RESTRICTED

SERIAL NO. 449. 1964

INSTRUCTION BOOK

For

NAVY MODEL TDO
RADIO TELEPHONE AND TELEGRAPH
TRANSMITTING EQUIPMENT

OUTPUT	EMISSION	FREQUENCY RANGE
250 Watts	Telephone	2000 Kc. to 18,100 Kc.
400 Watts	Telegraph	2000 Kc. to 18,100 Kc.
250 Watts	Modulated Telegraph	2000 Kc. to 18,100 Kc.

MANUFACTURED FOR

U. S. NAVY DEPARTMENT BUREAU OF SHIPS

By

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

Contract: NXss-20834
NXss-24869
Part No. 520 9067 00

Date of Contract: 5 January 1943
27 February 1943

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION BUT ALWAYS SHUT DOWN MOTOR GENERATORS OR OTHER ASSOCIATED POWER EQUIPMENT AND OPEN MAIN SWITCH IN POWER SUPPLY CIRCUIT. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

WARNING

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

The major portions of the equipment are within shielding enclosures, provided where necessary with access doors which are generally fitted with safety interlock switches which act to shut off dangerous voltages within the enclosures when the access doors are open.

It should be borne in mind that interlocks are provided only on normal access doors on certain major units and therefore side, back or top screens, commutator covers, if removed, will not cause interlocks to function and will thereby allow access to circuits carrying voltages dangerous to human life.

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

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 non-interlocked portion of the shielding or enclosure is removed or open. Whenever feasible in testing circuits, check for continuity and resistance rather than directly checking voltage at various points.

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.

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.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO BUREAU OF SHIPS MANUAL OF ENGINEERING INSTRUCTIONS, CHAPTER 31 (MIMEOGRAPHED FORM) OR SUBSEQUENT REVISIONS THEREOF ON THE SUBJECT OF 'RADIO—SAFETY PRECAUTIONS TO BE OBSERVED.'

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NOTE: Figs. 98, 99, 100 and 101 are enclosed in an envelope next to the rear cover of this Instruction Book.

GUARANTEE: 2 YEARS', 1 YEAR SERVICE

The equipment, including all parts and spare parts, except vacuum tubes, shall be guaranteed for a service period of **one year** with the understanding that, as a condition of this contract, all items found to be defective as to design, material, workmanship, or manufacture shall be replaced without delay and at no expense to the Government, provided that such guarantee and agreement shall not obligate the contractor to make replacement of defective material unless the failure, exclusive of normal shelf life deterioration, occurs within a period of two years from the date of delivery of the equipment to and acceptance by the Government, and provided further, that if any part or parts (except vacuum tubes) fail in service or are found defective in ten per cent (10%) or more, but not less than two, of the total number of equipments furnished under the contract, such part or parts, whether supplied in the equipment or as spares, shall be conclusively presumed to be of defective design, and as a condition of contract subject to one-hundred per cent (100%) replacement of all similar units supplied on subject contract by suitable redesigned replacements. Failure due to poor workmanship while not necessarily indicating poor design, will be considered in the same category as failure due to poor design. Redesigned replacements which will assure proper operation of the equipment shall be supplied promptly, transportation paid, to the Naval activities using such equipment, upon receipt of proper notice and without cost to the Government. All defective parts originally furnished under contract shall be held subject to rejection and return to the contractor.

This period of two years and the service period of one year shall not include any portion of the time that the equipment fails to give satisfactory performance due to defective items and the necessity for replacement thereof, and provided further, that any replacement part shall be guaranteed to give one year of satisfactory service.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 31 (mimeographed form) of the Manual of Engineering Instructions, or Bureau of Ships Radio and Sound Bulletin Number 7, dated July 1, 1942, or superseding instructions.

Contract: NXss-20834 Date of Contract: 5 January 1943
NXss-24869 27 February 1943

Serial Number of Equipment_____

Date of Acceptance by the Navy_____

Date of Delivery to Contract Destination_____

Date of Completion of Installation_____

Date Placed in Service_____

Blank spaces in this book shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date plate located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

All requests or requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

1. Name of part desired.
2. Navy Type number (if assigned) (including prefix and suffix as applicable.)
3. Model designation (including suffix) of equipment in which used.
4. Navy Type designation (including prefix and suffix where applicable) of major unit in which part is used.
5. Symbol designation of part.
6. (a) Navy Drawing Number.
   (b) Manufacturer's Drawing Number.
7. Rating or other descriptive data.
8. Commercial designation.

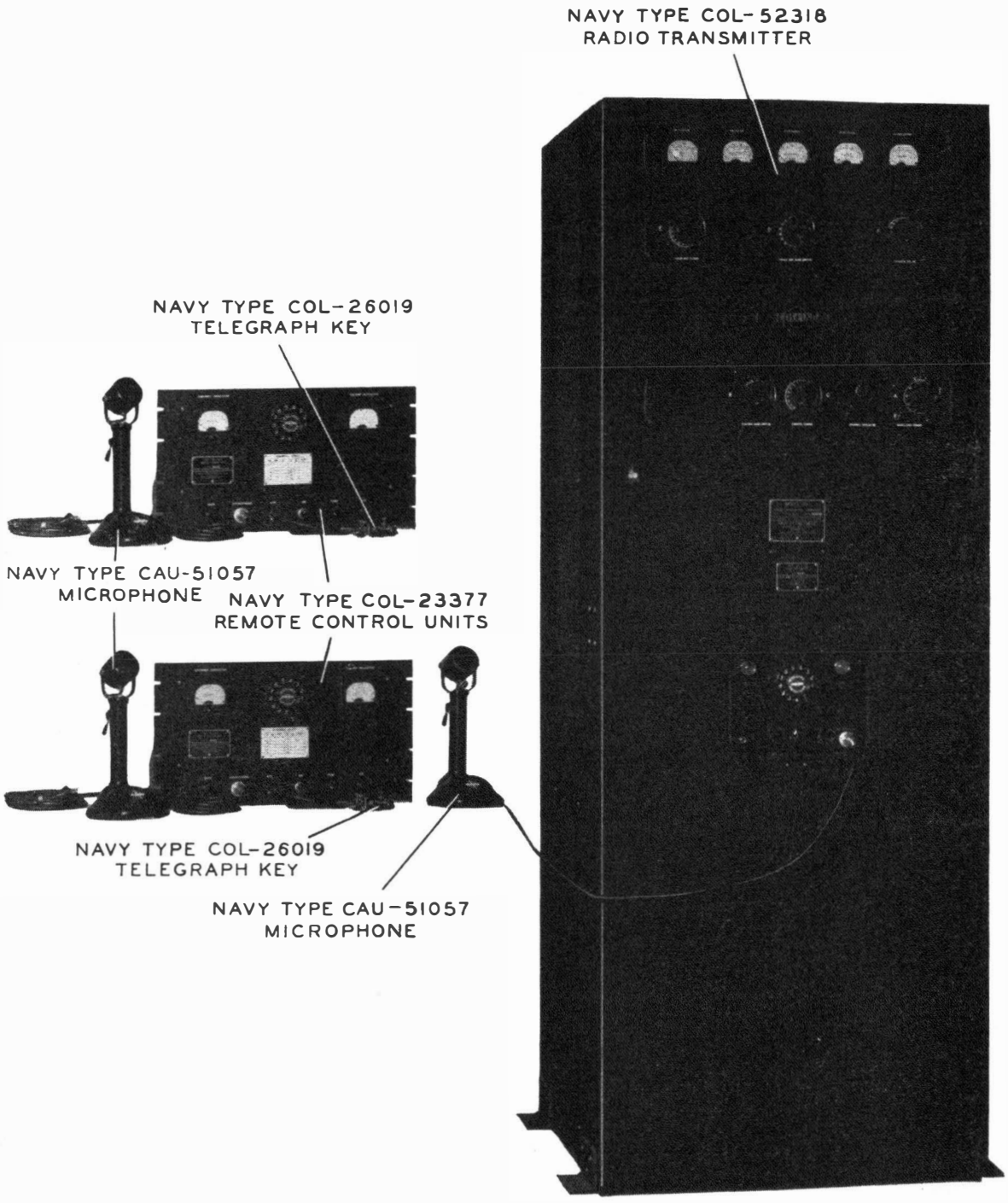


Fig. 1 TDO Radio Transmitting Equipment

I GENERAL DESCRIPTION

1.1. EQUIPMENT

1.1.1. Main Components. This Instruction Book covers the installation, adjustment, operation and maintenance of the Navy Model TDO Radio Transmitting Equipment. The complete equipment consists of the following units, accessories, sets of vacuum tubes and a set of spare parts:

Name	Qty.	Navy Type Designation	Collins Part No.	Overall Dimensions (Inches)		Volume (Cu. Ft.)		Weight (Lbs.)	
				Crated	Uncrated	Crated	Uncrated	Crated	Uncrated
Radio Transmitting Equipment	1	TDO	----------	----------	----------	165.0	----------	2362	1365
Radio Transmitter	1	COL-52318	16F-8	----------	28x28½ x80⅝	----------	35.5	----------	1140
Cabinet	1	----------	GB-104F	39x41x84	28x28½ x78	78.3	35.5	660	365
Output Network	1	----------	24J	2)x31x35	----------	12.5	----------	142	47
R-F Exciter Unit	1	----------	110D	2)x31x35	----------	12.5	----------	164	79
CFI Unit	1	----------	3Q						
Speech Amplifier Unit	1	----------	26H	2)x24x36	----------	10.0	----------	140	62
Autotune Control Unit	1	----------	103C						
Power Supply Unit	1	----------	401X	2¼x28x4(	----------	15.5	----------	450	308
High Voltage Transformer	1	----------	372N107	13x15x15	----------	1.5	----------	140	120
Modulation Transformer	1	----------	377N104	11x12x13	----------	1.0	----------	76	58
Autotransformer	1	----------	364S141	11x12x13	----------	1.0	----------	82	64
Meter Panel	1	----------	GA-2061A						
Autotune Motor	1	----------	232N914						
Blower Assembly	1	----------	9N219						
Resistor (R101)	1	----------	732NB3Meg						
Output Network Connectors	5	----------	----------						
Fuses (F114, F115)	2	----------	264N225A						
Fuse (F113)	1	----------	264N815						
Universal Joints	2	----------	X-6484	2)x24x36	----------	10.0	----------	165	92
Autotune Drive Shafts	3	----------	----------						
Microphones	3	CAU-51057	20N211						
Telegraph Keys	2	COL-26019	67A-3						
200KC Crystal Unit	1	----------	146A-1						
Accessories									
Metering Cord	1	----------	65J-9						
Test Cable	1	----------	GA-1198C						
Test Cable	1	COL-52356A	GB-1198C						
Pkg. of Hardware	1	----------	520 1128 00						
Remote Control Units	2	COL-23377	177G-8	2)x31x30	8-15/16 x10½ x19	10.7	4.32	140	60
Power Cords	2	----------	426N6						
Sets of Tubes	2								
2A3	4	2A3	255.2A3						
5U4G	2	5U4G	255.5U4G						
6A8	4	6A8	255.6A8						
6AG7	2	6AG7	255.6AG7						
6C8G	4	6C8G	255.6C8G						
6SJ7	8	6SJ7	255.6SJ7						
6SL7GT	4	6SL7GT	255.6SL7GT	2)x24x30	----------	8.3	----------	76	10
6SN7GT	8	6SN7GT	255.6SN7GT						
6X5GT	6	6X5GT	255.6X5GT						
249C	4	249C	256.249C						
805	4	805	256.805						
807	4	807	256.807						
813	4	813	256.813						
866/866A	4	866/866A	256.866/866A						
VR-150-30	2	VR-150-30	257.VR-150-30						
Set of Spare Parts	1	----------	----------	15x16x29	----------	3.6	----------	127	100

NOTE: In addition to the equipment listed above, it will be necessary to obtain a set of headphones to use in conjunction with the oscillator calibration unit. The circuit is designed to operate satisfactorily with headphones of from 500 ohm impedance up to and including high impedance phones such as the crystal type.

1.1.2. Tube Complement. One complete set of vacuum tubes for the equipment consists of:

TRANSMITTER

Navy Type Number	Qty.	Symbol Designation	Circuit Function	Unit
6A8	1	V101	R-F Oscillator	R-F
6AG7	1	V102	R-F Buffer-Amplifier	R-F
807	1	V103	R-F Multiplier	R-F
807	1	V104	Intermediate Amplifier	R-F
813	2	V105, V106	Power Amplifier	R-F
6SJ7	1	V107	Keyer	R-F
VR150-30	1	V108	Voltage Regulator	R-F
6A8	1	V109	CFI Oscillator	CFI
6SL7GT	1	V110	Converter	CFI
6SN7GT	1	V111	CFI Output Amplifier	CFI
6SN7GT	1	V112	MCW Oscillator-Amplifier	Speech Amp.
6SL7GT	1	V113	Audio Preamplifier	Speech Amp.
6C8G	1	V114	Volume Limiter	Speech Amp.
6C8G	1	V115	Audio Squelch	Speech Amp.
6SJ7	1	V116	Audio Amplifier	Speech Amp.
6X5GT	1	V117	Limiter Control	Speech Amp.
2A3	2	V118, V119	Audio Driver	Speech Amp.
805	2	V120, V121	Modulator	Power Supply
249C*	2	V122, V123	H.V. Rectifier	Power Supply
5U4G	1	V124	Bias Rectifier	Power Supply
866/866A	2	V125, V126	L.V. Rectifier	Power Supply

REMOTE CONTROL UNIT

6SJ7	1	V301	Audio Amplifier (Remote)	Remote Control
6SN7GT	1	V302	Audio Amplifier (Remote)	Remote Control
6X5GT	1	V303	Power Rectifier (Remote)	Remote Control

* Type 866/866A rectifier tubes may be substituted for Type 249C rectifier tubes in an emergency.

1.1.3. Line Switch. A main station switch capable of carrying at least 10 amperes should be installed in the power line when operating from a 230 volt 50/60 cps single phase power source. When operating from a 115 volt 50/60 cycle/sec power source, a switch capable of carrying 20 amperes should be installed.

1.1.4. Antenna Horn Gap. Refer to Fig. 15 Page 58. As discussed in the INSTALLATION Section of this Instruction Book, it is recommended that in localities subject to electrical storms a horn gap be installed in each transmission line to protect the transmitting equipment.

1.2. GENERAL DESCRIPTION. This equipment is designed for application involving point-to-point communication that requires operation on a number of readily selected frequency channels. The Collins Autotune system permits the selection of any one of ten pre-tuned frequency channels by operating a telephone dial on the transmitter control panel or the dial on the remote control unit panel.

1.2.1. Transmitter. The unit type of construction has been employed in this transmitter. All units are contained in a single cabinet constructed of heavy gauge reinforced sheet steel. The cabinet is finished with a zinc chromate primer and a final coat of black crinkle on the outside and is painted flat gray on the inside. A full length door on the front of the cabinet makes all units accessible from the front of the transmitter. This door is equipped with a safety interlock switch which removes the high voltage when the door is opened. A glass covered opening, located in the front door, permits the observing of all meters. Openings are provided so that the control panel and Autotune control knobs are accessible from the front of the transmitter without opening the cabinet door. The rear panel of the transmitter cabinet is held in place by sliding pins and may easily be removed to permit the installation, inspection and adjustment of components in the transmitter that are not accessible from the front. This rear panel is also provided with an interlock switch. This interlock switch, when opened, removes both high and low voltages from components in the transmitter but does not break the filament circuits.

The following paragraphs give a brief description of the various units comprising the transmitter proper:

(a) **Output Network.** This unit contains the components of the pi network that is used as a combination power amplifier plate tank and antenna coupling circuit. The two variable capacitors and the four section switch are driven by singleturn units that are associated with the Autotune system. The four section switch taps the plate tank inductor to connect the proper amount of inductance in the circuit for the Autotune channel that is selected, connects padding capacitors across the tuning capacitors on both sides of the pi network and connects the output of the power amplifier to the proper terminal on the antenna connecting strip.

(b) **R-F Unit.** All of the r-f components except those contained in the Output Network are contained in this unit. Two singleturn units and one multiturn unit associated with the Autotune system drive the variable components within the unit. The multiturn unit drives the tuning slug within the master oscillator tank inductor to vary the frequency of the r-f output. One singleturn unit drives the exciter plate tank tuning capacitors and the other singleturn unit drives the exciter band switch sections. The master oscillator components are sealed in a compartment and are packed in an insulating material. The temperature of this compartment is kept constant by a thermostatically controlled heater within the compartment. Components within the R-F Unit have been carefully placed and shielded to obtain the best possible performance. The CFI Unit is complete in itself and is designed to plug into a receptacle on top of the R-F Unit. The plate mounted near the power amplifier tubes is used as a neutralizing capacitor. Filament voltages for the tubes within this unit are supplied by two transformers mounted on the unit chassis. All connections to this unit except the connections to the power amplifier tubes plate caps, are made by two plug-in connectors on the rear of the chassis.

(c) **Speech Amplifier.** This unit contains the first and second audio amplifier stages, the audio driver stage, the audio squelch and limiter circuits and the tone oscillator circuit. Four controls on the front of the chassis control the MCW frequency, audio gain, MCW gain and limiter gain. Filament voltage for all tubes within this unit is supplied by a transformer mounted on the chassis. Connections to this unit are made by a plug-in connector on the rear of the chassis.

(d) **Autotune Control Unit.** All of the Autotune system control relays are mounted in this unit. These relays are of the 48 volt d.c. type and are supplied with voltage by a dry disc rectifier that is located in the Power Supply Unit. Connections to this unit are made by two plug-in connectors on the rear of the chassis. Access to all of the telephone type relays and the rotary switch may be gained by removing the dust cover. The power plug

receptacle for the Autotune motor is mounted on the bottom of the chassis.

(e) **Power Supply Unit.** All components in this unit are mounted on a vertical chassis to provide better accessibility for servicing. A control panel on the front of the unit permits the controlling of all functions of the transmitter from a position near the cabinet. The four rectifier systems, the relay supply, the bias supply, the low voltage supply and all components of the high voltage supply except the plate transformer are mounted on this chassis. This unit also contains the modulator tubes. Filament voltages for all tubes mounted in the unit are supplied by transformers mounted on the chassis. Connections to components in the power supply unit are made by a two-section terminal strip on the upper rear edge of the chassis and by cables to the unit. An interlock switch mounted below the control panel breaks the high voltage circuit when the front door of the transmitter cabinet is opened. The transmitter power switch is located on the left hand front side of the chassis.

NOTE: The rectifier heater circuit, consisting of R211, R212, R213, R214, S124 and F116, is included in transmitters with Nos. following 171 supplied on Contract NXss-20834 and to all transmitters supplied on Contract NXss-24869.

(f) **Transformers.** The high voltage power transformer and the modulation transformer are mounted in the base of the transmitter cabinet. The autotransformer is mounted on the wall of the transmitter cabinet. The terminals of all three transformers are accessible from the rear of transmitter if the transmitter cabinet rear panel is removed. The autotransformer is provided to permit transmitter operation from either a 115 volt or 230 volt 50/60 cps single phase power source.

(g) **Autotune Motor.** The Autotune motor drives the Autotune mechanism through a series of drive shafts and universal couplers. The motor is controlled by the relays that are located in the Autotune control unit. The motor is designed to operate from a 220 volts 50/60 cps single phase power source. When the transmitter is operated from a 115 volt power source the voltage for the operation of the transmitter components is stepped up to 220 volts by the autotransformer.

(h) **Ventilating Blower.** The ventilating blower assembly is mounted on the side of the transmitter cabinet opposite the autotransformer. The blower assembly is accessible if the transmitter cabinet rear panel is removed. The blower draws air in through the lower section of the rear panel and forces the air upward through the cabinet. The air cools the transmitter components and is exhausted through openings in the upper section of the rear panel. A spun glass filter over the air intake prevents dust from being drawn into the cabinet.

(i) **Microphones.** The microphones are sound-powered and have an impedance of approximately 600 ohms. The microphones are equipped with a desk type stand and a connecting cable. A push-to-talk switch is incorporated in the microphone stand. The operating of the switch closes two circuits, first an auxiliary circuit and secondly the microphone circuit. The microphone cable is composed of four conductors and is approximately five feet long.

(j) **Telegraph Keys.** The telegraph keys are built on a brass base and each is equipped with a shorting lever. The key connecting cable is approximately 34 inches long. The cable consists of two conductors enclosed in rubber. One conductor is black and the other is white. The white covered conductor is connected to the connector plug sleeve and the black conductor is connected to the connector plug tip.

(k) **Crystal Unit.** The 200 kc crystal unit is employed in the CFI Unit as a frequency standard. The crystal is mounted in a holder that is similar to a metal tube in appearance and is designed to plug into an octal type socket.

(l) **Accessories.** The accessories that are furnished with this equipment consist of a

metering cord, two test cables, two sets of tubes, a set of spare parts and a package of hardware. The metering cord is furnished to facilitate the measuring of the vacuum tube filament voltages. The cord is composed of two conductors, a two prong male connector and a four prong female connector. The cord is approximately six feet long. Two ten foot test cables are furnished to aid in the servicing of the equipment. Each cable is composed of 19 conductors, one male connector and one female connector. Refer to the MAINTENANCE Section of this Instruction Book for directions regarding the use of the cables.

1.2.2. **Remote Control Unit.** The remote control unit panel is finished in flat black and the chassis is finished in flat gray. The unit is designed to mount in a standard 19" relay rack. This unit may be placed at any distance from the transmitter up to the distance for which the line loss becomes greater than 25 db or the resistance of the line loop becomes greater than 1000 ohms. This unit may be used to control all functions of the transmitter. The unit includes a receiver disabling circuit that is operated by the carrier control system. A 110 volt 50 or 60 cps single phase power source is required. A power cord is furnished with each control unit.

1.3. **POWER SOURCE.** The transmitter is equipped with an autotransformer to permit operation from either a 115 volt or a 230 volt 60 cycle/sec single phase power source. Refer to the ADJUSTMENTS Section of this book for the proper connections for the power source that is available.

1.4. **POWER INPUT REQUIREMENTS.** The power input required for Type A1 emission is approximately 1560 watts, and 1570 watts for A2 or A3 emission with 100% modulation. In the standby position, that is, with the filament power on but the plate power off, the input is approximately 700 watts with the circuits set up for CW emission and 830 watts with the circuits set up for MCW or VOICE emission. The power factor in all cases is approximately 85%.

1.5. **TYPE OF EMISSION.** A1, A2, and A3 emissions are available. Electronic carrier control is used and permits keying speeds of several hundred words per minute with A1 emission. Keying speeds up to sixty words per minute may be used with A2 emission. The modulation frequency for A2 emission is variable in seven steps in the range of 400 to 1200 cycles per second.

1.6. **FREQUENCY RANGE.** The transmitter is capable of operation on any frequency within the range 2000 kc to 18,100 kc. The equipment is designed to work into unbalanced antennas or transmission lines having impedances of from 50 to 1200 ohms with a phase angle of 0 degrees, 70 to 850 ohms with a phase angle of ±45 degrees or 100 to 600 ohms with a phase angle of ± 60 degrees.

1.7. **FREQUENCY CONTROL.** The transmitter is provided with ten regular frequency channels. An eleventh frequency channel and manual tuning are provided. Automatic emission selection is available on the ten regular channels only. The frequency of the r-f output is controlled by a stable master oscillator operating in the frequency range 1000 kc to 1510 kc.

1.8. **FREQUENCY CHANGE SYSTEM.** The transmitter employs the Collins Autotune system of frequency selection. The Autotune system provides for quick frequency change by mechanically repositioning the various tuning elements to preset positions. The positioning elements are driven by a single motor which is controlled by a series of interlocking relays. The whole system will operate to change the frequency of transmission within a period of ten seconds when operating from a 60 cps power source. Any one of eleven preset frequency channels or manual tuning may be selected by dialing.

1.9. **AUDIO CHARACTERISTICS.** The overall frequency response, as measured between the 500 ohm input and the rectified carrier output, is uniform within 3 db from 150 cps to 3500 cps. The compression circuit has negligible effect with modulation levels below 70% modulation. For modulation levels above

70%, a change of 10 db in input level will cause a change in output level that does not exceed 3 db. The noise on the carrier, with a 500 ohm resistor connected across the audio input circuit, is more than 40 db below the 100% modulation level. The harmonic distortion with 100% modulation does not exceed 10% with input at 400 cps.

1.10. POWER OUTPUT. The power output when operating into a 300 ohm non-inductive load is not less than 400 watts with CW emission, 250 watts with MCW emission and 250 watts with VOICE emission throughout the frequency range 2000 kc to 18,100 kc. The voltage that is applied to the plates of the power amplifier tubes is automatically lowered when VOICE or MCW emission is selected by relay K118 changing the tap on the high voltage rectifier plate transformer primary.

The audio system is capable of modulating the r-f carrier 100% with full power output when operated with either Type A2 or Type A3 emission.

1.11. PANEL CONTROL. The panel controls on the transmitter consist of a telephone dial for selecting frequency channels and type of emission, a tune-operate switch, a local-remote switch, filament and plate power switches, a test key switch, a telegraph key cord plug receptacle and a microphone cord plug receptacle. The above controls allow the operator to apply or remove power, to select the frequency of transmission, to select the type of emission, and to control the emission from a position adjacent to the transmitter.

1.12. REMOTE CONTROL. The Remote Control Unit permits an operator to perform all the operations that are necessary to select the frequency channel, select the type of emission, control the emission and to turn the transmitter on and off from any distance up to the distance where the resistance of the remote line loop becomes greater than 1000 ohms or the loss in the line exceeds 25 db. All of the above functions except the control of the carrier are performed by dialing. The control system requires two cable pairs and a ground return circuit. A receiver disabling circuit has been incorporated in the control unit to disable the receiver when the transmitter carrier is on.

This unit is designed to operate from a 115 volt 50/60 cps single phase power source and requires approximately 25 watts of power.

1.13. ABBREVIATIONS. Throughout this Instruction Book abbreviations have been used in place of some of the more common radio terms and phrases. The abbreviations that are used in the sections that follow will not be defined but it will be assumed that reference will be made to the list below:

a-c—alternating current
a-f—audio frequency
amp.—amperes
ant.—antenna
A.W.G.—American Wire Gage
B.S.G.—Browne & Sharpe Gage
CFI—Crystal Frequency Indicator
cps—cycles per second
CT—Center Tapped
CW—Continuous Wave (telegraphy)
db—decibel
d-c—direct current
DPDT—Double Pole, Double Throw (switch)
DPST—Double Pole, Single Throw (switch)
Fil.—filament
Gnd.—ground (earth or chassis)
hy—henry (unit of inductance)
h-v—high voltage
kc—kilocycles
L.—symbol for inductance
LOCAL—Control of the transmitter using panel controls
l-v—low voltage
ma—milliamperes
mc—megacycles
MCW—Modulated Continuous Wave (telegraphy)
mfd—microfarads
mmfd—micromicrofarads
mh—millihenries
MO—Master Oscillator

MOD.—Modulator, Modulation
mw—milliwatts
N.C.—Normally Closed
N.O.—Normally Open
osc.—oscillator
P.A.—Power Amplifier
REMOTE — Control of the transmitter from a remote position
r-f—radio frequency
SPDT—Single Pole, Double Throw (switch)
T.—Turns (inductor)
term.—terminal
TV—Test Voltage
v—volts
VA—Volt-Amperes
Voice—speech modulated transmission (telephony)
w—watts
WV—Working Voltage

II CIRCUIT DESCRIPTION

2.1. **GENERAL.** Unit type of construction is employed in this transmitter. All of the components, except the larger transformers, are mounted on removable chassis or panels. All connections to the r-f, speech amplifier and control units are made with heavy duty multiterminal connector plugs. All connections to the power supply unit are made to a terminal strip on the upper rear edge of the chassis. Below is a tabulation of each of the units and the arbitrary letter which has been assigned to each unit for use as a reference to indicate interunit cabling connections:

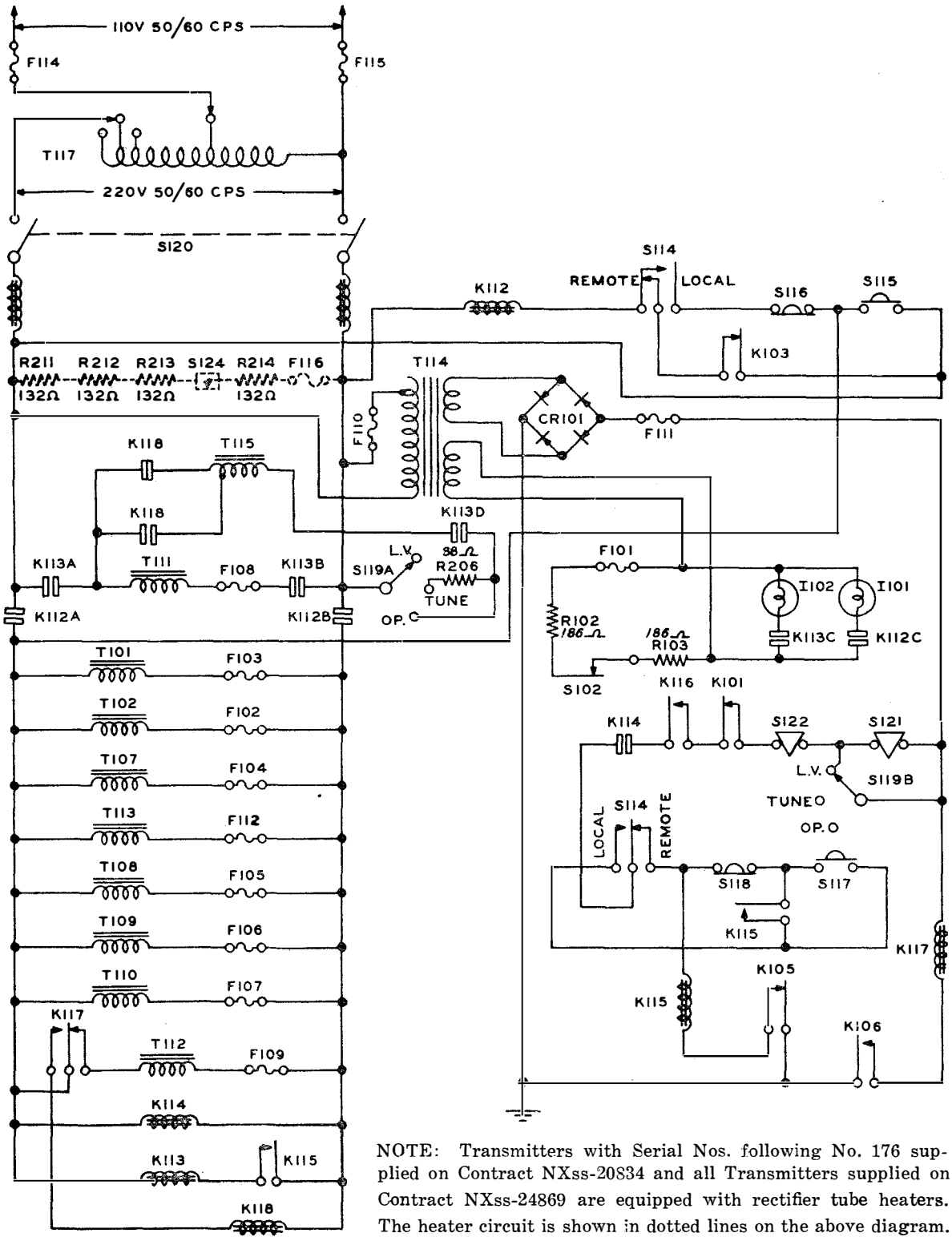
Letter Designation	Title
A	Meter Panel
B	Output Network
C	Radio Frequency Unit
D	Speech Amplifier
E	Control Unit
F	Power Supply
G	External Connections & Blower

2.2. **A-C PRIMARY CIRCUITS.** All power contactors in the equipment are of the 230 volt a-c type. All power circuits are controlled by opening or closing the transformer primary circuits. The operation of the filament power contactor, K112, applies filament power to all tubes in the transmitter and plate power to the bias rectifier. This transmitter is normally connected for voice emission and remote control.

Refer to Fig. 2 and Fig. 65 p. 172. When the power switch, S120, is operated, relay K112 is immediately energized by the circuit through S120, the contacts of the transmitter "OFF" relay, K103, the normally closed contacts of the LOCAL-REMOTE switch, S114, and the coil of relay K112. The operation of switch S120 also applies power to the primary of step-down transformer T114. Transformer T114 has two secondary windings, one supplies 110 volts for application to the filament power pilot lamp, I101, the plate power pilot lamp, I102, and the master oscillator compartment heater elements, R102 and R103, and the other supplies the a-c voltage that is applied to the rectifier, CR101. The dry disc rectifier supplies the 48 volts necessary for the operation of the Autotune control relays, the plate power auxiliary relay, K115, the PHONE-CW relay, K117, and the MCW relay, K102.

The low voltage plate power transformer, T111, is energized by the operation of K113. The L.V.-TUNE-OP. Switch, S119, permits the application of low voltage to the transmitter with the cabinet door open if the switch is operated to the L.V. position. Switch S119, when operated to the TUNE position, energizes the primary of the high voltage rectifier plate power transformer, T115, but connects resistor, R206, in series with the winding to reduce the voltage and to give poor regulation so that the tubes will not be damaged during "tune-up" operations. The voltage change relay, K118, connected in the primary of the high voltage power rectifier plate transformer, increases the voltage that is applied to the power amplifier tubes during periods of CW transmission by increasing the "turns-ratio" of transformer T115.

Both the rear panel and front door of the transmitter cabinet have been provided with interlock switches to prevent the operating personnel from coming in contact with dangerous voltages. The interlock switches, S121 and S122, are connected in series with the coil of the plate power auxiliary relay, K115. It is not possible to apply any plate power if the rear panel of the cabinet is removed, but if the rear panel is in position and if switch S119 is operated to the L.V. position, interlock switch S121 associated with the front door of the transmitter cabinet, is shorted-out and it is possible to apply voltage to the low power stages of the transmitter with the cabinet door open. Thus, it is possible to make tests and tuning adjustment on the low power stages of the transmitter with the front door open. With switch S119 in any position other than the L.V. position it is impossible to apply either low voltage or high voltage plate power to the transmitter tubes without first closing the cabinet door.



NOTE: Transmitters with Serial Nos. following No. 176 supplied on Contract NXss-20834 and all Transmitters supplied on Contract NXss-24869 are equipped with rectifier tube heaters. The heater circuit is shown in dotted lines on the above diagram.

Fig. 2 A-C Primary and Relay Control Circuits
(Dwg. No. 500 0091 00C)

A rectifier heater circuit was added to all transmitters with Serial Nos. following 170 on Contract NXss-20834 and to all transmitters on Contract NXss-24869. Heaters were added for both the low voltage and high voltage rectifier tubes. The heater circuit is controlled by a thermal switch, S124. The circuit is indicated with dotted lines on Fig. 2.

2.3. **POWER CONTROL CIRCUITS.** Refer to Fig. 2. This transmitter has been designed for normal operation from a remote position with complete control from the Remote Control Unit. The closing of the primary power switch, S120, energizes the coil of filament relay K112 and energizes the step-down transformer T114. The operation of relay K112 applies power to the primary of the P.A. filament transformer, T101, the exciter filament transformer, T102, the speech amplifier filament transformer, T107, the high voltage rectifier filament transformer, T113, the bias rectifier filament transformer, T108, the bias rectifier plate power transformer, T109, the L.V. rectifier filament transformer, T110, and the modulator filament transformer, T112. All transformer primary circuits are fused to prevent damage to the transformers and associated circuits. The operation of the filament relay also applies power to the filament pilot lamp, I101. A thermostat, S102, or thermostats S102 and S125 are connected in series with resistors R102 and R103, controls the temperature within the master oscillator compartment by opening and closing the circuit to the heating resistors.

The transmitter has been provided with time delay, interlock and overload relays to protect the equipment against damage. The time delay relay, K114, is energized upon the operation of filament relay K112 and prevents the application of plate power until sufficient time has elapsed to allow all tubes in the transmitter to warm up to the proper operating temperature. In addition to relay K114 a bias interlock relay, K116, has been connected in the output circuit of the bias supply and operates only after the bias rectifier tube has reached operating temperature and bias is being applied to the transmitting tubes. It is impossible to apply plate power until both the time delay relay and the bias interlock relay have operated. The contacts of these relays are connected in series with the coil of the auxiliary plate power relay K115. The door interlock switches, S121 and S122, are also connected in series with the coil of the auxiliary plate power relay. Interlock switch S121 may be shorted out by operating the L.V.-TUNE-OP. switch, S119, to the L.V. position. Interlock switch, S121, is associated with the front door of the transmitter cabinet. Interlock switch, S122, is associated with the rear panel of the transmitter cabinet and it is necessary that the rear panel of the transmitter cabinet be in position before any plate power can be applied.

The auxiliary plate power relay, K115, is supplied with power by the dry disc rectifier. When the time delay relay, K114, and the bias interlock relay, K116, have operated and if switch S119 is in the TUNE or OP. position, the energizing circuit for relay K115 is through the fuse, F111, the front door interlock switch, S121, the cabinet rear panel interlock switch, S122, the normally closed contacts of the overload relay, K101, the contacts of the bias interlock relay, K116, the contacts of the time delay relay, K114, the normally closed contacts of the LOCAL-REMOTE switch, S114, the coil of relay K115, and the normally closed contacts of the Autotune motor start relay, K105. The operation of relay K115 completes the circuit necessary for the operation of the plate power contactor, K113. When relay K113 operates, the low voltage plate power transformer, T111, is energized through relay contacts K113A and K113B. If the L.V.-TUNE-OP. switch, S119, is in the TUNE or OP. position, the high voltage rectifier plate power transformer, T115, will be energized through relay contact K113D, the contacts of relay K118 and relay contacts K113A. If switch S119 is operated to the TUNE position, resistor R206 is connected in series with the primary of the high voltage plate power rectifier transformer to reduce the voltage to a safe value during the period of adjustment of the r-f circuits. If

the energizing circuit for relay K115 is broken, the plate power contactor will immediately release and remove all plate power from the transmitting tubes. The continuity of the K115 energizing circuit may be broken by the failure of fuse F111, the opening of either of the interlock switches, S121 or S122, the operation of overload relay K101, the failure of the bias supply and the consequent release of relay K116, the failure of time delay relay, K114, the operation of LOCAL-REMOTE switch S114 from the REMOTE to the LOCAL position or by the operation of Autotune motor start relay K105. If the energizing circuit for relay K115 is completed by removing the cause of the circuit being opened, the sequence of operation as outlined for the initial starting will be repeated.

If CW emission is selected by dialing **A1**, the emission selecting relay, K106, will operate to complete the circuit necessary for the operation of the PHONE-CW relay, K117. When relay K117 operates, filament and plate power is removed from the modulator tubes, V120 and V121, the secondary of the modulation transformer, T116, is shorted and the Power Change relay, K118, is operated, increasing the voltage that is applied to the plates of the power amplifier tubes. If the transmitter is dialed off, which operates relay K103, it will be necessary to dial something other than **A0** or to open and close the transmitter power switch S120 to start the sequence of transmitter power application.

If it is desired to control the transmitter from the panel rather than from the remote control unit, the LOCAL-REMOTE switch, S114, should be operated to the LOCAL position. With switch S114 in the LOCAL position filament power is not immediately applied by the operation of the line switch, S120. Power control is manual and it is necessary to operate FILAMENT power switch S115 to start the sequence of power application. Operating switch S115 completes the circuit necessary for the energizing of filament power contactor K112 by the circuit through switch S115, switch S116, the normally open contacts of the LOCAL-REMOTE switch, S114, and the coil of relay K112. When switch S115 is released, relay K112 is held operated through relay contacts K112A. As described in the above paragraphs for remote control, the operation of relay K112 completes the circuit necessary for the energizing of the time delay relay, K114, and the bias interlock relay, K116. When sufficient time has elapsed for the operation of relays K114 and K116, the auxiliary plate power relay, K115, may be energized by operating the PLATE start switch, S117. The energizing circuit for relay K115 is from the dry disc rectifier, CR101, through fuse F111, interlock switches S121 and S122, the normally closed contacts of overload relay K101, the contacts of bias interlock relay K116, the contacts of the time delay relay, K114, the normally open contacts of the LOCAL-REMOTE switch, S114, the contacts of switch S117, the contacts of switch S118, the coil of relay K115 and the contacts of the Autotune motor start relay, K105. When switch S117 is released, relay K115 is held operated by the contacts of relay K115. The remaining steps of the power application sequence are exactly as outlined for remote control.

2.4. FILAMENT CIRCUITS. Refer to **Fig. 66 p. 174.** Filament power for all tubes in the transmitter is supplied by step-down transformers that are located in the same unit as the tubes that are being supplied. All filament transformers are energized when contactor K112 is operated. Transformer T101 furnishes voltage for application to the filaments of the power amplifier tubes (V105 and V106). Transformer T102 furnishes voltage for application to the filaments of the master oscillator (V101), the r-f amplifier (V102), the frequency multiplier (V103), the intermediate amplifier (V104) tubes and the calibration unit oscillator (V109), frequency converter (V110) and audio amplifier (V111) tubes. All of the above tubes are located in the R-F Unit. The filament voltage for all of the tubes in the R-F Unit may be measured by inserting the filament meter cord plug into plug receptacle J104. Two secondary wind-

ings on transformer T107 furnish filament voltages for all of the tubes in the Speech Amplifier Unit. The voltage across either winding may be measured by inserting the filament voltage metering cord plug into receptacle J108.

Separate filament transformers have been provided for each rectifier system and for the modulator tubes. Transformer T113 furnishes voltage for application to the filaments of the high voltage rectifiers (V122 and V123); transformer T108 furnishes voltage for application to the filament of the bias rectifier (V124); transformer T110 furnishes voltage for application to the filaments of the low voltage rectifiers (V125 and V126); transformer T112 furnishes voltage for application to the filaments of the modulators (V120 and V121). When CW emission is selected by dialing **A1**, relay K117 is operated and filament voltage is removed from the modulator tubes (V120 and V121). All filament voltages may be measured, using the extension cord and the voltmeter that is mounted in the meter panel.

Filament voltage for application to the two preamplifier tubes (V301 and V302) and the rectifier (V303) in the Remote Control Unit is furnished by power transformer T303.

All filament transformer primaries are fused. The output voltage of the transformers may be adjusted by changing the turns-ratio of the transformer windings.

2.5. HIGH VOLTAGE AND RELAY SUPPLY CIRCUITS. Refer to Fig. 65 p. 172 and Fig. 66 p. 174. Three vacuum tube rectifier systems and a dry disc rectifier supply d-c power for the operation of all vacuum tubes and the d-c relays within the transmitter. All four rectifier systems are located in the Power Supply Unit.

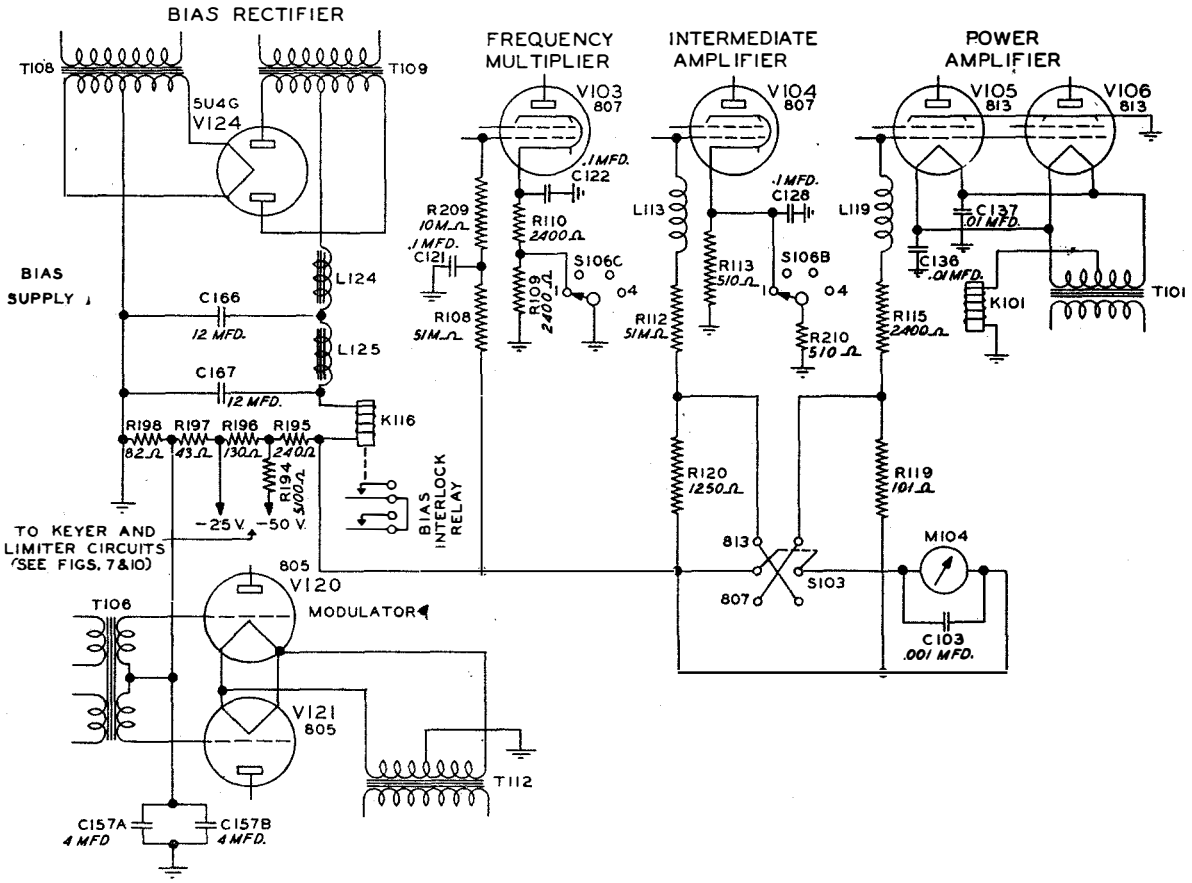


Fig. 3 Bias System (Dwg. No. 500 2655 00C)

The power that is necessary for application to the vacuum tubes that are located in the Remote Control Unit is supplied by a rectifier system that is contained within the control unit.

2.5.1. **Bias Supply.** Refer to Fig. 3. The bias supply employs a Type 5U4G high vacuum full-wave rectifier tube (V124). Both filament and plate voltages are applied to V124 when the line switch, S120, is operated if the LOCAL-REMOTE switch, S114, on the transmitter panel, is in the REMOTE position, or by the operation of the FILAMENT start switch, S115, when the switch S114 is in the LOCAL position. Both the bias rectifier filament transformer, T108, and the bias rectifier plate transformer, T109, primaries are fused. A two section choke input filter reduces the ripple voltage to a negligible value. The coil of the interlock relay, K116, is connected in series with bleeder resistors, R195, R196, R197 and R198 across the output of the filter. When the rectifier tube, V124, reaches operating temperature, the interlock relay is operated by the current that flows through the bleeder. Relay K116 must be operated before plate voltage can be applied to any of the r-f or audio tubes in the transmitter. The bleeder is tapped to provide the bias voltage necessary for application to the grids of the frequency multiplier, intermediate amplifier, power amplifier, modulator, limiter and keyer tubes.

2.5.2. **Low Voltage Supply.** Two Type 866/866A half-wave mercury vapor rectifier tubes (V125 and V126) are connected in a full-wave rectifier system. Filament power is applied to V125 and V126 when the filament power contactor is operated. Plate voltage is applied to the low voltage rectifiers by the operation of contactor K113. The output of the rectifiers is filtered by a two section choke input filter. A bleeder consisting of resistors R199, R200 and R201, is connected across the output of the supply. The supply furnishes voltage for application to the plates and screens of all of the low power transmitter tubes and the screens of the power amplifier tubes. The bleeder is tapped at the junction of resistors R199 and R200 to obtain the lower voltage necessary for application to the plates of the audio amplifier tubes.

2.5.3. **High Voltage Supply.** The high voltage supply furnishes power for application to the plates of the power amplifier and modulator tubes. The output of the two Type 249C half-wave mercury vapor rectifier tubes (V122 and V123) is filtered by a two section choke input filter. Voltage is applied to the filaments of V122 and V123 whenever contactor K112 is operated. Plate voltage is applied by the operation of contactor K113. When CW emission is selected by dialing A1, PHONE-CW relay K117 is operated to complete the circuit necessary for the operation of Power Change relay K118. Relay K118 has one set of normally open and one set of normally closed contacts. Both sets of contacts are connected to taps on the primary of transformer T115. When relay K118 operates, the tap on the transformer primary winding is changed to increase the voltage that is applied to the rectifier plates.

2.5.4. **Relay Power Supply.** A selenium rectifier (CR101) supplies the 48 volts d.c. that is necessary for the operation of all d-c relays in the transmitter. Transformer T114 supplies the a-c voltage for application to CR101. The transformer is energized whenever the power switch, S120, is operated to the ON position. Transformer T114 also provides voltage for application to the FILAMENT and PLATE pilot lamps. The primary of transformer and the output of the rectifier are fused.

2.6. **AUTOTUNE SYSTEM.** The Collins Autotune system is an electrically controlled means of mechanically repositioning adjustable elements such as tap switches, variable inductors, variable capacitors and variable resistors. Any combination of these items such as used in radio transmitters and receivers can be tuned to any one of a number of preselected frequencies in a period of less than ten seconds by the use of the Autotune system when operating from a 60 cps power source.

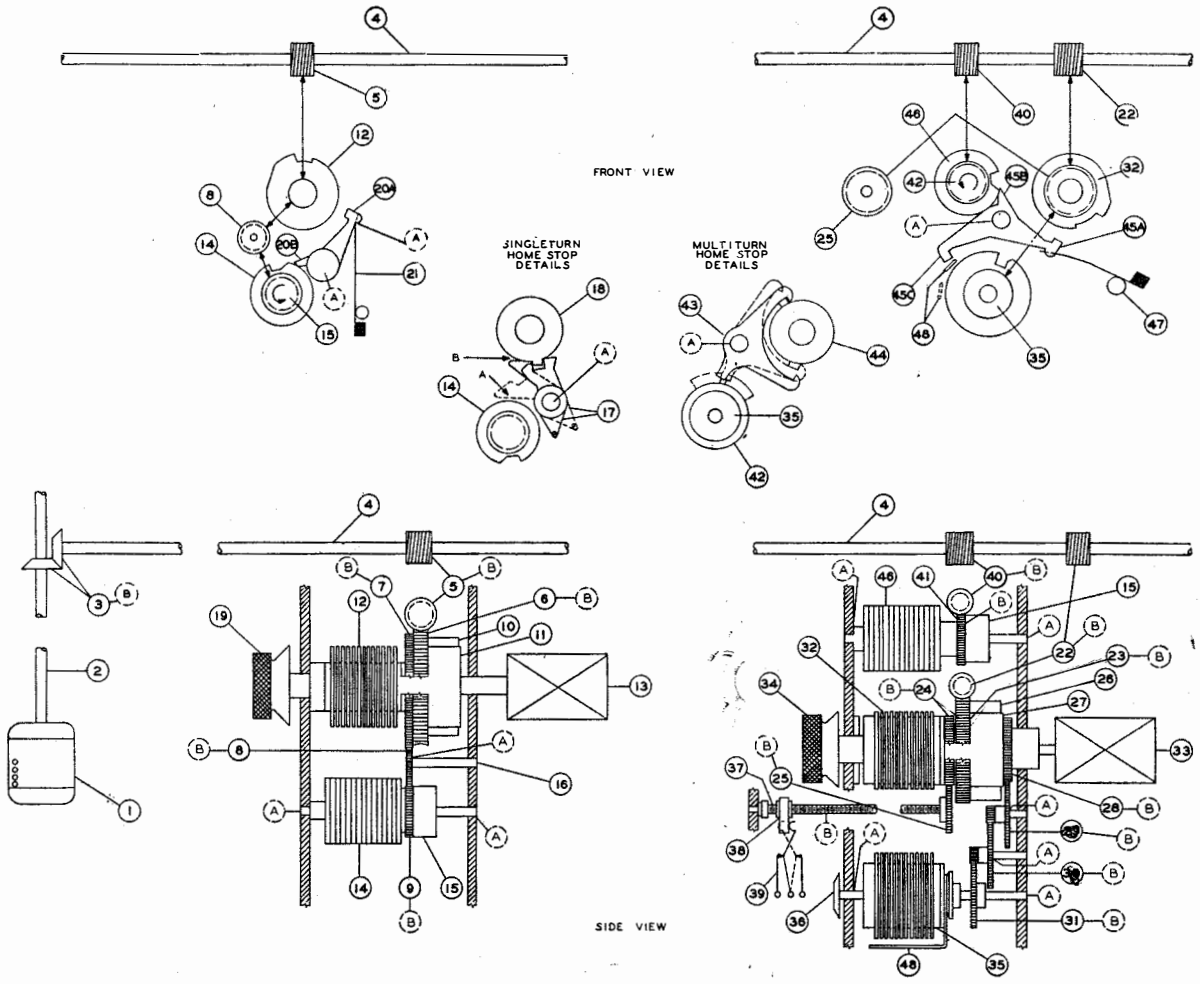
The Autotune consists of a group of positioning mechanisms, one connected to each tuning element. Each mechanism is provided with a tuning knob so that the elements may be adjusted manually. Each positioning mechanism provides precise angular setting of the tuning element with which it is associated. The position of the tuning element with respect to the mechanism is readily adjustable. The setting for each control is entirely independent of the other controls. Locking bars, located on each tuning dial, lock the tuning element to the mechanism for each predetermined setting of the control.

The accuracy of positioning of the Autotune system is of a very high order. Each setting is inherently independent of wear, backlash, alignment, line voltage, etc. The accuracy of the resetting of the tuning elements is comparable to that obtainable with vernier manual controls. All parts are machined within close limits and although operation is most precise there are no delicate adjustments or fragile mechanisms.

The Autotune system employed in this equipment utilizes five singleturn units and one multiturn unit to perform the tuning operations necessary for frequency selection, exciter tuning, power amplifier tuning and antenna loading. The multiturn unit operates a tuning slug within the master oscillator grid inductor, L104, to vary the frequency of the output of the oscillator within the frequency range 1000 kc to 1510 kc. Ten revolutions of the multiturn dial are necessary to cover this frequency range. The dial is divided into 100 divisions to permit the accurate positioning of the slug within the inductor. A counter dial divided into 10 divisions shows the number of full revolutions that the dial makes and the dial reading for any particular frequency within the band is obtained by reading the number of full revolutions on the counter dial and the fraction of the revolution on the large tuning dial. Two singleturn units are located on the R-F Unit, one operating the exciter band switch and the other tuning the frequency multiplier and the intermediate amplifier plate tank circuits. A channel indicator, located on the same Autotune assembly, is driven by the line shaft that drives the two singleturn units and the multiturn unit. The dial of the channel indicator is divided into 12 divisions engraved with numbers from 1 through 11 and the twelfth position is engraved with the letter M. The numbers indicate the frequency channel to which the Autotune system is operated. When the letter M is opposite the indicator mark, the Autotune system has been operated to the Manual position and all tuning dials may be operated manually without unlocking the stop rings or disturbing the positions of the rings. Thus by selecting manual control, tuning adjustments may be made without danger of disturbing the predetermined settings of the stop rings.

Three singleturn units mounted on the Output Network operate the power amplifier plate tuning capacitor, C108, the power amplifier band switch, S101, and the antenna loading capacitor, C105. These three singleturn units are driven by a line shaft and the line shaft is in turn coupled to the drive shaft by gears that are mounted near the left-hand end of the Autotune assembly. When aligning the Autotune system it is of utmost importance that the coupling shaft between the Autotune assemblies in the R-F and Output Network Units be in the proper position with respect to each other so that the units in the two assemblies are properly synchronized. The Autotune line shafts are driven by a motor that is mounted on the side of the transmitter cabinet. The motor shaft is coupled to the Autotune drive shaft by a short coupler that incorporates a universal joint to compensate for any misalignment of the drive shafts. The shafts between the Autotune motor and the assembly in the R-F Unit may be coupled without regard to the positions of the shafts. The complete procedure for synchronizing the units is included in the MAINTENANCE Section of this Instruction Book.

In order to identify individual contacts of telephone type relays, an arbitrary system of numbering has been used. The contact springs



LUBRICATING INFORMATION

NOTE SEE MAINTENANCE SECTION OF INSTRUCTION BOOK FOR DIRECTIONS FOR LUBRICATION

SYMBOL	RECOMMENDED LUBRICANT
(A)	VACTRA OIL EXTRA HEAVY X
(B)	SOCONY VACUUM VISCOLITE LUBRICANT #10

KEY TO SYMBOLS

1 AUTOTUNE MOTOR
2 DRIVE SHAFT
3 LINE SHAFT DRIVE GEARS
4 LINE SHAFT
5 SINGLETURN WORM
6 SLIP CLUTCH WORM GEAR
7 CAM DRUM DRIVE SPUR GEAR
8 IDLER GEAR
9 CAM DRUM SPUR GEAR
10 SLIP CLUTCH BAND
11 SLIP CLUTCH DRUM
12 STOP RING DRUM
13 TUNED ELEMENT
14 CAM DRUM
15 SINGLE TOOTH RACHET
16 IDLER GEAR SHAFT
17 SINGLETURN HOME STOP PAWL
18 SINGLETURN HOME STOP RING
19 SINGLETURN DIAL
20 PAWL (20A-TOE) (20B-HEEL)
21 PAWL SPRING
22 MULTITURN WORM #1
23 STOP RING DRUM WORM GEAR
24 STOP RING DRUM SPUR GEAR
25 LIMIT SWITCH DRIVE SHAFT SPUR GEAR
26 SLIP CLUTCH BAND
27 SLIP CLUTCH DRUM
28 COUNTER DRUM DRIVE GEAR
29 IDLER GEAR #1
30 IDLER GEAR #2
31 COUNTER DRUM SPUR GEAR
32 STOP RING DRUM
33 TUNED ELEMENT
34 MULTITURN DIAL
35 COUNTER DRUM
36 TURN COUNTER DIAL
37 LIMIT SWITCH DRIVE SHAFT
38 SWITCH OPERATING ARM
39 LIMIT SWITCH
40 MULTITURN WORM #2
41 CAM DRUM WORM GEAR
42 MULTITURN HOME STOP CAM
43 MULTITURN HOME STOP PAWL
44 MULTITURN HOME STOP RING
45 PAWL (45A-TOE)(45B-HEEL) (45C-TAIL)
46 CAM DRUM
47 PAWL SPRING
48 PAWL ANVIL

Fig. 4 Collins Autotune System—Mechanical Details
(Dwg. No. K865D)

are arranged in one or more "pile-ups." When viewing a relay from the heel end, that is with the contact spring terminals toward the viewer, and with the contacts at the top of the relay, the contact pile-up to the left is referred to as the "L" pile-up, and the contact pile-up to the right is referred to as the "R" pile-up. If a center pile-up is used, it is referred to as the "C" pile-up. If a relay has only one pile-up of contacts the reference to "L" or "R" is usually omitted. The individual contact springs in each pile-up are numbered consecutively beginning with number 1 spring as the one nearest the relay coil.

2.6.1. **Mechanical Details.** The Autotune system in this equipment consists of two assemblies driven by a motor through a series of line and drive shafts. Figure 4 shows, in simplified form, the mechanical details of the Collins Autotune System. The number that appears before the part or assembly description corresponds to the item number on the drawing.

1. AUTOTUNE MOTOR. The Autotune motor is of the capacitor, reversible type and drives the line shafts through a shaft and gear arrangement.

2. DRIVE SHAFT. The drive shaft couples the Autotune motor (1) to the Autotune assemblies. One section of shaft couples the motor to the assembly that is located in the r-f unit and the second section of shaft couples the line shafts of the two assemblies together.

3. LINE SHAFT DRIVE GEARS. Each Autotune assembly is provided with a gear box on the left-hand end of the assembly to couple the drive shaft (2) to the line shaft (4).

4. LINE SHAFT. The line shaft extends the entire length of the Autotune casting and drives all Autotune units within the casting. The line shaft is driven by the motor (1) through the gears (3) and the drive shaft (2).

5. SINGLETURN WORM. The singleturn worm drives the singleturn unit and is fastened to the line shaft (4) with a groove-pin.

6. SLIP CLUTCH WORM GEAR. This gear is fastened to the cam drum drive spur gear (7) and drives the stop-ring drum (12) through the slip clutch (11). The gear is driven by the singleturn worm (5).

7. CAM DRUM DRIVE SPUR GEAR. This gear is fastened directly to the slip clutch worm gear (6) and drives the cam drum spur gear (9) through the idler gear (8).

8. IDLER GEAR. This idler gear transmits power from the cam drum drive spur gear (7) to the cam drum spur gear (9).

9. CAM DRUM SPUR GEAR. The cam drum spur gear is driven by the line shaft through the singleturn worm (5), the cam drum drive spur gear (7) and the idler gear (8). The spur gear drives the cam drum (14) through the single tooth ratchet (15).

10. SLIP CLUTCH BAND. The band is driven directly from the slip clutch worm gear (6) and presses against the slip clutch drum (11).

11. SLIP CLUTCH DRUM. The clutch drum is fastened to the stop-ring drum shaft and is driven by the slip clutch band (10).

12. STOP-RING DRUM. The stop-ring drum assembly consists of 12 stop rings mounted on a shaft with spacers between the rings. The stop rings are free to rotate but the spacers are keyed to the shaft in a manner such that the rotation of a stop ring will not change the position of adjacent rings. The stop rings may be locked in position by rotating the locking bar on the front of the dial in a clockwise direction. The locking mechanism consists of a bar mounted on a screw that applies pressure to the stack of stop rings and spacers as the screw is rotated clockwise and thereby in effect locks the stop rings in position.

13. TUNED ELEMENT. The tuned element, capacitor, tuning slug, etc., is fastened rigidly to the stop-ring drum shaft.

14. CAM DRUM. The cam drum consists of 12 cams mounted on a shaft with adjacent

cam slots staggered 30 degrees. These cams are rigidly fastened to the cam drum. The singletooth ratchet (15), mounted on the shaft behind the drum, drives the drum.

15. SINGLE TOOTH RATCHET. The single tooth ratchet is fastened to the cam drum shaft and when engaged, drives the cam drum. This ratchet is used to keep the cam drum of the units synchronized.

16. IDLER GEAR SHAFT. This shaft is fastened rigidly to the back plate of the singleturn unit. The idler gear (8) is fastened to the shaft with a flat head screw.

17. SINGLETURN HOME STOP PAWL. The singleturn home stop pawl limits the rotation of the singleturn unit to one revolution. The pawl is located on the same shaft as the stop-ring pawl (20) and is engaged by the singleturn home stop ring (18). The pawl, shown in solid lines on the drawing, limits the rotation of the stop-ring drum (12) in the counterclockwise direction. The pawl cannot pivot further because of bearing on the stop-ring drum (12) at point B. The pawl shown in dotted lines, limits the rotation of the cam drum (12) in a clockwise direction. The pawl cannot pivot further in this position because of bearing on the cam drum (14) at point A.

18. SINGLETURN HOME STOP RING. This ring, mounted with the other stop rings on the stop-ring drum (12), is rigidly fastened to the drum. The home stop pawl (17) engages the ring to limit the rotation of the stop-ring drum (12) to one revolution.

19. SINGLETURN DIAL. The singleturn dial is fastened to the stop-ring drum (12) and permits the calibration of the tuned element (13). The locking bar is located on the front of the dial and requires only a fraction of a revolution to lock or unlock the stop rings.

20. STOP RING PAWL. The pawl heel (20B) is held against the cam drum (14) by the pawl spring (21). The pawl toe (20A) serves to position the tuned element (13) by stopping the stop-ring drum (12) at the predetermined position.

21. PAWL SPRING. The pawl spring presses the pawl (20) against the cam drum (14) and when the pawl (20) drops into the cam slot, the pawl spring presses the pawl (20) against the stop-ring drum (12).

22. MULTITURN WORM #1. This worm is keyed to the line shaft (4) and drives the stop-ring drum worm gear (23).

23. STOP-RING DRUM WORM GEAR. The worm gear is driven by the line shaft (4) and drives the stop-ring drum (32) through the slip clutch (27).

24. STOP-RING DRUM SPUR GEAR. This spur gear is fastened to the stop-ring drum and drives the limit switch drive shaft (37) through the drive shaft spur gear (25).

25. LIMIT SWITCH DRIVE SHAFT SPUR GEAR. The gear is driven by the stop-ring drum spur gear (24) and drives the limit switch drive shaft (37).

26. SLIP CLUTCH BAND. The slip clutch band is driven by the worm gear (23) and drives the stop-ring drum (32) through the slip clutch drum (27).

27. SLIP CLUTCH DRUM. This clutch, similar to the slip clutch drum (11) on the singleturn unit, is driven by the slip clutch band (26) and is fastened to the stop-ring drum shaft.

28. COUNTER DRUM DRIVE GEAR. The drive gear is fastened to the slip clutch drum (27) and drives the counter drum (35) through the idler gears (29 and 30) and the counter drum spur gear (31).

29. IDLER GEAR #1. This gear and idler gear #2 couple the counter drum (35) to the slip clutch spur gear (28).

30. IDLER GEAR #2. This gear and idler gear #1 (29) link the counter drum (35) to the slip clutch spur gear (28).

31. COUNTER DRUM SPUR GEAR. This gear is fastened to the counter drum shaft and drives the counter drum (35) and counter dial (36).

32. STOP-RING DRUM. See (12).

33. TUNED ELEMENT. The element, in this case an inductor tuning slug, is coupled directly to the stop-ring drum (32).

34. MULTITURN DIAL. This dial is equipped with a locking bar identical to that used to lock the singleturn dial (19). The multiturn stop rings may be locked in any position by operating the dial lock a fraction of a revolution in the clockwise direction.

35. COUNTER DRUM. The counter drum is made up of eleven cams and spacers. Like the stop-ring drums (12 and 32) the spacers are keyed to the shaft. A spring on the rear of the counter drum loads the stack of cams axially so that the rings will not turn too easily.

36. TURN COUNTER DIAL. The dial is fastened to the counter drum shaft. The numbers on the dial indicate the number of full revolutions of the stop-ring drum (32).

37. LIMIT SWITCH DRIVE SHAFT. The drive shaft is driven by the stop-ring drum spur gear (24). The switch operating arm (38) travels on the shaft and operates the limit switch (39).

38. SWITCH OPERATING ARM. The arm is threaded and travels on the limit switch drive shaft (37) when the shaft is rotated by the stop-ring drum (32) through gears (24 and 25).

39. LIMIT SWITCH. The limit switch is operated by the operating arm (38).

40. MULTITURN WORM #2. The worm drives the cam drum (46) through single tooth ratchet (15).

41. CAM DRUM WORM GEAR. This gear is driven by the line shaft (4) through the worm gear (40) and drives the cam drum (46) through the single tooth ratchet (15).

42. MULTITURN HOME STOP CAM. This cam is mounted with the other cams on the counter drum (35). The cam actuates the home stop pawl (43) and limits the rotation of the stop-ring drum (32) to 10 revolutions.

43. MULTITURN HOME STOP PAWL. This pawl is actuated by the home stop cam (42) and engages the projection on the home stop ring (44) to limit the rotation of the stop-ring drum (32) to 10 revolutions.

44. MULTITURN HOME STOP RING. This ring is mounted on the stop-ring drum (32) and engages the home stop pawl (43). The dotted lines on the drawing show the home stop ring (44), the home stop pawl (43) and the stop-ring drum (32) in the position corresponding to the maximum rotation in the counterclockwise direction. The solid outline shows the pawl in the position corresponding to the maximum rotation in a clockwise direction.

45. PAWL. This pawl engages the cam drum (46), the cam on the counter drum (35) and the stop ring of drum (32) to stop the tuned element in a position to which it has been previously set.

46. CAM DRUM. This drum is identical to cam drum (14).

47. PAWL SPRING. The pawl spring presses the pawl (45) against the cam drum (46) so that the projection on the pawl (45) drops into the cam drum slot and permits the tooth of the pawl to engage the stop ring on the stop-ring drum (32).

48. PAWL ANVIL. The anvil prevents the multiturn pawl tails (45C) from becoming engaged with the counter drum (35) ring slots until after the motor (1) reverses.

2.6.2 Electrical Details. The Autotune control circuits, in simplified form, are shown on Figure 5A. The item numbers opposite the component symbols correspond to the item numbers that are used on the transmitter schematic diagram and in the parts list. The following section has been compiled to aid the operator in better understanding the operation and control of the Collins Autotune system. A brief description of each component associated with the system and the function of the component is listed below:

B101 AUTOTUNE MOTOR. This motor is of the capacitor, reversible type and operates directly from the 230 volt 50/60 cps single phase power source. The motor drives the Autotune mechanism through a series of shafts.

CIRCUIT DESCRIPTION

B101 - AUTOTUNE MOTOR
K101 - OVERLOAD RELAY
K102 - MCW OSCILLATOR RELAY
K103 - TRANSMITTER OFF RELAY
K104 - AUTOTUNE MOTOR REVERSING RELAY
K105 - AUTOTUNE MOTOR STARTING RELAY
K106 - EMISSION SELECTION RELAY
K107 - ROTARY SWITCH
K108 - IMPULSE RELAY
K109 - HOMING RELAY
K110 - TIMING RELAY
K111 - TIMING RELAY

S109 - AUTOTUNE POSITIONING SWITCH
S110 - AUTOTUNE LIMIT SWITCH
S114 - LOCAL - REMOTE SWITCH
S301 - TELEPHONE DIAL

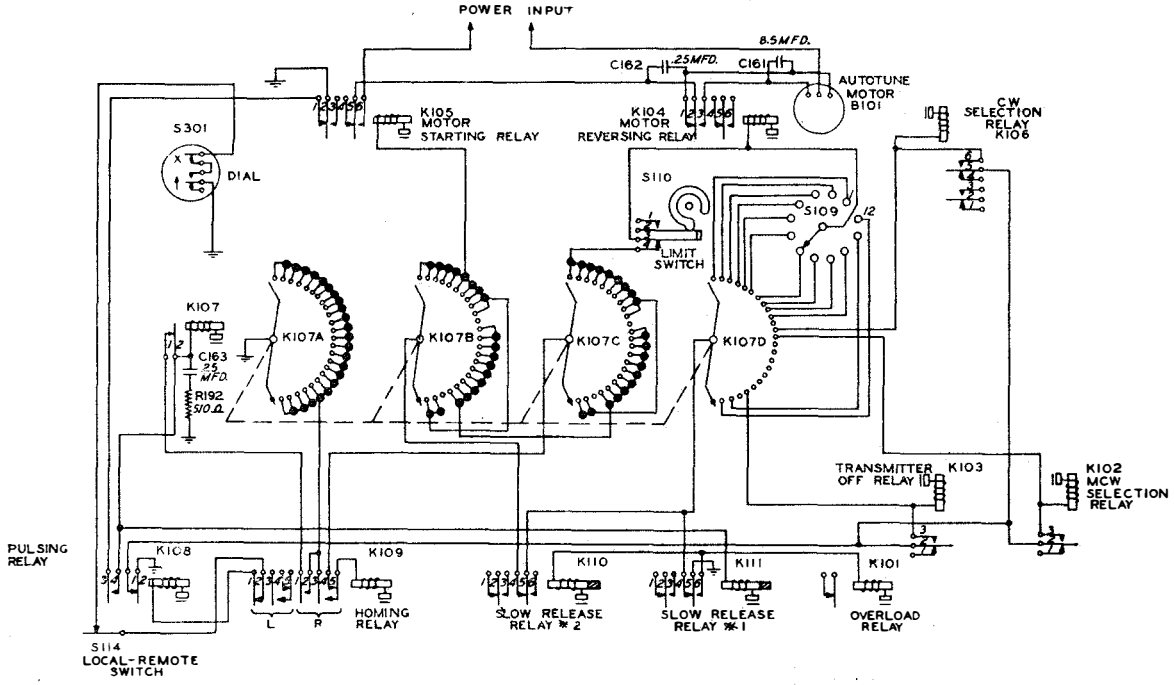


Fig. 5A Collins Autotune System—Electrical Details
(Dwg. No. 500 0092 00C)

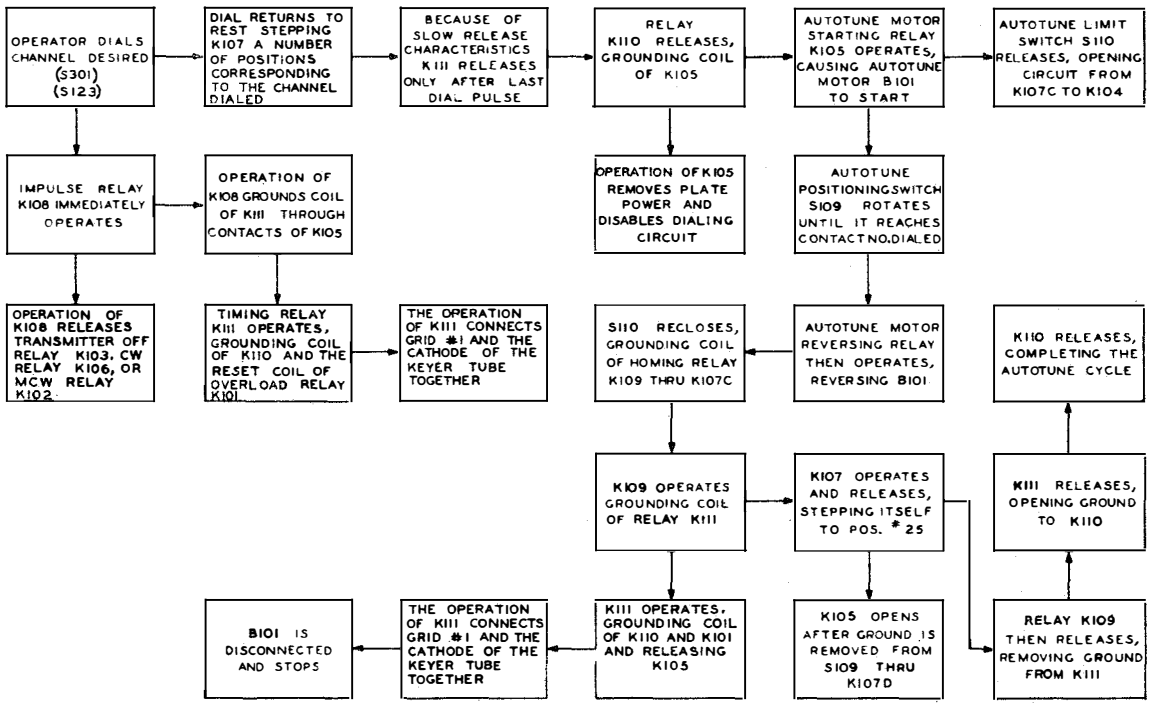


Fig. 5B Collins Autotune System—Sequence of Operation—Channel Selection
(Dwg. No. 500 0092 00C)

Motor B101 is controlled by relays K104 and K105.

K101 OVERLOAD RELAY. If relay K101 has been operated by an overload in the power amplifier circuit, the reset coil will be energized by any dialing operation.

K102 MCW RELAY. When relay K102 is operated the transmitter circuits are set up for MCW emission. This relay is operated by dialing A2. Dialing A2 steps the rotary switch, K107, to Position 13 and energizes relay K102 by the circuit through switch section K107D and Contacts 4 and 5 of relay K111. The relay is held operated by the circuit through Contacts 2 and 3 of relay K102 and Contacts 1 and 2 of relay K108. Any dialing operation will release relay K102. The operation of the MCW relay removes the ground from the grid of the oscillator section of V112, permitting the tube to oscillate, and opens the circuit from the audio line to the input transformer, T103.

K103 TRANSMITTER OFF RELAY. Relay K103 is operated when A0 is dialed. Dialing A0 operates the rotary switch, K107, to Position 21. When the rotary switch comes to rest in Position 21, relay K103 is energized by the circuit through the contacts of switch section K107D and Contacts 4 and 5 of relay K111. The holding circuit for the transmitter off relay is through Contacts 2 and 3 of relay K103 and Contacts 1 and 2 of relay K108. Any dialing operation will release relay K103.

K104 AUTOTUNE MOTOR REVERSING RELAY. When the positioning switch, S109, has been operated to the position corresponding to the channel that has been dialed, K104 will be energized by the circuit through the contacts of switch S109, the contacts of switch section K107D and Contacts 4 and 5 of relay K111. The operation of relay K104 changes the connections to motor B101 to cause the motor to reverse direction of rotation. With relay K104 unoperated the circuit from the power source to the motor is through Contacts 5 and 6 of relay K105 and Contacts 1 and 2 of relay K104. When the reversing relay is operated the circuit is changed to Contacts 2 and 3 of relay K104. Contacts 5 and 6 also close the automatic emission selection circuit to operate relay K102 or relay K106.

K105 AUTOTUNE MOTOR STARTING RELAY. This relay causes rotation of the Autotune motor by closing the circuit to the 220 volt single phase power line. The operation of K105 breaks the circuit necessary for the operation of the rotary switch K107 and therefore prevents emission selection and carrier application during the time that the Autotune motor is rotating the tuning elements. Relay K105 is energized by the circuit through contacts 1 through 10 and 23 and 24 of switch band K107B, Contacts 4 and 5 of relay K110 and Contacts 4 and 5 of relay K111. Relay K105 will only be energized after the last dialing impulse and after relay K111 has released to close Contacts 4 and 5 of the disconnect relay.

K106 CW RELAY. The selection of CW emission by dialing A1 operates relay K106. Dialing A1 causes the rotary switch K107 to step to Position 12. When switch K107 is operated to Position 12, relay K106 is energized by the circuit through switch section K107D and Contacts 4 and 5 of relay K111. The holding circuit for the emission selection relay is through Contacts 5 and 6 of relay K106 and Contacts 1 and 2 of relay K108. Any dialing operation will release K106.

K107 ROTARY SWITCH. This switch is of the 25 position telephone type consist-

ing of 4 banks and a set of normally closed auxiliary contacts. The coil of K107 is energized as the pulsing relay, K108, operates through Contacts 3 and 4 of relay K108 and Contacts 1 and 2 of relay K105. As the coil is energized a pawl and ratchet arrangement acts to compress a spring which when released rotates the switch banks one position for each impulse of relay K108. The rotary switch will be self-impulsed to Position 25 whenever K109 is in the operated position, by the circuit through the auxiliary Contacts 1 and 2 of relay K107, Contacts 1 and 2 of relay K109 and switch section K107A.

K108 IMPULSE RELAY. Relay K108 is of the quick acting type. The relay is energized by the circuit through Contacts 1 and 2 of relay K109, the normally closed contacts of the LOCAL-REMOTE switch, S114, and the contacts of the telephone dial S301. When switch S114 is operated to the LOCAL position the energizing circuit is through Contacts 1 and 2 of relay K109 the normally open contacts of switch S114 and the contacts of telephone dial S123. When the homing relay, K109, is operated the impulsing relay is prevented from operating by the opening of Contacts 1 and 2 of relay K109.

K109 HOMING RELAY. When the Autotune motor reverses to the place where the limit switch, S110, is closed, the homing relay is energized by the circuit through Contacts 4 and 5 of relay K109, switch section K107C, Contacts 3 and 4 of switch S110, the contacts of switch S109, the contacts of switch section K107D and Contacts 4 and 5 of relay K111. Relay K109 is held operated by Contacts 3 and 5 of relay K109 and switch section K107A until the rotary switch comes to rest in Position 25.

K110 SLOW RELEASE RELAY #2. This relay is operated by the circuit through Contacts 5 and 6 of relay K111 when the disconnect relay is in the operated position. The operation of K110 prevents the starting of the Autotune motor during dialing operations.

K111 SLOW RELEASE RELAY #1. This relay is operated by the circuit through Contacts 3 and 4 of the impulse relay, K108 and Contacts 1 and 2 of the motor start relay, K105, by the operation of the impulse relay K108. Because of the slow release characteristics of this relay, relay K111 is held operated until after the last dial impulse.

S109 AUTOTUNE POSITIONING SWITCH. This switch is mounted on the channel indicator assembly and is driven by the motor. The operation of this switch completes the circuit necessary for the energizing of the motor reversing relay, K104. When switch S109 reaches the contact that corresponds to the position to which the rotary switch has been operated, the motor reversing relay is energized.

S110 AUTOTUNE LIMIT SWITCH. This switch is mounted on the multiturn unit and is operated by the motor, B101, in such a manner that as soon as the motor starts to rotate, Contacts 3 and 4 of switch S110 open. When the motor has been reversed and returns switch S110 to the original position, Contacts 3 and 4 close and provide an energizing circuit for the homing relay, K109.

S114 LOCAL-REMOTE SWITCH. The LOCAL-REMOTE switch is located on the transmitter control panel and permits the switching of control from the remote unit to the transmitter proper. The switch is normal in the REMOTE position.

S301 TELEPHONE DIAL. This telephone dial is located in the Remote Control

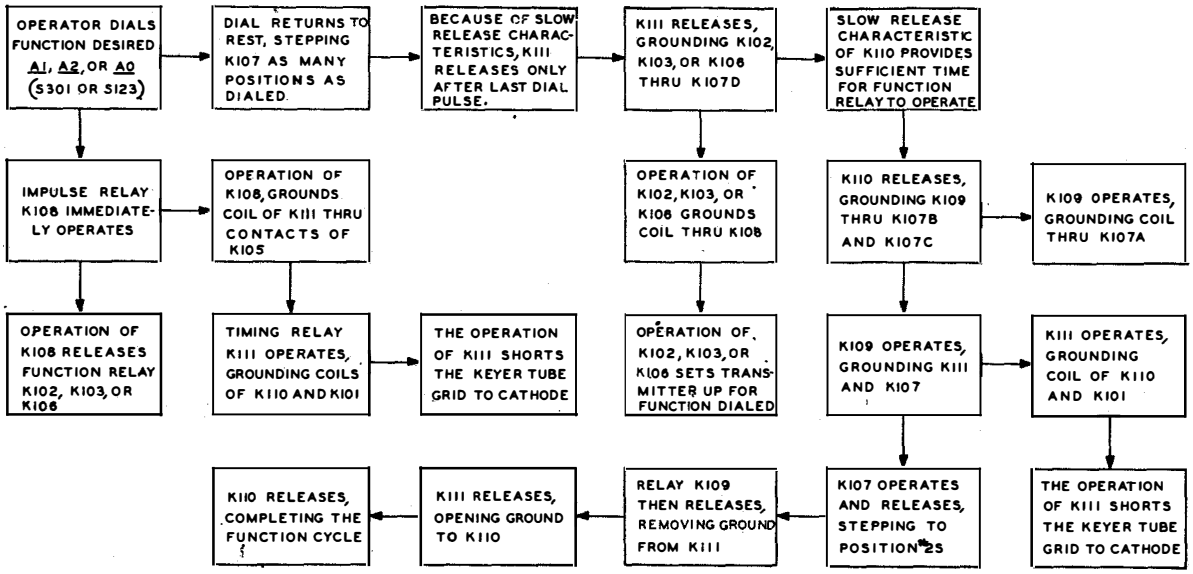


Fig. 5C Collins Autotune System—Sequence of Operation—Emission Selection (Dwg. No. 500 2685 00B)

Unit. The circuit through the dial is normally open. The dial will transmit a maximum of eleven impulses.

2.6.3. Sequence of Operation. Refer to Figs. 5B and 5C. The Autotune system is controlled by a number of interlocking relays. The sequence of operation must be preserved in order to accomplish the desired results. However, any disturbance of the sequence will not render the system inoperative for subsequent operations. A step-by-step description of the operation of the control circuits is given herewith:

(a) When the operator has selected LOCAL or REMOTE control of the transmitter with switch S114, he dials the desired channel.

(b) As the dial returns toward the rest position, the pulsing relay, K108, will operate a number of times corresponding to the number of the channel dialed. (For example: If Channel 6 has been dialed, relay K108 will operate six times.) The coil of relay K108 is energized by the circuit through the normally closed Contacts 1 and 2 of relay K109, the contacts of switch S114, and the contacts of the telephone dial.

(c) The operation of relay K108 releases the transmitter off relay K103, relay K102 or relay K106, if either has been held operated. Relay K111 and the rotary switch are energized by the circuit through Contacts 3 and 4 of the pulsing relay and Contacts 1 and 2 of the motor start relay K105.

(d) Relay K111 is of the slow release type and stays operated until after the telephone dial has come to rest. The operation of relay K111 completes the circuit necessary to energize relay K110. The rotary switch steps one position for each pulse of relay K108.

(e) The operation of relay K110 prevents power being applied to the motor, B101, by opening the energizing circuit of the motor starting relay which is ordinarily through Contacts 4 and 5 of Timing Relay, K110.

(f) When the telephone dial has returned to rest, relay K111 releases. The release of the timing relay opens the energizing circuit of relay K110.

(g) The returning of relay K110 to the unoperated position closes the circuit necessary for the energizing of the motor starting relay K105, by completing the circuit from the coil of K105, through the contacts of

switch section K107B, Contacts 4 and 5 of relay K110 and Contacts 4 and 5 of relay K111.

(h) When relay K105 operates the motor is energized by the circuit through Contacts 5 and 6 of the motor starting relay and Contacts 1 and 2 of the motor reversing relay K104.

(i) The starting of the Autotune motor operates the switch, S110, and opens the circuit through Contacts 3 and 4 of the limit switch.

(j) The positioning switch, S109, rotates until the arm reaches the position corresponding to the channel that was dialed.

(k) When switch S109 reaches the above position the direction of rotation of the motor is immediately reversed by the operation of relay K104. The motor reversing relay is energized by the circuit through the contacts of switch S109, the contacts of switch section K107D and Contacts 4 and 5 of relay K111.

(l) The reversing of the motor returns the limit switch, S110, to the original position, closing Contacts 3 and 4.

(m) When the limit switch has returned to the original position, the homing relay, K109, is energized by the circuit through Contacts 4 and 5 of relay K109, the contacts of switch section K107C, Contacts 3 and 4 of switch S110, the contacts of switch S109, the contacts of switch section K107D and Contacts 4 and 5 of relay K111. The homing relay is held operated by the circuit through Contacts 3 and 5 of relay K109 and the contacts of switch section K107A.

(n) The operation of relay K109 completes the energizing circuit for the rotary switch by the circuit through Contacts 1 and 2 of relay K107, Contacts 1 and 2 of relay K109 and the contacts of switch section K107A. The stepping switch will operate until the rotors reach Position 25 and the holding circuit for the homing relay, K109, is broken.

(o) The operation of relay K109 energizes the coil of relay K111 by the circuit through Contacts 1 and 2 of the rotary switch, K107, Contacts 1 and 2 of the homing relay and the contacts of switch section K107A.

(p) The operation of relay K111 energizes the coil of relay K110 which operates and releases the motor start relay, K105, to remove power from the motor and the motor stops.

(q) When the rotary switch has stepped to Position 25 and the homing relay has released, relay K110 and K111 will release.

When the above relays have released, the Autotune cycle has been completed.

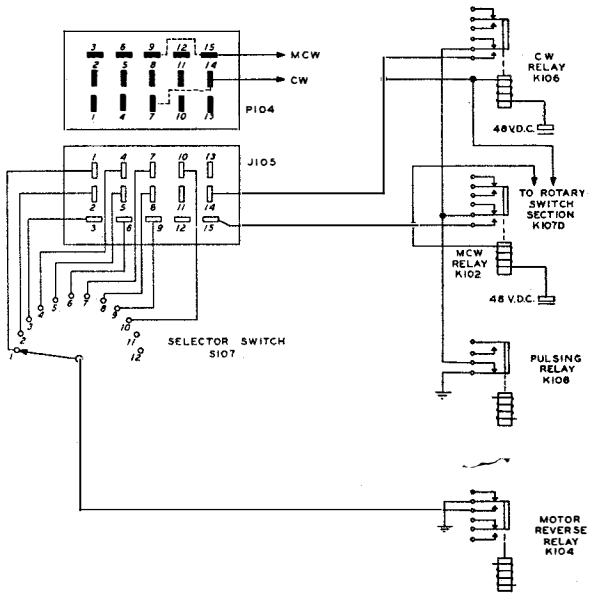


Fig. 6 Automatic Emission Selection Circuits (Dwg. No. 500 2657 00B)

2.6.4. Automatic Emission Selection. This transmitter has been provided with a means of making connections so that any chosen type of emission will be automatically selected when a channel is dialed. The transmitter normally sets up for voice emission when a channel is selected so that it is only necessary to decide which channels are to be operated with predominately CW or MCW emission and to make the proper connections in plug P104. By making connections from terminals #1 through #10 to terminals #14 and # 15 (Refer to Fig. 6) either CW or MCW emission will be selected when a channel is dialed, depending on which jumper connection was made.

Terminals #14 and #15 in plug receptacle J105 are connected to the coil of CW relay and coil of MCW relay, respectively. Terminals #1 through #10 are connected to the selector switch, S107. The rotor of the selector switch is connected to a normally open contact on the motor reverse relay, K104. If a channel is dialed, for example Channel #9, and terminal #9 in plug P104 is jumpered to plug terminal #15 and plug P104 is inserted in receptacle J105, MCW emission will be automatically selected.

The selection sequence is as follows:

(a) Dialing a channel starts the operation of the Autotune mechanism and rotates the selector switch to the position corresponding to the channel dialed.

(b) The motor reverse switch operates and the coil of the MCW relay is grounded through plug P104, the selector switch and the contacts of the motor reverse relay.

(c) The operation of the MCW relay permits the MCW oscillator, V112, to operate by removing the ground from the grid and opens the circuit from the audio lines to the primary of the audio input transformer, T103.

(d) The MCW relay is held operated by the circuit through the normally closed contacts of the pulsing relay. Any dialing operation will release the MCW relay.

The sequence of CW emission selection is the same as outlined for MCW emission selection. CW emission will be automatically selected when any channel is dialed for which connections have been made to terminal #14 in plug P104.

2.7. RADIO FREQUENCY CIRCUITS. Refer to Fig. 65 p. 172. The radio frequency system of this transmitter covers the frequency range 2000 kc to 18,100 kc. The frequency is controlled by a master oscillator. The master oscillator stage is followed by an r-f amplifier, a frequency multiplier, an intermediate amplifier and a power amplifier. The combination power amplifier plate tuning and antenna coupling network is designed to feed an unbalanced antenna system.

2.7.1. Master Oscillator. The master oscillator employs a Type 6A8 pentagrid tube in a transitron oscillator circuit. The transitron oscillator gives output of good wave form and excellent frequency stability.

The oscillator operates within the frequency range 1000 kc to 1510 kc. The frequency of the output is determined by the position of the tuning slug within inductor L104. The tuning slug is connected to a precision lead screw which is operated by the Autotune Multiturn Unit. The position of the tuning slug in relation to the lead screw may be adjusted to set one end point of the frequency band. Ten revolutions of the Multiturn Unit tunes the oscillator circuit to give output on any frequency within the range 1000 kc to 1510 kc.

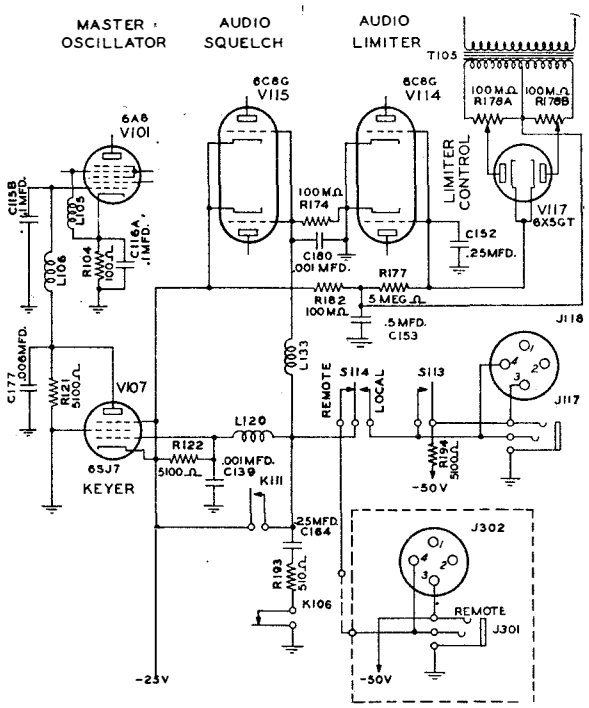


Fig. 7 Simplified Carrier Control Circuits (Dwg. No. 500 0087 00A)

In this application grid #2 (G_2) of the Type 6A8 operates as the anode of the primary oscillator circuit. Grid #4 (G_4) oper-

ates as the control grid of the primary oscillator circuit. This configuration of grid and anode gives a negative transconductance characteristic. The output of the oscillator section of V101 is coupled by the electron stream to the plate of the Type 6A8 tube. Refer to Fig. 7. The output of V101 is controlled by applying enough bias to the control grid (G_1) to cause the output of the oscillator to drop to zero whenever the circuit through the telegraph key, microphone push-to-talk switch and the test key is open. The necessary bias voltage for application to the grid of V101 is developed across resistor R121 when the keyer tube, V107, is drawing plate current. When the telegraph key, the microphone push-to-talk switch, or the test key is operated, a negative voltage from the transmitter bias supply or remote control unit is applied to the control grid of V107, stopping the flow of plate current and reducing the voltage that is developed across resistor R121 to zero. Thus, with the fixed bias removed from the control grid, V101 will oscillate. Keying speeds of several hundred words per minute are possible with this type of carrier control.

