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Radio Transmitter

MEMORANDUM

WHDH

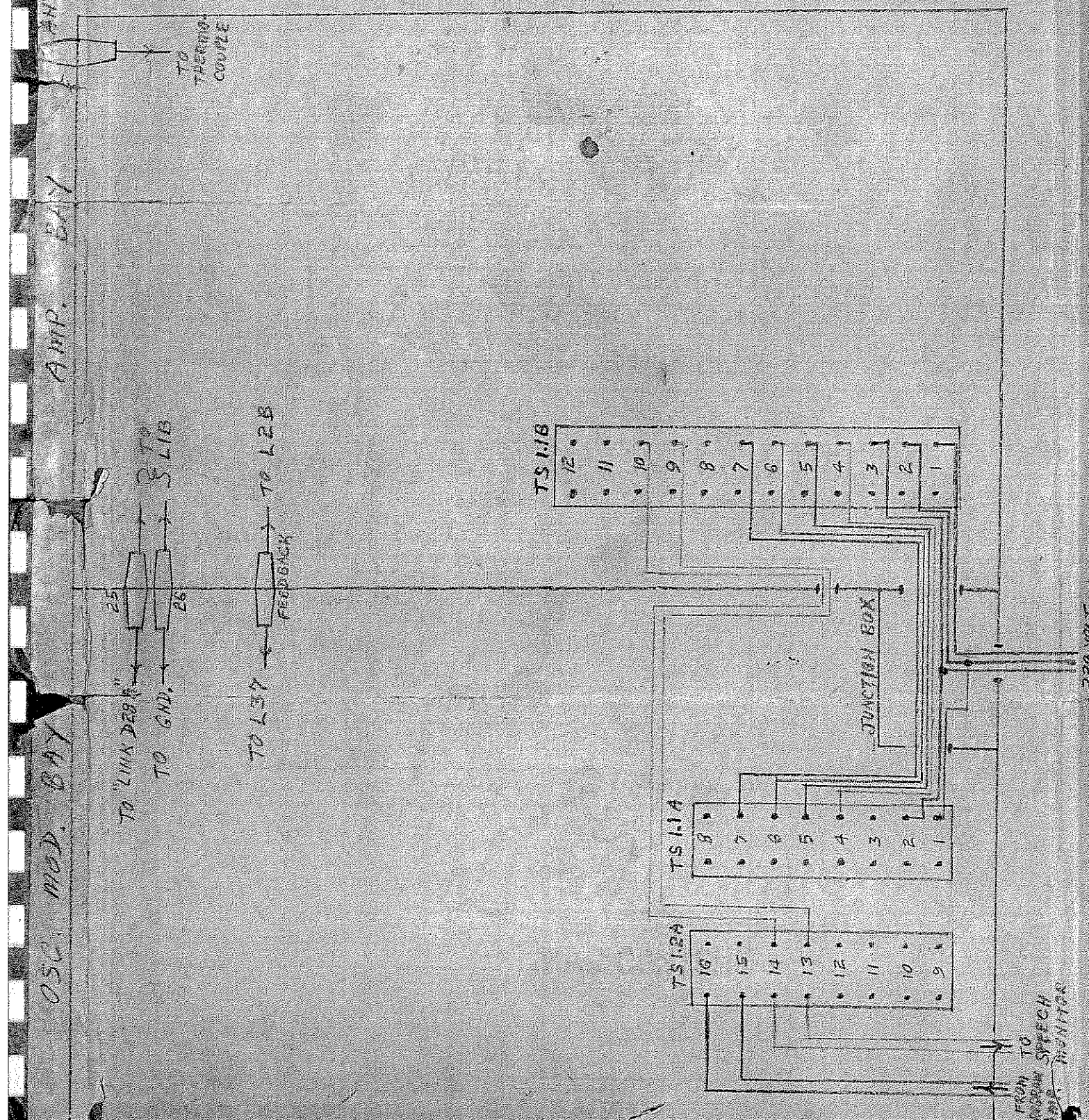
BOSTON, 16

TO W F B L

DATE 1/11/47

FROM W H D H - Donald Sawyer

SUBJECT Transmitter Interconnectio



OSCILLATOR-MODULATOR

No. D-98653

Instructions for Use

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No. D-98653 Oscillator-Modulator

INSTRUCTIONS FOR USE

Introduction

The Western Electric No. D-98653 Oscillator-Modulator is a complete 100 watt radio broadcasting transmitter. This equipment is completely AC operated, without rotating machinery or batteries, and is entirely enclosed in a steel cabinet with no outside apparatus except the speech input equipment, the monitoring arrangements and antenna connections. This equipment features 100 per cent modulation, thorough protection for the operating personnel from high voltages, precision frequency stability, careful suppression of radio frequency harmonics and a stabilized feedback circuit to reduce harmonic distortion and noise.

The apparatus requires 1670 watts, 110/220 volts, single phase power. The power factor is 0.85.

In general, the oscillator-modulator consists of a crystal controlled oscillator followed by three stages of amplification. The last stage is a balanced amplifier in which modulation is accomplished.

For ordinary operation and maintenance, complete access to all parts of the equipment is had through the doors in the unit. These doors are provided with safety switches for the protection of the operating personnel.

GENERAL DESCRIPTION

Oscillator

The carrier frequency of the oscillator-modulator is controlled by a No. 700A (quartz crystal controlled) Oscillator. This oscillator is adjusted as a unit to the operating frequency and will maintain its calibration well within $\pm$ 50 cycles.

The oscillator unit contains a quartz crystal, crystal heater, thermostat, a vacuum tube V1Y and associated circuits. It is mounted in the slide rail assembly in the upper compartment of the oscillator-modulator. Power connections to the oscillator are made by means of spring contacts which engage when the Oscillator is properly inserted. The radio frequency output is obtained from terminal 8 located at the right rear corner of the Oscillator and is connected to the first amplifier input circuit by means of the connector detail provided for this purpose. The quartz plate is maintained at a constant temperature by means of a heater controlled by a mercury thermostat, and power is available at all times for the crystal heater circuit after the transmitter is connected to the source of supply, irrespective of the operation of the transmitter.

In the temperature control circuit power is supplied to the heater through a three-element rectifier tube V12A acting as a relay. The grid

voltage of this tube is in phase with the plate voltage when the crystal temperature is low, and current then flows into the heater. When the crystal temperature reaches the proper value the contacts of the mercury thermostat close, applying an out-of-phase voltage to the grid of the rectifier tube, and no current flows into the heater. A single transformer T7A supplies all power for this circuit.

First Amplifier

The first amplifier V2A isolates the oscillator from the succeeding stages of amplification. The grid-bias is obtained from potentiometers R20A and R53A having adjustments marked "R. F. OUTPUT CONTROL," "COARSE" and "FINE," respectively. These adjustments are used to control the output of the transmitter, as the output of this amplifier may be smoothly varied by reducing the bias from a value so far beyond cut-off that no output is obtained to a value that gives the desired output. This amplifier is located in the compartment to the right of the Oscillator.

Second Amplifier

The second amplifier stage employs two tubes, V3.1A and V3.2A in parallel and is coupled to the first amplifier by the untuned radio frequency transformer T11A and to the third amplifier by a tuned radio frequency transformer L6A. This amplifier is located in the compartment with the first amplifier.

Third Amplifier

The third amplifier stage employs two tubes V4A and V5A in a balanced circuit and it is here that modulation takes place. It is effected by what is known as "grid-bias" modulation. The grids of the tubes are biased to considerably beyond cut-off and the radio frequency voltage is applied to the two grids out of phase, as in any push-pull amplifier. The audio frequency voltage is applied to both grids in parallel and is effectively in series with the DC grid-bias voltage. Thus the resulting grid-bias voltage is varied in accordance with the audio frequency modulating voltage, which accounts for the name "GRID-BIAS" modulation. By changing the bias in this manner, the radio frequency output voltage is varied between zero and twice the normal value, which constitutes complete modulation. The output impedance of this amplifier is such that the relationship between the output and input voltages is essentially linear and the audio distortion is thereby kept at a low value. The negative bias voltage for the modulator-amplifier tube is supplied through inductances L8A, L35A, L7A and the secondary of L6A.

Output Circuit

When the Oscillator-Modulator is used alone the output of the third amplifier is coupled to the antenna through an antenna coupling circuit for the suppression of radio frequency harmonics. However, when the Oscillator-Modulator is used in conjunction with an amplifier, the antenna

coupling circuit is slightly modified and becomes the power amplifier input circuit. The modifications necessary in the output circuit of the Oscillator-Modulator to adapt it for use with Western Electric amplifiers are described in the Amplifier instruction bulletins.

Monitoring Circuit

Monitoring in the Oscillator-Modulator is accomplished by means of an audio transformer T10A connected in the high voltage return lead of the third amplifier. The grids of the vacuum tubes in this stage are biased so far beyond cut-off that no audio frequency power flows in their plate circuits until the radio frequency is applied and modulation effected. The audio frequency component of the rectified carrier power then appears in this circuit and the output of the monitoring transformer T10A is a true reproduction of the program at the output of the Oscillator-Modulator. When the Oscillator-Modulator is used in conjunction with Western Electric Amplifiers, monitoring is accomplished in the amplifier and the monitor in the Oscillator-Modulator is not used.

Audio-Amplifier Unit

The amplifier which provides the necessary audio frequency modulating voltage has two impedance coupled stages employing tubes V13A and V14A. The input to this amplifier is the vector difference of two voltages, one the signal from the microphone across resistance R66A, the other a portion of this signal from the output stage, demodulated by a full wave rectifier V15A and applied across resistances R86A and R87A. This constitutes the "loop" feedback feature of the equipment.

In addition to "loop" feedback, "cathode" feedback is also incorporated. This consists of an impedance composed of R81A, L36A, the primary of T10A and S4A connected in the common plate return circuit of tubes V4A and V5A. Since these tubes are not operated as "Class A" radio frequency amplifiers, the audio frequency component of the rectified carrier power appears in the common plate return. A corresponding voltage appears across the cathode circuit impedance and hence is impressed on the grids of the tubes, in series but out-of-phase with the audio input. This constitutes the "cathode" feedback.

Power Supply Circuits

The Oscillator-Modulator is completely AC operated. The filaments of all vacuum tubes are heated by alternating current; grid-bias and plate voltages are supplied by mercury vapor rectifiers. The unit is arranged to be operated from either a 110 or 220 volt single phase, 50 cycle or 60 cycle power supply, but when operated in conjunction with Western Electric amplifiers, it is always operated from one phase of the 220 volt, three-phase supply.

Bias-Plate Rectifier—The bias-plate rectifier supplies grid-bias voltages for all the radio frequency amplifiers in the unit and plate voltages for the oscillator and first amplifier. This rectifier employs two mercury vapor tubes, V10A and V11A in a conventional full-wave rectifier circuit.

High Voltage Rectifier—The high voltage rectifier employs four mercury vapor tubes V6A, V7A, V8A and V9A in a single phase, full-wave, "bridge type" rectifier circuit. This rectifier supplies the plate voltage to the second and third amplifiers and audio amplifier unit.

Power Control and Protection Circuits

The power control and protection circuits control the sequence of power application to the various circuits and protect the equipment from possible damage in case of failure of any piece of apparatus.

The starting and protection circuits of both the Oscillator-Modulator and any amplifier units may be interlocked and the complete equipment started or stopped by operating the "MASTER CONTROL" switch (D9A) located on the Oscillator-Modulator unit. The "MASTER CONTROL" switch (D9A) actuates the starting circuit which applies power to the circuits of the Oscillator-Modulator (and amplifier) in the correct sequence, introducing such delays as are necessary for the protection of the equipment.

The auto-transformer T8A which supplies power to all circuits of the Oscillator-Modulator is provided with a tap switch "POWER VOLTAGE CONTROL" (D6A) which allows the operator to compensate for variations in the local line voltage during operation of the transmitter.

