RCA MANUFACTURING CO., INC.

INSTRUCTIONS OS-1283

500 KW BROADCAST AMPLIFIER-MODULATOR AND ASSOCIATED EQUIPMENT

RCA TYPE 500-A
FOR
THE CROSLEY RADIO CORPORATION
STATION WLW, CINCINNATI, OHIO

THE RCA MANUFACTURING COMPANY, INC.
CAMDEN, NEW JERSEY

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TABLE OF CONTENTS

1.00 SAFETY TO HUMAN LIFE

Since the use of high voltages which are dangerous to human life is necessary for the successful operation of the radio transmitting equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by the operating personnel during the operation, inspection and maintenance of the equipment.

Major portions of the equipment are within shielding enclosures or framework, provided where necessary with access doors or gates which are generally fitted with safety interlock switches. These interlock switches serve to shut off dangerous voltages within the enclosures when an access door or gate is opened.

The substation, switch enclosures, and tower insulator enclosure which may be non-interlocked and are normally unattended, should be kept locked and Rules 1 and 2 should apply particularly to these portions of the equipment.

Attention is invited to the fact that no provision is made to remove the 115 and 230 volt AC and 33 and 125 volt DC supply voltages from various contactors, switches, busses and terminal boards throughout the transmitting equipment. While such voltages are not considered dangerous to human life, the operating personnel is cautioned that severe burns may result should any of the low voltage circuits be shorted or grounded when supplied with voltage.

Attention is also invited to the presence of noninterlocked dangerous voltages present on the overhead 2300 volt disconnecting switches and associated apparatus supplying the main rectifier and the filament motor generator sets. Voltage may be completely removed from these switches only by disconnecting the power supply externally by means of apparatus not supplied with the equipment. The 2300 volt disconnecting switches should only be operated at no load and then by means of suitable switch hooks with insulated handles. It is recommended that when servicing operations are to be performed on these switches, or other portions of the circuit normally maintained at dangerously high voltage, the disconnecting device opened for protection be tagged to prevent its reclosure by unauthorized persons, and that each of the circuits on which work is performed be temporarily grounded by a conductor of adequate cross section.

Extreme caution should be observed in entering any unisolated unit or section of the equipment if d-c plate voltage has been applied to the main rectifier filter capacitor without appreciable discharge load during testing operations. The rectifier output voltmeters will generally indicate when the voltage has dropped to a safe value.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be observed.

1. KEEP AWAY FROM LIVE CIRCUITS

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

2. DON'T SERVICE OR ADJUST ALONE

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

3. DON'T TAMPER WITH INTERLOCKS

Under no circumstances should any access gate, door or safety interlock switch be removed, short circuited, or tampered with in any way, nor should reli-

ance be placed upon the interlock switches for removing voltages from the equipment.

4. USE THE SAFETY GROUNDING SWITCHES

Under no circumstances should any person be permitted to reach within or in any manner gain access to an isolated power amplifier or modulator unit without operating the safety grounding switch on the front access door of the unit.

2.00 EQUIPMENT FURNISHED

The following major radio transmitter units were furnished for this application:

Quantity	Name of Apparatus	RCA Type	Drawing Reference
1	Broadcast Amplifier-Modulator	500-A	-
3	Power Amplifiers	AA-4260	DL-7550353 G-1-2-3
1	Main Rectifier	AP-4261	DL-7550354 G-1
1	Operator's Console	UZ-4262	T-7659415 G-1
1	Harmonic Filter	AX-4263	W-7350485 G-1
1	Antenna Rectifier	AP-4264	T-7659411 G-1
1	Antenna Tuning Equipment	AL-4265	P-7760738 G-1
2	Modulators	AM-4266	DL-7501773 G-1
1	Low Power Rectifier	AP-4267	DL-7501779 G-1
1	High Power Audio Amplifier	AA-4268	DL-7501778 G-1
1	Distribution Panel	-	DL-7501780 G-1
1	Water Cooling System	-	DL-7501782 G-1
1	Air Cooling System	-	DL-7501783 G-1
1 set	Rotating Equipment	-	DL-7501781 G-1
1	RF Transmission Line	-	T-7659387 G-1
1	Isolation Switching Assembly	-	W-7350473 G-1
1	Control Panel	-	T-7659427 G-1

The tube complement of this transmitting equipment is listed below.

Quantity	RCA TUBE TYPE	FUNCTION
12	RCA-862	Power Amplifier
8	RCA-862	Modulator
2	RCA-848	High Power Audio Amplifier
2	RCA-849	Low Power Audio Amplifier (Third stage)
4	RCA-211	Low Power Audio Amplifier (First and second stages)
6	RCA-872	Low Power Rectifier
6*	RCA-870	Main Rectifier
1	RCA-217-C	Antenna Rectifier
1	FG-81	Over-modulation Alarm

*A socket and heater circuits are provided for one mounted spare RCA-870 rectifier tube.

3.00 GENERAL SPECIFICATIONS

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3.01 Power Supply

This equipment is designed to operate from a main power supply of 2300 volts, 3 phase, 3 wire, 60 cycles. The 3 phase voltages must be balanced within 5% and the supply voltage must be constant within 2%. The following values of 2300 volt power were measured for the percentages of modulation indicated:

% Modulation	2300 Volt Power
0	1283 KW
25	1335 KW
100	1680 KW

Approximately 190 KW input is required for the three filament M-G sets. The 2300 volt load has a power factor slightly in excess of 90%.

The substation apparatus, including step down transformers, voltage regulating apparatus, metering and protective apparatus is not furnished as a part of the transmitting equipment.

An additional 220 volt, 3 phase, 3 wire, 60 cycle power supply is required for the smaller rotating machines and certain auxiliaries. The 220 volt load is approximately 50 kva at 85% power factor.

A single phase, 115 volt, 60 cycle supply is taken from the station lighting circuits to operate devices which should be operated with the transmitter equipment shut down. The load is in the order of 10 amperes, but additional current may be required for such devices as the customer may wish to plug into the 115 volt a-c outlets on the operator's console.

3.02 R-F Driver

This broadcast transmitting equipment is designed to utilize the customer's 50 KW Western Electric broadcast transmitter as an r-f exciter. The adjustments of the 50 KW amplifier are approximately the same for delivering power to the antenna or the 500 KW amplifier grid circuits. The Western Electric phantom antenna for the 50 KW equipment has been reconnected as a grid loading resistor bank for the 500 KW power amplifiers. The 50 KW equipment is not modulated when it is used as an RF exciter. The necessary control circuit interconnections have been made between the 50 KW and 500 KW equipments to insure proper protection to personnel and correct sequence of operation for protection of the apparatus. A switching system is used permitting rapid changes to be made between the two output power levels.

3.03 Output Power

The three RF power amplifiers together furnish an antenna carrier power of 500 KW capable of being 100% modulated. This is equivalent to 2000 KW peak output.

3.04 Output Frequency

The RF equipment is designed to operate at a carrier frequency of 700 KC. This frequency is controlled by the frequency of the 50 KW Western Electric amplifier.

3.05 R-F Harmonics

The harmonic guarantee on the equipment was that the average field strength of the strongest harmonic should not exceed 500 microvolts per meter at one mile, the readings being taken on eight radials from the antenna at (or corrected to) a distance of one mile. Test measurements indicated that the harmonic radiation was less than the guarantee.

3.06 Audio Input Level

The audio level of the program line at the input of the audio amplifier in the 500 KW equipment should be approximately zero DB (12.5 milliwatts, 500 ohms) to give 100% modulation. The input level is automatically reduced when a transmitter unit is isolated and during the step-start application of plate voltage.

3.07 Modulation Capability

The combined output of the two modulator stages is sufficient to modulate the combined input of the three RF power amplifier stages 100%, thus securing full modulation of the carrier. Thus continuous program modulation with peaks of 100% is possible.

3.08 Audio Frequency Characteristic

The overall audio frequency characteristic from audio input to rectified antenna output at approximately 50% modulation does not vary more than plus or minus 0.5 DB between 100 and 5000 cycles and not more than plus or minus 2 DB between 30 to 100 cycles and 5000 to 10,000 cycles. The response-frequency curve is free from pronounced peaks and irregularities.

3.09 Audio Distortion

The audio distortion specification is as follows: If a sinusoidal tone of 200 cycle frequency is impressed on the audio input to this equipment, the modulation envelope at any modulation percentage between 0 and 95% will not contain more than 10% arithmetically added harmonics.

3.10 Cooling System Requirements

The capacity of the closed water system for tube cooling is approximately 200 gallons of distilled water, exclusive of the storage tank furnished by the customer.

4.00 DESCRIPTION OF APPARATUS

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4.01 Location of Units

A general view of the WLW broadcast transmitting station is shown in photograph 490104. The transmitter building is at the left, with the living quarters adjacent. The vertical-radiator antenna tower is in the background and the spray pond is in the foreground. The 500 kw equipment is housed in an addition to the rear of the transmitter building, only partially shown at the left of the photograph.

An interior view of the ground floor of the transmitter building is shown in photograph 490093. The customer's 50 kw transmitter, now used as an r-f exciter, is at the left and the audio control room is at the right. The main transmitter units of the 500 kw equipment are partially shown in the center.

The main transmitter units of the 500 kw equipment are shown in photograph 490105. The Operator's Console or control desk is in the foreground. The transmitter units are placed as follows, left to right:

Power Amplifier No. 1
Power Amplifier No. 2
Power Amplifier No. 3
Modulator No. 1
Modulator No. 2
Main Rectifier

The control panel (photo 487931) is in the rear of the main rectifier compartment. The high power audio amplifier and low power rectifier (photo 490091) are in a compartment behind the two modulator units. The control panel and audio amplifier face the rear of the building. The distilled water "stand pipe" and gauge glass are in the corner of the building behind PA-1.

The transmitter unit isolation switch assembly (photo 487609) is located on the basement ceiling beneath the PA and modulator units. The basement filament buses are also located near the basement ceiling and they run the length of the PA and modulator units. Three shielded r-f transmission lines of equal length run near the basement ceiling from the PA grid load resistor unit to the three PA input isolation switches. The input and output distilled water pipes and the main air duct for tube cooling run the length of the PA and modulator units near the basement ceiling. This apparatus is shown in photograph 489663. The filament and bias generator field rheostats, controlled from the console, are located beneath that unit on the basement ceiling (photo 490099).

The power distribution panel (photo 490099) is located in the basement beneath the console. Overhead 2300 volt wall switches for the complete equipment and for the filament machines are near the distribution panel. The audio equalizer and high pass filter unit is mounted in the basement in a room behind the distribution panel. The 125 volt storage battery (furnished by the customer) for operation of the oil circuit breakers, is located in the same room. The two modulation transformers (photo 490100) are in the basement beneath the modulator units. The oil circuit breaker unit (photo 490111) and the rectifier filter capacitor and modulator coupling capacitor banks (photo 490106) are located nearby, partially under the rectifier compartment. The r-f harmonic filter (photo 490101) is in the basement beneath and to the rear of PA-3. The three filament MG sets with their starters and control panels are near the center of the new basement (photo 490094). The pond pump, tube pump, heat interchanger, shop MG set, duplicate bias MG sets and the distilled water storage tank are located in the end of the basement beneath the grid load resistor unit and PA-1. (Photo 490103.)

The three plate transformers, main rectifier filter reactor and the modulation reactor are located out-of-doors inside protective grille work behind the transmitter building (photo 489684).

The output of the harmonic filter is connected to the antenna house by a concentric tubing type transmission line about 780 feet long (photo 489658). The antenna-ground shunt capacitor, antenna tuning inductance, antenna ammeter and antenna rectifier are located in the antenna house (photo 490095). This building

is adjacent to the base insulator supporting the 831 foot vertical radiator type antenna structure supplied by the customer (photo 490104). Tower lighting apparatus, not included as a part of this equipment, is also located in the antenna tuning house.

4.02 R-F Power Amplifiers

The 500 kw r-f power amplifier is composed of three identical unit amplifiers normally working together with each delivering about one third of the total output. The amplifier is split into three sections to permit servicing of one unit while the remaining units continue to carry the program at a somewhat reduced power level. Each amplifier, as shown in photograph 490096, is complete in itself with its own radio frequency, power and control circuits and cooling water connections.

The r-f input circuits for the three PA's, excited at 700 kc from the Western Electric 50 kw equipment, are paralleled at the grid loading resistor unit. The output coupling coils are connected in series with one end of the PA-1 coupling coil grounded during normal operation. Plate voltage is supplied to the PA units from the main rectifier through the modulation reactor. Modulation is introduced in the common plate supply circuit of the three PA's. Grid bias voltage is obtained from a common bias generator and a self-biasing resistor bank in each unit. Filament voltage is supplied from generators.

There are four UV-862 100 kw water cooled tubes in each power amplifier, connected in push pull with two paralleled tubes on each side of a balanced circuit. The push pull circuit is utilized to reduce r-f harmonics and to simplify neutralization. Each PA circuit is operated Class C to insure high efficiency in the stage which utilizes the major portion of the transmitter's input power. The power amplifier plate tank capacitor and inductance assembly is shown as assembled in the factory in photograph 487613.

4.03 R-F Harmonic Filter

The secondary or output coupling coils of the three r-f power amplifiers are connected in series and the output power is conducted to the isolation switch, the 50/500 kw transfer switch, the harmonic filter and through a concentric cylinder type transmission line to the line terminating and antenna tuning apparatus in the antenna house.

The harmonic filter unit (photo 490101) is fully shielded and is located below ground level. It consists of a single "T" section low pass filter with the three amplifier coupling coils forming the first inductive section. A second harmonic trap (series resonant) circuit may be connected across the output of the main harmonic filter to further reduce this harmonic, since it is the strongest harmonic and its frequency of 1400 kc falls within the broadcast band. The use of this trap is optional.

4.04 R-F Transmission Line

The concentric transmission line (photo 489658) which transmits modulated r-f power from the harmonic filter to the antenna house is made of aluminum tubing sections and is about 780 feet long. It is constructed close to the ground to reduce its effective height for possible harmonic radiation, and the outer tube is well grounded at short intervals for the same reason. The surge impedance of the line is 100 ohms. The inside diameter of the larger tube is 9.78 inches and the diameter of the smaller tube is 1 7/8 inches. The joints are spaced at about ten foot intervals and are designed for slippage to take care of longitudinal thermal expansion.

4.05 Antenna House Apparatus

The antenna house apparatus (photo 490095) consists essentially of a shunt capacitor across the base insulator of the antenna, to match the antenna resistance to the characteristic impedance of the line, and an inductance between the transmission line and the antenna, to tune out the capacity reactance of the antenna and antenna-to-ground capacitor network. Thus the transmission line

load is entirely resistive and is equal to the characteristic impedance of the line.

The antenna-ground shunt capacitor at the left of the photograph consists of six paralleled concentric tube type capacitor sections. The ratio of the tube diameters is such as to give maximum flash over potential. The capacity can be adjusted over a 12% range.

The antenna tuning inductance is made of copper tubing, mainly self supporting, mounted on the floor. The 220 volt wires for the antenna lighting system are threaded through the tubing in this coil. The antenna current is metered at the output of the transmission line.

A diode RF rectifier (RCA-217-C), with its coupling coil placed in inductive relation to the antenna tuning coil, is utilized to give a remote indication of antenna current at the operator's console in the main transmitter building. The output of the antenna rectifier is proportional to antenna current; that is, the output current is modulated DC. Sufficient resistance is added to the output circuit of this rectifier to make it linear. The plate resistance of the rectifier tube, which varies somewhat with load current during an audio cycle, is but a small percentage of the total load circuit resistance. This makes possible continuous checking of the antenna current at the transmitter, and also provides for the operation of the over-modulation alarm indicator and the carrier on light on the console. A string oscillograph may be connected in this circuit if desired.

4.06 Audio Amplifier

The audio amplifier (photo 490091) consists of four stages of push-pull amplification. The first stage is essentially a class A voltage amplifier using two RCA-211 tubes resistance-coupled to the grid circuit of the second stage. The second stage consists of two RCA-211 tubes operated class A and transformer coupled to the third stage. The third stage consists of two RCA-849 tubes operated at somewhat higher than class A bias. The output of this stage is transformer coupled to the fourth stage. The fourth stage consists of two RCA-848 tubes operating class B. The output of this stage is transformer coupled by means of two transformers to the grid circuits of the modulators.

The power supply for the first three stages is obtained from the three-thousand-volt low-power rectifier. Bias is obtained by means of potentiometers from the 1500-volt bias machine. Plate power for the fourth stage is obtained from the main rectifier. Bias voltage is obtained from the 1500-volt bias machine. Filament power for all stages is obtained from the filament generators through appropriate filament series resistors.

4.07 Modulators

The modulators, of which there are two, are each composed of four UV-862 tubes, two tubes being connected in parallel, and the two groups of parallel tubes being connected in a push-pull circuit. A modulator unit is shown in photograph 490097. The output of each modulator is coupled by a separate transformer to the load circuit. The secondaries of the transformers are connected in series and thence to the load circuit. The output is coupled to the load circuit by means of an inductance-capacitance network so designed as to isolate the direct current and alternating current circuits and yet transmit all audio frequencies from 30 cycles to 10,000 cycles with a minimum amount of attenuation.

Plate power for the modulators is obtained from the main rectifier. Grid bias voltage is obtained from the 100-volt bias machine. Filament power is obtained from the filament generators.

4.08 Main Rectifier

Plate power for all water cooled tubes in the new equipment is supplied by the main rectifier (photo 490098), which utilizes six RCA-870 hot-cathode mercury-vapor rectifier tubes in a three phase, full wave circuit. The rectifier

tube unit is a part of the main-floor transmitter assembly. The three single phase plate transformers and the filter reactor (photo 489684) are located out-of-doors in the transformer enclosure while the four oil circuit breakers for start, run, high voltage and low voltage, the plate starting resistors (photo 490111) and the filter capacitor bank (photo 490106) are located in the basement beneath the tube unit.

The secondaries of the plate transformers are always connected in delta while the primaries may be remotely switched to either the wye or delta connection by means of the oil circuit breakers for low and high voltage respectively. This arrangement provides one set of delta windings between the rectifier and the supply line for low voltage testing and two delta connections for full voltage operation of the rectifier, thus reducing third harmonics of supply frequency and odd multiples thereof in the power lines supplying the station.

With the plate transformer primaries connected wye the output rectifier voltage is approximately 7000; the delta connection gives approximately 12,000 volts d.c. Plus and minus 5% and 10% taps are provided on each plate transformer with a manual switch for changing voltage at no load. The input supply to the plate transformers is 2300 volts, 3 phase, 60 cycles.

The rectifier could be given a continuous rating of 1250 KW, but the nature of the load under conditions of varying percentage modulation makes this type of rating of little value as a criterion of performance. The d-c load current varies from about 70 amperes at zero modulation up to approximately 110 amperes for 100% sustained modulation, due to the class B operation of the high level modulator stages. The component electrical parts of the rectifier are designed to give a minimum change in voltage with this variation in load current. This is necessary even when using the voltage regulators supplied by the customer in the 2300 volt supply, since these induction regulators cannot be expected to follow the modulation at syllabic frequencies.

Since little regulation-producing impedance is present in the rectifier power supply and the rectifier itself, the rectifier starting oil circuit breaker was designed for high speed operation when opening a fault and also for high interrupting capacity.

4.09 Low-power Rectifier

The low-power rectifier unit (photo 490091) supplies plate power for the first three audio stages. It consists of six UV-872 rectifier tubes connected in a conventional 3 phase full-wave rectifying circuit. The output of the rectifier is filtered by means of a single stage filter.

The low-power rectifier receives its power supply from the 220-volt, 3 phase, 60 cycle power line. The power circuits are protected by instantaneous-operating overcurrent relays. The load circuit has an instantaneous opening time, delay closing, overcurrent relay which protects the rectifier in case of a failure in the load circuit.

4.10 Rotating Machines

The machines that come under this heading are the filament motor generators, the bias motor generators and the shop motor generator. These machines are shown in photographs 490094 and 490103.

The filament motor generators, of which there are three, consist of a 2300-volt, 3 phase, 60 cycle motor, direct connected to a 35-volt, direct current generator, motor and generator being mounted on a common bed-plate. The motor is of the induction type and is rated at 85 horsepower at 1175 RPM. The motor is designed for use as a linestart motor. The generator is rated at 52.5 KW corresponding to a load of 1500 amperes at 35 volts.

Each bias motor generator, of which there are two, one being a spare, consists of a 220-volt, three-phase, 60 cycle motor driving three generators. Two of the generators are mounted in one frame. The motor is direct connected to the generators. The generators and motor are mounted on a common bed-plate. The

motor is the middle unit. It is rated at 17.5 horsepower at 1750 RPM and is designed for use as a linestart motor. The generator which supplies bias to the power amplifiers is rated at 1000 volts, 12 amperes, direct current. The two generators mounted in one frame are the modulator bias machine and the high power audio bias machine. The modulator bias machine is rated at 100 volts, 12 amperes, while the high power audio bias machine is rated at 1500 volts, 0.25 ampere.

The shop motor generator consists of a 220-volt, 3 phase induction motor direct-connected to a direct current generator. Both motor and generator are mounted on a common bed-plate. The motor is rated 25 horsepower at 1750 RPM. It is designed for use as a linestart motor. The generator is rated at 15 KW at 125 volts direct current.

The filament motor generators and bias motor generators are designed so that ripple in the output voltage is kept at a minimum.

4.11 Water Cooling System

The water cooling system is composed of a closed circulating system for removing the heat from the tubes, and a spray pond system for transferring this heat to the outside air. The spray pond is shown in photograph 490104 and the pumps and heat exchanger are shown in photograph 493772. A portion of the water piping appears in photograph 489663.

The closed system consists of a pump by means of which distilled water is pumped through copper pipes to the water system of each of the power amplifier, modulator and high power audio units. The water system in each unit consists of a hose coil which is connected to the inlet connection of the tube jacket, another hose coil which is connected to the outlet connection of the tube jacket, a water flow meter, a temperature indicating thermometer and the necessary valves, and so forth. The water, after passing through a unit, is returned to the pump, through the heat interchanger. A stand pipe is attached to the system to take care of expansion of the water. The entire closed system is non-ferrous, the metals used being either brass, copper or bronze. The water pump is rated at 525 gallons per minute against a head of 110 feet of water. It is driven by a 220-volt, three-phase, 60 cycle, linestart induction motor rated at 20 horspower. Both pump and motor are mounted on a common bed-plate.

Two heat exchangers are provided. They are connected in parallel. Each exchanger consists of a bundle of brass pipes fitted into a large pipe. The brass pipes carry the distilled water used for tube cooling. The large pipe carries the water from the spray pond. Each heat exchanger has 235 square feet of transfer area and will cool 350 gallons per minute from 149° F. to 133° F. by circulating 512 gallons per minute of cooling water which may go in at 90° F. and come out at 100° F.

The water from the spray pond goes first through the heat exchangers, then through a pump, then through spray nozzles back to the pond. The pond pump is rated at 800 gallons per minute capacity against a head of 70 feet of water. It is driven by a 220-volt, 3 phase, 60 cycle, linestart induction motor rated 20 horsepower at 1750 RPM. Motor and pump are direct connected and mounted on a common bed-plate.

4.12 Air Cooling System

The air cooling system consists of a motor-driven centrifugal blower connected to an air duct (photo 489663) from which air for cooling the filament and plate seals of the UV-862 tubes and the bulbs of the RCA-870 tubes is obtained. The air inlet is outdoors. The motor is direct connected to the blower and is a variable speed D.C. motor having a nominal rating of 2.5 horsepower. It receives power from the 125-volt D.C. power supply. The blower is rated to deliver 2054 cubic feet of air per minute against a static head of four inches of water at a speed of 1845 RPM.

4.13 Distribution Panel

The distribution panel (photo 490099) handles all of the low voltage circuits. The first section at the left has a main 220-volt, 3 phase, A.C. switch and switches and fuses for each branch circuit. Similarly the second panel has a main 125 volt D.C. switch and switches and fuses for each branch circuit. This panel also has on it the D.C. line voltmeter and voltage control. The third panel has transfer switches by means of which either bias machine may be selected. The fourth panel has transfer switches by means of which the power supply to the tube water pump and the pond water pump may be switched to spare pump motor. The last panel has transfer switches by means of which the power supply for the motor of the air blower can be switched to a spare motor. It also has rheostats for speed control of the motors.

The various starters, relays, etc., associated with the low voltage power circuits, are mounted on the rear of the panel. The bias voltage relays are also mounted here.

4.14 Operator's Console

The sequence control switches and voltage changing controls, with their associated meters and indicator lights, and other devices for making adjustments during operation are grouped on the operator's desk or console shown in photograph 516160. The relays and contactors associated with these circuits are centralized on the control panel described in the next section. Relays and switches having coils and contacts in high voltage or high current circuits are of necessity located at those placed in the equipment where the high voltages and currents occur.

All parts of both the control panel and console are noninterlocked so as to be completely accessible during transmitter operation to permit servicing if necessary. No dangerous voltages (in excess of 220 volts a-c) are present on either the control panel or the console.

On the right hand panel of the console (as viewed from the front) are located the transmitter status controls and their associated indicator lights. The top row of switches and lights apply to the manual isolation and resetting of the PA and modulator units. The two lower rows of switches are the sequence control switches for starting or shutting down the 500 KW equipment. Below this panel are located the master filament voltage adjusting rheostat and the three bias voltage adjusting rheostats.

On the center panel are located six meters with transfer switches for two, an emergency shut down switch, an electric clock, two neon indicator lights and various telephone and telegraph drop signals. Meters are provided for d-c filament voltage, bias voltage (with transfer switch), main rectifier voltage, antenna current (operating from the output of the antenna rectifier), 2300 volt line voltage (with transfer switch), and for setting the overmodulation alarm indicator. The neon indicator lights are for "RF Carrier On" and "Overmodulation".

The top row of switches and lights on the left hand panel provides control for the plate power on the 50 KW exciter, for WSAI, the 5 KW Crosley broadcast transmitter and W8XAL, the Crosley high frequency experimental radiotelephone transmitter. The next row includes controls for the Oakley and Elmwood 33 KV line circuit breakers, a 125 volt battery "on" light, power supply control for the overmodulation indicator and a spare indicator light and switch which the customer may wish to use. The bottom row of controls is for the overmodulation indicator; two convenience outlets for 115 volts A.C. are also provided here.

4.15 Control Panel

The relays and contactors in the top sections of the control panel (photo 487931) are grouped according to the transmitter units to which these items apply. Separate groups are provided for each of three PA units, each of two modulator units and a group for the high power audio and rectifier units. The two panels at the bottom contain sequence and protective relays and switches which in general apply to the transmitter as a whole.

4.16 Transmitter Unit Isolation Switches

A bank of double-break power circuit brushes is located beneath each of the three power amplifier and two modulator transmitter units. The complete isolation switching assembly is shown in photograph 487609. These power circuit isolation brushes connect bias voltage, plate voltage, R.F. input, R.F. output, audio input and audio output to appropriate circuits in the power amplifier and modulator units when these units are in service.

When a given unit is isolated or taken out of service, the power circuit isolation brushes for all units are opened, the brushes for the faulty unit are rotated to the "isolated" position by means of a thrustor, and all brushes are reclosed by another thrustor. Thrustors are used to avoid mechanical switching shock.

The isolation switches may be manually operated from the unit "on" and "off" switches on the right hand panel of the console, or they may be automatically switched due to the operation of overcurrent relays, etc. in the various transmitter units. In either case, relays for the desired transmitter unit, located on the control panel, operate the isolation switch thrustors directly.

When a transmitter unit is isolated, the operator may safely enter the shielded enclosure for that unit to perform servicing operations with the remainder of the transmitter in operation.

5.00 ANALYSIS OF OPERATION - POWER, R-F AND AUDIO CIRCUITS

5.00 ANALYSIS OF OPERATION - POWER R-F AND AUDIO CIRCUITS

5.01 General

When analyzing the operation of the circuits employed in this equipment, reference should be made to schematic diagram WW-7350119. It is assumed that the operating staff is already familiar with the operation of the 50 KW Western Electric transmitter which is used as an RF driver for the 500 KW equipment. Only those portions of the 50 KW circuit are shown which are interconnected with the circuit of the 500 KW transmitter.

Considerable information may be obtained from the schematic diagram as to the physical location and interconnection of the various items, although since the diagram is for analysis of operation, the relative positions of items are not shown. For example, each item of electrical apparatus is designated by a symbol number shown on the diagram adjacent to the symbol for the item in question. These numbers serve to tell in which transmitter unit the item is located, thus:

100 series - Audio amplifier and modulator stages.
200 series - Power distribution panel, power apparatus and cooling apparatus.
300 series - Low power rectifier.
400 series - Main rectifier.
500 series - Power amplifiers.
600 series - Antenna house apparatus and harmonic filter.
700 series - Audio frequency equalizer and filter.
800 series - Control panel.
900 series - Operator's Console.

A few items of miscellaneous apparatus located at various points about the building are designated by symbol numbers from the series of that unit with which the item is most closely associated.

5.02 2300 Volt A-C Circuits

Two 2300 volt, 3 phase, 3 wire, 60 cycle underground cables, furnished by the customer, conduct 2300 volt power from the sub-station to the basement of the transmitter building. The 2300 volt basement bus may be connected to either cable by throwing three S.P.S.T. disconnect switches, furnished by the customer, for cable "A" or cable "B" as desired. These switches are so connected that the blades are supplied with voltage when the switches are open. Disconnecting switches are provided in the customer's sub-station to permit either cable "A" or "B" to be completely disconnected when not in service.

The 2300 volt bus in the transmitter building basement supplies two loads - the main rectifier and the motors of the filament MG sets.

5.021 Main Rectifier

The rectifier branch is first conducted to the oil circuit breaker unit in the basement, through disconnect switches 421 located on that unit. Two potential transformers 427, protected by fuses 427-A, are provided for the operation of the console 2300 volt line voltmeter 930. Any one of the three line-to-line voltages may be read, or the meter may be disconnected, by operation of line voltmeter transfer switch 931. Two current transformers 411 are mounted in the O.C.B. unit with their primaries in the 2300 volt line to the rectifier. The secondaries are connected to the coils of the a-c overcurrent relays 821-B on the control panel.

Two three pole oil circuit breakers, 415 and 417, are provided for applying and removing plate power for the main rectifier. The starting breaker 415 is closed first applying voltage to plate transformers 404 through starting resistors 416. These starting resistors are provided to absorb the switching transient which might otherwise apply abnormally high transient voltages to plate transformers 404 and rectifier tubes 401. The "run" OCB 417 is closed about one second after breaker 415, short circuiting each of the three starting resistors 416.

Two other oil circuit breakers 414-A and 414-B are provided for automatically switching the primary windings of the three single phase plate transformers 404 to the wye or delta connection. This change in primary connection changes the transformer output voltage by the factor 1.732 (square root of three), the delta connection giving the higher voltage. The use of the delta-wye oil circuit breakers provides a convenient means of obtaining a low voltage for testing since the d-c output voltage of the rectifier changes directly with the plate transformer output voltage. The transformation ratio of the three plate transformers is such as to provide a rectifier d-c output voltage of approximately 12,000 for normal operation with the primaries connected delta, and approximately 7000 volts for warming up periods and testing with the primaries connected wye. The plate transformer secondaries are connected delta at all times. Plus and minus 5% and 10% voltage taps are provided in the primary windings of plate transformers 404 for minor manual adjustment of plate voltage if required. It is extremely important that the tap changing switches of the three transformers are all in the same position when the windings are energized.

The rectifier starting O.C.B., 415, has a much higher interrupting capacity than the other oil circuit breakers since breaker 415 is the only one required to interrupt overloads and reclose immediately. All four oil circuit breakers are solenoid operated to permit changes in their status from the operator's console or in the operation of the automatic control circuit as described in Chapter 7.00.

The three high voltage AC lines for the rectifier input are conducted from outdoor plate transformers, 404, to the rectifier unit through plate transformer output switch, 422, located overhead in the rectifier compartment. An auxiliary switch, 422-A, attached to the mechanism for 422 is provided to ground the DC plate voltage circuit when switch, 422, is opened. Both switches are operated by the handle across the rectifier access door and are provided for protection of personnel.

Each of the six active rectifier tubes, 401, is provided with an arc back indicator, 403, in the anode circuit which trips a target on reverse current, indicating which tube has arced back or passed current in the reverse direction during the normally non-conducting portion of the cycle.

5.022 Filament M-G Motors

The 2300 volt, 3 phase, 60 cycle supply for the motors of the three filament MG sets, 211, is conducted to the machines through switches, 205, fuses, 206, and starters, 207. Each machine is provided with three SPST disconnects which may be used (at no load) to keep a machine from operating. In this case it is necessary to disconnect the filament generator from the load bus and to remove sufficient filament load so as not to overload the machines in operation. Starters, 207, are controlled by the operation of the automatic control circuit. Two current transformers are provided in the 2300 volt lines in each starter to operate thermal overloads. These devices directly open the coil circuit of a starter on sustained overload as explained in Chapter 7.00. The motors, 211, have sufficient reactance to permit the use of the linestart principle in starters 207.

5.03 220-Volt AC Circuits

The 220-volt, three-phase, 60 cycle power for this equipment is used to supply the following pieces of apparatus:

1. Bias motor generator sets
2. Spray pond pumps
3. Tube water pumps
4. Low power rectifier plate transformer
5. Low power rectifier filament transformer
6. Shop motor generator set
7. Main rectifier filament transformers.

Each of the circuits to the various items listed above has a switch and fuses mounted on the distribution panel as described in section 4.13 In the case

of the bias motor generator sets, the spray pond pump, the tube water pump and the shop machine, three-phase contactors are included for starting. These contactors are also mounted on the distribution panel. The contactors have thermal overload relays of the "grasshopper" type mounted on them. In case an overload causes the operation of one of these relays, it is necessary to reset it by hand. This is done by pulling on the string which hangs from each contactor.

The circuits to the remainder of the apparatus run directly from the distribution panel to the apparatus involved.

5.04 115 Volt AC Circuits

Certain auxiliary and convenience devices in the equipment, which should be energized when the transmitter equipment is shut down, are supplied from the 115 volt, single phase, 60 cycle station lighting supply. The customer's fuses for this circuit are located in the main fuse box in the transmitter control room.

The Telechron motor for the time clock switch, 810, on the control panel, is supplied continuously from this source. This switch is used for turning on the main rectifier filaments automatically at a predetermined time each day.

The motor for the harmonic filter air blower 601 is supplied from the 115 volt source for either 50 KW or 500 KW operation by means of contacts on the rectifier starting OCB 415 and on 50 KW interlock relay, 822.

On the console, electric clock 934, and convenience outlets 935, are supplied continuously from the station lighting supply. When the overmodulation indicator input switch 963 is closed, filament transformer 962, and overmodulation indicator "on" light 977 are also energized. As soon as carrier relay 980 closes its contacts, carrier "on" light (neon), 952, is energized from this supply.

The closing of switch 963 also energizes antenna rectifier filament transformer 622, in the antenna house, through rheostat 623, and causes voltmeter 621, across the secondary of the transformer to read 10 volts for normal operation.

Battery charger 151 in the high power audio unit is operated from the 115 volt supply through fuse 181 when switch 180 is closed.

5.05 Shop Machine 125-volt DC Circuits

The 125-volt DC power is used to supply the following circuits:

1. Air blower
2. Bias M.G. set fields
3. Filament M.G. set fields
4. All control circuits, relays, etc., except the high current closing and tripping circuits of the oil circuit breakers.

The line voltmeter 245 and voltage control rheostat 244 are mounted on the distribution panel. Each of the above listed circuits has a separate switch and fuse mounted on the distribution panel as described in section 4.13.

The air blower circuits include the time delay starting equipment and the speed control. Both of these pieces of apparatus are mounted on the distribution panel. The information for care and adjustment of the starter will be found in an instruction pamphlet in Chapter 12.00.

The bias M.G. set fields are supplied through a common switch 229 and fuse 230. The circuit, after leaving the switch and fuse, passes through relay contacts 227 shunted by resistor 228 which keeps the field current to a safe value when the machines are not running. From here the circuits leave the distribution panel, branching out to each separate field rheostat, the field coils and back to the machine.

The filament M.G. set fields are all supplied by a circuit similar to that of the bias M.G. set fields. The current flows through a switch 218 and fuse

219, relay contacts 813 shunted by resistor 217, the filament generator field rheostat 908, the field circuits of the machine and back to the shop generators.

The power for the control circuit is obtained through a switch 248 and fuses 249 on the distribution panel. From here it goes to the various branches of the control circuit in all units.

The negative DC supply line is grounded.

5.06 Battery 125 Volt DC Circuits

The customer's 125 volt battery is used for operating the substation oil circuit breakers and the oil circuit breakers in the 500 KW equipment. It is also used as a source of constant d-c voltage for the overmodulation indicator circuit.

An 85 ampere Convertifuse plug type switch has been provided in the customer's battery fuse box for protection of the battery control circuits in the 500 KW equipment. The two battery cables are connected from these fuses directly to the oil circuit breaker unit. The battery-operated portions of the control circuit are described in Chapter 7.00.

The battery circuit for the overmodulation indicator in the console is provided with a separate switch 985 and fuse 986 in the customer's battery fuse box. Switch 985 must be turned to the "off" position before the main 85 ampere fuses are removed to avoid burn-out of the battery "on" light 913 due to the inductive voltage present when the battery circuit is interrupted. The battery circuit to the console is used for the overmodulation indicator supply when input switch 963 is closed. The circuits of this device are described in section 5.14. Switch 963 has one pole in the 115 volt a-c supply to the overmodulation indicator so that one switch interrupts both voltages.

5.07 DC Filament Circuits

When the equipment is operating normally, all filament generators 211 are in use. The machines are paralleled on a common bus which runs on the ceiling of the basement underneath the three power amplifiers and the two modulators. The filament power for each unit is taken from this bus into each cell by means of heavy cables. These cables are connected to the filament switches and to the filament bus in each unit. A filament voltmeter circuit and a "filament on" relay circuit complete the d-c filament circuits. These circuits are connected to the positive filament bus in the basement through fuse 987 beneath PA-1. The transmitter unit negative filament bus is grounded in each unit; the basement negative bus is not grounded in the basement.

5.08 Bias Voltage Circuits

The bias voltages generated by either of the bias M.G. sets are delivered first to the distribution panel. There a three-pole double-throw switch selects the supply from either set of generators and delivers it to the common bias circuits. The circuits on the distribution panel include a relay for each bias supply and voltmeter multipliers for the voltmeter associated with the bias supply. The relays operate so as to prevent the application of plate power unless bias voltage is applied to the tubes.

In addition, the bias supply for the radio frequency amplifiers is filtered by means of a bank of capacitors, 543, mounted in the rear of the distribution panel. From the distribution panel the bias circuits proceed to the various units.

5.09 Plate Voltage Circuits - (Water Cooled Tubes)

The main rectifier supplies plate voltage for all the water cooled tubes in the transmitter. The three phase, full wave circuit is employed. In this circuit, the anode of one tube, 401, and the cathode of another are connected to each high voltage AC line from plate transformer, 404, so that both halves of the AC voltage wave are rectified. Two tubes operate in series, and each pair of tubes carries current one third of the time.

The rectifier filter is composed of reactor, 425, in the negative (grounded) lead and capacitor bank, 426, across the load. The rectifier negative terminal is grounded through meter shunt, 429-A, to the negative filament bus in the basement. This negative filament bus is the plate current return for all the tubes supplied by the main rectifier.

Meter, 429, on the rectifier panel, in connection with shunt, 429-A, indicates the total DC load current supplied by the rectifier. Voltmeter multiplier resistor bank, 430, behind the rectifier tube unit, supplies the two rectifier DC output voltmeters, 433, on the rectifier panel and 906 on the console. Voltmeter protective resistor, 431, is used to prevent the possibility of high voltage on the rectifier panel or in the console in case one of the voltmeters becomes open circuited.

The plate voltage supply for the RCA-848 high power audio amplifier tubes, 139, is conducted through the overhead manual disconnect switch, 169, in the basement to the primary mid-taps of HPA output transformers, 148. The primary windings are so connected that the flux due to the DC current is balanced out. The plate current circuit for each tube utilizes the paralleled half-primary windings in the two transformers. A plate ammeter, 144, DC overcurrent relay coil, 143, and indicating relay coil, 140, shunted by coil protective resistor, 142, and a surge current limiting resistor, 141, are connected in series with the plate of each RCA-848 tube.

DC plate current for each modulator is supplied through its isolation switch 184 and meter shunt 163-A to the primary mid-point of its modulation transformer 160. The flux due to the d-c current in the modulation transformers 160 is balanced out. Each shunt 163-A supplies a modulator total plate ammeter 163 on the modulator panel. These meters have been calibrated by means of calibrating rheostats 191.

The plate circuit of each modulator tube 155 is provided with an individual plate protective resistor 159 and overcurrent relay coil 157; the latter is shunted by protective resistor 158. A portion of each plate protective resistor 159 is used as a shunt for an individual modulator plate ammeter 156. Meters 156 have been calibrated with rheostats 156-A.

The common positive plate voltage supply lead for the three power amplifiers is connected to the rectifier through modulation reactor 166. The modulation reactor is connected so as to use the constant current system of plate modulation for the r-f amplifiers. Safety gap 197, in series with current limiting resistors 198, is shunted across the modulation reactor 166 so as to absorb the stored energy in the reactor in case the d-c current to the power amplifiers is suddenly interrupted. This might occur in case the crystal oscillator in the r-f exciter ceased to function.

The secondaries of modulation transformer 160 have d-c voltage on them but the d-c current is blocked off by modulator coupling capacitor bank 165.

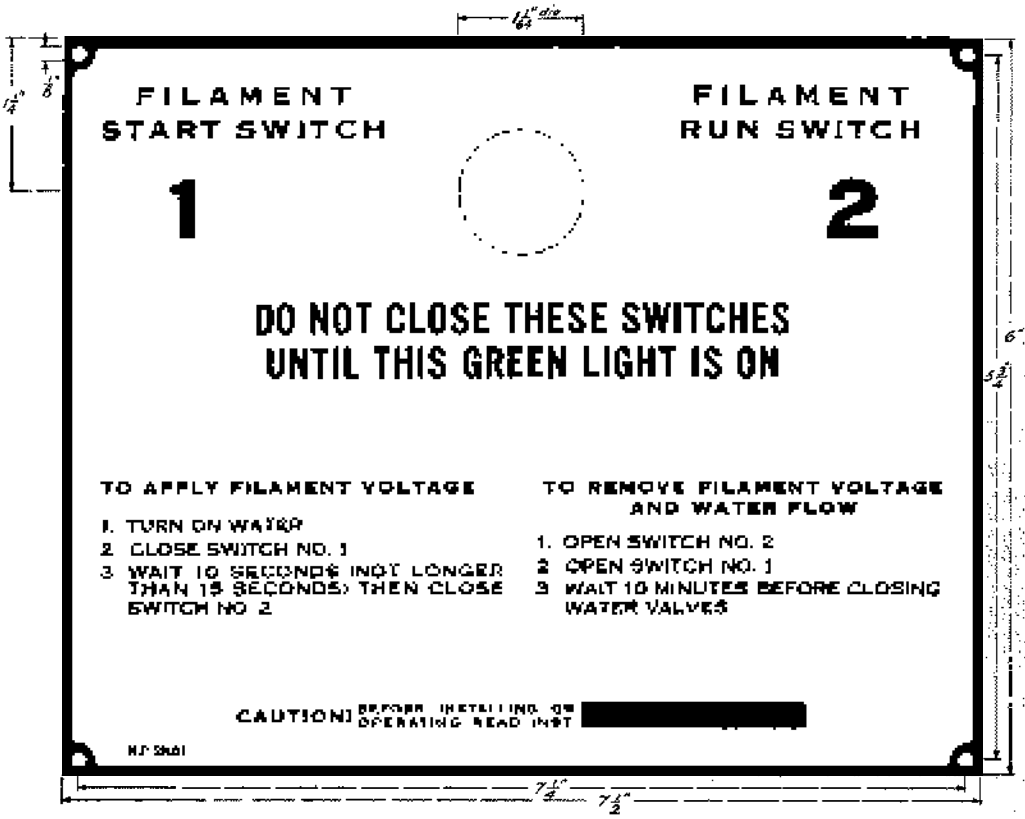
DC plate current for each PA is supplied through its isolation switch 527 to the mid-points of the two plate protective resistor banks in each unit. The plate circuit of each PA tube contains the protective resistor 511, d-c overcurrent relay coil 512 shunted by coil resistor 512-A, plate ammeter 513 by-passed by capacitor 514, r-f plate choke 510 and parasitic choke 509.

5.10 R-F Excitation

R-F excitation for the grids of the 500 KW power amplifier tubes is supplied from the output of the customer's Western Electric 50 KW broadcast transmitter, which is not modulated when used as an exciter. The driving power is inductively coupled from the tank of the 50 KW stage. A double pole double throw r-f switch is used to permit a transfer of the output from the circuit leading to the antenna to the circuit supplying the grids of the 500 KW amplifier. The two load circuits are balanced so that no appreciable change in the 50 KW tank tuning or loading is required in changing from 50 KW to 500 KW operation. For 500 KW operation the exciter output is fed into a balanced load while for 50 KW operation one side of the transmission line is grounded.

N.P 59031

500 Kw Power Amplifier
RS-62462



Area 45 sq. in.
Reversed etched nickel silver 1/32 thick, red background

Approved C. A. Paine 8 June 1933

For 50 KW operation, the output RF switch in the exciter is connected to the input of a concentric tubing transmission line which leads to the harmonic filter through switch 604 on that unit. Switch 604 must also be in the position for 50 KW operation. When in this position, auxiliary switch 604-A is closed to short circuit various interlocks in the 500 KW control circuit which, if open during 500 KW operation, would remove 50 KW exciter plate voltage. To modulate the transmitter for 50 KW output, it is of course necessary to switch the audio input from the audio amplifier in the 500 KW equipment to the audio amplifier in the 50 KW equipment. When a rapid change from 50 KW to 500 KW output is desired, it is permissible to apply plate voltage to the 500 KW amplifier before r-f excitation is applied.

For 500 KW operation, the r-f exciter output switch is thrown to connect the exciter output coupling coil to the overhead line to the 500 KW PA grid load resistor unit. This unit was formerly the phantom antenna for the 50 KW transmitter. The twelve ohmspun resistor plate assemblies are now connected in series across the line with the mid-point grounded. Each assembly contains three resistor groups connected in series and each group contains eight paralleled 110 ohm (nominal) ohmspun plates. The measured d-c resistance of the complete unit was 526 ohms line to line. Four UC-2513, 0.0012 mfd. capacitors in parallel are utilized in series with each line from the exciter to secure matched exciter loading for 50 KW and 500 KW operation. The line to the grids of the 500 KW amplifiers is a two conductor balanced line inside a shielding tube. This line is on the basement ceiling. It branches into three lines of equal length leading to the grid circuits of the three power amplifiers through grid r-f isolation switches 524. When a power amplifier unit is isolated, these switches disconnect and ground both lines leading to the PA grid circuit for the desired unit on the floor above.

5.11 R-F Power Amplifiers

The 500 KW power amplifier, operating on 700 KC, is composed of three identical unit amplifiers normally working together with their input circuits paralleled at the grid load resistor unit and their output coupling coils in series. Each PA delivers approximately 167 KW carrier power or one third the total power. The amplifier is divided into three physically separate shielded compartments to permit servicing operations when necessary in one unit while the remaining units continue to carry the program at a reduced power level.

Each amplifier is complete in itself with its own radio frequency and power circuits. There are four RCA-862 100 KW water cooled tubes 501 in each amplifier connected in push-pull with two tubes on each side of a balanced circuit.

