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TM 11-821

WAR DEPARTMENT TECHNICAL MANUAL

RADIOTELEGRAPH TRANSMITTER

2060

PRESS WIRELESS TYPE PW-15A

WAR DEPARTMENT • SEPTEMBER 1945

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TM 11-821, Radiotelegraph transmitter (Press Wireless type PW-15A), is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL
Chief of Staff

OFFICIAL:
EDWARD F. WITSELL
Major General
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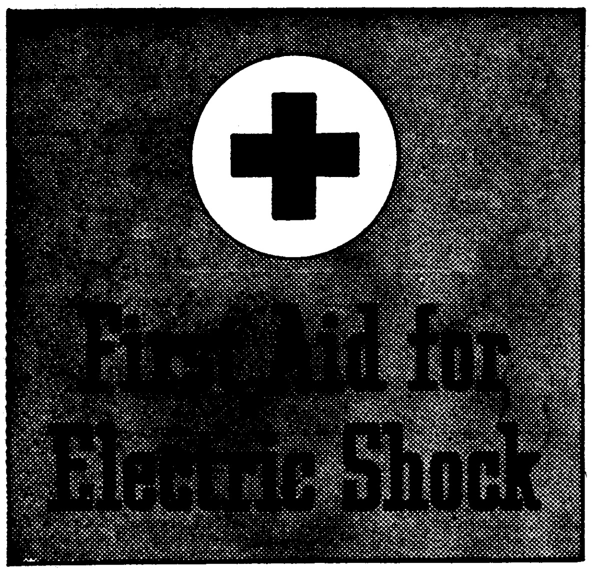
(For explanation of symbols see FM 21-6.)

CONTENTS

PART THREE. MAINTENANCE INSTRUCTIONS.

SAFETY NOTICE

Operation of this equipment involves the use of high voltages (7,000 volts) which are dangerous to life. Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high-voltage supply on. Do not depend upon door switches or interlocks for protection, but always shut-down motor generators or other power equipment. Under certain conditions dangerous potentials may exist in circuits with power controls in the off positions due to charges retained by capacitors, etc. To avoid casualties always remove power, discharge, and ground circuits prior to touching them.



RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(*1*) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(*2*) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(*3*) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(*4*) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

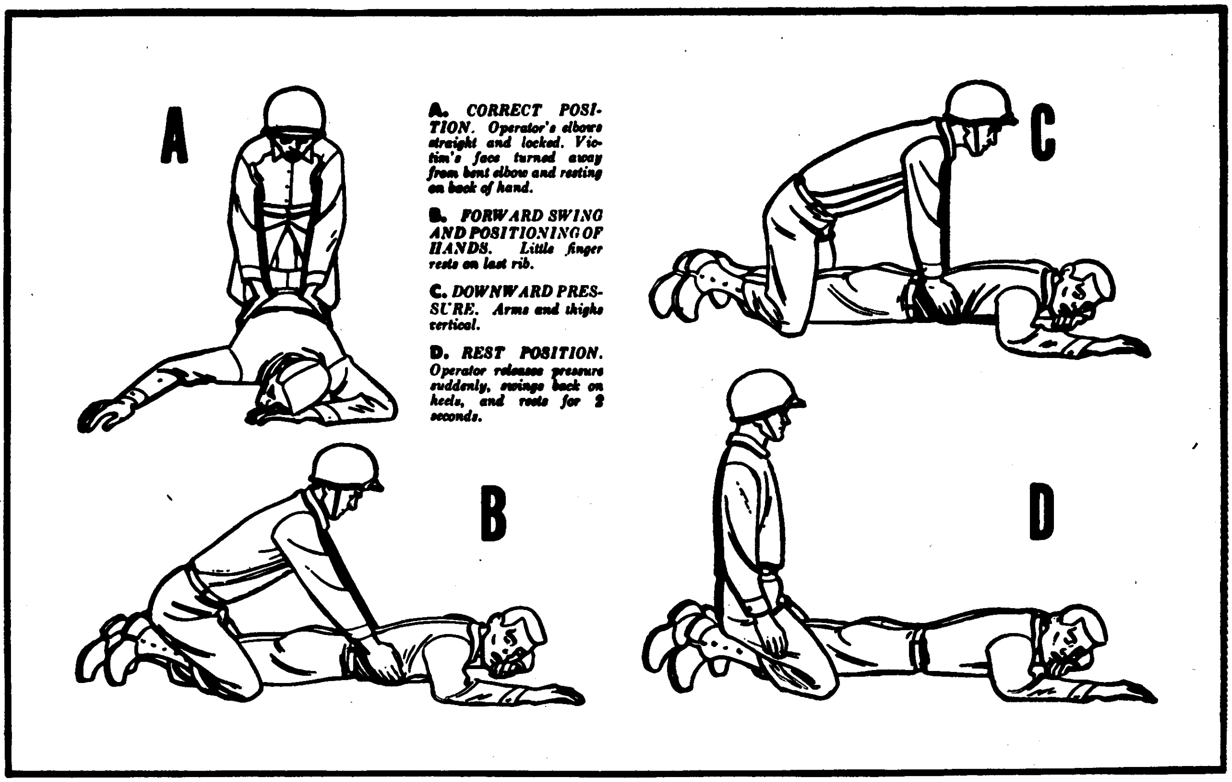
(*1*) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(*2*) Swing back, suddenly releasing pressure, and sit on the heels.

(*3*) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4

TL15338-D



A. *CORRECT POSITION. Operator's elbows straight and locked. Victim's face turned away from bent elbow and resting on back of hand.*

B. *FORWARD SWING AND POSITIONING OF HANDS. Little finger rests on last rib.*

C. *DOWNWARD PRESSURE. Arms and thighs vertical.*

D. *REST POSITION. Operator releases pressure suddenly, swings back on heels, and rests for 2 seconds.*

seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycl , he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Exampl : one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing ½ teaspoon of aromatic spirits of ammonia. *Do not give any liquids to an unconscious victim.*

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. *Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.*

TL15338-E

DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW—1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, matches.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives—Use firearms, grenades, TNT.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT—1. Smash—Variable capacitors, tubes, relays, coils, fuses, meters, handset, speaker, and switches.

2. Cut—All wires and cables.
3. Burn—Records, logs, messages, codes, charts, all papers, books, and documents.
4. Bend—Brackets, chassis, and shields.
5. Bury or scatter—Any or all of the above pieces after breaking.

DESTROY EVERYTHING

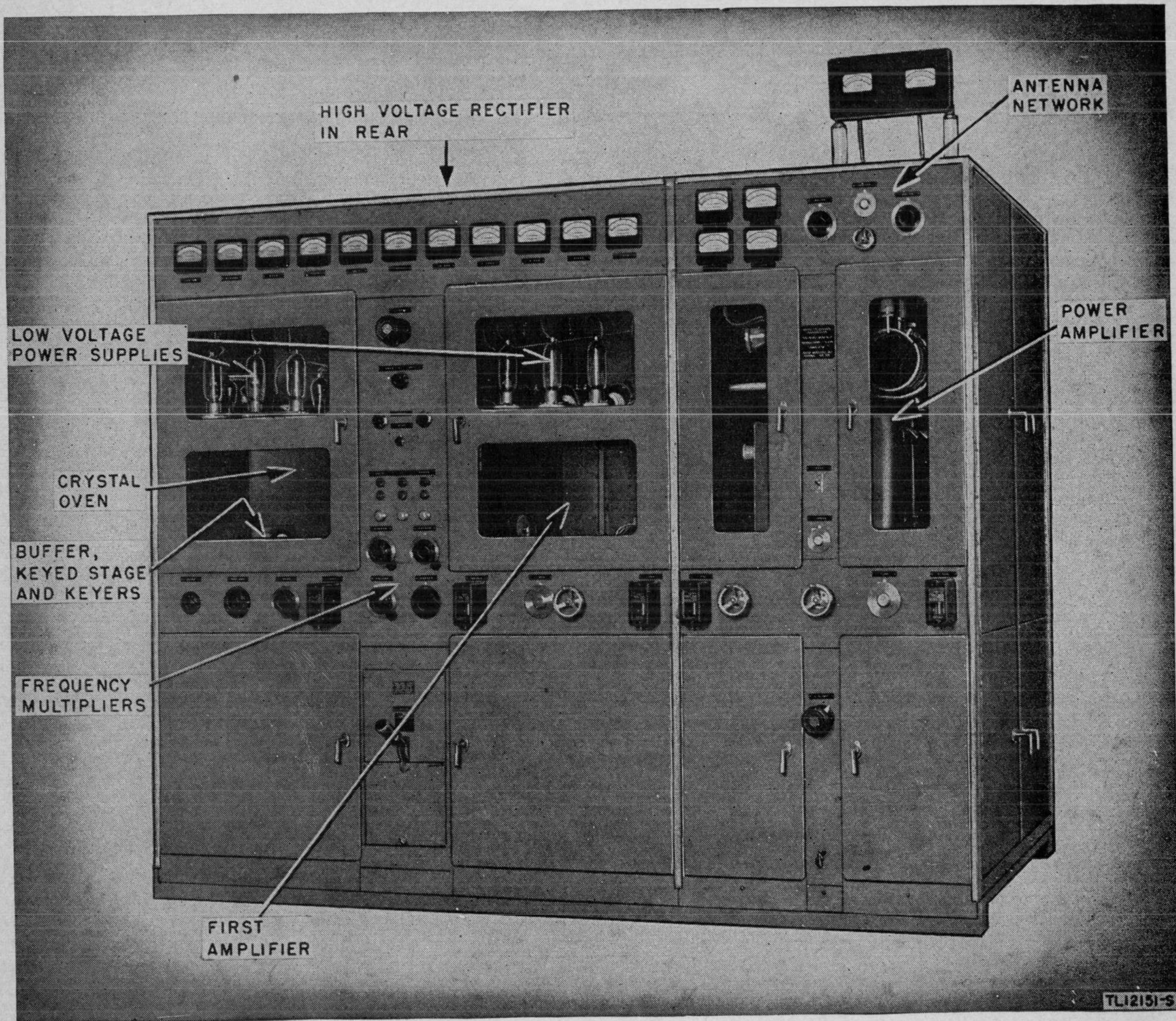


Figure 1. Radiotelegraph transmitter PW-15A.

PART ONE

INTRODUCTION

Section I. DESCRIPTION

1. G neral

This radiotelegraph transmitter (Press Wireless type PW-15A[1]) is designed for radiotelegraph operation over a frequency range of 4,000 to 21,000 kilocycles (kc) with a power output of 15 kilowatts (kw) over the entire frequency range. The circuit is designed for cw operation, and may be used for radioteletype operation with the necessary additional equipment. The output circuits are designed to work into a balanced two-wire transmission line of 550 to 650 ohms impedance with zero reactance. Because of its size and weight, this equipment is used primarily in fixed station installations for point to point communication. Figure 1 shows a front view of the transmitter.

a. The carrier may be controlled automatically from a remote or local point or it may be controlled manually from a local point.

b. The transmitter is made up of two basic units, a rectifier and exciter unit and a power-amplifier (p-a) unit. The former is located on the left and the latter on the right. (See fig. 20.) The transmitter may be divided into seven different sections as follows. (See fig. 2):

(1) Crystal oscillator.
(2) Buffer amplifier, keyed stage and keyers.
(3) Frequency multipliers.
(4) First amplifier.
(5) Power amplifier.
(6) Antenna network.
(7) Power supplies.

c. Cabinets containing this equipment are designed for forced air ventilation with adequate filtering.

d. A 230-volt alternating-current (a-c) 60-cycle 3-phase power source capable of supplying approximately 35 kw must be available for the operation of the transmitter. Fifty kilowatt regular and/or emergency power equipment is supplied with the transmitter as required.

[1] Commercial nomenclature.

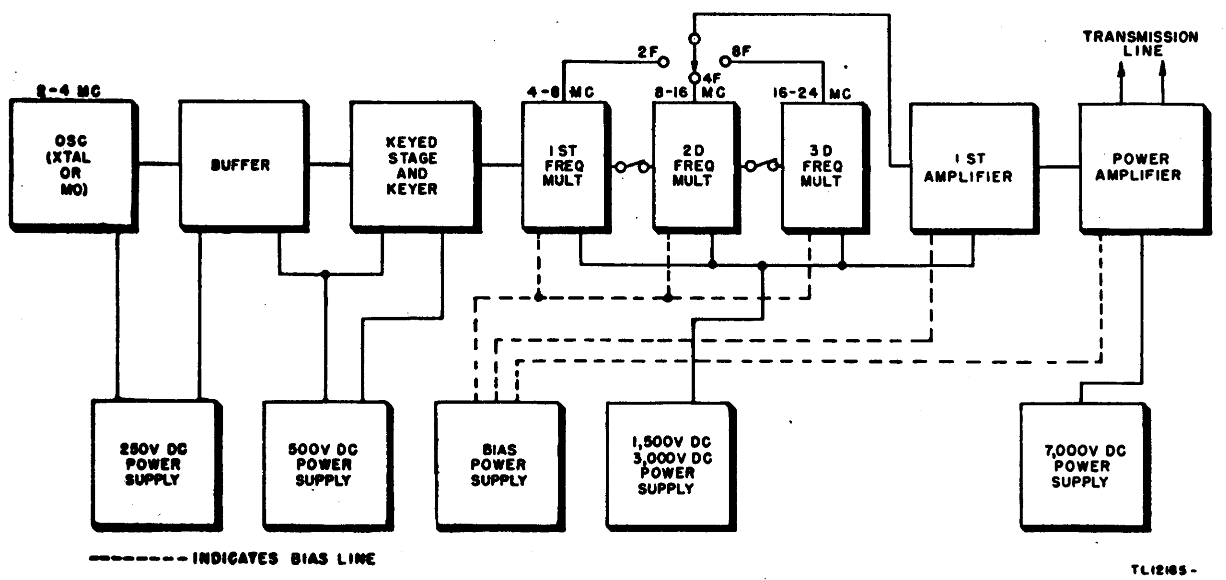


Figure 2. Radiotelegraph transmitter PW-15A, block diagram.

2. T chnical Charact ristics

Frequency range ....4 to 21 megacycles (mc)
Type of signal transmitted. continuous wave (cw) (may be used for radioteletype)
Frequency control ....crystal-controlled oscillator (or master oscillator for emergency)
Frequency stability ....better than 1 cycle per mc per degree centigrade (ambient)
Keying speed ....up to 350 words per minute
R-f frequency output termination ....550- to 650- ohm balanced transmission line
Carrier output power rating (nominal) 15-kw
A-c power line requirements:
Frequency ....50 to 60 cycles per second (cps)
Voltage ....207 to 253 volts (designed for an average voltage of 230 volts)
Power input:
Key up ....9.4 kw
Key down ....35.1 kw (17 kw output)
Number of tubes.......31

3. Frequency Spectrum Chart

For list of other radio sets with which the PW-15A will communicate. (See fig. 3.)

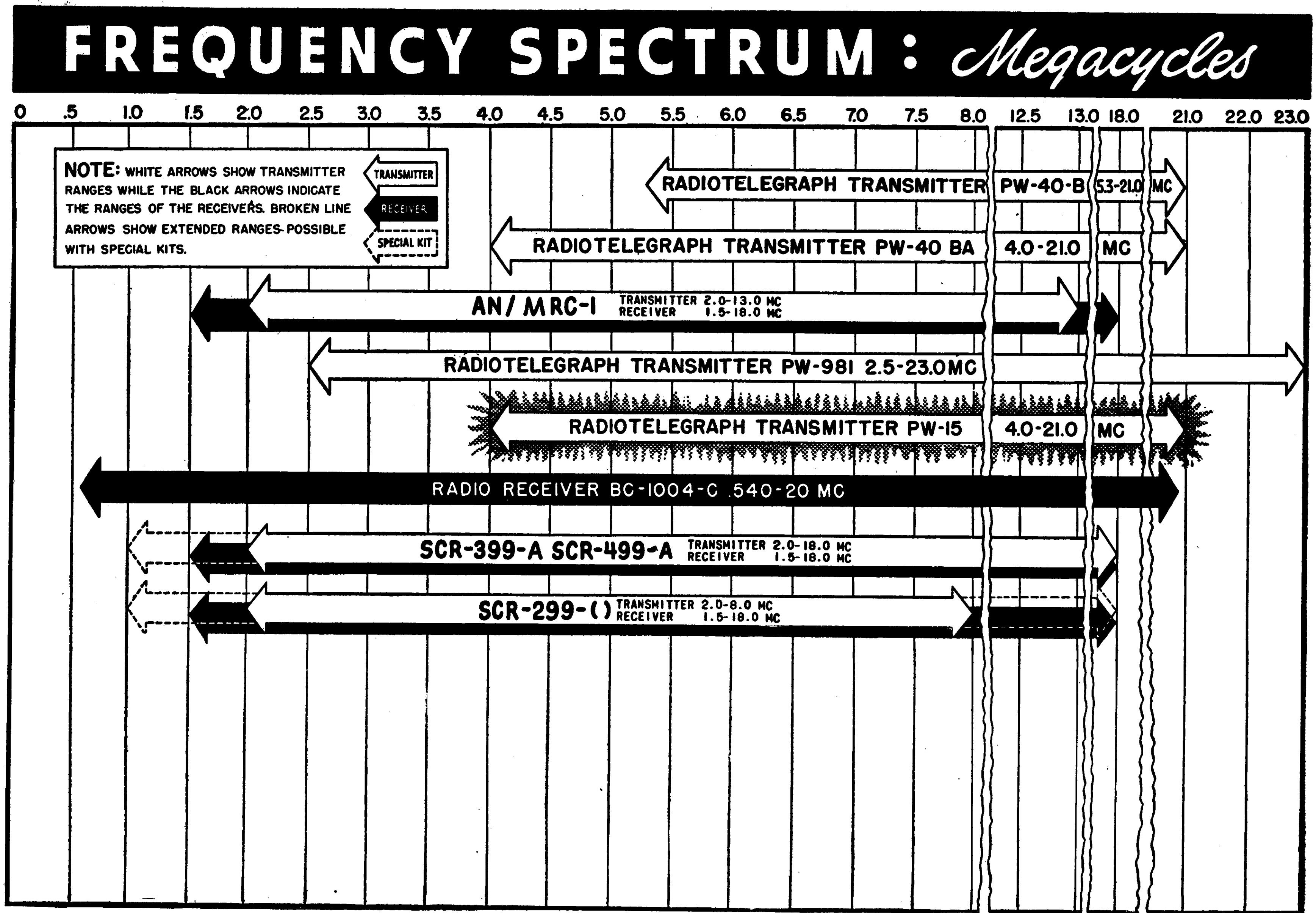


Figure 3. Frequency spectrum chart.

4. Tube C mplem nt

Stage	Type	Ref symbol
Oscillator	JAN-6J5GT/G	V1
Buffer	JAN-807	V2
Keyed stage	JAN-807	V3
Keyer	JAN-2A3	V4 and V5
Multipliers	JAN-4C22/HF100	V6, V7, and V8
First amplifier	JAN-HF-300	V9 and V10
Power amplifier	889R	V11 and V12
Power supply for oscillator and buffer	JAN-866A/866	V13 and V14
Power supply for buffer screen and keyer plate	JAN-866A/866	V15 and V16
Power supply for multipliers and intermediate power amplifier	JAN-872A	V19, V20, V21, V22, V23, and V24
Bias power supply	JAN-872A	V17 and V18
High-voltage power supply	575A	V25, V26, V27, V28, V29, and V30
Voltage regulator	JAN-OD3/VR150	V31

5. Table of Components

The transmitter is assembled as one unit and its dimensions are as follows:

Component	Weight (lb.)	Width (in.)	Height (in.)	Depth (in.)	Volume (cu. ft.)
Radiotelegraph transmitter (Press Wireless Type PW-15A)	6948	108	84½	56¼	294.2

6. Packaging Data

The PW-15A is packed for export shipping in 12 cases as follows:

Case No.	Contents†	Weight (lb.)	Width (ft.)	Height (ft.)	Depth (ft.)	Volume (cu. ft.)
1	Transmitter	6,793	10	8½	6	510.0
2	Main plate transformers	1,190	4½	3	1½	20.3
3	P-a tank assembly	1,035	5½	4½	3½	86.6
4	Spare parts	240	1½	2½	3½	13.2
5	Spare parts	240	1½	2½	3½	13.2
6	Spare parts	270	2½	2½	3½	21.9
7	Storage battery	35	1	1	1	1.0
8	Tubes	316	3½	3½	3⅔	44.6
9	Tubes	385	3½	3½	6	73.2
10	Two p-a tubes	251	2½	3	4½	33.8
11	Two p-a tubes	251	2½	3	4½	33.8
12	Two p-a tubes	251	2½	3	4½	33.8
	Total	11,227*				885.4

* Total shipping weight when packed.
† Items not separately stocked.

7. Description of Major Components

The majority of the components in the PW-15A are an integral part of the cabinet with the exception of the various chassis and assemblies that are assembled as individual units. The ventilation and cooling blowers, relays, meters, and switches, are some of the components that are a part of the cabinet. The entire metal framework is of welded construction and on this the majority of the major components are bolted. The sheet metal is fastened to the framework by means of machine screws. Meters, major controls, and overload relays are mounted on the front panels of the transmitter units. Six doors (four on the front and two on the back) on the rectifier-exciter unit and nine doors, four on the front, four on the end, and one on the back) on the p-a unit make the components easily accessible. Two terminal boards are located in the bottom of each unit to allow for interconnections between units.

a. Crystal-controlled Oscillator. The oscillator unit is contained in an electrically heated, insulated oven. (See fig. 4.) Access may be gained to it by opening the upper left-hand door of this unit. Receptacles for holding six different crystals are provided in the oven. A six-position FREQUENCY SELECTOR switch, located on the front of the transmitter, makes it possible for the operator to select any one of the six crystals. In addition, for emergency operation when crystals are not available, a plug-in master oscillator assembly is provided. The operation of this unit is covered in section XI, paragraph 90.

b. Buffer Amplifier, Keyed Stage, and Keyers. The buffer amplifier, keyed tube, and keyer tubes are combined on a single chassis directly in front of the oscillator oven. (See fig. 4.) Provision is made for the connection of an external oscillator unit for frequency-shift operation on radioteletype circuits. (See TM 11-2205 for description of Oscillator Unit O-5/FR.)

c. Frequency Multipliers. The three frequency multipliers are located directly to the right of the buffer-amplifier chassis in the central section of the rectifier-exciter unit. (See fig. 5.) Access may be gained to it by opening the upper left-hand door of this unit. The MULTIPLIER SELECTOR enables the operator to select either the first, second, or third frequency-multiplier output according to the frequency desired. The first frequency multiplier covers the frequency range of 4 to 8 mc, the second frequency multiplier covers the range of 8 to 16 mc, and the third multiplier covers the range of 16 to 21 mc.

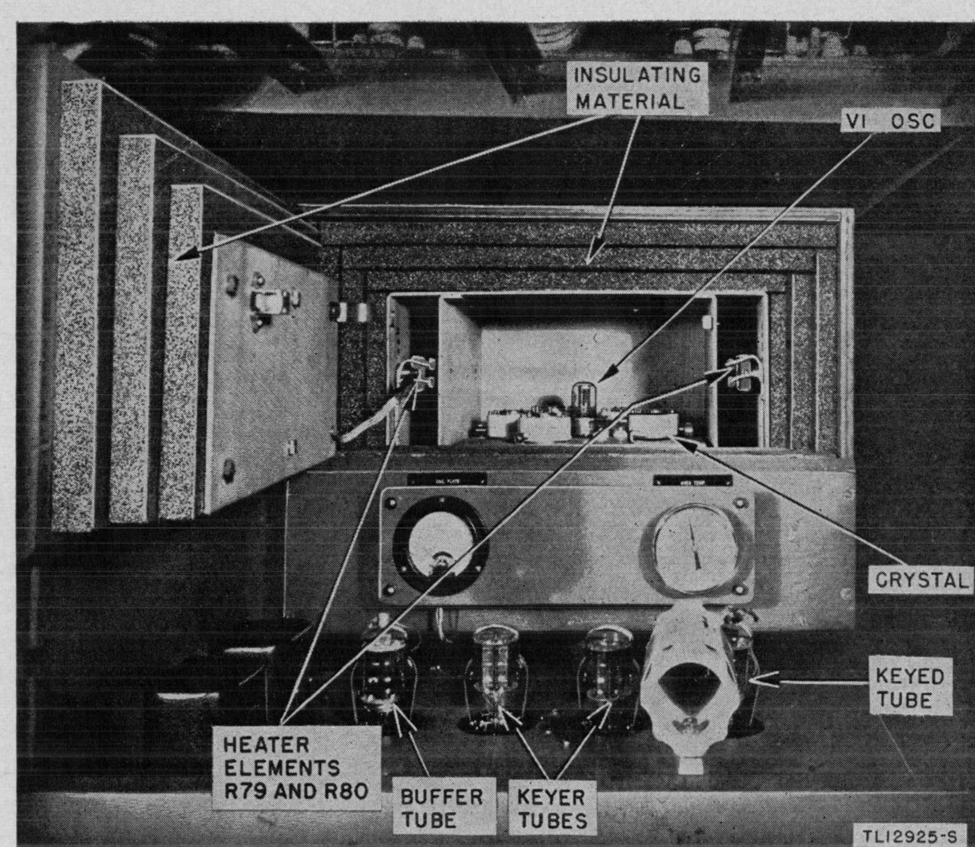


Figure 4. Crystal oven, door open.

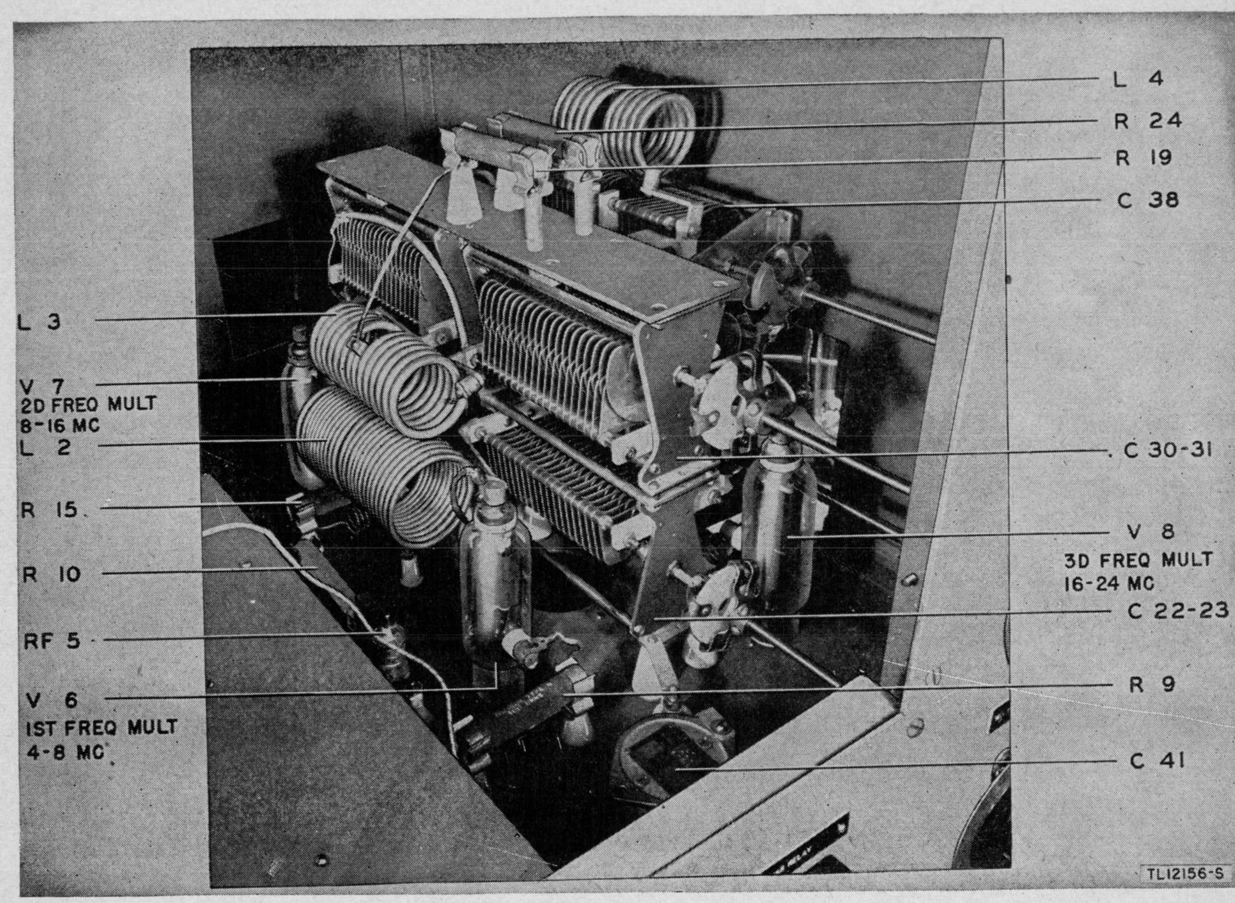


Figure 5. Frequency multipliers.

d. FIRST AMPLIFIER. The first amplifier is located in the right-hand section of the exciter-rectifier unit. (See fig. 6.) This stage has a frequency range of 4 to 21 mc.

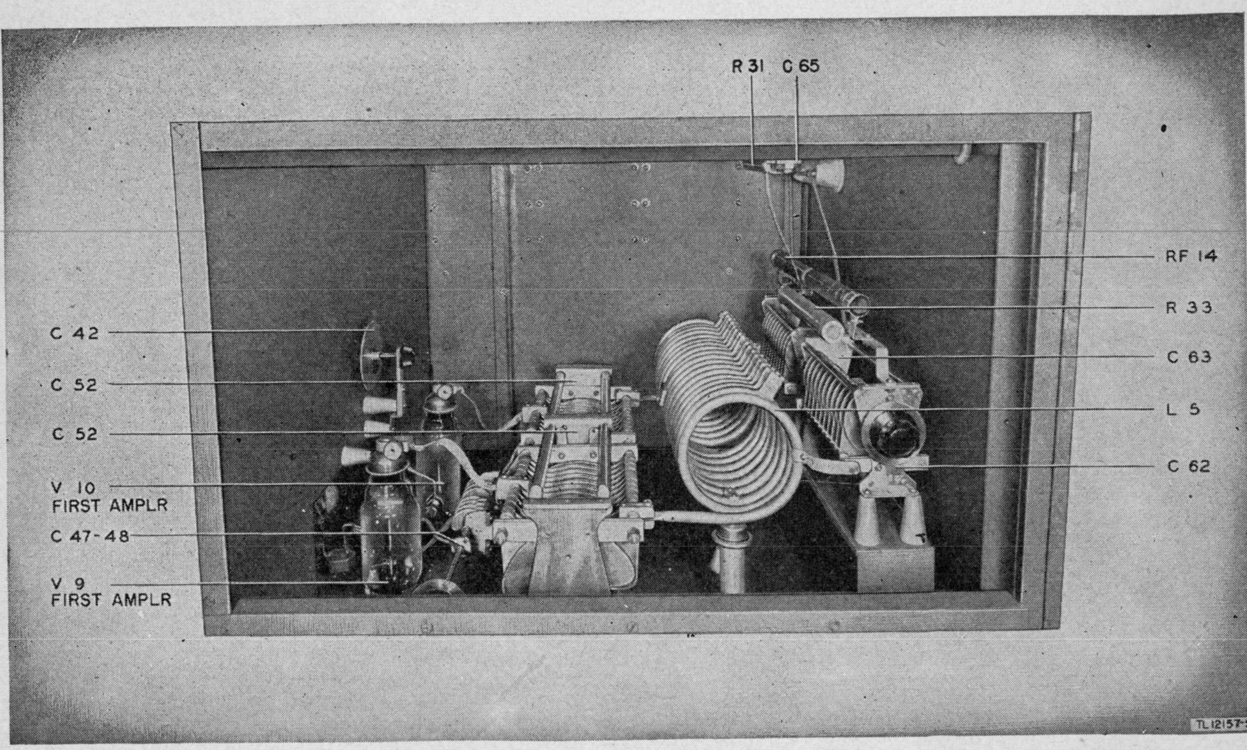


Figure 6. First amplifier.

e. POWER AMPLIFIER. The power amplifier compartment is located in the upper section of the p-a unit. (See fig. 7.) Access to this compartment may be gained through any of the upper doors of this unit. This stage has a frequency range of 4 to 21 mc. The power amplifier incorporates an air circulating system for the purpose of preventing the p-a tubes from reaching a destructively high temperature during operation.

f. ANTENNA NETWORK. The antenna network is located in the upper portion of the p-a unit. The degree of coupling between the antenna and the power-amplifier is variable and adjustment is made from the front panel.

g. LOW-VOLTAGE POWER SUPPLIES. The oscillator buffer and keyed stage power supplies are located in the left-hand upper section of the rectifier-exciter unit. (See fig. 8.) The 3 kv power supply for the three frequency multipliers and the first amplifier stages occupy part of the left-hand and right-hand sections. (See fig. 9.) The bias power supply is located in the central top portions of the rectifier-exciter unit, and supplies grid bias for the frequency multipliers, first amplifier, and power-amplifier.

h. HIGH-VOLTAGE POWER SUPPLY. The high-voltage power supply is located in the rear section of the rectifier-exciter unit. (See fig. 10.) It supplies 7 kilovolts (kv) to the plates of the p-a tubes.

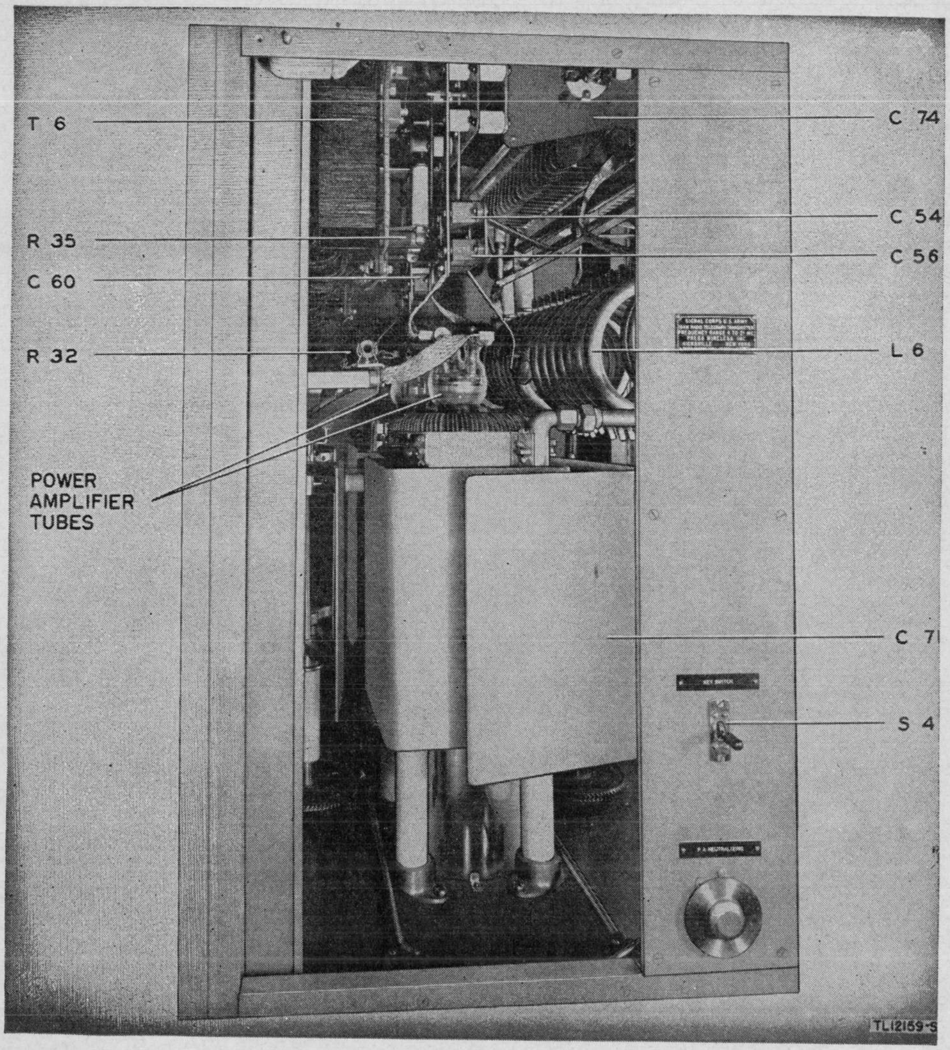


Figure 7. Power amplifier, front view through upper left door.

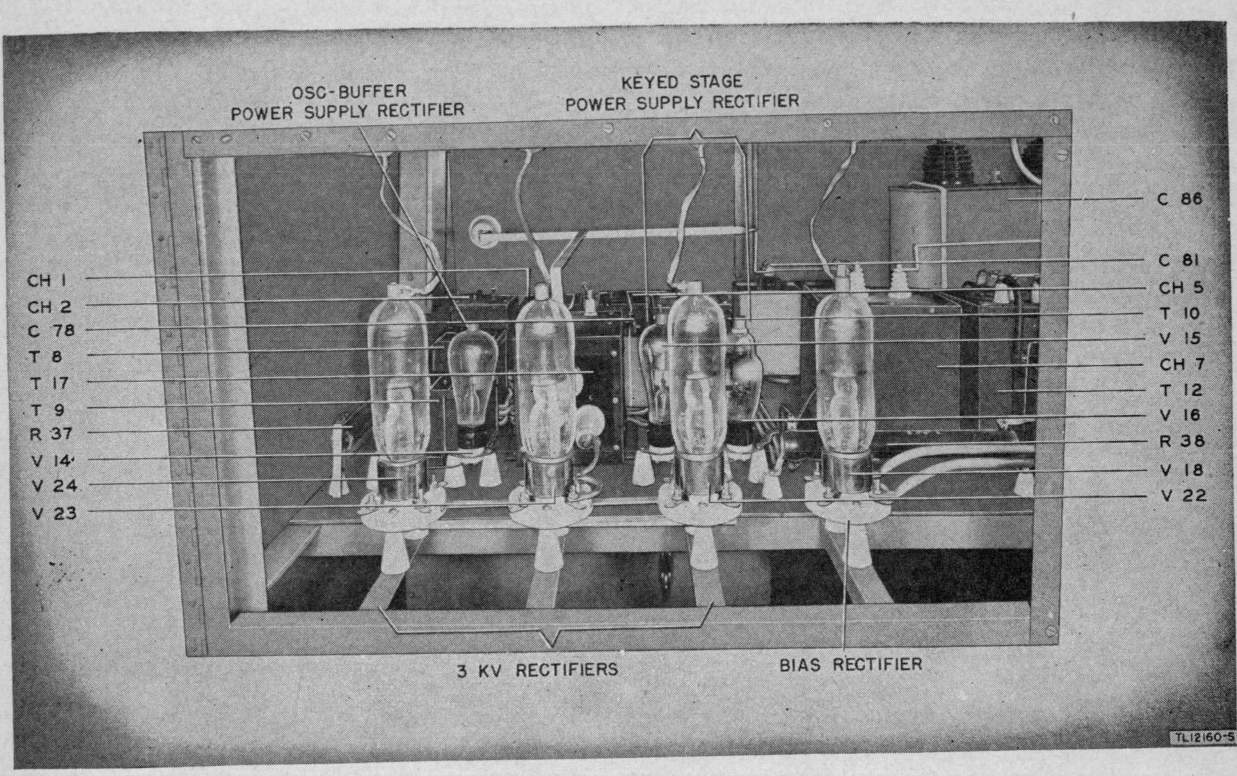


Figure 8. Low voltage rectifier, left side.

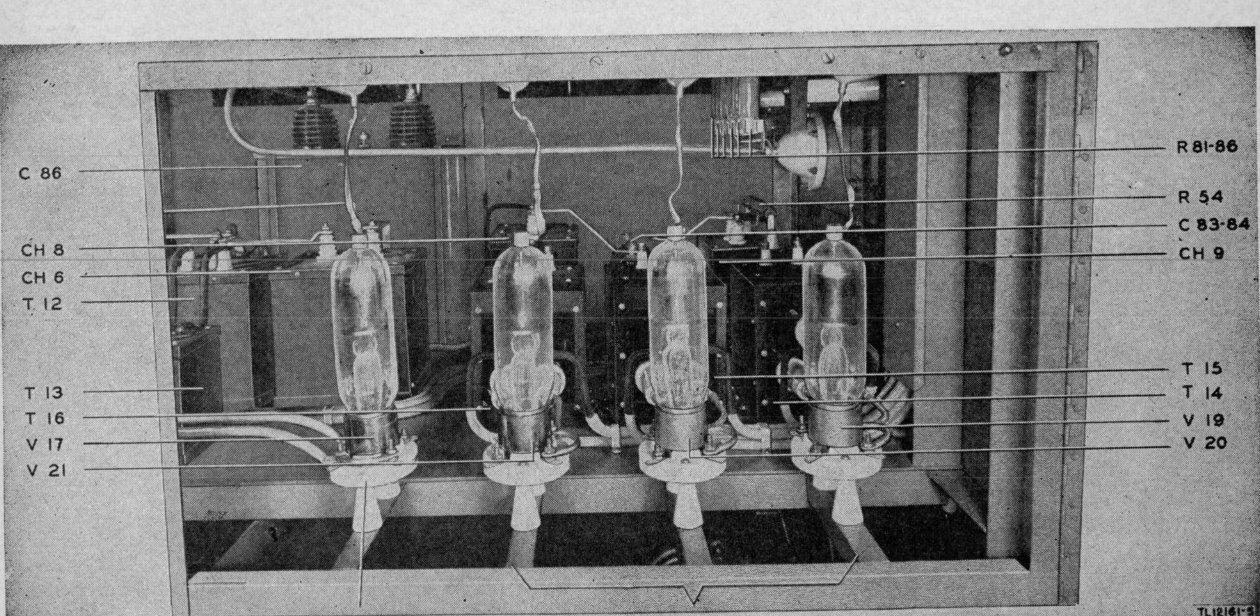


Figure 9. Low voltage rectifier, right side.

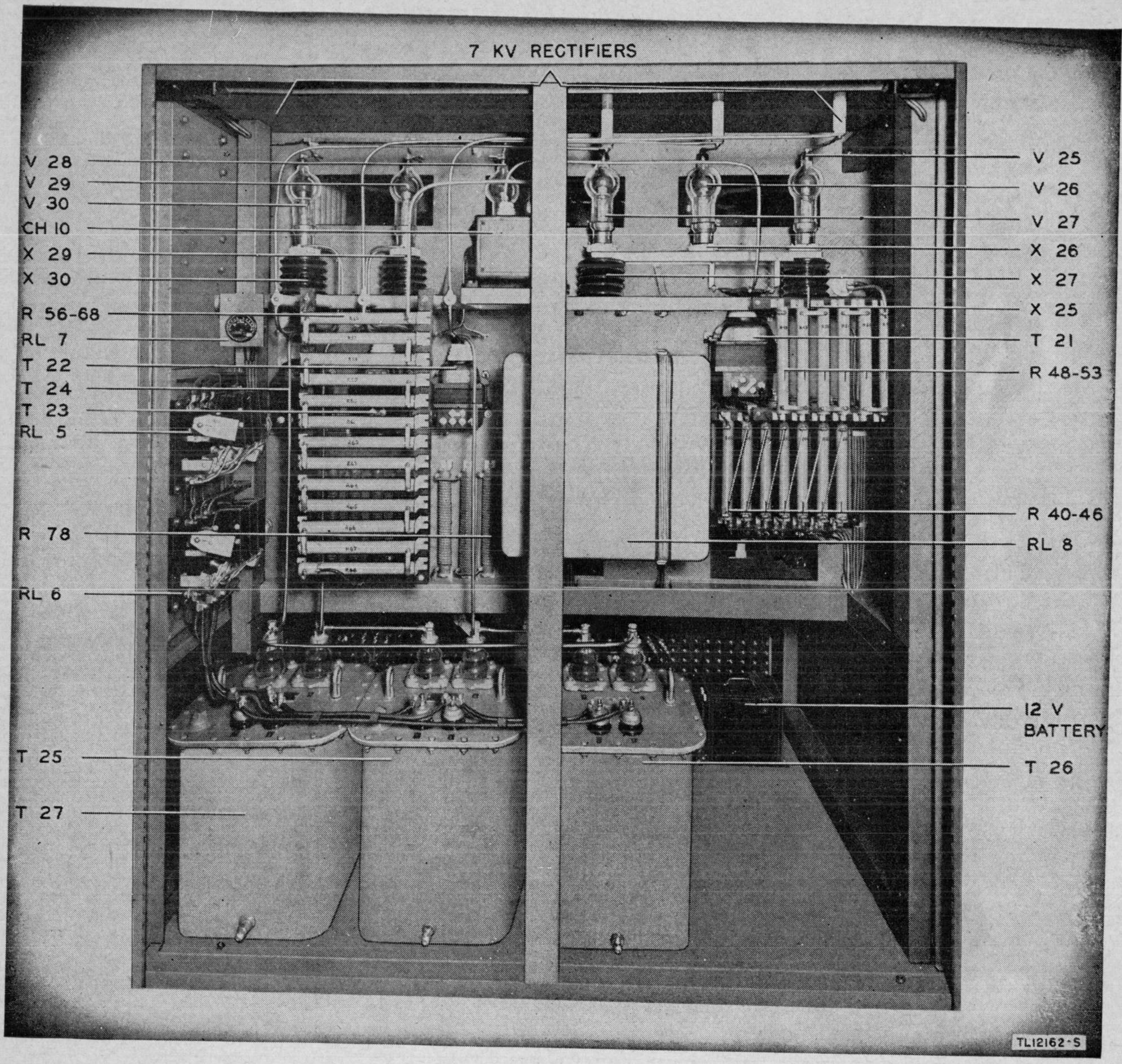


Figure 10. High voltage rectifier viewed from rear of cabinet.

Section II. INSTALLATION

8. Siting

A transmitter of this power is used primarily for long distance communication and functions usually with a rhombic antenna. The selection of site for the transmitter therefore depends largely upon the sites available for the erection of a rhombic antenna. The location of operating and receiver positions must also be taken into consideration.

a. The antenna should be located on level or evenly sloping open ground. Avoid obstructions, such as hills or buildings, directly in front of and on the bearing line of the antenna. No obstruction in front of the antenna should be more than 2° or 3° above the horizontal plane of the antenna. This is approximately 200 or 300 feet at a distance of 1 mile from the antenna.

b. A suitable building for the transmitter must be obtained. The building should be located near the antenna site to keep the transmission line as short as possible. If the building is to be constructed, it should be made to blend in with the surrounding structures. If the building is to be situated by itself, camouflage precautions should be observed to conceal the structure from enemy observation as much as possible. Thought should also be given to housing facilities for operating personnel and power installation if required.

c. The transmitter building should meet the following qualifications:

(1) Make certain that the floor construction is such that the added weight of the transmitter will not produce a strain on the floor.

(2) The room in which the transmitter is to be installed should have a ceiling height of at least 11 feet to allow for the r-f transmission lines.

(3) The room must be large enough so that sufficient space around the transmitter is available in the event that repairs must be made. Three additional feet of space are required for the door swing of the transmitter.

(4) The transmitter should be placed in a level position and must not be subject to any vibration from external sources.

d. It is desirable to have existing commercial power and telephone facilities nearby. Where commercial power lines are not available it will be necessary to generate sufficient power to operate this equipment. There should be a minimum of 35 kw of power available from generating equipment. Below is a list of some of the engine generator sets which may be used to supply power to the PW-15A. Power requirements for large installations involving a number of transmitters should be combined to call for a minimum number of large power units.

9. External Connections

Before installing the transmitter, the necessary conduits or trenches for the main a-c power line and the key line should be installed. (See fig. 11.) All external connections, with the exception of the r-f transmission lines, are made at the bottom of the transmitter directly below the main circuit breaker through two 3½-inch diameter holes. If conduit is used for the incoming three-phase power line, it should be of sufficient size to accommodate three AWG 4/0 lead-covered cables. A conduit 2½ inches or preferably 3 inches in diameter must be used. Use a separate conduit for the key line and auxiliary connections. Terminate this conduit through the additional entrance hole located on the bottom of the transmitter. Provision must be made to prevent dust or rodents from entering the transmitter through any gap left between the conduit and the conduit holes at the bottom of the transmitter. Install the conduit for the main a-c line between the main power board of the station and the main switch of the transmitter. A conduit installed in or under the concrete floor of the station is ideal. A trench with cover plates may also be used, in which case, the lead cables are laid in the trench. The keying line can be placed in a separate small trench.

Unit	Kilovolt amperes (kva)	Power factor (pf)	Kw	Rated volts	Phase	Freq in cps	Type
PE-142-B, C, D, and E	62.5	0.8	50	240	3	60	Diesel
PE-215-A	62.5	0.8	50	240	3	60	Diesel
PE-81-E, and F	43.7	0.8	35	240	3	60	Gas

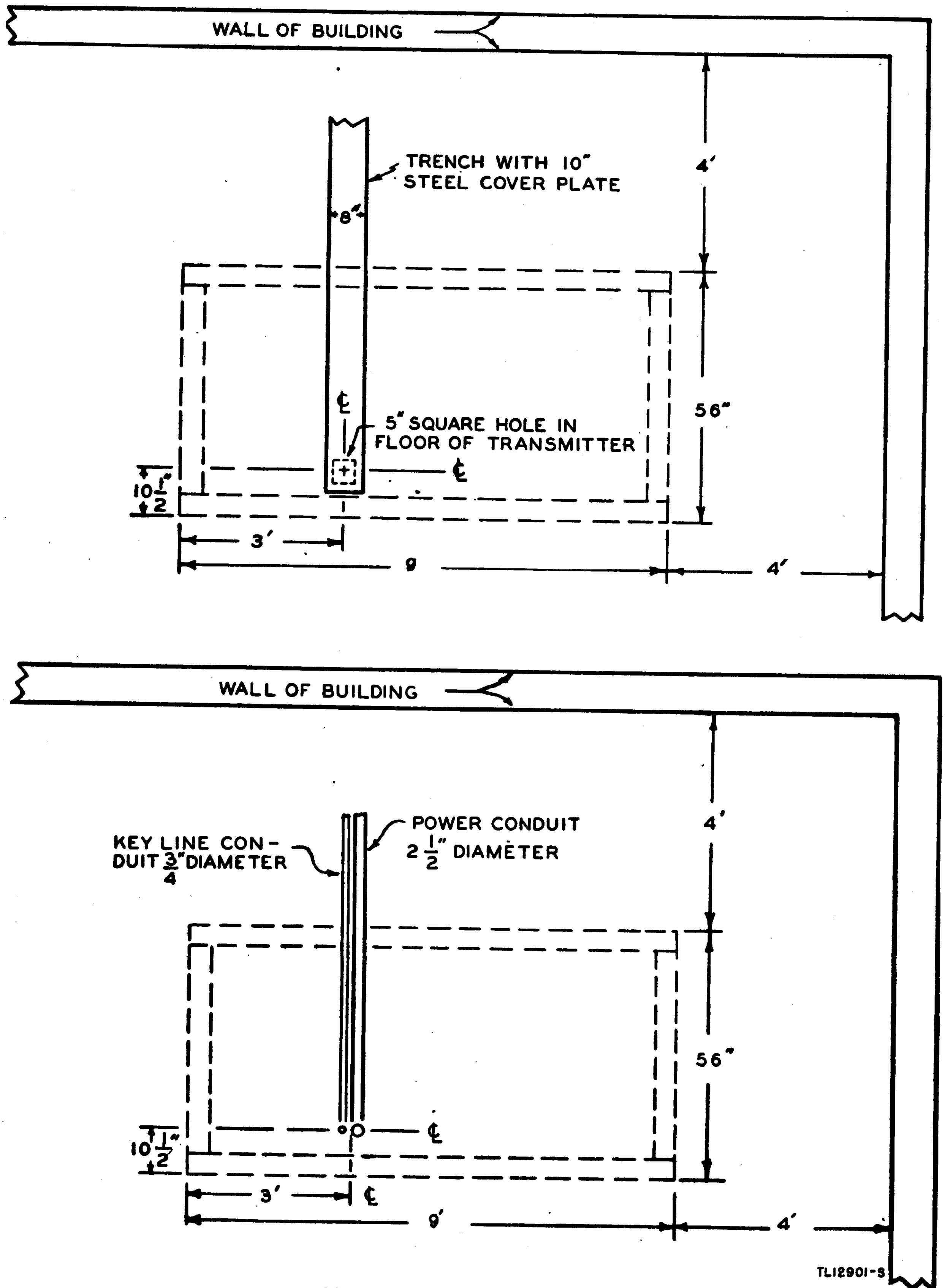


Figure 11. Installation layout diagram.

10. Unpacking

Caution: Be careful in uncrating, moving, handling, and unpacking the units to avoid damage.

The transmitter is packed in a wooden case with heavy skids at the bottom. In unpacking the transmitter, place it as near the final installation location as possible. After the sides of the wooden case have been disassembled, remove the transmitter from the skids and install it in its proper place. Carefully remove all the excess packing including the bags of dessicant which have been distributed throughout the transmitter for moisture absorption. Some of the parts of the transmitter have been blocked in place by means of wooden support and in some cases, padding is used. Remove all this excess material, untie all the components that have been found with tape, and make a thorough inspection to see that none of the components have become broken or bent. Inspect to see if the transmitter is level. If not, it must be leveled up accurately with suitable shims. This leveling process is important to insure smooth working control shafts in the unit. Ground the base plate of the transmitter to a good ground system using the shortest lead possible.

11. Installation f Miscellaneous Comp nents

Many of the transmitter components have been removed prior to shipping. Most of these components have been packed in separate boxes. Unpack all these components and install them in their proper places. The main plate transformers T25, T26, and T27 are packed in a separate crate and must be installed in the rectifier compartment. Their mounting position in the rectifier compartment is clearly shown in figure 10. All cables and electrical bus wire connections are clearly marked and tagged for proper assembly.

12. Installation of P-A Tank Assembly

The p-a tank assembly (fig. 12) is packed in a double case. Use extreme care in uncrating this assembly. After removing the assembly from its case, place it in a horizontal position using a table top or two wooden horses. Remove all packing material from around the assembly and remove the retaining pins in the gears which were installed to maintain rigidity of movable parts while in transit. Examine the entire assembly carefully for broken or bent parts. The assembly can then be placed in position in the p-a unit. Do not fasten the base plate of the assembly securely until the shaft couplings are connected and all controls work freely.

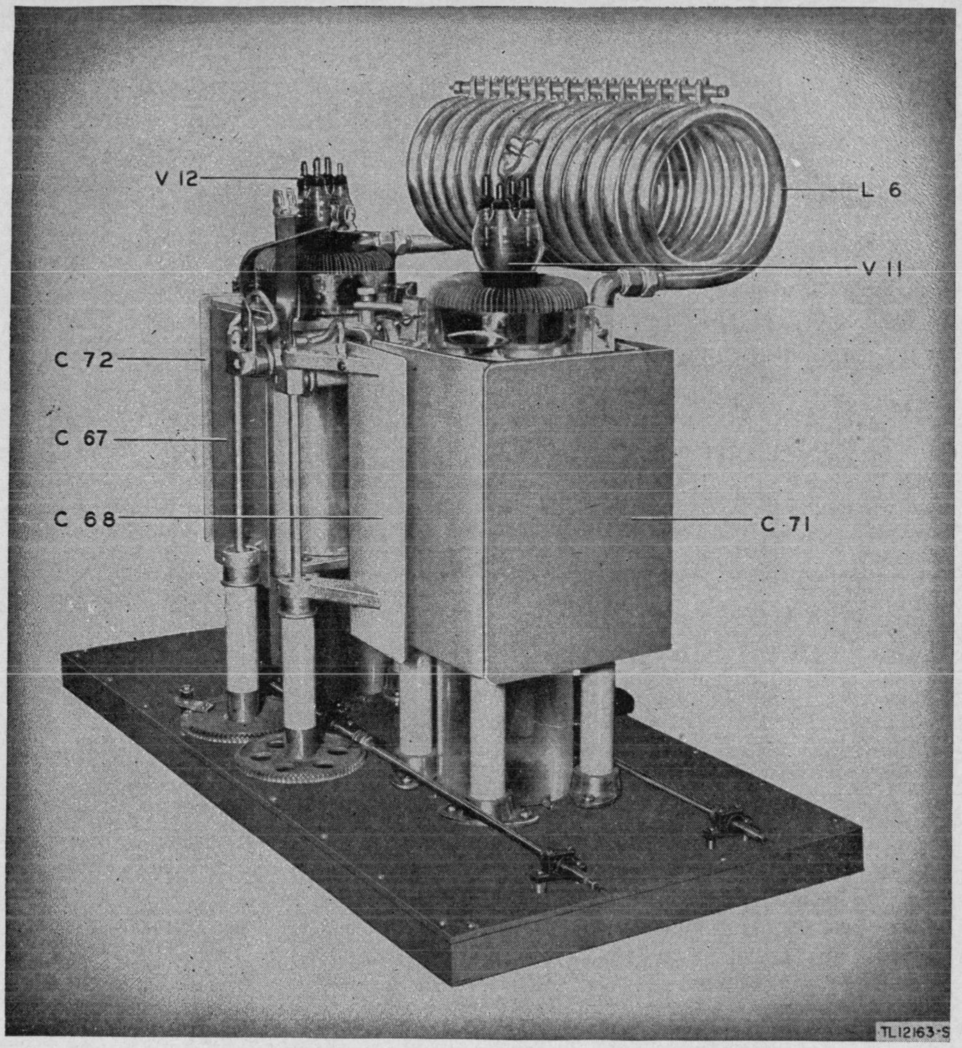


Figure 12. Power amplifier tank assembly.

13. Installation of 230-volt Power Line

Connect the 230-volt power line to the transmitter by pulling the three-phase supply wires through the previously installed conduit at the bottom of the transmitter. Connect these wires to the terminals at the top of the main switch. (See fig. 13.) Observe the proper phase sequence when making the connections.

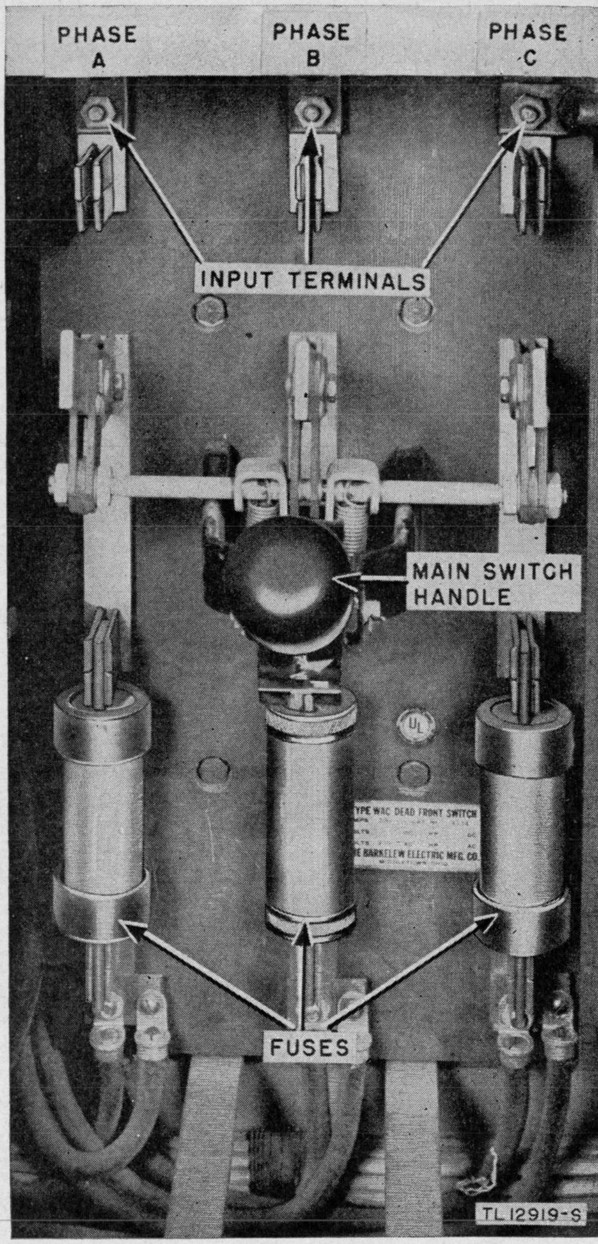


Figure 13. Main switch, cover removed.

14. Installation of Battery

The 12-volt storage battery must be serviced before installation as the electrolyte has been removed for shipping. Open and rinse out each compartment of the battery with distilled water to remove any undesirable accumulation. Now add the electrolyte to each compartment filling the compartments until the plates are covered. The battery box is located directly behind terminal board No. 1. (See fig. 54.) Place the battery in the box, and connect the two wires to the positive and negative terminals as marked. For other information on batteries see TM 11-430.