All power and high voltage circuits are adequately fused. The plate circuit of the third amplifier is protected against accidental overload by means of an overload relay S4A. An overload operates this relay which immediately removes the high voltage. When normal conditions have been restored, the plate voltage may be reapplied by momentarily depressing "OVERLOAD RESET" button (D4A) which opens the holding circuit of overload relay S4A.

The operating personnel is protected against accidental contact with high voltage circuit by means of door switches D14A on each of the four doors to the unit. These switches are series connected and may also be interconnected with similar door switches on any associated amplifier. The opening of any door will immediately remove all high voltage from the apparatus.

INSTALLATION

GENERAL

The Oscillator-Modulator should be installed in accordance with the installation drawings furnished. It should be installed in a light, well ventilated room and so situated as to provide easy access to the antenna and ground connections. At least 3 feet clearance should be allowed on all sides and top of the unit. If forced ventilation of the transmitter is employed, care should be exercised in arranging this ventilation so that dust and dirt are not blown or drawn into the equipment.

A hardwood base should be prepared for the unit in accordance with installation drawing ESO-601302, and if practicable, all ground leads,

power and audio conduits should be in place before the equipment is set up. The Oscillator-Modulator should be placed on the hardwood base (see installation drawings furnished).

Ground System

A typical interior ground system layout is shown on installation drawing ESR-601783. All metal structures such as building frame, water and steam pipes, conduits, roofs and stacks should be bonded to the interior ground system. All ground connections should be as short and direct as possible and all joints should be soldered or welded. Where installations are made in tall buildings the information given on ESR-601783 and associated drawings may not be entirely applicable and additional engineering information should be requested.

The main ground terminal of the Oscillator-Modulator is located at the extreme lower right-hand corner in front of the junction box. It consists of a cadmium plated copper strip 4¾ inches long which is fastened to the main frame by means of two bolts located at the ends of the strip. The ground connection should consist of a 4 inch x 1/64 inch copper strip, one end of which should be soldered to the removable strip which is then bolted to the ground terminal. The other end is soldered to the main ground system. It is suggested that the lugs which are bolted to the ground terminal be temporarily removed while soldering the ground strip. Ground connections should be as short and direct as possible.

Antenna

The Oscillator-Modulator can be operated with an antenna of any resistance and reactance but where antennae of less than 10 or more than 90 ohms are encountered, engineering advice should be requested. The antenna lead-in is connected to terminal 19 located on top of the unit. Copper tubing is recommended for this purpose. The equipment will also operate into a concentric transmission line.

Power and Audio Connections

A 1-inch conduit should be installed from the service entrance to the junction box in the Oscillator-Modulator and three No. 8 BRC wires should be pulled through from the 110/220 volt, 50/60 cycle power supply. Two of these wires connect to terminals 1 and 2 of the Oscillator-Modulator terminal block and the third wire is not connected but is available for power supply to future amplifiers.

The speech input and monitoring output leads should be run in ½-inch conduit (see installation drawings furnished) and brought out near the terminal blocks in the Oscillator-Modulator. The speech input leads connect to terminals 15 and 16 on the terminal block and the monitoring output leads connect to the terminals 11 and 12. No. 19 gauge twisted pair, rubber and lead covered cable per No. KS-6531 should be used for all audio leads. Both ends of the lead cable sheath should be

bonded to the ground system with a No. 16 bare copper wire and all conduits should be soldered or welded to the ground system. In grounding the lead cable sheaths terminal 10 may be used.

INSTALLING TRANSFORMERS

The three heaviest transformers T4A, T5A and T8A are shipped separately and should be mounted in their respective places in the lower compartment and the disconnected wires soldered in place. Each transformer terminal is plainly marked and each wire is correspondingly tagged. The metal tags should either be removed or so slid back on the wires as to afford no possible chance of short-circuiting the transformer terminals.

PRELIMINARY ADJUSTMENTS

Power Supply Circuits

Before placing fuses in any cutouts or applying power to the equipment, connect link switches D8A, D11.1A and D11.2A as follows:

Link Switch	*110-Volt Operation*	*220-Volt Operation*
D8A	Position 2 (right-hand)	Position 1 (left-hand)
D11.1A	Connect terminals 1 and 2	Connect terminals 2 and 3
D11.2A	Connect terminals 3 and 4	Connect terminals 2 and 3

Connect link switch D7A in accordance with the following table for the local line voltage:

Local Line Voltage	*Position of Tap Switch D7A*
98-102 or 197-205	5
103-107 or 206-215	4
108-112 or 216-225	3
113-117 or 226-235	2
118-125 or 236-249	1

For 220-volt operation, place two 15-ampere fuses in cutouts F1.1A and F1.2A. For 110-volt operation, use two 30-ampere fuses. Place 1-ampere Western Union Telegraph Fuses in cutouts F3.1A and F3.2A. After the links and fuses have been placed as directed, set the "POWER VOLTAGE CONTROL" switch (D6A) in position 3 (normal), and apply power to terminals 1 and 2 of the equipment. The closing of switches D10A and D9A should cause meter M6A to indicate 220 $\pm$ 5 volts.

If the line voltage is not known exactly, switch D7A may be properly connected in the following manner: Set the "POWER VOLTAGE CONTROL" switch in position 3, set link switch D8A for 110 or 220-volt operation as required, and then vary D7A until meter M6A indicates 220 $\pm$ 5 volts.

CAUTION: THE MAIN POWER SUPPLY SWITCH D10A SHOULD ALWAYS BE OPENED WHENEVER D7A IS ADJUSTED.

LOCATION OF SWITCHES

Apparatus Designation	*Location*	*Item or Purpose in the Circuit*
D1A	Upper Compartment, above Closed Circuit Inductance	Thermocouple Selector Switch
D2A	Upper Compartment, above "ANTENNA TUNING" Condenser C19A	Thermocouple Selector Switch
D3A	Lower Compartment, Extreme Left of VS6A	Plate Supply Disconnect Switch 3rd Amplifier V4A and V5A
D4A	Front Panel	"OVERLOAD RESET" Button
D5A	Front Panel	"HIGH VOLTAGE" Switch
D6A	Front Panel	"POWER SUPPLY VOLTAGE" Adjustment
D7A	Lower Compartment, Switch Panel	Primary Tap Switch on Auto-Transformer T8A
D8A	Lower Compartment, Switch Panel	Two Point Switch for 110 or 220 Volt Operation
D9A	Front Panel	"MASTER CONTROL" Switch
D10A	Lower Compartment, Switch Panel	Main Power Supply Switch
D11.1A, D11.2A	Lower Comparment Switch Panel	Temperature Control Circuit Transformer Switches for 110 or 220 Volt Operation
D12A	Lower Compartment, Switch Panel	Temperature Control Circuit Switch
D13A	Front Panel	"TEST METER" Switch
D14A	Front Doors	Door Switches (4)
D17A	Upper Compartment, above Closed Circuit Inductance	Thermocouple Selector Switch
D18.1A, D18.2A	Upper Compartment, Mounted on Front Terminal Strip of L6A	Tuning Coil Tap Connectors
D19A	Lower Compartment, Extreme Left of VS6A	Plate Supply Disconnect Switch, 2nd Amplifier, V3.1A and V3.2A
D20A	Upper Compartment, above "ANTENNA TUNING" Condenser, C19A	Shorts Antenna Series Condensers when not used
D21A	Upper Compartment, mounted on side of "2ND AMP. TUNING" Condenser	Furnished with C34A when required
D28A	Upper Compartment, mounted on Terminal of C20A	Connects Transmitter to Antenna

Upon completion of these adjustments insert six No. 258B Vacuum Tubes* in sockets VS6A, VS7A, VS8A, VS9A, VS10A and VS11A and connect the flexible plate leads to the corresponding anode caps. Insert five General Electric 5-watt 120-volt Edison (candelabra base) Mazda lamps in the meter panel light sockets and also General Electric Type 4, 18-volt, 2-watt lamp in the crystal heater indicator lamp socket ES2A which is located behind the colored bezel on the front panel.

Oscillator Heater Circuit

To prepare the slide-rail assembly for the Oscillator, the latches on the front of the runners should be opened so that the unit may be inserted

*The filaments of new mercury vapor tubes should be heated at least 15 minutes before the high voltage is applied. This pre-heating removes any particles of mercury adhering to the sides or elements of the tubes after shipment or handling, thus minimizing the possibility of flash-overs. (See section on "Maintenance.")

in position. The spring contacts on both the oscillator unit and transmitter terminal strips should be examined to see that they are not bent out of alignment and that good contact between the terminals on the Oscillator and the terminal strip is insured. When the oscillator unit has been properly inserted, close the two latches and secure them with the screws provided. Terminal 8 of the Oscillator should be connected by means of the connector detail provided to the similarly mounted terminal projecting through the shield which covers the base of the vacuum tube sockets VS2A, VS3.1A and VS3.2A.

Before inserting fuses F2.1A and F2.2A, disconnect the power supply from the transmitter at the service entrance. See that snap switch D12A is in the "OFF" position. Place 2-ampere D&W Fuses in cutouts F2.1A and F2.2A.

Insert a No. 287A Vacuum Tube in socket VS12A and a No. 271A Vacuum Tube in socket V1Y of the Oscillator. The filament of the No. 287A Vacuum Tube should begin to heat as soon as the service entrance switch is closed since this circuit is energized at all times independent of the transmitter power switches. When the filament of the No. 287A Vacuum Tube has been heating for about 15 minutes, switch D12A should be placed in the "ON" position. With the Oscillator in place, the indicator lamp (E2A) will light, indicating that the heater of the Oscillator is receiving current. The vacuum tube V12A will also indicate that heater current is flowing by the presence of a characteristic glow. If the vacuum tube indicates that the heater circuit is functioning, but the indicator lamp E2A does not light, the lamp may be defective and should be replaced. The lamp E2A will remain lighted approximately 45 to 75 minutes and will then operate intermittently, remaining on about 30 seconds and off about 30 seconds. Snap switch D12A should never be opened except when adjusting the contacts on the Oscillator Unit or when installing a new No. 287A Vacuum Tube.

This equipment requires little care once it is in operation as there are no mechanical relays in the system. However, the indicator lamp E2A should be observed from time to time to ascertain that the heater circuit is functioning correctly. Sufficient time should be allowed for this observation to permit a complete cycle of operation.

Adjustment of Power Control Circuits

Adjustment of Time Delay Relay, S2A.—When the "MASTER CONTROL" switch is closed, the heater winding of relay S2A is energized and after about 45 to 75 seconds the relay should close its front contacts and energize relay S1A which will lock up and at the same time open the heater circuit of S2A, thus allowing the armature of S2A to cool and return to its "normal" or "open" position.

The operation of S2A should be checked very carefully to see that the *back contacts open before the front contacts close.* After relay S1A has

operated, the back contacts of S2A should close in from two to thirty seconds.

NOTE: When looking at relay S2A from the front, the "back" contact spring is the right-hand spring and the "front" contact spring is the left-hand spring. The "armature" carries the heater winding and controls the two center springs which are mechanically linked together. Adjustments on this relay should be made with a Western Electric No. 259 Tool.

The "front" contact spring of the relay may be bent to adjust the operating time on the heating cycle. To increase this time, the "front" contact spring should be bent away from the armature. To decrease this time, the spring should be bent towards the armature.

If it becomes necessary to adjust the operating time on the heating cycle, the time interval on the cooling cycle should also be checked. The interval may be regulated by bending the "back" contact spring. Bending this spring towards the armature results in a decreased time interval. To increase the time interval, the "back" contact spring should be bent away from the armature. A reasonable amount of time should be allowed between tests so that the relay winding and spring will have time to return to room temperature.

Grid-Bias Control Relay, S1A. Relay S1A, which is mounted on the panel in the lower compartment operates in conjunction with the heater relay S2A. It has two distinct functions, (a) to break the heater circuit of relay S2A, (b) to complete the circuit to the bias-plate rectifier when the door switch relay S5A is closed. This relay should ordinarily require no adjustment. However, the armature must be free to move and its contacts must be kept clean.

