emitter stage Q6. Output stages Q7 and Q8 are also connected in a Darlington Compound configuration and are driven by Q6. The primary of output transformer T2 is connected in the emitter circuit of Q8 which operates as a Class A amplifier drawing approximately 160 milliamperes of current during normal operation. The secondary of the transformer is connected to terminals 8 and 9 of P1 to provide a 150- or 600-ohm balanced line output. The Elementary Diagram, Fig. 3, shows the output connected for 600 ohms.

## MAINTENANCE

### General

When operated under normal studio conditions, the Model 4BA28A1 Cue/TB Amplifier will require very little maintenance other than periodic inspection and occasional cleaning. If it should become necessary to troubleshoot the Cue/TB Amplifier, the voltage readings shown on the Elementary Diagram will be useful. If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first determining the cause of failure.

### Transistor Selection

The present state of transistor technology sometimes necessitates transistor selection in order to meet the specified signal-to-noise ratio of an amplifier.

Performance specifications of the transistors permit a broad operational range for most types. Because of this broad range of characteristics, some transistors of a given type will not perform as well as others when used in the same circuit.

In any well designed transistor circuit, variations in the transistor performance will exhibit a minimum effect on the frequency response and distortion characteristics of an amplifier. The most noticeable effect of transistor variations will be in the noise characteristics.

In general, the random replacement of a defective transistor type, by another of the same type, will restore the amplifier to service. However, to realize the specified noise figure of a particular design it will sometimes be necessary to select or interchange like transistors in a given circuit to obtain the lowest noise figure.

When checking the noise in an amplifier,

it is recommended that the two transistors in the Darlington Compound input circuit be interchanged to locate them for the best signal-to-noise ratio.

## Transistor Replacement

### CAUTION

DO NOT REMOVE TRANSISTORS FROM AN AMPLIFIER WHEN THE POWER IS ON.

Transistors Q1 through Q7 plug into sockets. These sockets are designed to accommodate both the old and new pin configurations found on small transistors. If it is necessary to replace a transistor, clip the leads of the new transistor to a 3/8-inch length and insert it into its proper socket.

Output transistor Q8 is a power transistor mounted to the chassis by means of insulated machine screws and an anodized aluminum washer. This washer acts as an electrical insulator between the chassis and the transistor case which is connected to the collector stud. To replace Q8, unplug the emitter-base connector and remove the nuts and associated hardware which bolt Q8 to the chassis. Care should be taken to avoid losing the insulating washers or scratching the anodized washer. If the surface of the anodized washer is scored or seriously scratched, it will lose its usefulness as an insulator. To install the new power transistor, reverse the steps taken in its removal. Be sure that all insulated bushings, etc., are replaced properly.

After mounting the new transistor and before replacing the emitter-base connector, make a preliminary check with an ohmmeter to make sure that no short circuits exist between the collector stud and the chassis. Replacing the emitter-base connector completes the replacement.

## Transistor Testing

The use of an ohmmeter to test small signal type transistors such as 2N324, 2N320, or 2N508, etc., is not recommended. There are several transistor testers available which are specifically designed for this purpose. If necessary, check stages by substitution of another transistor of the same type number.

Power type transistors such as the 2N553, 2N277, etc., may be given a non-conclusive good or bad test by means of an ohmmeter. To make such a test, turn the power off, and remove the emitter-base connector from the transistor. Using the ohmmeter set on its RX1 scale, check the resistance between the collector stud and the emitter. Note the resistance value and reverse the ohmmeter leads. If the same resistance is noted, it can be assumed that the transistor is shorted out. A good transistor will give a high resistance reading in one direction depending on the polarity of the ohmmeter leads.

## Printed Wiring Board Service Notes

### CAUTION

DO NOT USE LARGE SOLDERING IRONS TO SERVICE THE PRINTED WIRING BOARD.

The following steps will be of aid in replacing components on the board. Use only a 25- or 35-watt soldering iron to service the Cue/TB Amplifier as excessive heat can damage the printed wiring.

1. Grip the component to be removed at one end with a long-nose pliers, then apply a narrow-tip soldering iron to the component lead, barely touching the board wiring. Lightly pull away with the pliers, while the solder joint melts, until the lead can be pulled free of the board. Free the other lead in the same manner.

2. It is suggested that when a component has been removed, it be replaced by a new component of the same value. When installing a new component, observe the length and dress of the leads on the old component, then cut and bend the leads of the new component accordingly.

3. Try placing the leads in the holes. If residual solder prevents a lead from entering the hole, very gently ream out the solder with a sharply pointed square tipped awl. Then place the leads in the holes so that the component is held in place by friction

or slight spring tension of the leads.

4. Using a high-grade electrical solder, apply the soldering iron tip, then the solder to the junction of the hole so that a very small amount of solder flows around the lead and into the hole, thus bonding the lead to the board.

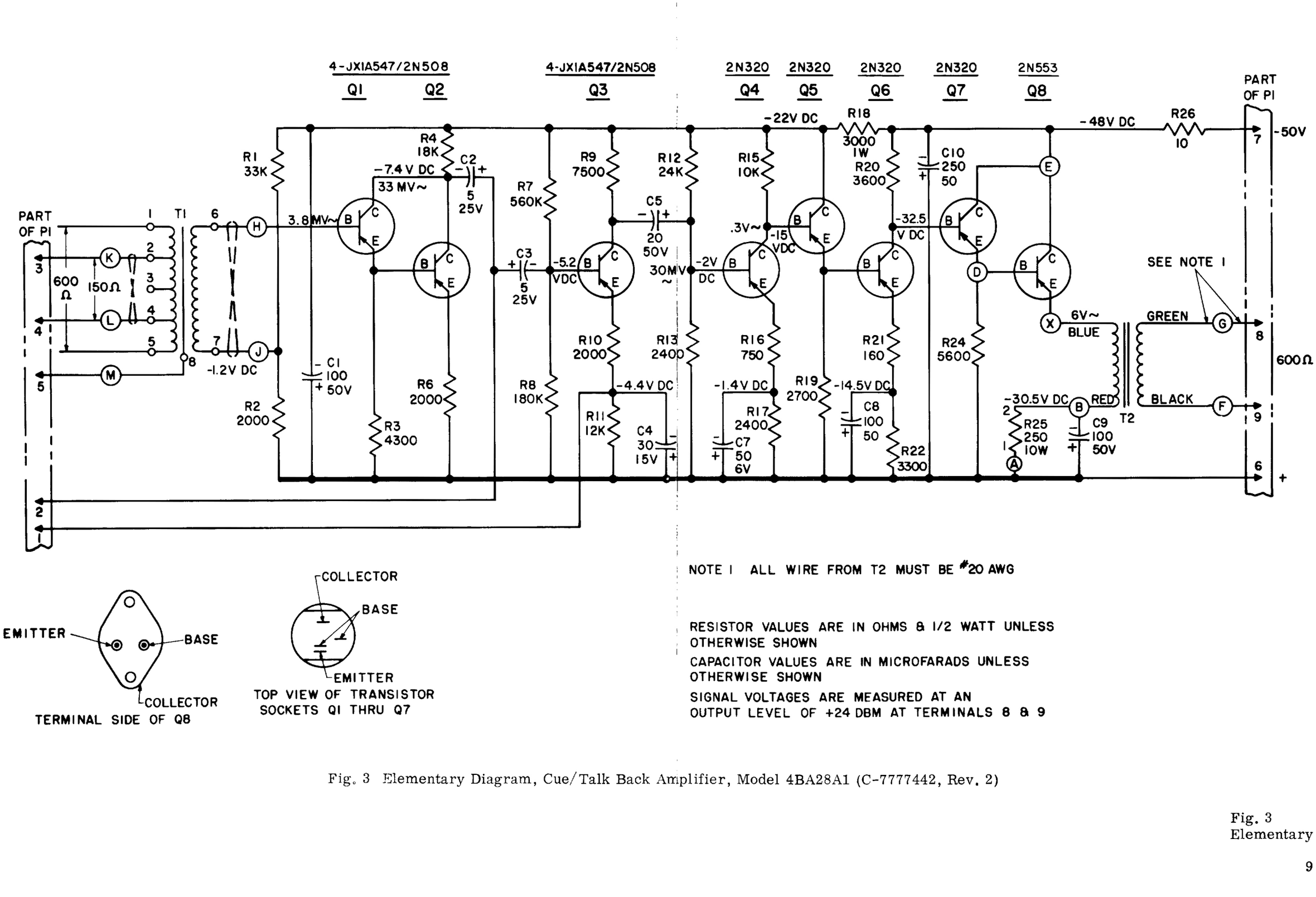
5. Examine the joint carefully. A good joint should withstand a light pull by the fingers. Clear away any loose solder, making sure that no solder scraps fall where they might cause a short.

6. In the unlikely event of a break in a printed wiring strip, the strip can be repaired by placing a short piece of tinned wire across the break and flowing solder over the length of the wire. Be careful that excess solder does not short adjacent strips.

## PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (Electrolytic) | |
| C1 | Polarized, insulated, tubular; 100 mfd +250% -10%, 50 v d-c w. Mallory Type TC-3501. | C-7775849-P6 |
| C2 and C3 | Hermetically sealed; 5.0 mfd +100% -15%, 25 v d-c w. Sprague Cat. #30D179A1. | B-7489483-P6 |
| C4 | Hermetically sealed; 35 mfd +100% -15%, 15 v d-c w. Sprague Cat. #30D169A1. | B-7489483-P10 |
| C5 | Hermetically sealed; 20 mfd +100% -15%, 50 v d-c w. Sprague Cat. #30D198A1. | B-7489483-P11 |
| C7 | Hermetically sealed; 50 mfd +100% -15%, 6 v d-c w. Sprague Cat. #30D133A1. | B-7489483-P4 |
| C8 and C9 | Polarized, insulated, tubular; 100 mfd +250% -10%, 50 v d-c w. Mallory Type TC-3501. | C-7775849-P6 |
| C10 | **Polarized, insulated, tubular; 250 mfd +100% -10%, 25 v d-c w. Sprague Type D18418.** | C-7775849-P1 |
| | TRANSISTORS | |
| Q1 thru Q3 | G-E Type 2N324/4JX1A547/2N508. | |
| Q4 thru Q7 | G-E Type 2N320. | |
| Q8 | Delco Type 2N553. | A-7164451-P8 |
| | RESISTORS (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R1 | 33,000 ohms. | C-3R77-P333J |
| R2 | 2000 ohms. | C-3R77-P202J |
| R3 | 4300 ohms. | C-3R77-P432J |
| R4 | 18,000 ohms. | C-3R77-P183J |
| R6 | 2000 ohms. | C-3R77-P202J |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (CONTINUED) (Composition, ± 5%, ½ w, unless otherwise specified) | |
| R7 | 0.56 megohm. | C-3R77-P564J |
| R8 | 0.18 megohm. | C-3R77-P184J |
| R9 | 7500 ohms. | C-3R77-P752J |
| R10 | 2000 ohms. | C-3R77-P202J |
| R11 | 12,000 ohms. | C-3R77-P123J |
| R12 | 24,000 ohms. | C-3R77-P243J |
| R13 | 2400 ohms. | C-3R77-P242J |
| R15 | 10,000 ohms. | C-3R77-P103J |
| R16 | 750 ohms. | C-3R77-P751J |
| R17 | 2400 ohms. | C-3R77-P242J |
| R18 | 3000 ohms, 1 w. | C-3R78-P302J |
| R19 | 2700 ohms. | C-3R77-P272J |
| R20 | 3600 ohms. | C-3R77-P362J |
| R21 | 160 ohms. | C-3R77-P161J |
| R22 | 3300 ohms. | C-3R77-P332J |
| R24 | 5600 ohms. | C-3R77-P562J |
| R25 | Wirewound, 250 ohms ± 5%, 10 w. Ward Leonard Cat. #10F250. | M-2R12-P25 |
| R26 | 10 ohms. | C-3R77-P100J |
| | TRANSFORMERS | |
| T1 | Audio input. Pri imp: 600/150/30 ohms; sec imp: 2400 ohms. | A-7165301-P1 |
| T2 | Audio output: Pri imp: 75 ohms; sec imp: 600 ohms; | B-7492848-P1 |
| | TRANSISTOR SOCKETS | |
| XQ1 thru XQ7 | Elco Cat. #3305. | B-5490277-P2 |







TERMINAL SIDE OF Q8




TOP VIEW OF TRANSISTOR SOCKETS Q1 THRU Q7

NOTE 1 ALL WIRE FROM T2 MUST BE #20 AWG

RESISTOR VALUES ARE IN OHMS & 1/2 WATT UNLESS OTHERWISE SHOWN

CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN

SIGNAL VOLTAGES ARE MEASURED AT AN OUTPUT LEVEL OF +24 DBM AT TERMINALS 8 & 9

Fig. 3 Elementary Diagram, Cue/Talk Back Amplifier, Model 4BA28A1 (C-7777442, Rev. 2)

*INSTRUCTIONS*

# 25-VOLT TRANSISTOR POWER SUPPLY

## MODEL 4BP20A1

**EBI—2183A**

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

10/61 (400)

PRINTED IN U.S.A.

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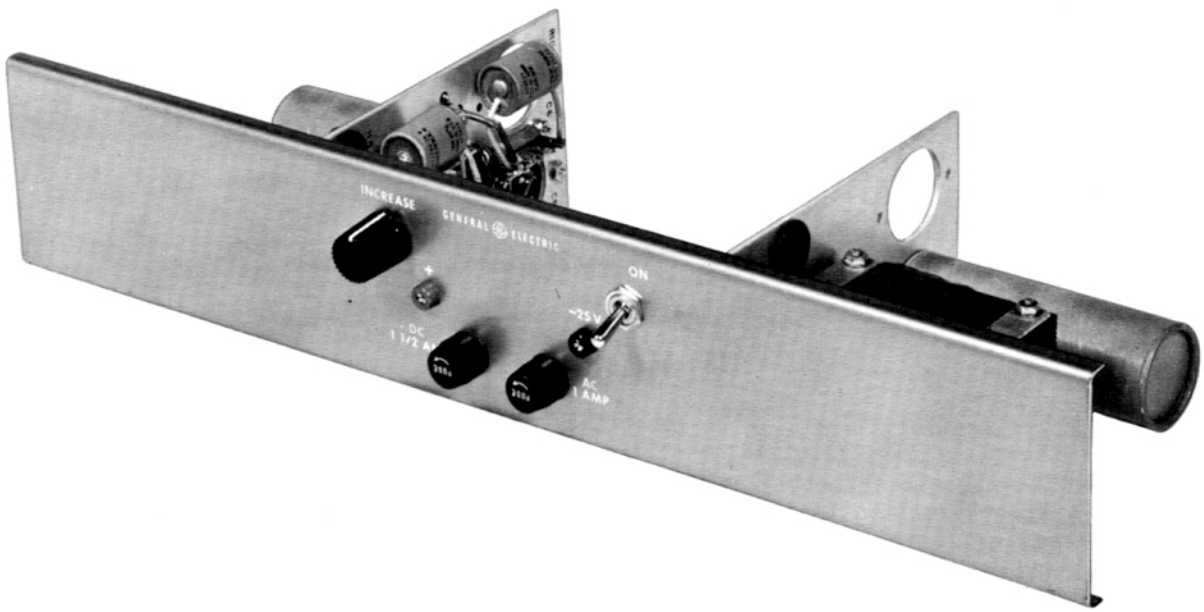



Fig. 1 Front View (8-10414)

## INTRODUCTION

The General Electric Model 4BP20A1 Transistor Power Supply (see Figs. 1 and 2) is a regulated supply designed to provide 25 volts d-c power for the Type BA-24-A Monitor Amplifier and relays associated with the Type BC-21-A Audio Console. The Power Supply will deliver sufficient power to operate two or three Type BA-24-A Monitor Amplifiers or similar 25-volt transistor amplifiers in audio system applications.