15. Mechanical Inspection of Transmitter

Make a complete mechanical check-up of the transmitter using the following sequence of checking.

a. Rectifier-exciter Unit. Inspect all the tube sockets and insulators supporting the rectifier tube sockets and replace any that are cracked or broken. Check the bolts and nuts holding capacitors, chokes, resistors, transformers, switches, relays, and rheostats in place. Replace any of these that are missing. Inspect the meters, and remove all the jumpers that have been placed across the terminals to prevent damage during shipment. Check all front and rear interlock switches to see that they are held firmly by their mounting bolts, and that their plungers work smoothly. Examine the contactor panel to make certain that all contactors are secured to their mounting boards.

b. P-A UNIT. The mechanical inspection of this unit is the same as that of the previous unit.

16. Installation of Tubes

In the following table the socket number corresponds to the V number of the tube. For example, tube VI goes in socket XI.

Type	Socket No.	Remarks
JAN-6J5 GT/G	XI	Insert tube in 8-prong octal socket in crystal oven (fig. 4).
JAN-807	X2, X3	Insert tubes in 5-prong sockets on buffer chassis and connect plate leads to cap on tube top (fig. 14).
JAN-2A3	X4, X5	Insert tubes in 4-prong sockets on buffer chassis (fig. 14).
JAN-4C22/HF-100	X6, X7, X8	Insert these tubes in the frequency-multiplier tube sockets. The large pins should enter the large hole and the small pins their corresponding small holes. Press the tube down firmly. Connect the plate (top) and grid (side) terminals (fig. 5).
JAN-HF-300	X9, X10	Insert these tubes in their 4-prong sockets in the intermediate power amplifier. Keep the guide pin on the tube base in line with the slot in the socket. Press the tube down firmly, then rotate the tube clockwise until the tube guide pin hits the socket stop. Connect the plate (top) and grid (side) terminals (fig. 6).
889R	XII, X12	These tubes are installed and held in place by means of their clamp mountings in the p-a tank (fig. 12). Connect the grid (tall posts) and filament (short posts) leads.
JAN-866A/866	X13, X14, X15, X16	Insert these tubes in their respective 4-prong sockets as shown in figure 8. Connect the plate terminals.
JAN-872A	X17, X18, X19, X20, X21, X22, X23, X24	Insert these tubes in their 4-prong sockets (figs. 8 and 9). Keep the pin on the tube base in line with the slot in the tube socket, and press the tube down firmly, then rotate the tube clockwise until the guide pin hits the socket stop. Connect the plate terminals.
575A	X25, X26, X27, X28, X29, X30	Insert these tubes in their 4-prong sockets (fig. 10). Keep the guide pin on the tube base in line with the slot in the tube socket, press the tube down firmly, then rotate the tube clockwise until the guide pin hits the socket stop. Connect the plate (top) terminals.
JAN-OD3/VR150	X31	Insert this tube in its socket (fig. 15).

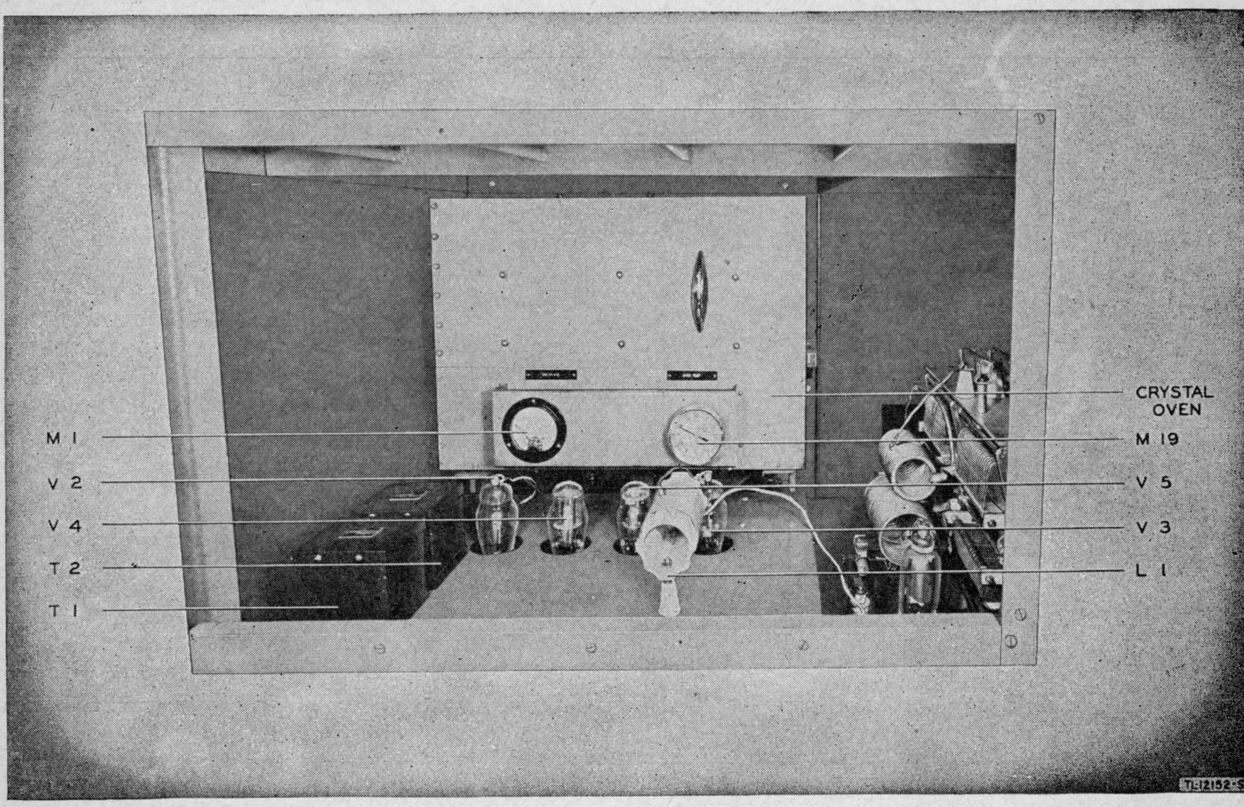


Figure 14. Oscillator oven and buffer chassis.

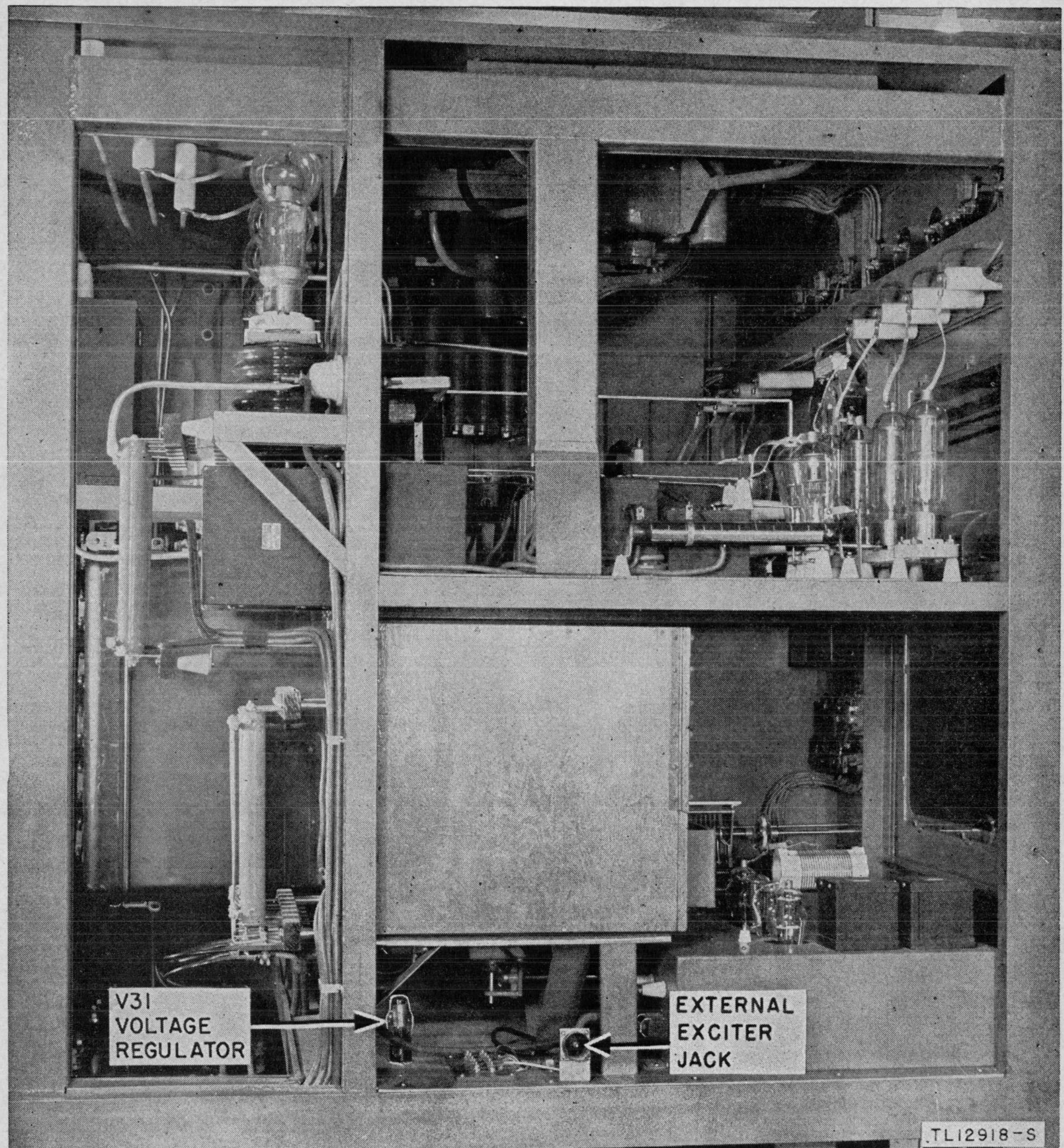


Figure 15. Rectifier-exciter unit, side view.

a. P-A TUBES. The handling of a p-a transmitting tube requires care since a tube may be damaged if subjected to shock or vibration. The tube should be tested upon receipt. The glass bulb, and particularly the glass area around the terminals, should be free from foreign matter. The leads become hot during operation so that any foreign material may become charred and cause puncture of the bulb. The standard mounting supports the tube in the correct vertical position with the glass end up. The tube must not be subjected to vibration or shock. It is advisable to secure the tube in its mounting jacket in the desired location before making the electrical connections. The grid and filament leads should not be taut, but should allow for some movement without placing a strain on the glass bulb. Before readjustment of the tube is made, the leads should be disconnected.

b. ELECTRICAL CONNECTIONS OF P-A TUBES. The installation of all wires and connections must be made so that they do not lie on or close to the glass of the tube. Otherwise, severe trouble may arise from corona discharge or increased dielectric loss which will result in almost certain puncture. The filament circuit carries a high current at low voltage. Therefore, precautions should be taken against loss of voltage and heating due to poor connections. The filament connectors particularly should be large and make good contact.

17. Installation of Crystals

Insert crystal holders in the sockets provided in the crystal oven. (See fig. 4.) The number stamped near each socket refers to a corresponding position of the FREQUENCY SELECTOR switch dial. All crystals are interchangeable to any of the six positions.

Note. Crystals and holders (Signal Corps Type FT-164) are supplied initially only when operating frequencies are known. Otherwise separate supply action will be necessary at the time frequencies are assigned.

18. Installation of Keying Line

A standard two-wire telephone line may be used for remote keying of the transmitter. High-speed keying up to 150 words a minute is possible with an open wire, twisted pair, or lead cable line as long as 10 miles. Higher speeds can be obtained with shorter lines. Voltage and current involved on the keying line is well beneath the limits prescribed for telephone lines. The two-wire line connection for remote keying by telephone line is made to terminal No. 44 on terminal board No. 1 and ground (figs. 20 and 66.)

19. Installation of Antenna Transmission Line

Connect the r-f transmission line to the open terminals of meters M13 and M14 located on top of the transmitter. (See fig. 20.) This line will be furnished separately as part of the transmitting antenna kit. A typical line consists of two three-strand 12 AWG copperweld wires spaced 12 inches apart. A line of this construction has a characteristic impedance of 600 ohms. Bring the transmission line into the building through bowl insulators. Keep the line at least 3 feet above the top of the transmitter, and take care to maintain proper spacing by keeping each wire equal in length. If more than one antenna is to be used, arrange a system of switching, by means of jumpers from the r-f ammeters to the corresponding transmission line of the antenna to be fed.

20. Electrical Inspection

a. RECTIFIER-EXCITER UNIT. Check all bus connections leading to the rectifier tube sockets to determine if they are making proper electrical connections. Make certain that the caps connecting to the tops of the rectifier tubes are securely on. Check all connections to the primary and secondary of the plate transformers. Following this, make a thorough examination of all the electrical connections to capacitors, chokes, resistors, contactor panel, filament rheostats, and all connections to the terminal boards. Make certain that all contactors work freely.

b. P-A UNIT. The electrical inspection for this unit is the same as for the previous unit. In addition, inspect the p-a tank capacitors and inductors thoroughly to make sure that they make the proper electrical connections. Check the tubes to see if they are seated properly in their sockets and if the electrical connections to the sockets are securely fastened.

21. Setting Relays

a. OVERLOAD RELAYS. These relays are of the type shown in figure 16. This type of relay may be adjusted for the amount of current required for tripping by turning the knurled knob. Screwing the knob down will increase the current required for tripping. The approximate tripping current may be set by placing the bottom edge of the knob opposite the desired point of the scale on the calibration tube. The current values represented by the various lines on the scale are marked in the relay calibration chart which is along the top of the name plate of each relay.

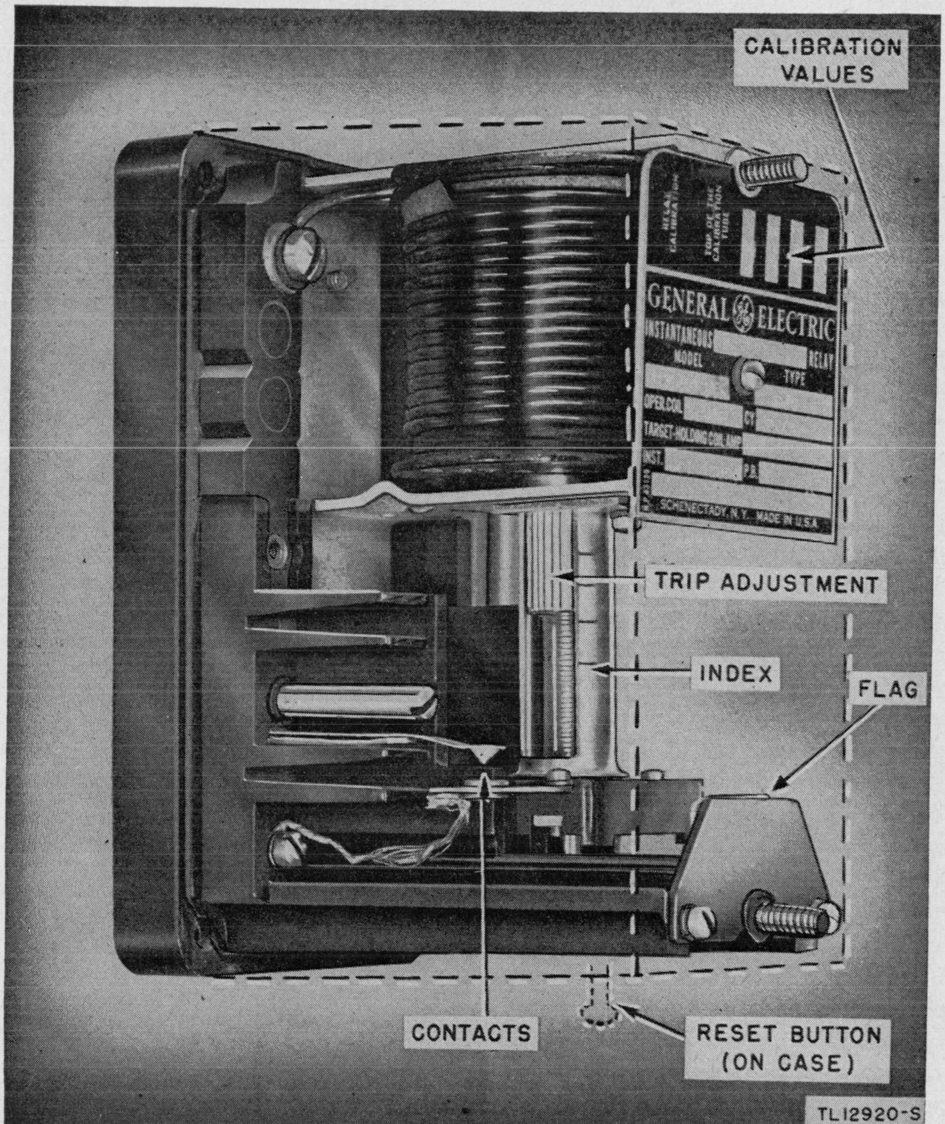


Figure 16. D-c overload relay.

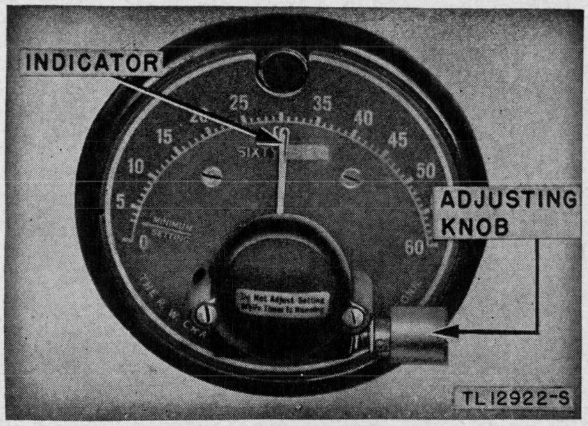


Figure 17. Time delay relay.

b. TIME DELAY RELAY. A time delay relay of the type used in the PW-15A is shown in figure 17. This relay has a maximum time delay of 60 seconds, and may be adjusted for any delay period up to 60 seconds by turning the knurled knob until the indicator points to the desired number of seconds.

c. HIGH-SPEED CIRCUIT BREAKER. This circuit breaker is shown in figures 18 and 19. Two adjustments are provided for setting the amount of tripping current required. The current scale reads from 225 amperes to 450 amperes and the adjustment is made by loosening the small knob and moving the index along the scale to the desired point. Both index adjustments should be set to the same value. To set the circuit breaker, the reset handle is first turned to full counterclockwise position and then rotated as far in the clockwise direction as it will go. The circuit breaker may be tripped manually by pushing the trip plunger.

d. OVEN THERMOSTAT. This thermostat has been set at the factory, but the operating temperature may be raised or lowered by turning the small knob located on the outside of the right-hand side of the oven and to the rear. The direction of rotation for raising or lowering the temperature is indicated on the knob with arrows.

e. RELAY AND THERMOSTAT SETTINGS. The following table shows the typical settings for relays and thermostat:

Relays and meters	Setting
Oven temperature thermostat D1 set on	50° C
BIAS RELAY RL9 set on	0.8 amp
EXCITER OVERLOAD relay RL10 set on	2.5 amp
D.C. OVERLOAD relay RL13 set on	6.0 amp
P.A. OVERLOAD relay RL11 (front) set on	3.2 amp
P.A. OVERLOAD relay RL12 (rear) set on	3.2 amp
Frequency multiplier rheostat R12 set on	6.0 amp
Time delay relay RL14 set on	30 seconds
Time delay relay RL7 set on	15 seconds

22. Final Inspection of Transmitter

At this time a voltage and electrical operation check of the transmitter should be made as described in section VII.

23. Repacking Information

If the transmitter is to be disassembled and shipped, it should be packed as listed in paragraph 6. All mounted parts shipped in a unit should be blocked in place to prevent movement in transit.

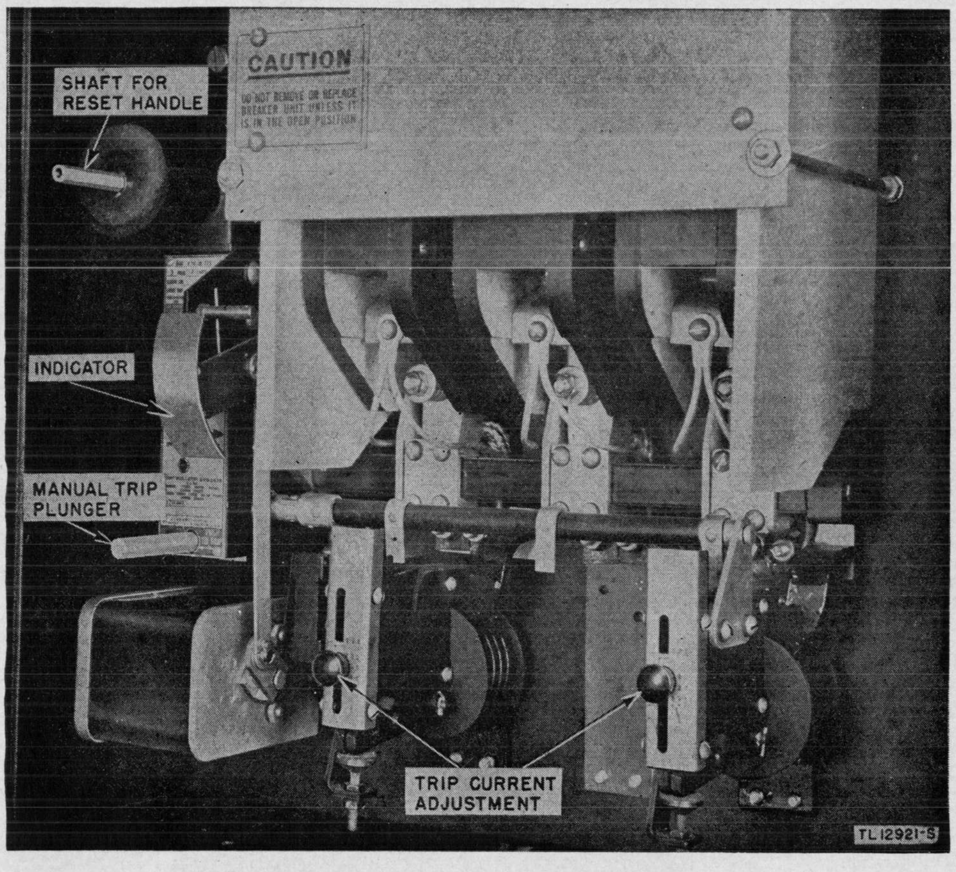


Figure 18. High speed circuit breaker, cover removed.

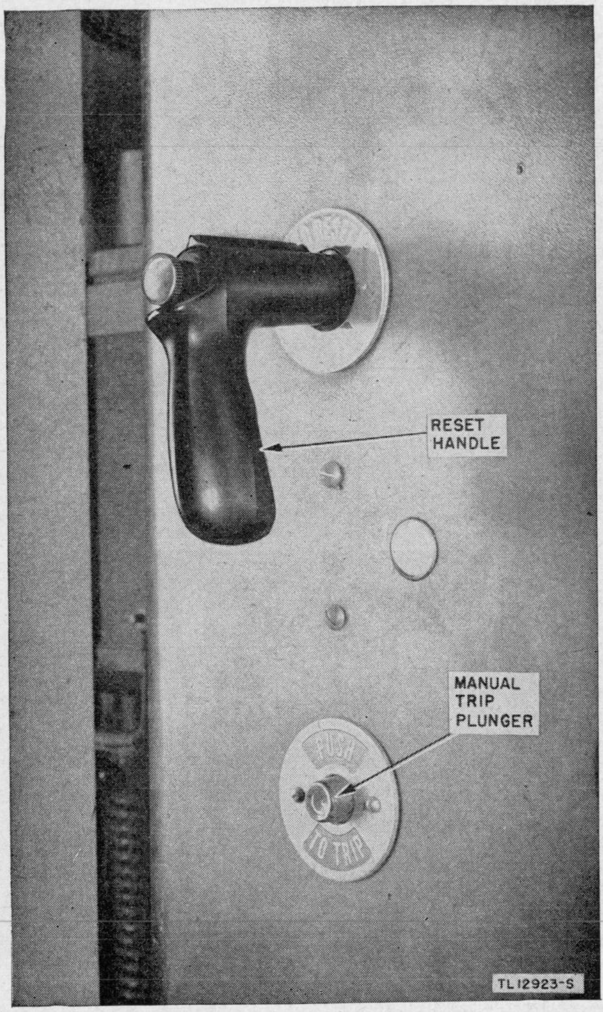


Figure 19. High speed circuit breaker.

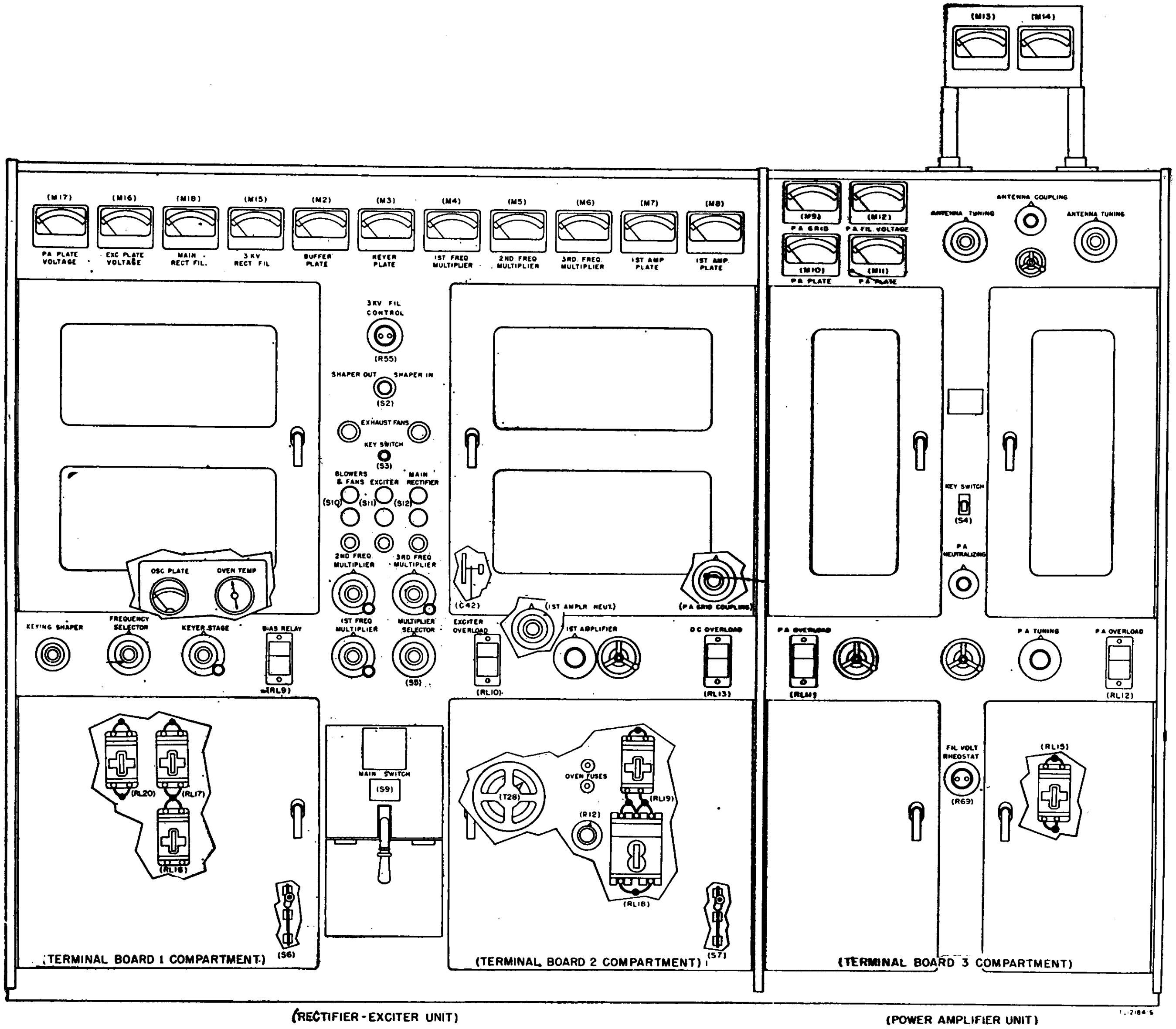


Figure 20. Radiotelegraph transmitter PW-15A, front view showing controls.

PART TWO

OPERATING INSTRUCTIONS

Note. For information on destroying the equipment to prevent enemy use, see destruction notice at the front of the manual.

Section III. CONTROLS AND THEIR USE

24. Rectifier-Exciter Unit (fig. 20)

The rectifier-exciter unit contains the following controls:

a. METERS. The 11 meters, located along the top of this unit, have the following functions:

(1) P.A. PLATE VOLTAGE meter measures the output voltage of the main power supply.

(2) EXC. PLATE VOLTAGE meter measures the output voltage of the 3-kv power supply.

(3) MAIN RECT. FIL. meter measures the primary voltage of the filament transformers for the main rectifier tubes.

(4) 3-KV RECT. FIL. meter measures the primary voltage of the filament transformers for the 3-kv rectifier tubes.

(5) BUFFER PLATE meter measures the cathode current of the buffer tube.

(6) KEYER PLATE meter measures the cathode current of the keyed tube.

(7) IST FREQ. MULTIPLIER meter measures the cathode current of the first frequency-multiplier tube.

(8) 2D FREQ. MULTIPLIER meter measures the cathode current of the second frequency-multiplier tube.

(9) 3D FREQ. MULTIPLIER meter measures the cathode current of the third frequency-multiplier tube.

(10) IST AMP. PLATE meters measure the cathode current of the two first amplifier tubes. The left-hand meter measures the current of the front tube and the right-hand meter measures the current of the rear tube.

b. MAIN SWITCH. This switch controls the input power of the entire transmitter.

c. 3 KV FIL. CONTROL. This rheostat controls the primary voltage to the filament transformers of the 3-kv and bias rectifier tubes.

d. SHAPER OUT-SHAPER IN SWITCH. This switch controls the shaper elements in the keyed stage circuit, placing them in or removing them from the circuit.

e. EXHAUST FANS CONTROLS. These two controls regulate the speed of the two exhaust fans in the transmitter. Each switch has four positions: HIGH, LOW, and two OFF.

f. KEY SWITCH. In clockwise position this switch closes the keying circuit of the transmitter while in the counterclockwise position it connects the remote keying line to the keying circuit.

g. BLOWERS & FANS SWITCH. When all controls are set properly, pressing the black button starts the exhaust fans and blowers. To stop these equipments, the red button is pressed. A green circuit indicator light is directly below the START-STOP buttons.

h. EXCITER SWITCH. When all controls are set properly, this switch starts and stops the filament power to all tubes and the plate power to all tubes except the p-a tubes. Pressing the black button connects the power to these circuits, and pressing the red button disconnects the power. A red circuit indicator light is located directly below the START-STOP button.

i. MAIN RECTIFIER SWITCH. After all controls have been properly set, operation of the START (black) button of this switch will apply high voltage to the p-a stage, and operation of the STOP (red) button will remove the voltage. A red circuit-indicator light is located directly below the START-STOP button.

j. KEYING SHAPER CONTROL. This control adjusts the shape of the transmitter carrier pulses.

k. FREQUENCY SELECTOR SWITCH. This switch places the desired crystal position in the oscillator circuit. Six crystal positions are available, or five crystal positions and one master oscillator (mo) if a tuning unit is plugged into the sixth crystal position.

l. KEYER STAGE CONTROL. This tuning control tunes the plate circuit of the keyed stage.

m. 1st Freq. Multiplier Control. This tuning control tunes the plate circuit of the first frequency-multiplier stage.

n. 2d Freq. Multiplier Control. This tuning control tunes the plate circuit of the second frequency-multiplier stage.

o. 3d Freq. Multiplier Control. This tuning control tunes the plate circuit of the third frequency-multiplier stage.

p. Multiplier Selector Switch. This switch has three positions which determine whether one, two, or three frequency-multiplier stages are in the circuit.

q. 1st Amplifier Control. This tuning control tunes the plate circuit of the first amplifier stage.

r. Bias Relay. This relay is in the interlock circuit of the 3-kv power supply, and protects against plate voltage being applied to the tubes without bias voltage. The relay closes when the bias power supply is operating, and is adjustable for closing current.

s. Exciter Overload Relay. This is a protective relay in the 3-kv power supply circuit which will remove primary power from the power supply if excessive d-c currents are drawn. The relay is adjustable for tripping current.

t. D-C Overload Relay. This is the direct-current (d-c) overload relay for the main rectifier circuit, protecting it from high currents. The relay is adjustable for tripping current.

u. Osc. Plate and Oven Temp. Meters. These two meters are located inside the upper left-hand door of this unit and on the outside of the crystal oven. The OSC. PLATE meter measures the plate current of the oscillator tube, and the OVEN TEMP. meter indicates the temperature inside the crystal oven.

v. Terminal Board No. 1 Compartment (fig. 61). The following controls are located in this compartment, and may be reached through the lower left-hand door of the rectifier-exciter unit.

(1) Thermal switch RL16 which is in the primary filament circuit of the oscillator, buffer, keyed, keyer, and frequency-multiplier tubes and all rectifier tubes except those in the main rectifier.

(2) Thermal switch RL17 which is in the primary filament circuit of the first amplifier and p-a tubes.

(3) Thermal switch RL20 which is in the primary circuit to the plate transformers for the oscillator, buffer-keyed stage, and bias power supplies.

(4) Knife switch S6 which connects the plate circuits of the frequency-multiplier stages either to ground or to the high voltage.

w. Terminal Board No. 2 Compartment (fig. 62). The following controls are located in this compartment, and may be reached through the lower right-hand door of the rectifier-exciter unit.

(1) Thermal switch RL18 which is in the primary circuit of the plate transformers in the 3-kv power supply.

(2) Thermal switch RL19 which is in the primary circuit of the filament transformers for the main rectifier tubes.

(3) R.F. FIL. CONTROL T28 which varies the primary voltage to the filament transformers for the first amplifier and power amplifier.

(4) Knife switch S7 which connects the plate circuit of the first amplifier either to ground or to the high voltage.

(5) Rheostat R12 which controls the primary voltage to the filament transformer for the frequency-multiplier tubes.

x. First Amplifier Compartment (fig. 6). This compartment is accessible through the upper right-hand door of this unit, and contains the following controls.

(1) The first amplifier grid circuit balancing capacitor is mounted on the left-hand wall of this compartment, and is used to balance the grid current of the first amplifier tubes.

(2) The neutralizing capacitors are located just to the right of the first amplifier tubes and are used to neutralize this stage.

(3) The coupling capacitors between the first amplifier plate circuit and the p-a grid circuit are gang tuned and are located at the extreme right of this compartment. These capacitors allow for varying the excitation to the power amplifier.

y. Rectifier Compartment (fig. 10). This compartment is reached through the rear doors on the rectifier-exciter unit and contains high-speed circuit breaker RL8. This circuit breaker is tripped under overload conditions of the power amplifier and removes input power from the main power supply plate transformers.

25. P-A Unit (fig. 20)

The p-a unit contains the following controls:

a. Meters. The six meters located across the top of this unit indicate the following currents and voltages.

(1) The P.A. GRID meter measures the combined grid current of the p-a tubes.

(2) The two P.A. PLATE meters measure the cathode current of the p-a tubes. The left-hand meter measures the current of the front tube and the right-hand meter measures the current of the rear tube.

(3) The P.A. FIL. VOLTAGE meter measures the filament voltage of the front p-a tube.

(4) The r-f ammeters on top of the p-a unit indicate the transmission line current in each leg of the r-f transmission line.

b. Antenna Tuning Controls. These two controls adjust the antenna capacitors.

c. Antenna Coupling Control. This control adjusts the distance between the antenna-coupling coils and the p-a tank coil.

d. Key Switch.. This switch, when placed in either up or down position, operates the transmitter keying circuit. This switch will stay in the up (test) position until manually released but will not stay in the down position. The switch has no position for connecting the keying circuit to the remote keying line as does the KEY SWITCH on the rectifier-exciter unit.

e. P.A. Neutralizing Control. This control adjusts the p-a neutralizing capacitors. The indicating dial is located directly below the panel label, while the tuning wheel is located on the front panel directly under the top left-hand door of this unit.

f. P.A. Tuning Control. This control adjusts the p-a plate tank capacitors. The indicating dial is located directly under the right-hand door while the tuning wheel is just to the left of the dial.

g. P.A. Overload Relays. These two relays are in the cathode circuits of the p-a tubes and will trip, removing the plate voltage from the tubes when excessive currents are drawn. The relays are adjustable for tripping current. The left-hand relay (RL11) is in the cathode circuit of the rear p-a tube, and the right-hand relay (RL12) is the cathode circuit of the front p-a tube.

h. Fil. Volt. Rheostat. This rheostat controls the primary voltage to the filament transformers for the 7-kv rectifier tubes.

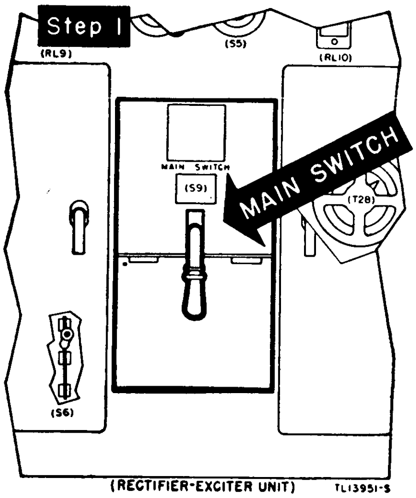
i. Terminal Board No. 3 Compartment (fig. 63). This terminal board is accessible through either bottom door of this unit. Thermal switch RL15, located in the right-hand side of the compartment is in the primary circuit of the two blowers.

26. Start Procedure

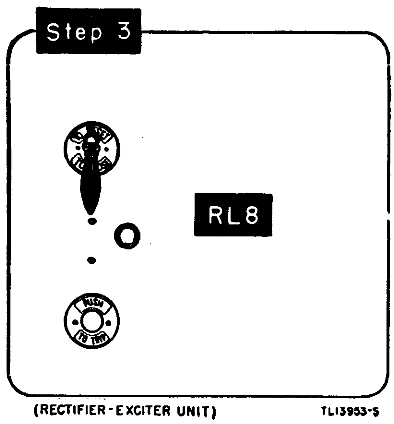
The following steps with illustrations give a step-by-step procedure for starting the transmitter after it has been tuned on the operating frequency. The tuning procedure for the transmitter is given in section XIII.

27. Starting Rectifier-Exciter Unit

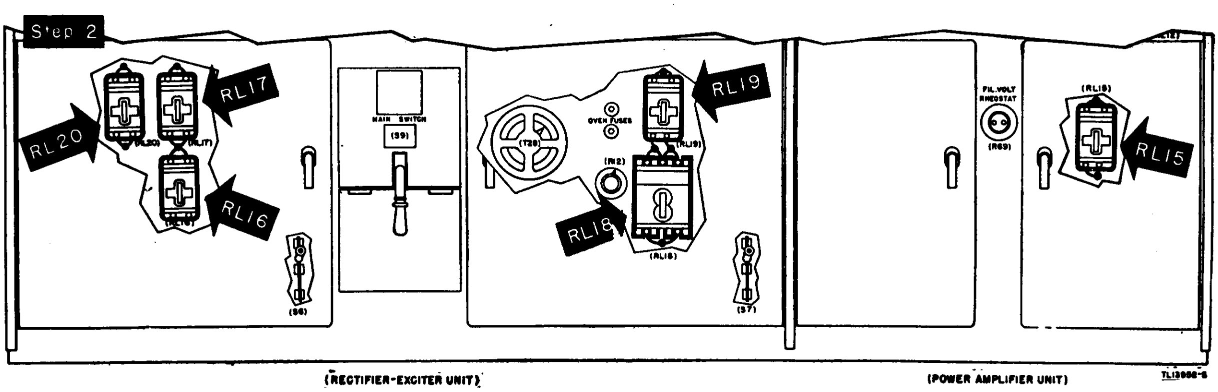
Step 1. Throw the MAIN SWITCH to the **on** (down) position. If this switch has been off **for** some time, allow at least 3 hours for the oven temperature to become constant. The dial thermometer on the oven should read 48° to 50.°



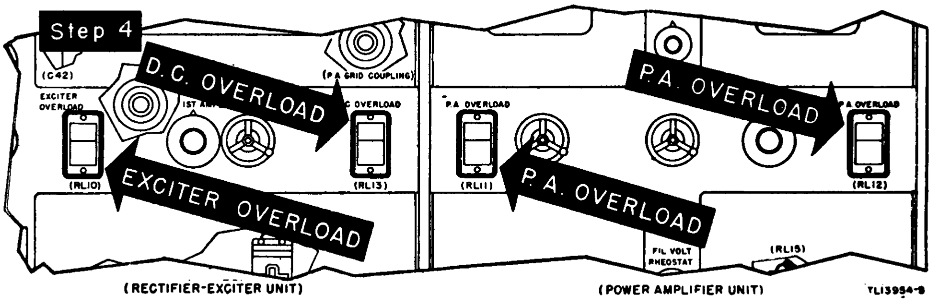
Step 3. Check the high-speed circuit breaker RL8 located in the rear of the transmitter to make **sure** it is set.



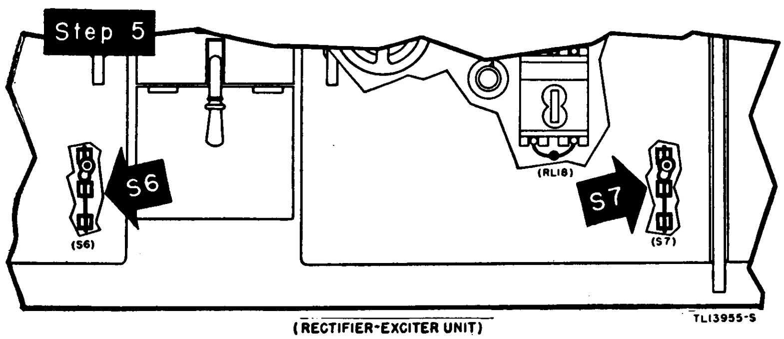
Step 2. Throw thermal circuit breaker switches RL15, RL16, RL17, RL18, RL19, and RL20 to ON.



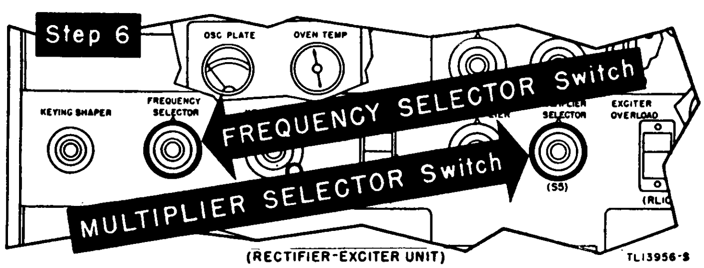
Step 4. Push up the reset buttons on the following relays: EXCITER OVERLOAD, D.C. OVERLOAD, and the two P.A. OVERLOAD relays.



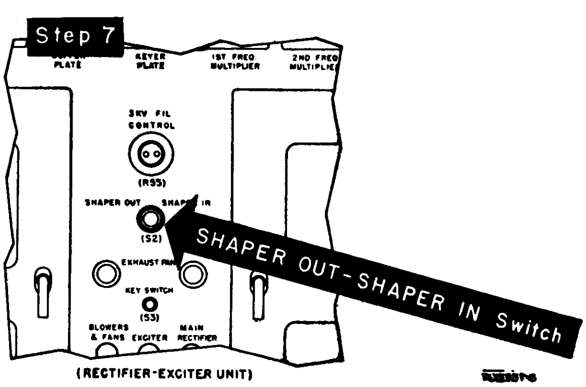
Step 5. Throw switches S6 and S7 to the up position.



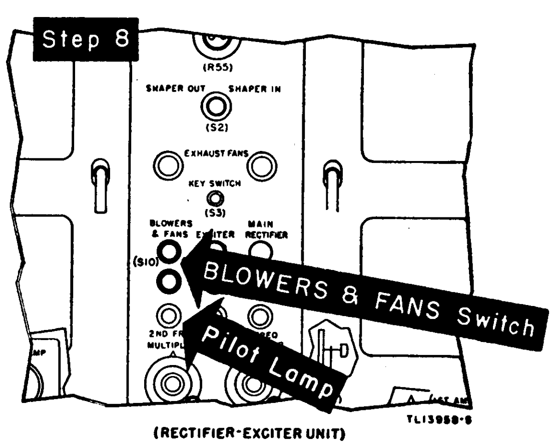
Step 6. Check setting of the FREQUENCY SELECTOR and MULTIPLIER SELECTOR switches for the operating frequency being used.



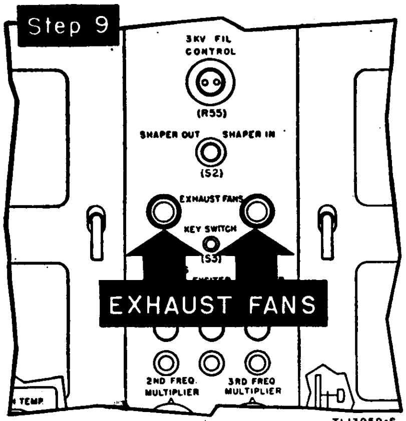
Step 7. Set SHAPER OUT-SHAPER IN switch to the desired position.



Step 8. Press the START (black) button on the BLOWERS AND FANS switch and watch for green pilot lamp to light.



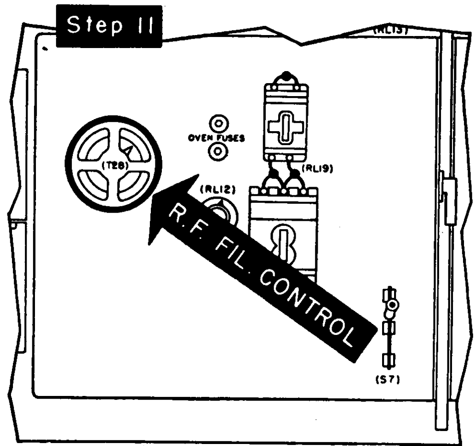
Step 9. Set EXHAUST FANS speed controls according to the ventilation required by the surrounding room temperature.



(RECTIFIER-EXCITER UNIT)

TL13959-S

Step 11. Open the lower right- door on the rectifier-exciter unit and turn the R.F. FIL. CONTROL to full counterclockwise position.



(RECTIFIER-EXCITER UNIT)

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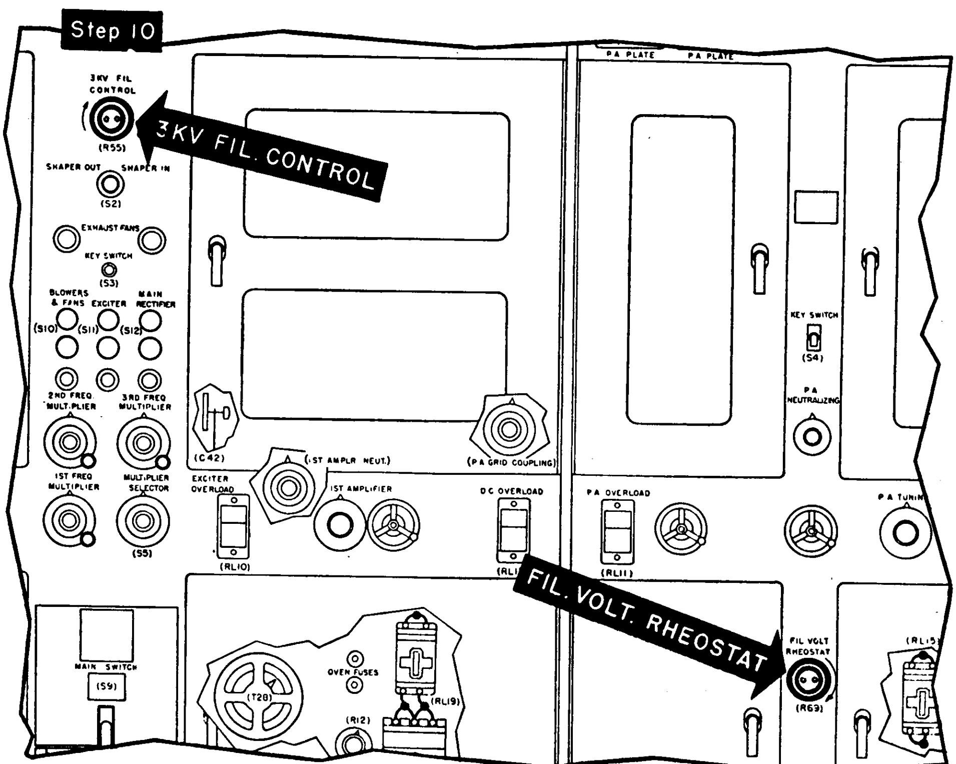
Step 10. Turn the 3 KV FIL. CONTROL and FIL. VOLT RHEOSTAT control to the full clockwise position.

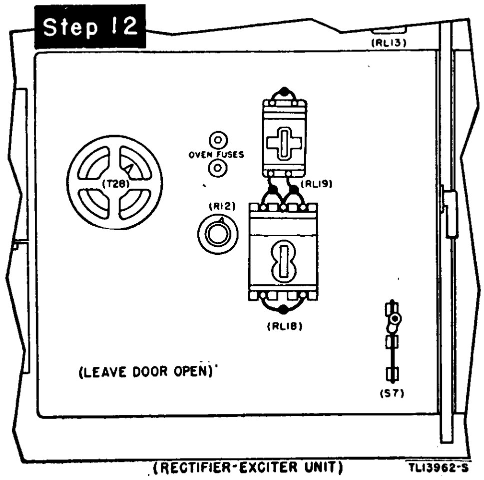


(RECTIFIER-EXCITER UNIT) (POWER AMPLIFIER UNIT)

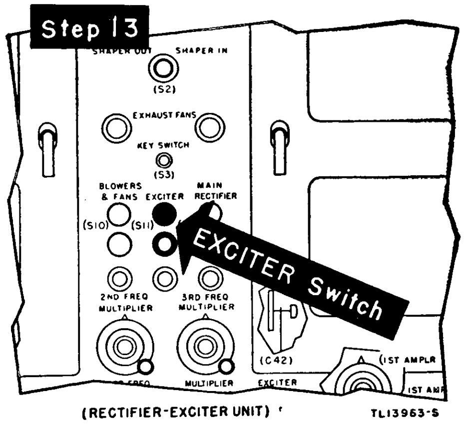
TL13960-S

Step 12. Leave the door that was opened in step 11 open.

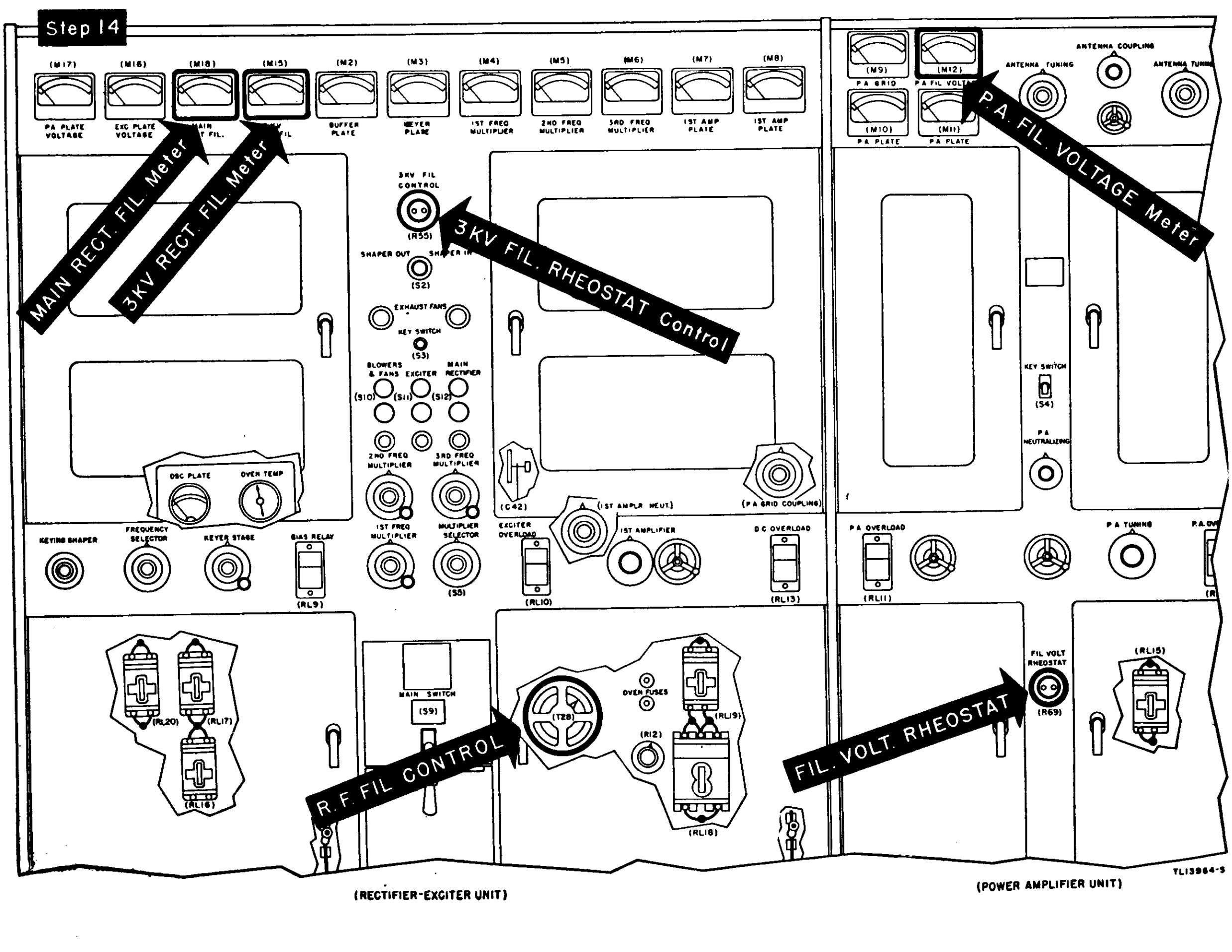
Note. When time is not available for step 15, omit step 12 and close all doors.



Step 13. Press START (black) button of the EXCITER switch. If step 12 above has been omitted the second pilot lamp (red) will light after approximately 30 seconds (time delay), and steps 15 and 16 should be omitted.

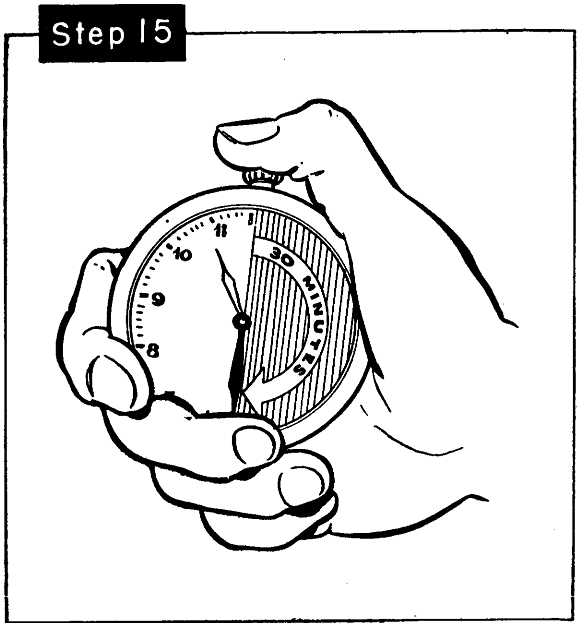


Step 14. Set R.F. FIL. CONTROL for a reading of 11 volts on the P.A. FIL. VOLTAGE meter. Turn the R.F. FIL. CONTROL slowly as the meter reading will lag the control setting and will continue to increase even after the operator has stopped turning the control. Set FIL. VOLT. RHEOSTAT control for a reading of 200 volts on the MAIN RECT. FIL. meter, and set 3 KV FIL. RHEOSTAT control for a reading of 200 volts on the 3 KV RECT. FIL. meter.



Step 15. Allow a 30 minute warm-up period.

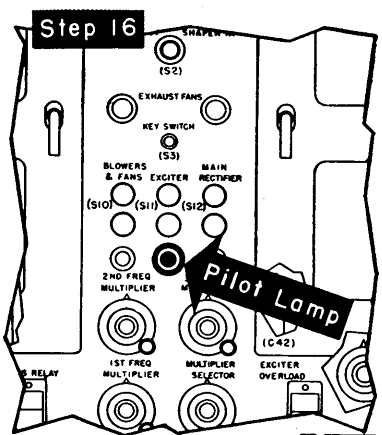
Note. If step 12 above is omitted, omit this step.



TL13965-S

Step 16. Close all doors and watch for exciter pilot lamp to light.

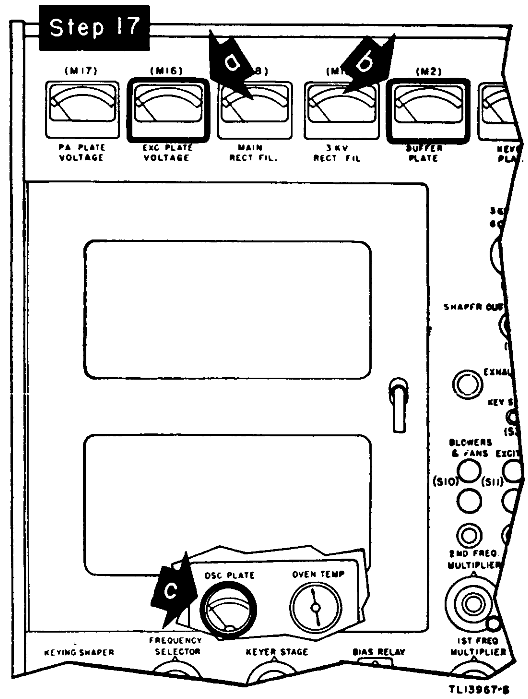
Note. If step 12 above is omitted, omit this step.



(POWER AMPLIFIER UNIT) TL13966-S

Step 17. Check the following meters for the indicated approximate readings:

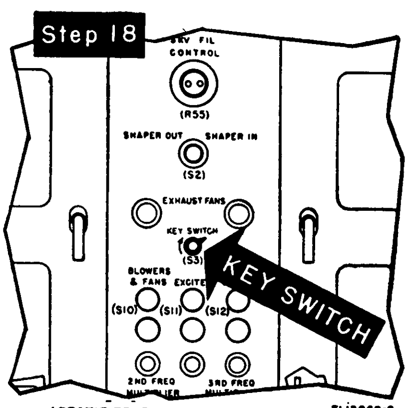
Ref symbol	Meter	Approximate reading
a	OSC. PLATE	5 to 6 ma
b	BUFFER PLATE	25 to 40 ma
c	EXC. PLATE VOLTAGE	3 kv



TL13967-S

(RECTIFIER-EXCITER UNIT)

Step 18. Turn KEY SWITCH (rectifier-exciter unit) to clockwise position.

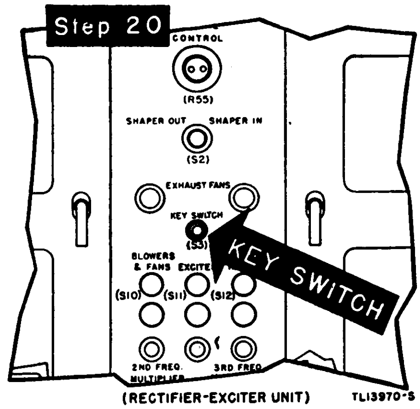


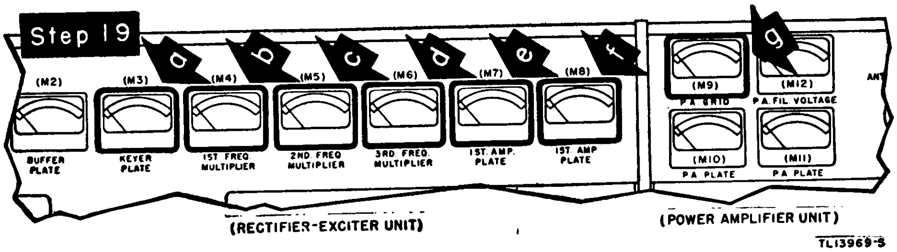
(RECTIFIER-EXCITER UNIT) TL13968-S

Step 19. Check the following meters for the indicated approximate readings:

Ref symbol	Meter	Approximate reading
a	KEYER PLATE	30 to 60 ma
b	1ST FREQ. MULTIPLIER	70 to 120 ma
c	2nd FREQ. MULTIPLIER (if used)	80 to 110 ma
d	3rd FREQ. MULTIPLIER (if used)	60 ma
e	1st AMP. PLATE (left)..	150 to 350 ma
f	1st AMP. PLATE (right).	150 to 350 ma
g	P.A. GRID	0.6 amp

Step 20. Place KEY SWITCH (rectifier-exciter unit) in neutral position.

