Instructions

50-KW HIGH-CHANNEL TELEVISION AMPLIFIER

MODELS 4TF5A1, 2

EBI-3295

GENERAL ELECTRIC

INSTRUCTIONS

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MODELS 4TF5A1, 2

EBI-3295

INDUSTRIAL ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

5/57 (400)

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INSERTS

EBI-3310	Harmonic Filter, Model 4PY25F1
EBI-3389	Vestigial-Sideband Filter, PL-7776403-G1, -G2
GEC-972	Small-Motor Service Station Plan
GEF-3506	Renewal Parts, Type AK-1-15 and AK-1-25 Air Circuit Breakers
GEH-790	Horizontal Polyphase Induction Motors
GEH-1790	Instantaneous Current Relays, Type PJC
GEH-1807	Air Circuit Breakers, Types AK-1-15-3 and AK-1-25-3
Form 7674-F	Installation and Operating Instructions for Motor Pump Types JCS and GS Shaft Seal (Ingersoll-Rand Co.)
Form 7720-E	The Cameron Standard Duty Motorpump: Instructions for Installation and Operation and List of Parts (Ingersoll-Rand Co.).
ET-T1165	GL-6251, Description and Rating

SAFETY TO HUMAN LIFE

Personnel are protected from accidental contact with high voltages dangerous to human life by shielding, interlocks, and shorting switches. The cubicles are fitted with control circuit interlocks and high-voltage a-c and d-c shorting switches actuated by the rear access doors. The interlocks open the rectifier contactors, while one shorting switch connects the positive and negative terminals of the rectifier and the other shorts the three secondary terminals of the high-voltage transformer. Thus, double protection against contact with high-voltage circuits is afforded operating personnel.

While every practicable safety precaution has been incorporated in this equipment, the following rules should be strictly observed:

1. KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person be permitted to reach within, or in any manner gain access to, the cubicles with interlocked doors closed (or with power supply line switches to the equipment closed); or to approach or handle any portion of the equipment which is supplied with power; or to connect any apparatus external to the enclosure to circuits within the equipment; or to apply voltages to the equipment for testing purposes while any noninterlocked portion of the shielding or enclosure is removed or opened.

2. DO NOT SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

3. DO NOT TAMPER WITH INTERLOCKS. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with.

4. FIRST AID. Study first aid procedures in handling electrical shock.

CONTENTS

ILLUSTRATIONS

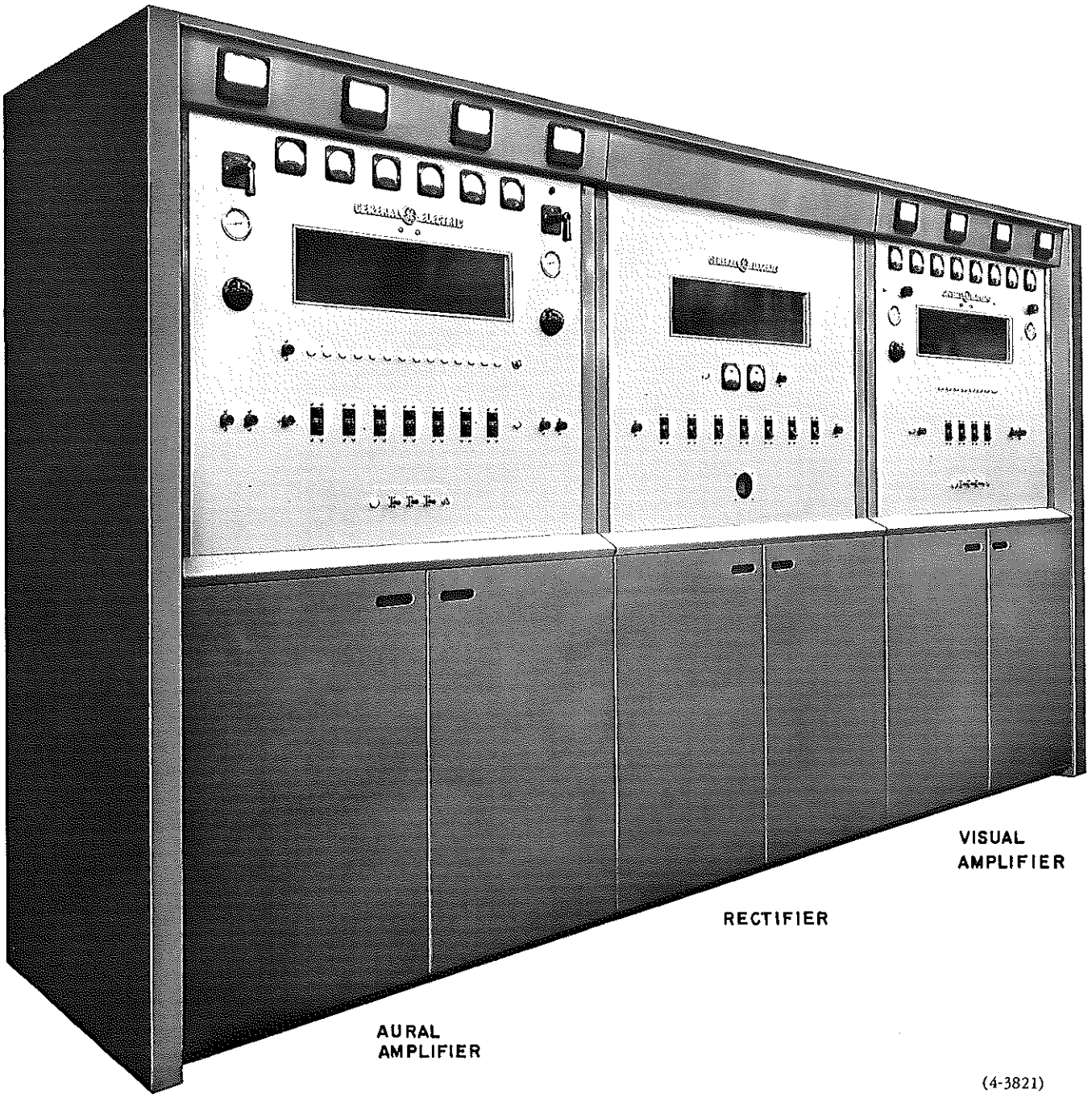


Fig. 1 Front View of 50-KW High-Channel Television Amplifier, Models 4TF5A1,2

INTRODUCTION

The General Electric 50-KW High-Channel Television Amplifier (Fig. 1), Models 4TF5A1,2, is an air- and water-cooled television amplifier designed to provide the broadcaster with modern equipment capable of high quality performance at low operating cost through amplification of the RF output of a 5-KW television transmitter to 50 KW. The Amplifier will supply a 50-KW synchronizing peak television visual signal and a 26.6-KW television aural frequency-modulated signal in any one of the high-channel VHF television channels 7 through 13 when driven by a transmitter normally rated at an output of 5 KW.

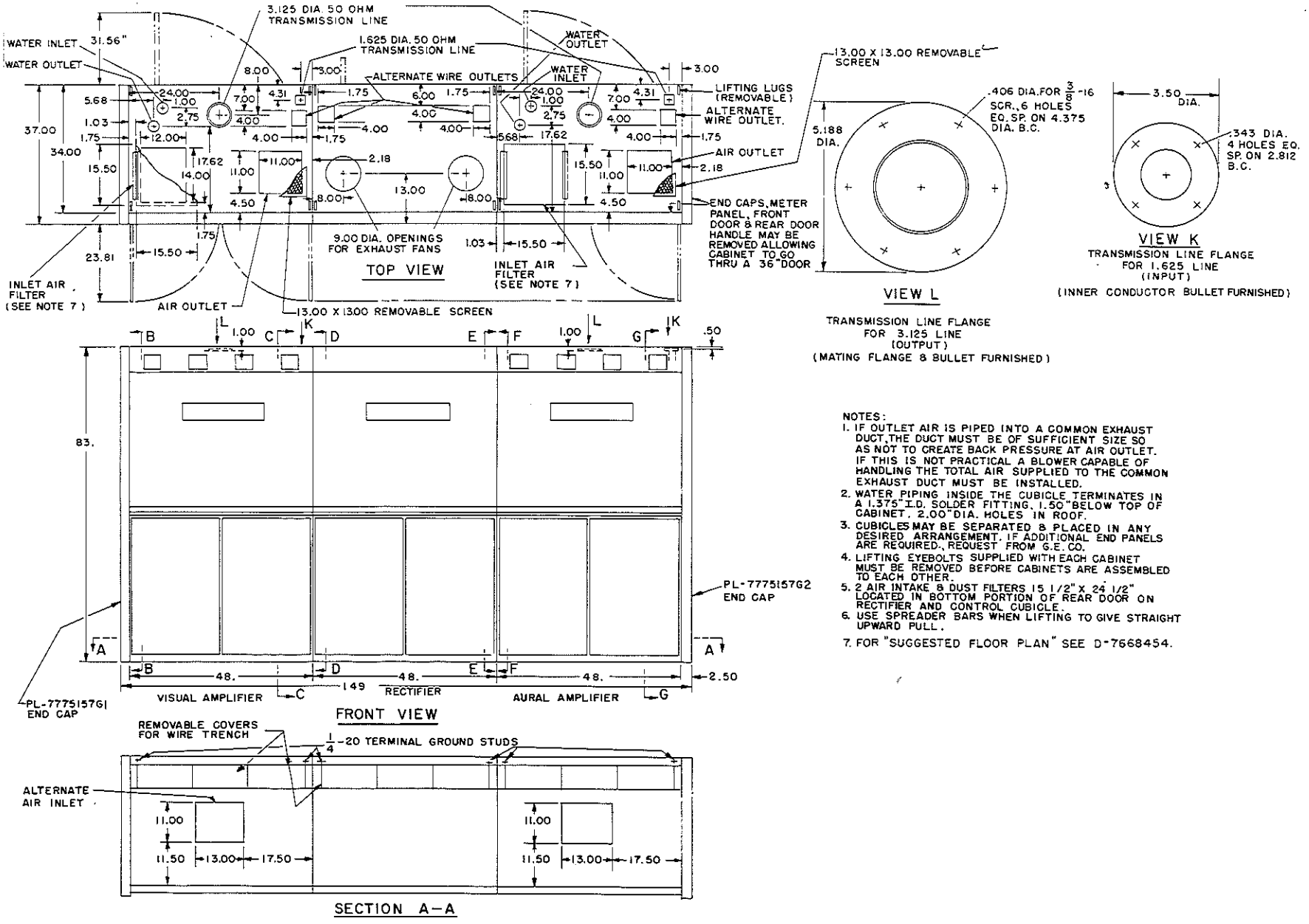
The Type TF-5-A Amplifier when used with the General Electric Type TT-6-E 5-KW Television Transmitter becomes the Type TT-26-A 50-KW Transmitter. The Type TF-5-A Amplifier when used with the General Electric Type TT-32-B Television Transmitter becomes the Type TT-36-A 50-KW Transmitter.

It is the purpose of this instruction book to provide detailed information concerning the circuits employed, the method for their adjustment, and the maintenance procedures to be followed so that long and satisfactory service can be had from the equipment.

TECHNICAL SUMMARY

ELECTRICAL

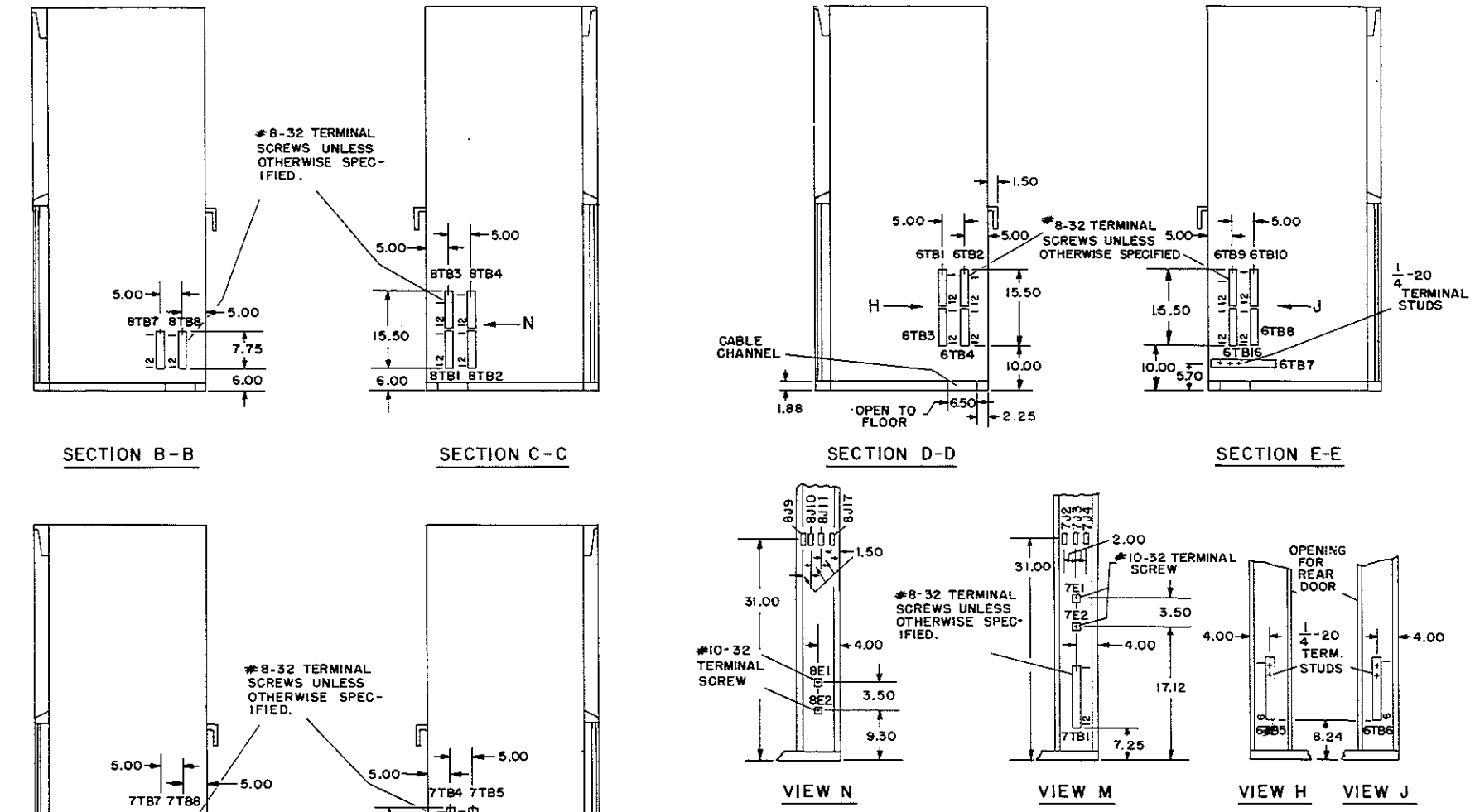
	Aural Amplifier	Visual Amplifier
Type of Emission:	FM	AM
Frequency Range:	(Carrier Freq.)	(Carrier Freq.)
Channel 7	179.75	175.25
Channel 8	185.75	181.25
Channel 9	191.75	187.25
Channel 10	197.75	193.25
Channel 11	203.75	199.25
Channel 12	209.75	205.25
Channel 13	215.75	211.25
Power Output:	26.6-KW maximum (14.249 dbk)	50-KW maximum peak (16.99 dbk)
Input Impedance:	50.0 ohms with VSWR of 1.2 to 1 or less. (1-5/8" rigid line)	50.0 ohms with VSWR of 1.1 to 1 or less at the center frequency. (1-5/8" rigid line)
Load Impedance Required:	50.0 ohms with VSWR of 1.75 to 1 or less. (3-1/8" rigid line)	50.0 ohms with VSWR of 1.1 to 1 or less. (3-1/8" rigid line)
RF Power Requirements:	Approx. 2.5 KW for full output	Approx. 5.0 KW peak for full output
Lower-Sideband Attenuation:		More than -20 db with the 200-kc sideband as a reference for a modulating frequency greater than 1.25 mc and more than -42 db for a modulating frequency of 3.58 mc when the exciter is a General Electric Type TT-6-D or TT-6-E Transmitter or equivalent
Upper-Sideband Attenuation:		Determined by the characteristic of the driving transmitter



NOTES:
1. IF OUTLET AIR IS PIPED INTO A COMMON EXHAUST DUCT, THE DUCT MUST BE OF SUFFICIENT SIZE SO AS NOT TO CREATE BACK PRESSURE AT AIR OUTLET. IF THIS IS NOT PRACTICAL A BLOWER CAPABLE OF HANDLING THE TOTAL AIR SUPPLIED TO THE COMMON EXHAUST DUCT MUST BE INSTALLED.
2. WATER PIPING INSIDE THE CUBICLE TERMINATES IN A 1.375" I.D. SOLDER FITTING, 1.50" BELOW TOP OF CABINET. 2.00" DIA. HOLES IN ROOF.
3. CUBICLES MAY BE SEPARATED & PLACED IN ANY DESIRED ARRANGEMENT. IF ADDITIONAL END PANELS ARE REQUIRED., REQUEST FROM G.E. CO.
4. LIFTING EYEBOLTS SUPPLIED WITH EACH CABINET MUST BE REMOVED BEFORE CABINETS ARE ASSEMBLED TO EACH OTHER.
5. 2 AIR INTAKE & DUST FILTERS 15 1/2" X 24 1/2" LOCATED IN BOTTOM PORTION OF REAR DOOR ON RECTIFIER AND CONTROL CUBICLE.
6. USE SPREADER BARS WHEN LIFTING TO GIVE STRAIGHT UPWARD PULL.
7. FOR "SUGGESTED FLOOR PLAN" SEE D-7668454.

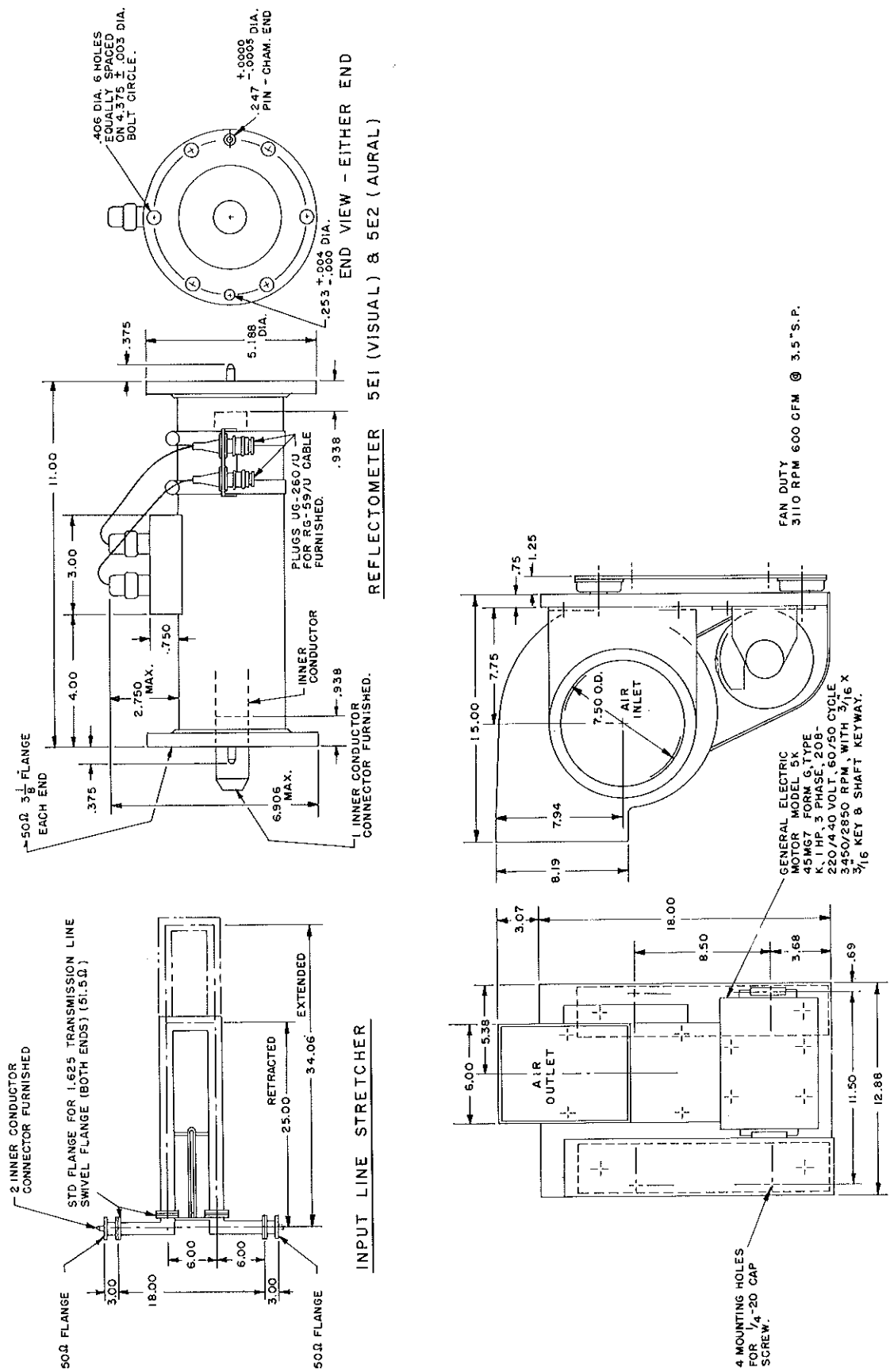
(C-7775337, Sheet 1, Rev. 2)

Fig. 2 Outline Drawing: Over-all Physical Dimensions



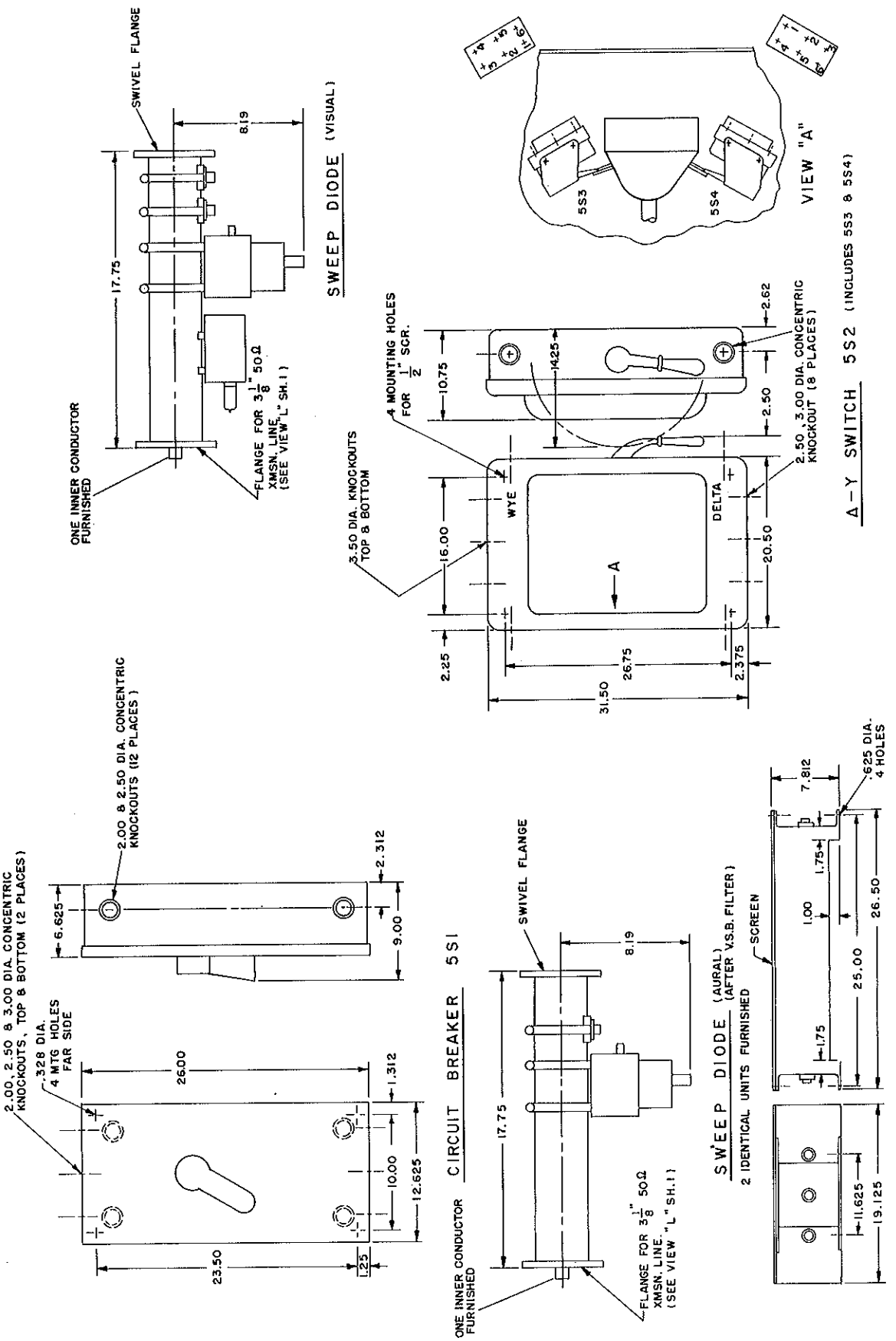
(C-7775337, Sheet 2)

Fig. 3 Outline Drawing: Terminal Board Locations



(C-7775337, Sheet 3, Rev. 1)

Fig. 4 Outline Drawing: Input Line Stretcher, Reflectometer, Motor and Blower



(C-7775337, Sheet 4)

Fig. 5 Outline Drawing: Circuit Breaker (5S1), Sweep Diodes, Resistor Box, Delta-Wye Switch

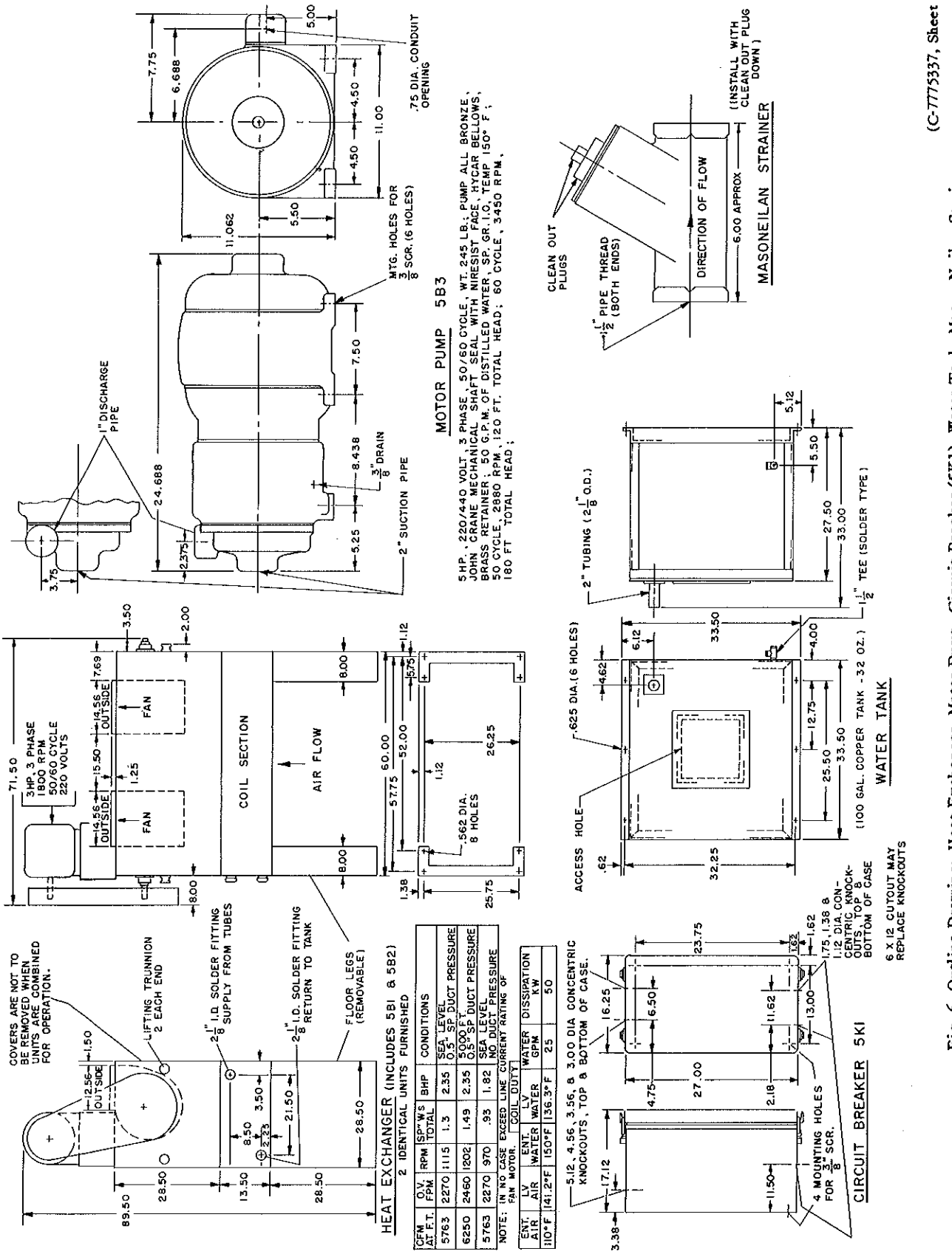


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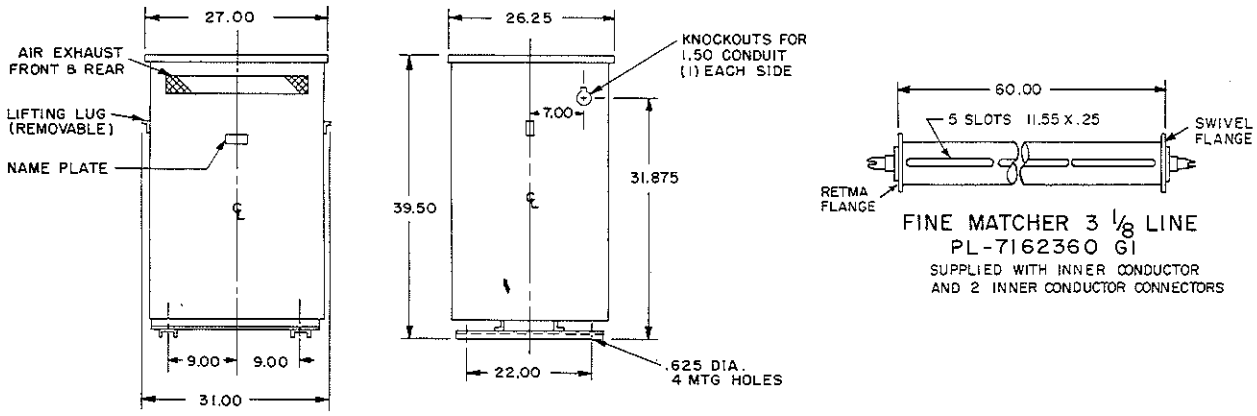
Fig. 6 Outline Drawing: Heat Exchanger, Motor Pump, Circuit Breaker (5K1), Water Tank, Mason-Neilon Strainer



REACTORS 5L7 & 5L8

(2 MECHANICALLY IDENTICAL UNITS FURNISHED)

