Instructions

250-WATT AM
BROADCAST TRANSMITTER

TYPE BT-20-A

MODEL 4BT20A1

ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

SYRACUSE, NEW YORK

INSTRUCTIONS

250-WATT AM
BROADCAST TRANSMITTER

TYPE BT-20-A

MODEL 4BT20A1

ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

ELECTRONICS PARK SYRACUSE 1, N.Y.

(In Canada, Canadian General Electric Company, Ltd., Toronto, Ont. Outside the U.S.A., and Canada, by: International General Electric Company, Inc., Electronics Dept., Schenectady, New York, U.S.A.)

3-48 (400)

PRINTED IN U.S.A.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SAFETY TO HUMAN LIFE

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

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

Antenna tuning houses, substations, and switch enclosures which are noninterlocked and normally unattended should be kept locked and Rules 1 and 2, below, should apply particularly to these portions of the equipment.

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

1. KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person be permitted to reach within or in any manner gain access to the 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 reliance be placed upon the interlock switches for removing voltages from the equipment.

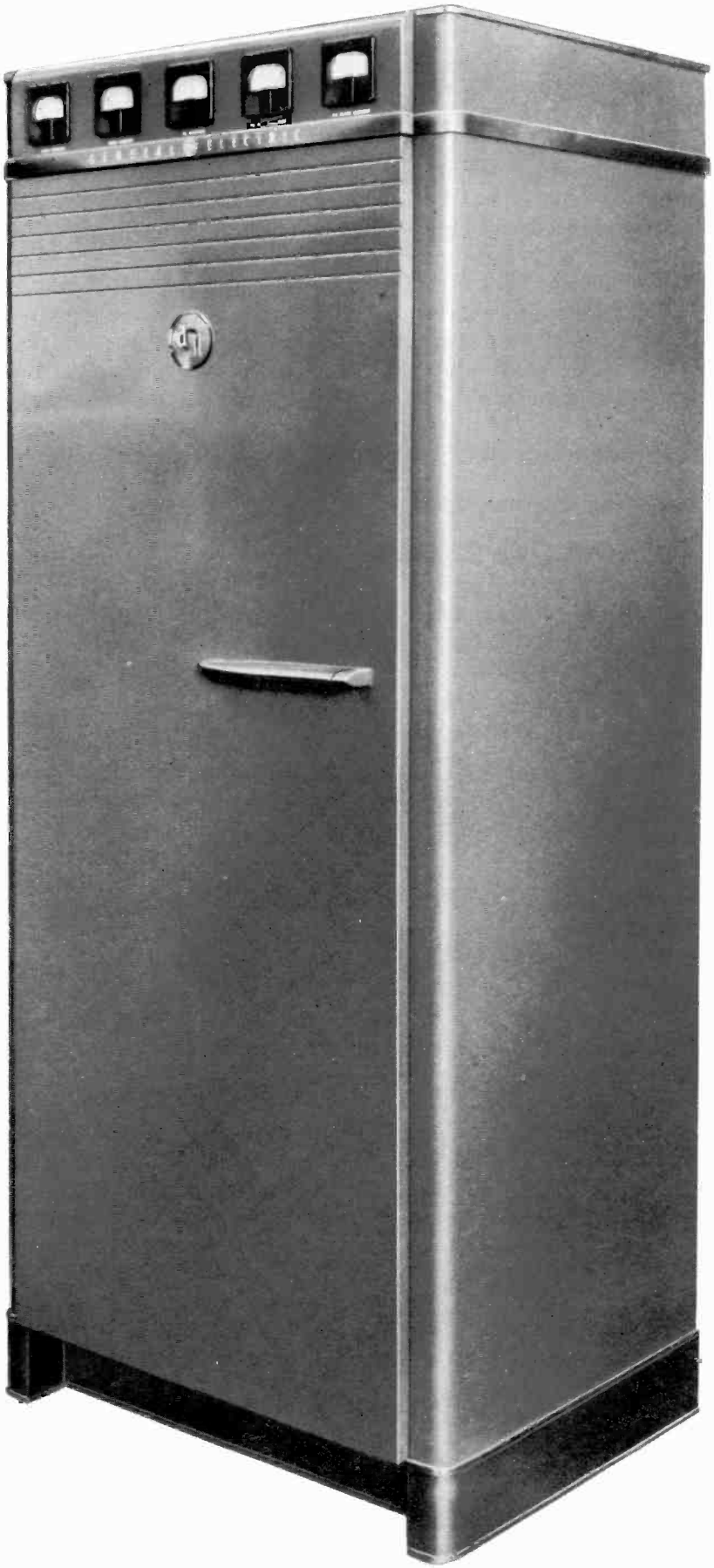


Fig. 1. Front View (SY1213A)

GENERAL SERVICE INFORMATION

SAFETY NOTICE

WARNING

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

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

PRODUCTION CHANGES

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

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

REPLACEMENT PARTS

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

REPLACEMENT TUBES

In all cases replacement tubes must be ordered from a local tube distributor.

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

INDUSTRIAL ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

EBI-17B 4/60 (10M)

PRINTED IN U.S.A.

WARRANTY

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

250-WATT AM BROADCAST TRANSMITTER

TYPE BT-20-A

MODEL 4BT20A1

INTRODUCTION

The General Electric Type BT-20-A Standard Broadcast Transmitter has been designed to provide the modern commercial broadcaster with an up-to-date 250-watt equipment capable of the highest quality performance at the lowest possible annual operating cost. The use of reliable components and carefully designed circuits insures a minimum of maintenance and program interruptions.

In designing the equipment, the best features of contemporary transmitters were carefully weighed. The opinions of many of the most experienced broadcasters have been thoughtfully considered. All of this, together with General Electric's many years of experience in building radio transmitters, has resulted in a design which we believe comes as close as possible to being the ideal broadcast transmitter in its power class.

The information contained in these instructions will familiarize you with your equipment and enable you to maintain top efficiency in performance.

SPECIFICATIONS

ELECTRICAL

Type of Emission: A3 (telephone)
Carrier Power Output (20-250 ohm load): 250 watts
Carrier Frequency Range: 540–1600 kc
Carrier Frequency Stability: Assigned frequency ±10 cycles
Power Supply: 115 volts ±5 per cent, 1-phase 50/60 cycles
Power Input:
Average program level: 1300 watts
100 per cent modulation: 1550 watts
Type of Modulation: High Level—Class B
Audio Input (600/150 ohms):
100 per cent modulation, sine wave: 10 dbm (10 milliwatts) ±2 db
Audio Frequency Response: Uniform within ±1.5 db, 30–10,000 cycles
Audio Frequency Distortion (at 95 per cent modulation): Less than 3 per cent RMS, 50 to 7500 cycles
Residual Noise and Hum (below 100 per cent modulation): 60 db unweighted
Methods and conditions of measurement conform with RMA Standards.

MECHANICAL

Height: 75 inches
Width: 30 inches
Depth: 25 inches
Depth (rear door open): 49 inches
Approximate Net Weight: 815 pounds.

FCC FILING DATA

In applying for a license, the following technical information may be entered in Section II-A, pages 1 and 2 of FCC Form 302:

2. Facilities authorized in construction permit:

Transmitter make	Type No.
General Electric	*BT-20-A*

4. Operating constants:

Class of operation of last radio frequency amplifier stage. (See Section 8 Standards of Good Engineering Practice Concerning Standard Broadcast Stations.)	A ☒ C ☐ B ☐ D ☐ BC ☐
Manufacturer's recommended operating efficiency for the last radio frequency amplifier stage in per cent.	65%

Tubes:

Make	Type	Number
General Electric	*GL-810*	2

Is inverse feedback utilized? Yes ☒ No ☐

If "Yes," to what value of feedback power is transmitter adjusted (in d.b.) *16 d.b.*

5. Indicating instruments in last radio stage:

	Manufacturer's name and type	Full scale reading
Plate voltmeter	*G-E TYPE DO-53*	*2 KV*
Plate ammeter	*G-E TYPE DO-53*	*500 ma*
Antenna ammeter	*G-E TYPE DO-54*	
Remote antenna ammeter		

9. Give method of varying power to compensate for variation of line voltage: *continuously variable r-f output coupling control on front panel.*

DESCRIPTION

GENERAL

The General Electric Type BT-20-A transmitter is a completely self-contained equipment mounted within an attractively-styled steel cabinet. The standard cabinet is finished in smooth-surfaced blue enamel with brushed stainless steel trim, and is constructed of heavy gage sheet steel with well-rounded corners and exceptionally sturdy non-sagging full-length doors, front and rear. A "kick-cove" is provided at the front of the cabinet to permit close approach without danger of marring the cabinet finish.

Five meters, which include all instruments necessary for visual inspection of normal operating conditions, are located across the top front of the cabinet at approximately eye level. These meters include a filament voltmeter, power amplifier plate voltmeter, power amplifier plate milliammeter and modulator plate milliammeters. To avoid confusion, all other meters which do not require frequent inspection, but are necessary for occasional circuit adjustments and metering of all tubes, are located on the dead-front control panel behind the front door. An r-f output or antenna ammeter is included.

The full-length front door, which covers all meters and controls except the five meters referred to above, serves two purposes. It improves the appearance of the transmitter by covering the meters and controls not requiring frequent inspection. It safeguards against accidental operation of these controls, thus insuring continuity of program.

The full-length rear door is electrically and mechanically interlocked so that high voltage is automatically removed and high-voltage circuits are grounded before the door can be opened. This furnishes complete safety

to the operating personnel.

Complete accessibility is maintained in all vital parts of this transmitter. Modified vertical chassis construction affords a new degree of ease in maintenance.

A new feature in a transmitter of this rating is its freedom from the effects of dust accumulation. The use of dust filters and a quiet-operating air blower unit almost completely eliminates the dust problem, and in addition insures much lower operating temperature for the cabinet interior than would be the case for natural draft ventilation. This results in longer life for both tubes and circuit components and greatly reduces the maintenance time required to keep the transmitter in first class operating condition.

EQUIPMENT FURNISHED

A standard equipment consists of the following units:

One G-E Type BT-20-A Transmitter

One R-F Ammeter, G-E Dwg. P-3R39

One Load-matching Capacitor, G-E Dwg. M-2R58

One Antenna Tuning Capacitor (if needed), G-E Dwg. M-2R52 or M-2R58

Vacuum-type Tank Capacitors, G-E Type GL-1L33 (quantity 2 to 6 depending on frequency)

Two Crystal Thermocells, G-E Type G-30

Two sets of Vacuum Tubes, each set consisting of the following:

Quantity	Type
1	GL-837
3	GL-828
2	GL-810
2	GL-1620
2	GL-8008
1	5R4GY

ACCESSORIES

Name of part	Quantity
Blue touch-up paint	1 pint
Gray touch-up paint	1 pint
G-E No. 1500 thinner	1 pint
Tinned wire—No. 10 gauge	3 feet
Wire terminals	11
No. 6 Allen wrench	2
No. 8 Allen wrench	2

AUXILIARY EQUIPMENT

A modulator load resistor for operation of the transmitter at reduced r-f output is available as extra equipment, if desired.

For installations experiencing high humidity, as in tropical locations, a Heater Unit G-E Type FH-1-A, is available, as extra equipment, which automatically applies heat to the cabinet interior whenever the main power line to the transmitter is de-energized.

INSTALLATION

GENERAL REQUIREMENTS

Upon receiving and unpacking the transmitter, give it a thorough inspection for possible shipping damage. Report any damage or shortages to the transportation company at once.

Requirements and information for installation are given on the included Installation Requirements Drawing (Fig. 14). Actual power requirements are given in the Electrical Specifications Section of this book.

The external wire recommended in Fig. 14 may be procured on separate order from the General Electric Company, if desired.

Install the Transmitter in a well-ventilated room where the temperature never exceeds 45 C (113 F). Conduits and external wiring should have been placed previously. Ground the cabinet to the station ground system by means of the ground stud provided.

If the slight noise produced by the cabinet blower is objectionable, locate studio and announcing facilities in a room separate from the Transmitter. A separate announcing booth will permit the operator to make announcements while still observing operation of the Transmitter through a glass panel. When this is impossible and where room temperatures do not exceed 35 C (95 F), natural ventilation may be used by removing the blower and the dust filters completely. In such cases a metal screen for protection to personnel should be placed over the opening from which the blower mounting plate was removed. More maintenance and general cleaning will be required when blower and dust filters are not used.

R.F. AMMETER IM6

TABLE 1 (250 WATTS)

ANTENNA OR TRANSMISSION LINE RESISTANCE RANGE (R)	ANTENNA OR TRANS. LINE CURRENT RANGE (UNMODULATED)	FULL SCALE OF METER	INSTRUMENT TO BE SUPPLIED
20 TO 45 OHMS	3.54 TO 2.36 AMP.	5 AMP.	P-3R39P24
45.1 TO 100 OHMS	2.36 TO 1.58 AMP.	3 AMP.	P-3R39P23
100.1 TO 250 OHMS	1.58 TO 1.00 AMP.	2 AMP.	P-3R39P22

VACUUM CAPACITOR IC30-IC35 INC.

TABLE 2

FREQUENCY (F) IN KC	NO OF CAPACITOR UNITS REQUIRED G.E. DWG. NO. K-7897602P3
540 - 600	6
601 - 700	5
701 - 900	4
901 - 1200	3
1201 - 1600	2

MICA CAPACITORS

TABLE 3

FREQUENCY (F) IN KC	LOAD-MATCHING CAPACITOR IC39 (ONE REQUIRED FOR EVERY TRANSMITTER) ANTENNA OR LINE RESISTANCE (R)		
	20 TO 45 OHMS	45 TO 100 OHMS	100 TO 250 OHMS
540 - 570	M-2R58 P23 (.009)	M-2R58 P20 (.006)	M-2R58 P18 (.004)
571 - 600	P22 (.008)	P19 (.005)	P18 (.004)
601 - 650	P21 (.007)	P18 (.004)	P17 (.003)
651 - 700	P20 (.006)	P17 (.003)	P16 (.0025)
701 - 800	P19 (.005)	P17 (.003)	P16 (.0025)
801 - 900	P18 (.004)	P16 (.0025)	P14 (.0015)
901 - 1050	P17 (.003)	P15 (.002)	P14 (.0015)
1051 - 1200	P15 (.002)	P14 (.0015)	P13 (.001)
1201 - 1400	P14 (.0015)	P14 (.0015)	P13 (.001)
1401 - 1600	M-2R58 P14 (.0015)	M-2R58 P13 (.001)	M-2R58 P8 (.0005)

TABLE 4

FREQUENCY (F) IN KC	ANTENNA-TUNING CAPACITOR IC40 (FOR TRANSMITTERS WORKING INTO INDUCTIVE ANTENNA WHEN +X EXCEEDS 50 OHMS) ANTENNA INDUCTIVE REACTANCE (+X)				
	+50 TO +150 OHMS	+150 TO +250 OHMS	+250 TO +350 OHMS	+350 TO +450 OHMS	+450 TO +550 OHMS
540 - 570	M2R58 P16 (.0025)	M-2R58 P14 (.0015)	M-2R52 P11 (.0009)	M-2R52 P9 (.0007)	M-2R52 P7 (.0005)
571 - 600	P16 (.0025)	P13 (.001)	P11 (.0009)	P8 (.0006)	P7 (.0005)
601 - 650	P16 (.0025)	P13 (.001)	P10 (.0008)	P8 (.0006)	P7 (.0005)
651 - 700	P15 (.002)	P13 (.001)	P9 (.0007)	P7 (.0005)	P6 (.0004)
701 - 800	P15 (.002)	P13 (.001)	P8 (.0006)	P7 (.0005)	P6 (.0004)
801 - 900	P14 (.0015)	P11 (.0008)	P8 (.0006)	P6 (.0004)	P5 (.0003)
901 - 1050	P14 (.0015)	P10 (.0007)	P7 (.0005)	P5 (.0003)	P5 (.0003)
1051 - 1200	P13 (.001)	P9 (.0006)	P6 (.0004)	P5 (.0003)	P4 (.00025)
1201 - 1400	P13 (.001)	P8 (.0005)	P6 (.0004)	P4 (.00025)	P3 (.0002)
1401 - 1600	M-2R58 P13 (.001)	M-2R58 P8 (.0005)	M-2R52 P5 (.0003)	M-2R52 P4 (.00025)	M-2R52 P3 (.0002)

PROCEDURE

I. CUSTOMER INFORMATION REQUIRED:
1. OPERATING FREQUENCY, F, IN KC.
2. ANTENNA OR TRANSMISSION-LINE RESISTANCE, R, IN OHMS.
3. IN CASE ANTENNA IS USED WITHOUT TRANSMISSION LINE, EITHER:
   A. ANTENNA INDUCTIVE REACTANCE, +X, IN OHMS, OR
   B. ANTENNA CAPACITIVE REACTANCE, -X, IN OHMS.