Grid line blocking capacitors 547 and series resistors 548 are connected in series with each line to each PA. The blocking capacitors permit reading of d-c grid current in each PA unit and prevent the possibility of PA bias being present in the grid load resistor unit. Resistors 548 are utilized for stabilization. The three grid tank circuits are permanently adjusted to resonate at the operating frequency. Bias voltage is supplied at the center of the grid tank coil 503 through the self bias resistors 553 and grid r-f choke 504. The low r-f voltage end of this choke is by-passed to ground by capacitor 541. One grid tank capacitor 502 is mounted close to the grid and filament connections of each PA tube to keep the grid-filament r-f circuit short in order to prevent the possibility of parasitic oscillations. The grid chuck assembly of each tube is combined with a resistor 549 surrounded by a choke 550 to further stabilize the grid circuit. The two grid tank capacitors 502 on each side of the circuit are provided with a common safety spark gap 532.

The plate tank capacitor assembly 517 for each unit consists of two similar air-dielectric capacitor banks in series with their common point grounded to the negative filament bus.

The plate tank inductance 521 is a spiral wound or "pancake" coil. The secondary or output coupling coil 522 is a flat spiral similar to the tank coil. An electrostatic shield consisting of a large number of parallel conductors in a plane is interposed between the tank and coupling coils to reduce the electro-

static coupling between them. The conductors in the shield are connected together at the top and grounded. Plate tank tuning and loading may be varied by front of panel controls. The tuning variation is accomplished by rotation of half the outer tank coil turn about a vertical axis in the plane of the coil. The loading variation is performed by moving the output coupling coil with respect to the tank coil by means of the panel control.

The tank ammeter 520 is operated from a standard interchangeable thermocouple, 519-A, rated 5 amp. RF, 10 millivolts DC. RF is supplied to the thermocouple from a one-turn coupling coil 519 (provided by the customer) loosely coupled to the tank coil. This scheme is used in lieu of the 160/5 ampere R-F current transformer originally supplied with the equipment to permit more direct grounding of the low voltage tank capacitor plates. A calibrating rheostat 519-B is provided adjacent to each tank ammeter 520. The rheostat setting should not be changed unless a standard RF ammeter is available for checking readjustment.

DC voltage is blocked off the tank capacitor and coil by means of an individual plate blocking capacitor 515 for each tube. A static drain for the tank circuit is provided by r-f choke coil 518.

Neutralizing capacitors 516 are connected from the grid circuit of one side to the plate circuit of the opposite side of each amplifier in the conventional balanced bridge circuit.

A plate parasitic choke 509 is connected directly in series with the plate of each tube. A safety gap 509-A is connected across each choke and another gap 551 is applied between plate leads on each side.

The d-c plate circuit of each tube is protected from r-f by a choke coil 510. The d-c plate circuit for each tube contains a plate ammeter 513, the coil of a d-c overcurrent relay 512 and a section of plate protective resistor bank 511. Each plate ammeter 513, tank ammeter 520 and d-c grid ammeter 505 is shunted by an r-f bypass capacitor 514. A resistor 512-A is shunted across the coil of each d-c overcurrent relay 512 to prevent the possibility of breaking down the insulation between turns if a rapid change of current produces a high voltage across the coil. The normally open and normally closed contacts of these relays are insulated for full plate voltage from the coil. These contacts are in the control circuits described in Chapter 7.00.

The two filament busses in each PA are supplied from the basement filament busses by heavy cables for each unit. Filament voltage may be applied in two steps manually, when the filament MG's 211 are already in operation, by first closing filament start switch 507 and then closing filament run switch 506 a few seconds later. When switch 507 only is closed, filament starting resistors 508 are in series with the tube filament load. These resistors are not designed for continuous operation so switch 507 should be closed not more than 15 seconds before switch 506 is closed.

Starting resistors 508 are used to prevent the inrush current to the cold tungsten filaments of the RCA-862's from reaching a dangerously high value. The precautions listed on the nameplate between switches 506 and 507 should be carefully followed. A print of this nameplate (NP-59031) is included here for references. The operator should immediately adjust the filament voltage to the correct value when switches 506 and 507 are operated, since the change in load produces a slight change in the output voltage of filament generators 211. The filament voltage may be adjusted by rheostats 908 and meter 907 located on the console.

The negative filament bus is grounded to the frame in each PA unit while the basement negative bus is ungrounded to prevent the possibility of undesired return current paths. The positive filament connection for each RCA-862 tube is made through a filament fuse 552.

5.12 R-F Harmonic Filter

The output coupling coil of PA-1 is grounded at one end through its isolation switch 525. The coupling coil of PA-3 is at highest voltage. The three coupling coils in series constitute the input inductive section of a single "T" section low pass filter. The remainder of the filter is located in a shielded unit below ground level. The purpose of the filter is to reduce the radiation of r-f harmonics by greatly attenuating them before they reach the r-f transmission line or any part of the radiating system. The other inductive leg of the filter is coil 602 which is in a separately shielded compartment. The capacitive or shunt section of the filter is composed of the bank of capacitors 603. These also are in a separately shielded compartment provided with an air blower 601.

Since the second harmonic frequency (1400 KC) falls within the broadcast band and is the strongest harmonic present in the output, a special trap circuit is provided across the transmission line input to further attenuate currents of this frequency. This trap consists of an inductance 628 and capacitor bank 629 operated in series resonance at 1400 KC. A flipper control is provided for inductance variation, but this should remain locked in position since the circuit tunes very sharply and optimum adjustment can only be determined by r-f harmonic field strength measurements at a point remote from the station. The use of the second harmonic trap is optional.

The main harmonic filter coil 602 is directly connected to the center or high voltage conductor of the concentric tubing transmission line. This line, when properly terminated, presents a non-reactive load of 100 ohms to the output of the harmonic filter.

5.13 R-F Line Terminating and Antenna Tuning Apparatus

The radio frequency transmission line conducts the transmitter output power to the antenna house. Here the antenna load is matched to the characteristic impedance of the r-f transmission line, and its reactive component is tuned out. This adjustment results in a minimum of reflection on the transmission line. The antenna house apparatus consists essentially of a shunt capacitor 611 across the base insulator of the vertical radiator antenna, to match the antenna resistance to the characteristic impedance of the line, and an inductance 607 between the high voltage transmission line conductor and the antenna, to tune out the capacity reactance of the antenna and antenna-to-ground capacitor network.

An r-f current transformer 605, thermocouple 605-A and ammeter 606 are utilized to measure the current input to the antenna network. Since this metering apparatus is connected in the high voltage line, the entire assembly is insulated from ground for the full transmission line voltage.

An antenna grounding switch 610 and horn gap 608 are connected across the antenna-ground shunt capacitor 611. The horn gap is for lightning protection and performs a function similar to the customer's safety gap across the base insulator. The antenna circuit may be grounded during severe lightning storms when the transmitter is not in use and should always be grounded when any person is working on the antenna house apparatus or tower.

5.14 Antenna Rectifier and Associated Circuits

An antenna rectifier is provided in the antenna house which furnishes modulated d-c, proportional to the antenna current envelope, to the transmitter building. This is used for the operation of the antenna ammeter, overmodulation indicator and carrier "on" light on the console. The modulated d-c may also be used to operate a string oscillograph if desired.

R-F energy is coupled from antenna loading coil 607 by means of antenna rectifier coupling coil 609. The coupling may be varied by moving this coil with respect to coil 607 on the rotatable arm supplied for the purpose. Capacitor 627 is provided to tune coil 609, resulting in higher r-f voltage on the input of antenna rectifier tube 620 (RCA-217-C). The filament of this tube is lighted from the 115 volt station lighting supply as described in section 5.04. The r-f

circuit is from the coupling tank, through the rectifier tube 620, through filament bypass capacitors 626 and R-F bypass capacitor 624 back to the coupling tank. The d-c component (modulated d-c) flows through coupling coil 609, rectifier tube 620, filament transformer secondary 622, carrier on relay coil 980 and shunt resistor 984, carrier potentiometer 967, antenna ammeter 901 paralleled with its adjusting potentiometer 902, through linearity resistor 625 back to coupling coil 609.

Linearity resistor 625 is several times the tube drop resistance of rectifier tube 620. The tube resistance unavoidably varies somewhat with the current over a modulation cycle but this does not introduce appreciable distortion since the varying resistance is so small a part of the total resistance. Resistor 625 has a total resistance of 10,000 ohms and is tapped at 7500 and 5000 ohms. Greater current outputs can be secured with the lower resistance values and improved linearity can be obtained at the higher resistance values.

The three devices on the operator's console which operate from the modulated d-c output of the antenna rectifier will next be considered.

The antenna ammeter 901 is a d-c milliammeter designed to give full scale deflection at 100 m.a. d.c. One advantage of the use of the antenna rectifier is that it permits the utilization of a linear scale antenna ammeter rather than the customary square law scale thermocouple type instrument. Potentiometer 902 may be used for vernier adjustments when bringing the reading of console antenna ammeter 901 into agreement with the reading of antenna ammeter 606 in the antenna house.

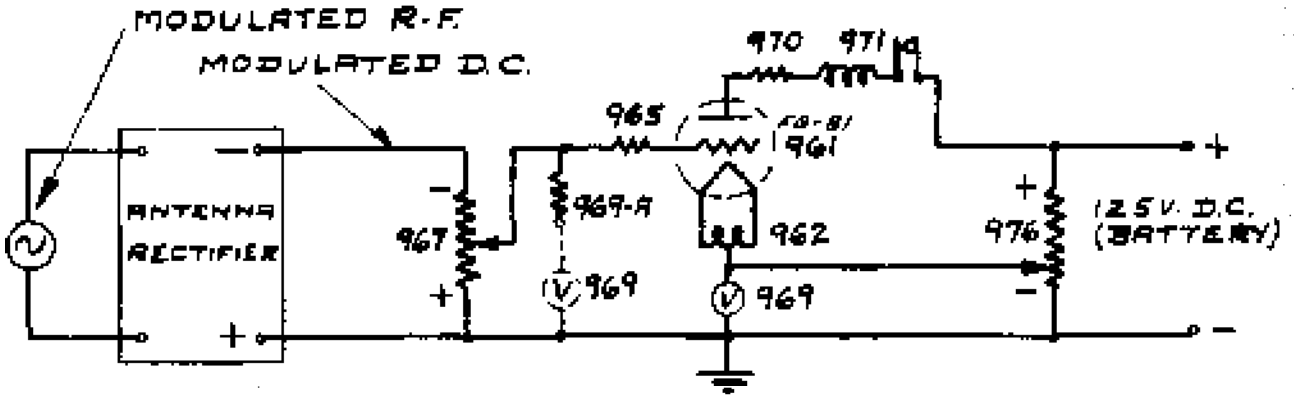
Symbols 952, 980, 981 and 983 represent apparatus connected with the carrier "on" light circuit. The contacts of carrier relay 980 close the 115 volt circuit to carrier "on" light 952 when the relay coil is energized from the output of the antenna rectifier. Coil shunt rheostat 984 is used to prevent overheating the coil of relay 980 when the antenna rectifier output current is adjusted for a high value to permit large deflections on a string oscillograph, etc. Capacitor 981 in series with resistor 983 is also shunted across the coil of relay 980. If rheostat 980 is turned to the off position for normal operation, coil 980, capacitor 981 and resistor 983 form a network, the impedance of which does not change appreciably with frequency.

Symbols 961 to 977 inclusive represent apparatus in the overmodulation indicator. A simplified schematic diagram and an operating diagram are shown on print H-5170722. The FG-81 thyratron 961 was applied to this circuit since its characteristics do not change appreciably with room temperature. The filament is heated by transformer 962 from the 115 volt station lighting supply through switch 963 as described in section 5.04.

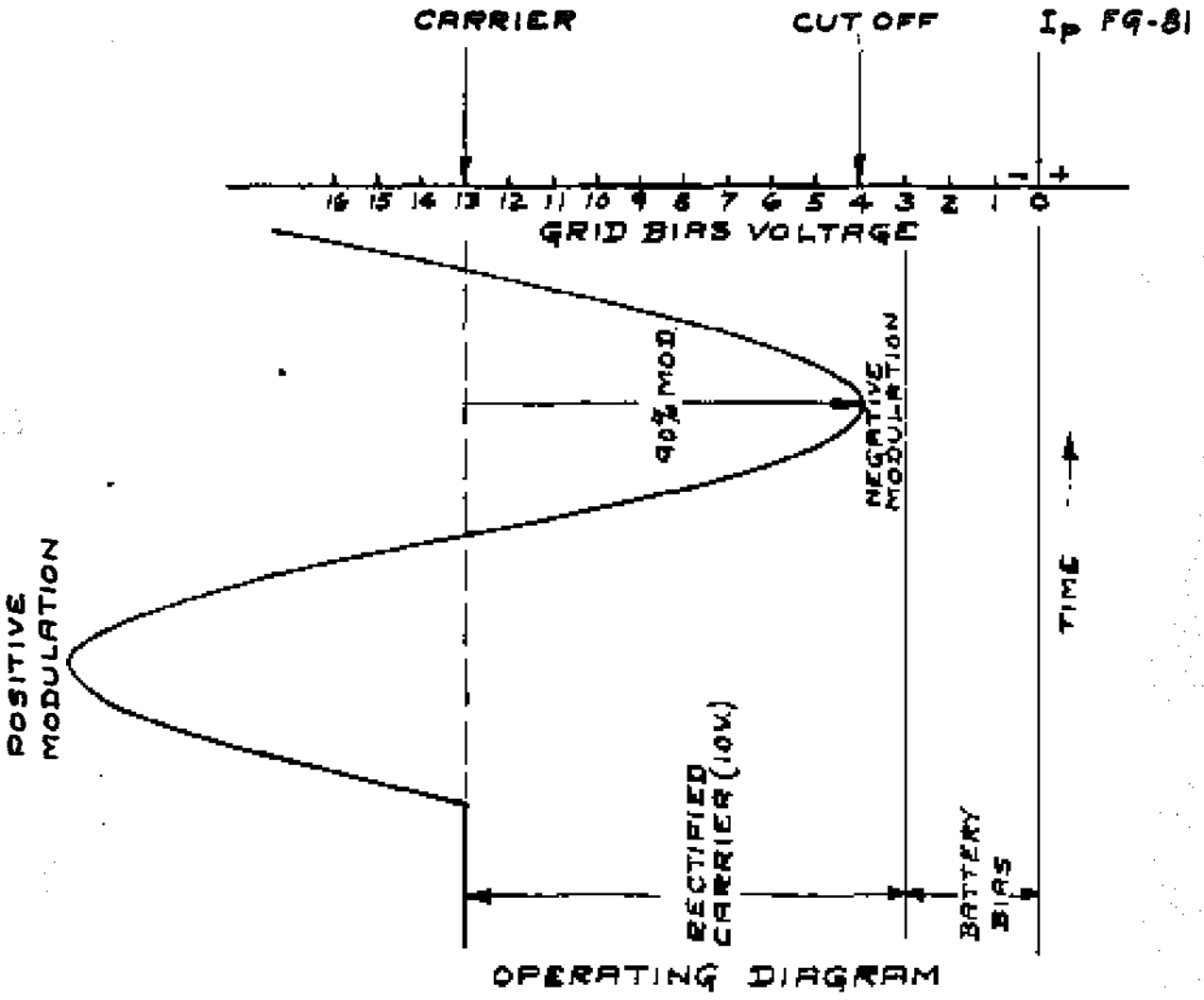
The secondary mid-point of filament transformer 962 is not at ground potential. The grid bias voltage impressed between this point and the grid of Thyratron 961 is derived from two additive sources. The voltage drop in potentiometer 967 due to modulated d-c from the antenna rectifier tends to bias the grid negatively as does the voltage drop in potentiometer 976 (and resistor 975) across the 125 volt battery supply.

If the bias of Thyratron 961 is reduced to a sufficiently low value (approximately four volts negative, depending on the plate voltage) plate current will start to flow. From the operating diagram on H-5170722 it is apparent that the Thyratron may be adjusted to indicate negative peaks of modulation, since only the negative peaks can reduce the total bias to a low enough value to cause plate current to flow. The positive modulation peaks increase the bias still further beyond cut off than the total bias for carrier only.

When the plate current is once started in a Thyratron, the grid cannot again gain control to stop plate current until the plate voltage has been removed or made negative. In this device the plate circuit is interrupted by relay 971 which has its coil and normally closed contacts both in series with the plate circuit. As soon as the plate current stops, the normally closed contacts close and the cycle is repeated. If the overmodulation is sustained, relay 971 operates as a buzzer producing an audible warning of overmodulation. Referring again to main



SIMPLIFIED SCHEMATIC DIAGRAM



OPERATING DIAGRAM

OVER MODULATION INDICATOR FOR WLW.

REFERENCE: SCHEMATIC DIAGRAM WW-7350119

GENERAL ELECTRIC CO. SCHENECTADY WORKS

DEPARTMENT - RADIO-ENG.

DATE April 30-34 DRAWN BY R.H.W.

H-5170722

schematic diagram WW-7350119, the interrupted plate current produces a voltage across the contacts of relay 971 which is sufficient to light the neon indicator lamp 974 for a visual warning of overmodulation. Capacitor 972 and resistor 973 are utilized to minimize sparking at the contacts of relay 971. Resistor 970 is also in series with the Thyratron plate circuit to limit the circuit current in case of failure of the tube.

Capacitor 964 and choke 966 operate as an r-f filter to prevent the possibility of any r-f voltages on the Thyratron grid. Grid resistor 965 is used to limit the grid current to a safe value under all operating conditions.

Overmodulation voltmeter 969 has a double scale and can be transferred into either of two circuits by means of switch 968. (On print H-5170722, this meter is shown in each circuit for simplicity.) When switch 968 is in one position (down, on diagram WW-7350119) meter 969 reads battery bias voltage from potentiometer 976 on its lower or 5 volt d-c scale. When switch 968 is in the other position, multiplier 967 is connected in series with the meter to extend its range to 25 volts d-c and the meter deflection is due to the rectified r-f voltage across potentiometer 967. The upper scale, for this position of switch 968, is calibrated in percentages of modulation to which the device can be adjusted so that an alarm will be given if the percentage is exceeded. The calibration is from 50% to 96% modulation.

To operate this device, the following adjustments are required. With the antenna rectifier in operation, set carrier potentiometer 967 to give zero voltage as indicated on the upper or percentage modulation scale of meter 969. Switch the meter to the other scale and adjust bias potentiometer 976 to the voltage where the Thyratron just fails to pass current. The passage of current is indicated by the buzzing of relay 971 and by neon light 974. Carrier potentiometer 967 is then adjusted to arbitrarily bias the grid more negatively due to rectified r-f. The amount need not be checked, but it must exceed one volt. Then adjust bias potentiometer 976 to one volt lower (less negative) bias than that previously obtained for cut off. Carrier potentiometer 967 was adjusted for an increased negative voltage so that plate current flow would not influence the second adjustment of bias potentiometer 976. Voltmeter 969 is then switched to the "carrier" position in which the reading is determined by carrier potentiometer 967. The meter reading can now be adjusted to indicate the desired percentage modulation which if exceeded will cause the alarm to be given.

The operating diagram on H-5170722 shows the voltage relations for the alarm to be given when the modulation exceeds 90%. The modulation percentage indicated by the a-c wave is the critical value which if exceeded will result in the passage of plate current through the Thyratron 961. The battery bias voltage on this diagram is adjusted to one volt less than cut-off which is here assumed to be minus 4 volts. The carrier voltmeter 969 reads bias due to rectified r-f only, not total bias, when switched to the carrier position. If this rectified carrier bias is made equal to 10 volts and the battery bias has been "stepped back" one volt from cut off, it can be seen that plate current will pass on a negative peak of modulation which reduces the total instantaneous bias to 4 volts or less and that such a peak of modulation will be 90% or greater. The upper scale of carrier voltmeter is marked "90%" at this point and is calibrated for corresponding percentages for other values of rectified r-f bias. It should be noted that a change in radiated power from the transmitter will cause a change in the percentage modulation at which the alarm is given. The alarm is also given in case the transmitter carrier goes off the air.

5.15 Plate Voltage Circuits (Audio Amplifier)

Plate power for all of the air cooled tubes in the High Power Audio Amplifier is obtained from the Low Power Rectifier. This rectifier utilizes the conventional three phase, full wave circuit. In this circuit, the anode of one tube 306 and the cathode of another are connected to each high voltage a-c line from plate transformer 307, so that both halves of the a-c voltage wave are rectified. Two tubes operate in series, and each pair of tubes carries current one third of the time.

The rectifier filter is composed of the reactor 308 in the negative (grounded) lead and the capacitor 149 across the load. The negative lead is grounded through the over current relay 310. Voltmeter 311 in connection with the voltmeter multiplier resistor 312 indicates the output voltage of the rectifier.

The full output voltage of the rectifier is delivered to the RCA-849 stage and the first RCA-211 stage. The plate voltage for the second RCA-211 stage is obtained from potentiometers 313 and 314. Capacitor 150 acts as additional filter for the RCA-211 plate supply, and also as a low reactance path to ground for the audio frequency components of RCA-211 plate current.

The plate current for each of the RCA-211 tubes in the first stage is indicated on separate plate current meters 114. Similarly the plate current for the second RCA-211 stage is indicated on separate plate current meters 124. The meters 134 read the plate current for each RCA-849.

5.16 High Pass Filter and Equalizer

The high pass filter was supplied to prevent excessively high voltages from appearing across the modulation coupling capacitor, the modulation reactor, and the main rectifier filter. This can occur if modulation of high amplitude at a frequency in the order of twenty-three cycles is present in the audio line. The high pass filter attenuates frequencies of this order approximately fifteen decibels more than frequencies in the band of thirty to ten thousand cycles, consequently the possibility of dangerously high voltages existing on the audio input to the High Power Audio Amplifier is eliminated.

The equalizer is supplied to compensate for the attenuation of frequencies in the band of thirty to one hundred cycles which is present in the audio amplifying system. This is accomplished in the equalizer by adjusting it to pass thirty cycles without attenuation and to gradually increase attenuation of frequencies from thirty to one hundred cycles whereupon the attenuation is constant for frequencies in excess of one hundred cycles. The attenuation of the equalizer is adjusted for approximately two decibels at one hundred cycles.

5.17 Audio Amplifier

The audio amplifier is composed of four stages, each stage having two tubes operated in push pull so as to minimize even harmonic distortion.

The input to the first stage is obtained from the audio line amplifiers. Approximately zero decibels (12.5 milliwatts) is required for full output. An "H" pad 101 and 102, is automatically inserted in the input line by means of relay 103 in case any unit is isolated; the attenuation is also automatically provided during "step-start" application of rectifier voltage. This cuts down the level the proper amount to prevent overloading or overmodulation which would otherwise occur. The input transformer 104 is loaded by resistors 105 so that it presents a 500 ohm load to the audio line. Bias for the first stage tubes is obtained from the 1500 volt bias generator by means of potentiometer 107 and 108. The bias is by-passed by capacitor 106. Filament voltage for each tube is obtained from the main filament bus. Resistors 110 and 111 are used to drop the voltage to the proper value. A switch, 112, is inserted in the circuit to remove filament voltage when necessary. Plate power for the first stage is obtained from the 3000 volt supply through resistors 113 which serve to reduce the voltage to the proper value and also to act as the plate load for the first stage. The output of the first stage is coupled by means of capacitors 115 to the grid circuit of the second stage.

The bias voltage for the second stage is obtained from the 1500 volt supply by means of potentiometer 117 and 118. It is applied to the grids of the tubes through resistors 116 and is bypassed by capacitor 117. Filament power is obtained from the 33 volt bus through switch 123 and is adjusted to the proper voltage by resistors 121 and 122. Plate power is obtained from the potentiometer across the 3000 volt supply and is applied to the tubes through transformer 125. The secondaries of this transformer are loaded by resistors 126 so as to present the proper load resistance to the tubes of the second stage.

Grid excitation for the third stage is obtained from the secondaries of transformer 123. Bias for each tube of the third stage is obtained from the 1500 volt bias generator by means of individual resistors 127 and fixed resistor 129. The bias is bypassed by capacitor 128. Filament power is obtained from the 33 volt bus through switch 133 and is adjusted to the proper voltage by resistors 131 and 132. Plate power is obtained from the 3000 volt rectifier through the primaries of transformer 135. The secondaries of this transformer are loaded by resistors 136 to present the proper load resistance to the plate circuit of the tubes of the third stage.

Grid excitation for the fourth stage is obtained from the secondaries of transformer 135. Bias for the fourth stage is obtained from the 1500 volt bias generator. In addition, separate bias voltages for each tube can be adjusted by use of the bias trimmer battery 138 which is in series with the main bias generator. Each bias lead is bypassed by capacitor 137. Filament power for the fourth stage is obtained from the 33 volt bus through switch 146 and adjusted to the proper value by means of resistors 145. Plate power is obtained from the main plate rectifier. It is fed through the primaries of two separate transformers 418 which are connected in parallel. The individual plate ammeters 144, the overcurrent relays 143, indicating relays 140, overcurrent relay protective resistors 142, and surge current limiting resistors 141, are included in the plate lead to each tube. The plate of each tube is water cooled by water from the distilled water circulating system. Each transformer 148 has two secondaries which are connected by means of isolation switch 152 to the grid circuit of each modulator.

5.18 Modulators

The modulator is divided into two similar units. Each unit has four tubes, Type RCA-862. These tubes are connected in pairs, each pair being connected in parallel and then utilized as a push-pull amplifier. The grid circuit includes a load resistor 153 for each pair of tubes. These resistors are designed to present the proper load through transformers 148 to the tubes of the fourth stage. Bias for the modulators is obtained from the 125 volt bias generator. Separate bias voltage for each pair of modulator tubes is obtained by means of the bias trimmer battery 147 which is connected in series with the bias supply. The bias is bypassed by capacitor 154. Filament power is obtained from the 33 volt bus through start switch 175, starting resistors 162 and run switch 161. The grid circuit has in series with each tube a resistor 193 shunted by a choke coil 193A. Also, the grids of each pair of tubes are bypassed by capacitor 194. The resistors, chokes, and capacitors stabilize the tubes under transient conditions.

Plate power for each modulator is obtained from the main rectifier and passes through totalling ammeter shunt 163-A, then through transformer 160. The plate circuit for each tube includes the surge limiting resistor 159, individual plate meters 156 and calibrating rheostats 156-A, the overcurrent relays 157 and overcurrent relay protective resistors 158. The total current for each modulator is indicated on meter 163 which operates in conjunction with shunt 163-A.

The output circuits of the transformers 160 are connected in series by means of the isolation switch 185. The output is coupled to the load by means of coupling capacitor 165 and the modulation reactor 166.

Cooling water for each modulator tube is supplied from the distilled water circulating system. Cooling air for the filament and plate seals of each tube is obtained from the air supply.

Filament fuses 193 are included in series with the positive filament lead of each tube. The negative filament lead is grounded in the unit. Filament starting resistors 162 are required to limit the current which flows when connecting the cold filaments to the full bus voltage. These resistors are not rated for continuous duty and should not be left in the circuit for longer than 15 seconds.

5.19 Isolation Switches

The high voltage and high current circuits associated with the unit isolation switching assembly are, on schematic diagram WW-7350119, distributed through the circuits of the three power amplifiers and two modulators. The isolation switching circuits are grouped and shown in their approximate relative positions on external connection diagram WW-7350122. These switches, together with their operating thrustors and auxiliary switch banks are located on the basement ceiling beneath the rear of the PA and modulator transmitter units. The power circuit double-break isolation switches are so interlocked that they are never required to make or interrupt circuits under load and they are not designed for operation under load.

The power circuit isolation brushes connect bias voltage, plate voltage, r-f input, r-f output, audio input and audio output to appropriate circuits in the PA and modulator units when these units are in service. When a given unit is isolated, or taken out of service, the power circuit isolation brushes for that unit are rotated by means of a thrustor to close on another set of contacts.

When these power contacts for a given power amplifier unit are in the "isolated" position, the following conditions obtain:

1. The bias voltage line to the unit is disconnected from the bias supply and grounded by switch 524.

2. The plate voltage line to the unit is disconnected from the plate supply and grounded by switch 527.

3. The r-f input lines to the unit are disconnected from the r-f grid supply and grounded by switch 524.

4. The r-f output lines to the unit are disconnected. The two outgoing r-f lines, connected to output coupling coil 522 for normal operation, are now connected together.

When the power circuit contacts for a modulator unit are in the "isolated" position, the following conditions obtain:

1. The plate voltage line to the primary of modulation transformer 160 is disconnected from the plate supply and grounded by switch 184.

2. The audio input lines for each pair of modulator tubes 155 is disconnected from the output of the high power audio stage and the input lines are grounded by switches 152. These switches are located at the rear of the high power audio unit and are mechanically operated by a thrustor 186 below the floor. The disconnecting and grounding of these circuits also removes bias voltage from an isolated modulator unit.

3. The audio output lines from the secondary of each modulation transformer 160 are disconnected. The two outgoing lines are connected together.

The control circuit for the operation of the isolation switches is described in section 7.06.

6.00 ANALYSIS OF OPERATION - COOLING SYSTEM

6.00 ANALYSIS OF OPERATION - COOLING SYSTEM

6.01 General

The cooling system used for this equipment is composed of three parts:

1. Distilled water system
2. Raw water system
3. Air cooling system

The Distilled Water System is used to supply cooling water to the anodes of the various water cooled tubes. The heat taken up by the water in this system is transferred to the raw water by the heat exchanger.

The heat in the water of the Raw Water System is transferred to the outside air by means of evaporation in the spray pond.

The Air Cooling System supplies air which cools the filament and plate seals of the UV-862 Radiotrons and also supplies air for the RCA-870 Radiotrons.

In order to assist in understanding the following discussion, reference should be made to Drawing T-7604065, the Water Piping Schematic.

6.02 Distilled Water System

In this discussion, it will be assumed that the system is completely drained and that the storage tank has sufficient water in it to fill the system. Valve #1 will, therefore, be closed. Valve #2 should also be closed. All other valves (including #6) should be open. Now with the pump motor shut off, open valve #1. This will allow the heat exchanger to fill with water. The small pet cocks on the pump should be opened to release trapped air until water flows from them. After a few minutes, close valve #5 and start the pump. As soon as pressure is built up in the pump water will flow from the storage tank through the pump and into each unit through main inlet valve #12 and flow adjusting valves #15, #16, #17 and #18. Water will then circulate through the hose coil, the tube jacket, back through the hose coil, and the flow meter to the fitting which holds the bulb for the water temperature thermometers. Here it will split into two streams, one of which flows through the main outlet valve #13 and the other through the air release valve #14. The stream which flows through the main outlet valve will be returned to the tank through valve #6. The stream which flows through the air release valve will go to the stand pipe and as valve #2 is closed the stand pipe will commence to fill up. The pump should be kept running until the stand pipe has filled to the level of the water gauge. Valves #6 and #1 should then be closed and valve #5 opened. This should be done slowly so that the air which was trapped in the pipe which brings the water from the main return line to the heat exchanger may be released into the system in small amounts. If this is not done, an air pocket will form in the pump and it will cease to function. The air may be released by means of the small pet cocks previously mentioned. After the valve #5 has been opened all the way, valve #2 should be closed and valve #1 opened. This will allow the stand pipe to fill up again as it will have lost some water which replaced the air trapped in the pipe to the heat exchanger. As soon as the water level is about half way up in the gauge, close valve #1 and open valve #2. The system should be full of water and ready for operation.

Due to the fact that air, occluded in the water, will be given off rapidly at first, it will be necessary to check the level of water in the stand pipe frequently. The water level may be raised by closing valve #2 and opening valve #1. The rate at which the pipe fills may be increased by partially closing valve #5 which will change the distribution of pressure so that there will be more pressure on the air release line. Care should be taken to maintain the water level so that the air release line is always discharging under water.

6.03 Raw Water System

When valves #7, #8, #9, #10, and #11 are open, the whole system will fill up to the level of the water in the pond due to the fact that, with the exception of the spray nozzles and a portion of the piping attached to them, all the system

is below the level of water in the pond. The air which is trapped in the pump may be released by opening the pet cocks on the pump. Now if the pump is started water will circulate through the system and will be returned to the pond in the form of a spray. The amount of water which flows can be controlled by valve #8. The amount which flows to each set of spray nozzles can be controlled by valves #10 and #11.

6.04 Air Cooling System

The air cooling system consists of a blower, which takes air from outside of the building and blows it into an air duct. From this duct, two pipes run into each unit. From one of these pipes, air is delivered to the two tubes. The major portion of the air is delivered through insulating hoses to the anode seal of each tube. The rest of the air is delivered through insulating hoses to the filament seal of each tube.

At the end of the main duct, a pressure operated control 268 is placed. This contact is in series with relay 833 and prevents the application of power to the equipment until the air pressure is adequate.

7.00 ANALYSIS OF OPERATION - CONTROL CIRCUITS

7.00 ANALYSIS OF OPERATION - CONTROL CIRCUITS

7.01 General

Any control circuit wire which runs from a given transmitter unit to one or more other units is designated by a circuit number shown adjacent to the wire on schematic diagram, WW-7350119. This circuit number appears as a terminal board number on each transmitter unit to which the circuit is connected. For example, circuit 189 is "ground" and appears on the terminal board of practically every transmitter unit in the equipment.

The approximate physical location of a control circuit item can, in general, be determined from the item number as indicated in section 5.01.

The coils and contacts of most relays are separated on the schematic diagram for the sake of clarity. A dash line on the diagram connects the contacts to the coil which operates them. All contacts are shown in the "normal" position. (No voltage on the coil, no air flow, or no water flow.) Access door and similar interlocks and manually operated switches are arbitrarily shown in the open position. Auxiliary switches mechanically operated by the isolation switches on the basement ceiling are shown in the position which corresponds to all transmitter units in operation.

All contacts may be assumed to be practically instantaneous in operation unless an arrow is shown connected to the contact symbol on the diagram. A contact which operates at a definite time after its coil is energized (or de-energized) may fall into one of the following classes:

1. Normally open, definite time closing; represented as an open contact symbol with an arrow pointing toward the closed position.
2. Normally open, definite time opening; represented by an open contact symbol with an arrow pointing toward the open position.
3. Normally closed, definite time closing; represented by a closed contact symbol with an arrow pointing toward the closed position.
4. Normally closed, definite time opening, represented by a closed contact symbol with an arrow pointing toward the open position.

In each case, the arrow points toward that position of the contact which is reached after a time delay.

The sequence of operation in starting up the equipment is largely that shown by progressing from top to bottom of the control circuit schematic diagram; in closing down, the reverse is true.

7.02 Starting up the Transmitter (Manual Step by Step Control)

In this description, it is assumed that all power switches on the distribution panel and rectifier circuit breaker unit are closed, their fuses in place and that transfer switches on the distribution panel are closed for the machines to be used. The 125 volt battery Converti-fuse switch plug should be in place, energizing the coil of the control voltage transfer relay 835 for the main circuit breaker 415. Battery on light 913 will light if switch 985 is closed and fuse 986 is in place. Both the latter are located in the customer's battery fuse box in the basement. The step-by-step control switches 954, 923, 924, 925, 926, 927 and 920 should all be open.

7.021 Main Transmitter Start

Push button 912 is operated to start up the transmitter, either for automatic or step-by-step manual control. This energizes the coils of shop MG starter 241 and main rectifier filament interlocking relay 852 from the 220 volt a-c supply. Starter 241 is provided with a seal-in contact which short circuits the momentary make contacts of push button 912 as soon as the coil of 241 is energized. When the transmitter is in full operation, the shop MG supplies 125

volts d-c for the rest of the control circuit, power for the air blower and excitation for the filament and bias generators. As soon as the self-excited shop generator voltage builds up, transmitter start light 940 will come up to full brilliance. Incidentally, buzzer 834 sounds at starting until the shop machine voltage builds up to a value sufficient to open the normally closed contact of relay 267. The buzzer thus serves to warn those in the building that the equipment is being started up although its primary function is to indicate over-temperature in the main distilled water outlet header, as described below. The coil of the auxiliary relay 275 for the air blower starter is energized as soon as the shop generator voltage builds up but the starter does not operate since switch 923 is open. Since shut down relay 811 is not energized at any time during the starting up or operation of the equipment, its normally closed contact connects 125 volt shop circuits 15 and 11 at all times except during shut down; hence the coils of all relays, starters and circuit breakers for the cooling system, filament, bias and plate supplies necessary to bring the transmitter to full operation now have their positive terminals energized by battery or shop machine. It is now only necessary to connect the other terminals of these coils to ground in the proper sequence, and through protective devices for apparatus and personnel, to put the transmitter on the air.

7.022 Main Rectifier Filaments

If main rectifier filament switch 954 is closed, the coil of filament contactor 804 is energized and filament voltage is applied to the main rectifier tubes 401. This voltage is first applied at reduced value for starting since resistor 829 is in the circuit; after a few seconds the time delay contact on 804 shorts out the resistor applying filament voltage at the operating value. Voltage is applied to the coil of the rectifier filament 30 minute timing relay 808 at the same time that the coil of 804 is energized. The normally open, time closing contact of this relay is in series with the plate control circuit and prevents the application of plate voltage until the rectifier filaments have reached operating temperature. In case it is necessary to remove filament voltage after the warm up period, for example to change a tube it is not desirable to wait the full 30 minutes for timing relay 808 to again permit the application of plate voltage since a spare tube has its filament heated ready for an immediate change during operation. Provision is made for this condition through the use of switch 413 for changing tubes. This switch, located near the rectifier access door, serves to open the filament contactor without tripping the timing relay 808. The rectifier filament under voltage bell 814, described below, will ring during the time that switch 413 is open. In case line voltage should fail momentarily or switch 954 should be inadvertently operated with the set on the air, timing relay 808 will trip and require 30 minutes before plate voltage can be reapplied automatically. However, in such an emergency, the timing element in 808 may be rotated manually to the closed contact position if the cover is removed. The operator should be very sure that the filaments of the rectifier tubes have reached full operating temperature if destruction of the tubes due to ionic bombardment of the filaments is to be avoided.

It should be noted that rectifier filament voltage may be applied independent of the status of console switch 954 and interlock relay contact 832 through the contacts of 810 and 830. 810 is an electrically operated clock switch to turn on the filaments at a predetermined time each day, omitting any desired days each week automatically. This clock switch may be operated manually if the operator desires to energize the rectifier filaments without starting the shop machine. If the automatic startup feature is not desired at any time, switch 830 may be opened. If the 115 volt a-c station lighting circuit supplying this clock switch is opened, it will be necessary to reset the timing device to the correct time. It should be noted that the contacts of clock switch 810 are only closed for about 30 minutes. If, at the end of this time, the operator has not started the shop machine and closed switch 954, the rectifier filament voltage will be removed.

The remaining contact of filament contactor 804 applies voltage to the over-current target control circuit, to the rectifier air blower 408 and also to the rectifier air heater resistors 428 provided that the contacts of thermostat 436 are closed.

Main rectifier filament on light 939 is so connected that it is dim while the filaments are on reduced voltage and bright when full voltage is applied.

Since the rectifier tubes may be easily damaged by filament under voltage, an undervoltage protective scheme is provided. Relays 809, 817, 831-A and 831-B are parts of this system. When undervoltage relay 809 closes its low voltage contacts, bell 814 rings and timing relay 831-A starts. If the operator has not increased the filament voltage to normal within approximately ten seconds after the bell starts to ring, the timing contact of 831-A will close, energizing the coil of relay 831-B which opens its normally closed contact in the plate control circuit. If the interlocking relay 832 is closed, the bell warning will be given if the filament voltage is reduced. However, if the filament voltage is applied by means of the clock switch, the bell will not operate unless console switch 954 is also closed. When the rectifier filaments are initially heated, the contacts of relay 809 will be in the low voltage position as shown on the diagram. They thus complete the bell circuit causing it to ring during the low voltage starting period. The coil of auxiliary relay 817 (on the rear of the control panel) is also energized at this time, and its contact seals in its coil even during the travel of the 809 contacts toward the full voltage position. However, when they reach the full voltage position, they short circuit the coil of relay 817 causing its sealing contact to open and placing full line voltage across resistor 817-A. The bell will now stop ringing and timing relay 831-A will trip open. The contacts of relay 809 may now travel slightly away from the full voltage closed position (as they do on the line voltage transient when the filament MG's are started) but the bell will not ring until the voltage drops sufficiently to close the low voltage contact.

7.023 Cooling System

With the shop machine running and auxiliary air blower relay 275 closed as described above, the tube pump, pond pump, and air blower may be started simultaneously by means of cooling system switch 923, provided that the manual-reset overload contacts in the coil circuit of each starter have not been tripped. Closing this switch energizes the coils of starters 263 for the tube pump, 258 for the pond pump, and 252 for the air blower. The purpose of auxiliary relay 275 is to keep the air blower starter from chattering when the shop machine voltage has built up to a low value during automatic start-up of the apparatus. The coils of pump and blower starters 252, 258 and 263 are provided with "soaking" resistors which are short circuited by normally closed auxiliary contacts while the starter is closing and are connected in the coil circuits when the starters are closed. The blower starter 252 has three time delay contacts in addition to the normally open pole which connects the negative side of the line to the motor armature. One is normally closed, time delay opening and serves to short circuit the field rheostat 254 during starting, so that full voltage appears across the field at this time. The other two contacts are normally open, time delay closing, but are adjusted to different values of operating time. They serve to short circuit first a part, then all of a resistance in series with the motor armature as the motor speed builds up.

The closing of the above starters is indicated by lights 943, 942 and 941 respectively; each light is energized by the line voltage on the load side of the starter whose closing it indicates. The 3 phase, 220 volt supply for the customer's air blowers in the roof of the transmitter compartments is obtained from the load side of starter 263 for the tube pump. If the operator wishes to check the operation of the tube pump, pond pump or air blower separately, he may do so by opening the a-c line switches, 261, 256, or 250 for the apparatus he does not wish to operate. None of these switches should be closed manually when its starter has already closed. If motor line transfer switches 264, 259 or 253 are used in checking separate operation of cooling system apparatus, false indications will be given by console lights 943, 942 or 941.

When the tube pump water reaches normal flow, flow interlocks will be closed by the water. The outlet side of the cooling jacket for each water cooled tube in the equipment is connected to a flow interlock. These are designated as symbols 535 in the PA's, 167 in the modulators and 168 for the high power audio tubes. The flow interlocks in each of the six transmitter units involved are connected in series with the coil of the corresponding flow interlock relay 815.

The coil of each of these relays is energized when the flow interlocks for the corresponding transmitter unit are all closed; the contacts of relays 815 are all in series with the filament MG control circuit described below. Green "water on" lights, 523 and 124, are in parallel with the coils of flow relays 815. These lights, located between the heavy filament load disconnect switches, give an indication that the operator may safely close the filament disconnect switches for a given unit after filament voltage has been applied to other units. The filament load start switches (No. 1) are symbols 507 in the PA's and 175 in the modulators; the filament run switches (No. 2) are 506 and 161. Each switch is provided with interlock contacts which close when the main switch is fully open. The start switch interlocks are 507-A and 175-A; the run switch interlocks are 506-A and 161-A. When both filament load disconnect switches in a unit are fully open, the interlock contacts short circuit the flow interlock contact for that unit so that water in that unit may be shut off without stopping the filament MG's. Run switch interlocks 506-A and 161-A are also utilized to light filament off lights 540 and 164 between the water valves on the front panels. The filament voltage is completely removed from the unit when one of these lights comes on, since, according to nameplate instructions, main switches 506 and 161 (No. 2) should be opened last when removing filament voltage. In any case, if the operator attempts to remove water flow from a given unit without completely opening the filament disconnect switches, filament, bias and plate voltages will automatically be removed from the complete transmitter; these voltages will be similarly removed if he attempts to apply filament voltage without full water flow, even though the unit be isolated. This system was incorporated to remove the human element from the protection of the water cooled tubes, which would probably be destroyed if filament voltage were applied even momentarily without cooling water flow.

Each PA and modulator is provided with two outlet water over-temperature interlocks, 533 and 171, and the HPA unit with one, 170. The contacts of these interlocks are paralleled across the coil of a temperature relay 803 for each unit. When the water temperature exceeds a predetermined value in any unit, the contacts of the corresponding temperature interlock close, short circuit the coil of relay 803 for that unit causing full shop machine voltage to appear across coil resistor 803-A. Normally, relays 803 close as soon as the shop machine starts. If the contacts of a relay 803 open twice within a minute or stay open over 5 seconds, the corresponding transmitter unit is isolated, or in the case of the high power audio stage, plate voltage is locked out. The operation of this isolation and lockout circuit is described below.

Another water over-temperature interlock 266 is located near the basement ceiling on the main outlet water header. Interlock 266 short circuits the coil of telephone relay 267 when the high temperature contacts close, leaving full shop voltage across resistor 267-A. When the coil of relay 267 is de-energized, its normally closed contact closes, causing alarm buzzer 834 to operate. Temperature interlock 266 is set about 10 degrees F. below the settings of similar interlocks on the transmitter units, so that the operator generally will be warned before a unit is isolated or plate voltage locked off due to water over-temperature.

An air pressure interlock 268 is provided on the main air duct, on the basement ceiling underneath the rectifier. When the air blower is started and air pressure is built up in the duct, the normally open contacts of this interlock close, energizing the coil of air interlock relay 833. The contacts of relay 833 are in the filament control circuit described below.

7.024 Low Power Rectifier Filaments

With the shop machine in operation, the low power rectifier filaments may be started at any time by closing switch 924. This switch energizes the coil of L.P. rectifier filament contactor 301, whose contacts light the a-c filaments. A "soaking" resistor 319 is inserted in the common coil circuits of L.P. rectifier contactors 301, 316 and 318 by the opening of a normally closed contact on rectifier plate run contactor 316 when plate voltage is applied. Red light 944 and timing relay 304 are also energized from the 220 volt a-c supply. The timing contacts of 30 second relay 304 are in the plate control circuit of the L.P. rectifier described below in section 7.027.

7.025 D-C Filament MG's

Filament MG start switch 925 is the beginning of a long series control circuit containing various switches and normally open and closed relay contacts. The first nine series-connected contacts beginning with switch 925 are in the d-c filament machine control circuit. The first nine plus eight more are in the bias machine control circuit. The first 17 plus six more constitute the L.P. rectifier plate control circuit. The first nine plus the first two bias circuit contacts plus 65 more contacts in series constitute the main plate rectifier control circuit.

If switch 925 is closed, and the six series connected contacts of flow interlock relays 815 are all closed as described above, the filament MG's 211 will start when d-c filament rheostat 908 is turned to the minimum voltage position closing an interlock on its shaft which is only closed with the rheostat in minimum voltage position. When all series contacts of the filament MG control circuit are closed, the coil of 813, auxiliary contactor for filament MG start, is energized. A normally open time delay contact on this relay short circuits the rheostat shaft interlock after about five seconds, permitting the rheostat to be turned to the normal voltage position. This time delay contact operates at about the time the MG's reach full speed. This manual method of insuring low inrush current to the cold filaments of the water cooled tubes is used because it is simpler and better than any automatic step-start arrangement which could be devised. Another contact of relay 813 applies field voltage to the three machines by short circuiting filament field resistor 217. Resistor 217 is used to provide more rapid dropping off of filament voltage at shut down than would be the case if full field were left on while the machines were coasting; at the same time, the abnormal voltage stresses which would obtain, were the field circuit completely opened at shut down, are eliminated. The third contact on relay 813 is used to operate the three 2300 volt motor line starters, 207. If the operator wishes to operate one or two of the filament MG's instead of the normal three (assuming a suitable portion of the filament load disconnected) he may open one or two of the filament load disconnect switches 213 and line switches 205, before starting the machines, in which case he must also open the corresponding starter control switch(es) 210, to prevent the starters of the unloaded machines from operating. An auxiliary contact on each starter 207 energizes the coil of auxiliary filament starter relay 207-A, which has two contacts. One normally closed contact opens leaving a soaking resistor in series with the 207 starter coil for normal operation. The other contact, normally open, completes the circuit to the filament MG on light 945 for a given machine. The status of the three lights 945 indicates at all times the number of filament machine starters closed. When the filament voltage starts to build up, it energizes the coil of d-c filament under-voltage relay 816, the normally open contacts of which are in series with the bias control circuit described below.