To further improve the frequency stability of the oscillator tube, V101, the oscillator circuit components have been enclosed in a shielded compartment. The compartment is kept at a constant temperature by heater resistors R102 and R103. High voltage for application to the plate, screen grid and anode grid of the oscillator is supplied by the low voltage supply that is located in the Power Supply Unit. The voltage regulator tube, V108, keeps the voltage that is applied to the screen grid and anode grid of V101, constant even though the supply voltage may vary.

2.7.2. **R-F Amplifier.** Refer to Fig. 65 p. 172. The output of the oscillator is fed to the grid of the untuned r-f amplifier stage. The amplifier stage employs a Type 6AG7 pentode tube. Screen and plate voltages for the r-f amplifier, V102, are supplied by the low voltage power supply and dropped to the required values by the voltage divider consisting of resistors R129, R130, R131 and R132, and the screen resistor, R107. The tube is self-biased by the voltages that are developed across resistors R105 and R106.

2.7.3. **Frequency Multiplier.** Refer to Fig. 20 p. 71. Exciter Tuning Curves. The frequency multiplier stage employs a Type 807 beam pentode tube. The output of the r-f amplifier is coupled to the grid of V103 by capacitor C120. Switch sections S104A and S104B are operated by the EXCITER BAND SWITCH. When the EXCITER BAND SWITCH is operated to Position 4 (2.0 mc to 3.0 mc) V103 operates as a frequency doubler. When the control is operated to Position 3 (3.0 mc to 6.0 mc) V103 operates as a frequency tripler in the frequency range 3.0 mc to 4.5 mc and as a frequency quadrupler in the range 4.0 mc to 6.0 mc. When the control is operated to Position 2 (6.0 mc to 9.0 mc) V103 operates as a frequency doubler and when the control is operated to Position 1 (9.0 mc to 18.1 mc) V103 operates as a frequency tripler in the frequency range 9.0 mc to 13.5 mc and as a frequency quadrupler in the range 13.5 mc to 18.1 mc. The plate tank tuning capacitor, C125, is operated by the EXCITER TUNING control and is ganged with the intermediate amplifier plate tank tuning capacitor, C132. Trimmer capacitor C126 has been provided to aid in obtaining proper tracking of the plate tank circuits.

The full voltage of the low voltage power supply is shunt fed to the plate of V103 through choke L110. Screen voltage is obtained from the same supply but is dropped through resistors R117, R118 and R129. The screen voltage is increased as the EXCITER BAND SWITCH is operated from Position 4 toward Position 1 by shorting out dropping resistors R117 and R118. Switch section S104C is operated by the EXCITER BAND SWITCH. When the control is operated to Position 4 and 3, both dropping resistors R117 and R118 are in series with the screen lead. When the EXCITER BAND SWITCH is operated to Position 2, resistor R118 is shorted

out to increase the screen voltage that is applied to V103 and when the control is operated to Position 1, both resistors R117 and R118 are shorted out to further increase the screen voltage. Increasing the voltage that is applied to the screen has the effect of increasing the output of the frequency multiplier, V103, and consequently the drive to the intermediate amplifier grid. More excitation is necessary to drive the intermediate amplifier when V104 is operated as a frequency tripler. The output of the frequency multiplier is coupled to the grid of the intermediate amplifier by capacitor C127.

2.7.4. Intermediate Amplifier. The Type 807 beam pentode tube, V104, operates as a straight amplifier when the transmitter is operating within the frequency range 2.0 mc to 6.0 mc and as a frequency tripler when operating within the frequency range 6.0 mc to 18.1 mc. Switch sections S105A, S105B, S105C and S106A, S106B and S106C operated by the EXCITER BAND SWITCH, select the proper plate tank inductor for the band of frequencies that includes the frequency upon which operation is desired and controls the excitation to the power amplifier. Tuning slugs within the inductors permit the adjustment of the inductance of the tank circuit to obtain tracking between the intermediate amplifier plate tank circuit and the preceding stages. The plate tank tuning capacitor, C132, is ganged with the frequency multiplier plate tank tuning capacitor, C125, and is operated by the EXCITER TUNING control.

This stage is connected so that a combination of fixed and self bias is applied to V104. Fixed grid bias for the intermediate amplifier is furnished by the bias supply located in the Power Supply Unit. The excitation to the intermediate amplifier may be checked by operating switch S103, located on top of the r-f unit chassis, to the position designated as "807," and reading the grid current on the GRID CURRENT meter, M104. Operating switch S103 to the "807" position connects meter M104 in series with the lead from the bias supply to the grid of V104 and connects the meter shunting resistor R120 across M104.

Screen and plate voltages for the intermediate amplifier are furnished by the low voltage supply. Voltage for the screen is dropped through resistors R117, R118 and R129. When operating in the frequency range 6.0 mc to 18.1 mc (EXCITER BAND SWITCH Positions 1 and 2) V104 is operated as a frequency tripler and, therefore, in order to keep the output near the same value as when operating in the frequency range 2.0 mc to 6.0 mc, the screen voltage that is applied to the intermediate amplifier is increased by shorting out the dropping resistors. When the EXCITER BAND SWITCH is operated to Position 2 (6.0 mc to 9.0 mc) only resistor R118 is shorted out. When the control is operated to Position 1 (9.0 mc to 18.1 mc) both resistors R117 and R118 are shorted out. The full output voltage of the low voltage power supply is shunt fed to the plate of V104 through choke L114.

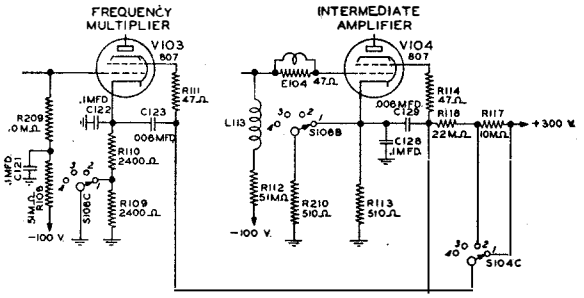


Fig. 8 Excitation Control Circuit (Dwg. No. 500 2658 00A)

It will be noted that the screen voltage for V103 and V104 is obtained through common series dropping resistors R117, R118 and R129. As the drive to V104 increases the screen current of V104 increases causing a greater voltage drop across the series dropping resistors. This lower screen voltage is then applied to V103 which in turn lowers the drive to V104 giving automatic excitation control. To further increase the excitation in the frequency range 9.0 mc to 18.1 mc one of the bias resistors that is connected in the cathode circuit of V103 is shorted out and a

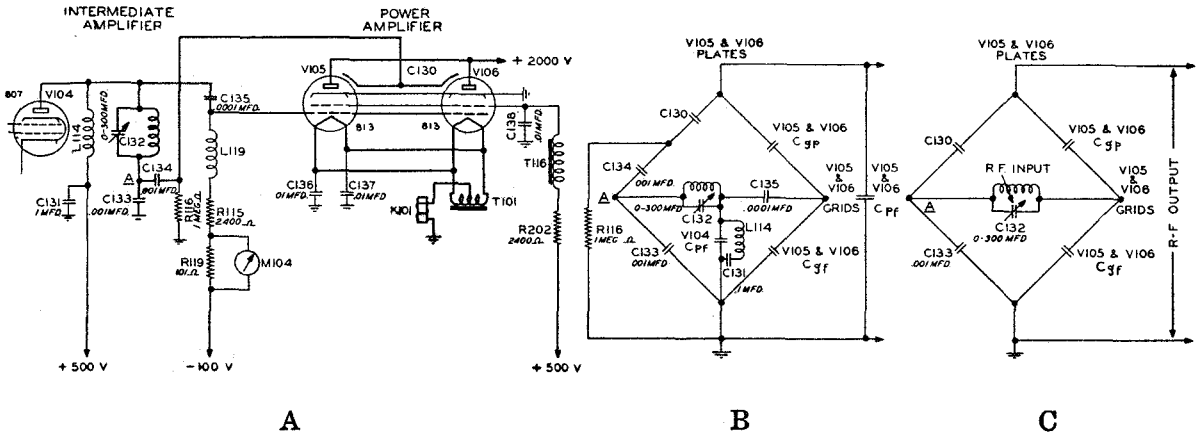


Fig. 9 P.A. Neutralization Circuit (Dwg. No. 500 2656 00C)

resistor is connected in parallel with the intermediate amplifier cathode resistor to reduce the bias on V104.

2.7.5. Power Amplifier. The power amplifier circuit employs two Type 813 beam pentodes in a parallel connected circuit. The output of the intermediate amplifier is coupled to the grids of V105 and V106 by capacitor C135. Grid bias for the power amplifier tubes is furnished by the bias supply. The grid current may be metered by operating switch S103 to the position designated as "813." Operating switch S103 to the "813" position connects the GRID CURRENT meter, M104, in series with the lead from the bias supply to the grids of V105 and V106 and connects the meter shunting resistor, R119, across the meter.

Screen voltage for the power amplifier tubes is supplied by the low voltage power supply through dropping resistor R202 and the screen winding of the modulation transformer, T116. Plate voltage for V105 and V106 is furnished by the high voltage supply that is located in the Power Supply Unit. The plates of the tubes are shunt fed with the full output voltage of the supply through the plate winding on the secondary of the modulation transformer and the plate feed choke, L103. When CW emission is selected, the plate winding on the secondary of the modulation transformer is shorted out and the plate voltage is fed to the power amplifier tubes through the normally open contacts of relay K117 and choke L103. The operating coil of the overload relay, K101, is connected between the center tap of the filament transformer, T101, and ground. If the cathode current of V105 and V106 exceeds the safe value, relay K101 will be operated and the holding circuit for the plate auxiliary relay, K115, will be broken to remove plate voltage from both the low voltage and the high voltage rectifiers.

While the internal construction of the Type 813 tube greatly reduces the feedback, it has been found that the performance of the tubes is greatly improved if the tubes are neutralized by adding a small external capacitance to feed a small out-of-phase voltage to the grids of the tubes. In this application a plate (C130) has been placed near the tubes.

The neutralizing circuit consists of capacitors C130 and C133. Capacitor C134 has been connected in series with C130 and resistor R116 has been connected between the junction of capacitors C130 and C134 and ground to protect the operating personnel from the shock due to the low voltage potential which would otherwise be applied to capacitor C130.

Fig. 9 shows the neutralization circuit. Fig. 9A shows the actual circuit, Fig. 9B a network representation of the same circuit and Fig. 9C the effective components in the neutralization circuit. The network shown

in Fig. 9B contains all of the circuit components that affect the neutralization of the power amplifier circuit. Capacitor C134 is very large in comparison to C130 and because the two capacitors are in series the effective capacity from the PLATES of the tubes to Point **A** is really the capacity of capacitor C130. Resistor R116 is a very high impedance and therefore has negligible effect upon the circuit. Capacitor C135 is very large in comparison to the effective capacity of the circuit made up by V104 C_{pf} (capacity plate to filament), L114 and C131 so that this capacity is effectively in parallel with V105 and V106 C_{gf} (capacity grid to filament).

Fig. 9C shows the simplified circuit with only the effective capacities. Theoretical balance of the circuit is obtained when C130 x C_{gf}=C133 x C_{gp} (capacity grid to plate).

2.7.6. Output Network. A pi network is used as a combination power amplifier plate tank circuit and antenna coupling network in this transmitter. The four switch sections, S101A, S101B, S101C, and S101D, are operated by the POWER AMP. BAND SWITCH Control, capacitor C108 is operated by the POWER AMP. TUNING Control and capacitor C105 is operated by the ANTENNA TUNING Control. The power amplifier plate tuning capacitor, C108, is a dual section variable. When the POWER AMP. BAND SWITCH is operated to Position 1 through 4, capacitor section C108A is connected across the input to the pi network, when operated to Positions 5 through 10 capacitor sections C108A and C108B are connected in parallel across the input to the network; when the control is operated to Positions 11 and 12 a padding capacitor C107, is connected in parallel with capacitor sections C108A and C108B. The capacity of the variable capacitor, C108, increases as the POWER AMP. TUNING Control is operated from 0 toward 100.

The network output capacitor, C105, is a dual section variable capacitor with sections C105A and C105B connected in parallel. Capacitor C105 is operated by the ANTENNA TUNING Control. When the POWER AMP. BAND SWITCH is operated to Positions 9, 10, or 11, padding capacitor C106 may be connected in parallel with capacitor C105 if additional capacity is necessary to match the antenna. Switch section S101C shorts out portions of the inductor, L102, to reduce the inductance that is connected in the circuit as the POWER AMP. BAND SWITCH is rotated from Position 12 toward Position 1. Two antennas may be used with this transmitter. Switch section S101D, operated by the POWER AMP. BAND SWITCH, connects the output of the power amplifier to terminal strip E101. By connecting jumpers between terminals on the strip, either antenna will be automatically selected for any frequency that has been selected for any particular position of the switch.

2.8. CRYSTAL FREQUENCY INDICATOR. Refer to Fig. 66 p. 174. The master oscillator calibration unit employs three tubes, a Type 6A8 as an oscillator, a Type 6SL7GT as a converter, and a Type 6SN7GT as an audio amplifier.

The oscillator section of V109, consisting of cathode, Grid #1 (G_1) and anode grid #2 (G_2), operates on 200 kc. The frequency upon which the oscillator operates is determined by the quartz crystal, Y101. The oscillator tank circuit, E105, is tuned to 200 kc.

When switch S111 is operated, plate and screen voltages are applied to the tubes in the calibration unit, the oscillator immediately starts and generates a 50 kc sub-harmonic of the 200 kc crystal. The 50 kc signal is not a sustained oscillation but lasts long enough to excite one triode section of V110 at 50 kc. The frequency of the signal is tripled in V110 to give a 150 kc signal. The output of the frequency multiplier section of V110 is coupled to grid #4 of V109 and is beat with the 200 kc output of the crystal oscillator to produce a 50 kc beat note to feed the frequency multiplier section of V110 to maintain operation. The output of V109 is coupled to the grid of the frequency multiplier section of V110 and to the cathode of the mixer section of the same tube. A portion of the output of the r-f

amplifier is coupled to the grid of the mixer section of V110 to beat against a harmonic of the 50 kc output of V109. The output of the mixer section of V110, an audio signal, is coupled to one triode section of the dual triode, V111, through tank circuit E112. The dual triode operates as a two stage audio amplifier, the output of the first triode section of V111 being coupled to the remaining triode section of V111 by capacitor C142. The output of the audio amplifier is coupled to the PHONES jack J122 by transformer T118. Headphones with an impedance of from 500 ohms up to and including phones of the crystal type may be used satisfactorily.

Plate and screen voltages for tubes in the CFI Unit are supplied by the low voltage power supply. Voltage is applied to the plate of V109 through tank circuit E106, one plate of V110 through tank circuit E107 and the other plate of V110 through tank circuit E112. Plate and screen voltages are applied to the tubes by the operation of the CFI power switch, S111. Filament voltage is applied to the tubes whenever the filament contactor, K112, is operated.

2.9. **AUDIO FREQUENCY CIRCUITS.** Refer to Fig. 65 p. 172. The audio-frequency system incorporated in the Transmitter Unit utilizes a Type 6SL7GT twin triode (V113) as a preamplifier, a Type 6C8G twin triode (V114) as a volume limiter, a Type 6C8G twin triode (V115) as an audio squelch tube, a Type 6SJ7 triple grid tube (V116) as an audio amplifier, a Type 6X5GT full-wave rectifier (V117) as a limiter control tube, a pair of Type 2A3 triodes (V118 and V119) as audio drivers, and a pair of Type 805 transmitting triodes (V120 and V121) as modulators. Two additional stages of audio amplification are incorporated in the Remote Control Unit. A Type 6SJ7 triple grid tube (V301) is employed as a first amplifier and one section of a Type 6SN7GT twin triode (V302) is employed in the second stage of amplification.

2.9.1. **Remote Amplifier.** Refer to Fig. 68 p. 177. Either of two input circuits to the amplifier may be used. The input transformer, T301, has two primary windings, a 75 ohm winding and a 500 ohm winding. Both transformer windings are brought out to terminal strip E301 on the rear of the unit. The MICROPHONE jack, J302, is connected across the 500 ohm winding so that a dynamic microphone may be used. Transformer T301 couples the output of the audio line or the microphone to the grid of the first preamplifier tube, V301, through the GAIN control, R301. Screen and plate voltages for V301 are furnished by the power rectifier, V303.

The output of the first amplifier stage is coupled to the grid of one triode section of the second amplifier tube, V302, by capacitor C302. The audio output of V302 is coupled to the 500 ohm transmission line by transformer T302. Meter M302 is connected directly across the secondary of transformer T302 and indicates the level of the audio output of the remote amplifier unit.

The remaining triode section of V302 is utilized to operate the receiver disabling circuit. With current flowing through the triode section, relay K301 is held operated. When the carrier control circuit is closed a bias voltage is applied to the grid of V302 and the flow of plate current is stopped, releasing relay K301.

2.9.2. **Preamplifier.** The first stage of the audio system that is incorporated in the transmitter, employs a Type 6SL7GT twin triode tube (V113) connected in a balanced circuit. Input transformer T103 couples the audio output of the transmission line or the local microphone to the grids of V113. With the LOCAL-REMOTE switch, S114, in the normal or REMOTE position the output of the 500 ohm remote line is coupled directly to the primary of transformer T103. When switch S114 is operated to the LOCAL position connections are made from the MICROPHONE jack, J118, to the primary of the audio input transformer so that a dynamic microphone may be used when it is desired to control the transmitter from a position near the installation.

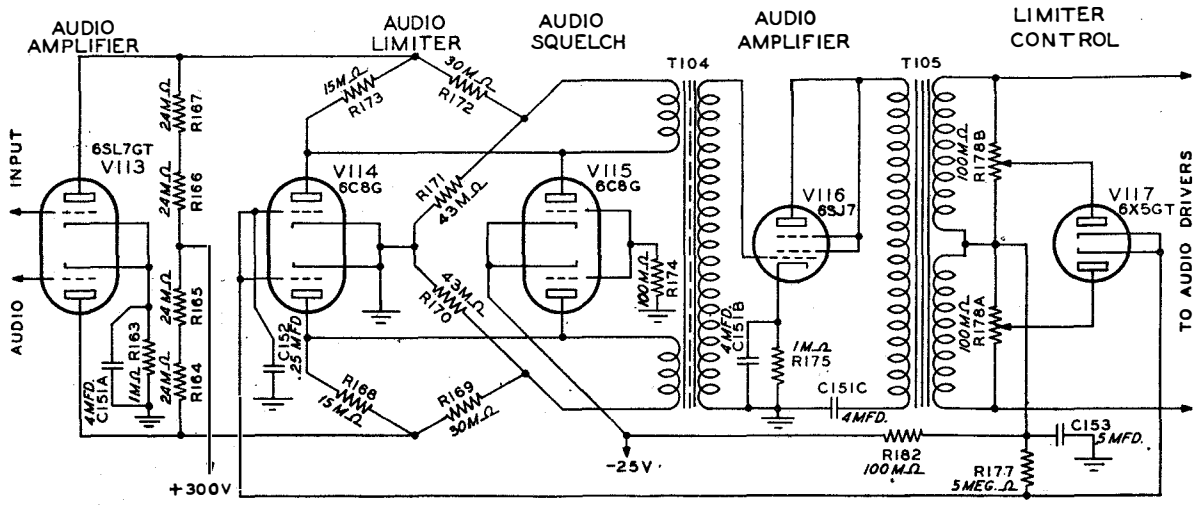


Fig. 10 Volume Limiter Circuit (Dwg. No. 500 0089 00A)

The dual section potentiometer, R162, controls the input to the grids of V113. Plate voltage is furnished by the low voltage power supply through resistors R166 and R167 and R164 and R165. Cathode bias is developed across resistor R163.

2.9.3. Volume Limiter and Audio Amplifier. Refer to Fig. 10. The volume limiter that is incorporated in this equipment has been designed to control the audio signal level and to give uniform speech amplifier output with a relatively wide variation of audio input. When the limiter control is properly adjusted, increasing the input to the preamplifier as much as 25 db will cause a rise in the speech amplifier output which will not exceed 3 db. The limiter circuit utilizes the principle of the familiar Wheatstone resistance bridge.

The limiter circuit employs two Type 6C8G twin triodes (V114 and V115) and a Type 6X5GT full-wave rectifier (V117). The two Type 6C8G tubes are connected in a double resistance bridge circuit with the triode sections of V114 and V115 acting as the variable legs of the bridges. The double bridge circuit provides proper termination for the balanced output of the preamplifier stage. One bridge circuit consists of resistors R168, R169, and R170 and a variable leg consisting of two triodes, one section of V114 and one section of V115, connected in parallel. The second bridge circuit consists of resistors R171, R172 and R173 and the remaining triode sections of the two Type 6C8G tubes. When the value of R168 x R170 = R169 x (the plate resistance of the vacuum tube leg of the bridge) and the value of R171 x R173 = R172 x (the plate resistance of the vacuum tube leg of the bridge), the loss across the bridge circuit will be very high and only a very small portion of the output of the preamplifier will be permitted to reach the primary winding of the interstage coupling transformer, T104. If however, the resistance of one leg of the bridge is very high compared to the other three legs, the bridge will be unbalanced and the loss in the circuit will be small.

Refer to Fig. 7 p. 42. Tube V115 has been connected in the circuit to protect the modulator tubes during the time that the transmitter is in the stand-by condition, that is, with filament and plate voltages on but with the microphone push-to-talk button released, the telegraph key open and the TEST switch in the off position. During the time that the r-f carrier is off, V115 is in a conducting condition with approximately —25 volts on the cathodes and no fixed bias on the grid, resulting in a comparatively low value of plate resistance. With zero audio input, the bias on the grids of V114 is approximately —25 volts, resulting in a high value of plate resistance. With one triode section of V114 connected in

parallel with a triode section of V115 the resistance of the variable bridge leg will be less than the plate resistance of the tube with the lower plate resistance. Under the conditions stated above the resistance of the variable leg will be less than the plate resistance of V115 and will be near the value necessary to balance the bridges. When the bridges are balanced very little voltage will appear across the windings of transformer T104 and the modulator tubes will be protected from damage as a result of driving the grids when the Class C load is removed.

When the r-f carrier is turned on by operating the TEST switch, telegraph key or the push-to-talk button on the microphone a fixed bias is applied to the grid of V115 so that the flow of plate current is cut-off and the plate resistance of the tube becomes very high to unbalance the bridges and permit the output of the preamplifier stage to appear across the primary of transformer T104. The output of the preamplifier, V113, drives the grid of the triode connected Type 6SJ7 audio amplifier (V116). The output of V116 is coupled to the grids of the push-pull audio driver stage by transformer T105. The limiter control tube V117 is also connected across the secondary of transformer T105. The voltage that is applied to the plates of V117 may be varied by the adjustment of potentiometer, R178. As the level of the audio signal is increased, the voltage across the secondary of transformer T105 increases, resulting in an increase in the amount of current that flows in the rectifier circuit. The current flowing through the rectifier, V117, develops a voltage across resistor R177 which varies directly with the flow of current through the rectifier and is opposite in polarity to the fixed bias that appears at the resistor. The sum of the fixed bias voltage and the developed voltage gives a voltage that is less negative than the fixed bias that is ordinarily applied to V114 and the result is a greater flow of current through the limiter tube. Increasing the flow of plate current through V114 results in a lower plate resistance and resistance of the vacuum tube legs approaches the value that is necessary to balance the bridges. The loss across the bridge increases rapidly as balance is approached and as a result less voltage is permitted to reach the primary of transformer T104. The flow of current through V117 and the resulting amount of compression may be regulated by adjusting R178. Plate voltage for the limiter and audio amplifier tubes is furnished by the low voltage power supply.

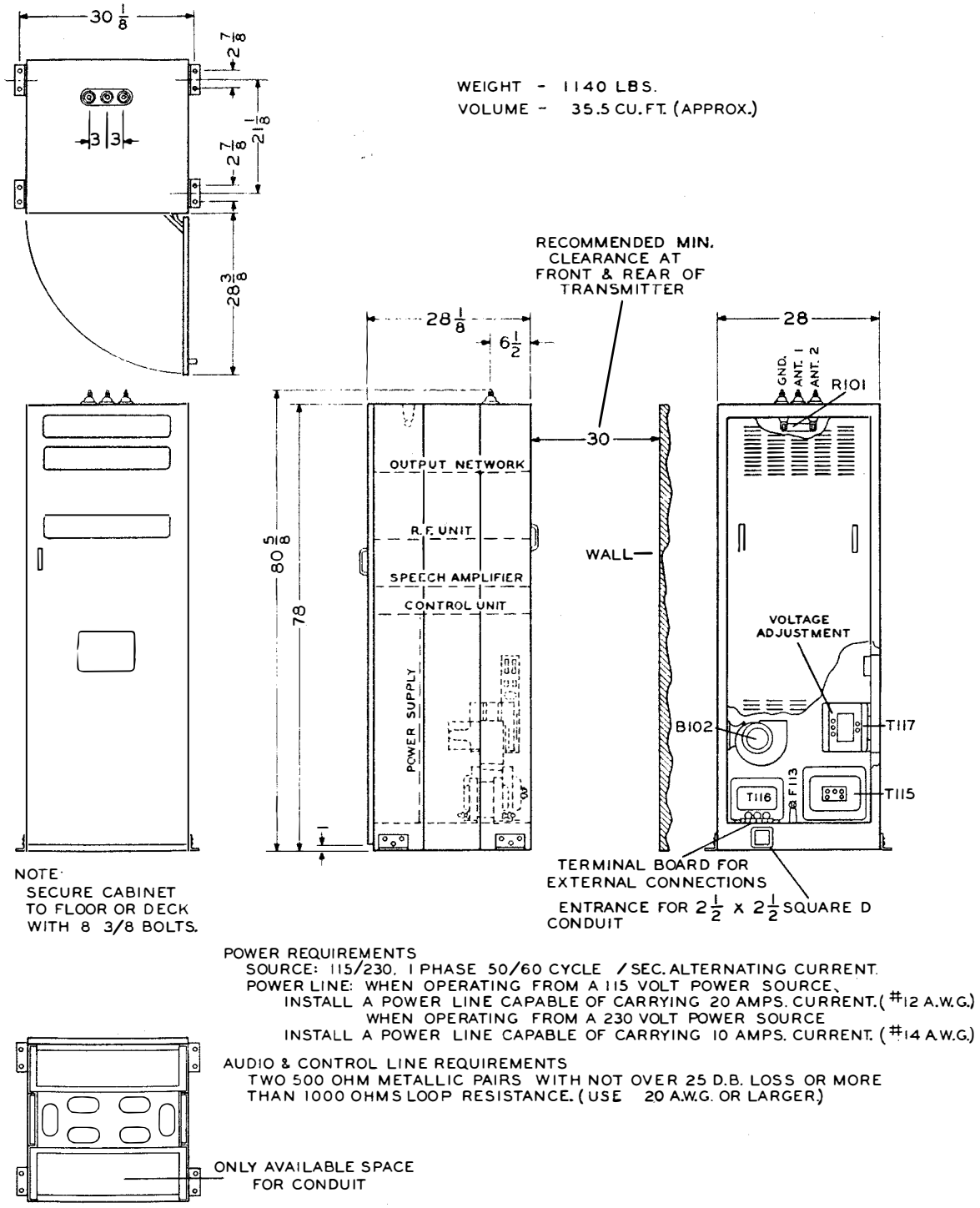
2.9.4. Audio Driver. The audio driver stage employs two Type 2A3 triodes (V118 and V119) in a push-pull amplifier circuit. The output of the audio amplifier stage is coupled to the grids of V118 and V119 by transformer T105 and capacitors C154 and C155. Bias voltage is developed across cathode resistor R181. Plate voltage is furnished by the low voltage power supply.

2.9.5. Modulator. The push-pull Class B modulator employs two Type 805 transmitting triodes (V120 and V121). The output of the audio driver stage is coupled to the grids of V120 and V121 by transformer T106. Grid bias for the modulator tubes is supplied by the bias rectifier through the center-tapped secondary of transformer T106. The full output voltage of the high voltage rectifier power unit is applied to the plates of the modulator tubes through the normally closed contacts of relay K117, high voltage fuse F113 and the primary winding of modulation transformer, T116. When CW emission has been selected relay K117 is operated, removing filament and plate voltages from V120 and V121 and shorting the secondary plate winding of transformer T116. Two secondary windings on the modulation transformer are connected so that both the plates and screens of the power amplifier tubes are modulated.

2.9.6. MCW Oscillator. One triode section of the Type 6SN7GT tube (V112) operates as an MCW oscillator and the remaining triode section is connected so as to present a high impedance to the MCW oscillator and a low impedance to the 75 ohm winding of the audio input transformer. The oscillator tank circuit, consisting of reactor L122 and capacitor

C158, may be tuned to any one of seven different frequencies in the range 400 cps to 1200 cps by operating switch S112. Capacitor C158 is made up of seven capacitor sections enclosed in a single case. Operating switch S112 changes the frequency of the output of the oscillator by varying the capacitance that is connected across reactor L122. The output of the oscillator section of V112 is coupled from the cathode to the grid of the remaining triode section of the same tube. The output of the MCW oscillator may be varied by operating potentiometer R187. Plate voltage for V112 is obtained from the low voltage power supply. When CW or VOICE emission is being used, the MCW oscillator is rendered inoperative by grounding the grid of the oscillator section of V112 through the normally closed contacts of relays K102 and K108. When MCW emission is selected by dialing **A2,** the ground is removed from the grid of the oscillator section of V112 and the circuit from the audio line to the speech amplifier input transformer, T103, is opened to prevent any audio signal except that of the audio oscillator from reaching the primary of the input transformer, T103. Resistor R189 provides cathode bias to the oscillator section of V112 during times that the tube is not oscillating.

III INSTRUCTIONS FOR INSTALLATION



POWER REQUIREMENTS
SOURCE: 115/230, 1 PHASE 50/60 CYCLE / SEC. ALTERNATING CURRENT.
POWER LINE: WHEN OPERATING FROM A 115 VOLT POWER SOURCE,
INSTALL A POWER LINE CAPABLE OF CARRYING 20 AMPS. CURRENT. (#12 A.W.G.)
WHEN OPERATING FROM A 230 VOLT POWER SOURCE
INSTALL A POWER LINE CAPABLE OF CARRYING 10 AMPS. CURRENT. (#14 A.W.G.)

AUDIO & CONTROL LINE REQUIREMENTS
TWO 500 OHM METALLIC PAIRS WITH NOT OVER 25 D.B. LOSS OR MORE THAN 1000 OHMS LOOP RESISTANCE. (USE 20 A.W.G. OR LARGER.)

Fig. 11 Transmitter Installation Diagram
(Dwg. No. 502 0029 003)

INSTRUCTIONS FOR INSTALLATION

3.1. UNCRATING. Remove the equipment from the shipping crates and inspect each unit carefully. Inspect cables and wiring and be sure that all cable connections are tight. Inspect each unit for loose screws and bolts. Be sure that all switches and tuning dials operate properly. All claims for damage should be filed promptly with the transportation company. It is necessary to preserve the original packing box and packing material in case a claim is to be filed with the transportation company.

3.2. LOCATION OF CABINET. The location of the transmitter unit should be such that there is a minimum clearance of 30 inches at the rear of the cabinet to permit free circulation of air and allow enough space for the removal of components. A minimum clearance of 30 inches is required in front of the cabinet to allow the front door to open. The back panel of the transmitter cabinet should not be put in place until all units have been mounted within the cabinet and all external connections made.

3.3. INSTALLATION OF UNITS. The unit assemblies making up the transmitter have been removed from the cabinet and packed separately for shipment. Figure 12 indicates the location of the units within the cabinet.

IMPORTANT: DO NOT REMOVE SEALS FROM AUTOTUNE COUPLERS UNTIL ALL UNITS HAVE BEEN SECURELY FASTENED IN POSITION.

The following procedure is recommended for the installation of the units:

(a) Install the meter panel by removing one of the pivot pins from the cabinet, slipping the other pin through the hole in the end of the meter bracket, slipping the removed pivot pin through the hole in the other end of the bracket and through the hole in the cabinet flange and replacing the nut.

(b) Connect the wires to the meter terminals. All leads were tagged when removed for packing.

(c) Remove the panels from the sides of the cabinet.

(d) Insert resistor R101 into the clips in the top of the cabinet.

Note: Do not place the tubes in any of the units until the circuits have been checked, as outlined under 4.4. in the ADJUSTMENTS Section of this book.

(e) Insert the Output Network Unit into the cabinet from the rear, fasten the unit to the mounting angles and connect the antenna, ground, antenna ammeter and high voltage leads to proper terminals.

(f) Lift the R-F Unit into place beneath the output network and fasten securely to the mounting angles.

(g) Insert the Power Supply Unit from the front of the cabinet and secure in position with the eight mounting bolts.

(h) Connect the leads to terminal strip E108 on the top of the Power Supply Unit.

(i) Connect the large black lead to the terminal near the right-hand end of the terminal strip.

(j) Place transformers T115 and T116 over the locating pins in the floor of the cabinet, connect the leads to the terminals and secure the transformers with the hold-down screws.

(k) Bolt the ventilating blower unit, B102, to the left-hand side of the cabinet (Refer to Figure 13).

(l) Insert fuse F113 in the mounting clips between transformers T115 and T116.

(m) Insert the bleeder resistors into the clips on the rear of the Power Supply Speech Amplifier and R-F Units. (**Note:** The chassis near the mounting clips has been stamped with item numbers corresponding to the item numbers that are stamped on the resistors.)

(n) Place the Speech Amplifier Unit on the angles beneath the R-F Unit, push the unit toward the rear of the cabinet and secure the unit with the mounting bolts.

(o) Using the same procedure, place the Control Unit in position beneath the Speech Amplifier Unit.

(p) Having completed the installation of all of the units in the cabinet, mount the

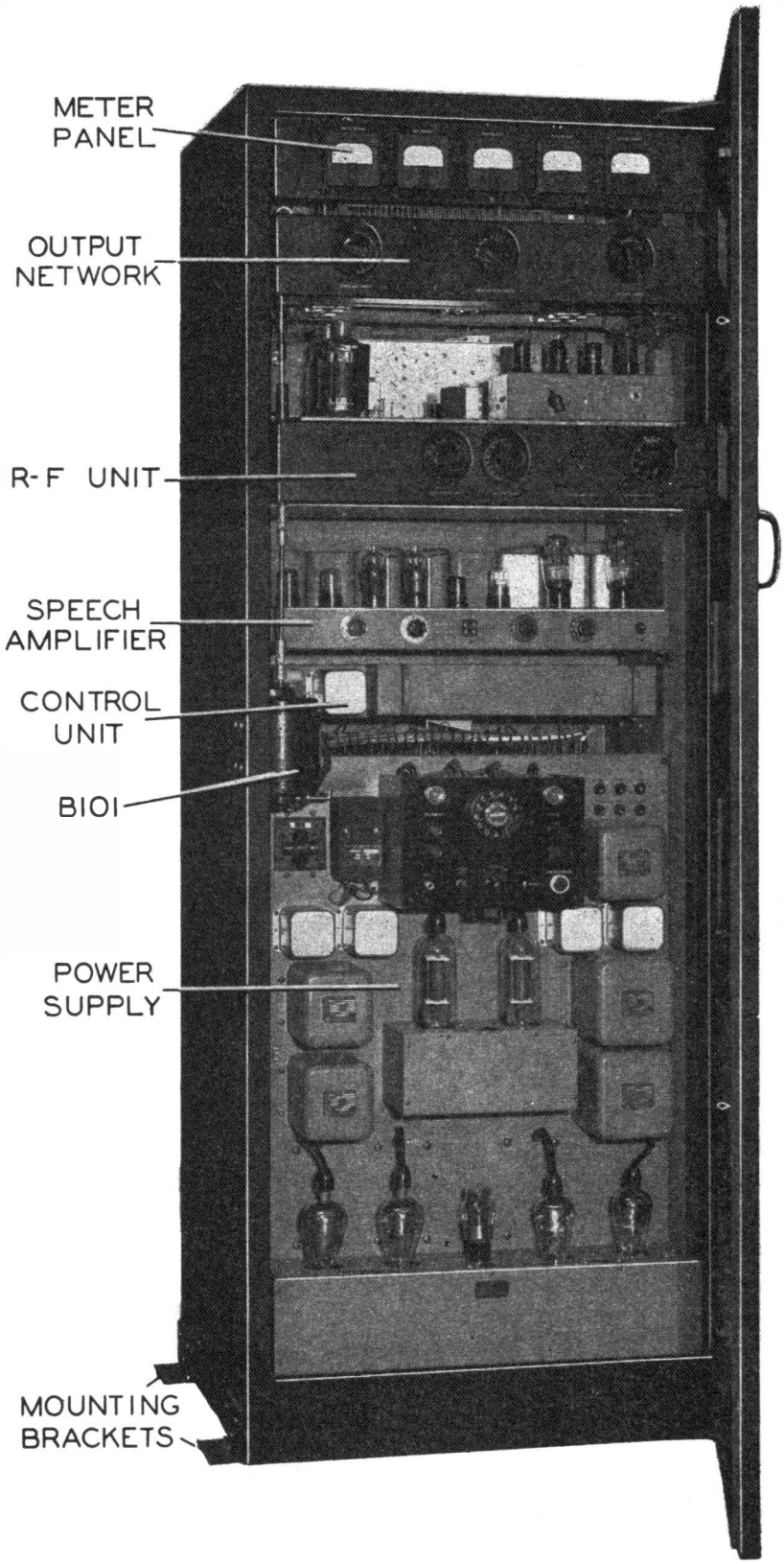


Fig. 12 Radio Transmitter (Front Open)

Autotune motor, B101, on the inner left-hand side of the cabinet (front view) and insert power plug P108 into plug receptacle J110, located beneath the Control Unit.

(q) Insert the metering cord plug, P101, into plug receptacle J101, located on the left-hand side of the cabinet (front view).

(r) Insert the ventilating blower power plug, P111, into the plug receptacle, J119, that is mounted on the rear of the Power Supply Chassis and is designated as "230 VOLTS A.C.".

(s) Transformer T117 should be bolted to the inner right-hand side of the cabinet. Fuses F114 and F115 should be inserted in the clips.

IMPORTANT: EACH UNIT MUST BE SECURELY BOLTED IN PLACE TO PREVENT MISALIGNMENT AND BINDING OF AUTOTUNE DRIVE SHAFTS, TO ASSURE POSITIVE CONTACT BETWEEN THE CONNECTOR PLUG RECEPTACLES MOUNTED WITHIN THE CABINET AND THE CONNECTOR PLUGS MOUNTED ON THE VARIOUS UNITS, AND TO ASSURE POSITIVE CONTACT BETWEEN THE UNIT CHASSIS AND THE CABINET. ALL SHIELDS SHOULD BE FASTENED SECURELY IN PLACE IN ORDER TO OBTAIN SATISFACTORY TRANSMITTER PERFORMANCE.

WHEN PLACING THE DRIVE SHAFTS BETWEEN THE AUTOTUNE UNITS EXTREME CARE SHOULD BE EXERCISED TO PREVENT DISPLACEMENT OF THE TAKE-OFF COUPLERS FROM THE POSITIONS AS TIED FOR SHIPMENT. The above matter is extremely important due to the fact that the two Autotune assemblies must be mechanically in phase if the tuning elements are to position properly. Due to the fact that the controlling circuit-seeking tap switch is located in the R-F Unit, the drive shaft between the Autotune motor and the Autotune assembly in the R-F Unit may be inserted in any position but the drive shaft between the R-F Unit and the Output Network must be properly placed in order to obtain correct phasing of the Autotune assemblies. When the transmitter was prepared for shipment, take-off couplers were tied solidly in position and the coupling shaft may be inserted as the couplers are lined up when received. A detailed outline of the procedure necessary for the proper alignment of the Autotune assemblies is given in the MAINTENANCE Section of this Instruction Book.

The order of designation of the inter-unit cables, which applies only to the cabling schematic, is as follows: When the wire terminates at a single numbered terminal on a unit or terminal board, the wire route is from the source to the terminal on a specified unit and is indicated by the unit letter designation followed by the terminal number. Thus, if a wire beginning at terminal No. 1 on Unit A is to be connected to terminal No. 1 on Unit B, an arrow at terminal No. 1 on Unit A would indicate B1 and a similar arrow at terminal No. 1 on Unit B would indicate A1.

On cabling and wiring diagrams, the size of wire and type of wire employed in inter-unit cabling is indicated by means of a letter. This is followed by one or more numerals to show the color code. The numerals used conform to the RMA color code system given here for reference.

0—Black	5—Green
1—Brown	6—Blue
2—Red	7—Violet
3—Orange	8—Slate
4—Yellow	9—White

For example, a No. 18 stranded type of wire with 500 volt insulation having a white body with a red tracer would be designated "A92."

A table showing the Standard Cable Wire Code may be found in the DATA Section of this book.

3.4. **FUSES.** All fuses should be examined and the ratings checked against the fuse chart that is fastened to the inside of the transmitter cabinet front door or the table given below. It is good practice to insert each fuse as required during the initial adjustment procedure in orded that any faults which may

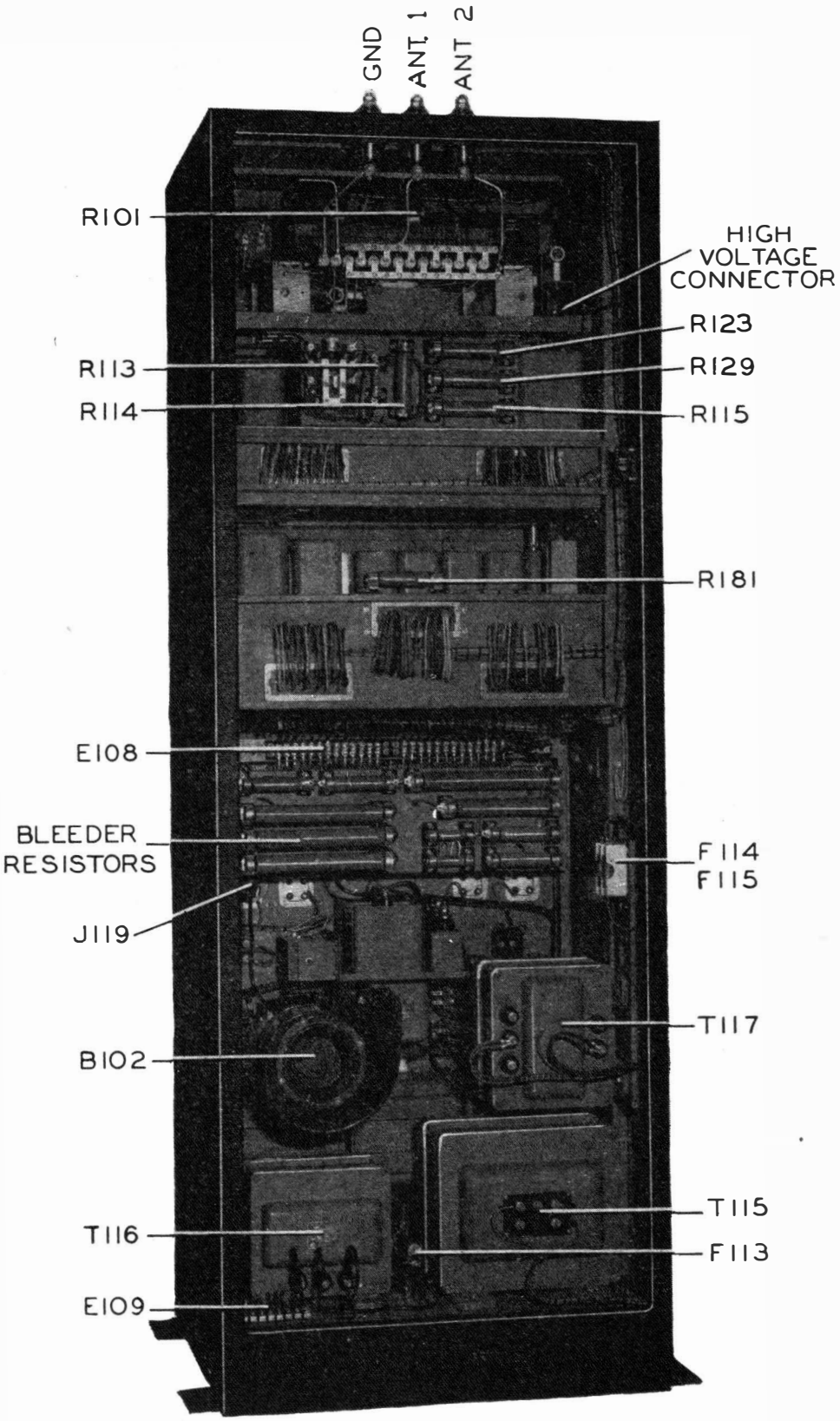


Fig. 13 Radio Transmitter (Rear Open)

be due to errors in connections to terminals or unintentional grounding of terminals may be quickly determined and also to check and clear each individual circuit in the proper sequence. The fuses used in this equipment, together with the item number of the fuse and the unit in which the fuse is located, are tabulated below:

Item No.	Rating Amps.	Circuit	Unit
F101	3/8*	Master Oscillator Heater	R-F
F102	1/4*	Exciter Filament Transformer Primary	R-F
F103	3/4*	P.A. Filament Transformer Primary	R-F
F104	3/8*	Speech Amplifier Filament Primary	Speech Amp.
F105	1/4*	Bias Rectifier Filament Primary	Power Supply
F106	1/4*	Bias Rectifier Plate Primary	Power Supply
F107	1/2*	L.V. Rectifier Filament Primary	Power Supply
F108	3	L.V. Rectifier Plate Primary	Power Supply
F109	1/2*	Modulator Filament Primary	Power Supply
F110	2	Relay Power Rectifier Primary	Power Supply
F111	2	Relay Power Rectifier Secondary	Power Supply
F112	1/2*	H.V. Rectifier Filament Primary	Power Supply
F113	1/2	Modulator H.V.	Transmitter
F114	25	Input Power	Transmitter
F115	25	Input Power	Transmitter
F116	3/4*	Rectifier Heater	Power Supply
F301	1/4	Preamp. Primary Power	Remote Control

* Slo-Blo type. Quick acting fuses should not be replaced with fuses of the Slo-Blo type.

3.5. EXTERNAL CONNECTIONS. External connections consist of the following:

3.5.1. A-C Power Line
3.5.2. Remote Lines
3.5.3. Radiation System

3.5.1. Power Line. The transmitter may be operated from either a 115 volt or a 230 volt 50/60 cycle/sec. single phase power source. When the transmitter is to be operated from a 110 volt power source a line capable of carrying at least 20 amperes (#12 B.S.G.) should be installed. When a 230 volt power source is to be used, a line capable of carrying at least 10 amperes (#14 B.S.G.) should be installed.

CAUTION: Before connecting the power line to the power input terminals of the transmitter, carefully check the connections to the terminals of the autotransformer, T117. Refer to Fig. 13A and the following table for the proper connections for the various power source voltages:

POWER SOURCE VOLTAGE	CONNECT				
	Black Wire To—	Black Wire To—	Green Wire To—	Red Wire With White Tracer To—	*Red Wire With White Tracer To—
115 Volts	PO	PO	S	P2	S
210 Volts	PO	PO	S	P2	P3
220 Volts	PO	PO	S	P2	P2
230 Volts	PO	PO	S	P2	P1

*This wire has been marked with a metal tag engraved with the designations "115V" and "230V".

The power line should be connected to terminals #2 and #3 of terminal strip E109 (located in the base of the transmitter cabinet).

3.5.2. Power Requirements. The following data indicates the power that is actually required

from the power line under the conditions indicated:

Condition	Watts	Power Factor
1. Dial A0	45	0.70
2. Filaments On—CW	462	0.80
3. Filaments On—MCW or VOICE	521	0.87
4. Filaments and Plate On (Standby) CW	700	0.77
5. Filaments and Plate On (Standby) MCW or VOICE	832	0.85
6. Carrier On—CW	1560	0.88
7. Carrier On—MCW or VOICE (No Mod.)	1300	0.86
8. Carrier On—MCW or VOICE (100% Mod.)	1570	0.88

Refer to paragraph 3.5.1. **Power Line** for the recommended size of conductor for connecting the transmitter to the power source.

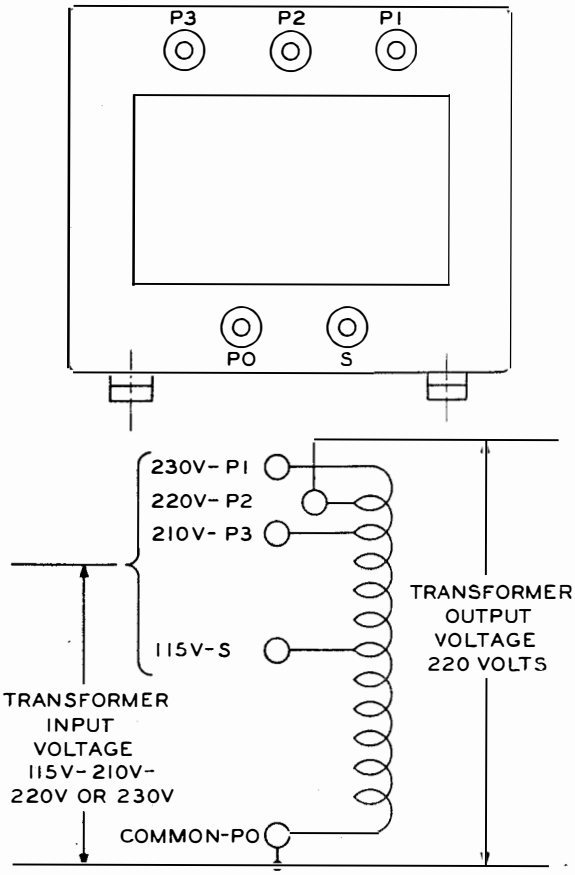


Fig. 13A Autotransformer Connections (Dwg. No. 502 0028 001)

A factor of safety has been allowed in these recommendations.

3.5.3. **Remote Lines.** The remainder of the terminals on the terminal board in the base of the transmitter are for the remote lines. The tabulation given below indicates the proper connection for each terminal:

Terminal No.	Connections
1	Ground (Return of Carrier Control and Dialing Circuit)
4	Dialing Control Line
5	Carrier Control (Key) Line
6 & 7	500 ohm Audio Input

The channel indicator circuit functions over the two audio wires and the ground return.

3.5.4. **Radiation System.** Provision has been made in the transmitter to use either one of two antennas on any of the ten frequency channels. (Refer to Fig. 13 p. 55.) It is recommended that vertical antenna systems be installed. Every effort should be made to choose antennas that do not have high reactive impedance components. Maximum impedance can be decreased by the use of an antenna conductor having a relatively large cross section. A conductor with a diameter of ⅜ inch will appreciably reduce the reactances encountered. Conductors of greater diameter, such as ¾ to 2 inches, will further improve multi-frequency operation. The height of a vertical radiator should be determined for the lowest operating frequency. It should be at least one-quarter wavelength at this frequency.

For an end fed antenna, the ratio of the length of the vertical portion to the horizontal portion should be as large as possible. Whenever possible, the height of the antenna should be near one-quarter wavelength at the lowest frequency. The total length of the antenna, including the vertical portion or lead end, should be adjusted to avoid the immediate vicinity of a half wavelength at any of the operating frequencies. Whenever this condition is obtained, regardless of the choice of total length, this end fed antenna should not be used.

The efficiency of the radiation system is largely dependent upon the ground system

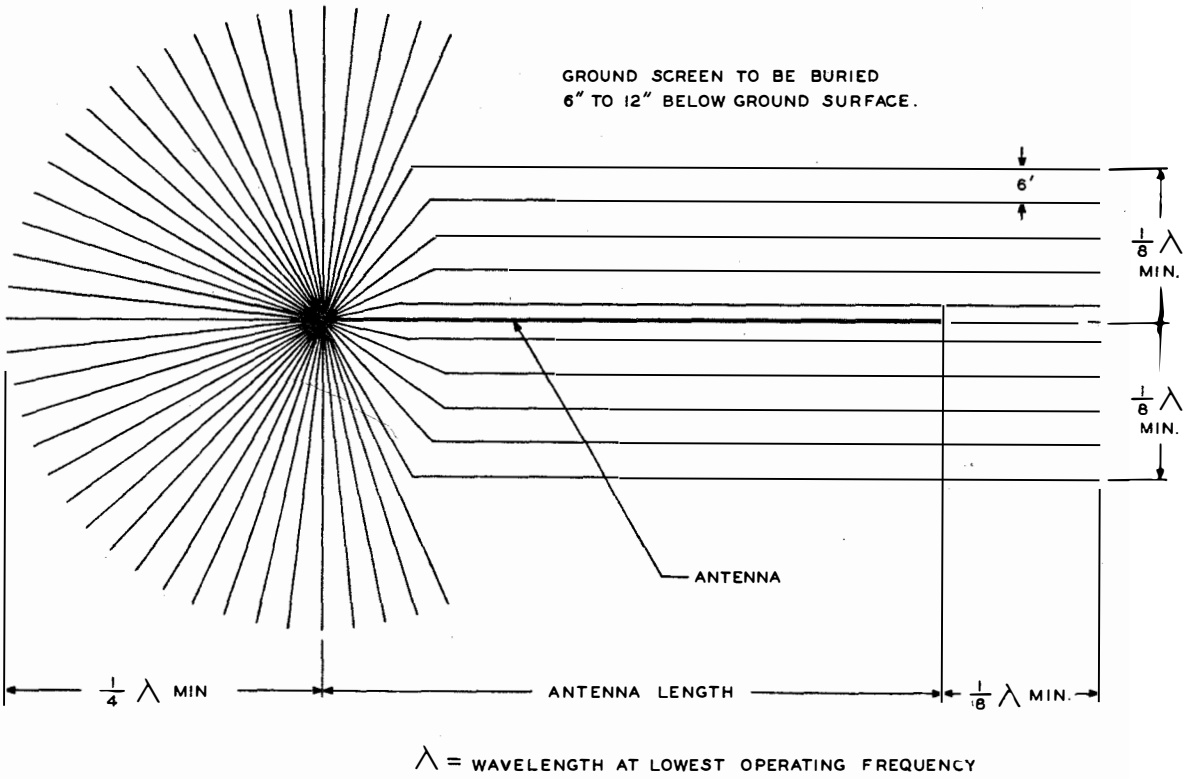


Fig. 14 Ground System (Dwg. No. 500 0034 00A)

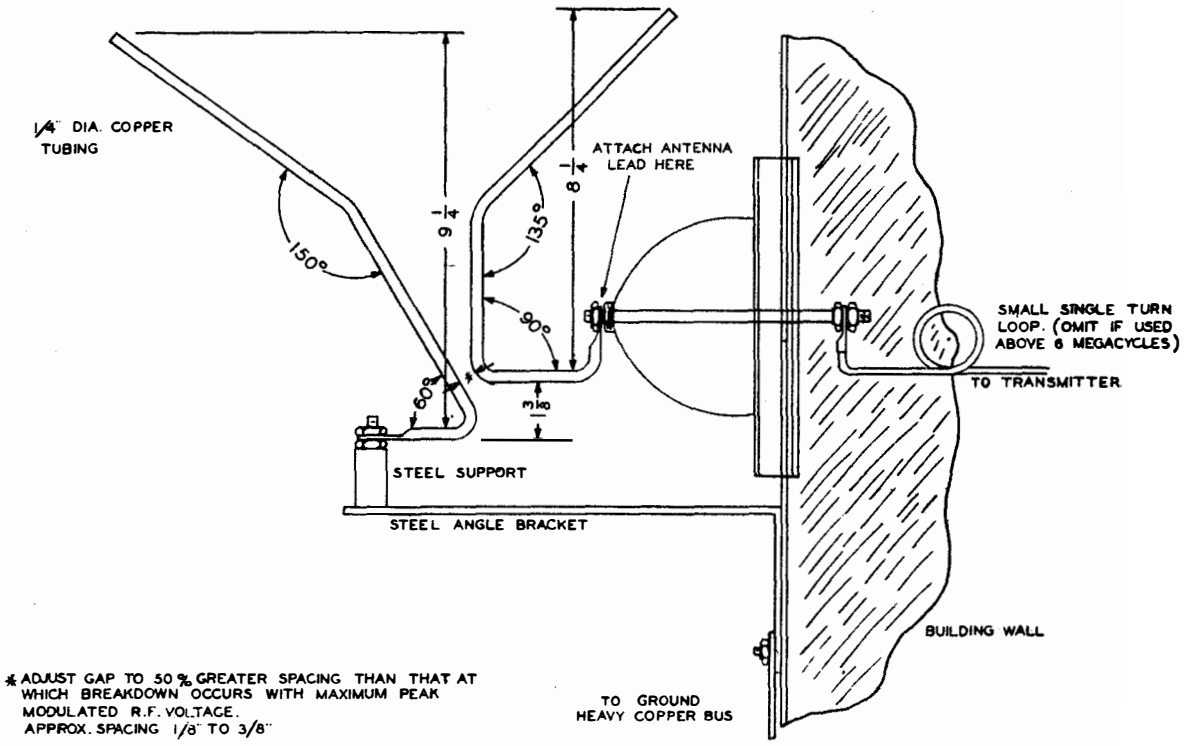
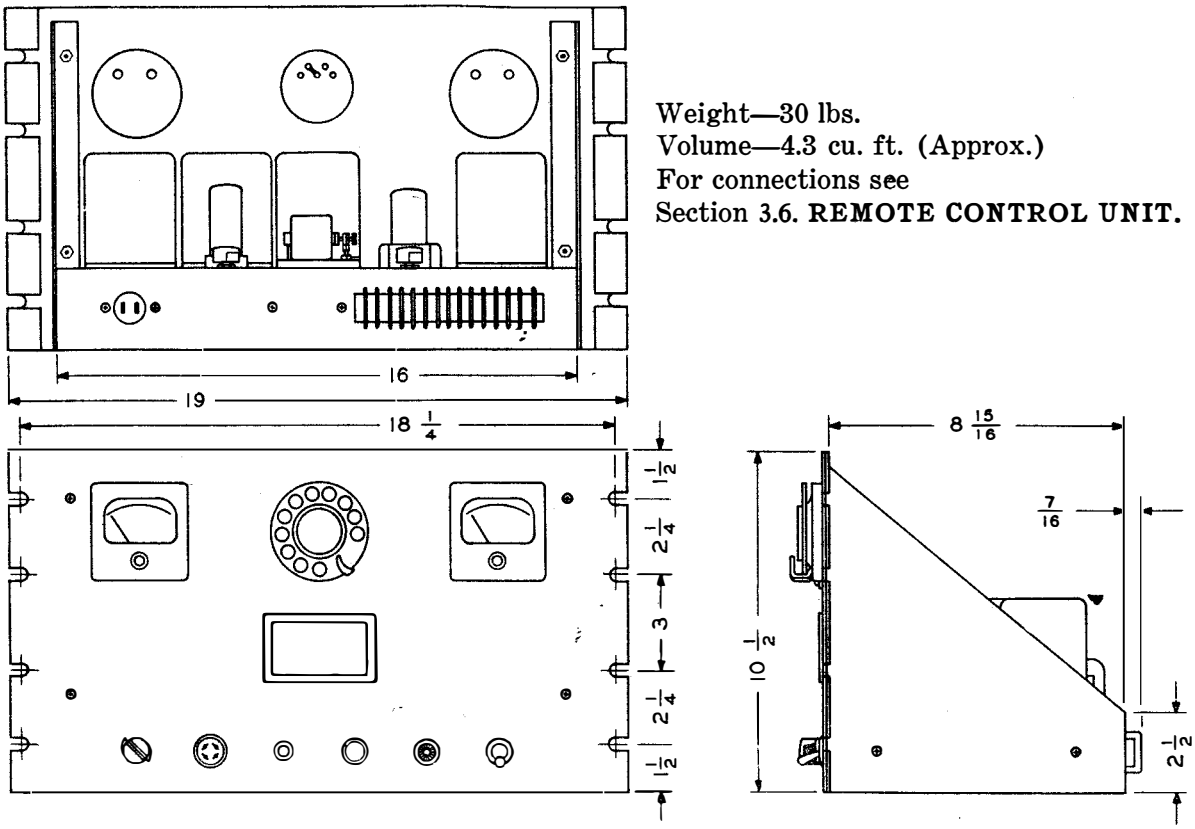


Fig. 15 Horn Gap Installation Details (Dwg. No. 1707A)



Weight—30 lbs.
Volume—4.3 cu. ft. (Approx.)
For connections see
Section 3.6. **REMOTE CONTROL UNIT.**

Fig. 16 Remote Control Unit Installation Diagram
(Dwg. No. 2573A)

used. In case of a vertical radiator, sixty radials of number 8 to 10 gauge bare copper wire spaced 6 degrees apart and terminated at a common heavy conductor as near the base of the radiator as possible should be used. The length of these radials should be at least a quarter wavelength referred to the lowest operating frequency. The connections from this ground mat to the transmitter ground terminal at the base of the cabinet should be made by means of a heavy copper conductor.

For a single wire, end fed horizontal antenna, the ground system shown in Fig. 14 is recommended. A system of radial wires of 8 or 10 gauge bare copper spaced 6 degrees apart covering approximately 225 degrees and extending for approximately a quarter wavelength (referred to the lowest operating frequency), should be installed with their center directly below the vertical or feedline portion of the antenna. The area covered by the radials should be that portion opposite the open end of the horizontal junction or center of the radial system should be a group of wires spaced five or six feet apart, laid parallel with the horizontal portion of the antenna and extending for at least an eight wavelength, referred to the lowest operating frequency, beyond the open end of the antenna and approximately an eighth wavelength in the direction normal to the horizontal portion of the antenna. A separate ground plate should be installed as near the transmitter cabinet as possible and a connection from this ground made directly to the cabinet.

The use of a suitable ground system such as outlined above will improve the radiating efficiency of the installation and will reduce excessive radio frequency voltages appearing in the control circuits, particularly the telephone line control equipment. **Many difficulties may be avoided by the immediate installation of such a ground system.**

At the building entrance for the antenna, a horn gap should be installed to reduce the

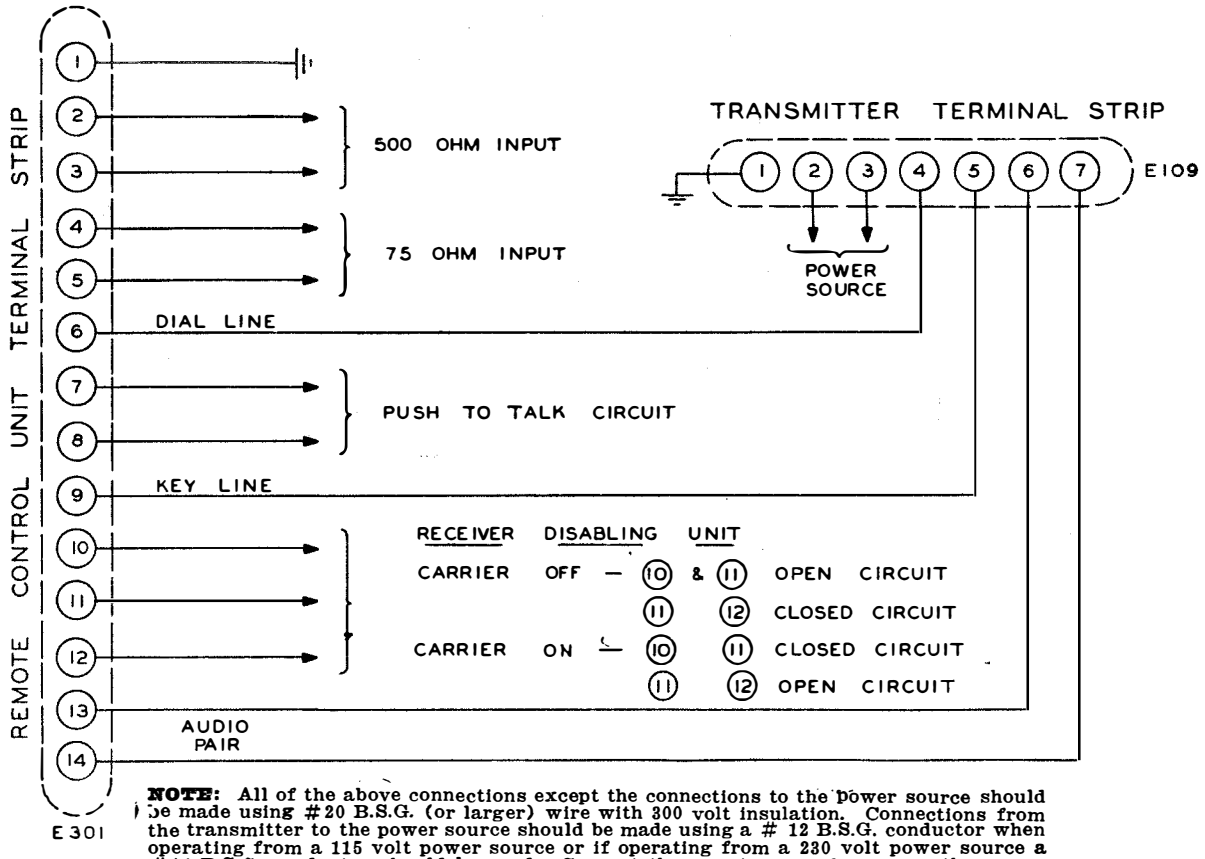
danger of damage to the equipment due to electrical storms or disturbances. A suitable horn gap is shown in Fig. 15.

3.6. **REMOTE CONTROL UNIT.** Refer to Fig. 16 for outline dimensions of the Remote Control Unit. The unit is designed to mount in a standard 19 inch rack.

Refer to Fig. 17 for control unit connections. The following table shows the connections and the terminal numbers on both the transmitter and control unit terminal boards:

Connect—Control Unit Terminal No.	—To—Transmitter Terminal No.	Circuit
1		Ground
2 & 3		Microphone Input
4 & 5		75 Ohm Input
6	4	Dial Line
7 & 8		Push-to-Talk
9	5	Key Line
10, 11, 12		Receiver Disabling
13 & 14	6 & 7	Audio Pair

Note: When more than one control unit is being used connect the terminals of the control units in parallel across the lines.



NOTE: All of the above connections except the connections to the power source should be made using #20 B.S.G. (or larger) wire with 300 volt insulation. Connections from the transmitter to the power source should be made using a # 12 B.S.G. conductor when operating from a 115 volt power source or if operating from a 230 volt power source a #14 B.S.G. conductor should be used. Connect the remote control units to the power source with the cords that are supplied.

Fig. 17 External Connections (Dwg. No. 500 2074 00A)

IV ADJUSTMENTS

4.1. **WARNING.** OPERATION OF THIS EQUIPMENT INVOLVES HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. SEE PAGES 7, 9 AND 10. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH THE HIGH VOLTAGE SUPPLY TURNED ON. DO NOT DEPEND UPON DOOR SWITCHES OR INTERLOCKS FOR PROTECTION BUT ALWAYS OPEN THE MAIN SWITCH IN THE SUPPLY LINE TO THE EQUIPMENT. BOTH THE REAR PANEL AND THE FRONT DOOR OF THE TRANSMITTER CABINET ARE PROVIDED WITH INTERLOCK SWITCHES. IT IS IMPOSSIBLE TO TURN ANY POWER ON WITH THE REAR PANEL REMOVED. WHEN THE L.V.-TUNE-OP. SWITCH IS OPERATED TO THE L.V. POSITION, THE INTERLOCK SWITCH ASSOCIATED WITH THE FRONT DOOR OF THE CABINET IS SHORTED OUT TO PERMIT TUNING ADJUSTMENTS OF THE EXCITER SECTION OF THE TRANSMITTER. GREAT CARE MUST BE EXERCISED WHEN MAKING EXCITER ADJUSTMENTS WITH THE FRONT DOOR OF THE TRANSMITTER CABINET OPEN BECAUSE MANY OF THE CIRCUITS ARE AT A POTENTIAL OF 500 VOLTS ABOVE GROUND.

4.2. **CONTROLS.** The transmitter may be controlled from a position near the transmitter cabinet or from a remote position. The controls are normal for remote control. All tuning adjustments must be made and the Autotune stop rings locked before assuming control from the remote operating position. Manual adjustment of all Autotune dials is possible without disturbing the position of the stop rings if **AA2** is dialed.

Refer to Fig. 18. The following paragraphs list the Control designations and give the elements controlled by each:

a. OSCILLATOR TUNING Control. The OSCILLATOR TUNING Control determines the frequency of the output of the oscillator, V101. The control operates a tuning slug within inductor L104. The oscillator operates in the frequency range 1000 kc to 1510 kc and output may be obtained on any frequency within this range by the operation of the OSCILLATOR TUNING Control. The dial is divided into 100 divisions covering the full 360 degrees of dial rotation. The frequency range is covered in ten revolutions of the dial, giving a total of 1000 divisions of dial rotation. The full revolutions of the dial are indicated on the revolution counter that is mounted near the large control. A dial reading for any frequency is determined by reading the whole number of revolutions on the counter dial and the fraction of a revolution on the tuning dial. For example: If the OSCILLATOR TUNING control is adjusted to give output on the desired frequency and the revolution counter indicates 4 and the large dial indicates 76, the dial setting at that particular frequency will be 476.

b. EXCITER BAND SWITCH. The EXCITER BAND SWITCH operates switches S104, S105 and S106. Switch sections S104A and S104B connect the proper inductor in the plate circuit of the frequency multiplier, V103. Switch section S104C controls the screen voltage that is applied to the intermediate amplifier, V104. Switch sections S105A, S105B, S105C, and S106A connect the proper inductor in the intermediate amplifier plate circuit. Switch sections S106B and S106C reduce the cathode bias on the frequency multiplier tube, V103, and the intermediate amplifier tube, V104, when the EXCITER BAND SWITCH is operated to Position 1. The dial is divided into four divisions. Position 4 of the EXCITER BAND SWITCH selects the proper inductors to give output in the frequency range 2.0 mc to 3.0 mc, Position 3 gives output in the range 3.0 mc to 6.0 mc, Position 2 gives output in the range 6.0 mc to 9.0 mc, and Position 1 of the control gives output in the frequency range 9.0 mc to 18.1 mc. Sixty degrees of dial rotation cover all four switch positions.

c. EXCITER TUNING Control. The EXCITER TUNING Control operates capacitors

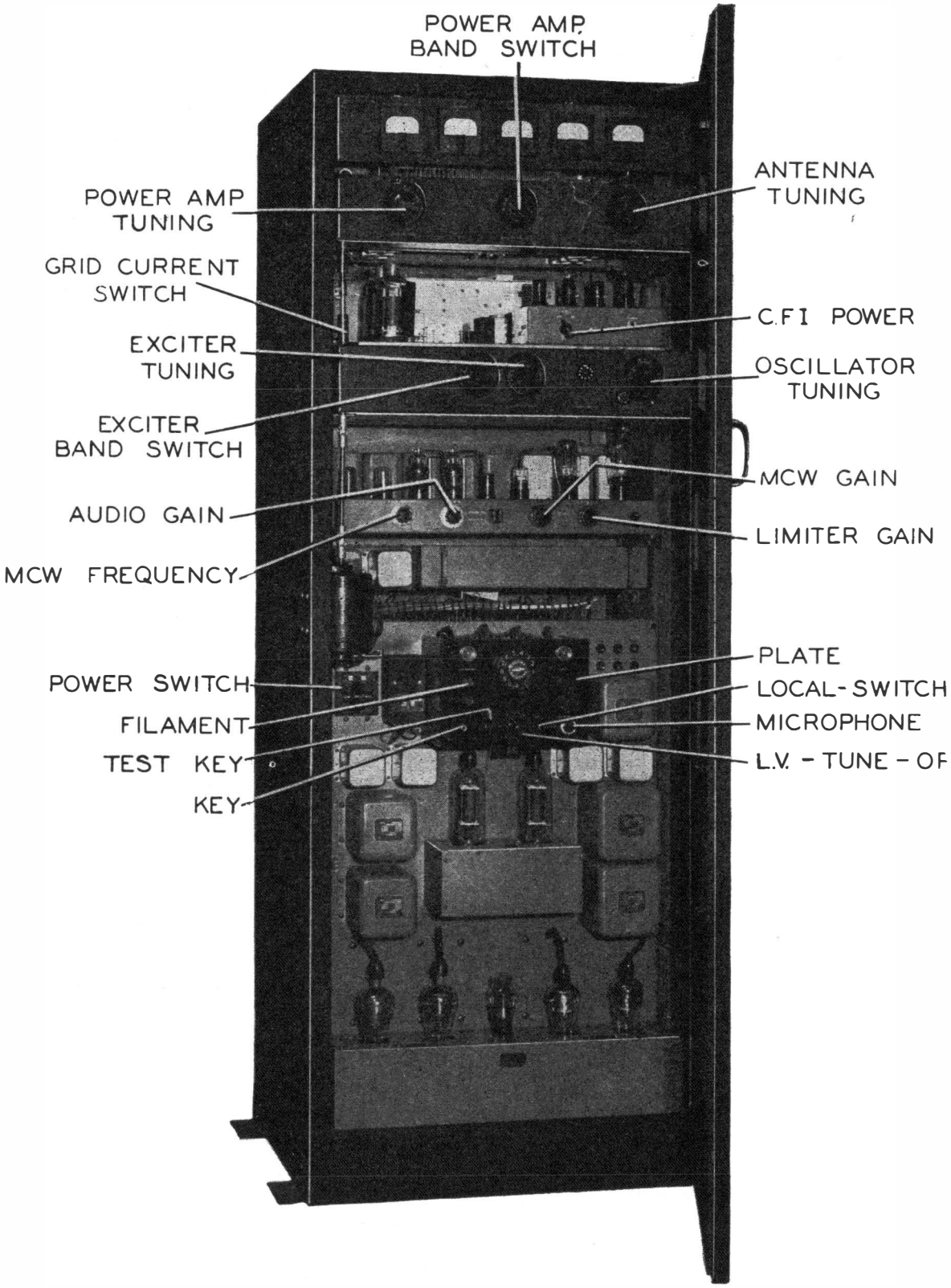


Fig. 18 Radio Transmitter (Front Open)

C125 and C132. The two capacitors are ganged so that both the frequency multiplier and the intermediate amplifier plate tank circuits may be tuned by a single control. Capacitor C125 is associated with the frequency multiplier plate tank circuit and capacitor C132 tunes the intermediate amplifier plate tank circuit. The dial is divided into 100 divisions over 180 degrees to cover the full range of the variable capacitors.

d. POWER AMP. BAND SWITCH. The POWER AMP. BAND SWITCH operates switch S101 in the Output Network Unit. Switch sections S101A, S101B, S101C and S101D make the proper capacitor connections, select the proper tap on the power amplifier plate inductor and select the antenna so that power amplifier tuning and antenna loading adjustments may be made. The dial is divided into 12 divisions with maximum capacity and maximum inductance in the circuit when the POWER AMP. BAND SWITCH is in Position 12. The twelve dial divisions cover 220 degrees of dial rotation.

e. POWER AMP. TUNING Control. The POWER AMP. TUNING Control operates the dual section variable capacitor C108. Capacitor C108 is connected across the input side of the pi network. When the POWER AMP. BAND SWITCH is in Positions 1 through 4 only one section of the capacitor is used. When the switch is operated to Positions 5 through 12 the two sections of capacitor C108 are connected in parallel. The dial is divided into 100 divisions, covering 180 degrees of the dial rotation. The 180 degrees of rotation permit the variation of the capacity from a minimum at 0 to a maximum at 100.

f. ANTENNA TUNING Control. The ANTENNA TUNING Control operates the dual section capacitor, C105, that is connected across the output side of the pi network. The two sections of the capacitor are connected in parallel. One half of the dial is divided into 100 divisions. The minimum capacity is in the circuit when the dial indicates 0 and the capacity is a maximum at a dial setting of 100.

g. MCW FREQUENCY Control. The MCW FREQUENCY Control operates switch S112 located in the speech amplifier unit. The switch changes the frequency of the output of the tone oscillator by varying the capacity of the tank circuit. Seven positions of the control are available, giving output in the frequency range 400 cps to 1200 cps. The frequency of the output increases as the control is rotated from 1 toward 7. The seven dial divisions cover 180 degrees of control rotation.

h. AUDIO GAIN Control. The AUDIO GAIN Control operates the dual potentiometer, R162. The control permits the adjusting of the input to the preamplifier tube V113. The dial is divided into 10 divisions, covering 280 degrees of control rotation. The input to the preamplifier tube, and consequently the speech amplifier gain, increases as the control is rotated from 0 toward 10.

i. MCW GAIN Control. The MCW GAIN Control operates potentiometer R187 and is located on the speech amplifier chassis. The control regulates the output of the tone oscillator V112. The dial is divided into 10 divisions, covering 280 degrees of rotation. The gain of V112 increases as the control is rotated from 0 toward 10.

j. LIMITER GAIN Control. The LIMITER GAIN Control operates potentiometer R178. The potentiometer permits the adjusting of the voltage that is applied to the plates of the limiter control tube, V117. (Refer to Section II of this book for details of the operation of the limiter circuits.) The dial is divided into 10 divisions, covering 280 degrees of rotation. The limiting effect increases as the dial is rotated from 0 toward 10.

k. TEST KEY. The TEST KEY, as the name implies, serves to close the carrier control circuit during the time that tuning adjustments are being made. If the switch is operated downward the key will immediately return to the normal position when released; if operated in the upward direction the key will lock to permit the making of tuning adjustments without the necessity of holding the telegraph key closed or the push-to-talk button on the microphone operated.

l. L.V.-TUNE-OP. Control. The L.V.-TUNE-OP. Control operates switch S119 and serves to regulate the voltage that is applied to the transmitting tubes. When operated to the L.V. position only the low voltage power supply will be operating. Also, when the switch is operated to the L.V. position, voltage may be applied to the low power stages without having the front door of the transmitter cabinet closed. When the switch is operated to the TUNE position high voltage is applied to the plates of the power amplifier and modulator tubes but a resistor is connected in series with primary of the high voltage transformer to reduce the output voltage of the high voltage supply and provide poor regulation to prevent the damaging of the tubes during tuning operations. When the L.V.-TUNE-OP. Control is operated to the OP. position, the full voltage of the high voltage supply is available for application to the plates of the power amplifier and modulator tubes. With the control in either the TUNE or OP. position the front door of the transmitter cabinet must be closed before plate voltage can be applied.

m. LOCAL-REMOTE Switch. The LOCAL-REMOTE Control operates switch S114. The switch is normal in the REMOTE position. When operated upward the switch is non-locking and will return to the REMOTE position as soon as released, but when operated downward the switch locks for LOCAL control of the transmitter.

4.3. **INSPECTION.** Before applying any voltage to the transmitter a thorough inspection of all connections and terminals should be made. **The rectifier tube plate leads and caps should be checked for clearance to metal objects.** The leads should be tied by means of insulating cord so that the caps do not touch a metal object or come in contact with one another. Inspect the rear panel and front door interlock switches to ascertain that the switches are operating properly.

Remove the Autotune cover plates and check the positions of the pawls on the Autotune units. The corresponding pawls should be operated on all six units. If the two singleturn units and the multiturn unit located on the R-F Unit are properly synchronized, that is, corresponding pawls are operated or may be operated by less than one-half revolution of the drive shaft, and the three singleturn units located on the Output Network Unit are synchronized with each other but are not synchronized with the units located in the R-F Unit, the short coupling drive shaft between the two Autotune assemblies should be removed and the drive shafts rotated manually in a clockwise direction until corresponding pawls on all of the Autotune units are operated. (Refer to the MAINTENANCE Section of this book for a detailed outline of the alignment procedure.)

4.4. **CIRCUIT TESTS.** Before any of the tubes are inserted in the units it is recommended that the control circuits be checked. The circuits should be cleared one at a time by removing all of the fuses from the receptacles and inserting each as needed to proceed with the operation of the transmitter controls. When replacing the fuses care should be exercised to place the proper fuse in the receptacle. The table below lists the item numbers and ratings of the fuses used in the equipment:

Item No.	Circuit	Rating
F101	M. O. Heater	⅜ amp*
F102	Exciter Filament Pri.	¼ amp*
F103	P.A. Filament Pri.	¾ amp*
F104	Speech Amp. Filament Pri.	⅜ amp*
F105	Bias Rectifier Filament Pri.	¼ amp*
F106	Bias Rectifier Plate Pri.	¼ amp*
F107	L.V. Rectifier Filament Pri.	½ amp*
F108	L.V. Rectifier Plate Pri.	3 amp
F109	Modulator Filament Pri.	½ amp*
F110	Relay Supply Pri.	2 amp
F111	Relay Power	2 amp
F112	H.V. Rectifier Filament	½ amp*
F113	Modulator H.V.	½ amp
F114	Power Input	25 amp
F115	Power Input	25 amp
F116	Rectifier Heater	¾ amp*

* Slo-Blo Fuse. Quick acting fuses should not be replaced with the Slo-Blo type.

When all the fuses have been removed from the equipment the procedure outlined below should be followed in the checking of the control and power circuits:

a. Insert fuses F114 and F115.

b. Insert fuse F101.

c. Insert fuse F110.

d. With the LOCAL-REMOTE switch in the REMOTE position, operate the transmitter power switch, S120, to the ON Position. The filament power relay, K112, should operate and the filament pilot lamp, I101, should glow.

e. Insert fuse F102 and using the extension cord and the LINE-FIL. VOLTAGE meter, M105, measure the secondary voltage of transformer T102 by inserting the cord plug into the EXCITER FIL. position of plug receptacle J104. If a voltage is indicated proceed to the next step. If the meter indicates no voltage check the fuse and the transformer circuit.

IMPORTANT: WITH THE TUBES REMOVED FROM THE SOCKETS AND THEREFORE NO LOAD ON THE SECONDARY OF THE FILAMENT TRANSFORMERS, THE VOLTAGES INDICATED ON METER M105 MAY VARY CONSIDERABLY FROM THE CORRECT VALUE BUT NO TRANSFORMER TAP ADJUSTMENTS SHOULD BE MADE UNTIL THE TUBES HAVE BEEN PLACED IN THE SOCKETS.

f. Insert fuse F103 and check the secondary voltage of transformer T101 by inserting the metering cord plug into the 813 FIL. position of plug receptacle J104.

g. Insert fuse F104 and check the voltages across both secondaries of transformer T107 by inserting the metering cord plug into the SPEECH FIL. and the DRIVER FIL. positions of plug receptacle J108 in the speech amplifier unit.

h. Insert fuse F105 and check the bias rectifier filament transformer circuit by inserting the voltage metering cord plug into plug receptacle J115.

i. Insert fuse F107 and check the low voltage rectifier filament transformer circuit by inserting the metering cord plug into plug receptacle J116.

j. Insert fuse F109 and check the modulator filament transformer circuit by inserting the metering cord plug into plug receptacle J113.

k. Insert fuse F112 and check the high voltage rectifier filament transformer circuit by inserting the metering cord plug into plug receptacle J114.

l. Operate the L.V.-TUNE-OP. switch, S119, to the L.V. position.

NOTICE: IF THE L.V.-TUNE-OP. SWITCH IS OPERATED TO THE L.V. POSITION, THE PRESSING OF THE PLATE START SWITCH OR THE OPERATION OF THE PLATE RELAY IF REMOTE CONTROL IS SELECTED, WILL APPLY VOLTAGES IN EXCESS OF 500 VOLTS TO MANY POINTS IN THE TRANSMITTER EVEN IF THE FRONT DOOR OF THE TRANSMITTER CABINET IS OPEN. THE OPERATION OF THE L.V.-TUNE-OP. SWITCH TO THE L.V. POSITION SHORTS OUT THE FRONT DOOR INTERLOCK SWITCH, S121.

m. When all filament transformer circuits have been checked and found to be operating satisfactorily, insert fuses F106, F108 and F111 and the bias rectifier tube, V124.

If the back panel of the transmitter cabinet is in place, the LOCAL-REMOTE switch, S114, is in the REMOTE position and enough time has elapsed for the time delay relay, K114, and the bias interlock relay, K116, to operate, the plate auxiliary relay, K115, should operate and energize the plate power relay, K113.

WARNING: THE OPERATION OF THE PLATE POWER RELAY APPLIES A POTENTIAL THAT EXCEEDS 500 VOLTS TO THE LOW VOLTAGE RECTIFIER TUBE PLATE CONNECTORS.

n. When relay K113 has been energized and operates, the plate pilot lamp, I102, should glow.

o. With the front door of the transmitter cabinet open, operate the L.V.-TUNE-OP. switch, S119, to the TUNE position. The plate pilot lamp, I102, should go out.

If switch S119 is operated to the TUNE or OP. position when the front door of the cabinet is open, plate power will be removed from the transmitter because the circuit necessary for the operation of the plate auxiliary relay, K115, is broken when the interlock switch, S121, is opened.

p. Operating switch S119 back to the L.V. position should again energize relay K114 and actuate the plate power relays, K115 and K113, and cause the plate power pilot lamp, I102, to glow.

To check the operation of the transmitter panel power controls, the LOCAL-REMOTE switch, S114, should be operated to the LOCAL locking position and the procedure outlined below followed:

q. Operate the FILAMENT power start switch, S115. The filament power pilot lamp, I101, should glow.

r. With the L.V.-TUNE-OP. switch in the L.V. position, operate the PLATE power start switch, S117. If the time delay relay, K114, has operated and the bias interlock relay, K116, has been energized, the plate power pilot lamp, I102, will glow.

WARNING: THE OPERATION OF THE PLATE POWER RELAY APPLIES A POTENTIAL THAT EXCEEDS 500 VOLTS TO THE LOW VOLTAGE RECTIFIER TUBE PLATE CONNECTORS.

s. With the front door of the transmitter cabinet open, operate the L.V.-TUNE-OP. switch, S119, to the TUNE position. The plate power contactors, K115 and K113, should be released and the plate power pilot lamp, I102, should go out. To reapply plate power it will be necessary to close the transmitter cabinet door or to operate S110 to the L.V. position and repeat Step **r.**

t. To check the operation of the interlock switch that is associated with the transmitter cabinet rear panel, the panel should be removed from the cabinet and an attempt made to apply plate power by the operation of the plate power start switch S117. The removing of the rear panel opens the circuit through the interlock switch, S122, and therefore it will be impossible to operate the plate auxiliary relay, K115. Insert fuse F113.

4.5. VOLTAGE ADJUSTMENT. When the procedure outlined under **4.4. CIRCUIT TESTS** has been completed and the circuits have been found to be operating satisfactorily, the transmitter power switch should be operated to the OFF position and the tubes inserted into the sockets. (Refer to **1.1.2 Tube Complement** in Section I of this Instruction Book.)

An autotransformer (T117) has been incorporated in the transmitter to permit the making of transmitter input voltage adjustments for varying power source voltages. The terminals on transformer T117 are stamped with designations as follows: 210 v, 220 v, 230 v, ± and 110 v SEC. (Refer to Fig. 66 page 159.) The lead that may be changed is marked with a metal band having **115 v** and **230 v** stamped on it. **This is the only lead that should be moved.** Before making any changes, insert the metering cord plug into plug receptacle J101 in the side of the transmitter cabinet and observe the reading on meter M105. The desired reading is **220 v.** If the reading is closer to 230 v than 220 v, remove fuse F114 from the holder and move the wire that is marked with the metal band to the terminal designated as **230 v.** If the meter reading is closer to 210 v than 220 v, move the wire to the terminal designated as **210 v.**

All filament transformers have tapped primaries so that the turns-ratio may be adjusted to give the correct voltage for application to the filaments of the tubes with a supply voltage of 210, 220, 230, 240, or 250 volts. The taps have been adjusted at the factory for a voltage of 230 volts. If the voltage, as indicated by the LINE-FIL. meter, is 5% above

or below this value the taps on the transformer primaries should be adjusted.

Filament voltages on all tubes in the transmitter unit may be measured using the LINE-FIL. VOLTAGE meter and the extension cord that is provided. No provision has been made for the metering of filament voltages in Remote Control Unit. The unit is designed to operate from a 115 volt a-c source and the single power transformer, T303, has a tapped primary so that the filament voltage may be kept constant by changing the taps if the supply voltage varies from the normal value.

The following list has been compiled to aid the operating personnel in checking voltages and making filament transformer adjustments:

WARNING: WHEN MEASURING THE FILAMENT VOLTAGES OF THE RECTIFIER TUBES THE PLATE VOLTAGE SHOULD BE TURNED OFF. THE CENTER TAP OF THE FILAMENT TRANSFORMER IS AT THE FULL POTENTIAL OF THE SUPPLY ABOVE GROUND.

Tube Symbol	Tube Type	Unit	Filament Transformer	Correct Voltage	Plug Receptacle
V101	6A8	R-F	T102	6.3	J104
V102	6AG7	R-F	T102	6.3	J104
V103	807	R-F	T102	6.3	J104
V104	807	R-F	T102	6.3	J104
V105	813	R-F	T101	10.0	J104
V106	813	R-F	T101	10.0	J104
V107	6SJ7	R-F	T102	6.3	J104
V108	VR-150-30	R-F			
V109	6A8	CFI	T102	6.3	J104
V110	6SL7GT	CFI	T102	6.3	J104
V111	6SN7GT	CFI	T102	6.3	J104
V112	6SN7GT	Speech Amp.	T107	6.3	J108
V113	6SL7GT	Speech Amp.	T107	6.3	J108
V114	6C8G	Speech Amp.	T107	6.3	J108
V115	6C8G	Speech Amp.	T107	6.3	J108
V116	6SJ7	Speech Amp.	T107	6.3	J108
V117	6X5GT	Speech Amp.	T107	6.3	J108
V118	2A3	Speech Amp.	T107	2.5	J108
V119	2A3	Speech Amp.	T107	2.5	J108
V120	805	Power	T112	10.0	J113
V121	805	Power	T112	10.0	J113
V122	249C	Power	T113	2.5	J114
V123	249C	Power	T113	2.5	J114
V124	5U4G	Power	T108	5.0	J115
V125	866/866A	Power	T110	2.5	J116
V126	866/866A	Power	T110	2.5	J116
V301	6SJ7	Remote Control	T303	6.3	None
V302	6SN7GT	Remote Control	T303	6.3	None
V303	6X5GT	Remote Control	T303	6.3	None

The rectifier plate power transformers also are provided with tapped primaries so that some compensation may be made for variations in source voltage. Before any taps are changed on the transformer primaries, the output of the supplies should be measured

under normal load and the voltage checked against the supply voltages given in the MAINTENANCE Section of this book.

4.6. R-F CIRCUIT ADJUSTMENT. The adjustment of six transmitter controls is necessary to obtain r-f output upon any particular frequency. Three of the controls, the OSCILLATOR TUNING, EXCITER BAND SWITCH, and EXCITER TUNING Controls are located on the R-F Unit. The three remaining controls, the POWER AMP. BAND SWITCH, POWER AMP. TUNING, and ANTENNA TUNING Controls, are located on the Output Network Unit. All six controls operate in conjunction with the Autotune positioning mechanism. When the controls have been properly adjusted, the Autotune stop rings may be locked in position by operating the locking bars on the front of each dial a fraction of a revolution in a clockwise direction. All six controls may be operated without disturbing the stop rings if Manual tuning is selected by dialing **AA2. (Note:** Dialing **A** gives eleven dial pulses, the maximum obtainable with a single operation of the telephone dial.)