FINE MATCHER 3 1/8 LINE
PL-7162360 G1
SUPPLIED WITH INNER CONDUCTOR AND 2 INNER CONDUCTOR CONNECTORS

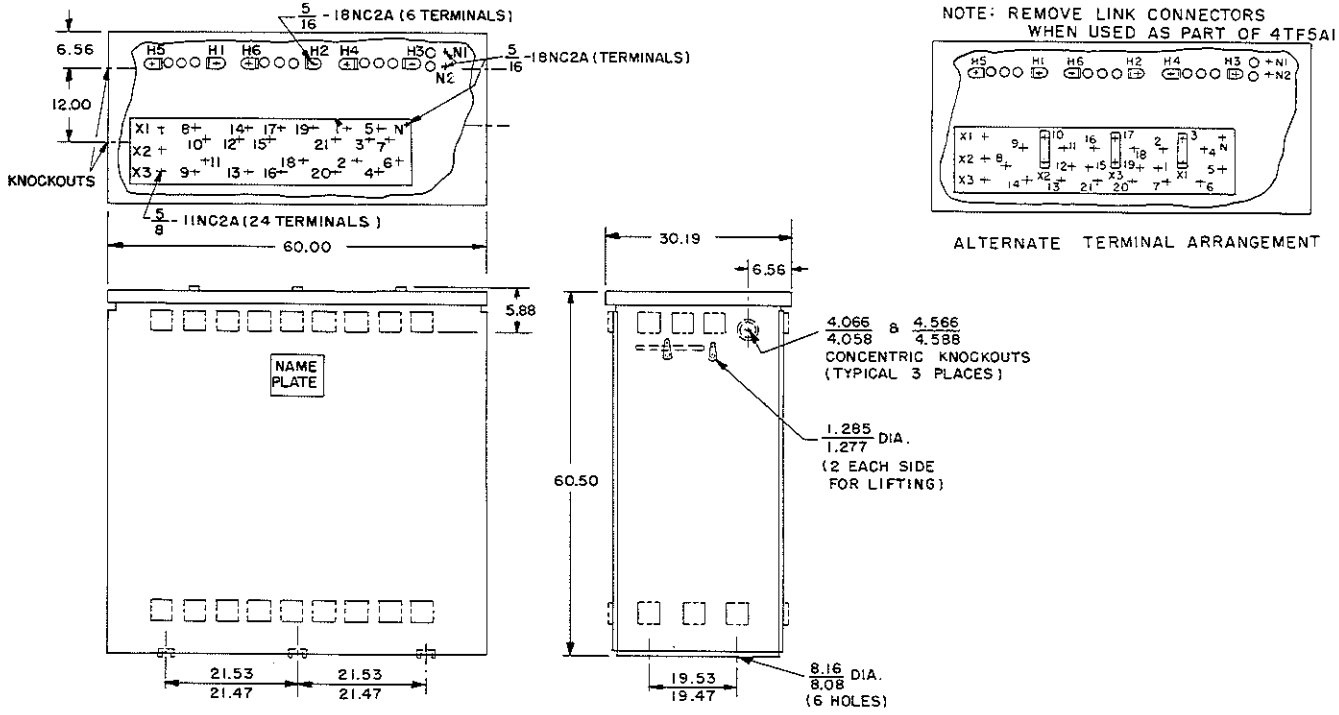


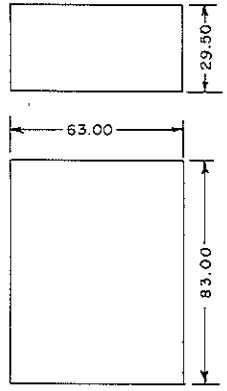
PLATE TRANSFORMER 5T1

WT 2400

SEE ALTERNATE VIEW OF 5T1

NOTE: REMOVE LINK CONNECTORS WHEN USED AS PART OF 4TF5A1

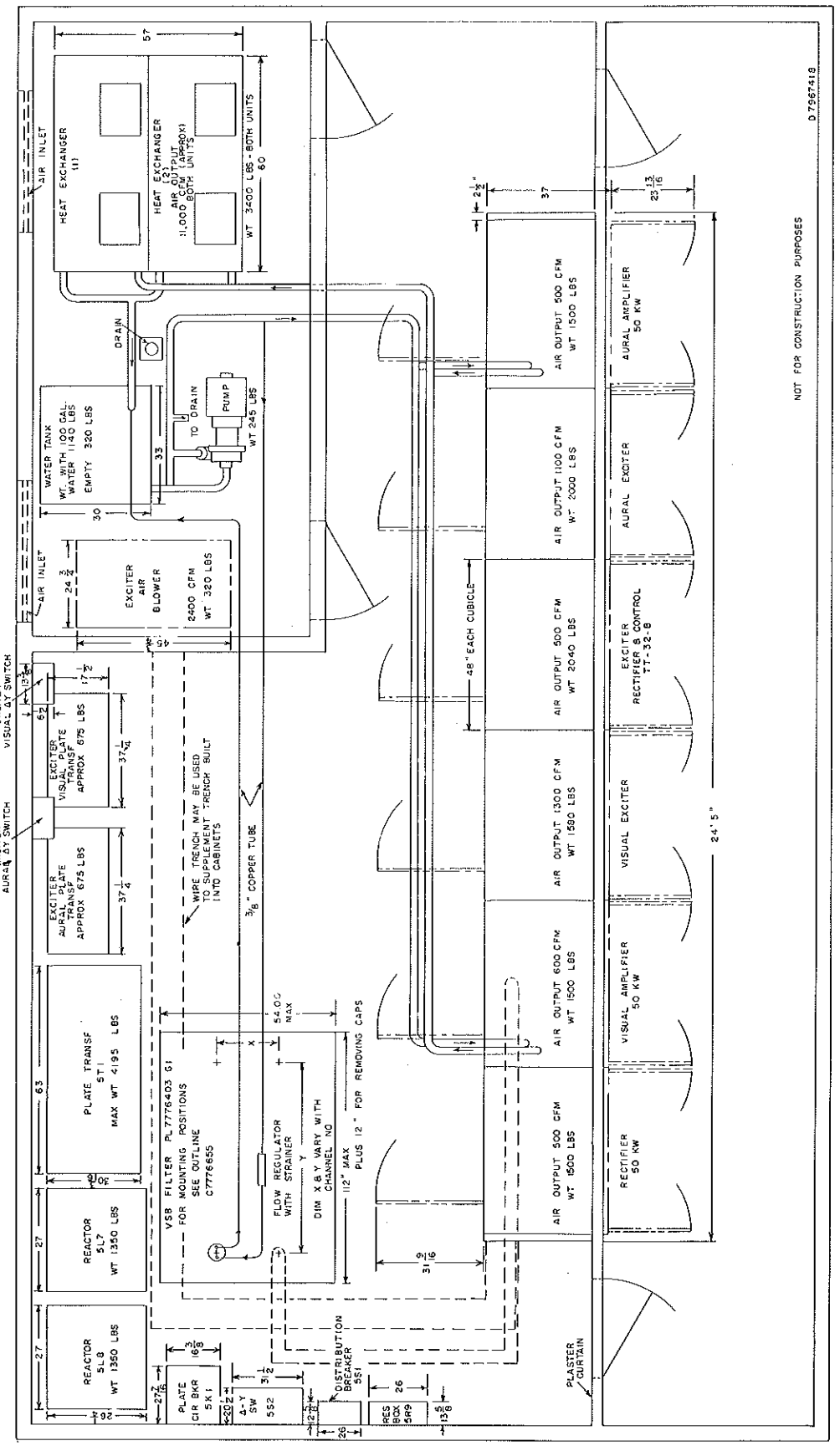
ALTERNATE TERMINAL ARRANGEMENT



ALTERNATE VIEW OF 5T1 AS SUPPLIED BY MOLONEY TRANSFORMER CO APPROX WT 4175

(C-7775337, Sheet 6, Rev. 3)

Fig. 7 Outline Drawing: Reactors, Plate Transformer, Fine Matcher



(D-7967418, Rev. 3)

Fig. 8 Suggested Station Layout, TT-32-B Driver

	Aural Amplifier	Visual Amplifier
Noise Level:		
AM Noise (RMS):	50 db (below carrier)*	40 db (below sync peak)*
Visual Output Variation:		Less than 5% of the average of the peak signal amplitude*
Harmonic Output:	The harmonic output from this equipment is attenuated more than 60 db at all harmonic frequencies	
Power Requirements:		
Line Voltage –	208/230 volts ± 5%	
Phase –	3	
Frequency –	60 cps (50 cps available on special order).	
Power Consumption –	Approximately 156 KW at black level	
Power Factor –	90%	
Convenience Outlets and Cabinet Lights –	117 volts, 50/60-cycle, single-phase	

TUBE COMPLEMENT

	Aural Amplifier	Visual Amplifier	Rectifier
RF Power Amplifier	2 Type GL-6251	2 Type GL-6251	
Screen Grid Supplies		4 Type 6AS7-G 1 Type 12AU7 1 Type 6AK5 3 Type GL-OC3/VR105	4 Type GL-8008
Sweep Generator	1 Type GL-832-A 1 Type 6BK7 2 Type 6U8	1 Type GL-832-A 1 Type 6BK7 2 Type 6U8	
Sweep Generator Power Supply	1 Type 5R4GY		
Reflectometer Amplifier	1 Type 6SN7-GT		
High-Voltage Rectifier			6 Type GL-869B
Arc-Back Indicator			6 Type 5823

External Equipment: Peak Reading Diode - 1 Type 6AL5

MECHANICAL

Refer to Figs. 2 through 7.

EQUIPMENT

The General Electric 50-KW High-Channel Television Amplifier, discussed in this instruction book and identified by the Model Numbers 4TF5A1,2, consists of the following items which are furnished:

Item	Quantity	Designation
Visual Cubicle	1	PL-7353376G1 (Cubicle 8)
Rectifier Cubicle	1	PL-7353375G1 (Cubicle 6)
Aural Cubicle	1	PL-7353377G1 (Cubicle 7)
Electronic Tubes	1 set	PLA-7142778G1
Heat Exchangers	2	C-7774270P1
Water Tank	1	C-7774662P1
Plate Transformer	1	B-7487257P1
Visual Reactor	1	B-7487258P1
Aural Reactor	1	B-7487258P1

* When the driving transmitter betters this by a reasonable margin.

Item	Quantity	Designation
Solenoid Closing Circuit Breaker	1	C-7773783P2
Motorpump * (Water Pump)	1	B-7487967P1
Sweep Diode Assembly (Visual)	1	A-7145086G2
Sweep Diode Assembly (Visual)	1	A-7145085G1
Sweep Diode Assembly (Aural)	1	PLA-7145086G1
Adapters (1-5/8 inch 50-ohm to 1-5/8 inch 51.5-ohm)	2	A-7145080G1
Connector	2	A-7144652P1
Reflectometer (1 for Visual and 1 for Aural)	2	PL-7488443G1
Resistor Box	1	A-7143544G1
Strainer	1	Mason-Neilon Strainer, Brass, 1-1/2 IPS
Line Stretcher, 1-5/8 inch	1	PL-7774758G1
Delta-Wye Switch	1	B-7486898G1
Harmonic Filter	2	4PY25F1
Vestigial-Sideband Filter	1	PL-7776403-G1
Circuit Breaker	1	C-7775284P1
Accessories	1 set	MLK-7134491G1

DESCRIPTION

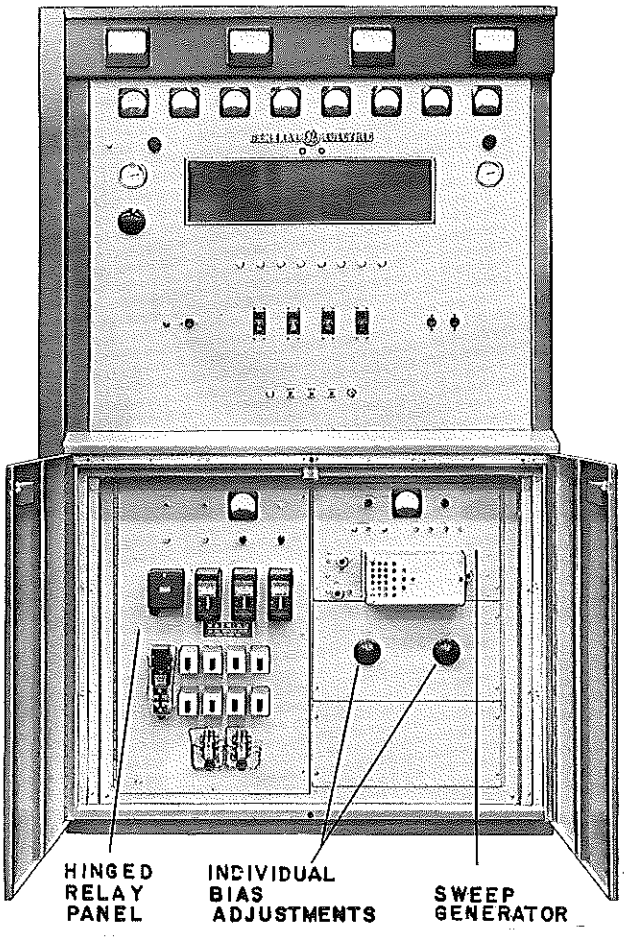


Fig. 9 Front View of Visual Amplifier Cubicle with Access Doors Open

CONSTRUCTION

The General Electric 50-KW High-Channel Television Amplifier, Models 4TF5A1,2, consists of three cubicles and the external equipment listed in this book under EQUIPMENT.

The cubicles may be placed in any physical relationship to each other or to the driving transmitter; however, it is advisable to keep the Visual Amplifier reasonably close to the Visual driver. Two or more cubicles can be bolted together in a line. Two removable end caps are provided for the end cubicles of a series. The upper front panels of the cubicles on which the frequently used controls, meters, supervisory lights, and viewing windows are located are exposed for easy accessibility. The lower front panels are recessed behind access doors. On these panels are mounted the sweep generators, the low-voltage supply for the sweep generators, BIAS and CATHODE BALANCE adjustments for the Amplifiers, and the control circuit relays. The control circuit relays are mounted on hinged panels so that access may be had to either side of the telephone-type relays mounted on them. These hinged panels are interlocked to remove high voltage if the panels are opened. Contactors carrying 230 volts are located within the cubicle for safety.

A recessed kick cove is provided along the front of each cubicle to prevent scuffing of the finish. Convenience outlets and a switch to turn on the interior lighting of the cabinet are provided on the rear of each cubicle. Convenience outlets and a switch for the interior lighting of the cabinet are also supplied inside

* Registered U. S. Patent Office

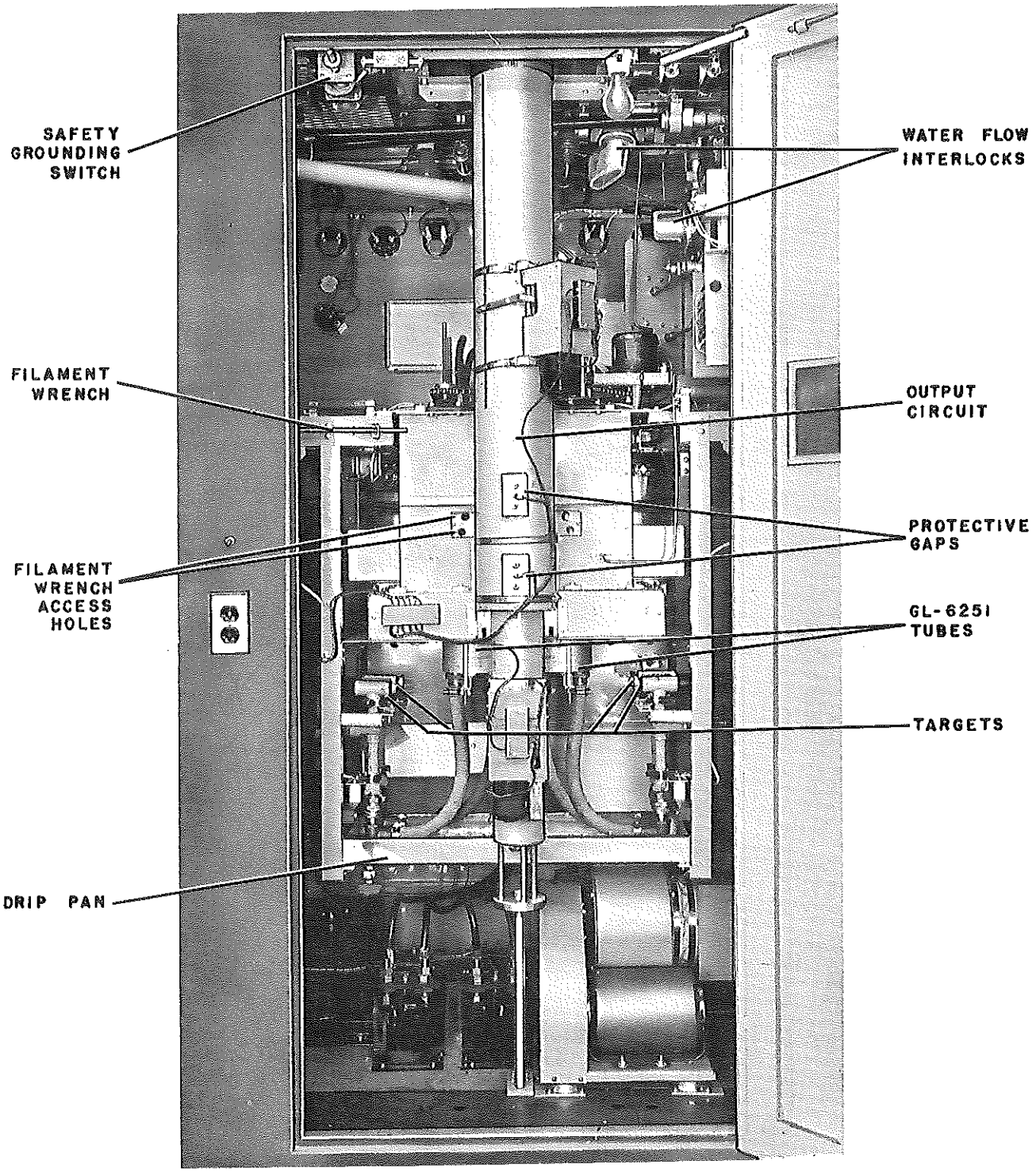


Fig. 10 Rear View of Visual Amplifier Cubicle

the front access doors of the Visual and Aural cubicles. A wiring trench is provided in the rear of each cubicle for intercubicle wiring. On the top rear left-hand corner of the Visual and Aural cubicles and the top rear right- and left-hand corners of the Rectifier cubicle there are provided cover plates which may be removed to allow for connection of a standard 4-inch square wiring duct for running the external wiring to the three cubicles from the top of the cubicle if desired.

VISUAL AMPLIFIER

See Figs. 9 through 12.

The Visual Amplifier consists of an RF power amplifier, a screen regulator, a selenium rectifier bias supply, a sweep generator, and the associated control equipment. The radio-frequency amplifier utilizes two General Electric Type GL-6251 tetrodes which operate in a grounded-grid or grid-separation circuit. In normal operation, plate tuning, the output circuit tuning, and the output circuit loading are adjustable. The input circuit consists of suitable matching to obtain approximate termination of the 50-ohm input transmission line at the center of the band of frequencies used. The two controls for adjusting the matching of the input circuit are available on the front panel for adjustment but are locked for normal operation.

The Vestigial-Sideband Filter is a constant-impedance device which is mounted externally to the Visual Amplifier cubicle.

The screen regulator is an electronically regulated power supply.

The bias supply is a selenium rectifier heavily loaded, so that the bias voltage does not vary appreciably with the grid current.

The sweep generator provides a constant RF voltage swept over a wide frequency range for use in adjusting the bandwidth of the radio-frequency power amplifier. It is also useful in checking antenna and transmission-line performance.

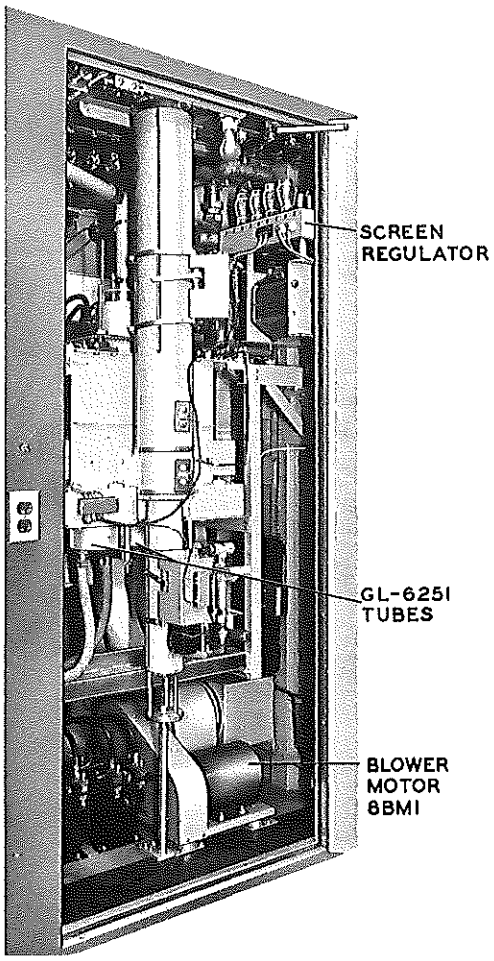


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Fig. 11 Rear and Right Wall View of Visual Amplifier Cubicle

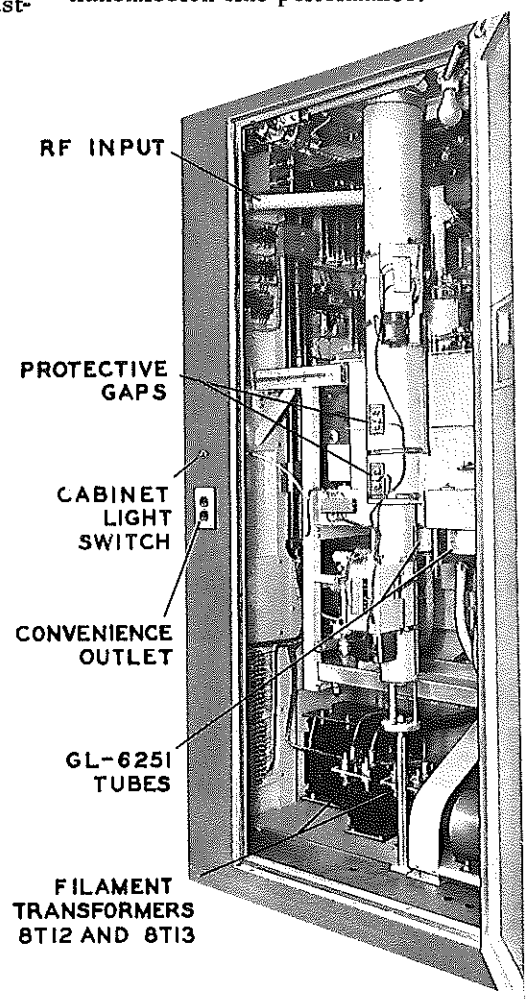

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Fig. 12 Rear and Left Wall View of Visual Amplifier Cubicle

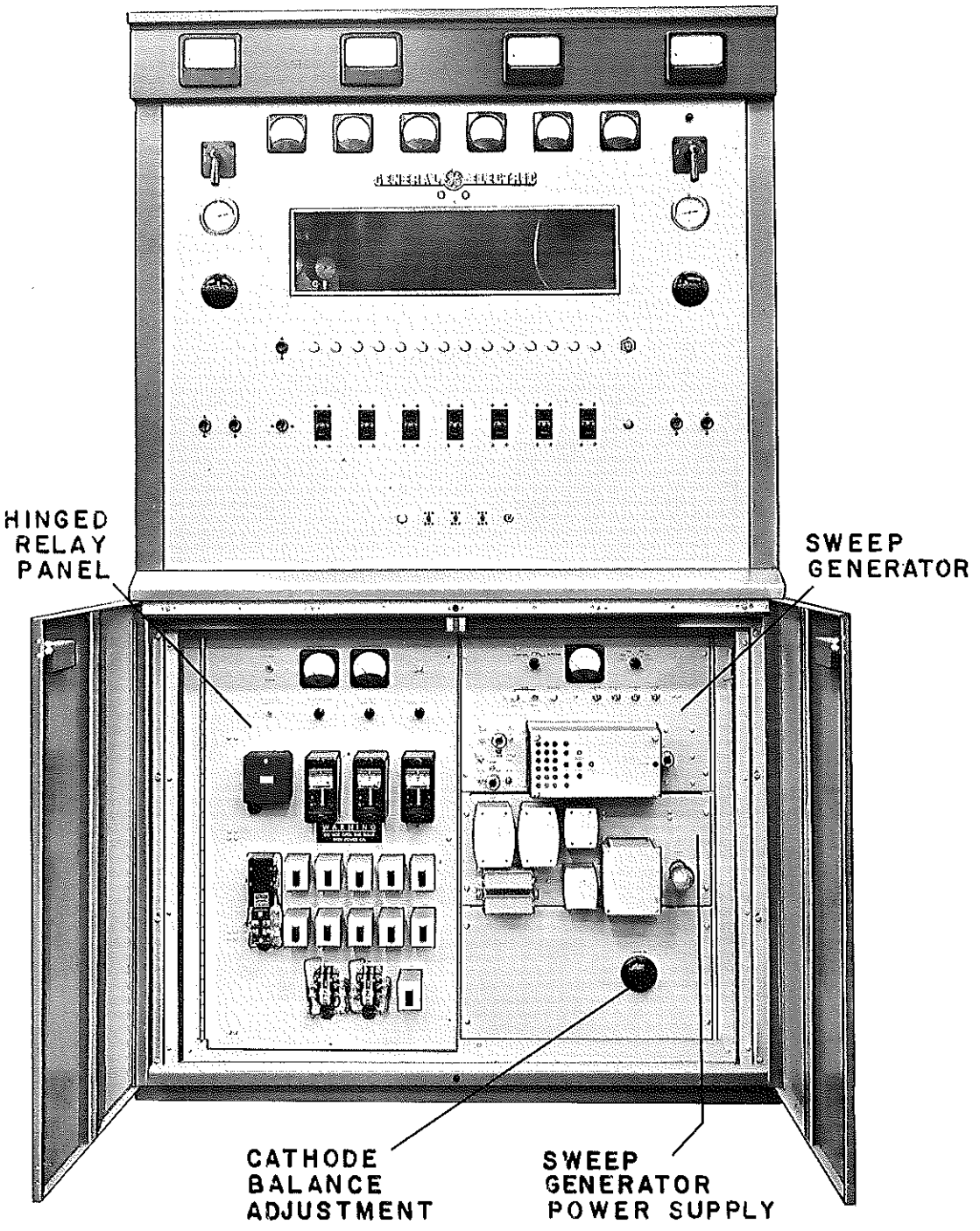

Fig. 13 Front View of Aural Amplifier Cubicle with Access Doors Open

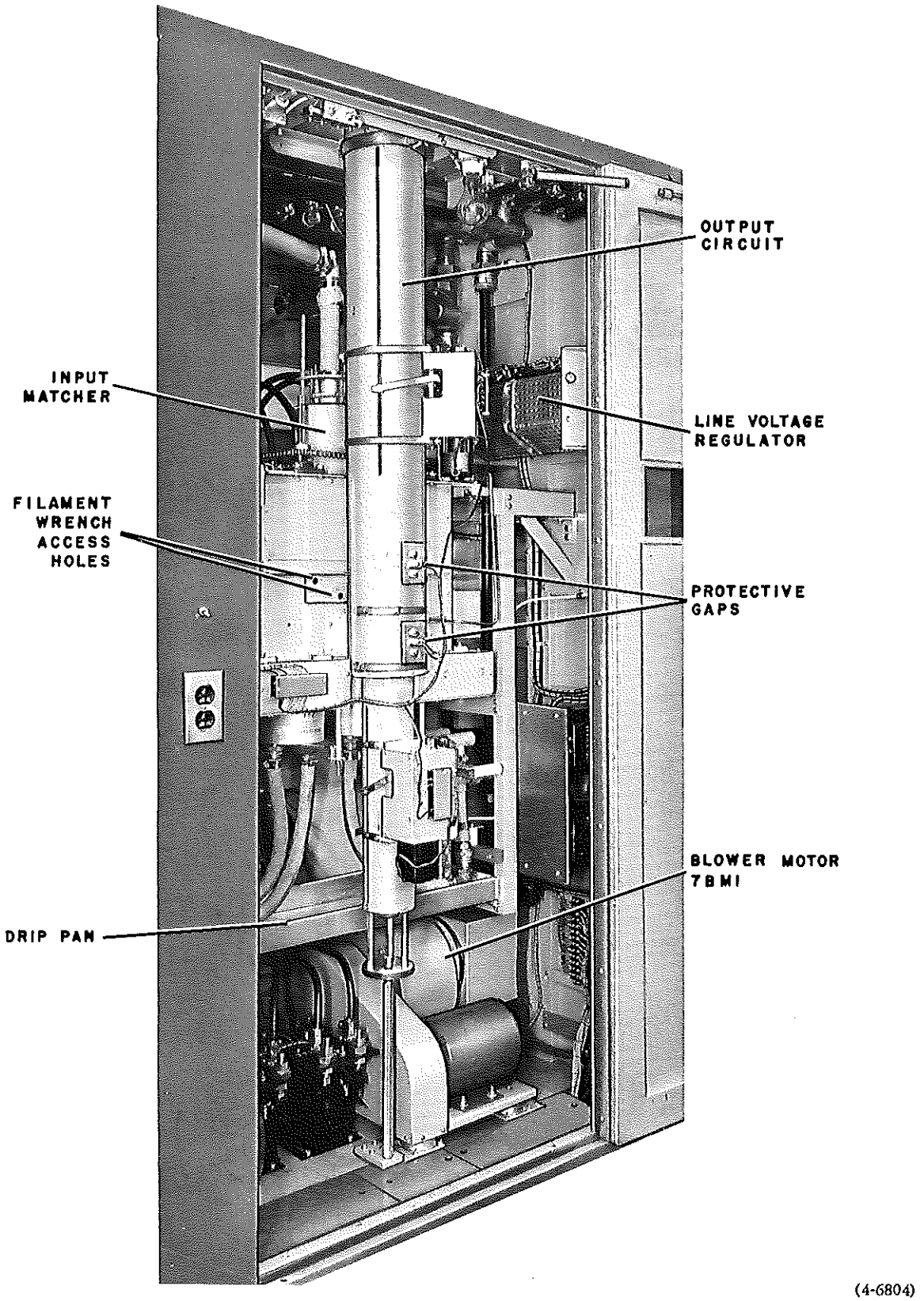

Fig. 14 Rear and Right Wall View of Aural Amplifier Cubicle

The high-voltage rectifier supplying the screen regulator is located in the Rectifier cubicle.

AURAL AMPLIFIER

See Figs. 13 through 15.

The Aural Amplifier consists of the input matching circuit, the Amplifier proper, a sweep generator, and the associated power supplies and controls.

The Amplifier circuit is fundamentally identical to that of the Visual Amplifier.

The input circuit is the same as that of the Visual Amplifier.

The Aural screen grid supply is located in the Rectifier cubicle.

The control grid protective bias supply is located in the Aural Amplifier cubicle.

The reflectometer amplifier operates in conjunction with the Aural reflectometer to remove both Aural and Visual power in the event of an antenna or transmission-line fault which increases the VSWR on the transmission line.

The Aural Amplifier Sweep Generator is supplied to facilitate output tuning and loading so that the optimum load impedance will be presented to the Amplifier tubes.

CONTROL SYSTEM

See Figs. 16 through 19.

The several functions of the control system include those of starting and stopping the Amplifier conveniently, properly maintaining the starting sequence, protecting the equipment from self-destruction, and protecting station personnel from accidental contact with the high-voltage circuits. The rear access doors are equipped with interlocks which remove the primary power from the rectifier transformer when the doors are opened. In addition, these doors actuate switches which mechanically ground the high-voltage a-c and d-c buses (see Fig. 20.) The relay panels are also interlocked.

Quick acting d-c overload relays and magnetically operated a-c switches protect the equipment against electrical overload. In case of a plate circuit overload, two plate reclosures will automatically occur before lockout. In addition, the Amplifier will recycle for power-line failures of less than two seconds.

AC protection is afforded the Rectifier by the use of an air circuit breaker, electrically operated, which serves as the primary contactor for the Rectifier. The breaker provides over-load protection of three types: (1) long time, which protects against sustained overloads but has sufficient inverse-time characteristic in order not to trip on transformer inrush currents; (2) short time, which will trip in 8 cycles at currents greater than five times rated (this reinforces the Rectifier d-c short-circuit protection); and (3) instantaneous, which will trip in less than 2 cycles for currents exceeding 15 times the breaker rating, thus providing protection against accidental short circuits or rectifier transformer failure. The electrical trip, actuated by the fast d-c overload relays, will clear the breaker in a maximum of two cycles. The breaker also has undervoltage protection. AC protection is furnished for the units mounted in cubicles by a disconnect switch mounted externally. The maximum short-circuit current that may be caused by a short circuit in the cubicles is limited by a resistance box mounted externally.

Although both Visual and Aural Amplifiers operate from a common high-voltage rectifier, d-c switches permit operation of either as desired. The Aural Amplifier can be operated with the rear door of the Visual Amplifier cubicle open; conversely, the Visual Amplifier can be operated with the rear door of the Aural Amplifier cubicle open. This allows tube replacement and minor servicing to be done on one section while the other is being operated. For a detailed discussion of the control system, see THEORY AND CIRCUIT ANALYSIS, CONTROL CIRCUITS section.