7.026 Bias MG's

In addition to the interlocks already discussed for the filament MG control circuit, the contacts of the six door interlock relays 805 are in series with the bias starter control circuit.

Each PA door interlock relay 805 has the following interlocks connected in series with its coil:

2 #536 Front access door interlocks,
1 #646 Safety grounding switch interlock,
2 #536 Rear access door interlocks,
1 #538 Cat-walk interlock.

Each modulator door interlock relay 805 has the following interlocks connected in series with its coil:

1 #190 Safety grounding switch interlock,
2 #172 Front access door interlocks,
1 #173 Cat-walk interlock.

The rectifier and HPA door interlock relay 805 has the following interlocks connected in series with its coil:

2 #189 HPA rear door interlocks,
1 #407 Rectifier front access door interlock,
1 #441 Safety grounding switch interlock,
1 #407 Rectifier front access door interlock,
1 #420 Rectifier Cat-walk interlock,
1 #424 Basement grille door interlock.

When these 33 interlocks are closed, the coils of the six door interlock relays are energized, and their contacts close. Each relay 805 has two normally open contacts. One of these contacts on each of the six relays constitutes a part of the series circuit for starting the bias MG's. Each of these contacts on the five 805 relays for the PA's and modulators can be shorted out by operation of the corresponding rotator auxiliary switch. These auxiliary switches, 542 for the PA's and 187 for the modulators, are the multiple contact type; one bank of contacts is located in the isolation switch frame adjacent to each rotator. The operation of the isolation switches is described below in section 7.06. The other normally open contact on each relay 805 is in series with the corresponding section of the plate control circuits which affects the isolation of a transmitter unit. The circuit is described below, but the operation with respect to isolation from opening of the door interlock relays is as follows: If a door is opened in a transmitter unit, bias and low power rectifier plate voltages are removed by the 805 relay contact in the bias control circuit and plate voltage is removed by the 805 relay contact in the plate control circuit. The contact in the plate control circuit serves a double function; when open, it sets up the isolation timing system for the unit so that if the door remains open for about five seconds (or is opened, closed and reopened in rapid succession) the transmitter unit will isolate. When this occurs, all dangerous voltages are disconnected from the transmitter unit, the 805 contacts in the bias control circuit are short circuited by rotator auxiliary switch contacts 542 or 187, the plate control contacts are similarly short circuited and the remaining units of the transmitter are again placed in operation. In the case of relay 805 for the main rectifier and high power audio stages, the opening of its contacts for about five seconds, (or their opening twice in rapid succession) will serve to lock out plate voltage.

Now assuming that the d-c filament voltage relay 816 is closed, bias switch 926 is closed, and all six door interlock relays 805 are closed, the coils of bias MG starter 222 and bias field contactor 227 will be energized in parallel and a bias machine 224 will start. Starter 222 has a normally closed auxiliary contact which places a soaking resistor in its own coil circuit for normal operation. Bias on light 946 is energized from one phase of the 220 volt supply on the load side of bias starter 222. The contacts of bias field contactor apply field voltage to the three bias generators in each bias MG set by short circuiting bias field resistor 228. Resistor 228 is used to provide more rapid dropping off of bias voltages at shut down than would be the case if full field were left on while the machines were coasting; at the same time, the abnormal voltage stresses which would obtain were the field circuit completely opened at shut down, are avoided.

As soon as the three bias voltages build up, three bias relay coils are energized through suitable resistors causing all their normally open contacts to close. These relays are as follows:

#231 HP audio bias relay (Two circuits.)
#233 Modulator bias relay (One circuit.)
#234 PA bias relay (Two circuits.)

One circuit of each of the three bias relays is in series with that portion of the main plate control circuit which provides for plate voltage lockout as well as plate voltage removal. The other HP audio bias relay 231 contact is in series with the low power rectifier plate control circuit to prevent the application of plate voltage to the low power audio amplifier stages before bias voltage is applied. The remaining PA bias relay 234 contact is in series with the coil of S12A, the 17 KV rectifier plate contactor in the 50 KW exciter, to pre-

vent the application of RF excitation to the grids of the PA tubes before bias voltage is applied to them. An access door interlock and grounding switch interlock in the PA grid load resistor unit and an auxiliary switch contact 534 on the main isolation thrustor are also in series with the 50 KW plate control circuit. The former removes plate voltage in case the door to the resistor unit is opened with RF voltage within. Auxiliary switch 534 removes 50 KW exciter plate voltage each time the isolation switch is operated to place a transmitter unit in or out of service. When the 50/500 KW RF transfer switch 604 is closed in the 50 KW-to-the-antenna position the above four interlock contacts are short circuited by auxiliary switch 604-A operated by main switch 604.

The coil of 50 KW interlocking relay 822 is energized in parallel with the 17 KV rectifier plate contactor S12A in the 50 KW equipment so that plate voltage can not be applied to the 500 KW equipment until the 17 KV rectifier voltage is applied to the 50 KW equipment; similarly if 50 KW exciter plate voltage is removed by operation of S12A, plate voltage is also removed from the 500 KW equipment. The other contact of relay 822 connects the harmonic filter air blower 601 to the 115 volt a-c station lighting supply for 50 KW operation to the antenna. This contact is short circuited by an auxiliary switch on main breaker 415 for 500 KW operation.

7.027 Low Power Rectifier Plate Voltage

To energize the coil of low power rectifier plate starting contactor 318, the following conditions must obtain:

All interlock circuits necessary for starting the bias MG's must be closed. Low power rectifier plate on switch 927 must be closed. The contacts of HPA bias relay 231 must be closed and the timing contact of the L.P. rectifier filament timing relay 304 must be closed as described above in section 7.024. It is assumed that the normally closed contacts of L.P. rectifier a-c overcurrent relays 315 and d-c overcurrent relay 310 are closed. When these conditions are fulfilled, the coil of L.P. rectifier plate starting contactor will be energized and its contacts will apply 3 phase a-c voltage to the primaries of plate transformer 307 through starting resistors 317. An auxiliary contact of relay 318 closes the coil circuit of run contactor 316, the contacts of which short circuit the starting resistors 317. An auxiliary normally closed contact on relay 316 opens, placing a "soaking" resistor in the common circuit to the coils of contactors 301, 316 and 318. L.P. rectifier plate on light 953 is energized by one phase of the 220 volt a-c supply for plate transformer 307; tube hour meter 435, on the main rectifer panel is also energized from this supply.

7.028 High-Low Main Rectifier Voltage Selector Circuits

Two circuit breakers 414-A and 414-B are connected in the primary circuits of main rectifier plate transformers 404 to change the primary connections from wye to delta, corresponding to low and high rectifier output voltage respectively. When breaker 414-A is closed, the transformer primaries are connected in wye and the rectifier output voltage is approximately 7 KV. When breaker 414-B is closed, the transformer primaries are connected in delta and the rectifier output voltage is approximately 12 KV. It is of course necessary that both these breakers never be closed at the same time to avoid short circuiting the 2300 volt power supply. It is also necessary that they never be switched under load, since this would eliminate the step-start application of main rectifier plate voltage and would subject breakers 414-A and 414-B to service for which they are not intended. Accordingly these breakers are interlocked with each other and with the main breaker 415 to prevent any of these conditions from occurring.

The changes from wye to delta may be made at any time the 125 volt battery is connected to the control circuit, since all wye-delta control power is from the battery. The console indicator lights will not indicate the status of the breakers, however, until the shop machine is started. All the oil circuit breakers in the circuit breaker unit are the latch-in type, requiring no control circuit power except at the time of closing and tripping. The change from low to high rectifier output voltage is not a part of the automatic sequence in starting up the transmitter, the 7 KV output voltage being provided only for

warming up or testing. This change should not be confused with the step-start reduction in rectifier input voltage accomplished by breakers 415 and 417 with resistors 416 each time plate voltage is applied.

Switch 918 is used to select the high or low voltage connection, and is always closed on either one position or the other. Suppose for example that it is closed on the low position, and that main breaker 415 is open so that its normally closed auxiliary switch, in series with the common positive connection to the trip coils of breakers 414-A and 414-B and their closing relays 418-A and 418-B respectively, is closed. Since switch 918 is now being closed on the "low" position, high voltage breaker 414-B must previously have been closed; it is impossible to get both breakers open at the same time except by manual operation of the main contacts. (They are both shown open on the schematic diagram as they were before initial application of battery voltage in testing the circuits for the first time.) First, the 414-B (high voltage) trip coil will be energized through the 414-B auxiliary switch contact which is closed when the breaker is closed. For an instant both breakers are open. Then the 418-A (low voltage) closing relay coil will be energized through the 414-A (low voltage) auxiliary switch contact which is closed when the breaker is open. The closing relay contact 418-A energizes the closing coil of low voltage breaker 414-A causing the breaker to close on the low voltage circuit. The auxiliary switch on 414-A in series with the coil of its closing relay now opens, de-energizing 418-A which in turn opens, de-energizing the closing coil of 414-A low voltage breaker. The breaker 414-A however, remains latched closed. Exactly the reverse process takes place in changing from low voltage to high voltage. If switch 918 is operated with main breaker 415 closed, nothing happens until the main breaker is opened, at which time the change preset by the operation of switch 918 takes place. Console light 948 is operated by an auxiliary switch on low voltage breaker 414-A and indicates that that breaker is closed.

7.029 Main Rectifier

The main rectifier plate protective control circuit, the automatic plate reclosure system, the unit isolation system and plate voltage lockout scheme all center around the sequence of opening and closing of the main rectifier reclosing oil circuit breaker 415. All interlocks in the bias control circuit, from the ground connection at filament switch 925 up to and including bias switch 926, are also in the plate series control circuit. The operation of any of these interlocks will hold plate voltage off while the contacts are open. That is, there will be no plate reclosure and unit isolation, or reclosure and plate lockout as is the case with most of the plate circuit interlocks yet to be discussed. Four more contacts in the plate series control circuit are not associated with the reclosure, isolation and lockout circuits. These are: the normally open 30 minute time delay contact of rectifier filament timing relay 808 and the 50 KW interlocking relay 822 described above, the plate off button 960 and the main thrustor auxiliary switch contact 534.

The purpose of the main thrustor auxiliary switch 534 is to insure that the isolation switches will never operate under load. If automatic switch 920 is in the "off" position, the opening of any of the contacts mentioned in the above paragraph will hold off plate voltage as long as it is open and when the contact closes, the operator must re-apply plate voltage by manually operating plate "on" switch 960. If automatic switch 920 is closed in the "on" position, the opening of any of the above interlocks will automatically remove plate voltage as many times as the interlock opens. For example, if the plate "off" button 960 is pressed with switch 920 on automatic, plate voltage will be removed while the operator holds his finger on button 960 but will be re-applied as soon as he removes his finger. This may be repeated any number of times, insofar as the control circuit is concerned, but should not be often repeated for obvious reasons.

In the antenna house, 630 is a grille door interlock, 612 is an emergency shut down switch of the "stay-put" type and 631 is a photo-cell relay (supplied by the customer) which operates when the antenna safety gap flashes over due to lightning, thereby opening the plate control circuit and momentarily removing plate voltage. These three sets of contacts are also in the plate series control circuit. A double pole, double throw switch 836 (supplied by the

customer) has been placed on the control panel and is wired so that the three antenna house interlocks may be short circuited in case of grounds or similar trouble in the long circuit to the antenna house. The high resistance coil of relay 837 (supplied by the customer) has been connected between the center contacts of switch 836. The coil of this relay is thus short circuited during operation for either position of switch 836. If, however, one or more of the three antenna house interlocks 630, 612 or 631, is opened during operation, the coil of relay 837 is energized in series with the coil of plate auxiliary contactor 806 with its shunting resistors 807-A and 807-B. The ratio of coil resistances of these two relays must be such that (1) the coil current of 837 will not hold 806 closed and (2) most of the voltage will appear across coil 837 when the two are in series. When the coil of relay 837 is energized, its contacts close causing one of the annunciator targets 438, on the main rectifier cat-walk panel, to operate. These annunciator targets are described in section 7.08.

The remaining series contacts in the plate control circuit are divided into six sections: One section for each of three PA's; one section for each of two modulators; and one section for all apparatus no unit of which can be isolated, or in circuits where isolation is not desired.

The first five sections of series plate control circuit are essentially alike since each contains a time delay isolation contactor circuit, 801-A, four d-c overcurrent relay contacts 512 or 157, a door interlock relay contact 805, and a temperature interlock relay contact 803. Any one of these contacts, in opening, sufficiently de-energizes the coil of plate auxiliary contactor 806, to cause its contacts to open, removing plate voltage as will be explained below. However, sufficient residual current remains through the coil of 806 and paralleled resistors 807-A and 807-B (tapped) to energize the high resistance coil of the telephone type relay 802 shunted across each group of series contacts listed above. Relay 802 operates on a sustained control circuit opening of five seconds or two momentary openings within a minute. If one of the contacts in a section of series plate control circuit (for example, temperature interlock relay 803) stays open for approximately five seconds or more, or if there are two openings of this circuit within a period of approximately one minute, the faulty PA or modulator unit is isolated after the second opening of the main breaker 415. The 801-A contact, in series with each section is normally closed, definite time closing; another 801-A contact, normally open, definite time closing contact, is connected across each series circuit. The coil of contactor 801-A is energized when a unit isolates. The series connected, normally closed contact is needed since the d-c overcurrent relay contacts close very rapidly when the overload has been removed and it is necessary to hold the plate series circuit open long enough to be sure that auxiliary switch 534 has opened it at another place during isolation to prevent operation of the main isolation switches under load. The shunt connected normally open 801-B contact is necessary when a unit is isolated to obtain this short but necessary time. Similarly, when a unit is returned to service, the lower contact (on the schematic diagram) of 801-A opens instantly, but the upper contact does not close until auxiliary switch contact 534 has time to block off plate voltage while the isolation switches are operating.

High speed tripping of the main breaker 415 is obtained from a-c overcurrent relays 821-B and d-c overcurrent relays 143, 157 and 512 by the closing of a set of normally open contacts on each at overload. When one or more of these normally open contacts closes, the main breaker 415 trip coil is energized by them directly. To permit manipulation or adjustment of relays 512 or 157 in an isolated unit without tripping off plate voltage from the remainder of the equipment, the ungrounded common connection of the four sets of normally open relay contacts in each unit is connected to the high speed tripping circuit through an auxiliary contact 542 or 187 operated mechanically by rotating isolation thrustor 530 or 186. This auxiliary contact is closed when the unit is in service and open when the unit is isolated. The high speed tripping circuit will be described in detail below.

The section for units which can not be isolated or where isolation is not desired will be described next. This section consists of the following contacts in series:

1 #803 H.P.A. temperature interlock relay
1 #805 H.P.A. and main rectifier door interlock relay
1 #831-B Main rectifier filament under-voltage auxiliary relay - control panel
2 #821-B High speed a-c overcurrent relays - control panel
1 #434 Emergency shut down switch - Main rectifier (Momentary contact type)
2 #143 H.P.A. (UV-848) d-c overcurrent relays
1 #179 Emergency shut down switch - Modulator 2 (Momentary contact type)
1 #179 Emergency shut down switch - Modulator 1 (Momentary contact type)
1 #539 Emergency shut down switch - PA-3 (Momentary contact type)
1 #539 Emergency shut down switch - PA-2 (Momentary contact type)
1 #539 Emergency shut down switch - PA-1 (Momentary contact type)
1 #917 Emergency shut down switch - console (Momentary contact type)
1 #419 Emergency shut down switch - basement grille (Momentary contact type)
1 #274 Emergency shut down switch - distribution panel (Stay-put type)
1 #234 PA bias relay
1 #233 Modulator bias relay
1 #231 H.P.A. bias relay

START

Any one of these contacts, in opening, sufficiently de-energizes the coil of plate auxiliary contactor 806 to cause its contacts to open, removing plate voltage as will be explained below. However, sufficient residual current remains through the coil of 806 and paralleled resistors 807-A and 807-B (tapped), to energize the high resistance coil of another telephone type relay 802 shunted across the entire group of series contacts listed in the preceding paragraph. If automatic switch 920 is "on", plate voltage will be re-applied as soon as the series circuit described above is closed. If one of the contacts in this series circuit (for example temperature interlock relay 803) stays open for approximately five seconds or more, or if there are two openings of this circuit within a period of approximately one minute, plate voltage will be locked off. In the case of the two momentary openings within a minute, the breaker will have reclosed between the first and second openings of the plate control circuit. The operation of the reclose and lockout circuit is described below.

When the entire plate series control circuit is closed, pressing "plate on" button 960 causes the plate breaker 415 to close, and one of its auxiliary switch contacts short circuits the momentary contact button 960, sealing it in. The plate control circuit energizes the coil of plate auxiliary relay 806 and its normally open contact completes the circuit to closing control relay 423, causing its high-current contacts to close. The contacts of 423 energize the 415 closing coil; as soon as the breaker is latched closed, one of its auxiliary switches opens the coil circuit of closing relay 423, the contacts of which de-energize the 415 closing coil. Another auxiliary switch on breaker 415 closes the coil circuit of trip coil relay 820. The normally open contacts of 820 close one side of the trip coil circuit of breaker 415, thus making the breaker ready for an overload. As soon as an overload causes one of the overcurrent relays to close its normally open contacts, the 415 trip coil is energized in series with the low resistance coil of trip-seal in relay 821-A. The normally open contact of this relay short circuits all the normally open high speed overcurrent tripping contacts so that whichever one of them closed may fall back to its normal position without arcing. When the breaker opens, the auxiliary switch on 415, in series with the coil of trip coil relay 820, opens and the contact of 820 breaks the heavy trip coil current.

A latch checking switch is utilized on breaker 415 to insure that, in case of rapid reclosure, the operating mechanism has time to assume the "completely open" position before a closing impulse is applied. The contacts of the latch checking switch operated mechanically from the latch arm of 415, are closed when breaker 415 is completely open; they are connected in series with closing control relay 423 for this breaker.

Another auxiliary switch on breaker 415 is normally closed, and prevents switching the high-low voltage circuit breakers 414-A and 414-B unless main breaker 415 is open. Another normally open 415 auxiliary switch operates plate start light 950-A above the automatic switch 920 on the console. A normally

closed 415 auxiliary switch is in series with the trip coil of rectifier run breaker 417, and prevents that breaker from being opened under load, a service for which it is not designed. A normally open auxiliary switch is in series with the 115 volt a-c control circuit to harmonic filter air blower 601. A normally closed auxiliary switch of breaker 415 is in series with the latch trip coil on the isolation switch as a double check that this switching system will not have to operate under load.

A normally closed contact of plate auxiliary relay 806 is connected across the high speed tripping control circuit for breaker 415. Thus, interrupting the coil current to 806 trips the main breaker. The speed of this tripping is adequate for all faults excepting d-c or a-c overcurrent, and the series trip circuit serves as a double check for overcurrent tripping.

When breaker 415 closes, starting resistors 416 are in series with the 2300 volt line to the plate transformers to absorb the switching transient. A time delay contact on auxiliary plate relay 806 completes the closing control relay 412 coil circuit, which in turn energizes the closing coil of rectifier run breaker 417. This circuit breaker short circuits the starting resistors 416. An auxiliary switch on breaker 417 de-energizes the coil of closing relay 412, which de-energizes the closing coil of breaker 417 when the breaker is latched closed. A 417 auxiliary switch closes the 417 trip coil circuit so that 417 will trip as soon as main breaker 415 is opened. Another 417 auxiliary switch lights plate run light 950-B on the console above plate control push buttons 960. A normally closed auxiliary switch on breaker 417 completes the circuit to H-pad relay 103 until breaker 417 is closed. This provides reduced audio input to the transmitter while plate voltage is being switched on by the step-start arrangement.

With the closing of run breaker 417, the transmitter is in full operation.

7.03 Shutting Down the Transmitter

When the transmitter is to be completely shut down, the operator should press the main transmitter stop button 912. This energizes the coils of shut down relay 811 and shut down time relay 812 in parallel. One contact of 811 seals in stop button 912; the other contact is normally closed and when open, disconnects the 125 volt shop machine from all parts of the control circuit except that for the pumps, blowers, and main rectifier filaments. This contact in opening removes plate, bias and filament voltages from all tubes in the transmitter (except rectifier filaments). The removal of the 125 volt shop MG supply from the control circuit trips the plate breakers 415 and 417 by de-energizing the coil of plate auxiliary contactor 806. The n.c. contact of 806 closes across the parallel high speed trip circuit and energizes the trip coil of 415 directly from the battery supply. The coil of seal-in relay 821-A in series with this trip coil, is also energized. Its contacts momentarily short circuit the high speed trip circuit until the trip coil and seal-in coil current is interrupted by the opening of the trip coil contactor, the coil of which has been de-energized by the opening of a normally open auxiliary switch on breaker 415. A normally closed auxiliary switch on 415 closes the trip coil circuit of rectifier run breaker 417; this current is interrupted a fraction of a second later by the opening of a normally open auxiliary switch on 417. All indicator lights go out excepting those for the cooling system, transmitter start light (indicating shop machine still running), rectifier filament "on" light and battery "on" light. Timing relay 812 runs for about ten minutes; then its normally closed contacts are opened in the shop machine starter 241 coil circuit. When the shop machine shuts down, the starters of the pumps and blowers drop open and these items shut down. The coil of shop MG main rectifier filament interlocking relay 832 is de-energized at the same time as shop machine starter 241, and will remove voltage from the rectifier filaments unless the time clock switch 810 is set to keep them on. All remaining lights on the console now go out except the battery on light 913 which remains on unless battery fuses are removed.

It is possible to shut down the transmitter step by step with the console sequence switches operated in the reverse order to that described for starting up the set. If, in shutting down, a sequence switch is operated out of its proper order, voltage is removed from all items following it in the control cir-

cuit sequence for starting up. In no case should the cooling system switch be operated to remove cooling water and air before the tubes have had ample time to become cool after filament voltage is removed. The full ten minutes is recommended.

7.04 Starting The Transmitter - Automatic Operation

If the sequence switches 954, 923, 924, 925, 926, 927 and 920 are all placed in the "on" position, and d-c filament rheostat 908 is turned to the minimum voltage position so that its shaft interlock 908-A is closed, the control circuit is ready for automatic startup. When the operator hears the filament MG's start up, he should adjust the d-c filament voltage to the normal value of 33 volts, after which the remaining voltages will be applied automatically in proper sequence. The operator will generally wish to use some combination of automatic and step by step start up to give an abundance of time for checking each status as it is reached. Generally, the operator will not wish to start the cooling system until the main rectifier filaments have heated for some time.

7.05 Automatic Reclosing and Plate Voltage Lockout

The conditions necessary to produce automatic reclosing, unit isolation and plate voltage lockout have been previously described but the circuits necessary for accomplishing these function have not been explained.

Automatic reclosing and plate voltage lockout will be described first.

Each of the six final sections of the main rectifier plate control circuit is interconnected with a bank of telephone type relays, 802, 823, 824, 825 and 826, located at the top of the control panel, in a separate assembly for each transmitter unit. If relay 802, for the HPA and rectifier section of the plate series control circuit, is energized due to the opening of any of the contacts with which it is in parallel, it closes its normally open contact circuit and energizes the coils of sustained overload isolation (or lockout) relay 823 and first reclosure relay 824. If the control circuit opening is sustained (over 5 seconds) such as would be occasioned by an open access door or over temperature in the HPA water, the time delay contact of relay 823 closes, energizing the coil of main breaker lockout relay 818 directly. Relay 818 seals itself closed and opens its normally closed contact in the plate series control circuit. Plate voltage is now locked off until automatic switch 920, one pole of which is in series with the coil of lockout relay 818, is moved to its "off" position, after which plate voltage may be again applied if the fault has cleared in the meantime.

Consider now that plate voltage is on automatic and an overcurrent relay in the HPA and main rectifier section of the main plate series control circuit operates momentarily. Both the main rectifier circuit breakers 415 and 417 open and immediately reclose as soon as the overcurrent relay contact drops to its normal position. The coil of relay 802 is momentarily energized, closing relays 823 and 824 as before. However, this time, relay 802 is immediately de-energized by the return of the overcurrent relay contact to its normal position. First reclosure relay 824 has sealed itself closed and when relay 802 is de-energized its normally closed contact energizes isolation (or lockout) ready relay 825, which seals itself in. A normally closed contact of relay 825 opens the coil circuit of sustained overload isolation (or lockout) relay 823 and a normally open contact closes the coil circuit of #826, the reset time (one minute) relay. If no further opening of the HPA and main rectifier section of the plate control circuit occurs within a minute after the first opening, the time delay normally closed contact of reset time relay 826 opens the common coil circuit to first reclosure relay 824, isolation (or lockout) ready relay 825 and its own (826) coil. All the telephone relays in the isolation relay assembly (802, 823, 824, 825 and 826) are now in the same status as they were before the momentary opening of the plate control circuit. If, however, a second opening of the HPA and rectifier section of the plate control circuit does occur within one minute after the first, the coil of relay 802 will again be energized, its normally open circuit will close, completing the coil circuit of main breaker lockout relay 818 through a normally open contact (now closed) of relay 825. Relay 818 seals itself in and its normally closed contact opens the

plate series control circuit next to manual rectifier start switch 960, and holds off main rectifier plate voltage as long as its coil is energized. The rectifier may be again placed in service by throwing rectifier automatic control switch 920 to the "off" position; one pole of this switch opens the coil circuit of lockout relay 818. Rectifier voltage may now be applied by operating the "on" button of rectifier manual control switch 960 or by throwing automatic switch 920 again to the "on" position. In general, the operator should learn the cause for the breaker's being locked out and if necessary take steps to remedy the situation before re-applying plate voltage after lockout has occurred. Failure to do so may result in destruction of apparatus. It should be noted that if plate voltage is immediately re-applied after lockout by operation of automatic control switch 920, that the next opening of the HPA and rectifier section of the plate control circuit will again lock out the main breaker unless reset time relay 826 has had time to open its contacts and return the telephone relays to their initial status.

The cause of a momentary opening of a d-c overcurrent relay in one or more of the five other sections of the plate control circuit may also result in the operation of a-c overcurrent relays 821-B in the main rectifier power supply circuit, since relays 821-B are very high speed in operation. It is not desirable in this case that plate voltage should be locked off since the trouble will be cleared by the isolation of the faulty transmitter unit after one reclosure, as will be described below. To prevent plate voltage lockout when isolation is desired, the coil of lockout preventing relay 819 is connected across the entire series of plate control circuit contacts associated with the other five transmitter units. (The antenna house interlock contacts are also included in this circuit, although they cannot cause plate voltage lockout.) When any one of these contacts opens, not only the isolation relay 802 of the faulty transmitter unit is operated but also the coil of lockout preventing relay 819 is energized. The normally closed contacts of this relay are in series with the common coil circuit of all the telephone type relays in the HPA and main rectifier group, so that whenever the coil of 819 is energized, all these relays return to their normal positions.

If the transmitter is operating with the automatic control switch 920 in the "off" position, plate voltage must be re-applied manually by switch 960 after each interruption. No plate voltage lockout can take place since an open contact of switch 920 keeps the coil of lockout relay 818 de-energized. Relays 802, 823, 824, 825 and 826 operate as before on sustained or momentary openings of the HPA and main rectifier section of the plate control circuits, but neither automatic reclosure nor lockout can occur due to the open position of automatic switch 920.

The complete telephone type relay assembly for the HPA and rectifier section of the plate control circuit can be removed from the control panel for servicing, during operation of the transmitter if desired. Since plate voltage lockout cannot now take place, the reclosing breaker 415 might conceivably be required to close on a fault many times, were automatic switch 920 in the "on" position. Since such operation is likely to result in the destruction of apparatus, switch 920 should always be in the "off" position for operation with this relay assembly removed.

The coil of the customer's unit lighting relay for the main rectifier is in parallel with the coil of relay 818 causing an overhead light to produce illumination in the rectifier unit, if desired, when lockout occurs.

7.06 Automatic Reclosing and Unit Isolation

An assembly of five telephone type relays, 802, 823, 824, 825 and 826 is employed for that section of the series plate control circuit associated with each of the three PA and two modulator transmitter units. The assembly and internal wiring of each of these five relay groups is identical to that described above for the HPA and rectifier circuit. Assuming that automatic switch 920 is closed in the "on" position, the function of these relay assemblies is to permit one automatic reclosing after a momentary opening of the plate control circuit section for the faulty unit and to provide for isolation of the faulty unit in case of two momentary openings of this circuit within a minute, or one

sustained opening of more than five seconds duration. All of the telephone type relays operate under the same conditions of control circuit opening as has previously been described for the HPA and rectifier circuit. In this case, instead of lockout relay 818 being energized at the end of the reclosure or timing sequence, the coils of isolation contactor 801-B and time delay isolation contactor 801-A are energized in parallel. The function of these relays is to connect and disconnect appropriate circuits in the proper sequence to manually or automatically produce unit isolation or to manually return a unit to service after isolation.

Assume now that the coils of relays 801-A and 801-B are energized either by the operation of sustained overload isolation relay 823 or directly by the second closing of isolation relay 802. The normally closed time delay closing contact of 801-A opens the section of plate control circuit for the faulty unit immediately and is ready for time delay closing when the transmitter unit is returned to service. The normally open time delay closing contact of 801-A short circuits the series section of plate control circuit to permit breaker reclosing after a short interval of time; this contact also short circuits the coil of isolation relay 802, and the timing is necessary to assure that relay 801-B has had time to seal in its coil and to further assure that one of the latch trip auxiliary switch 534 contacts has had time to open the plate control circuit (next to coil 806) during the rotation time of the main isolation switches to prevent their closing or opening under load. When a unit is returned to service, this 801-A short circuiting contact opens instantaneously. The normally closed circuit of relay 801-B lights a transmitter unit on light 951 when the corresponding unit is in service and causes the light to go out when the unit is isolated. The coils of the customer's unit lighting relays are paralleled with the coils of relays 801-A and 801-B and are connected to automatically produce internal illumination in an isolated unit when desired. A normally open contact of 801-B seals in the paralleled coils of relay 801-A and 801-B. Another normally open 801-B contact energizes the coils of H pad relay 103, the contacts of which insert a resistance H pad in the audio input so as to drop the audio level in case either a PA or a modulator unit is taken out of service. A third normally open contact of 801-B connects ground to the rotator motor 530 or 186, for the unit to be isolated. This motor operates, rotating the power circuit isolation brushes for the unit to be taken out of service, as soon as the latch trip auxiliary switch contact 534 and the shaft limit switch 545 for rotators have their contacts closed as described below. A fourth normally open contact of relay 801-B energizes the isolating latch trip solenoid 529, provided the normally closed auxiliary switch for main breaker 415 is closed, indicating that plate voltage has been removed, and providing that the rotator auxiliary switch 542 or 187 for the unit to be isolated is in its normally closed position. (The normal position for all switch contacts connected with the isolation switching system is that position which the contacts have when all transmitter units are in service.)

The operation of the isolation switches and associated auxiliary switches located in an assembly on the basement ceiling will now be described. A bank of double break power circuit isolation brushes is located beneath each of the three PA and two modulator transmitter units. These power circuit isolation brushes connect bias voltage, plate voltage, RF input, RF output, audio input and audio output to appropriate circuits in the PA and modulator units when these units are in service. When a given unit is isolated or taken out of service, the power circuit isolation brushes for that unit are rotated by means of a thrustor to close on another set of contacts. When these power contacts for a given transmitter unit are in the "isolated" position the following conditions obtain: Plate and bias voltage lines to a transmitter unit are disconnected and grounded; the RF input lines to a PA are disconnected and grounded. The RF output lines from a PA are disconnected and the circuit formerly occupied by a PA output coupling coil is shorted, the audio input lines to a modulator (including modulator bias) are disconnected and grounded; the audio output lines from a modulator are disconnected, and the circuit formerly occupied by a modulation transformer secondary is shorted.

When the latch trip solenoid 529 is energized, all the power circuit switches for all transmitter units come open at once due to the brush pressure of all the contacts and to a spring on the main shaft provided for the pur-

pose. The action is not violent due to the damping action of oil flow through an orifice in main closing thrustor 528. This thrustor 528 is mechanically connected to the main shaft which runs the entire length of the switch frame, and on which all rotatable power circuit isolation brushes are mounted in such a manner that they cannot slide on the shaft, but may be turned on the shaft by the rotator thrustor for a given unit. When a unit is to be isolated one of the rotator motors, 530 or 186, for a PA or modulator, is energized shortly after the latch has been tripped, causing the entire bank of power circuit isolation switches for that unit to rotate to the "isolated" position against a small spring pressure. Since the rotation is produced by a thrustor, the motion is not violent, hence there is little mechanical strain on the high voltage insulators. Shortly before the power brushes are completely rotated to their new position, an auxiliary switch completes the circuit to the motor in main closing thrustor 528. Thrustor 528 pulls all the power switches for all transmitter units closed against spring and brush pressure. Before the contacts of the rotated power switch bank for the isolated unit touch, rotation to the "isolated" position is complete. When all power switches are fully closed, the latch trip plunger 529 falls back into the latched-in position, all rotators are de-energized, and power circuit voltages are again applied.

A transmitter unit, once isolated, can be brought back into service only by manually operating a unit "on" switch 922. Latch 529 is tripped as before, the power circuit brushes for all transmitter units are opened, and the power contacts of any unit, whose rotator motor is not energized but which have been previously in the "isolated" position, now rotate to the "operate" position by spring tension damped by the flow of oil through an orifice in the rotator for the previously isolated unit. The rotation of power brushes toward the "operate" position starts as soon as the brush pressure is sufficiently relieved to permit the switches to turn and is complete before the power circuit brushes are closed far enough to touch the studs in the "operate" position. The closing of all power circuit brushes is, as before, produced by main thrustor 528.

There are several mechanically operated position, sequence, and auxiliary switches connected with the isolation switching scheme. An auxiliary switch bank 534 is operated mechanically by latch trip solenoid 529. During operation of the transmitter this latch trip solenoid is de-energized, (plunger drops down) and auxiliary switches 534 are in their normal positions. When the latch trip plunger 529 is up (either due to the solenoid being energized or due to the plunger being held up by an adjacent cam which permits it to drop or latch only when all power brushes are completely closed) the auxiliary switches 534 are in the opposite-to-normal position. One normally open 534 contact disconnects the common positive circuit to all rotators 530 and 186 except when the latch is tripped up. A normally closed contact of 534 removes plate voltage from the 50 KW exciter by being open when the latch is tripped up. A second normally closed contact of 534 holds open the plate series control circuit for the main rectifier, next to coil 806, during the time the latch is tripped up.

A similar auxiliary switch bank, 542, or 187, is mechanically operated by each PA and modulator rotator thrustor. The normal position of these contacts is their position when the transmitter unit is in service. They do not move with great rapidity from one position to another since their positions are determined by the damped motion of their respective thrustors. One normally open 542 (or 187) contact is utilized to short circuit the door interlock relay 805 contacts of an isolated unit; these contacts are in the bias and L.P. rectifier plate control circuits. Another normally open 542 (or 187) contact short circuits the normally open, momentary contact of transmitter unit "off" switch 922. The purpose of this is to re-energize isolation contactors 801-A and 801-B in case the shop motor-generator is shut down with a unit isolated and the transmitter (including shop motor-generator) is then started up. A transmitter unit which is isolated has its isolation switch contacts latched in the "isolated" position, so its status is not changed by removal or application of shop machine voltage to the control circuit. Relay coils 801-A and 801-B are sealed in as long as the corresponding transmitter unit is isolated. However, if the transmitter is shut completely down and re-started, relay coils 801-A and 801B would not be energized except for the normally open contact on the rotator auxiliary switches 542 (or 187). Latch trip solenoid 529 is energized by an 801-B contact through a normally closed 542 (or 187) contact. This normally

closed contact opens as soon as rotation toward the "isolated" position starts, and de-energizes latch trip solenoid 529. The 529 plunger remains tripped up after its solenoid is de-energized since it is held in the "up" position by the cam until all power brushes are completely closed. A paralleled pair of 542 (or 187) auxiliary switch contacts for each transmitter unit is in series with the main thrustor motor 528. One contact of the pair is normally open and the other normally closed. There is an interval during the rotation of the main power brushes when neither circuit of the pair is closed. Thus the main closing thrustor motor 528 can be started up when rotation toward the "isolated" position or toward the "operate" position is almost completed, but the closing thrustor motor cannot be energized at intermediate points due to the interval when neither contact of the pair is closed.

Main thrustor shaft limit switch 537 is operated by the same cam which holds up the latch trip plunger 529 while the power circuit brushes are open. Switch 537 is the "stay put" tumbler type. The contacts are open in normal operation and are mechanically closed to start the main closing thrustor 528 when the cam has rotated to a position corresponding to main power brushes completely open. When the cam rotates to this position, the switch 537 operating handle is pushed up (closed), permitting operation of main closing thrustor motor 528 until latch trip 529 drops into the latched-in position corresponding to main power brushes completely closed. The dropping of the latch pushes the handle of limit switch 537 down (open), stopping main closing thrustor 528.

Rotator thrustor shaft limit switch 545 is operated directly by the motion of main closing thrustor 528. When the plunger of 528 moves down to open the main brushes by spring pressure, the motion is used to turn "stay put" tumbler switch 545 to the "on" position. This permits energization of the rotator thrustor motors. When main thrustor 528 is energized to close the power circuit brushes, its plunger shaft is pushed up and the motion is used to turn off switch 545, stopping rotator thrustor motors just before the power brushes reach the closed position.

When a transmitter unit is to be isolated manually, the corresponding unit "off" switch 921 is depressed. 921 is a normally open, momentary contact tumbler switch with its contacts in series with the coils of isolation contactors 801-A and 801-B. When the coils of these relays are energized, the isolation sequence takes place as previously described. The handle of unit "off" switch 921 must be held down an appreciable length of time to insure that relay 801-B has had time to seal itself closed.

When a unit is to be placed in operation after isolation, the corresponding unit "on" switch 922 is depressed. 922 is the same type of switch as 921, except that both its normally open and normally closed contacts are used. Since the switch is the tumbler type, the operator is assured that one circuit will be made and the other broken simultaneously. The normally closed contact de-energizes the coils of isolation contactors 801-A and 801-B, while the normally open contact energizes the latch trip solenoid 529 directly, as soon as the main breaker 415 normally closed auxiliary switch closes. The unit is then placed in service as described above. Switch 922 must be depressed an appreciable time to assure that the sealing contact of relay 801-B has had time to open, and that the latch trip solenoid 529 has been energized long enough after breaker 415 opens to insure that its plunger is lifted and rests on the cam.

It will be seen from an analysis of the above that if the transmitter is on the air, a unit may be isolated or placed in service by operating the corresponding unit "off" switch 921 or unit "on" switch 922 without manual removal of plate or other voltages.

Any of the PA or modulator telephone relay assemblies may be removed from its position on the control panel, during operation, if desired, without interfering with the correct operation of the control circuit. The unit whose relays are removed will not isolate automatically but can be isolated and placed in service manually by the operation of switches 921 and 922. When one of these relay assemblies is removed, automatic switch 920 should be placed in the "off" position, so that main breaker 415 will not be required to close many times on a fault.

The operator may safely enter an isolated unit. He should, of course, operate the safety grounding switch provided for the purpose, whether he enters the front or rear door of the unit. The operator should use care to avoid high current flashes due to short circuiting of the filament bus or other circuits.

7.07 D-C Undervoltage Protection for Reclosing Breaker

If battery voltage is removed from the transmitter control circuit with the main breaker 415 closed, it could not be opened automatically to clear a fault if it were not for the control transfer relay 835, the contacts of which transfer the O.C.B. tripping circuit from the 125 volt battery to the 125 volt shop machine when battery voltage fails. Only the circuits to trip coil relay 820 and the trip coil of breaker 415 are transferred to the shop machine. This allows the breaker to be tripped once from the shop machine supply but it cannot be reclosed until the battery circuit is restored.

7.08 Overcurrent Target Circuits

Each of the four DC overcurrent relays 512 in each power amplifier, each of the four DC overcurrent relays 157 in each modulator, and each of the two DC overcurrent relays 143 in the HPA unit is provided with an auxiliary set of n.o. contacts. These contacts are utilized to energize drop signals 438. One manually reset drop signal is thus provided for each water cooled tube. These drop signals and their associated annunciator buzzers are located on the catwalk panel in front of the main rectifier. One enunciator assembly with four drop signals is provided for each PA and modulator unit. Two of the drop signals are used for the HPA tubes in one four-drop assembly; the third drop signal indicates an opening of the plate series control circuit in the antenna house as described in section 7.029; the fourth drop signal is unused.

The 12 volt power supply for these annunciators is obtained from transformers 439 connected 220/12 volts.

The use of these drop signals permits the operator to determine at a glance the location of a faulty water-cooled tube.

7.09 Convenience Circuits for Other Transmitters, etc.

Convenience circuits for various control and monitoring devices may be connected as shown on external connections diagram WW-7350122. Most of these circuits are connected to various items in the operator's console, the internal connections and relative positions of which are shown on the console connection diagram WW-7350120.

Connections for volume indicator and monitoring jacks 936 may be made to console terminals 57 to 64, 80 to 85, 96 to 103 and 116 to 125. The circuits are normalled through these jacks.

Telephone and telegraph circuits may be wired to jacks 958 by utilization of console terminals 86 to 95. Drop signals 959 are normalled across the contacts of jacks 958.

WSAI controls 932 and 933 with their indicator lights 916 and 919 may be connected to console terminals 110 to 113, 135 to 138 and 162 and 163.

W8XAL controls 928 and 929 with their indicator lights 914 and 915 may be connected to console terminals 106 to 109, and 157 to 160.

The Oakley line oil circuit breaker control switch 956 with its indicator light 938 may be utilized by making appropriate external connections to console terminals 139 to 143.

Similar external connections to console terminals 151 to 156 will permit utilization of the Elmwood line oil circuit breaker control switch 955 and its indicator light 937.

One set of normally open contacts on carrier relay 980 is connected to console terminals 148 and 149 to permit remote operation of a carrier "on" indicator lamp if desired.

The element of a string oscillograph or oscilloscope may be connected between console terminals 151 and 185 if the link is removed. The use of an oscilloscope will generally require readjustment of the antenna ammeter and overmodulation indicator circuits.

A convenient connection for a "plate on" light in the basement may be made to terminals 392 and 393 on the oil circuit breaker unit. These terminals are internally connected to a normally open auxiliary switch on the rectifier reclosing oil circuit breaker 415. A similar light on the main floor may be connected between control panel terminals 249 and 189 (ground). These terminals are internally connected to the coil of trip coil relay 820 which is energized when main breaker 415 is closed.

The customer has provided a system of relays and overhead lights for internal transmitter unit illumination. These lights may be turned on or off manually by means of the customer's switches located on the side of the main rectifier compartment, or they may be turned on in a given unit when that unit is isolated. The rectifier lights are turned on when the rectifier circuit breaker is locked out. The coils of the relays which turn on the lights in an isolated unit are energized in parallel with the coils of isolation relays 801-A and 801-B. The rectifier unit lighting relay is energized in parallel with main breaker lockout contactor 818. The control panel terminals for these unit lighting relays are as follows:

PA-1	- 45 and 46
PA-2	- 47 and 48
PA-3	- 49 and 50
Mod. 1	- 51 and 52
Mod. 2	- 53 and 54
HPA and Rectifier	- 55 and 405

8.00 ADJUSTMENTS FOR OPERATION

8.00 ADJUSTMENTS FOR OPERATION

8.01 Water Cooling System

Normally the distilled water cooling system will need no adjustment from day to day. However, the water level in the stand pipe should be maintained at the proper level as described in Chapter 6.00.

In order to conserve spray pond water it may be desirable to cut down the flow through the spray nozzles. This may be done in two places, either at the pump or at the spray pond. Closing the outlet valve at the pump will control the flow through all spray nozzles uniformly. Closing the valve for either group of spray nozzles will control the flow through that group separately. This latter method is advantageous when water is lost by being blown over the sides of the pond.

In cold weather the sprays should be closed off entirely and the cap removed from the tee which is in the main feeder to each set of sprays. This will allow the spray pond water to be discharged directly back into the spray pond.

8.02 Air Cooling System

While the speed of the air blower, and hence the volume of air delivered, can be controlled by means of the blower motor field rheostat 254, sufficient air is delivered by the blower when operating at its slowest speed, i.e., with the field rheostat cut out. For normal operation no adjustments are required.

8.03 Filament Voltage - Main Rectifier

The transformation ratio of rectifier filament transformers 402 is such that the rated value of 5 volts will be applied to the filaments of the RCA-870 rectifier tubes 401 when the primary voltage is 200 volts. Therefore filament voltmeter 410 should be adjusted to read 200 volts by means of filament rheostat 409 on the rectifier cat-walk panel.

The adjustment on the timing interlock for the rectifier filament contactor 804 should remain at the maximum time setting for low voltage filament starting.

The timing adjustment on the main rectifier filament time delay relay 808 should remain at 30 minutes to provide the proper time between the application of filament and plate voltages on the RCA-870 tubes.

The voltage adjustment on the main rectifier filament undervoltage relay 809 should remain so that the full voltage contacts close at 200 volts and the undervoltage contacts close at 190 volts (5% low) as indicated by filament voltmeter 410. The meter 410 should be checked at frequent intervals during operation to see that the voltage on the filament transformer primaries never exceeds 210 volts (5% high) since either under- or over-voltage will shorten the operating life of the RCA-870 tubes. The time setting on the main rectifier filament undervoltage time relay 831-A should remain at a value not in excess of 8 seconds. If the time delay is increased, there is a possibility of harming the RCA-870 rectifier tubes if plate voltage is on and filament voltage completely removed.

8.04 Rectifier Air Heater

The RCA-870 rectifier tubes are designed to operate in a controlled ambient temperature between the limits 95° F and 104° F. This temperature is indicated by thermometer 435 on the rectifier cat-walk panel. Thermostat 436 should remain adjusted to hold the temperature within these limits. For winter operation it is advisable to be sure that damper 437 is turned so as to utilize air from the rectifier unit while for summer operation the rectifier air blower intake should be connected to the main air duct to obtain cooling air from out-of-doors. If the coolest air obtainable during daytime operation in the summer is slightly warmer than the limits specified above for comparatively short intervals, no damage to the RCA-870 rectifier tubes is anticipated.

8.05 Filament Voltage - Low Power Rectifier

The filament transformer in this unit is designed to give rated filament voltage for the UV-872 tubes 306 when the primary voltage is 220 volts. For this reason the primary voltage as shown on meter 303 should be kept at 220 volts by means of rheostat 301.

8.06 D-C Filament Voltage

The d-c filament voltage is controlled by means of rheostat 908. However, although the bus voltage may be 33 volts, each of the filament generators may not be carrying the proper load current. Therefore, a separate voltage control is provided on each machine. This is the load adjusting rheostat 212. These rheostats should be adjusted until the currents delivered by the three machines as indicated by ammeters 215 are approximately equal. Additional rheostats 212-A are provided behind the control panel mounted on each machine. These rheostats should be set so that the maximum voltage the machine will deliver when rheostat 908 is in the minimum resistance position is approximately 35 volts. This will prevent damage to the tubes in case the filament rheostat 908 is accidentally turned to the maximum voltage position.

