

HANDBOOK FURNISHED
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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

RADIO SET
AN/GRC-9-GY

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RADIO SET
AN/GRC-9-GY

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WARNING

HIGH VOLTAGE

is used in the operation of
this equipment.

A DANGEROUS SHOCK

may result if operating personnel
fail to observe safety precautions.



RESCUE.

In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire. Use extreme caution to avoid the resulting electric flash.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breath center recovers after a while and normal breathing is resumed, provided that a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a very few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must still be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT.

a. Start artificial respiration immediately. At the same time send for a medical officer, if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only*, remove the victim to another location, but no farther than is necessary for safety. If the new location is more than

a few feet away, artificial respiration should be given while the victim is being moved. If the method of transportation prohibits the use of the Shaeffer prone pressure method, other methods of resuscitation may be used. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

b. Lay the victim in a prone position, one arm extended directly overhead, and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing.

c. Open the victim's mouth and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

d. If an assistant is available during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm, by applying blankets or other covering, or by applying hot rocks or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also be ever watchful to see that the victim does not swallow his tongue. He should continually wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

e. The resuscitating operator should straddle the victim's thighs, or one leg, in such manner that:

(1) the operator's arms and thighs will be vertical while applying pressure on the small of the victim's back;

(2) the operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib;

(3) the heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim;

(4) the operator's elbows are straight and locked.

f. The resuscitation procedure is as follows:

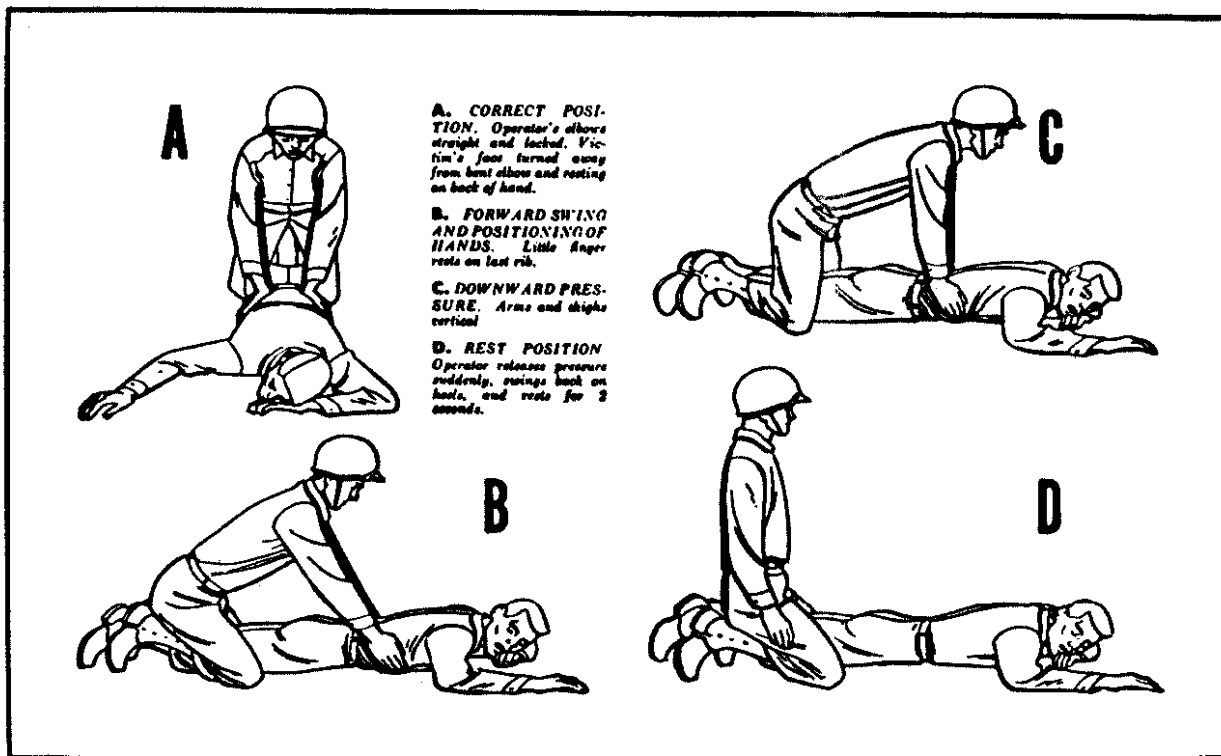
(1) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(2) Swing back, suddenly releasing pressure, and sit on the heels.

(3) After 2 seconds rest, swing forward again, positioning the hands exactly as before, and apply pressure for another second.

g. The forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion, which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of 4 seconds for a

First aid notice



complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: one thousand and one, one thousand and two, etc.

h. Artificial respiration should be continued until the victim regains normal breathing or is pronounced dead by a medical officer. Since it may be necessary to continue resuscitation for several hours, relief operators should be used if available.

RELIEVING OPERATOR.

The relief operator kneels beside the operator and follows him through several complete cycles. When the relief operator is sure he has the correct rhythm, he places his hands on the operator's hands without applying pressure. This indicates that he is ready to take over. On the backward swing, the operator moves and the relief operator takes his position. The relieved operator follows through several complete cycles to be sure that the new operator has the correct rhythm. He remains alert to take over instantly if the new operator falters or hesitates on the cycle.

STIMULANTS.

a. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the

stimulant should first test it himself to see how close he can hold the inhalant to his own nostril for comfortable breathing. Be sure that the inhalant is not held any closer to the victim's nostrils, and then for only 1 or 2 seconds every minute.

b. After the victim has regained consciousness, he may be given hot coffee, hot tea, or a glass of water containing $\frac{1}{2}$ teaspoon of aromatic spirits of ammonia. Do not give any liquids to an unconscious victim.

CAUTIONS.

a. After the victim revives, keep him LYING QUIETLY. Any injury a person may have received may cause a condition of shock. Shock is present if the victim is pale and has a cold sweat, his pulse is weak and rapid, and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body and his hips elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim must be watched carefully as he may suddenly stop breathing. Never leave a resuscitated person alone until it is CERTAIN that he is fully conscious and breathing normally.

First aid notice—Continued



Figure 1. Typical installations for Radio Set AN/GRC-9-GY.

CHAPTER I

INTRODUCTION

Section I. GENERAL

1. Scope

This handbook contains instructions for the installation, operation, maintenance, and repair of Radio Set AN/GRC-9-GY (fig. 1). The equipment is identical with Radio Set AN/GRC-9 of Signal Corps U.S. Army. The letters GY after official nomenclature of the equipment and major parts are to indicate that these items of equipment have been manufactured in Germany.

All component parts shown in this handbook and having a Signal Corps Stock No. of the U.S. Army followed by GY are interchangeable with the original American parts, even where they do not correspond with them in size. In the Identification Table of Parts (Appendix II)

Signal Corps Stock Numbers are again followed by GY; in case of repairs both original American parts and parts with the addition GY may be used.

In every case the items of equipment with the addition GY are in accordance with the recent original models of the U.S. Army as late as 1953. Official nomenclature of equipment not being part of Radio Set An/GRC-9-GY but which is described in this handbook e.g. as auxiliary equipment and which is followed by (+) is used to indicate all models of the items of equipment included in this handbook. Thus Power Unit PE-162-(+) represents Power Unit PE-162 and PE-162-B.

Section II. DESCRIPTION AND DATA

2. Purpose and Use

a. Radio Set AN/GRC-9-GY (fig. 1) is a combined radio transmitter and radio receiver which provides telephone, c-w (continuous-wave), and mcw (modulated continuous wave) communication as a portable field set (fig. 1). It also may be installed on a vehicle.

b. The equipment consists of Receiver-Transmitter RT-77/GRC-9-GY which can be either crystal- or master-oscillator controlled; it transmits phone, c-w, or mcw signals from 2 mc

(megacycles) to 12 mc. All modulation is a-m. (amplitude-modulation). Transmitter-Receiver RT-77/GRC-9-GY receives c-w, mcw, and phone signals in the same frequency range. Generator GN-58-A-GY, a hand-operated generator capable of supplying all the required power for operation of the set, is supplied. Dynamotor-Power Supply DY-88/GRC-9-GY which supplies all the power necessary to operate the set from a vehicular battery is included also. A number of additional components are listed in paragraph 6 (fig. 2). The operating equipment set up for normal field use is shown in figure 35.

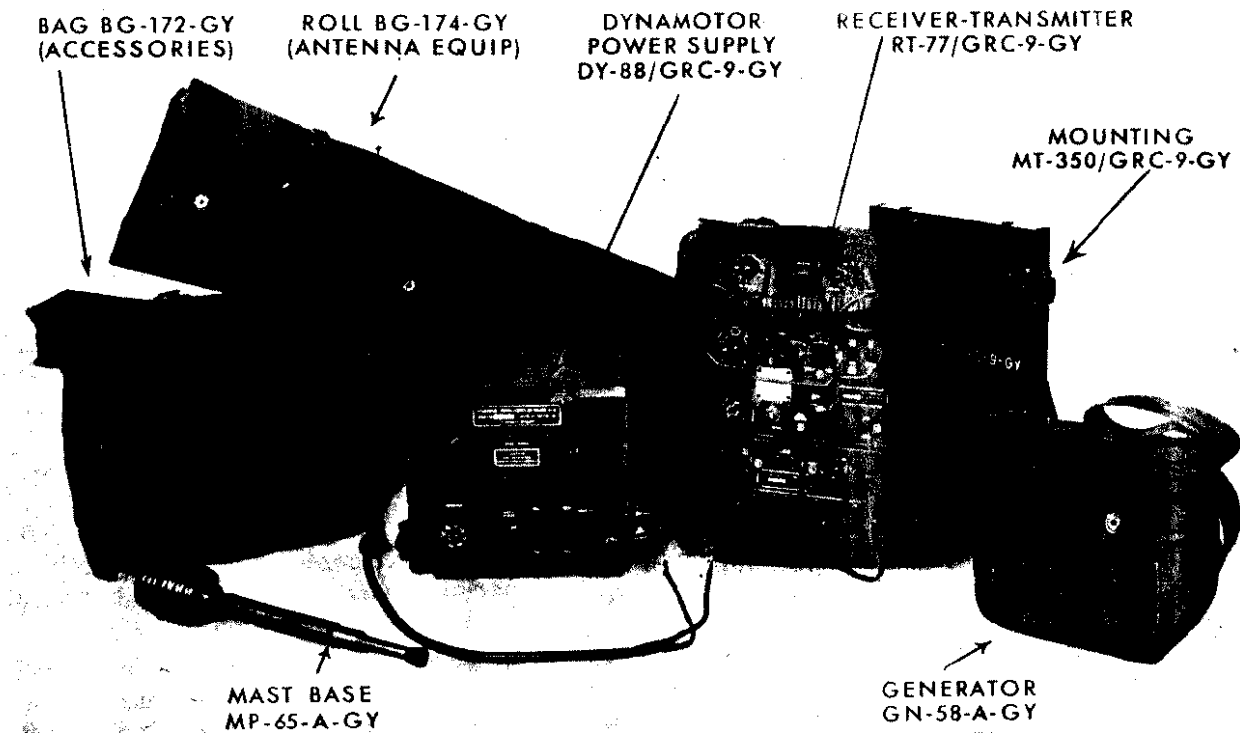


Figure 2. Radio set AN/GRC-9-GY, operating components.

3. System Application

a. Radio Set AN/GRC-9-GY is used to communicate with any a-m equipment that operates within the 2-mc to 12-mc band. It can be used as an isolated unit or in a net group. Under favorable conditions, Radio Set AN/GRY-9-GY will provide communication between moving vehicles of up to 15 miles on voice and up to 30 miles on c-w.

b. A simplified block diagram is shown in figure 3. Both the transmitter and the receiver use the same antenna. A relay, located in the transmitter cabinet and actuated by the transmitter key, switches the antenna to the transmitter unit when the key is depressed. When the key is not depressed, the antenna remains connected to the receiver, whereas the transmitter is made inoperative by other contacts of the same relay.

c. The receiver may be used with either high- or low-impedance headphones or Loudspeaker LS-7-GY. Loudspeaker LS-11 (not supplied) also may be used. The receiver can be operated with power supplied from Dynamotor-Power

Supply DY-88/GRC-9-GY, Generator GN-58-A-GY, or Battery BA-48.

d. The transmitter section generates a continuous r-f (radio-frequency) carrier and provides means for keying or voice modulation. Power is supplied to the transmitter by either Dynamotor-Power Supply DY-88/GRC-9-GY or Generator GN-58-A-GY. Battery BA-48 is not used to operate the transmitter. Gasoline engine-driven Power Supply PE-162 also may be used.

e. Dynamotor-Power Supply DY-88/GRC-9-GY supplies all power to Receiver-Transmitter RT-77/GRC-9-GY from a 6-, 12-, or 24-volt d-c (direct-current) vehicular storage battery supply.

f. When a source of current supply is not available, Receiver-Transmitter RT-77/GRC-9-GY may be operated by using Generator GN-58-A-GY which is hand operated.

g. Only the receiver may be used for stand-by operation, using Signal Corps Battery BA-48 (not supplied).

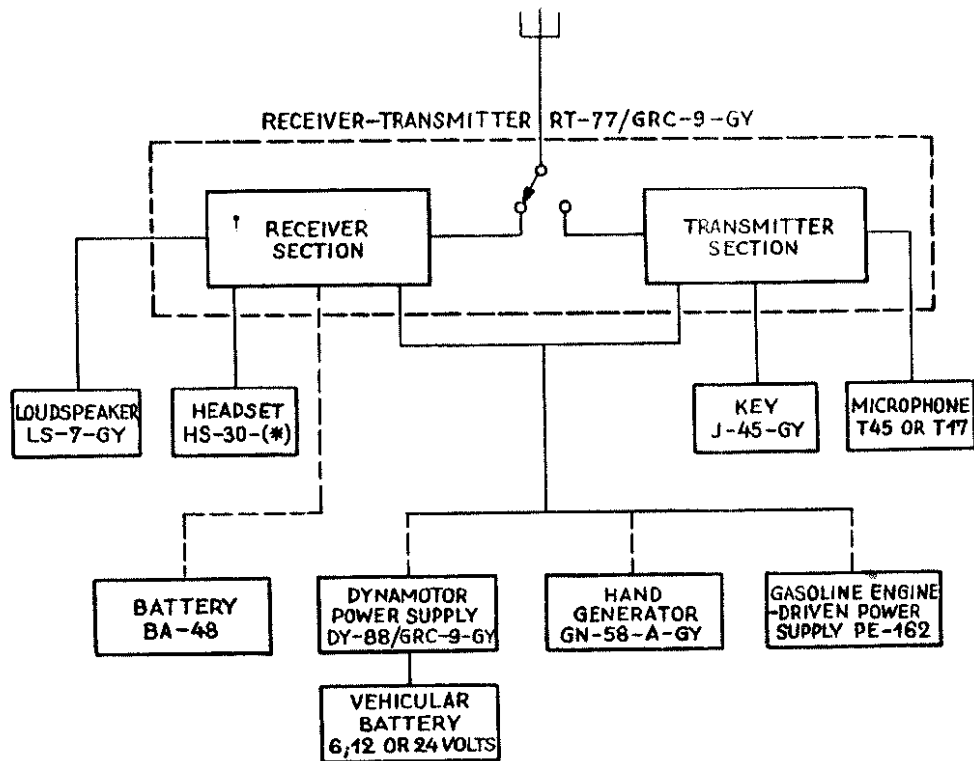


Figure 3. Radio set AN/GRC-9-GY, simplified block diagram.

4. Technical Characteristics

a. TRANSMITTER SECTION OF RECEIVER-TRANSMITTER RT-77/GRC-9-GY.

Frequency range:

Three bands covering . . .	2.0 mc to 12 mc.
Band 1	6.6 mc to 12 mc.
Band 2	3.6 mc to 6.6 mc.
Band 3	2.0 mc to 3.6 mc.

Transmitter type Crystal or master oscillator p-a (power-amplifier).

Crystal channels Two in each band (crystals not supplied).

Types of signals transmitted . . C-w, mcw, and phone.

Distance range:*

Stationary:

C-w	30 miles.
Mcw	20 miles.
Voice	15 miles.

Moving:

C-w	20 miles.
Mcw	10 miles.
Voice	10 miles.

Type of modulation Amplitude.

Number of tubes 5.

Power input to Dynamotor-Power Supply DY-88/GRC-9-GY with transmitter operating:

6-volt, high-power position . . .	27 amperes.
6-volt, low-power position . . .	24 amperes.
12-volt, high-power position . . .	13.2 amperes.
12-volt, low power position . . .	11 amperes.
24-volt, high-power position . . .	7 amperes.
24-volt, low-power position . . .	6.2 amperes.

*These values are approximations, since the range will vary considerably according to terrain, atmospheric conditions, frequencies, and time of year, month, and day.

Power output:**

Power switch D position	Dynamotor-Power Supply DY-88/GRC-9-GY		Generator GN-58-A-GY	
	Phone	CW	Phone	CW
High	7 watts . .	15 watts .	3.6 watts	10 watts.
Low	1 watt . . .	5 watts .	1.2 watts	5 watts.

**These values are only approximate and will vary with frequency.

Antennas:

Whip 15 feet long. Consists of three mast sections MS-116-A, one MS-117-A, and one MS-118-A.

Long-wire . . . 244.5 feet long. (The 137-foot length has calibration chart attached; 107.5 feet of the 244.5-foot length is detachable.)

Power supply . 6-, 12-, or 24-volt vehicular battery through Dynamotor-Power Supply DY-88/GRC-9-GY or hand Generator GN-58-A-GY.

Weight 16 pounds, less case.

b. RECEIVER SECTION OF RECEIVER-TRANSMITTER RT-77/GRC-9-GY.

Frequency range:

- Band 1 6.6 mc to 12 mc.
- Band 2 3.6 mc to 6.6 mc.
- Band 3 2.0 mc to 3.6 mc.

Receiver type Superheterodyne.

Types of signals which can be C-w, mcw, and received phone.

Number of tubes 7.

Intermediate frequency 456 kc (kilocycles).

Method of calibration Built-in crystal oscillator.

Calibration points 200-kc intervals.

Power input at STANDBY position using the stand-by section of Dynamotor-Power Supply DY-88/GRC-9-GY:

- 6-volt battery 1.25 amperes.
- 12-volt battery .8 ampere.
- 24-volt battery .6 ampere.

Power supply . . . 6-, 12-, or 24-volt vehicular battery operating Dynamotor-Power Supply DY-88/GRC-9-GY, Generator GN-58-A-GY and Battery BA-48 in a field installation.

Power required by receiver:

A-power . . . 1.4 volts at .45 ampere (maximum).

B-power 105 volts at .02 ampere (maximum).

Antenna Uses same antenna as transmitter.

Weight 8 pounds, less case.

c. DYNAMOTOR-POWER SUPPLY DY-88/GRC-9-GY.

Supply requirements: 6-, 12-, 24-volt vehicular battery.

Basic circuit: H-v dynamotor and an l-c vibrator supply.

Full-load output: Transmitter plate, 580 volts, at 100 ma. Receiver plate, 120 volts at 45 ma. Transmitter filament 6.5 volts at 2 amperes. Receiver filament, 1.5 volts at 500 ma. Keying relay, 6.9 volts at 575 ma.

Full-load input (with transmitter operating):

- 6-volt, high-power position . 27 amperes.
- 6-volt, low-power position . . 24 amperes.
- 12-volt, high-power position . 13.2 amperes.
- 12-volt, low-power position . 11 amperes.
- 24-volt, high-power position . 7 amperes.
- 24-volt, low-power position. . 6.2 amperes.

Tube complement:

Two ballast tubes 10-4A. One ballast tube 5TF4.

Weight: 35 lbs.

d. GENERATOR GN-58-A-GY.

Supply requirements . . . Hand operated.

Basic circuit Regulated and filtered dynamo having both an h-v and l-v winding on one armature.

Full-load output Transmitter plate, 425 volts at 115 ma (milliamperes). Receiver plate, 105 volts at 32 ma. Transmitter filament, 6.3 volts at 2.5 amperes. Receiver filament, 1.4 volt at 465 ma.

Weight 29 pounds.

5. Packaging Data

a. The components of Radio Set AN/GRC-9-GY are placed in cardboard cartons which are packed in three tarpaper lined wooden boxes.

The method of packing a typical component is shown in figures 29 and 30. The size, weight, contents, and volume of each crate are given in the following chart.

Box No.	Contents	Dimensions (in.)			Weight (lb)	Volume (cu ft)
		Length	Width	Depth		
1	Receiver-Transmitter RT-77/GRC-9-GY. Panel Cover CW-109/GRC-9-GY. Cord CD-1119-GY. Bag CW-140/GRC-9-GY. Equipment literature.	23	16	14	64	2.9
2	Bag BG-172-GY and contents Roll BG-174-GY and contents. Generator GN-58-A-GY. Bag BG-175-GY. Mast Base MP-65-A-GY. Mounting MT-350/GRC-9-GY.	48	20	12	123	6.7
3	Dynamotor-Power Supply DY-88/GRC-9-GY Cable Assembly CX-2031/U-GY Cord CD-1086-GY.	18	16	15	62	2.5



Figure 4. Generator GN-58-A-GY and Bag BG-175-GY.

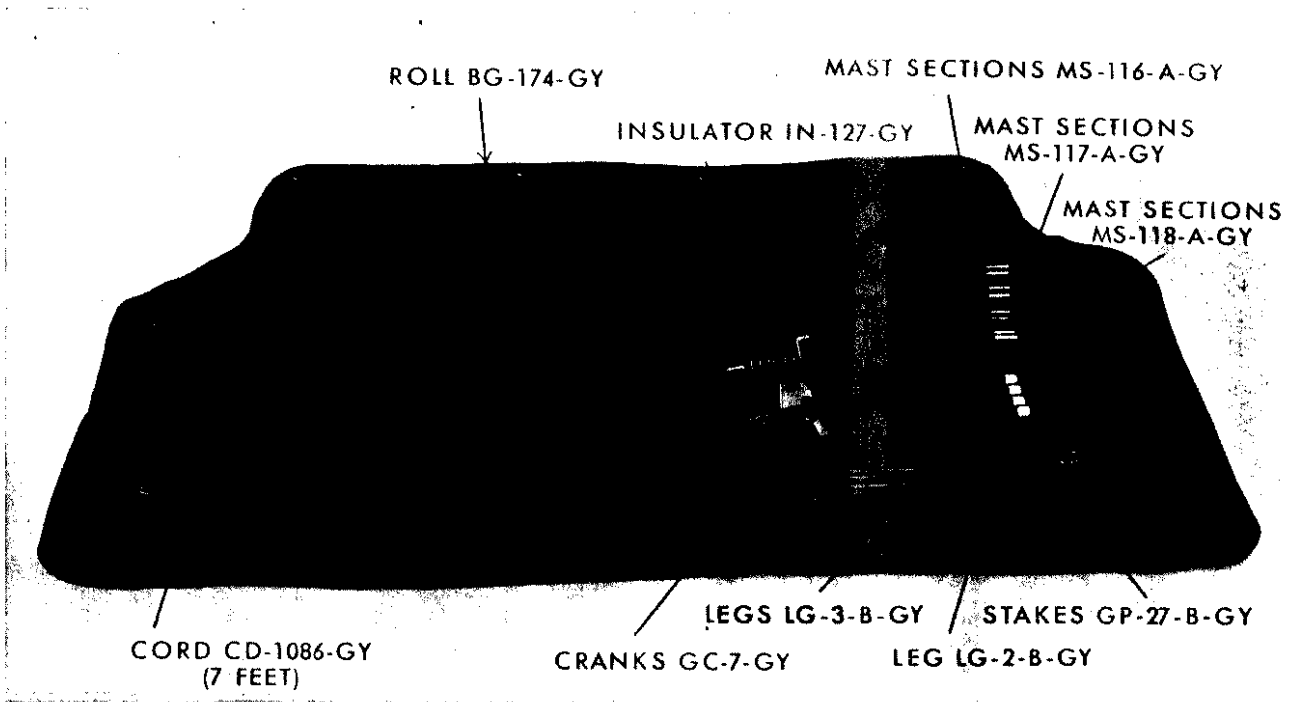
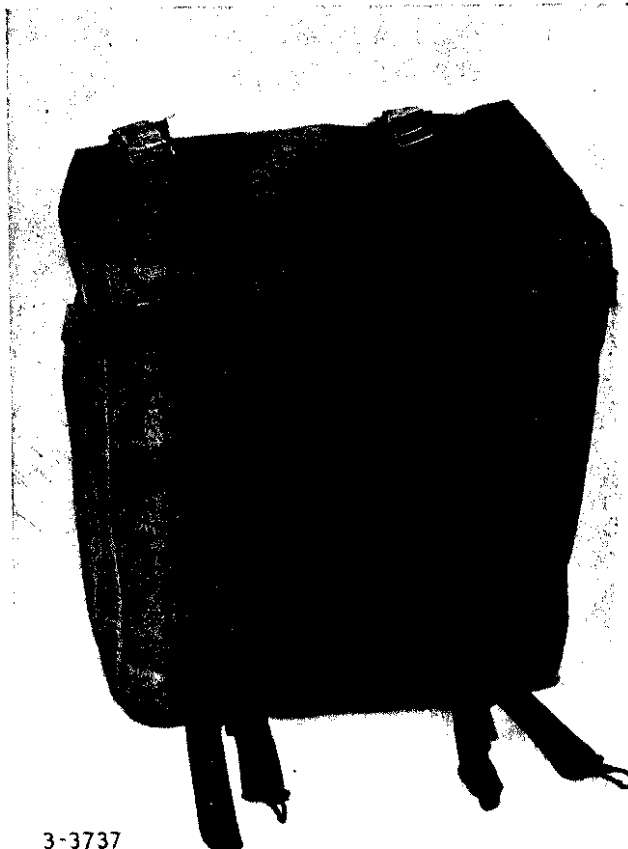


Figure 5. Roll BG-174-GY, with contents.



b. CARRYING BAGS (figs 4, 5, 6, and 7)
 Four carrying bags are provided for transporting the equipment in the field when using the hand generator as the source of supply. The carrying bags are constructed of heavy canvas and are provided with straps to facilitate carrying. The contents of the carrying bags are listed in the following charts:

Signal Corps stock No.	Quantity	Description
2Z553-140-GY	1	Bag CW-140/GRC-9-GY containing-
3E1999-119-GY	1	Cord CD-1119-GY
2Z3350-109-GY	1	Panel Cover CW-109/GRC-9-GY
2C5130-77-GY	1	Receiver-Transmitter RT-77/GRC-9-GY containing-
2JOC3-GY	1	Tube type OC3
2J1S5-GY	1	Tube type 1S5
2J1L4-GY	2	Tube type 1L4
2J1R5-GY	3	Tube type 1R5
2J2E22-GY	1	Tube type 2E22
2J3A4-GY	3	Tube type 3A4
2J3Q4-GY	1	Tube type 3Q4
2X105-200-GY	1	Crystal Unit CR-2/U-GY
2Z5971.1-GY	2	Lamp, incandescent
2Z5889-15-GY	1	Lamp, neon
3E7173-22-GY	1	Cable assembly, interconnecting

Figure 6. Bag BG-172-GY, packed.

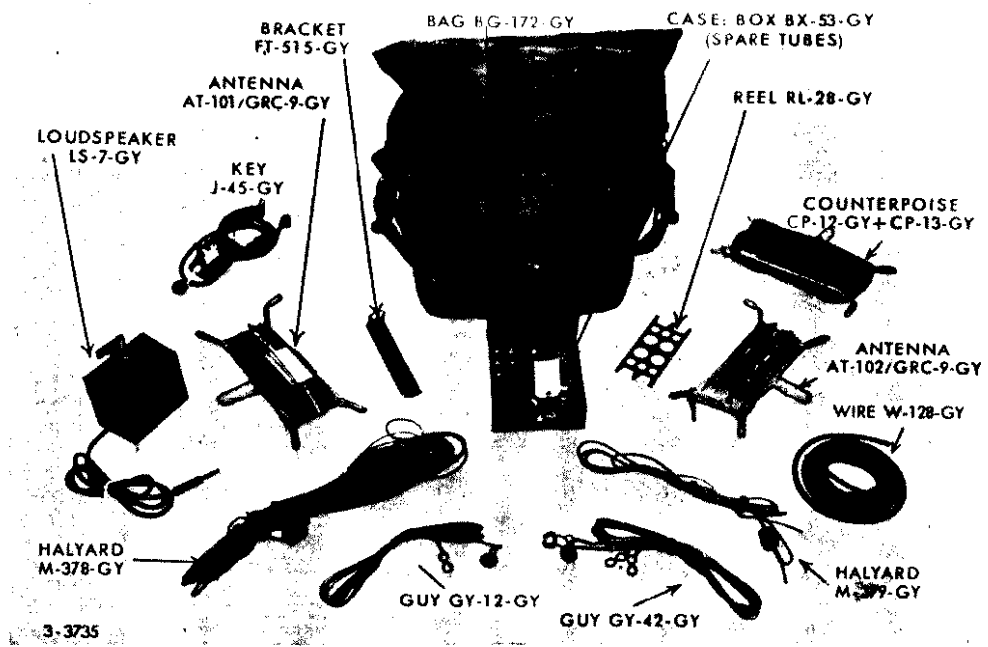


Figure 7. Bag BG-172-GY, contents.

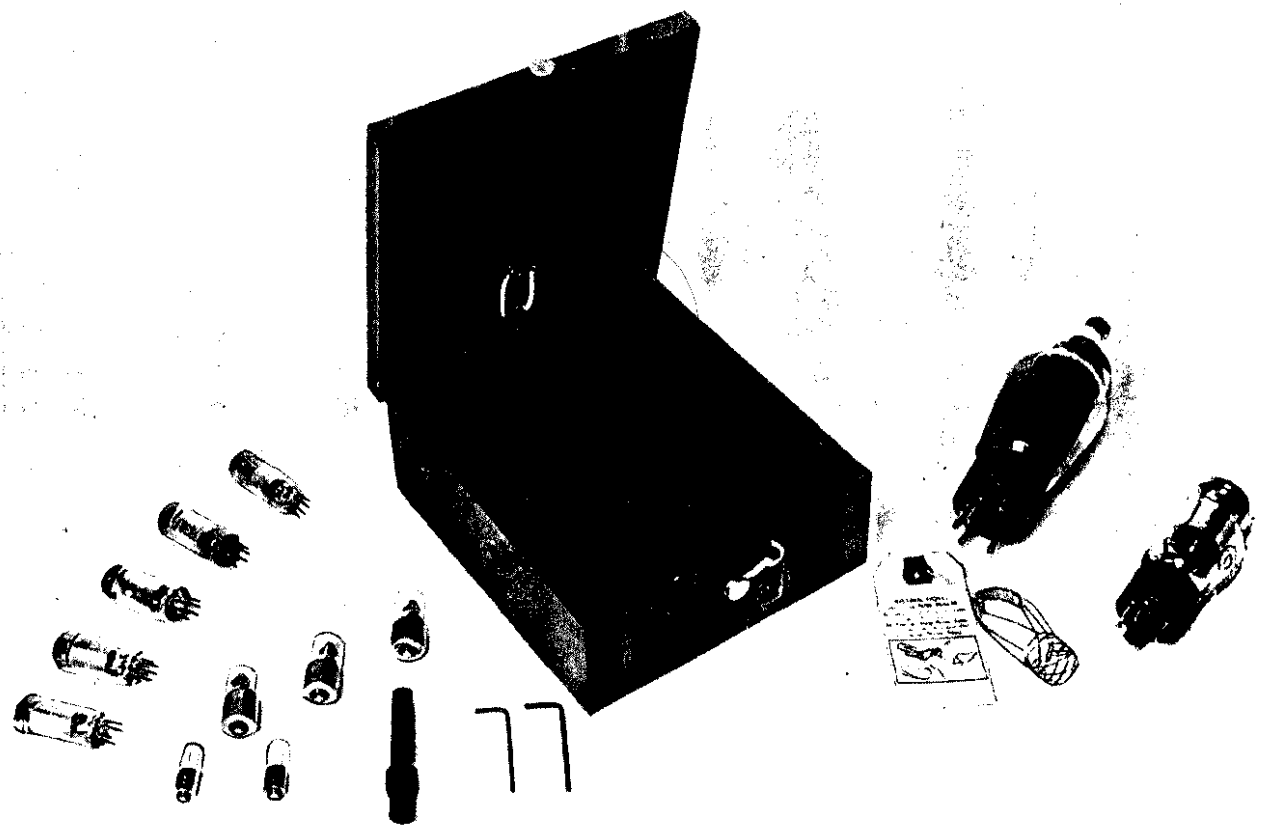


Figure 8. CASE: Box BX-53-GY and contents.

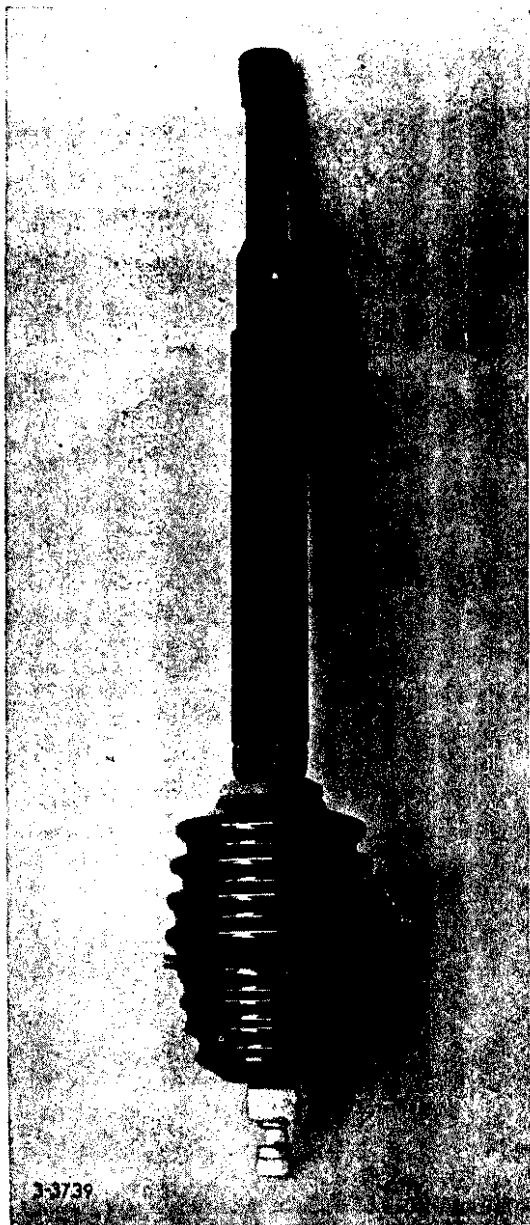


Figure 9. Mast base MP-65-A-GY.

Signal Corps stock No.	Quantity	Description
3H160-175-GY	1	Bag BG-175 containing-
3H2358-GY	1	Generator GN-58-A-GY containing-
3H2358/B6-GY	2	Brush set HV and LV

Signal Corps stock No.	Quantity	Description
2Z8060-174-GY	1	Roll BG-174-GY containing-
2Z2416-GY	6	Mast Section MS-116-A-GY
2A2417-GY	2	Mast Section MS-117-A-GY
2A2418-GY	2	Mast Section MS-118-A-GY
2A3327-GY	4	Stake GP-27-B-GY
2Z6102B-GY	1	Leg LG-2-B-GY
2Z6103B-GY	2	Leg LG-3-B-GY
3E1999-86-GY	1	Cord CD-1086-GY (7 ft)
3G627-GY	1	Insulator IN-127-GY
3H1407-GY	2	Crank, hand GC-7-GY

Signal Corps stock No.	Quantity	Description
2Z551-172-GY	1	Bag BG-172-GY containing-
1B128-GY	10ft	Wire W-128-GY
2A1312-GY	1	Guy GY-12-GY
2A1336-42-GY	1	Guy GY-42-GY
2A203-101-GY	1	Antenna AT-101/GRC-9-GY
2A203-102-GY	1	Antenna AT-102/GRC-9-GY
2A3128-GY	1	Reel RL-28-GY
2A3129-GY	3	Reel RL-29-GY
2A712-GY	1	Counterpoise CP-12-GY
2A713-GY	1	Counterpoise CP-13-GY
2Z1203-515-GY	1	Bracket FT-515-GY
2Z6310-7-GY	1	Loudspeaker LS-7-GY
2Z3445-GY	1	Key J-45-GY
6Z4938-GY	1	Halyard M-378-GY
6Z4939-GY	1	Halyard M-379-GY
6F153C-GY	1	Case: Box BX-53-GY contain-
2JOC3-GY	1	Tube type OC3 [ing-
2J1S5-GY	1	Tube type 1S5
2J1L4-GY	1	Tube type 1L4
2J1R5-GY	1	Tube type 1R5
2J2E22-GY	1	Tube type 2E22
2J3A4-GY	1	Tube type 3A4
2J3Q4-GY	1	Tube type 3Q4
2Z5971.1-GY	2	Lamp, pilot
2Z5889-15-GY	3	Lamp, neon
6R7443-4-GY	1	Extractor, tube
6Q36920-2-GY	1	Extractor, pilot lamp
6R55230-GY	1	Wrench No. 6
6R55231.1-GY	1	Wrench No. 8

c. ADDITIONAL COMPONENTS. Additional components not supplied in canvas bags are as follows:

Signal Corps stock No.	Quantity	Description
2A2088-65-GY	1	Mast Base MP-65-A-GY
2Z6763-350-GY	1	Mounting MT-350/GRC-9-GY containing-
6L80026-GY	1	Bag of hardware consisting of-
6L3608-32.3-GY	18	Nut, hex; steel, No. 8-32
6L6332-16.49S-GY	18	Screw, machine; steel No. 8-32
6L72208C-GY	18	Washer, lock; steel, No. 8

d. CONTENTS OF ONE OF THE PACKING CRATES.

Signal Corps stock No.	Quantity	Description
3H1535-88-GY	1	Dynamotor Power Supply DY-88/GRC-9-GY
3H6690-15-GY	2	Vibrator, synchronous
3Z2610.42-GY	6	Fuse 10 amp
3Z2620.20-GY	6	Fuse 20 amp
3Z2630.27-GY	6	Fuse 30 amp
3Z2605.32-GY	6	Fuse 5 amp
3Z6925-3.32-GY	2	Resistor, thermal 0.52 amp
3Z6926-15.2-GY	3	Resistor, thermal 1.0 amp
3H535T-3-GY	2	Brush set 6 volt
3H535T-GY	4	Brush set 12 and 24 volt
3H535T-2-GY	2	Brush set high voltage
NSNR	1	Circuit diagram
3E1999-86-3.8-GY	1	Cord CD-1086-GY (44 inch)
3E5999-7.26-GY	1	Cable Assembly CX-2031/U-GY
6L80150-88.1-GY	1	Hardware kit containing-
6L72220-32-GY	4	Lockwasher, steel, for $\frac{3}{8}$ " screw
6L3506-24Z-GY	4	Nut, hexagon for $\frac{3}{8}$ " screw
6L4906.24-GY	4	Screw, cap 2- $\frac{1}{2}$ " long

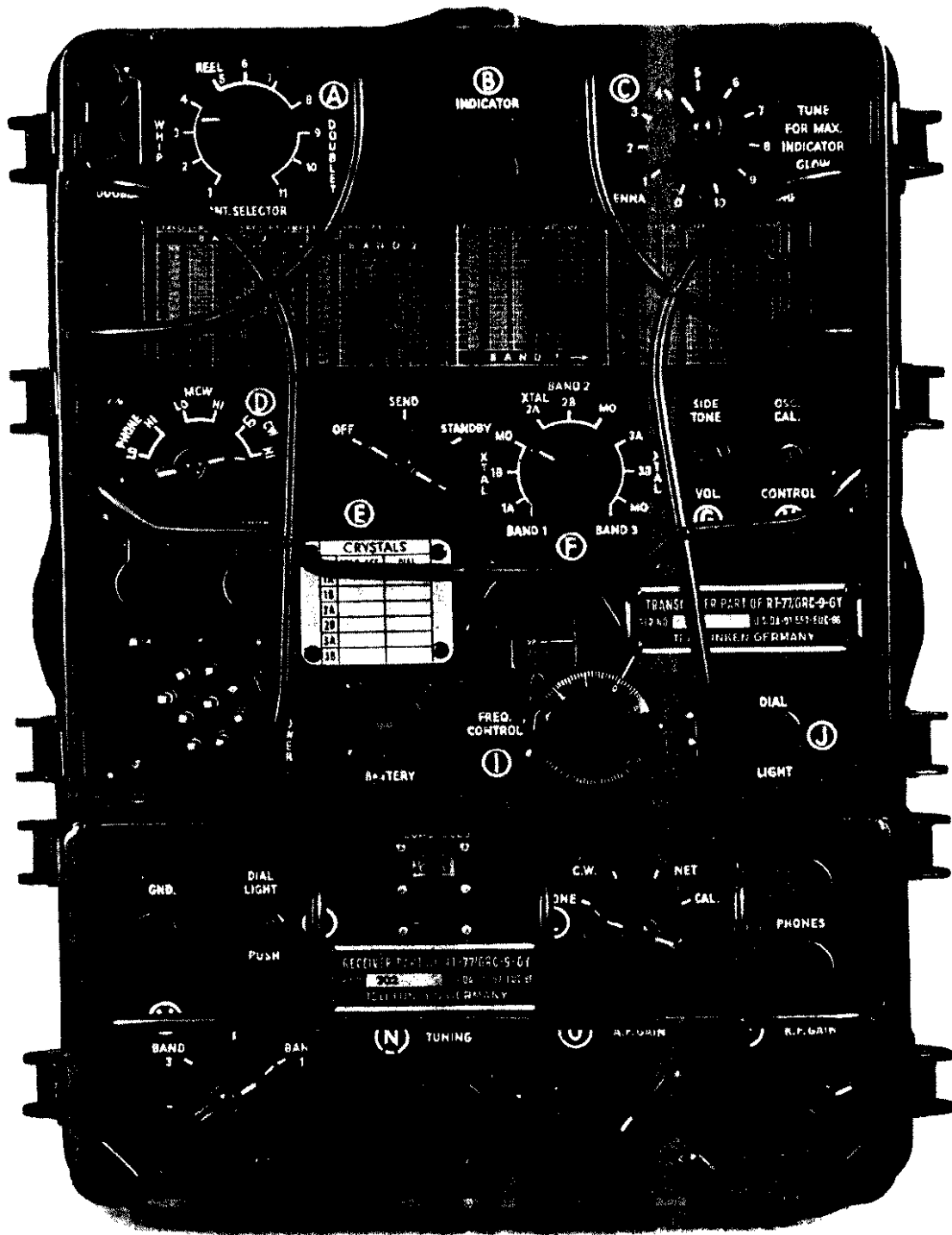


Figure 10. Receiver-transmitter RT-77/GRC-9-GY.

6. Table of Components

Component	Required No.	Length (in.)	Width (in.)	Depth (in.)	Weight (lb)
Antenna AT-101/GRC-9-GY } Wound on	1	12	8	3	2.6
Antenna AT-102/GRC-9-GY } Reel RL-29-GY	1	12	8	3	2.9
Bag BG-172-GY (for equipment accessories)	1	16	15	9	5.1
Bag CW-140/GRC-9-GY (for Receiver-Transmitter RT-77/GRC-9-GY)	1	14	13	16	4.4
Bag BG-175-GY (for Generator GN-58-A-GY)	1	9	9	7	1.7
Bracket FT-515-GY	1	9	1 1/2	2	0.4
Case: Box BX-53-GY (with contents)	1	7	6	2 1/2	1.5
Cable Assembly CX-2031/U-GY	1	97	—	—	2.0
Cord CD-1086 (for connecting Receiver-Transmitter to Generator)	1	90	—	—	2.3
Cord CD-1086-GY (for connecting Receiver-Transmitter to Dynamotor-Power Supply)	1	50	—	—	1.6
Cord CD-1119-GY (BA-48 to Receiver-Transmitter)	1	40	—	—	0.3
Counterpoise CP-12-GY } Wound on	1	12	8	4	4.3
Counterpoise CP-13-GY } Reel RL-29-GY	1	12	8	4	4.3
Cranks GC-7-GY	2	8	5	1 1/2	1.0
Dynamotor-Power Supply DY-88/GRC-9-GY	1	13	10	14	34.1
Generator GN-58-A-GY	1	10	7	8	24.0
Guy GY-12-GY } Wound on	1	6 1/2	3	1 1/2	0.6
Guy GY-42-GY } Reel RL-29-GY	1	6 1/2	3	1 1/2	0.6
Halyard M-378-GY	1	15	2	—	0.7
Halyard M-379-GY	1	4	3	—	0.2
Handbook for Radio Set AN/GRC-9-GY	2	10	8	1/2	3.3
Hardware Kit (for mounting Receiver-Transmitter)	1	5	4	1/2	0.2
Hardware Kit (for mounting Dynamotor-Power Supply)	1	5	4	1	0.5
Insulator IN-127-GY	1	14	3	3	17.2
Key J-45-GY	1	6	4 1/2	1 1/2	1.2
Leg LG-2-B-GY	1	30	6	2	3.5
Leg LG-3-B-GY	2	24	3	1	1.0
Loudspeaker LS-7-GY	1	7	5	3	3.1
Mast Base MP-65-A-GY	1	18	3 1/2	3 1/2	3.3
Mast Section MS-116-A-GY	6	40	—	—	2.1
Mast Section MS-117-A-GY	2	40	—	—	0.4
Mast Section MS-118-A-GY	2	40	—	—	0.3
Mounting MT-350/GRC-9-GY	1	16	12	1 1/2	4.4
Receiver-Transmitter RT-77/GRC-9-GY (complete)	1	16	12	8	33.0
Reel RL-28-GY (for Guys)	1	6 1/2	3	1/4	0.2
Reel RL-29-GY (for Antennas and Counterpoise)	3	12	8	1 1/2	0.8
Roll-BG-174-GY (Antenna sections)	1	43	14	5	5.8
Stake GP-27-B-GY	4	8	1/2	—	0.3
Wire W-128-GY	10 ft	—	—	—	0.7
Total Net Weight	—	—	—	—	151.8

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

7. Assembly Description of

Receiver-Transmitter RT-77/GRC-9-GY

a. The receiver-transmitter (fig. 10) consists of a complete separate receiver unit and a complete individual transmitter unit. The units are mounted in a metal case having a tight fitting metal cover which is removed for operation of the set.

b. This Panel Cover CW-109/GRC-9-GY has a rubber seal around its edge to prevent water from entering the set. When the cover is installed on the metal case, the entire assembly will float. To remove the cover, pull up gently on the metal clamps arranged along the sides (fig. 11).

Caution. Be sure to release the clamps in the manner shown in figure 11. Injury may result if the thumb is struck by the clamp as it is released. Hold the clamp firmly and pull up gently.

c. When the cover is completely removed from the case, the individual receiver and transmitter sections may be lifted partly out of the case. To prevent the possibility of these units falling out of the case, reset the clamps on the small projections on the receiver and transmitter front panels (fig. 12). The same precaution must be observed in unhooking the clamps from this position, as when the front cover was on.

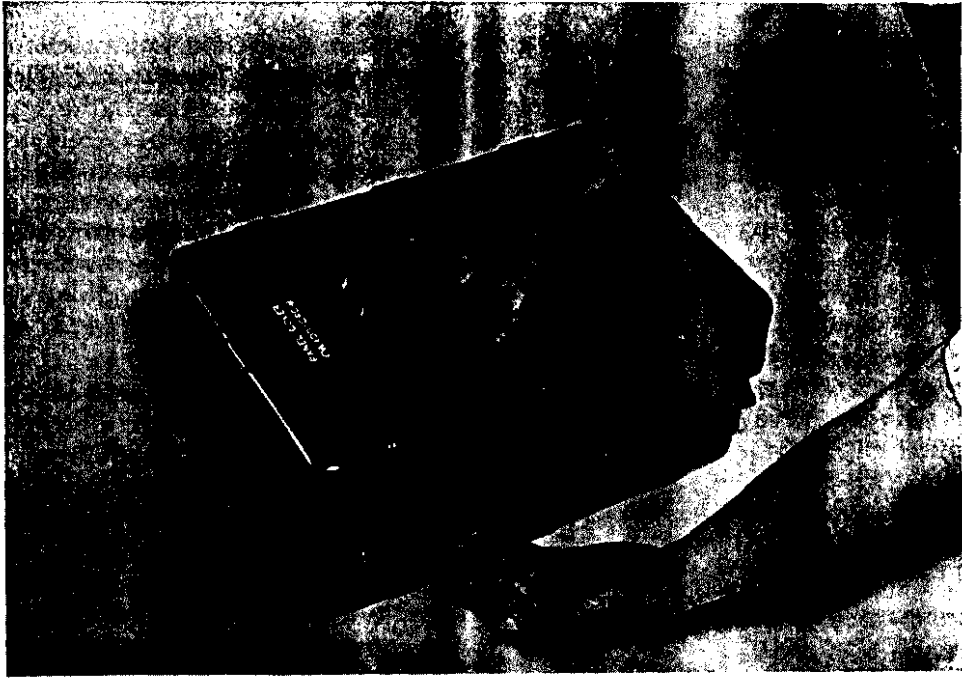


Figure 11. Removing front cover of receiver-transmitter RT-77/GRC-9-GY.

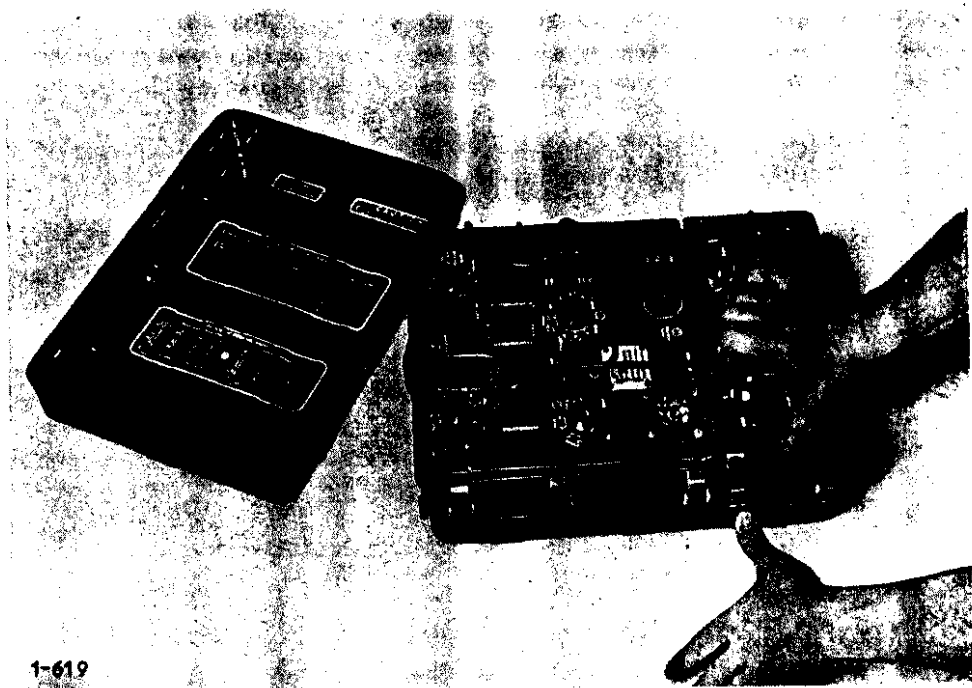


Figure 12. Resetting the clamps on the panels of receiver-transmitter RT-77/GRC-9-GY.

d. The individual units are physically and electrically divided into separate sections and are connected together electrically by a separate interconnecting cable assembly (3E7173-22-GY); the two ends plug into individual sockets on the transmitter and the receiver (fig. 39). All jacks and controls, except one, are located on the front panel. The one control in the rear of the receiver is the switch that accommodates the receiver output circuit to the different loud-speaker and headphone impedances (fig. 39).

e. All jacks, controls, and switches are waterproofed for complete protection of the radio set when operating under extremely humid conditions. The entire assembly is mounted in Bag CW-140/GRC-9-GY, which is a canvas bag used to provide additional carrying space when operating or transporting the radio set.

8. Receiver Section of Receiver-Transmitter RT-77/GRC-9-GY

(fig. 13)

a. The receiver is designed to receive a-m signals in the frequency range of 2 mc to 12 mc in three distinct bands.

b. The front panel of the receiver contains the controls necessary for its operation and is protected by an open grillwork. There are two phone jacks allowing two Headsets HS-30 to be used simultaneously. The jacks have covers

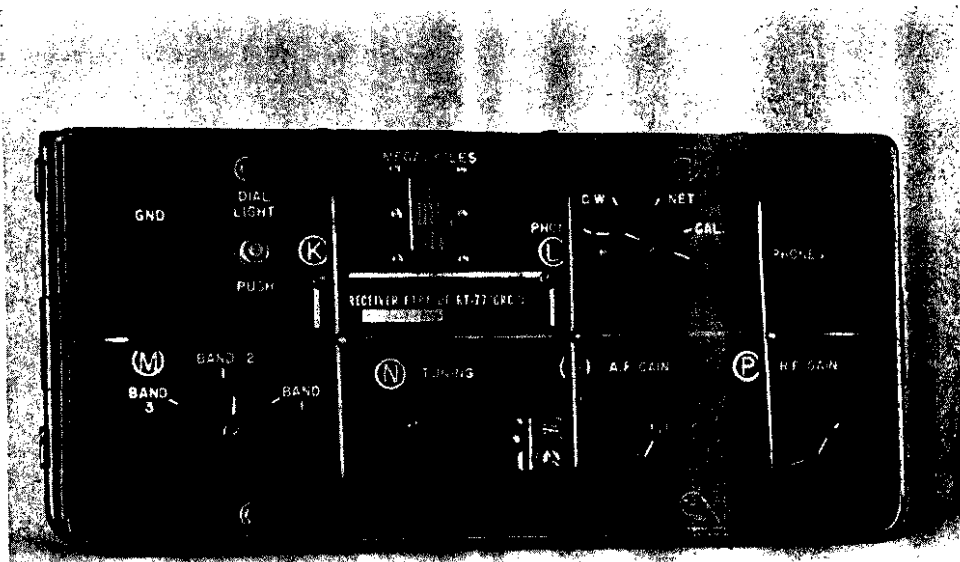
which are held tightly over the jack openings by springs. These covers protect the jacks from dirt and moisture. In the upper left-hand corner of the panel is the GND. (ground) connecting post for the lead from the counterpoise which is used when a vertical antenna is used. The TUNING knob, control N, has a device incorporated on the panel by which it may be locked at any desired dial position. The dial is shown unlocked in figure 13. To lock it, push the metal lever down.

c. Some knobs, such as those on controls M, O, P, have a white line on only one side of their centers. The knob on control L, however, has a white line on both sides of its center. Knobs having two white lines indicate that the control can be rotated in either direction continuously without having to stop. Knobs with one white line cannot be turned continuously in one direction, but upon reaching the stop position, they must be rotated back in the opposite direction. A knob with one white line must never be forced beyond the stop position or it will break.

9. Transmitter Section of Receiver-Transmitter RT-77/GRC-9-GY

(fig. 14)

a. On the front panel are located all the controls necessary for the operation of the trans-



3-3717

Figure 13. Receiver section of receiver-transmitter RT-77/GRC-9-GY.

white chart, marked CRYSTALS, on which should be marked in pencil, the frequency ranges of transmission obtained with the different crystals.

10. Dynamotor-Power Supply DY-88/GRC-9-GY

(fig. 15)

a. Dynamotor-Power Supply DY-88/GRC-9-GY is a vehicular operational component capable of supplying all voltages required for Receiver-Transmitter RT-77/GRC-9-GY. It consists of two sections, a dynamotor section to supply power to the transmitter and a vibrator section to supply power to the receiver and portions of the transmitter. Input voltage to the power supply may be 6, 12, or 24 volts, with the negative (—) grounded. A switch control (H206) provided behind the front panel allows the operator to change all internal connections simultaneously to correspond with the voltage of the vehicular battery (fig. 111).

b. A window on the front panel permits observation of a drum which indicates the voltage for which the switch control is set. The

case of the unit is immersionproof. It is corrugated for greater strength, for cooling, and for protection from warping or damage caused by vibration and shock. The entire unit is supported on four shock mounts through which bolts can be passed to secure it to the vehicle.

c. The power supply output receptacle is located on the lower left corner of the front panel. The contacts of the receptacle are arranged in a definite pattern so that the cable plug which fits into it will be in the correct position. A heavy rubber cable is used to connect the vehicular battery to the power supply.

11. Generator GN-58-A-GY

(fig. 16)

Generator GN-58-A-GY is a hand-operated unit designed to supply power to Receiver-Transmitter RT-77/GRC-9-GY when a vehicular battery is not available, as in portable field use. When using the generator, the transmitter output is not as great as when the dynamotor is used (par. 4a). The generator stands upright on

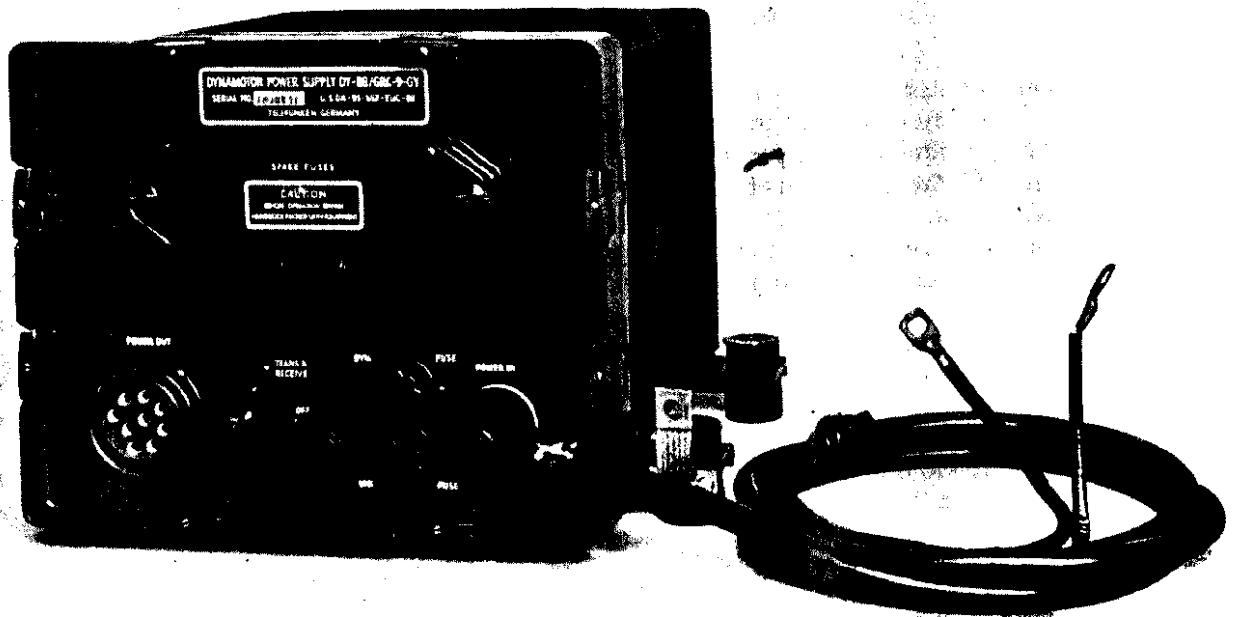
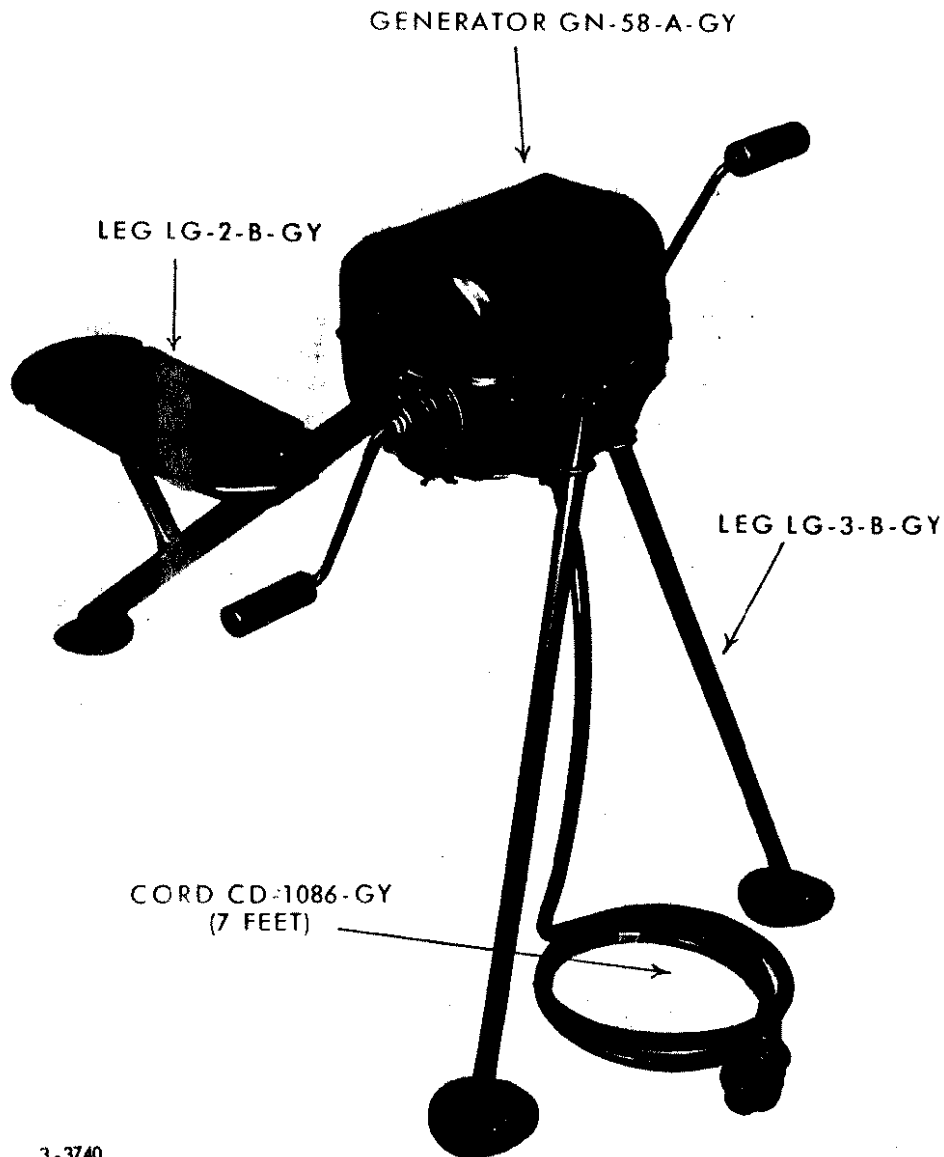


Figure 15. Dynamotor-Power Supply DY-88/GRC-9-GY.