COOLING SYSTEM

Forced air is used for tube seal and cubicle cooling. Internal blowers are provided for seal and cubicle cooling in the Visual and Aural Amplifier cubicles. The customer may remove these blowers and mount them externally if it is desired to minimize air noise. See Fig. 8 for the alternate mounting of these blowers and for drawings of the extra duct work required.

The anodes of the Amplifier tubes are cooled by water. The circulating pump and heat exchangers are externally mounted.

The Rectifier cubicle is cooled by two exhaust fans located in the roof which draw cooling air through a filter in the rear door. In addition, there are two small blowers which direct air at the bases of the GL-829-B rectifiers to aid in mercury condensation.

A combined exhaust duct for all units can be used for the removal of warm air provided that an exhaust fan is installed in the duct. This fan should be capable of moving approximately 1800 cfm of air against the duct resistance to prevent back pressure in the duct from retarding or unbalancing the exhaust air flow from the cubicles.

The blowers supplied in the Visual and Aural Amplifier cubicles are a belt-driven type. Adjustable shives permit changing the speed of the fan to compensate for 50-cycle or high-altitude operation.

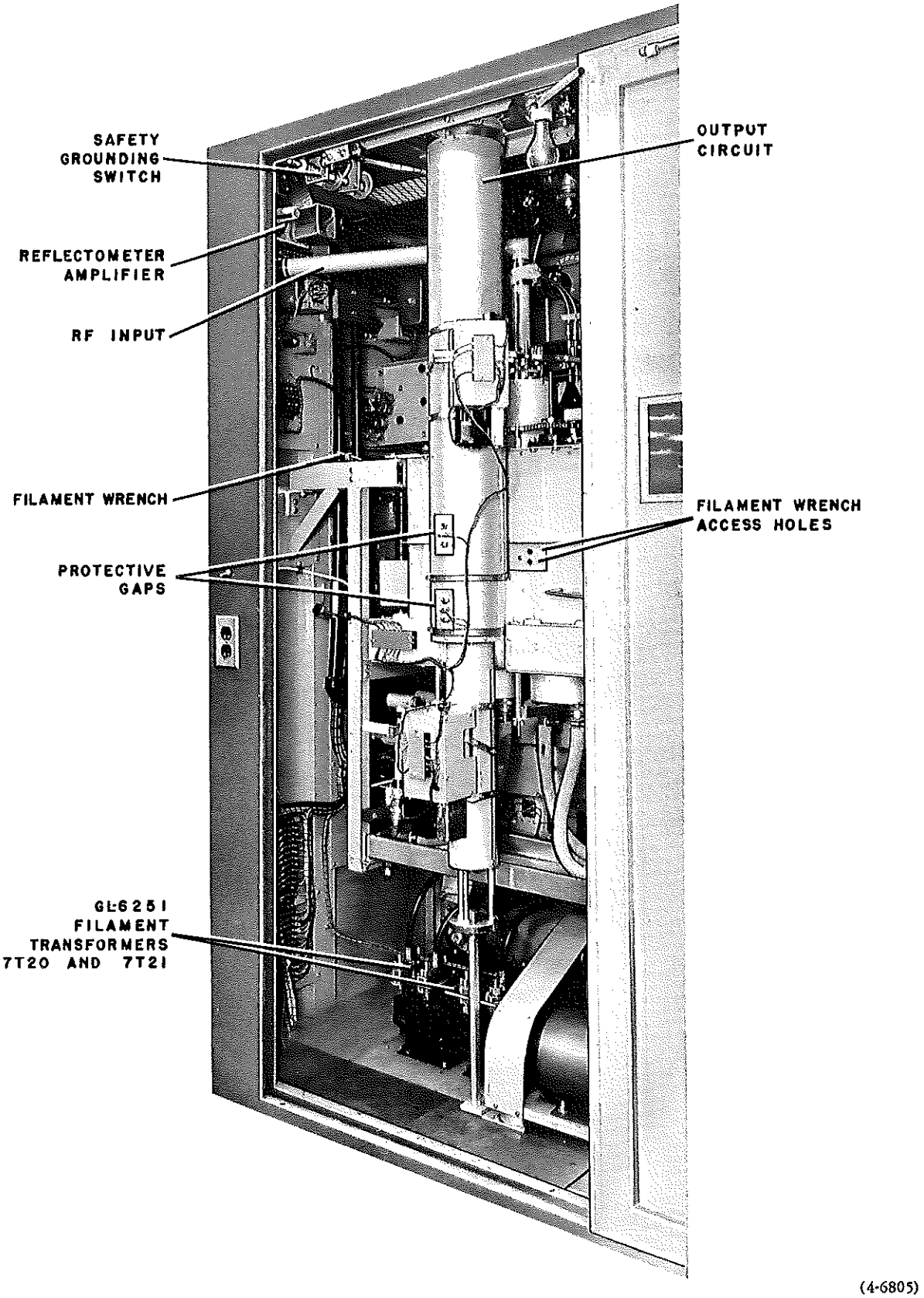

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Fig. 15 Rear and Left Wall View of Aural Amplifier Cubicle

EXTERNAL EQUIPMENT

In addition to the water pump and heat exchangers, the external equipment consists of the plate transformer, Visual and Aural filter reactors, delta-wye switch, main plate circuit breaker, resistor box, Vestigial-Sideband Filter, Harmonic Filters, Visual and Aural reflectometers, and transmission-line elements designed to measure the response of the Amplifiers and monitoring points required for the proper operation of the equipment.

The transformer, filter reactors, resistor box, plate circuit breaker, cubicle power disconnect switch, and delta-wye switch are enclosed in sheet metal cases for safety protection to personnel.

An externally mounted constant-impedance line stretcher is supplied as part of the Visual Amplifier input circuit.

POWER FEED

The 208/230-volt three-phase power for the plates of the high-voltage rectifier does not go directly to the cubicles because the air circuit breaker and transformer are external. Since the air circuit breaker has an interrupting capacity of 25,000 amperes, it may in most cases be connected directly to the incoming power lines without additional protection.

The externally mounted switch 5S1 which carries the remainder of the incoming power has an interrupting capacity of 15,000 amperes and, therefore, in most cases may also be connected directly to the incoming power lines without additional protection.

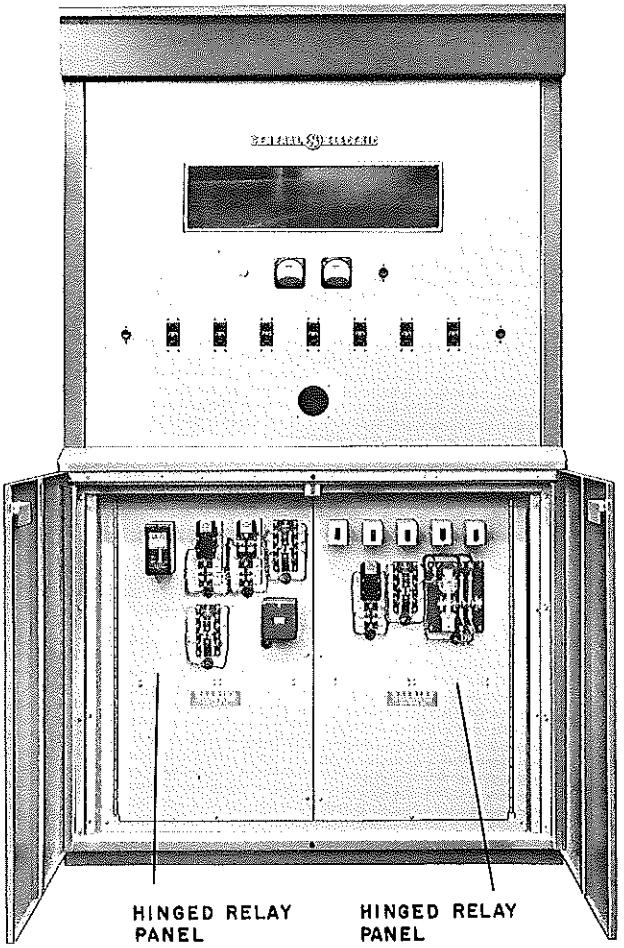

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Fig. 16 Front View of Rectifier Cubicle with Access Doors Open

DRAWINGS AND SYMBOLS

A list of the drawings, numbered and titled, in the order in which they are included may be found in the front of this book.

A letter, preceded and followed by a number, designated the circuit components according to type, as, for example, C for capcaitor, R for resistor, etc. The number preceding the type letter indicates the cubicle in which the component is located (5 designating external items, 6 the Rectifier cubicle, 7 the Aural cubicle, and 8 the Visual cubicle). An exception to this is the Sweep Generator which is identical in both Visual and Aural units and carries the prefix 8. The number following the type letter indicates the number of the part in that unit. All parts are listed alphabetically by symbol numbers in the Parts List, which also includes a description and a drawing number for each. Terminal board numbers are followed by a dash and the particular terminal number.

All controls on the Amplifier are labeled by name. All components in the Amplifier, wherever possible, are stamped with their symbol numbers for easy identification and are similarly identified in drawings.

INSTALLATION

UNPACKING

Inspect each package as it is received for possible shipping damage. Claims for damaged equipment must be filed against the carrier within ten days of delivery or the carrier will not accept the claim. When the equipment is delivered to the carrier by the General Electric Company, it becomes the property of the customer.

Check the equipment received against the shipping list. The packing cases of all units are stenciled with a number. If there is a shipping error or if, because of damage, replacement equipment must be ordered, notify the General Electric Company representative.

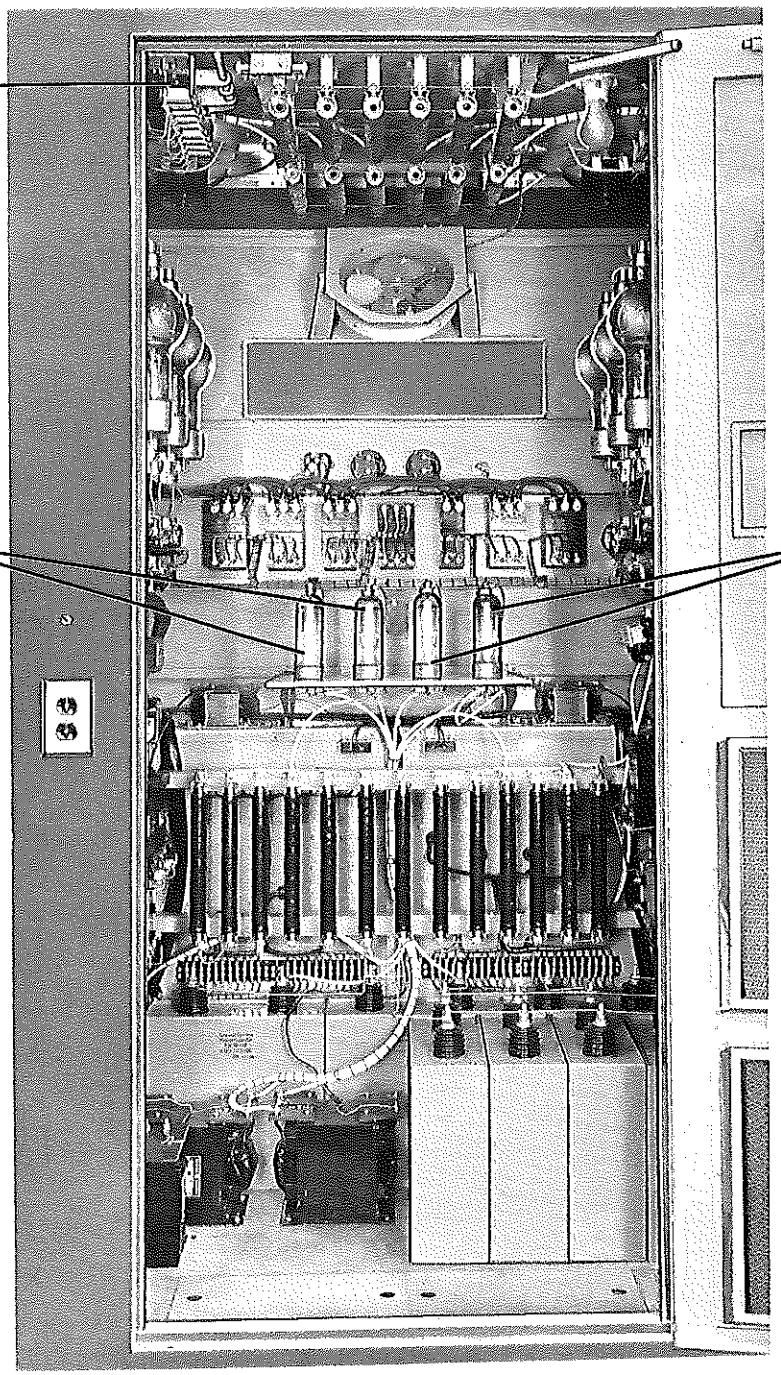

Fig. 17 Rear View of Rectifier and Control Cubicle

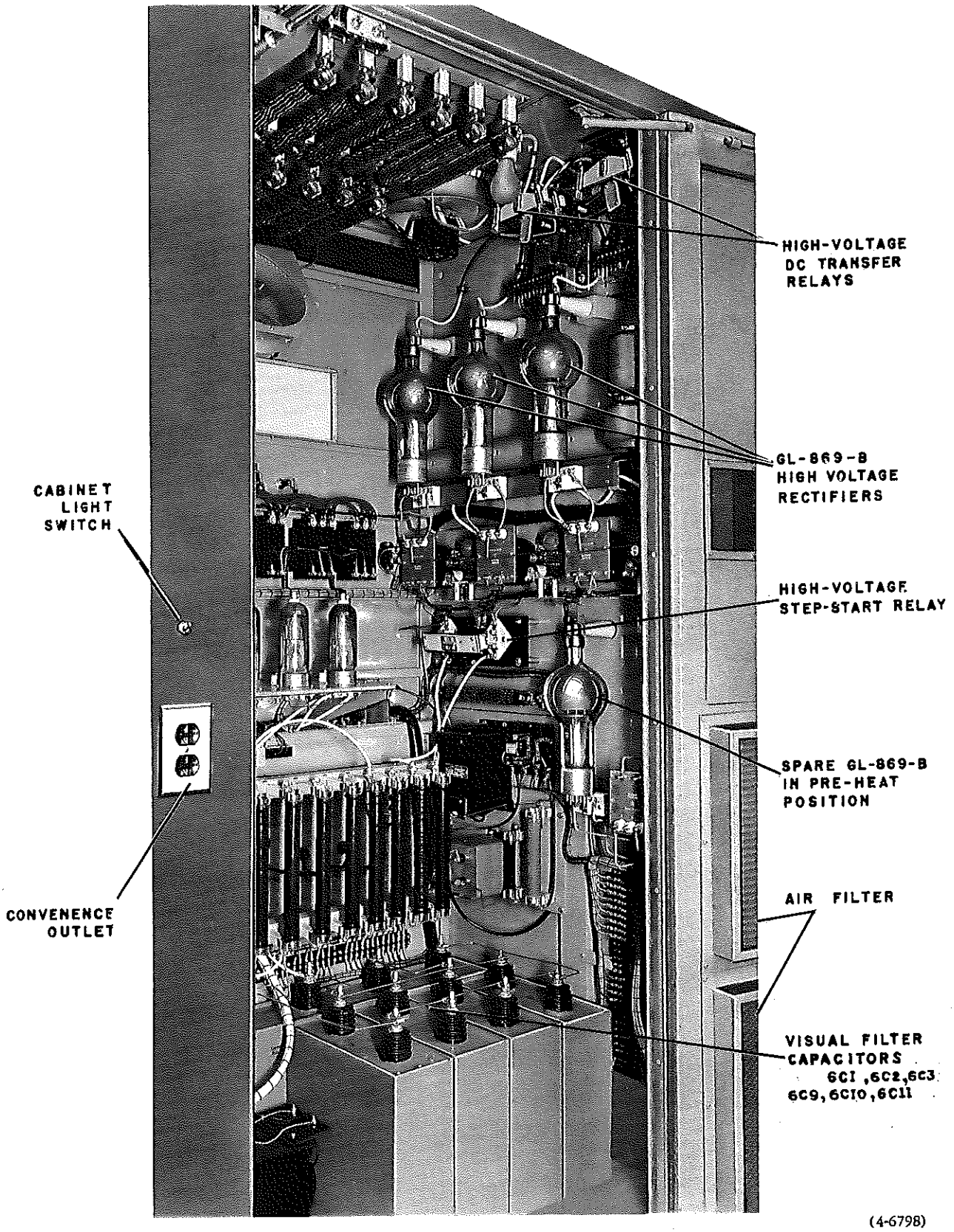

Fig. 18 Rear and Right Wall View of Rectifier and Control Cubicle

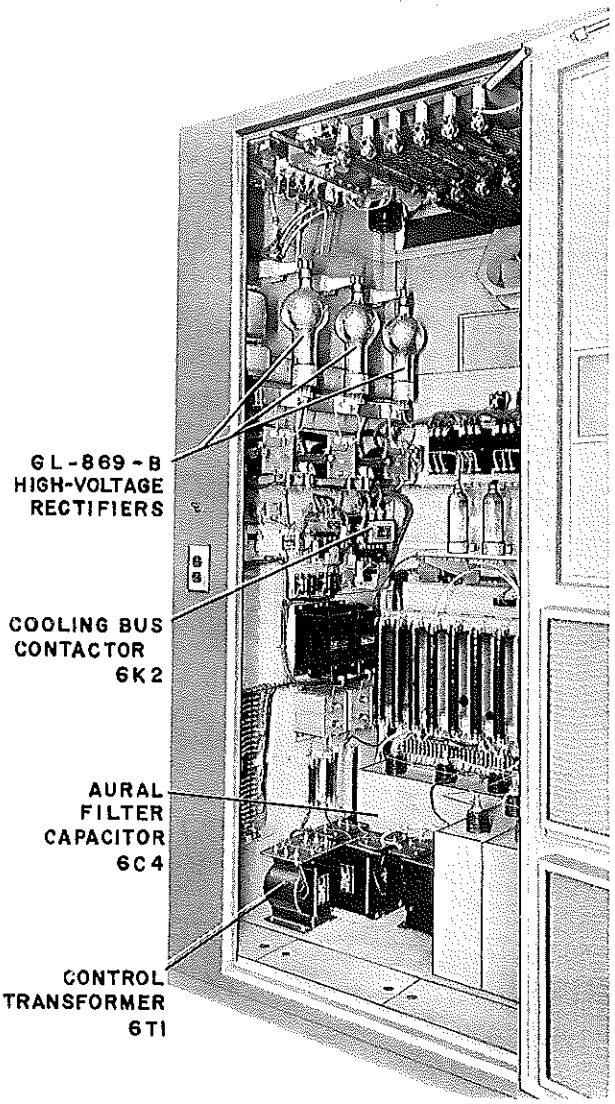

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Fig. 19 Rear and Left Wall View of Rectifier and Control Cubicle

The shipping list designates the various boxes by number and the contents by name, symbol number, and drawing or model number, thus permitting positive location and identification of all units.

All tubes and crystals are separately packed and listed on the shipping list by type and symbol number for ease in identification when they are installed. All loose items such as contactor arms are securely tied. Inspect these points and remove the fastenings. Any disassembled part which required the removal of screws, nuts, and other fastenings, has these parts attached either to the assembly or sub-assembly to insure ease in their location in the installation. The best procedure, however, is to locate the Amplifier cubicles permanently before reinstalling any of the components that have been removed to facilitate shipping.

Be sure to remove the wooden shipping support with care from inside the cavity.

Handle all electronic tubes and quartz crystals with care.

If the Amplifier site is not completed by the time the equipment is received, leave the units packed and place the boxes in a safe, dry place. This will prevent dust and dirt raised by sweeping, plastering, or drilling from settling into the electrical components, thereby causing serious maintenance problems later.

LOCATION

The three cubicles of the Amplifier may be placed in any physical relationship to each other or to the driving transmitter with the exception that it is best to locate the Visual Amplifier cubicle as close to the Visual driver as possible. Two removable end caps are provided for the end cubicles of a series. It is not necessary to locate the Rectifier cubicle where it may be seen during operation. Figs. 8 and 21 show possible floor plans of the Amplifier when used with General Electric drivers. Wiring ducts or conduits should be provided between the cubicles and between the Rectifier cubicle and the external equipment. See Figs. 61 and 81 for wire sizes and amount of wiring required between the various units. At the customer's option the interconnecting wires may be run through 4-inch square ducts overhead, since cutouts for this type of wiring duct are provided in the roof of each cubicle.

Other factors to be considered in laying out the station are the following: provision for incoming power supply lines and good ground connection; proper transmission-line, diplexer, and vestigial-sideband filter supports; and proper illumination. Sufficient space must be left in the front and the rear of the cubicles to permit the opening and closing of the cubicle doors.

If this equipment is to be operated in a locality where weather below freezing is expected, provision must be made to protect the piping of the cooling system, the heat exchangers, and the water tank from freezing. Attention should be given to the problem of preventing the air which circulates through the heat exchangers from dropping below the freezing point even during operation, since it is possible to freeze the water in the heat exchangers while the equipment is operating.

If a cubicle is to be hoisted, it should be left boxed until it has been approximately located in the over-all layout. If, however, the cubicle has been uncrated, it can be lifted by making use of the removable screw lifting lugs located in the top corners of each cubicle. To give a straight upward pull, use a spreader bar when lifting. The front door assemblies and end pieces are removable.

If the stainless steel trim strips above the front doors are out of line, loosen the four screws located

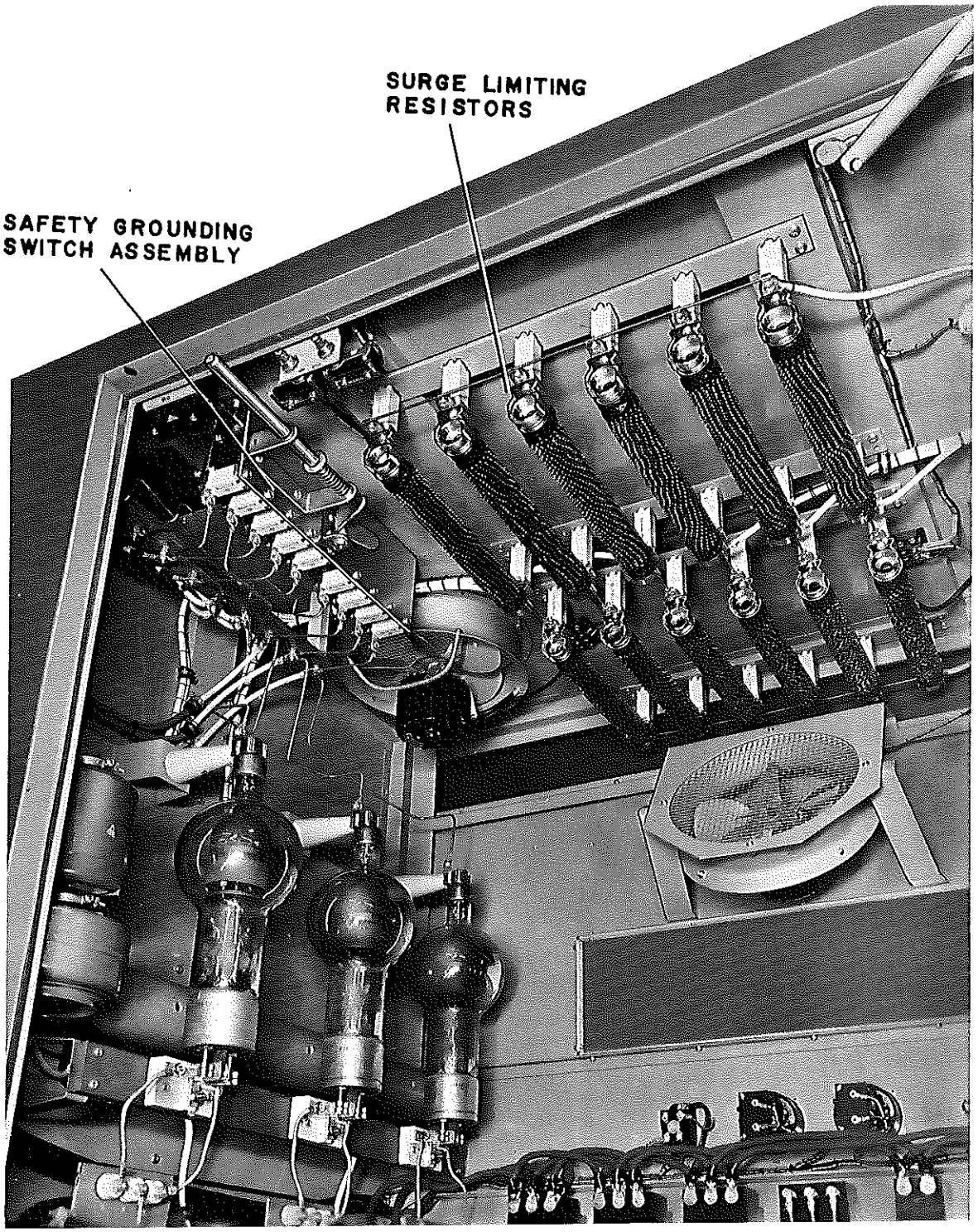

Fig. 20 Detail View of Rectifier and Control Cubicle Showing Grounding Switches

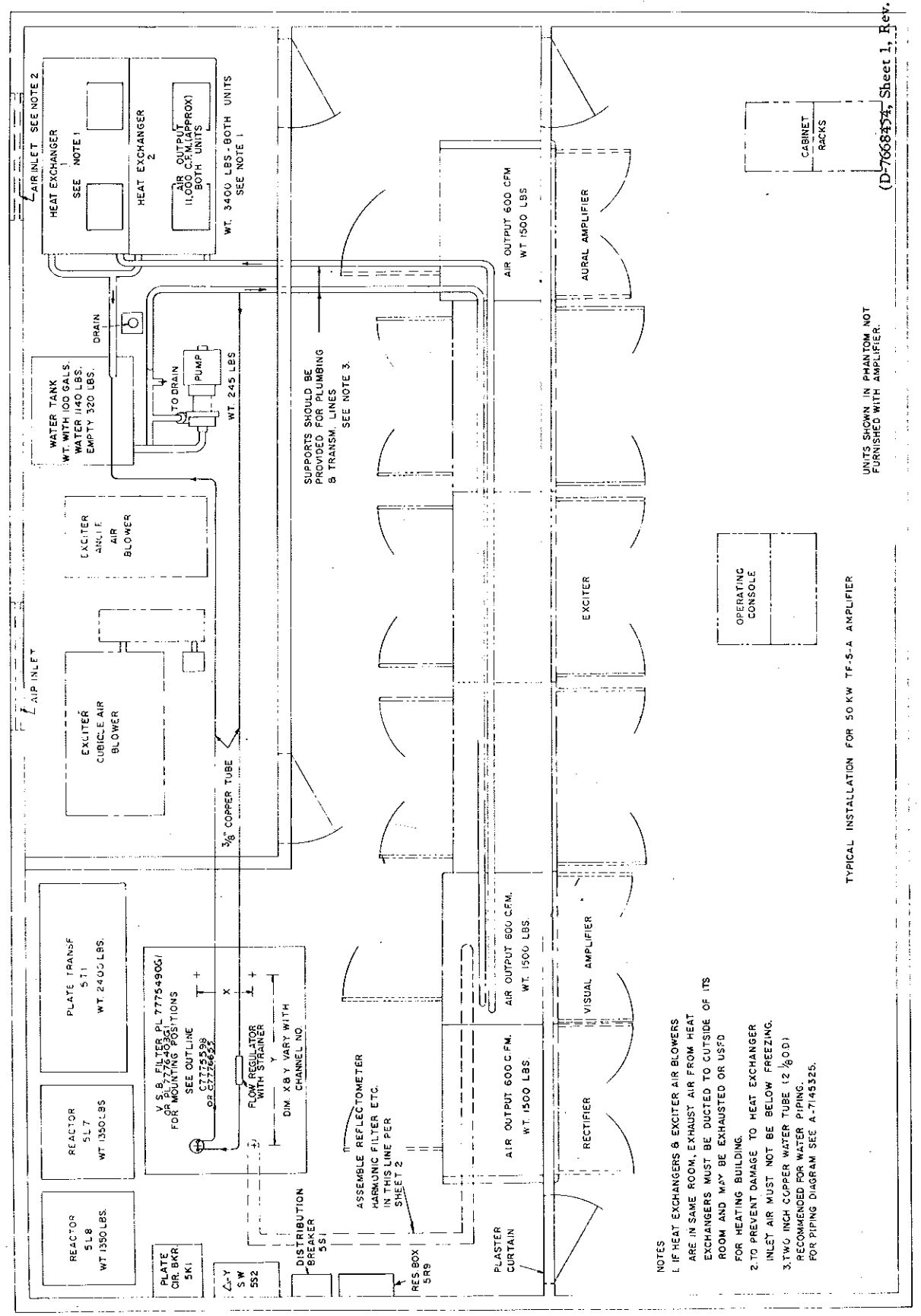

Fig. 21 Suggested Layout, TT-6-E Driver

near the front door hinges. The trim strip can then be adjusted until it is properly aligned.

INSTALLATION OF OUTPUT TUNING ASSEMBLY

See Fig. 22.

To prevent damage during shipment, the output tuning assembly is removed from the Amplifier cubicles and separately packaged.

Refer to Figs. 23 through 25, which show the method of assembly of this unit to the RF cavity. Fig. 26 shows the location of the screws which connect the output tuning assembly to the Amplifier cavity. A box-end ratchet wrench is supplied to facilitate the adjustment of the 1/4-20 hex-head bolts shown in Fig. 26.

The bottom of the output circuit rests on a screw arrangement to allow precise alignment of the height of the assembly in the cubicle. The assembly should be pushed in snugly against the cavity. Two shield covers are supplied to cover the opening on each side of the coupling loop. These covers are secured to the cavity proper by two Phillips-head screws for each cover and to the barrel of the output tuning assembly by two wrap-around clamps.

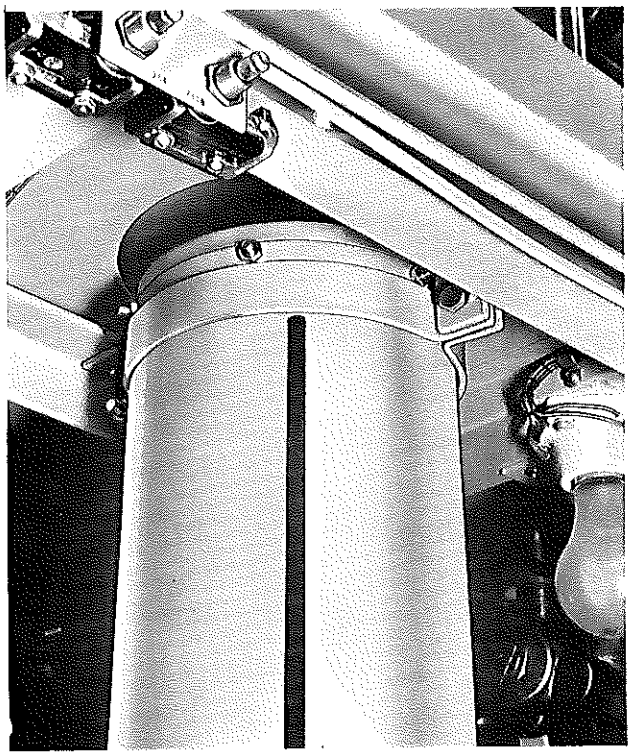

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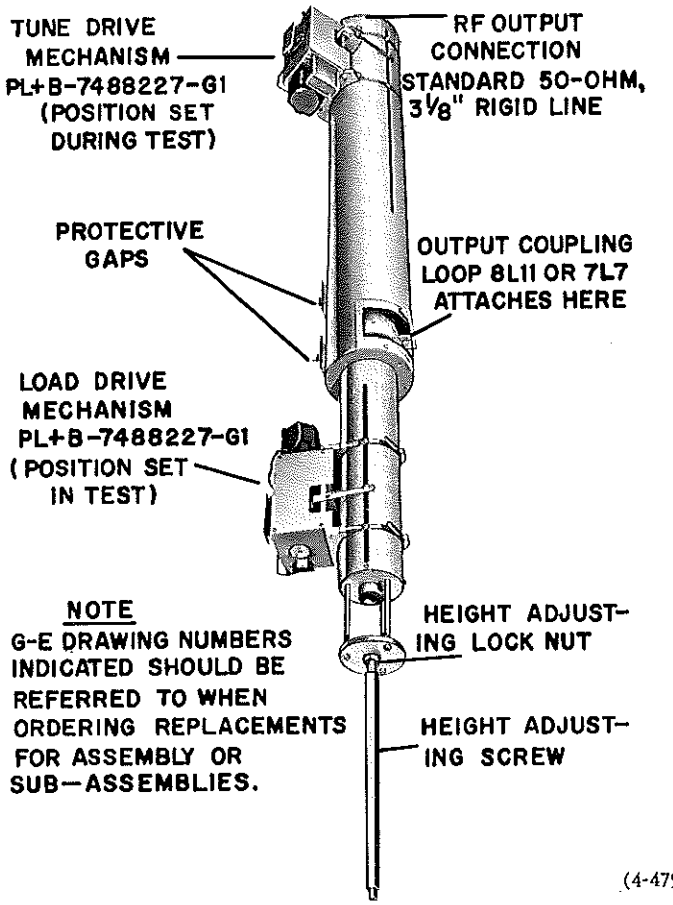
Fig. 23 Top Assembly of Output Circuit



(4-4796)

Fig. 22 Output Circuit Assembly, PL&D-7669025-G1

WIRING

All external wiring is normally supplied by the customer. Refer to Figs. 61 and 81 for interconnections and wire sizes.

