

*Everett*

*Collins*

**INSTRUCTION BOOK**

**COMMUNICATIONS  
TRANSMITTER**

**231D-20**

— **COLLINS RADIO COMPANY** —

## GUARANTEE

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts, or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory, transportation prepaid, provided

- (a) Notice of the claimed defect is given Collins within one (1) year from date of delivery and goods are returned in accordance with Collins' instructions.
- (b) Equipment, accessories, tubes, and batteries not manufactured by Collins or from Collins' designs are subject to only such adjustments as Collins may obtain from the supplier thereof.
- (c) No equipment or accessory shall be deemed to be defective if, due to exposure or excessive moisture in the atmosphere or otherwise after delivery, it shall fail to operate in a normal or proper manner.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins or its authorized service center.

No other warranties, expressed or implied, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

**HOW TO RETURN MATERIAL OR EQUIPMENT.** If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, insofar as applicable. If the item is thought to be defective, such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. (With respect to tubes we suggest that your adjustments can be speeded up if you give notice of defect directly to the tube manufacturer.) Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in handling of your returned merchandise.

### ADDRESS:

Collins Radio Company  
Sales Service Department  
Cedar Rapids, Iowa

### INFORMATION NEEDED:

- (A) Type number, name, and serial number of equipment
- (B) Date of delivery of equipment
- (C) Date placed in service
- (D) Number of hours of service
- (E) Nature of trouble
- (F) Cause of trouble if known
- (G) Part number (9 or 10 digit number) and name of part thought to be causing trouble
- (H) Item or symbol number of same obtained from parts list or schematic
- (I) Collins' number (and name) of unit sub-assemblies involved in trouble
- (J) Remarks

**HOW TO ORDER REPLACEMENT PARTS.** When ordering replacement parts, you should direct your order as indicated below and furnish the following information insofar as applicable. To enable us to give you better replacement service, please be sure to give us complete information.

### ADDRESS:

Collins Radio Company  
Sales Service Department  
Cedar Rapids, Iowa

### INFORMATION NEEDED:

- (A) Quantity required
- (B) Collins' part number (9 or 10 digit number) and description
- (C) Item or symbol number obtained from parts list or schematic
- (D) Collins' type number, name, and serial number of principal equipment
- (E) Unit sub-assembly number (where applicable)

To make certain that you receive all additional or revised pages for this Instruction Book, please tear out and return the post card. It is important that we know:

☆ Your Name and Address

☆ The Type Number and Serial Number of your equipment



## CUSTOMER PUBLICATIONS SERVICE REGISTRATION CARD

Date .....



We have purchased the following unit(s) of Collins Radio Equipment:

Type Number .....

Date Purchased ..... Serial Number .....

We request that you register our ownership of this equipment, and provide Customer Publications Service.

Owner's Name .....

Address .....

BE SURE TO SUPPLY ALL EQUIPMENT SERIAL NUMBERS. THANK YOU.

Postage  
Will Be Paid  
by  
Addressee

No  
Postage Stamp  
Necessary  
If Mailed in the  
United States

**BUSINESS REPLY CARD**

FIRST CLASS PERMIT No. 236 CEDAR RAPIDS, IOWA

**COLLINS RADIO COMPANY**  
**Cedar Rapids, Iowa**

PUBLICATIONS ENGINEERING DEPT.



**Instruction Book  
for  
231D-20 COMMUNICATIONS  
TRANSMITTER**

**COLLINS RADIO COMPANY  
Cedar Rapids, Iowa**

**520 9401 00  
1 November 1955  
Second Edition  
15 May 1956**

Printed in the United States of America

# TABLE OF CONTENTS

Paragraph		Page
<b>SECTION I. GENERAL DESCRIPTION</b>		
1. 1.	Equipment . . . . .	1
1. 2.	General Description . . . . .	1
1. 2. 1.	Transmitter . . . . .	1
1. 2. 2.	Remote Control Unit . . . . .	2
1. 2. 3.	Tube Complement . . . . .	2
1. 3.	Power Source . . . . .	3
1. 4.	Power Output . . . . .	3
1. 5.	Type of Emission . . . . .	3
1. 6.	Frequency Range . . . . .	3
1. 7.	Frequency Change System . . . . .	3
1. 8.	Frequency Control . . . . .	4
1. 9.	Audio Characteristics . . . . .	4
1. 10.	Panel Control . . . . .	4
1. 11.	Remote Control . . . . .	4
1. 12.	60 to 50 Cps Conversion Kit . . . . .	4
1. 13.	Abbreviations . . . . .	4
<b>SECTION II. CIRCUIT DESCRIPTION</b>		
2. 1.	General . . . . .	5
2. 2.	Power Control Circuits . . . . .	5
2. 2. 1.	Sequence of Power Application . . . . .	5
2. 2. 2.	Remote Control . . . . .	5
2. 2. 3.	Local Control . . . . .	7
2. 3.	A-C Primary Circuits . . . . .	7
2. 4.	Filament Circuits . . . . .	9
2. 5.	High-Voltage and Relay Supply Circuits . . . . .	10
2. 5. 1.	Bias Supply . . . . .	10
2. 5. 2.	Low-Voltage Supply . . . . .	10
2. 5. 3.	High-Voltage Power Supply . . . . .	10
2. 5. 4.	Relay Power Supply . . . . .	10
2. 6.	Autotune System . . . . .	11
2. 6. 1.	Mechanical Details . . . . .	12
2. 6. 2.	Electrical Details . . . . .	14
2. 6. 3.	Sequence of Operation . . . . .	17
2. 6. 4.	FSK Control or Automatic Emission Selection . . . . .	19
2. 7.	Radio Frequency Circuits . . . . .	20
2. 7. 1.	Crystal Oscillator . . . . .	20
2. 7. 2.	Frequency Multiplier . . . . .	20
2. 7. 3.	Intermediate Amplifier . . . . .	20
2. 7. 4.	Power Amplifier . . . . .	20
2. 7. 5.	Power Amplifier Stabilizer . . . . .	21
2. 7. 6.	Output Network . . . . .	21
2. 8.	Keying and Carrier Control . . . . .	22
2. 8. 1.	Frequency Shift Keying . . . . .	23
2. 9.	Audio Frequency Circuits . . . . .	23
2. 9. 1.	Remote Amplifier . . . . .	23
2. 9. 2.	First Audio Amplifier . . . . .	24
2. 9. 3.	Volume Limiter and 2nd Audio Amplifier . . . . .	24
2. 9. 4.	Audio Power Amplifier . . . . .	25
2. 9. 5.	Audio Driver . . . . .	25
2. 9. 6.	Modulator . . . . .	26

## TABLE OF CONTENTS (Cont)

Paragraph	SECTION III. INSTRUCTIONS FOR INSTALLATION	Page
3. 1.	General . . . . .	27
3. 2.	External Connections . . . . .	27
3. 2. 1.	Power Line . . . . .	27
3. 2. 2.	Remote Lines . . . . .	27
3. 2. 3.	FSK Units . . . . .	27
3. 2. 4.	Radiation System . . . . .	27
3. 3.	Uncrating . . . . .	27
3. 4.	Installation of Units . . . . .	30
3. 5.	Fuses . . . . .	34
3. 6.	Remote Unit . . . . .	34
SECTION IV. ADJUSTMENTS		
4. 1.	Warning . . . . .	37
4. 2.	Controls . . . . .	37
4. 3.	Inspection . . . . .	39
4. 4.	Circuit Tests . . . . .	40
4. 5.	Voltage Adjustment . . . . .	41
4. 6.	R-F Circuit Adjustment . . . . .	43
4. 6. 1.	Crystals . . . . .	43
4. 6. 2.	Exciter Tuning . . . . .	46
4. 6. 3.	Intermediate Amplifier Tuning . . . . .	46
4. 6. 4.	Power Amplifier and Antenna Tuning . . . . .	48
4. 7.	Neutralization . . . . .	49
4. 7. 1.	Intermediate Amplifier Neutralization . . . . .	50
4. 7. 1. 1.	Neutralization Check . . . . .	50
4. 7. 1. 2.	Neutralization Procedure . . . . .	50
4. 7. 2.	Power Amplifier Neutralization . . . . .	50
4. 7. 2. 1.	Neutralization Check . . . . .	50
4. 7. 2. 2.	Neutralization Procedure . . . . .	51
4. 8.	Audio Circuit Adjustment . . . . .	51
4. 8. 1.	Remote Control Unit Adjustments . . . . .	51
4. 8. 2.	Transmitter Control Adjustments . . . . .	52
4. 8. 2. 1.	Speech Amplifier and Limiter Adjustments . . . . .	52
4. 8. 2. 2.	MCW Control Adjustments . . . . .	52
4. 9.	Local Control (Voice) . . . . .	53
4. 10.	Emission Selection . . . . .	53
4. 11.	Channel Indicator and Disabling Circuit Adjustment . . . . .	54
4. 11. 1.	Channel Indicator Adjustment . . . . .	54
4. 11. 2.	Receiver Disabling Circuit Adjustment . . . . .	54
4. 12.	Limiter Bias Adjustment . . . . .	54
4. 13.	Modulator Bias Voltage Adjustment . . . . .	55
SECTION V. OPERATION		
5. 1.	General . . . . .	57
5. 2.	Routine Operating Procedure . . . . .	57
5. 2. 1.	Remote Control . . . . .	57
5. 2. 2.	Panel Control . . . . .	57

## TABLE OF CONTENTS (Cont)

Paragraph	SECTION VI. MAINTENANCE	Page
6. 1.	Autotune Maintenance . . . . .	59
6. 1. 1.	Lubrication . . . . .	59
6. 1. 2.	Autotune Synchronizing Theory . . . . .	61
6. 1. 3.	Synchronization Check . . . . .	62
6. 1. 4.	Synchronizing the Autotune System . . . . .	65
6. 1. 5.	Replacement of Parts . . . . .	66
6. 1. 6.	Limit Switch . . . . .	66
6. 2.	Relay Maintenance. . . . .	73
6. 2. 1.	Telephone Relays. . . . .	73
6. 2. 2.	A-C Contactors . . . . .	73
6. 2. 3.	Overload Relay Adjustment . . . . .	73
6. 3.	Fuses . . . . .	73
6. 4.	Ventilating Blower. . . . .	73
6. 5.	Cleaning . . . . .	74
6. 6.	Routine Checks . . . . .	74
6. 7.	Test Cables . . . . .	74
6. 8.	Location of Faults . . . . .	74
6. 8. 1.	Trouble Shooting . . . . .	75
6. 9.	Typical Voltages and Currents . . . . .	77
6. 10.	R-F Exciter Circuit Alignment . . . . .	80
6. 10. 1.	General . . . . .	80
6. 10. 2.	Details . . . . .	80
6. 11.	Intermediate Amplifier Neutralization . . . . .	80
6. 12.	PA Neutralization . . . . .	82
6. 13.	Network Tuning . . . . .	82
6. 14.	Thermal Switch Adjustment . . . . .	82
SECTION VII. DATA		
7. 1.	Transmitter Data . . . . .	83
7. 1. 1.	Power Input Requirements . . . . .	83
7. 1. 2.	Radio Frequency . . . . .	83
7. 1. 3.	Audio Frequency . . . . .	84
7. 1. 4.	Channel Reset Time . . . . .	84
7. 2.	Color Codes . . . . .	86
7. 3.	Tube Data . . . . .	87
SECTION VIII. PARTS LIST		
SECTION IX. ILLUSTRATIONS		



## LIST OF ILLUSTRATIONS

Figure	Title	Page
1	231D-20 Radio Transmitter . . . . .	vi
2	Power Control Circuits . . . . .	6
3	A-C Primary Circuits . . . . .	8
4	High-Voltage Rectifier Circuit . . . . .	11
5	Collins Autotune System - Mechanical Details . . . . .	13
6	Heavy-Duty Singleturn Unit - Mechanical Details . . . . .	15
7	Collins Autotune System - Electrical Details . . . . .	17
8	Autotune Operation Sequence . . . . .	18
9	Connections for Automatic Control of Collins 709D FSK Units . . . . .	19
10	Connection for Automatic Emission Selection . . . . .	19
11	Intermediate Amplifier Neutralization Circuit . . . . .	21
12	PA Stabilizer Circuit . . . . .	22
13	Simplified Carrier Control Circuits . . . . .	23
14	Limiter and Audio Amplifier Circuits . . . . .	24
15	Audio Driver and Modulator Circuits . . . . .	25
16	MCW Oscillator - Amplifier . . . . .	26
17	Installation Diagram . . . . .	28
18	External Connections . . . . .	29
19	Ground System . . . . .	29
20	Horn Gap Installation . . . . .	30
21	Modulator, Power Rectifier and Transmitter Units - Front . . . . .	32
22	Modulator Power Rectifier and Transmitter Units . . . . .	33
23	Remote Control Unit Installation . . . . .	35
24	Modulator, Power Rectifier and Transmitter . . . . .	38
25	Autotransformer Connections . . . . .	42
26A	Exciter Tuning Curve . . . . .	44
26B	Exciter Tuning Curve . . . . .	45
27A	Intermediate Amplifier Tuning Curve . . . . .	47
27B	Typical Tuning Curve Output Network with 600 $\Omega$ Balanced Load . . . . .	47
28	Output Network Impedance Matching Range . . . . .	48
29	Type 177G-9 Remote Control Unit - Top . . . . .	53
30	Autotune Lubrication Chart . . . . .	60
31	Autotune Time Base Diagram . . . . .	62
32	Singleturn Unit, Side . . . . .	63
33	Heavy-Duty Singleturn, Side . . . . .	64
34	R-F Exciter Unit Autotune Assembly (Complete) . . . . .	67
35	R-F Exciter Unit Autotune Assembly (Heads Removed) . . . . .	67
36	Power Amplifier Unit Autotune Assembly (Complete) . . . . .	67
37	Power Amplifier Unit Autotune Assembly (Heads Removed) . . . . .	67
38	Output Network Autotune Assembly (Complete) . . . . .	68
39	Output Network Autotune Assembly (Units Removed) . . . . .	68
40	R-F Exciter Unit - Top View . . . . .	81
41	R-F Exciter Unit - Bottom View . . . . .	81
42	Frequency Response Curve . . . . .	85
43	Limiter Curve . . . . .	85
44	Modulator and Audio Driver Unit . . . . .	118
45	Modulator and Audio Driver Unit . . . . .	118
46	Speech Amplifier Unit . . . . .	119
47	Speech Amplifier Unit . . . . .	119
48	Speech Amplifier and Modulator Filament Supply . . . . .	120
49	Speech Amplifier and Modulator Filament Supply . . . . .	120
50	Modulation Transformer . . . . .	121
51	Ventilating Blower . . . . .	122
52	Rectifier Power Unit . . . . .	123
53	Rectifier Power Unit . . . . .	124

## LIST OF ILLUSTRATIONS (Cont)

Figure	Title	Page
54	High-Voltage Power Transformer . . . . .	125
55	Output Network Unit . . . . .	126
56	Output Network Unit . . . . .	126
57	Power Amplifier Unit . . . . .	127
58	Power Amplifier Unit . . . . .	127
59	R-F Exciter Unit - Top View . . . . .	128
60	R-F Exciter Unit - Bottom View . . . . .	129
61	R-F Exciter Unit - Front and Rear View . . . . .	130
62	Autotune Control Unit . . . . .	131
63	Autotune Control Unit . . . . .	131
64	Power Amplifier Filament Supply . . . . .	132
65	Power Amplifier Filament Supply . . . . .	132
66	Phone-CW Relay . . . . .	133
67	Remote Control Unit . . . . .	134
68	Type 177G-9 Remote Control Unit - Top . . . . .	135
69	Type 177G-9 Remote Control Unit - Bottom . . . . .	135
70	Desk Set. . . . .	136
71	Telegraph Key . . . . .	136
72	Antenna Ammeter . . . . .	137
73	177G-10 Remote Control Unit - Front . . . . .	138
74	177G-10 Remote Control Unit - Top . . . . .	138
75	177G-10 Remote Control Unit - Bottom . . . . .	138
76	Handset Schematic . . . . .	139
77	Desk Set Schematic . . . . .	139
78	Key Cord Schematic . . . . .	139
79	Unit Test Cable Assembly . . . . .	140
80A	Type 177G-9 Remote Control Unit Schematic . . . . .	141
80B	Type 177G-10 Remote Control Unit Schematic . . . . .	142
81	231D-20 Transmitter Cabling Schematic . . . . .	143

SECTION I  
GENERAL DESCRIPTION

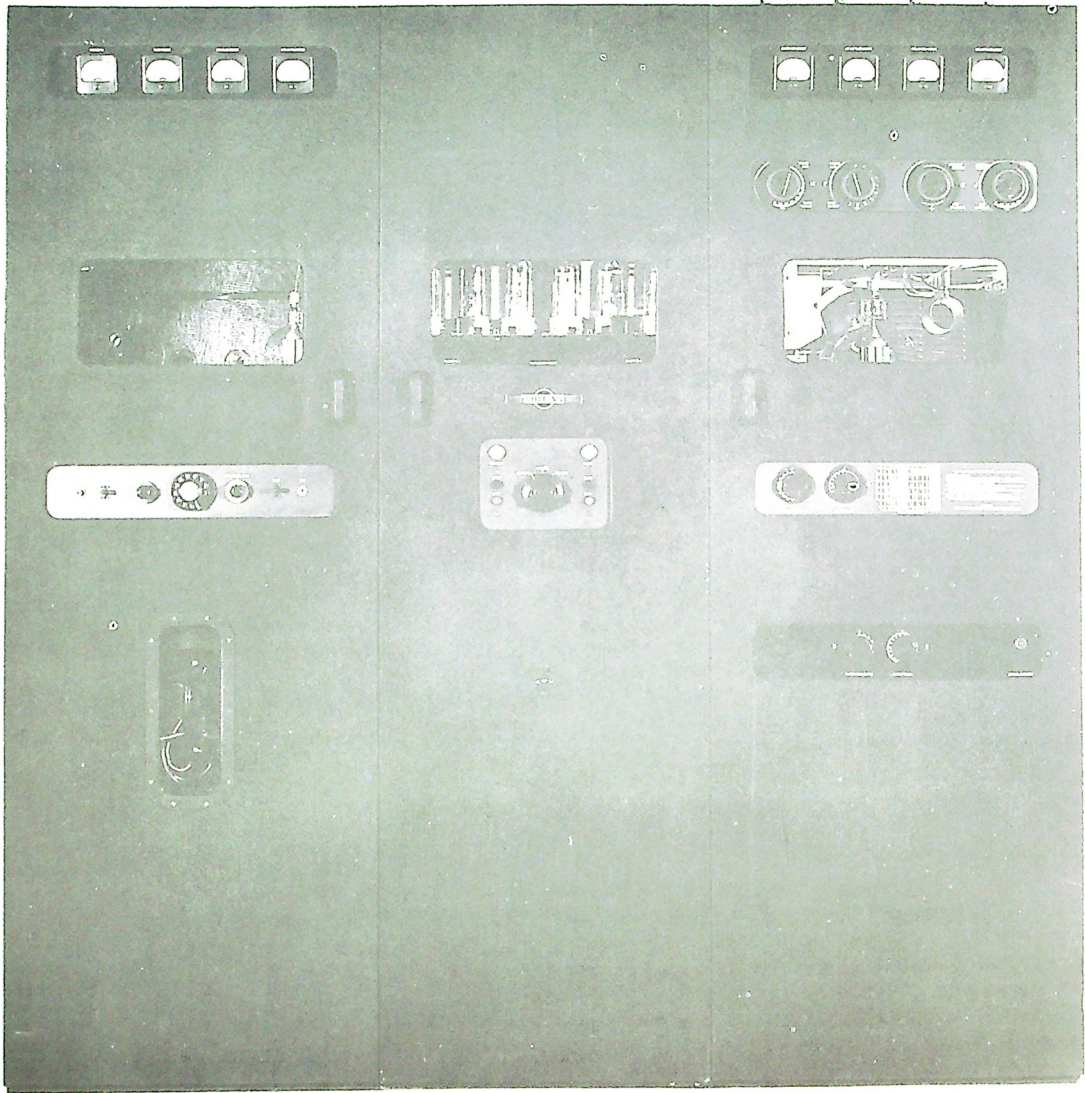


Figure 1. 231D-20 Radio Transmitter

## SECTION I

### GENERAL DESCRIPTION

1.1. EQUIPMENT. This instruction book covers the installation, adjustment, operation and maintenance of the Collins Type 231D-20 Radio Transmitting

equipment. The complete equipment consists of the following units and accessories:

Collins Part No.	Qty.	Description	Overall Dimensions	Weight Gross Net
1100C-1	1	Rectifier Power Unit	25" x 31" x 84"	1830# 1350#
1025-4	1	Modulator	28-1/2" x 31" x 84"	1390# 830#
	1	Radio Transmitter	28-1/2" x 31" x 95-5/8"	1730# 775#
177G-9	2	Remote Control Unit	8-29/32" x 10-7/8" x 19"	56#
or				
177G-10		Remote Control Unit	8-15/16" x 10-1/2" x 19"	30#
426N-6	1	Power Cord		
223G-8	2	Desk Set		
67A-3	2	Telegraph Key & Cord	3' (cord)	
GA-2649A	1	Meter Extension Cord	10'	
178B-2	3	Antenna Ammeter	11-5/8"	
GA-1198C	1	Test Cable (Red)	10'	
GB-1198C	1	Test Cable (Green)	10'	
	1	Kit Assembly Hardware		

When packed for shipment, the total gross weight of the complete equipment is 5716 lbs. The net weight of the complete equipment is 3325 lbs.

#### NOTE

The above list does not designate equipment shipped with this order but indicates a complete detailed installation.

1.2. GENERAL DESCRIPTION. This equipment has been designed for applications involving point-to-point communication, aeronautical ground stations and other services requiring operation on a number of readily selected frequency channels. The transmitter is equipped with the Collins Autotune\* system which permits the selection of any one of ten pretuned frequency channels by the operation of a telephone dial on the transmitter control panel or a dial located on the remote control unit.

1.2.1. Transmitter. The transmitter is contained in three bays or cabinets and requires a space 31" deep by 82-1/6" wide by 95-5/8" high and enough additional space to permit free circulation of air and the making of antenna and ground connections. The cabinets are finished with a zinc chromate primer and a final coat of black crinkle on the outside and are painted flat gray on the inside. The Collins Type 1016-5 Radio Transmitter cabinet contains all r-f units and the Autotune control system. The Collins Type 1100-2 Rectifier Power Unit cabinet contains the bias, low voltage and high voltage power supplies and all transmitter power controls. The Collins

Type 1025-4 Modulator cabinet contains the speech amplifier, audio driver and modulator circuit components. Each of the cabinets is equipped with full length front and rear doors. All three cabinets are equipped with door interlock switches so that power is immediately removed when either a front or rear door is opened. Glass windows in the front door of the r-f and audio bays permit viewing all indicating instruments without opening cabinet doors. All Autotune control knobs are accessible through openings in the front doors of the transmitter cabinet so that tuning adjustments may be made without opening the doors.

All three bays are ventilated by a blower located in the base of the Collins Type 1025-4 Modulator cabinet. The air is forced into the power and r-f bays through ducts located in the bases of the cabinet. The air is exhausted in such a manner that dust is not permitted to settle on the transmitter components.

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

(a) Output Network. This unit contains the components of the output balancing network and the pi network that is used as a combination power amplifier plate tank and antenna coupling circuit. The three variable capacitors, the SPDT switch and the two tap switches are driven by heavy-duty singleturn units that are associated with the Autotune system.

(b) Power Amplifier Unit. The power amplifier tubes, the intermediate amplifier plate tank circuit and a stabilizer circuit are contained in this unit.

\*Registered in U. S. Patent Office.

SECTION I  
GENERAL DESCRIPTION

The network contained in this unit is a combination intermediate amplifier plate tank and power amplifier grid circuit. The tank circuit utilizes a pair of tapped inductors and two variable capacitors to make up a balanced tank circuit. The variable capacitor and inductor tap switch are driven by singleturn units. The stabilizing circuit utilizes a Type 811 triode as an electronic load on the grid circuit of the power amplifier tubes.

(c) R-F Exciter Unit. The remaining r-f circuit components are contained in this unit. Two singleturn units, associated with the Autotune system, drive the variable components within the unit. One singleturn unit drives the exciter plate tank tuning capacitors and the other singleturn unit drives the exciter band switch sections. Components within the r-f unit have been carefully placed and shielded to obtain the best possible performance. The plate mounted near the intermediate amplifier tubes is used as a neutralizing capacitor. Filament voltages for tubes within the unit are supplied by three transformers mounted on the unit chassis. All connections to this unit except those to the plate caps of the intermediate amplifier tubes are made by two plug-in connectors on the rear of the chassis.

(d) Autotune Control Unit. All of the Autotune system control relays are mounted in this unit. All these relays are of the 48-volt d-c type and are supplied with voltage by a dry disk rectifier that is mounted on the power chassis. All connections to this unit are made by two plug-in connectors that are located on the rear of the chassis.

(e) Power Unit. All power supplies and all power controls are mounted on the vertical chassis that makes up the power unit. Four rectifier supplies furnish all voltages for operation of both r-f and audio circuits within the transmitter. The relay supply utilizes a dry-disk rectifier to obtain the 48 volts dc. Two autotransformers are located near the bottom of the vertical chassis. Terminals of the transformers are brought out through the front of the chassis so that adjustments may be made to compensate for low or high power source voltage. A panel, mounted

near the center of the unit, contains all of the power controls. The high voltage plate transformer mounts behind the vertical chassis.

(f) Modulator and Audio Driver Unit. This unit contains the components of the cathode-coupled audio driver and modulator stages and the hand-set coupling transformer. Components in this unit are mounted on a chassis that is bolted into the modulator cabinet. All connections are made by means of cables. The transformer that supplies voltage for filaments of the audio driver tubes is mounted in this unit but the transformer that supplies voltage for the modulator tubes is mounted on a separate chassis.

(g) Speech Amplifier Unit. This unit contains the first, second, and third audio amplifier stages, the audio limiter and audio squelch circuits and the MCW oscillator circuit. Four controls on the front of the chassis control the MCW frequency, MCW gain, audio gain and limiter gain. The local-remote switch, the test switch, the telephone dial, the key jack, and microphone jack are also mounted on this unit. Connections to the unit are made by two plugs that are mounted on the rear of the chassis. Filament voltages for all tubes in this unit are supplied by a transformer that is mounted on a chassis with the modulator filament transformer.

(h) Base Components. The PHONE-CW relay, the intermediate voltage filter capacitor and the high voltage filter capacitor are mounted in the base of the Collins Type 1016-5 Radio Transmitter cabinet. The modulation transformer and the ventilating blower are mounted in the base of the Collins Type 1025-4 Modulator cabinet.

1.2.2. Remote Control Unit. Panels of the remote control units are finished in flat black and the chassis finished in flat gray. This unit may be located 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 power supply for the tubes is contained within the unit and is designed for operation from a 115-volt 50/60-cps single-phase power source.

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

Collins Type 1016-5 Radio Transmitter

Symbol Designation	Type Number	Circuit Function	Unit
V101	6X5GT	Keying Rectifier	R-F Exciter
V102	6SJ7	Keyer	R-F Exciter
V103	837	Xtal Oscillator	R-F Exciter
V104	807	Frequency Multiplier	R-F Exciter
V105	4-125A	Intermediate Amplifier	R-F Exciter
V106	4-125A	Intermediate Amplifier	R-F Exciter
V114	750TL	Power Amplifier	Power Amp.
V115	750TL	Power Amplifier	Power Amp.
V116	811	P. A. Stabilizer	Power Amp.

Collins Type 1100C2 Rectifier Power Unit

Symbol Designation	Type Number	Circuit Function	Unit
V201	4B32	High-Voltage Rectifier	Power
V202	4B32	High-Voltage Rectifier	Power
V203	4B32	High-Voltage Rectifier	Power
V204	4B32	High-Voltage Rectifier	Power
V205	4B32	High-Voltage Rectifier	Power
V206	4B32	High-Voltage Rectifier	Power
V207	866/866A	Low-Voltage Rectifier	Power
V208	866/866A	Low-Voltage Rectifier	Power
V209	866/866A	Bias Rectifier	Power
V210	866/866A	Bias Rectifier	Power
<u>Collins Type 1025-4 Modulator</u>			
V301	6SL7GT	Audio Amplifier	Speech Amp.
V302	6C8G	Limiter	Speech Amp.
V303	6C8G	Audio Squelch	Speech Amp.
V304	6SJ7	Audio Amplifier	Speech Amp.
V305	6SN7GT	MCW Oscillator	Speech Amp.
V306	6X5GT	Limiter Rectifier	Speech Amp.
V307	801	Audio Amplifier	Speech Amp.
V308	801	Audio Amplifier	Speech Amp.
V309	845	Audio Driver	Mod. & Driver
V310	845	Audio Driver	Mod. & Driver
V311	450TL	Modulator	Mod. & Driver
V312	450TL	Modulator	Mod. & Driver
<u>Remote Control Unit Type 177G-9* or Type 177G-10**</u>			
*V401	6V6GT	Audio Amplifier	Remote Unit
*V402	6SJ7	Receiver Disabling Amp.	Remote Unit
*V403	5U4G	Rectifier	Remote Unit
**V301	6SJ7	Audio Amplifier	Remote Unit
**V302	6SN7GT	Audio Amplifier	Remote Unit
**V303	6X5GT	Rectifier	Remote Unit

1.3. POWER SOURCE. The transmitting equipment proper is designed to operate from a 230-volt 50/60-cps 3-phase power source. The equipment draws a maximum of 30 amperes when operating with full 3-kw output. The power required under varying operating conditions is tabulated below:

Condition	Power Input
CW - Standby	1840 watts
VOICE & MCW - Standby	3160 watts
CW - Key Closed	6480 watts
MCW - Key Closed	7240 watts
VOICE - 100 Modulation	9920 watts

The remote control unit is designed to operate from a 115-volt 50/60-cps single-phase power source and requires approximately 52 watts for normal operation. The power factor in all cases is approximately 85%.

1.4. POWER OUTPUT. Nominal power output of the 231D-18 is 3 kw. For CW only, power output of 4 kw is available.

1.5. TYPE OF EMISSION. CW (A1), MCW (A2), and VOICE (A3) emissions are available with this

equipment. Electronic carrier control is used and permits keying speeds of up to two hundred words per minute with A1 emission and keying speeds up to sixty words per minute with A2 emission. The modulation frequency for A2 emission is variable in seven steps in the range 400 cps to 1200 cps.

1.6. FREQUENCY RANGE. The equipment is capable of operation on any frequency within the range of 3000 kc to 26,000 kc. The power amplifier output coupling network is designed to work into unbalanced antennas or transmission lines having impedances of from 50 to 1200 ohms with a phase angle of 0°, 70 to 850 ohms with a phase angle of ±45° and 100 to 600 ohms with a phase angle of ±60°. A balancing network is available which will permit operation into a balanced transmission line of 300 to 1200 ohms resistive, with a standing wave of up to 2 to 1 ratio.

1.7. FREQUENCY CHANGE SYSTEM. The equipment employs the Collins Autotune system of frequency selection. The Autotune system provides for fast frequency change by mechanical repositioning of the various tuning elements to present positions. The positioning elements are driven by a single motor

SECTION I  
GENERAL DESCRIPTION

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. Any one of ten frequency channels or manual tuning may be selected by dialing.

The Autotune mechanisms are constructed with mechanical play and therefore can have two extreme rotational settings when locked. All dials, when operated automatically, approach the calibrated setting in a clockwise direction. Reset accuracy is thus assured, provided that in the preliminary manual tuning, the final direction of rotation is also in a clockwise direction. Details concerning the cams may be found in figure 5 and figure 6.

1.8. FREQUENCY CONTROL. The frequency of the r-f output is controlled by a crystal. Any one of ten crystals can be selected by the Autotune system.

1.9. AUDIO CHARACTERISTICS. The overall frequency response, as measured between 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 100% modulation level. The harmonic distortion with 100% modulation does not exceed 10% input at 400 cps. The audio input ranges from 0 to -25 db for 100% modulation. The noise level is at least 40 db below 100% modulation.

1.10. PANEL CONTROL. Panel controls on the transmitter consist of a telephone dial for selecting frequency channels and type of emission, a power level 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 permit the operator to apply or remove power, and to control the emission from a position adjacent to the transmitter proper.

1.11. REMOTE CONTROL. The remote control unit permits an operator to perform all operations that are necessary to select the frequency channel and type of emission, to 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 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.

1.12. 60 TO 50 CPS CONVERSION KIT. A conversion kit allows the transmitter to be converted from 60-cps

operation to 50-cps operation. Coils must be removed from K-202, K-203, K-205 and replaced with 50-cps coils. Part number of the kit is 505 5345 001.

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 used in the sections that follow will not be defined, but it will be assumed that reference will be made to the list following.

ABBREVIATIONS

ac	alternating current
a-f (a)	audio frequency
amp.	amperes
ant.	antenna
AWG	American Wire Gage
BSG	Browne & Sharpe Gage
CFI	Crystal Frequency Indicator
CT	Center Tapped
CW	Continuous Wave (telegraphy)
dc	direct current
DPDT	Double Pole, Double Throw (switch)
DPST	Double Pole, Single Throw (switch)
fil.	filament
FSK	frequency shift keyer
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 or relay)
T.	Turns (inductor)
term.	terminal
TV	Test Voltage
V	volts
VA	Volt-Amperes
Voice	speech modulated transmission (telephony)
w	watts
WV	Working Voltage

## SECTION II CIRCUIT DESCRIPTION

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

Letter Designation	Title
A	R-F Bay Meter Panel
B	Output Network
C	Power Amplifier
D	R-F Exciter
E	Autotune Control
G	PA Filament Supply
H	R-F Base Components
J	R-F Bay Terminals
K	Power Chassis
L	Modulator Bay Terminals
M	Modulator Bay Meter Panel
N	Modulator and Driver
P	Speech Amplifier
R	Filament Supply
S	Mod Bay Base Components

2.2. POWER CONTROL CIRCUITS. Refer to figure 2. This transmitter has been designed for normal control from a remote position using the Collins Type 177G-10 or 177G-9 Remote Control Units. A key switch located on the speech amplifier unit panel permits transfer of power and control of emission from the remote control unit to the panel controls.

2.2.1. Sequence of Power Application. The sequence of power application is the same whether LOCAL or REMOTE control is employed and is as follows:

(a) Remote Control. (Circuit breaker, S211, in ON position.)

1. FILAMENT relay operated by any dialing operation.
2. TIME DELAY relay operates.
3. PLATE CONTROL relay operates.
4. BIAS INTERLOCK relay operates.
5. LO-POWER relay or HI-POWER relay operates.

(b) Local Control.

1. Operate CIRCUIT BREAKER to ON position.
2. Press FILAMENT START button to operate FILAMENT relay.
3. TIME DELAY relay operates.
4. Press PLATE START button to operate PLATE CONTROL relay.
5. BIAS INTERLOCK relay operates.
6. LO-POWER relay or HI-POWER relay operates.

2.2.2. Remote Control. With the LOCAL-REMOTE switch, S303, in the normal or REMOTE position, the FILAMENT relay will be immediately energized by operation of the circuit breaker, S211, to the ON position. The FILAMENT relay will be energized by the circuit through contacts of the transmitter off relay, K106, and the contacts of the LOCAL-REMOTE switch. Operation of the FILAMENT relay energizes the TIME DELAY relay, K204, and all filament transformers. When sufficient time has elapsed, the TIME DELAY relay will operate and close the circuit necessary for the energizing of the PLATE CONTROL relay, K206. The PLATE CONTROL relay is of the 48-volt d-c type and is energized by the circuit through the contacts of the LOCAL-REMOTE switch, the contacts of the TIME DELAY relay, the contacts of the power amplifier overload relay, and the interlock switches of all three cabinets and the airflow switch. The airflow switch, S308, is located in the modulator cabinet and is operated by the air stream from the ventilating blower. If the blower fails to operate it is impossible to energize the high-voltage supply.

If the ADJUST-OPERATE switch, S210, is operated to the ADJUST position, the door interlock switches in the radio transmitter and modulator cabinets and the airflow interlock switch are shorted to permit the adjustment of low-power circuits within these bays with the cabinet doors open.

With the ADJUST-OPERATE switch in the OPERATE position and the TIME DELAY and BIAS INTERLOCK relays operative, either the LO-POWER relay, K202, or the HI-POWER relay, K203, will be energized. (The relay that is energized depends upon the position of the power level switch, S205, and the type of emission that has been selected.) If switch S205 is operated to the LO-POWER position, the LO-POWER relay will be energized by the circuit through the contacts of the FILAMENT relay, the contacts of



SECTION II  
CIRCUIT DESCRIPTION

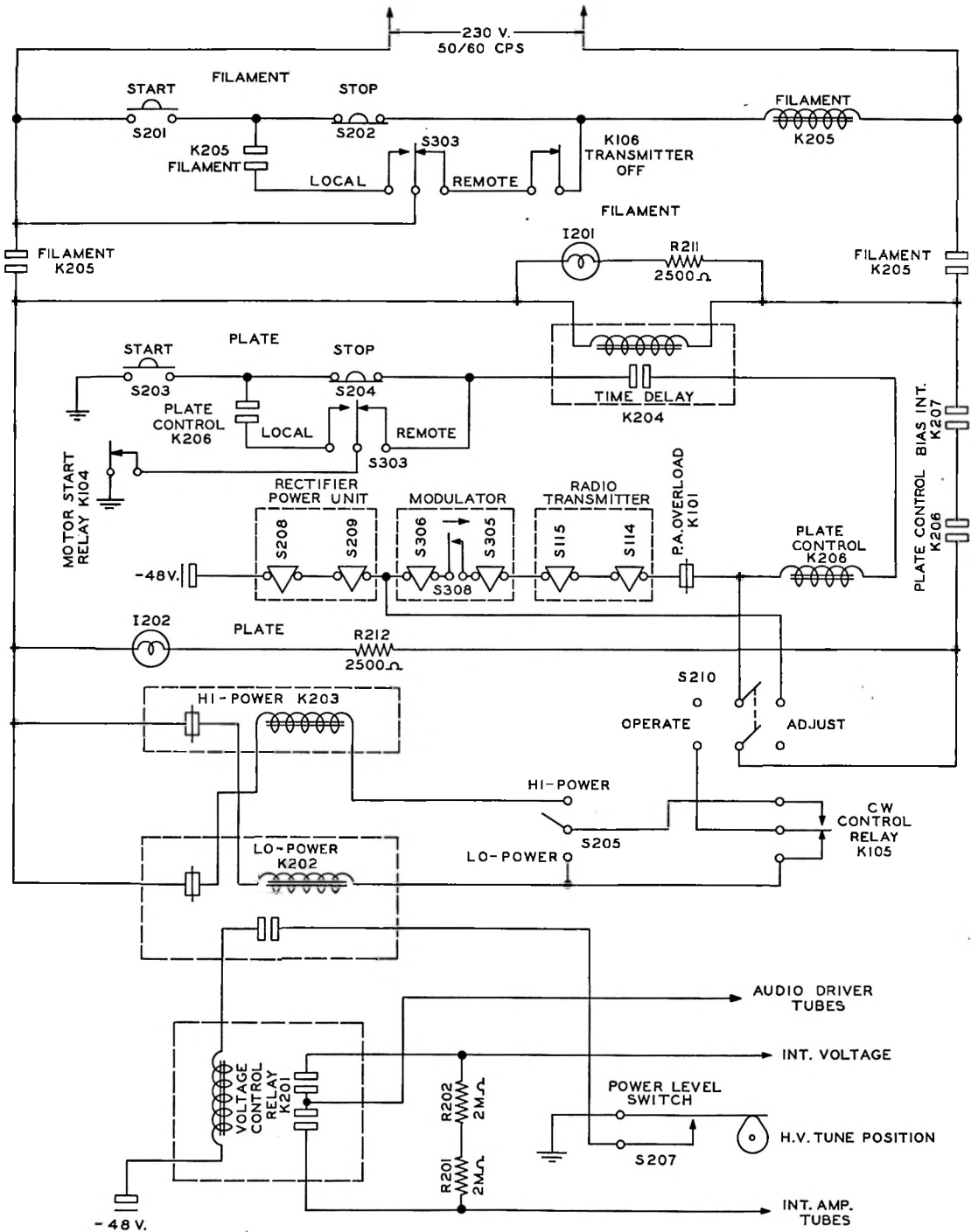


Figure 2. Power Control Circuits

the BIAS INTERLOCK relay, the contacts of the PLATE CONTROL relay, the contacts of the OPERATE-ADJUST switch, the contacts of the CW control relay, and the normally closed contacts of the HI-POWER relay.

High-power operation is only possible with CW emission. Even with the power level switch in the HIGH position, the circuit necessary for the energizing of the HI-POWER relay is not completed unless CW emission is selected by dialing A1. The change in power level is made by changing the turns ratio of the plate power transformer, T203.

Operation of the LO-POWER relay breaks the energizing circuit for the HI-POWER relay and the normally open contacts close the circuit to the voltage control relay, K201. If the TUNE-OPERATE switch, S207, is in the H.V. TUNE position (as shown in figure 2) the energizing circuit for the voltage control relay will be broken. If the switch is operated to the OPERATE position, the voltage control relay will operate following the operation of the LO-POWER relay. Operation of relay K201 applies plate voltage to the audio driver tubes and shorts out resistors R201 and R202 to increase voltage that is applied to the intermediate amplifier tube plates.

2.2.3. Local Control. If the LOCAL-REMOTE switch on the speech amplifier panel is operated to the LOCAL position, control of power and emission is transferred to controls located on the speech amplifier unit panel.

To begin the sequence of power application, press the FILAMENT START switch, S201. The momentary closing of the circuit through switch S201 actuates the FILAMENT relay, K205. The FILAMENT relay is held operated by the circuit through the normally closed contacts of the FILAMENT STOP switch, S202, the contacts of the FILAMENT relay, and the normally open (as shown on figure 2) contacts of the LOCAL-REMOTE switch.

Operation of the FILAMENT relay energizes the TIME DELAY relay, K204, and all filament transformers. Following the operation of the TIME DELAY relay, the low-voltage plate supplies will be energized if the PLATE START switch, S203, is pressed. The operating of switch S203 energizes the PLATE CONTROL relay, K206. The PLATE CONTROL relay is held operated by the circuit through contacts of the motor start relay, contacts of the LOCAL-REMOTE switch, contacts of the PLATE CONTROL relay, normally closed contacts of the PLATE STOP switch, contacts of the TIME DELAY relay, contacts of the power amplifier overload relay, the cabinet door interlock switches, and the airflow switch. Operation of the ADJUST-OPERATE switch to the ADJUST position shorts the interlock switches in the radio transmitter and modulator cabinets.

If the ADJUST-OPERATE switch is in the OPERATE position, the operation of the PLATE CONTROL relay completes the circuit necessary to energize the LO-POWER relay, K202. If CW emission is selected

by dialing A1 (operates the CW control relay, K105) and the power level switch is in the HI-POWER position, the HI-POWER relay, K203, will be operated. High power can be used only with CW emission, no matter what position the power level switch is in, because the CW control relay must be operated if the circuit necessary for the energizing of the HI-POWER relay is to be completed. If the TUNE-OPERATE switch, S207, is in the OPERATE position (H.V. TUNE position shown in figure 2), the operation of the LO-POWER relay will complete the circuit necessary for the energizing of the voltage control relay K201. The operation of the voltage control relay shorts out resistors R201 and R202 to increase the voltage that is applied to the intermediate amplifier tube plates and applies plate voltage to the audio driver tubes.

Pressing the FILAMENT STOP switch will release all relays and remove all power from the transmitter except that which is applied to the relay rectifier supply.

2.3. A-C PRIMARY CIRCUITS. Refer to figure 3. The transmitter has been designed to operate from a 230-volt 50/60-cps 3-phase power source. A circuit breaker, S211, is connected in the primary power line to permit the complete disconnecting of the primary power from the transmitter circuit. Two autotransformers, T209 and T210, are connected across the three-phase line so that voltage adjustments may be made to compensate for high- or low-power source voltage. The three-phase power is applied to the autotransformers by the operation of the circuit breaker, S211.

Primary power for application to the plate power transformer, T203, is controlled by the TUNE-OPERATE switch, S206, and the LO-POWER and HI-POWER relays K202, and K203. With the TUNE-OPERATE switch in the L.V. TUNE position, the circuit to the primary of the plate power transformer is broken. If the switch is operated to the H.V. TUNE position, tuning resistors R222, R223, and R224, are connected in series with the 230-volt leads to reduce voltage that is applied to the tubes during the period when the higher power r-f stages are being adjusted.

Whether the LO-POWER relay or the HI-POWER relay is operated depends upon the position of the power level switch, S205, and the type of emission that is selected. (The operation of the control circuit is described under 2.2. POWER CONTROL CIRCUITS.) The LO-POWER relay is always operated when transmitting with MCW or VOICE emission, no matter which position of switch S205 is selected. If the switch is operated to the HIGH position and CW emission is selected, the HI-POWER relay will be operated. Operation of the HI-POWER relay increases the turns ratio of the plate power transformer and thus increases voltage that is applied to the power amplifier tubes.

The relay rectifier and master oscillator compartment heater supply transformer are immediately energized following operation of the circuit breaker. The remaining transformer and motor primary circuits cannot be energized until the FILAMENT relay, K205, has been operated.

SECTION II  
CIRCUIT DESCRIPTION

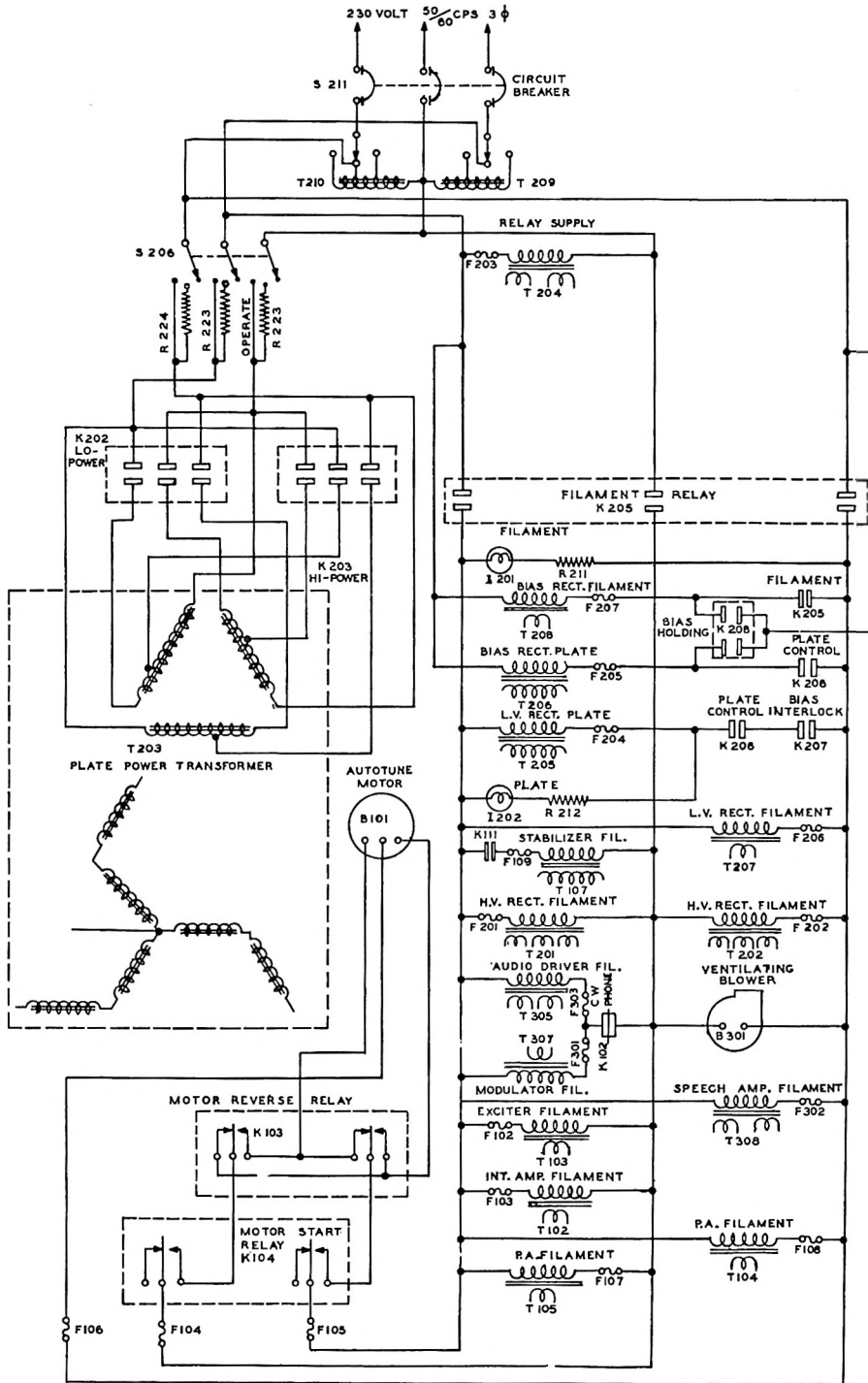


Figure 3. A-C Primary Circuits

As explained under 2.2. POWER CONTROL CIRCUITS, the equipment is designed for normal control from a remote position. With the LOCAL-REMOTE switch in the REMOTE position, the FILAMENT relay will immediately be energized by operation of the circuit breaker.

The operation of the FILAMENT relay lights the FILAMENT pilot lamp, I201, energizes the bias filament, low-voltage rectifier filament, the two high-voltage rectifier filaments, the audio driver filament, the modulator filament, the speech amplifier filament, the exciter filament, the intermediate amplifier filament and power amplifier filament transformers, and the ventilating blower.

Selection of CW emission by dialing A1 will operate the phone-CW relay to remove the filament voltage from the audio driver and modulator tubes.

When the TIME DELAY relay, K204, has operated, the PLATE CONTROL relay, K206, will be energized. Operation of the PLATE CONTROL relay energizes the PLATE pilot lamp, I202, and the bias rectifier plate transformer, T206. Application of plate voltage to the bias rectifiers energizes the BIAS INTERLOCK relay which when operated completes the circuit necessary to energize the low-voltage rectifier plate transformer, T205, and the circuit necessary to energize either the LO-POWER relay or the HI-POWER relay. (Refer to figure 2.) The operation of either of the plate power relays will energize the plate power transformer.

The bias holding relay coil is connected in series with the high-voltage supply bleeder. One pair of contacts functions to supply filament voltage, the other pair supplies plate voltage to the bias supply even though the FILAMENT relay K205 and/or PLATE CONTROL relay K206 has opened. Thus, to prevent damaging the higher power tubes by applying plate voltage without having bias on the grids, the bias supply is kept energized as long as the high-voltage supply is operating.

The Autotune motor control relays are controlled by the Autotune control circuits.

All transformer primaries, except the plate power transformer primary, are fused to prevent damaging the transformers by sudden overloads. The plate power transformer is protected by the transmitter circuit breaker.

With the LOCAL-REMOTE switch operated to the LOCAL position, the application of primary power is controlled by the operation of the FILAMENT and PLATE START and STOP switches, located on the power rectifier unit control panel. The functions of all other circuits are the same as described for REMOTE control.

2.4. FILAMENT CIRCUITS. Refer to the cabling and complete transmitter schematics in the appendix of this book. Filament power for all tubes in the transmitter is supplied by step-down transformers.

Filament voltage for the crystal oscillator (V103), and the r-f multiplier (V104) is supplied by transformer T102. T103 furnishes filament voltages for the keyer tube and the keying rectifier. Filament voltage for the intermediate amplifier tubes (V105 and V106) is supplied by transformer T101. All of the above tubes are located in the r-f exciter unit. Filament voltages for all tubes that are located in the r-f exciter unit may be measured by inserting the metering cord plug into plug receptacle J104. Filament voltage for the power amplifier tubes (V114 and V115) is supplied by transformers located in the power amplifier filament supply unit. A separate transformer is provided for each tube. The P.A. overload relay energizing coil is connected between the center taps of transformers T104 and T105 and ground so that if the cathode current of the power amplifier tubes exceeds a safe value the relay will operate and prevent the damaging of V114 and V115 by removing the plate voltage.

Four step-down transformers, located in the power supply unit, furnish voltages for application to the filaments of the bias, low-voltage, and high-voltage rectifiers. Transformers T201 and T202 furnish the voltage necessary for application to the filaments of the high-voltage rectifier tubes (V201, V202, V203, V204, V205, and V206). The output voltage of transformer T201 may be measured by inserting the metering cord plug into plug receptacle J201. The output voltage of transformer T202 may be measured by inserting the metering cord plug into plug receptacle J202.

Filament voltage for the low-voltage rectifier tubes (V207 and V208) is supplied by transformer T207. The output voltage of transformer T207 may be measured by inserting the metering cord plug into plug receptacle J203. Filament voltage for the bias rectifiers (V209 and V210) is furnished by transformers T208. The output voltage of transformer T208 may be metered by inserting the metering cord plug into plug receptacle J204.

Filament voltages for all tubes located in the speech amplifier unit are furnished by transformer T308 which is located in the filament supply unit. Two windings on the secondary of transformer T308 furnish 6.3 volts for the first audio amplifier (V301), the limiter (V302), the audio squelch (V303), the second audio amplifier (V304), the MCW oscillator (V305), and the limiter rectifier (V306) tubes, and 7.5 volts for application to the filaments of the audio power amplifier stage. The 6.3-volt winding may be metered by inserting the metering cord plug into plug receptacle J311 in the speech amplifier unit. No provision has been made for the metering of the 7.5-volt winding. The two filament voltage windings are on the same transformer; therefore, adjusting the output of the 6.3-volt winding to the correct value will regulate the output voltage of the other winding.

Filament voltage for the audio driver tubes (V309 and V310) is supplied by transformer T305 located in the modulator and driver unit. Because the cathode-follower type of audio driver is used, separate windings on the secondary of transformer T305 furnish the

## SECTION II CIRCUIT DESCRIPTION

voltages for V309 and V310. The secondary voltage of the transformer may be measured by inserting the metering cord plug into plug receptacle J305. Filament voltage for application to the filaments of the modulator tubes (V311 and V312) is furnished by transformer T307 in the filament supply unit. The output voltage of transformer T307 may be measured by inserting the metering cord plug into plug receptacle J304 in the modulator and driver unit. Filament voltage for application to the tubes in the remote control unit is supplied by transformers T403 and T404. No provision has been made for the metering of the filament windings of these transformers.

All filament transformers have tapped primary windings so that the secondary voltages may be adjusted to compensate for low or high supply voltage. The primary windings of all the transformers are fused.

**2.5. HIGH-VOLTAGE AND RELAY SUPPLY CIRCUITS.** Refer to the cabling and complete transmitter schematics in the appendix of this book. Three vacuum tube rectifier systems and a dry-disk 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 Collins Type 1100C-2 Rectifier Power Unit.

Relay K-209 is activated by the low-voltage supply and will turn off the high voltage when the low voltage fails.

Power that is necessary for application to plates of the vacuum tubes that are located in the Collins Type 177G-9 Remote Control Unit is supplied by a rectifier system which is contained within the control unit.

**2.5.1. Bias Supply.** The bias supply employs two type 866/866A half-wave mercury vapor rectifier tubes (V209 and V210). The two half-wave rectifiers are connected in a full-wave single-phase rectifier circuit. A two-section choke input filter is connected across the output of the rectifier system. The positive side of the rectifier system is at ground potential. A tapped bleeder furnishes the fixed bias voltages necessary for application to grids of the power amplifier tubes, grids of the modulator tubes, the grid of the r-f multiplier, grids of the intermediate amplifiers, grids of the limiter, squelch, keyer and audio power amplifier tubes. A variable resistor, R217, permits adjustment of the voltage that is applied to grids of the audio limiter tube and the push-to-talk relay K302. Another variable resistor, R203, makes possible the adjustment of bias voltage that is applied to grids of the modulator tubes. The bias rectifier filament voltage is applied by operation of the filament contractor and plate voltage by the operation of the PLATE CONTROL relay. The coil of the BIAS INTER-LOCK relay, K207, is connected in series with the bleeder and will operate following the operation of the TIME DELAY and PLATE CONTROL relays. Contacts of the no-bias relay, K207, are connected in the primary circuit of the low-voltage plate supply and prevent application of plate voltages to plates of the tubes until the bias voltage is applied to the grids.

As a further precautionary measure a bias-holding relay, K208, has been connected in the bias supply primary circuit to keep the bias supply on during the time that the high-voltage supply is energized. The coil of relay K208 is connected in series with the high-voltage supply bleeder. Thus, the bias voltage is kept on the tubes until the high voltage has decayed to a low value.

**2.5.2. Low-Voltage Supply.** The low-voltage power supply employs two type 866/866A half-wave mercury vapor rectifier tubes (V207 and V208) in a full-wave single-phase rectifier circuit. Operation of the FILAMENT relay applies filament voltage to V207 and V208. Plate voltage cannot be applied to the rectifiers until the FILAMENT relay and the no-bias relay have operated. When the filament contractor and no-bias relay have operated, plate voltage will be applied to V207 and V208 upon the operation of the PLATE CONTROL relay. The negative side of the supply is at ground potential.

The output of the rectifiers is filtered by a two-section choke input filter. Bleeder resistors R213 and R225 are connected across the output of the supply. Voltage developed across resistor R225 is applied to the microphone when using LOCAL transmitter control. The low-voltage supply furnishes plate and screen voltages for the r-f exciter and audio tubes and cathode voltage for the audio driver tubes.