3-3740

Figure 16. Generator GN-58-A-GY, set up for operation.

three removable legs and a folding seat is fastened to one of the legs. Hand cranks are inserted into holes on each side of the unit. A power outlet is located in the bottom of the generator. The complete unit is shown set up in figure 16. A model of Generator GN-58-A-GY is shown with the bag in which it is trans-

ported in figure 4. The clamps shown along the sides of the generator in this illustration are not to be opened for normal operation but only when repairs or adjustments are necessary. The accessories, such as legs and cranks, are carried in the antenna equipment roll, Roll BG-174-GY.

12. Antenna Components

a. **ANTENNA AT-101/GRC-9-GY.** Antenna AT-101/GRC-9-GY is a straight stranded copper wire, 107½ feet long, sectionalized by means of eight ceramic insulators and sets of jumpers. It may be adjusted to any required frequency between the ranges of 4,300 and 12,000 kc by opening and closing these jumpers as indicated on the calibration chart attached (fig. 31).

b. **ANTENNA AT-102/GRC-9-GY.** Antenna AT-102/GRC-9-GY is a similar type of antenna which is sectionalized by eight ceramic insulators and eight sets of jumpers. It is added to Antenna AT-101/GRC-9-GY so that the frequency range can be extended to cover the frequencies between 2,000 and 4,300 kc. Both Antenna AT-101/GRC-9-GY and Antenna AT-102/GRC-9-GY are supplied and, when not in use, are stored on Reels RL-29-GY. Halyards M-379-GY and M-378-GY are lengths of rope with an insulator at one end. They are used to secure the antenna between such supports as trees, buildings, or fence posts (fig. 32).

c. **VERTICAL WHIP ANTENNA.** The whip antenna consists of five sections of metal tubing, three Mast Sections MS-116-GY, one Mast Section MS-117-GY, and one Mast Section MS-118-GY. These sections are screwed together to form the whip antenna and can be used as a vehicular antenna or for portable field use. As a vehicular antenna, it is screwed into Mast Base MP-65-A-GY that is installed permanently on the vehicle and requires no further support (fig. 49). When used as a portable antenna, it fits into Insulator IN-127-GY that fastens to Bracket FT-515-GY which is secured to the case of Receiver-Transmitter RT-77/GRC-9-GY (fig. 37). The whip antenna is then further supported by the use of one Guy GY-12-GY and two Guys GY-42-GY that are secured to the ground by three Stakes GP-27-B-GY. Guys GY-12-GY and GY-42-GY are supplied and stored on Reel RL-28-GY. A short length cut form Wire W-128-GY connects the whip antenna mast to the post marked ANT. (antenna) on the transmitter panel (fig. 35).

d. **COUNTERPOISES CP-12-GY AND CP-13-GY** (fig. 17). When Receiver-Transmitter RT-77/GRC-9-GY is used as a portable unit with

the whip antenna, Counterpoises CP-12-GY and CP-13-GY are fitted together forming a radial network of eight wires and placed on the ground (fig. 35) beneath the whip antenna. They are used to act as a more efficient ground. Counterpoises CP-12-GY and CP-13-GY are supplied and stored together on Reel RL-29-GY. They are made up of heavy, flexible, rubber-covered wires. Figure 17 shows the connecting links.

e. **MAST BRACKET MP-50** (fig. 18). This is a heavy steel bracket which is used to mount Mast Base MP-65-A-GY on the rear of a vehicle (fig. 49).

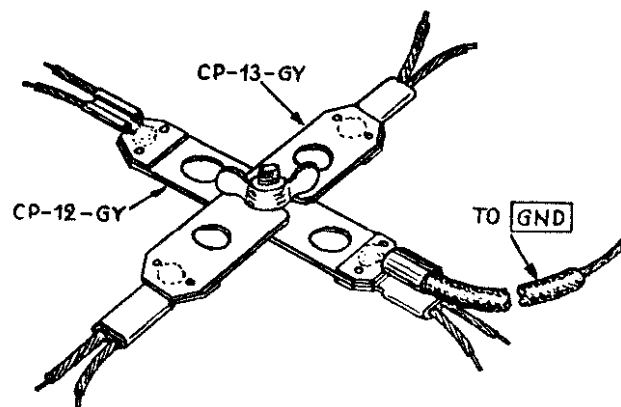


Figure 17. Counterpoises CP-12-GY and CP-13-GY

13. Microphone T-17 (fig. 19)

Microphone T-17 is of the single button, carbon granule type with a self-contained push button which is pressed when it is desired to transmit voice signals. The schematic diagram is shown in figure 20.

14. Microphone T-45 (figs. 21 and 22)

Microphone T-45 is held in front of the mouth by a harness which can be adjusted for comfort. The plug of Microphone T-45 connects to a corresponding receptacle on Cord CD-318-A. This cord leads to Switch SW-141 which is hung on the chest by means of a strap which fits around the neck. Then the cord emerges from the switch box and terminates in Plug PL-68

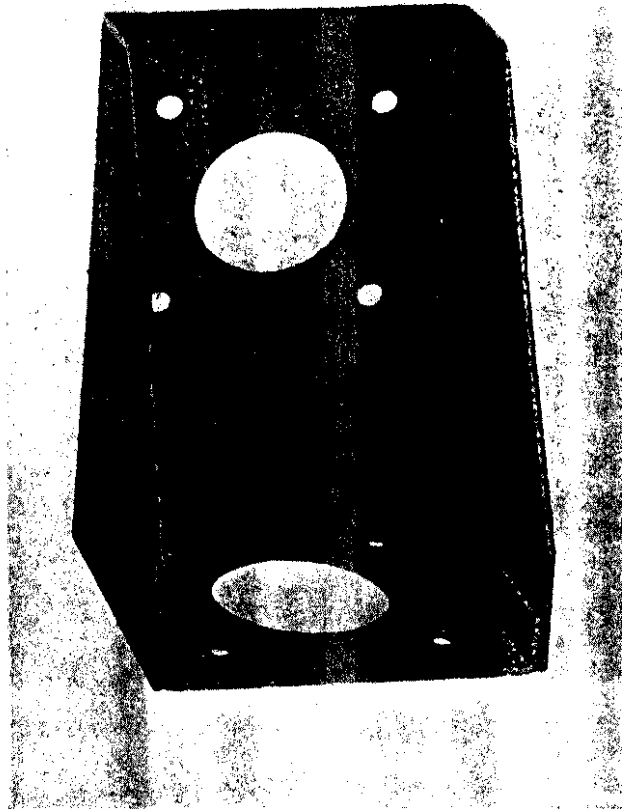


Figure 18. Mast bracket MP-50

which fits into the MIKE jack on the transmitter. Figure 22 shows Microphone T-45 in use.

15. Key J-45-GY

The key with all the important parts listed is shown in figure 23. The unit is designed to

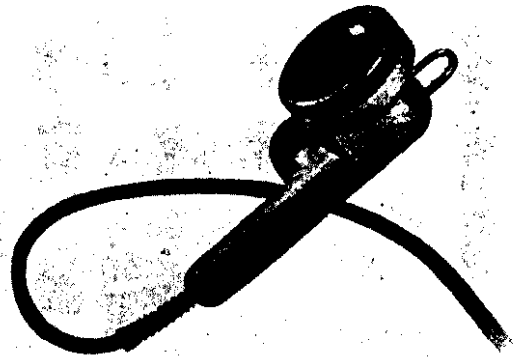


Figure 19. Hand microphone T-17.

be placed on the operator's leg by means of the metal bands attached. Plug PL-55, which is attached to the end of the cord connected to the key terminals, fits into the jack marked KEY on the transmitter panel.

16. Headset HS-30-(*)

The headset is shown in figure 24. Each earplug can slide partly up and down on the metal headband to adjust to the wearer's comfort. Figure 25 shows the unit in use. The earphones are of the magnetic type.

17. Loudspeaker LS-7-GY

This is a dynamic speaker of the permanent magnet type with a 4-inch cone. A self-contained matching transformer enables it to be connected to loads of 4,000 ohms output im-

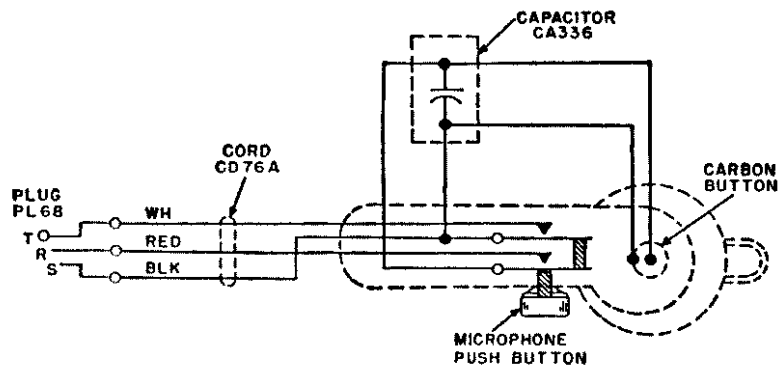


Figure 20. Internal schematic diagram of hand microphone T-17.

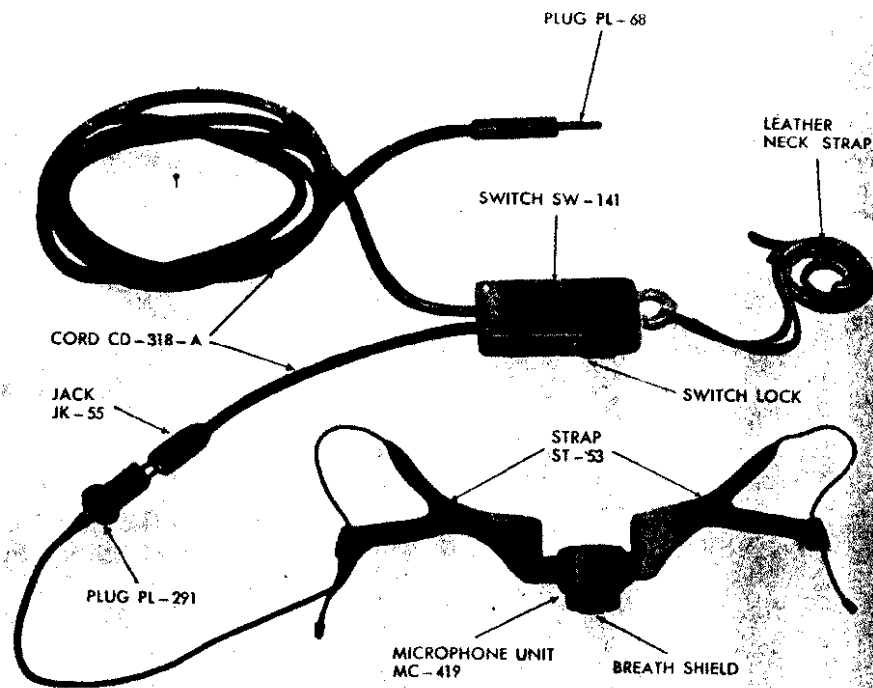


Figure 21. Microphone T-45 and cord CD-318-A.

pedance. The unit is connected to the receiver through either of the jacks marked PHONES on the receiver panel; the impedance-matching control on the back of the receiver must be switched to the 4,000-ohm position.

18. Power Cords

a. CORD CD-1119-GY (fig. 26). Cord CD-1119-GY is 34½ inches long.

This four-conductor cable is terminated at one end by a four-prong female receptacle for connection to the four-prong plug marked BATTERY on the transmitter panel. On the other end, a four-prong male battery plug is attached for connection to Battery BA-48.

b. POWER CORDS CD-1086-GY (fig. 27). Two main power cords are supplied, Cord CD-1086-GY (44 inches long) and Cord CD-1086-GY

(7 feet long). Cords CD-1086-GY are eight-conductor cables shielded with neoprene outer jackets. Cables are terminated at one end with one male, and, at the other end, one female nine-contact plug. Cords CD-1086-GY are used to supply power from either Dynamotor-Power Supply DY-88/GRC-9-GY or Generator GN-58-A-GY to Receiver-Transmitter RT-77/GRC-9-GY. The female connector plugs into the male receptacle marked POWER on the transmitter panel.

19. Running Spares

A group of running spares is supplied with each Radio Set AN/GRC-9-GY and is stored in the compartments of Case: Box BX-53-GY, Roll BG-174-GY, and in Dynamotor-Power Supply DY-88/GRC-9-GY. Spares are provided for all normally expendable items such as tubes, pilot



Figure 22. Microphone T-45 in use.

lamps, neon bulbs, and whip antenna sections. Extra vibrators, ballast tubes, fuses and brush sets for Dynamotor-Power Supply DY-88/GRC-9-GY are contained within its case. For Generator GN-58-A-GY brush sets are also provided. For a list of running spares, see paragraph 5.

20. Additional Equipment Required

The following equipment is not supplied as part of Radio Set AN/GRC-9-GY but may be required for use in the radio set.

a. Battery BA-48, for the operation of the receiver only.

b. Vehicular storage battery, either 6, 12, or 24 volts.

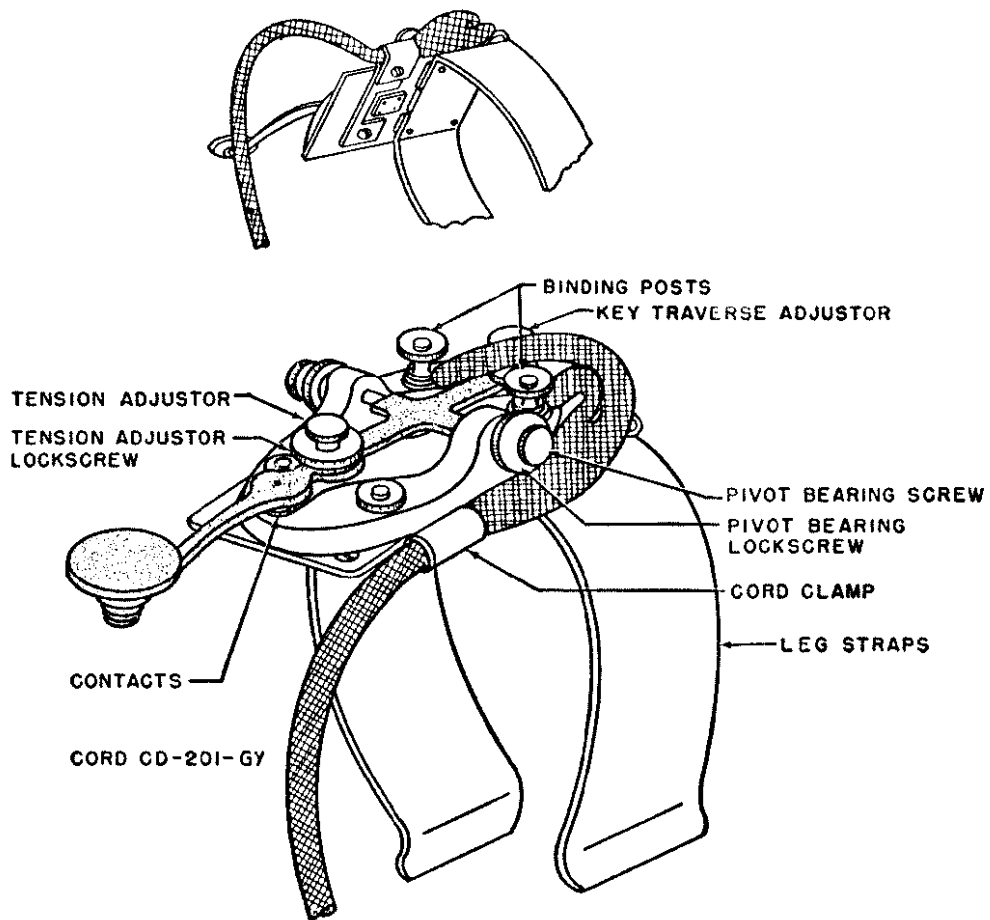


Figure 23. Key J-45-GY.

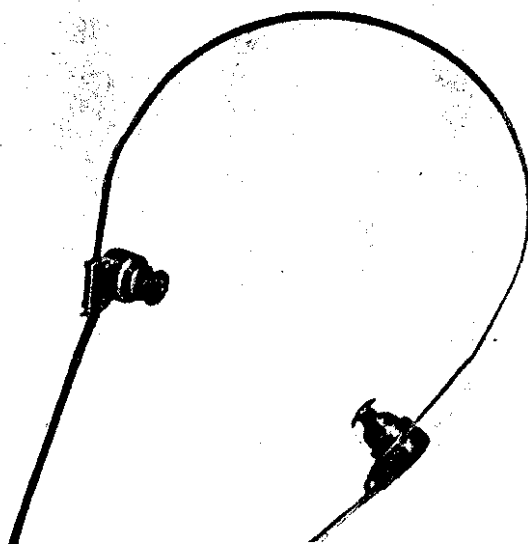


Figure 24. Headset HS-30-(*).

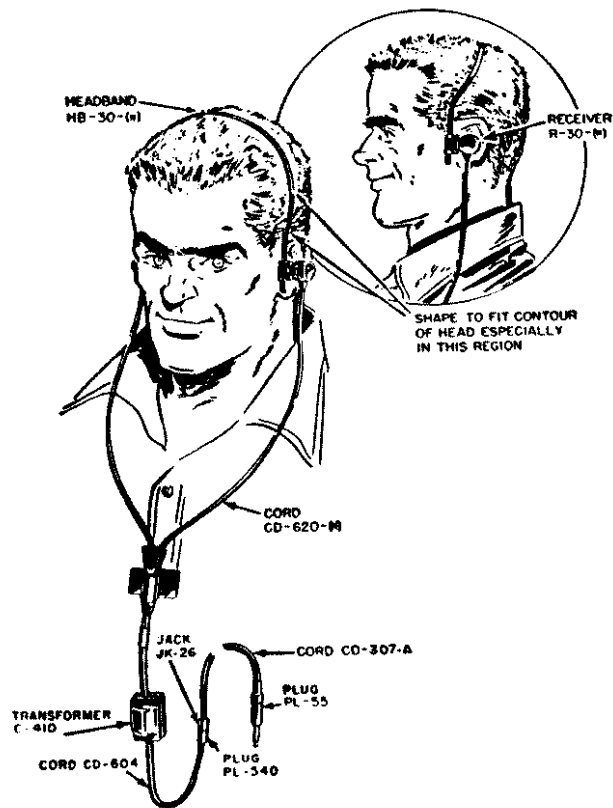


Figure 25. Headset HS-30(*) in use.

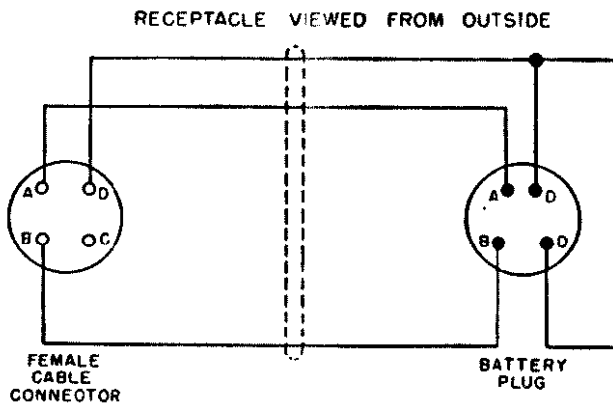


Figure 26. Cord CD-1119-GY, internal wiring.

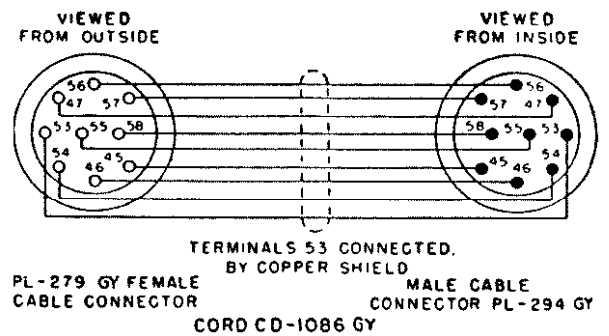


Figure 27. Cord CD-1086-GY, internal wiring.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF RADIO Set AN/GRC-9-GY

21. Siting

(fig. 28)

a. One of the most important factors to assure satisfactory transmission and reception of radio signals is the location of the antenna. The transmitter and receiver will have a greater range if the antenna is located in a position which is high and clear of hills, buildings, cliffs, densely wooded areas, and other obstructions. Dips, depressions, valleys, and low places are poor for radio transmission and reception because the surrounding high terrain tends to impede the r-f energy. Weak signals may be expected if the radio set is operated close to steel bridges, underpasses, or near power lines or power circuits (fig. 28).

b. The most desirable location for transmission and reception are hilltops, elevations, and slight rises of ground. Flat terrain also is good. As a general rule, transmission is better over water than over land. When selecting a flat site, remember that a tall object must be available for fastening the antenna if the straight-wire or doublet antenna is used. When the vertical mast is used, provisions are made on the receiver-transmitter to fasten the antenna by means of a mast antenna mounting.

Note. The whip antenna will require a circle of flat ground approximately 30 feet in diameter, and the supports for the straight-wire antenna should be spaced approximately 265 feet apart. The ground under the whip or vertical antenna must be free of rock so that stakes can be driven to support the guy wires for the antenna.

c. Maximum range can be expected when operating on top of a hill or knoll. Do not operate the radio set in a valley unless short distance ranges are to be expected or unless it is necessary.

22. Uncrating, Unpacking, and Checking New Equipment

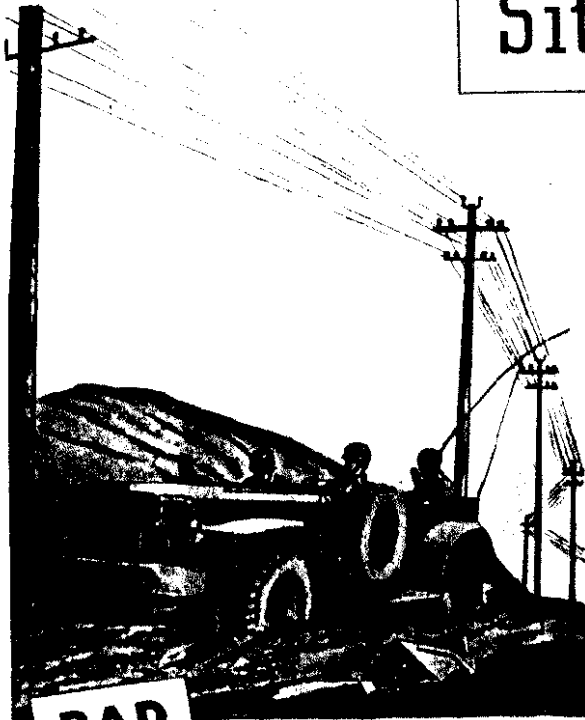
a. GENERAL. The following instruction corresponds with commercial packaging as shown in fig. 29 and 30. When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the permanent or semipermanent installation of the equipment. Paragraph 5 b lists the contents of all carrying bags and should be used for checking to make sure that all components are present and the equipment is undamaged. No special unpacking and uncrating procedures are necessary for equipment shipped in the carrying bags.

Note. Be careful in uncrating, unpacking, and handling the equipment; it can easily be damaged. If it becomes damaged or if left exposed to the elements, the equipment might be rendered useless and a complete overhaul might be required.

b. STEP-BY-STEP INSTRUCTIONS FOR UNCRATING AND UNPACKING THE EQUIPMENT.

- (1) Place the packing case as near the operating position as convenient.
- (2) Cut and fold back the steel straps.
- (3) Remove the nails with a nailpuller. Remove the top of the packing case. Do not attempt to pry off the sides and top; the equipment may be damaged.
- (4) Remove the case liner.
- (5) Open the various cardboard cartons.
- (6) Inspect all equipment for possible damage during shipment.

Siting



BAD

HIGH TENSION LINES



BAD

STEEL BRIDGES



BAD

VALLEYS OR DEPRESSIONS



GOOD

HILLTOP OR FLAT TERRAIN

Figure 28. Siting

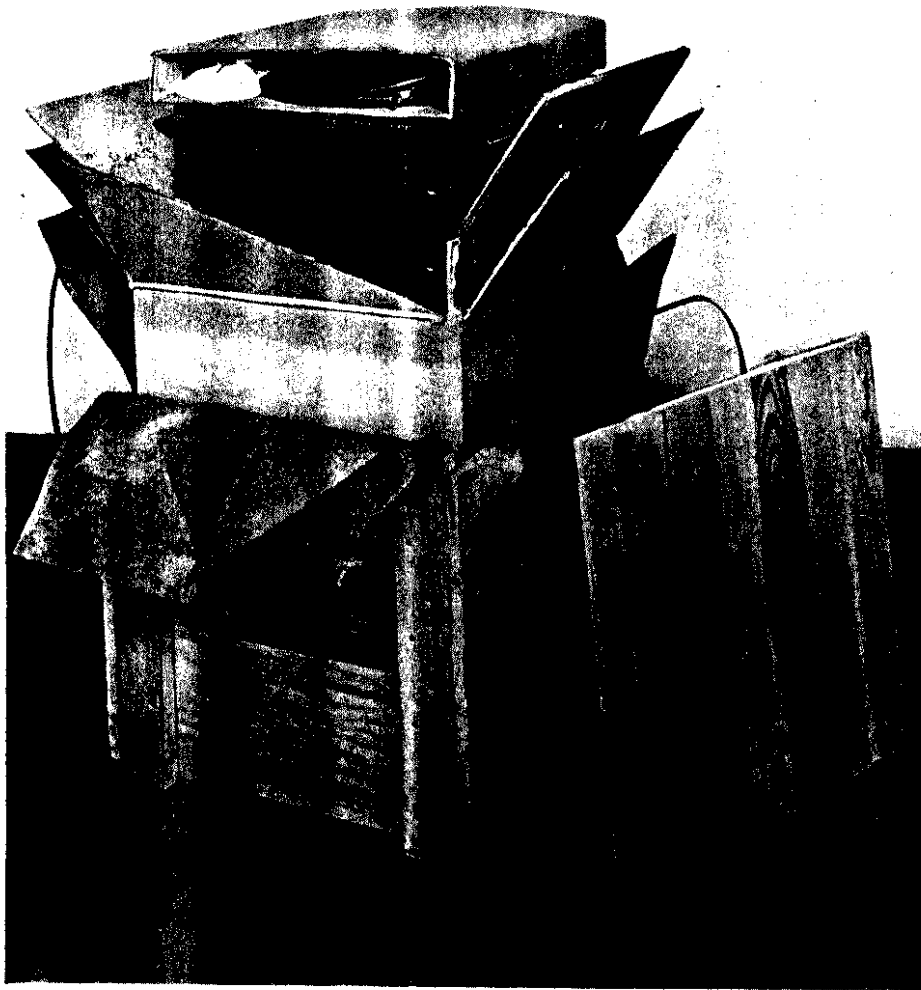


Figure 20. Method of packing typical component for overseas shipping.

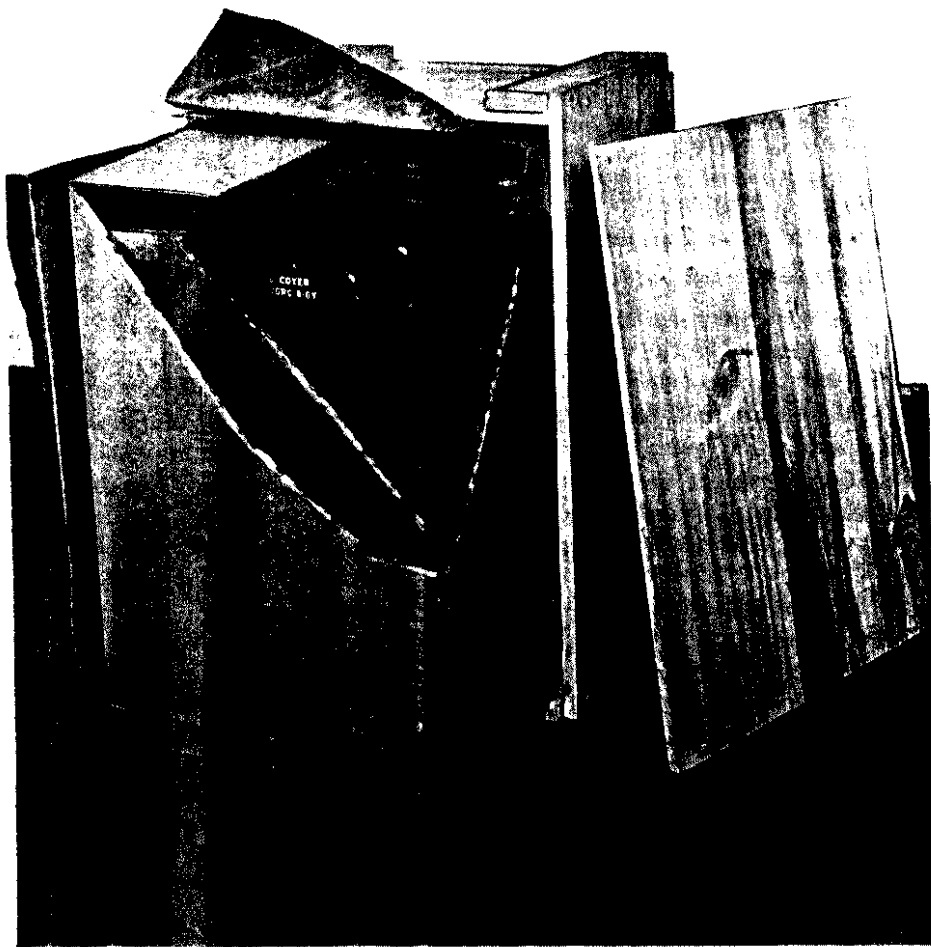


Figure 30. Typical packaging of radio set AN/GRC-9-GY components.

c. **CHECKING.** Check the contents against the master packing slips.

d. **UNPACKING DOMESTIC PACKING CASES.** Radio equipment may be received in domestic packing cases. The instructions given in b above apply also to unpacking domestic shipments. In general, follow the procedure below:

- (1) Cut the metal bands.
- (2) Open the cartons that protect the equipment; or, if heavy wrapping paper is used, remove it carefully and take out the components.
- (3) Check the contents of the packing case against the master packing slip.

Note. Save the original packing cases and containers for both export and domestic shipments. They can be used again when the equipment is repacked for storage or shipment.

23. Selection of Antenna Equipment for Field Operation

a. Most satisfactory performance will be obtained with the selection of the proper antenna, considering the advantages and the disadvantages of each of the three types available for Radio Set AN/GRC-9-GY.

- (1) When a permanent or semipermanent installation can be made, use the long-wire antenna. It will transmit farther and receive weak signals more satisfactorily than the whip antenna.
- (2) However, when the equipment must be moved rapidly and frequently from one location to another or is used as a vehicular installation (par. 32), use the vertical mast antenna.

b. The advantages of the vertical mast antenna are:—

- (1) It can be set up or taken down quickly.
- (2) It will permit satisfactory transmission and reception over short distances (up to approximately 25 miles).
- (3) The space required is small.
- (4) The presence of tall objects for support is not required.
- (5) It permits transmission equally well in all directions.
- (6) The antenna can be quickly tuned from one end of the frequency band to the other.

c. The principal disadvantage of the vertical mast antenna is that it is not highly efficient for distance in excess of 25 miles, as compared to the long-wire antenna.

d. The principal advantage of the long-wire antenna is its transmission efficiency. When properly installed, it will permit satisfactory transmission and reception over comparatively long distances.

e. The principal disadvantages of the long-wire antenna are—

- (1) It requires tall objects for support.
- (2) The antenna length must be changed if the frequency is to be shifted appreciably (more than 200 kc).
- (3) The direction of maximum transmission with respect to the orientation of the antenna will depend on the length of the antenna.

24. Installation of Long-wire Antenna

For installation of long-wire Antennas AT-101/GRC-9-GY and AT-102/GRC-9-GY, proceed as follows:

a. Select an open area where two upright supports for the antenna can be found, such as two trees. A minimum length of 250 feet is required to allow for the full length of the antenna at the low frequencies.

b. Making use of trees, buildings, or fence posts, erect the antenna as high as possible. In no case should the antenna be lower than 6 feet.

c. Connect Antenna AT-101/GRC-9-GY to its support by means of Halyard M-379-GY, as shown in figure 31. This length of antenna is shown with the calibration chart attached.

d. Connect the clip on Antenna AT-102/GRC-9-GY to the small ring on the free end of Antenna AT-101/GRC-9-GY and fasten the other

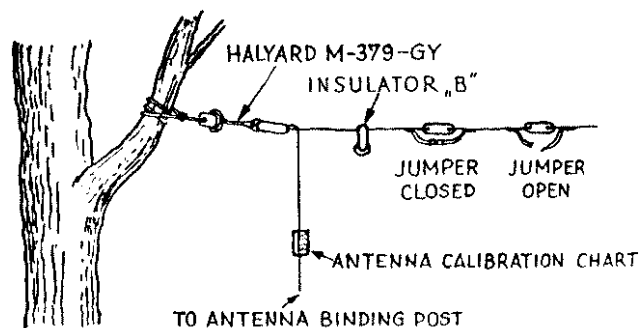


Figure 31. Antenna supports and connections.

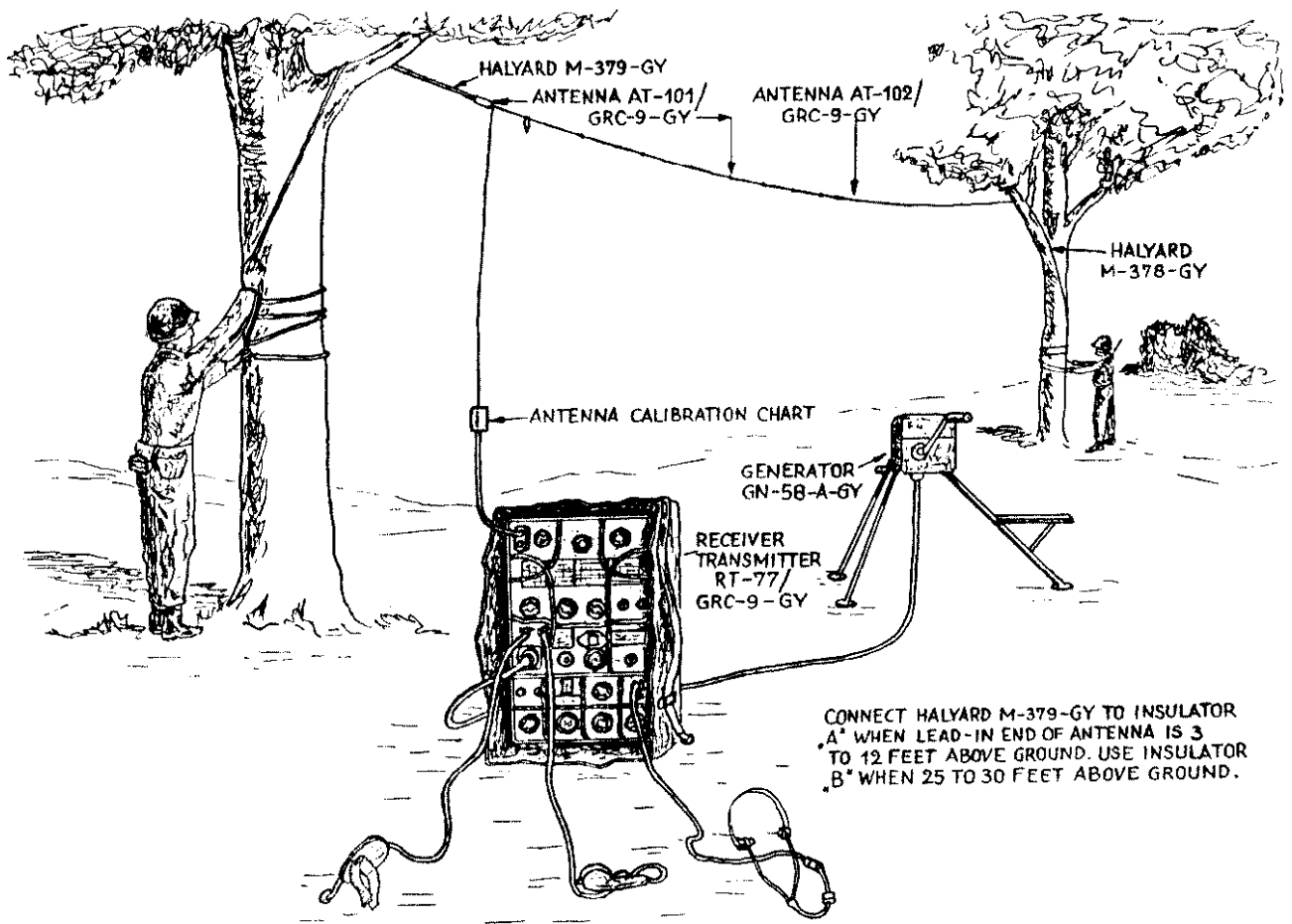


Figure 32. Installation of long-wire antennas AT-101/GRC-9-GY and AT-102/GRC-9-GY.

end of Antenna AT-102/GRC-9-GY to its support by Halyard M-378-GY. In figure 32, the entire installation of the long-wire antenna is shown.

e. Locate the radio set at any point that will not allow the lead-in to touch the ground or any other objects such as trees, buildings, or metal fences. Connect the lead-in from the calibra-

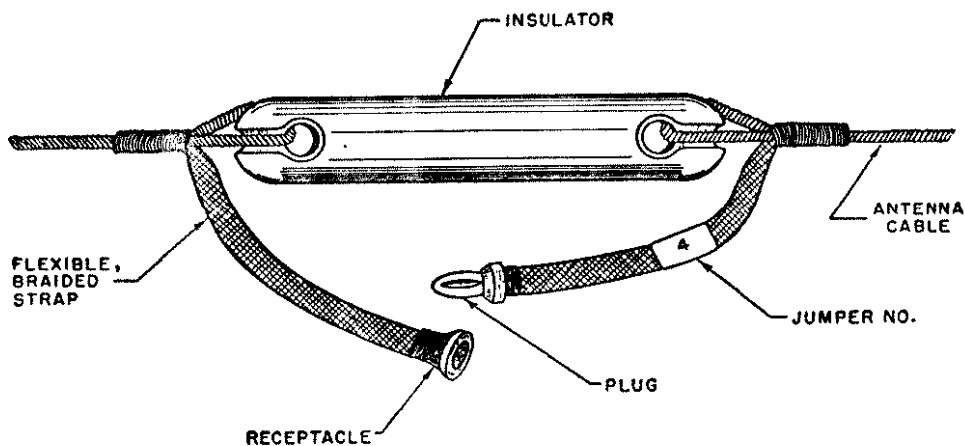


Figure 33. Typical antenna jumper.

tion chart end of the antenna to the ANT. binding post on the transmitter.

Note. Since the antenna length, for the best transmission and reception, is directly dependent on the frequency of the signal, it is necessary to adjust the antenna length to the frequency at which the transmitter is to be operated. Jumpers are placed on the antenna. The calibration chart, showing the length of the antenna required for the various frequencies, indicates which jumpers must be opened and closed for the frequencies. A typical jumper is shown in figure 33.

f. In case the antenna calibration chart should be lost or become illegible, it is reproduced here exactly as it looks (fig. 34). The

Transmitting frequency (kc)		Antenna length, including lead-in (ft)
From	To	
2,000	2,200	245.5
2,200	2,400	228.0
2,400	2,550	210.0
2,550	2,700	193.0
2,700	2,900	177.5
2,900	3,100	163.0
3,100	3,200	151.5
3,200	3,900	139.0
3,900	4,300	122.0
4,300	4,900	107.5
4,900	5,300	93.0
5,300	6,000	85.5
6,000	7,500	73.5
7,500	8,400	63.0
8,400	9,000	57.5
9,000	9,900	53.0
9,900	12,000	46.0

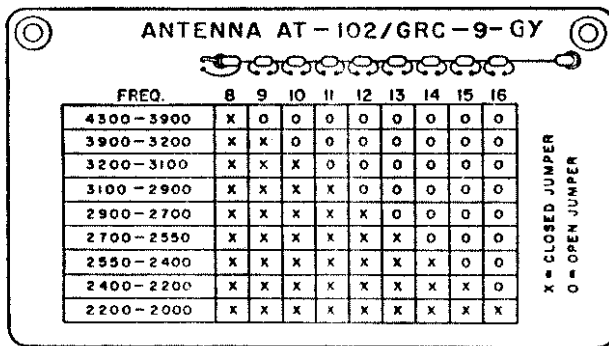
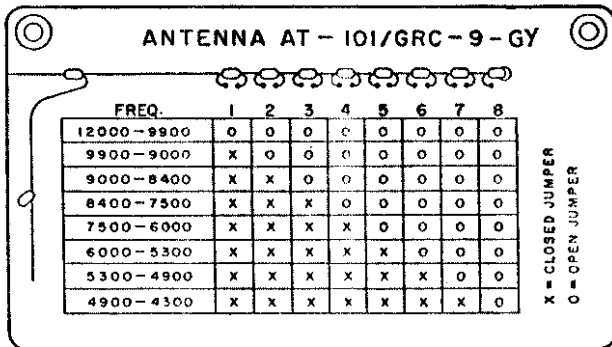


Figure 34. Antenna calibration chart.

number of antenna lengths to be closed in succession always should start at the lead-in end.

g. If the antenna should be lost or destroyed, another one can be made from any other stranded copper wire available. The following chart gives the correct lengths including the lead-in.

25. Installation of Whip Antenna

a. Place the radio set in an area free of large obstructions such as trees, buildings, and power lines.

b. Set up the counterpoise by placing link Counterpoise CP-13-GY on top of Counterpoise CP-12-GY and clamping them together by means of the wingnut attached (fig. 17).

c. Spread out the eight wires of Counterpoises CP-12-GY and CP-13-GY as far as they will reach radially, like the spokes of a wheel. To hold the counterpoises in place, drive Stake GP-27-B-GY through one of the holes in the connecting links. Connect the heavy lead on the bar of Counterpoise CP-12-GY to the GND. post on the receiver panel.

d. Extend the hinged supports on the side of the radio set case through the opening in the side of Bag CW-140/GRC-9-GY. Insert Insulator IN-127-GY in these supports.

e. Connect the binding post marked ANT. on the transmitter panel to the insulator binding post with a 12-inch length of Wire W-128-GY. Run the wire through the upper hinge slot in the bag.

f. Screw together three Mast Sections MS-116-A-GY, one Mast Section MS-117-A-GY, and one Mast Section MS-118-A-GY.

g. Close the clamp ring of Guy GY-42-GY and hook the end of Guy GY-12-GY through the holes in the collar clamps to keep the

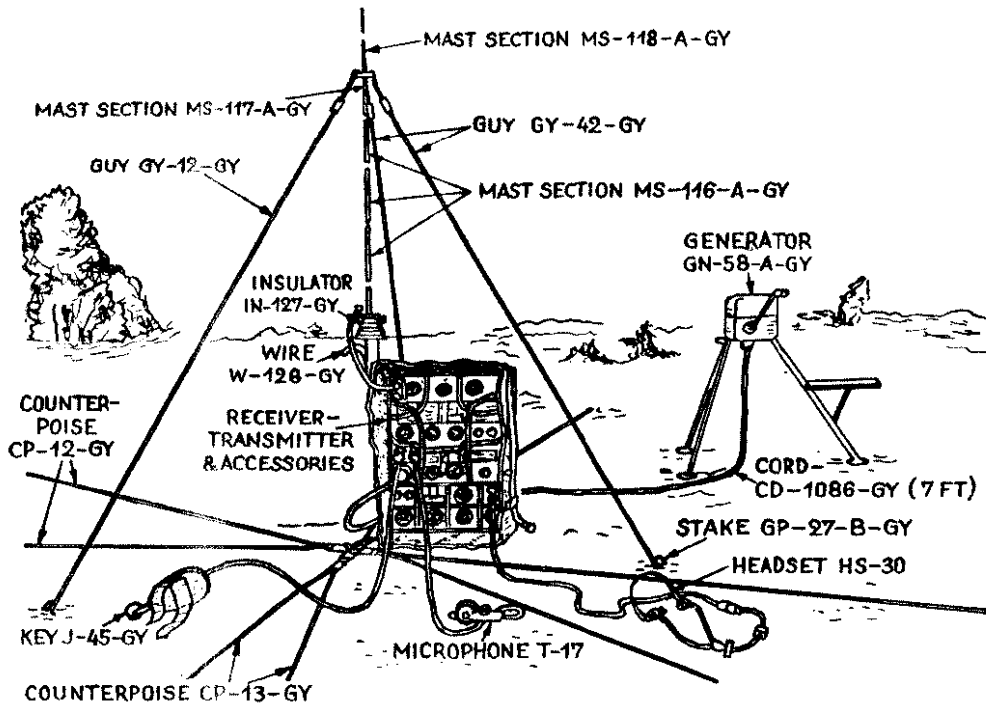


Figure 35. Radio set AN/GRC-9-GY set up for normal field use.

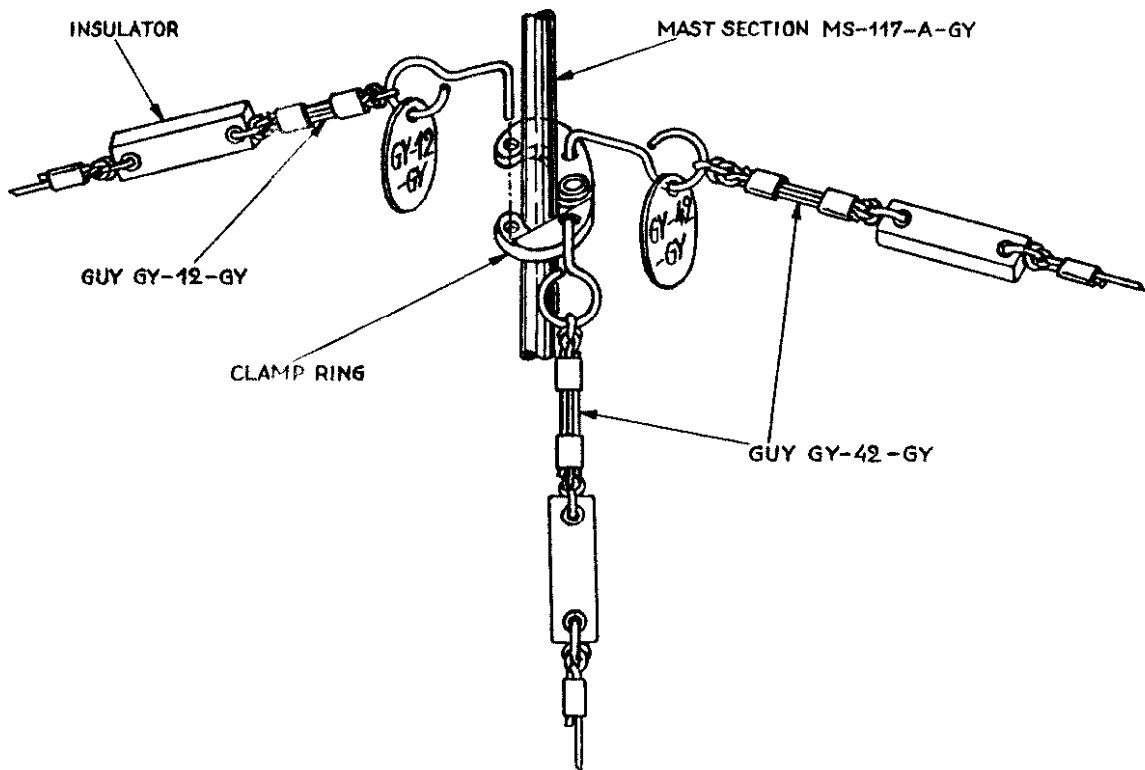
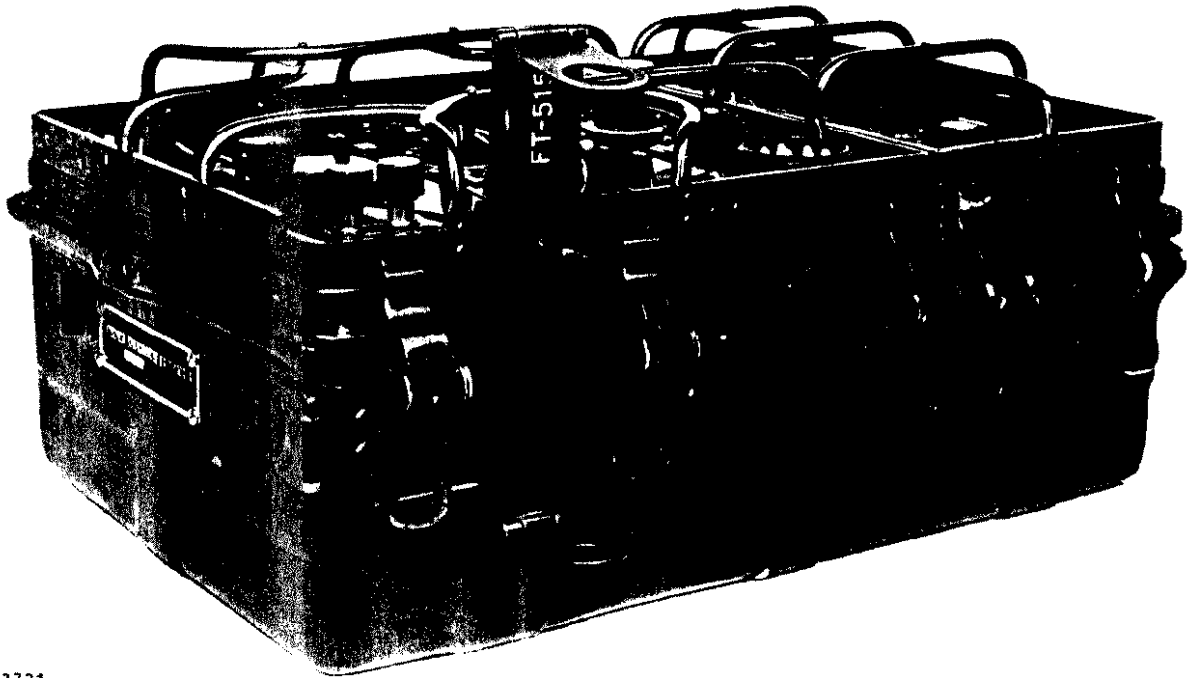


Figure 36. Clamp ring for connecting guy cords to vertical mast antenna.



3-3721

Figure 37. Application of bracket FT-515-GY.

clamps closed (fig. 36). Insert Mast Section MS-116-A-GY into Insulator IN-127-GY.

h. Slip Stakes GP-27-B-GY through the S hooks attached to the ends of the guy cords and drive the stakes into the ground at equally spaced points around the set to hold the mast erect (fig. 35).

26. Bracket FT-515-GY

If it is necessary to operate the radio set in a horizontal position, the antenna is mounted by means of Bracket FT-515-GY. This is shown in Figure 37.

27. Doublet Antenna

At times, the possibility arises that the radio set must be used as a semipermanent installa-

tion to hold communication with other sets located in a fixed direction from the first set. In this case, a doublet antenna is advised because of its greater directivity when operated as a half-wave radiator. The lead-in or feeder to the doublet antenna should be a 50- to 72-ohm transmission line, whose ends are attached to the ANT. and DOUBLET binding posts on the transmitter panel. It is cautioned that a doublet antenna must not be used unless the exact locations of the other radio stations are known, so that the antenna may be orientated for the maximum transmission in that direction. The correct orientation is shown in figure 38. The following table gives the antenna lengths necessary for maximum transmission efficiency over the frequency range of Radio Set AN/GRC-9-GY.

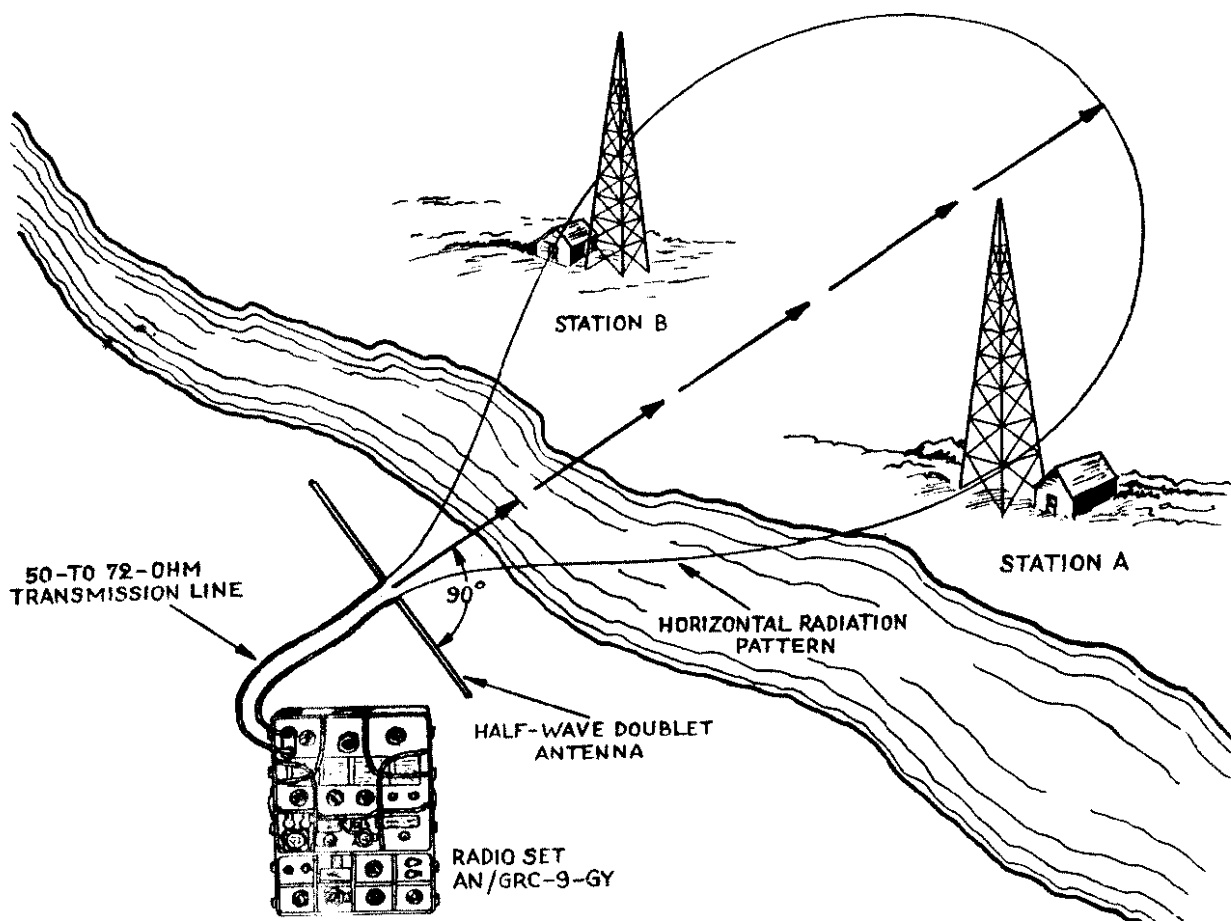
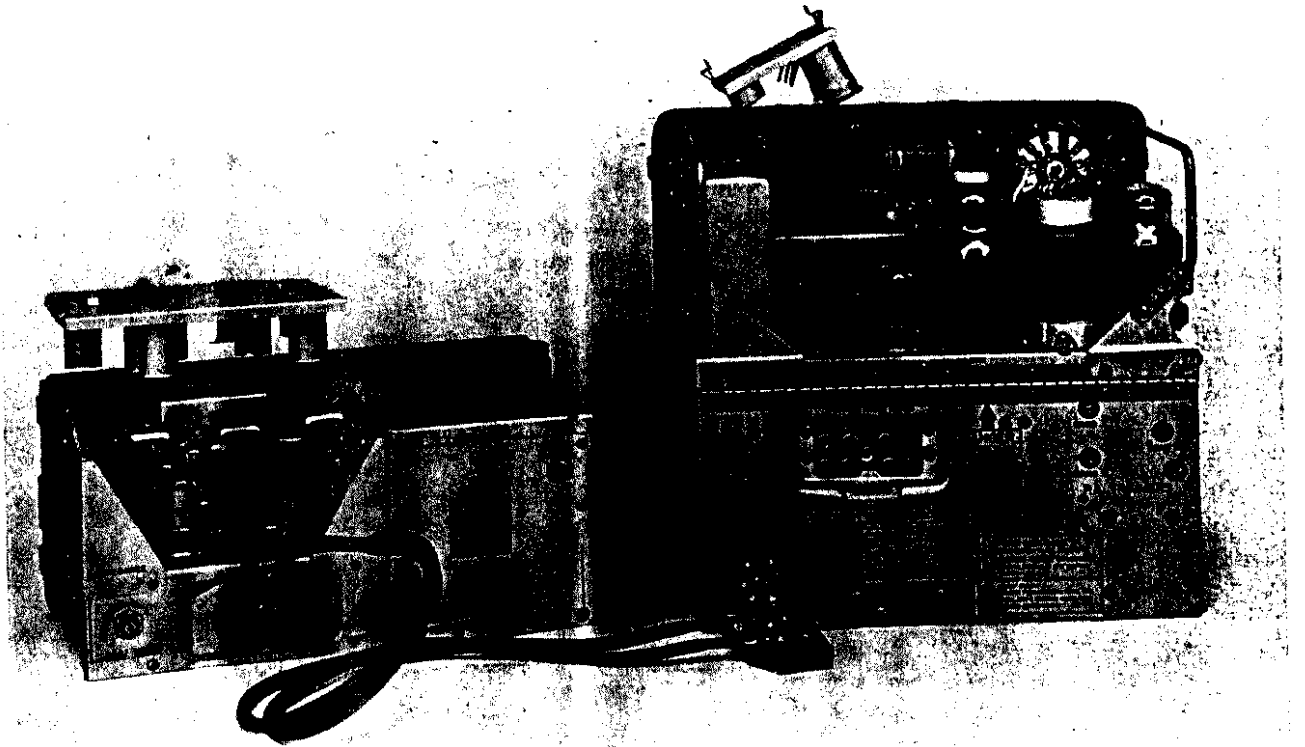


Figure 38. Orientation of a half-wave doublet antenna for maximum range.

Frequency range		Antenna "L" in feet $\frac{1}{4}$ wave (each side of feeders)	Feeders length	Frequency range	Antenna "L" in feet $\frac{1}{4}$ wave (each side of feeders)	Feeders length	
<i>From</i>	<i>To</i>						
2,000	2,200	116 ft 7 in.	95 ft 6 in.	4,725	4,850	50 ft 6 in.	42 ft
2,200	2,400	106 ft 6 in.	87 ft	4,850	5,000	49 ft	41 ft
2,400	2,575	98 ft	80 ft 6 in.	5,000	5,150	47 ft 6 in.	39 ft 6 in.
2,575	2,725	91 ft 10 in.	75 ft 6 in.	5,150	5,300	46 ft	38 ft 6 in.
2,725	2,875	86 ft 10 in.	71 ft 6 in.	5,300	5,450	44 ft 8 in.	37 ft 6 in.
2,875	3,025	82 ft 3 in.	68 ft	5,450	5,600	43 ft 3 in.	36 ft 6 in.
3,025	3,150	78 ft 7 in.	65 ft	5,600	5,750	42 ft	35 ft 6 in.
3,150	3,250	75 ft 10 in.	62 ft 6 in.	5,750	5,900	40 ft 11 in.	34 ft 6 in.
3,250	3,350	73 ft 6 in.	60 ft 6 in.	5,900	6,100	39 ft 8 in.	33 ft 6 in.
3,350	3,440	71 ft 7 in.	59 ft	6,100	6,300	38 ft 3 in.	32 ft 6 in.
3,440	3,520	69 ft 10 in.	57 ft 6 in.	6,300	6,500	37 ft	31 ft 6 in.
3,520	3,600	68 ft	56 ft 6 in.	6,500	6,900	35 ft 10 in.	30 ft 6 in.
3,600	3,725	66 ft	54 ft 6 in.	6,900	7,500	32 ft 10 in.	28 ft
3,725	3,850	63 ft 9 in.	53 ft	7,500	8,100	30 ft 2 in.	25 ft 6 in.
3,850	3,975	61 ft 8 in.	51 ft	8,100	8,700	28 ft	24 ft
3,975	4,100	59 ft 8 in.	49 ft 6 in.	8,700	9,300	26 ft	22 ft 6 in.
4,100	4,225	57 ft 10 in.	48 ft	9,300	9,900	24 ft 4 in.	21 ft
4,225	4,350	56 ft 3 in.	47 ft	9,900	10,500	23 ft	19 ft 6 in.
4,350	4,475	54 ft 9 in.	45 ft 6 in.	10,500	11,100	21 ft 10 in.	18 ft 6 in.
4,475	4,600	53 ft 3 in.	44 ft 6 in.	11,100	12,000	20 ft 3 in.	17 ft 6 in.
4,600	4,725	51 ft 9 in.	43 ft				



3-3734

Figure 39. Rear view of transmitter and receiver, and interconnecting cable assembly 3E7173-22-GY.