8.07 Bias Voltages

The bias voltages are controlled separately by three rheostats, as follows:

Rheostat 909 for modulator bias
Rheostat 910 for audio amplifier bias
Rheostat 911 for power amplifier bias

These controls should be adjusted so that the voltages as indicated by the bias voltmeter 903 are approximately as indicated in the list of typical meter readings, Section 9.01.

8.08 Plate Voltage - Main Rectifier

The main rectifier output voltage of approximately 7000 volts for warming up or testing may be obtained by operating the high-low rectifier voltage switch 918 on the console. This switch controls the status of delta-wye oil circuit breakers 414-A and 414-B as explained in Section 7.028. When switch 918 is in the high voltage position, the primaries of the plate transformers 404 are connected in delta and the rectifier output voltage is approximately 12,000.

Plus and minus 5% and 10% primary taps are provided on plate transformers 404, but these should not normally be changed. Extreme care should be used to see that the tap switches on all three plate transformers are on the same tap before voltage is applied. These tap switches should not be operated under load.

8.09 Plate Voltage - Low Power Rectifier

Normally, this voltage needs no adjustment. However, if an adjustment is desired, this can be obtained by means of primary taps on the rectifier transformer 307. These taps give plus and minus five and ten per cent variations about the normal operating voltage.

8.10 Power Amplifier Tuning and Loading

The following describes the procedure for adjusting the radio frequency circuits and supply voltages for the 500 KW amplifier.

Excitation and Bias

The 50 KW exciter drives the 500 KW amplifier when the output selector switch is connected to the 500 KW input load. The load on the exciter in this position consists of the dummy load with tuning capacitors and the grid circuits of the three amplifiers. The grid circuits are tuned to parallel resonance by adjustment of the taps on the grid inductance coils 503. These were

adjusted to be resonant at 700 KC and should not require further adjustment unless the frequency is changed. The load presented to the 50 KW amplifier is approximately the same with either the 500 KW input circuit connected or with the concentric transmission line and antenna circuit.

The loading of the antenna circuit is first adjusted to properly load the 50 KW exciter by adjusting the coupling coil 522. The adjustment of the antenna circuit will be described later. With the 50 KW transmitter adjusted to the antenna circuit load, it is desirable that the load presented by the 500 KW amplifier grid circuit be practically the same so that no retuning or readjustment of loading in the exciter will be required.

The bias voltage of the three amplifiers is normally set at approximately 700 volts total negative potential (self bias plus 650 volts generator bias) for obtaining good efficiency in these class C amplifiers. With this bias and with the correct excitation voltage in the amplifiers, the resulting d-c grid current should be approximately 1 ampere per tube or 4 amperes total per amplifier (meter 505) with the normal plate voltage and plate loading of the amplifiers. During normal operation the grid current should be so adjusted that its value will be close to the maximum allowed, in order to assure best efficiency and least audio harmonic distortion. It is permissible, if required, to have a maximum d-c grid current of 1.25 amperes per tube.

The total load on the 50 KW exciter is the sum of the 500 KW PA grid driving power and the dissipation in the grid loading resistor. The latter was adjusted during installation so that the total load on the exciter would be approximately 50 KW. If a total load of 50 KW is desired with a higher voltage on the 50 KW power amplifier tubes, fewer plates in parallel in the grid load resistor may be used, leaving the same number of series sections.

Capacitors, furnished by the customer, are connected in series with the transmission line between the exciter coupling coil and the grid load resistor to partially tune out the inductive reactance of the coupling coil circuit at the frequency of operation so that the correct value of load impedance is obtained.

The excitation to the 500 KW amplifier may be adjusted over a small range by changes in the bias of the power amplifier tubes or by changing the plate voltage or excitation in the 50 KW exciter.

Neutralization

Each of the three amplifiers is neutralized by fixed mica capacitors 516 connected between the grids of the amplifier tubes and the opposite plate tank high voltage connections. The plate d-c potential is removed from the neutralizing capacitors by the plate blocking capacitors 515. Approximately 155 mmfd. of capacity is required in each neutralizing capacitor as found by tests during the installation of the transmitter. No further adjustment in neutralization should be required unless the frequency is changed considerably.

In order to check the neutralization at any time, the following method is recommended. A 100 ma thermogalvanometer is connected in series with the plate tank circuit of an amplifier. The plate voltage must not be applied while this meter is in the circuit with the excitation applied to the three amplifiers. The output coupling coil should be disconnected when this test is being made. The excitation is applied at a low level to only the amplifier under test and the voltage is increased until a small reading is obtained on the thermogalvanometer.

The plate tank circuit is then tuned for maximum deflection of the same meter. Small calibrated variable capacitors may be substituted for the fixed neutralizing capacitors to measure the capacity required to reduce the reading of the plate tank thermogalvanometer to a minimum. With four amperes total d-c grid current (meter 505) and the plate tank circuit in tune, the reading of the thermogalvanometer should be approximately 100 ma or less. Minor adjustments in the neutralization may be made by variation of the spacing of the neutraliz-

ing leads where they are parallel to each other for a few feet. The spacing must not be reduced to a point where there will be flashovers.

Tuning and Loading

The plate tank circuits consist of air dielectric fixed capacitors 517 and variable tank inductances 521. These were so designed and adjusted that the correct tuning point for minimum plate current would be within the tuning range. The plate tank inductance is varied by adjusting the position of the half turn. This adjustment may be made while the transmitter is operating by the front of panel control. Each amplifier may be tuned independently for minimum plate current. When all three amplifiers are correctly adjusted, the plate currents and grid currents should be approximately the same in all amplifiers. The value of the plate current in any amplifier when tuned to minimum plate current is determined by the degree of loading in the power amplifier and also by the plate voltage. The d-c plate voltage should not exceed 12,000 volts and the plate current should not be more than 5 amperes in any tube. The plate voltage may be adjusted at 5% intervals by the tap changing switches in the main rectifier plate transformers 404, but may be further reduced by variation of the power amplifier series plate resistor 442, if desired. The losses in resistor bank 442 are not modulated.

The loading is adjusted by variation of the position of the coupling coil 522 with respect to the tank coil 521 and is adjusted by the front of panel control. When the amplifier is correctly loaded for the plate current of 5 amperes maximum, the plate tank current should be approximately 95 amperes (meter 520) and the antenna current approximately 72 amperes (meters 901 and 606).

8.11 Harmonic Filter

The harmonic filter consists of a capacitor bank 603 across the output circuit and an inductance 602 in series with the transmission line. The harmonic filter and the amplifier coupling coils were designed to function as a T section low pass filter and to be in resonance at the frequency of operation, in which case the inductive reactance of the three PA coupling coils 522 in series, the capacity reactance of the shunt capacitor, and the inductive reactance of the series line coil would each equal approximately the surge impedance of the transmission line, which is 100 ohms. The termination resistance is also 100 ohms.

The second harmonic trip circuit consists of inductance 628 and capacitors 620 operating in series resonance at 1400 KC. The capacitors are fixed but the inductance is variable by means of a short-circuited turn or "flipper" or by changing taps on the coil. Since the circuit is not loaded, the resonance point is very sharp. The flipper should remain locked in position at all times unless the operating staff is prepared to take 1400 KC field strength measurements at a remote point to check the adjustment. The use of this circuit is optional.

8.12 Line Termination

The capacity of the antenna-ground shunt capacitor 611 can be adjusted by raising or lowering the top section of the outside tubes, thus changing the length of these tubes. Major capacity changes can be made by removing or replacing inside tubes in the assembly. This capacitor has been adjusted during installation so that no further adjustment should be required.

The number of turns in antenna tuning inductance 607 was adjusted during installation so that the inductive reactance of the coil would tune out the combined capacity reactance of the antenna and antenna-ground shunt capacitor. A permanent connection was made and no further adjustment should be required.

The antenna impedance measured between the antenna terminal and ground is approximately 196 ohms -J175 ohms. The variable antenna shunt capacitor connected between antenna and ground is adjusted to change the antenna resistance to approximately 100 ohms with the capacitor connected. The resulting negative reactance is tuned out by the series inductance so as to make the termination impedance for the transmission line a resistance of 100 ohms. This value is correct for the transmission line as installed. With the antenna termination

adjusted for 100 ohms at the point where the antenna ammeter is connected, the power delivered to the antenna is simply I^2R or $(100)(I)^2$.

8.13 Audio Equalizer and High Pass Filter

The amount of attenuation in the equalizer can be adjusted by means of resistors 704 and 707. However, these resistors have been adjusted to the proper value and should not be changed.

No adjustments are provided on the high pass filter.

8.14 Antenna Rectifier and Associated Circuits

The general adjustment of these circuits is described in the analysis of their operation, section 5.14.

The filament voltage on the antenna rectifier tube 620 should be maintained at approximately 10 volts as indicated by voltmeter 621. This adjustment is made with primary rheostat 623.

Linearity resistor 625 has a total resistance of 10,000 ohms with taps at 7500 and 5000 ohms. Greater current outputs for oscillograph operation may be obtained with the lower resistances and the linearity is improved as the resistance is increased.

When bringing the console antenna ammeter 901 into agreement with the antenna house meter 606, the position of r-f coupling coil 609 should be varied with an insulating stick until the console meter reads slightly higher with no modulation on the carrier. Antenna potentiometer 901 should be set on full resistance (highest meter reading) for this adjustment; the two meters may be brought into exact agreement by slightly decreasing the resistance of 901. The tap on coupling coil 609 was adjusted during installation so that this coil would resonate with capacitor 627 at 700 KC. If this tap is not changed, sufficient coupling between coils 609 and 607 can be obtained with ample clearance for insulation.

If the 50 KW exciter is operated as a transmitter and sufficient antenna rectifier output current is obtained to cause the contacts of carrier "on" light relay 980 to close, the coil of this relay will overheat when the power level is changed to 500 KW without changing the antenna metering circuit. To avoid this trouble in a simple manner, potentiometer 984 is shunted across the coil of relay 980. This should be in the "off" position for 50 KW operation and should be adjusted to a value where the relay contacts just close positively when the change to 500 KW power is made. It is recommended, when operating continuously on 500 KW power, that the output current of the antenna rectifier be reduced to a value only slightly more than is required for meter 901. This will result in lighter loading of the antenna rectifier and will permit potentiometer 984 to be turned to the "off" position, so that the total impedance of symbols 980, 981 and 983 will remain constant over the audio frequency band.

9.00 TYPICAL PERFORMANCE DATA

9.00 TYPICAL PERFORMANCE DATA

The following adjustments and instrument readings are intended to be a guide to the operator in checking the performance of the equipment. They are approximate and are not necessarily the optimum adjustments possible to obtain. Under no conditions should the transmitter be adjusted in such a manner that electrical apparatus is required to operate over its current, voltage or other rating. This is particularly true of vacuum tubes.

9.01 All Units - Carrier

General	Reading	Instrument Symbol No.
Frequency	700 kc	-
% Modulation	Zero	-
Antenna Current	72 a	606, 901
Antenna Power	518 kw	-
Power Amplifier No. 1		
Plate Current - Tube 1	4.9 a	513
Plate Current - Tube 2	5.0 a	513
Plate Current - Tube 3	4.4 a	513
Plate Current - Tube 4	4.2 a	513
D-C Grid Current (tubes 1 to 4)	4.0a*	505
Tank Current	95 a	520
Tuning Control	496	521
Loading Control	337	522
Power Amplifier No. 2		
Plate Current - Tube 5	4.4 a	513
Plate Current - Tube 6	4.4 a	513
Plate Current - Tube 7	4.6 a	513
Plate Current - Tube 8	5.0 a	513
D-C Grid Current (tubes 5 to 8)	4.0 a*	505
Tank Current	95 a	520
Tuning Control	202	521
Loading Control	359	522
Power Amplifier No. 3		
Plate Current - Tube 9	4.8 a	513
Plate Current - Tube 10	4.6 a	513
Plate Current - Tube 11	4.8 a	513
Plate Current - Tube 12	4.6 a	513
D-C Grid Current (tubes 9 to 12)	4.3 a*	505
Tank Current	95 a	520
Tuning Control	490	521
Loading Control	277	522
Rectifier		
D-C Output Voltage	12.0 kv	433
D-C Output Current	78 a	429
Filament Transformer Primary Voltage	200 v	410
Console		
Antenna Current	72 a	901
D-C Voltage from Rectifier	12.0 kv	906
A-C Line Voltage	2300 v	930
D-C Filament Voltage	33.7 v*	907

*5 amperes permissible maximum.

*To give 33 volts at tube terminals.

Console (Cont'd)	Reading	Instrument Symbol No.
PA Bias Generator Voltage	650 v	903
Modulator Bias Generator Voltage	0 v	903
HPA bias generator Voltage	1500 v	903

9.02 All Units - Sustained 100% Modulation

For sustained 100% modulation the following instrument readings change approximately as indicated below. Unchanged values are as listed in section 9.01.

General	Reading	Instrument Symbol No.
% Modulation	100%	-
Antenna Current	87 a.	606
Antenna Power	752 KW	-
Power Amplifier		
Tank Current	124 a.	520
Modulator		
Total Plate Current per Unit (100% mod.)	32	163
High Power Audio Amplifier (100% mod.)		
RCA-848 Plate Current (each)	1.1 a.	144
RCA-849 Plate Current (each)	0.1 a.	134
RCA-211 Plate Current (2nd stage, each)	40 ma	124
RCA-211 Plate Current (1st stage, each)	40 ma	114
Low Power Rectifier		
D-C Output Voltage	3000 V	312
Modulator No. 1		
Plate Current - Tube 1	2.0 a	156
Plate Current - Tube 2	2.0 a	156
Plate Current - Tube 3	2.0 a	156
Plate Current - Tube 4	2.0 a	156
Plate Current - (tubes 1 to 4)	8.0 a	163
Modulator No. 2		
Plate Current - Tube 5	2.0 a	156
Plate Current - Tube 6	2.0 a	156
Plate Current - Tube 7	2.0 a	156
Plate Current - Tube 8	2.0 a	156
Plate Current - (tubes 5 to 8)	8.0 a	163
High Power Audio Amplifier		
RCA-848 Plate Current - Tube 1	485 ma	144
RCA-848 Plate Current - Tube 2	485 ma	144
RCA-849 Plate Current - Tube 1	65 ma	134
RCA-849 Plate Current - Tube 2	65 ma	134
RCA-211 Plate Current - Tube 1	40 ma	124
RCA-211 Plate Current - Tube 2	40 ma	124
RCA-211 Plate Current - Tube 1*	40 ma	114
RCA-211 Plate Current - Tube 2*	40 ma	114

*First stage.

Low Power Rectifier	Reading	Instrument Symbol No.
D-C Output Voltage	3000 v	312
Filament Transformer Primary Voltage	225 v	303
Miscellaneous		
Shop Machine Voltage	125 v	245
Filament Generator No. 1 Load Current	1450 a	215
Filament Generator No. 2 Load Current	1450 a	215
Filament Generator No. 3 Load Current	1450 a	215
Filament Generator Total Load Current	4350 a	-
Antenna Ammeter Rectifier Filament Voltage	10 v	621
Rectifier (100% mod.)		
D-C Output Voltage	12.0 kv	433
D-C Output Voltage	125 a	429
Console		
Antenna Current	7	901
D-C Voltage from Rectifier	12.0	906

9.03 Two PA's and Two Modulators - Carrier

Readings not listed are the same as in section 9.01, for the units in service.

General	Reading	Instrument Symbol No.
% Modulation	Zero	-
Antenna Current		606
Antenna Power		-
Power Amplifiers #1 and #2		
Tuning Control, PA-1		521
Loading Control, PA-1		522
Tuning Control, PA-2		521
Loading Control, PA-2		522
Power Amplifiers #2 and #3		
Tuning Control, PA-2		521
Loading Control, PA-2		522
Tuning Control, PA-3		521
Loading Control, PA-3		522
Power Amplifiers #1 and #3		
Tuning Control, PA-1		521
Loading Control, PA-1		522
Tuning Control, PA-3		521
Loading Control, PA-3		522
Rectifier		
D-C Output Voltage		433
D-C Output Current		429
Console		
Antenna Current		901
D-C Voltage from Rectifier		906

9.04 Three Power Amplifiers and One Modulator - Carrier

All readings are the same as listed in section 9.01 except for the modulator unit which is isolated.

9.05 Two Power Amplifiers and One Modulator - Carrier

All readings are the same as listed in section 9.03, except for the modulator unit which is isolated.

10.00 INSPECTION & MAINTENANCE

10.00 INSPECTION & MAINTENANCE

10.01 General

The schedule for inspection and maintenance should be definitely formulated after the transmitter has been in operation several months, when the necessary frequency of inspection under the operating conditions of the station can be determined from experience. The length of time between inspections and maintenance operations depends on climatic and operating conditions. Some of the more important of these factors are:

1. Room temperature.
2. Relative humidity.
3. The prevalence of dust particles in the air.
4. The presence of insects in the transmitter room.
5. Thoroughness of previous maintenance operations.
6. The number of hours per day the transmitter is used.
7. The correctness of adjustment during operation.

It is important that the room temperature be maintained sufficiently high to prevent freezing of the cooling water when the transmitter is off the air. It is also important during summer operation to correctly adjust the roof ventilators and air blowers so that the inside temperature in the transmitter unit is as low as possible. Adequate ventilation must also be provided in the basement and in the antenna house.

It is recommended that the transmitter building and antenna house be kept as free from dust as possible, since dust collections on insulators result in dangerous flashovers.

The buildings should be thoroughly screened to prevent the possibility of small insects entering the transmitter enclosure and causing flash-overs in the air dielectric tank capacitors. To this end it is also desirable that the service lights inside the enclosure be turned off during night time operation.

An inspection and maintenance schedule should be very carefully followed, since adequate service from the transmitter can be expected only when the equipment has proper care. All the apparatus will have a longer service life if care is used in maintaining correct circuit adjustments.

It is recommended that when time permits, the equipment be started up at low power for several minutes prior to the initial operating on a schedule. This procedure will provide a slightly longer operating life for the vacuum tubes and will permit the operators to check the operation as satisfactory before the station is actually placed in service.

When changing a vacuum tube in any part of the equipment, a record should be kept of the serial number of the tube and its service life.

A station log should be kept in which all meter, gauge and indicator readings are recorded at frequent intervals. The operators should be thoroughly familiar with the safe range of these readings, so that faulty adjustments may be promptly corrected.

The proposed schedules for inspection in subsequent sections of this chapter are deemed adequate as a basis for a more definite schedule to be formulated later.

10.02 Recommended Daily Schedule

1. At the conclusion of each day's operation thoroughly inspect the inside of all transmitter units for undue accumulations of dust and for signs of overheating.

10.03 Recommended Weekly Schedule

1. Thoroughly dust the complete transmitter equipment, including all auxiliaries. The dust should be removed from air dielectric tank capaci-

tor plates and other inaccessible parts by means of a compressed air jet. The air should be free from oil and other impurities. A damp cloth may be used to advantage on all accessible parts. Particular care should be used to see that all insulators, resistors and capacitors are thoroughly cleaned.

2. The grease or oil in the bearings of all rotating machines should be checked. The following machines are included:

CIRCUIT SYMBOL	QUANT.	NAME
211	3	Filament Motor-Generator Sets
224	2	Bias Motor-Generator Sets
243	1	Shop Motor-Generator Set
255	1	Main Air Blower and Motor
260	1	Pond Pump and Motor
265	1	Tube Pump and Motor
408	1	Rectifier Air Blower and Motor
601	1	Harmonic Filter Air Blower and Motor

3. The spare bias motor-generator set should be placed in service alternate weeks.

10.04 Recommended Monthly Schedule

1. Check the operation of all access door, water and air interlocks and the operation of all overcurrent, under-voltage, timing, isolation and control relays. In most cases these interlocks and relays may be operated manually to check their performance. The water flow interlocks should not be operated manually. Correct any defects.

2. Check the condition of contacts on the oil circuit breakers, motor starters and contactors. These contacts should be dressed down and replaced where needed. Refer to pamphlet instructions in Chapter 12.00 for details.

3. Inspect the brushes and commutators on the d-c generators, and treat in accordance with pamphlet instructions in Chapter 12.00.

4. Check the oil level and appearance of oil in the plate transformers, modulation transformers, reactors, oil circuit breakers, filament MG starters and thrustors. Fill to proper level if necessary and check the dielectric strength if oil is appreciably discolored.

10.05 Recommended Quarterly Schedule

1. Test the dielectric strength of the oil in the plate transformers, modulation transformers, reactors, oil circuit breakers and filament MG starters. Filter or renew if necessary. Follow pamphlet instructions in Chapter 12.00.

2. Examine the contacts on all rheostats, switches and small tube sockets. Clean them if necessary.

10.06 Recommended Yearly Schedule

1. Inspect the inside surfaces of all water cooled tube jackets and clean out if necessary.

2. Inspect all hose connections and hose for signs of deterioration. Clean or replace if necessary.

3. Check the alignment of all contacts in relays, contactors, starters, oil circuit breakers, etc. Adjust or replace if necessary. Refer to pamphlet instructions in Chapter 12.00.

4. Remove the oil from oil circuit breakers and filament MG starters, and thoroughly clean the tanks and all oil immersed parts. Refer to pamphlet instructions in Chapter 12.00.

10.07 Rotating Equipment

All units should be checked by the operator on his hourly trips to read meters, for such things as hot bearings and such signs of distress as overheated parts or poor commutation. Small pin point blue sparks are ordinarily not injurious. The large snapping sparks or yellow ones, with or without streamers, cause damage.

The maintenance inspection should be as follows:

1. BEARINGS

A. General

The cause of hot bearings is probably one of the following:

1. Too much lubricant causing churning in ball bearing units.
2. Poor lubrication due to failure of oil ring to revolve or the use of a poor grade or insufficient quantity of lubricant in sleeve bearing units.
3. Poor alignment causing excessive end thrust or binding.
4. Rough bearing surface (sleeve bearing).
5. Bent shaft.
6. Dirt in bearing (ball bearing).

The treatment of hot bearings should be as follows:

Ball Bearings - Ball bearings should not be operated at greater than a total temperature of 100°C. The average open ball bearing unit will operate with a bearing temperature rise of not more than 30°C.

The unit should be taken out of service as soon as possible and checked for the foregoing causes.

Sleeve Bearings - Reduce the load and feed a liberal supply of heavy lubricant. If bearing remains hot it will then be necessary to shut down the unit keeping the armature revolving slowly until the bearing cools to prevent "sticking" or "freezing". Determine and remove the cause.

Lubricants recommended are:

1. Ball Bearings.

(a) Hot locations - Texas Oil Co. Marfak #3 or equivalent.
(b) Average locations - Texas Oil Co. Marfak #2 or equivalent.
(c) Cold locations - Texas Oil Co. Marfak #1 or equivalent.

2. Sleeve Bearings.

(a) American Red Engine Oil - Gulf Refining Co.
(b) Avon. Med. Dynamo Oil - Associated Oil Co.
(c) Colol Special Turbine Oil - Std. Oil Co. of Cal.
(d) #2 Pale Oil - Shell Oil Co.
(e) Nabob Oil - Texas Oil Co.
(f) Ruddy Engine Oil - Atlantic Refining Co.
(g) Shasta Eng. Dynamo & Turbine Oil - Union Oil Co.
(h) VF-965 Oil - Vacuum Oil Co.
(i) or any good quality oil having a viscosity of from 185 to 212 seconds at 40° Cent.

These oils are satisfactory for normal temperaturesdown to 0° Cent. For lower temperatures special recommendations should be obtained.

B. Inspections

(a) Daily inspection should consist of temperature check.

(b) Monthly inspection should consist of oil level check on sleeve bearings. Oil level should be from 1/8" to 1/4" below the top of overflow plug. Oil should only be added through the overflow plug.

(c) Quarterly inspection of grease in ball bearings. It is not necessary to open bearings but a small quantity of grease should be added with a small hand grease gun. Avoid any possibility of getting dirt in the bearings.

(d) Yearly inspection should consist of:

1. Sleeve Bearings

(a) Drain out the old oil, flush out the reservoir with oil, and refill with new oil.

(b) Check to be sure bearings have not worn excessively. Bearings should not be permitted to wear sufficiently to allow the armature to rub on the stator or poles. If this should occur it will probably cause considerable damage and be expensive to repair.

2. Ball Bearings

(a) Housing should be dis-assembled and all the old grease removed from the bearing and housing. Fill the annular spaces between the inner and outer races on both sides of the bearing level full of grease and reassemble. Avoid any possibility of getting dirt into the bearing. Bearing will operate best when chamber is approximately 1/3 full of grease.

2. WINDINGS

A. General

1. The windings should never be subjected to oil or grease thrown from bearings or spilled due to careless filling. Oil or grease working out of bearings along the shaft usually results from too much lubricant in the bearing or worn seals.

2. Dust conditions may arise from installation of new brushes, construction work or cleaning out of other apparatus and machines should be covered to exclude the dust from the windings and commutator. Units should not be operated under voltage after being subjected to dust conditions without first thoroughly blowing the machine out with dry air.

B. Inspections

1. Daily inspection need only be very general and sufficient to be sure that they are not overheating.

2. Monthly inspection should consist of thoroughly blowing out all windings with dry compressed air. Particular care should be used to blow out the space between the back of the commutator and the core on the filament and bias generators. It is essential that this be done very carefully so as not to damage the insulation.

3. Armatures having insulated windings should be removed every two years and reconditioned by cleaning, drying, dipping in high grade insulating varnish, and baking dry. This may be done at the same time the commutator is reconditioned on d-c machines.

3. COMMUTATORS AND BRUSHES

A. General

Keep the commutator clean, wiping it at frequent intervals with a clean canvas cloth free from lint. A commutator that is taking on a polish and shows no signs of wear requires no other attention. A rough, raw, copper colored commutator should be smoothed with a piece of sandpaper or sandstone ground to fit and polished with #00 sandpaper. Always lift the brushes when polishing the commutator and do not replace them until all grit has been removed. Brushes should have contact with the commutator or slip ring over the entire face. Brush pressure springs should be kept so adjusted as to maintain 1-1/2# to 2# pressure per square inch of brush contact face. The limit of brush wear is, of course, to such a length that the pressure finger strikes some part of the holder and releases the pressure from the brush. Brushes should never be used to a length less than the circumferential thickness as this would permit too great a movement in the box and possibly sufficient rotation to cause it to lock in the holder. The brush position is set before the unit leaves the works and needs no further adjustment. Use only those brushes recommended by W.E. & M. Co.

B. Inspections

Commutator polish and commutation of the brushes should be noted daily.

Once each week an inspection should be made to be sure that brushes are free in the holders. They sometimes stick due to accumulation of dust or swelling of the brush due to changes in temperature. They should be a sliding fit in the holder but not loose.

Each month the spring pressure should be adjusted so that all brushes have approximately equal pressure per square inch of contact area. Undercutting between bars should be cleaned and examined for evidence of high mica, particularly slivers sticking up above the face of the commutator. Commutator should be re-undercut before bar has worn to the depth of the undercutting. Commutator should be re-conditioned whenever it becomes rough or eccentric enough to cause the brush to jump and spark as this then aggravates the condition.

10.08 Special Precautions for Vacuum Tubes

The flow and temperature of water in the jackets are important. The water must not be allowed to boil and the flow must be large enough to prevent the formation of steam bubbles on the plate surfaces. The water outlet temperature should not exceed 70°C (158°F.). If the water flow fails, even for a short time, the Radiotron will be damaged. Without cooling water, the filament heat alone is sufficient to damage the Radiotron.

Scale formation on the plates of Radiotrons must not be allowed to occur, since the accumulation of scale prevents the proper transfer of heat from the plate to the water. In emergency cases when scale is formed, such as in a temporary shortage of water supply or failure of the softening device, it is recommended that a regular schedule for cleaning the scale from the plates be adopted. A 10% solution of hydrochloric acid will ordinarily dissolve the scale in case of necessity. After treatment, the plate should be carefully rinsed in water. The frequency of cleaning should depend upon the rate at which the scale is formed. Obviously, the frequent removal of Radiotrons from the jackets is objectionable because of the danger of accidental breakage. Therefore, the only possible insurance against failure, due to scale, is the entire elimination of its cause.

The air supplied to the air cooling nozzles must not contain water or other foreign material.

Particular care should be given to the maintenance of all overload protective equipment provided for the tubes.

Care in handling and manipulation of Radiotrons RCA-870, RCA-862, and RCA-848 is necessary. Keep the Radiotron vertical with the glass end up and prevent the filament leads from swinging or striking the glass. Do not subject the Radiotron to any vibration or shock. Before using the tube, note whether any foreign matter has fallen into the stem opening and lodged between the glass and the filament leads. Such material must be removed before the tube is used.

Do not drop the Radiotron into the water jacket. The plate is secured rigidly in the jacket so that any strains put on the filament or grid leads are transmitted to the glass. Therefore, it is advisable first to secure the Radiotron in the jacket and then make the connectors loose enough to allow for movement without strain and in no case subsequently make readjustment of the Radiotron or jacket without first disconnecting the leads.

After operating the Radiotron and before turning off the water preparatory to removing the Radiotron, be sure that the inner electrodes are below red heat. Air and water cooling must be continued for 10 minutes after operation of the Radiotron. Do not force the Radiotron when removing it from the jacket. Release the securing device wholly so it will not stick, then manipulate carefully to avoid putting strains on the glass.

To prevent stocking of inoperative tubes, caused either by transportation or the development of an incipient manufacturing defect, each tube should be tested upon receipt by the customer in the equipment in which it is to be used. If spare tubes are stocked for long periods, a check test should be made at least every three months.

The initial test of a new Radiotron should be made by operating the filament at one-half rated voltage for five minutes and then at full rated voltage for another five minutes, both periods being without plate voltage. The plate voltage may be applied without modulation at as low a value as possible. Initial test of new RCA-862 Radiotrons should be made in a power amplifier. If the tube operates properly, the plate voltage may then be increased to the normal operating value without modulation. If the tube still operates properly, modulation at a high audio frequency, but at a very low percentage of modulation, may be applied and increased carefully to the desired value during an interval of about 15 minutes. The Radiotron should then be operated under normal operating conditions for a period of not less than two hours. When making adjustments it is advisable to operate at low plate voltage to prevent damage due to circuit misadjustment.

Severe overload may impair the vacuum in the Radiotron. It is possible sometimes to correct the difficulty by operating the Radiotron as an r-f power amplifier using reduced plate voltage. The voltage may then be increased until normal operating voltage is obtained.

Spare vacuum tubes of all types used in the transmitter should be stored in racks in a convenient but safe location so as to be immediately available in case of need. In no case should the RCA-862, RCA-848 or RCA-870 tubes be carried or stored in other than a vertical position as shipped and as used in the transmitter. To do so may cause undue strains in the metal to glass seals of the water cooled tubes and improper distribution of the mercury in the rectifier tubes.

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CAUTION

Make sure that the 2300 volt power supply is disconnected external to the transmitter before servicing operations are performed on any high voltage apparatus.

11.00 REFERENCE LIST OF ELECTRICAL PARTS

11.00 REFERENCE LIST OF ELECTRICAL PARTS

11.01 Ordering of Renewal Electrical Parts

In the ordering of renewal electrical parts, the following information should be given:

(1) RCA Type Number of complete equipment (Type 500-A).
(2) Circuit Symbol Number or Sub Number of the part.
(3) Connection Diagram on which the circuit symbol number appears (see page headings in subsequent sections of this chapter.)
(4) Manufacturer of part, if known.
(5) All the information given under the circuit symbol number or sub number in subsequent sections of this chapter.

11.02 Ordering of Renewal Mechanical Parts

In the ordering of renewal mechanical parts, not designated by circuit symbol numbers on the connection diagrams, the following information should be given:

(1) Drawing list and group number, or drawing and group number, of the main transmitter unit in which the part appears. (Refer to the unit nameplates appearing on the panels, or to information in Chapter 2.00 of these instructions.)
(2) Name and description of part.
(3) Location and function of part.

11.03 Explanation of Column Headings in Part List

In Sections 11.04 to 11.16, inclusive, the column headings have the following significance:

Circuit Symbol Number. This phrase refers to the numbers placed near symbols for component electrical parts as they are shown on schematic and connection diagrams. The numbers in this column agree with those shown on all schematic and connection diagrams.

Circuit Symbol Sub Number. In case a piece of electrical apparatus must be broken down into its component parts for purposes of electrical rating, each of the component parts is assigned a circuit symbol sub number, composed of the circuit symbol number and a suffixed numeral. The sub numbers do not appear on schematic or connection diagrams.

Quant. The total quantity of complete electrical parts or sub parts, designated by the same circuit symbol number, is tabulated in this column. In certain cases, however, the same type of electrical part is designated by different circuit symbol numbers, where different functions are performed.

Name and Electrical Rating (Each). The name given to each electrical part or sub part and, where necessary, a brief description of the part appear in this column. In some cases, the manufacturer's type number appears here since, although it does not constitute an essential part of the name or ordering information, it is the factory designation most commonly used in referring to the particular class of apparatus.

The rated voltage, current carrying capacity, power dissipation, and other standard rating identifications, as commonly used appear in this column, where required.

Mfr's. Cat. or Drawing Reference. The manufacturer's catalog or drawing reference, in general, forms a complete identification of the part. In the case of contactors, relays and certain other classes of apparatus, the words "(Catalog Number) and description" are included. In such cases, the number and electrical rating of the poles, interlocks and coil, or similar information applicable to the part in question, should be included in a renewal order for a complete piece of apparatus, to insure full identification.

Assembly Part Reference. In this column are tabulated the manufacturer's drawing and part reference showing the assembled position of each electrical part.

Spares Quant. In this column the customer may tabulate the quantities of various spare parts for electrical items which he may wish to retain in stock.

Circuit symbol numbers will be found in sections as indicated below, with the exceptions noted:

Symbol Number Block	Transmitter Unit	Instruction Book Section
101 to 199	HPA & Modulators	11.04/11.05
201 to 276	Distribution Panel	11.06
301 to 319	Low Power Rectifier	11.07
401 to 442	Main Rectifier	11.08
401 to 441	Oil Circuit Breaker Unit	11.09
501 to 553	Power Amplifiers	11.10
601 to 631	Antenna House	11.11
620 to 627	Antenna Rectifier	11.12
701 to 709	Audio Equalizer & High Pass Filter	11.13
801-A to 837	Control Panel	11.14
901 to 984	Operator's Console	11.15

In addition to the above, the "External Apparatus" listed in section 11.16 includes symbol numbers from all the above blocks except the 300, 700 and 800 groups.

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
101		4	"H" Pad Series resistors 200 ohm, 25 watt, with variable slider.	Electrad Type B-2	M-7404950 P-4	
102		1	"H" Pad shunt resistor 5000 ohm, 25 watt, with variable slider	Electrad Type B-50	M-7404950 P-5	
103		1	"H" Pad Relay. Automatic Electric, single wound quick acting for use on 100 to 125 volts D.C.	Series AQA	M-7404950 P-3	
104		1	Audio input transformer. Ratio 1 : 3.16. To match 500 ohm line to 5000 ohm load.	S#552151	T-7603497 P-4	
105		2	Load resistors for item 104. 2500 ohm, 1 watt. International Resistor Co.	IRC Type WW3	T-7603497 P-35	
106		1	Bias potentiometer by-pass capacitor 8 mfd. 500 volts D.C.	PL-5036	T-7603497 P-31	
107		1	Bias potentiometer resistor. Electrad 5000 ohm variable with slider. Rated at 25 watts.	B-50	T-7603497 P-37	

11.04/11.05 High Power Audio Amplifier - Modulator Drwgs. 7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
108		3	Bias potentiometer fixed resistors. Electrad 25,000 ohm, 25 watt.	B-250	T-7603497 P-38	
109		2	Tube sockets 50 watt size (W) for RCA-211.	S#552123	T-7603497 P-69	
110		2	Filament rheostats. National Electric Controller Co. 2 ohm 3.5 amp.	R-4	T-7603497 P-24	
111		2	Filament fixed series resistors. Ohmite 6 ohm, 100 watt	Code BUBAL	T-7603497 P-28	
112		1	Filament switch for first stage tubes. Bryant Electric Double pole indicating type 125 volts 10 amperes.	Cat.#3962	T-7603497 P-29	
113		2	Plate series resistors for first audio stage. Ohmite 32,000 ohm 200 watt.	Code BOZZE	P-7704461 P-3	
114		2	Plate milliammeters for first audio stage. 100 milliamperes full scale (W).	S#563199	T-7603497 P-32	

11.04/11.05 High Power Audio Amplifier - Modulator Dwg.7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
115		2	Audio coupling capacitor .2 mfd. capacity, rated at 3000 volts DC.	Type 818	T-7603497 P-33	
116		2	Audio coupling resistors. International Resistance Co.,250,000 ohms 1 watt	Type WW-4	T-7603497 P-34	
117		1	Bias potentiometer by-pass capacitor. 8 mfd. capacity rated at 500 volts DC.	PL-5036	T-7603497 P-31	
118		1	Bias potentiometer variable resistor. Electrad 5000 ohm 25 watt with sliding clip.	B-50	T-7603497 P-37	
119		3	Bias potentiometer fixed resistors. Electrad 25,000 ohm 25 watt	B-250	T-7603497 P-38	
120		2	Tube sockets 50 watt size (W) for RCA-211	S#552123	T-7603497 P-69	
121		2	Filament rheostats for second audio stage. National Electric Controller Co. 2 ohm 3.5 amps.	R-4	T-7603497 P-24	
122		2	Filament series resistors. Ohmite 6 ohm 100 watt	Code BUBAL	T-7603497 P-28	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
123		1	Filament switch for second audio stage. Bryant Electric Co. Double pole indicating 125 volt 10 amperes.	Cat. #3962	T-7603497 P-29	
124		2	Plate milliammeters for second audio stage. 100 milliampers full scale deflection (W)	S#563199	T-7603497 P-32	
125		1	Interstage transformer. Rating 30 watts. Frequency range 30 to 10,000 cycles. Primary voltage 1414 maximum. Secondary voltage 282 maximum. Primary has two windings in series. Secondary has two windings in series. (W)	SO-66-K-12	T-7603497 P-12	
126		2	Load resistors for item 125. Electrad 5000 ohm 25 watt.	Type B-50	T-7603497 P-37	
127		2	Bias potentiometer variable resistors. Electrical 2000 ohm 75 watt.	Type D-10	M-7404959 P-2	
127-A		2	Modulation limiting resistors. Semi-variable, 2000 ohms, 20 watts.	Ohmite and description	Customer	
128		4	Bias by-pass capacitors. 8 mfd. capacity rated at 500 volts DC.	PL-5036	T-7603497 P-31	

11.04/11.05 High Power Audio Amplifier - Modulator Dwgs. 7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
129		3	Bias potentiometer fixed resistors. Ohmite 3000 ohm, 130 watt.	Code BROCK	P-7704461 P-14	
130		2	Tube sockets, 250 watt size (W) Plate end Filament end For RCA-849	 P-7651887 G4 P-7651887 G6	 T-7603497 -21 T-7603497 -20	
131		2	Filament rheostats for third audio stage. National Electric Controller Co. 1 ohm 5 amps.	Type R-4	T-7603497 P-25	
132		4	Filament fixed series resistors for third audio stage. Ohmite 8 ohm 100 watt	Code BUBAL	T-7603497 P-27	
133		1	Filament switch for third audio stage. Bryant Electric Co. Double pole, indicating 125 volt 10 amperes.	Cat.#3962	T-7603497 P-29	
134		2	Plate milliammeters for third audio stage 200 milliamperes full scale (W)	S#563201	T-7603497 P-30	
135		1	Interstage transformer. Rating 600 watts. Frequency range 30 to 10,000 cycles. Primary voltage 3536 volts maximum. Secondary voltage 2968 volts maximum. Primary has two windings in series. Secondary has two windings in series.	SO-66K-13	T-7603497 P-22	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
136		2	Load resistors for item 135. Ohmite 10,000 ohms, 200 watts.	Code BOUIL	P-7704461 P-2	
137		2	Bias supply bypass capacitors. 4.5 mfd. capacity rated at 2000 volts (W)	S#831725	T-7603497 P-26	
138		4	Bias adjusting batteries Exide type 48 volt 5000 milliampere hours	Type 24LR2 Cat. #15293	P-7704474 P-2	
139		2	Tube jackets for fourth audio stage (W) for RCA-848	T-7601907 G-1	T-7603497 P-14	
140		2	Overcurrent indicating relays for RCA-848's. Type SC. Calibrated 16 to 48 amp. AC or DC.	Style N-800494	-	
141		2	Surge current limiting plate series resistors 1 amp. continuous duty 80 ohms.	Fabricated	P-7704454 P-6	
142		2	Overload relay shunt resistor Ohmite 3 ohm 60 watt	Code BUEYL	P-7704454 P-7	
143		2	Plate overload relays for fourth audio stage. Trips at 5 amps. Type K62 special with one NC and two NO contacts (W).	T-7608522 G-1 and G-2	P-7704454 P-3 and P-4	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
144		2	Fourth audio stage plate ammeters. 2 amperes full scale deflection (W)	S#568273	P-7704454 P-5	
145		2	Fourth audio stage variable filament series resistors. Type M .24 ohms 61 amperes continuous (W)	S#567399	P-7704502 P-3	
146		1	Fourth audio stage filament switch. Single pole 200 amp. 250 volts dc.(W)	S#554471	P-7704502 P-4	
147		8	Bias adjusting batteries. Exide 6 volt 75 ampere hour	Type 3 - LXL - 7 - 1 Cat.#16451 Code CHUNK	P-7704474 P-3	
148		2	Interstage transformers. Rating 8.36 KVA Primary voltage 13720 volts maximum. Secondary voltage 1556 volts maximum. Primary has two windings in series. Secondary has two windings in series (W)	SO 66K 9	K-7807721 P-1	
149		1	Plate supply by-pass capacitor. 20 mfd. capacity rated at 3000 volts DC (W)	SO 81M 276	T-7603532 P-17	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
150		1	Plate supply by-pass capacitor. 8 mfd. capacity rated at 2200 volts DC (W)	S#700633	T-7603532 Pt.18	
151		1	Bias battery charger. 115 volts, 50-60 cycle AC supply. Delivers 7½ to 100 volts DC at 1 to 6 amperes. Requires Rectigon bulb S#289416	S#553276	P-7704474 P-5	
152		2	Grid circuit isolation switches for modulator units (W)	T-7603527 G1	W-7300244 P-24	
153		4	Modulator grid load resistors. Each unit consists of 36 ohmspun plates. Each plate having 220 ohms resistance Then are arranged in series parallel so as to give a net load resistance of 220 ohms.		W-7300244 P-50	
154		16	Modulator bias supply by-pass capacitors. 50 mfd. capacity rated at 500 volts DC (W)	S#831723	W-7300244 P-87	
155		8	Tube jackets for 862 modulator tubes (W) HCA	T-7603565 G-1	W-7300244 P-59	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
156		8	Plate ammeters for modulator tubes. 50 millivolts full scale deflection. Calibrated for 10 amperes dc full scale.	S#567600 Whse.	P-7704541 P-6	
156A		8	Calibration rheostats for 156. Electrad 10 ohm 1 amp.			
157		8	Plate overload relays for modulator tubes. KG2 special. Each relay has one NC and two NO contacts (W)	T-7603522 G1 & G2	P-7704519 Pts.4 & 5	
158		8	RCA-862 overload relay shunting resistors .5 ohm #20 Nichrome wire		P-7704519 P-8	
159		8	RCA-862 surge current limiting resistors 10 ohms resistance rated at 1200 amperes for one twelfth second.			
160		2	Output transformers rated at 180 KVA maximum. Broadcast program load factor. Primary voltage 14,430/12,730. Secondary voltage 4250. 30 to 10,000 cycles. 7500# oil - Total weight 37,750 lbs. approximate	M-7405043-1	T-7603532 P-9	

11.04/11.05 High Power Audio Amplifier - Modulator - Dwgs. 7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
161		2	Filament run switches. Rated at 250 volts dc 1200 amperes.	S#554839 Westinghouse	P-7704517 P-3	
161A		2	Filament off interlocks. One circuit 5 amperes.	F-7847	P-7704517 P-4	
162		14	Filament starting resistors rated at .13 ohms, 91 amperes continuous. Seven in parallel in each unit.	S#388991 Westinghouse	WW-7300244 P-43	
163		2	Modulator total plate current ammeters. Full scale 50 amperes. Full scale deflection obtained with 50 MV across the terminals of the leads supplied.	S#304523 Westinghouse	P-7704479 P-3	
163A		2	Shunts for meter #163 - 50 mv. across terminals for 50 amp. through shunt.	S#703928 Westinghouse	P-7704479 P-8	
164		2	Filament "On" indicator lights. T-4 bulb. Miniature screw base .11 amp. 18 volts.	S#549474 Westinghouse	M-7404990 P-13	
166		1	Modulator coupling reactor. Rated at 4.5 henries at 60 amperes dc. Total weight 23,450 lbs. Oil 3350#	31-B-436	T-7603532 P-13	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
167		8 4 4	Modulator water flow interlocks Left to right flow 30GPM Right to left flow 30GPM Contacts rated 3 amps. 250 V. AC	 M-7460200 P2 M-7460200 P4	WW-7300244 P-44-45	
168		2	High power audio water flow interlocks 10 GPM Contacts rated at 3 amps. 250 volts DC	M-7460200 P-6	WW-7300244 P-46	
169		1	RCA-848 plate disconnect switch. Rated at 15,000 volts 200 amps.	S#534202 Westinghouse	F-8749	
170		1	High power audio water temperature interlock 60 to 180° F. Foxboro	Cat.GC-100A-1	M-7404989 P-3	
171		4	Modulator water temperature interlock 60 to 180° F. Foxboro	Cat.GC-100A-1	M-7404990 P-4	
172		4	Modulator door interlock. One circuit. Opens when door opens. Rated at 5 amperes.	M-7460330 G-1	T-7603545	
173		2	Modulator cat walk interlocks. Bryant Electric Co.	F-102538		

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
174		2	Modulator water on light T4 bulb miniature screw base .11 amp. 18 volts.	M-7401579 G-5	P-7704517 P-5	
175		2	Filament start switch. Rated at 1200 amperes, 250 volts DC.	S#554839 Westinghouse	P-7704517 P-3	
175A		2	Filament off interlocks for 175. One circuit 5 amperes.	F-7847	P-7704517 P-1	
176		1	Modulator bias protective Electrolytic arrester. Rated at 500 volts DC.	S#324172 Westinghouse	P-7704474 P-8	
177		1	High power audio bias protective Electrolytic arrester. Rated at 2000 volts dc.	S#324176 Westinghouse	P-7704474 P-7	
178		8	Modulator safety grounding switches	T-7603569 G1 & G2	WW-7300244 P-89-90	
179		2	Emergency shut down push button. Each has one circuit N.O., one N.C., 8 amperes, 220 volts AC.	M-7452891 G-1	M-7404990 P-8	

11.04/11.05 High power audio amplifier - Modulator - Dwgs. 7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
180		1	Line switch for charger item 151. Included in charger.			
181		1	Fuse for charger item 151. Included in charger.			
182		1	Modulator bias battery charger disconnect switch. Rated at 250 volts, 30 amperes DC. Double pole single throw.	S#554196-B Westinghouse	P-7704571 P-3	
183		1	High power audio bias battery charger disconnect switch. Rated at 250 volts, 30 amperes DC. Double pole single throw.	S#554196-B Westinghouse	P-7704571 P-3	
188		1	Battery charging series resistor 100 ohms, 200 watts	Code BUEYL	P-7704571	
189		2	High power audio cell door interlocks. One circuit opens when door is opened. 5 amperes 220 volts AC	M-7460330 G-1		
190		2	Modulator safety grounding switch interlocks. One circuit opens when switch closes. 5 amps. 220 volts AC	M-7460330 G-1		

11.04/11.05 High Power Audio Amplifier - Modulator - Dwgs. 7704540

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
191		2	Modulator total plate current ammeters calibrating resistance. Rated at .1 ohm.			
192		8	Filament fuses 250 amp. 250 volt	GE-1053		
193		8	Grid series resistors. Rated at 4 ohms, 25 watts. Joseph Dixon Co.	Type D-10		
193-A		8	Grid stabilizing choke	-	P-7760945 P-11	
194		4	RCA-862 grid by-pass condensers Rated at .001 mfd. 15000 volt	Type UC-2325 Faradon		
195		2	RCA-848 grid by-pass condensers Rated at .00035 mfd. 10,000 volts	UC-2603 Faradon		
196		4	Modulation transformer primary safety gaps. Normal spacing .625 inches			
197		1	Modulation reactor safety gap. Normal spacing .375 inches.			
198		8	Current limiting resistors for 197. Rated 250 watts. 2.5 ohms each. Ward Leonard.	Ribflex		
199		2	RCA-848 grid safety gaps. Normal spacing 1/4".			