## TECHNICAL SUMMARY

### Electrical

POWER INPUT

110/117/125 volts a-c, 50/60 cycles; 45 watts

POWER OUTPUT

25 volts d-c, 1 ampere

REGULATION

Change in output voltage is less than 1% with load changes from no load to 1 ampere, and input voltage changes of ± 10 volts.

RIPPLE

3 millivolts or less at full load of 1 ampere

### Mechanical

Height: $3\frac{1}{2}$ inches
Width: 19 inches
Depth: $6\frac{1}{4}$ inches
Weight: 5-3/4 pounds

MAXIMUM OPERATING TEMPERATURES

Maximum Room Ambient Temperature (continuous): 113 F (45 C)

Maximum Room Ambient Temperature (5% of time): 122 F (50 C)

### Transistor Complement

1 Delco Type 2N277 (Q1)
1 Delco Type 2N441 (Q3)
1 G-E Type 2N320 (Q4)

## DESCRIPTION

The Model 4BP20A1 Transistor Power Supply is a rack mounted unit, requiring $3\frac{1}{2}$ inches of panel space. A power switch, fuse holders, test jacks, and a voltage control are mounted on the front panel.

## INSTALLATION

### General

The Transistor Power Supply has been tested and inspected before being shipped, and should be ready for operation when received and properly installed. Unpack the unit carefully and inspect it for damage that may have occurred in transit. Notify the shipping company of any such damage immediately.

### Location

A number of factors must be considered in finding a suitable location for this Power Supply when used in applications other than the Type BC-21-A Audio Console.

1. Do not mount the Power Supply adjacent to any pre-amplifiers, or other low-level audio devices because of possible interference caused by radiated fields from the power transformer.
2. Do not mount the Power Supply immediately above other heat producing equipment.

### Mounting

The Power Supply is designed for standard EIA rack mounting and may be mounted in any standard rack cabinet or similar facility.

The unit is mechanically mounted to a rack by means of four chassis clamps located on the back of the panel. To install, loosen the clamp screws and rotate the clamps to the position in which they will clear the rack rails. Place the Power Supply in the rack and while holding it in position, rotate the clamps to their clamping position and tighten the screws.

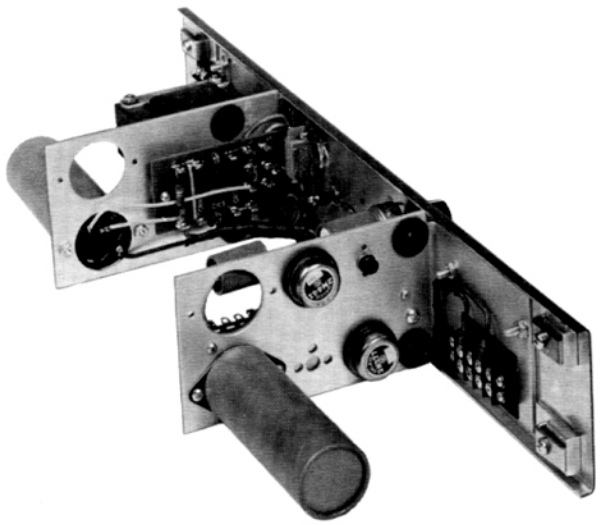


Fig. 2 Rear Oblique View (8-10413)

### Connections

The Elementary Diagram, Fig. 3, shows the electrical connections. Connect the a-c input power to TB1-1 and TB1-2. As shipped, the Power Supply is connected for 117-volt line use. The input transformer is tapped to provide for use with higher or lower supply voltages. The taps are located on the rectifier terminal board and the lead connected to the 117-volt point can be moved to the 110-volt or 125-volt point if necessary.

The d-c output connections are made at TB2-1 and TB2-3. The positive lead is connected to TB2-3. Observe correct polarity when making connections between the Power Supply and transistor amplifiers since serious damage to the transistors can occur if the polarity is reversed.

It is recommended that #16 AWG size wire or larger be used for power wiring between the Power Supply and amplifiers. In some cases it may be desirable to run separate power leads from each Monitor Amplifier to the Power Supply to minimize coupling effects which may develop in long power supply leads.

The positive voltage line should be grounded at one point only to minimize noise. It is recommended that it be grounded as near to the amplifiers as possible. NEVER GROUND THE NEGATIVE LEAD.

## OPERATION

Before turning on the Power Supply for the first time, the following checks should be made:

1. Check wiring for correct polarity.
2. Check for accidental grounds on the negative output lead.
3. Determine if proper fuses are being used in the Power Supply.
4. Determine if the input wiring is placed on the correct tap for the normal voltage input being used.

To operate the Power Supply, connect a d-c voltmeter to jacks J1 (negative) and J3 (positive) and turn power switch S1 to the ON position. Adjust potentiometer R8 until the voltage read at J1 and J3 is 25 volts. This voltage should remain within a quarter of a volt or less with a no load condition to full load or one-ampere output.

## THEORY AND CIRCUIT ANALYSIS

The Model 4BP20A1 Power Supply is designed to operate from an a-c line source of 105-125 volts, 50/60 cycles. Three primary taps (105, 117, or 125 volts) are provided on the power transformer to accomplish this. See the Elementary Diagram, Fig. 3.

Silicon diodes CR1 and CR3, connected in a full wave center-tapped configuration, are used for rectification. A surge limiting resistor (R1) of 1.2 ohms, 5 watts provides protection against breakdown of the diodes due to initial charging current drawn by C1 when the power is turned on.

Regulation is accomplished by means of a transistorized series regulator circuit. All current delivered by the Power Supply passes through Q1, the series regulator transistor. Q3 is compound connected to Q1 to provide maximum control gain of Q1. Output voltage changes due to load current changes cause Q4 to develop a correction current which in turn controls the series operation of Q1 and Q3.

Potentiometer R8, in the base of Q4, sets the voltage operating point of the Power Supply. Stability of voltage control is provided Q4 by means of a Zener diode (CR5) which maintains a fixed reference voltage point.

## MAINTENANCE

When operated under normal conditions, the Model 4BP20A1 Transistor Power Supply requires little or no maintenance other than a periodic cleaning or dusting.

## Service Hints

### CAUTION

NEVER REMOVE TRANSISTOR Q4 WHEN THE POWER IS ON.

The cases of power transistors Q1 and Q3 are negative by 25 volts from chassis ground. The cases are connected to the collector circuit, and therefore, must not be grounded. Insulation between the power transistors and chassis is provided by an anodized aluminum washer.

Types 2N277 and 2N441 power transistors may be tested by means of an ohmmeter to determine if they are defective. Unsolder the base and emitter leads from their respective tie points. Use care not to apply an excess of heat to the transistor leads which can cause damage to the elements. A recommended method to avoid this is to hold the transistor lead with a long-nose pliers. The pliers will help in dissipating the excess heat. When the leads are free, use an ohmmeter set to the RX1 scale and read the resistance between the stud (collector) and the green lead (base) of the transistor. A reading between zero and approximately 100 ohms should be noted. If the same reading is obtained when the leads are reversed, the transistor is defective. In one of the meter positions, a high resistance reading should be obtained.

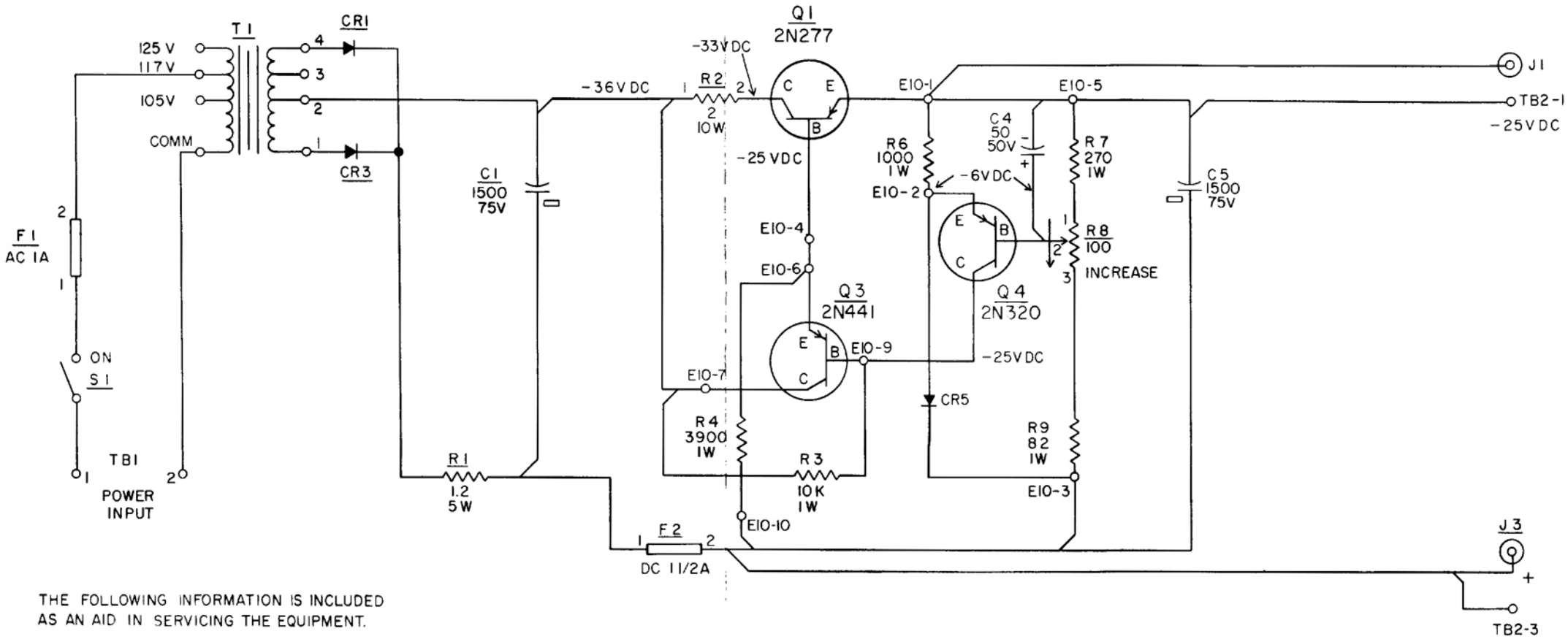
If it should become necessary to replace a power transistor, unsolder the green lead (base) and the yellow lead (emitter) from their respective tie points. Remove the collector stud nut to free the transistor from the chassis. Do not allow the anodized washer to become scratched or marred since this will destroy its effectiveness as an insulator.

When installing the new power transistor, be sure to use the insulating washer between the transistor and the chassis, and the small fiber shoulder washer on the chassis back side to prevent the stud from grounding to the chassis. When the transistor has been bolted down in place, check between the transistor case and the chassis with an ohmmeter to determine if there are any existing short circuits. Complete the replacement by resoldering the emitter and base lead to their proper connections.

## PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (Electrolytic) | |
| C1 | Polarized twist prong base; 1500 mfd +100% -10%, 75 v d-c w. Mallory Type FP. | P-7772471-P32 |
| C4 | Insulated, tubular; 50 mfd +250% -10%, 50 v d-c w. PR Mallory Cat. #TC39. | C-7774786-P9 |
| C5 | Polarized twist prong base; 1500 mfd +100% -10%, 75 v d-c w. Mallory Type FP. | P-7772471-P32 |
| | RECTIFIERS | |
| CR1 | Diode. Type 1N538. | |
| CR3 | Diode. Type 1N538. | |
| CR5 | Silicon regulator, hermetically sealed in glass case, with axial leads. Transitron Type SV-6. | B-7492377-P2 |
| | FUSES (250 v, Type 3AG) | |
| F1 | 1 amp. Littelfuse Cat. #312001, Bussman Cat. #AGC-1. | K-1R16-P3 |
| F2 | 1½ amp. Littelfuse Cat. #31201.5, Bussman Cat. #AGC-1½. | K-1R16-P4 |
| | TEST POINT JACKS (Nylon) | |
| J1 | EF Johnson Cat. #105-603-1 (black). | A-7143959-P3 |
| J3 | EF Johnson Cat. #105-602-1 (red). | A-7143959-P2 |
| | TRANSISTORS | |
| Q1 | Delco Type 2N277. | |
| Q3 | Delco Type 2N441. | |
| Q4 | G-E Type 2N320. | |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (Composition, ± 10%, 1 w, unless otherwise specified) | |
| R1 | Wirewound, 1.2 ohms ± 5%, 5 w. Sprague Type 5KT with pigtail terminals. | M-7478711-P2 |
| R2 | Wirewound, 2.0 ohms ± 5%, 10 w. Ward Leonard Cat. #10F2.0. | M-2R12-P4 |
| R3 | 10,000 ohms ± 5%, 2 w. | C-3R79-P103J |
| R4 | 3900 ohms. | C-3R78-P392K |
| R6 | 1000 ohms. | C-3R78-P102K |
| R7 | 270 ohms ± 5%. | C-3R78-P271J |
| R8 | Potentiometer, composition: 100 ohms ± 20%, 2.25 w, linear taper. Allen Bradley Type J. | M-2R73-P2 |
| R9 | 82 ohms ± 5%. | C-3R78-P820J |
| | SWITCH | |
| S1 | Toggle style, midget, spst contacts rated 3 amp at 250 v. Arrow Hart and Hegeman Cat. #20994-WJB; Carling Cat. #110-73. | C-7775772-P1 |
| | TRANSFORMER | |
| T1 | Rectifier, single phase. Pri: 125/117/105 v, 50/60 cycles; sec: 54CT/45 v, 1.25 amp d-c. | B-7492934-P1 |
| | TERMINAL BOARDS | |
| TB1 | 2 terminals. HB Jones Type #2-164. | C-7774524-P1 |
| TB2 | 4 terminals. HB Jones Type #4-164. | C-7774524-P2 |
| | FUSE HOLDER | |
| XF1 and XF2 | Bussman Type HKP. | K-7115179-P1 |
| | TRANSISTOR SOCKET | |
| XQ4 | Elco Corp. Cat. #3301. | A-7163873-P11 |




THE FOLLOWING INFORMATION IS INCLUDED AS AN AID IN SERVICING THE EQUIPMENT.

SLANT LINES INDICATE THE DIRECTION TO THE NEAREST CONNECTION POINT.

SMALL CIRCLES DESIGNATED BY "E" NO'S INDICATE TIE POINTS. ( TIE POINTS PHYSICALLY MOUNTED ON COMPONENTS OR TUBE SOCKETS ARE PRECEDED BY THE COMPONENT OR SOCKET SYMBOL.)