28. Installation of Receiver Tubes and Crystal

a. The receiver tubes and crystal are already installed when shipped. To inspect or replace them, proceed as follows: Remove the cover of Receiver-Transmitter RT-77/GRC-9-GY (par. 7b). Lift the receiver portion partially out of the case and remove the plug of cable assembly 3E7173-22-GY (fig. 39). The tubes and crystal are located beneath a single metal cover (fig. 39) which is removed without tools.

Caution. Remove this cover by releasing all four cover retaining springs and then lifting cover straight up without tilting it. This is necessary to avoid any damage which may occur if the tube shields on the cover are forced, pushing any tube which is in the receiver, thus causing the tube prongs to snap. Insert or replace tubes and crystal as necessary in accordance with the tube layout chart on the side of the receiver. The same information is found on the cover just removed.

b. There are seven tubes; each one will fit into its socket in only one position. Do not jam

the tube in the socket. Rotate the tube gently, until the tube prongs are lined up with their corresponding socket holes; then press the tube straight down into its socket.

Note. Do not mistake the transmitter tubes for receiver tubes. Some transmitter tubes look exactly like those used in the receiver.

c. There is only one crystal to be inserted. To remove the crystal, insert a screw driver between bias cell BT1 and capacitor C55 and gently pry the crystal upward, and, at the same time, pull it with the fingers. The dial light lamp may be removed by using the pilot lamp extractor contained in Case: Box BX-53-GY of carrying Bag BG-172-GY (fig. 40). Always remove the pilot lamp from the extractor by pulling on the glass bulb and not the brass bayonet pin base.

29. Installation of Transmitter Tubes and Crystals

a. The receiver tubes and crystals are already installed when shipped. To inspect or replace them proceed as follows: When opening the

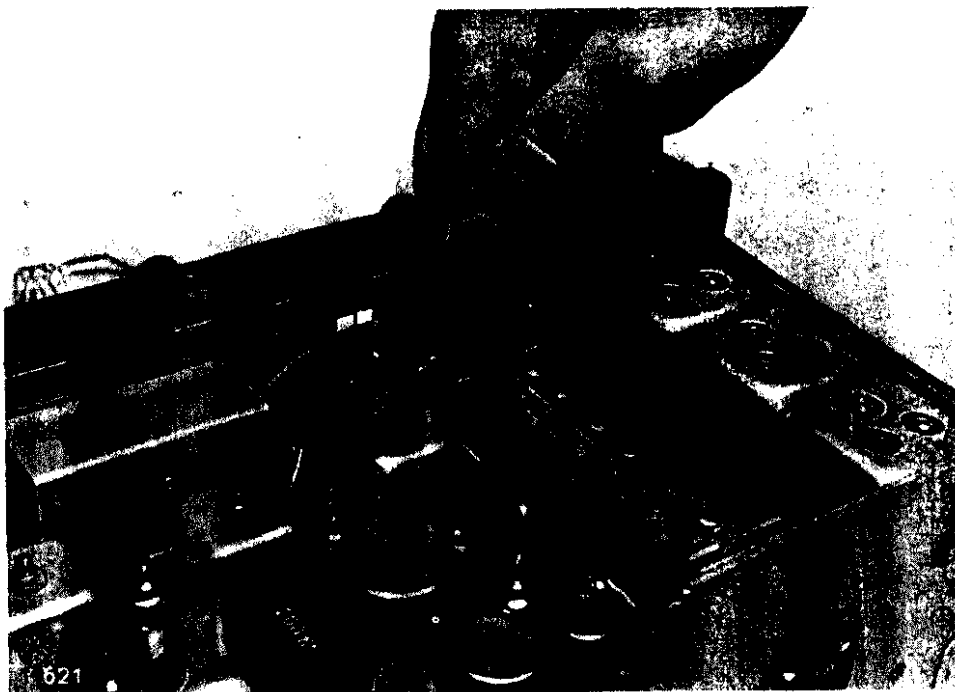


Figure 40. Removing pilot lamp.

transmitter, be sure that the power is shut off. Remove the receptacle of power Cord CD-1086-GY from the transmitter POWER receptacle. The power amplifier tube 2E22, V103, is easily accessible and may be removed by gently rocking it with a circular motion, pulling upward at the same time. Always remove the connection to the plate cap first. The voltage regulator tube OC3 (V104) can be removed by opening the safety clamp around the base of the tube. The clamp may be opened very easily by inserting a screw driver tip in the small slot on the clamping lever and by twisting the screw driver counterclockwise slowly. To tighten the clamp, twist the screw driver in a clockwise direction.

b. The remainder of the tubes and crystals are located under a small plate (fig. 39). The tubes are V101, V102, and V105 and the crystals are 1A, 1B, 2A, 2B, 3A, and 3B. The cover plate can be removed by releasing the spring catches at both ends of the plate and lifting straight upward. The tubes and crystals are then easily accessible. The tubes can be removed as shown in figure 41.

30. Installation of Generator GN-58-A-GY

The hand generator is used to supply power to the receiver-transmitter during field or

portable operation. The generator is carried in Bag BG-175-GY and the supporting legs are carried in antenna equipment Roll BG-174-GY. To prepare the generator for operation, refer to figure 16 and proceed as follows:

a. Insert two Legs LG-3-B-GY upward through the metal loops on the side of the generator which has the order number plate on it. Be sure that the flat metal retaining springs fit into the hollow insides of the legs.

b. Rest the generator on the two legs and slip the bottom of the attachment of Leg LG-2-B-GY into its retainer on the opposite face of the generator. Drop the metal loop over the top of the attachment on the leg.

c. Loosen the thumbscrew on the bottom plate covering the power cable socket and connect the male plug of Cord CD-1086-GY (7 feet) to the generator receptacle.

d. Loosen one screw on each of the cover plates for the handles, and swing the covers downward. On later models of the unit, the plates are forced open by a spring to expose the crank openings.

e. Insert Crank GC-7-GY into the sockets on the sides of the generator. The crank handles, when each is fully inserted, should be as far

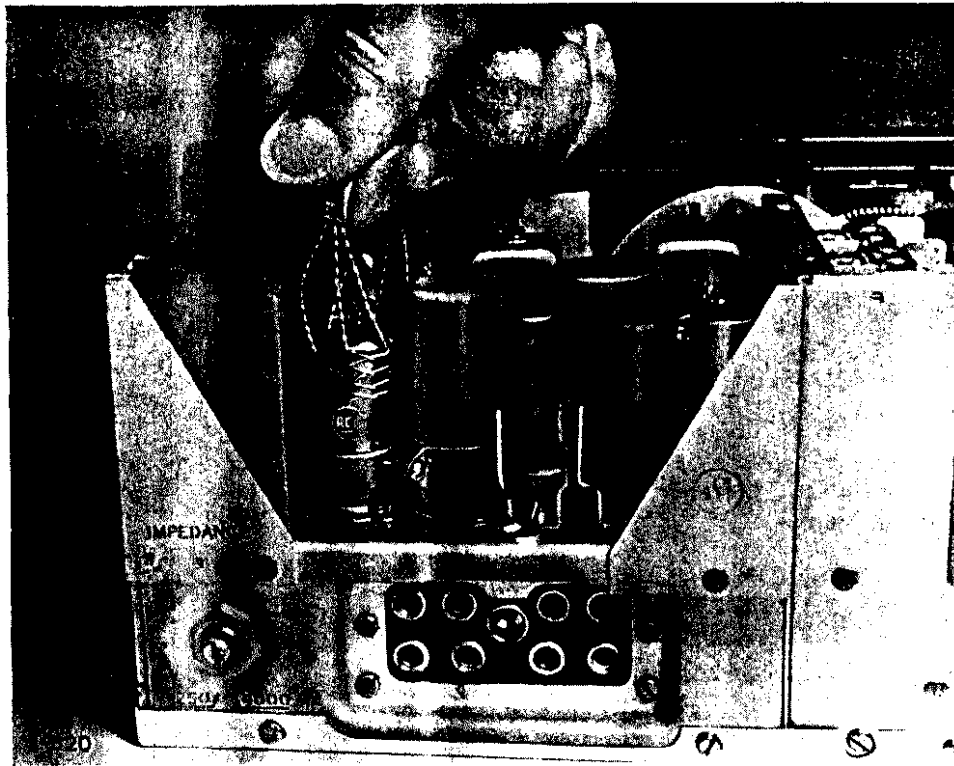


Figure 41. Removing tubes by means of tube extractor.

apart as possible. This means that if one handle is at its nearest point to the ground, the other handle should be at its highest point in the air (fig. 16).

31. Connections

a. INTERNAL CONNECTIONS. The separate transmitter and receiver sections are connected by cable assembly 3E7173-22-GY which is concealed by the front panels of the radio set. The cable is shown in figure 39. To replace the receiver and transmitter in the metal case, proceed as follows:

- (1) Place the empty case in a horizontal position with the open face upward and insert either plug of cable assembly 3E7173-22-GY through the opening in the left-hand corner of the separating partition.
- (2) Insert the connecting cord plug into the corresponding jack on the back of the receiver chassis and gently lower the receiver into the cabinet and fasten the clamps along the side in accordance with paragraph 7.
- (3) Next, place the cable in the small

bracket riveted to the back of the case. It is important that this be done to protect the cable from any damage which may occur if it is left to move about freely inside the case. This cable bracket is not found in some models of Receiver-Transmitter RT-77/GRC-9-GY.

- (4) Connect the remaining plug of the cable to the jack on the back of the transmitter chassis and lower the transmitter gently into the case.
- (5) Fasten the clamps on the side of the case to the transmitter panel.

b. EXTERNAL CONNECTIONS. Connect all operating components of Radio Set AN/GRC-9-GY in accordance with the cording diagram shown in figure 42 and the illustration in figure 43. Use the cords supplied with the radio set as follows:

- (1) Install Cord CD-1086-GY connecting one end to the POWER receptacle on the radio set and the other end to Generator GN-58-A-GY or Dynamotor-Power Supply DY-88/GRC-9-GY. When

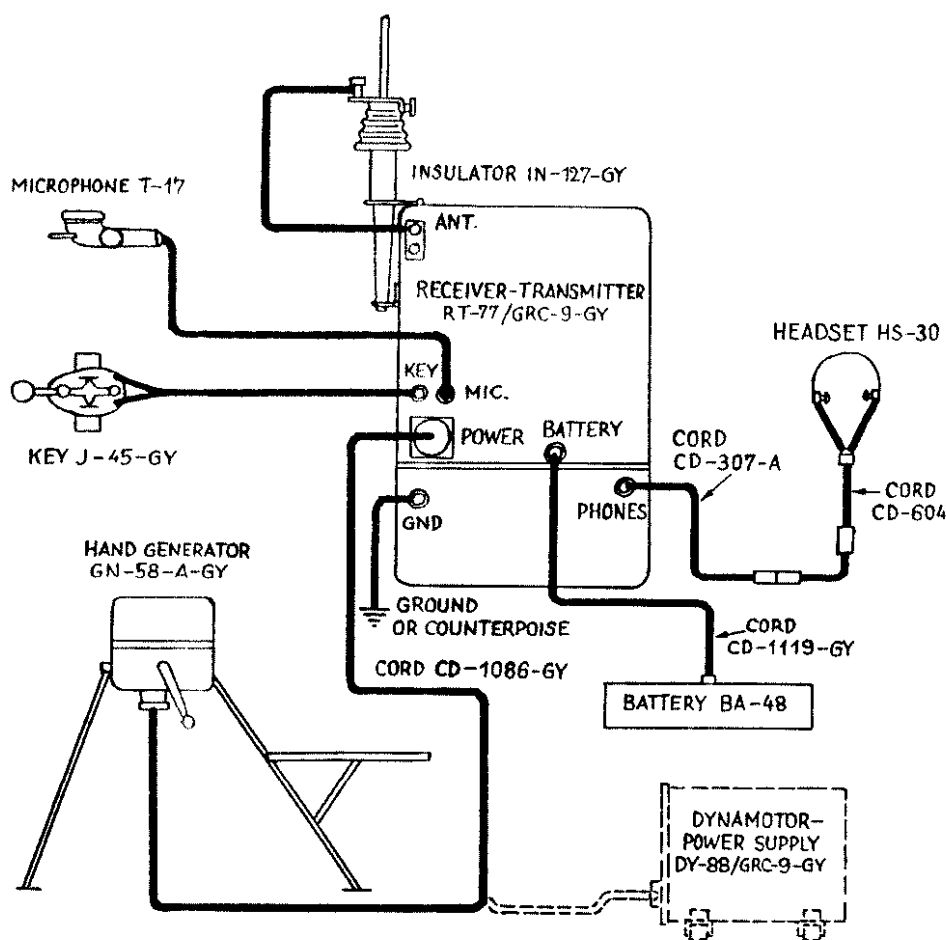


Figure 42. Radio set AN/GRC-9-GY, cording diagram.

using Generator GN-58-A-GY, use Cord CD-1086-GY (7 feet long). For Dynamotor-Power Supply DY-88/GRC-9-GY, install Cord CD-1086-GY (44 inch. long). These two cords are both marked Cord CD-1086-GY and are identical except for length.

Note. Dynamotor-Power Supply DY-88/GRC-9-GY is used in vehicular installations. Refer to paragraphs 32 through 35.

- (2) Insert Plug PL-55 of the headset into the PHONES jack on the receiver panel.
- (3) Insert Plug PL-55 of Key J-45-GY into the KEY jack of the transmitter if the key is to be used.
- (4) Insert Plug PL-68 of the microphone cord into the MIKE jack on the transmitter panel if the microphone is to be used.
- (5) Connect the antenna lead into the antenna binding posts on the transmitter

panel in accordance with paragraph 24, 25, or 27, whichever is appropriate.

- (6) When using Battery BA-48 for operating the receiver only, or when used in conjunction with Generator GN-58-A-GY, connect Cord CD-1119-GY into Battery BA-48 and to the BATTERY receptacle on the transmitter panel.

32. Vehicular Installation

(fig. 44)

a. Complete instructions for standard vehicular radio installations are given in technical manuals of the TM 11-2700 series. One manual of this series is normally published for every common type of vehicle requiring radio installations, and new sections are added as new radio requirements arise. Refer to SR 310-20-4 for the applicable manual of the series.

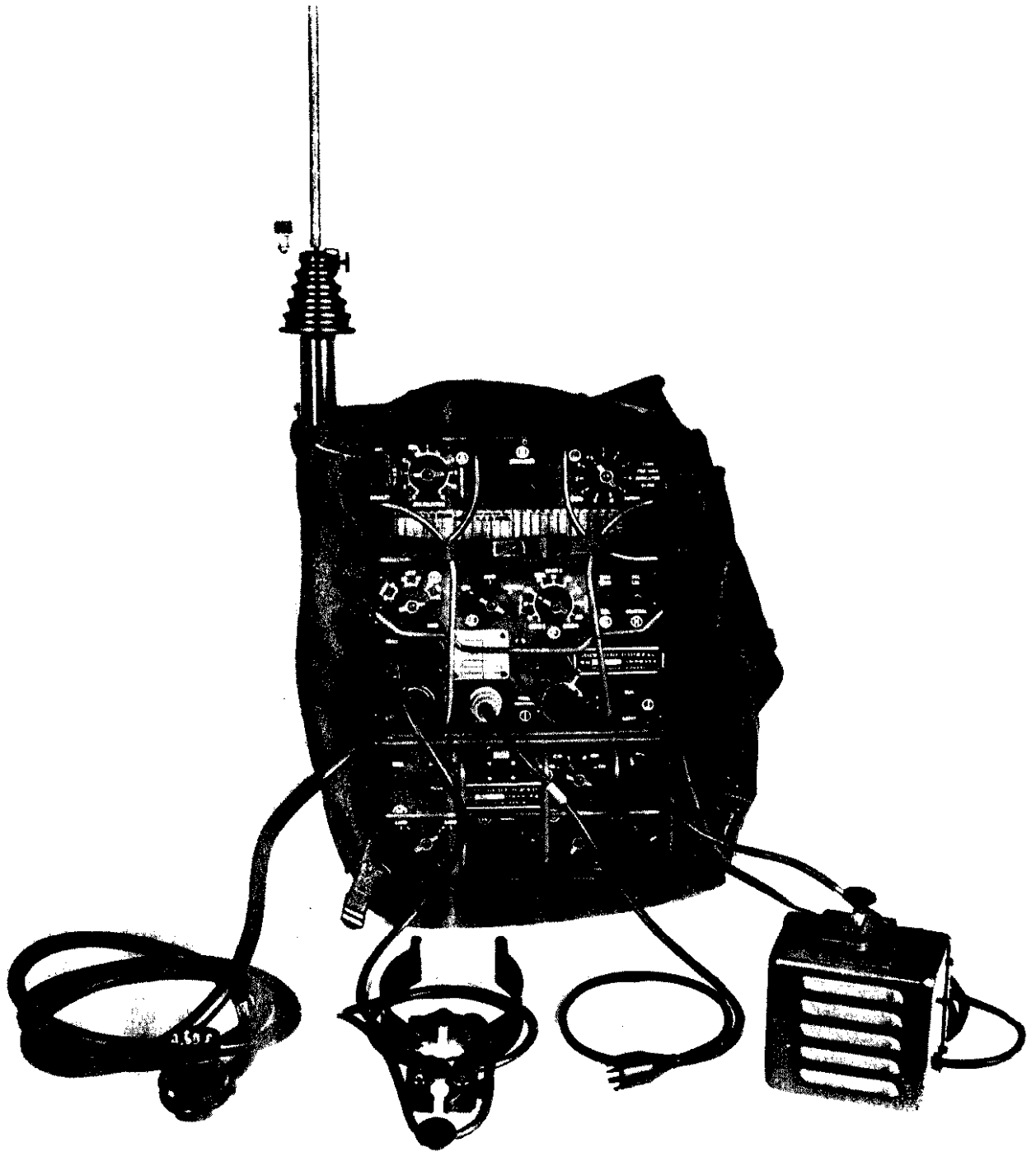


Figure 41. External connections to receiver-transmitter RT-77/GRC-9-GY.

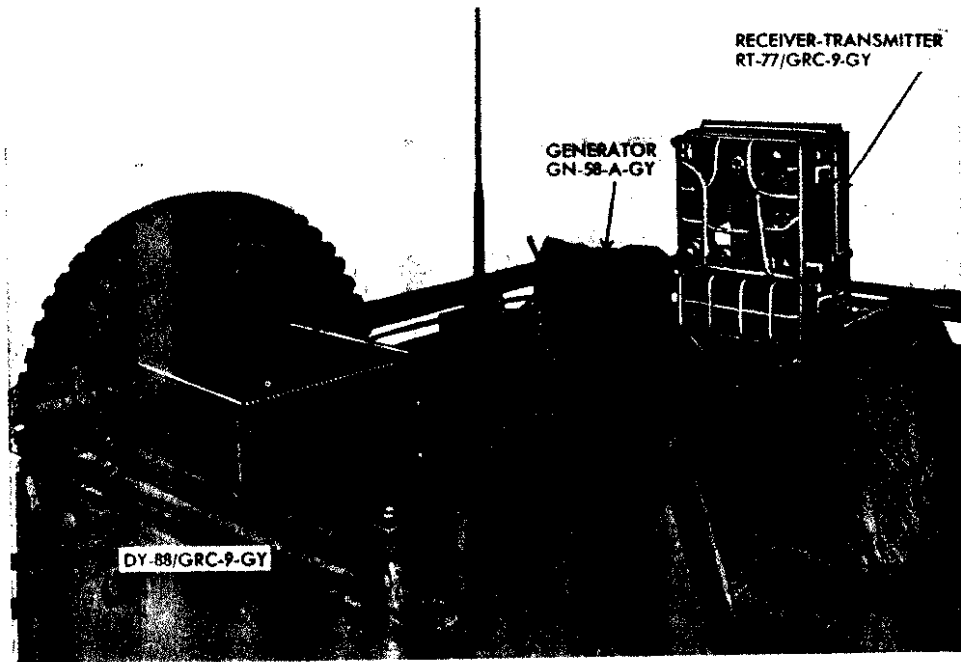


Figure 44. Typical vehicular installation of radio set AN/GRC-9-GY.

b. For vehicular installations of Radio Set AN/GRC-9-GY not covered by a technical manual of the TM 11-2700 series, follow the general instructions given in this manual (pars. 33, 34 and 35).

c. If possible, install Radio Set AN/GRC-9-GY in a vehicle having a 12-volt or 24-volt electrical system. Installation in vehicles having 6-volt systems should be avoided, since the high current drain at 6 volts makes it difficult to keep the vehicular storage battery charged.

d. A vehicle having an electrical system with negative ground must be used. The radio set will not operate properly in vehicles having positive grounded electrical systems.

e. A typical vehicular installation of Radio Set AN/GRC-9-GY is shown in figure 44.

33. Vehicular Installation of Receiver-Transmitter RT-77/GRC-9-GY

a. Select a location in which the controls will be accessible to the operator, and which is close to the position chosen for the antenna.

b. Use Mounting MT-350/GRC-9-GY to support and shockmount the receiver-transmitter. Mounting MT-350/GRC-9-GY is fastened directly to a vertical surface in the vehicle,

using the screws provided. If a horizontal surface is selected, install Mounting MT-350/GRC-9-GY on Frame FM-85 (Signal Corps

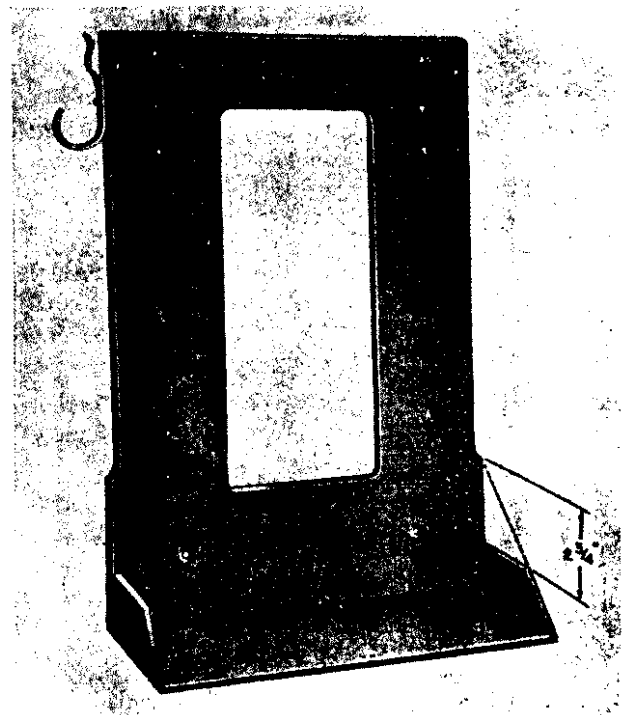
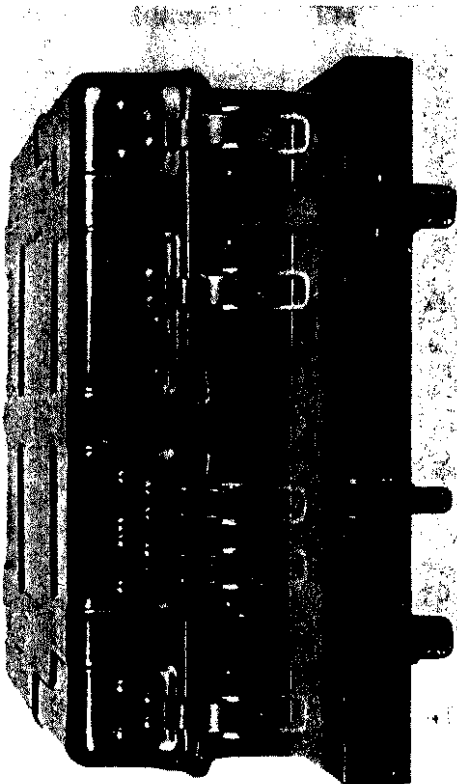


Figure 45. Frame FM-85, with gussets notched to accommodate mounting MT-350/GRC-9-GY.

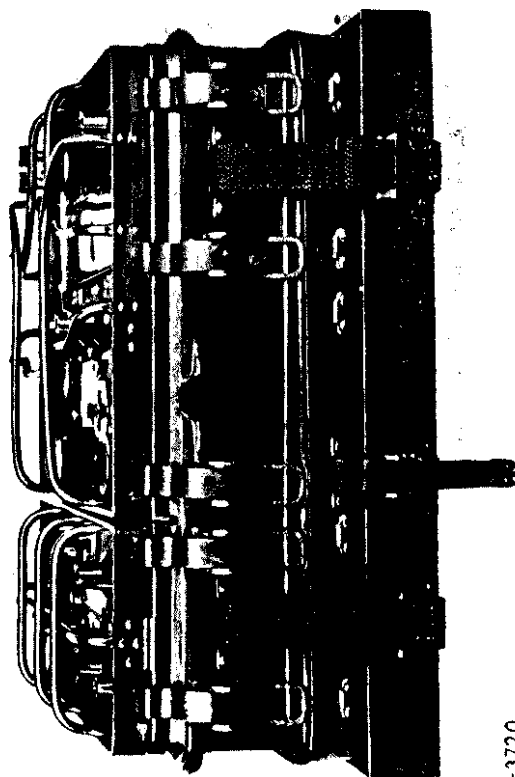


Figure 46. Mounting MT-350/GRC-9-GY and modified frame FM-85, installed in vehicle.



3-3719

Figure 47. Receiver-Transmitter RT-77/GRC-9-GY, mounted for vehicular transportation or storage.



3-3720

Figure 48. Receiver-Transmitter RT-77/GRC-9-GY, mounted for vehicular use.

stock No. 2Z4660-85), modified as shown in figure 45. Figure 46 shows the mounting and frame installed in a vehicle.

c. For transportation or storage, strap the receiver-transmitter in Mounting MT-350/GRC-9-GY with Panel Cover CW-109/GRC-9-GY secured over the face with the clamps (fig. 47). WHEN REMOVING THE PANEL COVER, BE SURE TO REFASTEN THE CLAMPS TO SECURE THE RECEIVER - TRANSMITTER CHASSIS TO THE CASE.

d. For normal operation, place the cover between the receiver-transmitter and Mounting MT-350/GRC-9-GY (fig. 48). Secure the unit with the straps (fig. 48).

e. Connect a ground lead (as short as possible) from the GND. post on the receiver panel to a nearby grounded metal portion of the vehicle.

34. Installation of Vehicular Antenna

a. The vehicular antenna consists of Mast Base MP-65-A-GY and five mast sections (three Mast Sections MS-116-A-GY, one Mast Section MS-117-A-GY, and one Mast Section MS-118-A-GY). Secure the antenna to the vehicle by means of a Mast Bracket MP-50 (Signal Corps stock No. 2A2090-50) or other appropriate brackets (fig. 49).

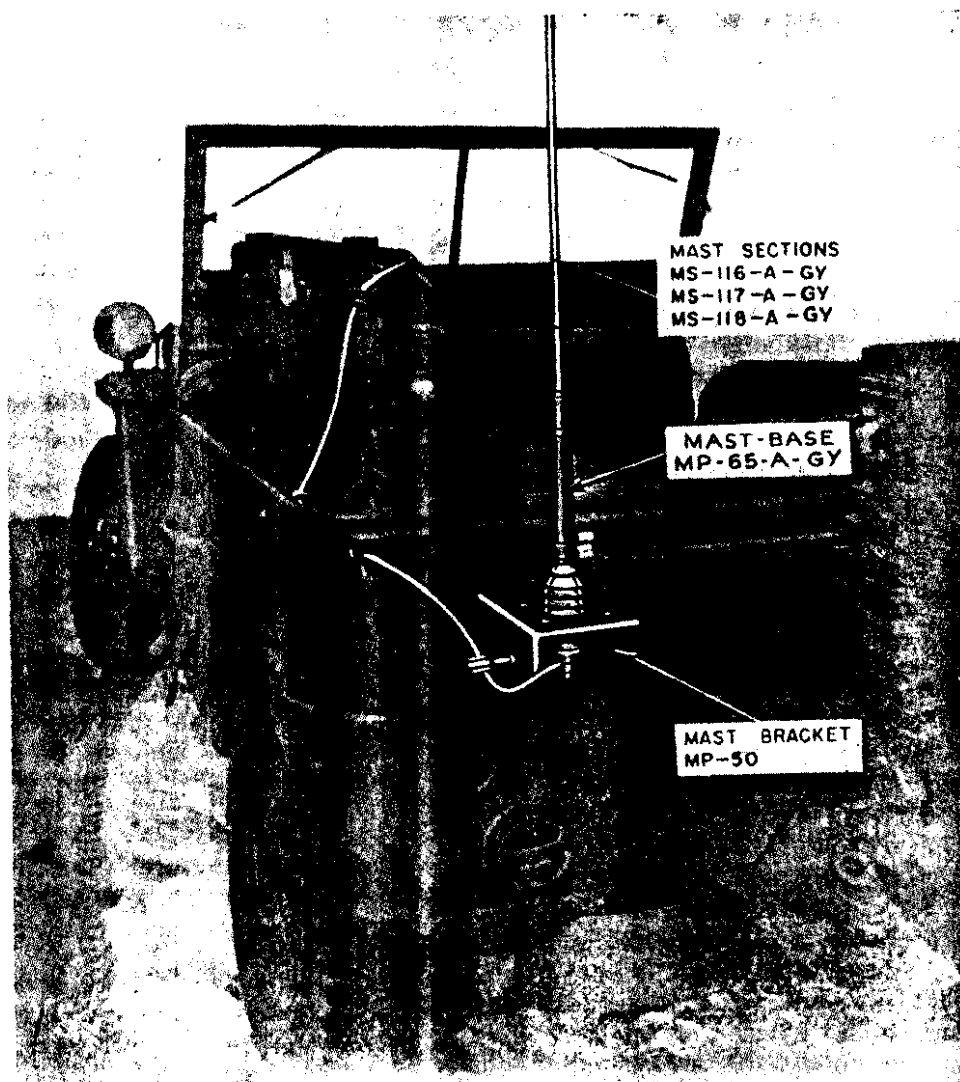


Figure 49. Typical installation of vehicular antenna of radio set ANIGRC-9-GY.

b. Select an antenna location close to the receiver-transmitter to permit a short antenna lead of Wire W-128-GY. If possible, use a lead length of 19 inches or less. Where this is not possible, lengths up to 6 feet may be used; however, for antenna leads between 19 inches and 6 feet, use 4 mast sections instead of 5 when operating on frequencies above 11 mc. This is necessary to permit resonance of the transmitter at these upper frequencies when using a long antenna lead.

c. Install the antenna.

- (1) So that it is not shielded by adjacent metal.
- (2) On a part of the vehicle strong enough to withstand the shock of trees or other obstacles which might hit the antenna.

d. Connect the antenna lead of Wire W-128-GY from the binding post on Mast Base MP-65-A-GY to the upper antenna binding post on the transmitter marked ANT.

35. Vehicular Installation of Dynamotor-Power Supply DY-88/GRC-9-GY

a. Select a horizontal mounting surface which permits Cable Assembly CX-2031/U-GY to reach the vehicular power terminal box or battery, and which permits Cord CD-1086-GY (44" or 7' 0") to reach the receiver-transmitter. Allow clearance to permit free movement of the power supply on its shock mounts.

b. When the power supply front panel does not overhang the edge of the mounting surface, be sure to use 5/16-inch thick washers between the shock mounts and the mounting surface. This is necessary to provide clearance for operating the thumbscrew fasteners at the bottom of the front panel. When bolting the power supply to a grounded metal mounting surface, be sure that one of the mounting bolts passes through the free end of the ground strap. Use one of the internal-external toothed lockwashers (provided in the hardware bag) between the ground strap lug and the head of the mounting bolt, and another similar type lockwasher between the nut and the mounting surface. When the power supply is mounted on an un-

grounded surface, connect the free end of the ground strap to a nearby grounded metal portion of the vehicle.

c. Connect the power cable to the vehicle terminal box; be sure of the following:

- (1) The negative (—) terminal of the vehicle storage battery is grounded to the vehicle frame. (The set will not operate properly in vehicles with the positive battery terminal grounded.)
- (2) The negative lead of the power cable is connected to the ground terminal in the vehicle terminal box.
- (3) The input voltage setting of the power supply (par. 10) corresponds to the vehicular battery voltage.

d. Push the TRANS & RECEIVE-OFF switch on the front panel of the dynamotor power supply to the OFF position. Connect Cord CD-1086-GY (44" or 7' 0") between the dynamotor power supply and the receiver-transmitter and secure it in a manner which permits ready removal for field use.

36. Service upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 22 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in the wiring or operation of the equipment. If any changes in wiring have been made, note the change in the appropriate section of this manual. Be sure to change the main schematic so that it agrees with the equipment received.

c. Check the operating controls for ease of rotation. If lubrication is required, refer to the lubrication instructions in chapter 3, section III.

d. Inspect all the cables for possible internal or external damage and repair those that might appear to give trouble later.

e. Perform the installation and connection procedures given in paragraphs 23 through 35 as required.

Section II. CONTROLS AND INSTRUMENTS

37. Transmitter section of Receiver-Transmitter RT-77/GRC-9-GY

The following chart lists the controls of the

transmitter section of Receiver-Transmitter RT-77/GRC-9-GY and indicates what they do.

Figure 50 shows the front panel controls.

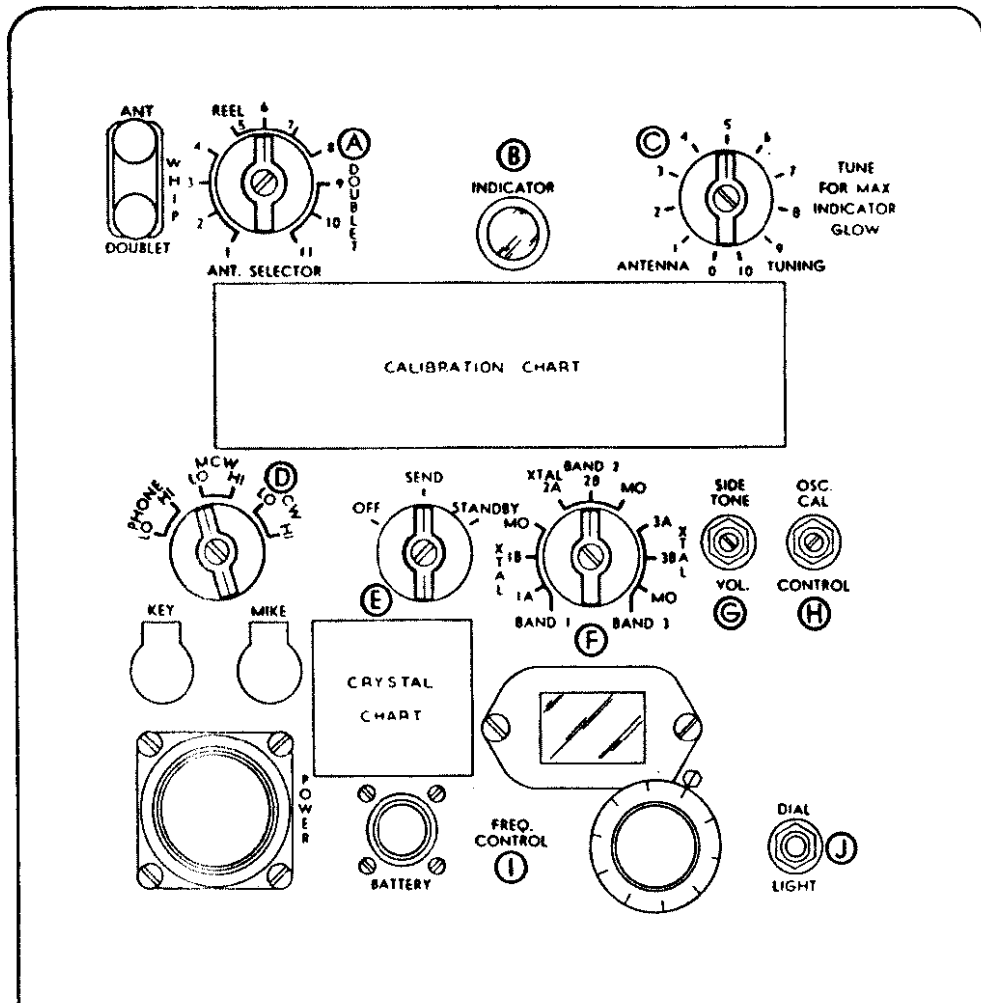


Figure 50. Transmitter controls.

Panel letter	Control	Function
A	ANT. SELECTOR dial switch (S102).	This switch is a multicontact switch which arranges the components in the output circuits of the final power amplifier so that any of the three available antennas connected will be properly tuned to resonance. Positions 1, 2, 3, and 4 match the power amplifier coil to a vertical mast or whip antenna to cover the frequency range of the transmitter. Positions 5, 6, 7, and 8 match the coil to an end-fed long-wire antenna, and positions 9, 10, and 11 match the coil to a center-fed or doublet antenna.

Panel letter	Control	Function
B	INDICATOR (I101)	This control is a neon indicator bulb which is connected in the antenna matching circuit; it glows at its brightest level when the antenna is tuned to resonance with the transmitter signal. The bulb is located behind two circular Polaroid lenses; the inner one is stationary whereas the outer one can be rotated around an axis perpendicular to its center. When two red dots on the outer barrels of both lenses are lined up, these lenses will allow the maximum amount of light to penetrate through them. When the two red dots are 90° apart, the light emerging from the indicator bulb will not be allowed to penetrate the lenses. This system is a safety measure for blackout conditions.
C	ANTENNA TUNING part of coils T110A and T110B.	This control adjusts the position of powdered iron cores which slide in and out of the antenna matching transformers T110A and T110B. When the proper position of these cores is found, the antenna will be tuned for the frequency of transmission desired and the INDICATOR (control B) will glow with maximum brilliancy. Thus, the ANTENNA TUNING control is rotated until the neon indicator shows the brightest glow.
D	PHONE-MCW-CW control S-105.	<ol style="list-style-type: none"> 1. This switch is used to select any of the three types of transmission available on this radio set. <ol style="list-style-type: none"> a. PHONE: This position permits the transmission of voice signals, using a microphone which is inserted in the MIKE jack. b. MCW: In this position, the radio set transmits a signal of constant frequency depending on the tuning dial (control I) position. This signal is modulated by a constant audio frequency which is generated by an audio oscillator located in the transmitter. The transmitter is keyed in the usual manner as for c-w signals. This system is also called tone modulation. With this system, the radio set receiving these signals need not have a bfo (beat-frequency oscillator) to make them audible, since they already are modulated and can be detected in the usual manner. c. CW: The signal is keyed by means of a key which is inserted in the KEY jack, and for reception, it requires that the station being sent to have a bfo. Otherwise the signal would be inaudible, as received. 2. Each of the three positions described has a HI and LO position also. In the HI position, the maximum power is available for transmission, while in the LO position, the transmitter output is greatly reduced so that operation over only short distance ranges is possible.
E	OFF-SEND-STANDBY control S103.	<p>This switch has three positions:</p> <ol style="list-style-type: none"> 1. OFF: In this position, both the receiver and transmitter are not in operation. All power to both units is completely shut off. 2. SEND: This position is used when it is desired to transmit or receive signals. When the key is not depressed or the microphone press-to-talk switch is not pushed, only the receiver is supplied with voltage and receives signals. As soon as the key is depressed, relays in the transmitter switch the voltage from the receiver to the transmitter. The transmitter is automatically placed in operation and sends out the desired signal. 3. STANDBY: This position is used when Battery BA-48 or when Dynamotor-Power Supply DY-88/GRC-9-GY is supplying power. When the switch is turned to STANDBY, only the receiver is in operation. In this position, less power is needed to operate the radio set, so that during long periods of listening there will be less current drain on the battery.
F	XTAL-MO-BAND switch S101.	This switch allows the operator to select either crystal control or master oscillator (MO) control of the transmitter on any of the three bands. The crystal portions of this control operate in conjunction with six Crystal Units CR-8B/U, inserted in sockets on the transmitter chassis. Each crystal operates at a particular frequency in the selected band.
G	SIDE TONE VOL. potentiometer R115.	It is advantageous to have the operator of the radio set be able to listen to the voice and code signals which he is transmitting. This is especially important for code signals. A special arrangement in the transmitter feeds back to the receiver headset a sidetone signal from an audio oscillator circuit during keying operation. Each time the key is depressed, the oscillations are fed to the headset. For voice transmission, the audio signal from the output of the modulator stage is fed to the headset. The volume of this sidetone signal is adjusted by the SIDE TONE VOL. control. It has a slotted shaft which is turned with a screw driver.

Panel letter	Control	Function
H	OSC. CAL. CONTROL variable capacitor C102.	This is another screw driver control which turns a small variable capacitor in the mo (master oscillator) circuit, and thus, varies the frequency between fine limits. The control is used in conjunction with the receiver 200-kc crystal calibrating circuit.
I	FREQ. CONTROL variable capacitor C101.	The frequency control is the tuning adjustment for selecting the transmitting frequency. Transmitting frequencies with respect to dial calibration of the drum dial and tuning knob are shown on the calibration chart fastened to the front panel of the transmitter.
J	DIAL LIGHT control S104 . .	This is a push-button switch which, when pressed, lights a small panel light in back of the transmitter dial thus illuminating it. The dial light will be illuminated only when Generator GN-58-A-GY or Dynamo-Power Supply DY-88/GRC-9-GY (SEND position) is used. Further, on PHONE position of control D, the dial light can be lighted only when the key is depressed or the MIKE press-to-talk switch is closed.

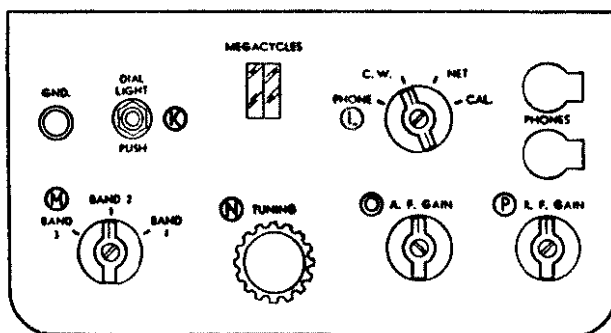


Figure 51. Receiver controls.

38. Receiver Section of Receiver-Transmitter RT-77/GRC-9-GY

The following table lists the controls of the receiver section of Receiver-Transmitter RT-77/GRC-9-GY and indicates what they do. The receiver controls are shown in figure 51.

Panel letter	Control	Function
K	DIAL LIGHT PUSH control S2.	This is a push-button switch which, when pressed, lights a small panel light in back of the receiver dial, illuminating it.
L	PHONE-C.W.-NET-CAL. switch S3	<p>The function of this switch is to select the type of operation desired and to check the dial calibration of the receiver.</p> <ol style="list-style-type: none"> 1. PHONE: This position allows the reception of voice signals or mcw signals. The output is heard in the headset or the loudspeaker, either of which may be plugged into one of the two jacks marked PHONES. 2. C. W.: When placed on this position, c-w signals can be received. A bfo in the receiver beats with the incoming cw and an audio frequency beat note is heard in the headset. 3. NET: On NET position, it is possible to tune the transmitter to the frequency of any station in which it is desired to hold communication. Also, once the receiver dial calibration is known to be accurate, the transmitter-oscillator frequency can be adjusted (control H) by matching it with the receiver dial calibration. In the NET position, the gain of the receiver is greatly reduced. 4. CAL.: A crystal-oscillator circuit in the receiver permits the dial calibration of the receiver. Frequency check points are available over the entire band at every 200 kc.
M	BAND 3-BAND-2-BAND 1 switch S1.	This switch permits the selection of any of the three frequency bands available. BAND 3 is the lowest frequency range while BAND 1 is the highest. As the band switch is turned from one band to another, a mechanically coupled mask operates to cover the dial calibration of the unused frequency bands.

Panel letter	Control	Function
N	TUNING capacitor C7A C7B C7C	This knob tunes the radio receiver circuits and controls the operation of the calibrated dial which is viewed through the dial window. There are three dial scales. <ul style="list-style-type: none"> a. The lower scale on the dial is BAND 3 which covers the frequency range of 2.0 mc to 3.6 mc, with dial mark at each 20 kc. b. The middle scale on the dial is BAND 2, which covers the frequency range of 3.6 mc to 6.6 mc with dial marks at every 20 kc. c. The top scale is BAND 1 which covers the frequency range of 6.6 mc to 12.0 mc with dial marks at every 50 kc. A shutter exposes the portion of the dial being used and covers the unused scales by a mechanical connection to the band switch (control M). A dial lock on the tuning knob allows the dial to be locked in a fixed position once it is set on the desired frequency.
O	A. F. GAIN potentiometers R19A and R19B.	This is a volume control which varies the strength of the audio signal delivered to either the headset or the loudspeaker. The volume will be a minimum when this control is rotated to its furthest counter-clockwise position.
P	R. F. GAIN potentiometer R9	This control varies the d-c voltage on the screen grid of the first r-f amplifier, thus controlling the gain of this stage to prevent overloading of the following stages on strong signals. On all positions but NET of (control L) the screen grid of tube V3 is also controlled by the R. F. GAIN control.
	IMPEDANCE switch S4	This switch is found in the back of the receiver and is used to match the output circuit of the receiver to headsets or Loudspeaker LS-7-GY. Output loads of either 250 or 4,000 ohms impedance can be matched (fig. 39). The switch is adjusted with a screw driver. For Loudspeaker LS-7-GY, the switch is placed at 4,000 ohms.

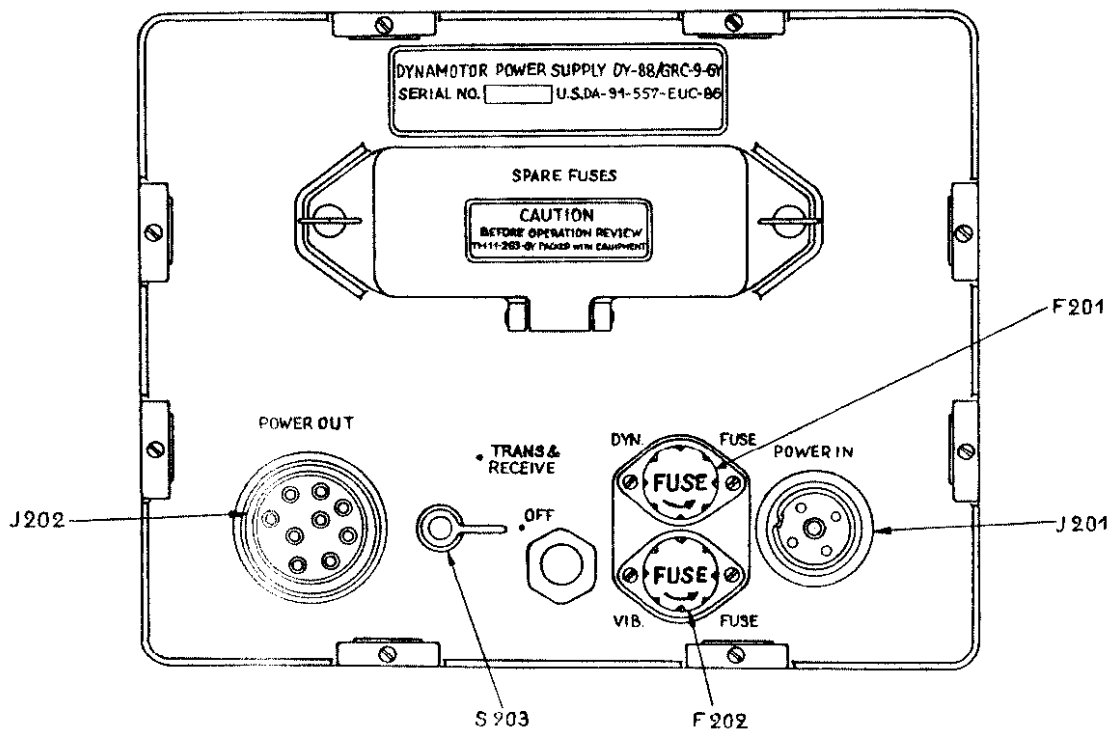


Figure 51.1 Dynamotor-Power Supply DY-88/GRC-9-GY, front panel.

39. Dynamotor-Power Supply DY-88/GRC-9-GY
(fig. 51.1)

a. **TRANS & RECEIVE-OFF SWITCH.** The unit can be controlled from the receiver-transmitter when this switch is turned to the TRANS & RECEIVE position. When the switch is in the OFF position, no power is supplied to the receiver-transmitter.

b. **VOLTAGE SELECTOR SWITCH.** When the unit is removed from the case, ganged switches S201 and S202 can be adjusted to 6, 12, or 24 volts by means of switch control H206 to correspond with that of the vehicular battery used (fig. 111). When the unit is encased, the switch setting can be checked visually by looking through the transparent window on the front panel.

Section III. OPERATION OF POWER SUPPLIES UNDER USUAL CONDITIONS

40. Generator GN-58-A-GY

The operator sits astride the leg seat and rotates the generator cranks in the direction indicated by the arrow, next to the crank opening in the side of the generator housing. Do not attempt to rotate the cranks in the reverse direction to that indicated by the arrow, or damage to the generator will be done, which will require a major repair. Satisfactory operation may be obtained if the cranks are turned at a speed from 50 to 70 rpm (revolutions per minute).

41. Dynamotor-Power Supply DY-88/GRC-9-GY

a. Vehicular installation instructions are given in paragraph 35.

b. The operation of the dynamotor power supply is automatic, being controlled by relays in the power supply which are connected to the OFF-SEND-STANDBY switch (control E) on the transmitter. To operate the receiver-transmitter, the TRANS & RECEIVE-OFF switch must first be set to TRANS & RECEIVE. It is then necessary for the OFF-SEND-STANDBY switch control E on the transmitter to be in any position but OFF before the dynamotor power supply will begin to operate. Thus if the transmitter is shut off, the dynamotor power supply is shut off automatically. When control

E is turned to the SEND or STANDBY position, the dynamotor power supply is turned on automatically.

c. To shut off the dynamotor power supply, switch the TRANS & RECEIVE-OFF switch to the OFF position. This will make the dynamotor power supply independent of the setting of the OFF-SEND-STANDBY switch, control E, and regardless of the position of control E, the dynamotor power supply will remain off and no power will be supplied to the receiver-transmitter.

42. Battery BA-48

This battery can be used to supply power to the receiver only. The transmitter cannot be operated from it. It is possible to use the battery in conjunction with the hand generator in which case both the receiver and transmitter can be operated. The battery will power the receiver, while the generator is turned only when it is desired to use the transmitter. With this arrangement, the generator does not require the usual full manual energy to turn since it powers only the transmitter. The OFF-SEND-STANDBY switch on the transmitter must be on STANDBY at all times during this system of operation.

Section IV. OPERATION OF RECEIVER UNDER USUAL CONDITIONS

43. Receiver Operation from Dynamotor-Power Supply DY-88/GRC-9-GY

Check the voltage of the storage battery to be used. If the voltage does not agree with

that shown on the indicator drum as viewed through the window in the front panel, remove the unit from its case and set the voltage selector switch control H206 to the proper position (fig. 111). Reinstall the unit in its case.

a. Remove the DYN FUSE (F201). Check it against the voltage of the storage battery to be used. The rating of the dynamotor fuse must be as shown in the table below.

Battery voltage (volts)	DYN FUSE rating (amperes)
6	30
12	20
24	10

b. Turn the TRANS & RECEIVE-OFF switch on the dynamotor power supply to the TRANS & RECEIVE position.

c. Turn control E on the transmitter to the STANDBY position. In this position, the vibrator section of the dynamotor power supply feeds power to the receiver only. By placing the hand on the dynamotor power supply case, vibrations from the vibrator may be felt.

d. To use the transmitter along with the receiver, turn control E to the SEND position, thereby allowing the dynamotor to start. The steady hum of the dynamotor should be audible through the case.

44. Receiver Operation from Generator GN-58-A-GY

a. Turn OFF-SEND-STANDBY control E on the transmitter to SEND. The generator will not supply power to the receiver if control E is in any other position.

b. Except for steps b and c above, the operation of the receiver is the same as described in paragraph 43 above.

c. The generator should be turned at a speed of approximately 60 rpm, and it should be turned in the direction indicated by the arrow on the side of the generator housing.

d. If the turning of the generator is stopped, the receiver and the transmitter will no longer be supplied with power.

45. Receiver Operation from Battery BA-48

The battery will supply power to the receiver only and not to the transmitter. For this operation, perform the following steps:

a. Insert the female connector of Cord CD-1119-GY into the BATTERY receptacle on the transmitter panel and tighten the retaining ring.

b. Insert the male connector of Cord CD-1119-GY into the receptacle on the Battery BA-48.

c. Turn OFF-SEND-STANDBY control E on the transmitter to the STANDBY position. The battery will not supply power in any other position of this switch.

d. Except for steps b and c, the operation of the receiver is the same as described in paragraph 43.

46. Receiver Operation from Generator GN-58-A-GY and Battery BA-48

a. The radio set can be used with this combination, making it necessary to turn the cranks of the generator only when transmitting since the battery will operate the receiver. The generator will not supply any power to the receiver.

b. The OFF-SEND-STANDBY control E must be on STANDBY for this type of operation.

c. The operation is the same as in paragraph 43, except that the generator must be turned only when transmission is desired.

47. Phone Operation and Net Operation

a. The PHONE position of control L will allow the reception of voice and mcw signals.

b. The NET position allows the transmitter to be tuned exactly to any frequency which the receiver section is receiving. The NET position is not to be used for normal reception since, at this position, the sensitivity of the receiver is purposely reduced. NET position is to be used only in conjunction with the transmitter, when it is desired to place the receiver-transmitter in a radio communications group or net. For more detailed explanation see paragraph 54.

48. Receiver Calibration

This operation is a means to check whether the dial reading for tuning control N actually gives the true frequency to which the receiver is tuned.

a. A 200-kc crystal installed in the receiver supplies a series of crystal-controlled check frequencies against which to check the calibration of the receiver and transmitter. These check frequencies are all harmonics of 200 kc. The calibration check points are 2,000 kc, 2,200 kc,

2,400 kc, and up to 12 mc, thus covering the entire band of the radio set. To check the calibration of the receiver dial, connect a pair of earphones to the receiver and proceed as follows:

- (1) Turn control **L** to **CAL.** (calibrate).
- (2) When using Dynamotor-Power supply **DY-88/GRC-9-GY** or Battery **BA-48**, turn control **E** on the transmitter to **STANDBY**. When using Generator **GN-58-A-GY**, turn control **E** to **SEND**.
- (3) Turn control **D** on the transmitter to **PHONE**. In the **PHONE** position, the filaments of all the transmitter tubes are not supplied with power and are inoperative unless the **MIKE** push button is pressed. This is a desirable condition during the calibration operation, since the transmitter cannot interfere with the receiver.
- (4) Turn the **A. F. GAIN** control **O** to the maximum or greatest clockwise position.
- (5) Turn the **R. F. GAIN** control **P** to the minimum or greatest counterclockwise position.
- (6) Turn control **M** to **BAND 3**.
- (7) Turn the **TUNING KNOB N** to the lowest frequency check point (2.0 mc). Increase **R. F. GAIN** control **P** slightly, until the signal is heard. Adjust the

TUNING knob until zero beat is heard on the strongest beat note in the vicinity of the crystal check point. At this point, the receiver tuning circuits should be near the 2.0-mc dial.

- (8) After checking the receiver calibration at 2,000 kc, proceed through the entire tuning range on **BAND 3**, checking the calibration every 200 kc apart such as 2,200, 2,400, 2,600, and up to 3,600 c or 3.6 mc.
- (9) Turn control **M** to **BAND 2** and turn control **N** to 3.6 mc. Check calibration points every 200 kc on **BAND 2** up to 6.6 mc.
- (10) Turn control **M** to **BAND 1** and turn control **N** to 6.6 mc. Check calibration points up to 12.0 mc.
- (11) If the calibration is off enough to cause confusion, it may be corrected as described in chapter 6, section IV.

b. If, during calibration, interference from strong signals is being picked up, the antenna lead-in can be disconnected from the **ANT.** post to avoid misleading beats.

49. Stopping Procedure

- a. Turn control **E** to the **OFF** position.
- b. Stop cranking the hand generator or press the **OFF** button on the vibrator power unit.

Section V. OPERATION OF TRANSMITTER UNDER USUAL CONDITIONS

50. Transmitter Operation

a. **GENERAL.** The transmitter functions only when the **OFF-SEND-STANDBY** control **E** is on the **SEND** position. In this position, the receiver also may be used. Special circuits and relays in the transmitter determine which section of the receiver-transmitter will be placed in operation. When the key or the press-to-talk switch on the microphone is not depressed, the receiver automatically functions and receives all signals to which it is tuned. When the key or microphone switch is closed, power is supplied to the transmitter and removed from the receiver. The receiver ceases to function while the transmitter sends out the desired signal

Before the operations of the transmitter are described, the use of the transmitter dial and dial charts will be explained.

b. **DIAL READING.** The tuning dial control **I** consists of two graduated scales; one scale is located behind a glass window and the other scale is marked around the edge of the tuning control knob. The numbers on both of these scales are taken as one reading and they determine the frequency to which the transmitter is tuned. The numbers are not the actual transmitting frequencies but are related to these frequencies by the chart on the transmitter panel. Several dial settings with the corresponding dial readings are shown in figure 52.

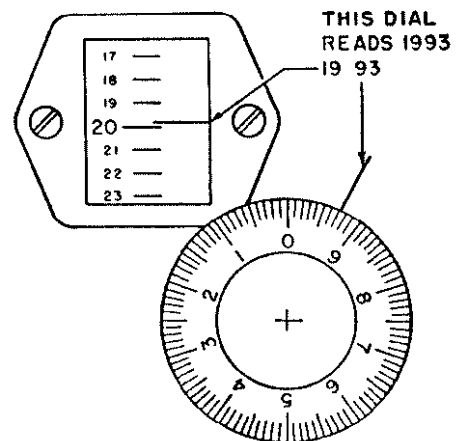
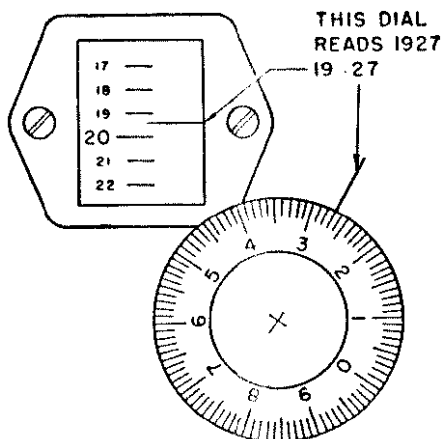
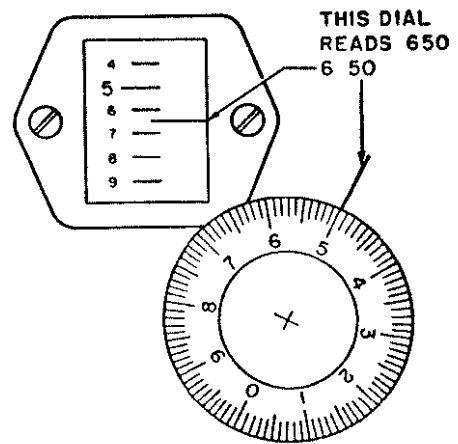
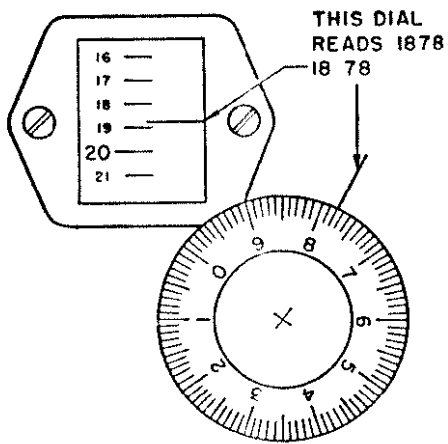
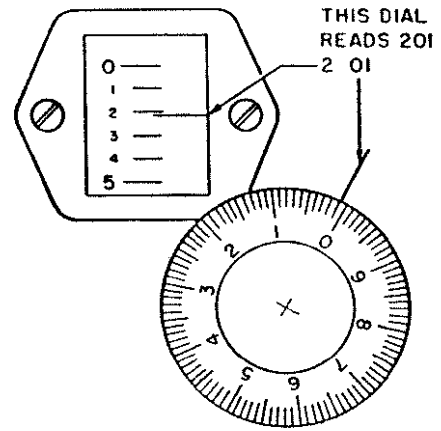
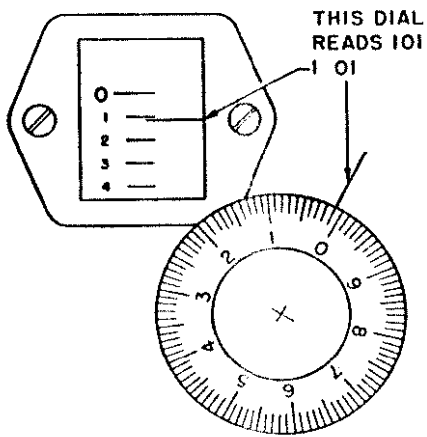


Figure 52. Transmitter dial readings.