WARNING: BE SURE TO RELEASE THE TEST SWITCH BEFORE OPERATING EITHER THE EXCITER BAND SWITCH OR THE POWER AMP. BAND SWITCH.

4.6.1. Oscillator Calibration. The master oscillator is continuously tunable in the frequency range 1000 kc to 1510 kc. A calibration circuit has been incorporated in the transmitter to permit the accurate setting of the output frequency of the oscillator. The standard of frequency is a 200 kc quartz crystal that is connected in the oscillator section of the CFI circuit. By dividing the frequency of the output of the 200 kc oscillator and beating the r-f output of the master oscillator with the output of the CFI oscillator, audio beat notes are obtained and are used as "check points" in conjunction with the calibration table that is furnished with each transmitter. **(IMPORTANT:** The data in the Calibration Tables are for the transmitter with the Serial No. corresponding to the Serial No. on the CALIBRATION BOOK only.) The "check points" have been printed in heavy black type in the Calibration Tables. The audible beat notes are used to set the movable indicator mark on the OSCILLATOR TUNING Control. **The frequencies given in the tables are the transmitter output frequencies and not the oscillator output frequency.**

A total of ten revolutions of the multiturn dial (OSCILLATOR TUNING) is necessary to cover the oscillator tuning range. The counter dial indicates the number of full revolutions of the multiturn dial and the fraction of a revolution is indicated by the position of the dial with respect to the indicator mark.

For example: If the Calibration Table indicates that the dial setting for a particular frequency is 864 the multiturn dial should be rotated until the counter dial indicates 8 and the indicator mark is opposite 64 on the large dial.

(a) Interpolation of Dial Settings

The dial settings for frequencies between the "check points" are given for intervals that become greater as the operating frequency becomes higher. For frequencies between those given in the table the dial settings may be obtained by interpolation. To obtain a dial setting for a frequency that is not included in the table use the following method:

1. Find the difference between the desired frequency and the next lower frequency that is given in the table.

2. Multiply the figure that is obtained by the number that is shown in parenthesis at the right of the column of figures that contains the frequency near to the frequency that is desired.

3. Add the product thus obtained to the dial setting that is listed in the table, the same setting that was obtained from the table and used for Step 1. The sum is the dial setting for the desired frequency.

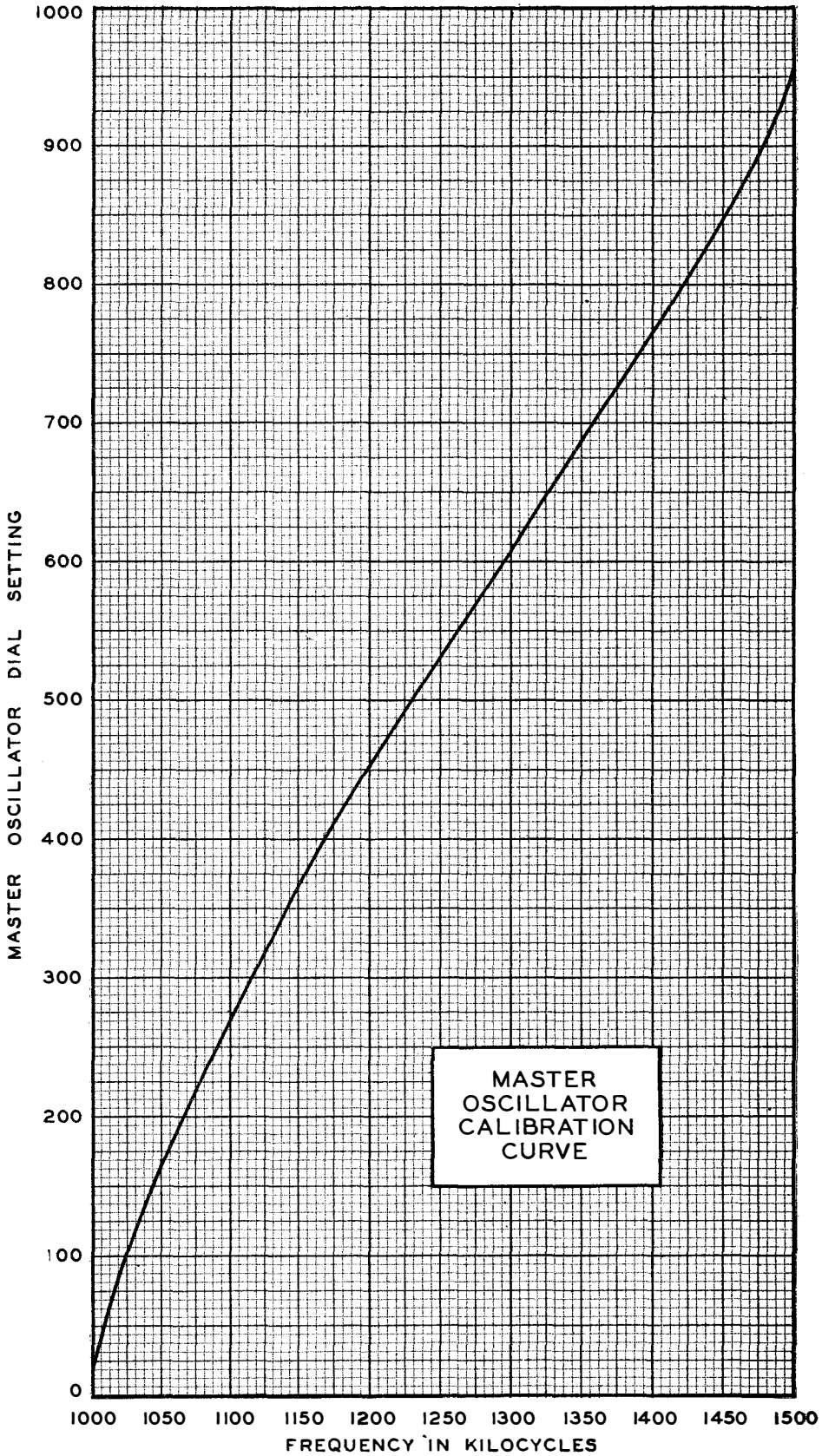


Fig. 19 Master Oscillator Calibration Curve (Dwg. No. 502 0187 003)

(b) Calibration

The following procedure is recommended for the setting of the oscillator frequency:

1. Having chosen an operating frequency, refer to the Calibration Table and locate the "check point" that is nearest the chosen frequency in the FREQUENCY column. Dial a channel and when the Autotune mechanism has come to rest, operate the locking bar on the OSCILLATOR TUNING Control in a counterclockwise direction and rotate the control until the revolution counter dial and large dial readings correspond to the setting obtained from the table.

2. Operate the power level switch to the L.V. position.

3. Insert an earphones cord plug into the CFI PHONES jack, J122.

4. Rotate the CFI power switch to the ON position.

5. Operate the TEST key to the locking position.

6. While listening to the output of the CFI Unit, rotate the OSCILLATOR TUNING Control a few dial divisions in either direction until zero beat is obtained between the output of the master oscillator and the harmonic of the 200 kc oscillator.

7. Adjust the indicator mark until the dial setting corresponds to that obtained from the table for the same "check point."

8. With the indicator mark set as explained under Step 7, refer to the Calibration Table and obtain the dial setting for the frequency upon which output is desired.

9. Operate the OSCILLATOR TUNING Control until the counter dial indicates the correct number of full revolutions of the multiturn dial and the last two figures of the dial setting that was obtained from the table, are opposite the indicator mark.

10. With the control set as described under Step 9, hold the dial in position and operate the locking-bar in a clockwise direction until the Autotune stop rings are locked. **(NOTE:** ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

11. Release the TEST switch.

The above procedure completes the calibration of the oscillator for one frequency. Repeat the above procedure for the remaining ten frequency channels.

WARNING: IT IS OF UTMOST IMPORTANCE THAT THE CFI UNIT POWER SWITCH BE TURNED TO THE **OFF** POSITION AFTER THE OSCILLATOR HAS BEEN CALIBRATED SO AS TO PREVENT THE MODULATION OF THE CARRIER BY THE OUTPUT OF THE CALIBRATION FREQUENCY INDICATOR.

4.6.2. Exciter Tuning. The remaining two controls, the EXCITER BAND SWITCH and the EXCITER TUNING Controls, control the frequency and the amount of excitation that is applied to the power amplifier tube grids. The EXCITER BAND SWITCH determines the number of times that the frequency of the output of the oscillator is multiplied in the frequency multiplier and intermediate amplifier stages. The EXCITER TUNING Control operates the variable capacitors in the frequency multiplier and intermediate amplifier plate tank circuits.

The exciter tuning procedure is outlined below:

(a) Operate the EXCITER BAND SWITCH to the position that includes the frequency upon which operation is desired.

(b) Operate the GRID CURRENT switch, S103, (located on top left-hand side of r-f unit) to the 813 position.

(c) With the LOCAL-REMOTE switch in the LOCAL position operate the transmitter power switch to the ON position and press the FILAMENT start button.

(d) Operate the power level switch to the L.V. position.

(e) When the time delay and the bias in-

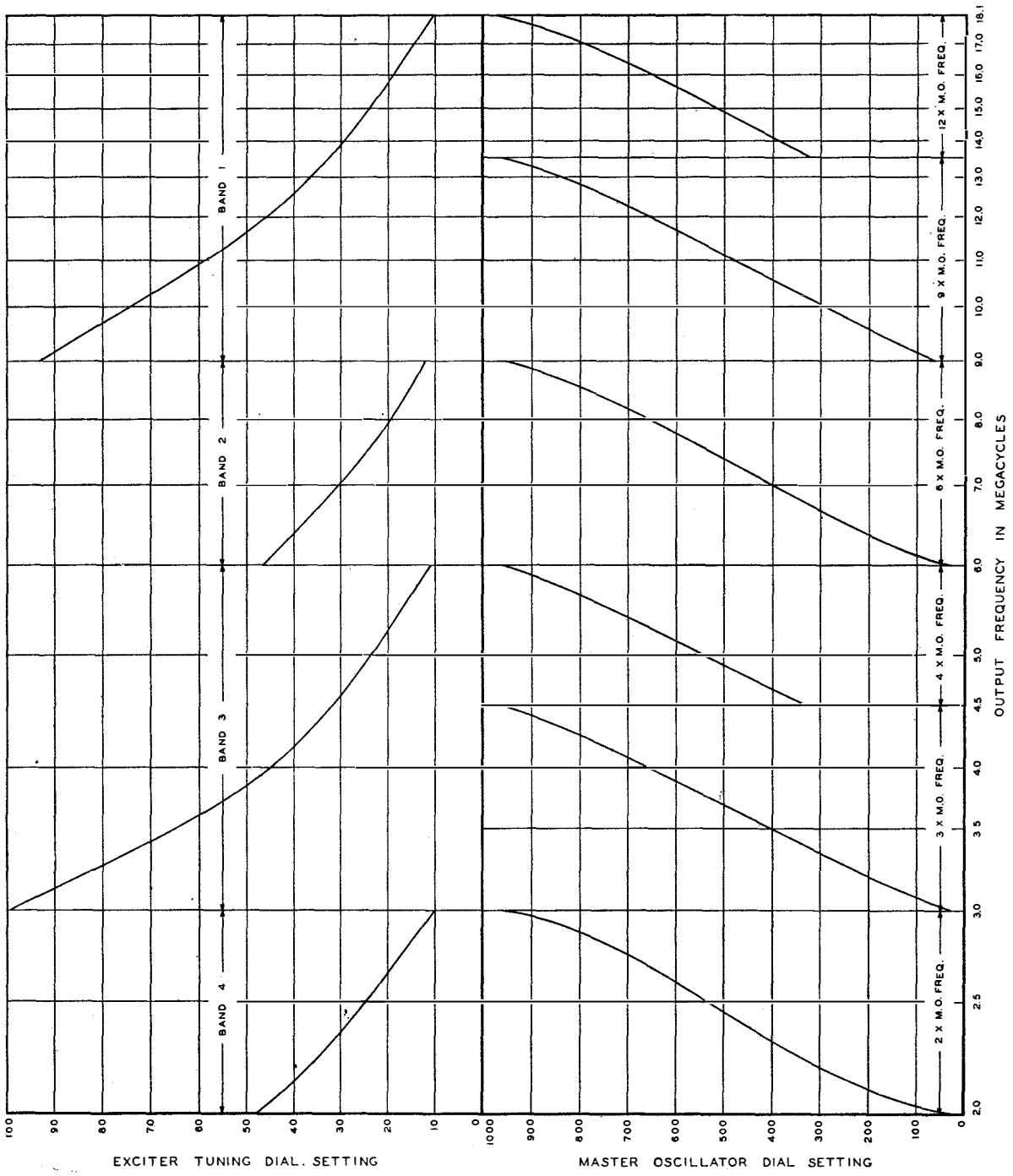


Fig. 20 Exciter Tuning Curves (Dwg. No. 1631C)

terlock relays have operated, apply plate voltage (500 v.) by pressing the PLATE start button.

(f) Operate the TEST switch to the locking position.

(g) Unlock the stop rings on the EXCITER TUNING Control by operating the locking bar in a counterclockwise direction.

(h) Tune for maximum GRID CURRENT reading. (The power amplifier grid current should be between 15 ma and 30 ma.) Refer to Exciter Tuning Curves to be sure that the output is in the correct harmonic.

(i) With the EXCITER TUNING set in the position that gives the maximum power amplifier grid current meter reading, lock the stop rings by operating the locking bar in a clockwise direction.

(j) Release the TEST switch.

The above procedure completes the tuning of the exciter circuits for one frequency channel. It is recommended that the r-f circuit adjustment for each channel be completed, by tuning the power amplifier and antenna circuits, before going on to the next channel.

4.6.3. Power Amplifier and Antenna Tuning. The power amplifier plate tank and antenna loading circuits in this transmitter are combined in a pi network. The network is designed to couple the output of the power amplifier to an unbalanced antenna system. The circuit will couple the power amplifier circuit to antennas having impedances of from 50 to 1200 ohms with a phase angle of 0 degrees, 70 to 850 ohms with a phase angle of ±45 degrees and 100 to 600 ohms with a phase angle of ±60 degrees. Refer to Fig. 20A. By making the proper jumper connections on terminal strip E101 on the rear of the network, either of two antennas may be selected for a particular position of the POWER AMP. BAND SWITCH.

The POWER AMP. BAND SWITCH positions and the approximate frequency range of each when working into a 300 ohm resistive load are tabulated below:

POWER AMP. BAND SWITCH Position	Frequency Range
1	13.5 mc to 18.1 mc
2	11.5 mc to 13.5 mc
3	9.0 mc to 11.5 mc
4	6.9 mc to 9.0 mc
5	5.8 mc to 6.9 mc
6	4.9 mc to 5.8 mc
7	4.2 mc to 4.9 mc
8	3.6 mc to 4.2 mc
9	3.1 mc to 3.6 mc
10	2.3 mc to 3.1 mc
11	2.0 mc to 2.3 mc
12	

While the exact settings of the controls will depend to a large extent upon the type of antenna that is being used, the general procedure outlined below for the tuning of the power amplifier and antenna coupling circuits should be followed:

(a) Unlock the stop rings on all three Autotune units in the Output Network Unit.

(b) With the exciter circuits tuned as described under 4.6.2. operate the POWER AMP. BAND SWITCH to the position that includes the frequency upon which operation is desired. (Refer to table above.)

(c) Operate the power level switch to the TUNE position and select CW emission by dialing A1.

(d) Set the POWER AMP. TUNING and ANTENNA TUNING Controls to approximately mid-scale.

(e) With the cabinet door closed, operate the TEST switch and immediately attempt to resonate the power amplifier plate tank circuit by rotating the POWER AMP. TUNING Control. If resonance cannot be established (indicated by a sharp dip in PLATE CURRENT) release the TEST switch, change the position of the ANTENNA TUNING Control and make another attempt to resonate the tank circuit.

(f) If it is impossible to bring the power amplifier plate tank circuit into resonance, no matter where the ANTENNA TUNING Control is set, release the TEST switch and op-

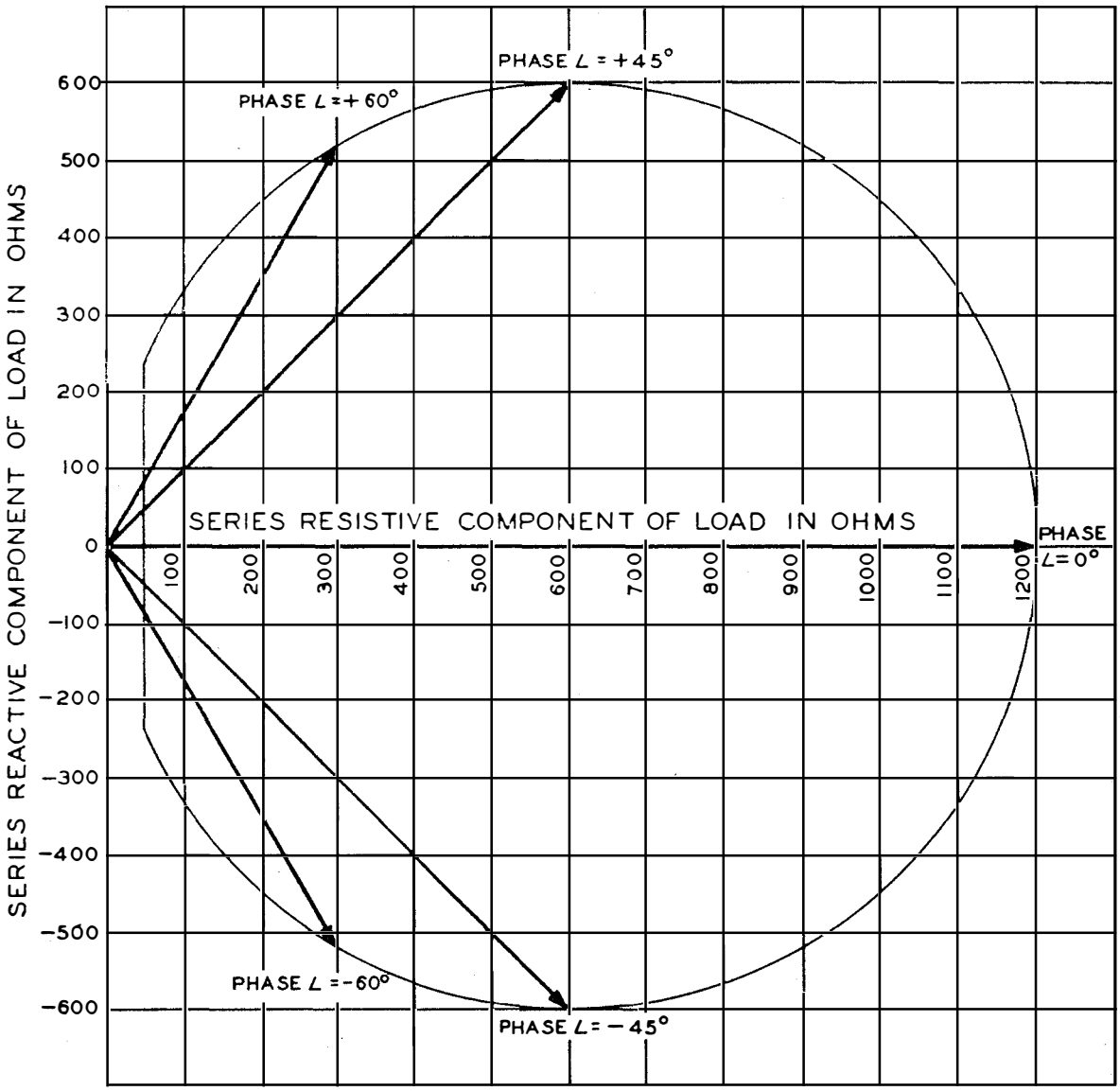


Fig. 20A Output Network Impedance Matching Range (Dwg. No. 500 4383 00C)

erate the POWER AMP. BAND SWITCH one position in either direction and repeat Step (e).

(g) When resonance of the power amplifier plate tank circuit has been established operate the power level switch to the OP. position and load the stage, using the ANTENNA TUNING Control, until the PLATE CURRENT meter indicates that the power amplifier tubes are drawing 360 ma of plate current. While increasing the loading with the ANTENNA TUNING Control keep the tank circuit in resonance with the POWER AMP. TUNING Control.

Note: It is recommended that the power amplifier circuit be loaded for the type of emission that is to be used predominately on any particular channel. Under Step (c), dial the correct type of emission for the channel selected and proceed as above except load the power amplifier until the PLATE CURRENT meter indicates **300 ma more than the modulator static plate current,** rather than 360 ma, if the channel is to be used predominately for

A2 or A3 emission. **The meter indicates both power amplifier plate and modulator plate current when A2 or A3 emission is selected.** The modulator static plate current is approximately 80 ma.

(h) Lock the stop rings on the three network controls by operating the locking bars in a clockwise direction.

The above steps complete the tuning of the power amplifier circuits. Repeat the procedure for the remaining ten frequency channels.

4.6.4. Power Amplifier Neutralization. The power amplifier circuit was neutralized at the factory and the neutralizing capacitor, C130, locked in position so that no further adjustment of the neutralization circuit should be necessary. However, if it becomes necessary to make adjustments of capacitor C130, the procedure outlined below should be followed:

WARNING: REMOVE PLATE POWER WHILE LOOSENING AND TIGHTENING NUTS ON NEUTRALIZING CAPACITOR. USE AN INSULATED ROD WHEN ADJUSTING THE NEUTRALIZING CAPACITOR.

(a) With the POWER AMP. TUNING Control adjusted to exact resonance, as explained under Section 4.6.3. operate the power level switch to the L.V. position.

(b) Couple an oscilloscope to the power amplifier plate tank inductor, L102. (Very close coupling is necessary.)

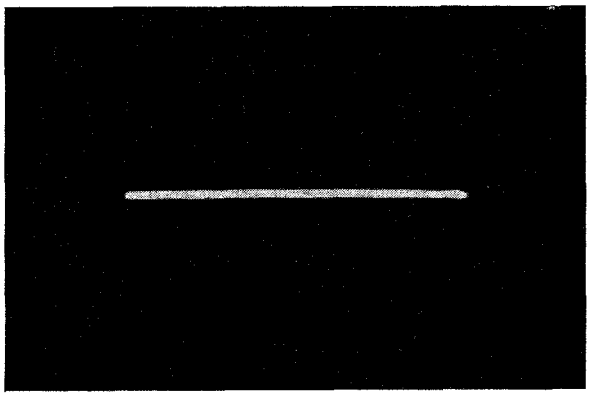


Fig. 21 Oscilloscope Pattern—Transmitter Properly Neutralized

(c) Remove the power amplifier filament primary fuse, F103, from the receptacle.

(d) Adjust the oscilloscope sweep frequency so that a flourescent streak appears on the screen. (Refer to Fig. 21.)

(e) Press the PLATE start button on the transmitter panel and operate the TEST switch to the on position.

(f) While operating the TEST switch observe the oscilloscope pattern. If some r-f appears on the oscilloscope screen (Refer to Fig. 22) the power amplifier circuit is not properly neutralized. If no change appears on the oscilloscope pattern the circuit is properly neutralized.

(g) If the circuit is not properly neutralized, press the PLATE stop button and loosen the nuts that hold the neutralizing capacitor, C130, (large plate near P.A. tubes) in position.

(h) Apply PLATE power and using an insulated rod adjust capacitor C130 until no r-f pattern appears on the oscilloscope screen.

(i) Turn off the transmitter and tighten the mounting nuts on the neutralizing capacitor.

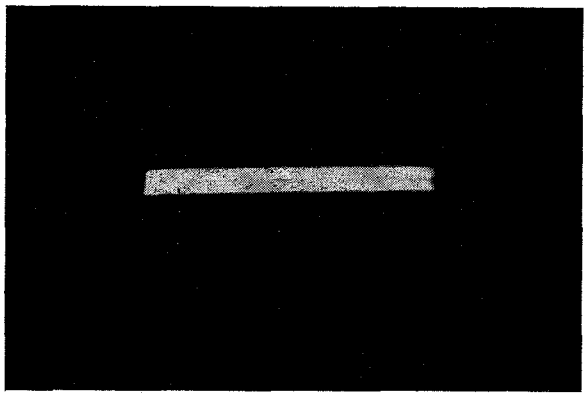


Fig. 22 Oscilloscope Pattern—Transmitter Not Properly Neutralized

4.7. AUDIO CIRCUIT ADJUSTMENT. Two adjustments are provided in the speech amplifier in the transmitter, one to regulate the input to the first stage of the unit and the other to control the amount of compression. When once properly adjusted, the controls will not need any attention until tubes are replaced

or the characteristics of the tubes change enough with use to affect the operation of the compression circuit.

A control in the remote control unit permits the adjusting of the input to the audio lines to the transmitter to compensate for variation in line loss.

The adjustments should be begun at the remote control unit.

An audio oscillator capable of putting out 0 db in the frequency range 500 cps to 1500 cps and equipped with a db meter, a db meter with a pair of leads about six or eight feet long with connector clips on the ends and an oscilloscope will be necessary in order to make the adjustments of the controls.

The following procedure is recommended for the adjustment of the Audio Controls:

4.7.1. Remote Control Unit Adjustments. This transmitter has been designed for normal operation with the functions controlled by a remote control unit. The distance from which the transmitter may be controlled is determined by the line loss. The loss in the line can not exceed 25 db. If more than one remote control unit is to be used, preliminary adjustments should first be made on the control unit that is farthest from the transmitter.

The procedure outlined below should be followed when making the adjustments of the remote control unit farthest from the transmitter:

(a) Connect the output of the audio oscillator to terminals #2 and #3 on terminal strip E301 on the Remote Control Unit.

(b) Apply filament and plate power to the tubes in the unit by operating the power switch to the ON position.

(c) Rotate the GAIN Control as far as possible in a counterclockwise direction.

(d) With the oscillator gain control partially advanced rotate the Remote Control Unit GAIN Control in a clockwise direction until the output level meter, M302, indicates zero db. (Zero level—6 mw into 500 ohm.)

(e) Close the shorting-lever on the telegraph key.

With the control set as outlined above proceed with the adjustment of the transmitter controls. If two remote control units are being used the adjustment of the GAIN Control of the unit nearest the transmitter should not be made until the adjustments of the controls in the transmitter have been completed.

When the adjustments of the transmitter AUDIO GAIN and LIMITER GAIN Controls have been completed return to the remaining Remote Control Unit, connect the audio oscillator to the input terminals of the unit and adjust the GAIN Control until 100% modulation of the carrier is obtained.

Note: If one control unit is near the transmitter, so that there is very little line loss, the volume level meter on the control unit panel can not be used as an indicator of signal level because even when properly adjusted the meter needle may only give a slight "kick" on signal peaks.

4.7.2. Transmitter Control Adjustments. With the controls at the remote position set so that an audio signal of zero db level is being fed into the audio lines, proceed to make transmitter adjustments as outlined below:

(a) Remove the rear panel from the transmitter cabinet and the cover plate from the cable connector duct that is located to the rear of the speech amplifier unit.

(b) Refer to Fig. 23. Connect the meter leads to terminals 13 and 19 on plug receptacle, J109. (Output terminals of the audio driver transformer, T106). Bring the leads out over the top of the speech amplifier unit, through the cabinet front door and connect to the db meter.

(c) Replace the cabinet rear panel. (Leave the duct cover off.)

(d) Rotate the AUDIO GAIN and LIMITER GAIN Controls as far as possible in a counterclockwise direction.

(e) Couple the oscilloscope to the transmitter output circuit.

(f) Assuming that all r-f circuit adjustments have been completed, operate the transmitter power switch to the ON position and close the cabinet front door.

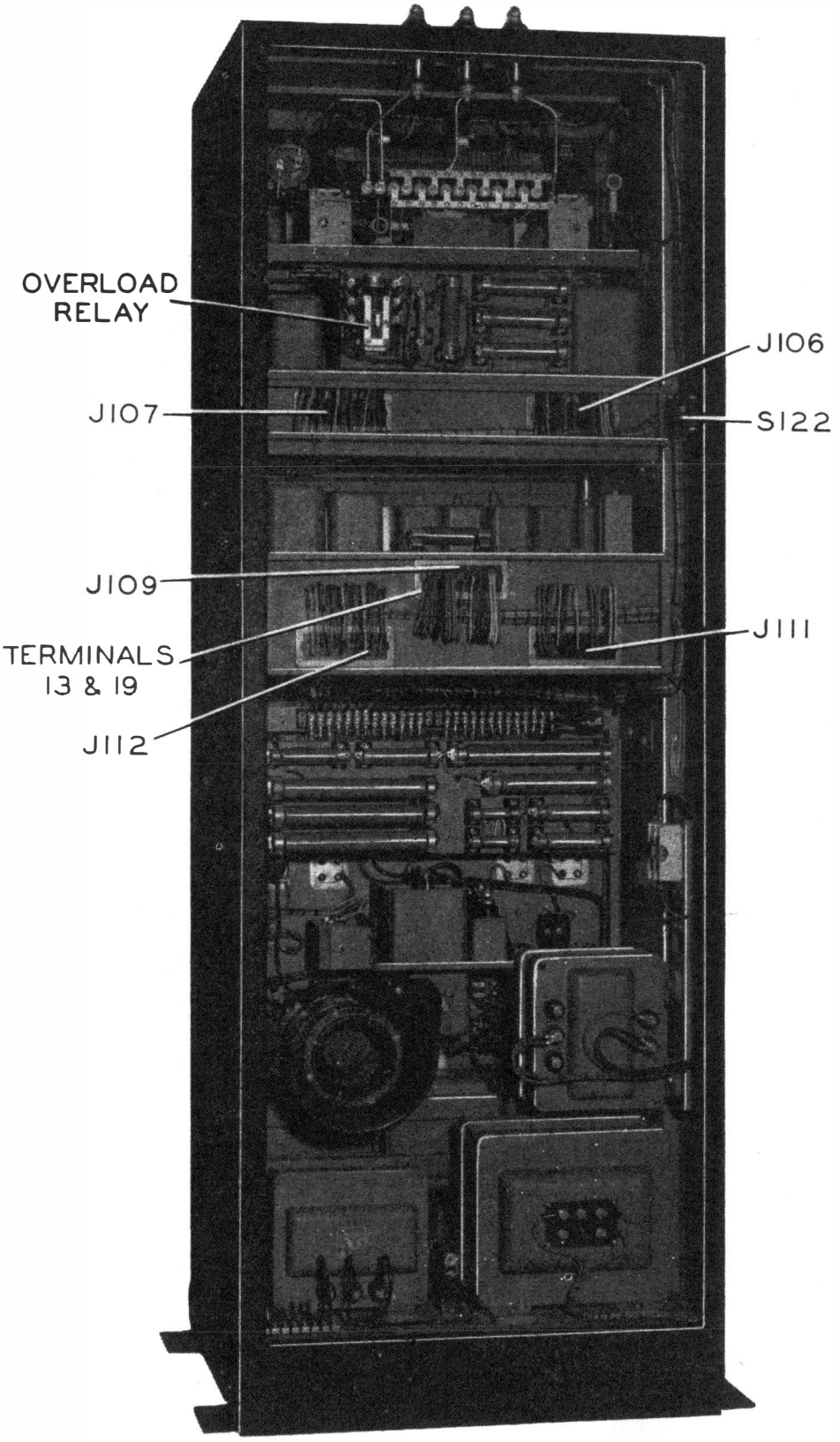


Fig. 23 Radio Transmitter (Rear Open)

(g) When the time delay and interlock relays have operated, check the pattern on the oscilloscope screen. A pattern similar to the one shown in Fig. 24 should appear.

(h) Assuming that very little, if any, modulation is indicated, open the cabinet door, advance the AUDIO GAIN Control one dial division, close the door and check the percentage of modulation by observing the pattern on the oscilloscope screen. Refer to Figs. 25, 26 and 27.

(i) Repeat Step (h) until the oscilloscope pattern indicates approximately 100% modulation of the r-f carrier. (Fig. 26.)

(j) When 100% modulation level has been obtained, observe the reading on the db meter.

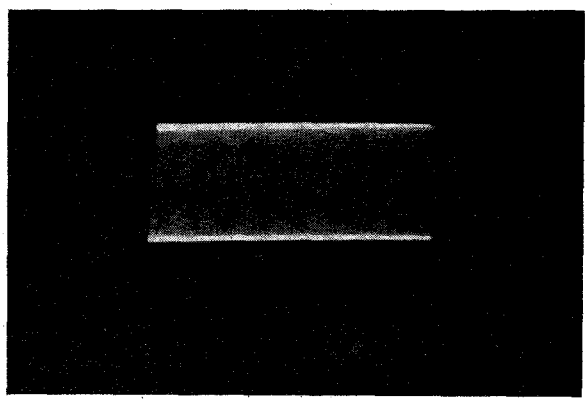


Fig. 24 Oscilloscope Pattern—R-F Carrier

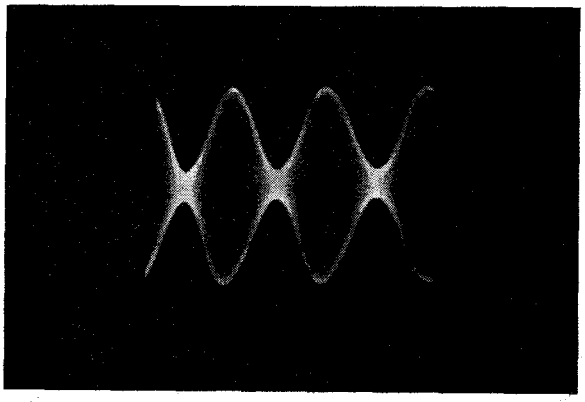


Fig. 25 Oscilloscope Pattern—80% Modulation

(k) Operate the L.V.-TUNE-OP. switch to the L.V. position.

(l) Open the transmitter cabinet front door and advance the LIMITER GAIN Control until the audio output drops 2 db.

(m) Repeat Steps (k) and (l), advancing the LIMITER GAIN Control, R178, one step at a time until the speech amplifier output drops 2 db.

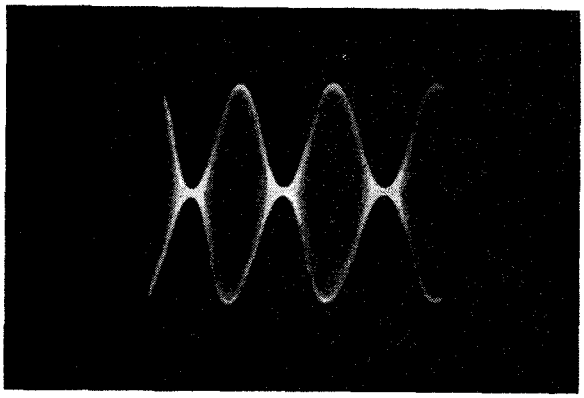


Fig. 26 Oscilloscope Pattern—100% Modulation

The limiter is very effective and with the controls set as above the limiter begins operation at approximately 80% modulation. (Fig. 25.) Increasing the input 20 db will not cause overmodulation. (Fig. 27)

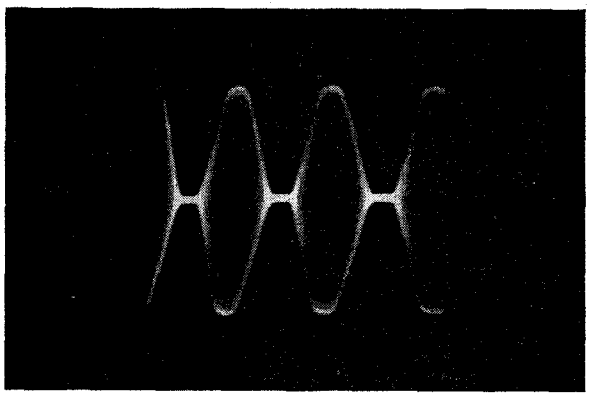


Fig. 27 Oscilloscope Pattern—Overmodulation

The transmitter is now ready for operation with voice emission. No further adjustment of the AUDIO GAIN and LIMITER GAIN Controls will be necessary for REMOTE operation. The LIMITER GAIN Control is now properly adjusted for both LOCAL and RE-

MOTE operation. Remove the db meter leads, replace the cable duct cover plate and fasten the rear panel of the transmitter cabinet in place. Before removing the oscilloscope connections, the MCW GAIN control should be set so that the r-f carrier is modulated 100% when using MCW emission.

To properly adjust the MCW GAIN Control, follow the procedure outlined below:

(n) Operate the transmitter LOCAL-REMOTE switch to the LOCAL position.

(o) Select MCW emission by dialing **A2**.

(p) Rotate the MCW GAIN Control as far as possible in a counterclockwise direction and turn on the r-f carrier.

(q) While keying check the modulation by observing the pattern on the oscilloscope screen.

(r) Advance the MCW GAIN Control, R187, one step at a time until the oscilloscope pattern indicates 100% modulation of the carrier when keyed.

Fig. 28 shows CW emission keyed at 100 words per minute.

Fig. 29 shows the oscilloscope pattern of MCW emission keyed at 60 words per minute with the sweep voltage synchronized with the keying but not synchronized with the audio.

The transmitter circuits are now properly adjusted for CW, MCW, and VOICE emissions. The circuits are normal for voice emission, that is, when a channel is dialed voice emission is automatically selected. CW or MCW emission may be selected by dialing **A1** and **A2**, respectively.

To complete the adjustments, return to the remote control unit farthest from the transmitter (or greatest loop loss), insert the microphone cord plug into plug receptacle J301, and while speaking into the microphone at normal level, adjust the GAIN Control on the control unit panel until the needle of the output meter swings up to zero on voice peaks.

IMPORTANT: Do not change the position of the AUDIO GAIN or LIMITER GAIN Controls on the transmitter proper.

If 100% modulation of the r-f carrier cannot be obtained with the LIMITER GAIN Control set at zero, the line loss is too great.

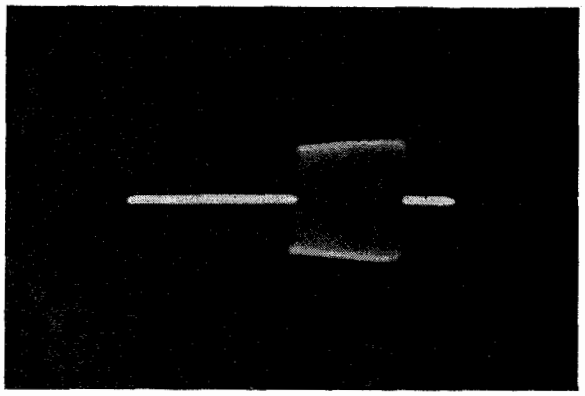


Fig. 28 Oscilloscope Pattern—CW Keying 100 W.P.M.

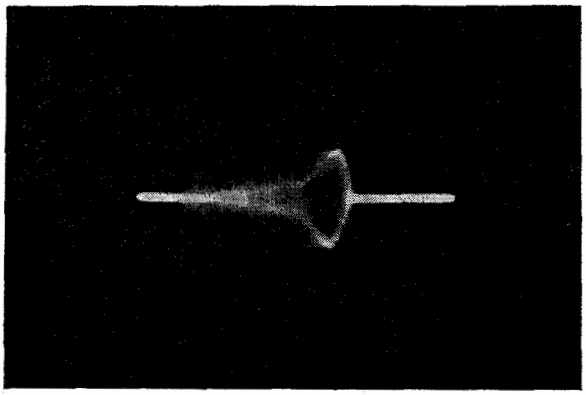


Fig. 29 Oscilloscope Pattern—MCW Keying 60 W.P.M.

4.8. **LOCAL CONTROL (VOICE).** If it is desired to operate with LOCAL control and VOICE emission follow the procedure outlined below:

(a) Operate the LOCAL-REMOTE switch to the LOCAL position.

(b) Insert the microphone cord plug into the MICROPHONE jack.

(c) Carefully observe the position of the AUDIO GAIN Control so that the control can be reset to this setting for REMOTE operation.

(d) Turn the transmitter on.

(e) Dial **A3**.

(f) Operate the push-to-talk switch on the

microphone and speak into the microphone at normal voice level and observe the PLATE CURRENT reading on voice peaks.

(g) Adjust the AUDIO GAIN Control a little at a time until the PLATE CURRENT meter reading on voice peaks is near 500 ma.

IMPORTANT: WHEN SELECTING MCW EMISSION OR RETURNING TO REMOTE CONTROL BE SURE TO RETURN THE AUDIO GAIN CONTROL TO THE SETTING ESTABLISHED AS BEING CORRECT UNDER 4.7.2., THE CORRECT SETTING FOR REMOTE OPERATION.

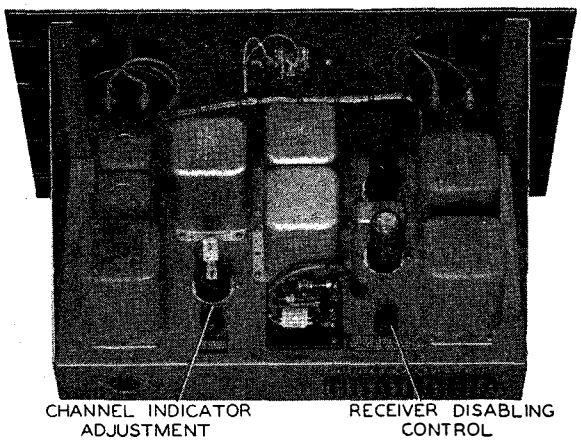


Fig. 30 Remote Control Unit (Top)

4.9. EMISSION SELECTION. While the transmitter connections are normal for VOICE emission, either CW or MCW emission may be automatically selected if the proper connections are made on plug P104 on the R-F Unit.

If it is desired to operate with CW emission on any or all channels remove the cap from plug P104 and connect the plug terminals to terminal 14 (the terminal numbers correspond to the Autotune channels).

MCW emission will be automatically selected for the Autotune channels if connections are made to plug terminal 15.

If a type of emission other than that which is automatically selected for any particular channel is desired, the desired type of emission may be selected by dialing.

4.10. CHANNEL INDICATOR AND DISABLING CIRCUIT ADJUSTMENT

4.10.1. Channel Indicator Adjustment. The remote Control Unit has been provided with a channel indicator so that the operator at the remote position may see on which frequency channel the transmitter is operating. The meter is a voltmeter with a scale graduated to show the channel numbers.

A variable resistor, R310, has been connected between the meter and ground. The operating knob is located on the top rear edge of the chassis. Refer to Fig. 30. To set the indicator, dial a channel, preferably Channel 5 or 6 and when the meter needle has come to rest, rotate the adjusting knob until the needle is opposite the number of the channel that was dialed. Check the operation of the CHANNEL INDICATOR by dialing several other channels and observing the position of the meter needle. Dial **A0** and check to see that the meter needle comes to rest opposite OFF on the meter dial.

4.10.2. Receiver Disabling Circuit Adjustment. A receiver disabling circuit has been incorporated in the remote control unit. The relay, K301, releases when the push-to-talk switch on the microphone is pressed or the telegraph key is closed. A variable resistor, R315, has been connected in the circuit to provide a means of bucking the bias voltage applied to the transmitter keyer which is also applied to the key line under "key up" conditions. The control knob is located on the top rear edge of the chassis.

The transmitter bias supply must be on when making the above adjustments.

Follow the procedure outlined below for the adjustment of the receiver disabling circuit:

(a) Rotate the circuit control, R315, as far as possible in a counterclockwise direction.

(b) Close the telegraph key.

(c) If the relay releases no further adjustment will be necessary.

(d) If the relay does not release when the key is pressed release the telegraph key and

rotate the control in a clockwise direction until the relay operates.

(e) Check operation of the circuit by opening and closing the telegraph key.

Note: Where more than one remote control unit is being used begin adjustment of the receiver disabling circuits by rotating the control on one unit as far as possible in a counterclockwise direction and adjusting the other as outlined above. When one circuit is operating correctly adjust the other.

WARNING: THE RECEIVER DISABLING CIRCUIT ADJUSTMENT SHOULD NOT BE ROTATED FARTHER CLOCKWISE THAN NECESSARY FOR PROPER OPERATION OF RELAY K301 AS IT MAY PLACE SUFFICIENT VOLTAGE ON THE CARRIER CONTROL LINE TO OPERATE THE TRANSMITTER CARRIER CONTROL CIRCUIT.

V OPERATION

5.1. GENERAL. In compiling this section it has been assumed that all tuning adjustments have been made in accordance with the procedure outlined in the ADJUSTMENT section of this Instruction Book and that all that remains to be done to place the equipment in operation is to operate the controls.

5.2. OPERATIONAL CHECK. Before proceeding with the routine operation of the equipment the meter readings on the transmitter should be checked. If the meters indicate voltages and currents near the values listed below, it may be assumed that the transmitter is operating normally:

PLATE VOLTAGE
(A1 Emission)—2000 v.
PLATE CURRENT
(A1 Emission)—360 ma,
813 GRID CURRENT—15 to 30 ma.

The meter readings may vary slightly from the above values without materially affecting the operation of the transmitter. The PLATE VOLTAGE reading will vary considerably with line voltage. The PLATE CURRENT and GRID CURRENT may vary slightly with frequency. The GRID CURRENT meter is the best indicator of transmitter adjustment. The transmitter will operate with GRID CURRENT readings as low as 15 ma but any reading below this value will indicate that some adjustment of the tuning controls is necessary. **In all instances the 813 GRID CURRENT must be peaked.**

Use the following procedure to check the meter readings:

(a) Operate the LOCAL REMOTE switch to the LOCAL position.

(b) Operate the transmitter power switch, S120, to the ON position.

(c) Press the FILAMENT start button.

(d) Dial an Autotune channel.

(e) Dial **A1.**

(f) Operate the TUNE-OP. switch to the OP. position.

(g) When the time delay and interlock relays have operated, apply plate voltage (2000 volts) by pressing the PLATE start button.

(h) Operate the TEST key and check the meter readings.

IMPORTANT: When making the above check, be sure that the GRID CURRENT meter switch, S103, is in the "813" position. (The switch is located on the top left-hand side of the R-F Unit chassis.)

If the meter readings vary considerably from normal, check the voltage by inserting the cord plug attached to the LINE-FIL. meter into the receptacle in the side of the cabinet wall. The meter should indicate voltage normal to the installation (near 230 volts). If the voltage appears to be normal, some tuning adjustments of the r-f circuits may be necessary. Refer to the ADJUSTMENTS section of this Instruction Book for detailed adjustment procedure.

5.3. ROUTINE OPERATING PROCEDURE. If the meters indicate normal operation of the r-f circuits proceed with the routine operation of the equipment. The procedure is outlined below:

5.3.1. Remote Control. This transmitter has been designed for normal operation with all functions controlled from a remote point. The following steps give a brief outline of the operations that are necessary to set the transmitter up for CW, MCW and VOICE emission:

Note: The operation of the time delay relays in the transmitter, applying plate voltage (2000 volts) to the transmitter tubes, is indicated by the operation of the CHANNEL INDICATOR meter on the panel of the Remote Control Unit.

(a) VOICE Emission.

1. Operate the control unit power switch to the ON position.

(IMPORTANT: The transmitter power switch, S120, must be in the ON position and

the LOCAL - REMOTE switch in the REMOTE position before assuming control from the Remote Control Unit.)

2. Select a frequency channel by dialing.
3. Operate the push-to-talk switch on the microphone.
4. Continue operation using the microphone push-to-talk switch to control the carrier and the telephone dial to select the frequency channels.
5. To turn the transmitter off, dial **A0.**

(b) CW Emission.

1. Operate the control unit power switch to the ON position.
2. Select the desired frequency channel by dialing.
3. Dial **A1** to set up the transmitter circuits for CW emission.
4. Insert the key cord plug into the KEY jack.
5. Operate the telegraph key to control the emission.
6. Turn the transmitter off by dialing **A0.**

(c) MCW Emission.

1. Operate the control unit power switch to the ON position.
2. Select the desired frequency channel by dialing.
3. Dial **A2** to set up the transmitter circuits for MCW emission.
4. Insert the key cord plug into the KEY jack.
5. When the time delay relay has closed, operate the telegraph key to control the emission.
6. Turn the transmitter off by dialing **A0.**

5.3.2. Panel Control. All of the functions of the transmitter may be controlled from the transmitter panel if the LOCAL-REMOTE switch is operated to the LOCAL position.

The following sections list the steps that are necessary to select and control VOICE, CW and MCW emission from the transmitter panel:

(a) VOICE Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Connect the microphone cord plug to the MICROPHONE jack.
4. Select the desired frequency channel by dialing.
5. Press the FILAMENT start button.
6. When the time delay and interlock relays have operated, apply plate voltages (1500 volts) by pressing the PLATE start button.
7. Press the push-to-talk switch on the microphone and proceed with the transmission.
8. To turn the transmitter off, press the FILAMENT stop button.

(b) CW Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Insert the telegraph key cord plug into the KEY jack.
4. Select the desired frequency channel by dialing.
5. Select CW emission by dialing **A1.**
6. Press the FILAMENT start button.
7. When the time delay and interlock relays have operated apply plate

voltage (2000 volts) by pressing the PLATE start button.

8. Operate the telegraph key and proceed with the transmission.
9. Turn the transmitter off by pressing the FILAMENT stop button.

(c) MCW Emission.

1. Operate the transmitter power switch to the ON position.
2. Operate the LOCAL-REMOTE switch to the LOCAL position.
3. Insert the telegraph key cord plug into the KEY jack.
4. Select the frequency channel by dialing.
5. Select MCW emission by dialing **A2.**
6. Press the FILAMENT start button.
7. When the time delay and interlock relays have operated, apply plate voltage (1500 volts) by pressing the PLATE start button.
8. Proceed with the transmission by operating the telegraph key.
9. Turn the transmitter off by pressing the FILAMENT stop button.

Note: Channel 11 may be selected by dialing **AA1.** Manual tuning may be selected by dialing **AA2.** Channel 11 and Manual do not provide automatic emission selection. When Manual is selected the transmitter controls may be operated without disturbing the Autotune mechanism. When either Channel 11 or Manual is dialed the meter on the Remote Control Unit indicates **OFF.**

If it is desired to return the transmitter to REMOTE control after operating with LOCAL control, turn the transmitter off by dialing **A0** and operate the LOCAL-REMOTE switch to the REMOTE position.

Also by operating the LOCAL-REMOTE switch to the LOCAL position when operating with REMOTE control a channel or function may be selected by using the LOCAL dial.

VI MAINTENANCE

6.1. **AUTOTUNE MAINTENANCE.** While the Autotune mechanism has been designed and constructed to give many hours of trouble free service and has been properly adjusted before leaving the factory, some maintenance and adjustment of the units may be necessary to maintain dependable and efficient service. Or if it becomes necessary to replace component parts of a unit it may be necessary to make some adjustments to obtain proper synchronization between the repaired unit and the other Autotune units in the transmitter.

6.1.1. **Lubrication.** It is not necessary to remove the individual Autotune heads for lubrication. If the Autotune cover plates are removed the Autotune heads are easily accessible and may be lubricated without dismantling the assemblies. The gears that couple the line shafts to the inter-connecting drive shafts are enclosed in small boxes near the left hand ends of the Autotune castings and to gain access to these gears the small cover plates should be removed.

The motor bearings should be lubricated every six months with Vactra Oil Extra Heavy X. In no case should animal or vegetable oil be used to lubricate the motor or any part of the Autotune mechanism.

Two types of lubricants are required for the Autotune mechanism. The lubricants that are required are Vactra Oil Extra Heavy X and Viscolite Lubricant #10, manufactured by the Socony-Vacuum Oil Company.

Parts to be oiled should be given all of the oil that the bearings will take but no excess should be applied. The equipment to be oiled should be kept free of dirt and excessive oil. The grease should be applied in an even layer.

A regular schedule for the lubrication of the Autotune mechanism should be established. Some parts require lubrication every month while others will only require lubrication every six months.

Note: On drawings and photographs, referred to under the lubrication schedule below, the letters **A** and **B** have been used to designate the type of lubricant. **A** enclosed in a broken circle means that Vactra Oil Extra Heavy X should be used to lubricate the part or parts indicated and the letter **B** enclosed in a circle means that Viscolite #10 should be used to lubricate the part or parts indicated. **See Fig. 4.**

The following is a suggested schedule for the lubrication of the Autotune mechanism:

(a) Parts to be lubricated each month.

1. The eight worm gears on the Autotune line shafts with Viscolite Lubricant #10. (Refer to Figs. 37 and 39.) **Note:** Be careful so that none of the grease gets into the Autotune clutch mechanism.

2. The helical gears on the left ends of the line shafts with Viscolite Lubricant #10. (Refer to Figs 37 and 39.)

3. The two ball and socket couplers on the interunit drive shaft with Viscolite Lubricant #10. (Refer to Fig. 46.)

4. The two universal couplers on the interunit drive shaft with Vactra Oil Extra Heavy X. (Refer to Fig. 46.)

5. The fourteen bronze bearings on the line shafts and the two bronze bearings on the drive shafts with Vactra Oil Extra Heavy X lubricant. (Refer to Figs. 37 and 39.)

Note: The four sealed ball bearings to the left and top of the gear boxes do not require lubrication as these bearings have been packed and sealed for the life of the bearings.

(b) Parts to be lubricated every six months.

1. Lubricate all parts as outlined above for the monthly lubrication.

2. Refer to Fig. 4 and lubricate all points designated as **A** with Vactra Oil Extra Heavy X and lubricate all points designated by **B** with Viscolite Lubricant #10.

3. The four universal couplers that connect the Autotune heads to the variable components in the transmitter with Vactra Oil Extra Heavy X. (Refer to Figs. 48 and 51.)

4. The four tuning capacitor bearings in the R-F Unit and the four tuning capacitor bearings in the Output Network Unit with Vactra Oil Extra Heavy X. (Refer to Figs. 41 and 48.)

5. The two bronze bearings in the Channel Indicator mechanism in the R-F Unit assembly with Vactra Oil Extra Heavy X. (Refer to Fig. 41.)

6. The bearings in the three ceramic tap switches in the R-F Unit and the four ceramic tap switches in the Output Network Unit with Vactra Oil Extra Heavy X. (Refer to Figs. 41, 48 and 49.) **Note:** Be careful not to apply too much oil to the bearings of the tap switches.

7. The Autotune and ventilating blower motors with Vactra Oil Extra Heavy X.

8. The door hinges with Vactra Oil Extra Heavy X.

If the worm and worm gear should run dry to the extent that bronze is worn from the worm gear it will be necessary to thoroughly clean the old grease from the worms and worm gears and to remove all of the galled bronze from the worms. The galled metal may be removed from the worms by using a fine carborundum paper or a similar fine abrasive.

If excessive wear of the contact surfaces of the ceramic tap switches in the R-F and Output Network Units is noted, petroleum jelly (Uncarbolated Vaseline) may be applied sparingly until the contacts burnish each other. In dusty climates, grease on these contacts may cause more wear than no lubricant at all since dust would accumulate on the contacts and cause excessive wear.

6.1.2. Autotune Synchronizing Theory. The purpose of synchronizing Autotune heads is to reach an adjustment condition which will assure proper setting up of all Autotune heads under any operating condition within the design limits of the transmitter. Before outlining the correct procedure, a brief explanation will be given of the factors which must be considered in attaining proper synchronism.

There are two conditions which must be met before proper synchronism is obtained. For any given channel, they are:

1. All pawls must be engaged before Autotune motor reverses.
2. No pawl must rise out of engagement before Autotune motor reverses.

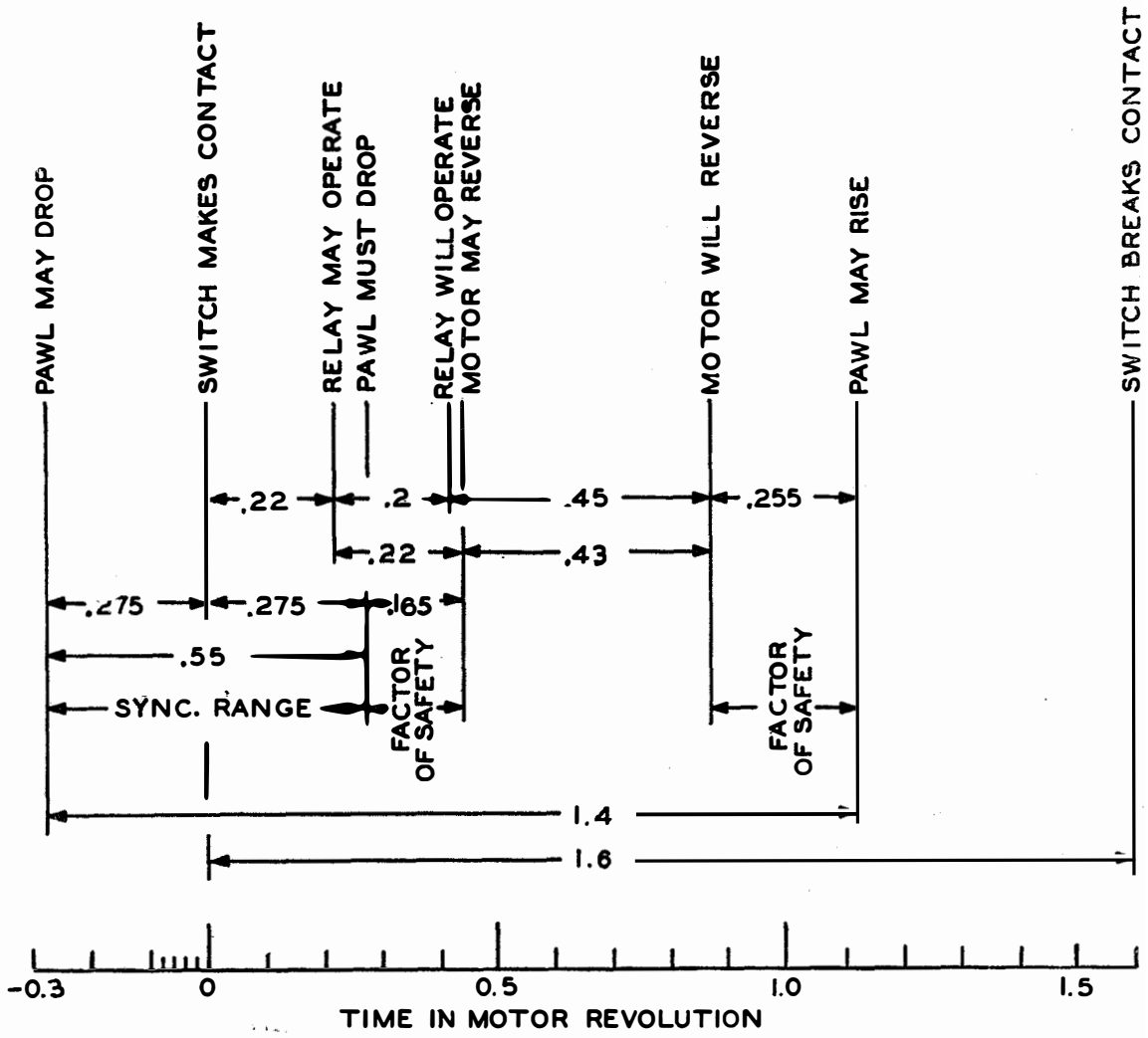
To meet these conditions, it is necessary to consider several factors, the most important of which are the time required to operate the motor reversing relay, the time required for the motor to reverse after the relay has operated, and the amount of effective pawl dwell available.

The operate time of the reversing relay may be divided into two parts: a basic operate time and an operating variation. The basic operate time is the shortest time the relay requires to fully operate under any normal operating condition, such as low or high line voltage. The variation is the difference between the maximum operate time ever experienced and the basic operate time. The reversing time of the motor may also be divided in the same fashion into a basic reversal time and a reversal variation.

Consider the sequence of events which must occur in reversing the Autotune motor. In order of occurrence they are:

1. Seeking switch makes contact.
2. Relay operates (basic operate plus variation).
3. Motor reverses (basic reversal plus variation).

It is readily apparent that there is a definite time period after the seeking switch makes contact during which the motor will always reverse. This period will begin at a time following occurrence of seeking switch contact equal to the relay basic time plus the motor basic time. The period will be of a time length equal to the sum of the relay variation plus the motor variation.



MOTOR SPEED	= 1300 R.P.M.	≈ 22 R.P.S.
BASIC RELAY OPERATE TIME	= 10 MILLISECONDS	= 0.22 MOTOR REVOLUTIONS
RELAY VARIATION	= 9 MILLISECONDS	≈ 0.2 MOTOR REVOLUTIONS
BASIC MOTOR REVERSE TIME	= 0.22 MOTOR REVOLUTION	
MOTOR REVERSAL VARIATION	= 0.23 MOTOR REVOLUTION	
MAXIMUM PAWL DWELL	= 1.4 MOTOR	
BASIC SWITCH DWELL	= 1.6 MOTOR REVOLUTIONS	
TOTAL FACTOR OF SAFETY	= 0.42 MOTOR REVOLUTION .165 PAWL DROP + .255 PAWL RISE	
SYNCRONIZING RANGE	= 1.4 − .42 − .43 = .55 MOTOR REVOLUTION	
SYNCRONIZING LEAD	= 1.4 − .255 − .45 − .2 − .22 = .275 MOTOR REVOLUTION	

THE ABOVE DIAGRAM APPLIES TO COLLINS TYPE 96J−6, 96J−7, AND 96K−2 AUTOTUNE HEADS AS APPLIED TO THE COLLINS TYPE 16F−8 TRANSMITTER.

Fig. 31 Autotune Operation Time Base Diagram
(Dwg. No. 500 2672 00B)

Since any synchronizing adjustment made must remain fixed, while both relay and motor functioning may vary, it is apparent that the total operating variation (sum of relay variation and motor variation) must never exceed the total available effective pawl dwell. It must, in fact, be considerably less in order to allow a factor of safety, to allow some leeway for error in adjusting synchronism, and to allow for such manufacturing errors as may exist such as deviations from 30 degree normal spacing of seeking switch contacts, and cam drum slot spacing.

Before computing any actual synchronizing information, some basic facts and relationships will be listed.

Motor speed = 1300 RPM ≅ 22 rps.

Relay Basic Operate Time = 10 milliseconds = 0.22 motor revolution.

Relay Variation = 9 milliseconds ≅ 0.2 motor revolution.

Motor Basic Reverse Time = 0.22 revolution.

Motor Reversal Variation = 0.23 revolution.

Maximum Pawl Dwell = 1.4 motor revolutions.

Total Factor of Safety = 0.42 motor revolution.

With the above figures available, a time base diagram can be drawn which will clarify the conditions of synchronizing and enable easy computation of correct synchronizing limits.

To summarize, the requirements of synchronization of Autotune heads are as follows:

Cam drums on 96J-6, 96J-7, 96K-2 Autotune heads must be adjusted so that the pawls on any channel do not drop into engagement with cam drum more than 0.275 motor revolutions before, nor more than 0.275 motor revolutions after seeking switch makes contact.

6.1.3. Synchronization Check. If there is reason to believe that the Autotune units are out of synchronization, the following steps should be taken to check the operation of the Autotune system:

IMPORTANT: IN THE FOLLOWING STEPS, THE WORDS "CLOCKWISE" AND "COUNTERCLOCKWISE" ARE USED WITH REGARD TO THE DIRECTION OF ROTATION WHILE VIEWING THE MOTOR FROM THE BOTTOM. **TRANSMITTER POWER MUST BE OFF.**

(a) Remove the Autotune covers from both assemblies.

(b) Manually rotate the drive shaft in a clockwise direction until all cam drums are set in motion. Continue to rotate the drive shaft until the stop ring drum on the multiturn unit has reached home stop and has ceased to turn. (A carpenter's brace and a length of $\frac{5}{16}$ inch rod may be used to advantage.)

(c) After the stop ring drum on the multiturn unit has ceased to rotate and only the cam drums are turning, pull the fork of the anvil (Fig. 34) in a counterclockwise direction away from under the tails of the pawls so that the tails are free to fall to the surface of the counter drum. If at any time the drive shaft should be turned counterclockwise, it will be necessary to turn the shaft again in the clockwise direction far enough to reach home stop before pulling the anvil out from under the tails of the pawls; otherwise, as soon as the line shaft is turned clockwise, the anvil will be rotated up under the tails of the pawls.

(d) Connect an ohmmeter or continuity checker from the common connection to the channel selector switch to contact No. 5. NOTE: The channel selector switch is wired so that contact No. 1, corresponding to channel number 1, is in line with the common con-

nection and the contacts are numbered in a counterclockwise direction. Thus, contact No. 5 would be on the left side of the switch just below the mounting bolt.

(e) Continue to rotate the drive shaft slowly until the No. 5 pawl on any Autotune unit just drops or channel selector switch just makes contact. NOTE: Count from the front of the Autotune unit toward the back, omitting the first or manual pawl. **The manual pawl on the multiturn unit does not engage the counter drum.**

(f) Note the position of the shaft and then slowly rotate the shaft, noting the points at which the No. 5 pawl on the other units drop and where the switch just makes contact. All of the pawls should drop into place within .275 revolution before or .275 revolution of the drive shaft after the switch just makes contact. All pawls should drop sharply with a "click."

(g) Repeat steps (d), (e), and (f) checking the operation in turn of channels 6, 7, 8, 9, 10, 11, manual 1, 2, 3, and 4.

If the Autotune units located on the R-F Unit are properly synchronized, but all three single turn units on the output network are out of synchronization, it may be possible to bring these units into synchronization by removing the short drive shaft that couples the two Autotune assemblies and manually operating the drive shafts until the pawls drop into position on the cam drums under the conditions stated in step (f). If it is impossible to synchronize the two Autotune assemblies in this manner, or if it is impossible to meet the conditions stated in step (f) with one or more of the Autotune heads, it will be necessary to make adjustments on the individual units.

6.1.4. Synchronizing the Autotune System. The complete alignment procedure is outlined below:

(a) Before attempting to synchronize the Autotune system a synchronizing check should be made as outlined in Section **6.1.3. Synchronization Check.** This will determine if there is a need for synchronizing.

(b) Align the channel selector switch with the emission selector and channel indicator switch.

(1) Operate the Autotune mechanism electrically several times to determine the position of the rotor contact with respect to the stator contact at the end of each Autotune cycle.

(2) Remove the R-F Unit from the transmitter and remove the bottom shield.

(3) Center the rotor contacts of the emission selector and channel indicator switch on a stator contact.

(4) Adjust the channel selector switch mounting plate until the rotor contact is in position noted in Step (b) (1). Keep in mind that when the emission selector and channel indicator switch is on contact number 5, the channel selector switch must also be on contact number 5, etc.

(5) Check this adjustment in all positions. The rotor contact of the emission selector and channel indicator switch does not have to be absolutely centered in each position, but should not be far off of center.

(6) When the channel selector switch is properly aligned securely, tighten the channel selector switch mounting plate locking screw.

IMPORTANT: AFTER THE CHANNEL SELECTOR SWITCH HAS BEEN ALIGNED WITH THE EMISSION SELECTOR AND CHANNEL INDICATOR SWITCH, DO NOT CHANGE THIS ADJUSTMENT FOR ANY REASON.

(7) Replace the bottom shield and install the R-F Unit in the transmitter.

All Autotune heads are factory assembled so that the cam drum adjustment set screws are accessible on channel number 5. The heads are uniformly assembled to castings so

that heads are approximately synchronized to each other. For this reason, synchronizing should ordinarily be done on channel number 5. All following instructions assume that synchronizing is being done on channel number 5, and must be modified if any other channel is being used.

Note that all rotation is specified as viewed from the front of the transmitter. **The drive shaft rotation is always clockwise as viewed from the bottom of the motor. TRANSMITTER POWER MUST BE OFF.**

(c) Repeat steps (b), (c) and (d) of Section 6.1.3. **Synchronizing Check.**

(d) Continue to rotate the drive shaft slowly until the number 5 pawl of the multiturn unit **just drops.** NOTE: Count the pawls from the front of the Autotune unit toward the back, omitting the first or manual pawl. **The manual pawl on the multiturn unit does not engage the counter drum.**

(e) Adjust the channel selector switch.

(1) Loosen the two set screws in the switch driving mechanism.

(2) Using a Phillips head screwdriver, rotate the switch in a counterclockwise direction until the switch **just makes** contact as indicated by the ohmmeter or continuity checker.

(3) Rotate the collar in a clockwise direction until all slack is taken up and carefully tighten the set screws.

(4) Check synchronism of channel selector switch and multiturn unit.

(5) The channel indicator dial may be made to read correctly by loosening the Phillips head screw at the center of the dial, rotate the dial until it reads correctly, and tighten the screw.

(f) Repeat steps (b), (c) and (d) of Section 6.1.3. **Synchronizing Check.**

(g) Continue to rotate shaft slowly until the channel selector switch **just makes** contact. At this point the cam drums on the singleturn units should be in a position so that the set screws in the ratchet drum, just to the rear of the cam drum, are accessible. In case one of the set screws is inaccessible, tighten the accessible set screw with a number 6 Bristo wrench and continue to turn the drive shaft clockwise until the set screws can be reached and loosened. After loosening the screw, it will be necessary to continue to turn the drive shaft in a clockwise direction until the channel selector switch **just makes** contact. When this point is reached the remaining set screws in the ratchet drums should be loosened. In case the above conditions cannot be met, it will be necessary to choose some other channel position that will allow these conditions. The cam drums in the singleturn units are now free to be turned with the fingers.

(h) Insert a 0.005 inch feeler gauge between the rear of the ratchet drum and spacer washer directly behind it.

(i) Rotate the ratchet drum in a clockwise direction and hold it tight against the internal driving mechanism. Use the set screw wrench to do this and at the same time keep the ratchet drum tight against the spacer shim.

(j) Rotate cam drum counterclockwise until pawl number 5 **just drops** into engagement with the cam drum. Tighten ratchet drum set screws and remove shim.

Synchronize each singleturn unit in order starting with the heads on the R-F Unit.

After synchronization procedure is completed, check the synchronism as outlined in Section 6.1.3. **Synchronizing Check.**

6.1.5. Limit Switch Adjustment. The limit switch is mounted on the multiturn unit. Refer to Fig. 35 p. 91. In order to secure proper operation of the Autotune mechanism the switch must be adjusted so that the two contacts that are connected in the control circuit are making contact when the mechanism is at rest. The contacts should open as soon as the motor starts.

The contact springs should be adjusted using an ordinary telephone relay spring bender.

To check the adjustment of the switch proceed as follows:

(a) Remove the Autotune cover plate from the R-F Unit.

(b) Unlock the stop rings on the multiturn unit by operating the locking bar in a counterclockwise direction.

(c) Manually rotate the Autotune drive shaft in a counterclockwise direction (as the motor is viewed from the bottom) until the counter dial on the multiturn unit indicates 10.

(d) Check the contacts of the limit switch. The contacts that are connected to the Autotune control system should be closed.

(e) If the contacts are not closed, rotate the drive shaft in a clockwise direction until the operating arm is not touching the switch contact spring.

(f) Bend the contact spring that is farthest from the switch operating arm until the space between the contacts is only about 1/32 of an inch.

(g) Rotate the drive shaft until the counter dial indicates 10 and check the switch contacts.

If the contacts still do not touch it will be necessary to bend both of the contact springs.

(h) Rotate the drive shaft in a clockwise direction until there is sufficient space between the switch operating arm and the contact spring to permit the bending of the spring that is operated by arm enough to obtain proper operation of the switch.

(i) Bend both contacts toward the switch operating arm, being sure that the contact break is approximately 1/32 of an inch after the adjustments have been made.

(j) Rotate the drive shaft until the counter dial indicates 10 and check the switch contacts.

Repeat the above procedure until the contacts are closed when the multiturn revolution counter indicates 10 but open immediately when the motor is started or the drive shaft is rotated manually in a clockwise direction.

6.1.6. Replacement of Parts. Since the Autotune mechanism is necessarily complicated, complete shop equipment is required if it becomes necessary to replace many of the parts. Only skilled and experienced personnel should be permitted to replace parts in the Autotune assemblies.

The Autotune parts list has been made up in such a manner that if it becomes necessary to order replacements, complete assemblies should be ordered rather than individual parts. It is deemed impractical to replace parts of assemblies such as the cam drums and therefore, only the part numbers of these assemblies have been included in the list.

REPLACEABLE AUTOTUNE PARTS

Item	Quan.	Description	Used With	Collins Part No.
1	1	Multiturn Autotune Unit		96K-2
2	1	Tuning Knob	1	NX-5524
3	1	Front Plate Assembly	1	GA-825A
4	1	Rear Plate Assembly	1	GA-826A
5	1	Stop Ring Shaft Assembly	1	GA-1522B
6	1	Cam Drum Shaft Assembly	1	GB-981B
7	1	Pawl Shaft Assembly	1	GA-977B
8	1	Counter Drum Shaft Assembly	1	GB-979B
9	1	Limit Switch Shaft Assembly	1	GA-1553B

REPLACEABLE AUTOTUNE PARTS (Cont.)

Item	Quan.	Description	Used With	Collins Part No.
10	1	Pawl Spring Bar Assembly	1	GA-842A
11	1	Limit Switch	1	GA-1557B
12	1	Second Idler Shaft Assembly	1	GA-837A
13	1	First Idler Shaft Assembly	1	GA-835A
14	2	Bearing Plate Spreader	1	X-5528
15	1	Locking Bar Stop	1	X-5620
16	1	Locking Bar	1	X-5525
17	1	Vernier Index Adj. Knob	1	X-6502
18	2	Limit Switch Standoffs	1	X-6483
19	1	Rev. Counter Dial	1	X-6443
20	4	Singleturn Autotune Units		96J-6
21	1	Singleturn Autotune Unit		96J-7
22	1	Front Plate Assembly	20, 21	GA-843A
23	1	Rear Plate Assembly	20, 21	GA-844A
24	1	Pawl Shaft Assembly	20, 21	GA-984B
25	1	Idler Gear Post Assembly	20, 21	GA-851A
26	1	Pawl Spring Bar Assembly	20, 21	GA-852A
27	1	Tension Spring	20, 21	NX-6053
28	1	Locking Bar Stop	20, 21	NX-5620
29	1	Stop Ring Shaft Assembly	20	GE-983B
30	1	Stop Ring Shaft Assembly	21	GF-983B
31	1	Cam Drum Shaft Assembly	20, 21	GC-986B
32	3	Tuning Knobs (EXCITER TUNING, POWER AMP. TUNING AND ANTENNA TUNING)	20	NX-5586
33	1	Tuning Knob (EXCITER BAND SWITCH)	20	GA-1536B
34	1	Tuning Knob (POWER AMP. BAND SWITCH)	21	GA-1537B
35	1	Line Shaft Assembly (Part of Output Network Autotune Assembly)	20, 21	GA-1209C
36	1	Line Shaft Assembly (Part of R-F Unit Autotune Assembly)	1, 20, 37	GA-1211C
37	1	Channel Indicator Assembly	1, 20, 36	GA-1144C
38	1	Channel Indicator Shaft Assembly	37	GA-2114A
39	1	Rear Plate & Standoff Assembly	37	GA-2119A
40	1	Front Plate Assembly	37	GA-2116A
41	1	Adjusting Plate	37	X-6441
42	1	Index Plate	37	X-6485
43	1	Channel Indicator Dial	37	X-6486
44	1	Shaft Spacer	37	GA-2101A
45	1	Worm Gear	37	X-6431
46	1	Collar	37	X-6435
47	1	Drive Dog	37	X-6437
48	1	Drive Dog	37	X-6436
49	1	Spacer	37	X-6440

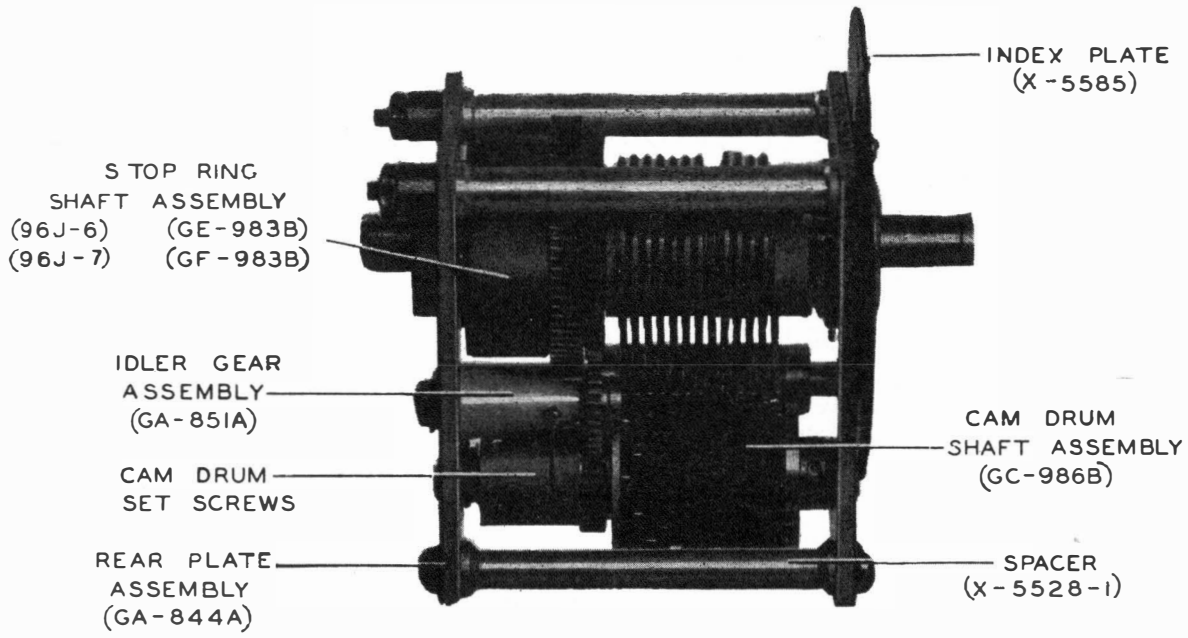


Fig. 32 Autotune Singleturn Unit

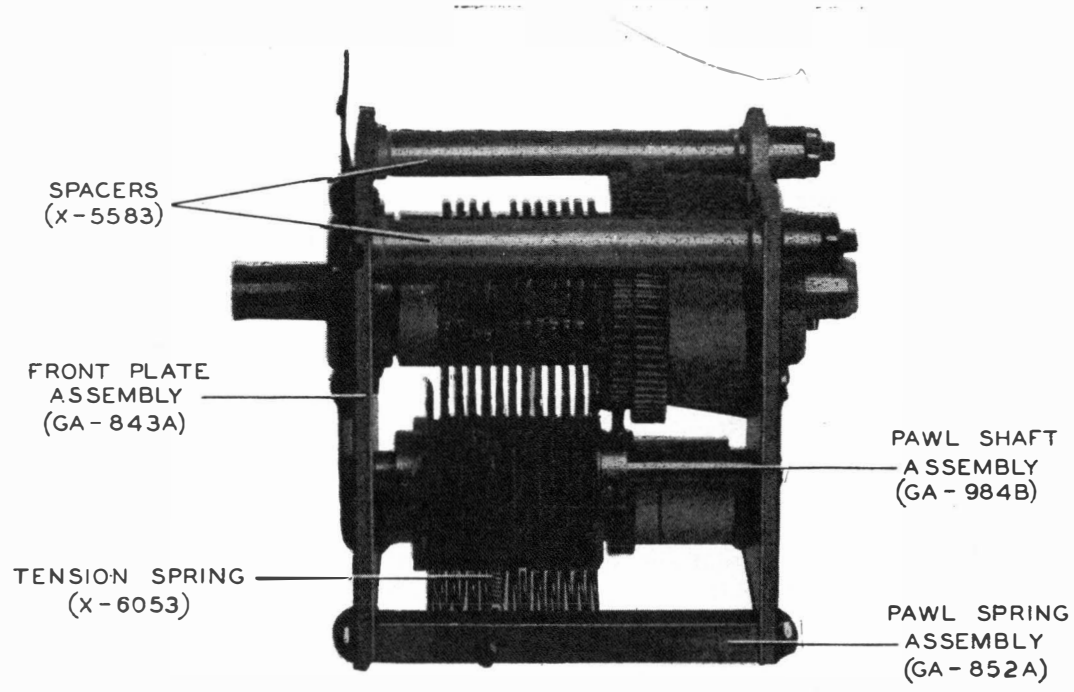


Fig. 33 Autotune Singleturn Unit

REPLACEABLE AUTOTUNE PARTS (Cont.)

Item	Quan.	Description	Used With	Collins Part No.
50	1	Dust Seal	37	X-5534
51	1	Selector Switch	37	269N37
52	1	Grommet		201N203
53	2	Oilite Bearing		309N558
54	1	Bearing Retainer Cap		X-6459
55	1	Bearing Retainer Cap		X-6461
56	2	Gear Box Cover Plate		X-6467
57	14	Oilite Bearing		NX-6468
58	1	Universal Coupler		X-6484
59	1	Coupler Spring		GA-2098A
60	1	Autotune Cover (Part of Output Network Autotune Assembly)		GA-518D
61	1	Autotune Cover (Part of R-F Unit Autotune Assembly)		GA-516D
62		Groov-pin-1/16" x 13/32"		311NA801T
63		Groov-pin-1/16" x 5/16"		311NA852T
64		Groov-pin-3/32" x ½"		311NA143T
65		Groov-pin-3/32" x ⅝"		311NA144T
66		Locking Bar		GA-2524A

The above Autotune parts are contained in two assemblies, one on the R-F Unit and the other on the Output Network Unit. The R-F Unit Assembly contains two singleturn units and a multiturn unit. The Output Network Assembly contains three singleturn units. The singleturn and multiturn units may be removed from the Autotune castings as complete units.

1. Autotune Assembly Dismantling.

(a) Removing the Singleturn Units.

(1) Remove the cover plates from both Autotune assemblies.

IMPORTANT: BE SURE TO CAREFULLY MARK THE SINGLETURN UNIT THAT IS REMOVED FROM THE POWER AMP. BAND SWITCH. THIS SINGLETURN UNIT IS A TYPE 96J-7 AND ALL OF THE OTHER SINGLETURN UNITS THAT ARE USED IN THE EQUIPMENT ARE TYPE 96J-6.

(2) Turn dial locking bar to unlocked position and loosen the two #10 Bristo set screws on the dial.

(3) Turn dial and locking bar in a counterclockwise direction until bar comes free. Remove both dial and locking bar.

(4) Loosen the two long screws on the top of the unit and the short screw on the bottom of the rear plate and lift the unit out.

(b) Removing the Multiturn Unit.

(1) Turn the dial locking bar to the unlocked position and loosen the two #10 Bristo set screws that hold the dial on the stop ring shaft.

(2) Turn the dial and locking bar in a counterclockwise direction until the bar comes free. Remove both dial and locking bar.

(3) Loosen the set screw on the coupler nearest the Autotune casting.

(4) Remove the two mounting screws along the upper edge of the back plate of the multiturn unit; also re-

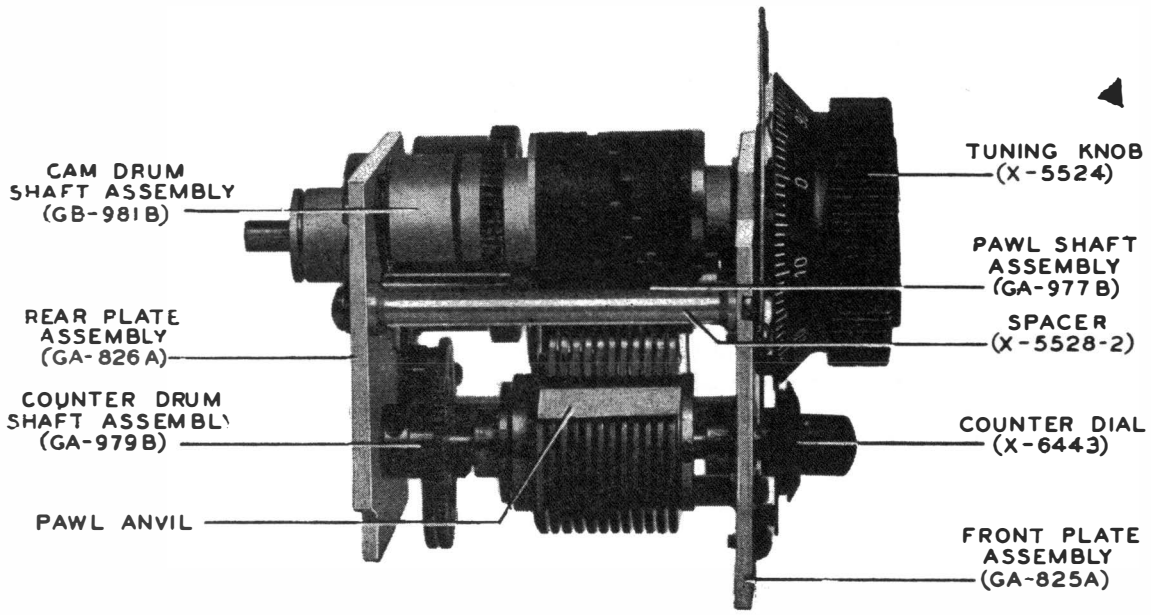


Fig. 34 Autotune Multiturn Unit

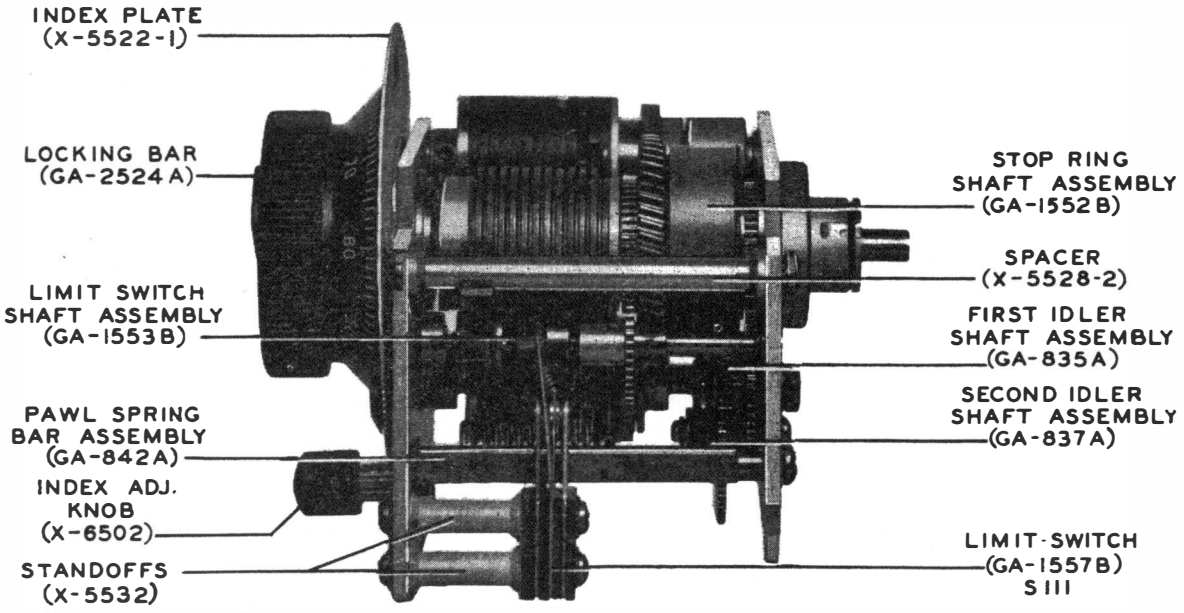


Fig. 35 Autotune Multiturn Unit

move the single screw along the lower edge.

(5) Remove the two screws which hold the limit switch and carefully pull the switch away from the assembly.

(6) Carefully pull the assembly out of the casting, being very careful not to turn the tuning slug on the lead-screw.

(7) Recalibrate the oscillator. Refer to 6.11. **MASTER OSCILLATOR CALIBRATION.**

(c) Removing the Line Shaft.

The general procedure for the removal of the line shafts in the two assemblies is very much the same. The only difference in the procedure being that when removing the line shaft from the output network assembly there are three singleturn units to remove and when removing the shaft from the r-f unit Autotune assembly there are two singleturn and one multiturn units to remove.

The general procedure is as follows:

(1) Remove the Autotune units from the assembly.

(2) Remove the groov-pins from the worm gears.

CAUTION: Be very careful not to spring the line shaft when driving out the groov-pins. Support the shaft adjacent to the gears when removing or replacing the groov-pins. Keep the pins and gears separate and in order so that each may be replaced in the same position on the shaft from which it was removed.

(3) Remove the retainer plate from the left-hand end of the casting.

(4) Slowly work the shaft and bearing assembly out of the casting. Remove each worm as the worm nears the end of the shaft. Place each worm with the proper groov-pin and be sure that each combination is properly identified so as to be replaced in the original position. These worms are not interchangeable.

2. Parts Replacement.

(a) Replacing a Singleturn Worm.

The replacement singleturn worm is furnished undrilled. The following procedure is recommended for replacing a singleturn worm:

(1) Center-punch the hub of the worm in the spot corresponding to the center of the larger hole on the old worm.

(2) Using a $\frac{1}{16}$" drill, drill through one side of the worm sleeve.

(3) Slide the worm on the shaft with the hub end toward the thrust bearings assembly. Match the hole on the worm hub with the hole in the line shaft to which the old worm was pinned. CAUTION: **Do not get the wrong line shaft hole or the smaller end of the correct hole.**

(4) Drill through the shaft to the other side of the worm hub with the $\frac{1}{16}$" drill.

(5) Drive a new $\frac{1}{16}$" groov-pin into the hole to be sure the new worm will pin properly. Reassemble the line shaft in the reverse order from the foregoing disassembling procedure described under (c).

(b) Replacing a Line Shaft Bearing.

The oilite type line shaft bearings are held in place by means of a press fit. A thin steel sleeve fits over these bearings. After removing the line shaft the defective bearing should be driven out gently, using a mallet and a rod or blunt end punch. The new bearing should then be gently driven into place using the shaft as a pilot. Be careful not to deform the bearing.

(c) Replacing the Main Line Shaft Thrust Bearing.

In replacing this bearing, it will not be necessary to remove the entire line shaft assembly. The following procedure is recommended:

(1) Remove the four screws from the bearing retainer plate on the left end of the casting.

NOTE: If the thrust bearing that is associated with the R-F Unit is being replaced it will be necessary to drive the groov-pin out of the multiturn worm.

(2) Work the shaft and bearing out about ¾ inch from the end of the casting.

(3) Carefully block up the outside bearing collar and drive out the groov-pin from the inside bearing collar. CAUTION: Be careful not to spring the line shaft when driving the pin out.

(4) Remove the bearing and collars, marking the exposed side of the inside collar so that the collar will not be reversed when replaced on the shaft.

(5) Replace the inside collar on the shaft, slide the new bearing onto the shaft and slide the outside collar through the bearing and into the inside collar.

(6) After making sure that the hole on the inside collar and the hole in the outside collar are aligned with the larger end of the line shaft hole, insert the groov-pin and gently drive the pin home. CAUTION: Be sure the outside collar is blocked up properly so that line shaft will not be sprung.

(7) Slide the shaft back to the original position and replace the bearing plate.

(d) Replacing the Line Shaft.

The task of installing a new line shaft is difficult and lengthy and should only be attempted by an experienced mechanic who has adequate tools available.

The following procedure is recommended for replacing the main line shaft:

(1) Remove the line shaft as previously described.

(2) Reassemble the worms on the shaft and drive the groov-pins in lightly.

(3) Carefully measure the distance from the milled end of the shaft to one end of each worm and the thrust bearing.

(4) Completely disassemble the line shaft.

(5) Centerpunch each worm at a point which is at a right angle to the previously used groov-pin hole and the same distance from the end.

(6) Drill each gear through on one side only.

(7) Put one of the worm on the shaft, in the predetermined position, block the shaft well and, using a 1/16" drill, drill through the new hole in the gear into the line shaft and through the other side of the gear.

(8) Mark the new hole on the sleeve of the gear.

(9) Repeat the steps (7) and (8) for the remaining worms.

(10) Assemble the bearing and slide bearing assembly onto the end of the shaft.

(11) Clamp the bearing, block the shaft and drill through the two sleeves and the shaft at a point at right angles to the old hole. Use a 1/16" drill.

(12) Mark the new hole on both sleeves.

(13) Using new groov-pins assemble the line shaft while still removed from the casting. Check to be sure there is no play in any of the gears after lightly driving the pins through the holes.

Note: Be careful not to use the old holes in the worms.