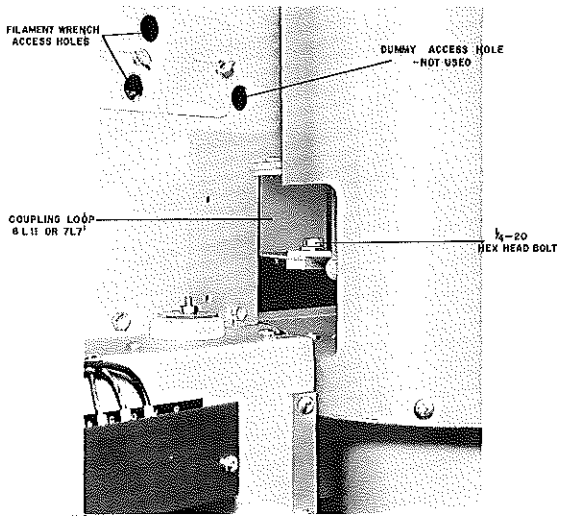
The RF input lines to both Amplifiers are RETMA standard 50-ohm, 1-5/8 inch standard line. Two adapters to connect from 1-5/8 inch, 50-ohm, to 1-5/8 inch, 51.5-ohm line are supplied with this equipment. The RF output lines of both Amplifiers are RETMA standard 50-ohm, 3-1/8 inch transmission line. The amount of external transmission line and transmission-line fittings needed is determined by the relative location of the diplexer, Vestigial-Sideband Filter, dummy load, driving transmitter, and antenna and is normally supplied by the customer. See Fig. 27 for the proper connection sequence of the transmission-line elements.

INSTALLATION OF PLUMBING

The plumbing in the Aural and Visual Amplifier cubicles was thoroughly cleaned inside when the Amplifier was in test at the factory.

The coils of the heat exchanger, and the water pump, were cleaned by the manufacturer.

To prevent contamination of the water system care should be taken when installing the interconnecting



(4-4787)

Fig. 24 Cavity Connection to Output Circuit Assembly, Covers Removed

plumbing. All pipes and fittings must be copper or brass and must be clean inside. Care should be taken to prevent solder flux from getting inside the piping. Pipe joint cement should be used only on the male threads of the threaded pipe fittings. If these precautions are taken during installation, the procedures listed under Preparation for Use of the OPERATION section will result in a clean system without further difficulty. See Figs. 28 and 29 for the installation sequence and the location of components.

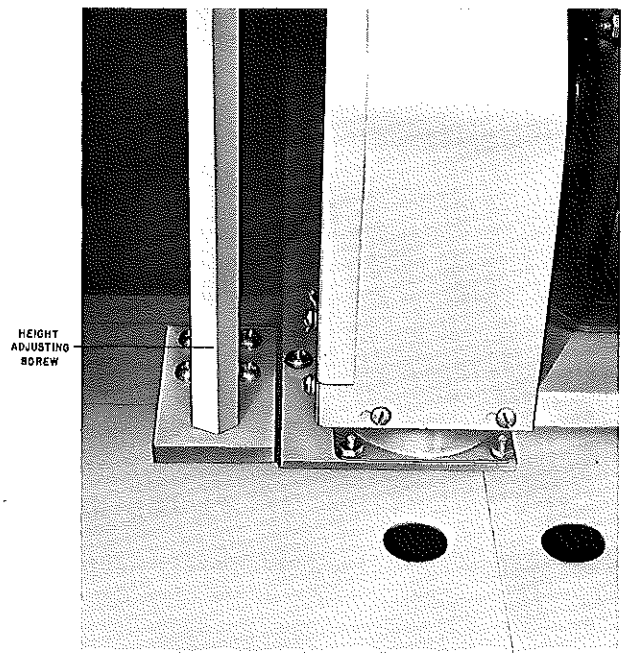


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Fig. 25 Bottom Support for Output Circuit Assembly

50-CYCLE OPERATION

The Amplifier as shipped is connected for 60-cycle operation. The following changes must be made for 50-cycle operation.

1. The wire on terminal X3 of the control transformer 6T1 should be moved to X2. This changes the control circuit voltage from 115 volts to 96 volts for proper operation of a-c relays and contactors.

2. Two 50-cycle filament time meters (G-E Drawing P-3R142-P6) should be ordered and installed in place of the 60-cycle meters, 6M1 and 6M2.

3. Move the lead on 7T21-terminal 2 to 7T21-terminal 3. Move the lead on 7T20-terminal 2 to 7T20-terminal 1 and 7T20-terminal 4 to 7T20-terminal 5.

Move the lead on 8T13-terminal 2 to 8T13-terminal 3. Move the lead on 8T12-terminal 2 to 8T12-terminal 1 and 8T12-terminal 4 to 8T12-terminal 5.

4. Refer to Fig. 6. On the chart under the outline of the heat exchanger there is given the RPM for various conditions of operation. Set the adjustable shives on this unit to obtain the correct RPM on the fan shaft.

5. Refer to Fig. 4. The speed of the blower unit shown in this figure should be set at 3110 RPM by means of the adjustable shives in the Visual and Aural Amplifier cubicles.

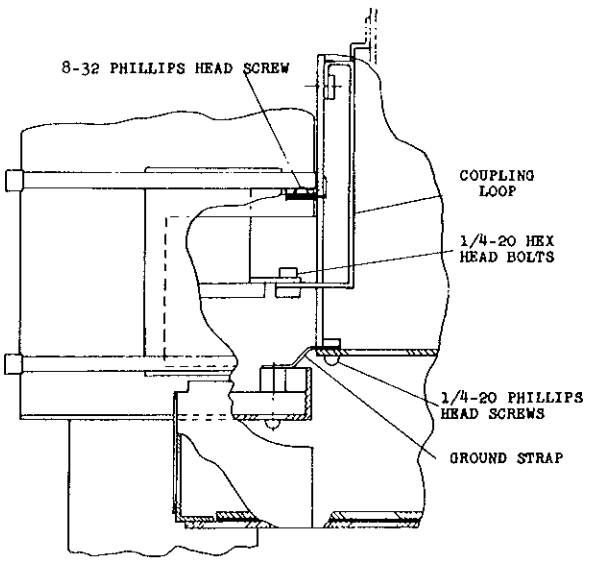

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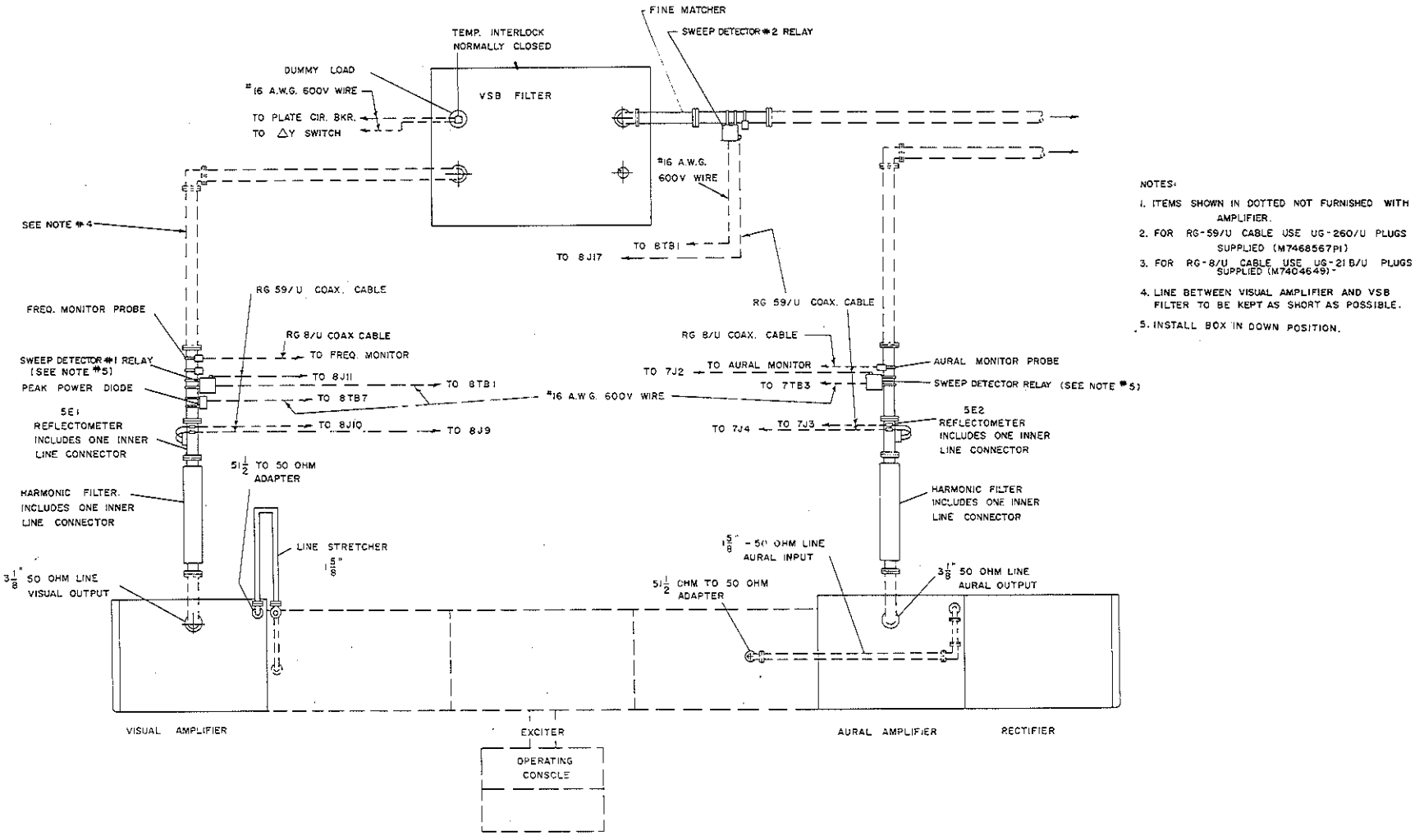
Fig. 26 Output Coupling Connection

TUBE INSTALLATION

See Figs. 30 through 32.

All tubes with the exception of the General Electric Type GL-6251 are installed in the normal manner.

The sockets for the Type GL-6251 amplifier tubes are plug-in except for the filament connectors. Clamp



NOTES:

1. ITEMS SHOWN IN DOTTED NOT FURNISHED WITH AMPLIFIER.
2. FOR RG-59/U CABLE USE UG-260/U PLUGS SUPPLIED (M7468567P1)
3. FOR RG-8/U CABLE USE UG-21B/U PLUGS SUPPLIED (M7404649)-
4. LINE BETWEEN VISUAL AMPLIFIER AND VSB FILTER TO BE KEPT AS SHORT AS POSSIBLE.
5. INSTALL BOX IN DOWN POSITION.

(D-7668454, Sheet 2, Rev. 5)

Fig. 27 Layout of External Transmission-Line Elements

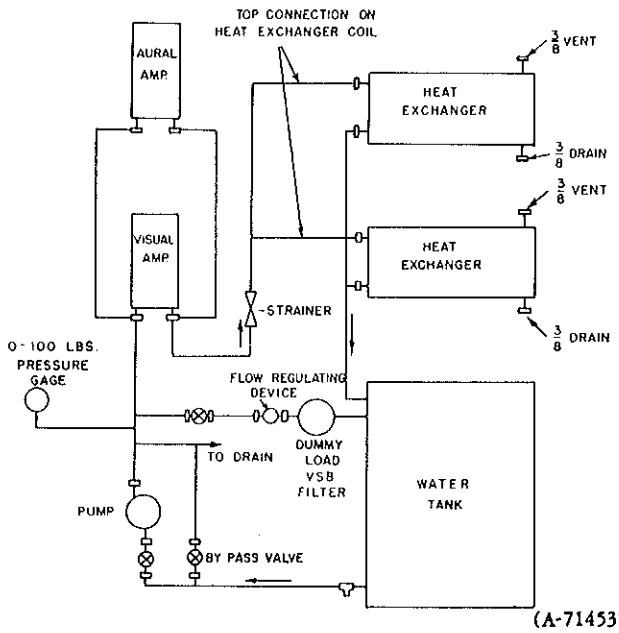


Fig. 28 Piping Diagram

type filament connectors are used to eliminate the possibility of contact heating due to high contact resistance.

When installing the GL-6251 tubes in their sockets, push them up into the socket with a slight clockwise rotation (to make for a good contact and to prevent damage to the springs). A line drawn through the water connections must be parallel with the front of the cavity. The clamping block hanging from the front of the cavity is then placed between the water connections and tightened by means of the wing nut on the supporting post on the rear of the cavity. When the tube is in place, it will be resting on the clamping block.

To tighten the filament connectors, insert the filament wrench through the hole in the side of the circuit exposed by pushing back the corner plate and turn it slowly until it engages the Allen cap screw. It is necessary to tighten the tube filament connector only until it is firm. Excessive pressure may damage the clamp. There are two connectors per tube that must be tightened.

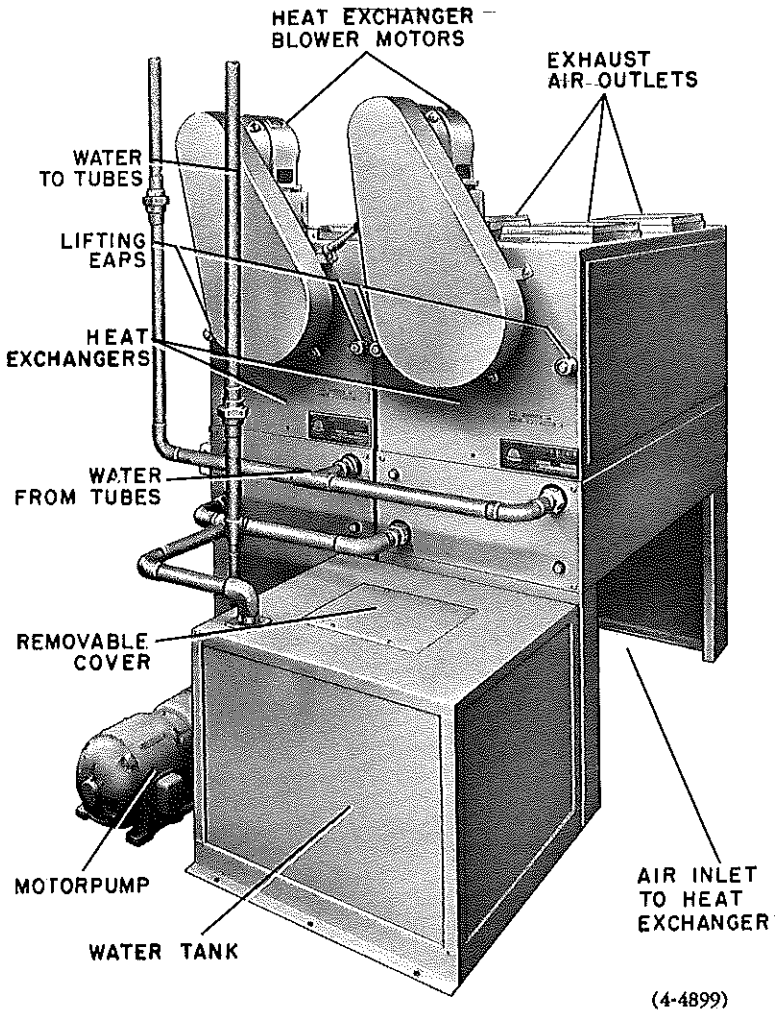


Fig. 29 Heat Exchanger, Water Tank, Water Pump

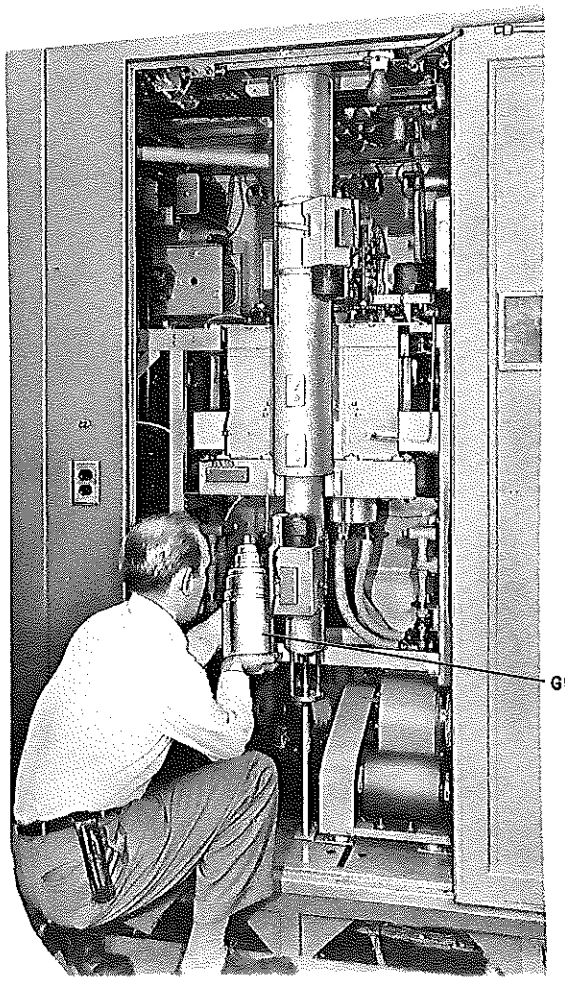


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Fig. 30 Tube Installation - A

The water connections to the anode are made with quick disconnect fittings to the mating connections on the tube. Make certain that the fittings are firmly seated on each connection before turning on the water. The correct direction of flow must be observed. The tube jacket is labeled IN for the water inlet. As observed from the rear of the cubicle the label IN on the tube should be on the left. The inlet and outlet connections are labeled at the valves.

When removing a tube, first shut off both water valves associated with the tube to be removed, shutting off the inlet valve first. Remove the hoses supplying water to the tubes at the quick disconnect fitting immediately underneath the shut-off valves and allow the water in the tube to drain into the drain pan. Then insert the filament wrench and loosen both filament clamps. Ordinarily it is necessary only to loosen the clamp screw. If the connector tends to hold when the tube is lowered, it may be necessary to back the clamp screw out to the point where the filament clamp is slightly spread apart. Back the screw only sufficiently to release the filament. The holding clamp bar is then loosened from the post on the rear of the cavity and allowed to drop clear. The tube may then be removed by turning it slightly clockwise (to prevent damage to the spring) as it is lowered.

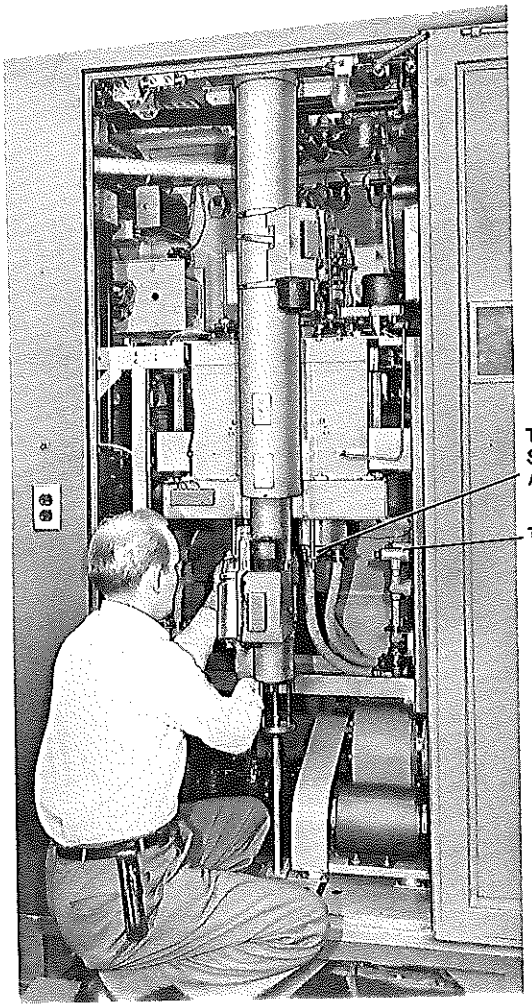

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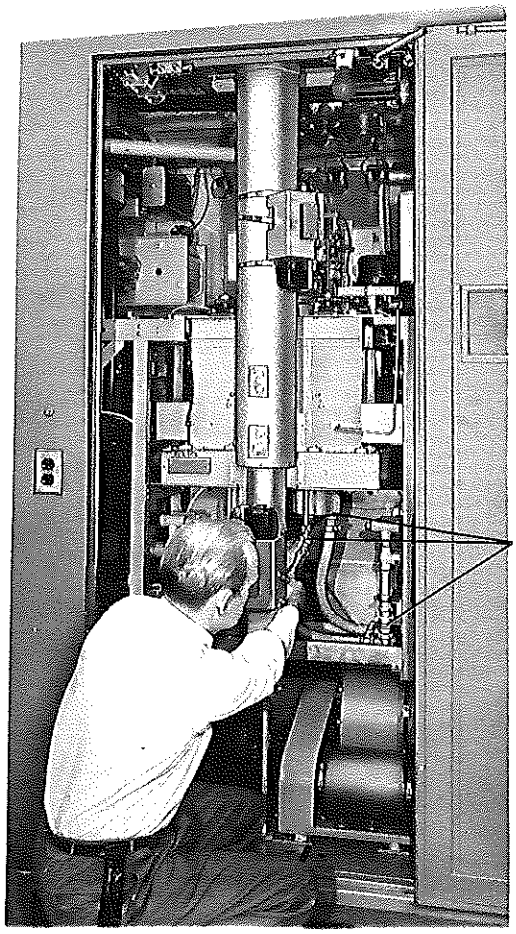
Fig. 31 Tube Installation - B

INTERLOCKS WITH DRIVING TRANSMITTER

Since the Amplifier operates grounded-grid, there is no load on the exciter until the Amplifier plate voltage is on and the plate current is flowing. It is therefore necessary to interlock the exciter so that there will be no power output unless there is plate voltage on the Amplifier.

It is also necessary to provide interlocks so that there can be no excitation power to either Aural or Visual Amplifier when either SWEEP-OPERATE switch is in the SWEEP position. This will prevent accidental burn-out of the germanium sweep diodes on the Amplifier output transmission lines.

The necessary interlocking between the Type TF-5-A Amplifier and the G-E Type TT-6-E Transmitter



(4-4898)

Fig. 32 Tube Installation - C

used as a driver is as follows (all wires should be 16-gauge, 600 volts d-c):

REMOVE wire from 2TB501-8 and 1TB311-1 (in the intercubicle harness of the Type TT-6-E Transmitter).

CONNECT from 5K1-7 to 1TB311-1
8TB7-5 to 2TB501-8
8TB7-6 to 7TB2-9.
(Removes plate power from the Visual exciter on the TT-6-E when the Visual Amplifier is in the SWEEP position or plate voltage is not on the Visual Amplifier.)

REMOVE internal wire going to 3T802-3 and
CONNECT this wire to 3TB3-2.

CONNECT from 3TB3-5 to 3T802-3
5K1-9 to 3TB3-2
7TB2-7 to 3TB3-5.
(Removes drive to the Aural Amplifier when plate voltage is not applied to the Aural Amplifier.)

CONNECT from 7TB1-5 to 3TB2-3
7TB1-6 to 3TB2-4
7TB1-5 to 8TB7-9
7TB1-6 to 8TB7-10.
(Turns Aural driver off when either the Aural or Visual Amplifier is in the SWEEP position.)

CONNECT from 1TB307-9 to 7TB1-3
1TB307-1 to 7TB1-2.
(Turns off the Visual driver when the Aural Amplifier is in the SWEEP position.)

If another type transmitter is used as the exciter, ways and means must be found to provide the same interlocking functions as those described above.

EXTERNAL SAFETY SWITCH

Electrical codes generally require that a visible disconnect switch be located adjacent to any rotating machinery in order to disable the machinery during servicing operations. Refer to Note 20 on the Interconnection Diagram, Fig. 61. If desired by the customer, a switch may be placed in the same location as the heat exchangers and water pump and connected between 6TB9-12 and 6TB10-4 in place of the jumper called for. As may be seen from the Rectifier Elementary Diagram, Fig. 72, interrupting this circuit at this point will prevent the closing of 6K2; the cooling contactor. No voltage can be supplied to the motors until 6K2 closes.

REMOTE METERS

The leads on the ground side of 7M10, the Aural power level meter, and 8M12, the Visual power level meter, have been brought out to terminal boards to facilitate the installation of remote indicating meters if so desired. Referring to Fig. 68 for the Aural Amplifier cubicle, it will be seen that removing the jumper between 7TB2-2 and 7TB2-1 and installing a 200-microampere meter in its place will allow a remote indicating meter to be placed wherever desired. Referring to Fig. 65 for the Visual Amplifier cubicle, the jumper is between 8TB3-2 and 8TB3-1. Meters identical to those used in the Amplifier may be ordered by specifying G-E Drawing P-3R91-P12.

PROTECTIVE GAPS

Protective gaps are provided at various points in this equipment. The following spacing is set at the factory and is given here for the customer's reference:

Plate Transformer - Spherical Gaps, 0.463 inch
Reactor - Gaps, 0.1875 inch
Plate Lead Protective Gap on Cavity (see Fig. 55), 0.180 inch
Screen Contact Plate Protective Gap Inside Cavity (see Fig. 54), 0.020 inch
Protective Gaps on Output Tuning Assembly (see Figs. 10 and 22), adjusting screw projects 0.8 inch from the mounting plate

INITIAL LUBRICATION

Before the equipment is first operated, the following points should be lubricated, using the "General Electric Grease for Ball and Roller Bearing Motors." A one-pound can of this grease is supplied with the equipment.

"Motorpump" Water Pump - Remove the relief plugs from each end of the motor and grease the motor, using a grease gun until grease appears at the relief plug holes. Do not replace the relief plugs until the pump has run for 15 minutes.

Motors on the Heat Exchanger Blowers - Remove the relief plugs from each end of the motor and grease as described above.

Bearings on the Heat Exchanger Fan Shaft - Grease with General Electric Grease, using a low-pressure grease gun. Two strokes of the gun will be sufficient. Do not use a high-pressure gun or over-grease these bearings, since the grease seals may be ruptured.

All other bearings and motors are initially lubricated.

See the MAINTENANCE section for routine lubrication.

OPERATION

PREPARATION FOR USE

1. Wire check all interconnecting cables.
2. Inspect the installation for cleanliness.
3. Install all tubes (see Tube Installation under INSTALLATION) and the sweep generator crystals (refer to the Parts List).
4. Place all of the Amplifier breakers and the AUTO RECLOSER switch in the OFF position.
5. Turn the REG LINE VOLTAGE control as far counterclockwise as it will go.
6. Close the external disconnect switch 5S1, energizing the power input to the cubicles.
7. Close the REG LINE switch 7S7 on the front panel of the Aural Amplifier cubicle.
8. Check the regulated line voltage on the REG LINE VOLTAGE meter 7M8 (in conjunction with the REG LINE VOLTAGE switch 7S16). Adjust the regulated line voltage by means of the REG LINE VOLTAGE control 7T14 to an average phase voltage of 230 volts.
9. Close the CONTROL breaker 7S12. The green AMPLIFIER START push button and the AUTO RECLOSER switch supervisory lights should be illuminated.
10. Press the AMPLIFIER START push button. The Aural and Visual AIR supervisory lights should come on, indicating no air flow to the tube.
11. Momentarily close the AURAL BLOWER switch mounted on the Rectifier panel and observe the rotation of the Aural blower as it coasts to a stop. Looking at the blower from the pulley end, the shaft should be rotating in a clockwise direction. If the rotation is incorrect, reverse the leads going to terminal 6TB7-1 and 6TB7-2. Check the rotation of the Aural blower again as described above. It will now be correct.

Momentarily close the VISUAL BLOWER switch and observe the rotation of the Visual blower as it coasts to a stop as described above. If the corrections have been correctly made, this motor rotation should be correct. If it is not, reverse the intercubicle leads going to 8TB8-10 and 8TB8-11.

Close the AURAL and VISUAL BLOWER switches located on the front panel of the Rectifier cubicle. The main blowers should come up to speed, and the AIR supervisory lights should be extinguished, indicating that air flow to the tubes has been established. If the supervisory lights are not extinguished, the following conditions may exist:

a. The filament-wrench interlock may be open because the filament-wrench has not been restored to its storage position.

b. The air interlock switch may be defective.

12. Momentarily close the BLOWER 1 switch on the Rectifier cubicle panel and observe the rotation of the blower on the heat exchanger as it coasts to a stop. The rotation as viewed from the pulley end should be counterclockwise. If the rotation is incorrect, reverse the interconnection leads going to 6TB1-1 and 6TB1-2. Repeat the above procedure to check for proper rotation.
13. Momentarily close the BLOWER 2 switch on the Rectifier cubicle panel and observe the blower on the heat exchanger as it coasts to a stop. The rotation observed should be the same as that indicated in step 12 above. To reverse the rotation of this unit, reverse the leads going to 6TB1-4 and 6TB1-5.
14. Open all the water valves in the Visual and

Aural cubicles. Check to make sure that all the quick disconnect fittings are properly seated. Open the bypass valve on the water pump all the way. Fill the water tank half full with ordinary tap water. Momentarily close the WATER PUMP switch on the Rectifier cubicle panel and observe the rotation of the water pump as it coasts to a stop. The correct rotation for this unit is indicated by an arrow on the nameplate of the pump. If the rotation observed is incorrect, reverse the leads in the interconnection cable going to 6TB1-7 and 6TB1-8. Turn on the WATER PUMP switch. Without closing the bypass valve on the water pump, inspect the plumbing system for leaks. Start closing the bypass valve on the water pump slowly and continue to inspect the plumbing for leaks. Add tap water to the water tank to replace the water used in filling the system.

Looking through the window of the Visual and Aural Amplifier cubicles, note the readings on the water pressure meters labeled LEFT WATER, RIGHT WATER, and OUTLET WATER. The reading on the LEFT WATER and RIGHT WATER pressure meters will be higher than that on the OUTLET WATER pressure meter. Continue closing the bypass valve on the water pump until the pressure difference between LEFT WATER or RIGHT WATER and OUTLET WATER is 7.2 pounds in each Amplifier cubicle. These pressure meters are connected across each water flow interlock, and, referring to the graph in Fig. 33, it can be seen that a 7.2-pound difference across the flow interlock corresponds to a water flow of 12 gallons per minute through the tube.

After the procedure described above has been completed, both WATER supervisory lights on the front panels of the Visual and Aural Amplifier cubicles should be extinguished.