**2.5.3. High-Voltage Power Supply.** The high-voltage power supply employs six type 4B32 half-wave mercury vapor rectifier tubes (V201, V202, V203, V204, V205, and V206) in a three-phase full-wave rectifier circuit. The plate power transformer, T203, has a delta-connected primary and a Y-connected secondary. The full output voltage of the supply is applied to plates of the r-f power amplifier tubes and the modulator tubes. By tapping the center point of the secondary, one half the full voltage of the supply is obtained for application to plates of the intermediate amplifier tubes. This type of rectifier gives output with a low percentage of ripple. Each voltage is filtered by a single-section choke input filter. The negative side of the rectifier system is at ground potential. The full output voltage of the supply is indicated by meter M302, located in the modulator bay. When the power level switch, S205, is operated to the LOW position, the full primary winding of the plate power transformer is used. If switch S205 is operated to the HIGH position, the turns ratio of the plate power transformer is increased by tapping the transformer primary so that the 230 volts is impressed on only a section of the primary winding.

During the time that tuning adjustments are being made with the TUNE-OPERATE switch in the H. V. TUNE position, resistors are connected in series with the leads to the transformer primary and in series with the intermediate voltage lead. Refer to figure 3.

**2.5.4. Relay Power Supply.** A selenium rectifier (CR201) supplies the 48 volts dc that is necessary for operation of all d-c relays in the transmitter. Transformer T204 supplies the a-c voltage for application to CR201. The transformer is energized whenever

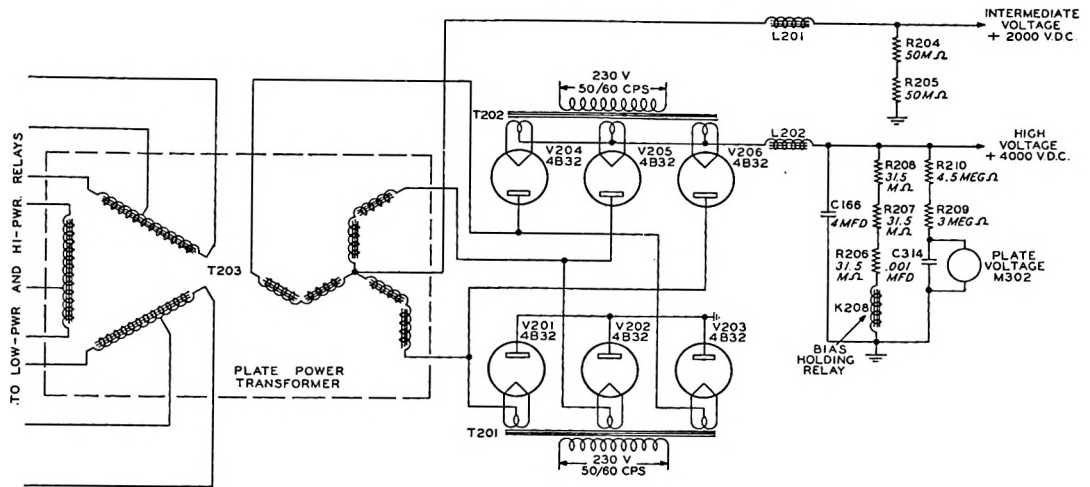


Figure 4. High-Voltage Rectifier Circuit

the power switch, S211, is operated to the ON position. Transformer T204 also provides voltage for application to the crystal compartment heater resistors, R102 and R103. The primary of the 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 are 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 use of the Autotune system.

The Autotune system 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 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 eight singleturn units to perform the tuning operations necessary for frequency selection, exciter tuning, power amplifier tuning, antenna loading, and balancing. Two singleturn units are located on the r-f exciter unit, one operating the exciter band switch and the other tuning the crystal oscillator and the frequency multiplier plate tank circuits. A channel indicator, located on the same Autotune assembly, is driven by the line shaft that drives the two singleturn units. The channel indicator dial 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.

Two singleturn units are mounted on the power amplifier unit and operate the power amplifier grid network switches, S112 and S116, and the grid tuning capacitor, C105.

Four heavy-duty singleturn units mounted on the output network operate the power amplifier plate tuning capacitor, C158, the power amplifier band switches, S111 and S119, the antenna loading capacitor, C159, the antenna selector switch, S118, and the balance capacitor, C178.

The singleturn units are driven by line shafts and the line shafts are in turn coupled to the drive shaft by gears that are mounted near the left-hand end of

## SECTION II CIRCUIT DESCRIPTION

the Autotune assemblies. When aligning the Autotune system it is of utmost importance that the coupling shaft between the Autotune assemblies in the r-f exciter, power amplifier, and output network units be in the proper position with respect to each other so that units in the three 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 exciter unit may be coupled without regard to shaft positions. Complete procedure for synchronizing the units is included in the Maintenance section of this instruction book.

2.6.1. Mechanical Details. The Autotune system in this equipment consists of three assemblies driven by a motor through a series of line and drive shafts. Refer to the drawings of the Collins Autotune system - mechanical details, figures 5 and 6. One drawing shows the details of the light-duty Autotune and the other drawing shows the details of the heavy-duty Autotune. The number that appears before the part or assembly description corresponds to the item number on the drawing.

### (a) Standard Autotune Units.

1. AUTOTUNE MOTOR. The Autotune motor is a three-phase motor 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 exciter unit, and the second section of shaft couples the line shafts of the assemblies on the power amplifier and network units.

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 single-turn 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 such a manner 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.

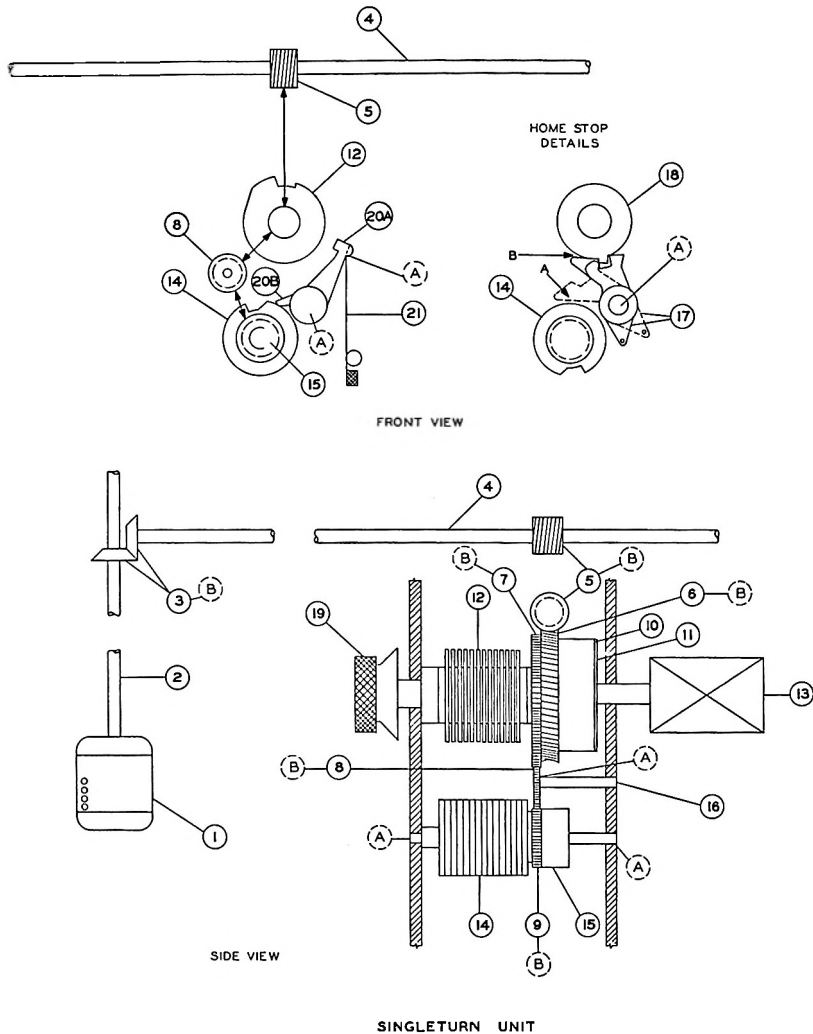
13. TUNED ELEMENT. The tuned element, capacitor, etc., is fastened rigidly to the stop-ring drum shaft.

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. SINGLETOOTH 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 drums 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 flathead 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 counter-clockwise 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 stop-ring 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.



SINGLETURN UNIT

LUBRICATING INFORMATION

NOTE: SEE MAINTENANCE SECTION OF INSTRUCTION BOOK FOR DIRECTIONS FOR LUBRICATION

SYMBOL	RECOMMENDED LUBRICANT
(A)	VACTRA OIL-EXTRA HEAVY X
(B)	TROJAN GREASE-GRADE MO

KEY TO SYMBOLS

- |                             |                               |
|-----------------------------|-------------------------------|
| 1. AUTOTUNE MOTOR           | 11. SLIP CLUTCH DRUM          |
| 2. DRIVE SHAFT              | 12. STOP RING DRUM            |
| 3. LINE SHAFT DRIVE GEAR    | 13. TUNED ELEMENT             |
| 4. LINE SHAFT               | 14. CAM DRUM                  |
| 5. SINGLETURN WORM          | 15. SINGLETOOTH RACHET        |
| 6. SLIP CLUTCH WORM GEAR    | 16. IDLER GEAR SHAFT          |
| 7. CAM DRUM DRIVE SPUR GEAR | 17. SINGLETURN HOME STOP PAWL |
| 8. IDLER GEAR               | 18. SINGLETURN HOME STOP RING |
| 9. CAM DRUM SPUR GEAR       | 19. SINGLETURN DIAL           |
| 10. SLIP CLUTCH BAND        | 20. PAWL (20A TOE) (20B-HEEL) |
|                             | 21. PAWL SPRING               |

Figure 5. Collins Autotune System - Mechanical Details



## SECTION II CIRCUIT DESCRIPTION

18. SINGLETURN HOME STOP RING. This ring, mounted with the other stop rings on the stop-ring drum (12), is fastened rigidly 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 heel (20B) against the cam drum (14) and when the pawl (20) drops into the cam slot, the pawl spring presses the pawl toe (20A) against the stop-ring drum (12).

### b. Heavy-Duty Autotune Units. (Figure 6)

1. 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 through the drive gears and the drive shaft.

2. SINGLETURN WORM. The singleturn worm drives the singleturn unit and is fastened to the line shaft (1) with a groov-pin.

3. SLIP CLUTCH WORM GEAR. This gear is fastened to the cam drum drive spur gear (4) and drives the stop-ring drum (9) through the slip clutch. The gear is driven by the singleturn worm (2).

4. CAM DRUM DRIVE SPUR GEAR. This gear is fastened directly to the slip clutch worm gear (3) and drives the cam drum spur gear (6) through the idler gear (5).

5. IDLER GEAR. This idler gear transmits power from the cam drum drive spur gear (4) to the cam drum spur gear (6).

6. CAM DRUM SPUR GEAR. The cam drum spur gear is driven by the line shaft through the singleturn worm (2), the cam drum drive spur gear (4), and the idler gear (5). The spur gear drives the cam drum (11) through the drive dog (12).

7. SLIP CLUTCH BAND. The band is driven directly from the slip clutch worm gear (2) and presses against the slip clutch drum (8).

8. SLIP CLUTCH DRUM. The clutch drum is fastened to the stop-ring drum shaft and is driven by the slip clutch band (7).

9. 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 such a manner 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.

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

11. CAM DRUM. The cam drum consists of 12 cams mounted on a shaft with adjacent cam slots staggered 30 degrees. These cams are fastened rigidly to the cam drum. The drive dog (12), mounted on the shaft behind the drum, drives the drum.

12. DRIVE DOG ASSEMBLY. The drive dog assembly is made up of six drive dogs held apart by spacers. The assembly is driven by the idler gear (5) and drives the cam drum (11).

13. IDLER GEAR SHAFT. The shaft is a bolt that is inserted through a hole in the rear plate.

14. 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 and is engaged by the singleturn home stop ring (15). The pawl, shown in solid lines on the drawing, limits the rotation of the stop-ring drum (9) in the counterclockwise direction.

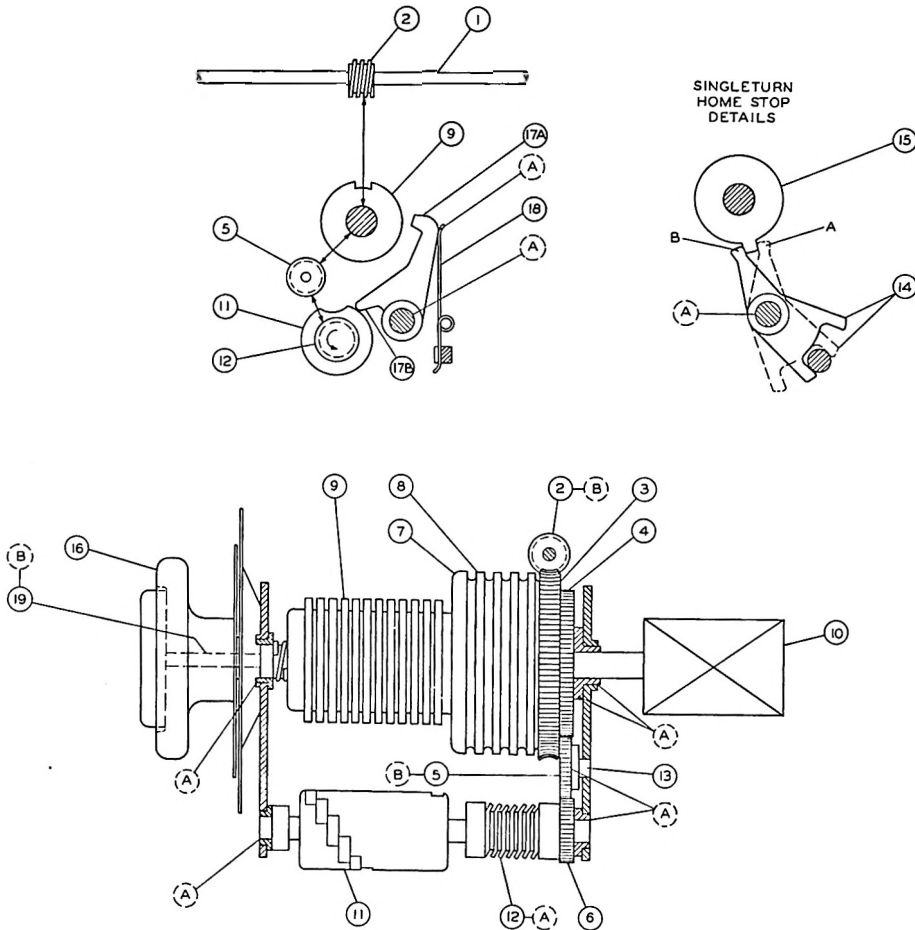
15. SINGLETURN HOME STOP RING. This ring, mounted with the other stop rings on the stop-ring drum (9), is fastened rigidly to the drum. The home stop pawl (14) engages the ring to limit the rotation of the stop-ring drum (9) to one revolution.

16. SINGLETURN DIAL. The singleturn dial is fastened to the stop-ring drum (9) and permits the calibration of the tuned element (10). 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.

17. STOP-RING PAWL. The pawl is held against the cam drum by the pawl spring (18). The pawl serves to position the tuned element (10) by stopping the stop-ring drum (9) at the predetermined position.

18. PAWL SPRING. The pawl spring presses the pawl (17) against the cam drum (12) and when the pawl drops into the cam slot, the pawl spring presses the pawl against the stop-ring drum (9).

2.6.2. Electrical Details. Refer to Collins Autotune system - Electrical Details. The symbol designations opposite the description of the component correspond to the symbol designations that are used on the transmitter schematic diagrams and in the parts list. The following section has been compiled to aid the operator



LUBRICATING INFORMATION

NOTE: SEE MAINTENANCE SECTION OF INSTRUCTION BOOK FOR DIRECTIONS FOR LUBRICATION

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

KEY TO SYMBOLS

- |                            |                              |
|----------------------------|------------------------------|
| 1 LINE SHAFT               | 11 CAM DRUM                  |
| 2 SINGLETURN WORM          | 12 DRIVE DRUM                |
| 3 SLIP CLUTCH WORM GEAR    | 13 IDLER GEAR SHAFT          |
| 4 CAM DRUM DRIVE SPUR GEAR | 14 SINGLETURN HOME STOP PAWL |
| 5 IDLER GEAR               | 15 SINGLETURN HOME STOP RING |
| 6 CAM DRUM SPUR GEAR       | 16 SINGLETURN KNOB           |
| 7 SLIP CLUTCH BAND         | 17 PAWL (17A TOE) (17B HEEL) |
| 8 SLIP CLUTCH DRUM         | 18 PAWL SPRING               |
| 9 STOP RING DRUM           | 19 T LOCKING BAR             |
| 10 TUNED ELEMENT           |                              |

Figure 6. Heavy-Duty Singleturn Unit - Mechanical Details

## SECTION II CIRCUIT DESCRIPTION

to understand better the operation and control of the Collins Autotune system. A brief description of each component associated with the system and a function of each is given below:

- B101 AUTOTUNE MOTOR.** This motor operates directly from the 230-volt 3-phase power source. The motor drives the Autotune mechanism through a series of drive and line shafts. The motor is controlled by the motor start relay, K104, and the motor reverse relay, K103.
- K101 OVERLOAD RELAY.** If the overload relay has been operated by an overload in the power amplifier circuit, any dialing operation will energize the reset coil and permit power to be applied to the high-voltage supply.
- K103 MOTOR REVERSE RELAY.** When the circuit seeking switch, S108, has been operated to the position corresponding to the frequency channel that has been dialed, the motor relay will be energized by the circuit through the contacts of the circuit seeking switch, the contacts of switch section S113D and the contacts of slow release relay #1, K107. The operation of relay K103 changes the connections of the Autotune motor and reverses the direction of rotation.
- K104 MOTOR START RELAY.** This relay causes the forward rotation of the Autotune motor by completing the connections to the 230-volt 3-phase power source. The motor start relay also serves as an interlock relay in the dialing circuit to prevent emission selection, channel selection and carrier application during the time that the motor is operating. Relay K104 may be energized only after the last dial impulse and the consequent release of the slow release relays, K107 and K108.
- K105 CW CONTROL RELAY.** The CW control relay is operated by dialing A1. If the automatic emission selector circuit is employed, relay K105 will be energized whenever the channel is selected that has been connected for automatic selection of CW emission. The CW control relay is held operated by the circuit through the contacts of K105 and the normally closed contacts of the pulsing relay. Any dialing operation will release the CW control relay.
- K106 TRANSMITTER OFF CONTROL RELAY.** The transmitter off control relay is operated by dialing A0. The operation of relay K106 breaks the circuit to the coil of the filament relay. The holding circuit for relay K106 is through the normally closed contacts of the pulsing relay. Any dialing operation will release relay K106 and permit the application of filament and plate power to the transmitter.
- K107 SLOW RELEASE RELAY #1.** Slow release relay #1 is operated by a dialing operation. The slow release characteristic of the relay holds the relay operated until after the last dial impulse.
- Slow release relay #1, when operated, energizes the reset coil of the overload relay to reset the overload relay and permits the application of plate voltage to the power amplifier tubes. When relay K107 releases, the motor reverse relay is operated by the circuit through the rotary switch and the circuit seeking switch.
- K108 SLOW RELEASE RELAY #2.** Relay K108 is operated by the circuit through the normally open contacts of slow release relay #1. The operation of relay K108 prevents the starting of the Autotune motor during dialing operations.
- K109 HOMING RELAY.** After a dialing operation and when slow release relay #1 has returned to the unoperated position, the homing relay will operate to complete the circuit necessary for the operation of the rotary switch. The rotary switch will continue to operate until position #25 is reached. The operation of the homing relay also prevents any further dialing operation by opening the energizing circuit of the pulsing relay.
- K110 PULSING RELAY.** The pulsing relay is of the quick-acting type and follows the operation of the telephone dial. The operation of relay K110 releases the transmitter off relay and either the CW relay or the MCW relay if either has been operated. The rotary switch is stepped one position for each operation of the pulsing relay.
- K112 REVERSE INTERLOCK RELAY.** The contacts of K112 when open prevent the holding ground on the CW relay or the MCW relay from keeping the motor reverse relay K103 closed when the automatic emission selector plug is used. The coil of K112 is paralleled with the coil of the motor start relay K104, therefore the energizing sequence for K104 applies also to K112
- K301 MCW CONTROL RELAY.** Relay K301 is operated by dialing A2. If connections are made for automatic emission selection the relay will be operated whenever a channel is selected upon which MCW emission is to be used. Relay K301 is held operated by the circuit through the normally closed contacts of the pulsing relay. Any dialing operation will release the MCW control relay.
- S108 CIRCUIT SEEKING SWITCH.** The circuit seeking switch is mounted on the channel indicator. When the rotor of switch S108 reaches the contact corresponding to the channel that has been dialed the circuit is completed for the operation of the motor reverse relay.
- S110 LIMIT SWITCH.** The limit switch is mounted on the exciter Autotune casting. The contacts are immediately opened when the motor begins to rotate. When the motor has reversed and returned to the original position the switch contacts are closed and the circuit necessary for the operation of the homing relay is completed.

- S113 ROTARY SWITCH.** This switch is of the 25-position telephone type and consists of 4 banks and a set of normally closed auxiliary contacts. The rotary switch is energized by the operation of the pulsing relay. 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 the pulsing relay.
- S302 TELEPHONE DIAL.** This telephone dial is located in the control unit in the modulator bay. The dial will transmit a maximum of 11 impulses. The circuit through the dial is normally open.
- S303 LOCAL-REMOTE SWITCH.** Switch S303 is normal in the REMOTE position. Operating the switch to the LOCAL position transfers transmitter control from the remote control unit to the panel controls.
- S502 REMOTE TELEPHONE DIAL.** This dial is located in the remote control unit. The dial is of the same type as telephone dial S302, the dial located in the modulator bay.

to accomplish the desired results. A step-by-step description of the operation of the control circuits is outlined below:

(a) When the operator has selected LOCAL or REMOTE control, he dials the desired frequency channel.

(b) As the dial returns toward the rest position, the pulsing relay will be operated a number of times corresponding to the number of the channel dialed. (For example: If frequency channel 6 has been dialed the pulsing relay will be operated six times.) The pulsing relay is energized by the circuit through the normally closed contacts of the homing relay, K109, the contacts of the LOCAL-REMOTE switch and the contacts of the telephone dial.

(c) The operation of the pulsing relay releases the transmitter off control relay, K106, releases the CW control relay, K105, or the MCW relay, K301, if either has been operated, operates slow release relay #1 and steps the rotary switch, S113, one position for each pulse.

(d) Slow release relay #1 and the rotary switch are energized by the circuit through the normally open contacts of the pulsing relay and the normally closed contacts of the motor start relay, K104.

**2.6.3. Sequence of Operation.** Refer to figure 7 and figure 8. The Autotune system is controlled by a number of interlocking relays. The sequence of operation of these relays must be preserved in order

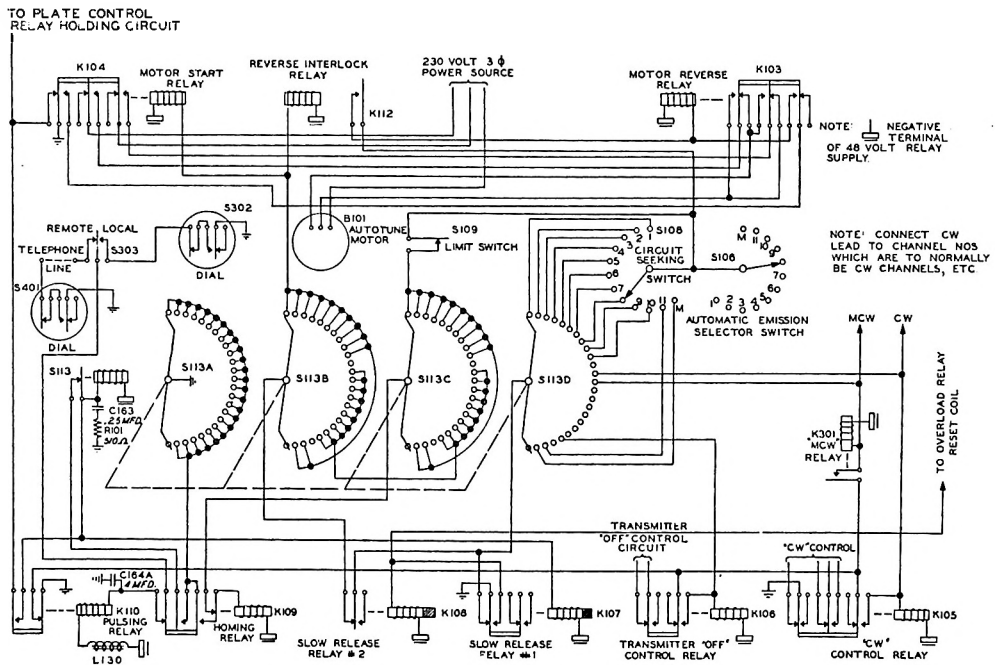


Figure 7. Collins Autotune System - Electrical Details

SECTION II  
CIRCUIT DESCRIPTION

(e) The operation of slow release relay #1 energizes slow release relay #2 and resets the power amplifier overload relay, K101.

(f) Because of the slow release characteristic of relay K107, slow release relays #1 and #2 are held operated until after the last dial pulse.

(g) When the telephone dial has returned to rest, slow release relay #1 will release and break the energizing circuit to slow release relay #2.

(h) The release of slow release relay #2 energizes the motor start relay and the reverse interlock relay by the circuit through switch section S113B, the normally closed contacts of slow release relay #2 and the normally closed contacts of slow release relay #1.

(i) The operation of the motor start relay energizes the Autotune motor, B101, by the circuit through the contacts of the motor start and motor reverse relays.

(j) The operation of the motor start relay opens the plate power holding circuit and prevents turning on the r-f carrier during the time that the motor is operating.

(k) The limit switch, S110, the circuit seeking switch, S108, and the automatic emission selector switch, S107, are operated by the motor.

(l) When the motor begins to operate, the limit switch immediately opens and the motor continues to rotate until the rotor arm of the circuit seeking switch reaches the position corresponding to the channel that has been dialed.

(m) When the circuit seeking switch reaches the position corresponding to the channel dialed, the motor reverse relay is operated through the closed contacts of the reverse interlock relay.

(n) The operation of the motor reverse relay changes the power input connections to the motor so that the direction of rotation is reversed.

(o) The motor reverses until the limit switch is closed.

(p) The closing of the limit switch energizes the homing relay, K109, through the contacts of switch section S113C, the contacts of the limit switch, the contacts of the circuit seeking switch, the contacts of switch section S113D and the normally closed contacts of slow release relay #1.

(q) The operation of the homing relay energizes slow release relay #1 by the circuit through the auxiliary contacts of the rotary switch, the normally open contacts of the homing relay and the contacts of rotary switch section S113A.

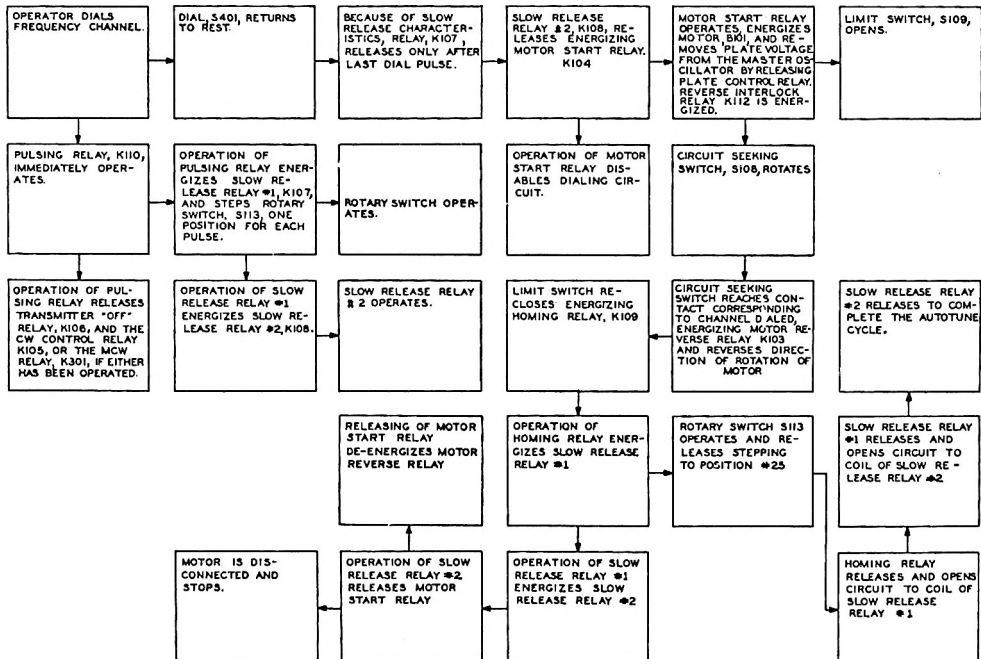


Figure 8. Autotune Operation Sequence

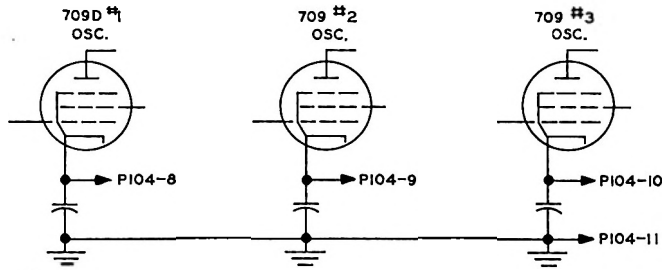


Figure 9. Connections for Automatic Control of Collins 709D FSK Units

(r) The operation of slow release relay #1 energizes slow release relay #2.

(s) The operation of slow release relay #2 releases the motor start relay to stop the Autotune motor.

(t) The rotary switch also is energized by the operation of the homing relay and operates and releases, stepping to position #25.

(u) The operation of the rotary switch to position #25 releases the homing relay and slow release #1.

(v) The release of slow release relay #1 releases slow release relay #2 completing the Autotune cycle.

2.6.4. FSK Control or Automatic Emission Selection. This transmitter has been provided with a spare switch (S107) ganged to the Autotune and wired to receptacle J105. If external FSK exciters are to be used on channels 8, 9, and 10, these exciters may be connected to plug P104 and S107 used to turn on the proper FSK unit according to the channel selected. Figure 9 shows connections used with the Collins 709S-1 FS Keyer.

The transmitter normally sets up for voice (A3) emission when a new channel is selected and CW (A1) or MCW (A2) may be had by dialing A1 or A2 on the telephone dial.

If CW or FSK emission is to be used predominately, the transmitter may be made to set up normally for CW emission by connecting terminal #6 to terminal #12 on P105. Then, if A2 or A3 is desired, it must be dialed on the telephone dial. However, if it is desired to have the type of emission selected automatically when a channel is selected, S107 may be used for this purpose instead of to control external units.

Terminals #14 and #15 in plug receptacle J105 (see figure 10) may be connected to terminals #6 and #19 on P105 which will then connect 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 may be connected to terminal #13 on P105 which will connect it 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.

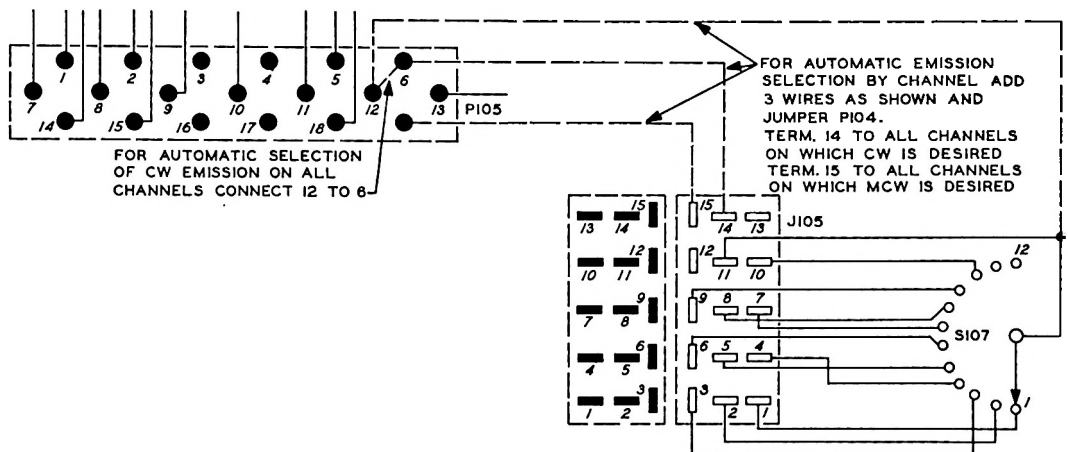


Figure 10. Connection for Automatic Emission Selection

## SECTION II CIRCUIT DESCRIPTION

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 selected automatically when any channel is dialed for which connections have been made to terminal #14 in plug P104.

**2.7. RADIO FREQUENCY CIRCUITS.** Refer to transmitter cabling and complete schematics in the appendix section of this book. The radio frequency system of this transmitter covers the frequency range 3000 kc to 26,000 kc. The frequency is controlled by crystals, any one of the ten of which may be selected automatically by the Autotune system. The crystal oscillator is followed by an r-f multiplier, an intermediate amplifier and a power amplifier. The combination power amplifier plate tuning and antenna coupling network is designed to feed either a balanced or an unbalanced antenna system.

**2.7.1. Crystal Oscillator.** The crystal oscillator employs a type 837 R-F Power Amplifier pentode. The grid and screen together with the cathode constitute the primary oscillator circuit which oscillates whenever voltage is applied to the screen. The oscillator circuit is electronically coupled to the plate circuit. The coupling is controlled by the suppressor grid. When a negative potential from the bias supply or from the remote unit is applied to the grid of the keyer tube, current flow through the tube is effectively blocked. Thus, the negative potential on the suppressor grid of the oscillator is reduced to virtually zero. With the keyer tube blocked the signal from the oscillator section of V103 appears in the output section of the tube. As the frequency is increased, the oscillator drive to the doubler grid decreases, causing the current through R126 to decrease. Thus, the small bias on the oscillator output gives automatic control of the excitation.

A small trimmer capacitor, C114, is shunted across the crystal circuit to act as a trimmer for final frequency setting. Increasing the capacity of the condenser will lower the crystal frequency. Adjustment of this trimmer effects a shift of all of the crystal output frequencies and this fact must be kept in mind when adjusting the capacitor. Frequency adjustment can not be made for one crystal only.

To further improve the frequency stability, the entire oscillator circuit is completely shielded. Ten crystal positions are provided in the shielded oscillator compartment and a constant temperature is maintained by two series thermostats, S102 and S103, and series heater elements R102 and R103.

The transmitter is capable of operating on either two or four times crystal frequency in all bands. However, since the crystals are usually in the range of 1000 to 6500 kc, the operating frequency is normally four times crystal frequency.

**2.7.2. Frequency Multiplier.** The frequency multiplier employs a Type 807 beam power amplifier tube. The plate circuit of the tube is tuned by a variable capacitor that is ganged with the oscillator plate tuning capacitor. Five coils are used in the oscillator doubler circuit; only two are used in any one frequency band. The tube has both cathode and fixed bias, the latter being supplied by the keyer tube. When the keyer tube is conducting the positive end of the keyer rectifier tube, V101, is in effect grounded and a high negative bias is applied to the grid of the doubler. This is the same keying potential that is supplied to the suppressor of the oscillator. Therefore both tubes are effectively blocked.

**2.7.3. Intermediate Amplifier.** The intermediate amplifier circuit employs two Type 4D21/4-125A power tetrode tubes in a parallel connected circuit. Fixed bias for the tubes is furnished by the bias supply. The grid current may be metered by operating switch S101 to the position designated as "4-125A." Operating switch S101 to the "4-125A" position connects the exciter grid current meter, M101, in series with the lead from the bias supply to the grids of V105 and V106 and connects the meter shunting resistor, R111, across the meter. The neutralizing circuit consists of capacitors C143 and C134. Capacitor C135 has been connected in series with C143 and resistor R112 has been connected between the junction of capacitors C143 and C135 and ground to protect the operating personnel from the shock due to the low voltage potential which would otherwise be applied to capacitor C143.

Refer to figure 11 int. amplifier neutralization circuit. The actual circuit is shown on the left and the effective components in the neutralization circuit are shown on the right. Capacitor C135 is very large in comparison to C143 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 C143. Resistor R112 is a very high impedance and therefore has negligible effect upon the circuit. The drawing on the right shows the simplified circuit with only the effective capacities. Theoretical balance of the circuit is obtained when  $C134 \times C_{gf}$  (capacity grid to filament) =  $C143 \times C_{gp}$  (capacity grid to plate).

**2.7.4. Power Amplifier.** The power amplifier circuit employs two Type 750TL transmitting triodes (V114 and V115). The tubes are connected in parallel with the grids fed by the parallel connected intermediate amplifier stage. The full output voltage of the bias supply is applied to the grids of the power amplifier tubes and is fed through choke L101 and grid inductors

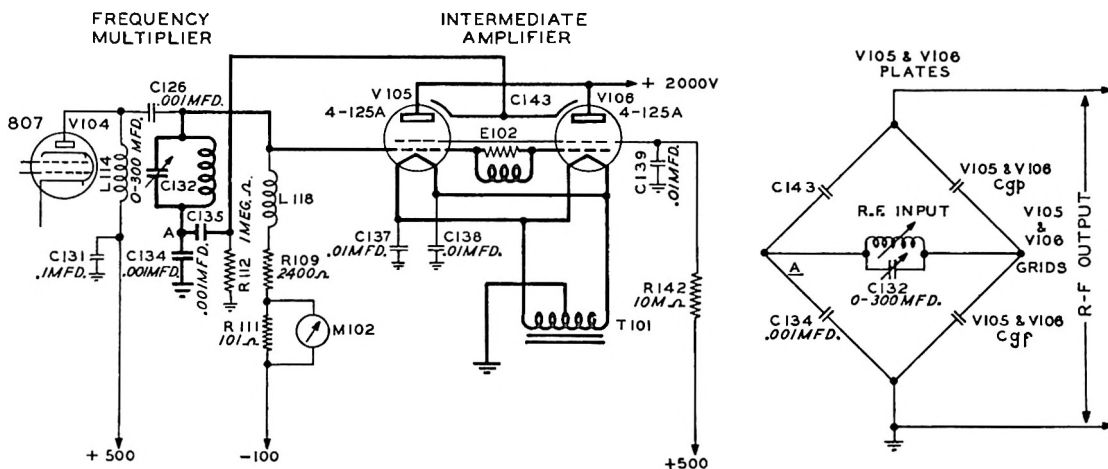


Figure 11. Intermediate Amplifier Neutralization Circuit

L128B and L129. The full output voltage of the high voltage rectifier supply is applied to the plates of V114 and V115 through choke L122. The grid tank circuit consisting of L127, L128A, L128B, L129 and capacitor C105 permits the tuning of the grid circuit for maximum excitation. The amount of inductance in the grid circuit may be varied by the operation of the INT. AMP. BAND SWITCH and the circuit may be tuned by the operation of the INT. AMP. PLATE tuning control. The INT. AMP. PLATE tuning control operates variable capacitor C105. Neutralizing capacitor C157 is of the semivariable type. Capacitor C157 consists of two parallel disks. The gap between the disks may be varied by moving one disk with respect to the other.

2.7.5. Power Amplifier Stabilizer. See figure 12. Some of the Type 750TL tubes require stabilization the instant the drive is removed. The instant the key is opened or microphone switch is released the grid voltage on the tubes is such that unless the grid circuit is loaded the plate current of the power amplifier tubes will rise to a value that will damage the tubes, if not stabilized.

A vacuum tube load is connected in the grid circuit of the power amplifier to stabilize the stage. A high- $\mu$  transmitting triode (Type 811) is used as an electronic load across the grid circuit. The plate of V116 is connected to the grids of the power amplifier tubes (V114 and V115) and the grid of the Type 811 tube is connected between the power amplifier grid resistors and the grid network. The center tap of the stabilizer filament transformer is connected to the bias supply. Thus, with no drive to the grids of the power amplifier tubes, the grids of the power amplifier tubes and the grid and plate of the stabilizer tube are all at the same potential (-500 volts).

During the time that the key is closed an additional 600 volts of bias is developed across the grid resistors R214 and R215. With -1100 volts applied to the grid of V116, the plate resistance of the stabilizer tube becomes so high that the operation of the power amplifier is not effected by electronic load across the grid circuit. The instant that the key is opened the voltage on the grid of V116 drops to -500 volts (the same as on the cathode) and a load is applied to the grids of the power amplifier tubes.

The stabilizer circuit is in operation only when the TUNE-OPERATE is in the OPERATE position. For proper operation of the stabilizer circuit, the grid drive to the power amplifier tubes must be high enough to develop enough voltage across resistors R214 and R215 to stop current flow through V116. During tuning operations, the power amplifier grid current will vary considerably and at times will be too low to cut off current flow through V116. To disable the stabilizer circuit, the filament voltage is removed from V116 when the TUNE-OPERATE switch is operated to the H. V. TUNE position.

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. An additional network provides a balanced output where necessary. The output of the power amplifier stage is coupled to the pi network by capacitor C155. The POWER AMP. BAND SWITCH operates switch S111 and S119. Operation of S111 shorts out sections of inductor L125 as the control is operated from position 10 to position 2. A high frequency inductor L123 is connected in series with inductor L125 to permit operation in the high frequency end of the frequency range 2000 kc to 18,100 kc. When the control is operated to position 1 only a part of inductor L123 is in the circuit; inductor L125 is shorted out. Switch S119, when balanced output is selected, varies the



SECTION II  
CIRCUIT DESCRIPTION

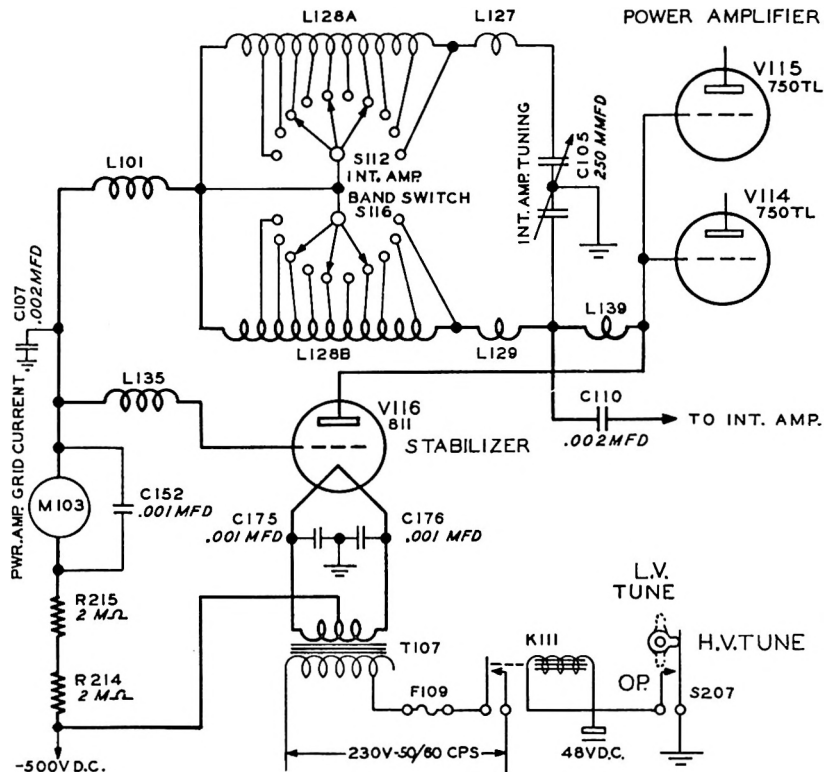


Figure 12. PA Stabilizer Circuit

inductance of the balancing circuit. The network input capacitor, C158, is operated by the POWER AMP. TUNING control. Capacitor C159, connected across the output side of the pi network, is operated by the ANTENNA LOADING control. The ANTENNA SELECTOR AND BALANCING control operates the antenna selector switch, S118, and the balancing capacitor, C178. Operation of this control to the position where the engraved line, lettered "Unbalanced Output," is opposite the fixed indicator line results in an unbalanced output. Turning the control off at this point places the balancing circuit across the output of the pi network. This permits balanced output operation. The control could be turned until the engraved dial divisions are opposite the fixed indicator line. The balancing capacitor C178 is then operative and must be adjusted correctly for proper circuit balance. The output of the network is connected to the antenna terminals on the roof of the r-f bay. External r-f ammeters, M105, M106, and M107, are mounted on the antenna terminals and in series with the leads to the antenna feeders.

**2.8. KEYING AND CARRIER CONTROL.** Refer to the diagram of the simplified carrier control circuits, figure 13. When the grid of the keyer tube is at ground potential, the tube is in a conducting condition and the

tube drop between cathode and plate becomes very small. This, in effect, grounds the positive end of the keyer rectifier tube, V101, placing a high negative potential on the suppressor grid of the oscillator tube, V103, and the control grid of the buffer tube, V104. When the test key S304, the remote key, or the push-to-talk switch is operated, a negative potential of approximately 50 volts from the bias supply or from the remote unit is applied to the grid of the keyer tube. This effectively blocks the plate current of the tube and reduces the negative potential on the suppressor grid of the oscillator tube, V103, and the control grid of the buffer tube, V104. Thus a signal is permitted to appear in the output section of the buffer stage.

The negative potential which is placed on the grid of the keyer tube by the operation of the test key, remote control unit, or the closing of the push-to-talk switch, is also applied to the control grids of the audio squelch tube, V303. This negative voltage blocks the electron flow of the tube and causes the impedance of V303 to approach infinity and greatly unbalances the bridge limiting circuit. The unbalancing of the bridge circuits permits the unrestricted flow of audio through the amplifier. The squelch circuit prevents the modulator tubes from operating until the r-f carrier has

been switched on through the keyer circuit. Thus, if an audio signal were impressed upon the audio system before the carrier was switched on, the modulator is prevented from being operated without the proper class "C" r-f load.

The filter circuit, consisting of R166 and C165, is provided for use when keying with MCW (A2) emission. This circuit controls the rate of decay of the radio frequency voltage produced by the r-f oscillator in such a manner that the transient voltages normally produced in the output circuit (due to the high rate of decay of current in the modulation transformer) are reduced to small values.

2.8.1. Frequency Shift Keying. Provision is made for FSK operation by connecting FSK units to three coaxial input plugs, J123, J124, and J125, located on the bottom side of the r-f exciter unit.

2.9. AUDIO FREQUENCY CIRCUITS. Refer to transmitter cabling and complete schematics in the appendix of this book. The audio frequency system incorporated in the transmitter unit utilizes a Type 6SL7GT twin triode (V301) as the first audio amplifier, a Type 6C8G twin triode (V302) as a volume limiter, a Type 6C8G twin triode (V303) as an audio squelch tube, a Type 6SJ7 triple grid tube (V304) as 2nd audio amplifier, a Type 6X5GT full-wave rectifier (V306) as a limiter control tube, a pair of Type 801 triodes (V307 and

V308) as an audio power amplifier stage, a pair of Type 845 triodes (V309 and V310) as audio drivers, and a pair of Type 450 TL triodes (V311 and V312) as modulators. An additional stage of audio amplification is incorporated in the remote control unit. A Type 6V6GT tube (V401) is employed as audio amplifier.

2.9.1. Remote Amplifier. (Although the circuit description given below is for the Type 177G-9 remote unit it applies generally to the Type 177G-10 remote unit with appropriate changes in symbol numbers since the basic circuit and function of the two types are similar.) A single stage audio amplifier is incorporated in the remote control unit to overcome the loss in the lines. The input transformer T401 has two primary windings, a 75-ohm winding and a 500-ohm winding. The 500-ohm transformer winding is brought out to terminal strip E402 on the rear of the unit. The MICROPHONE jack, J402, is connected across the 75-ohm winding so that a low impedance microphone may be used. Transformer T401 couples the output of the audio line or the microphone to the grid of the amplifier tube, V401, through the GAIN control, R401. Screen and plate voltages for V401 and V402 are furnished by the power rectifier, V403. The audio output of V401 is coupled to the 500-ohm transmission line by transformer T402. Meter M402 is connected directly across the secondary of transformer T402 and indicates the level of the audio output of the remote amplifier unit.

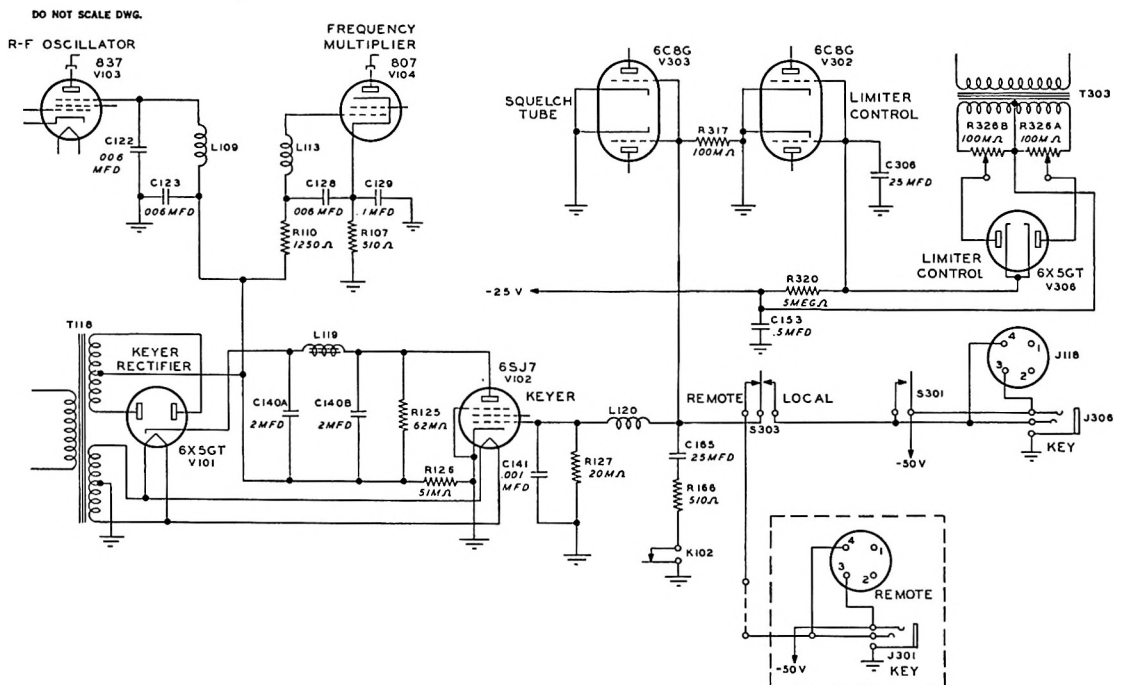


Figure 13. Simplified Carrier Control Circuits

SECTION II  
CIRCUIT DESCRIPTION

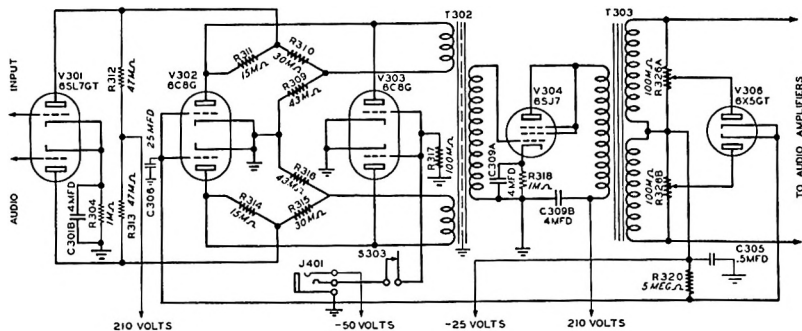


Figure 14. Limiter and Audio Amplifier Circuits

A Type 6SJ7 tube, V402, is utilized to operate the receiver disabling circuit. With current flowing through tube V402 relay K402 is held operated. When the carrier control circuit is closed a bias voltage is applied to the grid of V402 and the flow of plate current is stopped, releasing relay K402.

**2.9.2. First Audio Amplifier.** The first stage of the audio system that is incorporated in the modulator bay employs a Type 6SL7GT twin triode tube (V301) connected in a balanced circuit. Input transformer T301 couples the audio output of the transmission line or the local microphone to the grids of V301. With the LOCAL-REMOTE switch, S303, in the normal or REMOTE position, the output of the 500-ohm remote line is coupled directly to the primary of transformer T301. When switch S303 is operated to the LOCAL position, connections are made from the MICROPHONE jack, J307, to the primary of the audio input transformer so that a local microphone may be used when it is desired to control the transmitter from a position near the installation.

The dual-section potentiometer, R324, controls the input to the grids of V301. Plate voltage is furnished by the low-voltage power supply through resistors R312 and R313. Cathode bias is developed across resistor R304.

**2.9.3. Volume Limiter and 2nd Audio Amplifier.** Refer to figure 14. 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 (V302 and V303) and a Type 6X5GT full-wave rectifier (V305). The two Type 6C8G tubes are connected in a double resistance bridge circuit with the

triode sections of V302 and V303 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 R309, R310, R311 and a variable leg consisting of two triodes, one section of V302 and one section of V303, connected in parallel. The second bridge circuit consists of resistors R314, R315, and R316, and the remaining triode sections of the two 6C8G tubes. When the value of  $R309 \times R311 = R310 \times$  (the plate resistance of the vacuum tube leg of the bridge) and the value of  $R314 \times R316 = R315 \times$  (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, T302. 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.

Tube V303 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, V303 is in a conducting condition resulting in a comparatively low value of plate resistance. With zero audio input, the bias on the grids of V302 is approximately -25 volts, resulting in a high value of plate resistance. With one triode section of V302 connected in parallel with a triode section of V303, 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 V303 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 the transformer T302 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 V303 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 T302. The output of the preamplifier, V301, drives the grid of the triode-connected Type 6SJ7 audio amplifier (V304). The output of V304 is coupled to the grids of the push-pull audio amplifier stage by transformer T303. The limiter control tube, V306, is also connected across the secondary of transformer T303. The voltage that is applied to the plates of V306 may be varied by the adjustment of potentiometer, R326. As the level of the audio signal is increased, the voltage across the secondary of transformer T303 increases, resulting in an increase in the amount of current that flows in the rectifier circuit. The current flowing through the rectifier, V306, develops a voltage across resistor R320 which varies directly with the flow of current through the rectifier and is opposite in polarity to the fixed bias that appears across 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 V302 and the result is a greater flow of current through the limiter tube. Increasing the flow of plate current through V302 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 T302. The flow of current through V306 and the resulting amount of compression may be regulated by adjusting R326. Plate voltage for the limiter and audio amplifier tubes is furnished by the low-voltage power supply.

2.9.4. Audio Power Amplifier. The audio power amplifier stage employs two Type 801 transmitting triodes in a push-pull circuit. The output of the

second audio amplifier stage is coupled to the grids of V307 and V308 by transformer T303. The output of the audio power amplifiers is coupled to the grids of the audio driver tubes by transformer T304. The full output voltage of the low-voltage power supply is applied to the plates of V307 and V308. This audio amplifier stage operates Class A. Fixed bias for the grids is furnished by the bias supply. The bias voltage is applied to the junction of grid resistors R321 and R322.

2.9.5. Audio Driver. Refer to figure 15. A cathode-coupled push-pull audio driver is employed to drive the Class B modulator stage. The audio driver employs two Type 845 transmitter triodes (V309 and V310). By taking the output from the cathode circuit rather than the plate circuit a much lower impedance output is obtained, making it much easier to couple the output of the audio amplifier to the grids of the modulator tubes.

The output of the audio driver stage is coupled to the grids of the modulator tubes (V311 and V312) by transformers T305 and T306. Because the Type 845 tube is of the direct heater type, having no cathode, it is necessary to couple from the center taps of the filament transformer windings.

The actual potential difference between the cathodes and plates of V309 and V310 is considerably less than the voltage that is applied to the plates. The grids of the tubes are at a potential of approximately 500 volts above ground and cathode bias of between 200 volts and 300 volts is developed across resistor R331 by the static plate current so that the actual effective plate voltage under static conditions is between 1100 volts and 1300 volts. The voltage that is applied to the grids of V309 and V310 is furnished by the low-voltage power supply and the plate voltage is obtained by connecting to the center tap of the plate power transformer, T203.

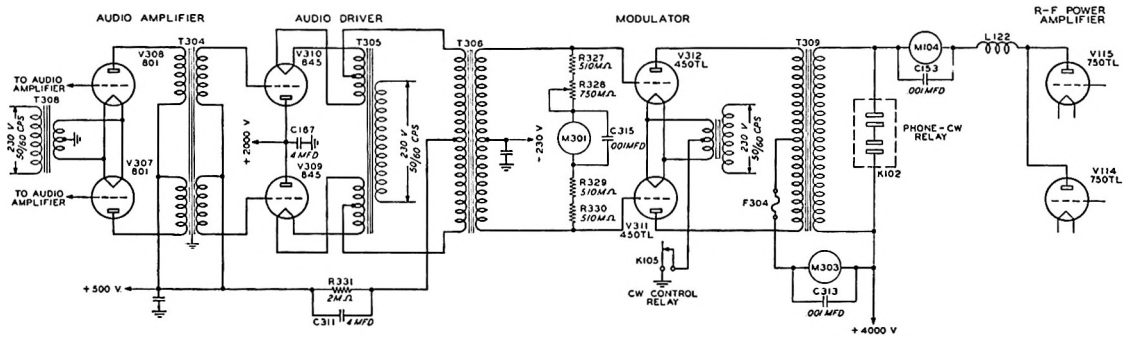


Figure 15. Audio Driver and Modulator Circuits

SECTION II  
CIRCUIT DESCRIPTION

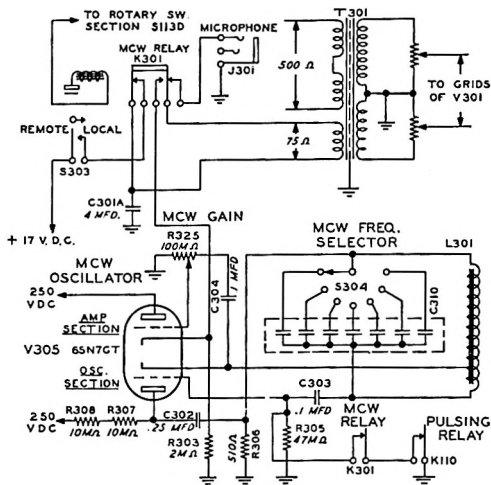


Figure 16. MCW Oscillator - Amplifier

2.9.6. Modulator. Two Type 450TL transmitting triodes operating Class B are employed to modulate the output of the r-f power amplifier. The output of the audio driver stage is coupled to the grids of the modulator tubes, V311 and V312, by transformer T306. The bias voltage that is applied to the grids of V311 and V312 is supplied by the bias supply and is coupled through a rheostat. Thus the bias that is applied to the grids of the modulator tubes may be adjusted to obtain the best possible performance of the modulator stage. An audio level meter is connected across the input to V311 and V312 to aid in properly adjusting the audio stages. A variable resistor, R328, permits the adjusting of the voltage that is applied to meter M301. The output of the modulator tubes is coupled to the Class C load by modulation transformer T309. The full output voltage of the high-voltage rectifier is applied to the plates of V311 and V312. During periods of CW transmission the filament voltage is removed from the filaments of the modulator and audio driver tubes by the operation of the Phone-CW relay, K102, and the ground is removed from the center tap of the modulator filament transformer, T307, by the operation of CW control relay, K105.