High Voltage Control Relay, S3A. Relay S3A has two contacts connected in parallel in order to carry safely the current required by transformer T4A. These contacts should close simultaneously and the armature should move freely during operation. This relay should require no adjustment.

Plate Overload Relay, S4A. Relay S4A is adjusted at the factory so that it will operate between 400 milliamperes minimum and 450 milliamperes maximum. If it becomes necessary to adjust this relay, all switches except D12A should be in the "Off" position and a source of DC voltage (about 2 volts) should be applied in series with a suitable milliammeter and variable resistance from terminal 1 of transformer T10A to ground. The tension of the contact springs may then be adjusted with the No. 259 Tool until the relay operates at the correct current value. Relay S4A should be tested with the relay cover in place.

Door Switch Relay, S5A. This relay should require no adjustment but should function smoothly and have clean, non-sticking contacts. In general, all AC relays of the double contact type must have the same pressure on each contact so that audible chatter and hum may be suppressed.

Control Relay, S6A. This relay is not used when the Oscillator-Modulator is used alone.

Starting Circuit Sequence. When all relays have been adjusted, the complete starting circuit of the transmitter should be checked. With the "HIGH VOLTAGE" switch in the "Off" position, operate the "MASTER CONTROL" switch. The operation of this switch energizes auto-transformer T8A and the following operations should result immediately:

(a) Filaments of all installed vacuum tubes are lighted.
(b) The meter panel is illuminated.
(c) Meter M6A indicates.
(d) Door switch relay S5A is energized if all doors are closed.

CAUTION: IF THE NEW MERCURY VAPOR TUBES HAVE NOT BEEN PREVIOUSLY PREHEATED, THEY SHOULD BE AT THIS POINT, BY LEAVING THE DOORS OF THE TRANSMITTER UNIT OPEN UNTIL THE FILAMENTS HAVE RECEIVED THE REQUIRED HEATING.

After a delay of about 45 seconds the armature of S2A operates, causing relay S1A to be energized. S1A then locks up, disconnecting the heater winding of S2A and completing the primary circuit of transformer T5A. This transformer applies voltage to the bias-plate rectifier. Transformer T5A will not be energized, however, if relay S5A has failed to operate due to an open door switch.

After relay S1A has operated, disconnecting the heater winding of S2A, there is a small time delay during which the bi-metallic element of S2A is cooling. At the completion of this cooling cycle, the back contacts of relay S2A close and complete the circuit of relay S3A which is operated by the grid-bias voltage. Relay S3A will not operate unless the grid-bias potential is sufficiently high to protect the power tubes against abnormal plate current. The operation of relay S3A will complete the primary circuit to high voltage transformer T4A when the "HIGH VOLTAGE" switch is "On."

Preliminary Adjustment of Radio Frequency Circuits

The condensers C12A, C16.1A, C17.1A, C34A, C42A and C43A, link switches D18.1A, D18.2A, and inductance coils L11A and L13A should be adjusted in accordance with Tables I and II. The rotor of coupling coil L37A should be tuned to the extreme counter clock-wise position.

Place No. 271A Vacuum Tubes in sockets VS2A, VS3.1A, VS3.2A, and VS13A and No. 212E Vacuum Tubes in sockets VS4A and VS5A. Place a No. 242A Vacuum Tube in socket VS14A, and an RCA-84 Vacuum Tube in socket VS15A. *Make sure that the "HIGH VOLTAGE" switch is in the "Off"* position, close the switch D10A and the "MASTER CONTROL" switch and adjust the "POWER VOLTAGE CONTROL" switch so that the "POWER SUPPLY VOLTAGE" meter will indicate 220 volts ± 5 volts. In about a minute, the various relays of the power circuits

should have functioned. Closing the doors will cause relays S5A and S3A to operate and supply the grid-bias and plate voltages to vacuum tubes V1Y and V2A.

TABLE I—ADJUSTMENT OF CONDENSERS AND LINK SWITCHES

Freq. KC	*No. 12A MMF*	*C16.1A C17.1A (0.0002 MF)*	*C34A* (0.0003 MF)*	*C43A* (0.0003 MF)*	*C42A** (0.0005 MF)*	*D18.1A D18.2A (***)*
550 to 600	250	Place in circuit	Place in circuit	Remove from circuit	Place in circuit	Open
610 to 620	250	Place in circuit	Place in circuit	Remove from circuit	Remove from circuit	Open
630 to 800	250	Place in circuit	Place in circuit in series with C43A	Place in circuit in series with C34A	Remove from circuit	Open
810 to 1190	150	Remove from circuit	Remove from circuit	Remove from circuit	Remove from circuit	Open
1200 to 1290	100	Remove from circuit	Remove from circuit	Remove from circuit	Remove from circuit	Open
1300 to 1500	100	Remove from circuit	Remove from circuit	Remove from circuit	Remove from circuit	Close

Set R86A to maximum resistance and R87A to ⅔ of maximum resistance. (Total resistance of R86A and R87A in series approximately 4000 ohms.)

TABLE II—ADJUSTMENT OF INDUCTANCE COILS

Frequency, Kilocycles	*Closed Circuit Inductance, L11A (Active turns each side of center section)*	*Second Mesh Tuning Inductance, L13A (Total number of active turns)*
550 to 580	37	61
590 to 680	33	55
690 to 790	30	47
800 to 990	24	40
1000 to 1160	20	34
1170 to 1370	17	30
1380 to 1500	15	27

TUNING ADJUSTMENTS

Oscillator Unit

The heater circuit of the Oscillator should have been in operation for at least one hour before any tuning adjustments are made on the transmitter. The operation of the Oscillator should now be checked as follows: Place "TEST METER" switch (D13A)† on the "OSC. PLATE X10" and

*Connect across C11A by means of the links provided.
**C42A is furnished separately for frequencies between 550 and 600 kilocycles. It is to be mounted directly behind C19A and connected to the terminals of C19A by means of the connectors furnished.
***To be connected across terminals 1 and 2, and 3 and 4, respectively, of L6A.

†The readings of the "TEST METER" M1A are to be multiplied by 1, 10, or 20 as indicated by the dial plate of the associated switch D13A. In the "OSC. PLATE X10" position of switch D13A, the readings of meter M1A are to be multiplied by 10.

then on the "OSC. GRID" positions, in order to determine that the observed readings of meter M1A fall within limits specified in Table III.

TABLE III—TYPICAL METER READINGS

Power Supply Voltage—M6A	220 ± 5 Volts
1st Amplifier Plate Current—M1A	3—20 Milliamperes
Oscillator Plate Current—M1A	6—12 Milliamperes
2nd Amplifier Plate Current—M1A	10—30 Milliamperes
Oscillator Grid Current—M1A	0.05—1.0 Milliamperes
3rd Amplifier Grid Current—M1A	0
Feedback Current—M1A	7 ma.
1st A.F. Plate—M1A	25 ma. ± 5 ma.
2nd A.F. Plate—M1A	45 ma. ± 5 ma.
3rd Amplifier Plate Voltage—M5A	3000 ± 100 Volts
3rd Amplifier Plate Current—M4A	130 ± 2 Milliamperes***
3rd Amplifier Output Current—M2A	0.8—1.1 Amperes
Antenna Current (Mesh)—M3A*	0.8—1.2 Amperes
Antenna Current—M3A**	

First and Second Amplifier Tuning

Resonance is obtained in all circuits except the antenna circuit and the first amplifier by an adjustment for minimum DC plate current of the tube whose tuned output circuit is being adjusted. In tuning the second or third amplifier, care should be taken that neither stage is tuned to the second harmonic of the fundamental frequency. Should two points of minimum plate current be found with coarse adjustment as specified, the one at which the capacitance of the variable condenser is maximum is the correct adjustment. This will correspond to the point of higher dial reading and higher output current.

The first amplifier requires no tuning adjustment as its plate circuit is coupled to the following stage by means of an untuned radio frequency transformer. The radio frequency output of this stage, and thus the output of the transmitter, is controlled by the "R. F. OUTPUT" control.

Before tuning the second amplifier, set the neutralizing condenser C9A so that its plates are about one-sixth engaged. This condenser is adjusted by means of a screw-driver through the lower hole located directly above the "R. F. OUTPUT" control. This opening in the panel is normally concealed by a pivoted cover. Open link switch D3A and see that link switch D19A is closed. This allows the plate voltage to be applied to the second amplifier but not to the third amplifier.

With the "R. F. OUTPUT" control in the minimum position place "HIGH VOLTAGE" switch in the "On" position and set the "TEST METER" switch on the "2ND AMPLIFIER PLATE X20" position. Adjust the "R. F. OUTPUT" control until the "TEST METER" M1A reading

*Link switch D2A must be placed in the 2-3 position in order to read mesh current.
**The antenna current will equal the square root of the quotient of the operating power in watts divided by the effective antenna resistance at the operating frequency.
***When using the indirect method of measuring antenna power, it will be necessary to adjust for a plate current of 150 milliamperes.

increases approximately 10 milliamperes. Now vary the "2ND AMP. TUNING"* condenser C11A until the "TEST METER" indicates a minimum. If difficulty is experienced in tuning this stage, a slight readjustment of condenser C9A should be made. After obtaining an approximate adjustment, but before the final tuning of the second and third amplifiers, these stages must be neutralized.

Second and Third Amplifier Neutralization

In the neutralizing procedure, the third amplifier is neutralized first. Place the "HIGH VOLTAGE" switch in the "Off" position, and open the doors.** Leave the link switch D3A open and link switch D19A closed. Using a screw-driver, set the neutralizing condenser C14A-C15A so that their plates are a little more than one-third engaged. Connect the sensitive thermocouple TC1.1A in the closed circuit by means of the links provided. *The correct polarity must be maintained when the meter leads are transferred to this sensitive thermocouple.* Set the "R. F. OUTPUT" control and the "3RD AMP. OUTPUT" coupling control at minimum.

Close the "HIGH VOLTAGE" switch and then slowly vary "3RD AMP. TUNING" condenser C18A in conjunction with the "R. F. OUTPUT" control until "3RD AMP. OUTPUT CURRENT" meter M2A indicates a maximum. If the reading indicated by this meter becomes excessive, adjust neutralizing condensers C14A-C15A until a reading of approximately 1 ampere is indicated. Continued by increasing the "R. F. OUTPUT" control to its maximum, meanwhile adjusting condensers C14A-C15A to keep the "3RD AMP. OUTPUT CURRENT" at approximately 1 ampere. Check the tuning by readjusting both the "2ND AMP. TUNING" condenser and "3RD AMP. TUNING" condenser until the "3RD AMP. OUTPUT CURRENT" meter indicates a maximum, and then adjust neutralizing condensers C14A-C15A until the "3RD AMP. OUTPUT CURRENT" meter indicates approximately zero current. When this has been accomplished, the third amplifier is neutralized.

The second amplifier should now be neutralized as follows: Place the "HIGH VOLTAGE" switch in the "Off" position and reduce the "R. F. OUTPUT" control to minimum.

CAUTION: WHILE THE SENSITIVE THERMOCOUPLE TC1.1A IS IN CIRCUIT, THE DOORS OF THE UNIT SHOULD NEVER BE OPENED UNTIL THE "HIGH VOLTAGE" SWITCH IS "OFF" AND THE VOLTAGE INDICATION OF THE "3RD AMP. PLATE VOLTAGE" METER M5A IS LESS THAN 500 VOLTS. FAILURE TO OBSERVE THIS PRECAUTION RESULTS IN A TRANSIENT SURGE WHICH MAY BURN OUT THE SENSITIVE THERMOCOUPLE.

*All radio frequency controls located on the front panel with the exception of the "R.F. OUTPUT" control are adjusted by means of a special spanner wrench (Western Electric No. 704A Tool). This tool is included with the equipment.

**When opening the doors of the equipment to adjust or handle any of the apparatus, always ascertain that the door switch relay has operated by noting that the "3RD AMP. PLATE VOLTAGE" meter reads zero.