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
201		1	220 volt main line switch 3 P.S.T. Rated 400 amps., 250 volts AC,	S#554545 Westinghouse	T-7603547 P-7	
202		3	Fuses for switch 201 400 amperes. 250 volts. Bryant	Cat. #7089	T-7603547 P-12	
203		1	Main rectifier filament switch DPST. Rated at 60 amps., 250 volts AC.	S#554256 Westinghouse	T-7603547 P-11	
204		2	FUses for switch 203. 40 amperes, 250 volts. Bryant	Cat. #7063	T-7603547 P-16	
205		9	Filament motor generator line switch. SPST. Rated at 2300 volt 200 amps.	S#534129 Westinghouse		
206		9	Fuses for switch #205 - Rated at 2300 volts AC 30 amps.	S#318431 Westinghouse		
207		3	Filament motor generator starters. Oil immersed for use with 2300 volt 85 HP motor. Line start type.	Class 11-200J Westinghouse	T-7603532 P-8 Note 2	
207-A		3	Auxiliary relay for filament MG starter. Type KM-2. 3 n.o. contacts 3 n.c. contacts rated 1 amp. at 250 volts DC	S#816918		
210		3	Filament motor generator stop switch. S.P.S.T. Rated 10 amp. 250 volt Bryant	Cat. #3961	22C-16 P-24	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
211		3	Filament motor generator motor 85 HP 2300 volt, 3 phase, 60 cycle, 19.8 amp. per terminal. 1175 RPM Generator 52.5 KW 35 volt, 1500 amps. DC 1175 RPM	3S80M909	T-7603532 P-8	
212		3	VOltage limiting rheostat Type WL 1- 8" plate 2.5 ohms 11.5 amp.	S#664191 Westinghouse	22-C-16 P-21	
212-A		3	Voltage limiting rheostat. 2.5 ohms, 11.5 amp., 33 steps of equal resistance	S#664191	22-C-16 part 21	
213		3	Filament motor generator load disconnect switch S.P.S.T. Type AL. Rated at 1600 amp., 250 volts	S#554903 Westinghouse	22-C-16 P-2	
213-A		3	Switch for resistor 213B. Type AL. Rated at 30 amps., 250 volt S.P.S.T.	S#554195 Westinghouse	22-C-16 P-3	
213-B		3	Line switch shunt resistor 10" long 40 ohm, 125 watt	S#204532 Westinghouse	22-C-16 P-5	
214		3	Filament generator field disconnect switch. Rated at 100 amps. 250 volts.	S#693437 Westinghouse	22-C-16 P-4	
214-A		3	Filament generator field discharge resistor. 10" long, 100 ohm, 125 watts	S#204562 Westinghouse	22-C-16 P-6	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
215		3	Filament generator load ammeter. Calibrated 3000 amps. full scale. Full scale reading with 50 MV at input of meter leads.	S#364351 Westinghouse	22-C-16 P-18	
216		3	Shunt for meter 215. Rated 50 MV drop at 3000 amp.	S#282648 - Westinghouse	22-C-16 P-19	
217		2	Filament generator field series resistors. 12 ohms, 200 watts	Code BOVIL	T-7603547 P-83	
218		1	Filament generator field disconnect switch. Rated at 30 amp.,250 volts DC.	S#554203 Westinghouse	T-7603547 P-20	
219		1	Filament generator field fuse. Rated 30 amp. 250 volts. Bryant	Cat.#7061	T-7603547 P-24	
220		1	Bias motor generator line switch 3 P.S.T. Rated 100 amps.,250 volts	S#554353 Westinghouse	T-7603547 P-9	
221		3	Fuses for 220. Rated 100 amps.,250 volts.	Cat.#7075	T-7603547 P-15	

11.06 Disbribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
222		1	Bias motor generator line starter. Rated 220 volt 3 phase 60 cycles 30 HP Class 11-200-C6.	S#688973 Westinghouse	T-7603547 P-38	
223		1	Bias motor generator transfer switch (motor) 3 P.D.T. Rated 250 volt 60 amps.	S#554253	T-7603547 P-36	
224		2	Bias motor generator units Motor: Rated 17.5 HP at 220 volt, 3 phase, 60 cycles, 1750 RPM. Induction type 17.5 amps. per terminal Generator: Rated 12 KW, 1000 volts, 12 amps. dc., 1750 RPM. Generator Rated .375 KW, 1500 volt, .25 amp.dc. 1750 RPM Generator rated 1.2 KW, 100 volts, 12 amps.DC 1750 RPM	80M902 Westinghouse 80M903 80M904 80M904	T-7603532 P-6	
225		1	Bias load transfer switch. 3 P.D.T. Rated 1500 volts.	M-7704480	T-7603547 P-30	
226		1	Bias generator field transfer switch 3 PDT Rated 250 volts 60 Amp.	S#554253	T-7603547 P-36	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
227		1	Field contactor. Type 12C2. Rated 25 amperes, 250 volts.	S#474035 Westinghouse	T-7603547 P-25	
228		1	Field series resistor 100 ohm 200 watt	Code BOVIL	T-7603547 P-82	
229		1	Field disconnect switch S.P.S.T. Rated 30 amp. 250 volts.	S#554203 Westinghouse	T-7603547 P-20	
230		1	Fuse for switch 229. Rated 30 amp. 250 volts - Bryant	Cat.#7061	T-7603547 P-24	
231		1	High power audio bias relay. Type KM. Rated 1 Amp. 250 volts dc. Inductive load.	S#546346 Westinghouse	T-7603547 P-94	
232		1	Resistor for coil of 231. 23,000 ohm, 200 watt	Code BOVIL	T-7603547 P-32	
233		1	Modulator bias relay Type KG2. Rated 5 amp. 250 volts dc.	S#518924 Westinghouse	T-7603547 P-28	
234		1	Power amplifier bias relay. Type KM Rated 1 amp. 250 volts DC Inductive load.	S#546346 Westinghouse	T-7603547 P-94	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
235		1	Resistor for coil of relay 234. Rated 11,000 ohms, 200 watts.	Code BOVIL	T-7603547 P-31	
236		1	High power audio bias voltmeter multiplier. Calibrated with meter 903	(G.E.)	T-7603547 P-35	
237		1	Power amplifier bias voltmeter multiplier. Calibrated with meter 903.	(G.E.)	T-7603547 P-33	
238		1	Modulator bias voltmeter multiplier Calibrated with meter 903.	(G.E.)	T-7603547 P-34	
239		1	Line switch for shop machine. 3 P.S.T. Rated 200 amp. 250 volts	S#554449 Westinghouse	T-7603547 P-8	
240		3	Fuses for switch 239. Rated 200 amp., 250 volt - Bryant	Cat.#7081	T-7603547 P-14	
241		1	Shop motor generator starter. Rated 220 volts, 3 phase, 60 cycle, 30 HP	S#688973 Westinghouse	T-7603547 P-23	
242		2	Fuses for coil of 241. Rated 10 amps., 250 volts.	Cat.#7056		
243		1	Shop motor generator Motor: Rated 220 volts, 3 phase,60 cycle, 25 HP, 1750 RPM Generator: Rated 15 KW, 125 volts, 120 amps.DC 1750 RPM	80M906 80M907	T-7603532 P-7	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
244		1	Shop generator field rheostat. Rated 400 ohms 3.5 amp. - .5 amp. 2 - 8" plates.	S#664246 Westinghouse	T-7603547 P-18	
245		1	Shop generator voltmeter. Rated 125 volts full scale self contained	S#293402 Westinghouse	T-7603547 P-17	
246		1	Shop machine load disconnect switch DPST Rated 200 amp., 250 volts	S#554448 Westinghouse	T-7603547 P-22	
247		2	Fuses for switch 246. Rated 200 amp., 250 volts.	Cat.#7081	T-7603547 P-14	
248		1	Control circuit switch DPST - Rated 100 amps., 250 volts.	S#554352 Westinghouse	T-7603547 P-21	
249		2	Fuses for switch 248 - Rated 100 amperes, 250 volts.	Cat.#7075	T-7603547 P-15	
250		1	Air blower disconnect switch DPST. Rated 30 amps., 250 volts	S#554204 Westinghouse	T-7603547 P-19	
251		2	Fuses for switch 250. Rated 30 amps., 250 volts.	Cat.#7061	T-7603547 P-24	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
252		1	Starter for air blower motor. Rated at 115 volts dc., 3 HP, speed control, step start type Class 85-12F	S#695991 Westinghouse	T-7603547 P-42	
253		1	Air blower line transfer switch 3 PDT. Rated at 60 amps.,250 volts	S#554253	T-7603547 P-36	
254		2	Air blower speed control rheostat. Rated 350 ohms 2.3 amp. to .54 amp. 1 - 8" plate.	S#664211 Westinghouse	T-7603547 P-41	
255		1	Air blower Motor: 3 HP, 1750 RPM maximum 115 volts dc variable speed. Blower: #2 American Sirocco blower	F-225 SA-2338	T-7603532 P-4,5	
256		1	Line switch for pond pump motor 3 PST Rated 100 amps. 250 volts.	S#554353	T-7603547 P-9	
257		3	Fuses for switch 256 - Rated at 100 amps. 250 volts - Bryant	Cat.#7075	T-7603547 P-15	
258		1	Starter for pond pump motor - Rated 220 volt, 3 phase, 60 cycle 30 HP	S#688973 Westinghouse	T-7603547 P-38	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
259		1	Pond pump transfer switch 3 PDT Rated 60 amps. 250 volts	S#554253 Westinghouse	T-7603547 P-36	
260		1	Pond water pump Motor: Rated 220 volts, 3 phase, 60 cycles, 1750 RPM 20 HP Pump: 800 GPM at 1745 RPM 70' head	S#678182X Gould Fig.3085	T-7603532 P-1,3	
261		1	Line switch for tube water pump 3 PST - Rated at 200 amp. 250 volts	S#554353 Westinghouse	T-7603547 P-8	
262		3	Fuses for switch 261 - Rated at 110 amps. 250 volts.	Cat.#7075	T-7603547 P-13	
263		1	Starter for tube water pump - Rated at 250 volts, 3 phase, 60 cycle, 30 HP.	S#688973	T-7603547 P-38	
264		1	Transfer switch for 3 PDT tube water pump - Rated at 60 amps.,250 volts	S#554253	T-7603547 P-36	
265		1	Tube water pump Motor: Rated 220 volts, 3 phase, 60 cycle, 1750 RPM 20 HP Pump: 525 GPM, 1745 RPM 110' head	S#678182X Westinghouse Gould Fig. 3085	T-7603532 P-2,3	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
266		1	Main temperature interlock - Foxboro Calibrated from 60 to 180° F.	S.V. # 83 1781		
267		1	Relay for interlock 266. Automatic Electric low current type 1 NO contact			
267A		1	Resistor for 267. 1100 ohms 60 watt			
268		1	Air interlock 1 NO contact - 5 amps. 250 volts			
270		1	Filament line switch 3000 volt rectifier. DPST Rated 250 volts 30 amps.	S#554203 Westinghouse	T-7603547 P-11	
271		2	Fuses for switch 270 - Rated 10 amps. 250 volts	Cat.#7056	T-7603547 P-16	
272		1	3000 volt rectifier line switch 3 PST Rated 30 amps. 250 volts	S#554205 Westinghouse	T-7603547 P-10	
273		3	Fuses for 272. Rated 10 amps. 250 volts	Cat.#7056	T-7603547 P-16	

11.06 Distribution Panel - Diagram T-7603547

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
274		1	Emergency shutdown switch - Bryant SPST Rated 125 volts 5 amps.	Cat. #3961	T-7603547 P-39	
275		1	Auxiliary relay for blower starter item 252. Type KG-2 rated 5 amps. 250 volts.	S#518924 Westinghouse		
276		1	Resistor for modulator bias rheostat 909. 1000 ohms, 200 watts.	Ohmite code BOZZE and description		

11.07 Low Power Rectifier - Diagram P-7704469

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
301		1	Rectifier filament contactor Type 12K Rated at 5 amps. 250 volts	S#437202 Westinghouse	T-7603504 P-6	
302		1	Rectifier filament rheostat National Electric Controller Co. 25 ohms, 1.5 amps. 250 volts	Type R-8	T-7603504 P-7	
303		1	Rectifier filament voltmeter - Calibrated 0-250 volts, 60 cycle, full scale. Self contained multiplier.	S#630117 Westinghouse	T-7603504 P-8	
304		1	Filament time delay relay 1.5 minutes maximum time delay. Contacts rated at 1.5 amp. 125 volts. Motor rated at 220 volts, 60 cycles.	S#813820 Westinghouse	T-7603504 P-9	
305		1	Filament transformer Primary 210 volts 60 cycles 3 secondaries each rated at 5 volts 10 amps. One secondary rated at 5 volts 30 amps. Compensated for full load. Insulated for 4000 volts.			
306		6	Tube sockets for RCA-872	S#552123 Westinghouse	T-7603504 P-11	

11.07 Low Power Rectifier - Diagram P-7704469

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
307		1	Plate transformer - Primary rated at 220 volts, 3 phase 50/60 cycles. Tapped to give ± 5%, ± 10% and 65% rated output voltage. Secondary rated at 1300 volts 2.2 amps.	Req. 195622 Westinghouse	T-7603532 P-12	
308		1	Filter reactor rated at 5 henries at 1 ampere dc.	S#651449 Westinghouse	T-7603504 P-13	
309		1	Overload relay resistor Ohmite 15 ohms, 40 watts	Code CESIL	T-7603504 P-14	
310		1	D-C overload relay. Instantaneous opening, timedelay closing	12PAC12A1 (G.E.)		
	310-1	1	Relay coil, calibrated 1-1.5-2-3 amp. d.c.	WSF-3128749		
311		1	Plate voltmeter calibrated for 0-3500 volts d.c. External multiplier included in S#563185.	S#563185 Westinghouse	T-7603504 P-16	
312		1	Multiplier for meter 311. Included in S#563185.			

11.07 Low Power Rectifier - Diagram P-7704469

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
313		4	Potentiometer Resistors Rated 2500 ohms, 200 watts tapped every 250 ohms	Code BOVIL	T-7603504 P-17	
314		3	Potentiometer resistors rated at 4500 ohms 200 watts	Code BOVIL	T-7603504 P-18	
315		2	AC Overload Relay Type SC1 with latch. Adjustable from 8 to 24 amps. Contacts rated at 1 amp., 125 volts dc.	S#679375 Westinghouse	T-7603504 P-19	
316		1	Plate run contactor Type 15F5 per dwg. 7-A-481 with break interlock. Rated at 25 amps., 250 volts	S#750007 Westinghouse	T-7603504 P-20	
317		3	Plate transformer series resistor. Rated at 2 ohms 60 watts Ohmite Co.	Code AIGUA	T-7603504 P-21	
318		1	Plate start contactor Type 15F5 Ref. Dwg. 7-A-481 - Rated at 250 volts, 25 amps.	S#750007 Westinghouse	T-7603504 P-22	
319		1	Series resistor for coils of 316 and 318. 100 ohms, 200 watt	Code BOVIL		

11.08 MAIN RECTIFIER TUBE UNIT. CONNECTION DIAGRAM P-7760701

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
401		7	Main rectifier tubes.	RCA-870	W-7350480 P-32	
402		7	Filament transformers. 0.44 KVA, 50/60 cycles. Primary 220 volts. Secondary 5.5 volts, 80 amp., insulated 15 KV AC.	9TD419A1 (G.E.)	T-7659347 P-2	
403		6	Arc-back indicators. 128 amp. RMS or 75 amp. D.C. continuous, 20 to 30 amp. reverse current to trip. 15 KV insulation, coil to frame.	9XY18A1 (G.E.)	T-7659347 P-3	
405		7	Heater tube loading resistors. Each rated 5 ohms, 80 watts open. Series connected.	QCK-1924017 5 ohms (G.E.)	T-7659351 P-2	
406		1	Heater tube filament resistor. 13 ohms tapped at 12, 11 and 10 ohms. 80 watts open.	QCK-1924017 & description (G.E.)	T-7659351 P-3	
407		2	Door interlocks. One circuit opens with door. 5 amp., 220 volts a.c.	M-7460330 G-1 (G.E.)	P-7760658 P-3	

11.08 MAIN RECTIFIER TUBE UNIT. CONNECTION DIAGRAM P-7760701

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
408		1	Air blower & motor.			
	408-1	1	Air blower. American Blower Corp. "Sirocco", size A, type F, with exhauster, arrangement #4. Rated to supply 170 cu. ft. of air per minute against 1 ounce static pressure.	Description (Sirocco)	T-7659418 P-17	
	408-2	1	Motor. Frame 37, single phase, 220 volts, 60 cycles, 1/4 H.P., 3450 R.P.M. at full load, line start, 1.85 amp. running, 13.7 amp. full load starting.	5KH37BA230 (G.E.)	T-7659418 P-18	
409		1	Filament rheostat. (Type CR-8001-B05). Two 15" plates in parallel. Overall rating 3 ohms, 20 amp. first and last steps, 60 steps.	DL-2209412 G-23 Insulated Shaft (G.E.)	W-7350480 P-17	
410		1	Filament voltmeter. Full scale deflection at 250 volts a-c, Bakelite case.	Type AR-2 & description (G.E.)	W-7350480 P-13	
413		1	Filament switch for changing tubes D.P.S.T., 250 volt, 30 amp. Circuits in parallel.	Cat. GE2924 (G.E.)	W-7350480 P-12	
420		1	Catwalk interlock. Modified Cat. GE274 door switch. Circuit opens when floor plate is lifted. 6 amp., 125 volts.	M-7460288 G-3 (G.E.)	W-7350478 P-71	

11.08 MAIN RECTIFIER TUBE UNIT. CONNECTION DIAGRAM P-7760701

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
422		1	Plate transformer output switch. 3 pole, single throw, remote manually operated. Front connected hinge, back connected contacts. 15,000 volts, 400 amp.	6028061 G-2 less parts 39 to 45 incl. (G.E.)	T-7659400 P-39	
422-A		1	Plate safety grounding switch. S.P.S.T., closed when switch 422 is open.	T-7659410 G-1 (G.E.)	T-7659400 P-63	
428		8	Rectifier air heater resistors (type Y-3219). Each rated 230 volts, 352 ohms, 150 watts. Resistors in parallel.	51X335 (G.E.)	T-7659416 P-36	
429		1	Load ammeter. 150 ampere scale, 100 millivolts for full scale deflection. To be used with shunt 429-A, section 11.15. Each of two connecting leads is #14 wire, 50 ft. long. Bakelite case.	Type DR-2 & description (G.E.)	W-7350480 P-15	
430		12	Voltmeter multiplier resistors. Each rated 20,000 ohms, accurate to 2%, 80 watts open. Resistors in series.	QCK-1924017 & description (G.E.)	T-7659352 P-2	
431		1	Voltmeter protective resistor. 1000 ohms, 80 watts open.	QCK-1924017 1000 ohms (G.E.)	T-7659352 P-3	

11.08 MAIN RECTIFIER TUBE UNIT. CONNECTION DIAGRAM P-7760701

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
432		1	Rectifier tube hour meter. 220 volt, 60 cycle Telechron motor. 99999 hours maximum. Bakelite case.	8KTY1 (G.E.)	W-7350480 P-16	
433		1	Rectifier voltmeter. Full scale deflection at 62.5 milliamperes d-c., corresponding to 15 KV on scale. Bakelite case.	Type DR-2 & description (G.E.)	W-7350480 P-14	
434		1	Emergency shut down switch. One circuit n.c., one n.c.; n.o. not used. 8 amp., 220 volts a.c. (G.E.)	M-7452891 G-1	W-7350480 P-10	
435		1	Rectifier air temperature indicator. Foxboro indicating thermometer, 60 to 180 deg. F. 8 foot connecting tube, copper bulb #726, black figures on white dial.	M-7460202 P-3	W-7350480 P-11	
436		1	Rectifier air thermostat. Type CR-2992-E-1. Operating range 85 to 107 deg. F.	4980631 G-76 (G.E.)	T-7659416 P-37	
437		1	Rectifier air bellows & damper. Operating range 80 to 150 deg. F.	4924969 P-16 (G.E.)	T-7659418 P-28	
438		6	D-C overcurrent relay target assemblies. 4 drop annunciator 12 volts a.c.	#130 and description (Edwards & Co.)	W-7350480 P-34	

11.08 MAIN RECTIFIER TUBE UNIT. CONNECTION DIAGRAM P-7760701

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
439		2	Transformers for relay targets. 25 watt, 110 volt, 60 cycle primary. 6/8/14 volt secondary.	#86-T and description (Edwards & Co.)	W-7350480 P-35	
440		2	Fuses for relay targets 6 amp., 250 volts.	GE1457 (G.E.)	W-7350480 P-36	
441		1	Safety switch interlock. One circuit opens when switch is closed. 5 amp., 220 volts a.c.	M-7450350 G-1 (G.E.)	T-7659400 P-64	

11.09 OIL CIRCUIT BREAKER UNIT. CONNECTION DIAGRAM P-6120104

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
411		2	Tripping current transformers. Type WF-1. 5000 volt, 400/5 amperes, 80:1 ratio. Spec. 3151262-17.	46X942 (G.E.)	T-6038302-401	
412		1	Closing relay for circuit breaker 417. Type PB-54, hesitating relay.	2182135 G-8 (G.E.)	T-6038302-305	
	412-1	1	Coil, 125 volts, 2.27 amp. d.c. Intermittent service.	WSF-324528		
414-A		1	"Low voltage" oil circuit breaker (wye connection of plate transformer primaries). Type FK-33, solenoid operated, 3 pole, single throw, 5000 volts, 400 amp. continuous.	DL-2883228 G-2 & description (G.E.)	T-6038302-201	
	414-A-1	1	Closing coil. 15 amp. at 125 volts d.c. Operating range 90 to 130 volts d.c. Intermittent service.	WSF-324171		
	414-A-2	1	Trip coil. 6 amp. at 125 volts d.c. Intermittent service.	WSF-324161		
	414-A-3	1	Auxiliary switch assembly, 3 n.o., 2 n.c. circuits, double break. 10 amp. continuous, 250 amp. for 3 seconds.	P-6024988 G-5		
	414-A-4	4 gal.	Circuit breaker oil.	GE#21 (G.E.)		
414-B		1	"High voltage" oil circuit breaker. (Delta connection of plate transformer primaries.) Duplicate of symbol 414-A, this section.	DL-2883228 G-2 and description (G.E.)	T-6038302-201	

11.09 Oil Circuit Breaker Unit. Connection Diagram P-6120104

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
415		1	Reclosing oil circuit breakerfor main rectifier starting. Type FK-44-BY2, solenoid operated, 3 pole, single throw, 15,000 volts, 600 amp. continuous. Interrupting capacity 50,000 KVA as applied, 100,000 KVA for N.E.M.A. duty cycle	DL-6052204 G-1 & description (G.E.)	T-6038302-501 Change A only 30000A not 4P	
	415-1	1	Closing coil. 61 amp. at 125 volts d.c. Intermittent service. Operating range 90 to 130 volts d.c.	F-3121585		
	415-2	1	High speed trip coil. 27 amp. at 125 volts d.c. Intermittent service. Operating range 70 to 140 volts d.c.			
	415-3	1	Auxiliary switch assembly, 4 n.o., 4 n.c. circuits, double break, 10 amp. continuous, 250 amp. for 3 seconds.	P-6028591 G-2		
	415-4	1	Trip coil plunger.	M-6019336 G-1		
416		3	Plate starting resistors. Type SG, CR-3227. 1.92 ohms per bank; 1 bank in series with each 2300 volt line. 210 amp. for 8 seconds.	K-4959002 (G.E.)	T-6038302-405	
	416-1	48	Resistance grids.	SG-#12 (G.E.)		
417		1	Rectifier "run" oil circuit breaker. Duplicate of symbol 414-A, this section.	DL-2883228 G-2 and description (G.E.)	T-6038302-201	

11.09 OIL CIRCUIT BREAKER UNIT. CONNECTION DIAGRAM P-6120104

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
418-A		1	Closing relay for circuit breaker 414-A, (type PB-54). Duplicate of symbol 412, this section.	2182135 G-8 (G.E.)	T-6038302-305	
418-B		1	Closing relay for circuit breaker 414-B. (Type PB-54). Duplicate of symbol 412, this section.	2182135 G-8 (G.E.)	T-6038302-305	
421		3	2300 volt disconnects for rectifier. (Type LG-118-B). S.P.S.T., 15,000 volt, 400 amp., front connected, with blade latch.	T-3692700 G-28 (G.E.)	T-6038302-301	
	421-1	1	Switchhook - 10 ft. long.	3850077 G-7 (G.E.)		
423		1	Closing relay for oil circuit breaker 415. (Type PB-54). Duplicate of symbol 412, this section.	2182135 G-8 (G.E.)	T-6038302-305	
427		2	Potential transformers. (Type E-32) 2000 to 3000 volts, 100 volt-amperes, 20:1 ratio. Spec. 3151015-62.	8X946 (G.E.)	T-6038302-403	
427-A		4	Potential transformer fuses.	197563 (Included with symbol 427) (G.E.)		

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
501		12	Power amplifier tubes.	RCA -862	T-7659423 P-51	
502		12	Grid tank capacitors. Casing No. 77, 0.001 mfd., 15 KV at 60 cycles.	UC-2325 (Faradon)	T-7659423 P-23	
503		3	Grid tank coils.	T-7659353 G-1 (G.E.)	T-7659423 P-7	
504		3	Grid chokes.	M-7461295 G-1 (G.E.)	T-7659423 P-9	
505		3	D-C grid ammeters. 10 amp. d.c. for full scale deflection. Bakelite case.	Type DR-2 & description (G.E.)	T-7659423 P-24	
506		3	Filament "run" switches. S.P.S.T. 1200 amp., 250 volts d.c. continuous.	Type AL S#554839-A (Westinghouse)	T-7659407 P-6	
506-A		3	Filament "off" interlocks on 506. One circuit, opens when switch is opened. 5 amp., 220 volts a.c.	M-7460530 G-1 (G.E.)	T-7659407 P-27	
507		3	Filament "start" switches. S.P.S.T. 1200 amp., 250 volts d.c. continuous.	Type AL S#554839-A (Westinghouse)	T-7659407 P-6	

Quantities are total for three P.A. units.

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
507-A	2	3	Filament "off" interlocks on 507. One circuit opens when switch is opened. 5 amp., 220 volts a.c.	M-7460330 G-1 (G.E.)	T-7659407 P-27	
508		6	Filament starting resistors. Two in parallel in each unit. Each resistor rated 0.03 ohms, 85 amp. d.c. continuous.	Type CR-9143 Cat. #187489 (G.E.)	T-7659407 P-7	
509		12	Plate parasitic chokes.	M-7461294 G-1 (G.E.)	T-7659388 P-4	
509-A		12	Plate parasitic choke safety gaps. Normal spacing 3/4".	K-7867290 Parts 1, 2 and 3 (G.E.)	T-7659388 Parts 66, 67 and 68	
510		12	Plate chokes.	M-7461297 G-1 (G.E.)	T-7659388 P-5	
511		144	Plate protective resistors. 12 resistors in series with the plate of each tube. Each resistor rated 3.2 ohms, 250 watts for 150 deg. C. rise.	CR-9010-R-FL 3.2 ohms (G.E.)	T-7659356 P-2	
512		12	D-C overcurrent relays. Type PQ-31 relay modified to insulate coil from contacts. One n.c. one n.c. contact circuit; one auxiliary n.o. contact circuit for drop signal.	T-7659389 G-1 (G.E.)	T-7659423 P-16	
	512-1	12	Relay coils. 5 amp., 0.156 ohms.	WSF-323230		

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
512-A		12	Coil shunt resistor for relays 512. 1.5 ohms, 200 watts open.	QCK-2673192 1.5 ohms (G.E.)	T-7659356 P-3	
513		12	Plate ammeters. Full scale deflection at 10 amp. d.c. with armature WS-83372, Pg. 1, sub 1, except total torque 0.25 GMM, rectangular magnet, printed scale, 50 millivolt drop, bakelite case.	Type 8D024AY & description (G.E.)	T-7659388 P-6	
514		18	Meter by-pass capacitors. 0.01 mfd., 2500 volts.	Model AF, 0.01 mfd. (Sangamo)	T-7659423 P-25 T-7659388 P-27	
515		12	Plate blocking capacitors. Casing No. 140, 0.002 mfd., 30,000 volts R.M.S. at 60 cycles.	UC-3059 (Faradon)	T-7659388 P-7	
516		12	Neutralizing capacitors. Casing #111, 0.000310 mfd., 35 KV. eff., 60 cycles. 8 amp. at 700 KC. Two capacitors in series in each neutralizing lead.	UC-3165-K	T-7659423 P-53	

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
517		3	Tank capacitor assemblies. 19 plates per half tank.	W-7350475 G-1 (Includes symbols 518, 519, 519-A, 521 & 522) (G.E.)	T-7659423 P-6	
518		3	Static drain chokes.	M-7461297 G-1 (G.E.)	W-7350475 P-29	
519		3	Coupling coil for tank ammeter	-	Customer	
519-A		3	Thermocouples for tank ammeter. 5 amp. R.F., 10 millivolts d.c. Form 2.	1290452 G-1 (G.E.)	-	
519-B		3	Calibrating rheostats for tank ammeters. 4 watts, 2 ohms.	Cat. H2R (Yaxley)	T-7659423 P-55	
520		3	Tank ammeters. Full scale deflection at 10 millivolts d.c., corresponding to 160 amp. R.F. on scale. To be used with symbols 519, 519-A and 519-B. 0.065 ohms total lead resistance to thermocouple. Bakelite case.	Type DR-2 & description (G.E.)	T-7659423 P-26	

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
521		3	Tank coils.	T-7659348 G-1 (G.E.)	W-7350475 P-2	
522		3	Coupling coils.	T-7659349 G-1 (G.E.)	W-7350475 P-3	
523		3	Water "on" lights.			
	523-1	3	Lamp indicators, with 1200 ohm resistor for 125 volts.	S#549462-D (Westinghouse)	T-7659407 P-8	
	523-2	3	Lamps. Mazda T-4, 0.11 amp., 18 volts.	S#549474 (Westinghouse)	T-7659407 P-9	
	523-3	3	Lens, Green.	S#549469 (Westinghouse)	T-7659407 P-10	
551		3	Safety grounding switches. 3 pole, single throw.	T-7659400 G-2 Includes symbol 546 (G.E.)	T-7659423 P-15	
532		6	Grid safety gaps. Normal spacing 1".	M-7461327 P-7 and P-8 (G.E.)	M-7461327 P-7 and P-8	
533		6	Water temperature interlocks. 60 to 180 deg. F.	M-7460202 P-2 (Foxboro); order through G.E.)	WW-7300196 P-10	

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
535		12	Water flow interlocks.		WW-7300196 P-9	
		6	Left to right flow, 30 G.P.M.	M-7460200 P-2		
		6	Right to left flow, 30 G.P.M.	M-7460200 P-4		
			NOTE: Parts mechanically interchangeable for both directions of flow. Electrical circuit closed at full flow; contacts rated 3 amp., 250 volts a.c.			
536		12	Door interlocks. One circuit, opens when door is opened. 5 amp., 220 volts a.c.	M-7460330 G-1 (G.E.)	TT-7650781 P-9	
538		3	Cat walk interlocks. Modified GE274 door switch. Circuit opens when floor plate is lifted. 6 amp., 125 volts.	M-7460288 G-3 (G.E.)	W-7350478 P-71	
539		3	Emergency shut down switches. Each has one circuit n.o., one n.c.; n.o. not used. 8 amp., 220 volts a.c.	M-7452691 G-1 (G.E.)	T-7659423 P-10	
540		3	Filament "off" lights.			
	540-1	3	Lamp indicator, with 1200 ohm resistor for 125 volts.	S#549462-D (Westinghouse)	T-7659423 P-27	
	540-2	3	Lamp. Mazda T-4, 0.11 amp., 18 volts.	S#549474 (Westinghouse)	T-7659423 P-28	
	540-3	3	Lens, green.	S#549469 (Westinghouse)	T-7659423 P-29	

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7659413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
541		3	Grid bypass capacitors. Casing 7-B, 0.01 mfd., 15 KV eff. at 60 cycles.	UC-2218-A (Faradon)	T-7659423 P-30	
546		3	Grounding switch interlocks. One circuit opens when main switch is closed. 5 amp., 220 volts a.c.	M-7460330 G-1 (G.E.)	T-7659400 P-64	
547		6	Grid line blocking capacitors. Casing 111, 0.01 mfd. 10,000 volts eff., 60 cycles.	UC-3141-K (Faradon)	K-7867481 P-10	
548		6	Grid line series resistors.	M-7461603 G-1 (G.E.)	T-7659423 P-58	
	548-1	12	Resistor elements. 1000 watts at 110 volts.	110-U-252 (Anderson-Pitts, Kansas City, Mo.)	M-7461603 P-13	
549		12	Grid stabilizing resistors. 1/2" diam. x 4 1/4" long carbon rod, 3/8" copper plating each end. 2 ohms, 22 watts.	Type D-10 and Description (Joseph Dixon Crucible Co., Jersey City, N.J.)	P-7760945 P-21	
550		12	Grid stabilizing chokes.	P-7760945 P-11 (G.E.)	P-7760945 P-11	
551		6	Plate safety gaps. Normal spacing 3/4".	T-7659388 P-66, P-67 and P-68 (G.E.)	T-7659388 P-66, P-67 and P-68	

Quantities are total for three P.A. units

11.10 POWER AMPLIFIERS. CONNECTION DIAGRAM T-7559413

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
552		12	Filament fuses. 250 amp., 250 volt.	GE1053 (G.E.)	P-7760704 P-26	
553		27	Self bias resistors. 10 ohms.	CR-9010-R-Y 10 ohms (G.E.)	M-7461614 P-13	

11.11 ANTENNA HOUSE. CONNECTION DIAGRAM M-7461371

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
605		1	R-F current transformer. 100/5 amp., 20:1 ratio at 700 KC.	GL-49978 & description (G.E.)	P-7760705 P-4	
	605-1	1	Film cut out cartridge	224577		
605-A		1	Thermo-couple for 605. 5 amp. R-F, 10 milli-volts d.c. Form 2.	1290452 G-1 (G.E.)	P-7760705 P-3	
606		1	Antenna ammeter. Full scale deflection at 10 milli-volts d.c. corresponding to a scale reading of 100 amperes RF. To be used with thermocouple 605-A and R-F current transformer 605.	Type DR-2 & description (G.E.)	P-7760705 P-2	
607		1	Antenna tuning inductance.	P-7760738 G-1 (G.E.)	DL-7550350 Item 9, page 1.	
608		1	Antenna horn gap.	T-7659429 G-1 (Includes symbol 610) (G.E.)	W-7350484 P-8 (Includes symbol 610)	
609		1	Antenna rectifier coupling coil.	T-7659465 G-1 (G.E.)	DL-7550352 Item 25, page 1.	
610		1	Antenna grounding switch. S.P.S.T. Connected across horn gap 608.	T-7659429 G-1 (Includes symbol 608) (G.E.)	W-7350484 P-8 (Includes symbol 608)	

11.11 ANTENNA HOUSE. CONNECTION DIAGRAM M-7461371

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
611		1	Antenna-ground shunt capacitor.	W-7350484 G-1 (Includes symbols 608 & 610) (G.E.)	DL-7550352 Item 27, sheet 1 (Includes symbols 608 & 610)	
612		1	Emergency shut down switch. S.P.S.T. tumbler switch. Brown handle. 10 amp., 125 volts.	GE2513 (G.E.)	DL-7550352 Item 29, page 1	
627		1	Antenna rectifier tuning capacitor. Casing 13-B, 0.0015 mfd., 5000 volts at 60 cycles.	UC-3063 (Faradon)	DL-7550352 Item 30, page 1.	
630		1	Door interlock. One circuit, opens when door is open. 5 amp.	M-7460330 G-1 (G.E.)	DL-7550352 Item 32, page 1.	
631		1	Photo-cell relay for antenna gap. S.P.D.T. contacts.	Customer		

11.12 ANTENNA RECTIFIER. CONNECTION DIAGRAM K-7867176

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
620		1	Antenna rectifier tube.	RCA-217-C	T-7659411 P-8	
621		1	Filament voltmeter. Full scale deflection at 15 volts a.c.	8AD22VAM (G.E.)	T-7659411 P-39	
622		1	Filament transformer. 0.050 KVA, 110 or 220 volt, 60 cycle primary; 11 volt secondary with mid tap. Insulated for 750 volts a.c.	Y-2081 (G.E.)	T-7659411 P-10	
623		1	Filament rheostat. Type HD-25, 100 ohms, 25 watts.	Description (Dejurmaco Co.)	T-7659411 P-40	
624		1	R-F bypass capacitor. Casing 351. 0.001 mfd., 5000 volts at 60 cycles.	UC-3071 (Faradon)	T-7659411 P-12	
625		1	Linearity resistor. 10,000 ohms, 122 watts open, tapped at 7500 and 5000 ohms.	QCK-1924017 & description (G.E.)	T-7659411 P-13	
626		1	Filament by-pass capacitor. Casing #25. 0.1 mfd. each side of grounded mid point, 250 volts, 60 cycles.	UC-1839 (Faradon)	T-7659411 P-29	

11.13 High Pass Filter - Equalizer Dwg. [illegible]-7405529

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
701		4	High pass filter input and output capacitors. Each unit consists of two 13.33 mfd., 110 volt capacitors in parallel.	Dubilier Type MC-120		
702		2	High pass filter series capacitors. The capacitor is rated 13.33 mfd., 110 volts, 60 cycles AC.	Dubilier Type MC-120		
703		2	High pass filter shunt inductances. Rated 1.66 henries.	L-303599 Whse.		
704		1	Equalizer shunt resistor 200 ohm resistor 200 ohm resistor with sliding clip. Rated 25 watts.	Electrad B-2		
705		1	Equalizer series capacitor. Rated 35 mfd., 100 volts.	Dubilier Type 808		
706		1	Equalizer series inductance. Rated .8 henry	General Radio Special		

11.13 High Pass Filter - Equalizer - Dwg. M-7405529

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
707		1	Equalizer series resistor 2500 ohm resistor with sliding clip. Rated 25 watts.	Electrad Type B-25		
708		1	Equalizer shunt capacitor Rated 35 mfd. 100 volt	Dubilier Type 808		
709		1	Equalizer shunt inductance Rated .8 henry	General Radio Special		

11.14 CONTROL PANEL. CONNECTION DIAGRAM WW-7350121

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
801-A		5	Time delay isolation contactor. Type CR-2800-1138-CN-1. 2 poles; one n.o., one n.c.; both time delay closing, 0.5 to 5 seconds adjustable; instantaneous opening; 10 amp.	DL-4980744 & description (G.E.)	T-7659427 P-8	
	801-A-1	10	Relay coils, two in parallel per relay. Each rated 125 volts, 0.166 amp. d.c.	22D11G3 (G.E.)		
801-B		5	Isolation contactor. Type CR-2800-1137-M-1. 7 poles; four n.o., three n.c.; 10 amp.	DL-3888243 (G.E.)	T-7659427 P-9	
	801-B-1	5	Relay coils. Each rated 125 volts, 0.166 amp.	22D11G3 (G.E.)		
802		6	Isolation relays. Refer to symbols 823, 824, 825 and 826 in this section.			
803		6	Water temperature relays. Type CR-2800-1112-BN-4. One n.o. pole, 40 amp.	DL-2827784 (Includes symbol 803-A)	T-7659427 P-10 Includes symbol 803-A	
	803-1	6	Relay coils. Rated 60 volts, 0.144 amp. d.c. To be used with resistors 803-A on 125 volts d-c.	22D8G5 (G.E).		
803-A		6	Coil resistors for 803. Type CR-9158. 450 ohms, 80 watts open.	DL-2880121 G-38 (G.E.)	T-7659427 P-10 Includes symbol 803.	

11.14 CONTROL PANEL. CONNECTION DIAGRAM WW-7350121

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
804		1	Main rectifier filament contactor. Type CR-2810-1342-C-2. Two n.o. poles, 75 amps.; one n.o. definite time closing pole, 20 amp.	DL-2822714 & description (G.E.)	T-7659427 P-11	
	804-1	1	Relay coil. Rated 220 volts, 60 cycles, 0.95 amp.	22D15G3		
805		6	Door interlock relays. Type CR-2800-1114-B-1. Two n.o. poles, 20 amp.	DL-1950212 (G.E.)	T-7659427 P-12	
	805-1	6	Relay coils, 125 volts, 0.1 amp. d.c.	22D8G3		
806		1	Plate auxiliary contactor. Type CR-2800-1138-CQ-1. One n.o. pole; one n.c. pole; one n.o. definite time closing pole; 10 amp.	DL-4980746 & description (G.E.)	T-7659427 P-13	
	806-1	2	Relay coils, in parallel. Each rated 125 volts, 0.166 amp. d.c.	22D11G3		
807-A		1	Coil shunt resistor for 806. 3000 ohms, 200 watts open.	QCK-2673192 3000 ohms (G.E.)	T-7659427 P-14	
807-B		1	Tapped coil shunt resistor for 806 1000 ohms, 200 watts open, tapped at each 100 ohm step.	QCK-2673191 & description (G.E.)	T-7659427 P-38	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
808		1	Main rectifier filament time delay relay. Type MC-10. 3 poles, one n.c.; one n.o., time delay closing; one n.c., time delay opening; 3 amp.; time delay adjustable 0.04 to 33 minutes; adjusted at 30 minutes. Holding coil rated 220 volts, 60 cycles, 0.1 amp. Motor rated 220 volts, 60 cycles, 0.12 amp.	3120002 G-2 (G.E.)	T-7659427 P-15	
809		1	Main rectifier filament undervoltage relay. 230 volts, 60 cycles. Two circuit. Adjusted to close one circuit at 200 volts and to close other circuit at 190 volts.	12IAV13A2 (G.E.)	T-7659427 P-16	
810		1	Time clock switch. Type CR-2823, T-13. One pole, single throw with omitting device and plain dial. Motor rated 115 volts, 60 cycles. Mercury contacts rated 30 amp. a.c.	9T13AE7 (G.E.)	T-7659427 P-17	
811		1	Shut down relay. Type CR-2800-1131-K-1. One n.c. pole with 40 amp. blow out coil; one n.o. interlock, 10 amp.	DL-2822776 & description (G.E.)	T-7659427 P-18	
	811-1	1	Relay coil. 125 volts, 0.166 amp. d.c.	22D11G3		
812		1	Shut down time relay. Type MC-13. Contacts same as symbol 808 above. Delay adjustable 0.05 to 36 minutes. Motor rated 0.3 amp., 125 volts d.c.	3120101 G-1 (G.E.)	T-7659427 P-19	
	812-1	1	Coil. 0.14 amp., 125 volts d.c.	WBF-4237365		

11.14 CONTROL PANEL. CONNECTION DIAGRAM WW-7350121

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
813		1	Filament M-G start auxiliary contactor. Type CR-2800-1138-CP-1. Three n.o. poles; one has 10 amp. blow out coil; one has 0.5&0.5 second time delay closing.	DL-4980745 & description (G.E.)	T-7659427 P-20	
	813-1	2	Relay coils in parallel, each 0.166 amp., 125 volts d.c.	22D11G3		
814		1	Alarm bell for main rectifier filament undervoltage. Edwards CO. RECTI-BELL; 6 inch gong. For use with series resistor 814-A on 220 volts, 60 cycles a.c.; 0.43 amp.	219-A (Edwards Co.)	T-7659427 P-21	
814-A		1	Series resistor for bell. Type CR-9158. One 1-tube cage. 200 ohms, 80 watts open.	DL-2880121 G-29 (G.E.)	T-7659427 P-22	
815		6	Water flow relays. Type CR-2800-1112-BN-1. One pole, 40 amp.	DL-2827784 (G.E.)	T-7659427 P-23	
	815-1	6	Relay coils. 125 volts, 0.1 amp. d.c.	22D8G3		
816		1	B-C filament undervoltage relay. Type EC-2.	S#518924 (Westinghouse)	T-7659427 P-24	
	816-1	2	Relay coils connected in parallel.	L Spec. 225139 (Westinghouse)		

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
817		1	Aux. relay for rectifier filament undervoltage. Type HG-2. One circuit, n.c., double break, 5 amp.	2841462 G-2 (Includes symbol 817-A) (G.E.)	T-7659427 P-62 (Includes symbol 817-A)	
	817-1	1	Relay coil. 220 volts, 60 cycle, 0.18 amp. when used with series resistor 817-A.	WSF-3040472		
817-A		1	Coil resistor for relay 817. Type CR-9158, one 1-tube cage. 800 ohms, 80 watts open.	DL-2880121 G-42 (G.E.)	T-7659427 P-62 (Includes symbol 817)	
818		1	Main breaker lockout relay. Type CR-2800-1131-H-1. One n.c. pole with 5 amp. blow out coil; one n.c. interlock, 10 amp.	DL-2822774 & description (G.E.)	T-7659427 P-36	
	818-1	1	Relay coil, 125 volts, 0.11 amp. d.c.	22D11G3		
819		1	Lockout preventing relay. Series AQA, quick acting, right mounting, with dust cover and mounting bracket. Contacts two type H (heavy duty), form B (n.c.).	Description (Automatic Elec.)	T-7659427 P-37	
	819-1	1	Relay coil. 6500 ohms.	B-281175 (Automatic Elec.)		
820		1	Trip coil relay for breaker 415. Type CR-2800-1135-A3-1. One n.o. pole with 40 amp. blow out coil.	DL-3658038 (G.E.)	T-7659427 P-34	
	820-1	1	Relay coil. 125 volts, 0.104 amp. d.c.	22D11G3 (old spec. WSF-3020034)		

11.14 CONTROL PANEL. CONNECTION DIAGRAM WW-7350121.

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
821-A		1	Trip-seal in relay. Relays 821-A and 821-B mounted in one assembly; 821-A in center. One n.o. circuit.	12PHC13A1 (Includes symbol 821-B (G.E.)	T-7659427 P-61 (Includes symbol 821-B)	
	821-A-1	1	Relay coil. Approx. 0.01 ohms.	3128921		
821-B		2	A-C overcurrent relays, mounted in same assembly as relay 821-A. Each relay has one n.o. and one n.c. circuit.	12PHC13A1 (Includes symbol 821-A.) (G.E.)	T-7659427 P-61 (Includes symbol 821-A.)	
	821-B-1	2	Relay coils. 5 amp. a-c.	3128903		
822		1	50 KW interlock relay. Type CR-2810-1532-A-3. Two n.o. poles, 15 amp.	DL-4382880 (G.E.)	T-7659427 P-25	
	822-1	1	Relay coil. 220 volts, 60 cycles, 0.1 amp.	22D2G32		
802 823 824 825 826		6	Isolation relay assemblies. Automatic Electric Co. schematic diagram SK-37-1422; running list and assembly H-60242. One each of symbols 802, 823, 824, 825 and 826 mounted in each assembly. Assemblies are removable and have removable dust covers. All contacts are type H (heavy duty, platinum) and are duplicated for reliability.	Description (Automatic Elec.)	T-7659427 P-35	
802		6	Isolation relays. Left mounting. Six type H contact springs arranged to provide two single pole, double throw circuits; rated 110 Watts.	R-1181-A6 (Automatic Elec.)		
	802-1	6	Relay coils. 6500 ohms, approx. 9.5 watts.	D-281175		

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
823		6	Sustained overload isolation (or lockout) relays. Similar to D-811602A special dash pot relay, except different coil. Left mounting. Four type H contact springs arranged as two n.o. time delay closing circuits. Time delay adjusted to 5 seconds.	Description (Aut. Elec. Co.)		
	823-1	6	Relay coils. 2200 ohms, approx. 7.5 watts	D-282240		
	823-2	-	Dash pot oil (13 to 14 c.c. per relay)	Spec. 5273 (Autom. Elec.)		
824		6	First reclosure relays. Left mounting. 8 type H contact springs arranged as 4 n.o. circuits.	R-967-A-7 (Autom. Elec.)		
	824-1	6	Relay coils. 6500 ohms, approx. 9.5 watts.	D-281175		
825		6	Isolation (or lockout) ready relays. 18 type H contact springs arranged in two like banks to give a total of 2 n.c. circuits, 4 n.o. circuits and 2 S.P.D.T. circuits.	R-2478A-3 (Autom. Elec.)		
	825-1	6	Relay coils. 6500 ohms. approx. 9.5 watts.	D-281175		
826		6	Reset time relays. Right mounting dash pot relay. Similar to D-811565-3 special dash pot relay, except changed coil and contact spring assemblies. 4 type H contact springs arranged as 2 n.o. circuits. Time delay adjusted to 60 seconds.	Description (Autom. Elec.)		
	826-1	6	Relay coils. 2200 ohms, approx. 7.5 watts.	D-282240		
	826-2	-	Dash pot oil (13 to 14 c.c. per relay).	Spec. 5273 (Autom. Elec.)		