## SECTION III

# INSTRUCTIONS FOR INSTALLATION

3.1. GENERAL. Before placing the cabinets be sure that arrangements are complete (especially the power input conduit) for the external connections to the equipment. Refer to figure 17 for the overall dimensions of the cabinets and the positions of the wiring ducts.

3.2. EXTERNAL CONNECTIONS. The external connections consist of 230-volt 50/60-cps 3-phase power input connections, the remote control lines FSK units, if used, and the radiation system.

3.2.1. Power Line. The transmitter requires a 230-volt 50/60-cps 3-phase power source. The power lines should be brought in through a conduit and in such a manner that the leads can be brought up through a grommet in the base of the power rectifier unit. Refer to figure 16.

A station switch should be installed in the power line to permit the complete disconnecting of the power from the transmitter.

The power line and station switch should be capable of carrying at least 30 amperes.

3.2.2. Remote Lines. Refer to figure 18 for 177G-9 (or figure 80b and figure 18 for 177G-10) remote control unit and modulator bay terminal strip connections. The remote control unit is designed to control the transmitter over two cable pairs and a ground return circuit. The control system will function satisfactorily up to the distance where the line loss exceeds 25 db or the loop resistance of the line exceeds 1000 ohms. The channel indicator functions over the audio pair and the ground return.

3.2.3. FSK Units. FSK connections are described in 2.6.4. and 2.8.1. The FSK inputs are designed for connections with RG8U 50-ohm coaxial cable.

3.2.4. Radiation System. 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 3/8 inch will appreciably reduce the reactances encountered. Conductors of greater diameter, such as 3/4 to 2 inches, will further improve multifrequency 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 or multiple of a half-wavelength at any of the operating frequencies.

The efficiency of the radiation system is largely dependent upon the ground system 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 figure 19 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 the 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 eighth 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 figure 20.

3.3. UNCRATING. The units were removed from the cabinets when the equipment was packed for shipment. If any of the cabinets or units have been damaged in shipment the original packing crate and packing material should be preserved and a claim for damage filed promptly with the transportation company.

SECTION III  
INSTRUCTIONS FOR INSTALLATION

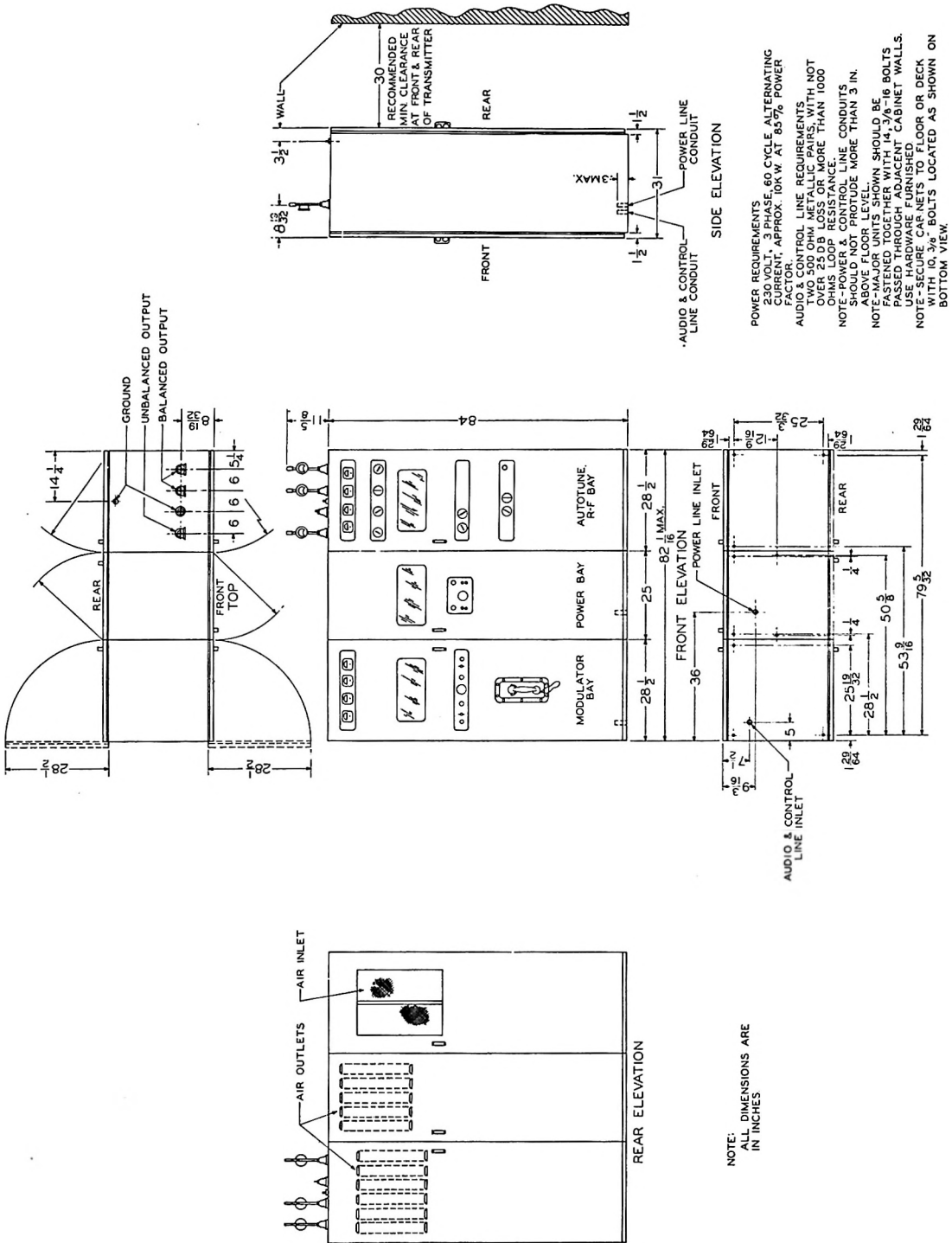


Figure 17. Installation Diagram

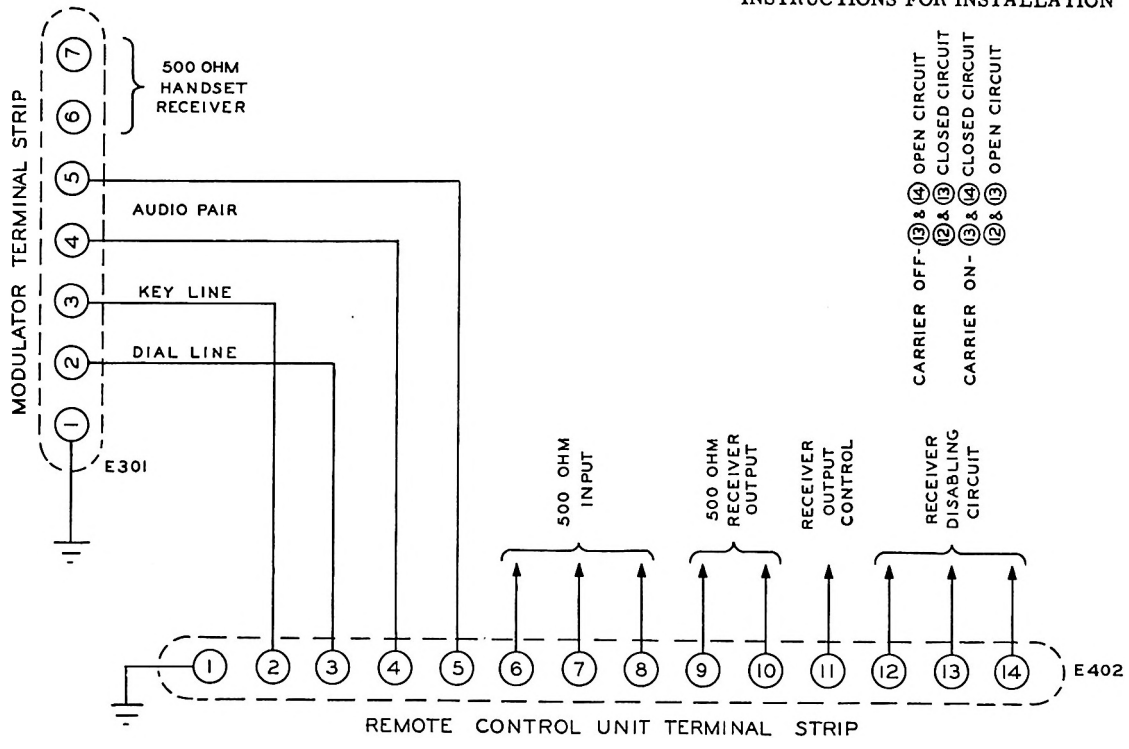
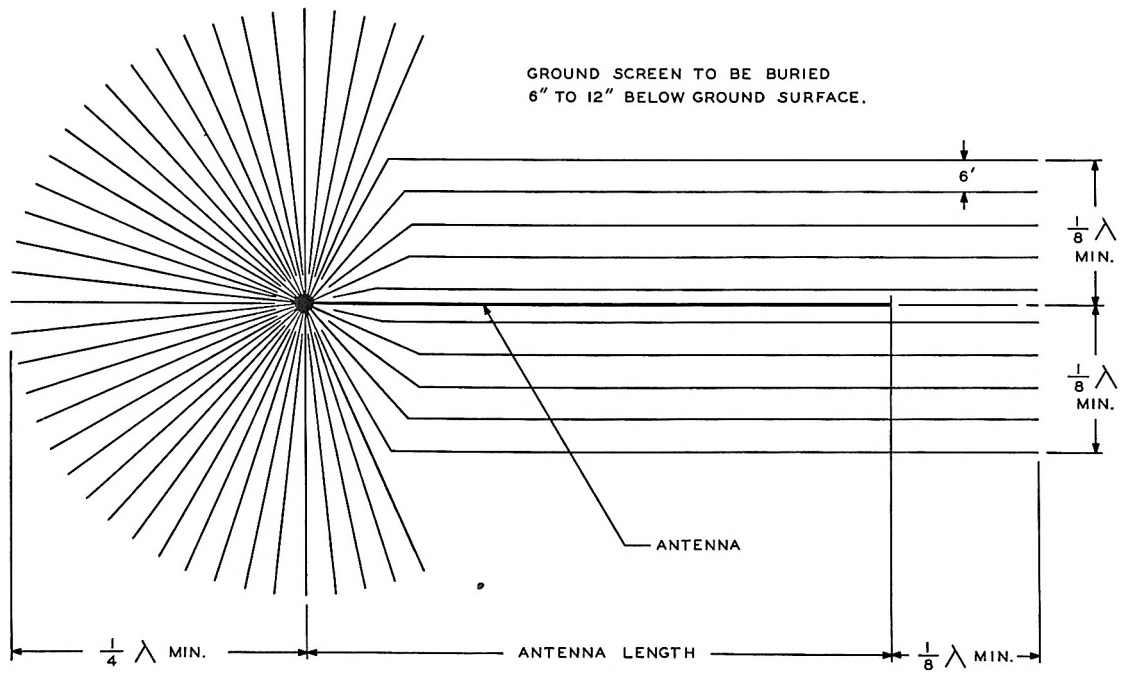


Figure 18. External Connections



$\lambda$  = WAVELENGTH AT LOWEST OPERATING FREQUENCY

Figure 19. Ground System



**SECTION III  
INSTRUCTIONS FOR INSTALLATION**

The large cabinets and vertical chassis should be unpacked first. When bolted together the three bays require a space 31" deep by 82-1/16" wide and 95-5/8" high. In addition, a clearance of 28-1/2" is necessary in the front and the rear of the cabinets to allow the doors to open and to permit the free circulation of air.

Refer to figure 17 for the proper placement of the cabinets. First place the center, or Collins Type 1100C-2 Rectifier Power Unit, in position. The Collins Type 1025-4 Modulator cabinet (identified by the handset mounted in the cabinet door) should be placed on the left side of the Collins Type 1100C-2 Rectifier Power Unit (as viewed from the front). Place the Collins Type 1016-5 Radio Transmitter on the right side of the rectifier power unit.

When the cabinets have been placed, one on either side of the vertical chassis, the units may be fastened together with the bolts as supplied in the small cloth sacks. The long bolts are inserted through the vertical stiffeners in the end cabinets, four from the modulator side and four from the transmitter side. The smaller bolts are placed one on each side of the row of stiffener bolts at the top and one bolt behind the row of stiffener bolts at the bottom on each side of the vertical chassis. Insert all bolts so that the nuts come within the vertical chassis. The cabinets now may be secured to the floor or deck with 10-3/8" bolts located as shown on the bottom view of the installation diagram.

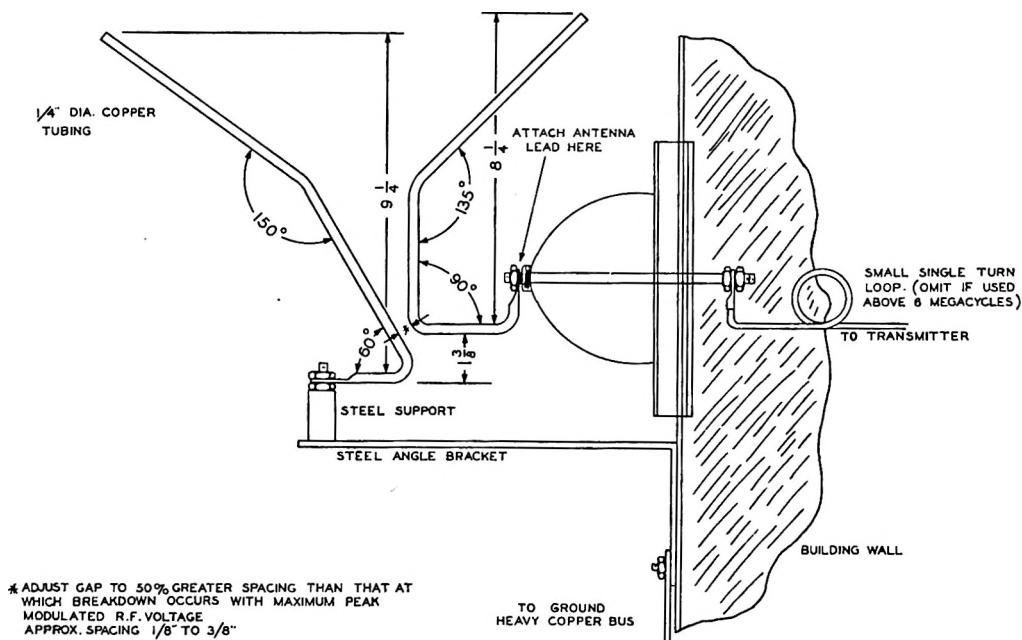
Using a hoist, lift the high-voltage transformer, T203, into place on the rear platform of the vertical chassis. To install the doors on the vertical chassis first remove the door-stop arm bolt from the cabinet. Lift the door and set it over the hinge pins and let drop into place. Place the bolt through the door-stop arm slot and screw back into place. Both doors are installed in the same manner.

**3.4. INSTALLATION OF UNITS.** The unit assemblies were removed from the cabinets and packed separately for shipment. The unit installation diagram shows the proper location of the units in the cabinets. The following procedure is recommended for the installation of units and components not associated with any particular unit:

**IMPORTANT**

**DO NOT REMOVE SEALS FROM AUTOTUNE COUPLERS UNTIL ALL UNITS HAVE BEEN SECURELY BOLTED IN POSITION.**

(a) Install the ventilating blower in the modulator cabinet base by placing the blower unit over the mounting bolts, tightening the nuts that fasten the blower mounting base to the shockmounts, and fastening the canvas bellows to air vent in the base of the cabinet. Connect the blue and red wires to the motor input terminals on strip E302.



**Figure 20. Horn Gap Installation**

IMPORTANT

(b) Fasten the modulation transformer, T309, to the base of the modulator bay cabinet just in front of the ventilating blower. The transformer terminals are numbered. Connect the large black leads to the terminals. (Two leads should be connected to terminal #4.)

(c) Install the motor panels in the modulator and radio transmitter bays. Fasten each panel in position with the mounting screws. (The panel that contains the AUDIO LEVEL, PLATE VOLTAGE, MOD. PLATE CURRENT and LINE AND FILAMENT VOLTAGE meters belongs in the modulator cabinet.) Connect the leads to the meter terminals. (Wires and meter terminals that are to be connected together have been marked with like numbered tags.)

(d) Connect the wires that are contained in the interbay cables to the terminal strips on the Collins Type 1100C-2 Rectifier Power Unit, Units J and L. The numbers on the tags on the wires refer to the terminal numbers on the two strips. Connect like numbered wires and terminals.

(e) Connect the large black leads to the large terminals, numbered 28, 29, 30, and 31.

(f) Fasten the transmitter power switch, S211, to the mounting bracket on the front of the Collins Type 1100C-2 Rectifier Power Unit and connect the wires to the switch terminals.

(g) Insert the resistors into the clips on the rear of the vertical chassis. Use the item numbers stamped on the resistors and chassis to find the proper positions for the resistors.

(h) Fasten filter capacitor C166 and C167 to the base of the Collins Type 1016-5 Radio Transmitter cabinet.

(i) Connect leads to capacitors C166 and C167 in the radio transmitter bay.

(j) Fasten the Autotune motor to the bracket on the lower left side of the radio transmitter bay cabinet.

(k) Slide the filament supply unit into position below the modulator and driver unit in the modulator cabinet.

(l) Slide the speech amplifier unit into position in front of the modulator and driver unit.

(m) Insert the handset (HS301) connector plug, P305, into plug receptacle J312 beneath the front edge of the speech amplifier unit chassis.

(n) Place the output network unit on the brackets that are just above the power amplifier unit. (Note: The output network unit should be inserted in the cabinet from the rear.)

(o) Fasten the neutralizing capacitor, C157, to the large insulating standoffs in the radio transmitter cabinet. (Large aluminum disks.)

BE EXTREMELY CAREFUL WHEN INSTALLING THE NEUTRALIZING CAPACITOR. DO NOT CHANGE THE ADJUSTMENT OF THE ALUMINUM DISKS. IF EITHER DISK IS DISPLACED FROM THE POSITION IN WHICH IT WAS LOCKED AT THE FACTORY, IT WILL BE NECESSARY TO NEUTRALIZE THE POWER AMPLIFIER STAGE BEFORE PLACING THE TRANSMITTER IN OPERATION.

(p) Using the copper tubing that is provided, connect the neutralizing capacitor (C157) to the center tap of C155. (Junction of C155 and L122.)

(q) Connect the high voltage lead from the PWR. AMP. PLATE CURRENT meter to capacitor C154 near the front of the unit.

(r) Connect the front ground terminal (on roof of cabinet) to the output network chassis with the copper tubing connector.

The connection point is a bolt hole located on the upper left front side of the chassis.

(s) Connect the two balanced antenna terminals (on right side of roof of cabinet) to the front and middle standoffs mounted on C178.

(t) Connect the unbalanced antenna terminal (on left side of roof of cabinet) to the third or rear standoff mounted on C178.

(u) Connect the cabinet ground strap from the underside of the bolt on top rear of transmitter unit to the rear plate of the output network chassis.

(v) Slide the power amplifier filament supply unit into position in the lower section of the radio transmitter cabinet.

(w) Connect like numbered leads and terminals on the strips on the rear of the filament supply.

(x) Place the r-f exciter unit in the radio transmitter cabinet and fasten the chassis to the mounting brackets with bolts. (Note: It is necessary to put the bolts in the exciter chassis because when the Autotune control unit is in place it is impossible to insert the bolts.)

(y) Slide the Autotune control unit into position beneath the r-f exciter unit.

(z) Place the power amplifier unit on the brackets just above the exciter unit.

(aa) Connect the intermediate amplifier plate voltage lead (large black lead) to terminal 11, the terminal on the left rear edge of the power amplifier unit chassis.

(ab) Connect the power amplifier grid voltage lead (large black lead) to terminal 10, the terminal on the right rear edge of the power amplifier unit chassis.

SECTION III  
INSTRUCTIONS FOR INSTALLATION

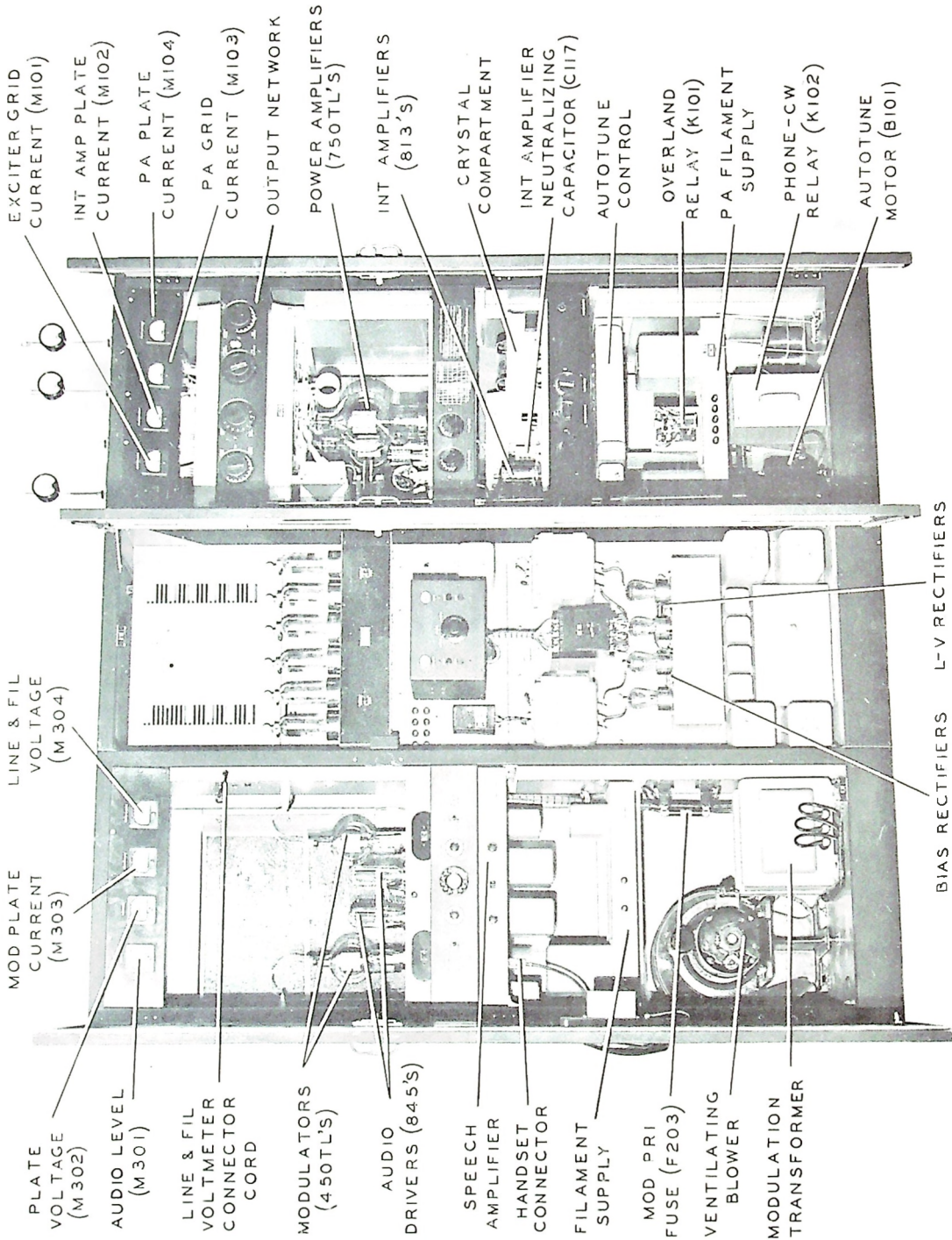


Figure 21. Modulator, Power Rectifier and Transmitter Units - Front

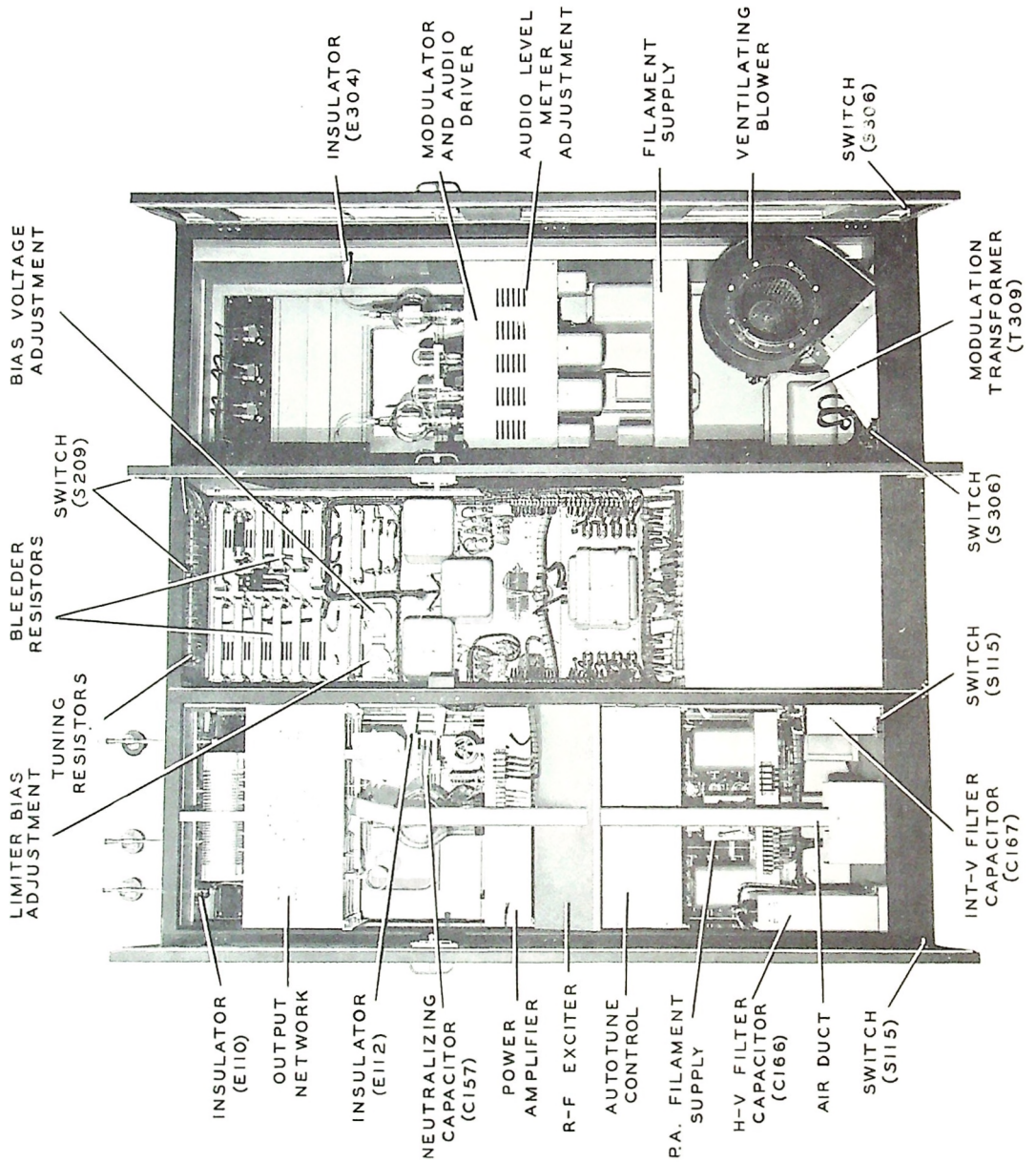


Figure 22. Modulator Power Rectifier and Transmitter Units

**SECTION III  
INSTRUCTIONS FOR INSTALLATION**

(ac) Connect the leads to terminal strips E103 and E108. (Like numbered leads and terminals together.)

(ad) Screw the antenna ammeters into position on the ANTENNA terminals.

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 LOCKED FOR SHIPMENT. The above matter is extremely important due to the fact that the 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 exciter unit, the drive shafts between the Autotune motor and the Autotune assembly in the r-f exciter unit may be inserted in any position but the drive shafts between the r-f exciter unit and the power amplifier unit and between power amplifier unit and the output network unit 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.

(ae) Remove the seals from the Autotune drive shaft connectors and CAREFULLY insert the drive shafts and tighten the couplers.

**IMPORTANT**

EACH UNIT MUST BE BOLTED SECURELY IN PLACE TO PREVENT MISALIGNMENT AND BINDING OF THE 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 KEEP ALL PARTS OF THE CHASSIS AT THE SAME POTENTIAL AS THE CABINET.

The order of designation of the interunit 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 interunit 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 by "A92."

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

3.5. FUSES. All fuses should be examined and the ratings checked against the parts list or the table given below. It is good practice to insert each fuse as required during the initial adjustment procedure in order that any faults which may be due to errors in connections to terminals or unintentional grounding of terminals may be determined quickly and also to check and clear each individual circuit in the proper sequence. The fuses used in this equipment, together with the symbol designation of the fuse and the unit in which the fuse is located, are tabulated in paragraph 4.4.

3.6. REMOTE UNIT. The outline dimensions of the Type 177G-9 Remote Control Unit are shown in figure 23. It may be rack mounted or desk mounted. If rack mounted, sufficient space above the unit must be allowed for opening the cover. The Type 177G-10 Remote Control Unit is designed for rack mounting on a standard 19-inch relay rack.

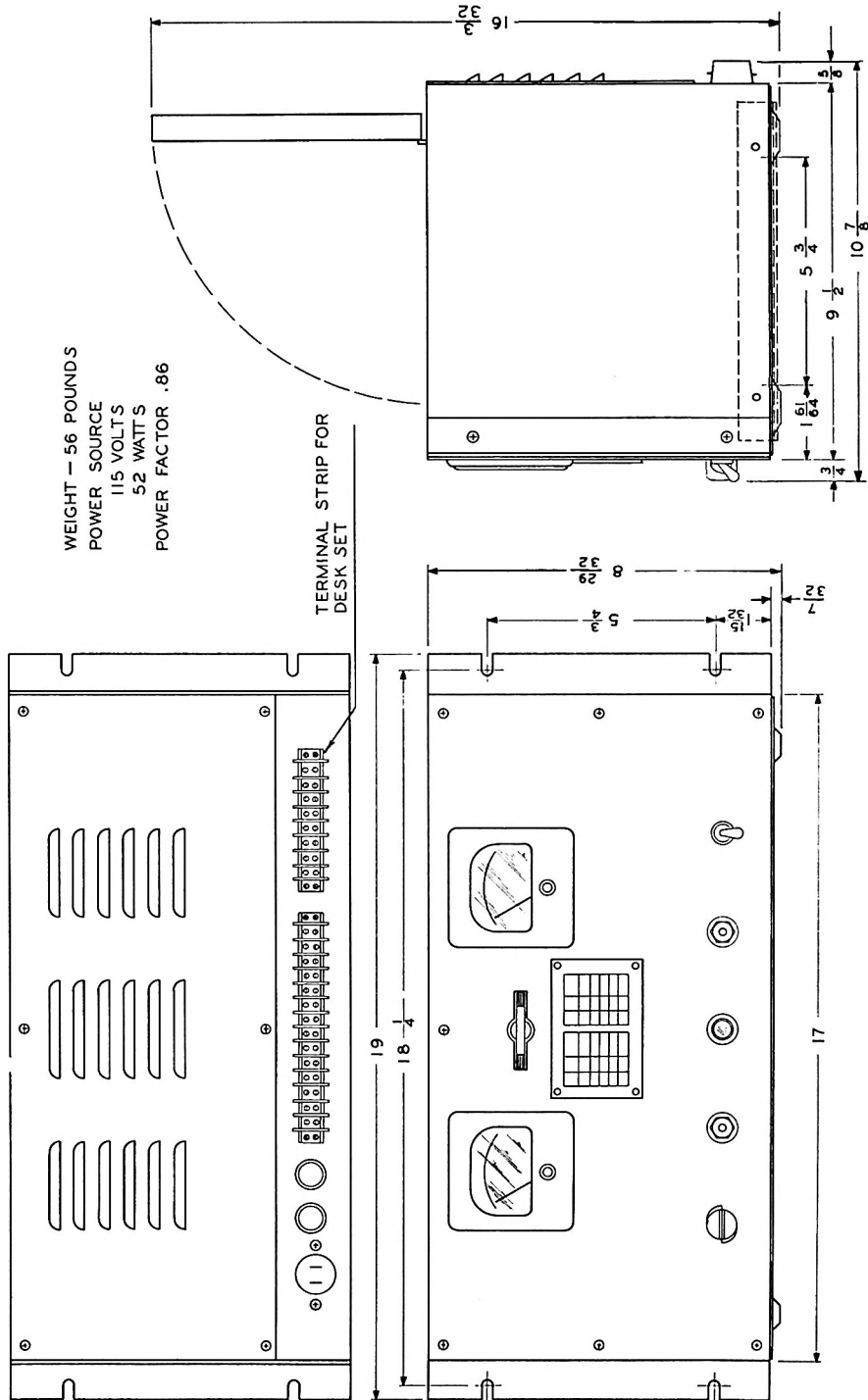


Figure 23. Remote Control Unit Installation

SECTION IV  
ADJUSTMENTS

4.1. WARNING. 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 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 FRONT AND REAR DOORS OF THE TRANSMITTER CABINETS ARE PROVIDED WITH INTERLOCK SWITCHES. WHEN THE L. V. TUNE OPERATE SWITCH IS OPERATED TO THE L. V. TUNE POSITION, THE INTERLOCK SWITCHES ASSOCIATED WITH THE RADIO TRANSMITTER AND MODULATOR CABINETS ARE SHORTED OUT TO PERMIT THE MAKING OF TUNING ADJUSTMENTS OF THE EXCITER SECTION OF THE TRANSMITTER. GREAT CARE MUST BE EXERCISED WHEN MAKING EXCITER ADJUSTMENTS WITH THE CABINET DOORS OPEN BECAUSE MANY OF THE CIRCUITS ARE AT A POTENTIAL OF 500 VOLTS ABOVE GROUND.

Typical tuning curves are provided in this section. Reference to these curves is recommended as it is possible to tune the PA grid and plate circuits to harmonics of the desired frequency and cause excessive voltages and currents in the transmitter.

4.2. CONTROLS. See figure 24. 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.

## IMPORTANT

IT IS OF UTMOST IMPORTANCE THAT AFTER THE SELECTION OF A FREQUENCY CHANNEL AND IF THE SINGLETURN DIALS COME TO REST IN A POSITION SUCH THAT THE INDICATOR MARK IS OPPOSITE THE BLANK SPACE ON THE TUNING KNOB, THAT THE DIALS BE ROTATED IN A COUNTERCLOCKWISE DIRECTION TO MAKE TUNING ADJUSTMENTS. FINAL ADJUSTMENT OF ALL CONTROLS SHOULD BE MADE BY ROTATING THE CONTROLS IN A CLOCKWISE DIRECTION. IF AN ATTEMPT IS MADE TO ROTATE THE TUNING DIALS IN A CLOCKWISE DIRECTION THE DIALS MAY BE LOOSENED ON THE SHAFTS

BECAUSE THE SINGLETURN UNIT HOME STOP PAWL PREVENTS THE ROTATION OF THE SHAFT THROUGH MORE THAN 360 DEGREES.

The following paragraphs list the control designations and give the elements controlled by each:

(a) EXCITER BAND SWITCH. The EXCITER BAND SWITCH operates switches S104, S105, and S106. Switch sections S104A, S104B, S104C, S105A, S105C, S106A, S106B, and S106C connect the proper inductors in grid circuits of the buffer, V104, and intermediate amplifiers V105, V106. Position 4 of the EXCITER BAND SWITCH selects the proper inductors to give output in the frequency range 2.0 mc to 4.0 mc, position 3 gives output in the range 4 mc to 8 mc, position 2 gives output in the range 8 mc to 16 mc, and position 1 of the control gives output in the frequency range 16.0 mc to 26.0 mc. Sixty degrees of dial rotation cover all four switch positions.

(b) EXCITER TUNING Control. The EXCITER TUNING control operates capacitors C125 and C132. The two capacitors are ganged so that both the crystal oscillator and the buffer plate tank circuits may be tuned by a single control. Capacitor C125 is associated with the crystal oscillator tank circuit and capacitor C132 tunes the buffer plate tank circuit. The dial is divided into 100 divisions over 180 degrees to cover the full range of the variable capacitors.

(c) INT. AMP. PLATE Tuning Control (E). This control operates the dual-section variable capacitor, C105, to tune the intermediate amplifier plate tank circuit. Each section tunes one-half of the balanced tank circuit.

(d) POWER AMP. BAND SWITCH (F). The POWER BAND SWITCH operates switch S111 and S119 in the output network unit. The switch S111 is of the shorting type and shorts out sections of inductor L125 as the switch is operated. The dial is divided into 10 divisions. Maximum inductance is in the circuit when the POWER AMP. BAND SWITCH is in position 10. The switch, S119, is of the shorting type and shorts out sections of L138 and L137. Maximum inductance is across the balanced output when the POWER AMP. BAND SWITCH is in positions 5 through 10.

(e) ANTENNA SELECTOR AND BALANCING Control (G). This control operates switch S118 to select either balanced or unbalanced mode of operation and balancing circuit capacitor C178.

(f) POWER AMP. TUNING Control (H). The POWER AMP. TUNING control operates the variable capacitor C158. Capacitor C158 is connected across the input side of the pi network which is used as a

SECTION IV  
ADJUSTMENTS

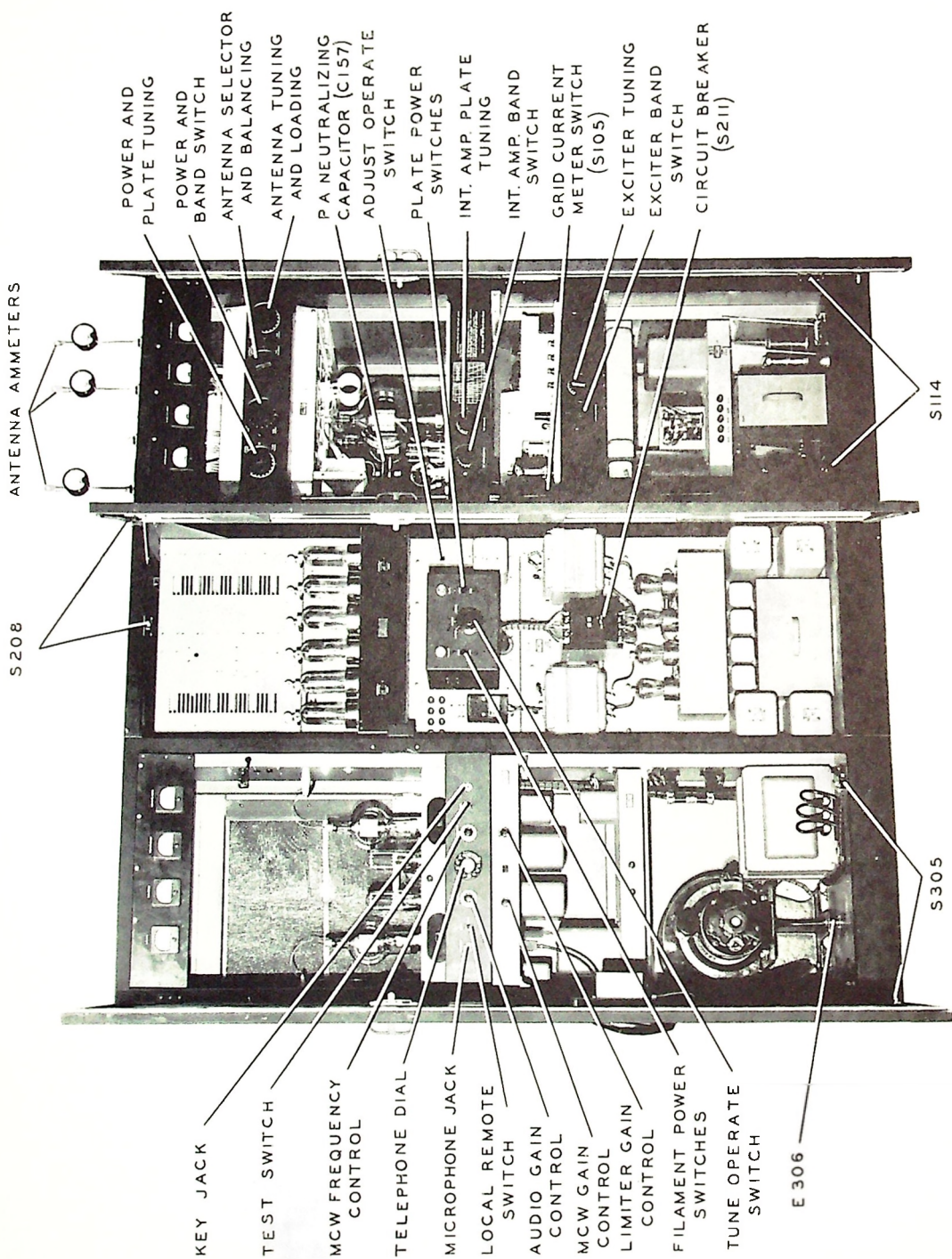


Figure 24. Modulator, Power Rectifier and Transmitter



combination plate tank and antenna coupling. 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.

(g) ANTENNA TUNING AND LOADING Control (J). The ANTENNA TUNING control operates the variable capacitor, C159, that is connected across the output side of the pi network. 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.

(h) MCW FREQUENCY Control. The MCW FREQUENCY control operates switch S304 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 280 degrees of control rotation.

(i) AUDIO GAIN Control. The AUDIO GAIN control operates the dual potentiometer, R324. The control permits the adjusting of the input to the first audio amplifier tube V301. The dial is divided into 10 divisions, covering 280 degrees of control rotation. The input to the first audio amplifier tube, and consequently the speech amplifier gain, increases as the control is rotated from 0 toward 10.

(j) MCW GAIN Control. The MCW GAIN control operates potentiometer R325 and is located on the speech amplifier chassis. The control is accessible if the front door of the modulator cabinet is opened. The control regulates the output of the tone oscillator V305. The dial is divided into 10 divisions, covering 280 degrees of rotation. The gain of V305 increases as the control is rotated from 0 toward 10.

(k) LIMITER GAIN Control. The LIMITER GAIN control operates potentiometer R326. The potentiometer permits the adjusting of the voltage that is applied to the plates of the limiter rectifier tube, V306. (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.

(l) 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 in one direction the key will return immediately to the normal position when released; if operated in the opposite 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.

(m) L. V. TUNE - H. V. TUNE - OPERATE Switch. This control operates switch S206. When the control is operated to the L. V. TUNE position

the circuit from the power line to the plate power contactors is broken to prevent the application of high voltage to any of the transmitter circuits. When operated to the H. V. TUNE position, switch S206 connects a resistor in series with each power input lead to reduce the voltage that is applied to the primary of the high voltage transformer and to give poor regulation. When the control is operated to the OPERATE position the tuning resistors are removed from the primary power leads to permit the application of full voltage to the primary of the plate power transformer.

(n) LOCAL-REMOTE Switch. The LOCAL-REMOTE control operates switch S303. The switch is normal in the REMOTE position. When operated in one direction the switch is nonlocking and will return to the REMOTE position as soon as released, but when operated in the opposite direction the switch locks for LOCAL control of the transmitter.

(o) POWER LEVEL Switch. The power level switch, S205, is located on the vertical chassis inside the cabinet door of the power bay. If operated to the HIGH position, output up to 5 kw of r-f power may be obtained with CW emission. The switch operates relay K202 when operated to the LOW position and relay K203 when operated to the HIGH position if CW emission is selected. Selecting either MCW or VOICE emission breaks the circuit necessary for the operation of relay K203 and gives r-f power output of up to 3 kw. When LOW power operation is selected the contacts of relay K202 connect the full primary winding of the plate power transformer in the circuit. When HIGH power operation is selected the contacts of relay K203 select a tap on the primary of transformer T203 to increase the turns-ratio and consequently the output voltage.

(p) ADJUST-OPERATE Switch. When this switch, S210, is operated to the ADJUST position the interlock switches in the radio transmitter and modulator bays are shorted out to permit the adjustment of the low power transmitter stages with the doors of the cabinets open. The ADJUST-OPERATE switch is located on the vertical chassis and is accessible if the cabinet front door is opened.

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 units. If the two single-turn units located on the r-f exciter 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 single-turn units located on the power amplifier unit and the output network unit are synchronized with each other but are not synchronized with the units located in the

SECTION IV  
ADJUSTMENTS

r-f exciter unit, the short coupling drive shaft between the 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:

NOTE

Ventilating blower B301 is driven by a 3-phase motor and should be checked for correct rotation. If direction of rotation is incorrect, interchange any two leads to the motor.

(c) Open the front door of the Collins Type 110C-2 Rectifier Power Unit cabinet and insert fuse F203 into the 48 V PRI. fuse receptacle.

(d) Insert fuse F208 into the 48 V d-c fuse receptacle.

(e) Open the front door of the Collins Type 1016-5 Radio Transmitter and insert AUTOTUNE MOTOR fuses F104, F105 and F106 (1, 2, and 3).

Symbol Designation	Rating Amps.	Circuit	Unit
F101	1/4 amp*	Crystal Compartment Heater	R-F Exciter
F102	3/8 amp*	Oscillator and Frequency Mult. Fil. Pri.	R-F Exciter
F103	1/4 amp*	Keyer Rectifier Transformer Pri.	R-F Exciter
F104	8 amp	Autotune Motor	P. A. Fil. Supply
F105	8 amp	Autotune Motor	P. A. Fil. Supply
F106	8 amp	Autotune Motor	P. A. Fil. Supply
F107	2 amp	P. A. Filament Pri.	P. A. Fil. Supply
F108	2 amp	P. A. Filament Pri.	P. A. Fil. Supply
F109	1/4 amp*	Stabilizer Fil. Pri.	Power Amplifier
F110	3/4 amp*	Int. Amp. Filament Pri.	R-F Exciter
F201	3 amp	H. V. Rectifier Filament Pri.	Power
F202	3 amp	H. V. Rectifier Filament Pri.	Power
F203	2 amp	Relay Rectifier Supply Pri.	Power
F204	3 amp	L. V. Rectifier Plate Pri.	Power
F205	3 amp	Bias Rect. Plate Pri.	Power
F206	1 amp	L. V. Rectifier Fil. Pri.	Power
F207	1 amp	Bias Rectifier Fil. Pri.	Power
F208	3 amp	Relay Supply Output	Power
F301	1 amp*	Modulator Fil. Pri.	Fil. Supply
F302	3/8 amp*	Speech Amp. Fil. Pri.	Fil. Supply
F303	3/8 amp*	Audio Driver Fil. Pri.	Mod. & Audio Driver
F304	2 amp	Mod. Plate Supply	Base Components
F401	1/2 amp*	Remote Unit Fil. Pri.	Remote Control
F402	1 amp*	Remote Unit Plate Supply	Remote Control

\*Slo-Blo type. Do not replace a Slo-Blo fuse with a fuse of the quick-acting type.

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

(a) Insert the LINE AND FIL. VOLTAGE meter cord plug into the cord plug receptacle designated as LINE (located in wall of COL-50129 Modulator Unit Cabinet).

(b) Operate the circuit breaker, S211, to the ON position and observe the reading on the LINE AND FIL. VOLTAGE meter. (Refer to 4.5 VOLTAGE ADJUSTMENT if the meter indicates above or below 230 volts.)

(f) With the circuit breaker in the ON position, press the FILAMENT START switch and dial a frequency channel. If the motor operates, continue the circuit check. If the motor fails to operate, check all fuses that have been inserted thus far. If the fuses are all in good condition, look for loose connections.

If the motor starts but immediately stops or the motor starts to rotate in the wrong direction (correct direction of rotation is indicated by all controls rotating in a counterclockwise direction when the motor starts) the power phasing is incorrect. Correct this condition by interchanging any two of the leads from the power source.

(g) When the above circuits are operating satisfactorily insert the EXCITER FIL. fuse, F102, and KEYER FIL. fuse, F103 into the receptacle on top of the r-f exciter unit chassis.

(h) Insert the extension cord plug into the FIL. EXT. position of receptacle J303.

(i) Insert the plug that is on the opposite end of the extension cord into the plug receptacle designated as 6.3 EXCITER FIL. (Located on the r-f exciter unit chassis.)

#### IMPORTANT

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

(j) If a reading is indicated on the voltmeter insert the 4-125A FIL. fuse, F110.

(k) Insert the metering cord plug into the 5 V 4-125A FIL. plug receptacle. A voltage reading indicates proper operation of the circuit.

(l) Insert PWR. AMP. FIL. FRONT fuse, F107.

(m) Insert the metering cord plug into the 7.5 VOLT FIL. plug receptacle near the front type 750TL tube and check the voltmeter reading.

(n) Insert the PWR. AMP. FIL. REAR fuse, F108, and insert the metering cord plug into the 7.5 VOLT FIL. plug receptacle that is near the rear type 750TL tube. Check the voltmeter reading.

(o) Insert the 811 FIL. fuse, F109, into the receptacle on the power amplifier unit chassis.

(p) Insert the metering cord plug into the 6.3 VOLT FIL. plug receptacle (located near the type 811 tube) and check for an indication of voltage on the voltmeter.

(q) Open the front door of the Collins Type 1100C-2 Rectifier Power Unit cabinet and insert the BIAS FIL. fuse, F207.

(r) Insert the metering cord plug into the BIAS FIL. 2.5 V plug receptacle and check the meter reading.

(s) Insert the L. V. FIL. fuse, F206.

(t) Insert the metering cord plug into the L. V. FIL. 2.5 V plug receptacle and check the voltmeter reading.

(u) Insert the H. V. FIL. fuses, F201 and F202, and check the circuits by inserting the metering cord plug into the H. V. RECT. FIL. 1 and H. V. RECT. FIL. 2 plug receptacle.

(v) Returning to the Collins Type 1025-4 Modulator Bay, insert the SP. AMP. FIL. fuse, F302, and insert the metering plug into the unmarked plug receptacle on the front of the speech amplifier unit chassis. Check the voltmeter for an indication of voltage.

(w) Insert the MOD. FIL. fuse, F301, and check the operation of the circuit by inserting the metering cord plug into 7.5 VOLTS plug receptacle on the modulator and audio driver unit chassis.

(x) Insert the DRIVER FIL. fuse, F303, and check the operation of the audio driver filament circuit by inserting the metering cord plug into the 10 VOLTS plug receptacle.

#### WARNING

FILAMENT IS 500V ABOVE GROUND. DO NOT METER CIRCUIT WITH PLATE VOLTAGE ON.

(y) Return to the Collins Type 1100C-2 Rectifier Power Unit and insert the BIAS PLATE fuse, F205.

(z) With the TUNE-OPERATE switch in the L. V. TUNE position, press the PLATE START switch. If the PLATE pilot lamp glows the bias supply is operating satisfactorily.

(aa) Press the PLATE STOP switch and insert the L. V. PLATE fuse, F204, into the fuse receptacle.

(ab) Dial an Autotune channel.

(ac) Press the PLATE START switch and check the reading on the CHANNEL INDICATOR meter on the remote control unit. (The meter is operated by voltage supplied by the L-V power supply and therefore if the channel indicator operates the L-V power supply circuits are operating satisfactorily.)

(ad) Return to the Collins Type 1016-5 Radio Transmitter Bay and insert the crystal HEATER fuse, F101. (Located on top of the r-f exciter unit chassis.)

(ae) Insert the modulator circuit primary fuse, F304, into the clips near the base of the Collins Type 1025-4 Modulator Unit cabinet.

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 circuit breaker, S211, 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.)

SECTION IV  
ADJUSTMENTS

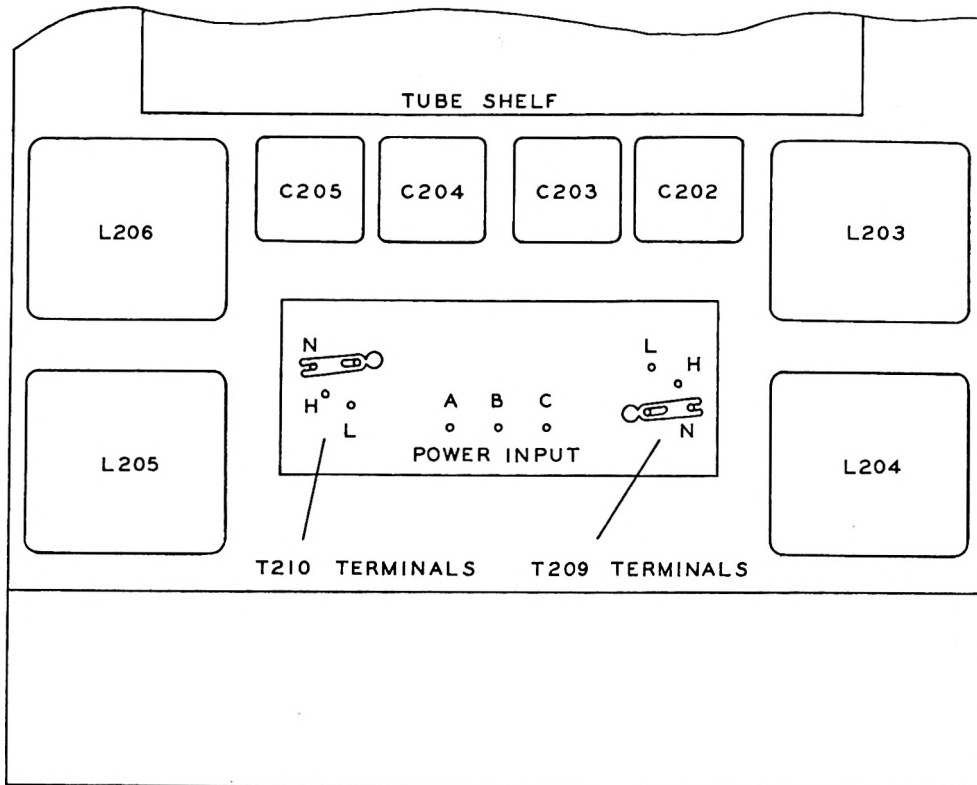


Figure 25. Autotransformer Connections

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 LINE AND FIL. VOLTAGE meter reads 220 volts or 240 volts, the input voltage is either 10 volts too high or too low and may be corrected by the taps on the autotransformers T209 and T210. If the meter indicates voltage closer to 220 volts than to 230 volts, remove the cover plate from the autotransformer terminals located near the front bottom edge of the vertical chassis in the Collins Type 1100C-2 Power Rectifier Unit, and with the circuit breaker S211 in the OFF position change the jumpers from terminals N to terminal L. If the meter indicates voltage near 240 volts, change the jumpers to terminals H. Further adjustments of filament voltages may be made by changing the taps on the individual filament transformers. See figure 25.

Filament voltages on the tubes in the transmitter unit may be measured using the LINE AND FIL. VOLTAGE meter and the extension cord that is provided. No provision has been made for the metering of filament voltages in the remote control unit. The control unit is designed to operate from a 115-volt a-c source and the single power transformer, T403, 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.

**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.**

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

FILAMENT VOLTAGE CHART

Tube Symbol	Tube Type	Unit	Filament Transformer	Correct Voltage	Plug Receptacle
V101	6X5GT	R-F Exciter	T103	6.3	J104
V102	6SJ7	R-F Exciter	T103	6.3	J104
V103	837	R-F Exciter	T102	6.3	----
V104	807	R-F Exciter	T102	6.3	J104
V105	4-125A	R-F Exciter	T101	5.0	J104
V106	4-125A	R-F Exciter	T101	5.0	J104
V114	750TL	Power Amplifier	T104	7.5	J110
V115	750TL	Power Amplifier	T105	7.5	J111
V116	811	Power Amplifier	T107	6.3	J122
V201	4B32	Power	T201	5.0	J201
V202	4B32	Power	T201	5.0	J201
V203	4B32	Power	T201	5.0	J201
V204	4B32	Power	T202	5.0	J202
V205	4B32	Power	T202	5.0	J202
V206	4B32	Power	T202	5.0	J202
V207	866/866A	Power	T207	2.5	J203
V208	866/866A	Power	T207	2.5	J203
V209	866/866A	Power	T208	2.5	J204
V210	866/866A	Power	T208	2.5	J204
V301	6SL7GT	Speech Amp.	T308	6.3	J311
V302	6C8G	Speech Amp.	T308	6.3	J311
V303	6C8G	Speech Amp.	T308	6.3	J311
V304	6SJ7	Speech Amp.	T308	6.3	J311
V305	6SN7GT	Speech Amp.	T308	6.3	J311
V306	6X5GT	Speech Amp.	T308	6.3	J311
V307	801	Speech Amp.	T308	7.5	----
V308	801	Speech Amp.	T308	7.5	----
V309	845	Mod. & Driver	T305	10.0	J305
V310	845	Mod. & Driver	T305	10.0	J305
V311	450TL	Mod. & Driver	T307	7.5	J304
V312	450TL	Mod. & Driver	T307	7.5	J304
V401	6V6GT	Remote Control	T404	6.3	----
V402	6SJ7	Remote Control	T404	6.3	----
V403	5U4G	Remote Control	T403	6.3	----

The bias and low voltage 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 eight transmitter controls is necessary to obtain the maximum r-f output upon any particular frequency. Two of the controls, the EXCITER BAND SWITCH, and EXCITER TUNING controls are located on the r-f exciter unit. Two controls, the INT. AMP. BAND switch and the INT. AMP. PLATE tuning controls are located on the power amplifier unit. The four remaining controls, the POWER AMP. BAND SWITCH, POWER AMP. PLATE TUNING, the ANTENNA SELECTOR AND BALANCING, and ANTENNA TUNING AND LOADING controls, are located on the output

network unit. All eight 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 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.) Channel 11 may be selected by dialing AA1.