Observing the foregoing caution, open link switch D19A and close link switch D3A. Using a screw-driver operate the potentiometer P1A to either the extreme right or left, first having taken note of its original position. This will apply sufficient modulation to give a readable deflection of the "3RD AMP. OUTPUT CURRENT" meter while neutralizing. Operate the "HIGH VOLTAGE" switch. Vary the "R. F. OUTPUT" control and neutralizing condenser C9A until the "3RD AMP. OUTPUT CURRENT" meter indicates approximately 1 ampere. Check the setting of the "3RD AMP. TUNING" condenser and the "2ND AMP. TUNING" condenser for a maximum reading of the "3RD AMP. OUTPUT CURRENT" meter. Then vary neutralizing condenser C9A for a minimum reading of this meter, meanwhile advancing the "R. F. OUTPUT" control. When the "R. F. OUTPUT" control is at a maximum and neutralizing condenser C9A is so adjusted that there is little or no current indication by the "3RD AMP. OUTPUT CURRENT" meter, the second amplifier is neutralized. Open the "HIGH VOLTAGE" switch and after the reading on M5A has decreased below 500 volts open the doors and close link switch D19A. Leave all other controls in position so that the process of tuning the third amplifier output circuits will be simplified.

Reconnect thermocouple TC1.2A and transfer the meter leads to it, maintaining the correct polarity. Restore potentiometer P1A to its original position.

Third Amplifier Tuning and Second Mesh Adjustment

Place link switch D2A in the 3-4 position, adjust the antenna coupling condenser C21A in accordance with the chart on page 29 and see that taps on the second mesh tuning coil L13A are adjusted in accordance with Table II. Open D28A and temporarily short circuit the antenna coupling condenser by placing link switch D20A across the studs occupied by C21A. Set the "R. F. OUTPUT" control to minimum, and apply the high voltage.

After setting "3RD AMP. OUTPUT COUPLING" at a dial reading between 5 and 10, increase the "R. F. OUTPUT" control until the "3RD AMP. OUTPUT CURRENT" meter indicates approximately 1 ampere. Check the tuning of the *second* amplifier for minimum plate current. Again adjust the "R. F. OUTPUT" control until the "3RD AMP. OUTPUT CURRENT" meter indicates about 1.5 amperes. Then vary "ANTENNA TUNING" condenser C19A until the "3RD AMP. OUTPUT CURRENT" meter indicates a minimum. Adjust "3RD AMP. OUTPUT COUPLING" in conjunction with the "R. F. OUTPUT" control until "ANTENNA CURRENT" meter M3A indicates 1 ampere and "3RD AMP. PLATE CURRENT" meter M4A reads 130 milliamperes.* The "3RD AMP. OUTPUT CURRENT" meter then should read between 0.8 and 1.1 amperes. If the reading of the "3RD AMP. OUTPUT CURRENT" meter is low, it is an indication that the primary of L11A has too many

*When using the indirect method of measuring antenna power, it will be necessary to adjust for a plate current of 150 milliamperes.

active turns; if the reading is high, the primary of L11A has too few active turns. It will then be necessary to decrease or increase, by a turn or two, the number of turns on each half of the coil and repeat the above tuning procedure. The reading of the "3RD AMP. OUTPUT CURRENT" meter should not exceed 1.1 amperes under normal conditions.

At this point a check should be made on the position of the "R. F. OUTPUT" control. If the position of the "COARSE" control is above "80" or below "65" on the scale when the meter readings are within the limits given, the plate voltage on the second amplifier should be increased or decreased respectively by moving the tap connection on R47.1A to the next higher or lower numbered tap. This process should be repeated until the required meter readings are obtained with the "COARSE" control of the "R. F. OUTPUT" between "65" and "80" on the scale. If it is impossible to secure an adjustment within these limits, the tap on R47.1A should be selected which most nearly meets the limits specified.

Record "3RD AMP. OUTPUT CURRENT" and "3RD AMP. PLATE CURRENT."

After the transmitter is tuned as above switch D13A should be placed in the "FEEDBACK CURRENT" position and the rotor of L37A adjusted until meter M1A indicates 7 milliamperes. Each adjustment of L37A must be made with the "HIGH VOLTAGE" switch in the "Off" position. After each change of L37A it may be necessary to make a minor change in adjustment of the second mesh circuit by means of the "ANTENNA TUNING CONDENSER" for a minimum on meter M2A. With the feedback current properly adjusted the audio input level for complete modulation with speech is +4 db.

The filament center tap potentiometer P1A is provided to adjust for a minimum noise level from the audio amplifier. This minimum noise level condition can be determined by listening to the monitor output or by noise level measurements and P1A should be left at the point giving minimum noise.

Antenna Tuning

Open the "HIGH VOLTAGE" switch and reduce the "R. F. OUTPUT" control to zero. Remove the coupling condenser C21A from its normal position and connect it to the studs normally used for the antenna series condenser C20A. Care should be taken that the adjustment of the "ANTENNA TUNING" condenser is not changed. Remove link switch D2A from the circuit, leave link switch D20A open and close D28A. Apply high voltage, *reduce coupling to zero* and gradually increase "R. F. OUTPUT" control until the "3RD AMP. OUTPUT CURRENT" meter indicates about 1.5 amperes. Adjust the "3RD AMP. TUNING" condenser for a minimum indication of the "3RD AMP. PLATE CURRENT" meter. Increase the coupling slightly and vary the taps on L14A until antenna resonance is indicated by a minimum indication of the "3RD AMP. OUTPUT CURRENT" meter. In case resonance cannot be obtained

by varying the taps on L14A,* it will be necessary to employ a series condenser C20A in the antenna circuit. This is done by temporarily connecting one of the C20A condensers (whose reactance does not exceed 200 ohms for the carrier frequency employed) in series with the external antenna lead-in. When resonance has been obtained, the equipment is shut down, coupling condenser C21A is returned to its normal position, and link switch D2A is put in the 2-3 position. If the series condenser was found necessary it should be placed in its normal position (C20A) otherwise the C20A studs should be short-circuited by means of link switch D20A.

Operate the unit and vary the "R. F. OUTPUT" control until the "3RD AMP. OUTPUT CURRENT" meter indicates about 1.5 amperes. Adjust the "ANTENNA TUNING" condenser for a minimum indication of the "3RD AMP. OUTPUT CURRENT" meter and then adjust "R. F. OUTPUT" control in conjunction with "3RD AMP. OUTPUT COUPLING" until the "3RD AMP. PLATE CURRENT" meter and the "3RD AMP. OUTPUT CURRENT" meter indicate those readings obtained in the section under "THIRD AMPLIFIER TUNING AND SECOND MESH ADJUSTMENT." Check the tuning of the third amplifier by varying the "3RD AMP. TUNING" condenser for a minimum reading of the "3RD AMP. PLATE CURRENT" meter. If this point is not found at or near the former setting of the "3RD AMP. TUNING" condenser, it is an indication that the antenna circuit is not exactly tuned and the above tuning procedure must be repeated. If the reading of the "ANTENNA CURRENT" meter exceeds 1.2 amperes, decrease the capacity of the coupling condenser C21A. Increase this capacity if the current is less than 0.8 ampere. All meter readings should fall within the limits shown in Table III.

OPERATING PROCEDURE

Starting

Before starting, ascertain that the antenna grounding switch is in the "OPERATE" position. In the normal operation of the transmitter, full-automatic starting should be used. The "HIGH VOLTAGE" switch is always left in the "On" position, and the unit is started by operating the "MASTER CONTROL" switch. However, where two or more stations are sharing time on the same frequency and a minimum starting time is desirable after one station signs off, it is advantageous to use semi-automatic starting. This consists in placing the "HIGH VOLTAGE" switch in the "Off" position and operating the "MASTER CONTROL" switch. This may be done several minutes before the preceding station signs off thus allowing the time delay circuit to function and the vacuum tubes to reach normal operating temperature. The operator can then start instantly by operating the "HIGH VOLTAGE" switch.

*In the case of an inefficient antenna, it may be necessary to employ additional series inductance in the antenna circuit in order to obtain resonance. In such cases the additional inductance may be mounted external to the unit and connected in series with the antenna lead-in.

As soon as the equipment is in operation, all meter readings should be checked and any necessary adjustments made.

Stopping

To stop the equipment, operate the "MASTER CONTROL" switch. Ground the antenna. When stopping for a brief interval, it is sufficient to operate only the "HIGH VOLTAGE" switch. This deenergizes the high voltage rectifier and eliminates the time delay when restarting.

Crystal Temperature Control Circuit

The temperature control circuit will require occasional replacements of the relay tube and indicator lamp which are in service continuously. However, *because of the vital function of the relay tube in maintaining the correct oscillator frequency, it is imperative that the tube employed be in an operative condition. Normal operation of this tube is indicated by the periodic flashing of the indicator lamp located on the front of the unit and any irregularity in the operation of this lamp should be promptly investigated.*

The crystal heater circuit should be in operation at least 4 hours before the station is put on the air.

Modulation

The audio input system to the Oscillator-Modulator is arranged to operate from a 500-ohm circuit and requires a speech input level of +4 db for complete modulation.

During operation, the third amplifier grid current should occasionally be checked. Any grid current during the program, with the exception of occasional pulses, is an indication of over-modulation. *The "TEST METER" switch D13A should not be left on the "3RD AMPLIFIER GRID" position.*

Monitoring

When the Oscillator-Modulator is operated as previously described, the monitoring output level at terminals 11 and 12 is approximately +10 db. The output of the monitoring transformer T10A should normally be terminated in 500 ohms, as otherwise the quality of the transmitted program will be impaired. This is provided for by resistance R37A which is connected across the output terminals of transformer T10A.

If a monitoring device of 500 ± 100 ohms is used, it should be connected directly to the output of the monitoring circuit (terminals 11 and 12) and resistance R37A should be disconnected. If a monitoring device of other than 500 ± 100 ohms is used, it will be necessary to provide a suitable output transformer to connect between the output of T10A and the monitoring device. This transformer must be of such ratio that T10A is effectively terminated in 500 ohms. Resistance R37A should be disconnected.

If no monitoring device is connected to the output of transformer T10A, resistance R37A must be left connected.

Overloading

Should the overload relay operate during a program it is usually sufficient to press the "OVERLOAD RESET" button D4A. If the overload relay continues to operate each time the "OVERLOAD RESET" button is pressed, trouble in the Third Amplifier output circuit is indicated and it should be determined in accordance with the procedure outlined under "Location of Trouble."

Use of "ANTENNA CURRENT" Meter

The "ANTENNA CURRENT" meter may be connected in either the second mesh circuit or the antenna circuit by means of link switch D2A. To connect the meter in the second mesh circuit, link switch D2A should be placed in the (2-3) position. To connect the meter in the antenna circuit, the link should be placed in the (1-2) position. The antenna coupling circuit is so arranged that when the correct value of coupling capacity C21A is used, and the antenna is connected and properly tuned, the resistance introduced into the second mesh circuit by means of the coupling capacity is always 100 ohms. Thus, with the "ANTENNA CURRENT" meter connected in this circuit, one ampere will always be indicated for 100 watts output ($I^2R = 100$) regardless of the actual resistance of the physical antenna.

The permanent use of the "ANTENNA CURRENT" meter in the antenna circuit (link switch D2A in the 1-2 position) is not essential for correct operation. However, if it is desired to employ the meter in this circuit and it is found that the antenna resistance is less than 40 ohms it will be necessary to provide a meter of suitable range for the particular antenna involved. While it is possible to substitute the new meter for the "ANTENNA CURRENT" position, it is advisable to install it external to the unit.