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
827		-	Omit			
828		-	Omit			
829		1	Main rectifier filament starting resistor. 6 ohms, 930 watts for 1 minute.	CR-9010-Z-R 6.0 ohms (G.E.)	T-7659427 P-26	
830		1	Time clock contact "off" switch. S.P.S.T. tumbler switch, black handle. 10 amp., 125 volts.	GE2588 (G.E.)	T-7659427 P-27	
831-A		1	Main rectifier filament undervoltage time relay. Type CR-2820-1099-G3. Time adjustable 2 to 40 seconds; adjusted to 8 seconds. 1 n.o. circuit; 1 n.c. time delay closing circuit; one n.c. time delay opening circuit; 15 amp.	DL-4387547 (G.E.)	T-7659427 P-28	
	831-A-1	1	Relay coil. 220 volts, 50 cycles, 0.07 amp.	22D2G78		
	831-A-2	1	Telechron motor, 110 volts, 60 cycles, 0.12 amp.	189X508		
831-B		1	Auxiliary relay for 831-A. Type CR-2800-1131-H-1. One n.c. pole with 5 amp. blow out coil.	DL-2822774 & description (G.E.)	T-7659427 P-29	
	831-B-1	1	Relay coil, 125 volts, 0.166 amp. d.c.	22D11G3		
832		1	Shop M-G starter auxiliary relay. Type CR-2810-1532-A3. Two n.o. poles, 15 amp.	DL-4382880 (G.E.)	T-7659427 P-25	
	832-1	1	Relay coil. 220 volts, 60 cycles, 0.1 amp.	22D2G32		

11.14 CONTROL PANEL. CONNECTION DIAGRAM WW-7350121

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
833		1	Air interlock relay. Type CR-2800-1112-BN-1. One pole, 40 amp.	DL-2827784 (G.E.)	T-7659427 P-23	
	833-1	1	Relay coil.	22D8G3		
834		1	Water header temperature alarm buzzer. 220 volts, 50 cycles, 0.1 amp.	Cat. 8297-A (Benjamin Co.)	T-7659427 P-30	
835		1	Control circuit supply transfer relay. Type PAV instantaneous undervoltage relay. 2 circuits, 1 n. o., 1 n.c. continuous	Model E2PAV11A1		
	835-1	1	Relay coil, 125 volts, 0.15 a., with resistor 835-2.	WSF-3128740		
	835-2	1	Relay coil resistor, type CR-9158, one 1-tube cage, 425 ohms, 80 watts.	DL-2880141 G-10		
836		1	Antenna house control shorting switch, D.P.D.T.	Customer		
837		1	Target relay for photo-cell in antenna house. One n.o. pole, 125 V. DC coil.	Customer		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
901		1	Antenna ammeter. Full scale deflection at 100 milliamperes d.c. Linear scale, 100 amp. R.F.	8D014ABD5Y (G.E.)	T-7659421 P-9	
902		1	Antenna ammeter potentiometer. General Radio type 301-A, 25 ohms, 0.5 amperes.	Description (Gen. Radio)	T-7659415 P-24	
903		1	Bias voltmeter. Full scale deflection at 10 milliamperes d.c. Double scale, 200 volts and 2000 volts d.c. Calibrated with multiplier, symbols 236, 237 and 238.	Type 8D014 & description (G.E.)	T-7659421 P-5	
904		1	Bias voltmeter transfer switch. Two circuit, 3 positions and "off". 10 amperes, 600 volts.	16SB1C6 (G.E.)	T-7659421 P-13	
905		3	Transfer switch grounding resistors. 1000 ohms, 10 watts open.	QCK-2673190 1000 ohms (G.E.)	M-7461354 P-5	
906		1	Main rectifier d-c voltmeter. Full scale deflection at 62.5 milliamperes d.c. corresponding to a scale reading of 15 KV d.c. For use with multiplier, symbol 430.	Type 8D014 & description (G.E.)	T-7659421 P-6	
907		1	D-C filament voltmeter. Full scale deflection at 50 volts d.c.	Type 8D014 & description (G.E.)	T-7659421 P-4	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
912		1 2	Transmitter start-stop switch, composed of: Switches, one for start and one for stop. Each has separate n.c. and n.c. circuits, 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
913		1	125 volt battery "on" light. (125 volts)	6005406 G-5	T-7659421 P-24	
	913-1	1	Red color cap.	6009134 P-2		
	913-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	913-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
914		1	W8XAL "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	914-1	1	Red color cap.	6009134 P-2		
	914-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	914-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
915		1	W8XAL high voltage "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	915-1	1	Red color cap.	6009134 P-2		
	915-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	915-3	1	Lamp, 24 volts, 0.035 amp.	59X243		
916		1	W8AI high voltage "on" light (220 volts).	6005406 G-7	T-7659421 P-25	
	916-1	1	Red color cap.	6009134 P-2		
	916-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	916-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
917		1	Emergency shut down switch. One n.o. and one n.c. circuit, 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
918		1	Low-high main rectifier voltage switch. S.P.D.T. 10 amp., 125 volts. Shallow box, black handle.	GE2590 (G.E.)	T-7659421 P-23	
919		1	WSAI "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	919-1	1	Red color cap.	6009134 P-2		
	919-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	919-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
920		1	Main rectifier automatic control switch. D.P.S.T. 10 amp., 250 volts. Shallow box, black handle.	GE2589 (G.E.)	T-7659421 P-27	
921		5	Transmitter unit "off" switches. Arrow-Hart & Hegeman Co. One circuit n.o., one circuit n.c., momentary contact, tumbler type. 10 amp. at 125 volts.	1640-A (A.H. & H.)	T-7659421 P-19 & P-20	
922		5	Transmitter unit "on" switches. Arrow-Hart & Hegeman Co. One circuit n.o., one circuit n.c., momentary contact, tumbler type, 10 amp. at 125 volts.	1640-A (A.H. & H.)	T-7659421 P-19 & P-20	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
923		1	Cooling system start switch. S.P.S.T., 20 amp., 125 volts.	GE2783 (G.E.)	T-7659421 P-21	
924		1	Low power rectifier filament switch. S.P.S.T., 20 amp., 125 volts.	GE2783 (G.E.)	T-7659421 P-21	
925		1	Filament MG start switch. S.P.S.T., 20 amp., 125 volts.	GE2783 (G.E.)	T-7659421 P-21	
926		1	Bias M-G start switch. S.P.S.T., 20 amp., 125 volts.	GE2783	T-7659421 P-21	
927		1	Low power rectifier plate start switch. S.P.S.T., 20 amp., 125 volts.	GE2783 (G.E.)	T-7659421 P-21	
928		1	W8XAL shut down switch. One circuit n.o., one n.c. 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
929		1	W8XAL high voltage "off" switch. One circuit n.o., one n.c. 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
930		1	2500 volt line voltmeter. 3000 volts a-c., full scale. To be used with 20:1 ratio potential transformers, symbols 427.	Type 8A014 & description (G.E.)	T-7659421 P-8	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
931		1	Line voltmeter transfer switch. Positions 1-2, 2-3, 3-1 and off. 10 amp., 600 volt.	16SB1C1 (G.E.)	T-7659421 P-14	
932		1	WSAI high voltage control switch. S.P.S.T., 20 amp., 125 volts.	GE-2783 (G.E.)	T-7659421 P-21	
933		1 2	WSAI control switch, composed of Switches, one for start, one for stop. Each has one n.o. and one n.c. circuit, 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
934		1	Electric clock. Cyclometer type dial. 115 volt, 60 cycle, Telechron motor.	AB8B02 (G.E.)	T-7659421 P-17	
935		2	115 volt a-c outlets. Side wired, black, single socket, 15 amp. at 125 volts.	GE2257 (G.E.)	T-7659421 P-18	
936		8	Jacks for volume indicator and monitor. Yaxley No. 4 interstage type. (Special)	Description (Yaxley)	T-7659421 P-16	
937		1	Elmwood line "on" light. (115 volts)	6005406 G-4	T-7659421 P-26	
	937-1	1	Red color cap.	6009134 P-2		
	937-2	1	Resistor, 2500 ohms, 12 watts.	60X206		
	937-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
938		1	Oakley line "on" light. (115 volts)	6005406 G-4	T-7659421 P-26	
	938-1	1	Red color cap.	6009134 P-2		
	938-2	1	Resistor, 2500 ohms, 12 watts.	60X206		
	938-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
939		1	Main rectifier filament "on" light (220 volts)	6005406 G-7	T-7659421 P-25	
	939-1	1	Red color cap.	6009134 P-2		
	939-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	939-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
940		1	Transmitter "start" light (125 volts).	6005406 G-5	T-7659421 P-24	
	940-1	1	Red color cap.	6009134 P-2		
	940-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	940-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
941		1	Air blower "on" light. (125 volts)	6005406 G-5	T-7659421 P-24	
	941-1	1	Red color cap.	6009134 P-2		
	941-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	941-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
942		1	Pond pump "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	942-1	1	Red color cap.	6009134 P-2		
	942-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	942-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7550120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
943		1	Tube pump "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	943-1	1	Red color cap.	6009134 P-2		
	943-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	943-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
944		1	Low power rectifier filament "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	944-1	1	Red color cap.	6009134 P-2		
	944-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	944-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
945		3	Filament M-G "on" lights (125 volts).	6005406 G-5	T-7659421 P-24	
	945-1	3	Red color cap.	6009134 P-2		
	945-2	3	Resistor, 2885 ohms, 12 watts.	60X207		
	945-3	3	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
946		1	Bias M-G "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	946-1	1	Red color cap.	6009134 P-2		
	946-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	946-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
947		1	50 KW amateur plate "on" light. (220 volts)	6005406 G-7	T-7659421 P-25	
	947-1	1	Red color cap.	6009134 P-2		
	947-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	947-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
948		1	Main rectifier "low voltage" light. (125 volts)	6005406 G-5	T-7659421 P-24	
	948-1	1	Red color cap.	6009134 P-2		
	948-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	948-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
949		1	Main rectifier high voltage light. (125 volts)	6005406 G-5	T-7659421 P-24	
	949-1	1	Red color cap.	6009134 P-2		
	949-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	949-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
950-A		1	Main rectifier "start" light. (125 volts)	6005406 G-5	T-7659421 P-24	
	950-A-1	1	Red color cap.	6009134 P-2		
	950-A-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	950-A-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
950-B		1	Main rectifier "run" light. (125 volts)	6005406 G-5	T-7659421 P-24	
	950-B-1	1	Red color cap.	6009134 P-2		
	950-B-2	1	Resistor, 2885 ohms, 12 watts.	60X207		
	950-B-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
951		5	Modulator & power amplifier "on" lights. (125 volts)	6005406 G-5	T-7659421 P-24	
	951-1	5	Red color caps.	6009134 P-2		
	951-2	5	Resistors, 2885 ohms, 12 watts.	60X207		
	951-3	5	Lamps, 24 volts, 0.035 amp.	59X243 (G.E.)		
952		1	R-F carrier "on" light. Neon glow lamp, type G-10, 60 to 110 volts, a-c. or d-c., 1 watt, clear glass, medium screw base, internal 3500 ohm series resistor, 0.05 candle power, cylindrical and helical electrodes. General Electric Vapor Lamp Co., Hoboken, N.J.	Description	T-7659421 P-11	
953		1	Low power rectifier plate "on" light. (220 volts)	6005405 G-7	T-7659421 P-25	
	953-1	1	Red color cap.	6009134 P-2		
	953-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	953-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
954		1	Main rectifier filament switch. S.P.S.T., 20 amp., 125 volts.	GE2783	T-7659421 P-21	
955		1 2	Elmwood line "off-on" switch, composed of: Switches. Each has one n.o. and one n.c. circuit, 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
956		1 2	Oakley line "off-on" switch, composed of: Switches. Each has one n.c. and one n.c. circuit. 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10	
957		1 2	50 KW exciter plate voltage switch, composed of: Switches. Each has one n.o. and one n.c. circuit, 8 amp.	M-7452891 G-3	T-7659421 P-10	
958		5	Telephone & telegraph jacks. Included in symbol 959 below. Jacks are for No. 42 plugs.		T-7659421 P-15 (Includes symbol 959)	
959		5	Telephone & telegraph drop signals. 5 drop signals and 5 jacks in one assembly, Stromberg Carlson Code 140. Drop signals have 500 ohm coils.	(each) Code 11-A (Stromberg Carlson)	T-7659421 P-15 (Includes symbol 958)	
960		1 2	Main rectifier manual control switch, composed of: Switches. Each has one n.o. and one n.c. circuit, 8 amp.	M-7452891 G-3 (G.E.)	T-7659421 P-10 T-7659421 P-10	
961		1	Overmodulation indicator tube. (Thyratron)	FG-81 (G.E.)	T-7659415 P-12	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
962		1	Filament transformer. 115 volt, 50/60 cycle primary; 2.5 volt, 5 ampere secondary with mid tap; 750 volts insulation.	Y-2103 (G.E.)	T-7659415 P-25	
963		1	Overmodulation indicator input switch. D.P.S.T., 10 amp., 250 volts.	GE2569 (G.E.)	T-7659421 P-27	
964		1	Grid by-pass capacitor. Faradon Model AF, 0.01 mfd., 700 volts.	Description (Faradon)	T-7659415 P-26	
965		1	Grid resistor. 500 ohms, 10 watts.	QCK-2673190 500 ohms (G.E.)	M-7461354 P-4	
966		1	Grid choke.	M-7460961 G-1 (G.E.)	T-7659421 P-88	
967		1	Carrier potentiometer. General Radio type 214-A, 400 ohms, 12 watts.	Description (Gen. Radio)	T-7659421 P-29	
968		1	Overmodulation voltmeter switch D.P.D.T., 5 amp., 125 volts.	289739 (G.E.)	T-7659421 P-28	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7550120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
969		1	Overmodulation voltmeter. Double scale. Lower scale 5 volts d-c; no external resistance. Upper scale "percent modulation alarm", calibrated from 50% to 96% modulation. External multiplier 969-A used with upper scale to give full scale deflection at 25 volts d.c.	6D014SAB2 (G.E.)	T-7659421 P-7	
969-A		1	Multiplier for overmodulation voltmeter. One 1-tube cage, type CR-9158.	Included with symbol 969. (G.E.)	T-7659421 P-89	
970		1	Plate resistor. 500 ohms, 10 watts.	QCK-2673190 500 ohms (G.E.)	E-7461354 P-4	
971		1	Overmodulation alarm relay. Series AQA, single wound, right mounted, 1.5 inch slug on heel end. Three type E contact springs arranged to make before break; n.c. circuit used. Dust cover and mounting bracket included.	Description (Autom. Elec.)	T-7659415 P-27	
	971-1	1	Relay coil, 800 ohms.	B-280054		
972		1	Alarm relay capacitor. 0.1 mfd., 450 volts d.c.	DL-5905156 (G.E.)	T-7659415 P-28	
973		1	Alarm relay resistor, 5000 ohms, 5 watts. International Resistance Co. type PB.	Description	T-7659421 P-22	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
974		1	Overmodulation alarm light. Neon glow lamp, type G-10, 60 to 110 volts, a.c. or d.c., 1 watt, clear glass, medium screw base, internal 3500 ohm series resistor, 0.05 candle power, cylindrical & helical electrodes. General Electric Vapor Lamp Co., Hoboken, N.J.	Description	T-7659421 P-11	
975		1	Bias potentiometer resistor, 5000 ohms, 5 watts. International Resistance Co., type PB.	Description	T-7659421 P-22	
976		1	Bias potentiometer. General Radio type 214-A, 400 ohms, 12 watts.	Description (Gen. Radio)	T-7659421 P-29	
977		1	Overmodulation indicator "on" light. (115 volts)	6005406 G-4	T-7659421 P-26	
	977-1	1	Red color cap.	6009134 P-2		
	977-2	1	Resistor, 2500 ohms, 12 watts.	60X206		
	977-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
978		1	Spare indicator light. (220 volts)	6005406 G-7	T-7659421 P-25	
	978-1	1	Red color cap.	6009134 P-2		
	978-2	1	Resistor, 5600 ohms, 12 watts.	60X209		
	978-3	1	Lamp, 24 volts, 0.035 amp.	59X243 (G.E.)		
979		1	Spare tumbler switch. D.P.D.T., 5 amp., 125 volts.	289739 (G.E.)	T-7659421 P-28	

11.15 OPERATOR'S CONSOLE. CONNECTION DIAGRAM WW-7350120

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
980		1	Carrier "on" light relay. Series AQA, quick-acting, d-c relay, right mounting; two contact springs, type L, form A, arranged as one n.o. circuit. Includes dust cover & mounting bracket.	Description (Autom. Elec.)	T-7659415 P-29	
	980-1	1	Relay coil. 300 ohms.	D-280069		
981		1	Carrier relay by-pass capacitor. Case No. 863, 2.5 mfd., 200 volts d.c.	Type 4983 (Dubilier)	T-7659415 P-30	
982		1	115 volt outlet for electric clock. Side wired, black, single socket, 15 amp. at 125 volts.	GE2257 (G.E.)	T-7659421 P-18	
983		1	Resistor for 981. 300 ohms, plus or minus 2%, 4 watts.	QLK-2155993 & description (G.E.)	T-7659415 P-31	
984		1	Coil shunt potentiometer for relay 980. 1000 ohms, 150 milliamperes.	Type 371-A 1000 ohms (Gen. Radio)	T-7659415 P-47	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7350122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
165		33	Modulator coupling capacitors. 1.5 mfd., 15,000 volts d.c. One terminal grounded to case. Capacitors connected in parallel.	9CL1B15 (G.E.)	ML-7861708 P-3	
184		2	Modulator plate voltage isolation switches. One circuit, two closed positions.	Description (G.E.)	T-7659362 Parts 11 & 42	
185		2	Modulator output switches. Two circuit, two closed positions.	Description (G.E.)	T-7659362 Parts 11 & 42	
186		2	Modulator rotator thrustors. Type CR-9504-L, 2 inch stroke, 75 lb. thrust. Cat. 3888831 G-3 modified per M-4912145.	Description (G.E.)	T-7659370 P-17	
	186-1	2	Motors, 110 watt, 125 volts d.c., 4100 R.P.M., 4.8 amp. starting, 2.4 amp. running.			
	186-2	-	Oil, 1/2 gallon per thrustor.	GE No. 21		
187		2	Modulator rotator thrustor auxiliary switch banks. Modified CR-2820-1097-D relay, Cat. 3888290 G-2. Coil removed. Six circuits, three n.o. and three n.c.	M-7461510 P-1 (G.E.)	T-7659370 P-16	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7350122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
404		8	Plate transformers. 430 KVA, single phase, 60 cycle, secondary 9500 volts, primary 2300 volts. Primary tapped to give 90, 95, 100, 105 and 110% of rated secondary voltage. Outdoor type. Total weight approx. 7050 lb.	K-2410 (G.E.)	ML-7861708 P-1	
	404-1	180 gal.	Oil	Transil 10-C (G.E.)		
419		1	Emergency shut down switch. (Basement grille) 6 amp.	M-7452391 G-1 (G.E.)	ML-7861708 P-5	
424		1	Grille door interlock (basement) 5 amp.	M-7460330 G-1 (G.E.)	ML-7861708 P-4	
425		1	Filter reactor. 0.25 henries, 90 amp. d.c. continuous. 125 amp. d.c. intermittent rating without saturation. 0.351 ohms d-c resistance. Insulated 10 KV d.c. Outdoor type. Total weight approx. 3190 lb.	Y-3052-A (G.E.)	ML-7861708 P-2	
	425-1	160 gal.	Oil	Transil 10-C (G.E.)		
426		114	Filter capacitors. 1.5 mfd., 15000 volts d.c. One terminal grounded to case. Capacitors connected in parallel.	9CL1B15 (G.E.)	ML-7861708 P-3	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7550122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
429-A		1	Rectifier load ammeter shunt. Form 15. 150 amperes, 100 millivolts for full scale deflection of meter 429. Calibrated with meter and two fifty foot #14 leads.	Included with symbol 429 (G.E.)	W-7550480 P-15 (Includes symbol 429)	
442		24	Power amplifier plate voltage reducing resistors. Type 566A18. 1.08 ohms per box, 60 amp. d.c. continuous for 200 deg. C. rise. Resistors in series as required.	1928116 G-6 (G.E.)	T-7659549 P-2	
	442-1	432	Grids. 0.06 ohms, 60 amp. d.c. continuous.	187491		
524		3	Grid R-F isolating switches. Two circuits, two closed positions.	Description (G.E.)	T-7659362 Parts 3 and 12	
525		3	Output R-F isolating switches. Two circuits, two closed positions.	Description (G.E.)	T-7659362 Parts 11 & 42	
526		3	Bias isolating switches. One circuit, two closed positions.	Description (G.E.)	T-7659362 Parts 11 & 42	
527		3	Plate isolating switches. One circuit, two closed positions.	Description (G.E.)	T-7659362 Parts 11 & 42	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7350122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
528		1	Main closing thrustor for isolation. Type CR-9504-B, 3 inch stroke, 150 lb. thrust.	3888868 G-8 (G.E.)	T-7659360 P-19	
	528-1	1	Motor. 1/4 H.P., 5000 R.P.M., 125 volts d.c., 3.5 amp. starting, 1.86 amp. running.			
	528-2	1 gal.	Oil	GE No. 21		
529		1	Isolating latch trip solenoid. Type CR-9503. Push-pull type, 1.25 inch stroke.	2237032-AE80 (G.E.)	T-7659360 P-39	
	529-1	1	Solenoid coil. 70 volts d.c. continuous, 125 volts d.c. intermittent, 18 amp. at maximum stroke, 0.12 amp. at zero stroke.	F-5175780		
530		3	P.A. isolating rotator thrustors. Type CR-9504-L, 2 inch stroke, 75 lb. thrust. Cat. 3888831 G-3 modified per M-4912145.	Description (G.E.)	T-7659370 P-17	
	530-1	3	Motors. 110 watt, 125 volts d.c., 4100 R.P.M., 4.8 amp. starting. 2.8 amp. running.			
	530-2	-	Oil. 1/2 gallon per thrustor.	GE No. 21.		
534		1	Auxiliary switch for latch trip. Modified CR-2820-1097-D relay, Cat. 3888290 G-2. Coil removed. Six circuits, three n.o. and three n.c.	M-7461310 P-1 (G.E.)	T-7659360 P-49	
537		1	Shaft limit switch for main thrustor. Three way switch. 10 amp., 125 volts.	GE2514 (G.E.)	T-7659360 P-54	

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
542		3	Auxiliary switches for P.A. rotators. Modified CR-2820-1097-D relay, Cat. 3888290 G-2. Coil removed. Six circuits, three n.o., three n.c.	M-7461310 P-1 (G.E.)	T-7659370 P-16	
543		10	P.A. bias filter capacitors. Type CE. 12 mfd., 1980 volts d.c.	55X664 (G.E.)	DL-7550552, item 21, sheet 1	
544		1	Bias capacitor safety gap. Adjusted to 1/4 inch.	-	Installation	
545		1	Shaft limit switch for rotators. D.P.S.T., 250 volt, 30 amp. Poles connected in series for double break.	GE2924 (G.E.)	P-7760781 P-15	
601		1	Harmonic filter air blower.			
	601-1	1	Motor, single phase, 110 volts, 0.45 amp., 60 cycles, 1050 R.P.M., 8 watts.	5KH25AA147 (G.E.)	W-7350485 P-11	
	601-2	1	Fan, Three 10 inch blades.	P-4928705 G-1 (G.E.)	W-7350485 P-12	
602		1	Harmonic filter coil.	P-7760738 G-2 (G.E.)	W-7350485 P-2	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7350122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
603		50	Harmonic filter capacitors. Casing 77. 0.001 mfd., 15 KV at 60 cycles. Ten paralleled banks with five capacitors in series per bank.	UC-2325-K (Faradon)	W-7350485 P-4	
604		1	Transmission line 50/500 KW switch. S.P.D.T.	T-7659458 G-1 (Includes symbol 604-A) (G.E.)	W-7350485 P-9	
604-A		1	Interlock on 604. S.P.S.T., 20 amp., 125 volts.	GE2782 (G.E.)	T-7659458 P-17	
628		1	1400 KC trap coil.	K-7867487 and description (G.E.)	W-7350485 P-27 (Includes symbol 629)	
629		4	1400 KC trap capacitors. Casing 77, 0.001 mfd.; capacitors in series.	UC-2325-K (Faradon)	W-7350485 P-27 (Includes symbol 628)	
908		5	D-C filament rheostats. 3.3 amp. maximum, 130 ohms. Three 8 inch plates on common operating shaft.	S#664052 (Westinghouse)	P-7760712 P-2	
908-A		1	Shaft interlock for 908. One circuit, 5 amp., closed when rheostat turned to maximum resistance.	T-7659419 Parts 6 and 11 (G.E.)	P-7760712 Parts 15 & 20	

11.16 EXTERNAL APPARATUS. EXTERNAL CONNECTION DIAGRAM WW-7550122

Circuit Symbol Number	Circuit Symbol Sub No.	Quant.	Name and Electrical Rating (Each)	Mfgr's Cat. or Drawing Reference	Assembly Part Reference	Spares Quant.
909		1	Modulator bias rheostat. 0.48 amp. maximum, 400 ohms. One 8 inch plate.	S#-664056 (Westinghouse)	P-776 0712 P-3	
910		1	H.P.A. bias rheostat. 0.48 amp. maximum, 400 ohms. One 8 inch plate.	S#-664056 (Westinghouse)	P-776 0712 P-3	
911		1	P.A. bias rheostat. 2.95 amp. maximum, 80 ohms. One 8 inch plate.	S#-664050 (Westinghouse)	P-7760712 P-4	
911-A		1	Resistor for 911. 50 ohms, 122 watts open.	QCK-1924017 50 ohms (G.E.)	P-7760712 P-43	
985		1	Console circuit battery switch. Surface rotary switch, S.P.S.T., indicating, 10 amp., 125 volts.	60447 (G.E.)	DL-7550352 Item 35, sheet 1	
986		1	Console circuit battery fuse. 3 amp., 250 volt.	GE1454 (G.E.)	DL-7550352 Item 35, sheet 1	
987		1	Fuse for d-c filament meter & relay. 3 amp., 250 volt.	GE1454 (G.E.)	DL-7550352 Item 35, sheet 1	

12.00 INDEX TO ENCLOSURES

12.01 PHOTOGRAPHS (Between pages 18 and 19)

Number	Abbreviated Title
487609	Isolation Switch
487613	Power Amplifier Tank Circuit Assembly
487931	Control Panel
489658	R-F Transmission Line
489663	Basement Ceiling
489665	Horn Gap and Protective Resistor for Modulation Reactor
489684	Plate Transformers and Reactors
490091	High Power Audio Amplifier and Low Power Rectifier
490093	Interior of Transmitter Building
490094	Filament Motor Generator Sets
490095	Antenna House Apparatus
490096	Power Amplifier - Front Panel
490097	Modulator Unit
490098	Main Rectifier Unit
490099	Distribution Panel
490100	Modulation Transformers
490101	Harmonic Filter
490103	Shop and Bias Motor Generator Sets
490104	Station Buildings, Spray Pond and Antenna Tower
490105	500 KW equipment - Front Panel
490106	Filter and Modulator Coupling Capacitor Bank
490111	Oil Circuit Breaker Unit
493772	Water Cooling Apparatus
516160	Operator's Console

12.02 Prints

Number	Title	Follows Page #
NP-59031	Instructions for Filament Start and Run Switches	26
H-5170722	Overmodulation Indicator	28

12.03 Instruction Pamphlets

Number	Apparatus	Applies to Symbol
GEI-4971	D-C Time Relay (MC-13)	812
GEI-6506	Oil Circuit Breaker (FK-44B-Y2)	415
GEH-58	Plate Transformers (K-2410)	404
GEH-92	Grid Type Resistors (CR9143)	416, 442, 508
GEH-102	Circuit Breaker Closing Relays (PB-54)	412, 418-A, 418-B, 423
GEH-119	Isolation Latch Trip Solenoid (CR9503)	529
GEH-129	D-C Contactors (CR2800)	803, 805, 811, 815, 818, 820, 831-B, 833
GEH-223	Pendulum Type Definite Time Interlocks(CR2953)	801-A, 806, 813
GEH-230	Instrument Transformers	411, 427, 427-A
GEH-402	A-C Time Relay (MC-10)	808
GEH-636	A-C Auxiliary Relay (HG-2)	817
GEH-637	A-C Contactors (CR2810)	804, 822, 832
GEH-773	Oil Circuit Breakers (FK-33)	414-A, 414-B, 417
GEH-781	Thrustors (CR9504)	186, 523, 530
GEH-804	Thermostat (CR2992-A1)	436
GEH-874	A-C Undervoltage Relay(IAV)	809
GEH-875	A-C Time Relay (CR2320-1099)	831-A

Number	Apparatus	Applies to Symbol
GEH-886	Isolation Aux. Switches (CR2820-1097)	187, 534, 542
GEH-918	Console Indicating Lamps	All Console Lamps
GEH-954	Plunger Relays (PAV and PAC)	310, 835
GEF-99	A-C Time Relay Parts (MC-10)	808
GEF-221	Circuit Breaker Closing Relay Parts (PB-54)	412, 418-A, 418-B 423
GEF-708	D-C Contactor Parts (CR2800-1114)	805
GEF-791	A-C Contactor Parts (CR2810-1342)	804
GEF-1005	Cage Type Resistors (CR9158)	803-A, 814-A, 817-A
GEF-1283	Oil Circuit Breaker Parts (FK-33)	414-A, 414-B, 417
GEF-1406	Definite Time Interlock Parts (CR-2953)	801-A, 806, 813
GEF-1555	Solenoid Parts (CR-9503-211E)	529
GEF-1658	D-C Contactor Parts (CR-2800-1112)	803, 815, 833
GEF-2041	D-C Contactor Parts (CR-2800-1135)	820
GEF-2091	D-C Contactor Parts (CR2800-1131)	811, 818, 831-B
GEF-2149	A-C Undervoltage Relay Parts (IAV)	809
GEF-2159	Thermostat Parts (CR-2992)	436
GEF-2316	Fractional Horse Power Motor Parts (KH)	408, 601
GEF-2332	Isolation Aux. Switch Parts (CR-2820-1097)	187, 534, 542
GEF-2337	Plunger Relay Parts (PAV, PAC)	310, 835
GEF-2348	A-C Time Relay Parts (CR-2820-1099)	831-A
GEF-2414	A-C Contactor Parts (CR-2810-1532)	822, 832
GEF-2457	Thrustor Parts (CR-9504)	186, 528, 530
GEG-753	D-C Definite Time Relay (MC-13)	812
GEG-970	Trip-Seal in Relay Parts (12PHC)	821-A, 821-B
GEJ-176	Filter Reactor (Y-3052-A)	425
*GEJ-213	Fractional HP Motor (KH)	408, 601
*GEJ-320	Automatic Time Switch (T-13)	810
C-1924	Heat Exchanger	-
IB-5094-I	OISC Transformer and Reactor	160, 166
IB-5244	Type AR Electrolytic Arresters	176, 177
IL-1485-A	Generators Type SK	224, 243
IL-1777-C	Linestarters - Class 11-200-C6	223, 241, 258, 263
IL-1800	Relay type KG2A	142, 157, 233, 275
IL-1877-B	Induction Motor Type CS GLB	224, 243
IL-1881-A	Induction Motor Type CS OLB	224, 243, 260, 265
IL-1931	Generators Type SK	224, 243
IL-2018	Time Delay Relay Type TD	304
IL-2073-A	Meters Type SX	163, 215, 245
L-1034-E	Motors Type SK	255
L-20018-B	Thermal Indicators	160, 166
L-20243	Transformer Dehydrating Breather	160, 166
L-20386-A	Induction Motor Type CS	211
L-20394-D	Linestarters Class 11-200-J	207
L-20460	Relays Type SC-1	310, 315
L-20476	Timestarters Class 8512	252
PC-6179-4	Type AR Electrolytic Arresters	176, 177
PC-6216	Meters Type CX & SX	114, 124, 134, 144, 156, 163, 215, 245
RP-3100	CX Motors	211, 260, 265
RP-4000	SK Motors and generators	243, 255

* In envelope.

13.00 INDEX TO INSTRUCTION BOOK DRAWINGS

Drawing No.	Title
WW-7350119	Main Schematic Diagram
WW-7350122	Main External Connection Diagram
T-7659413	Power Amplifier Connection Diagram
P-7760701	Main Rectifier Connection Diagram
P-6120104	Oil Circuit Breaker Unit Connection Diagram
WW-7350121	Control Panel Connection Diagram
WW-7350120	Operator's Console Connection Diagram
M-7461371	Antenna House Connection Diagram
K-7867176	Antenna Rectifier Connection Diagram
T-7603597	Distribution Panel Connection Diagram
P-7704540	Modulator Schematic Diagram
T-7603523	Audio Amplifier Schematic Diagram
P-7703137	Battery Rack Schematic Diagram
P-7704469	Low Power Rectifier Schematic Diagram
M-7405529	Audio Equalizer & Low Pass Filter Schematic Diagram
T-7604065	Cooling System Schematic Diagram

The above drawings accompany this instruction book.

Suggestions For Use: Recommended Procedure To Prolong Tube Life

WATER-COOLED POWER TUBES
By Federal

Storage

Handling a transmitting tube requires care. The internal structure is liable to damage if the tube is subjected to shock or vibration. In general, and particularly in the case of the heavier and larger types, *tubes should not be lifted by the bulb* as the seals are apt to be damaged due to the tube weight.

It is recommended that tubes be stored in racks with the filaments in a vertical position. The racks should be protected against vibration, moisture, and extreme changes of temperature. In the instance of tubes with flexible leads, special care should be taken to prevent the leads striking the glass, avoiding possible breakage.

Installation in Jacket

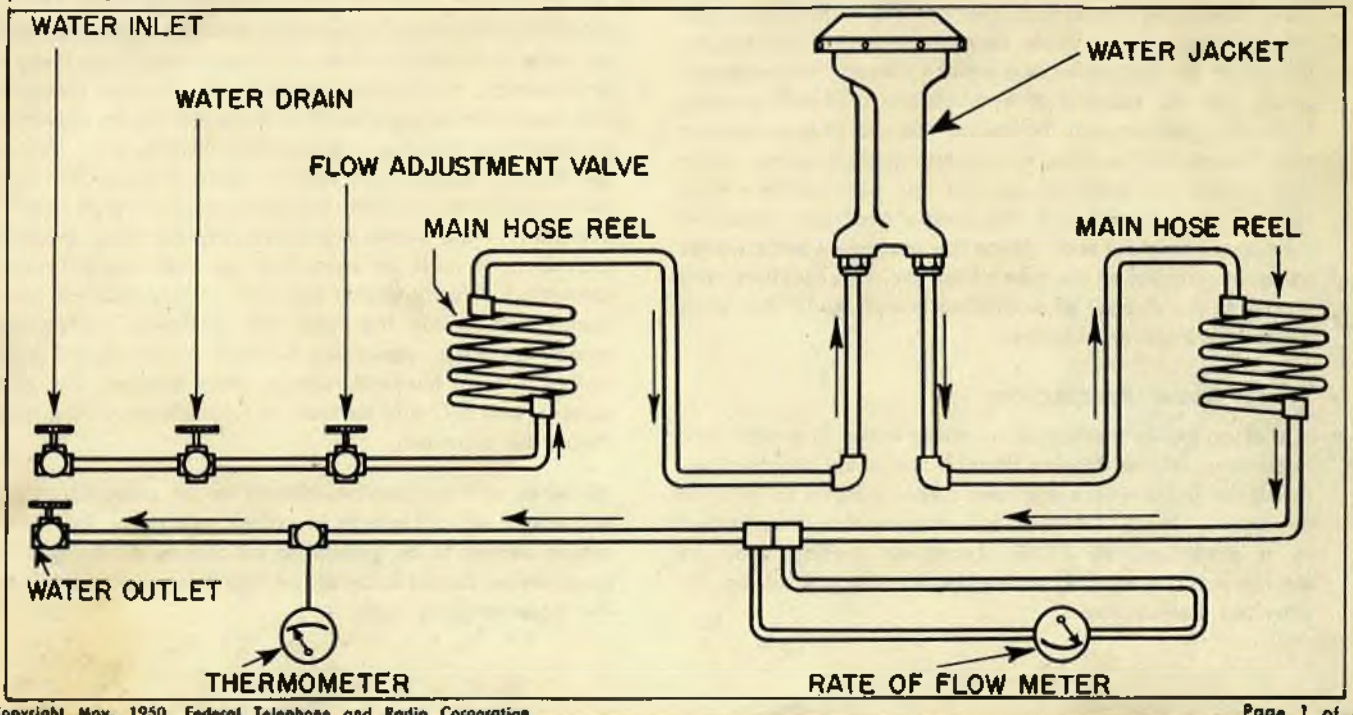
Installation of water-cooled tubes is fairly simple if accomplished with reasonable care. Spare gaskets are supplied with each tube. A new gasket should be used when a tube is placed in the socket. It is recommended that the gasket be coated with a thin film of Prodag to prevent sticking, and that all moving parts of the jacket be covered with a light film of oil to prevent corrosion and sticking. After placing the proper gasket on the anode, the tube should be inserted in the water jacket carefully, and turned gently to make sure the flange seats properly in the jacket. The clamping device first should be tightened with caution to prevent possible strain at the anode seal caused by improper seating of the flange. When preliminary adjustment indicates the tube is seated correctly, the jacket may be tightened securely. Do not tighten more than is needed to prevent water leaks, otherwise the flange may be distorted.

Connections

After clamping in the jacket, filament and grid leads should be connected in such a way as not to be taut, and should allow for some movement without placing a strain on the glass bulb. When making connections, care should be taken to exert as little bending movement as possible at the terminal pins. These leads always should be disconnected before unclamping the tube and removing it from the water jacket. Allow tube to cool before removal from socket, and do not place it on any cold, metallic or heat conducting surface. Sudden change of temperature may crack the glass.

The glass bulb should be clean and free of foreign matter. A soft rag may be used to clean the glass, or if it is excessively dirty, carbon tetrachloride may be used, making sure the glass is cold before it is applied. Care should be taken to remove all foreign matter from recessed or re-entrant areas used in the construction of the tube envelope or stem.

For the protection of personnel during the installation or removal of power tubes, face shields and gloves should be worn at all times.



WATER-COOLED POWER TUBES
By Federal

To get the greatest return from your tube investment, follow these instructions with attention and care.

Water Cooling Systems

In general, the water cooling system for the anode consists of a water source, a water jacket, and a feed-pipe system which carries the water to and from the jacket.

For a small number of tubes, the cooling system may consist of a fan-cooled radiator, a pump, and the water jacket interconnected in a closed circulating system. The system is usually insulated from ground, has a water gauge to indicate the height of water in the radiator, and a thermometer to record the water temperature at the jacket outlet.

Where a number of water-cooled tubes is employed, the water usually is obtained from a large storage tank, or from water mains, whichever is available. To assure an adequate supply, the water is circulated, under pressure, through an interconnected piping system. Lengths of rubber hose or ceramic pipes carry the water from a grounded position in the system to and from the water jackets. It is extremely important that the hose, connected at both inlet and outlet of the jacket, be of sufficient length to reduce leakage current to a minimum.

Distilled water is recommended for cooling. It greatly reduces the possibility of scale formation on the anode during life. A sample of the cooling water should be analyzed when planning the water system. In general, water which shows a hardness greater than 10 grains per gallon should not be used.

Scale Formation

Scale formation prevents proper cooling of the tubes and may damage them. Scale formation can be avoided by the use of distilled water or a water softener. In emergency cases, a 10% solution of hydrochloric acid will dissolve scale from the anode. Following the use of hydrochloric acid the anode should be rinsed thoroughly in water. Care also should be taken to prevent this acid solution from coming into contact with the anode near the region of the copper-to-glass seal. Since this procedure necessitates frequent removal of the tubes from the water jackets, and increases the danger of accidental breakage, it should be avoided whenever possible.

Water Flow Precautions

Use of an outlet thermometer and a water flowmeter are advisable. Water flowing through the jacket should never reach the point where it allows steam bubbles to form on the anode. The outlet water temperature should be limited to a maximum of 70°C. Localized boiling may be detected by a singing noise, or by the use of an improvised stethoscope.

The stethoscope may consist of six feet of insulating tubing . . . *with proper safety precautions taken*. The stethoscope is pressed at various points on the jacket while listening observations are made.

The piping system should be installed and operated properly to prevent any water hammer which might result in pressures high enough to damage the anode. In general, the pressure in the jacket should not exceed 80 pounds per square inch, and relief valves should be installed, when necessary, to prevent excessive pressure.

Proper functioning of the water cooling system is of the greatest importance. Even a momentary failure of the water system may result in the destruction of the tube. It is essential that water flow interlocks be used to open the filament and plate supplies whenever the flow stops or is insufficient. The heat alone from the filament is sufficient to cause serious damage.

Maximum glass and seal temperatures (as specified on data sheets) should not be exceeded. One method of checking these temperatures during operation is the use of temperature-sensitive paints or crayons.

Circuit Requirements

The circuit in which these tubes operate is a high power, high voltage system and *should be safeguarded in the proper manner with interlocking means to protect personnel.*

Installation of proper overload protection measures should be made to protect the tube and equipment against excessive currents. An instantaneous overload relay should be installed in the ground lead of the plate return, protecting the tube from drawing a large plate current. The relay, set for slightly higher than normal plate current, will open the circuit in the rectifier transformer primary in event of overload. Plate series protective resistors also should be provided. It must be seen that no high capacitance is connected directly across the tube in any manner that a disturbance within the tube will discharge appreciable energy from the capacitor. Suitable meters should be installed to read filament voltage, plate voltage, D-C plate current, and D-C grid current. A tube life recording meter should be provided.

All wires and connections should be so placed that they will not lie on or close to the glass, otherwise, the bulb is almost certain to be punctured by corona discharges. All connections should be so made that there are no strains on the metal-to-glass seals.

These precautionary advices on safety, tube care and usage were prepared for you by Federal engineers.

WATER-COOLED POWER TUBES
By Federal

Filament Circuit

The filament connectors should be large and make good contact since the filament circuit carries a low voltage at high current. The filament voltage always should be measured directly at the tube terminals. The filament should be maintained at constant voltage rather than constant current, and provision made for accurate setting and maintenance of this voltage. The high in-rush of filament current, when the switch is first closed, should be limited to the maximum value printed on the data sheets by some form of filament starter. This may be a resistance step method, high reactance transformer, or manual control. Filament power may be A-C or D-C. With A-C the grid and plate returns are connected to the center point of the filament supply. When D-C is used, these returns should be to the negative terminal. When D-C filament excitation is used, the leads should be reversed every 500 hours.

If two or more tubes are used in the circuit, controls should be provided so the plate currents drawn by each tube may be balanced.

In the case of multi-phase filaments, it is essential they be connected as shown on the data sheets to prevent possible bowing and failure of the filament. Single phase operation of all multi-phase filaments is recommended.

Operation

It is suggested that tubes be tested and inspected immediately upon their receipt. Recommended procedure when installing a new tube is to operate without plate voltage and at the rated filament voltage for a period of 15 minutes; then set the plate voltage at as low a value as possible, and operate for approximately 15 minutes at one-half the normal plate voltage. Increase the voltage slowly, if possible, to the normal voltage, and operate for an hour or more. Spare tubes should be given the schedule here outlined every three months.

Filament Voltage

The filament should be operated at constant voltage and its normal operating temperature reached before the plate voltage is applied. For operation at low output, where less than the normal emission of the filament is required, pure tungsten filaments may be operated at reduced filament voltage for longer life. This may be set by reducing the filament voltage in operation to a point where a reduction in output or increase in distortion can just be detected. The filament voltage then should be increased by an amount equivalent to the maximum percentage regulation of the filament supply voltage. A 5% reduction in filament voltage will result in almost doubling the life due to filament burnout. Conversely, operation at 5% over voltage will result in a 50% decrease in life. The foregoing indicates the advantages obtainable with good regulation of the filament supply voltage. Thoriated tungsten filaments should be operated within $\pm 5\%$ of their rated value for *maximum life*.

For frequent standby periods, it is recommended that filaments be operated at reduced voltage to conserve life. Provision may be made to reduce voltage to 80% of normal for periods up to 2 hours on small pure tungsten types, up to 12 hours on large types. Where standby time exceeds 2 hours for small types, and 12 hours for large, voltage may be removed.

Gas Clean-up

When a new circuit is tried or adjustments are made, it is suggested the plate voltage be reduced to approximately one-half normal and increased in steps, adjusting for optimum operating conditions at each step. In the case of a severe overload and the resultant gassing of the tube, it is sometimes possible to effect clean-up of the gas by operating the tube as an oscillator or an RF power amplifier at reduced plate voltage, gradually increasing the voltage to maximum after permitting the tube to reach stable operation at each step. A series resistor may be used in the plate supply and cut-out in steps as stable operation is attained. If the tube has a thoriated tungsten filament, the gas liberated may have impaired the emission of the filament. It may be possible to restore the activity of the filament by operating at 150% of rated voltage for several minutes, then continuing for 15 minutes at 20% over rated voltage. As a last resort, it may be possible to restore the filament by operation at voltages up to 100% over ratings for several minutes followed by operation at 20% over rating for 15 minutes.