**4.6.1. Crystals.** Ten crystal positions are provided in the shielded oscillator compartment. These positions are numbered to correspond with the channel number 1 to 10. As set up at the factory, the channels were arranged in sequence with the highest frequency on channel 1. The crystals required should be placed in the proper position and the inner shield covers securely placed over the crystal compartment. The large cover encloses the entire oscillator assembly. Crystals in channels 8, 9, and 10 may be replaced

SECTION IV  
ADJUSTMENTS

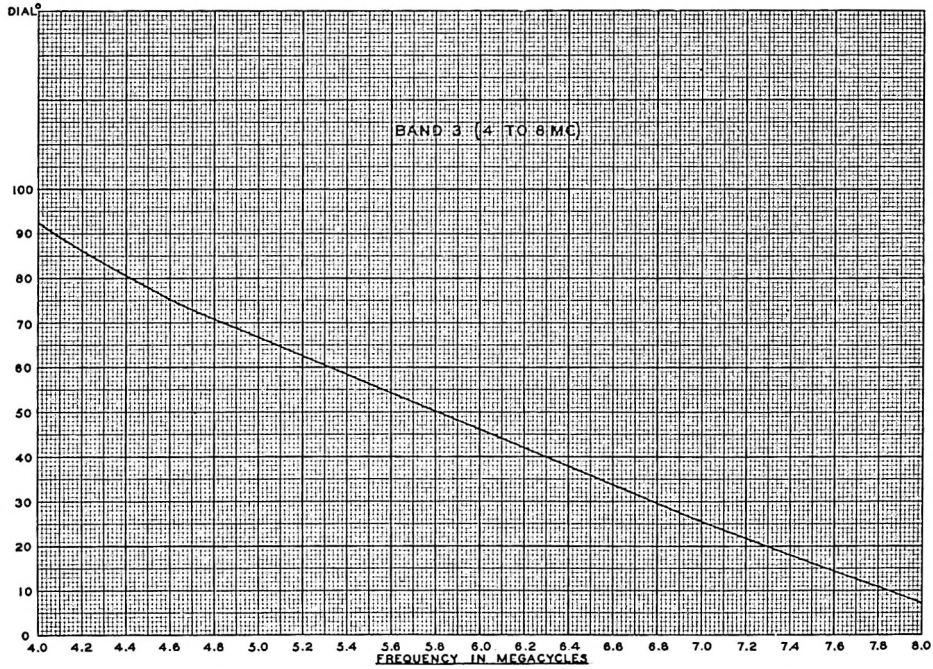
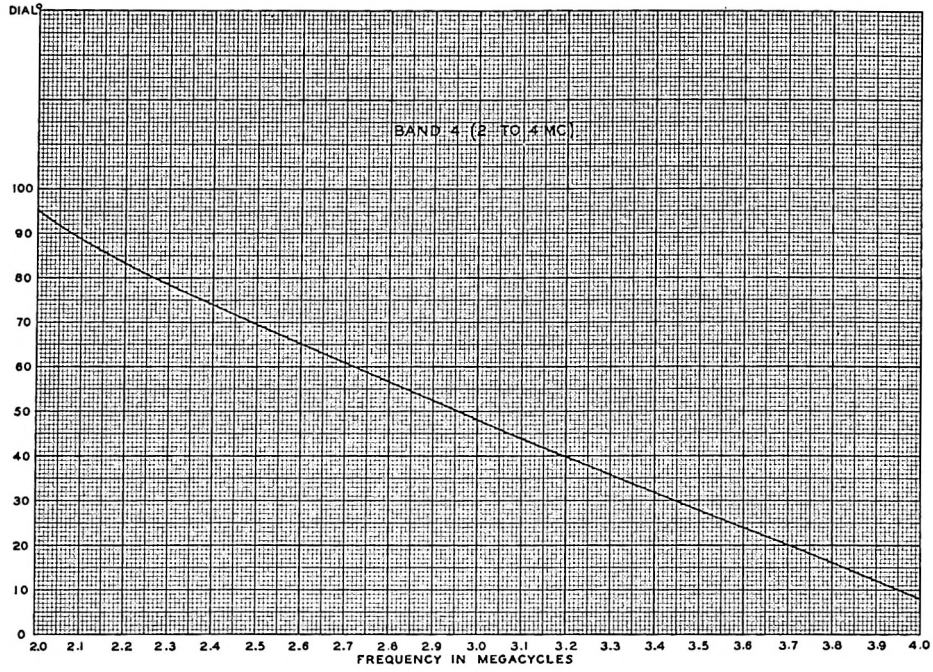


Figure 26A. Exciter Tuning Curve

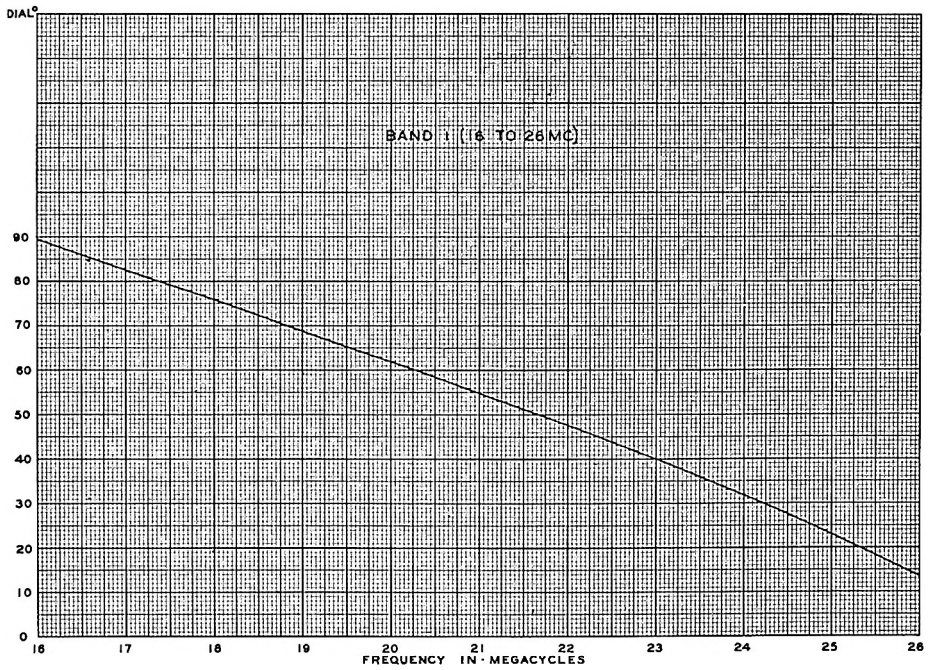
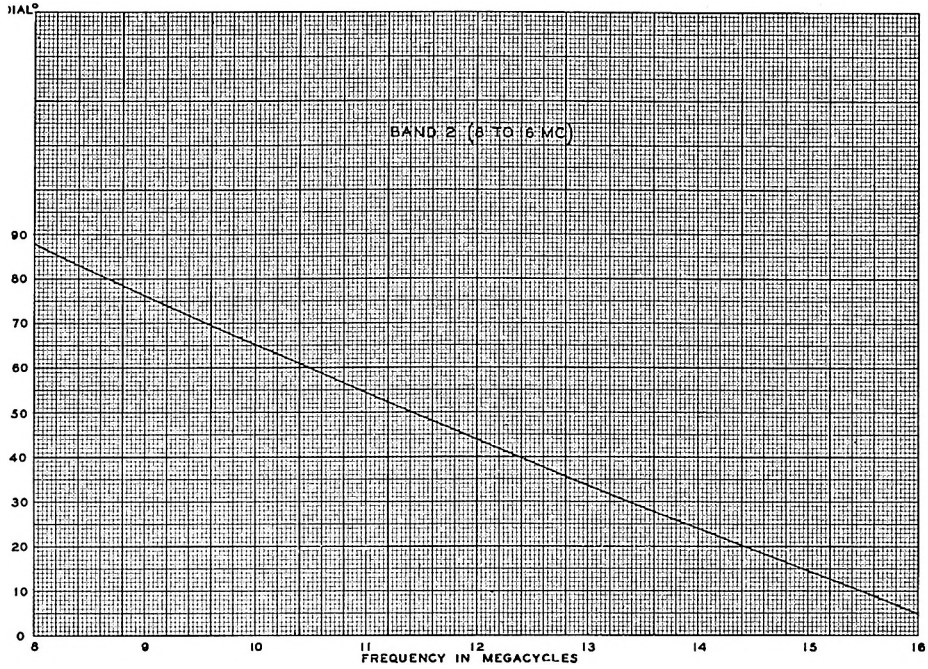


Figure 26B. Exciter Tuning Curve

**SECTION IV  
ADJUSTMENTS**

with FSK coupling unit if desired. The operating frequency of the transmitter is normally four times the crystal frequency.

4.6.2. Exciter Tuning. (See figure 26A, B.) The 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 crystal is multiplied. The EXCITER TUNING control operates the variable capacitors in the crystal oscillator and intermediate amplifier plate tank circuits.

The exciter tuning procedure is outlined below, together with the band switch positions and the approximate frequency range covered by each:

EXCITER BAND SWITCH Position	Frequency Range
1	16 - 26 mc
2	8 - 16 mc
3	4 - 8 mc
4	2 - 4 mc

(a) After the Autotune has been dialed to select the proper crystal, operate the EXCITER BAND SWITCH to the position that includes the frequency upon which operation is desired.

(b) Operate the GRID CURRENT switch, S101, (located on top left-hand side of r-f unit) to the 4-125A 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 TUNE-OPERATE switch to the L. V. TUNE position.

(e) When the time delay relay and the interlock relay have operated, apply plate voltage (500V) 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. Refer to figure 26 for the approximate setting of the control for the frequency that has been selected.

(h) With the EXCITER TUNING set in the position that gives the maximum intermediate amplifier grid current meter reading, lock the stop rings by operating the locking bar in a clockwise direction. (NOTE: ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

(i) Release the TEST switch and press the PLATE STOP button.

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 intermediate amplifier power amplifier and antenna coupling circuits, before going on to the next channel.

4.6.3. Intermediate Amplifier Tuning. (See figure 27A.) The tank circuit mounted in the power amplifier unit combines the intermediate amplifier plate tank and power amplifier grid tank circuits.

The INT. AMP. BAND SWITCH positions and the approximate frequency range covered by each are listed below:

INT. AMP. BAND SWITCH Position	Frequency Range
1	20 mc to 26 mc
2	16 mc to 20 mc
3	12 mc to 16 mc
4	9 mc to 12 mc
5	7 mc to 9 mc
6	5.0 mc to 7 mc
7	4.0 mc to 5.0 mc
8	3.3 mc to 4.0 mc
9	3.0 mc to 3.3 mc

(a) Unlock the Autotune stop rings on the INT. AMP. BAND SWITCH and the INT. AMP. TUNING controls.

(b) Refer to the table above and operate the INT. AMP. BAND SWITCH to the range position that contains the frequency upon which operation is desired. Always approach the switch position in a clockwise direction.

(c) Operate the TUNE-OPERATE switch to the H. V. TUNE position.

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

(e) Apply FILAMENT and PLATE voltages.

(f) Operate the TEST switch and immediately resonate the circuit by operating the INT. AMP. TUNING control. (Resonance indicated by sharp dip in INT. AMP. PLATE CURRENT.)

If resonance cannot be established, release the TEST switch and try another position of the INT. AMP. BAND SWITCH.

**NOTE**

Considerable care should be exercised when choosing the position for the INT. AMP. BAND SWITCH. It is possible to obtain the wrong harmonic output from the exciter if the correct position of the switch is not chosen. It should not be necessary to operate the switch more than one position in either direction from those given in the above table for any chosen frequency.



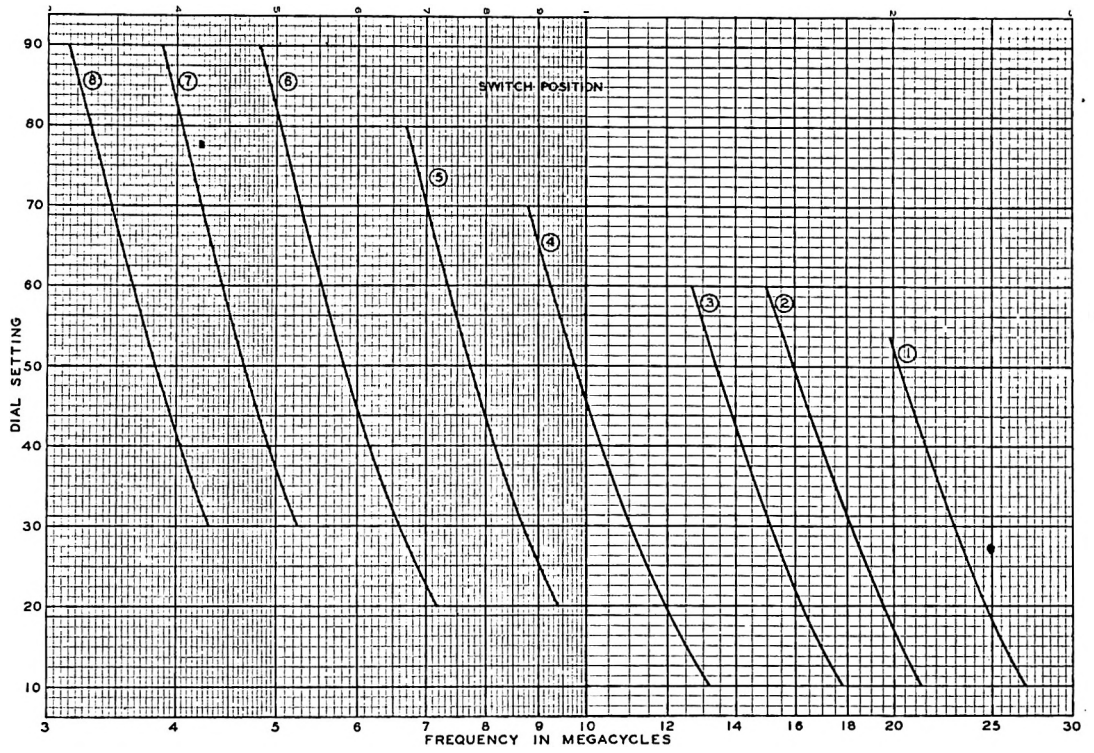


Figure 27A. Intermediate Amplifier Tuning Curve

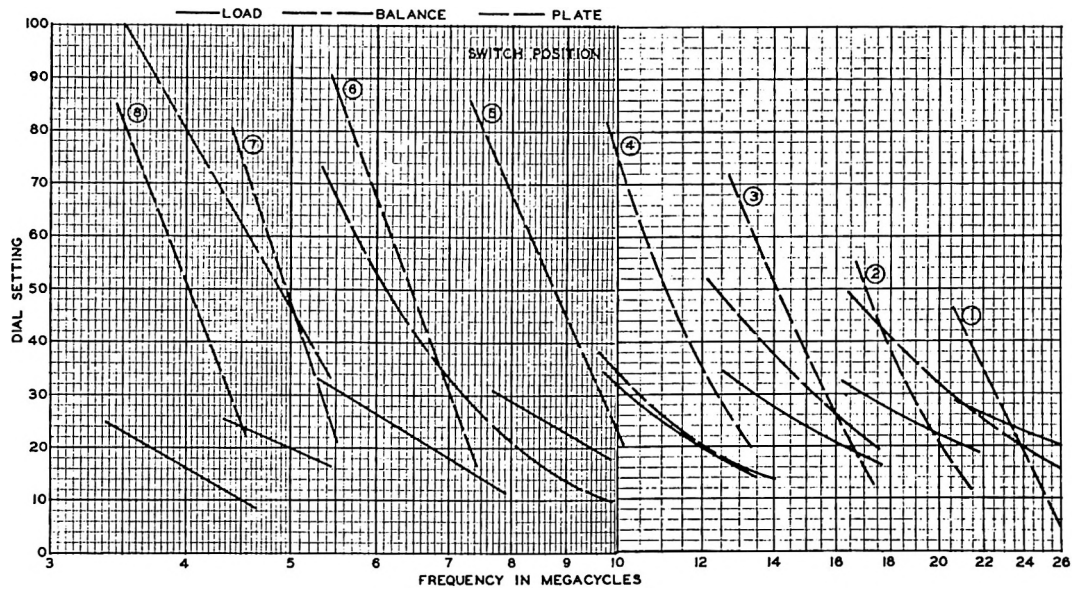


Figure 27B. Typical Tuning Curve Output Network with 600  $\Omega$  Balanced Load

SECTION IV  
ADJUSTMENTS

4.6.4. Power Amplifier and Antenna Tuning. (See figure 27B and 28.) This transmitter has been designed for operation into an unbalanced or balanced antenna system. Either type of operation may be selected at will. The power amplifier plate tank and antenna loading circuits are combined in a pi network. The network is designed to couple the output of the power amplifier to an unbalanced or balanced antenna system. (The balancing circuit must be used when exciting a balanced 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  $\pm 0$  degrees, 70 to 850 ohms with a phase angle of  $\pm 45$  degrees, and 100 to 600 ohms with a phase angle of  $\pm 60$  degrees. (Refer to figure 27.) The balancing circuit when used will permit operation into a transmission line of 300 to 1200 ohms resistive, with a standing wave of up to 2-to-1 ratio.

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	20 mc to 26 mc
2	16 mc to 20 mc
3	12 mc to 16 mc
4	9 mc to 12 mc
5	7 mc to 9 mc
6	5.5 mc to 7 mc
7	4.5 mc to 5.5 mc
8	3.5 mc to 4.5 mc
9	3 mc to 3.5 mc

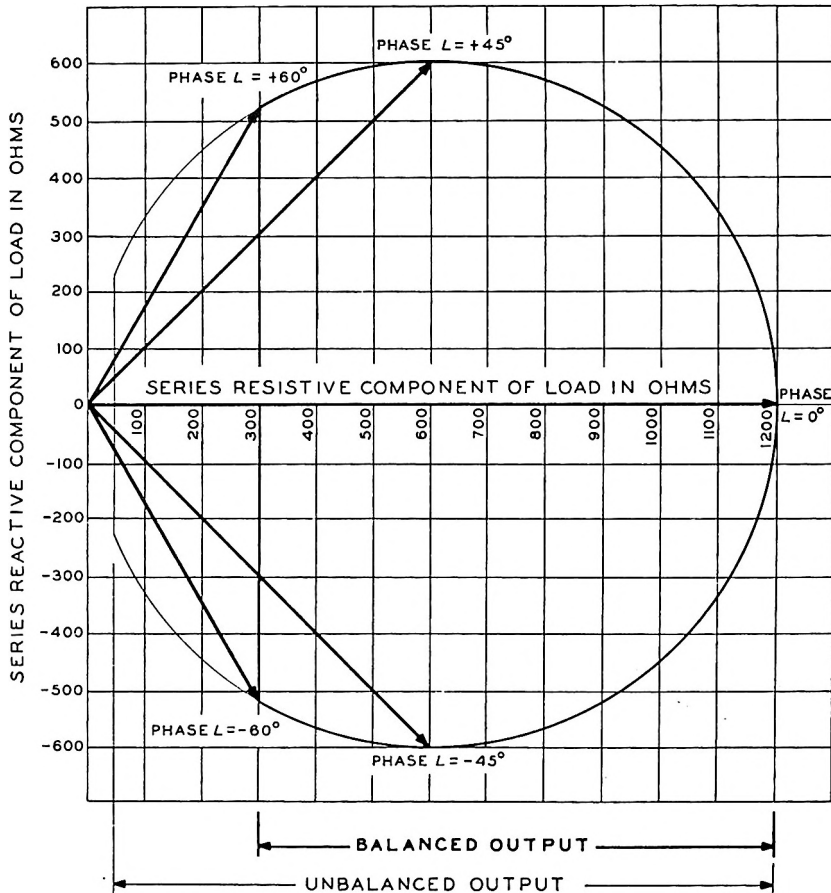


Figure 28. Output Network Impedance Matching Range

IMPORTANT

When a frequency in the range 12 mc to 26 mc has been chosen, select the POWER AMP. BAND SWITCH position so that resonance of the power amplifier plate tank circuit is obtained with the POWER AMP. TUNING control set to near minimum capacity. When a frequency in the range 4 mc to 12 mc is chosen, choose the POWER AMP. BAND SWITCH position that permits tuning with the greatest amount of capacity.

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 the four Autotune units on the output network unit.

(b) Set the ANTENNA SELECTOR and BALANCING control.

1. For operating into an unbalanced antenna system, turn this control to the "Unbalanced Output" position.

2. When operating into a balanced antenna system, turn the control until the engraved dial divisions are opposite the fixed indicator line. Set initially at midscale.

(c) Refer to the table above and operate the POWER AMP. BAND SWITCH to the range position that contains the frequency upon which operation is desired.

(d) Operate the ANTENNA TUNING control to approximately midscale.

(e) With the TUNE-OPERATE switch in the H. V. TUNE position and the LOCAL-REMOTE switch in the LOCAL position, apply FILAMENT and PLATE voltages.

(f) Operate the TEST switch and immediately attempt to resonate the power amplifier plate tank circuit by operating the POWER AMP. TUNING control. (Resonance indicated by sharp dip in PWR. AMP. PLATE CURRENT.) If resonance cannot be established, operate the ANTENNA TUNING control about 25 divisions in either direction and make another attempt to resonate the circuit.

(g) If it is impossible to obtain resonance no matter where the ANTENNA TUNING control is set, release the TEST switch and try another position of the POWER AMP. BAND SWITCH and repeat step (e).

WARNING

BE CAREFUL NOT TO DOUBLE FREQUENCY IN THIS STAGE. REFER TO TABLE OF BAND SWITCH POSITIONS VERSUS FREQUENCY RANGE.

(h) Using the ANTENNA TUNING control, load the power amplifier stage until the PWR. AMP. PLATE CURRENT meter indicates 0.4 amp. While increasing the loading with the ANTENNA TUNING control, keep the tank circuit in resonance with the POWER AMP. TUNING control. The ANTENNA TUNING control should be operated toward 0 dial setting to increase loading. If the transmitter is operating into a balanced antenna system, rotate the ANTENNA SELECTOR and BALANCING control until the antenna ammeters M106 and M107 read the same. The PWR. AMP. PLATE CURRENT meter may change with this adjustment. Reset the ANTENNA TUNING and the POWER AMP. controls until 0.4 amps is obtained again.

(i) Operate the TUNE-OPERATE switch to the OPERATE position and repeat step (g) until the PWR. AMP. PLATE CURRENT meter indicates 1.0 amp.

(j) At the lower frequencies the power amplifier will operate at best efficiency if tuned on the high efficiency side of resonance as evidenced by an increase in antenna current and a decrease in plate color.

(k) When loading has been completed, lock the stop rings on the four controls on the output network unit by operating the locking bars in a clockwise direction. (NOTE: ALWAYS APPROACH A DIAL SETTING IN A CLOCKWISE DIRECTION.)

This completes the adjustment of the r-f circuits for one frequency channel. Repeat the procedure outlined under 4.6.1., 4.6.2., 4.6.3., and 4.6.4. for the remaining ten frequency channels. NOTE: Channel 11 may be selected by dialing AA1.

4.7. NEUTRALIZATION. To obtain the best performance from the r-f circuits both the intermediate amplifier and power amplifier circuits require neutralization.

The intermediate amplifier tubes, V105 and V106, are of the tetrode type (4-125A). The internal construction of this type of tube greatly reduces the feedback but it has been found that the performance of the stage is greatly improved if a small external neutralizing capacity is added. In this application, an adjustable metal plate has been mounted near the two type 4-125A tubes. The amount of capacitance may be changed by moving the plate nearer to or away from the tubes.

A semivariable capacitor, consisting of two aluminum disks, is used to neutralize the power amplifier stage. The neutralizing capacitor is mounted near the power amplifier tubes, V114 and V115, on the cabinet wall. The capacity may be changed by changing the gap between the two disks. The adjusting screw is held in position by a locking nut.

Both the intermediate amplifier and power amplifier stages were neutralized properly at the factory and the neutralizing capacitors locked in position. No adjustment of these capacitors should be made until it has been proved definitely that the circuit or circuits require some change in feedback capacity.

## SECTION IV ADJUSTMENTS

Proper neutralization of a circuit is indicated by the simultaneous occurrence of maximum grid current and minimum plate current of the stage being checked.

### NOTE

The changing of tubes may necessitate re-neutralizing a circuit.

4.7.1. Intermediate Amplifier Neutralization. Before changing the position of the plate (capacitor C143), carefully check the operation of the intermediate amplifier stage.

4.7.1.1. Neutralization Check. Follow the procedure outlined below for checking the neutralization of this circuit:

- (a) Operate the GRID CURRENT switch (top of r-f exciter chassis to the 4-125A position).
- (b) Operate the TUNE-OPERATE switch to the H. V. TUNE position.
- (c) Apply FILAMENT and PLATE power.
- (d) Unlock the stop rings on the INT. AMP. TUNING control.
- (e) Operate the TEST switch to the locking position.
- (f) While observing the INT. AMP. PLATE CURRENT and the EXCITER GRID CURRENT meters, rotate the INT. AMP. TUNING control through resonance. The INT. AMP. PLATE CURRENT meter should indicate a minimum at the same time as the EXCITER GRID CURRENT meter indicates a maximum.

### NOTE

A slight deviation from the above condition will not affect materially the operation of the transmitter. Due to manufacturing tolerances, it may be impossible to obtain perfect neutralization of the intermediate amplifier circuit.

(g) If the maximum grid current and minimum plate current readings do not occur simultaneously, or nearly so, proceed as outlined under section 4.7.1.2.

(h) Press the PLATE STOP switch.

4.7.1.2. Neutralization Procedure. If it has been proved that some readjustment of the neutralizing capacity is necessary (refer to 4.7.1.1.), proceed as outlined below:

(a) Operate the transmitter circuit breaker to the OFF position and operate the TUNE-OPERATE switch to the H. V. TUNE position.

### WARNING

DO NOT ATTEMPT ANY NEUTRALIZATION ADJUSTMENTS WITH THE PLATE VOLTAGE (4000 V) ON. OPENING THE TEST KEY DOES NOT REMOVE PLATE VOLTAGE. PRESS THE PLATE STOP SWITCH.

(b) Open the cabinet door and loosen the two nuts that hold the neutralization capacitor (plate near 4-125A's) in position.

(c) Move the plate (neutralizing capacitor) a fraction of an inch in either direction and close the cabinet door.

(d) Operate the circuit-breaker to the ON position and the LOCAL-REMOTE switch to the LOCAL position.

(e) Press the FILAMENT START switch.

(f) When the time delay relay and interlock relays have operated, press the PLATE START switch.

(g) Loosen the locking bar on the INT. AMP. TUNING control.

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

(i) Rotate the INT. AMP. TUNING control through resonance while observing the INT. AMP. PLATE CURRENT and EXCITER GRID CURRENT meters. (Proper neutralization is indicated by the simultaneous occurrence of minimum INT. AMP. PLATE CURRENT and maximum EXCITER GRID CURRENT.)

(j) If the intermediate amplifier circuit is not neutralized properly, press the PLATE STOP button and try another setting of the neutralizing capacitor.

(k) Repeat steps (f) thru (i) until the condition stated under step (i) is met or as nearly met as is possible.

(l) Press the PLATE STOP switch and tighten the neutralizing capacitor lock nuts.

4.7.2. Power Amplifier Neutralization. Before changing the air gap between the disks of the neutralizing capacitor, carefully check the operation of the power amplifier stage to be sure that a change in neutralizing capacity is necessary. The changing of power amplifier tubes does not usually necessitate changing the neutralizing capacity.

4.7.2.1. Neutralization Check. Follow the procedure outlined below for the checking of the neutralization of the power amplifier circuit:

(a) Operate the TUNE-OPERATE switch to the H. V. TUNE position.

(b) Apply FILAMENT and PLATE power.

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

(d) While watching the PWR. AMP. PLATE CURRENT and the PWR. AMP. GRID CURRENT meters, rotate the POWER AMP. TUNING control through resonance. (The PWR. AMP. PLATE CURRENT meter should indicate a minimum at the same time that the PWR. AMP. GRID CURRENT meter indicates a maximum.)

(e) If the condition stated above does not exist, some adjustment of the neutralizing capacity will be necessary.

(f) Press the PLATE STOP switch.

(g) Refer to 4.7.2.2. for the neutralization procedure.

4.7.2.2. Neutralization Procedure. The procedure that is outlined below, should be followed in detail to obtain proper neutralization of the power amplifier circuit:

#### WARNING

DO NOT ATTEMPT ANY NEUTRALIZATION ADJUSTMENTS WITH THE PLATE VOLTAGE (4000 V) ON. OPENING THE TEST KEY DOES NOT REMOVE PLATE VOLTAGE. PRESS THE PLATE STOP SWITCH.

(a) After having checked the operation of the power amplifier circuit, as outlined under 4.7.2.1., and with the PLATE power off, loosen the locking nut on the lower disk section of the neutralizing capacitor, C157, (mounted on left-hand inner wall of radio transmitter cabinet.)

(b) Using a screwdriver, rotate the adjusting screw a fraction of a revolution.

(c) With the TUNE-OPERATE switch in the H. V. TUNE position and the LOCAL-REMOTE switch in the LOCAL position, apply FILAMENT and PLATE power.

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

(e) While observing the PWR. AMP. PLATE CURRENT and PWR. AMP. GRID CURRENT meters, rotate the POWER AMP. TUNING control through resonance. Record the dial reading of the PWR. AMP. TUNING control at point of minimum PWR. AMP. PLATE CURRENT. Maximum capacity corresponds to a dial reading of 100, minimum capacity to zero. Continue to rotate the tuning control either left or right until the maximum point of PWR. AMP. GRID CURRENT is reached and record this dial reading. Subtract the first recorded reading from the last. If a positive answer is obtained this indicates that the capacity of C157 must be decreased. A negative answer indicates that more capacity is needed.

(f) Press the PLATE STOP switch.

(g) Rotate the capacitor (C157) adjusting screw in the direction indicated by (e) clockwise to increase the capacity, counterclockwise to decrease the capacity. The amount of rotation depends on the magnitude of the difference between the recorded readings.

(h) Press the PLATE START switch.

(i) Repeat steps (e) through (h) until the difference between recorded readings becomes practically zero.

4.8. AUDIO CIRCUIT ADJUSTMENT. Two adjustments are provided in the speech amplifier in the transmitter, one to regulate the input to the first amplifier stage of the unit, and the other to control the amount of compression. When once adjusted properly, 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 begin at the remote control unit.

An audio oscillator capable of putting out 0 db in the frequency range 500 cps to 1500 cps will be necessary in order to make the adjustments of the controls. While not absolutely essential, an oscilloscope is of considerable value when making transmitter adjustments.

The following procedure is recommended for the adjustment of the audio controls.

4.8.1. Remote Control Unit Adjustments. (Although the adjustment procedure outlined below is given with reference to the type 177G-9 Remote Unit, the procedure, with appropriate changes in symbol numbers, applies equally well to the type 177G-10 Remote Unit.) 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 cannot exceed 25 db or the line loop resistance cannot exceed 1000 ohms. When more than one remote control unit is to be used, preliminary adjustments should be made first on the control unit that is farthest from the transmitter. The procedure outlined below should be followed when making the adjustments of the controls on the remote control unit that is farthest from the transmitter:

(a) Connect the output of the audio oscillator to terminals #6 and #8 on terminal strip E402 on the rear of the remote control unit.

(b) Rotate the GAIN control, R401, as far as possible in a counterclockwise direction.

(c) Apply filament and plate power to the tubes in the unit by operating the power switch, S401, to the ON position.

## SECTION IV ADJUSTMENTS

(d) Adjust the audio oscillator frequency to 1000 kc and partially advance the oscillator gain control.

(e) When the tubes in the remote control unit have reached operating temperature, rotate the GAIN control in a clockwise direction until the output level meter, M402, indicates zero db. (Zero level corresponds to 6 mw into 500 ohms.)

(f) Insert the telegraph key cord plug into the KEY jack, J401, and operate the shorting lever to the closed position.

4.8.2. Transmitter Control Adjustments. With the controls on the remote control unit 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:

### 4.8.2.1. Speech Amplifier and Limiter Adjustments.

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

(b) Operate the LOCAL-OPERATE switch to the REMOTE position.

(c) Operate the TUNE-OPERATE switch to the OPERATE position.

(d) Close the transmitter cabinet doors and operate the circuit breaker to the ON position.

(e) When the time delay and the interlock relays have operated observe the reading on the AUDIO LEVEL meter in the Collins Type 1025-4 Modulator Unit.

(f) Advance the AUDIO GAIN control 5 dial divisions.

(g) Observe the level on the AUDIO LEVEL meter.

(h) Adjust the AUDIO GAIN control until the AUDIO LEVEL meter indicates zero db.

(i) Open the modulator cabinet door and advance the LIMITER GAIN control approximately 5 dial divisions.

(j) Close the cabinet door and when the time delay relay and interlock relays have operated observe the reading on the AUDIO LEVEL meter. (The LIMITER GAIN control is set properly when the AUDIO LEVEL meter indicates that the output level of the audio drivers has dropped 2 db.)

(k) If the audio level has not dropped 2 db, open the cabinet door and advance the LIMITER GAIN control a fraction of a dial division.

(l) Repeat step (k) until the AUDIO LEVEL meter indicates that the output of the audio driver stage has dropped 2 db.

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

Now the transmitter is ready for operation with voice emission. No further adjustment of the AUDIO GAIN and the LIMITER GAIN controls will be necessary for REMOTE operation.

## IMPORTANT

THE LIMITER GAIN CONTROL NOW IS PROPERLY ADJUSTED FOR BOTH THE LOCAL AND REMOTE OPERATION AND UNDER NO CIRCUMSTANCES SHOULD THE SETTING OF THIS CONTROL BE CHANGED.

While observing the AUDIO LEVEL meter on the transmitter proper, have someone speak into the microphone that is used in conjunction with the control unit nearest to the transmitter, and have him adjust the GAIN control on the control unit panel until the meter (transmitter AUDIO LEVEL meter) indicates 0 db on voice peaks.

### 4.8.2.2. MCW Control Adjustments.

(a) Open the modulator cabinet door and rotate the MCW GAIN control as far as possible in a counterclockwise direction.

(b) Returning to the remote control unit, dial A2.

(c) Return to the transmitter proper, open the modulator cabinet door and advance the MCW GAIN control 5 dial divisions.

(d) Close the cabinet door and when the time delay relay and interlock relays have operated, observe the reading on the AUDIO LEVEL meter. (When the MCW GAIN control is adjusted properly the AUDIO LEVEL meter will indicate -2 db.)

(e) If the modulation level is too low, open the modulator cabinet door and advance the MCW GAIN control a fraction of a dial division.

(f) Close the modulator cabinet door and when the time delay relay and interlock relays have operated, observe the reading on the AUDIO LEVEL meter.

(g) Repeat steps (e) and (f) until the AUDIO LEVEL meter indicates -2 db.

The transmitter circuits now are adjusted properly 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 or A2, respectively.

To complete the control adjustments return to the remote control unit upon which adjustments were made under section 4.9.1., insert the microphone cord plug into plug receptacle J402 and, while speaking into the microphone at normal level, adjust the GAIN

control on the remote control unit panel until the needle of the output meter swings up to zero db on voice peaks.

4.9. LOCAL CONTROL (VOICE). If it is desired to operate with LOCAL control and VOICE emission follow the procedure outlined below for the adjustment of the AUDIO GAIN control:

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

(b) Insert the microphone cord plug into the MICROPHONE jack or remove door handset from hook.

(c) Carefully observe the position of the AUDIO GAIN control so that the control may be reset to this position when returning to REMOTE operation.

(d) Turn the transmitter on by operating the FILAMENT START switch and when the time delay relay and interlock relays have operated press the PLATE START switch.

(e) Dial A3.

(f) Operate the push-to-talk switch on the microphone or handset and while speaking into the microphone at normal voice level observe the reading on the AUDIO LEVEL meter on voice peaks.

(g) Adjust the AUDIO GAIN control on the modulator bay control panel until the audio level meter swings up to zero db on voice peaks.

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 FOR REMOTE OPERATION.

4.10. EMISSION SELECTION. While the transmitter connections are normal for VOICE emission, either CW or MCW emission may be selected automatically if the proper connections are made on plug P104 on the r-f exciter 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 selected automatically for the Autotune channels if connections are made to plug terminal 15.

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

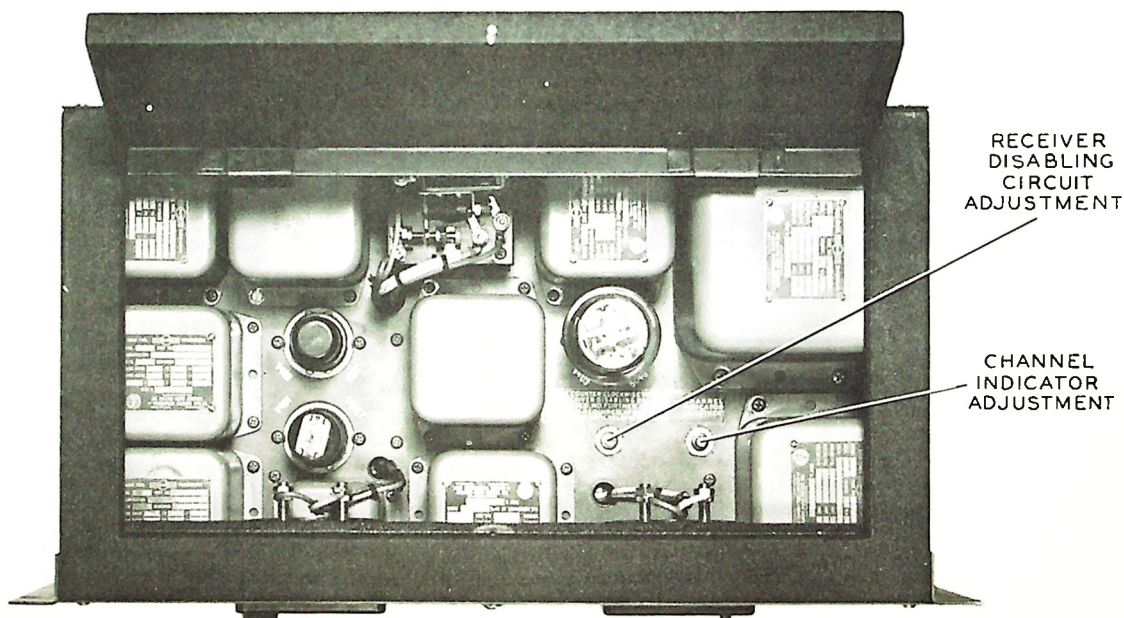


Figure 29. Type 177G-9 Remote Control Unit - Top

## SECTION IV ADJUSTMENTS

4.11. CHANNEL INDICATOR AND DISABLING CIRCUIT ADJUSTMENT. (Although the adjustment procedure outlined below is given with reference to the type 177G-9 Remote Control Unit, the procedure, with appropriate changes in symbol numbers, applies equally well to the type 177G-10 Remote Control Unit.) Refer to figure 29.

4.11.1. Channel Indicator Adjustment. The remote control unit has been provided with a channel indicator so 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, R406, has been connected between the meter and ground. The operating knob is located on the top rear edge of the chassis. 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.

4.11.2. Receiver Disabling Circuit Adjustment. A receiver disabling circuit has been incorporated in the remote control unit. The relay, K402, releases when the push-to-talk switch on the microphone is pressed or the telegraph key is closed. A variable resistor, R419, has been connected in the circuit to provide a means of bucking the bias voltage applied to the transmitter keyer which is applied also 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, R419, 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 CLOCKWISE FARTHER THAN NECESSARY FOR PROPER OPERATION OF RELAY K402 AS IT MAY PLACE SUFFICIENT VOLTAGE ON THE CARRIER CONTROL LINE TO OPERATE THE TRANSMITTER CARRIER CONTROL CIRCUIT.

4.12. LIMITER BIAS ADJUSTMENT. For best transmitter performance, the voltage that is applied to the grids of the limiter tube V302, should be -25 volts. This voltage also operates the push-to-talk relay K302. A potentiometer has been connected across the output of the bias supply so that the voltage applied to these grids may be adjusted. The potentiometer, R217, is mounted on the rear of the vertical chassis.

## CAUTION

PLATE VOLTAGE CAN BE REMOVED ONLY BY PRESSING THE PLATE STOP SWITCH WHILE IN LOCAL POSITION OR OPERATING CIRCUIT BREAKER TO THE OFF POSITION. OPENING THE TEST KEY WILL NOT REMOVE THE PLATE VOLTAGE. VOLTAGES ARE IN THE VICINITY OF 500 VOLTS.

The procedure outlined below should be followed for the checking and adjustment of the bias voltage:

(a) Operate the circuit breaker to the OFF position.

(b) Open the rear door of the Collins Type 1016-5 Radio Transmitter Unit cabinet.

(c) Connect a d-c voltmeter between the chassis and terminal 37 on plug receptacle J309.

(d) Open the front door of the Collins Type 1100C-2 Rectifier Power Unit cabinet and operate the ADJUST-OPERATE switch to the ADJUST position.

(e) Close the front door of the rectifier power unit.

(f) Operate the circuit breaker to the ON position.

(g) Operate the TUNE-OPERATE switch to the L. V. TUNE position.

(h) Press the FILAMENT START switch.

(i) When the time delay relay and interlock relays have operated, press the PLATE START switch.

(j) Observe the reading on the voltmeter. If the meter does not indicate -25 volts some adjustment of the potentiometer will be necessary. If some adjustment of the bias voltage is necessary, proceed as follows:

1. Operate the circuit breaker to the OFF position.



2. Open the rear door of the Collins Type 1100C-2 Rectifier Power Unit. Remove the lock nut from potentiometer R217 (potentiometer nearest left-hand edge of vertical chassis, as viewed from the rear).

3. Using a screwdriver, rotate the potentiometer shaft to raise or lower the bias voltage as necessary. (To raise the voltage, rotate the shaft a few degrees in a clockwise direction.)

4. Close the rear door of the Collins Type 1100C-2 Rectifier Power Unit cabinet, operate the circuit breaker to the ON position, and apply FILAMENT and PLATE voltages.

(k) Check the voltage by observing the reading on the voltmeter.

(l) Repeat step (j) until the voltmeter indicates -25 volts.

#### 4.13. MODULATOR BIAS VOLTAGE ADJUSTMENT.

A potentiometer connected in the bias supply output circuit permits the adjusting of the voltage that is applied to the grids of the modulator tubes (V311 and V312). The potentiometer R203 was adjusted at the factory and should not require any further adjustment until the modulator tubes are changed. Even then it may not be necessary to change the setting of the control. The characteristics of tubes vary somewhat and the bias voltage required to give a certain static plate current for one set of tubes may be different from that required to give the same static plate current for another set of the same type of tubes. The setting of potentiometer R203 is not extremely critical but adjustment should be made so that with full voltage on the plates and with no audio input the static plate current, as indicated on the MOD. PLATE CURRENT meter, is between 100 ma and 200 ma.

To check the bias on the modulator tube grids, operate the TUNE-OPERATE switch to the OPERATE position, apply FILAMENT and PLATE voltages and observe the reading on the MOD. PLATE CURRENT meter.

If the reading is below 100 ma or above 200 ma, some adjustment of the bias voltage that is being applied to the modulator tube grids will be necessary. The procedure outlined below should be followed for the adjustment of the bias voltage:

(a) After checking the modulator static plate current, operate the circuit breaker to the OFF position.

#### CAUTION

PLATE VOLTAGE CAN BE REMOVED ONLY BY PRESSING THE PLATE STOP SWITCH WHILE IN LOCAL POSITION OR OPERATING CIRCUIT BREAKER SWITCH TO THE OFF POSITION. OPENING THE TEST KEY WILL NOT REMOVE THE PLATE VOLTAGE. VOLTAGES ARE IN THE VICINITY OF 4000 VOLTS.

(b) Open the rear door of the Collins Type 1100C-2 Rectifier Power Unit, remove the lock nut from the shaft of R203 (potentiometer nearest center of vertical chassis) and using a screwdriver rotate the potentiometer shaft a few degrees.

#### IMPORTANT

TO INCREASE THE VOLTAGE THAT IS APPLIED TO THE MODULATOR TUBE GRIDS, (REDUCE THE STATIC PLATE CURRENT) ROTATE THE POTENTIOMETER SHAFT IN A CLOCKWISE DIRECTION.

(c) Close the cabinet door and operate the circuit breaker to the ON position.

(d) Apply FILAMENT and PLATE power.

(e) Observe the modulator static plate current on the MOD. PLATE CURRENT meter.

(f) Repeat the above procedure until the modulator static plate current is between 100 ma and 200 ma.

SECTION 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. ROUTINE OPERATING PROCEDURE.

5.2.1. 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 emissions:

## NOTE

The operation of the TIME DELAY relays in the transmitter, applying plate voltage (4000 volts) to the transmitter power amplifier and modulator tubes, is indicated by the operation of the CHANNEL INDICATOR meter on the panel of the remote control unit. If the CHANNEL INDICATOR does not operate within one minute or less, check to be sure that channel 11 or manual has not been selected. The CHANNEL INDICATOR will indicate OFF in either case.

## (a) VOICE Emission

1. Operate the control unit power switch to the ON position. (IMPORTANT: The transmitter circuit breaker, S211, 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. Dial A3 to set up the transmitter circuits for VOICE emission.

4. Operate the push-to-talk switch on the microphone.

5. Speak into the microphone and check the audio level on meter M402.

6. Continue operation using the microphone push-to-talk switch to control the carrier and the telephone dial to select the frequency channels.

7. 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 (if A2 emission is not automatically selected).

4. Insert the key cord plug into the KEY jack.

5. When the TIME DELAY relay has closed, as indicated by the operation of the CHANNEL INDICATOR, operate the telegraph key to control the emission.

6. Turn the transmitter off by dialing A0.

5.2.2. 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. Insert the microphone cord plug into the MICROPHONE jack.

4. Select the desired frequency channel by dialing.

SECTION V  
OPERATION

5. Press the FILAMENT START button.

6. When the TIME DELAY and interlock relays have operated, apply plate voltages (4000 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 (4000 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 ON 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 (4000 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.

When manual tuning is selected the transmitter controls may be operated without disturbing the Autotune mechanism.

WARNING

WHEN DIALING MANUAL (AA2) TO SET UP A FREQUENCY INDEPENDENT OF THE 11 PRESET CHANNELS, ALL DIALS WILL COME TO REST AT THE EXTREME CLOCKWISE END OF TRAVEL. NO PART OF THE ENGRAVED SCALES ARE THEN ADJACENT TO THE INDICATOR MARKS. THEREFORE, ALL DIALS SHOULD BE ROTATED COUNTERCLOCKWISE SUFFICIENTLY TO REACH THE ENGRAVED PORTION OF THE DIALS. THE DIALS MAY THEN BE SET UP IN THE NORMAL MANNER. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN THE DIALS SLIPPING ON THE SHAFTS WITH CONSEQUENT INVALIDATION OF ALL CALIBRATIONS OF THE 11 PRESET CHANNELS.

SECTION 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 adjusted properly before leaving the factory, some maintenance and adjustment of the units may be necessary to maintain dependable and efficient operation. If it becomes necessary to replace 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 units from the casting assemblies for lubrication. If the Autotune cover plates are removed the Autotune units are easily accessible and may be lubricated without dismantling the assemblies. The gears that couple the line shafts to the interconnecting drive shafts are enclosed in small boxes near the left-hand ends of the Autotune castings. To gain access to these gears the small cover plates should be removed.

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

## WARNING

THE AUTOTUNE CLUTCHES MAY SQUEAK BUT UNDER NO CONDITION SHOULD ANY LUBRICANT BE APPLIED TO THE CLUTCH BAND. THE SQUEAKING IS CAUSED BY THE FRICTION OF THE BRAKE BAND AGAINST THE BRAKE DRUM AND DOES NOT DAMAGE THE CLUTCH.

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 or annually.

Three (3) types of lubricants are required for the Autotune mechanism. It is of utmost importance that the correct type of lubricant be used. The following lubricants have been proven to be most satisfactory for this purpose:

(a) Vactra Oil, Extra Heavy X - Produced by the Socony-Vacuum Oil Company.

(b) "Trojan" Grease, Grade MO - Produced by the Cities Service Oil Company.

(c) Colloidal Graphite (Trade Name Aquadag) - Produced by Acheson Colloids Corporation, Port Huron, Michigan.

Grease-impregnated wicks are used to provide proper lubrication in addition to the lubricants listed. These are held in place where necessary by special wick-holder assemblies. (See lubrication chart, figure 30, for exact locations.)

## NOTE

The letters shown before the list of lubricants above are used on drawings, figures 5, 6 and 30, to indicate the type of lubricant that is to be applied to the Autotune units at the designated points.

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

## (a) PARTS TO BE LUBRICATED EACH MONTH.

1. Remove the Autotune covers from the three (3) assemblies.

2. Lubricate the six (6) oilite bronze bearings in the r-f exciter unit Autotune casting, the one (1) oilite bronze bearing in the r-f exciter Autotune casting cross-shaft, the three (3) oilite bronze bearings in the power amplifier unit Autotune casting, the one (1) oilite bronze bearing in the power amplifier unit cross-shaft, the eight (8) oilite bronze bearings in the output network Autotune casting and the one (1) oilite bronze bearing in the output network cross-shaft with Vactra Oil.

## (b) PARTS TO BE LUBRICATED EVERY SIX MONTHS.

1. Remove the Autotune assembly covers and lubricate all of the parts listed under section (a) above.

2. Refer to figure 30 and lubricate the Autotune singleturn units as designated on these drawings.

3. Lubricate the universal coupler on the tap switch shaft in the r-f exciter unit and the two (2) universal couplers on the power amplifier unit with Vactra Oil.

4. Apply one or two drops of Vactra Oil to the four (4) tuning capacitor bearings in the r-f exciter unit, the two (2) tuning capacitor bearings in the power amplifier unit, the three (3) ball bearings at the rear of the output network unit, and the two (2) ball bearings of the center capacitor in this unit.

5. Apply one or two drops of Vactra Oil to each of the three (3) selector tap switch bearings in the r-f exciter unit and to each of the two selector tap switch bearings in the power amplifier unit.

SECTION VI  
MAINTENANCE

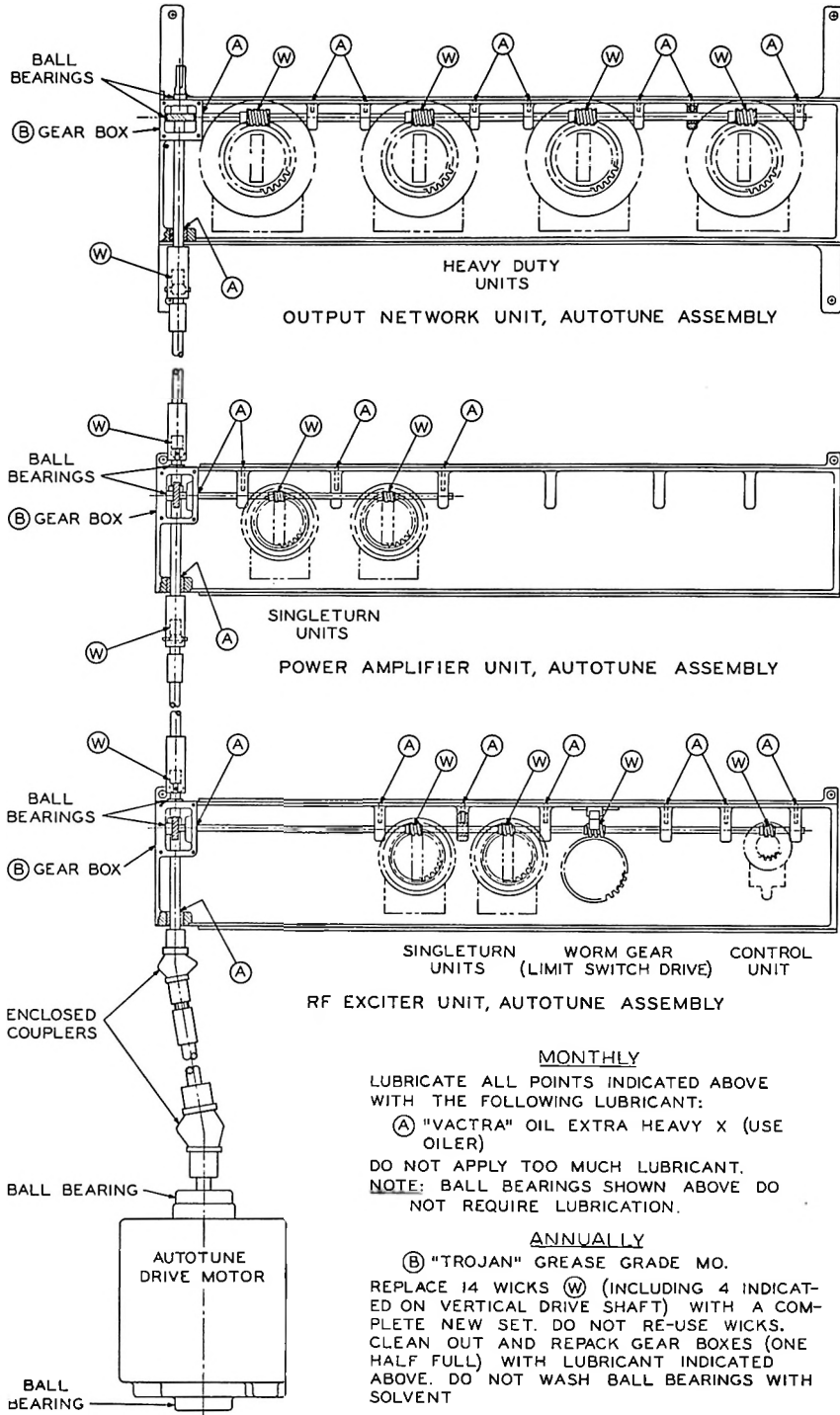


Figure 30. Autotune Lubrication Chart

## NOTE

Be very careful that none of the oil that is applied to the bearings runs down on the ceramic parts of the switches.

6. Apply a very thin film of petroleum jelly to all tap switch contacts (except in the output network) in the transmitter. Note: Be careful not to get any of the petroleum jelly on the ceramic parts of the switches.

7. Apply a thin film of Colloidal Graphite to all silver contact surfaces and collector rings on the tap switches in the output network unit. Note: Use a brush to apply the lubricant and be very careful not to leave any of the lubricant on ceramic parts because this lubricant is an electrical conductor.

8. Lubricate the four (4) collectors on the output network tuning capacitors with Colloidal Graphite.

9. The blower motor has wool-packed bearings and should be lubricated with Vactra Oil.

10. Lubricate the door latches and door hinges with Vactra Oil.

## (c) PARTS TO BE LUBRICATED ANNUALLY.

1. Remove the Autotune assembly covers and lubricate all of the parts listed under section (a) and (b) above.

2. Remove the cover plates from the gear boxes.

3. Clean out and repack gear boxes (one-half full). Use "Trojan" MO grease. Do not wash ball bearings with a solvent.

4. Replace 14 wicks (including 4 in vertical drive shafts) with a complete new set. DO NOT RE-USE WICKS. Refer to figure 30.

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:

(a) All pawls must be engaged before Autotune motor reverses.

(b) 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 operate fully 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 also may 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:

(a) Seeking switch makes contact.

(b) Relay operates (basic operate plus variations).

(c) 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.

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 manufacturing errors that may exist, such as deviations from 30 degree nominal 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 = 1725 RPM.

Relay Basic Operate Time = 12 milliseconds = 0.36 motor revolution.

Relay Variation = 10 milliseconds = 0.3 motor revolution.

Motor Basic Reverse Time = 0.2 revolution.

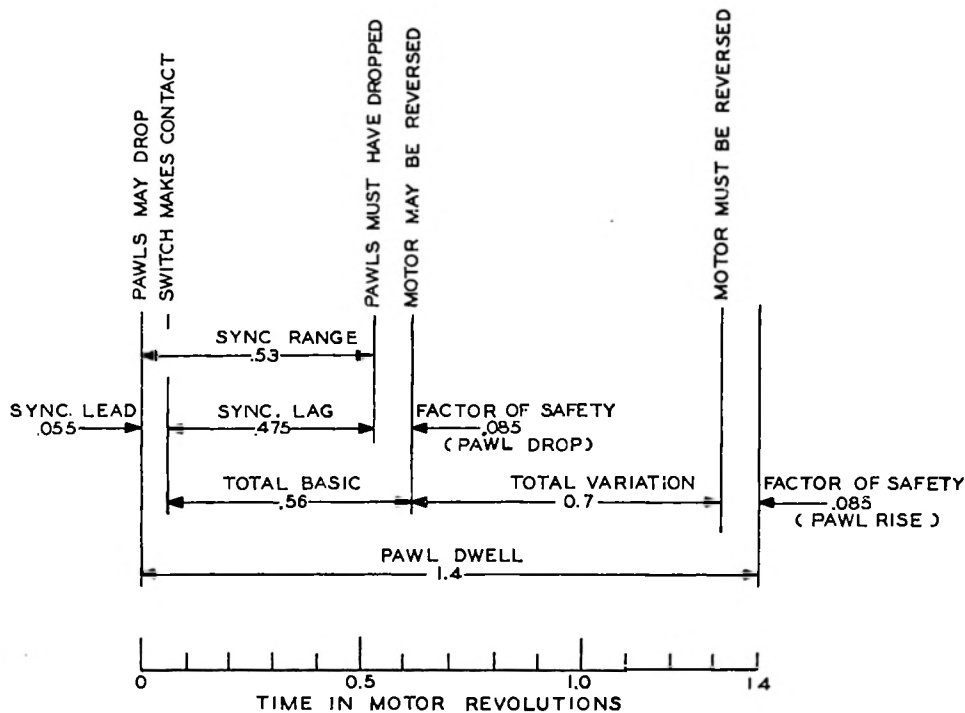
Motor Reversal Variation = 0.4 revolution.