II. SELECTION OF R-F AMMETER, IM6.
1. QUANTITY 1 REQUIRED PER TRANSMITTER)
   FOR 250-WATT OPERATION SEE TABLE 1.
   FOR 100-WATT OPERATION SEE TABLE 5.

III. SELECTION OF VACUUM CAPACITORS IC30 TO IC35 INCL.
1. SEE TABLE 2 FOR QUANTITY.

IV. SELECTION OF MICA CAPACITOR IC39
1. SEE TABLE 3, QUANTITY 1 REQUIRED PER TRANSMITTER.

V. SELECTION OF MICA CAPACITOR IC40
1. NOT REQUIRED IF TRANSMISSION LINE IS USED (X=0)
2. NOT REQUIRED IF ANTENNA REACTANCE IS CAPACITIVE (-X)
3. NOT REQUIRED IF ANTENNA REACTANCE IS INDUCTIVE (+X) LESS THAN 50 OHMS.
4. IF ANTENNA REACTANCE IS INDUCTIVE, (+X) AND EXCEEDS 50 OHMS, SEE TABLE 4. QUANTITY 1 REQUIRED PER TRANSMITTER, IF USED.

VI. WHEN REFERENCE TO ENGINEERING IS REQUIRED.
1. IF ANTENNA HAVING CAPACITIVE REACTANCE (-X) IS USED WITHOUT TRANSMISSION LINE, AND ONLY IF -X EXCEEDS F/2 OHMS (WHERE F IS OPERATING FREQUENCY IN KC).

VII FOR 100 WATT OPERATION ONLY
SUPPLY RESISTOR 1R74, MOUNTING AND CONNECTIONS PER. G.E. DWG. ML-7479583 G1.

R.F. AMMETER IM6.

TABLE 5 (100 WATTS)

ANTENNA OR TRANSMISSION LINE RESISTANCE RANGE (R)	ANTENNA OR TRANSMISSION LINE CURRENT RANGE (UNMODULATED)	FULL SCALE OF METER	INSTRUMENT TO BE SUPPLIED
20 TO 45 OHMS	2.24 TO 1.49 AMP.	3 AMP.	P-3R39P23
45.1 TO 100 OHMS	1.49 TO 1.00 AMP.	2 AMP.	P-3R39P22
100.1 TO 250 OHMS	1.00 TO 0.633 AMP.	1.5 AMP.	P-3R39P21

EXAMPLES

FREQUENCY (F) IN KC	CUSTOMERS LOAD R	CUSTOMERS LOAD X	R.F. AMMETER IM6	VACUUM CAPACITORS IC30 TO IC35	MICA CAPACITORS IC39	MICA CAPACITORS IC40
580	30	+35	P-3R39 P24 (5 AMPS)	6	M-2R58 P22 (.008 mf)	NOT USED
750	77	-200	P-3R39 P23 (3 AMPS)	4	M-2R58 P17 (.003 mf)	NOT USED
1250	127	+410	P-3R39 P22 (2 AMPS)	2	M-2R58 P13 (.001 mf)	M-2R52 P4 (.00025 mf)
950	230	0	P-3R39 P22 (2 AMPS)	3	M-2R58 P14 (.0015 mf)	NOT USED
660	195	-425	P-3R39 P22 (2 AMPS)	5	M-2R58 P16 (.0025 mf)	REFER TO ENGINEERING

Fig. 2. Load and Frequency Application Drawing (P-7769376, Rev. 1)

IMPORTANT

The transmitter as shipped is connected for operation on 60-cycle supply. For 50-cycle operation change following internal connection in the Transmitter: remove the green-white control circuit supply wire from terminal 5 of transformer 1T13, and connect it to terminal 4. Leave the black-white-orange wire which is connected to the selenium rectifier, 1MR1, on transformer terminal 5. 1T13 is mounted on the lower right corner of the lower control panel as viewed from rear of cabinet. See Figs. 13 and 15.

INSTALLATION OF VACUUM CAPACITORS, MICA CAPACITORS AND R-F AMMETER

Refer to Load and Frequency Application Chart, Fig. 2, for proper type and quantity of vacuum capacitors, 1C30-1C35, load-matching capacitor, 1C39, antenna-tuning capacitor, 1C40, and r-f ammeter, 1M6. These parts are normally not installed at the factory. For installation of these parts, refer to Fig. 12, and mount in positions shown. Antenna capacitor 1C40 is needed only for inductive antennas. Connect 1C40 as shown on the Schematic Diagram, using the No. 10 tinned wire and terminals provided. Remove the phenolic panel located above the p-a tank coil, 1L10, by means of three mounting screws, to install the r-f ammeter, 1M6, and load-matching capacitor, 1C39. Make r-f connections by means of leads provided.

In case a remote-indicating antenna ammeter is to be used, mount the d-c instrument on the phenolic panel. Install a shielded pair of wires inside the cabinet, and terminate them on spare terminals of board 1TB13. Secure the shielded pair in such manner as to prevent accidental contact with other circuits. The r-f instrument, 1M6, may then be placed in the antenna lead at the base of the tower along with the r-f rectifier and line-terminating equipment.

INSTALLATION OF TUBES

After the Transmitter is installed and ready for operation (except for the actual application of power), install the tubes, as follows:

One Type GL-828 (1V2) on the buffer amplifier shelf. See Fig. 12 for location.

Two Type GL-810 power amplifiers (1V3 and 1V4) on PA shelf. See Fig. 12.

Two Type GL-1620 audio amplifiers (1V5 and 1V6) in audio amplifier unit. See Fig. 11.

Two Type GL-828 modulators (1V7 and 1V8) on modulator shelf. See Fig. 12.

Two Type GL-8008 high voltage rectifiers (1V10 and 1V11) on rectifier shelf. See Fig. 13.

One Type 5R4GY low power rectifier (1V9) on rectifier shelf. See Fig. 13.

The Type GL-837 tube (1V1) and the two Type G-30 crystal Thermocells (1Y1 and 1Y2) are to be installed later, as described under OPERATING PROCEDURE.

CONNECTION OF ANTENNA OR TRANSMISSION LINE

If direct operation into the antenna is desired, the Transmitter r-f output leads may be connected to wall bushings by copper tubing.

When a multi-wire 230-ohm transmission line is used, it will normally run from the antenna to wall bushings at the transmitter building as near as possible to the Transmitter. From these bushings the two circuits may be extended by two copper-tube conductors to the two output posts at the top of the Transmitter.

For installations using coaxial transmission line, this line may be extended overhead directly to the output posts. If desired, coaxial line may be brought up through the bottom of the cabinet at the right rear corner through the entrance hole provided. The line should extend upward to a point near the output posts where it can be cleated to the rear wall alongside the door. Short flexible connections may then be made from line to posts. The line must be securely fastened to prevent contact with high voltage near the latch-operated grounding switch.

INSTALLATION OF LIGHTNING PROTECTION CIRCUIT

It is recommended that protection be provided in the antenna lead-in against lightning or static damage. This may consist of a horn gap between the antenna lead-in and ground, a 2-turn inductive loop in series with the antenna line, and a static drain choke from the antenna lead in to ground. These may be installed at the point where the lead-in enters the building or at the antenna terminating unit. See Fig. 3.

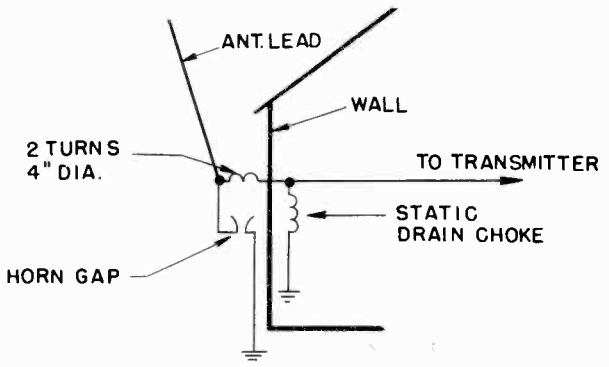


Fig. 3. Suggested Circuit for Lightning Protection

INSTALLATION OF RESISTOR FOR 100-WATT OPERATION

For 100-watt operation, a modulator-loading resistor, 1R74, is available. This resistor and mounting should be installed and wired in accordance with Fig. 4, by removing two cable cleats, placing resistor mounting straps *under* the cable, and replacing the cleats and screws so as to hold down both the cable and resistor mounting. The resistor mounting should be connected between the rear terminal of 1C41 and the lower terminal of 1R13 as shown, using wire and solder terminals provided. No dropping resistor is needed in the d-c plate supply to the power amplifier since r-f output may be reduced to any desired value by means of the LOAD COUPLING control, thus saving the d-c power which would otherwise be lost by such a resistor.

INSTALLATION OF HEATER UNIT

For locations subject to high humidity, a cabinet heater unit, G-E Type FH-1-A, should be installed on the left side of the cabinet near the bottom by means of the four tapped holes provided in the side wall channel section. See Fig. 4. The heater sockets should be wired to the crystal heater line fuses 1F1 and 1F2 to insure a continuous power supply. The relay coil circuit should be wired to terminals 1 and 2 of terminal board 1TB8. When installed in this manner, the heaters are energized whenever circuit breaker 1S7 is open, thus preventing condensation of moisture within the cabinet during shutdown periods. Heater elements are not supplied with this unit. Standard incandescent lamps of suitable wattage rating may be placed in the two sockets provided. Only enough heat is needed to raise the internal cabinet temperature a few degrees above the room ambient to prevent condensation of moisture during "off" periods.

CONNECTING POWER LINES

Be sure that the POWER circuit breaker switch, 1S7, on the front panel is in the OFF (down) position before applying power to terminals 13–7 and 13–8 of the Transmitter.

The power for the crystal heaters (connected to the lower terminals of fuses, 1F1 and 1F2) should come from a continuous supply such as the building lighting circuit.

THEORY OF OPERATION

Frequent reference should be made to the Schematic Diagram, Fig. 15, throughout this analysis.

RADIO FREQUENCY CIRCUITS

The crystal oscillator circuit is shown in the upper left-hand section of the Schematic Diagram. Two G-E Type G30 Crystal Thermocells, 1Y1 and 1Y2, are maintained at operating temperature (60 C) by power supplied through transformer 1T1. Either of the crystals may be switched into the oscillator circuit by means of front-panel switch 1S1 which also selects the proper frequency-trimmer capacitor, 1C4 or 1C5. The screen, cathode and control grid of the Type GL-837 tube, 1V1, provide the necessary tube elements for the grounded-plate triode oscillator of the Colpitts type. Capacitors 1C6 and 1C7 serve as the split-tank capacitors of the Colpitts circuit. The cathode is maintained at an r-f potential above ground by means of r-f choke 1L1. The screen grid in this circuit serves as the plate electrode of the oscillator, operating at r-f ground potential. Screen and suppressor d-c potentials are obtained from voltage-divider resistors 1R5, 1R6, 1R7, and 1R8. The electron-coupled load or output circuit consists of the 3-section coil, 1L2, and the variable capacitor 1C13, and forms a voltage-peaking circuit for obtaining maximum output voltage. It has no effect on oscillating capabilities of the oscillator portion of the circuit, and because of the excellent internal shielding of the tube, has negligible effect on crystal frequency.

The buffer amplifier uses a GL-828 tube, 1V2, operated under conditions approaching Class A to provide proper isolation between the crystal oscillator and modulated power amplifier. An adjustable pick-up coil, 1L4, is coupled to the plate-tank circuit of this stage to furnish a signal for frequency monitors of the type requiring an unmodulated input.

The modulated power amplifier employs two Type GL-810 tubes, 1V3 and 1V4, in parallel in a coil-neutralized circuit. The plate-tank circuit is tuned by variable capacitor, 1C36, in parallel with from two to six fixed vacuum-type capacitors, the exact number depending on the operating frequency. The plate-tank inductor, 1L10, is adjusted by means of "shorting" leads and taps to provide the proper inductance. The

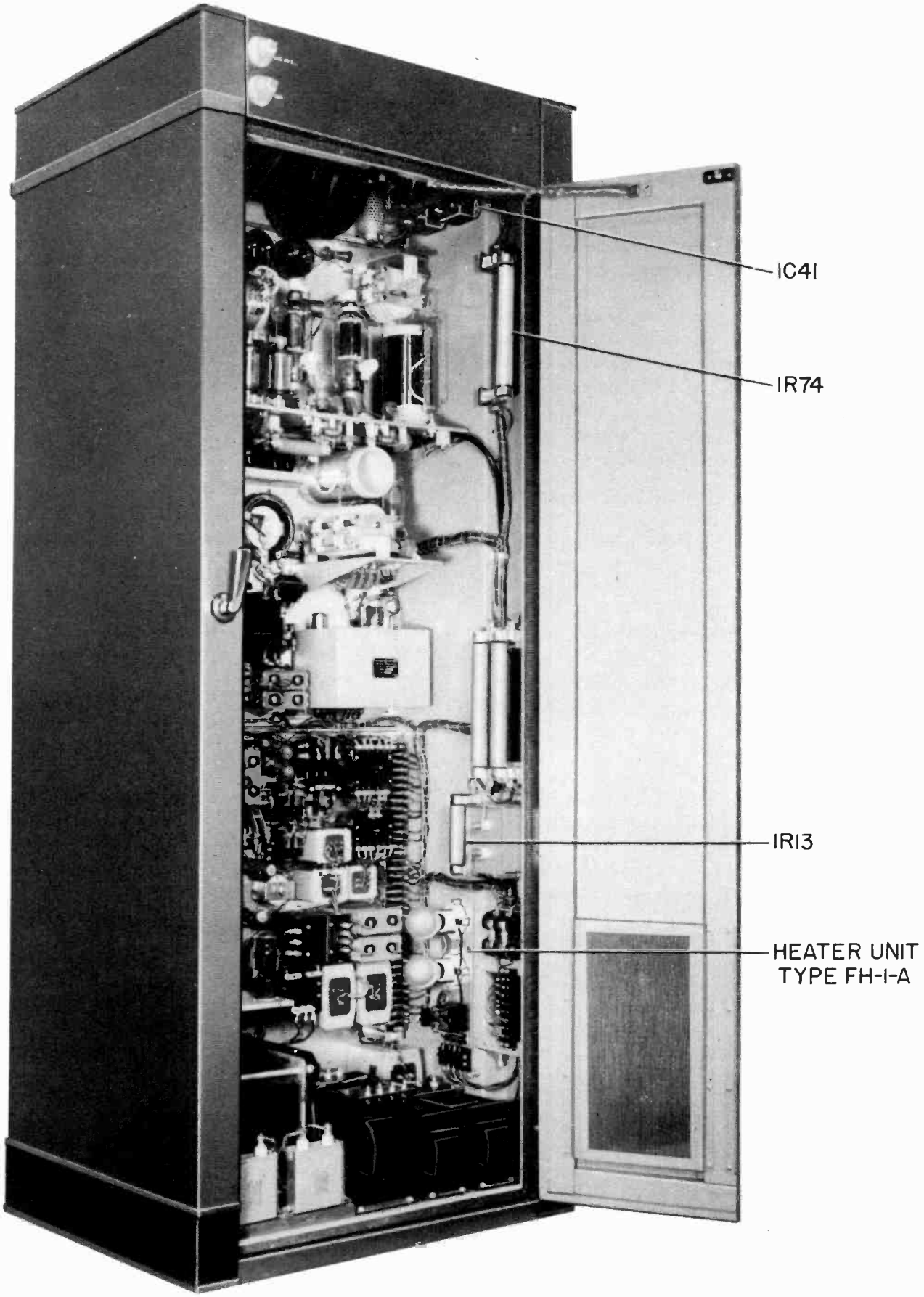


Fig. 4. Rear View Showing Heater Unit and Modulator Loading Resistor Installed (SY4945A)

coupling coil, 1L11, provides continuously variable loading. Inductors 1L13 and 1L18, together with capacitor 1C39, form the T-network for matching the external load to the optimum load for the tank circuit. This matching network also serves as a very effective filter for r-f harmonics. Inductor 1L18 is also used for tuning out capacitive reactance of the antenna if the Transmitter is to operate directly into it. For highly inductive antennas, capacitor 1C40 must be added to approximately tune out antenna inductance. Ammeter 1M6 may be used directly in the antenna circuit or in the transmission line. A d-c operated remote antenna ammeter may be mounted in this same location if desired. Overcurrent relay 1K6 serves to protect the power amplifier and rectifier tubes against excessive overloads.