Federal Telephone and Radio Corporation
100 Kingsland Road Clifton, New Jersey

Suggestions For Use: To Get The Most From Your Tube Investment

FORCED-AIR-COOLED POWER TUBES
By FEDERAL

Storage

Handling a transmitting tube requires care. The internal structure is liable to damage if the tube is subjected to shock or vibration. In general, and particularly in the case of the heavier and larger types, *tubes should not be lifted by the bulb* as the seals are apt to be damaged due to the weight of tube and radiator.

Federal recommends that tubes be stored in a vertical position, the radiator end down. The larger types may be stored in the shipping crate with the filament end up, and they should be protected from vibration, moisture, and extreme changes of temperature. In the case of tubes with flexible leads, care should be taken to prevent the leads from striking the glass to avoid possible breakage.

Installation

Upon receipt the tube should be tested in the equipment in which it is to be used. Standard mountings support the tube in the correct vertical position with the filament end up. Care must be taken to avoid subjecting the tube to vibration and shock during the installation or operation.

Connections

After mounting the tube in the socket, filament and grid leads should be connected in such a way as not to be taut, and should allow for some movement without placing a strain on the glass bulb. When making connections, care should be taken to exert as little bending movement as possible at the terminal pins. These leads always should be disconnected before unclamping the tube and removing it from the mounting.

The glass bulb should be clean and free of foreign matter. A soft rag may be used to clean the glass, or if it is excessively dirty, carbon tetrachloride may be used, making sure the glass is cold before it is applied. Care should be taken to remove all foreign matter from recessed or re-entrant areas used in the construction of the tube envelope or stem.

For the protection of personnel during the installation or removal of power tubes, face shields and gloves should be worn at all times.

Cooling

The air cooling system consists of a blower and a suitable air duct to the radiator of the tube. The cooling air must not contain any foreign matter. The cooling system should be electrically interlocked with the filament and plate supplies to prevent application of any voltages to the tube without suitable cooling. An air-flow interlock which removes plate and filament power, in event the air flow is insufficient or ceases, should be provided.

As specified on the data sheets, maximum glass and seal temperatures should not be exceeded. One method of checking these temperatures during operation is by the use of temperature-sensitive paints and crayons available. Usually, the bulb and stem of the tube can be cooled adequately by deflecting air from the air stream through the radiator by use of deflecting vanes.

Circuit Requirements

The circuit in which these tubes operate is a high power, high voltage system and *should be safeguarded in the proper manner with interlocking means to protect personnel.*

Installation of proper overload protection measures should be made to protect the tube and equipment against excessive currents. An instantaneous overload relay should be installed in the ground lead of the plate return, protecting the tube from drawing a large plate current. The relay, set for slightly higher than normal plate current, will open the circuit in the rectifier transformer primary in event of overload. Plate series protective resistors also should be provided. It must be seen that no high capacitance is connected directly across the tube in any manner that a disturbance within the tube will discharge appreciable energy from the capacitor. Suitable meters should be installed to read filament voltage, plate voltage, D-C plate current, and D-C grid current. A tube life recording meter should be provided.

All wires and connections should be so placed that they will not lie on or close to the glass, otherwise, the bulb is almost certain to be punctured by corona discharges. All connections should be so made that there are no strains on the metal-to-glass seals.

Federal Telephone and Radio Corporation

FORCED-AIR-COOLED POWER TUBES
By FEDERAL

From the very moment you receive your new tube, *follow these instructions.* It will save you money.

Filament Circuit

The filament connectors should be large and make good contact since the filament circuit carries a low voltage at high current. The filament voltage always should be measured directly at the tube terminals. The filament should be maintained at constant voltage rather than constant current, and provision made for accurate setting and maintenance of this voltage. The high in-rush of filament current, when the switch is first closed, should be limited to the maximum value printed on the data sheets by some form of filament starter. This may be a resistance step method, high reactance transformer, or manual control. Filament power may be A-C or D-C. With A-C the grid and plate returns are connected to the center point of the filament supply. When D-C is used, these returns should be to the negative terminal. When D-C filament excitation is used, the leads should be reversed every 500 hours.

If two or more tubes are used in the circuit, controls should be provided so the plate currents drawn by each tube may be balanced.

In the case of multi-phase filaments, it is essential they be connected as shown on the data sheets to prevent possible bowing and failure of the filament. Single phase operation of all multi-phase filaments is recommended.

Operation

It is suggested that tubes be tested and inspected immediately upon their receipt. Recommended procedure when installing a new tube is to operate without plate voltage and at the rated filament voltage for a period of 15 minutes; then set the plate voltage at as low a value as possible, and operate for approximately 15 minutes at one-half the normal plate voltage. Increase the voltage slowly, if possible, to the normal voltage, and operate for an hour or more. Spare tubes should be given the schedule here outlined every three months.

Filament Voltage

The filament should be operated at constant voltage and its normal operating temperature reached before the plate voltage is applied. For operation at low output, where less than the normal emission of the filament is required, pure tungsten filaments may be operated at reduced filament voltage for longer life. This may be set by reducing the filament voltage in operation to a point where a reduction in output or increase in distortion can just be detected. The filament voltage then should be increased by an amount equivalent to the maximum percentage regulation of the filament supply voltage. A 5% reduction in filament voltage will result in almost doubling the filament life of the tube . . . conversely, operation at 5% over voltage will result in a 50% decrease in life. The foregoing indicates the advantages obtainable with good regulation of the filament supply voltage. Thoiated tungsten filaments should be operated within ± 5% of their rated value *for maximum life.*

For frequent standby periods, it is recommended that filaments be operated at reduced voltage to conserve life. Provision may be made to reduce voltage to 80% of normal for periods up to 2 hours on small pure tungsten types, up to 12 hours on large types. Where standby time exceeds 2 hours for small types, and 12 hours for large, voltage may be removed.

Gas Clean-up

When a new circuit is tried or adjustments are made, it is suggested the plate voltage be reduced to approximately one-half normal and increased in steps, adjusting for optimum operating conditions at each step. In the case of a severe overload and the resultant gassing of the tube, it is sometimes possible to effect clean-up of the gas by operating the tube as an oscillator or an RF power amplifier at reduced plate voltage, gradually increasing the voltage to maximum after permitting the tube to reach stable operation at each step. A series resistor may be used in the plate supply and cut-out in steps as stable operation is attained. If the tube has a thoriated tungsten filament, the gas liberated may have impaired the emission of the filament. It may be possible to restore the activity of the filament by operating at 150% of rated voltage for several minutes, then continuing for 15 minutes at 20% over rated voltage. As a last resort, it may be possible to restore the filament by operation at voltages up to 100% over ratings for several minutes followed by operation at 20% over rating for 15 minutes.

Printed in U. S. A.
Form FJ-459

An IT&T Associate
Federal Telephone and Radio Corporation
100 Kingsland Road Clifton, New Jersey

FEDERAL POWER TRIODE
Type F-862-A
100 Kilowatts Plate Dissipation

GENERAL DATA

DESCRIPTION:

Federal's F-862-A is a three-electrode tube engineered for use as a radio-frequency amplifier, oscillator, or as a Class B modulator. The water-cooled anode is capable of dissipating 100 kilowatts. The cathode is a pure tungsten filament. Maximum ratings apply up to 1.6 megacycles.

Electrical:

Filament Voltage	33 Volts
Filament Current	207 Amperes
Filament Starting Current	400 Amperes max.
Filament Cold Resistance	.014 Ohms
Amplification Factor, at I_b = 3 amps., E_c = —100 volts	45
Interelectrode Capacitances	
Grid-Plate	64 $\mu\mu$f
Grid-Filament	56 $\mu\mu$f
Plate-Filament	4.7 $\mu\mu$f

Mechanical:

Mounting Position— Vertical, anode down	
Type of Cooling— Water and Forced Air	
Minimum Water Flow on Anode	20 GPM
Maximum Outgoing Water Temperature	70° C
Air Flow (to bulb and seals)	15 CFM
Maximum Glass Temperature	150° C
Net Weight, approximate	37 Pounds

FEDERAL POWER TRIODE
Type F-862-A
100 Kilowatts Plate Dissipation

In all parts of the U. S. A. Federal's F-862-A is giving an excellent account of itself in 50 kilowatt, low level modulated transmitters.

Maximum Ratings and Typical Operating Conditions

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values

DC Plate Voltage	15,000 Volts
Max. Signal DC Plate Current†	7.5 Amperes
Max. Signal Plate Input†	100 Kilowatts
Plate Dissipation†	50 Kilowatts

Typical Operation

(Unless otherwise specified, values are for two tubes)

DC Plate Voltage	12,000 Volts
DC Grid Voltage	0 Volts
Peak A-F Grid-to-Grid Voltage	2,000 Volts
Zero Signal DC Plate Current	3 Amperes
Max. Signal DC Plate Current	13 Amperes
Effective Load Resistance (plate to plate)	1,800 Ohms
Max. Signal Driving Power, approx.	450 Watts
Max. Signal Power Output, approx.	90 Kilowatts

†Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

(Carrier conditions per tube for use with a maximum modulation factor of 1.0)

Maximum Ratings, Absolute Values

DC Plate Voltage	20,000 Volts
DC Plate Current	5.0 Amperes
Plate Input	100 Kilowatts
Plate Dissipation	75 Kilowatts

Typical Operation

DC Plate Voltage	18,000 Volts
DC Grid Voltage	—200 Volts
Peak R-F Grid Voltage	750 Volts
DC Plate Current	4.2 Amperes
Driving Power, approx.‡	1.1 Kilowatts
Power Output, approx.	25 Kilowatts

‡At crest of audio-frequency cycle with modulation factor of 1.0.

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEPHONY

(Carrier conditions per tube for use with a maximum modulation factor of 1.0)

Maximum Ratings, Absolute Values

DC Plate Voltage	12,000 Volts
DC Grid Voltage	—3,000 Volts
DC Plate Current	5.0 Amperes
DC Grid Current	1.25 Amperes
Plate Input	60 Kilowatts
Plate Dissipation	50 Kilowatts

Typical Operation

DC Plate Voltage	12,000 Volts
DC Grid Voltage	—800 Volts
Peak R-F Grid Voltage	2,000 Volts
DC Plate Current	5 Amperes
DC Grid Current, approx.	1 Ampere
Driving Power, approx.	2 Kilowatts
Power Output, approx.	45 Kilowatts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

(Key-down conditions per tube without amplitude Modulation)¶

Maximum Ratings, Absolute Values

DC Plate Voltage	20,000 Volts
DC Grid Voltage	—3,000 Volts
DC Plate Current	10 Amperes
DC Grid Current	1.0 Ampere
Plate Input	200 Kilowatts
Plate Dissipation	100 Kilowatts

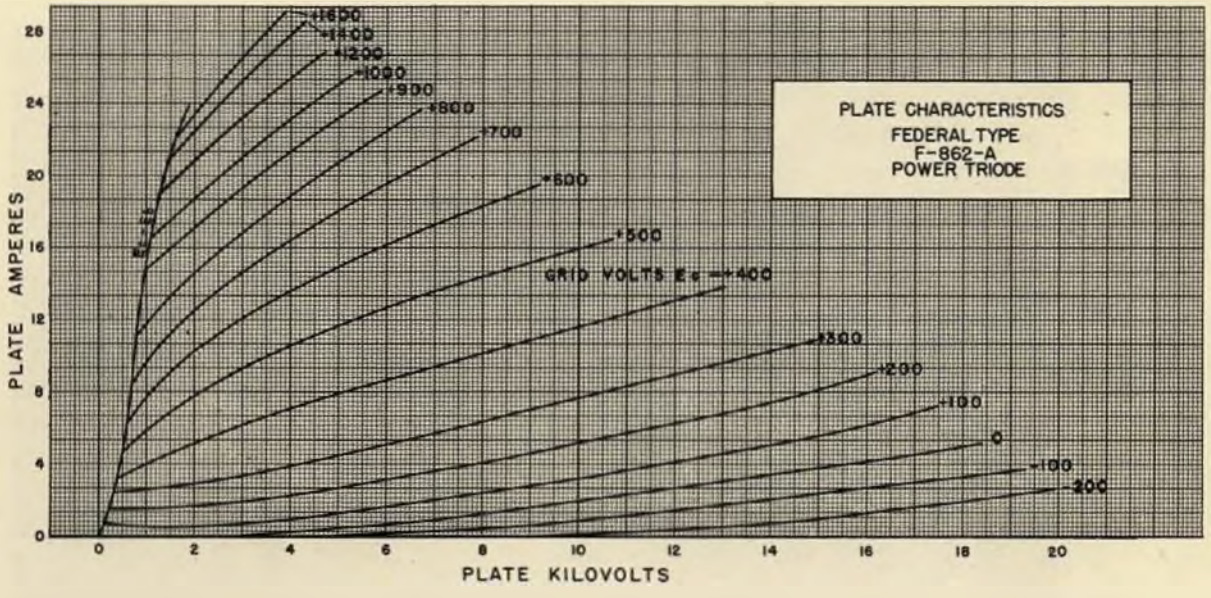
Typical Operation

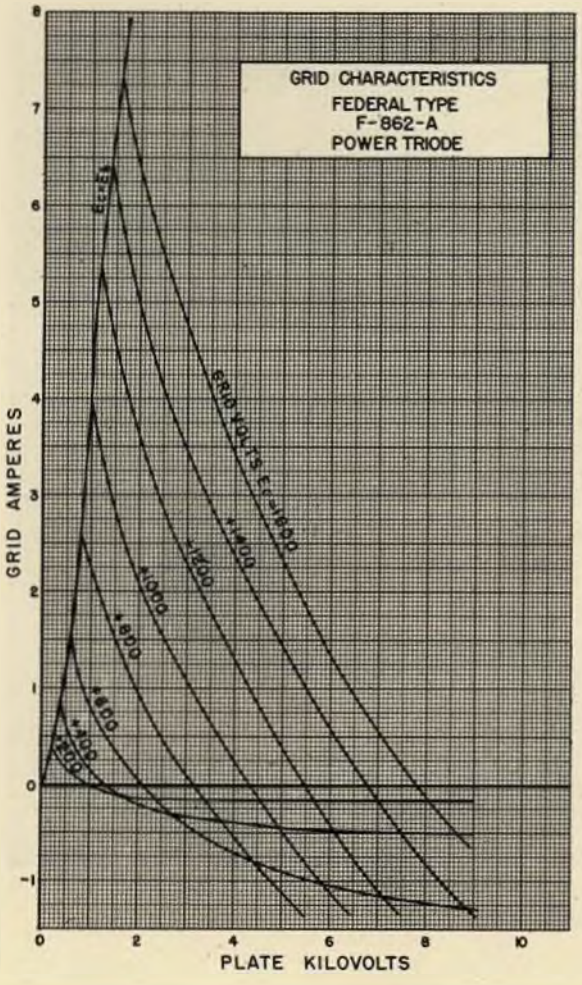
DC Plate Voltage	18,000 Volts
DC Grid Voltage	—1,000 Volts
Peak R-F Grid Voltage	2,550 Volts
DC Plate Current	8.33 Amperes
DC Grid Current, approx.	0.9 Amperes
Driving Power, approx.	2.4 Kilowatts
Power Output, approx.	100 Kilowatts

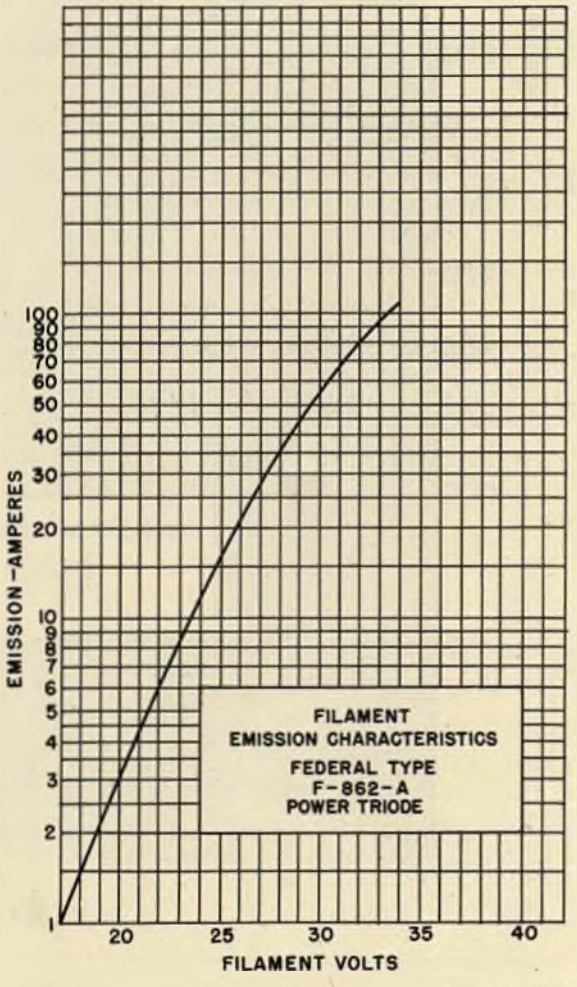
¶Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of carrier conditions.

It's the internal construction of the F-862-A and F-898-A which contributes to the *smoother* performance of these Federal tubes in 50 kilowatt Doherty amplifiers.

FEDERAL POWER TRIODE
Type F-862-A
100 Kilowatts Plate Dissipation

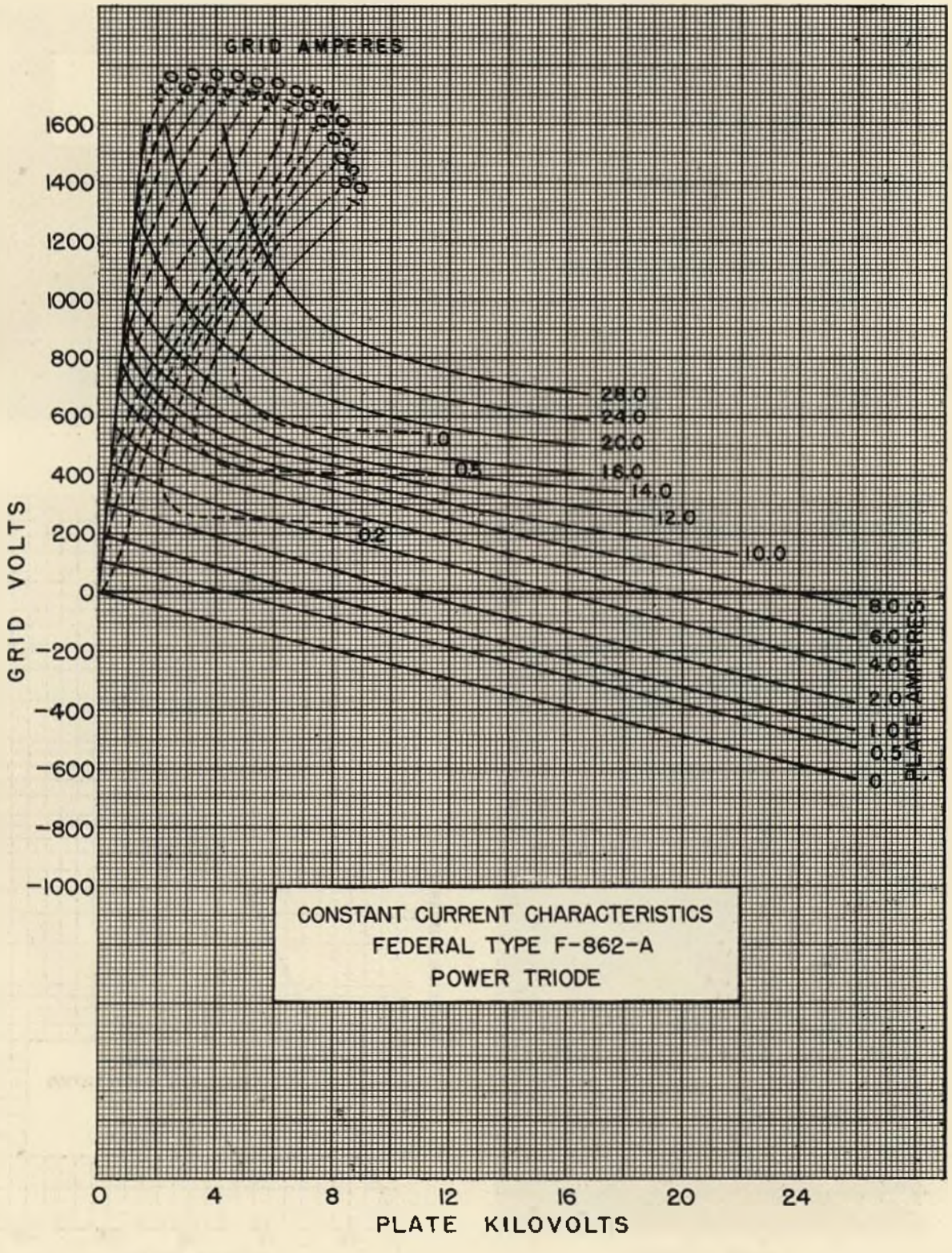






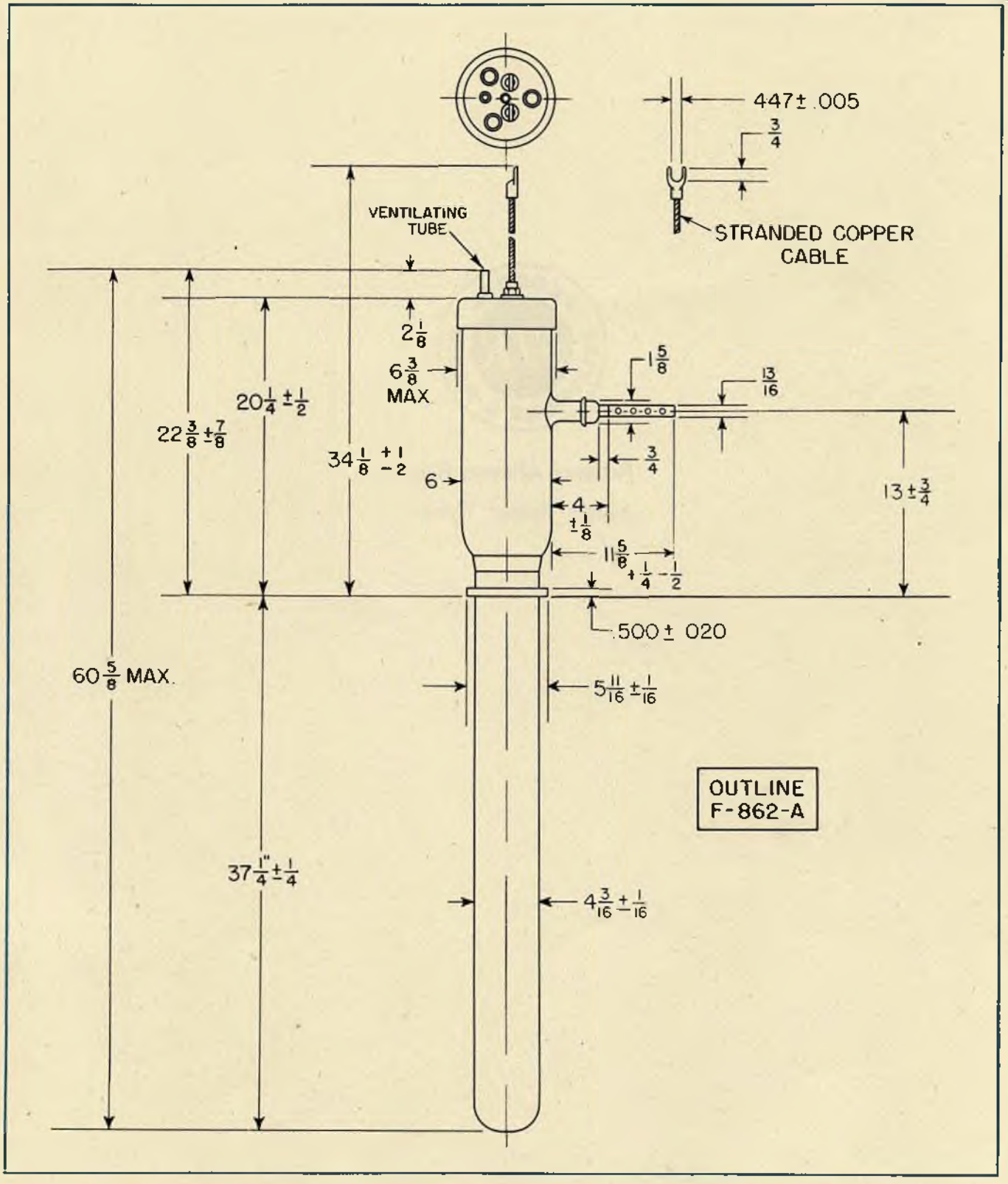
FEDERAL POWER TRIODE
Type F-862-A
100 Kilowatts Plate Dissipation

Federal tubes are precision-designed to meet the specific needs of communications and industrial applications . . . are produced under the most rigid standards of quality-control.



Federal's best tube advertisement is the tube itself, its performance, its service, its long life span.

FEDERAL POWER TRIODE
Type F-862-A
100 Kilowatts Plate Dissipation



Federal Telephone and Radio Corporation
100 Kingsland Road Clifton, New Jersey

An IT&T Associate

Federal Always Has
Made Better Tubes

Form FJ-156. Printed in U. S. A.

Federal TUBE PRICE LIST

Effective SEPT. 12, 1951

POWER TRIODES—WATER COOLED

TYPE	PRICE	DESCRIPTION	Maximum Plate Dissipation	Mu	Maximum Plate Input	Maximum DC Plate Voltage	Maximum Frequency for Maximum Ratings	Filament Voltage
F-6C22	$288.00	UHF General Purpose	1 KW	9	2 KW	3,000 V	600 MC	6.5
F-8002	150.00	VHF General Purpose	1.2	21.5	3	3,500	150	16
F-5917	218.00	VHF Amplifier	5	20	8	4,000	110	7.5
F-328-A	325.00	General Purpose	5	16	8	8,000	3	21.5
F-328-B	325.00	General Purpose (Two Phase Filament)	5	16	8	8,000	3	21.5
F-889-A	210.50	HF General Purpose	5	21	16	8,500	50	11
F-6009	204.00	HF General Purpose	6	25	12	6,000	30	13
F-891	223.00	General Purpose	6	8.5	18	12,000	1.6	11/22
F-129-B	345.00	HF General Purpose	7.5	26	18	12,000	30	18
F-5874	287.00	Audio Amplifier	7.5	6	15	6,000		7
F-220C/ 320-B	350.00	General Purpose	10	40	22.5	15,000	4.0	21.5
F-343-A	350.00	General Purpose	10	40	36	18,000	4.0	21.5
F-892-A	223.00	General Purpose	10	50	30	15,000	1.6	11/22
F-5666	225.00	Industrial, HF General Purpose	12.5	21	20	10,000	22.5	11
F-893-A	630.00	General Purpose	20	36	70	20,000	5	10 per section
F-858	500.00	General Purpose	20	42	40	20,000	1.5	22
F-880	483.00	HF General Purpose	20	20	60	10,500	25	12.6
F-5658	483.00	HF General Purpose	20	20.5	60	10,500	25	12
F-5771	510.00	HF General Purpose	22.5	20	60	12,500	25	7.5
F-342-A	582.00	General Purpose	25	40	50	20,000	4.0	20
F-9C23	490.00	HF General Purpose	25	32	50	15,000	20	22
F-5512	1,759.00	VHF General Purpose Oscillator	25	38	80	9,000	110	6.2
F-124-A	996.00	HF General Purpose	40	42	135	20,000	20	13.6 per section
F-9C30	1,110.00	HF General Purpose	40	42	120	15,000	20	7.5 per section
F-125-A	1,035.00	Audio Amplifier	40	4.75	100	15,000		13.6 per section
F-9C28	1,150.00	Audio Amplifier	40	4.75	100	15,000		7.5 per section
F-895	950.00	HF General Purpose	40	37	140	17,000	6	19 per section
F-5918	1,925.00	HF General Purpose	60	37	300	17,500	22	28.5
F-862-A	1,322.00	General Purpose	100	45	200	20,000	1.6	33
F-898-A	1,322.00	General Purpose	100	45	200	20,000	1.6	16.5 per section
F-134	2,700.00	HF General Purpose	150	21	450	20,000	22	25

WATER JACKETS

TYPE	DESCRIPTION	PRICE
F-1000-A	For F-207, F-848, F-863, F-891, F-892	$ 50.00
F-1005-A	For F-320-B, F-343-A, F-342-A, F-222-A, F-237-A, 9C23	50.00
F-1006-A	For F-328-A, F-328-B	50.00
F-1010-A	For F-893, F-858, F-124-A, F-125-A, F-9C28, F-9C30	150.00
F-1012-A	For F-129-B	50.00
F-1015-A	For F-134	360.00

RECTIFYING TUBES

TYPE	PRICE	DESCRIPTION	Maximum Peak Inverse Voltage	Maximum Peak Current (Amperes)	Filament Voltage
F-872-A	$ 8.20	Mercury Vapor	10,000	5	5
F-8008	8.20	Mercury Vapor	10,000	5	5
F-315-A	38.60	Mercury Vapor	15,000	6	5
F-321-A	38.60	Mercury Vapor	12,500	4	5
F-575-A	21.00	Mercury Vapor	15,000	6	5
F-869-B	132.00	Mercury Vapor	20,000	10	5
F-857-B	209.00	Mercury Vapor	22,000	40	5
F-266-B	209.00	Mercury Vapor	22,000	40	5
F-873	12.00	Grid Controlled Mercury Vapor	10,000	10	5
F-5563	40.00	Grid Controlled Mercury Vapor	15,000	6.4	5
F-222-A	300.00	Water Cooled—High Vacuum	50;000	5.5	21.5

POWER TRIODES—AIR COOLED

TYPE	PRICE	DESCRIPTION	Maximum Plate Dissipation	Mu	Maximum Plate Input	Maximum DC Plate Voltage	Maximum Frequency for Maximum Ratings	Filament Voltage
F-123-A	$ 17.15	HF General Purpose	125 W	14.5	375 W	2,000	30 MC	10
F-127-A	55.20	HF General Purpose	200	38	950	3,000	30	10
F-204-A	115.00	General Purpose	250	23	690	2,500	3	11
F-212-E	104.00	General Purpose	275	16	700	2,000	4.5	14
F-849	138.00	General Purpose	400	19	875	2,500	3.0	11
F-450TH	60.00	HF General Purpose	450	38	3 KW	6,000	40	7.5
F-128-A	184.00	HF General Purpose	600	36	3	3,500	30	11
F-132-A	230.00	Audio Amplifier	600	10	1.8	3,500		11
F-7C26	146.00	VHF Amplifier	1 KW	17	3	3,000	150	9.0
F-8002-R	173.00	VHF General Purpose	1.2	21.5	3	3,500	120	16
F-7C23	173.00	Pulse	1.2	25		17,000	5	11.0
F-5680	185.00	Pulse	1.2	25		17,000	5	13.0
F-5680	185.00	HF General Purpose	2.5	25	12	6,000	30	13.0
F-5996	185.00	HF Industrial	2.5	25	12	6,000	30	13.0
F-7C25	154.00	HF Industrial	2.5	25	5.6	4,500	50	11
F-3X2500A3	198.00	VHF Amplifier	2.5	20	8	4,000	110	7.5
F-891-R	362.00	General Purpose	4	8.5	15	10,000	1.6	11/22
F-892-R	362.00	General Purpose	4	50	18	10,000	1.6	11/22
F-129-R	431.00	HF General Purpose	5	26	18	12,000	30	18
F-889-RA	285.00	HF General Purpose	5	21	16	8,500	25	11
F-343-AA	435.00	General Purpose	5	40	20	18,000	4	21.5
F-220CA/ 320BA	430.00	General Purpose	5	40	22.5	15,000	4	21.5
F-8C25	345.00	Audio Amplifier	5	6	10	5,000		7
F-5667	302.50	Industrial, HF General Purpose	7.5	21	20	10,000	22.5	11.0
F-124-R	1,357.00	HF General Purpose	20	42	100	20,000	20	13.6 per section
F-9C31	1,460.00	HF General Purpose	20	42	100	15,000	20	7.5 per section
F-9C29	1,505.00	Audio Amplifier	20	4.75	50	15,000		7.5 per section
F-893-AR	1,150.00	General Purpose	20	36	70	20,000	5	10 per section
F-895-R	1,300.00	General Purpose	20	37	110	17,000	6	19 per section

CREDIT ALLOWANCES: Credits towards the purchase of renewal tubes are allowed on return of tube and/or radiator and crate in good condition. Allowances below apply when material is returned prepaid:

TUBE TYPE	TUBE	TUBE AND RADIATOR	CRATE	TUBE AND CRATE
F-124-A, F-125-A, F-9C28, F-9C30, F-893, F-895, F-5918				$7.00
F-134	$60.00		$20.00	
F-862-A, F-898-A	$10.00		$25.00	
F-328-A, F-328-B, F-891, F-892, F-320-B, F-342-A, F-343-A, F-9C23, F-880, F-5666				$5.00
F-7C26, F-7C23, F-5680, F-7C25, F-5996	$4.00			
F-891-R, F-892-R, F-8C25		$20.00	$10.00	
F-124-R, F-893-AR, F-9C29, F-9C31, F-895-R		$110.00	$40.00	
F-5667, F-889-RA, F-129-R				$20.00
F-129-B				$3.00
F-343-AA, F-220CA/320BA		$40.00		
F-5917, F-6009	$30.00			

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE—Terms and conditions of sale and general information are set forth in Federal's Form F-296.

Federal Telephone and Radio Corporation

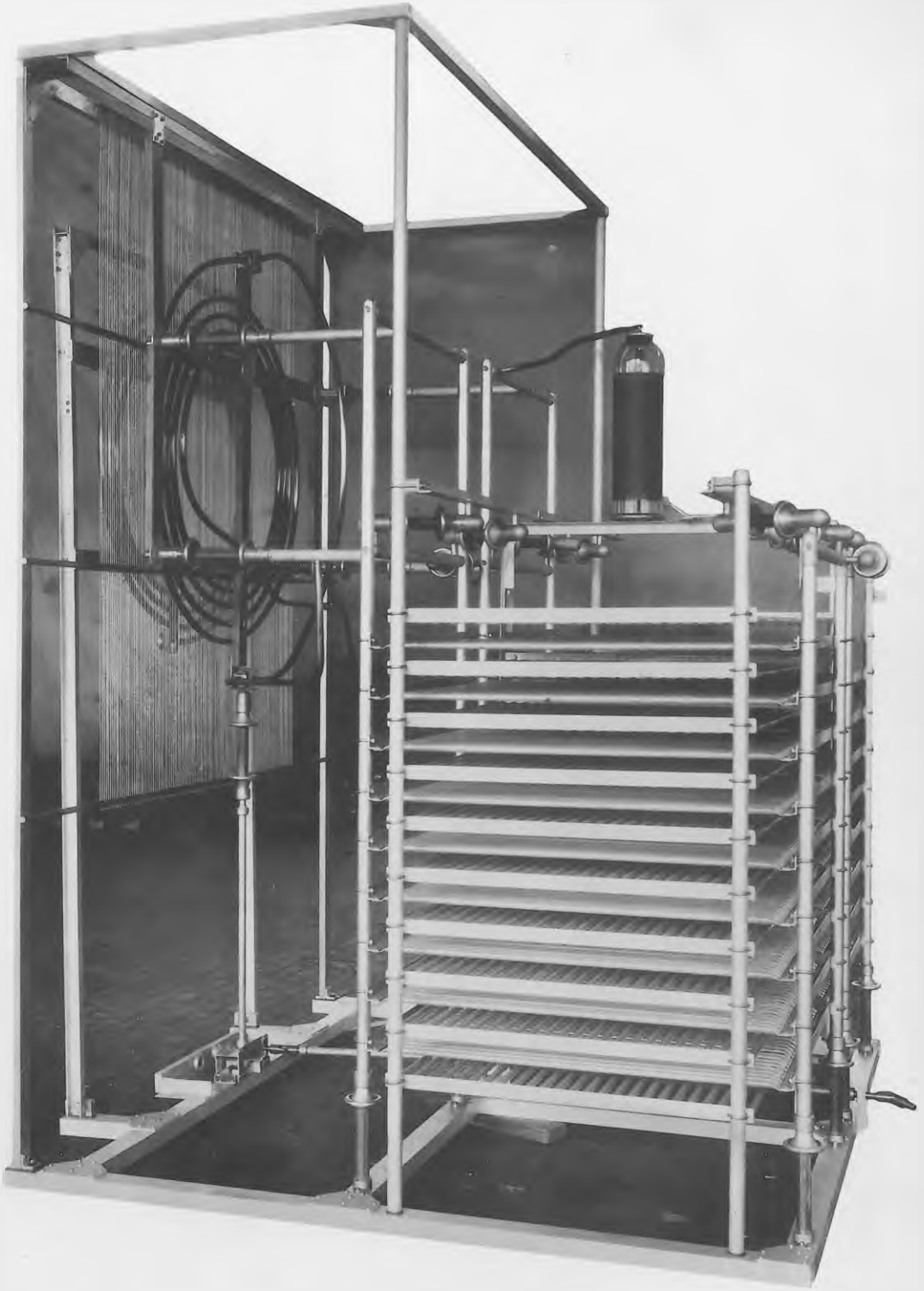
An IT&T Associate

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

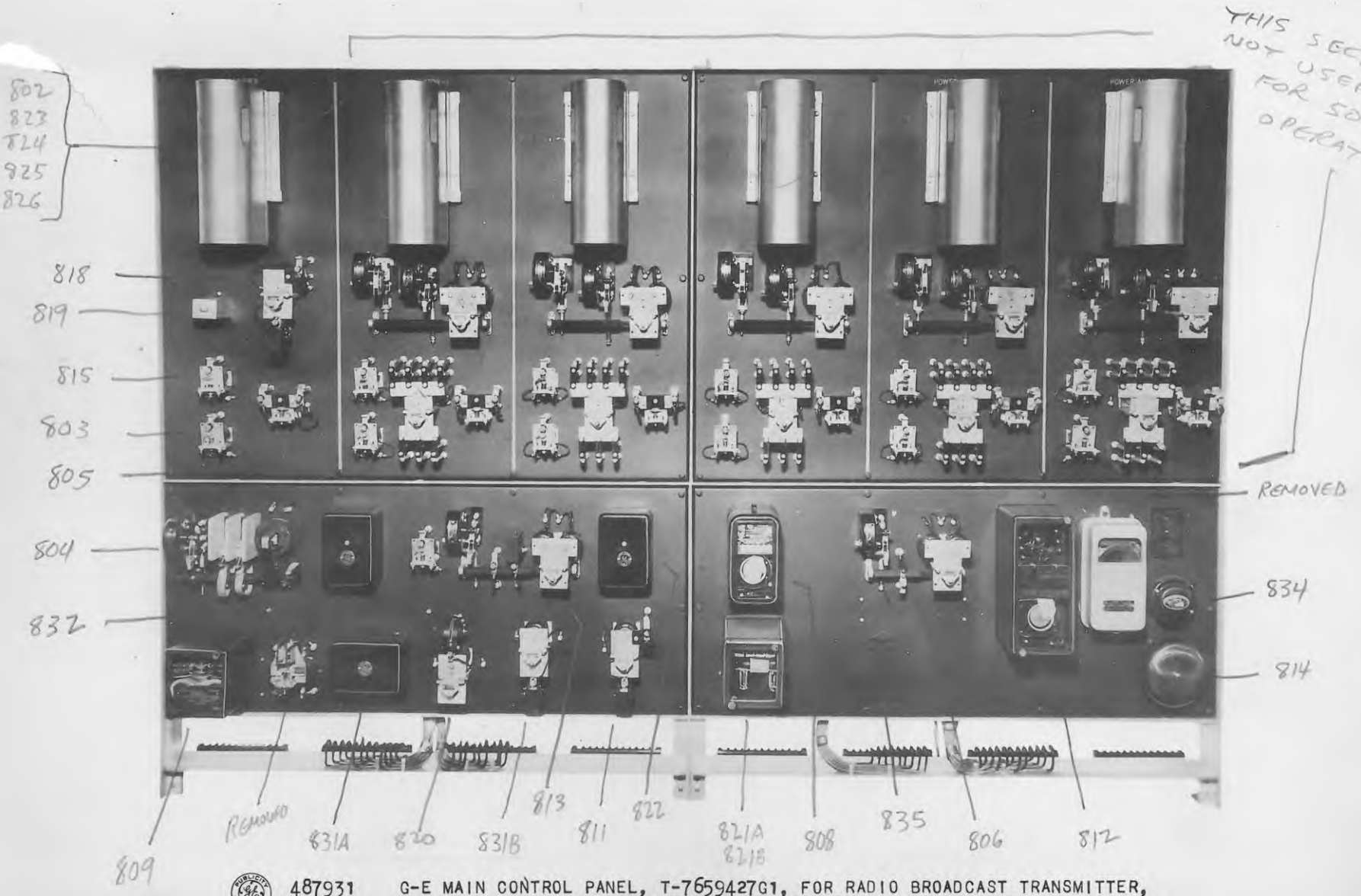
100 Kingsland Road
Clifton, New Jersey

Printed in U. S. A.—Form F-476A

487609 RADIO TRANSMITTER-UNIT ISOLATION SWITCH (WITHOUT NORTH-SIDE SHIELDS) USING G-E THRUSTORS. FOR STATION WLW 500-KW. BROADCAST TRANSMITTER, DL.7550352G1. VIEW DURING FACTORY TEST. SWITCH DRG.W-7350473G1.

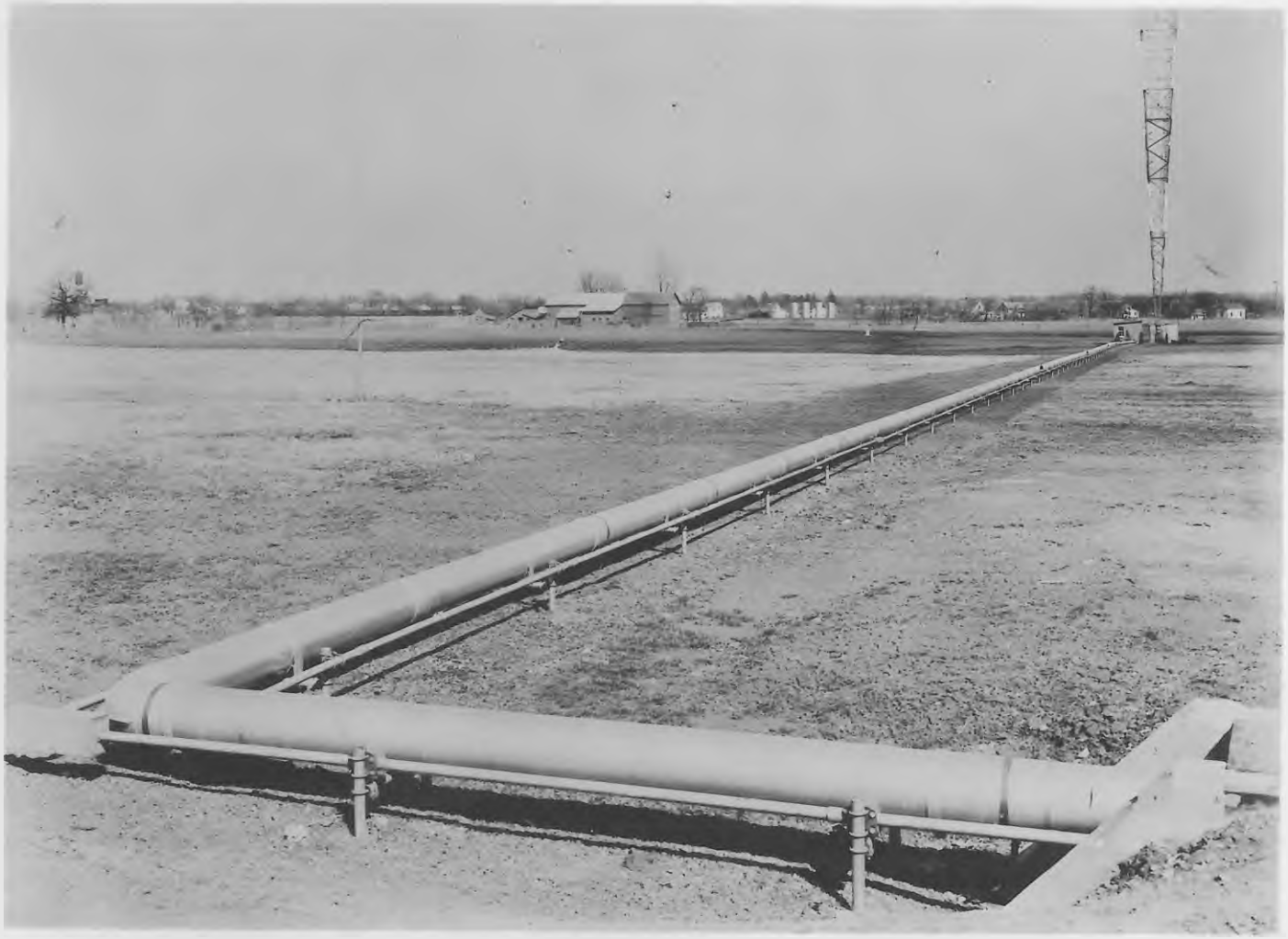


487613 RADIO POWER AMPLIFIER TANK CIRCUIT ASSEMBLY FOR STATION WLW 500-KW. BROADCAST TRANSMITTER, DL.755352G1. PARTLY ASSEMBLED THREE-QUARTER VIEW. FRONT, LEFT SIDE. TANK UNIT ASSEMBLY ORG. W-735047SG1.