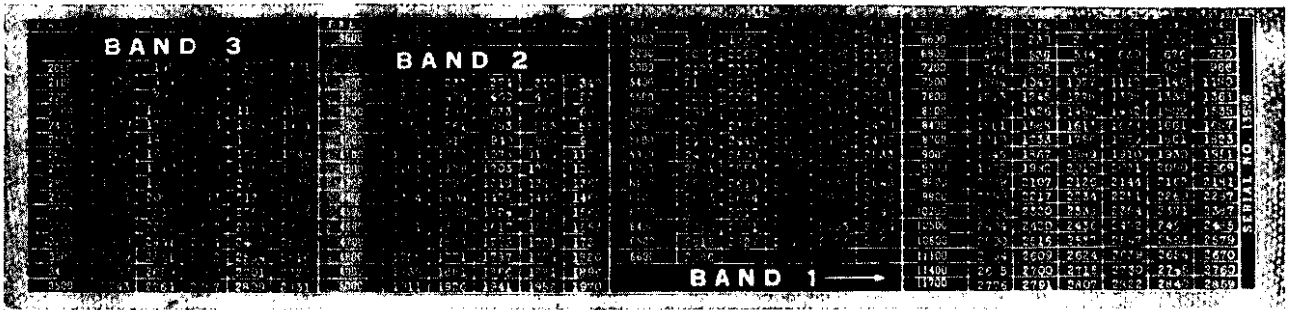


Figure 53. Transmitter dial calibration chart.

c. DIAL READING CALIBRATION CHART.

On the transmitter panel is a dial reading calibration chart (fig. 53), which relates the different frequencies of transmission to the dial settings. This chart will not be the same on the different models of the transmitter. Each individual set must be tuned by the chart on its panel. Assume that it is desired to transmit on a frequency of 5,540 kc in BAND 2, refer to figure 53 and proceed as follows:

- (1) Find 5,500 kc in the frequency column of the BAND 2 section. To the right on the same line as the 5,500 kc, there are 5 columns, each with headings of from +00 kc to +80 kc.
- (2) Since the dial setting for 5,540 kc is wanted, the +40 kc column is the one referred to.
- (3) In the small box where lines through 5,500 kc and +40 kc intersect, number 2284 is found. This is the number to which the dial should be set in order to transmit a frequency of 5,540 kc.

d. UNLISTED DIAL SETTINGS. Sometimes a frequency of transmission will be wanted that is between two listed dial settings on the chart; for instance, in BAND 1, 9,283.5 kc. The following interpolation is necessary:

- (1) From the desired frequency (9238.5 kc), subtract the first calibrated frequency below it (9200 kc).

$$\begin{array}{r} 9238.5 \\ -9200 \\ \hline 38.5 \end{array}$$

- (2) Find the difference between the dial readings for the frequencies listed just above and just below the desired frequency.

9250 kc has a dial reading of 1932
 9200 kc has a dial reading of —1911
 21

- (3) Multiply the value obtained in step 1 above by that in step 2.

$$\begin{array}{r} 38.5 \\ \times 21 \\ \hline 385 \\ 770 \\ \hline 808.5 \end{array}$$

- (4) Divide this answer obtained in step 3 above by 50 for BAND 1.

Note. When using any frequency in BAND 3 or BAND 2, divide the answer of step 3 by 20, not 50.

$$\begin{array}{r} 16.17 \\ 50 \overline{) 808.50} \\ \underline{50} \\ 308 \\ \underline{300} \\ 85 \\ \underline{50} \\ 350 \\ \underline{350} \\ 0 \end{array}$$

- (5) Add the answer obtained in step 3 to the dial setting corresponding to the first calibrated frequency just below the desired frequency. This answer is the dial setting for the unlisted frequency.

Dial setting for
 9200 kc is 1911
 Add +16.17
 1927.17

This 1927.17 corresponds to the desired frequency of 9238.5 kc.

- (6) In the actual setting of the dial to this frequency, the dial numbers after the decimal point are not included. The dial setting is shown in figure 52.

51. Master Oscillator (MO) Operation

a. The oscillator section of the transmitter may be either crystal-controlled or a self-sustaining oscillator called a master oscillator. The mo can tune over the entire band, while the transmission frequencies with the crystal oscillator are fixed, depending on the frequencies of the crystals used. The crystal oscillator is more stable however and should be used when there is no necessity of changing rapidly from one frequency to another.

b. To transmit using the mo, proceed as follows:

- (1) Connect the antenna, key, microphone, power cables, etc., according to paragraph 31.
- (2) Set switch **D** to PHONE, MCW, or CW, whichever type of transmission is desired. If low-power emission is desired for short distance range transmission, set the switch to the LO position for that type of transmission.
- (3) Set control **F** to the mo position for the desired frequency band.
- (4) Adjust **FREQ. CONTROL** knob (control **I** to correspond with the transmitting frequency as shown on the calibration chart. If an unlisted frequency is used, interpolate (par. 50d) to obtain the correct dial setting.

Note. If there is any reason to believe that the transmitter is out of calibration, it can be checked and corrected as described in paragraph 53.

- (5) Turn **ANT. SELECTOR** switch **A** to the highest numbered position for the type of antenna being used.
- (6) Turn the outer barrel of **INDICATOR B** clockwise until the two red dots on the side of the barrel are in line.
- (7) Turn switch **E** to the **SEND** or **STANDBY** position, depending on the type of power supply being used.

- (a) Dynamotor-Power Supply **DY-88/GRC-9-GY** or Generator **GN-58-A-GY** by itself; turn switch **E** to **SEND**.

- (b) Generator **GN-58-A-GY** in conjunction with Battery **BA-48**; turn switch **E** to **STANDBY**.

- (8) Turn control **L** on the receiver to **PHONE** or **C.W.** position so that the sidetone can be heard.
- (9) Depress the button on the microphone or close the key and rotate **ANTENNA TUNING** control **C** until **INDICATOR** control **B** glows at its maximum intensity. If the indicator does not glow through a complete sweep of knob **C**, turn **ANT. SELECTOR** knob **A** to the next lower number. Rotate knob **C** again until maximum glow is seen. If there is still no glow, repeat with knob **A**.

Note. If the indicator glows with more than one setting of knob **A**, always use the highest numbered position of this switch at which the indicator will glow. When using a long-wire antenna, it is sometimes difficult to see any indication of resonance on **INDICATOR B** when control **C** is tuned through resonance. In that case, temporarily remove the antenna lead from the antenna binding post; adjust control **C** to give maximum **INDICATOR** glow, then reconnect the antenna lead and proceed with normal operation. Be sure that the jumpers in the antenna are connected correctly for the selected frequency of operation, according to the instructions on the calibration chart attached to the antenna. When the antenna lead-in is reconnected, it will probably be necessary to readjust control **C** for maximum brilliance.

Caution: When tuning for an indication of resonance, never leave the transmitter on in excess of 15 seconds with the antenna lead disconnected from the **ANT.** binding post.

- (10) Adjust **SIDE TONE VOL.** control **G** for desired volume.

c. To operate Microphone **T-17**, hold it close to the lips, press the button on the handle, and speak in a loud, clear voice. Hold the button until finished talking, then release the button to listen for the reply.

Note. About 2 seconds are required for the tubes to heat properly each time the button is pressed. Wait 2 seconds after pressing the button before talking. Always release the button *immediately* after transmitting, since no reply can be heard from the receiver with the button switch closed.

52. Crystal (XTAL) Operation

a. Positions have been provided for the installation of a total of six Crystal Units **CR-8 U**

on the transmitter chassis. The installation of the crystal units is described in paragraph 29. In the crystal operation, only six frequencies of transmission are possible depending on the crystals inserted.

b. A frequency doubler circuit is incorporated in the transmitter; because of this, the transmission frequency will be twice the natural frequency of the crystal. Therefore, if it is desired to transmit on a frequency of approximately 3,000 kc in BAND 3, a crystal with natural frequency of 1,500 kc should be installed in the appropriate socket. Two crystal oscillator frequencies are available for each of the three bands. Either of the crystals in any one band may be inserted in either of the two sockets available for that band. The crystal sockets are shown in figure 120. Therefore, the 1,500-kc crystal should be inserted in either socket 3A or 3B. The transmitted frequency (2X crystal frequency) with the corresponding dial setting for each of the six crystals, should be written on the small white chart on the transmitter panel.

c. For crystal operation, perform the following procedure:

- (1) Connect the antenna, key, microphone, power cables, and headset to the receiver-transmitter.
- (2) Set switch **D** to PHONE, MCW, or CW, whichever type of transmission is desired. If low power emission for short distance is desired, set control **D** to the LO position for that type of transmission selected.
- (3) Set switch **F** to the XTAL position for the frequency band selected.
- (4) Adjust **FREQ. CONTROL I** to the proper dial setting as indicated on the calibration chart, on which the transmission frequency (2X crystal frequency) with corresponding dial setting is recorded.
- (5) Turn **ANT. SELECTOR control A** to the highest numbered position for the type of antenna used.
- (6) Turn the outer barrel of **INDICATOR B** clockwise until the two red dots on the side of the barrel are in line.
- (7) Turn switch **E** to SEND or STANDBY, depending on the type of power supply being used. With Generator GN-58-A-

GY or Dynamotor-Power Supply DY-88/GRC-9-GY, turn to the SEND position. Use the STANDBY position when Battery BA-48 is used in conjunction with Generator GN-58-A-GY.

- (8) Turn control **L** on the receiver to the PHONE or C.W. position.
- (9) Depress the button on the microphone or close the key and rotate **ANTENNA TUNING control C** until the indicator reaches its maximum glow. Follow the procedure outlined in paragraph 51b, step 9.
- (10) Adjust **SIDE TONE VOL. control G** for desired volume.

53. Transmitter Calibration

It is important to know if the transmitter actually transmits on the frequencies corresponding to the dial settings on the calibration chart. Thus, if it is desired to send a signal of approximately 5,500 kc, the **FREQ. CONTROL knob I** is set at the appropriated setting. When this setting is made, the calibration operation assures that the transmitter will send a signal of 5,500 kc. This is accomplished by first accurately tuning the receiver and then feeding a reduced signal output of the transmitter into the receiver. The procedure is as follows:

a. First calibrate the receiver as described in paragraph 48. The selected calibration frequency of the receiver must be some multiple of 200 kc, which is closest to the desired signal output of the transmitter. Assume that a transmitter signal of 5,835 kc is desired. The receiver should first be calibrated at 5,800 kc and not at 5,835 kc, because receiver calibration is accomplished by using the harmonics of a 200-kc crystal.

b. Turn control **F** to MO for the band being used.

c. From the transmitter calibration chart, determine the dial setting corresponding to the calibration check frequency and turn **FREQ. CONTROL knob I** to that dial setting.

d. Turn control **L** on the receiver to the NET position.

e. Set control **D** on the transmitter to MCW or CW. Do not set it to PHONE because calibration will be impossible in that position.

f. Turn control **E** to **SEND** if Generator GN-58-A-GY is used alone, or if Dynamotor-Power Supply DY-88/GRC-9-GY is used. Turn control **E** to **STANDBY** if Battery BA-48 is used in conjunction with the hand generator.

g. Adjust A. F. **GAIN** control **O** for the desired volume.

h. Adjust **OSC. CAL. CONTROL H** with a screw driver until the beat note which is heard disappears, and a zero beat condition is obtained. This corrects the calibration for that particular frequency, and all other frequencies within that band also will be correct.

i. To restore the receiver to normal operation, turn control **L** to **C. W.** or **Phone**.

54. Net Operation

Net operation means that the transmitter sends out signals which are of the same frequency as those that the receiver is receiving. To make sure that the transmitter is tuned to the same frequency as the receiver, proceed as follows:

a. With Radio Set AN/GRC-9-GY set up for operation, turn switch **E** to the **SEND** or **STANDBY** position depending on the power supply being used. Refer to paragraphs 43 through 46.

b. Receive the desired signal with receiver control **L** on either **PHONE** or **C.W.**, and lock the tuning dial at this frequency point.

c. Observe the frequency of the net control station and, referring to the transmitter calibration chart, adjust the transmitter **FREQ. CONTROL** dial **I** to the approximate frequency.

Note. If an end-feed long-wire antenna is being used, make sure that the proper antenna jumpers are closed and that the transmitting antenna is matched to the transmitter.

d. Turn switch **L** on the receiver to the **NET** position.

e. Turn switch **D** on the transmitter to **MCW** or **CW**. Do not place switch **D** on **PHONE** or it will be impossible to tune the transmitter to the receiver frequency.

f. With the earphones still connected to the receiver, tune the transmitter **FREQ. CONTROL I** until the strongest beat note is heard in the headset.

g. Adjust **FREQ. CONTROL I** on the transmitter until the beat note disappears and a condition of zero beat is obtained.

Caution: During the entire process of tuning the transmitter to the receiver, do not depress the key or microphone button because this will cause the transmitter to have full output, and the station which the receiver is receiving will be blocked out.

h. After the zero beat is found, lock the tuning knob of **FREQ. CONTROL I**.

i. Turn control **D** on the transmitter to **PHONE**, **MCW**, or **CW**, whichever type of transmission is desired.

j. Turn control **L** on the receiver to **PHONE** or **C. W.**, whichever type of reception is obtained from the other net stations.

55. Stopping Procedure

For any type of transmission or reception, the stopping procedure for the transmitter and receiver is exactly the same.

a. Turn control **E** to the **OFF** position.

b. Stop cranking the hand generator or turn the **TRANS & RECEIVE-OFF** switch to the **OFF** position on Dynamotor-Power Supply DY-88/GRC-9-GY.

Section VI. OPERATION UNDER UNUSUAL CONDITIONS

56. General

The operation of Radio Set AN/GRC-9-GY may be difficult in regions where extreme cold, heat, humidity and moisture, sand conditions, etc., prevail. In the following paragraphs instructions are given on procedures for minimizing the effect of these unusual operating conditions.

57. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep the equipment warm and dry. If the set is not in a heated inclosure, construct an insulated box for the set.

c. Heavy coatings of frost will gather on mouth-type microphones in extreme cold weather when the microphones are used in the open air or in a cold room. Frost will form from the breath in the small holes of the cap and will affect transmitter modulation. Rubber diaphragms have been designed to protect some types of microphones; use them when available. Have a spare microphone ready, if possible, in case the one in use fails to function properly.

d. Wear a knitted woolen cap over the earphones when operating in the open air with headsets that do not have rubber earpieces. Frequently, when headsets without rubber earpieces are worn, the edges of the ears may freeze without the operator being conscious of this condition. Never flex rubber earcaps, since this action may render them useless. If water gets into the phones, or if moisture condenses within them, it may freeze and impede the actuation of the diaphragm. When this happens, remove the bakelite cap and remove the ice and moisture from the earphone.

e. When equipment which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. When the equipment has reached room temperature, dry it thoroughly. This condition also arises when the equipment warms up during the day after exposure during a cold night.

f. Use any improvised means to protect dry batteries, since they will fail if not protected against the cold. Preheat the batteries. To prevent heat loss, place them in bags lined with kapok, spun glass fiber materials, animal skins, or woolen clothing.

58. Operation in Tropical Climates

When operated in tropical climates, radio equipment may be installed in tents, huts, or, when necessary, in underground dugouts. When

equipment is installed below ground and when it is set up in swampy areas, moisture conditions are more acute than normal in the tropics. Ventilation is usually very poor, and the high relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. To minimize this condition, place lighted electric bulbs under the equipment. Be sure that the equipment is moisture-fungi-proofed.

59. Operation in Desert Climates

a. Conditions similar to these encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem which arises with equipment operation in desert areas is the large amount of sand or dust and dirt which enters the moving parts of the equipment. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials. Hang wet sacking over the windows and doors, cover the inside walls with heavy paper, and, with sand, secure the side walls of tents to prevent their flapping in the wind.

c. Never tie power cords, signal cords, or other wiring connections to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

d. Be careful to keep the equipment as free from dust as possible. Make frequent preventive maintenance checks (par. 64). Pay particular attention to the lubrication of the equipment. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

60. Tools Supplied with Radio Set AN/GRC-9-GY

a. EXTRACTOR, TUBE (Signal Corps stock No. 6R7443-4-GY). This is a tube extractor for the small peanut tubes contained in the receiver-transmitter. It is located in Case: Box BX-53-GY. Its use is illustrated in figure 41.

b. EXTRACTOR, PILOT LAMP (Signal Corps stock No. 6Q36920-2-GY). This is an extractor for removing and replacing the small dial illuminating lights located behind the transmitter and receiver panels. It is located in

Case: Box BX-53-GY and its use is illustrated in figure 40.

c. WRENCH BRISTO No. 6 (Signal Corps stock No. 6R55230-GY). This wrench is located in Case: Box BX-53-GY.

d. WRENCH BRISTO No. 8 (Signal Corps stock No. 6R55231.1-GY). This wrench is located in Case: Box BX-53-GY.

61. Special Tools

No special tools are required.

Section II. PREVENTIVE MAINTENANCE SERVICES

62. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that break-downs and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See TM 38-650.

63. General Preventive Maintenance Techniques

a. Use No. 0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with Solvent, dry-cleaning (SD); then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 P.S.I. to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

e. Whenever a loose connection is tightened, it should be moisture-fungiproofed by applying the varnish with a small brush.

64. Performing Preventive Maintenance

The following preventive maintenance operations should be performed by organizational personnel at the intervals indicated, unless these intervals are reduced by the local commander.

Caution: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

1. Cabinets.

(a) Inspect and clean the outside of each cabinet thoroughly with a clean dry cloth. Use dry compressed air to blow out all accumulated dust and dirt. Repaint any surface which is scratched, rusted, or chipped. Tighten all mounting bolts, panel screws, plugs, and control knobs found loose.

(b) Inspect the glass dial covers for cracks and breaks and replace if necessary.

(c) See that the INDICATOR control B Polaroid glass shields are securely mounted on the panel.

(d) Correct the legibility of the writing on the CRYSTALS calibration chart.

(e) See that the panel lights operate on both the receiver and transmitter when the unit again is assembled ready to operate.

2. Antenna components.

(a) Check that the antenna insulating supports are clean. The threaded portions of the whip mast sections should be cleaned and freed from any green scale which usually collects on copper exposed to the air.

(b) Any breaks in the long-wire antenna should be carefully spliced and soldered. Guy cords and halyards should be inspected.

3. Cords and cables. The condition of the cabling must be observed closely.

(a) Inspect cables for cracked or deteriorated insulation, frayed or cut insulation at connecting and supporting points, and improper placement which strains cables or connections. Also watch for kinks.

(b) Clean connections on cables when they are dirty or corroded. Clean corroded connectors with No. 0000 sandpaper. Clean entire surface of connector, but do not make any attempt to remove individual prongs from cable plugs.

4. Headsets, microphone, and key.

(a) Inspect cords and see that they are not kinked, cut, or abraded.

(b) See that Plugs PL-55 and PL-68 are bright and clean.

(c) Check that the key does not bind and can be manipulated at normal speed. Clean the contacts with No. 0000 sandpaper if they are blackened or corroded.

WEEKLY

Caution: Disconnect all power to the receiver-transmitter before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.

1. Cabinets and chassis. Clean interior of receiver-transmitter cabinet, exterior of the chassis, and all parts accessible without removal from chassis.

2. Tubes.

Note. Do not work on tubes immediately after shut-down. Severe burns may result from contact with the hot envelopes.

(a) Inspect glass and metal tube envelopes, tube cap on tube type 2E22, and tube bases for cracks and accumulation of dirt and corrosion. Tubes with loose plate cap or envelopes should be replaced, if possible.

(b) Examine spring clip on tube type 2E22 plate cap for loss of tension, corrosion, and faulty contact to the connecting lead.

(c) Inspect firmness of tubes in their sockets. Press them firmly, but gently, straight down in their sockets. Do not jiggle the tubes from side to side as this may break the pins or spread the contacts of the socket. Inspect tube sockets at times when removal of the tubes is required.

(d) Tubes operated at high voltage, such as tube type 2E22 with exposed plate connections, should be kept extraordinarily free from dirt and dust to prevent leakage of current from the plate cap to the chassis. Remove dirt and dust from glass or metal envelopes with a clean, lint-free, dry cloth. If the proper care is used, the plate cap may be cleaned with a piece of No. 0000 sandpaper by wrapping the paper around the cap and gently rubbing the surface. Excessive pressure is not needed. Wipe the cap with a clean dry cloth.

3. Gears. Inspect the teeth on the gears of the antenna coil T-110A and T-110B tuning slug assembly. Check the antibacklash gear on the receiver tuning shaft. If the gears are dirty, clean them with a small brush dipped in dry-cleaning solvent (SD).

4. Headsets, microphone, and key. Clean telephone type Plugs PL-55 and PL-68 with Polish, Metal Paste, Signal Corps stock No. 6G1516. After cleaning, remove all traces of polish on the plugs.

5. Coils. Inspect all coils for the cleanliness of the coil forms and, if dirty, clean the coils and coil forms with a soft brush. Tighten any coil mounting studs and resolder any leads which are loose.

6. Dynamotor-Power Supply DY-88/GRC-9-GY.

(a) Remove case and see that all components are securely screwed down to the chassis.

(b) Check that Vibrator E201 and ballast tubes R208, R209 and R210 are correctly seated in their sockets.

(c) Check that the voltage change switch viewing window is not cracked or broken.

MONTHLY

1. Receiver-Transmitter. Remove all cover plates exposing under side of both chassis.

(a) *Resistors.* Inspect all resistors for blistering, discoloration, and other signs of overheating. Inspect the coating of the cement-coated resistors for signs of cracks and chipping. Inspect all leads but be careful not to move resistors with delicate pigtail leads or these leads may break at the point where they enter the resistor body. Resistors with discolored bodies indicate they are overloaded and there may be circuit trouble which requires analysis and correction.

Note. When fungiproofed resistors are heated, a harmless brown stain may appear.

(b) *Capacitors.* Inspect terminals of the large fixed capacitors for corrosion and loose connections. Carefully inspect mountings to discover loose mounting screws, studs, or brackets. Examine leads for poor insulation, cracks, and evidences of dry rot. Cut away frayed strands on insulation. If wire is exposed, wrap it with friction tape. See that the terminals of capacitors are not cracked or broken.

(1) Thoroughly inspect the case of each large fixed capacitor for leaks, bulges, and discoloration.

(2) Inspect the plates of the variable capacitors for dirt, dust, or lint. Examine the movable set of plates for signs of damage or misalignment that causes them to touch the fixed plates while tuning. Rotate the movable plates, using the panel tuning control. Listen and feel for any scraping or scratching which may occur.

Caution. Do not bend any plates of the tunable capacitors.

(3) Clean the case of fixed capacitors, the insulating bushings, and all connections that are dirty or corroded. Capacitor cases and bushings can usually be cleaned with a dry cloth. However, if the deposit of dirt is hard to remove, moisten cloth in solvent (SD).

(4) Clean plates of variable capacitors with a small brush or pipe cleaner, removing all dust and lint. Dust, if present, may cause arcing.

(c) *Switches.*

(1) Inspect the mechanical action of each switch. Look for signs of dirt or corrosion on all exposed elements of the switch.

(2) Examine the ganged switches to see that their shafts are lubricated properly and that the electrical contacts are clean. The inspection is visual. Do not pry the leaves of the switch apart. The rotary members should make good contact with the stationary members, and as the former slides into the latter, a spreading of the stationary contact leaves should be noticed.

(3) Clean the exterior surfaces of switches with a stiff brush moistened with solvent (SD).

(d) *Relays and circuit breakers.* The relays in the receiver-transmitter, hand generator, and dynamotor-power supply are considered normal if the exterior is free from dirt or dust, the contacts are not burned, pitted, or corroded, the contacts are lined up and spaced correctly, the moving parts travel freely and function properly, the connections to the relay are tight, the wire insulation is not frayed or torn, the relay assembly is securely mounted, and the field coil shows no signs of overheating.

(1) Examine the contacts of the relays with the aid of a flashlight.

(2) Tighten all loose connections and mounting screws, but do not apply enough force to damage the screw or break the parts they hold.

(3) Brush the exterior with a soft brush. If it is very dirty, clean it with a brush dipped in solvent (SD). If loose connections are found, they should be corrected. If they are dirty or corroded, remove, clean, and replace them carefully.

(4) When it is necessary to clean the contact surfaces, burnish them with a clean blade of the contact burnishing tool. Place the blade between the contacts, press the contacts together, and move the blade back and forth. If the contacts require additional cleaning, apply carbon tetrachloride with a toothpick and again burnish with a clean blade of a burnishing tool. Remove all traces of white film formed by carbon tetrachloride.

(e) *Insulators.* The insulators are constructed of ceramic material with a glazed surface. Any deposit of foreign substance on the surface of this insulator will materially reduce its insulating value. Therefore, it is necessary to inspect the insulator frequently.

(1) Inspect the physical condition of the insulator. It should be clean without cracks or chips. It is possible for a highly glazed insulator to develop fine-line surface cracks where moisture and dust will accumulate and eventually form a leakage path.

(2) If an insulator is loose, tighten it but do not exert excessive pressure, or damage is certain to occur. The insulator may not fail at that time but when the high voltage is impressed across it, it may fail with serious consequences.

(3) If the insulators are dirty, they can easily be cleaned. Never use abrasive materials; the glazed finish will be destroyed. A clean cloth is usually satisfactory. If deposits of grime or dirt on the surface are hard to remove, use solvent (SD). After the surface has been cleaned with a solvent, polish with a dry cloth. Otherwise, a thin film of the solvent will be left which will impair the effectiveness of the insulator.

2. *Dynamotor-Power Supply DY-88/GRC-9-GY.* The dynamotor should not be further disassembled beyond removal of the case and the brush cover plates. If definite repairs are necessary, refer to chapter 6.

(a) Check all the plug-in capacitors, vibrators relays, and the transformer. Feel and inspect all the capacitors and resistors that are accessible. There should be no excessive heating, discoloration, or bulging.

(b) Inspect the brushes and the commutators at regular intervals. The brushes should be long enough to make firm contact with the commutator. The brush springs must have adequate tension and be in firm contact with the brushes. If the brushes are in good condition, be sure they are re-inserted with polarity markings facing upward. Do not invert the brushes, as they will not seat properly.

(c) The commutators must be clean and smooth. Press a piece of canvas folded to the exact width of the commutators against the commutators and turn the armature by hand.

(d) If the commutators have been burned or pitted, hold a piece of No. 0000 sandpaper against the commutators and turn the armature by hand.

(e) If necessary, a cloth moistened in carbon tetrachloride may be used to remove the dirt and grease.

(f) Polish the commutators with a piece of canvas, as in subparagraph (d) above, and wipe with a clean, dry cloth.

3. *Generator GN-58-A-GY.*

(a) The generator is not to be further disassembled than removing the top part of the generator housing, unless definite repairs are necessary. In this case, refer to chapter 6.

(b) For field maintenance, the following is all that should be done.

(1) Inspect the brushes and the commutators at regular intervals. The brushes should be long enough to make firm contact with the commutator. The brush springs must have adequate tension and be in firm con-

tact with the brushes. The commutators must be clean and smooth.

(2) Press a piece of canvas, folded to the exact width of the commutator against the commutator and turn the armature by hand.

(3) If the commutator has been burned or pitted, hold a piece of No. 0000 sandpaper against the commutator and turn it by hand.

(4) If necessary, a cloth moistened in carbon tetrachloride may be used to remove caked dirt and grease.

(5) Polish the commutator with a piece of canvas, as in step (2) above, and wipe with a clean, dry cloth.

(6) Feel and inspect all of the capacitors and resistors which are accessible. There should be no overheating or discoloration.

Section III. LUBRICATION

Note. There is no lubrication order (LO) for this equipment. Lubrication operations will be performed in accordance with the following instructions.

65. Approved Lubricants for Radio Set An/GRC-9-GY

a. LUBRICATING MATERIALS. The following table lists the lubricating materials necessary in servicing Radio Set AN/GRC-9-GY:

<i>Symbols</i>	<i>Standard Nomenclature</i>
OE-10	Oil, engine
PL-Special	Oil, lubricating, preservative, special
GL	Grease, lubricating, special

b. PRELIMINARY LUBRICATION INSTRUCTIONS.

- (1) Do not use excessive amounts of grease or oil and do not allow electrical contacts to become greasy.
- (2) Make certain that lubricants and points to be lubricated are clean and free from sand, grit, or dirt. These abrasives are the chief causes of bearing wear and often necessitate bearing replacements.
- (3) Use solvent (SD) to clean all parts. Before lubrication, wipe clean all surfaces to be lubricated; use a lint-free cloth dampened with solvent (SD). Keep solvent off surrounding parts.
- (4) GASOLINE WILL NOT BE USED AS A CLEANING FLUID FOR ANY PURPOSE.

66. Lubricating Instructions for Receiver-Transmitter RT-77/GRC-9-GY

a. Each month, clean the exposed bearing surfaces of switch detent surfaces, hinges, and fasteners, and sparingly apply oil (PL-Special). Remove excess oil to prevent possible malfunctioning.

Be sure to keep the switch contacts free of all oil and grease.

b. Each month, clean exposed surfaces of antenna tuning slug drive gears, receiver and transmitter tuning capacitor drive gears, and apply to the gear teeth grease (GL). Avoid an excess of grease.

67. Generator GN-58-A-GY Lubrication At First and Second Echelons

On the very early models, where oilite bearings were not used, apply a few drops of oil (OE-10) or oil (PL-Special) every 3 months. Apply the oil to the handcrank bearings at the sides of the generator case. DO NOT LOOSEN ANY OF THE SEALED SCREWS OF THE WATERPROOF CASE.

68. Generator GN-58-A-GY Lubrication at Third or Higher Echelons

When Generator GN-58-A-GY is disassembled for general overhaul or repairs, lubricate as follows:

a. Clean old grease and oil from the lubricated parts with solvent (SD). Invert the generator, when cleaning, so that the solvent does not flow into the commutator or armature windings.

b. Relubricate with grease (GL) during re-assembly, or after the unit is assembled. Spread the grease evenly and avoid an excess of grease which cannot adhere to the greased mechanism.

69. Lubrication under Unusual Conditions

a. ARCTIC REGIONS. Lubricants which are satisfactory at moderate temperatures stiffen and solidify at subzero temperatures; as a result, moving parts bind or become inoperative.

When preparing equipment for low-temperature operation, see that lubricants used for moderate temperatures are thoroughly removed. Even small amounts of such lubricants, if allowed to remain, may impair the operation of moving parts. Be sure to use the lubricant specified for low-temperature operation.

b. **TROPICAL REGIONS.** High temperatures and moisture due to rain, condensation, etc., may cause lubricants which are normally satisfactory to flow from moving parts and other surfaces. These bearing surfaces will wear excessively, and hinges, fasteners, and other parts

will be damaged or destroyed by rust and corrosion. Inspect the equipment daily and lubricate it as required to insure efficient operation, using lubricants suitable for high temperatures.

c. **DESERT REGIONS.** Dust and sand infiltration into the equipment causes grit in the lubricants and will seriously impair and damage the moving parts of the set. Hot dry temperatures cause the lubricants to flow from the moving parts, and conditions similar to those described in b above occur. Use lubricants suitable for high temperatures. Inspect and clean the equipment daily.

Section IV. WEATHERPROOFING

70. Weatherproofing

a. **GENERAL.** Signal Corps equipment, when operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. **TROPICAL MAINTENANCE.** A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is fully explained in TB SIG 13 and TB SIG 72.

c. **WINTER MAINTENANCE.** Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperatures are fully explained in TB SIG 66.

d. **DESERT MAINTENANCE.** Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are fully explained in TB SIG 75.

e. **LUBRICATION.** The effects of extreme cold and heat on materials and lubricants are ex-

plained in TB SIG 69. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat. Refer to section III of this chapter for detailed instructions.

71. Rustproofing and Painting

a. When the finish on the case has been badly scarred or damaged, rust and corrosion can be prevented by touching up bared surfaces. Use No. 00 or No. 000 sandpaper to clean the surface down to the bare metal. Obtain a bright, smooth finish.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When a touch-up job is necessary, apply paint with a small brush. Remove rust from the case by cleaning corroded metal with solvent (SD). In severe cases it may be necessary to use solvent (SD) to soften the rust, and sandpaper to complete the preparation for painting. Paint used will be authorized and consistent with existing regulations.

Section V. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

72. Scope

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is

necessarily limited in scope by the tools, test equipment, and replaceable parts issued and by the existing tactical situation. Accordingly, trouble shooting is based on the performance of the equipment and the use of the senses in

determining such troubles as burned-out tubes, cracked insulators, etc.

b. The following paragraphs in this section help in determining which of the components, such as the receiver-transmitter or power supplies, are at fault and in localizing the fault in that component to the defective stage or item, such as a tube or relay.

73. Visual Inspection

a. Failure of this equipment to operate properly will usually be caused by one or more of the following faults.

- (1) Improperly connected battery cable Cord CD-1119-GY or generator Cord CD-1086-GY.
- (2) Worn, broken, or disconnected cords or plugs.
- (3) Antenna lead-in improperly connected to ANT. binding post.
- (4) Receiver - transmitter interconnecting cable not connected properly, defective.
- (5) Defective tubes or crystals.
- (6) Loose or broken internal wiring.
- (7) Dirty or broken switch contacts.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble occurred.

c. Visually inspect the antenna system for obvious abnormalities.

74. System Sectionalization of Trouble to a Component

System sectionalization is the tracing of a fault to a particular component of Radio Set AN/GRC-9-GY responsible for the abnormal operation of the set. By carefully observing the performance of the receiver and transmitter when the equipment is in operation the fault can often be determined immediately as either a transmitter, receiver, or power supply fault.

a. Operate the radio set and observe its performance. Refer to the equipment performance checklist (par 75) for normal operating conditions.

b. If neither the transmitter nor the receiver works, try the two panel lights. If these do not

operate, the trouble, most likely, is in the power supply being used.

c. If either the receiver or the transmitter works, but not both, the trouble is probably in the section that does not work. Although with this condition, the power cables may be at fault.

d. If the receiver exhibits unsatisfactory performance such as excessive noise, howling, or weak signals, replace it with a good receiver, if obtainable. If the trouble disappears, the replaced receiver is defective. If the trouble persists, it is probably not in the receivers but is either in the vehicle or due to conditions external to the vehicle.

e. If removal of the antenna causes the symptoms to become less pronounced or to disappear entirely, the trouble is in the antenna or is external to the antenna.

f. By the use of procedures similar to the simple checks given above, the trouble can be isolated to a particular unit.

75. Trouble Shooting by Using Equipment Performance Checklist

a. GENERAL. The equipment performance checklist (e below) will help the operator to determine if Radio Set AN/GRC-9-GY is functioning properly. The checklist gives the items to be checked, the normal indications of correct operation, and the corrective measures that the operator can take. Items 1 through 18 are checked before starting, items 19 through 21 when starting, items 22 through 31 during operation, and items 32 and 33 when stopping. To use this list, follow the items in numerical sequence.

b. ACTION OR CONDITION. For some items, this column gives the conditions and switch settings under which the item is to be checked. For other items, this column states what must be done to the item to check for normal indications given in the next column.

c. NORMAL INDICATIONS. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the item. If the indications are not normal, the operator should apply the recommended corrective measures.

d. CORRECTIVE MEASURES. The corrective measures listed are those the operator can make without turning in the equipment for repairs.

A reference in the table to chapter 6 indicates that the trouble cannot be corrected during operation and that trouble shooting by an experienced repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inopera-

tive, the operator must maintain the set in operation as long as it is possible to do so.

Note. The operator must familiarize himself with the radio set so that he can immediately recognize any changes in the normal operating characteristics and apply simple corrective measures when possible. By becoming familiar with the operation of the receiver, for example, the operator will know the normal position of the A. F. GAIN control for a particular station, and this knowledge will aid in determining the normal sensitivity and amplification of the receiver.

e. EQUIPMENT PERFORMANCE CHECKLIST.

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	Antennas AT-101/GRC-9-GY, AT-102/GRC-9-GY.	Lead-in wire connected to ANT. binding post on transmitter.		
	2	Counterpoises CP-12-GY, CP-13-GY.	Counterpoise lead connected to GND. binding post on receiver.		
	3	Cord CD-1086-GY	Connect female connector to POWER receptacle and make connection to power source (Dynamotor-Power Supply DY-88/GRC-9-GY or Generator GN-58-A-GY).		
	4	Cord CD-1119-GY	When using radio set with Battery BA-48, connect cord to BATTERY receptacle on transmitter panel.		
	5	Headset HS-30-(")	Headset plug set completely into either of the PHONES jacks on receiver panel.		
	6	Key J-45-GY, Microphone T-17, or T-45.	Key plugged into KEY jack and microphone plugged into MIKE jack.		
	7	PHONE MCW-CW control D.	Set to any of the three types of transmission available.		
	8	OFF-SEND-STANDBY control E.	Set to OFF position.		
	9	BAND control F	Set to the frequency band desired and place on either MO or XTAL for that band.		
	10	PHONE-C.W-NET-CAL. control L.	Set to PHONE or C.W., whichever type of reception is desired.		
	11	BAND switch control M.	Set to the frequency band of reception desired.		
	12	A. F. GAIN control O.	Set to approximate midpoint of its range.		
	13	R. F. GAIN control P.	Set to approximate midpoint of its range.		

e. EQUIPMENT PERFORMANCE CHECKLIST - Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	14	Dynamotor-Power Supply DY-88/GRC-9-GY.			
	15	TRANS & RECEIVE-OFF switch.	Turn to OFF position (DY-88/GRC-9-GY).		
	16	Voltage selector switch control.	Set to proper input voltage to correspond with vehicle battery voltage (par 39).		
	17	Battery lead-in Cable Assembly CX-2031/U-GY (DY-88/GRC-9-GY).	Connect the battery cable to the vehicle battery: 6, 12, or 24 volts, negative grounded. Pay attention to the polarity of the leads.		
	18	Power output receptacle.	Plug the male connector of Cord CD-1086-GY into the power output receptacle.		
	19	OFF-SEND-STANDBY control E.	Set to SEND when using Dynamotor-Power Supply DY-88/GRC-9-GY or Generator GN-58-A-GY. Turn to STANDBY when using Battery BA-48.		
START	20	TRANS & RECEIVE-OFF switch on Dynamotor-Power Supply DY-88/GRC-9-GY.	Turn to TRANS & RECEIVE position (DY-88/GRC-9-GY).	Dynamotor rotates (DY-88/GRC-9-GY). Panel lights illuminated when DIAL LIGHT push buttons are pressed.	Check voltage selector switch position. Check power Cord CD-1086-GY. Check to see that correct fuse is being used (DY-88/GRC-9-GY). See that the headset plug is inserted fully in the PHONES jack. Trouble shooting may be necessary (ch. 6).
	21	A. F. GAIN control O.	Turn clockwise	Background noises or signals heard in headset.	Phone plug must be completely inserted in PHONES jack. Receiver-transmitter interconnecting cable must be fully inserted. Check position of IMPEDANCE matching switch, S4, in back of receiver chassis. The handkey or microphone push-button switch may be shorted, keeping the transmitter in operation, thus not allowing the receiver to operate. Check or replace the voltage regulating tube V104 (OC3) in the transmitter.

e. EQUIPMENT PERFORMANCE CHECKLIST - Continued

EQUIPMENT PERFORMANCE

Item No.	Item	Action or condition	Normal indications	Corrective measures
22	FREQ. CONTROL I.	Set to frequency of transmission desired.	Dial behind window does not turn.	Release dial lock.
23	ANT. SELECTOR control A and ANTENNA TUNING control C.	Set to proper positions as explained in paragraph 51 b (9) and close the handkey.	INDICATOR B glows	Tighten knob setscrew. Set two red dots on INDICATOR in line. When using long-wire antenna, see that the correct jumpers are closed. Make sure that the neon indicator lamp is not broken.
24	Key J-45-GY	PHONE-MCW-CW switch D at CW position.	When key is depressed, relay clicks are heard from the transmitter. INDICATOR B glows . Sidetone should be heard in Headset HS-30-(*).	See that the key plug is fully inserted in KEY jack. Check power cable connections. Set two red dots on INDICATOR B line. Adjust SIDE TONE VOL. control G. See that receiver-transmitter interconnecting cable is in good condition and is connected. See that the headset plug is fully inserted in the PHONES jack.
25	Microphone T-17 or T-45 (voice operation).	PHONE-MCW-CW switch D set at PHONE. Press the microphone push button.	When microphone push button is pressed, relay clicks are heard in the transmitter. INDICATOR B glows The voice sidetone is heard in Headset HS-30-(*).	Check microphone plug and switch. Check power cables. Check two red dots on INDICATOR D. Inspect interconnecting cable for receiver-transmitter. Check modulator tube V105 (3A4).
26	PHONE-C.W. NET-CAL. switch L.	Turn to PHONE Turn to C.W.	When push button is released, the transmitter panel light will not operate. This is normal for the PHONE position of control D. Voice signals should be heard in Headset HS-30-(*). Mcw signals also can be heard. It should be possible to hear c-w code signals.	If dial light goes on when control J is pressed and microphone pushbutton is released, refer to chapter 6. See that antenna lead-in is connected. Headset plug should be fully inserted in PHONES jack. When using Generator GN-58-A-GY alone, control E must be at SEND position. See chapter 6. Same as for PHONE. If phone signals were heard in the PHONE position of control L and no c-w signals in the C.W. position, check the blo tube V7 (1R5).

e. EQUIPMENT PERFORMANCE CHECKLIST - Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE			Turn to NET	Voice, mcw, or c-w signals should be heard at reduced volume. No sidetone should be audible.	Trouble shooting is necessary. See chapter 6.
	27	A. F. GAIN control O.	Turn to CAL. and turn TUNING control N to a frequency which is a multiple of 200 kc. Turn control D on transmitter to PHONE.	Unless the receiver is accurately calibrated a beat note should be heard. If the receiver is accurately calibrated, a beat note should be heard on either side of the dial setting, but exactly at the dial setting the beat note disappears and no note is heard in the headset.	Check that the 200-kc crystal in the receiver is fully inserted and not broken. If c-w signals were heard in the C. W. position of control L and no beat note on CAL., check the second i-f (intermediate-frequency) amplifier tube V4 (1R5), or replace the 200-kc crystal. See chapter 6 for trouble shooting.
	28	R. F. GAIN control P.	With a signal tuned in, rotate control O clockwise and counterclockwise. Switch control L on PHONE or C.W. position.	The intensity of sound in the phones or loudspeaker should increase for the clockwise direction and decrease for the counterclockwise direction.	See chapter 6 for trouble shooting.
	29	TUNING control N.	With a signal in the headset, rotate control P clockwise and counterclockwise. Switch control L on PHONE or C. W. position. Set to desired frequency of reception.	Same as item 27	See chapter 6 for trouble shooting.
	30	Generator GN-58-A-GY used without Battery BA-48.	OFF-SEND-STANDBY switch E placed on SEND. PHONE-C.W.-NET-CAL. switch L placed on PHONE or C.W. Turn generator hand cranks at approximately 60 rpm.	Dial behind window should turn. Different stations should be received as the dial is turned. Only one station should be heard at a particular point on the dial. With the key up, noise or signals should be heard in the receiver headset. Transmitter and receiver panel lights should light when controls J and K are pressed with key down.	Tighten setscrew on knob. Check converter tube V2 (1R5). See chapter 6. See that the correct antenna jumpers are closed. Check converter tube V2 (1R5), if only a few stations are heard, at greatly reduced volume. Assuming that the receiver-transmitter is in perfect condition: Turn generator in the direction indicated by the arrow on the side of the generator housing at a speed approximately 60 rpm. See that Cord CD-1086-GY is properly connected. Check the brushes riding on the commutators and see that the springs have the correct tension. Replace the vibrator regulator unit in the generator.

e. EQUIPMENT PERFORMANCE CHECKLIST - Continued

	Item No.	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	31	Generator GN-88-A-GY used with Battery BA-48.	OFF-SEND-STANDBY switch to STANDBY. Turn hand generator. Press key down.	Assuming that the antenna circuits are properly tuned, INDICATOR B should light. Sidetone should be heard in receiver headset.	Battery BA-48 supplies the plate power to the low power transmitter tubes. If the transmitter does not operate, change the battery. Check Cord CD-1119-GY. If the receiver does not operate when the key is released, change the battery. The generator does not supply power to the receiver in STANDBY position of control E.
STOP	32	OFF-SEND-STANDBY control E.	Turn to OFF.	Vibrator and Dynamotor stop (DY-88/GRC-9-GY).	Turn TRANS & RECEIVE-OFF switch to OFF. (DY-88/GRC-9-GY). If trouble shooting is necessary see chapter 6.
	33	TRANS & RECEIVE-OFF switch.	Turn to OFF (DY-88/GRC-9-GY).	Receiver or transmitter will not operate regardless of position of any of the receiver-transmitter controls. This is normal when Dynamotor-Power Supply DY-88/GRC-9-GY is set to OFF.	See chapter 6.
	34	Generator GN-88-A-GY.	If the hand generator is being used, turn OFF-SEND-STANDBY control to OFF. Stop turning the hand cranks.	Panel lights will no longer light and the receiver-transmitter will be inoperative.	

CHAPTER 4

AUXILIARY EQUIPMENT

76. Power Unit PE-162-[*] (fig. 54)

a. This power unit is used for operation of both the receiver and transmitter. It is a light-weight gasoline-engine-driven generator of a manual starting type, having an electrical output of 150 watts at d-c voltages of 6.2 and 500 volts. The components of this unit include Engine GE-12-[*], Generator GN-50-A, and Filter FL-43-A. The weight of this unit, when packed for export, is 125 pounds with a volume of 5 cubic feet.

b. The gasoline engine is a single-cylinder, two-cycle, air-cooled type, having a fuel tank capacity of one-half gallon. It is rated at 1 horsepower for a speed of 3,000 rpm.

Caution: Operation of this unit must not be attempted until the instructions given in TM 11-971 have been read and understood. The unit may be completely ruined unless the proper procedure is followed.

c. When using Power Unit PE-162-[*] with Radio Set AN/GRC-9-GY, it is necessary to connect the generator to the radio set by means of Cord CX-75/TRC-2. No wiring changes are necessary in the cords or plugs to operate the radio set when using this power supply. When using Power Unit PE-162-[*], operation of the radio set, with respect to control settings, is the same as when using Dynamotor-Power Supply DY-88/GRC-9-GY.

d. Complete data on the B model of this equipment is given in TM 11-971.

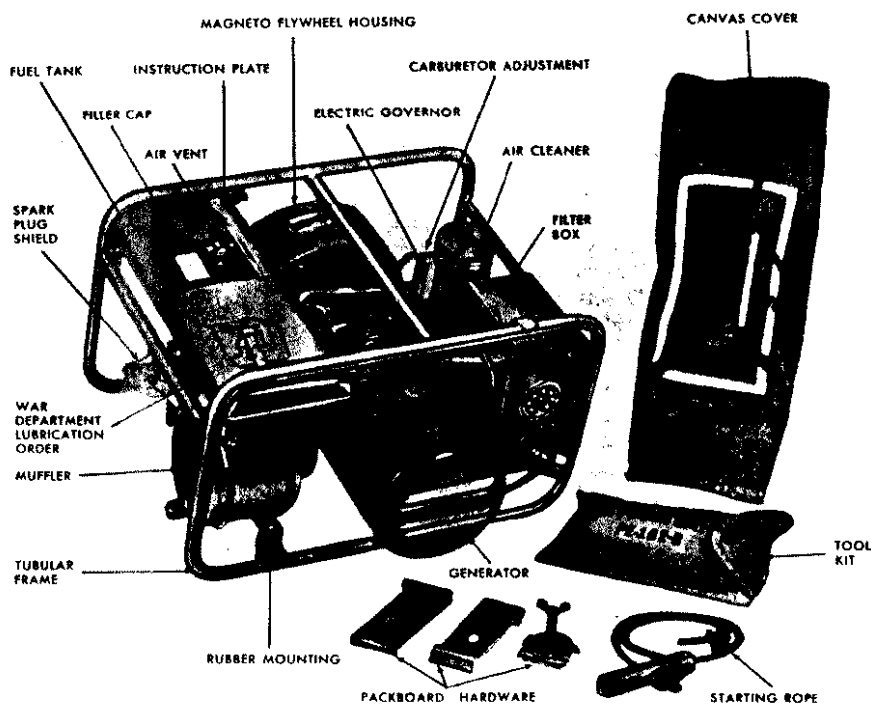


Figure 54. Power unit PE-162-B and equipment.

77. CRYSTAL KIT CK-4/GRC-9

Crystal Kit CK-4/GRC-9 (Stock No. 2X190-1-2) contains 4,470 crystals, covering a fre-

quency range from 1,000 kc 6,000 kc, which are used in the operation of Radio Set AN/GR-9-GY. The components are—

Description	Quantity	Stock No.
Case CS-140, for storing and transporting Crystal Units CR-8/U for Radio Set AN/GRC-9-GY	5	2Z1890-140
Crystal Unit CR-8/U (1,000 kc), transmitting	10	2X53-1000
Crystal Unit CR-8/U (1,005 kc), transmitting	10	2X53-1005
Crystal Unit CR-8/U (1,010 kc), transmitting	10	2X53-1010
Crystal Unit CR-8/U (1,015 kc), transmitting	10	2X53-1015
Crystal Unit CR-8/U (1,020 kc), transmitting	10	2X53-1020
Crystal Unit CR-8/U (1,025 kc), transmitting	10	2X53-1025
Crystal Unit CR-8/U (1,030 kc), transmitting	10	2X53-1030
Crystal Unit CR-8/U (1,035 kc), transmitting	10	2X53-1035
Crystal Unit CR-8/U (1,040 kc), transmitting	10	2X53-1040
Crystal Unit CR-8/U (1,045 kc), transmitting	10	2X53-1045
Crystal Unit CR-8/U (1,050 kc), transmitting	10	2X53-1050
Crystal Unit CR-8/U (1,055 kc), transmitting	10	2X53-1055
Crystal Unit CR-8/U (1,060 kc), transmitting	10	2X53-1060
Crystal Unit CR-8/U (1,065 kc), transmitting	10	2X53-1065
Crystal Unit CR-8/U (1,070 kc), transmitting	10	2X53-1070
Crystal Unit CR-8/U (1,075 kc), transmitting	10	2X53-1075
Crystal Unit CR-8/U (1,080 kc), transmitting	10	2X53-1080
Crystal Unit CR-8/U (1,085 kc), transmitting	10	2X53-1085
Crystal Unit CR-8/U (1,090 kc), transmitting	10	2X53-1090
Crystal Unit CR-8/U (1,095 kc), transmitting	10	2X53-1095
Crystal Unit CR-8/U (1,100 kc), transmitting	10	2X53-1100
Crystal Unit CR-8/U (1,105 kc), transmitting	10	2X53-1105
Crystal Unit CR-8/U (1,110 kc), transmitting	10	2X53-1110
Crystal Unit CR-8/U (1,115 kc), transmitting	10	2X53-1115
Crystal Unit CR-8/U (1,120 kc), transmitting	10	2X53-1120
Crystal Unit CR-8/U (1,125 kc), transmitting	10	2X53-1125
Crystal Unit CR-8/U (1,130 kc), transmitting	10	2X53-1130
Crystal Unit CR-8/U (1,135 kc), transmitting	10	2X53-1135
Crystal Unit CR-8/U (1,140 kc), transmitting	10	2X53-1140
Crystal Unit CR-8/U (1,145 kc), transmitting	10	2X53-1145
Crystal Unit CR-8/U (1,150 kc), transmitting	10	2X53-1150
Crystal Unit CR-8/U (1,155 kc), transmitting	10	2X53-1155
Crystal Unit CR-8/U (1,160 kc), transmitting	10	2X53-1160
Crystal Unit CR-8/U (1,165 kc), transmitting	10	2X53-1165
Crystal Unit CR-8/U (1,170 kc), transmitting	10	2X53-1170
Crystal Unit CR-8/U (1,175 kc), transmitting	10	2X53-1175
Crystal Unit CR-8/U (1,180 kc), transmitting	10	2X53-1180
Crystal Unit CR-8/U (1,185 kc), transmitting	10	2X53-1185
Crystal Unit CR-8/U (1,190 kc), transmitting	10	2X53-1190
Crystal Unit CR-8/U (1,195 kc), transmitting	10	2X53-1195
Crystal Unit CR-8/U (1,200 kc), transmitting	10	2X53-1200
Crystal Unit CR-8/U (1,205 kc), transmitting	10	2X53-1205
Crystal Unit CR-8/U (1,210 kc), transmitting	10	2X53-1210
Crystal Unit CR-8/U (1,215 kc), transmitting	10	2X53-1215
Crystal Unit CR-8/U (1,220 kc), transmitting	10	2X53-1220
Crystal Unit CR-8/U (1,225 kc), transmitting	10	2X53-1225
Crystal Unit CR-8/U (1,230 kc), transmitting	10	2X53-1230
Crystal Unit CR-8/U (1,235 kc), transmitting	10	2X53-1235
Crystal Unit CR-8/U (1,240 kc), transmitting	10	2X53-1240
Crystal Unit CR-8/U (1,245 kc), transmitting	10	2X53-1245
Crystal Unit CR-8/U (1,250 kc), transmitting	10	2X53-1250
Crystal Unit CR-8/U (1,255 kc), transmitting	10	2X53-1255
Crystal Unit CR-8/U (1,260 kc), transmitting	10	2X53-1260
Crystal Unit CR-8/U (1,265 kc), transmitting	10	2X53-1265
Crystal Unit CR-8/U (1,270 kc), transmitting	10	2X53-1270

Description	Quantity	Stock No.
Crystal Unit CR-8/U (1,585 kc), transmitting	10	2X53-1585
Crystal Unit CR-8/U (1,590 kc), transmitting	10	2X53-1590
Crystal Unit CR-8/U (1,595 kc), transmitting	10	2X53-1595
Crystal Unit CR-8/U (1,600 kc), transmitting	10	2X53-1600
Crystal Unit CR-8/U (1,605 kc), transmitting	10	2X53-1605
Crystal Unit CR-8/U (1,610 kc), transmitting	10	2X53-1610
Crystal Unit CR-8/U (1,615 kc), transmitting	10	2X53-1615
Crystal Unit CR-8/U (1,620 kc), transmitting	10	2X53-1620
Crystal Unit CR-8/U (1,625 kc), transmitting	10	2X53-1625
Crystal Unit CR-8/U (1,630 kc), transmitting	10	2X53-1630
Crystal Unit CR-8/U (1,635 kc), transmitting	10	2X53-1635
Crystal Unit CR-8/U (1,640 kc), transmitting	10	2X53-1640
Crystal Unit CR-8/U (1,645 kc), transmitting	10	2X53-1645
Crystal Unit CR-8/U (1,650 kc), transmitting	10	2X53-1650
Crystal Unit CR-8/U (1,655 kc), transmitting	10	2X53-1655
Crystal Unit CR-8/U (1,660 kc), transmitting	10	2X53-1660
Crystal Unit CR-8/U (1,665 kc), transmitting	10	2X53-1665
Crystal Unit CR-8/U (1,670 kc), transmitting	10	2X53-1670
Crystal Unit CR-8/U (1,675 kc), transmitting	10	2X53-1675
Crystal Unit CR-8/U (1,680 kc), transmitting	10	2X53-1680
Crystal Unit CR-8/U (1,685 kc), transmitting	10	2X53-1685
Crystal Unit CR-8/U (1,690 kc), transmitting	10	2X53-1690
Crystal Unit CR-8/U (1,695 kc), transmitting	10	2X53-1695
Crystal Unit CR-8/U (1,700 kc), transmitting	10	2X53-1700
Crystal Unit CR-8/U (1,705 kc), transmitting	10	2X53-1705
Crystal Unit CR-8/U (1,710 kc), transmitting	10	2X53-1710
Crystal Unit CR-8/U (1,715 kc), transmitting	10	2X53-1715
Crystal Unit CR-8/U (1,720 kc), transmitting	10	2X53-1720
Crystal Unit CR-8/U (1,725 kc), transmitting	10	2X53-1725
Crystal Unit CR-8/U (1,730 kc), transmitting	10	2X53-1730
Crystal Unit CR-8/U (1,735 kc), transmitting	10	2X53-1735
Crystal Unit CR-8/U (1,740 kc), transmitting	10	2X53-1740
Crystal Unit CR-8/U (1,745 kc), transmitting	10	2X53-1745
Crystal Unit CR-8/U (1,750 kc), transmitting	10	2X53-1750
Crystal Unit CR-8/U (1,755 kc), transmitting	10	2X53-1755
Crystal Unit CR-8/U (1,760 kc), transmitting	10	2X53-1760
Crystal Unit CR-8/U (1,765 kc), transmitting	10	2X53-1765
Crystal Unit CR-8/U (1,770 kc), transmitting	10	2X53-1770
Crystal Unit CR-8/U (1,775 kc), transmitting	10	2X53-1775
Crystal Unit CR-8/U (1,780 kc), transmitting	10	2X53-1780
Crystal Unit CR-8/U (1,785 kc), transmitting	10	2X53-1785
Crystal Unit CR-8/U (1,790 kc), transmitting	10	2X53-1790
Crystal Unit CR-8/U (1,795 kc), transmitting	10	2X53-1795
Crystal Unit CR-8/U (1,800 kc), transmitting	10	2X53-1800
Crystal Unit CR-8/U (1,810 kc), transmitting	10	2X53-1810
Crystal Unit CR-8/U (1,820 kc), transmitting	10	2X53-1820
Crystal Unit CR-8/U (1,830 kc), transmitting	10	2X53-1830
Crystal Unit CR-8/U (1,840 kc), transmitting	10	2X53-1840
Crystal Unit CR-8/U (1,850 kc), transmitting	10	2X53-1850
Crystal Unit CR-8/U (1,860 kc), transmitting	10	2X53-1860
Crystal Unit CR-8/U (1,870 kc), transmitting	10	2X53-1870
Crystal Unit CR-8/U (1,880 kc), transmitting	10	2X53-1880
Crystal Unit CR-8/U (1,890 kc), transmitting	10	2X53-1890
Crystal Unit CR-8/U (3,250 kc), transmitting	10	2X53-3250
Crystal Unit CR-8/U (3,260 kc), transmitting	10	2X53-3260
Crystal Unit CR-8/U (3,270 kc), transmitting	10	2X53-3270
Crystal Unit CR-8/U (3,280 kc), transmitting	10	2X53-3280
Crystal Unit CR-8/U (3,290 kc), transmitting	10	2X53-3290
Crystal Unit CR-8/U (3,300 kc), transmitting	10	2X53-3300
Crystal Unit CR-8/U (3,310 kc), transmitting	10	2X53-3310
Crystal Unit CR-8/U (3,320 kc), transmitting	10	2X53-3320
Crystal Unit CR-8/U (3,330 kc), transmitting	10	2X53-3330

Description	Quantity	Stock No.
Crystal Unit CR-8/U (5,820 kc), transmitting	10	2X53-5820
Crystal Unit CR-8/U (5,830 kc), transmitting	10	2X53-5830
Crystal Unit CR-8/U (5,840 kc), transmitting	10	2X53-5840
Crystal Unit CR-8/U (5,850 kc), transmitting	10	2X53-5850
Crystal Unit CR-8/U (5,860 kc), transmitting	10	2X53-5860
Crystal Unit CR-8/U (5,870 kc), transmitting	10	2X53-5870
Crystal Unit CR-8/U (5,880 kc), transmitting	10	2X53-5880
Crystal Unit CR-8/U (5,890 kc), transmitting	10	2X53-5890
Crystal Unit CR-8/U (5,900 kc), transmitting	10	2X53-5900
Crystal Unit CR-8/U (5,910 kc), transmitting	10	2X53-5910
Crystal Unit CR-8/U (5,920 kc), transmitting	10	2X53-5920
Crystal Unit CR-8/U (5,930 kc), transmitting	10	2X53-5930
Crystal Unit CR-8/U (5,940 kc), transmitting	10	2X53-5940
Crystal Unit CR-8/U (5,950 kc), transmitting	10	2X53-5950
Crystal Unit CR-8/U (5,960 kc), transmitting	10	2X53-5960
Crystal Unit CR-8/U (5,970 kc), transmitting	10	2X53-5970
Crystal Unit CR-8/U (5,980 kc), transmitting	10	2X53-5980
Crystal Unit CR-8/U (5,990 kc), transmitting	10	2X53-5990
Crystal Unit CR-8/U (6,000 kc), transmitting	10	2X53-6000

CHAPTER 5

THEORY

Section I. THEORY OF RECEIVER SECTION OF RADIO SET AN/GRC-9-GY

78. Block Diagram (fig. 55)

a. GENERAL. The receiver section of Receiver-Transmitter RT-77/GRC-9-GY consists of a 7-tube superheterodyne receiver designed for the reception of c-w and a-m signals over a frequency range of from 2.0 to 12.0 mc. Three bands are used to cover this range; band 1 covers from 6.6 to 12.0 mc, band 2 covers from 3.6 to 6.6 mc, and band 3 covers from 2.0 to 3.6 mc. The block diagram (fig. 55) shows the signal path through the receiver. A complete schematic diagram is shown in figure 125. The same antenna is used for transmitting and receiving; switching between the two sections is accomplished by a relay in the transmitter, which is operated by the key or press-to-talk switch on the microphone.

b. FIRST R-F AMPLIFIER. The signal is fed from the antenna to the tuned r-f amplifier V1. The r-f amplifier not only increases the signal voltage, but serves to isolate the oscillator section of tube V2 from the antenna, and also stops unwanted signals from entering the converter.

c. CONVERTER. The signal then is fed to the mixer section of the combination mixer and oscillator tube V2. The oscillator section of tube V2 produces an h-f oscillator voltage which is 456 kc higher than the signal frequency. This voltage is combined with the received signal in the mixer section of tube V2 to produce a difference beat frequency of 456 kc which is then amplified by the i-f tubes, V3 and V4.

d. I-F AMPLIFIER. The i-f amplifier is a high-gain circuit which is permanently tuned to the frequency difference between the h-f oscillator and the incoming r-f signal, and is thus a constant, single-frequency amplifier, operating on 456 kc. Most of the signal amplification occurs in tube stages V3 and V4.

e. DETECTOR AND FIRST A-F AMPLIFIER. The amplified signal is fed to the detector tube, V5, for demodulation. V5 is a dual tube, which serves as a detector and a first a-f (audio-frequency) amplifier. The detector stage also produces the avc (automatic volume control) voltage which is used to control the bias voltage on the grids of tubes V3 and V1. A bfo tube, V7, is used in conjunction with the detector stage for the reception of unmodulated c-w signals. After demodulation, the signal is fed to the other part of V5, the first a-f amplifier, where it is further amplified and then applied to the final a-f power amplifier V6.

f. FINAL AUDIO POWER AMPLIFIER. The output of the power amplifier V6 is applied across an impedance matching output transformer which permits headset or loudspeaker loads of 250 or 4,000 ohms impedance to be connected to the set.

g. CRYSTAL OSCILLATOR CALIBRATOR. Tube V4 is used as a crystal oscillator in addition to serving as a second i-f amplifier. A 200-kc crystal is installed in the set and operates in conjunction with V4 to generate harmonics of 200 kc which are fed back to the control grid of V1. These harmonics are used to check the dial calibration of the receiver.

h. BEAT-FREQUENCY OSCILLATOR. The bfo, tube V7 (tube type 1R5), is a circuit designed to allow the operator of the set to hear unmodulated c-w signals. The bfo generates a signal of 228 kc, whose second harmonic, 456 kc, is used to beat against the incoming i-f signal. If the receiver tuning dial is slightly detuned, the bfo harmonic will then beat against the i-f signal and produce an audible beat note which is passed on to the a-f amplifiers and can be heard in the headset. The pitch of the note is dependent on the amount of detuning.