15. Close the RECT BLOWER switch. The Rectifier cubicle exhaust and tube blowers should start.

16. Close the RECT FILAMENT switch. The Rectifier filaments should light.

17. Close the MAIN FILAMENT and LP FILAMENT switches on both the Visual and Aural Amplifier cubi-

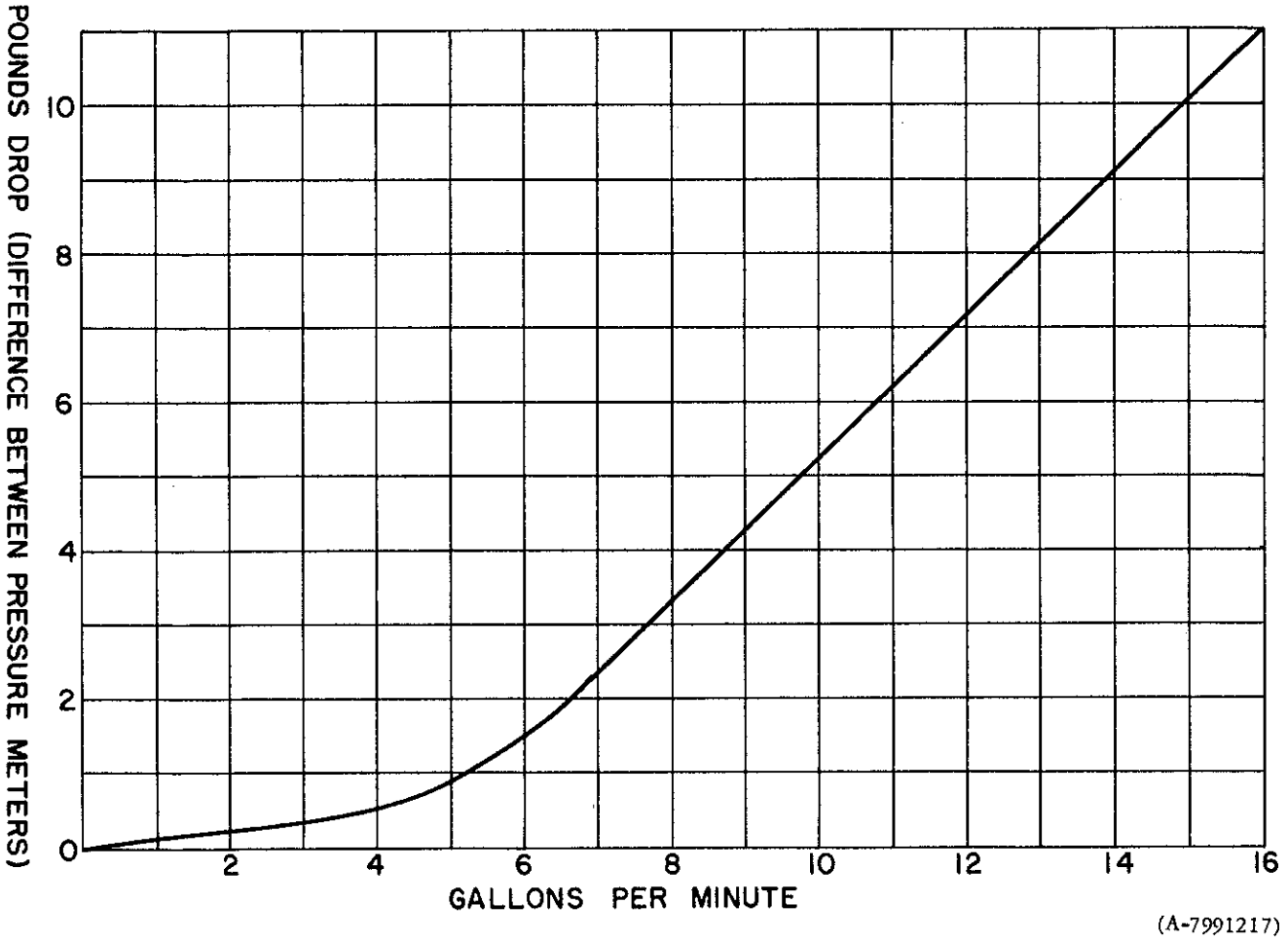


Fig. 33 Graph of Water Flow versus Pressure

TABLE SHOWING TRANSFORMER TAPS FOR FILAMENT TRANSFORMER VOLTAGE CONTROL

8T9 Secondary					8T10 Secondary		
8T12 Sec. Voltage	Terminal Numbers For Wires Lettered				8T13 Sec. Voltage	Terminal Numbers For Wires Lettered	
	A	B	C	D		E	F
-4.55%	4	8	9	13	-4.55%	3	7
-2.27%	4	7	9	12	-2.27%	3	6
5.5 volts	4	6	9	11	5.5 volts	3	5
+2.27%	4	5	9	10	+2.27%	3	4
+4.55%	4	4	9	9	+4.55%	3	3
+6.82%	5	4	10	9	+6.82%	4	3
+9.1%	6	4	11	9	+9.1%	5	3
+11.35%	7	4	12	9	+11.35%	6	3
+13.65%	8	4	13	9	+13.65%	7	3

cles. All the filaments in the Visual and Aural Amplifier cubicles should be illuminated. Check the filament voltage on the GL-6251 tubes in the Visual and Aural Amplifier cubicles by means of the PA FILAMENT VOLTAGE meter and the PA FILAMENT-LEFT-RIGHT switch located behind the front access door on the left panel of each cubicle. The voltage should be 5.5 volts $\pm$0.15 volt for each tube when the regulated line Powerstat* is set to give a regulated line voltage of 230 volts average on all three phases as measured on the REG LINE VOLTAGE meter. The filament voltage may be adjusted by means of the "buck-boost" transformers 7T18 and 7T19 in the Aural Amplifier cubicle.

The amplifier filaments are provided with separate means of control so that their voltage may be adjusted independently. A FILAMENT VOLTAGE meter with a selector switch is provided so that each tube may be metered independently. The filament voltage of each tube should be adjusted as nearly as possible to the nominal rating of 5.5 volts. By use of taps on the secondaries of the two Scott-connected "buck-boost" transformers 8T9 and 8T10 sufficient variation of voltage may be obtained to correct for transformer winding tolerance, filament wiring voltage drop, or voltage unbalance on the input line. A change of taps on 8T9 affects the filament voltage of the left tube; a change of the taps on 8T10 affects the filament voltage of the right tube.

If the voltage is slightly off after a tube change during operation, it may be reset after normal shutdown.

The preceding discussion concerning the Visual Amplifier also applies to the Aural Amplifier, 7T18 and 7T19 being equivalent to 8T9 and 8T10, respectively.

18. Open the valve and allow the water to circulate through the dummy load on the Vestigial-Sideband Filter. Correct flow is insured by the flow regulating strainer supplied with the Vestigial-Sideband Filter.

19. With the HEAT EXCHANGER BLOWER 1 and BLOWER 2 off, allow the equipment to operate until the water has been heated by the filaments of the GL-6251 tubes to a temperature of 120 degrees as indicated by the temperature meters on the Visual and Aural Amplifier cubicles. Hold the water temperature to around 120 degrees by turning on either the BLOWER 1 or BLOWER 2 switch intermittently. After the equipment has been running for half an hour, push the AMPLIFIER STOP push button. After the blowers and pump time out in three minutes, drain the water from the system. Clean out any bits of solder that may be found in the water tank and refill the system with ordinary tap water.

20. Push the AMPLIFIER START button and repeat step 19 except for refilling the water tank.

21. After draining the system, clean out any bits of solder found in the water tank, clean the water strainers, and fill the tank three-quarters full with distilled water.

22. Push the AMPLIFIER START button, turn on the BLOWER 1 and BLOWER 2 switches on the front panel of the Rectifier cubicle. Maintain a supply of distilled water in the water tank to three-fourths of its full capacity. During the first week of operation, skim off any film that may appear on the surface of the water in the tank. It will be noted that the readings of the water pressure meters in the Visual and Aural Amplifier cubicles will "bounce" when the equipment is

* Registered U. S. Patent Office

placed in service for the first time. This results from the air trapped in the lines to the pressure gauges; the "bounce" will diminish and disappear during the first weeks of operation.

AURAL AMPLIFIER

1. Operate the DC SWITCH to the AURAL position.

2. The following switches should be closed on the Aural Amplifier cubicle: REG LINE, CONTROL, MAIN FILAMENT, and LP FILAMENT. The rear door of the Aural Amplifier and Rectifier cubicles must be closed. The Aural time-delay relay 7K2 should have timed out one minute after the MAIN FILAMENT and LP FILAMENT switches were closed, and the Aural FIL TD STATUS and Aural BIAS supervisory lights should be illuminated.

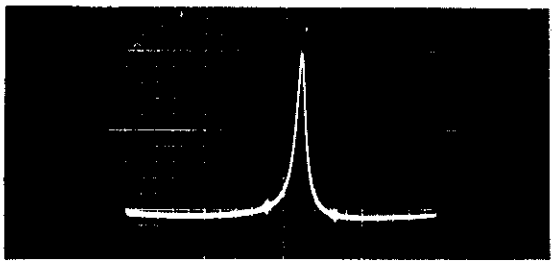


Fig. 34 "Spike" Showing Only Plate Circuit of Aural Amplifier Tuned

3. Close the Aural BIAS switch. The Aural BIAS supervisory light should be extinguished, indicating that Aural bias voltage has been established. Simultaneously, the lamps in the green RECTIFIER ON push buttons of the Aural and Visual Amplifier cubicles and the green RECT ON push button of the Rectifier cubicle should be illuminated.

4. Operate the BLANKING, MARKERS, FILAMENT, and MOTOR switches on the sweep generator panel to the ON position.

5. Close the SWEEP switch and operate the OPERATE-SWEEP switch to the SWEEP position. This will apply power to the sweep generator.

6. Normally the sweep generator will be adjusted before shipment from the factory and will need little, if any, further adjustment. If adjustment is necessary, align the sweep generator as described in the THEORY AND CIRCUIT ANALYSIS, VISUAL AMPLIFIER section. Refer to the Parts List for the correct sweep marker crystals to be used in the Aural sweep generator.

7. Connect a high-gain oscilloscope such as a G-E Type ST-2-A to the SCOPE INPUT jack on the sweep generator panel and place the Sweep Generator 'scope input selector switch in the first DETECTOR position.

8. Align the output circuit of the Amplifier as follows with the Aural output connected to a dummy load:

a. Place the TUNING motor POWER switch 7S32 in the ON position. The TUNING motor POWER supervisory light 7I15 should be illuminated, indicating that power is available for operating the tuning motors.

b. Operate the PLATE TUNING switch 7S29 to resonate the plate circuit. Unless the TUNE (7S30) or output tuning happens to be in resonance, the response obtained by tuning the plate circuit will be a single response which can be tuned to a frequency midway between the marker signals (1.5 megacycles above and below the aural carrier frequency); see Fig. 34.

c. Operate the TUNE switch 7S30 to resonate the output circuit. Depending upon the output coupling and loading, the resultant response will be either a broader "single-humped" response or a "double-humped" response.

d. Adjust the LOAD switch 7S31 to obtain a response similar to that shown in Fig. 35, 36, or 37. The correct bandpass is shown in Fig. 37. If the bandpass is too narrow, as shown in Fig. 35, or too wide, as shown in Fig. 36, the coupling must be adjusted. To do this, remove the shield covers on the output circuit on each side of the coupling loop. Then, using the box-end ratchet wrench supplied with this equipment, loosen the 1/4-20 hexhead bolts connecting the coupling loop to the output circuit. If the bandpass was found to be too narrow, the coupling loop should be pushed slightly into the cavity to increase the coupling. If the bandpass was found to be too wide, the coupling should be pulled back toward the output circuit to decrease the coupling. Tighten the hexhead 1/4-20 bolts securely and replace the shield covers before proceeding.

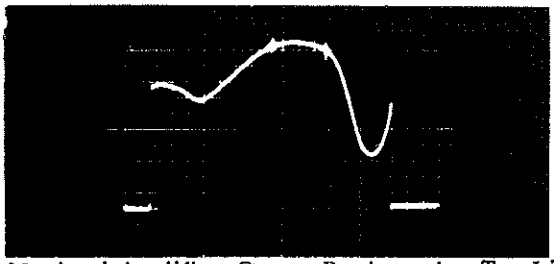


Fig. 35 Aural Amplifier: Correct Bandpass but Too Little Coupling

e. At this point, mention should be made of the Amplifier neutralization. The neutralization control is located on the front of the plate cavity in the center just above the sweep termination on box (see Fig. 50). The access hole is covered by a small plate which must be moved to make the adjustment.

The neutralization of the Amplifier is not critical, since there is very little feed-through in the tetrode tubes with both grids at ground potential. The neutralizing adjustment is set during factory test and should need no further adjustment. However, if for any reason adjustment is necessary, the following procedure should be used.

With plate and screen voltage off but with grid

bias voltage on (the rear door of the cubicle must be closed), the output circuit response as observed on the oscilloscope may show a small, sharp "nick". This is due to the resonance within the band of the input line between the exciter and the Amplifier. Being unloaded under these conditions, this circuit comprises a high-Q circuit coupled to the plate circuit very lightly through the cathode-plate capacitance in the tubes. Note that resonance of the input line may or may not occur in the bandpass, depending upon its length. Also, all power, including filaments, should be off in the exciter, since this might "load" the input line so that a sharp resonant condition could not be obtained. The nick in the response should be minimized by rotating the neutralizing loop. A special tool is supplied to make this adjustment (G-E Drawing A-7145267-P1).

If no nick is found, the input line is not resonant in the band, and it will be necessary to change its length by disconnecting or substituting lengths of line until resonance is obtained.

f. When the output coupling and loading are correct and the circuits tuned, the response as shown on the oscilloscope should be approximately that shown in Fig. 37.

9. Refer to Fig. 38 and connect the main plate transformer primary leads to the proper primary terminals for a rectifier output voltage as near 6500 volts as possible.

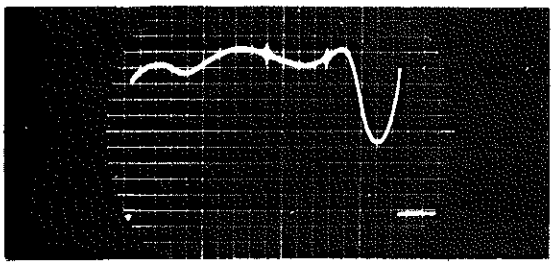


Fig. 36 Aural Amplifier: Correct Bandpass but Too Much Coupling

Check the holding bias on each tube. It should be approximately 20 volts when measured at 7C20 and 7C21 on top of the cavity.

10. Place the DELTA-WYE switch in the WYE position.

11. Turn the Aural PA SCREEN VOLTAGE control to the full counterclockwise position and operate the SCREEN switch to the ON position.

12. Make sure that the GL-869-B mercury vapor rectifiers in the Rectifier cubicle have been "cooked in" for at least 30 minutes with filament voltage and then depress the RECTIFIER ON push button. The main plate breaker should close, followed by the step-start contactor 6K10 in approximately one second. When the main breaker closes, plate voltage will be established and should be approximately sixty percent of 6500 volts, or 3900 volts.

13. Turn the PA SCREEN VOLTAGE control in the clockwise direction until the SCREEN VOLTAGE is 500 to 700 volts. As the screen voltage increases, the plate current should increase to approximately 2.5 amperes.

14. The six GL-869-B mercury vapor rectifiers used in this equipment must be quarter-phased to obtain maximum tube life. This procedure must be followed for each new installation of this equipment. Refer to Fig. 39 for the schematic connection of the equipment required for this adjustment. The oscilloscope used for this procedure may be any service-type unit, since the measurement is made at 60 cycles. The oscilloscope should be checked by applying 6 volts a-c to the vertical and horizontal amplifier inputs simultaneously, and by noting that the presentation on the screen of the oscilloscope is a straight line at an angle of 45 or 135 degrees. This indicates that there is no phase shift in the oscilloscope which will interfere with the accuracy of the following measurements. Most oscilloscopes will meet this requirement.

The transformer required may be any transformer having a 220- to 500-volt winding together with a low-voltage filament winding. Most small transformers used in receiver power supplies meet this specification.

The phase of the current pulse through the resistor in the cathode of each GL-869-B tube is compared to the phase of the filament voltage of the tube. In making this adjustment IT IS NOT NECESSARY TO INTERFERE WITH THE INTERLOCKS. DO NOT TAMPER WITH ANY SAFETY DEVICE IN THE RECTIFIER.

Insulated test lead wire rated at 10,000 volts should be used in making the following hookup. The leads may be brought from inside the Rectifier cubicle by removing the cover plate over the convenience outlet and feeding the wires through this opening. Disconnect the leads going to 6T10, the SPARE HEAT POSITION transformer and connect as shown in Fig. 39. The leads from terminals 3 and 5 of 6T10 should be long enough to reach all of the six resistors listed. Refer to Fig. 72 for the Elementary Diagram of the Rectifier and Figs. 69 through 71 for the location of

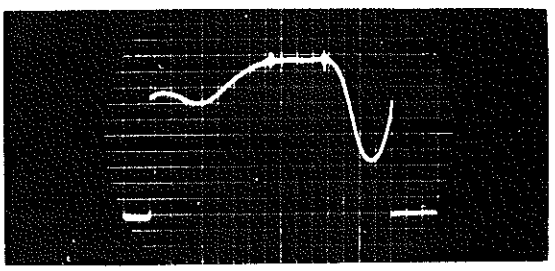
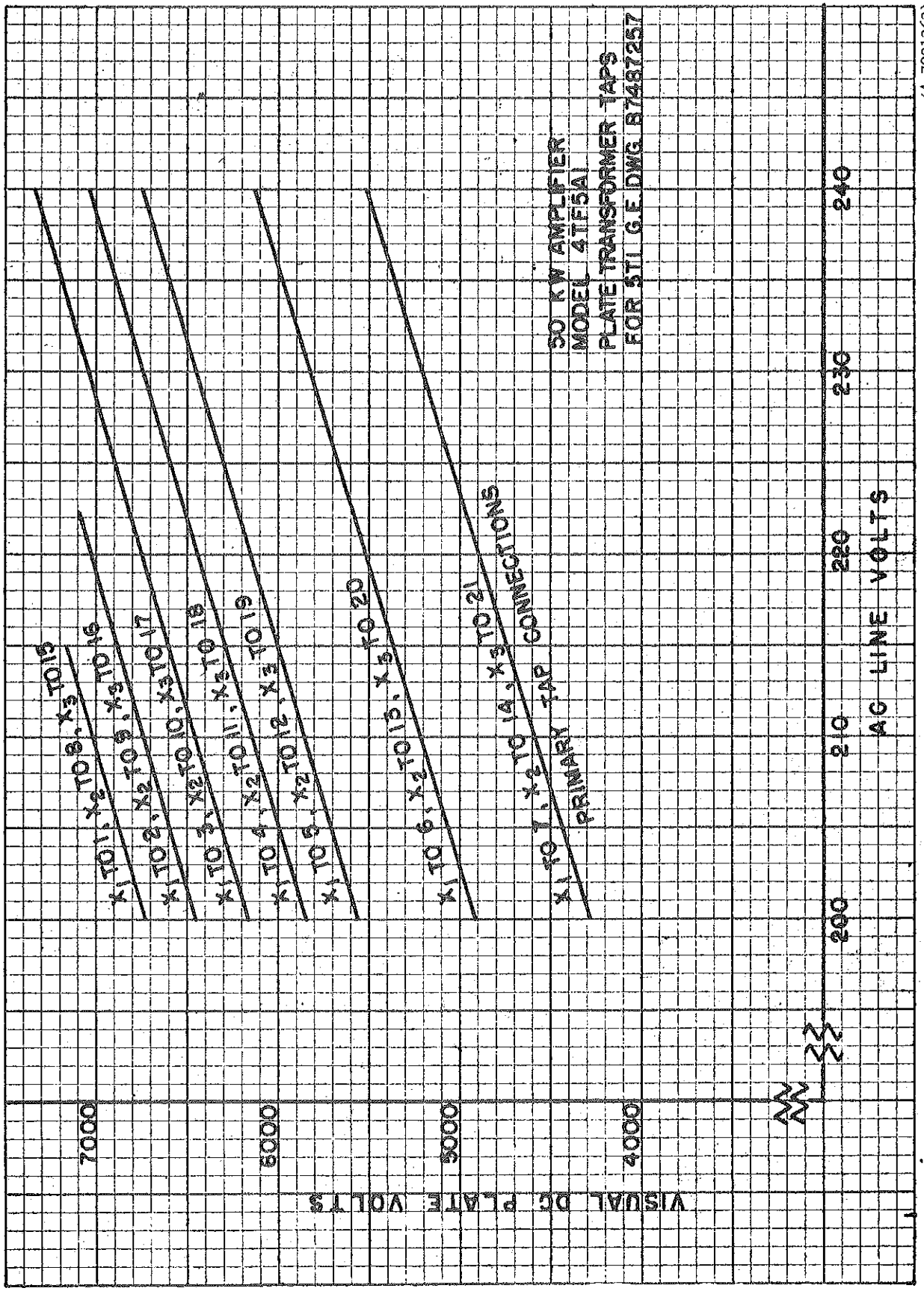


Fig. 37 Aural Amplifier: Correct Bandpass, Lower Marker 1.5 MC Below and Upper Marker 1.5 MC Above Carrier



(A-7991262)

Fig. 38 Graph of Plate Transformer Tap Connections

the parts in the cubicle. The other transformer used should be placed on the floor of the Rectifier cubicle, and the leads from the high-voltage winding should be long enough to reach the primaries of the Rectifier filament transformers listed. The oscilloscope should be placed outside the Rectifier cubicle. Be sure to ground the set-up as shown in Fig. 39. Connect the equipment to the resistor and transformer associated with one tube, for example, 6T6 and 6R5.

Place the DELTA-WYE switch 5S2 in the DELTA position and apply plate voltage with the VISUAL-BOTH-AURAL DC transfer switch in the AURAL position. Increase the screen voltage by means of the SCREEN VOLT ADJUSTMENT until a plate current of 2.5 amperes is read on the PLATE CURRENT meter.

Observe the pattern on the oscilloscope. It will be like that shown in Fig. 40 or 41.

The correct quarter-phasing condition is shown in Fig. 41. If the pattern observed on the oscilloscope is correct, turn off the PLATE VOLTAGE by depressing the RECT OFF push button and move the leads to the next resistor and transformer, and repeat. If the pattern is again like that shown in Fig. 41, move the leads to the next resistor and transformer combination.

If three tubes on one side show correct phasing, the three tubes on the opposite side will be found to be correctly phased. If one side is correctly phased and one tube on the other side shows incorrect phasing, the high-voltage wiring from the secondary of 5T1 is in error.

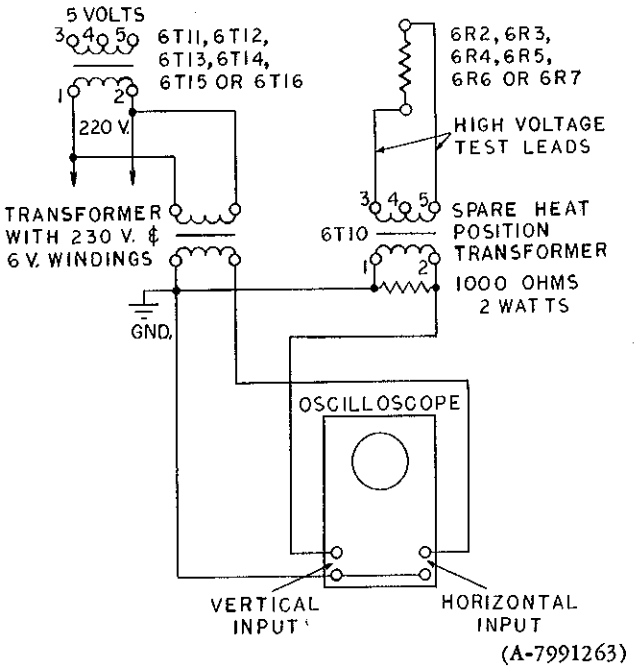


Fig. 39 Quarter-Phasing Connections

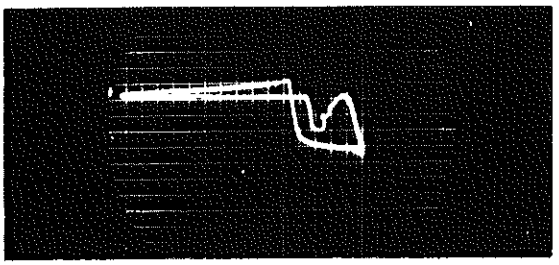


Fig. 40 Incorrect Quarter Phasing

If incorrect phasing is found when checking the first three tubes, the phasing of the Rectifier filament line must be changed. Refer to the Rectifier Elementary Diagram, Fig. 72. The three-phase input to the rectifier filaments are on 6TB2-4, 6TB2-5, and 6TB2-6.

When an incorrect phase is shown for one of the first three tubes, change the leads in the intercubicle connection going to 6TB2-4, 6TB2-5, and 6TB2-6. There are six possible combinations for connecting these three intercubicle wires to the three terminals on the Rectifier terminal board. One combination will give correct phasing for all six tubes. When the correct phasing is obtained for all six rectifier tubes, the equipment is correctly quarter-phased.

15. Adjust the CATHODE BALANCE control 7R9 to obtain the best balance of RIGHT and LEFT CATHODE currents. The currents should be balanced within ± 5%.

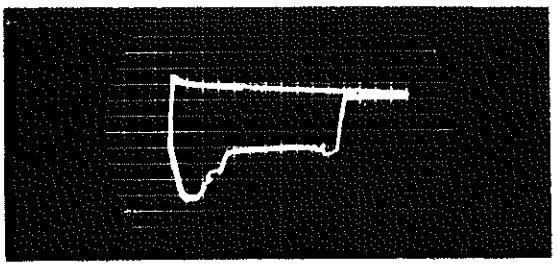


Fig. 41 Correct Quarter Phasing

16. Place the REFLECTOMETER FORWARD-REVERSE switch on the lower panel in the FORWARD position. Rotate the REFLECTOMETER AMP GAIN control 7R34 in the direction to obtain minimum reflectometer relay current as indicated by the REFLECTOMETER RELAY current meter 7M7. Place the DELTA-WYE switch 5S2 in the WYE position.

17. The Aural Amplifier is now ready for the application of driving power. Apply power gradually from the exciter. When sufficient excitation has been applied to cause the plate current to increase to approximately 6 amperes, watch the RF OUTPUT meter and operate the PLATE TUNING switch to maximize this reading. The power output at this point should be 5 to 10 kilowatts, and the screen currents should be

less than 50 milliamperes with the screen voltage at 500 to 700 volts.

18. Remove excitation power and operate the Aural RECTIFIER OFF push button to remove Amplifier plate power. Operate the transformer DELTA-WYE switch to the DELTA position.

19. Re-apply plate power to the Amplifier by depressing the Aural RECTIFIER ON push button. Gradually apply excitation power to the Amplifier. Increase the screen voltage to 600 volts. When sufficient drive power has been applied to bring the Amplifier plate current up to 9.5 amperes, the measured power output should be approximately 27 kilowatts. The PLATE TUNING should be checked to be sure that the RF OUTPUT is maximized, since there is some plate detuning resulting from change of tube capacitance as the tube heats up.

20. Proper tube loading is important. If the tubes are too lightly loaded (bandpass too narrow), the plate voltage swing will be abnormally high, and the tube's ceramic and plate and grid seals will overheat. Prolonged operation under these conditions will cause failure of the tube. If the tube loading is too heavy, that is, the tube load impedance is too low (bandpass too wide), the efficiency of the amplifier will be too low. The correct load impedance is obtained when the sweep response is approximately like that shown in Fig. 37. If the plate current required for 27 kilowatts is greater than 9.75 amperes, the bandpass must be narrowed by reducing the coupling and loading and retuning the output. The Aural Amplifier loading is adjusted to give a certain specified efficiency which is a compromise between the too heavy and too light conditions referred to above. The PLATE tuning switch should be used to maximize the RF OUTPUT meter readings under drive.

21. Under full power operating conditions, it may be necessary to adjust the CATHODE BALANCE control 7R9 to obtain the best balance of RIGHT and LEFT CATHODE currents. The cathode unbalance relay will operate when the unbalance between right and left cathode currents exceeds 10%.

22. With the Amplifier delivering the desired power into the dummy load and the REFLECTOMETER FORWARD-REVERSE switch 7S14 in the FORWARD position, adjust the REFLECTOMETER SENSITIVITY control 7R24 to obtain a reference deflection of 100 on the RF OUTPUT meter. This reference deflection is used as the standard reading for rated power output when the Amplifier is connected to the antenna and will correspond closely with the rated power output determined by the graph of aural efficiency (see Fig. 80) when the correct load impedance is obtained for this Amplifier.

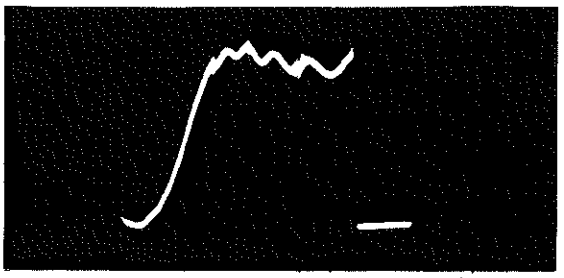


Fig. 42 Aural Amplifier: Correct Bandpass with 500-Foot Transmission-Line Feed to Antenna

23. With power removed, transfer the Amplifier output to the diplexer and the antenna. Check the alignment with the sweep generator to be sure that the Amplifier load is essentially the same as the dummy load. Power may then be re-applied, and the new loading condition should be observed to see whether a slight change of SWR on the output transmission line has changed the tube loading condition. If so, the loading may be slightly readjusted as described above, but this is not usually necessary unless the SWR changes considerably.

See Fig. 42 for the bandpass obtained when feeding an antenna with 500 feet of transmission line. The "wrinkles" on the bandpass are caused by the VSWR of the antenna itself as it is transformed down the length of the transmission line. The amplitude of the wrinkles is a function of the VSWR of the antenna, and the number of wrinkles in the pass band is a function of the actual length of transmission line between the Amplifier and the antenna. A record should be made of the sweep response obtained for each particular installation at the time of original installation. Any major change in the amplitude of the wrinkles indicates trouble in the antenna system.

24. Finally, with the Amplifier delivering rated power and the REFLECTOMETER FORWARD-REVERSE switch 7S14 in the FORWARD position, adjust the REFLECTOMETER AMP GAIN control 7R34 in the direction to obtain a reflectomerer relay current of approximately 2.5 milliamperes as indicated by the REFLECTOMETER RELAY meter 7M7. This relay, 7K17, will pick up at a current of 3.5 to 4 milliamperes and will remove plate power. Under this adjustment, if the transmission-line SWR increases appreciably because of antenna or transmission-line fault, the reflectometer REVERSE voltage will increase, causing 7K17 to pick up, thus protecting the Amplifier and the antenna or transmission line.

25. The Aural Amplifier is now adjusted for normal operation. It is recommended that the shutdown procedure be that of removing drive power before removing plate power from the Amplifier.

VISUAL AMPLIFIER

1. Operate the DC SWITCH 7S8 to the Visual position.

2. The following switches should be closed on the Visual Amplifier cubicle: MAIN FILAMENT and LP FILAMENT. The rear door of the Visual Amplifier and Rectifier cubicles must be closed. The Visual time-delay relay 8K2 will time out one minute after the MAIN FILAMENT and LP FILAMENT switches are closed, and the Visual BIAS and FIL TD STATUS lights should be illuminated.

3. Close the Visual BIAS switch. The Visual BIAS supervisory light should be extinguished, indicating that the Visual bias voltage has been established. Adjust the BIAS ADJUST rheostats 8R38 and 8R39 to give a bias of 20 volts on the right and left amplifier tubes as read on 8M3, the BIAS voltmeter. The lamps in the green RECTIFIER ON push buttons on the Visual and Aural Amplifier cubicles and in the green RECT ON push button on the Rectifier cubicle should be illuminated.

4. Operate the BLANKING, MARKERS, FILAMENT, and MOTOR switches on the sweep generator panel to the ON position.

5. Close the SWEEP switch and operate the OPERATE-SWEEP switch to the SWEEP position. This will apply power to the sweep generator and energize the relays in Sweep Detectors No. 1 and No. 2.

6. Normally the sweep generator will be adjusted before shipment from the factory and will need little, if any, further adjustment. If adjustment is necessary, align the sweep generator as described in the THEORY AND CIRCUIT ANALYSIS, VISUAL AMPLIFIER section. Refer to the Parts List for the correct marker crystals to be used in the Visual sweep generator.

7. Connect a high-gain oscilloscope, such as the G-E Type ST-2-A, to the SCOPE INPUT jack on the sweep generator panel and place the sweep generator 'scope input selector switch in the first DETECTOR position. When the 'scope input selector switch is in this first DETECTOR position, the bandpass of the Visual Amplifier is observed ahead of the Vestigial-Sideband Filter. When the 'scope input switch is in the second DETECTOR position, the bandpass is observed after the Vestigial-Sideband Filter. Refer to the Visual Amplifier Elementary Diagram, Fig. 65. For a complete description of and adjustment procedure for the Vestigial-Sideband Filter, refer to EBI-3326 which is included as an insert in this book.