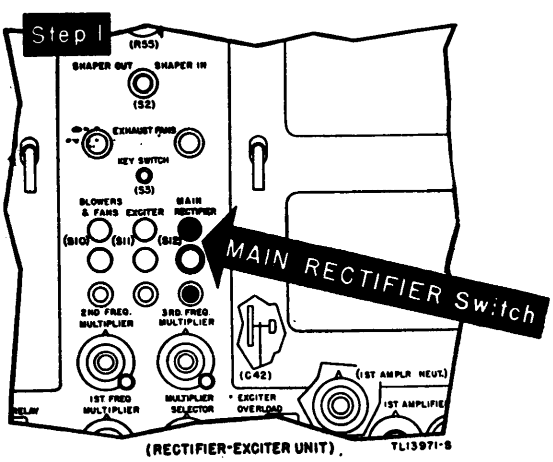




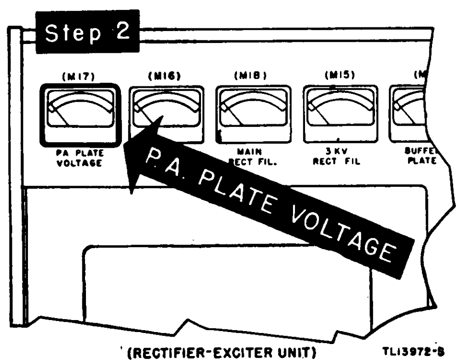
28. Starting P-A Unit

After all the steps in paragraph 27 have been performed, the following steps will start the power amplifier.

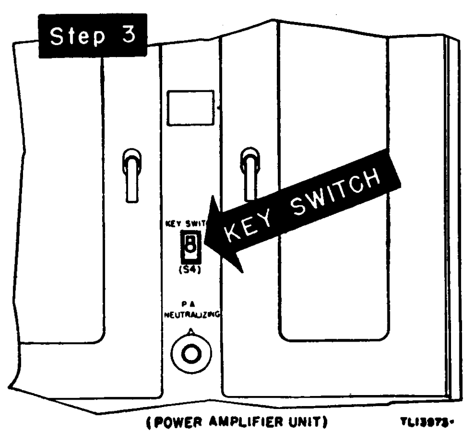
Step 1. Press START (black) button of MAIN RECTIFIER switch and wait approximately 30 seconds (time delay) for pilot lamp (red) to light.



Step 2. Check P.A. PLATE VOLTAGE meter for a reading of approximately 8 kv.



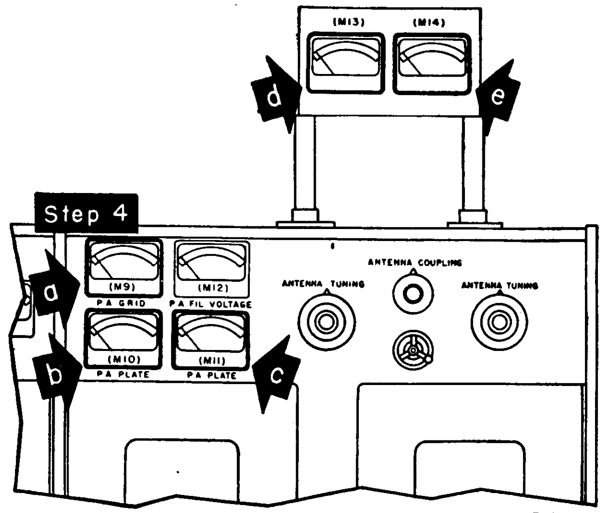
Step 3. Place the KEY SWITCH (p-a unit) in the up position.



Step 4. Check the following meters for the indicated approximate readings:

Ref symbol	Meter	Approximate reading
a	P.A. GRID	400 to 500 ma
b	P.A. PLATE (left).......	1.8 to 1.95 amp
c	P.A. PLATE (right)	1.8 to 1.95 amp
d	Antenna meter (left)......	4.8 to 6.2 amp
e	Antenna meter (right)	4.8 to 6.2 amp

Note. These meter readings will vary with loading but will be approximately the indicated values when the transmitter is loaded for rated output.



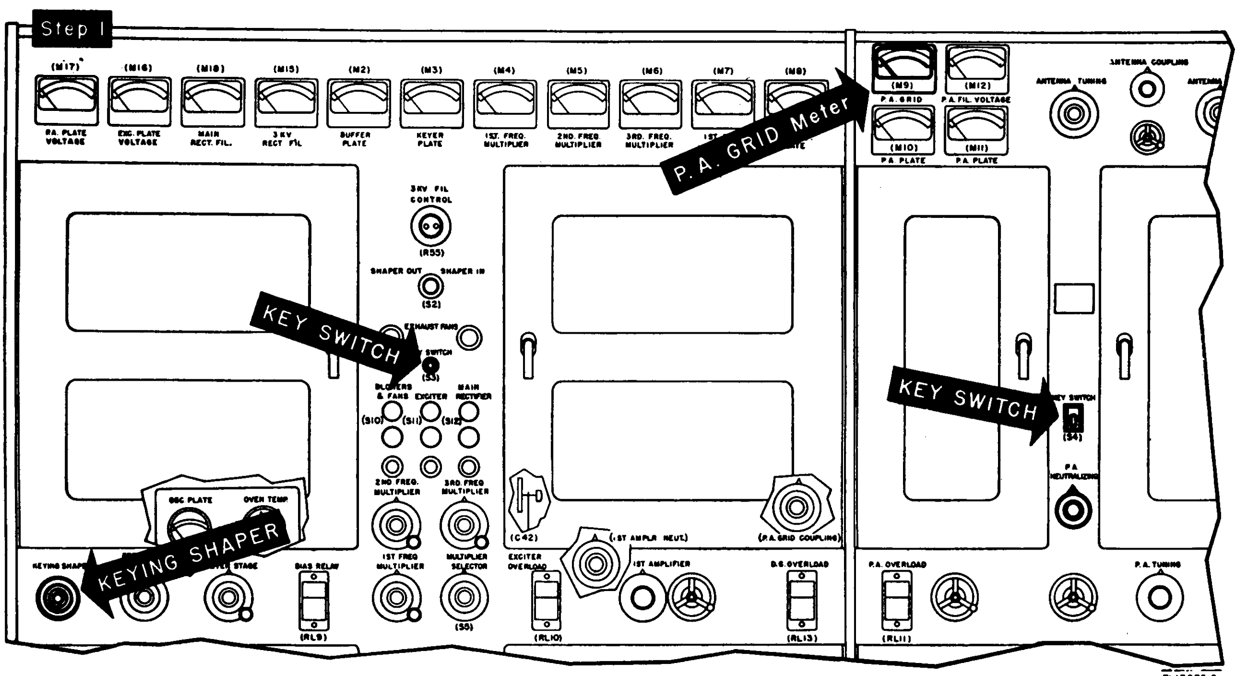
(POWER AMPLIFIER UNIT)

TL13974-S

29. Adjusting Keying Circuit

After all the steps in paragraphs 27 and 28 have been performed, it will be necessary to perform the following steps before keying the transmitter.

Step 1. Release KEY SWITCH (p-a unit) and place KEY SWITCH (rectifier-exciter unit) in clockwise position. Set KEYING SHAPER control at point where p-a grid current begins to decrease as indicated on P.A. GRID meter.

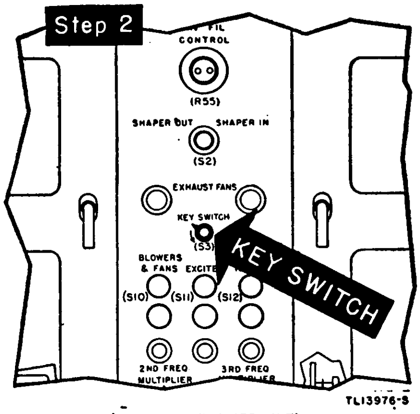


(RECTIFIER-EXCITER UNIT)

(POWER AMPLIFIER UNIT)

TL13975-S

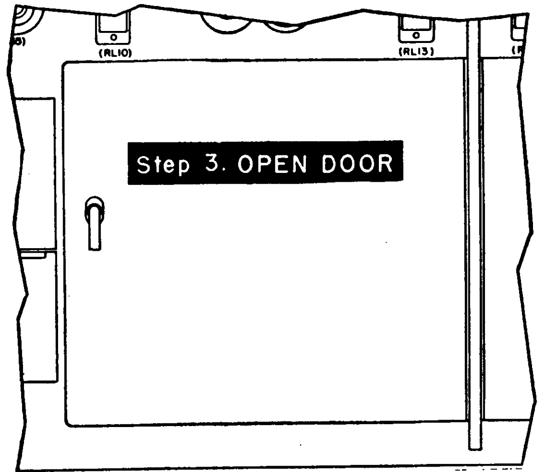
Step 2. Turn KEY SWITCH (rectifier-exciter unit) to counterclockwise position. The transmitter is ready to operate and is connected to the keying line.



TL13976-S

(RECTIFIER-EXCITER UNIT)

Step 3. Open bottom right-hand door of rectifier-exciter unit to operate interlock circuit.

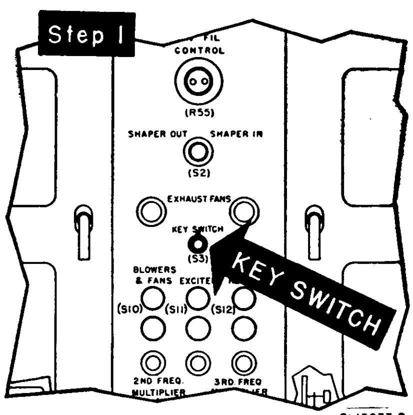


(RECTIFIER-EXCITER UNIT) TL13979-S

30. Stop Procedure

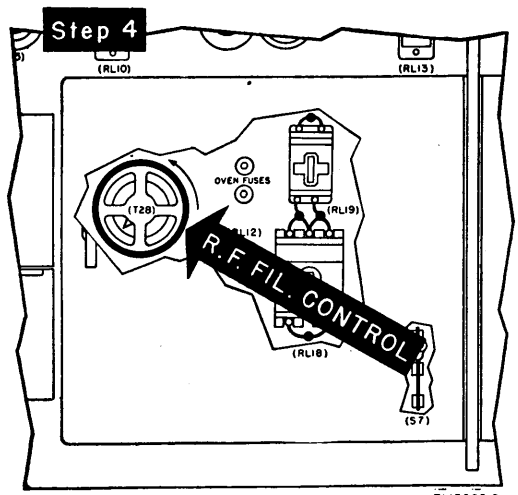
The following steps with illustrations give a step-by-step procedure for stopping the transmitter.

Step 1. Turn the KEY SWITCH (rectifier-exciter unit) to the neutral position.



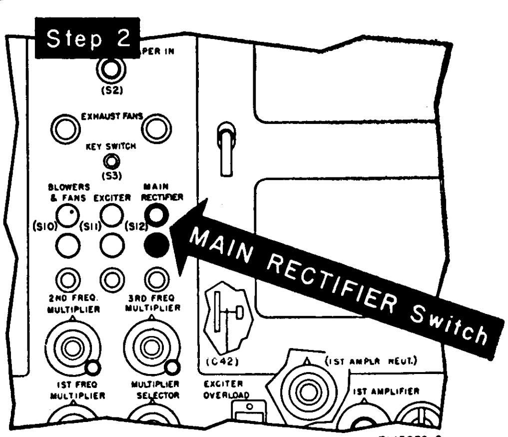
(RECTIFIER-EXCITER UNIT) TL13977-S

Step 4. Slowly turn the R.F. FIL. CONTROL to full counterclockwise position.



(RECTIFIER-EXCITER UNIT) TL13980-S

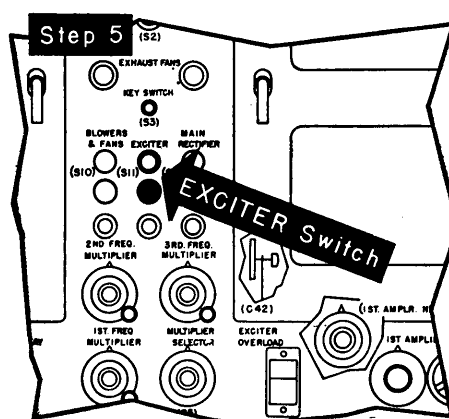
Step 2. Press STOP (red) button of MAIN RECTIFIER switch.



TL13978-S

(RECTIFIER-EXCITER UNIT)

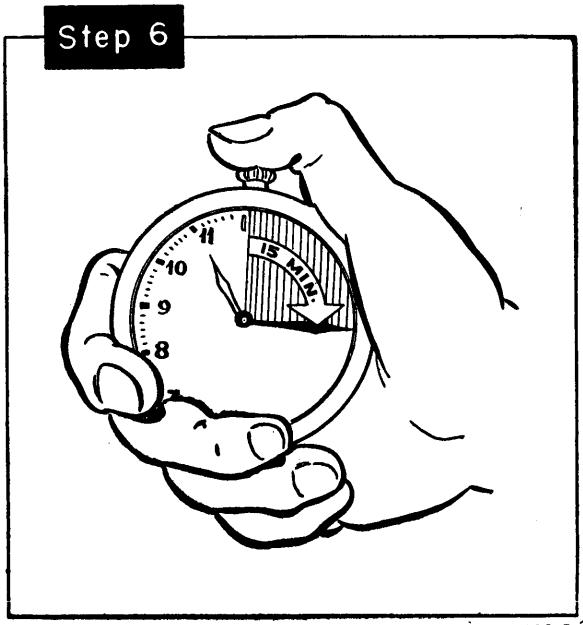
Step 5. Press the STOP (red) button of the EXCITER switch.



TL13981-S

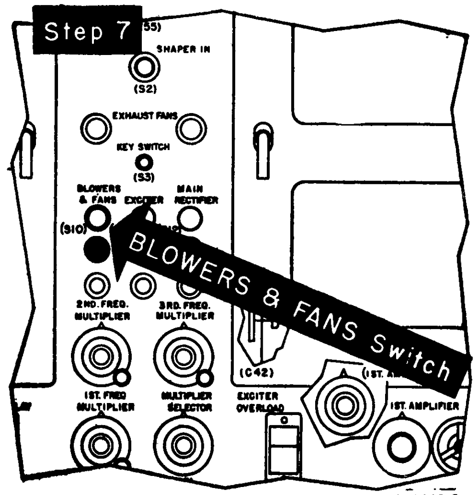
(RECTIFIER-EXCITER UNIT)

Step 6. Allow exhaust fans and blowers to run at least 15 minutes.



TL13982-S

Step 7. Press the STOP (red) button of the BLOWERS AND FANS switch.



(RECTIFIER-EXCITER UNIT) TL13983-S

Note. For complete shut-down of equipment throw the MAIN SWITCH to OFF (up).

Section V. EQUIPMENT PERFORMANCE

31. Purpose and Use of Check List

a. General. The equipment performance check list (par. 32) will help the operator to determine whether the PW-15A is functioning properly. The check list gives the item to be checked, the conditions under which the item is checked, the normal indications and tolerances of correct operation, and the corrective measures that the operator can take. Items 1 through 7 are checked before starting, items 8 through 11 when starting, items 12 through 23 for exciter operation, items 24 and 25 for starting power amplifier, items 26 through 29 for operation of power amplifier, items 30 and 31 for preparing transmitter for keying, and items 32 through 38 when stopping. Items 12 through 23 and 26 through 29 should be checked at least once an hour during normal operation.

b. Action or Condition. For some items the information given in the action or condition column consists of the settings of various switches and controls under which the item is to be checked. For other items it represents an action that must be taken in order to check the normal indication given in the normal indication column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator will perceive when he checks the items. In the case of meter readings, the allowable tolerances or approximate readings are given. When a meter reads between or near the limits specified, operation can be considered satisfactory. A meter reading outside the limits given is a sign of impending trouble. If the indications are not normal, the operator should apply the recommended corrective measures.

Note. The meter readings given in the check list are those present when the transmitter is loaded for full rated output of 15 KW.

d. Corrective Measures. The corrective measures listed are those that might correct minor misadjustments of controls. When overload relays kick out and meter readings are abnormal, see section XII, Trouble Shooting, and section XIII, Adjustment.

e. Items 1 Through 7. Items 1 through 7 should be checked each time the equipment is put into operation.

f. Items 8 Through 11. Items 8 through 11 should be checked when starting the exciter which includes all stages except the p-a stage.

g. Items 12 Through 23. Items 12 through 23 give the meter readings for the exciter stages plus filament voltages and p-a grid current when the power amplifier is not operating.

h. ITEMS 24 AND 25. Items 24 and 25 should be checked when starting the power amplifier.

i. ITEMS 26 THROUGH 29. Items 26 through 29 give the meter readings for the p-a stage loaded for full rated output.

j. ITEMS 30 AND 31. Items 30 and 31 should be checked when getting the transmittter ready for keying.

k. ITEMS 32 THROUGH 38. Items 32 through 38 are checked when stopping the transmitter.

32. Equipment Performance Check List

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	MAIN SWITCH.	Throw switch to ON.		
	2	Thermal switches RL15, RL16, RL17, RL18, RL19, and RL20.	Throw switches to ON.		
	3	High-speed circuit breaker RL8.	Make sure circuit breaker is set.	Indicator window shows red.	Turn reset handle.
	4	Overload relays: EXCITER OVERLOAD, D.C. OVERLOAD, and two P.A. OVERLOAD.	Push up reset buttons.		
	5	Switches S6 and S7.	Throw to up position.		
	6	FREQUENCY SELECTOR and MULTIPLIER SELECTOR switches.	Set to correct positions.		
	7	SHAPER IN-SHAPER OUT switch.	Set to desired position.		
START EXCITER	8	BLOWER & FANS switch.	Press START button.	Contactor will close and pilot lamp will light. Exhaust fans and blowers will start.	Check EXHAUST FANS speed control switches. Check blower switch RL15.
	9	FIL. VOLT. RHEOSTAT and 3 KV FIL. CONTROL.	Turn to full clockwise position.		
	10	R.F. FIL. CONTROL.	Turn to full counterclockwise position.		
	11	EXCITER switch.	Press START button.	Contactor will close and tube filaments will light. After time delay relay has cycled two contactors will close and pilot lamp will light.	Check door interlocks. Check relay RL21. If third contactor fails to close or switch RL18 is open pilot lamp will not light. Check BIAS RELAY and EXCITER OVERLOAD relay.
EXCITER PERFORMANCE	12	P-a filament voltage.	Set R.F. FIL. CONTROL. When setting this control turn it in short steps and watch the P.A. FIL. VOLTAGE as the meter reading will lag the setting of the control and the meter reading will increase even after the turning of the control is stopped.	P.A. FIL. VOLTAGE meter should read 11 volts.	
	13	Main rectifier filament voltage.	Set FIL. VOLT. RHEOSTAT.	MAIN RECT. FIL. should read 200 volts.	

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EXCITER PERFORMANCE	14	Rectifier filament voltage on 3-kv.	Set 3 KV FIL. RHEOSTAT.	3 KV RECT. FIL. meter should read 200 volts.	
	15	Oscillator plate current.	Read OSC. PLATE meter.	6 ma.	
	16	Buffer plate current.	Read BUFFER PLATE meter.	25 ma to 40 ma.	
	17	First amplifier plate voltage.	Read EXC. PLATE VOLTAGE meter.	3 kv.	
	18	Keyed stage plate.	KEY SWITCH S3 in clockwise position. Read KEYER PLATE meter.	30 ma to 60 ma.	
	19	First frequency-multiplier plate current.	KEY SWITCH S3 in clockwise position. Read 1ST FREQ. MULTIPLIER meter.	70 ma to 120 ma.	
	20	Second frequency-multiplier plate current.	KEY SWITCH S3 in clockwise position. Read 2D FREQ. MULTIPLIER meter.	80 ma to 110 ma.	
	21	Third frequency-multiplier plate current.	KEY SWITCH S3 in clockwise position. Read 3D FREQ. MULTIPLIER meter.	60 ma.	
	22	First amplifier plate current.	KEY SWITCH S3 in clockwise position. Read both 1ST AMP. PLATE meters.	150 ma to 350 ma.	
	23	P-a grid current.	KEY SWITCH S3 in clockwise position. Read P.A. GRID meter.	0.6 amp.	
START POWER AMPLIFIER	24	KEY SWITCH S4.	Place in neutral position.	Meters in items 18 through 23 will read zero.	
	25	MAIN RECTIFIER switch.	Press START button.	Contactor will be heard to close. After time delay relay has cycled, second contactor will close and pilot lamp will light.	Check P.A. OVERLOAD and D.C. OVERLOAD relays.
PA PERFORMANCE	26	P-a plate voltage.	Read P.A. PLATE VOLTAGE meter.	8 kv.	
	27	P-a grid current.	KEY SWITCH S4 in up position. Read P.A. GRID meter.	400 ma to 500 ma.	
	28	P-a plate current.	KEY SWITCH S4 in up position. Read both P.A. PLATE meters.	1.8 amp to 1.95 amp.	
	29	Transmission line current.	KEY SWITCH S4 in up position. Read both antenna meters.	4.8 amp to 6.2 amp.	

	Item No.	Item	Action or condition	Normal indications	Corrective measures
KEYING	30	KEYING SHAPER control.	KEY SWITCH S4 in up position. Set KEYING SHAPER control at the point where p-a grid current begins to decrease as indicated on P.A. GRID meter.		
	31	Remote keying.	Both KEY SWITCH controls in neutral position. Turn KEY SWITCH S3 on rectifier-exciter unit to counterclockwise position.		
STOP	32	KEY SWITCH S4.	Place in neutral position.	Transmitter cannot be keyed.	
	33	MAIN RECTIFIER switch.	Press STOP button.	Contactors will open, pilot lamp will go out, and P.A. PLATE VOLTAGE meter will read zero.	
	34	Lower right-hand door of rectifier-exciter unit.	Open door to operate interlock circuit.	Contactors will be heard to open, pilot lamp will go out, and EXC. PLATE VOLTAGE meter will read zero.	
	35	R.F. FIL. CONTROL.	Turn control slowly to full counterclockwise position. This control is located behind the door opened in item 34.	Reading on P.A. FIL. VOLTAGE meter will decrease to zero, and filaments of p-a and first amplifier tubes will dim out.	
	36	EXCITER switch.	Press STOP button.	All tube filaments will go out.	
	37	Exhaust fans and blowers.	Allow these units to run for a minimum of 15 minutes after item 36 is completed.		
	38	BLOWERS & FANS switch.	Press STOP button. *Note.* For complete shutdown of equipment throw MAIN SWITCH to OFF (up).	Pilot light will go out, and exhaust fans and blowers will stop.	

PART THREE

MAINTENANCE INSTRUCTIONS

Section VI. PREVENTIVE MAINTENANCE TECHNIQUES

Warning: Before doing any work inside the transmitter discharge capacitors.

33. Meaning of Preventive Maintenance

Preventive maintenance is a systematic series of operations performed at regular intervals on equipment, when turned off, to eliminate major breakdowns, unwanted interruptions in service, and to keep equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The prime function of preventive maintenance is to *prevent breakdowns* and, therefore, the need for repair. On the other hand, the prime function of trouble shooting and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. A system of radio communication depends on the performance of every set. It must be *ready* to go on the air when it is needed, and it *must* operate efficiently. Therefore, it is vitally important that radio operators and repairmen maintain their radio sets properly.

34. Description of Preventive Maintenance Techniques

a. GENERAL. Most of the electrical parts used in the PW-15A require routine preventive maintenance. This preventive maintenance varies. Some parts require a different kind of maintenance than others. Some require more, some less. Definite and specific instructions must be followed. Hit-or-miss techniques cannot be applied. This section of the manual contains these specific instructions to guide personnel assigned to perform the six basic maintenance operations: Feel, Inspect, Tighten, Clean, Adjust, and Lubricate. Throughout this manual the lettering system for the six operations will be as follows:

F—Feel
I—Inspect
T—Tighten
C—Clean
A—Adjust
L—Lubricate

The first two operations show if the other four are needed. Selection of operations is based on a knowledge of field needs. For example, dust encountered on dirt roads during cross-country travel filters into equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary tightening, cleaning, and lubricating operations, equipment becomes undependable and subject to break-down when it is needed most.

b. FEEL. The feel operation is used most often to check rotating machinery, such as dynamotors, blower motors, and drive motors, also to determine whether electrical connections and bushings are overheated. Feeling will show the need for lubrication or the existence of other defects requiring correction. The maintenance man *must* become familiar with the normal operating temperatures of motors, transformers, and other parts, to recognize signs of overheating.

Note. It is important to perform the feel operation as soon as possible after shut-down and always before any other maintenance is done.

c. INSPECT. Inspection is the most important operation in preventive maintenance. A careless observer will overlook evidences of minor trouble. Although these defects may not at the moment interfere with performance of the equipment, invaluable time and effort can be saved if they are corrected *before* they lead to major and costly break-downs. To be able to recognize the signs of a defective set, make every effort to become thoroughly familiar with indications of *normal* functioning. Inspection consists of *carefully* observing all parts of the equipment, noticing their color, placement, state of cleanliness, etc. Inspect for the following conditions:

(1) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the

container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(2) Placement, by observing that all leads and cabling are in their original positions.

(3) Cleanliness, by carefully examining all recesses in the units for accumulation of dust, especially between connecting terminals and binding posts. Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity areas, look for fungus growth and mildew.

(4) Tightness, by testing any connection or mounting which appears to be loose.

d. Tighten, Clean, and Adjust. These operations explain themselves. Specific procedures to be followed in performing them are given wherever necessary throughout part three.

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

Whenever a loose connection is tightened, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush. See section X for details of moistureproofing and fungiproofing.

e. Lubricate. Lubrication refers to the application of grease or oil to the bearings of motors or rotating shafts. It may also mean the application of a light oil to door hinges or other sliding surfaces on equipment. Where the need for lubrication is indicated, see section VIII.

35. Vacuum Tubes

Note. Do not work on the tubes immediately after shutdown. Severe burns may result from contact with the envelopes of hot tubes.

a. Inspect (I). (1) Inspect glass and metal tube envelopes, tube caps, and tube connector clips for accumulation of dirt and for corrosion. Tubes with loose plate caps, grid caps, or envelopes should be replaced if possible.

(2) Examine the spring clips that make contact with the grid caps for corrosion and for loss of tension with resulting looseness. Check the condition of wires soldered to the spring clips. The wires should be free of frayed insulation or broken strands.

(3) Inspect the firmness of tubes in their sockets. Make the inspection by pressing the tubes down in the sockets and testing them in that position, *not* by partially withdrawing the tubes and jiggling them from side to side. Movement of a tube tends to weaken the pins in the base and unnecessarily spread the contacts in the socket. Inspect the tube sockets at the time the tubes are removed.

(4) Be careful when removing a tube from its socket, especially if it is a high-power tube. Never jar a warm tube. Always remove connections to the grid caps and plate caps.

b. Tighten (T). Tighten all loose connections to the tube sockets or to the tubes. If the connections are dirty or corroded, clean them before tightening. When tightening locknuts that hold the sockets to the insulated bushings, do not apply excessive pressure. Too much pressure will crack the bushings.

c. Adjust (A). Adjust loose tube connector clips. Do not flatten tube connector clips during adjustment. Flattened clips do not make adequate contact with the surface of the tube cap. If the clip is made of thin metal, it can be adjusted by gently compressing it with the fingers. If it is made of heavy-gauge metal, suitable pressure can be applied with a pair of long-nose pliers.

d. Clean (C). (1) Clean the tubes, if necessary. Tubes operated at high voltages and with exposed plate and grid connections must be kept free of dirt and dust because of possible leakage between grid and plate terminals. In contrast, tubes operating at low voltages and not having exposed grid and plate caps do not require frequent cleaning. However, do not permit dirt to accumulate on low-voltage tubes.

(2) Remove dust and dirt from the glass or metal envelopes with a clean, lint-free, dry cloth. If proper care is used, the grid and plate caps may be cleaned with a piece of #0000 sandpaper by wrapping the paper around the cap and *gently* rubbing the surface. Excessive pressure is not needed; nor is it necessary to grip the cap tightly. Wipe the cap with a clean dry cloth.

(3) When tube sockets are cleaned and the contacts are accessible, fine sandpaper may be used to remove corrosion, oxidation, and dirt.

36. Capacitors

Warning: Discharge capacitors before attempting any work.

a. Inspect (I). (1) Inspect the terminals of large fixed capacitors for corrosion and loose connections. Carefully inspect the mountings to discover loose mounting screws, studs, or brackets. Examine the leads for poor insulation, cracks, and evidences of dry rot. Cut away frayed strands on the insulation. If the wire is exposed, wrap it with friction tape. See that the terminals of the capacitors are not cracked or broken.

(2) Thoroughly inspect the case of each large fixed capacitor for leaks, bulges, and discoloration.

(3) Inspect the plates of variable capacitors for dirt, dust, or lint. Examine the movable set of plates for signs of damage or misalignment that would cause them to touch the fixed plates during tuning. Rotate the movable plates, using the panel tuning control, and thus check for proper operation of the capacitor.

b. TIGHTEN (T). Tighten loose terminals, mountings, and connections on the capacitors, when necessary. Do not break the bushing or damage the gasket.

c. CLEAN (C). (1) Clean the cases of fixed capacitors, the insulated bushings, and all connections that are dirty or corroded. The capacitor cases and bushings can usually be cleaned with a dry cloth. However, if the deposit of dirt is hard to remove, moisten the cloth in dry-cleaning solvent (SD).

(2) Clean the plates of variable capacitors with a small brush or pipe cleaner, removing all dust and lint. Dust, if present, may cause arcing.

d. LUBRICATE (L). (See sec. VIII.)

37. Resistors

a. GENERAL. Various types of resistors are used in the PW-15A. The connections to the various resistors are either of the pigtail or solder-lug type.

b. INSPECT (I). Inspect the coating of the vitreous-enameled resistors for signs of cracks and chipping, especially at the ends. Examine the bodies of all types of resistors for blistering, discoloration, and other indications of overheating. Inspect leads and all other connections for corrosion, dirt, dust, looseness, and broken strands in the connecting wires. Check the security of all mountings. Do not attempt to move resistors with pigtail connections, because there is danger of breaking the connections at the point where they enter the body of the resistor. Such defects cannot be repaired.

c. TIGHTEN (T). Tighten resistor connections and mountings whenever they are found loose. If a resistor is allowed to remain loose, vibration may break the connection or damage the body.

d. CLEAN (C). (1) Clean all carbon resistors with a small brush.

(2) The vitreous-enameled resistors must be kept clean to avoid leakage between the terminals. Wipe them with a dry cloth. However, if the dirt deposit is unusually hard to remove, use dry-cleaning solvent (SD).

(3) Resistors with discolored bodies cannot be cleaned. Discoloration indicates that there has been overloading and overheating at some time prior to the inspection. The discoloration is probably due to circuit trouble which requires analysis and correction. Trouble-shooting procedures are described in part five.

38. Fuses (fig. 21)

a. DESCRIPTION. Fuses are small strips of metal with a low melting point, which are inserted in series with an electrical circuit to open the circuit when the amount of current exceeds a prescribed value. Being very rapid in action, fuses serve to protect equipment against overload and damage. Two types of fuses are used in the PW-15A: the nonrenewable type (figs. 54 and 62), and the renewable type. (See fig. 13.) Whenever a fuse is blown, an attempt should be made to discover the reason for the failure and to make corrections, if possible, before a new fuse is installed.

b. NONRENEWABLE FUSES. The nonrenewable fuses used in the PW-15A are the screw-in type and must be replaced in their entirety when blown. They should be checked for tightness and cleanliness of contacts.

c. RENEWABLE FUSES. These fuses consist of a case with screw caps on both ends and a renewable fuse link.

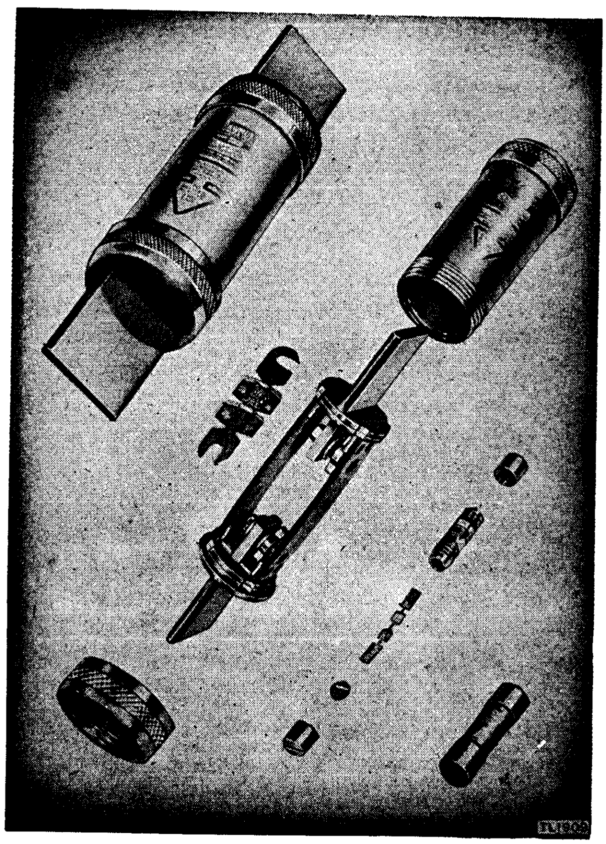


Figure 21. Fuses.

(1) *Low-ampere fuses.* When renewing the fuse link, both end caps are removed together with the slotted disk contained under one of the caps. The pieces of the old fuse link are then removed. The new fuse link should then be inserted through the end of the case from which the disk was removed. The end of the link is guided through the slot on the opposite end of the case, and is bent over flat against the end of the case. The slotted disk is then placed on the open end of the case such that the fuse link passes through the slot. Next the extending end of the link should be bent down flat against the end disk, and both end caps replaced.

(2) *High-ampere fuses.* When renewing links in these fuses, remove the end cap with the circular opening and pull out the fuse assembly. Loosen the two bolts holding the old fuse link, and remove the pieces. Insert the new fuse link, tighten the bolts, and replace the assembly.

d. INSPECT (I). Inspect the fuse caps for evidence of burning, charring, and corrosion; the fuse clips for dirt, loose connections, and loss of tension.

e. TIGHTEN (T). The tension of the fuse clips may be increased by pressing the sides closer together. If necessary, use a pair of pliers to adjust the tension.

f. CLEAN (C). Clean fuse ends and fuse clips with emery cloth; then wipe them with a clean cloth. When using a file to remove deep pits on the clips, fuse ends, or contacts, always finish up with crocus cloth to leave a smooth contact surface. As a final step, wipe the surface with a clean dry cloth.

39. Bushings and Insulators

a. DESCRIPTION. (1) Insulated bushings are used in the high-voltage and r-f circuits. They are constructed of ceramic material with a glazed surface. Because an insulator is not better than its surface, deposits of foreign substances on the surface will reduce the insulation value of the bushing. Therefore, it is very important that all bushings used in the high-voltage circuits be inspected frequently.

(2) Insulated bushings are used as supports for high-voltage tube sockets, for high-voltage terminals of capacitors, and for tank coils. They are used as mountings for resistors in high-voltage circuits and as supports for panels which mount other parts. The condition of insulated bushings that are used solely as panel supports is not too critical, but the condition of bushings used as high-voltage insulators is extremely important.

b. INSPECT (I). (1) Inspect the physical condition of the insulated bushings. They should be clean without cracks or chips. A highly glazed insulator may develop fine-line surface cracks where moisture and dust will accumulate and eventually form a leakage for a high-voltage flash-over.

(2) As a rule, the bushings are held in position with nuts screwed onto the threaded conductors. These can be replaced very easily. If replacement is not possible because of a shortage of supplies, clean the defective bushing frequently and thoroughly with dry-cleaning solvent (SD). Sometimes it is difficult to see dust on a glazed surface. A satisfactory check can be made by sliding a clean finger across the bushing.

c. TIGHTEN (T). The procedure to be used in tightening loose bushings is self-evident. However, one precaution must be observed. *Avoid forcing the nuts or screws down too tight.* If excessive pressure is exerted on the bushings, damage or breakage is almost certain. If the threads on bushing stud bolts are found stripped so that they cannot be tightened, replace the entire bushing.

d. CLEAN (C). Insulated bushings are easily cleaned. Never use abrasive materials because the glazed finish will be destroyed, thus permitting moisture to be absorbed. A clean cloth is usually satisfactory. If deposits of grime or dirt on the surface of a bushing are hard to remove, use dry-cleaning solvent (SD). After the surface has been cleaned with solvent, carefully polish it with a dry cloth. Otherwise, a thin film of the solvent will be left which may impair the effectiveness of the bushing as a high-voltage insulator.

40. Relay Contacts

a. In general, relay contacts are of two varieties, hard surface and soft surface. Hard surface contacts make use of different kinds of alloys among which are palladium and elkonium. The soft surface contacts are of two kinds. Both are silver, one being solid silver while the other is silver-plated. Improper cleaning of silver-plated relay contacts will soon remove the plating and reduce their effective-

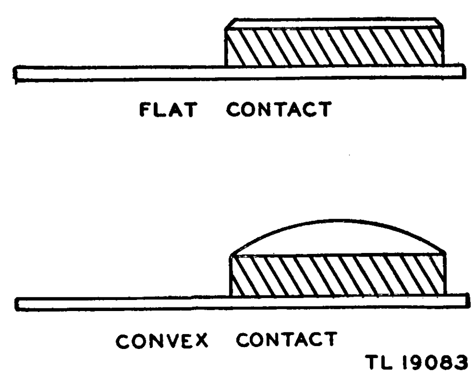


Figure 22. Flat and convex relay contacts.

ness. The care of solid silver contacts also deserves special attention. Although they are not as vulnerable as silver-plated contacts, they are made of soft material and the metal will wear away at an excessive rate if carelessly cleaned.

b. Relay contacts are of varied shapes, depending upon their size and application. In some instances, both contacts are flat; in others, one contact is convex while its mate is flat. (See fig. 22.)
The original shape of a contact must be retained during cleaning. If burning or pitting has distorted the contact so that it must be reshaped, the original shape must be restored. It is essential that the maintenance personnel familiarize itself with all details of the relays by examining them while they are in good condition.

41. Cleaning Relay Contacts

a. HARD ALLOY CONTACTS. (1) *Dirty contacts.* Hard alloy contacts are cleaned, when dirty, by drawing a strip of clean wrapping paper between them while holding them together. It may be necessary, in some cases, to moisten the paper with carbon tetrachloride. A dry paper or paper strip is used for polishing. Never use soft-finished paper which will disintegrate and leave small particles on the contacts.

(2) *Corroded, burned, or pitted contacts.* Corroded, burned, or pitted contacts must be cleaned with a burnishing tool (Tool, switchboard, WECo No. 256C, Sig C stock No. 6R41065C).

b. SOLID SILVER CONTACTS. (1) *Dirty contacts.* Dirty solid silver contacts are easily cleaned with a cloth or brush dipped in carbon tetrachloride. After being cleaned, the contacts are polished with a dry cloth.

Note. The brown discoloration that is found on silver and silver-plated relay contacts is silver oxide and is a good conductor. It should be left alone unless the contacts must be cleaned for some other reason. It may be removed, at any time, with a cloth moistened with carbon tetrachloride.

(2) *Corroded contacts.* Dress the contacts first with a burnishing tool. When all of the corrosion has been removed, wipe with a clean cloth moistened with carbon tetrachloride, and polish with a piece of folded cloth. Make certain that the shape of the contacts has been not altered from the original.

(3) *Burned or pitted contacts.* Resurface the contacts, if necessary, with #0000 sandpaper, making certain that when the work is done the shape of the contact has not been changed. Then smooth the surface with crocus cloth. After a high polish has been obtained, wipe thoroughly with clean cloth, using carbon tetrachloride when required.

(4) *Very badly burned or pitted contacts* (replacement not available). Use #0000 sandpaper.

c. SILVER-PLATED CONTACTS. (1) *Dirty contacts.* Dirty silver-plated contacts are cleaned with a cloth or brush dipped in carbon tetrachloride. After being cleaned, the contacts are polished with a dry cloth.

(2) *Corroded contacts.* Dress first with a burnishing tool. The work must be done very carefully so that an excessive amount of silver plating will not be removed. When all of the corrosion has been removed, polish with a cloth. Make certain that the shape of the contacts has not been changed.

(3) *Burned or pitted contacts.* Dress the contacts with a burnishing tool until the burned or pitted spots are removed. This may require an appreciable amount of time, but it is to be preferred to the use of a file or sandpaper. (If it is found that a burnishing tool does not remove the burns or the pits, then use the sandpaper tool very carefully.) If the sandpaper is used, follow with crocus cloth to polish the contact, wipe thoroughly with a cloth moistened with carbon tetrachloride, and dry with a clean cloth.

Warning: Never use highly abrasive materials, such as emery cloth, coarse sandpaper, or carborundum paper for surfacing relay contacts. They will damage the contacts.

d. TYPE CONTACTS. The following table gives the type of metal used in the contacts of the various relays in the PW-15A.

Relay	Type contact
RL 1, 2, 3, 4, 5, 6, 15, 16, 17, 18, 19, 20	Hard alloy, cadmium plated.
RL 9, 10, 11, 12, 13	Copper, silver plated.
RL 7, 8, 14, 21	Solid silver.

42. Switches

a. INSPECT (I). (1) Inspect the mechanical action of each switch and, while so doing, look for signs of dirt or corrosion on all exposed elements. In some cases, it will be necessary to examine the elements of the switch visually; in others, the action of the switch is checked by flipping the control knob or toggle, or pressing the switch button and noting the freedom of movement and amount of spring tension.

(2) Examine ganged switches to see that they are properly lubricated and that the contacts are clean. Inspection is visual. Do not pry the leaves of the switch apart. The rotary members should

make good contact with the stationary members. and as the former slide into the latter, a spreading of the stationary contact leaves should be visible. Switch action should be free. Wiping action of contacts usually removes any dirt at the point of contact.

b. CLEAN (C). Clean the exterior surfaces of switches with a stiff brush, moistened with dry-cleaning solvent (SD).

c. LUBRICATE (L). (See sec. VIII.)

43. Coils

a. INSPECT (I). Inspect coils for cleanliness of the ceramic coil form and secureness of mounting supports. Check all connections and sliding clips for proper contact and spring tension.

b. TIGHTEN (T). Tighten any loose coil mounting or connections by resoldering wires or tightening screws.

c. CLEAN (C). Clean the coil form and coil with a soft brush. Remember the ceramic coil form is actually performing the function of a high-voltage insulator. Therefore, the same preventive maintenance will apply to the coil as to high-voltage insulators and bushings. Clean sliding contacts with crocus cloth when corroded.

44. Rheostats and Potentiometers

a. INSPECT (I). (1) Inspect the mechanical condition of rheostats. The arm should be keyed tightly to the shaft, and the shaft should turn easily in the bushing which supports it.

(2) Inspect the assembly and mounting screws, setscrews, and nuts.

(3) Examine the insulating body of the rheostat for dust, dirt, cracks, and chipped places.

(4) Examine all metallic parts for dust, dirt, and corrosion.

b. TIGHTEN (T). Tighten loose assembly or mounting screws.

c. CLEAN (C). (1) Clean the exposed contact surfaces of the rheostat and the connections whenever they are dirty or corroded.

(2) Remove grease and dirt from the rheostat parts with carbon tetrachloride.

(3) If the contact surfaces are corroded, clean them with crocus cloth.

(4) Clean the contact surface of the arm by inserting a strip of crocus cloth between the arm and the rheostat winding and drawing the cloth back and forth.

(5) Clean the body of the rheostat or potentiometer with a brush or cloth.

45. Terminal Blocks

a. INSPECT (I). (1) Inspect terminal blocks for cracks, breakage, dirt, loose connections, and loose mounting screws.

(2) Carefully examine connections for mechanical defects, dirt, and corrosion.

b. TIGHTEN (T). Tighten loose screws, lugs, and mounting bolts. When tightening screws, be sure to select a screw driver of correct size. Do not exert too much pressure. Tighten loose connections.

c. CLEAN (C). Clean terminal blocks, when they require it, with a dry brush. When necessary, use a cloth moistened with dry-cleaning solvent (SD). Thoroughly wipe the block with a cloth and then brush it to remove any lint.

46. Multiple Connectors

a. INSPECT (I). Inspect the female ends of the connectors for corrosion and collected dust. Inspect the mountings for cracks and loose connections. Inspect the male ends for loose and broken pins and for proper spring in the plugs.

b. CLEAN (C). Clean the male and female ends of the connectors with a brush moistened in carbon tetrachloride. Remove corrosion with #0000 sandpaper, then wipe with a clean cloth.

47. Meters

Meters are extremely delicate instruments and must be handled carefully. They require very little maintenance. They are precision instruments and ordinarily cannot be repaired in the field.

a. INSPECT (I). Inspect the leads and connections of the meters. Look for loose, dirty, and corroded connections. Look for cracked or broken cover glasses. Since the movement of a meter is extremely delicate, its accuracy will be seriously affected if the glass is broken and dirt and water filter through.

b. TIGHTEN (T). Tighten all connections found loose. Any loose meter wires should be inspected for dirt or corrosion before they are tightened. The tightening of meter connections requires a special technique because careless handling can easily crack the meter case.

c. CLEAN (C). Meter cases can usually be cleaned with a dry cloth. If cleaning is difficult, dampen the cloth with dry-cleaning solvent (SD). Clean dirty connections with a small brush dipped in dry-cleaning solvent (SD), or with a small piece of cloth dipped in the solvent.

d. ADJUST (A). Normally, meters in the PW-15A should indicate zero when the equipment is turned off. Before deciding that a meter needs readjusting, tap the meter case *lightly* with the tip of one finger. This will help the needle to overcome the slight friction which sometimes exists at the bearings and prevents an otherwise normal unit from coming to rest at zero. If adjustment is needed, insert the tip of the thinnest screw driver available into the slotted screw head located below the meter glass and *slowly* turn the adjusting screw until the pointer is at zero. Lightly tap the meter case again and view the meter face and pointer *full on* and not from either side. Avoid turning the screw too far, because the needle may be bent or the hairspring damaged.

48. Pilot Lamps

Pilot lamps are used to indicate when power has been applied to a circuit. They are easily removed and replaced.

a. Inspect (I). Inspect the pilot-lamp assemblies for loose lamps, loose mounting screws, and loose, dirty, or corroded connections.

b. Tighten (T). (1) Tighten loose mounting screws and resolder any loose connections. If the connections are dirty or corroded, clean them before soldering.

(2) Screw loose lamps tightly into their sockets.

49. Coupling Shafts and Control Knobs

The control of various capacitors, switches, and resistors, found throughout the set is effected through coupling shafts that connect these items to control knobs located on the front panels. It is important that these shafts and control knobs be kept tight at all times.

50. Gears

a. Inspect (I) Inspect the teeth of the gears for dirt or corrosion. Check the antibacklash gears for proper operation by varying the panel tuning controls.

b. Clean (C). If the gears are dirty, clean them with a pipe cleaner or small brush dipped in dry-cleaning solvent (SD).

c. Lubricate (L). (See sec. VIII.)

51. Power Transformers and Filter Chokes

Since power transformers and filter chokes, used in the PW-15A are of similar potted construction, preventive maintenance for them is similar.

a. Feel (F). As soon as possible after shutdown, feel filter chokes for abnormal heating which may indicate an overloaded condition, or imminent failure due to moisture absorption or other causes. Likewise feel power transformers for abnormal heating.

b. Inspect (I). Inspect transformers for signs of blistering, bulging, or leakage of insulating compounds. Inspect for external signs of electrolytic action or corrosion.

c. Tighten (T). Tighten all mounting bolts or screws, but not to the point that threads are destroyed.

d. Clean (C). Clean power transformers and filter chokes with a dry cloth. Be sure that no dirt, lint, threads, or foreign material is present between terminals. Dirt, lint, and thread absorb moisture which may provide a leakage path for high voltages between these terminals. Be sure that none are present.

52. Reading Meters

Reading meters accurately requires common sense plus care. (See fig. 23.) The following rules and cautions help prevent errors:

a. Scale Numbering. In reading a meter, observe how the scale is numbered, that is, whether the numbering is 1-2-3, 2-4-6, 5-10-15, 10-20-30, 20-40-60, or in some other sequence.

b. Obtaining Value of a Subdivision. Count the divisions of scale space between the two main numbered graduations on each side of the needle. Divide the two main numerical differences between the two numbers by the number of divisions of scale space. This process gives the value of each subdivision, as illustrated in figure 23.

c. Scale Reading Accuracy. In general, the construction of the pointer and the graduation of the scale are such that, under steady conditions, the position of the pointer may be read by estimation to one-tenth of a scale division.

d. Avoiding Parallax Error. Guard against the error caused by parallax. To prevent this error, stand directly in line with the meter. If possible, have your eye on the same level as the meter; if this is impossible, be sure your eye is on the plane of the meter needle and the needle axis.

e. Linear Scales. In reading a meter, observe whether or not the scale is linear, that is, whether or not the needle deflection is directly proportional to the quantity being measured. A-c ammeters and voltmeters usually have scales on which the graduations are not directly proportional to the measured quantity. Linear scales are usually found on d-c instruments.

f. Nonlinear Scales. One meter using a nonlinear scale is known as the current-squared type. The needle deflection on this type of meter is proportional to the square of the current. This nonlinearity must be considered when estimating the reading on such a meter. For instance, when the needle is halfway between 2 and 3 on the meter, the reading is not 2.5 but approximately 2.55. During operation of the unit some fluctuations in the readings may occur, but the readings usually can be averaged mentally.

53. Adjusting Meters

a. CHECKING. Make an inspection of the zero setting of the meters during the shut-down period. The zero settings cannot be checked while the unit is in operation.

b. ADJUSTMENT. For changing of the zero setting of a meter see paragraph 47.

c. ZERO SHIFT. Zero shift is caused by the gradual yielding of the spring when the instrument is kept at a large deflection for a considerable length of time. If on breaking the circuit, the pointer does not return at once to its original zero position, it will probably do so gradually. For this reason, it is most important that the zero settings of meters be checked and readjusted ONLY AFTER THE UNIT HAS BEEN OFF THE AIR FOR SOME TIME.

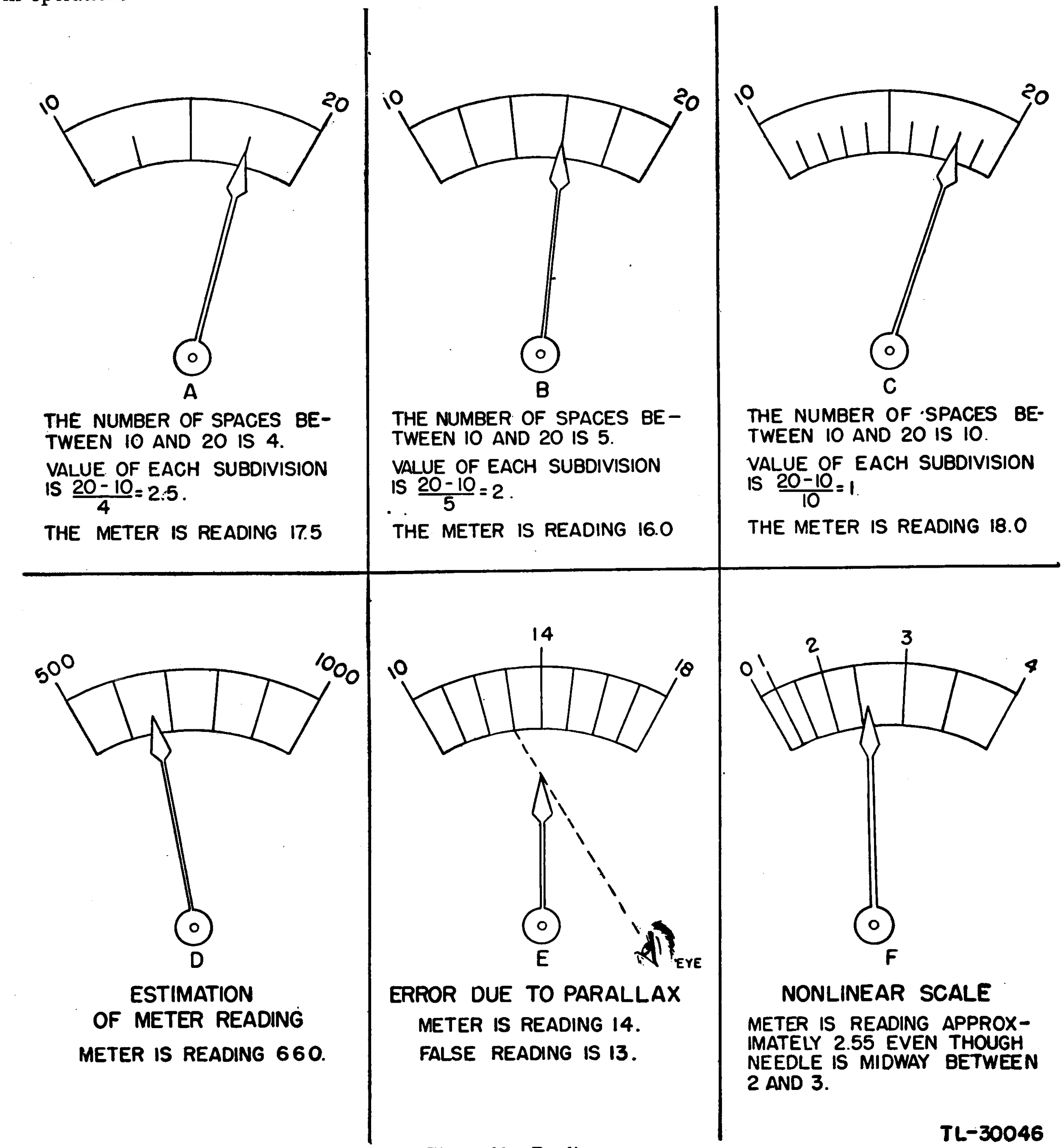


Figure 23. Reading meters.

Secti n VII. ITEMIZED PREVENTIVE MAINTENANCE

54. Introduction

For ease and efficiency of performance, preventive maintenance on the PW-15A will be broken down into operations that can be performed at different time intervals. In this section the preventive maintenance work to be performed on the transmitter at the specified time intervals is broken down into units of work called items. The general techniques involved and the application of the FITCAL operations in performing preventive maintenance on individual parts are discussed in section VI. These general instructions are not repeated in this section. When performing preventive maintenance, see section VI if more information is required for the following items. All work is to be performed with the power removed from the equipment. After preventive maintenance has been performed on a given day, the equipment should be put into operation and checked for satisfactory performance. (See par. 32, Equipment Performance Check Sheet.)

55. Preventive Maintenance Tools and Materials

The following preventive maintenance tools and materials will be needed:

Common hand tools.
Clean cloth.
#0000 sandpaper.
Crocus cloth.
Fine file or relay burnishing tool.
Thin screw driver.
Dry-cleaning solvent (SD).
Carbon tetrachloride.

Note. Gasoline will not be used as a cleaning fluid for any purpose. Solvent, Dry-cleaning, is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, may be used for cleaning purposes when dry-cleaning solvent (SD) is not at hand. Carbon tetrachloride will be used as a cleaning fluid only in the following cases: where inflammable solvents cannot be used because of the fire hazard, and for cleaning electrical contacts including relay contacts, plugs, commutators, etc.

56. Item 1. Exterior of Transmitter

OPERATIONS.

ITC Cabinet.
ITC Pilot lights.
IT Control knobs.
ICA Meters.

REMARKS. With an Allen wrench, tighten all control knobs found loose. Choose a wrench of proper size. When tightening knobs check to see that the scale and index are properly set for the position of the control. If a knob has become loose it may slip and the scale will read incorrectly. Pilot lamps are accessible by merely removing the jewels from the front panel. Inspect and clean the meter cases and adjust the zero set when it is found necessary. For the adjustment of the meters see paragraph 53.

57. Item 2. Tubes and Sockets

Note. Do not work on the tubes immediately after shutdown. Severe burns may result from contact with the envelopes of hot tubes.

OPERATIONS.

ITCA Tubes and sockets.

REMARKS.

a. To obtain maximum life from tubes, it is important that they be operated within their operating limits and within 5 percent of correct filament voltages. High-voltage rectifiers when new, should have filament voltage applied for 30 minutes before plate voltage is turned on to remove all condensed mercury from plates and to prevent arc-back. Spare rectifier tubes may be prepared for immediate use by lighting the filaments for 30 minutes with no plate voltage and storing in a rack or in an upright position. Do not allow mercury in the tube to splash over the filaments after this treatment. Handle the tubes with care. It is a good practice to use second sets of tubes for the transmitter and to rotate each set so that its period of activity is approximately 1,000 hours.

b. When intermittent operation is anticipated and conditions permit, filament voltages can be removed during stand-by periods of 2 hours or more. If a stand-by is of shorter duration, the filament potentials can be lowered by reducing the voltage control. If this is done, the operator must adjust to normal value before applying plate voltage.

c. When the rectifier tubes reach the end of their usefulness, they usually change in color under load from a bright greenish-blue glow to a very pale blue, and the glass envelope becomes black.

d. When a new p-a tube is first placed in operation, it should be operated without plate voltage for 15 minutes at a rated filament voltage. After this initial preheating schedule, plate voltage can be applied. Operate the new tube for 15 minutes at approximately one-half the usual plate voltage. Full voltage may then be applied and the tube operated under the normal load conditions for a period of 1 hour or more. Every 3 months spare tubes should be given this preheating and initial operation schedule. In case of overload and resultant overheating of the tube, the vacuum may be impaired. When the quantity of gas is not too great, the tube may be operated to bring about an electrical clean-up of the gas. The first step in the process should be a short period of operation at a plate voltage of one-half the normal value. The plate voltage should then be increased to the normal value and the tube allowed to operate for a period of 1 hour or more. In severe cases it may be possible to age the tube by operating with a series resistor in the plate supply. Short periods of operation may be conducted at each step as the resistor is reduced until stable operation at the normal plate voltage is obtained.

58. Item 3. Insulators

OPERATIONS.

ITC Insulators.

REMARKS. Insulators supporting the p-a tank capacitor assembly should be closely checked. The screws holding the bar insulator to the gear wheel may become loose resulting in considerable play in the tuning mechanism. The insulators are easily cracked when put under strain because of the weight supported by them. Keep the air tubes leading from the blowers to the p-a tubes clean.

59. Item 4. Capacitors

Warning: DISCHARGE CAPACITORS BEFORE ATTEMPTING ANY WORK.

OPERATIONS.

ITC Fixed capacitors.

ITCL Variable capacitors.

REMARKS. Check for play in the rotor plates of the p-a tank capacitors. When cleaning capacitor plates it will be necessary to use a dry cloth and brush; air pressure alone will not do the job. Check the couplings between all ganged capacitors to make sure they are tight. Fixed capacitors should be disconnected from the circuit and meggered every 6 months to anticipate break-downs. Insulation should average about 1 megohm per 1,000 volts. A small brush should be used to clean the plates of the fixed air capacitors used in the frequency-multiplier stages.

60. Item 5. Resistors

OPERATIONS.

ITC Resistors.

REMARKS. The resistors in the PW-15A, for the most part, are the clip-in type. These spring clips should be checked for tension, and the contacts kept clean. Resistors R1 and R2 are located under the crystal sockets in the crystal oven and can be reached by removing the plate inside the oven. Resistor values should be measured every 6 months to anticipate failures.

61. Item 6. Rheostats

OPERATIONS.

ITC Rheostats.

REMARKS. Transtat T28 should be cleaned in the same way as the rheostats.

62. Item 7. Transformers

OPERATIONS.

FITC Transformers.

REMARKS. The three-phase transformers for the main rectifier are oil filled. Any signs of oil leaks should be immediately investigated, the cause determined, and the leak stopped.

63. Item 8. Switches

OPERATIONS.

ICL Switches.

REMARKS. Switch S1 is located inside the crystal oven. Run a continuity check on all interlock switches to make sure they are operating properly. Thermal switch contacts should be dressed down similar to relays.

64. Item 9. Relays and Contactors

OPERATIONS.

ICA Relay and contactors.