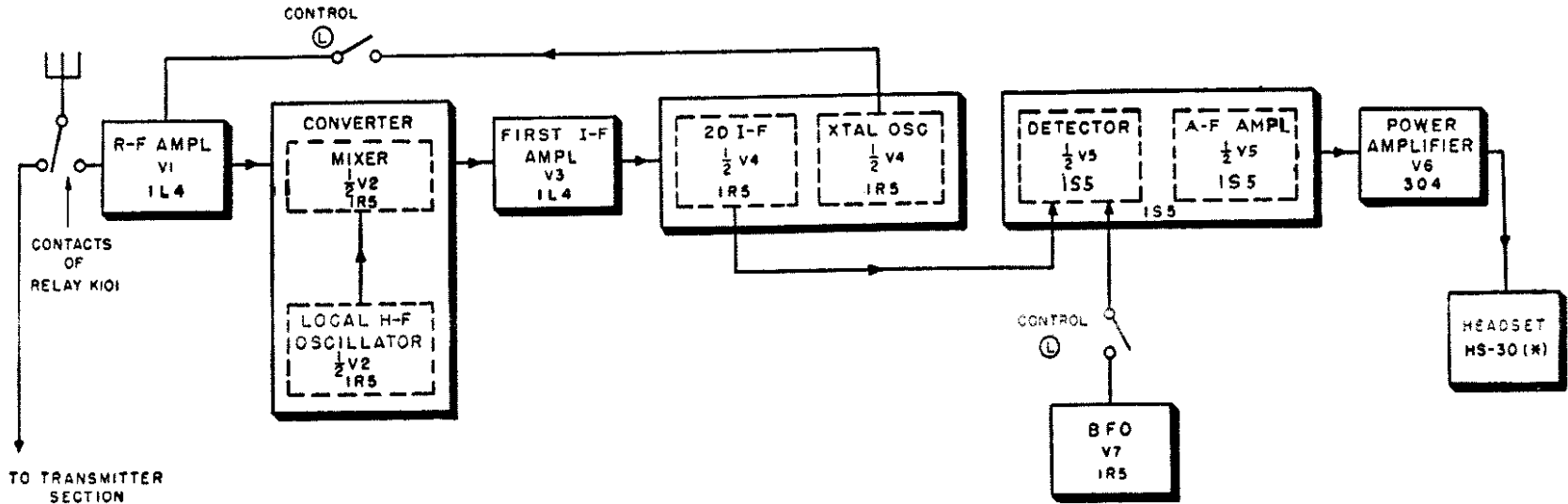


Figure 55. Block diagram of receiver section of receiver-transmitter RT-77/GRC-9-GY.

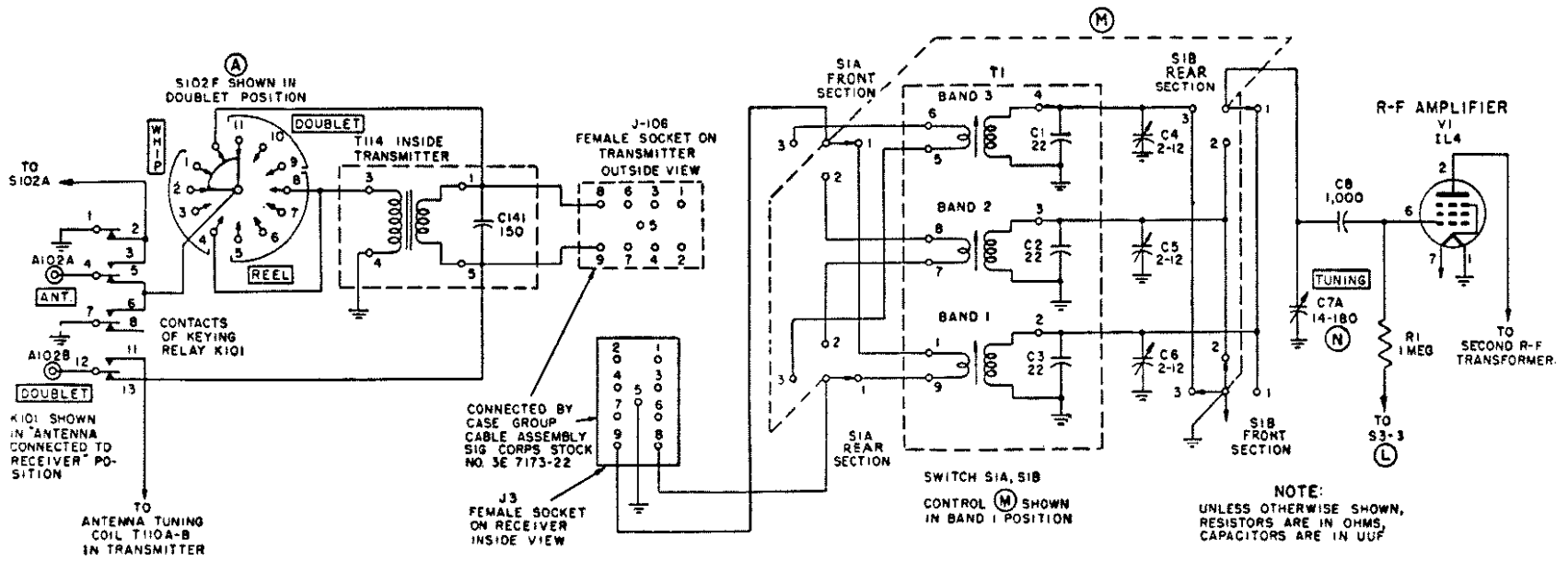


Figure 56. Antenna switching and tuning circuit for receiver.

i. SIDETONE MONITOR. When the transmitter is in operation, a portion of the transmitter modulation is fed to the receiver audio output transformer so that the intelligence going out from the transmitter can be heard in the receiver headset and thus monitored.

79. Antenna Switching and Tuning Circuits (fig. 56)

a. A vertical mast (whip), long-wire, or doublet antenna may be selected by means of the terminals in the upper left-hand corner of the transmitter. The signal is picked up by the antenna and is fed to the contacts of keying relay K101. The relay is controlled by both the transmitter key and the press-to-talk switch on the microphone, and automatically connects the antenna to the transmitter when either of these is operated. The antenna is connected to the receiver at all times that the key or microphone is not in use. Receiver operation only will be described in this section.

b. The signal leaves the relay contacts and is fed to control A, antenna selector switch S102F, which connects the antenna to the matching transformer, T114. Transformer T114 is located inside the transmitter cabinet. When a doublet is used, it is connected to the ANT. and DOUBLET binding posts. With antenna selector switch A in DOUBLET positions 9, 10, or 11, the doublet antenna is connected across the secondary of transformer T114. The impedance of the doublet should be from 50 to 72 ohms for a proper match. When a mast or long antenna is used, it is connected to the ANT. binding post. With antenna selector switch A in WHIP positions 1, 2, 3, and 4, or REEL positions 5, 6, 7, and 8, the antenna is connected to the primary of transformer T114.

c. From T114, the signal is fed to female plug J106 on the transmitter and is connected to the receiver female plug by means of a cable with male plugs on both ends. The female plug J3 on the receiver is connected through switch S1A to antenna transformer T1 which contains three tuned circuits used to tune the antenna to resonance. Switch S1A is a 3-position band change switch, marked M on the receiver panel, which applies the signal to the proper tuned circuit for the band selected. Each switch wafer is actually in two sections: The section

nearest the control knob is denoted as the front section (fig. 56), while the section behind it or furthest from the knob is the rear section.

d. Considering only band 1, capacitor C3 is inside of transformer T1 and is part of the total tuning capacity. C3 is a temperature compensating capacitor. Capacitor C6 is the antenna trimmer and is used to adjust the h-f end of band 1. These two capacitors in conjunction with N tuning capacitor C7A (antenna section of the receiver gang) are in parallel, and they tune the input circuit to resonance with the incoming signal. The lower end of band 1 is adjusted by varying the position of the transformer iron core slug. The selected r-f signal in the resonant secondary circuit is coupled to the control grid of r-f amplifier V1 by the coupling capacitor C8. Capacitor C8 isolates the control grid d-c bias voltage of tube V1 from the tuning circuit. Switch S1B is a double-section switch, having a front and a rear part. The rear section selects the output of the tuning circuit which is being used. The front section of switch S1B shorts to ground the two unused secondaries of transformer T1.

80. R-F Amplifier V1 (fig. 57)

a. The first stage of the receiver section is an r-f amplifier which uses tube type 1L4. Resistor R1 is the grid resistor across which the selected signal voltage is applied. In addition, this resistor permits the application of the avc voltage, but does not allow the currents to be shorted to ground through the avc filter capacitor C33. The amplified output of V1 is coupled through band change switch S1C to the second r-f transformer T2. The secondary of T2 is tuned by tuning capacitor C7B. Considering only band 1, capacitor C7B works in conjunction with trimmer C17 and fixed capacitor C14. Capacitor C9 bypasses the screen-dropping resistors so that r-f currents will not flow through these resistors and cause degeneration. Resistor R2 is the plate-dropping resistor and it is bypassed by capacitor C10 so that r-f will not flow into the d-c supply. The screen grid voltage of tube V1 is used as a means to control the r-f gain. This screen voltage is obtained across variable resistor R9, control P R.F. GAIN, and is fed through screen-dropping resistor R11 to the screen grid.

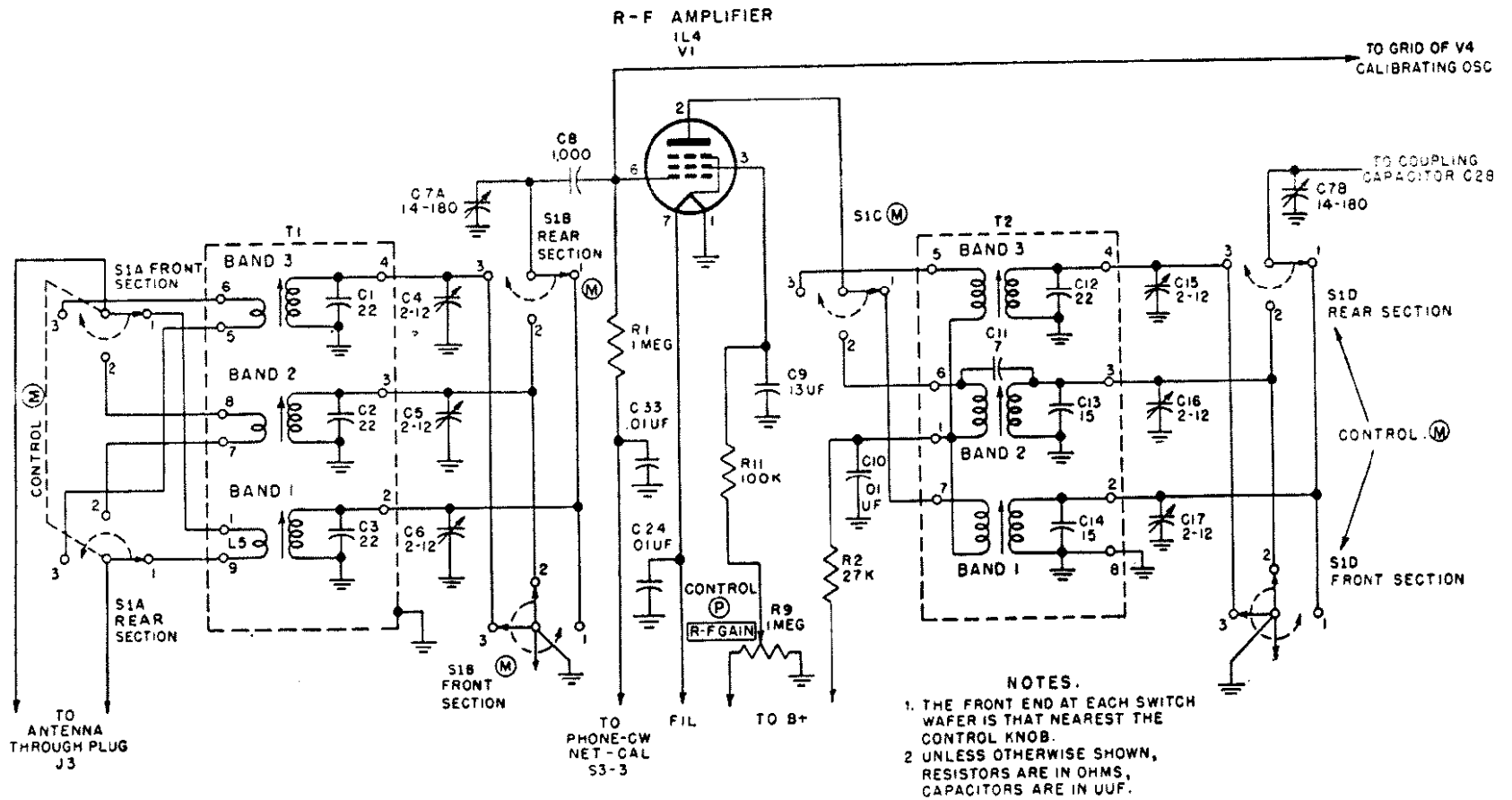


Figure 57. R-f amplifier, simplified schematic.

b. The signal leaves T2 and enters band switch S1D, rear section, from which it is then coupled, by means of capacitor C28, to the control grid of converter tube V2.

c. Capacitor C11 improves the coupling of band 2 at the higher frequencies. The front section of S1D shorts to ground the two tuned secondaries of T2, which are not being used.

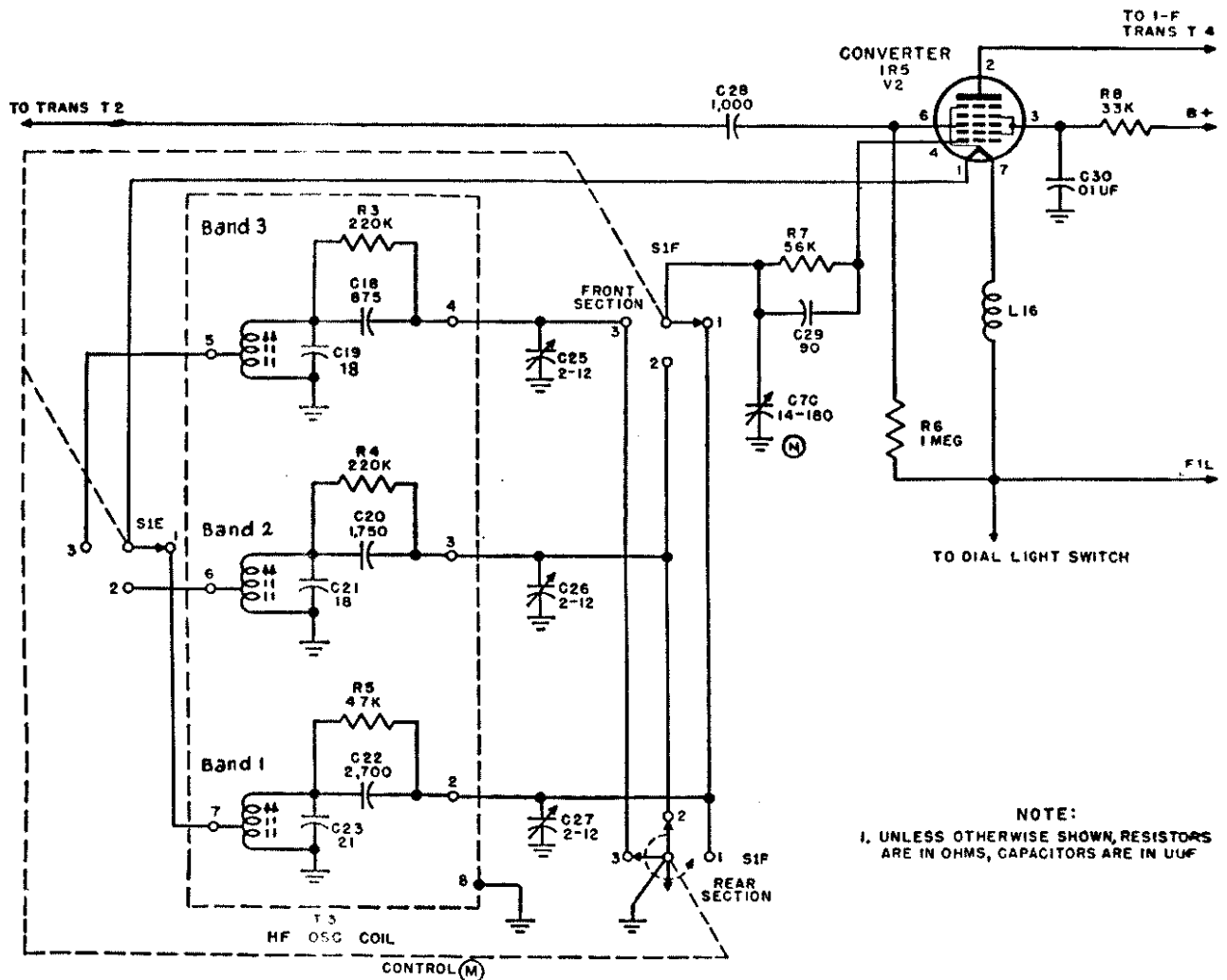


Figure 58. Converter stage, simplified schematic.

81. Converter Stage V2 (fig. 58)

a. The converter stage uses tube type 1R5 as a combined mixer and h-f oscillator of the series fed Hartley type, using the first two grids and the filament.

b. The resonant circuit in the oscillator portion of V2 is formed by one coil of T3, which is selected by switches S1E and S1F and, assuming band 1 is chosen, is tuned to resonance by the ganged capacitor C7C N, adjustable

trimmer C27, and capacitor C23. Capacitor C23 is used as a frequency corrector for temperature changes. When the temperature increases, the coil inductance increases, thus lowering the frequency; however, the capacitor is so made as to decrease its capacity when the temperature increases. The decreased capacitance opposes the increased inductance and the temperature effect on tuning is nullified.

c. Resistor-capacitor combination R5 and C22 provides the grid-leak bias for the oscillator grid (band 1) pin 4 of tube V2.

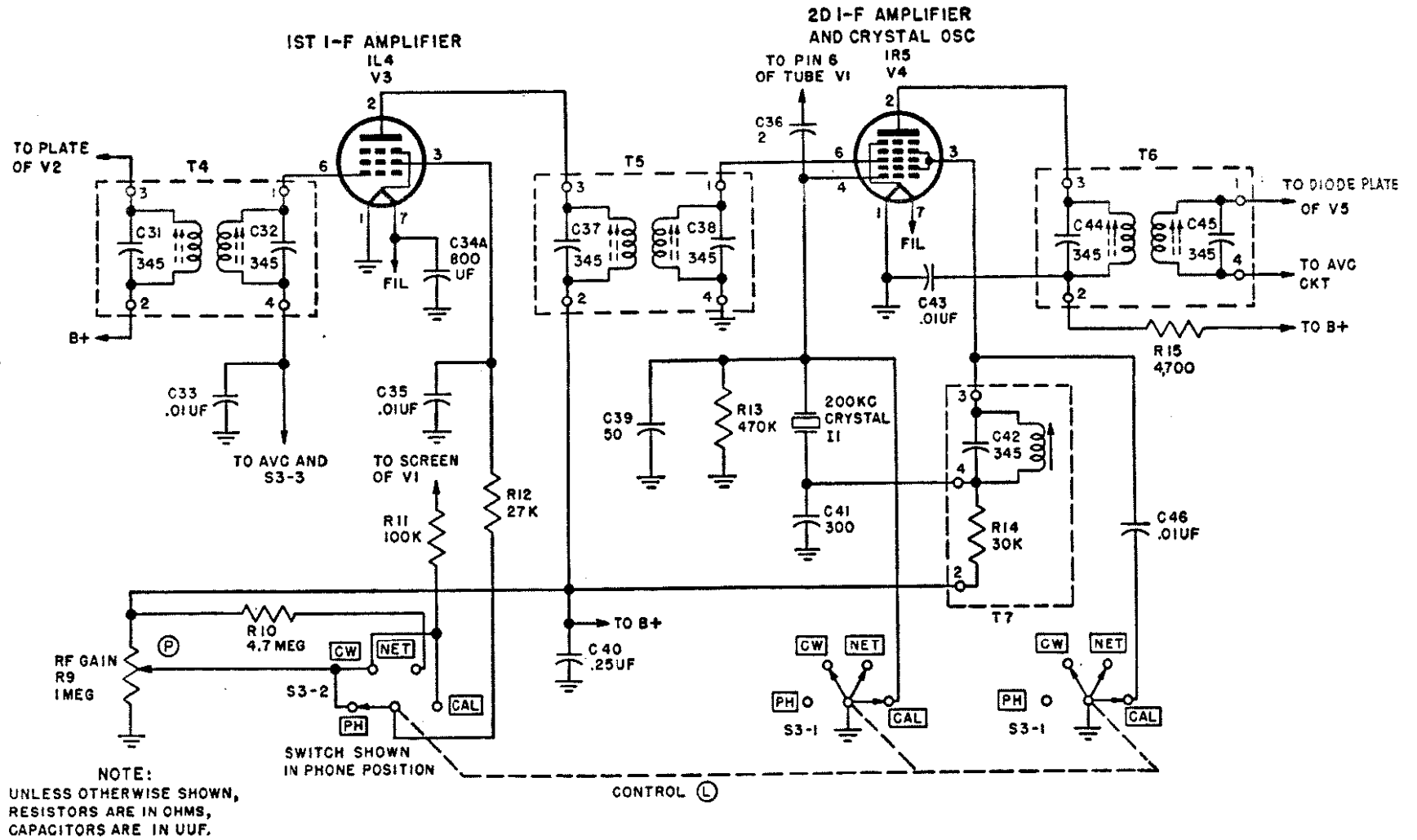


Figure 59. I-f amplifiers, simplified schematic.

d. Resistor-capacitor combination R7 and C29 is placed in the grid circuit to provide additional bias.

e. Grid 2, pin 3 of tube V2, acts as the oscillator plate and receives its plate voltage through resistor R8 which is bypassed to ground for r-f through capacitor C30.

f. Choke coil L16 prevents r-f currents from entering the filament circuit and causing disturbances in the other tubes. Resistor R6 is the signal grid return resistor.

g. The h-f oscillator is tuned by N TUNING capacitor C7C so that it is always 456 kc higher in frequency than the signal frequency. Thus, when the received signal from the r-f amplifier is applied to grid 3, pin 6 of tube V2, the two frequencies will beat together, forming sum and difference frequencies. The tuned primary of i-f transformer T4 in the plate of the mixer section is resonant at the difference frequency of 456 kc and, therefore, allows only this frequency to continue on to the first i-f amplifier V3 (fig. 59). The primary and secondary of i-f transformer T4 are shunted by capacitors C31 and C32, respectively. These capacitors, combined with adjustable powdered iron cores inserted in the primary and secondary coils, tune the transformer to 456 kc.

82. I-F Amplifiers V3 and V4 (fig. 59)

a. Two i-f amplifier stages are used, the first stage, V3, using tube type 1L4, and the second stage, V4, using tube type 1R5. The 456-kc signal leaves the transformer T4 secondary and is applied to V3. The gain of V3 is controlled by the voltage on the screen grid, pin 3, which is fed through resistor R12 from switch S3-2. Switch S3-2, control L, leads to potentiometer R9, control P R.F. GAIN, which is across the plate supply voltage. The screen grid voltage for tube V3 may be controlled only when switch S3-2 is in the PHONE, C.W., or CAL. position. During net operation, the r-f gain may be varied by changing the screen voltage to the first r-f tube V1 only. Thus, switch S3-2 permits tube V3 to be used together with the tube V1, or not at all, to control the r-f gain. Also, during net operation, the gain of tube V3 is reduced because of the introduction of the larger screen circuit dropping resistor R10.

b. Capacitor C35 acts as a bypass for the screen voltage supply resistors, R12 and R9. Capacitor C33 is used as a filter capacitor for the avc voltage, supplying bias to the control grid, pin 6 of tube V3. Capacitor C33 also completes the r-f path from the low side of i-f transformer T4 to the filament of tube V3. Capacitor C40 is a bypass capacitor for the B+ supply line.

c. The output of V3 is fed through the primary of transformer T5 which is identical to T4 and the signal is applied to the input grid, pin 6 of tube V4. Tube V4, tube type 1R5, acts as a second i-f amplifier and crystal oscillator. When switch S3-1, control L, is in the PHONE, C.W., or NET position, the oscillator portion is shorted out and the tube acts as a straight i-f amplifier. There is no d-c grid bias on the signal grid of V4 since the low side of i-f transformer T5 is connected directly to the filament, pin 1 of V4. Plate voltage is fed through r-f filter resistor R15, which is bypassed to the filament by filter capacitor C43.

d. The amplified output signal from V4 is fed to i-f transformer T6, which is identical to T5 and T4; from T6, the signal is applied to the detector tube V5.

83. Crystal Calibrating Circuit (fig. 60)

a. A crystal calibrating circuit is included as part of the second i-f stage and utilizes grids 1 and 2 of tube V4. Grid 1 (pin 4) is the oscillator grid, and the screen grid (pin 3) is used as the oscillator plate. This circuit is resonant at 200 kc and provides the means of checking accurately the receiver calibration at 200-kc intervals. This oscillator will operate only when switch S3-1 is in the CAL. position. Calibration of the receiver is obtained by feeding harmonics of the crystal oscillator signal from the oscillator grid (pin 4) through coupling capacitor C36 to the control grid of V1.

b. This signal is amplified by the first r-f amplifier and fed to the signal grid, pin 6 of the converter tube V2. In this tube it is mixed with the h-f oscillator signal to form an i-f signal of 456 kc which is passed on through the intermediate amplifier stages. Upon leaving i-f transformer T6, the signal is mixed with the output of the bfo. Since the bfo generates a signal of

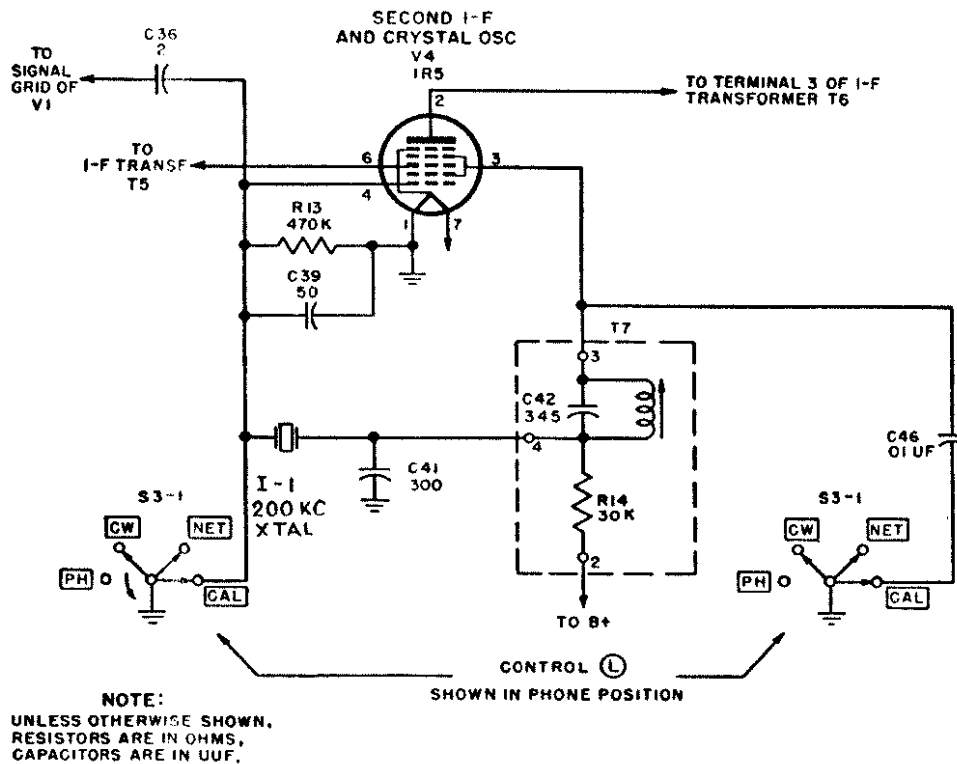


Figure 60. Crystal calibrator circuit.

456 kc, a zero beat results, because the i-f signal is also 456 kc.

c. The tuning dial is placed at any setting corresponding to a harmonic of the 200-kc crystal. If the r-f and h-f oscillator tuned circuits are not tuned exactly to the frequency stated on the dial, it will be evident that the converter tube will not produce an i-f signal of precisely 456 kc. It will then be necessary to detune the TUNING knob slightly so that a frequency of 456 kc will be produced to zero-beat with the 456-kc output signal of the bfo. The amount of detuning necessary to obtain zero beat is the error in the dial calibration. If the zero-beat note occurs when the dial number, corresponding to the crystal harmonic frequency, is exactly under the hairline, the receiver dial is accurately calibrated.

d. The calibration may in this manner be checked at any dial point which corresponds to a frequency equal to any of the harmonics of the crystal oscillator 200-kc crystal. The crystal oscillator therefore acts as a very accurate signal generator. An external oscillator

could be used but it is advantageous to have a self-contained signal generator, so that the receiver dial calibration can be checked at any time and at any place.

e. Transformer T7 is tuned to slightly higher than the crystal frequency of 200 kc, by means of capacitor C42 and an adjustable iron core. It is necessary for the tank circuit to be tuned to slightly above the crystal frequency, otherwise the circuit will not oscillate. Accurate adjustment of the iron core is made by the manufacturer and should not be disturbed.

f. Resistor R14 which is located within T7 is the screen grid voltage-dropping resistor. Capacitor C39 and grid leak resistor R13 develop the d-c bias voltage for the oscillator grid (pin 4). Capacitor C46 is the usual screen grid (pin 3) bypass when switch S3-1 is in any position but CAL. A plug-in type Crystal Unit CR-2/U-GY 200-kc crystal is used.

g. The crystal oscillator is prevented from working in any but the CAL. position by a section of switch S3-1 that returns grid 1 to ground.

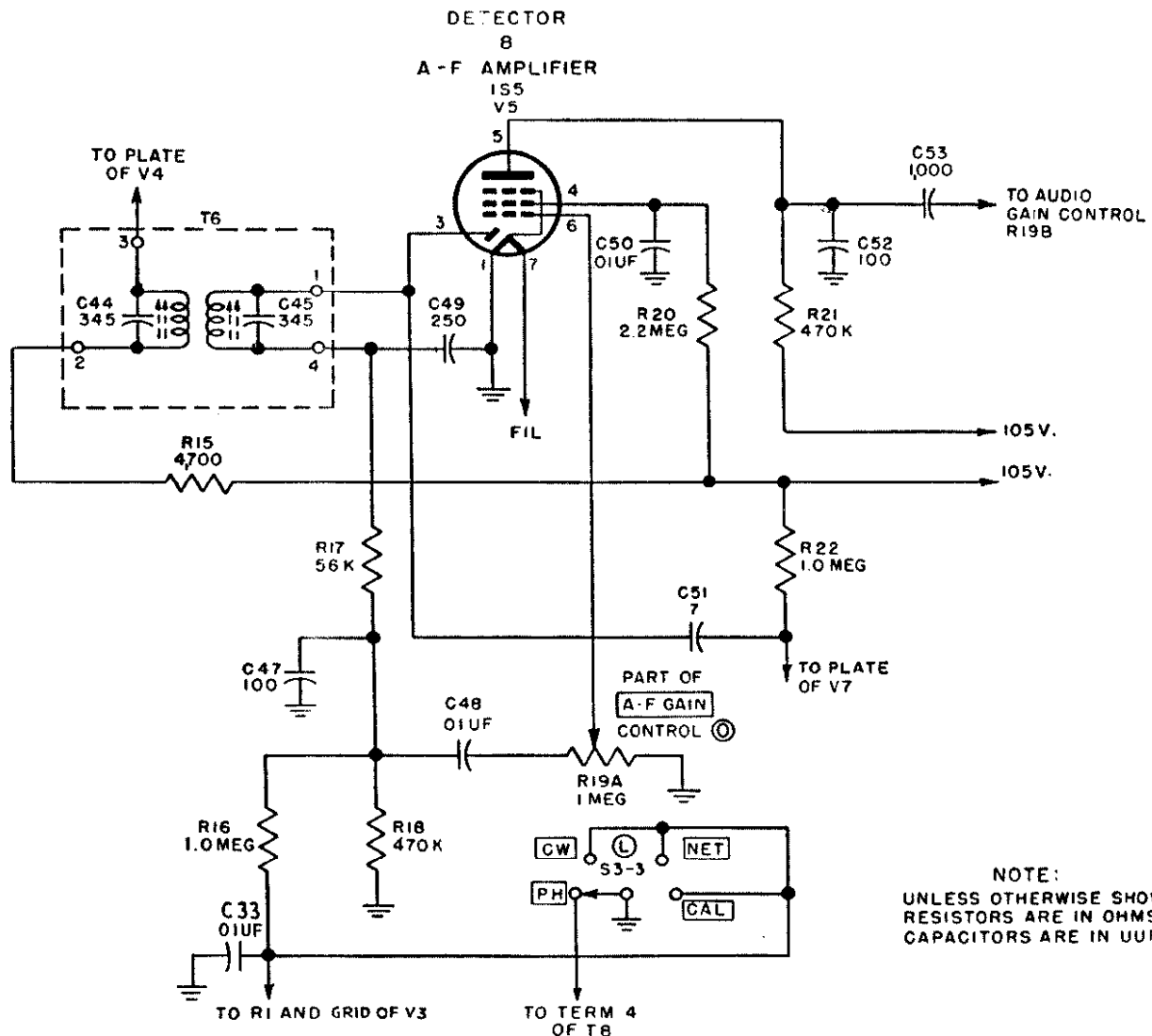


Figure 61. Detector and first audio amplifier, simplified schematic.

84. Detector and First Audio Amplifier (fig. 61)

a. The detector stage uses the diode section of V5, tube type 1S5, as a diode detector. The output of the secondary of T6 is applied to the diode section, pin 3 of V5, where the signal voltage is rectified. Resistor R18 is the diode load across which is developed the audio voltage and avc voltage. Shunted across the diode load is capacitor C49 which, along with R17 and C47, filters out the i-f component.

b. Resistor R16 and capacitor C33 constitute a filter circuit which supplies the avc voltage to the grids of tubes V1 and V3. This filter is

necessary to insure that only the d-c voltage and not the audio variations is applied to the avc controlled tubes. The avc voltage can be shorted to ground by means of switch S3-3, which is the case when any switch position but PHONE is in use.

c. The audio voltage appearing across the diode load resistors is tapped off above R18 and applied through coupling capacitor C48 to the A.F. GAIN control, R19A, marked O on the receiver panel. From there the a-f signal goes to the control grid, pin 6 of tube V5.

d. The d-c plate voltage is fed through plate load resistor R21 and the d-c screen voltage through dropping resistor R20 which is by-

passed by capacitor C50. Plate resistor R21 is also bypassed, but the value of capacitor C52 is so chosen that only i-f and not a-f is bypassed to ground.

e. Capacitor C53 couples the a-f signal to A.F. GAIN control R19B which is ganged to R19A. The signal is then fed directly to the control grid of tube V6.

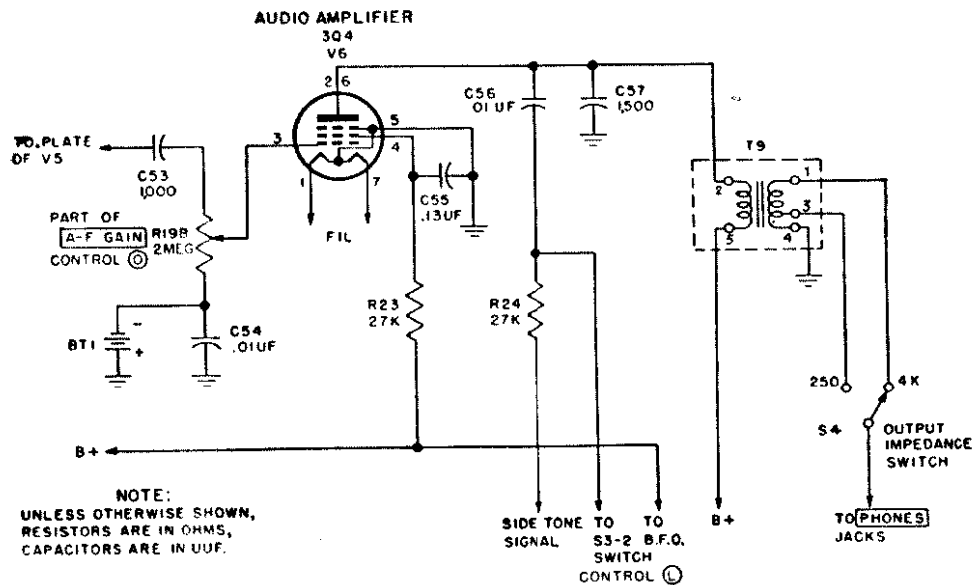


Figure 62. Second audio amplifier stage V6.

85. Second Audio Amplifier (fig. 62)

a. Variable resistor R19B is the second section of the A.F. GAIN control. Better control of the audio gain is effected by ganging together the first audio control for V5 and the control for V6. The grid of V6 is biased by means of bias cell BT1, fixed bias is used to minimize distortion. The bias cell is bypassed for audio by capacitor C54. The plate load of audio amplifier V6 is the audio output transformer T9 which provides secondary output impedances of 250 and 4,000 ohms. The required output impedance is selected by switch S4 which is located on the rear of the receiver chassis. Capacitor C57 bypasses unwanted h-f and improves the stability of the audio signal. The screen receives voltage from resistor R23 which is bypassed by C55.

b. A sidetone monitoring system is incorporated to monitor the transmitter. When switch S3-2, control L, is in the PHONE, C.W., or CAL. position and during operation of the transmitter, a sidetone signal is taken from the secondary of the modulation transformer in

the transmitter and is connected to the primary of the receiver output transformer through resistor R24 and coupling capacitor C56. The sidetone volume is adjusted by means of the sidetone volume control located on the transmitter. The sidetone is shorted to ground when switch S3-2 is in the NET position.

c. Two phone jacks are provided so that two headsets can be placed in parallel across the secondary of output transformer T9.

86. Beat-frequency Oscillator (fig. 63)

a. Since the received c-w code signal is not audible, it is necessary to provide means for producing an audible note. The bfo consists of an electron-coupled oscillator, the oscillator section being a series-fed Hartley circuit. The oscillator output, when beat against the amplified c-w i-f signal, produces an audible difference frequency. The fundamental of the bfo is 228 kc, but the second harmonic of 456 kc does the actual heterodyning.

b. The oscillator section of V7 uses grid 1 (pin 4) as the oscillator grid and uses grid 2

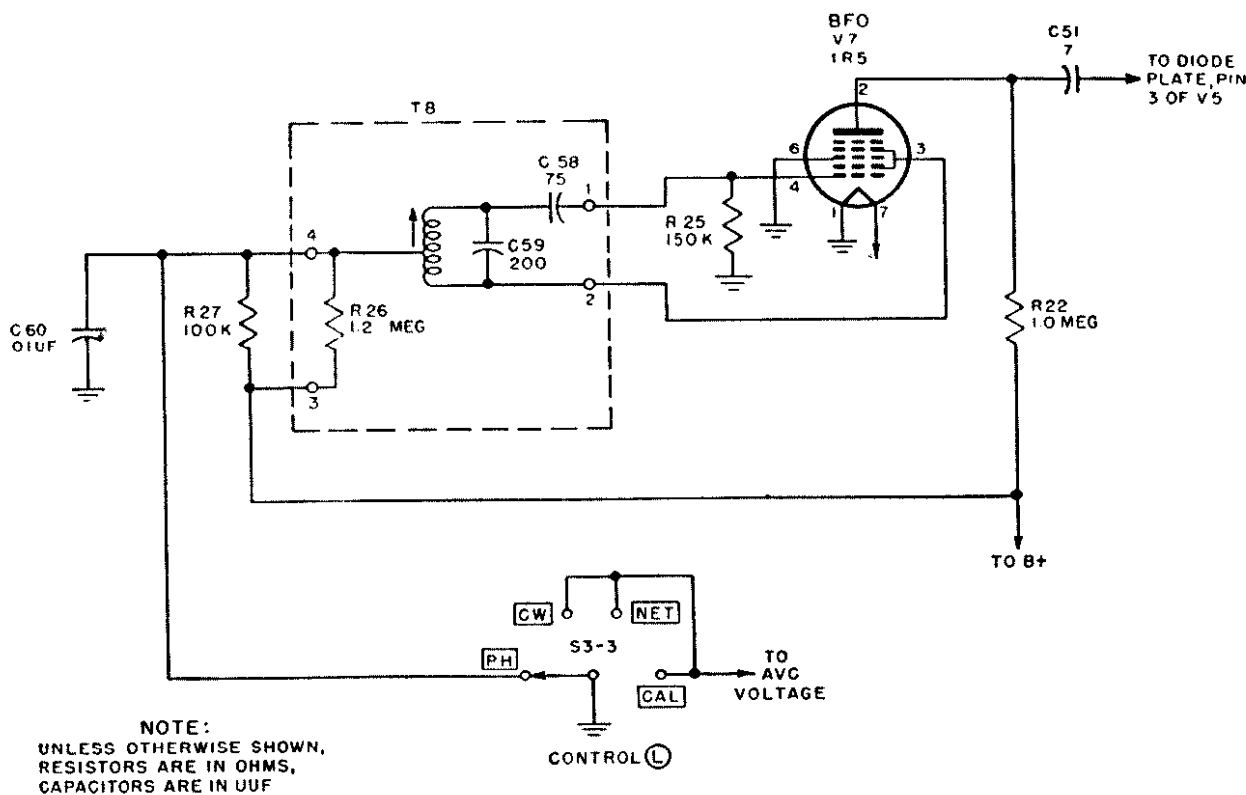


Figure 63. Beat-frequency oscillator.

(pin 3) as the oscillator plate. The coil of T8 is tapped at the correct point to maintain oscillations, and is directly connected for r-f, through capacitor C60, to the filament of V7. The tank coil is tuned to resonance by capacitor C59. Capacitor C58 is placed between the tank circuit and the oscillator grid so as to prevent the d-c voltage in the tank circuit from entering the oscillator grid circuit. The d-c bias is developed across grid-leak resistor R25, C58 acting as the grid leak capacitor. The oscillator plate (pin 3) receives its voltage through the parallel combination of resistors R26 and R27. The bfo is aligned by adjustment of a powdered iron slug in coil T8.

c. The oscillations produced by the oscillator section of V7 are electronically coupled to the plate circuit of V7, are amplified, and appear across resistor load R22. From resistor R22, the 456-kc signal is applied through capacitor C51 to the diode plate of detector tube V5. At the diode, it mixes with the incoming i-f signal and, if the main tuning capacitor is slightly detuned, there will be produced an audible beat note, the frequency of which is dependent on the amount of detuning. Capacitor C51 is

necessary to keep the d-c plate voltage of V7 off the diode plate of tube V5.

d. The bfo is made inoperative on PHONE by means of switch S3-3 which connects the center tap of the tank coil directly to ground, thereby shorting out the bfo plate voltage.

87. Receiver Filament Voltage Supply (fig. 64)

a. The dynamotor-power supply, the battery, or the hand-driven generator may be used to supply filament power. Connections of the various cables to the radio set can be seen from the cording diagram (fig. 42).

b. Cord CD-1086-GY connects either Dynamotor - Power Supply DY-88/GRC-9-GY or Generator GN-58-A-GY to male plug J102 on the transmitter, which in turn is connected to switch S103C, control E. Battery BA-48 also is connected to S103C and is in effect, in parallel with the generator and dynamotor. Switch S103C allows the battery to be used for the STANDBY position only. In the SEND position, only the dynamotor or the generator may be used.

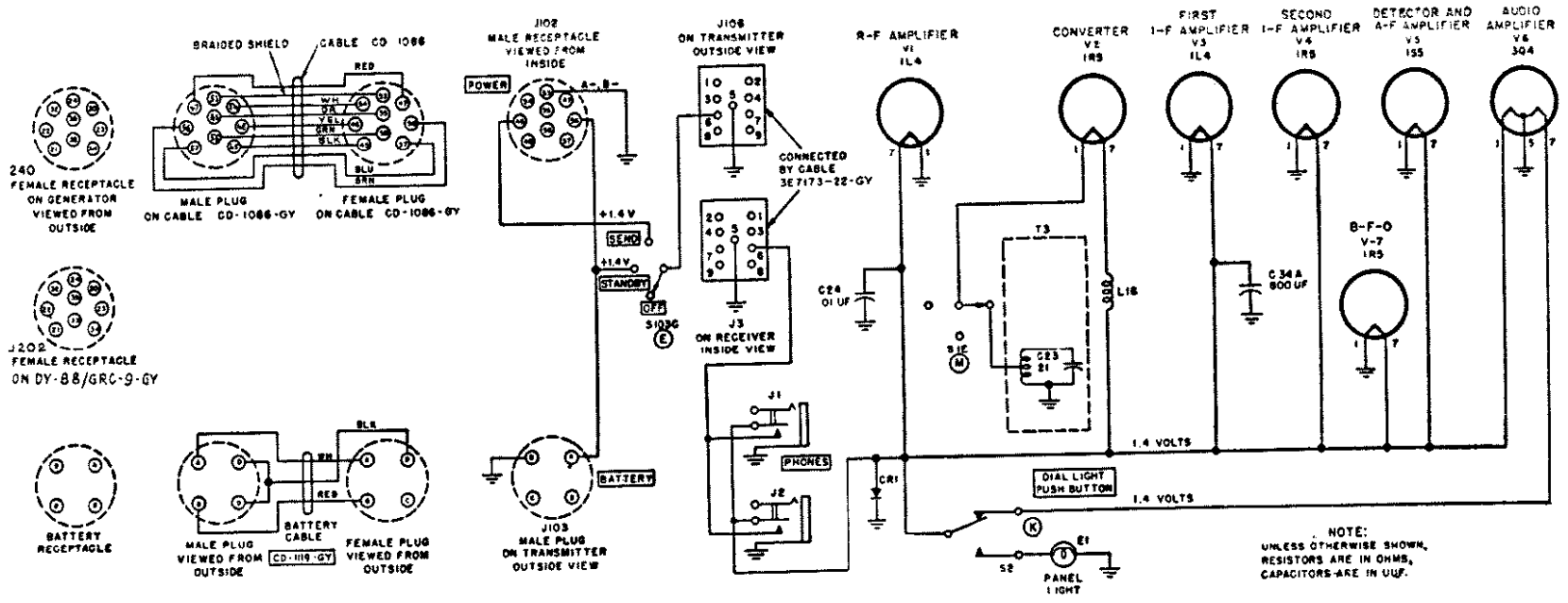


Figure 64. Receiver filament supply circuits.

c. Switch S103C then leads to the female transmitter jack, J106, which is connected by cable assembly 3E7173-22-GY to female receiver jack J3. Jack J3 is connected to the headphone jacks J1 and J2. These headphone jacks act as a switch; when the headphones are not plugged into the jack, the filament circuit is disconnected.

d. The filaments are all connected in parallel, including the two filaments in tube V6 (tube type 3Q4). The dial light switch S2, control K, disconnects one half of the filament of tube V6, and connects in its place the dial light E1.

e. CR1 is a selenium metallic rectifier which serves as a filament voltage regulator, maintaining it at 1.4 volts. Capacitor C24 is an r-f bypass which is so connected that the r-f will not enter the filament supply lines. Choke L16 in the filament lead of tube V2 also serves this purpose. The filament of V2 is connected to the h-f oscillator coils by means of band switch S1E, control M. C-34A acts as an r-f and i-f filter capacitor.

88. Receiver Plate and Screen Grid Circuits (fig. 65)

a. The plate and screen grid voltages are obtained from the generator, the dynamotor-power supply, or the battery. Either the generator or the dynamotor-power supply may be selected by means of connecting Cord CD-1086-GY, as shown in the cording diagram (fig. 42).

b. The selected power supply is connected through Cord CD-1086-GY to the transmitter receptacle J102. Receptacle J102 is then connected to switch S103D, control E, which determines if the battery is to be used instead of the generator or dynamotor-power supply. The contact marked STANDBY is connected to pin B on the battery plug and to pin 58 on J102. Pin 58 is connected by cable to pin 33 of generator receptacle 240. The generator wiring diagram (fig. 124) shows that pin 33 is not connected to anything. Therefore, on the STANDBY position of switch S103D, only the battery supplies power to the receiver. On the SEND position of control E, the battery is disconnected, and the receiver is connected through pin 57 on J102 to pin 21 on receptacle 240 and from there to the h-v coil on the generator.

c. From switch S103D, the voltage is applied across tube V104, a voltage regulator which keeps the voltage that is fed to the plate circuit equal to exactly 105 volts. The output of tube V104, pin 5, is externally connected to pin 3 which is internally connected to pin 7. Pin 7 is then connected to pin 4 on terminal board J106 and to contact 18 on keying relay K101. Relay K101 further determines whether pin 3 or pin 2 is to be connected to the supply voltage. Pin 4 is constantly energized, regardless of the position of relay K101, because it is directly connected to pin 7 of the voltage regulator tube V104.

d. Transmitter terminal board J106 is connected to receiver terminal board J3 through cable assembly 3E7173-22-GY. The plate voltages of tubes V5 and V6 only are obtained from pin 4 on J3. All other plate and screen voltages are obtained from pin 3 on J3.

e. When the transmitter section is not in use, contact 19 of relay K101 is connected with contact 18 to the power supply, and all the receiver tubes receive plate and screen grid voltage. However, when the transmitter key is depressed or the press-to-talk switch on the microphone is pushed, relay K101 disconnects contact 19 and connects contact 17 to the power supply. The disconnection of contact 19 removes screen voltage from all tubes, and plate voltage from all tubes but tubes V5 and V6.

f. In order to tune the transmitter to the receiver frequency for net operation, it is necessary that both the transmitter and receiver operate simultaneously. However, it has been pointed out that, because of relay K101, only the receiver or the transmitter may function at any one time, depending on the position of the key or microphone button. If the handkey is left up, the receiver will automatically obtain voltage since relay contacts 18 and 19 will remain closed. Thus it will be necessary only to short contacts 18 and 17 by some external means, to provide voltage to the transmitter. This is the function of switch S3-3, control L, located within the receiver cabinet. Figure 65 shows that relay contact 17 is connected to pin 2 on receptacle J106, which is in turn connected by cable assembly 3E7173-22-GY to pin 2 of receptacle J3 in the receiver cabinet. Pin 2 of receptacle J3 connects to the movable rotor of switch S3-3. When switch S3-3 is placed on NET

position pin 2 is directly connected to pin 4 on receptacle J3. This effectively shorts contacts 17 and 18 of relay K101, thus supplying voltage to the transmitter tubes. Only some of the transmitter tubes are energized to permit net operation.

g. The plates of tubes V5 and V6 receive their voltage through dropping resistor R29

while the plate and screen currents of the other tubes pass through resistor R28. This is done so that the low-frequency audio signals of V5 and V6 cannot modulate the r-f signals in the other tubes, or cause oscillations, which might occur if allowed to pass through the same dropping resistor used by the r-f and i-f stages.

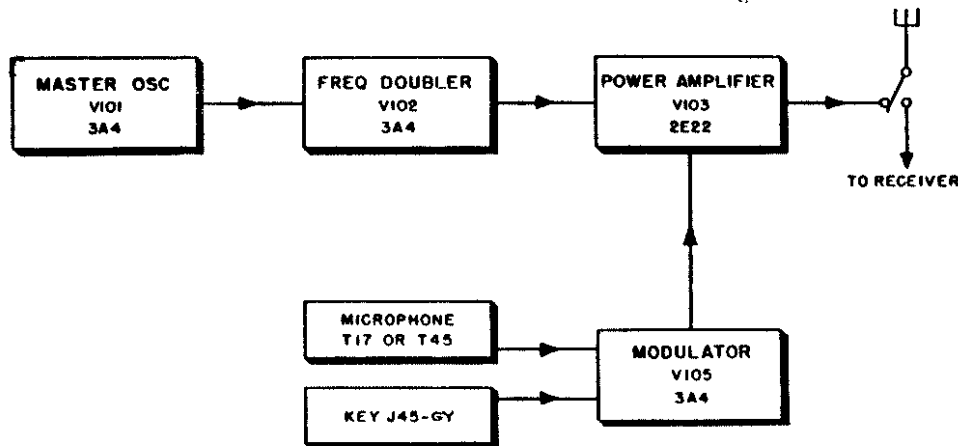


Figure 66. Block diagram of transmitter section of receiver-transmitter RT-77/GRC-9-GY.

Section II. THEORY OF TRANSMITTER SECTION OF RADIO SET AN/GRC-9-GY

89. Block Diagram

(fig. 66)

a. GENERAL. The transmitter section of Receiver-Transmitter RT-77/GRC-9-GY consists of a master oscillator, frequency doubler, power amplifier, and modulator circuit as shown in the block diagram (fig. 66). The circuit is designed to provide c-w, mcw, and voice modulated signals over a frequency range of 2.0 to 12.0 mc. As in the case of the receiver, the frequency range is covered in three bands, 2.0 to 3.6 mc, 3.6 to 6.6 mc, and 6.6 to 12.0 mc.

b. BLOCK DIAGRAM (fig. 66). The block diagram shows a master oscillator, which can be either self-excited or crystal-controlled, to supply an r-f signal voltage to the grid of the doubler stage whose plate circuit is tuned to the second harmonic of the input signal. The output of this stage is fed to the grid of the power amplifier stage at a sufficient power level to drive the power amplifier as a Class C amplifier. The modulator circuit supplies the audio power necessary to suppress grid modulate the power amplifier during phone and mcw operation. The

output of the power amplifier is then coupled to the antenna through a suitable coupling network.

90. Master Oscillator (Noncrystal-controlled) Tube V101, Tube Type 3A4

(fig. 67)

a. The oscillator section of the transmitter may be either crystal-controlled or a self-excited tuned-plate tickler coil feedback oscillator. For the present, the noncrystal-controlled master oscillator will be discussed for band 1.

b. The upper coil of assembly T101 is in the plate circuit of V101 and is tuned to any frequency from 3.3 to 6 mc, considering band 1 only, by means of ganged capacitor C101A, control I, alignment trimmer C106B, calibrating capacitor C102, control H, and fixed capacitor C149. Ganged capacitor C101A is plugged into terminal board J101A, and is therefore a complete plug-in unit. Plate voltage to V101 is applied through filter resistor R103 which is bypassed for r-f by filter capacitor C104 and resistors R105, R120, and R121. Screen grid

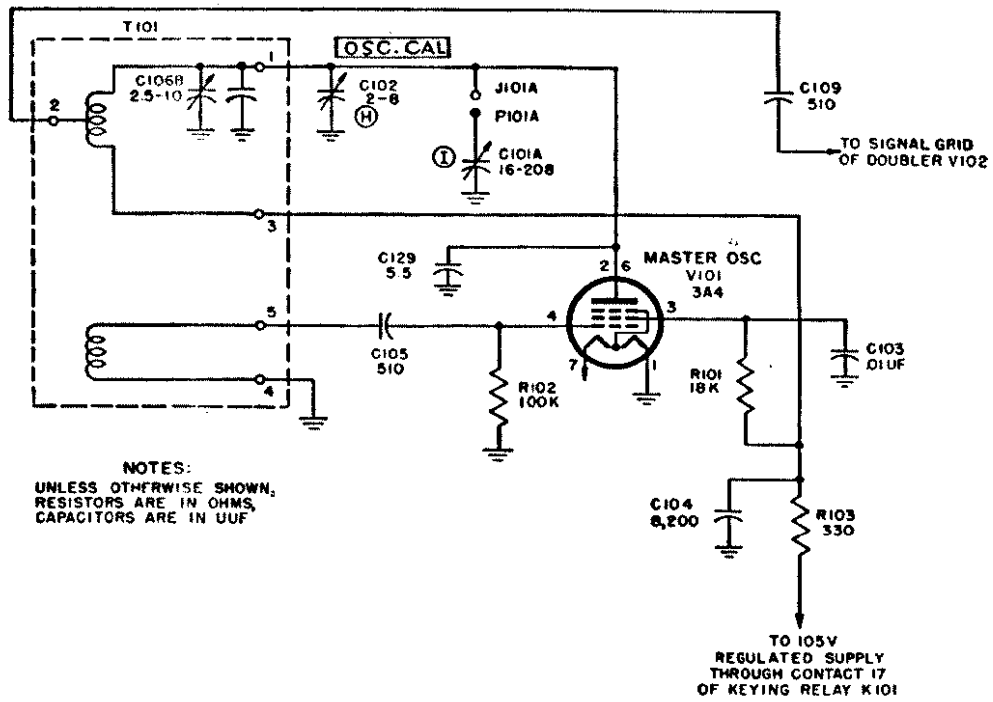


Figure 67. Transmitter master oscillator, simplified schematic.

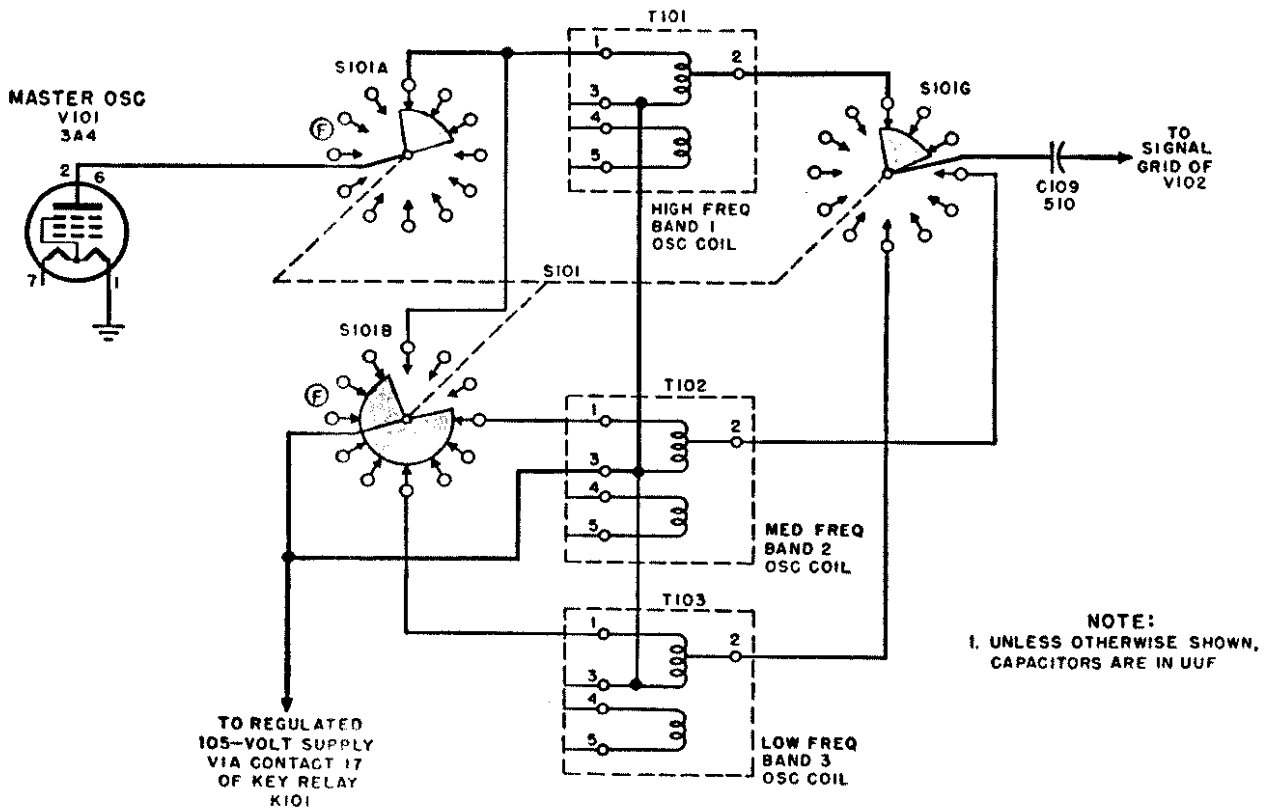


Figure 68. Master oscillator switch sections S101A and S101B.