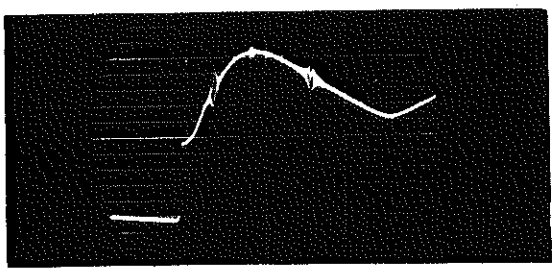


Fig. 43 Visual Amplifier: Sweep Detector No. 1, Correct Bandpass Before VSB Filter, But Too Little Coupling

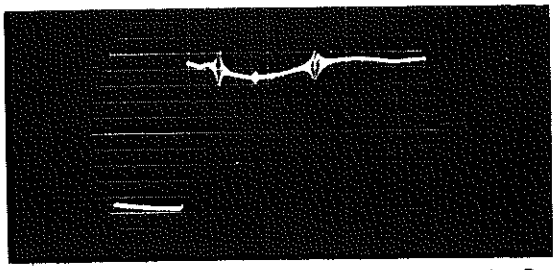


Fig. 44 Visual Amplifier: Sweep Detector No. 1, Correct Bandpass Before VSB Filter, But Too Much Coupling

8. Align the output circuit of the Amplifier as follows. Refer to Fig. 27. The output of the Visual Amplifier cubicle should be connected to the external transmission-line elements, the Vestigial-Sideband Filter, and the Sweep Detector assemblies as shown. A dummy load capable of dissipating 30 kilowatts of RF power should be connected following the Sweep Detector No. 2 assembly.

a. Place the TUNING motor POWER switch 8S29 in the ON position. The TUNING motor POWER supervisory light 8I8 should be illuminated, indicating that power is available for operating the tuning motors.

b. Operate the PLATE TUNING switch 8S28 to resonate the plate circuit. Unless the TUNE (8S27) or output tuning happens to be in resonance, the response obtained by tuning the plate circuit will be a single response which can be tuned to a frequency midway between the marker signals (0.75 megacycles below and 4.2 megacycles above the carrier frequency), a condition similar to that shown in Fig. 34.

c. Operate the TUNE switch 8S27 to resonate the output circuit. Depending upon the output coupling and loading, the resultant response will be either a broader "single-humped" response or a "double-humped" response.

d. Adjust the LOAD switch 8S28 to obtain a response similar to that shown in Fig. 43, 44, or 45. The correct bandpass is shown in Fig. 45. If the bandpass is too narrow, as shown in Fig. 43, or too wide, as shown in Fig. 44, the coupling must be adjusted. To do this, remove the shield covers on the output circuit on each side of the coupling loop. Then, using the box-end ratchet wrench supplied with this equipment, loosen the 1/4-20 hex-head bolts connecting the coupling loop to the output circuit. If the bandpass is found to be too narrow, the coupling loop should be

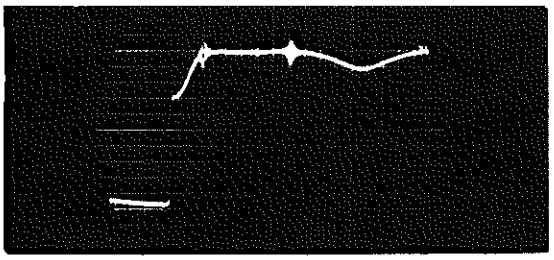


Fig. 45 Visual Amplifier: Sweep Detector No. 1, Correct Bandpass Before VSB Filter, Lower Marker 0.75 MC Below and Upper Marker 4.2 MC Above Carrier

pushed slightly into the cavity to increase the coupling. If the bandpass is found to be too wide, the coupling should be pulled back toward the output circuit to decrease the coupling. Tighten the hex-head 1/4-20 bolts securely and replace the shield covers before proceeding.

e. Place the sweep generator 'scope input selector switch in the second DETECTOR position. The response should be like that shown in Fig. 46 or 47. The adjustment of the Vestigial-Sideband Filter is carefully set and locked at the factory before shipment so that no further adjustment should be required. See EBI-3326 for complete information about this unit.

f. The neutralization of the Visual Amplifier is the same as that of the Aural Amplifier; therefore, refer to the Aural Amplifier subsection for the complete neutralization procedure.

9. Check the bias on the right and left tubes by means of the GRID VOLTAGE meter 8M3 and the transfer switch 8S30.

10. Place the DELTA-WYE switch in the WYE position.

11. Turn the SCREEN REG SUPPLY Powerstat and the SCREEN VOLTAGE CONTROL adjustment to the extreme counterclockwise position. Operate the SCREEN switch to the ON position.

12. Depress the RECTIFIER ON push button. The main plate breaker 5K1 should close, followed by the step-start contactors 6K10 and 6K9 in approximately one second. When the main breaker closes, plate voltage will be established and should be approximately 60 percent of 6500 volts, or 3900 volts.

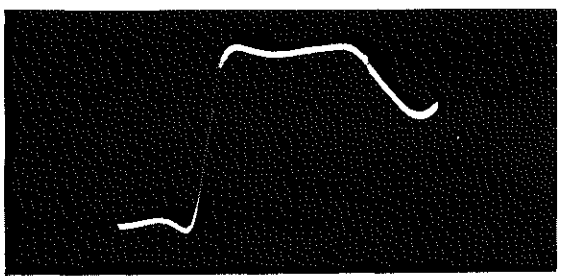


Fig. 46 Visual Amplifier: Sweep Detector No. 2, Correct Bandpass After VSB Filter, Lower Marker 0.75 MC Below Carrier

13. Rotate the SCREEN REG switch to the VOLTAGE position. In this position the SCREEN REG meter reads the voltage drop across the Type 6AS7G screen regulator tubes. Slowly rotate the SCREEN REG SUPPLY control in the "increase" direction. It will be noted that the SCREEN REG voltage will increase as this control is advanced up to approximately 150 to 200 volts and will suddenly drop to zero as the gas-discharge tubes in the screen regulator break down. As the control is increased the SCREEN VOLTAGE will increase to approximatelv 600 volts. At this point, as the SCREEN REG SUPPLY control is further increased, the SCREEN REG VOLTAGE should start to increase and the SCREEN VOLTAGE should remain constant. If not, adjust the SCREEN VOLT ADJUST control until this condition is met. With a SCREEN VOLTAGE of 600 volts the SCREEN REG VOLTAGE should be 125 to 150 volts.

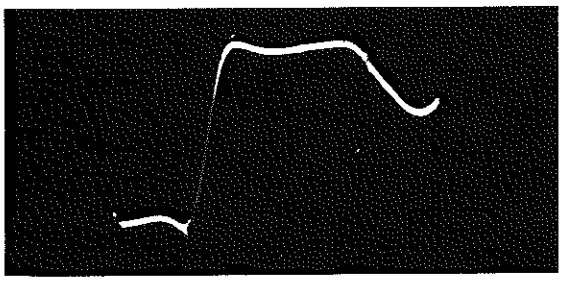


Fig. 47 Visual Amplifier: Sweep Detector No. 2, Correct Bandpass After VSB Filter, Lower Marker 1.25 MC Below Carrier

14. Note the RIGHT and LEFT CATHODE currents and set the RIGHT and LEFT BIAS ADJUST rheostats 8R39 and 8R38 to give a cathode current of 1.25 amperes for each tube.

15. The Visual Amplifier is now ready for the application of excitation power. With normal power supply voltages as described above, the VSWR on the input line to the Amplifier will be 1.2 to 1 or less at the center of the particular channel.

The only remaining circuit adjustment which should be made is the adjustment of the external 1-5/8 inch line stretcher.

The exciter may be adjusted to operate into a dummy load with good SWR and its output then connected to the Amplifier input. Then the Amplifier input may be used in exactly the same way as the dummy load. If the adjustment of the driving transmitter includes the use of a sweep generator to align its circuit, the transmitter may be aligned in the normal manner using the Amplifier input as its load. In this case, either the sweep diode detector at the output of the exciter or at the output of the Amplifier may be

used. When the Amplifier output sweep diode detector is used, the oscilloscope should be connected in the same way as when aligning the Amplifier output circuit, and the Amplifier sweep generator should be made inoperative by placing the sweep generator FILAMENT switch in the OFF position. This prevents the Amplifier sweep generator from superimposing its voltage upon the sweep generator voltage from the exciter.

When the output circuits of the driving transmitter are being adjusted by means of a sweep generator, the oscilloscope should be used to determine whether the indicated circuit response is essentially the same at the exciter output as at the Amplifier output. If one has a definite "tip" or "slope" to what should be the "flat" part of the bandpass, adjust the input line stretcher to make the two responses as nearly alike as possible in this respect.

The two matching adjustments on the front panel of the Amplifier may also be adjusted to give the same bandwidth as obtained with the driving transmitter connected to a dummy load. To use these adjustments it will be necessary to unlock the matcher drive assembly by loosening the nuts holding the push rods actuating the plate on the input matcher. The screwdriver adjustment may then be made from the front panel by removing the two plug buttons above the General Electric nameplate on the front panel.

When a sweep generator is being used to align the exciter, such as would be the case with the G-E Type TT-6-E 5-KW Transmitter, the Amplifier SWEEP-OPERATE switch must be in the SWEEP position when the last two or three stages are being adjusted and when the Amplifier sweep diode detector is being used. However, when the first two or three circuits are being adjusted, the RF level at the Amplifier output resulting from the exciter sweep generator will be high enough to damage the germanium diode detector unless the Amplifier SWEEP-OPERATE switch is in the OPERATE position. In this position the diode is disconnected from the transmission line by a relay. There will be sufficient feed-through in this position to allow the use of this diode under the higher RF drive conditions.

16. Place the Amplifier SWEEP-OPERATE switch in the OPERATE position, the PEAK POWER-REFLECTOMETER switch in the REFLECTOMETER position, and the reflectometer FORWARD-REVERSE switch in the FORWARD position.

17. Gradually apply a black picture (picture at pedestal level) from the exciter and check the average power output into the Amplifier dummy load. Increase the excitation level until a power output of 30 kilowatts is reached. Note the indication of the RF OUTPUT meter. This is the reflectometer "forward" indication which corresponds to this power load.

18. Use an RF output waveform monitor which will accurately measure sync percentage and adjust the exciter sync control to obtain a 25% synchronizing pulse (pedestal level at 75% of synchronizing pulse). Operate the Amplifier PEAK POWER-REFLECTOMETER switch to the PEAK POWER position and observe the indication on the RF OUTPUT meter. Adjust the PEAK POWER ADJUST control until the RF OUTPUT meter reads 100. This is now the reference reading corresponding to 50-KW synchronizing pulse power. This meter reading should be used for normal monitoring of the Visual power output.

19. It is recommended that after the Amplifier has been operating at black level power for two or three minutes the excitation be removed and the Amplifier output circuit alignment be checked.

20. If it is found that there is some unbalance of the CATHODE currents under operating conditions, the individual grid bias may be adjusted for a closer balance (the average of the two cathode currents under a no-excitation condition should be 1.25 amperes).

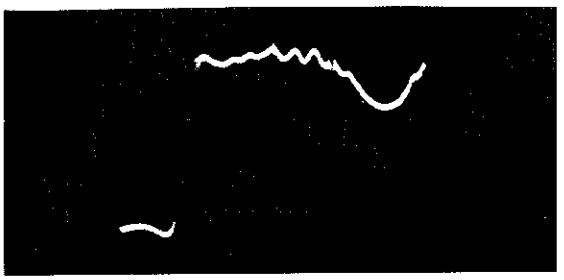


Fig. 48 Visual Amplifier: Correct Bandpass with 500-Foot Transmission-Line Feed to Antenna

21. The Visual Amplifier is now ready for normal operation into the antenna. It may or may not be desirable to make minor readjustments of the circuit alignment when changing from the dummy load to the antenna, depending upon the particular standing-wave ratios which are encountered. See Fig. 48 for the correct bandpass when feeding an antenna with 500 feet of transmission line.

22. It is recommended that the shutdown procedure consist always of removing drive power before removing plate power on the Amplifier.

AURAL AND VISUAL AMPLIFIER

For simultaneous operation of the Aural and Visual Amplifiers, place the DC SWITCH 7S8 on the Aural Amplifier panel in the BOTH position. Plate voltage will now be applied to both Amplifiers simultaneously.

Excitation power may be applied to either or both Amplifiers without effect on the other.

If automatic-plate-reclosure operation is desired in the event of a fault, place the AUTO-RECLOSER switch in the ON position.

ROUTINE OPERATION

During routine operation, it is intended that all power switches on the cubicles be left in the ON position. Power should be removed from the cubicles during the time that the transmitter is shut down by means of the external disconnect switch 5S2.

STARTING PROCEDURE

1. Close the external disconnect switch 5S2, energizing the control circuit.
2. Press the green illuminated AMPLIFIER START push button.
3. After one minute the green RECTIFIER ON push buttons on the Visual and Aural Amplifier cubicles and the green RECT ON push button on the Rectifier cubicle will be illuminated, indicating that the Amplifiers are ready for operation.
4. Press any one of the push buttons mentioned in 3, above, thus applying Amplifier plate power.
5. Apply excitation power to both Amplifiers.

STOPPING PROCEDURE

1. Remove excitation power from both Amplifiers.
2. Press either of the red illuminated RECTIFIER OFF push buttons on the Visual and Aural Amplifier cubicles or the red illuminated RECT OFF push button on the Rectifier cubicle, thus removing plate voltage.
3. Press the red illuminated AMPLIFIER STOP push button on the Aural Amplifier cubicle. The anode blowers will continue to run for three minutes.
4. After the blowers have stopped, open the external disconnect switch 5S2.

TYPICAL METER READINGS

AURAL AMPLIFIER (26.6-KW OUTPUT)

Plate Voltage	6500 volts
Plate Current	9.75 amperes
Grid Current	800 milliamperes
Right Cathode Current	5.4 amperes
Left Cathode Current	5.4 amperes
Right Screen Current	100 milliamperes
Left Screen Current	100 milliamperes
Screen Voltage	700 volts
Regulated Line Voltage (Average)	230 volts
Grid Supply Voltage (Zero Grid Current)	20 volts
Sweep Generator Power Supply	345 volts
Reflectometer Relay Current	2.5 milliamperes

VISUAL AMPLIFIER (50-KW SYNC AND PEDESTAL-BLACK PICTURE)

Plate Voltage	6600 volts
Plate Current	11.5 amperes
Grid Current	1.15 amperes
Right Cathode Current	6.35 amperes
Left Cathode Current	6.35 amperes
Right Screen Current	50 milliamperes
Left Screen Current	50 milliamperes
Screen Voltage	700 volts
Screen Regulated Voltage	150 volts
Right Grid Bias Voltage	22 volts
Left Grid Bias Voltage	22 volts

SWEEP GENERATOR

Oscillator (Blanking Off)	0.38
Oscillator (Blanking On)	0.26
Amplifier (Blanking Off)	0.52
Amplifier (Blanking On)	0.52
MK 1	0.28
MK 2	0.28
Crystal 1	0.35
Crystal 2	0.35

ARC-BACK INDICATOR SUPPLY

175 volts d-c

REFLECTOMETER AMPLIFIER SUPPLY

Approximately 330 volts d-c

GENERAL OPERATING INSTRUCTIONS

The following general comments are intended either to emphasize items covered elsewhere in this book or to supplement them.

1. Since all filaments and low-voltage supplies are controlled by the regulated line voltage, this voltage should be monitored at all times and maintained as nearly as possible at 230 volts. This consideration is important to tube life and to the proper operation of the equipment.

2. The Visual SCREEN REG voltage (anode-to-cathode voltage of the Type 6AS7-G tubes in the screen grid supply) should be maintained in the range of 100 to 150 volts. This voltage will decrease as the screen current increases. It may be adjusted by means of the SCREEN REG SUPPLY control.

3. The Visual SCREEN REG switch and the SCREEN REG meter may be used to measure the individual

cathode currents of the series regulator tubes in the regulated screen supply.

4. It is recommended that new power amplifier tubes be first tested with the plate voltage lowered by placing the DELTA-WYE switch in the WYE position before operating at full power. If the tube has been damaged in shipment or in handling, there is less likelihood of damage to the equipment or to tubes at the reduced voltage.

5. Never operate the SWEEP-OPERATE switch of either Amplifier from the OPERATE to SWEEP positions when excitation power is being applied. Time decay of the exciter power supply voltage may cause burn-out and may necessitate the replacement of the Amplifier sweep diode detector germanium crystals.

6. Note that each reflectometer has a spare crystal mounted adjacent to the forward and reverse couplers. The crystals may be checked by rotating them in the forward coupler. All should give approximately the same reading on the RF OUTPUT meter.

7. The phase of the sweep generator blanking may be adjusted with respect to the image trace by loosening the coupling between the sweep motor 8B101 and the sweep capacitor 8C106 and shifting the angular position of one with respect to the other slightly.

8. In order to obtain reasonable tube efficiency commensurate with best tube plate loading for good tube life, the Visual Amplifier is operated under conditions which will give approximately 5% to 7% compression of sync peak RF voltage. In other words, 30% to 32% sync will be required at the exciter output to produce 25% sync at the Amplifier output (50-KW level). Less compression can be obtained only by heavier plate loading, which reduces efficiency and increases plate current and dissipation.

9. In case of a failure and necessary replacement of a GL-6251 tube, generally the only Amplifier circuit readjustment required will be the PLATE TUNING. In the Aural Amplifier this adjustment can be quickly made by adjusting the PLATE TUNING for maximum RF OUTPUT under operating conditions after tube replacement. (Approximate adjustment should be made under reduced excitation conditions before proceeding to full-power operation.)

In the Visual Amplifier the same procedure may be followed for an approximate circuit adjustment after tube replacement if it is necessary to re-establish operation in a minimum amount of time. However, adjusting for maximum RF OUTPUT may result in the bandpass response being tipped up at the low-frequency or carrier end. This will be indicated by higher than normal screen grid current and by loss of "sync percentage" (sync compression) at the Amplifier output. To remedy this situation, operate the PLATE TUNING control in the up position momentarily (thus adjusting the plate circuit to higher frequency) to obtain as nearly as possible normal sync percentage and screen grid current simultaneously with normal output. Do not adjust the TUNE or LOAD tuning without benefit of the sweep generator.

Check the circuit alignment in the normal manner at the earliest opportunity.

10. Adequate cooling of the power amplifier anodes should be maintained at all times. Refer to the MAINTENANCE section for the daily inspection to be made for this Amplifier.

SAFETY INSPECTION

The Amplifier was designed with the safety of the operating personnel as a prime consideration. All protective circuits were designed to "FAIL SAFE." To insure the proper operation of all interlocks a periodic check should be scheduled and should include the following considerations:

CHECK OF AMPLIFIER INTERLOCKS

1. With all power removed from the equipment, inspect each safety grounding switch for easy operation. Check all connections on the grounding switches for tightness. Make sure that all grounding washers and contacts are firmly seated when the doors are open. Place the DELTA-WYE switch in its neutral position and connect a jumper from 5S3-3 to 5S3-6 inside the DELTA-WYE switch assembly. Turn off the SCREEN switches on the Visual and Aural Amplifier cubicles.

2. Start the Amplifier, and after it times out, proceed to check the electrical interlocks as follows:

Push the green RECTIFIER ON push button. 5K1 will operate, but since the DELTA-WYE switch is in its neutral position there will be no plate voltage on the Amplifier. The screen voltage was initially removed by turning off the SCREEN switches.

Open the rear door of the Visual Amplifier cubicle. 5K1 should drop out.

Close the rear door of the Visual Amplifier cubicle. 5K1 should not come back on.

Repeat the above procedure, checking the rear door interlock operation of the Aural Amplifier and Rectifier cubicles.

Push the green RECTIFIER ON push button. 5K1 should be activated. Open each hinged panel (behind the front access doors of the Visual and Aural Amplifier cubicles) by removing the five screws which hold them secure. 5K1 should drop out each time an individual hinged panel is opened, and the UNDERVOLT-

AGE supervisory light on the Aural Amplifier cubicle should be illuminated. (5K1 will come back on when the door is closed).

The above procedures will check all of the electrical interlocks of the Amplifier.

CHECK OF INTERLOCKS WITH DRIVING TRANSMITTER

Refer to the INSTALLATION section under Interlocks with Driving Transmitter. The following procedure will check these interlocks when the driver used is a General Electric Type TT-6-E Transmitter; a similar procedure should be followed when another type of driving transmitter is used.

1. Turn off the RECTIFIER NO. 1, NO. 2, and NO. 3 circuit breakers located on the front panel of the center cubicle of the Type TT-6-E Transmitter.
2. Turn off the MODULATOR PLATE circuit breaker of the Aural cubicle of the Type TT-6-E Transmitter.
3. Place the SWEEP-OPERATE switches of both Visual and Aural Amplifier cubicles in the OPERATE position.
4. Push a RECTIFIER ON push button on the Amplifier. 5K1 should latch in.
5. Start the Type TT-6-E Transmitter with the circuit breakers mentioned in 1 and 2 above, in the OFF position.
6. After the Type TT-6-E Transmitter times out, push the MAIN ON push button on the Rectifier cubicle and the AURAL PLATE ON push button of the Transmitter each time the interlocks drop them out.

When the SWEEP-OPERATE switch on the Aural Amplifier cubicle is turned to the SWEEP position,

a. The MAIN OFF push button on the TT-6-E Visual Rectifier cubicle is electrically operated and the main Visual plate breaker drops out.

b. The PLATE OFF push button on the Aural cubicle of the TT-6-E is electrically operated and the main Aural plate contactor drops out.

When the SWEEP-OPERATE switch on the Visual Amplifier cubicle is tuned to the SWEEP position,

a. The plate voltage is removed from the Visual exciter in the center cubicle of the TT-6-E.

b. The PLATE OFF push button on the Aural cubicle of the TT-6-E is electrically operated and the main Aural plate contactor drops out.

With the SWEEP-OPERATE switches on both Visual and Aural Amplifier cubicles in the OPERATE position, push a RECTIFIER OFF push button on the Amplifier and observe the following:

a. Plate voltage should be removed from the Visual exciter in the center cubicle of the TT-6-E.

b. Plate voltage should be removed from the second stage Aural of the TT-6-E.

Place the switches turned off in steps 1 and 2, above, in the ON position.

Remove the jumper from 5S3-3 to 5S3-6. Place the DELTA-WYE switch of the Amplifier in the DELTA position. Turn on the SCREEN switches on the Visual and Aural Amplifier cubicles.

The equipment is now ready for normal operation.

MAINTENANCE

PREVENTIVE

GENERAL

When the Amplifier was installed and put into operation, it was in good operating condition. During the final test at the factory, a very careful check is made to make certain that all adjustments are optimum for both peak performance and conservative operation of components, so that with proper care the equipment will give years of reliable service.

Proper care requires the establishment of a definite program of preventive maintenance. This involves a daily, weekly, and semi-annual routine of inspection and adjustment which will maintain the equipment for a period of years at the same efficiency and quality of picture as at the time of installation.

The following sections give general suggestions for caring for the equipment as well as for preventing trouble from developing while on the air.

DAILY

While the Amplifier is on the air, the operator should be continually alert to any change in meter readings, temperatures, and even odors. Periodically he should look for anything unusual on the various meters. At this time he should also reset the REG LINE VOLTAGE to 230 volts. A good operator will immediately notice the characteristic odor of a resistor or transformer as he moves past each cubicle; he is thus likely to be warned of an unusual condition of operation. Upon finding anything unusual, he can look into every circuit from the front and, if necessary, observe components through the windows in the rear doors of the cubicles. If he is able to localize a minor difficulty in this way, he can decide whether or not the equipment can be operated for the remainder of the program without damage.

The readings on the LEFT WATER, RIGHT WATER, and OUTLET WATER pressure meters should be ob-

served to assure that sufficient waterflow is going through each tube. See Fig. 33 for a graph of pressure difference versus water flow. The flow interlock will trip out at 8 gpm or 3.3 pounds difference. Check the reading of the air pressure meter. A pressure of 2.1 inches (water) must be available at all times to adequately cool the seals of the Amplifier tubes.

The power meter reading on the Vestigial-Sideband Filter dummy load should be noted and its value compared to previous readings. This reading will vary with picture content and will be very small.

The level of water in the water tank should be checked.

The cathode currents of the screen regulator tubes should be monitored by means of the front panel switch on the upper left corner of the Visual Amplifier cubicle. These currents will vary with picture content, but unbalance between cathodes of a single 6AS7G tube may be detected, or the lack of emission.

WEEKLY

Once a week the over-all alignment should be checked by following the procedure described in the OPERATION section. This will normally take only a minute or two and will verify proper operation of the Amplifier.

In addition to this operational check, a routine inspection should be made WITH ALL POWER OFF and where repair is needed, it should be made immediately to avoid future trouble. Dust off all surfaces, inspect terminal boards for loose connections and the blower belt for proper tension. Inspect the air filters. Examine all filament connections for evidence of overheating. Tight connections and good contact will help prevent trouble.

Observe all mercury-vapor rectifier tubes while operating. A clear blue glow is characteristic of a good tube; a greenish color indicates that the tube is nearing the end of its useful life.

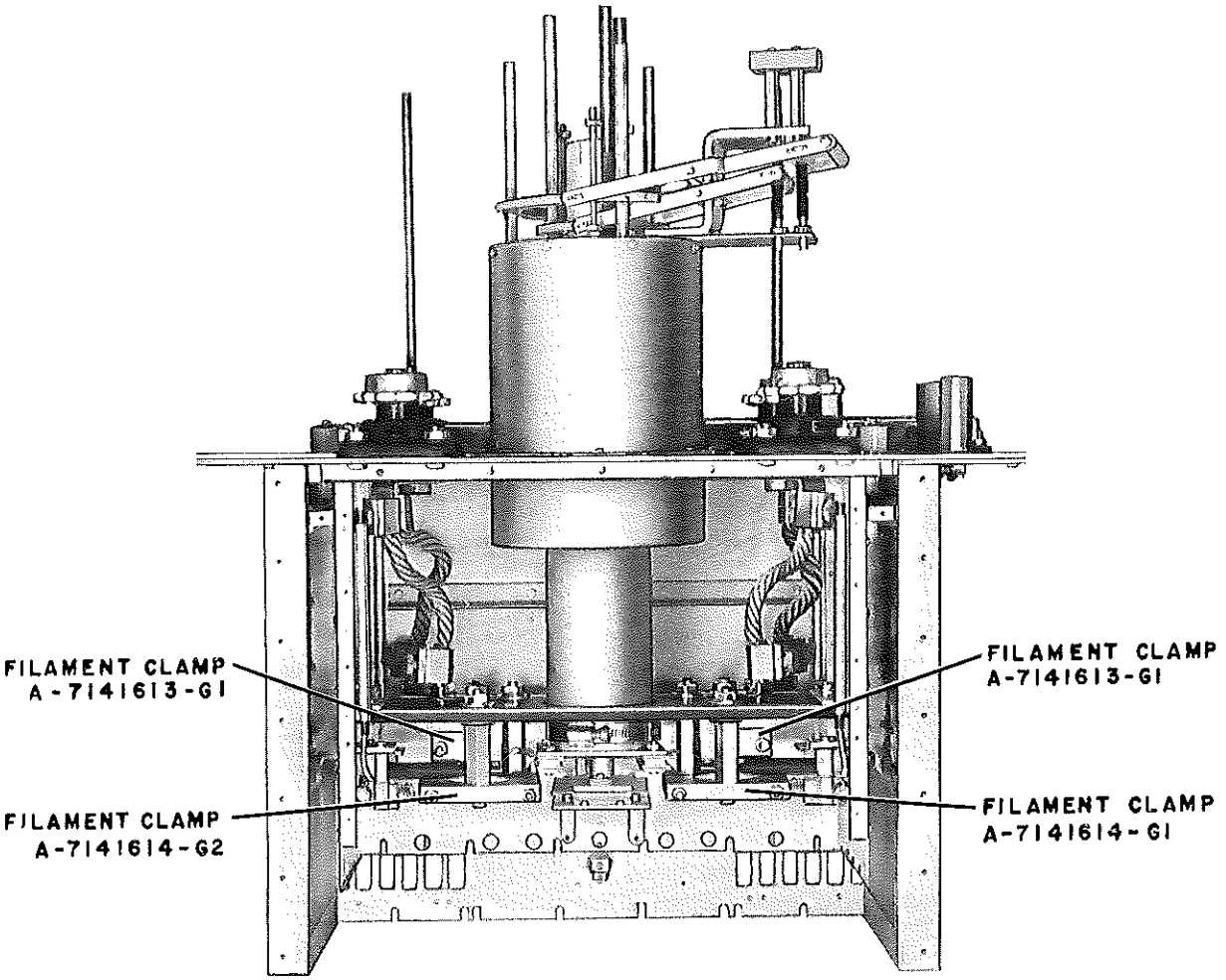


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Fig. 49 Cavity in Process of Construction: Contact Assemblies Lacking, Rear View

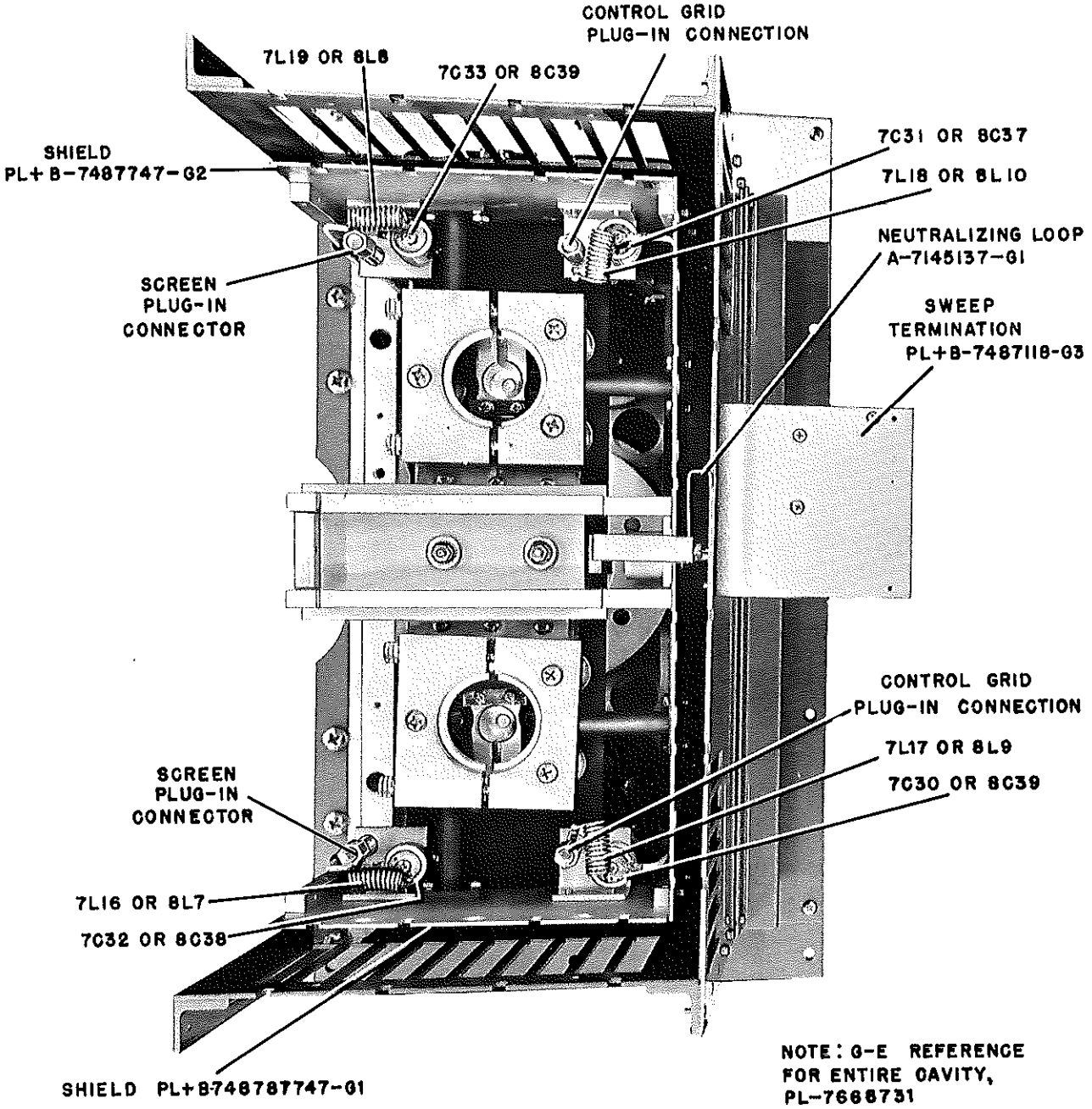

Fig. 50 Cavity in Process of Construction: Contact Assemblies Lacking, Bottom View

SEMI-ANNUALLY

At least twice a year the following maintenance should be performed:

1. Remove and test all receiving-type tubes in a reliable tube checker.

2. Inspect and clean the contacts on all switches, contactors, and relays. Contacts should be dressed if pitted. Use a burnishing tool to clean contacts on all telephone-type relays, the sweep-diode relays on the output transmission lines, and the sweep-termination relays on the front of the PA cavities.