REMARKS. Some contactors are subject to high currents and will wear contacts faster than others. Always keep contacts smooth. Remove the glass covers on overload relays only when necessary. In general, these relay contacts will not require the same amount of servicing as other relays.

65. Item 10. Terminal Boards

OPERATIONS.

ITC Terminal board connections.

66. Item 11. Control Shafts, Gears, and Bearings

OPERATIONS.

ITCL Control shafts, gears, and bearings.

67. It m 12. Blow rs and Exhaust Fans

OPERATIONS.

FICL Blowers and exhaust fans.

REMARKS. Fan and blower motors are of the induction type and therefore have no commutators to be serviced. Be sure fans and blowers are mounted securely. In transmitters which have been modified according to MWO SIG 41, Modification of Radio Transmitter PW-10LF, PW-15A, and PW-40B to provide a cleanable air filter, it will be necessary to disassemble the air filter and clean periodically.

68. Item 13. Battery

OPERATIONS.

IC Exterior.
IT Connections.
IA Electrolyte level.

REMARKS. The exterior of the battery may be washed off with soda water and then clear water. Remove all corrosion.

69. Item 14. Electrical and Mechanical Connections

OPERATIONS.

ITC All electrical connections.
IT Mounting bolts and mechanical joints.

REMARKS. Check all bus wire connections leading to the tube sockets and other components to determine if they are making proper electrical connections. Make sure all components are mounted securely.

70. Preventive Maintenance Check List

The following check list is a summary of the preventive maintenance operations to be performed on PW-15A. The time intervals shown on the check list may be reduced at any time by the local commander. For best performance of the equipment, perform operations at least as frequently as called for in the check list. The echelon column indicates which operations are first echelon maintenance and which operations are second echelon maintenance. Operations are indicated by the letters of the word FITCAL. For example, if the letters ITCA appear in the "Operations" column, the item to be treated must be inspected (I), tightened (T), cleaned (C), and adjusted (A).

Item No.	Operations	Item	When performed			Echelon
			Weekly	Monthly	Quarterly	
1	ITCA	Exterior of transmitter	x			1st
2	ITCA	Tubes and sockets	x			1st
3	ITC	Insulators	x			1st
4	ITC	Capacitors	x			1st
4	L	Capacitors			x	1st
5	ITC	Resistors	x			1st
6	ITC	Rheostats	x			1st
7	FITC	Transformers	x			1st
8	IC	Switches	x			1st
8	L	Switches		x		1st
9	ICA	Relays and contactors	x			1st
10	ITC	Terminal boards	x			1st
11	ITC	Control shafts, gears, and bearings	x			1st
11	L	Control shafts, gears, and bearings		x		1st
12	FIC	Blowers and exhaust fans	x			1st
12	L	Blowers		x		1st
12	L	Fans		x		1st
13	ITCA	Battery	x			1st
14	ITC	Electrical and mechanical connections	x			1st

Feel	Inspect	Tighten	Clean	Adjust	Lubricate
F	I	T	C	A	L

Section VIII. LUBRICATION

71. Approved Lubricants for Radiotelegraph Transmitter PW-15A

The following table lists the lubricating materials necessary in servicing radiotelegraph transmitter PW-15A.

Approved symbol	Standard nomenclature
OE 30	Oil, Engine
GL	Grease, Lubricating, Special
PS	Oil, Lubricating, Preservative, Special

Warning: The high voltages in this equipment make it imperative that *all power* be shut off before lubrication is done. Discharge all high-voltage capacitors.

72. Exhaust Fans (fig. 24)

Lubricate the two exhaust fans in the top of the rectifier-exciter unit every month* using the following procedure:

a. Remove the threaded plugs.

b. Apply special lubricating grease (GL) sparingly through plug holes. (If available, the use of a grease gun and fitting will facilitate lubrication).

c. Wipe off excess lubricant around plug holes and fitting.

d. Replace threaded plugs.

73. Blower Motors (fig. 24)

Lubricate the two blower motors in the bottom of the p-a unit every month using the following procedure:

a. Refill bearing housing with engine oil (OE 30) through ball and spring arrangement or by removing oil well cover, until it reaches overflow level in oil cup on side of oil well.

b. Replace oil well cover if so equipped.

c. If unit is equipped with drain plugs, remove drain plugs every 6 months and allow all old lubricant to flow out. Replace drain plugs and perform steps a and b above.

74. Other Components (fig. 24)

The following components should be checked and if necessary lubricated sparingly every 3 months:

a. VARIABLE CAPACITOR BEARINGS. Apply one or two drops of special preservative lubricating oil (PS).

b. WORM GEARS AND ROTARY SWITCHES. Apply special lubricating grease (GL).

c. DOOR LATCHES AND HINGES. Apply one or two drops of engine oil (OE 30).

Note. For applying oil, dip a B & S No. 22 gauge wire ½ inch into lubricant, withdraw, and apply drops where specified.

* The lubrication intervals are based on an average operating day of 8 hours under normal conditions. Under unusual conditions reduce the intervals.

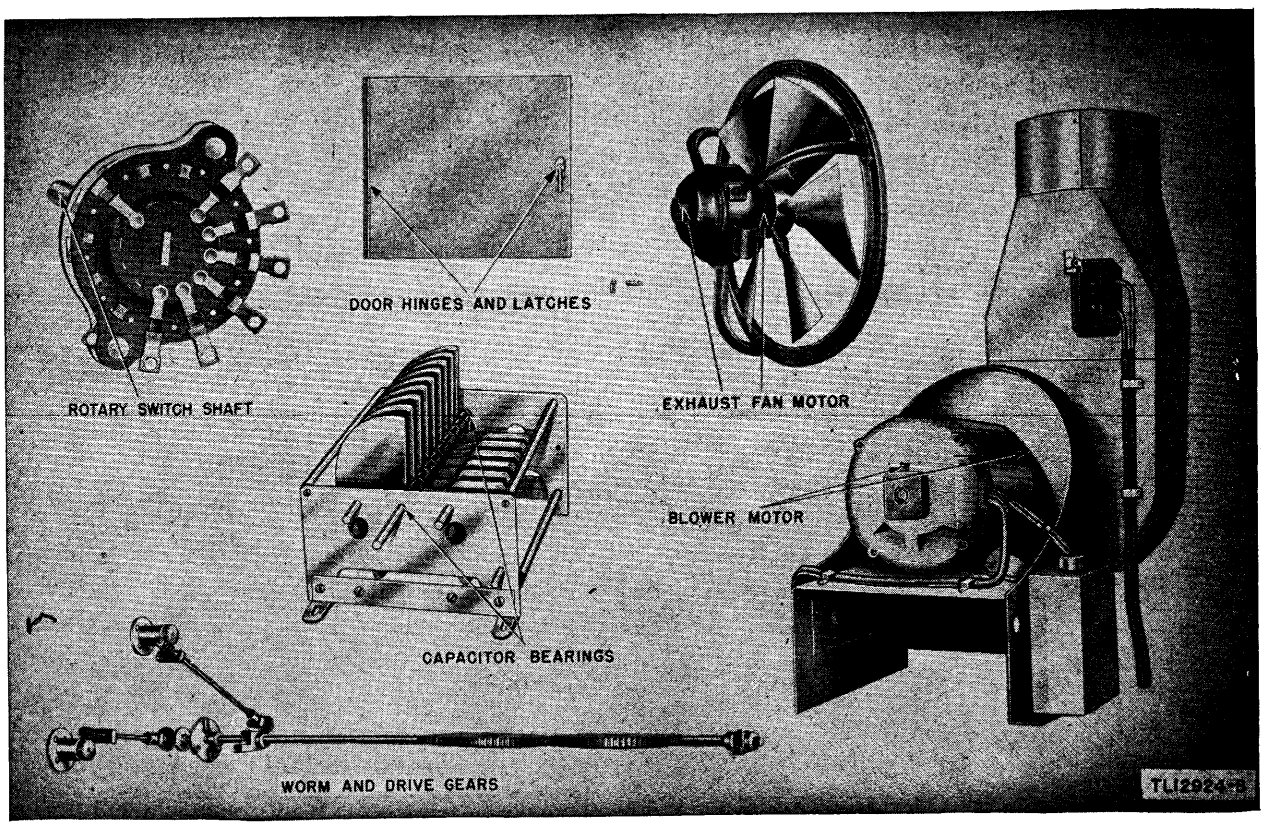


Figure 24. Lubrication points.

Section IX. SPECIAL TOOLS

75. Relay and Commutator Tools

A number of items in preventive maintenance require work of a special and somewhat delicate nature. These include cleaning silver-plated relay contacts, removing pitted surfaces from contacts, polishing and dressing commutators and slip rings, and dressing motor and generator brushes. To do the work properly, special supplies and a few specially constructed tools are needed. Most of the required materials are furnished with the equipment, but a few must be improvised.

76. Construction of Special Relay and Commutator Tools

Crocus cloth, canvas, and sandpaper sticks are constructed in the following manner:

a. Obtain one length of wood (or suitable substitute) 1/32-inch thick, 3/8-inch wide, and 3¾-inches long; and three lengths of wood (or suitable substitute) ¼-inch thick, 1-inch wide, and 8-inches long. Cut two pieces of crocus cloth, one piece 1-inch wide and 2½-inches long, and the other 1-inch wide and 5¼-inches long. Cut one piece of #0000 sandpaper and one piece of canvas, each 1-inch wide and 5¼-inches long.

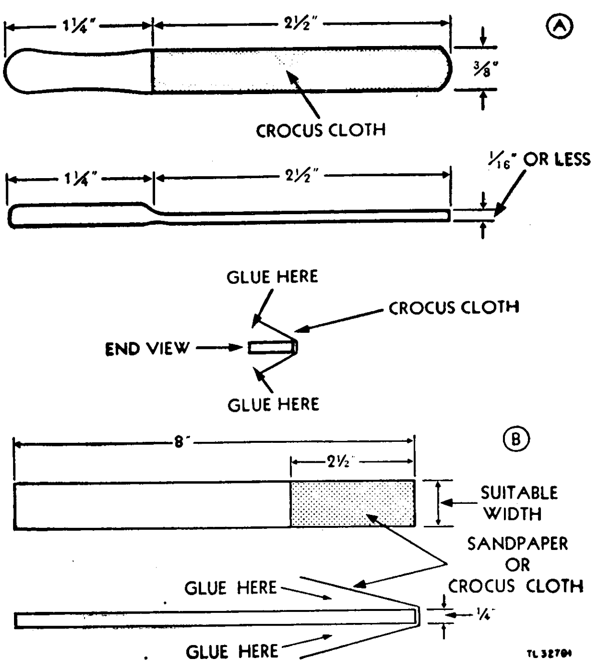


Figure 25. Relay and commutator tools, method of construction.

b. Cement the small piece of crocus cloth to the small stick, as shown in figure 25A. Note that both sides of the stick are covered. Place the stick in the vise until the cement hardens. The pieces of crocus cloth which extend over the edge of the stick may be cut off with a knife. The finished product is shown in figure 25A.

c. The long, narrow pieces of crocus cloth, sandpaper, and canvas are cemented to the three long sticks, as shown in figure 25B. Note that in this case the fold is over one end of the stick rather than over the side. Again the vise should be used to hold the cover material flat on the stick until the cement has hardened. This finished product is shown in figure 25B.

77. Safety Shorting Stick and Jumper Wires

It will be necessary for the maintenance personnel to construct a safety shorting stick and several jumper wires. The suggested method of construction (fig. 26) is as follows:

a. Secure a dry piece of wood or some other material which is a good electrical insulator. It should be about 3-feet long and about 1-inch square. The latter dimension is not very important. Securely fasten a piece of copper or brass rod (or thin tubing) to one end of the stick in such a manner that the rod extends 6 inches beyond the end of the stick. The free end of the rod should be bent in the form of a small hook. Solder a piece of heavy flexible hook-up wire, about 18-inches long, to the metal rod at the point where it is fastened to the stick. Attach a heavy clip to the free end of the wire.

b. The jumper wires are made from heavy flexible wire, about 18-inches long, with heavy clips attached to each end. These are intended for use as shorting links across high voltage capacitors in components that are being repaired or cleaned.

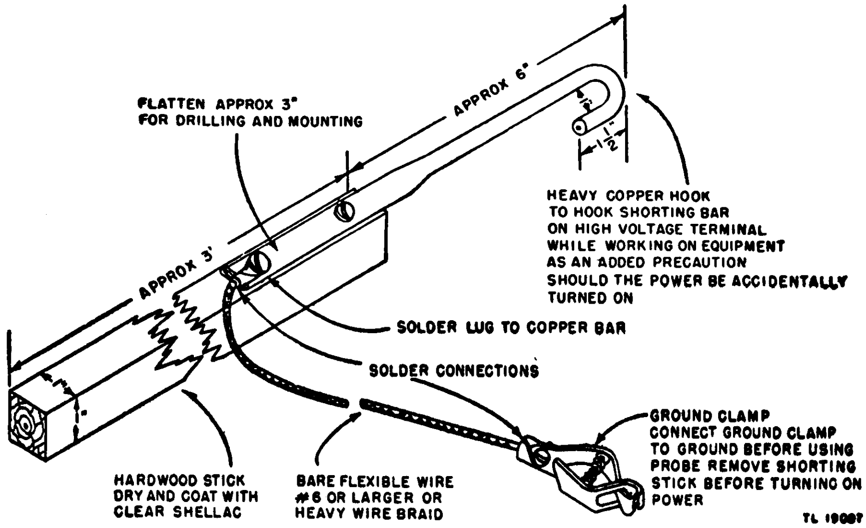


Figure 26. Shorting stick, method of construction.

Section X. Moistureproofing and Fungiproofing

Note. The parts outlined in white in figures 27 through 40 are parts to be masked as described in the text.

78. Gen ral

When operated in tropical areas where temperature and relative humidity are extremely high, Signal Corps equipment requires special attention. These are some of the problems met:

a. Resistors, capacitors, coils, chokes, transformer windings, etc., fail because of the effects of fungus growth and excessive moisture.

b. Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, chokes, transformer windings, etc., causing eventual breakdown.

c. Hook-up wire insulation and cable insulation break down. Fungus growth accelerates deterioration.

d. Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flashovers and crosstalk.

e. Moisture provides leakage paths between battery terminals.

79. Treatment

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. See TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing and the supplies and equipment required in this treatment.

Caution: Varnish spray may have poisonous effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth. Never spray varnish or lacquer near an open flame. Do not smoke in a room where varnish or lacquer is being sprayed. The spray may be highly explosive.

Note. Remove a-c power and discharge all capacitors before beginning work on the transmitter.

80. High-Voltage Rectifier

a. PREPARATION. Make all repairs and adjustments necessary for proper operation of the equipment.

b. DISASSEMBLY. All component parts can be reached through hinged doors, except those under the oscillator and first amplifier compartments. Remove the left end panel to gain access to these parts.

(1) Remove the six type 575A rectifier tubes V29 and V30 (fig. 27) and V25, V26, V27, and V28 (fig. 28).

(2) Remove the reset handle of high-speed circuit breaker RL8 (fig. 28) by extracting the thumbscrew in the end and pulling the handle off the shaft.

(3) Remove the cover of circuit breaker RL8. (See fig. 28.)

c. CLEANING. Clean all dirt, dust, rust, and fungus from the equipment to be processed. Clean all oil and grease from the surfaces to be varnished.

Note. Unless cleaning is done very carefully and thoroughly, the effectiveness of the moistureproofing and fungiproofing operation will be impaired.

d. MASKING. (1) Mask the six rectifier plate connector clips E. (See figs. 27 and 28.)

(2) Mask the three plate lead stand-off insulators D1. (See fig. 28.)

(3) Mask the six rectifier tube sockets X29 and X30 (fig. 27) and X25 through X28 (fig. 28), by filling them with tissue paper.

(4) Mask the five tube socket mounting insulators F. (See figs. 27 and 28.)

(5) Mask the front of time delay relay RL7. (See fig. 27.)

(6) Mask the ceramic insulators on filament transformers T21, T22, T23, and T24. (See figs. 27 and 28.)

(7) Mask the contacts of contactors RL5 and RL6. (See fig. 27.)

(8) Mask the ceramic insulators on the three transformers T25, T26, and T27 (figs. 27 and 28) (only two insulators visible in each photograph).

(9) Mask resistors R56 through R68 (fig. 27) with paper and masking tape.

(10) Mask the contacts and any small moving parts of the high-speed circuit breaker RL8. (See fig. 28.)

(11) Mask resistors R40 through R46 and R48 through R53. (See fig. 28.)

e. DRYING. (1) Place enough heat lamps or strip heaters inside of the equipment compartments to raise the temperature to 140° F. Each compartment may be heated separately if enough lamps or heater strips are not available for the entire equipment.

(2) Replace the left end panel and close all doors.

(3) Cover the ventilator grill on top of the transmitter to prevent the heat from escaping.

(4) Cover the air intake grill on the lower side of the r-f section.

Caution: Do not exceed 160° F. If insulating compound in any of the components should begin to soften, decrease the temperature and increase the drying time approximately 1 hour for each 10° F. decrease in temperature.

f. VARNISHING. (1) Spray three coats of moistureproofing and fungiproofing varnish (Lacquer Fungus-resistant Spec No. 71-2202 (Stock No. 6G1005.3) or equal).

Note. Spraying should be done immediately after the equipment is dried. If varnish is not applied immediately, moisture condenses on the equipment. Varnish applied over a moist surface peels off readily after it has dried.

(2) After each coat of varnish has been applied, allow the equipment to air-dry for a period of 15 to 20 minutes.

(3) Repeat the spraying and drying process until three coats of varnish have been applied to all parts that have not been masked.

(4) All variable tuning capacitors should be left in the open position (minimum capacity) and sprayed very lightly. An excess of varnish on the plates may change the capacity, thus impairing the operation of the transmitter.

(5) When the spraying process has been completed, remove all masking and apply one coat of varnish with a brush to any wiring that may have been covered. Be very careful not to get any varnish on contacts or small moving parts.

(6) Apply one coat of varnish to all cabled wire with a brush.

g. REASSEMBLY. (1) Check the contacts and small moving parts of all relays and contactors to be sure no varnish has gotten on them.

(2) If necessary, clean the contacts with drycleaning solvent (SD) and burnishing tool. Do not use varnish thinner.

(3) Inspect all tube sockets before replacing the tubes to be sure no lacquer has gotten on the contacts.

(4) Reassemble the equipment by following instructions for disassembly in reverse order.

(5) Make a complete operational check of the equipment to be sure it is in good operating condition.

Note. The electrical characteristics of electronic equipment are subject to change over a period of approximately 10 days after the application of lacquer. For this reason, it is desirable to wait until this period has elapsed before making the final check.

h. MARKING. Mark the letters MFP and the date of treatment on or near the most conspicuous or most important nameplate on the equipment and in such a location that the marking will not become obliterated or rubbed off.

Example: 8 March 1945.

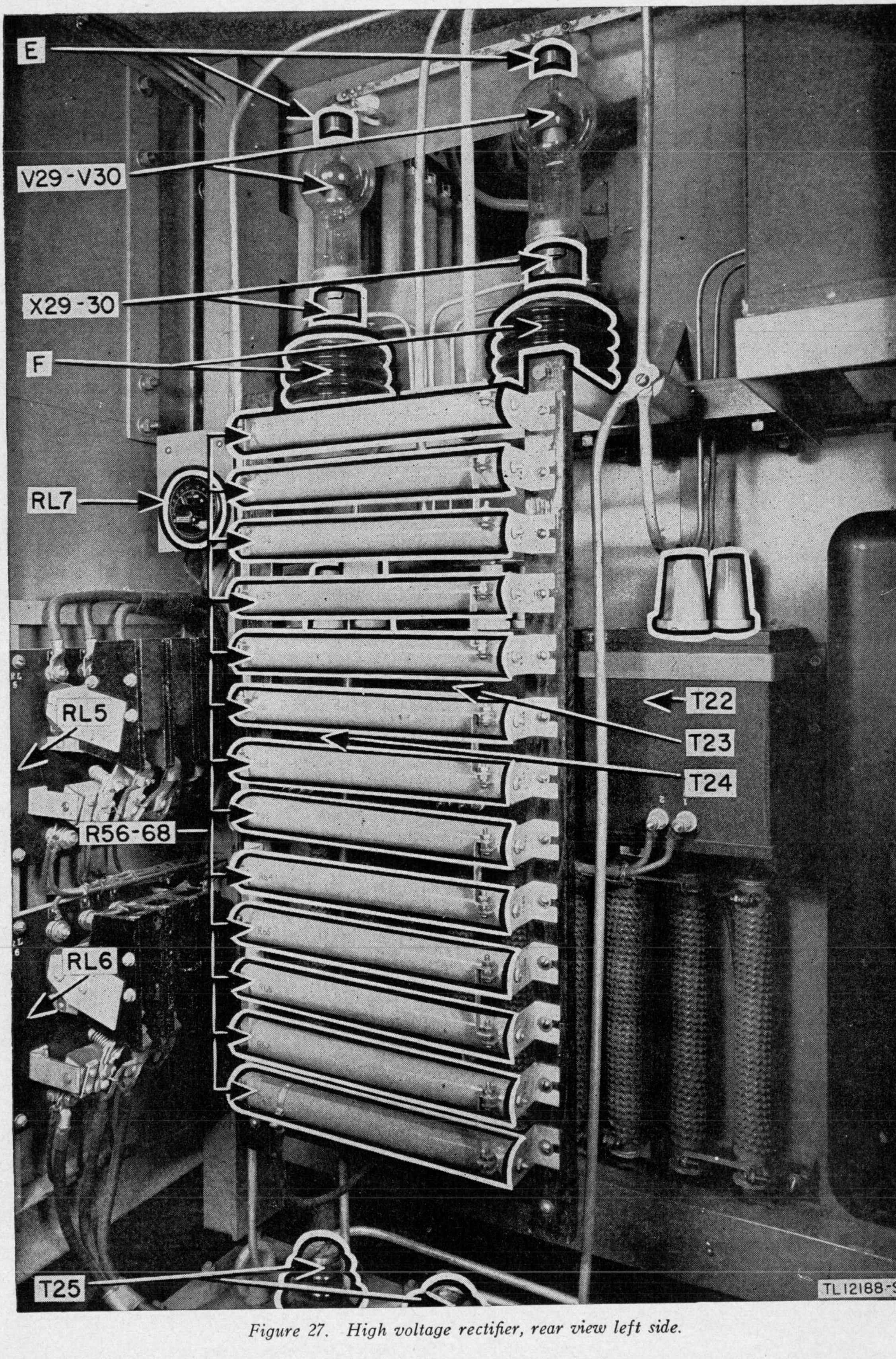


Figure 27. High voltage rectifier, rear view left side.

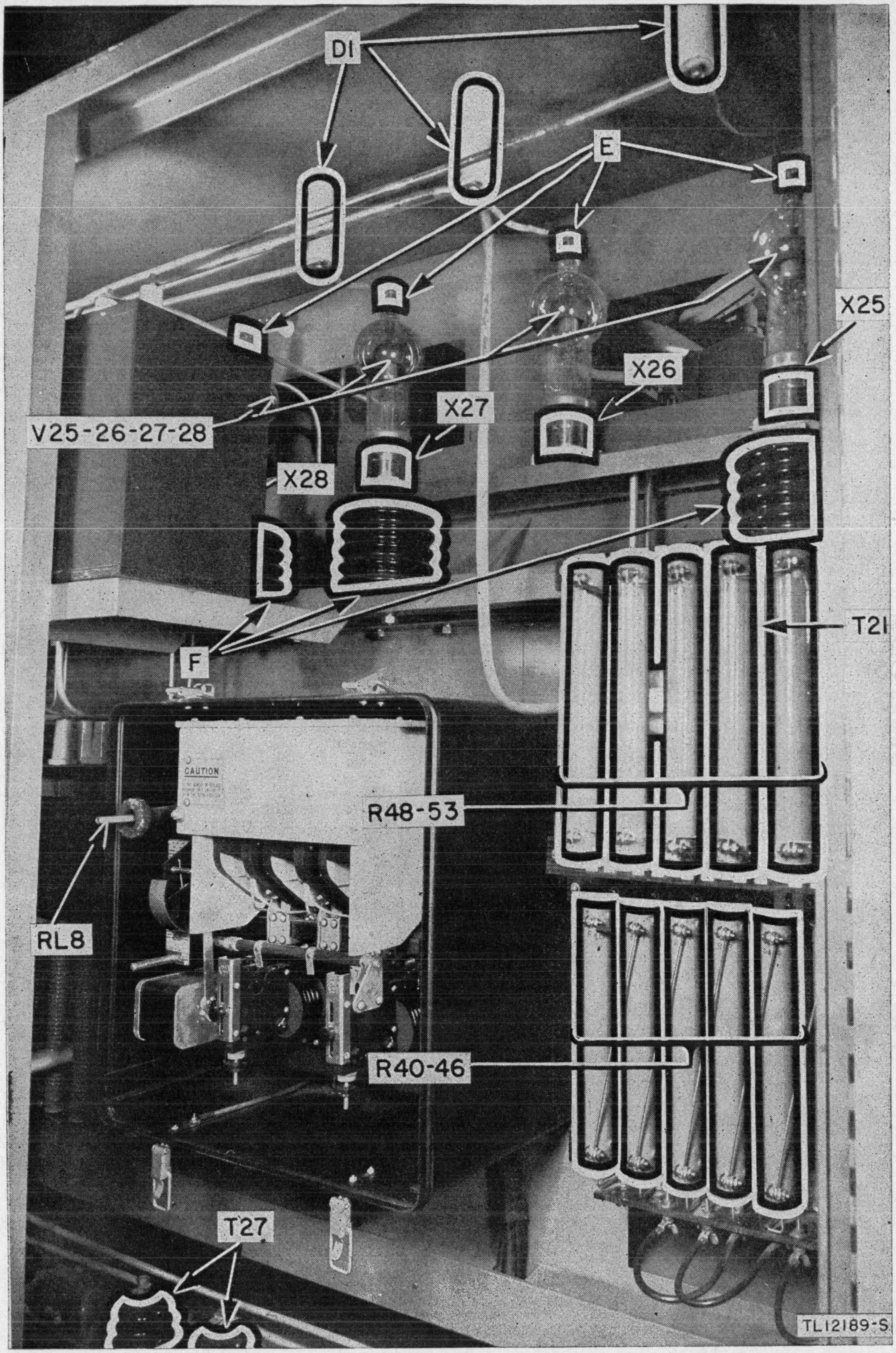


Figure 28. High voltage rectifier, rear view right side.

81. Rectifier-Exciter Unit

a. PREPARATION. (See par. 80.)

b. DISASSEMBLY. (1) *Power Unit.*

(*a*) Remove the eight rectifier Tubes JAN-872A, V17 through V24. (See figs. 29 and 30.)

(*b*) Remove the four rectifier Tubes JAN-866A, V13 through V16. (See fig. 29.)

(*c*) Remove resistors R81 through R86. (See fig. 30.)

(2) *Oscillator Unit.* (*a*) Remove the six crystals from the crystal oven.

(*b*) Remove the seven screws SS (fig. 29) of the lower front panel of the crystal oven and pull the panel forward as far as the wiring will permit.

(*c*) Remove the oscillator plate meter wires A and ground wire B. (See fig. 31.)

(*d*) Remove the three triode amplifier Tubes JAN-4C22/HF-100, V6, V7, and V8 (fig. 31) (tube V8 not visible in photograph).

(*e*) Remove the master oscillator assembly MO (fig. 31), if used.

(3) *First Amplifier Unit.* Remove the two triode amplifier Tubes JAN-HF-300, V9 and V10. (See fig. 30.)

c. CLEANING. (See par. 80.)

d. MASKING. (1) *Power unit.*

(*a*) Mask the plate lead stand-off insulators G. (See figs. 29 and 30.)

(*b*) Mask the plate connector clips CL. (See figs. 29 and 30.)

(*c*) Mask the eight sockets of rectifier Tubes JAN-872A, by filling with tissue paper.

(*d*) Mask the four sockets (X13 through X16) of Tube JAN-866A. (See fig. 29.)

(*e*) Mask the capacitor terminal insulators of C86. (See fig. 30.)

(*f*) Mask all stand-off insulators.

(*g*) Mask all filament transformer terminal insulators.

(*h*) Mask the high-voltage feedthrough insulator H. (See figs. 30 and 32.)

(*i*) Mask the terminal clips of R81 through R86. (See fig. 30.)

(*j*) Mask the sliding tap resistor R37. (See fig. 33.)

(2) *Oscillator unit.* (*a*) Mask the crystal clip connections XC. (See fig. 31.)

(*b*) Mask the strip heaters, one on each side of the crystal compartment R79 and R80. (See fig. 31.)

(*c*) Mask the Helix spring of thermostat I. (See fig. 31.)

(*d*) Mask the thermostat body and adjusting knob T. (See fig. 29.)

(*e*) Mask the thermometer stem (not visible in the photograph).

(*f*) Mask driver gears K1 (fig. 33) of the FREQUENCY SELECTOR switch.

(*g*) Mask the glass face of oscillator plate meter M1 (fig. 29), and oven thermometer M19. (See fig. 29.)

(*h*) Mask the glass portion of tubes V2, V3, V4, and V5. (See fig. 29.)

Note. Leave the grid clips of V2 and V3 in place while spraying with lacquer.

(*i*) Mask the grid and plate clips of triode amplifier Tubes JAN-4C22/HF-100, V6, V7, and V8 (fig. 31) (V8 tube not visible in the photograph).

(*j*) Mask the tube bases of the above tubes.

(*k*) Mask the wiping contacts and contact surfaces of variable capacitors C22, C23, C31, and C38. (See fig. 31.)

(*l*) Mask the contacts and contact arm of the 3-kv rectifier filament rheostat R55. (See fig. 33.)

(*m*) Mask KEY SWITCH S3 (fig. 34, back of panel).

(*n*) Mask the contacts and contact arms of the MULTIPLIER SELECTOR switch S5 (fig. 34, back of panel).

(*o*) Mask the insulators that support the inner crystal compartment D2. (See fig. 31.)

(*p*) Mask the oscillator feedback capacitor C1. (See fig. 31.)

(*q*) Mask the contact arm and contact surface of the keying shaper rheostat R39 (fig. 34, back of panel).

(*r*) Mask all ceramic insulators.

(*s*) Mask the glass portion of the oscillator tube V31. (See fig. 33.)

(*t*) Mask the terminals of the oscillator plate meter leads and the ground lead A and B. (See fig. 31.)

(3) *First amplifier unit.* (*a*) Mask the grid and plate connectors of the two Tubes, JAN-HF-300 V9 and V10. (See fig. 30.)

(*b*) Mask the sockets of the above tubes.

(*c*) Mask the threads of variable capacitor C42. (See fig. 30.)

(*d*) Mask the wiping contacts and contacts surfaces of variable capacitors C52, C62, C63, C47, and C48. (See fig. 30.)

(*e*) Mask the shorting bar contacts of L5. (See fig. 30.)

(*f*) Mask the variable capacitor drive gears of C52.

(*g*) Mask all ceramic insulators.

(*h*) Mask the feedthrough insulators D3. (See figs. 30 and 32.)

e. Drying. (See par. 80*e*.)

f. Varnishing. (See par. 80*f*.)

g. Reassembly. (See par. 80*g*.)

h. Marking. (See par. 80*h*.)

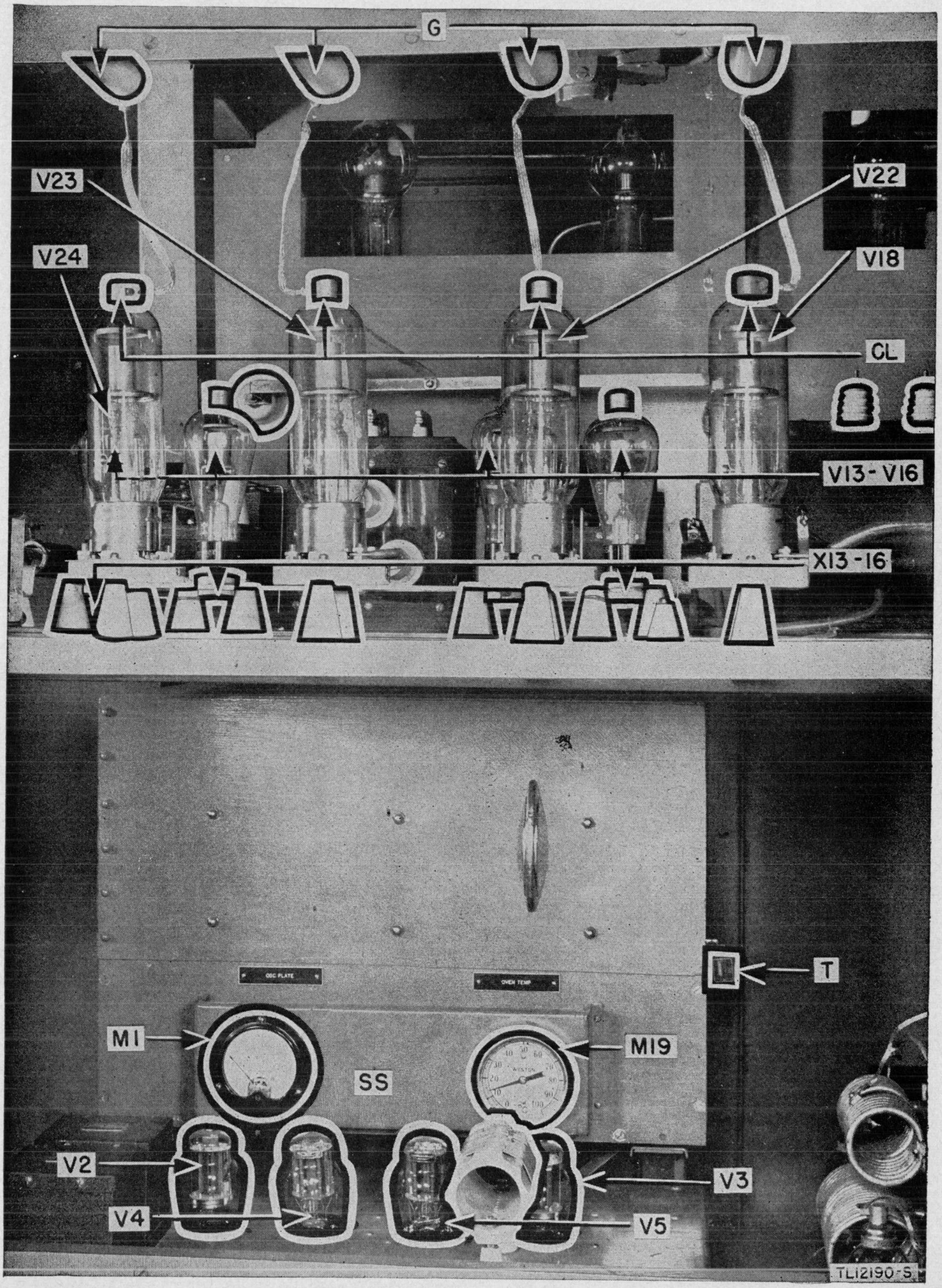


Figure 29. Power and oscillator units.

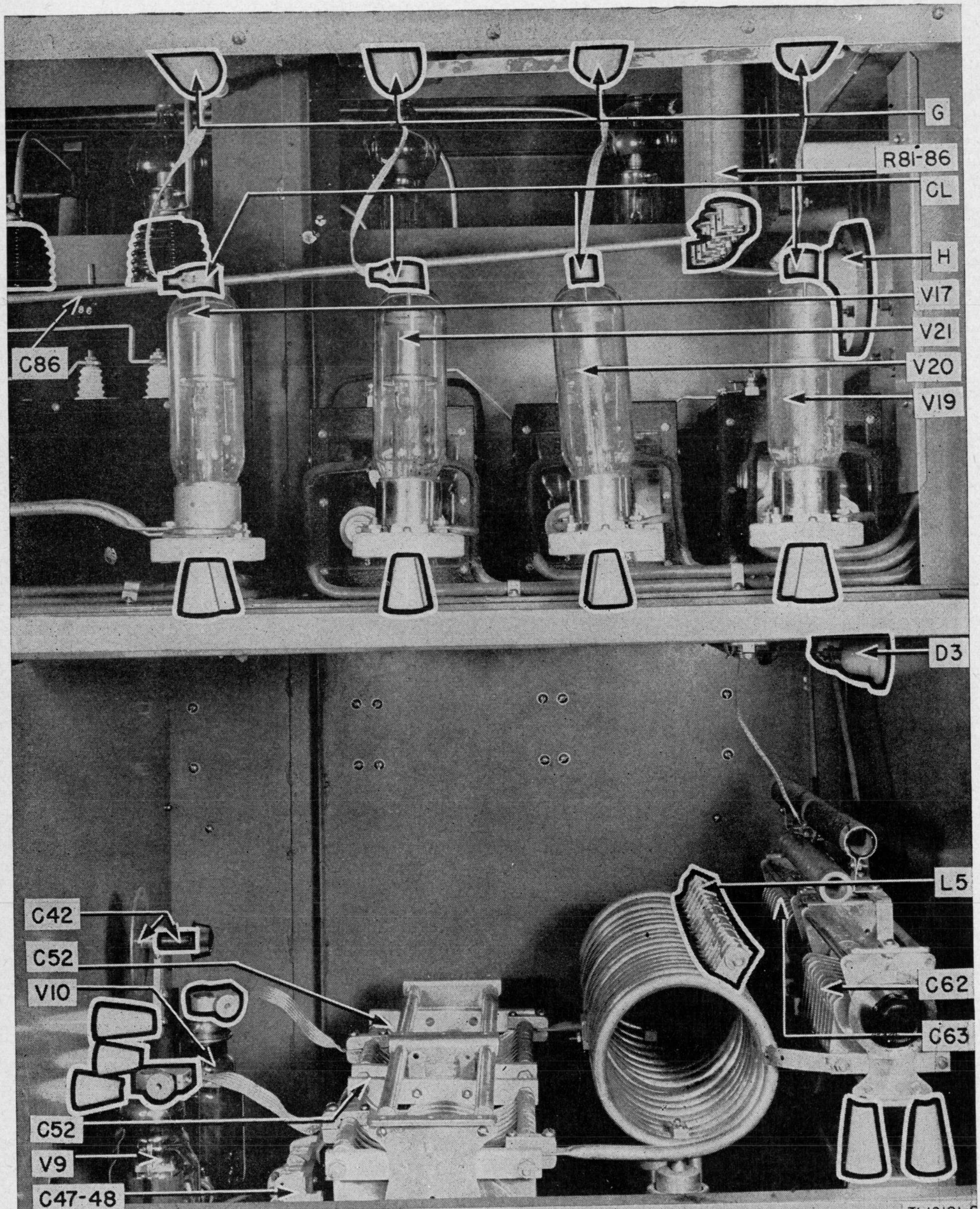


Figure 30. Power and first amplifier units.

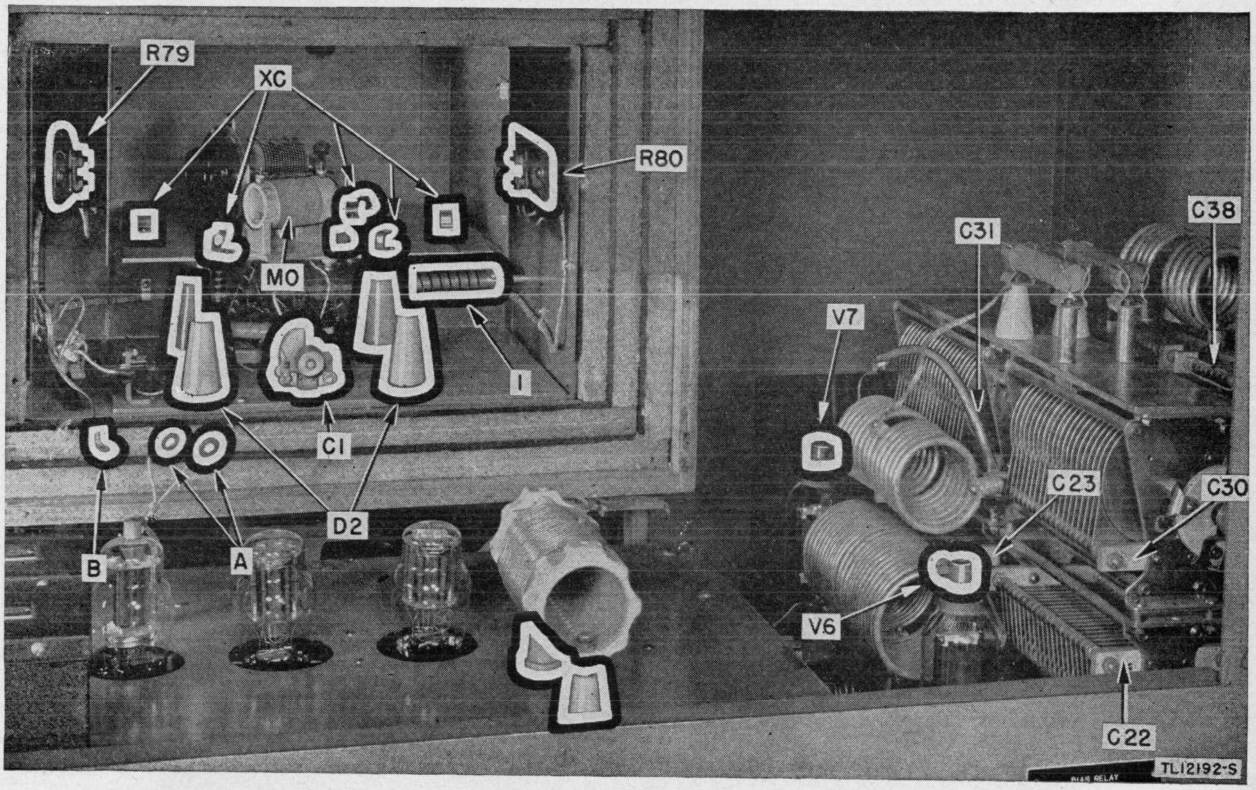


Figure 31. Oscillator unit.

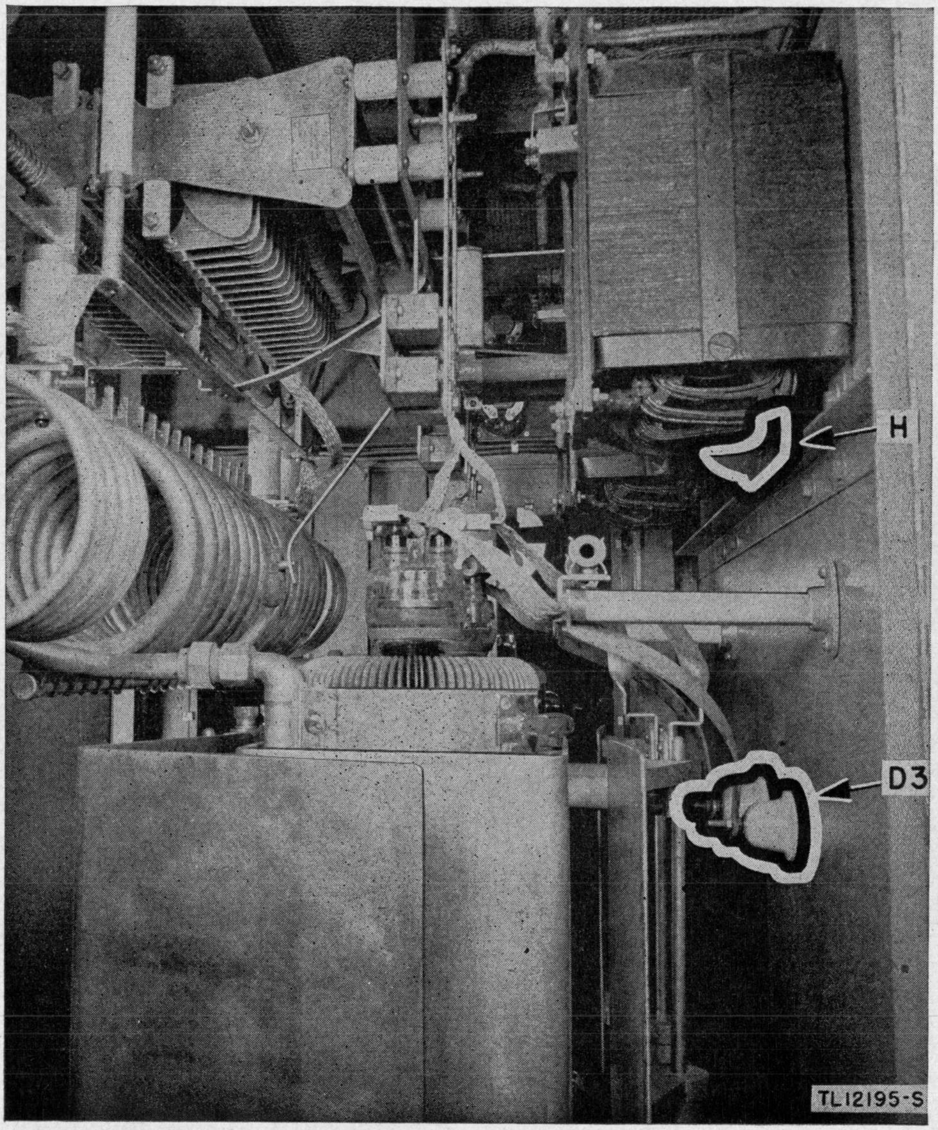


Figure 32. Power amplifier, rear view.

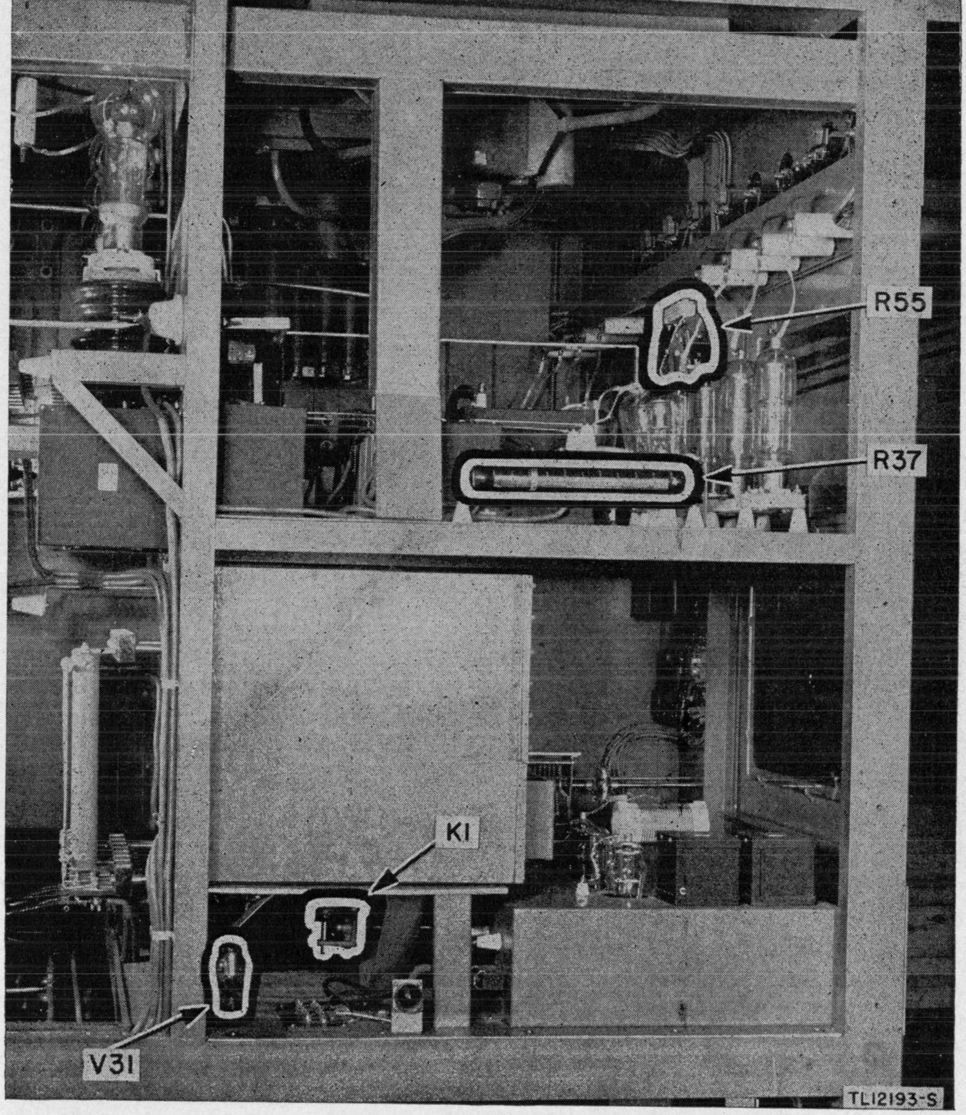


Figure 33. Transmitter, left end view with panel removed.

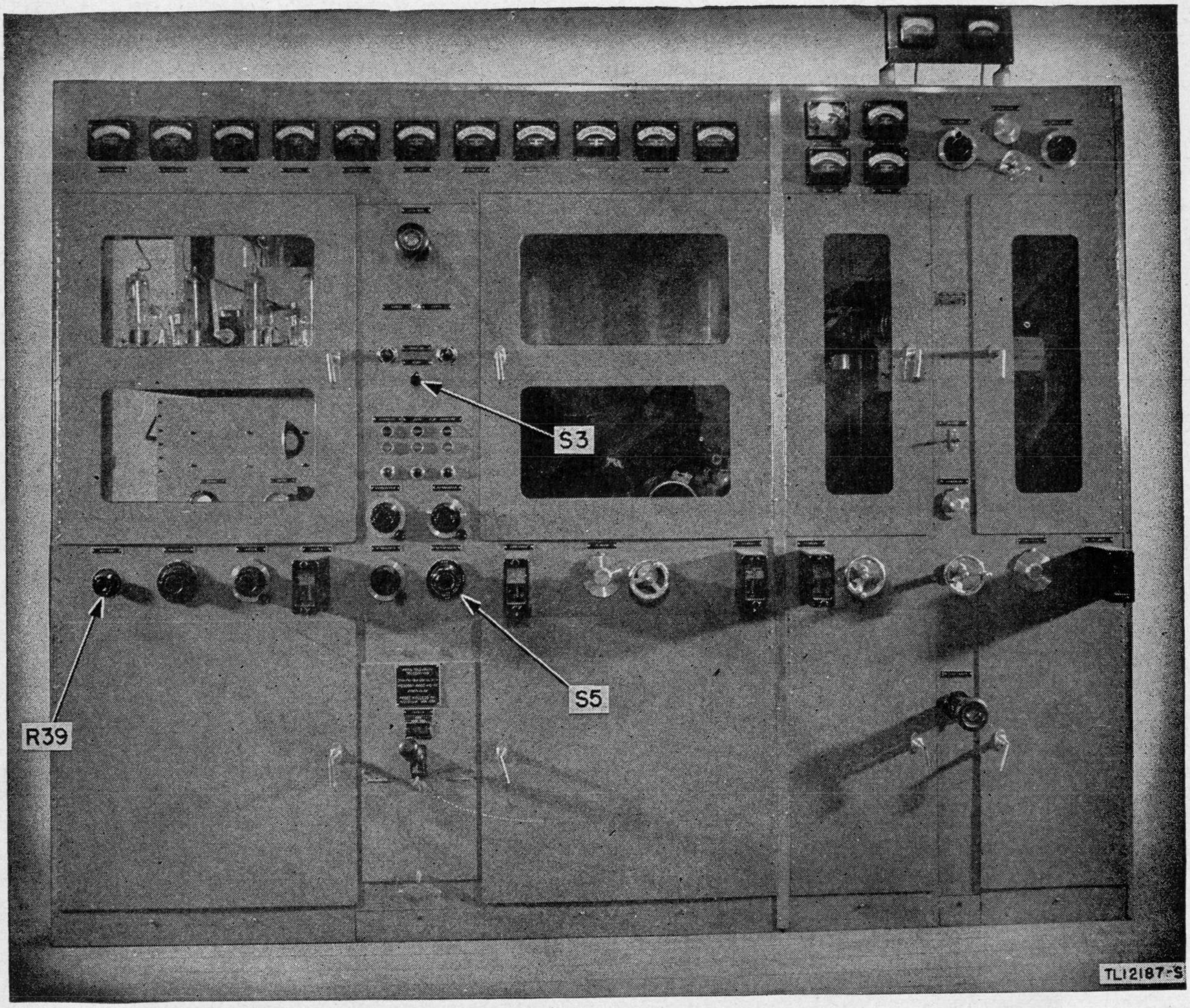


Figure 34. Transmitter, front view.

82. P-A Unit

a. Preparation. (See par. 80*a.*)

b. Disassembly. No disassembly necessary.

c. Cleaning. (See par. 80*c.*)

d. Masking. (1) Mask all variable capacitor drive gears K2. (See fig. 35.)

(2) Mask the two pyrex air ducts AD. (See fig 35.)

(3) Mask the threads of spiral worm shaft K3. (See fig. 35.)

(4) Adjust coils L7 and L8 (fig. 35) to their maximum decoupled position and then mask the sleeve shaft N (fig. 35) from the end of the coil mounting sleeve O (fig. 35) to the sleeve stop collar P. (See fig. 35.)

(5) Mask the coil drive gears K4. (See fig. 35.)

(6) Mask all coil shorting bar terminals of L6, L7, and L8. (See fig. 35.)

(7) Mask all ceramic insulators.

(8) Mask the glass portion and cooling fins of the two type 889R tubes V11 and V12. (See fig. 35.)

(9) Mask the wiper contacts and contact surfaces of capacitors C73 and C74, C. (See fig. 35.)

(10) Mask the contacts and contact spring roller of KEY SWITCH S4. (See fig. 35.)

e. Drying. (See par. 80*e.*)

f. Varnishing. (See par. 80*f.*)

g. Reassembly. No reassembly necessary.

h. Marking. (See par. 80*h.*)

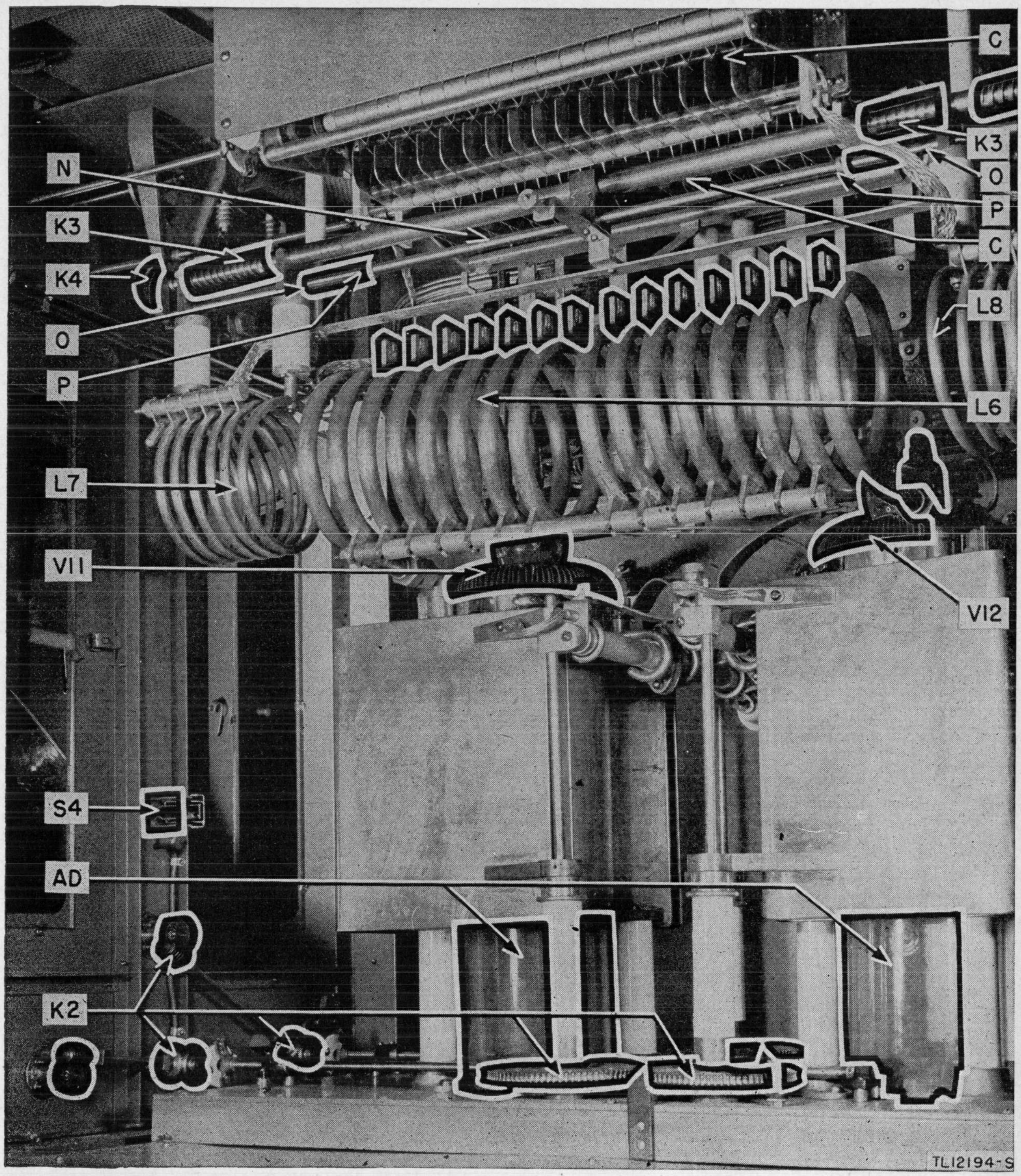


Figure 35. Power amplifier, side view.

83. Terminal Board No. 1

a. PREPARATION. (See par. 80*a*.)

b. DISASSEMBLY. No disassembly necessary.

c. CLEANING. (See par. 80*c*.)

d. MASKING. (1) Mask the contacts of contactors RL2 and RL3. (See fig. 36.)

(2) Mask the openings at the top of circuit breakers RL16, RL17, and RL20 (fig. 36).

(3) Mask relay RL21. (See fig. 36.)

(4) Mask time delay relay RL14. (See fig. 36.)

(5) Mask blades and jaws of switch S6. (See fig. 36.)

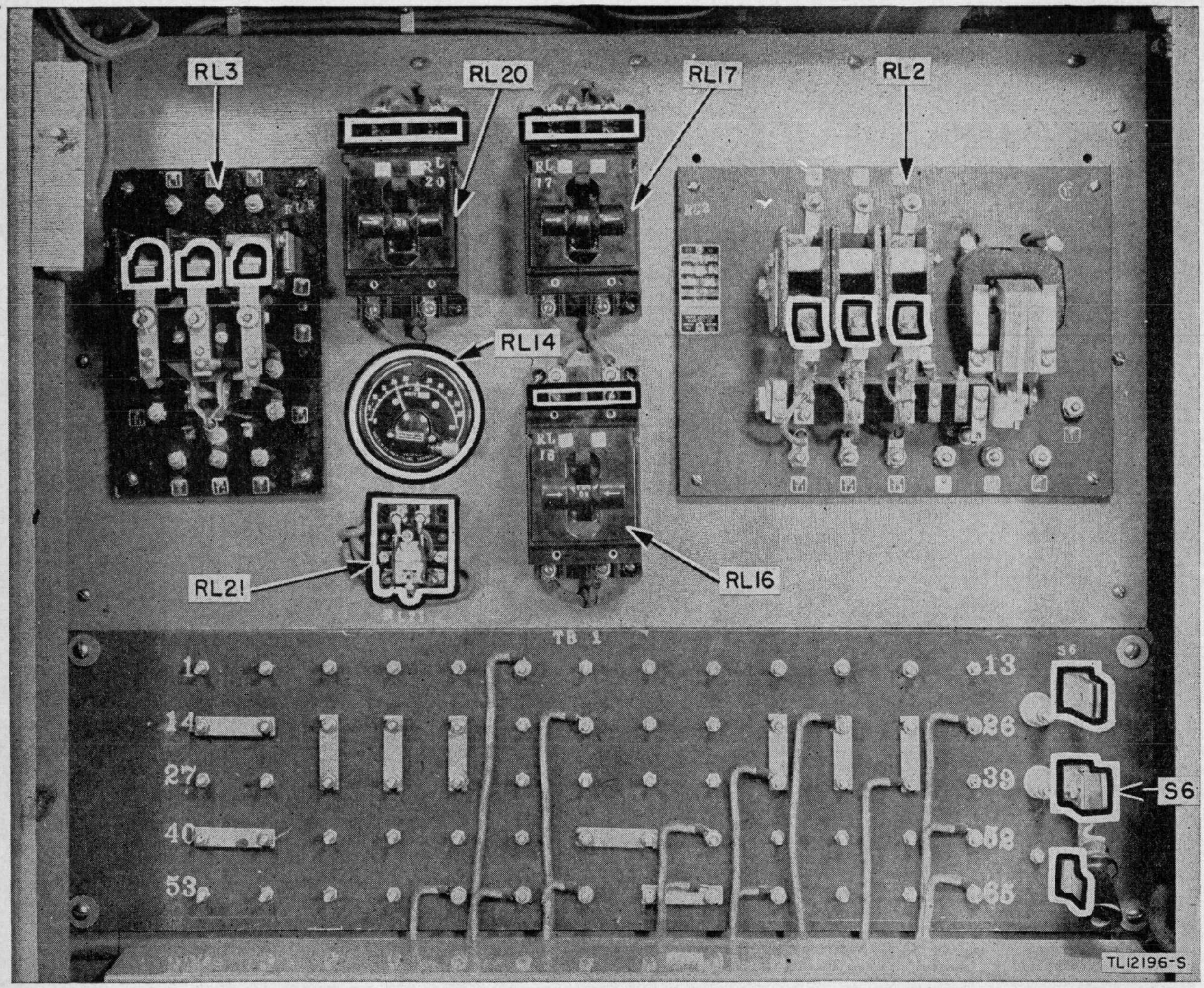


Figure 36. Terminal board No. 1.