Load Resistance

A load resistance of 100 ohms (R12A) is provided in the Oscillator-Modulator which may be connected in the second mesh circuit by placing link switch D2A in the 3-4 position. This resistance duplicates the resistance introduced by the antenna into the second mesh circuit by means of the antenna coupling capacity C21A and allows the unit to be operated for test purposes under actual load conditions without causing interference to other stations assigned to the same frequency. When this load resistance is used, the antenna should be disconnected by removing the antenna series condenser C20A and the short-circuiting link D20A (when used) from the circuit. Meter readings taken with the load resistance in circuit can always be duplicated with the antenna connected and are always an assurance that the equipment is delivering its full rated power to the antenna.

Meter Readings

All meter readings should be checked periodically during operation. If the "POWER SUPPLY VOLTAGE" should vary appreciably from 220 volts, it should be adjusted to the proper value by means of "POWER VOLTAGE CONTROL" switch.

Check frequently the oscillator grid and antenna current readings. Should the antenna current vary slightly while warming up, it should be adjusted to the correct value by means of the "R. F. OUTPUT" control. This adjustment should be made if possible without modulation. Otherwise, care should be exercised that the adjustment is made during low points of modulation.

MAINTENANCE

General

The Oscillator-Modulator must be kept free from dust and dirt. Compressed air is recommended for cleaning the apparatus inside the enclosure, but a soft clean cloth may be used with good results. Waste or oily cloth should never be used.

All nuts, bolts and screws should be examined occasionally and any loose ones tightened. Examine all electrical connections and tighten any loose contacts. Trouble can often be prevented by such precautions.

To Clean and Polish Aluminum Gray Lacquer

Any visible grease, oil or wax should first be removed from the finishes by wiping with a clean rag moistened with carbon tetrachloride. If the finished parts are only smudged and finger printed and showing no visible greasy or oily materials this wiping operation will not be necessary since the following polishing operation will sufficiently clean the surfaces.

The wiped chromium or lacquered surfaces and the ones requiring no preliminary cleaning should then be polished by rubbing them with a piece of soft cloth, such as cheese cloth, moistened with "The Master Finish," a polish produced by The Master Finish Company, 8 Caroline Street, New York City, and finally wiping with a dry, clean, soft cloth.

To Touch-Up Aluminum Gray Lacquer

The marred areas of the Aluminum Gray, No. 476 Finish should be thoroughly cleaned from grease, oil, wax or polish by wiping with a clean rag moistened with carbon tetrachloride.

The aluminum powder and the Gray Enamel used for touching-up are supplied in a double compartment can as per Specification D-97106. The double compartment container of powder and enamel is ordered from the Western Electric Company by this number.

All of the alumnium powder should be thoroughly stirred into the gray enamel before using and at frequent intervals during use. Employing a small soft hair brush, apply a coat of the mixed enamel with a minimum

amount of brushing. The enamel is supplied at brushing consistency and requires no thinning.

Do not use the mixture if the aluminum powder has been in the enamel for more than eight hours.

Cleaning Air Condensers

The exposed variable air condensers should be cleaned at least once a week with compressed air or its equivalent. The presence of any dust or dirt on the plates may result in the condenser arcing thereby taking the station off the air. A small bellows and a clean dry cloth can be used to advantage for this purpose where a high pressure air system is not available.

Vacuum Tubes

In order to obtain both maximum life and satisfactory performance, it is important that vacuum tubes be operated within the voltage limits previously specified in this bulletin.

As far as possible the operator should anticipate tube failures and make the required tube replacements. Tube failures may be guarded against to some extent by keeping a careful record of the length of time the tubes have been in service and by observing from time to time the condition of the tube elements. Sagging or warped elements will, of course, increase the probability of tube trouble and such tubes should be replaced when discovered.

It is essential that the filaments of *new* mercury vapor tubes be heated at least fifteen minutes before the high voltage is applied. This is done in order to remove any particles of mercury adhering to the sides or elements of the tubes which might result in flashovers. It is therefore suggested that spare rectifier tubes be prepared for service in advance by placing them in the Oscillator-Modulator when not in use and giving the filaments the necessary pre-heating with the "HIGH VOLTAGE" switch in the "Off" position, and the doors of the unit opened. This procedure should be repeated at least once a month. Spare rectifier tubes thus pre-heated should be kept in an upright position until they are required.

It is also recommended that the No. 287A Vacuum Tube employed in the heater circuit be operated without plate voltage for about 15 minutes before placing the tube in actual service. This can be done by opening snap switch D12A.

Vacuum Tube Sockets

It is essential that the contacts of all tube sockets be kept clean and smooth at all times. Care should be exercised to see that the third amplifier tubes V4A and V5A are not subjected to any mechanical strains when placed in the sockets.

Relays

The contacts of all relays should be inspected and carefully cleaned once a month. Dust collects on the contacts in spite of relay covers and sometimes causes a failure in the operation of an important circuit. Relay contacts in the protective and high voltage circuits should receive special attention. Crocus cloth can be used to advantage in cleaning relay contacts. Badly pitted power relay contacts may be carefully smoothed with a fine file.

Carrier Frequency Deviation

In order that there may be no appreciable deviation of the carrier frequency from the assigned value, periodic observations should be made of the crystal heater indicator light located on the front panel. The intermittent operation of this light indicates whether or not the No. 287A Vacuum Tube is supplying heater current to the Oscillator. A defective No. 287A Vacuum Tube should be replaced immediately while a defective indicator lamp should be replaced as soon as possible without interrupting the program. The failure of this lamp does not prevent the operation of the crystal heated circuit and the intermittent flashing of the No. 287A Vacuum Tube will serve temporarily to indicate whether or not heater current is being supplied. (See section on "Operating Procedure.")

LOCATION OF TROUBLE

General

If this equipment is regularly and carefully maintained very little trouble will be experienced. The operator should endeavor to become familiar with the circuits, their functions and the location of apparatus as quickly as possible. A detailed schematic diagram of the complete unit is given in this bulletin.

In case of trouble in any of the control or protection circuits, the operator should remember that these circuits are interlocked so that the failure of one piece of apparatus often prevents other pieces from functioning. For example, should the bias-plate rectifier fail to operate correctly, the high voltage relay S3A cannot operate to energize the high voltage transformer T4A. In case a piece of apparatus fails to function the operator should first ascertain that the previous interlocking circuits have operated, and then examine the piece of apparatus for defects. Relay contacts should be cleaned regularly as outlined under "Maintenance."

Trouble in the radio frequency circuits is usually caused by the improper adjustment of the circuits. The first step in the case of trouble in these circuits should be to see that all adjustments are in accordance with those described in this instruction bulletin, as well as with those recorded in the station log.

It is not practical to attempt to describe every possible cause of trouble but the following paragraphs give some of the more possible ones. It should be remembered that these are only suggestions.

Power Supply Circuits

Bias Voltage Failure—This condition (unless a rectifier tube fails) is probably due to the failure of relay S5A or a faulty door switch. If relay S5A does not operate when doors are closed, examine each door switch for an open circuit. Assuming that relay S5A operated correctly, and yet the rectifier does not function, the trouble might be due to improper operation of relay S1A. If the bias-plate rectifier is functioning as indicated by a blue glow in tubes V10A and V11A, but the grid-bias and plate voltages are incorrect, the load distribution of the potentiometer may be incorrect. This may be brought about by a breakdown to ground or open circuit condition of any equipment energized by this rectifier. In general, if the bias potentials are above normal, the fault is due to excessive loading on the positive side of the rectifier, and vice versa for excessive positive potentials.

High Voltage Failure—If the filaments of the high voltage rectifier are energized, the trouble may be due to failure of some of the preceding interlocking circuits or the failure of relay S3A. The last mentioned trouble may be due to previous operation of overload relay S4A which would short-circuit the winding of relay S3A. Pressing "OVERLOAD RESET" button D4A will ascertain if this is the case.

Temperature Control Circuit Failure—If the filament of the No. 287A Vacuum Tube fails to heat (assuming that the tube is in good condition), examine fuses in cut-outs F2.1A, F2.2A. Check setting of link switches D11.1A-D11.2A for correct voltage settings. (See section on "Adjustment of Apparatus.") Check for line voltage by closing switches D9A and D10A and see if meter M6A reads. When voltage has been checked, and the No. 287A Vacuum Tube heats properly, and yet the heater circuit does not function, look for bad connections at the terminal strip at the back of the Oscillator Unit. The No. 287A Vacuum Tube will light up with a characteristic glow when heater current is flowing. Snap switch D12A might be examined for a possible open circuit.

Oscillator

Check all voltages and the heater circuit. If the voltages are correct, try a new No. 271A Vacuum Tube. If trouble is found to be in the Oscillator, it must be returned to the nearest distributor for repairs.

Plate Circuits

If the output circuit of an amplifier is not tuned to resonance, the plate current of that amplifier will be excessive. Improper tuning of the amplifier is apt to result in excessive plate current due to incorrect plate circuit impedance. If plate current increases suddenly while tuning, and varies erratically with tuning condenser variation, this stage or a previous stage is no doubt oscillating at some parasitic frequency. A periodic variation of output plate current may be caused by a beat note brought about by "singing" in two successive stages. This condition exists whenever the

equipment is not properly neutralized and proper neutralization will usually correct such trouble.

Balance of Third Amplifier Vacuum Tubes

A careful balance of the load should be maintained between the two No. 212E Vacuum Tubes in the third amplifier stage. In this connection, it is to be understood that two vacuum tubes may be poorly matched and yet each be electrically perfect. Poor quality may be due to mismatched vacuum tubes in the third amplifier stage. Balance is indicated by the relative color of the third amplifier vacuum tube plates when the transmitter is operating under load. Equalization of the load handled by these tubes is accomplished by loosening the set screw of the condenser C18.1A adjusting its capacity with reference to C18.2A until proper balance is indicated. The tuning of the output circuit should be rechecked after each such adjustment.

Filament Circuits

If all filaments (including meter lights) should not light when the "Master Control" switch D9A is closed, the main power is off or switch D10A is in the open position. Check main power bus by noting if heater circuit indicator lamp E2A is functioning. A single tube filament not lighted indicates either a faulty socket connection, or a burned out filament. The filaments of the second amplifier tubes, V3.1A and V3.2A, are connected in series and the failure of either filament will deprive the other tube of filament current. Group filament trouble probably is caused by a faulty transformer or an open circuit. If possible, determine the trouble which caused the failure before any replacement is made.

Excessive Noise Level

This condition may be brought about by improper tuning of the radio frequency stages. Faulty filter sections, resulting from broken down condensers or damaged inductances, also will cause an increase in noise level. Arcing in any radio frequency circuit or poor filament contacts will produce erratic noises in the output. In general, the type of noise often will indicate the probable source of the trouble. Improper adjustment of P1A will result in excessive noise. (See page 17.)

APPARATUS INFORMATION

An apparatus list for the Oscillator-Modulator is given on drawings ESA-741209 to ESA-741220, inclusive.

Voltages Obtained from the Bias-Plate and the High Voltage Rectifiers

The tabulated voltages are obtained between the following points and ground when measured with a high resistance voltmeter (1000 ohms per volt).

Bias-Plate Rectifier

Junction between R23A and R22.2A	— 20 volts ± 5%
Junction between R22.2A andR22.1A	— 50 volts ± 5%
Junction between R22.1A and R21A	— 70 volts ± 5%
Junction between R19A and R18A	— 250 volts ± 10%
Load Side of Resistance R14A	+ 130 volts ± 5%
Load Side of Resistance R15A	+ 360 volts ± 5%

High Voltage Rectifier

Junction of L18A and C25A	+ 375 to + 400 Volts

VACUUM TUBES

Designation	*Code Numbers*	*Designation*	*Code Numbers*
V1Y	271A	V11A	258B
V2A	271A	V12A	287A
V3.1A	271A	V13A	271A
V3.2A	271A	V14A	242A
V4A	212E	V15A	RCA-84
V5A	212E	E3.1A	General Electric S-6, 5-watt,
V6A	258B	to	120-volt, Edison Mazda Lamps
V7A	258B	E3.5A	(Candelabra Base).
V8A	258B		General Electric T-4, 2-watt,
V9A	258B	E2A	18-volt, Edison Mazda Lamps
V10A	258B		(Candelabra Base).