MAINTENANCE OF THE POWERSTAT

Maintain the Powerstat as follows:

CAUTION

A Powerstat variable transformer is essentially a continuously tapped auto-transformer. The rotor should not be slammed against the stop. Such a practice tends to damage and weaken the entire structure of the Powerstat.

If ordinary care is accorded the Powerstat, the brushes are the only element that might require replacement if arcing takes place or if they are badly worn. To replace the brushes proceed in the following manner:

1. Remove the perforated screen.

2. Take out the brushes by removing the brush springs which are held in place by the binding head screws.

3. Insert new brushes obtained from the Superior Electric Company at Bristol, Connecticut. Do not attempt to replace brushes with ordinary grades of carbon, since the brush material used is of special material. Tighten the screws holding the brush springs.

4. Push a screwdriver blade or wood wedge under one brush spring to raise the brushes slightly off the commutator surface. Then place a strip of crocus cloth or very fine sandpaper about one inch wide and 3-1/2 inches long on the commutator and the abrasive surface against the brush.

5. Use some implement to hold the crocus cloth flat against the commutator surface. While holding the cloth tightly in place remove the wedge under the springs and carefully rotate the brush holder assembly over a short arc. Blow out excess carbon particles.

6. Again raise the brush springs and remove the crocus cloth.

7. Rotate the entire assembly many times over the normal full range. This procedure will work in the brushes. After working the brushes in, remove the knob. The brushes should fit flat over the entire commutator range and light should not be visible between the brushes and the commutator surface.

8. Replace the screen, and the Powerstat is again set for service.

Whenever trouble is encountered regarding mechanical or electrical difficulties in the operation of the Powerstat, consult the Superior Electric Company at Bristol, Connecticut.

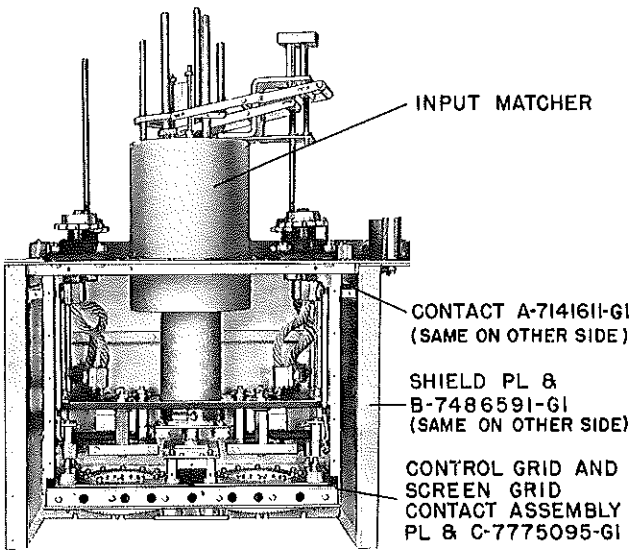

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Fig. 51 Cavity in Process of Construction: Screen Grid and Control Grid Contact Assembly in Place, Rear View

MAINTENANCE OF BLOWERS, PUMP, AND AIR FILTERS

Maintain the blowers, pump, and air filters as described in the following as often as required (semi-annually for ordinary installations).

Oil the motor bearing on the blower motors in the Visual and Aural cubicles. Add one-half teaspoon of electric motor oil or SAE-#10. Grease the bearings on the fan shaft of the blower and heat exchangers with General Electric Grease for Ball and Roller Bearing Motors, using a low-pressure gun. A very small amount of grease will be required. Do not overgrease.

The General Electric Tri-Clad Motors used on the heat exchangers and the water pump are greased as follows. Remove the relief plugs under the bearings to be lubricated. There is a relief plug at each end of each motor. The relief plug for the pump end of the water pump is found underneath the pump, directly under the bearing on the motor. Pump the General Electric grease specified above into the grease fitting until the grease which escapes from the relief hole runs clear. Run the motor with the relief plug out for 15 minutes before replacing the relief plug.

The air filters used on top of the Aural and Visual Amplifier cubicles and in the rear door of the Rectifier cubicle are made by the Farr Company of Los Angeles,

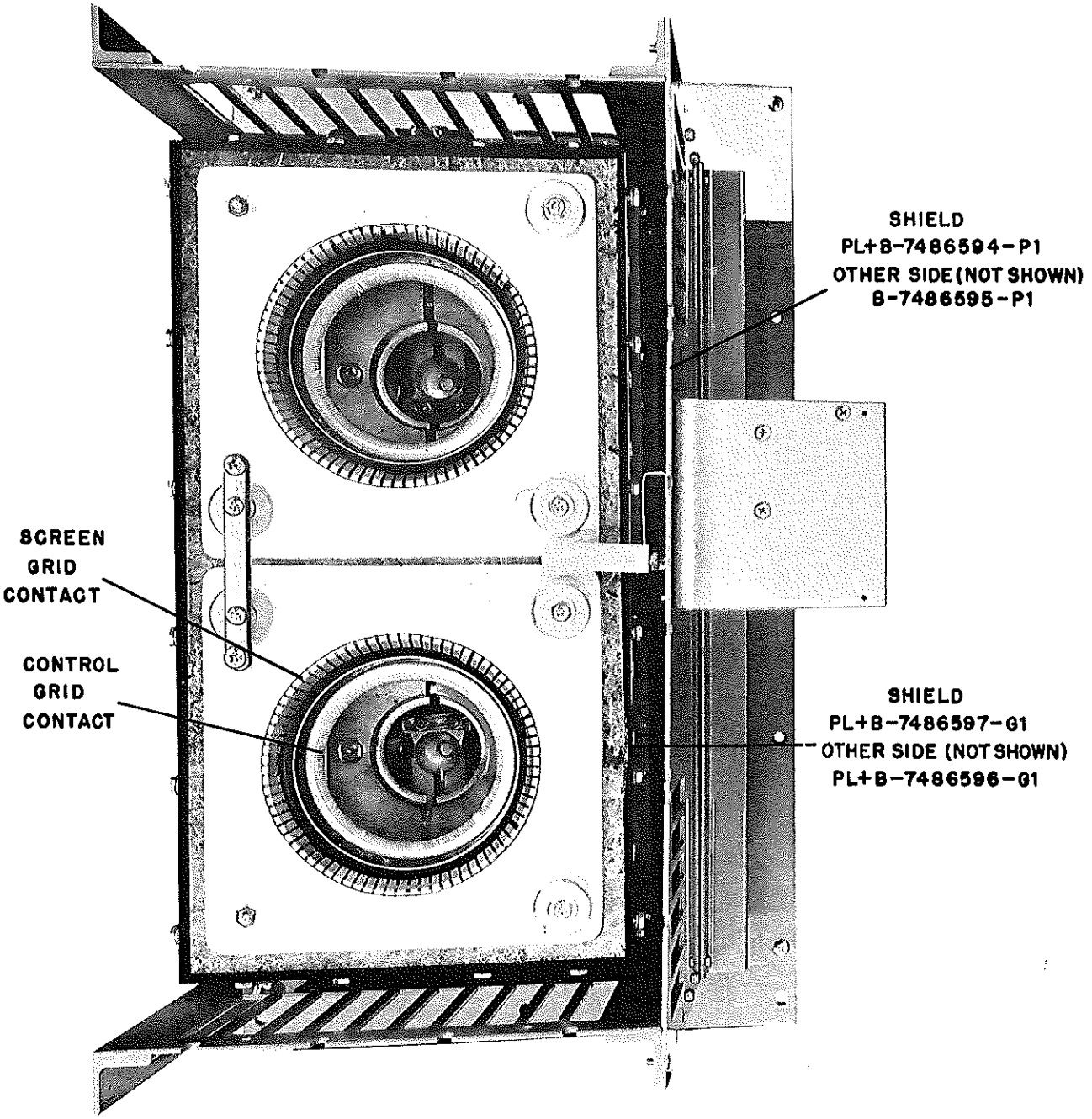

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Fig. 52 Cavity in Process of Construction: Screen Grid and Control Grid Contact Assembly in Place, Bottom View

California, with offices in the principal cities of the United States and Canada.

In general, filters should be cleaned whenever the pressure drop across the filter reaches 1/4 inch of water. Under ordinary conditions Farr-Air filters may be cleaned with hot or cold water. For this cleaning a garden hose and nozzle can be used.

After the filter has been cleaned, it must be oiled by either spraying or dipping. Allow excess oil to drop out of the filter before replacing it.

The Farr Company will service the filters periodically for a nominal fee if the customer so desires. Offices are located in the principal cities of the United States and Canada.

TARGETS

Refer to Fig. 10.

Targets are used on the high-voltage side of each insulating column to prevent electrolytic corrosion of the plumbing fittings used on this equipment. Each target assembly consists of a brass pipe plug to which a brass rod and a platinum wire 0.040 inch in diameter and 3 inches long have been silver-soldered. The platinum wire extends into the insulating tubing and is the point where all electrolytic corrosion will occur. The rate of disintegration of this platinum wire depends upon the leakage current in the insulating columns. The length of the target should be checked semi-annually. In order to do this, it will be necessary to drain the water system and to remove and inspect the target assembly. The targets should be replaced when the remaining length of platinum is less than 3/8 of an inch. FAILURE TO REPLACE THE TARGET BEFORE THE PLATINUM SECTION IS COMPLETELY GONE WILL RESULT IN SERIOUS ELECTROLYTIC CORROSION OF THE PLUMBING FITTINGS.

WATER SYSTEM

The WATER LEAKAGE meter 8M14 reads the current flowing in one of the insulated columns through the water. When the system is clean and uncontaminated, the current will be less than 8 milliamperes. When the current rises to 20 milliamperes, the distilled water in the system should be changed. The system should be flushed twice with tap water each time it becomes necessary to change the distilled water. See steps 19 through 21 under Initial Operation of the OPERATION section.

USE OF SOLVENTS IN FLUSHING THE WATER SYSTEM

It is generally not advisable to use any solvent in cleaning the plumbing in this equipment. Experience has shown that considerable difficulty can be caused by deposits left in the system by the cleaning agent. If it is deemed necessary, because of the hardness of the water obtainable in certain localities, to clean with a solvent, the procedure which follows is suggested.

The only solvent recommended for cleaning this type of plumbing is "Oakite." Use a standard 10-ounce package, obtainable at any grocery store. Before removing the distilled water which has shown increased leakage, add the contents of one package of "Oakite" to the water tank. Run the equipment without applying plate voltage, and heat the water to 120 degrees Fahrenheit by means of filament power only. Keep the temperature of the water at 120 degrees by intermittently turning the HEAT EXCHANGER BLOWERS on. After one-half hour, open the drain on the plumbing system and run tapwater into the water tank. Keep running the tap water into the tank while draining the system until the water running out of the drain is completely clear. Close the drain and heat the water to 120 degrees for another one-half hour. Remove the water through the drain. Refill the system with tap water and let it run for one-half hour after the temperature of the water reaches 120 degrees. Drain the system and refill with distilled water. If the water in your locality is reasonably soft, the system is now ready for operation. If it is not soft, the distilled water should be run for one-half hour at 120 degrees in order to dissolve the minerals left by the tap water and

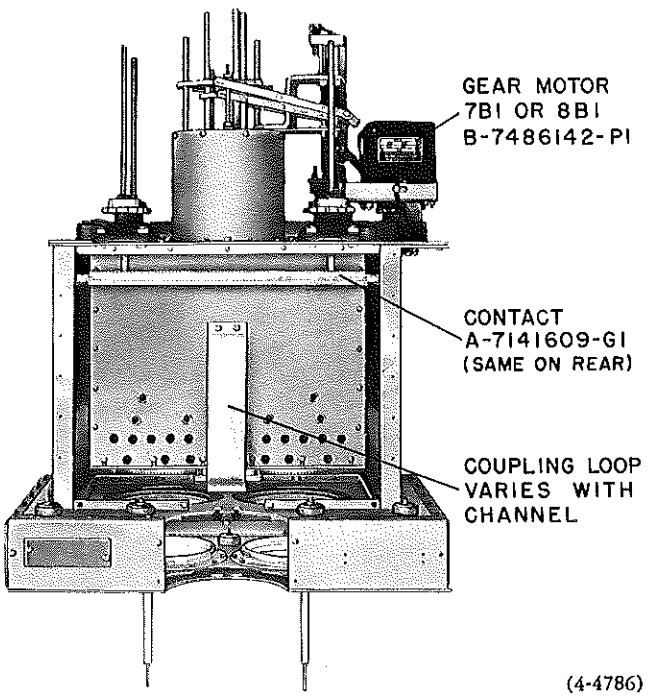

Fig. 53 Cavity in Process of Construction: View of Coupling Loop

should then be discarded. After refilling with distilled water, the system is ready for normal operation.

CORRECTIVE

Effective corrective maintenance depends to a large extent on two factors: properly trained operators and spare parts. It should be the operator's unremitting duty to prepare himself to analyze any possible situation which may cause a failure of the equipment. Because of the expense and complexity of the equipment, it is not usually feasible to have complete standby units; therefore, if a failure should occur, the operator must be prepared to get the Transmitter back on the air with a minimum of delay. In case of failure, the following general procedure is recommended:

1. Notice all the unusual conditions and try to remember them accurately.
2. If possible, analyze the evidence and decide what the trouble must be.
3. Take whatever measures are necessary to get the equipment back on the air, on either a regular or emergency basis, in order to finish the program.

WARNING

During the excitement of getting a failure isolated and repaired the operated must be extremely careful to observe all safety regulations.

In addition to being unusually cautious from the standpoint of personal safety, the operator should be reasonably certain that he has diagnosed the trouble properly before changing a large component which will involve considerable work and time.

It is assumed that the operator will familiarize himself with the control and rectifier circuits sufficiently to know what to do immediately if any supervisory lamp is energized or if any tube or tubes are extinguished.

CAUTION

Whenever about to enter a cubicle to make an adjustment or changes, always open the external disconnect switch so that all voltage (except 115 volts) is disconnected. The input 208/230-volt studs have a current capacity of approximately 60 amperes. Dropping a metal tool across this bus will cause a flash which may cause a severe burn as well as cause damage to the equipment.

ORDERING REPLACEMENT PARTS

In general, parts listed in the Parts List will be stocked and made available from the General Electric Company, Electronics Division, Syracuse, New York. To expedite delivery, the parts requested should be identified by the G-E drawing number where known. Certain mechanical items of the cavity and plumbing are listed in a Mechanical Parts list following the Parts List of electrical components; these may be ordered by the G-E drawing number indicated. Other items are called out in the various photographic illustrations appearing throughout this instruction book and may be ordered by description and by reference to the figure number of the illustration in which they appear. Cavity assembly items are further called out in the photographic illustrations referred to in the sub-section which follows, Cavity Construction, and may be ordered by the appropriate G-E drawing number.

Included in this instruction book there will be found inserts which deal with major components of this equipment, such as motors, water pump, relays, and main contactor. The Electronics Division of the General Electric Company in Syracuse will be happy to supply replacement parts for any of these items, but faster service may be obtained by dealing directly with the nearest service office listed in the applicable insert. Special attention is called to the insert titled "General Electric Small Motor Service Station Plan." All the motors used in this equipment may be supplied with parts by contacting the nearest service shop in this insert. The main plate contactor 5K1 is a General Electric Type AK-1-25 Air Circuit Breaker. The insert dealing with this breaker (GEH-1807) lists the service shops throughout the United States where expert service and spare parts may be quickly obtained. The apparatus shops listed in this insert can also give fast service on any large transformer or reactor used in this equipment.

CAVITY CONSTRUCTION

The Cavity Assembly, G-E Drawing PL-7668731-G1, is identical in the Visual and Aural Amplifiers. Figs. 49 through 55 are photographs taken during the assembly of a cavity. They are supplied here for the convenience of the customer in identifying the various parts of the cavity and in ordering replacement parts by reference to the G-E drawing numbers supplied.

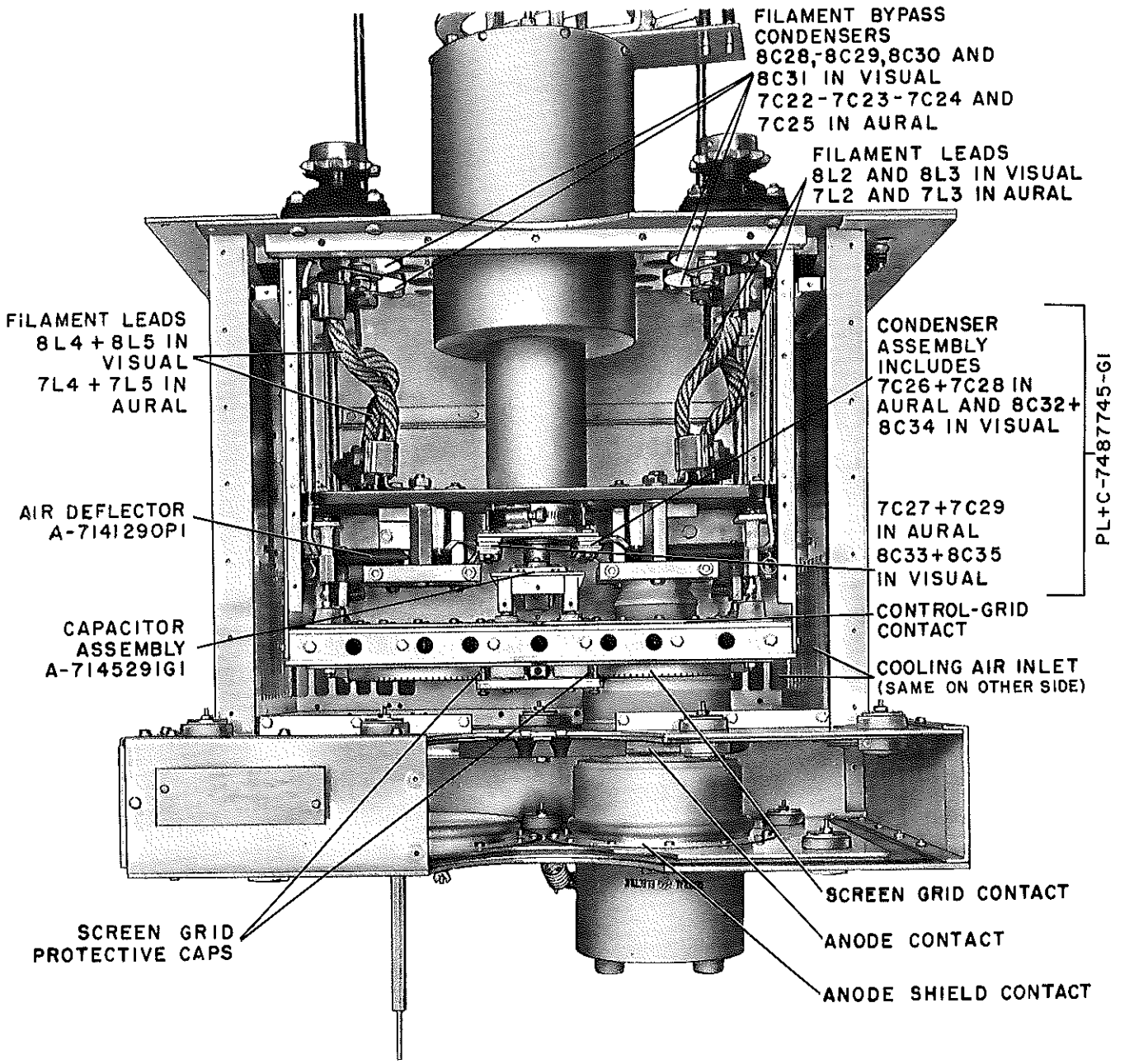

Fig. 54 Cavity in Process of Construction: Anode Contact Assembly and Shield in Place, One Tube Installed, Rear View

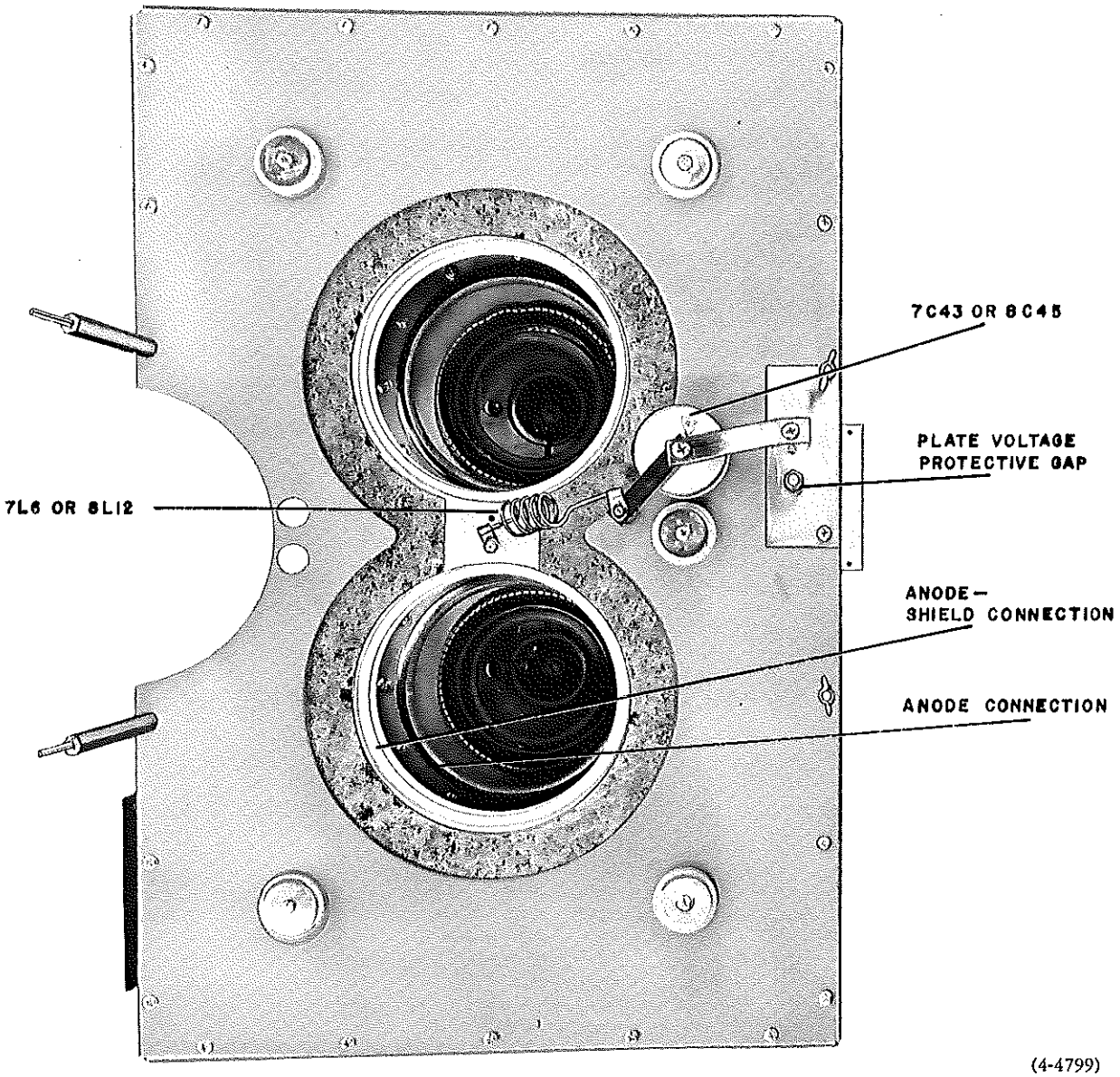

Fig. 55 Cavity in Process of Construction: Anode Contact Assembly and Shield in Place, Tubes Lacking, Bottom View

THEORY AND CIRCUIT ANALYSIS

CONTROL CIRCUITS

GENERAL

In the design of the control circuits, particular attention has been given to safety of personnel, protection of the equipment, and reliability of operation.

Front-of-panel operation is provided for the filament and low-voltage supplies. Adjustment of the high-voltage plate supply is accomplished by primary tap-changing of the high-voltage transformer 5T1.

All relays and contactors, with the exception of overload relays, filament interlock relays, and the main close coil of the circuit breaker 5K1, operate from a 115-volt control transformer, 6T1, with one side grounded. All overload relays are d-c operated; the filament interlock relays operate from the controlled-voltage source for all filaments and low-voltage supplies; and the main close coil of the plate circuit breaker is operated from the main transmitter supply voltage. All relays with more than 115 volts on their terminals are located within the cubicles and are not accessible when the transmitter is in operation.

The rear doors of all the cubicles are equipped with suitable interlocks to remove power from all power supplies. In addition, high-voltage grounding switches short the high-voltage supplies to ground and short circuit the secondary winding of the high-voltage plate transformer.

Circuit protection is provided by direct-current overcurrent relays and magnetically operated circuit breakers. A system of supervisory lights indicates the operation of the d-c overload relays as well as certain other circuit conditions.

Amplifier start-stop and rectifier on-off push buttons are supplied with internal lights to indicate circuit status.

The indicating-light color selection is such that green always indicates ready. It shows that power is available and that the starting sequence has been completed up to that point. Red shows that the circuit is energized and in operation. White indicates an abnormal condition, such as an overload, open door, etc.

Automatic power failure restart and plate overload reclosure with automatic reset are provided for both the Aural and Visual sections.

All a-c operated relays must have their coil voltages reduced to 5/6 of the 60-cps value if operated from a 50-cps power source. This is accomplished by changing a tap on the control transformer 6T1 as described in the INSTALLATION section.

Relays 6K1, 6K5, and 6K14 are latching-type relays. When the latch-in coil is momentarily energized, the operating mechanism is held in the closed position by a mechanical latching device. When the reset coil is momentarily energized, the mechanical latching device is tripped, opening the relay.

The reclosure relay 6K15 is the cycling type. Each time the cycling coil is momentarily energized the relay advances one step until the final step is reached. There are four stepping positions. When the reset coil is energized, the relay returns to its starting position.

Note that the Simplified Control Circuit Elementary Diagram, Fig. 73, shows all relay contacts in their normally energized position, and all latch-type relays in the reset position, with the exception of 6K14. Relay 6K14 is shown in the latched-in position, since this is the normal position, the reset coil being energized only when a plate circuit reclosure is in order.

CONTROL CIRCUIT COMPONENTS AND THEIR FUNCTIONS

Component	Name	Function
6I2	Rectifier DOOR supervisory light	6I2 is energized when the Rectifier door interlock switch 6S11 is closed, indicating that the Rectifier door is open.
6IS1	RECTifier ON push button	Momentary contact of 6IS1 energizes the latch coil of the Rectifier-on latch relay 6K5 and energizes the reclosure reset relay 6K16.
6IS2	RECTifier OFF push button	Momentary contact of 6IS2 energizes the reset coil of the Rectifier-on latch relay 6K5.
6IS3	ARC BACK RESET indicator push button	The normally closed contact opens when 6IS3 is depressed, removing plate power from the arc-back indicating tubes 6V10 through 6V15.

Component	Name	Function
6K1	Amplifier start-stop latch relay	6K1 energizes the blower contactor 6K2, the Visual air contactor 8K8, the Aural air contactor 7K8, the Visual water indicator light relay 8K9, the Aural water indicator light relay 7K9, and the Rectifier filament contactor 6K4. In the reset position, 6K1 energizes the shutdown time-delay relay 6K3 and the lamp in the green AMPLIFIER START push button 7IS2.
6K2	Blower contactor	6K2 energizes the Rectifier blower motors 6BM1 through 6BM4, the Aural blower 7BM1, the Visual blower 8BM1, the Aural blower interlock relay 6K31, the Visual blower interlock relay 6K32, the main water pump, and the two heat exchanger blowers.
6K3	Shutdown time-delay relay	6K3 provides a three-minute time delay in de-energizing 6K2 after the filaments have been de-energized by operating the AMPLIFIER STOP push button.
6K4	Rectifier filament contactor	6K4 energizes the filaments of the high-voltage rectifier tubes 6V1 through 6V6.
6K5	Rectifier-on latch relay	6K5 energizes the auxiliary close solenoid of the main Rectifier breaker 5K1 when in the latch position. In the reset position, 6K5 energizes the shunt trip solenoid of 5K1.
6K6	Restart auxiliary time-delay relay	6K6 delays the reapplication of power to the main Rectifier breaker auxiliary close solenoid after plate power off-on operation.
6K7	Lockout relay	When energized through the normally open auxiliary contact on the main Rectifier breaker, 6K7 removes power from the breaker auxiliary close solenoid and the cutoff-device circuit after a short time delay. 6K7 also provides time delay for the step-start run contactor 6K10 and the Rectifier reclosure auxiliary latch relay 6K14.
6K9	Screen voltage step-start run contactor	6K9 short circuits the step-start resistors in series with the filter capacitors for both Aural and Visual screen voltage supplies a short time after the Rectifier breaker 5K1 closes. These resistors prevent a heavy charging surge through the rectifier tubes.
6K10	High-voltage step-start run contactor	6K10 short circuits the step-start resistors in series with the high-voltage power supply filter capacitors for both Aural and Visual sections of the high-voltage power supply a short time after Rectifier breaker 5K1 closes. These resistors prevent a heavy charging surge through the high-voltage rectifier tubes.
6K11	DC switch transfer relay	6K11 is energized only when the DC switches are in the position specified by the multi-contact selector switch 7S8. When energized, 6K11 ener-

Component	Name	Function
		gizes the red DC SWITCH STATUS supervisory light 7I16 and the restart time-delay relay 6K6.
6K12	Visual HV DC switch	When in the closed position, 6K12 connects the output of the high-voltage rectifier to the Visual HV rectifier filter. When 6K12 is in the open position, the filter is disconnected and grounded. Auxiliary contacts on 6K12 remove power from the momentary-duty transfer solenoids and energize the DC switch transfer relay 6K11 upon completion of the transfer operation.
6K13	Aural HV DC switch	When in the closed position, 6K13 connects the output of the high-voltage rectifier to the Aural rectifier filter. When 6K13 is in the open position, the filter is disconnected and grounded. Auxiliary contacts on 6K13 remove power from the momentary-duty transfer solenoids and energize the DC switch transfer relay 6K11 upon completion of the transfer operation.
6K14	Rectifier reclosure auxiliary latch relay	6K14 de-energizes the lockout relay 6K7 and the restart auxiliary time-delay relay 6K6, and energizes the reclosure coil of the reclosure relay 6K15 when the reset coil of 6K14 is energized. This reset coil is energized whenever the main Rectifier breaker is tripped out and the Rectifier-on latch relay 6K5 is in the latch position, which will be its condition if an overload relay is operated. Note that the contacts of 6K14 are shown in the Elementary Diagram to be in the latch position, which is the normal operating position.
6K15	Rectifier reclosure relay	6K15 operates through one latch position each time the auxiliary relay 6K14 operates to the reset position, resetting 6K14 to the latch position twice and remaining in the reset or lockout position after the third operation.
6K16	Rectifier reclosure manual reset relay	6K16 operates when a RECT ON push button is depressed. It energizes the reset coil of the Rectifier reclosure relay 6K15 and the latch coil of the Rectifier reclosure auxiliary latch relay 6K14.
6K17	Rectifier reclosure automatic reset relay	6K17 is energized when the Rectifier reclosure relay 6K15 is in either the 2nd or 3rd position. After a delay of approximately ten seconds, the contact closes, energizing the reset coil on the Rectifier reclosure relay 6K15.
6K20	Rectifier arc-back supervisory light relay	6K20 is energized by any one of the arc-back indicator tubes 6V1 through 6V6. It energizes the ARC BACK supervisory light 7I12 on the front panel of the Aural Amplifier cubicle.
6K21	Rectifier arc-back relay	When operated, 6K21 energizes the starter anode of the arc-back indicator tube 6V2 and the shunt trip solenoid of the main breaker 5K1.