AUDIO FREQUENCY CIRCUITS

Audio input is applied from a 600-ohm line, through input transformer 1T3 to the grids of the Type GL-1620 amplifier tubes, 1V5 and 1V6. Input impedance of 150 ohms is available if desired by disconnecting the primary leads from terminals 1 and 4 of 1T3 and reconnecting these leads to terminals 9 and 10. Capacitors 1C45 and 1C46 bypass high frequency noises that may appear on the audio line. Resistors 1R20 and 1R21 terminate 1T3 in its proper load impedance. By means of capacitor 1C47 and resistor 1R71, a voltage pulse is applied to the grids of the input audio amplifier tubes through the secondary of input transformer 1T3 at the instant plate voltage is applied. This counteracts or neutralizes the surge appearing on the grids of the modulator tubes due to charging of coupling capacitors 1C49 and 1C52. In this manner the starting current surge, which would otherwise appear on the plate circuit of the modulator tubes, is eliminated.

Inverse feedback voltage, obtained from the modulator-plate circuit, is applied to the cathodes of the input-audio amplifier. Approximately 16 db of feedback is used. Inductor 1L23, together with capacitor 1C44 and resistors 1R31 and 1R32, forms an audio compensation circuit connected across the feedback circuit, resulting in a flattening of the audio response in the middle range of frequencies.

The modulator consists of two Type GL-828 tubes, 1V7 and 1V8, operating as a Class B amplifier with nearly cut-off bias. Overcurrent relay, 1K7, protects the tubes and plate supply against loss of bias, short circuits, etc. The modulation transformer, 1T6, couples the modulator tubes to the Class C load for efficient operation.

The circuit consisting of 1L22 and 1C42, together with the characteristics of modulation transformer 1T6, serves as a constant impedance network to obtain optimum performance of the modulator over the entire audio-frequency range. An additional network, 1L21 and 1C41, provides a very sharp cutoff in audio response above 10 kc to avoid adjacent channel interference. The over-all result is an efficient low pass filter providing an almost ideal transmission characteristic.

RECTIFIERS

A half-wave selenium-type rectifier supplies grid-bias voltage to the modulator tubes.

A Type 5R4GY full-wave rectifier tube, 1V9, supplies screen voltage of good regulation to the modulator tubes. By means of a voltage divider, this rectifier also supplies plate voltage to the crystal oscillator and input-audio amplifier, screen and suppressor voltage to the buffer amplifier, and suppressor voltage to the modulator.

Two Type GL-8008 tubes, 1V10 and 1V11, as single-phase full-wave rectifiers supply plate voltage for the modulator, power amplifier and, through a dropping resistor, to the buffer amplifier. Taps on the primaries of plate transformers 1T8 and 1T10 permit adjustment of d-c voltages in approximately 5 per cent steps to compensate for low- or high-supply line voltage.

A latch-operated safety grounding switch directly grounds the high voltage source whenever the transmitter rear door is opened. The door latch also operates an interlock switch, 1S4, connected in the high-voltage control circuit.

POWER AND CONTROL CIRCUITS

Referring again to the Schematic Diagram, Fig. 15, the power and control circuits are shown in the lower right section. All power except the crystal heater supply is applied to the transmitter through the magnetic-trip circuit breaker, 1S7, which is mounted on the front panel. When this breaker, 1S7, is closed, power is applied to control supply transformer 1T13, cabinet-ventilating blower 1BM1, and the primaries of all filament transformers. Filament voltages may be adjusted by rheostat 1R70 until filament voltmeter 1M10 indicates the normal primary voltage of 100.

Control supply transformer 1T13 has a ratio of 1 to 1 and serves to isolate the supply line from the control circuit so that the latter may have one side grounded in accordance with the latest practice for providing maximum protection to operating personnel. Transformer 1T13, by virtue of its tapped secondary, also provides a means of obtaining 5/6 of the primary voltage for the various 60-cycle relays and contactors when operating on 50-cycle supply.

When the control circuit is first energized, the

motor of rectifier time delay relay 1K1 begins its operation. In approximately 30 seconds a normally-open contact of this relay closes, energizing the green "ready" light in the PLATE ON push button switch 1S2, through transformer 1T12, providing latch-operated interlock switch, 1S4, and door interlock, 1S5, are closed. A second contact in relay 1K1 de-energizes its driving motor after the main contact has closed.

The lighting of the green PLATE ON button indicates the equipment is ready for application of plate voltage. If PLATE ON button 1S2 is now depressed, the coil of relay 1K3 will be energized, closing its normally-open contact momentarily. This supplies power through the normally-closed contact of the plate "off" relay 1K5 to the coil of plate contactor 1K2, which then closes, supplying power to the primary of plate transformers 1T8 and 1T10. Simultaneously, another contact of 1K2 closes across the contact of plate "on" relay 1K3, thus locking 1K2 "in." A normally-closed contact of 1K2 opens and de-energizes the light in the green PLATE ON button, 1S2. The light in the red PLATE OFF button 1S3 is now energized through transformer 1T11 across the coil of 1K2.

When plate contactor 1K2 is energized, power-failure-reclosing relay 1K4 is also excited and, by means of its instantaneous-closing, time-delay-opening contact, bridges across the contacts of time delay relay 1K1 and plate "on" relay 1K3. Whenever power is interrupted momentarily, as during an electrical storm, the contact of relay 1K4 remains closed up to 3 seconds. If power is re-applied during this 3-second interval, the program automatically returns "to the air" with no additional delay. A re-application of power after a failure of longer than 3 seconds necessitates waiting 30 seconds for relay 1K1 to close. This permits the rectifier tube filaments to reach normal temperature before plate voltage is re-applied manually.

Plate voltage is removed by depressing PLATE OFF button 1S3 which energizes plate "off" relay 1K5. Relay 1K5 locks itself "in" with its normally-open contact. Its normally-closed contact, in series with the coil of 1K2, is thus held open until the PLATE ON button is depressed, thus energizing the plate "on" relay 1K3 which in turn opens the "lock-in" circuit of relay 1K5.

Overcurrent relays 1K6 and 1K7 act in a manner similar to that of the PLATE OFF button by energizing the plate "off" relay 1K5, when a heavy d-c overload or short circuit occurs in the power amplifier or modulator. Plate voltage must then be re-applied manually by use of the PLATE ON button. Slight overloads will not cause these relays to "trip." Therefore overloads of this type, if allowed to persist, will result in shortened tube life, and should be avoided.

PLATE ON and PLATE OFF control circuits may be extended to a transmitter control console by means of the terminals provided.

Heavy a-c overloads, such as those caused by rectifier tube arc-backs, will trip the magnetic circuit breaker 1S7. This device is of trip-free design. To reclose 1S7 after an overload trip, the handle must be returned to full "off" position and then closed in the normal manner.

OPERATING PROCEDURE

GENERAL

The following describes the proper method of placing the Transmitter in operation for the first time after installation. Because dial tuning controls probably will not be in their proper position when the equipment is received, their tuning is included. Adjustment of certain other controls is also covered because the setting of these controls may be affected by the installation of tubes other than those used during test.

PRELIMINARY ADJUSTMENTS

(a) First be sure that the POWER circuit breaker switch is in the OFF (down) position.

(b) Remove the plate caps from the Type GL-8008 high-voltage rectifier tubes (1V10 an 1V11).

(c) Turn FIL VOLTAGE as far in counterclockwise direction as it will go.

(d) Turn MODULATOR BIAS controls to their extreme counterclockwise position by means of a screw driver.

(e) Connect flexible lead between bottom of neutralizing coil, 1L8, upward, with bottom tap as No. 1, as follows:

Frequency (KC)	Connect between Taps
540–750	1 and 1 (no "short")
751–950	1 and 2
951–1250	1 and 3
1251–1600	1 and 4

(f) Connect buffer plate tank coil, 1L3, as follows:

Frequency (KC)	
540–970	use whole coil
971–1600	"short" out rear section from end to tap near center

(g) Make proper tap connections to p-a tank coil, 1L10, by means of the *two* flexible connectors. Make rough adjustment of inductance by connecting the coarse tap "SHORTING LEAD" (longer of the two leads) between two or more of the 8-turn taps, in accordance with Fig. 5*, to "short out" as much as

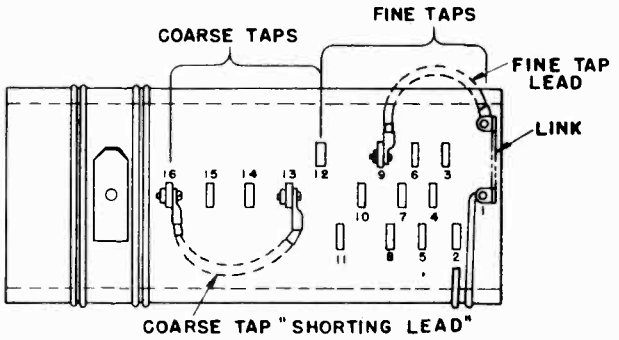


PLATE TANK INDUCTOR, 1L10 (REAR VIEW)

FREQUENCY RANGE (KC)	COARSE TAPS SHORTED
540 - 760	NONE
760 - 810	13 - 12
810 - 1030	14 - 13
1030 - 1370	15 - 13
1370 - 1600	16 - 13

Fig. 5. Plate Tank Tap Chart (K-7989514, Rev. 1)

necessary of the center section of the coil. Make finer adjustment by connecting the FINE TAP LEAD (shorter lead), in one of two ways; either by "shorting out" turns at the end, or by tapping in single turns. The latter method is preferred, and, in this case, the short LINK between the terminal stud and tap No. 1 at the end of the coil must be removed and the free end of FINE TAP LEAD placed on some tap between taps 1 and 12, depending upon frequency. If the "shorting" method is used, never "short" less than five turns from the end to avoid overheating the "shorted" section of winding.

The FINE TAP LEAD can, as yet, only be placed in an estimated position. Its correct final location will be determined by the procedure described under TUNING.

By proper selection of coarse and fine tap adjustment, it is possible to obtain resonance very nearly in the center of the PA TUNING dial which controls the variable tank tuning capacitor, 1C36.

* Tap 12 was not included in early production. Tap #11 may be substituted in such cases, adding the short LINK, if necessary.

(h) Remove the cover of the crystal oscillator unit and solder the connection link across the proper terminals of plate coil, 1L2, as follows:

Frequency (KC)	Connect Terminals
540–700	no link
701–1100	1 to 2
1101–1600	1 to 3

Replace cover, install Type GL-837, 1V1, oscillator tube and the two Type G-30 crystal Thermocells, 1Y1 and 1Y2. See Fig. 12.

(i) Place POWER switch in ON position and adjust FIL VOLTAGE control until FIL VOLTAGE meter indicates 100 volts (red line).

Approximately 30 seconds after the POWER switch is closed, the green PLATE ON push button should light, provided the rear door is closed. This indicates that plate voltage may now be applied.

At initial installation, or at any time the GL-8008 rectifier tubes are removed and replaced, these tubes should be allowed to heat for 15 or 20 minutes until all mercury has evaporated off the glass envelopes and other elements of the tubes.

(j) After power has been connected 15 or 20 minutes to the crystal heater circuits, the heater indicator lamps on the front panel should light intermittently, indicating that the crystals have reached operating temperature.

TUNING

NOTE

Always use the PLATE OFF button on the front panel for removing plate voltage. Do not use the rear-door latch-operated safety grounding switch for this purpose. This switch, 1S6, with its interlock, 1S4, is intended as a safety device only. Never apply screen voltage to the GL-828 tubes with plate caps or plate voltage removed.

(a) Press PLATE ON button.

(b) Adjust OSC PLATE tuning by means of a small screw driver to the point where a slight "dip" or minimum current reading is obtained on the CRYSTAL OSC CURRENT meter.

(c) Remove plate voltage and attach plate cap connector to *only one* of the Type GL-8008 high voltage rectifier tubes. This provides a plate supply of poor regulation and approximately half voltage for preliminary tuning.

(d) Set LOAD COUPLING control at zero.

(e) Apply plate voltage and adjust BUFFER TUNING to a point near, but not at, the minimum reading on the BUFFER CURRENT meter, to allow only a *small* flow of PA GRID CURRENT (10 to 25 ma).

(f) Adjust PA TUNING for a "dip" or minimum on the PA PLATE CURRENT meter, readjusting p-a tank-coil taps, if necessary, to locate the tuning point

near the center of the PA TUNING dial. See PRELIMINARY ADJUSTMENTS, paragraph (g).

(g) Remove plate voltage. Then disconnect the p-a high-voltage supply lead from ceramic terminal post, PO-3, located under the right hand end of the power amplifier shelf, as viewed from the rear of the Transmitter. Make certain this lead touches no other wires or parts of the Transmitter. This operation disconnects the plate voltage from the power amplifier.

(h) Apply plate voltage and adjust BUFFER TUNING for *maximum* PA GRID CURRENT.

(i) Adjust the PA TUNING control from side to side through its tuning point and note the reaction on the PA GRID CURRENT. Simultaneously adjust the NEUTRALIZING control to minimize this reaction. A position of the NEUTRALIZING dial will be found where no reaction is visible on the PA GRID CURRENT meter when the PA TUNING control is varied through resonance. Vary the PA TUNING widely on both sides of the resonance point at which grid reaction was last observed to make certain you have not passed through the correct point on the NEUTRALIZING control which would result in shifting the resonance point on the PA TUNING dial.

(j) Attach second plate-cap connector to high-voltage rectifier tube and re-apply plate voltage.

(k) Recheck neutralizing operation under (i). The PA GRID CURRENT should now read at least 100 ma.