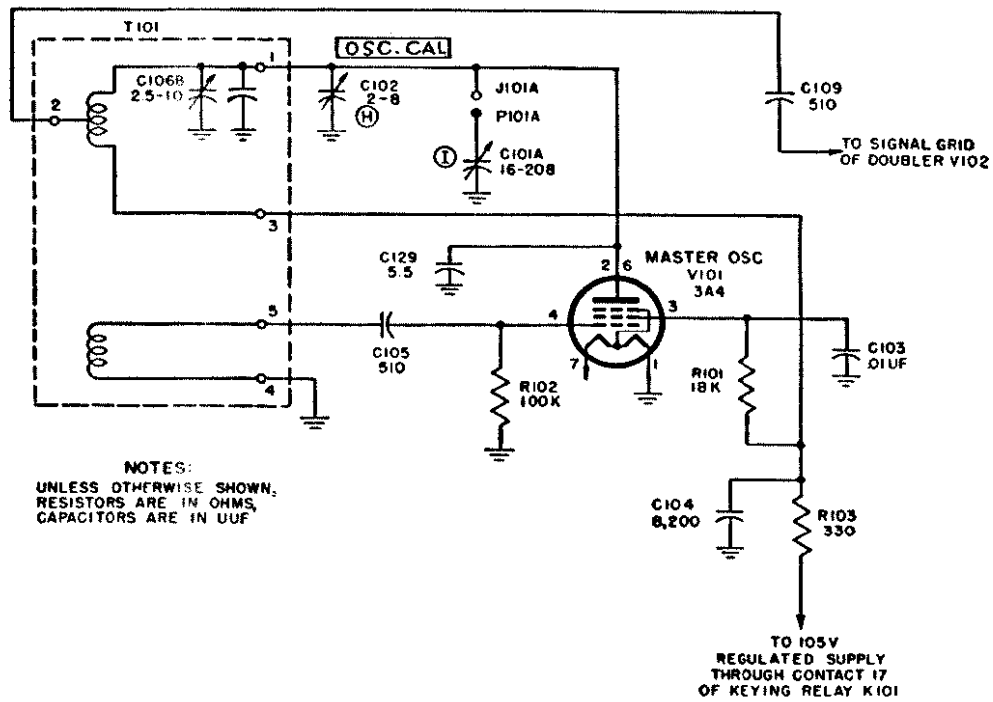


Figure 67. Transmitter master oscillator, simplified schematic.

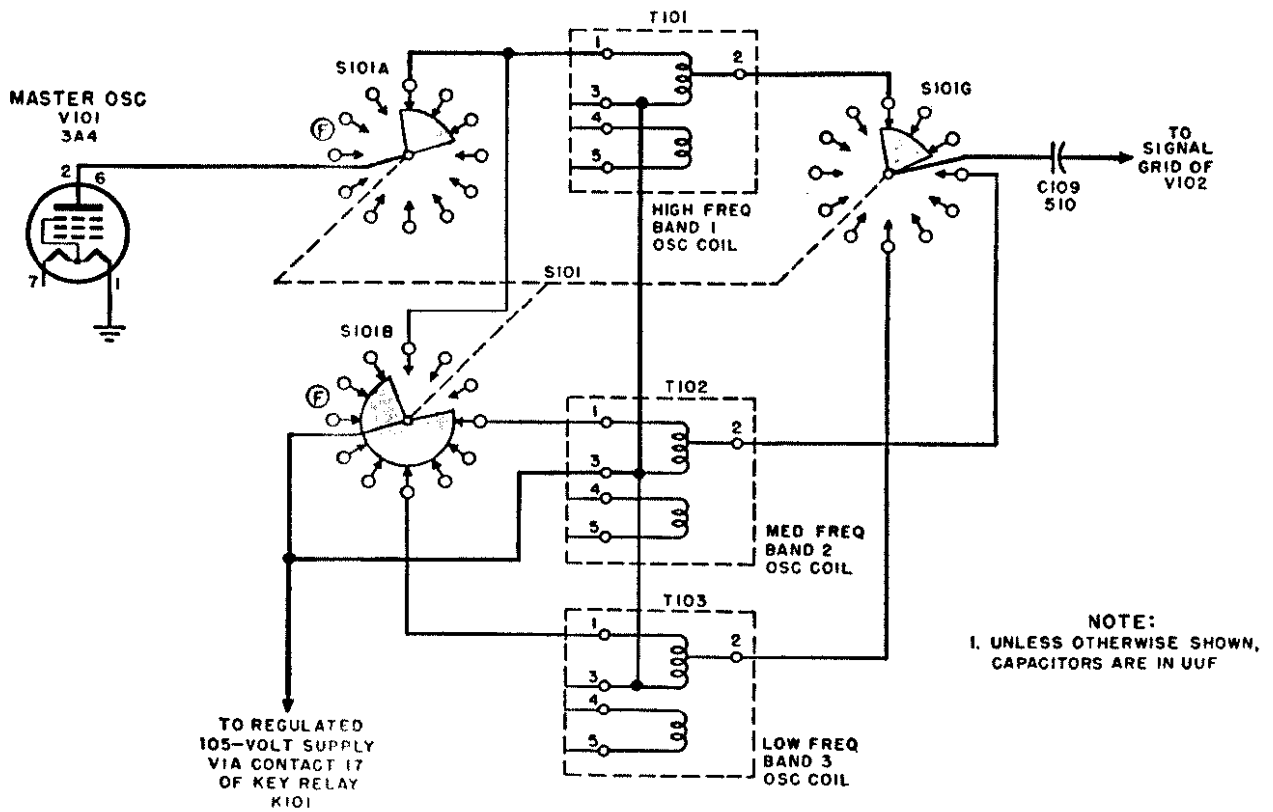


Figure 68. Master oscillator switch sections S101A and S101B.

voltage is fed through dropping resistor R101 which is bypassed for r-f by capacitor C103.

c. The coupling necessary to sustain oscillations is produced magnetically by the plate and grid circuit coils of T101.

d. The control grid receives its d-c bias from the combination of grid leak resistor R102 and

capacitor C105. The output from the oscillator is fed through capacitor C109 to the frequency doubler V102. C149 is a temperature compensating capacitor.

e. From the upper left of the main schematic (fig. 126), it can be seen that seven sections of switch S101, control F, are associated with the oscillator circuit of V101.

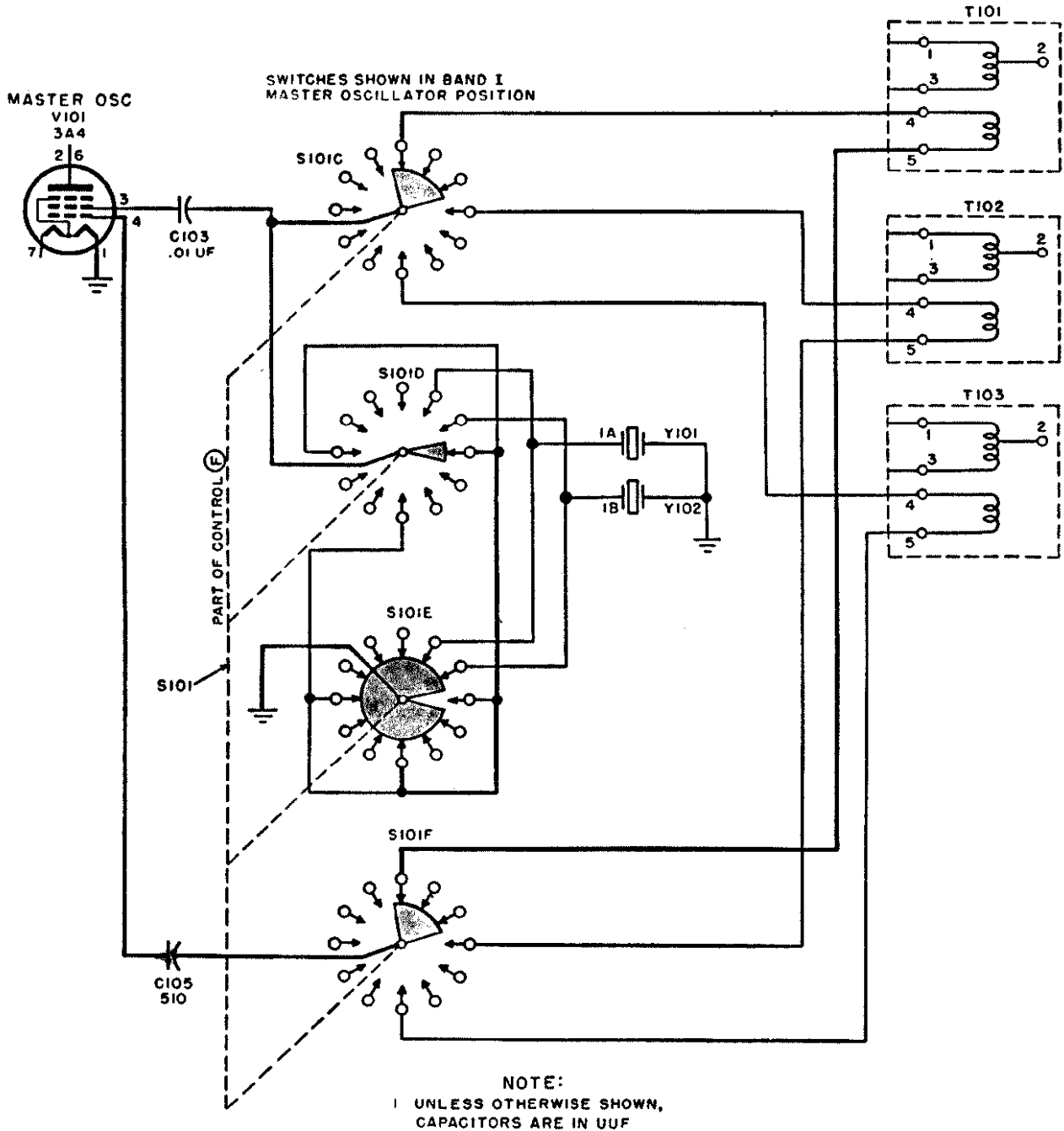


Figure 69. Master oscillator switch sections S101C, D, E, and F.

- (1) S101A (fig. 68). Section A of S101 determines which of the three plate circuit coils is to be used. Thus, should control F on the transmitter panel be turned to BAND 1, switch S101A would lead the plate current of tube V101 to the larger coil in transformer T101, and no other. This is shown by the weighted line in figure 68.
- (2) S101B (fig. 68). Section B of S101 shorts out the other unused plate coils so as to prevent interaction with the coil circuit being used; such interaction tends to cause undesirable parasitic oscillations.
- (3) S101C (fig. 69). Section C of S101 selects the proper grid circuit coil for the frequency selected. This is done in conjunction with switches S101D, S101E, and S101F which connect the coil selected to the grid by capacitor C105. Since the entire bank of switches is ganged, the grid coil is automatically connected to the grid circuit. By following the weighted line, starting at the signal grid of V101, the entire

- grid circuit path may be traced through the various switches.
- (4) S101D. Section D of S101 selects, during crystal operation, the proper crystal to be used for the frequency desired. Section D also connects the grid coil to ground through section E, as shown in figure 69.
- (5) S101E. The rotor of section E is permanently connected to ground and serves as the actual ground connection for the coil selected. It also shorts out all or any crystals that are not in use.
- (6) S101F. Section F of S101 connects the selected coil to the grid of tube V101 through capacitor C105.
- (7) S101G (fig. 68). Section G of S101 connects oscillator voltage from the plate coil in use to the signal grid of the frequency doubler V102.

91. Crystal Oscillator (Crystal-controlled) (fig. 70)

- a. When control F is at one of the XTAL positions, the circuit then functions as a crystal oscillator. Crystal 1A is placed in the grid cir-

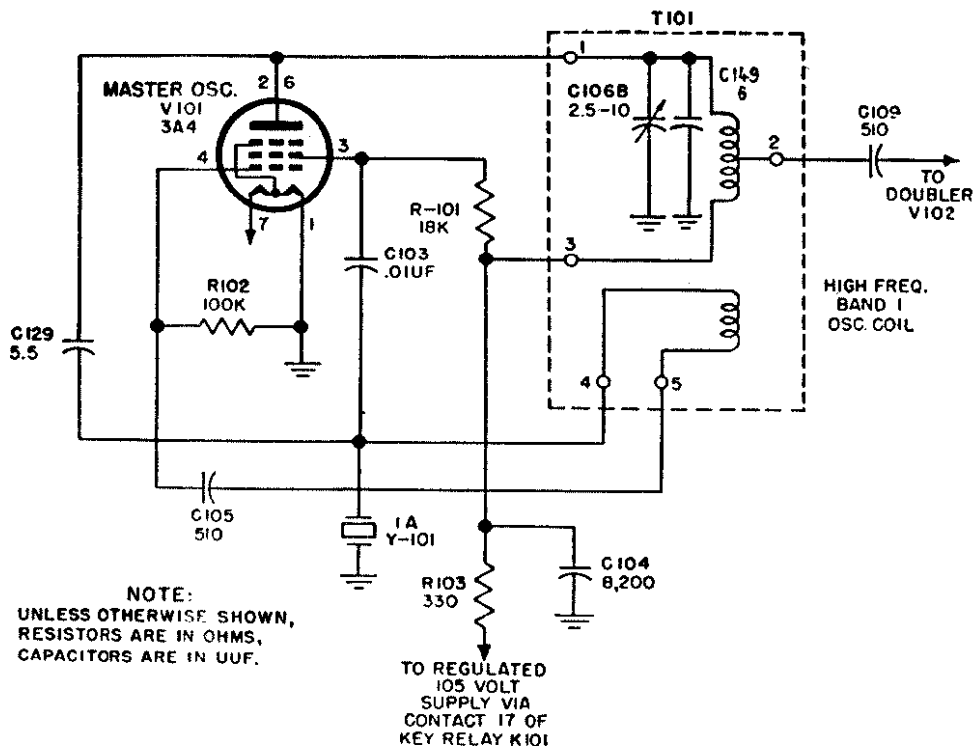


Figure 70. Transmitter master oscillator (crystal-controlled), simplified schematic.

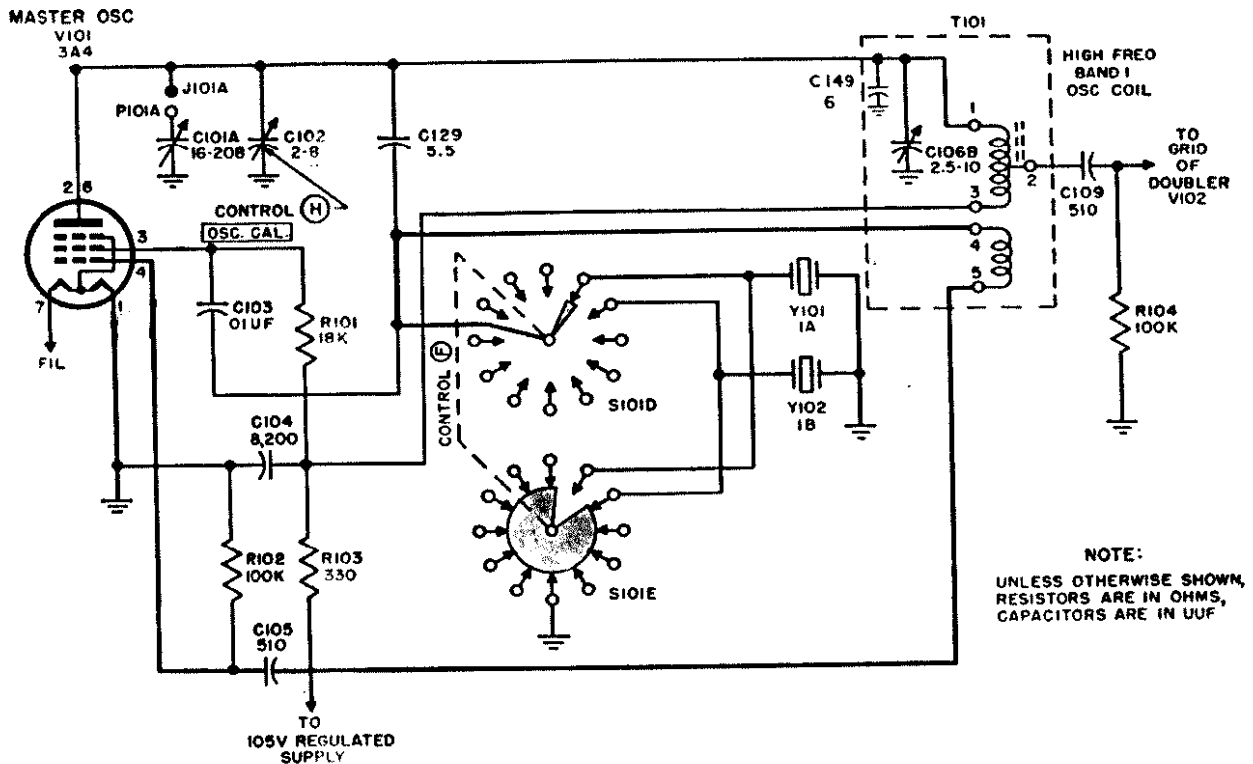


Figure 71. Transmitter master oscillator (crystal-controlled), switch sections S101D and S101E, simplified schematic.

circuit by means of switches S101D and S101E (fig. 71). Switch S101E disconnects from ground the crystal used, and connects to ground all unused crystals.

b. Screen grid capacitor C103, which was an r-f bypass for MO operation, becomes by means of switches S101D and S101E, the coupling capacitor from the screen grid to the oscillator crystal. When control F is at one of the XTAL positions, the circuit function is the same as for

MO operation except that the ungrounded crystal circuit is coupled to the screen. When the tuned circuit is adjusted to the crystal, frequency V101 will oscillate by virtue of the fact that the combination of capacitor C103 and the crystal results in a low-impedance circuit on the screen grid. If the circuit is tuned to any other frequency but the crystal frequency, the resultant high-impedance circuit is not effectively bypassed to ground and the oscillation

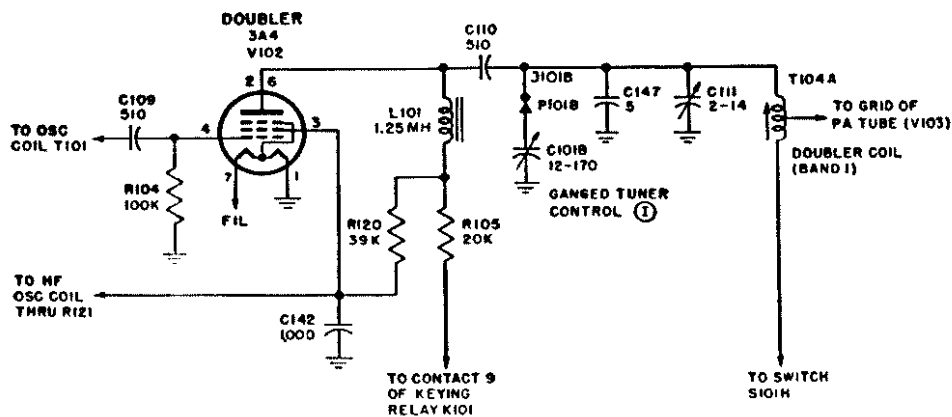


Figure 72. Frequency doubler stage V102, simplified schematic

will cease since neither the screen grid nor the low r-f side of the feedback winding in the oscillator grid (pin 4) circuit is effectively bypassed to ground.

c. Resistor R102 is still the grid bias resistor as in MO operation, while capacitor C105 is the grid leak capacitor. R104 is an r-f decoupling resistor.

d. Capacitor C129, which connects from the tube plate to the crystal, is used to provide degenerative feedback from the plate circuit to the crystal. This circuit allows crystals of a wide range of activities to be used. The plate circuit is tuned to the crystal frequency desired by capacitor C101A, control I.

e. Tube V101 is in operation only when the key is depressed or the press-to-talk switch on the microphone is pushed. This is so because V101 derives its plate and screen voltage through keying relay K101 and the relay is actuated only when the microphone or key is in use. Tube V101 also operates on the NET position of control L, regardless of the position of relay K101.

92. Frequency Doubler V102, Tube Type 3A4 (fig. 72)

a. The output of the oscillator V101 is coupled by capacitor C109 to the frequency doubler stage V102, which uses a tube type 3A4.

b. The doubler is operated as a Class C amplifier and is adjusted to distort the frequency input to its grid. The tuned tank coil in the plate circuit is tuned to resonance at a frequency just twice that of the incoming oscillator signal and, therefore, selects only the second harmonic of the oscillator output to pass on to the power amplifier.

c. The output of the oscillator stage is coupled to the control grid of the doubler stage by capacitor C109 and grid return resistor R104. The load in the plate circuit of V102 consists of a parallel resonant circuit, using T104A which is slug-tuned, alignment capacitor C111, fixed capacitor C147, and ganged tuning capacitor C101B. Capacitor C101B is connected to the transmitter through plug P101B by means of which it may be easily removed from the transmitter for replacement. Capacitor C110 is used to block the d-c plate voltage from the tuned circuit.

d. The plate of V102 is shunt-fed through choke coil L101 in series with dropping resistor R105. The voltage to the screen is made lower than the plate voltage by means of dropping resistor R120. The combination of R120 and R105 is bypassed to ground, for r-f screen current, through capacitor C142. Plate and screen voltages to the doubler are cut off when the keying relay is open. When the key is depressed, the relay closes and the doubler then receives voltage for operation.

e. From the main schematic (fig. 126), it can be seen that switches S101H, S101I, and S101J are associated with the doubler tuned circuits. These are part of control F on the transmitter panel. There are three plate coils, one for each of the three transmission bands. Switch S101I determines which of these coils is connected to the plate of tube V102. Switch S101H shorts out the other two coils that are not being used. Switch S101J connects the doubler output from the coil in use to grid, pin 3, of the power amplifier tube V103. All these switches are ganged.

93. Power Amplifier Stage V103, Tube Type 2E22 (fig. 73)

a. GENERAL. In order that the antenna receive sufficient power for radiation of the signal, a power amplifier is coupled between the frequency doubler and the antenna. This amplifier is operated Class C. Modulation of the signal takes place in the power amplifier stage. Three types of signal are possible: cw, mcw, and phone. The process by which modulation is accomplished is the variance of the suppressor grid voltage by means of a modulator tube, and is explained more fully in paragraph 95.

b. SIGNAL PATH. The signal enters the amplifier grid, pin 3, directly from the plate load coil of the preceding doubler stage V102, through the switch S101J. After amplification by the tube the signal leaves the plate and enters one of the tuned tank circuits selected by band switch S101L, control F. Since the transmitter is designed to operate with a whip, long-wire, or doublet (with a 72-ohm transmission line) antenna, it is necessary to provide the correct matching circuit for maximum power transfer. Thus S101M, which selects the output from the

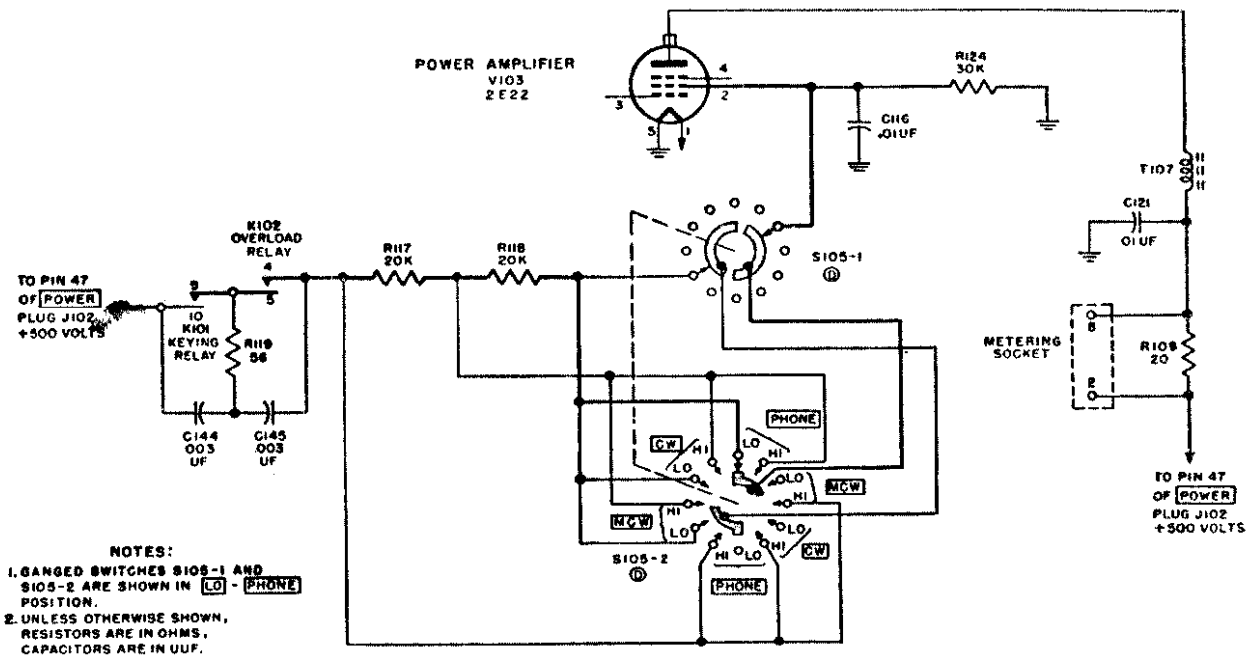


Figure 74. Power amplifier screen grid circuits arranged for LO (low) power operation.

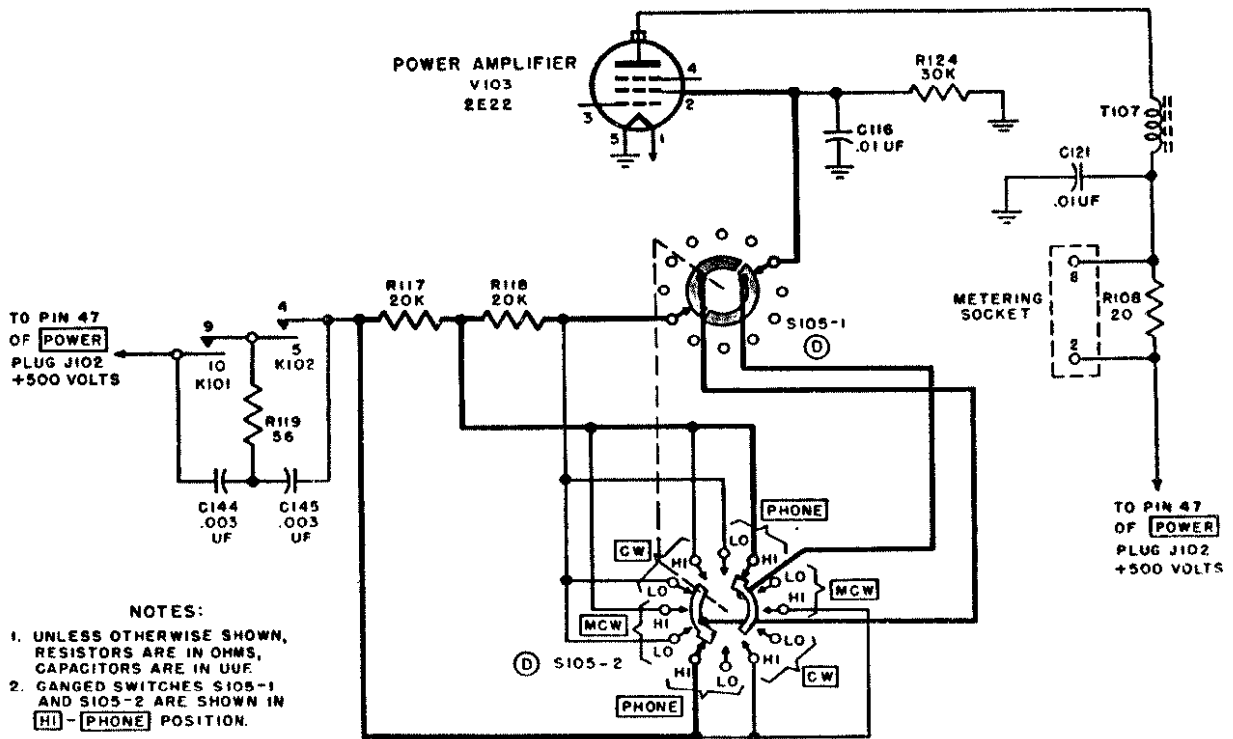


Figure 75. Power amplifier screen grid circuits arranged for HI (high) power operation.

plate coil in use, leads the signal to switches S102A, B, C, D, and E, control A. This last bank of switches selects the proper matching circuits for the antenna being used. After the signal has been led to the proper transformer T110A or B, it goes to contacts 3 and 11 of keying relay K101, and when the key or microphone is in use, it is fed to the antenna and radiated out into space.

c. ~~SIGNAL~~ SIGNAL GRID CIRCUIT. Switch S101J selects the output of the doubler coil for the band in use and applies this output to the grid, pin 3, of the power amplifier. The grid return is through resistor R106, relay coil K102A, and resistor R107. The d-c bias for the tube is developed across these three items, while they are bypassed for r-f by capacitor C114. Pin 1 of the filament is bypassed to pin 5 of the filament with capacitor C115. Capacitor C115 bypasses to ground the unwanted r-f pickup of the lead connected to pin 1. Relay coil K102A has its contacts in the screen grid circuit and should grid excitation fail, these contacts open, removing voltage from the screen and preventing destruction of the tube (f below).

d. SCREEN GRID CIRCUIT, HI AND LO POWER (fig. 74).

(1) The power output of the power amplifier is controlled by varying the screen grid voltage. R124, the screen grid bleeder, stabilizes the screen grid voltage. There are two possible levels of output; HI and LO power, and these are selected by switches S105-1 and S105-2, control D. If the weighted line in figure 74 is followed from the screen grid, pin 2 of V103, it will be seen that the screen current passes through S105-1 and S105-2 to the series combination of resistors R117 and R118, and then to the power supply through the contacts of relays K102 and K101. This series arrangement of the two resistors is the LO power circuit since the screen of V103 is at a low potential because of the large drop across the series combination of R117 and R118. When HI power output is desired, ganged switches S105-1 and S105-2 are turned to HI and R117 is then placed in parallel with R118 (fig. 75). There is less voltage drop

across the parallel combination than the series combination and thus the screen grid has more voltage placed upon it. The screen grid voltage determines, to a large extent, the current through the tube and therefore the power output.

(2) Resistor R124 forms a voltage divider system with the combination of R117 and R118 across the power supply, and the screen grid receives its voltage from across R124. Capacitor C116 is the screen grid bypass which is used to bypass r-f currents directly to ground, and not through the screen supply circuit.

e. SCREEN CIRCUIT CUT-OUT RELAYS.

The contacts of two different relays are in series with the screen to open or close the circuit. Relay K101 is controlled by the keying circuit and is normally open, so that the screen grid does not receive any voltage and the power output of the power amplifier stage is almost zero. This makes the transmitter inoperative while the receiver is being listened to. However, when the key is depressed or the press-to-talk switch on the microphone is pushed, relay coil K101 is energized and contacts 9 and 10 in the screen circuit of V103 are closed. These contacts permit screen current to flow and the transmitter is then in operation.

f. RELAY K102A. The contacts of relay K102A are located in series with the screen grid, but the relay coil is in series with the control grid, pin 3 of V103 (fig. 126). Thus, the direct current in the control grid circuit flows through the relay, keeping contacts 4 and 5 closed during transmitter operation. Should the signal grid excitation be cut off for any reason, the grid current would cease and the relay would no longer be energized; the contacts in the screen circuit would open and the screen would no longer receive any voltage. This arrangement, which cuts off screen grid voltage when excitation fails, is necessary to prevent damage to the power amplifier tube and circuit. The tube is a Class C amplifier with 500 volts on the plate, and the negative grid bias is developed solely by the d-c grid current. Therefore, if the grid excitation should fail, there would be no negative bias on the grid. This would result in a plate current large enough to ruin the tube.

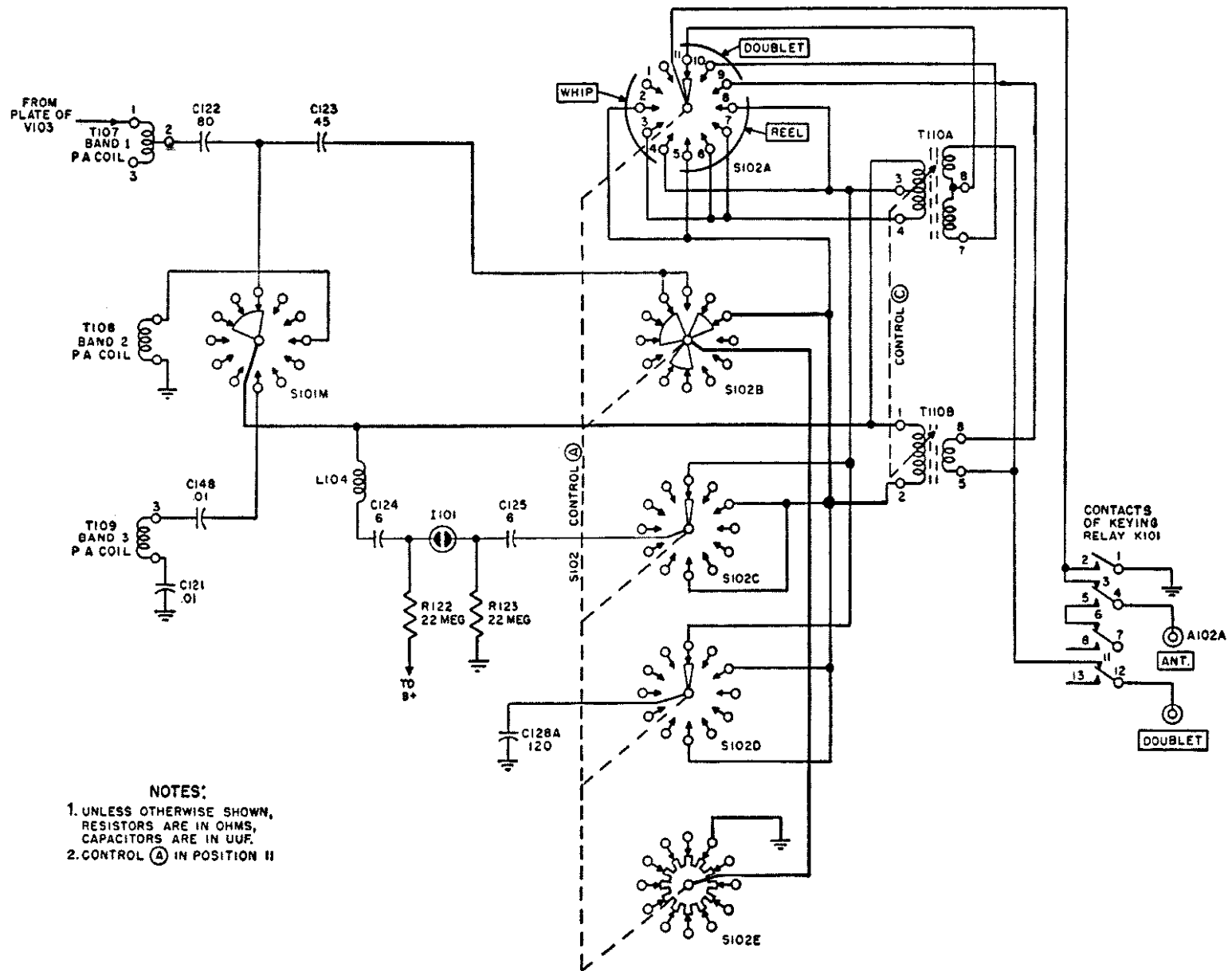


Figure 76. Antenna switching and tuning circuits for transmitter

g. RELAY COIL K102B.

- (1) Relay coil K102B is placed on the same iron core as section K102A. One end of K102B connects to ground. The other end leads through contacts 15 and 16 of keying relay K101 (fig. 126) to switch S103A, which connects to the 6.3-volt regulated supply voltage. Contacts 15 and 16 are closed only when the receiver is being operated and, therefore, coil K102B is energized only when the receiver is operating. Thus, there is some magnetism in the iron core even when the transmitter is not in use, as when the key is up, or when the press-to-talk switch in the microphone is not depressed.
- (2) As soon as the key is pressed down, a small signal current starts to flow in the power amplifier grid circuit, causing coil K102A to be energized and contacts 4 and 5 to close. Because coil K102B had already been energized and the iron core magnetized when the key was up, it is possible for the signal current through K102A to be only a very small value to close contacts 4 and 5. Therefore, more rapid keying is allowed since, almost immediately upon key closure, coil K102A has enough energy to close the power amplifier screen grid circuit.
- (3) If coil K102A had to magnetize the iron core from a point of zero magnetism, there would be an appreciable time lag until the current through K102A became great enough to produce a magnetic field strong enough to close contacts 4 and 5.

h. ARC SUPPRESSION. When the contacts of relays K101 and K102 open, arcs are formed which create r-f disturbances, called key-clicks, in addition to damaging the contacts. These arcs can not be eliminated but the length of their duration with each opening of the contact can be shortened considerably by means of a suitable filter or arc suppression circuit. This is the function of capacitors C144 and C145 and resistor R119 (fig. 75).

i. PLATE CIRCUIT (fig. 73). The signal from the plate of V103 enters the coil selector switch S101L, control F. Coil T107, T108, or T109 may

be selected, depending on the band of transmission desired. Capacitor C101C is the main tuning capacitor for the coil selected and is ganged to the other tuning capacitors, control I, for the preceding stages. Switch S101K shorts out those tuning coils which are not in use. Considering band 1, capacitor C118 is the alignment trimmer. The bottom of each coil is connected to resistor R108 and from there directly to the 500-volt d-c supply (fig. 73). Two leads are connected from across R108 to the metering socket. This is a means whereby the current in the plate circuit can be measured. Capacitor C121 is the bypass for R108, and places the lower end of coils T107, T108, and T109 at ground r-f potential.

94. Antenna Switching and Tuning Circuits for Transmitter (fig. 76)

a. There are 11 possible positions for ganged switch bank S102, control A (fig. 76). Only switches A through E enter into transmitter operation. Section F is for receiver operation only. These 11 different positions are necessary so that the antenna will be matched to the power amplifier output coil for maximum power transfer throughout the entire frequency range of the transmitter. The functions of the different switch positions are:

- (1) Positions 1, 2, 3, and 4 match the power amplifier coil to a vertical mast or whip antenna for all frequencies.
- (2) Positions 5, 6, 7, and 8 match the power amplifier coil to an end-fed antenna for all frequencies.
- (3) Positions 9, 10, and 11 match the power amplifier coil to a center-fed or doublet antenna for all frequencies.

Note. Figure 77 shows, in simplified form, the different circuit elements connected for each of the 11 distinct positions of control A.

b. The whip or long-wire antenna when connected to the ANT. post can be considered as an impedance to ground. For positions 1 through 8 of control A, the antenna is in series with the primary of either transformer T110A or T110B and this series circuit is in parallel with a portion of coil T107. In position 1 only, loading coil L102 is added to the series combination. In positions 5, 6, 7, and 8 additional capacity is placed in parallel with the antenna by means of capacitor C128A, C128B, or C128C. For the doublet

circuit, positions 9, 10, and 11, the primary of transformer T110A or T110B is completed to ground through capacitor C128A.

c. Control C is an adjustable powdered iron core that slides within coils T110A and T110B, tuning them to resonance. Indicator I101 is a small neon bulb which, by means of its highest brilliance, indicates when control C has tuned the antenna coils to resonance. Figure 77 shows that the neon bulb is in series with coil L104, capacitor C124, and capacitor C125. This high-impedance series combination is placed across the primary of either transformer T110A or T110B, depending on the switch position of control A. Thus the r-f voltage across the primary

coil is impressed across this series circuit and this causes a voltage to appear across the neon indicator. The indicator glows at brilliance which is roughly proportional to the r-f voltage across the primary coil, and is therefore an indication of how closely the transformer is tuned to resonance. Resistors R122 and R123 are in series with the neon indicator bulb and this series combination is placed across the 500-volt, d-c line, when contacts 9 and 10 of relay K101 close. This arrangement is necessary to provide a break-down voltage so that the neon tube will be ready to light as soon as enough r-f voltage is put across it. The d-c is thus like a keep-alive voltage.

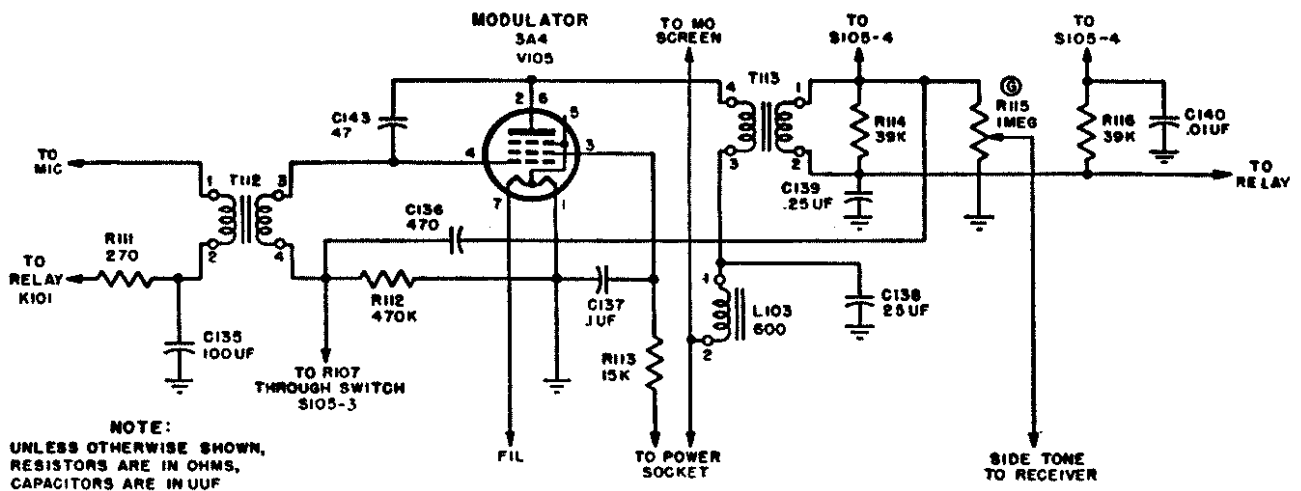


Figure 78. Modulator stage V105, simplified schematic.

95. Modulator Stage V105, Tube Type 3A4 (fig. 78)

a. GENERAL. The modulator circuit develops the audio voltage to suppressor-grid modulate the power amplifier during phone and mcw operation. These audio variations from the microphone are fed from the matching transformer T112 to the control grid of V105; they are amplified and appear across the modulation transformer T113. If the suppressor grid circuit of the power tube is traced on the main schematic (fig. 126) from pin 4 of V103, it will be seen that it goes through switch S105-4 to resistor R114, which is connected across the secondary of the modulation transformer. The other end of R114 connects to relay coil K102A in series with resistor R107 to the grounded

filament lead of the power tube. Thus, the modulation voltage is in series with the negative voltage on the suppressor grid, developed by the control grid current through K102A and resistor R107. The modulation voltage, therefore, varies the voltage on the suppressor grid in accordance with the intelligence in the microphone, and the suppressor voltage determines to a large extent the plate current of the power amplifier.

b. PHONE OPERATION.

- (1) If the signal grid lead from pin 4 of modulator tube V105 is traced, it will be found that terminal 4 of T112 connects to switch S105-3 which, in the PHONE position only, leads to resistor R107 in the signal grid circuit of power

amplifier tube V103 and from there to ground (fig. 126). The grid current of V103 develops a voltage across R107 and since this resistor is also in the grid circuit of V105, tube V105 is also biased to its correct operating point by this resistor.

- (2) The modulator tube receives its plate voltage through the decoupling filter composed of L103 and capacitor C138. This filter is connected to the power supply through contacts 17 and 18 of keying relay K101. Thus, unless the key of the microphone button is depressed, the contacts are open and the modulator does not receive any plate voltage.
- (3) The screen receives its voltage from dropping resistor R113 which connects to terminal 7 on receptacle J106 (see main schematic). Terminal 7 on J106 is connected to terminal 2 on J106 by means of connections through circuits located inside the receiver cabinet (fig. 81). Terminal 2 is connected to B+ through contacts 17 and 18 of keying relay K101. Thus the screen voltage depends, as with the plate, on the position of the keying relay. If the key is up, there is no screen or plate voltage on the modulator tube. Capacitor C137 is the screen bypass capacitor.

c. MCW OPERATION. During mcw operation, the fixed bias which the modulator tube received from the power amplifier grid circuit is no longer present because the connection is broken by means of switch S105-3 (see main schematic). Therefore, the modulator tube becomes an audio oscillator due to the positive feedback through capacitor C136 and C143. The tube then develops its own bias across R112 of just the right value to sustain oscillations. Resistor R116 is placed across the output of the modulation transformer T113 by switch S105-4 to adjust circuit conditions for oscillation. No change is made in the connection to the suppressor grid of V103 and, therefore, the transmitter signal is modulated by the audio oscillations of the modulator tube and a mcw is radiated from the antenna.

d. C-W OPERATION (fig. 126). For c-w operation, the modulator tube does not receive any grid bias from the power amplifier tube and,

therefore, continues to operate as an audio oscillator. However, switch S105-4 connects the suppressor grid of V103 directly to the positive side of the filament of V103, and disconnects it from the modulator tube. Thus, the signal radiated is c-w without any modulation. Although the modulator tube no longer modulates the radiated signal, it still oscillates to provide a sidetone signal.

96. Sidetone Monitoring Circuit

a. A sidetone circuit in the transmitter permits the operator to monitor his transmissions on phone, mcw, or c-w. The sidetone signal is obtained directly from the modulator and, therefore, does not depend on the r-f power transmitted. It is possible to hear a sidetone even though there may be no r-f power transmitted. Potentiometer R115, control G, across the secondary of the modulation transformer, adjusts the volume of the sidetone signal delivered to the receiver through pin 1 of plug J106 on the transmitter, cable assembly 3E7173-22-GY in the case, and pin 1 of plug J3 in the receiver.

b. When transmitting mcw or c-w, the modulator tube operates as an audio oscillator, furnishing the sidetone. The keying relay interrupts the plate voltage of the modulator tube at the same time that it interrupts the plate circuit of the master oscillator, doubler, and the screen circuit of the power amplifier. The relay thus keys the sidetone oscillator in synchronism with the transmitted signals. When switch S3-3 (control L on the receiver) is turned to NET or CAL, the sidetone oscillator is made inoperative by the removal of the screen voltage. This prevents sidetone from interfering with zero beating of the transmitter to the receiver.

97. Microphone and Key Connections

(fig. 79)

a. Both the microphone and the key are arranged so that either may complete the electrical circuit of relay K101. The microphone does so by means of a self-contained push-button switch, while the key acts as its own switch. The current for energizing the relay coil enters the transmitter through pin 45 of receptacle J102. It then flows through switch S101N to the relay coil and from there to the tip, marked T, on both the microphone and key receptacles. It can be seen from the diagram that the key, when

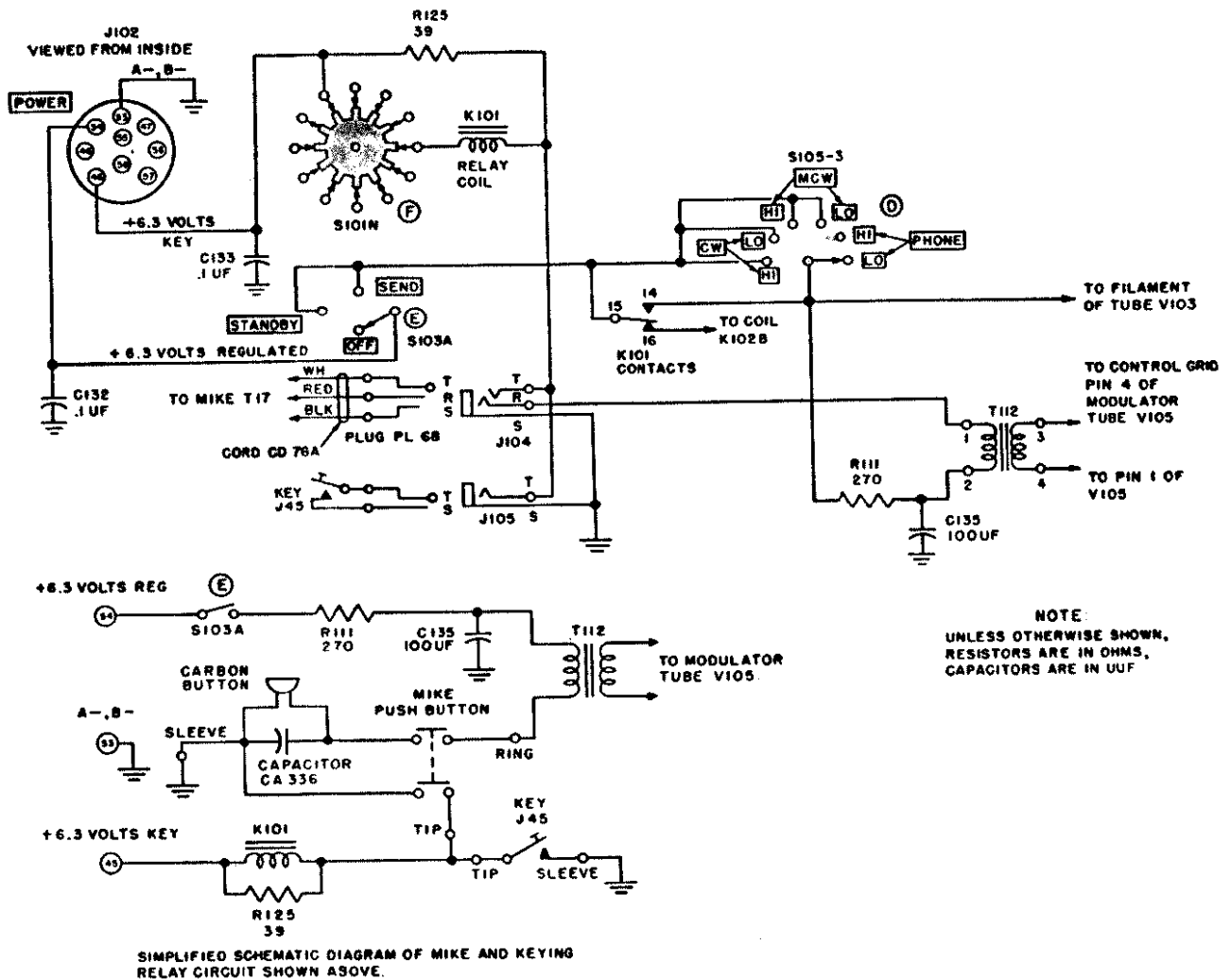


Figure 79. Microphone and key connections.

closed, connects the relay through the sleeve of J105 to ground, thus completing the relay circuit. Should the press-to-talk switch on the microphone be depressed instead of the key the relay circuit would be closed through the internal switch of the microphone. The relay current flows through the tip on J104 to the white lead in microphone Cord CD-76-A, through the switch to the black lead connected to the sleeve on Plug PL-68. The sleeve on Plug PL-68 fits into the sleeve on J104, which is directly connected to ground.

b. In order for the microphone to perform its function, there must be a d-c current flowing in its circuit. The current enters the transmitter from pin 54 of receptacle J102 and flows through the SEND position of switch S103A to

the contacts of relay K101, and switch S105-3. If S105-3 is in the CW or MCW position, the current will reach the microphone regardless of the position of the relay contacts (fig. 79). However, if S105-3 is in PHONE position, the only way that the microphone can be energized is if relay contacts 15 and 14 are closed. From the pole arm of S105-3, the current goes through current limiting resistor R111 to the primary of T112, and from there to ring on jack J104. The connection within the microphone itself is from ring on Plug PL-68, through the microphone carbon button. From the button the current flows to the black lead connected to the sleeve of Plug PL-68, which fits into the sleeve of jack J104 and from there to ground. Capaci-

tor CA-336 (inside the microphone [fig. 20]) is a filter to bypass any disturbances set up between the carbon granules. Capacitor C135 is a filter capacitor which is used to lessen microphone hiss.

c. Capacitors C132 and C133 are bypasses to keep interference from the power supply.

d. Because of the high inductance of the relay coil, there is an appreciable time lag before the current through it can build up or die down, which is undesirable for rapid keying. Therefore, resistor R125 is placed across the coil so that the current through the coil can follow the key variations more closely because of the dampening of the inductance effect by R125.

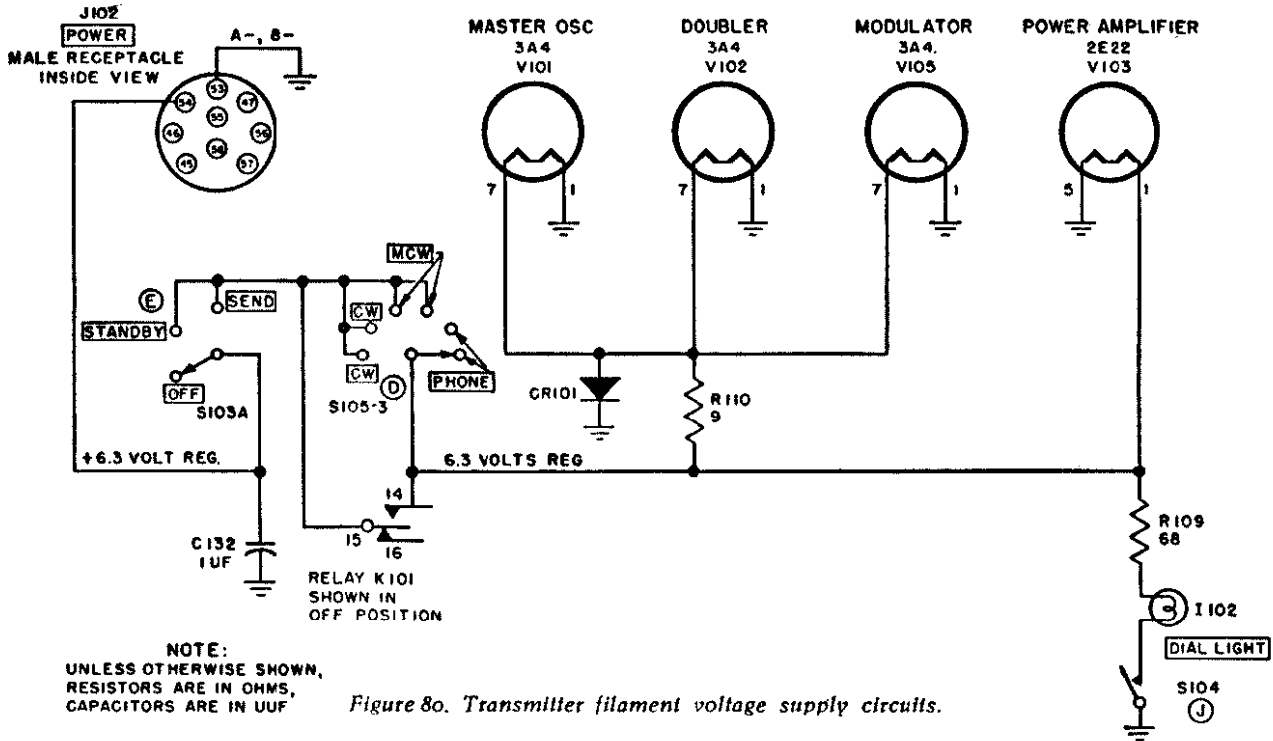


Figure 80. Transmitter filament voltage supply circuits.

98. Transmitter Filament Supply Connections (fig. 80)

a. The transmitter filaments receive their voltage from pin 54 of receptacle J102. The regulated 6.3-volt supply is fed to switch S103A, control E, and from there to S105-3, control D, and also to contact 15 of keying relay K101. In the PHONE position of control D, the tubes can receive filament voltage only if contacts 15 and 14 of K101 close; which they do only when the key or microphone button is depressed. In the mcw and c-w positions of control D, the filaments receive voltage regardless of the position of the relay contacts.

b. Capacitor C132 is an r-f bypass capacitor to keep r-f out of the power supply. R110 and R109 are voltage-dropping resistors.

c. A small dial light, Indicator I-102, is located in the transmitter and may be turned on by means of push-button switch S104, control J, which normally is held open by a spring.

d. CR101 is a selenium voltage regulator used to keep the filament voltage on tubes V101, V102, and V105 constant at 2.8 volts.

99. Transmitter Plate and Screen Supply Circuits (fig. 81)

a. GENERAL. The transmitter plate and screen voltages may be obtained from either the handoperated generator or the dynamotor-power supply, depending on whether Cord CD-1086-GY is connected to the generator or the dynamotor-power supply. Voltage from these two sources enters the transmitter through plug J102.

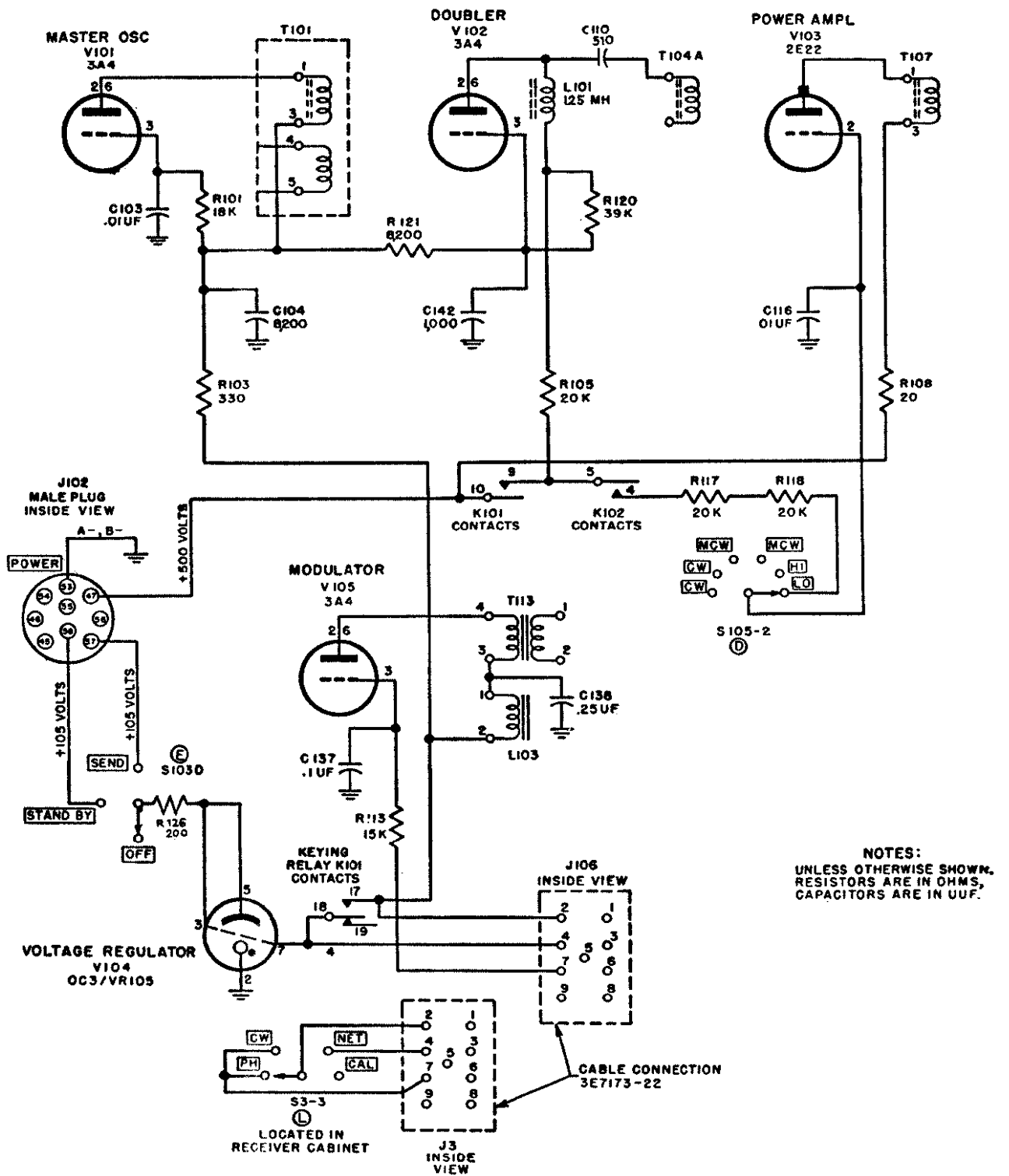


Figure 81. Transmitter plate and screen grid voltage supply circuits.