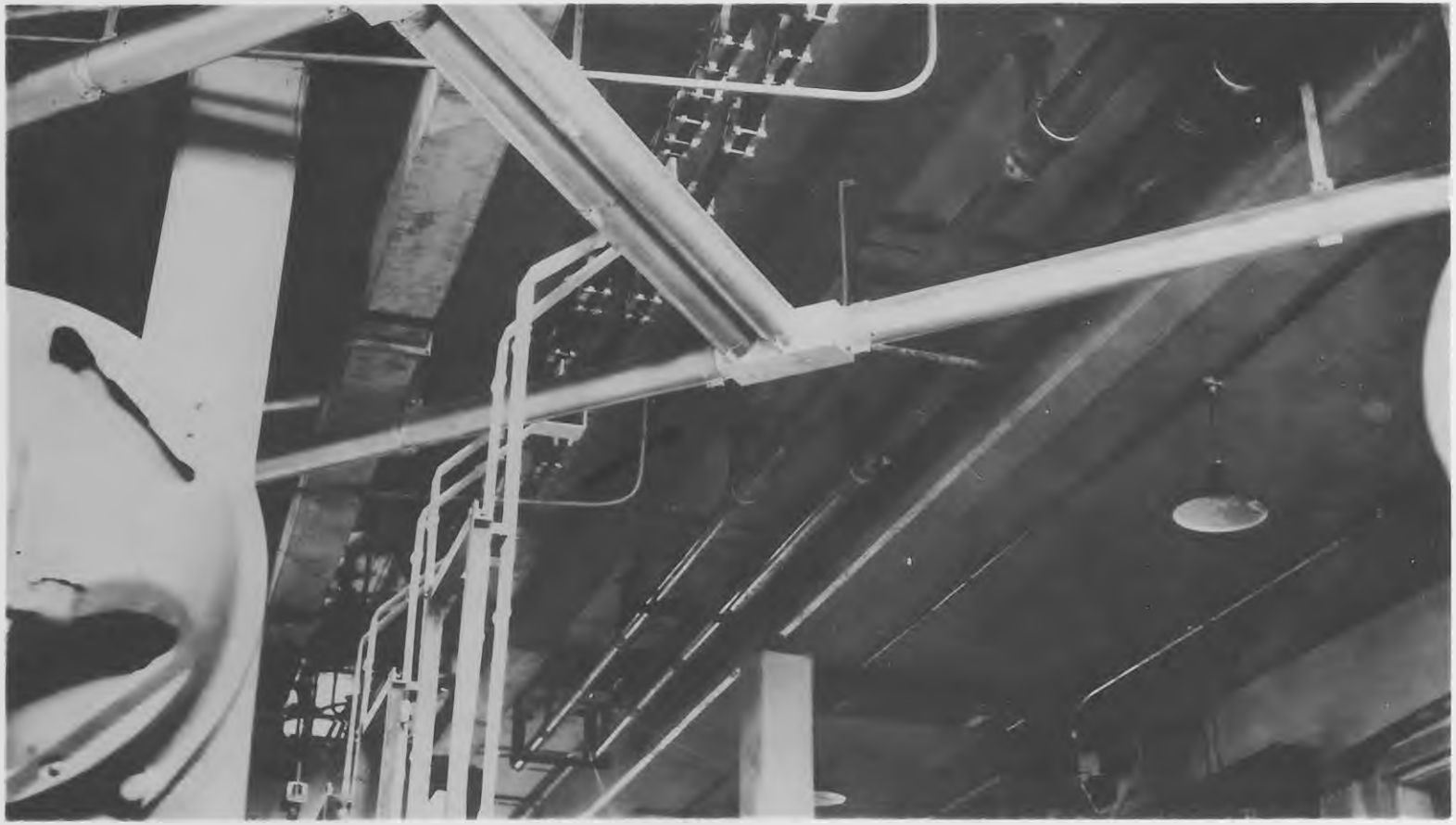
487931 G-E MAIN CONTROL PANEL, T-7659427G1, FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, RCA TYPE 500-A (DL.7550352G1, G-E TYPE RT-113-A) FOR CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 E353.2 654-3 9-1-33



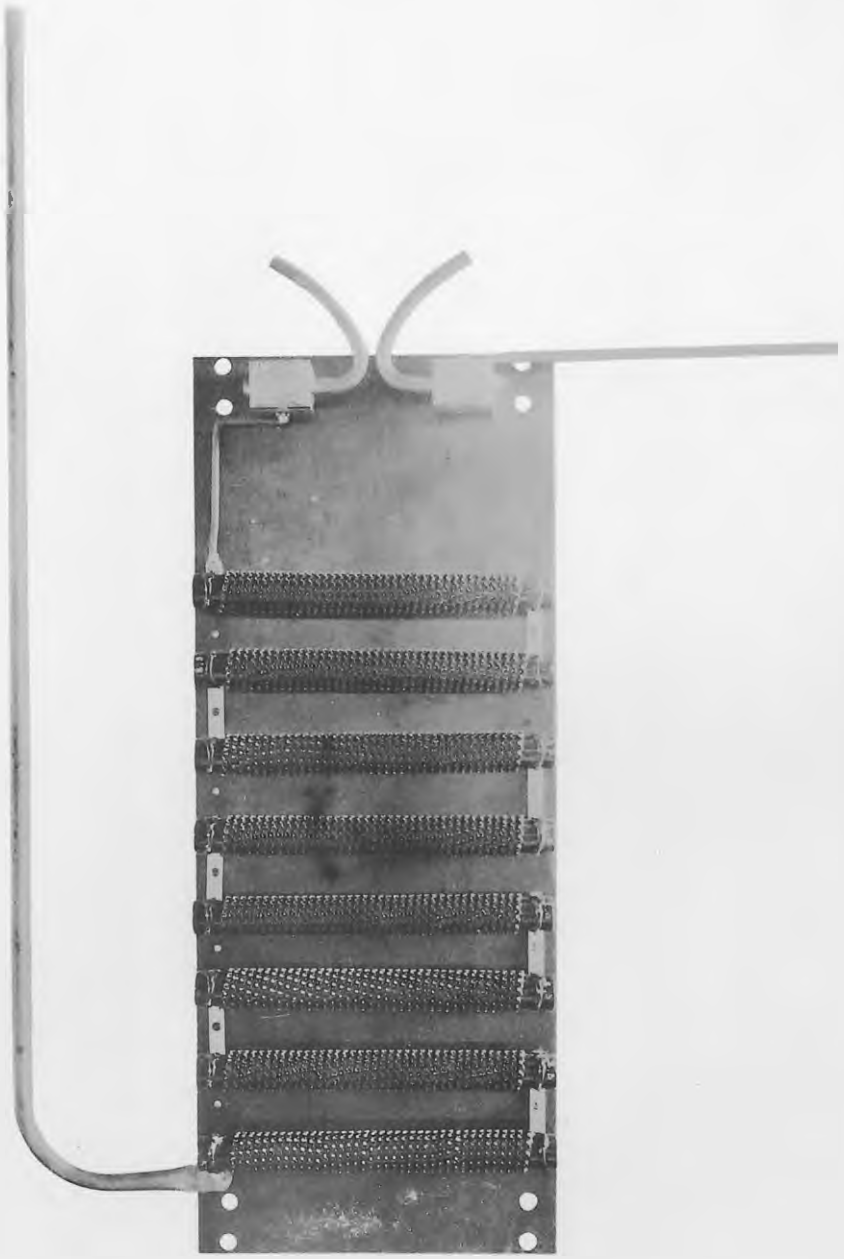
489658 G-E RADIO-FREQUENCY TRANSMISSION LINE, T-7659387G1, FOR BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A, (DL.755035 2G1, G-E TYPE RT-113-A). CONCENTRIC-TUBE LINE APPROX. 775 FT. LONG. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-4 3-29-34



489663 RADIO-FREQUENCY TRANSMISSION LINES, FILAMENT BUSSES, AIR DUCT, AND MUELLER CO. PIPES FOR COOLING WATER, ON BASEMENT CEILING OF BUILDING FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. G-E PART OF EQUIPMENT, DL.7550352G1, TYPE RT-113-A; WESTINGHOUSE PART, DL.7501777G1, TYPE EA. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-S 3-29-34



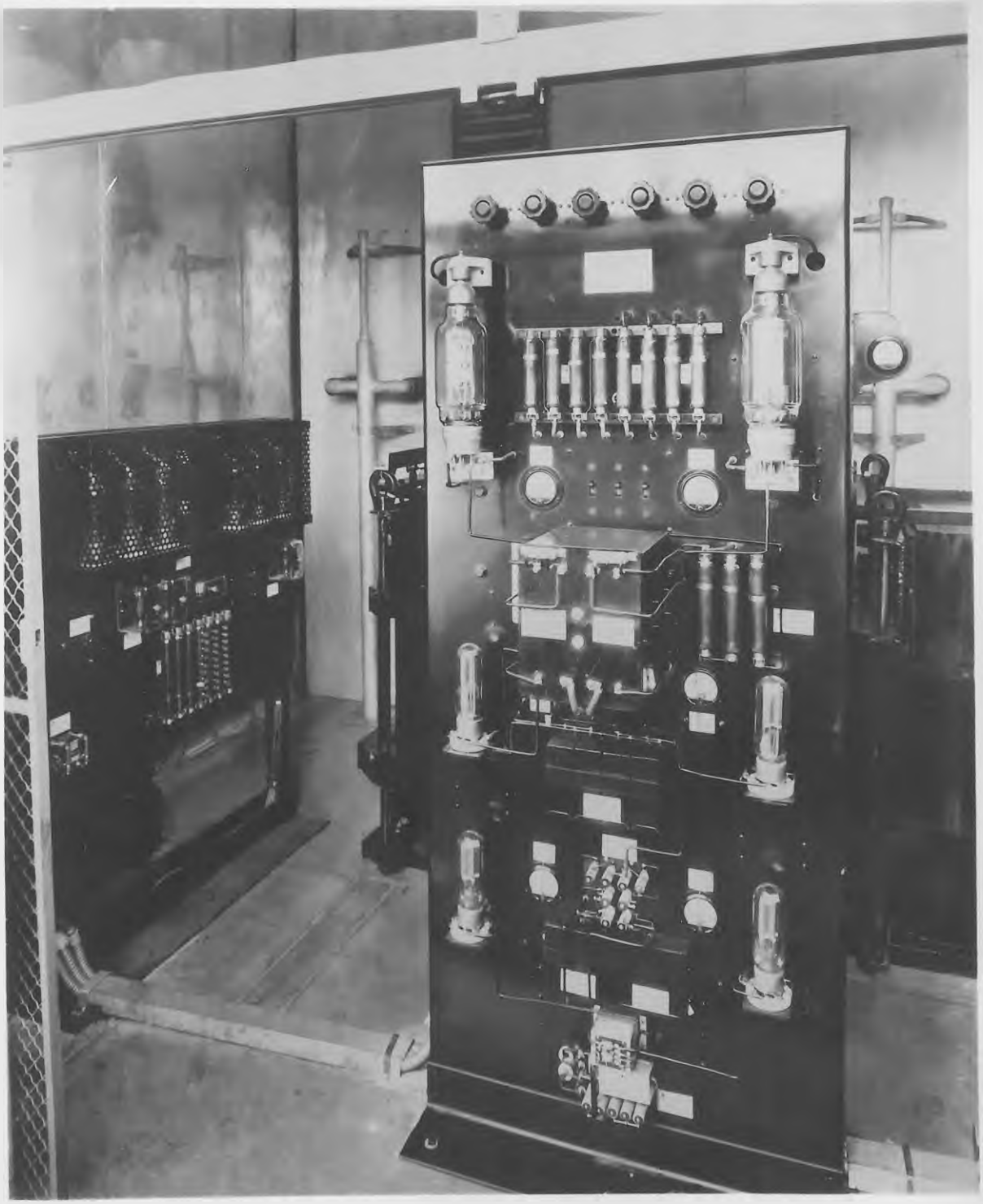
489665 WESTINGHOUSE HORN-GAP AND CURRENT-LIMITING RESISTORS CONNECTED TO PROTECT MODULATION REACTOR FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.750177G1, TYPE EA, G-E PART, DL.7550352G1, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-6 3-29-34

489684

3 G-E PLATE TRANSFORMERS (AT LEFT) AND RECTIFIER FILTER REACTOR, AND WESTINGHOUSE MODULATION REACTOR (AT RIGHT). POWER AMPLIFIER PLATE VOLTAGE-REDUCING RESISTOR HOUSING NOT YET INSTALLED. PART OF RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT (DL.7550352G1, G-E TYPE RT-113-A) AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 - 7 3-29-34

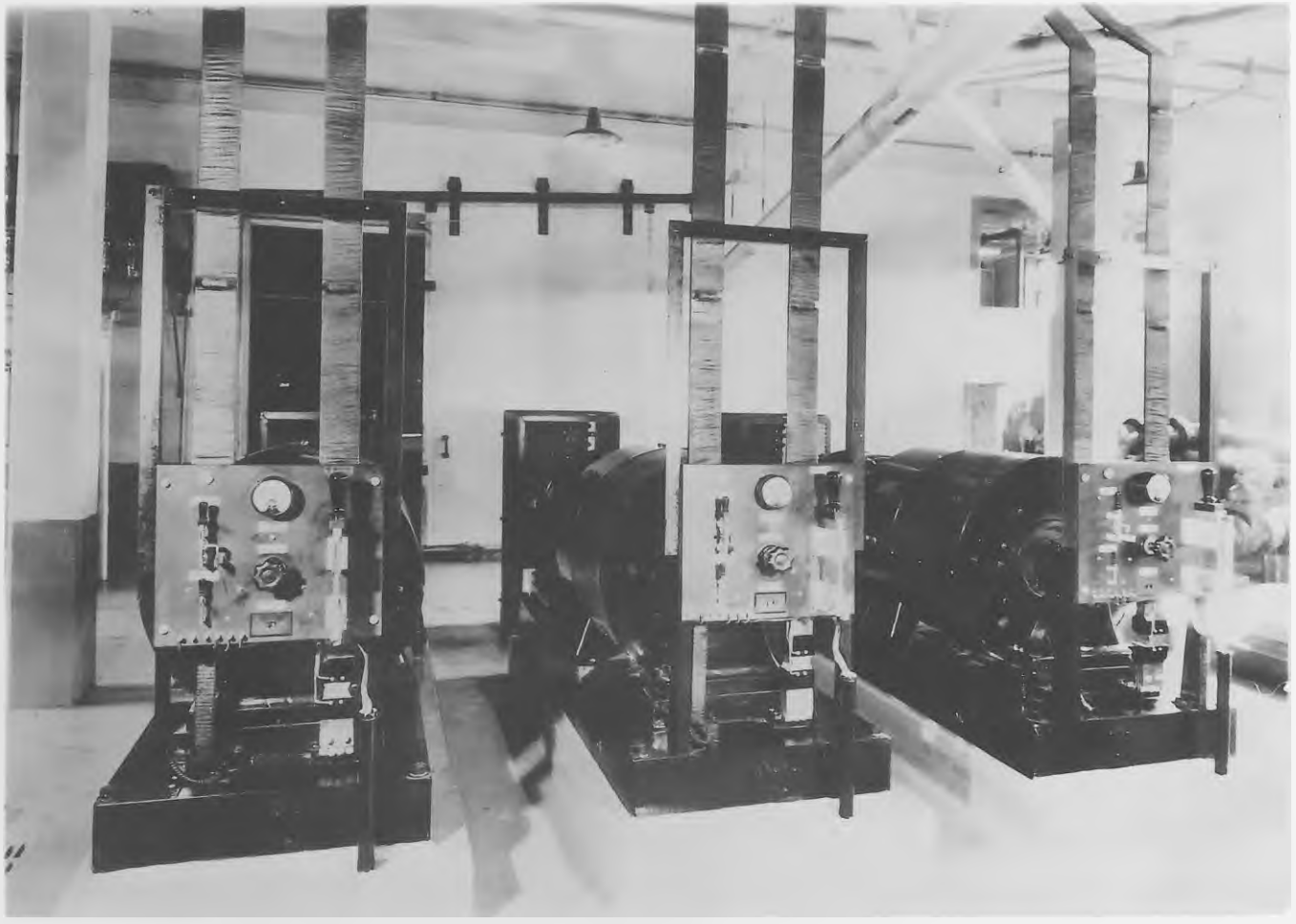


490091 WESTINGHOUSE HIGH-POWER AUDIO AMPLIFIER, DL.7501778G1, RCA TYPE AA-4268, AT RIGHT, AND LOW-POWER RECTIFIER, DL.7501779G1, RCA TYPE AP-4267, AT LEFT. FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.7501777G1, TYPE EA; G-E PART, DL.7550352G1, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 -8 4-26-34

490093 RADIO BROADCAST TRANSMITTER BUILDING. GENERAL INTERIOR VIEW OF MAIN FLOOR FROM FRONT DOOR, SHOWING WESTERN ELECTRIC 50-KW. EXCITER AT LEFT; 500-KW. AMPLIFIER-MODULATOR EQUIPMENT, RCA TYPE 500-A. IN BACKGROUND; AND AUDIO CONTROL ROOM AT RIGHT. G-E PART OF EQUIPMENT, DL.7550352G1, TYPE RT-113-A; WESTINGHOUSE PART, DL.7501777G1, TYPE EA. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 - 9 4-26-34

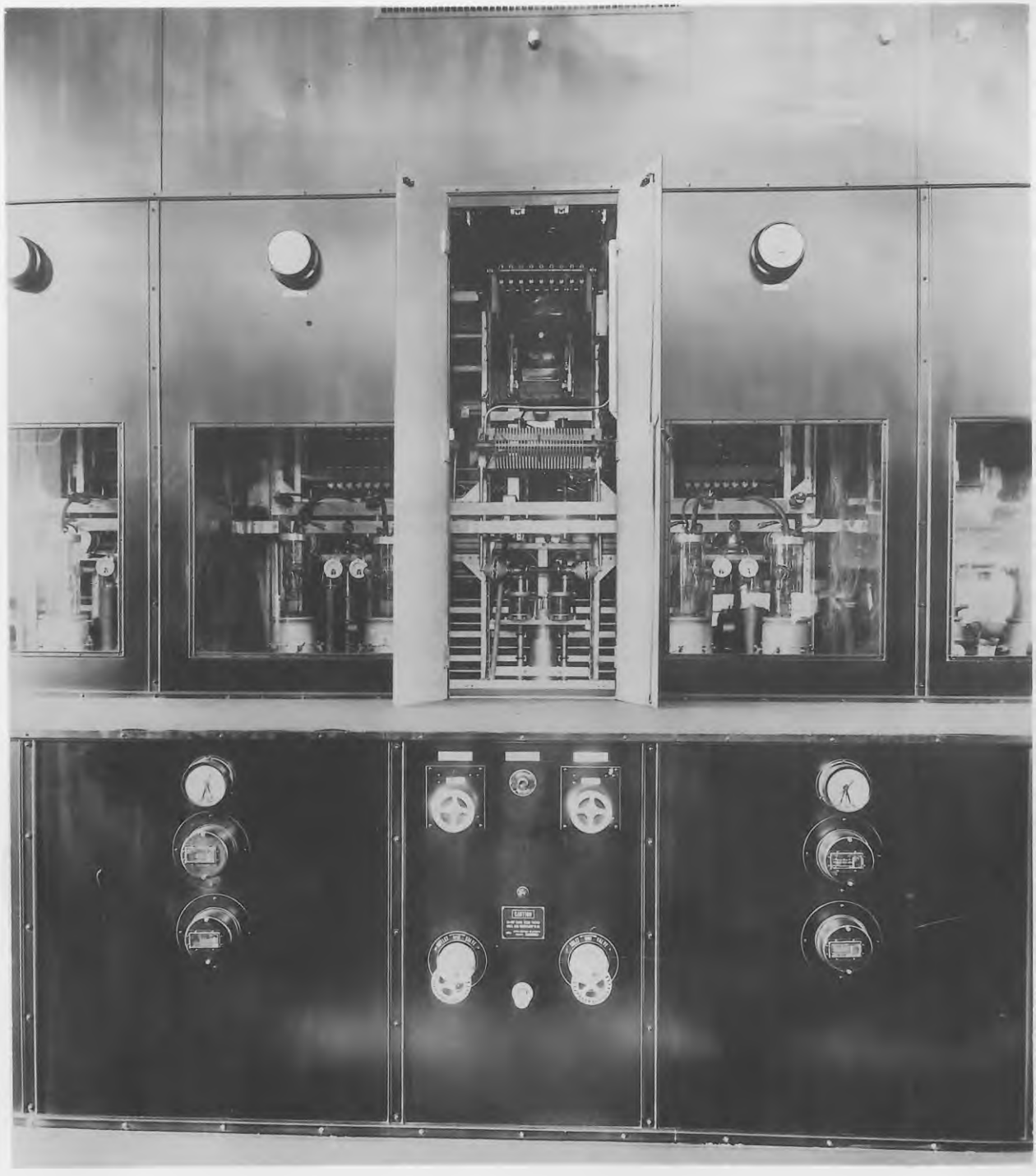


490094 3 WESTINGHOUSE FILAMENT MOTOR-GENERATOR SETS: EACH MOTOR, 85 HP., 2300 VOLTS, 3-PHASE, 60 CYCLES; AND EACH GENERATOR, 1500 AMPERES, 33 VOLTS, D.C.; PART OF RADIO BROADCAST TRANSMITTER, RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.750177G1, TYPE EA; G-E PART, DL.755035261, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-10 4-26-34

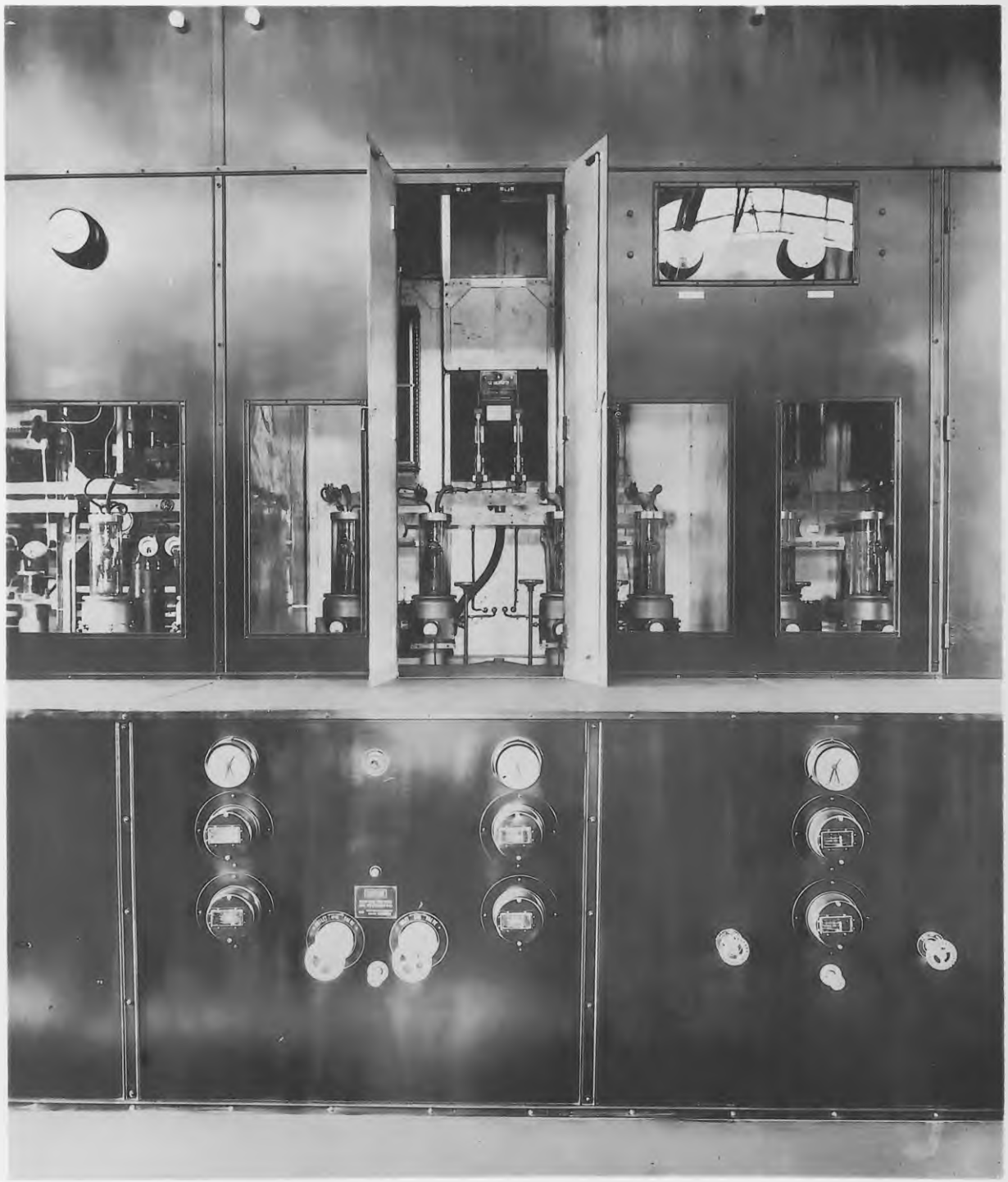
490095 G-E ANTENNA HOUSE APPARATUS FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC. (DL.755035201, G-E TYPE RT-113-A). AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-11 4-26-34



490096 G-E RADIO-FREQUENCY POWER AMPLIFIER, DL.7550353, RCA TYPE AA-4260, FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A (DL.7550352G1, G-E TYPE RT-113-A). AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-12 4-26-34

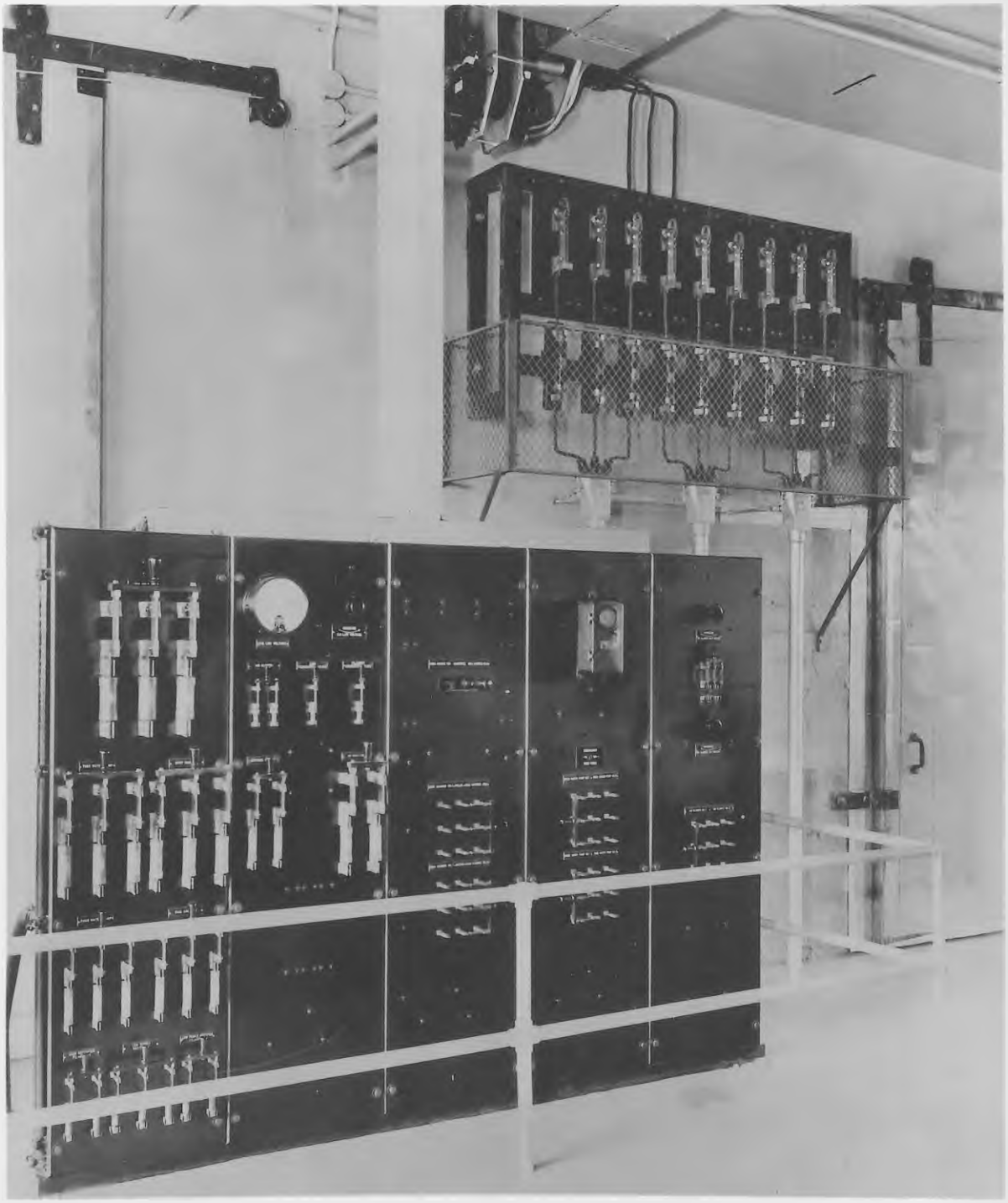


490097 WESTINGHOUSE MODULATOR UNIT, DL.750177361, RCA TYPE AM-4266, FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.7501777G1, TYPE EA; G-E PART, DL.7550352G1, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-13 4-26-34

490098 G-E MAIN RECTIFIER, DL.7550354G1, RCA TYPE AP-4261, WITHOUT PLATE TRANSFORMERS, FILTER AND SWITCHGEAR. NOMINAL RATING 1200-KW. OUTPUT AT 12,000 VOLTS D.C. FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, RCA TYPE 500-A, (DL.7550352G1, G-E TYPE RT-113-A) ACCESS DOORS OPEN, RCA-870 RECTIFIER TUBES IN PLACE. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 - 14 4-26-34

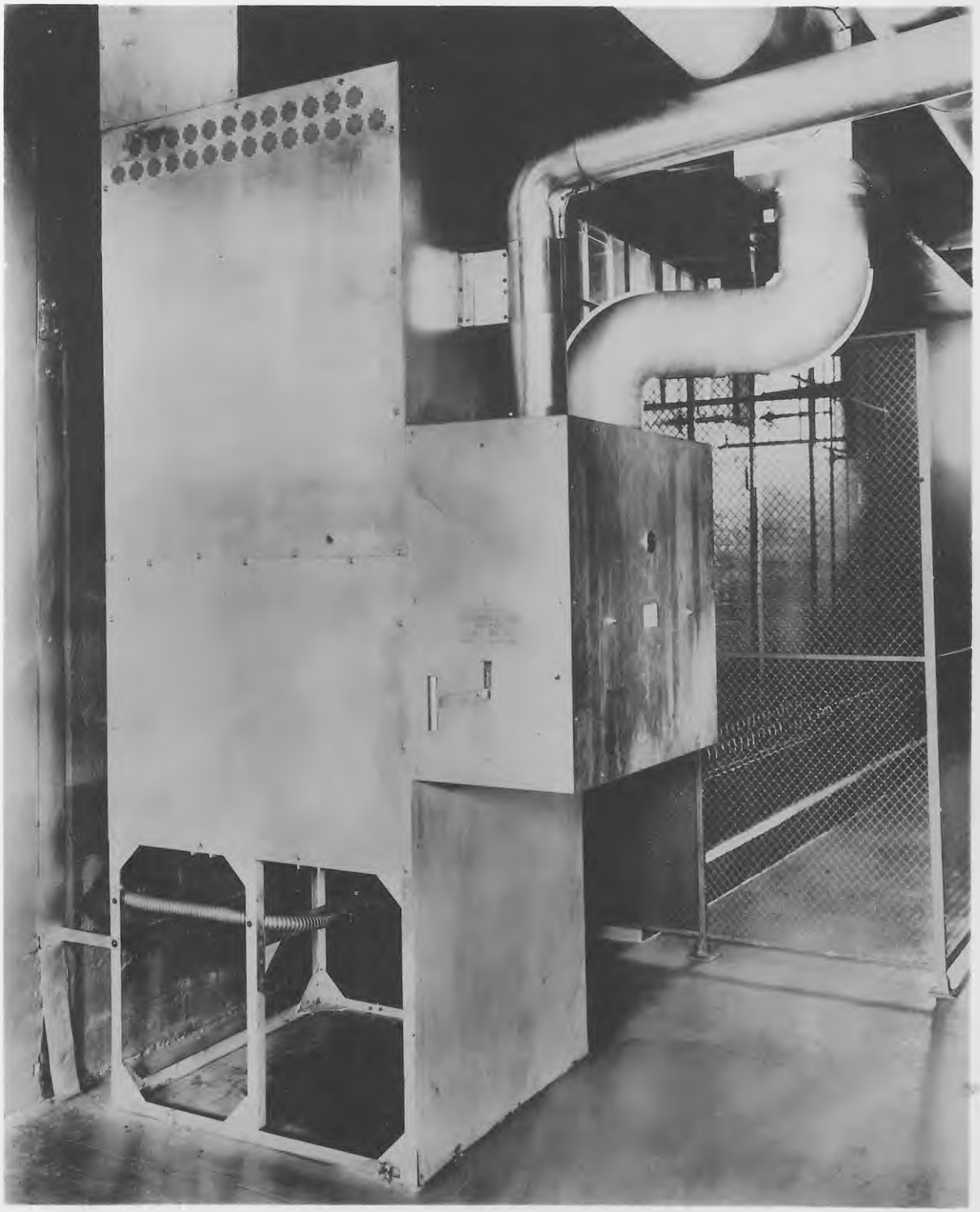


490099 WESTINGHOUSE DISTRIBUTION PANEL, DL.7501780G1, FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.7501777G1, TYPE EA; G-E PART, DL.7550352G1, TYPE RT-113-A. VIEW SHOWS DISCONNECTING SWITCHES, 2300 VOLTS, FOR FILAMENT MOTOR-GENERATOR SETS AT RIGHT AND FILAMENT AND BIAS RHEOSTAT ASSEMBLY, P-7760712G1, AT TOP. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-15 4-26-34

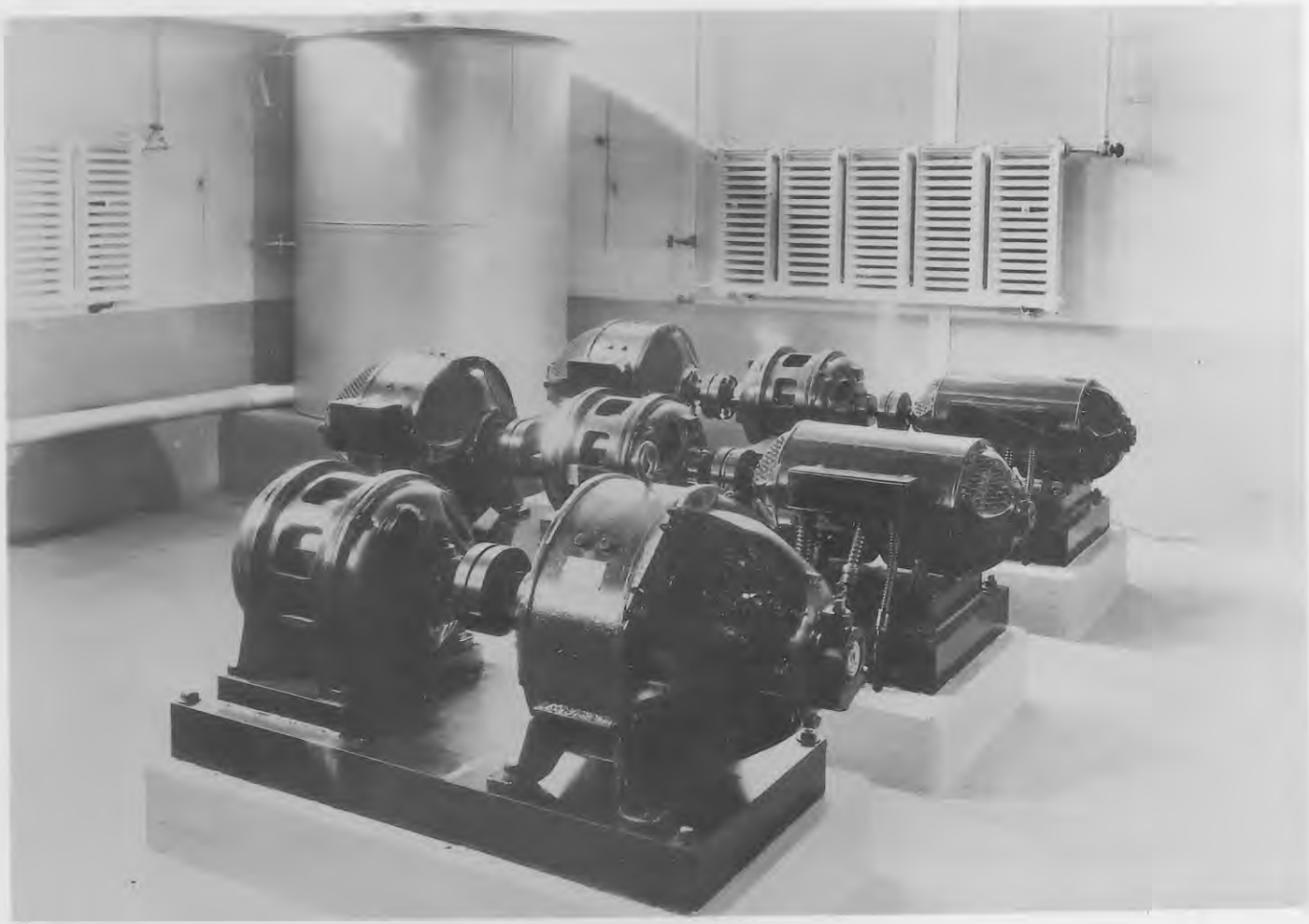
490100 WESTINGHOUSE MODULATION TRANSFORMERS, WEIGHING APPROX. 37,000 LB. EACH, PART OF RADIO BROADCAST TRANSMITTER, RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.750177G1, TYPE EA, G-E PART, DL.755035261, TYPE RT-113-A. HONEY ADAMS AND LLOYD SHAFFER (HOLDING SMALL AUDIO-FREQUENCY TRANSFORMER) OF CROSLEY STUDIO STAFF IN FOREGROUND. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654-16 4-26-34



490101 RADIO-FREQUENCY HARMONIC FILTER, W-7350485G1, RCA TYPE AX-4263, FOR RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A (DL.7550352G1, G-E TYPE RT-113-A). AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO. 163 654-17 4-26-34



490103 3 WESTINGHOUSE MOTOR-GENERATOR SETS AND CROSLEY DISTILLED-WATER STORAGE TANK. 125-VOLT D-C. CONTROL-CIRCUIT SET IN FOREGROUND; DUPLICATE 3-VOLTAGE BIAS MOTOR-GENERATOR SETS AT REAR, WATER TANK IN BACKGROUND. PART OF BROADCAST TRANSMITTER, RCA TYPE 500-A. WESTINGHOUSE PART OF EQUIPMENT, DL.750177G1, TYPE EA; G-E PART, DL.755035 2G1, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 E313.3 654 —18 4-26-34

490104 BLAW KNOX VERTICAL RADIATOR ANTENNA, 831-FT. HIGH, USED WITH RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC. (DL.7550352G1, G-E TYPE RT-113-A). VIEW ALSO SHOWS SPRAY POND IN FOREGROUND, AND STATION BUILDINGS. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

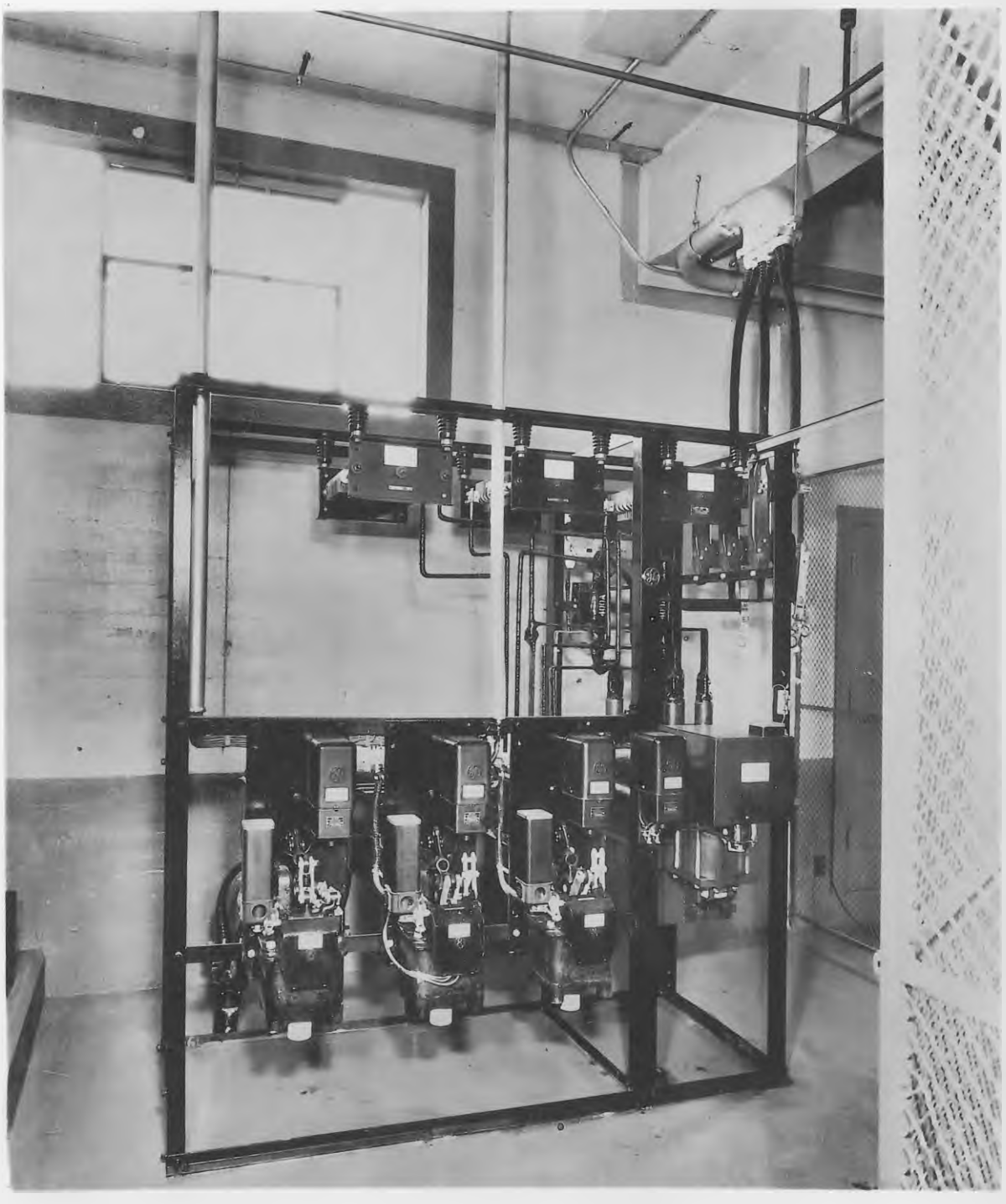
FILING NO.163 654-19 4-26-34

490105 RADIO AMPLIFIER-MODULATOR EQUIPMENT, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A. G-E PART OF EQUIPMENT, DL.755035261, TYPE RT-113-A; WESTINGHOUSE PART, DL.750177761, TYPE EA. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 -20 4-26-34

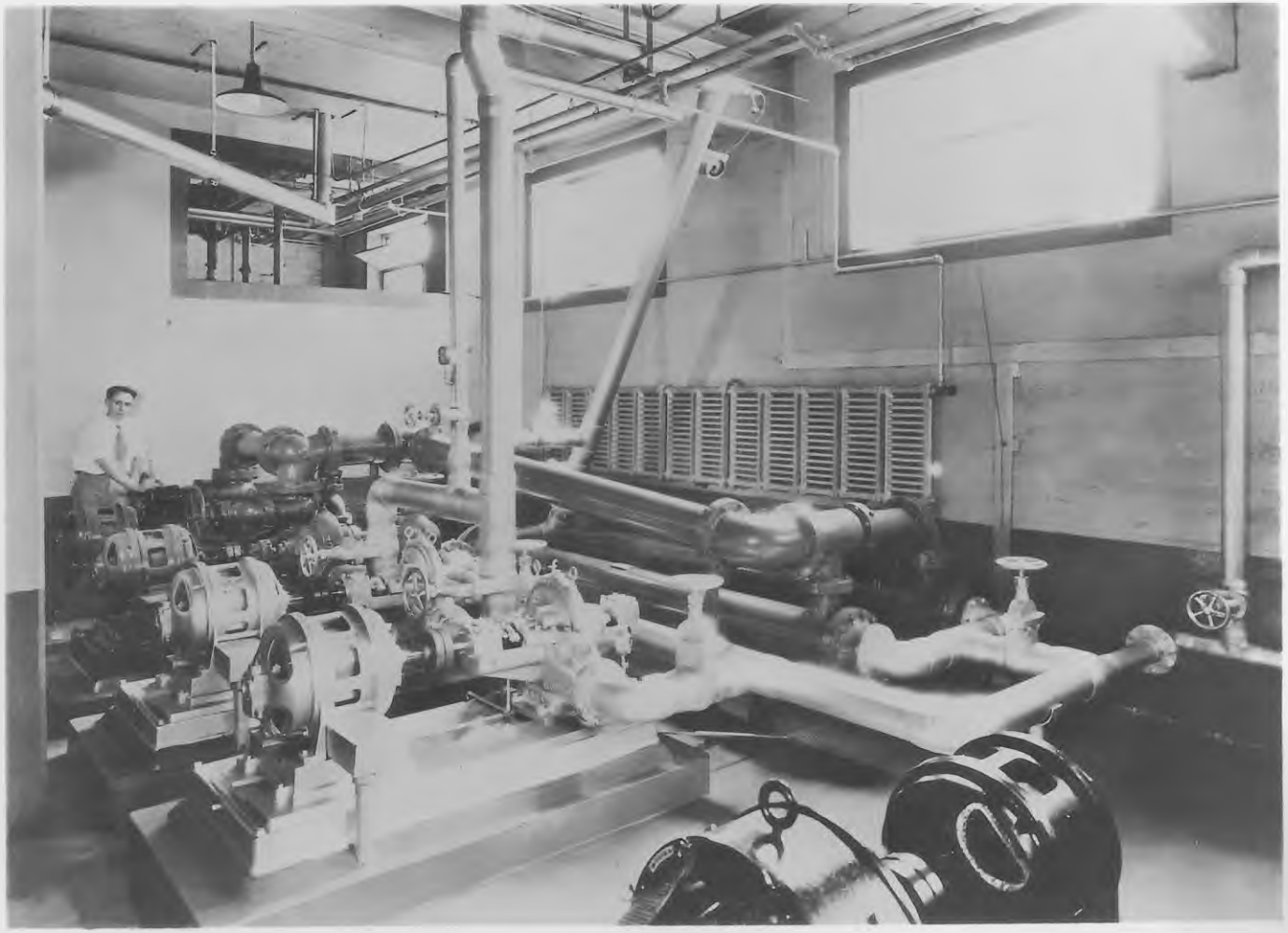
490106 147 G-E CAPACITORS, EACH 1.5 MFD., 15 KV., D.C., MODEL 9CL1B15, USED AS PART OF MAIN-RECTIFIER FILTER AND AS MODULATOR COUPLING CAPACITOR IN RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, RCA TYPE 500-A. (DL.7550352G1, G-E TYPE RT-113-A). AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 E338.1 654 -21 4-26-34



490111 G-E OIL CIRCUIT BREAKER UNIT, T-6038302, FOR MAIN RECTIFIER, DL.7550354G1, RCA TYPE AP-4261, PART OF RADIO BROADCAST TRANSMITTER, 500-KW. OUTPUT, 700 KC., RCA TYPE 500-A (DL.7550352G1, G-E TYPE RT-113-A). AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

FILING NO.163 654 - 22 4-26-34



493772 WESTINGHOUSE WATER CIRCULATING AND COOLING APPARATUS FOR RADIO BROADCAST TRANSMITTER, RCA TYPE 500-A. VIEW SHOWS DUPLICATE DISTILLED-WATER PUMPS AND MOTORS IN CENTER, DUPLICATE POND PUMPS AND MOTORS AT LEFT AND HEAT EXCHANGER AT RIGHT CENTER. J.A.CHAMBERS, CROSLEY TECHNICAL SUPERVISOR OF BROADCASTING, IN BACKGROUND. WESTINGHOUSE PART OF EQUIPMENT DL.7501777G1 TYPE EA; G-E PART, DL.7550352G1, TYPE RT-113-A. AT CROSLEY BROADCASTING STATION WLW, CINCINNATI, OHIO.

654-23

516160 OPERATOR'S CONTROL UNIT, DRG.T-765941SG1, RCA TYPE UZ-4263, FOR 500-KW. RADIO BROADCAST TRANSMITTER, DL.7550352G1, RCA TYPE 500-A.

FILING NO.163 654-24 9-26-33