(l) The power amplifier is now properly neutralized. Replace the high-voltage supply lead on post PO-3.

CAUTION

The PA TUNING dial should be carefully adjusted to minimum PA PLATE CURRENT when full r-f drive is applied, to avoid overheating the tubes.

(m) The FINE TAP LEAD at the end of the p-a tank coil, 1L10, may now require slight readjustment to bring the tuning point near the center of the PA TUNING dial. Carefully note the final dial reading. This is the tuning point when loading into *pure resistance load*.

It is assumed the LOAD COUPLING control remained at zero for all adjustments described above.

LOADING THE TRANSMITTER

The load-matching circuit consists of a T-network, including inductors 1L13, 1L18, and capacitor, 1C39. The values required for these three components depend on the load resistance to be used, and the correct values result in transforming the external load impedance to a value suitable for efficient operation of the power amplifier. The inductors are adjustable, and the capacitor, 1C39, has been supplied to meet a particular range of loads.

Inductor 1L18 has considerably more inductance than inductor 1L13. This extra inductance is used to "tune out" capacitance in a capacitively reactive load.

Antenna tuning capacitor 1C40 is used in combination with inductor 1L18 to "tune out" inductive reactance of the load. This capacitor is not supplied where resistive or capacitive loads are to be used, or where the load has less than 50-ohms inductive reactance.

First, it will be assumed that a pure resistance load is to be used. This is the case where a properly terminated transmission line is used between the transmitter and the antenna.

Adjust the load-matching coil, 1L13, to approximately half inductance by means of the LOAD MATCHING dial on the front panel.

"Short out" approximately two-thirds of the antenna tuning coil, 1L18, from the panel end.

Apply plate voltage and slowly increase LOAD COUPLING, starting from zero on the dial. The PA

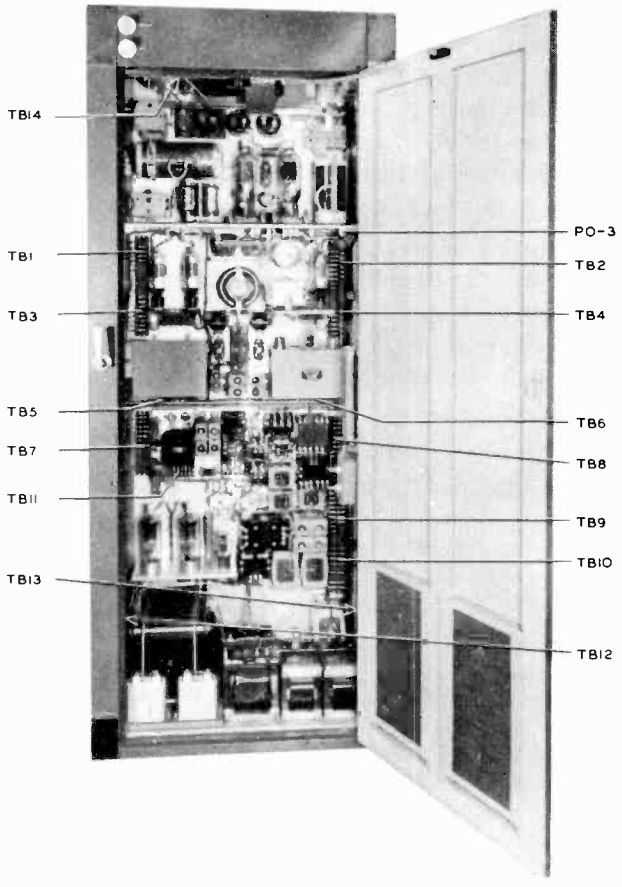


Fig. 6. Rear View, Parts Identified (SY2379B)

PLATE CURRENT should increase. Readjust the PA TUNING for *minimum* PA PLATE CURRENT and simultaneously adjust the LOAD MATCHING control in a direction to increase the loading (PA PLATE CURRENT).

Any need for readjusting the PA TUNING to a dial setting different from that originally obtained at zero LOAD COUPLING is an indication that undesirable reactance is being coupled into the power amplifier tank. Proper adjustment of LOAD MATCHING results in coupling-in only pure resistance, with no effect on PA TUNING. This adjustment will be found at or very near maximum loading as determined by the LOAD MATCHING control.

Maximum LOAD COUPLING occurs at 50 divisions (half scale) on the dial. The impedance transformation should be such as to result in full load coupling at approximately 30 on the dial, to allow for reasonable leeway of adjustment in either direction during day-to-day operation, thus keeping power output constant. The LOAD COUPLING control provides a smooth, continuously variable power-output control, with no readjustment of PA TUNING required.

If normal loading occurs at LOAD COUPLING much less than 30 divisions, the resistance reflected in to the power amplifier is too low for maximum efficiency. If normal loading occurs at settings much above 30, the reflected resistance is too high to obtain reasonable room for adjustment of the dial. By proper adjustment of taps on the antenna tuning coil, 1L18, the reflected-in resistance may be made the correct value.

The LOAD MATCHING control should always be adjusted to or near maximum loading (PA PLATE CURRENT) to prevent any detuning of the power amplifier tank when the LOAD COUPLING is varied.

After correct load matching, the tuning point on the PA TUNING dial should be the same at either full load or no load.

The load matching coil, 1L13, should preferably not be operated nearly all "shorted out," since r-f harmonic radiation is greatly reduced by this coil. A good rule is to use a minimum of four or five turns in this coil; more if correct matching is possible. In general, fewer turns will be needed in 1L13 and 1L18 for low resistance loads, and more turns for high resistance.

By reducing LOAD COUPLING slightly to result in about one division (10 ma) less than normal full-load PA PLATE CURRENT, and then readjusting the PA TUNING control five or 10 divisions toward the high-frequency (high dial reading) side, to increase PA PLATE CURRENT to the original full load value, it is possible to reach a maximum in power amplifier plate efficiency. Readjustment of LOAD MATCHING may then be made so that PA TUNING occurs at the same point on the dial for either full load or zero load.

While load matching, by means of taps on antenna tuning coil, 1L18, has a great effect on the amount of LOAD COUPLING available. This coupling may also be affected by positioning of the central "shorted" section of the p-a tank coil, 1L10. The nearer the "shorted" section is to the coupling rotor, 1L11, the less LOAD COUPLING is available. Accordingly, near 1600 kc, the "shorted" section should start near the coupling rotor end of 1L10, while at lower frequencies it should be relatively farther away to increase the load coupling available, in accordance with Fig. 5.

So far, we have assumed the load connected to the Transmitter is pure resistance. This is the case where a transmission line is used, since the line must be properly terminated and matched to the antenna by an antenna tuning unit at the antenna end of the line.

For operation direct into the antenna, without a transmission line, the antenna tuning coil, 1L18, must be used to exactly "tune out" all capacitance ($-jX$) in the antenna. This simply means that more of 1L18 is needed in the circuit than would be the case for pure resistance loads.

For antennas having inductive ($+jX$) reactance less than about 50 ohms, the matching network will operate satisfactorily by reducing inductance in 1L18 below that normally needed for pure resistance loads. For inductive loads greater than 50 ohms, antenna tuning capacitor, 1C40, should be installed to approximately "tune out" the antenna inductance. Exact tuning can be accomplished by using the fine tap at the end of coil 1L18.

FREQUENCY ADJUSTMENT

The crystal oscillator unit is provided with two frequency-adjusting capacitors labeled FREQ TRIMMER on the front panel. These trimmers provide a few cycles of frequency adjustment for each of the two crystals. A small insulated screw driver, or one having insulating sleeving slipped over its shank so as not to electrically contact the panel, should be used for frequency adjustment.

At initial operation of the Transmitter, these two FREQ TRIMMERS should be adjusted, one for each crystal position, after the heat has been applied at least one-half hour to the crystal Thermocells, until the station frequency monitor indicates that the carrier is exactly on its assigned frequency. Thereafter, the FREQ TRIMMERS need adjustment very rarely. By means of the CRYSTAL SELECTOR switch, the operator may periodically place the spare crystal in operation, thus assuring that an operative spare crystal is always ready for service.

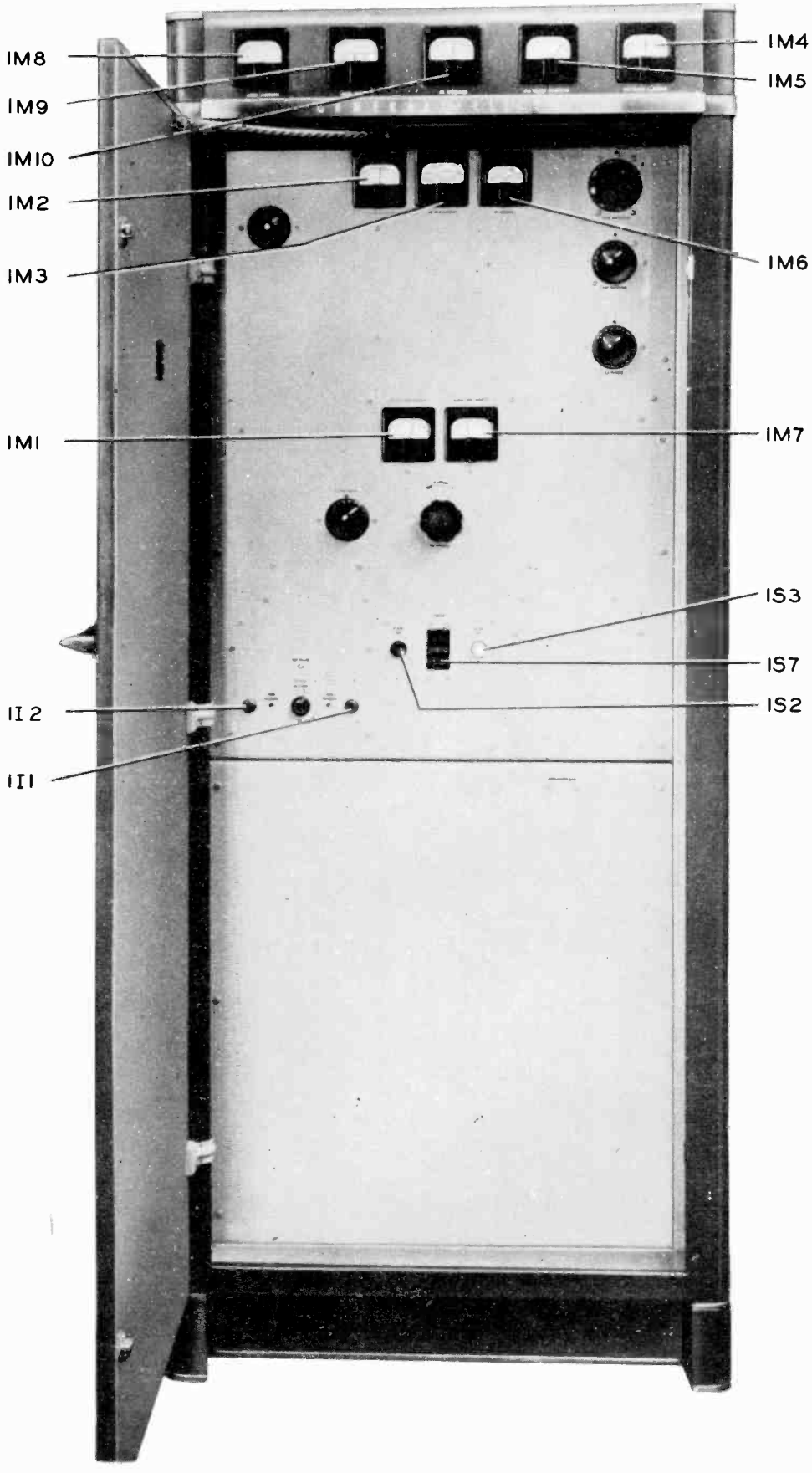


Fig. 7. Front View, Parts Identified (SY1209A)

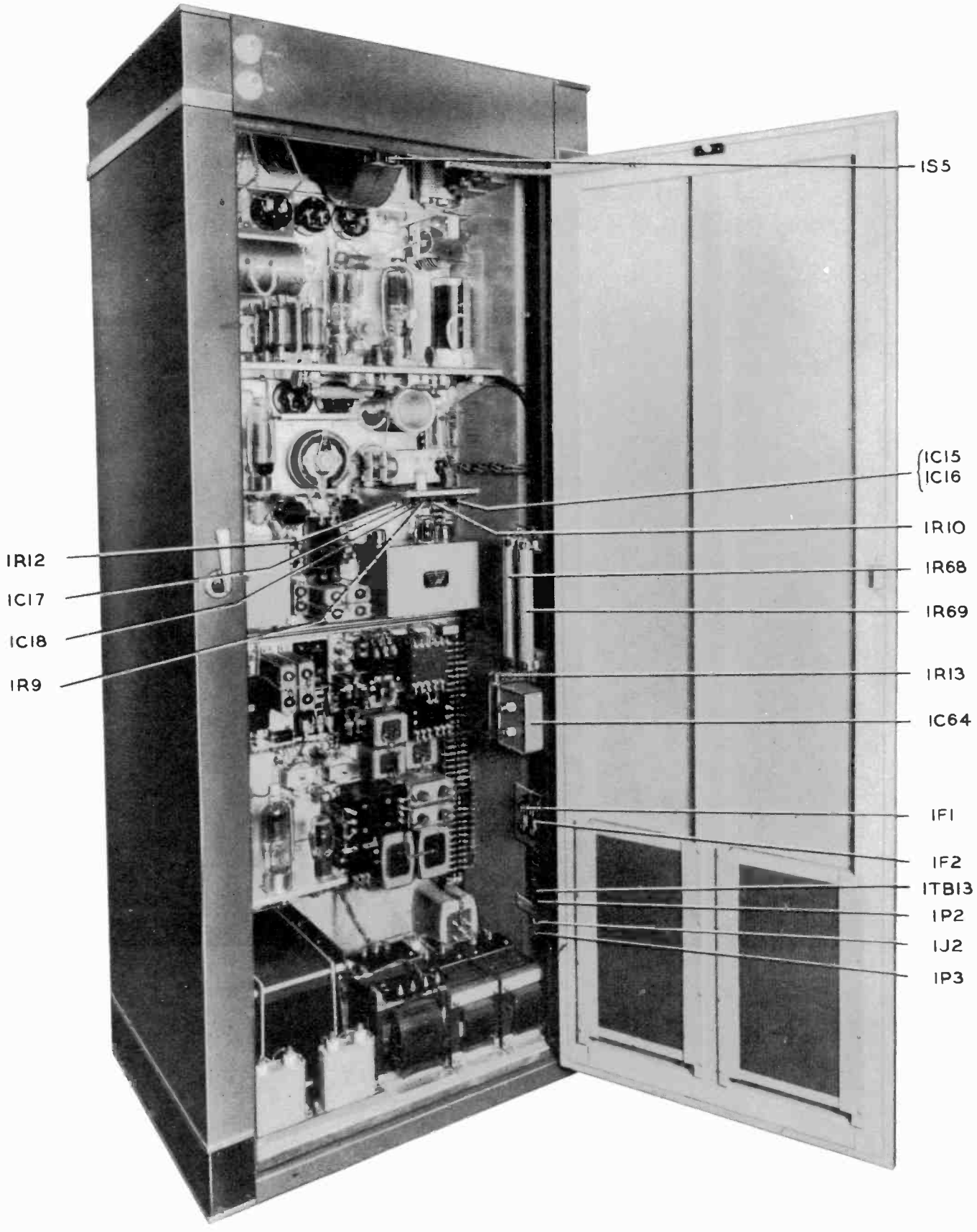


Fig. 8. Rear View, Parts on Left Side Identified (SY2382A)

APPLYING MODULATION

Apply plate voltage and adjust the MODULATOR BIAS potentiometers with a small screw driver by turning each control *slowly* in a clockwise direction until the two MOD CURRENT meters each indicate a value of 25 ma with no audio signal applied.