RESISTOR VALUES ARE IN OHMS & 1/2 WATT UNLESS OTHERWISE SHOWN.
K = 1,000 OHMS MEG = 1,000,000 OHMS

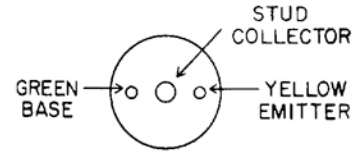
CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN.
μμf = MICROMICROFARADS

COIL VALUES ARE IN MICROHENRIES UNLESS OTHERWISE SHOWN
MH = MILLIHENRIES HY = HENRIES

ALL COMPONENTS MECHANICALLY MOUNTED ARE UNDERLINED.

* RUN DIRECT, DRESS AWAY FROM CHASSIS GND; AND/OR DO NOT LACE IN CABLE.

DC VOLTAGES NOTED ARE TYPICAL VALUES




DELCO 2N277
&
2N441

Fig. 3 Elementary Diagram, 25-Volt Transistor Power Supply, Model 4BP20A1 (C-7777543, Rev. A)

Fig. 3
Elementary

*INSTRUCTIONS*

# 50/25-VOLT TRANSISTOR POWER SUPPLY

## MODEL 4BP21A1

**EBI—2184A**

DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

10/61 (400)

PRINTED IN U.S.A.

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## ILLUSTRATIONS

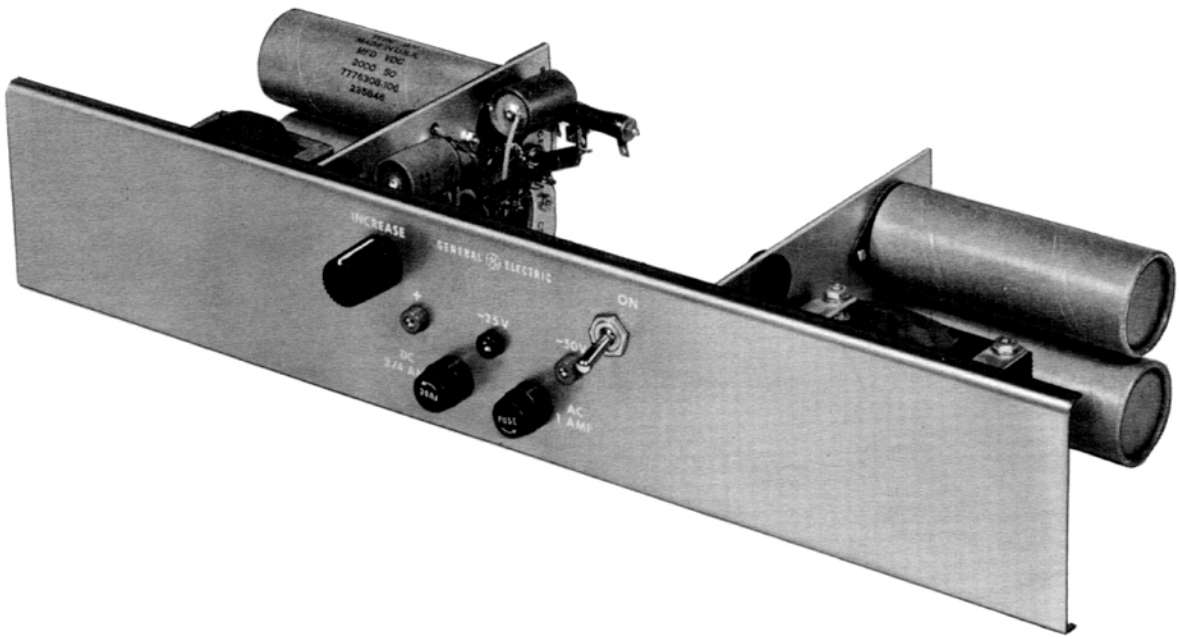



Fig. 1 Front View (8-10415)

## INTRODUCTION

The General Electric Model 4BP21A1 Transistor Power Supply (see Figs. 1 and 2) is a regulated supply designed to provide 50 and 25 volts d-c power for the Type BA-22-A Program Amplifier, the Type BA-28-A Cue/TB Amplifier, and the Type BA-21-A Pre-Amplifiers all associated with the Type BC-21-A Audio Console. In audio system applications the Power Supply may be used to provide power for as many as five Type BA-21-A Pre-Amplifiers, three Type BA-22-A Program Amplifiers, or three Type BA-28-A Cue/TB Amplifiers.

## TECHNICAL SUMMARY

### Electrical

POWER INPUT

110/117/125 volts a-c, 50/60 cycles; 45 watts

POWER OUTPUT

50 volts d-c, 560 ma; 25 volts d-c, 40 ma

REGULATION

Change in output voltage is less than 1% with load changes of 0 to 560 ma or line changes of ± 10 volts.

RIPPLE

500 microvolts or less at full load of 560 ma

### Mechanical

Height: $3\frac{1}{2}$ inches
Width: 19 inches
Depth: $6\frac{1}{4}$ inches
Weight: 5-3/4 pounds

MAXIMUM OPERATING TEMPERATURES

Maximum Room Ambient Temperature (continuous): 113 F (45 C)

Maximum Room Ambient Temperature (5% of time): 122 F (50 C)

### Transistor Complement

1 Delco Type 2N173 (Q1)
1 Delco Type 2N277 (Q2)
1 Delco Type 2N441 (Q3)
1 G-E Type 2N44 or 2N524 (Q4)

## DESCRIPTION

The Model 4BP21A1 Transistor Power Supply is a rack mounted unit, requiring $3\frac{1}{2}$ inches of panel space. A power switch, two fuse holders, three test jacks, and a voltage control are mounted on the front of the panel.

## INSTALLATION

### General

The Transistor Power Supply has been tested and inspected before being shipped, and should be ready for operation when received and properly installed. Unpack the unit carefully and inspect it for damage that may have occurred in transit. Notify the shipping company of any such damage.

### Location

A number of factors must be considered in finding a suitable location for this Power Supply when used in applications other than the Type BC-21-A Audio Console.

1. Do not mount the Power Supply adjacent to any pre-amplifiers, or other low-level audio devices because of possible interference caused by radiated fields from the power transformer.
2. Do not mount the Power Supply immediately above other heat producing equipment.

### Mounting

The Power Supply is designed for standard EIA rack mounting and may be mounted in any standard rack cabinet or similar facility.

The unit is mechanically mounted to a rack by means of four chassis clamps located on the back of the panel. To install, loosen the clamp screws and rotate the clamps to the position in which they will clear the rack rails. Place the Power Supply in the rack and while holding it in position, rotate the clamps to their clamping position and tighten the screws.

### Connections

The Elementary Diagram, Fig. 3, shows the electrical connections. Connect the a-c input power to TB1-1 and TB1-2. As shipped, the Power Supply is connected for 117-volt line use. The input transformer is tapped to provide for use with higher or lower supply voltages. The taps are located on the rectifier terminal board and the lead connected to the 117-volt point can be moved to the 110-volt or 125-volt point if necessary.

The d-c output connections are made at TB2-1, TB2-2, and TB2-3. The positive lead is connected to TB2-3 and the -50 output at TB2-1. The -25-volt output is available on TB2-2. OBSERVE CORRECT POLARITY WHEN MAKING CONNECTIONS BETWEEN THE POWER SUPPLY AND TRANSISTOR AMPLIFIERS SINCE SERIOUS DAMAGE TO THE TRANSISTORS CAN OCCUR IF THE POLARITY IS REVERSED.

It is recommended that #16 AWG size wire or larger be used for power wiring between the Power Supply and amplifiers. In some cases it may be desirable to run separate power leads from the Power Supply to each amplifier to minimize coupling effects which may develop in long power supply leads.

Ground the positive voltage line at one point only to minimize noise. It is recommended that it be grounded as near to the amplifier as possible. NEVER GROUND THE NEGATIVE LEAD.

## OPERATION

Before turning on the Power Supply for the first time, the following checks should be made:

1. Check wiring for correct polarity.
2. Check for accidental grounds on the negative output lead.
3. Determine if proper fuses are being used in the Power Supply.
4. Determine if the input wiring is placed on the correct tap for the normal voltage input being used.

To operate the Power Supply, connect a d-c voltmeter to jacks J1 (negative) and J3 (positive) and turn power switch S1 to the ON position. Adjust potentiometer R8 until the voltage read at J1 and J3 is 50 volts. This voltage should remain within one-quarter of a volt or less with a no load condition to full load or 0.5 ampere output.

The 25-volt d-c output for the pre-amplifiers should be adjusted by means of the slider on R10. This adjustment is to be made only after the entire amplifier load is connected to the Power Supply. The 25-volt output of the Power Supply is not regulated and depends upon the load. In adjusting R10 use care not to overtighten the slider which can damage the resistor wire. Adjust R10 so that with four or five BA-21-A Pre-Amplifiers connected the d-c voltage between jacks J3 (positive) and J2 (negative) is 25 volts.

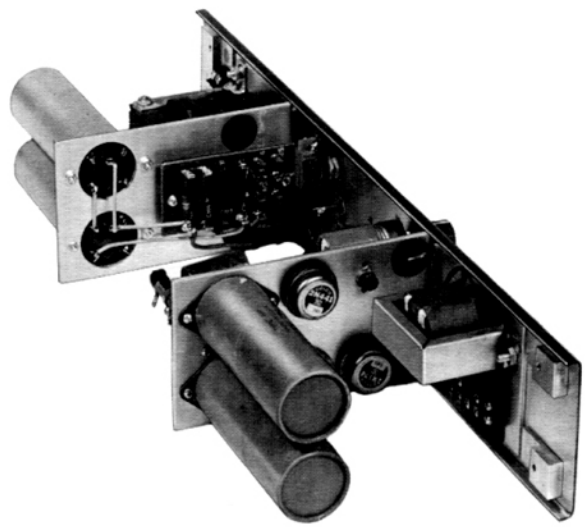


Fig. 2 Rear Oblique View (8-10412)

## THEORY AND CIRCUIT ANALYSIS

The Model 4BP21A1 Power Supply is designed to operate from an a-c line source of 105-125 volts, 50/60 cycles. Three primary taps (105, 117, or 125 volts) are provided on the power transformer to accomplish this. See the Elementary Diagram, Fig. 3.

Silicon diodes, connected in a full wave bridge configuration, are used for rectification. A surge limiting resistor (R1) of 1.2 ohms, 5 watts provides protection for the diodes against initial charging current drawn by C1 and C2 when the power is turned on.

Regulation is accomplished by means of a transistorized series regulator circuit. All current delivered by the Power Supply passes through Q1, the series regulator transistor. Q2 is compound connected to Q1 to provide maximum control gain of Q1. Output voltage changes due to load current changes cause Q4 to develop a correction current which is amplified by Q3 and controls the series operation of Q1, through Q2.

Potentiometer R8, in the base of Q4,

sets the voltage operating point of the Power Supply. Stability of voltage control is provided Q4 by means of a Zener diode (CR5) which maintains a fixed reference voltage point.

The Power Supply also provides a 25-volt output section for the operation of four or five Type BA-21-A Pre-Amplifiers. Choke L1, resistors R10, R11, and R13, and capacitor C6 comprise the 25-volt portion of the Power Supply. When loaded for 32 to 40 milliamperes of current, the resistance of L1 causes the desired voltage drop. The choke also provides additional decoupling between pre-amplifiers and program amplifiers.

## MAINTENANCE

When operated under normal conditions, the Model 4BP21A1 Transistor Power Supply requires little or no maintenance other than a periodic cleaning or dusting.

### Service Hints

### CAUTION

NEVER REMOVE TRANSISTOR Q4 WHEN THE POWER IS ON.

The cases of power transistors Q1, Q2, and Q3 are negative by 50 volts from chassis ground. The cases are connected to the collector circuit, and therefore, must not be grounded. Insulation between the power transistors and chassis is provided by an anodized aluminum washer.

Power transistors Types 2N173, 2N277, and 2N441 may be tested by means of an ohmmeter to determine if they are defective. Unsolder the base and emitter leads from their respective tie points. Use care not to apply an excess of heat to the transistor leads which can cause damage to the elements. A recommended method to avoid this, when applying the soldering iron, is to hold the transistor lead with a long-nose pliers. The pliers will help in dissipating the excess heat. When the leads are free, use an ohmmeter set to the RX1 scale and read the resistance between the (collector) stud and base (green lead) of the transistor. A reading between zero and approximately 100 ohms may be noted. Now reverse the ohmmeter leads. If the same reading is obtained, the transistor is defective. In one of the meter positions, a high resistance reading should be obtained.

If it becomes necessary to change a power transistor, unsolder the base (green lead) and the emitter (yellow lead) from their respective tie points, then remove the collector stud nut. This will release the transistor from the chassis. Do not allow the anodized washer to become scratched or marred since this will destroy its effectiveness as an insulator.

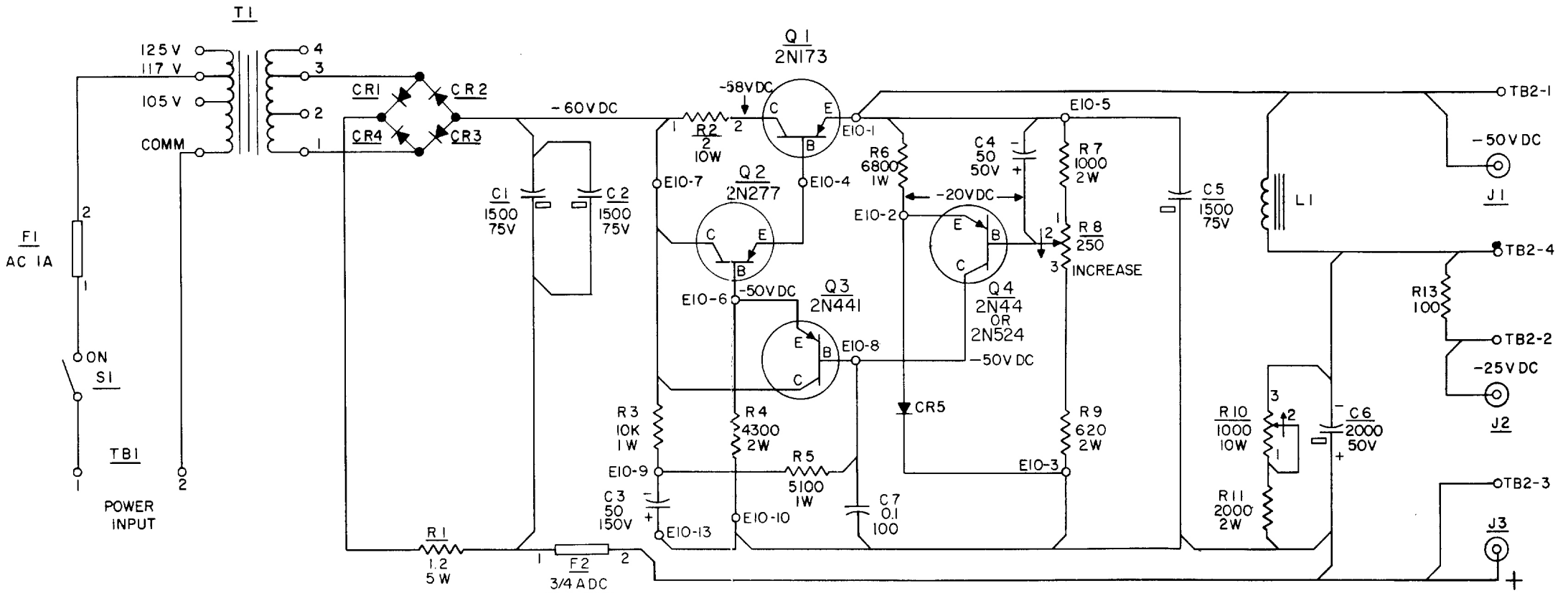
Install the new power transistor by reversing the steps taken to remove the old transistor. Be sure to use the insulating washer the transistor and the chassis, and the small fiber shoulder washer on the chassis back side to prevent the stud from grounding to the chassis. When the transistor has been bolted down in place, check between the transistor case and the chassis with an ohmmeter to determine if there are any existing short circuits. Complete the replacement by resoldering the emitter and base lead to their proper connections.