(14) Assemble the shaft in the casting as previously described. Note: **Be sure to place the gears in the proper order on the shaft.**

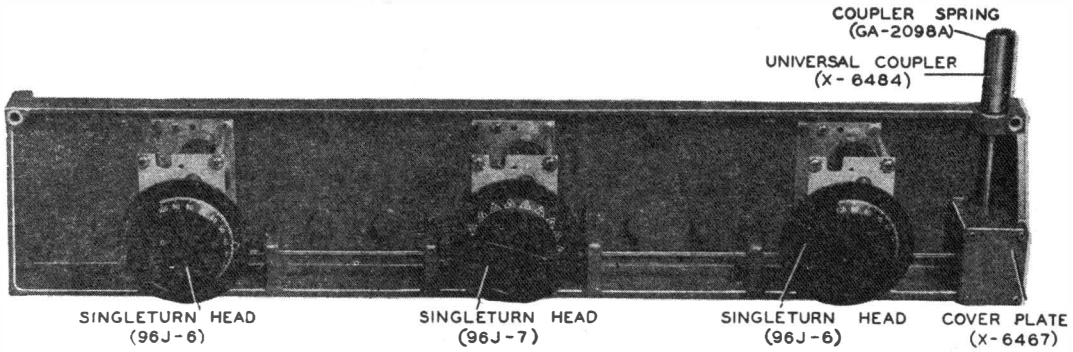


Fig. 36 Output Network Autotune Assembly (Complete)

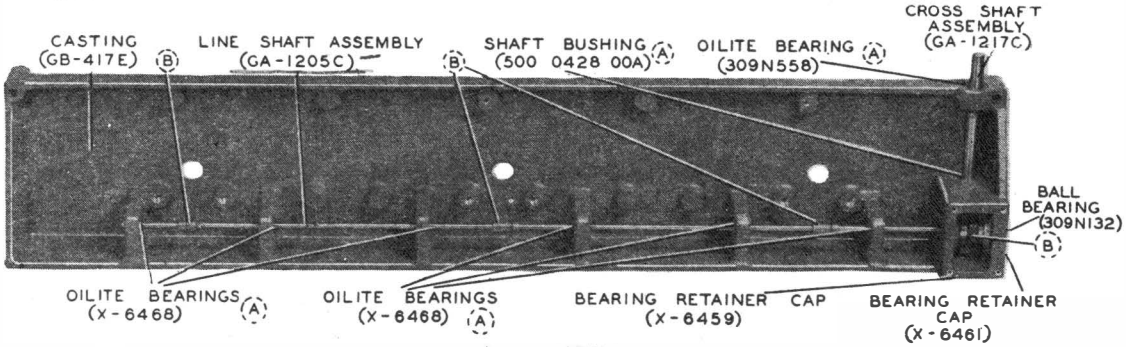


Fig. 37 Output Network Autotune Assembly (Heads Removed)

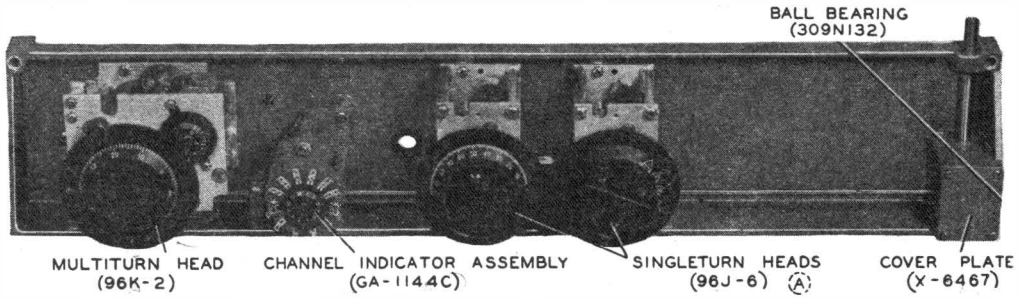


Fig. 38 R-F Unit Autotune Assembly (Complete)

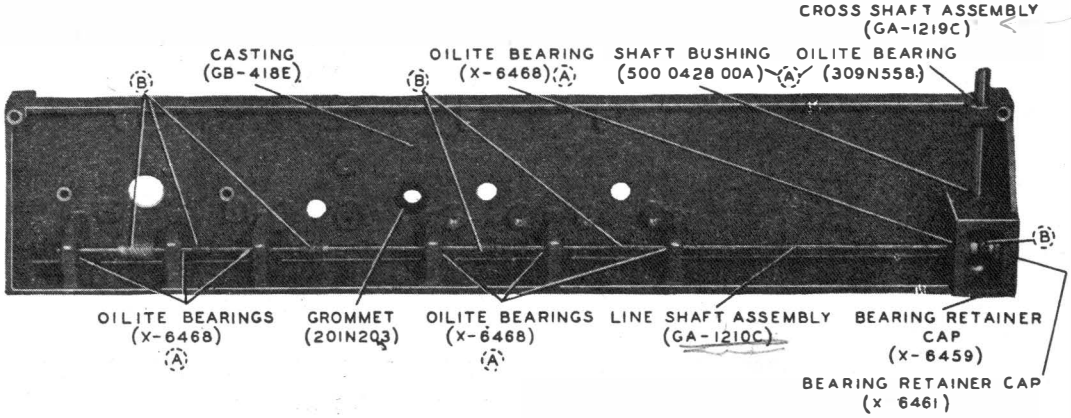


Fig. 39 R-F Unit Autotune Assembly (Heads Removed)

6.2. **RELAY MAINTENANCE.** Dependable operation of this equipment requires proper operation of all relays. Although each relay used has been chosen because of satisfactory performance in similar service, some of these relays have rather critical adjustments and should not be tampered with.

6.2.1. **Telephone Relays.** In case of failure of the telephone type relays, it is recommended that the entire relay be replaced. However, adjustment instructions will be found in the Appendix and may be used when necessary. The only maintenance recommended is the periodic use of a burnishing tool to clean the contact surfaces.

6.2.2. **A-C Contactors.** In general, the contact adjustment of the a-c type of power relay is not critical. Contact assemblies and coils may be replaced in case of failure. Never use sandpaper or emery cloth on the contact surfaces. Relays which have excessive hum are usually not seating properly. Dirt on the pole faces is most likely the cause of this, and can be remedied by washing with carbon tetrachloride.

6.2.3. **Overload Relay Adjustment.** The overload relay has been adjusted at the factory and should require no further adjustments. However, if the relay does not turn off all plate voltage when the PLATE CURRENT meter indicates 450 ma or the relay operates to turn off the plate voltage when operating with MCW emission, some adjustment will be necessary.

If either of the above conditions exists the procedure outlined below should be followed in adjusting the overload relay:

(a) Refer to Fig. 23 for the location of the overload relay K101.

(b) Turn the transmitter on, select CW emission and determine the PLATE CURRENT reading at which the relay operates.

(c) Press the PLATE stop button and remove the rear panel from the transmitter cabinet.

(d) If more than 450 ma of PLATE CURRENT must flow before the relay will operate, rotate the adjusting cap on the relay in a clockwise direction (as relay is viewed from top). If the relay operates when MCW emission is used or with 100% modulation of the r-f carrier and VOICE emission, the relay adjusting cap should be rotated in a counterclockwise direction (as relay is viewed from top).

(e) Replace the transmitter cabinet rear panel, turn the transmitter on and check the operation of the relay as outlined under Step (b).

(f) Repeat Steps (d) and (e) until the relay operates when the meter indicates PLATE CURRENT near 450 ma. (Relay operation with current readings within 50 ma either side of the above figure will be satisfactory.)

6.3. **FUSES.** The equipment is supplied with fuses of the correct rating in each position. Fuses which have failed should be replaced with spares only after the circuit in question has been carefully examined to make certain that no permanent fault exists. Always replace a fuse with one having exactly the same rating. Do not replace a quick-acting fuse with one of the slo-blo type.

6.4. **VENTILATING BLOWER.** The motor of the ventilating blower has bearings which require lubrication about every six months. Use only Vactra Extra Heavy X oil or equal.

The spun glass filter elements at the rear of the transmitter cabinet will give more satisfactory life if the elements are cleaned about once every two weeks. A small vacuum cleaner is a satisfactory means of removing surface dirt. The elements should be replaced whenever spun glass appears to be appreciably clogged by dust and grease. Filters may be removed entirely in localities free of dust.

6.5. **RELAY VOLTAGE ADJUSTMENT.** When the equipment has operated about 10,000 hours it may be necessary to make some adjustment of the relay supply voltage.

Increase the voltage that is applied to the selenium rectifier by changing the tap on transformer T114 from tap 8 to tap 9.

6.6. **CLEANING.** The greatest enemy to uninterrupted service in equipment of this type is corrosion and dirt. Corrosion is accelerated by the presence of dust and moisture on the component parts in the assembly. It is impossible to keep moisture out of the equipment in certain localities, but foreign particles and dust can be periodically removed by means of a soft brush and a dry oil-free jet of air. Although the cabinet is equipped with a spun glass dust filter which will remove most of the dust particles, there is always a slight accumulation of dust in the vicinity of circuits at a high potential above ground. Remove the dust by the above method as often as a perceptible quantity accumulates at any place in the equipment. It is very important that rotating equipment such as the variable capacitors, tap switches, etc., be kept free from dust to prevent undue wear. Likewise, variable capacitor plates should be kept free from dirt to avoid flashovers on modulation peaks.

6.7. **ROUTINE CHECKS.** Routine inspection schedules should be set up for periodic checks of terminals and fastenings as well as examination of the equipment for broken insulators, parts, etc. This inspection should include examination of the mechanical system for excessive wear and of the electrical system for excessive heating of parts. A check on the emission of all vacuum tubes should be made at least every 1000 hours of service. After the emission check, examine the prongs on all tubes to make sure that all are free from corrosion. When the tubes are replaced in the proper sockets. a thorough check should be made to determine that good electrical contact is made between the tube prong and socket. Check all relays for proper operation and inspect relay contacts to make certain that the contact surfaces are clean and free of pits and projections. Make certain that the contacts of all receptacles and plugs on individual units are clean and that these make firm mechanical connections between one another. Set screws on tap switch drives and all dogs associated with the Autotune driving mechanism should be checked and tightened when necessary.

6.8. **TEST CABLES.** A pair of test cables has been supplied with the equipment. The cables are equipped with the same type of plugs and plug receptacles as are used in the transmitter. The cables are furnished to aid in the servicing of the R-F, Speech Amplifier and Autotune Control Units.

WARNING: EXTREME CARE SHOULD BE EXERCISED WHEN OPERATING UNITS ON THE TEST BENCH. THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE. WITH THE L.V.-TUNE-OP. SWITCH IN THE L.V. POSITION, THE APPLYING OF PLATE VOLTAGE WILL CAUSE A POTENTIAL OF 500 VOLTS TO EXIST BETWEEN NUMEROUS POINTS IN THE UNITS AND THE CHASSIS.

When servicing any one of the above units, remove the unit from the cabinet, place on the work bench, insert the male cable plug into the plug receptacle in the transmitter cabinet and insert the female cable plug into the receptacle on the unit. **NOTE: Be sure to insert the cable connectors with the side of the connector marked TOP facing upward.** Before applying voltage, check the connectors on both ends of the cables to make certain that each cable is connected between the proper connector on the unit and the proper connector in the cabinet.

WARNING: DO NOT ATTEMPT TO TEST OR OPERATE THE TRANSMITTER WITH THE OUTPUT NETWORK ON THE TEST BENCH. ONLY THE EXCITER STAGES OF THE R-F UNIT WILL OPERATE NORMALLY WHEN THE R-F UNIT IS OPERATED ON THE TEST BENCH.

6.9. **LOCATION OF FAULTS.** The most frequent cause of trouble in transmitting equip-

ment is tube failure. If a fault occurs in the equipment, each tube should be checked immediately and those found lacking emission replaced with a similar tube from stock. Isolation of the circuit at fault is often helpful in determining the position of the faulty tube.

A check of all fuses should be made immediately if the equipment is inoperative. In case an open fuse is found, it is an indication of an overload in some circuit of the equipment. The overload may be caused by a faulty part, a short circuit due to a foreign particle or a bad electrical connection. Occasionally a high voltage arc may be the cause of fuse failure in an associated circuit. If there is a reason to believe that an arc has occurred, all capacitor plates, tap switches, etc., associated with the circuit should be thoroughly cleaned before placing the equipment back in service. Short circuited components may be readily found by means of an ohmmeter or continuity checker. The d-c resistance of the various circuits may be checked in order to locate the fault.

Defective tubes causing an overload in power circuits may usually be located by inspection. It will be found that excessive heating or sputtering within vacuum tubes is a good indication of fault in the tube circuit. Arc-overs in the high voltage circuit may be caused by bent capacitor plates, corrosion or dust.

It is well known that one of the greatest sources of trouble in equipment located in a salt atmosphere is corrosion. Corrosion resulting from salt spray or salt laden atmosphere may cause failure of the equipment for no apparent reason. In general, it will be found that contacts such as the tap switches, tube prongs, cable plug connectors, and telephone type relay contacts are most affected by corrosion. When it is necessary to operate the equipment in localities subject to such corrosive atmosphere, inspection of wiping contacts, cable plugs, relays, etc., should be made more frequently in order to keep the equipment in good condition.

It is good policy when making checks for faults in equipment to refer to the original test data sheets in order to isolate the source of the difficulty. If the section of the equipment in which the fault occurs can be isolated, the trouble may be located with a minimum of effort. Continuity checks and voltage measurements in circuits still operative will be helpful in isolating the trouble. For this purpose an a-c, d-c voltmeter having an internal resistance of not less than 1000 ohms per volt and equipped with a battery for continuity and resistance measurements is necessary. A portable oscilloscope is very useful in running down faults in the radio frequency section of the equipment.

6.10. TYPICAL VOLTAGES. The following table of Typical Operating Voltages and Currents has been compiled to aid in locating the cause of transmitter failure or erratic operation:

WARNING: OPERATING PERSONNEL SHOULD NOT ATTEMPT TO MEASURE POTENTIALS IN EXCESS OF 250 VOLTS WITHIN THE EQUIPMENT DUE TO HAZARDS TO LIFE.

TYPICAL VOLTAGES AND CURRENTS

Tube	Pin	Key Open	Key Closed
MASTER OSCILLATOR (V101) 6A8			
Filament Voltage	2–7	6.4	6.4
Cathode Voltage	8	0.25	0.6
Grid (G_1) Voltage	5	—6.6	0
Grid (G_2) (Anode) Voltage	6	150.0	150.0
Grid (G_3) & (G_5) Voltage	4	90.0	50.0
Grid (G_4) Voltage	C	0.2	0.6
Plate Voltage	3	270.0	260.0
R.F. AMPLIFIER (V102) 6AG7			
Filament Voltage	2–7	6.4	6.4
Cathode Voltage	5	5.2	4.6
Screen Voltage	6	200.0	155.0
Grid (G_1) Voltage	4	0	0.1
Grid (G_1) Current (M.A.)	4	0	0
Plate Voltage	8	353.0	350.0
FREQUENCY MULTIPLIER (V103) 807			
Filament Voltage	1–5	6.4	6.4
Cathode Voltage	4	0	74.0
Screen Voltage	2	340.0	195.0
Grid Voltage	3	–105.0	–112.0
Grid Current (M.A.)		0	0
Plate Voltage	3	560.0	540.0
INTERMEDIATE AMPLIFIER (V104) 807			
Filament Voltage	1–5	6.4	6.4
Cathode Voltage	2	0	18.2
Screen Voltage	4	360.0	185.0
Grid Voltage	3	–107.0	–157.0
Grid Current (M.A.)		0	3.3
Plate Voltage	3	560.0	540.0
POWER AMPLIFIER (V105-106) 2-813's			
Filament Voltage		10.0	10.0
Screen Voltage		560.0	340.0
Grid Voltage (C.W.)		–105.0	–175.0
Grid Current (C.W.) (M.A.)		0	25.0
Plate Voltage (C.W.)		2000.0	2000.0
Plate Current (C.W.) (M.A.)		0	360.0
Plate Voltage (Phone)		1550.0	1450.0
Plate Current (Phone) (M.A.)		0	265.0
KEYER (V107) 6SJ7			
Filament Voltage	2–7	6.4	6.4
Cathode Voltage	5	–25.5	–28.5
Screen Voltage	6	0	0
Grid (G_1) Voltage	4	–25.5	–44.0
Grid (G_3) Voltage	3	–25.5	–28.5
Plate Voltage	8	–7.8	0

TYPICAL VOLTAGES AND CURRENTS (Cont.)

Tube	Pin	Operating	
CFI OSCILLATOR (V109) 6A8			
Filament Voltage	2–7	6.4	
Cathode Voltage	8	0	
Grid (G_1) Voltage	5	–17.5	
Grid (G_2) Voltage	6	210.0	
Grid (G_3) & (G_5) Voltage	4	125.0	
Grid (G_4) Voltage	C	–11.5	
Plate Voltage	3	210.0	
CFI CONVERTER (V110) 6SL7GT			
Filament Voltage	7–8	6.4	
Cathode Voltage	3	0	
Grid Voltage	1	–9.2	
Plate Voltage	2	52.0	
Cathode Voltage	6	0	
Grid Voltage	4	–13.0	
Plate Voltage	5	165.0	
CFI AMPLIFIER (V111) 6SN7GT			
Filament Voltage	7–8	6.4	
Cathode Voltage	3	9.2	
Grid Voltage	1	0	
Plate Voltage	2	275.0	
Cathode Voltage	6	3.6	
Grid Voltage	4	0	
Plate Voltage	5	130.0	
MCW OSC. (V112) 6SN7GT		Not Osc.	In Osc.
Filament Voltage	6–7	6.4	6.4
Cathode Voltage	3	12.0	12.3
Cathode Voltage	6	8.0	7.0
Grid Voltage (S112 in Pos. 7)	4	–16.0	0
Grid Voltage	1	0	0
Plate Voltage	5	187.0	207.0
Plate Voltage	2	320.0	320.0
PREAMPLIFIER (V113) 6SL7GT		100% Mod.	No Mod.
Filament Voltage	7–8	6.4	6.4
Cathode Voltage	3–6	1.7	1.7
Grid Voltage	1	0	0
Plate Voltage	2	158.0	160.0
Grid Voltage	4	0	0
Plate Voltage	5	156.0	157.0

TYPICAL VOLTAGES AND CURRENTS (Cont.)

Tube		Pin	100% Mod.	No Mod.
VOLUME LIMITER (V114) 6C8G				
Plate Voltage	Max. Limiting	6	116.0	128.0
Filament Voltage	Max. Limiting	2–7	6.4	6.4
Cathode Voltage		8–4	0	0
Grid Voltage	Min. Limiting	5–C	–26.0	–21.0
Plate Voltage	Min. Limiting	6	127.0	127.0
Grid Voltage	Max. Limiting	5–C	–2.4	–21.0
Plate Voltage	Max. Limiting	3	112.0	130.0
Plate Voltage	Min. Limiting	3	130.0	130.0
SQUELCH (V115) 6C8G				
Filament Voltage		2–7	6.4	6.4
Cathode Voltage		8–4	–32.0	–29.0
Grid Voltage		5–C	–43.0	–45.0
Plate Voltage		6	115.0	125.0
Plate Voltage		3	118.0	130.0
AUDIO AMPLIFIER (V116) 6SJ7				
Filament Voltage		2–7	6.4	6.4
Cathode Voltage		5	9.5	9.5
Grid Voltage		4	0	0
Plate Voltage		8	295.0	295.0
LIMITER CONTROL (V117) 6X5GT				
Filament Voltage		2–7	6.4	6.4
Cathode Voltage		8	–2.5	–20.7
Plate Voltage		3–5	–31.0	–29.0
DRIVERS (V118-119) 2A3's				
Filament Voltage		1–4	2.5	2.5
Grid Voltage 10 db in comp.		3	0	0
Plate Voltage 10 db in comp.		2	345.0	345.0
MODULATORS (V120-121) 2-805's				
Filament Voltage			10.0	10.0
Grid Voltage			–22.1	–17.5
Plate Voltage			1450.0	1550.0
Plate Current (M.A.)			220.0	80.0
H.V. RECTIFIERS (V122-123) 2-249C's			Operating	
Filament Voltage			2.5	
Plate Voltage			2000.0	
BIAS RECTIFIER (V124) 5U4G				
Filament Voltage			5.0	
Plate Voltage			120.0	
L. V. RECTIFIERS (V125-126) 2-866A's				
Filament Voltage			2.5	
Plate Voltage			510.0	

TYPICAL VOLTAGES AND CURRENTS (Cont.)

Tube	Pin	No Signal Key open
AUDIO AMPLIFIER (V301) 6SJ7		
Filament Voltage	2–7	6.4
Cathode Voltage	5	2.8
Screen Voltage	6	63.0
Grid (G_1) Voltage	4	0
Grid (G_2) Voltage	3	2.8
Plate Voltage	8	74.0
AUDIO AMPLIFIER (V302) 6SN7GT		
Filament Voltage	7–8	6.4
Cathode Voltage	3	–29.0
Grid Voltage	1	–29.0
Plate Voltage	2	65.0
Cathode Voltage	6	–25.0
Grid Voltage	4	0
Plate Voltage	5	105.0
RECTIFIER (V303) 6X5GT		
Filament Voltage	2–7	6.4
Cathode Voltage	8	130.0
Plate Voltage (Plate to plate)	3–5	280.0

Notes: 1. All voltages except filament voltages measured between tube terminals and chassis with a vacuum tube voltmeter.

2. Voltages shown as plate voltages of bias, low voltage and high voltage rectifiers are actually output voltages of the supplies.

3. Above measurements made with transmitter operating with r-f output on 3000 Kc.

4. The source voltage was 230 volts when the above measurements were taken.

6.11. MASTER OSCILLATOR CALIBRATION. The master oscillator will require calibrating if the multiturn unit has been removed or because of aging of circuit components. The calibration procedure is outlined below.

(a) Remove the R-F Unit from the cabinet and place the unit on either edge on a table or bench near the transmitter.

(b) Using the test cables, connect the unit to the plugs in the cabinet.

(c) Adjust the indicator mark to the mid point of the scale.

(d) Rotate the dial to exactly 20.0.

(e) Loosen the set screw that holds the coupler to the multiturn shaft.

(f) Operate the power level switch to the L.V. position, turn the transmitter on and close the TEST key.

(g) With the dial set to exactly the reading obtained from the Calibration Table and while listening to the output of the CFI Unit, reach beneath the chassis and rotate the lead screw until zero beat is obtained between the output of the oscillator and the output of the calibration oscillator. Be very careful when rotating the tuning slug lead screw so that the multiturn shaft is not moved.

(h) Carefully tighten the coupler set screw and check the calibration at other points in the band.

6.12. R-F EXCITER CIRCUIT ALIGNMENT. The exciter circuits have been carefully aligned at the factory and should require no further adjustment unless the equipment has been subject to extremely rough handling or it has been necessary to replace components within the frequency multiplier or intermediate amplifier circuits. Satisfactory alignment is indicated when the GRID CURRENT meter indicates power amplifier grid current of not less than 15 ma over the entire frequency range of the transmitter. If the grid drive is lower than the above value, do not attempt any adjustment of the trimmers until all other probable causes of low excitation have been carefully checked. Only realign the exciter circuits as a last resort. Before adjusting any of the inductance or capacitance trimmers in the tank circuits of the frequency multiplier and intermediate amplifier tubes, measure the voltage on each element of each tube in the exciter and compare the voltages with those given in the table of Typical Operating Voltages. Check each tube by replacing with a tube known to be in good condition. Turn the transmitter on after each replacement and check the power amplifier grid current. If all voltages appear to be normal and all exciter tubes are in good condition, it will be necessary to realign the exciter tank circuits to bring the excitation up to normal (20 ma.).

6.12.1. General. The alignment of the exciter circuits is accomplished by adjusting tuning slugs within the frequency multiplier and intermediate amplifier plate tank inductors and the adjustment of a trimmer capacitor that is connected across the frequency multiplier plate tank tuning capacitor.

The inductance of the plate tank inductors is determined by the position of the tuning slug within the inductor. The slugs are connected to Phillips head screws so that the inductance of all of the inductors and the capacity of the trimmer capacitor may be varied with a screwdriver from the top of the R-F Unit Chassis. To adjust the capacity trimmer use a ¼" spin tight wrench.

Refer to Figs. 40 and 41. Listed below are the exciter tank inductors and the location of each (R-F Unit viewed from top and front):

Item No.	Location
L111	Right Rear
L112	Left Rear
L115	Left Front
L116	Right Front
L117	Left Center
L118	Right Center

The trimmer capacitor, C126, is located between inductors L111 and L118.

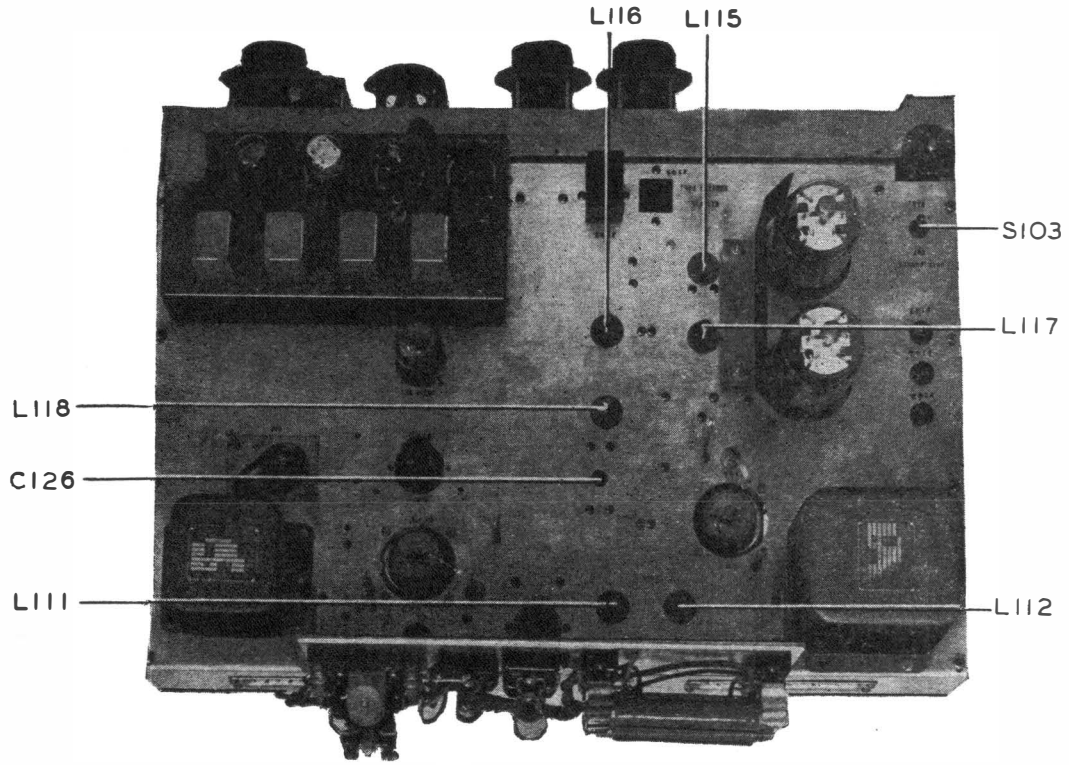


Fig. 40 Radio Frequency Unit (Top)

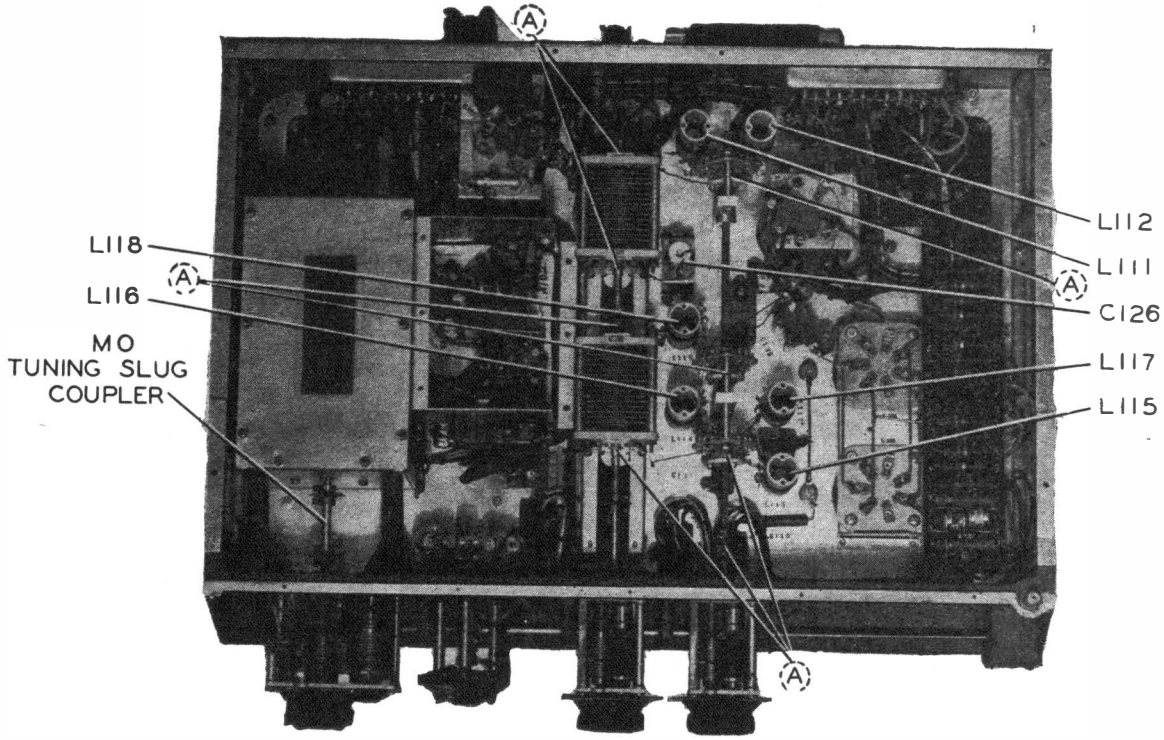


Fig. 41 Radio Frequency Unit (Bottom)

The proper exciter plate tank inductors for a particular frequency range are selected by the operation of the EXCITER BAND SWITCH. Inductors not in use are shorted out by switches S104 and S105 and S106.

The following table shows the BAND SWITCH positions and the inductors used for each frequency range:

EXCITER BAND SWITCH Position	Frequency Range (Mc)	Inductors Used
4	2.0 to 3.0	L111 & L115
3	3.0 to 6.0	L112 & L116
2	6.0 to 9.0	L111 & L117
1	9.0 to 18.1	L112 & L118

6.12.2. Details. The alignment procedure must be followed in detail and it is recommended that only experienced and skilled personnel attempt the alignment of the exciter circuits. **Note:** It has been found advantageous to make up a tuning wand if a number of exciters are to be aligned. The wand may be made from an insulated sleeve 7/16" in diameter, a copper slug and a powdered iron slug. Glue one slug in each end of sleeve.

With the carrier on, insert first one and then the other end of the tuning wand into the coil. If it requires the iron core to track the circuit, the slug associated with the equipment should be drawn out of the coil. If the copper slug is required, the slug associated with the equipment should be inserted farther into the coil.

CAUTION: DO NOT TOUCH ANY EXPOSED WIRING OR TUBE CONNECTIONS. MANY OF THE WIRES AND PLATE VOLTAGE LEADS ARE AT A POTENTIAL OF 500 VOLTS ABOVE GROUND. THE 500 VOLT SUPPLY ASSOCIATED WITH THIS EQUIPMENT HAS SUFFICIENT POWER CAPABILITIES TO BE DANGEROUS TO LIFE. EVEN A MOMENTARY CONTACT WITH THIS SUPPLY WILL BURN DEEP INTO THE FLESH. DO NOT ATTEMPT TO MAKE THE ALIGNMENT ADJUSTMENTS WHILE ALONE.

(The bottom shield cover may be removed for this adjustment.) The exciter alignment procedure is outlined below:

(a) Operate the power level switch to the L.V. position and the LOCAL-REMOTE switch to the LOCAL position.

(b) With the transmitter power switch in the OFF position, set trimmer capacitor, C126, at approximately 25% capacity.

(c) Operate the transmitter power switch to the ON position.

(d) Operate the EXCITER BAND SWITCH to Position 1.

(e) Rotate the EXCITER TUNING Control until the dial indicates 95.

(f) Refer to the Calibration Book and obtain the correct dial setting for an output frequency of 18 mc. (The Calibration Data is for the Serial No. transmitter indicated on the Calibration Book only.)

(g) Rotate the OSCILLATOR TUNING Control until the dial is set to the reading obtained under step (f).

(h) When the time delay and bias interlock relays have operated, press the PLATE start switch, operate the TEST KEY to the locking position.

(i) Operate the GRID CURRENT switch to the 807 position.

(j) Adjust the trimmer within inductor L112 for maximum GRID CURRENT reading.

(k) Operate the GRID CURRENT switch to the 813 position.

(l) Adjust the tuning slug within inductor L118 for maximum GRID CURRENT reading.

(m) Rotate the EXCITER TUNING Control to the low end of the scale (5 to 15) and tune for maximum power amplifier GRID CURRENT reading.

(n) Operate the GRID CURRENT switch to the 807 position.

(o) Adjust trimmer capacitor C126 for maximum GRID CURRENT meter reading.

(p) Rotate EXCITER TUNING Control to the high end of the scale (95) and tune for maximum GRID CURRENT reading.

(q) Repeat Steps (k), (l), (m), (n), (o), and (p).

(r) Repeat Step (q) until exact alignment is obtained between L112 and L118. (Maximum readings at dial settings of approximately 10 and 95.)

Note: Capacitor C126 is now properly adjusted. No further adjustment of this capacitor should be made.

(s) Adjust EXCITER TUNING Control to give maximum power amplifier grid current (dial setting of approximately 95).

(t) Operate the EXCITER BAND SWITCH to Position 3.

(u) Operate the GRID CURRENT switch to the 813 position.

(v) Adjust the tuning slug within inductor L116 for maximum power amplifier GRID CURRENT reading.

(w) Operate the GRID CURRENT switch to the 807 position.

(x) Operate the EXCITER BAND SWITCH to Position 2.

(y) Adjust the trimmer within inductor L111 for maximum GRID CURRENT reading.

(z) Operate the GRID CURRENT switch to the 813 position.

(aa) Adjust the tuning slug within inductor L117 for maximum power amplifier grid current.

(bb) Operate the EXCITER BAND SWITCH to Position 4.

(cc) Adjust the tuning slug within inductor L115 for maximum GRID CURRENT reading.

The above procedure completes the alignment of the exciter circuits. The power amplifier grid current should be between 15 ma and 30 ma over the entire frequency range of the transmitter.

The tuning capacitors C125 and C132 were mechanically and electrically tracked at the factory and no further adjustment of these capacitors should be necessary. However, if the final amplifier grid current is less than 15 ma in the middle of the range of Band 1, when it is properly tracked at both ends, it will be necessary to track these capacitors. First the two capacitors should be mechanically aligned so that maximum capacity of the two capacitors occur simultaneously. The capacitor stators must be properly centered in the rotor. The electrical alignment is accomplished by bending the end rotor plates.

On checking the tracking of the exciter, it will be noticed that the tracking is very poor at the high frequency end of Band 2. This is due to the low distributed capacity of inductor L117. However, with the transmitter tuned so that the 813 grid current is peaked, sufficient drive is obtained to the 813's and the mistuning of L111 will not cause any deleterious effect or objectionable operation.

If it is found that one or more of the bands can not be made to resonate as outlined it will be necessary to repeat the adjustments using a slightly different dial reading for the high capacity end (93 to 97).

6.13. **CFI ALIGNMENT.** The Crystal Frequency Indicator Unit has been carefully adjusted before leaving the factory and unless the unit has been damaged or components within the unit have been replaced, no adjustment of the tank circuits should be attempted.

If, however, it has been definitely established that the circuits do require realignment, the procedure outlined below should be followed (Refer to Fig. 42 and Fig. 43):

a. Remove the CFI Unit from the transmitter by loosening the two securing screws (one on top of chassis between V109 and E105

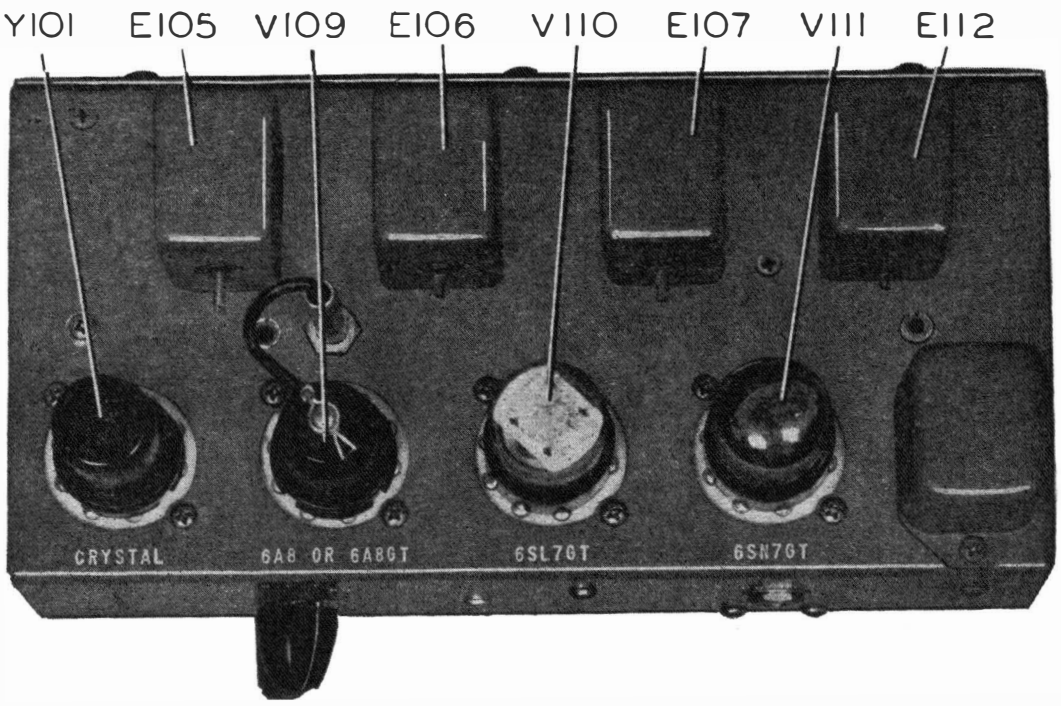


Fig. 42 Crystal Frequency Indicator Unit (Top)

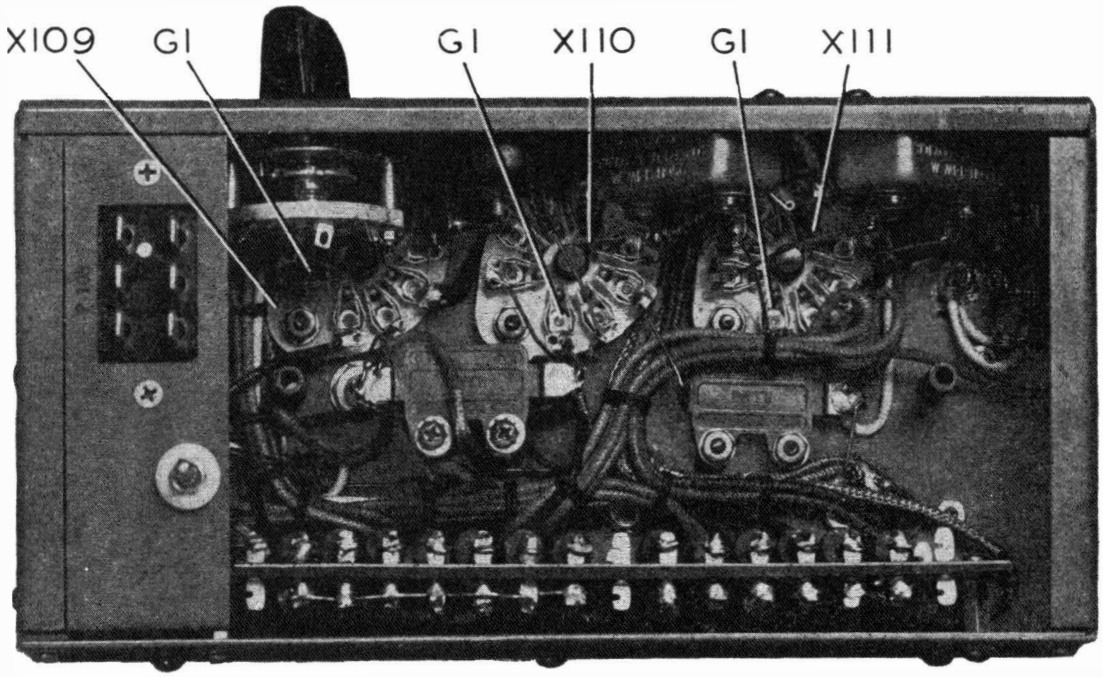


Fig. 43 Crystal Frequency Indicator Unit (Bottom)

and the other between E112 and the output transformer) and lift the unit upward. Place the unit on a work bench and make power connections from the unit to the transmitter with a test cable.

b. Connect the leads of a high impedance voltmeter, such as a meter of the vacuum tube type, between terminal #5 (G_1) on socket X109 and the chassis.

c. Operate the transmitter power switch, S120, to the ON position, the power level switch, S119, to the L.V. position, the LOCAL-REMOTE switch to the LOCAL position, and press the FILAMENT and PLATE power start buttons.

d. Operate the CFI Unit power switch, S111, to the ON position.

e. Rotate the tuning screw within tank circuit E105 until the maximum grid voltage is indicated on the meter. (Between 15 and 25 volts.)

Note: Voltages are negative with respect to ground.

f. Rotate switch S111 to the OFF position, remove the meter lead from socket X109 and connect the same lead to terminal #4 of socket X110.

g. Operate the power switch to the ON position and rotate the tuning screw within tank circuit E106 until a maximum voltage reading is obtained. (Between 10 and 18 volts.)

h. Operate the power switch to the OFF position and connect the meter lead to the cap of V109 (G_4).

i. Operate the power switch to the ON position and adjust the tuning screw within tank circuit E107 for maximum voltage reading. (Between 10 and 18 volts.)

j. Return the meter lead to terminal #4 (G_1) of socket X110 and readjust tank circuit E106 for maximum voltage reading.

k. Connect the meter lead to the cap of tube V109 and readjust tank circuit E107 for a maximum voltage reading.

l. Using a precision frequency measuring device, measure the frequency of the output of the oscillator, V109, and adjust the slug within tank circuit E105 until the frequency of the output is exactly 200 kc.

m. Connect a db meter to the PHONES jack.

n. Operate the power switch to the ON position and adjust the slug within tank circuit E112 for minimum meter reading.

The above procedure completes the adjustment of the tank circuits of the CFI Unit. Remove the test cable and plug the unit into the R-F Unit. To check the operation of the CFI Unit the following additional steps are recommended:

o. With the CFI Unit plugged into plug receptacle J103, operate the transmitter power switch, S120, to the ON position, the power level switch, S119, to the L.V. position, dial an Autotune channel, operate the TEST switch, S113, to the locking position, insert an earphones cord plug into the PHONES jack, J122, dial Manual (AA2), operate the CFI power switch, S111, to the ON position and while listening to the output of the phones rotate the OSCILLATOR TUNING Control until an audio beat note is heard. A strong beat note should be heard every 50 Kc.

IMPORTANT: It is most important that the tuning slugs in the two tank circuits, E106 and E107, be rotated not more than **one-half revolution** in either direction from the setting found in Steps (j) and (k). Rotating the tuning screws more than one-half revolution may detune the circuits until it will be necessary to remove the CFI Unit and to repeat the entire alignment procedure.

6.14. MASTER OSCILLATOR DISASSEMBLY. The following procedure is recommended for gaining access to the components located in the master oscillator compartment.

a. Remove the r-f exciter unit from the transmitter. Remove the bottom shield and the Autotune cover from the exciter unit.

b. Remove the screws that secure the right end casting to the exciter chassis.

c. Place the exciter unit on the edge of the work bench with the end of the unit that contains the master oscillator extending beyond the end of the bench. Place a container directly beneath the master oscillator compartment.

d. Remove the ten screws that hold the shield cover on the master oscillator compartment and allow the puffed mica that surrounds the oscillator coil and heater assembly to fall into the container. Remove all of the puffed mica from inside the oscillator compartment.

e. Remove the eight screws that hold the master oscillator annex shield cover to the annex chassis and lift the shield off.

f. Remove the four screws that secure the master oscillator shield partition to the master oscillator main shield. Two of these screws are accessible from inside the master oscillator annex. **Caution:** Care must be exercised in removing these last two screws to prevent the damaging of components in the master oscillator annex. The lower one of these two screws is most easily removed by using a Phillips screwdriver with a shank 1/8" in dia. and at least 5" long.

g. Remove the master oscillator tube shield, disconnect the grid cap and remove the tube (Type 6A8) from the socket.

h. Loosen the oscillator tube grid cap connector post from the inside sufficiently to allow the "feed thru" insulators to slip out of the chassis. The object is to allow the post to be moved freely in all directions.

i. Loosen all of the set screws in the flexible couplings that secure the master oscillator shaft to the Multiturn Unit shaft. Take care that the split reduction sleeve inside the coupler that is adjacent to the oscillator is retained inside the coupling. Slide the shaft and the couplers in the direction of the Multiturn Unit as far as possible.

j. Remove the three screws that hold the coil and heater assembly to the front plate of the oscillator shield.

k. Slide back and raise the front of the coil and heater assembly. Remove the bakelite standoffs and the nuts that hold the front bearing plate and remove the plate. **Caution:** Observe the order of disassembly of the bearing and spring on the oscillator shaft. These two items must be reassembled in the same order.

l. The heater assembly can now be removed. Removal of this assembly exposes the remaining master oscillator components. **Note:** It may be necessary in early models to disconnect the leads to the heater element before it can be removed.

WARNING: Do not tamper with the heater thermal operated switch (S102). The screw that extends through one end of the switch is the adjusting screw. Rotating the screw one revolution will change the temperature at which the switch will operate by approximately 30° F. (Refer to **6.15. THERMAL SWITCH ADJUSTMENT.**)

In reassembling it is important to see that the tuning slug guide arm spring fits snugly on the steel spacer rod. Take care that the asbestos sheet that is part of the heater assembly (or any small particles thereof) does not remain between the heater assembly and the bearing plates. Leave one pair of coupler set screws loose until the unit is recalibrated.

Recalibrate the master oscillator while the unit is still on the bench. Connect the exciter to the transmitter power and control circuits with the test cables and apply filament and plate voltages. Rotate the OSCILLATOR TUNING knob until the Multiturn Unit dial indicates "20" (approach the setting clockwise through at least one-eighth revolution). Using a frequency standard, adjust the master oscillator to a frequency of 1000 kc and tighten the two remaining coupler set screws. Refer to **Master Oscillator Calibration** in this section of the book. Replace the exciter unit

bottom shield and replace the exciter unit in the cabinet.

If it becomes necessary to remove the entire oscillator assembly, the following procedure is recommended:

a. Remove the r-f exciter unit from the transmitter and remove the bottom shield and the Autotune cover from the unit.

b. Heat the solder that holds C175 to the mounting screw and remove the screw.

c. Disconnect the bus lead that comes out of the master oscillator annex directly under C175 where the lead connects to the tube socket. Disconnect the leads that are attached to the terminal blocks on the master oscillator and the master oscillator annex.

d. Remove the master oscillator tube shield, disconnect the grid cap and remove the oscillator tube (Type 6A8) from the socket.

e. Loosen the two screws that secure the flexible coupler to the Autotune shaft.

f. Remove the three short screws that attach the back plate of the Multiturn unit to the Autotune Casting. Remove the Multiturn unit. **Caution:** Care must be exercised not to move any of the Autotune mechanism from the time the unit is loosened until the unit is again securely in place. If the shafts are moved the Autotune mechanism may be thrown out of synchronization.

g. Remove the short screw that is located on top of the chassis just behind the master oscillator tube shield. Loosen the two long screws that secure the master oscillator unit to the Autotune casting. (The heads of these screws are exposed by the removal of the Multiturn unit.)

h. The master oscillator unit with the master oscillator annex attached may now be lifted out of the exciter chassis. For further disassembly of this unit follow the procedure that was outlined in the first part of this section, **6.14.**

6.15. THERMAL SWITCH ADJUSTMENT. Two thermal operated switches are employed in this equipment, one to control the master oscillator compartment heater and the other to control the rectifier tube heaters. The two switches are identical but are adjusted to operate at different temperatures. The oscillator compartment heater switch, S102, should be adjusted to operate when the temperature within the compartment is between 65°C and 70°C. The rectifier heater control switch, S124, should be adjusted to operate when the temperature inside the transmitter cabinet is between 15°C and 20°C.

The adjustment procedure is outlined below:

(a.) Obtain a pan or earthenware bowl of water, a source of heat (electric plate, gas burner, etc.) an accurate thermometer (preferably graduated in degrees C.), a lamp, batteries or other source of voltage to operate the lamp and a supply of hook-up wire.

(b.) Connect the switch, pilot lamp and voltage source in series. The lamp should light. The switch is normally closed.

(c.) Place the switch in the cool water.

(d.) Place the thermometer in the water near the switch.

(e.) Place the container of water over the source of heat.

(f.) Raise the temperature of the water slowly.

(g.) Watch the thermometer and pilot lamp and carefully note the temperature of the water at the time that the circuit is broken.

(h.) Record the temperature at which the switch operated, cool the water and repeat Steps c. thru g. until three trials have been made.

To change the temperature at which the switch will operate rotate the adjusting screw that protrudes from the end of the switch assembly. **Rotate the adjusting screw in a counterclockwise direction to raise the temperature reading at which the switch will operate.** Rotating the screw one revolution changes the

adjustment so that the switch will operate at a temperature approximately 15°C higher or lower than the temperature at which it originally operated.

(i.) Calculate the number of revolutions or fraction of a revolution that it will be necessary to rotate the adjusting screw to obtain switch operation in the proper temperature range (between 65°C and 70°C for S102 and between 15°C and 20°C for S124).

(j.) Repeat the checking and adjustment procedure until the switch operates consistently within the proper temperature range.

6.16. TROUBLE SHOOTING. The following material has been compiled to aid the operating and maintenance personnel in locating the cause of erratic operation or transmitter failure. Considerable time may be saved in locating trouble if reference is made to this material.

Note: An outlet has been provided in the transmitter for the connecting of soldering irons, trouble lamps, etc. The voltage that is available at this outlet is 115 volts, 50/60 cps, single phase. The outlet consists of two two-terminal plug receptacles and is accessible when the rear panel is removed from the transmitter cabinet.

a. Power Amplifier Tubes (813's) Operating Too Hot

(1) **Symptoms:** Power amplifier tubes (813's) plates glowing red when key is held down.

(2) **Probable Cause:** Power amplifier stage is operating as a frequency doubler rather than as a straight amplifier.

(3) **Cure:** Refer to the table of POWER AMP. BAND SWITCH Position vs Frequency Range and determine the correct position for the BAND SWITCH for the frequency that has been chosen. The table is included in the ADJUSTMENT Section of this Instruction Book under **4.6.3. Power Amplifier and Antenna Tuning.**

b. Cannot Key Transmitter

(1) **Symptom:** R-F carrier comes on when plate voltages are applied but is impossible to turn it off without turning off the plate voltage.

(2) **Probable Cause:** Defective keyer tube (V107).

(3) **Cure:** Replace the keyer tube with a 6SJ7 that is known to be in good condition.

c. Impossible to Modulate R-F Carrier

(1) **Symptoms:** R-F carrier on but impossible to modulate carrier on either MCW or phone.

(2) **Probable Cause:** Defective high voltage fuse (F113) in the modulator plate circuit. Check the fuse by selecting phone emission, applying plate voltage and observing the reading on the PLATE CURRENT meter. The meter will indicate static plate current if the fuse and the modulator tubes are in good condition.

(3) **Cure:** Replace fuse F113 with a fuse that is known to be in good condition. (F113 is accessible if the rear panel of the transmitter cabinet is removed.) Repeat the check outlined above. If modulator static plate current still is not indicated try replacing one or both modulator tubes.

d. Impossible To Neutralize Power Amplifier Stage

(1) **Symptoms:** Needles on PLATE CURRENT and GRID CURRENT meters "wandering" over the scales as the POWER AMP. TUNING control is rotated through resonance, that is, the minimum PLATE CURRENT and maximum GRID CURRENT

meter readings do not occur at the same point.

(2) **Probable Cause:** If the stage is only slightly out of neutralization refer to **4.6.4. Power Amplifier Neutralization.** If the stage is completely out of neutralization the power amplifier tubes (813's) are probably defective.

(3) **Cure:** Replace 813's with tubes known to be in good condition.

e. **Dialing Does Not Operate Autotune System**

(1) **Symptoms:** The Autotune mechanism is inoperative. Dialing on Autotune channel does not start the Autotune mechanism.

(2) **Probable Causes:** The power switch may be in the OFF position, the mechanism is set to the channel that is being dialed, fuse F110 or F111 is blown or the contacts of the homing relay, K109, are not seating properly. Check fuses F110 and F111. If both fuses are in good condition check the contacts of the homing relay, K109.

(3) **Cure:** Check the position of the power switch and dial a different Autotune channel. If the mechanism still does not operate check the 48 volt supply. If either of the two 48 volt supply fuses, F110 or F111, has been blown replace with a new fuse. Clean the contacts of the homing relay, K109, with a burnishing tool and check the normally open contacts for closing when the relay is operated.

f. **Dialing A0 Does Not Turn Transmitter Off**

(1) **Symptoms:** Impossible to turn transmitter off by dialing **A0.**

(2) **Probable Cause:** Contacts of the LOCAL-REMOTE Switch are not making proper contacts.

(3) **Cure:** Clean contacts of the switch with a burnishing tool. Check the "make-before-break" contacts of the switch and adjust the contact leaves with a bending tool if the contacts are not operating properly.

g. **Pilot Lamps Flicker**

(1) **Symptoms:** It is possible to turn on both the filament and plate voltages but the pilot lamp or lamps flicker or fail to light.

(2) **Probable Causes:** Defective pilot lamps or improper seating of the relay contacts that control the pilot lamp energizing circuits.

(3) **Cure:** Replace the erratic or inoperative pilot lamp with a new one. If the lamp still does not operate properly check the contacts of the relay. The filament relay is directly behind the FILAMENT pilot lamp and the plate relay is behind the PLATE pilot lamp. The third set of contacts, counting the sets of contacts from the front of the transmitter, control the pilot lamps. Clean the contacts with a burnishing tool and check for proper seating.

h. **Low Voltage Supply Will Not Turn On**

(1) **Symptoms:** Pressing the PLATE Start Switch does not turn on the plate voltage.

(2) **Probable Causes:** Poor seating of the contacts of the door interlock switches, the LOCAL-REMOTE Switch, the filament relay, the time delay relay, the overload relay, the bias interlock relay or the Autotune motor starting relay.

(3) **Cure:** Check the rear panel interlock switch by operating the L.V.-TUNE-OP Switch to the L.V. position and, operating the LOCAL-REMOTE Switch to the REMOTE position, operating the power switch to the ON position, allowing approx-

imately 30 seconds for the time delay relay to operate and pressing the rear panel of the transmitter cabinet inward. If the PLATE pilot lamp comes on, the trouble is in the rear panel interlock switch. The rear panel may have been sprung out of shape. Remove the rear panel and attempt to shape the panel so that the interlock switch will be held closed when the panel is in position.

If the pressing inward of the rear panel does not turn on the plate voltage check the operation of the bias interlock relay by loosening the holder for fuse F106 and removing the fuse. Insert and remove fuse F106 several times and listen for the "click" of a relay operating. If a noticeable click is heard as the fuse is inserted and removed the bias interlock relay is operating. NOTE: FILAMENT power must be on when making the above check.

If the bias interlock relay is operating satisfactorily, check the contacts of the other relays that are mentioned above. Check the contacts of each relay by observing the seating of the movable contacts against the fixed contacts when the relay is operated. The overload relay is located on the rear of the R-F Unit and is accessible if the rear panel of the transmitter cabinet is removed. The time delay relay is located on the left-hand front side of the Power Supply Unit beneath the black cover. Remove the black cover to gain access to the time delay relay mechanism.

Check the operation of the time delay relay by removing filament power and then reapplying filament voltage by pressing the FILAMENT Start Switch. The relay should operate in approximately 30 seconds.

The filament relay and the LOCAL-REMOTE Switch are located behind the control panel. Check the contacts on both the relay and the switch.

i. No 50 Kc CFI Calibrating Points Audible

(1) **Symptoms:** The 200 kc CFI points are audible but the 50 kc points are not audible.

(2) **Probable Cause:** Defective tubes are usually the cause of the above condition.

(3) **Cure:** Replace the Type 6A8 with a tube known to be in good condition. Check the operation of the CFI circuit by turning the transmitter and the CFI Unit on and listening for check points. If the 50 kc points are still not audible turn the transmitter off and replace the Type 6SL7 tube. Repeat the checking procedure. **Try several tubes of each type from stock before coming to the conclusion that failure is due to something other than tubes.**

j. An Autotune Head Overruns

(1) **Symptoms:** When an Autotune channel is selected and the system operates and one of the Autotune dials does not stop at the position at which it was locked.

(2) **Probable Cause:** A pawl may have failed to fall into the stop ring slot.

(3) **Cure:** Remove the Autotune cover from the casting and dial the channel upon which erratic operation has been encountered. If the tuning dial fails to stop in the correct position, check the pawl. The spring that normally holds the pawl against stop ring drum may be binding in the slot of the pawl. If binding is indicated clean the slot and spring until the spring slides easily in the slot.

k. **Plate Voltage Goes Off If a Channel Is Dialed**

(1) **Symptoms:** Any dialing operation turns off the plate voltage.

(2) **Probable Cause:** The contacts of overload relay may not be seating properly.

(3) **Cure:** Remove the rear panel from the transmitter cabinet and check the reset contacts of the overload relay. The overload relay is mounted on the rear of the R-F Unit. The reset contacts of the relay are mounted on two bars. The springs that hold the movable contacts against the fixed contacts may be too loose. To increase the tension of the springs, remove the cotter pins, stretch the springs and replace the springs and cotter pins.

l. **Fuse In L.V. Rectifier Plate Circuit "Blows" Repeatedly**

(1) **Symptoms:** The fuse in the low voltage rectifier plate circuit "blows out" whenever the PLATE voltage is applied.

(2) **Probable Cause:** The plate lead to the frequency multiplier tube or the plate lead to the intermediate amplifier tube may be shorted to a shield.

(3) **Cure:** Remove the shields from the tubes and check the positions of the plate leads. Bend the leads so that even with the shield in place the leads are clear of the shield and chassis. Replace the shields.

m. **Amplitude of Plate Current Varies on MCW Emission**

(1) **Symptoms:** The needle of the PLATE CURRENT meter "wanders" over the scale if MCW emission is selected and the key is held closed. The current will vary from a minimum to a maximum in from 1 to 5 seconds.

(2) **Probable Cause:** A variation of the output of the MCW oscillator because of a defective oscillator tube.

(3) **Cure:** The above condition is usually most noticeable when operating with the lowest frequency audio tone. Remove the MCW tube and replace with a tube known to be in good condition.

n. **Sudden Operation of the Primary Power Switch or the Blowing of Power Input Fuses**

(1) **Symptoms:** The primary power switch opens or the line fuses, F114 and F115, "blow" suddenly.

(2) **Probable Causes:** High voltage rectifier tubes (249C's) are "flashing-over" or the gap between the spark gap between the modulation transformer terminals and the case are too small.

(3) **Cure:** Replace the rectifier tubes with tubes known to be in good condition. Turn the transmitter on and check the operation. If the trouble has not been cured, check the gap between the metal strip, that extends from one of the modulation transformer terminals and the transformer case. The strip may have been bent so near to the case that the voltage jumps the gap. Widen the gap by bending the metal strip away from the transformer case.

VII DATA

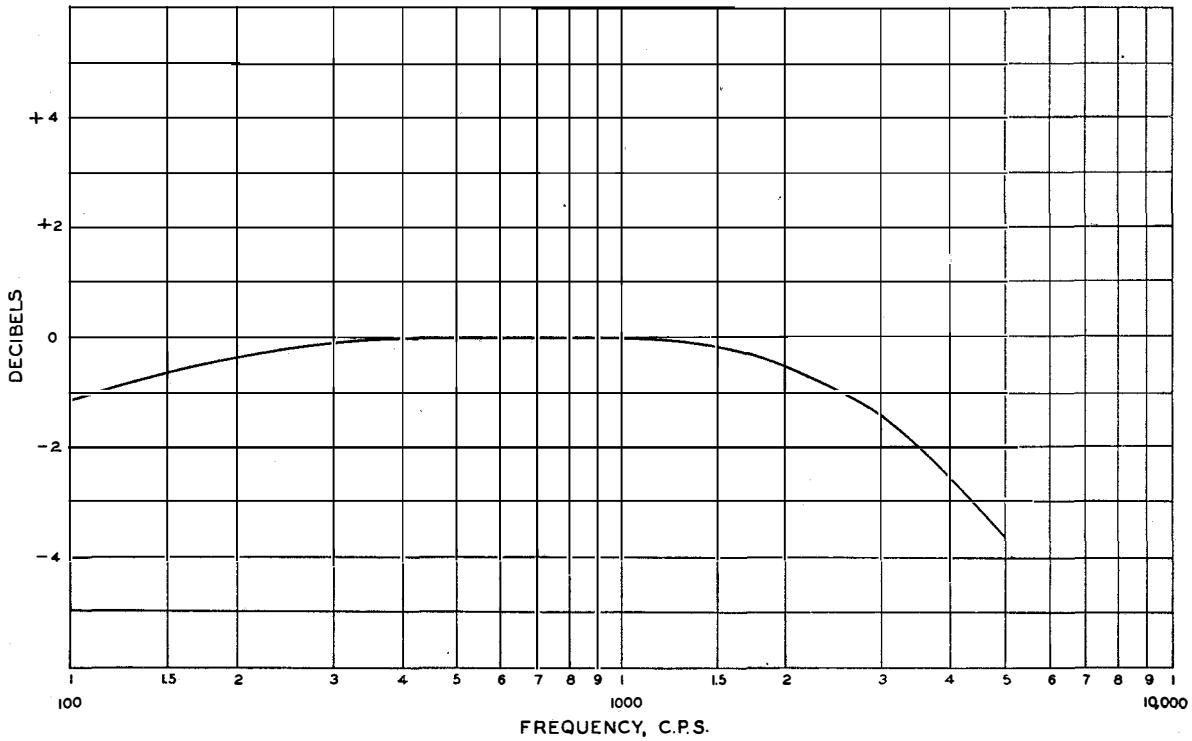


Fig. 44 Overall Frequency Response Curve (Dwg. No. 1978B)

7.1. TRANSMITTER DATA.

7.1.1. Power.

(a) Power Input Requirements.

Condition	Watts	Power Factor
1. Dial A0	45	0.70
2. Filaments On—CW	462	0.80
3. Filaments On—MCW or VOICE	521	0.87
4. Filaments and Plate On (Standby)—CW	700	0.77
5. Filaments and Plate On (Standby)—MCW or VOICE	832	0.85
6. Carrier On—CW	1560	0.88
7. Carrier On—MCW or VOICE (No Mod.)	1300	0.86
8. Carrier On—MCW or VOICE (100% Mod.)	1570	0.88

(b) Power Output—CW.

Frequency (Mc)	Watts	Frequency (Mc)	Watts
2.0	450	10.5	614
2.5	546	11.0	614
3.0	492	11.5	620
3.5	555	12.0	587
4.0	570	12.5	587
4.5	595	13.0	595
5.0	595	13.5	614
5.5	587	14.0	555
6.0	587	14.5	570
6.5	587	15.0	580
7.0	587	15.5	580
7.5	587	16.0	587
8.0	587	16.5	587
8.5	587	17.0	595
9.0	587	17.5	546
9.5	595	18.1	546
10.0	605		

Note: Above measurements made using a 300 ohm dummy antenna load.

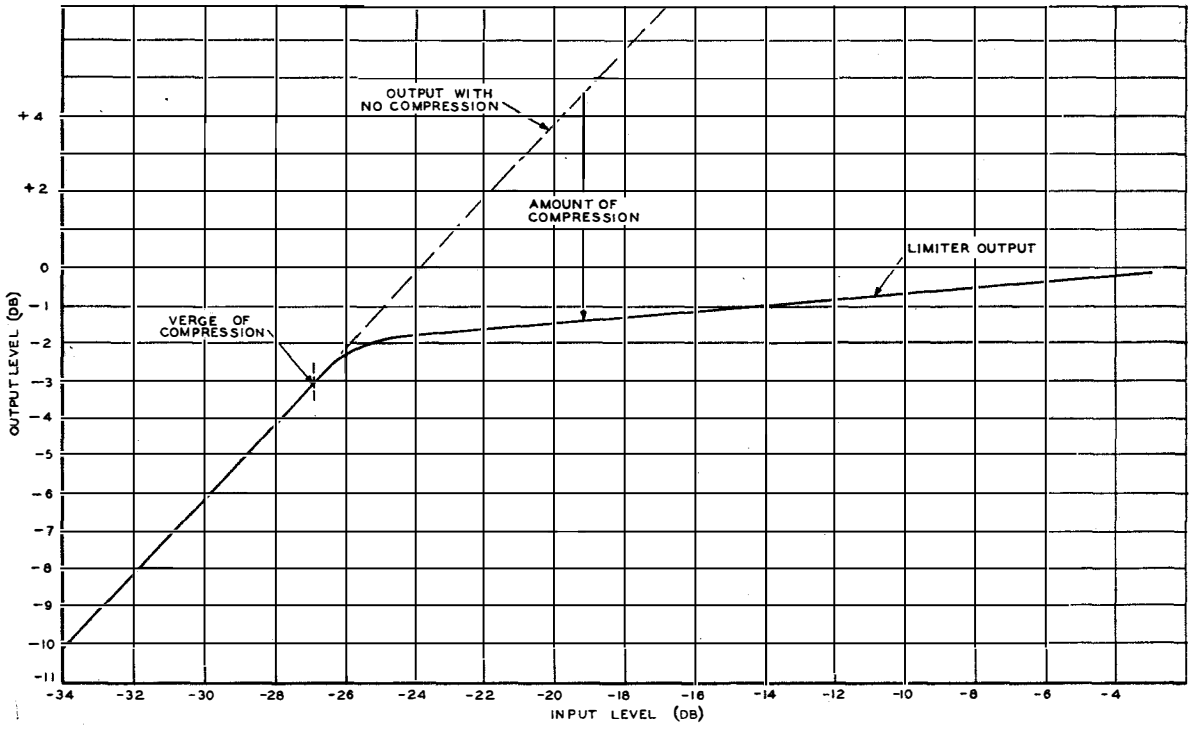


Fig. 45 Typical Volume Limiter Curve (Dwg. No. 1632C)

7.1.2. Radio Frequency.

(a) Frequency Coverage.

1. EXCITER BAND SWITCH

Position	Frequency Range (Mc)
1	9.0 to 18.1
2	6.0 to 9.0
3	3.0 to 6.0
4	2.0 to 3.0

2. POWER AMP. BAND SWITCH

Position	Frequency Range (Mc)
1	13.5 to 18.1
2	11.5 to 13.5
3	9.0 to 11.5
4	6.9 to 9.0
5	5.8 to 6.9
6	4.9 to 5.8
7	4.2 to 4.9
8	3.6 to 4.2
9	3.1 to 3.6
10	2.3 to 3.1
11	2.0 to 2.3
12	

Note: The above coverage measurements were made using a 300 ohm dummy antenna load.

7.1.3. Audio Frequency.

(a) Frequency Response (100% Mod.).

1. With LIMITER GAIN Control set for 10 db of compression.

Frequency (cps)	Output (db)	Plate Current
50	—4.0	435
100	—1.1	450
150	—0.6	455
400	0.0	455
1000	0.0	460
1500	—0.1	460
2000	—0.5	460
3000	—1.4	480
3500	—1.9	490
4000	—2.5	495
5000	—3.6	505
6000	—3.9	510

2. With LIMITER GAIN Control set at 0.

Frequency (cps)	Output (db)	Plate Current
50	—18.0	345
100	—3.3	415
150	—1.4	440
200	—0.4	460
300	—0.3	460
400	—0.2	460
500	—0.2	460
600	—0.1	460
700	0.0	460
800	0.0	460
900	0.0	460
1000	0.0	460
1500	0.0	460
2000	—0.2	470
3000	—1.1	490
3500	—1.7	495
4000	—2.3	500
5000	—3.7	505
6000	—3.9	510

(b) Distortion.

Input Freq. (cps)	Distortion (%)
100	4.0
400	2.3
1000	3.1
5000	10.0

Note: Above measurements made with —15 db input, 10 db of compression and 100% modulation.

(c) Noise Level.
57 db below 100% modulation level (10 db compression).

(d) Audio Input.
—25 db required for 100% modulation with LIMITER GAIN Control set at verge of compression.

(e) MCW Oscillator Frequency.

MCW Frequency Control Position	Output Frequency (cps)
1	380
2	540
3	700
4	850
5	1000
6	1160
7	1320

VIII APPENDIX

APPENDIX

TABLE I

LIST OF MAJOR UNITS

NAVY TYPE DESIGNATION	NAME OF MAJOR UNIT	SYMBOL GROUP OR UNIT NUMBER	ASSEMBLY DRAWING
COL-52318	Radio Transmitter	100, 200	1933B
COL-23377	Remote Control Unit	300	2573A
CAU-51057	Sound Powered Microphone	-------	20N211
COL-26019	Telegraph Key	-------	67A-3
---------	Metering Cord	-------	430A
---------	Test Cables	-------	1198C

APPENDIX

PARTS LISTS

Component parts of the equipment are identified by means of symbol designations. Wherever it is required to reference a component, the same symbol designation is used. Thus, a part appearing on a simplified schematic, a complete circuit diagram, a wiring diagram, photograph or layout drawing, will always be identified by means of the same symbol designation. In addition, each component part is stamped with its corresponding symbol designation. These symbol designations identify the various component parts which appear in the following parts lists. No symbol designation is used to identify more than one part.

The alphabetical portion of symbol designations have been selected from the following list in accordance with the classification of the component parts concerned.

(A) Structural parts, panels, frames, castings, etc.
(B) Motors and other prime movers, self-synchronous motors, etc.
(C) Capacitors of all types.
(D) Dynamotors.
(E) Miscellaneous electrical parts: insulators, knobs, brushes, etc.
(F) Fuses.
(G) Generators, exciters, etc.
(H) Hardware, screws, bolts, studs, pins, snapslides, etc.
(I) Indicating devices (except meters and thermometers), pilot lamps, etc.
(J) Jacks and receptacles (stationary).
(K) Contactors, relays, circuit breakers, etc.
(L) Inductors, R.F., and A.F.
(M) Meters of all types, gauges, thermometers, etc.
(N) Nameplates, dials, charts, etc.
(O) Mechanical parts, bearings, shafts, couplings, gears, ferrules, flexible shafts, housings, etc.
(P) Plugs.
(Q) Diaphragms, (microphone, telephone, projector, etc.)
(R) Resistors, fixed and variable, potentiometers, etc.
(S) Switches, interlocks, thermostats.
(T) Transformers, R.F and A.F., and power.
(U) Hydraulic parts.
(V) Vacuum and gaseous discharge tubes.
(W) Wires, interconnecting cables, without plugs.
(X) Sockets.
(Y) Mechanical oscillators, crystals, magnetestriction tubes, etc.
(Z) Filters, IF trasnformers, compound tuned circuit assemblies, etc., in a common container.
(CR) Dry Disc Rectifiers.

The numerical portion of the Symbol Designation has been assigned to identify the component part with a particular major unit assembly. The numerical portion of symbol designations begin with 101 for the first component part in each class (i.e., component part in each alphabetical class as described above) and run consecutively for the remaining component parts in a particular class. A different numerical series of numbers is used for each major unit of the equipment. The series 101 to 199 is reserved for the first major unit. The series 201 to 299 is reserved for the second major unit. The series 301 to 399 is reserved for the third major unit. In this manner, each major unit of the entire equipment is identified with a series of numerals to be used for the designation of component parts.

Only one Symbol Designation is assigned to cover component parts with multiple electrical or mechanical characteristics. However, since at times it is desirable to identify certain electrical or mechanical sections of these component parts, suffix letters are added when necessary. Thus, C121A, C121B, and C121C identify each section of triple capacitor C121, and K101A, K101B, K101C, and K101D identify the relay coil and various contacts of relay K101.

TABLE II

PARTS LIST BY SYMBOL DESIGNATION

Navy Type COL-52318 Radio Transmitter

MOTORS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
B101	Autotune Motor	1/5 h.p. 220/230 v 60 cps 1 phase 1300 rpm cap.			40B			232N914
B102	Ventilating Blower	1/20 h.p. 220 v 60 cps 1 phase 1750 rpm			05J	B9		9N219

CAPACITORS

C101	Cap., PLATE VOLTAGE Meter Bypass	.001 mf ±20% 1000 TV	-48645-B-5		75C	4LSE		910N210D-M
C102	Cap., PLATE CURRENT Meter Bypass	Same as C101						
C103	Cap., GRID CURRENT Meter Bypass	Same as C101						
C104	Cap., LINE-FIL. Voltmeter Bypass	Same as C101						
C105	C105A, C105B	465-465 mmf Split Stator Variable			05H	TCD		920N35A
C105A	Cap., Antenna Loading	Section of C105						
C105B	Cap., Antenna Loading	Section of C105						
C106	Cap., Output Padding	.0007 mf ±10% 5000 TV			75C 66S 02S	6LS F2		906N370A-K
C107	Cap., Network Input Padding	.0001 mf ±20% 5000 TV			75C	6L		906N310A-M
C108	C108A & C108B	110-110 mmf Air-dielectric Var.			05H	TCD		920N38A
C108A	Cap., P.A. Plate Tuning	Section of C108						
C108B	Cap., P. A. Plate Tuning	Section of C108						
C109	Cap., P. A. Plate Coupl.	.001 mf ±20% 5000 TV			75C	6LS		906N210A-M
C110	Cap., H. V. Bypass	Same as C109						
C111	Cap., V101 Grid Tank	.0023 mf ±5% 500 WV			25C			913 0006 00
C112	Cap., V101 Grid Tank	.00002 mf ± .5 mmf 500 WV			25C			913 0004 00
C113	Cap., 300 Volt Bypass	.006 mf ±20% 1500 TV	-481411-B20		02S	BE-15		915N260E-M
C114	Cap., V101 Anode Coupl.	.001 mf ±5% 500 WV			25C			913 0007 00

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C115	C115A, C115B, C115C	0.1/0.1/0.1 mf ±20% 600 WV	-48849-A20		75C 64S 66S	 2427-8		956NT01W-M
C115A	Cap., V101 H. V. Supply Bypass	Section of C115						
C115B	Cap., V101 Grid Bypass	Section of C115						
C115C	Cap., V101 Screen Bypass	Section of C115						
C116	C116A, C116B & C116C	Same as C115						
C116A	Cap., V101 Cathode Bypass	Section of C116						
C116B	Cap., V101 Fil. Bypass	Section of C116						
C116C	Cap., V101 Fil. Bypass	Section of C116						
C117	Cap., V101 Output Coupl.	Same as C113						
C118	C118A & C118B	.1 mf Dual Sect. ±20% 600 WV	-48312-B20		66S			956ND01W-M
C118A	Cap., V101 Plate Supply Filter	Section of C118						
C118B	Cap., V102 Plate Supply Filter	Section of C118						
C119	C119A & C119B	Same as C118						
C119A	Cap., V102 Cathode Bypass	Section of C119						
C119B	Cap., V102 Screen Bypass	Section of C119						
C120	Cap., V102 Output Coupl.	.001 mf ±20% 1500 TV	-481410-B20		02S	BE-15		915N210E-M
C121	Cap., V103 Grid Supply Filter	.1 mf ±20% 1200 TV			75C			956NS01W-M
C122	Cap., V103 Cathode Bypass	.1 mf ±20% 600 WV			66S 75C			956NS01Y-M
C123	Cap., V103 Cathode Coupl.	Same as C113						
C124	Cap., V103 Output Coupl.	Same as C120						
C125	Cap., V103 Plate Tuning	300 mmf Variable Air-Dielectric			77J	E		920N116
C126	Cap., V103 Plate Trimmer	44 mmf Midget Variable Air-Dielectric			34S	ATR		922N32
C127	Cap., V104 Grid Coupl.	Same as C120						
C128	Cap., V104 Cathode Bypass	Same as C122						
C129	Cap., V104 Screen Bypass	Same as C113						
C130	Cap., P.A. Neutralizing	Adjustable Plate			64C	YA-1771B		1771B
C131	Cap., V104 Pl. Supply Filter	Same as C121						
C132	Cap., V104 Plate Tuning	Same as C125						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C133	Cap., V104 H.V. Blocking	Same as C120						
C134	Cap., P.A. Neutralizing	Same as C120						
C135	Cap., P.A. Grid Coupling	.0001 mf ±10% 1500 TV			02S	BE-15		915N310E-K
C136	Cap., P.A. Fil. Bypass	.01 mf ±20% 1000 TV			75C	9L		910N110A-M
					02S	A-10		
					64S	XM		
C137	Cap., P.A. Fil. Bypass	Same as C136						
C138	Cap., P.A. Screen Bypass	Same as C136						
C139	Cap., V107 Grid Bypass	Same as C120						
C140	Cap., V110 Grid Coupl.	Same ae C114						
C141	Cap., V111 Grid Coupl.	.02 mf ±20% 600 WV			75C			956NS14W-M
					64S			
					66S			
C142	Cap., V111 Grid Coupl.	Same as C141						
C143	Cap., V109 Grid Coupl.	Same as C120						
C144	Cap., V110 Cath. Coupl.	.00025 mf ±20% 1500 TV			02S	BE-15		915N325E-M
C145	Cap., CFI H. V. Supply Filt.	.5 mf ±20% 600 WV			75C	DYRT		956NS08W-M
C146	C146A, C146B, C146C	Same as C115						
C146A	Cap., V109 Screen Bypass	Section of C146						
C146B	Cap., V109 Plate Bypass	Section of C146						
C146C	Cap., V109 Grid Bypass	Section of C146						
C147	Cap., V109 Grid Coupling	Same as C113						
C148	Cap., V110 Grid Coupling	Same as C113						
C149	Cap., V110 Plate Bypass	Same as C120						
C150	Cap., V111 Plate Coupl.	Same as C113						
C151	C151A, C151B & C151C	4/4/4 mf ±20% 600 WV			75C			956NT7J-M
C151A	Cap., V113 Cathode Bypass	Section of C151						
C151B	Cap., V116 Cathode Bypass	Section of C151						
C151C	Cap., V116 Plate Bypass	Section of C151						
C152	Cap., V114 Grid Bypass	.25 mf ±20% 600 WV	-481401-20		34S			956NS05V-M
C153	Cap., V117 Plate Bypass	Same as C145						
C154	Cap., V118 Grid Coupling	.25 mf ±20% 600 WV	-481392-20		75C			956NS05W-M
C155	Cap., V119 Grid Coupling	Same as C154						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C156	C156A, C156B & C156C	Same as C151						
C156A	Cap., Speech Amp. 26H H. V. Supply Filter	Section of C156						
C156B	Cap., V118, V119 Cathode Bypass	Section of C156						
C156C	Cap., V112 Plate Coupling	Section of C156						
C157	C157A, C157B & C157C	Same as C151						
C157A	Cap., Mod. Grid Bypass	Section of C157						
C157B	Cap., Mod. Grid Bypass	Section of C157						
C157C	Cap., V112 Plate Decoupl.	Section of C157						
C158	Cap., V112 Grid Tank	Spec. Mult. Section ±10% 600 WV	-481402-10		75C			956NM1-K
C159	Cap., V112 Plate Coupl.	Same as C152						
C160	Cap., V112 Feedback Coupl.	.1 mf ±20% 600 WV			64S			956NS01V-M
C161	Cap., Autotune Motor	8.5 mf ±10% 350 WV			75C	KGTU		933N1-K
C162	Cap., K104 Spark Suppr.	Same as C154						
C163	Cap., Spark Suppressing	Same as C154						
C164	Cap., Keying Transient Suppressing	Same as C154						
C165	C165A, C165B & C165C	Same as C151						
C165A	Cap., Dialing Voltage Filter	Section of C165						
C165B	Cap., Dialing Voltage Filter	Section of C165						
C166	C166A, C166B & C166C	Same as C151						
C166A	Cap., Bias Supply Filter	Section of C166						
C166B	Cap., Bias Supply Filter	Section of C166						
C166C	Cap., Bias Supply Filter	Section of C166						
C167	C167A, C167B & C167C	Same as C151						
C167A	Cap., Bias Supply Filter	Section of C167						
C167B	Cap., Bias Supply Filter	Section of C167						
C167C	Cap., Bias Supply Filter	Section of C167						
C168	C168A, C168B & C168C	Same as C151						
C168A	Cap., L. V. Filter	Section of C168						
C168B	Cap. L. V. Filter	Section of C168						
C168C	Cap., L. V. Filter	Section of C168						

PARTS LIST BY SYMBOL DESIGNATION

CAPACITORS (Cont.)