Audio voltage may now be applied to the Transmitter. The readings on both MOD CURRENT meters should increase in proportion to the audio voltage. At high levels of modulation, the two meter indications may not be exactly the same because of tube variations. This unbalance may sometimes be minimized by interchanging the two modulator tubes, and re-adjusting the MODULATOR BIAS controls as described in the preceding paragraph.

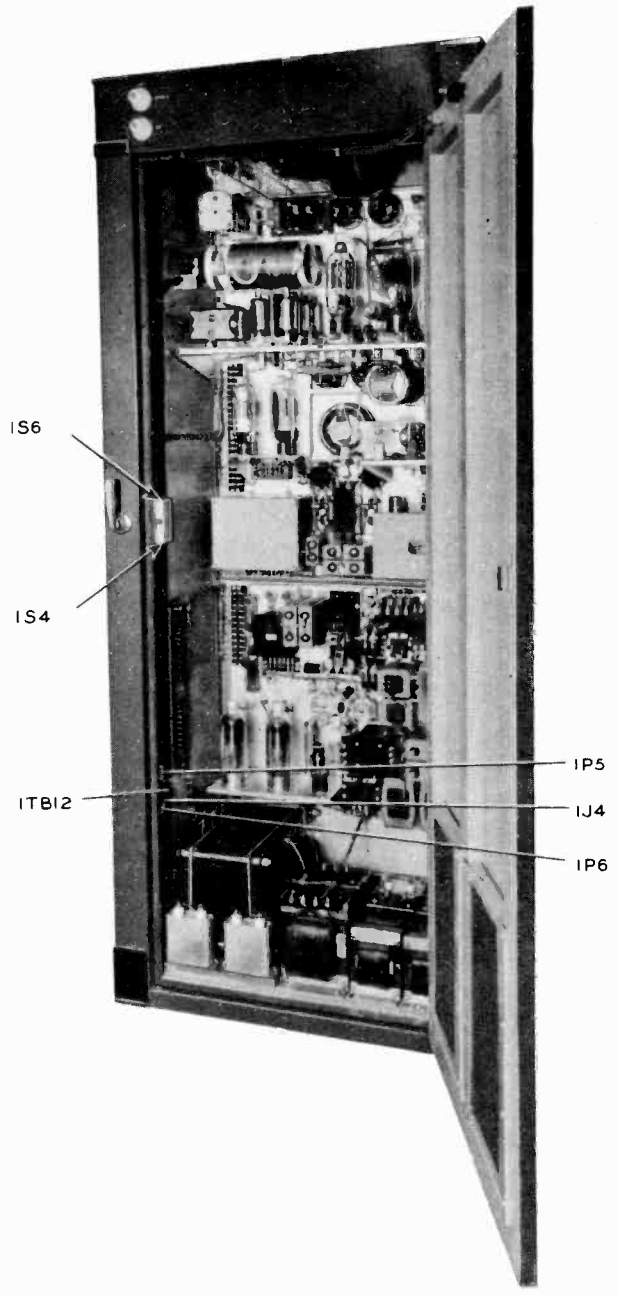


Fig. 9. Rear View, Parts on Right Side Identified (SY2378A)

TYPICAL METER READINGS

	POWER OUTPUT	
	250-W	100-W
MOD CURRENT, left and right 0 per cent modulation (ma)	25	25
100 per cent sine wave modulation (ma), 1000 cycles	125	125
FIL VOLTAGE (primary)	100	100
*PA PLATE VOLTAGE (kv) (Select proper primary tap on 1T10)	1.550±.050	1.550±.050
PA PLATE CURRENT (ma)	245±15	120±10
BUFFER CURRENT (ma)	80±10	80±10
PA GRID CURRENT (ma)	100±20	100±20
CRYSTAL OSC CURRENT (ma)	12±2	12±2
AUDIO AMPL CURRENT (ma)	3.8±0.4	3.8±0.4

*This is approximately 50 volts less than voltage to ground.

VOLTAGE MEASUREMENTS AND ADJUSTMENTS

Voltages to Ground Under Normal Operating Conditions

Crystal Oscillator Plate (adjustable by 1R61)	400
Crystal Oscillator Screen	135±15
Modulator and Buffer Suppressor (adjustable by 1R63)	85
Modulator Screens (no modulation) (select proper primary tap on 1T8)	750±25
Modulator Bias Rectifier	140
Modulator Bias (at 1R66 or 1R67) (for 25 ma plate current)	85 to 130
Modulator Plate	1600±50
Buffer Amplifier Plate	1150±100
Buffer Amplifier Screen	330±30
Audio Amplifier Plate	115±15
Audio Amplifier Screen	90±10

MAINTENANCE

PREVENTIVE MAINTENANCE

It is important to consider maintenance from a preventive standpoint, rather than one of trouble shooting. Routine maintenance requires periodic inspection with immediate repair, where needed, to avoid future trouble. If there is not time for such preventive repair, when it is needed, record the work to be done and do it as soon as possible.

(a) Routine inspection and cleaning. During inspection, notice the condition of various parts and sections of the Transmitter, especially as to the cleanliness. Clean where needed. Make routine inspection of all relay contacts and adjust and clean them, if necessary. Tighten any loose connections and any loose components on the terminal boards.

(b) Blower motor lubrication. Routine maintenance of the motor calls for annual dismantling and thorough cleaning of bearings and housings. The bearings should be repacked with G-E ball-bearing grease, available in tubes.

In repacking the bearings, fill in the space between the inner and outer races one-third full. Be careful not to overgrease. When assembling the bearing in the housing, fill the space in back of the housing one-third full of grease, as a reserve supply.

(c) Cleaning air filters. The intake air filters located at the bottom of the rear door, should be cleaned whenever inspection reveals appreciable dust. To remove them for cleaning, remove the clamping strips which are held by screws. Be careful of the felt seal. Oiled metal is used as a filter medium. Clean by dipping in gasoline or cleaning fluid: then dip in light lubricating oil, and drain smooth side downward.

(d) Relays. Power amplifier and modulator overcurrent relays, 1K6 and 1K7 respectively, are of the telephone type, and have closely spaced contacts. These relays should be inspected by pushing the armature against the pole-piece by hand and noting that the normally open contacts just barely close. The contacts may be bent slightly if necessary to attain this condition. This adjustment provides maximum space between open contacts (approximately $\frac{1}{32}$-inch) to prevent "chattering" or occasional closing with low-frequency modulation. The armature hinge and the space between armature and pole-piece should be kept free of magnetic dust which will cause erratic action. Relay 1K6 should operate at 600 ± 50 ma d-c. Relay 1K7 (shunted by resistor 1R72) should operate at 750 ± 50 ma d-c. They may be easily checked by means of a battery, ammeter and rheostat if desired, without removal of connections.

Power-failure reclosing relay 1K4 should be tested occasionally by lifting the armature by hand and then releasing it. The drop action should take place in approximately three seconds without a tendency to stick on the way down. The timing may be adjusted by loosening a nut and positioning a pin up or down in a slotted inertia disc.

CHECKING METER READINGS

Note the readings of all meters daily and compare to previous readings. A certain amount of day-to-day variation can be expected, but any trend is cause for suspicion. For instance, if the p-a plate current should drop slightly, day-by-day, chances are that one or both p-a tubes are losing emission.

The balance of current between the two p-a tubes may be checked by opening the link between terminals 7 and 8 on terminal board 1TB10 and comparing the voltage drop to ground from each of these terminals. The difference between the two voltages should not exceed 10 per cent of the greater of the two with new tubes. Gradual loss of emission in a tube may be discovered by making this balance test with 100 per cent modulation, 1000 cycles steady tone, applied to the transmitter. A record of such tests made monthly will indicate when a tube should be replaced. Always replace terminal board link after testing for p-a tube balance.

REPLACING A CABINET METER

Access to the cabinet meters is gained by removal of the protective shield located below the meters slightly above the top of the front door opening. This shield is prevented from being pushed upward by two stop screws at the rear and by a horizontal groove at the front. The stop screws are removable from the rear of the cabinet. They are located just above the upper lip of the p-a panel, near the edge. Remove them with a screw driver.

Push up the rear edge of the protective screen until the front edge leaves the groove. The shield now can be dropped down and out.

The meters are secured by four screws, one in each corner, which clear through holes in the cabinet and tap into brass inserts in the case. Remove the screws with a short screw driver and disconnect the meter leads.

TROUBLE SHOOTING TIPS

First, check the meter reading, and compare with previous readings. Replace the tube whose meter

INSTRUCTIONS FOR MAINTENANCE OF CABINET-COOLING BLOWER MOTORS

G-E DRAWING REFERENCE P-7767980-P2

G-E MOTOR CAT. NO. 5KH25AC272

(1BM1 IN TYPES BT-1-A AND BT-1-B 250-WATT FM TRANSMITTERS)

(4BM1 IN TYPE BF-3-A 10 KW FM AMPLIFIER)

AND

G-E DRAWING REFERENCE P-7769350-P1

G-E CAT. NO. 5KH25AC275

(1BM1 IN TYPE BT-20-A 250 WATT AM BROADCAST TRANSMITTER)

Routine maintenance of the cabinet cooling blower motor calls for annual dismantling and thorough cleaning of the bearings and housings. The bearings should then be repacked with G-E ball bearing grease or other ball bearing grease recommended by competent lubricant distributors. G-E grease is available in bulk or in tubes from G-E distributors.

A. DISASSEMBLY

To disassemble the blower proceed as follows:

1. Remove all power to the blower circuit and disconnect the internal leads from the terminal board on the blower shock mount plate.

2. Remover the blower and shock mount plate from the cabinet by removing the four screws which extend through the shock mounts.

3. Disconnect the motor power leads from the terminal board.

4. Remove the motor from the shock-mount plate by removing the nuts on the four motor mounting studs.

5. Remove the two flanges on the blower intake by removing the four nuts on the flange mounting studs.

6. Mark the motor shaft and blower impeller hub so that, in reassembling, the impeller can be replaced on the motor shaft in the same axial and angular position.

7. Loosen the two Allen set screws on the blower impeller using a No. 1/4-20 Allen wrench and remove the impeller.

8. Loosen the four through bolts at the nameplate end of the motor, using a properly fitting screwdriver.

9. Pull off motor flange with impeller housing attached. Take care not to lose the insulating sleeve on each of the four through bolts.

10. Pull out the armature and end casting at the nameplate end of the motor as far as the switch leads will permit.

11. Remove the four through bolts; be careful not to lose insulating sleeves.

12. One of the screws holding the switch is covered by the nameplate. Drive out (from inside) one of the two escutcheon pins holding the nameplate, and swing the nameplate out of the way.

13. Remove the small screws which hold the switch.

14. Remove the motor end flange.

B. CLEANING AND REPACKING

Clean both bearings and housings with a small stiff brush and carbon tetrachloride. When using this solvent, be careful to remove all traces of it from the bearing housing and do not allow it to remain in contact with the insulated windings. The room should be well ventilated while using it.

Repack the bearings with G-E ball bearing grease or other ball bearing grease recommended by competent lubricant distributors. In repacking the bearings, fill the space between the inner and outer races 1/3 full. Be careful not to overgrease. When assembling the bearings in the housings, fill the space back of the housings 1/3 full of grease.

C. REASSEMBLY

To re-assemble the blower proceed as follows:

1. Replace the two small screws holding the starting switch to the end flange.

2. Prepare to replace end flange. Be sure that the leads are not pinched and that the switch leads do not interfere with the operation of the switch or armature. Replace the four through bolts into the end flange and slip an insulating sleeve on each bolt. The sleeves must insulate between the through bolts and the motor field winding.

3. Replace the end flange. Be sure that the grommet on the power leads is in place.

4. Place the four remaining insulating sleeve on the free ends of the through bolts.

5. Replace the motor flange with fan housing attached and tighten the through bolts.

6. Swing the nameplate back into position and re-insert the escutcheon pin.

7. Replace the impeller on the motor shaft making sure that the axial and angular position are the same as before disassembly.

8. Replace the flanges on the blower housing, making sure that the intake flange with the small hole has the flange projecting inward and that the flange with the large hole has the flange projecting outward.

9. Replace the blower on the shock mounting plate, making sure that the blower exhaust is centered in the hole in the shock-mounting plate and that the blower is positioned square with respect to the mounting plate.

10. Test the blower on the power supply to make sure it runs freely and smoothly.

11. Remount the assembly in the cabinet and connect the power leads as they were before dis-assembly.

NOTE

Emergency lubrication:

Under normal conditions it is not recommended that the bearings be re-lubricated between period of regular servicing in accordance with the instructions given above. The plug in the end flange on the switch end of the motor is provided for unusual needs such as when a few drops of oil need to be inserted to restore grease to suitable condition after long storage, or during over-load operation which may require the addition of some grease.

ELECTRONICS DEPARTMENT

GENERAL ELECTRIC COMPANY

SYRACUSE, NEW YORK

8/48 (1500) Printed in USA

reading indicates improper operation. Should the same condition remain, a bad connection or component may be at fault. Refer to the Schematic Diagram and check continuity to the various socket terminals for voltage. Check the resistors associated with the stage. Finally, replace capacitors, if necessary.

In cases where operation seems normal despite an unusual meter reading, check the meter itself.