SPARE PARTS

The following parts are recommended as spare equipment which may be purchased at the customer's option:

Vacuum Tubes

5—Western Electric No. 271A Vacuum Tubes
2—Western Electric No. 212E Vacuum Tubes
2—Western Electric No. 287A Vacuum Tubes
2—Western Electric No. 242A Vacuum Tubes
2—RCA-84 Vacuum Tubes
6—Western Electric No. 258B Vacuum Tubes
5—General Electric Edison Mazda Lamps, Type S-6 (Candelabra Base), 5 watts, 120 volts
2—General Electric Edison Mazda Lamps, Type T-4 (Candelabra Base), 2 watts, 18 volts

Fuses

12—Telegraph Fuses, 1 ampere, 2500 volts, D&W, Catalog No. 2760
12—Fuses, 2 amperes, 250 volts, D&W Catalog No. 91002

20 volts ± 5%
50 volts ± 5%
70 volts ± 5%
50 volts ± 10%
30 volts ± 5%
360 volts ± 5%

375 to + 400 Volts

Code Numbers
258B
287A
271A
242A
RCA-84

ral Electric S-6, 5-watt,
, Edison Mazda Lamps
delabra Base).
ral Electric T-4, 2-watt,
Edison Mazda Lamps
labra Base).

e equipment which may

S-6 (Candelabra Base),

4 (Candelabra Base),

atalog No. 2760
91002

12—Fuses selected as specified below:
a. When equipment is to operate on a power supply of 110 volts, 50-60 cycles
6—Enclosed Fuses, 30 amperes, 250 volts, D&W, Catalog No. 1466
b. When equipment is to operate on a power supply of 220 volts, 50-60 cycles
6—Enclosed Fuses, 15 amperes, 250 volts, D&W Catalog No. 1463

Filter Condensers

3—Western Electric No. D-96887 (1 MF) Condensers
6—Western Electric No. 180A (1 MF) Condensers
2—Western Electric No. 181A (1 MF) Condensers
6—Western Electric No. D-96859 (2 MF) Condensers

Other Condensers

2—Western Electric No. 149A (1 MF) Condensers
2—Faradon Model "F" (0.01 MF) Condensers
1—Western Electric, Type AE-18 (0.015 MF) Condenser
1—Western Electric No. 226A (1 MF) Condenser
1—Western Electric No. 296A (3 MF) Condenser

Resistors

1—(R20A) General Radio Potentiometer, Type 214, 2000 ohms
1—(R24A-R25A) Assembly, Ward-Leonard, two deck Resistors per K-40202
1—(R44A) Ward-Leonard Type "A" with No. 206 type terminals, 130 ohms ± 5 per cent
1—(R47.1A) Ward-Leonard Type "D" Resistor, 8000 ohms ± 2 per cent, tapped at 4600, 4800, 5000, 5200, 5400, 5600 and 6000 ohms
2—(R48A, R49A) Ward-Leonard K-40210 Plaque Resistors 50 ohms ± 10 per cent

Retardation Coils

2—Western Electric No. 190A Retardation Coils
2—Western Electric No. 198A Retardation Coils

Transformers

1—(T1A) Western Electric No. 247M Input Transformer
1—(T11A) Western Electric No. 262A Input Transformer

Other Parts

1—Western Electric No. 700A Oscillator
1—Western Electric No. 704A Tool
1—(TC1.1A) Weston Heating Element per Weston Drawing CD-51014, range 0-100 milliamperes

ENGINEERING SERVICE AND INFORMATION FOR ORDERING REPLACEMENTS

Engineering service may be obtained through the nearest Branch House of the Graybar Electric Company, and authorization for such service should be placed with them. In Canada, this service may be obtained through the Northern Electric Company, Ltd., and in other foreign countries with the International Standard Electric Corporation.

Orders for replacement apparatus should specify the apparatus designation (such as R2A) shown on the drawings and usually stamped on the apparatus as well as the name, catalog number, nameplate data and serial number of Oscillator-Modulator and other pertinent information which is available.

Note: In case it becomes necessary to return a thermocouple for repairs, remove all the thumb nuts which secure either the meter leads or links. This is done to avoid loss or improper replacement of the thumb nuts.

NOTES ON SCHEMATIC (Fig. 1)

Note 1—For (100W) R.T.E. with the antenna connected directly to terminal No. 19, short-circuit terminals Nos. 6 and 7 and omit ESL-608320 entirely.

Note 2—This connection is to be removed for the (100W) R.T.E.

Note 3—All interconnecting wires and wires external to the equipment are shown thus ——·——·——. These wires are not used in the (100W) R.T.E.

Note 4—When the D-98653 Oscillator Modulator Unit is followed by a 71B Amplifier, remove condensers C21.1A to C21.5A, inclusive.

Note 5—These connections are to be used only in the (100W) R.T.E.

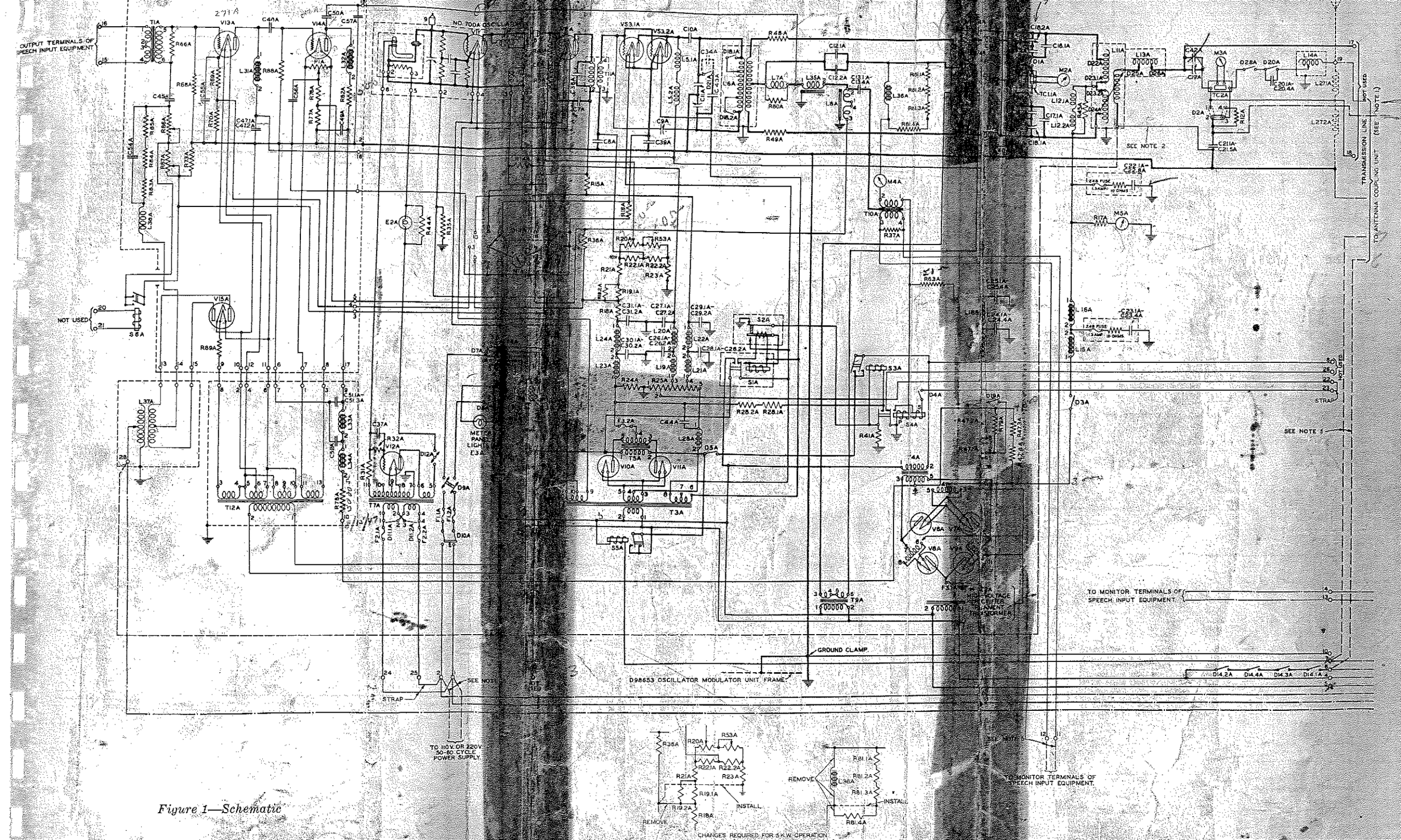
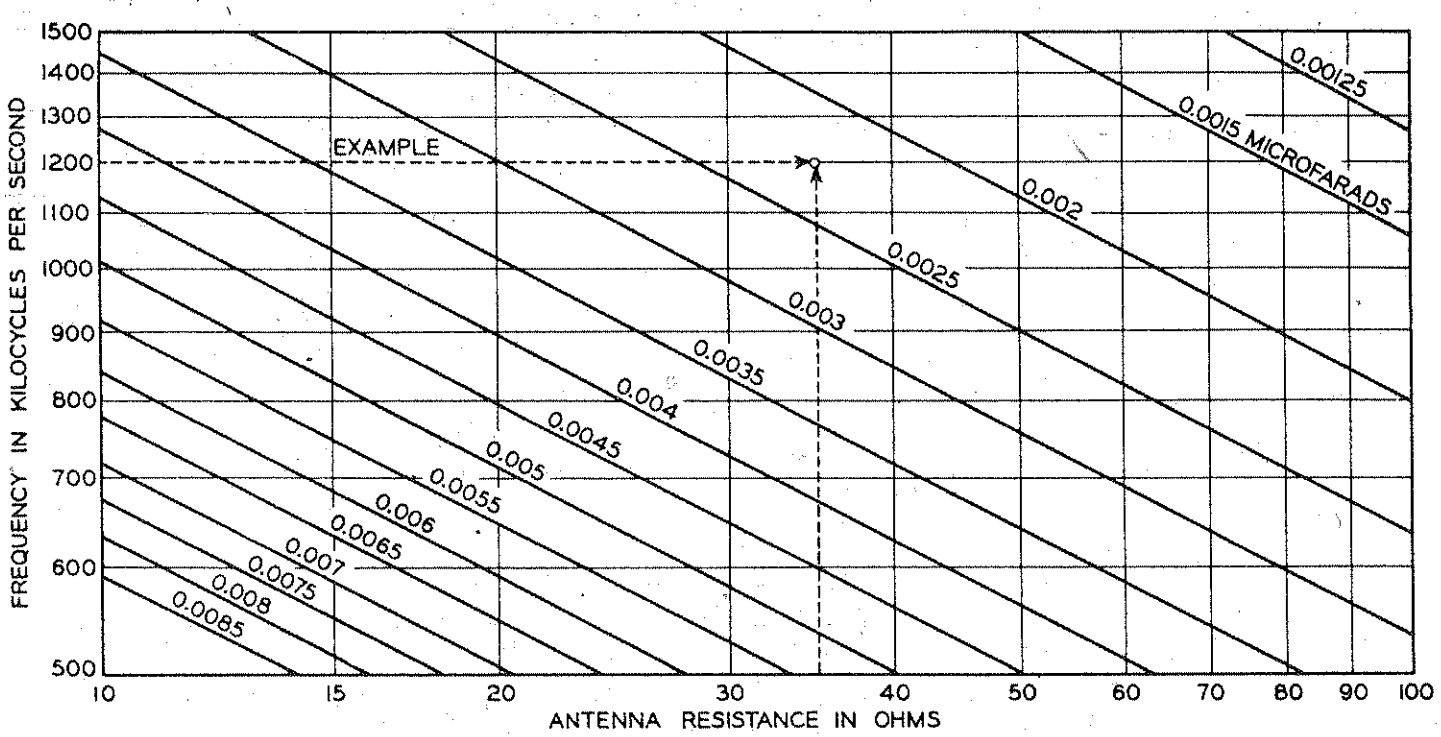


Figure 1—Schematic



Example: For an antenna of 35 ohms at a frequency of 1,200 kilocycles, the exact value of coupling capacity would be 0.00225 MF. Use the nearest larger value obtainable with the condensers furnished, i.e., 0.0025MF.