Sym Desig nation	unction	Description	Navy Type Desig- nation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Desig- nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C169	C169A, C169B & C169C	Same as C151						
C169A	Cap., L. V. Filter	Section of C169						
C169B	Cap., L. V. Filter	Section of C169						
C169C	Cap., L. V. Filter	Section of C169						
C170	Cap., H. V. Filter	.15 mf ±10% 4000 WV			75C	TJU		930N85-K
C171	Cap., H. V. Filter	4 mf ±20% 3000 WV	-481395-20		75C			930N43A-M
C172	Cap., H. V. Filter	Same as C171						
C173	Cap., V112 Cathode Coupl.	Same as C160						
C174	Cap., V109 Grid Coupl.	Same as C113						
C175	Cap., CFI Voltage Dividing	Coaxial Line, Approx. 5 mmf						
C176	Cap., CFI Voltage Dividing	Shielded Wire, Approx. 50 mmf						
C177	Cap., Keying Voltage Bypass	Same as C113						
C178	Cap., Filament Bypass	Same as C113						
C179	Cap., 250 V Bypass	Same as C113						
C180	Cap., Keying Voltage Bypass	Same as C114						

DISC RECTIFIERS

CR101	Rectifier, Relay Supply	Output: 48 v d.c. at .52 amp Continuous Duty			27B	1EOB5S1		353N26

MISCELLANEOUS ELECTRICAL PARTS

E101	Output Network Unit Term. Strip	Bakelite Terminal Strip			64C	GA-1528B		1528B
E102	M. O. Heater Terminal Strip	2 Term. Conn. Strip			91J	140-2		367 0001 00
E103	M. O. Terminal Strip	4 Term. Conn. Strip			91J	140-4		367 0002 00
E104	V104 Grid Parasitic Sup.	10 ohm 1 w 8 turns			64C	GA-1064A		1064A
E105	V109 Grid Tank Assembly	200 kc variable tank circuit			68S			278N39
E106	V109 Plate Tank Assembly	50 kc variable tank circuit			34S 19W 16A			278N41

PARTS LIST BY SYMBOL DESIGNATION

MISCELLANEOUS ELECTRICAL PARTS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
E107	V110 Plate Tank Assembly	150 kc variable tank circuit			34S 19W 16A			278N42
E108	E108A, E108B							
E108A	Power Unit Conn. Strip	13 Term. Conn. Strip			91J	142		367N513
E108B	Power Unit Conn. Strip	Same as E108A						
E109	Remote Lines Conn. Strip	7 Term. Conn. Strip			91J	142		367N507M1
E110	E110A, E110B, E110C							
E110A	ANT. Feedthrus	1-⅝" x 2-½" Pyrex			77C			192N202
E110B	ANT. Feedthrus	Same as E110A						
E110C	GND. Feedthrus	Same as E110A						
E111	High Voltage Terminal	2-⅜" high tapered Porcelain standoff			14A			193N2
E112	V111 Grid Coupl. Circuit	Same as E106						
E113	L101 & L103 Mtg. Standoffs	½" Diam. x 1-¼" Long Ceramic			25C			190NSL23
E114	C109 Mtg. Standoffs	½" x 1-¼" Cylindrical Ceramic			42J			190NSL4
E115	C106 & C107 Mtg. Blocks	1-⅝" x 1" x ¾" Block			14A			193N1
E116	V104 Plate Lead Feedthru	Male Section			42J			190NBI20
		Female Section			42J	979A		190NBI19
E117	R-F Unit Resistor Mtg. Blocks	Same as E115						
E118	Speech Amp. Unit Resistor Mtg. Blocks	Same as E115						
E119	Power Unit Resistor Mtg. Blocks	Same as E115						
E120	Power Unit Resistor Mtg. Blocks	Same as E111						
E121	Calib. Unit Conn. Plug Bushing	3/16" x ⅝" bushing insert			42J			190NBI7
E122	Resistor Mounting Block	Same as E111						
E123	E101 Feedthru	¾" O.D. Ceramic Bushing			42J	484		190NBI1
E124	Output Network Term. Plate	2-¾" x 3" Mycalex Plate			64C	X-6478		X-6478

PARTS LIST BY SYMBOL DESIGNATION

FUSES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
F101	Fuse, M.O. Heater	3/8 amp 250 v 1-1/4" x 1/4" cartridge Slo-Blo			78L	3AG		264N425
F102	Fuse, T102 Primary	1/4 amp 250 v 1-1/4" x 1/4" cartridge Slo-Blo			78L	3AG		264N424
F103	Fuse, T101 Primary	3/4 amp 250 v 1-1/4" x 1/4" cartridge Slo-Blo			78L	3AG		264N427
F104	Fuse, T107 Primary	Same as F101						
F105	Fuse, T108 Primary	Same as F102						
F106	Fuse, T109 Primary	Same as F102						
F107	Fuse, T110 Primary	1/2 amp 250 v 1-1/4" x 1/4" cartridge Slo-Blo			78L	3AG		264N426
F108	Fuse, T111 Primary	3 amp 250 v 1-1/4" x 1/4" cartridge			78L 97B	3AG 3AG		264N408
F109	Fuse, T112 Primary	Same as F107						
F110	Fuse, T114 Primary	2 amp 250 v 1-1/4" x 1/4" cartridge			78L 97B	3AG 3AG		264N407
F111	Fuse, CR101 Output	Same as F110						
F112	Fuse, T113 Primary	Same as F107						
F113	Fuse, T116 Primary	1/2 amp 5000 v 5" x 13/16" Cart.			78L	3024		264N815
F114	Fuse, Power Input	25 amp 240 v 9/16" x 2" cartridge			65J	380-025		264N225A
F115	Fuse, Power Input	Same as F114						
F116	Fuse, Rectifier Heater	Same as F103						

LAMPS

I101	Filament Power Pilot Lamp	3 w 125 v Candelabra Green Disk Clear White Bulls Eye			40G	S-6		262N331 262N237 262N136
I102	Plate Power Pilot Lamp	3 w 125 v Candelabra Red Disk Clear White Bulls Eye			40G	S-6		262N331 262N236 262N136

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J101	Voltage Metering Plug Receptacle	4 term. conn. socket			91J	SS-4-AB1/16		364N204
J102	Voltage Metering Plug Receptacle	4 term. conn. socket			91J	SS-4-FHE		364N504C
J103	Calib. Unit Conn. Plug Receptacle	6 term. Conn. socket			91J	SS-6-AB1/16		364N206
J104	Exc. & P.A. Fil. Voltage Metering Plug Recept	Same as J101						
J105	Automatic Emission Selection Conn.	15 term. conn. socket			91J	300		366N215
J106	R-F Unit Conn. Plug Receptacle	15 term. plug receptacle			64C	AC103C		AC103
J107	R-F Unit Conn. Plug Receptacle	19 term. plug receptacle			64C	AC104A		AC104
J108	Speech Amp. Fil. Mtrg. Plug Receptacle	Same as J101						
J109	Speech Amp. Conn. Plug Receptacle	Same as J106						
J110	Autotune Motor Conn. Plug Receptacle	Same as J101						
J111	Control Unit Conn. Plug Receptacle	11 term. plug receptacle			64C	AC103E		AC103
J112	Control Unit Conn. Plug Receptacle	Same as J107						
J113	Mod. Fil. Voltage Metering Plug Recpt.	Two terminal female			40G			368N45
J114	H.V. Rect. Fil. Vltg. Metering Plug Recpt.	Same as J113						
J115	Bias Rect. Fil. Voltage Metering Plug Recpt.	Same as J113						
J116	L.V. Rect. Fil. Voltage Metering Plug Recpt.	Same as J113						
J117	Telegraph Key Cord Plug Receptacle	Phone Jack			20W	246E		360N114
J118	Microphone Cord Plug Receptacle	4 term. conn. female chassis Mtg.			60A	PC4F		369N9

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J119	Blower Motor Connector Plug Receptacle	Same as J113						
J120	110 V Output	Same as J113						
J121	110 V Output	Same as J113						
J122	CFI Earphone Cord Plug Jack	2 circuit midget phone jack			21N			358N109
J123	Calib. Unit Input Coupl. Plug Receptacle	Recept. for banana plug			77J	Special-74		360N207
J124	Receptacle for F101	Extractor post type holder for 3AG & 4AG fuses			97B	HCM		265N206
J125	Receptacle for F102	Same as J124						
J126	Receptacle for F103	Same as J124						
J127	Receptacle for F104	Same as J124						
J128	Receptacle for F105	Same as J124						
J129	Receptacle for F106	Same as J124						
J130	Receptacle for F107	Same as J124						
J131	Receptacle for F108	Same as J124						
J132	Receptacle for F109	Same as J124						
J133	Receptacle for F110	Same as J124						
J134	Receptacle for F111	Same as J124						
J135	Receptacle for F112	Same as J124						
J136	Receptacle for F113	Same as J124						
J137	Receptacle for F114	Same as J124						
J138	Receptacle for F115	Same as J124						
J139	Receptacle for F116	Same as J124						

RELAYS

K101	Relay, Overload	400 to 800 ma d.c. trip coil 48 v d.c. operate coil N.O.			88S	CX		405NC4
K102	Relay, MCW Emission Selecting	110 w 3 amp d-c coil fixed cont.			34A	AQA		972N4
K103	Relay, Transmitter "OFF"	48 v d.c. DPDT Continuous Duty			65G	JD48RR		405NB209

PARTS LIST BY SYMBOL DESIGNATION

RELAYS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
K104	Relay, Autotune Motor Reversing	Same as K103						
K105	Relay, Autotune MotorStarting	Same as K103						
K106	Relay, CW Emission Selec.	Same as K102						
K107	Relay, Rotary Stepping	447 ma 48 v d.c. 1 bridging 3 non-bridging			34A	H-70228 ASM1		978N2
K108	Relay, Pulsing	120 ma 48 v d.c. coil adjustable contacts			34A	AQA		972N1
K109	Relay, Homing	110 w 3 amp 48 v d.c. coil fixed contacts			34A	AQA		972N15
K110	Relay, Interlock Delay	110 w 3 amp 48 v d.c. coil			34A	ASR		972N13
K111	Relay, Disconnecting	Same as K110						
K112	Relay, Filament Power	220 v 60 cps coil 10 amp 4 P.N.O. contacts			22A	Bul. 700		405NA104
K113	Relay, Plate Power	Same as K112						
K114	Relay, Time Delay	220 v 60 cps coil 5 amp N.O. Cont.			55A	NA11C NE11AC		402N22 or 402 0001 00
K115	Relay, Plate Power Aux.	Same as K103						
K116	Relay, Bias Interlock	130 ma 1 P.N.O. Double Break Cont.			65G	J		405NB212
K117	Relay, PHONE-CW	31 ma 48 v d.c. coil DPDT Cont.			42L	1407-MX		407N61
K118	Relay, Power Change	220 v 60 cps coil 10 amp cont. 1 P.N.O. 1 P.N.C.			22A	Bul. 700		405NA105

INDUCTORS AND REACTORS

L101	Antenna Static Drain Ch.	96 microh choke, single layer wound			64C	X-3779		X-3779-5
L102	P.A. Plate Tank and Antenna Loading Inductor	51 ¼ T Edge Wound silver plated copper ribbon			64C	GA-500 1267 00D		500 1267 00D
L103	P.A. Plate Feed Choke	Same as L101						
L104	V101 Tuning Inductor	18 turns #18 bus			64C	GA-2051A		2051A
L105	V101 Grid Choke	2.5 mh ±10% Mult. Sect. duo-lateral wound			05N	R-100U		240N53

PARTS LIST BY SYMBOL DESIGNATION

INDUCTORS AND REACTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
L106	V101 Grid Choke	Same as L105						
L107	V101 Plate Feed Choke	Same as L105						
L108	V102 Plate Feed Choke	Same as L105						
L109	Band Pass Filter Choke	1.0 mh Dual Sect. duo-lateral wound ±20%			05N			240N23
L110	V103 Plate Feed Choke	Same as L105						
L111	V103 Plate Tank Inductor	1.5 mc to 3.0 mc			64C	GA-1435C		1435C
L112	V103 Plate Tank Inductor	3.0 mc to 6.0 mc			64C	GA-1437C		1437C
L113	V104 Grid Choke	2.5 mh Mult. Sect. duo-lateral			05N			240N2A
L114	V104 Plate Feed Choke	Same as L105						
L115	V104 Plate Tank Inductor	Same as L111						
L116	V104 Plate Tank Inductor	Same as L112						
L117	V104 Plate Tank Inductor	4.5 mc to 9.0 mc			64C	GA-1438C		1438C
L118	V104 Plate Tank Inductor	9.0 mc to 18.1 mc			64C	GA-1436C		1436C
L119	P.A. Grid Choke	Same as L105						
L120	V107 Grid Choke	Same as L105						
L121	V110 Cathode Coupl. Choke	16.0 mh ±10% Single Section			35M	19-5590		240N56
L122	MCW Osc. Tuning Reactor	0.0333 hy 0-5 v rms 300-1500 cps			55C	68D-BO		678N119B
L123	Relay Supply Filter Reac.	2 hy 0.15 amp 50 ohm			55C	8A-BO		678N159
L124	Bias Supply Filter Reac.	4 hy 0.3 amp 40 ohm			55C			678N117A
L125	Bias Supply Filter Reac.	Same as L124						
L126	L-V Filter Reactor	4 hy 0.5 amp 40 ohm			55C			678N115A
L127	L-V Filter Reactor	Same as L126						
L128	H-V Filter Reactor	6 hy 0.7 amp 40 ohm			55C			678N116
L129	H-V Filter Reactor	Same as L128						
L130	V102 H-V Filter Choke	Same as L105						
L131	V101 H-V Filter Choke	Same as L105						
L132	V101 & V102 Fil. Decoupl.	0.25 mh per sect. 2 sect.			75M			240N52
L133	V115 Grid Choke	Same as L105						

METERS

M101	ANT. CURRENT Ammeter	0-3 amp 60 scale div. .05 amp per division	-22369		45W	425E		451NC3EN

PARTS LIST BY SYMBOL DESIGNATION

METERS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
M102	PLATE VOLTAGE Meter	3 kv 60 scale div. 50 volts per div.	-22371		45W	301		458N024CN
M103	PLATE CURRENT Milliammeter.	0-800 ma d.c. 40 scale div. 20 ma per div.	-22367		45W	301		450NC800N
M104	GRID CURRENT Milliammeter	0-5 v d-c Special Scale			40G	DO-53		458N0314CN
					45W	301		
M105	LINE-FIL. Voltmeter	Spec. Mult. Scale a-c accy. 2%	-22374		45W	476		548N061CN

CONNECTOR PLUGS

P101	Voltage Metering Plug	4 term. male conn.			91J	P-4-RSE		363N904
P102	Voltage Metering Plug	2 term. male conn.			83M			372N1
P103	Calib. Unit Conn. Plug	6 term. male conn. chassis mtg.			91J	P-6-AB1/16		363N206
P104	Automatic Emission Selection Conn. Plug	15 term. male conn.			91J	P-315		365N115
P105	R-F Unit Connector Plug	19 term. male plug			64C	AC106C		AC106
P106	R-F Unit Connector Plug	19 term. male plug			64C	AC107A		AC107
P107	Sp. Amp. Unit Conn. Plug	Same as P105						
P108	Autotune Motor Conn. Plug	Same as P101						
P109	Control Unit Conn. Plug	11 term. male plug			64C	AC106E		AC106
P110	Control Unit Conn. Plug	11 term. male plug			64C	AC107E		AC107
P111	Blower Motor Conn. Plug	Same as P102						
P112	Calib. Unit Conn. Plug	Banana Type 6-32 thread			77J	75A		361N206

RESISTORS

R101	Res., Voltmeter Mult.	3 Megohms Ferrule			28J			732NB3Meg.
R102	Res., M.O. Comp. Heater	186 ohm ±20% 18 w			16W			711NR2-M
R103	Res., M.O. Comp. Heater	186 ohm ±20% 18 w			16W			711 0004 00
R104	Res., V101 Cathode	100 ohm ±20% ½ w			28J	BW½		707N100N-M
R105	Res., V102 Grid	10,000 ohm ±10% 2 w	RC41BF103K		28J	BT2-Navy		729NH10M-K
R106	Res., V102 Cathode	200 ohm ±20% 2 w			28J	133-0200-7		709N200N-M
R107	Res., V102 Screen	30,000 ohm ±20% 2 w			28J	BT2-Navy		729NH30M-M

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R108	Res., V103 Grid	51,000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH51M-M
R109	Res., V103 Cathode	2400 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH2400-M
R110	Res., V103 Cathode	Same as R109						
R111	Res., V103 Screen	47 ohm ±20% 1 w	RC30BF470M		65S			729NG47-M
R112	Res., V104 Grid	Same as R108						
R113	Res., V104 Cathode	510 ohm ±20% 6 w			25P 05W			733NF510-M
R114	Res., V104 Screen	Same as R111						
R115	Res., P.A. Grid.	2400 ohm ±10% 28 w			25P			733NC2400-K
R116	Res., C130 Discharging	1 Megohm ±20% .2 w	-63426		28J	BT2-Navy		729NH1Meg-M
R117	Res., Freq. Mult. Screen	Same as R105						
R118	Res., Freq. Mult. Screen	22,000 ohm± 20% 2 w	RC41BF223M		28J	BT2		729NH22M-M
R119	Res., Grid Meter Shunt	101 ohm ±1% WW3			28J	WW3		721N101-F
R120	Res., Grid Meter Shunt	1250 ohm ±1% WW3			28J	WW3		721N1250-F
R121	Res., V107 Plate	5100 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH5100-M
R122	Res., V107 Grid	Same as R121						
R123	Res., V101 H.V. Dropping	10,000 ohm ±10% 28 w			05W			733NC10M-K
R124	Res., V101 Grid Voltage Dropping	1500 ohm ±10% 2 w			28J	BT-2		729NH1500-K
R125	Res., V101 Grid Voltage Dropping	Same as R124						
R126	Res., V101 Grid Voltage Dropping	Same as R124						
R127	Res., V101 Screen Voltage Dropping	Same as R108						
R128	Res., V101 Voltage Div.	100,000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH100M-M
R129	Res., Exc. H.V. Dropping	5600 ohm ±5% 28 w			25P			733NC5600-J
R130	Res., Exc. Voltage Div.	16,000 ohm ±10% 2 w			28J	BT2-Navy		729NH16M-K
R131	Res., Exc. Voltage Div.	Same as R130						
R132	Res., Exc. H.V. Dividing	Same as R130						
R133	Res., Channel Indicator	Same as R130						
R134	Res., Channel Indicator	Same as R130						
R135	Res., Channel Indicator	Same as R130						
R136	Res., Channel Indicator	Same as R130						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R137	Res., Channel Indicator	1000 ohm ±1% WW3			28J	WW3		721N1M-F
R138	Res., Channel Indicator	Same as R137						
R139	Res., Channel Indicator	Same as R137						
R140	Res., Channel Indicator	Same as R137						
R141	Res., Channel Indicator	Same as R137						
R142	Res., Channel Indicator	Same as R137						
R143	Res., Channel Indicator	Same as R137						
R144	Res., Channel Indicator	Same as R137						
R145	Res., Channel Indicator	Same as R137						
R146	Res., Channel Indicator	Same as R137						
R147	Res., CFI H. V. Dropping	8200 ohm ±10% 24 w			25P			733ND8200-K
R148	Res., V109 Grid	Same as R116						
R149	Res., V109 Grid	24,000 ohm ±10% 2 w	-63426		28J	BT2-Navy		729NH24M-K
R150	Res., V109 Screen	36,000 ohm ±10% 2 w			28J	BT2-Navy		729NH36M-K
R151	Res., V110 Plate Voltage Dropping	Same as R107						
R152	Res., V110 Grid	20,000 ohm ±20% 2 w	RC41BF203M		28J	BT2-Navy		729NH20M-M
R153	Res., V110 Grid	Same as R116						
R154	Res., V111 Grid	Same as R108						
R155	Res., V111 Cathode	1000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH1M-M
R156	Res., V111 Cathode	Same as R155						
R157	Res., V111 Grid	Same as R128						
R158	Res., V111 Plate Voltage Dropping	Same as R108						
R159	Res., CFI Voltage Div.	12,000 ohm ±10% 2 w	-63426		28J	BT2-Navy		729NH12M-K
R160	Res., CFI Voltage Div.	Same as R159						
R161	Res., CFI Voltage Div.	Same as R150						
R162	R162A & R162B	100,000 ohm-100,000 ohm Pot.			28J			380N202
R162A	Res., V113 Grid	Section of R162						
R162B	Res., V113 Grid	Section of R162						
R163	Res., V113 Cathode	Same as R155						
R164	Res., V113 Plate	24,000 ohm ±10% 2 w	-63426					729NH24M-K
R165	Res., V113 Plate	Same as R164						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R166	Res., V113 Plate	Same as R164						
R167	Res., V113 Plate	Same as R164						
R168	Res., Limiter Bridge	15,000 ohm ±5% 2 w	-63426		28J	BT2		729NH15M-J
R169	Res., Limiter Bridge	30,000 ohm ±5% 2 w			28J	BT2-Navy		729NH30M-J
R170	Res., Limiter Bridge	43,000 ohm ±5% 2 w			28J	BT2-Navy		729NH43M-J
R171	Res., Limiter Bridge	Same as R170						
R172	Res., Limiter Bridge	Same as R169						
R173	Res., Limiter Bridge	Same as R168						
R174	Res., V115 Grid	Same as R128						
R175	Res., V116 Cathode	Same as R155						
R176	Res., V116 H. V. Dropping	Same as R121						
R177	Res., V114 Grid	5 Megohm ±20% 2 w	-63426		28J	BT2-Navy		729NH5Meg-M
R178	R178A & R178B	Same as R162						
R178A	Res., Limiter Control	Section of R178						
R178B	Res., Limiter Control	Section of R178						
R179	Res., V119 Grid	Same as R128						
R180	Res., V118 Grid	Same as R128						
R181	Res., Audio Driver Cathode	750 ohm ±20% 24 w			25P 05W			733ND750-M
R182	Res., V114 & V117 Bias	Same as R128						
R183	Res., V112 Cathode	2000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH2M-M
R184	Res., V112 Plate Voltage Dropping	Same as R121						
R185	Res., V112 Plate Voltage Dropping	10,000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH10M-M
R186	Res., V112 Plate Voltage Dropping	Same as R185						
R187	Res., MCW Gain Control	100,000 ohm Pot.	-63854		28J	9851-9111		380NC100M
R188	Res., V112 Grid	47,000 ohm ±20% 2 w	RC41BF473M		28J	BT2-Navy		729NH47M-M
R189	Res., V112 Cathode	Same as R155						
R190	Res., Channel Ind. Coupling	Same as R121						
R191	Res., Channel Ind. Coupling	Same as R121						
R192	Res., K107 Spark Suppr.	510 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH510-M
R193	Res., MCW Transient Suppr.	Same as R192						
R194	Res., Keying Voltage Dropping	Same as R121						

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R195	Res., Bias Supply Bleeder	240 ohm ±10% 24 w			25P			733ND240-K
R196	Res., Bias Supply Bleeder	130 ohm ±10% 24 w			05W			733ND130-K
R197	Res., Bias Supply Bleeder	43 ohm ±10% 10 w			05W			733NE43-K
R198	Res., Bias Supply Bleeder	82 ohm ±10% 10 w			05W			733NE82-K
R199	Res., L. V. Supply Bleeder	1300 ohm ±10% 80 w			05W			733NA1300-K
R200	Res., L. V. Supply Bleeder	5100 ohm ±10% 24 w			05W			733ND5100-K
R201	Res., L. V. Supply Bleeder	Same as R200						
R202	Res., P. A. Screen	2400 ohm ±10% 60 w			25P 05W			733NB2400-K
R203	Res., H. V. Supply Bleeder	20,000 ohm ±20% 80 w			05W			733NA20M-M
R204	Res., H. V. Supply Bleeder	Same as R203						
R205	Res. H. V. Supply Bleeder	Same as R203						
R206	Res., Tuning	88 ohm ±20% 600 w			65W	RB60		711NE88-M
R207	Res., V109 Plate	Same as R130						
R208	Res., V110 Plate	510,000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH510M-M
R209	Res., V103 Grid	Same as R105						
R210	Res., V104 Cathode	Same as R192						
R211	Res., Rectifier Heater	115 v a-c 100 w 132 ohm			16W	781		711 0001 00
R212	Res., Rectifier Heater	Same as R211						
R213	Res., Rectifier Heater	Same as R211						
R214	Res., Rectifier Heater	Same as R211						
R215	Res., V112 Cathode	Same as R155						

SWITCHES

S101	S101A, S101B, S101C & S101D							
S101A	Switch, Network Padder Connecting	Stator, 12 Contact Rotor, Single Arm			64C 64C	YO-626B Y-622B		626B 622B
S101B	Switch, Network Padder Contacting	Stator, 8 Contact Rotor Double Arm			64C 64C	YP-626B Y-619B		626B 619B
S101C	Switch, Inductor Tap	Stator, 12 Contact Rotor Double Arm			64C 64C	YO-626B Y-619B		626B 619B
S101D	Switch, Antenna Selecting	Same as S101A						

PARTS LIST BY SYMBOL DESIGNATION

SWITCHES (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
S102	Switch, M. O. Heater	115 v 10 amp 0.400 °F.			40F	731RC		292N24
S103	Switch, Grid Circuit Selecting	1 amp 250 v d.c. DPDT Toggle			84A	20905-GH		266N103
S104	S104A, S104B &S104C	3 point Rotor 10 point Stator			64C	186M-8		186M-8
S104A	Switch, V103 Plate Ind. Conn.	Section of S104						
S104B	Switch, V103 Plate Ind. Conn.	Section of S104						
S104C	Switch, Screen Res. Sel.	Section of S104						
S105	S105A, S105B & S105C	Same as S104						
S105A	Switch, V104 Plate Ind. Conn.	Section of S105						
S105B	Switch, V104 Plate Ind. Conn.	Section of S105						
S105C	Switch, V104 Plate Ind. Conn.	Section of S105						
S106	S106A, S106B, S106C	Same as S104						
S106A	Switch, V104 Plate Ind. Conn.	Section of S106						
S106B	Switch, V104 Cathode	Section of S106						
S106C	Switch, V103 Cathode	Section of S106						
S107	Switch, Automatic Emission Selector	Stator, 12 Contact Rotor, 3 Arms			05P	DH		269N36
S108	Switch, Channel Ind.	Same as S107						
S109	Switch, Autotune Channel Sel.	12 Cont. Non-shorting			05P	DH		269N37
S110	Switch, Autotune Limit	1 N.O. 1 N.C. Cont.			64C	GA-1557B		1557B
S111	Switch, CFI Unit Plate Power	2 Pole 2 Pos. 1 Sect. Non-shorting			25C			259N103A
S112	Switch, MCW Freq. Cont.	1 Pole 7 Pos. 1 Sect. Shorting			25C			259N106
S113	Switch, TEST	Pos. 1: 2 c Pos. 2: 2 c 110 w 3 amp			34A	H-70224-1		374N1
S114	Switch, LOCAL-REMOTE	2 Pos. 110 w 3 amp			34A	H-77041-1		374N4
S115	Switch, Filament ON	Black Push Button 1 N.O. & 1 N.C.			84A 10V	27900		260N202
S116	Switch, Filament OFF	Red Push Button 1 N.O. & 1 N.C.			84A	27900		260N203
S117	Switch, Plate Power ON	Same as S115						
S118	Switch, Plate Power OFF	Same as S116						
S119	S119A, & S119B	10 amp 150 v 3 Pos. 2 ckt			25P	111		259N130
S119A	Switch, Power Level	Section of S119						
S119B	Switch, Power Level	Section of S119						

PARTS LIST BY SYMBOL DESIGNATION

SWITCHES (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
S120	Switch, Primary Power	10 amp 230 v a.c. Time Delay			45H			260N428TD
S121	Switch, Front Door	Female Section			40G			260N405
		Male Section			40G			260N404
S122	Switch, Rear Panel	Same as S121						
S123	Switch, Telephone Dial	Delayed Impulse 11 point			34A	H-70227		978N1
S124	Switch, Rectifier Heater	Same as S102						
S125	Switch, M.O. Heater	Same as S102						

TRANSFORMERS

T101	Trans., P.A. Filament	Pri: 210, 220, 230, 240, 250 v 50/60 cps 100 VA Sec: 10.0 v 10.0 amp CT			55C			672N109C
T102	Trans., Exciter Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps 31.5 VA Sec: 6.3 v 5.0 amp CT			55C			672N112A
T103	Trans., Speech Amp. Input	Pri #1: 500 ohm Pri #2: 75 ohm Sec: 40,000 ohm 50 mw Max. 100 to 5000 cps			55C			677N270
T104	Trans., Speech Amp. Interstage Coupling	Pri: 20,000 ohm Sec. #1: 20,000 ohm Sec. #2: 20,000 ohm 50 to 10,000 cps			20T 55C	T44542 CD141		677N141
T105	Trans., Audio Driver Input	Pri: 10,000 ohm Sec: 40,000 ohm 100 to 5000 cps			20T			677N102A
T106	Trans., Audio Driver Output	Pri: 3200 ohm CT Sec: 1420 ohm CT 15w			20T			677N272

PARTS LIST BY SYMBOL DESIGNATION

TRANSFORMERS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
T107	Trans., Speech Amp. Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps Sec. #1: 6.3 v Sec. #2: 50 v 5.5 amp			55C			672N271
T108	Trans., Bias Rect. Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps 15 VA Sec. 5.0 v 3.0 amp CT			55C			672N113A
T109	Trans., Bias Rect. Plate	Pri: 210, 220, 230, 240, 250 v 50/60 cps Sec: 430 v 0.18 amp CT			55C			672N257
T110	Trans., L.V. Rect. Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps 37.5 VA Sec: 2.50 v 15.0 amp CT			55C			672N148
T111	Trans., L.V. Rect. Plate	Pri: 220, 230, 240 v 50/60 cps 240 VA Sec: 1200 v 0.283 amp CT 340 VA			55C			672N106A
T112	Trans., Modulator Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps 65 VA Sec: 10.0 v 6.5 amp CT			55C			672N110A
T113	Trans., H.V. Rect. Fil.	Pri: 210, 220, 230, 240, 250 v 50/60 cps 37.5 VA Sec: 2.5 v 15.0 amp CT			55C			672N114A
T114	Trans., Relay Supply	Pri: 210, 220, 230, 240, 250 v 50/60 cps Sec. # 1: 150 v 0.75 amp Sec. # 2: 110 v 0.5 amp			55C			674N269
T115	Trans., H.V. Rect. Plate	Pri: 240, 230, 220 v 50/60 cps 1035 VA Sec: 4600 v 0.325 amp CT			55C			672N107
T116	Trans., Modulation	Pri: 12,500 ohm CT Sec #1: 5000 ohm Sec #2: 320 ohm 100-5000 cps			55C			677N104
T117	Trans., Line Voltage Adj.	Pri: 230, 220, 210 v Sec: 110 v 2750 VA 50/60 cps			55C			664S141
T118	CFI Output Coupling	Pri: 10,000 ohm Sec: 500 ohm CT 0.25 w			55C			677 0001 00

PARTS LIST BY SYMBOL DESIGNATION

VACUUM TUBES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
V101	Tube, R-F Master Osc.	Pentagrid Converter			* *	6A8		255.6A8
V102	Tube, R-F Buffer-Amp.	Video Beam Power Amp.			* *	6AG7		255.6AG7
V103	Tube, 1st R-F Freq. Mult.	Beam Pentode Power Amp.			10R	807		256.807
V104	Tube, 2nd R-F Freq. Mult.	Same as V103						
V105	Tube, Power Amplifier	Beam Pentode Power			10R	813		256.813
V106	Tube, Power Amplifier	Same as V105						
V107	Tube, Keyer	Triple Grid Amplifier			* *	6SJ7		255.6SJ7
V108	Tube, Voltage Regulator	Volt. Reg. 150 v 30 ma max.			* *	VR150-30		257.VR150-30
V109	Tube, Calibration Osc.	Same as V101						
V110	Tube, Converter	Twin-Triode Amplifier			* *	6SL7GT		255.6SL7GT
V111	Tube, CFI Audio Amp.	Twin-Triode Amplifier			* *	6SN7GT		255.6SN7GT
V112	Tube, MCW Osc.-Amp.	Same as V111						
V113	Tube, Audio Preamp.	Same as V110						
V114	Tube, Volume Limiter	Twin Triode			* *	6C8G		255.6C8G
V115	Tube, Audio Squelch	Same as V114						
V116	Tube, Audio Amp.	Same as V107						
V117	Tube, Limiter Control	Full Wave, High Vacuum Rectifier			* *	6X5GT		255.6X5GT
V118	Tube, Audio Driver	Triode Power Amplifier			* *	2A3		255.2A3
V119	Tube, Audio Driver	Same as V118						
V120	Tube, Modulator	Triode Power Amplifier			10R	805		256.805
V121	Tube, Modulator	Same as V120						
V122	Tube, H.V. Rect.	Half-Wave, Mercury Vapor Rect.			70A	249C		256.249C
V123	Tube, H.V. Rect.	Same as V122						
V124	Tube, Bias Rect.	Full Wave, High Vacuum Rect.			* *	5U4G		255.5U4G
V125	Tube, L.V. Rect.	Full Wave, Mercury Vapor Rect.			10R	866/866A		256.866/866A
V126	Tube, L.V. Rect.	Same as V125						

* * Supplied by numerous well known manufacturers.

SOCKETS

X101	Socket for V101	Iso Octal Base	-49367		77J			220N581
X102	Socket for V102	Same as X101						
X103	Socket for V103	Iso 5 Prong Base			77J	225		220N552
X104	Socket for V104	Same as X103						

PARTS LIST BY SYMBOL DESIGNATION

SOCKETS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
X105	Socket for V105	Wafer 7 Prong "Jumbo"			77J	237		220N571
X106	Socket for V106	Same as X105						
X107	Socket for V107	Same as X101						
X108	Socket for V108	Same as X101						
X109	Socket for V109	Same as X101						
X110	Socket for V110	Same as X101						
X111	Socket for V111	Same as X101						
X112	Socket for V112	Same as X101						
X113	Socket for V113	Same as X101						
X114	Socket for V114	Same as X101						
X115	Socket for V115	Same as X101						
X116	Socket for V116	Same as X101						
X117	Socket for V117	Same as X101						
X118	Socket for V118	Iso 4 Prong Low Loss Ceramic			77J	224		220N545
X119	Socket for V119	Same as X118						
X120	Socket for V120	Bayonet 4 Prong Socket			77J	211		220N542
X121	Socket for V121	Same as X120						
X122	Socket for V122	Bayonet 4 Prong Socket			05N	XM-10		220N641
X123	Socket for V123	Same as X122						
X124	Socket for V124	Same as X101						
X125	Socket for V125	Same as X122						
X126	Socket for V126	Same as X122						
X127	Socket for Y101	Same as X101						

CRYSTALS

Y101	Calib. Osc. Crystal	200 Kc Quartz			64C	146A		146A

PARTS LIST BY SYMBOL DESIGNATION

Navy Type COL-23377 Remote Control Unit

CAPACITORS

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
C301	Cap., V301 Cathode Bypass	.25 mf ±20% 600 WV	-481392-20		75C 64S 66S			956NS05W-M
C302	Cap., V301 Output Coupl.	.1 mf ±20% 600 WV			64S			956NS01V-M
C303	C303A, C303B & C303C	4/4/4 mf ±20% 600 WV	-481401-20		75C	KC-6		956NT7J-M
C303A	Cap., V301 H.V. Filter	Section of C303						
C303B	Cap., V302 Cathode Bypass	Section of C303						
C303C	Cap., V302 Plate Supply Filter	Section of C303						
C304	Cap., V301 Screen Decoupl.	.1 mf ±20% 600 WV			75C			956NS01W-M
C305	C305A, C305B & C305C	Same as C303						
C305A	Cap., Preamp. H.V. Filter	Section of C305						
C305B	Cap., Preamp. H.V. Filter	Section of C305						
C305C	Cap., Preamp. H.F. Filter	Section of C305						
C306	C306A, C306B & C306C	Same as C303						
C306A	Cap., Preamp. H.V. Filter	Section of C306						
C306B	Cap., Preamp. H.V. Filter	Section of C306						
C306C	Cap., Preamp. H.F. Filter	Section of C306						

MISCELLANEOUS ELECTRICAL PARTS

E301	Terminal Strip	14 Term. Conn. Strip			91J	240		367N614

FUSE

F301	Fuse, Preamp. Pri. Power	¼ amp 250 v 1-¼" x ¼" Cart.			78L	3AG		264N424

LAMPS

I301	Unit Power Pilot Lamp	6.3 v 0.15 amp Miniature Bayonet Base			40G 66R	47		262N324

PARTS LIST BY SYMBOL DESIGNATION

JACKS AND RECEPTACLES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
J301	Key Cord Plug Recpt.	Phone Jack			20W	248E		360N116
J302	Microphone Plug Recpt.	4 Term. female conn.			60A	PC4F		369N9
J303	Receptacle for F301	Extracter or post type			97B	HCM		265N206

RELAYS

K301	Relay, Receiver Disabling	12 to 24 ma 24 to 48 v 1950 ohm Coil			78K	2C-38-S		408N7

INDUCTORS AND REACTORS

L301	Preamp. H.V. Filter Reactor	15 hy 0.02 amp 500 ohm			55C			678N118A
L302	Preamp. H.V. Filter Reactor	Same as L301						

METERS

M301	Meter, Channel Ind.	0-50 v d-c 10 Div.			45W 40G	301		458N035CN
M302	Meter, Audio Level	16 Scale Div.			45W	301		455N2N

CONNECTOR PLUGS

P301	Unit Primary Power Conn. Plug	2 term. male conn.			40G	GE-2711		368N37

RESISTORS

R301	Res., Preamp. Gain Cont.	50,000 ohm Pot.			28J	CS		380NC50M
R302	Res., V301 Grid	100,000 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH100M-M
R303	Res., V301 Cathode	2700 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH2700-M
R304	Res., V301 Pl. Decoupling	47,000 ohm ±20% 2 w	-63426		28J	BT2		729NH47M-M
R305	Res., V301 Screen	270,000 ohm ±20% 2 w			28J	BT2-Navy		729NH270M-M
R306	Res., V301 H.V. Dropping	5600 ohm ±20% 2 w			28J	BT2-Navy		729NH5600-M
R307	Res., V302 Feedback Coupling	1 Megohm ±20% 2 w	-63426		28J	BT2-Navy		729NH1Meg-M
R308	Res., V302 Grid	510,000 ohm ±20% 2 w	-63426		28J	BT2:Navy		729NH510M-M
R309	Res., V302 Cathode	820 ohm ±20% 2 w			28J	BT2-Navy		729NH820-M
R310	Res., Channel Ind. Adj.	50,000 ohm Pot.	-63854		28J	CS		380NA50M

PARTS LIST BY SYMBOL DESIGNATION

RESISTORS (Cont.)

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
R311	Res., V302 Grid	Same as R307						
R312	Res., Voltage Dividing	1300 ohm ±20% 2 w			28J	BT2-Navy		729NH1300-M
R313	Res., V302 Plate	10,000 ohm ±20% 2 w	RC41BF103M		28J	BT2-Navy		729NH10M-M
R314	Res., V302 Grid	Same as R307						
R315	Res., Rec. Disabling Control	10,000 ohm Pot.			28J	W-1000		381NA10M
R316	Res., Voltage Dividing	2400 ohm ±20% 2 w	-63426		28J	BT2-Navy		729NH2400-M
R317	Res., Voltage Dividing	Same as R316						
R318	Res., Voltage Dividing	Same as R316						
R319	Res., Voltage Dividing	1100 ohm ±20% 2 w			28J	BT2-Navy		729NH1100-M
R320	Res., Voltage Dividing	Same as R319						
R321	Res., Voltage Dividing	Same as R319						

SWITCHES

S301	Switch, Telephone Dial	11 Point Delayed Impulse			34A	H-70227		978N1
S302	Switch, Remote Control Unit Power	DPDT 1 amp 250 v d.c. Toggle			84A			266N103

TRANSFORMERS

T301	Trans., Preamp. Input	Pri #1: 500 ohm Pri #2: 75 ohm Sec: 40,000 ohm 100 to 5000 cps			55C			677N270
T302	Trans., Preamp. Output	Pri: 15,000 ohm Sec: 500 ohm 100 to 5000 cps			20T			677N143
T303	Trans., Preamp. Power	Pri: #1: 105, 110, 115, 120, 125 v 50/60 cps Sec #1: 400 v 0.025 amp CT Sec #2: 6.3 v 2.0 amp CT			55C			672N255

PARTS LIST BY SYMBOL DESIGNATION

VACUUM TUBES

Symbol Designation	Function	Description	Navy Type Designation	Navy Spec. or Dr. Number	Mfr. Code	Mfr's Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
V301	Tube, 1st Amplitier	Triple Grid Amplifier			* *	6SJ7		255.6SJ7
V302	Tube, 2nd Amplifier	Twin-Triode Amplifier			* *	6SN7GT		255.6SN7GT
V303	Tube, Unit Power Rect.	Full Wave, High Vacuum Rect.			* *	6X5GT		255.6X5GT

SOCKETS

X301	Socket for V301	Iso Octal Base Socket	-49367		77J			220N581
X302	Socket for V302	Same as X301						
X303	Socket for V303	Same as X301						

* * Supplied by numerous well known manufacturers.

APPENDIX

TABLE III

PARTS LIST BY NAVY TYPE NUMBER

Quantity	Navy Type Number	All Symbol Designations Involved
		MOTORS
1		B101
1		B102
		CAPACITORS
2	-48312-B20	C118, C119
4	-48645-B5	C101, C102, C103, C104
3	-48849-A20	C115, C116, C146
6	-481392-20	C154, C155, C162, C163, C164, C301
2	-481395-10	C171, C172
5	-481401-20	C152, C159, C303, C305, C306
1	-481402-10	C158
8	-481410-B20	C120, C124, C127, C133, C134, C139, C143, C149
11	-481411-B20	C113, C117, C123, C129, C147, C148, C150, C174, C177, C178, C179
1		C105
1		C106
1		C107
1		C108
2		C109, C110
1		C111
1		C112
3		C114, C140, C180
2		C121, C131
2		C122, C128
2		C125, C132
1		C126
1		C130
1		C135
3		C136, C137, C138
2		C141, C142
1		C144
2		C145, C153
8		C151, C156, C157, C165, C166, C167, C168, C169
2		C160, C173
1		C161
1		C170
1		C175
1		C176
1		C180
1		C302
1		C304

Quantity	Navy Type Number	All Symbol Designations Involved
		DISC RECTIFIERS
1		CR101
		MISCELLANEOUS ELECTRICAL PARTS
1		E101
1		E102
1		E103
1		E104
1		E105
2		E106, E112
1		E107
1		E108
1		E109
1		E110
2		E111, E122
1		E113
1		E114
4		E115, E117, E118, E119
1		E116
1		E120
1		E121
1		E123
1		E124
1		E301
		FUSES
2		F101, F104
3		F102, F105, F106
2		F103, F116
3		F107, F109, F112
1		F108
2		F110, F111
1		F113
2		F114, F115
1		F301
		LAMPS
1		I101
1		I102
1		I301
		JACKS & RECEPTACLES
4		J101, J104, J108, J110
1		J102
1		J103

APPENDIX

PARTS LIST BY NAVY TYPE NUMBER

Quantity	Navy Type Number	All Symbol Designations Involved
		JACKS & RECEPTACLES (Cont.)
1		J105
2		J106, J109
2		J107, J112
1		J111
7		J113, J114, J115, J116, J119, J120, J121
1		J117
1		J118
1		J122
1		J123
1		J301
1		J302
		RELAYS
1		K101
2		K102, K106
4		K103, K104, K105, K115
1		K107
1		K108
1		K109
2		K110, K111
2		K112, K113
1		K114
1		K116
1		K117
1		K118
1		K301
		INDUCTORS & REACTORS
2		L101, L103
1		L102
1		L104
11		L105, L106, L107, L108, L110, L114, L119, L120, L130, L131, L133
1		L109
2		L111, L115
2		L112, L116
1		L113
1		L117
1		L118
1		L121
1		L122
1		L123
2		L124, L125
2		L126, L127
2		L128, L129
1		L132
2		L301, L302
		METERS
1	-22367	M103
1	-22369	M101
1	-22371	M102
1	-22374	M105
1		M104
1		M301
1		M302
		CONNECTOR PLUGS
2		P101, P108
2		P102, P111
1		P103
1		P104
2		P105, P107
1		P106
1		P109
1		P110
1		P112
1		P301
		RESISTORS
55	-63426	R108, R109, R110, R112, R116, R121, R122, R127, R128, R148, R149, R153, R154, R155, R156, R157, R158, R159, R160, R163, R164, R165, R166, R167, R168, R173, R174, R175, R176, R177, R179, R180, R182, R183, R184, R185, R186, R189, R190, R191, R192, R193, R194, R208, R210, R302, R303, R304, R307, R308, R311, R314, R316, R317, R318
2	-63854	R187, R310
2	RC 30BF470M	R111, R114
4	RC 41BF103M	R105, R117, R209, R313
1	RC 41BF203M	R152
1	RC 41BF223M	R118
1	RC 41BF473M	R188
1		R101
2		R102, R103
1		R104
1		R106
2		R107, R151
1		R113
1		R115
1		R119

APPENDIX

PARTS LIST BY NAVY TYPE NUMBER

Quantity	Navy Type Number	All Symbol Designations Involved
		RESISTORS (Cont.)
1		R120
1		R123
3		R124, R125, R126
1		R129
8		R130, R131, R132, R133, R134, R135, R136, R207
10		R137, R138, R139, R140, R141, R142, R143, R144, R145, R146
1		R147
2		R150, R161
2		R162, R178
2		R169, R172
2		R170, R171
1		R181
1		R195
1		R196
1		R197
1		R198
1		R199
2		R200, R201
1		R202
3		R203, R204, R205
1		R206
4		R211, R212, R213, R214
1		R301
1		R305
1		R306
1		R309
1		R312
1		R315
3		R319, R320, R321
		SWITCHES
1		S101
2		S102, S124
1		S103
3		S104, S105, S106
2		S107, S108
1		S109
1		S110
1		S111
1		S112
1		S113
1		S114
2		S115, S117
2		S116, S118
1		S119
1		S120
2		S121, S122
1		S123
1		S301
1		S302
		TRANSFORMERS
1		T101
1		T102
1		T103
1		T104
1		T105
1		T106
1		T107
1		T108
1		T109
1		T110
1		T111
1		T112
1		T113
1		T114
1		T115
1		T116
1		T117
1		T118
1		T301
1		T302
1		T303
		VACUUM TUBES
2		V101, V109
1		V102
2		V103, V104
2		V105, V106
2		V107, V116
1		V108
2		V110, V113
2		V111, V112
2		V114, V115
1		V117
2		V118, V119
2		V120, V121
2		V122, V123
1		V124
2		V125, V126
1		V301
1		V302
1		V303

APPENDIX

PARTS LIST BY NAVY TYPE NUMBER

Quantity	Navy Type Number	All Symbol Designations Involved
		SOCKETS
18	-49367	X101, X102, X107, X108, X109, X110, X111, X112, X113, X114, X115, X116, X117, X124, X127, X301, X302, X303
2		X103, X104
2		X105, X106
2		X118, X119
2		X120, X121
4		X122, X123, X125, X126
		CRYSTALS
1		Y101

TABLE IV

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

CAPACITORS

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and/or Spec.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1	-48312-B20	C118, C119	.1 mf Dual Sect. ±20% 600 WV		66S			956ND01W-M
2	-48645-B5	C101, C102, C103, C104	.001 mf ±20% 1000 TV		75C	4LSE		910N210D-M
2	-48849-A20	C115, C116, C146	.1 mf Triple Sect. ±20% 600 WV		75C 64S 66S	 2527-8		956NT01W-M
1	-481392-20	C152, C159	.25 mf ±20% 600 WV		34S			956NS05V-M
1	-481395-20	C171, C172	4 mf ±20% 3000 WV		75C			930N43A-M
1	-481402-10	C158	Spec. Mult. Sect. ±10% 600 WV		75C			956NM1-K
4	-481410-B20	C120, C124, C127, C133, C134, C139, C143, C149	.001 mf ±20% 1500 TV		02S	BE-15		915N210E-M
6	-481411-B20	C113, C117, C123, C129, C147, C148, C150, C174, C177, C178, C179	.006 mf ±20% 1500 TV		02S	BE-15		915N260E-M
1		C106	.0007 mf ±10% 5000 TV		66S 75C 02S	 6LS F2		906N370A-K
1		C107	.0001 mf ±20% 5000 TV		75C	6L		906N310A-M
1		C109, C110	.001 mf ±20% 5000 TV		75C	6LS		906N210A-M
1		C111	.0023 mf ±5% 500 WV		25C			913 0006 00
1		C112	.00002 mf ±.5 mmf 500 WV		25C	D		913 0004 00
1		C114	.001 mf ±5% 500 WV		25C			913 0007 00
2		C121, C131, C304	.1 mf ±20% 1200 TV		75C			956NS01W-M
1		C122, C128	.1 mf ±20% 600 WV		66S 75C 64S	 		956NS01Y-M
1		C135	.0001 mf ±10% 1500 TV		02S	BE-15		915N310E-K
2		C136, C137, C138	.01 mf ±20% 1000 TV		75C 02S 64S	9L A-10 XM		910N110A-M

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

CAPACITORS (Cont.)

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and/or Spec.	Mfr. Code	Mfr's. Design-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		C140, C180	.001 ±5% 500 TV		34S			912N210H-M
1		C141, C142	.02 mf ±20% 600 WV		75C 64S 66S			956NS14W-M
1		C144	.00025 mf ±20% 1500 TV		02S			915N325E-M
1		C145, C153	.5 mf ±20% 600 WV		75C	DYRT		956NS08W-M
7		C151, C156, C157, C165, C166, C167, C168, C169, C303, C305, C306	4/4/4 mf ±20% 600 WV		75C			956NT7J-M
4		C154, C155, C162, C163, C164, C301	.25 mf ±20% 600 WV		75C 64S 66S			956NS05W-M
2		C160, C173, C302	.1 mf ±20% 600 WV		64S			956NS01V-M
1		C161	8.5 mf ±10% 600 TV		75C 64S 66S			933N1-K
1		C170	0.15 mf ±10% 4000 WV		75C	TJU		930N85-K

MISCELLANEOUS ELECTRICAL PARTS

1		E104	10 ohm ±20% 1 w 8 turns		64C	GA-1064A		1064A

FUSES

20		F101, F104	⅜ amp Slo-Blo Fuse		78L	3AG		264N425
50		F102, F105, F106, F301	¼ amp 250 v Slo-Blo 1¼" x ¼" cartridge		78L	3AG		264N424
20		F103, F116	¾ amp 250 v Slo-Blo 1¼" x ¼" cartridge		78L	3AG		264N427
30		F107, F109, F112	½ amp 250 v Slo-Blo 1¼" x ¼" cartridge		78L	3AG		264N426

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

FUSES (Cont.)

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and/or Spec.	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
10		F108	3 amp 250 v 1¼" x ¼" cartridge		78L	3AG		264N408
					97B	3AG		
20		F110, F111	2 amp 250 v 1¼" x ¼" cartridge		78L	3AG		264N407
					97B	3AG		
10		F113	½ amp 5000 v		78L	3024		264N815
4		F114, F115	25 amp 250 v cartridge		65J	380-025		264N225A
20		F114, F115	25 amp 250 v Link for Part No. 264N225A (F114, F115)		65J	381-025		264N225B

PILOT LAMPS

6		I101, I102	110 v Pilot Lamp		40G	S-6		262N331
6		I301	6.3 v Pilot Lamp		40G	47		262N324

RELAYS

1		K101	Current Coil for 405NC4		88S	PB		406NC5
1		K101	Voltage Coil for 405NC4		88S	M		406NC6
4		K101	Stat. Contact for 405NC4		88S			406NC7
2		K101	Movable Cont. for 405NC4		88S			406NC8
4		K102, K106	Contacts for 972N4		34A	H-70357-4		973N4
3		K102, K106, K109	Coil for 972N4 and 972N15		34A	H-70226-14		973N18
8		K103, K104, K105, K115	48 v d-c DPDT		65G	JD48RR		405NB209
1		K107	25 Pos. Rotary Switch		34A			978N2
2		K108	Contacts for 972N1		34A	H-70357-1		973N1
1		K108	Coil for 972N1		34A	H-70226-12		973N16
2		K109	Contacts for 972N15		34A			973N27
4		K110, K111	Contacts for 972N13		34A	H-73507-5		973N5
2		K110, K111	Coil for 972N13		34A			973N26
20		K112, K113, K118	Mov. Cont. for 405NA104 and 405NA105		22A	X-68996		406NA102

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

RELAYS (Cont.)

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and/or Spec.	Mfr. Code	Mfr's. Designation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
3		K112, K113, K118	Coils for 405NA104 and 405NA105		22A			406NA106
4		K112, K113	Stat. Cont. for 405NA104		22A			406NA104
2		K116	130 ma 1 PNO Double-Break Cont.		65G	J		405NB212
1		K117	Coil for 407N61		42L	359		409N5
4		K117	Movable Cont. for 407N61		42L			409N16
4		K117	Top Stat. Cont. for 407N61		42L			409N24
4		K117	Bottom Stat. Cont. for 407N61		42L			409N25
2		K118	Stat. Cont. for 405NA105		22A			406NA107
2		K301	Coil for 408N7		78K	#38		409N10
4		K301	Mov. Cont. for 408N7		78K	205A		409N12
8		K301	Stat. Cont. for 408N7		78K			409N13

METERS

1		M101	0-3 amp R. F. Ammeter		45W	425E		451NC3EN
1		M102	0-3 kv D. C. Voltmeter		45W	301		458N024CN
1		M103	0-800 D. C. Milliammeter		45W	301		450NC800N
1		M104	0-5 v 1000 ohm/v Voltmeter		40G 45W	DO-53 301		458N0314CN
1		M105	0-300 a. c. Voltmeter		45W	476		458N061CN
1		M301	Channel Indicator		45W 40G	301		458N035CN
1		M302	Output Indicator		45W	301		455N2N

RESISTORS

3	-63426	R108, R112, R127, R154, R158	51,000 ohm ±20% 2 w		28J	BT2-Navy		729NH51M-M
4	-63426	R109, R110, R316, R317, R318	2400 ohm ±20% 2 w		28J	BT2-Navy		729NH2400-M

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

RESISTORS (Cont.)

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and/or Spec.	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
5	-63426	R116, R148, R153, R307, R311, R314	1 Megohm ±20% 2 w		28J	BT2-Navy		729NH1Meg-M
4	-63426	R121, R122, R176, R184, R190, R191, R194	5100 ohm ±20% 2 w		28J	BT2-Navy		729NH5100-M
4	-63426	R128, R157, R174, R179, R180, R182, R302	100,000 ohm ±20% 2 w		28J	BT2-Navy		729NH100M-M
3	-63426	R149, R164, R165, R166, R167	24,000 ohm ±10% 2 w		28J	BT2-Navy		729NH24M-K
3	-63426	R155, R156, R163, R175, R189	1000 ohm ±20% 2 w		28J	BT2-Navy		729NH1M-M
1	-63426	R159, R160	12,000 ohm ±10% 2 w		28J	BT2-Navy		729NH12M-K
1	-63426	R168, R173	15,000 ohm ±5% 2 w		28J	BT2		729NH15M-J
1	-63426	R177	5 Megohm ±20% 2 w		28J	BT2-Navy		729NH5Meg-M
1	-63426	R183	2000 ohm ±20% 2 w		28J	BT2-Navy		729NH2M-M
2	-63426	R192, R193, R210, R215	510 ohm ±20% 2 w		28J	BT2-Navy		729NH510-M
2	-63426	R208, R308	510, 000 ohm ±20% 2 w		28J	BT2-Navy		729NH510M-M
1	-63426	R303	2700 ohm ±20% 2 w		28J	BT2-Navy		729NH2700-M
1	RC30BF470M	R111, R114	47 ohm ±20% 1 w		65S			729NG47-M
2	RC41BF103M	R185, R186, R313	10,000 ohm ±20% 2 w		28J	BT2-Navy		729NH10M-M
1	RC41BF203M	R152	20,000 ohm ±20% 2 w		28J	BT2-Navy		729NH20M-M
1	RC41BF203M	R118	22,000 ohm ±20% 2 w		28J	BT2		729NH22M-M
2	RC41BF473M	R188, R304	47,000 ohm ±20% 2 w		28J	BT2-Navy		729NH47M-M
1		R101	3 Megohm Ferrule		28J			732NB3Meg
1		R102, R103	186 ohm ±20% 18 w		16W			711 0004 00
1		R104	100 ohm ±20% ½ w		28J	BW½		707N100N-M
2		R105, R117, R209	10,000 ohm ±10% 2 w		28J	BT2-Navy		729NH10M-K
1		R106	200 ohm ±20% 2 w		28J	133-0200-7		709N200N-M
1		R107, R151	30,000 ohm ±20% 2 w		28J	BT2-Navy		729NH30M-M
1		R113	510 ohm ±20% 6 w		25P 05W			733NF510-M
1		R115	2400 ohm ±10% 28 w		25P			733NC2400-K
1		R119	101 ohm ±1% WW3		28J	WW3		721N101-F

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

RESISTORS (Cont.)

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and /or Spec.	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1		R120	1250 ohm ±1% WW3		28J	WW3		721N1250-F
1		R123	10,000 ohm ±10% 28 w		05W			733NC10M-K
2		R124, R125, R126	1500 ohm ±10% 2 w		28J	BT2		729NH1500-K
1		R129	5600 ohm ±5% 28 w		25P			733NC5600-J
4		R130, R131, R132, R133, R134, R135, R136, R207	16,000 ohm ±10% 2 w		28J	BT2-Navy		729NH16M-K
5		R137, R138, R139, R140, R141, R142, R143, R144, R145, R146	1000 ohm ±1% WW3		28J	WW3		721N1M-F
1		R147	8200 ohm ±10% 24 w		25P			733ND8200-K
1		R150, R161	36,000 ohm ±10% 2 w		28J	BT2-Navy		729NH36M-K
1		R169, R172	30,000 ohm ±5% 2 w		28J	BT2-Navy		729NH30M-J
1		R170, R171	43,000 ohm ±5% 2 w		28J	BT2-Navy		729NH43M-J
1		R181	750 ohm ±20% 24 w		25P 05W			733ND750-M
1		R195	240 ohm ±10% 24 w		25P			733ND240-K
1		R196	130 ohm ±10% 24 w		05W			733ND130-K
1		R197	43 ohm ±10% 10 w		05W			733NE43-K
1		R198	82 ohm ±10% 10 w		05W			733NE82-K
1		R199	1300 ohm ±10% 80 w		05W			733NA1300-K
1		R200, R201	5100 ohm ±10% 24 w		05W			733ND5100-K
1		R202	2400 ohm ±10% 60 w		25P 05W			733NB2400-K
2		R203, R204, R205	20,000 ohm ±20% 80 w		05W			733NA20M-M
1		R206	88 ohm ±20% 600 w		65W	RB60		711NE88-M
2		R211, R212, R213, R214	115 v 100 w 132 ohm		16W	781		711 0001 00
1		R305	270,000 ohm ±20% 2 w		28J	BT2-Navy		729NH270M-M
1		R306	5600 ohm ±20% 2 w		28J	BT2-Navy		729NH5600-M
1		R309	820 ohm ±20% 2 w		28J	BT2-Navy		729NH820-M
1		R312	1300 ohm ±20% 2 w		28J	BT2-Navy		729NH1300-M
3		R319, R320, R321	1100 ohm ±20% 2 w		28J			729NH1100-M

SPARE PARTS LIST BY NAVY TYPE NUMBER

Spare Parts for The Navy Model TDO Radio Transmitting Equipment

MISCELLANEOUS

Quan.	Navy Type Number	All Symbol Designations Involved	Description	Navy Dr. and /or Spec.	Mfr. Code	Mfr's. Desig-nation	Spcl. Tol. or Mod.	Contractor's Drawing or Part Number
1			#4 Bristo Wrench		72B			24N29
1			#6 Bristo Wrench		72B			24N973
1			#8 Bristo Wrench		72B			24N972
1			#10 Bristo Wrench		72B			24N971
1			#1 Phillips Scr. Driver		48B			24N4557
1			#2 Phillips Scr. Driver		48B			24N4558
1			#1 Angle Phillips Scr. Driver		01V			24N30
1			Spare Parts Box					500 0731 00D
2			Spare Parts Box Tray					500 0727 00C
1			Spare Parts Box Tray					500 0728 00C
1			¼" Hex. Spintite Wrench		78S			024 0016 00
1			.005" Feeler Gauge		83G			024 0017 00
1			Relay Adj. Tool		34A			24N35

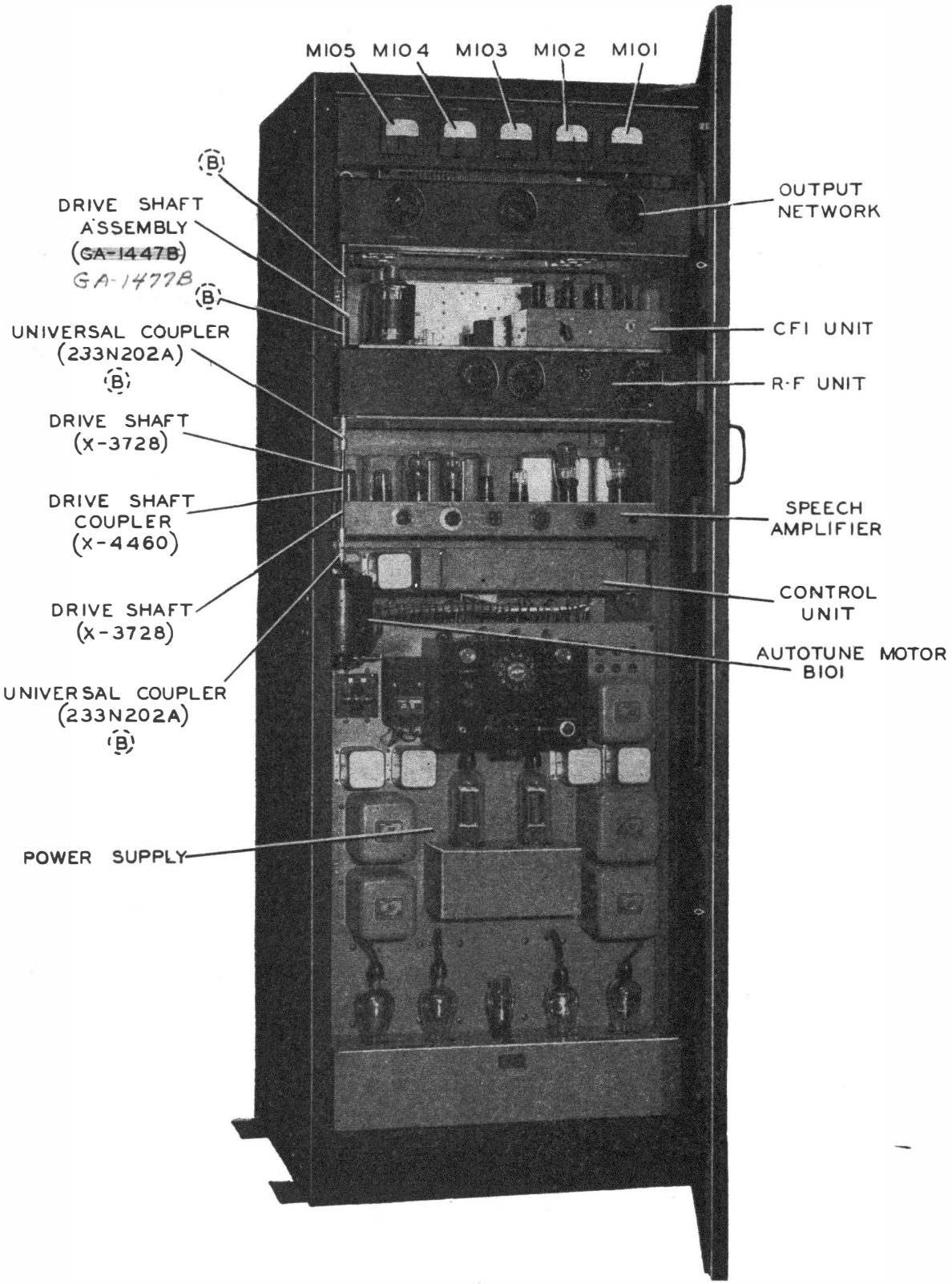


Fig. 46 Radio Transmitter—Front Open View

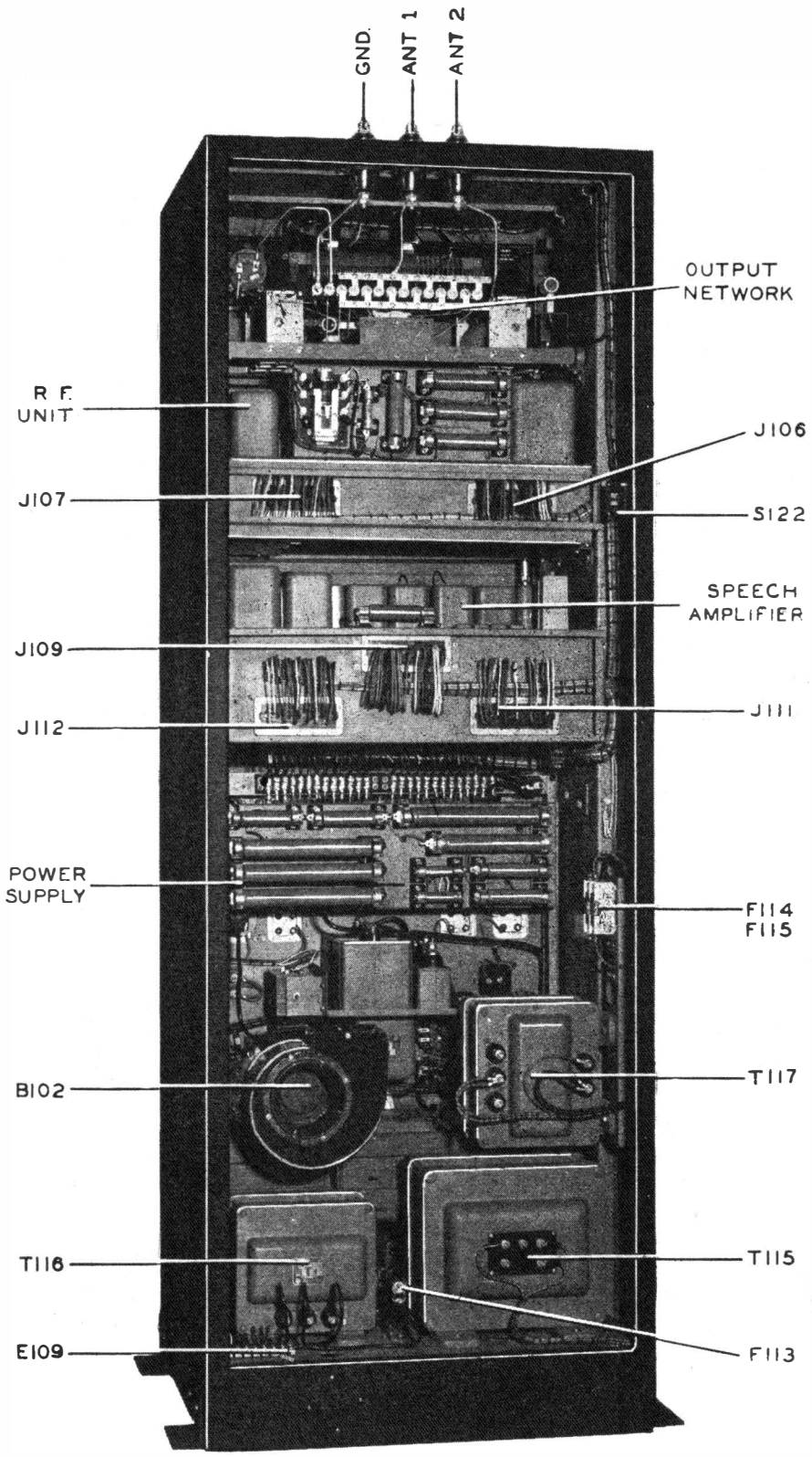


Fig. 47 Radio Transmitter—Rear Open View

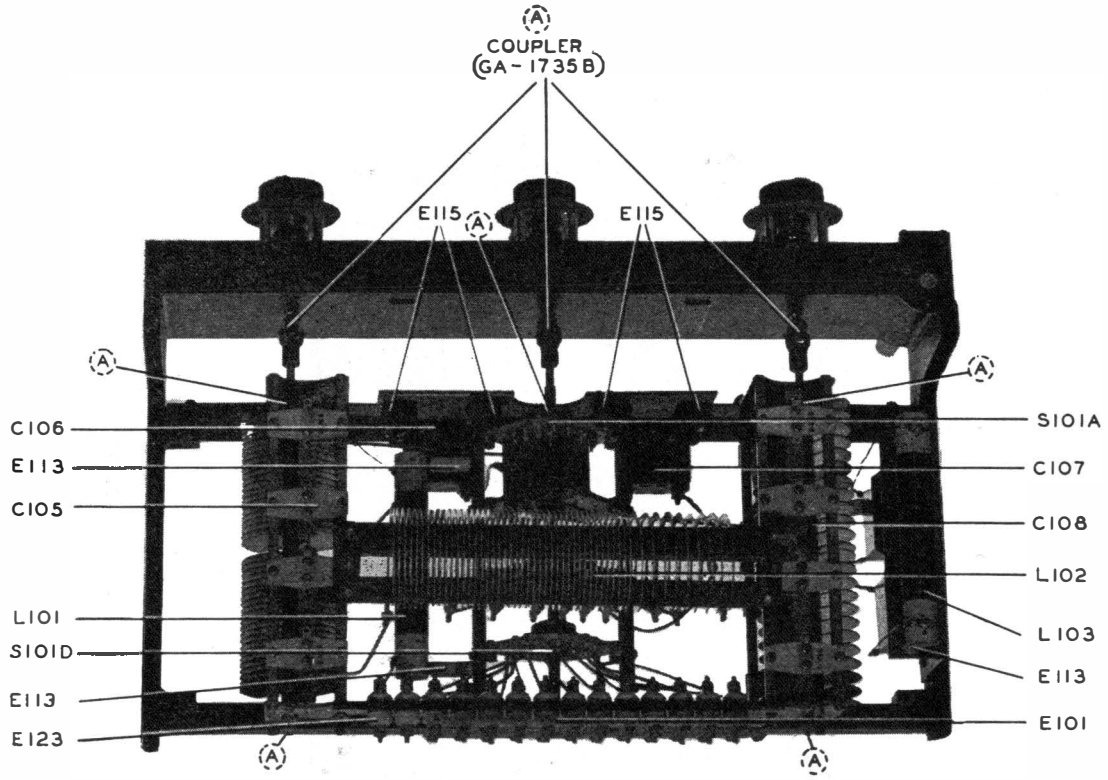


Fig. 48 Output Network—Top View

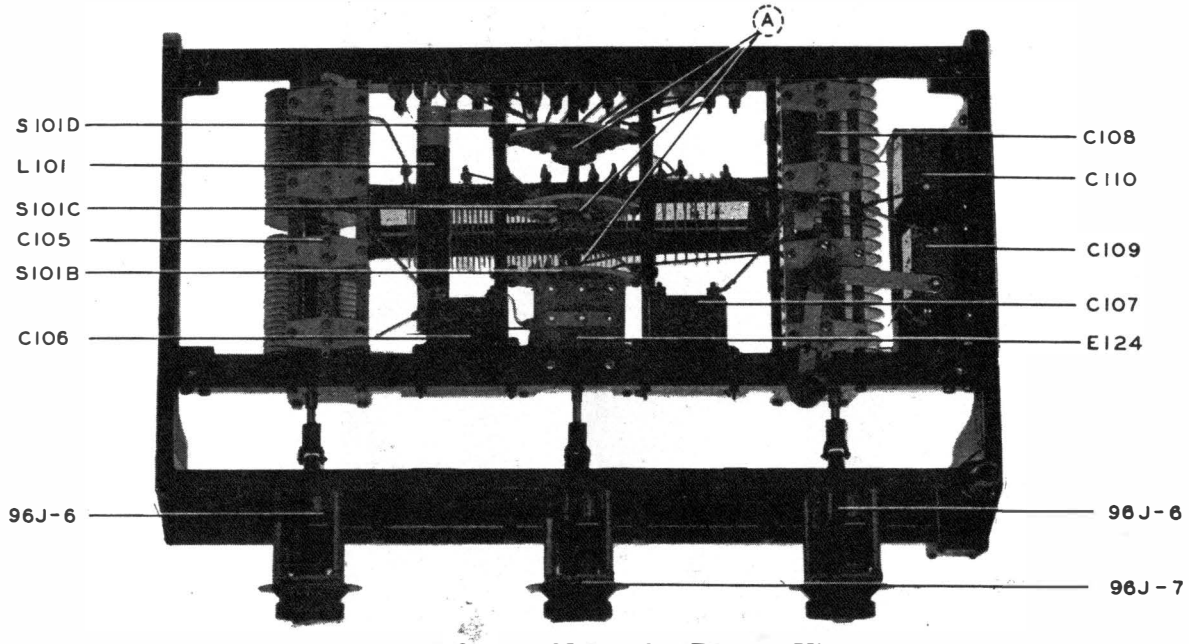


Fig. 49 Output Network—Bottom View

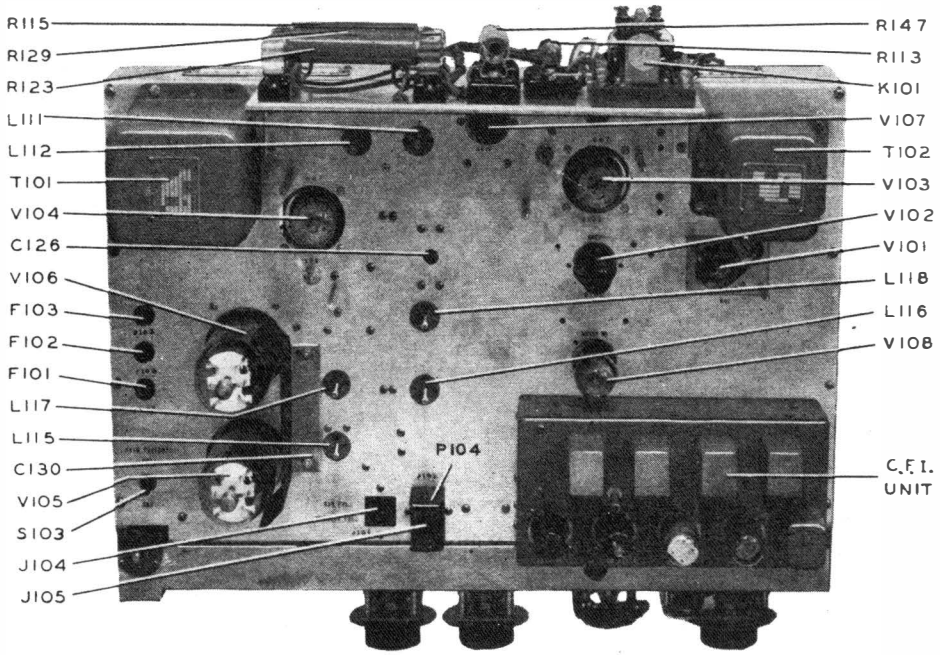


Fig. 50 Radio-Frequency Unit—Top View

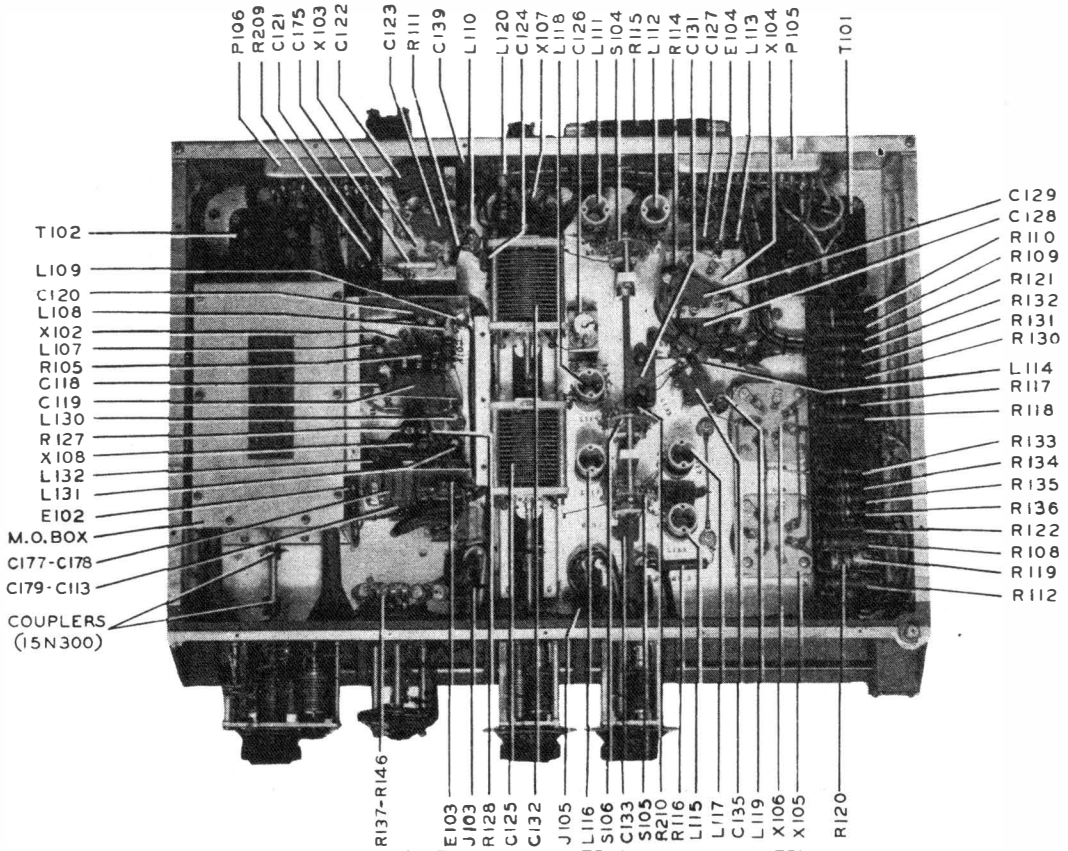


Fig. 51 Radio-Frequency Unit—Bottom View

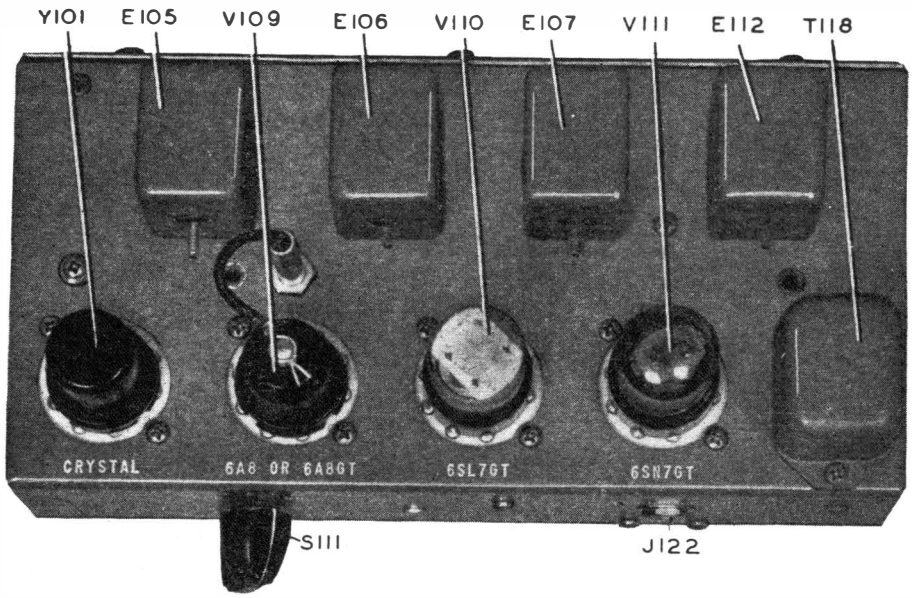


Fig. 52 Crystal Frequency Indicator—Top View

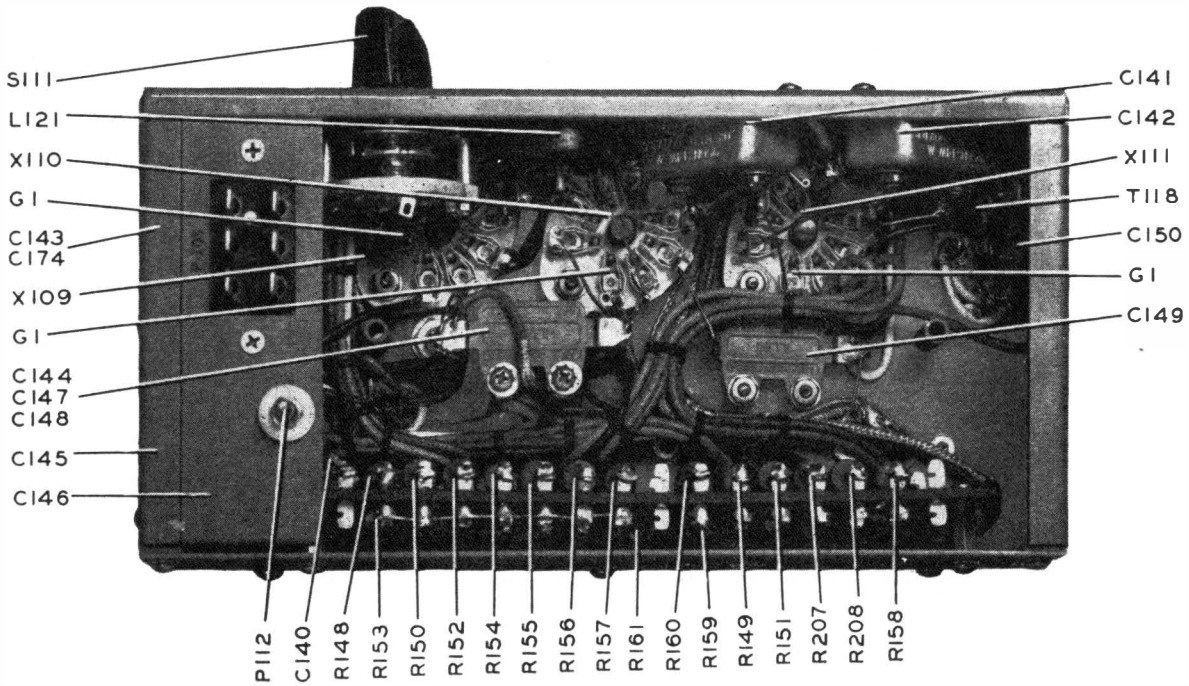
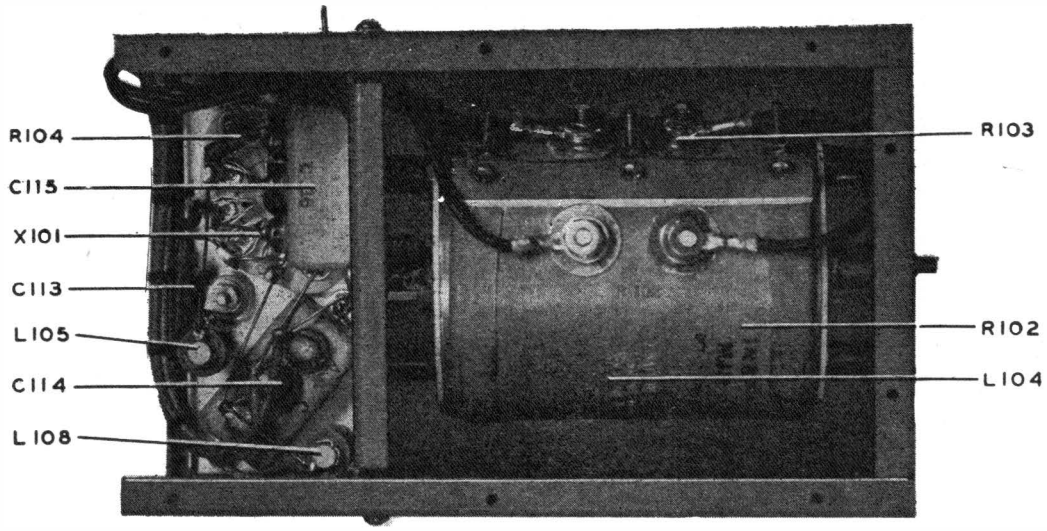


Fig. 53 Crystal Frequency Indicator—Bottom View



NOTE: Transmitters with Serial Nos. following No. 16 supplied on Contract NXss-24869 are equipped with two MO compartment thermostats. The thermostats, S102 and S125, are mounted on the outside of heaters R102 and R103.

Fig. 54 Master Oscillator—Bottom View

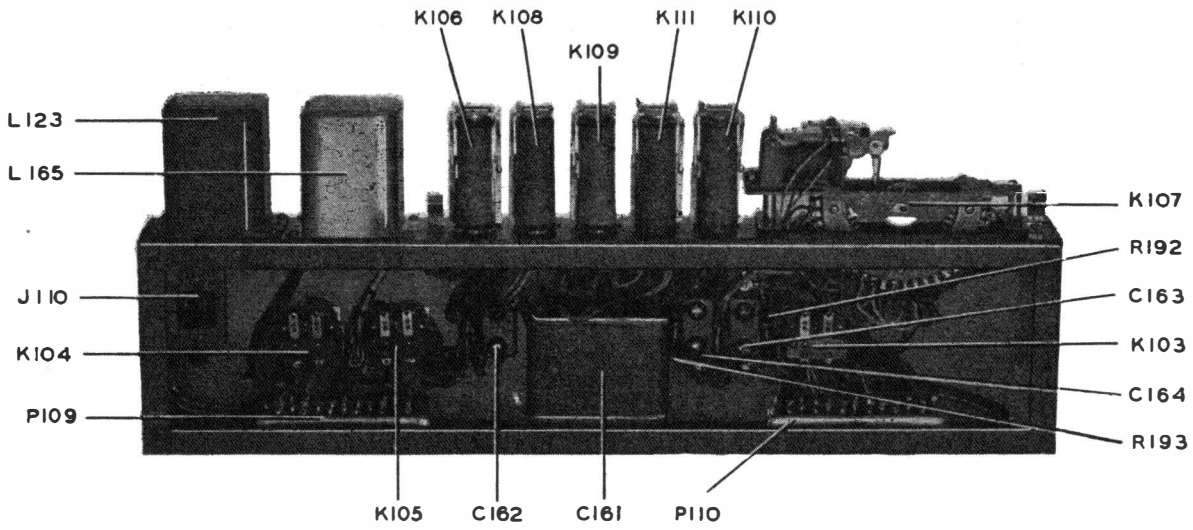


Fig. 55 Autotune Control Unit—Inside View

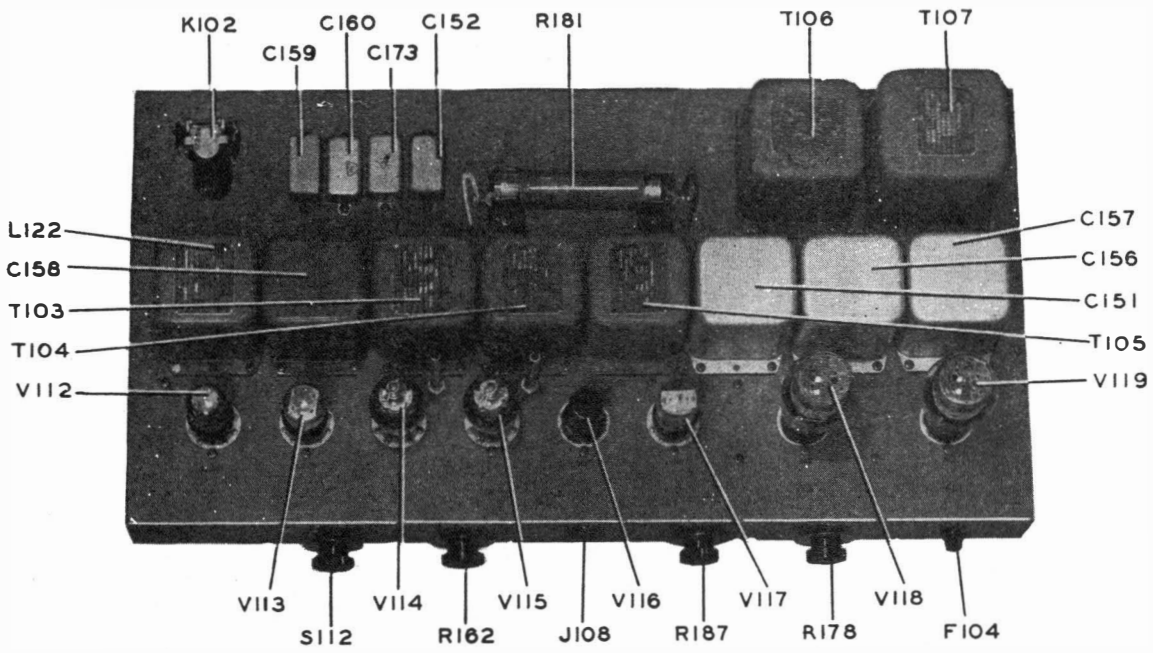


Fig. 56 Speech Amplifier Unit—Top View

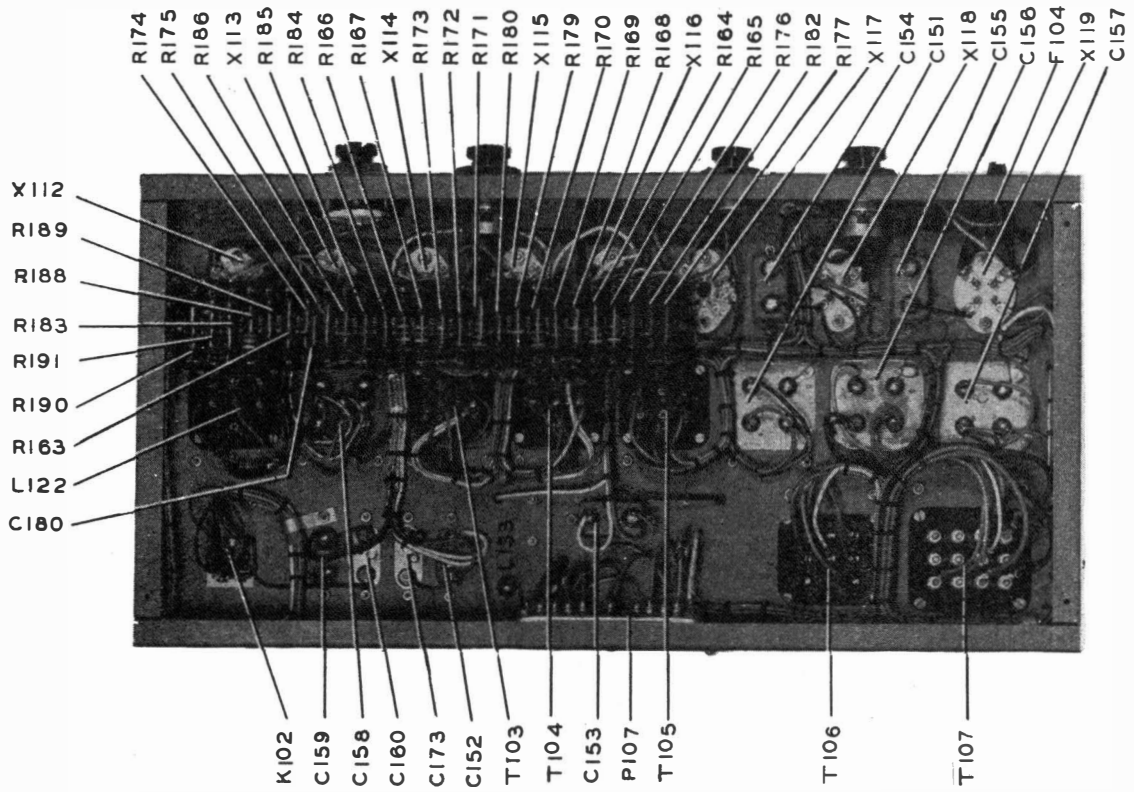
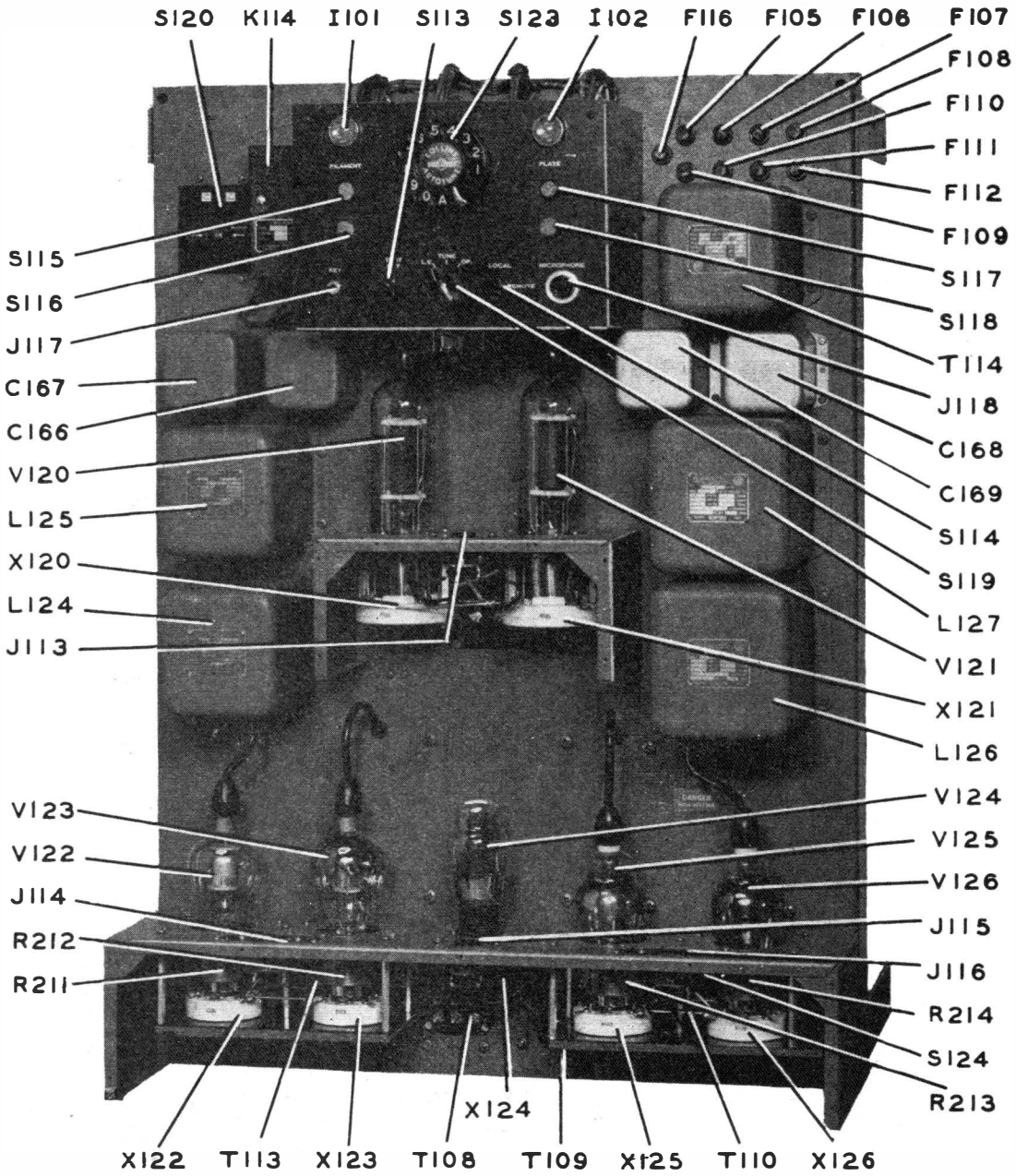


Fig. 57 Speech Amplifier Unit—Bottom View



NOTE: Rectifier heater resistors R211, R212, R213 and R214 and switch S124 are included in transmitters with Serial Nos. following No. 171 supplied on Contract NXss-20834 and are included in all transmitters supplied on Contract NXss-24869.

Fig. 58 Power Supply Unit—Front View

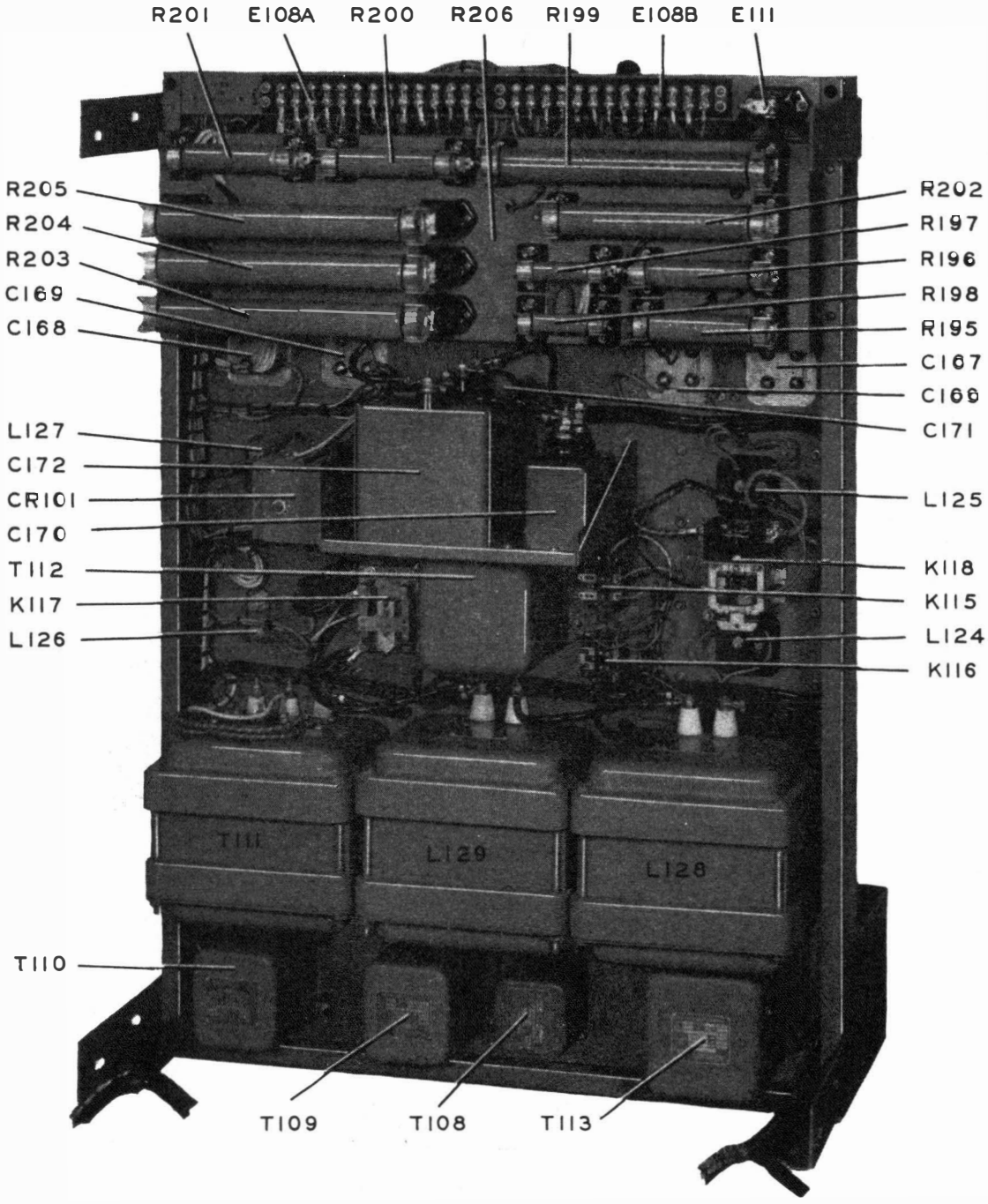


Fig. 59 Power Supply Unit—Rear View

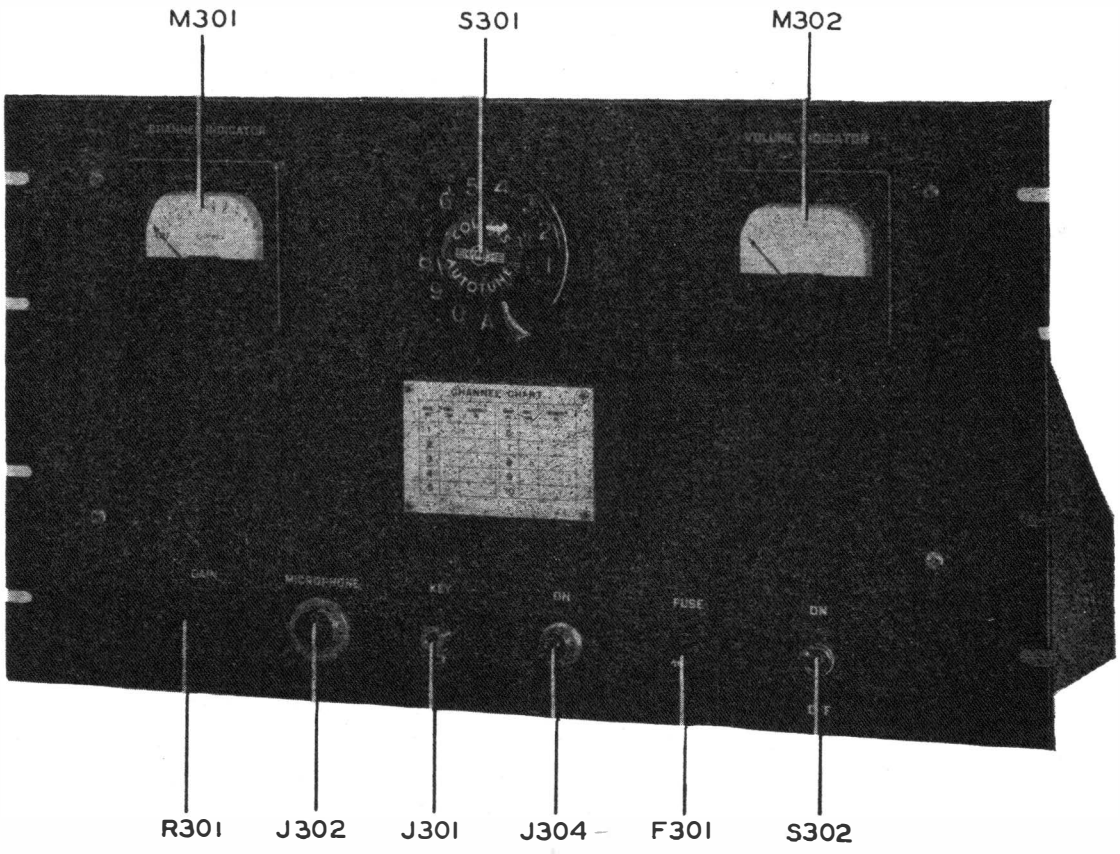


Fig. 60 Remote Control Unit—Front View

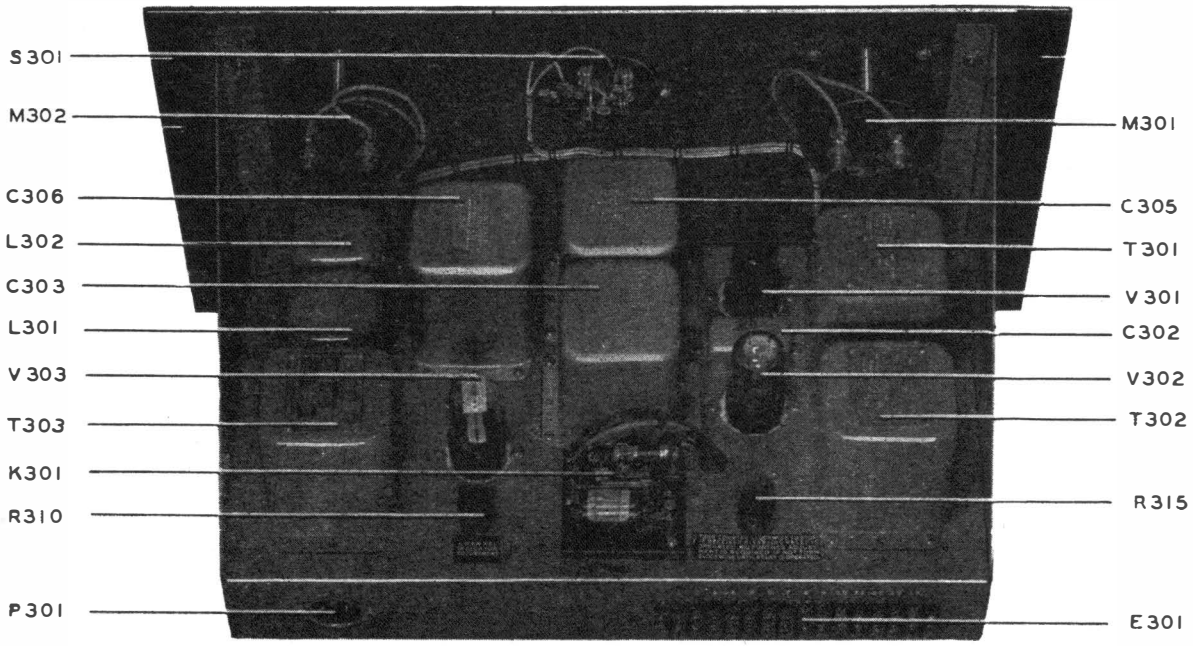


Fig. 61 Remote Control Unit—Top View

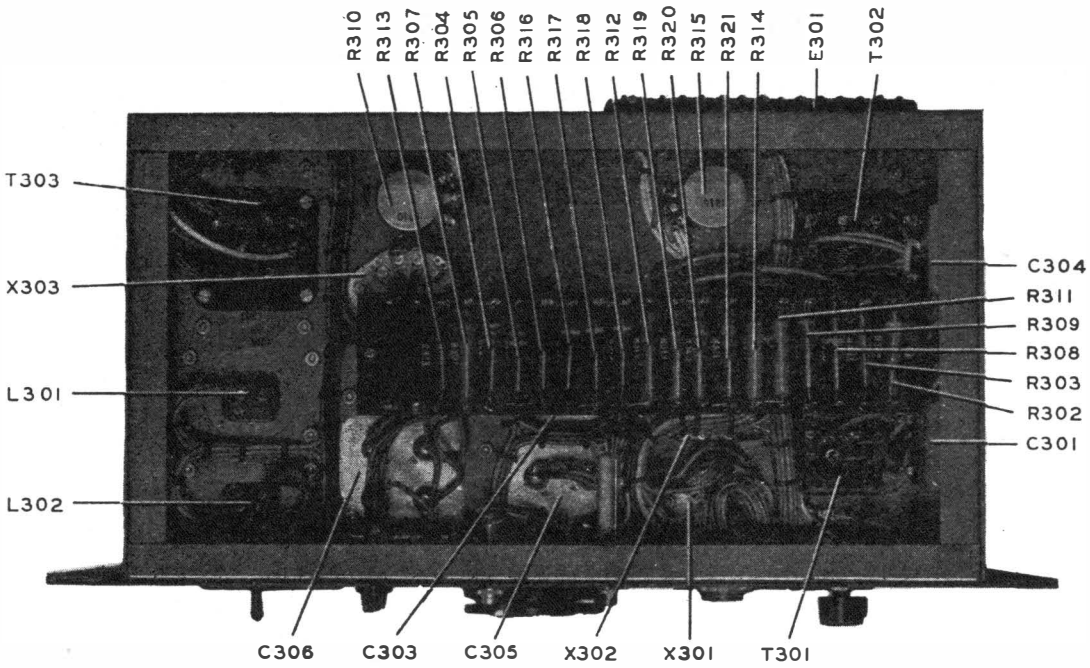


Fig. 62 Remote Control Unit—Bottom View

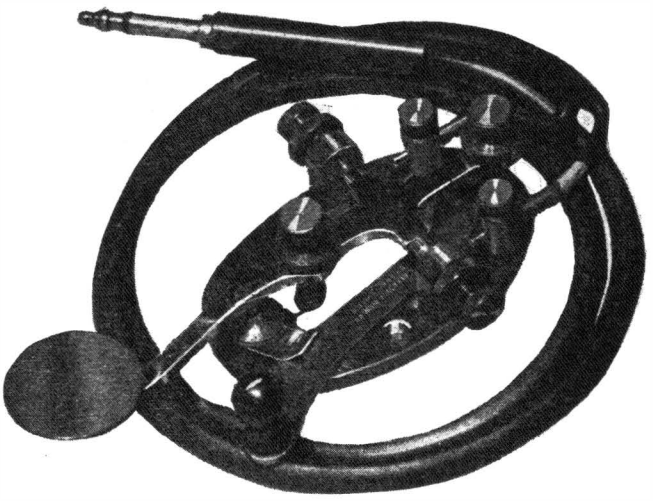


Fig. 63 Telegraph Key

Fig. 64 Microphone

IMPORTANT

This schematic diagram and Figs. 66A, 98 and 100 apply to transmitters with Serial Nos. preceding No. 172 that were supplied on Contract NXss-20834.