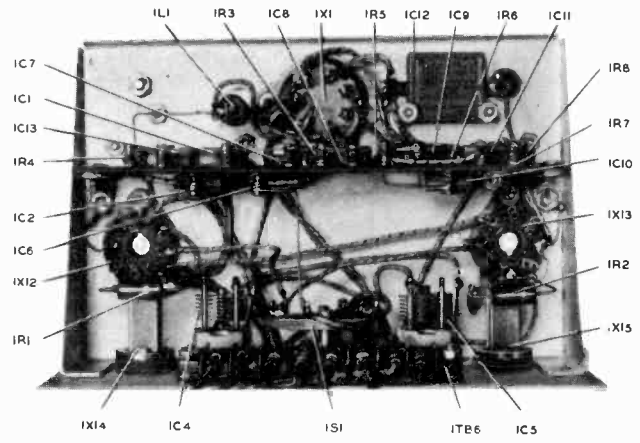


Fig. 10. Bottom View, Crystal Oscillator, Parts Identified (SY2070A)

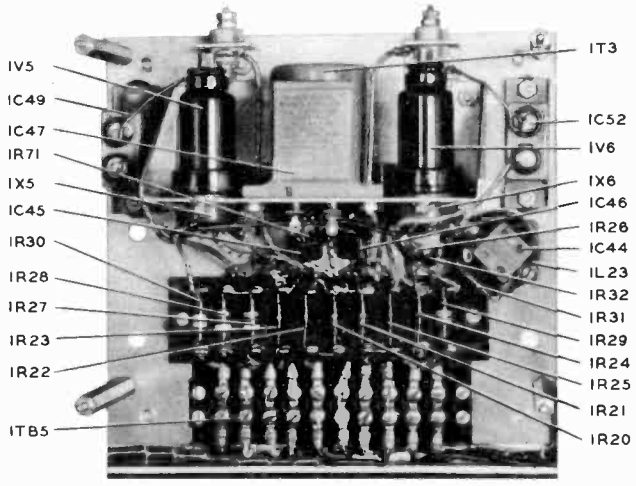


Fig. 11. Rear View, Audio Amplifier, Parts Identified (SY2381A)

OPERATING CONTROLS AND METERS ON FRONT PANEL:

Name	*Circuit Symbol*
POWER	1S7
PLATE ON	1S2
PLATE OFF	1S3
MODULATOR BIAS	1R66 and 1R67
CRYSTAL SELECTOR	1S1
FREQ TRIMMER	1C4 and 1C5
FIL VOLTAGE	1R70
BUFFER TUNING	1C19
NEUTRALIZING	1C28
PA TUNING	1C36
LOAD COUPLING	1L11
LOAD MATCHING	1L13
CRYSTAL OSC CURRENT	1M1
AUDIO AMPL CURRENT	1M7
BUFFER CURRENT	1M2
PA GRID CURRENT	1M3
RF CURRENT	1M6
MOD CURRENT	1M8
MOD CURRENT	1M9
FIL VOLTAGE	1M10
PA PLATE VOLTAGE	1M5
PA PLATE CURRENT	1M4

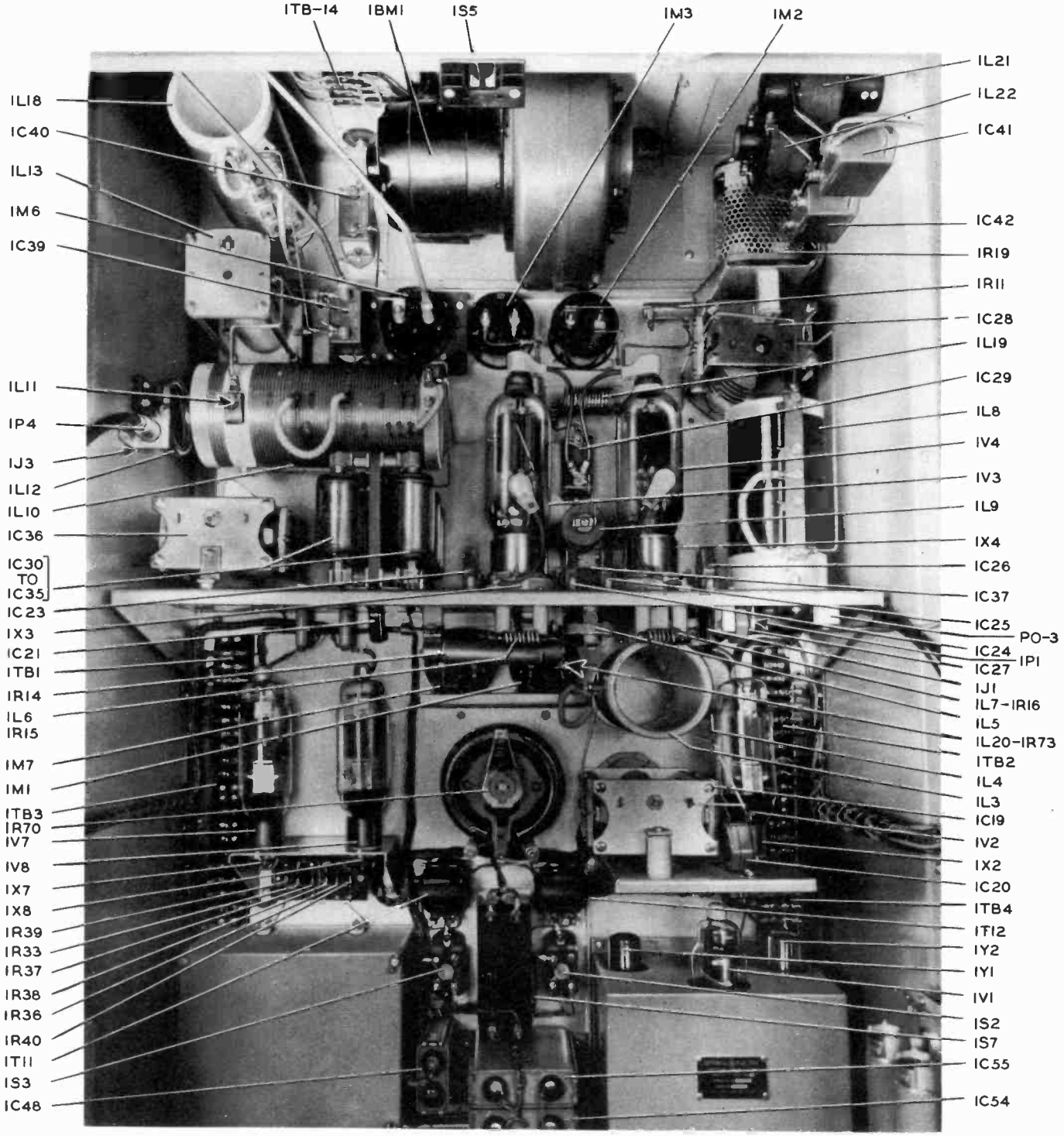


Fig. 12. Rear View, Upper Panel, Parts Identified (SY2380A)

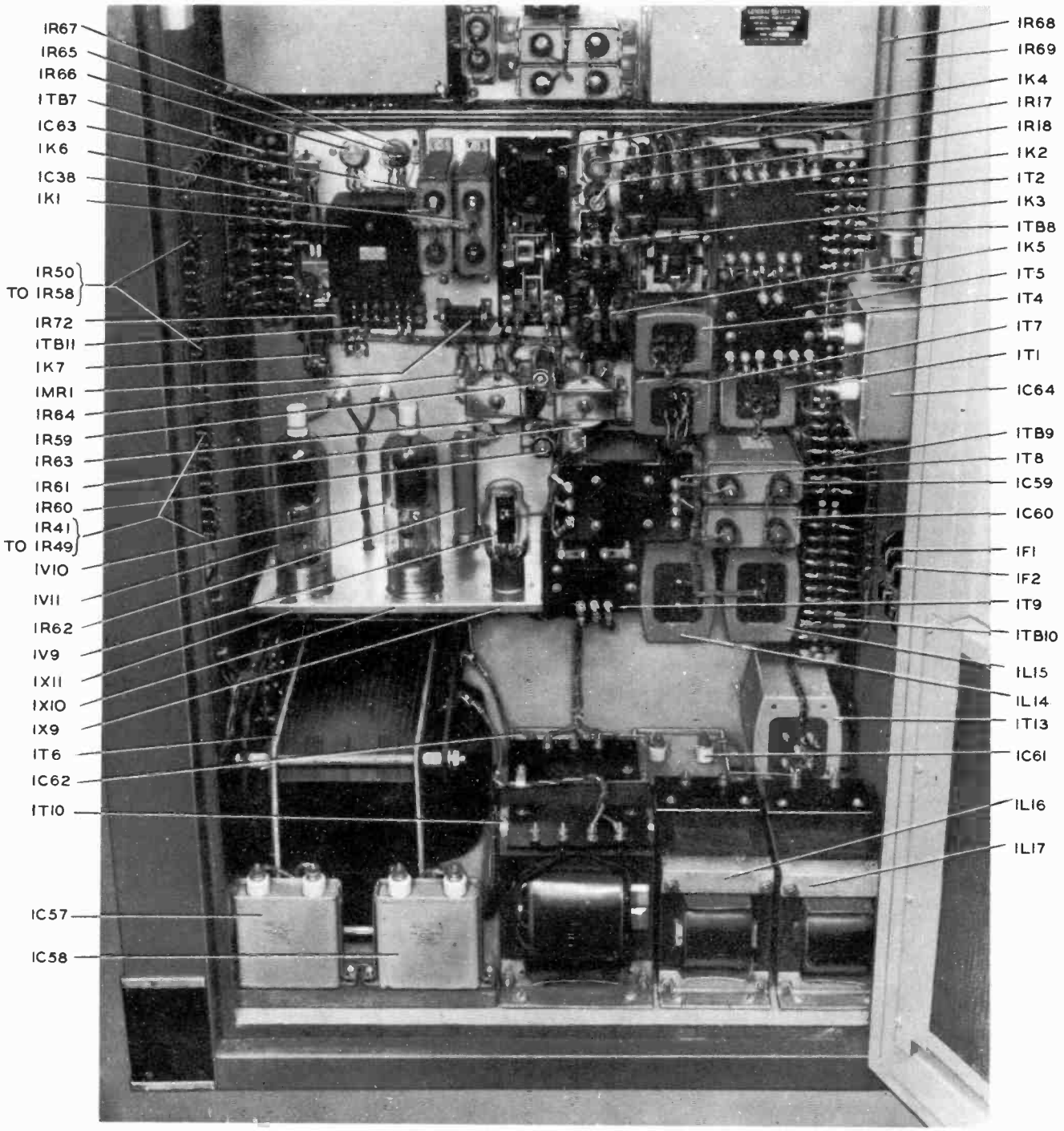


Fig. 13 Rear View, Lower Panel, Parts Identified (SY2377A)

PARTS LIST

This list includes all of the principal replacement parts. The symbol numbers used are the same as those appearing on schematic and other diagrams.

When ordering a replacement part, please include description, symbol designation and reference number of the part and model number of the equipment. Orders may be sent to the nearest General Electric Office or to the General Electric Company, Transmitter Division, Electronics Department, Syracuse, New York.

Symbol	*Description*	*G-E Dwg.*
	BLOWER MOTOR	
1BM1	Cabinet Blower.	P-7769350-P1
	CAPACITORS	
*1C1	Crystal Heater By-pass. Mica, 10,000 mmfd ±10%, 300 VDCW.	P-3R28-P9
*1C2	Crystal Heater By-pass. Same as 1C1.	
*1C3	Cathode By-pass. Same as 1C1.	
1C4	Vernier Frequency Control. Variable, 50 mmfd.	P-3R47-P2
1C5	Vernier Frequency Control. Same as 1C4.	
1C6	Voltage-dividing. Silver mica, 22 mmfd ±5%, 500 VDCW.	P-3R26-P64
1C7	Voltage-dividing. Silver mica, 330 mmfd ±5%, 500 VDCW.	P-3R26-P75
*1C8	Tube Heater By-pass. Mica, 10,000 mmfd ±10%, 300 VDCW.	P-3R28-P9
*1C9	Tube Heater By-pass. Same as 1C8.	
*1C10	Suppressor By-pass. Same as 1C8.	
*1C11	Screen By-pass. Same as 1C8.	
1C12	Plate By-pass. Mica, 10,000 mmfd ±10%, 600 VDCW.	P-3R31-P15
1C13	Plate Tuning. Variable; 100 mmfd meshed. Hammarlund Cat. #HFA-100-B, or equivalent.	M-2R26-P24
*1C14	Output Coupling. Mica, 220 mmfd ±10%, 500 VDCW.	P-3R26-P14
1C15	Buffer Amplifier Filament By-pass. Mica, 10,000 mmfd ±10%, 600 VDCW.	P-7769838-P13
1C16	Buffer Amplifier Filament By-pass. Same as 1C15.	
1C17	Buffer Amplifier Screen By-pass. Same as 1C15.	
1C18	Buffer Amplifier Suppressor By-pass. Same as 1C15.	
1C19	Buffer Plate Tank. Variable, capacity, 32 mmfd open, 335 mmfd meshed. Hammarlund Cat. #TC-330-K, or equivalent.	P-3R25-P13
1C20	Buffer Plate By-pass. Mica, 10,000 mmfd ±10%, 2500 VDCW.	P-3R32-P75

Symbol	*Description*	*G-E Dwg.*
	CAPACITORS CONTINUED	
1C21	Power Amplifier Grid By-pass. Mica, 10,000 mmfd ±10%, 600 VDCW.	P-7769838-P13
1C22	Power Amplifier Grid Coupling Mica, 100 mmfd ±10%, 2500 VDCW.	P-3R32-P5
1C23	Power Amplifier Filament By-pass. Same as 1C21.	
1C24	Power Amplifier Filament By-pass. Same as 1C21.	
1C25	Power Amplifier Filament By-pass. Same as 1C21.	
1C26	Power Amplifier Filament By-pass. Same as 1C21.	
1C27	Neutralizing, Series. Same as 1C21.	
1C28	Power Amplifier Neutralizing. Variable, capacity 15 mmfd open, 53 mmfd meshed. Hammarlund Cat. #TC-50-H, or equivalent.	P-3R25-P7
1C29	Plate Blocking. Mica, 470 mmfd ±5%, 5000 VDCW.	M-2R23-P7
1C30	Plate Tank. Vacuum capacitor, 100 mmfd, 7500 VDCW, G-E type, #GL-1L33; or equivalent.	K-7897602-P3
1C31	Plate Tank. Same as 1C30.	
1C32†	Plate Tank. Same as 1C30.	
1C33†	Plate Tank. Same as 1C30.	
1C34†	Plate Tank. Same as 1C30.	
1C35†	Plate Tank. Same as 1C30.	
1C36	Plate Tank Tuning. Variable, capacity 28.5 mmfd open, 115 mmfd meshed. Hammarlund Cat. #TC-110-H, or equivalent.	P-3R25-P8
1C37	P.A. Plate By-pass. Mica, 470 mmfd ±5%, 5000 VDCW.	M-2R23-P7
1C38	P.A. Cathode By-pass. Pyranol, 10 mfd ±10%, 600 VDCW. G-E Cat. #23F354, or equivalent.	P-3R88-P5
1C39	Load Matching. Mica; rating depends on customer's requirements. (When ordering replacements specify G-E drawing number and rating.)	M-2R58
1C40	Antenna-Tuning Mica, rating depends on customer's antenna and line constants. (For replacements, specify rating and vendor's type No. of capacitor.)	M-2R52 or M-2R58

* *This item or equivalent can often be obtained from a local radio dealer.*

† *Use depends on operating frequency. See chart in Instruction Book.*

Symbol	Description	G-E Dwg.
	CAPACITORS CONTINUED	
1C41	Low-pass Filter. Mica, 0.004 mfd ±5%, 3000 peak V.W. Cornell Dubilier type #184-6L, or equivalent.	M-2R58-P18
1C42	Low-pass Filter. Same as 1C41.	
1C43	Not Used.	
1C44	Audio Compensating. Mica, .0068 mfd ±5%, 300 VDCW.	P-3R28-P47
1C45	1st. Audio Grid. Mica, 220 mmfd ±5%, 500 VDCW.	P-3R26-P54
1C46	1st Audio Grid. Same as 1C45.	
1C47	Surge Suppressor. Pyranol, 1 mfd ±10%, 600 VDCW. G-E Cat. #23F326, or equivalent.	P-3R48-P11
1C48	1st Audio Plate By-pass. Pyranol, 4 mfd ±10%, 600 VDCW. G-E Cat. #23F351, or equivalent.	P-3R88-P3
1C49	2nd Audio Grid Coupling. Pyranol, 0.25 mfd ±10%, 1000 VDCW. G-E Cat. #23F324, or equivalent.	P-3R48-P5
1C50	Not Used.	
1C51	Not Used.	
1C52	2nd. Audio Grid. Pyranol, 0.25 mfd ±10%, 1000 VDCW. G-E Cat. #23F324, or equivalent.	P-3R48-P5
1C53	Not Used.	
1C54	2nd Audio Grid By-pass. Pyranol, 8 mfd ±10%, 600 VDCW. G-E Cat. #23F353, or equivalent.	P-3R88-P4
1C55	2nd Audio Grid By-pass. Same as 1C54.	
1C56	Not Used.	
1C57	Feedback Insulating. Pyranol, 2 mfd ±10%, 2000 VDCW. G-E Cat. #23F382, or equivalent.	P-3R87-P2
1C58	Feedback Insulating. Same as 1C57.	
1C59	Low-voltage Rectifier Filter. Pyranol, 10 mfd ±10%, 1000 VDCW. G-E Cat. #23F364, or equivalent.	P-3R88-P9
1C60	Low-voltage Rectifier Filter. Same as 1C59.	
1C61	High-voltage Rectifier Filter. Pyranol, 10 mfd ±10%, 2000 VDCW. G-E Cat. #23F386, or equivalent.	P-3R87-P4
IC62	High-voltage Rectifier Filter. Pyranol, 10 mfd ±10%, 2000 VDCW. G-E Cat. #23F386, or equivalent.	P-3R87-P4
1C63	Bias Filter. Pyranol, 10 mfd ±10%, 600 VDCW. G-E Cat. #23F354, or equivalent.	P-3R88-P5
1C64	High-voltage Rectifier Filter. Same as 1C62.	
	FUSES	
*1F1	Crystal Heater Line. 3-amp, 250-volt, G-E Cat. #3167, or equivalent.	K-1R11-P1
*1F2	Crystal Heater Line. Same as 1F1.	
	INDICATING DEVICES	
*1I1	Crystal Heater Indicator. Type #47 Lamp, 6–8-volt, 0.15 amp.	
*1I2	Crystal Heater Indicator. Same as 1I1.	