Figure 2—Tuning Chart for Antenna Coupling Capacity, C21A

APPARATUS LIST

Design No.	*Ordering Information*
C6A	Western Electric No. 149A Condenser, 1.0 mf., manufacturer's rating 200 Volts DC
C7A	Cornell-Dubilier Type 9 Condenser, .01 mf. ± 10% 2000 Volt DC Test
C8A	Western Electric No. 149A Condenser, 1.0 mf., manufacturer's rating 200 Volts DC
C9A	General Radio No. 368B Variable Air Condenser, 50 mmf. max. (Modified per Det. 1A, ESO-600935)
C10A	Cornell-Dubilier Type 9 Condenser, .01 mf., ± 10% 2000 Volt DC Test
C11A	Cardwell No. 156B Variable Air Condenser, .001 mf., with Mycalex Insulation (Modified per Det. 10A, ESO-600935)
C12.1A	Cornell-Dubilier Type 9A Condenser, .0001 mf. ± 10% 5000 Volt DC Test
C12.2A	Cornell-Dubilier Type 9A Condenser, .00015 mf. ± 10% 5000 Volt DC Test
C13.1A C13.2A C13.3A C13.4A	Western Electric No. D-96859 Condensers, 2 mf., manufacturer's rating 800 volts DC
C14A C15A	Western Electric KS-6943 Condenser Assemblies (Modified per Det. 9A, ESO-600935), 30 mmf.
C16.1A	Cornell-Dubilier PL-309-40 Condenser, .0002 mf., (Used only from 550 to 800 KC)
C16.2A	Cornell-Dubilier PL-154-40 Condenser, .01 mf.
C17.1A	Cornell-Dubilier PL-309-40 Condenser, .0002 mf., (Used only from 550 to 800 KC)
C17.2A	Cornell-Dubilier PL-154-40 Condenser, .01 mf.
C18.1A C18.2A	Cardwell T-199 Condensers with Mycalex Insulation, 330 mmf. max.
C19A	Cardwell S-3298 Condenser with Mycalex Insulation, 250 mmf. max.
C20.1A	Cornell-Dubilier Type 9A Condenser, .001 mf. ± 10% 5000 Volts DC Test
C20.2A	Cornell-Dubilier Type 9A Condenser, .002 mf. ± 10% 5000 Volts DC Test
C20.3A	Cornell-Dubilier Type 9A Condenser, .003 mf. ± 10% 5000 Volts DC Test
C20.4A	Cornell-Dubilier Type 9A Condenser, .004 mf. ± 10% 5000 Volts DC Test
C21.1A	Cornell-Dubilier Type 9A Condenser, .001 mf. ± 10% 5000 Volts DC Test
C21.2A	Cornell-Dubilier Type 9A Condenser, .002 mf. ± 10% 5000 Volts DC Test
C21.3A	Cornell-Dubilier Type 9A Condenser, .003 mf. ± 10% 5000 Volts DC Test
C21.4A	Cornell-Dubilier Type 9A Condenser, .004 mf. ± 10% 5000 Volts DC Test
C21.5A	Cornell-Dubilier Type 9A Condenser, .0005 mf. ± 10% 5000 Volts DC Test

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
C22.1A C22.2A C22.3A C22.4A C22.5A C22.6A C22.7A C22.8A C23.1A C23.2A C23.3A C23.4A	Western Electric No. D-96887 Condensers, 1 mf. manufacturer's rating 3500 Volts DC
C24.1A C24.2A C24.3A C24.4A C25.1A C25.2A C25.3A C25.4A	Western Electric No. 180A Condensers, 1 mf. manufacturer's rating 2000 Volts DC
C26.1A C26.2A C27.1A C27.2A C28.1A C29.1A C29.2A C30.1A C30.2A C31.1A C31.2A	Western Electric No. D-96859 Condensers, 2 mf. manufacturer's rating 800 Volts DC
C34A	Cornell-Dubilier Type 9 Condenser, .0003 mf. ± 10% 5000 Volt DC Test
C36A	Cornell-Dubilier Type 9 Condenser, .00003 mf. ± 10% Modified per 17A, ESO-600815
C37A	Western Electric No. 254A Condenser (3 sections .05 to .07 mf. each) manufacturer's rating 300 Volts DC
C39A	Cornell-Dubilier Type 9 Condenser, .01 mf. ± 10% 2000 Volt DC Test
C40A	Cornell-Dubilier Type 9 Condenser, .001 mf. ± 10% 5000 Volt DC Test
C41A	Cornell-Dubilier Type 9 Condenser, .001 mf. ± 10% 5000 Volt DC Test
C42A	Cornell-Dubilier PL-390-6 Condenser, .00005 mf. (Used only from 550 to 600 KC, inclusive)
C43A	Cornell-Dubilier Type 9 Condenser, .0003 mf. (Used only from 620 to 800 KC) 5000 Volt DC Test
C44A	Western Electric No. 221A Condenser, 1 mf. manufacturer's rating 1000 Volts DC
C45A	Western Electric No. 230A Condenser, .4 mf. manufacturer's rating 250 Volts DC
C47.1A C47.2A	Western Electric No. 226A Condensers, 1 mf., manufacturer's rating 650 Volts DC
C48A	Western Electric No. 227A Condenser, .5 mf., manufacturer's rating 650 Volts DC
C49A ~~C50A~~ C51.1A C51.2A C51.3A C52A	Western Electric No. 296A Condensers, 3 mf., manufacturer's rating 1500 Volts DC

C50A D98949 Condenser 1-MF 5000 Volts Test Applied on Units beginning with Serial No 104

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
C54A	Cornell-Dubilier Condenser Cat. No. 4-13025 — .00025 mf.
C55A	Cornell-Dubilier Condenser Cat. No. 4-12040 — .004 mf.
C56A	Cornell-Dubilier Condenser Cat. No. 4-12020 — .002 mf.
C57A	Cornell-Dubilier Condenser Cat. No. 4-13050 — .0005 mf.
D1A	Western Electric Detail 8, ESO-600857
D2A	Western Electric Detail 15, ESO-600898
D3A	Western Electric Detail 7, ESO-600857
D4A	Western Electric No. 464A Key
D5A	Hart and Hegeman Tumbler Switch, 250 Volts, 30 Amps. Double Pole, Catalog No. 21598-A
D6A	Western Electric No. 707A Switch
D7A	Western Electric Detail 5, ESO-600704
D8A	Western Electric Detail 5, ESO-600704
D9A	Hart and Hegeman Tumbler Switch, 250 Volts, 30 Amps. Double Pole, Catalog No. 21598-A
D10A	Trumbull Type "A" Switch, 250 Volts, 30 Amps. Catalog No. 3841, Double Pole Single Throw
D11.1A	Western Electric Detail 8, ESO-600704
D11.2A	Western Electric Detail 8, ESO-600704
D12A	Hart and Hegeman Switch, 250 Volts, 3 Amps. Catalog No. 610-BC
D13A	Westinghouse 8-Position Instrument Switch, Catalog No. SO19N551
D14.1A D14.2A D14.3A D14.4A	Hart and Hegeman Door Switches, Catalog No. 3592
D17A	Western Electric Detail 8, ESO-600857
D18.1A	Western Electric Detail 3, ESO-600790
D18.2A	Western Electric Detail 3, ESO-600790
D19A	Western Electric Detail 7, ESO-600857
D20A	Western Electric Detail 7, ESO-600857
D21A	Western Electric Detail 14, ESO-600815
D22A	Western Electric Flexible Connector, Detail 13, ESO-600763 and Clip, Detail 1A, ESA-600647
D23.1A D23.2A	Western Electric Flexible Connectors, Detail 14, ESO-600763 and Clips, Detail 1A, ESA-600647
D24A	Western Electric Flexible Connector, Detail 13, ESO-600763, and Clip, Detail 1A, ESA-600647
D25A	Western Electric Flexible Connector, Detail 5, ESO-600643 and Clip, Detail 1A, ESA-600647
D26A	Western Electric Flexible Connector, Detail 6, ESO-600643 and Clip, Detail 1A, ESA-600647
D27A	Western Electric Flexible Connector, Detail 4A, ESL-327288
D28A	Western Electric Detail 1, ESL-603012
E2A	General Electric Type 4, 18 Volts, 2 Watt Lamp

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
E3.1A, E3.2A, E3.3A, E3.4A, E3.5A	General Electric 120 Volts, 5 Watts Candelabra Base Mazda "B" Lamps
ES2A	Candelabra Keyless Lamp Holder Graybar Cat. No. 9444
ES3.1A, ES3.2A, ES3.3A, ES3.4A, ES3.5A	Bryant Candelabra Porcelain Receptacles Cat. No. 388
F1.1A, F1.2A	D.&W. Indicating Cartridge Fuses, 250 Volts, 15 Amps. for 220 Volts or 30 Amps. for 110 Volts, No. 1463 or No. 1466, respectively
F2.1A, F2.2A	D.&W. Indicating Cartridge Fuses, 250 Volts, 2 Amps. No. 91102
F3.1A, F3.2A	D.&W. Telegraph Fuses, 2500 Volts, 1 Amp. No. 2760
L5.1A, L5.2A	Western Electric No. 190A Retardation Coils
L6A	Western Electric Det. 1A, ESO-600295 (Assembled coil, shield, C12A, D18A, etc.) or Det. 1A, ESO-600790 (Coil assembled only)
L7A	Western Electric No. 190A Retardation Coil
L8A	Western Electric No. 123B Retardation Coil
L9A, L10A	Western Electric No. 198A Retardation Coils
L11A	Western Electric Detail 1A, ESO-600780 (Assembled, coil and shield) or Det. 1A, ESR-600294 (Coil assembled with D22A, D23A and D24A)
L12.1A, L12.2A	Western Electric No. 190A Retardation Coils
L13A	Western Electric Detail 1A, ESO-600670 (Assembled, Coil and Shield) or Detail 1A, ESO-600643 (Coil assembled without shield)
L14A	Western Electric Detail 1A, ESO-600673 (Assembled, Coil with Shield, Insulators, etc.) or Detail 1A, ESO-325217
L15A, L16A	Western Electric No. 206B Retardation Coils
L17A, L18A	Western Electric No. 172C Retardation Coils
L19A, L20A, L21A, L22A, L23A, L24A	Western Electric No. 148F Retardation Coils
L27.1A, L27.2A	Western Electric No. 190A Retardation Coils
L28A	Western Electric No. 206B Retardation Coil
L31A	Western Electric No. 199D Retard Coil
L32A	Western Electric No. D-98571 Retard Coil
L33A	Western Electric No. D-98571 Retard Coil
L34A	Western Electric No. D-98571 Retard Coil
L35A	Western Electric No. D-98572 Retard Coil
L36A	Western Electric No. 206B Retard Coil
L37A	R.F. Pick-Up Coil per Drawing No. ESO-608851
L38A	Western Electric No. 200C Retard Coil
M1A	Western Electric KS-7365 DC Milliammeter, 0-5 Ma. (Weston Model 301 DC Milliammeter)