Transmitters with Serial Nos. following No. 171 supplied on Contract NXss-20834 and the transmitters supplied on Contract NXss-24869 differ from transmitters with Serial Nos. 1 through 171 supplied on Contract NXss-20834 in the following respects:

1. Transmitters with Serial Nos. following No. 171 supplied on Contract NXss-20834 and all transmitters supplied on Contract NXss-24869 are equipped with rectifier tube heaters. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101.
2. A bias voltage is applied to the center tap of the speech amplifier filament transformer (Terminal #8 of T107) in transmitters with Serial Nos. following No. 177 supplied on Contract NXss-20834 and in all transmitters supplied on Contract NXss-24869. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101.
3. A 510 ohm resistor (R215) is connected in parallel with the MCW oscillator cathode resistor (R189) in transmitters with Serial Nos. following No. 54 supplied on Contract NXss-24869. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 100.
4. Transmitters with Serial Nos. following No. 16 supplied on Contract NXss-24869 are equipped with two MO compartment heater control thermostats. The additional thermostat, S125, is connected in series with thermostat S102. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 100 for these connections.

NOTE: Obtain the Serial No. of your transmitter from the name plate on the outside of the transmitter Cabinet door.

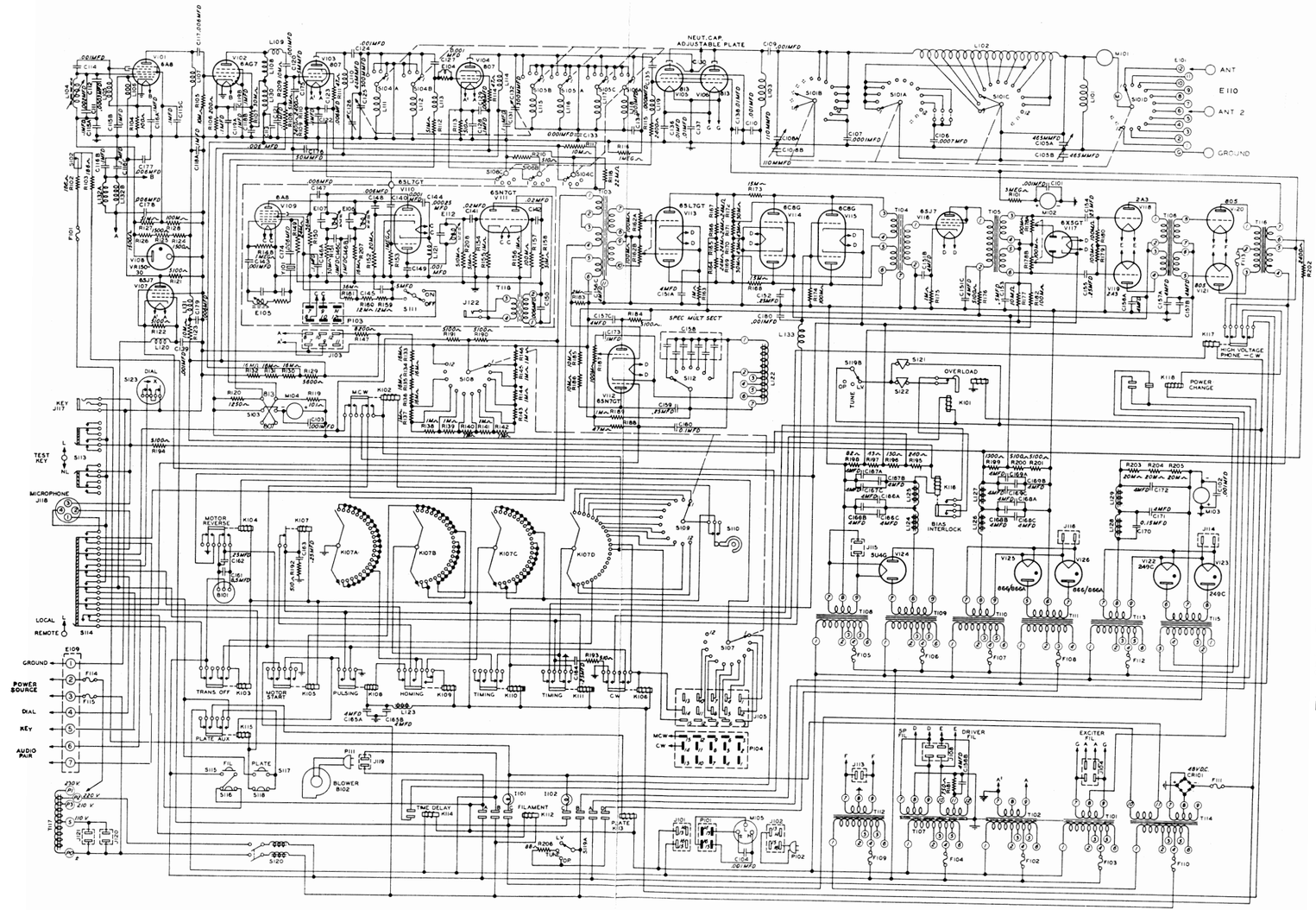


Fig. 65A Radio Transmitter Complete Schematic (Dwg. No. 921D)

IMPORTANT

For the application of this schematic diagram refer to the notes that are printed on the sheet that is attached to Fig. 65A in a position corresponding to the position of this sheet.

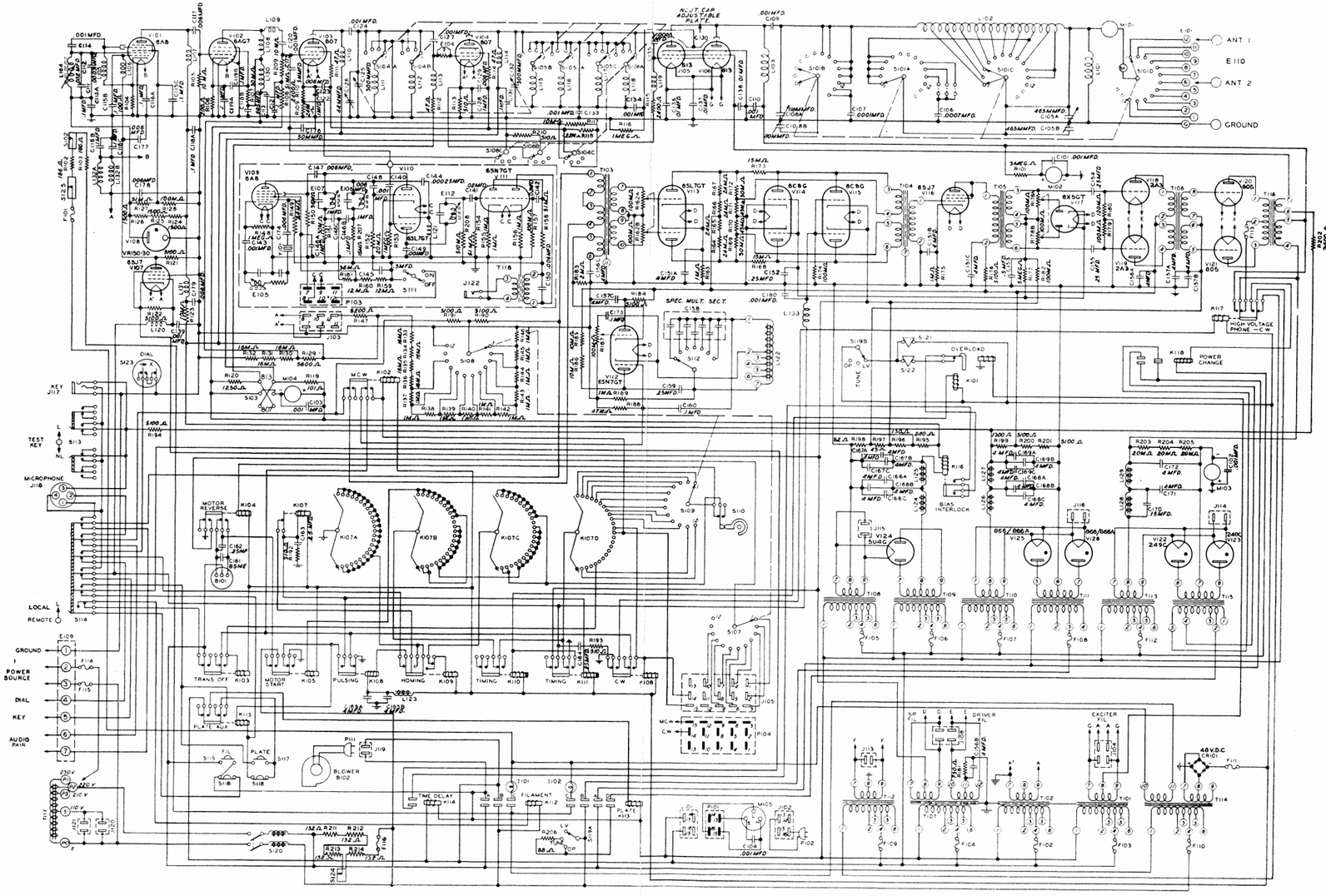


Fig. 65B Radio Transmitter Complete Schematic (Dwg. No. 500 3528 00D)

Fig. 65B Radio Transmitter Complete Schematic (Dwg. No. 500 3528 00D)

IMPORTANT

This schematic diagram and Figs. 65A, 98 and 100 apply to transmitters with Serial Nos. preceding No. 172 that were supplied on Contract NXss-20834.

Transmitters with Serial Nos. following No. 171 supplied on Contract NXss-20834 and the transmitters supplied on Contract NXss-24869 differ from transmitters with Serial Nos. 1 through 171 supplied on Contract NXss-20834 in the following respects:

1. Transmitters with Serial Nos. following No. 171 supplied on Contract NXss-20834 and all transmitters supplied on Contract NXss-24869 are equipped with rectifier tube heaters. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101.

2. A bias voltage is applied to the center tap of the speech amplifier filament transformer (Terminal #8 of T107) in transmitters with Serial Nos. following No. 177 supplied on Contract NXss-20834 and in all transmitters supplied on Contract NXss-24869. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101.

3. A 510 ohm resistor (R215) is connected in parallel with the MCW oscillator cathode resistor (R189) in transmitters with Serial Nos. following No. 54 supplied on Contract NXss-24869. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101.

4. Transmitters with Serial Nos. following No. 16 supplied on Contract NXss-24869 are equipped with two MO compartment heater control thermostats. The additional thermostat, S125, is connected in series with thermostat S102. Refer to Fig. 65B, Fig. 66B, Fig. 99 and Fig. 101 for these connections.

NOTE: Obtain the Serial No. of your transmitter from the name plate on the outside of the transmitter Cabinet door.

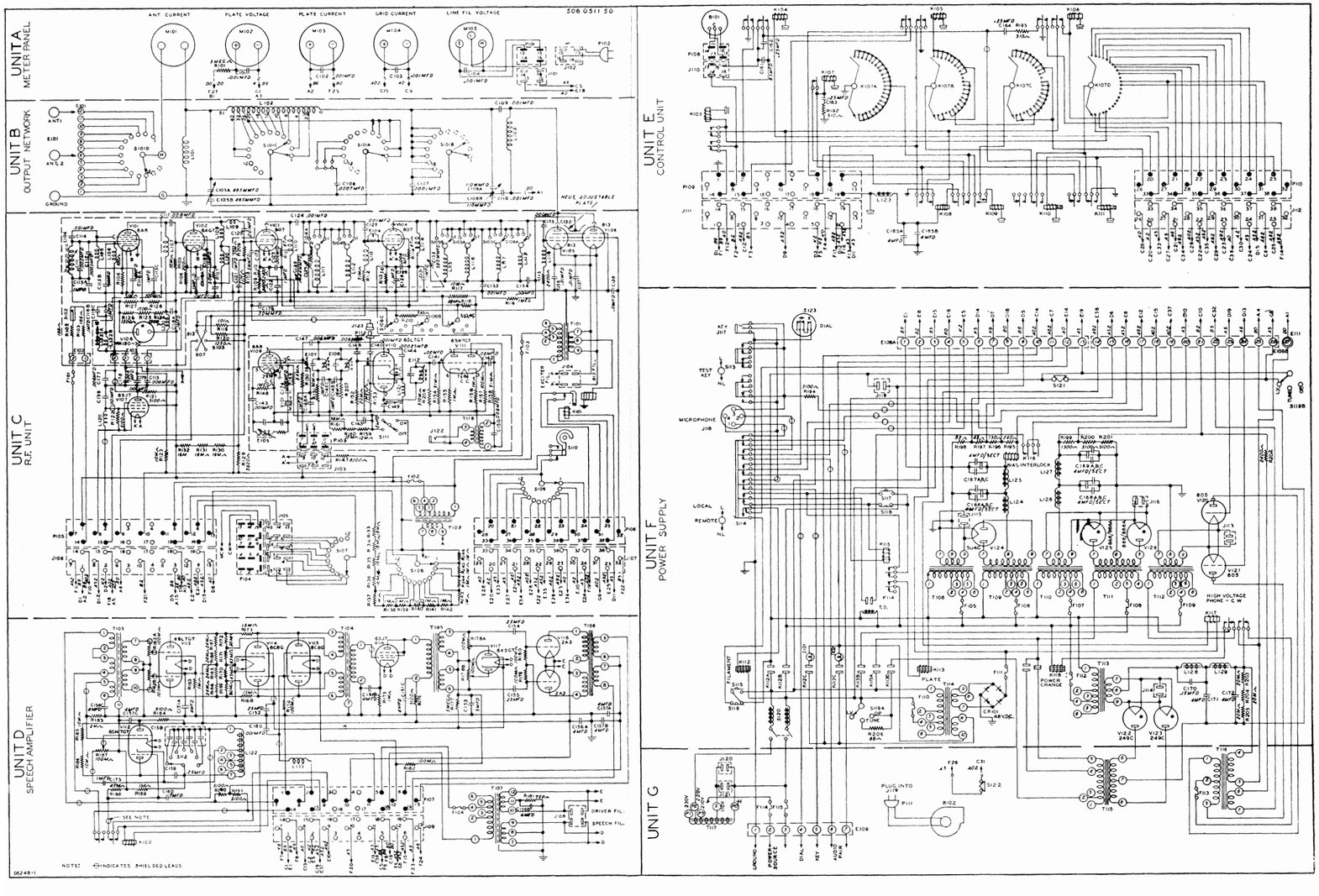


Fig. 66A Radio Transmitter Cabling Schematic (Dwg. No. 511E)

IMPORTANT

For the application of this schematic diagram refer to the notes that are printed on the sheet that is attached to **Fig. 66A** in a position corresponding to the position of this sheet.

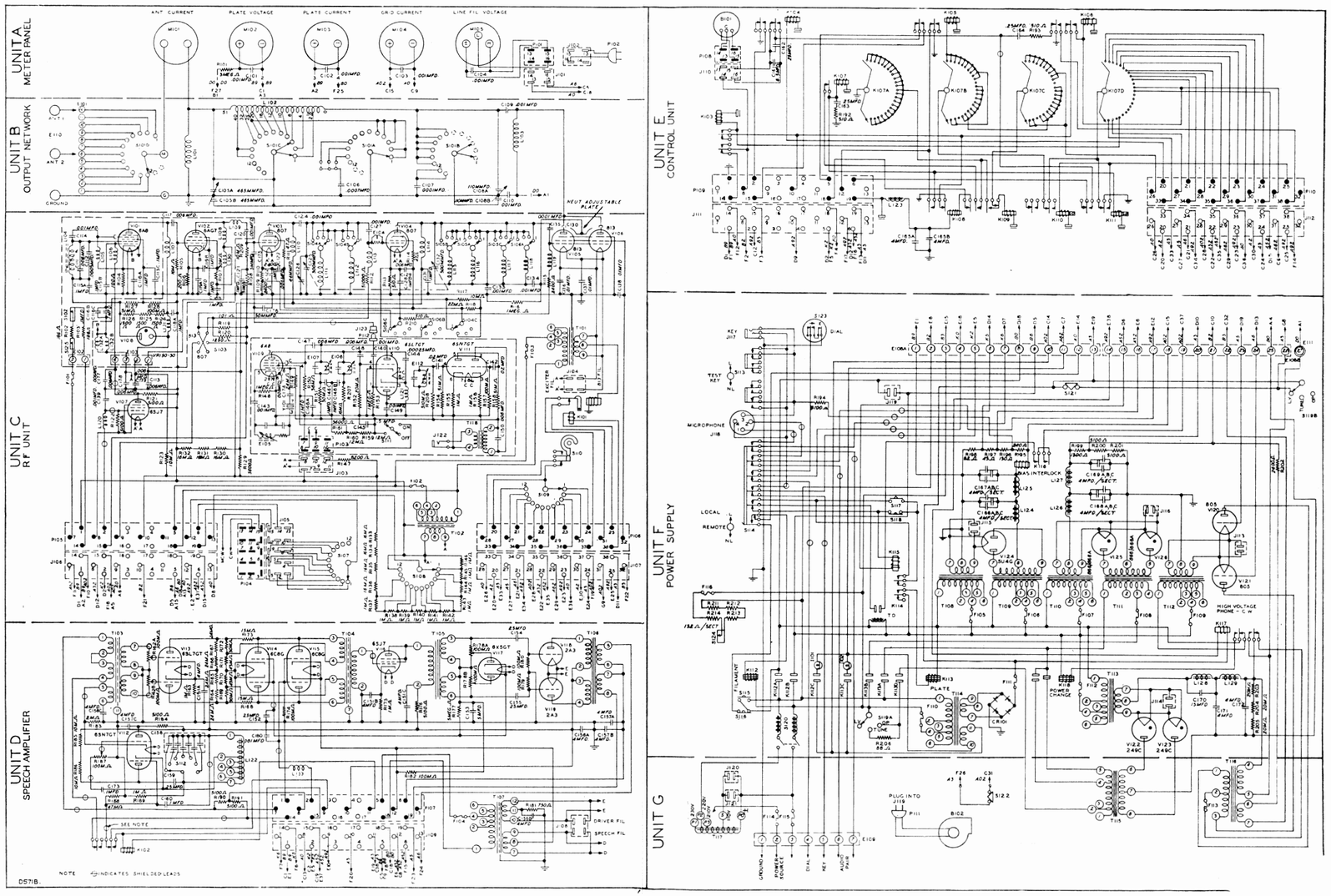


Fig. 66B Radio Transmitter Cabling Schematic (Dwg. No. 500 3527 00E)

APPENDIX

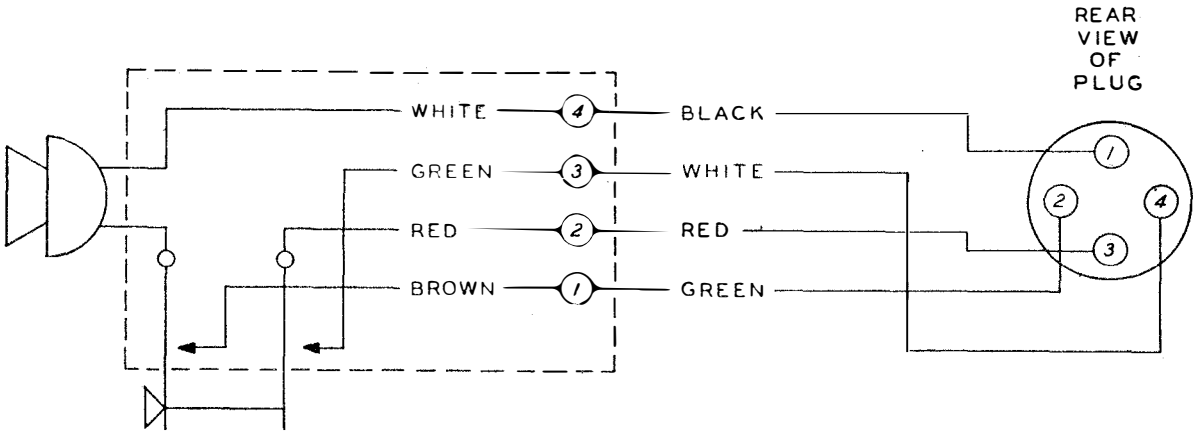


Fig. 67 Microphone & Cord Schematic (Dwg. No. 500 0088 00A)

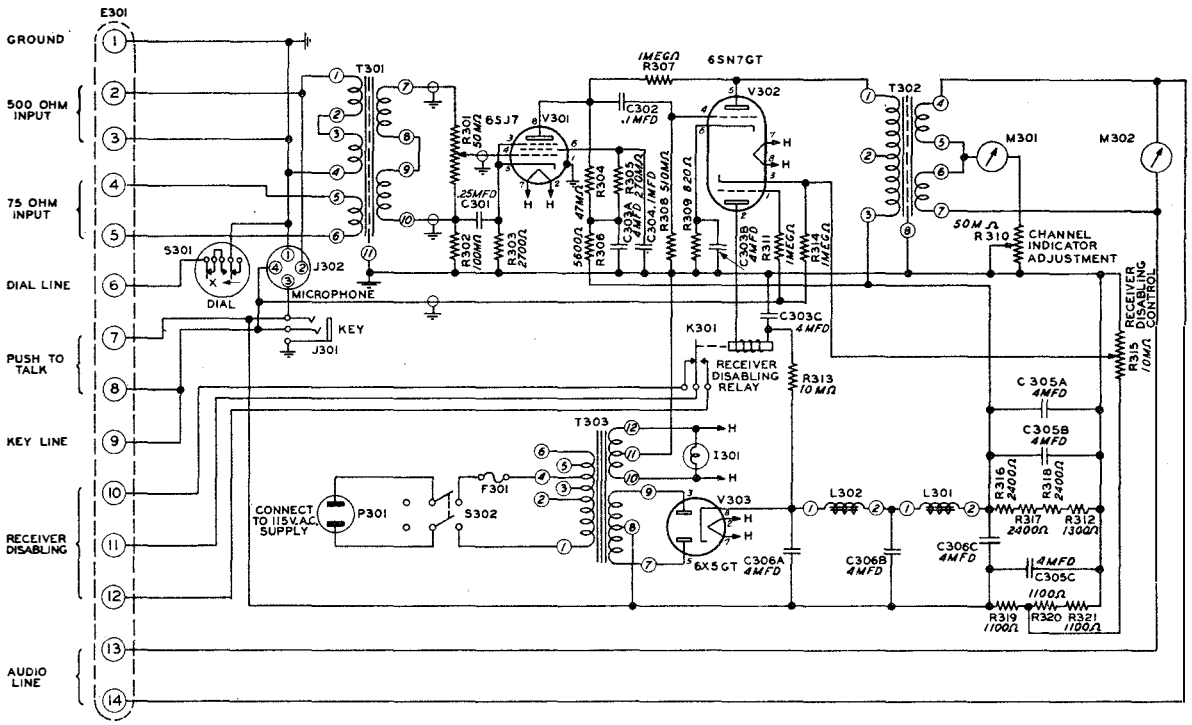
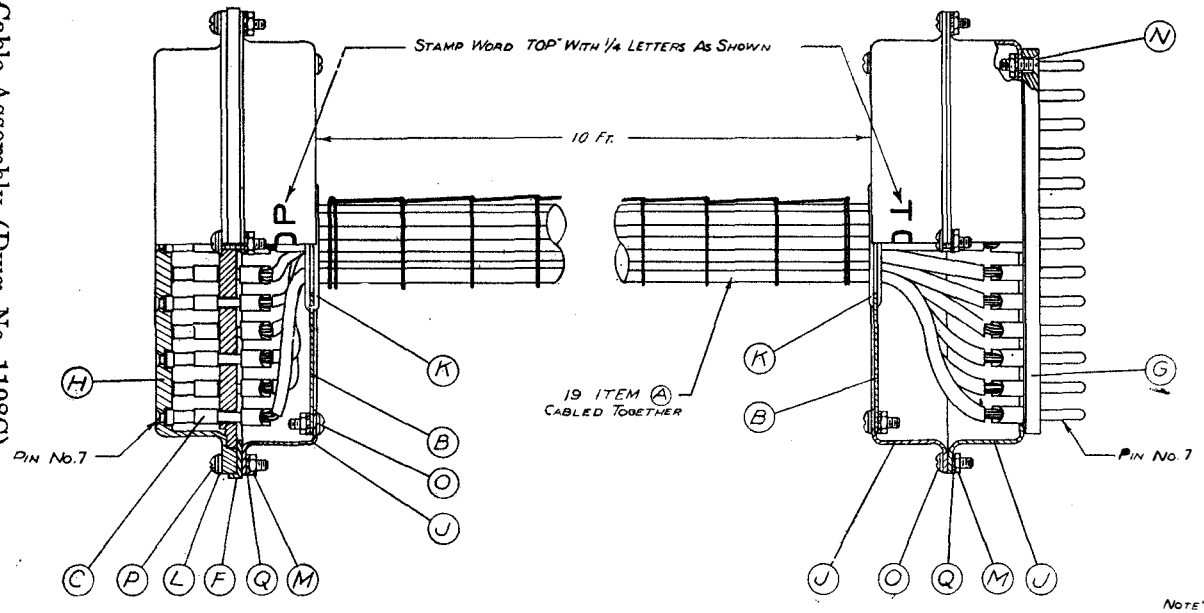


Fig. 68 Remote Control Unit Schematic (Dwg. No. 2073B)

●	▲	IT	PART NO.	DESCRIPTION	MAT'L	FIN.
	1	X	GA-1198C	ASS'Y PER QUAN. A		
	REF	A	423NC2	RED WIRE		
1		X	GB-1198C	ASS'Y PER QUAN B		
REF		A	423NC5	GREEN WIRE		
2	2	B	X-6337SIE1	GROMMET PLATE		
1	1	C	AC103A	CONNECTOR JACK ASSEMBLY		
1	1	F	AA190A	JACK MTG PLATE RETAINER		
1	1	G	AC106A	CONNECTOR PLUG ASS'Y		
1	1	H	AB101A	CONNECTOR JACK COVER		
3	3	J	138N101	CONNECTOR PLUG SHELL		
2	2	K	201N120	1¼ NEOPRENE GROMMET		
6	6	L	310NFS6	#6 FLAT STEEL WASHER		
24	24	M	313N10EUTP35	#6-32 STEEL NUT		
4	4	N	342N8EUTP	#6-32 x ½ PH. F.H. SCREW		
14	14	O	343N6EUTP	#6-32 x ⅜ PH. B.HD SCREW		
6	6	P	343N9EUTP	#6-32 x 9/16 PH. B. HD SCREW		
24	24	Q	373N802	#6 SHAKEPROOF WASHER		



NOTE:
1. CONNECT SAME PINS TOGETHER WITH ITEM (A) EXAMPLE 1 TO 1 2 TO 2, ETC
2. NOTE RELATIVE POSITION OF PIN No.7 AND WORD "TOP" IN EACH END OF CABLE

Fig. 69 Test Cable Assembly (Dwg. No. 1198C)

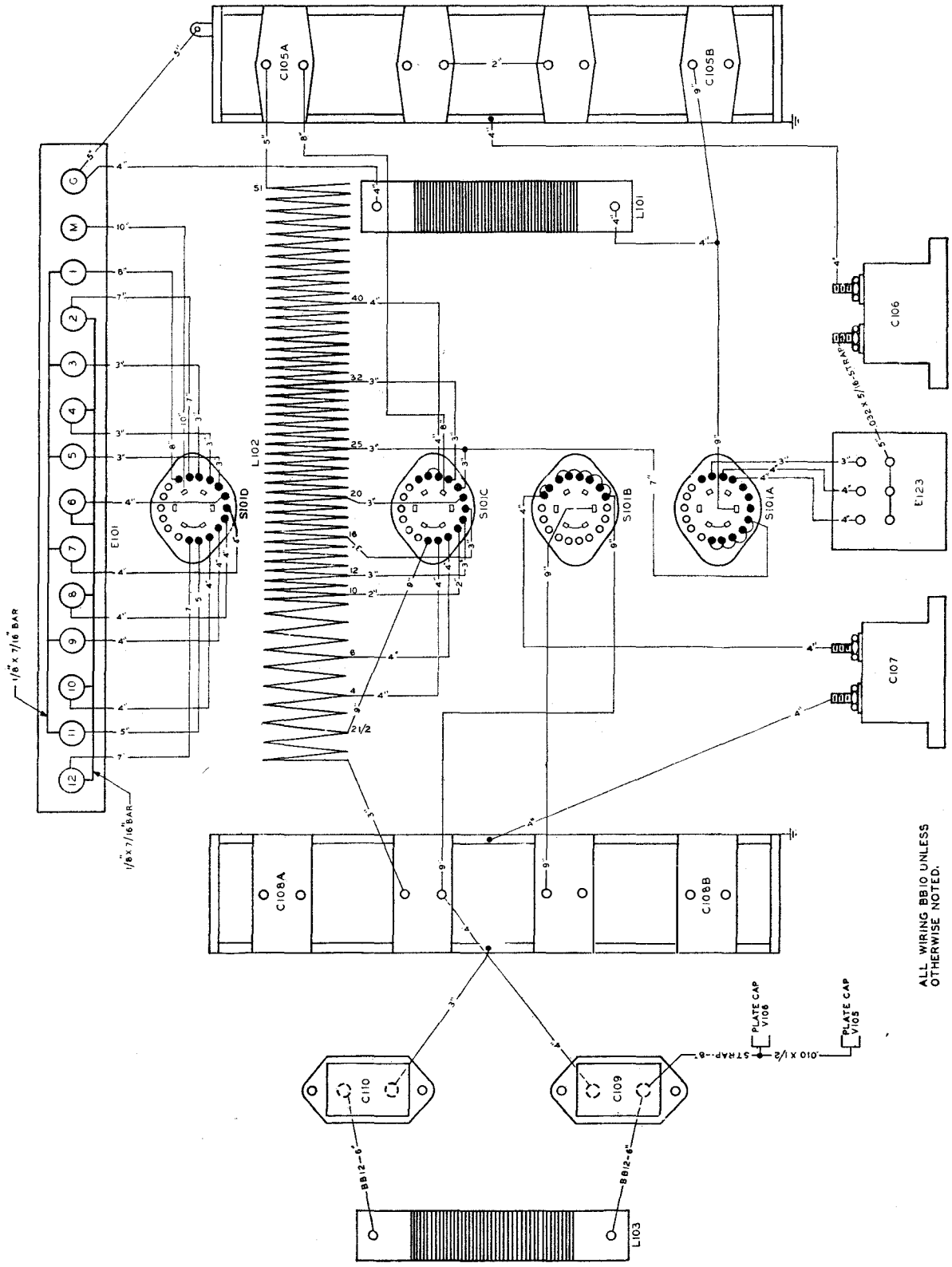
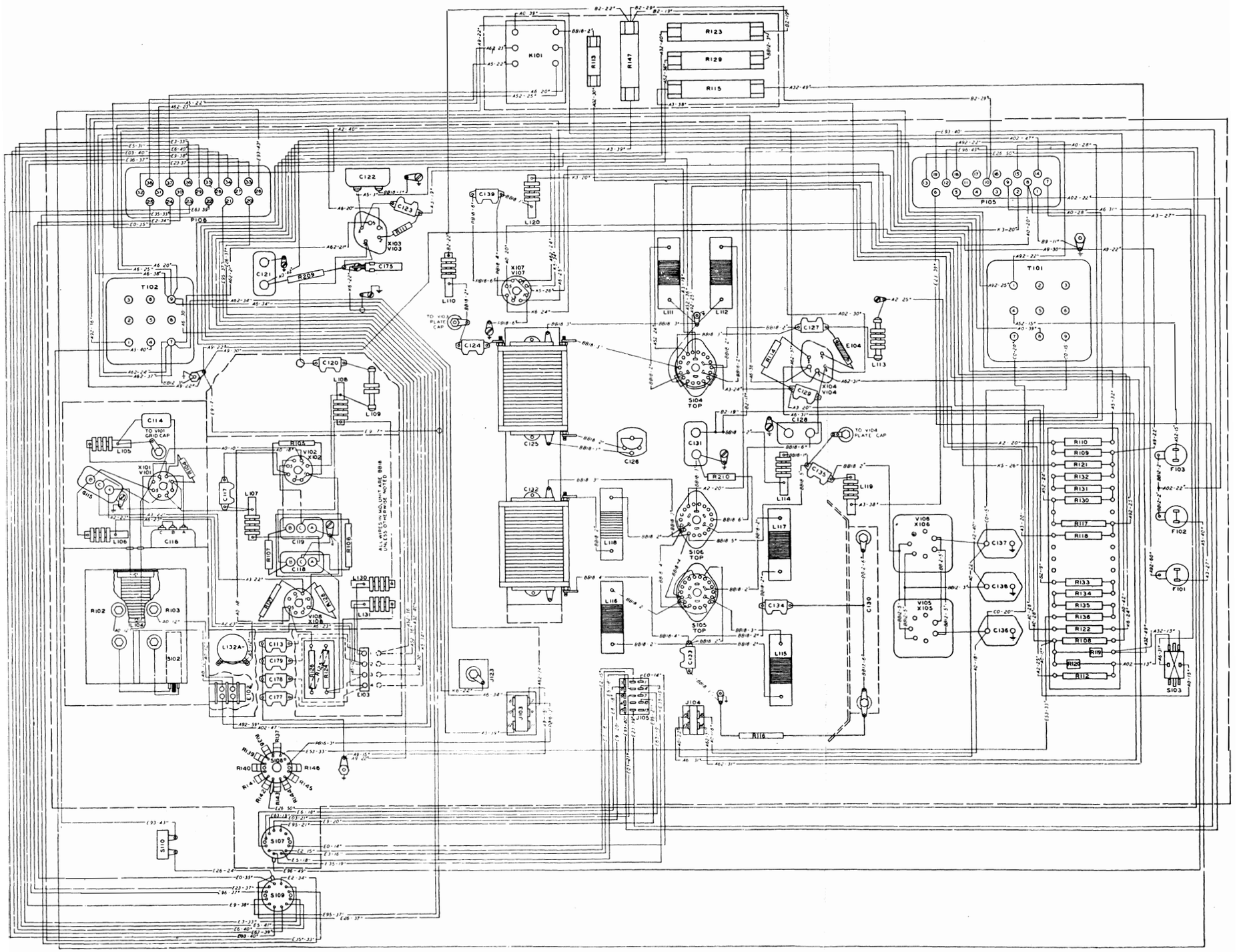


Fig. 70 Output Network Unit, Practical Wiring Diagram (Dwg. No. 500 1349 00C)



NOTE: Transmitters with Serial Nos. following No. 16 supplied on Contract NXss-24869 are equipped with two MO compartment heater control thermostats. The additional thermostat is connected in series with thermostat S102 and both thermostats are mounted on the outside of heaters R102 and R103. Refer to Figs. 65B and 66B.

Fig. 71 R-F Unit, Practical Wiring Diagram (Dwg. No. 500 3969 00E)

Fig. 71 R-F Unit, Practical Wiring Diagram (Dwg. No. 500 3969 00E)

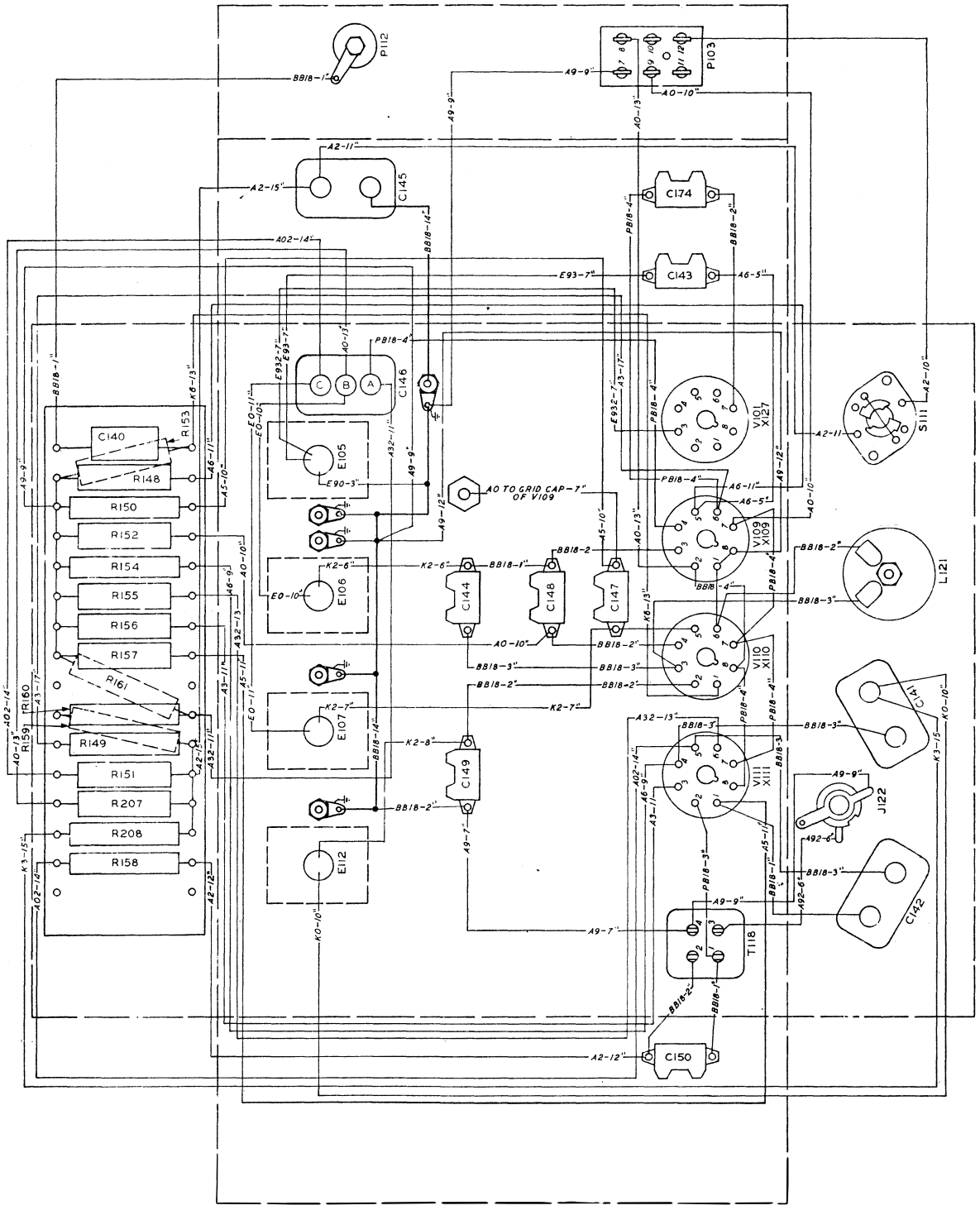


Fig. 72 CFI Unit Practical Wiring Diagram (Dwg. No. 500 3253 00C)

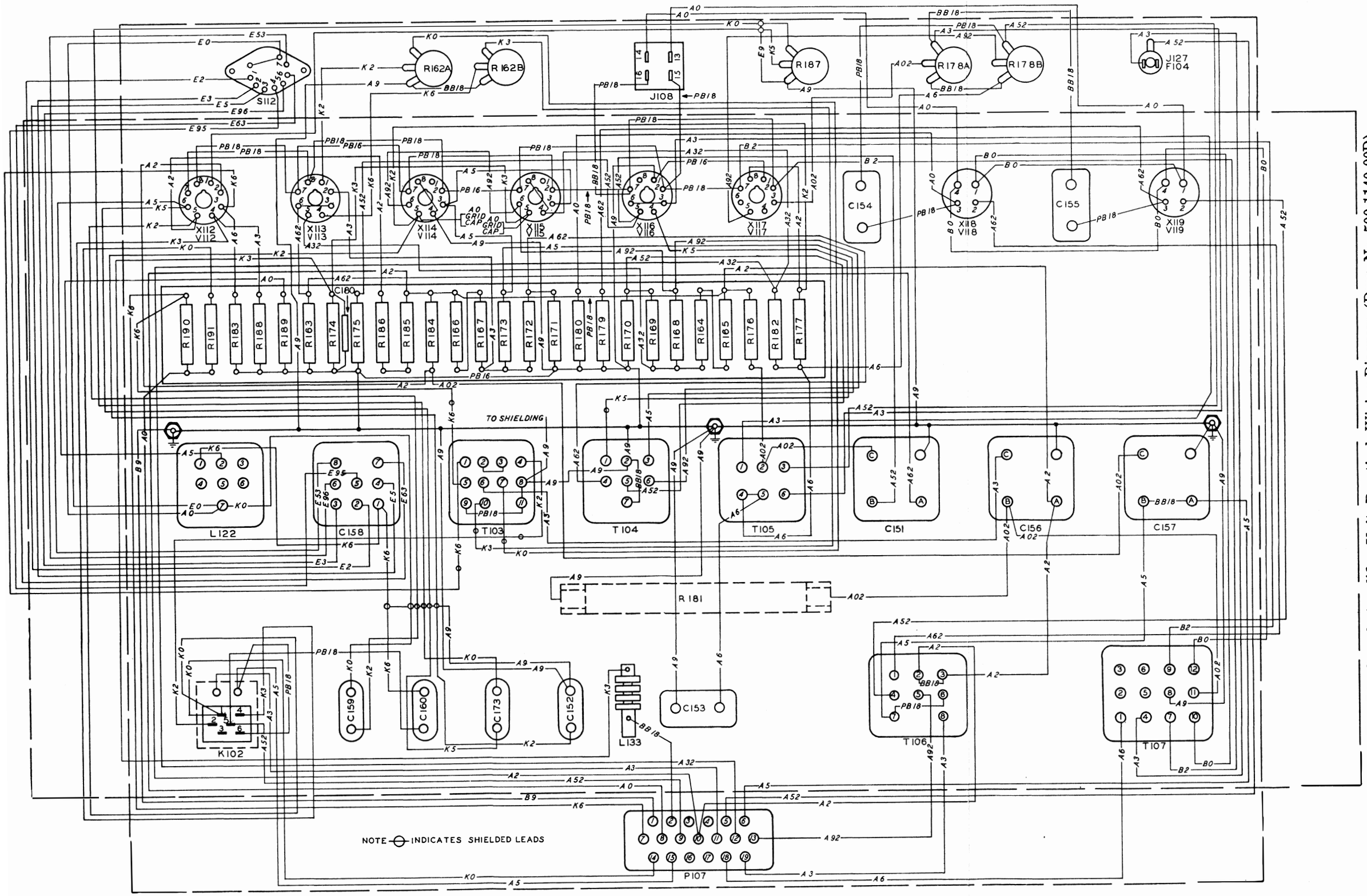


Fig. 73 Speech Amplifier Unit, Practical Wiring Diagram (Dwg. No. 500 1140 00D)

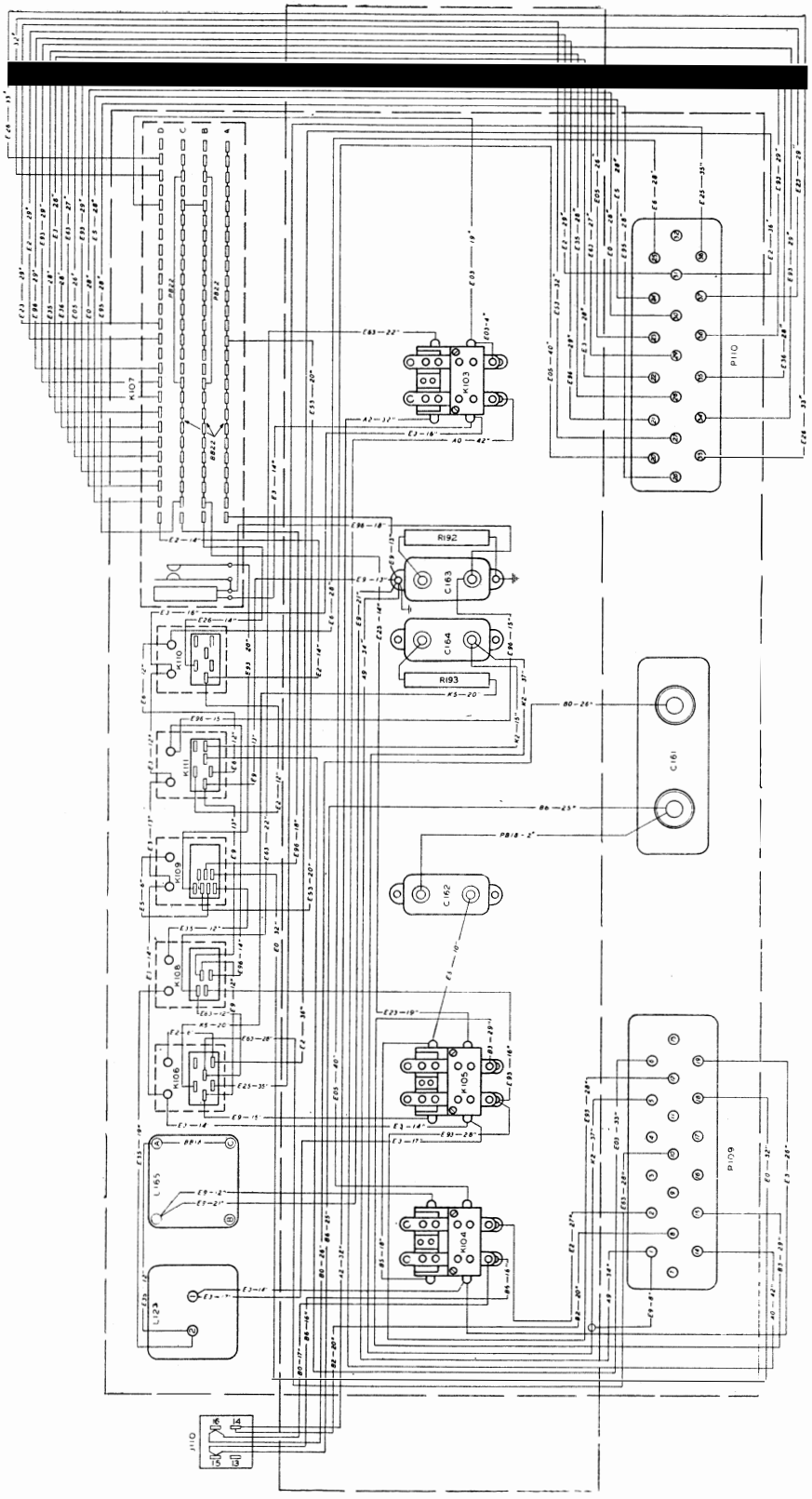
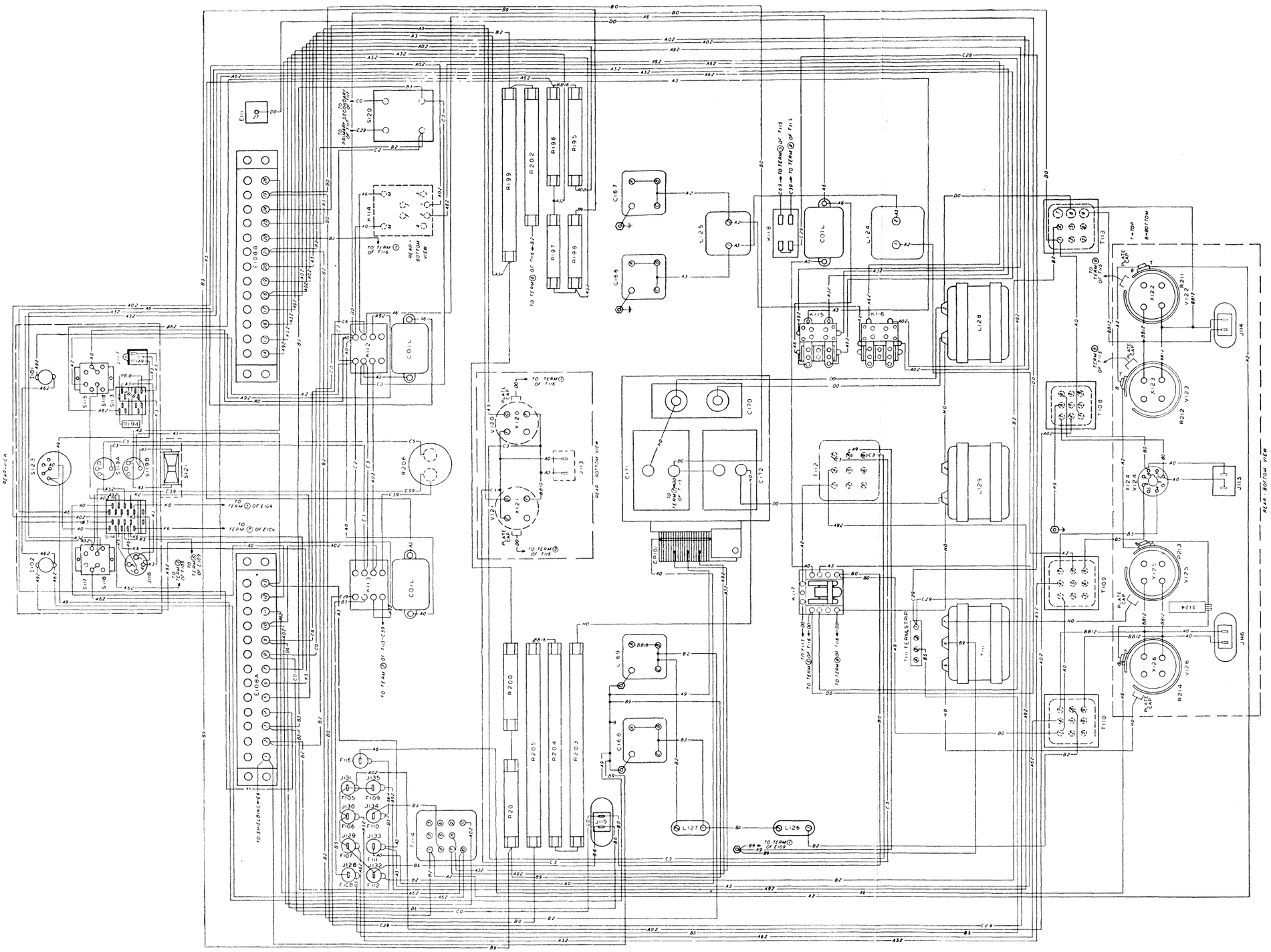


Fig. 74 Control Unit, Practical Wiring Diagram (Dwg. No. 500 1038 00C)



NOTE: Transmitters with Serial Nos. from No. 1 through No. 171 supplied on Contract NXss-20834 are not equipped with the rectifier heater circuit that is shown on this diagram.

Fig. 75 Power Supply Unit, Practical Wiring Diagram (Dwg. No. 500 4142 00E)

Fig. 75 Power Supply Unit, Practical Wiring Diagram (Dwg. No. 500 4142 00E)

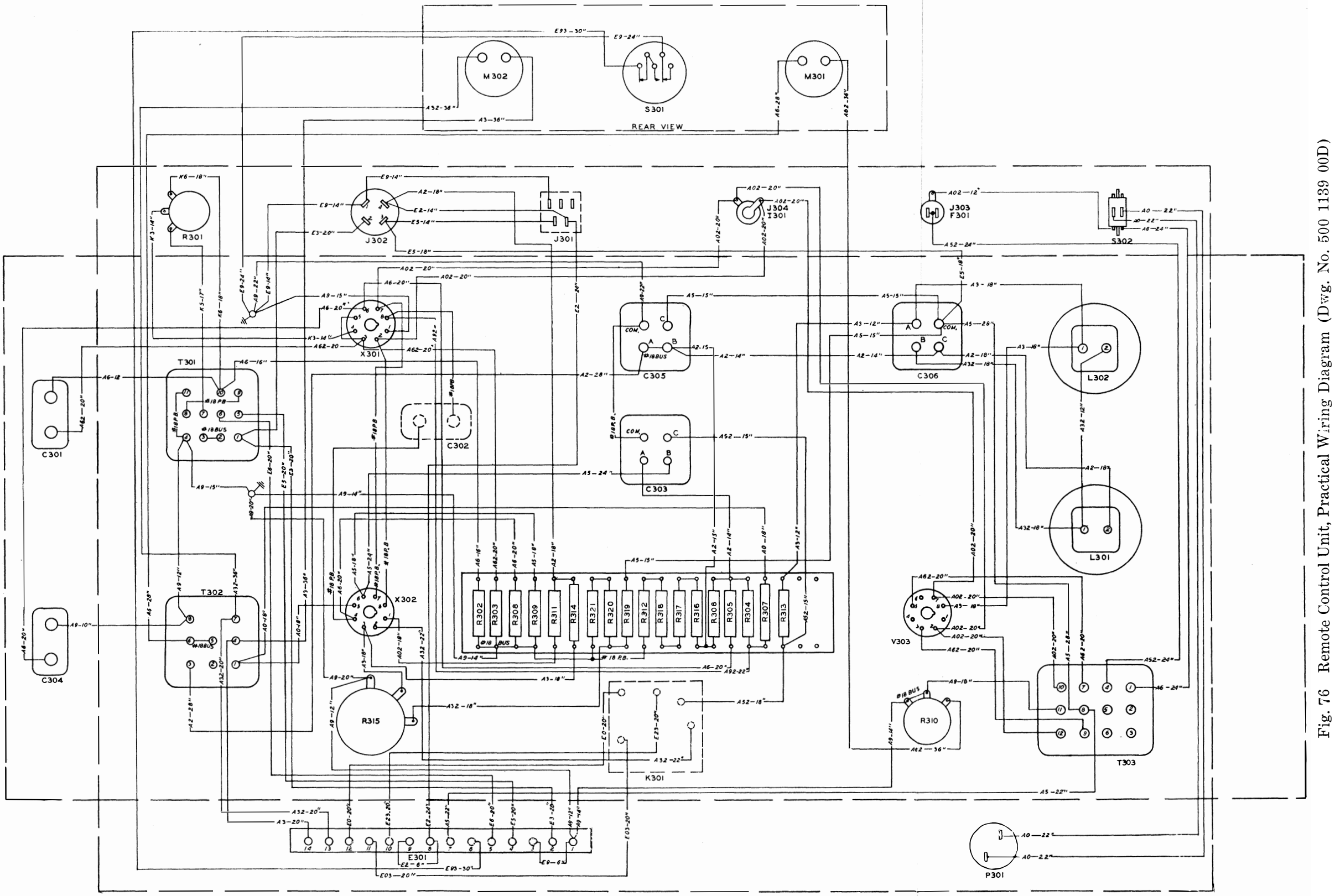
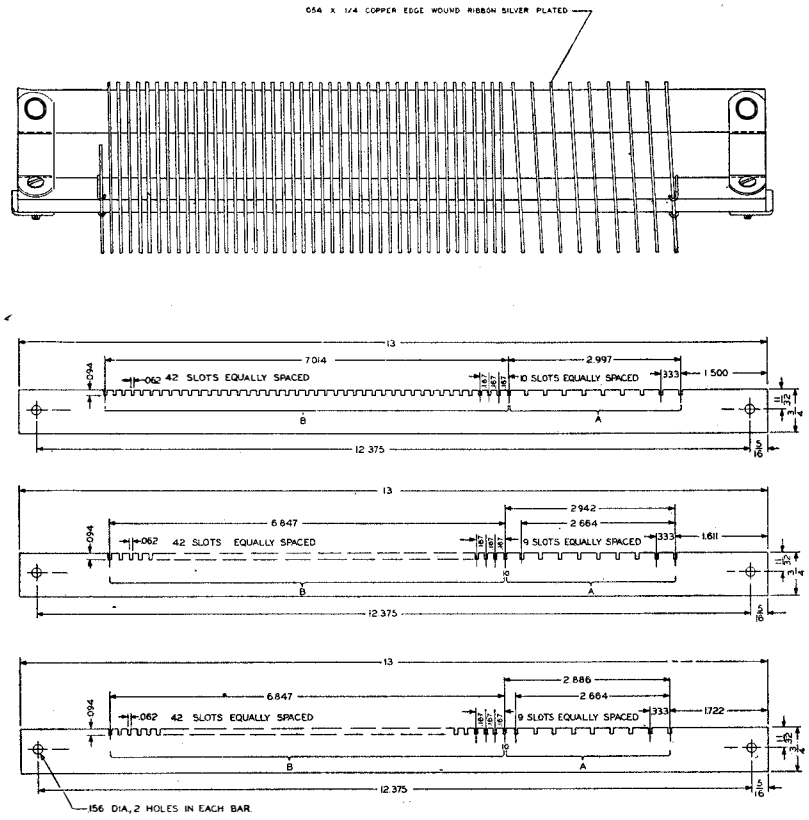
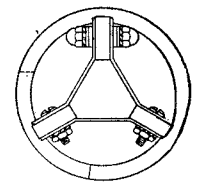
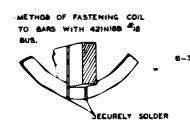


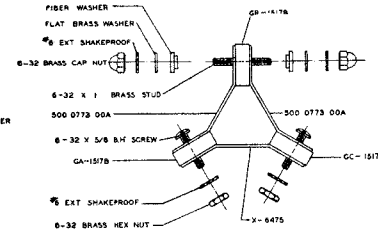
Fig. 76 Remote Control Unit, Practical Wiring Diagram (Dwg. No. 500 1139 00D)

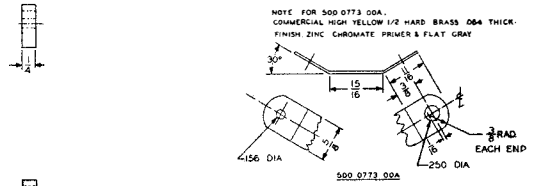
ITEM	QTY.	DESCRIPTION	PART NO	MAT'L	FIN
1	1	5-1/4 TURNS EDGE WOUND RIBBON	500 0732 00B		
2	1	MYCALEX COIL BAR	GA-1517B		
3	1	MYCALEX COIL BAR	GB-1517B		
4	1	MYCALEX COIL BAR	GC-1517B		
5	4	COIL BAR MTG. BRACKET	500 0773 00A		
6	2	COIL BAR MTG. BRACKET	X-6475		
7	2	6-32 X 1" BRASS STUD	312N302		
8	4	CAP NUT	334N302		
9	4	FIBER WASHER	302N4		
10	4	6 FLAT BRASS WASHER	310NF66		
11	4	6-32 X 5/8 BRASS B.H. SCREW	323N10EU8C		
12	4	6-32 BRASS NUT	323N10EU8C35		
13	8	6 EXT. SHAKEPROOF	373N702		











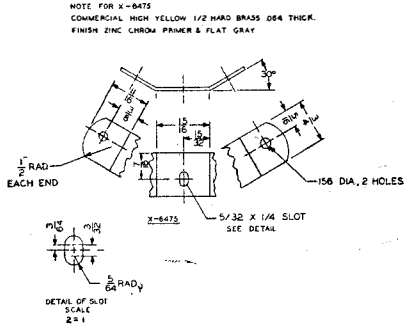
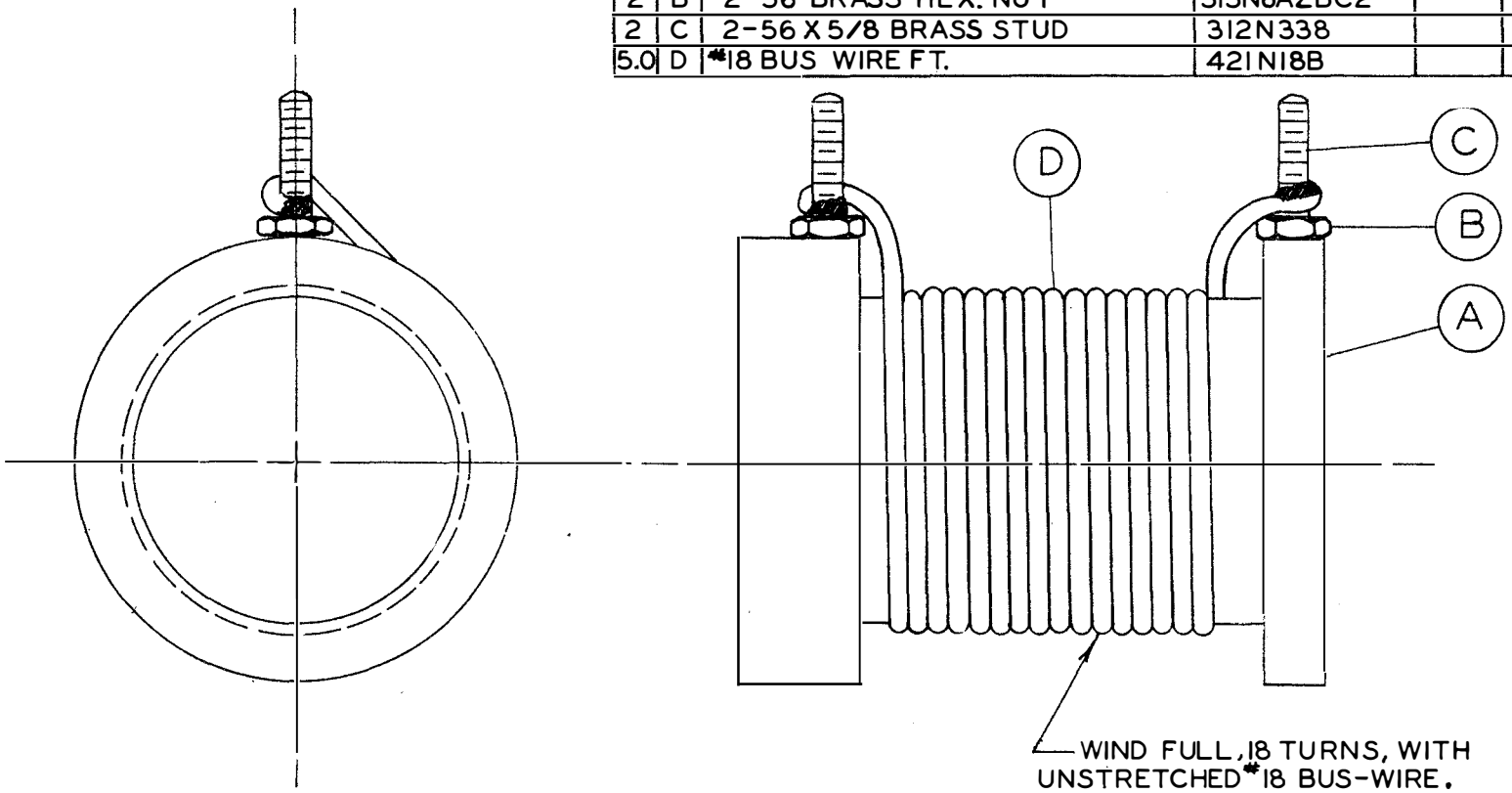


Fig. 77 P.A. Plate Tank Inductor (L102) (Dwg. No. 500 1267 00D)

A	IT.	DESCRIPTION	PART NO.	MAT'L	FIN.
1	X	M.O. COIL ASSEMBLY	GA-2051A		
1	A	COIL FORM	GA-1207B		
2	B	2-56 BRASS HEX. NUT	313N6AZBC2		
2	C	2-56 X 5/8 BRASS STUD	312N338		
5.0	D	#18 BUS WIRE FT.	421N18B		



1-MAINTAIN 10 TO 12 POUNDS TENSION ON THE WIRE WHILE WINDING AND TERMINATING.
2-WRAP ENDS OF WIRE AROUND STUDS, SOLDER, AND REMOVE ALL EXCESS SOLDER AND FLUX.
3-INDUCTANCE MUST BE WITHIN ± 1.0 % WHEN CHECKED AGAINST A STANDARD GA-2051A INDUCTANCE. (APPROXIMATE INDUCTANCE 5 MICRO HENRYS).

Fig. 78 M.O. Grid Inductor (L104) (Dwg. No. 2051A)

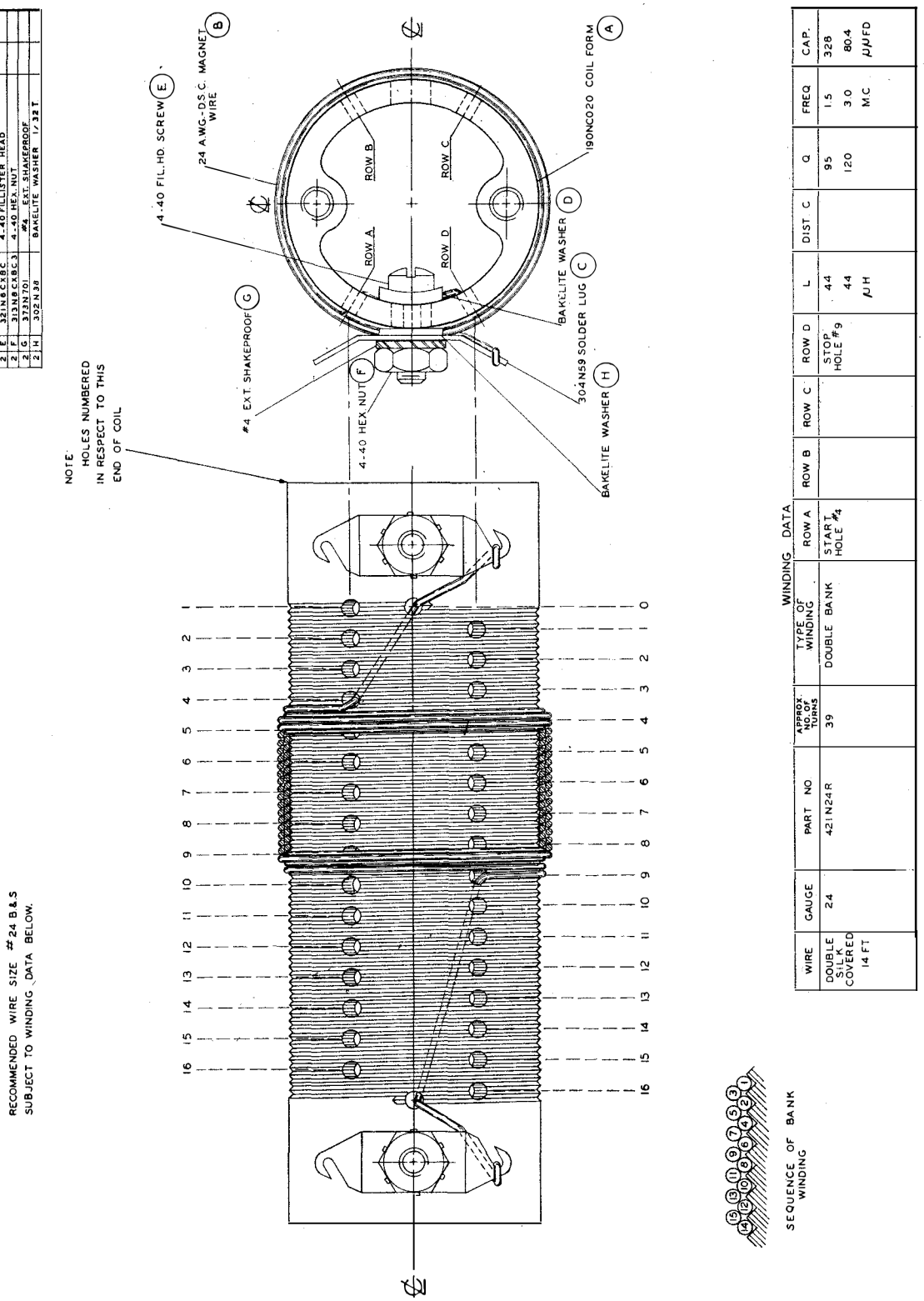


Fig. 79 Exciter Plate Tank Inductor (L111, L115) (Dwg. No. 1435C)

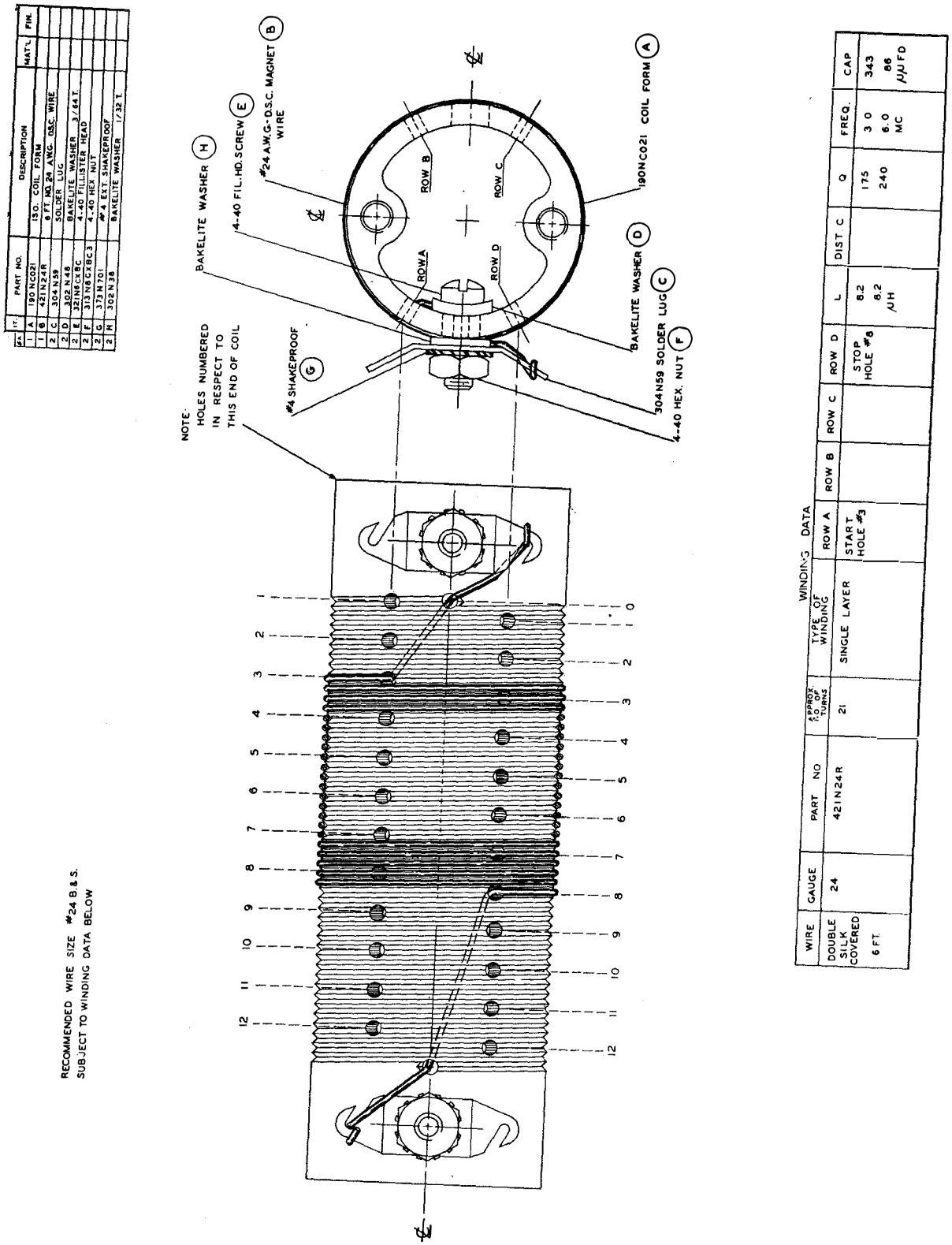
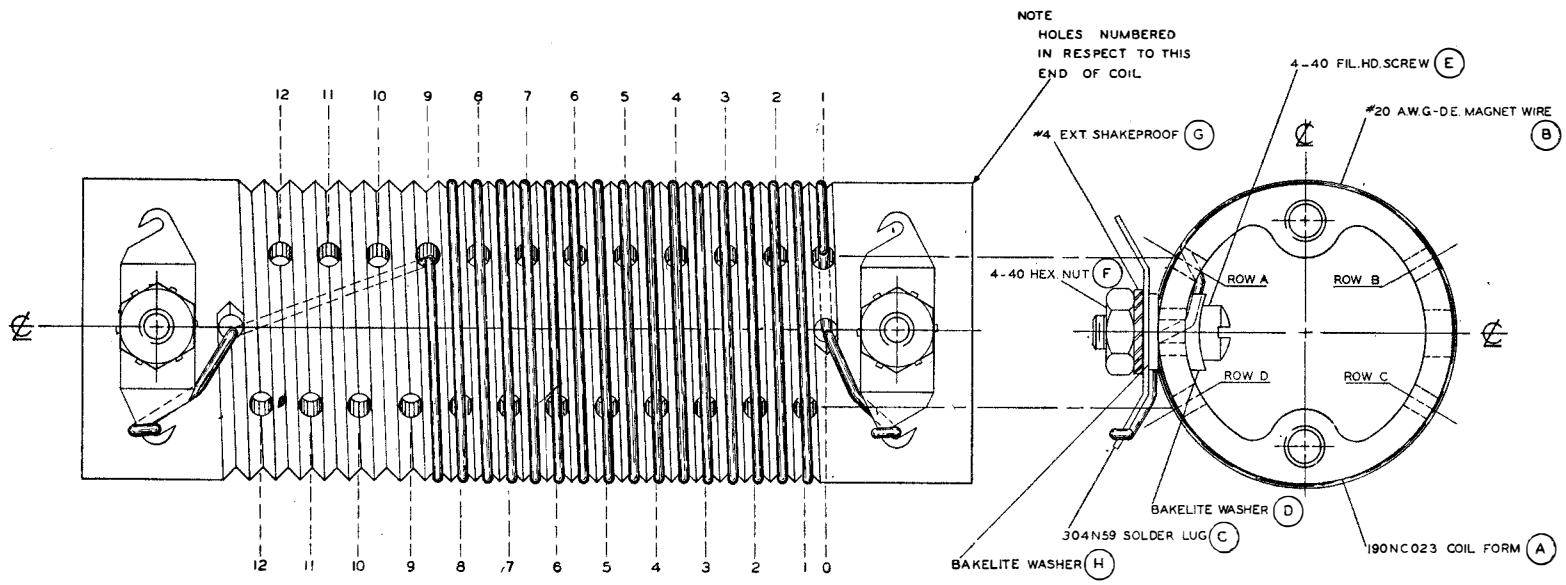


Fig. 80 Exciter Plate Tank Inductor (L112, L116) (Dwg. No. 1437C)

Qa	IT	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190NC023	130. COIL FORM		
1	B	421N20D	5 FT NO.20 A.W.G. D.E. WIRE		
2	C	304N59	SOLDER LUG		
2	D	302N48	BAKELITE WASHER 3/64 T		
2	E	321N6CXBC	4-40 FILLISTER HEAD		
2	F	313N8CXBC3	4-40 HEX. NUT		
2	G	373N701	#4 EXT. SHAKEPROOF		
2	H	302N38	BAKELITE WASHER 1/32 T.		

RECOMMENDED WIRE SIZE #20 B. & S
SUBJECT TO WINDING DATA BELOW



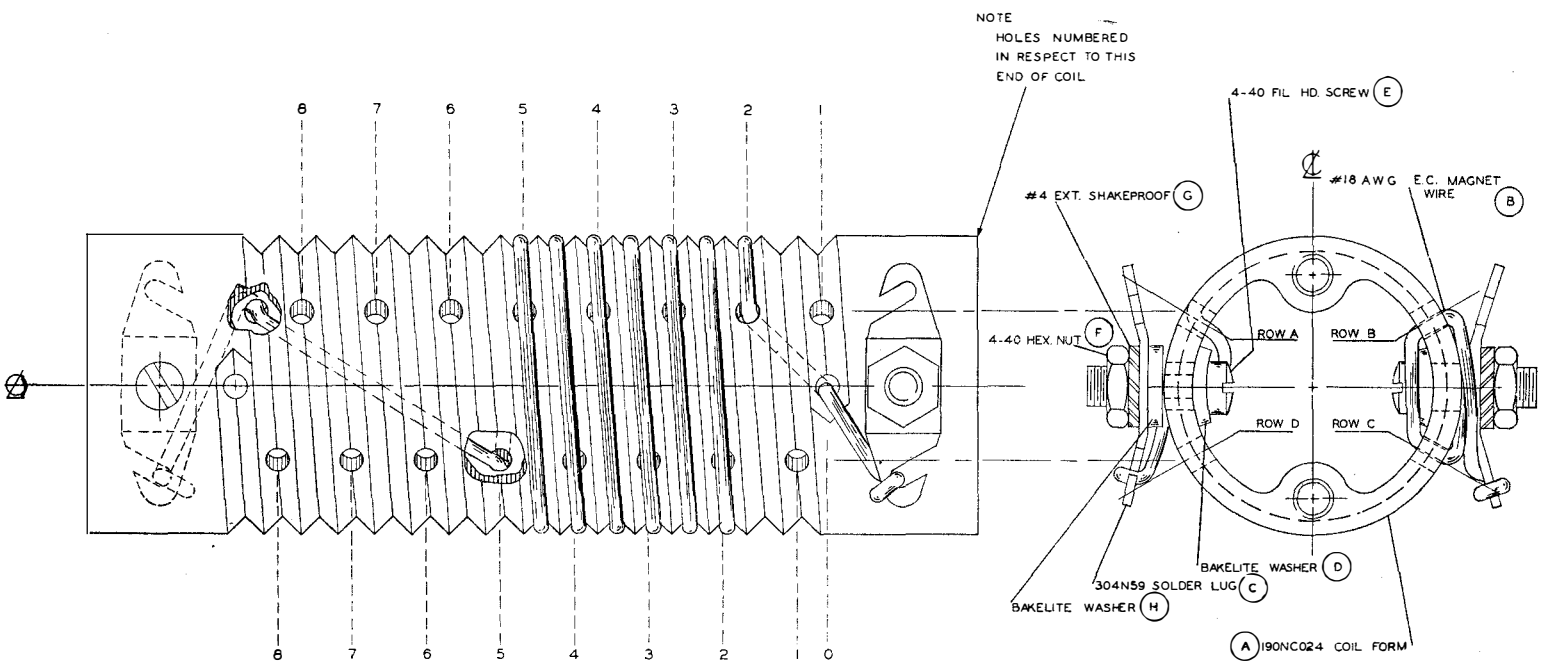
WINDING DATA

WIRE	GAUGE	PART NO.	APPROX. NO. OF TURNS	TYPE OF WINDING	ROW A	ROW B	ROW C	ROW D	L	DIST C	Q	FREQ	CAP
DOUBLE ENAMEL-ED 5 FT	20	421N20D	16	SINGLE LAYER	START HOLE #1 STOP HOLE #9				3.6 3.6 μH		200 260	4.5 9.0 MC	350 85 μμFD

Fig. 81 Exciter Plate Tank Inductor (L117) (Dwg. No. 1438C)

QTY.	IT.	PART NO.	DESCRIPTION	MAT'L	FIN.
1	A	190NC024	ISO COIL FORM		
1	B	42IN18D	2FT. NO. 18 A.W.G E.C. WIRE		
2	C	304N59	SOLDER LUG		
2	D	302N48	BAKELITE WASHER 3/64 T.		
2	E	32IN8CXBC	4-40 FILLISTER HEAD		
2	F	313N8CXBC3	4-40 HEX. NUT		
2	G	373N701	#4 EXT. SHAKEPROOF		
2	H	302N38	BAKELITE WASHER 1/32 T.		

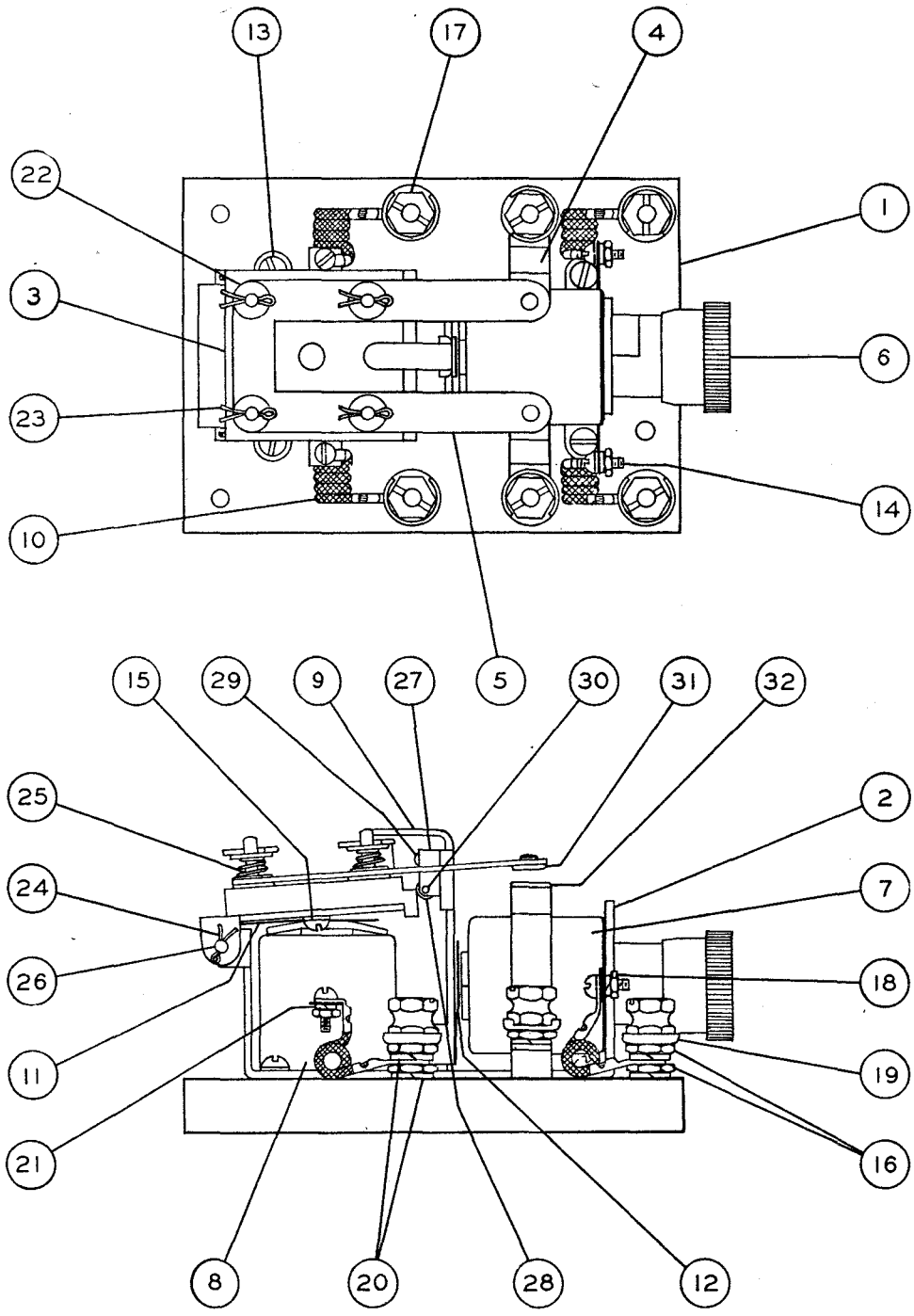
RECOMMENDED WIRE SIZE #18 B.& S.
SUBJECT TO WINDING DATA BELOW.