Maximum Pawl Dwell = 1.4 motor revolutions.

Total Factor of Safety = 0.17 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. See figure 31.

SECTION VI  
MAINTENANCE



MOTOR SPEED	= 1725 R.P.M.
RELAY BASIC OPERATE TIME	= 12 MILLISECONDS - 0.36 MOTOR REVOLUTIONS
RELAY VARIATION	= 10 MILLISECONDS - 0.3 MOTOR REVOLUTIONS
MOTOR BASIC REVERSE TIME	= 0.2 MOTOR REVOLUTIONS
MOTOR REVERSAL VARIATION	= 0.4 MOTOR REVOLUTIONS
MAXIMUM PAWL DWELL	= 1.4 MOTOR REVOLUTIONS
TOTAL FACTOR OF SAFETY	= 0.17 MOTOR REVOLUTIONS

Figure 31. Autotune Time Base Diagram

The diagram applies to Collins Type 96J-6, 96J-7 and 96K-2 Autotune Heads. To apply this data to Type 96L-4 Heavy-Duty Heads, it is only necessary to apply a correction factor which takes into consideration the different cam drum contour. This type of head employs a milled cam slot of true circular shape, which allows a gradual drop of the pawl, in place of a quick drop. This drum is so designed that the effective pawl dwell is the same as for the 96J series heads. Since the beginning of pawl drop is the most readily found point to synchronize to, a correction factor equal to the distance from the start of pawl drop to the beginning of pawl dwell may be applied to the figures already obtained. This correction factor is equal to 0.91 motor revolution.

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

Cam drums on 96J-6 Singleturn and 96J-7 Singleturn Autotune Units must be adjusted so that the pawls

on any channel do not drop into engagement with cam drum more than 0.05 motor revolution before, nor more than 0.47 motor revolution after seeking switch makes contact.

Cam drums on Heavy-Duty 96L-4 Singleturn Autotune Units must be adjusted so that the pawls on any channel do not start to drop into engagement with cam drum more than 0.96 motor revolution before, nor less than 0.44 motor revolution after the 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 all 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 a singleturn unit has reached home stop and has ceased to turn. (A carpenter's brace and a length of 5/16-inch rod may be used to advantage.)

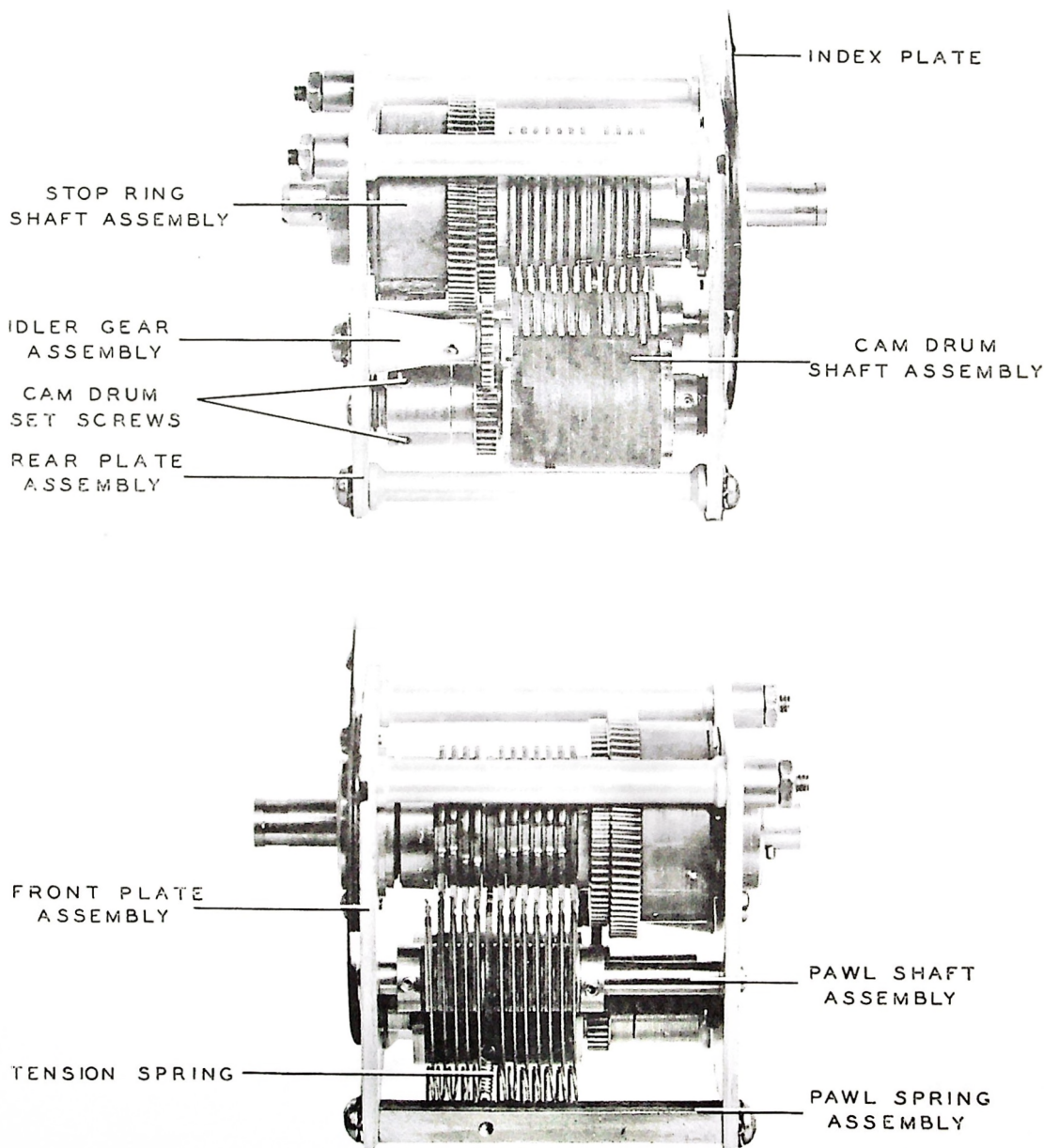


Figure 32. Singleturn Unit, Side



SECTION VI  
MAINTENANCE

(c) Connect an ohmmeter or continuity checker from the common connection to the channel selector switch, S108, 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 connection 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.

(d) 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 Heavy-Duty 96L-4 Autotune Units do not have a manual pawl.

(e) 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 of the 96J-6 and 96J-7 Autotune Units should drop into place within 0.05 revolution before or 0.47 revolution after the switch just makes contact. (Revolution, as used here,

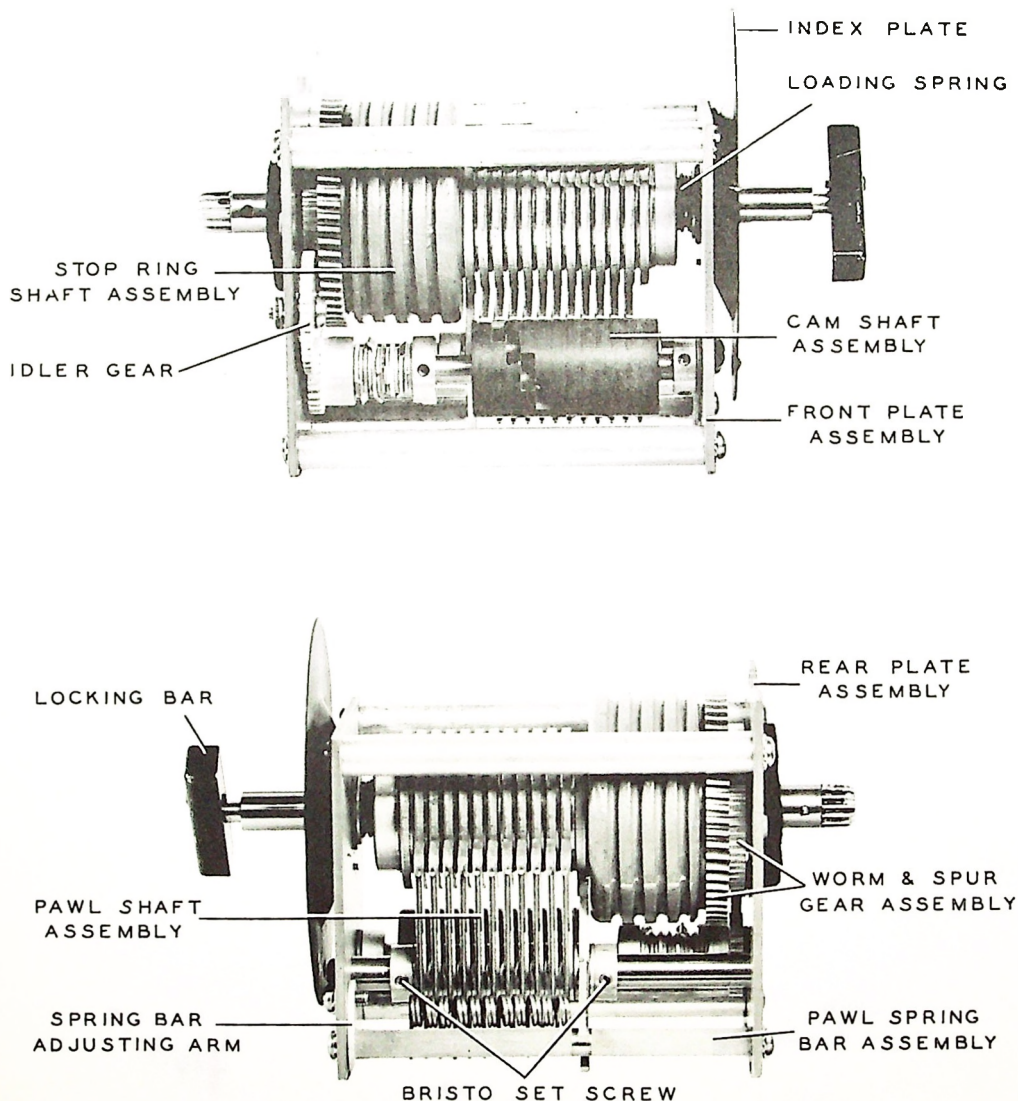


Figure 33. Heavy-Duty Singleturn, Side

refers to the rotating of the Autotune motor drive shaft.) All pawls should drop sharply with a "click". The pawls of the 96L-4 Heavy-Duty Autotune Units should not start to drop more than 0.96 revolution before, nor less than 0.44 revolution after the seeking switch makes contact.

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

If the units located on the r-f exciter unit are properly synchronized, but all four singleturn 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 crystal selector emission selector and channel indicator switch.

1. Electrically operate the Autotune mechanism 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 exciter 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 crystal selector, 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 crystal selector, emission selector, and channel indicator switch does not have to be absolutely centered in each position, but should not be far off center.

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

### IMPORTANT

**AFTER THE CHANNEL SELECTOR SWITCH HAS BEEN ALIGNED WITH THE CRYSTAL SELECTOR, EMISSION SELECTOR, AND CHANNEL INDICATOR SWITCH, DO NOT CHANGE THIS ADJUSTMENT.**

7. Replace the bottom shield and install the r-f exciter unit in the transmitter.

All Autotune heads are factory assembled so that the cam drum adjustment setscrews are accessible on channel number 5. The heads are uniformly assembled to castings so that the heads are approximately synchronized to each other. For this reason, synchronizing ordinarily should 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 a number 5 pawl just drops. NOTE: Count the pawls from the front of the Autotune unit toward the back, omitting the first or manual pawl.

(e) Adjust the channel selector switch.

1. Loosen the two setscrews 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 setscrews.

4. Check synchronism of channel selector switch.

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 96J-6 and 96J-7 singleturn units should be in a position so that the setscrews in the ratchet drum, just to the rear of the cam drum, are accessible. In case one of the setscrews is

## SECTION VI MAINTENANCE

inaccessible, tighten the accessible setscrew with a number 6 Bristo wrench and continue to turn the drive shaft clockwise until the setscrews 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 setscrews 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 96J-6 and 96J-7 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 tightly against the internal driving mechanism. Use the setscrew 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 setscrews and remove shim.

The procedure for synchronizing the Type 96L-4 Heavy-Duty Singleturn Heads is different due to the contour of the cam drums on these units.

Some means of determining the amount of rotation of the motor drive shaft will be necessary. A cardboard disk with the periphery marked off in 100 equal parts can be used. Remove the short Autotune shaft which couples the exciter and power amplifier units. Slip the cardboard disk over the socket end of the shaft. This disk should fit tightly against the shaft. Replace the shaft with disk attached. Loosen one of the cover screws from the Autotune gear case. A short piece of wire can be fashioned into an indicator and held in place by the cover screw.

Proceed to synchronize as follows:

(a) Rotate the motor drive shaft clockwise until the channel selector switch rotor makes a connection with contact #4. Note this position of the drive shaft by observing the position of the disk in reference to the indicator.

(b) Continue rotating the drive shaft in the clockwise direction for an additional 1.54 revolutions.

(c) Properly synchronize all three 96L-4 heads at this point as follows:

1. Loosen setscrews on the back collar of the cam drum.

2. Turn the collar clockwise as far as possible; then apply pressure with a Bristo wrench in a clockwise and backward (toward chassis) manner.

3. Insert a piece of .006 shim stock between the front collar and washer.

4. Rotate the cam drum counterclockwise until the #5 pawl just starts to move. (There is no manual pawl on these heads.)

5. Apply pressure forward with hand (away from chassis) on drum against the .006 shim maintaining at the same time conditions under step 2.

6. Tighten setscrew in back collar. Remove .006 shim.

Check the synchronizing of these heads as follows:

(a) Rotate motor drive shaft clockwise for 2.50 revolutions from position at time of synchronizing.

(b) Visually inspect each heavy-duty head at this point. Pawl #6 should not have started to drop.

(c) Continue the rotation of the drive shaft for 1.40 revolutions.

(d) Pawl #6 should be down in cam groove on all four heads at end of rotation.

Synchronize each singleturn unit in order, starting with the heads on the r-f exciter unit.

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

6.1.5. Replacement of Parts. Since the Autotune mechanism is necessarily complicated, complete ship 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.

6.1.6. Limit Switch. The limit switch is mounted on the exciter Autotune casting between the EXCITER TUNING control and the CHANNEL INDICATOR. In order to secure proper operation of the Autotune mechanism the switch must be closed when the mechanism is at rest and must open as soon as the motor starts.

There has been a sufficient amount of lost motion allowed in the selector switch so that the limit switch will reach the proper setting before the circuit-seeking switch selects the channel dialed. Therefore, as long as the switch is not defective, no adjustment will be necessary.

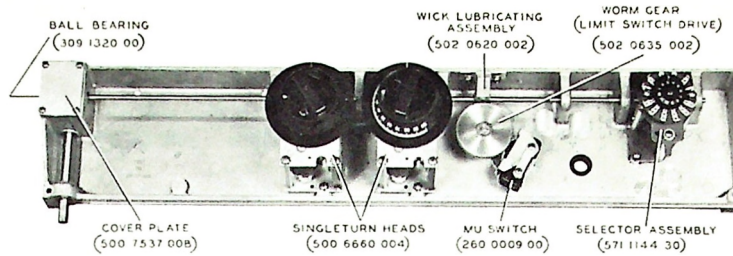


Figure 34. R-F Exciter Unit Autotune Assembly (Complete)

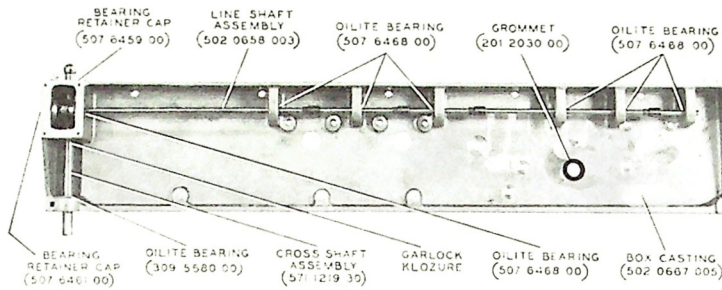


Figure 35. R-F Exciter Unit Autotune Assembly (Heads Removed)

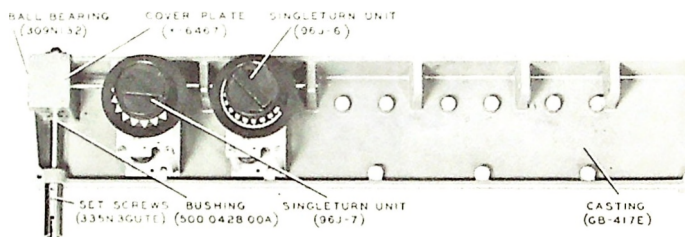


Figure 36. Power Amplifier Unit Autotune Assembly (Complete)

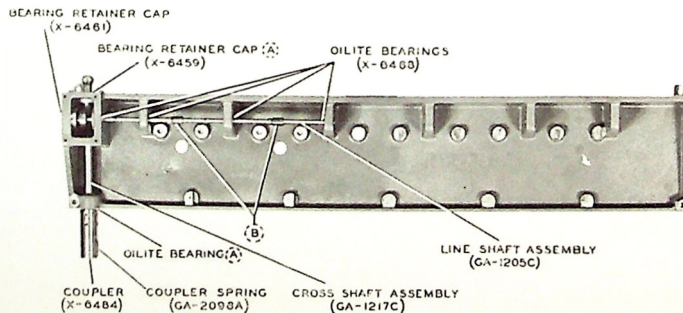


Figure 37. Power Amplifier Unit Autotune Assembly (Heads Removed)

SECTION VI  
MAINTENANCE

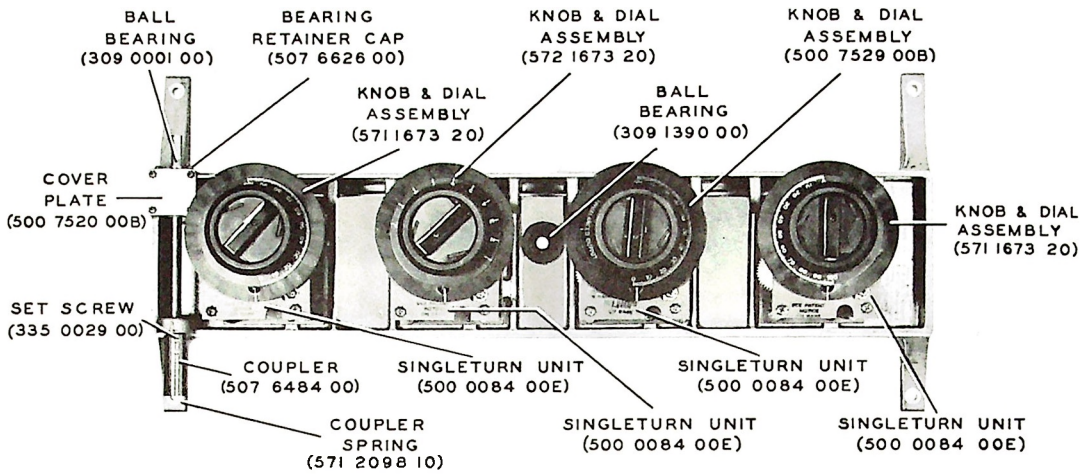


Figure 38. Output Network Autotune Assembly (Complete)

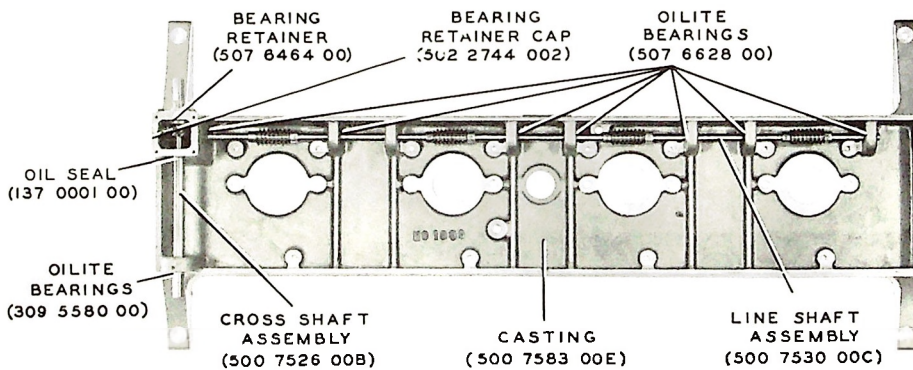


Figure 39. Output Network Autotune Assembly (Units Removed)

## REPLACEABLE AUTOTUNE PARTS

Item	Quan.	Description	Used with Item*	Collins Part No.
1	1	Limit Switch	31	260 0009 00
2	3	Locking Bar Stop	4, 5	X-5620
3	3	Locking Bar	4, 5	GA-2524A
4	3	Singleturn Autotune Units		96J-6
5	1	Singleturn Autotune Unit (Int. Amp. Sw)		96J-7
6		Front Plate Assembly	4, 5	GA-843A
7		Rear Plate Assembly	4, 5	GA-844A
8		Pawl Shaft Assembly	4, 5	GA-984B
9		Idler Gear Post Assembly	4, 5	GA-851A
10		Pawl Spring Bar Assembly	4, 5	GA-852A
11		Tension Spring	4, 5	X-6053
12	1	Stop-Ring Shaft Assembly	4	GE-983B
13	1	Stop-Ring Shaft Assembly	5	GC-983B
14		Cam Drum Shaft Assembly	4, 5	GC-986B
15	1	Line Shaft Assembly		GA-1210C
16	1	Line Shaft	15	X-6466-23-3/8
17	4	Worm	15	X-5513
18	1	Worm	15	X-5519
19	1	Helical Gear	15	990NL10
20	1	Gear Bushing	15	X-6463
21	1	Key	15	X-6469
22	1	Collar	15	X-6481
23	1	N.D. Ball Bearing 77R4-A	15	309N137
24	1	Bearing Bushing	15	GA-2100A
25	1	Bearing Retainer	15	X-6488
26	1	1/16 x 3/8 Groov-Pin	15	311NA122T
27	4	1/16 x 1/4 Groov-Pin	15	311NA121T
28	1	1/16 x 1/2 Groov-Pin	15	311NA123T
29	1	1/16 x 5/16 Groov-Pin	15	311NA853T
30	1	Line Shaft Assembly		GA-1297C
31	1	Line Shaft	30	X-6466-10-9/16
32	2	Worm	30	X-5513
33	1	Helical Gear L. H.	30	990NL10
34	1	Gear Bushing	30	X-6463
35	1	Key	30	X-6469
36	1	Collar	30	X-6481
37	1	N.D. Ball Bearing 77R4-A	30	309N137
38	1	Bearing Bushing	30	GA-2100A
39	1	Bearing Retainer	30	X-6488
40	2	1/16 x 1/4 Groov-Pin	30	311NA121T
41	1	1/16 x 1/2 Groov-Pin	30	311NA123T
42	1	1/16 x 5/16 Groov-Pin	30	311NA853T
43	1	Line Shaft Assembly		GA-1202C
44	1	Line Shaft	43	X-6581
45	3	Worm	43	X-6589
46	1	Helical Gear R. H.	43	990NL15
47	1	Gear Bushing	43	X-6590
48	1	Key	43	X-6469
49	1	Collar	43	X-6462
50	1	N.D. Ball Bearing	43	309N132
51	1	Bearing Bushing	43	X-6593
52	1	Bearing Retainer	43	X-6464
53	3	3/32 x 3/8 Groov-Pin	43	311NA142T
54	1	3/32 x 5/8 Groov-Pin	43	311NA144T
55	1	3/32 x 7/16 Groov-Pin	43	311NA856T
56	1	Cross Shaft Assembly		1220C
57	1	Cross Shaft	56	X-6474
58	1	Coupler Pin	56	X-6391
59	1	N.D. Ball Bearing 77R-6	56	309N132
60	1	Bearing Retainer	56	X-6464
61	1	Gear Bushing	56	X-6460

\*Numbers appearing in this column refer to the item numbers listed in the first column of this table.

SECTION VI  
MAINTENANCE

REPLACEABLE AUTOTUNE PARTS, Cont.

Item	Quan.	Description	Used with Item*	Collins Part No.
62	1	Helical Gear	56	990NL16
63	1	Key	56	X-6465
64	1	Collar	56	X-6462
65	1	3/32 x 5/8 Groov-Pin	56	311NA144T
66	1	Cross Shaft Assembly		1215C
67	1	Cross Shaft	66	X-6487-6-1/8
68	1	Gear Bushing	66	X-6591
69	1	Helical Gear	66	990NL15
70	1	Key	66	X-6465
71	1	Collar	66	X-6462
72	1	N.D. Ball Bearing	66	309N132
73	1	Ball Bearing Retainer	66	X-6464
74	1	Collar	66	X-6481
75	1	3/32 x 5/8 Groov-Pin	66	311NA143T
76	1	3/32 x 1/2 Groov-Pin	66	311NA144T
77	1	Autotune Casting and Cover Assembly		GA-445E
78	1	Line Shaft Assembly	77	GA-1210C
79	1	Cross Shaft Assembly	77	GA-1219C
80	7	Oilite Bearing	77	X-6468
81	1	Oilite Bearing	77	309N558
82	1	Cover Plate	77	500 7537 00B
83	1	Grommet	77	201N203
84	1	Dial Knob (EXCITER TUNING)	77	X-5586
85	1	Bearing Retainer Cap	77	507 6459 00
86	7	No. 4 Ext. Shakeproof	77	373N801
87	17	4-40 Ph. B.H. Screw 1/4 long	77	343N4CXTP
88	1	Bearing Retainer Cap	77	502 2745 002
89	4	8-36 x 1/4 St. Bristo Setscrew	77	335N4FVTP
90	1	Band Switch Knob	77	GA-1536B
91	1	Casting	77	GB-418E
92	2	Felt Seal	77	508 5610 00
93	1	Autotune Cover	77	GA-516D
94	2	Felt Seal	77	X-5609
95	1	Selector Assembly	77	503 8238 004
96	2	Channel Switch Pie	77	269N36
97	4	Spacer	77	X-5641-1/2"BLE
98	4	Dower Screw	77	X-5601
99	1	Felt Seal	77	507 5609 00
100	1	Bushing	77	500 0428 00A
101	1	Autotune Casting and Cover Assembly		GA-448E
102	1	Line Shaft Assembly	101	571 1298 30
103	1	Cross Shaft Assembly	101	571 1219 30
104	1	Oilite Bearing	101	309 5580 00
105	4	Oilite Bearing	101	507 6468 00
106	1	Cover Plate	101	500 7537 00B
107	1	Dial Knob (Int. Amp. Plate)	101	X-5586
108	1	Bearing Retainer Cap	101	502 2745 002
109	1	Bearing Retainer Cap	101	507 6459 00
110	1	Universal Coupler	101	507 6484 00
111	1	Coupler Spring	101	571 2098 10
112	1	Casting	101	500 5610 00
113	1	Cover Plate	101	500 7537 00B
114	1	Autotune Cover	101	573 0642 40
115	1	Band Switch Knob (Int. Amp. Band Sw)	101	GA-1652B
116	2	Felt Seal	101	507 5610 00
117	1	Bushing	101	500 0428 00A
118	1	Autotune Casting and Cover Assem.		500 7581 004
119	1	Line Shaft Assembly	118	500 7530 003
120	1	Cross Shaft Assembly	118	500 7526 002
121	6	Oilite Bearing	118	507 6628 00

\*Numbers appearing in this column refer to the item numbers listed in the first column of this table.

## REPLACEABLE AUTOTUNE PARTS, Cont.

Item	Quan.	Description	Used with Item*	Collins Part No.
122	1	Oilite Bearing	118	309 1390 00
123	1	Gear Box Cover Plate	118	500 7520 002
124	1	Box Casting	118	GB-436E
125	1	Bearing Retainer Cap	118	502 2744 002
126	1	Bearing Retainer Cap	118	507 6626 00
127	1	Universal Coupler	118	507 6484 00
128	1	Coupler Spring	118	571 2098 10
129	1	Autotune Cover	118	GA-571D
130	3	Felt Seal	118	X-16623-13
131	1	Knob and Dial Assembly	118	GB-1673B
132	2	Knob and Dial Assembly	118	GA-1673B
133	1	Bushing	118	500 0428 00A
134	1	Selector Assembly		503 8238 00A
135	1	Shaft Assembly	134	GA-2114A
136	1	Bottom Plate and Standoff Assembly	134	GA-2119A
137	1	Top Plate and Bushing Assembly	134	GA-2116A
138	1	Adjusting Plate	134	X-6441
139	1	Index Plate	134	X-6485
140	1	Channel Indicator Dial	134	X-6486
141	1	Spacer	134	GA-2101A
142	1	Worm-Gear	134	X-6431
143	1	Collar	134	X-6431
144	2	Drive Dog	134	X-6437
145	5	Drive Dog	134	X-6436
146	6	Spacer	134	X-6440
147	1	Selector Switch	134	269N37
148	2	Selector Switch Spacer	134	X-5641-1/8 B1E1
149	2	Selector Switch Spacer	134	X-5641-3/16 B1E1
150	1	Dust Seal	134	X-5534
151	4	Heavy-Duty Autotune Head		96L-4
152	1	Stop Ring Drum and Shaft	151	GA-1651B
153	1	Cam Drum and Shaft	151	GB-1636B
154	1	Bar and Springs	151	GA-2283A
155	1	Back End Plate	151	GA-2282A
156	1	Front End Plate	151	GA-2274A
157	1	Pawl Assembly	151	GA-1655B
158	1	Locking Bar and Screw	151	GA-2265A
159	1	Worm Gear	151	GB-1647B
160	1	Cam Shaft Gear Assembly	151	GA-2372A
161	1	Spur Gear Assembly	151	GA-2371A
	3	Universal Coupler Assembly (Band Sw. #1, #2, and Int. Amp. Tuning)		500 4421 00B

\*Numbers appearing in this column refer to the item numbers listed in the first column of this table.

The above Autotune parts are contained in three assemblies, one on the r-f exciter unit, one on the power amplifier unit, and one on the output network unit. The r-f exciter unit assembly contains two singleturn units. The power amplifier assembly contains two singleturn units. The output network assembly contains four singleturn units. The singleturn units may be removed from the Autotune castings as complete units.

1. Autotune Assembly Dismantling.

(a) Removing the Standard Singleturn Units.

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

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

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

(4) Remove the dial back plate.

(5) 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.



SECTION VI  
MAINTENANCE

(b) Removing the Heavy-Duty Singleturn Unit.

(1) Remove 3-3/32 Phillips fillister-head screws from the back plate of the Autotune head.

(2) Tip the front of the Autotune head up and pull out.

(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 differences in the procedure are that when removing the line shaft from the output network assembly there are four singleturn units to remove; when removing the shaft from the power amplifier assembly there are two singleturn units to be removed; and when removing the shaft from the r-f unit Autotune assembly there are two singleturn 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 gear nears the end of the shaft. Place each gear with the proper groove-pin and be sure that each combination is properly identified so as to be replaced in the original position. These gears 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 sleeve of the worm in the spot corresponding to the center of the larger hole on the old worm.

(2) Using the 1/16" drill, drill through one side of the worm sleeve.

(3) Slide the worm on the shaft with the sleeve end toward the thrust bearings assembly.

Match the hole on the worm sleeve with the hole in the line shaft to which the old gear was pinned. CAUTION: Do not get the wrong line shaft hole or the smaller end of the correct hole.

(4) Drill through to the other side of the worm sleeve with the 1/16" drill.

(5) Drive a new 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 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. 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.

(2) Work the shaft and bearing out about 3/4 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 out the pin.

(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 home the pin. 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 gears 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) Center-punch each gear and the sprocket 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 worms 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 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 reamed 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 worm gears.
- (14) Assemble the shaft in the casting as previously described. NOTE: Be sure to place the gears in the proper order on the shaft.

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. 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 adjustment but if the relay should fail to operate when the PWR. AMP. PLATE CURRENT reaches 1.4 amp or if the relay operates when the PWR. AMP. PLATE CURRENT is below 1.1 amp, make adjustments as follows:

- (a) Press the PLATE STOP switch and open the front door of the Collins Type 1016-5 Radio Transmitter cabinet.
- (b) Rotate the adjusting nut a fraction of a revolution (overload relay is located on P. A. filament supply unit), the direction of rotation depending on the condition that necessitates overload relay adjustment.

NOTE

To reduce the value of PWR. AMP. PLATE CURRENT at which the overload relay operates, rotate the adjusting nut in a clockwise direction (as viewed from the top).

- (c) Close the cabinet door and reapply PLATE power.

- (d) Operate the TEST switch to the locking position and while observing the PWR. AMP. PLATE CURRENT meter, detune the power amplifier plate tank circuit.

WARNING

Do not permit the PWR. AMP. PLATE CURRENT to go beyond 1.5 amp.

- (e) Carefully check the meter reading at which the overload relay operates.

- (f) Repeat steps (a) through (e) until the overload relay operates when the PWR. AMP. PLATE CURRENT meter indicates between 1.3 amp and 1.4 amp.

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 Socony-Vacuum Gargoyle Arctic C Light oil or equal.

## SECTION VI MAINTENANCE

The air filter in this equipment is of the washable type. When loaded with collected matter it should be removed from the frame of the rear door. The filter should then be immersed in any solvent such as gasoline or a solution of Tri-Sodium-Phosphate and water or Climalene and water, after which the filter should be allowed to dry very THOROUGHLY. Then the filter unit should be recharged as follows: Dip the unit in an oil of approximately SAE 20 or 40 viscosity when used in temperatures of 20 degrees F. or higher, or SAE 10 viscosity when used between 19 degrees F. above and 45 degrees F. below zero. The filter should then be drained THOROUGHLY to remove excess oil. The correct and best method to drain the filter is to lay it flat with the "approach face" (air-entering side) down.

6.5. 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 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.

6.6. 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. Setscrews on tap switch drives and all dogs associated with the Autotune driving mechanism should be checked and tightened when necessary.

6.7. TEST CABLES. A pair of test cables has been supplied with the equipment. The cables are equipped with the same type of plugs and receptacles as is used in the transmitter proper. These cables are provided to aid in the checking of the r-f exciter, speech amplifier, and 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 APPLICATION 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 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.

6.8. LOCATION OF FAULTS. The most frequent cause of trouble in transmitting equipment 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, 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 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 found readily 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 usually may be located by inspection. It will be found that excessive heating or sputtering within the 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. 8. 1. Trouble Shooting.

##### a. Autotune Troubles.

(1) Autotune Mechanism Does Not Operate When a Channel Is Dialed.

##### (a) Symptoms:

1. Relays in Autotune control unit do not function.
2. Relays function but Autotune motor does not start.

##### (b) Probable Cause:

1. LOCAL-REMOTE switch in wrong position.
2. Fuse "blown" in 48-volt relay rectifier supply.
3. Filament voltage not turned on.

(2) Autotune Motor Starts When a Channel Is Dialed but Immediately Stops or the Motor Rotates in a Reverse Direction.

##### (a) Symptoms:

1. Motor starts but stops after a few revolutions.
2. Motor starts but in a reverse direction. (Normally the dials on the Autotune heads rotate in a counterclockwise direction at the beginning of the positioning cycle.)

##### (b) Probable Cause:

1. Transmitter incorrectly connected to the power source (improper phase relationship).

##### (c) Cure:

1. Disconnect any two of the three power leads from the transmitter to the power source and interchange the two leads.

#### (3) Autotune Mechanism "Hunts".

##### (a) Symptoms:

1. Autotune mechanism operates normally at the beginning of the cycle, begins operation in the proper direction and reverses, but instead of completing the reverse part of the cycle the motor immediately again changes direction of rotation. This changing of the direction of motor rotation continues until the FILAMENT STOP switch is pressed.

##### (b) Probable Cause:

1. Grease or dirt in "dogs" that operate the circuit-seeking switch.

##### (c) Cure:

1. Clean "dogs" with carbon tetrachloride.

#### (4) Autotune Sets Up On Wrong Channel.

##### (a) Symptoms:

1. Dialing any frequency channel results in the transmitter setting up on a channel with a number lower than the number of the channel that was dialed.

##### (b) Probable Cause:

1. Due to the forcing the telephone dial back with the finger when dialing, the number of electrical impulses transmitted to the pulsing relay by the telephone dial is incorrect.

##### (c) Cure:

1. Remove finger from the dial as soon as the dial has been rotated clockwise to the stop. Do not attempt to "speed up" the dialing operation by rotating the dial counterclockwise with the finger.

#### (5) Autotune Heads Do Not "Set Up" Properly.

##### (a) Symptoms:

1. Instead of stopping at the proper setting, the dials continue to rotate in a clockwise direction to the limit stop. That is, the dial continues to rotate in a clockwise direction until the indicator point is opposite the portion of the dial that is not engraved.

SECTION VI  
MAINTENANCE

2. The indicator point above the tuning dials are all opposite the engraved portions of the dials but the meters indicate improper tuning.

(b) Probable Cause:

1. Dials were not set properly when the transmitter was originally tuned.

2. The stop rings on the particular Autotune head were not locked tightly enough when the tuning adjustments were made.

3. The Autotune mechanism is out of synchronization.

(c) Cure:

1. Retune the circuit that is out of adjustment by unlocking the stop rings and readjusting the dial. Carefully lock the stop rings.

2. If the mechanism appears to be out of synchronization, refer to the instructions for Autotune synchronization that are included in this section of this instruction book.

(6) Incorrect Adjustment of MCW Relay and Homing Relay Contacts.

(a) Symptoms:

1. The circuits do not set up for MCW emission with the automatic emission selection circuit connected for MCW selection.

2. The circuits set up automatically on MCW the first time a channel is dialed but if the same channel is dialed again MCW emission is not automatically selected.

(b) Probable Cause:

1. Incorrect relay timing. Homing relay contacts close and the rotary switch moves before the MCW relay energizing circuit is completed through the rotary switch contacts.

(c) Cure:

1. Increase the spacing of the contacts of the homing relay.

2. Decrease the spacing of the MCW relay holding contacts.

b. Power Supply Troubles.

(1) High Voltage (4000 V) Does Not Come On When Plate START Button Is Pressed.

(a) Symptoms:

1. PLATE pilot lamp lights but PLATE VOLTAGE meter does not indicate a voltage.

2. The PLATE pilot lamp does not light and the PLATE VOLTAGE meter does not indicate a voltage.

(b) Probable Cause:

1. ADJUST-OPERATE switch is in the ADJUST position.

2. TIME DELAY relay has not operated. (At least 30 seconds should elapse before this relay operates.)

3. Interlocks on cabinet doors are not closed.

4. Blower not operating to close the air flow switch.

5. Overload relay held in open position as a result of an overload.

6. No-bias relay is in open position because of the failure of the bias supply.

(c) Cure:

1. Operate the ADJUST-OPERATE switch to the OPERATE position.

2. Check operation of cabinet door interlock switches.

3. Check to determine whether blower is operating.

4. Check operation of door interlock and air interlock switches with a continuity checker.

5. Dial any channel to reset the overload relay.

6. Check the bias supply fuses.

c. Radio Frequency Troubles.

(1) Transmitter Does Not Key Properly.

(a) Symptoms:

1. Carrier stays on with TEST switch open (middle position).

2. Carrier does not come on when TEST switch is closed (up position).

(b) Probable Cause:

1. Carrier stays on.

a. Type 6SJ7 (V102) or Type 837 (V103) tube in r-f exciter unit, is defective.

b. Grid voltage on Type 6SJ7 (V102) tube is too high - should be -0.2 (key open).

c. LOCAL-REMOTE switch in wrong position.

2. Carrier does not come on.

- a. Type 6SJ7 (V102) or Type 837 (V103), tube in r-f exciter unit is defective.
- b. Improper grid bias on Type 6SJ7 (V102) (should be -50 V KEY closed).
- c. LOCAL-REMOTE switch in wrong position.
- d. Shorted lug on handset.

(c) Cure:

- 1. Check voltages on oscillator (V103) and keyer (V102) tubes.
- 2. Check tubes by replacing (V103) and (V102) with tubes known to be in good condition.
- 3. Check position of LOCAL-REMOTE switch.
- 4. Remove back cover from door handset holder to determine if any of the lugs are shorting to ground or if the lugs are shorted together.

(2) Keying Transients Present When Operating With Phone MCW Emission.

(a) Symptoms:

- 1. Audio level meter indicates up to -10 db when the TEST switch is operated with no modulation on the carrier.
- 2. Arcing in the output network unit.

(b) Probable Cause:

- 1. Unbalanced elements in the Type 6C8G tube (V303).

(c) Cure:

- 1. Replace V303 with a tube that is known to be in good condition.

(3) Stabilizer Tube (V116) Plate Shows Color.

(a) Symptoms:

- 1. Plate of Type 811 (V303) tube shows color.

- 2. Plate dissipation of the power amplifier tubes (750TL) increases.
- 3. Power amplifier grid current drops.
- 4. Antenna current drops.

(b) Probable Cause:

- 1. Type 811 tube (V303) has become "gassy."
- 2. Type 750TL tube losing filament emission.

(c) Cure:

- 1. Replace Type 811 tube (V303) with a tube known to be in good condition.

(4) Power Amplifier Stage Not Neutralized.

(a) Symptoms:

- 1. Power amplifier grid current maximum and power amplifier plate current minimum do not occur simultaneously.
- 2. Impossible to modulate the r-f carrier 100%.

(b) Probable Cause:

- 1. Grid-to-plate capacity of power amplifier tubes has changed with aging of tubes.
- 2. New tubes have been installed and the grid-to-plate capacity of these new tubes is different than the grid-to-plate capacity of the old tubes.
- 3. The neutralizing capacitor is out of adjustment.

(c) Cure:

- 1. Refer to the section on power amplifier neutralization, in the adjustments section of this instruction book and re-neutralize the stage.

6.9. TYPICAL VOLTAGES AND CURRENTS.

Carrier Frequency MC	26 MC			10 MC	4 MC
	Pin	Key Open	Key Closed	Key Closed	Key Closed
<b>CRYSTAL OSCILLATOR (V103) 837</b>					
Filament Voltage	1-7	12.6	12.6		
Cathode Voltage	6	2.3	5.0		
Grid (C1) Voltage	4	-5.5	-14.5		
Screen Voltage	3	86.0	115.0		
Suppressor Voltage	5	-270.0	-62.0		
Plate Voltage	C	525.0	510.0		

SECTION VI  
MAINTENANCE

TYPICAL VOLTAGES AND CURRENTS (Cont)

Carrier Frequency MC	26 MC			10 MC	4 MC
	Tube	Pin	Key Open	Key Closed	Key Closed
<b>KEYER TUBE (V102) 6SJ7</b>					
Filament Voltage	2-7	6.3	6.3		
Cathode & Suppress. Volt.	3-5	-23.0	-24.5		
Grid (G1) Voltage	4	-23.0	-52.0		
Screen Voltage	6	100.0	117.0		
Plate Voltage	8	-15.5	207.0		
<b>R. F. AMPLIFIER (V104) 807</b>					
Filament Voltage	1-5	6.3	6.3		
Cathode Voltage	4	0.0	33.0	33.0	33.0
Grid (G1) Voltage	3	-270.0	-57.0	-57.0	-75.0
Grid Current MA.	M				
Screen Voltage	2	333.0	300.0	300.0	300.0
Plate Voltage	C	525.0	510.0	510.0	510.0
<b>INT. AMPLIFIER (V105-V106) 2-4-125A</b>					
Filament Voltage	1-5	5.0	5.0		
Grid (G1) Voltage	3		-157.0	-172.0	-187.0
Fixed Bias Voltage	3	-100.0			
Grid Current MA.	M				
Screen Voltage	2	370.0	310.0	225.0	140.0
Plate Voltage High Power	C	2000.0	1900.0	1960.0	1980.0
Plate Voltage Low Power	C	2500.0	1900.0	1980.0	2140.0

Tube	Key Open	Key Closed
<b>POWER AMPLIFIER (V114-V115) 2-750TL</b>		
Filament Voltage	7.4	7.4
Grid Voltage	-510.0	-1100.0
Plate Voltage	4100.0	4000.0
Plate Current (MA)	0	1250
<b>PARASITIC SUPPRESSOR (V116) 811</b>		
Filament Voltage	6.3	6.3
Cathode Voltage	-510.0	-510.0
Grid Voltage	-510.0	-1100.0
Plate Voltage	-510.0	-1100.0

Tube	Pin	Key Closed		10 db Of Comp. 100% Mod.
		No	Mod.	
<b>PREAMPLIFIER (V301) 6SL7GT</b>				
Filament Voltage	7-8	6.1		6.1
Cathode Voltage	3-6	1.3		1.3
Grid Voltage	1	0		0
Plate Voltage	2	125.0		120.0
Grid Voltage	4	0		0
Plate Voltage	5	125.0		120.0
<b>VOLUME LIMITER (V302) 6C8G*</b>				
Plate Voltage	6	105.0		100.0
Filament Voltage	2-7	6.1		6.1
Cathode Voltage	8-4	0		0
Grid Voltage	5-C	-22.0		-2.8
Plate Voltage	3	105.0		100.0

\*MCW frequency selector switch set on position 7.

## TYPICAL VOLTAGES AND CURRENTS (Cont)

Tube	Pin	Key Open	Key Closed (100% Mod.)
<b>SQUELCH (V303) 6C8G</b>			
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	8-4	-28.0	-32.0
Grid Voltage	5-C	-28.0	-59.0
Plate Voltage	6	44.0	100.0
Plate Voltage	3	44.0	100.0

Tube	Pin	Key Closed No Mod.	100% Mod.
<b>AUDIO AMPLIFIER (V304) 6SJ7</b>			
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	5	7.5	7.6
Grid Voltage	4	0	0
Plate Voltage	8	215.0	215.0

Tube	Pin	Not Osc.	In Osc.
<b>MCW OSC. (V305) 6SN7GT*</b>			
Filament Voltage	6-7	6.1	6.1
Cathode Voltage	3	7.5	6.5
Cathode Voltage	6	3.6	4.6
Grid Voltage	4	0	-14.5
Grid Voltage	1	0	0
Plate Voltage	5	140.0	140.0
Plate Voltage	2	250.0	250.0
<b>LIMITER CONTROL (V306) 6X5GT</b>			
Filament Voltage	2-7	6.1	6.1
Cathode Voltage	8	-22.0	2.8
Plate Voltage	3	-28.0	-32.0
Plate Voltage	5	-28.0	-32.0
<b>AUDIO AMPLIFIERS (V307-V308) 801</b>			
Filament Voltage		7.5	7.7
Grid Voltage 10 db in comp.		-53.0	-54.0
Plate Voltage		505.0	505.0
Plate Current, MA		30.0	25.0

Tube	Key Closed No Mod.	100% Mod.
<b>AUDIO DRIVERS (V309-V310) 845</b>		
Filament Voltage	10.0	10.0
Grid Voltage	505.0	503.0
Cathode Voltage	690.0	685.0
Plate Voltage	1875.0	1825.0
Plate Current (MA)	85.0	80.0
<b>MODULATORS (V311-V312) 450TL</b>		
Filament Voltage	7.5	7.5
Grid Voltage	-200	-212
Plate Voltage	3875	3750
Plate Current (MA)	100	690

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

2. Measurements made at an r-f output frequency of 4.0 mc.

\*MCW frequency selector switch set on position 7.



**SECTION VI  
MAINTENANCE**

**6. 10. 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 intermediate 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. Realign the exciter circuits, as a last resort. Check to determine if a crystal of proper frequency is being used. Before adjusting any of the inductance or capacitance trimmers in the tank circuits of the crystal oscillator 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. 10. 1. General.** The alignment of the exciter circuits is accomplished by adjusting tuning slugs within the crystal oscillator and intermediate amplifier plate tank inductors and the adjustment of trimmer capacitors that are connected across the oscillator plate tank coils.

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 capacity of the trimmer capacitors may be varied with a screwdriver from the top of the r-f unit chassis. To adjust the capacity trimmer use an insulated alignment tool or screwdriver.

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

The following table shows the BAND SWITCH positions and the inductors used for each frequency range: (See figures 40 and 41.)

Band	Osc. Inductor	Trimmer	Range Mc	Buffer Inductor	Range Mc
1	L111	C126	8.0 - 13.0	L116	16. - 26.
2	L112	C127	4. - 8.	L117	8. - 16.
3	L113	C133	2. - 4.	L118	4. - 8.
4	L115	C136	1. - 2.	L121	2. - 4.

**6. 10. 2. Details. Tuning Range:**

Band	807 Grid Circuit		4-125A Grid Circuit	
	High	Low	High	Low
1	13 mc	8 mc	26 mc	16 mc
2	8 mc	4 mc	16 mc	8 mc
3	2 mc	1 mc	4 mc	2 mc

All exciter adjustments may be made from the top of the chassis with all covers on. A trimmer capacitor is provided across each of the 807 grid coils so that the minimum capacity of the circuits can be matched on each band. All coils have slugs to correct for inductance variations caused by winding and wiring variations.

**ALIGNMENT PROCEDURE:**

1. The tuning capacitors C125 and C132 should be ganged so that they track properly. This can usually be accomplished by visual inspection to see that both reach maximum at the same time and none of the stator sections are loose or out of line. Also, the ganging of the tuning capacitors to the Autotune head should be checked to insure that the Autotune hits its stop on both sides before the capacitors short out.

2. On each band the 4-125A grid coil in use should be adjusted with the slug so that this circuit covers the frequency range specified in (a) above with the high frequency limit at or near 10 on the dial.

3. The trimmer capacitors in the 807 grid circuit should be set to align this circuit with the 4-125A grid circuit at a frequency near the high frequency limit (10 to 20 on the dial) of the band being aligned. Since the trimmers are in the low frequency stage they must be "rocked" in by observing the 4-125A grid current and adjusting first the tuning capacitor and then the trimmer for peak and repeating until no further peak can be reached.

4. The coil slugs in the 807 grid circuits should be set to align this circuit with the 4-125A grid circuit at a frequency near the low frequency limit (80 to 90 on the dial) of the band being aligned. Here again, it is necessary to observe the 4-125A grid current and adjust the tuning capacitor and then the coil slug to peak.

**6. 11. Intermediate Amplifier Neutralization.**

The 4-125A tubes are neutralized with C143. The plate is mounted on feedthroughs adjacent to the tubes.

Proper neutralization is indicated when the 4-125A grid current peaks as the plate circuit is tuned through resonance.

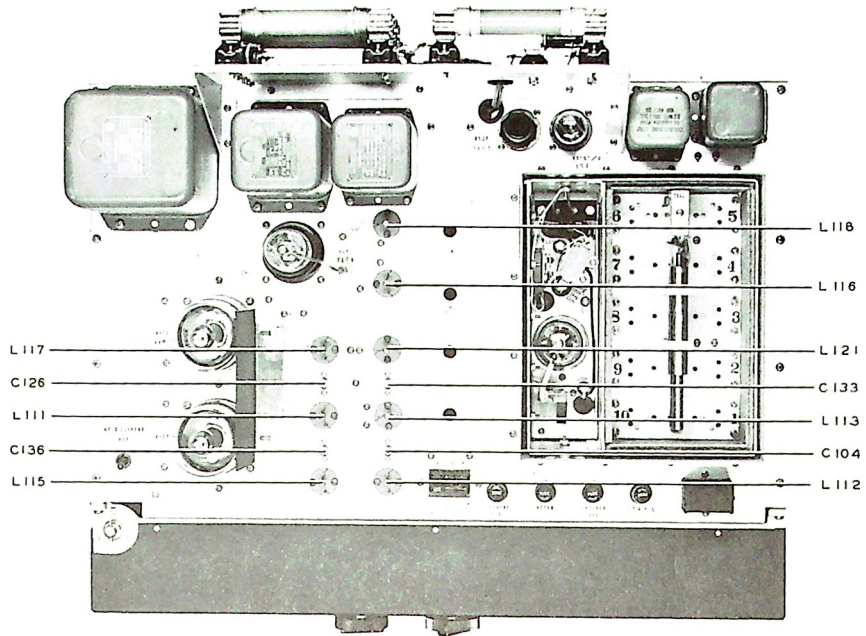


Figure 40. R-F Exciter Unit - Top View

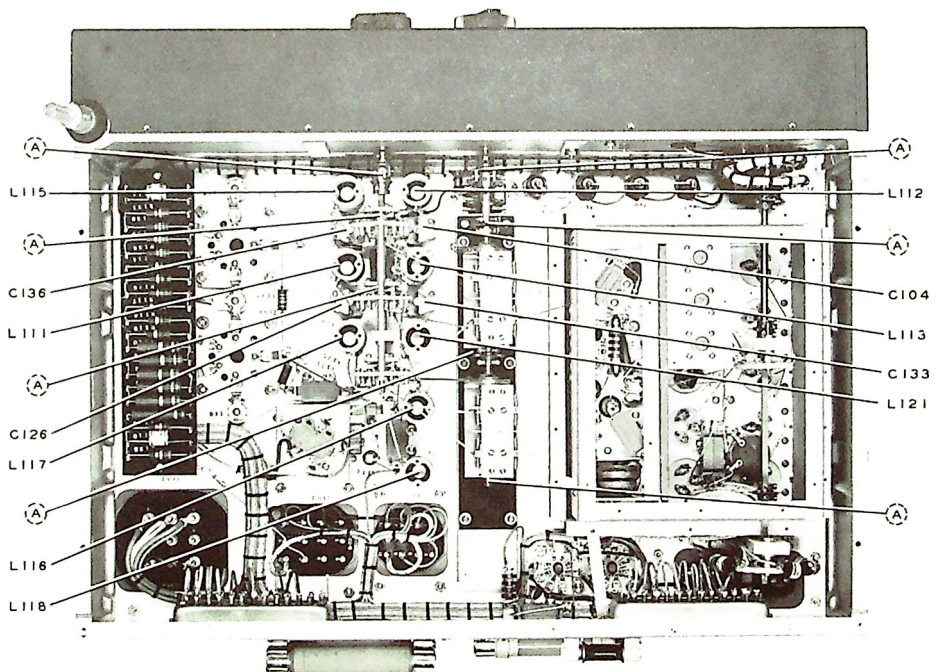


Figure 41. R-F Exciter Unit - Bottom View

## SECTION VI MAINTENANCE

It may not be possible to get this stage perfectly neutralized over the entire frequency range, in which case C143 should be adjusted to give the best neutralization over all of band 1.

### 6. 12. P. A. Neutralization.

The 750TL tubes are neutralized with C157, the large disk-type capacitor mounted on the side of the cabinet adjacent to the tubes. Just as in the intermediate amplifier stage, proper neutralization is indicated when the grid current peaks as the plate circuit is tuned through resonance.

### 6. 13. Network Tuning.

#### (a) Grid Network.

The tap switch should be set so that the tuning capacity tunes in the lower portion of the dial at frequencies above 10 mc and in the upper portion at frequencies below 10 mc. The tuning capacitor is tuned for dip in INT. AMP. plate current.

#### (b) Output Network.

The tap switch should be set so that the tuning capacity tunes in the lower portion of the dial at frequencies above 10 mc and in the upper portion at frequencies below 10 mc.

The PLATE TUNING is tuned to dip in P. A. plate current. The ANT. TUNING is tuned for proper loading. The BALANCE TUNING is tuned for balanced r-f current.

As a final tuning of the output network, the PLATE TUNING should be tuned off resonance to the point of maximum efficiency as evidenced by an increase in r-f current and a decrease in plate color.

6. 14. THERMAL SWITCH ADJUSTMENT. Two thermal-operated switches are employed in the crystal compartment. The two switches, S102 and S103, are connected in series to insure positive control of the current flow through the two heater elements, R102 and R103. The two switches are identical but are adjusted to operate at slightly different temperatures. Switch S102 should be adjusted to open when the temperature of the crystal compartment is 70°C. Switch S103 should be adjusted to open when the temperature is 80°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) Slowly raise the temperature of the water.

(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 will be necessary to rotate the adjusting screw to obtain switch operation in the proper temperature range.

(j) Repeat the checking and adjustment procedure until the switch operates consistently within the proper temperature range.

SECTION VII  
DATA

## 7.1. TRANSMITTER DATA

## 7.1.1. Power Input Requirements.

For MCW operation, 100% modulation, 9.2 KW is required at a phase voltage of 222 volts, current 24.5, 26.0, and 25.5 amperes respectively at 95% P.F.

Conditions	Watts	Power Factor
1. Dial A0	155	0.945
2. Filaments on - CW	1105	0.847
3. Filaments on MCW or VOICE	1385	0.888
4. Filaments and Plate On (Standby) - CW	1840	0.870
5. Filaments and Plate On (Standby) - MCW or VOICE	3160	0.930
6. Carrier On - CW	6480	0.956
7. Carrier On - MCW or VOICE (No Mod.)	7240	0.960
8. Carrier On - MCW or VOICE (100% Mod.)	9920	0.956

## 7.1.2. Radio Frequency.

## (a) Frequency Coverage.

## 1. EXCITER BAND SWITCH

Position	Frequency Range (Mc)
1	16 to 26
2	8 to 16
3	4 to 8

## 2. INT. AMP. BAND SWITCH

Position	Frequency Range (Mc)
1	20 to 26
2	16 to 20

## 2. INT. AMP. BAND SWITCH (Cont)

Position	Frequency Range (Mc)
3	12 to 16
4	9 to 12
5	7 to 9
6	5 to 7
7	4 to 5
8	3.3 to 4.0
9	3.0 to 3.3

## 3. POWER AMP. BAND SWITCH

Position	Frequency Range (Mc)
1	20 to 26
2	16 to 20
3	12 to 16
4	9 to 12
5	7 to 9
*6	5.5 to 7
7	4.5 to 5.5
8	3.5 to 4.5
9	3.0 to 3.5

NOTE: The above coverage measurements were made using a 300-ohm dummy antenna load.