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
M2A	Western Electric KS-7381 Thermoammeter, 0-2 Amps. (Weston Model 425 Thermoammeter, KS-7276, furnished with 2 amp. external heating element (TC1.2A))
M3A	Western Electric KS-7373 Thermoammeter, 0-2 Amps. (Weston Model 425 Thermoammeter, furnished with external heating element (TC2A))
M4A	Western Electric KS-7366 DC Milliammeter, 0-300 ma. (Weston Model 301 DC Milliammeter)
M5A	Western Electric KS-7371 DC Voltmeter, 0-4000 volts (Weston Model 301 DC Voltmeter)
M6A	Western Electric KS-7379 AC Voltmeter, 0-300 volts (Weston Model 476 AC Voltmeter)
P1A	~~Yaxley M401~~ KS7767 Potentiometer, 40 ohms
R5A	Western Electric No. 38W Resistance, 100,000 ohms ± 4%
R9A	Ward Leonard Type A, 2" Resistance, 40 ohms ± 5% tapped at 20 ohms ± 5%, Type 206 Terminals
R12A	Western Electric KS-6985 Resistance, 100 ohms (Ohmspun)
R14A, R15A	Western Electric No. 18CH Resistances, 1.2 ohms ± 1%
R16A	Western Electric No. 18CS Resistance, 0.6 ohms ± 5%
R17A	Weston Type "4-1" Multiplier (Furnished with M5A)
R18A	Western Electric No. 18BM Resistance, 1000 ohms ± 1%
R19.1A, R19.2A	Western Electric No. 18EC Resistances, 6000 ohms ± 5%
R20A	General Radio Potentiometer Type No. 214, 2000 ohms (modified per Detail 1A, ESO-600703)
R21A	Western Electric No. 18GH Resistance, 600 ohms ± 1%
R22.1A	Western Electric No. 18GF Resistance 800 ohms ± 1%
R22.2A	Western Electric D-75440 Resistance, 1200 ohms ± 1%
R23A	Western Electric No. 18BG Resistance, 400 ohms ± 1%
R24A, R25A	Ward Leonard 2 Deck Resistors per K-40202, No. 205 Type Terminals, Type "D" Resistances, R24A 4200 ohms ± 5%, R25A 2640 ohms ± 5% with tapped sections of 275 ohms, 705 ohms, 1510 ohms, 150 ohms.
R28.1A, R28.2A	Ward Leonard Type "B" Resistances, 7500 ohms ± 10%, No. 205 Terminals
R30.1A, R30.2A	Ward Leonard Two Deck Resistances No. 205 Terminals, 2 Type "D" Resistances each 1 ohm ± 10%
R31A	Ward Leonard Type "A" Resistance, No. 206 Terminals, 2000 ohms ± 5%
R32A	Durham Resistor MF 4½ 0.5 watts, 0.5 megohm
R35A, R36A	Western Electric No. 18BU Resistances, 300 ohms ± 1%
R37A	Western Electric No. 18AC Resistance, 500 ohms ± 5%
R40A	Western Electric No. 38A Resistance, 48,000 ohms ± 5%
R41A	Western Electric No. 38N Resistance, 24,000 ohms ± 4%
R44A	Ward Leonard Type "A" Resistance, No. 206 Terminals, 130 ohms ± 5%
R45A	Western Electric No. 38C Resistance, 15,000 ohms ± 5%

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
R47.1A	Ward-Leonard Type "D" Resistance, Type 205 Terminals 8000 ohms ± 2% tapped at 4600, 4800, 5000, 5200, 5400, 5600, 5800 and 6000 ohms
R47.2A	Ward-Leonard Type "D" Resistance, No. 205 Terminals, 8500 ohms ± 2%
R47.3A, R47.4A	Ward-Leonard Type "D" Resistances, No. 205 Terminals, 15,000 ohms ± 10%
R48A, R49A	Ward-Leonard Plaque Type Resistances, K-40210, 50 ohms ± 10%
R50A, R51A	Durham MF-4 Resistances, 1 watt, 1 megohm
R53A	General Radio Potentiometer 50 ohms, Type No. 214 (Modified per Detail 1A, ESO-600703)
R63A	Western Electric No. 1J Resistance, 20 ohms ± 5%
R66A	Continental Resistor Company Type D2 Resistance, 20,000 ohms
R68A	Continental Resistor Company Type D2 Resistance, 100,000 ohms
R69A	Western Electric No. 18BL Resistance, 750 ohms ± 5%
R70A	Western Electric No. 18CH Resistance, 1.2 ohms ± 1%
R73A	Western Electric No. 18CH Resistance, 1.2 ohms ± 1%
R76A	Ward-Leonard Type Z Resistance, 1½" long, 1500 ohms, Type 219 Terminals
R77A	Western Electric No. 18CS Resistance, 0.6 ohm ± 5%
R78A	Ward Leonard Type "D" Resistance, 2" long, 1500 ohms ± 10%, Type 219 Terminals
R79A	Ward-Leonard Type "D" Resistance, 8½" long, 32,000 ohms ± 10%, Type 219 Terminals
R80A	Western Electric No. 38AA Resistance, 10,000 ohms ± 4%
R81.1A R81.2A R81.3A R81.4A	Ward-Leonard Type No. K-40026 Plaque Resistances, 600 ohms
R82A	Ward-Leonard Type "D" Resistance, 2" long, 1500 ohms ± 10%, Type 219 Terminals
R83A R84A R85A	Western Electric No. 18EW Resistances, 5000 ohms ± 5%
R86A R87A	General Radio Potentiometers Cat. No. 301A, 2500 ohms
R88A	Western Electric No. 38C Resistance, 15,000 ohms ± 5%
R89A	Western Electric No. 1AH Resistance, 1.4 ohms ± 1%
S1A	Western Electric KS-6994 Relay
S2A	Western Electric No. 235C Relay
S3A	Western Electric KS-7157 Relay
S4A	Western Electric No. E704 Relay with E1 Relay Cover
S5A	Western Electric KS-6995 Relay.
S6A	Signal Eng. Co. B4Z1 Relay

R94A Ward Leonard No 507-109 Resistor 10,000 Ohms ± 10% (Connected Across Terminals 1 and 4 of L35A)

APPARATUS LIST (Cont'd.)

Design No.	*Ordering Information*
T1A	Western Electric No. 247M Input Transformer
T2A	Western Electric No. 316D Transformer
T3A	Western Electric No. 316F Transformer
T4A	Western Electric No. 324A Transformer
T5A	Western Electric No. 315B Transformer
T7A	Western Electric No. 316E Transformer
T8A	Western Electric No. 324B Transformer
T9A	Western Electric No. 320D Transformer
T10A	Western Electric No. 105B Repeating Coil
T11A	Western Electric No. 262A Input Transformer.
T12A	Western Electric No. D-98573 Transformer
TC1.1A	Weston Heating Element per Weston Drawing CD-51014, 0-100 ma.
TC1.2A	Weston Heating Element per Weston Drawing CD-51014, (Calibrated with M2A) 0-2 amp.
TC2A	Weston Heating Element per Weston Drawing CD-51014, (Calibrated with M3A) 0-2 amp.
V1Y, V2A, V3.1A, V3.2A	Western Electric No. 271A Vacuum Tubes
V4A, V5A	Western Electric No. 212E Vacuum Tubes
V6A, V7A, V8A, V9A, V10A, V11A	Western Electric No. 258B (Rectifier) Vacuum Tubes
V12A	Western Electric No. 287A Vacuum Tube
V13A	Western Electric No. 271A Tube
V14A	Western Electric No. 242A Tube
V15A	RCA 84 Tube
VS2A, VS3.1A, VS3.2A	Eby 4-11-UY Vacuum Tube Sockets
VS4A, VS5A	Western Electric Tube Mounting Detail per ESO-600668
VS6A, VS7A, VS8A, VS9A, VS10A, VS11A	Western Electric No. 139A Vacuum Tube Sockets
VS12A	Western Electric No. 137A Vacuum Tube Socket
VS13A	Eby 33-11-B Vacuum Tube Socket
VS14A	Western Electric No. 145A Vacuum Tube Socket
VS15	Eby 33-11-A Vacuum Tube Socket

1, 0-100 ma.
(Calibrated
4, (Calibrated

The equipment described in this Bulletin
was designed and developed for the

Western Electric Company

by

BELL TELEPHONE LABORATORIES

Distributor in the United States

Graybar
ELECTRIC COMPANY

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A National Electric Service

Distributor for Canada and Newfoundland

Northern Electric Company
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International Standard Electric Corporation

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DENMARK
Standard Electric A/S., Raad-Mandsgade 71, **Copenhagen, N.**

EGYPT
Standard Telephones and Cables, Ltd., Shell House, Sharia Cherifein, **Cairo**

FRANCE
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HOLLAND
Bell Telephone Manufacturing Co., Scheldestraat 160-162, **The Hague**

HUNGARY
Standard Electric Co., Ltd., **Ujpest 4, n. Budapest**

INDIA
Standard Telephones and Cables, Ltd., 4, Esplanade East (P. O. Box 413), **Calcutta**

ITALY
Fabbrica Apparecchiature per Comunicazioni Elettriche, via Luigi Bodio N. 39, **Milan, (5-19)**

JAPAN
Nippon Electric Co., Ltd., 2 Mita Shikokumachi, Shiba-Ku, **Tokyo**

NEW ZEALAND
Standard Telephones and Cables (Australasia) Ltd., 24-26 Ballance Street, P. O. Box 638, **Wellington**

NORWAY
Standard Electric Aktieselskap, Hovin, Ostre Akre, **Oslo**

POLAND
Standard Electric Co. W. Polsce, Sp. Z.O.O. Wspolna 53, **Warsaw**

PORTUGAL
Standard Electrica, S.A. Praca Dos Restauradores 47-1, **Lisbon**

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Standard Electric Romana, S. A. 37 Calea Victoriei, **Bucuresti**

SOUTH AFRICA
Standard Telephones and Cables, Ltd., Court Chambers, 189 St. Andries St. (P. O. Box 515), **Pretoria**

SPAIN
Standard Electrica, S/A., Calle Ramirez de Prado 5 (Post Office Box 7040), **Madrid**

SWITZERLAND
Bell Telephone Manufacturing Co., 10 Bubenbergplatz, **Berne**

YUGOSLAVIA
Jugoslavensko Standard Electric Company, Akcionarsko Drustvo Kralja Aleksandra ul. 17, **Beograd**

90% Modulation

50	5.5%
100	6.5%
400	7.0%
1000	5.5%
5000	9.0%
7500	12.0%

Note If S1A fails to close in 15 Seconds by reason of S2A failing to function -- Close S1A in Manually

After sequence relays have operated and plate voltage is on the osc mod unit -- If no plate current is noted on 3RD AMPL PLATE CURRENT METER -- Possible cause failure of Xtal in 7000 unit to oscillate.

Distortion Measurement 1KW Auxilary Trans

Date June 30 1950
Eng Mabes- Mueller

Auxiliary transmitter retuned and modulated stage loaded to 180 Ma
Final stage loaded to approx 1.2 Amps
Twenty two and one half percent increase noted in both 100 watt and 1 Kw Final

RF power to sampling circuit for operating scope, distortion meter and percentage modulation reduced (seven turns on pickup coil reduced to two)

High freq Distortion on both 5000 & 7500 cycles reduced from 14-15 % to values shown in run.

50 Cycles	3.7 %
100 Cycles	4.2 %
400 Cycles	3.0 %
000 Cycles	4.5 %
000 Cycles	7.5 %
500 Cycles	7.5 %

Western Electric Company
INCORPORATED
195 BROADWAY NEW YORK
COrtlandt 7-7700

IN REPLY REFER TO

January 22, 1937

TO ALL VACUUM TUBE CATALOG HOLDERS

Enclosed herewith are new data sheets for your Vacuum Tube Catalog covering the tubes listed below:

220C	242C	281A
222A	245A	308B
232B	261A	313A
240B	267B	316A
241B	276A	

We are also enclosing a new classification list, dated December 21, 1936, which replaces Issue 1 of the Index dated June 15, 1936. The old index should be removed from the catalog and destroyed.

It will be noted that the new classification list, in addition to serving as an index to the catalog, rates the tubes under various classes of service in accordance with their output power. Moreover, the filament voltage and current and the plate voltage for each tube are also listed in tabular form.

It will be appreciated if the enclosed card, acknowledging receipt of this information, is signed and returned promptly.

Very truly yours

L. F. Rockoven

Sales Promotion Engineer

CFR:GW

Enc.