WINDING DATA

WIRE	GAUGE	PART NO	APPROX NO. OF TURNS	TYPE OF WINDING	ROW A	ROW B	ROW C	ROW D	L	DIST C	Q	FREQ	CAP
24 IN.	18	42IN18●	6 1/2	SINGLE LAYER	START HOLE# 2		STOP HOLE#5		92 92 /UH		180 245	9.0 18.0 M.C.	340 84 /UUF

Fig. 82 Exciter Plate Tank Inductor (L118) (Dwg. No. 1436C)

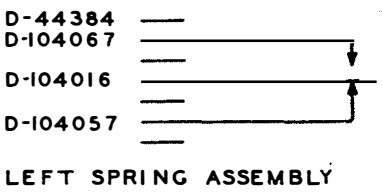


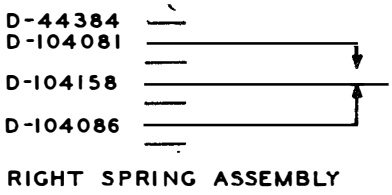
STRUTHERS DUNN INCORPORATED PHILADELPHIA, PENNSYLVANIA		COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA	
STRUTHERS DUNN PART NUMBER:	CX3390	COLLINS PART NO:	405NC4

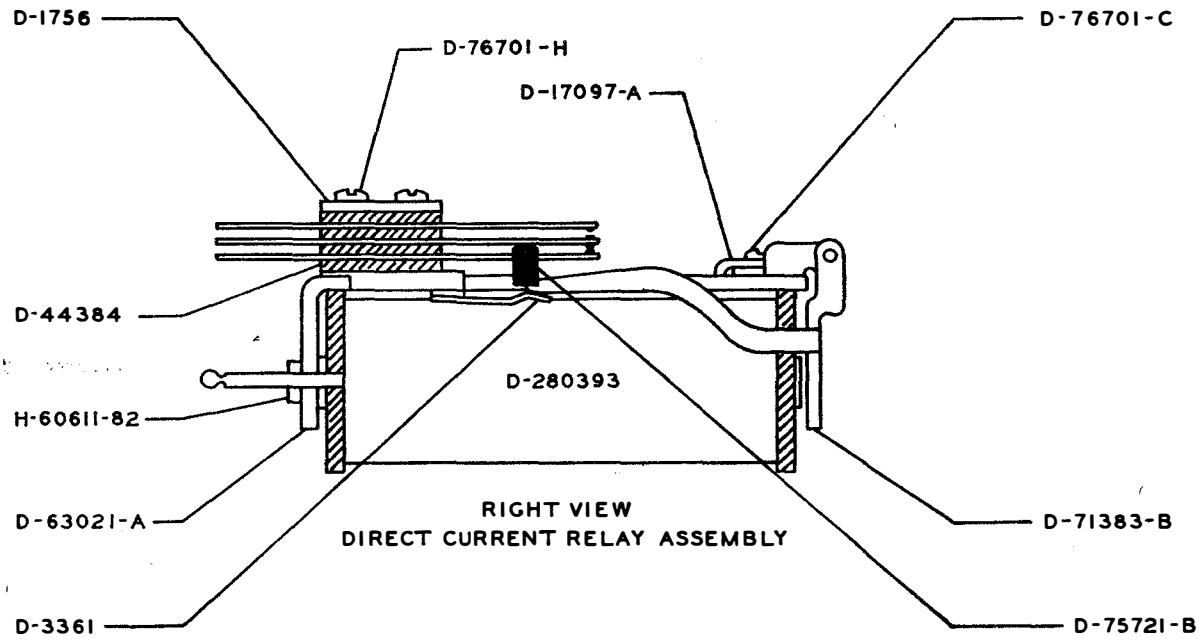
Fig. 83 Relay Assembly (K101) (Dwg. No. 1272B)

APPENDIX

Item	Quantity	Part Number	Description
1	1	P3433	4½ x 3¼ x ½ Base
2	1	P2190	Coil Frame
3	1	P3122	Yoke Block
4	2	P1107	Contact Bracket
5	1	P1118	Yoke
6	1	P2291	Adj. Core
7	1	P1179	Coil—180° lug
8	1	P1179	Coil—180° lug
9	1	P3572	Arm. Latch
10	4	P1205	Pigtail
11	1	P1103	Spring
12	1	P1104	Spring
13	4	144	½" Screw
14	4	841	¼" Screw
15	2	841	¼" Screw
16	10	11	Nut
17	6	35	Nut
18	4	434	Nut
19	6	14	Cup Washer
20	10	3145	Washer
21	10	997	Washer
22	4	264	Washer
23	4	233	Cotter Pin
24	4	204	Cotter Pin
25	4	202	Compression Spring
26	2	491	S. Steel Hinge Pin
27	1	P3437	Roller Support
28	1	P3437	Roller
29	2	246	Escutcheon Pin
30	1	3301	⅜" Dowel Pin
31	2	P1122	Contact
32	2	P1121	Contact

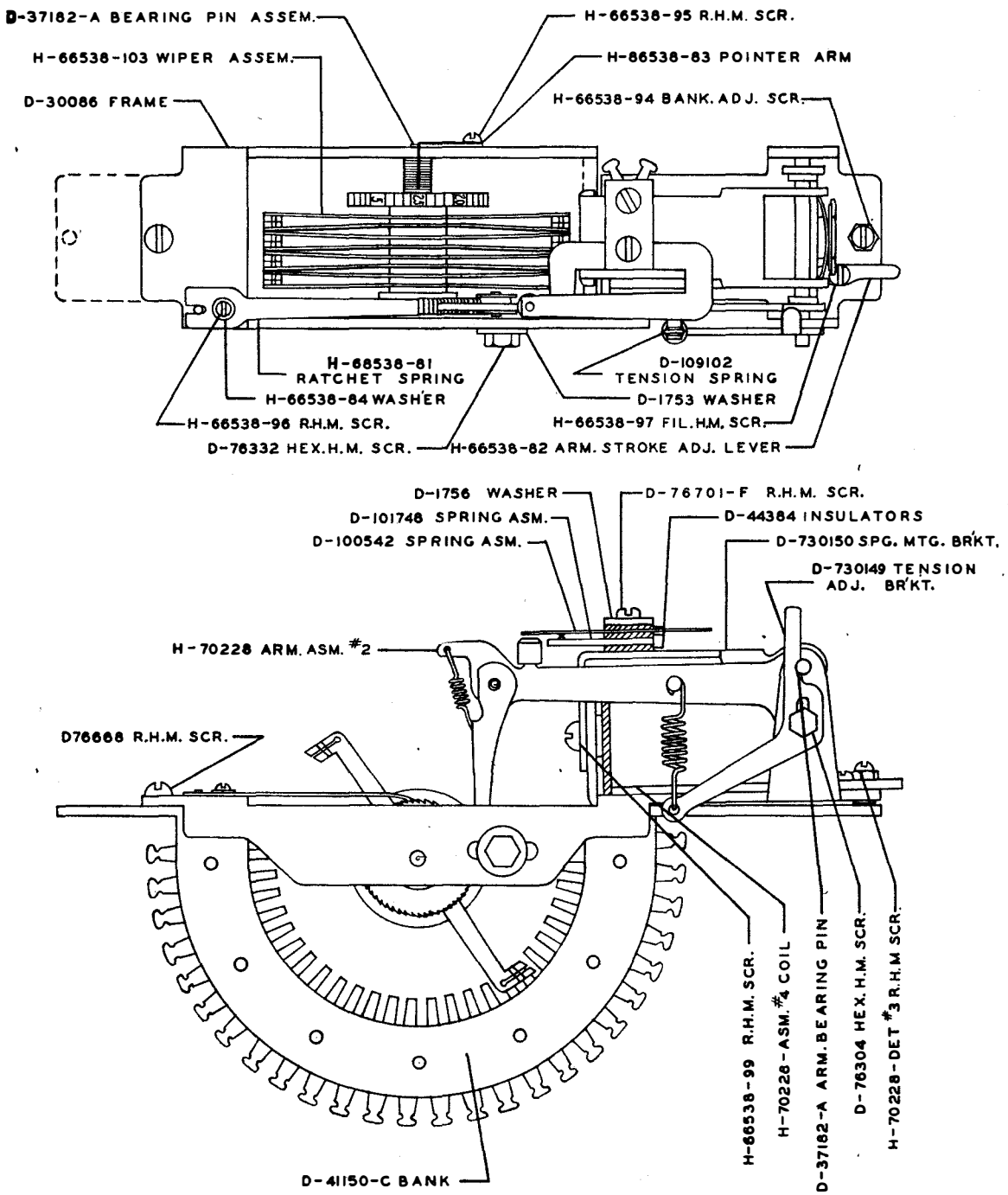






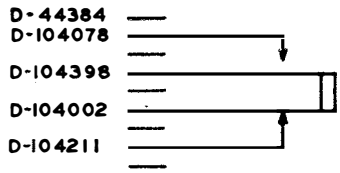
AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC CO. PART NUMBER H-70226-4	COLLINS PART NO: 972N4

Fig. 84 Relay Assembly (K102, K106) (Dwg. No. 966B)

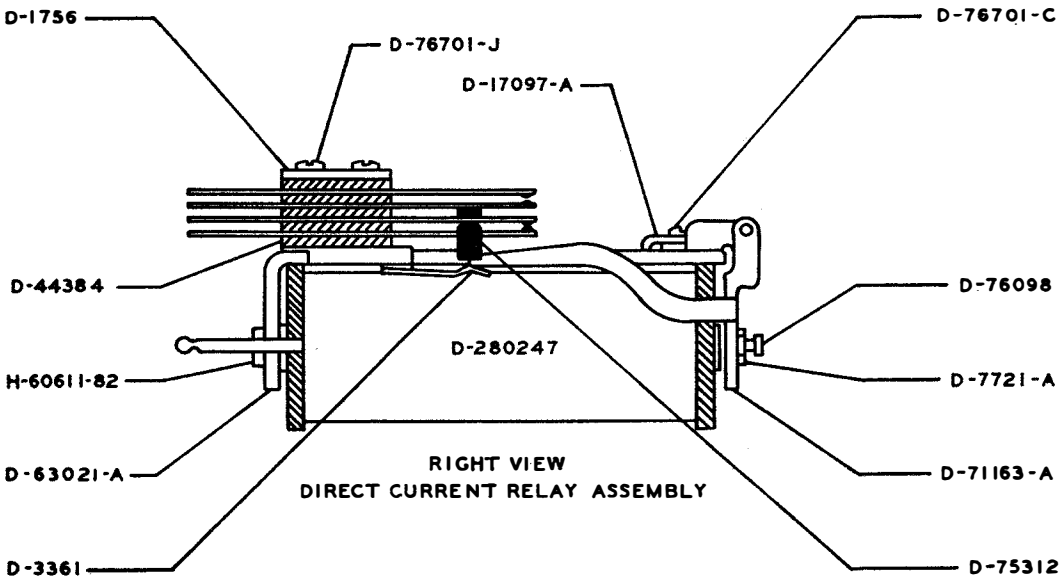


AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS		COLLINS RADIO COMPANY CEDAR RAPIDS IOWA	
AUTO-ELEC. CO. NUMBER:	H-70228-1	COLLINS PART NO:	978N2

Fig. 85 Relay Assembly (K107) (Dwg. No. 774C)



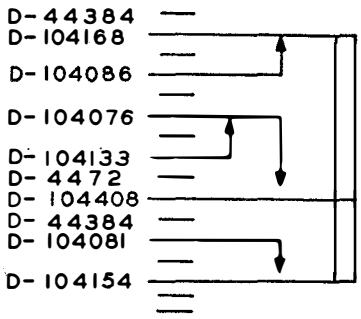
SPRING ASSEMBLY



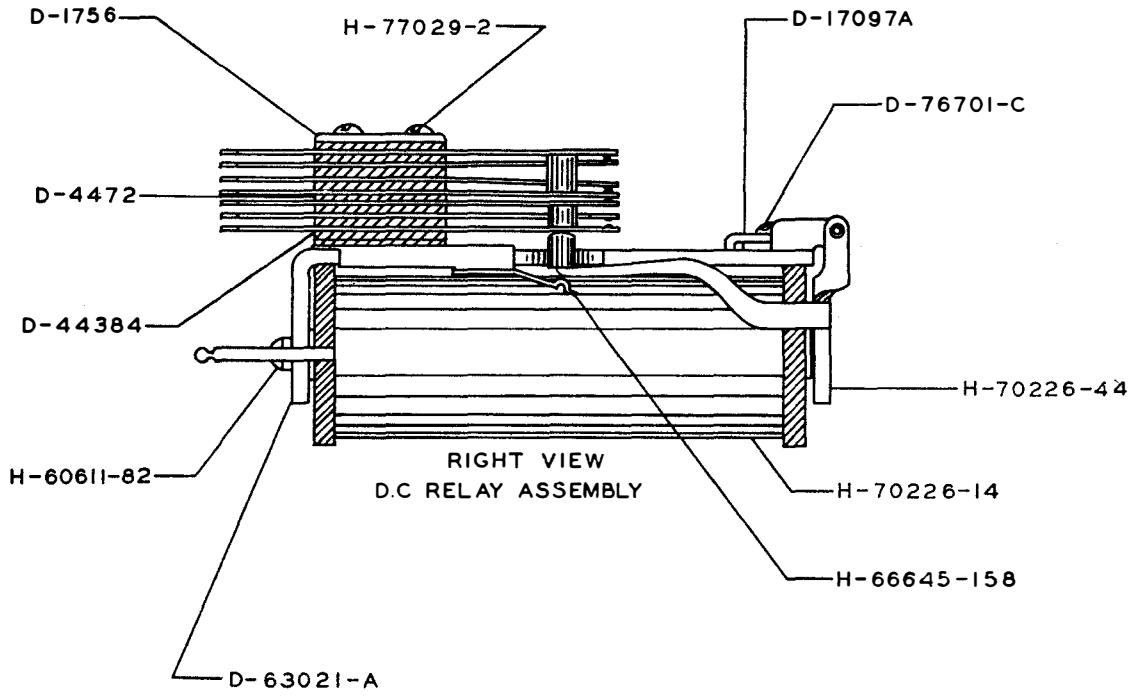
RIGHT VIEW
DIRECT CURRENT RELAY ASSEMBLY

AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC. CO. PART NUMBER: H-70226-1	COLLINS PART NO: 972N1

Fig. 86 Relay Assembly (K108) (Dwg. No. 963B)



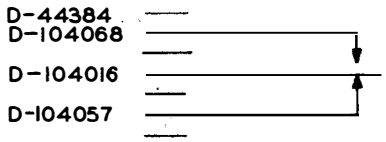
SPRING ASSEMBLY



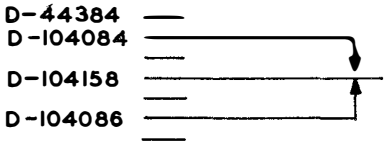
RIGHT VIEW
D.C RELAY ASSEMBLY

AUTOMATIC ELECTRIC CO. CHICAGO, ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
AUTO. ELEC. CO. PART NUMBER: H-77029-1	COLLINS PART NO: 972N15

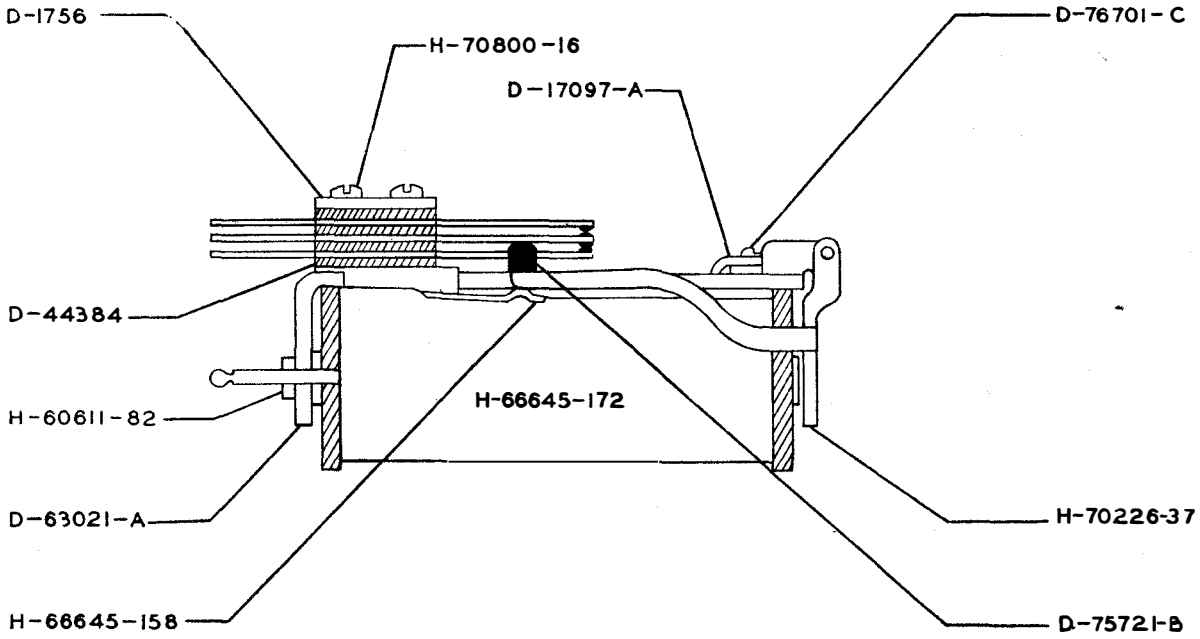
Fig. 87 Relay Assembly (K109) (Dwg. No. 1913B)



LEFT SPRING ASSEMBLY



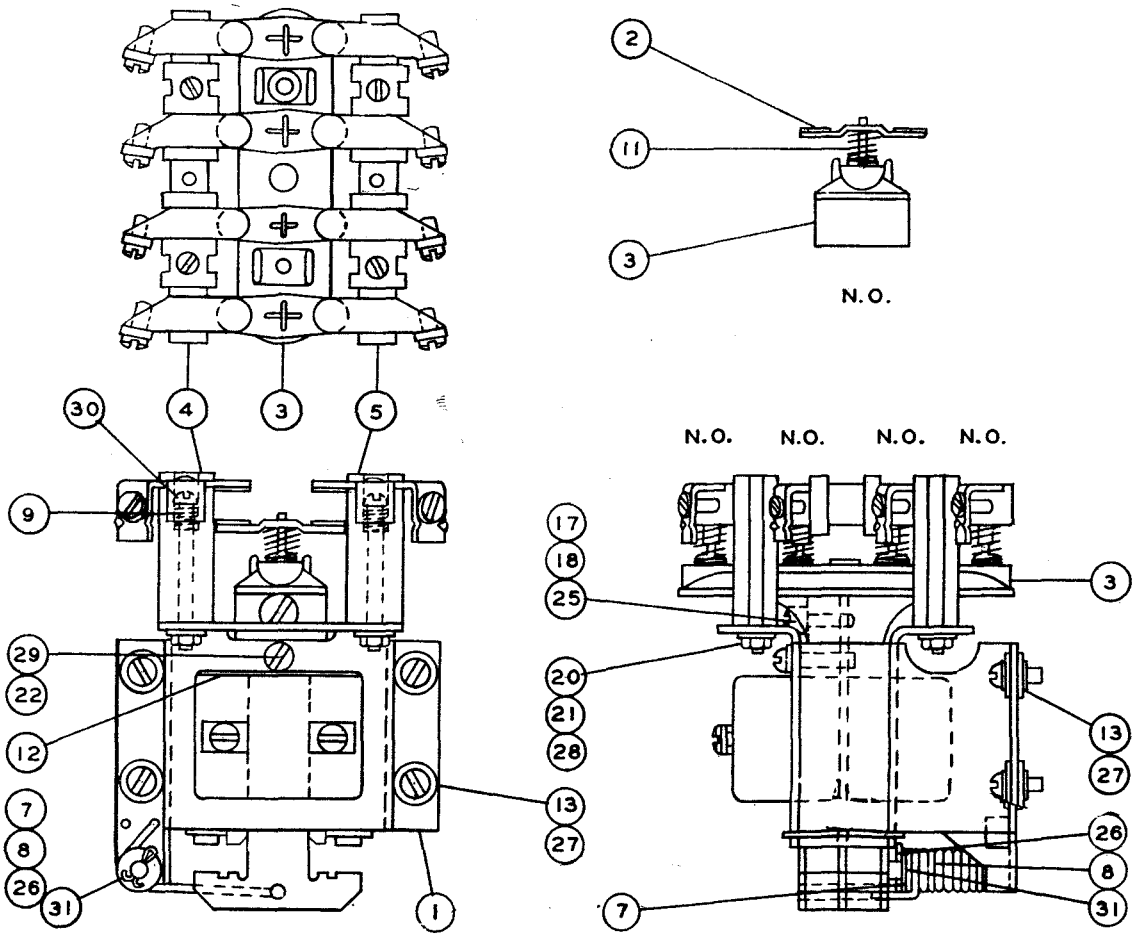
RIGHT SPRING ASSEMBLY



AUTOMATIC ELECTRIC CO. CHICAGO ILLINOIS	COLLINS RADIO COMPANY CEDAR RAPIDS IOWA
AUTO. ELEC. CO. PART NUMBER: H-70800-10	COLLINS PART NO. 972N13

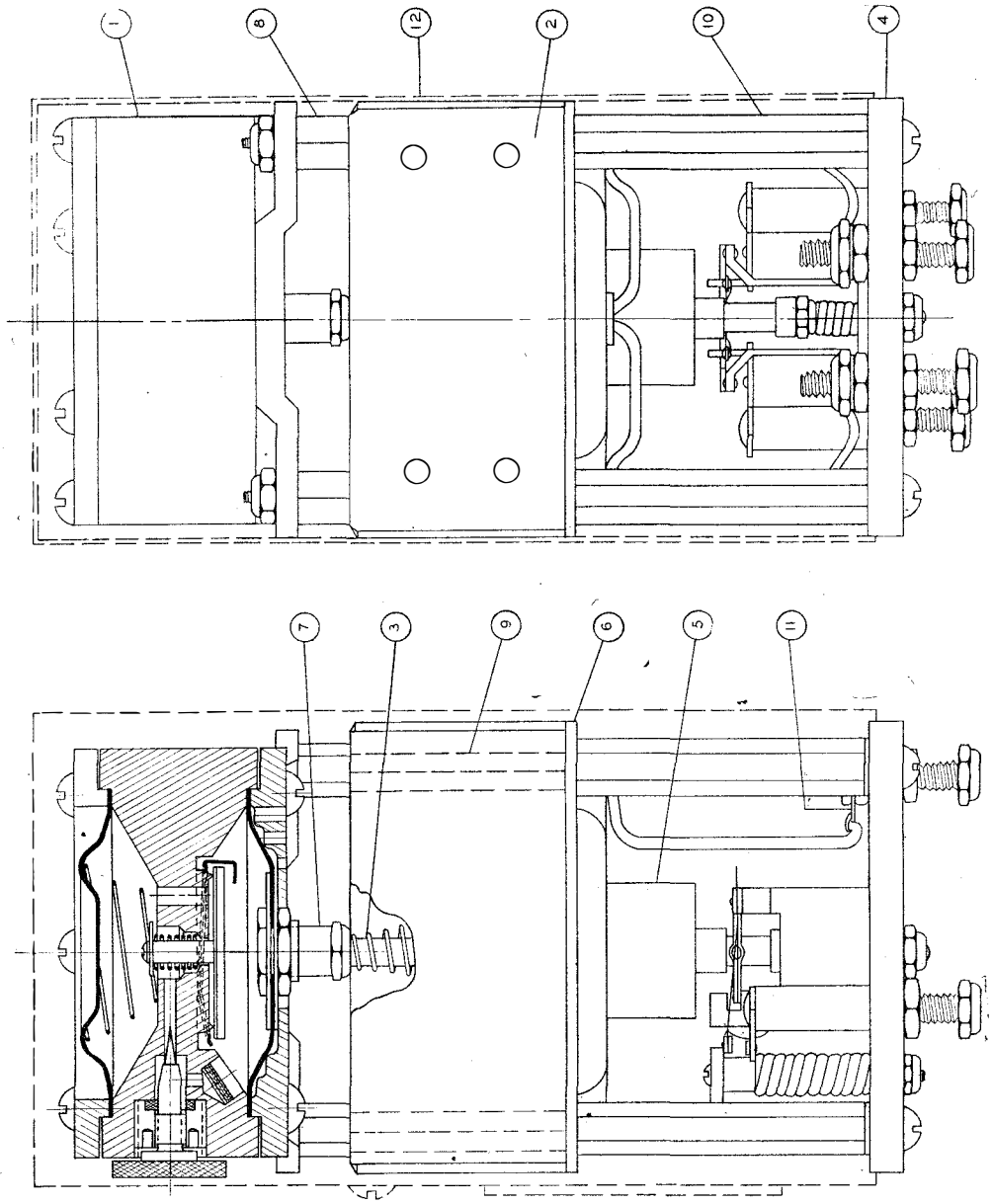
Fig. 88 Relay Assembly (K110, K111) (Dwg. No. 1723B)

Item	Qty.	Part No.	Description
1	1	X-48504	#2 Solenoid
2	4	X-68996	Movable Contact
3	1	X-43576	Cross Bar
4	1	X-48680	Cont. Base
5	1	X-48681	Cont. Base
7	1	M-1112	Cotter Pin
8	1	B-10424	Spring
9	4	B-8590	Spring
11	4	E-10113	Spring
12	1	E-8672	Coil Clamp
17	1	M-1100	#8 Spr. Washer
18	1	M-2240	Spec. Washer
20	4	M-1309	Ir. Washer
21	4	M-1445	4-40 Ir. Nut
22	1	M-971	6-32 x 5/8 R. H. I. M. S.
25	1	M-2355	8-32 x 1/2 Fil. Scr.
26	1	B-11103	Bushing
28	4	M-1510	#4 Spr. Washer
29	1	M-1090	#6 Spr. Washer
30	4	M-1870	4-40 x 1 1/8 R. H. I. M. S.
31	1	M-1155	



ALLEN-BRADLEY COMPANY MILWAUKEE WISCONSIN		COLLINS RADIO COMPANY CEDAR RAPIDS IOWA	
ALLEN-BRADLEY PART NUMBER:	BUL-700 B-400	COLLINS PART NO:	405NA104

Fig. 89 Relay Assembly (K112, K113) (Dwg. No. 1798B)



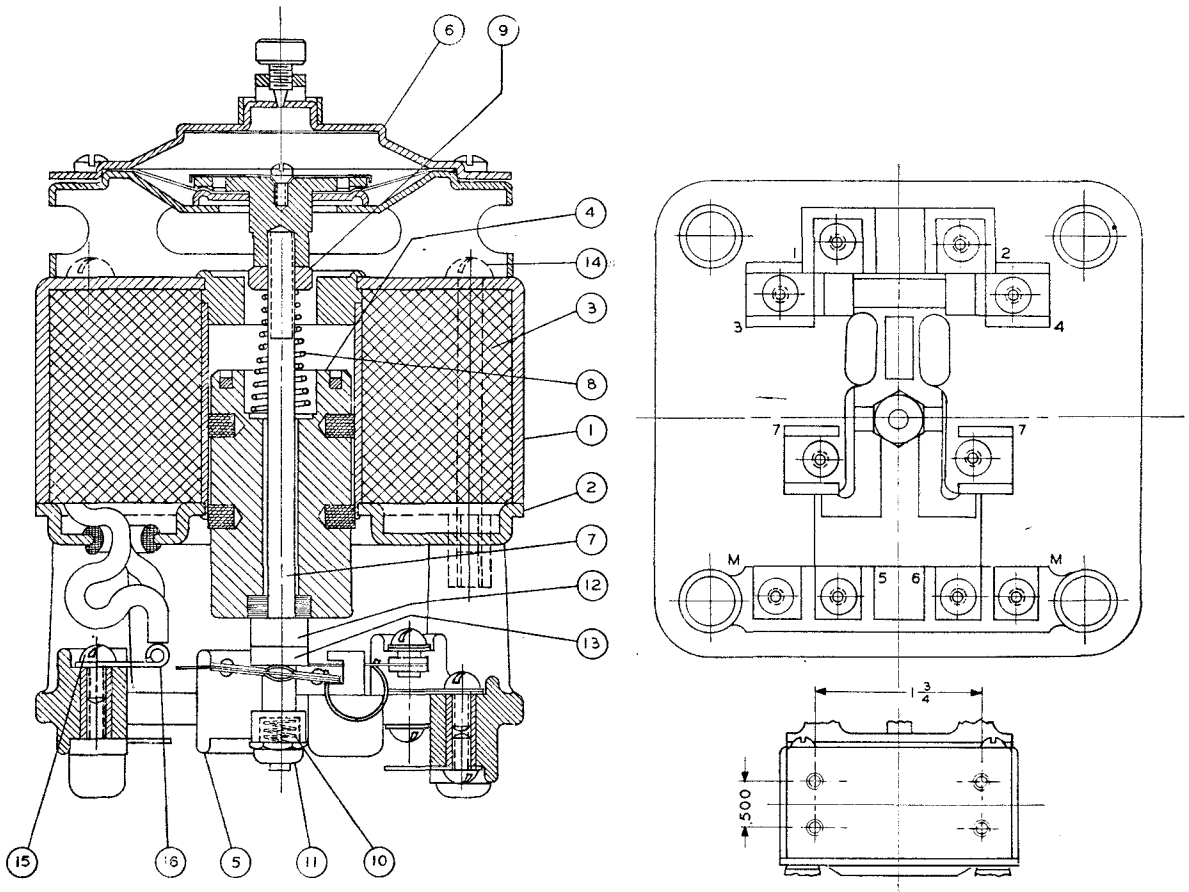
Item	Qty.	Part No.	Description	Item	Qty.	Part No.	Description
1	1	1287-C1	Timing Head Assembly	7	1	1218-150	Spindle Assembly
2	1	1218-88	A.C. Magnet Coil (As Spec.)	8	4	1218-28	Spacer (Short)
3	1	1218-77	Conical Coil Spring	9	4	1218-26	Stud
4	**1**	**1218-35**	Terminal Block Assembly	10	4	1218-168	Spacer (Long)
5	1	1218-146	A.C. Magnet Core Assembly	11	2	701-38	Terminal Lug
6	1	1218-157	Coil Box Cover Assembly	12	1	1218-40	A.C. Coil Box, Sub-Assembly

AMERICAN GAS ACCUMULATOR CO. ELIZABETH, NEW JERSEY	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
ACCUMULATOR CO. NUMBER: NAII - C	COLLINS PART NO: 402N22

Fig. 90 Relay Assembly (K114) (Dwg. No. 1579C)

APPENDIX

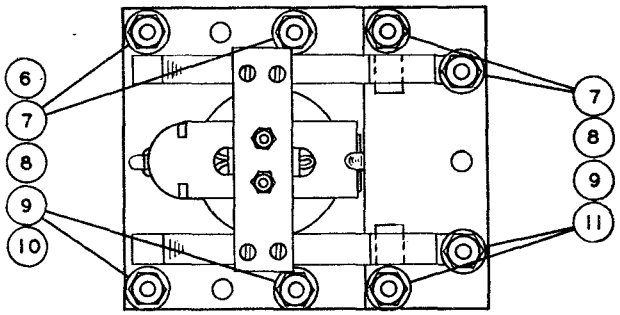
Item	Qty.	Part No.	Description	Item	Qty.	Part No.	Description
1	1	1218-40	Coil Box Assembly	10	1	1641-19	Spring
2	1	1218-157	Coil Box Cover Assembly	11	1	1641-20	Stop Nut
3	1	1218-139	Magnet Coil as Specified	12	1	1645-02	Spacer
4	1	1218-146	Magnet Core Assembly	13	1	1641-11	Collar
5	1	1218-206	Terminal Block Assembly	14	4		#6-32 x 1-1/2" R'd. H'd. Screw—Brass
6	1	1641-14	Timing Head Assembly				
7	1	1641-23	Spindle	15	2		#3-48 x 3/16" R'd. H'd. Screw—Brass
8	1	1218-77	Conical Spring				
9	1		#6-40 Hex. Lock Nut—Brass	16	2	C-841	Diamond Grip Lug

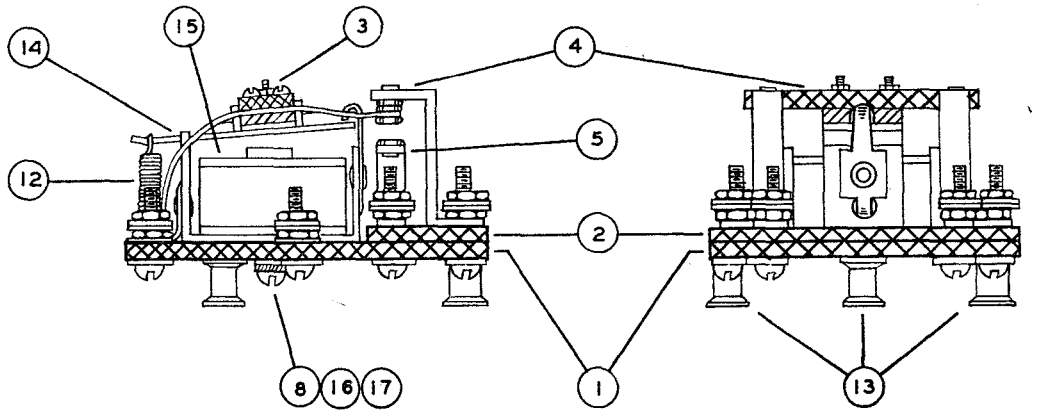


AMERICAN GAS ACCUMULATOR CO. ELIZABETH, NEW JERSEY	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
ACCUMULATOR CO. NUMBER: NE-11 AC	COLLINS PART NO: 402000100

Fig. 91 Relay Assembly (K114) (Dwg. No. 500 1553 00C)

Part	Qty.	Description	Material
1	1	Main Base	1/8 Mycalex
2	1	Contact Bracket Mount Block	1/8 Mycalex
3	1	Armature & Moving Contact Ass'y	
4	2	Top Stationary Contact & Bracket	Silver & Brass
5	2	Lower Stationary Contact & Bracket	Silver & Brass
6	4	Screws 6-32 x 5/8 R. H.	Brass N. P.
7	16	Nuts 6-32 Hex.	Brass N. P.
8	21	Washers #6 3/8 O. D. x 1/32	Brass N. P.
9	4	Lugs 2124 S. P.	Bronze Tin'd
10	8	Washers #6 5/16 O. D. x 1/32	Brass N. P.
11	4	Screws 6-32 x 3/4 R. H.	Brass N. P.
12	1	Return Spring	Stainless Steel
13	3	Mounting Spacers	Dural
14	1	Coil Frame	Electrical Iron
15	1	Coil & Core	
16	1	Screw 8-32 x 1/2 R. H.	Brass N. P.
17	1	1908 Lock Washer	Bronze N. P.



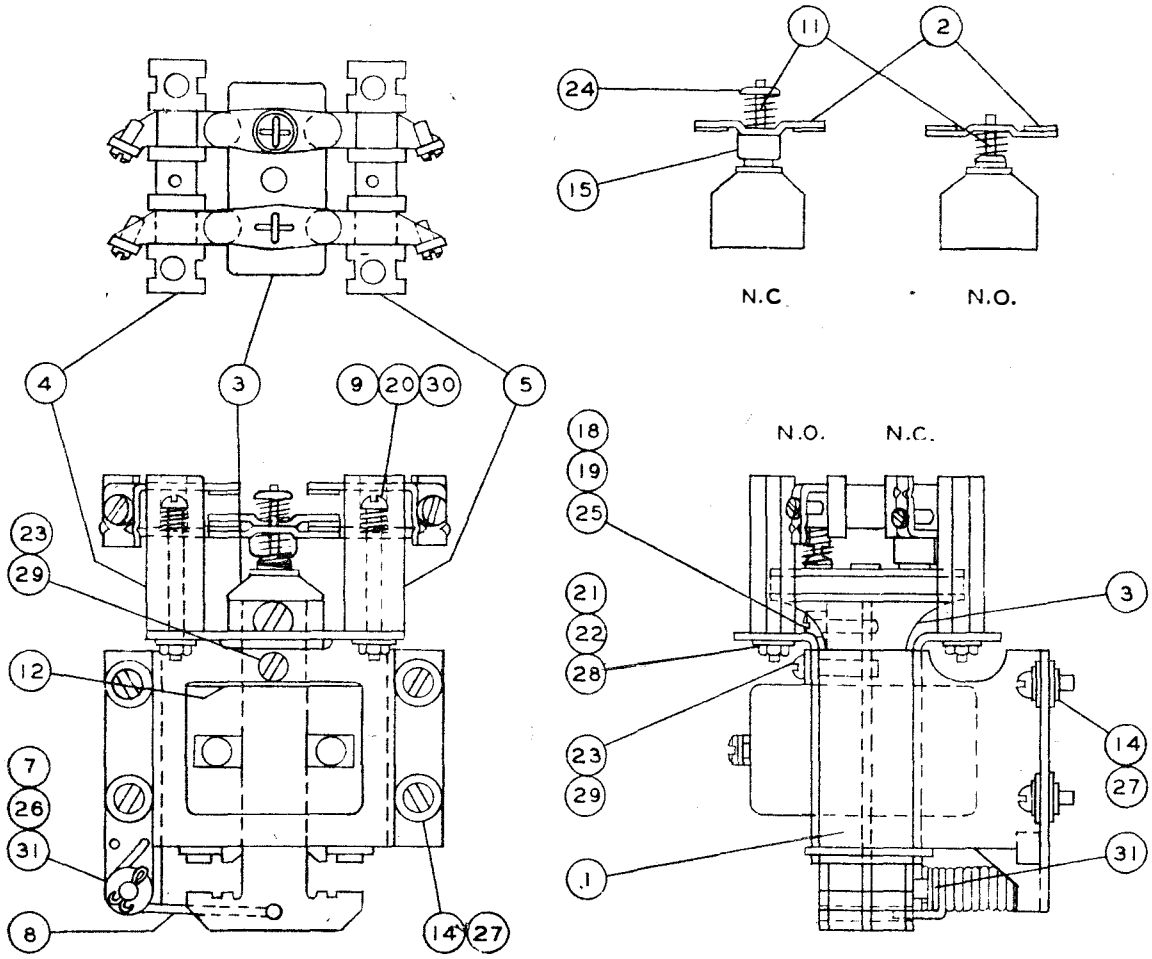


LEACH RELAY COMPANY LOS ANGELES, CALIFORNIA	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
LEACH RELAY NUMBER: 1407-MX	COLLINS PART NO: 407N61

Fig. 92 Relay Assembly (K117) (Dwg. No. 584B)

APPENDIX

Item	Qty.	Part No.	Description	Item	Qty.	Part No.	Description
1	1	X-48504	#2 Solenoid	19	1	M-1100	#8 Spr. Washer
2	2	X-68996	Movable Contact	20	4	B-8590	Spring
3	1	X-44819	Cross Bar	21	4	M-1510	#4 Spr. Washer
4	1	X-53385	Cont. Base L. H.	22	4	M-1309	Ir. Washer
5	1	X-53386	Cont. Base R. H.	23	1	M-1090	#6 Spr. Washer
7	1	M-1112	Cotter Pin	24	1	M-2429	Cup Washer
8	1	B-10424	Spring	25	1	M-2355	8-32 x ½ Fil. H. Screw
9	4	M-1870	4-40 x 1⅛ R. H. I. M. S.	26	1	M-1155	Washer
11	2	E-10113	Spring	28	4	M-1445	4-40 Ir. Nut
12	1	E-8672	Coil Clamp	29	1	M-971	6-32 x ⅝ R. H. I. M. S.
15	1	F-11303	Ins. Bushing	30	4	M-1689	Ir. Washer
18	1	M-2240	Spec. Washer	31	1	B-11103	Bushing

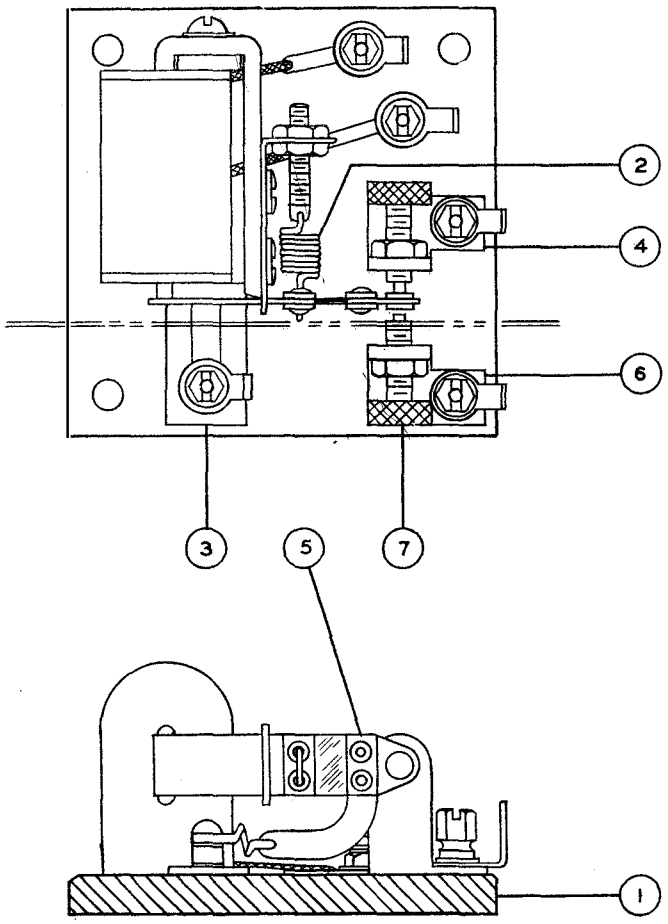


ALLEN-BRADLEY COMPANY MILWAUKEE WISCONSIN		COLLINS RADIO COMPANY CEDAR RAPIDS IOWA	
ALLEN-BRADLEY PART NUMBER:	BUL-700 B-110	COLLINS PART NO:	405NA105

Fig. 93 Relay Assembly (K118) (Dwg. No. 1797B)

APPENDIX

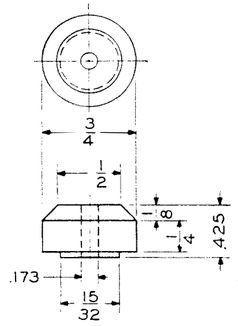
Item	Part	Qty.	Description	Material
1	201A	1	Base 2⅝ x 2⅝ x ¼	Black Bakelite
2	212C	1	Load Spring	Phos. Bronze
3	213	1	Ins. Strip	Canvas Bakelite (D-34)
4	111	1	Contact Post—Left Hd.	C. R. S.—Cd. P.
5	205A	1	Armature Assembly	
6	111A	1	Contact Post—Right Hd.	C. R. S.—Cd. P.
7	112	2	Contact Screw	Brass—Cd. P.



KURMAN ELECTRIC CO., INC. NEW YORK CITY, NEW YORK	COLLINS RADIO COMPANY CEDAR RAPIDS, IOWA
KURMAN NUMBER: 223C38A	COLLINS NUMBER: 408N7

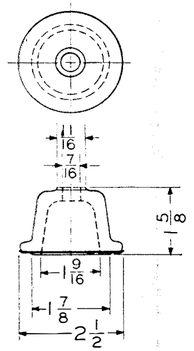
Fig. 94 Relay Assembly (K301) (Dwg. No. 574B)

SYMBOL DESIGNATION	COLLINS PART NO
E123	190NBI1



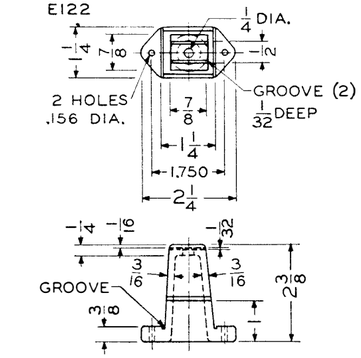
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E110	192N202



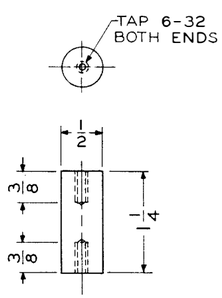
MATERIAL: CLEAR PYREX

SYMBOL DESIGNATION	COLLINS PART NO.
E111 E120 E122	193N2



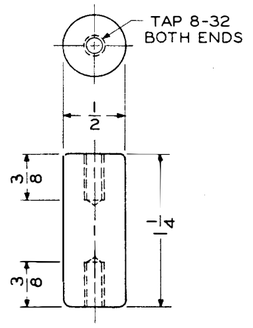
MATERIAL: PORCELAIN

SYMBOL DESIGNATION	COLLINS PART NO.
E113	190NSL23



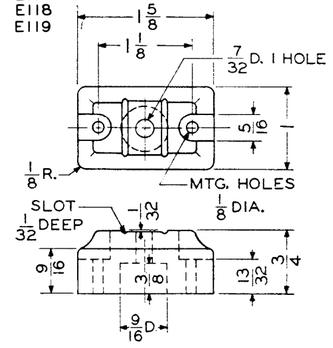
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E114	190NSL4



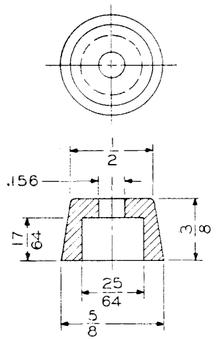
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E115 E117 E118 E119	193N1



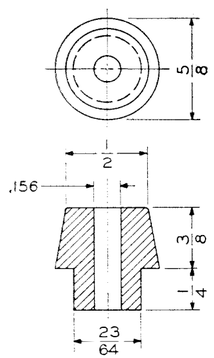
MATERIAL: GRAY PORCELAIN

SYMBOL DESIGNATION	COLLINS PART NO.
E116	190NBI19



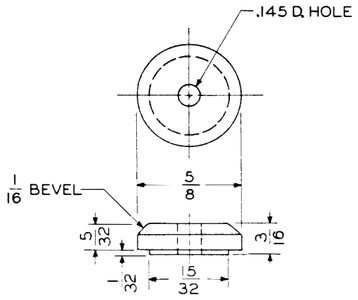
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E116	190NBI20



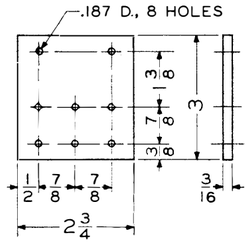
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E121	190NBI7



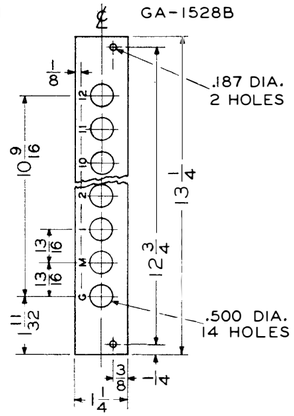
MATERIAL: LOW LOSS CERAMIC

SYMBOL DESIGNATION	COLLINS PART NO.
E124	X-6478



MATERIAL: MYCALEX

SYMBOL DESIGNATION	COLLINS PART NO.
E101	GA-1528B

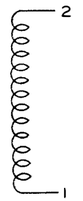


MATERIAL: BAKELITE (1/4)

Fig. 95 Insulator Details (Dwg. No. 502 1320 004)

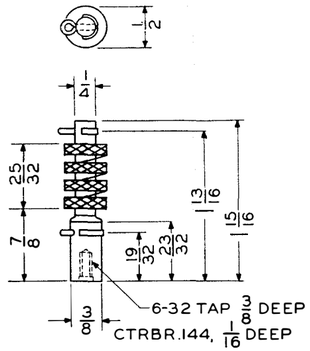
Fig. 95 Insulator Details (Dwg. No. 502 1320 004)

SYMBOL DESIGNATION	COLLINS PART NO.
L101 L103	X-3779-5



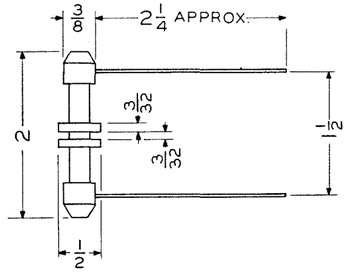
190N COIL
S. LAYER
#24EN.
96 MICROH.
40 FT. WIRE

SYMBOL DESIGNATION		COLLINS PART NO.
L105	L119	240N53
L106	L120	
L107	L130	
L108	L131	
L110	L133	
L114		



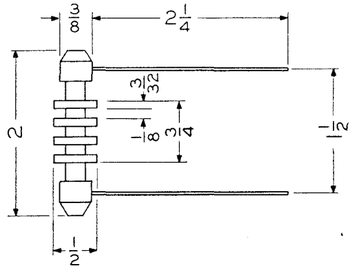
4 PIE 220T/PIE
#36 S.S.EN.

SYMBOL DESIGNATION	COLLINS PART NO
L109	240N23



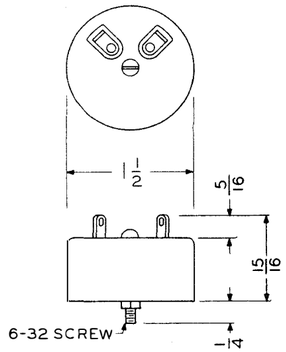
2 SECTIONS UNIVERSAL WOUND
222T/SECTION #36 S.S.EN

SYMBOL DESIGNATION	COLLINS PART NO.
L113	240N2A



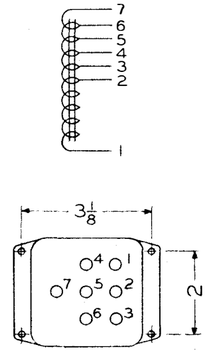
4 SECTIONS UNIVERSAL WOUND
222T/SECTION #35 SSEN

SYMBOL DESIGNATION	COLLINS PART NO
L121	240N56



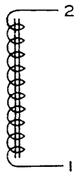
1000T #35 S.S.EN

SYMBOL DESIGNATION	COLLINS PART NO
L122	678N119B



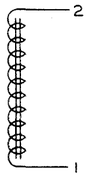
372T #21EN
127T #22EN
WINDINGS CONNECTED
IN SERIES

SYMBOL DESIGNATION	COLLINS PART NO
L123	678N159



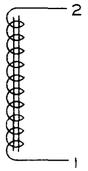
1520T
#29 EN

SYMBOL DESIGNATION	COLLINS PART NO
L124 L125	678N117A



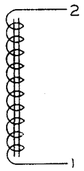
1664T
#24 EN

SYMBOL DESIGNATION	COLLINS PART NO
L126 L127	678N115A



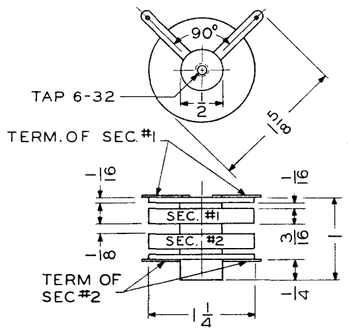
1900T
#23EN

SYMBOL DESIGNATION	COLLINS PART NO
L128 L129	678N116



2970 T
#21 EN

SYMBOL DESIGNATION	COLLINS PART NO
L132	240N52



2 SECT
120T/SECT
#24 D.S

LEGEND

EN - PLAIN ENAMEL WIRE
D.S. - DOUBLE SILK
SSEN - SINGLE SILK ENAMEL
T - TURNS

Fig. 96 Choke and Reactor Winding Data (Dwg. No. 502 1319 004)

Fig. 96 Choke and Reactor Winding Data (Dwg. No. 502 1319 004)

SYMBOL DESIGNATION	COLLINS PART NO.
T106	677N272

PRI 1 608T #31E N.
PRI.2 608T #31E N.
SEC.1 870T #32E N.
SEC.2 870T #32E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T107	672N271

PRI.1 1100T #27E N.
SEC.1 30T CT #14S.C.E.
SEC.2 12T CT #14S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T108	672N113A

PRI. 1350T #32E N.
SEC. 29T CT #15S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T109	672N257

PRI.1 1122T #27E N.
SEC.1 2140T CT #30E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T101	672N109C

PRI. 695T #23E N.
SEC. 29T CT #11SQ. P.C.

SYMBOL DESIGNATION	COLLINS PART NO.
T102	672N112A

PRI. 1320T #28E N.
SEC. 36T CT #13S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T103	677N270

PRI.1 472T #34E N.
PRI.2 472T #34E N.
PRI.3 2-178T-P #30E N.
SEC.1 4285T #38E N.
SEC.2 4285T #38E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T104	677N141

PRI.1 2-5308T-P #40E N.
SEC.1 2-3050T-P #41E N.
SEC-2 2-3050T-P #41E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T105	677N102A

PRI.1 2-4050T-P #38E N.
SEC.1 4240T #38E N.
SEC.2 4240T #38E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T115	672N107

PRI 240T 12SQ.D.P.
2-900T-P #22S.C.E.
2-900T-P #22S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T116	677N104

2-1115T-S 28S.C.E.
2-1115T-S #28S.C.E.
SEC.1 2-1420T-P #25S.C.E.
SEC.2 715T #32S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T117	664S141

P1
P2
P3
S
270T #9SQ.P.C.
PO

SYMBOL DESIGNATION	COLLINS PART NO.
T118	677000100

PRI. 3040T #39E N.
SEC. 760T #35E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T110	672N148

PRI. 937T #28E N.
SEC. 10T CT #10SQ. D.P.

SYMBOL DESIGNATION	COLLINS PART NO.
T111	672N106A

PRI. 2850T #23E N.
SEC. 542T CT #18E N.

SYMBOL DESIGNATION	COLLINS PART NO.
T112	672N110A

PRI. 995T #25E N.
SEC. 842T CT #12S.C.E.

SYMBOL DESIGNATION	COLLINS PART NO.
T113	672N114A

PRI. 1094T #27E N.
SEC. 12T CT #9SQ. D.P.

SYMBOL DESIGNATION	COLLINS PART NO.
T114	674N269

PRI.1 845T #24E N.
SEC.1 290T #24E N.
SEC.2 400T #24E N.

LEGEND
P.C. PAPER COVERED
E.N. PLAIN ENAMEL WIRE
S.C.E. SINGLE COTTON ENAMEL
D.P. DOUBLE PAPER
SQ. SQUARE WIRE
T TURNS
C.T. CENTER TAPPED
P COILS IN PARALLEL
S COILS IN SERIES

Fig. 97 Transformer Winding Data (Dwg. No. 502 1318 005)

Fig. 97 Transformer Winding Data (Dwg. No. 502 1318 005)

APPENDIX

ADJUSTMENT DATA FOR COMMERCIAL ASSEMBLIES

APPENDIX

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

A—GENERAL:

1. Definitions: Various terms used in the requirements throughout this standard adjustment will have the following meanings:

   "Spring Combination" is the entire spring assembly of either a single or double armature relay.

   "Spring Pile-up" is an assembly of all the springs operated by one armature arm. "Contact Springs" are the individual springs of a spring pile-up or a spring combination.

   "Two step operation relays" are relays having separate electrical requirements for one or more pairs of contact springs.

2. When a "Z" relay is mounted on the frame of a Strowger switch, the relay armature shall clear the nearest point on the lower rotary magnet coil spool head by minimum $\frac{1}{32}$".

3. On break combinations disk type contacts shall not be out of alignment (gauged visually) by more than $\frac{1}{5}$ of their face diameter, and in their normal position shall be engaged by not less than $\frac{1}{2}$ the area of the contact faces. (A barely perceptible gap caused by contact face irregularities, etc., shall be regarded as a closed contact.)

4. On make combinations disk type contacts shall not be out of alignment (gauged visually) by more than $\frac{1}{5}$ of their face diameter, and shall be engaged by not less than $\frac{1}{2}$ the area of the contact faces during some part of the stroke.

B—ALIGNMENT:

1. When relays are mounted on their associated mounting plates, the relays shall be well aligned. There shall be a minimum space of $\frac{1}{32}$" between the armature or springs of any relay and the armature, springs, or heelpiece of the relay above or below it, and the armature back stop of any relay shall not touch the heelpiece of the relay above it. This may be gauged by eye.

2. In either the normal or operated position, there shall be a clearance of .010" minimum between springs not designed to make contact.

3. All contact springs, when assembled on the relay, shall line up uniformly with respect to each other and to the relay structure proper as gauged by eye.

4. Spring operating bushings shall be approximately in alignment with the center of and perpendicular to the springs against which they strike, as gauged by eye.

C—ARMATURE:

1. The relay armature shall be set so as not to make contact with the heelpiece, but so as to clear the heelpiece by not more than .003" for adjustment and .004" for inspection at the closest point with the armature operated, unless otherwise specified. The armature shall be parallel to the heelpiece end, as gauged by eye.

   NOTE: In case of short lever slow release relays, the maximum air gap may be .005" for adjustment and .006" for inspection.

2. The relay armature shall not bind at its bearings or on the heelpiece and shall have side play of maximum .020", minimum .002".

3. The armature back stop shall be adjusted to allow perceptible play in the armature between the #2 spring and the armature back stop on spring pileups where the #1 spring is a back contact.

4. The "Z" relay armature back stop shall

APPENDIX

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

be positioned so that the point of contact between the armature and the formed edge of the back stop is 1/32" minimum from the end of the armature arm.

5. The armature bushing shall be securely assembled on its associated mounting.

   NOTE: This requirement shall be considered as having been met if the bushing is forced onto the mounting lug with a pressure of minimum 20 lbs. while the bushing is at an approximate temperature of 200° F.

D—RESIDUALS:

1. This is an adjustment of the space between the core and the armature with the relay electrically operated.
2. Where the residual specified on the Relay Adjustment Sheet is .003" or more, a tolerance not to exceed plus or minus .001" for adjustment and .002" for Inspection shall be allowed unless otherwise specified.
3. Where the residual is specified as .0015" the armature shall not touch the core nor be over .003" for Adjustment and .004" for Inspection from the core at the closest point, with the armature operated electrically.

E—SPRINGS:

1. Relays shall be gauged between the armature (or residual screw when used) and core, with the armature operated electrically.
2. For adjustment plus or minus less than .001" in the case of standard armatures, or .002" in the case of short lever armatures, variation from the values specified shall be allowed unless otherwise specified.
3. Upon inspection, plus or minus less than .002" in the case of standard armatures, or .003" in the case of short lever armatures, variation from the values specified shall be allowed unless otherwise specified.
   (a) When a make or break contact is specified as .033", or less, the variation allowed for Adjustment shall be plus less than .001" or minus —0— and for Inspection shall be plus less than .002" or minus —0—.

   (b) When a make or break contact is specified as .004" the variation allowed for Adjustment shall be plus less .001" or minus less than .001" and for Inspection shall be plus less than .002" or minus less than .001".

   (c) On make - before - break assemblies where the difference between the values specified for the make and break adjustment is as indicated in the following table, the variation allowed for Inspection or Adjustment as determined by E2, E2(a) or E2(b), shall not cause the break contacts to break when a gauge is used which is the indicated amount smaller than the gauge on which the make contacts actually make:

Difference between make and break specified	Break contacts shall not break with following size gauge smaller than gauge on which contact actually makes.	
	For Inspection	For Adjustment
.003" and .004" for slug Type C Relay of selectors	.001"	.002"
.003"	.002"	.003"
.004"	.002"	.003"
.005"	.003"	.004"
.006"	.004"	.005"
.007"	.005"	.006"
.008"	.006"	.007"

These tolerances shall be checked with gauges which vary in steps of .001".

APPENDIX

STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS AND SHORT LEVER ARMATURE RELAYS

(d) Where a stroke measurement is specified, the variation allowed for inspection shall be as follows:

1. A gauge .003″ in the case of a standard armature and .005″ in the case of a short lever armature larger than the specified stroke gauging should not enter between the armature (or residual screw when used) and the core when the relay is not energized, or if it does enter the armature shall not leave the armature back stop when the relay is electrically energized.
2. When the difference between the values specified for stroke gauging and the highest make contact gauging is .005″ or more, the armature shall leave the back stop when a thickness gauge of .002″ less than the values specified for the stroke is inserted between the armature (or residual when used) and the core.
3. When the difference between the values specified for the stroke gauging and the highest make contact gauging is .004″ or less, the armature shall leave the back stop when a thickness gauge of .002″ more than the value on which the make contact actually makes, (gauged within .001″), is inserted between the armature (or residual screw when used) and the core.

(e) When there are two or more back contacts in spring pile-up, the variation allowed shall not change the sequence of operation, as indicated by the specified mechanical gauging.

NOTE: The above requirements do not apply to the back contacts of the standard make-before-break assemblies as illustrated by springs #2 and #3 of Figure 7.

(f) When the gauging specified for a make contact assembly is .004″, or more, greater than any other make contact gauging value for the same relay, no variation shall be allowed that will alter the sequence of operation indicated by the .004″ or more difference.

(g) When the difference between the values specified for the break and make springs of a break-make assembly is .002″ or less the make springs shall not make when a gauge is used which is .002″ less for Adjustment or .001″ less for Inspection, than that on which the break contacts actually break. When the difference between the values specified for the break and make springs of a break-make assembly is .003″ or more, the make springs shall not make when a gauge is used which is .002″ less than that on which the break contacts actually break.

4. When the gauging or separate electrical requirements indicate that one or more pairs of contacts shall make or break before the next succeeding pair of contacts break, they shall be adjusted as follows:
(a) When the gauging difference between the pairs of contacts is .006″ or more, the make or break contacts shall make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring.

(b) When the gauging difference between the pairs of contacts is .005″ or less, the make or break contacts may or may not make or break before the bushing on the armature spring of the succeeding pair of break contacts is struck by the preceding armature spring, but the make or break contacts must make or break before the succeeding break contacts break.

5. Variation in the mechanical gauging shall not be permitted which will allow the nor-

mal or operated contact gap to be less than .005" as gauged by eye.

6. Unless otherwise specified, relays shall fully operate all springs and the armature (or residual screw when used) shall touch the core on the "Operate" tests shown on the Relay Adjustment Sheet.

7. Unless otherwise specified, relays shall not open any back contact circuits nor close any make contact circuits on the "non-operate" tests shown on Relay Adjustment Sheets except as follows:

   (a) On relays having three or more back contacts the first two back contact assemblies in the sequence of operation, as indicated by the specified mechanical gauging, may break contact on the "non-operate" tests.

   NOTE: The above requirement does not apply to the back contacts of the standard make-before-break assemblies as illustrated by springs #2 and #3 of figure 7. However, the above requirement applies to the back contacts of the special make-before-break assemblies as illustrated by springs #1 and #2 of Figure 8.

   (b) On special make-before-break contact springs as illustrated by Figure 8, the make contacts may make on the non-operate requirements specified for the entire spring combination.

   (c) On two step relays the contact to which the separate electrical requirements apply may make or break on the "non-operate" requirements specified for the entire spring combination.

8. Spring tension shall be accurately adjusted in accordance with the "Adjust" values (current or resistance) and inspected in accordance with the "Test" values (current or resistance) shown on the Relay Adjustment Sheets.

9. A variation of plus or minus one volt shall be allowed in the voltage specified for adjusting and inspecting the relays according to the "Adjust" and "Test" resistance values.

F—SATURATION:

1. Relays shall be saturated at a minimum of 300 ampere turns for an interval of minimum one second before being adjusted or checked to the electrical current flow requirements unless otherwise specified. The saturating current shall be in the same direction as the other current flow requirements unless otherwise specified. The other current flow requirements shall not be applied until an interval of minimum 1 second after saturation.

   (a) This requirement may be met by applying voltage to the operating winding of the relays as follows: Windings of 100 ohms resistance or more, connect directly to 46 volts ±1 volt. Windings of less than 100 ohms resistance, connect to 46 volts ±1 volt with a protective resistance of approximately 45 ohms (or switch magnets) in series.

G—LOCKING TYPE RELAYS:

1. With the armature at normal, the pressure of the locking spring against the armature shall be minimum 75 grams, maximum 150 grams for Adjustment and minimum 50 grams, maximum 200 grams for Inspection.

2. The locking spring shall latch the armature when the armature is manually operated with .0015" between the core and the armature (or residual screw when used), and shall not latch the armature without binding when the armature is manually operated with .003" between the

core and armature (or residual screw when used).

3. The tongue of the locking spring shall engage the armature to a depth at least equal to the thickness of the tongue.

H—STROKE ADJUSTMENT OF 3 POLE RELAYS, WITH STROKE ADJUSTING SCREW:

The front pole-piece shall be located so as to be approximately flush with the edge of the center pole-piece as gauged by eye.

The armature travel is adjusted with the aid of the screw and lock nut located in the front pole-piece. When the armature travel has been set the position of the screw shall be secured by tightening the lock nut. The end of the screw shall extend a minimum of .030" beyond the inside surface of the front pole-piece.

NOTE: In case of large armature travels it may be necessary in order to meet the above .030" requirement, to reset the front pole-piece further toward the armature end of the relay.

J—LUBRICATION:

1. Whenever a horizontal relay is to be operated as much as one million times a year, it is recommended that the armature bearings be lubricated by a #4 Artist's Sable Rigger brush which has been dipped ⅜" into spindle oil and scraped on the edge of the container to remove surplus oil. There should not be sufficient oil adhering to the brush to form a drop on the end at the bristles. Six relays may be oiled with one such "dip."

2. During manufacture, relays shall be oiled only when the adjustment sheets or cards carry a note "Oil Bearings."

APPENDIX

STANDARD ADJUSTMENT FOR LEVER KEYS

A—GENERAL:

1. Keys shall meet the general requirements specified in Standard Adjustments for General Requirements that are applicable.

B—SPRINGS:

1. The tips of lever springs which have associated back contacts shall be adjusted to clear their respective rollers by minimum perceptible, maximum .005" with all the play in the key lever taken up in the direction away from the spring tips which are being gauged.
2. The tips of lever springs shall contact the entire width of their respective rollers when the key is operated.
3. With the key at normal, the formed lever spring of any pile-up shall rest against either a back contact or an insulator with a tension of minimum 50 grams measured at the form.
4. A lever spring not having a back contact shall be tensioned against its adjacent lever spring or against the insulator with a minimum pressure of 20 grams measured at the tip of the spring when the key is normal.
5. Break contacts in a spring pile-up shall break in sequence, the break contact nearest the key frame opening first.
6. Unless otherwise specified all the break contacts on one side of a key except the break contacts of make-before-break assemblies, shall open before any make contact closes, including makes of make-before breaks.
7. Break contact springs shall have a minimum follow of .010" when breaking contact.
8. Make contact springs shall have a minimum follow of .015" after making contact.
9. The normal contact separation of make or break contacts shall be minimum .010".
10. There shall be a clearance of minimum .010" between terminals of the same key or between terminals of adjacent keys.
11. There shall be a minimum of $\frac{1}{32}$" between springs in adjacent spring pile-ups.
12. On A.E. Co. type lever keys, there shall be a clearance of not less than .005" between the lever springs and the key frame when the key is in the normal position.

C—ROLLERS:

1. Rollers shall turn freely when the key is being operated.
2. Rollers shall not have perceptible bind on the frame when the key is being operated.

D—HANDLES:

1. Key handles shall seat on shoulders of cam.
2. Handles of adjacent keys shall be in approximate alignment.

PUSH KEYS TYPE D-59094-A

E—SPRINGS:

1. There shall be just perceptible clearance between the roller bushing and the main springs when the key is in the normal position.
2. The normal contact separation of make contacts shall be not less than .015" and shall allow the make contact to "follow" not less than $\frac{1}{64}$" after making contact.

F—ROLLER PLUNGER ASSEMBLY:

1. The roller bushing shall turn freely on its bearing.
2. The main rollers shall turn freely while the key is being operated.
3. The assembly shall not bind and shall restore to normal with the tension of the contact springs removed.

APPENDIX

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

A—GENERAL:

1. The dial shall meet the general requirements specified in Standard Adjustments for General Requirements which are applicable.
2. The finger plate shall not bind on the finger stop.
3. The enamel on the number plate shall be clean and shall not be broken or excessively cracked.

B—IMPULSE SPRINGS:

1. When not engaged by the impulse shorting arm, the middle impulse spring shall rest firmly against the heavy stop spring from its own tension.
2. With the finger plate off normal and the tip of the main impulse spring opposite a low side of the cam, the main impulse spring shall rest against the contact of the middle spring with minimum 25 grams, maximum 50 grams contact pressure.
3. With the finger plate off normal and the tip of the main impulse spring opposite a low side of the cam, the heavy stop spring shall hold the middle and main impulse springs so as to make the separation between the main impulse spring and a low side of the impulse cam approximately the same as the space between contacts when the main impulse spring is resting against the high side of the cam.

C—MAIN SPRING AND SHUNT SPRINGS:

1. The main spring shall have one to one and a third turns tension with the dial at normal.
2. When an impulse shorting arm is used, the plane parallel to the dial mounting plate which passes through the center line of the buffer on the middle impulse spring shall pass through a point within the width of the contacting portion of the impulse shorting arm.
3. The impulse shorting arm, when used, shall cause the main impulse spring to clear the cam by minimum .015", maximum .030" during the shorted impulse.
4. The impulse shorting arm shall not cause the impulse springs to move until after the completion of the last pulse sent out.
5. Shunt springs shall be tensioned so that as the dial returns to normal or moves off normal each spring will make contact with its adjacent spring while traveling through a space of not less than .015".
6. Contact separation for shunt springs either in their operated or normal position shall be from .015" to .030".
7. The main spring of a break-make combination shall break contact from its back contact before making contact at its front contact.

   NOTE: This requirement also applies to three springs of a four-spring combination when the operating spring opens a back contact and closes a make contact.

8. When there are two break contacts (normally open) in the shunt spring assembly, springs 1 and 2 shall break contact before springs 3 and 4 break contact. There shall not be more than perceptible clearance (if any) between the bushing of spring 4 and spring 2.
9. The shunt spring operating cam width shall be aligned within the width of the buffer on the operating shunt spring in the normal position with respect to shaft end play.

   NOTE: Alignment shall be such that contact gap is min. .005" when dial finger plate is pulled out when at normal.

APPENDIX

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

D—GOVERNOR:

1. There shall be perceptible end play in the governor but this end play shall not exceed 1/64".
2. The governor wings shall be formed as nearly as possible alike.
3. The dial shall operate at a speed of not less than eight impulses per second nor more than twelve impulses per second unless otherwise specified on the assembly drawing.

E—RATCHET:

1. With the dial at normal the pawl shall rest against its stop so as to give minimum .008" maximum .030" clearance between the shaft stop arm and its associated stop.

F—OPERATION:

1. The dial shall operate freely as it restores to normal.

   NOTE: Tests for sticking shall be made as follows: Pull the "one" toward the finger stop until the pawl engages the next tooth of the ratchet and allows the dial to return to normal. Repeat once. Pull the "three" to the finger stop and release. Then pull the "six" and finally the "0." If the dial does not stick the requirement is satisfactorily met.

G—LUBRICATION:

1. One drop of watch oil (see Specification 5228) shall be applied to each of the following parts during manufacture and for maintenance:

   NOTE: A drop of oil shall be considered to be the amount released from a piece of number 22 B&S gauge, bare tinned copper wire after it has been dipped 1/2" into the lubricant and quickly withdrawn.

   (a) Worn wheel shaft bearings.

   (b) Governor shaft bearings.

   (c) Pawl bearing.

2. One dip of watch oil (see Specification 5228) shall be applied to the following parts during manufacture and for maintenance:

   NOTE: A dip of oil shall be considered to be the amount retained in a #4 Artist's Sable*Rigger brush after being dipped in the lubricant to a depth of 3/8" and then scraped on the edge of the container to remove surplus oil. There should not be sufficient lubricant adhering to the brush to form a drop at the end of the bristles.

   (a) Dial shaft bearings.

   (b) Main gear wheel bearing.

   (c) Exposed portion of main bearing on governor side of mounting plate. (Cover this surface with a film of oil for rust protection.)

   (d) Governor shaft worm.

3. One dip of light mineral oil shall be applied to the following parts during manufacture and for maintenance:

   (a) Ratchet teeth on main gear.

   (b) Cam (apply to the edge of the cam and then wipe off the surplus oil.)

   (c) Fibre buffers (when used) on shunt or impulse springs. Apply to the fibre and then wipe off the surplus oil.

   NOTE: Oil is not to be applied to the hard rubber buffers.

4. Excessive oil shall not be allowed to remain on any surface.

APPENDIX

ADJUSTMENT FOR 978N1 TELEPHONE DIAL

H—SPECIAL REQUIREMENTS FOR OPERATION AT LOW TEMPERATURES:

The following special requirements shall apply to dials which are exposed to cold weather.

1. The main spring shall be adjusted to the maximum tension specified in C-1 (one and one-third turns.)
2. The minimum speed requirement of D-3 shall be increased from eight impulses per second to ten impulses per second (at approximately 70° F.) for all dials with a nominal speed of ten impulses per second.
3. Before lubrication, all bearings and gears, the governor cup, governor weights, and dial shaft shall be thoroughly washed with a liberal amount of carbon tetrachloride. All loose dirt and dust shall be removed from the dial parts. All parts shall then be lubricated in accordance with Section G except that watch oil shall be substituted for the light mineral oil specified in G-4. No oil other than watch oil shall be permitted upon any part of the dial.

APPENDIX

ADJUSTMENT FOR 978N2 ROTARY SWITCH

A—GENERAL:

1. The switch shall meet the general requirements specified in Standard Adjustments for General Requirements which are applicable.
2. The armature stop and ratchet spring shall always be loosened before making adjustments to meet requirements C and D.

B—BRUSH SPRINGS:

1. The brush springs (wiper terminal springs) shall be tensioned and curved so that with all pressure relieved, the ends of the two springs in a pair shall be separated approximately ¼" and when assembled in the wiper assembly the two springs will close to within approximately ¼" of their ends.

C—PAWL STOP:

1. The edges of the rotary pawl along its length shall be parallel to the sides of the ratchet wheel, and the tip of the pawl shall be parallel to the outer edge of the ratchet teeth as gauged by eye.

D—WIPER ALIGNMENT:

1. The edge of the bridging or private wiper shall be approximately in alignment with the front edge of contacts #1 and #25 and the edge of the non-bridging or line wipers shall rest from ¼ and ½ of the contact width ahead of the front edge of contacts #1 and #25.
2. With the wiper assembly in any normal position of rest, the bridging or private wipers shall not bridge adjacent contacts within 1/64".

   NOTE: The above requirements are adjustments of the pawl stop and bank adjusting screw.

E—ARMATURE STOP:

1. After requirements C and D have been met, the armature stop shall be set to relieve the pressure of the pawl against the pawl stop.
2. The armature stop shall allow play in the wiper assembly when the armature is against the stop and is engaging any ratchet tooth. This play shall be just perceptible on at least one tooth.

F—RATCHET SPRING:

1. The tip of the ratchet spring shall clear the radial surface of each ratchet tooth with the armature against the armature stop.

   (a) The above clearance shall not exceed .004".
2. The ratchet spring shall be tensioned to have a pressure against the ratchet teeth of 50 grams minimum to 125 grams maximum measured at the curve near the tip of the spring.

G—ARMATURE:

1. The armature shall not bind on its bearing nor on the bearing pin locking spring.
2. The pawl shall not bind on its bearing nor on the switch frame.
3. The pawl spring shall cause the tip of the pawl to rest firmly against the ratchet when the armature is operated.
4. The contact spring operating bushing shall fit tightly on the armature and shall have minimum two-thirds of its width opposite the associated springs.
5. The spring washer shall hold the armature stroke adjusting screw securely in place.
6. The stroke adjusting screw shall be set so that the pawl just drops in on the next tooth without binding on the tip of the tooth when there is .002" between the screw and coil core and does not drop in without binding with .005" between the screw and coil core.

   (a) The above conditions shall be determined by moving the pawl from one tooth to the other by hand, with the

ADJUSTMENT FOR 978N2 ROTARY SWITCH

magnet energized directly on the nominal voltage (46 volts, usually).

H—MOTOR MAGNET SPRINGS:

1. When the first contact is a make contact the combined tension of the contact springs and the armature driving spring shall be adjusted in accordance with the associated relay adjustment sheet. The armature spring shall rest against the armature bushing with 25 grams minimum, 75 grams maximum pressure, measured where the armature spring strikes the bushing.

I—WIPER ASSEMBLY:

1. The wiper assembly shall turn freely on its bearings.
2. The backs of all wipers shall be slightly flared.
3. The sets of wipers shall be aligned so that they pass onto the base of brush terminals without excessive movement to one side or the other.

   NOTE: With this adjustment, the wiper springs of the first level shall clear the pawl and pawl stop by minimum 1/64" during rotation.
4. Each spring of a wiper having a broad flat tip for contact surface shall be tensioned to follow approximately 3/32" measured at the tip when its opposing spring is deflected.
5. Each spring of a wiper having a knife edge contact shall be tensioned to follow approximately 1/16" measured at the tip when its opposing spring is deflected.
6. The indicator shall point to the number or line on the indicating wheel corresponding to the bank contacts on which the wipers are resting.

J—LUBRICATION:

1. One drop of spindle oil (Specification **5231) shall be** applied to each of the following parts:

   NOTE: A drop of oil shall be considered to be the amount released from a piece of number 22 B&S gauge, bare tinned copper wire after it has been dipped 1/2" into the lubricant and quickly withdrawn.

   (a) Armature bearings (between the armature and the frame for the regular type switch and on both sides of each armature bearing for the heavy duty type).

   (b) Pawl bearing.

   (c) Wiper assembly bearings (bearing screw type).
2. Two dips of Switch Lubricant (Specification 5232) shall be applied to the ratchet teeth with the wiper assembly rotating to distribute the lubricant.

   NOTE: One dip of oil is defined as the amount of oil retained by a #4 Artist's Sable Rigger brush after being dipped into the oil to a depth of approximately 3/8" and then scraped on the edge of the container to remove the surplus oil.
3. The wipers and bank shall be lubricated by distributing one dip of spindle oil (Specification 5231) between the wiper tips of one end of three pairs of wiper springs. Both ends of the wiper springs shall be lubricated; i.e., a three level wiper assembly would require two dips of oil, one for each end. Rotate the switch after applying the lubricant to distribute the oil on the bank.
4. Hollow shaft type wiper bearing; apply #33 Alemite Lubricant to end portion of the bearing pin opposite link and approximately fill center or under cut portion. Assemble the bearing pin without causing the lubricant on the center portion to drop off. (Machine Oil is satisfactory for maintenance if desired.)
5. Excessive oil shall not be allowed to remain on any surface.

APPENDIX

TUBE DATA

Type	Symbol Designations
2A3	V118, V119
5U4G	V124
6A8	V101, V109
6AG7	V102
6C8G	V114, V115
6SJ7	V107, V116, V301
6SL7GT	V110, V113
6SN7GT	V111, V112, V302
6X5GT	V117, V303
249C*	V122, V123
805	V120, V121
807	V103, V104
813	V105, V106
866/866A	V125, V126
VR150-30	V108

* Type 866/866A rectifier tubes may be substituted for Type 249C rectifier tubes in an emergency.

WARNING: In order to obtain satisfactory tube life the following precautions must be taken:

1. Operate all tube filaments within ±5% of rated voltage.
2. Do not exceed rated plate current in any of the tubes during normal operation of the equipment.
3. When tuning, do not exceed rated plate current except for periods of short duration.

Failure to observe the above precautions may result in the destruction of the tubes.

ALL TUBES SUPPLIED WITH THE EQUIPMENT OR AS SPARES ON THE EQUIPMENT CONTRACT SHALL BE USED IN THE EQUIPMENT PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

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2A3

POWER AMPLIFIER TRIODE

Filament	Coated	
Voltage	2.5	a-c or d-c volts
Current	2.5	amp.
Direct Interelectrode Capacitances (Approx.):		
Grid to Plate	16.5	μμf
Grid to Filament	7.5	μμf
Plate to Filament	5.5	μμf
Maximum Overall Length		5-3/8"
Maximum Seated Height		4-3/4"
Maximum Diameter		2-1/16"
Bulb		ST-16
Base		Medium 4-Pin
Pin 1 - Filament +		Pin 3 - Grid
Pin 2 - Plate		Pin 4 - Filament-
Mounting Position	BOTTOM VIEW (4D)	Vertical◊ ◄

Maximum Ratings Are Design-Center Values

SINGLE-TUBE AMPLIFIER

Plate Voltage	300 max.	volts ◄
Plate Dissipation	15 max.	watts ◄
Typical Operation and Characteristics-Class A_1 Amplifier:		
Plate	250	volts
Grid*	-45	volts
Plate Cur.	60	ma.
Amp. Fact.	4.2	
Plate Res.	800	ohms
Transcond.	5250	μmhos
Load Res.	2500	ohms
Second Harmonic Distortion	5	%
Power Output	3.5	watts

PUSH-PULL AMPLIFIER

Unless otherwise specified, values are for 2 tubes

Plate Voltage	300 max.	volts
Plate Dissipation	15 max.	watts ◄

Typical Operation and Characteristics-Class AB_1 Amplifier:

	Fixed Bias	*Cathode Bias*	
Plate	300	300	volts
Grid*	-62	-	volts
Cathode-Bias Resistor	-	780	ohms
Zero-Sig. Plate Cur.	80	80	ma.
Load Res. (per tube)	750	1250	ohms
Effec. Load Res. (plate to plate)	3000	5000	ohms
Total Harmonic Distortion	2.5	5.0	%
Power Output	15	10	watts

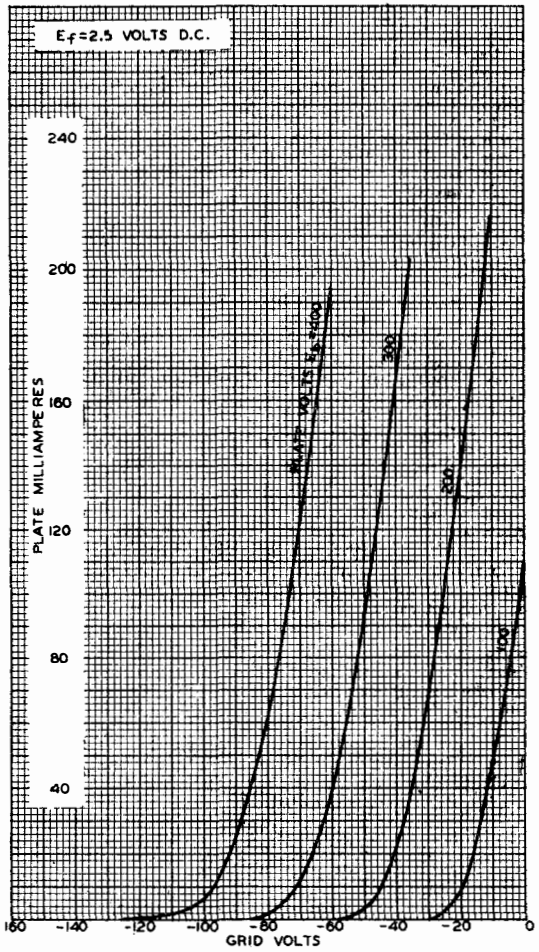
If a single 2A3 is operated cathode-biased, the cathode-biasing resistor should be 750 ohms.

The type of coupling used should not introduce too much resistance in the grid circuit. Transformer- or impedance-coupling devices are recommended. When the grid circuit has a resistance not higher than 0.05 megohm, fixed bias may be used; for higher values, cathode bias is required. With cathode bias, the grid circuit may have a resistance not to exceed 0.5 megohm.

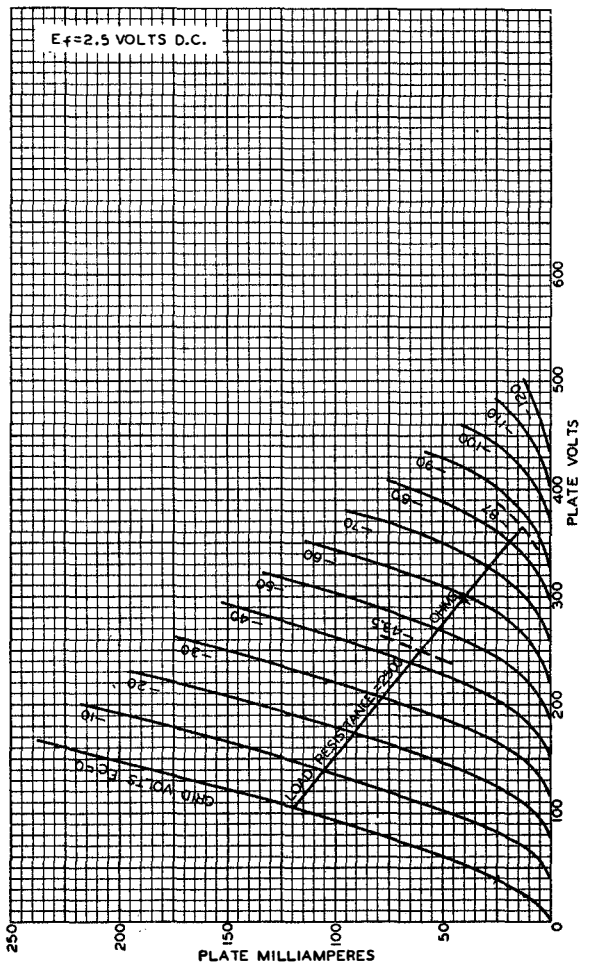
* Grid voltage referred to mid-point of a-c operated filament.
◊ Horizontal operation is permissible if pins 1 & 4 are in a horizontal plane.
◄ Indicates a change.

2A3

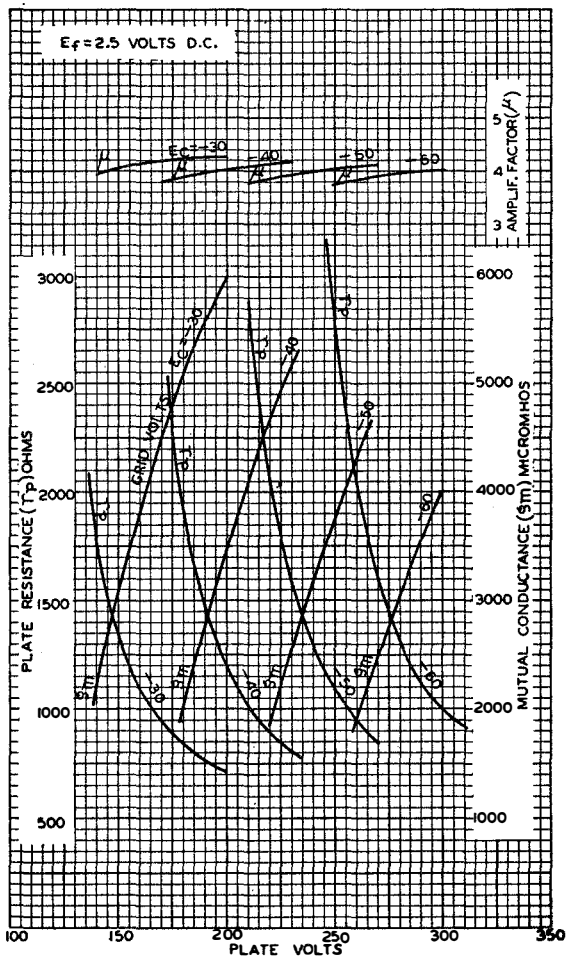
AVERAGE CHARACTERISTICS



2A3
AVERAGE PLATE CHARACTERISTICS



2A3
AVERAGE CHARACTERISTICS



5U4-G

FULL-WAVE HIGH-VACUUM RECTIFIER

Filament	Coated	
Voltage	5.0	a-c volts
Current	3.0	amp.
Maximum Overall Length		5-5/16"
Maximum Diameter		2-1/16"
Bulb		ST-16
Base		Medium Shell Octal 5-Pin
Pin 1 - No Connection		Pin 6 - Plate #1
Pin 2 - Filament		Pin 8 - Filament
Pin 4 - Plate #2		
Mounting Position		Vertical◊

BOTTOM VIEW (G-5T)

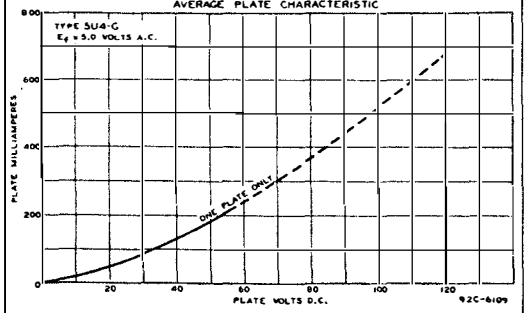
FULL-WAVE RECTIFIER

Peak Inverse Voltage	1550 max. volts
Peak Plate Current per Plate	675 max. ma.
Typical Operation with Condenser-Input Filter:	
A-C Plate Voltage per Plate (RMS)	450 max. volts
Total Effective Plate-Supply Impedance per Plate▲	75 min. ohms
D-C Output Current	225 max. ma.
Typical Operation with Choke-Input Filter:	
A-C Plate Voltage per Plate (RMS)	550 max. volts
Input-Choke Inductance	3 min. henries
D-C Output Current	225 max. ma.

◊ Horizontal operation permitted if pins 1 and 4 are in vertical plane.

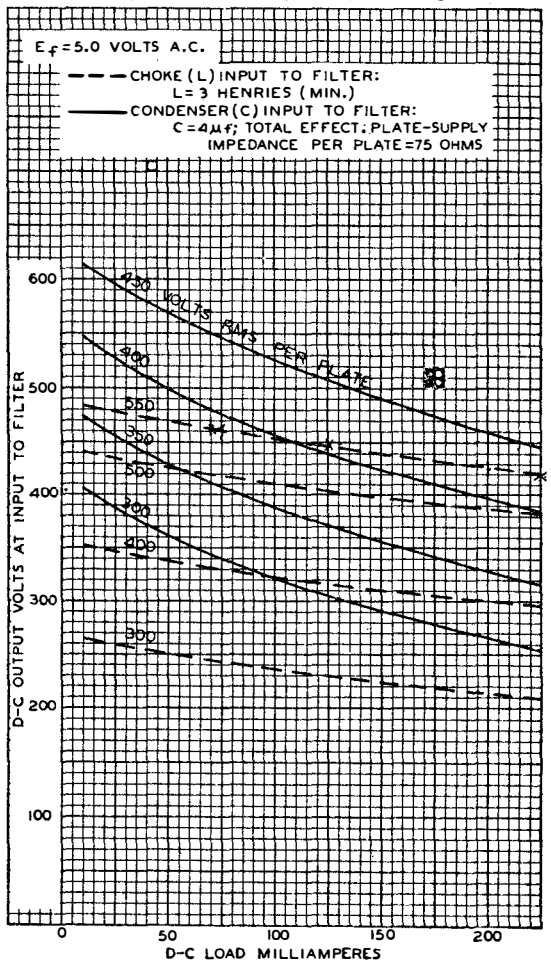
▲ When a filter-input condenser larger than 40 μf is used, it may be necessary to use more plate-supply impedance than the minimum value shown to limit the peak plate current to the rated value.

AVERAGE PLATE CHARACTERISTIC



5U4-G

OPERATION CHARACTERISTICS



6A8, 6A8-G, 6A8-GT
PENTAGRID CONVERTER

Heater ● Voltage	6.3		a-c or d-c volts
Current	0.3		amp.
Direct Interelectrode Cap.°	6A8	6A8-G	6A8-GT
Grid #1 to Plate	0.06	0.26	0.26 μμf
Grid #1 to Grid #2	0.1	0.19	0.19 μμf
Grid #3 to Grid #1	0.09	0.16	0.16 μμf
Grid #1 to Grid #2	0.8	1.1	1.1 μμf
Grid #1 to All Other Electrodes (R-F Input)	12	9.5	9.5 μμf
Grid #2 to All Other Electrodes Except Grid #1 (Osc. Output)	5	4.6	4.6 μμf
Grid #1 to All Other Electrodes Except Grid #2 (Osc. Input)	6.5	6	6 μμf
Plate to All Other Electrodes (Mixer Output)	12	12	12 μμf
Overall Length	3-1/8" max.	4-7/32" to 4-15/32"	3-5/16" max.
Seated Height	2-9/16" max.	3-21/32" to 3-29/32"	2-3/4" max.
Maximum Diameter	1-5/16"	1-9/16"	1-5/16"
Bulb	Metal Shell, MT-8	ST-12	T-9
Cap	Miniature	Skirted Min.	Skirted Min. Style C

● In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

° with shell of 6A8 connected to cathode, and with close-fitting shield on 6A8-G and 6A8-GT connected to cathode.

← Indicates a change.

6A8, 6A8-G, 6A8-GT
PENTAGRID CONVERTER

(continued from preceding page)

	6A8	6A8-G	6A8-GT
Base	Small Wafer Octal 8-Pin	Small Shell Octal 8-Pin	Small Wafer Octal 8-Pin, Sleeve
Basing Designation	8A	G-8A	GT-8A
Pin 1	6A8, Shell / 6A8-G, No Con. / 6A8-GT, Base Sleeve		
Pin 2 - Heater			
Pin 3 - Plate			
Pin 4 - Grids #3 & #5			
Pin 5 - Grid #1			
Pin 6 - Grid #2			
Pin 7 - Heater			
Pin 8 - Cathode			
Cap - Grid #4			
Mounting Position			Any

BOTTOM VIEW

CONVERTER SERVICE

Plate Voltage		300 max.	volts
Screen (Grids #3 & #5) Voltage		100 max.	volts
Screen Supply Voltage		300 max.	volts
Anode-Grid (Grid #2) Voltage		200 max.	volts
Anode-Grid Supply Voltage ●		300 max.	volts
Control-Grid (Grid #4) Voltage		0 min.	volts
Plate Dissipation		1.0 max.	watt
Screen Dissipation		0.3 max.	watt
Anode-Grid Dissipation		0.75 max.	watt
Total Cathode Current		14 max.	ma.
Typical Operation:			
Plate Voltage	100	250	volts
Screen Voltage	50	100	volts
Anode-Grid Voltage	100	-	volts
Anode-Grid Supply Voltage	-	250*	volts
Control-Grid Voltage	-1.5	-3	volts
Osc.-Grid (Grid #1) Resistor	50000	50000	ohms
Plate Resistance	0.6	0.36	approx. ohms
Conversion Transconductance	360	550	μmhos
Conver. Transcond. (approx.) with Control-Grid Bias of -20 volts	3	-	μmhos
Conver. Transcond. (approx.) with Control-Grid Bias of -35 volts	-	6	μmhos
Plate Current	1.1	3.5	ma.
Screen Current	1.3	2.7	ma.
Anode-Grid Current	2	4	ma.
Oscillator-Grid Current	0.25	0.4	ma.
Total Cathode Current	4.6	10.6	m .

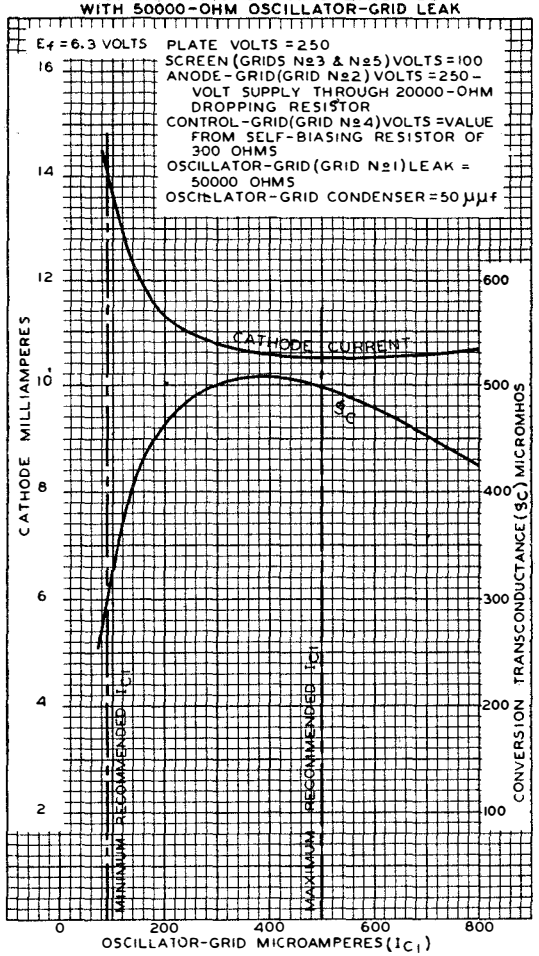
NOTE: The transconductance of the oscillator portion (not oscillating) is 1150 micromhos under the following conditions: plate volts, 250; screen volts, 55; control-grid volts, -2; anode-grid volts, 100; and oscillator-grid volts, -1.