(6) Mask blades and jaws of main power switch. (See fig. 34, back panel.)

e. Drying. (See par. 80*e.*)

f. Varnishing. (See par. 80*f.*)

g. Reassembly. No reassembly necessary.

h. Marking. (See par. 80*h.*)

84. Terminal Board No. 2

a. Preparation. (See par. 80*a*).

b. Disassembly. No disassembly necessary.

c. Cleaning. (See par. 80*c.*)

d. Masking. (1) Mask the contact arm and resistance element of rheostat R12 (fig. 37, back panel) and transtat T28. (See fig. 38.)

(2) Mask the openings at the top of circuit breakers RL17 and RL18. (See fig. 37.)

(3) Mask the contacts of contactor RL4. (See fig. 37.)

(4) Mask the windows of the two crystal oven fuses P. (See fig. 37.)

(5) Mask the jaws and blades of switch S7. (See fig. 37.)

e. Drying. (See par. 80*e.*)

f. Varnishing. (See par. 80*f.*)

g. Reassembly. No reassembly necessary.

h. Marking. (See par. 80*h.*)

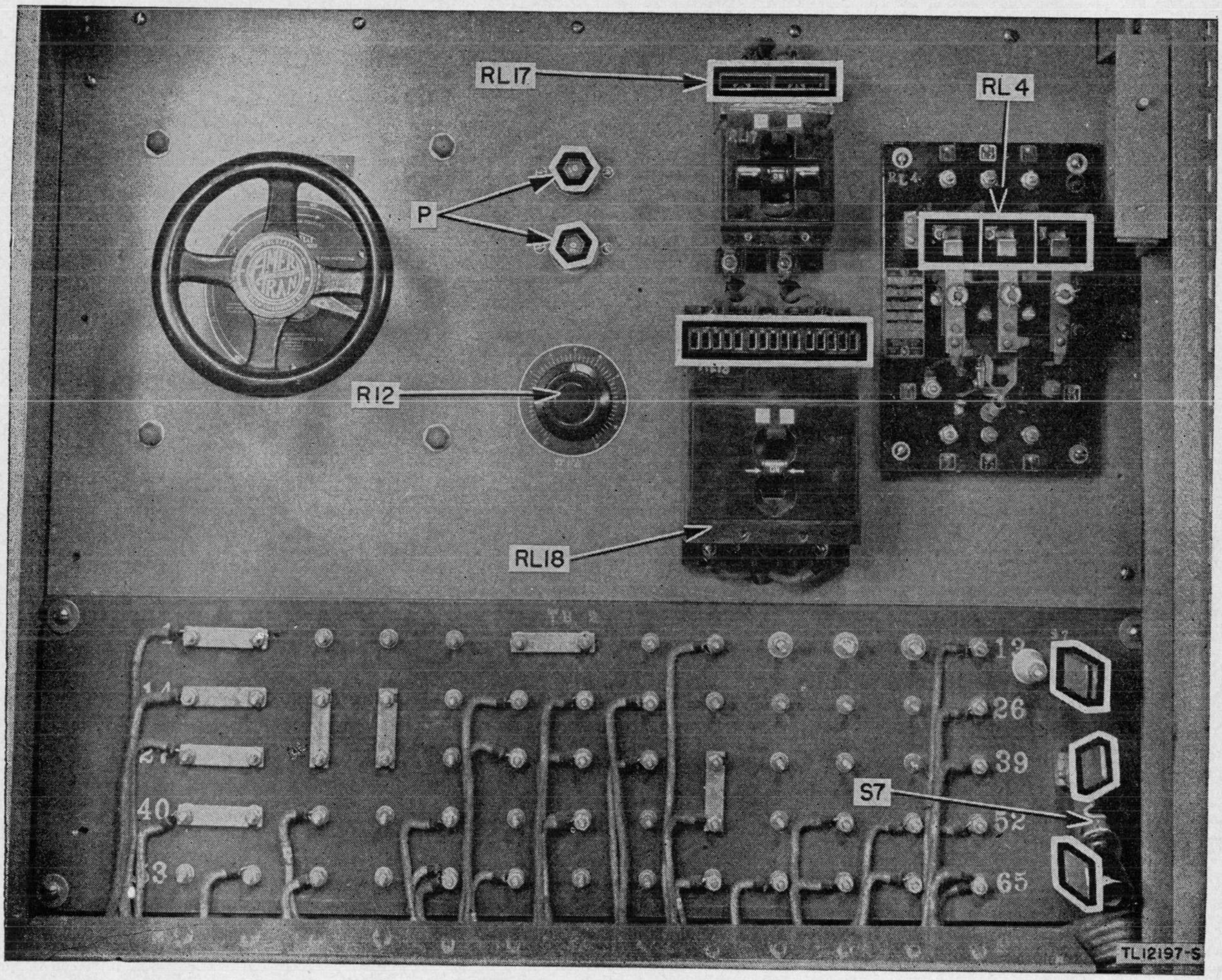


Figure 37. Terminal board No. 2.

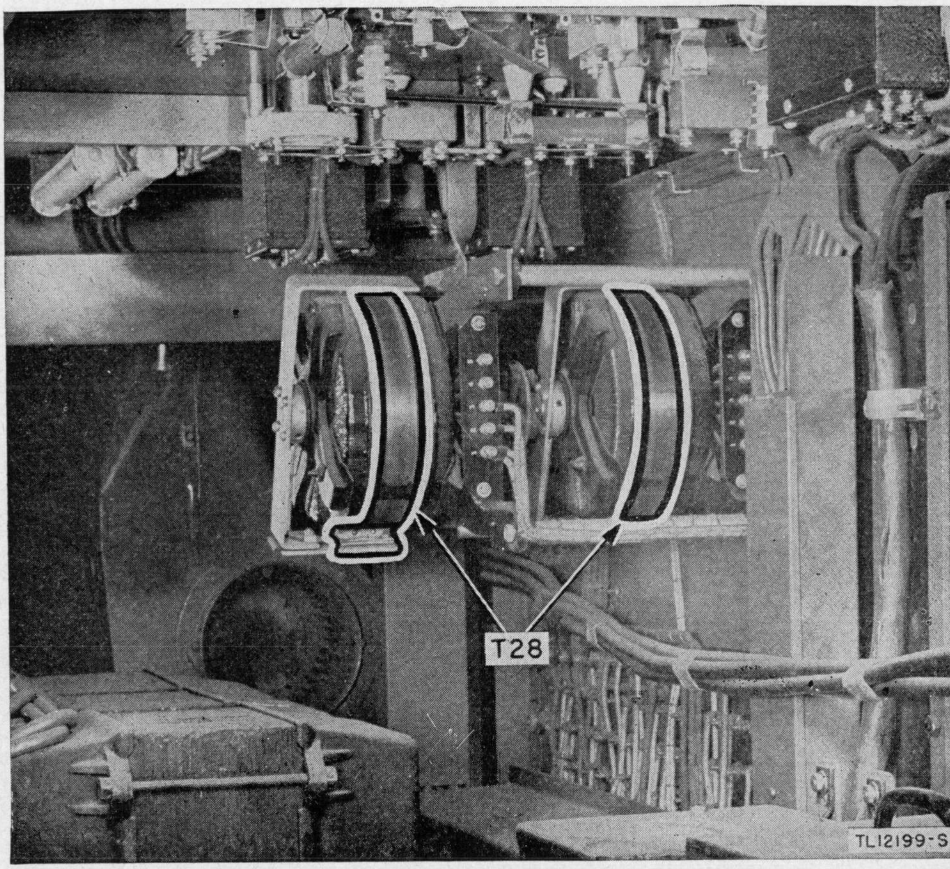


Figure 38. Rectifier-exciter unit showing transtat T28.

85. Terminal Board No. 3

a. PREPARATION. (See par. 80*a.*)

b. DISASSEMBLY. No disassembly necessary.

c. CLEANING. (See par. 80*c.*)

d. MASKING. (1) Mask the opening at the top of circuit breaker RL15. (See fig. 39.)

(2) Mask the contacts of contactor RL1. (See fig. 39.)

e. DRYING. (See par. 80*e.*)

f. VARNISHING. (See par. 80*f.*)

g. REASSEMBLY. No reassembly necessary.

h. MARKING. (See par. 80*h.*)

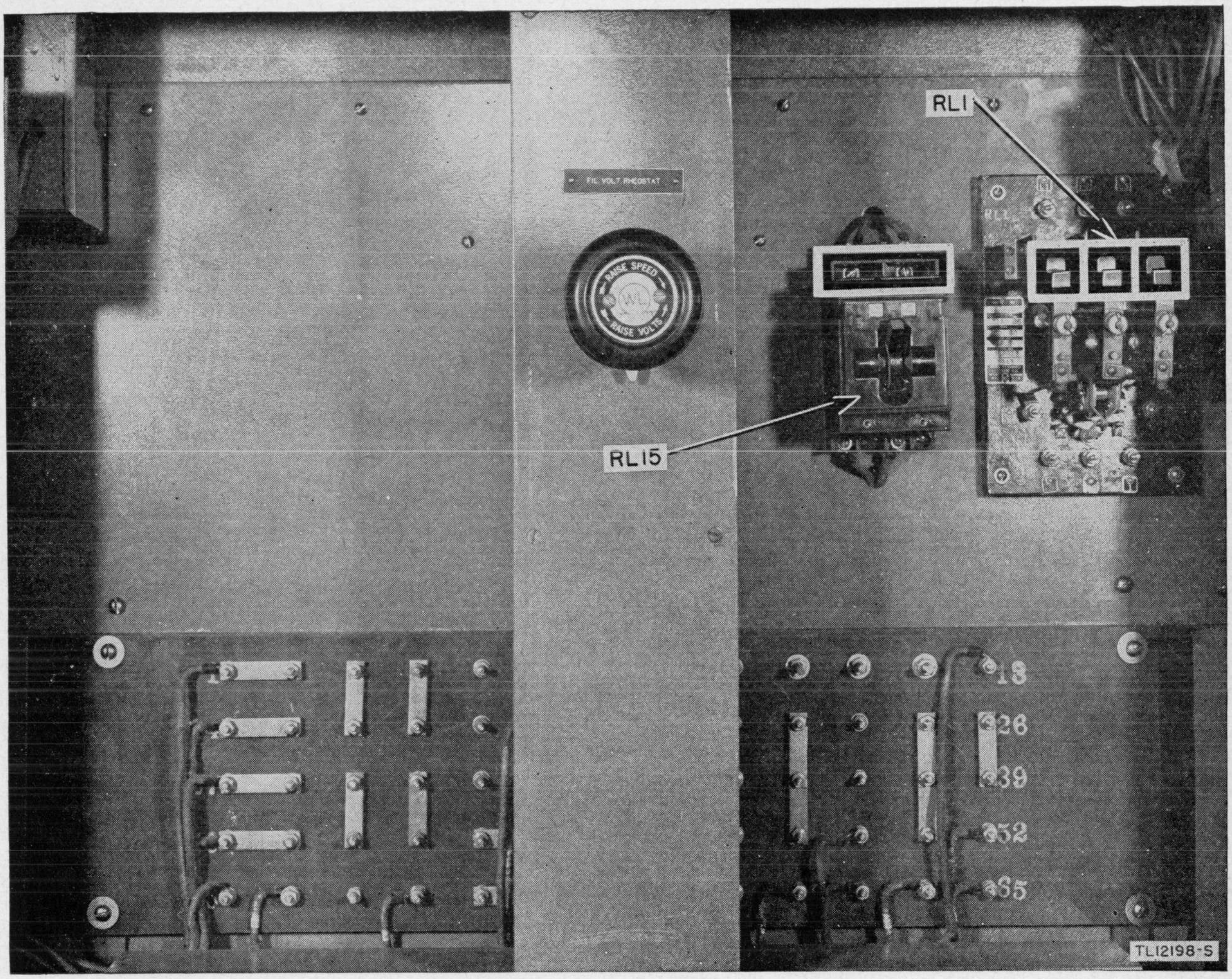


Figure 39. Terminal board No. 3.

86. Blower Compartment

a. PREPARATION. (See par. 80*a.*)

b. DISASSEMBLY. No disassembly necessary.

c. CLEANING. (See par. 80*c.*)

d. MASKING. (1) Mask the contacts and contact arm of rheostat R69. (See fig. 40.)

(2) Mask blower microswitches S15 and S16. (See fig. 40.)

e. DRYING. (See par. 80*e.*)

f. VARNISHING. (See par. 80*f.*)

g. REASSEMBLY. No reassembly necessary.

h. MARKING. (See par. 80*h.*)

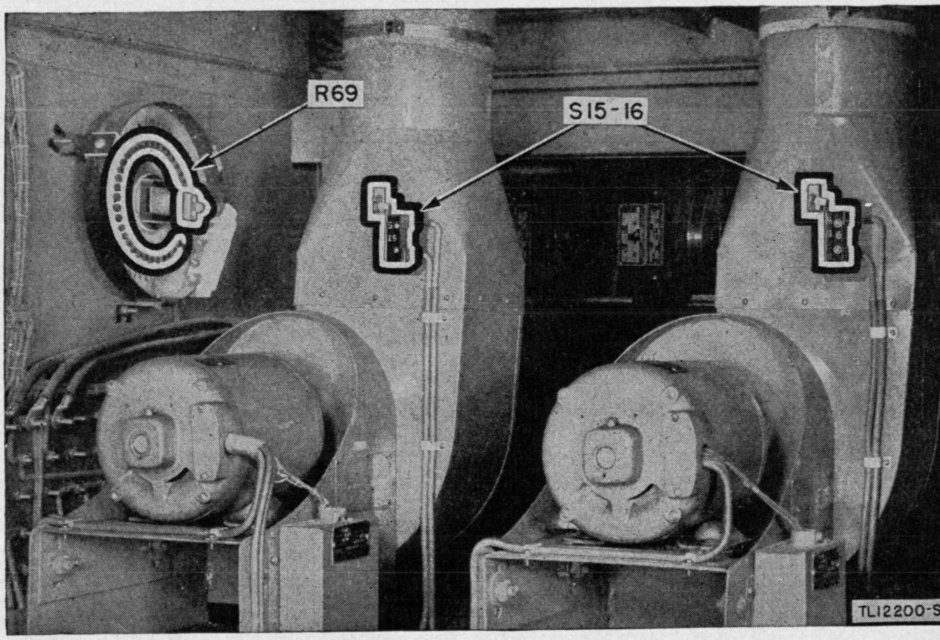


Figure 40. Blower unit.

87. Front Panel

a. PREPARATION. (See par. 80*a*.)

b. DISASSEMBLY. No disassembly necessary.

c. CLEANING. (See par. 80*c*.)

d. MASKING. Completely mask the inside of the glass windows to protect them from varnish.

Note. The front of the transmitter is not to be varnished, hence no outside masking is required.

e. DRYING. (See par. 80*e*.)

f. VARNISHING. (See par. 80*f*.)

g. REASSEMBLY. No reassembly necessary.

h. MARKING. (See par. 80*h*.)

88. Moistureproofing and Fungiproofing After Repairs

If, during repair, the coating of protective varnish has been punctured or broken, and if complete treatment is not needed to reseal the equipment, apply a brush coat to the affected part. Be sure the break is completely sealed.

PART FOUR

AUXILIARY EQUIPMENT

(Not used).

REPAIR INSTRUCTIONS

Note. Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on WD AGO Form 468 (Unsatisfactory Equipment Report); by Army Air Forces, on Army Air Forces Form 54 (unsatisfactory report). If either form is not available, prepare letter containing the data elicited by the sample form reproduced in figure 70 without reproducing copies of the form.

Section XI. Theory

89. General

The PW-15A is made up of eight r-f stages and five power supplies as shown in figure 2. The r-f oscillations generated by the oscillator pass in succession through the buffer amplifier, keyed stage, frequency multipliers, first amplifier, and p-a to the antenna coupling coils and the transmission lines.

90. Oscillator

a. CRYSTAL CONTROLLED. (1) The crystal-controlled Pierce oscillator circuit is shown in figures 41 and 84. The oscillator provides the source of the r-f energy to be amplified through the succeeding stages of the transmitter. The crystal selector switch S1 makes it possible to select any one of six crystals in the oven for the oscillator circuit. The oscillator tube V1 is triode Tube JAN-6J5 GT/G. A small portion of the r-f voltage in the plate circuit, properly phased and controlled in frequency, is fed back into the grid circuit through the crystal causing the circuit to oscillate. The energy fed back through the crystal overcomes the grid circuit losses. The crystal acts as a series tuned circuit with a low impedance at the resonant frequency. At the resonant frequency a portion of the plate circuit r-f voltage is applied to the grid circuit with 180° phase difference. Since the proper feedback occurs only at the crystal frequency, oscillations will be sustained only at that frequency.

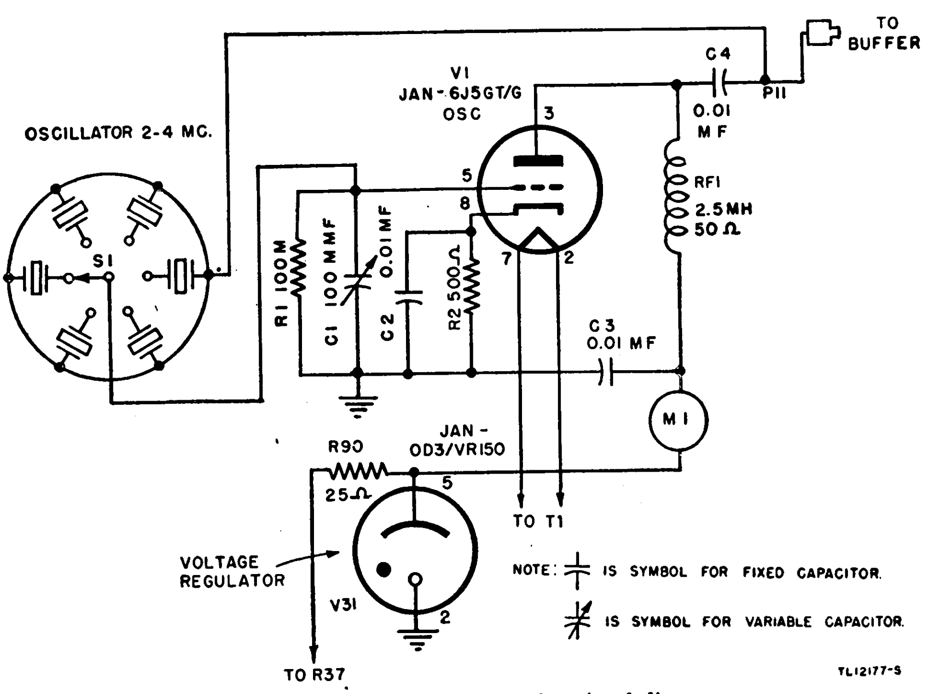


Figure 41. Crystal oscillator, functional diagram.

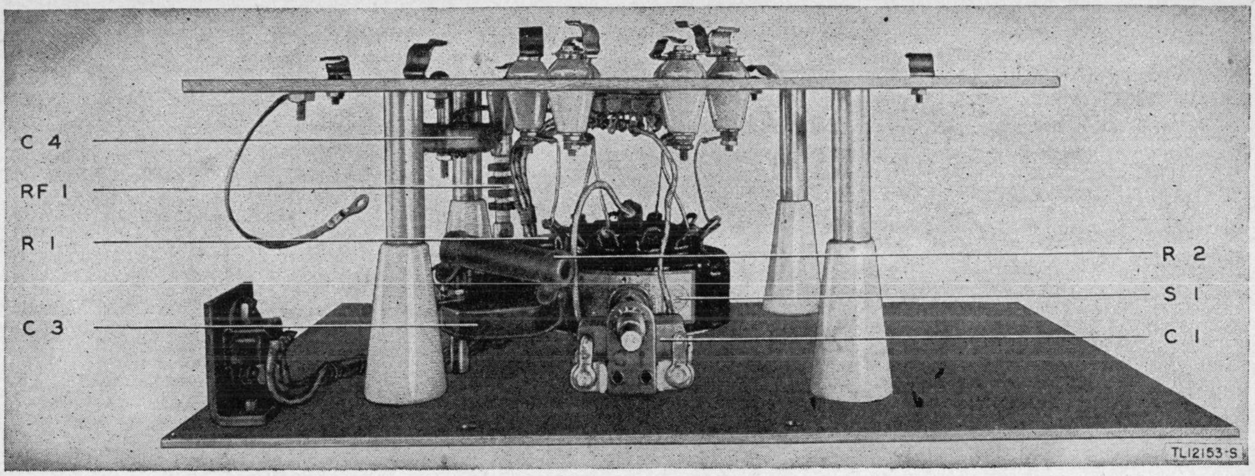


Figure 42. Oscillator unit.

(2) Capacitor C1 (fig. 42), when varied, will change the oscillating frequency of the oscillator slightly. An increase in the capacitance of capacitor C1 decreases the circuit reactance, and results in increased crystal current and a slight reduction in the crystal frequency. Capacitor C1 is set to the correct value at the factory for crystals in the range from 2 to 4 mc. The bias for the oscillator is obtained by means of grid resistor R1 and cathode resistor R2, which is bypassed by capacitor C2.

(3) To sustain oscillation, the plate circuit must have a capacitive reactance. This condition is attained by means of plate inductor RF1 whose resonant frequency, as determined by the circuit capacitance in parallel with it, is below the crystal frequency. Inductor RF1 offers a high r-f impedance, and r-f voltages are developed across the inductor. Capacitor C3 is an r-f bypass capacitor which places the bottom end of inductor RF1 at r-f ground potential. The r-f voltage developed across inductor RF1 is applied to the grid circuit of the buffer stage through capacitor C4. The crystal is connected on the grid side of capacitor C4 to prevent the d-c oscillator plate voltage from being applied across the crystal.

(4) To maintain frequency stability and prevent damage to the crystal, the plate voltage is adjusted to 150 volts and maintained constant by voltage regulator Tube JAN-OD3/VR150 and resistor R90. A d-c path can be traced from the plate supply through plate current meter M1 and inductor RF1 to the plate of tube V1 and back through cathode resistor R2 to ground, completing the circuit. Filament transformer, T1 provides filament power for oscillator tube **V1.**

b. M-O Controlled. For emergency operation, where crystals are not available, a parallel tuned circuit assembly consisting of capititor C90 and inductor L9 together with a series capacitor **C91** may be used. (See fig. 43.) The tuned circuit which is the same as the equivalent circuit of a crystal, replaces the crystal to control the frequency and phase of the r-f energy fed back from the oscillator plate circuit to grid circuit. (See fig. 44). The assembly plugs in to crystal position 6 and the selector switch S1 is set for that position. The assembly can be tuned between 2 and 4 mc by means of the 0 to 100 dial which operates capacitor C90. A calibration curve for the settings to cover the frequency range is shown in figure 71.

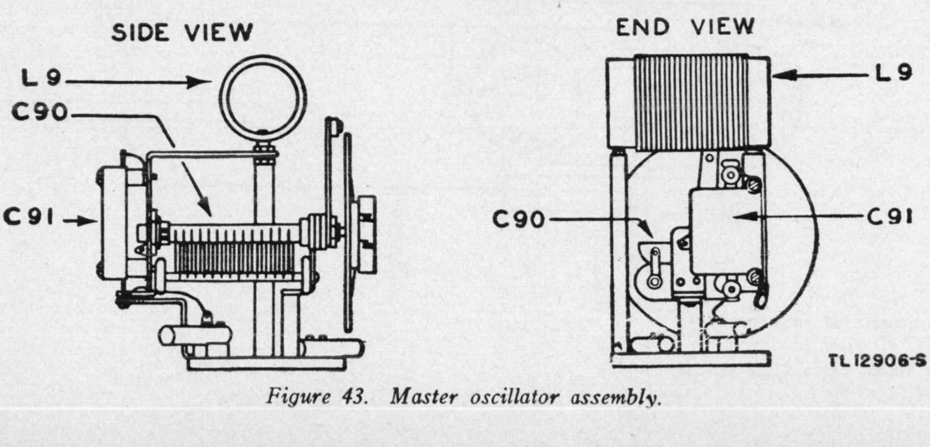


Figure 43. Master oscillator assembly.

c. OVEN. The entire oscillator unit is placed in a constant temperature oven (fig. 4) to maintain good frequency stability. The temperature is maintained by thermostat D11. (See fig. 31.) The oven temperature is indicated by dial thermometer M19 (fig. 14) which is visible from the front of the transmitter. Capacitor C89 is the oven thermostat capacitor which prevents arcs from occurring across the thermostat contacts as they open and close. Oven heaters, resistors R79 and R80 (fig. 4) are connected directly across the main supply line in series with the thermostat. The heater resistors operate at half their rated value.

91. Buffer (figs. 45 and 84)

In order to maintain stability of the crystal-oscillator frequency, an untuned buffer-amplifier stage operating class A is used between the oscillator and the succeeding stages. This buffer stage prevents variations in the plate circuit loads of the other stages, caused by the interruption of the keyed

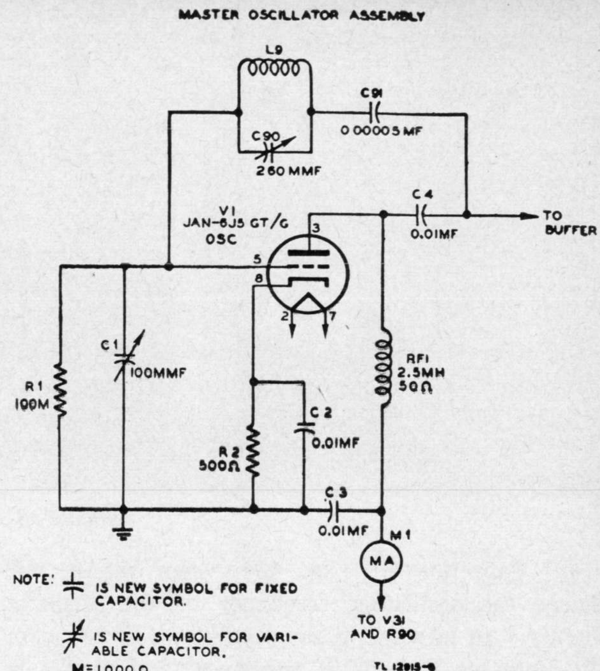


Figure 44. Master oscillator, functional diagram.

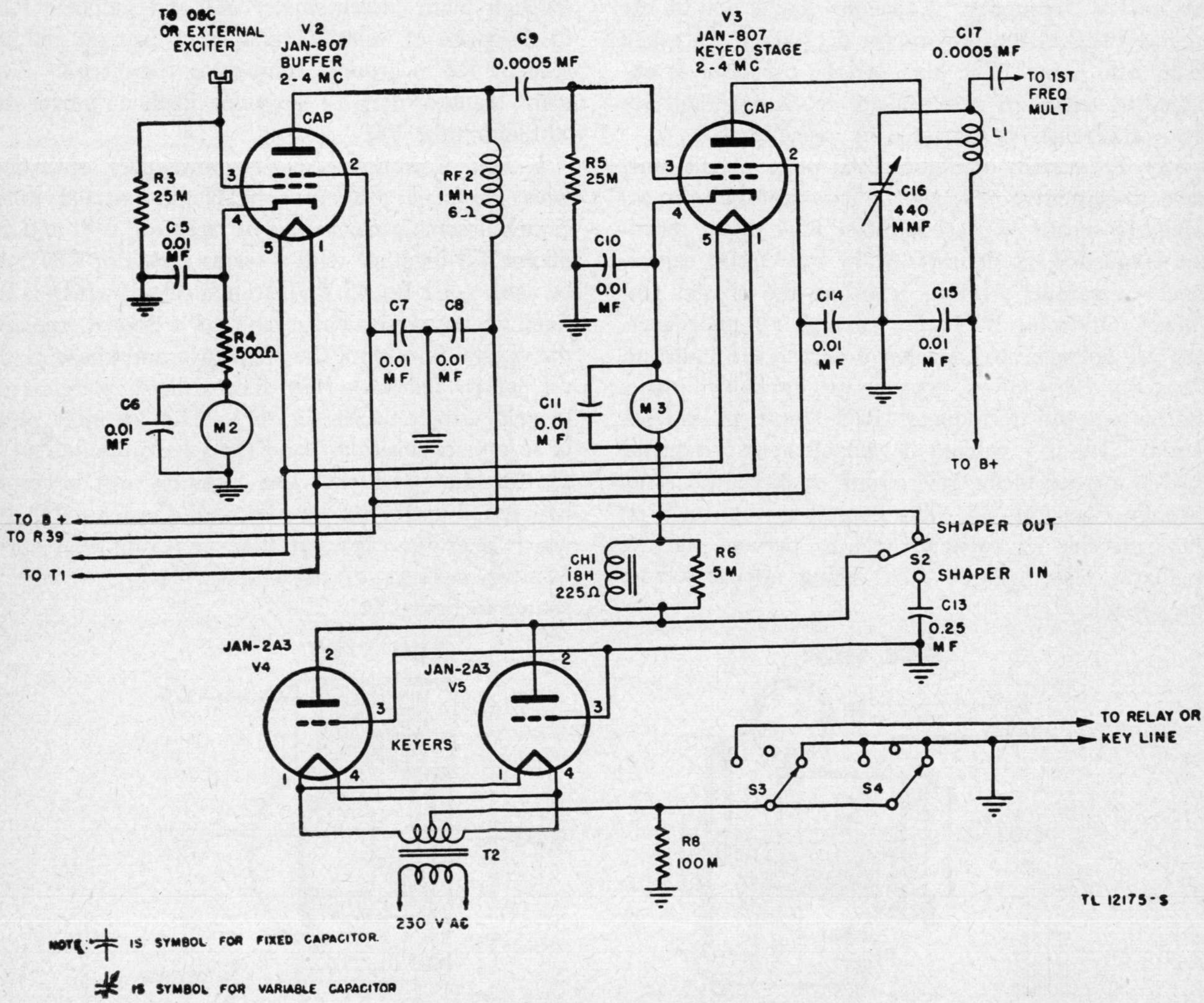


Figure 45. Buffer-Keyer, functional diagram.

stage plate current flow, from affecting the plate load on the oscillator.

a. Buffer tube V2 (fig. 46) is a beam power tetrode Tube JAN-807. Since a screen grid tube is used in the amplifier and the circuit components are properly shielded, neutralizing of this stage is unnecessary. Bias for the stage is developed by grid resistor R3 and cathode resistor R4, which is bypassed for r-f by capacitor C5. Meter M2, which is bypassed for r-f by capacitor C6, measures the cathode current of the stage. In this case the cathode current will be the same as the plate current. The plate load for the tube is inductor RF2, the bottom end of which is at r-f ground potential through capacitor C8. The r-f voltage developed across inductor RF2 is applied to the grid of V3 through coupling capacitor C9. Screen grid voltage for V2 is obtained from potentiometer R39 (KEYING SHAPER) which is connected across part of bleeder resistor R38. Adjustment of potentiometer R39 provides a convenient method of varying the screen grid voltage and thus the output of the stage. Capacitor C7 is the screen grid r-f bypass capacitor maintaining the screen grid of tube V2 at r-f ground potential. Filament power for tube V2 is obtained from transformer T1. A d-c path can be traced from the oscillator buffer power supply through inductor RF2 to the plate of tube V2, and from the cathode of tube V2 through resistor R4 and meter M2 to ground.

b. An excitation jack (fig. 15) on the back of the buffer chassis provides a means of connecting an external frequency shifter. The oscillator is disconnected and the frequency shifter connected.

92. Keyed Stage (figs. 45 and 84)

To transmit radiotelegraph signals, some means must be provided to intermittently start and stop the r-f power being fed into the antenna system as the telegraph key is closed and opened. In the PW-15A this is accomplished by a low-power r-f stage, keyed in the cathode circuit by two keyer tubes. With the keyed stage at this point in the transmitter a lower power level is keyed and the succeeding stages are under load only when the key is closed.

a. The keyed stage tube V3 (fig. 46) is a beam power tetrode Tube JAN-807, and the keyer tubes V4 and V5 are triode Tubes JAN-2A3. The keyed

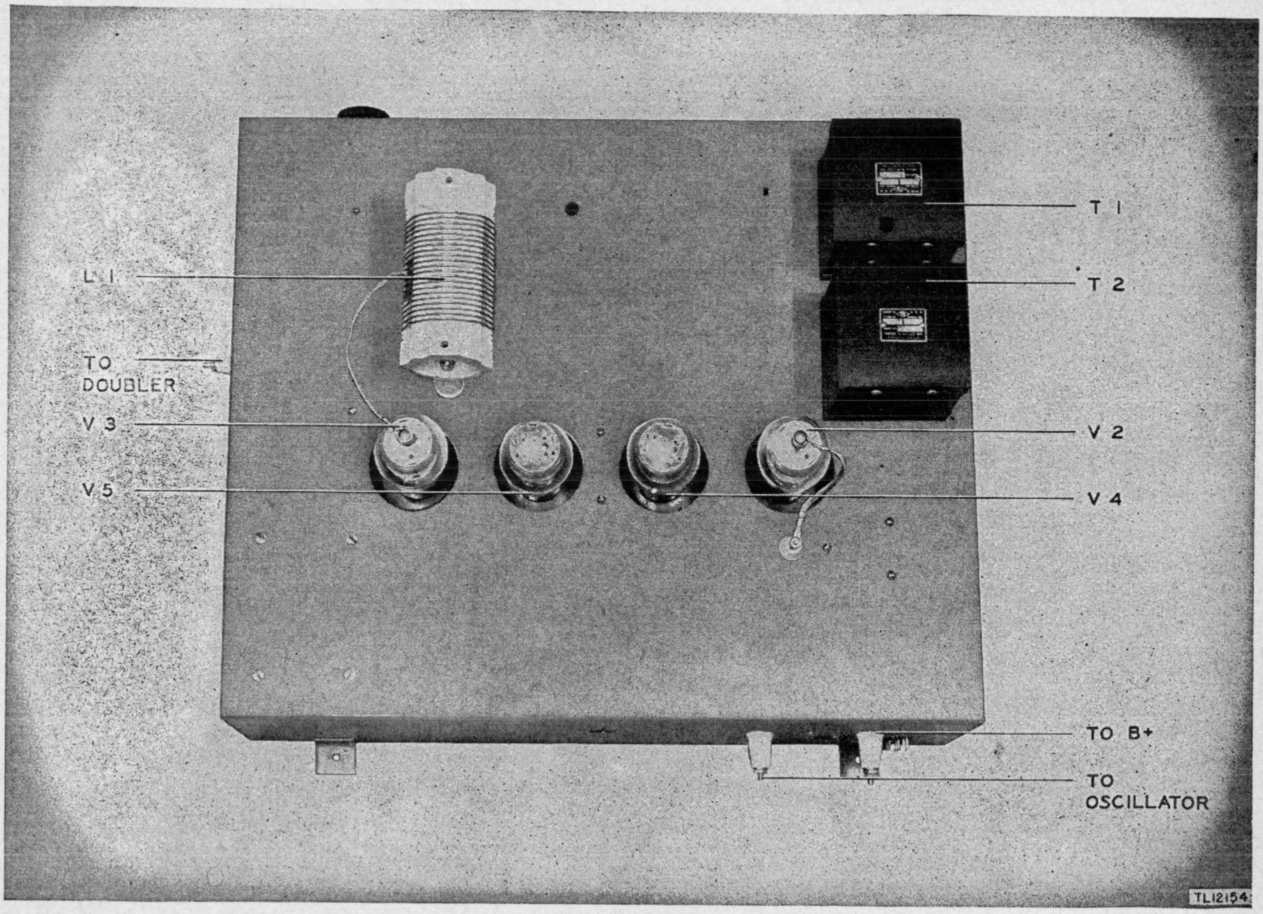


Figure 46. Buffer chassis, top view.

stage is a tuned r-f amplifier operated class C. The r-f voltage is fed from the buffer plate circuit through capacitor C9 to the grid of tube V3. The operating grid bias for the stage, during key-down conditions, is developed across grid resistor R5 and the parallel inductor resistor combination CH1 and R6 (when not shorted by switch S2). Capacitor C10 is the cathode circuit r-f bypass capacitor which places the cathode of tube V3 at r-f ground potential. Meter M3, bypassed for r-f currents by capacitor C11 measures the cathode current of tube V3. The plate tank circuit consists of tank coil L1, variable capacitor C16, (fig. 47) and plate circuit r-f bypass capacitor C15. Tube V3 is worked into approximately half the total impedance developed across the tank circuit by tapping the plate lead down on the coil. Screen grid voltage is obtained from potentiometer R39, the screen grid circuits of the buffer and keyed stages being connected together. Capacitor C14 is the screen grid r-f bypass capacitor for tube V3. Filament power for tube V3 is obtained from transformer T1.

b. A d-c path can be traced from the keyed stage plate supply to the center tap of coil L1, through tube V3 and cathode meter M3 to the keyer circuit. The d-c path continues in the keyer circuit through the keyer filter, inductor CH1, and resistor R6 to the plates of keyer tubes V4 and V5, which are connected in parallel to reduce their impedance. The circuit continues to the tube filaments, out through the center tap of filament transformer T2 to ground through keyer bias resistor R8.

c. The keyer tubes act as an electronic switch in series with the d-c path. When cut-off bias is applied to the grids of the keyer tubes, current flow through the tubes is stopped and no plate current will flow in the keyed stage. During key-up conditions when the d-c path is completed through resistor R8, a large amount of bias will be developed across resistor R8 and applied to the grids of tubes V4 and V5. This bias will limit the current flow through the keyer tubes to a very small value which will interrupt the output of the keyed stage. The contacts of the telegraph key or relay are connected across this bias resistor, shorting it out, and allowing plate current to flow when the relay closes or the key is pressed.

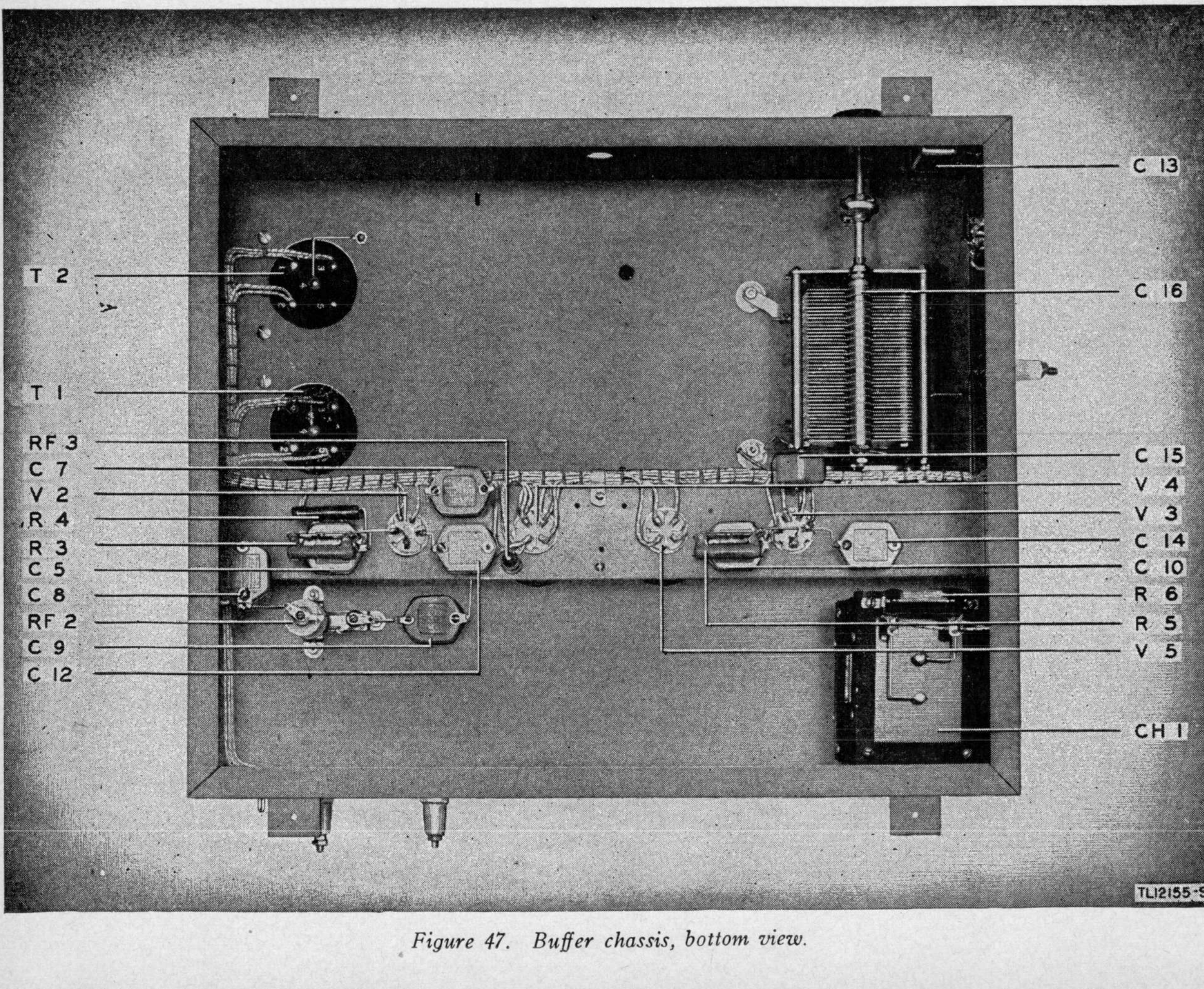


Figure 47. Buffer chassis, bottom view.

KEY SWITCH S3 and KEY SWITCH S4 are provided for keying the transmitter during the tuning procedure. Switch S3 is also used to connect an external relay or key line. Switch S4, during normal operation, is in neutral open circuit position. When pressed down, this switch cuts out bias resistor R8 by closing the circuit to ground, but releases when the pressure is removed. When pushed upward, from the neutral position, the switch closes the circuit to ground until manually released. On the circuit diagram, this switch is shown schematically as operating from right to left. During the time that the key line is used, S4 is in a neutral, no-contact position, and S3 completes the circuit to the key line. Switch S3 is conveniently located for use while tuning the exciter stages, and S4 while tuning the power amplifier. Key clicks are prevented from being transmitted by the key-click filter. The filter consists of an iron core inductor CH1 and resistor R6 connected in series with the keyer plates, and capacitor C13 connected from the keyer plates to ground. SHAPER OUT-SHAPER IN switch S2 is provided for removing the key-click filter for maximum squareness of keying while transmitting high-speed signals. In the early PW-15A transmitters the keying circuit is connected as shown in figure 48. Switch S2 is a four position switch in-

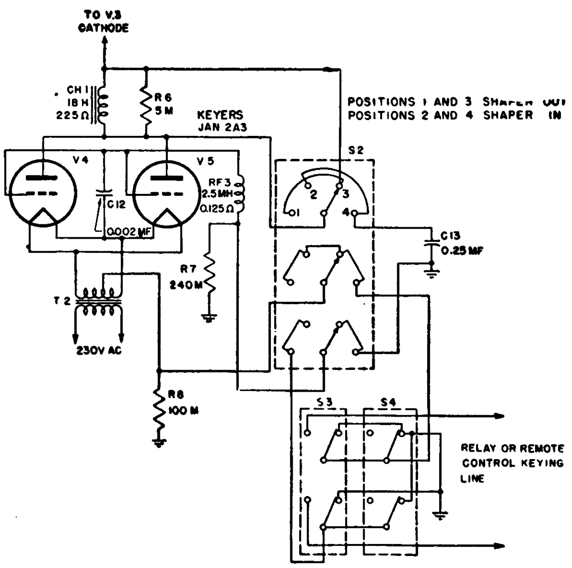


Figure 48. Early model keying circuit, functional diagram.

stead of a two position. Capacitor C12, choke RF3 and resistor R7 are provided to give further control over the keying wave shape.

d. The voltage applied to the buffer and keyed stage screen grid is controlled by KEYING SHAPER potentiometer R39. As the screen grid voltage is increased, the r-f output of both stages is increased causing the shape of the key pulses to become heavier and reduce the spacing. Variations of the power output of the buffer and keyer stages are also compensated for by adjustment of the KEYING SHAPER potentiometer when shifting from one crystal to another. Thus, the power output of these stages can be maintained at the optimum value and key clicks are reduced to a minimum. The power sensitivity of the keyer stage is very high, that is, the r-f power output is high in comparison with the r-f power necessary to properly excite its grid circuit.

93. Frequency Multipliers (figs. 49 and 84)

Frequency-multiplier tubes V6, V7, and V8 (fig. 5) are Tubes JAN 4C22/HF-100. All three multiplier stages are similar in design and function. These multipliers are used to increase the output carrier frequency of the transmitter to the required value while using crystals in a lower range. The frequency of the signal applied to the grid of a multiplier stage is doubled by tuning the plate tank circuit to resonate at the second harmonic of the input signal frequency. In order to have an output rich in harmonics, the frequency multiplier requires more bias and greater input excitation than a straight class C amplifier.

a. By means of MULTIPLIER SELECTOR switch S5 it is possible to select the use of one, two, or three frequency-multiplier stages. The output of the first multiplier can, therefore, be fed into either the second frequency multiplier or the first amplifier. The second and third multipliers are driven from only one end of the plate tank coil since each stage is a single tube. However, when a multiplier drives the first amplifier the excitation from both ends of the multiplier plate tank coil is used. The circuit function of all three multiplier stages is similar and only the first stage will be discussed in detail.

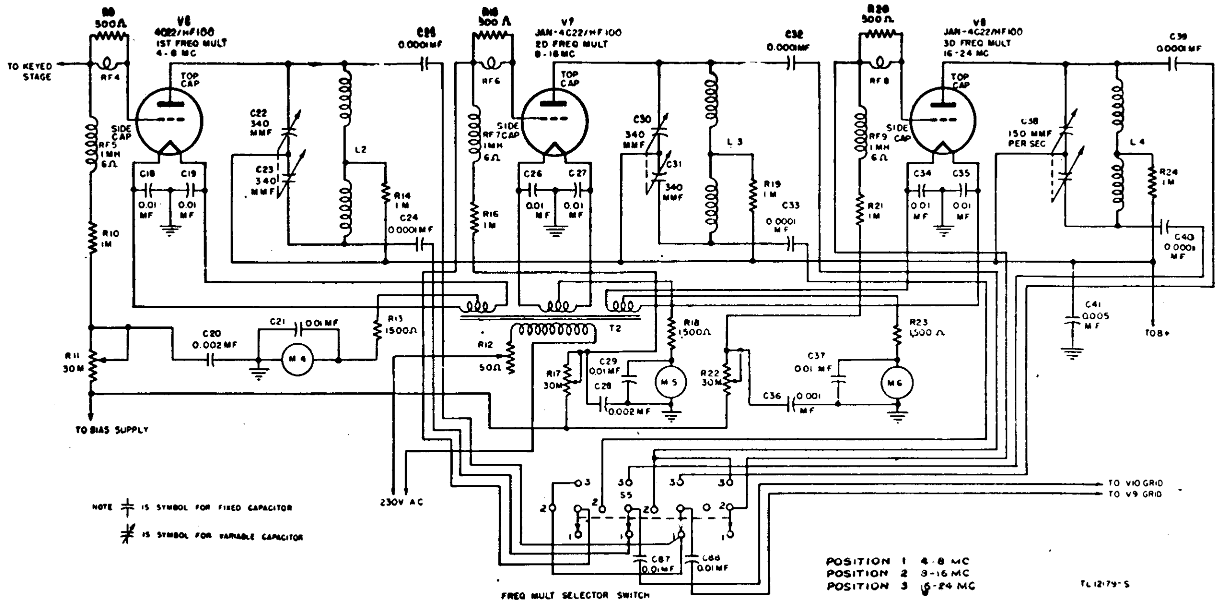


Figure 49. Frequency multipliers, functional diagram.

b. The r-f input is fed to the first multiplier stage from the keyer stage through coupling capacitor C17. The r-f grid voltage is developed across inductor RF5 and resistor R10, the lower end of resistor R10 being at r-f ground potential through capacitor C20. Because of the small grid resistor (1,000-ohm) used, it is necessary to insert inductor RF5 (r-f choke) in the grid circuit to bring the input impedance of the circuit up to several thousand ohms. The grid bias for the stage, during excitation, is a combination of grid leak, cathode, and fixed bias. The grid leak bias results from the voltage drop caused by the passage of the rectified grid current through resistor R10 and adjustable resistor R11. The fixed bias is secured from terminal 1 of the grid bias supply. This fixed voltage is sufficient to bias the tube beyond cut-off so that no plate current flows without grid excitation. In the event of bias power supply failure filament (cathode) resistor R13 provides sufficient bias to prevent any damage to the multiplier tube. This combination of bias also provides an added advantage as slight undesirable variations in any one voltage will produce a very small effect upon the total bias and the operation of the stage. Capacitors C18 and C19 are filament r-f bypass capacitors placing the filament at r-f ground potential. Meter M4, bypassed for r-f by capacitor C21, measures the total of the plate and grid currents (cathode current) of the stage. Inductor RF4 and resistor R9 act to suppress parasitic oscillations. The plate tank circuit for the stage consists of capacitors C22 and C23 together with reverse wound coil L2. Each half of the coil is wound in the opposite direction starting at the center. Resistor R14 is the plate circuit isolating and parasitic resistor. Capacitor C41 is the plate circuit r-f bypass capacitor common to all three multiplier stages. The d-c path can be traced through plate circuit grounding switch S6, resistor R14, and plate coil L2 to the plate of tube V6. The path continues from the filament circuit of tube V6 through resistor R13 and meter M4 to ground. The frequency-multiplier tube filaments are supplied with power from filament transformer T2 which has three secondary windings. Variable resistor R12 provides a means of adjusting the filament voltage to the proper operating value.

c. The maximum frequency in the case of the first and second frequency multipliers is twice the minimum frequency. The maximum frequency of the third multiplier is approximately 1.5 times the minimum frequency.

d. It is not necessary to neutralize the frequency multiplier stages since grid and plate circuits are not operating at the same frequency.

94. First Amplifier (figs. 50 and 84)

The first r-f amplifier is used to amplify the power output of the frequency multipliers to a sufficient value to drive the p-a stage. The first amplifier (fig. 6) is a push-pull, plate neutralized circuit, using Tubes JAN-HF-300 (V9 and V10).

a. The r-f output of the multiplier stages is fed

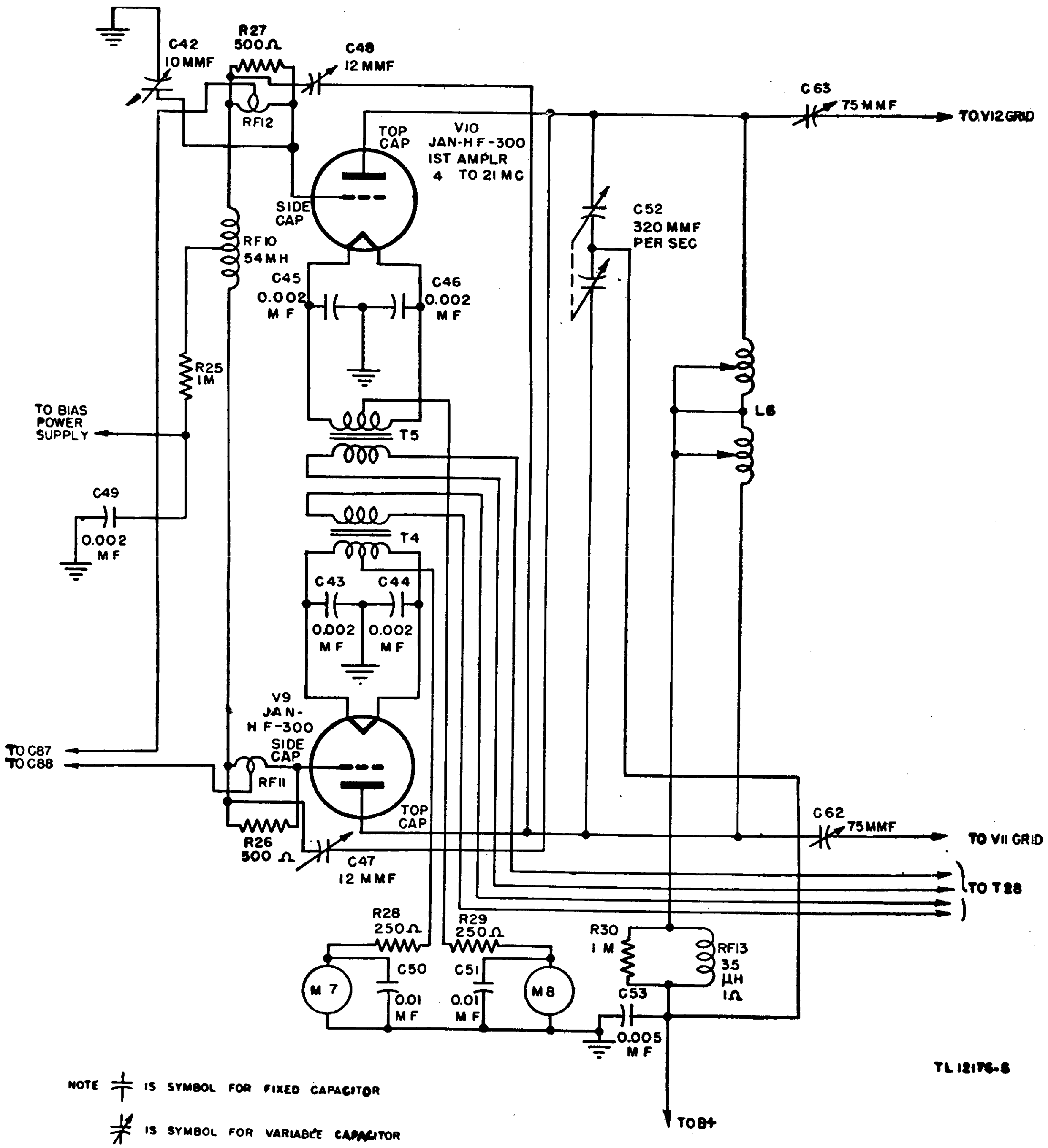


Figure 50. First amplifier, functional diagram.

through either coupling capacitors C24 and C25, C32 and C33, or C39 and C40 depending upon the setting of selector switch S5 to the grids of tubes V9 and V10. Capacitors C87 and C88 are coupling capacitors common to all positions of switch S5. Capacitor C42 is provided to balance out any difference in input capacitance in the grid circuits of tubes V9 and V10, so that both tubes will receive the same amount of excitation. Resistor R27 and inductor RF12 make up the parasitic oscillation suppressor in the grid circuit of tube V10, while resistor R26 and inductor RF11 have the same function in the grid circuit of tube V9. R-f input to the grids of the tubes is applied across r-f choke RF10. Resistor R25 is the grid resistor, the lower end of the resistor being at r-f ground potential through capacitor C49. Grid bias for this stage is a combination of grid leak, cathode, and fixed bias. The grid leak bias results from the voltage drop caused by the passage of the rectified grid current through resistor R25. The cathode bias is developed across resistors R28 and R29, and the fixed cut-off bias is taken from tap 2 on the bias supply bleeder. Capacitors C43, C44, C45, and C46 are filament r-f bypass capacitors. Meter M7, bypassed for r-f by capacitor C50, and meter M8, bypassed for r-f by capacitor C51, measure the cathode current of tubes V9 and V10 respectively. The plate tank circuit is made up of tank coil L5 and dual capacitor C52. Coil L5 is provided with shorting bars so that the amount of inductance in the circuit may be varied. Resistor R30 and inductor RF13 make up the plate circuit parasitic oscillation suppression filter. Capacitor C53 is the plate circuit r-f bypass capacitor, and capacitors C47 and C48 are the neutralizing capacitors for the first amplifier stage.

b. D-c plate current is supplied from the three-phase, 3-kv power supply. The plate current path can be traced from the power supply through the plate disconnect switch S7, the parasitic filter resistor R30 and inductor RF13, to plate coil L5, where the path divides and passes through the amplifier tubes. From tube V9, the circuit passes through the filament transformer center tap through the cathode bias resistor R28 and meter M7 to ground. The plate current return path from tube V10 is similar, the current passing through the filament transformer center tap, the cathode bias resistor R29, and the cathode current meter M8 to ground. S7, the plate voltage disconnect switch, is provided so that the plate voltage can be removed from the first amplifier stage for purposes of neutralization or test. The fila-

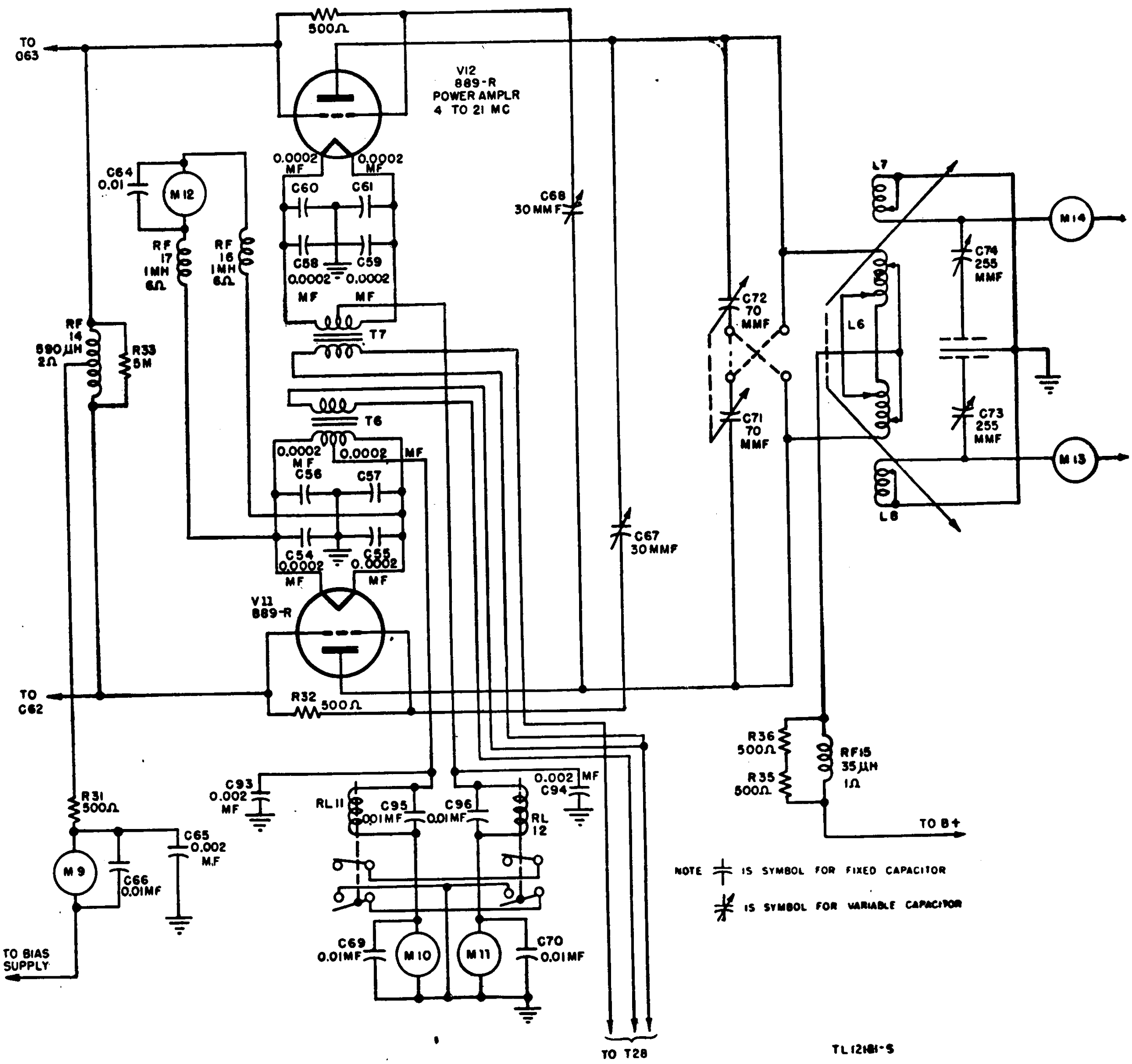


Figure 51. Power amplifier, functional diagram.

ment power for the first amplifier tubes is supplied through filament transformers T4 and T5. The filament voltage on these tubes can be regulated by use of the transtat voltage regulator T28 which is in the filament primary supply circuit. The r-f output energy of the first amplifier is fed to the p-a stage through coupling resistors C62 and C63. The first amplifier stage has a normal power output of approximately 450 watts.