## PARTS LIST

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (Electrolytic, unless otherwise specified) | |
| C1 and C2 | Polarized twist prong base; 1500 mfd +100% -10%, 75 v d-c w. Mallory Type FP. | P-7772471-P32 |
| C3 | Insulated, tubular; 50 mfd +100% -10%, 150 v d-c w. PR Mallory Cat. #TC49. | C-7774786-P16 |
| | CAPACITORS (CONTINUED) (Electrolytic, unless otherwise specified) | |
| C4 | Insulated, tubular; 50 mfd +250% -10%, 50 v d-c w. PR Mallory Cat. #TC39. | C-7774786-P9 |
| C5 | Polarized twist prong base; 1500 mfd +100% -10%, 75 v d-c w. Mallory Type FP. | P-7772471-P32 |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | CAPACITORS (CONTINUED)<br>(Electrolytic, unless otherwise specified) | |
| C6 | Low inductance, polarized twist prong base; 2000 mfd +250% -15%, 50 v d-c w. | C-7776308-P106 |
| C7 | Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #109P10402. | B-7491096-P13 |
| | RECTIFIERS | |
| CR1 thru CR4 | Diodes. Type 1N538. | |
| CR5 | Silicon regulator, hermetically sealed in glass case, with axial leads. Transitron Type SV-18. | B-7492377-P8 |
| | FUSES<br>(250 v, Type 3AG) | |
| F1 | 1 amp. Littelfuse Cat. #312001, Bussman Cat. #AGC-1. | K-1R16-P3 |
| F2 | Slow blow, 3/4 amp. Bussman Cat. #MDL3/4. | B-7487942-P4 |
| | TEST POINT JACKS<br>(Nylon, stake in) | |
| J1 | EF Johnson Cat. #105-610-1 (dark blue). | A-7143959-P10 |
| J2 | EF Johnson Cat. #105-603-1 (black). | A-7143959-P3 |
| J3 | EF Johnson Cat. #105-602-1. (red). | A-7143959-P2 |
| | CHOKE | |
| L1 | Stancor Cat. #C-1003. | |
| | TRANSISTORS | |
| Q1 | Delco Type 2N173. | |
| Q2 | Delco Type 2N277. | |
| Q3 | Delco Type 2N441. | |
| Q4 | G-E Type 2N44 or 2N524. | |
| | RESISTORS<br>(Composition, ± 5%, 1 w, unless otherwise specified) | |
| R1 | Wirewound, 1.2 ohms ± 5%, 5 w. Sprague Type 5KT with pigtail terminals. | M-7478711-P2 |

| SYMBOL | DESCRIPTION | G-E DRAWING |
|---|---|---|
| | RESISTORS (CONTINUED)<br>(Composition, ± 5%, 1 w, unless otherwise specified) | |
| R2 | Wirewound, 2.0 ohms ± 5%, 10 w. Ward Leonard Cat. #10F2.0. | M-2R12-P4 |
| R3 | 10,000 ohms. | C-3R78-P103J |
| R4 | 4300 ohms, 2 w. | C-3R79-P432J |
| R5 | 5100 ohms. | C-3R78-P512J |
| R6 | 6800 ohms. | C-3R78-P682J |
| R7 | 1000 ohms, 2 w. | C-3R79-P102J |
| R8 | Potentiometer, composition; 250 ohms ± 20%, 2.25 w, linear taper. Allen Bradley Type J. | M-2R73-P4 |
| R9 | 620 ohms, 2 w. | C-3R79-P621J |
| R10 | Wirewound, adjustable, 1000 ohms ± 10%, 10 w, B coating. IRC Type ABA. | K-7102116-P8 |
| R11 | 2000 ohms, 2 w. | C-3R79-P202J |
| R13 | 100 ohms, ½ w. | C-3R77-P101J |
| | SWITCH | |
| S1 | Toggle style, midget, spst contacts rated 3 amp at 250 v, Arrow Hart and Hegeman Cat. #20994-WJB; Carling Cat. #110-73. | C-7775772-P1 |
| | TRANSFORMER | |
| T1 | Rectifier, single phase.<br>Pri: 125/117/105 v, 50/60 cycles;<br>sec: 54 CT/45 v, 1.25 amp d-c. | B-7492934-P1 |
| | TERMINAL BOARDS | |
| TB1 | 2 terminals. HB Jones Type #2-164. | C-7774524-P1 |
| TB2 | 4 terminals. HB Jones Type #4-164. | C-7774524-P2 |
| | FUSE HOLDERS | |
| XF1 and XF2 | Bussman Type HKP. | K-7115179-P1 |
| | TRANSISTOR SOCKET | |
| XQ4 | Elco Corp. Cat. #3301. | A-7163873-P11 |




THE FOLLOWING INFORMATION IS INCLUDED AS AN AID IN SERVICING THE EQUIPMENT

SLANT LINES INDICATE THE DIRECTION TO THE NEAREST CONNECTION POINT

SMALL CIRCLES DESIGNATED BY "E" NO'S INDICATE TIE POINTS. (TIE POINTS PHYSICALLY MOUNTED ON COMPONENTS OR TUBE SOCKETS ARE PRECEDED BY THE COMPONENT OR SOCKET SYMBOL

RESISTOR VALUES ARE IN OHMS & 1/2 WATT UNLESS OTHERWISE SHOWN.
K = 1,000 OHMS MEG = 1,000,000 OHMS

CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN.
μμf = MICROMICROFARADS

COIL VALUES ARE IN MICROHENRIES UNLESS OTHERWISE SHOWN.
MH = MILLIHENRIES HY = HENRIES

ALL COMPOMENTS MECHANICALLY MOUNTED ARE UNDERLINED.

*RUN DIRECT, DRESS AWAY FROM CHASSIS GND; AND/OR DO NOT LACE IN CABLE.

D C VOLTAGES NOTED ARE TYPICAL VALUES

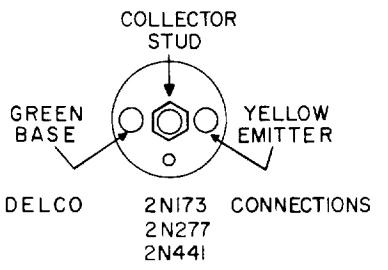



Fig. 3 Elementary Diagram, 50/25-Volt Transistor Power Supply, Model 4BP21A1 (C-7777542, Rev. A)

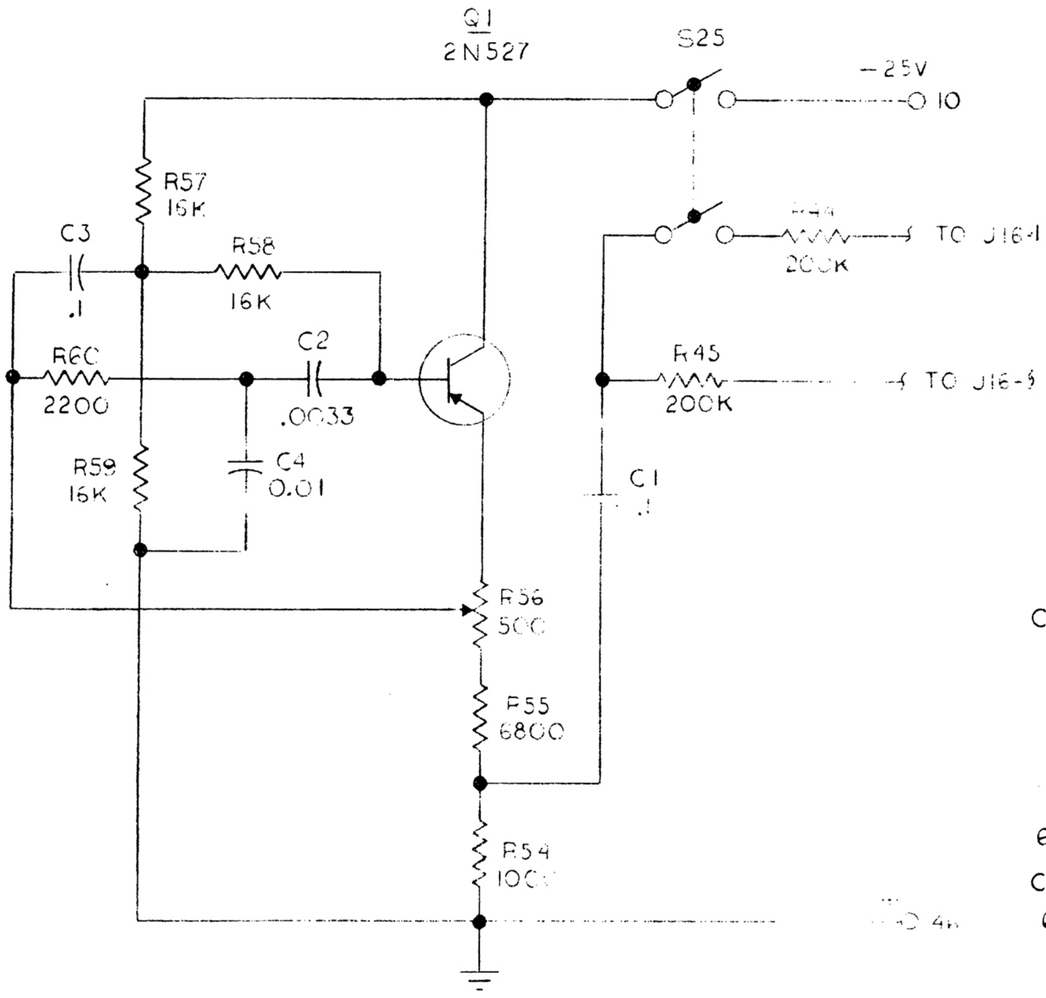
## WHERE TO OBTAIN SERVICE

Request for engineering service information or replacement parts not obtainable from a local dealer may be directed to the nearest office lised below or to the General Electric Company, Service Engineering, Technical Products Operation, Division Street Plant, Syracuse, New York.

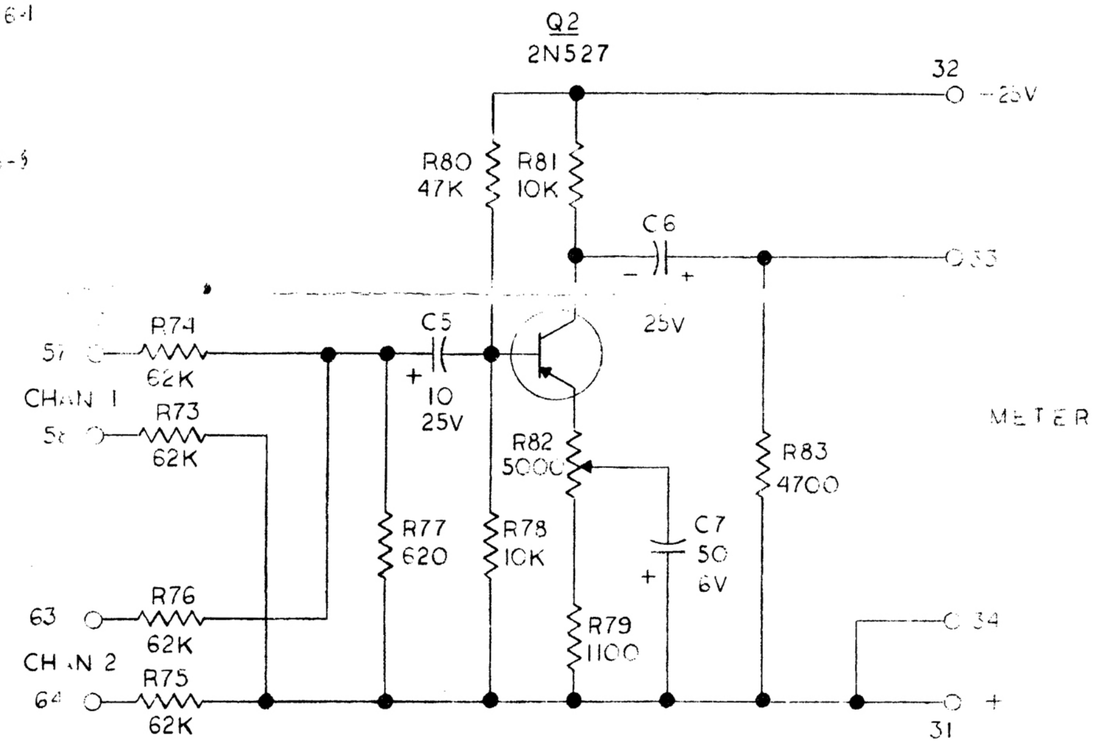
| | | |
|---|---|---|
| **ATLANTA** | Room 517<br>1330 W. Peachtree St. N.W. | TRinity 5-6691 |
| **CHICAGO** | 478 Northwest Highway<br>Des Plaines, Illinois | CYpress 9-3369 |
| **CLEVELAND** | 1013 Williamson Bldg. | SUperior 1-6822 |
| **DALLAS** | 4447 N. Central Expressway<br>Room 400 | LAkeside 6-0426 |
| **KANSAS CITY, MO.** | 3628 West 95th St.<br>Shawnee Mission, Kansas | MItchell 9-7131 |
| **LOS ANGELES** | Suite 210, North Lake Bldg.<br>232 North Lake Ave.<br>Pasadena, Calif. | SYcamore 5-1209<br>MUrray 1-5965 |
| **NEW YORK** | 2801 Graybar Bldg.<br>420 Lexington Ave. | PLaza 1-1311,<br>Ext. 2663 |
| **SAN FRANCISCO** | Suite 2219, Whelan Bldg.<br>701 Welch Road<br>Palo Alto, Calif. | 323-4108 |
| **SCHENECTADY** | 1 River Road<br>Bldg. 33, Room 204 | EXpress 3-9110 |
| **SEATTLE** | 220 South Dawson St. | PArkway 5-3366 |
| **SYRACUSE** | Service Engineering<br>Technical Products Operation<br>Division Street Plant | 456-6358<br>Area Code 315 |
| **WASHINGTON** | 739 Wyatt Bldg.<br>777 14th St. N.W. | EXecutive 3-3600,<br>Ext. 210 |

EBI-21 11/62 (5M)

| REVISIONS | | | | |
|---|---|---|---|---|
| SYM | ZONE | DESCRIPTION | DATE | APPROVED |
| | | | | |




TONE OSCILLATOR
PART OF TB5




V U METER AMPLIFIER
PART OF TB5

NOTES:

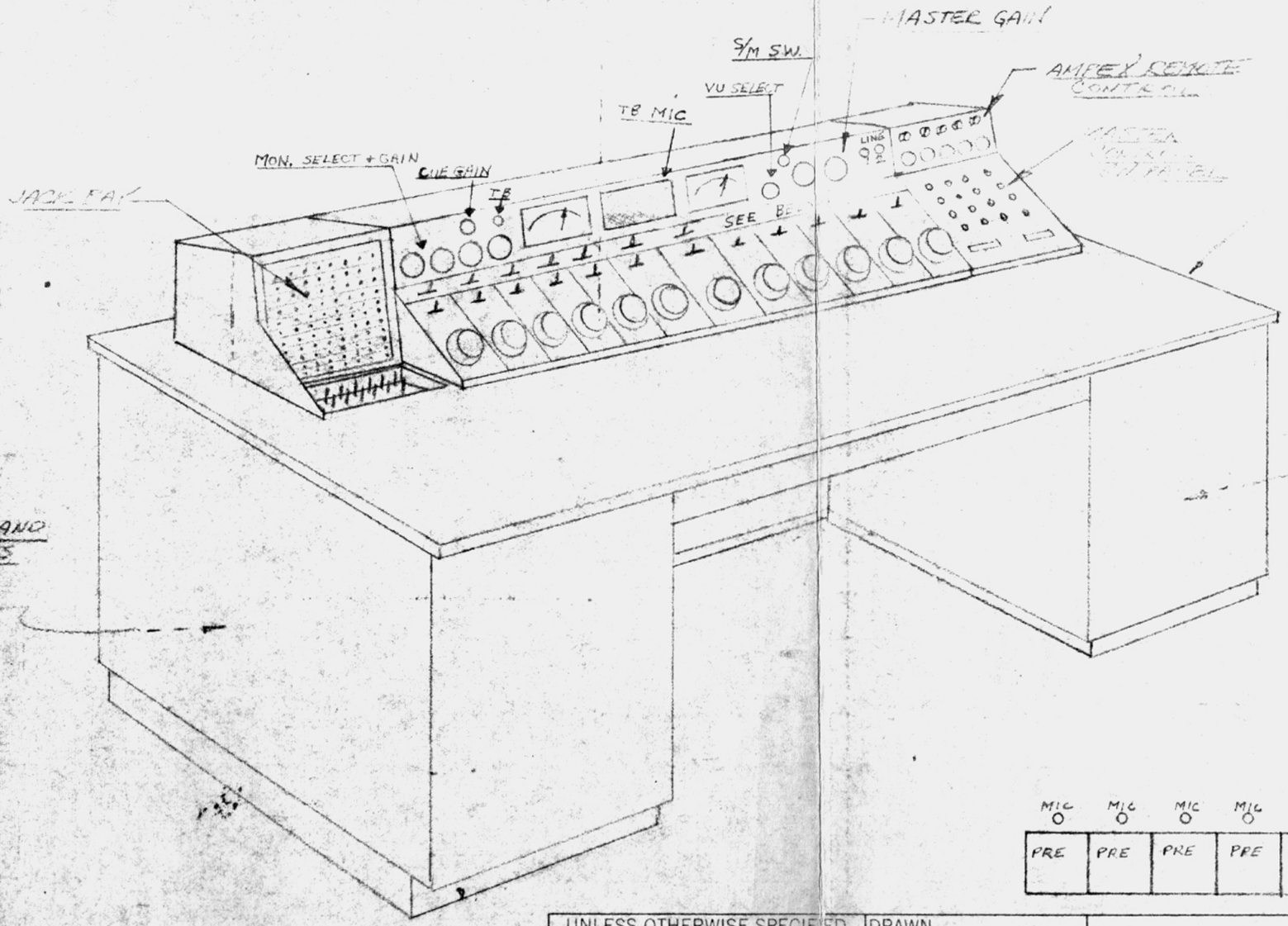
1. RESISTOR VALUES ARE IN OHMS AND 1/2 WATT UNLESS OTHERWISE SHOWN
   K = 1000 OHMS
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE SHOWN

| UNLESS OTHERWISE SPECIFIED | SIGNATURES | DATE | GENERAL ELECTRIC VCPP SYRACUSE |
|---|---|---|---|
| DIMENSIONS ARE IN INCHES | | | TITLE DIAGRAM, ELEMENTARY |
| TOLERANCES ON: | | | TONE OSCILLATOR |
| ONE DECIMALS ± | | | VU METER AMPLIFIER |
| TWO DECIMALS ± | | | FME 4BC31B |
| ANGLES ± | | | CONTRACT NO. |
| SURFACES ✓ | | | SIZE C 7/-1146 |
| MATERIAL | | | SCALE |

FN-903-P (2-63)
PRINTED IN U.S.A.

| REVISIONS | | SIZE | | REV |
|---|---|---|---|---|
| | | CONT ON SHEET | SH NO | |

| SYM | DESCRIPTION | DATE | APPROVAL |
|---|---|---|---|
| | UPDATED | 2-25-63<br>3-11-63 | N SH |




| MIC | MIC | MIC | MIC | MIC | MIC | TT | TT | CART. | 0000 0000 0000 / 0000 0000 0000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PRE | PRE | PRE | PRE | PRE SUM | PRE SUM | HIGH | HIGH | HIGH | HIGH | HIGH | HIGH |

PRINTS TO

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ± DECIMALS ± ANGLES ±
ALL SURFACES ✓

MATERIAL
GOVT OR COML
G-E

| | APPROVED | DATE |
|---|---|---|
| DRAWN | W.T. | |
| DATE | 6/8/61 | |
| APPD | | |
| ISSUED | | |
| ENGR | | |
| MFG | | |
| MATL | | |

STUDIO CONSOLE
WOR NEW YORK CITY

SCALE | WT CALC ACTUAL

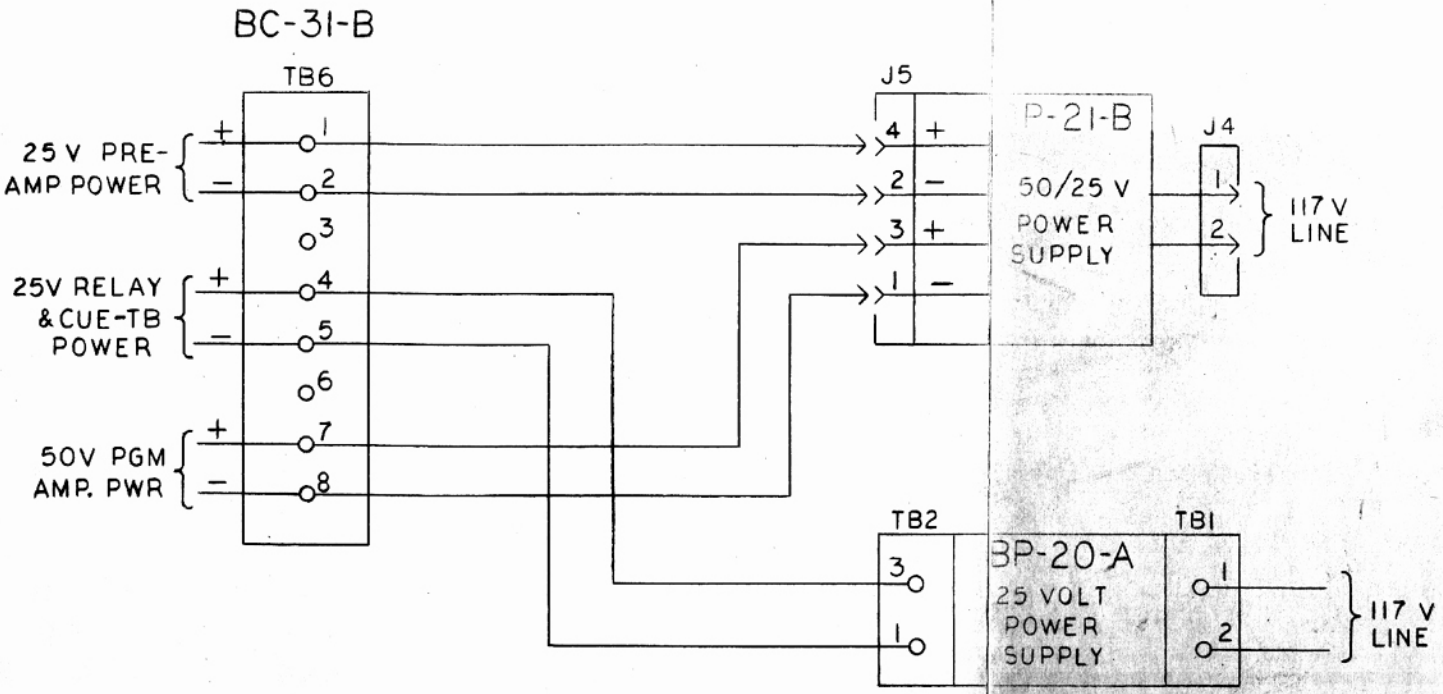
GENERAL ELECTRIC
DIV OR DEPT
LOCATION
SIZE
CONT ON SHEET SH NO
CODE IDENT NO

FF-752 (6-60) PRINTED IN U.S.A.

B 7498826

REVISIONS

| SYM | DESCRIPTION | DATE |
|---|---|---|




WIRING BETWEEN CONSOLE AND POWER SUPPLIES TO BE #16 AWG

| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: FRACTIONS DECIMALS ANGLES ± ± ± ALL SURFACES √ MATL — LCV? OR COML | SIGNATURES | DATE |
|---|---|---|
| | DRAWN W Hamt | 5 Nov. '63 |
| | CHECKED | |
| | ISSUED W Hamt | 13 NOV 1963 |
| | ENGRG | |
| | MFG | |
| | MATLS | |

GENERAL ELECTRIC
MCD DEPT 100 SYRACUSE

TITLE DIAGRAM, WIRING
BC-31-B AUDIO CONSOLE POWER

CONTRACT NO.

| CODE IDENT NO. | SIZE | DWG NO. |
|---|---|---|
| 08838 | B | 7498826 |

SCALE NONE | WT CALC ACTUAL | SHEET 1 OF 1

EC-3

2

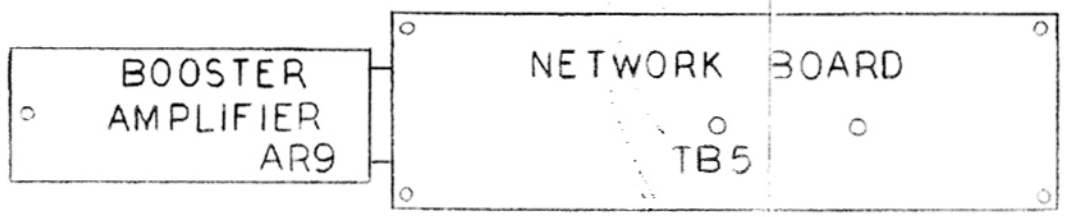
PRINTS TO C5

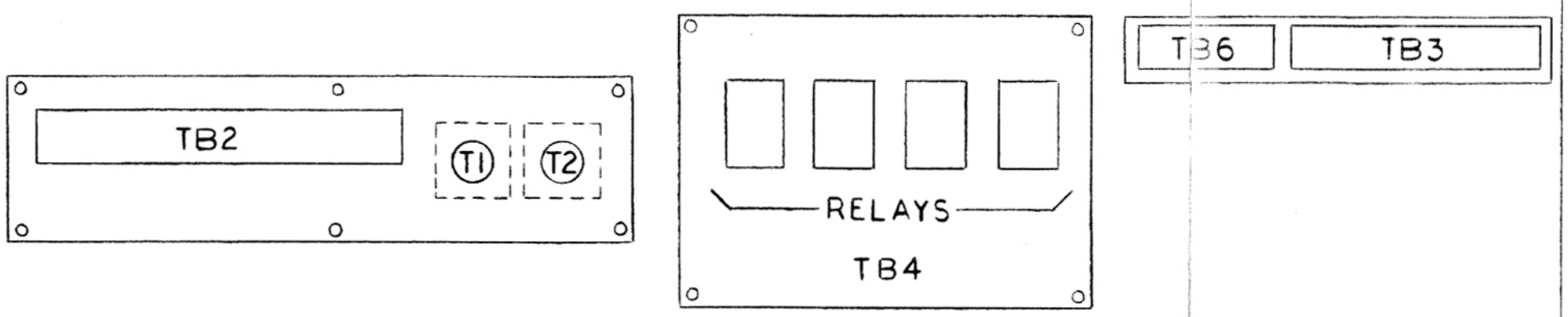
SIZE B | 7498851 | SHEET 1 OF 1

REVISIONS

| SYM | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|

## HOOD SECTION




## BASE SECTION

HIGH LEVEL INPUT BOARDS

| MIC INPUT BOARD TB1 | IC FACILITY | CUE TB AMP | TB7 | TB8 | TB9 | TB10 | TB11 | TB12 |
|---|---|---|---|---|---|---|---|---|

| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: | SIGNATURES | DATE |
|---|---|---|
| FRACTIONS ± DECIMALS ± ANGLES ± | DRAWN W. K. Lamb | 23 NOV 1963 |
| ALL SURFACES ✓ | CHECKED | |
| MATL—GOVT OR COML | ISSUED W. K. Lamb | 26 NOV 1963 |
| | ENGRG A. C. Angus | 11-25-63 |
| | MFG | |
| GE | MATLS | |

FMF 4BC31B1

GENERAL ELECTRIC MCD DEPT LOC SYRACUSE

TITLE LAYOUT
STEREO/MONAURAL 4BC31B1

CONTRACT NO.