● Anode-grid supply voltages in excess of 200 volts require use of 20000-ohm voltage-dropping resistor by-passed by 0.1 μf condenser.

For Typical Circuit and Coil Design Details, refer to Type 2A7.

← Indicates a change.

6A8
OPERATION CHARACTERISTICS
WITH 50000-OHM OSCILLATOR-GRID LEAK



6AG7

VIDEO POWER AMPLIFIER PENTODE

SINGLE-ENDED METAL TYPE

Heater ♣	Coated Unipotential Cathode	
Voltage	6.3	a-c or d-c volts
Current	0.65	amp.
Direct Interelectrode Capacitances: ○		
Grid to Plate	0.06 max.	μμf
Input	13	μμf
Output	7.5	μμf
Grid to Screen	5.8 approx.	μμf
Grid to Cathode	5.2 approx.	μμf
Heater to Cathode	10.7 approx.	μμf
Maximum Overall Length		3-1/4"
Maximum Seated Height		2-11/16"
Maximum Diameter		1-5/16"
Bulb		Metal Shell, MT-8
Base		Small Wafer Octal 8-Pin
Pin 1 - Shell -		Pin 5 - Cathode
Pin 2 - Heater		Pin 6 - Screen
Pin 3 - Interlead Shield		Pin 7 - Heater
Pin 4 - Grid		Pin 8 - Plate
Mounting Position	BOTTOM VIEW (BY)	Vertical #

Maximum and Minimum Ratings Are Design-Center Values

AMPLIFIER

Plate Voltage	300 max.	volts
Screen Voltage	300 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	9.0 max.	watts
Screen Dissipation	1.5 max.	watts
Typical Operation and Characteristics - Class A_1 Amplifier:		
Plate	300	volts
Screen	150	volts
Grid *	-3	volts
Peak A-F Grid	3	volts
Zero-Sig. Plate Cur.	30	ma.
Max.-Sig. Plate Cur.	30.5	ma.
Zero-Sig. Screen Cur	7	ma.
Max.-Sig. Screen Cur	9	ma.
Plate Res.	0.13	megohm
Transcond.	11000	μmhos
Load Res.	10000	ohms
Total Harmonic Distortion	7	%
Max-Sig. Power Output	3	watts

Typical Operation in 4 Mc Bandwith Video Voltage Amplifier (Class A_1):

	Grid-Leak Bias ▽	Cathode Bias	
Plate-Supply	300	300	volts
Screen	115 □ ▲	125 □□	volts
Grid	0	-2	volts

♣ The heater voltage should not deviate more than 10% from 6.3 volts. In circuits where the cathode is not connected directly to the heater, the potential difference between heater and cathode should be kept as low as possible.
○ With shell and interlead shield connected to cathode.
Horizontal operation permitted if pins #2 and #7 are in a vertical plane.
* When the grid circuit has a resistance not higher than 0.25 megohm, fixed bias may be used; for higher values cathode bias is required. With cathode bias, the grid circuit may have a resistance not to exceed 1.0 megohm.
▽ Intended for use where d-c restoration is accomplished in the grid circuit of the 6AG7.
▲ Zero-signal value.
□ Obtained from supply having good regulation.
□□ Obtained preferably from the 300-volt plate supply through a 25000-ohm series screen resistor.
→ Indicates a change.

6AG7

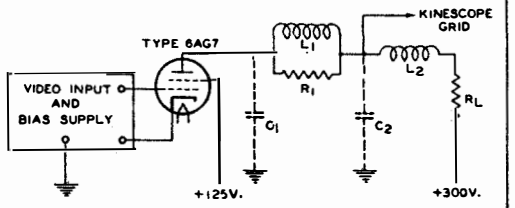
VIDEO POWER AMPLIFIER PENTODE

(continued from preceding page)

Grid Resistor	0.25-0.5	-	megohm
Cathode Resistor ##	-	57	ohms
Interlead Shield	Connected to ground		
Grid Signal Swing (peak to peak)	4	4	volts
Zero-Sig. Plate Cur.	45	28	ma.
Zero-Sig. Screen Cur.	13	7	ma.
Load Resistance	3500	3500	ohms
Voltage Output (peak to peak)	135	140	volts

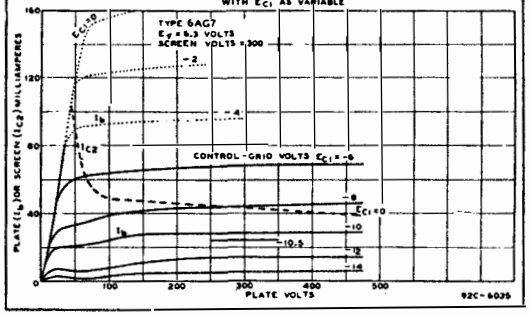
By-passed by 250 μf approx.

TYPICAL VIDEO VOLTAGE AMPLIFIER
HAVING BANDWIDTH OF 4 MEGACYCLES

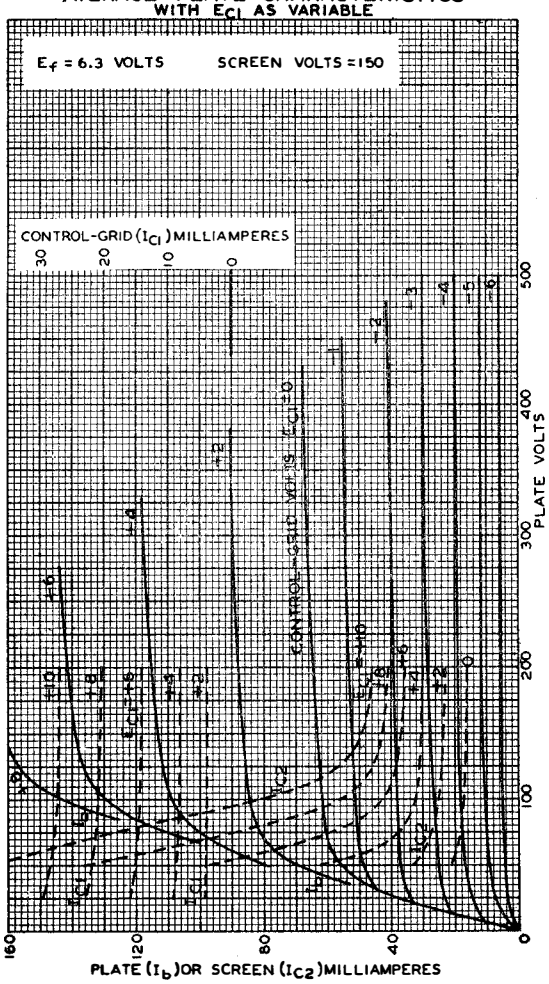


C_1 = 9.5 μμf = TUBE OUTPUT CAPACITANCE + SOCKET CAPACITANCE + WIRING CAPACITANCE + COIL CAPACITANCE
C_2 = 19 μμf = KINESCOPE CAPACITANCE + SOCKET CAPACITANCE + WIRING CAPACITANCE + COIL CAPACITANCE
L_1 = 250 μh FILTER INDUCTOR
L_2 = 125 μh FILTER INDUCTOR
R_1 = 20000-OHM, NON-REACTIVE RESISTOR
R_L = 3500-OHM, 10-WATT, NON-REACTIVE RESISTOR

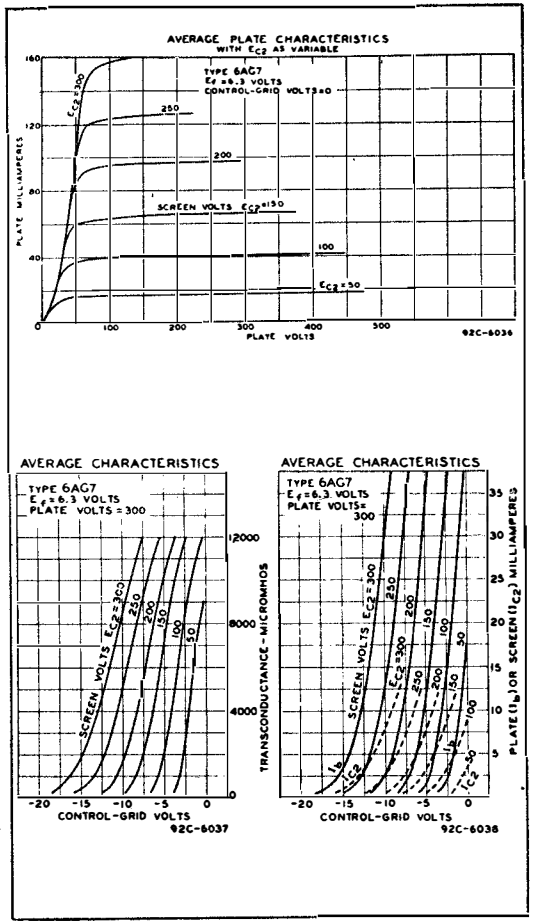
AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE



6AG7
AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE



6AG7
VIDEO POWER AMPLIFIER PENTODE



6C8-G

TWIN-TRIODE AMPLIFIER

Heater ■	Coated Unipotential Cathodes		
Voltage	6.3		a-c or d-c volts
Current	0.3		amp.
Direct Interelectrode Capacitances (Approx.):	*Triode Unit T_1*	*Triode Unit T_2*	
Grid to Plate	2.6	1.8	μμf
Grid to Cathode	2.6	1.3	μμf
Plate to Cathode	2.0	2.2	μμf
Grid to Grid	0.1		μμf
Plate to Plate	2.0		μμf
Overall Length	4-7/32" to 4-15/32"		
Seated Height	3-21/32" to 3-29/32"		
Maximum Diameter	1-9/16"		
Bulb	ST-12		
Cap	Skirted Miniature, Style A		
Base	Small Shell Octal 8-Pin		
Pin 1 - No Connection	Pin 6 - Plate (Triode T_1)		
Pin 2 - Heater	Pin 7 - Heater		
Pin 3 - Plate (Triode T_2)	Pin 8 - Cathode (Triode T_1)		
Pin 4 - Cathode (Triode T_2)	Cap - Grid (Triode T_2)		
Pin 5 - Grid (Triode T_1)			
Mounting Position	Any		

BOTTOM VIEW (C-8G)

EACH TRIODE UNIT

Plate Voltage	250 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	1.0 max.	watt
Characteristics - Class A_1 Amplifier:		
Plate	250	volts
Grid	-4.5	volts
Amp. Fact.	36	
Plate Res.	22500	ohms
Transcond.	1600	μmhos
Plate Cur.	3.2	ma.

Typical Operation - Resistance-Coupled Amplifier:
See RESISTANCE-COUPLED AMPLIFIER CHART.

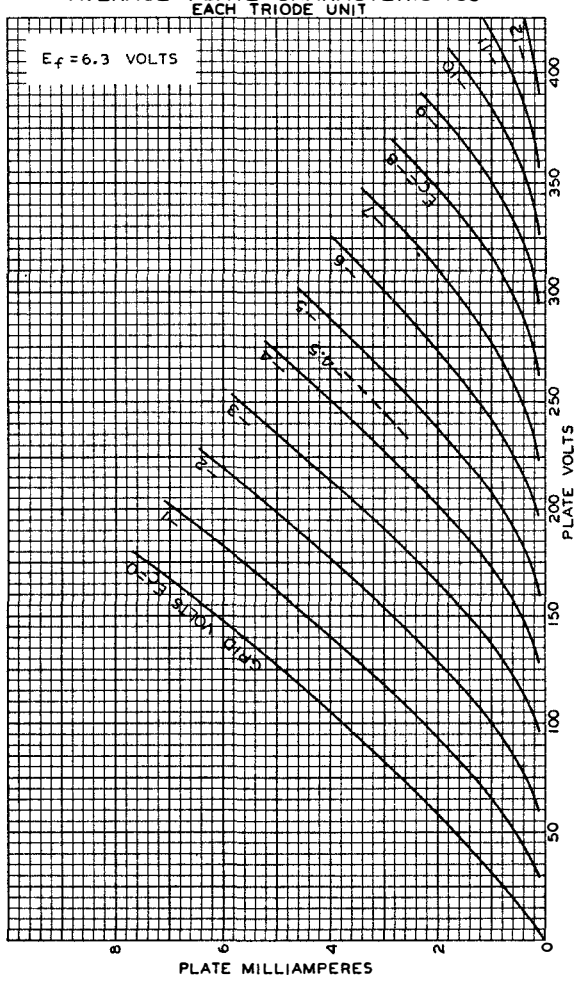
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

← indicates a change.

6C8-G

AVERAGE PLATE CHARACTERISTICS

EACH TRIODE UNIT



6SJ7, 6SJ7-GT

TRIPLE-GRID DETECTOR AMPLIFIER

Heater ■ Voltage	Coated Unipotential Cathode 6.3	a-c or d-c volts	
Current	0.3	amp.	
Direct Inter. Cap. ○	6SJ7	6SJ7-GT	
Pentode Conn. Grid to Plate	0.005	0.005 max.	μμf
Pentode Conn. Input	6.0	6.3	μμf
Pentode Conn. Output	7.0	10	μμf
Triode Conn.† Grid to Plate	2.8	2.8	μμf
Triode Conn.† Grid to Cathode	3.4	3.4	μμf
Triode Conn.† Plate to Cathode	11	11.0	μμf
Maximum Overall Length	2-5/8"	3-5/16"	
Maximum Seated Height	2-1/16"	2-3/4"	
Maximum Diameter	1-5/16"	1-5/16"	
Bulb	Metal Shell MT-8	T-9	
Base	Small Wafer Octal 8-Pin	Sm. Wafer Octal 8-Pin Sleeve GT-8N	
Basing Designation	8N		
Pin 1 (6SJ7, Shell; 6SJ7-GT, Base Sleeve)		Pin 4 - Grid	
Pin 2 - Heater		Pin 5 - Cathode	
Pin 3 - Suppressor		Pin 6 - Screen	
Mounting Position		Pin 7 - Heater; Pin 8 - Plate	
			Any

BOTTOM VIEW

Maximum And Minimum Ratings Are Design-Center Values

AMPLIFIER (Pentode Connection)

Plate Voltage		300 max.	volts
Screen Voltage		125 max.	volts
Screen Supply Voltage		300 max.	volts
Grid Voltage		0 min.	volts
Plate Dissipation		2.5 max.	watts
Screen Dissipation		0.3 max.	watt
Typical Operation and Characteristics-Class A_1 Amplifier:			
Plate	100	250	volts
Screen	100	100	volts
Grid	-3	-3	volts
Suppressor	Connected to cathode at socket		
Plate Res.	0.7	#	megohm
Transcond.	1575	1650	μmhos
Grid Bias for plate current = 10 μamp.	-8	-8	volts
Plate Cur.	2.9	3	ma.
Screen Cur.	0.9	0.8	ma.

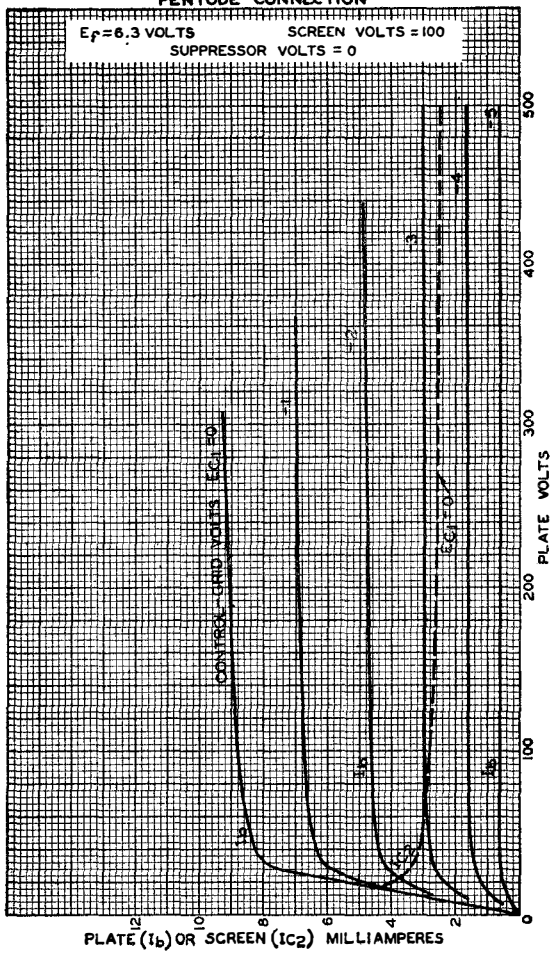
AMPLIFIER (Triode Connection)†

Plate Voltage		250 max.	volts
Grid Voltage		0 min.	volts
Plate Dissipation		2.5 max.	watts
Typical Operation and Characteristics-Class A_1 Amplifier:			
Plate	180	250	volts
Grid	-6	-8.5	volts
Amp. Fact.	19	19	
Plate Res.	8250	7600	ohms
Transcond.	2300	2500	μmhos
Plate Cur.	6	9.2	ma.

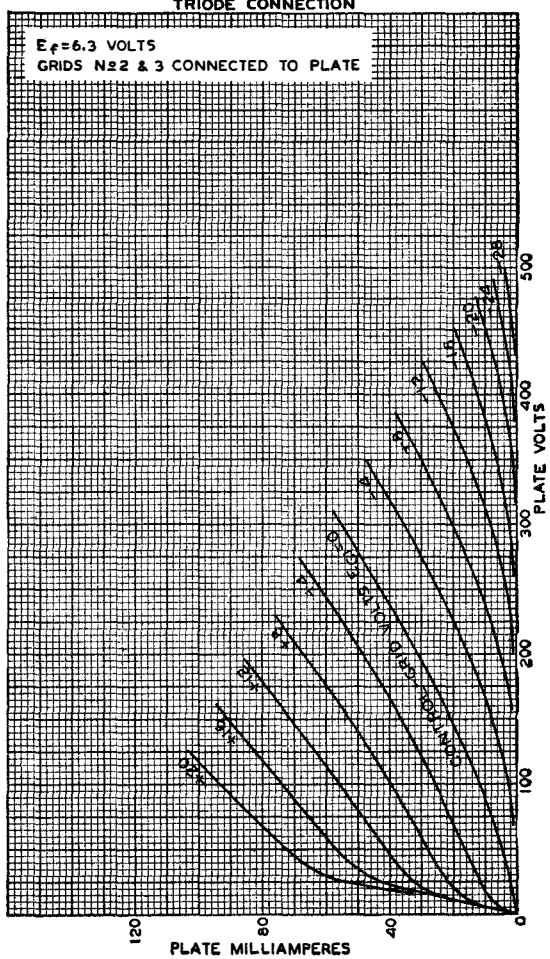
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.
○ With shell or external shield connected to cathode.
Greater than 1.0 megohm.
† With screen and suppressor connected to plate.
← Indicates a change.

For additional data, refer to RESISTANCE-COUPLED AMPLIFIER CHART.

6SJ7
AVERAGE PLATE CHARACTERISTICS
PENTODE CONNECTION



6SJ7
AVERAGE PLATE CHARACTERISTICS
TRIODE CONNECTION



6SL7-GT

TWIN-TRIODE AMPLIFIER

Heater■	Coated Unipotential Cathodes		
Voltage	6.3		a-c or d-c volts
Current	0.3		amp.
Direct Interelectrode Capacitances (Approx.):○	*Triode Unit T_1*	*Triode Unit T_2*	
Grid to Plate	2.8	2.8	μμf
Grid to Cathode	3.0	3.4	μμf
Plate to Cathode	3.8	3.2	μμf
Plate to Plate	0.4		μμf
Grid to Grid	0.65		μμf
Grid T_2 to Plate T_1	0.13		μμf
Maximum Overall Length			3-5/16"
Maximum Seated Height			2-3/4"
Maximum Diameter			1-5/16"
Bulb			T-9
Base			Intermediate Shell Octal 8-Pin
Pin 1 - Grid T_2		Pin 5 - Plate T_1	
Pin 2 - Plate T_2		Pin 6 - Cathode T_1	
Pin 3 - Cathode T_2		Pin 7 - Heater	
Pin 4 - Grid T_1		Pin 8 - Heater	
Mounting Position			Any

BOTTOM VIEW (8BD)

For convenience, one triode unit is identified as T_1; the other as T_2

AMPLIFIER - Each Unit

Plate Voltage	250 max.	volts
Grid Voltage	0 min.	volts
Plate Dissipation	1 max.	watt
Characteristics - Class A_1 Amplifier:		
Plate	250	volts
Grid	-2	volts
Amp. Fact.	70	
Plate Res.	44000	ohms
Transcond.	1600	μmhos
Plate Cur.	2.3	ma.

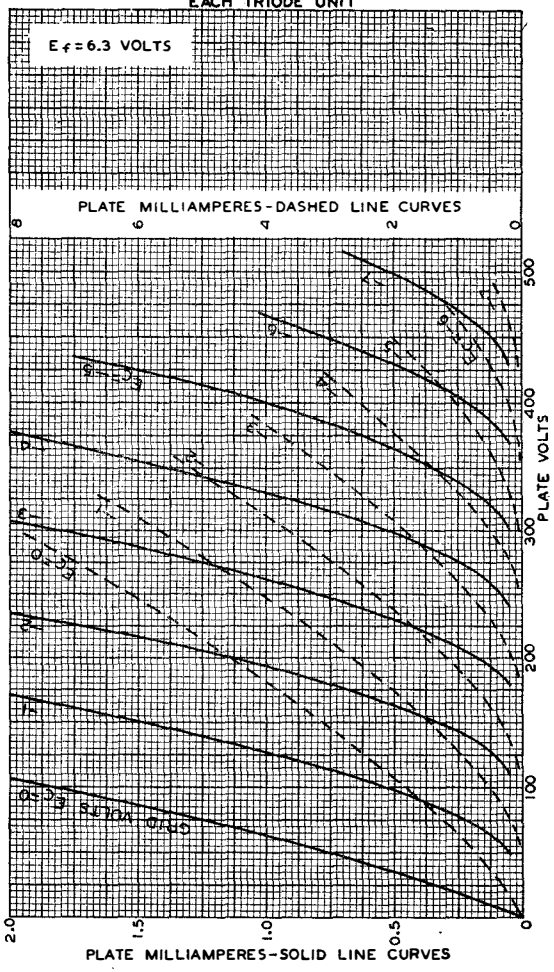
■ In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

○ With close-fitting shield connected to cathode.

6SL7-GT

AVERAGE PLATE CHARACTERISTICS

EACH TRIODE UNIT



6SN7-GT

TWIN-TRIODE AMPLIFIER

Heater ●	Coated Unipotential Cathodes		
Voltage	6.3		a-c or d-c volts
Current	0.6		amp.
Direct Interelectrode Capacitances (Approx.): ○	*Triode Unit T_1*	*Triode Unit T_2*	
Grid to Plate	3.8	4.0	μμf
Grid to Cathode	3.0	3.0	μμf
Plate to Cathode	0.8	1.2	μμf
Maximum Overall Length			3-5/16"
Maximum Seated Height			2-3/4"
Maximum Diameter			1-5/16"
Bulb			T-9
Base			Intermediate Shell Octal 8-Pin
Pin 1 - Grid T_2			Pin 5 - Plate T_1
Pin 2 - Plate T_2			Pin 6 - Cathode T_1
Pin 3 - Cathode T_2			Pin 7 - Heater
Pin 4 - Grid T_1			Pin 8 - Heater
Mounting Position			Any

BOTTOM VIEW (8B0)

For convenience, one triode unit is identified as T_1; the other as T_2.

Maximum And Minimum Ratings Are Design-Center Values

AMPLIFIER - Each Unit

Plate Voltage		300 max.	volts
Grid Voltage		0 min.	volts
Plate Dissipation		2.5 max.	watts
Characteristics — Class A_1 Amplifier:			
Plate	90	250	volts
Grid #	0	-8	volts
Amp. Fact.	20	20	
Plate Res.	6700	7700	ohms
Transcond.	3000	2600	μmhos
Plate Cur.	10	9	ma.

Typical Operation with Resistance Coupling:

Same as for Type 6FB-G in RESISTANCE-COUPLED AMPLIFIER CHART.

● In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

○ With shield connected to cathode.

The d-c resistance in the grid circuit should not exceed 1.0 megohm under maximum rated conditions per unit.

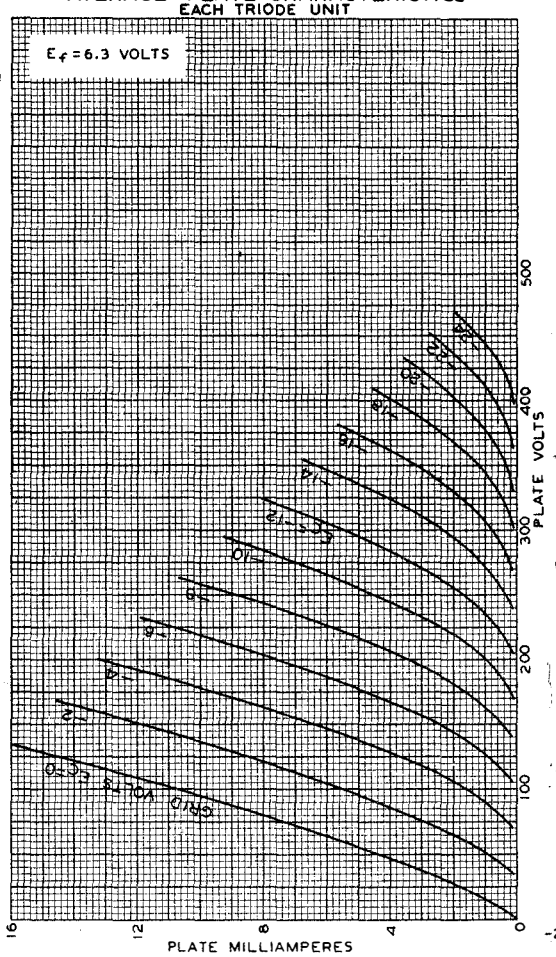
The curves under Type 6J5 also apply to each unit of the 6SN7-GT.

→ Indicates a change.

6SN7-GT

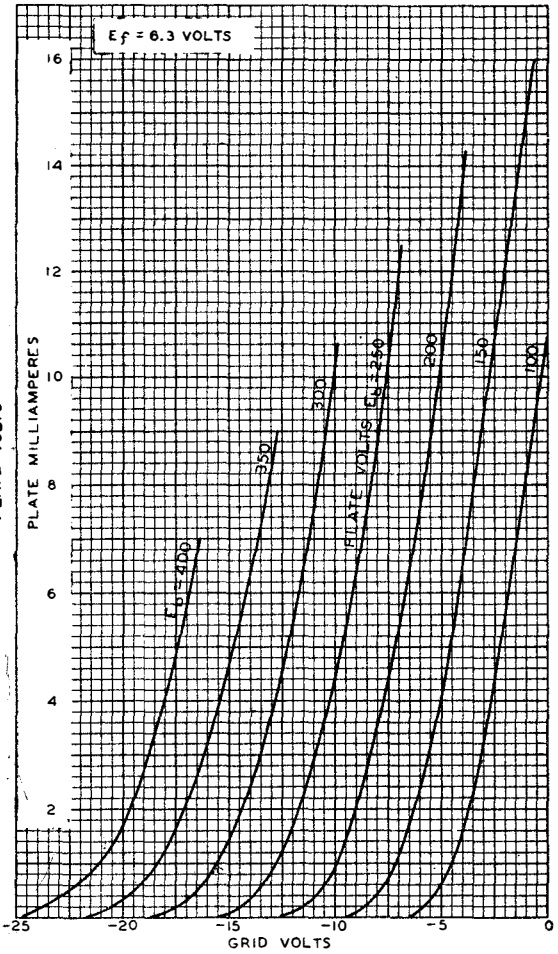
AVERAGE PLATE CHARACTERISTICS

EACH TRIODE UNIT



6J5

AVERAGE CHARACTERISTICS



6X5, 6X5-GT/G

FULL-WAVE HIGH-VACUUM RECTIFIER

Heater	Coated Unipotential Cathode		
Voltage	6.3		a-c or d-c volts
Current	0.6		amp.
	6X5	*6X5-GT/G*	
Maximum Overall Length	3-1/4"	3-5/16"	
Maximum Seated Height	2-11/16"	2-3/4"	
Maximum Diameter	1-5/16"	1-5/16"	
Bulb	Metal Shell, MT-8	T-9	
Base	Small Wafer, Octal 6-Pin	Intermed. Sh., Octal 6-Pin	
Basing Designation	6S	G-6S	
Pin 1	6X5, Shell; 6X5-GT/G, No Con.	Pin 5 - Plate #1	
Pin 2	Heater	Pin 7 - Heater	
Pin 3	Plate #2	Pin 8 - Cathode	
Mounting Position		6X5: Vertical◊; 6X5-GT/G: Any	

BOTTOM VIEW

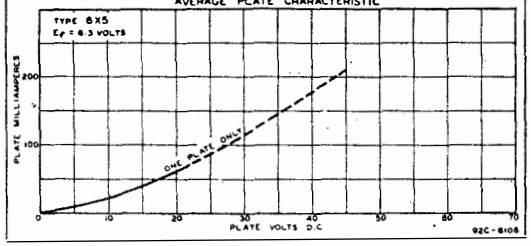
Maximum Ratings Are Design-Center Values

FULL-WAVE RECTIFIER

Peak Inverse Plate Voltage		1250 max.	volts
Peak Plate Current per Plate		210 max.	ma.
D-C Output Current:			
With condenser input to filter		70 max.	ma.
With choke input to filter		70 max.	ma.
D-C Heater-Cathode Potential		450 max.	volts
Typical Operation:	*Condenser-Input Filter*	*Choke-Input Filter*	
A-C Plate-to-Plate Supply Voltage (RMS)	650	900	volts
Filter Input Condenser	4	-	μf
Min. Total Effect. Plate-Supply Imped. per Plate	150	-	ohms
Filter Input Choke	-	8	henries
D-C Output Current	70	70	ma.
D-C Voltage (At input to filter):*			
At half-load current (35 ma.)	405	385	volts
At full-load current (70 ma.)	370	380	volts
Difference (Voltage Regulation)	35	5	volts
Percentage Regulation	8.5	1.3	%

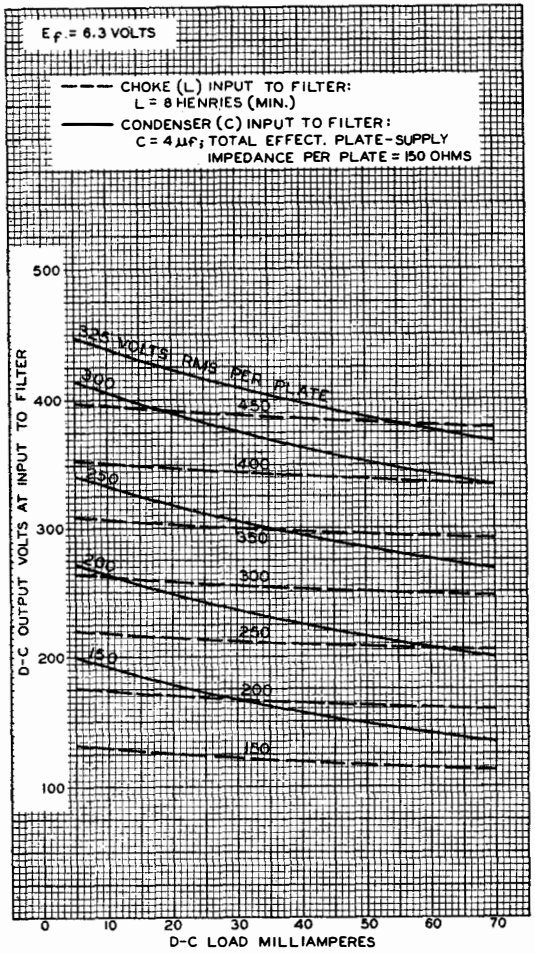
◊ Horizontal operation permitted if pins 3 & 5 are in a horizontal plane.
● For choke not less than 8 henries.
* Approximate values.

AVERAGE PLATE CHARACTERISTIC

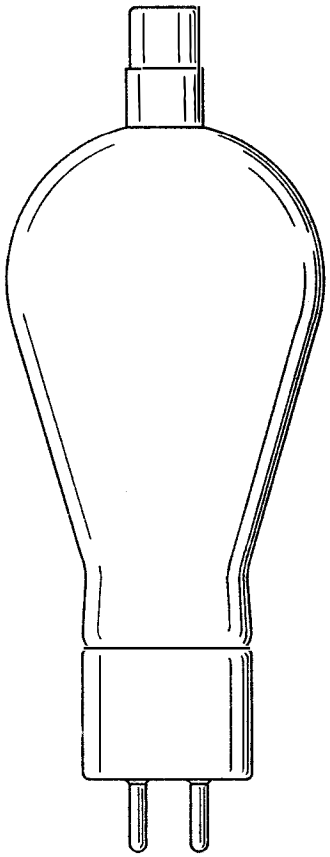


6X5

OPERATION CHARACTERISTICS



249C
HALF-WAVE RECTIFIER

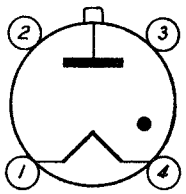


FILAMENT	
VOLTAGE	2.5 V A-C
CURRENT	7.5 AMPERES
CAP	METAL, WITH INSULATING COLLAR
BASE	MEDIUM 4-PIN, BAYONET

MAXIMUM RATINGS

PEAK INVERSE VOLTAGE	7500 VOLTS
PEAK PLATE CURRENT	1.5 AMPERES
APPROXIMATE AVERAGE PLATE	0.5 AMPERES*

* *ACTUAL VALUE WILL DEPEND ON WAVE-FORM RESULTING FROM LOAD AND FILTER CIRCUIT.*



PIN 1 - FILAMENT
PIN 2 - NO CONNECTION
PIN 3 - NO CONNECTION
PIN 4 - FILAMENT
CAP - PLATE
● - GAS TUBE TYPE (*MERCURY VAPOR*)

NOTE: THIS TUBE MANUFACTURED BY AMPEREX ELECTRONIC PRODUCTS, 79 WASHINGTON ST., BROOKLYN, N.Y.

805
R-F POWER AMPLIFIER, OSCILLATOR, CLASS B MODULATOR

Filament	Thoriated Tungsten	
Voltage	10	a-c or d-c volts
Current	3.25	amp.
Direct Interelectrode Capacitances (approx.):		
Grid to Plate	6.5	μμf
Grid to Filament	8.5	μμf
Plate to Filament	10.5	μμf
Maximum Overall length		8-1/2"
Maximum Diameter		2-5/16"
Bulb		T-18
Cap		Medium Metal
Base		Jumbo 4-Large Pin

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

A-F POWER AMPLIFIER & MODULATOR - Class B

D-C Plate Voltage	1500 max.		volts
Max-Signal D-C Plate Current *	210 max.		ma.
Max-Signal Plate Input *	315 max.		watts
Plate Dissipation *	125 max.		watts
Typical Operation - 2 tubes:			
Unless otherwise specified, values are for 2 tubes.			
Filament Voltage	10	10	a-c volts
D-C Plate Voltage	1250	1500	volts
D-C Grid Voltage	0	-16	volts
Peak A-F Grid-to-Grid Voltage	235	280	volts
Zero-Sig. D-C Plate Current	148	84	ma.
Max-Sig. D-C Plate Current	400	400	ma.
Load Resistance (per tube)	1675	2050	ohms
Effective Load Res.(plate to plate)	6700	8200	ohms
Max-Signal Driving Power	6	7	approx.watts
Max-Signal Power Output	300 ##	370#	approx.watts

* Averaged over any audio-frequency cycle.
** With 4% harmonic distortion approx.
\# With 3% harmonic distortion approx.

R-F POWER AMPLIFIER - Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage	1500 max.		volts
D-C Plate Current	150 max.		ma.
Plate Input	185 max.		watts
Plate Dissipation	125 max.		watts
Typical Operation:			
Filament Voltage	10	10	a-c volts
D-C Plate Voltage	1250	1500	volts
D-C Grid Voltage	0	-10	volts
Peak R-F Grid Voltage	75	70	volts
D-C Plate Current	135	115	ma.
D-C Grid Current **	15	15	approx.ma.
Driving Power ** o	11	7.5	approx.watts
Power Output	55	57.5	approx.watts

o At crest of a-f cycle with modulation factor of 1.0.
** See next page.

(continued on next page)

805
R-F POWER AMPLIFIER, OSCILLATOR, CLASS B MODULATOR

(continued from preceding page)

PLATE-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage	1250 max.		volts
D-C Grid Voltage	-500 max.		volts
D-C Plate Current	175 max.		ma.
D-C Grid Current	70 max.		ma.
Plate Input	220 max.		watts
Plate Dissipation	86 max.		watts
Typical Operation:			
Filament Voltage	10	10	a-c volts
D-C Plate Voltage	1000	1250	volts
D-C Grid Voltage	-155	-160	volts
Peak R-F Grid Voltage	295	300	volts
D-C Plate Current	160	160	ma.
D-C Grid Current **	60	60	approx.ma.
Driving Power **	16	16	approx.watts
Power Output	110	140	approx.watts

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

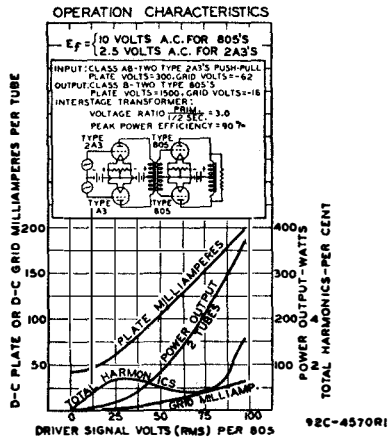
D-C Plate Voltage	1500 max.		volts
D-C Grid Voltage	-500 max.		volts
D-C Plate Current	210 max.		ma.
D-C Grid Current	70 max.		ma.
Plate Input	315 max.		watts
Plate Dissipation	125 max.		watts
Typical Operation:			
Filament Voltage	10	10	a-c volts
D-C Plate Voltage	1000	1250	volts
D-C Grid Voltage	-95	-100	volts
Peak R-F Grid Voltage	225	230	volts
D-C Plate Current	200	200	ma.
D-C Grid Current **	40	40	approx.ma.
Driving Power **	8.5	8.5	approx.watts
Power Output	130	170	approx.watts

** Subject to wide variations as explained on sheet TRANS. TUBE RATINGS.
\#\# Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

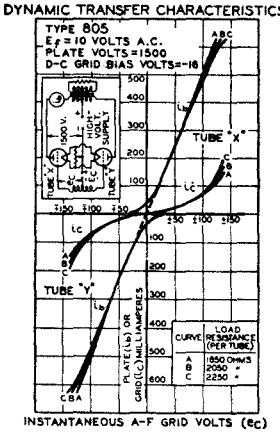
For use of the 805 at the higher frequencies, refer to sheet TRANS. TUBE RATINGS vs FREQUENCY.

805
R-F POWER AMPLIFIER, OSCILLATOR CLASS B MODULATOR

OPERATION CHARACTERISTICS



DYNAMIC TRANSFER CHARACTERISTICS

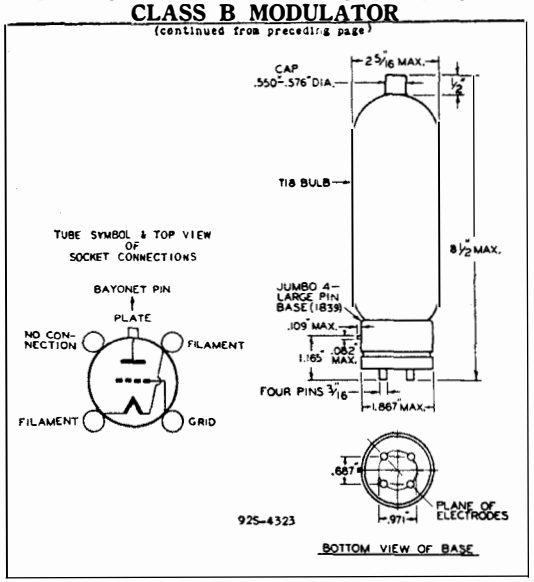


92C-4570R1 & 4571R1

805

R-F POWER AMPLIFIER. OSCILLATOR. CLASS B MODULATOR

(continued from preceding page)

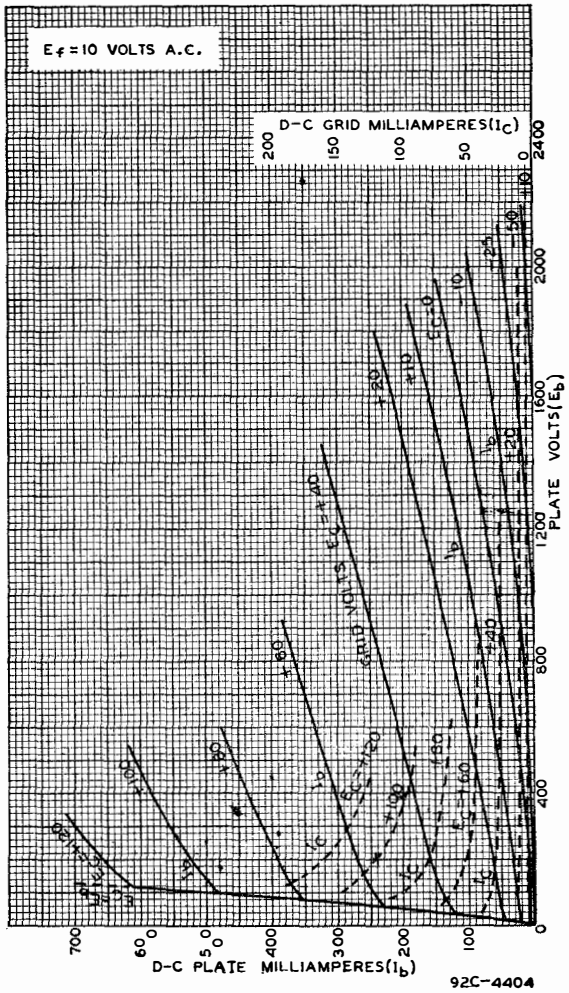


FOR PLATE FAMILY, REFER TO CURVE 92C-4404 UNDER TYPE 838.

←Indicates a change

838

AVERAGE PLATE CHARACTERISTICS



TRANSMITTING BEAM POWER AMPLIFIER

Heater •	Coated Unipotential Cathode	
Voltage	6.3	a-c or d-c volts
Current	0.9	amp.
Transconductance for plate cur. of 72 ma.	6000 approx.	μmhos
Grid-Screen Mu-Factor	8	
Direct Interelectrode Capacitances:		
Grid to Plate (With external shielding)	0.2 max.	μμf
Input	11	μμf
Output	7	μμf
Maximum Overall Length	5-3/4"	
Maximum Diameter	2-1/16"	
Bulb	ST-16	
Cap	Small Metal	
Base	Medium 5-Pin, MICANOL△	

MAXIMUM CCS and ICAS RATINGS with TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service
ICAS = Intermittent Commercial and Amateur Service

A-F POWER AMPLIFIER & MODULATOR - Class AB_2#

	CCS	ICAS	
D-C Plate Voltage	600 max.	750 max.	volts
D-C Screen Voltage (Grid #2)	300 max.	300 max.	volts
Max.-Signal D-C Plate Cur.*	120 max.	120 max.	ma.
Max.-Signal Plate Input*	60 max.	90 max.	watts
Screen Input*	3.5 max.	3.5 max.	watts
Plate Dissipation*	25 max.	30 max.	watts
Typical Operation: *Unless otherwise specified, values are for 2 tubes*			
D-C Plate Voltage	400 / 500 / 600	750	volts
D-C Screen Voltage	300 / 300 / 300	300	volts
D-C Grid Voltage (Fixed bias, Grid #1)	-25 / -25 / -30	-32	volts
Peak A-F Grid-to-Grid Voltage	78 / 78 / 78	92	volts
Zero-Sig. D-C Plate Cur.	100 / 100 / 60	60	ma.
Max.-Sig. D-C Plate Cur.	240 / 240 / 200	240	ma.
Zero-Sig. D-C Screen Cur.	5 / 5 / 5	5	ma.
Max.-Sig. D-C Screen Cur.	10 / 10 / 10	10	ma.
Load Resistance (Per tube)	800 / 1060 / 1600	1740	ohms
Effective Load Resistance (Plate to plate)	3200 / 4240 / 6400	6950	ohms
Peak Grid Input Power◇	0.2 / 0.2 / 0.1	0.2	approx.watt
Max.-Sig. Power Output**	55 / 75 / 80	120	approx.watts

• In circuits where the cathode is not directly connected to the heater, the potential difference between them should not exceed 100 volts. Under the maximum plate and screen dissipation conditions, the heater voltage should not fluctuate so that it exceeds 7.0 volts.
* Averaged over any audio-frequency cycle of sine-wave form.
# Subscript 2 indicates that grid current flows during some part of input cycle.
△Registered trademark.
◇, **: See next page.
←Indicates a change.

TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

R-F POWER AMPLIFIER - Class B Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

		CCS		ICAS		
D-C Plate Voltage		600 max.		750 max.		volts
D-C Screen Voltage (Grid #2)		300 max.		300 max.		volts
D-C Plate Current		80 max.		90 max.		ma.
Plate Input		37.5 max.		45 max.		watts
Screen Input		2.5 max.		2.5 max.		watts
Plate Dissipation		25 max.		30 max.		watts
Typical Operation:						
D-C Plate Voltage	400	500	600	750		volts
D-C Screen Voltage	250	250	250	300		volts
D-C Grid Volt. (Grid #1)†	-25	-25	-25	-35		volts
Peak R-F Grid Voltage	30	30	20	27		volts
D-C Plate Current	75	75	62.5	60		ma.
D-C Screen Current	4	4	3	3		ma.
D-C Grid Cur. (Approx.)	0	0	0	0		ma.
Driving Power (Approx.)°°	0.25	0.25	0.2	0.12		watt
Power Output (Approx.)	9	12.5	12.5	15		watts

°° At crest of a-f cycle with modulation factor of 1.0.

PLATE-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

		CCS		ICAS		
D-C Plate Voltage		475 max.		600 max.		volts
D-C Screen Voltage (Grid #2)		300 max.		300 max.		volts
D-C Grid Voltage (Grid #1)		-200 max.		-200 max.		volts
D-C Plate Current		83 max.		100 max.		ma.
D-C Grid Current,		5 max.		5 max.		ma.
Plate Input		40 max.		60 max.		watts
Screen Input		2.5 max.		2.5 max.		watts
Plate Dissipation		16.5 max.		25 max.		watts
Typical Operation:						
D-C Plate Voltage	325	400	475	600		volts
D-C Screen Voltage◇	225	225	225	275		volts
	20000	30000	50000	50000		ohms
D-C Grid Voltage▲†	-75	-80	-85	-90		volts
	25000	22800	21300	22500		ohms
Peak R-F Grid Voltage	90	95	110	115		volts
D-C Plate Current	80	80	83	100		ma.
D-C Screen Current	5	5.75	5	6.5		ma.

° Driver stage should be capable of supplying the grids of the class AB_2 stage with the specified peak values at low distortion. The effective resistance per grid circuit of the class AB_2 stage should be kept below 500 ohms and the effective impedance at the highest desired response frequency should not exceed 700 ohms.
◇ Obtained preferably from modulated fixed supply, or from modulated plate supply through resistor of value shown.
▲ May be obtained from grid resistor (25000, 22800, 21300, 22500) although combination of either grid resistor and cathode resistor or grid resistor and fixed supply is recommended.
** With zero-impedance driver and perfect regulation, plate-circuit distortion does not exceed 2%. In practice, plate-voltage regulation, screen-voltage regulation, and grid-bias regulation, should not be greater than 5%, 5%, and 3%, respectively.
† See end of tabulation.
← Indicates a change.

TRANSMITTING BEAM POWER AMPLIFIER

(continued from preceding page)

	CCS			ICAS	
D-C Grid Current (Approx.)	3	3.5	4	4	ma.
Driving Power (Approx.)	0.25	0.3	0.4	0.4	watt
Power Output (Approx.)	17.5	22.5	27.5	42.5	watts

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

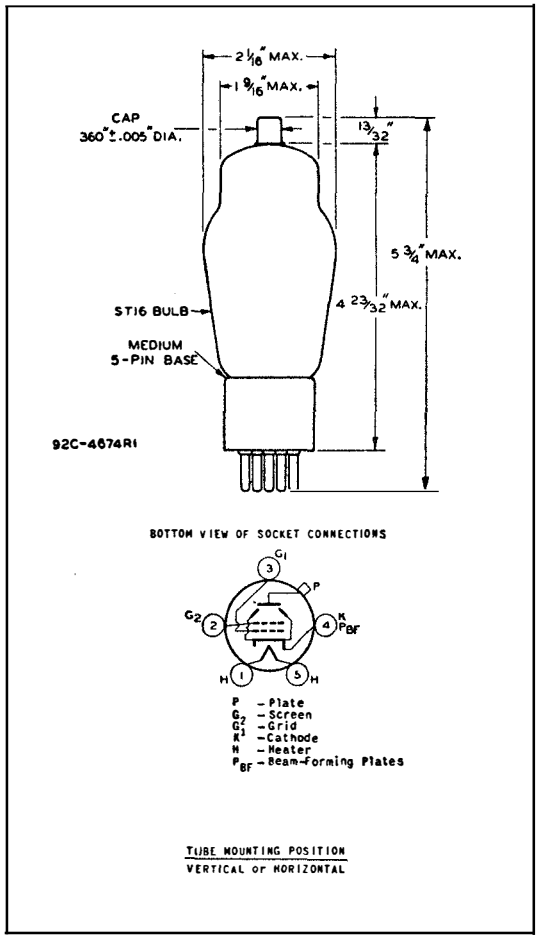
		CCS			ICAS	
D-C Plate Voltage		600 max.			750 max.	volts
D-C Screen Voltage (Grid #2)		300 max.			300 max.	volts
D-C Grid Voltage (Grid #1)		-200 max.			-200 max.	volts
D-C Plate Current		100 max.			100 max.	ma.
D-C Grid Current		5 max.			5 max.	ma.
Plate Input		60 max.			75 max.	watts
Screen Input		3.5 max.			3.5 max.	watts
Plate Dissipation		25 max.			30 max.	watts
Typical Operation:						
D-C Plate Voltage	400	500	600		750	volts
D-C Screen Voltage §	250	250	250		250	volts
	20000	42000	50000		85000	ohms
D-C Grid Voltage□ †	-45	-45	-45		-45	volts
	12800	12800	12800		12800	ohms
	410	410	410		410	ohms
Peak R-F Grid Voltage	65	65	65		65	volts
D-C Plate Current	100	100	100		100	ma.
D-C Screen Current	7.5	6	7		6	ma.
D-C Grid Cur. (Approx.)	3.5	3.5	3.5		3.5	ma.
Driving Power (Approx.)	0.2	0.2	0.2		0.2	watt
Power Output (Approx.)	25	30	40		50	watts

† The total effective grid-circuit resistance should not exceed 25000 ohms.
Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.
§ Obtained from separate source, from a potentiometer, or from plate supply through a series resistor of value shown.
□ Obtained from fixed supply, by grid resistor (12800), by cathode resistor (410), or by combination methods.

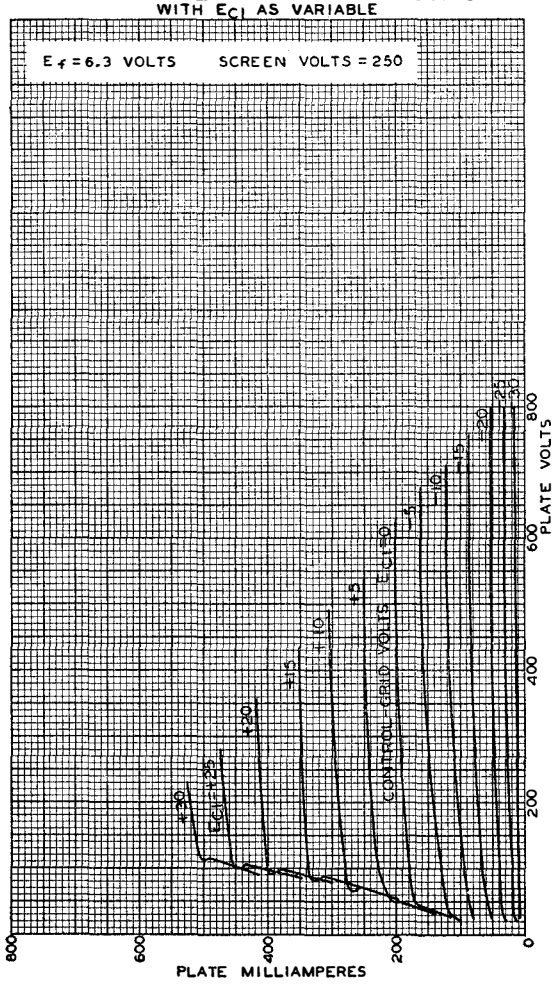
Data on operating frequencies for the 807 are given on the sheet TRANS. TUBE RATINGS vs FREQUENCY.

←Indicates a change.

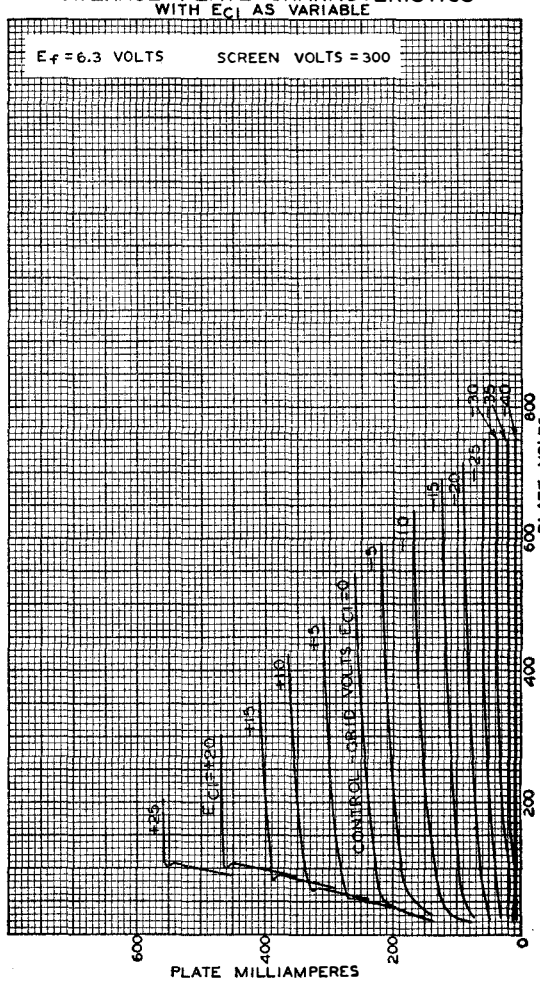
807
TRANSMITTING BEAM POWER AMPLIFIER



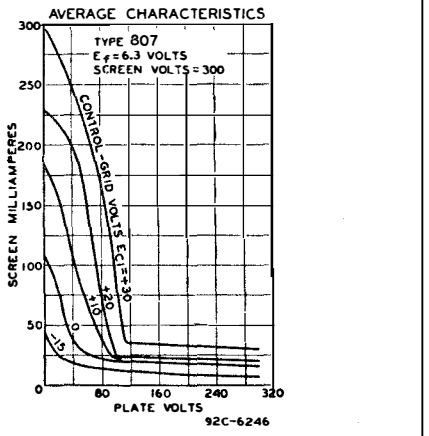
807
AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE

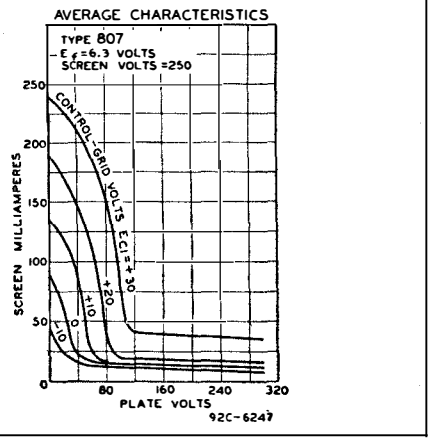


807
AVERAGE PLATE CHARACTERISTICS
WITH E_{C1} AS VARIABLE



807
TRANSMITTING BEAM POWER AMPLIFIER





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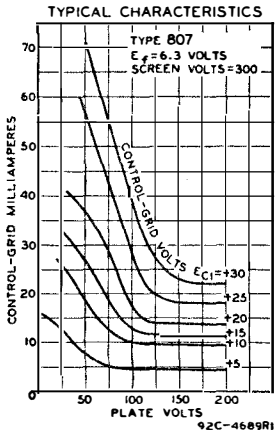
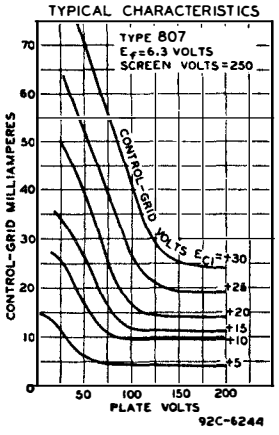
TRANSMITTING BEAM POWER AMPLIFIER





813
TRANSMITTING BEAM POWER AMPLIFIER

Filament	Thoriated Tungsten	
Voltage	10.0	a-c or d-c volts
Current	5	amp.
Transconductance for plate current of 50 ma.	3750 approx.	μmhos
Direct Interelectrode Capacitances:		
Grid to Plate (with external shielding)	0.2 max.	μμf
Input	16.3	μμf
Output	14	μμf
Maximum Overall Length		7-1/2"
Maximum Diameter		2-9/16"
Bulb		T-20
Cap		Medium Metal
Base		Giant 7-Pin, Bayonet
RCA Socket		Type UT-104

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

R-F POWER AMPLIFIER - Class B Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage		2000 max.	volts
D-C Screen Voltage (Grid #2)		400 max.	volts
D-C Plate Current		100 max.	ma.
Plate Input		150 max.	watts
Screen Input		15 max.	watts
Plate Dissipation		100 max.	watts
Typical Operation:			
D-C Plate Voltage	1500	2000	volts
D-C Screen Voltage	400	400	volts
D-C Grid Voltage (Grid #1) ●	-60	-75	volts
Peak R-F Grid Voltage	70	80	volts
Beam-Forming Plate Voltage *	0	0	volts
D-C Plate Current	100	75	ma.
D-C Screen Current	4	3	ma.
D-C Grid Current ♦	-	-	approx.ma.
Driving Power ○ ▲	-	-	approx.watt
Power Output	50	50	approx.watts

♦ Usually negligible. Fixed supply or by-passed cathode-resistor bias recommended.
▲ Usually negligible. Never more than 2 watts.

GRID-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage		2000 max.	volts
D-C Screen Voltage (Grid #2)		400 max.	volts
D-C Grid Voltage (Grid #1)		-200 max.	volts
D-C Plate Current		100 max.	ma.
Plate Input		150 max.	watts
Screen Input		15 max.	watts
Plate Dissipation		100 max.	watts
Typical Operation:			
D-C Plate Voltage	1500	2000	volts
D-C Screen Voltage	400	400	volts

●, *, ○: See end of tabulation.

(continued from preceding page)

D-C Grid Voltage ●	-140	-120	volts
Peak R-F Grid Voltage	145	120	volts
Peak A-F Grid Voltage	60	60	volts
Beam-Forming Poate Voltage *	0	0	volts
D-C Plate Current	70	75	ma.
D-C Screen Current	3	3	ma.
D-C Grid Current ♦	-	-	approx.ma.
Driving Power ○ ▲	-	-	approx.watt
Power Output	40	50	approx.watts

♦ Usually negligible. Fixed supply or unby-passed cathode-resistor bias recommended.
▲ Usually negligible. Never more than 2 watts.

PLATE-MODULATED R-F POWER AMPLIFIER - Class C Telephony

Carrier conditions per tube for use with a max. modulation fact. of 1.0

D-C Plate Voltage			1600 max.	volts
D-C Screen Voltage (Grid #2)			400 max.	volts
D-C Grid Voltage (Grid #1)			-300 max.	volts
D-C Plate Current			150 max.	ma.
D-C Grid Current			25 max.	ma.
Plate Input			240 max.	watts
Screen Input			15 max.	watts
Plate Dissipation			67 max.	watts
Typical Operation:				
D-C Plate Voltage	1250	1600		volts
D-C Screen Voltage □	400	400		volts
D-C Grid Voltage † ●	-120	-130		volts
	30000	21600		ohms
Peak R-F Grid Voltage	195	210		volts
Beam-Forming Plate Voltage *	0	0		volts
D-C Plate Current	150	150		ma.
D-C Screen Current	16	20		ma.
D-C Grid Current	4	6	approx.ma.	
Driving Power	0.7	1.2	approx.watts	
Power Output	135	175	approx.watts	

† Total effective grid-circuit resistance should not exceed 30000 ohms. Grid bias obtained by grid leak or by partial self-bias methods.
□ Obtained from fixed supply, modulated simultaneously with plate voltage.

R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation ##

D-C Plate Voltage			2000 max.	volts
D-C Screen Voltage (Grid #2)			400 max.	volts
D-C Grid Voltage (Grid #1)			-300 max.	volts
D-C Plate Current			180 max.	ma.
D-C Grid Current			25 max.	ma.
Plate Input			360 max.	watts
Screen Input			22 max.	watts
Plate Dissipation			100 max.	watts
Typical Operation:				
D-C Plate Voltage	1250	1500	2000	volts

○, ●, *, **: See end of tabulation.

(continued from preceding page)

D-C Screen Voltage §	300	300	400	volts
	42000	60000	107000	ohms
D-C Grid Voltage *	-60	-70	-90	volts
	8500	11700	30000	ohms
Peak R-F Grid Voltage	145	150	160	volts
Beam-Forming Plate Voltage *	0	0	0	volts
D-C Plate Current	180	180	180	ma.
D-C Screen Current	23	20	15	ma.
D-C Grid Current	7	6	3	approx.ma.
Driving Power	1	0.8	0.5	approx.watt
Power Output	155	190	260	approx.watts

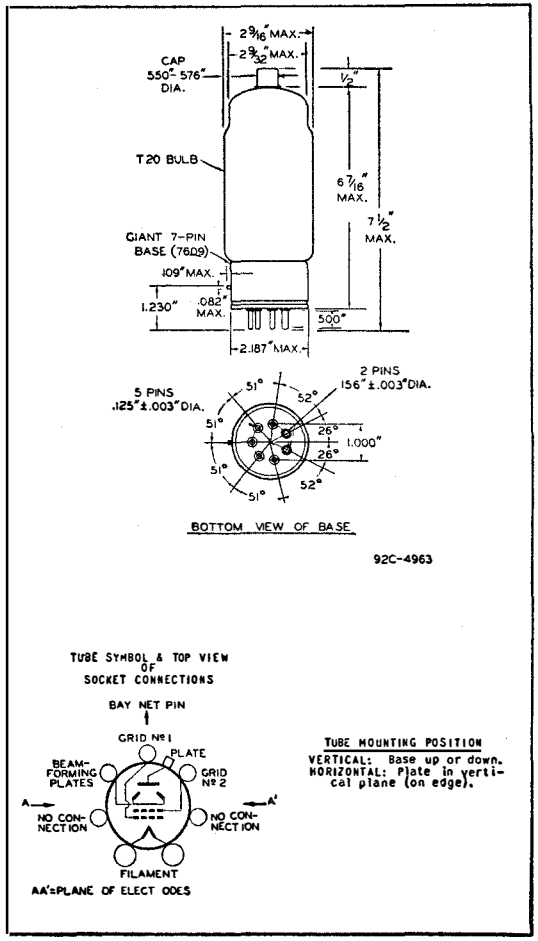
Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.
* Obtained by grid leak or other self- or fixed-bias method.
§ Preferably obtained from separate source or potentiometer, although series resistor connected to plate supply may be used.
* Beam-forming plates should be connected to the mid-point of filament circuit operated on a.c., or to the negative end of filament operated on d.c.
● For a-c filament supply. If d.c. is used, the stated voltages should be decreased by 7 volts.
○ At crest of audio-frequency cycle with modulation factor of 1.0.

OPERATION AT HIGH FREQUENCIES

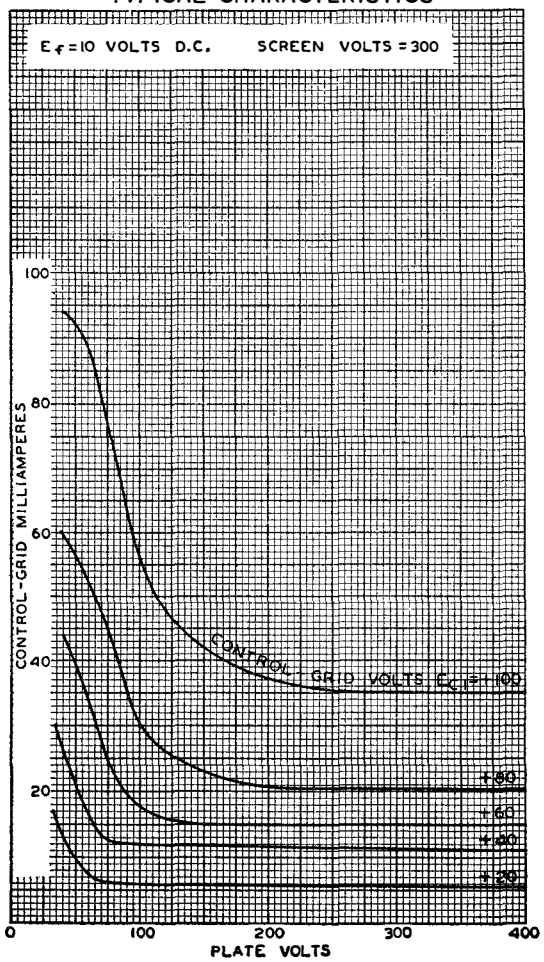
Maximum permissible percentage of maximum rated plate voltage and plate input

FREQUENCY (MC)		30	45	60	120
TELEPHONY	Class B	100%	93%	88%	76%
	Class C Grid Mod.	100	93	88	76
	Class C Plate Mod.	100	87	75	50
TELEGRAPHY - Class C		100	87	75	50

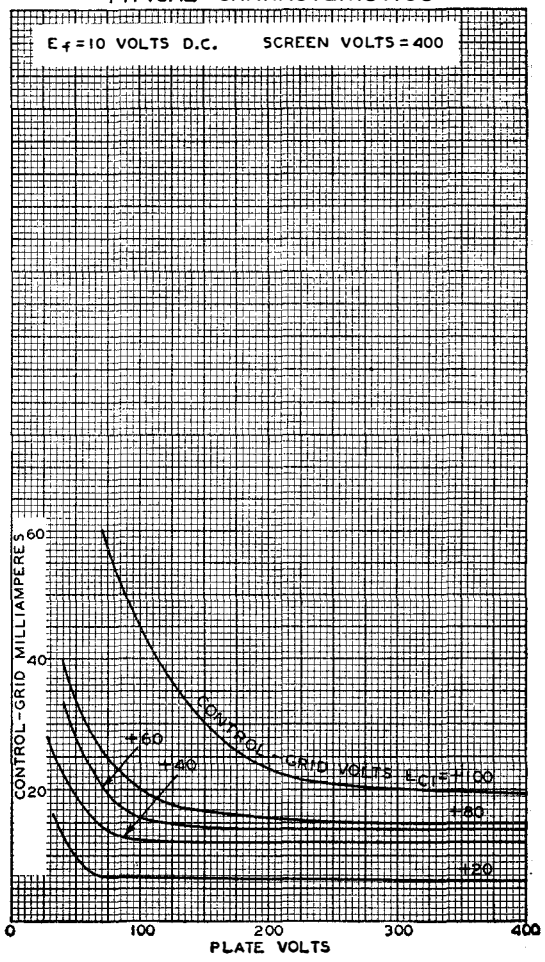
813
TRANSMITTING BEAM POWER AMPLIFIER

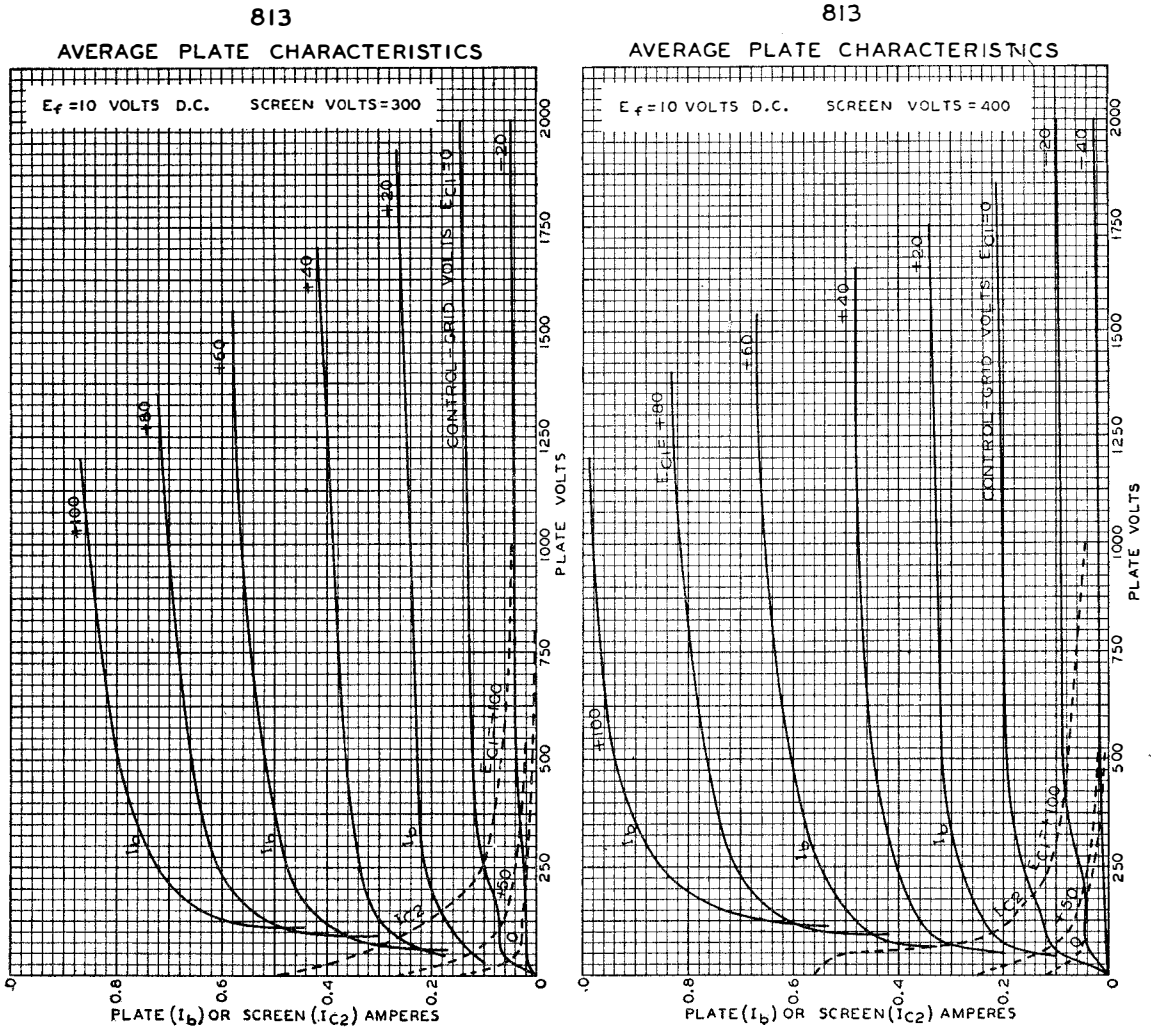


813
TYPICAL CHARACTERISTICS



813
TYPICAL CHARACTERISTICS




813
AVERAGE PLATE CHARACTERISTICS
Ef =10 VOLTS D.C. SCREEN VOLTS=300
CONTROL-GRID VOLTS Ec1=0
+20
+40
+60
+80
+100
-20
Ec1=-100
-50
0
Ib
Ic2
PLATE VOLTS
PLATE (Ib) OR SCREEN (Ic2) AMPERES
813
AVERAGE PLATE CHARACTERISTICS
Ef =10 VOLTS D.C. SCREEN VOLTS = 400
CONTROL-GRID VOLTS Ec1=0
+20
+40
+60
+80
+100
-20
-40
Ec1=-100
-50
0
Ib
Ic2
PLATE VOLTS
PLATE (Ib) OR SCREEN (Ic2) AMPERES

866-A/866

HALF-WAVE MERCURY VAPOR RECTIFIER

This type supersedes RCA types 866 and 866-A

Filament*	Coated	
Voltage	2.5	a-c volts
Current	5.0	amp.
Maximum Overall Length		6-5/8"
Maximum Diameter		2-7/16"
Bulb		ST-19
Cap	Medium Metal, with Insulating Collar	
Base	Medium 4-Pin, Bayonet	
RCA Socket		UR-542A

MAXIMUM RATINGS

Peak Inverse Voltage:	Column I	Column II
For supply frequency up to 150~		
Cond. Mercury Temp. 25° to 60°C#	-	10000 max. volts
Cond. Mercury Temp. 25° to 70°C#	200 max.	- volts
For supply frequency up to 1000~		
Cond. Mercury Temp. 25° to 70°C#	-	5000 max. volts
Peak Plate Current	2.0 max.	1.0 max. amp.
Average Plate Current	0.5 max.	0.25 max. amp.
Tube Voltage Drop (Approx.)	15	15 volts

* The filament of the 866-A/866 is partially shielded from the plate to permit operation from a power supply having a frequency up to 1000 cycles per second. The filament should be allowed to come up to operating temperature before plate voltage is applied. For average conditions, the delay is approximately 30 seconds.

Operation at 40° ± 5°C is recommended.

For *shielding* and *r-f filter circuits*, refer to Type 871.

NOTES ON COLUMN II

The table on the next page gives empirical values of choke inductance (L) and the condenser capacitance (C) for choke-input-to-filter circuits which will keep the peak plate current below the recommended maximum, provided the average d-c load current does not exceed the maximum load-current values shown. Values of (L) and (C) are based on a 60-cycle a-c voltage supply.

The capacitance (C) is small enough to prevent excessive surges when power is first applied to the circuit, and yet large enough to give adequate filtering. If the inductance (L) is increased, it is permissible to increase the capacitance in the same proportion. In a two-section filter with two inductances of unequal value, the larger inductance should be placed next to the rectifier tubes. With such an arrangement, the maximum value of each capacitance should be determined on the basis of the value of the inductance preceding it.

The circuits (see Type 872) of Figs. 1, 2, and 3 will give a ripple voltage less than 5% when used with a two-section filter having the minimum of inductance and the corresponding maximum of capacitance. The circuits of Figs. 4 and 5 will give a ripple voltage of less than 1%. For any of these circuits, better filtering may be obtained with the inductances larger than the minimum given in the table. For these larger inductances, the corresponding capacitances may be increased by the same percentage as the inductances to give still better results.

866-A/866

HALF-WAVE MERCURY VAPOR RECTIFIER

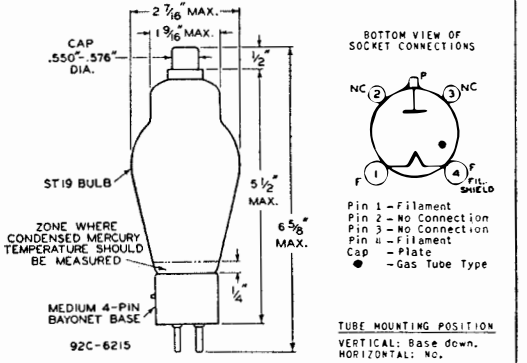
For Circuits, refer to Type 872.

(continued from preceding page)

CIRCUIT	A-C INPUT VOLTS** (RMS)	MAX. D-C OUTPUT VOLTS TO FILTER	CHOKE INPUT ONE-SECTION FILTER MIN. CHOKE (L) henrys	CHOKE INPUT ONE-SECTION FILTER MAX. CONDENSER (c) µf	MAX. D-C LOAD CURRENT amperes
SINGLE-PHASE FULL-WAVE (2 tubes) FIG.1	3535 per tube	3180	8.0	1.25	0.5
	3000 " "	2700	6.8	1.5	0.5
	2000 " "	1800	4.5	2.1	0.5
	1500 " "	1350	3.4	2.8	0.5
SINGLE-PHASE FULL-WAVE (4 tubes) FIG.2	7070 total	6360	16.0	0.6	0.5
	6000 "	5400	13.5	0.7	0.5
	5000 "	4500	11.0	0.9	0.5
	4000 "	3600	8.9	1.1	0.5
THREE PHASE HALF-WAVE FIG.3	4080 per leg	4780	3.2	1.4	0.75
	3000 " "	3510	2.2	2.0	0.75
	2000 " "	2340	1.4	3.0	0.75
	1500 " "	1750	1.1	4.0	0.75
THREE-PHASE DOUBLE-Y PARALLEL FIG.4	4080 per leg	4780	2.0	0.5	1.5
	3000 " "	3510	1.5	0.7	1.5
	2000 " "	2340	1.0	1.1	1.5
	1500 " "	1750	0.7	1.5	1.5
THREE-PHASE FULL-WAVE FIG.5	4080 per leg	9570	1.8	0.5	0.75
	3000 " "	7020	1.4	0.7	0.75
	2000 " "	4680	0.9	1.2	0.75
	1500 " "	3510	0.7	1.5	0.75
SINGLE-PHASE FULL-WAVE (2 tubes) FIG.1*	3535 per tube	3950	-	-	0.25
	3000 " "	3390	-	-	0.25
	2000 " "	2260	-	-	0.25
	1500 " "	1700	-	-	0.25

* With condenser input to filter.

** For use under the conditions of the 10000-volt peak inverse rating. If the 866-A/866 is to be used under frequency and/or temperature conditions such that the peak inverse voltage is limited to 5000 volts, the a-c input voltage and d-c output voltage values in the table should be multiplied by a factor of 0.5 to give new values for the 5000-volt conditions.



Pin 1 - Filament
Pin 2 - No Connection
Pin 3 - No Connection
Pin 4 - Filament
Cap - Plate
● - Gas Tube Type

TUBE MOUNTING POSITION

VERTICAL: Base down.
HORIZONTAL: No.

VR150-30

VOLTAGE REGULATOR

Type	Glow Discharge	
Maximum Overall Length		4-1/8"
Maximum Seated Height		3-9/16" ←
Maximum Diameter		1-9/16"
Bulb		ST-12
Base		Small Shell Octal 6-Pin
Pin 1 - No Connection		Pin 5 - Anode
Pin 2 - Cathode		Pin 7 - Jumper #
Pin 3 - Jumper #		Pin 8 - No Connection
Mounting Position	BOTTOM VIEW	Any ←

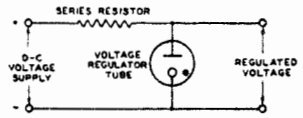
Maximum and Minimum Ratings Are Absolute Values

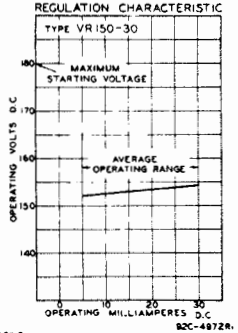
Operating Conditions:		
Starting Supply-Voltage	180 min.	d-c volts
Operating Voltage (approx.)	150	d-c volts
Operating Current *	5 min.	d-c ma.
	30 max.	d-c ma.

* With suitable socket connections, jumper within base acts as switch to open power-supply circuit when voltage regulator tube is removed from socket

* Sufficient resistance must always be used in series with the tube to limit the current through it to 30 ma.

OUTLINE DIMENSIONS for the VR150-30 are the same as those for Type 884





← Indicates a change.

TABLE V

APPLICABLE COLOR CODES

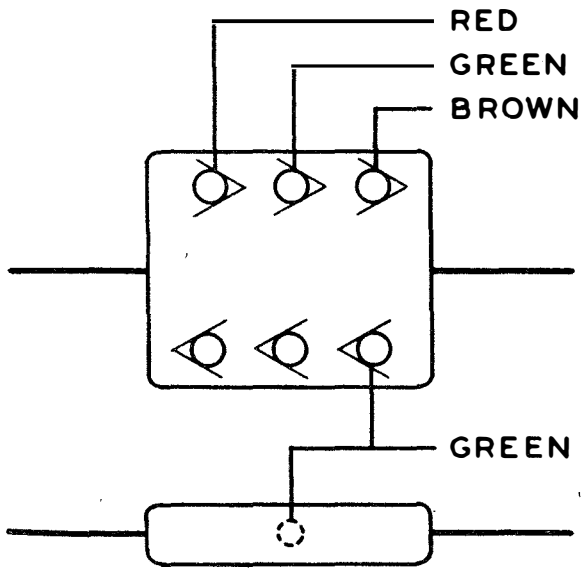
CAPACITOR COLOR CODE

The Standard RMA Color Code is used to indicate the capacity of some of the midget mica capacitors used in the equipment. The colors and corresponding numbers are listed below:

0—Black	5—Green
1—Brown	6—Blue
2—Red	7—Violet
3—Orange	8—Gray
4—Yellow	9—White

Three colored dots, with arrows indicating the sequence of colors indicate the capacity. The third dot of color indicates the number of zeros following the first two figures. All capacity values are in micromicrofarads (mmfd). The tolerance in percent is indicated by the spot of color on the edge of the capacitor.

For example, the capacitor shown below has a capacity of 250 mmfd (0.00025 mfd). The color sequence is red (2), green (5) and brown (1). The tolerance is ±5% as indicated by the spot of green on the edge or the color of the fourth dot on the top of the capacitor.



Dwg. No. 500 0246 00A

RESISTOR COLOR CODE

The Standard RMA Color Code is used to indicate the resistance of the small resistors used in the equipment. The colors and corresponding numbers are listed below:

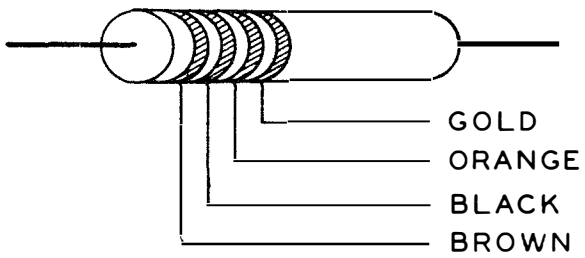
0—Black	5—Green
1—Brown	6—Blue
2—Red	7—Violet
3—Orange	8—Gray
4—Yellow	9—White

The resistors are marked with three colored "bands" near one end. All resistance values are in ohms. The color sequence begins with the color nearest the end of the resistor. The first "band" indicates the first number of the sequence, the second "band" the second number and the third "band" the number of zeros following the second number.

Tolerance values for the resistors are designated by the fourth "band" on the resistor body using the following colors to indicate the percentage of tolerance:

1%—Brown	6%—Blue
2%—Red	7%—Violet
3%—Orange	8%—Gray
4%—Yellow	9%—White
5%—Green	5%—Gold
	10%—Silver

For example, the resistor shown below has a resistance of 10,000 ohms and a tolerance of ±5%. Brown (1), black (0), orange (3), and gold (5).



Dwg. No. 500 0242 00A

COLOR CODES

STANDARD CABLE WIRE CODE

Numerals Refer to RMA Color Code
Letters Refer to Wire Size and Type

COLOR CODE	COLOR	CONSTRUCTION RATINGS
A0	Black	16 Strands No. 30 A. W. G. Tinned
A1	Brown	0.0156" Rubber Comp. Wall
A2	Red	Glazed Cotton Braid
A3	Orange	
A4	Yellow	3 amp. 300 volts d. c.
A5	Green	
A6	Blue	
A9	White	
A02	Black—Red Tracer	
A32	Orange—Red Tracer	
A52	Green—Red Tracer	
A62	Blue—Red Tracer	
A92	White—Red Tracer	
B0	Black	26 Strands No. 30 A. W. G. Tinned
B2	Red	0.0313" Rubber Comp. Wall
B3	Orange	Glazed Cotton Braid
B4	Yellow	
B5	Green	6 amp. 500 volts d. c.
B6	Blue	
B9	White	
BB10	Tinned	1 Strand No. 10 A. W. G. Tinned 30 amp.
BB12	Tinned	1 Strand No. 12 A. W. G. Tinned 25 amp.
BB14	Tinned	1 Strand No. 14 A. W. G. Tinned 20 amp.
BB16	Tinned	1 Strand No. 16 A. W. G. Tinned 10 amp.
C0	Black	65 Strands No. 30 A. W. G. Tinned
C2	Red	0.031" Rubber Comp. Wall
C3	Orange	Glazed Cotton Braid
C5	Green	
C6	Blue	20 amp. 500 volts d. c.
C9	White	
C09	Black—White Tracer	
C29	Red—White Tracer	
C39	Orange—White Tracer	

COLOR CODES

STANDARD CABLE WIRE CODE

COLOR CODE	COLOR	CONSTRUCTION RATINGS
C59 C69 C10 C40 C90	Green—White Tracer Blue—White Tracer Brown—Black Tracer Yellow—Black Tracer White—Black Tracer	
D0	Black	19 Strands No. 27 A. W. G. Tinned 3/64'' Live Rubber Wall Lacquered Double Braid—5KV
E0 E2 E3 E5 E6 E9 E03 E23 E53 E63 E93 E05 E25 E35 E95 E06 E26 E36 E96	Black Red Orange Green Blue White Black—Orange Tracer Red—Orange Tracer Green—Orange Tracer Blue—Orange Tracer White—Orange Tracer Black—Green Tracer Red—Green Tracer Orange—Green Tracer White—Green Tracer Black—Blue Tracer Red—Blue Tracer Orange—Blue Tracer White—Blue Tracer	7 Strands No. 30 A. W. G. Tinned 0.01'' Unvulcanized Rubber Wall Glazed Cotton Braid 1.5 amp. 300 volts d. c.
K0 K2 K3 K5 K6	Black Red Orange Green Blue	10 Strands No. 30 A. W. G. Tinned 0.0156'' Rubber Comp. Wall Glazed Cotton Braid Tinned Copper Braid Shielding 3 amp. 300 volts d. c.
N0	Black	16 Strands No. 30 A. W. G. Felted Asbestos Wall Overall Cotton Braid Nominal Diameter 0.135'' Rated at 6-10 amps 300 volts

TABLE VI

LIST OF MANUFACTURERS

Code No.	Mfr's. Prefix	Name	Address
01V		Vaco Products Co.	1123 W. Washington Blvd. Chicago, Illinois
02S	CAN	Sangamo Electric Co.	1935 Funk Street Springfield, Illinois
05H	CHC	Hammarlund Mfg. Co.	424 W. 33rd New York, New York
05J		I. L. G. Electric Ventilating Co.	2850 N. Crawford Ave. Chicago, Illinois
05N	CNA	National Company, Inc.	Malden, Massachusetts
05P	COC	Oak Manfuacturing Co.	711 West Lake Street Chicago, Illinois
05W	CAO	Ward Leonard Elec. Co.	6 South Street Mount Vernon, New York
10R	CRV	R. C. A. Mfg. Company	Point & Cooper Streets Camden, New Jersey
10V		The Van Meter Company	526 4th Avenue, S. E. Cedar Rapids, Iowa
14A	COA	The Akron Porcelain Co.	Kenmore Station Akron, Ohio
16A	CAI	Aladdin Radio Industries, Inc.	501 W. 35th Street Chicago, Illinois
16W		Watlow Electric Mfg. Co.	1320 N. 23rd Street St. Louis, Missouri
19W	CWQ	Wells-Gardner & Co.	2701 N. Kildaire Chicago, Illinois
20T	CTH	Thordarson Electric Mfg. Company	Huron & Kingsburg Streets Chicago, Illinois
20W	CW	Western Electric Company	195 Broadway New York, New York
21N		National Fabricated Products Company	2650 Belden Avenue Chicago, Illinois
22A	CBZ	Allen-Bradley Company	118 W. Greenfield Ave. Milwaukee, Wisconsin
25C		Centralab, Inc.	900 East Keefe Milwaukee, Wisconsin
25P	COM	Ohmite Mfg. Company	4837 Flournoy Street Chicago, Illinois

LIST OF MANUFACTURERS

Code No.	Mfr's. Prefix	Name	Address
27B		Benwood-Linze Company	19th & Washington Ave. St. Louis, Missouri
28J	CIR	International Resistance Co.	1100 Terminal Commerce Bldg. Philadelphia, Pennsylvania
34A		American Automatic Elec. Company	1031 W. Van Buren St. Chicago, Illinois
34S	CFW	F. W. Sickles Company	Springfield, Massachusetts
35M	CML	Meissner Mfg. Company	Mt. Carmel, Illinois
40B	CBX	Bodine Electric	2272 West Ohio Street Chicago, Illinois
40F	CCM	Fenwal, Incorporated	400 Main Street Ashland, Massachusetts
40G	CG	General Electric Co.	Schenectady, New York
42J	CBU	Isolantite Corporation	10 Park Place New York, New York
42L	CLR	Leach Relay Company	5915 Avalon St. Los Angeles, California
45H	CHN	Heinemann Circuit Breaker Company	939 Plum Street Trenton, New Jersey
45W	CV	Weston Electrical Inst. Corp.	619 Frelinghuysen Ave. Newark, New Jersey
48B		Bonney Forge & Tool Works	Durham & Meadow Streets Allentown, Pennsylvania
55A		American Gas Accumulator Co.	1003 Newark Avenue Elizabeth, New Jersey
55C	CTR	Chicago Transformer Corp.	3501 West Addison Chicago, Illinois
60A	CPH	American Phenolic Corp.	1250 W. Van Buren St. Chicago, Illinois
64C	COL	Collins Radio Company	Cedar Rapids, Iowa
64S	CSL	Solar Mfg. Corporation	Bayonne, New Jersey
65G	CGX	G-M Laboratories, Inc.	4326 N. Knox Avenue Chicago, Illinois
65J	CJE	Jefferson Electric Co.	Bellwood, Illinois
65S	CPQ	Speer Resistor Corp.	St. Mary's, Penna.

LIST OF MANUFACTURERS

Code No.	Mfr's. Prefix	Name	Address
65W		Edwin L. Wiegand Co.	7506 Thomas Blvd. Pittsburgh, Penna.
66R	CRP	Raytheon Production Corp.	55 Chappel Street Newton, Massachusetts
66S	CSF	The Sprague Specialties Co.	North Adams, Mass.
68S		S-W Indicator Company	1056-58 N. Wood Street Chicago, Illinois
70A	CEP	Amperex Electronics Product, Inc.	79 Washington Brooklyn, New York
72B	CTB	Bristol Company	66 Bride Street Waterbury, Connecticut
75C	CD	Cornell-Dubilier Electric	1000 Hamilton Blvd. South Plainfield, N. J.
75M	CMM	J. W. Miller, Inc.	5917 S. Main Los Angles, California
77C	CBI	Corning Glass Works	1940 Crystal Street Corning, New York
77J	CEJ	E. F. Johnson Company	Waseca, Minnesota
78K	CKU	Kurman Elec. Co., Inc.	239 Lafayette St. New York, New York
78L	CLF	Littlefuse Laboratories	4765 Ravenswood Ave. Chicago, Illinois
78S		Stevens Walden, Inc.	Worcester, Massachusetts
83G		Goodell-Pratt Co.	Greenfield, Mass.
83M		Monowatt Electric Corp.	95 Hathaway Street Providence, Rhode Island
84A	CHH	Arrow-Hart & Hegeman Co.	103 Hawthorne Street Hartford, Connecticut
88S	CSD	Struthers Dunn Company	139 N. Juniper Street Philadelphia, Penna.
91J	CJC	Howard B. Jones	2300 W. Wabansia Ave. Chicago, Illinois
97B	CFA	Bussman Mfg. Company	2538 W. University St. St. Louis, Missouri

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