95. Power Amplifier (figs. 51 and 84)

The p-a stage is a plate neutralized push-pull r-f amplifier normally operated class C. Two commercial type 889R air-cooled tubes, V11 and V12, are used. The approximate power output of this stage when operated class C is 15,000 watts. The p-a stage is shown in figures 7, 52, and 53.

a. The excitation power is fed from the first amplifier stage to the grids of tubes V11 and V12 through variable coupling capacitors C62 and C63. This coupling permits adjustment for balance and regulation of the energy fed to the grids. Two connections to the grid are provided on the top of each tube. Resistors R32 and R34 are connected between these two grid caps on the respective tubes to aid in the suppression of grid circuit parasitic oscillations. Excitation voltage is developed across the center tapped grid inductor RF14 which is damped by resistor R33. This damping prevents the establishment of any resonance points along the inductor which might cause parasitic oscillations. The grid to cathode r-f return is through capacitor C65. Grid bias for the p-a stage is primarily fixed bias obtained from tap 7 on the bias supply bleeder. However, some grid leak bias will be developed across parasitic suppression resistor R31. Meter M9, bypassed for rf by capacitor C66, measures the grid current of both tubes V11 and V12.

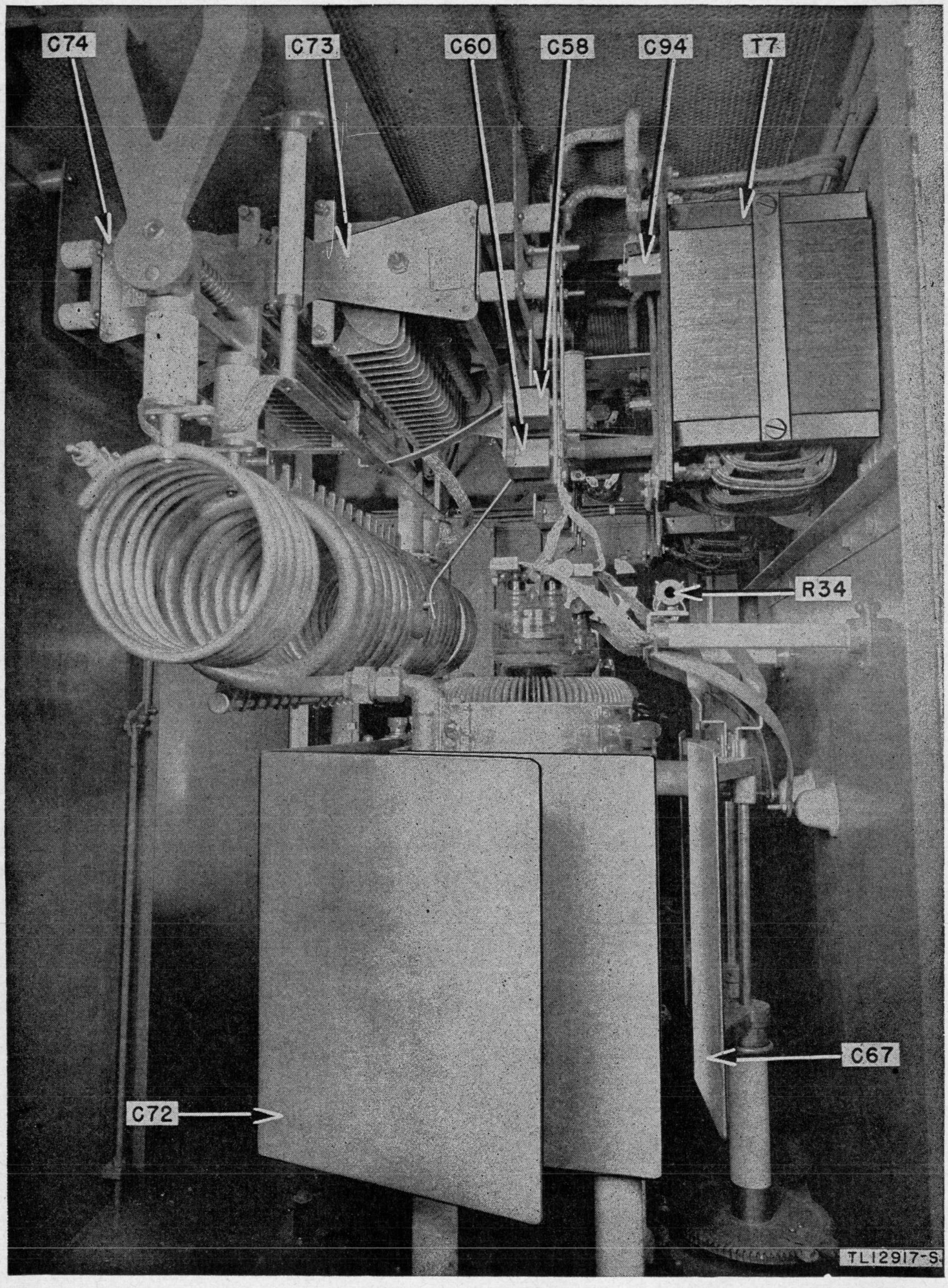


Figure 52. Power amplifier unit, rear view.

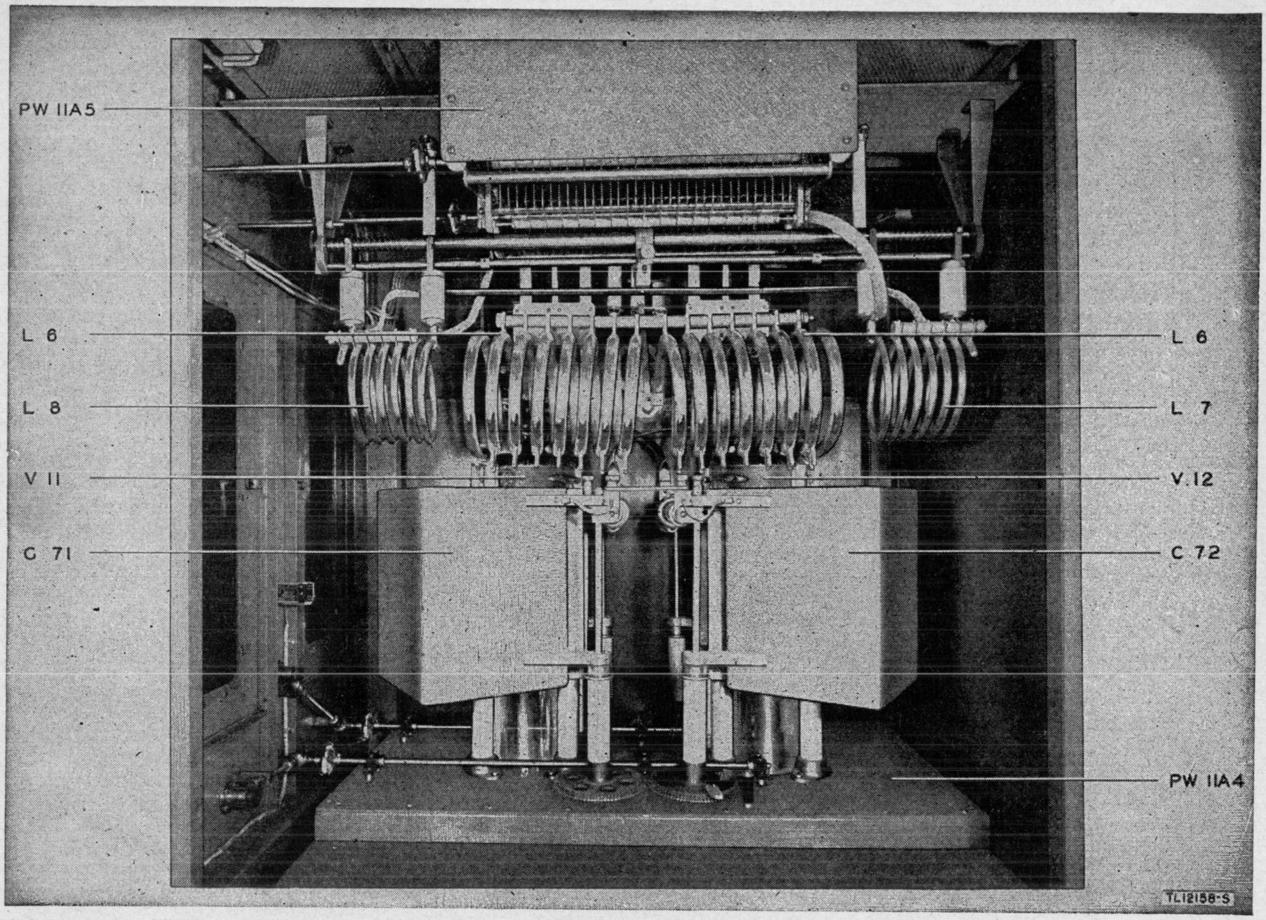


Figure 53. Power amplifier unit, end view

b. The plate tank circuit consists of capacitors C71 and C72 (fig. 12) together with reverse wound tank coil L6, and is tuned by adjusting the capacitors and attaching the proper coil shorting bars across the coil. Tank capacitors C71 and C72 may be connected in parallel or, for high-frequency (h-f) operation, in series. When the tank capacitors are series connected, a ground connection is provided to the connecting link. Figure 51 shows methods of connecting tank capacitors. For parallel connection two straps are used, one with hump in the middle for crossing over the second strap. The parallel connecting straps are connected so that each one goes from the terminal on the movable plate of one tank capacitor to the terminal on the fixed plate tube mounting of the other tank capacitor. The plate tank coil of the p-a stage is split into two halves as is the first amplifier tank coil, one half being wound in a clockwise direction and the other half being wound in a counterclockwise direction so that the center of the coil is always at r-f ground potential. This type of coil provides improved r-f circuit balance, and the stray capacitance to ground as well as the r-f voltage at each end of the tank coil are more nearly equal. Inductor RF 15 and resistors R35 and R36 make up the plate circuit parasitic oscillation suppressor. Capacitors C54, C55, C56, C57, C58, C59, C60, and C61 are r-f bypass capacitors in the filament circuit. The large amount of r-f grid current and r-f plate current make necessary the use of four filament bypass capacitors on each tube to accommodate the r-f current flow. The filament voltage for the p-a tubes is secured from transformers T6 and T7 which connect to transtat T28. (See fig. 54.) The filament voltage of front tube V11 is measured with meter M12 which is protected against r-f currents by inductors RF16 and RF17, and the r-f bypass capacitor C64. The plate and grid current of tubes V11 and V12 are measured by meters M10 and M11, respectively. Capacitors C69 and C70 are r-f bypass capacitors for the meters. Relays RL11 and RL12 are overload relays in the filament ground return leads of tubes V11 and V12. These relays operate when an overload current of sufficient value flows through them. The operation of either relay will open the high-speed CIRCUIT BREAKER RL8 and plate contactor RL5. These relays shown in figure 16 may be set for the value of desired tripping current as explained in paragraph 21. After the relay has tripped, it is necessary to push the reset plunger to put the contacts back in operating position.

96. Air-Cooling System

a. The commercial type 889R tube used in the p-a stage is forced-air cooled. Radiator fins are attached to the anode (plate) of the tube, and the cooling air is forced through these fins by a blower. A vertical air flow of 500 cubic feet per minute should be delivered by the blower to the cooling radiator. The air flow must be started before any voltages are applied to the tube. The temperature of the incoming air should not exceed 45° C, and cooling must be adequate to limit the glass temperature to not more than 150° C at the hottest point.

b. Two blowers BL1 and BL 2 are provided, one for each tube. (See fig. 55.) An air interlock switch is attached to the airduct of each blower (S15 and S16) and prevents any voltage being applied to the p-a tubes until the air flow has started. This interlock assembly consists of a vane inside the duct which operates a microswitch when the air flow is sufficient to move the vane. Thermal switch RL15 is in the primary circuit of the blower motors.

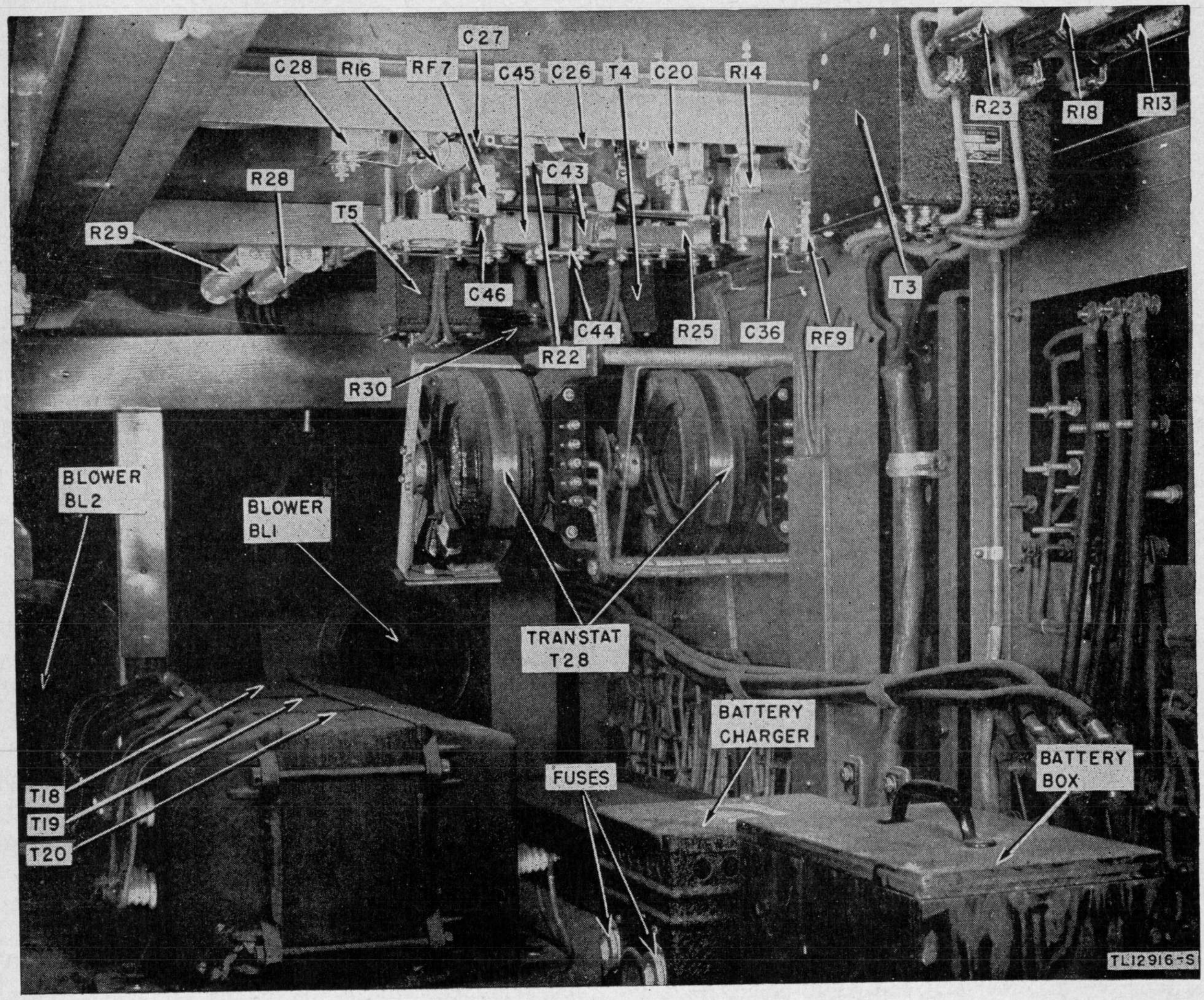


Figure 54. Rectifier-exciter unit, sub compartment.

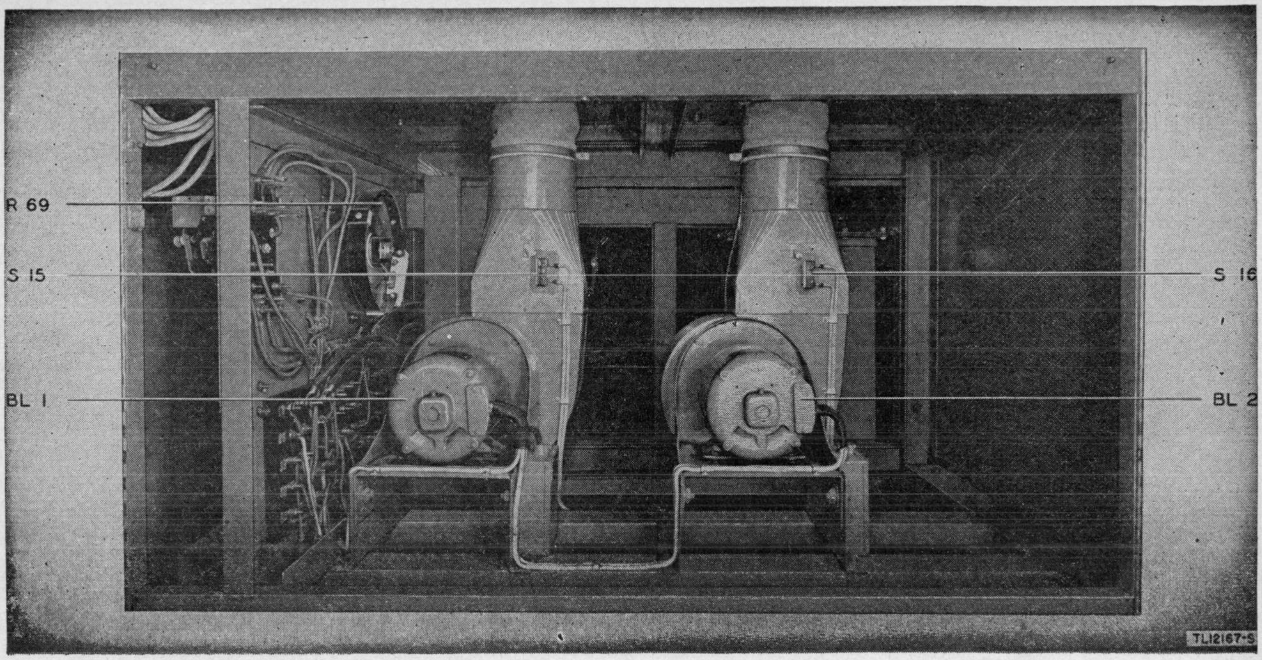


Figure 55. Power amplifier blower compartment.

97. Antenna Network (fig. 51)

a. The antenna-coupling network consists of two coupling coils L7 and L8, one on each end of tank coil L6, and two antenna-tuning capacitors C73 and C74 connected in parallel with the coils forming a balanced parallel tuning network. Shorting bars are used as required to vary the coil inductances when tuning the network to the various transmitter frequencies. The network is tuned to resonance by adjusting the antenna-tuning capacitors, resonance being indicated by a maximum r-f feeder current. Capacitors C73 and C74 have no wire connection between them or ground. Each capacitor is mounted on a metal plate which is insulated from ground by stand-off insulators. The rotor of each capacitor is connected to its mounting plate. The mounting plate acts as one plate of a fixed capacitor, the other plate being the transmitter cabinet. Thus, each variable capacitor (C73 and C74) is in series with a fixed capacitor to ground.

b. The interaction between the coupling network and the tank circuit makes it necessary to retune the power amplifier as the network is adjusted. The antenna-coupling unit is designed to work into an open-wire type of transmission line with an impedance of approximately 600 ohms. These lines are untuned and known as nonresonant or flat lines and the characteristic impedance remains constant so long as the conductor size and spacing remain constant. The antenna network affects an impedance match between the tank coil and the transmission line. By means of the adjustable coupling control it is possible to regulate the amount of current delivered to the antenna; this maintains the desired loading of the final amplifier by the transmission line for any frequency within the range of the transmitter.

c. The coupling coils are maintained at d-c ground potential. This protects the r-f ammeters and final amplifier from static charges that might build up and cause flash-over in the tank circuit. It also eliminates all danger of shock to the personnel in the event that the final plate tank circuit should flash over into the antenna network. For frequencies higher than 18 mc, an additional flexible shorting strap is provided for connection between the two coupling coils. A high degree of harmonic suppression is possible through the use of this circuit. but in order to maintain this condition a selection of minimum inductance and maximum capacitance should always be used. In this way a low impedance to ground for harmonic frequencies is maintained.

98. Power Circuits

The transmitter power supplies may be divided into five separate units: oscillator and buffer power supply; keyed stage power supply; bias power supply; frequency-multiplier and first amplifier power supply; and p-a power supply. All power for the operation of the transmitter is secured from an external three-phase, 230-volt, 60-cycle a-c circuit.

a. The distribution of electrical energy in a high-power transmitter require considerable circuit-controlled equipment for the protection of the components of the transmitter. In addition, the presence of high voltages makes necessary the installation of additional control equipment for the safety of the operating personnel. This control equipment includes switches, magnetic contactors, thermal switches, time delay relays, overload relays, door interlock switches, and START-STOP push buttons.

b. The magnetic contactors are closed by the passage of electric current through the coil of the contactor thereby establishing a magnetic field attracting the armature which causes the contacts to close. These contactors, which are designed to carry heavy loads, make possible rapid switch action by remote control together with greater protection for operating personnel and equipment.

c. The thermal switches are set manually and open automatically when overload currents pass through them. The contacts are opened by the expansion of wire coils which are heated by the heavy current flow.

d. Time delay relays are provided in the transmitter to prevent the application of plate voltage to the mercury vapor rectifier tubes until the filaments of these tubes have reached their proper operating temperature. The time delay relay, which contains a small motor, may be adjusted to run for any interval of time up to 1 minute. Thus, after the reset period of time has elapsed, a movable contactor closes against the stationary contact completing the relay control circuit.

e. In addition, overload relays are also used in certain transmitter circuits. The relay is so constructed that, in the event of an overload, a contact closes or opens, depending upon the relay. These relays may be set for the value of current which will be required for tripping. The setting index is shown in figure 16. Several interlock relays are provided for circuit protection.

f. The door interlocks are provided for the protection of the operating personnel when adjustments or repairs in high-voltage circuits are undertaken. The interlock, which is a small plugger type switch, causes the high voltages present in the transmitter stage to be removed whenever a door or panel is open.

99. Control Circuits

A complete schematic diagram of the control circuits of the transmitter is shown in figure 84.

a. The main line power input is controlled by MAIN SWITCH, S9, which upon closing connects the transmitter to the external power line, and applies power to the oven heaters R79 and R80.

b. The fans and blowers, which are necessary for the maintenance of normal operation of the transmitter, can be placed in operation by closing the BLOWERS AND FANS switch, S10. Closing the START switch causes contactor RL1 to close. This will be indicated by pilot light P1, which will be connected through RL1 across A and B phases of the main power line. Place fans F1 and F2 in operation. When thermal switch RL15 is closed, place blowers B1 and B2 in operation. Switches S37 and 38 provide for speed control.

c. The blower system air interlock switches S15 and S16 together with the spare contact on contactor RL1 prevent filament contactor RL2 from closing until contactor RL1 has been closed and normal air flow is obtained.

d. Closing the START button of switch S11 after switches S15 and S16 and contactor RL1 have closed will close filament contactor RL2. When thermal switches RL16, RL17, and RL18 are closed, power from the main line will be applied to all filament transformers. When contactor RL2 closes, the coil of time delay relay RL14 will be connected between B and C phases of the power line. After the delay period has elapsed bias plate contactor RL3 will close provided all door interlocks are closed and voltage has been applied to relay RL21 which is in the primary filament circuit of the last two r-f stages. After contactor RL3 closes, contactor RL4 will close providing overload relay RL10 has been set and bias interlock relay RL9 closed. The closing of the 3-kv contactor RL4 will be indicated by pilot light P2 which is placed across A and B phases of the power circuit if thermal switch RL18 is closed. Power will now be applied to plate transformers T18, T19, and T20 of the 3-kv power supply. All stages of the transmitter will now be in operation except the final power amplifier.

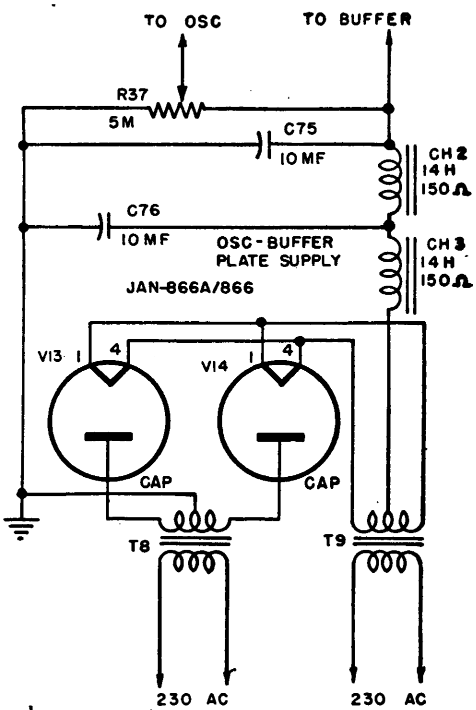
e. The contactor energizing circuit for the main power supply starts at B phase on filament contactor RL2. The circuit goes through the door interlocks, contactor RL4, p-a overload relays RL11 and RL12, the d-c overload RL13 in the main rectifier and through the coil of contactor RL5 to switch S12. When the START button of switch S14 is closed the circuit continues to A phase. Closing switch S12 closes contactor RL5 and also energizes time delay relay RL7. When contactor RL5 closes, power is applied to the primary of transformers T25, T26, and T27 through the three combinations of starting resistors, R70 through R72, R73 through R75, and R76 through R78. When contactor RL5 is energized its coil is connected to A phase, holding the contactor closed through the STOP button of switch S12. After time delay relay

RL17 closes, the full-voltage contactor RL6 is energized and closes, shorting out the starting resistors. When contactor RL6 closes pilot light P3 is connected between A and B phases of the power circuit.

f. If an overload occurs in the d-c circuit of the power amplifier, the coil of the high-speed CIRCUIT BREAKER RL8 is energized by the 12-volt battery through RL11, RL12, or RL13. Circuit breaker RL8 will open and remove input power from transformers T25, T26, and T27. In addition, the high-speed circuit breaker is tripped by its own action when overload currents of sufficient value flow through it. The main rectifier voltage contactors will open if any of the door interlocks or relays, which are in series with the energizing circuit, open and will thus remove input power from transformers T25, T26, and T27.

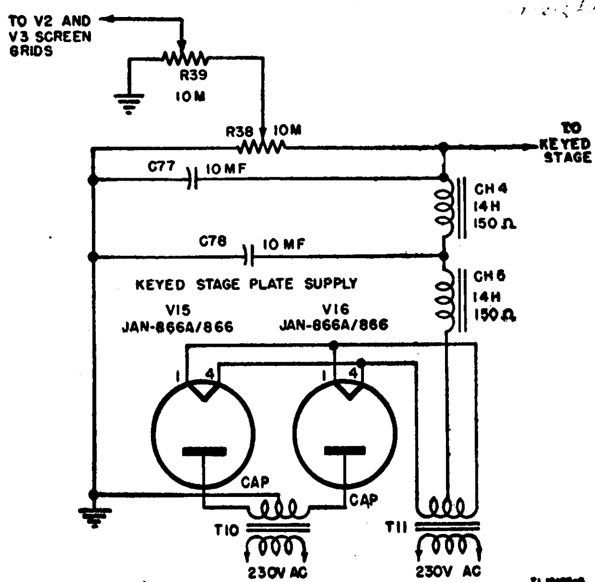
100. Oscillator and Buffer Power Supply (figs. 56 and 84)

The oscillator buffer power supply uses a full-wave rectifier circuit with two mercury vapor rectifier Tubes JAN-866A/866 (V13 and V14). Transformer T9 supplies filament voltage to the rectifier tubes, and transformer T8 is the high-voltage transformer for the supply. The center tap of the secondary winding of transformer T8 goes to ground for the negative terminal of the power supply, while the positive lead to the filter circuit is taken from the center tap of the filament winding on T9. A choke input filter is used consisting of chokes CH2 and CH3 with filter capacitors C75 and C76. Resistor R37 is the bleeder resistor for the supply and is tapped for plate voltage to the oscillator. Plate voltage for the buffer stage is taken from the positive end of resistor R37.



NOTE: ⊥ IS SYMBOL FOR FIXED CAPACITOR TL12178-S

Figure 56. Oscillator-buffer power supply, functional diagram.



NOTE ⊥ IS SYMBOL FOR FIXED CAPACITOR

Figure 57. Keyed stage power supply, functional diagram.

101. Keyed Stage Power Supply (figs. 57 and 84)

The keyed stage power supply uses a full-wave rectifier circuit with two mercury vapor rectifier Tubes JAN-866A/866 (V15 and V16). Transformer T10 is the high-voltage transformer for the supply and the center tap of the secondary winding connects to ground for the negative terminal of the power supply. Transformer T11 is the filament transformer for the rectifier tubes, and the center tap of the filament winding is the positive terminal of the rectifiers and connects to the filter circuit. A choke input filter circuit is used consisting of chokes CH4 and CH5 with filter capacitors C77 and C78. Resistor R38 is the bleeder resistor for the power supply, and is tapped to supply screen voltage to the buffer and keyed tubes V2 and V3. Plate voltage for the keyed stage is taken from the end of resistor R38.

102. Bias Power Supply (figs. 58 and 84)

The bias power supply uses a full-wave rectifier circuit with two mercury vapor rectifier Tubes JAN-872A (V17 and V18). Transformer T12 supplies filament voltage to the rectifier tubes, and the center tap of the filament winding is grounded. This grounds the positive side of the power supply and places the negative side below ground potential as is required for grid bias. Transformer T13 is the high-voltage transformer connected to the plates of the rectifier tubes. The center tap of the high-voltage transformer (negative terminal of the rectifier circuit) connects to the filter circuit. A choke input filter is used, consisting of chokes CH6 and CH7 with filter capacitors C79, C80, and C92. Resistors R40 through R46 form the bleeder resistor for the power supply. These resistors function in three ways: to provide good voltage regulation in the power supply; to provide a path through which the filter capacitors can discharge when the power supply is turned off; and to act as a voltage divider for the bias voltages for the various stages of the transmitter. Bias interlock relay RL9, normally open, is placed in series with the bleeder resistors to prevent the 3-kv contactor RL4 from closing until the bias supply is operating. When sufficient current is flowing through the bleeder circuit relay RL9 will close.

103. 3-KV P wer Supply (figs. 59 and 84)

a. The 3-kv power supply furnishes plate voltage to the frequency-multiplier and first amplifier stages. A three-phase, full-wave rectifier circuit is used, consisting of six mercury vapor rectifier Tubes JAN-872A (V19 through V24). High voltage is obtained from transformers T18, T19, and T20 which are delta-wye connected. The entire voltage output of the power supply is applied to the first amplifier stage, while 1.5 kv is obtained for the frequency-multiplier stages from a three-phase half-wave power supply formed by a connection to the common point of the transformer secondary windings. Transformers T14, T15, T16, and T17 supply filament voltage to the rectifier tubes. Rheostat R55 regulates the primary voltage to the filament transformers which is measured by meter M15. The filter for the 3-kv power supply consists of capacitors C81 and C82 with chokes CH9 and its damping resistor R54. Resistors R48 through R53 form the bleeder network for the power supply. These bleeder resistors also serve as a dropping resistor for voltmeter M16. Resistor R47 is used to calibrate the meter, and capacitor C85 bypasses r-f around the meter. Plate voltage for the first amplifier is taken from the secondary center tap of transformer T17 and the return path is through overload relay RL10. Filter choke CH9 is connected in the negative side of the power supply to facilitate installation by keeping the choke at ground potential.

b. Plate voltage for the frequency-multiplier stages is brought out through the lead connected to the common tap of the plate transformer secondary windings. The filter network for this circuit consists of choke CH8 and filter capacitors C83 and C84; the output of the filter is connected to the center of the bleeder network.

c. The d-c circuit of the full-wave rectifier is

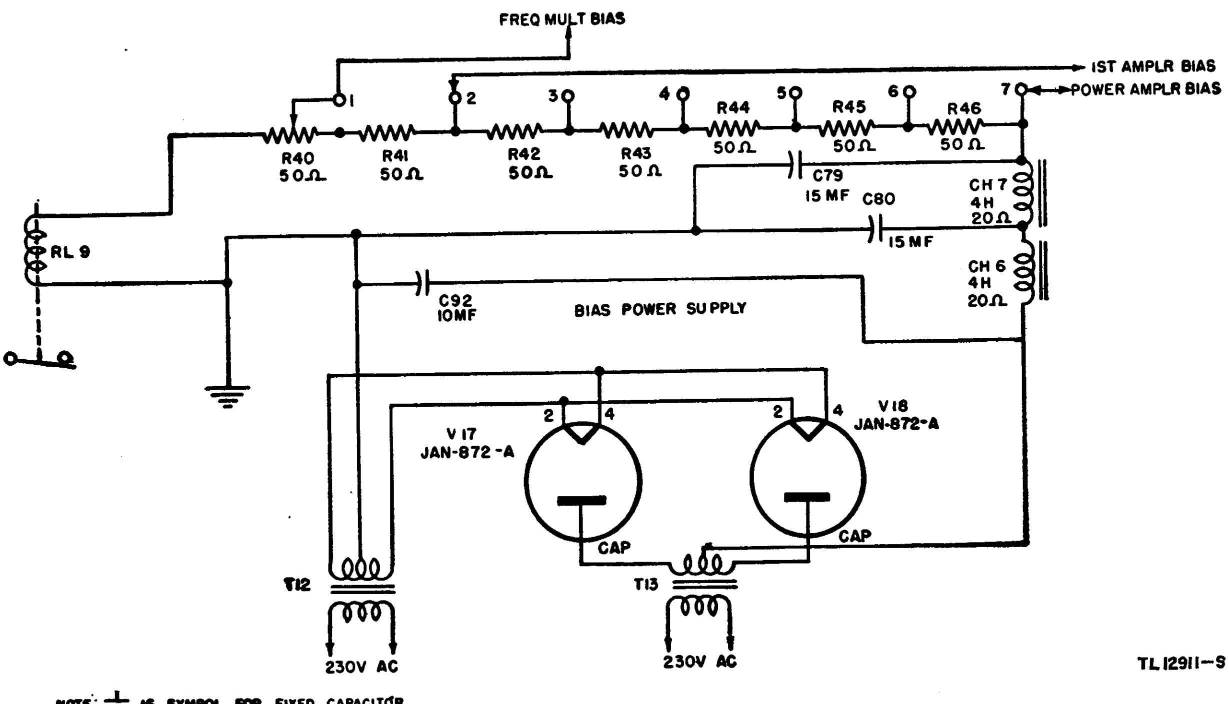


Figure 58. Bias power supply, functional diagram.

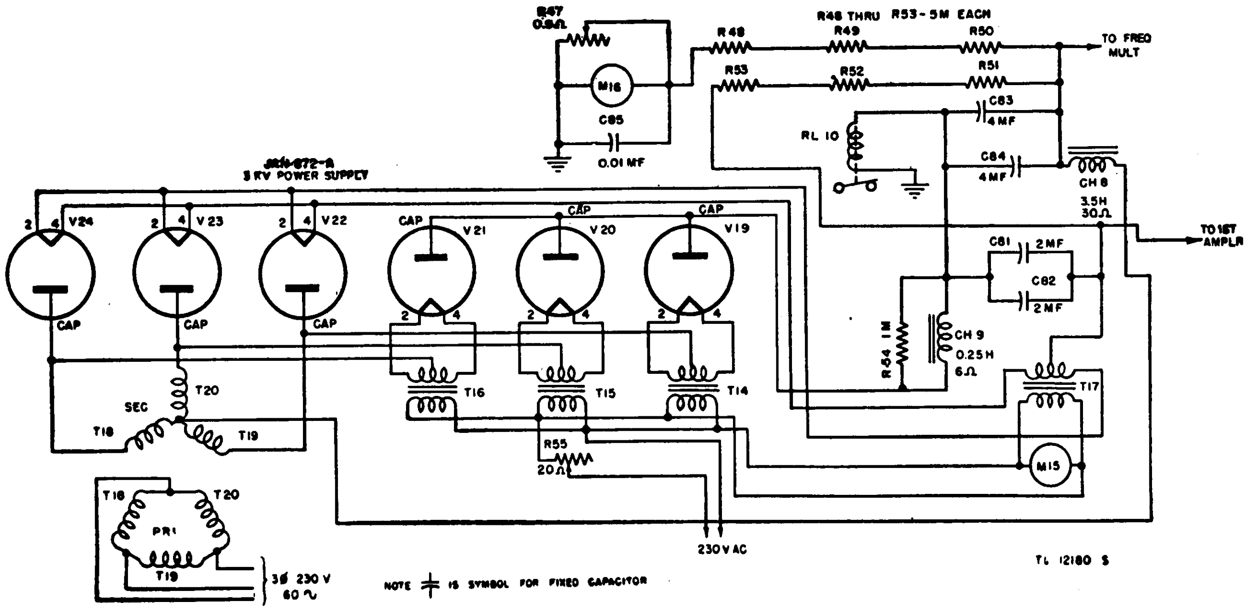


Figure 59. 3-kv power supply, functional diagram.

traced as follows: taking transformer T18 secondary as an example with the outside end of the winding at peak positive, the circuit goes through tube V24 to the secondary windings of transformer T17. From the center tap of the secondary winding, the path continues to the first amplifier stage. The circuit returns from ground through relay RL10, choke CH9 with resistor R54, tubes V19 and V20, and out of the center taps of transformers T14 and T15 through the secondaries of transformers T19 and T20 to the secondary winding of transformer T18. Circuits from the other secondary windings may be traced in a similar manner.

d. For the half-wave rectifier with the same conditions as in *c* above, the circuit is traced as follows: starting at the common point of the secondary windings, the path goes through choke CH8 to the plate circuits of the frequency-multiplier stages, and through these stages to ground. From ground the return path is the same as in *c* above.

104. PIA Power Supply (figs. 60 and 84)

a. The main power supply is a three-phase full-wave rectifier using six mercury vapor rectifier tubes type 575-A (V25 through V30). High voltage is supplied to the rectifier tubes by the three-single-phase transformers T25, T26, and T27 are delta-delta connected. The primary circuit is provided

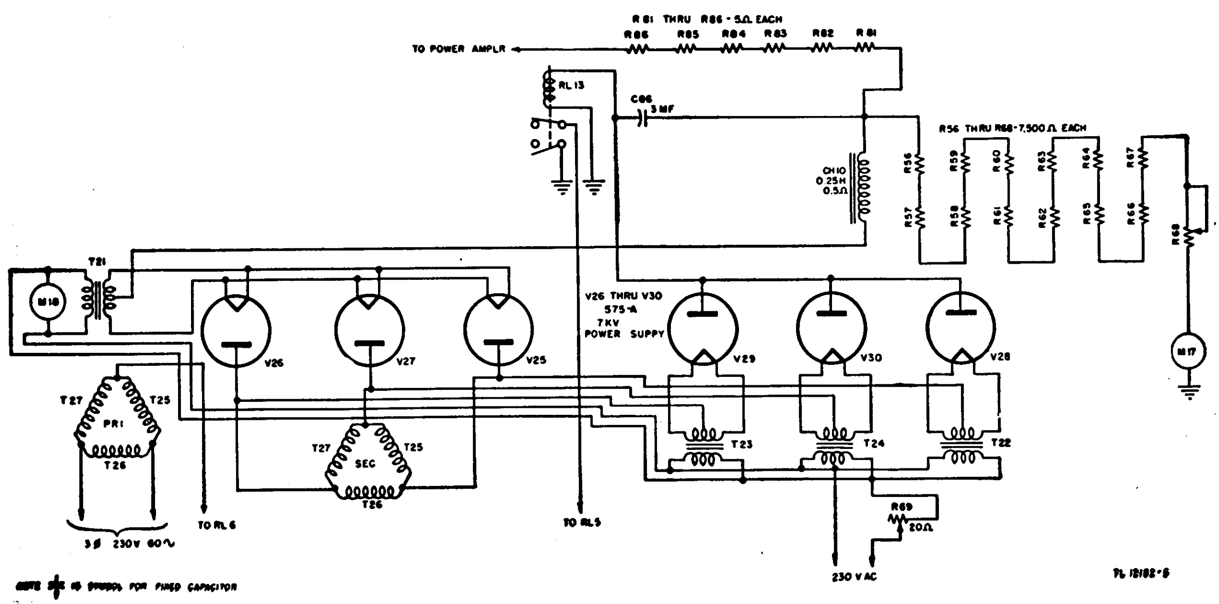


Figure 60. Power amplifier power supply, functional diagram.

with starting resistors R70 through R78, so that an initial half-voltage is applied to the rectifiers during the starting period. These resistors are connected in series with the transformer's primary terminals. When time delay relay RL7 closes, these resistors are shorted out of the circuit by the full-voltage contactor RL6.

b. A single-section filter circuit is used consisting of choke CH10 and filter capacitor C86. Surge resistors R81 through R86 are placed in series with high-voltage lead to the p-a stage to limit surge currents. Resistors R56 through R68 make up the bleeder resistor and in addition serve as a multiplier for voltmeter M17. Resistor R68 is adjustable and provides a method of calibrating the voltmeter. Filament voltage for the rectifier tubes is supplied by transformers T21, T22, T23, and T24. Rheostat R69, connected in series with the primary circuit of the filament transformers, making possible proper adjustment of the tube filament voltage. Primary voltage of the filament transformers is measured by meter M18. For complete operation of the input circuit see paragraph 99.

c. The d-c path may be traced through this power supply in the manner described in paragraph 103 for the 3-kv power supply.

Section XII. TROUBLE SHOOTING

105. General Trouble-Shooting Information

No matter how well equipment is designed and manufactured, faults occur in service. When such faults occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting.

a. TROUBLE-SHOOTING DATA. Take advantage of the material supplied in this manual to help in the rapid location of faults. Consult the following trouble-shooting data when necessary:

(1) Block diagram of radiotelegraph transmitter PW-15A. (See fig. 2.)

(2) Complete schematic diagram. (See fig. 84.)

(3) A-c wiring diagrams. (See figs. 80, 81, and 82.) Terminal boards are shown in figures 61 through 66.

(4) Simplified and partial schematic diagrams. These diagrams are particularly useful in trouble shooting, because the repairman can follow the electrical functioning of the circuits more easily than on the regular schematics, thus speeding trouble location. A simplified control circuit diagram is shown in figure 83.

(5) Illustrations of components. Front, top, and bottom views aid in locating and identifying parts.

(6) Pin connections. Pin connections on sockets, plugs, and receptacles are numbered or lettered on the various diagrams. Figures 67 and 68 show plug connections for the oscillator, buffer, and keyed stage. Seen from the bottom, pin connections are numbered in a clockwise direction around the sockets. On octal sockets the first pin clockwise from the keyway is the No. 1 pin.

b. TROUBLE-SHOOTING STEPS. The first step in servicing the PW-15A is to sectionalize the fault. Sectionalization means tracing the fault to the component or circuit responsible for the abnormal operation of the sets. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, r-f arcing, and shorted transformers can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage and resistance.

c. SECTIONALIZATION. Careful observation of the meters on the transmitter front panel often determines the stage or circuit at fault. The chart given in paragraph 107 will help in sectionalizing.

d. LOCALIZATION. After the fault has been sectionalized, voltage and resistance measurements should be used in conjunction with the various schematic diagrams to locate the part at fault.

e. VOLTAGE MEASUREMENT. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages. Voltage measurements are taken easily, because they are always made between two points in a circuit and the circuit need not be interrupted. In the PW-15A main circuit voltages appear on panel meters. When measuring inside the transmitter, door interlocks must be held closed.

(1) Always begin by setting the voltmeter on the highest range so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

(2) In checking cathode voltage, remember that

a reading can be obtained when the cathode resistor is actually open. The resistance of the meter may act as a cathode resistor. Thus, the cathode voltage may be approximately normal only as long as the voltmeter is connected between cathode and ground. Before the cathode voltage is measured, make a resistance check with a cold circuit to determine whether the cathode resistor is normal.

f. Precautions Against High Voltage. Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages are dangerous and can be fatal. When it is necessary to measure high voltage, observe the following rules:

(1) Connect the ground lead to the voltmeter.

(2) Place one hand in your pocket. This will eliminate the possibility of making accidental contact with either ground or another part of the circuit thus causing the electricity to travel from one hand to the other.

(3) If the voltage is less than 300 volts, connect the test lead to the hot terminal (which may be either positive or negative with respect to ground).

(4) If the voltage is greater than 300 volts, shut off the power, connect the hot lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage betwen two points which are above ground.

g. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If not, the voltmeter will indicate a voltage lower than the actual voltage present when the voltmeter is removed from the circuit.

(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: resistance of the voltmeter equals the ohms per volt multiplied by the full-scale range in volts. For example, the resistance of a 1,000-ohm-per-volt meter on the 300-volt range is 300,000 ohms (R = 1,000 ohms per volt times 300 volts = 300,000 ohms).

(2) To minimize the voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading of the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the highest range will be greater than that on the lowest range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

h. Control Circuits. When trouble is localized to the control or a-c circuits it must be remembered that these circuits are interconnected. Consequently, one defective part may prevent several other components from operating normally.

i. R-f Circuits. Troubles in the r-f circuits may be caused by improper adjustment, defective tubes, and by defective components. A recommended procedure for correcting trouble in these circuits follows:

(1) Make certain the transmitter is properly tuned to the desired operating frequency.

(2) Check for defective tubes. A set of tubes known to be in good condition may be substituted for those in the transmitter. After this is done, substitute the original tubes, one at a time, to find the defective tube or tubes.

(3) If trouble has not been found by the foregoing methods, a defective component, such as a shorted bypass capacitor, burnt out resistor, or open circuit in wiring or plugs may be suspected. This can be remedied by making a thorough continuity check of the transmitter circuits using an ohmmeter and the schematic diagram in figure 84.

106. Trouble-Shooting Procedures

The accompanying trouble-shooting chart, if properly used, will help in trouble shooting. The chart lists the various symptoms which may be recognized easily by the operator, and gives the probable location for the existing trouble as well as the recommended correction. The chart also localizes the trouble in the transmitter to the individual part in the circuit which is causing the abnormal condition.

107. Trouble Chart for Radiotelegraph Transmitter PW-15A

Symptoms	Probable trouble	Corrections
1. Blowers fail to start when contactor RL1 closes.	1. Open circuit breaker RL15.	1. Close circuit breaker RL15.
2. Filament contactor RL2 fails to close.	2. Open interlock switches S15 and S16 due to blower trouble or faulty switches.	2. Replace switches.
3. Filaments of the oscillator, buffer, keyed stage, keyers, frequency multipliers, and the 3-kv rectifier tubes fail to light.	3. Open circuit breaker RL16.	3. Close circuit breaker or replace if necessary. If RL16 fails to stay closed, check these tubes for shorted filament or defective transformers and associated wiring.
4. Filaments of the 7-kv rectifier tubes fail to light.	4. Open circuit breaker RL19.	4. Close circuit breaker or replace if necessary. Check these tubes for shorted filaments or defective filament transformers and associated wiring.
5. Filaments of the first and p-a tubes fail to light.	5. Open circuit breaker RL17.	5. Close circuit breaker or replace if necessary. Check these tubes for shorted filaments or defective filament transformers and associated wiring.
	Faulty transtat T28.	Check transtat.
6. Bias plate contactor RL3 fails to close.	6. Time delay relay RL14 defective. Door interlocks open. Filament interlocks relay RL21 open.	6. Check contacts and operation. Repair or replace relay. See that doors are closed. Check for defective door interlock switch. Check relay RL21 and switch RL17.
7. 3-kv contactor RL4 fails to close.	7. Bias plate contactor RL3 open. Door interlocks open. Overload relay RL10 tripped. Bias relay RL9 contacts not closed.	7. See step 6. Check door interlocks. Push up reset button. Check contacts of RL9.
8. 3 kv and 1.5 kv fail to appear on the plates of the frequency-multiplier and first amplifier tubes.	8. Open circuit breaker RL18. Switches S6 and S7 open.	8. Close circuit breaker RL18. Repair or replace if necessary. Close switches. Check rectifier tubes and associated wiring.
9. High-speed circuit breaker RL8 fails to stay closed.	9. D-c current overload relay RL13 tripped. P-a overload relays RL11 and RL12 tripped. Battery circuit shorted to ground.	9. Push up reset buttons on RL13, RL11, and RL12.
10. 7-kv starting contactor fails to close when switch S12 is operated.	10. Switch S12 defective. Relays RL11, RL12, or RL13 tripped. Contactor RL4 not closed.	10. Check switch. Reset relays. See step 7.
11. Full-voltage contactor RL6 fails to close.	11. Time delay relay RL7 fails to operate.	11. Check relay, repair or replace if necessary.
12. 3-kv d-c overload relay RL10 trips.	12. Improper tuning. Defective tubes.	12. Check tuning of frequency multipliers and first amplifier tubes for resonance. Check tubes in these circuits.
13. P-a overload relays RL11 and RL12 trips and opens RL8.	13. Improper tuning. Defective tubes.	13. Check tuning. Check for defective tubes and replace any if necessary.
14. 7-kv d-c overload relay RL13 trips and opens RL8.	14. Defective rectifier tubes.	14. Check tubes for gas and arc-back and replace any if necessary.
15. Oscillator not oscillating; no current indication on M1.	15. Oscillator Tube JAN-6J5GT/G defective tube socket. Resistor R2 or R90 open. Capacitor C3* shorted. Meter M1 open. R-f choke RF1 open. Defective plate or filament supply.	15. Check and replace if necessary. Inspect, clean, or replace if necessary. Check all suspected components by resistance measurements. Use necessary precautions. Replace defective parts. Check filament transformer and oscillator supply.
16. Excessive current indication on M1.	16. Defective crystal. Dirty or defective contact on switch S1.	16. Replace crystal. Try operation on different frequency. Inspect, clean, repair, or replace.
	Resistor R1 open, capacitors C1 or C2 shorted.	Check by means of resistance measurements, using necessary precautions. Replace defective components.
	Capacitor C4 open.	See NOTE.

Symptoms	Probable trouble	Corrections
17. Oscillator functions properly but no output is obtained from buffer	17. Excitation plugs dirty or defective.	17. Inspect, clean, or replace.
	Defective Tube JAN-807.	Check; replace if necessary.
	Dirty or defective tube socket. Capacitor C7 or C8 shorted. Resistor R3 or R4 open. Choke RF2 open. Meter M2 open.	Inspect, clean or replace. Check by means of resistance measurements, using necessary precautions. Replace defective parts.
18. Keyed stage faulty; r-f output from buffer but keyed stage inoperative (key down).	18. Defective Tubes JAN-807 or JAN-2A3.	18. Check, replace if necessary.
	Dirty or defective tube sockets.	Inspect, clean or replace.
	Capacitor C14 or C15 shorted. Resistor R5 open. Meter M3 open.	Check by means of resistance measurements, using necessary precautions. Replace defective parts.
	Capacitor C9 open.	See NOTE.
	Defective plate or filament supply.	Check circuits.
	Plate tank out of resonance.	Retune plate tank. See paragraph 113.
19. Stage operates continuously (key up or down).	19. Capacitor C10 shorted.	19. Check by resistance measurements.
	Switches S3 or S4 defective. Short in T2 section to ground. Key line shorted to ground.	Replace if necessary. Inspect, repair or replace. Check by resistance measurements. Use necessary corrective measures.
20. No output, first frequency multiplier.	20. Defective Tube JAN 4C22/HF-100.	20. Check, replace if necessary.
	Dirty or defective tube socket or plate or grid cap.	Inspect, clean, or replace.
	Capacitor C17 open.	See NOTE.
	Resistor R10, R11, R13 or R14 open. Choke RF5 open. Meter M4 open.	Check by resistance measurements using necessary precautions. Replace defective parts.
	Plate tank out of resonance.	Retune stage. See paragraph 113.
	Defective plate, filament or bias supply.	Check circuits.
	Switch S6 open, defective.	Check, replace if necessary.
	Crystal not the proper frequency.	Check, use crystal of proper frequency.
21. Faulty operation of second frequency multiplier.	21. Defective Tube JAN 4C22/HF-100.	21. Check; replace if necessary.
	Dirty or defective tube socket or plate or grid caps.	Inspect, clean, or replace.
	Dirty or defective switch S5.	Inspect, clean, repair, or replace.
	Plate tank out of resonance.	Retune plate tank. See paragraph 113.
	Resistor R16, R17, R18 or R19 open. Choke RF7 open. Meter M5 open.	Check by resistance measurements using necessary precautions. Replace defective parts.
22. Faulty operation of third frequency multiplier.	22. Defective Tube JAN 4C22/HF-100.	22. Check; replace if necessary.
	Dirty or defective tube socket or plate cap.	Inspect, clean, or replace.
	Dirty or defective switch S5.	Inspect, clean, repair, or replace.
	Plate tank out of resonance.	Retune plate tank. See paragraph 113.
	Resistor R21, R22, R23 or R24 open. Choke RF9 open. Meter M6 open.	Check by resistance measurements using necessary precautions. Replace defective parts.
23. Faulty operation of first amplifier.	23. Defective Tube or Tubes JAN-HF-300.	23. Check; replace if necessary.
	Dirty or defective plate or grid caps, or tube sockets.	Inspect, clean, or replace.
	Plate tank out of resonance.	Return tank circuit. See paragraph 113.
	Stage out of neutralization.	Reneutralize. See paragraph 113.
	Switch S7 open or defective.	Check; replace if necessary.

Symptoms	Probable trouble	Corrections
23. Faulty operation of first amplifier. —(*Cont.*)	Resistor R25, R28 or R29 open. Meter M7 or M8 open. Choke RF10 open.	Check by resistance measurements using necessary precautions. Replace defective parts.
	Defective filament supply.	
24. Faulty operation of power amplifier.	24. Weak or defective tube or tubes 889R.	24. Check; replace if necessary.
	Dirty or defective tube mounts.	Inspect, clean, or repair.
	Plate tank circuit out of resonance or stage out of neutralization.	Retune or reneutralize. See paragraph 114.
	Antenna not tuned properly.	See paragraph 114.
	Meters M9, M10, or M11 open. Relay coil RL11 or RL12 open.	Check by resistance measurements using necessary precautions. Replace defective parts.
	Defective plate or filament supply.	

Notes.

* If a short should occur in capacitor C3 excessive current will damage meter M1. If it is necessary to replace M1, make sure that C3 is not defective.

See paragraph 120 for emergency operation without the power amplifier.

To check a capacitor suspected of being open, substitute with an identical capacitor known to be good.

Note. This table is prepared only as a guide to aid the serviceman in locating troubles in a minimum of time. It must be understood that it would be impossible to list all the possible troubles that may be encountered while servicing this unit. Loose or corroded connections will be responsible for many of the service interruptions. Do not neglect to check the wiring between terminal boards as well as between circuit components. In locating troubles, a good indication of the stage at fault is an abnormal meter reading in that particular stage. This is not always true as faulty operation of one stage may effect other stages. Failure of power supplies can very often be traced to the control circuits which have not operated because of some other abnormality. (See par. 99.) Check rectifier tubes, filters, and bleeders only after it has been determined that the primary circuits are normal.

108. Typical Transmitter Data

a. A-c Power Measurements.

Line	Current (amperes)		Voltage (volts)	
	Key Up	Key Down	Key Up	Key Down
A	19.2	52.8	230	230
B	30.0	62.5	230	230
C	29.0	62.5	230	230

b. Over-all Efficiency.

Frequency	20,800 kc
Total input	37.0 kva
Power factor	95.0%
R-f output	17.0 kw
Efficiency	48.5%

c. Rectifier Filament Voltages.

Tube		Fil Voltage	Pri Voltage
JAN-866A/866	V13, V14, V15, and V16	2.5 a-c	
JAN-872A	V17 and V18	5.0 a-c	
JAN-872A	V19 through V24	5.0 a-c	200 volts on meter M19
JAN-575	V25 through V30	5.0 a-c	200 volts on meter M22

d. Transmitter Stage Data. In the followingchart voltage readings are in volts and current readings in amperes.

Stage	Item	Reading — Frequency in kc 3,981.7	12,000	20,800
Oscillator-buffer	Type operation	mo	mo	crystal
	Frequency selector	6	6	1
	Oven temperature	50.0	50.0	49.0
	Oscillator-plate current	0.006	0.0065	0.0055
	Buffer-plate current	0.013	0.007	0.012
	Plate-voltage supply	170	170	170
	Filament voltage	6.3	6.3	6.3
Keyed	Tuning dial	84	27	41
	Shaper control dial	2.2	1.0	1.5
	Plate current	0.016	0.006	0.010
	Filament voltage	6.3	6.3	6.3
Frequency-multipliers	1st mult dial	76	30	42
	2d mult dial	....	25	46
	3d mult dial	....	....	10
	1st mult plate current	0.65	0.55	0.50
	2d mult plate current	....	0.080	0.085
	3d mult plate current	....	....	0.135
	Plate-voltage supply	1500	1500	1500
	Bias tap	1	1	1
	Filament voltage	10.5	10.5	10.5
	R12 dial	5.6	5.6	5.6
First amplifier	Tuning dial	82	27	8
	Neutralization dial	34	34	38
	Coupling dial	100	100	54
	Shorting bars	0	14	16
	Left plate current	0.145	0.130	0.285
	Right plate current	0.190	0.165	0.290
	Plate-voltage supply	3000	3000	3000
	Bias tap	3	3	3
	Filament voltage	12.0	12.0	12.0
Power amplifier	Tuning dial	92	47	91.5
	Neutralization dial	7	7	7
	Left plate current	1.95	1.95	1.90
	Right plate current	1.80	1.90	1.80
	Grid current	0.500	0.410	0.400
	Plate-voltage supply	7900	7900	7800
	Shorting bars	0	14-hole top	14-hole bottom
	Capacitor connections	Parallel	Parallel	Series
Antenna	Tuning dial No. 1	100	0	0
	Tuning dial No. 2	100	0	0
	Coupling dial	94	89	84
	Left antenna meter	5.0	6.2	6.0
	Right antenna meter	4.8	6.0	5.8
	Shorting bars	2-collar	5-collar	6-collar

e. P-a Efficiency.

Item	Frequency in kc 3,981.7	12,000	20,800
Kilowatt input	25.25	27.00	26.00
Kilowatt output	18.1	18.0	17.0
Operating efficiency	72.0	67.0	65.5

f. Wave Shape of Carrier Pulses. Figure 69 shows the wave shape of the carrier pulses for various keying speeds with different setting of the shaper switch.