| CODE IDENT NO. | SIZE | DWG NO. |
|---|---|---|
| 08838 | B | 7498851 |

SCALE NONE | WT CALC ACTUAL — | SHEET 1 OF 1

3

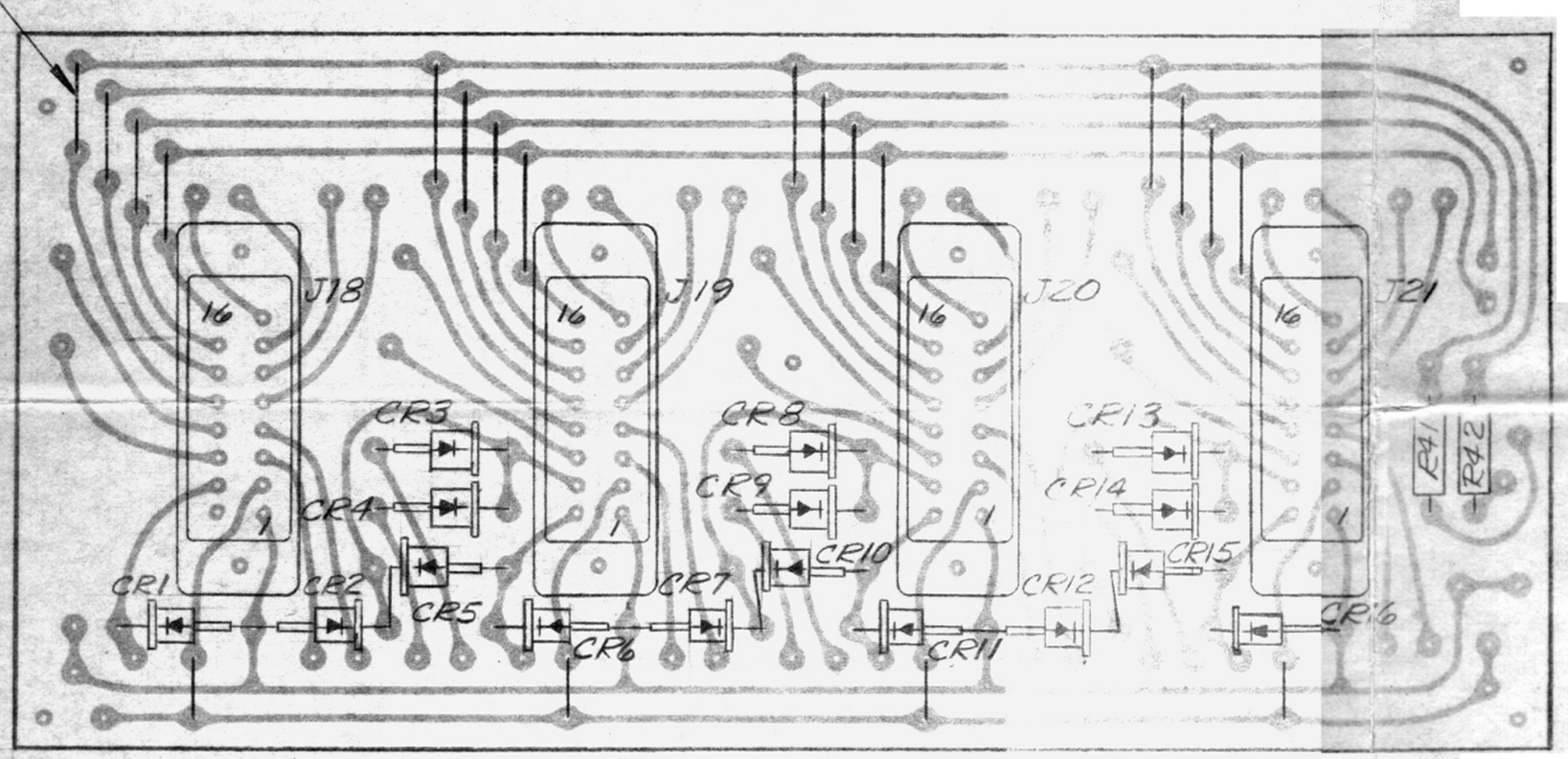
PRINTS TO C107

EC3

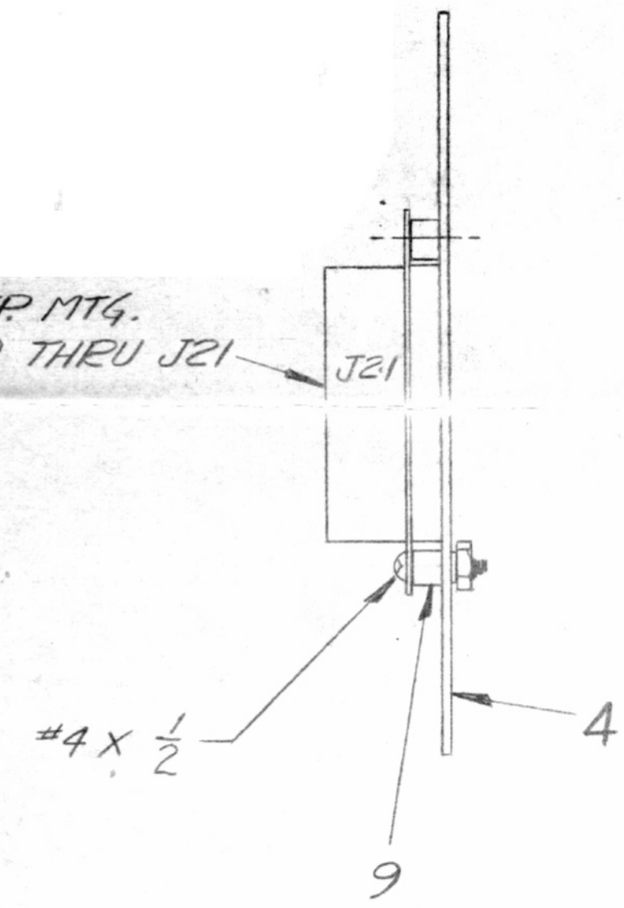
C 7781034

| REVISIONS | | | | |
|---|---|---|---|---|
| SYM | ZONE | DESCRIPTION | DATE | APPROVED |
| A | | #4 X 1/2 SCREW WAS #6 X 7/16 GE-32001 | 10-22-63 | French |
| B | | CHANGED ORIENTATION OF CR16-GE32001 | 11-16-63 | French |

JUMPER WIRE TYP 20 PLACES




TYP. MTG.
J18 THRU J21




(1) ASSY
FOR ASSY OF G2 & 3 SEE SH. 5

SEE SEPARATE PARTS LIST

| | | | |
|---|---|---|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES — TOLERANCES ON: 2-PLACE DECIMALS ± 3-PLACE DECIMALS ± ANGLES ± ALL SURFACES ✓ | SIGNATURES | DATE | GENERAL ELECTRIC TPO DIV. SYRACUSE |
| MATERIAL — GOVT OR COML | DRAWN Robert W. French | 7-15-63 | TITLE BOARD ASSY COMPONENT SIDE |
| GE | CHECKED | | |
| FMF 4BC31B1 | ISSUED RRR | 7/19/63 | CONTRACT NO. |
| | ENGRG D. Traver | 7/19/63 | CODE IDENT NO. 08838 SIZE C DWG NO. 7781034 |
| | MFG Erk | 7/23/63 | SCALE WT CALC ACTL SHEET 1 OF 5 |
| | MATLS FCFO 4BC31B1 | | |

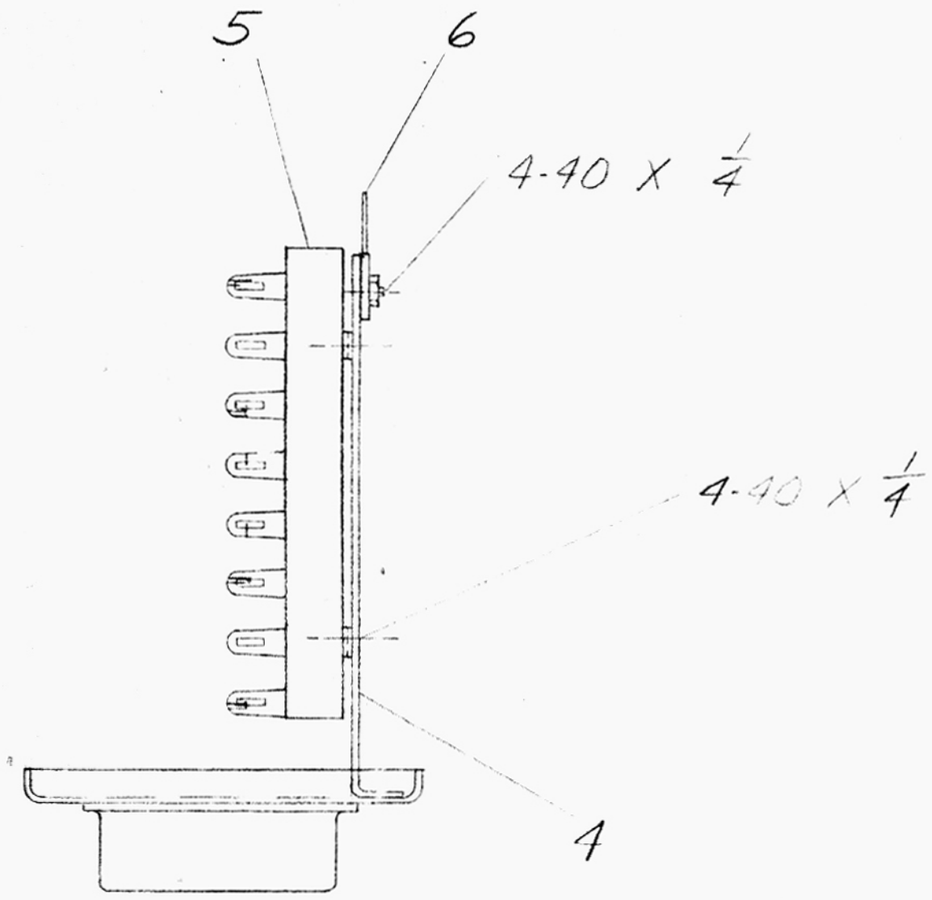
FN-903-F (11-62) NEW

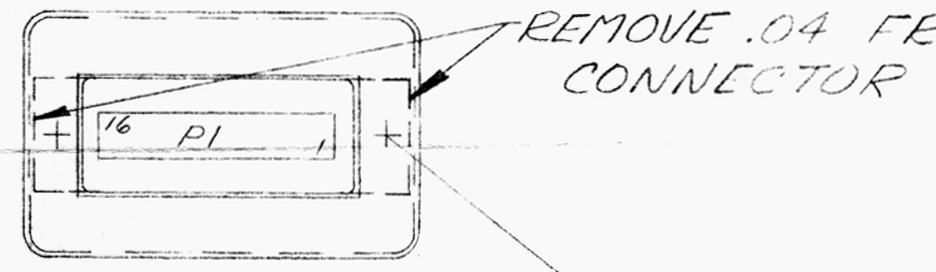
GR 3 & 3 PB (2)

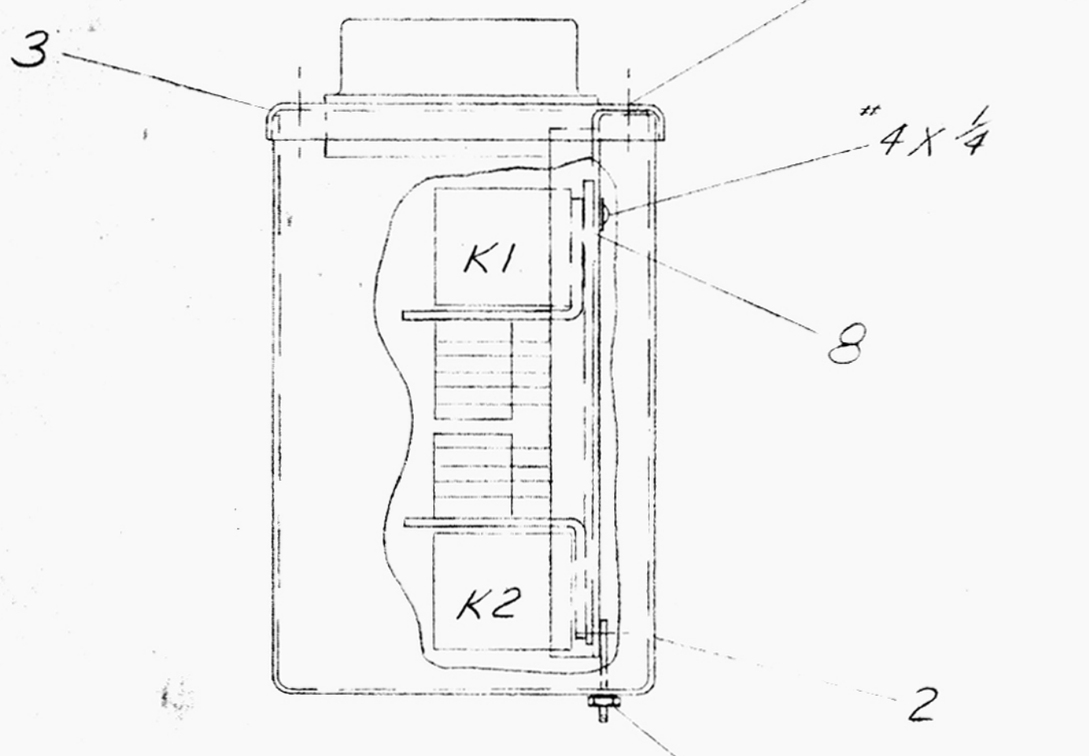
EC-3

C 7779817

| REVISIONS | | | | |
|---|---|---|---|---|
| SYM | ZONE | DESCRIPTION | DATE | APPROVED |
| A | | ADDED PT. 8, 4-40 X 1/4 LIEBE #4 X 3/16 GE 32001 SH. 25 | 10/25/63 | French |




(1)

SEE SEPARATE PL

| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: 2-PLACE DECIMALS ± 3-PLACE DECIMALS ± ANGLES ± ALL SURFACES ✓ | SIGNATURES | DATE | GENERAL ELECTRIC TPO DEPT SYRACUSE |
|---|---|---|---|
| MATERIAL — GOVT OR COML | DRAWN [illegible] | 9/8/63 | TITLE RELAY MODULE |
| GE | CHECKED | | |
| FMF 4BC31B | ISSUED [illegible] | 6/23/63 | CONTRACT NO |
| | ENGR [illegible] | 6/24/63 | CODE IDENT NO 08836 |
| FCFO 4BC31B1 | MFG | | SIZE C |
| | MATLS | | DWG NO 7779817 |
| | | | SCALE WT LBS SHEET OF |

REV A
SIZE C 7779817
B
1
C2

FN-903-P (10-62) new

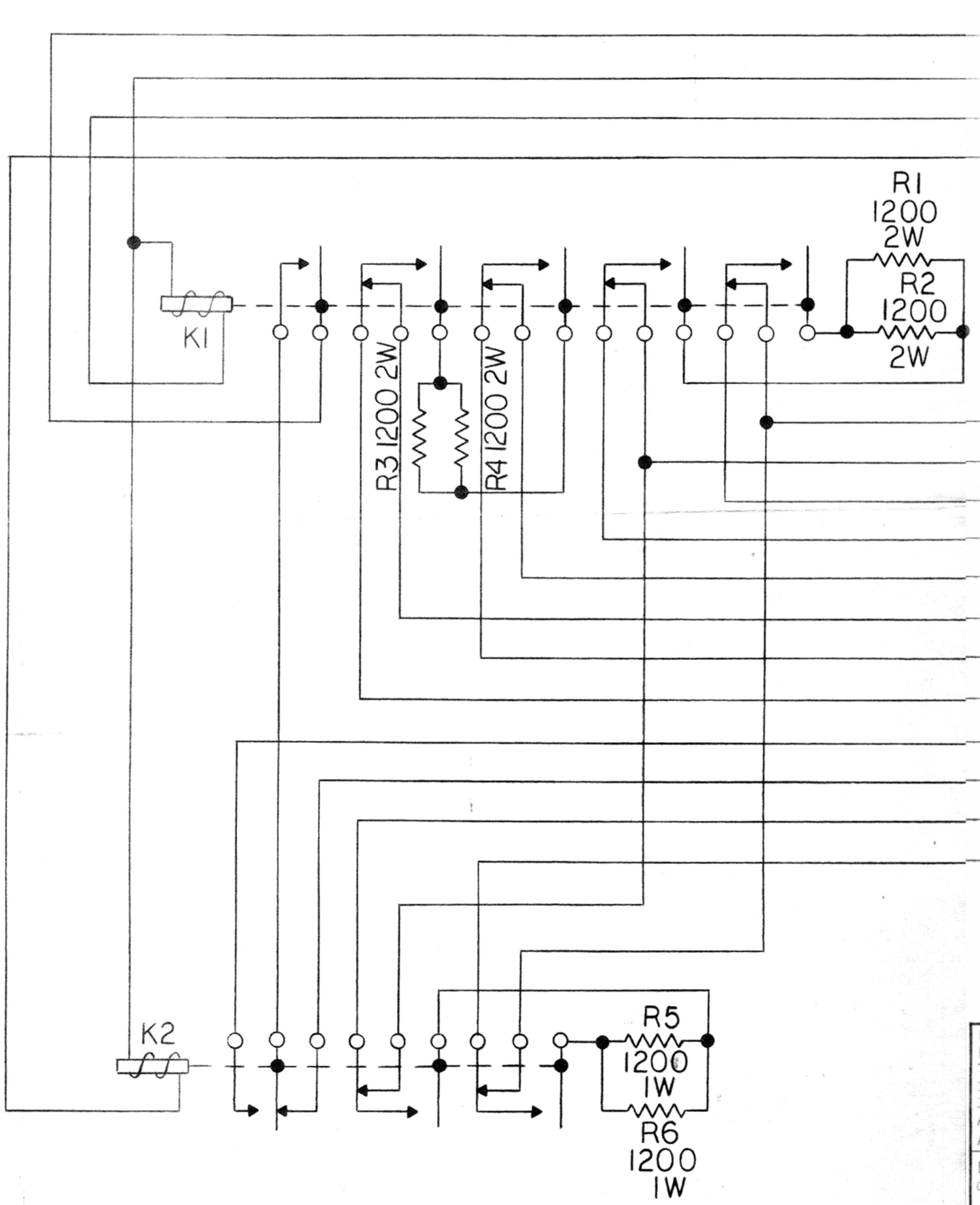
FOLD

PRINTS TO

| SIZE | | REV |
|---|---|---|
| C | 7781114 | A |

REVISIONS

| SYM | ZONE | DESCRIPTION | DATE | APPROVED |
|---|---|---|---|---|
| A | D-2 | RETRACED TERM. NO.10 WAS 9<br>TERM. NO. 9 WAS 10 GE32220 | NOV26 1963 | M.A. Hamb |