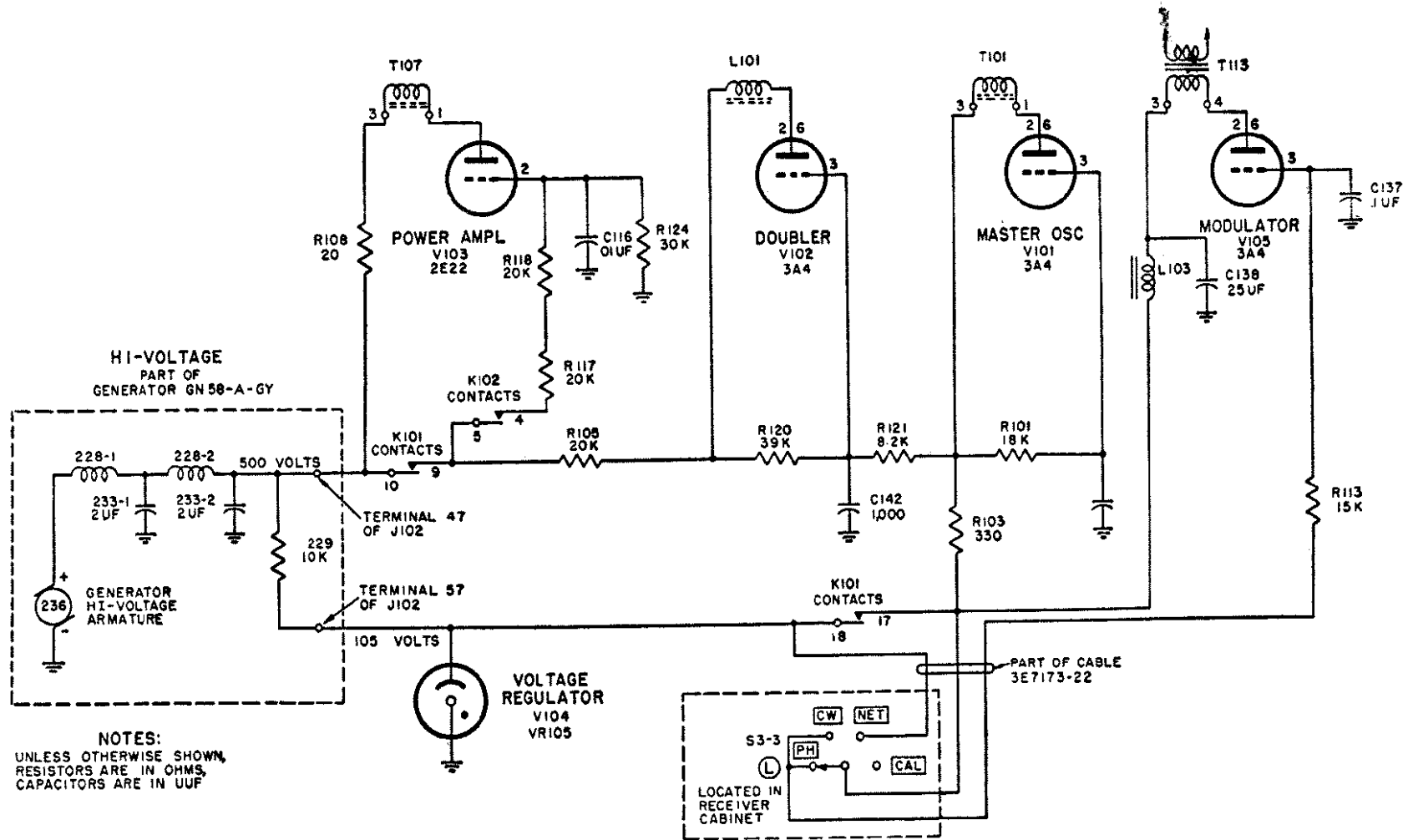


Figure 82. Transmitter plate and screen grid voltage supply circuits, simplified schematic.

b. **POWER AMPLIFIER PLATE.** Terminal 47 supplies 500 volts d-c plate voltage for power amplifier tube V103. The plate of V103 is connected by T107 and R108 to pin 47 of J102 (fig. 81). Thus, the moment the generator is cranked, or the dynamotor-power supply is switched on, the power amplifier plate is energized.

c. **GENERATOR POWER SUPPLY.** The 105-volt output of the generator enters the transmitter through terminal 57 of J102 and is fed to the SEND tap on switch S103D, control E. When control E is placed on SEND, the voltage is fed to pins 3 and 5 of V104 (voltage regulator tube) and reaches the contacts of keying relay K101, through the internal connection between pins 3 and 7 of V104. When contacts 17 and 18 and contacts 9 and 10 of relay K101 are open, none of the plates or screens of the tubes receive voltage, except the plate of V103 (fig. 82). If the key or press-to-talk switch on the microphone is depressed, these contacts close; all tubes receive voltage and the transmitter is in operation.

d. **OVERLOAD RELAY.** Contacts 5 and 4 of overload relay K102 are in series with the dropping resistors to the screen grid of the power amplifier tube V103 (fig. 82). These contacts normally are closed. Should the signal voltage on the control grid of V103 fail, the tube would no longer be negatively biased, and a very large plate current would result, which could ruin the tube. In order to avoid this possibility, a relay coil is placed in series with the signal grid and the contacts of the coil are placed in series with the screen grid. These are contacts 5 and 4. Therefore, if the signal fails, no current is drawn and the relay coil is deenergized; the contacts open, thus removing screen grid voltage from V103 and reducing the plate current to almost zero.

e. **NET OPERATION** (par. 54). In order to tune the transmitter to the frequency of the net, it is necessary first to tune the receiver to the net frequency and then to tune the transmitter oscillator tuning dial to zero-beat with the incoming net signal in the receiver. If the full power of the transmitter is used, it will drown out the net signal making it impossible to zero-beat. Therefore, the key or microphone button should not be depressed during the tuning of the transmitter for net operation. However, if the key or microphone

button is not depressed, relay K101 contacts 17 and 18 will not be closed and the transmitter tubes will not receive plate and screen voltages. To overcome this, only oscillator tube V101 and doubler tube V102 are fed with enough operating plate and screen grid voltages. This is accomplished with switch S3-3, control L, which is located in the receiver cabinet and is connected to the transmitter by cable assembly 3E7173-22-GY. When switch S3-3 is turned to NET, it shorts out contacts 17 and 18 of relay K101 (fig. 82). This allows the combined plate and screen grid currents of the doubler and oscillator tubes to flow through resistor R103 and switch S3-3 to terminal 57 of receptacle J102, and from there, by Cord CD-1086-GY, to the generator. Switch S3-3 also disconnects the screen grid of the modulator tube V105 from the voltage source so that the tube is inoperative. This prevents sidetone from interfering with the zero beating in preparation for net operation.

f. **DYNAMOTOR-POWER SUPPLY DY-88/GRC-9-GY.** In order for the transmitter to receive power from the dynamotor power supply, Cord CD-1086-GY is plugged from J102 on the transmitter to plug J202 on the dynamotor power supply. When the set is used for long periods of listening only, the l-v vibrator portion of the dynamotor power supply is in operation. The l-v power supply requires much less vehicular battery current than does the h-v supply. This portion operates when switch S103D, control E is at STANDBY (fig. 81). When control E is at the SEND position, both the dynamotor and vibrator portions of the power supply operate to supply power to the receiver and transmitter.

g. **VOLTAGE REGULATOR TUBE V104.** Tube V104 is a gas-filled diode which draws just enough current through it so that the voltage drop across resistor 229 in the generator will just compensate for any rise or fall of voltage in the power supply. Thus, the plate and screen voltages of the master oscillator and modulator tubes are regulated, as are the plate and screen voltages to the receiving tubes, during receiver operation.

100. Keying Relay K101

Keying relay K101 is actuated by either the telegraph key or by the microphone press-to-talk switch. When neither of these devices is

depressed, the receiver is in operation, while for transmitter operation, the key or microphone switch must be closed. When the key or microphone switch is closed, the following functions are performed by keying relay K101:

a. The antenna circuit is switched from the receiver to the transmitter.

- (1) Contacts 1 and 2 open, disconnecting the ground from switch S102A.
- (2) Contacts 3 and 4 close, connecting terminal A102A to switch S102A.
- (3) Contacts 6 and 7 close, connecting the receiver antenna-matching transformer T114 to ground.
- (4) Contacts 11 and 12 close, connecting the doublet lead to transmitter coil T110A.

b. Plate voltages are removed from all receiver tubes except V5 and V6. Screen voltages are removed from all receiver tubes. Contacts 18 and 19 open, disconnecting terminal 3 on receptacle J106 from the power feed line. Plate voltages are not removed from tubes V5 and V6 because of the higher currents they carry which, if allowed to flow through the contacts of the relay, would pit and burn them upon the opening of the contacts.

c. Plate and screen voltages are applied to the master oscillator and doubler stages. Contacts 17 and 18 close, connecting the plates and screens to the power line through pin 7 of voltage regulator tube V104.

d. Screen voltage is applied to power amplifier tube V103. Contacts 9 and 10 close, connecting the screen voltage-dropping resistors R117 and R118 to terminal 47 of power receptacle J102.

e. When switch S105-3, control D, is in the PHONE position only, the filaments of the transmitter tubes are off, unless the key or press-to-talk switch on the microphone is depressed. Contacts 14 and 15 close, connecting resistor R110 and filament pin 1 of tube V103 to terminal 54 of receptacle J102, through switch S103A.

f. Direct current is fed to the microphone circuit. Contacts 14 and 15 close, connecting resistor R111 to the 6.3-volt supply entering terminal 54 of receptacle J102.

g. Coil K102B, which is part of overload relay K102, is constantly energized during receiver operation. For transmitter operation the voltage across the coil is removed. Contacts 15 and 16 open, disconnecting K102B from the 6.3-volt supply entering terminal 54 of receptacle J102.

Section III. THEORY OF THE GENERATOR

101. General

Generator GN-58-A-GY is a hand-driven machine with its armature rotated through a step-up gear train from cranks. The output of the generator consists of two independent voltages which are regulated by a voltage regulator. Both voltages are filtered to eliminate commutator ripple and r-f interference. Generator GN-58-A-GY is a two-pole machine which has two wound field coils, 237-1 and 237-2. The armature consists of two independent windings; a 6-volt winding connected to a l-v commutator and a 425-volt winding connected to a h-v commutator.

102. H-v Circuit

(fig. 124)

a. In a d-c generator, the output is not a pure constant direct voltage because the magnetic

field set up by the field poles is not uniform. The magnitude of the voltage induced in the armature coils depends on the speed of rotation of the armature and the strength of the magnetic field. Since the magnetic field is not of the same strength at all points around the armature, the voltage output of the armature will have a ripple in it instead of a smooth constant value. This is called commutator ripple. In order to smooth out this ripple, a filter circuit is incorporated in the generator housing. This filter consists of choke coils 228-1 and 228-2 and capacitors 233-1 and 233-2. The filter also serves another purpose. The sparks under the brushes, which rest on the commutator, cause r-f interference. The filter removes this interference from the power leads by bypassing the r-f to ground through the capacitors.

b. Because power amplifier tube V103 requires about 500 volts on the plate, while the

other tubes require only about 105 volts, part of the h-v output of the generator is dropped down to 105 volts by means of resistor 229. The actual current through resistor 229 required to cause the voltage drop is drawn not only by the tubes, but by voltage regulator tube V104. This tube always takes just enough current through it to make the voltage drop across resistor 229 of the correct value which, when subtracted from the generator voltage, will leave exactly 105 volts. This 105 volts is connected to terminal 21 on terminal board 239. If the voltage at the terminal board end of resistor 229 is measured without the voltage regulator tube in its socket, the reading will be the full commutator voltage because no current will pass through resistor 229 to cause a voltage drop across it.

103. L-v Circuit (fig. 124)

a. The l-v winding on the armature supplies power to heat the filaments of the radio tubes, to energize the keying relay, and to operate the microphone circuit. The l-v winding also supplies power to operate the voltage regulator 224. The voltage regulator acts to keep the output of the generator at a constant voltage.

b. The l-v output of the generator is filtered by choke coils 227, 226, and 225 and capacitors 231 and 230. The iron core choke coils 227 and 225 are not adequate for r-f suppression, since at the very high frequencies created by an arc, an iron-core coil may actually act as a capacitor because of the high distributed capacity of such a coil. This distributed capacity may be high enough to allow the very high frequencies to pass on to the radio set. Therefore, the air core choke coil 226 is used since at the high frequencies its stray capacitance will be negligible because of its size, but the inductance will still be large enough to suppress the r-f disturbances.

c. Iron core choke coil 225 is, in addition, a voltage-dropping resistor that drops the voltage output of the generator to 1.4 volts for the filaments of the receiving tubes.

104. Voltage Regulating Circuit of Generator GN-58-A-GY (fig. 124)

a. Because the generator is a hand-driven device, the voltage output will depend on the

speed at which the hand cranks are turned. This situation is not desirable since the radio set requires a fixed, unvariable voltage supply. Therefore, a plug-in voltage regulator unit is incorporated which operates to keep the output voltage constant, regardless of the speed of rotation or the amount of load on the generator, within 50 to 70 rpm limits.

b. The regulator performs this function by decreasing the field current when the output voltage rises and by increasing the field current when the voltage output falls. This method of regulation depends on the fact that the output voltage of the generator is proportional to the speed of rotation and the strength of the field. Thus, if the speed of rotation should be raised by too rapid turning of the hand cranks, decreasing the field current would counteract the effect of greater speed. The opposite condition also applies. If the hand cranks are turned too slowly, the voltage output of the generator goes down. The obvious means of raising the voltage is to increase the field current. The following is an explanation of Generator GN-58-A-GY regulator (fig. 124):

c. In series with the field coils is a multi-tapped resistor (plaques 1 and 2), the sections of which can be shorted out by the contact fingers of voltage regulator 224 (fig. 124). The force that moves these fingers is the magnetic field created by the current flow in the regulator coil. The grounded negative lead of h-v armature 235 connects to the positive side of the l-v armature 236 through variable resistor 245, the parallel combination of the 7-ohm and N.T.C. (Negative Temperature Coefficient) resistors, the regulator coil, and pin 13. Thus, since the regulator coil is connected across the l-v armature coil, the current through the regulator coil varies with the voltage output of the l-v armature.

d. The finger contacts of the regulator are all normally closed so that when the hand cranks are being turned at the correct speed, the field coils receive the correct current to produce the magnetic field necessary for normal voltage output. If the generator is turned too rapidly the following occurs:

- (1) The outputs of the l-v and h-v armature coils increase.
- (2) The current through the regulator coil increases since it is across the l-v commutator.

- (3) The magnetic field of the regulator coil becomes stronger and is able to attract and open the first two or three contact fingers, depending on the strength of the field.
- (4) With the contacts open, the short is removed from the first two or three resistors, marked .2, .4, etc.
- (5) Since there is now added resistance in the field circuit, the field current is reduced slightly.
- (6) The reduced field current lowers the generator field strength and the lowered field strength results in less output voltage from the generator. Thus, the output voltage returns to the normal operating value.

e. The number of contacts that the regulator coil opens depends on the current in the coil which in turn varies with the output voltage of the l-v winding. Therefore, the resistance which is inserted in the generator field circuit is directly dependent on the output voltage. Controlling the generator field in this manner regulates the output of both the h-v and l-v armature coils since both rotate in the same magnetic field.

f. The regulating unit comes into operation only when the hand cranks are rotated above 50 rpm. If the cranks are turned too slowly, the only possible result is the decrease of voltage output from the generator. This can be remedied by a more rapid turning.

g. If the regulator itself becomes defective, do not attempt to adjust it. Remove it and plug in a new regulator unit. Some slight voltage adjustment can be made by varying the slider position on resistor 245. If the tap is moved to increase the resistance of resistor 245, there will be less current in the regulator coil and it will not have a strong enough field to keep as many contacts open, as were open before resistor 245 was manipulated. Some of the contacts will then close, allowing more current to flow in the generator field circuit, causing a higher output voltage from the generator. The tap on resistor 245 should be adjusted so that when the transmitter key is depressed, presenting full load to the generator, the voltage to ground from pin 20 on output receptacle 240 will be 6.3 volts.

h. An N.T.C. resistor is incorporated in the regulator coil circuit. If the temperature of the regulator coil should increase, the resistance of the windings increases, with a resultant decrease in current through the coil. Obviously, this will affect the output of the generator and this is undesirable. Therefore an N.T.C. resistor is placed in series with the coil circuit and the characteristics of this device are such that its resistance decreases when the temperature goes up. Thus, since its resistance is lowered, it will allow more current to flow, thereby compensating for the higher resistance of the regulator coil when the temperature increases.

Section IV. THEORY OF DYNAMOTOR-POWER SUPPLY DY-88/GRC-9-GY

105. General

(fig. 83)

This unit is designed to convert a 6-, 12-, or 24-volt d-c input from a vehicular storage battery into the necessary operating voltages for the receiver and transmitter. It consists of two major circuits: the dynamotor section and the vibrator section. The vibrator section operates when the OFF-SEND-STANDBY switch (control E) is turned to SEND or STANDBY. Both the dynamotor and vibrator sections operate when control E is turned to the SEND position. In stand-by operation, only the receiver is supplied with power and this presents less of a drain on the battery than when the

dynamotor section also is used. This is advantageous for prolonged periods of listening. In the SEND position, power is supplied to both the receiver and the transmitter for normal two-way communications.

a. STANDBY OPERATION. With TRANS & RECEIVE-OFF switch S203 on the dynamotor power supply in the TRANS & RECEIVE position, and control E on the transmitter in the STANDBY position, the following operations take place:

- (1) The receiver filament path is completed through switch S202D, receiver start relay K203, ballast tube R210 and the receiver tube filaments to ground.

- (2) Contacts 3 and 7 of K203 close, to complete the path for stand-by operation through switch S202B and C, vibrator E201, switch S202E and F, transformer T201, the normally closed contacts 2 and 3 of transmitter start relay K202 and dropping resistor R213.

b. SEND OPERATION. With S203 on the dynamotor power supply in the TRANS & RECEIVE position, and control E on the transmitter in the SEND position, the following operations take place:

- (1) The receiver filament path is completed through the same circuit shown in subparagraph a. (1) above.
- (2) Transmitter start relay K202 is energized through switch S202C, terminal 35, through the transmitter to ground.
- (3) When K202 is energized, contacts 5 and 6, and contacts 3 and 4 will close, completing the path through S202B and C, vibrator E201, switch S202E and F, and transformer T201. This circuit supplies 105 volts to the transmitter and to the audio section of the receiver (par. 88).
- (4) Contacts 11 and 12 of K202 also close to complete circuit which energizes the dynamotor start relay K201. When the contacts of K201 close, voltage will be supplied to the dynamotor through S201. The dynamotor supplies 580 volts for the transmitter at terminal 32 of J202. A 12-volt output from the dynamotor is reduced to 6.3 volts for the keying voltage at terminal 34, and 6.3 volts for the transmitter filaments at terminal 20. R201 is a voltage dropping resistor. Ballast tubes R208 and R209 maintain the current to the transmitter filament at a constant value.

c. OPERATION OF THE FILAMENT CONTROL RELAY When the receiver-transmitter is in PHONE-SEND operation and the key is up, the voltage at terminal 20 could rise as high as 16 volts. This voltage, without overload protection, would be applied instantaneously to relay K102 and the transmitter filaments when the transmitter is keyed. This condition is eliminated through the use of K204 and resistor R211 which act to reduce the voltage to a safe value (par. 111).

106. Fuses and Switches

a. FUSES. The vehicular battery is connected to the + and — terminals of the dynamotor power supply across capacitor C213 (fig. 84). C213 is an r-f bypass capacitor which prevents the input cables from radiating r-f noise that would interfere with radio reception. DYN FUSE F201 protects the dynamotor circuits. This fuse must be changed each time the battery voltage is changed (par. 43). VIB Fuse F202 protects the vibrator circuits.

b. Switches. The voltage selector switches, S201 and S202, in the dynamotor power supply are ganged to one common shaft and perform the function of connecting the correct circuit components when a 6-, 12-, or 24-volt vehicular battery is used. There are several wafer sections of S202, numbered S202A to S202G (figs. 84 and 85). TRANS & RECEIVE-OFF switch S203 is a single-section rotary switch.

107. Receiver Filament Supply (fig. 84)

a. When control E on the transmitter is in the SEND or STANDBY position, 1.4 volts d-c is supplied to the filaments of the receiver tubes. The battery voltage is fed through VIB FUSE F202 and switch S203 in the TRANS & RECEIVE position to switch S202D. S202D introduces the proper resistance to permit the circuit to operate from each of the three different battery voltages used. In the 6-volt position, no resistance is introduced; in the 12-volt position, R202 is switched into the circuit; in the 24-volt position, R202 and R203 in series are switched into the circuit.

b. The circuit then is completed through the coil of receiver start relay K203, ballast R210, and the receiver filaments to ground. The current that flows in this circuit energizes K203. C215 acts to eliminate ripple.

c. Ballast tube R210 is a thermal resistor in series with the receiver filament supply. It acts as a voltage regulator, maintaining a constant voltage output for the receiver filaments under conditions of varying input voltage. Capacitor C216 provides additional filtering.

d. When control E is in the STANDBY position, the receiver filaments receive their power through terminal 22 of J202. When control E is in the SEND position, the receiver filaments receive their power through terminal 23 of J202.

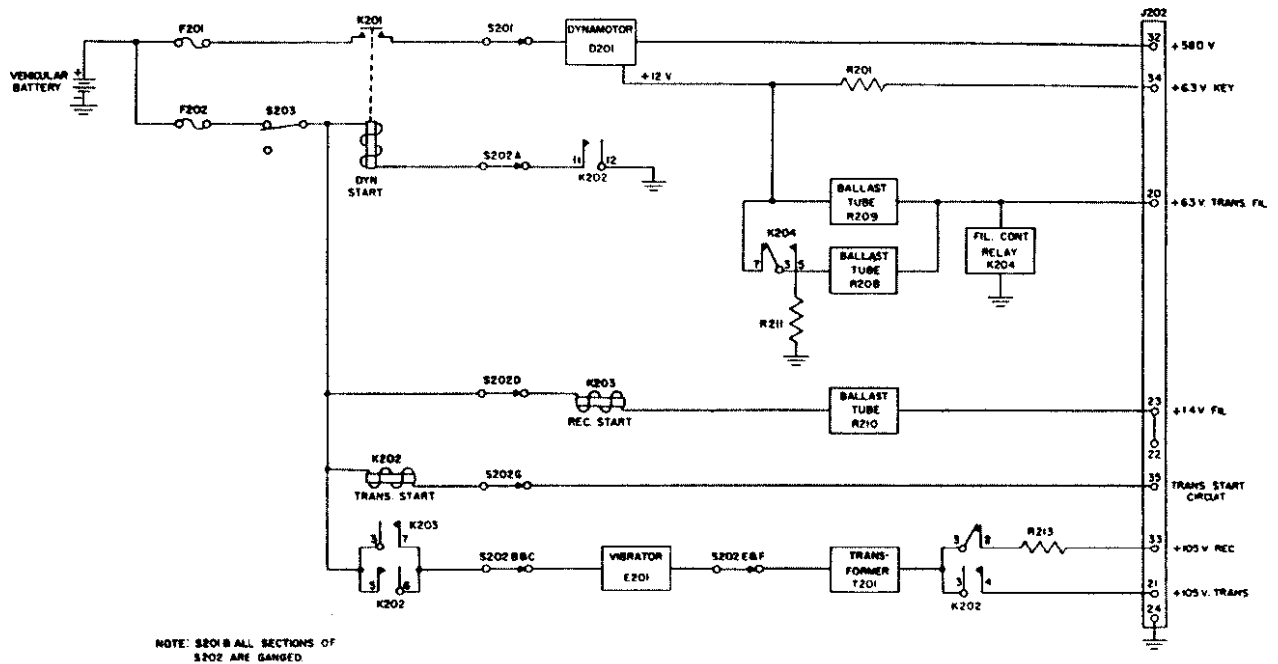


Figure 83. Dynamotor-Power Supply DY-88/GRC-9-GY, block diagram.

108. Receiver Plate and Screen Supply

a. Synchronous vibrator E201 and transformer T201 (fig. 84) are used to supply 105 volts d-c at 17 ma to the receiver plate and screen circuits during stand-by periods, and

105 volts d-c at 45 ma to the plate and screen circuits of V5 and V6 in the receiver (fig. 65) and to the oscillator, doubler, and modulator plates and screens of the transmitter, during send periods (figs. 81 and 82).

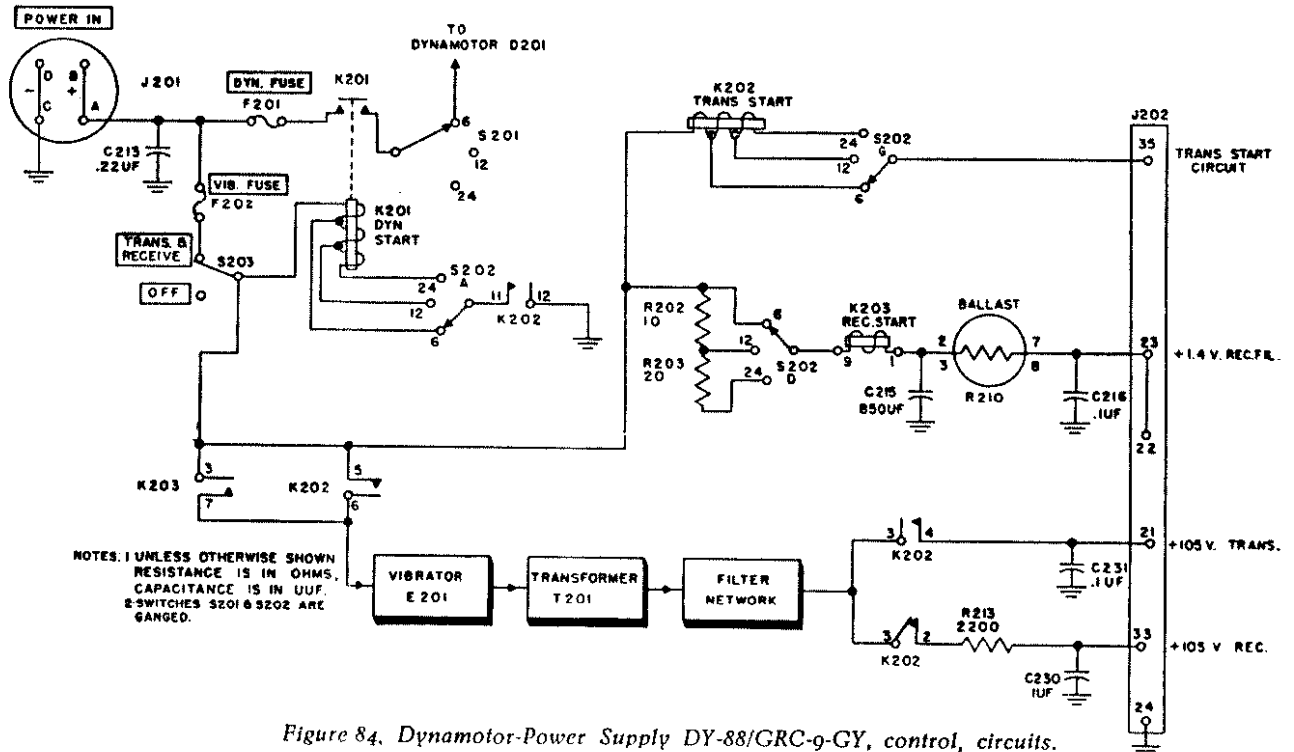


Figure 84. Dynamotor-Power Supply DY-88/GRC-9-GY, control, circuits.

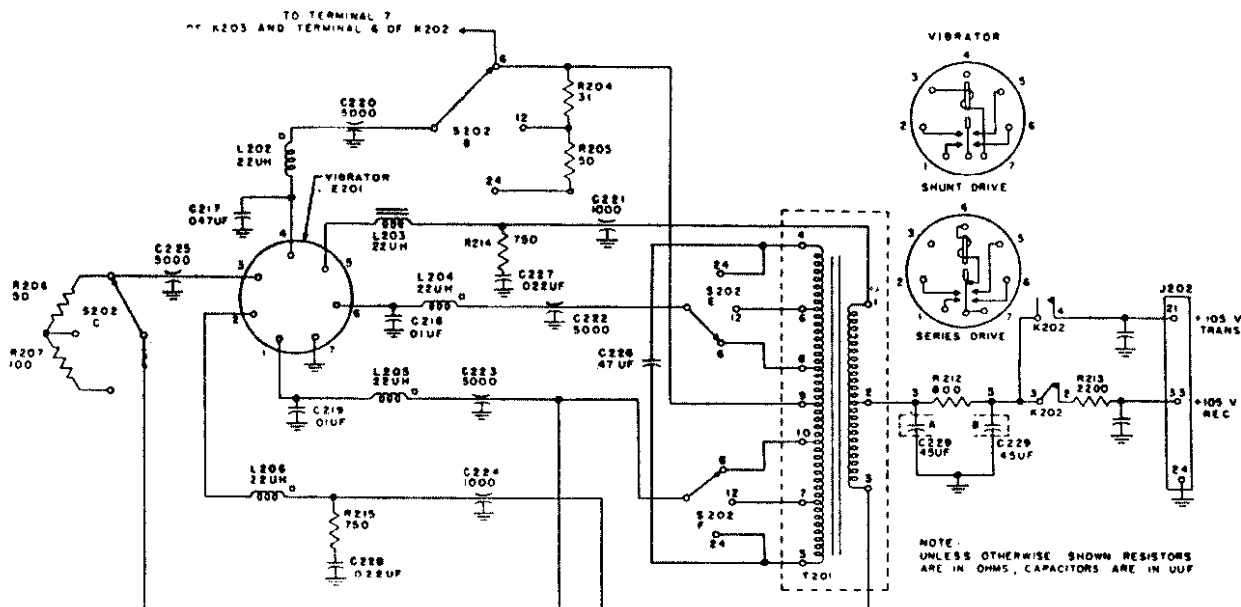


Figure 85. Dynamotor-Power Supply DY-88/GRC-9-GY, vibrator circuits.

b. Receiver start relay K203 is energized when control E is at the SEND or STANDBY position (par. 107). Battery current passes through closed contacts 3 and 7 of K203, or 5 and 6 of K202, or both (fig. 84), to voltage selector switch S202B and to the center tap (terminal 9) of transformer T201 (fig. 85). S202B introduces the proper resistance into the circuit to permit the circuit to operate from each of the three different battery voltages used.

c. Either a series-drive or a shunt-drive vibrator may be used in the vibrator section of the power supply. The principles of operation are basically the same. For purposes of discussion, the series-drive vibrator will be considered.

- (1) The series-driven vibrator coil, connected from pin 4 to the stationary contact, and the movable arm, connected to pin 7, constitute an ordinary buzzer similar to the doorbell type (fig. 85). However, the vibrating arm or reed moves back and forth many times more rapidly than in the familiar doorbell buzzer. The current through the vibrator coil attracts the reed, breaking the circuit to ground. This de-energizes the coil and the reed swings back in the opposite direction, completing the circuit to ground again. This action continues, causing the reed

to swing back and forth rapidly. The movable arm connects to ground through pin 7, and also makes contact with pins 1 and 6 in the two opposite directions of its vibration, thus connecting each pin alternately to ground. (Pins 2 and 5 are considered in subparagraph [2] below.) Pins 1 and 6 are connected to voltage selector switches S202E and S202F, which select the proper voltage for operation of transformer T201. Therefore, as the movable arm vibrates alternately to connect the top and the bottom of the primary of T201 to ground, the center tap (terminal 9) of the transformer connects to the positive terminal of the battery. Because of this center tap, the current in the primary flows from the center to either the top or the bottom half of the primary, depending on whether pin 1 or pin 6 of the vibrator is connected by the vibrating arm to ground. Therefore, the function of the portion of the vibrator considered so far is to cause an alternating current to flow through the transformer primary by making the battery current flow first in one direction and then in the opposite direction through the primary, simulating an alternating current. It is

actually the pulses of d-c current sent through alternate halves of the primary which cause a voltage to be induced in the secondary.

- (2) The vibrator contains an extra pair of contacts (pins 2 and 5) which is used to rectify the output voltage of T201, thereby dispensing with the need for a rectifier tube. Pins 2 and 5 are grounded alternately as explained in subparagraph (1) above. The secondary output from T201 is across transformer terminals 2 and 1 or 2 and 3 depending on whether vibrator pin 5 or 2 is grounded. The transformer windings are phased so that the voltage from terminal 2 to ground is always positive. Thus, terminal 2 on transformer T201 becomes a d-c source.
- (3) When a shunt drive vibrator is used, switch S202C and resistors R206 and R207 provide the correct operating voltage for the vibrator coil.

d. The rectified output from T201 is filtered by resistor R212 and capacitors C229A and C229B. During stand-by operation, the output is fed through contacts 3 and 2 of K202 to voltage-dropping resistor R213. The 105-volt d-c at 17 ma then is fed through terminal 33 of

output receptacle J202 to the receiver plates and screens.

e. With control E in SEND, K202 is energized and contacts 3 and 2 open while contacts 3 and 4 close. The filtered output then is fed through contacts 3 and 4 to terminal 21 on output receptacle J202.

f. In the explanation of the receiver plate and screen supply circuits several circuit elements were omitted. This was done to clarify the essential points of operation. The functions of these elements are explained below.

- (1) Filter chokes L202, L203, L204, L205, and L206 and r-f filter capacitors C217, C218, C219, C220, C221, C222, C223, C224, and C225 are incorporated for elimination of hash caused by the vibrator.
- (2) Capacitor C226 is the primary buffer. Its function is to minimize arcing of the vibrator contacts.
- (3) Capacitors C227 and C228 and resistors R214 and R215 function as arc suppressors and also as the secondary buffers.
- (4) Capacitors C230 and C231 are used to filter out r-f hash in the 105-volt d-c output.

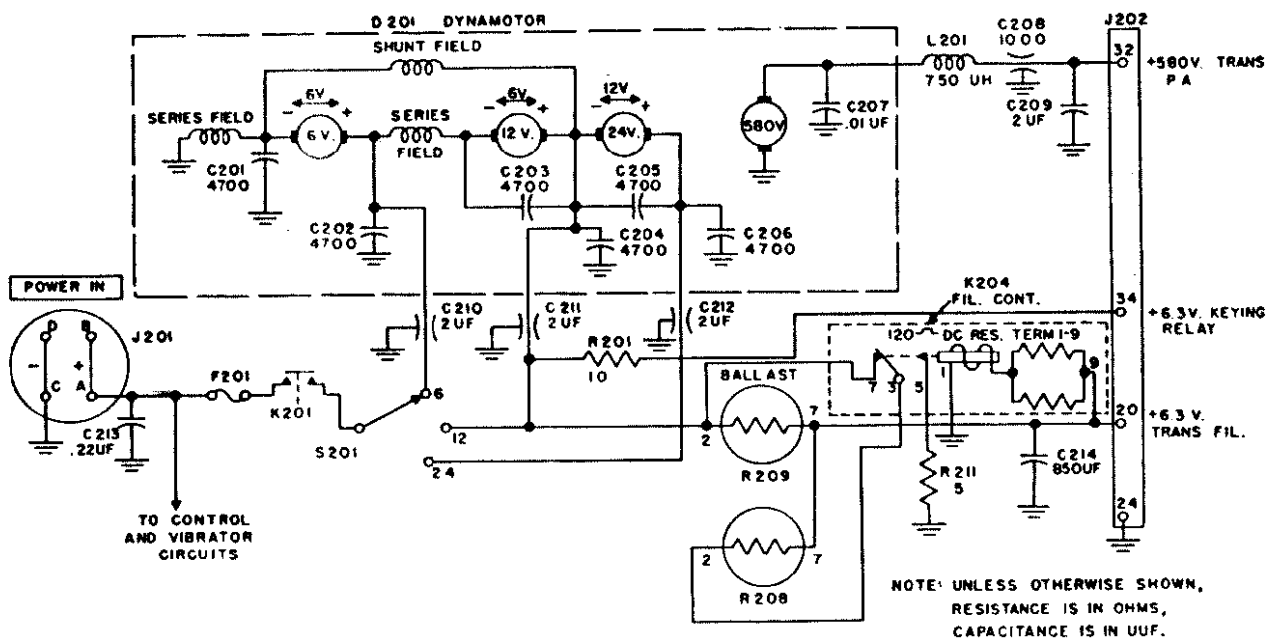


Figure 86. Dynamotor-Power Supply DY-88/GRC-9-GY, dynamotor circuits.

109. Transmitter Start Circuit

a. TRANSMITTER START RELAY. When control E is turned to the SEND position, transmitter start relay K202 is energized and contacts 11 and 12 close to apply power to dynamotor start relay K201 (fig. 84). At the same time, contacts 5 and 6 and 3 and 4 of K202 close, while contacts 2 and 3 open (par. 110). Voltage selector switch S202G permits the relay to operate from a 6-, 12-, or 24-volt battery.

b. DYNAMOTOR START CIRCUIT. Battery power is applied to the dynamotor through DYN FUSE F201, the closed contacts of dynamotor start relay K201, and voltage selector switch S201 (fig. 86). Voltage selector switches S201 and S202A permit operation from a 6-, 12-, or 24-volt battery.

110. Transmitter Plate and Screen Supply

a. Closed contacts 5 and 6 of K202 apply battery power to the vibrator portion of the dynamotor power supply (fig. 84). The 105-volt output is applied through closed contacts 3 and 4 of K202 (contacts 2 and 3 now are open), terminal 21 of J202, and closed contacts 18 and 19 of keying relay K101 to the receiver (fig. 65).

b. During send periods, keying relay K101 is energized, which causes contacts 18 and 19 to open and contacts 17 and 18 to close. This action transfers the 105 volts at 45 ma from all the receiver plate and screen circuits (except the last two audio stages) to the oscillator, doubler, and modulator stages in the transmitter (figs. 80 and 81).

c. Ordinarily contacts 5 and 6 of K202 are shorted by closed contacts 3 and 7 of receiver start relay K203 so that the 105-volt supply is operating continuously. Contacts 5 and 6 of K202 insure that 105 volts are available for the transmitter even though K203 is not energized, as would be the case if the receiver were inoperative.

d. The h-v output from the dynamotor is fed through terminal 32 of J202 and is applied to the p-a plate when control E is turned to the SEND position (fig. 86). No p-a plate current flows until keying relay K101 is energized and contacts 9 and 10 close to apply high voltage to the p-a screen (figs. 80 and 81).

e. Capacitors C201, C202, C203, C204, C205, and C206 are used to eliminate r-f noise. Capacitors C210, C211, and C212 reduce r-f hash from the dynamotor, which might enter the battery cable and cause interference with other radio equipment. Capacitors C207, C208, and C209 and r-f choke coil L201 serve to prevent radiation of r-f energy and to reduce commutator ripple in the output voltage.

111. Transmitter Filament and Keying Relay Supply (fig. 86).

Depending on the voltage of the vehicle battery, 12 volts are made available for the transmitter filament and keying relay circuits either directly from the battery or from the 12-volt output of the dynamotor (par. 112). Voltage selector switches S201 and S202A permit operation from a 6-, 12-, or 24-volt battery.

a. TRANSMITTER FILAMENTS SUPPLY. A regulated 6.3-volt d-c output is fed to the transmitter filaments through terminal 20 of output receptacle J202. Twelve volts are fed to the ballast tubes from the dynamotor on the vehicle battery (par. 112). Ballasts R208 and R209 are thermal resistors used to regulate the filament voltage at 6.3 volts. R208 and R209 are normally connected in parallel through normally closed contacts 3 and 7 of relay K204. Transmitter filament control relay K204 is used as an additional precaution to prevent the application of excessive voltage to relay K102B. When the radio set is in PHONE-SEND operation, no transmitter filament current is drawn until the push-to-talk button on the microphone is pressed (figs. 79 and 80). Under these conditions, insufficient current is drawn through R208 and R209 to drop the voltage down to 6.3 volts as required by relay K102B. If the voltage becomes excessive, K204 is energized and contacts 3 and 7 open. At the same time, contacts 3 and 5 close to connect R209, R208, and surge limiting resistor R211 in series to form a voltage divider. Reduced voltage for relay K102B then is taken from the junction of R208 and R209. When the push-to-talk button is pressed and the transmitter filaments are energized, the voltage across the coil of relay K204 drops so that K204 is de-energized. Contacts 3 and 5 open and contacts

3 and 7 close again to connect the two ballasts in parallel.

b. **KEYING RELAY SUPPLY.** The keying relay is supplied through terminal 34 of J202. Twelve volts are fed to voltage-dropping resistor R201 from the dynamotor or the vehicle battery. Resistor R201 provides the necessary voltage drop so that 6.3 volts are supplied to keying relay K101 when it is energized.

112. Dynamotor D201

a. Dynamotor D201 furnishes h-v d-c power to the plate and screen circuits of the transmitter and 1-v d-c power to the transmitter filaments and keying relay. A switching arrangement in the power supply permits operation from a 6-, 12-, or 24-volt storage battery while still maintaining the same output voltages.

b. The dynamotor is essentially a motor and a generator that operates from a common magnetic field. It has one armature which incorporates four windings and four commutators. Three 1-v windings are connected in series to form the motor section of the dynamotor armature. Two of the windings are 6-volt windings; the third is a 12-volt winding. For 6-volt operation, one 6-volt winding is used as the motor portion of the dynamotor; for 12-volt operation, the two 6-volt windings are connected in series; for 24-volt operation, all three windings are connected in series. The fourth winding is the h-v section of the armature and furnishes 580 volts for the transmitter plate and screen circuits. The armature and its four windings revolve on a common shaft in a common magnetic field. The shaft is mounted on ball bearings to provide free rotation. The voltage across each of the armatures is proportional to the voltage for which each armature is designed to operate. This is true because a motor, when driven by another motor, will act as a generator, when its field is excited.

c. All armatures have a common field, so that any non-driving armature acts as a generator. Thus when S201 (fig. 86) is in the

6-volt position, the first 6-volt armature acts as a motor and the second 6-volt armature acts as a generator and will produce approximately 6 volts that will add to the battery voltage to make approximately 12 volts d-c. Likewise, when switch S201 is in the 24-volt position, the voltage across the two 6-volt armatures in series will be approximately 12 volts because of the voltage dividing action of motors connected in series. Therefore, with S201 in any position (6, 12, or 24 volts), the voltage across the two 6-volt windings of the dynamotor always will be approximately 12 volts. This characteristic provides a convenient source of voltage which can be reduced by means of ballast tubes R208 and R209 in parallel to 6.3 volts for the transmitter filament (par. 111) even though the battery of the vehicle may be above or below this voltage. Therefore, because of the regulating action of the dynamotor on 6 volts and on 24 volts and because of the regulating action of the ballast tubes, the transmitter filaments are assured of the well-regulated voltage that their filaments require. On 12-volt operation, the filament circuit is connected directly to the battery through ballasts R208 and R209.

d. When d-c voltage is applied to the dynamotor, current flows through the field coils and the 1-v armature windings. This current sets up magnetic fields in both the field and armature windings that are opposite in polarity, causing the armature to rotate. Since the h-v winding is wound on the same armature, it cuts the lines of the common magnetic field, generating an alternating voltage which is converted to the 580-volt d-c voltage by the commutators. This voltage then is picked up from the commutators by a set of brushes. From the brushes, the high voltage passes through a filter circuit composed of capacitors C207, C209, C208 and choke L201. The brushes and commutators on the 1-v windings are used to transfer the d-c voltages from the battery to the windings. The field is compound wound; that is, part of the field winding is in series and part in shunt with the armature windings. This type of winding provides high starting torque and quick acceleration besides giving fairly constant output and speed for various loads.

CHAPTER 6

FIELD MAINTENANCE INSTRUCTIONS

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and equipment available, and by the skill of the repairman.

Section I. PREREPAIR PROCEDURES

Note. The prerepair procedures in this section can be used prior to a complete overhaul of the equipment. If the equipment merely requires trouble shooting and replacement of defective parts, refer to section II of this chapter.

113. Tools, Materials, and Test Equipment

Tools, materials, and test equipment for performing the prerepair procedures in this section are listed below:

Tool Equipment TE-113.

Cleaning fluid: Solvent (SD); Federal Specification P-S-661a.

Test Unit I-176 or

Multimeter TS-352/U.

114. Removal of Pluck-out Parts

a. RECEIVER-TRANSMITTER.

- (1) Tubes and pilot lights. Follow the instructions given in paragraphs 28 and 29 for the replacement of tubes and pilot lights. Wait until the tubes have cooled off. Some of the transmitter tubes look exactly like the receiver tubes. When replacing the receiver and transmitter tubes, be very sure not to mistake the tubes marked 3A4 with those which are used in the receiver. The 3A4 tubes are used only in the transmitter and not in the receiver. If a receiver tube is placed in a transmitter socket, it will burn out soon after the power is turned on.

Caution: Be sure that all power cables to the receiver-transmitter are removed. There are voltages present

which are dangerous to life. The plate cap on power amplifier tube V1013 (2E22) has 500 volts on it regardless of the position of the hand key.

- (2) Neon indicator bulb. Remove the indicator Polaroid lenses by grasping the stationary section (the part nearest the transmitter panel) and unscrew it by turning counterclockwise, as with an ordinary screw. When the lenses are removed, the top of the neon bulb is exposed. The bulb can be removed from its bayonet type socket by pressing it in gently with the pilot lamp extractor and twisting it in a counterclockwise direction. Tilt the transmitter panel slightly and the bulb will fall out. The pilot lamp extractor is found in Case: Box BX-53-GY. To replace the neon lamp, reverse the above procedure, making sure that the Polaroid lenses are screwed back on tightly.
- b. Dynamotor-Power Supply DY-88/GRC-9-GY. To remove pluck-out parts on the dynamotor power supply, remove the cover and proceed as follows:
 - (1) Vibrator E201 and ballast tubes R208, R209, and R210 are located on the upper side of the chassis (fig. 110). E201, R208, and R209 can be removed without further disassembly. R210 is shielded by E207. The shield is removed by twisting it in a counterclockwise direction and then pulling it straight up off the tube. R210 then can be removed without difficulty

(2) Capacitors C214, C215, and C229 (fig. 111) and relays K202, K203, and K204 are located on the under side of the chassis, toward the rear of the unit. To gain access to the capacitors and relays, first remove the two screws holding bracket C214 to the unit. Remove C214. The capacitors and relays now can be removed.

(3) Do not attempt to repair the hermetically sealed relays. If they are defective, they must be replaced.

c. GENERATOR GN-58-A-GY. The only pluckout part in the hand generator is the voltage regulator unit. The top half of the generator housing is fastened to the bottom by clamps (fig. 4). On some models, the clamps are fastened to the bottom half of the housing by screws. These screws must be completely removed before the clamps can be released. Once the top half is lifted off the bottom half of the

housing, the voltage regulator unit is clearly seen. Figure 108 shows the regulator for the Generator GN-58-A-GY.

115. Cleaning, Inspecting, and Testing Tubes and Pilot Lamps

a. CLEANING. Clean all the tubes with a cloth moistened with solvent (SD); if necessary, clean the grip caps and prongs with crocus cloth.

b. INSPECTING. Inspect the tubes for cracks in glass and base and for bent and broken prongs. Inspect the pilot lamp for continuity of filament, and make sure that the lamp base is not loose. When replacing the pilot lamp, be sure that the lamp is completely inserted in its socket.

c. TESTING. Test the tubes for proper emission, leakage, and short circuits; use a tube tester or place doubtful tubes in a receiver known to be operating normally.

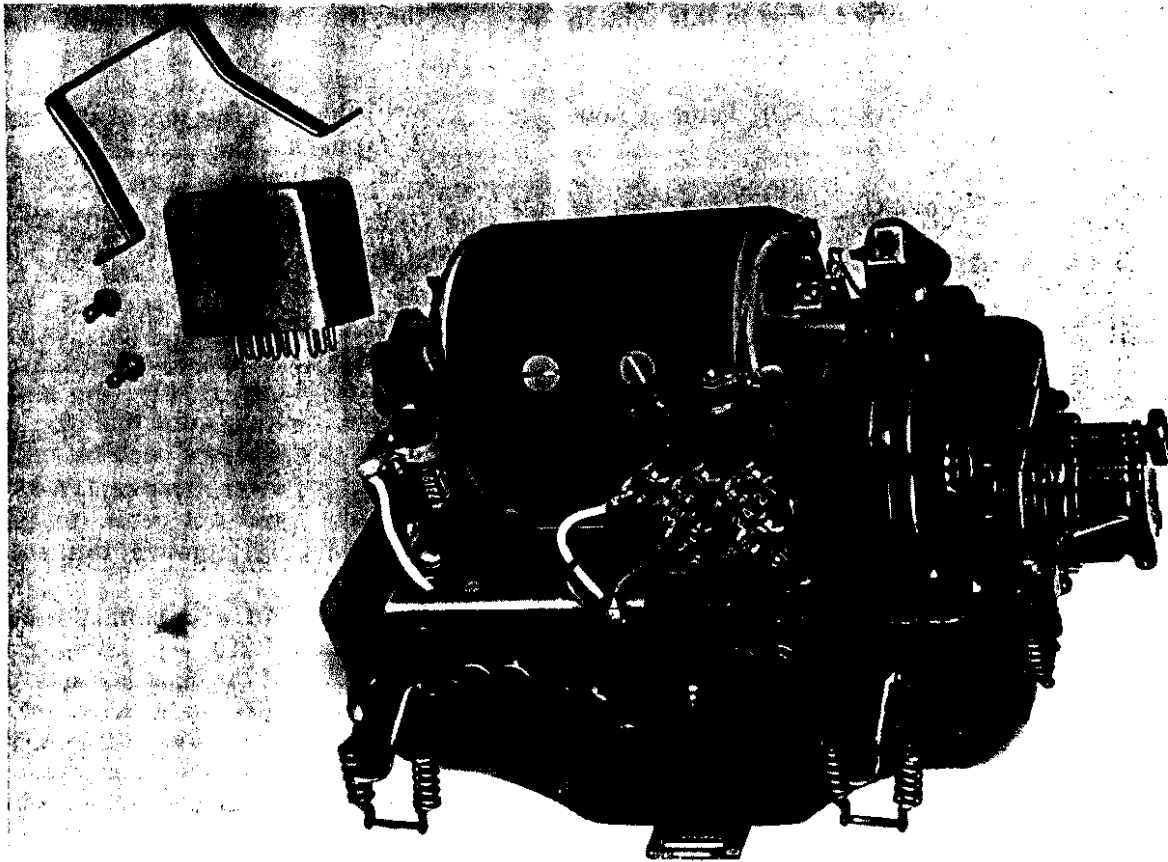


Figure 87. Disassembly of voltage regulator in generator GN-58-A-GY.

116. Cleaning and Inspecting Chassis Assembly

a. **CLEANING.** Thorough cleaning of the receiver-transmitter is necessary to insure optimum performance by preventing corrosion, rust, and dust from damaging parts or causing arc-over or low-resistance leakage between h-v points and ground. Remove loose dust and dirt with a brush or blower. With a brush or cloth and solvent (SD), remove dirt and grease which adheres to the chassis and parts. Remove the shield covers from the tube and crystal compartments, and remove all signs of corrosion.

b. **INSPECTION.** After the unit has been thoroughly cleaned, make a visual inspection

of parts and wiring for rust, corrosion, loose connections, frayed and burned insulation, loose screws, and burned or charred resistors and coils. Carefully inspect tube sockets for dirt or bent or broken contacts.

117. Reassembling Receiver-Transmitter

Replace the tubes, pilot light, and neon indicator in their proper sockets. Do not mistake the receiving tubes for the transmitting tubes. When replacing the transmitting crystals, be sure that they are put into the sockets in accordance with the information given in the CRYSTALS chart on the transmitter front panel. Carefully replace the tube and crystal cover plates.

Section II. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing Radio Set AN/GRC-9-GY be careful because of the high voltages exposed. Always disconnect the source of power to the unit before disassembling or doing any testing. For the receiver-transmitter, always pull out the plugs of Cords CD-1086-GY and CD-1119-GY. If it is necessary to measure high voltages, use the following procedure:

a. Connect the negative lead of the voltmeter to the chassis of the unit so that the connection requires no further attention.

b. Place one hand in your pocket. This will avoid the possibility of electricity traveling through the body, should both hands be across a high voltage.

c. If the voltage is greater than 300 volts (such as the plate cap of tube type 2E22), shut off the power, temporarily ground the terminal to drain off any accumulated charge, then remove the ground from the terminal, connect the positive test lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points which are both above ground.

118. Trouble-Shooting Procedures

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization

means tracing the fault to the major component or circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, r-f arcing, and shorted transformers often can be located by sight, smell, and sound. The majority of faults, however, must be localized by checking voltage and resistance.

a. **SYSTEM SECTIONALIZATION.** System sectionalization is discussed in paragraph 74.

b. **COMPONENT SECTIONALIZATION AND LOCALIZATION.** The tests listed below aid in isolating the source of trouble. To be effective, the procedure should be followed in the order given. Remember that the servicing procedure should cause no further damage to the receiver. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

- (1) Visual inspection. The purpose of visual inspection (par. 73) is to locate any visible trouble. Through this inspection alone, the repairman may frequently discover the trouble or determine the stage in which the trouble exists. This inspection is valuable in

avoiding additional damage to the receiver which might occur through improper servicing methods and in forestalling future failures.

- (2) **Input resistance measurements.** These measurements (par. 122) prevent further damage to the receiver from possible short circuits. Since this test gives an indication of the condition of the filter circuits, its function is more than preventive.
- (3) **Operational test.** The operational test (par. 123) is important because it frequently indicates the general location of trouble. In many instances the information gained will determine the exact nature of the fault. In order to utilize this information fully, all symptoms must be interpreted in relation to one another.
- (4) **Trouble-shooting chart.** The trouble symptoms listed in this chart (par. 124) will aid greatly in localizing trouble.
- (5) **Signal substitution.** The principal advantage of the signal substitution method (par. 130) is that it usually enables the repairman to localize a trouble accurately and quickly to a given stage when the general location of the trouble is not immediately evident from the above tests.
- (6) **Intermittents.** In all these tests, the possibility of intermittents should not be overlooked. If present, this type often may be made to appear by tapping or jarring the set. It is possible that the trouble is not in the radio set itself but in the installation (mounting, cabling system, or vehicle), or the trouble may be due to external conditions. In this event, test the installation if possible.

119. Trouble-Shooting Data

Take advantage of the material supplied in this manual. It will help in the rapid location of faults. Consult the following trouble-shooting data:

a. RECEIVER SECTION OF RECEIVER-TRANSMITTER RT-77/GRC-9-GY.

Fig. or par. No.	Description
Fig. 125	Receiver section of Receiver-Transmitter RT-77/GRC-9-GY, schematic diagram.
Fig. 56	Antenna switching and tuning circuits for receiver.
Fig. 64	Receiver filament supply circuits.
Fig. 65	Receiver plate and screen grid voltage supply circuits.
Fig. 90	Receiver top, parts location.
Fig. 88	Receiver power receptacle J3.
Fig. 89	Transmitter POWER socket resistances to ground.
Fig. 91	Receiver transformer and electrolytic capacitor terminal designations.
Fig. 92	Receiver bottom, parts location.
Fig. 93	Receiver bottom, parts location.
Fig. 94	Receiver bottom, parts location.
Fig. 95	Receiver tube socket, voltage and resistance diagram.
Fig. 96	Location of wafer sections of switch S3.
Par. 129	D-c resistances of transformers and coils.

b. TRANSMITTER SECTION OF RECEIVER-TRANSMITTER RT-77/GRC-9-GY.

Fig. or par. No.	Description
Fig. 97	Transmitter capacitor and dial retaining screws.
Fig. 98	Location of screws A and B.
Fig. 99	Back panel of transmitter shown swung up to expose tuning capacitor.
Fig. 100	Transmitter parts location (top).
Fig. 101	Transmitter parts location (bottom).
Fig. 102	Transmitter parts location (bottom).
Fig. 103	Transformer pin designation on transmitter.
Fig. 104	Transmitter tube socket voltage and resistance diagram.
Fig. 105	Transmitter wafer switch sections.
Par. 137	D-c resistance of transmitter coils and transformers.

c. GENERATOR GN-58-A-GY.

Fig. or par. No.	Description
Fig. 124	Generator GN-58-A-GY, schematic diagram.
Fig. 106	Generator GN-58-A-GY, disassembly illustration.
Fig. 107	Generator-GN-58-A-GY, removed from bottom half of housing.
Fig. 108	Generator GN-58-A-GY, parts location (top).
Fig. 109	Generator GN-58-A-GY, parts location (bottom).
Par. 141	D-c resistances of Generator GN-58-A-GY choke coils.

d. DYNAMOTOR-POWER SUPPLY DY-88/GRC-9-GY.

Fig. No.	Description
Fig. 110	Dynamotor-Power Supply DY-88/GRC-9-GY, cover removed, top view.
Fig. 111	Dynamotor-Power Supply DY-88/GRC-9-GY, cover removed, bottom view.
Fig. 112.1	Dynamotor D201 manufactured by the Carter Motor Company.
Fig. 112.2	Dynamotor D201 manufactured by Electro Engineering Products Company.
Fig. 127	Dynamotor-Power Supply DY-88/GRC-9-GY, schematic diagram.

120. Test Equipment Required for Trouble Shooting

The test equipment required for trouble shooting Radio Set AN/GRC-9-GY is listed below. The technical manuals associated with the test equipment are also listed.

Test equipment	Technical manual
Signal Generator I-72 or equal	TM 11-307
Oscillator I-151 or equal	TM 11-2524
Tube Tester I-177 or equal	TM 11-2627
Test Unit I-176 or	TM 11-2626
Multimeter TS-352/U.	TM 11-5527
	(TO 16-35TS352-3)

121. General Precautions

Whenever the receiver-transmitter is serviced, observe the following precautions very carefully:

- a. Be careful when the cover is removed; dangerous voltages are exposed.
- b. Careless replacement of parts often makes new faults inevitable. Note the following points:
 - (1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads to it.
 - (2) Be careful not to damage other leads by pulling or pushing them out of the way.
 - (3) Do not allow drops of solder to fall into the set, since they may cause short circuits.
 - (4) A carelessly soldered connections may create a new fault. It is very important to make well-soldered joints, since a

poorly soldered joint is one of the most difficult faults to find.

- (5) When a part is replaced in r-f or i-f circuits, it must be placed exactly as the original one was. A part which has the same electrical value but different physical size may cause trouble in h-f circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in decreased gain or possibly in oscillation of the circuit.
- (6) Do not disturb the adjustment of calibration control C102.
- (7) Avoid displacing any leads when getting at a particular component. If it is unavoidable, move the lead, but replace it in its original position after the faulty component has been replaced.

122. Checking Filament and B+ Circuits for Shorts

Trouble within the receiver or transmitter often may be detected by checking the resistance of the filament and h-v circuits before applying power to the equipment, thereby preventing damage to the power supply. Make the following checks before attempting to put the receiver-transmitter into operation.

- a. RECEIVER FILAMENT AND PLATE CIRCUITS (figs. 64, 65, and 88). Remove the receiver-transmitter interconnecting cable from the socket in back of the receiver chassis. The resistances to be obtained between ground and terminals 3, 4, and 6 are clearly shown in figure

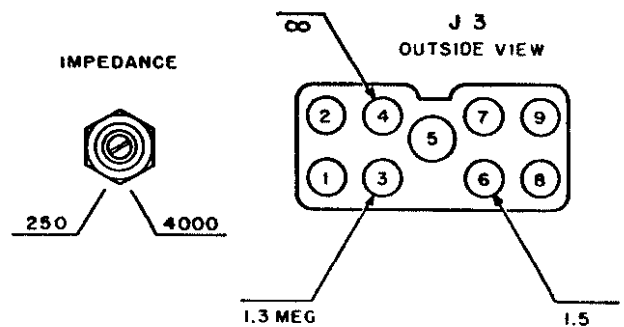


Figure 88. Receiver power receptacle J3.

88 If these readings are not obtained, do not supply power to the radio set, but trace the circuits to see where the shorts or opens are located. If this is not done, the power supply may be damaged.

b. TRANSMITTER POWER SUPPLY CIRCUITS (figs. 80, 81, 82, and 89). Disconnect power cables, Cords CD-1086-GY and CD-1119-GY, from the transmitter and remove the key and microphone from their jacks. Check the resistances to ground of the contacts of the transmitter POWER socket (fig. 89). If the readings shown are not obtained, do not apply power to the radio set; trace the circuits to see where the trouble is located. Otherwise, damage may be done to the power supply. Correct all conditions leading to abnormal readings before applying power to the radio set.

123. Operational Test

a. If the foregoing tests in paragraph 122 have not shown any abnormal readings, connect the power supply to the radio set and set up the unit for normal operation. Refer to the equip-

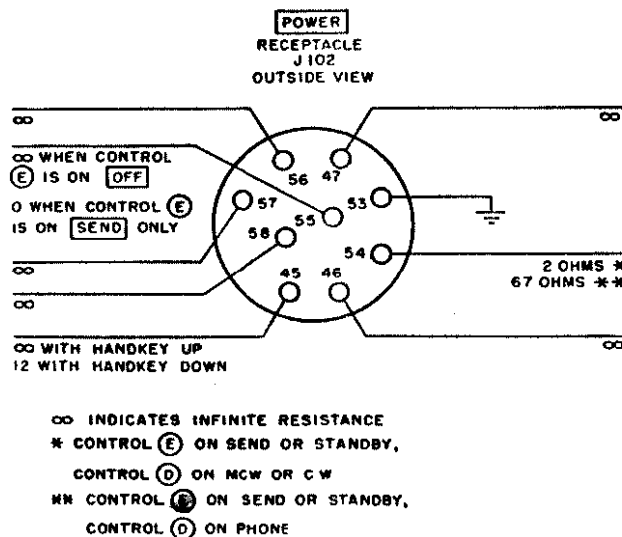


Figure 89. Transmitter power socket resistances to ground.

ment performance checklist in paragraph 75 and operate the set as described in the checklist. This step is important because it frequently indicates the general location of trouble. Also listen for crackling or buzzing noises, which indicate h-v arcing.

b. In some of the tests to be described later, it may be desirable to use a dummy antenna instead of an actual radiator. The dummy antenna for transmitter tests is a 20-ohm noninductive resistor in series with a 70-uuf (micro-microfarad) capacitor and an 0 to 2 amperes r-f meter. This is equivalent to a 15-foot whip antenna. Connect the meter end to the chassis or GND. post on the receiver. The resistor end connects to the ANT. post on the transmitter.

Note. A 5,400-ohm noninductive resistor is equivalent to a half-wave antenna (control A in REEL position).

124. Trouble-shooting Charts

The following ten trouble-shooting charts are supplied as an aid in locating trouble in the equipment.

a. The chart in paragraph 125 covers sectionalizing trouble in Radio Set AN/GRC-9-GY; it lists the various symptoms which may be easily recognized and gives the probable location of the existing trouble as well as the recommended correction. The chart also tells the operator if the trouble is in the transmitter section, receiver section, power supply, or antenna. By proper use of the charts, the operator can readily recognize troubles that may occur in the components of the equipment.

b. The chart in paragraph 126 covers sectionalizing trouble in the receiver section of the receiver-transmitter. This chart will aid in determining which stage in the receiver is at fault.

c. The chart in paragraph 127 is to be used to localize trouble in the receiver to an individual part within the faulty stage.

d. The chart in paragraph 134 is similar to paragraph 126, except that it deals with sectionalizing trouble in the transmitter section of the radio set.

e. The chart in paragraph 135 localizes the trouble in the transmitter to an individual part within the faulty stage.

f. The chart in paragraph 138 sectionalizes trouble in the hand generator.

g. The chart in paragraph 140 localizes trouble in the hand generator.

h. The chart in paragraph 142 localizes trouble in the dynamotor power unit.