109. Power Control Settings

Item	Setting
Oven temperature thermostat D1 set on...	50° C
BIAS RELAY RL9 set on..............	0.8 amp
EXCITER OVERLOAD relay RL10 set on	2.5 amp
D.C. OVERLOAD relay RL13 set on....	6.0 amp
P.A. OVERLOAD relay RL11 (front) set on	3.2 amp
P.A. OVERLOAD relay RL12 (rear) set on	3.2 amp
Frequency-multiplier rheostat R12 set on..	6.0 amp
Time delay relay RL14 set on...........	30 seconds
Time delay relay RL7 set on............	15 seconds

110. Checking Operating Voltages in Transmitter

After all the mechanical and electrical inspections have been made, the next step is to check all voltages in the transmitter. Observe the following procedure when making these voltage checks.

a. Pull out the reset plunger on each overload relay.

b. Throw switches S6 and S7 off (down position).

c. Turn circuit breakers RL15, RL16, RL17 and RL19 on and leave RL18 and RL20 off. These switches and circuit breakers are accessible through the bottom doors of the various units.

d. Throw the MAIN SWITCH to on position.

e. Press the START button (S10) labeled BLOWERS and FANS switch. This button controls contactor RL1, which in turn starts the blowers and fans.

f. Check the two blowers and the two exhaust fans located inside the transmitter to see that they are operating. The two rotary type switches directly above the contactor buttons control the speed of the exhaust fans in the r-f exciter and rectifier compartment, unit 1. Unless ambient temperature in the transmitter room exceeds 90° F, it is not necessary to run these exhaust fans at full speed; they may be individually turned off or run at low speeds. The blowers in the p-a compartment, BL1 and BL2 respectively, are equipped with two air interlock switches, S15 and S16. If for any reason blowers BL1 and BL2 are not operating, filament power will not be applied to all tubes in the transmitter.

g. Turn the filament rheostats and transtat to their minimum settings and close all doors.

h. Press the filament contactor switch S11 (labeled EXCITER) controlling contactor RL2. See that the filaments of all tubes light.

i. Bring up all filament rheostats until their respective indicating meters show the proper voltage. (See par. 108.) At this point, allow a preheating period of 30 minutes for all tubes.

j. Close circuit breaker RL20. The filament contactor RL2 also supplies power to the 60-second time delay relay RL14, set to operate in 30 seconds. This relay closes contactor RL3 which controls the a-c power supplied to the plates of the rectifier tubes, associated with supplying d-c voltage to the oscillator-buffer plates, buffer-keyed stage screen voltage and bias voltages.

k. Check the OSC. PLATE, 3KV RECT. FIL. MAIN RECT. FIL., P.A. FIL. voltage, and buffer-plate meters. If all these meters are indicating proper voltages and currents (par. 108), it is safe to assume that all voltage supply circuits are operating normally, except the 3-kv rectifier and the main rectifier.

Note. The plunger on RL9 (bias relay) has raised, closing the contact and indicating that the bias supply is functioning normally.

l. Check for normal tube glow in the bias rectifier tubes and in the low-power rectifier tubes.

m. Open the right-hand bottom door of unit 1 and close circuit breaker RL18. After the door has been closed again, the EXC. PLATE VOLTAGE meter should indicate approximately 3 kv. Note the slight blue glow in the 3-kv rectifier tubes.

n. Push the STOP button S11, controlling contactor RL2, to remove all voltages from the transmitter circuit except blowers and fans.

o. To check the main rectifier, first remove resistor R81 from the surge resistor bank at the upper right-hand side of the rectifier-exciter unit. (See fig. 9.)

p. Close all doors.

q. Push the START button S11 of the EXCITER switch which will start the exciter section of the transmitter previously checked.

r. After allowing the necessary time for its associated circuits to operate, close the high-speed circuit breaker RL8 (rear of the rectifier-exciter unit).

s. Press the START button S12 of the MAIN RECTIFIER switch. RL5 will close immediately and after a set time interval of 15 seconds (controlled by time delay relay RL7) contactor RL6 will close supplying full a-c power to the primary of plate transformers T25, T26, and T27. If all the main rectifier circuits are operating normally, the main rectifier P.A. PLATE VOLTAGE meter M17 on the front of the rectifier-exciter unit will indicate approximately 8 kv.

t. If any of the contactors trip out due to flash- or arc-over in the rectifier circuit, it is probable there is a defective rectifier tube. Locate and replace it by watching for the arc back in the faulty tube. Such tubes can usually be used after longer conditioning periods with lower voltage applied to the plate.

u. Press the stop buttons of switches S12 and S11.

v. Open the high-speed circuit breaker RL8.

w. Replace the surge resistor R81 in the surge resistor bank.

111. Unsatisfactory Equipment Report

a. When trouble in equipment used by Army Ground Forces or Army Service Forces occurs more often than repair personnel feel is normal, War Department Unsatisfactory Equipment Report, WD AGO Form 468 should be filled out and forwarded through channels to the Office of the Chief Signal Officer, Washington 25, D. C.

b. When trouble in equipment used by Army Air Forces occurs more often than repair personnel feel is normal, Army Air Forces Form 54 should be filled out and forwarded through channels.

c. If either form is not available, prepare the data according to the sample form reproduced in figure 70.

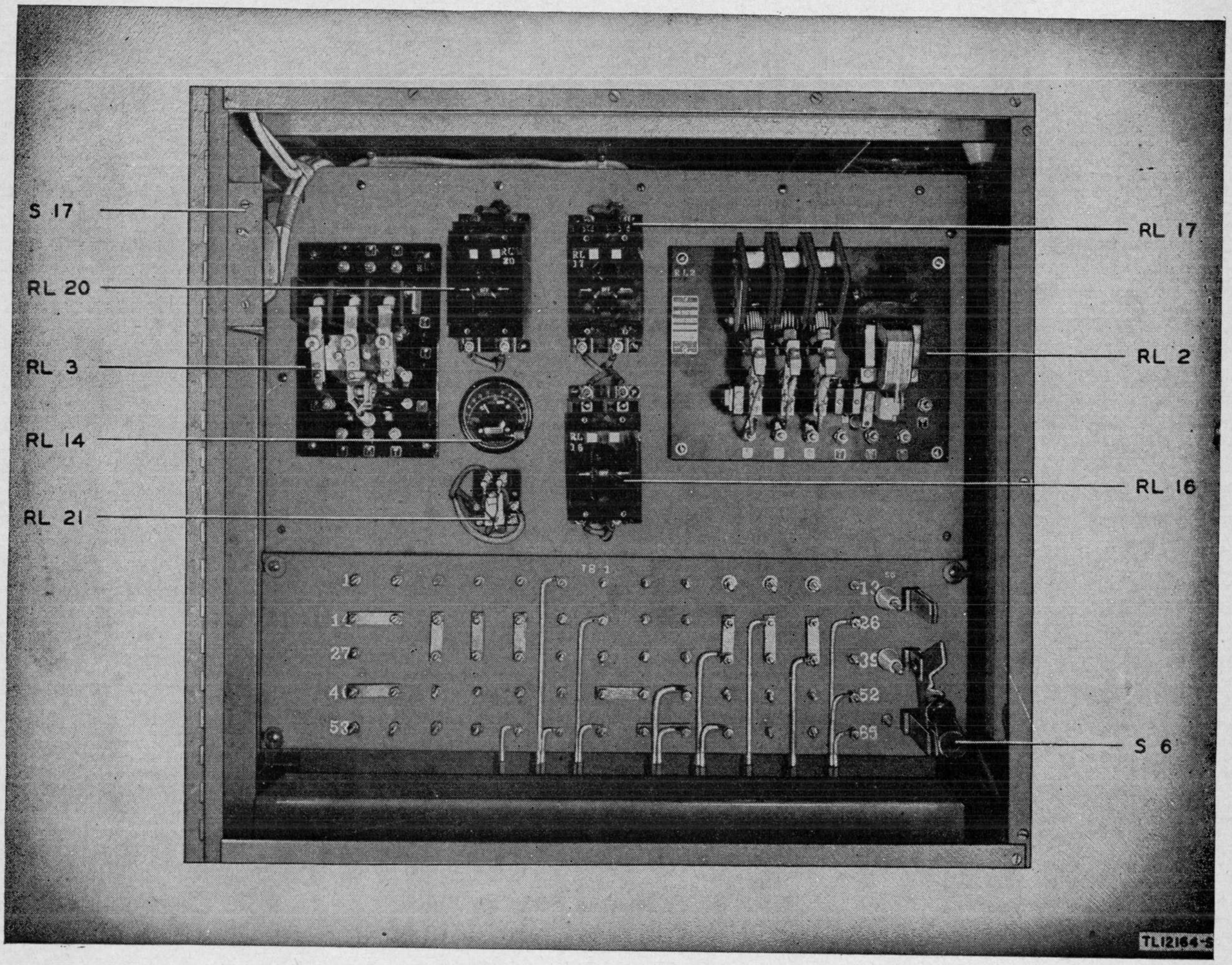


Figure 61. Terminal board No. 1.

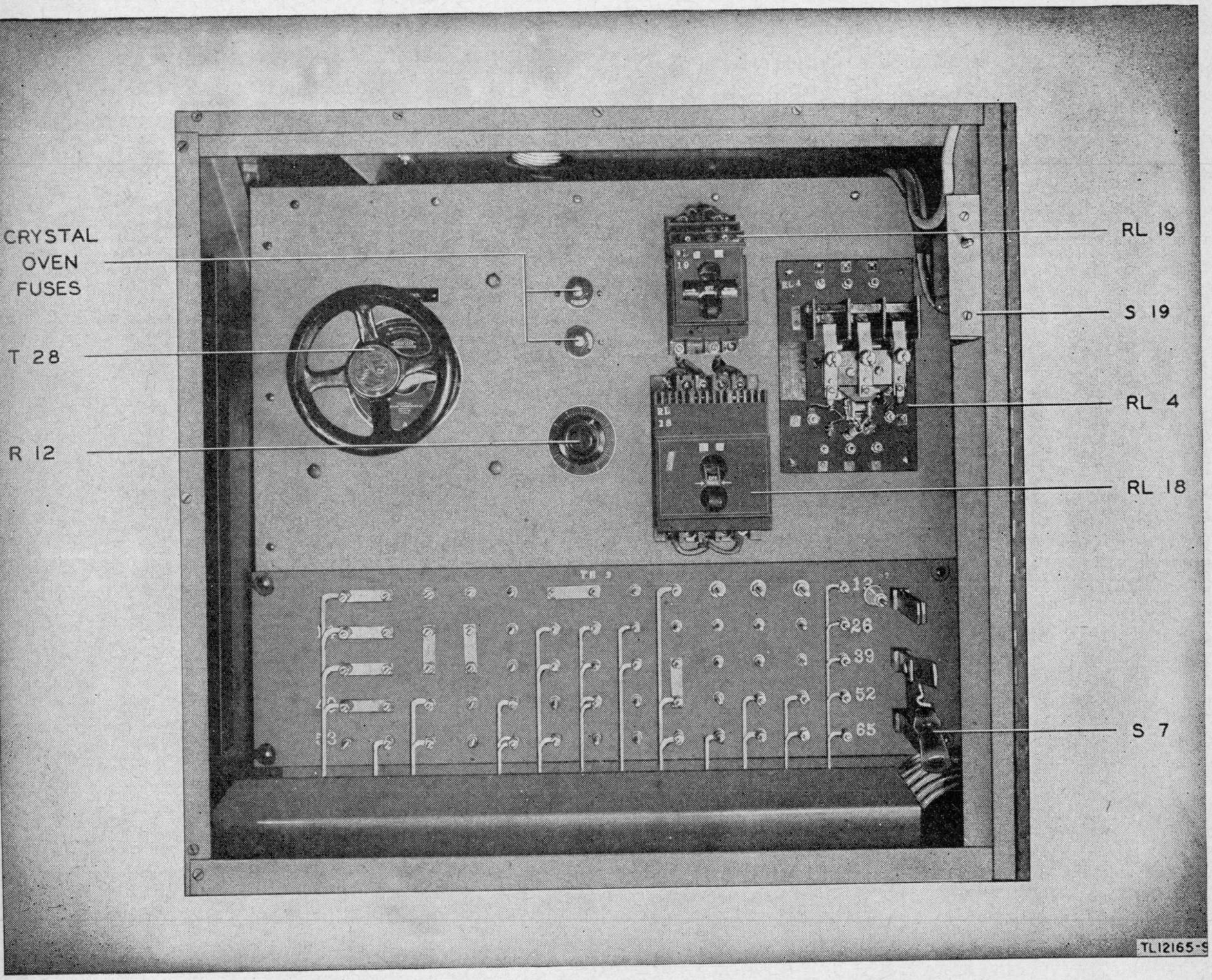


Figure 62. Terminal board No. 2.

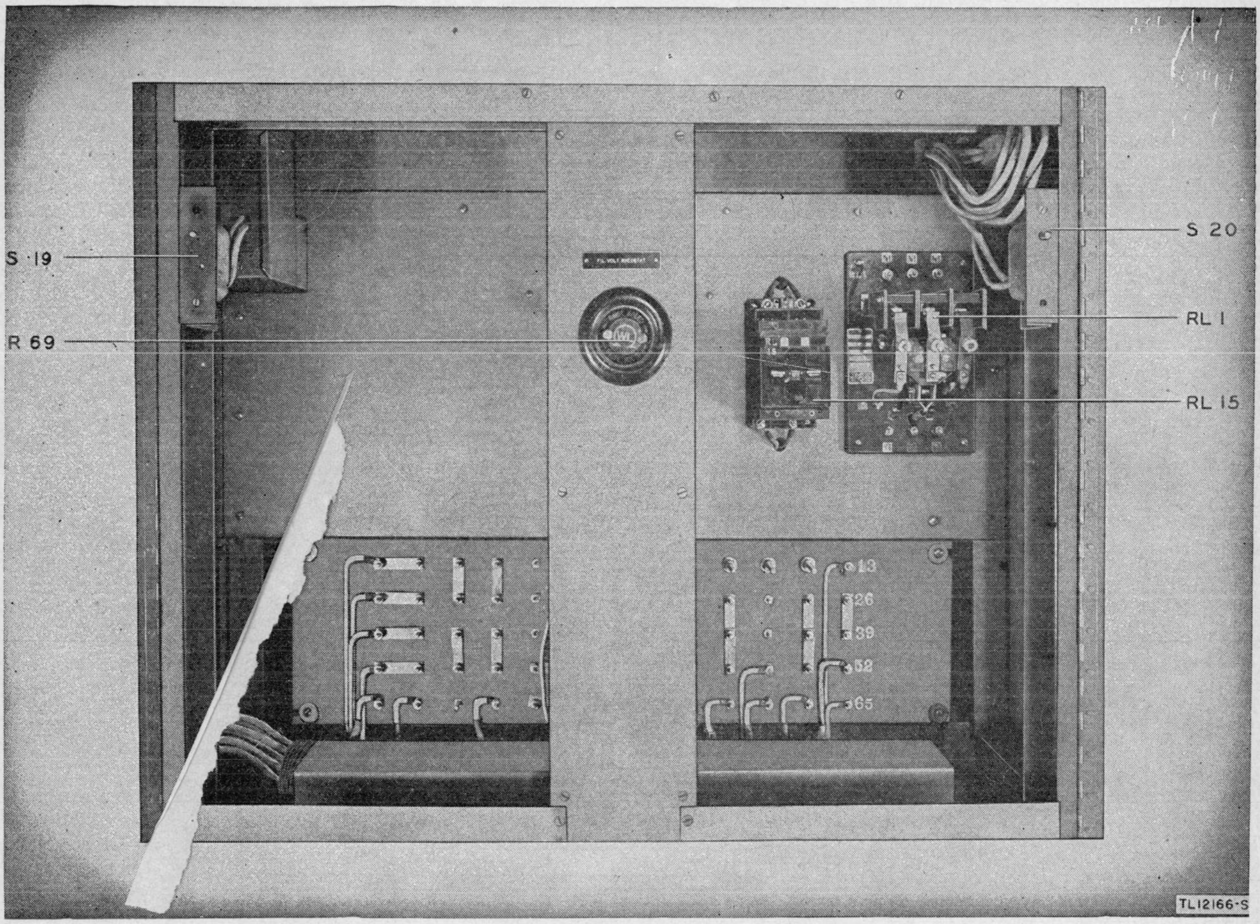


Figure 63. Terminal board No. 3.

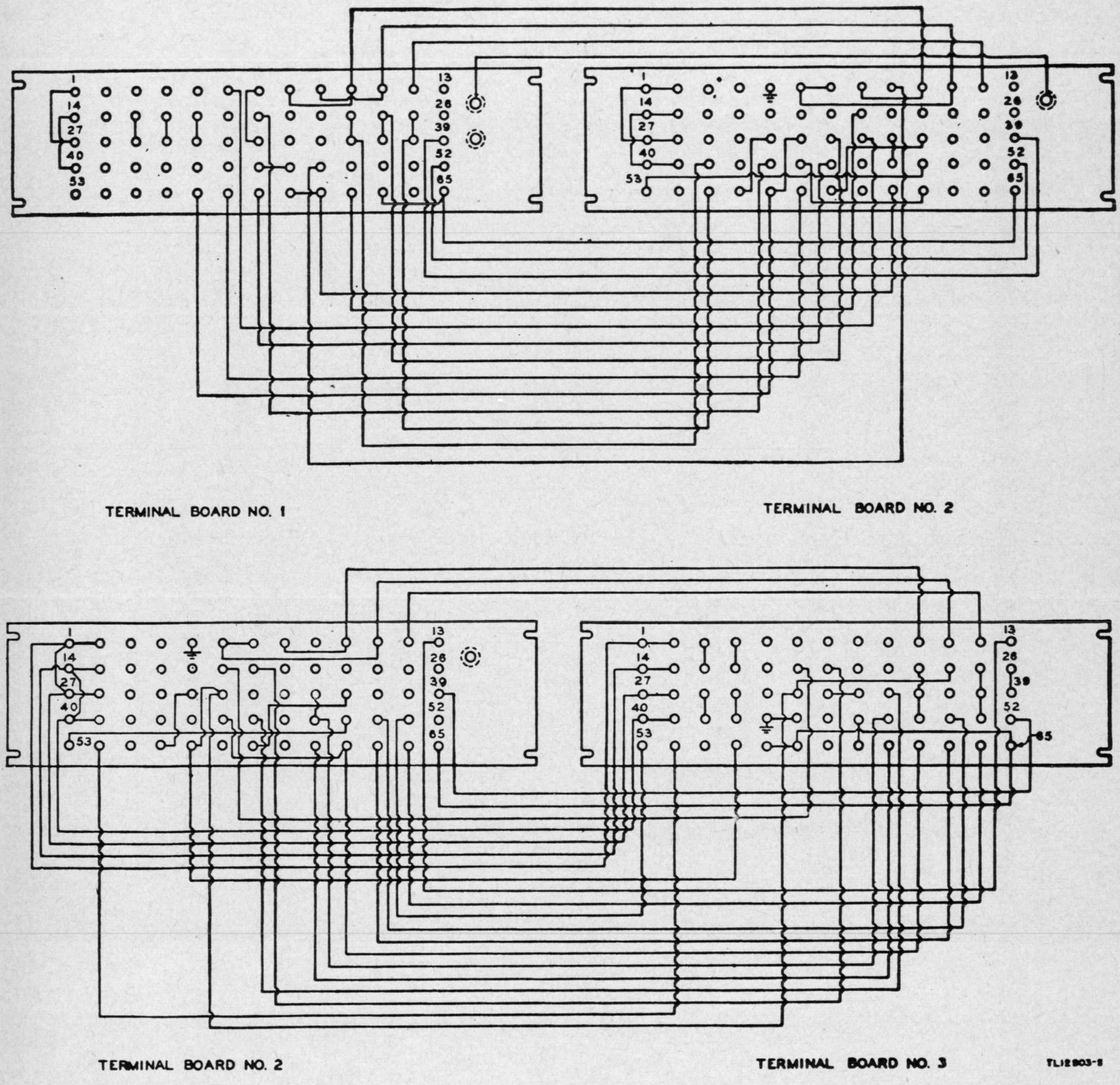
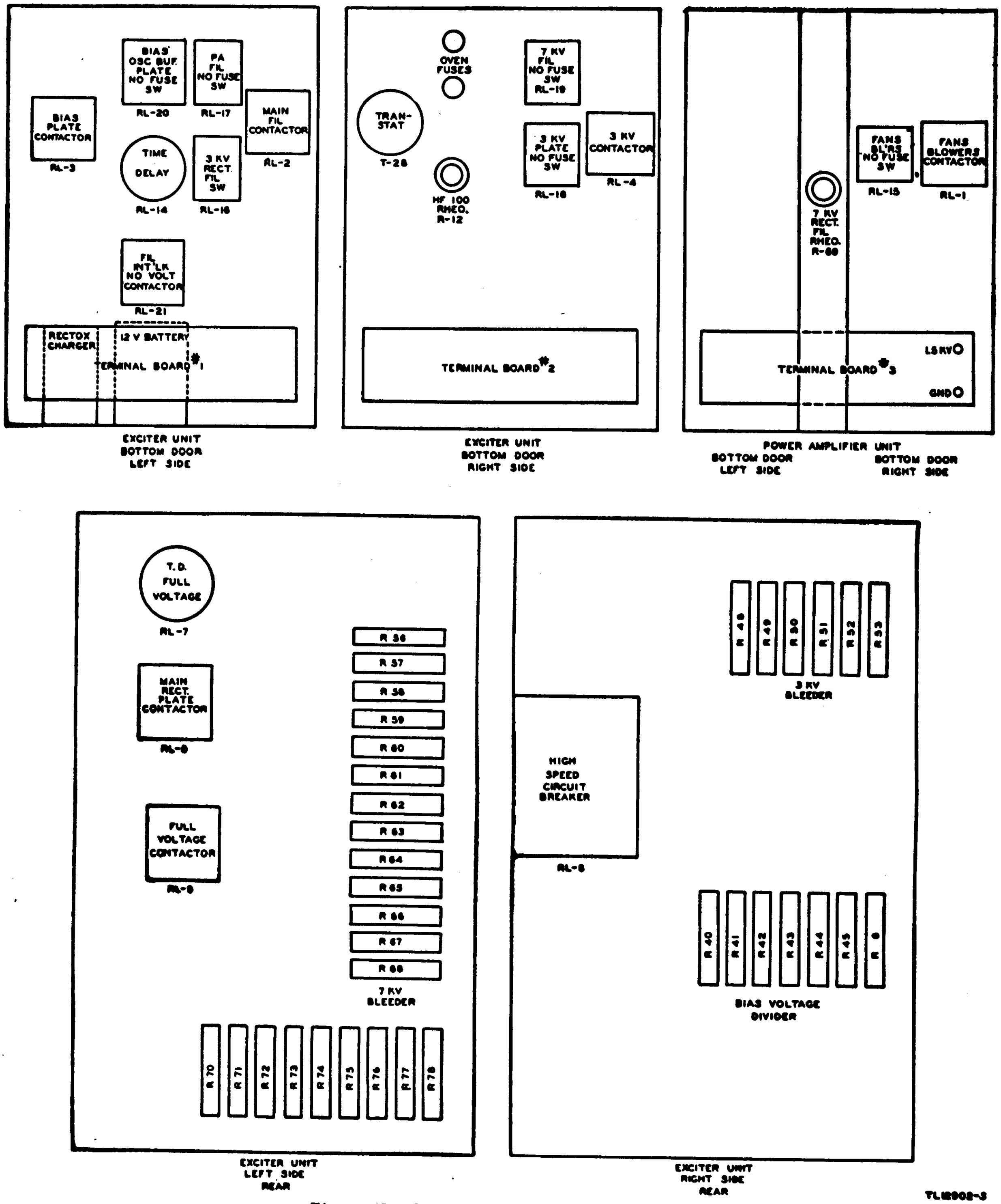


Figure 64. Terminal board interconnections.



TL12902-3

Figure 65. Cabinets layout, block diagram.

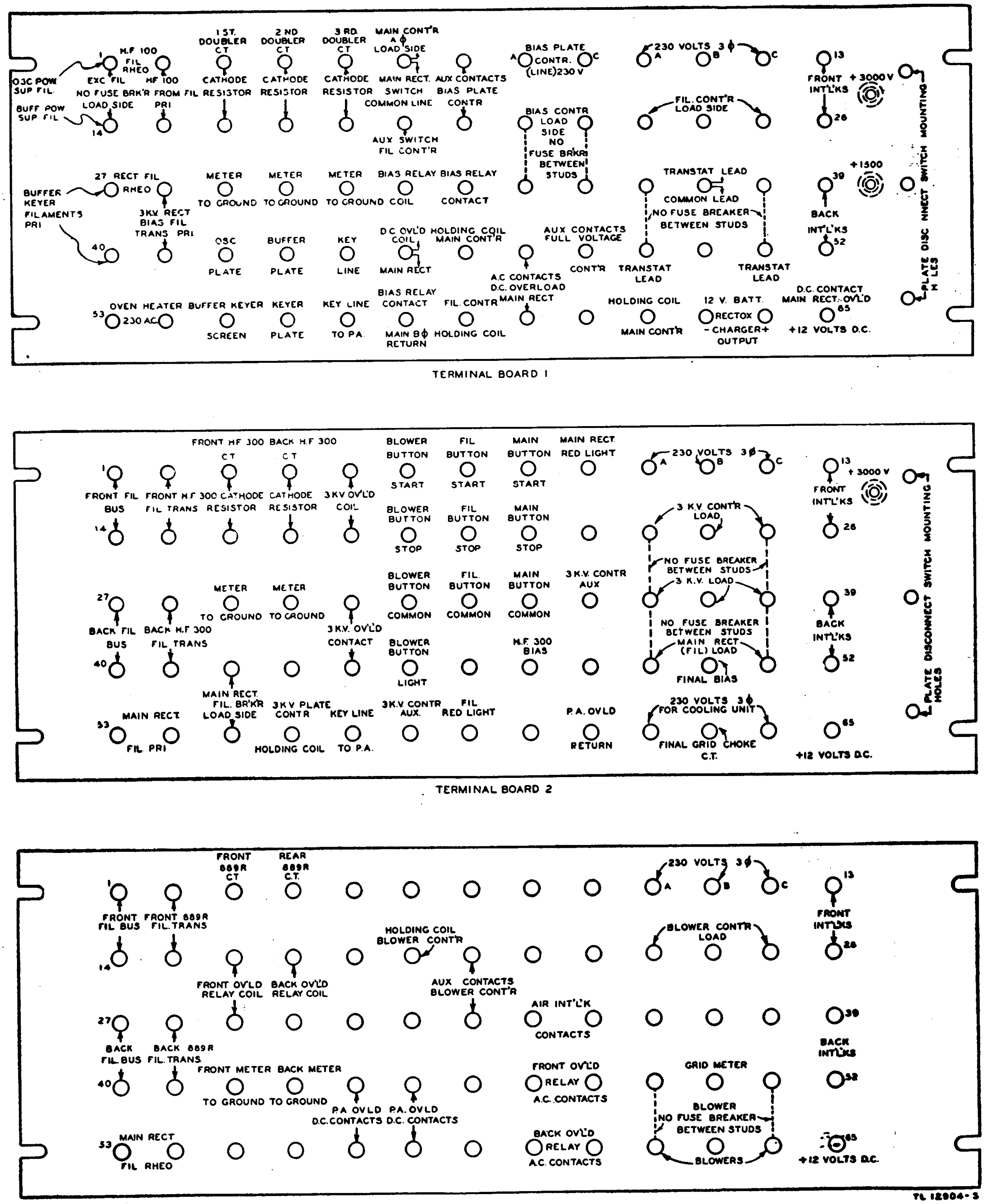


Figure 66. Terminal board connections.

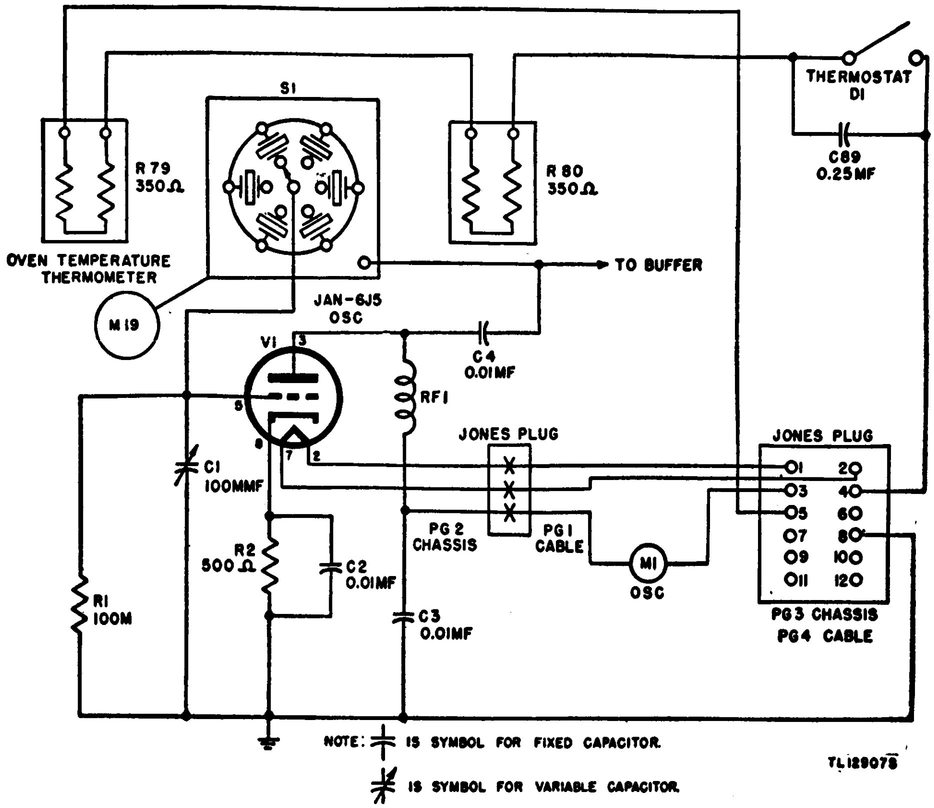


Figure 67. Crystal oscillator wiring diagram.

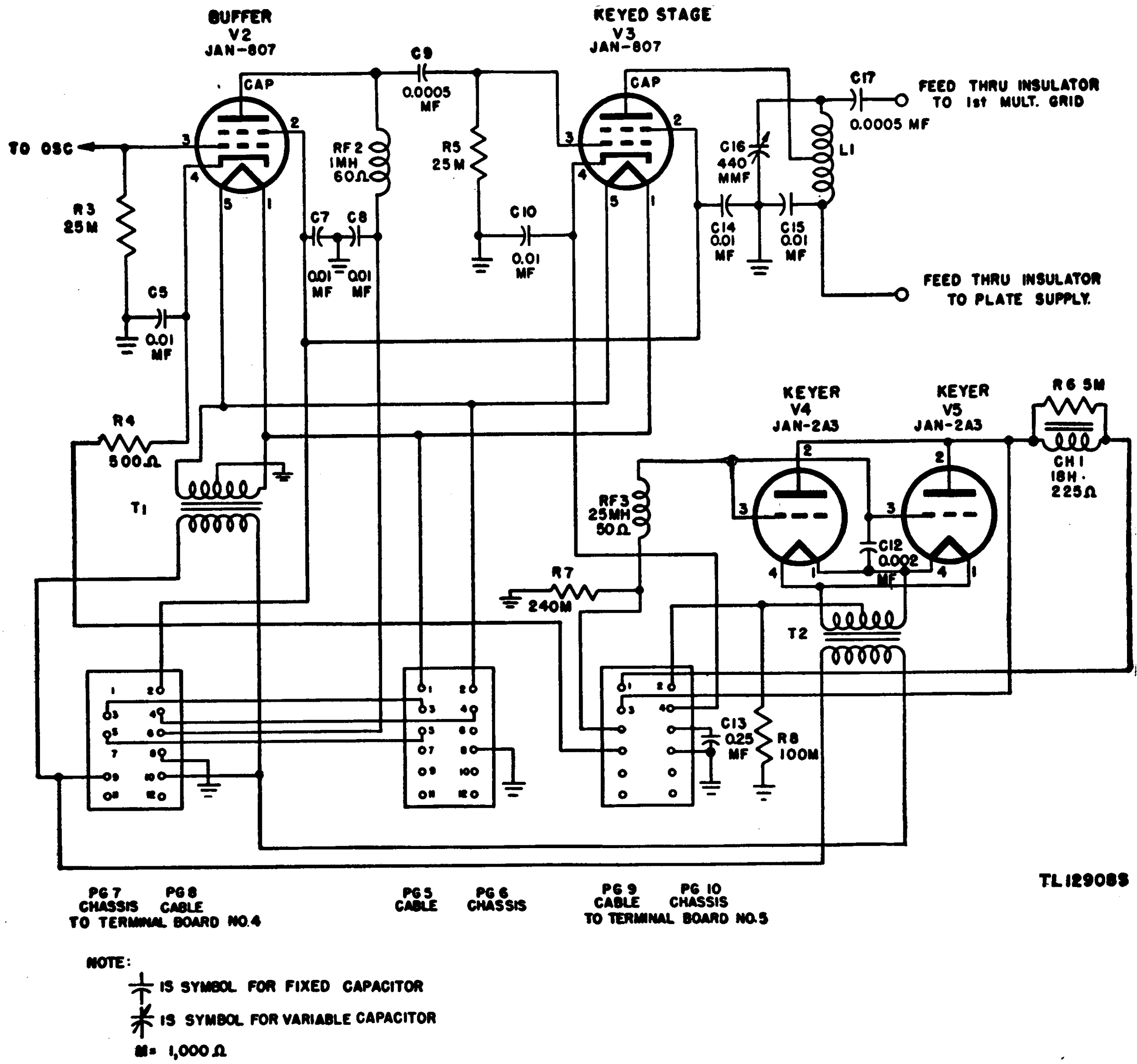
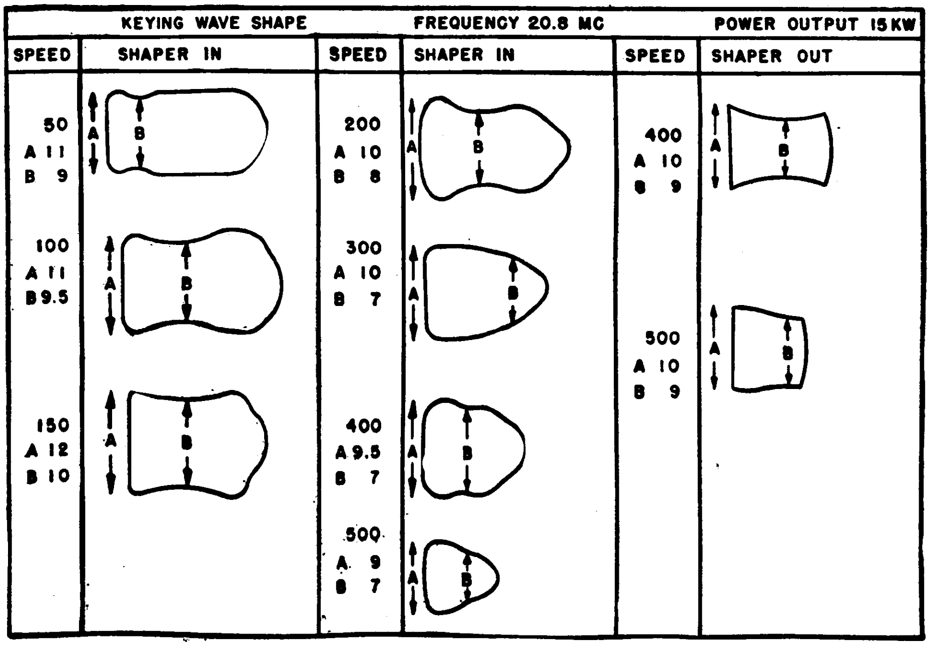


Figure 68. Buffer amplifier and keyer wiring diagram.



TL 129058.

Figure 69. Keying wave shape chart.

WAR DEPARTMENT

UNSATISFACTORY EQUIPMENT REPORT

MATÉRIEL

FOR	TECHNICAL SERVICE: Signal Corps		DATE: 1 Feb 45
FROM	ORGANIZATION: 175 Signal Repair Co		STATION: APO 102
TO	NEXT SUPERIOR HEADQUARTERS: Supply Sec, Hq Fourth Army Sig Sv	STATION: APO 110	TECHNICAL SERVICE: Signal Corps

COMPLETE MAJOR ITEM

NOMENCLATURE: Radio Transmitter BC-123-A	TYPE: Ground, vehicular	MODEL: A	
MANUFACTURER: American Radio Corp	U. S. A. REG. NO.: Order No. 1234-Phila-45	SERIAL NO.: 12345	DATE RECEIVED: 5 Jan 45

EQUIPMENT WITH WHICH USED (*If applicable*): Radio Set SCR-456-A in Tank, Medium, M4

DEFECTIVE COMPONENT—DESCRIPTION AND CAUSE OF TROUBLE

PART NO.: Sig C Stk No. 3E47-2	TYPE: Capacitor C20; fixed; 1-mf; 500 vdcw	MANUFACTURER: American Radio Corp	DATE INSTALLED: When manufactured

DESCRIPTION OF FAILURE AND PROBABLE CAUSE (*If additional space is required, use back of form*): Capacitor C20 shorts out due to humid operating conditions

DATE OF INITIAL TROUBLE	TOTAL TIME INSTALLED: YEARS	MONTHS	DAYS	TOTAL PERIOD OF OPERATION BEFORE FAILURE: YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
15 Jan 45	-	-	-	0	0	5		-	-

BRIEF DESCRIPTION OF UNUSUAL SERVICE CONDITIONS AND ANY REMEDIAL ACTION TAKEN: Op ration in tropics; heavy rainfall. Was replaced and set given moistureproofing and fungiproofing treatment, 20 Jan 45.

TRAINING OR SKILL OF USING PERSONNEL: POOR	FAIR	GOOD	RECOMMENDATIONS (*If additional space is required, use back of form*)
		X	Substitute capacitor designed for tropical operation

ORIGINATING OFFICER

TYPED NAME, GRADE, AND ORGANIZATION: E.A. Wilson, 1st Lt, Sig C, 175 Signal Repair Co	SIGNATURE: E. A. Wilson

FIRST ENDORSEMENT

TO CHIEF	TECHNICAL SERVICE	OFFICE	
NAME, GRADE, AND STATION		STATION	DATE

Instructions

1. It is imperative that the chief of technical service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
2. This form will be used for reporting manufacturing, design, or operational defects in matériel, petroleum fuels, lubricants, and preserving materials with a view to improving and correcting such defects, and for use in recommending modifications of matériel.
3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (change No. 3).
5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches, or other illustrative material are highly desirable.
6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
7. This form will be made out in triplicate by using or service organization. Two copies will be forwarded direct to the technical service; one copy will be forwarded through command channels.
8. Necessity for using this form will be determined by the using or service troops.

This form supersedes W. D., A. G. O. Form No. 468, 1 December 1943, which may be used until existing stocks are exhausted.

W. D., A. G. O. Form No. 468
30 August 1944

U. S. GOVERNMENT PRINTING OFFICE 10—41560-1

TL19589C

Figure 70. Unsatisfactory equipment report, sample form.

Section XIII. ADJUSTMENT

Warning: BEFORE MAKING ANY CONNECTIONS INSIDE THE TRANSMITTER USE THE SHORTING STICK (FIG. 26) TO DISCHARGE CAPACITORS.

112. Preliminary Tuning Adjustments

Before attempting to tune the PW-15A, the operator should be thoroughly familiar with sections III and IV of this manual.

a. Attach the proper shorting bars to the first amplifier and p-a tank coils as determined by the operating frequency and figures 76 and 77. When shorting bars are properly attached to the tank coils, an equal number of turns will be shorted on each side of the coil center tap. Be sure the bars are attached wrench tight. It is sometimes necessary, depending upon the frequency, to use two shorting bars simultaneously on the p-a tank coil.

b. Connect the p-a tank capacitors for either parallel or series operation as indicated on the p-a tuning chart figure 77.

c. When shorting bars are used on the p-a tank coil, bars of equal size must be placed on each of the antenna-coupling coils. The number of turns to be shorted will depend upon the r-f transmission line which will vary with each installation. (See par. 117*e*.) On the highest operating frequencies, it is necessary to place additional flexible strap connections between the antenna-coupling coils.

d. Turn the ANTENNA COUPLING dial to its extreme counterclockwise position, and set the ANTENNA TUNING dials to zero setting.

e. Set tuning controls according to the tuning charts shown in figures 71 through 77.

f. Place the proper crystal in the oven. The crystal frequency will be an even fraction of the carrier frequency, calculated so as to be within the range of 2 or 4 mc.

g. Throw the MAIN SWITCH to on. Set thermal switches RL15, RL16, RL17, RL18, RL19, RL20, and RL8 to ON (fig. 20).

h. Push up the reset buttons on the DC OVERLOAD relay, EXCITER OVERLOAD relay, and P. A. OVERLOAD relays (fig. 20).

i. Throw switches S6 and S7 to the *down* position (fig. 20).

Warning: SWITCHES S6 AND S7, CARRY VOLTAGES RANGING FROM 1,500 to 3,000 VOLTS. DO NOT TOUCH THE SWITCH BLADES.

j. Now perform the steps 6 through 16 in paragraph 27.

113. Tuning Exciter Stages

a. Oscillator and Buffer. The oscillator and buffer stages should now be in operation, and their circuit meters should be checked. The OSC. PLATE current meter M1 should indicate approximately 6 milliamperes (ma). The BUFFER PLATE current meter will read between 25 and 40 ma depending upon the position of the KEYING SHAPER control and the physical characteristics of the particular crystal being used.

Note. For radioteletype operation a separate external exciter unit is required. The PW-15A includes a jack for connecting the exciter to the transmitter. Detailed description of Exciter Unit 0-5/FR is contained in TM 11-2205. This frequency shifter for teletype operation utilizes crystals in Signal Corps Type FT-249 holders. The assigned frequency is the mean between the mark and space signals which are 425 cycles respectively, above and below the assigned carrier frequency. The crystal frequency is based on the mark frequency and is 200 kc lower than the output frequency of Exciter Unit 0-5/FR. The crystal frequency also depends on the number of multiplier stages used in the transmitter, factors 2, 4, or 8 being applied to bring the crystal within the range of 2 to 4 mc.

b. Keyed Stage. Turn the KEY SWITCH to clockwise position (test) and tune the keyed stage to resonance by adjusting the KEYER STAGE tuning dial. The best indication of resonance will be a maximum reading on the 1ST FREQ. MULTIPLIER METER. This meter will be indicating the grid current of the first multiplier stage. Only a slight dip will be noted on the KEYER PLATE meter as resonance is approached. The KEYER PLATE meter will read 30 to 60 ma at resonance. For tuning the KEYING SHAPER control should be set at maximum clockwise position. Set the KEY SWITCH at neutral position.

c. Frequency-multiplier Stages. Open the lower left-hand door of rectifier-exciter unit, throw switch S6 up, close the door, and turn the KEY SWITCH to the clockwise position. Tune the first frequency multiplier to resonance by adjusting the 1ST FREQ. MULTIPLIER tuning dial to the point of maximum dip indicated on the 1ST FREQ. MULTIPLIER meter. If additional multipliers are being used, they are tuned to resonance in a similar manner by using their respective tuning dials and meters.

Note. The frequency-multiplier and keyer stage dials will indicate approximately the same dial setting when these stages are at resonance. The final setting of these dials should all be approximately the same and should be near that setting indicated by the tuning charts. Any great difference of the dial settings may result in frequency tripling.

The normal cathode current for a multiplier stage is between 50 and 160 ma, depending on whether it is driving a succeeding multiplier stage or the first amplifier.

d. First Amplifier. With the KEY SWITCH still in clockwise position, adjust the 1ST AMPLIFIER dial for minimum current as indicated by a dip on the 1ST AMP. PLATE meters. After noting the extent of the dip, open the upper right-hand door on the rectifier-exciter unit and turn the neutralizing dial (capacitors C47 and C48) to a slightly different position. Close the door, and again rock the 1ST AMPLIFIER dial through resonance noting whether the minimum current value on the 1ST AMP. PLATE meters has increased or decreased. If the minimum current value has increased (the dip is less pronounced) continue to adjust the neutralizing capacitors in the same direction as before until little or no dip occurs as the 1ST AMPLIFIER dial is rotated through resonance point. However, if the minimum current value has decreased (the dip is greater) after the initial adjustment of the neutralizing capacitors, turn the neutralizing dial in the opposite direction and neutralize as above. An alternate method of neutralization is given in paragraph 116. After neutralization is completed, set the 1ST AMPLIFIER dial near the resonance setting and put the KEY SWITCH in neutral position. Open the lower right-hand door of the rectifier-exciter unit and throw switch S7 to the up position. Close the door, and turn the KEY SWITCH to clockwise position. Tune the first amplifier to resonance by adjusting the 1ST AMPLIFIER dial for a minimum current on the 1ST AMP. PLATE meters which should also correspond to the maximum grid current of the power amplifier as indicated on the P.A. GRID meter. Place the KEY SWITCH to neutral position and check to see if the 1ST AMP. PLATE meter drops to zero. If current flow is still indicated by the meters, the stage is not properly neutralized. The neutralizing capacitors will be at approximate half meshed and will require slightly increased capacitance as the frequency increases.

Note. If it is found difficult to tune the first amplifier or power amplifier because of the rapidity with which the overload relays kick out before resonance is reached, the excitation should be reduced. This may be done by detuning the keyed stage or by turning the KEYING SHAPER control until the drive is sufficiently reduced. This will produce amplifier plate currents which, even off resonance, will not trip overload relays. When proper tuning has been completed, the drive may be raised to normal.

e. Checking Tuning. Go over all tuning thus far performed and touch up the adjustment of the controls as required. Operate the KEY SWITCH several times to see if all plate current meters follow the keying. The frequency-multiplier tubes may draw a slight amount of plate current with no excitation, but his should never exceed 15 ma per tube with the bias adjustments as set in the transmitter at the factory. All amplifier stages are operated with just sufficient bias to keep the no signal plate current at or near zero. The additional bias required for class C operation is obtained from cathode resistors and grid resistors. This is done to get the best possible keying wave form.

114. Tuning Power Amplifier

Warning: BEFORE ENTERING THE POWER AMPLIFIER, MAKE CERTAIN THAT THE HIGH-SPEED CIRCUIT BREAKER IS IN THE OFF POSITION BY PRESSING THE RED RELEASE BUTTON LOCATED JUST BELOW THE RESET HANDLE ON THE CIRCUIT BREAKER HOUSING.

a. Apply excitation and neutralize the p-a stage using the method described in paragraph 113*d* or by the method discussed in paragraph 116. During neutralization the p-a grid current should be limited to a maximum of 0.2 amperes either by decreasing the coupling with the grid coupling dial or by reducing the drive as described in paragraph 113*d*. The p-a neutralizing capacitors are adjusted by using the P.A. NEUTRALIZING dial, and the p-a grid current is indicated on the P.A. GRID meter.

b. After neutralization is complete, adjust the grid coupling control until a current flow of approximately 0.6 amperes is indicated on the P.A. GRID meter. Retune the first amplifier stage to resonance each time the grid coupling is adjusted. Throw the KEY SWITCH to neutral position. Close the circuit breaker, and press the START button of the MAIN RECTIFIER switch.

Note. After the high voltage comes on, it is possible that the circuit breaker will immediately release indicating a flash-over in the p-a tubes and a resulting flash-over of the filament spark gaps. This condition is normal in tubes that are being used for the first time. Reclosing the circuit breaker following each flash-over should remedy this trouble after a few such operations. Throw the KEY SWITCH to the up position. *Quickly* tune the P.A. TUNING dial for maximum grid current as indicated on the P.A. GRID meter. *This tuning must be done before the full-voltage contactor closes.* After the full voltage comes on, one of the overload relays will release if the circuit is not tuned to resonance. However, by repeating this operation, the operator will be able to tune the circuit to resonance, after which the overload relays will hold.

c. Adjust the ANTENNA COUPLING and ANTENNA TUNING in order to give the optimum loading. The grid coupling should be set to a point that will give recommended grid current to the p-a tubes when full voltage is applied and the antenna has been coupled for optimum loading. Antenna loading will produce a rise in plate current and a drop in grid current. The grid coupling adjustment provides a means of compensating this effect. Always retune the first amplifier plate circuit to resonance after a change in the grid coupling adjustments. For actual values of antenna current the antenna meter readings should be corrected using the curves given in figure 78.

d. After the transmitter has been tuned to a given frequency all control settings and meter readings should be logged for future reference.

115. Correction for Unbalanced Grid Current

a. First Amplifier. Unbalanced grid current to the first amplifier tubes, as indicated by the 1ST AMP. PLATE meters when excitation but no plate voltage is applied to the stage, may be compensated by capacitor C42. (See fig. 6.)

b. Power Amplifier. Unbalanced p-a grid current, due to differences in p-a tube characteristics or unbalanced circuits, can be compensated for by adjustment of the two first amplifier coupling capacitors C62 and C63. This is done by loosening the Allen setscrews on the coupling capacitor shafts and rotating one capacitor at a time in small increments until balance grid current on the p-a tubes is indicated on the P.A. PLATE meters. These adjustments are made with no plate voltage on the power amplifier but with excitation.

Warning: THE COUPLING CAPACITORS SHOULD BE TOUCHED ONLY AFTER ALL EXCITATION HAS BEEN REMOVED.

After the balance is obtained, tighten the Allen setscrews.

116. Alt rnat Method of Neutralization

Warning: THIS METHOD OF NEUTRALIZATION REQUIRES THE OPERATOR TO REACH INSIDE THE TRANSMITTER WHILE HIGH VOLTAGE IS APPLIED TO THE CIRCUITS. BE CAREFUL TO TOUCH ONLY THE NEUTRALIZING DIALS.

a. The indicating device used is a loop of wire with a flashlight bulb in series with it. This assembly is fastened to a stick as shown in figure 79. Also required is a door interlock clamp. Such a clamp is made of a block of wood U-shaped notch cut out of it. This notch should be made of such a size that when the clamp is slipped over the interlock switch it will hold the switch plunger in.

b. Two stages of the PW-15A require neutralization; the first amplifier and the power-amplifier. When neutralizing a stage the plate voltage should be removed by throwing its plate disconnect switch (S6 or S7) to the down position. Open the compartment door giving access to the stage and clamp the interlock down. For safety, while applying the clamp, open one of the other doors. With excitation applied to the stage, place the wire loop near the end of the plate-tank coil and adjust the plate-tank capacitor control for maximum brightness of the bulb. Then adjust the neutralizing capacitor control for minimum brightness of the bulb. Repeat this operation, moving the loop closer to the tank inductor. Alternately adjust the plate-tank capacitors and the neutralizing capacitors until a minimum glow or none at all is obtained from the bulb. The neutralizing capacitors should be set midway between the two points where the bulb stops glowing and where it starts again as rotation of the capacitors is continued. The stage will now be neutralized.

c. A good test for neutralization is obtained by running the transmitter on high-speed dots. It will be found that by moving the neutralizing capacitors to lower settings of the dial, there will result some point where the amplifier stage plate current will tend to hang up. Moving back through the neutralizing position and going to higher settings on the dial, a point will be found where the amplifier stage current again hangs up. By taking the mean position between the two hang-up positions, a correct neutralizing setting can be found.

117. Recommended Operating Conditions for P wer Amplifier

a. A good compromise between tube life and maximum power output may be obtained by operating the power amplifier under the following conditions:

Item	Condition
Plate current	1.5 amperes per tube
Filament voltage	10.5 volts
Grid current	0.35 amperes (two tubes)
Plate voltage	7.200 volts
Total input	21.6 kilowatts
Approximate power delivered transmission line	15.0 kilowatts

b. The grid current should be approximately 0.6 amperes with no voltage applied to the plates. After the plate voltage is applied, the antenna should be loaded by means of the ANTENNA COUPLING and ANTENNA TUNING controls until the above conditions are reached. Under these conditions the p-a tubes should have a life of 5,000 hours or more.

c. When using the series connection of the p-a tank tuning capacitors, the connecting link should join to the center of the tank coil. For paralled connections of the capacitor sections wherein two long curved connections are used, no junction to the center of the tank coil should be employed.

d. Where there is a choice of inductance straps for any given frequency, the smallest strap should be used in order to give the highest possible inductance and the smallest possible capacity. This will result in somewhat improved over-all efficiency as compared with the high-capacity-low-inductance condition.

e. Antenna coil straps are not included in the tuning charts supplied by the manufacturer because they will vary somewhat with the particular type of antenna employed. In general, however, for the guidance of the operator, the following combinations may be tried:

Frequency	Strap
4-11 mc	Use whole coil.
11-14 mc	Use three-hole shorting bar.
14-17 mc	Use four-hole shorting bar.
17-20 mc	Use five-hole shorting bar plus shorting strap.

118. Unusual Antenna Operating Conditions

a. The antenna circuit of this transmitter is designed to work into an antenna, presenting a real impedance of from 400 to 800 ohms. Should the impedance fall below 400 ohms, it may be difficult to load the transmitter to its full power output of 15kw. Should the load impedance be higher than 800 ohms, there will be no difficulty in loading, but the antenna-tuning capacitors may arc over. An open wire transmission line which has no more than a two to one standing wave ratio should be satisfactory. Long wire periodic antennas such as the terminated V or Rhombic in general require no matching devices between the transmission line and antenna; however, antennas of Array type, in which a number of phased dipoles are coupled to one transmission line, generally require a matching section to keep the standing wave ratios down to a satisfactory figure. The physical dimensions of these matching sections are often critical and may change during severe icing conditions or in extremely heavy rainstorms. In such cases, the antenna transmission line may present some impedance to the antenna circuit which varies widely from its normal value. In such a case, it may be necessary to reduce transmitter power or reduce antenna coupling so that none of the antenna or tank circuits will arc over because of abnormally high voltages.

b. Under all conditions where fairly high standing waves occur on the transmission line, the antenna circuit should be tuned for maximum coupling to the transmitter. In other words, the antenna transmission line and antenna circuits are tuned to resonance. Loading to the transmitter is then adjusted to the desired value by moving the antenna-coupling coils in relation to the tank circuit. However, in cases where the standing wave ratio on the transmission line is low, the position of the coupling coils in reference to the tank circuit can remain fixed and coupling adjusted by means of the antenna capacitors. It is desirable to use reasonably large amounts of antenna-tuning capacity consistent with required loading for effecting a reduction in the harmonic output of the transmitter.

119. Operating with Emergency Oscillator

If it becomes necessary to use the emergency oscillator in cases where the crystal of the desired frequency is not available, use the following procedure for connecting this oscillator into the circuit.

a. Place the parallel tuned emergency oscillator tank assembly (fig. 43) in the No. 6 crystal position.

b. Turn the emergency oscillator tuning capacitor C90 to the proper setting according to the tuning chart. (See fig. 71.)

c. Set the FREQUENCY SELECTOR switch S1 to position No. 6.

d. After the transmitter is turned on, check the output frequency of the oscillator with an accurate frequency meter, such as FREQUENCY METER SET SCR-211*( ), since the emergency oscillator tuning curve is only approximate. Tune the remainder of the transmitter as previously described.

120. Em rgency Operation with ut Power Amplifier

a. In case it becomes necessary to operate without the p-a stage because of tube or cooling system trouble, disconnect one filament lead from each of the p-a tubes and start the transmitter in the usual manner with the exception of the main rectifier.

b. The plate current reading for the first amplifier tubes, as indicated on the 1ST. AMP. PLATE meters should be very low when the first amplifier tank circuit is tuned to resonance. Tune the p-a tank circuit for resonance and deneutralize by increasing the setting of the P.A. NEUTRALIZING dial. The deneutralization should be adjusted until the first amplifier tubes are loaded to 250 or 275 ma per tube; however, it will be necessary to retune the first amplifier and p-a tank circuit for each readjustment of the neutralizing capacitors.

c. Under these conditions it is possible to obtain an output of approximately 750 watts. If the blowers are not being used, it will be necessary to close the air interlock switches before the filament contactor will close. The air interlock switches may be closed by placing a small block of wood between the air vane arm and the switch roller, or a more permanent method is to short around each switch with a piece of wire connected between the terminals of the switch.

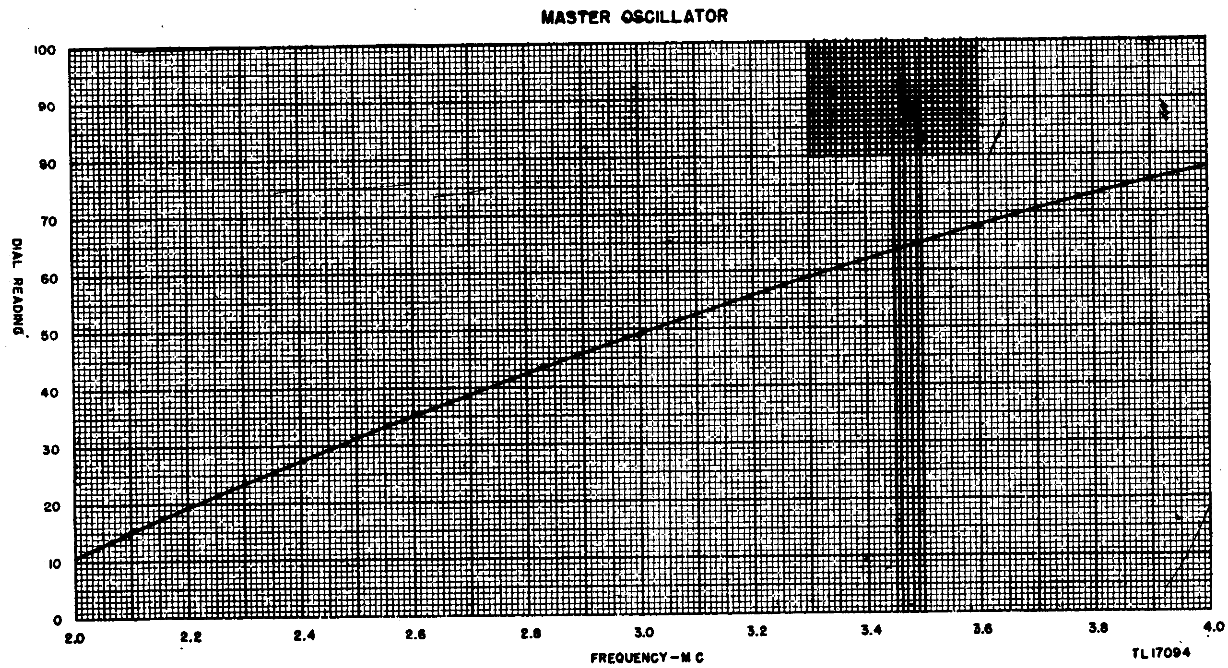


Figure 71. Master oscillator tuning curve.

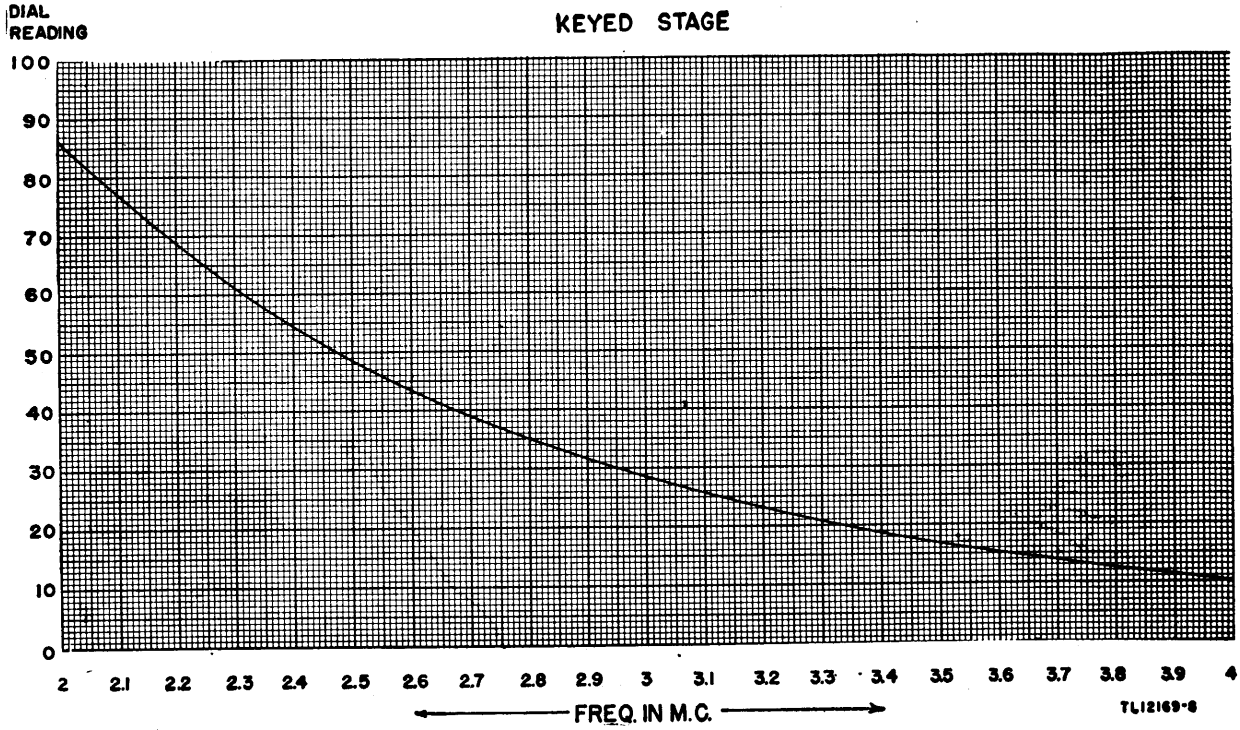


Figure 72. Keyed stage tuning curve.