\*Balanced antenna operation not available below 4 mc.

## (b) Frequency Deviation.

Operation	Frequency Change (%)
1. Detuning Exciter	0.00066
2. Changing Oscillator Tubes	0.02000
3. Changing Voltage Regulator Tubes	0.00100

SECTION VII  
DATA

(b) Frequency Deviation.(Cont)

Operation	Frequency Change (%)
4. Detuning Power Amplifier	None
5. Change Line Voltage $\pm 10\%$ in 1 minute	None
6. Operating Power Level Switch from L. V. to TUNE	0.00015
7. Operating Power Level Switch from TUNE to OP.	0.00015

(c) Frequency Stability.

1. Frequency vs. Temperature

Temperature Change (Degrees)	Frequency Change (%)
0 - 10	0.0005
10 - 20	0.0003
20 - 30	0.0016
30 - 40	0.0004
40 - 50	0.0001

NOTE: Above measurements made at an output frequency of 2000 kc and using a 300-ohm load.

2. Frequency vs. Humidity

Humidity Change	Frequency Change (%)
30% to 95%	0.0026

NOTE: Above measurements made at an output frequency of 2000 kc and at a temperature of 40 degrees C.

7.1.3. Audio Frequency.

(a) Frequency Response.

1. Reference 1000 cps, 70% modulation

Frequency (cps)	Output (db)	Mod. Plate Current (ma)
100	-2.0	490
150	-1.0	490
300	-0.3	500
400	-0.1	500

1. Reference 1000 cps, 70% modulation (Cont)

Frequency (cps)	Output (db)	Mod. Plate Current (ma)
500	0.0	500
1000	0.0	500
1500	+0.1	500
2000	+0.1	500
3000	+0.3	550
3500	+0.4	560
4000	+0.4	600
5000	+0.7	650

(b) Distortion.

The distortion is 5.0% at 400 cps and 5.6% at 1000 cps for -15 db input, 10 db into compression, 100% modulation. The noise level on carrier (settings as for distortion) is -54 db below 100% modulation.

(c) Noise Level.

53 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	370
2	530
3	700
4	830
5	960
6	1110
7	1320

7.1.4. Channel Reset Time.

When dialing from channel number 10 to channel number 9 the measured time that the signal is off is 8 seconds.

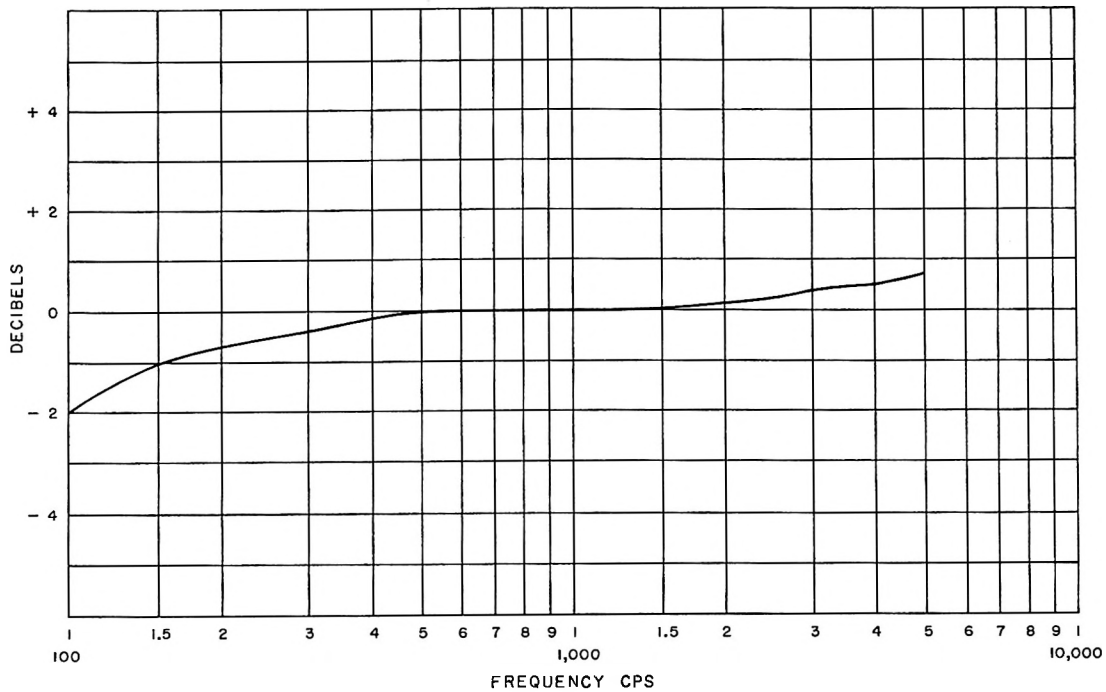


Figure 42. Frequency Response Curve

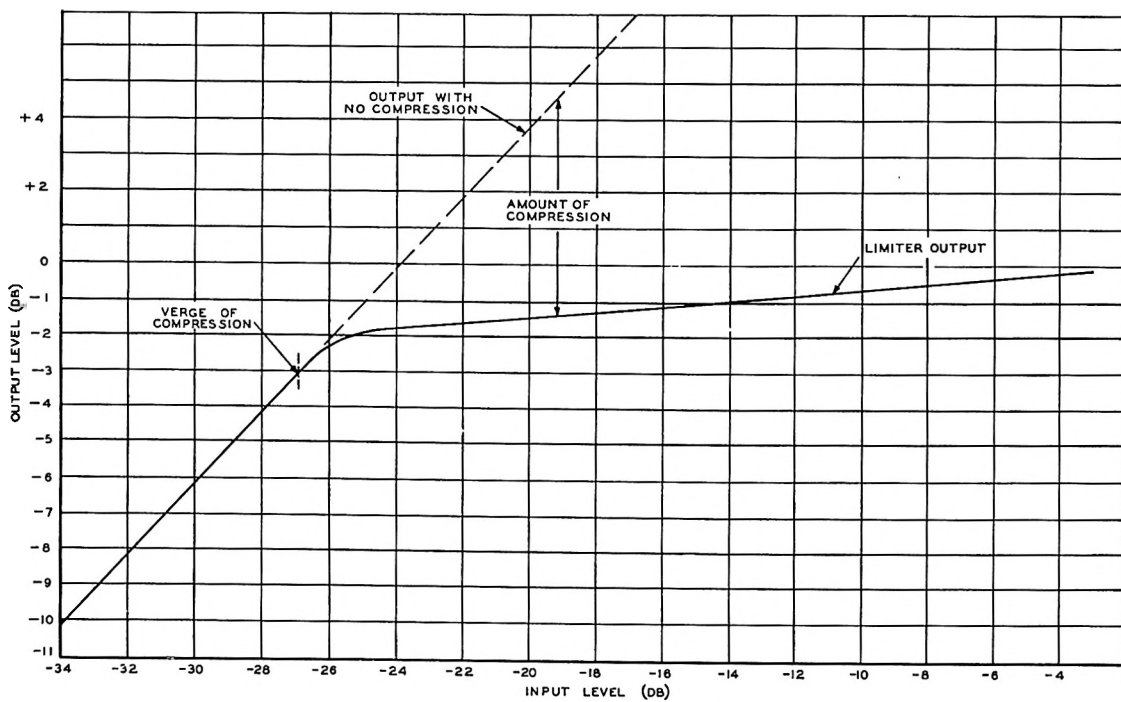


Figure 43. Limiter Curve

SECTION VII  
DATA

7.2. COLOR CODES

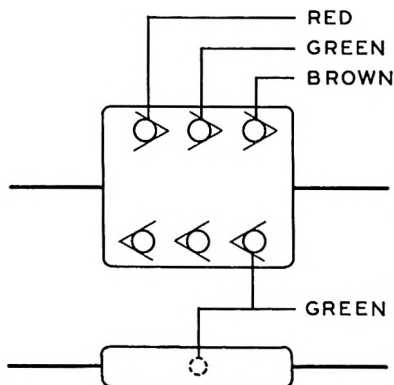
CAPACITOR COLOR CODE

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 per cent is indicated by the spot of color on the edge of the capacitors.

For example, the capacitor shown below has a capacity of 250 mmfd (0.00025mfd). The color sequency is red (2), green (5), and brown (1). The tolerance is  $\pm 5\%$  as indicated by the spot of green on the edge or the color of the fourth dot on the top of the capacitor.



CAPACITOR COLOR CODE

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:

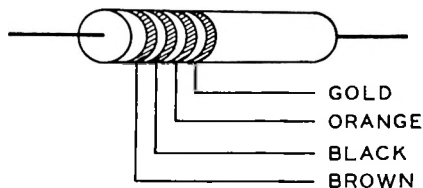
0-Black	5-Green
1-Brown	6-Blue
2-Red	7-Violet
3-Orange	8-Gray
4-Yellow	9-White

The resistors are marked with three colored "bands" near one end. All resistance values are in ohms. The color sequency 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 or Gold	10%-Silver

For example, the resistor shown below has a resistance of 10,000 ohms and a tolerance of  $\pm 5\%$ . Brown (1), black (0), orange (3), and gold (5).



RESISTOR COLOR CODE

## 7.3. TUBE DATA

Type	Symbol Designations
5U4G	V403
6C8G	V302, V303
6SJ7	V304, V402, V102
6SL7GT	V301
6SN7GT	V305
6V6GT	V401
6X5GT	V306, V101
450TL	V311, V312
750TL	V114, V115
801	V307, V308
807	V104
811	V116
4-125A	V105, V106
845	V309, V310
866/866A	V207, V208, V209, V210

## 7.3. TUBE DATA (Cont)

Type	Symbol Designations
4B32	V201, V202, V203, V204, V205, V206
837	V103

## WARNING

IN ORDER TO OBTAIN SATISFACTORY TUBE LIFE THE FOLLOWING PRECAUTIONS MUST BE TAKEN:

1. Operate all tube filaments within  $\pm 5\%$  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.



## SECTION VIII PARTS LIST

### 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
B-101	Autotune motor	MOTOR: a-c, 1/3 hp, 230 V, 50/60 cps, 3 phase, 1/4 hp, 230 V, 50/60 cps, 1 phase	232 0004 00 or 232 0005 00
B-301	Ventilating blower	BLOWER-MOTOR ASSEM: 1/3 hp, 110/220 V, 50/60 cps, 3 phase, 1140 rpm	009 1078 00 or 009 1077 00 or 009 2210 00
C-101	V-114 fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-102	V-114 fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-103	V-115 fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-104	V-115 fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-105	Int amplifier plate tuning	CAPACITOR: variable, dual sect, air, 250 uuf max	500 4421 002
C-106	Grid circuit balancing	CAPACITOR: air, 56 uuf	503 9502 002
C-107	Pwr amp bias filter	CAPACITOR: mica, 0.002 uf $\pm 20\%$ , 6000 test v	906 2208 40
C-108	Int amp feedback coupling	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-109	Int amp plate supply bypass	CAPACITOR: mica, 0.002 uf $\pm 20\%$ , 6000 test v	906 2208 40
C-110	Int amp output coupling	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-111	Spark suppressor	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 500 vdcw	935 2110 00
C-112	Line filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-113	Line filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-114	V-103 crystal trimmer	CAPACITOR: variable, air, 34 uuf max, 6 uuf min	922 3500 00
C-115	V-103 cathode	CAPACITOR: mica, 0.0003 uf $\pm 5\%$ , 350 vdcw	912 0001 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-116	PA neutralizing	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-117	V-103 filament filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-118	V-103 filament filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-119	V-103 screen filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-120	V-103 screen filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-121	V-103 screen filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-122	V-103 suppressor filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-123	V-103 suppressor filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-124	V-103 output coupling	CAPACITOR: mica, 0.001 uf $\pm 20\%$ , 750 vdcw	915 2105 40
C-125	V-103 plate tuning	CAPACITOR: variable, air, dual, 140 uuf max, 7.8 uuf min per section	922 0041 00
C-125A	V-103 plate tuning	CAPACITOR: section of C-125	
C-125B	V-103 plate tuning	CAPACITOR: section of C-125	
C-126	V-103 plate trimmer	CAPACITOR: variable, air, 25.7 uuf max, 3.9 uuf min	922 0017 00
C-127	V-103 plate trimmer	CAPACITOR: variable, air, 25.7 uuf max, 3.9 uuf min	922 0017 00
C-128	V-104 plate coupling	CAPACITOR: mica, 0.001 uf $\pm 20\%$ , 750 vdcw	915 2105 40
C-129	V-104 cathode bypass	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-130	V-104 screen bypass	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-131	V-104 plate supply filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-132	V-104 plate tuning	CAPACITOR: variable, air, dual, 140 uuf max, 7.8 uuf min per section	922 0041 00
C-132A	V-104 plate tuning	CAPACITOR: section of C-132	
C-132B	V-104 plate tuning	CAPACITOR: section of C-132	
C-133	V-103 plate trimmer	CAPACITOR: variable, air, 25.7 uuf max, 3.9 uuf min	922 0017 00
C-134	PA neutralizing	CAPACITOR: mica, 0.0008 uf $\pm 10\%$ , 500 vdcw	910 3805 20
C-135	PA neutralizing	CAPACITOR: mica, 0.001 uf $\pm 20\%$ , 750 vdcw	915 2105 40
C-136	V-103 plate trimmer	CAPACITOR: variable, air, 25.7 uuf max, 3.9 uuf min	922 0017 00
C-137	PA fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-138	PA fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-139	PA fil bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00

## 231D-2C TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-140	C-140A and C-140B	CAPACITOR: paper, 2/2 uf $\pm 10\%$ , 600 vdcw	956 4414 00
C-140A	Keying voltage filter	CAPACITOR: section of C-140	
C-140B	Keying voltage filter	CAPACITOR: section of C-140	
C-141	V-102 grid	CAPACITOR: mica, .001 uf $\pm 20\%$ , 750 vdcw	915 2105 40
C-142	V-102 screen	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-143	PA neutralizing	CAPACITOR: neutralizing plate	503 8190 002
C-144	V-103 plate filter	CAPACITOR: mica, 0.006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-145	PA screen bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-146	PA screen bypass	CAPACITOR: ceramic, 1000 uuf $\pm 20\%$ , 5000 vdcw	913 0101 00
C-147	V-104 grid blocking	CAPACITOR: mica, .006 uf $\pm 20\%$ , 750 vdcw	915 2605 40
C-150	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-151	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-152	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-153	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-154	PA high voltage filter	CAPACITOR: mica, 2000 uuf $\pm 20\%$ , 10,000 test v	900 2204 00
C-155	PA plate blocking	CAPACITOR: vacuum, 250 uuf, 12,000 peak v	919 0087 00
C-157	PA neutralizing	CAPACITOR: neutralizing assem	571 1652 30
C-158	PA plate tank tuning	CAPACITOR: min 30 uuf, max 140 uuf ROTOR STATOR	503 9525 004 571 1175 30
C-159	PA loading	CAPACITOR: min 80 uuf, max 1680 uuf ROTOR STATOR (2)	500 7614 004 571 1173 30
C-163	Spark suppressing	CAPACITOR: paper, .25 uf $\pm 10\%$ , 600 vdcw	961 5126 00
C-164	Relay voltage filter	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-164A	Relay voltage filter	CAPACITOR: section of C-164	
C-164B	Relay voltage filter	CAPACITOR: section of C-164	
C-164C	Relay voltage filter	CAPACITOR: section of C-164	
C-165	Transient suppressor	CAPACITOR: paper, .25 uf $+20\%$ $-10\%$ 600 vdcw	961 4130 00
C-166	High voltage filter	CAPACITOR: paper, 4 uf $\pm 20\%$ , 7500 vdcw	930 9140 00
C-167	Int voltage filter	CAPACITOR: paper, 4 uf $\pm 20\%$ , 4000 vdcw CLAMP: 2 req	930 0045 00 139 0038 00
C-175	V-116 filament bypass	CAPACITOR: mica, 0.001 uf $\pm 20\%$ , 750 vdcw	915 2105 40

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-176	V-116 filament bypass	CAPACITOR: mica, .001 uf $\pm 20\%$ , 750 vdcw	915 2105 40
C-178	Antenna balancing	CAPACITOR: variable, dual, 500 uuf each sect	500 7576 004
C-180	Spark suppressor	CAPACITOR: paper, 4 uf $\pm 20\%$ , 600 vdcw	930 3014 00
		CAPACITOR: paper, 4 uf $\pm 10\%$ , 600 vdcw	930 3012 00
		CAPACITOR: paper, 4 uf $\pm 20\%$ , 600 vdcw	930 0001 00
C-202	Low voltage supply filter	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-203	Low voltage supply filter	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-204	Bias supply filter	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-205	Bias supply filter	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-301	C-301A, C-301B, C-301C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-301A	Audio input coupling	CAPACITOR: section of C-301	
C-301B	V-301 cathode bypass	CAPACITOR: section of C-301	
C-301C	P1 voltage filter	CAPACITOR: section of C-301	
C-302	V-305 pl coupling	CAPACITOR: paper, 0.25 uf $\pm 20\%$ , 600 vdcw	961 6124 00
C-303	V-305 grid coupling	CAPACITOR: paper, 0.1 uf $\pm 20\%$ , 600 vdcw	961 6106 00
C-304	V-305 cathode coupling	CAPACITOR: paper, 0.1 uf $\pm 20\%$ , 600 vdcw	961 6106 00
C-305	V-303 cathode coupling	CAPACITOR: paper, 0.5 uf $\pm 20\%$ , 600 vdcw	961 6310 00
C-306	V-302 grid bypass	CAPACITOR: paper, 0.25 uf $\pm 20\%$ , 600 vdcw	961 6124 00
C-307	V-307 grid coupling	CAPACITOR: paper, 0.25 uf $\pm 20\%$ , 600 vdcw	961 6124 00
C-308	V-308 grid coupling	CAPACITOR: paper, 0.25 uf $\pm 20\%$ , 600 vdcw	961 6124 00
C-309	C-309A, C-309B, C-309C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-309A	V-304 cathode bypass	CAPACITOR: section of C-309	
C-309B	V-304 pl decoupling	CAPACITOR: section of C-309	
C-309C	P1 voltage filter	CAPACITOR: section of C-309	
C-310	MCW osc tank	CAPACITOR: paper, .22/.3/.4/.55/.82/1.4/ 2.8 uf $\pm 10\%$ , 600 vdcw	956 4120 00
C-311	Audio driver cathode bypass	CAPACITOR: paper, 4 uf $\pm 20\%$ , 600 vdcw	930 3014 00
C-312	Mod grid bypass	CAPACITOR: paper, 4 uf $\pm 20\%$ , 600 vdcw	930 3014 00
C-313	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-314	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-315	Meter bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 2500 vdcw	936 0250 00
C-316	Squelch grid bypass	CAPACITOR: mica, 1000 uuf $\pm 20\%$ , 500 vdcw	935 4054 00
CR-201	Relay supply rectifier	RECTIFIER: dry disc, output 48 V d-c at .52 amp continuous, input, 70 V 60 cps	353 2600 00
E-101	V-104	PARASITIC SUPPRESSOR: 100 ohms 2 w, 5 turns	503 8180 001
E-102	V-105, V-106 grid	PARASITIC SUPPRESSOR: 100 ohms 2 w, 5 turns	503 8180 001
E-103	PA fil conn strip	BOARD,TERM: 4 term conn strip	571 1986 20
E-105	PA filter supply term strip	BOARD,TERM: 11 term conn strip	571 1985 20
E-106	PA filter supply term strip	BOARD,TERM: 4 term conn strip	571 1986 20
E-108	PA stabilizer term strip	BOARD, TERM: 5 term conn strip	367 5050 00
E-201	Power unit terminal strip	BOARD, TERM: 13 term conn strip	367 4130 00
E-202	Power unit terminal strip	BOARD, TERM: 14 term conn strip	367 5140 00
E-203	Power unit terminal strip	BOARD, TERM: 13 term conn strip	367 4130 00
E-204	Power unit terminal strip	BOARD, TERM: 14 term conn strip	367 5140 00
E-301	Remote conn terminal strip	BOARD, TERM: 7 term conn strip	367 4070 00
E-302	Blower connector strip	BOARD, TERM: 2 term conn strip	367 4030 00
E-501	Desk set conn strip	BOARD, TERM: 8 term conn strip	367 3080 00
E-502	Desk set term block	BOARD, TERM: integral part of desk set base, see S-502	
E-503	Desk set coupling	FSK COUPLING UNIT: includes HOLDER: Crystal CAPACITOR: 1000 uuf $\pm 20\%$ , 500 vdcw	520 4438 00
F-101	Crystal compartment heater	FUSE: 1/4 amp 250 V	264 4020 00
F-102	T-102 primary	FUSE: 3/8 amp 250 V	264 4250 00
F-103	T-103 primary	FUSE: 1/4 amp 250 V	264 4240 00
F-104	Autotune motor	FUSE: 8 amp 250 V FUSE: 8 amp 250 V	264 0002 00 or 264 4110 00
F-105	Autotune motor	FUSE: 8 amp 250 V FUSE: 8 amp 250 V	264 0002 00 or 264 4110 00
F-106	Autotune motor	FUSE: 8 amp 250 V FUSE: 8 amp 250 V	264 0002 00 or 264 4110 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
F-107	PA filament primary	FUSE: 2 amp 250 V	264 4070 00
F-108	PA filament primary	FUSE: 2 amp 250 V	264 4070 00
F-109	V-116 filament primary	FUSE: 1/4 amp 250 V	264 4240 00
F-110	T-101 primary	FUSE: 3/4 amp 250 V	264 4270 00
F-201	H-v rect fil primary	FUSE: 3 amp 250 V	264 4080 00
F-202	H-v rect fil primary	FUSE: 3 amp 250 V	264 4080 00
F-203	Relay rect supply	FUSE: 2 amp 250 V	264 4070 00
F-204	L-v rect pl primary	FUSE: 3 amp 250 V	264 4080 00
F-205	Bias rect pl primary	FUSE: 3 amp 250 V	264 4080 00
F-206	L-v rect fil primary	FUSE: 1 amp 250 V	264 4050 00
F-207	Bias rect fil primary	FUSE: 1 amp 250 V	264 4050 00
F-208	Relay supply output	FUSE: 3 amp 250 V	264 4080 00
F-301	Mod fil primary	FUSE: 1 amp 250 V	264 4280 00
F-302	Speech amp fil primary	FUSE: 3/8 amp 250 V	264 4250 00
F-303	Audio driver fil primary	FUSE: 3/8 amp 250 V	264 4250 00
F-304	Mod pl supply	FUSE: 2 amp 5000 V	264 8190 00
HS-301	Local control handset	HANDSET: push-button switch on handle	977 1800 00
HS-501	Desk set handset	HANDSET: push-button switch on handle	977 1800 00
I-101	Switching indicator	LAMP: neon, 1/25 w, used with external resistor	262 0021 00
I-201	Filament pilot lamp	LAMP: 110 V, 6 w candelabra base DISC: green	262 3330 00 262 2370 00
I-202	Plate pilot lamp	LAMP: 110 V, 6 w candelabra base DISC: red	262 3330 00 262 2360 00
J-101	Receptacle for Autotune control unit conn plug P-101	CONNECTOR: 17 term socket	502 1621 004
J-102	Receptacle for Autotune control unit conn plug P-102	CONNECTOR: 19 term socket	502 1627 004
J-104	Exciter and PA fil voltage metering plug receptacle	CONNECTOR: 6 term socket	364 2060 00
J-105	Automatic emission selector plug receptacle	CONNECTOR: 15 term socket	366 2150 00
J-106	Crystal osc fil primary fuse	HOLDER: 3 AG AG fuse extractor post	265 2060 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
J-107	Receptacle for r-f exc conn plug P-105	CONNECTOR: 15 term socket	502 1622 004
J-108	Receptacle for r-f exc conn plug P-106	CONNECTOR: 19 term socket	502 1627 004
J-109	Autotune motor conn plug rec	CONNECTOR: 6 term socket	364 2060 00
J-110	PA fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-111	PA fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-113	Receptacle, crystal heater fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-114	Receptacle, ex fil primary fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-115	Receptacle, int amp fil primary fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-116	Receptacle, Autotune	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-117	Receptacle, Autotune motor fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-118	Receptacle, Autotune motor fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-119	Receptacle, PA fil primary fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-120	Receptacle, PA fil primary fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-121	Receptacle, V-116 fil primary fuse	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-122	Receptacle, voltage metering plug	CONNECTOR: 2 term socket	368 4500 00
J-123	Freq shift keyer input	CONNECTOR: coaxial, right angle CONNECTOR: straight, r-f concentric cable CONNECTOR: receptacle	357 9024 00 357 9014 00 357 9005 00
J-124	Freq shift keyer input	CONNECTOR: coaxial, right angle CONNECTOR: straight, r-f concentric cable CONNECTOR: receptacle	357 9024 00 357 9014 00 357 9005 00
J-125	Freq shift keyer input	CONNECTOR: coaxial, right angle CONNECTOR: straight, r-f concentric cable CONNECTOR: receptacle	357 9024 00 357 9014 00 357 9005 00
J-201	H-v rect fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-202	H-v rect fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-203	L-v rect fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
J-204	Bias rect fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-205	Receptacle for F-201	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-206	Receptacle for F-202	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-207	Receptacle for F-203	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-208	Receptacle for F-204	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-209	Receptacle for F-205	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-210	Receptacle for F-206	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-211	Receptacle for F-207	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-212	Receptacle for J-208	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-301	Line voltage metering cord plug receptacle	CONNECTOR: 4 term socket	364 2040 00
J-302	Filament voltage metering cord plug receptacle	CONNECTOR: 4 term socket	364 2040 00
J-303	Filament voltage metering cord plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-304	Mod fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-305	Audio driver fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-306	Key jack	JACK: phone, 3 circuit midget	358 1020 00
J-307	Microphone jack	JACK: phone	360 1160 00
J-308	Receptacle for speech amp conn plug P-301	CONNECTOR: 19 term socket	502 1620 004
J-309	Receptacle for speech amp conn plug P-302	CONNECTOR: 9 term socket	502 1632 004
J-310	Receptacle for fil supply conn plug P-303	CONNECTOR: 13 term socket	502 1623 004
J-311	Speech amp fil voltage metering plug receptacle	CONNECTOR: 2 term socket	368 4500 00
J-312	Handset conn plug receptacle	CONNECTOR: 4 term socket	364 2040 00
J-313	Receptacle for F-301	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-314	Receptacle for F-302	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00
J-315	Receptacle for F-303	HOLDER: 3AG and 4AG fuse extractor post	265 2060 00



## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
J-501	Desk set key jack	JACK: 3 cond midget	358 1100 00
K-101	PA overload	RELAY: overload NO, 400 to 800 ma d-c trip coil and 48 V dc reset coil	405 3400 00
K-102	Phone - cw	RELAY ASSEM: phone - cw (includes C-165 and R-166)	571 0514 40
K-103	Autotune motor reverse	RELAY: circuit control, 3 pdt, 48 V d-c	405 0007 00
K-104	Autotune motor start	RELAY: circuit control, 3 pdt, 48 V d-c	405 2215 00
K-105	CW control	RELAY: circuit control, 3 pdt, 48 V d-c	405 2215 00
K-106	Transmitter off	RELAY: circuit control, dpdt, 48 V d-c	405 0016 00
K-107	Slow release #1	RELAY: single wound, 48 V d-c, telephone type, 600 ohms $\pm 10\%$ or RELAY: single wound, 48 V d-c, telephone type, 600 ohms $\pm 10\%$	972 1023 00 970 1008 00
K-108	Slow release #2	RELAY: single wound, 48 V d-c, telephone type	970 1007 00
K-109	Homing	RELAY: single wound, quick acting d-c, 3 amp, 150 w	972 1038 00
K-110	Pulsing	RELAY: single wound, quick acting d-c, 3 amp, 150 w, telephone type	972 1041 00
K-111	V-116 fil voltage control	RELAY: circuit control, dpdt, 48 V d-c	405 0016 00
K-112	Motor reverse interlock	RELAY: circuit control, dpdt, 48 V d-c	405 0016 00
K-201	Voltage control	RELAY: 48 V d-c coil, 2 NO contacts	571 1524 20
K-202	Low power plate	RELAY: power contactor, 50 amp, 3 pole normally open, 1 R aux NC, 1 L aux NO, 220 V 60 cyc	405 1400 00
K-203	High power plate	RELAY: power contactor, 50 amp, 3 pole normally open, 1 aux NC, 220 V 60 cyc	405 1200 00
K-204	Time delay	RELAY: time delay, spdt 230 V, 60 cps	503 5691 002
K-205	Filament power	RELAY: power contactor, 25 amp, 3 pole normally open, 220 V 60 cps coil	405 0151 00
K-206	Plate power control	RELAY: circuit control, 3 pdt, 48 V d-c	405 2215 00
K-207	Bias interlock	RELAY: circuit control, .5 amp, approx 7.5 ohm, dp normally open	405 0020 00
K-208	Bias holding	RELAY: circuit control, dpdt, 48 V d-c	405 0016 00
K-209	H-v interlock	RELAY: circuit control, .130 amp, approx 85 ohm dp normally open	405 2212 00
K-301	MCW oscillator	RELAY: single wound, 1350 ohm $\pm 10\%$ , 48 V d-c	972 1020 00
K-302	Push-to-talk	RELAY: sensitive, 1950 ohm coil, nominal 12 to 24 ma, 24 to 48 V	408 7000 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
L-101	Power amp bias feed	COIL: r-f choke, static drain, 94 turns #24 wire	503 9526 004
L-102	L-102A, L-102B	COIL: r-f choke, two sect, 76, 87 turns #24 wire	503 9527 004
L-102A	Int amp output coupling choke	COIL: section of L-102	
L-102B	Int amp output coupling choke	COIL: section of L-102	
L-104	L-104A, L-104B	COIL: r-f choke, two sect, .25 uh $\pm 10\%$ per sect	240 5200 00
L-104A	Heater line filt choke	COIL: section of L-104	
L-104B	Heater line filt choke	COIL: section of L-104	
L-105	V-103 cathode choke	COIL: r-f choke, 2.5 uh $\pm 20\%$ , 4 sect	240 2100 00
L-106	L-106A, L-106B	COIL: r-f choke, .25 uh $\pm 10\%$ per sect, 2 sect	240 5200 00
L-106A	V-103 fil filter choke	COIL: section of L-106	
L-106B	V-103 fil filter choke	COIL: section of L-106	
L-107	V-103 screen feed choke	COIL: r-f choke, 2.5 uh $\pm 10\%$ , 4 sect	240 5300 00
L-108	V-103 feed choke	COIL: r-f choke, 2.5 uh $\pm 20\%$ , 4 sect	240 2100 00
L-109	Bypass filter choke	COIL: r-f choke, 2.5 uh $\pm 20\%$ , 4 sect	240 2100 00
L-110	V-103 plate feed choke	COIL: r-f choke, 2.5 uh $\pm 10\%$ , 4 sect	240 5300 00
L-111	Grid tank inductor	COIL: 13.5 mc, 53 uuf $\pm 3$ uuf	503 9515 003
L-112	Grid tank inductor	COIL: 8 mc, 67 uuf $\pm 3$ uuf	503 9517 003
L-113	Grid tank inductor	COIL: 4 mc, 65 uuf $\pm 3$ uuf	503 9521 003
L-114	V-104 pl feed choke	COIL: r-f choke, 2.5 uh $\pm 10\%$ , 4 sect	240 5300 00
L-115	Grid tank inductor	COIL: 2 mc, 59 uuf $\pm 3$ uuf	503 9520 003
L-116	Grid tank inductor	COIL: 26 mc, 61 uuf $\pm 3$ uuf	503 9519 003
L-117	Grid tank inductor	COIL: 16 mc, 71 uuf $\pm 3$ uuf	503 9516 003
L-118	Grid tank inductor	COIL: 8 mc, 67 uuf $\pm 3$ uuf	503 9518 003
L-119	Keying supply filter reactor	REACTOR: 15 hy 0.02 amp	678 1181 00
L-120	V-102 grid choke	COIL: r-f choke, 2.5 mh $\pm 10\%$ , 4 sect	240 5300 00
L-121	Grid tank inductor	COIL: 4 mc, 67 uuf $\pm 3$ uuf	503 9522 003
L-122	PA pl feed choke	COIL: r-f choke, static drain, 94 turns #24 wire	503 9526 004
L-123	H-f PA plate tank inductor	COIL: h-f tank assy, 7 turns	503 9524 004
L-125	PA plate tank inductor	COIL: r-f tank assy	500 7578 004

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
L-127	High-frequency inductor	COIL: 4 turns copper tubing	503 9511 003
L-128	L-128A, L-128B	COIL: 30-1/3 turns copper strip, edge wound	571 1413 30
L-128A	PA grid inductor	COIL: section of L-128	
L-128B	PA grid inductor	COIL: section of L-128	
L-129	PA grid inductor	COIL: 4 turns copper tubing	503 9514 003
L-130	Relay supply filter	REACTOR: 2 hy, 0.15 amp, 50 ohms, 120 cps 2500 test v	678 1590 00
L-134	Int amp plate choke	COIL: choke, 68 turns single layer wound	500 2071 002
L-135	Stabilizer grid choke	COIL: r-f choke, 2.5 uh $\pm 10\%$ , 4 sect	240 5300 00
L-136	PA plate tank balancing inductor	COIL: r-f, 3 turns	503 9509 003
L-137	PA plate tank balancing inductor	COIL: r-f, 11 turns	502 1465 002
L-138	PA plate tank balancing inductor	COIL: r-f, 13 turns	500 7434 002
L-140	Static drain choke	COIL: r-f choke, static drain, 94 turns #24 wire	503 9526 004
L-141	Static drain choke	COIL: r-f choke, static drain, 94 turns #24 wire	503 9526 004
L-142	Static drain choke	COIL: r-f choke, static drain, 84 turns #24 wire	503 9526 004
L-201	High voltage filter reactor	REACTOR: 12 hy, 0.5 amp, 25 V rms, 120 cps, 12,000 test v	678 2800 00
L-202	High voltage filter reactor	REACTOR: subassembly 2 hy, 2 amp nominal, 12,000 test v	500 0307 002
L-203	Low voltage filter reactor	REACTOR: 4 hy, 0.5 amp, 40 ohms, 120 cps, 2500 test v	678 1151 00
L-204	Low voltage filter reactor	REACTOR: 4 hy, 0.5 amp, 40 ohms, 120 cps, 2500 test v	678 1151 00
L-205	Bias supply filter reactor	REACTOR: 4 hy, 0.5 amp, 40 ohms, 120 cps, 2500 test v	678 1151 00
L-206	Bias supply filter reactor	REACTOR: 4 hy, 0.5 amp, 40 ohms, 120 cps, 2500 test v	678 1151 00
L-301	MCW osc tank reactor	REACTOR: 0.0665 hy $\pm 5\%$ , 300 to 1500 cps, 1200 test v	678 0010 00
L-302	Squelch grid choke	COIL: r-f choke, 2.5 uh $\pm 20\%$ , .125 amp	240 2100 00 or 240 2000 00
M-101	Exciter grid current	METER: d-c voltmeter 0-5 V, dual scale 0-5 ma, 0-50 ma	458 0010 00
M-102	Int amp plate current meter	METER: d-c milliammeter 0-500 ma, 50 scale divisions	450 3500 50

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
M-103	Pwr amp grid current meter	METER: d-c milliammeter, 0-300 ma, 60 scale divisions	450 3300 50
M-104	Pwr amp plate current	METER: d-c ammeter, 0-2 amp, 40 scale divisions	458 0833 50
M-105	Antenna current meter	METER: a-c thermoammeter, 0-10 amp, 50 scale divisions	451 2101 00
M-105	Antenna current meter	(Alternate)	451 0097 00
M-106	Antenna current meter (bal)	METER: a-c thermoammeter, 0-5 amp, scale divisions	451 2510 00
M-106	Antenna current meter (bal)	(Alternate)	451 0095 00
M-107	Antenna current meter (bal)	METER: a-c thermoammeter, 0-5 amp, 50 scale divisions	451 2510 00
M-107	Antenna current meter (bal)	(Alternate)	451 0095 00
M-301	Audio level meter	METER: power level indicator, 16 scale divisions	455 2500 00
M-302	Plate voltage meter	METER: d-c voltmeter 7.5 kv, 75 scale divisions 100 V per division	458 0233 50
M-303	Mod pl current meter	METER: d-c ammeter, 0-2 amp, 40 scale divisions	458 0833 50
M-304	Line and filament voltage meter	METER: spec mult scale, a-c voltmeter	458 0613 50
P-101	Autotune control unit conn plug	CONNECTOR: 17 term plug	502 1635 004
P-102	Autotune control unit conn plug	CONNECTOR: 19 term plug	502 1641 004
P-104	Automatic emission selector plug	CONNECTOR: 15 term plug	365 1150 00
P-105	R-f unit conn plug	CONNECTOR: 19 term plug	502 1634 004
P-106	R-f unit conn plug	CONNECTOR: 19 term plug	502 1641 004
P-107	Autotune motor conn	CONNECTOR: 6 term cable	363 9062 00
P-301	Speech amp conn plug	CONNECTOR: 19 term plug assy	502 1634 004
P-302	Speech amp conn plug	CONNECTOR: 9 term plug assy	502 1646 004
P-303	Fil supply conn plug	CONNECTOR: 13 term cable	502 1637 004
P-304	Voltage metering plug	CONNECTOR: 4 term cable	363 9040 00
P-305	Handset conn plug	CONNECTOR: 4 term cable	363 8042 00
R-101	Relay spark suppressing	RESISTOR: comp, 510 ohms $\pm 5\%$ , 2 w	745 5640 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R-102	Crystal comp heater	HEATER UNIT: 230 V, 150 w	711 0005 00
R-103	Crystal comp heater	HEATER UNIT: 230 V, 150 w	711 0005 00
R-104	V-103 grid	RESISTOR: comp, 100,000 ohms $\pm 10\%$ , 2 w	745 5736 00
R-105	V-103 cathode	RESISTOR: comp, 330 ohms $\pm 10\%$ , 1 w	745 3331 00
R-106	V-103 screen	RESISTOR: comp, 150,000 ohms $\pm 10\%$ , 2 w	745 5743 00
R-107	V-104 cathode	RESISTOR: wire wound, 500 ohms $\pm 5\%$ , 14 w	746 3037 00
R-108	V-105, V-106 screen bleeder	RESISTOR: wire wound, 22,000 ohms $\pm 5\%$ , 50 w	746 1608 00
R-109	Int amp grid	RESISTOR: wire wound, 2500 ohms $\pm 5\%$ , 50 w	746 1544 00
R-110	Grid meter shunt	RESISTOR: wire wound, 1250 ohms $\pm 1\%$ , 1 w	721 1250 60
R-111	Grid meter shunt	RESISTOR: wire wound, 101 ohms $\pm 1\%$ , 1 w	721 1016 00
R-112	C-143 discharging	RESISTOR: comp, 1 megohm $\pm 10\%$ , 2 w	745 5778 00
R-113	V-104 screen	RESISTOR: wire wound, 8000 ohms $\pm 5\%$ , 50 w	746 1549 00
R-114	V-104 screen	RESISTOR: comp, 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-115	V-104 screen	RESISTOR: comp, 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-116	V-104 screen	RESISTOR: comp, 510 ohms $\pm 5\%$ , 2 w	745 5640 00
R-117	V-104 screen	RESISTOR: comp, 510 ohms $\pm 5\%$ , 2 w	745 5640 00
R-118	V-104 screen	RESISTOR: comp, 1500 ohms $\pm 10\%$ , 2 w	745 5659 00
R-119	V-104 screen	RESISTOR: comp, 1500 ohms $\pm 10\%$ , 2 w	745 5659 00
R-120	V-104 screen	RESISTOR: comp, 1800 ohms $\pm 10\%$ , 2 w	745 5663 00
R-121	V-104 screen	RESISTOR: comp, 1800 ohms $\pm 10\%$ , 2 w	745 5663 00
R-122	V-104 screen	RESISTOR: comp, 1800 ohms $\pm 10\%$ , 2 w	745 5663 00
R-123	V-104 screen	RESISTOR: comp, 1800 ohms $\pm 10\%$ , 2 w	745 5663 00
R-124	V-104 screen	RESISTOR: comp, 1800 ohms $\pm 10\%$ , 2 w	745 5663 00
R-125	Exciter voltage divider	RESISTOR: comp, 62,000 ohms $\pm 5\%$ , 2 w	745 5727 00
R-126	Exciter voltage divider	RESISTOR: comp, 51,000 ohms $\pm 5\%$ , 2 w	745 5724 00
R-127	V-102 grid	RESISTOR: comp, 20,000 ohms $\pm 5\%$ , 2 w	745 5706 00
R-128	Channel indicator	RESISTOR: comp, 16,000 ohms $\pm 5\%$ , 2 w	745 5703 00
R-129	Channel indicator	RESISTOR: comp, 16,000 ohms $\pm 5\%$ , 2 w	745 5703 00
R-130	Channel indicator	RESISTOR: comp, 16,000 ohms $\pm 5\%$ , 2 w	745 5703 00
R-131	Channel indicator	RESISTOR: comp, 16,000 ohms $\pm 5\%$ , 2 w	745 5703 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R-132	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-133	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-134	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-135	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-136	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-137	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-138	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-139	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-140	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-141	Channel indicator	RESISTOR: wire wound, 1000 ohms $\pm 1\%$ , 1 w	721 1460 00
R-142	Int amp screen	RESISTOR: wire wound, 5000 ohms $\pm 5\%$ , 50 w	746 1547 00
R-143	Freq shift input	RESISTOR: comp, 120 ohms $\pm 10\%$ , 2 w	745 5614 00
R-144	Freq shift input	RESISTOR: comp, 120 ohms $\pm 10\%$ , 2 w (2)	745 5614 00
R-145	Freq shift input	RESISTOR: comp, 120 ohms $\pm 10\%$ , 2 w (2)	745 5614 00
R-146		RESISTOR: comp, 10,000 ohms $\pm 10\%$ , 1 w	745 3394 00
R-149	Transient suppressor	RESISTOR: comp, 220 ohms $\pm 10\%$ , 2 w	745 5624 00
R-166	Transient suppressor	RESISTOR: comp, 510 ohms $\pm 5\%$ , 2 w	745 5640 00
R-167	PA cathode	RESISTOR: wire wound, 16 ohms $\pm 5\%$ , 20 w	746 2522 00
R-176	Suppressor	RESISTOR: global, 50 ohms $\pm 20\%$	712 4400 00
R-201	Int voltage dropping	RESISTOR: wire wound, 1000 ohms $\pm 5\%$ , 116 w	746 0540 00
R-202	Int voltage dropping	RESISTOR: wire wound, 1000 ohms $\pm 5\%$ , 116 w	746 0540 00
R-203	Mod bias control	RESISTOR: 3 term rheostat, 200 ohms $\pm 5\%$ , 100 w	738 2001 00
R-204	Int voltage bleeder	RESISTOR: wire wound, 50,000 ohms $\pm 5\%$ , 86 w	746 1057 00
R-205	Int voltage bleeder	RESISTOR: wire wound, 50,000 ohms $\pm 5\%$ , 86 w	746 1057 00
R-206	High voltage bleeder	RESISTOR: wire wound, 31,000 ohms $\pm 5\%$ , 116 w	746 0555 00
R-207	High voltage bleeder	RESISTOR: wire wound, 31,000 ohms $\pm 5\%$ , 116 w	746 0555 00
R-208	High voltage bleeder	RESISTOR: wire wound, 31,000 ohms $\pm 5\%$ , 116 w	746 0555 00
R-209	Plate voltmeter multiplier	RESISTOR: 3.0 megohm $\pm 0.5\%$ , 3.0 kv	732 0014 00
R-210	Plate voltmeter multiplier	RESISTOR: 4.5 megohm $\pm 1/2$ of 1%, 4500 V max	732 0005 00
R-211	I-201 voltage dropping	RESISTOR: wire wound, 2500 ohms $\pm 5\%$ , 14 w	746 3044 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R-212	I-202 voltage dropping	RESISTOR: wire wound, 2500 ohms $\pm 5\%$ , 14 w	746 3044 00
R-213	Low voltage supp bleeder	RESISTOR: wire wound, 25,000 ohms $\pm 5\%$ , 50 w	746 1554 00
R-214	PA grid	RESISTOR: wire wound, 2000 ohms $\pm 5\%$ , 116 w	746 0543 00
R-215	PA grid	RESISTOR: wire wound, 2000 ohms $\pm 5\%$ , 116 w	746 0543 00
R-217	Keying voltage adjusting	RESISTOR: 100 ohms $\pm 5\%$ , 100 w	738 0001 00
R-218	Bias supply bleeder	RESISTOR: wire wound, 100 ohms $\pm 5\%$ , 40 w	746 2030 00
R-219	Bias supply bleeder	RESISTOR: wire wound, 160 ohms $\pm 5\%$ , 86 w	746 1032 00
R-220	Bias supply bleeder	RESISTOR: wire wound, 160 ohms $\pm 5\%$ , 86 w	746 1032 00
R-221	Bias supply bleeder	RESISTOR: wire wound, 250 ohms $\pm 5\%$ , 86 w	746 1034 00
R-222	High voltage tuning	RESISTOR: strip heater, 1400 w, 115 V	711 9100 00
R-223	High voltage tuning	RESISTOR: strip heater, 1400 w, 115 V	711 9100 00
R-224	High voltage tuning	RESISTOR: strip heater, 1400 w, 115 V	711 9100 00
R-225	Microphone voltage level	RESISTOR: comp, 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-236	Transient suppressor	RESISTOR: comp, 330 ohms $\pm 10\%$ , 1 w	745 3331 00
R-301	Audio input matching	RESISTOR: comp, 5100 ohms $\pm 5\%$ , 2 w	745 5682 00
R-302	Audio input	RESISTOR: comp, 5100 ohms $\pm 5\%$ , 2 w	745 5682 00
R-303	V-305 cathode	RESISTOR: comp, 2000 ohms $\pm 5\%$ , 2 w	745 5664 00
R-304	V-301 cathode	RESISTOR: comp, 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-305	V-305 grid	RESISTOR: comp, 47,000 ohms $\pm 5\%$ , 2 w	745 5721 00
R-306	V-305 cathode	RESISTOR: comp, 510 ohms $\pm 5\%$ , 2 w	745 5640 00
R-307	V-305 plate	RESISTOR: comp, 10,000 ohms $\pm 10\%$ , 2 w	745 5694 00
R-308	V-305 plate	RESISTOR: comp, 10,000 ohms $\pm 10\%$ , 2 w	745 5694 00
R-309	Limiter bridge	RESISTOR: comp, 43,000 ohms $\pm 5\%$ , 2 w	745 5720 00
R-310	Limiter bridge	RESISTOR: comp, 30,000 ohms $\pm 5\%$ , 2 w	745 5713 00
R-311	Limiter bridge	RESISTOR: comp, 15,000 ohms $\pm 5\%$ , 2 w	745 5700 00
R-312	V-301 plate	RESISTOR: comp, 47,000 ohms $\pm 5\%$ , 2 w	745 5721 00
R-313	V-301 plate	RESISTOR: comp, 47,000 ohms $\pm 5\%$ , 2 w	745 5721 00
R-314	Limiter bridge	RESISTOR: comp, 15,000 ohms $\pm 5\%$ , 2 w	745 5700 00
R-315	Limiter bridge	RESISTOR: comp, 30,000 ohms $\pm 5\%$ , 2 w	745 5713 00
R-316	Limiter bridge	RESISTOR: comp, 43,000 ohms $\pm 5\%$ , 2 w	745 5720 00
R-317	V-303 grid	RESISTOR: comp, 100,000 ohms $\pm 10\%$ , 2 w	745 5736 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R-318	V-304 cathode	RESISTOR: comp, 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-319	V-304 plate decoupling	RESISTOR: comp, 5100 ohms $\pm 5\%$ , 2 w	745 5682 00
R-320	V-306 cathode	RESISTOR: comp, 4.7 megohm $\pm 10\%$ , 2 w	745 5806 00
R-321	V-307 grid	RESISTOR: comp, 100,000 ohms $\pm 10\%$ , 2 w	745 5736 00
R-322	V-308 grid	RESISTOR: comp, 100,000 ohms $\pm 10\%$ , 2 w	745 5736 00
R-323	Speech amp voltage dropping	RESISTOR: wire wound, 12,000 ohms $\pm 5\%$ , 40 w	746 2051 00
R-324	R-324A, R-324B	RESISTOR: variable, 0.10 megohm $\pm 20\%$ , 1/2 w	376 2020 00
R-324A	Audio gain control	RESISTOR: section of R-324	
R-324B	Audio gain control	RESISTOR: section of R-324	
R-325	MCW gain control	RESISTOR: variable, 0.10 megohm $\pm 20\%$ , 1/2 w	376 3025 00
R-326	R-326A, R-326B	RESISTOR: variable, dual, 1/2 w per sect, 0.10 ohms $\pm 20\%$	376 2020 00
R-326A	Limiting gain control	RESISTOR: section of R-326	
R-326B	Limiting gain control	RESISTOR: section of R-326	
R-327	Audio level metering	RESISTOR: comp, 0.51 megohm $\pm 5\%$ , 2 w	745 5766 00
R-328	Audio level meter adjusting	RESISTOR: variable, 1.0 megohm $\pm 20\%$ , 1 w min	376 0059 00
R-329	Audio level metering	RESISTOR: comp, 0.51 megohm $\pm 5\%$ , 2 w	745 5766 00
R-330	Audio level metering	RESISTOR: comp, 0.51 megohm $\pm 5\%$ , 2 w	745 5766 00
R-331	Audio driver cathode	RESISTOR: wire wound, 2000 ohms $\pm 5\%$ , 40 w	746 2043 00
S-101	Grid selecting	SWITCH: 1 amp, 250 V d-c, dpdt toggle	266 1030 00
S-102	Switch, crystal comp heater	THERMOSWITCH: 115 V, 10 amp, 0-400° F	292 2400 00
S-103	Switch, crystal comp heater	THERMOSWITCH: 115 V, 10 amp, 0-400° F	292 2400 00
S-104	S-104A, S-104B, S-104C	SWITCH: 3 point rotor 10 point stator	502 0806 003
S-104A	V-105 grid ind conn	SWITCH: section of S-104	
S-104B	V-105 grid ind conn	SWITCH: section of S-104	
S-104C	V-105 grid ind conn	SWITCH: section of S-104	
S-105	S-105A, S-105B, S-105C	SWITCH: 3 point rotor 10 point stator	502 0806 003
S-105A	V-105 grid ind conn	SWITCH: section of S-105	
S-105B	Not used	SWITCH: section of S-105	



## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
S-105C	V-104 grid ind conn	SWITCH: section of S-105	
S-106	S-106A, S-106B,	SWITCH: 3 point rotor 10 point stator	502 0806 003
S-106A	V-104 grid ind conn	SWITCH: section of S-106	
S-106B	V-104 grid ind conn	SWITCH: section of S-106	
S-106C	V-104 grid ind conn	SWITCH: section of S-106	
S-107	Autotune emission selector	SWITCH: tap, 1 circuit, shorting, 12 pos	269 3600 00
S-108	Channel indicator	SWITCH: tap, 1 circuit, nonshorting, 11 pos	269 4100 00
S-109	Autotune channel selector	SWITCH: tap, 1 circuit, shorting, 12 pos	269 3600 00
S-110	Autotune limit	SWITCH: snap, spdt	260 0009 00
S-111	PA plate tank	SWITCH: 10 contract shorting, rotor arms	500 7573 003
S-112	PA grid tank	SWITCH: subassembly, 10 contacts, rotor 4 arms	541 7007 00
S-113	Autotune rotary stepping	SWITCH: rotary, 25 pt, 4 levels, 1 bridging, 3 nonbridging	978 2000 00
S-113A	Autotune rotary stepping	SWITCH: section of S-113	
S-113B	Autotune rotary stepping	SWITCH: section of S-113	
S-113C	Autotune rotary stepping	SWITCH: section of S-113	
S-113D	Autotune rotary stepping	SWITCH: section of S-113	
S-114A	Front door interlock	SWITCH: male section door interlock	260 4040 00
S-114B	Front door interlock	SWITCH: female section door interlock	260 4050 00
S-115A	Rear door interlock	SWITCH: male section door interlock	260 4040 00
S-115B	Rear door interlock	SWITCH: female section door interlock	260 4050 00
S-116	PA grid tank	SWITCH: subassembly, 10 contacts, rotor 4 arms	541 7007 00
S-117	Switching aligning	SWITCH: breaker arm assy	503 8230 002
S-118	Antenna selector	SWITCH: arm assy	504 1280 003
S-119	Balancing coil selector	SWITCH: rotor assy	500 7571 003
S-120	Crystal selector	SWITCH: tap, 1 circuit, nonshorting, 11 pos	269 4100 00
S-201	Filament start	SWITCH: push button, black, NO	260 2020 00
S-202	Filament stop	SWITCH: push button, red, NC	260 2030 00
S-203	Plate start	SWITCH: push button, black, NO	260 2020 00
S-204	Plate stop	SWITCH: push button, red, NC	260 2030 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
S-205	Power level	SWITCH: 1 amp, 250 V d-c, dpdt toggle	266 1030 00
S-206	Tune-operate	SWITCH: 3 pole, nonshorting, 3 pos	571 1994 20
S-207	Voltage control	SWITCH: 1 NC contact leaf spring assy contacts 1/8" dia silver	269 4000 00
S-208A	Front door interlock	SWITCH: male section door interlock	260 4040 00
S-208B	Front door interlock	SWITCH: female section door interlock	260 4050 00
S-209A	Rear door interlock	SWITCH: male section door interlock	260 4040 00
S-209B	Rear door interlock	SWITCH: female section door interlock	260 4050 00
S-210	Adjust-operate	SWITCH: dpdt toggle, dpdt 1 amp 250 V d-c	266 1030 00
S-211	Transmitter power	SWITCH: magnetic time delay, triple pole, 3 over- load coils, rating 50 amp, 230 V a-c	260 1180 30
S-301	Test switch	SWITCH: 10 amp, 110 V a-c lever 2 pos	374 0009 00
S-301	Test switch	(Alternate)	374 0001 00
S-302	Telephone dial	DIAL: telephone, splash proof, delayed impulse 11 pts	978 1000 00
S-303	Local-remote	SWITCH: locking in position 1 or 2 contact arrangement pos 1: 2C, 1B, pos 2: 2C, 2C, 110 V 10 amp a-c max	374 0002 00
S-304	MCW frequency control	SWITCH: open tap, 1 pole 7 pos, 1 sec shorting	259 1060 00
S-305A	Front door interlock	SWITCH: male section door interlock	260 4040 00
S-305B	Front door interlock	SWITCH: female section door interlock	260 4050 00
S-306A	Rear door interlock	SWITCH: male section door interlock	260 4040 00
S-306B	Rear door interlock	SWITCH: female section door interlock	260 4050 00
S-307	Handset mounting hook switch	HANDSET: mounting without bracket, 2 NC contact leaf switch	997 3500 00
S-308	Air interlock	SWITCH: micro, snap, spdt, NO	260 0002 00
S-501	Desk set conn switch	SWITCH: integral part of desk set base, see E-502 ASSEMBLY: S-502 and E-502	571 1595 30
S-502	Desk set telephone dial	DIAL: telephone, splash proof, 8-12 impulses per sec	978 1000 00
T-101	4D21/4-125A filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 100 va, sec 10 V, 10 amp	672 1093 00
T-102	Exciter filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 20 va, sec #1S, 13.7 V CT 1 amp, sec #2, 6.3 V CT, 1 amp	672 1081 00
T-103	Keying rect supply	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 10.3 va, sec #1, 400 V CT, .025 amp, sec #2, 6.3 V CT, 1.0 amp	672 0015 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
T-104	PA filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 180 va, sec, 7.5 V, 24 amp, 2500 test v	672 2110 00
T-105	PA	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 180 va, sec, 7.5 V, 24 amp, 2500 test v	672 2110 00
T-107	V-116 filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 31.5 va sec, 6.3 V, 5 amp CT, 2500 test v	672 1121 00
T-201	High voltage rect filament	TRANSFORMER: pri, 220, 230, 240 V, 50/60 cps, 150 va, sec #1, 5 V 10 amp rms, sec #2, 5 V 10 amp rms, sec #3, 5 V 10 amp rms	672 2101 00
T-202	High voltage rect	TRANSFORMER: pri, 220, 230, 240 V, 50/60 cps, 150 va, sec #1, 5 V 10 amp rms, sec #2, 5 V 10 amp rms, sec #3, 5 V 10 amp rms	672 2101 00
T-203	High voltage power	TRANSFORMER: 3 phase plate, 4000 V and 2000 V lv, 5250 V and 2625 V hv, 50/60 cps	674 2750 00
T-204	Relay rect supply	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, sec #1, 70, 80 V sec #2, 110 V 2500 test v	674 2690 00
T-205	Low voltage rect plate	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 300 va, sec, 1200 V CT 0.353 amp 2500 test v 425 va	500 0272 002
T-206	Bias rect plate	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 300 va, sec, 1200 V CT, 0.353 amp 2500 test v, 425 va	500 0272 002
T-207	Low voltage rect	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 37.5 va, sec, 2.5 V CT, 15 amp 2500 test v	672 1480 00
T-208	Bias rect filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 37.5 va, sec, 2.5 V CT, 15 amp 2500 test v	672 1480 00
T-209	Input voltage adj	AUTOTRANSFORMER: 220, 230, 240 V, 50/60 cps, 300 va	674 1670 00
T-210	Input voltage adj	AUTOTRANSFORMER: 220, 230, 240 V, 50/60 cps, 300 va	674 1670 00
T-301	Audio input	TRANSFORMER: pri #1 and #2, 500 ohms CT, pri #3, 75 ohms, sec, 40,000 ohms CT, 1000 test v, 50 MW max	677 2700 00
T-302	Audio coupling	TRANSFORMER: pri, 20,000 ohms, sec #1, 20,000 ohms, sec #2, 20,000 ohms, 1500 test v	677 1410 00
T-303	Audio coupling	TRANSFORMER: pri, 10,000 ohms, sec, 40,000 ohms CT, 1000 test v, .2 w	677 1021 00
T-304	Audio amp output coupling	TRANSFORMER: pri, 16,000 ohms CT, sec, 64,000 ohms CT, 3000 test v	677 2780 00
T-305	Audio driver fil	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps 65 va, sec #1, 10 V CT, sec #2, 10 V CT, 65 va	672 2790 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
T-306	Audio driver output coupling	TRANSFORMER: pri, 15,000 ohms CT, 4000 test v 60-70 w audio, sec, 15,000 ohms CT, 2500 test v	677 2770 00
T-307	Modulator filament	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 180 va, sec, 7.5 V, 24 amp, 2500 test v	672 2110 00
T-308	Speech amp fil	TRANSFORMER: pri, 210, 220, 230, 240, 250 V, 50/60 cps, 47 va, sec #1, 6.5 V CT, sec #2, 7.5 V CT	672 2760 00
T-309	Modulation	TRANSFORMER: pri, 12,000 ohms CT, sec, 4000 ohms, 15,000 test v, 2000 w	571 1988 20
T-310	Handset coupling	TRANSFORMER: pri, 500 ohms CT, 100-5000 cps, sec, 500 ohms, 1500 test v	677 1440 00
V-101	Keying rectifier	TUBE: type 6X5GT, full wave rectifier	255 0037 00
V-102	Keyer	TUBE: type 6SJ7, triple grid amplifier	255 0030 00
V-103	Crystal oscillator	TUBE: type 837, h-f power amplifier	256 0060 00
V-104	R-f frequency multiplier	TUBE: type 807, beam pentode power amp	256 0033 00
V-105	Int amplifier	TUBE: type 4-125A, tetrode	256 0068 00
V-106	Int amplifier	TUBE: type 4-125A, tetrode	256 0068 00
V-114	Power amplifier	TUBE: type 750TL, transmitting triode	256 0059 00
V-115	Power amplifier	TUBE: type 750TL, transmitting triode	256 0059 00
V-116	Parasitic suppressor	TUBE: type 811, triode	256 0053 00
V-201	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-202	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-203	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-204	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-205	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-206	High voltage rectifier	TUBE: type 872A, half-wave mercury-vapor rectifier	256 0057 00
V-207	Low voltage rectifier	TUBE: type 866A/866, half-wave rectifier	256 0049 00
V-208	Low voltage rectifier	TUBE: type 866A/866, half-wave rectifier	256 0049 00
V-209	Bias rectifier	TUBE: type 866A/866, half-wave rectifier	256 0049 00
V-210	Bias rectifier	TUBE: type 866A/866, half-wave rectifier	256 0049 00
V-301	Audio amplifier	TUBE: type 6SL7/GT, twin triode amp	255 0040 00