| | |
|---|---|
| 2 | LIGHT CONTROL RELAY |
| 1 | RELAY COMMON (−) |
| 10 | K1 COIL OPERATE |
| 9 | K2 COIL OPERATE |
| 6 | TO LEFT SPEAKER |
| 5 | |
| 14 | LEFT CH MON AUDIO IN |
| 13 | |
| 8 | TO RIGHT SPEAKER |
| 7 | |
| 16 | RIGHT CH MON AUDIO IN |
| 15 | |
| 12 | "ON AIR" RELAY CONTROL |
| 11 | "AUDITION" RELAY CONTROL |
| 3 | I.C. AUDIO IN |
| 4 | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2-PLACE DECIMALS ±
3-PLACE DECIMALS ±
ANGLES ±
ALL EDGES ✓
MATERIAL
GOVT.
GE

| SIGNATURES | | DATE |
|---|---|---|
| DRAWN | R.E. BOYD | 9/12/63 |
| CHECKED | | |
| ISSUED | M.A. Hamb | 25 NOV. '63 |
| ENGRG | A.R. ANGUS | 9/12/63 |
| MFG | | |
| MATLS | | |

FMF 4 BC-31-B1

GENERAL ELECTRIC
MCD DEPT LOC SYRACUSE

TITLE DIAGRAM, WIRING

# PLUG-IN RELAY MODULE

CONTRACT NO.

| CODE IDENT NO. | SIZE | DWG NO. |
|---|---|---|
| 08838 | C | 7781114 |

SCALE NONE | WT CALC ACTUAL — | SHEET 1 OF 1

FN-903-F (3-63)
PRINTED IN U.S.A.

FC-3

7174863

CONT ON SHEET SH NO.

REV NO.

CONT ON SHEET SH NO.

TITLE BA-32-A PGM AMP.
TEST CIRCUIT

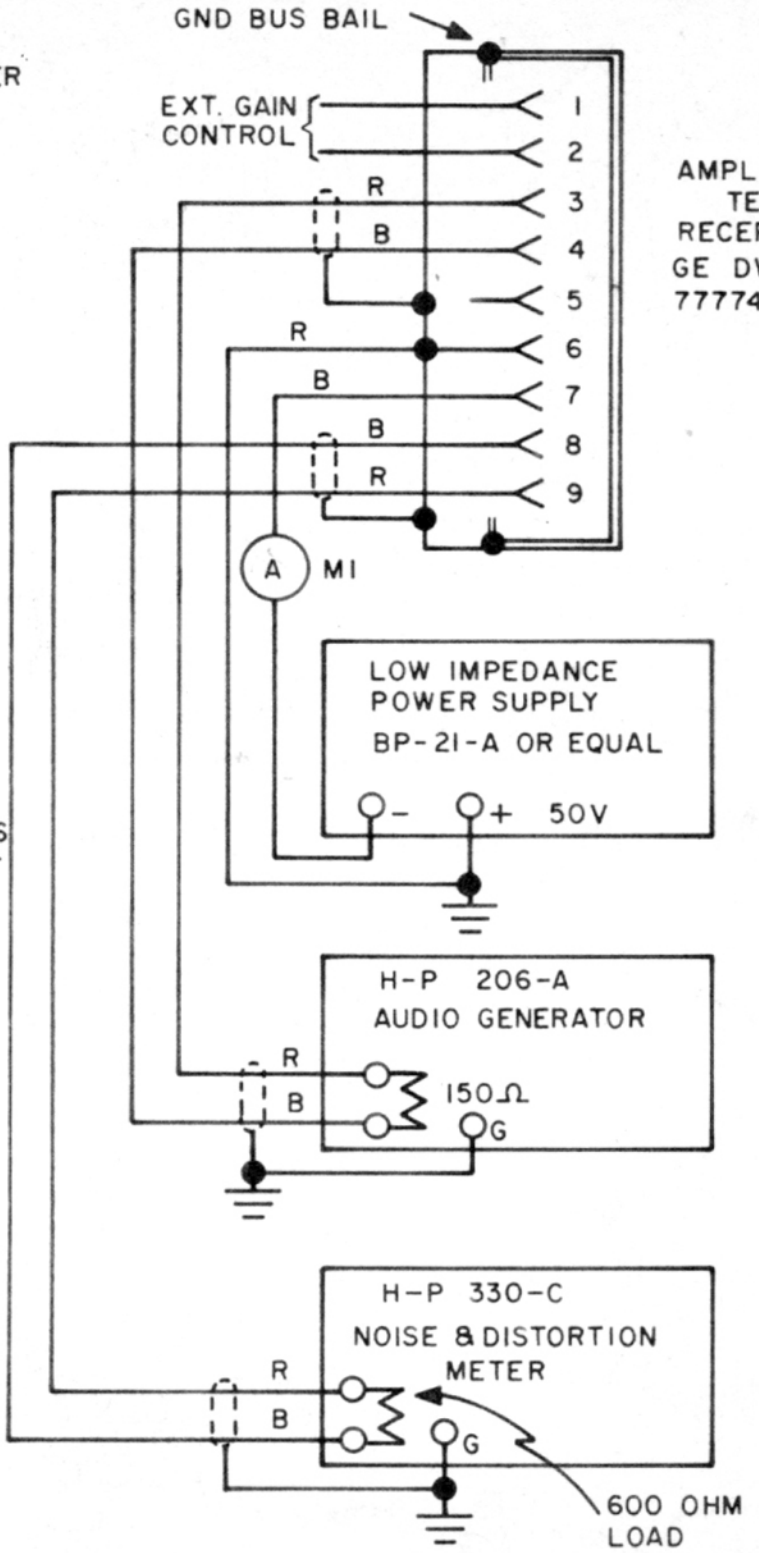
FIRST MADE FOR BC-31-A AUDIO CONSOLE

MI SHOULD BE A 0-250
OR 500 MA DC MILLIAMETER

AT MAX. OUTPUT
LEVEL (+30 DBM)
DC SHOULD BE
APPROX 160 MA.

BA-32-A GAIN
IS 75DB±2DB

TEST PROGRAM AMPLIFIERS
WITH BOTH INPUT & OUTPUT
TERMINATED




AMPLIFIER
TEST
RECEPTACLE
GE DWG #
7777466P3

2
725
C2

MADE BY R. E. Boyd 8/27/63
ISSUED November 25, '63

APPROVALS

T.P.O. DIV OR DEPT.
SYRACUSE LOCATION

7174863
CONT ON SHEET SH NO

14 13 12 11

K J I H G

MIC 1 MIC 2 MIC 3

STU 1 STU 2 STU 1 STU 2 STU 1 STU 2

S1 S2 S3

4D 3D 2D 1D 1B 2B 3B 4B

J1 J2 J3

2 1 3

1 2

MIXER KEY 1

PART OF BA21B
PREAMPLIFIER

AR-1

MIXER KEY 2

PART OF BA21B
# 2

AR-2

MIXER KEY 3

PART OF BA21B
# 3

AR-3

FOLD

11 | 10 | 9 | 8 | FOLD

MIC 4

STU 1 STU 2

S4

4D 3D 2D 1D 1B 2B 3B 4B

MIC 5

STU 1 STU 2

S5

4D 3D 2D 1D 1B 2B 3B 4B

ANNOUNCE MIC

C R MIC

S6

4D 3D 2D 1D 1B 2B 3B 4B

J4 2 1 3

J5 2 1 3

J6 2 1 3

1 2

MIXER KEY 4

PART OF BA21B #4

AR-4

1 2

MIXER KEY 5

PART OF BA21B #5

AR-5

1 2

MIXER KEY 6

PART OF BA21B #6

AR-6

24V DC RELAY PWR

+ — TB6-4 TB6-5

TB5 TB5

— + 68 66

Z1 CONTROL ROO

J18

37 2 1 9 10

CR1 36

39 3

40 4

Z2 ANNOUNC BOOTH

J19

2 1 9 10

ANNOUNCE I.C. AUDIO IN 3 4

Z3 STUDIC

CR6

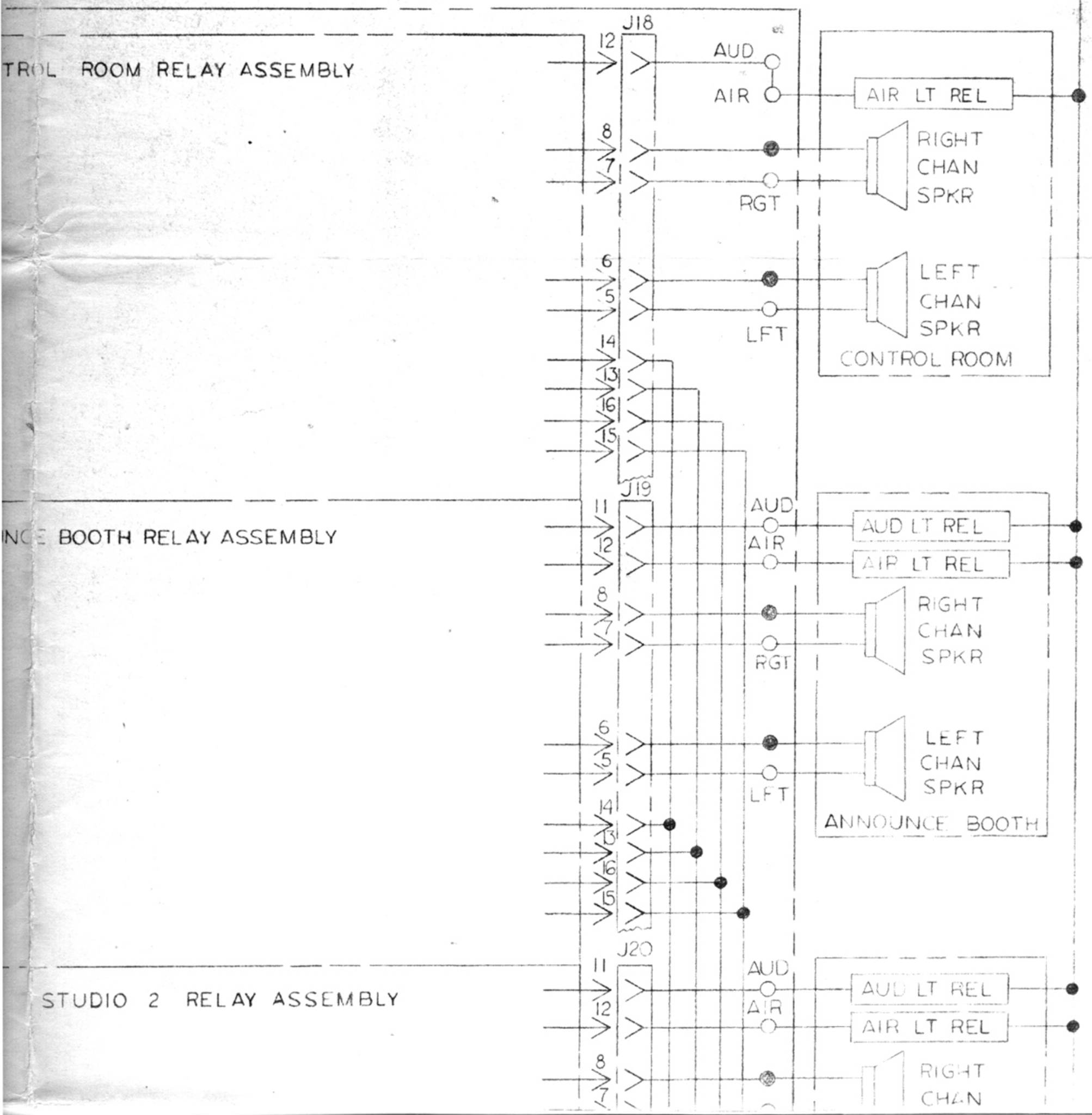
CR2 J20 2

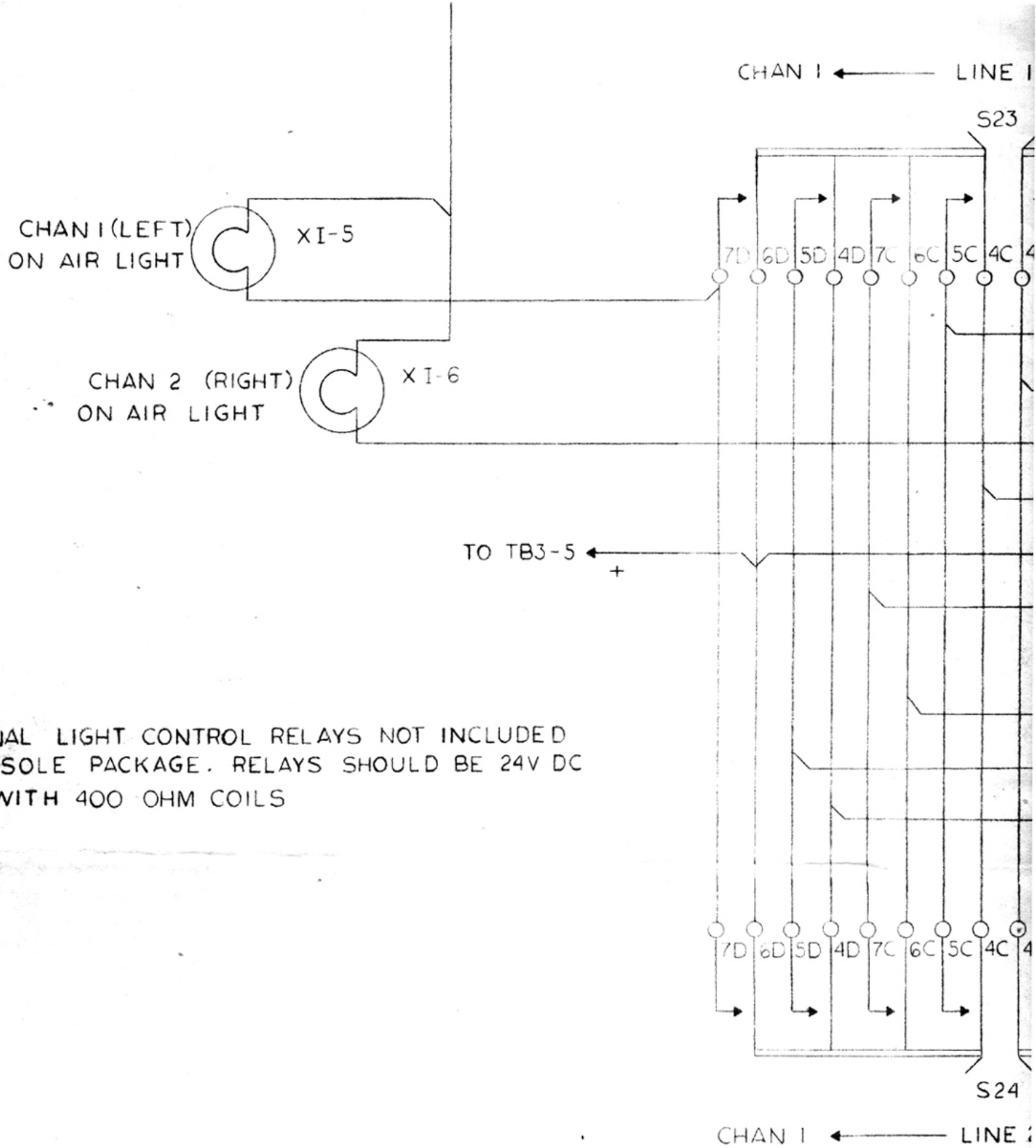
| REVISIONS | | | | |
|---|---|---|---|---|
| SYM | ZONE | DESCRIPTION | DATE | APPROVED |
| A | | REVISED | 11/13 | D.M. |
| B | | REVISED | 11/18 | REP |
| C | | REVISED | 11/26 | Final |