Symbol	Description	G-E Dwg.
	RECEPTACLES	
1J1	Frequency Monitor. High-frequency co-axial connector, female, Amphenol Cat. #83-1R, or equivalent.	M-2R22-P3
1J2	Frequency Monitor. High-frequency co-axial connector. Double-ended, female, Amphenol Cat. #83-1F, or equivalent.	M-2R22-P6
1J3	Modulation Monitor. Same as 1J1.	
1J4	Modulation Monitor. Same as 1J2.	
	RELAYS	
1K1	Rectifier Plate Time Delay. 115 volts, 60 cycles; time delay 30 sec. ±10%; contact rating 10 amp, 125 volts N.I.A.C., 5 amp, 250 volts N.I.A.C.	M-7478040-P1
1K2	Rectifier Plate. 3 main poles; 1 N.C. interlock; 115 volts, 60 cycles, G-E type #CR2810-1811M2X9, G-E Cat. #4986958M2, or equivalent.	P-7767981-P26
1K3	Rectifier Plate "On". 115 volts, 60 cycles, 2 N.O., 2 N.C., D.P.D.T. contacts.	P-7767982-P1
1K4	Power-Failure Reclosing. Coil rating 115 volts, 60 cycles; time interval 3 sec. ±0.5 sec. G-E Cat. #CR2820-173IC, or equivalent.	M-7477464-P1
1K5	Rectifier Plate "Off". Same as 1K3.	
1K6	Power Amplifier Overcurrent. Coil resistance 10 ohms or less, pull in 600 ma ±25, current break ½ amp, inductive 115 VAC; 1 form A, 1 form B contacts.	P-7767488-P35
1K7	Modulator Overcurrent. Same as 1K6.	
	COILS	
1L1	Cathode. Inductance 2.5 mh, distributed capacitance 1 mmfd; d-c resistance 50 ohms; current rating 125 ma.	K-7107898
1L2	Plate. 3-section.	ML-7478058-G1
1L3	Buffer Plate.	ML-7478085-G1
1L4	Frequency Monitor Coupling.	ML-7118755-G1
1L5	Power Amplifier Grid Choke. Inductance 4.40 millihenries ±5%, at 1000 cycles.	ML-7478165-G1
*1L6	Power Amplifier Stabilizing Choke. Suppressor; resistor value noninductive 50 ohms; choke coil d-c resistance, 0.003 ohm, inductance 0.3 mh. (Includes IR15.) Ohmite Cat. #P-300, or equivalent.	M-7476387-P1
*1L7	Power Amplifier Stabilizing Choke. Same as 1L6. (Includes IR-16.)	
1L8	Power Amplifier Neutralizing.	ML-7478082-G1
1L9	Power Amplifier Plate Choke. Total inductance 5.8 mh ±5% at 1000 cycles.	ML-7478157-G1
1L10	Power Amplifier Plate Tank. (1L11 included.)	ML-7769373-G1
1L11	Power Amplifier Output Coupling. (Included in 1L10.)	
1L12	Modulation Monitor Coupling. Same as 1L4.	
1L13	Load Matching. Rotating coil assembly.	ML-7769371-G1
1L14	Low-voltage Rectifier Filter. Inductance 10 henries min. at 0.175 amp; resistance 125 ohms d.c.	M-7475693

** This item or equivalent can often be obtained from a local radio dealer.*

Symbol	Description	G-E Dwg.
	COILS CONTINUED	
1L15	Low-voltage Rectifier Filter. Same as 1L14.	
1L16	High-voltage Rectifier Filter. Inductance 10 henries min. at 0.65 amp; resistance 50 ohms d.c.	M-7475694
1L17	High-voltage Rectifier Filter. Same as 1L16.	
1L18	Antenna-Tuning.	ML-7478169-G1
1L19	Power Amplifier Stabilizing Choke. 15 turns 1 inch ID of 0.080 inch dia. copper wire.	ML-7118844-G1
*1L20	Stabilizing Choke. Suppressor; resistor value noninductive 50 ohms; choke coil d-c resistance 0.003 ohm, inductance 0.3 mh. (Includes 1R73.) Ohmite Cat. #P-300, or equivalent.	M-7476387-P1
1L21	Low-pass Filter	K-7119736
1L22	Low-pass Filter.	K-7119737
1L23	Audio Compensating Reactor. 200 mh ±6%, 270 ohms ±15%.	K-57J560-G2
	METERS	
1M1	Crystal Oscillator Milliammeter. 3½-inch square case, panel mounted; d-c rating 20 ma.	P-3R35-P28
1M2	Buffer Amplifier Milliammeter. 3½-inch square case, panel mounted; d-c rating 150 ma.	P-3R35-P33
1M3	Power Amplifier Grid Milliammeter. 3½-inch square case, panel mounted; d-c rating 200 ma.	P-3R35-P34
1M4	Power Amplifier Plate Milliammeter. 3½-inch square case, panel mounted; d-c rating 500 ma.	P-3R43-P36
1M5	Power Amplifier Plate Kilovoltmeter. 3½-inch square case, panel mounted; d-c rating 2 kv. (External resistor 1R19 supplied.)	P-3R42-P22
1M6	Output R-F Ammeter. 3½-inch square case, panel mounted. (When ordering replacements specify G-E drawing number and full-scale rating of ammeter.)	P-3R39
1M7	1st Audio Milliammeter. 3½-inch square case, panel mounted; d-c rating 10 ma.	P-3R35-P26
1M8	Modulator Plate Milliammeter. 3½-inch square case, panel mounted; d-c rating 300 ma.	P-3R43-P35
1M9	Modulator Plate Milliammeter. Same as 1M8.	
1M10	Filament Control Voltmeter. 3½-inch square case, panel mounted; a-c rating, 150 volts. G-E type #AO-25, or equivalent.	M-7475041-P1
	METALLIC RECTIFIERS	
1MR1	Modulator Bias. Selenium. G-E model #6RS114FB1, or equivalent.	M-7477462-P2
	PLUGS	
1P1	Frequency Monitor Cable. Straight, pin contact, female. Amphenol Cat. #83-1SP, or equivalent.	M-2R22-P1
1P2	Frequency Monitor Cable. Same as 1P1.	
1P3	Frequency Monitor Cable. Same as 1P1.	
1P4	Modulation Monitor Cable. Same as 1P1.	
1P5	Modulation Monitor Cable. Same as 1P1.	
1P6	Modulation Monitor Cable. Same as 1P1.	

Symbol	Description	G-E Dwg.
	RESISTORS	
*1R1	Crystal Heater Series. Composition, 15 ohms ±5%, 2 watts.	P-3R67-P115
*1R2	Crystal Heater Series. Same as 1R1.	
*1R3	Grid Composition, 0.10 meg ±10%, 1 watt.	P-3R13-P86
*1R4	Cathode. Composition, 1800 ohms ±10%, 1 watt.	P-3R13-P65
*1R5	Voltage Divider. Composition, 10,000 ohms ±5%, 1 watt.	P-3R13-P183
*1R6	Voltage Divider. Same as 1R5.	
*1R7	Voltage Divider. Composition, 15,000 ohms ±5%, 2 watts.	P-3R67-P187
*1R8	Voltage Divider. Same as 1R7.	
*1R9	Buffer Amplifier Grid. Composition, 33,000 ohms ±10%, 2 watts.	P-3R67-P80
*1R10	Buffer Amplifier Series Grid. Composition, 100 ohms ±10%, 2 watts.	P-3R67-P50
1R11	Buffer Amplifier Cathode. Wirewound, 800 ohms ±5%, 25 watts. Ward Leonard Cat. #K-41383-1, or equivalent.	M-2R14-P30
*1R12	Buffer Amplifier Series Screen. Composition, 4700 ohms ±10%, 2 watts.	P-3R67-P70
1R13	Buffer Amplifier Series Plate. Wirewound, 6300 ohms ±5%, 60 watts.	M-7464827-P39
1R14	Power Amplifier Grid. Wirewound, 2500 ohms ±5%, 50 watts.	M-7464828-P35
1R15	Power Amplifier Stabilizing. Noninductive, 50 ohms (included in 1L6).	
1R16	Power Amplifier Stabilizing. Same as 1R15 (included in 1L7).	
1R17	Power Amplifier Cathode. Wirewound, 310 ohms ±5%, 25 watts. Ward Leonard Cat. #K-41383-1, or equivalent.	M-2R14-P26
1R18	Power Amplifier Cathode. Same as 1R17.	
1R19	Kilovoltmeter Multiplier. 1 unit; 2 meg ±0.2%, 2 kv. (External resistor for 1M5.)	M-7475042-P3
*1R20	1st. Audio Grid. Composition, 33,000 ohms ±5%, 1 watt.	P-3R13-P195
*1R21	1st Audio Grid. Same as R120.	
*1R22	1st Audio Series Grid. Composition, 100 ohms ±10%, ½ watt.	P-3R11-P50
*1R23	1st Audio Cathode. Composition, 1000 ohms ±5%, 1 watt.	P-3R13-P159
*1R24	1st Audio Cathode. Same as 1R23.	
*1R25	1st. Audio Series Grid. Same as 1R22.	
*1R26	1st Audio Screen Divider. Composition, 33,000 ohms ±10%, 1 watt.	P-3R13-P80
*1R27	1st Audio Screen Divider. Composition, 39,000 ohms ±10%, 2 watts.	P-3R67-P81
*1R28	1st Audio Screen Divider. Same as 1R27.	
*1R29	1st Audio Plate. Composition, 0.15 meg ±5%, 2 watts.	P-3R67-P211
*1R30	1st Audio Plate. Same as 1R29.	

* *This item or equivalent can often be obtained from a local radio dealer.*

Symbol	Description	G-E Dwg.
	RESISTORS CONTINUED	
1R31	Audio Compensating. Composition, 33,000 ohms ±5%, 1 watt.	P-3R13-P195
1R32	Audio Compensating. Composition, 8200 ohms ±5%, 1 watt.	P-3R13-P181
*1R33	Modulator Grid. Composition, 0.33 meg ±10%, 1 watt.	P-3R13-P92
1R34	Not Used.	
1R35	Not Used.	
*1R36	Modulator Grid. Same as 1R33.	
*1R37	Modulator Bias Filter Composition, 22,000 ohms ±10%, 1 watt.	P-3R13-P78
*1R38	Modulator Bias Filter. Same as 1R37.	
*1R39	Modulator Series Grid. Composition, 100 ohms ±10%, ½ watt.	P-3R11-P50
*1R40	Modulator Series Grid. Same as 1R39.	
*1R41	Audio Feedback Divider. Composition, 10,000 ohms ±5%, 2 watts.	P-3R67-P183
*1R42	Audio Feedback Divider. Same as 1R41.	
*1R43	Audio Feedback Divider. Same as 1R41.	
*1R44	Audio Feedback Divider. Same as 1R41.	
*1R45	Audio Feedback Divider. Same as 1R41.	
*1R46	Audio Feedback Divider. Same as 1R41.	
*1R47	Audio Feedback Divider. Same as 1R41.	
*1R48	Audio Feedback Divider. Same as 1R41.	
*1R49	Audio Feedback Divider. Same as 1R41.	
*1R50	Audio Feedback Divider. Same as 1R41.	
*1R51	Audio Feedback Divider. Same as 1R41.	
*1R52	Audio Feedback Divider. Same as 1R41.	
*1R53	Audio Feedback Divider. Same as 1R41.	
*1R54	Audio Feedback Divider. Same as 1R41.	
*1R55	Audio Feedback Divider. Same as 1R41.	
*1R56	Audio Feedback Divider. Composition, 10,000 ohms ±5%, 2 watts.	P-3R67-P183
*1R57	Audio Feedback Divider. Same as 1R56.	
*1R58	Audio Feedback Divider. Same as 1R56.	
1R59	Voltage Divider. Wirewound, 2000 ohms ±5%, 35 watts. Ward Leonard Cat. #K-41388-1, or equivalent.	M-2R15-P44
1R60	Voltage Divider. Wirewound, 1600 ohms ±5%, 25 watts. Ward Leonard Cat. #K-41383-1, or equivalent.	M-2R14-P33
1R61	Voltage Divider. Rheostat, power; wirewound, 800 ohms ±10%, 50 watts. Ohmite Model J, Cat. #0325, or equivalent.	M-2R34-P43
1R62	Voltage Divider. Wirewound, 5000 ohms ±5%, 50 watts.	M-7464828-P38
1R63	Voltage Divider. Same as 1R61.	
1R64	Voltage Divider. Wirewound, 1000 ohms ±5%, 10 watts. Ward Leonard Cat. #K-41382-1, or equivalent.	M-2R12-P31
*1R65	Bias Voltage Divider. Composition, 12,000 ohms ±10%, 2 watts.	P-3R67-P75
1R66	Bias Voltage Potentiometer. 22,000 ohms ±20%, 1.5 watt.	M-2R25-P57
1R67	Bias-voltage Potentiometer. Same as 1R66.	
1R68	High-voltage Bleeder. Wirewound, 50,000 ohms ±5%, 160 watts.	M-7464825-P48
1R69	High-voltage Bleeder. Same as 1R68.	
1R70	Filament Rheostat. Wirewound, 10 ohms ±10%, 225 watts. Ohmite Model P, Cat. #1256, or equivalent.	M-2R38-P7
1R71	Surge Suppressor Resistor. Composition, 0.22 meg. ±10%, 1 watt.	P-3R13-P90
1R72	Relay Protective Resistor. Wirewound, 1.0 ohm ±10%, 1 watt.	P-3R19-P4
1R73	Stabilizing Resistor. Noninductive, 50 ohms. (Included in 1L20.)	
1R74†	Modulator Loading Resistor. Wirewound, 12,500 ohms ±5%, 160 watts.	M-7464825-P42
	SWITCHES	
1S1	Crystal Transfer. Rotary, 1 section, 2 positions, 2 circuits.	M-7478059-P1
1S2	Plate "On." Push-button type; green translucent button; G-E Cat. #2280664-G3, or equivalent. Type #46 lamp.	K-7107849-P6
1S3	Plate "Off." Push-button type; red translucent button; G-E Cat. #2280664-G2, or equivalent. Type #46 lamp.	K-7107849-P5
1S4	Ground Switch Auxiliary Interlock. Push-button type, single circuit, N.O. momentary contact, 3 amp, 125 volts. G-E Cat. #1GA19A30. (Included in 1S6.)	K-7870464
1S5	Rear Door Interlock. Continuous capacity 10 amp at 110 or 220 volts a-c or d-c; 2-element, SPST.	M-7460330-G4
1S6	Rear Door Grounding. (1S4 included.)	ML-7474516-G1
1S7	Power Line Circuit Breaker. 2-pole, rating 25 amp, 250 volts max. a-c, 25 to 60 cycles. Heinemann Cat. #2263S-25, or equivalent.	P-7768829-P19
	TRANSFORMERS	
1T1	Crystal Heater.	M-7479609
1T2	P.A. Buffer Filament.	M-7475690
1T3	Audio Input.	M-7478088
1T4	1st Audio-C.O. Filament.	M-7475687
1T5	Modulator Filament.	M-7475688
1T6	Modulation.	M-7478847
1T7	L.V. Rectifier Filament	M-7475692
1T8	L.V. Rectifier Plate.	M-7475696
1T9	H.V. Rectifier Filament.	M-7475691
1T10	H.V. Rectifier Plate.	M-7475695
1T11	Plate "On" Indicating Light. G-E Cat. #74G657, or equivalent.	M-7467402
1T12	Plate "Off" Indicating Light. Same as 1T11.	
1T13	Control Circuit Supply.	M-7477995