## 231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
V-302	Audio limiter	TUBE: type 6C8G, twin triode	255 0034 00
V-303	Audio squelch	TUBE: type 6C8G, twin triode	255 0034 00
V-304	Audio amplifier	TUBE: type 6SJ7, triple grid detector amp	255 0030 00
V-305	MCW oscillator	TUBE: type 6SN7GT, twin triode amplifier	255 0033 00
V-306	Limiter rectifier	TUBE: type 6X5GT/G, full wave high vacuum rectifier	255 0037 00
V-307	Audio amplifier	TUBE: type 801A/801, a-f power amplifier, triode	256 0040 00
V-308	Audio amplifier	TUBE: type 801A/801, a-f power amplifier, triode	256 0040 00
V-309	Audio driver	TUBE: type 845, a-f power amplifier, triode	256 0034 00
V-310	Audio driver	TUBE: type 845, a-f power amplifier, triode	256 0034 00
V-311	Modulator	TUBE: type 450TL, transmitting triode	256 0052 00
V-312	Modulator	TUBE: type 450TL, transmitting triode	256 0052 00
X-101	V-101	SOCKET: iso 8 prong base	220 5810 00
X-102	V-102	SOCKET: iso 8 prong base	220 5810 00
X-103	V-103	SOCKET: iso 7 prong base	220 5730 00
X-104	V-104	SOCKET: 5 prong base	220 5520 00
X-105	V-105	SOCKET: 5 prong, ceramic	220 1016 00
X-106	V-106	SOCKET: 5 prong, ceramic	220 1016 00
X-114	V-114	SOCKET: 4 prong, porcelain base	220 5440 00
X-115	V-115	SOCKET: 4 prong, porcelain base	220 5440 00
X-116	V-116	SOCKET: 4 term low-loss ceramic	220 5450 00
X-122/ X-123	Crystal socket (1)	SOCKET: crystal, dual	220 8130 00
X-124/ X-125	Crystal socket (1)	SOCKET: crystal, dual	220 8130 00
X-126/ X-127	Crystal socket (1)	SOCKET: crystal, dual	220 8130 00
X-128/ X-129	Crystal socket (1)	SOCKET: crystal, dual	220 8130 00
X-130/ X-131	Crystal socket (1)	SOCKET: crystal, dual	220 8130 00
X-201	V-201	SOCKET: 4 term tube socket, bayonet lock 50 w base	220 5420 00
X-202	V-202	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00

Section VIII  
PARTS LIST

231D-20 TRANSMITTER

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
X-203	V-203	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-204	V-204	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-205	V-205	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-206	V-206	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-207	V-207	SOCKET: 4 prong, bayonet lock, UX base	220 6410 00
X-208	V-208	SOCKET: 4 prong, bayonet lock, UX base	220 6410 00
X-209	V-209	SOCKET: 4 prong, bayonet lock, UX base	220 6410 00
X-210	V-210	SOCKET: 4 prong, bayonet lock, UX base	220 6410 00
X-211	I-201	SOCKET: pilot light mtg, for candelabra base bulbs	262 1360 00
X-212	I-202	SOCKET: pilot light mtg for candelabra base bulbs	262 1360 00
X-301	V-301	SOCKET: 8 term iso tube	220 5810 00
X-302	V-302	SOCKET: 8 term iso	220 5810 00
X-303	V-303	SOCKET: 8 term iso	220 5810 00
X-304	V-304	SOCKET: 8 term iso	220 5810 00
X-305	V-305	SOCKET: 8 term iso	220 5810 00
X-306	V-306	SOCKET: 8 term iso	220 5810 00
X-307	V-307	SOCKET: 4 term low loss ceramic	220 5450 00
X-308	V-308	SOCKET: 4 term low loss ceramic	220 5450 00
X-309	V-309	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-310	V-310	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-311	V-311	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00
X-312	V-312	SOCKET: 4 term, bayonet lock, 50 w base	220 5420 00

## 177G-10 REMOTE CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-301	V-301 cathode coupling	CAPACITOR: paper, .25 uf $\pm 20\%$ , 600 vdcw	956 2056 40
C-302	V-302 d-c blocking	CAPACITOR: paper, 0.1 uf $\pm 20\%$ , 600 vdcw	956 2056 40
C-303	A, B, C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-303A	V-301 B + decoupling filter	CAPACITOR: section of C-303	
C-303B	V-302 cathode bypass	CAPACITOR: section of C-303	
C-303C	K-301 bypass	CAPACITOR: section of C-303	
C-304	V-301 screen bypass	CAPACITOR: paper, 0.1 uf $\pm 20\%$ , 600 vdcw	956 2016 40
C-305	A, B, C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 40
C-305A	V-302 plate load bypass	CAPACITOR: section of C-305	
C-305B	Microphone voltage bypass	CAPACITOR: section of C-305	
C-305C	B - bypass	CAPACITOR: section of C-305	
C-306	A, B, C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-306A	Power supply input capacitor	CAPACITOR: section of C-306	
C-306B	Power supply filter capacitor	CAPACITOR: section of C-306	
C-306C	Power supply filter capacitor	CAPACITOR: section of C-306	
E-301	External connections	BOARD, TERMINAL: 14 term bakelite conn, strip	367 6140 00
F-301	Power transformer primary fuse	FUSE: 1/2 amp 250 V	264 4240 00
I-301	On-off pilot light	LAMP: 6.3 V, .15 amp, min bayonet base	262 3240 00
J-301	Key jack	JACK: phone	360 1160 00
J-302	Carbon microphone jack	JACK: phone, 3 circuit	358 1050 00
K-301	Receiver disabling relay	RELAY: sensitive, spdt, 1900 ohms, 2 amp, 110 V a-c, 3 w	408 1002 00
K-302	Push-to-talk relay	RELAY: sensitive, spdt, 1900 ohms, 2 amp, 110 V a-c, 3 w	408 1002 00
L-301	Power supply 2nd filter choke	REACTOR: 15 hy, 0.02 amp, 120 cps, 2500 test v	678 1181 00
L-302	Power supply 1st filter choke	REACTOR: 15 hy, 0.02 amp, 120 cps, 2500 test v	678 1181 00
M-301	Channel indicator	METER: d-c voltmeter, 0-50 V internal resistance 100,000 ohms	458 0353 50
M-302	Volume indicator	METER: power level indicator 16 scale divisions	455 2500 00

Section VIII  
PARTS LIST

177G-10 REMOTE CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
P-301	A-c power input connector	CONNECTOR: 2 term, flush mtg	368 3700 00
R-301	Amplifier gain control V-301 grid	RESISTOR: potentiometer 50,000 ohms	380 3504 00
R-302	Signal input isolation	RESISTOR: 100,000 ohms $\pm 20\%$ , 2 w	729 8100 00
R-303	V-301 cathode	RESISTOR: 2700 ohms $\pm 20\%$ , 2 w	745 5670 00
R-304	V-301 plate	RESISTOR: 47,000 ohms $\pm 20\%$ , 2 w	745 5723 00
R-305	V-301 screen	RESISTOR: 270,000 ohms $\pm 20\%$ , 2 w	745 5754 00
R-306	V-301 B+ decoupling filter	RESISTOR: 5600 ohms $\pm 10\%$ , 2 w	745 5684 00
R-307	V-302, V-301 feedback	RESISTOR: 1 megohm $\pm 20\%$ , 2 w	745 5779 00
R-308	V-302 grid	RESISTOR: 510,000 ohms $\pm 20\%$ , 2 w	745 5766 00
R-309	V-302 cathode	RESISTOR: 820 ohms $\pm 20\%$ , 2 w	745 5649 00
R-310	Channel indicator adjustment	RESISTOR: potentiometer, 50,000 ohms $\pm 20\%$ , 1/2 w	380 1504 00
R-311	V-302 grid	RESISTOR: 1 megohm $\pm 20\%$ , 2 w	745 5779 00
R-312	Power supply voltage divider	RESISTOR: 1300 ohms $\pm 5\%$ , 2 w	745 5657 00
R-313	K-301 B+ filter	RESISTOR: 10,000 ohms $\pm 20\%$ , 2 w	745 5695 00
R-314	V-302 cathode	RESISTOR: 1 megohm $\pm 20\%$ , 2 w	745 5779 00
R-315	Receiver disabling	RESISTOR: potentiometer, 10,000 ohms $\pm 10\%$ , 2 w	381 1104 00
R-316	Power supply voltage divider	RESISTOR: 2400 ohms $\pm 5\%$ , 2 w	745 5668 00
R-317	Power supply voltage divider	RESISTOR: 2400 ohms $\pm 5\%$ , 2 w	745 5668 00
R-318	Power supply voltage divider	RESISTOR: 2400 ohms $\pm 5\%$ , 2 w	745 5668 00
R-319	Power supply voltage divider	RESISTOR: 1100 ohms $\pm 5\%$ , 2 w	745 5654 00
R-320	Power supply voltage divider	RESISTOR: 1100 ohms $\pm 5\%$ , 2 w	745 5654 00
R-321	Power supply voltage divider	RESISTOR: 1100 ohms $\pm 5\%$ , 2 w	745 5654 00
R-322	K-302 B+ lead	RESISTOR: 10,000 ohms $\pm 10\%$ , 2 w	745 5694 00
S-301	Dial	DIAL: telephone, 11 hole finger plate	502 0428 002
S-302	A-c power line on-off switch	SWITCH: dpdt, toggle, 1 amp 250 V d-c	266 1030 00



## 177G-10 REMOTE CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
T-301	Input transformer	TRANSFORMER: pri #1, 500 ohms, 100-5000 cps, 50 mw max, pri #2, 75 ohms, 1000 test v sec #1, 40,000 ohms, 1000 test v	677 2700 00
T-302	Output transformer	TRANSFORMER: pri #1, 15,000 ohms, 2500 test v sec #1 and #2, 500 ohms, 2000 test v	677 1430 00
T-303	Power transformer	TRANSFORMER: pri, 105, 110, 115, 120, 125 V, 2500 test v, sec #1, 200/200 V, 0.025 amp, 2500 test v, sec #2, 3.15/3.15 V, 2.0 amp, 2500 test v	672 2550 00
V-301	Voltage amplifier	TUBE: type 6SJ7, pentode	255 0030 00
V-302	Output amplifier	TUBE: type 6SN7GT, triode	255 0033 00
V-303	Power supply rectifier	TUBE: type 6X5GT, rectifier	255 0037 00
XI-301	Socket for I-301	MOUNTING: pilot light, for miniature bayonet base JEWEL: red	262 1230 00
XV-301	Socket for V-301	SOCKET: 8 term iso tube	220 5810 00
XV-302	Socket for V-302	SOCKET: 8 term iso	220 5810 00
XV-303	Socket for V-303	SOCKET: 8 term iso	220 5810 00

## 177G-9 CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
C-401	V-401 cathode bypass	CAPACITOR: paper, .25 uf $\pm 20\%$ , 600 vdcw	956 2056 40
C-402	C-402A, C-402B, C-402C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-402A	V-401 screen decoupling	CAPACITOR: section of C-402	
C-402B	V-401 pl decoupling	CAPACITOR: section of C-402	
C-402C	V-401 pl decoupling	CAPACITOR: section of C-402	
C-403	C-403A, C-403B, C-403C	CAPACITOR: paper, 4/4/4 uf $\pm 20\%$ , 600 vdcw	956 3714 00
C-403A	High voltage supply filter	CAPACITOR: section of C-403	
C-403B	High voltage supply filter	CAPACITOR: section of C-403	
C-403C	High voltage supply filter	CAPACITOR: section of C-403	
C-404	V-403 high voltage filter	CAPACITOR: paper, 4 uf $+10\%$ $-3\%$ , 600 vdcw	956 2714 00
C-405	K-401 supply filter	CAPACITOR: paper, .25 uf $\pm 20\%$ , 600 vdcw	956 2056 40
C-406	V-401 pl decoupling	CAPACITOR: paper, .006 uf $+60\%$ $-20\%$ , 600 vdcw	934 0002 00
E-401		BOARD, TERMINAL: 8 term conn strip	367 3080 00
E-402		BOARD, TERMINAL: 14 term bakelite conn strip	367 6140 00

Section VIII  
PARTS LIST

177G-9 CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
F-401	Remote unit fil primary	FUSE: 1/2 amp 250 V	264 4260 00
F-402	Remote unit pl supply	FUSE: 1 amp 250 V	264 4280 00
I-401	Pilot lamp	LAMP: 6.3 V, .15 amp, min bayonet base	262 3240 00
J-401	Control unit key jack	JACK: 3 cond midget	358 1100 00
J-402	Microphone jack	JACK: 3 cond midget	358 1100 00
J-403	Receptacle for F-401	HOLDER: fuse, extractor type	265 2060 00
J-404	Receptacle for F-402	HOLDER: fuse, extractor type	265 2060 00
K-401	Push-to-talk	RELAY: sensitive, 1950 ohms coil, nominal 12 to 24 ma, 24 to 48 V	408 7000 00
K-402	Receiver disabling	RELAY: sensitive, 1950 ohms coil, nominal 12 to 24 ma, 24 to 48 V	408 7000 00
L-401	High voltage filter reactor	REACTOR: 8 hy 0.1 amp, 120 cps, 2500 test v	678 1250 00
L-402	High voltage filter reactor	REACTOR: 8 hy 0.1 amp, 120 cps, 2500 test v	678 1250 00
M-401	Channel indicator meter	METER: d-c voltmeter, 0.50 V, internal resistance 100,000 ohms	458 0353 50
M-402	Volume level meter	METER: power level indicator scale divisions	455 2500 00
P-401	Power input conn plug	CONNECTOR: 2 term, flush mtg	268 3700 00
R-401	Audio gain control	RESISTOR: potentiometer, 50,000 ohms	380 3504 00
R-402	V-401 grid	RESISTOR: 100,000 ohms $\pm 20\%$ , 2 w	745 9181 00
R-403	V-401 cathode	RESISTOR: 100 ohms $\pm 10\%$ , 2 w	709 1005 20
R-404	V-401 cathode	RESISTOR: 300 ohms $\pm 10\%$ , 2 w	709 3005 20
R-405	V-401 screen	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
R-406	Channel indicator	RESISTOR: 50,000 ohms $\pm 20\%$ , 1/2 w, potentiometer	380 1504 10
R-407	V-402 cathode	RESISTOR: 1000 ohms $\pm 10\%$ , 2 w	745 5652 00
R-408	V-402 grid	RESISTOR: 1 megohm $\pm 10\%$ , 2 w	745 5778 00
R-409	V-402 grid	RESISTOR: 1 megohm $\pm 10\%$ , 2 w	745 5778 00
R-410	High voltage supply bleeder	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
R-411	High voltage supply bleeder	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
R-412	High voltage supply bleeder	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
R-413	High voltage supply bleeder	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00

## 177G-9 CONTROL

ITEM	CIRCUIT FUNCTION	DESCRIPTION	COLLINS PART NUMBER
R-414	High voltage supply bleeder	RESISTOR: 250 ohms $\pm 10\%$ , 2 w	709 2505 20
R-415	High voltage supply bleeder	RESISTOR: 250 ohms $\pm 10\%$ , 2 w	709 2505 20
R-416	High voltage supply bleeder	RESISTOR: 250 ohms $\pm 10\%$ , 2 w	709 2505 20
R-417	High voltage supply bleeder	RESISTOR: 250 ohms $\pm 10\%$ , 2 w	709 2505 20
R-418	High voltage supply bleeder	RESISTOR: 250 ohms $\pm 10\%$ , 2 w	709 2505 20
R-419	Disabling circuit adjusting	RESISTOR: 10,000 ohms $\pm 10\%$ , 2 w potentiometer	381 1104 10
R-420	K-402 voltage dropping	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
R-421	K-402 voltage dropping	RESISTOR: 6200 ohms $\pm 5\%$ , 2 w	745 5685 00
S-401	Control unit power	SWITCH: dpdt, toggle, 1 amp, 250 V d-c	266 1030 00
T-401	Audio input	TRANSFORMER: pri, #1, 500 ohms, 100-5000 cps, 50 mw max, pri #2, 75 ohms 1000 test v, sec #1, 40,000 ohms, 100 test v	677 2700 00
T-402	Audio input	TRANSFORMER: pri, 7500 ohms, 100-5000 cps, sec, 500 ohms, CT, 1500 test v, 3.5 w	677 0013 00
T-403	High voltage power	TRANSFORMER: pri, 105, 110, 115, 120, 125 V, 50/60 cps, sec #1, 600 V, CT, .125 amp, sec #2, 5 V, CT, 3 amp, 2500 test v, 90 va	672 1540 00
T-404	V-401, V-402 fil	TRANSFORMER: pri, 105, 110, 115, 120, 125 V, 50/60 cps, 19 va, sec, 6.3 V, CT, 19 va	672 1460 00
T-405	Receiver coupling	TRANSFORMER: pri, 500 ohms CT, 100-5000 cps sec, 500 ohms CT, 1500 test v	677 1440 00
V-401	Audio amplifier	TUBE: type 6V6GT/G, pentode, beam power	255 0021 00
V-402	Receiver disabling	TUBE: type 6SJ7, pentode	255 0030 00
V-403	Power rectifier	TUBE: type 5U4G, rectifier	255 0032 00
XI-401	Socket for I-401	MOUNTING: pilot light, for miniature bayonet base JEWEL: red	262 1230 00 262 2160 00
XV-401	V-401	SOCKET: 8 term iso	220 5810 00
XV-402	V-402	SOCKET: 8 term iso	220 5810 00
XV-403	V-403	SOCKET: 8 term iso	220 5810 00

**SECTION IX**  
**ILLUSTRATIONS**

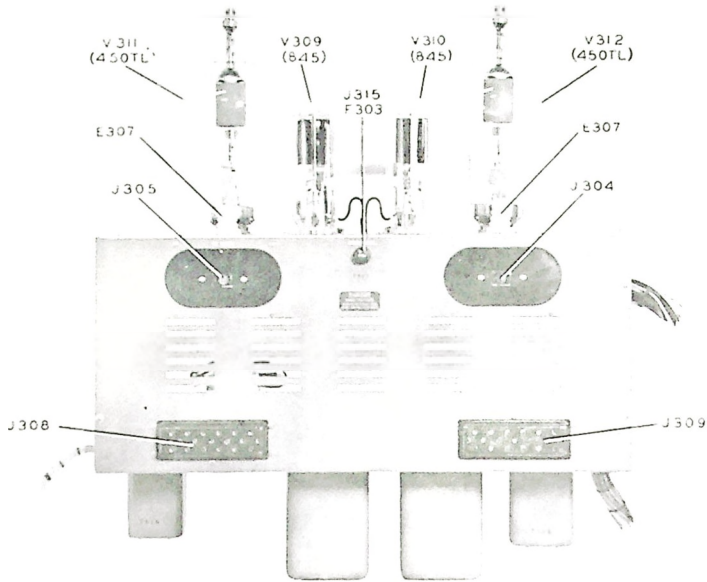


Figure 44. Modulator and Audio Driver Unit

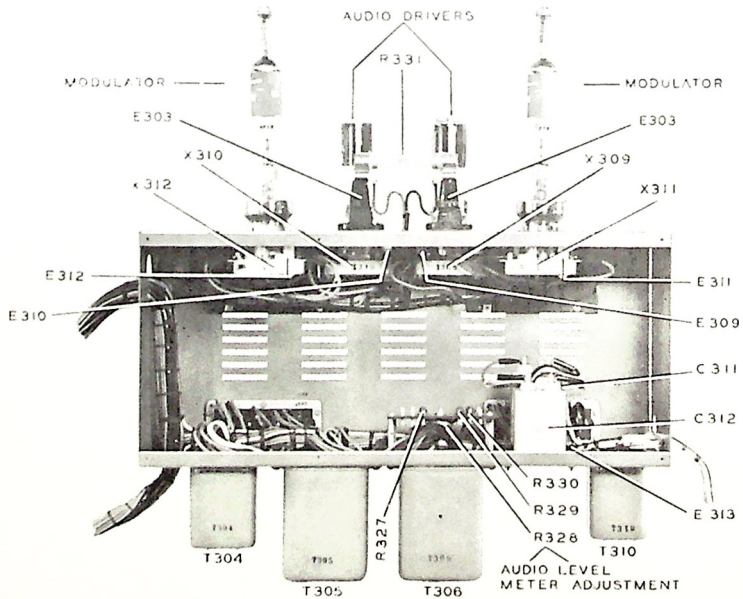


Figure 45. Modulator and Audio Driver Unit

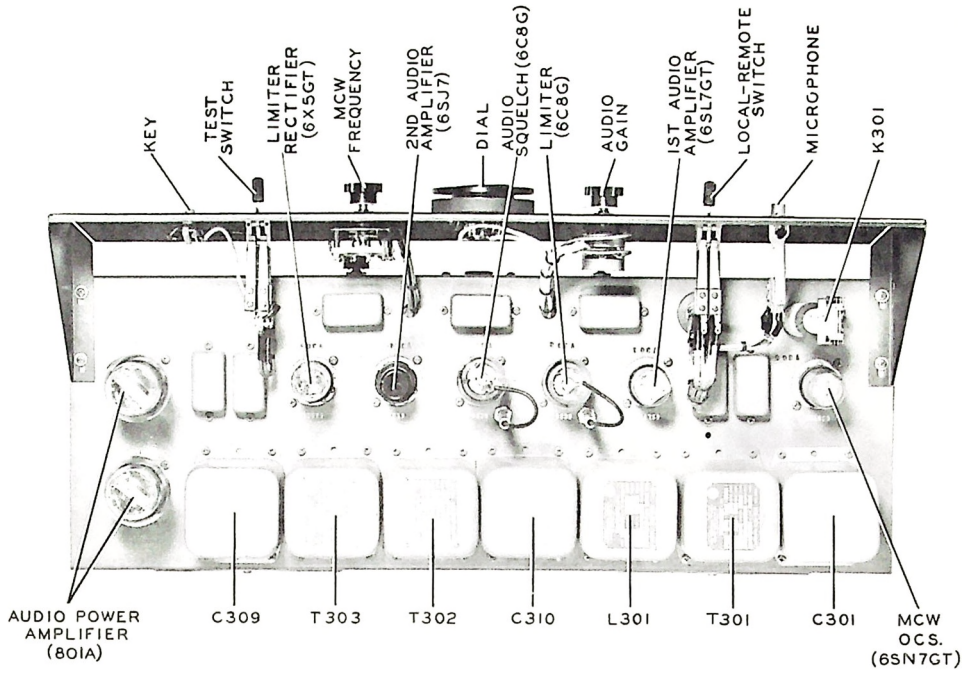


Figure 46. Speech Amplifier Unit

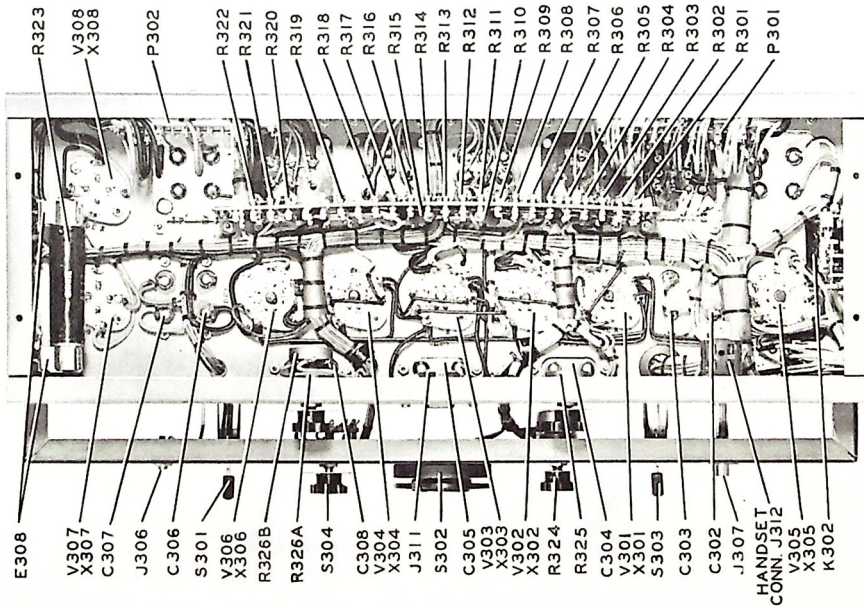


Figure 47. Speech Amplifier Unit

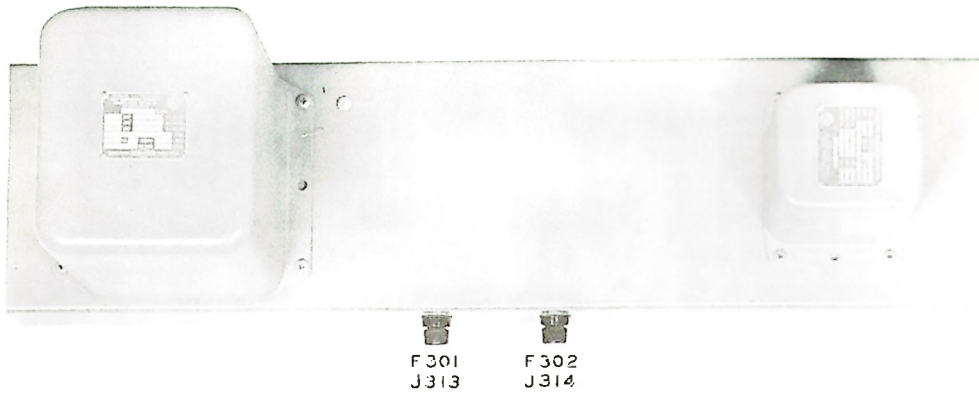


Figure 48. Speech Amplifier and Modulator Filament Supply

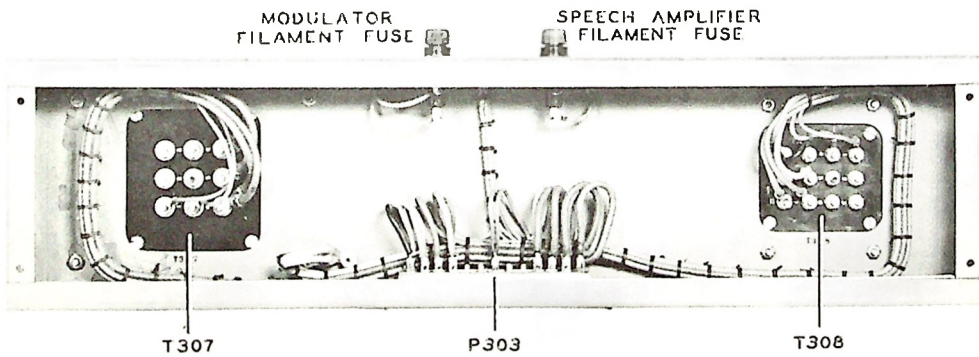


Figure 49. Speech Amplifier and Modulator Filament Supply

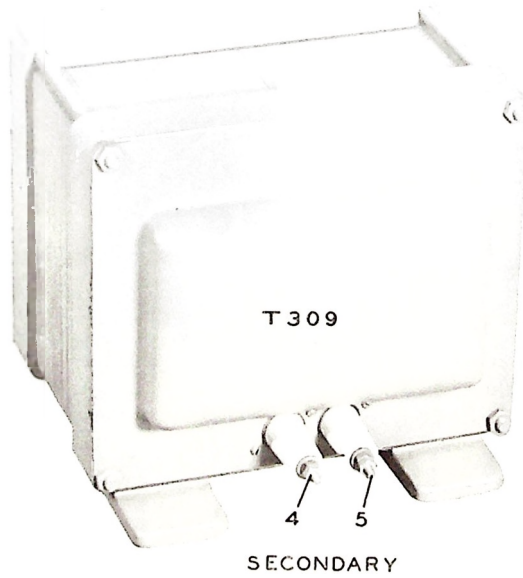
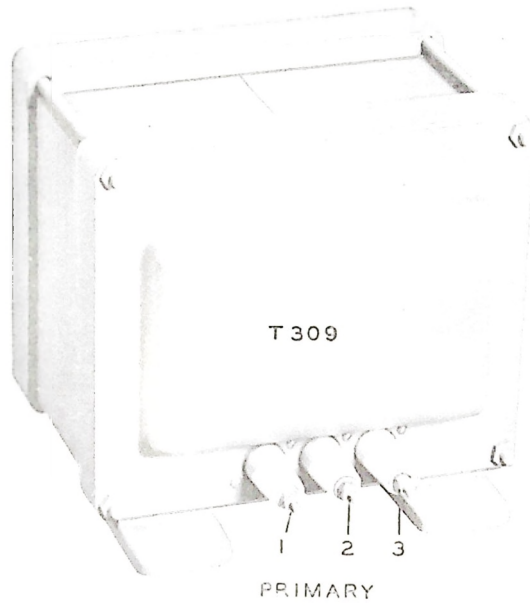


Figure 50. Modulation Transformer



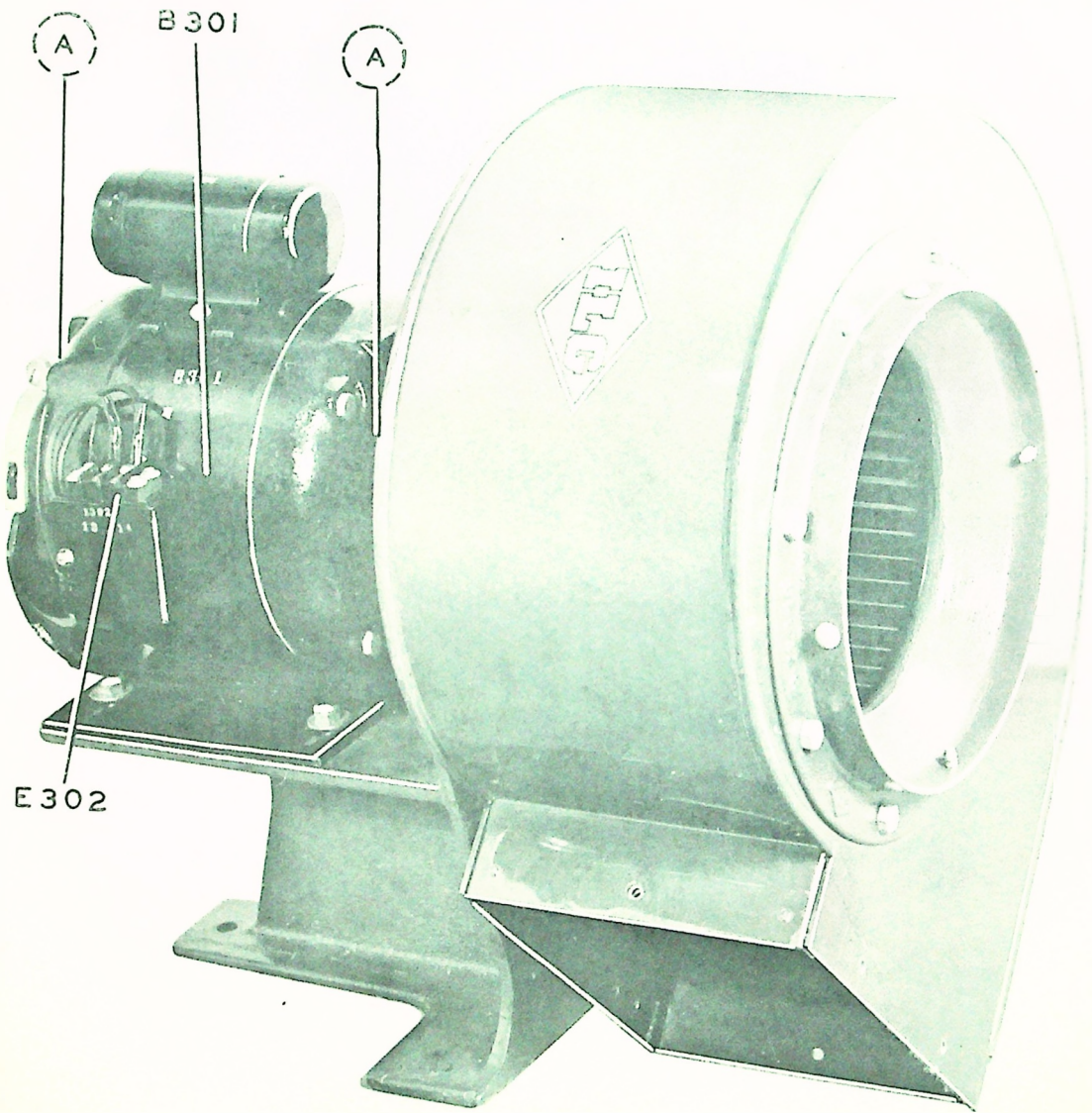


Figure 51. Ventilating Blower

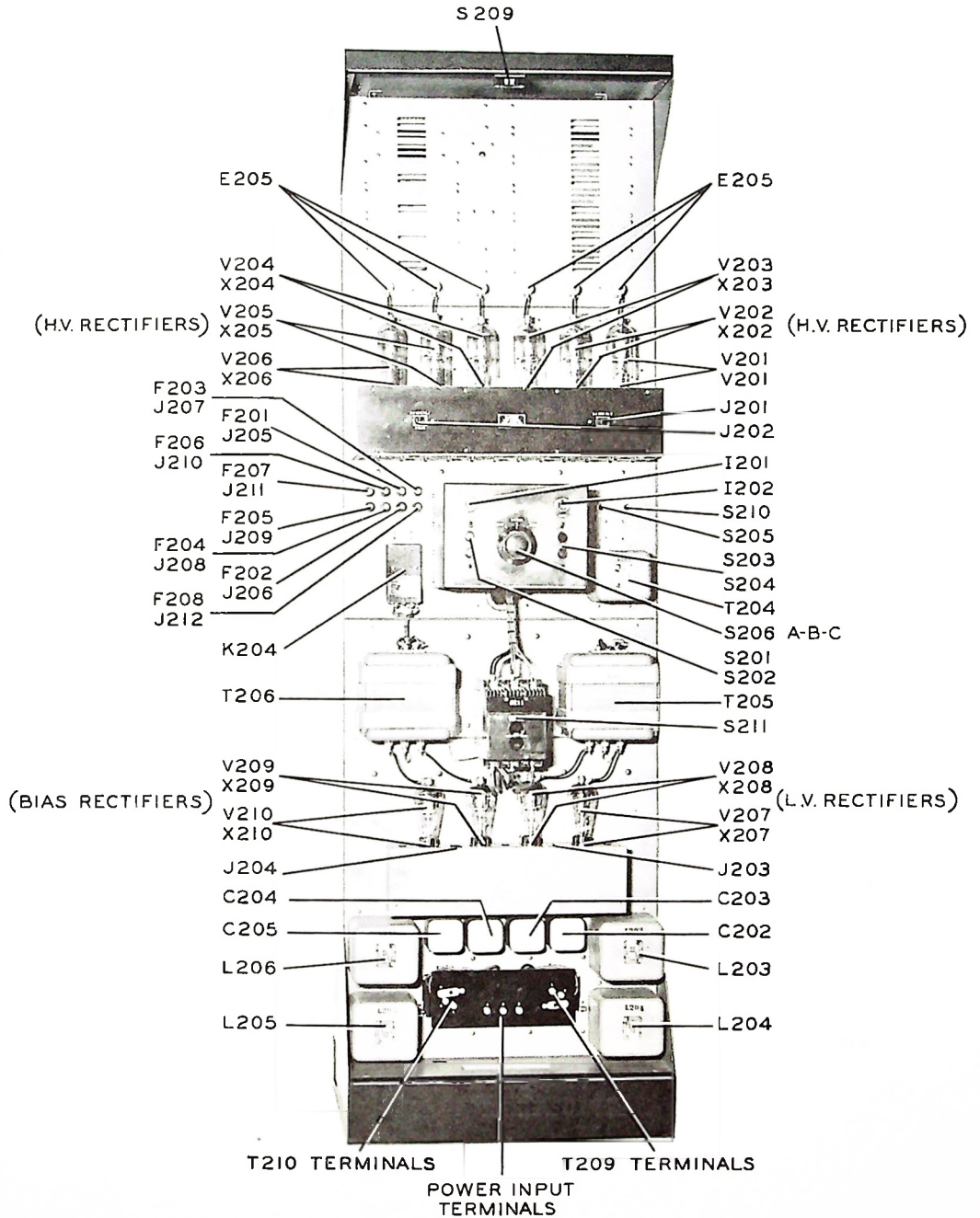


Figure 52. Rectifier Power Unit

SECTION IX  
ILLUSTRATIONS

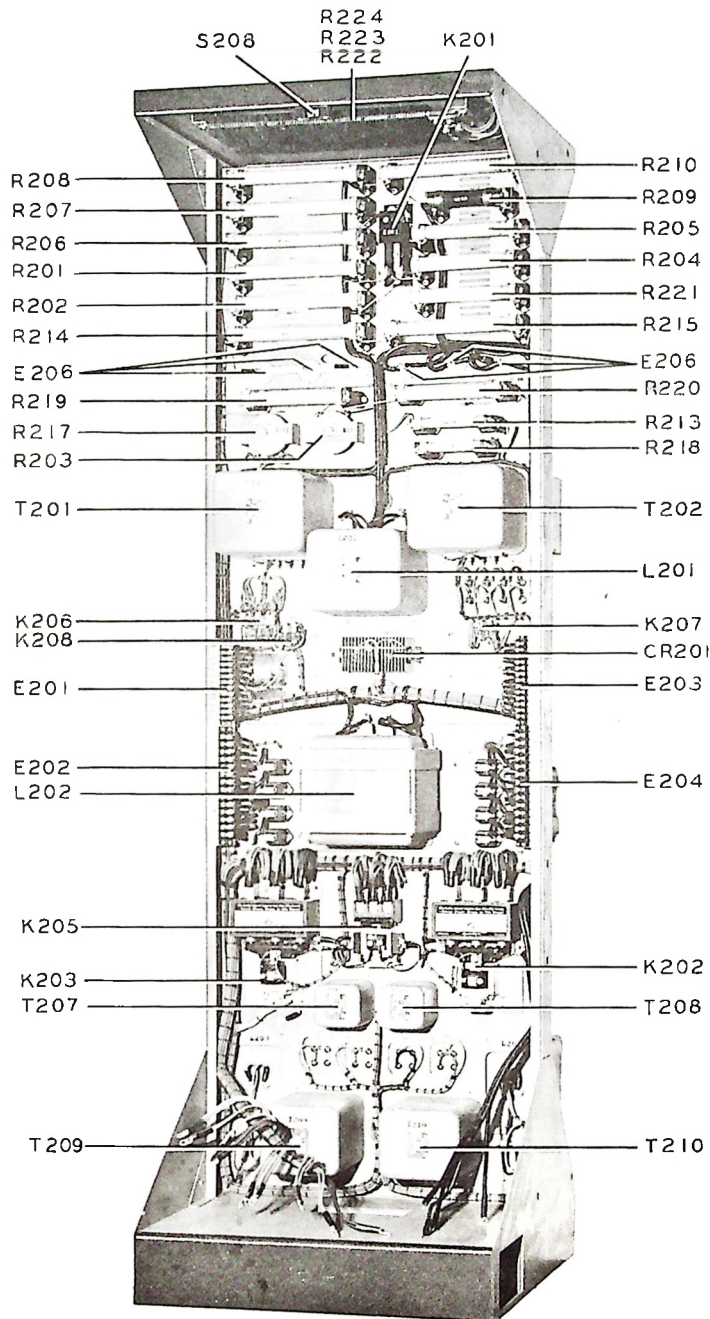


Figure 53. Rectifier Power Unit

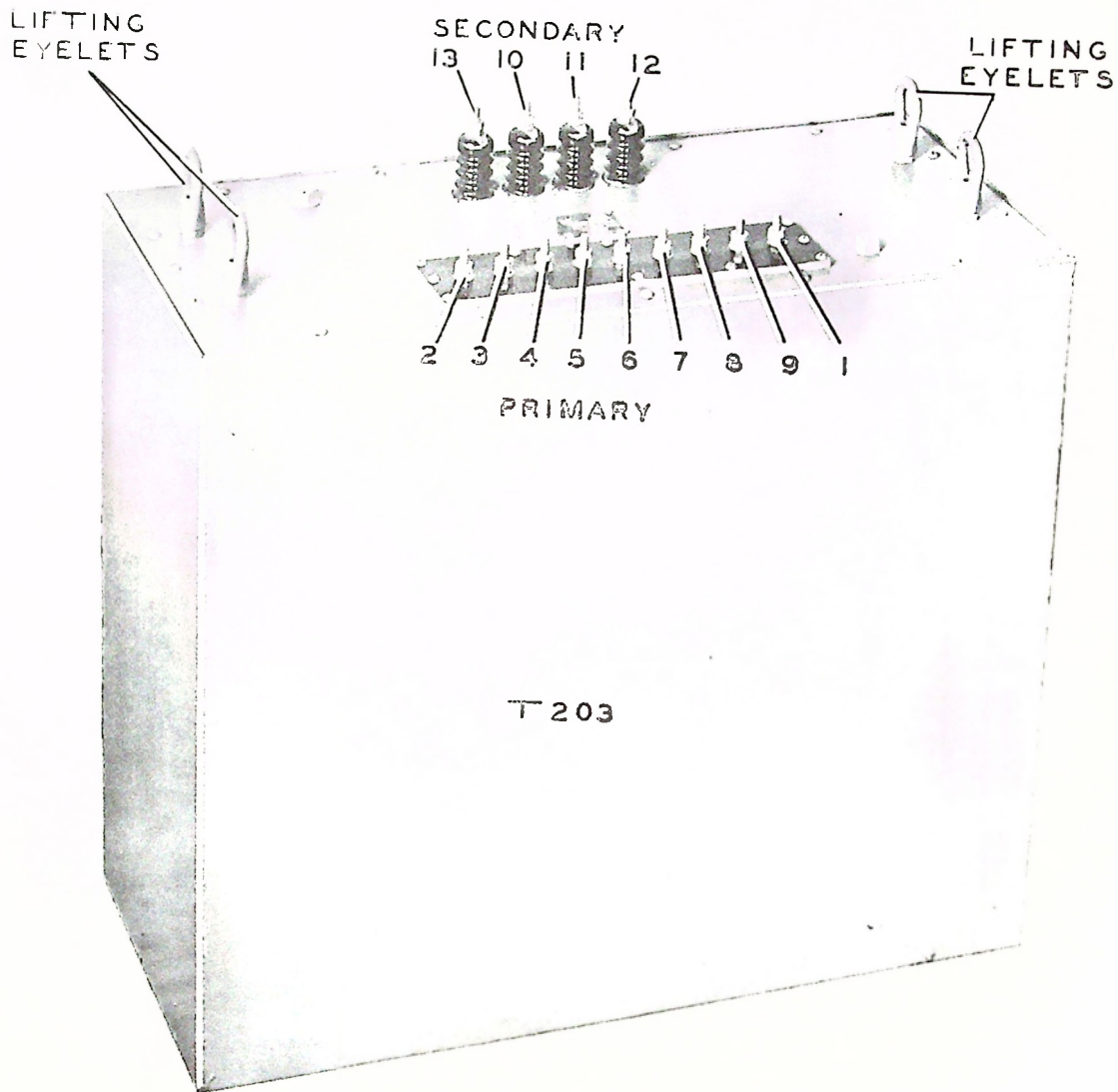


Figure 54. High-Voltage Power Transformer

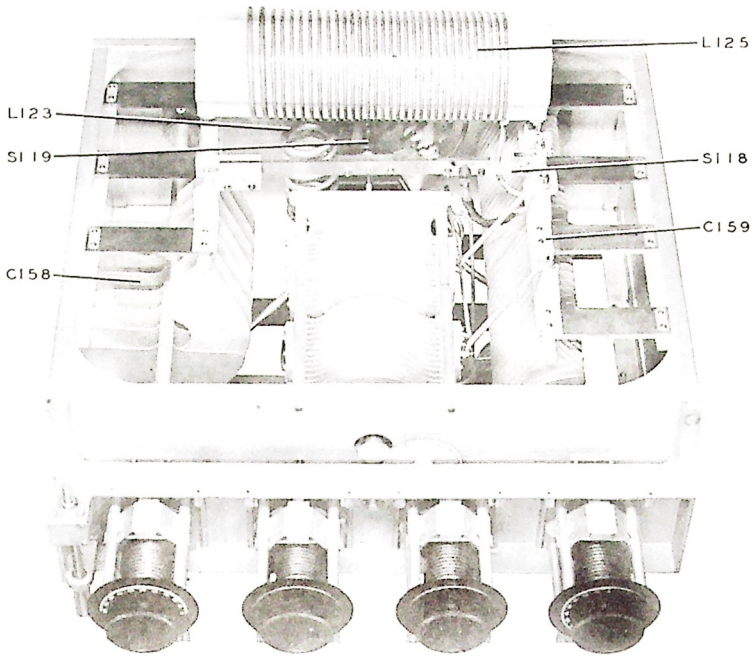


Figure 55. Output Network Unit

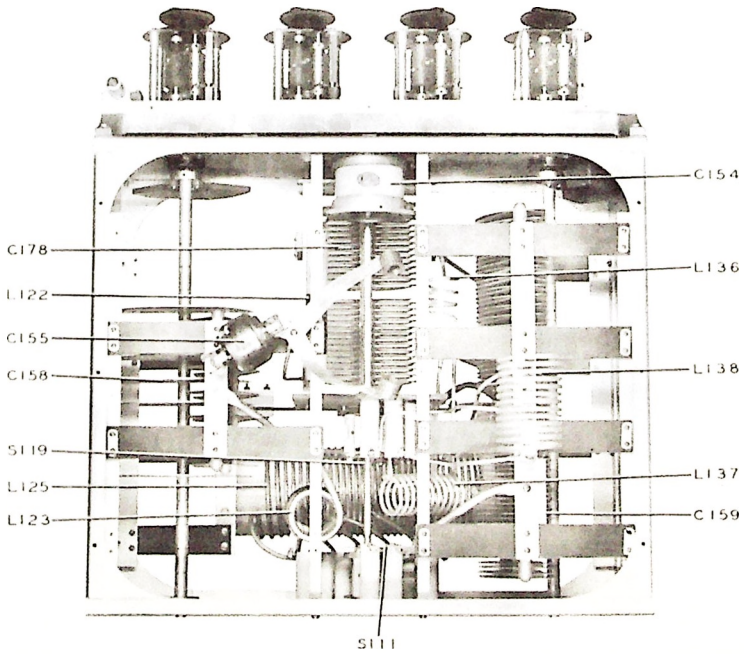


Figure 56. Output Network Unit

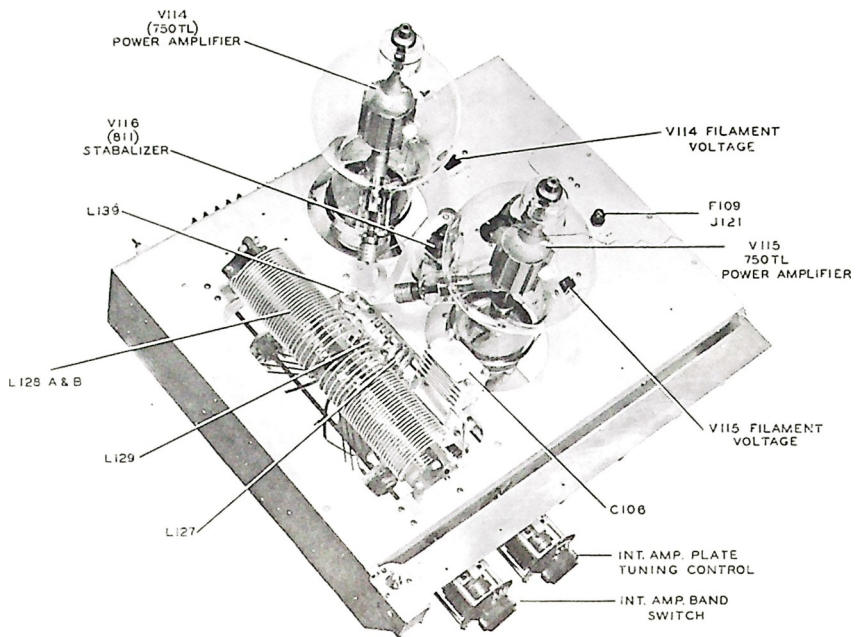


Figure 57. Power Amplifier Unit.