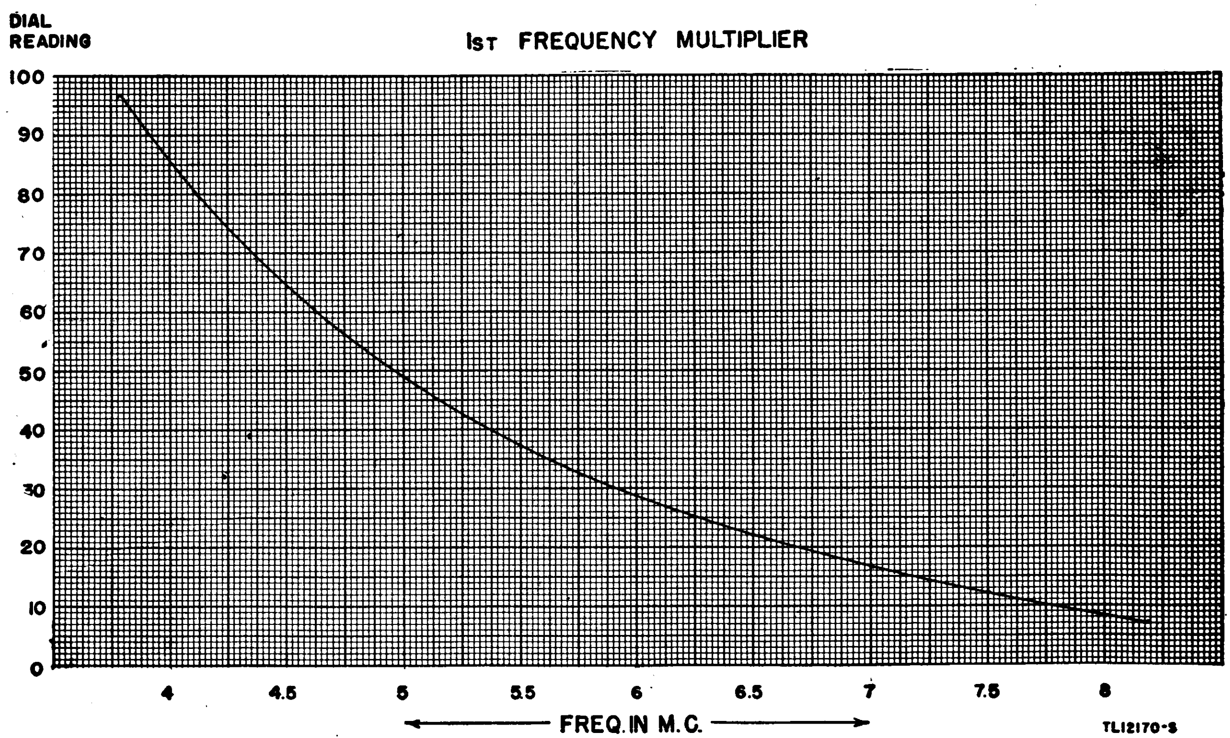


Figure 73. First frequency multiplier tuning curve.

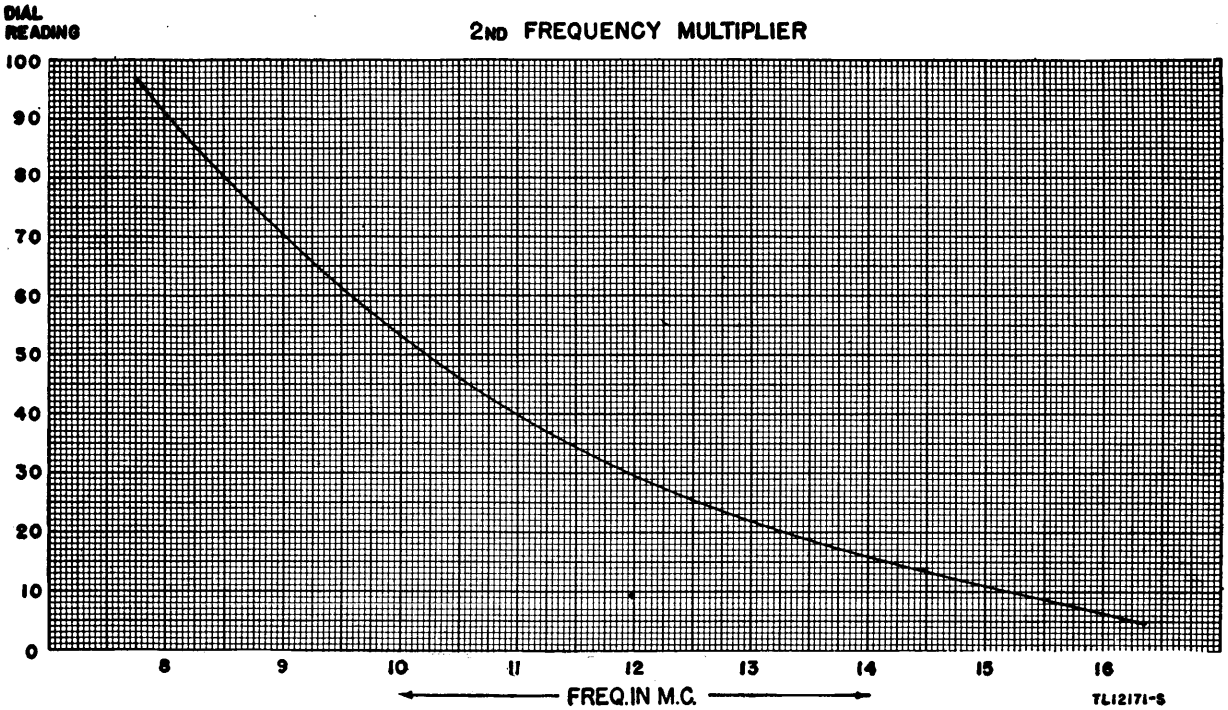


Figure 74. Second frequency multiplier tuning curve.

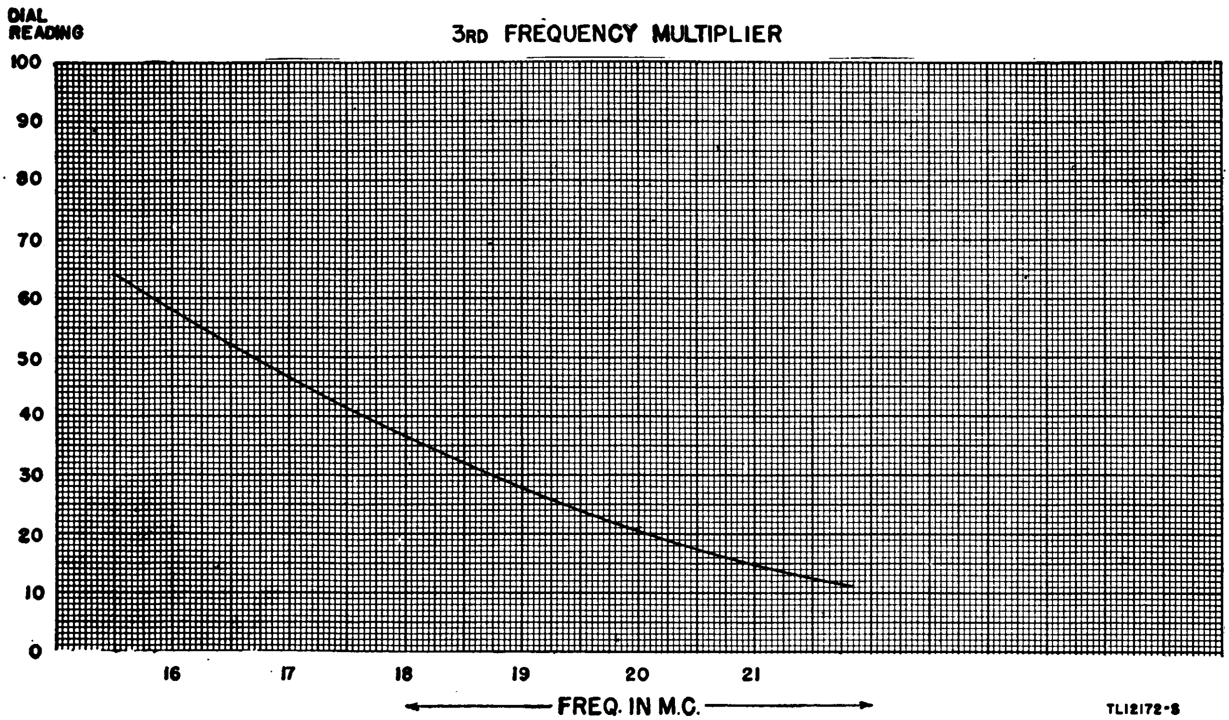


Figure 75. Third frequency multiplier tuning curve.

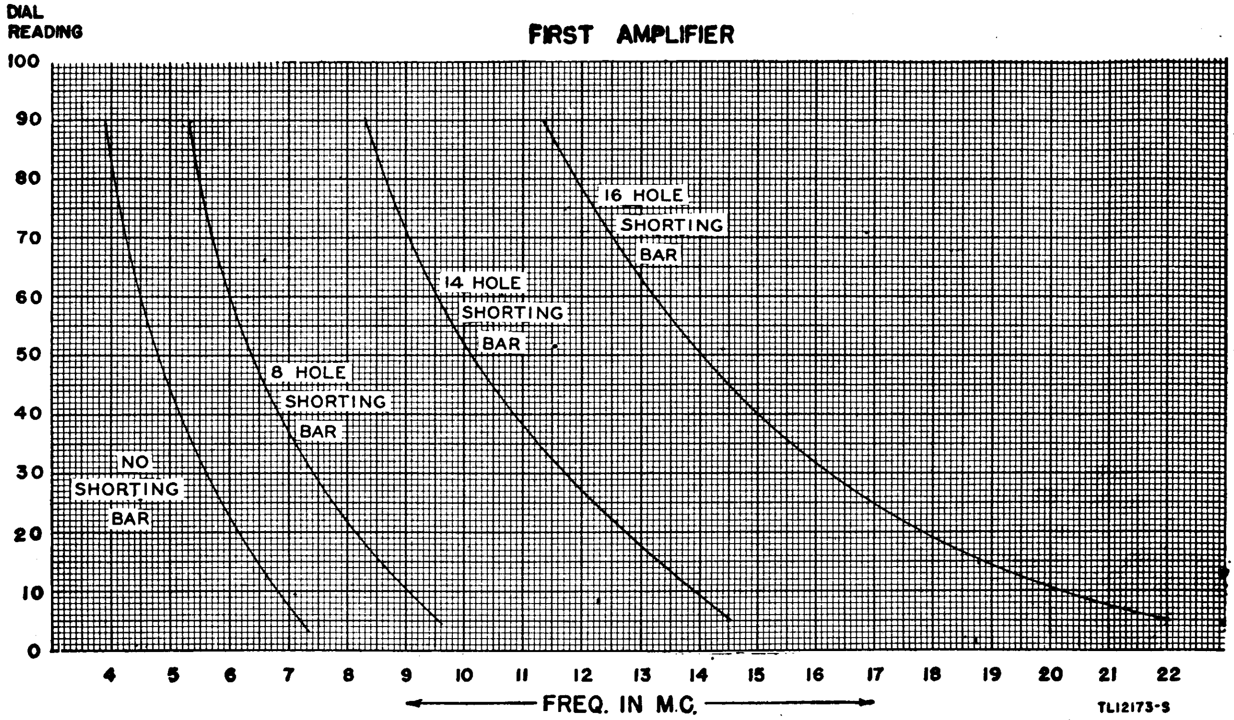


Figure 76. First amplifier tuning curve.

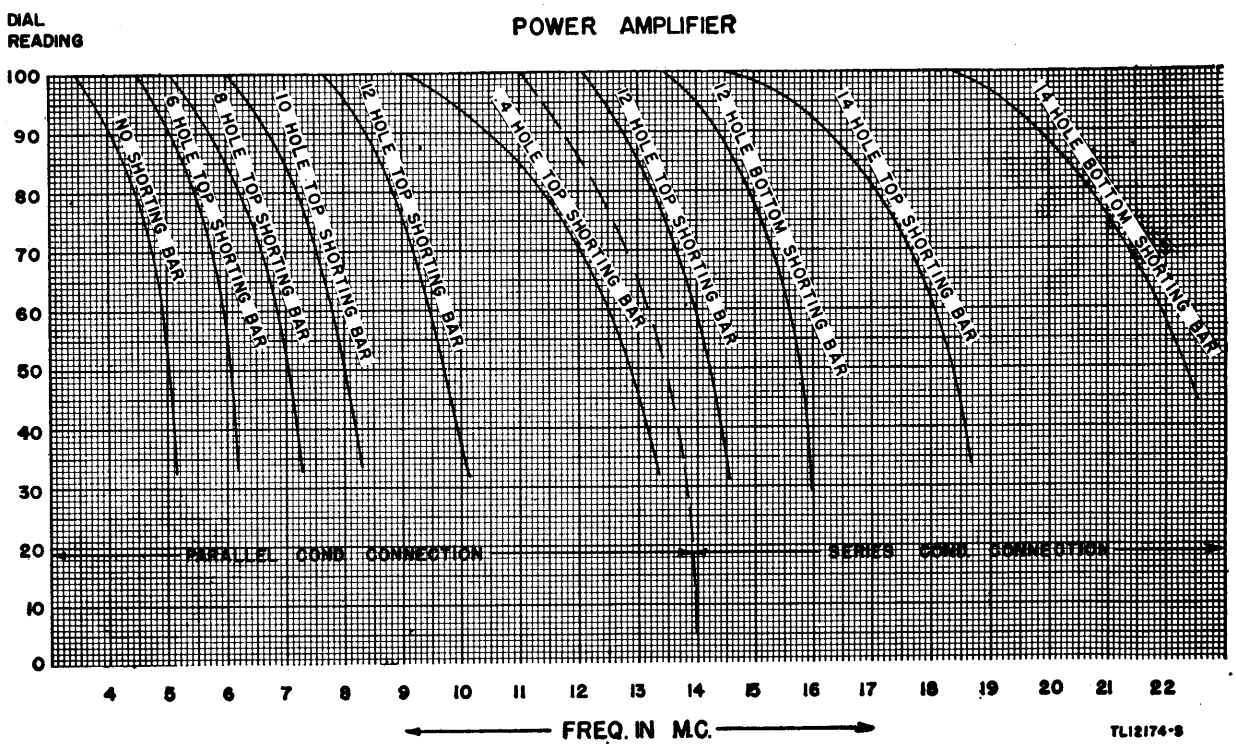


Figure 77. Power amplifier tuning curve.

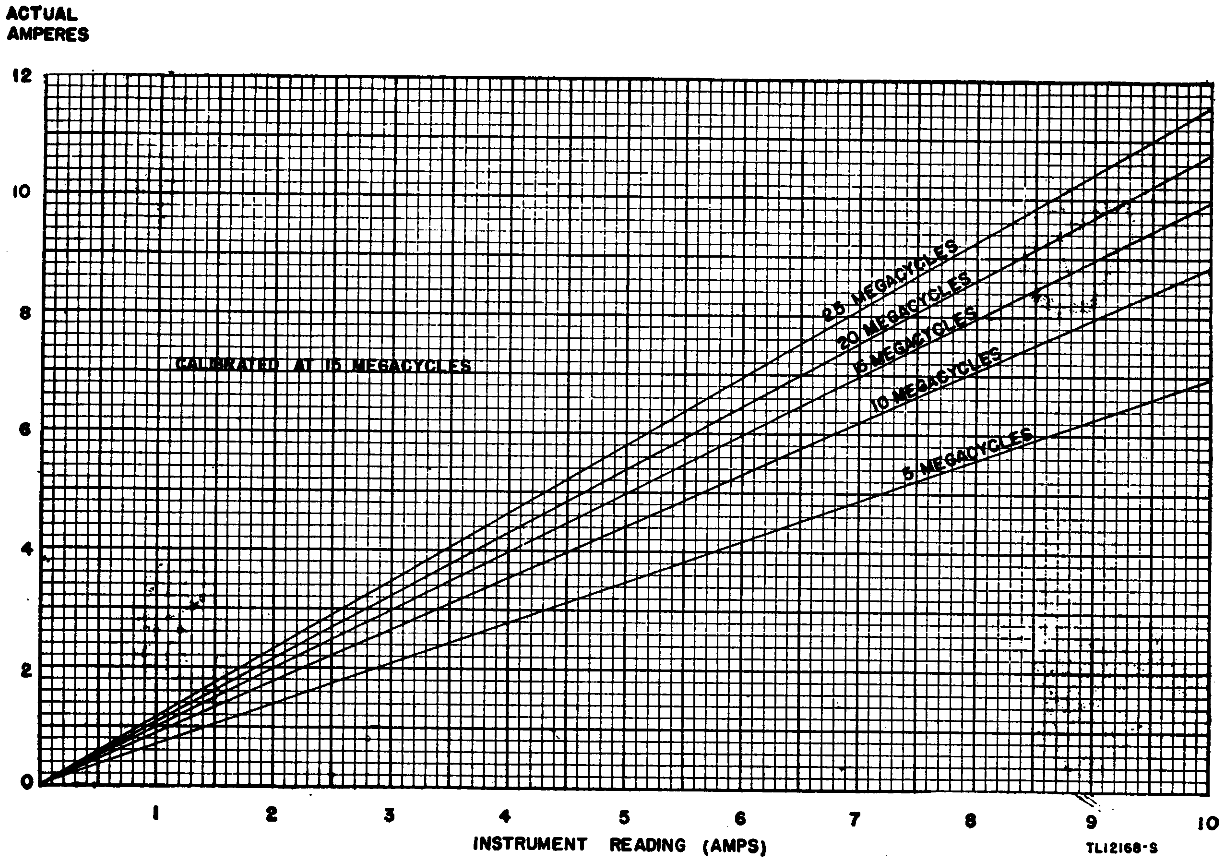


Figure 78. R-f ammeter correction curve.

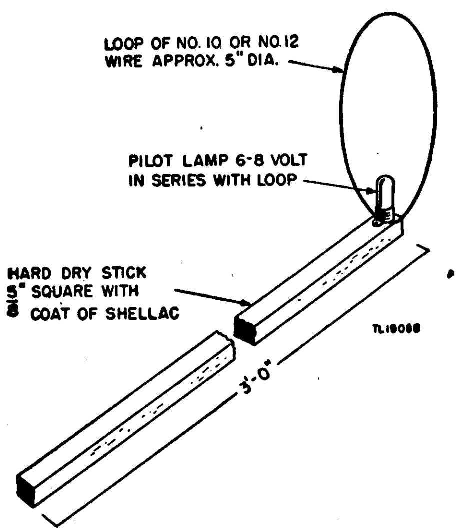


Figure 79. Neutralization indicator, method of construction.

REFERENCES

1. Army R gulations

AR 380-5, Safeguarding Military Information.

2. Supply Publications

SIG 1, Introduction to ASF Signal Supply Catalogue (when published).
SIG 2, Complete Index to ASF Signal Supply Catalogue (when published).
SIG 3, List of Items for Troop Issue.
SIG 4-1, Allowances of Expendable Supplies.
SIG 4-2, Allowances of Expendable Supplies for Schools, Training Centers, and Boards.
SIG 5, Stock List of All Items.
SIG 10, Fixed Plant Maintenance List.
SB 11-10, Signal Corps Kit and Materials for Moisture and Fungi-Resistant Treatment.
SB 11-17, Electron Tube Supply Data.

3. Technical Manuals on Auxiliary Equipment and Test Equipment

TM 11-300, Frequency Meter Sets SCR-211-A, B, C, D, E, F, J, K, L, M, N, O, P, Q, R, T, AA, AC, AE, AF, AG, AH, AJ, AK, AL.
TM 11-303, Test Sets I-56-C, I-56-D, I-56-H, and I-56-J.
TM 11-307, Signal Generators I-72-G and I-72-H and I-72-J.
TM 11-321, Test Set I-56-E.
TM 11-472, Repair and Calibration of Electrical Measuring Instruments.
TM 11-2613, Voltohmmeter I-166.
TM 11-2626, Test Unit I-176.
TM 11-2627, Tube Tester I-177.

4. Painting, Preserving, and Lubrication

TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69, Lubrication of Ground Signal Equipment.

5. Shipping Instructions

U. S. Army Spec No. 100-14A. Army-Navy General Specifications for Packaging and Packing for Overseas Shipment.

6. Decontamination

TM 3-220, Decontamination.

7. Demolition

FM 5-25, Explosives and Demolitions.

8. Camouflage

FM 5-20, Camouflage, Basic Principles.

9. Other Publications

FM 21-6, List and Index of War Department Publications.
FM 24-18, Radio Communication.
TB SIG 5, Defense Against Radio Jamming.
TB SIG 66, Winter Maintenance of Ground Signal Equipment.
TB SIG 72, Tropical Maintenance of Ground Signal Equipment.
TB SIG 75, Desert Maintenance of Ground Signal Equipment.
TB SIG 123, Preventive Maintenance Practices for Ground Signal Equipment.
TM 1-455, Electrical Fundamentals.
TM 11-227, Signal Communication Equipment Directory, Radio Communication Equipment.
TM 11-310, Schematic Diagrams for Maintenance of Ground Radio Communication Sets.
TM 11-314, Antennas and Antenna Systems.
TM 11-453, Shop Work.
TM 11-455, Radio Fundamentals.
TM 11-462, Signal Corps Reference Data.
TM 11-483, Suppression of Radio Noises.
TM 11-486, Electrical Communication Systems Engineering.
TM 11-487, Electrical Communications Systems Equipment.
TM 11-499, (Preliminary), Radio Propagation Handbook.
TM 11-2205, Exciter Unit O-5/FR.
TM 11-2617, Antenna Kit for Rhombic Transmitting Antenna (Drawing ES-E-368-D).
TM 37-250, Basic Maintenance Manual.
MWO SIG 41, Modification of Radio Transmitter

PW-10LF, PW-15A, and PW-40B To Provide a Cleanable Air Filter.

10. Forms

WD AGO Form 468 (Unsatisfactory Equipment Report.

11. Abbreviations

a-c .... alternating-current
cps .... cycles per second
c-w .... continuous-wave
db .... decibel
d-c .... direct-current
h-f .... high-frequency
JAN .... prefix designation for radio electron tubes procured under joint Army-Navy Specification JAN-1A.
kc .... kilocycle
kv .... kilovolt
kva .... kilovolt amperes
kw .... kilowatt
ma .... milliamperes
mc .... megacycle
mf .... microfarad
mmf .... micromicrofarad
m-o .... master-oscillator
p-a .... power-amplifier
pf .... power factor
r-f .... radio-frequency

Note. See appendix of TM 11-455 for additional abbreviations of radio terms.

12. Glossary

See the glossary in TM 11-455.

MAINTENANCE PARTS

The following information was compiled on 20 March 1945. The appropriate pamphlet of the ASF Signal Supply Catalog for radiotelegraph transmitter PW-15A is:

Fixed Plant Maintenance List
SIG 10-49, Radio Transmitter.

For the index of available catalog pamphlets, see the latest issue of ASF Signal Supply Catalog SIG 2.

Note. The following list covers station stock maintenance parts.

Ref symbol	Signal Corps stock No.	Name of part and description
C2, 3, 4, 5, 6, 7, 8, 10, 11, 14, 18, 19, 21, 26, 27, 29, 34, 35, 37, 50, 51, 64, 66, 69, 70, 85, 95, 96	3K5510321	CAPACITOR.
C9, 17	3K5551122	CAPACITOR.
C12	3K5520222	CAPACITOR.
C13, 89	3DA250-60	CAPACITOR.
C15, 87, 88	3K6010324	CAPACITOR.
C91	3K4551022	CAPACITOR.
Fig. 62	3Z2010-1	FUSE: 10-amp; 250-v.
	3Z3010.5	LINKS: for above fuse.
Fig. 13	3Z2800-2.1	FUSE: 200-amp; 250-v.
	3Z3200	LINKS: for above fuse.
Fig. 54	3Z2003	FUSE: 3-amp; 125-v.
Fig. 1	2Z5886	LAMP.
RL8	3H900-225-1/C10	CONTACTS: moveable.
RL8	3H900-225-1/C11	CONTACT: stationary.
RL9	2Z3189-15	CONTACTS: for relay interlock.
R1, 8	3Z6700-109	RESISTOR.
R2, 4	3Z6050-52	RESISTOR.
R3, 5	3Z6625-35	RESISTOR.
R6	3Z6500-104	RESISTOR.
R7	3RC41BE244J	RESISTOR.
R9, 15, 20, 26, 27	3Z6050-76	RESISTOR.
R10, 14, 16, 19, 21, 24, 25, 30	3Z6100-101	RESISTOR.
R11, 17, 22	3Z6630-32	RESISTOR.
R13, 18, 23	3Z6150-42	RESISTOR.
R28, 29	3Z6025-28	RESISTOR.
R31, 32, 34, 35, 36	3Z6050-75	RESISTOR.
R33, 48, 49, 50, 51, 52, 53	3Z5450.11	RESISTOR.
R37	3Z6500-84	RESISTOR.
R38	3Z6610-82	RESISTOR.
R39	3Z7410-2	RESISTOR.
R40, 41, 42, 43, 44, 45, 46	3Z4850-2	RESISTOR.
R54	3Z6100-86	RESISTOR.
R56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68	3Z5475-1	RESISTOR.
R70, 71, 72, 73, 74, 75, 76, 77, 78	3Z4807-1	RESISTOR.
R79, 80	2Z5014.1	RESISTOR.
R81, 82, 83, 84, 85, 86	3Z4805-5	RESISTOR.
R87, 88, 89	3Z6320-2	RESISTOR.
V1	2J6J5GT/G	TUBE.
V2, 3	2J807	TUBE.

Ref symbol	Signal Corps stock No.	Name of part and description
V4, 5	2J2A3	TUBE.
V6, 7, 8	2J4C22	TUBE.
V9, 10	2JHF300	TUBE.
V11, 12	2J889R	TUBE.
V13, 14, 15, 16	2J866A/866	TUBE.
V17, 18, 19, 20, 21, 22, 23, 24	2J872A	TUBE.
V25, 26, 27, 28, 29, 30	2J575A	TUBE.
V31	2JOD3/VR150	TUBE.
Fig. 9	3G1350-33	INSULATOR: lead-in; bowl; 5¼" diam x 2⅝"; 7/16" lead-in hole.
Fig. 6	3G1350-34	INSULATOR: lead-in cup; 2½" diam x 1⅝"; 7/16" lead-in hole.
Fig. 6	3G1050-12	INSULATOR: lead-in; bushing; 1¾" diam x 4 15/16" lg; ¼" stud.
Fig. 61	3G1050-44	INSULATOR: bushing; shoulder; ⅞" diam x 2¾" lg; 10-32 stud.
Fig. 46	3G1000-1.1	INSULATOR: bushing; shoulder; 13/16" diam x 2¼" lg; 6-32 stud.
Fig. 42	3G1050-26	INSULATOR: bushing; shoulder; ⅝" diam x 1⅝" lg; 6-32 stud.
Fig. 7	3G1300-128.4	INSULATOR: cyl; stand-off; 1" diam x 8"; 2-hole metal base and metal top cap.
Fig. 10	3G1250-96.4	INSULATOR: cyl; stand-off; 1¼" diam x 6"; tapped both ends for ¼-20 thread.
Fig. 53	3G1250-48.4	INSULATOR: cyl; stand-off; 1¾" diam x 3"; 4 tapped holes both ends for 8-32 thread.
Fig. 15	3G1250-64.9	INSULATOR: cyl; stand-off; 1¼" diam x 4"; tapped both ends for ¼-20 thread (PW 42-13).
Fig. 7	3G1250-24.1	INSULATOR: cyl; stand-off; 1¼" diam x 1½"; tapped both ends for ¼-20 thread (PW 42-16).
Fig. 6	3G1000-16	INSULATOR: conical; stand-off; 1⅛" diam x ⅝" diam x 2"; tapped both ends for 10-32 thread.
Fig. 6	3G1000-12	INSULATOR: conical; stand-off; 1" diam x ½" diam x 1½"; tapped both ends for 8-32 thread.
Fig. 63	3G1000-8.2	INSULATOR: Conical; stand-off; 1" diam x ½" diam x 1"; tapped both ends for 8-32 thread.
Fig. 6	3G1100-108	INSULATOR: rectangular; 6¾" x ⅞" x ⅜".
Fig. 6	3G1100-60	INSULATOR: rectangular; 3¾" x ⅝" x ¼".
Fig. 53	3G1300-128.2	INSULATOR: cyl; stand-off; 1¾" diam x 8"; with 2-hole metal base.
Fig. 62	3G1300-128.3	INSULATOR: cyl; stand-off; 1¼" diam x 8"; with 2-hole metal base and metal cap.
Fig. 53	3G1300-172	INSULATOR: cyl; stand-off; 1¾" diam x 10¾"; with special end caps to fit tank capacitor gears.
Fig. 12	3G1830-61854	INSULATOR: cyl; pyrex glass; air duct, 7" OD x 7⅞" lg x ¼"; thick glass.

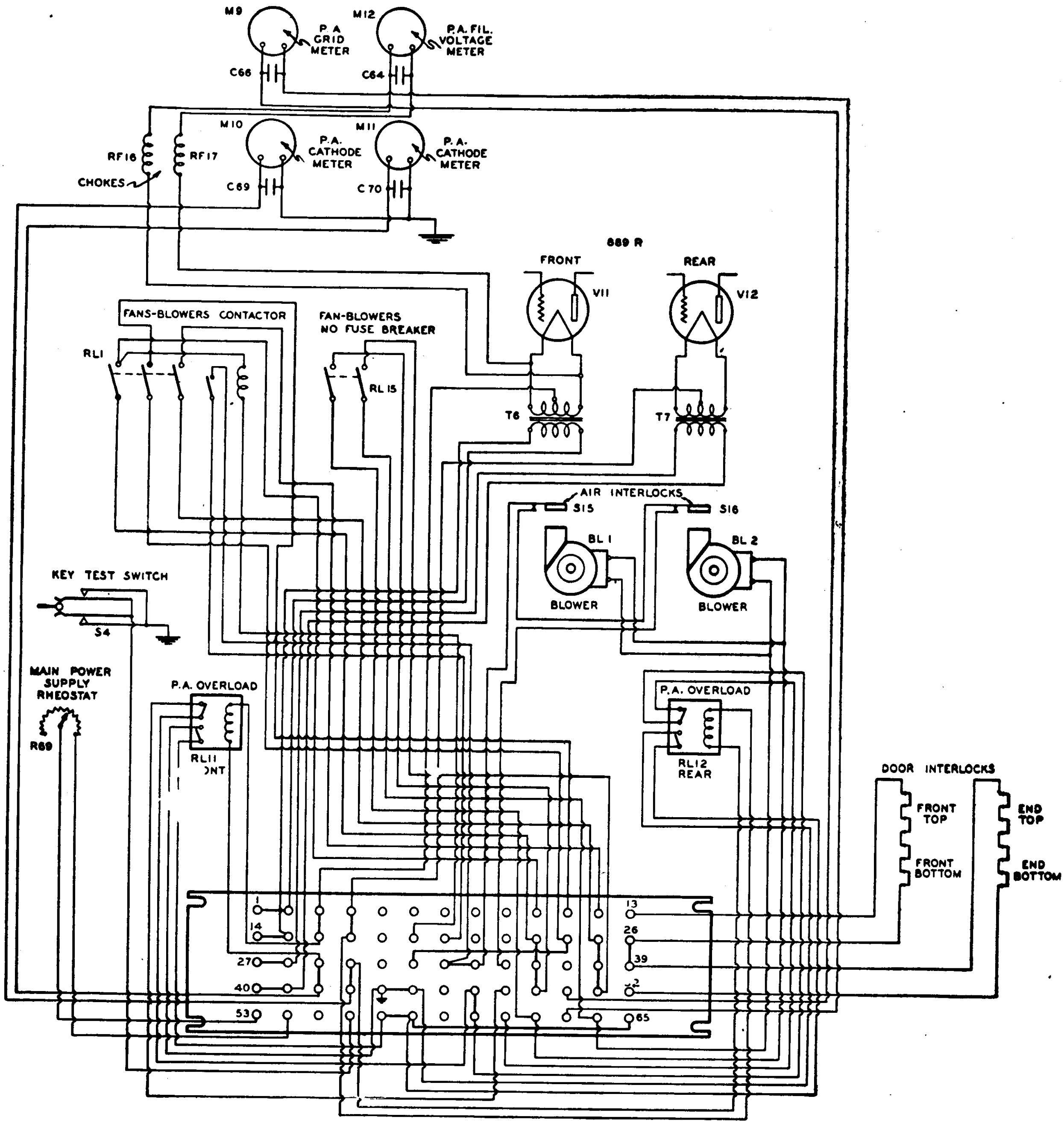


Figure 81. Power amplifier terminal board wiring diagram.

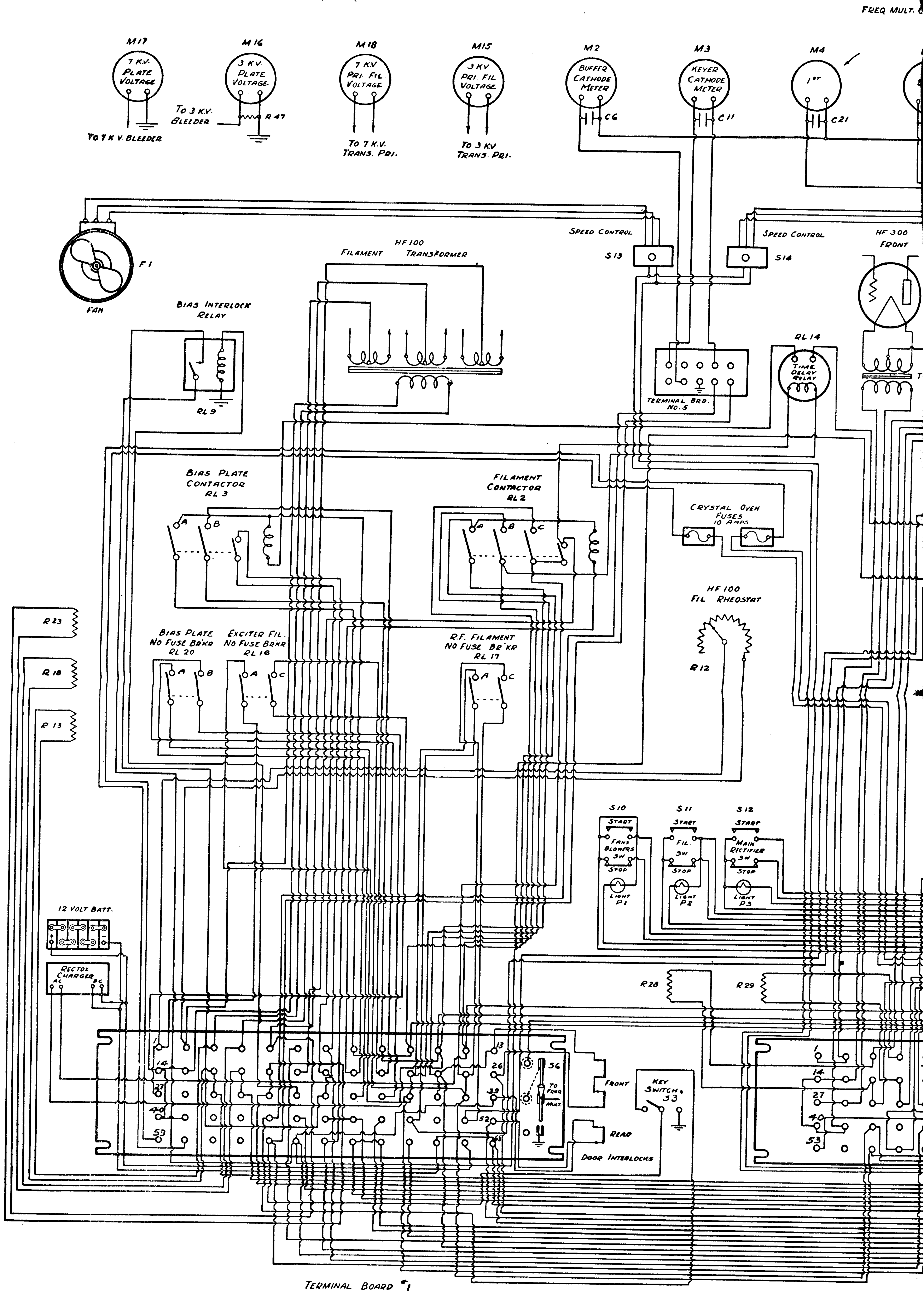
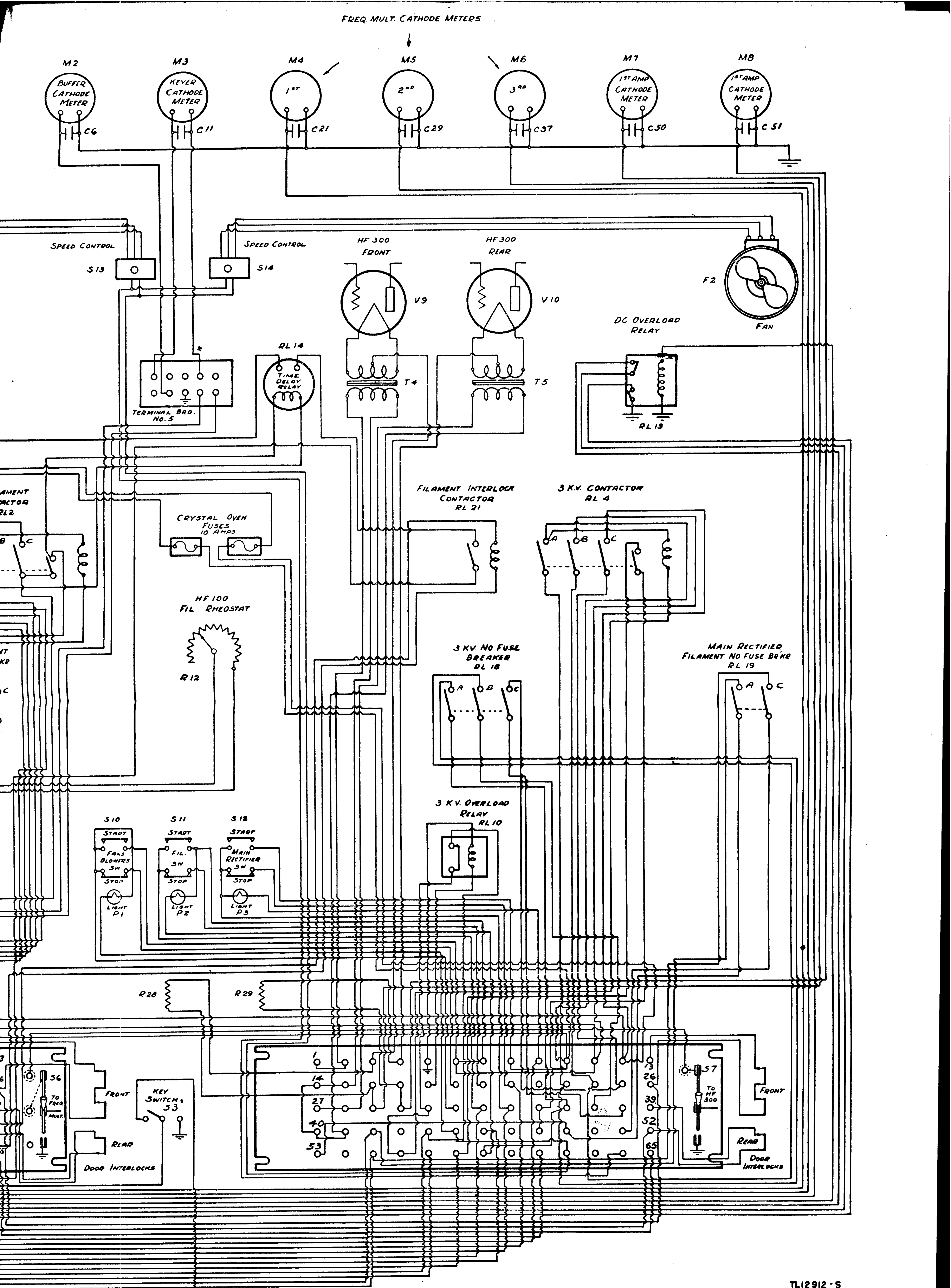
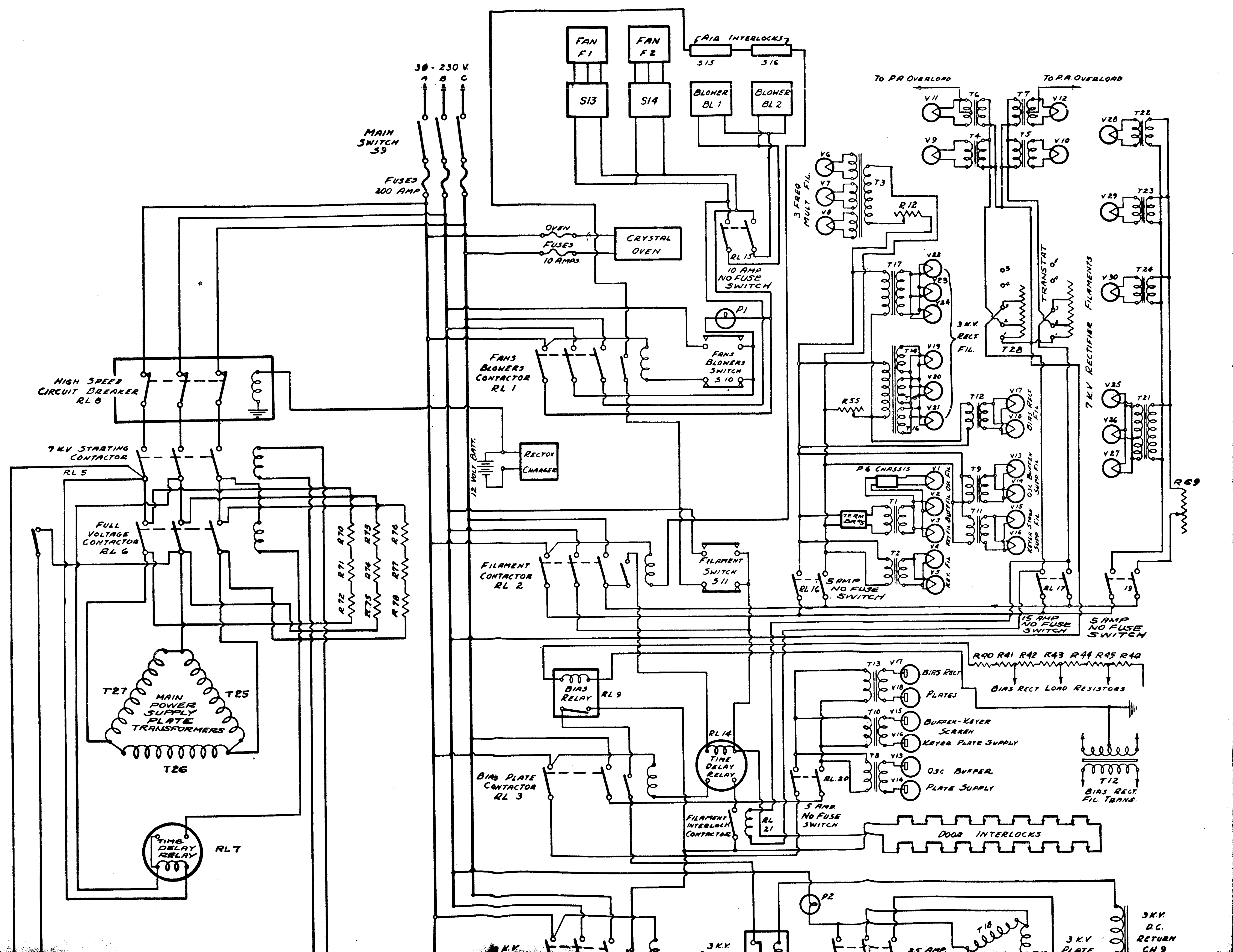


Figure 80. Rectifier-exciter unit terminal board wiring diagram.



TL12912-S

Figure 80. Rectifier-exciter unit terminal board wiring diagram.



3φ - 230 V.
A B C
MAIN SWITCH S9
FUSES 200 AMP
FAN F1
FAN F2
S13
S14
AIR INTERLOCKS
S15
S16
BLOWER BL 1
BLOWER BL 2
TO P.A OVERLOAD
TO P.A OVERLOAD
3 FREQ MULT FIL.
OVEN FUSES 10 AMPS
CRYSTAL OVEN
RL 15
10 AMP NO FUSE SWITCH
TRANSTAT
T28
3 K.V. RECT FIL.
7 K.V RECTIFIER FILAMENTS
BIAS RECT FIL.
OSC BUFFER SUPP FIL.
KEYER STAGE SUPP. FIL.
P6 CHASSIS
TERM BRD
KEY. FIL.
FANS BLOWERS CONTACTOR RL 1
FANS BLOWERS SWITCH S 10
HIGH SPEED CIRCUIT BREAKER RL 8
7 K.V STARTING CONTACTOR RL 5
FULL VOLTAGE CONTACTOR RL 6
12 VOLT BATT.
RECTOX CHARGER
FILAMENT CONTACTOR RL 2
FILAMENT SWITCH S 11
RL 16
5 AMP NO FUSE SWITCH
RL 17
15 AMP NO FUSE SWITCH
5 AMP NO FUSE SWITCH
R69
R70 R71 R72
R73 R74 R75
R76 R77 R78
MAIN POWER SUPPLY PLATE TRANSFORMERS
T25
T26
T27
TIME DELAY RELAY
RL 7
BIAS RELAY
RL 9
BIAS PLATE CONTACTOR RL 3
RL 14
TIME DELAY RELAY
FILAMENT INTERLOCK CONTACTOR
RL 21
RL 20
5 AMP NO FUSE SWITCH
R40 R41 R42 R43 R44 R45 R46
BIAS RECT. LOAD RESISTORS
BIAS RECT
PLATES
BUFFER-KEYER SCREEN
KEYER PLATE SUPPLY
OSC BUFFER
PLATE SUPPLY
T12
BIAS RECT. FIL TRANS.
DOOR INTERLOCKS
P2
3 K.V. D.C. RETURN CH 9
3 K.V PLATE

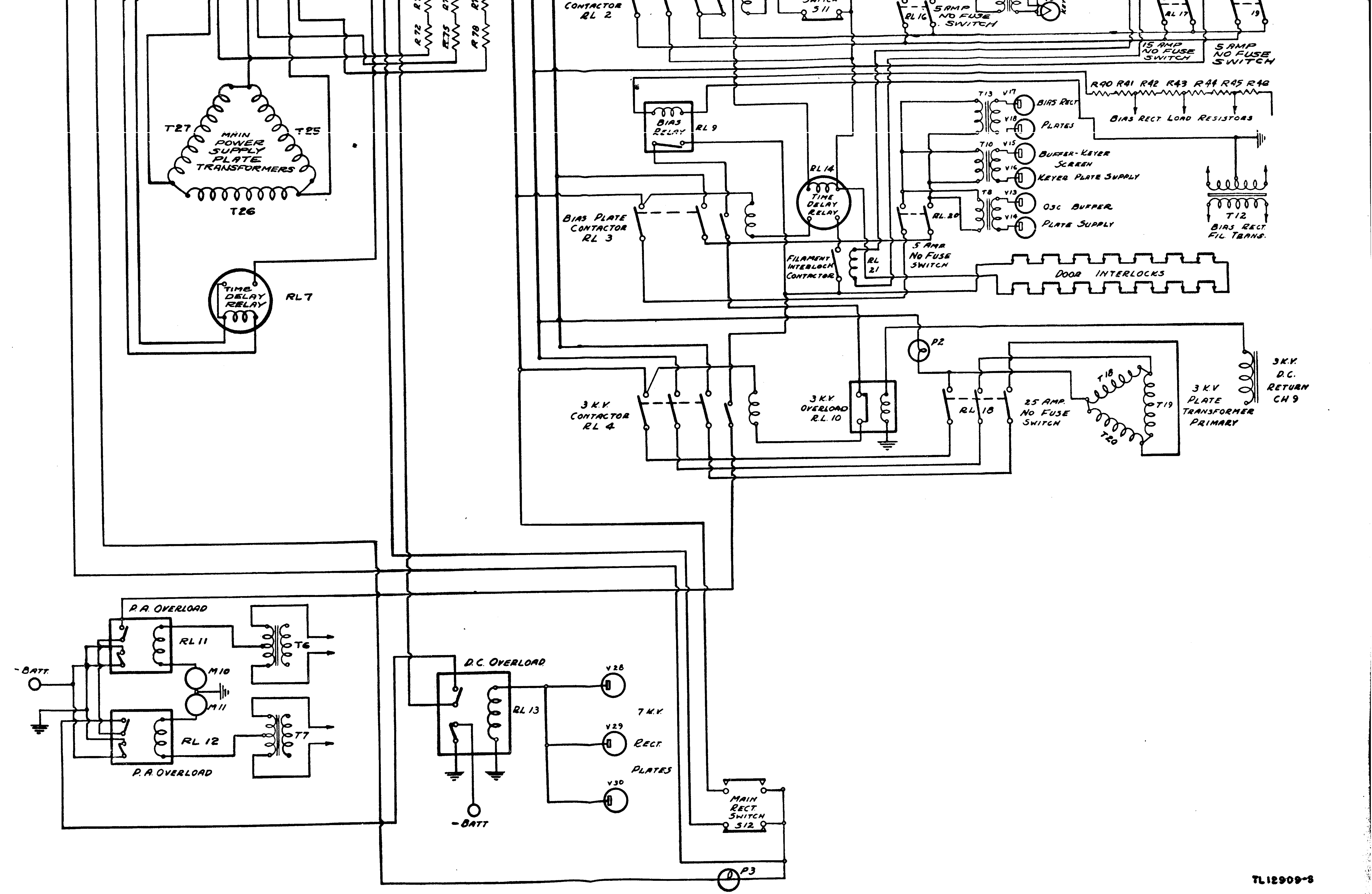
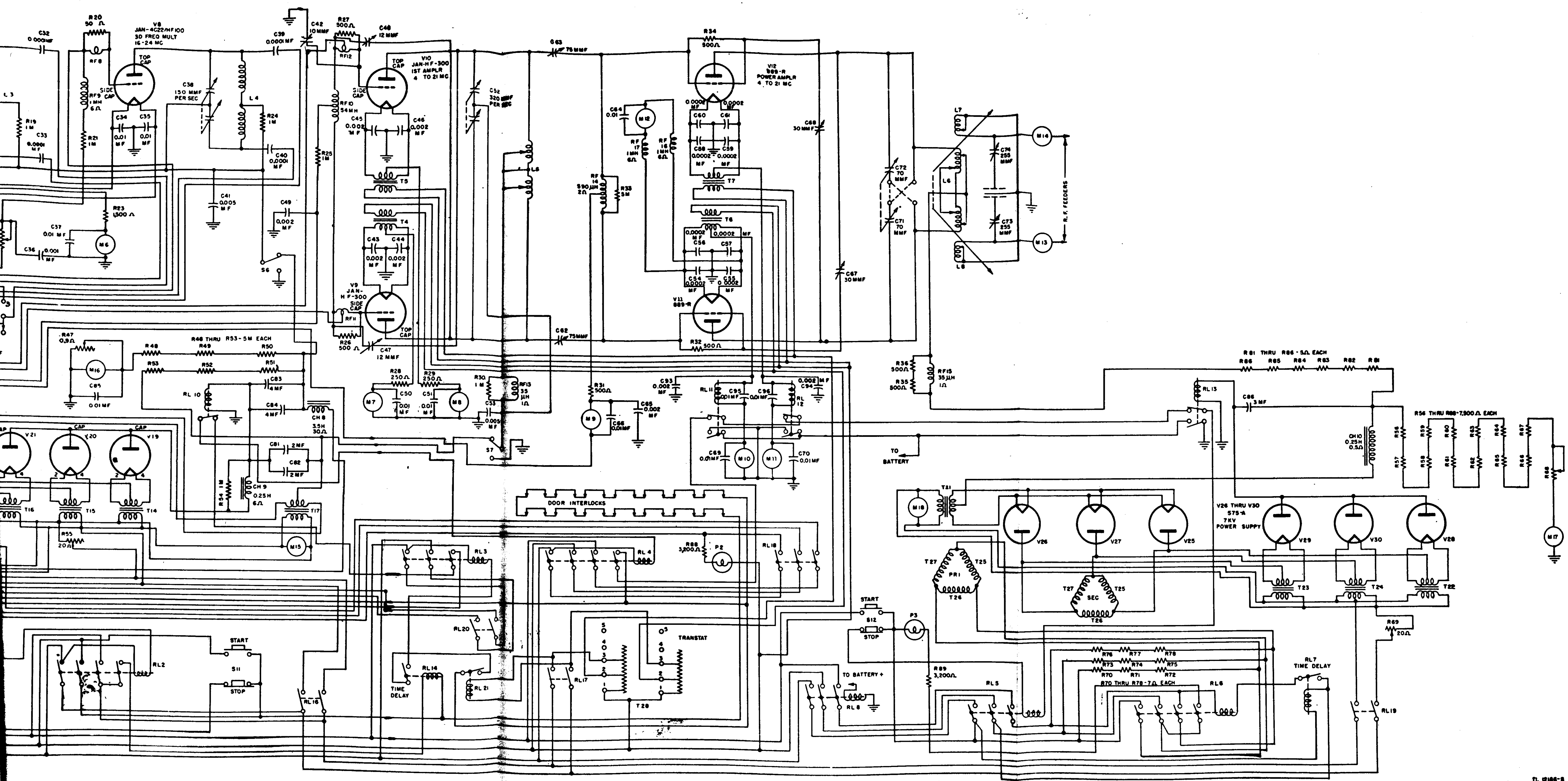


Figure 83. Control circuit diagram.



* POSITION 1 4-8 MC
POSITION 2 8-16 MC
POSITION 3 16-24 MC

NOTES: (fixed-capacitor symbol) IS SYMBOL FOR FIXED CAPACITOR; (variable-capacitor symbol) IS SYMBOL FOR VARIABLE CAPACITOR

...V-15A, complete schematic.

ISTORS
WATTS
24
24
200
200
50
200
200
200
200
200
200
200
200
200
200
200
200
200
100
335
200
200
200
200
200
200
200
200
200
200
200
200
200
335
250
250
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200
200
15
15
15

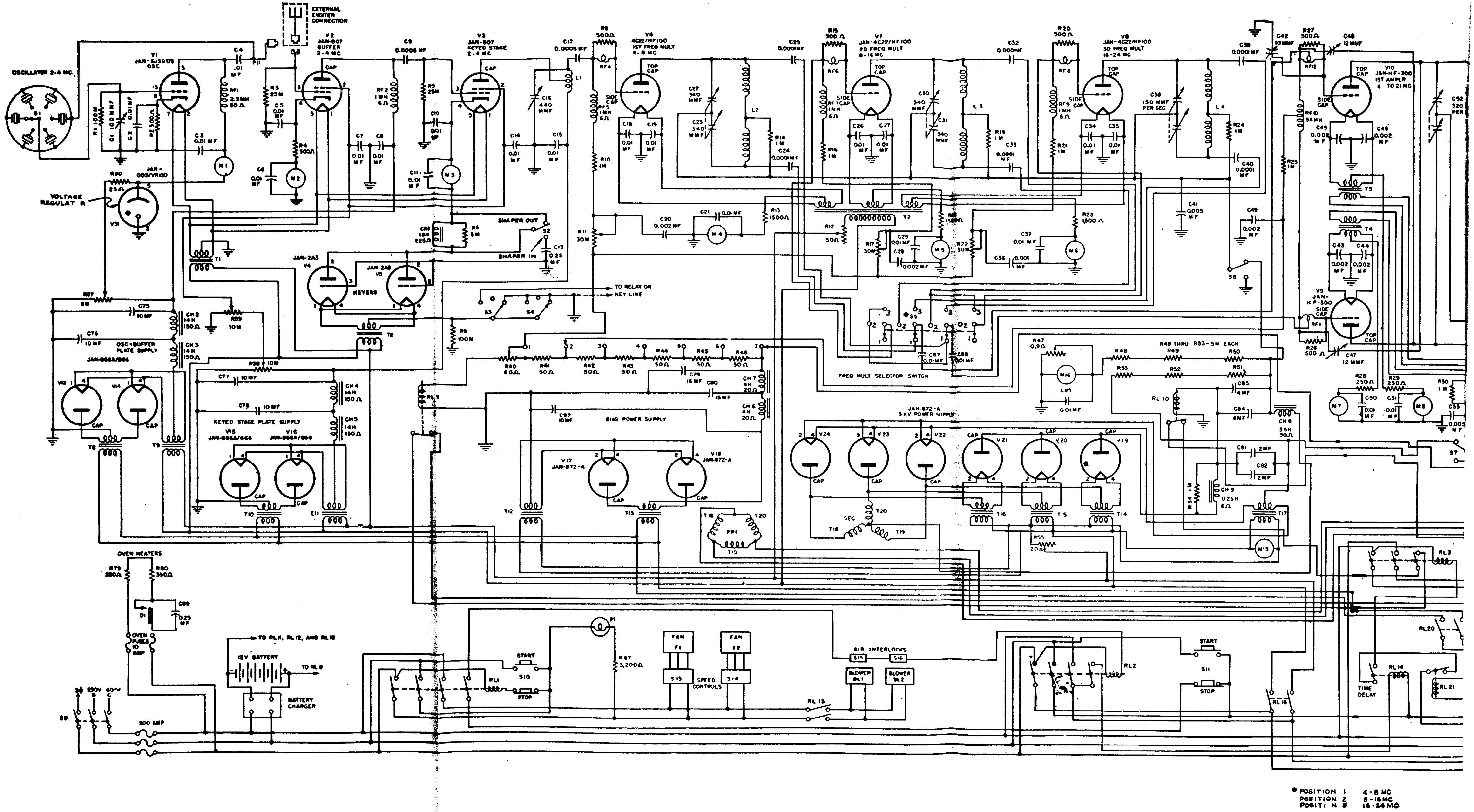

Figure 84. Radiotelegraph transmitter PW-15A, complete schematic.

CAPACITORS NO.	VOLTS (dc)
C2	1,200
C3	1,200
C4	1,200
C5	1,200
C6	1,200
C7	1,200
C8	1,200
C9	2,500
C10	1,200
C11	1,200
C12	2,500
C13	600
C14	1,200
C15	2,500
C17	2,500
C18	1,200
C19	1,200
C20	5,000
C21	1,200
C24	2,500
C25	2,500
C26	1,200
C27	1,200
C28	5,000
C29	1,200
C32	2,500
C33	2,500
C34	1,200
C35	1,200
C36	5,000
C37	1,200
C39	2,500
C40	2,500
C41	4,000
C43	5,000
C44	5,000
C45	5,000
C46	5,000
C49	5,000
C50	1,200
C51	1,200
C53	4,000
C54	5,000
C55	5,000
C56	5,000
C57	5,000
C58	5,000
C59	5,000
C60	5,000
C61	5,000
C64	1,200
C65	5,000
C66	1,200
C69	1,200
C70	1,200
C75	1,000

CAPACITORS NO.	VOLTS (dc)
C76	1,000
C77	1,000
C78	1,000
C79	1,000
C80	1,000
C81	5,000
C82	5,000
C83	3,000
C84	3,000
C85	1,200
C86	12,500
C87	2,500
C88	2,500
C89	600
C91	2,500
C92	1,000
C93	5,000
C94	5,000
C95	1,200
C96	1,200

RESISTORS NO.	WATTS
R1	20
R2	10
R3	10
R4	10
R5	10
R6	25
R7	2
R8	20
R9	8.5
R10	8.5
R11	50
R12	50
R13	100
R14	8.5
R15	8.5
R16	8.5
R17	50
R18	100
R19	8.5
R20	8.5
R21	8.5
R22	50
R23	100
R24	8.5
R25	8.5
R26	8.5
R27	8.5
R28	200
R29	200
R30	8.5
R31	24
R32	24
R33	200
R34	24

RESISTORS NO.	WATTS
R35	24
R36	24
R37	200
R38	200
R39	50
R40	200
R41	200
R42	200
R43	200
R44	200
R45	200
R46	200
R48	200
R49	200
R50	200
R51	200
R52	200
R53	200
R54	100
R55	335
R56	200
R57	200
R58	200
R59	200
R60	200
R61	200
R62	200
R63	200
R64	200
R65	200
R66	200
R67	200
R68	200
R69	335
R70	250
R71	250
R72	250
R73	250
R74	250
R75	250
R75	250
R76	250
R77	250
R78	250
R79	150
R80	150
R81	200
R82	200
R83	200
R84	200
R85	200
R86	200
R87	15
R88	15
R89	15