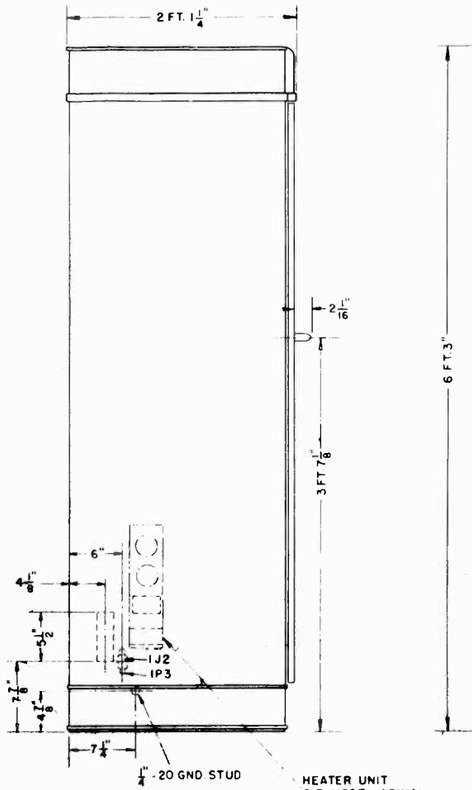
* *This item or equivalent can often be obtained from a local radio dealer.*

† *Supplied for 100-watt operation only.*

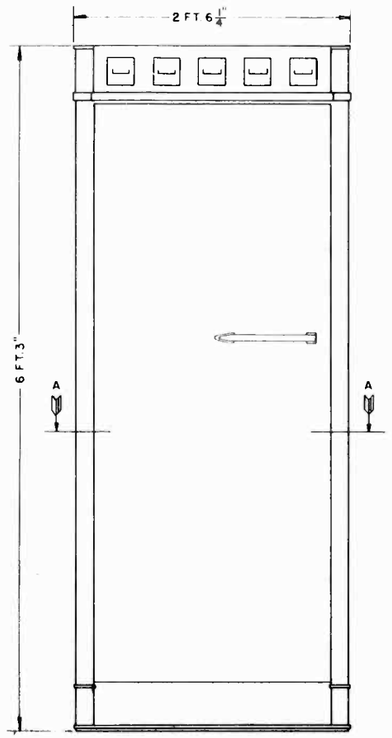
Symbol	Description	G-E Dwg.
	TUBES	
1V1	Crystal Oscillator. Type GL-837.	
1V2	Buffer Amplifier. Type GL-828.	
1V3	Power Amplifier. Type GL-810.	
1V4	Power Amplifier. Same as 1V3.	
1V5	1st Audio Amplifier. Type GE-1620.	
1V6	1st Audio Amplifier. Same as 1V5.	
1V7	Modulator. Type GL-828.	
1V8	Modulator. Same as 1V7.	
1V9	Low-voltage Rectifier. GE-5R4GY.	
1V10	High-voltage Rectifier. GL-8008.	
1V11	High-voltage Rectifier. Same as 1V10.	
	SOCKETS	
1X1	Crystal Oscillator. Steatite, 7 contacts, large. Amphenol Cat. #RSS7L, or equivalent.	K-1R13-P45
1X2	Buffer Amplifier. Steatite, 5 contacts. Amphenol type #RSS5, or equivalent.	K-1R13-P42
1X3	Power Amplifier. Standard 50-watt socket. E. F. Johnson Cat. #211B, or equivalent.	M-7475054-P2
1X4	Power Amplifier. Same as 1X3.	

Symbol	Description	G-E Dwg.
	SOCKETS CONTINUED	
*1X5	1st Audio Amplifier. Octal, 8 contacts. Amphenol type #MIP8T, or equivalent.	K-1R14-P26
*1X6	1st Audio Amplifier. Same as 1X5.	
1X7	Modulator. Steatite, 5 contacts. Amphenol type #RSS5, or equivalent.	K-1R13-P42
1X8	Modulator. Same as 1X7.	
1X9	Low-voltage Rectifier. Steatite, octal, 8 contacts. Amphenol type #RSS8, or equivalent.	K-1R13-P47
1X10	High-voltage Rectifier. Wafer type, jumbo size, 4 contacts. E. F. Johnson Co. socket #244, or equivalent.	K-7115212-P1
1X11	High-voltage Rectifier. Same as 1X10.	
1X12	Crystal. Same as 1X5.	
1X13	Crystal. Same as 1X5.	
1X14	Crystal Heater Lamp. Green jewel, bayonet base for use with G3½ or T3¼ bulb size. Drake Mfg. Co. type #80, or equivalent.	K-7108403-P3
1X15	Crystal Heater Lamp. Same as 1X14.	
	CRYSTALS	
†1Y1	Crystal Thermocell. Holder G-E type 32C401G30; thermocell heater 6.3 volts 50/60 cycles. (When ordering replacements specify frequency used.)	M-7478061
1Y2	Crystal Thermocell. Same as 1Y1.	

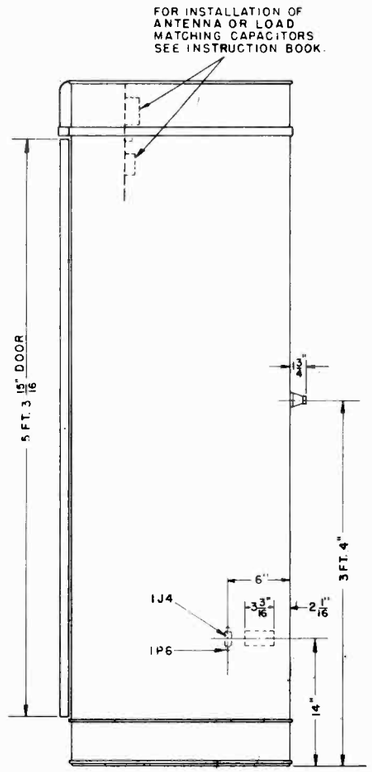
* *This item or equivalent can often be obtained from a local radio dealer.*
† *Interchangeable with G-E Type 32C401G30B.*



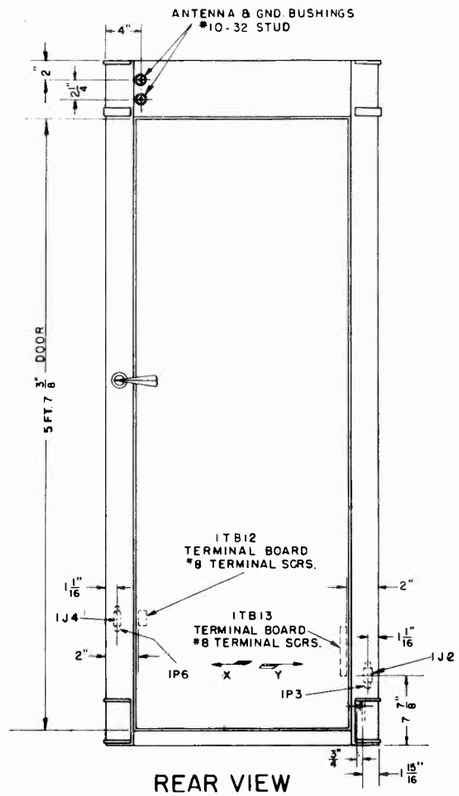
LEFT SIDE VIEW



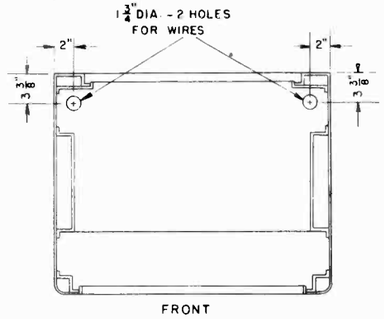
FRONT VIEW



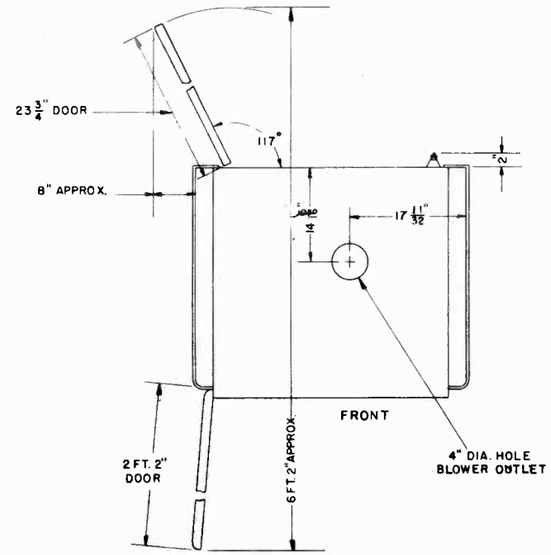
RIGHT SIDE VIEW



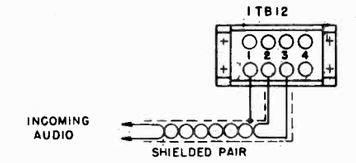
REAR VIEW



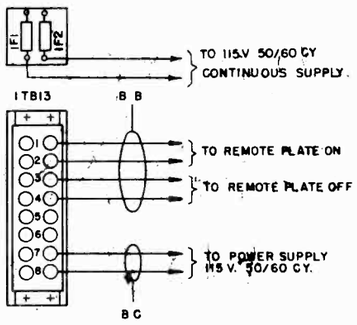
SECTION A-A

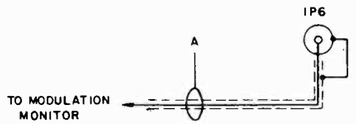


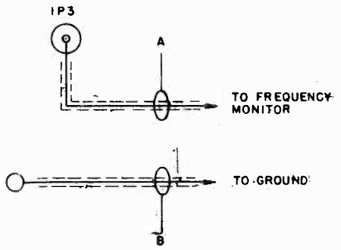
VIEW AT "X"



VIEW AT "Y"





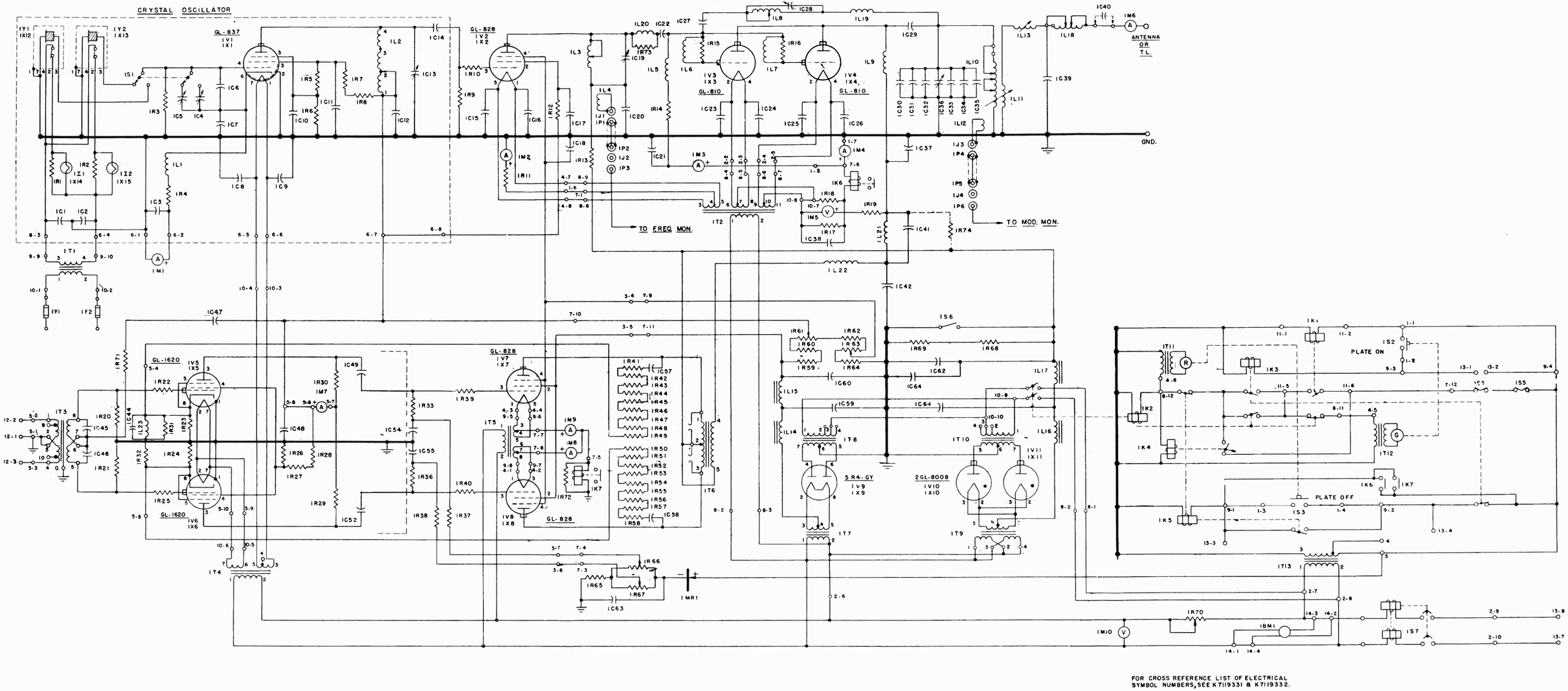


WIRE TABLE

RECOMMENDED WIRE SIZE - (CODE)	DESCRIPTION
B B	#14 A.W.G. SOLID, 3/64" VARNISHED CAMBRIC INSULATION, .025" LEAD, O.D. - .241". G.E. SPEC. S-392382-1-A1 OR EQUIV.
B C	#10 A.W.G. SOLID, 3/64" VARNISHED CAMBRIC INSULATION, 1/32" LEAD, O.D. - .292". G.E. SPEC. S-392382-1-A1 OR EQUIV.
A	ARMY-NAVY TYPE RG-11/U OR EQUIVALENT.
B	#6 A.W.G. STRANDED BARE COPPER.

EXTERNAL WIRING FURNISHED BY CUSTOMER

Fig. 14. Installation Requirements Drawing (T-7665065, Rev. 1)



FOR CROSS REFERENCE LIST OF ELECTRICAL SYMBOL NUMBERS, SEE K7119331 & K7119332.

Fig. 15. Schematic Drawing (TT-7664905, Rev. 6)

INSTRUCTIONS

250-WATT AM
BROADCAST TRANSMITTER

TYPE BT-20-A

MODEL 4BT20A1

ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

ELECTRONICS PARK SYRACUSE 1, N.Y.

(In Canada, Canadian General Electric Company, Ltd., Toronto, Ont. Outside the U.S.A., and Canada, by: International General Electric Company, Inc., Electronics Dept., Schenectady, New York, U.S.A.)

3-48 (400)

PRINTED IN U.S.A.