TROL ROOM RELAY ASSEMBLY

INC E BOOTH RELAY ASSEMBLY

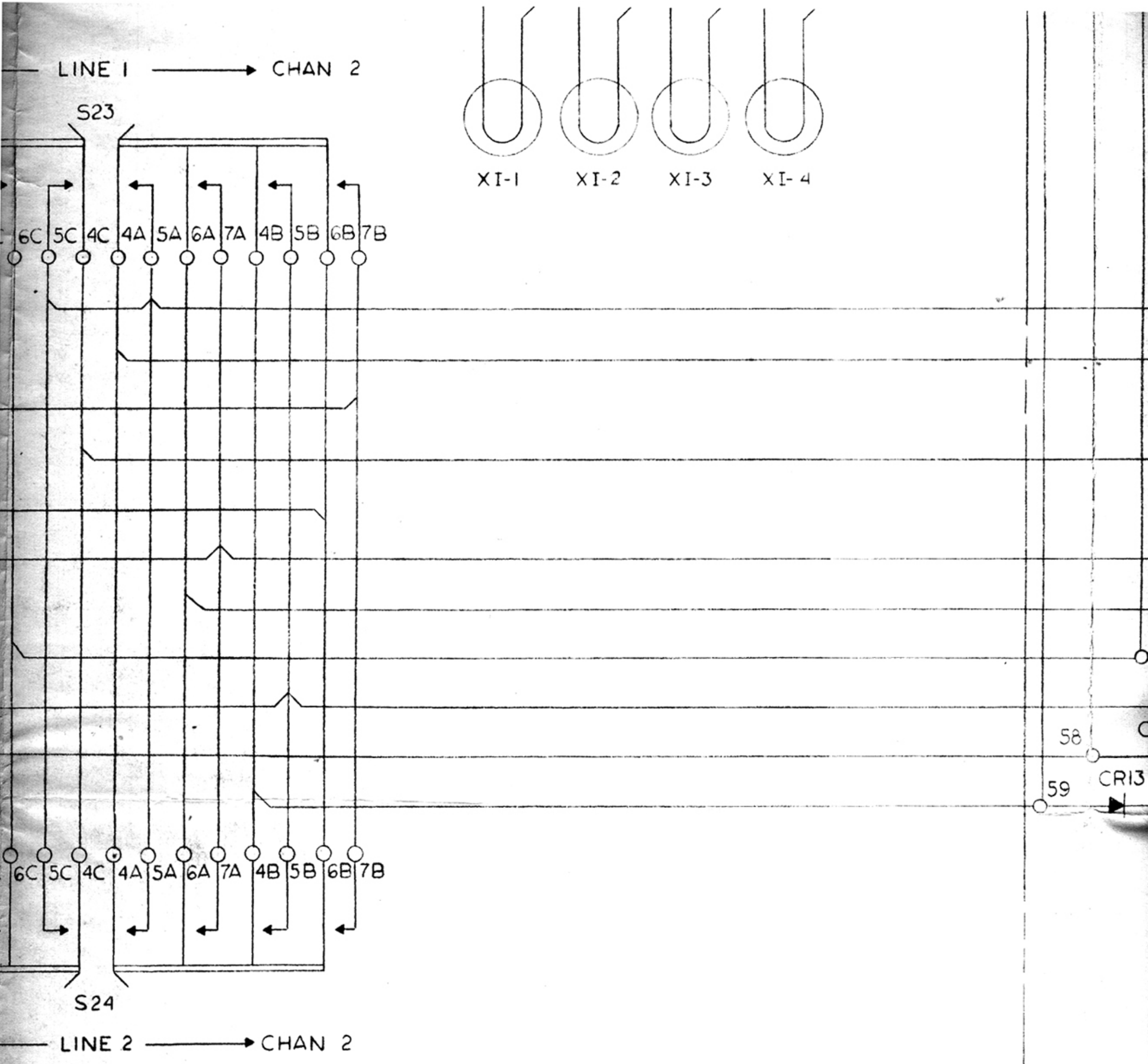
STUDIO 2 RELAY ASSEMBLY

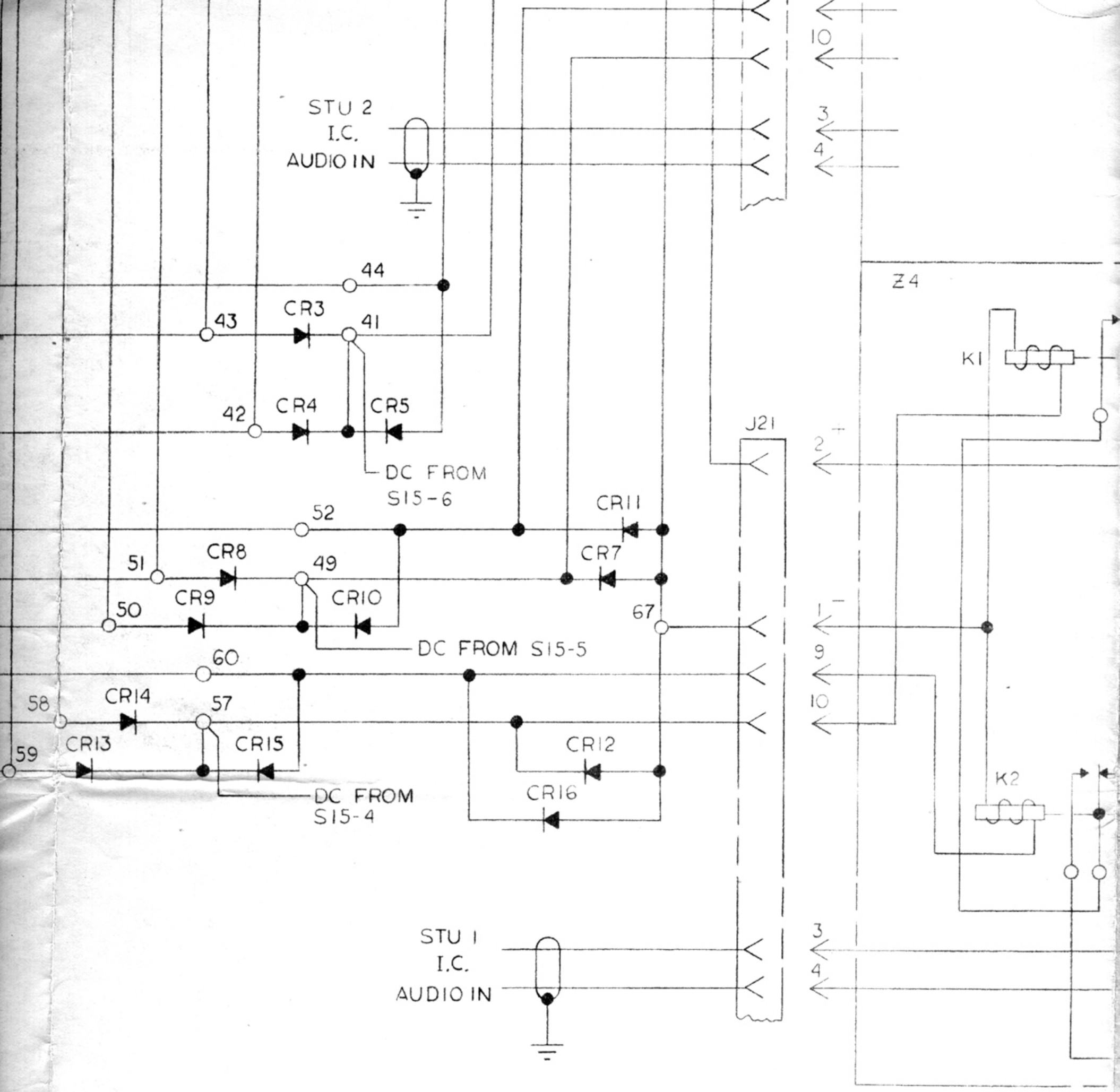




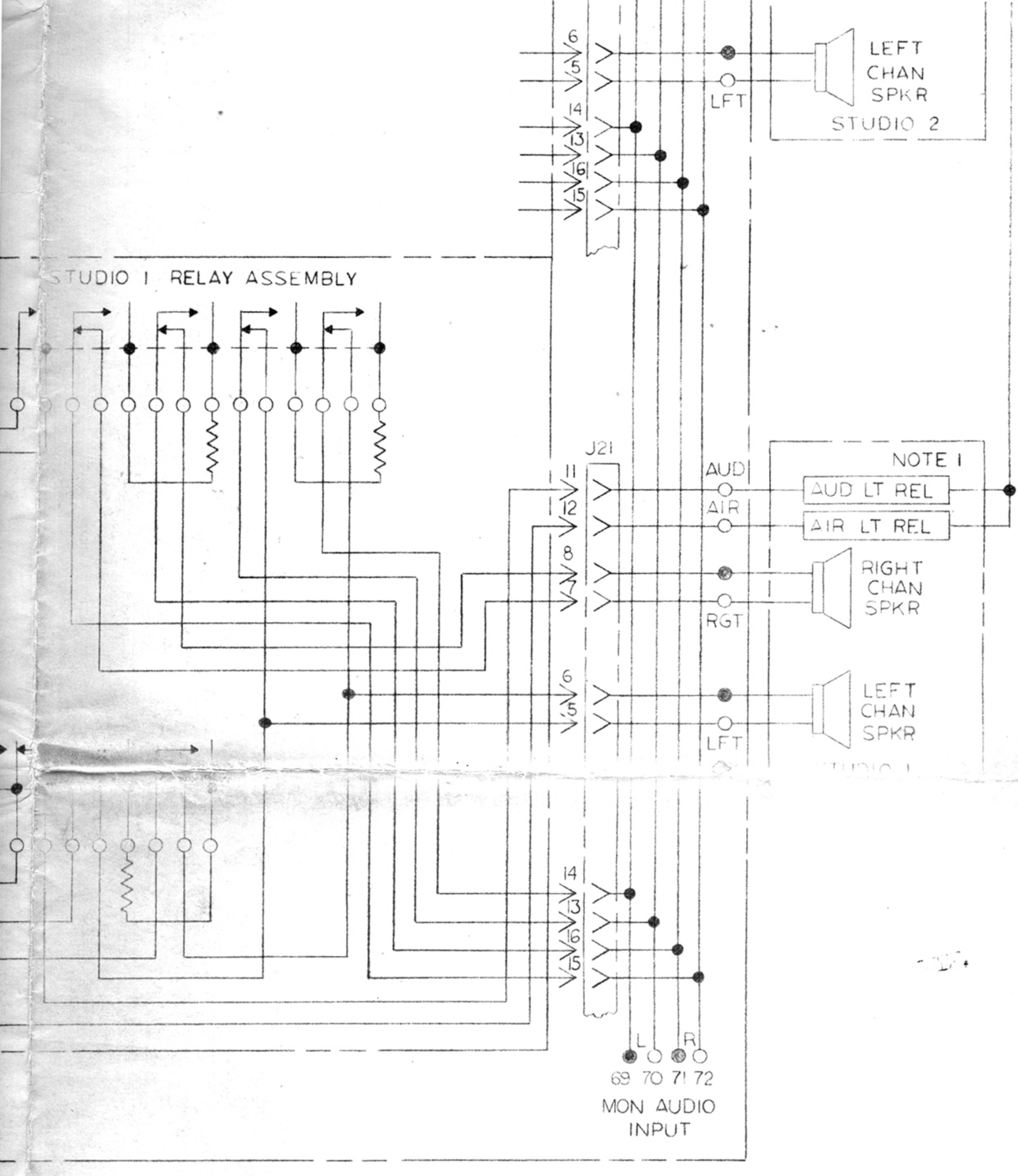

NOTES:

1. EXTERNAL LIGHT CONTROL RELAYS NOT INCLUDED IN CONSOLE PACKAGE. RELAYS SHOULD BE 24V DC TYPE WITH 400 OHM COILS


LINE 1
CHAN 2
S23
6C 5C 4C 4A 5A 6A 7A 4B 5B 6B 7B
XI-1
XI-2
XI-3
XI-4
58
59
CR13
6C 5C 4C 4A 5A 6A 7A 4B 5B 6B 7B
S24
LINE 2
CHAN 2




RELAY MOUNTING BOARD TB4




PRELIMINARY

| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES— TOLERANCES ON: 2-PLACE DECIMALS ± 3-PLACE DECIMALS ± ANGLES ± ALL SURFACES ✓ | SIGNATURES | DATE |
|---|---|---|
| MATERIAL — GOVT OR COML | DRAWN E. E. Boyd | 10/7/63 |
| GE | CHECKED | |
| | ISSUED | |
| | ENGRG | |
| | MFG | |
| | MATLS | |

GENERAL ELECTRIC
TPO DEPT SYRACUSE

TITLE DIAGRAM, WIRING
DC CONTROL
FMF-BC31-B AUDIO CONSOLE

CONTRACT NO.

| CODE IDENT NO. | SIZE | DWG NO |
|---|---|---|
| | E | 7355197 |

SCALE | WT CALC ACTUA. | SHEET 1 OF 1

REV | SIZE E 7355197 | E | D | SIZE E 7355197 | B | CIO7 | PRINTS TO

4 OLD | 3 | 2 | 1