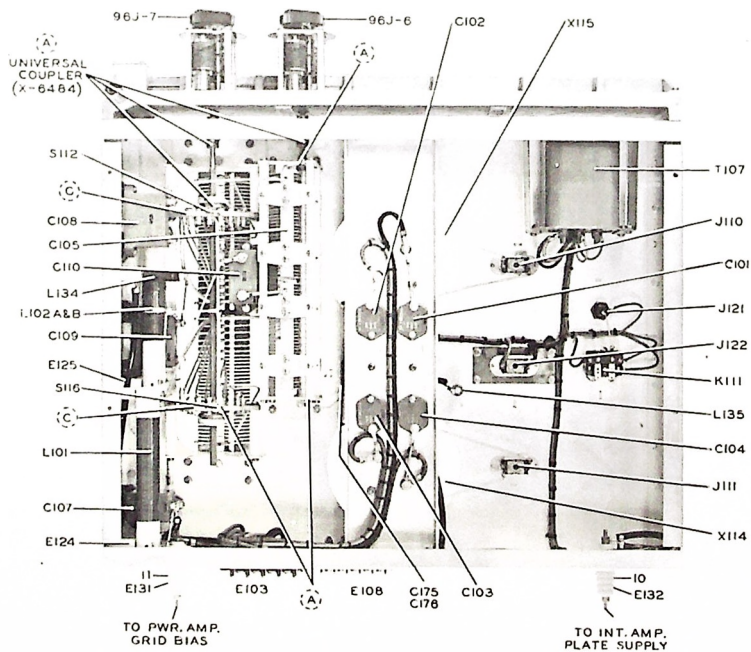


Figure 58. Power Amplifier Unit

SECTION IX  
ILLUSTRATIONS

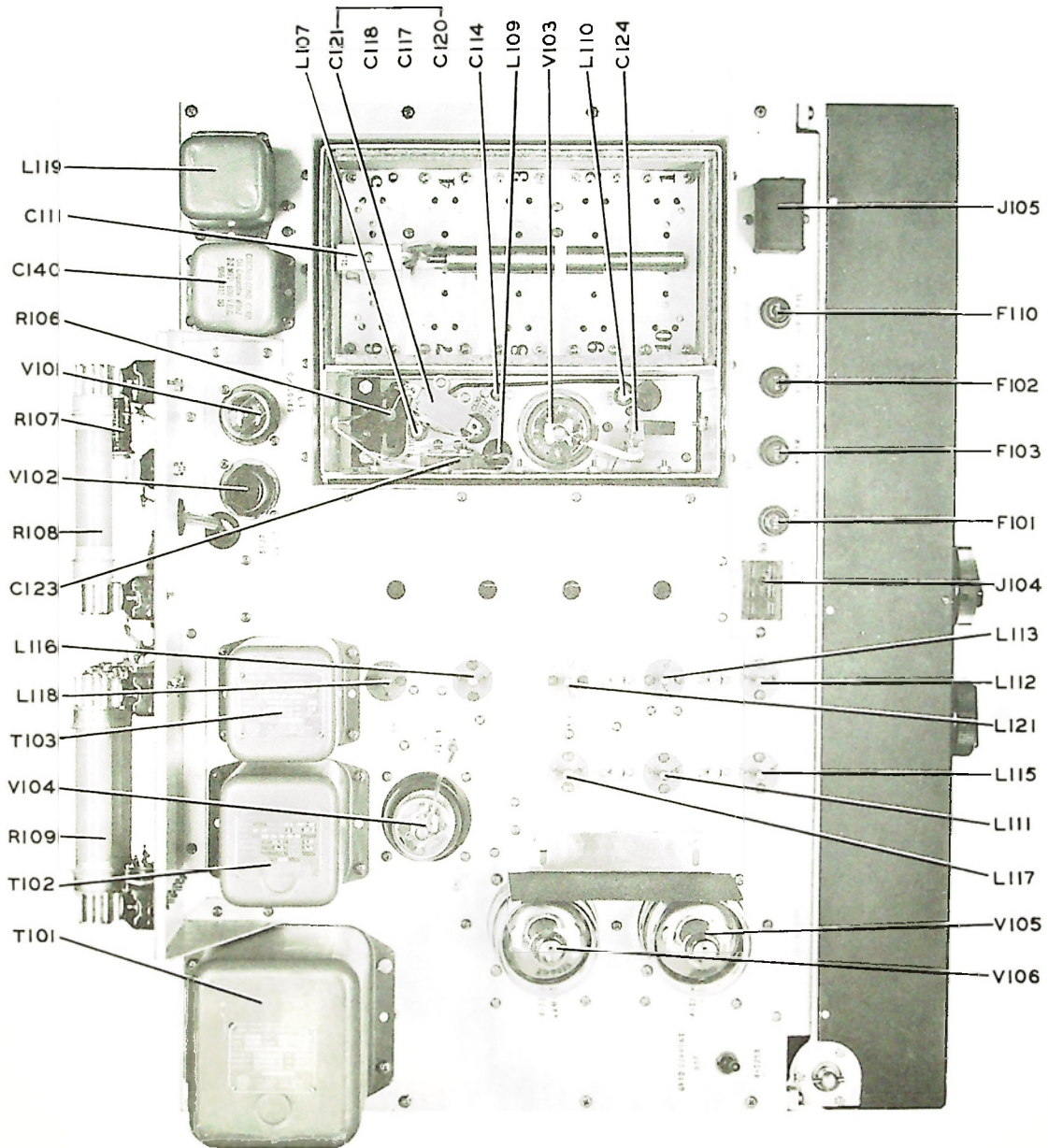


Figure 59. R-F Exciter Unit - Top View

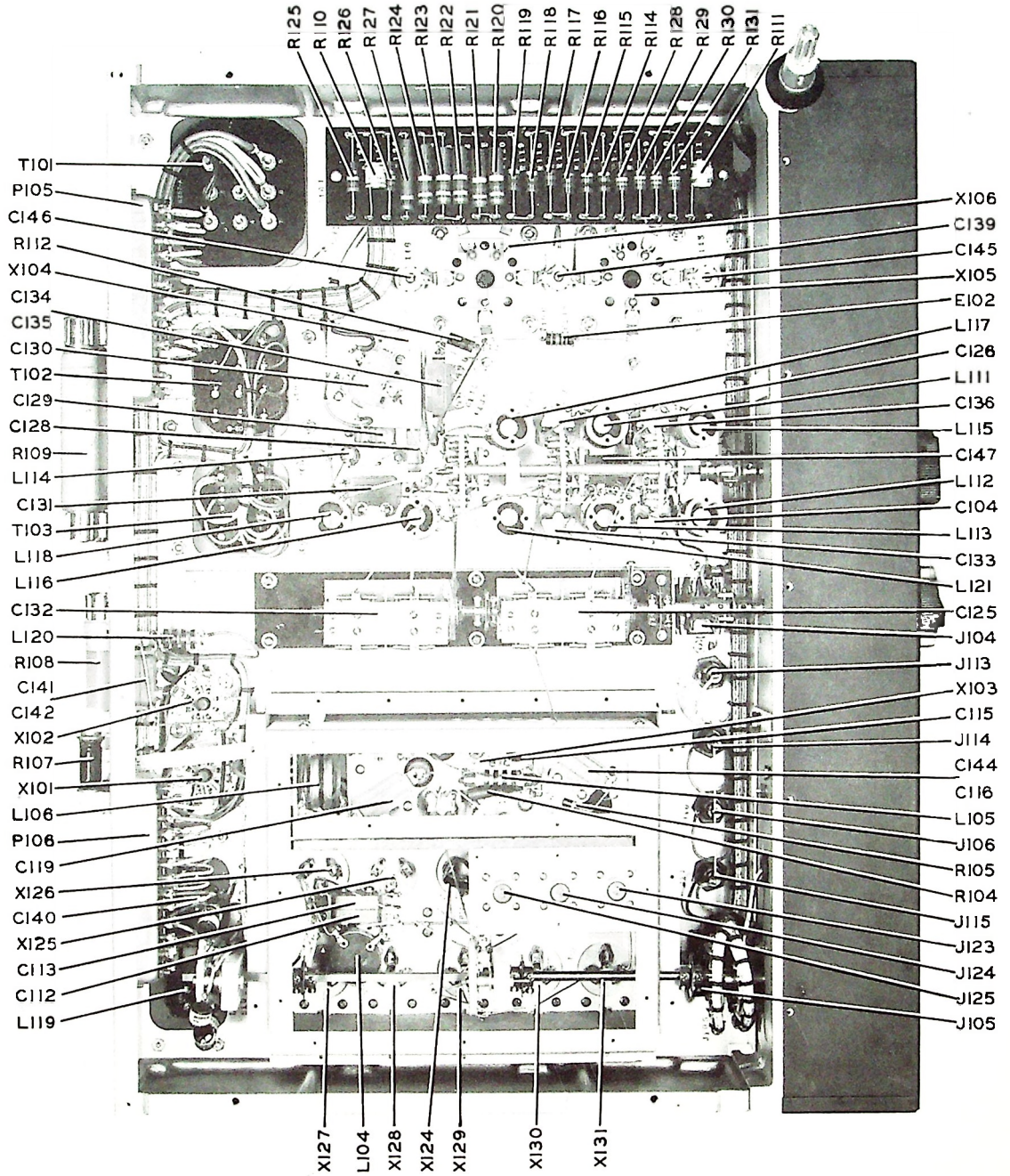


Figure 60. R-F Exciter Unit - Bottom View



SECTION IX  
ILLUSTRATIONS

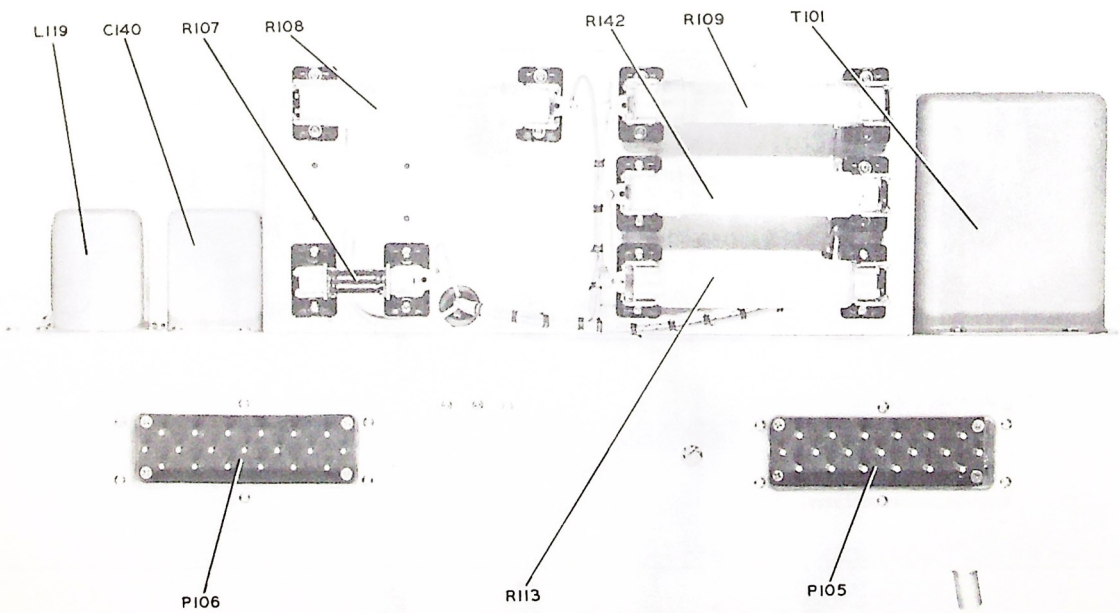
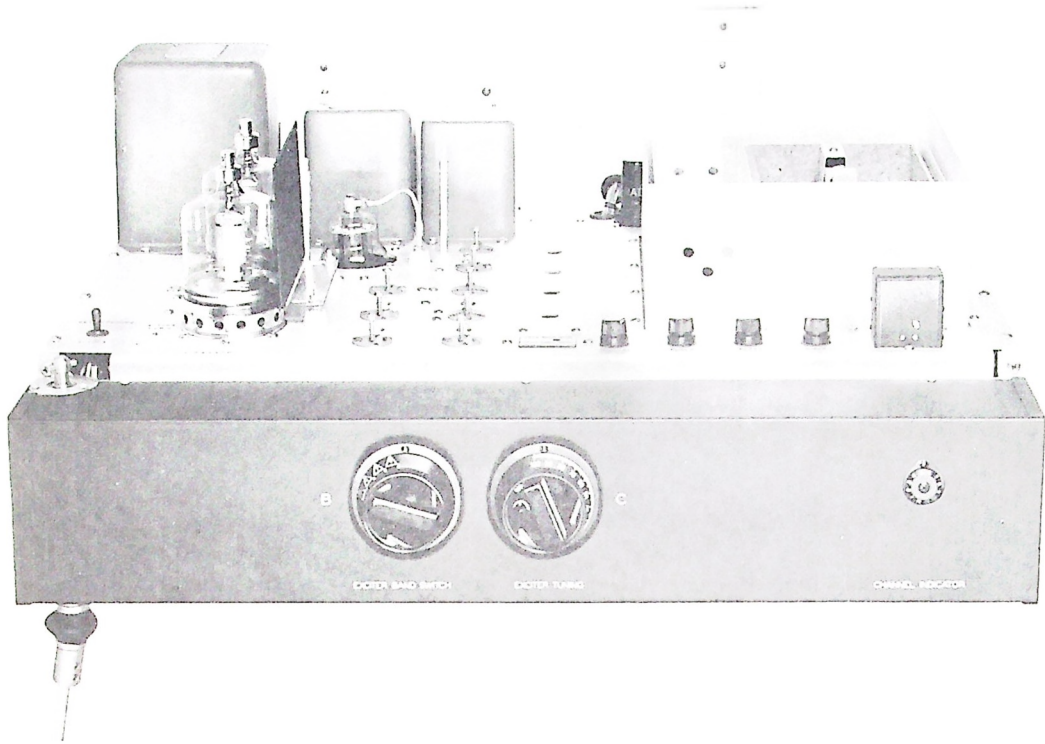


Figure 61. R-F Exciter Unit - Front and Rear View

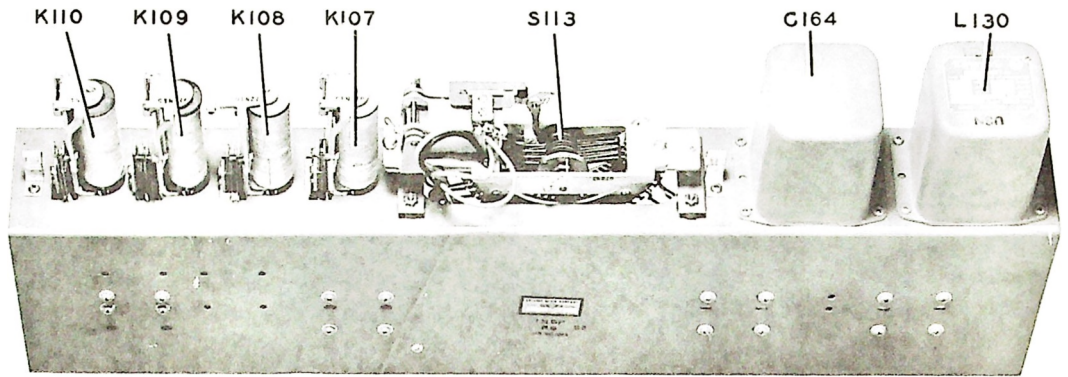


Figure 62. Autotune Control Unit

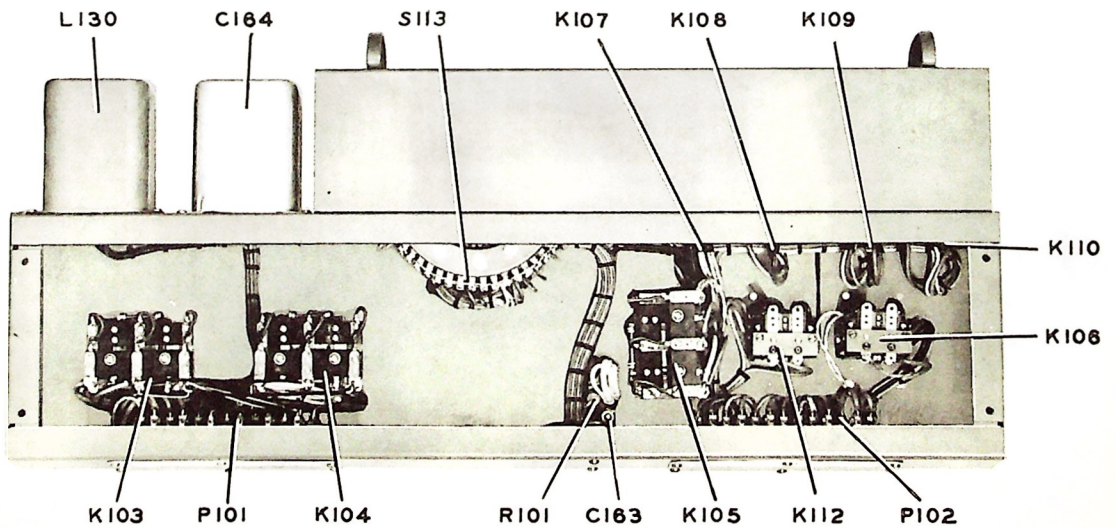


Figure 63. Autotune Control Unit

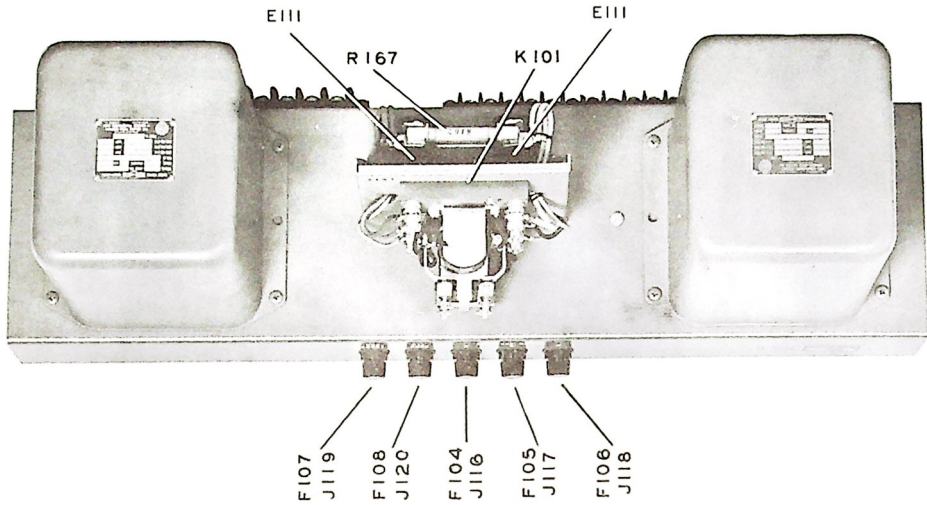


Figure 64. Power Amplifier Filament Supply

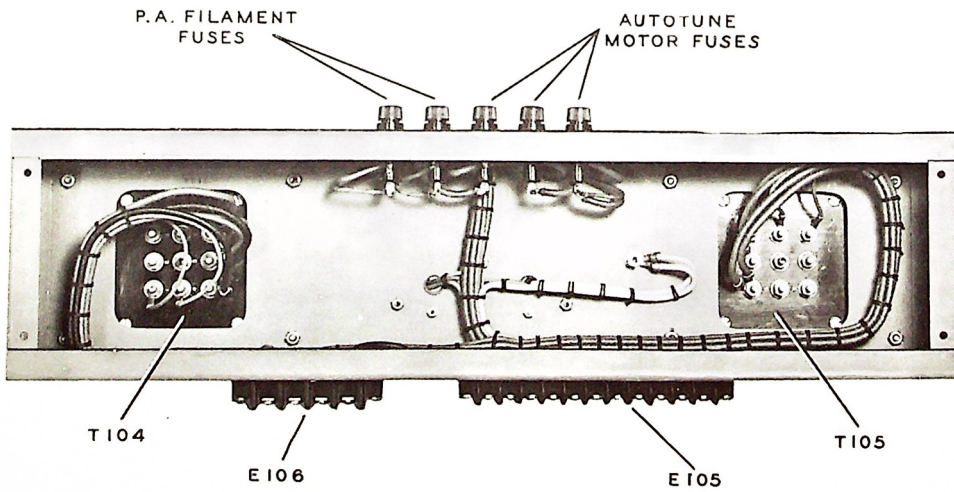


Figure 65. Power Amplifier Filament Supply

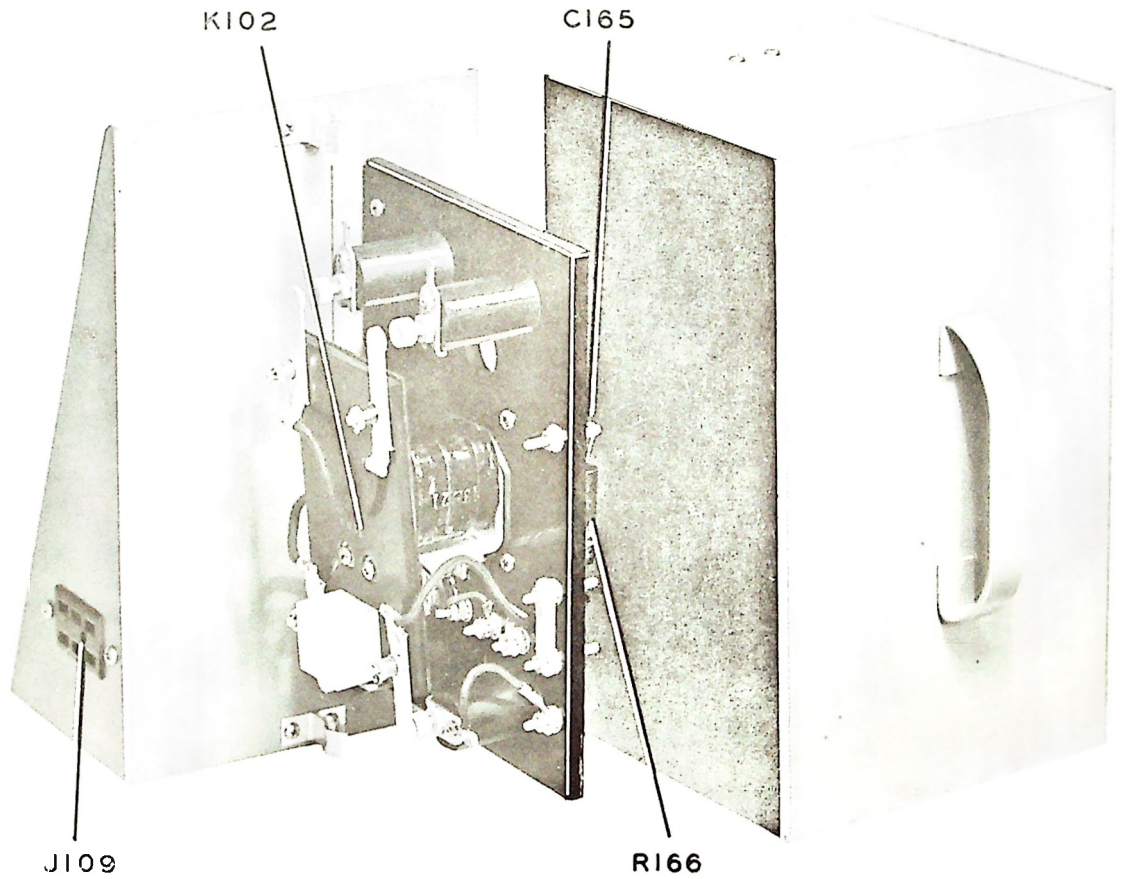
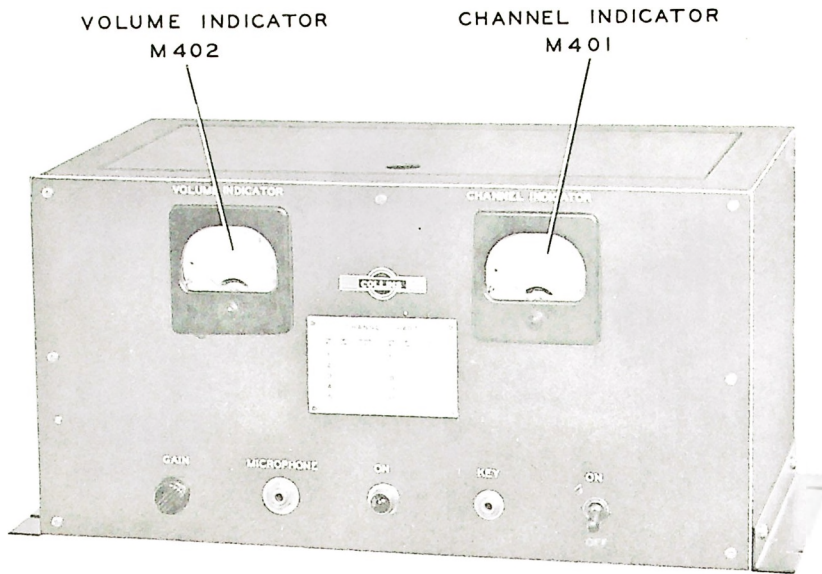
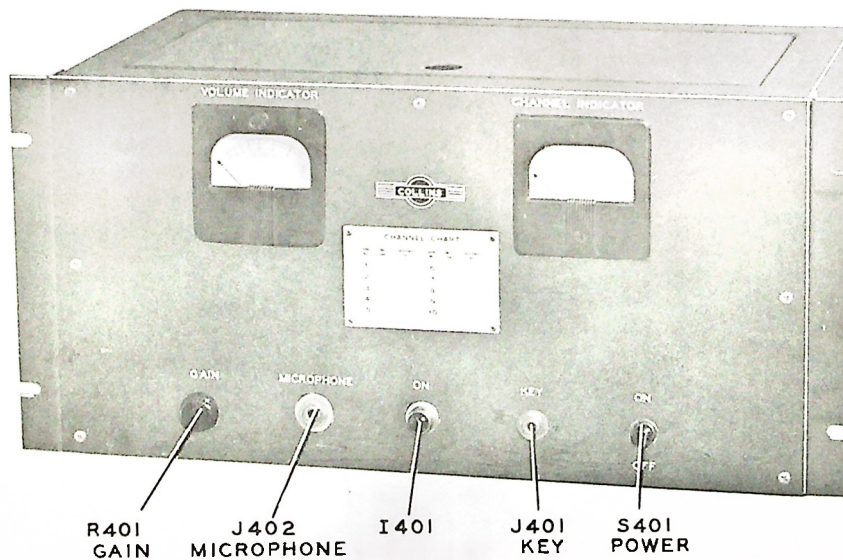


Figure 66. Phone-CW Relay

SECTION IX  
ILLUSTRATIONS



BASE MOUNTING



PANEL MOUNTING

Figure 67. Remote Control Unit

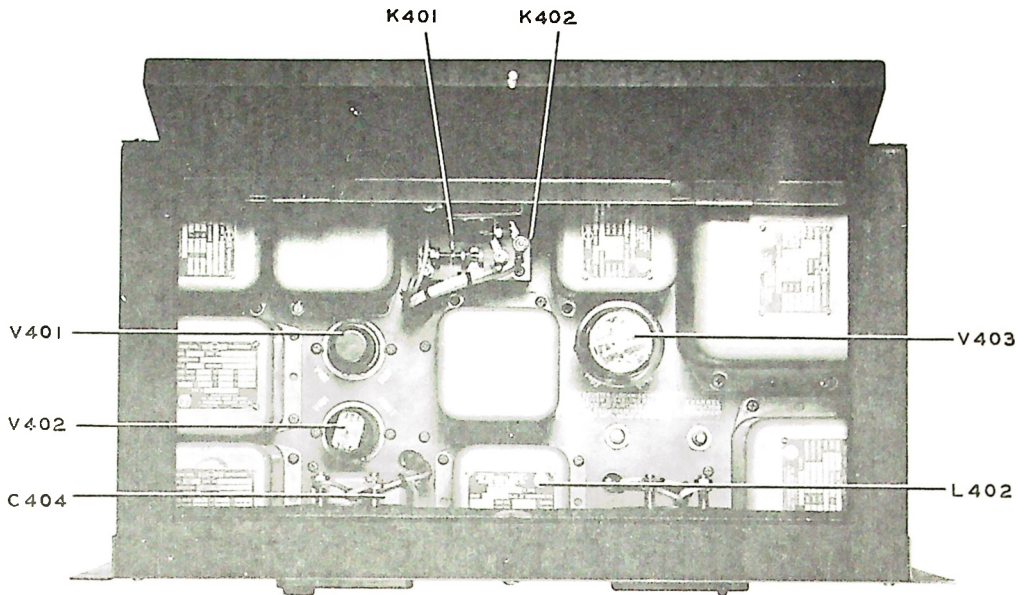


Figure 68. Type 177G-9 Remote Control Unit - Top

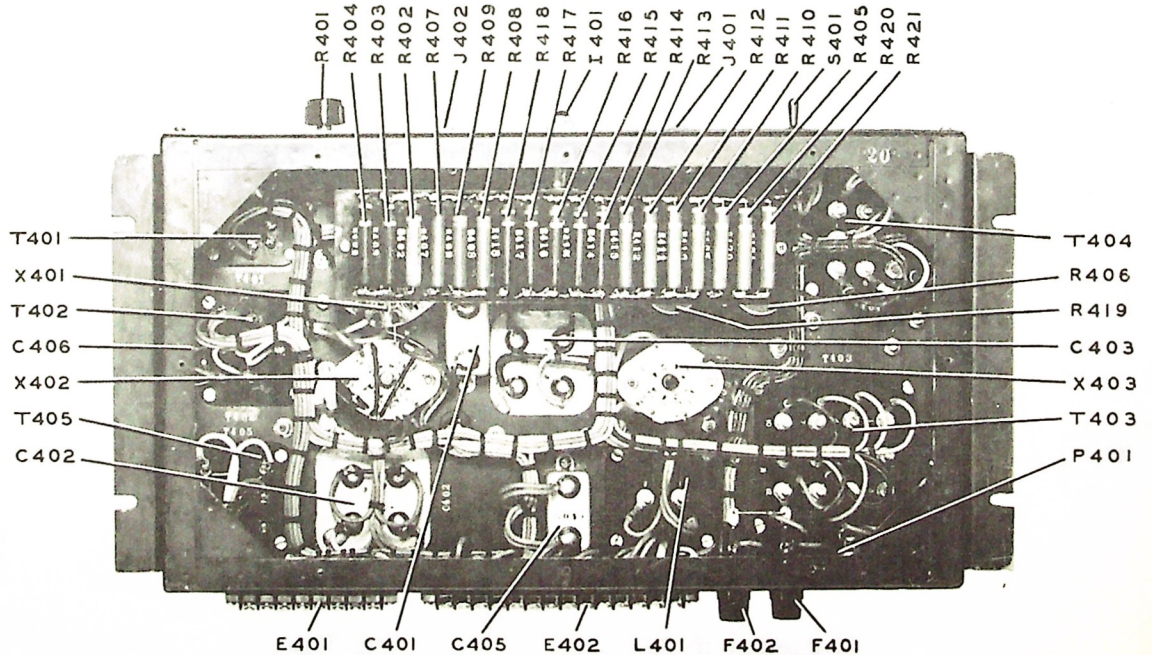


Figure 69. Type 177G-9 Remote Control Unit - Bottom



Figure 70. Desk Set

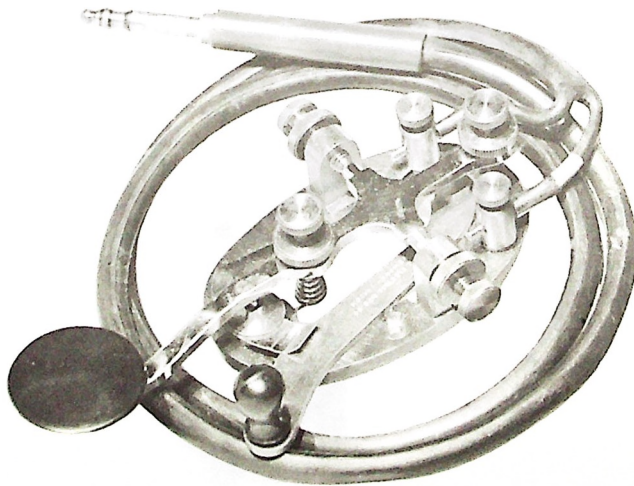


Figure 71. Telegraph Key

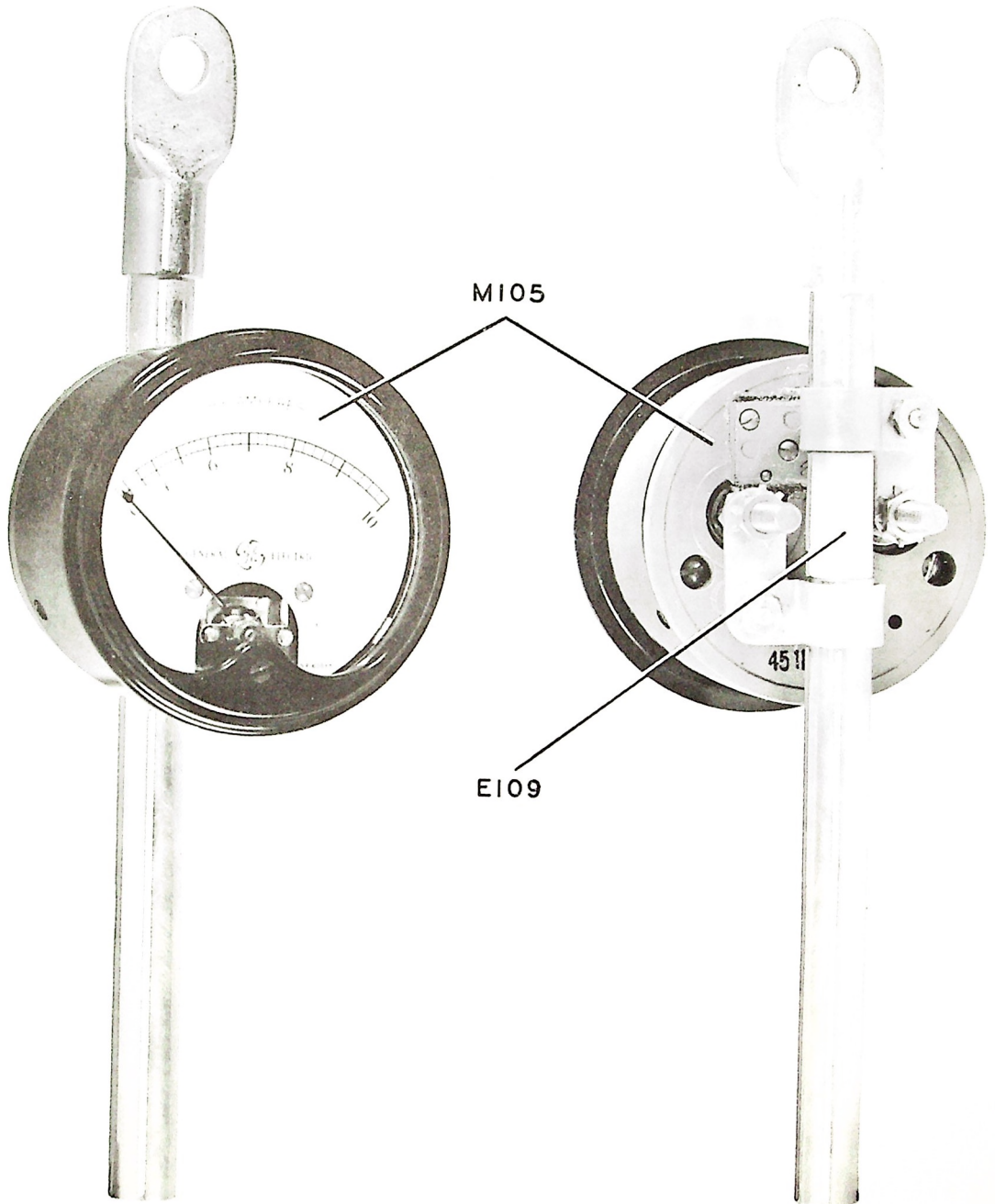


Figure 72. Antenna Ammeter



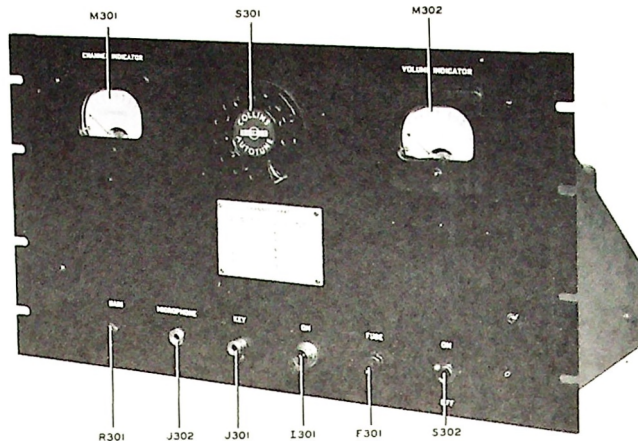


Figure 73. 177G-10 Remote Control Unit - Front

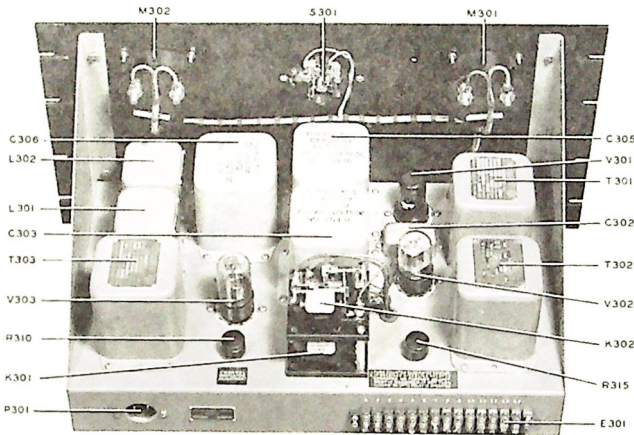


Figure 74. 177G-10 Remote Control Unit - Top

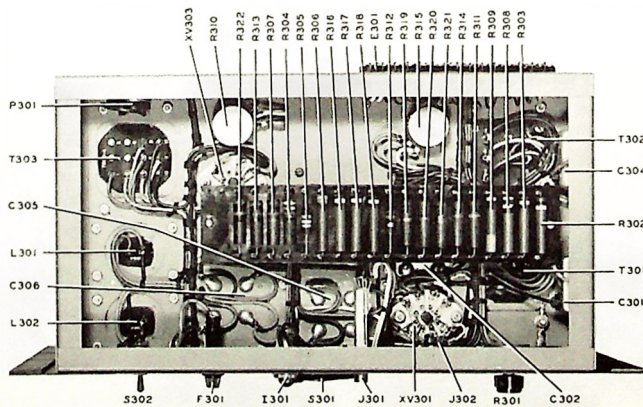


Figure 75. 177G-10 Remote Control Unit - Bottom

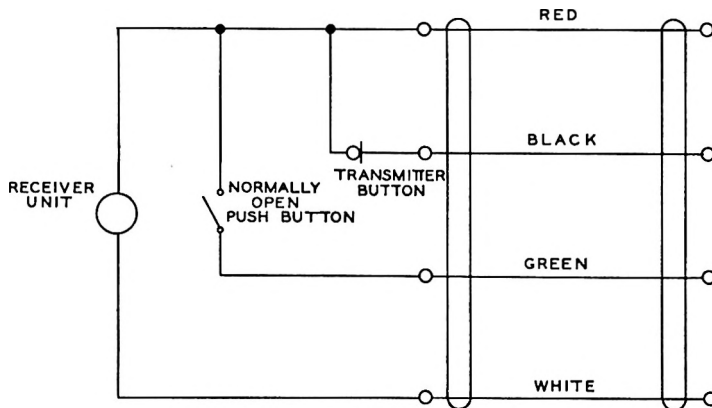


Figure 76. Handset Schematic

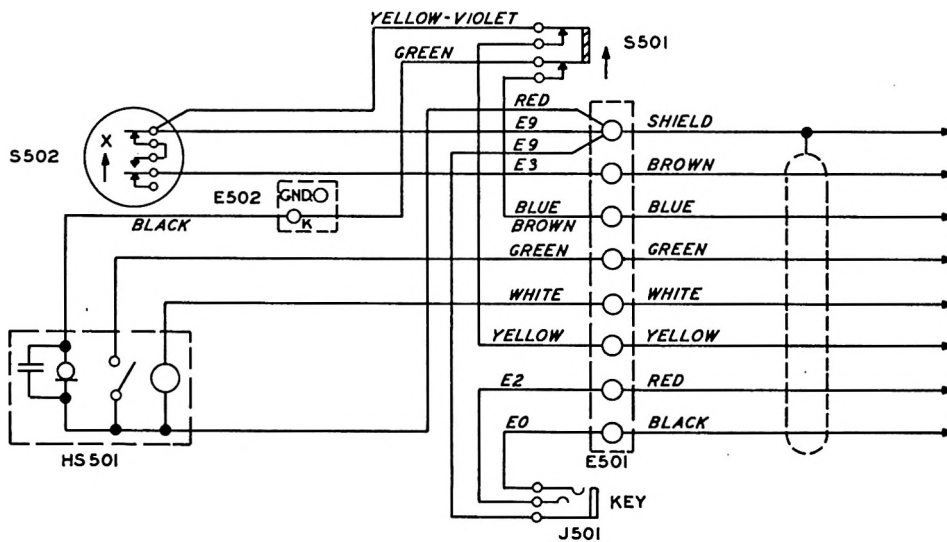


Figure 77. Desk Set Schematic

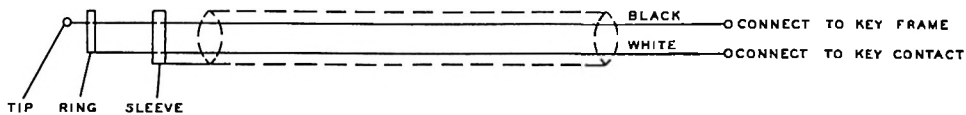


Figure 78. Key Cord Schematic

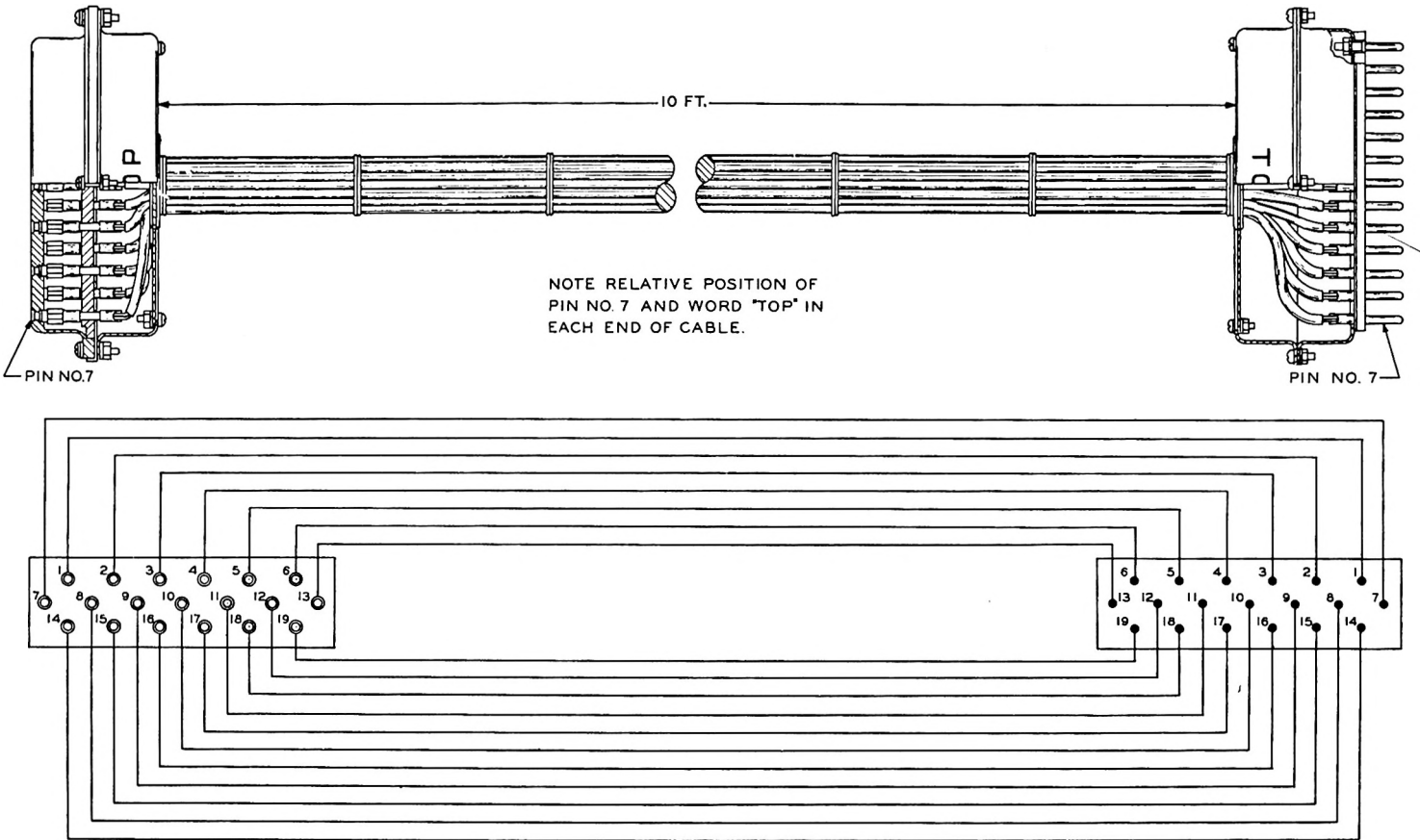


Figure 79. Unit Test Cable Assembly

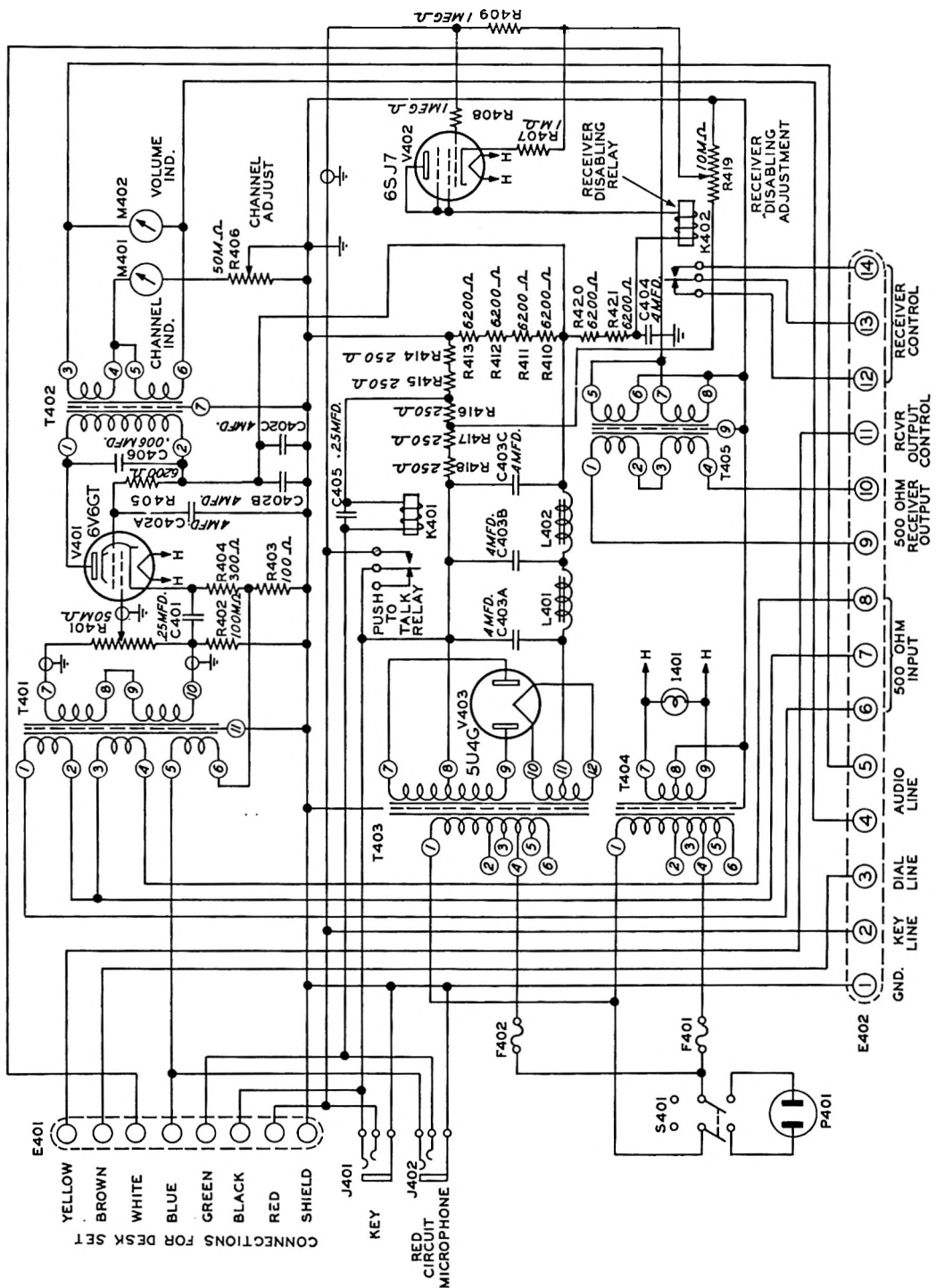


Figure 80A. Type 177G-9 Remote Control Unit Schematic

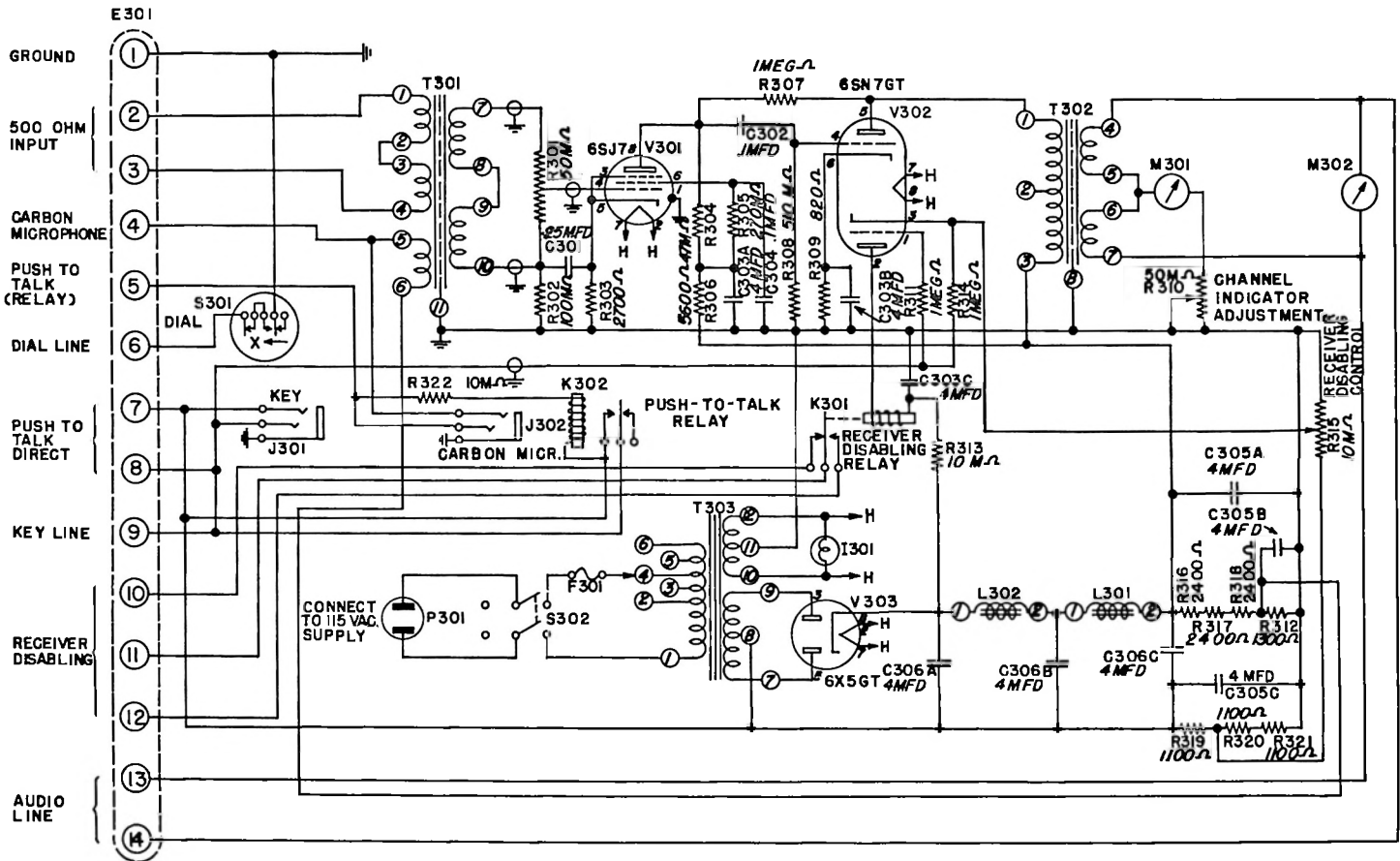


Figure 80B. Type 177G-10 Remote Control Unit Schematic

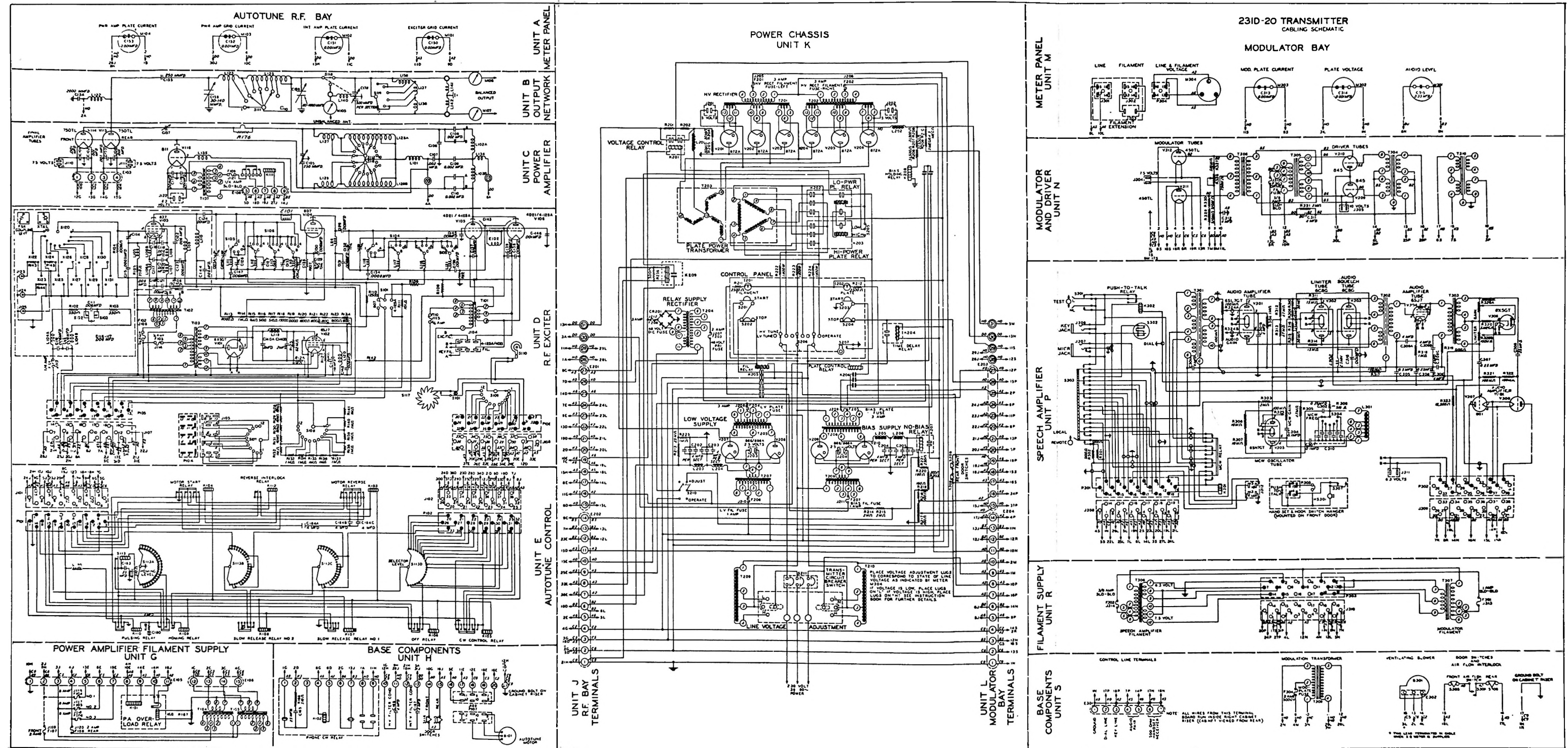


Figure 81. 231D-20 Transmitter Cabling Schematic

## APPENDIX

### ADJUSTMENT DATA FOR COMMERCIAL ASSEMBLIES

Standard Adjustment for Horizontal Relays and Short Level Armature Relays

Standard Adjustment for Lever Keys

Standard Adjustment for Push Keys Type D-59094-A

Adjustment for 978 1000 00 Telephone Dial

Adjustment for 978 2000 00 Rotary Switch

APPENDIX  
STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS  
AND SHORT LEVER ARMATURE RELAYS

A. GENERAL:

1. Definitions: Various terms used in the requirements through this standard adjustment will have the following meanings:

"Spring Combination" is the entire spring assembly of either a single or double armature relay.

"Spring Pileup" is an assembly of all the springs operated by one armature arm.

"Contacts Springs" are the individual springs of a spring pileup 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 1/32".

3. On break combinations disk-type contacts shall not be out of alignment (gauged visually) by more than 1/5 of their face diameter, and in their normal position shall be engaged by not less than 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 1/5 of their face diameter, and shall be engaged by not less than 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 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 not to make contact with the heelpiece, but 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 sideplay of maximum .020", minimum .002".

3. The armature backstop shall be adjusted to allow perceptible play in the armature between the No. 2 spring and the armature backstop in spring pileups where the No. 1 spring is a back contact.

4. The "Z" relay armature backstop shall be positioned so that the point of contact between the armature and the formed edge of the backstop 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 lb while the bushing is at an approximate temperature of 200°F.

D. RESIDUAL:

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.



APPENDIX  
STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS  
AND SHORT LEVER ARMATURE RELAYS

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 than .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 Adjustments
.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".

(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 backstop 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 backstop 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 backstop 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 pileup, 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 No. 2 and No. 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 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

APPENDIX  
STANDARD ADJUSTMENT FOR HORIZONTAL RELAYS  
AND SHORT LEVER ARMATURE RELAYS

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 normal 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 "Nonoperate" 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 "Nonoperate" tests.

NOTE

The above requirement does not apply to the back contacts of the standard make-before-break assemblies as illustrated by springs No. 2 and No. 3 of figure 7. However, the above requirement applies to the back contacts of the special make-before-break assemblies as illustrated by springs No. 1 and No. 2 of figure 8.

(b) On special make-before-break contact springs as illustrated by figure 8, the make contacts may make on the "Nonoperate" 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 "Nonoperate" 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 on 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 one second after saturation.

(a) This requirement must 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  $\pm 1$  volt. Windings of less than 100 ohms resistance, connected to 46 volts  $\pm 1$  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 to 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" requirements, to re-set the front pole piece farther 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 No. 4 Artist's Sable Rigger brush which has been dipped 3/8" into spindle oil (Automatic Electric Co. No. 5231) 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 at the end of 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 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.

APPENDIX  
STANDARD ADJUSTMENT FOR PUSH KEYS  
TYPE D-59094-A

A. SPRING:

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 1/64" after making contact.

B. 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.

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 one-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 .30" 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 .30".

7. The main spring of a break-make combination shall break contact from its back contact before making contact at its front contact.

NOTE

The 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 plate is pulled out when at normal.

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 reset 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) Worm wheel shaft bearings.
- (b) Governor shaft bearings.
- (c) Pawl bearing.

2. One dip of watch oil (Automatic Electric Co. #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 Artists 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) Fiber buffers (when used) or shunt or impulse springs. Apply to the fiber 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.

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 the 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.

**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 1/4" and when assembled in the wiper assembly the two springs will close to within approximately 1/4" 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 nonbridging or line wipers shall rest from 1/4 and 1/2 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 screws.

**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 stoke adjusting screw securely in place.

6. The stoke 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 magnet energized directly on the nominal voltage (46 volts, usually).

**H. MOTOR MAGNET SPRING:**

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.

APPENDIX  
ADJUSTMENT FOR 978 2000 00 ROTARY SWITCH

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 (Automatic Electric Co. #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 (Automatic Electric Co. #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 (Automatic Electric Co. #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, 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 undercut 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.



# HOOK-UP WIRE CODE

The characteristics of the hook-up wire used in this equipment are indicated by groups of symbols on the diagrams. Each symbol group consists of a maximum of three letters followed by a maximum of three numerals. When three letters are used the first indicates the type of wire, the second represents the size of wire, and the third is the letter "S", used only when the wire is shielded. When two letters are used, the first and second letters indicate either the type and size of wire or the size of wire and shielding, respectively. When one letter is used it indicates the wire size only. The first numeral indicates the color of the wire body and the second and third numerals, if any, represent the colors of tracers, all numerals being in accordance with the standard RTMA and JAN-C-76 color code.

The symbols are assigned according to the following table.

FIRST LETTER	TYPE OF WIRE	SECOND LETTER	AWG# WIRE SIZE	THIRD LETTER	
A	Cotton Braid Over Plastic (Formerly AN-J-C-48)	A	#22	S	Shielded
B		B	#20	None	Unshielded
C	Jan Type WL(600 Volts)	C	#18	NUMBER OR LETTER	BODY OR TRACER COLOR
D	Miniature Jan Wire	D	#16		
E	Extra Flexible Varnished Cambric	E	#14	0	Black
F		F	#12	1	Brown
G	General Electric Deltabeston	G	#10	2	Red
H	KEL-F (Monochlorotrifluoroethylene)	H	#8	3	Orange
J		J	#6	4	Yellow
K	Neon Sign Cable (15,000 Volts)	K	#4	5	Green
L	Silicone	L	#2	6	Blue
M	Single Conductor Stranded (Not Rubber Covered)	M	#1	7	Violet
N		N	#0	8	Gray (Slate)
P	Single Conductor Stranded (Rubber Covered)	P	#00	9	White
Q	Jan Type SRIR(1000 Volts)	Q	#000	a	Clear
R		R	#0000	b	Tan
T	Teflon (Polytetrafluoroethylene)	T	#28	c	Pink
V	Jan Type SRHV (2500 Volts)	V	#26	d	Maroon
W		W	#24	e	Light Green
X		X	#19	f	Light Blue
Y	Acetate Yarn, Telephone Type	Y	#30		
Z		Z			

### EXAMPLES

UNSHIELDED WIRE, JAN TYPE WL, #22AWG, WHITE WITH RED AND GREEN TRACERS:

C	A	9	25	4 1/4	
Type of Wire	Size of Wire	Color of Body	Color of Tracers	-- Length of Wire in Inches	
					(Includes Stripping & Tinning)

SHIELDED WIRE (SINGLE), JAN TYPE SPIR, #16AWG, WHITE WITH RED AND GREEN TRACERS:

R	D	S	9	25	4 1/4	
Type of Wire	Size of Wire	Shielded	Color of Body	Color of Tracers	-- Length of Wire in Inches	
					(Includes Stripping & Tinning)	

SHIELDED WIRE (MULTIPLE), MINIATURE JAN, #22AWG, WHITE, AND WHITE WITH RED TRACER:

D	A	S	(9)	(92)	4 1/4	
Type of Wire	Size of Wire	Shielded	First Conductor	Second Conductor	-- Length of Wire in Inches	
					(Includes Stripping & Tinning)	



— COLLINS RADIO COMPANY —