Component	Name	Function
6K22	Rectifier arc-back relay	When operated, 6K22 energizes the starter anode of the arc-back indicator tube 6V4 and the shunt trip solenoid of the main breaker 5K1.
6K23	Rectifier arc-back relay	When operated, 6K23 energizes the starter anode of the arc-back indicator tube 6V6 and the shunt trip solenoid of the main breaker 5K1.
6K24	Rectifier arc-back relay	When operated, 6K24 energizes the starter anode of the arc-back indicator tube 6V5 and the shunt trip solenoid of the main breaker 5K1.
6K25	Rectifier arc-back relay	When operated, 6K25 energizes the starter anode of the arc-back indicator tube 6V3 and the shunt trip solenoid of the main breaker 5K1.
6K26	Rectifier arc-back relay	When operated, 6K26 energizes the starter anode of the arc-back indicator tube 6V1 and the shunt trip solenoid of the main breaker 5K1.
6K27	Rectifier DC overload relay	When energized, 6K27 energizes the main breaker shunt trip solenoid and its associated supervisory light relay 7K11.
6K30	Rectifier filament interlock relay	6K30 is energized by the high-voltage rectifier filament circuit. It prevents the application of power to the filament time-delay relays 8K2 and 7K2 and interlocks the main breaker undervoltage circuit before the filament circuit is energized.
6K31	Aural blower interlock relay	6K31 is energized by the Aural blower motor circuit. It prevents the application of power to the Aural filament contactor 7K1 before the Aural blower motor is energized.
6K32	Visual blower interlock relay	6K32 is energized by the Visual blower motor circuit. It prevents the application of power to the Visual filament contactor 8K1 before the Visual blower motor is energized.
6S8	Rectifier panel interlock	6S8 de-energizes the main breaker undervoltage (UV) solenoid when the relay panel is opened, causing the breaker to fall out.
6S9	Rectifier panel interlock	Same as 6S8, above.
6S10	Rectifier door interlock	6S10 de-energizes the main breaker undervoltage (UV) solenoid when the rear door of the cubicle is opened, causing the breaker to fall out.
6S11	Rectifier door interlock	The normally closed contacts on 6S11 energize the reset coil of the Rectifier-on latch relay 6K5 and the Rectifier DOOR supervisory light 6I2 when the rear door of the cubicle is opened.
7I1	Aural AIR supervisory light	7I1 is energized when the Aural air interlock switch 7S1 or the filament-wrench switch 7S21 is open, preventing the Aural filament contactor 7K1 from operating.
7I2	Aural WATER supervisory light	7I2 is energized when the water flow interlocks 7S33 and 7S34 or the water temperature inter-

Component	Name	Function
		locks 7S35 and 7S36 are open, preventing the Aural filament contactor 7K1 from operating.
7I3	Aural DOOR supervisory light	7I3 is energized when the Aural door interlock switch 7S2 is open, preventing the Aural bias contactor 7K4 from operating.
7I4	Aural BIAS supervisory light	7I4 is energized when the Aural bias undervoltage relay 7K12 is not energized, preventing the application of Aural plate voltage. It indicates failure of the bias voltage.
7I5	Aural CATHODE UNBALance supervisory light	7I5 is energized when the Aural cathode unbalance relay 7K22 operates. It indicates when the cathode currents of the Aural amplifier tubes differ by more than 10 percent.
7I6	Aural CATHODE (LEFT) overload supervisory light	7I6 is energized after each operation of the Aural cathode overload relay 7K15. It indicates momentary abnormal current in the Aural PA tube 7V7.
7I7	Aural CATHODE (RIGHT) overload supervisory light	7I7 is energized after each operation of the Aural cathode overload relay 7K16. It indicates momentary abnormal current in the Aural PA tube 7V6.
7I8	Aural SCREEN overload supervisory light	7I8 is energized after each operation of the Aural screen overload relay 7K14. It indicates momentary abnormal load on the Aural screen power supply.
7I9	RF OUTPUT supervisory light	7I9 is energized after each operation of the Aural antenna relay 7K17, the Aural output protection relay 7K21, or the Visual output protection relay 8K19. It indicates excessive standing wave ratio in the Aural or Visual transmission line.
7I10	Rectifier DC (HV) supervisory light	7I10 is energized after each operation of the Rectifier DC overload relay 6K27. It indicates momentary abnormal d-c load on the HV plate supply.
7I11	Main breaker UNDER VOLTAGE circuit supervisory light	7I11 is energized by the normally closed contacts of the undervoltage circuit supervisory light relay 7K19 which is not energized when the main breaker undervoltage circuit is open.
7I12	Rectifier ARC BACK supervisory light	7I12 is energized by the Rectifier arc-back supervisory light relay 6K20. It indicates that an arc back has occurred in a HV rectifier tube and that one of the Rectifier arc-back tubes has been ignited.
7I13	Rectifier reclosure LOCK OUT supervisory light	7I13 is energized when the Rectifier reclosure auxiliary latch relay 6K14 is in the reset position. It indicates either that the reclosure relay 6K15 has been operated three times in less than 10 seconds and is in its final position, or that the AUTO RECLOSER switch 7S5 is in the OFF

Component	Name	Function
		position, preventing 6K15 from operating and that 6K14 is preventing subsequent closing of the main Rectifier breaker 5K1.
7I14	AUTO RECLOSER SWITCH supervisory light	7I14 is energized when the AUTO RECLOSER switch 7S5 is in the OFF position. It indicates that the reclosure relay 6K15 has been disconnected, so that no plate reclosures can occur following an overload condition.
7I15	TUNING motor POWER supervisory light	7I15 is energized when the TUNING motor POWER switch 7S32 is closed. It indicates that power is available to operate the tuning motors 7B1, 7B2, and 7B3 whenever TUNING controls 7S29 (PLATE), 7S30 (TUNE), and 7S31 (LOAD) are operated.
7I16	DC SWITCH STATUS supervisory light	7I16 is energized when the DC switch transfer relay 6K11 is operated. It indicates that the DC switches 6K12 and 6K13 have properly operated in accordance with the position of the VISUAL-BOTH-AURAL DC SWITCH 7S8.
7I17	Aural FIL TD STATUS supervisory light	7I17 is energized when the Aural filament time-delay relay 7K2 has timed out or when the EMERGENCY START push button 7S3 has been operated. It indicates that sufficient filament heating time has elapsed to apply HV plate power safely.
7IS1	AMPLIFIER STOP push button	Momentary contact of 7IS1 energizes the reset coil of the latch relay 6K1.
7IS2	AMPLIFIER START push button	Momentary contact of 7IS2 energizes the latch coil of the latch relay 6K1.
7IS3	RECTIFIER ON push button	Momentary contact of 7IS3 energizes the latch coil of the Rectifier-on latch relay 6K5 and the reclosure reset relay 6K16.
7IS4	RECTIFIER OFF push button	Momentary contact of 7IS4 energizes the reset coil of the Rectifier-on latch relay 6K5.
7IS5	Supervisory light RESET push button	The normally closed contact of 7IS5 de-energizes the supervisory light relays 7K5, 7K6, 7K7, 7K10, 7K11, and 8K5, 8K6, 8K7 when 7IS5 is depressed.
7K1	Aural filament contactor	7K1 energizes the filaments of all tubes in the Aural section of the Amplifier.
7K2	Aural filament time-delay relay	7K2 delays the application of plate power for approximately one minute after the application of filament power.
7K3	Aural filament time-delay bypass time-delay relay	7K3 provides a two-second delay in drop-out of the filament time-delay circuit should a momentary power failure occur. It permits instant reapplication of plate power within this time.
7K4	Aural bias contactor	7K4 energizes the aural bias supply.

Component	Name	Function
7K5	Aural cathode supervisory light relay	7K5 is energized by the supervisory light relay 7K15. It locks in, energizing the Aural CATHODE (LEFT) overload supervisory light 7I6.
7K6	Aural cathode supervisory light relay	7K6 is energized by the supervisory light relay 7K16. It locks in, energizing the Aural CATHODE (RIGHT) overload supervisory light 7I7.
7K7	Aural screen supervisory light relay	7K7 is energized by 7K14. It locks in, energizing the Aural SCREEN overload supervisory light 7I8.
7K8	Aural air interlock relay	7K8 prevents the application of filament power to the Aural Amplifier before the Aural blower is operating.
7K9	Aural water interlock relay	7K9 prevents the application of filament power to the Aural Amplifier before the Aural water is circulating.
7K10	RF output supervisory light relay	7K10 is energized by 7K17. It locks in, energizing the RF OUTPUT supervisory light 7I9.
7K11	Rectifier DC supervisory light relay	7K11 is energized by 6K27. It locks in, energizing the rectifier DC (HV) supervisory light 7I10.
7K12	Aural bias undervoltage relay	7K12 prevents the application of plate power to the Aural Amplifier before bias voltage is established.
7K13	Aural filament interlock relay	7K13 is energized by the Aural Amplifier filament circuit. It prevents the application of power to the Aural filament time-delay relay 7K2 and interlocks the main breaker 5K1 before the filament circuit is energized.
7K14	Aural screen overload relay	When energized, 7K14 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 7K7.
7K15	Aural cathode overload relay (left)	When energized, 7K15 de-energizes the main breaker under-voltage solenoid, energizes the main breaker shunt trip solenoid, and energizes its associated supervisory light relay 7K5.
7K16	Aural cathode overload relay (right)	When energized, 7K16 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 7K6.
7K17	Aural RF output relay	When energized, 7K17 de-energizes the main breaker under-voltage solenoid, energizes the main breaker shunt trip solenoid, and energizes the associated supervisory light relay 7K10.
7K18	Aural cathode unbalance supervisory light relay	7K18 is energized by 7K22. It locks in, energizing the CATHODE UNBALANCE supervisory light 7I5.
7K19	Main breaker undervoltage circuit supervisory light relay	7K19 is energized simultaneously with the main breaker undervoltage circuit. When energized, 7K19 de-energizes the main breaker UNDER VOLTAGE circuit supervisory light 7I11.

Component	Name	Function
7K20	Aural sweep termination relay	When energized by the OPERATE-SWEEP switch 7S20 (on the lower front panel), 7K20 connects the Aural sweep termination to the plate circuit RF probe.
7K21	Aural RF output protective relay	When energized, 7K21 energizes the main breaker shunt trip solenoid and energizes the associated supervisory light relay 7K10.
7K22	Aural cathode unbalance relay	When energized, 7K22 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 7K18.
7K23	Aural and Visual screen supply contactor	When energized by the main breaker interlock, 7K23 energizes the Aural and Visual Amplifier screen supply.
7S1	Aural air interlock switch	7S1 is an air-velocity operated switch which prevents operation of the Aural filament contactor 7K1 until there is tube-cooling air flowing past the Aural PA tubes.
7S2	Aural door interlock switch	7S2 prevents the application of power to the Aural bias contactor 7K4 when the rear door of the Aural Amplifier cubicle is open.
7S3	Aural EMERGENCY START push button	Momentary contact of 7S3 bypasses the Aural time-delay relay 7K2, sealing in the bypass time-delay relay 7K3. This permits emergency application of plate power in less than one minute after a power failure.
7S4	Aural door interlock switch	7S4 energizes the reset coil of the Rectifier-on latch relay 6K5 when the rear door of the Aural Amplifier cubicle is open, unless 7S8 is in the VISUAL position.
7S5	Plate reclosure switch (AUTO RECLOSER switch)	When in the OFF position, 7S5 prevents the reclosure relay 6K15 from operating and energizes the reclosure switch supervisory light transformer 7T11.
7S8	VISUAL-BOTH-AURAL DC SWITCH	This multiple-contact switch performs all the switching necessary to enable operation of either the Aural or Visual Amplifier separately, or both simultaneously from a common high-voltage rectifier while maintaining all control circuit features and safety provisions in all three positions. The specific functions of its contacts, numbered below as they appear on the Power Distribution and Control Elementary Diagram, Fig. 76, are as follows: (1) In the AURAL position, this contact permits the application of power to the latch coil of the Rectifier-on relay 6K5 when the Visual filament interlock relay 8K10 and the Visual bias undervoltage relays 8K12 and 8K13 are de-energized.

Component	Name	Function
		(2) In the VISUAL position, this contact permits the application of power to the latch coil of the Rectifier-on latch relay 6K5 when the Aural filament interlock relay 7K13 and the Aural bias undervoltage relay 7K12 are de-energized.
		(3) In the AURAL position, this contact prevents the Visual door interlock 8S3 from energizing the reset coil of the Rectifier-on latch relay 6K5 when the rear door of the Visual Amplifier cubicle is open.
		(4) In the VISUAL position, this contact prevents the Aural door interlock 7S4 from energizing the reset coil of the Rectifier-on latch relay 6K5 when the rear door of the Aural Amplifier cubicle is open.
		(5) In the VISUAL position, this contact prevents the Aural cathode overload relays 7K15 and 7K16, the Aural screen overload relay 7K14, and the Aural RF output relay 7K17 from energizing the shunt trip solenoid of the main breaker 5K1.
		(6) In the AURAL position, this contact prevents the Visual cathode overload relays 8K14 and 8K15, the Visual screen overload relay 8K11, and the Visual cathode unbalance relay 8K13 from energizing the shunt trip solenoid of the main breaker 5K1.
		(7) In the AURAL position, this contact shorts out the contacts of the Visual interlocking and overload relays 8K10, 8K12, 8K13 and the Visual panel interlock switch 8S11, preventing them from de-energizing the undervoltage solenoid of the main breaker 5K1.
		(8) In the VISUAL position, this contact shorts out the contacts of the Aural interlocking and overload relays 7K12, 7K13, 7K17 and the Aural panel interlock switch 7S22, preventing them from de-energizing the undervoltage solenoid of the main breaker 5K1.
		(9) This contact opens the main breaker undervoltage solenoid circuit when 7S8 is between the main positions of AURAL only, BOTH, or VISUAL only. This insures that there can be no transfer switching with HV plate power on.
		(10) When closed in the VISUAL or BOTH position, this contact energizes the close solenoid on the Visual HV DC switch 6K12.

Component	Name	Function
		(11) When closed in the AURAL position, this contact energizes the open solenoid on the Visual HV DC switch 6K12.
		(12) When closed in the AURAL or BOTH position, this contact energizes the close solenoid on the Aural HV DC switch 6K13.
		(13) When closed in the VISUAL position, this contact energizes the open solenoid on the Aural HV DC switch 6K13.
		(14) and (15) When open in the AURAL position, these contacts prevent the application of power to the Visual screen supply.
		(16) and (17) When open in the VISUAL position, these contacts prevent the application of power to the Aural screen supply.
		(18) When open in the AURAL position, this contact interlocks the Visual exciter control circuit to prevent the application of excitation power to the Visual Amplifier.
		(19) When open in the VISUAL position, this contact interlocks the Aural exciter control circuit to prevent the application of excitation power to the Aural Amplifier.
		(20) and (21) These contacts operate in conjunction with the auxiliary contacts on the HV DC switches 6K12 and 6K13 to insure that the transfer auxiliary relay 6K11 will be energized only when 6K12 and 6K13 have properly transferred to the positions called for by the transfer switch 7S8.
7S21	Aural filament wrench interlock switch	When the Aural filament wrench is not in its proper storage position, 7S21 de-energizes the Aural air interlock relay 7K8, preventing the Aural filament contactor 7K1 from operating.
7S22	Aural relay panel interlock switch	7S22 prevents the application of power to the undervoltage solenoid of the main breaker 5K1.
7S33	Aural water flow interlock switch (left)	When the water flow drops below 8 gallons per minute, 7S33 de-energizes the Aural water interlock relay 7K9, preventing the Aural filament contactor 7K1 from operating.
7S34	Aural water flow interlock switch (right)	When the water flow drops below 8 gallons per minute, 7S34 de-energizes the Aural water interlock relay 7K9, preventing the Aural filament contactor 7K1 from operating.
7S35	Aural water temperature interlock switch (left)	When the Aural water temperature exceeds 70 C (158F), 7S35 de-energizes the Aural water interlock 7K9, preventing the Aural filament contactor 7K1 from operating.

Component	Name	Function
7S36	Aural water temperature interlock switch (right)	When the Aural water temperature exceeds 70C (158F), 7S36 de-energizes the Aural water interlock 7K9, preventing the Aural filament contactor 7K1 from operating.
8I1	Visual AIR supervisory light	8I1 is energized when the Visual air interlock switch 8S8 or the Visual filament-wrench interlock 8S18 is open, preventing the Visual filament contactor 8K1 from operating.
8I2	Visual DOOR supervisory light	8I2 is energized when the Visual door interlock 8S1 is open, preventing the Visual bias contactor 8K4 from operating.
8I3	Visual BIAS supervisory light	8I3 is energized when the Visual bias undervoltage relay 8K12 is not energized, preventing the application of Visual plate voltage. It indicates bias voltage failure.
8I4	Visual CATHODE overload supervisory light (RIGHT)	8I4 is energized after each operation of the Visual cathode overload relay 8K14. It indicates momentary abnormal cathode current in the Visual PA tube 8V11.
8I5	Visual CATHODE overload supervisory light (LEFT)	8I5 is energized after each operation of the Visual cathode overload relay 8K15. It indicates momentary abnormal cathode current in the Visual PA tube 8V10.
8I6	Visual SCREEN supervisory light	8I6 is energized after each operation of the Visual screen overload relay 8K11. It indicates momentary abnormal screen current to the PA.
8I7	Visual FIL TD STATUS supervisory light	8I7 is energized when the Visual filament time-delay relay 8K2 has timed out, or when the EMERGENCY START push button 8S2 has been operated. It indicates that sufficient filament heating time has elapsed to apply HV plate power safely.
8I8	TUNING motor POWER supervisory light	8I8 is energized when the TUNING motor POWER switch 8S29 is closed. It indicates that power is available to operate the tuning motors, 8B1, 8B2, and 8B3 whenever the tuning controls 8S26, 8S27, and 8S28 are operated.
8I9	Visual WATER supervisory light	8I9 is energized when the water flow interlocks 8S31 and 8S32 or the water temperature interlocks 8S33 and 8S34 are open, preventing the Visual filament contactor 8K1 from operating.
8I10	Visual CATHODE UNBALance supervisory light	8I10 is energized when the Visual cathode unbalance relay 8K13 operates. It indicates when the cathode currents of the Visual PA tubes differ by more than 10 percent.
8IS1	Visual RECTIFIER ON push button	Momentary contact of 8IS1 energizes the latch coil of the Rectifier-on latch relay 6K5 and energizes the reclosure reset relay 6K16.
8IS2	Visual RECTIFIER OFF push button	Momentary contact of 8IS2 energizes the reset coil of the Rectifier-on latch relay 6K5.

Component	Name	Function
8K1	Visual filament contactor	8K1 energizes the filaments of all tubes in the Visual section of the Amplifier.
8K2	Visual filament time-delay relay	8K2 delays the application of plate power for approximately one minute after the application of filament power.
8K3	Visual filament time-delay bypass time-delay relay	8K3 provides a two-second delay in the drop-out of the filament time-delay circuit should a momentary power failure occur. It permits instant re-application of plate power within this time.
8K4	Visual bias contactor	8K4 energizes the Visual bias supply.
8K5	Visual cathode supervisory light relay (right)	8K5 is energized by 8K14. It locks in, energizing the Visual CATHODE (RIGHT) overload supervisory light 8I4.
8K6	Visual cathode supervisory light relay (left)	8K6 is energized by 8K15. It locks in, energizing the Visual CATHODE (LEFT) overload supervisory light 8I5.
8K7	Visual screen supervisory light relay	8K7 is energized by 8K11. It locks in, energizing the Visual SCREEN overload supervisory light 8I6.
8K8	Visual air interlock	8K8 prevents the application of filament power to the Visual Amplifier before the Visual blower is operating.
8K9	Visual water interlock relay	8K9 prevents the application of filament power to the Visual Amplifier before Visual water is circulating.
8K10	Visual filament interlock relay	8K10 is energized by the Visual Amplifier filament circuit. It prevents the application of power to the Visual filament time-delay relay 8K2 and interlocks the main breaker 5K1 before the filament circuit is energized.
8K11	Visual screen overload relay	When energized, 8K11 de-energizes the main breaker undervoltage solenoid, energizes the main breaker shunt trip solenoid, and energizes its associated supervisory light relay 8K7.
8K12	Visual bias undervoltage relay	8K12 interlocks the main breaker 5K1 and prevents the application of plate power to the Visual Amplifier before the bias voltage is established.
8K13	Visual cathode unbalance relay	When energized, 8K13 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 8K16.
8K14	Visual cathode overload relay (right)	When energized, 8K14 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 8K5.
8K15	Visual cathode overload relay (left)	When energized, 8K15 energizes the main breaker shunt trip solenoid and energizes its associated supervisory light relay 8K6.

Component	Name	Function
8K16	Visual cathode unbalance supervisory light relay	8K16 is energized by 8K13. It locks in, energizing the CATHODE UNBALANCE supervisory light 8I10.
8K17	Visual overdrive relay	8K17 is energized by an excessive flow of screen current. It will close its normally closed contacts much faster than the screen overload relay 8K11 operates. If the excessive screen current was caused by excessive drive and the contacts of 8K17 are connected back to the driving transmitter in a circuit to reduce the drive, it will prevent a screen overload. Relay 8K17 need not be connected when using a driving transmitter rated at 5 kilowatts. 8R3 adjusts the operating point of this relay.
8K18	Visual sweep termination relay	When energized by the OPERATE-SWEEP switch 8S17 (on the lower front panel), 8K18 connects the Visual sweep termination to the plate circuit RF probe.
8K19	Visual RF output protective relay	When energized, 8K19 energizes the main breaker shunt trip solenoid and energizes the associated supervisory light relay 7K10.
8S1	Visual door interlock switch	8S1 prevents the application of power to the Visual bias contactor when the rear door of the Visual Amplifier cubicle is open.
8S2	Visual EMERGENCY START push button	Momentary contact of 8S2 bypasses the Visual filament time-delay relay 8K2, sealing in the bypass time-delay relay 8K3. This permits emergency application of plate power in less than one minute after a power failure.
8S3	Visual door interlock switch	8S3 energizes the reset coil of the Rectifier-on latch relay 6K5 when the rear door of the Visual Amplifier cubicle is open, unless 7S8 is in the Aural position.
8S8	Visual air interlock switch	8S8 is an air-velocity operated switch which prevents operation of the Visual filament contactor 8K1 until there is tube-cooling air flowing past the Visual PA tubes.
8S11	Visual relay panel interlock switch	8S11 prevents the application of power to the undervoltage solenoid of the main breaker 5K1.
8S18	Visual filament wrench interlock switch	When the Visual filament wrench is not in its proper storage position, 8S18 de-energizes the Visual filament contactor 8K1.
8S31	Visual water flow interlock switch (left)	When the water flow drops below 8 gallons per minute, 8S31 de-energizes the Visual water interlock relay 8K9, preventing the Visual filament contactor 8K1 from operating.
8S32	Visual water flow interlock switch (right)	When the water flow drops below 8 gallons per minute, 8S32 de-energizes the Visual water interlock relay 8K9, preventing the Visual filament contactor 8K1 from operating.

Component	Name	Function
8S33	Visual water temperature interlock switch (left)	When the Visual water temperature exceeds 70C (158F), 8S33 de-energizes the Visual water interlock relay 8K9, preventing the Visual filament contactor 8K1 from operating.
8S34	Visual water temperature interlock switch (right)	When the Visual water temperature exceeds 70C (158F), 8S34 de-energizes the Visual water interlock relay 8K9, preventing the Visual filament contactor 8K1 from operating.

STARTING SEQUENCE

Assuming that all circuit breakers and the doors of all cubicles are closed, the starting sequence is as follows:

Pressing the green AMPLIFIER START push button 7IS2 on the front panel of the Aural Amplifier cubicle energizes the latch coil of the Amplifier start-stop latch relay 6K1, which mechanically latches in. Relay 6K1 energizes the cooling contactor 6K2, applying power to the blower and water pump motors, de-energizes the shutdown time-delay relay 6K3, de-energizes the lamp in 7IS2, energizes the lamp in the red AMPLIFIER STOP push button 7IS1, energizes the Rectifier filament contactor 6K4, which applies power in the Rectifier and Control cubicle, partially completes the circuit of the Aural (7K8) and Visual (8K8) air interlock relays and the Aural (7K9) and Visual (8K9) water interlock relays. The blower interlock relays 6K31 and 6K32 are energized as soon as power is applied to the blower motors. As soon as the Aural and Visual blower motors come up to speed and the proper air flow is established, air interlock switches 7S1 and 8S8 close. The Aural (7K8) and Visual (8K8) air interlock relays are then energized, partially closing the circuit to their respective filament contactors 7K1 and 8K1 and de-energizing the Aural (7I1) and Visual (8I1) AIR supervisory lights. The Aural (7K9) and Visual (8K9) water interlock relays are energized when the proper water flow is established, completing the circuit to their respective filament contactors 7K1 and 8K1 and de-energizing the Aural (7I2) and Visual (8I9) WATER supervisory lights.

Filament power having been applied, the Rectifier filament interlock relay 6K30, the Visual filament interlock relay 8K10, and the Aural filament interlock relay 7K13 are all energized. These in turn energize the filament time-delay relays 8K2 and 7K2, partially complete the circuits of the latch coil of the Rectifier-on latch relay 6K5, and partially complete the undervoltage solenoid circuit of the main breaker 5K1. When the contacts of 8K2 and 7K2 close, the filament time-delay bypass time-delay relays 8K3 and 7K3 are energized, closing their contacts; the lamps in the filament time-delay status lights 8I7 and 7I17 are energized; the Visual and Aural BIAS supervisory lights 8I3 and 7I4 are energized; the Visual and Aural DOOR supervisory lights 8I2 and 7I3 are energized; and the bias contactors 8K4 and 7K4 are energized. Energizing 8K4 and 7K4 immediately de-energizes the DOOR supervisory lights 8I2 and 7I3 and applies power to the Visual and Aural bias supplies. As soon as bias voltages are established, the bias undervoltage relays 8K12 and 7K12 are energized. Contacts on these relays de-energize the BIAS supervisory lights 8I3 and 7I4, partially complete the circuit of the latch coil of the Rectifier-on latch relay 6K5, energize the green RECTIFIER ON push buttons 7IS3 and 8IS1 and the green RECT ON push button 6IS1, energize the restart auxiliary relay 6K6 through a normally closed (NC) contact of 6K14 and a normally open (NO) contact of the transfer auxiliary relay 6K11 (relay 6K11 is energized in normal operation), and complete the undervoltage solenoid circuit of the main breaker 5K1.

Note that the BIAS supervisory lights are energized only when the bias contactors 8K4 and 7K4 are closed and the bias undervoltage relays have not operated. Also, the DOOR supervisory lights are energized only when the bias contactors are not energized because of an open door interlock.

Both the Visual and Aural sections of the Amplifier are now ready for the application of HV plate power. Depressing the RECTIFIER ON push buttons 8IS1, 7IS3 or the RECT ON push button 6IS1 momentarily energizes the latch coil of 6K5 and the reclosure reset relay 6K16. Relay 6K5 latches in mechanically. One of its normally closed (NC) contacts in the main breaker shunt trip circuit opens, and the other normally open (NO) contact in the auxiliary close solenoid circuit closes, applying power to the auxiliary close solenoid of 5K1.

The main breaker auxiliary close relay completes the circuit of the main close solenoid (assuming that the main close switch 5S1 is closed), causing the main breaker to operate. Power is then applied to the main plate transformer 5T1 and to both the Visual and Aural screen supplies. Auxiliary contacts in the main break-

er also de-energize the lamps in the green push buttons 6IS1, 7IS3, and 8IS1, complete the interlock circuits for the power supplies of the Aural and Visual sections of the exciter, energize the lockout relay 6K7, close in series with the breaker shunt trip circuit, open the solenoid circuits of DC switches 6K12 and 6K13, and open in series with the reset coil of the reclosure auxiliary latch relay 6K14. Breaker 5K1 mechanically latches in, and the contacts of the cutoff device are transferred mechanically by the up-stroke of the solenoid, the normally closed (NC) contact opening the auxiliary close solenoid, which de-energizes the main close solenoid.

When the lockout relay 6K7 is energized, one of its normally open (NO) contacts closes immediately in parallel with the auxiliary contact of 5K1 which initially energized 6K7, sealing it in; a second normally closed (NC) contact with time-delay opening opens after a short time and de-energizes the auxiliary close solenoid and the cutoff device circuit; and a third normally open (NO) contact with time-delay closing closes, energizing the Rectifier step-start run contactor 6K10 and the Aural and Visual step-start run contactor 6K9, energizes the lamps in the red RECTIFIER OFF push buttons 8IS2 and 7IS4 and in the red RECT OFF push button 6IS2, and partially completes the circuit of the reset coil of the Rectifier reclosure auxiliary latch relay 6K14. This completes the application of HV plate power to both sections of the Amplifier.

STOPPING SEQUENCE

Rectifier Off

Depressing either one of the red RECTIFIER OFF push buttons 7IS4 or 8IS2, or the red RECT OFF push button 6IS2 energizes the reset coil of the Rectifier-on latch relay 6K5. When 6K5 resets, a normally closed (NC) contact energizes the shunt trip solenoid of 5K1 through one of its normally open (NO) auxiliary contacts, which opens as soon as 5K1 drops out. The other contact of 6K5, which is a normally open (NO) contact, opens and de-energizes the lockout relay 6K7. Simultaneously, the step-start run contactors 6K9 and 6K10 are de-energized, and the lamps in the RECTIFIER OFF push buttons 7IS4 and 8IS2 and in the RECT OFF push button 6IS2 are extinguished.

When 5K1 drops out, plate power is removed. Auxiliary contacts remove both the Aural and Visual screen supply voltages, close in series with the reset coil of 6K14 (this circuit is already de-energized by the drop-out of 6K5), close in series with the high-voltage d-c switches 6K12 and 6K13, open across the instantaneous normally open (NO) contact of 6K7, open the control circuit interlocks for both the Aural and Visual exciter power supplies, and close, energizing the Aural and Visual green RECTIFIER ON push button lights 7IS3 and 8IS1 and the green RECT ON push button light 6IS1.

Amplifier Stop

Depressing the red AMPLIFIER STOP push button 7IS1 momentarily energizes the reset coil of 6K1, allowing it to drop out. When 6K1 is in the reset position, the Rectifier filament contactor 6K4, the water and air interlock relays 8K8, 7K8, 8K9, 7K9, and the shutdown relay 6K3 are first de-energized. The filament contactors 8K1 and 7K1 are de-energized by the water and air interlock relays. The lamp in the red AMPLIFIER STOP push button 7IS1 is de-energized; the filament time-delay relays 8K2 and 7K2 are de-energized; the filament time-delay bypass time-delay relays 8K3 and 7K3 are de-energized; the bias contactors 8K4 and 7K4 are de-energized; the bias undervoltage relays 8K12 and 7K12 are de-energized: the filament time-delay status lights 8I7 and 7I17 are de-energized; the lamps in the green push buttons 7IS3, 8IS1, and 6IS1 are de-energized; and the transfer auxiliary relay 6K11 and the restart auxiliary relay 6K6 are energized. Also, the shutdown time-delay relay 6K3 is energized, and the normally open (NO) contact of 6K1 which energized the blower contactor 6K2 during the AMPLIFIER START procedure opens. The blower contactor 6K2, however, is sealed in through its own normally open (NO) interlock and the normally closed (NC) time-delay opening contact of 6K3. This contact of 6K3 opens after approximately one minute, breaking the seal of 6K2, allowing it to fall out, which action de-energizes the blower motors.

All the circuits have now been returned to the initial off position.

AUTOMATIC RECLOSURE

Automatic Plate Overload Reclosure

The automatic plate reclosure circuit is designed to energize the main plate breaker and to reclose it whenever it drops out for any reason other than an intended plate-off operation (which resets 6K5). On repeated drop-out, the breaker will reset twice and will remain in the lockout position after the third drop-out if all these occur within a 10-second interval. If there are less than three drop-outs in 10 seconds, the reclosure cycling relay 6K15 is automatically reset and the count is removed. This is accomplished as follows:

If 5K1 drops out because of the operation of one of the overload relays which operate its shunt trip circuit as well as de-energize its undervoltage circuit or because of the operation of the over-current trip circuits