125. Sectionalizing Trouble in Radio Set AN/GRC-9-GY

Symptom	Probable trouble	Correction
1. All controls in correct position for operation of receiver and transmitter, but neither operates; dial lights do not light.	1a. Cord CD-1086-GY defective ... b. Power supply defective	1a. Replace Cord CD-1086-GY. b. See charts for Dynamotor-Power Supply or Generator GN-58-A-GY. c. Turn control E to SEND.
2. Transmitter normal. Receiver does not operate.	c. If only transmitter panel light works, and only Generator GN-58-A-GY is being used, control E may not be on send. 2a. Headset plug not fully inserted in PHONES jack. b. Open circuit in headset	2a. Push in headset plug. b. Replace headset; repair defective unit. c. Remove receiver-transmitter from the case and check the cable.
3. Transmitter normal, receiver weak.	3a. If Battery BA-48 is being used, it may be weak. b. Poor antenna installation or location. c. Check for correct position of IMPEDANCE switch S4 for headset in use. d. Receiver switch control L on NET. e. Defective receiver tubes	3a. Replace Battery BA-48. b. Increase antenna height. Change location. c. Place switch S4 on correct position for headset being used. d. Change control L to PHONE or C.W. position. e. Replace receiver tubes. f. See power supply charts.
4. Receiver normal, transmitter dead.	f. Check voltage output of power supply. g. Major trouble in receiver 4a. Control E not on SEND	f. See receiver charts. 4a. Turn control E to SEND. b. See power supply charts.
5. Receiver normal, transmitter weak.	b. Check voltage output of power supply. c. Turn control D to PHONE and depress key. Listen for relay K101 clicking. With key closed, depress DIAL LIGHT control J. If it does not light, then relay K101 is probably at fault. d. Check metering socket voltages according to chart in back of transmitter. 5a. Check metering socket voltages b. Defective transmitter tubes c. If transmitter is normal on either MO or XTAL operation, but not both, transmitter is at fault.	b. See transmitter charts. c. See transmitter charts. d. See transmitter charts. 5a. See transmitter charts. b. Replace tubes. c. See transmitter charts.

126. Sectionalizing Trouble in Receiver Section (figs. 64, 65, and 125)

Symptom	Probable trouble	Correction
1. Receiver dead. Tubes and dial light do not light up.	1a. PHONES jacks dirty or broken b. Shorted selenium voltage regulator CR1. c. Shorted capacitor C24	1a. Repair, clean, or replace PHONES jacks. b. Replace selenium voltage regulator CR1. c. Replace capacitor C24. d. Replace capacitor C34A

126. Sectionalizing Trouble in Receiver Section-Continued
(figs. 64, 65, and 125)

Symptom	Probable trouble	Correction
	<ul style="list-style-type: none"> e. Shorted DIAL LIGHT switch S2 f. One of the tube filaments is shorted. 	<ul style="list-style-type: none"> e. Replace switch S2. f. Check tubes.
2. Signals very weak, with volume controls on full maximum position.	<ul style="list-style-type: none"> 2a. The alinement of one or several stages is off. b. Tube plate and screen grid voltages are low. c. Faulty tubes d. If signals are normal, with loud volume, on C.W. position of control L, resistor R16 or capacitor C33 may be open. 	<ul style="list-style-type: none"> 2a. Use signal substitution check (pars. 132 and 133). b. Use signal substitution check (par. 132) to find which weak stages are not supplied with full voltage. c. Check tubes. d. Replace resistor R16 or capacitor C33.
3. Reception badly distorted	<ul style="list-style-type: none"> 3a. Defective tubes b. Defective headset c. Incorrect bias voltage on the audio stages. Leaky bias resistor, bypass capacitors, and coupling capacitors. Shorted or open bias resistors. d. Defective bias cell BT1 in signal grid circuit of tube V6. Check the cell, <i>only with a vacuum-tube voltmeter</i>. It should produce 4 to 6 volts. e. Incorrect plate and screen grid voltages on the tubes. 	<ul style="list-style-type: none"> 3a. Check tubes for gas. b. Replace the headset. c. Use headset with .1-uf capacitor in series with one lead to localize the faulty stage, then refer to paragraph 127 to find the defective component. d. Replace bias cell BT1.
4. Constant, objectionable hum, buzzing, or sizzling in receiver output on all bands.	<ul style="list-style-type: none"> 4a. Power supply filter units defective. Filters or vibrator E201 in Dynamotor-Power Supply DY-88/GRC-9-GY defective. Generator GN-58-A-GY regulator not functioning properly. b. One of the plate or screen grid resistors may be defective. Look for burned, charred, discolored, or blistered resistors. c. Dirty contacts in the A. F. GAIN or R. F. GAIN control. Look for dirt on the shafts. d. Leaky coupling capacitors in audio circuits. 	<ul style="list-style-type: none"> e. Check plate and screen grid d-c voltages (par. 128). 4a. Change power supplies or operate radio receiver on Battery BA-48 alone. If symptoms clear up, see chart for appropriate power supply. b. Replace the faulty resistor. c. Replace the control. d. Test and replace faulty capacitor.
5. Oscillation, whistling, squeals, and motorboating.	<ul style="list-style-type: none"> 5a. The antenna may be too short because the correct number of jumpers are not closed. b. Open plate supply and screen grid bypass capacitors. Momentarily, short these capacitors with others of equal capacity, known to be good: C34B, C40, C43, C55, C50, C46, C35, C30, and C9. Check choke coil L16, in the filament circuit of tube V2, for shorts. c. When a previous repair job has been completed, some of the wiring in the r-f and i-f circuits may have been displaced. Placing plate leads close to grid leads causes oscillation. d. Check the tubes for gas e. Incorrect plate and screen grid voltages. f. Incorrect tracking of h-f oscillator with r-f tuning stages. 	<ul style="list-style-type: none"> 5a. Close the jumpers in accordance with the calibration chart. b. Replace those capacitors found to be open. Replace choke coil L16. c. Place all leads differing in h-f potential as far apart as possible. Leads differing in d-c potential do not matter, as long as they are adequately bypassed to ground. d. Replace the defective tube. e. Replace defective components. f. Refer to alinement (par. 156).

126. Sectionalizing Trouble in Receiver Section-Continued
(figs. 64, 65, and 125)

Symptom	Probable trouble	Correction
6. Intermittent operation. Abrupt cutting in and out.	6a. Defective tube. Resistor or capacitor opens intermittently. Loose wiring. b. One of the stages is not working	6a. With an insulated prod, tap all tubes, resistors, capacitors, soldered connections, and transformer shield cans. b. Use signal substitution method in paragraph 130.
7. Periodic fading when radio set is not on a moving vehicle.	7a. Defective tube	7a. Do not check the tubes, as a tube may check very well in a tube tester but may not be suitable in the receiver. Replace all tubes with those known to be in good condition.
	b. Open grid leak resistors	b. Check the resistance of the following resistors: R1, R6, R16, R18, and R19B.
	c. Antenna may be swaying in the wind.	c. Secure guy wires.
	d. AVC inoperative	d. Refer to receiver trouble localization chart (tube V5).
	e. Atmospheric disturbances	e. Use long-wire antenna and orientate it in the direction of the station desired.
8. Fading or intermittents on C.W. and CAL. positions only.	8a. Open capacitor C51	8a. Momentarily, parallel capacitor C51 with a capacitor of equal capacity.
	b. Bfo intermittent	b. Refer to paragraph 127, No. 31.
9. No beat note heard on CAL., but receiver normal, otherwise.	9a. Capacitor C36 open	9a. Momentarily, place a capacitor of the same capacity in parallel with capacitor C36.
	b. 200 kc. Crystal II defective ...	b. Replace Crystal II.
	c. Crystal-oscillator circuit defective	c. Refer to receiver trouble localization chart (tube V4).

127. Localizing Trouble in Receiver Section

Symptom	Probable trouble	Correction
R-F AMPLIFIER V1 (1L4).		
1. No signal passes through. Voltages are normal.	1a. Capacitor C8 open	1a. Momentarily, parallel capacitor C8 with one of equal capacity.
	b. Capacitor C7A shorted	b. Check variable air capacitor plates for dirt, dust, burs, and direct shorts.
	c. Capacitor C36 shorted	c. Momentarily, unsolder capacitor C36 from pin 6 of the r-f amplifier (V1).
	d. Resistor R1 open	d. Check resistor R1.
	e. Check trimmers and the secondaries of transformer T2 for shorts.	e. Clean out any dust and dirt. Remove shorts.
	f. Tube V1 shorted internally ..	f. Replace tube V1.
2. Incorrect d-c voltage on pin 2 for all three bands.	2a. Capacitor C10 shorted	2a. Replace capacitor C10.
	b. Resistor R2 open or shorted ..	b. Replace resistor R2.
	c. Open switch S1C	c. Repair or replace switch S1C.
	d. The primary coil for that band is open.	d. Repair or replace transformer T2.
3. Incorrect d-c voltage on pin 3.	3a. Capacitor C9 shorted	3a. Replace capacitor C9.
	b. Resistor R11 open	b. Replace resistor R11.
4. Incorrect d-c voltage on pin 7.	4a. If all tubes but V1 light, then the connection to pin 7 is broken.	4a. Trace lead to pin 7.
	b. If all tubes do not light refer to paragraph 126.	b. Refer to paragraph 126.

127. Localizing Trouble in Receiver Section-Continued

Symptom	Probable trouble	Correction									
CONVERTER TUBE V2 (1R5):											
<p>5. No signal passes through. Voltages are normal. Noise heard in headset.</p> <p>6. Incorrect d-c voltage on pin 2.</p> <p>7. Incorrect d-c voltage on pin 3.</p> <p>8. Incorrect d-c voltage on pin 7.</p> <p>FIRST I-F AMPLIFIER V3 (1L4):</p> <p>9. No signal passes through. Voltages are normal.</p> <p>10. Incorrect d-c voltage on pin 2.</p>	<p>5a. Switch S1D (rear) is dirty or open</p> <p>b. Capacitor C28 is open</p> <p>c. Resistor R6 open</p> <p>d. Capacitor C31 shorted</p> <p>e. Oscillator section of the converter tube V2 is not oscillating.</p> <p>f. Components in oscillator grid circuit from pin 4 of converter tube V2 to ground may be faulty.</p>	<p>5a. Repair or replace switch S1D.</p> <p>b. Momentarily, parallel capacitor C28 with a capacitor of equal capacity.</p> <p>c. Momentarily, parallel resistor R6 with one of equal resistance.</p> <p>d. Replace capacitor C31.</p> <p>e. If the oscillator section is operating correctly, there will be a voltage of minus 4.5 volts with respect to ground on pin 4 of tube V2. Check this negative voltage with a VTVM <i>only</i>.</p> <p>f. Check the resistances from pin 4 to ground of the converter tube V2 on each of the three bands.</p>									
			<table border="1"> <thead> <tr> <th>Position of control M</th> <th>Resistance from pin 4 to ground</th> </tr> </thead> <tbody> <tr> <td>BAND 1</td> <td>103,000 ohms.</td> </tr> <tr> <td>BAND 2</td> <td>276,000 ohms.</td> </tr> <tr> <td>BAND 3</td> <td>276,000 ohms.</td> </tr> </tbody> </table>	Position of control M	Resistance from pin 4 to ground	BAND 1	103,000 ohms.	BAND 2	276,000 ohms.	BAND 3	276,000 ohms.
	Position of control M	Resistance from pin 4 to ground									
	BAND 1	103,000 ohms.									
	BAND 2	276,000 ohms.									
	BAND 3	276,000 ohms.									
		<p>g. Defective converter tube V2 (1R5).</p> <p>h. Oscillator coils may not be tracking correctly.</p>	<p>g. Do not check the tube, but replace it with two or three different ones. If the oscillator section still does not work, reinsert the original tube.</p> <p>h. See alignment section on receiver (par. 152).</p>								
		6. Open primary of i-f transformer T4.	6. Check the resistance of primary of transformer T4 (lugs 3 and 2) (par. 129).								
		<p>7a. Resistor R8 opens</p> <p>b. Capacitor C30 shorted</p>	<p>7a. Check resistor R8.</p> <p>b. Remove capacitor C30 and replace with one of equal value.</p>								
		8. Open or shorted choke L16	8. Remove converter tube V2, and check coil L16 for open or short.								
	<p>9a. Open in secondary of transformer T4 or shorted primary of transformer T5.</p> <p>b. If signal comes through with normal volume on C.W. position of control L but not on PHONE, check signal grid return resistor R16 for open (return resistor).</p> <p>c. Capacitor C35 open</p> <p>d. Transformer T4 or T5 misaligned</p>	<p>9a. Check transformer resistances (par. 129).</p> <p>b. Turn control L to PHONE and check resistor R16.</p> <p>c. Momentarily, short capacitor C35 with one of equal capacity.</p> <p>d. Refer to paragraph 154.</p>									
	<p>10a. Open or shorted primary of transformer T5.</p> <p>b. Capacitor C37</p>	<p>10a. Check transformer T5 primary resistance.</p> <p>b. Replace capacitor C37.</p>									

127. Localizing Trouble in Receiver Section-Continued

Symptom	Probable trouble	Correction
11. Incorrect d-c voltage on pin 3.	11a. Open resistor R12 shorted capacitor C35. b. Open switch S3-2	11a. Replace defective component. b. Check the voltage from pin 3 of the r-f amplifier tube V1 to ground. If it is normal, then switch S3-2 is probably defective. c. Check control P.
SECOND I-F AMPLIFIER AND CRYSTAL OSC V4 (1R5):		
12. No signal passes through. Voltages normal. Switch L on PHONE or C.W. position.	12a. Open or shorted secondary of transformer T5. Shorted primary of transformer T6. Shorted capacitor C38, C44, or C43. b. Faulty ground connection to lug 4 of transformer T5. c. Capacitor C46 open	12a. Check and replace faulty components. b. Check, clean, and tighten the ground connection to lug 4. c. Short capacitor C46 with one of equal capacity. d. Refer to paragraph 154.
13. Signal passes, but reduced in volume.	13. Transformer T5 or T6 misaligned	13. Refer to paragraph 154.
14. Control L on CAL. No beat note heard in headset. Set normal when on C.W. or PHONE.	14. Crystal oscillator section not functioning. With a VTVM, check for a negative voltage to ground on pin 4 of tube V4. If no negative voltage or a positive voltage is obtained, the circuit is not operating. a. Crystal unit defective	14a. Replace crystal unit. b. Try two or three replacements; if the oscillator still does not work, reinsert the original tube. c. Turn control L to CAL. and check resistance of resistor R13. d. Check capacitors C39 and C42. e. Check continuity of coil T7.
	b. Tube V4 defective	
	c. Faulty resistor R13	
	d. Capacitors C39 and C42 open or shorted.	
	e. Coil T7 open	
15. Incorrect d-c voltage on pin 2.	15a. Primary of transformer T6 open	15a. Check primary resistance. b. Check resistance of resistor R15. c. Replace capacitor C43.
	b. Resistor R15 open	
	c. Capacitor C43 shorted	
16. Incorrect d-c voltage on pin 3 in CAL. position of control L.	16a. Resistor R14 open	16a. Check for resistance from terminals 2 to 4 on transformer T7. b. Replace capacitor C41.
	b. Capacitor C41 shorted	
17. No d-c voltage on pin 7. All other tubes normal.	17. Filament open or shorted	17. Replace tube V4.
DETECTOR SECTION OF TUBE V5 (1S5):		
18. No signal passes through, Voltages on tube are normal.	18a. Open circuit in secondary of transformer T6. b. Capacitors C49 and C48 open or shorted. c. Resistor R17, R18, or A. F. GAIN control O (R19A) may be open.	18a. Check resistance of secondary. b. Check these components and replace if necessary. c. Turn control L to PHONE and check the resistance of each resistor individually.
19. Signal comes through badly distorted. Voltages on tube are normal.	19a. One of resistors R17, R18, or R19A has changed in value. b. Capacitor C49, C47, C33, or C48 shorted or open. c. Secondary of transformer T6 misaligned.	19a. Turn control L to PHONE and check each resistor individually. b. Check component. c. Refer to paragraph 154.

127. Localizing Trouble in Receiver Section-Continued

Symptom	Probable trouble	Correction				
A-F AMPLIFIER SECTION OF TUBE V5 (1S5):						
20. No signal passes through. Tube voltages are normal.	20a. A. F. GAIN control O may be open or shorted to ground. b. Defective tube c. Capacitor C52 leaking d. Capacitor C53 open	20a. Check the resistance of R19A. b. Replace tube. c. Replace capacitor C52. d. Momentarily, short capacitor C53 with one of equal capacity.				
21. Oscillations, motorboating, and squeals.	21a. Plate and signal grid leads may be too close together. b. Capacitor C52 open c. Capacitor C34B open d. Capacitor C57 (plate bypass for tube V6, 3Q4) may be open. e. Capacitor C48 may be shorted	21a. Gently separate these leads as far apart as is possible. b. Momentarily, short capacitor C52 with one of equal capacity. c. Momentarily, short capacitor C34B with one of equal capacity. d. Momentarily, short capacitor C57 with one of equal capacity. e. Replace capacitor C48.				
22. Incorrect d-c voltage on pin 4. Other tubes normal.	22a. Resistor R20 open b. Capacitor C50 shorted	22a. Check resistor R20. b. Remove capacitor C50.				
23. Incorrect d-c voltage on pin 5.	23a. Resistor R21 defective b. Capacitor C52 shorted c. Resistor R29 open d. Capacitor C34B shorted e. Primary coil of transformer T9 may be shorted to ground.	23a. Replace resistor R21. b. Replace capacitor C52. c. Check resistor R29. d. Replace C34B. e. Take a resistance check from terminal 5 on transformer T9 to ground. There should be infinite (∞) impedance. Be sure however that capacitor C34B is not shorted or transformer may be wrongly suspected.				
24. No voltage on pin 7	24. Defective tube	24. Check tube.				
SECOND AUDIO AMPLIFIER V6 (3Q4):						
25. No signal passes through. Tube voltages are normal.	25a. A. F. GAIN control O (R19B) open or shorted. b. Bias cell BT-1 defective c. Tube defective d. Capacitor C57 shorted or leaky e. Primary of output transformer T9 shorted.	25a. Check potentiometer R19B. b. Replace bias cell BT-1. c. Replace tube. d. Replace capacitor C57. e. Check resistance between terminals 2-5 on transformer T9.				
26. Signal badly distorted. Voltages normal.	26a. Capacitor C54 open or shorted b. Capacitor C53 leaking c. Capacitor C57 defective d. Tube gassy e. DIAL LIGHT-PUSH control K defective.	26a. Replace capacitor C54. b. Replace capacitor C53. c. Replace capacitor C57. d. Replace tube. e. When DIAL LIGHT-PUSH control K is not depressed, be sure that both sides of tube 3Q4 filament light.				
27. Signal output very low. Volume controls in maximum position. Voltages normal. Headset normal.	27a. Output IMPEDANCE switch S4 in incorrect position. b. Capacitor C55 open c. Tube V6 (3Q4) defective d. Capacitor C56 leaky e. Capacitor C34B open f. If the sidetone signal also is low, the trouble is probably in the output impedance-matching transformer T9. g. Capacitor C61 shorted h. PHONES jacks J1 and J2 defective.	27a. For the following reproducers turn IMPEDANCE control to: <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Loudspeaker LS-7-GY</td> <td>4000</td> </tr> <tr> <td>Headset HS-30-(*)</td> <td>250</td> </tr> </table> b. Momentarily, short capacitor C55 with one of equal capacity. c. Replace tube V6 (3Q4). d. Replace capacitor C56. e. Replace capacitor C34B. f. Check the coil resistances of the transformer. g. Replace capacitor C61. h. Inspect and clean PHONES jacks J1 and J2.	Loudspeaker LS-7-GY	4000	Headset HS-30-(*)	250
Loudspeaker LS-7-GY	4000					
Headset HS-30-(*)	250					

127. Localizing Trouble in Receiver Section-Continued

Symptom	Probable trouble	Correction
28. Incorrect d-c voltage on pins 2 and 6. All other tubes are normal.	28a. Primary of transformer T9 open or shorted to ground. b. Capacitor C57 shorted or leaking c. Capacitor C56 shorted or leaking	28a. Check primary resistance, and resistance between terminals 5 and 4 which should be infinite (8). b. Replace capacitor C57. c. Replace capacitor C56.
29. Incorrect d-c voltage on pin 4. All other tubes are normal.	29a. Resistor R23 shorted or open . b. Capacitor C55 is shorted	29a. Replace resistor R23. b. Replace capacitor C55.
30. Incorrect d-c voltage on pin 7.	30a. DIAL LIGHT-PUSH control K (S2) open or shorted. b. Tube V6 (3Q4) defective	30a. Check switch S2. b. Replace tube VE (3Q4).
BFO TUBE V7 (1R5):		
31. Bfo inoperative. No tone is heard on C.W. or CAL. position. PHONE operation is normal. All d-c voltages are normal.	31a. Turn switch L to C.W. With a VTVM, take voltage reading from pin 4 to ground of tube V7 (1R5). Pin 4 should be 10 volts <i>below</i> ground potential. If reading obtained shows pin 4 to be much less than -10 volts or even positive, then the bfo circuit is not oscillating. b. Tube V7 (1R5) defective c. Resistor R25 may be open d. Coil T8 may be open or shorted e. Capacitor C60 may be open .. f. Coil T8 not alined	31a. See symptom 31b in probable trouble column. If correct reading is obtained, check capacitor C51 for a possible open circuit. b. Replace tube V7 (1R5). Checking not necessary. c. Short resistor R25 with one of equal value. d. Make resistance checks on the terminals of coil T8. Replace coil T8 if another unit is available. e. Short capacitor C60 with one of equal value. f. Refer to paragraph 155.
32. Incorrect d-c voltage on pin 2. All other tubes are normal.	32. Resistor R22 open or shorted ..	32. Replace resistor R22.
33. Incorrect d-c voltage on pin 3. All other tubes normal. Control L on C.W. or CAL.	33a. Part of coil T8 open b. Capacitor C60 shorted c. Resistors R26 and R27 defective d. Tube V7 (1R5) internally shorted	33a. Check the resistance between terminals 2 and 4 of coil T8. b. Replace capacitor C60. c. Replace resistors R26 and R27. d. Replace tube V7 (1R5).
34. No d-c voltage on pin 7. All other tubes normal.	34a. Short or open in the supply line to tube V7. b. Tube V7 (1R5) defective	34a. Remove tube V7 and check for zero resistance between pin 7, of socket V7 and pin 7 of tube V4 (1R5). b. Replace tube V7 (1R5).

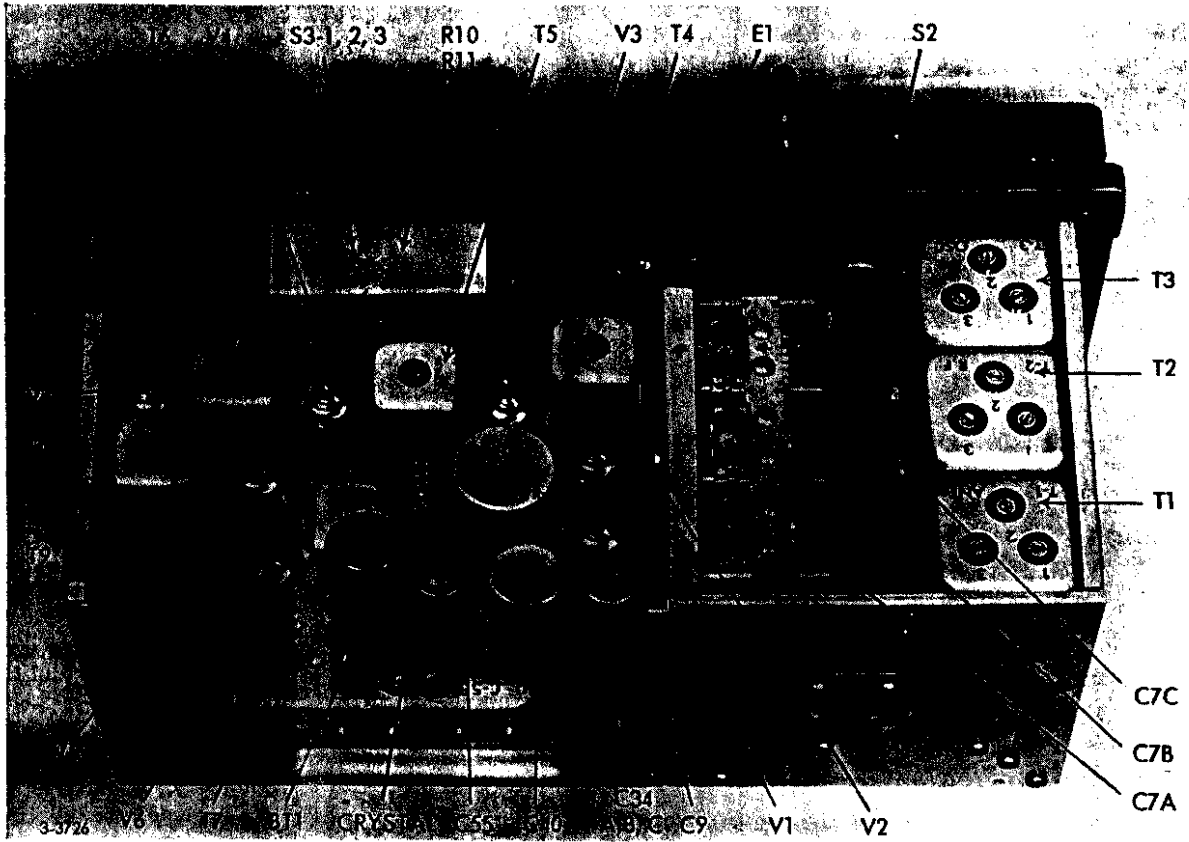


Figure 90. Receiver top, parts location.

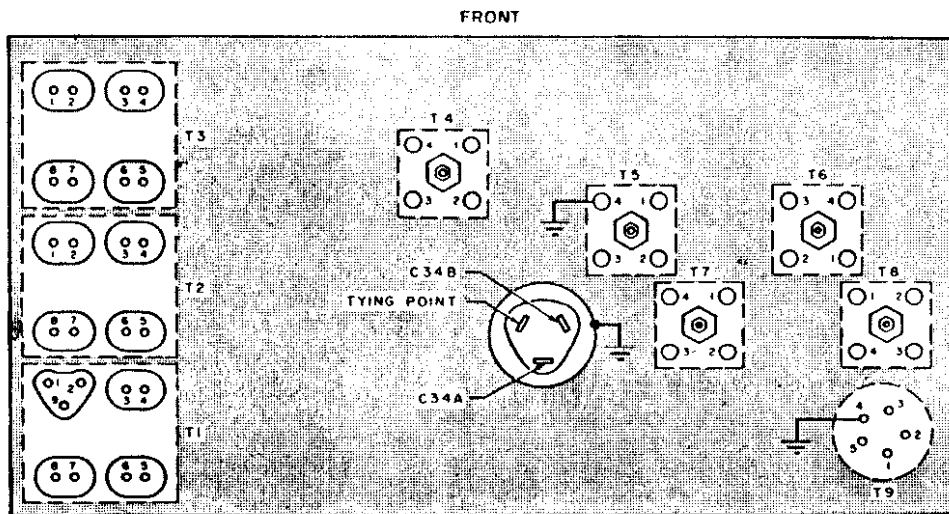


Figure 91. Receiver transformer and electrolytic capacitor terminal designattons.

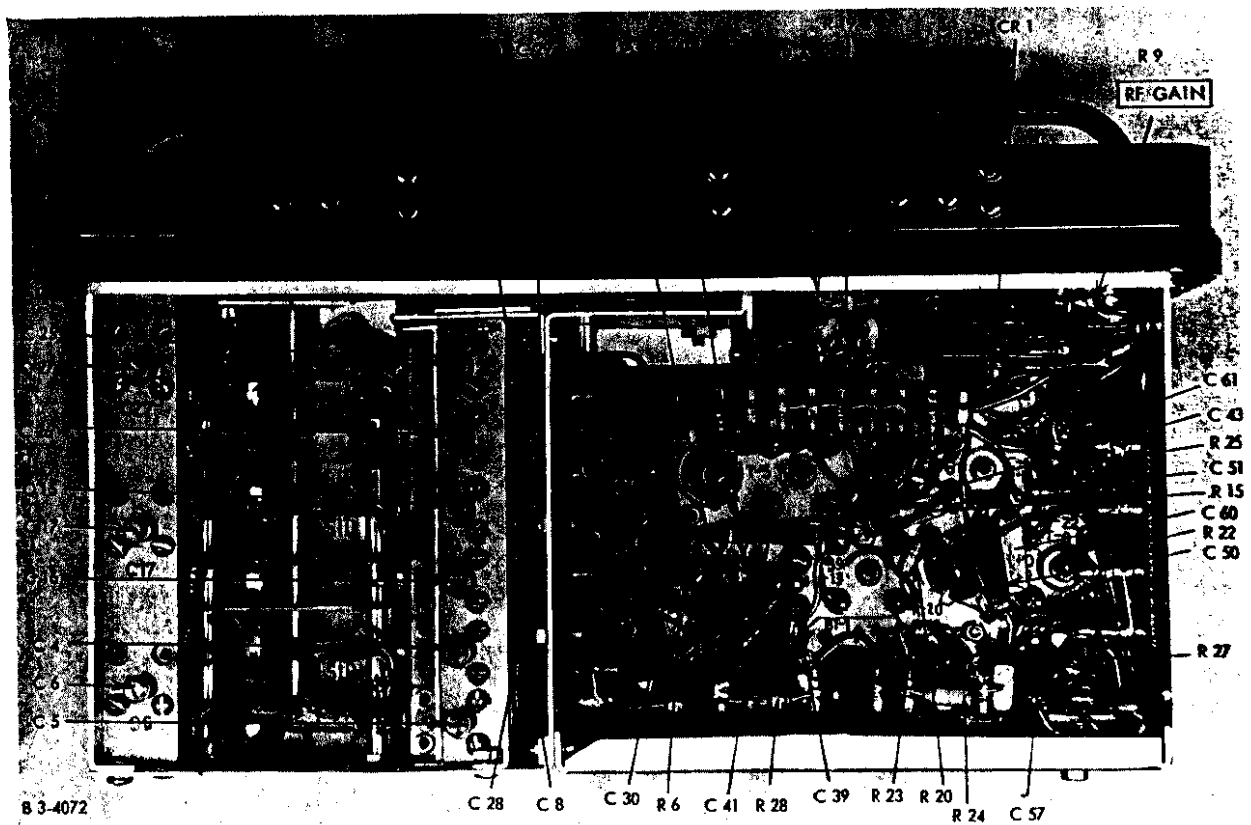
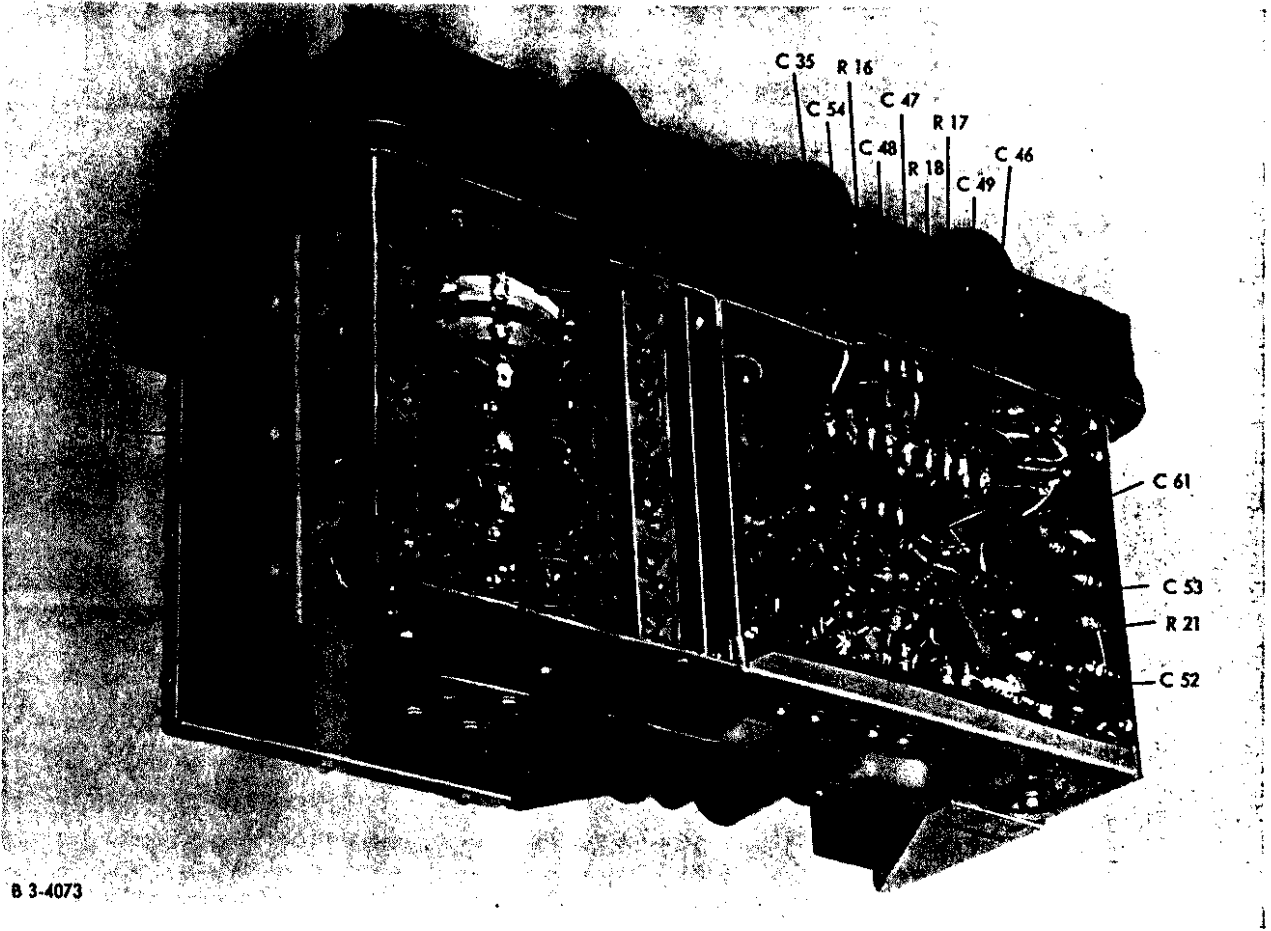
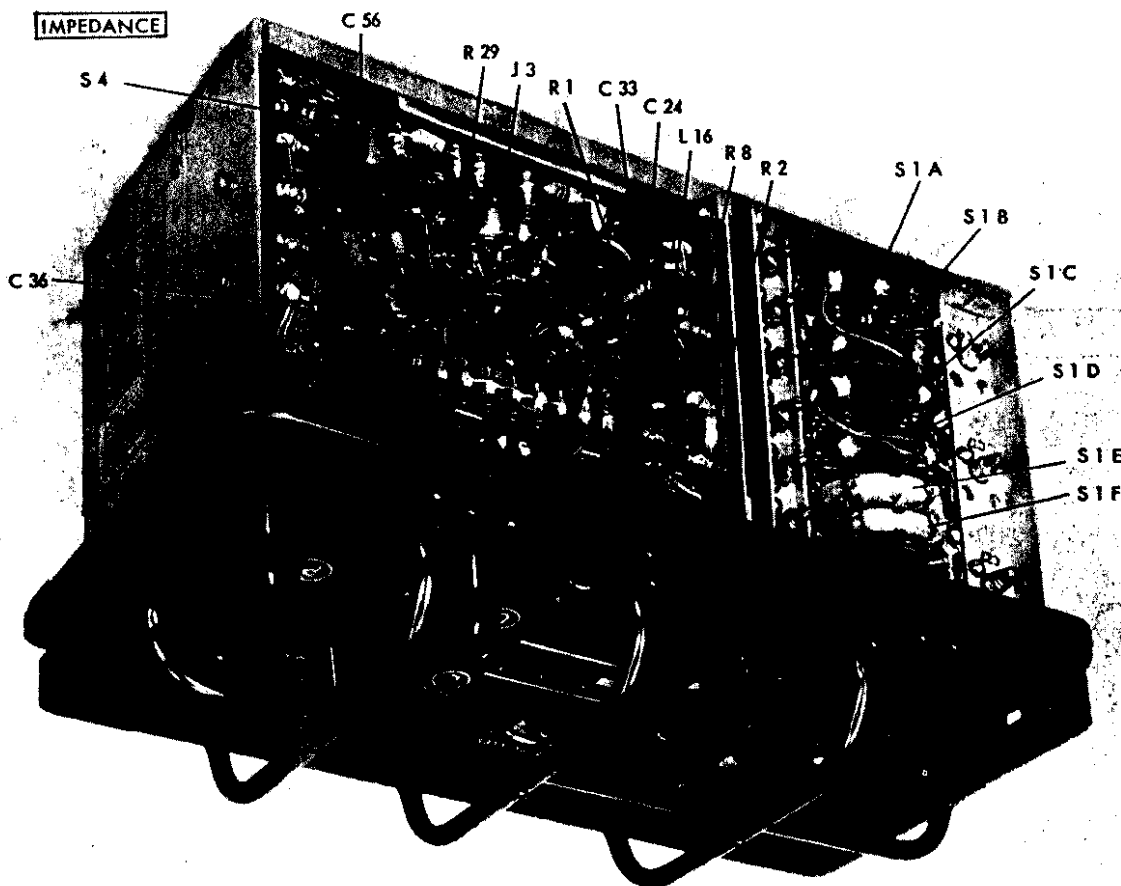


Figure 92. Receiver bottom, parts location.



B 3-4073

Figure 93. Receiver bottom, parts location.



B 3-4071

Figure 94. Receiver bottom, parts location.

128. Receiver Tube Socket, Voltage and Resistance Diagram

a. The d-c voltages given in figure 95 were made with a 20,000-ohm per volt meter under the following conditions, except as noted on the diagram. Those voltage readings which are marked with an asterisk (*) were made with a VTVM.

- (1) Switch E (on transmitter) at SEND.
- (2) Switch F (on transmitter) at BAND 2-MO.
- (3) Switch D (on transmitter) at CW-HI.
- (4) TUNING control N on receiver tuned to 5,100 kc.
- (5) Control L on receiver at C.W.

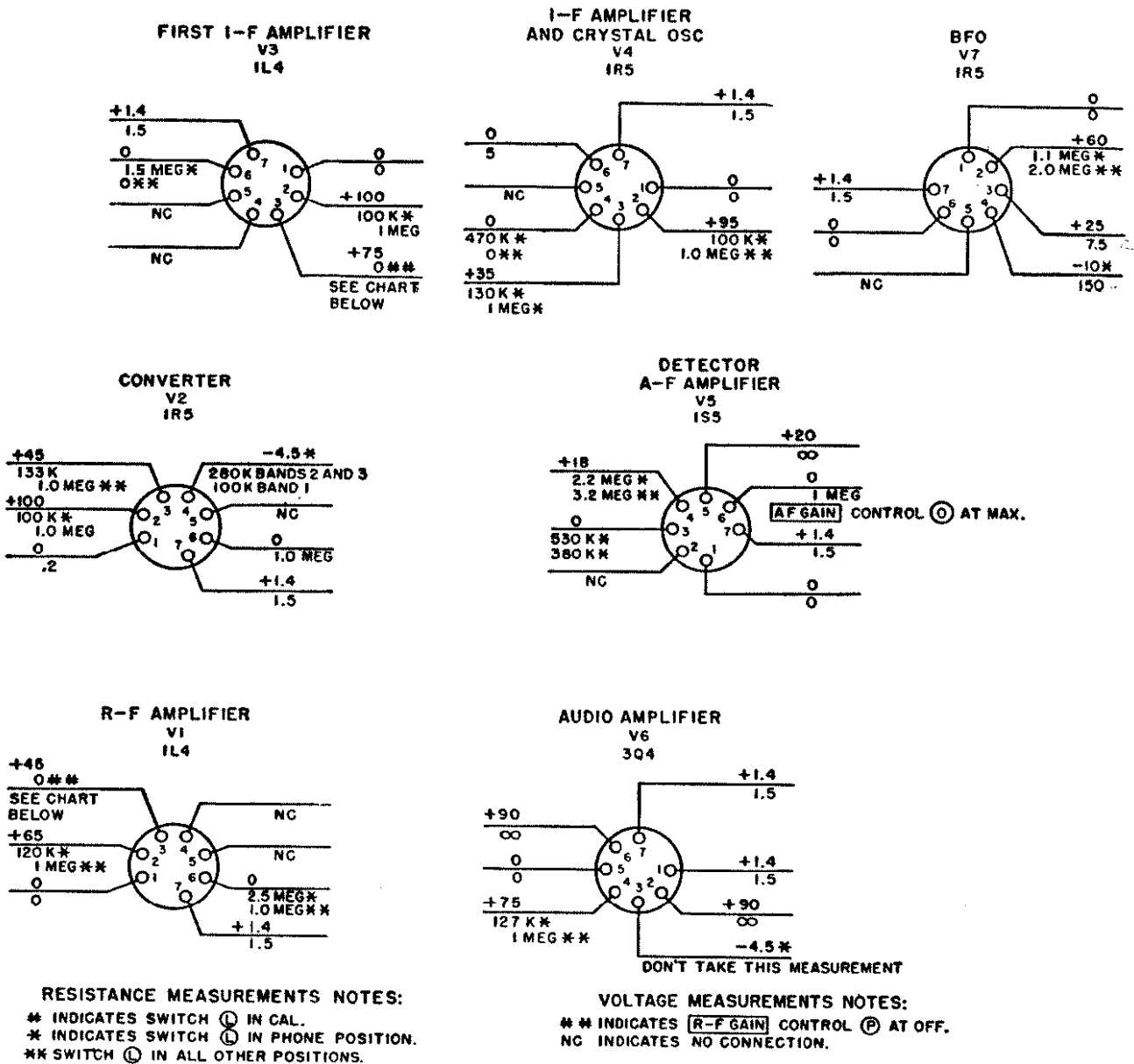
(6) Switch M at BAND 2.

(7) Controls O and P (A. F. GAIN and R. F. GAIN) at full ON position, except as noted.

(8) All voltages measured to chassis, except as noted.

b. The resistance values were measured with an ohmmeter under the following conditions:

- (1) All resistances are measured with tubes in sockets and are measured from tube pin to chassis.
- (2) Receiver is disconnected from transmitter.
- (3) Phone plug is disconnected from PHONE jack.



V1 PIN 3 (SCREEN) RESISTANCE TO CHASSIS			V3 PIN 3 (SCREEN) RESISTANCE TO CHASSIS		
SWITCH POSITION	R-F GAIN CONTROL		SWITCH POSITION	R-F GAIN CONTROL	
	MAXIMUM	MINIMUM		MAXIMUM	MINIMUM
PHONE	190 K	100 K	PHONE	120 K	27 K
CW	1.1 MEG	100 K	CW	500K	27 K
NET	1.1 MEG	100 K	NET	5.7 MEG	5.7 MEG
CAL	1.1 MEG	100 K	CAL	500K	27 K

Figure 95. Receiver tube socket, voltage and resistance diagram.

129. D-c Resistances of Transformers and Coils

The d-c resistances of the transformers and coils in the receiver are listed below:

Transformer or coil	Terminals	Ohms
T1	Place test prods into 8-9 on power socket J3 to test all three primary coils of transformer T1.	BAND 1* .5**
		BAND 2 .5**
		BAND 3 .5**
	T2	4-GND. BAND 3* .5**
		3-GND. BAND 2 .5**
		2-GND. BAND 1 .5**
		5-1 21
		6-1 10
		7-1 1
		4-GND. BAND 3 .5**
3-GND. BAND 2 .5**		
2-GND. BAND 1 .5**		
T3		4-GND. BAND 3* 220,000
	3-GND. BAND 2 220,000	
	2-GND. BAND 1 47,000	
	5-GND. BAND 3 .5**	
	6-GND. BAND 2 .5**	
	7-GND. BAND 1 .5**	
	Remove tube V2	
	Remove tube V2	
	Remove tube V2	
	Remove tube V2	
T4	3-2 5	
T5	1-4 5	
T6		
T7	3-4 26	
T8	4-2 30,000	
	1-4 Cannot be checked because capacitor C58 is in series with coil.	
T9	2-5 1,200	
	1-3 350	
	3-4 22	
L16 .....	.5**
	With converter tube V2 removed.	

* Turn control M to the band indicated for the terminals to be checked.

** Resistance negligible, .5 ohm or less.

130. Signal Substitution Notes

At times the condition arises where the trouble-shooting charts will not disclose the source of trouble in the receiver. For such a situation, the signal substitution or signal tracing method must be used.

a. Signal substitution requires a source of audio, i-f, and r-f signals. Signal Generator I-72-(*) is suitable for this purpose.

b. In addition, a headset or permanent magnet loudspeaker such as Headset HS-30-(*) or Loudspeaker LS-7-GY, respectively, is necessary. In the tests indicated, ground the ne-

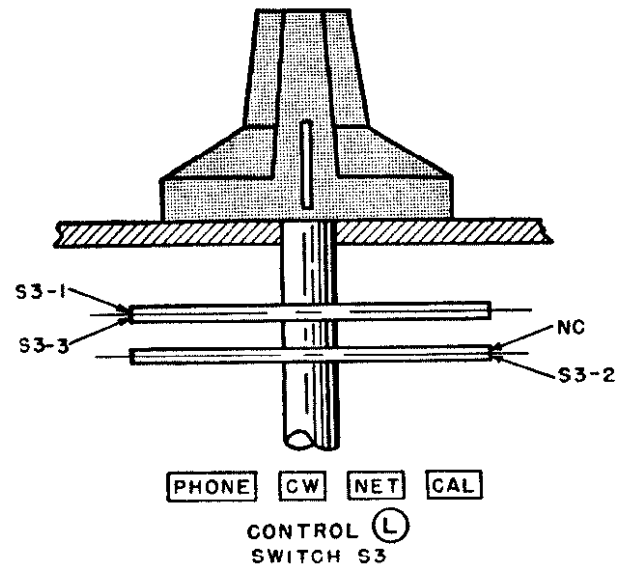


Figure 96. Location of water sections of switch S3.

gative lead of the signal generator to the receiver chassis. For r-f signals connect the other lead of the signal generator through a 110-uuf capacitor. For i-f signals, use a .05-uf (microfarad) capacitor.

c. Note the volume, and listen for serious distortion from the loudspeaker or headset at the various points in the signal substitution procedure. When working back from the output to the input stages, decrease the output of the signal generator as much as possible. If possible, compare the defective receiver with a receiver known to be in good condition.

d. Check the wiring and soldering in each stage during the procedure.

Caution: Do not remove shield cans from transformers unless the trouble has been traced to a specific unit. Do not damage the wiring by pushing it back and forth during inspection. Be careful not to damage the receiver in any other way.

e. Misalignment of one or more stages of the receiver will cause reduced output. Misalignment of the h-f oscillator may prevent any output.

f. When trouble is localized in a given stage, first test the tube; then measure the voltage; and finally measure the resistance at the tube socket of that stage.

g. Trouble in a circuit or stage may not cause changes in voltage and resistance measurements

at the tube socket. The instructions included in this paragraph are merely used as a guide and should suggest other procedures, such as voltage and resistance measurements on individual parts.

h. Remove only one tube at a time when testing. Check the number of the tube, and, if it is not defective, return it to its proper socket before another tube is removed.

i. At each step, it is assumed that all previous steps were completed satisfactorily. Isolate and clear any trouble located before proceeding with the succeeding steps.

131. A-f Tests

Place control L on PHONE position. For the signal substitution method, use the following procedure:

a. TRANSFORMER T9. Set Signal Generator I-72-(*) to an audio frequency note such as 1,000 cycles, and connect the hot lead through a .05-uf capacitor to terminal 2 of transformer T9. A weak undistorted signal should be heard in the headset. If not, the trouble is isolated to the components making up the output section.

b. AUDIO AMPLIFIER V6. Clip the hot lead through a .05-uf capacitor to pin 3 of tube V6. The signal should be heard with slightly greater intensity in the headset. If no signal or a decidedly weaker signal is heard, then either tube V6 or its associated circuit is defective. Refer to paragraph 127.

c. FIRST AUDIO AMPLIFIER V5.

- (1) Place the hot lead through a .05-uf capacitor on pin 5 of tube V5. If tube V6 is found normal, the signal heard should be slightly lower than on pin 3 of tube V6. If the signal is not heard at all, the trouble thus has been traced to the circuit comprised of resistors R21, R19B, capacitors C52, C53, C54, and bias cell BT1. Also, the plate of tube V5 may be shorted to another element in the tube envelope.
- (2) Next, clip the hot lead through a .05-uf capacitor to pin 6 of tube V5. A louder signal should be heard in the headset.

If not, refer to paragraph 127 for tube V5.

d. DETECTOR SECTION OF TUBE V5. For the net series of tests, the signal generator should be set to 456 kc with 30 percent modulation at 400 cycles. Connect the hot side of the signal generator through a .05-uf capacitor to the diode plate (pin 3) of tube V5. The signal heard should be of approximately the same magnitude as for pin 6 of the same tube. If the signal is not heard at all, the trouble therefore has been isolated to the detector circuits. Refer to paragraph 127.

e. BFO V7. For checking the bfo only, all modulation should be removed from the signal generator, and control L on the receiver should be set to C.W. position. Clip the hot lead to the diode plate (pin 3) of tube V5. Increase the signal generator output volume until a beat note is heard. If no sound is heard in the phones, the bfo is not operating. Refer to paragraph 127.

132. I-f Tests

a. SECOND I-F AMPLIFIER V4. Place control L on PHONE. Restore the modulation to the signal generator. Place the hot lead through a .05-uf capacitor on pin 2 of tube V4. If no signal is heard, transformer T6 is probably defective or out of alignment. Clip the hot lead through a .05-capacitor to the signal grid (pin 6). The signal heard should be loud enough so that the output volume of the signal generator will have to be reduced. If a weak signal or no signal is heard, refer to paragraph 127, tube V4.

b. FIRST I-F AMPLIFIER V3. Repeat the same procedure as for the second i-f amplifier (par. 132a). The signal heard should be very loud.

c. CONVERTER TUBE V2.

- (1) Connect the hot lead through a .05-uf capacitor to the plate (pin 2) of tube V2. If no signal is heard, transformer T4 may be defective or misaligned.
- (2) To determine if the oscillator part of the converter stage is at fault, measure the d-c voltage from pin 4 to ground with a VTVM. A reading of about —4 volts indicates that the oscillator section is working.

133. R-f Tests

a. CONVERTER TUBE V2.

- (1) Set the signal generator to a frequency of 12 mc, modulated 30 percent at 400 cycles. Turn control **M** to BAND 1. Tune TUNING control **N** to 12 mc. Connect the hot lead through a capacitor of 110-uuf capacity to the signal grid (pin 6) of the converter tube V2. A loud, clear signal should be heard in the headset. If not, either the oscillator section is defective or the h-v supply to the tube has failed. Refer to paragraph 127.
- (2) Repeat the above procedure for the highest and lowest frequencies in each wave band.

b. R-F AMPLIFIER.

- (1) Clip the hot lead of the signal generator through a 110-uuf capacitor to the plate of the r-f amplifier (pin 2). The signal should come through to the headset with high volume for each of the lowest and highest frequencies in the three bands. If not, transformer T2 probably needs realinement.
- (2) Next clip the hot lead through a 110-uuf capacitor to the signal grid (pin 6) of tube V1. If the signal does not come through louder than for any of the other stages, the tube is defective or the supply voltages to the tube are incorrect. Refer to paragraph 127.

c. ANTENNA CIRCUITS (fig. 56).

- (1) Connect the hot lead through a 110-uuf capacitor to terminal 8 of receiver receptacle J3. Disconnect the ground lead of the signal generator from the chassis, and reconnect it to terminal 9 of receptacle J3. The signal should come through loudly and clearly for the high and low frequencies of all three bands. If not, transformer T1 is either defective or misalined.
- (2) The possibility that the antenna circuit may be defective within the transmitter must not be overlooked. To check this, remove the hot lead from terminal 8 of receptacle J3, and reconnect it to the ANT. binding post on the transmitter. Turn control **D**

on the transmitter to PHONE. If the signal does not come through with loud volume, transformer T114, switch S102F, or relay K101 may be defective.

134. Sectionalizing Trouble in the Transmitter Section of Radio Set AN/GRC-9-GY

The transmitter section is constructed as a compact unit that does not lend itself readily to the usual methods used in sectionalizing trouble in the average transmitter. Sectionalization can be done best with a voltohmmeter, since there are no visual indications other than the resonance indicator to determine whether or not the transmitter is functioning properly. A simple test is to set the controls for calibrating the transmitter against the receiver, such as operating as a net station. If the beat note is not heard, and the receiver is known to be perfect, and it is impossible to tune the transmitter to resonance by use of the resonance indicator, the transmitter is probably defective. Remove the transmitter by unfastening the four catches and the connecting cable and pulling the unit straight out of the case. Check all the tubes, preferably by replacing them with others. After it has been determined that the tubes are satisfactory, check the voltages at the metering socket with a voltmeter to determine whether they are in conformance with the metering socket voltage chart on the back of the transmitter chassis. A reproduction of the chart is shown below. If any of the voltages are abnormal, refer to the sectionalization and localization charts.

Caution: Be very careful not to touch the plate cap of power amplifier tube V103 (2E22). It carries a potential of 500 volts to ground at all times.

Metering Socket Voltages P. A.—High Power

Term.	Term.	Voltage	Measurement
2+	8—	.10	PLATE CURRENT-NO LOAD-PHONE*
3+	7—	180	SCREEN GRID-PHONE
4—	7+	40	SUPPRESSOR GRID BIAS-PHONE
5—	7+	60	GRID BIAS
6+	7—	105	MO.-MOD.-REC. PLATE VOLTAGE
8+	7—	500	PLATE VOLTAGE
1+	7—	6.3	FIL. VOLTAGE

Meter leads dangerous when power is on. Current in M. A. = volt. x 50.

134. Sectionalizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY

Symptom	Probable trouble	Correction
1. Transmitter inoperative. No voltage between 1 and 7 at metering socket. Control D on CW key down. All other metering socket voltages are normal.	1a. Capacitor C132 shorted b. Capacitor C115 shorted	1. See figure 80. a. Replace capacitor C132. b. Replace capacitor C115.
2. No voltage between 6 and 7 of metering socket.	2a. Switch S103D defective or dirty b. Tube V104 defective c. Capacitor C134 shorted d. Capacitor C138 shorted	2. See figure 81. a. Repair and clean switch S103D. b. Replace tube V104. c. Replace capacitor C134. d. Replace capacitor C138.
3. No voltage between 8 and 7 of metering socket.	3a. Keying relay K101 contacts 7 and 8 are shorted together. b. If there is no voltage for only one or two bands, any of capacitors C118, C119, or C120 may be shorted. If on all bands, either capacitor C101C or capacitor C121 is shorted.	3a. Remove short and clean contacts. b. Inspect capacitors and remove short. Replace capacitor C121.
4. Beat note not heard when receiver-transmitter is set up for net operation. Metering socket voltages are normal.	4. MO or DOUBLER stage not operating.	4. Refer to paragraph 134.
5. Beat note heard when receiver-transmitter is set up for net operation.	5. Check metering socket voltage between 2 and 8. If an incorrect reading is obtained, the POWER AMPLIFIER stage is faulty.	5. Refer to paragraph 134.
6. Signal is radiated, but without modulation on PHONE and MCW positions of control D.	6a. Modulator tube V105 defective b. Incorrect voltages on modulator tube elements. c. Suppressor grid of power amplifier V103 incorrectly biased. d. MODULATOR stage circuit defective.	6a. Replace tube. b. See paragraph 135 (modulator). c. See paragraph 135 (symptom 14). d. See paragraph 135 (modulator).

135. Localizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY

Because of the compactness of the transmitter, it may be difficult to localize trouble without first removing the main tuning capacitor C101. This tuning capacitor is a complete plug-in unit and can be removed as follows:

a. Refer to figure 97. Remove the dial lock-screws and dial knob from the main tuning capacitor shaft on the front panel of the transmitter. On some transmitter models, the dial knob is held to the shaft by a small setscrew which can be loosened with the larger Bristo wrench contained in Case: Box BX-53-GY.

b. With a screw driver, remove all screws marked "A" and "B" on the bottom of the

transmitter assembly, and remove the cover plate held on by these screws (fig. 98).

c. Swing up the hinged back panel of the transmitter to allow exposure of the main tuning capacitor as in figure 99.

d. Remove the spade lug on the side of the tuning capacitor shown in figure 99.

e. Following this step, remove the three capacitor retaining screws on the front panel of the transmitter seen in figure 97.

f. Again, from the rear of the transmitter, gently rock the entire capacitor assembly toward and away from the back of the front panel, lifting it outward at the same time.

Caution: Any variation in the plates that might occur from the removal will seriously affect the calibration of the transmitter.

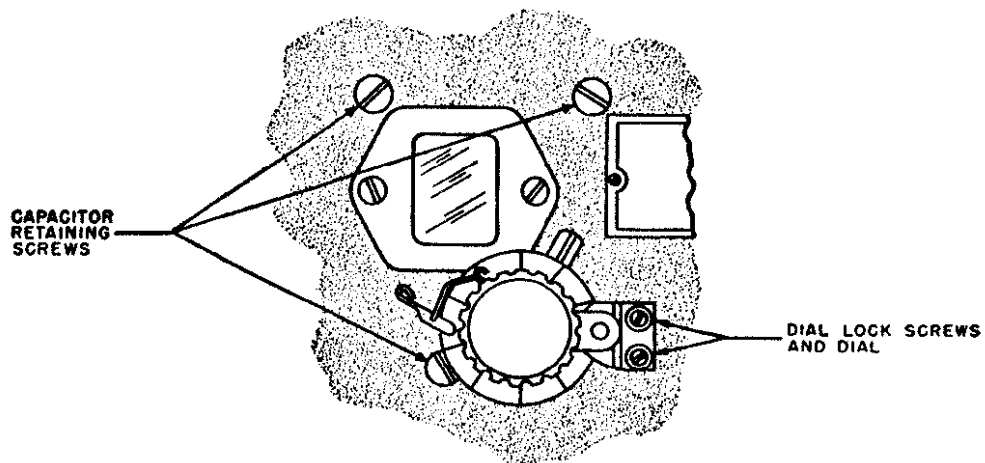


Figure 97. Transmitter capacitor and dial retaining screws.

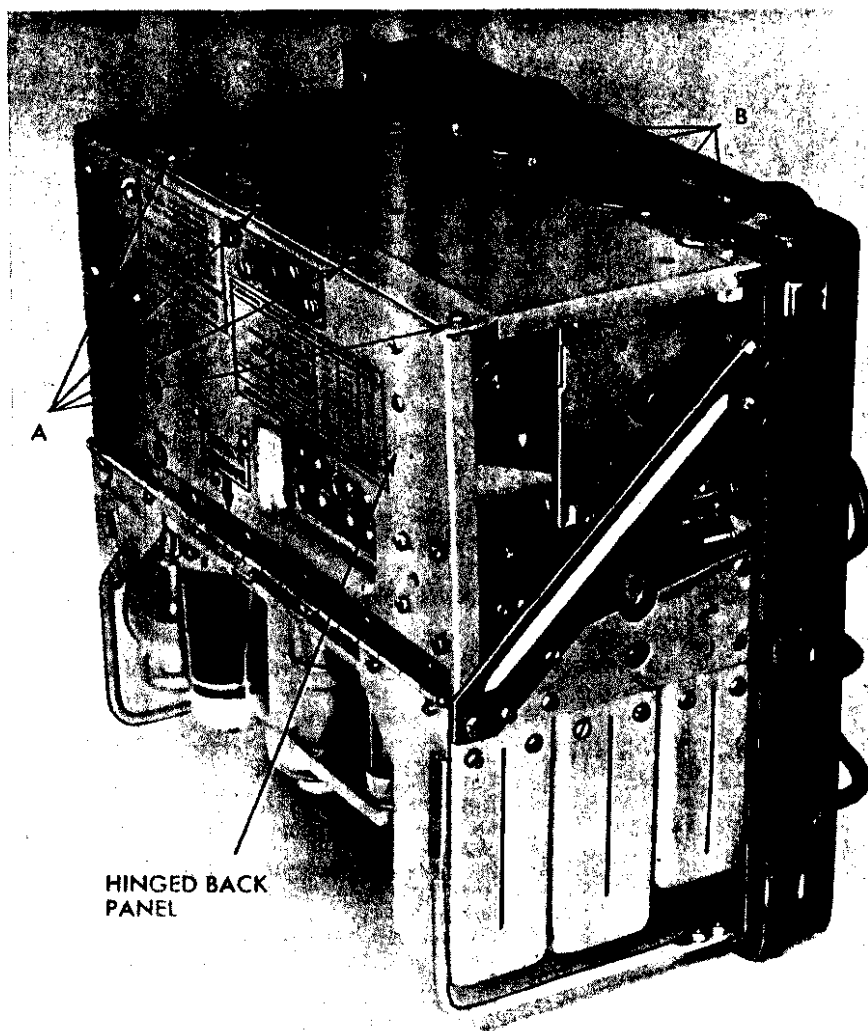


Figure 98. Location of screws A and B.

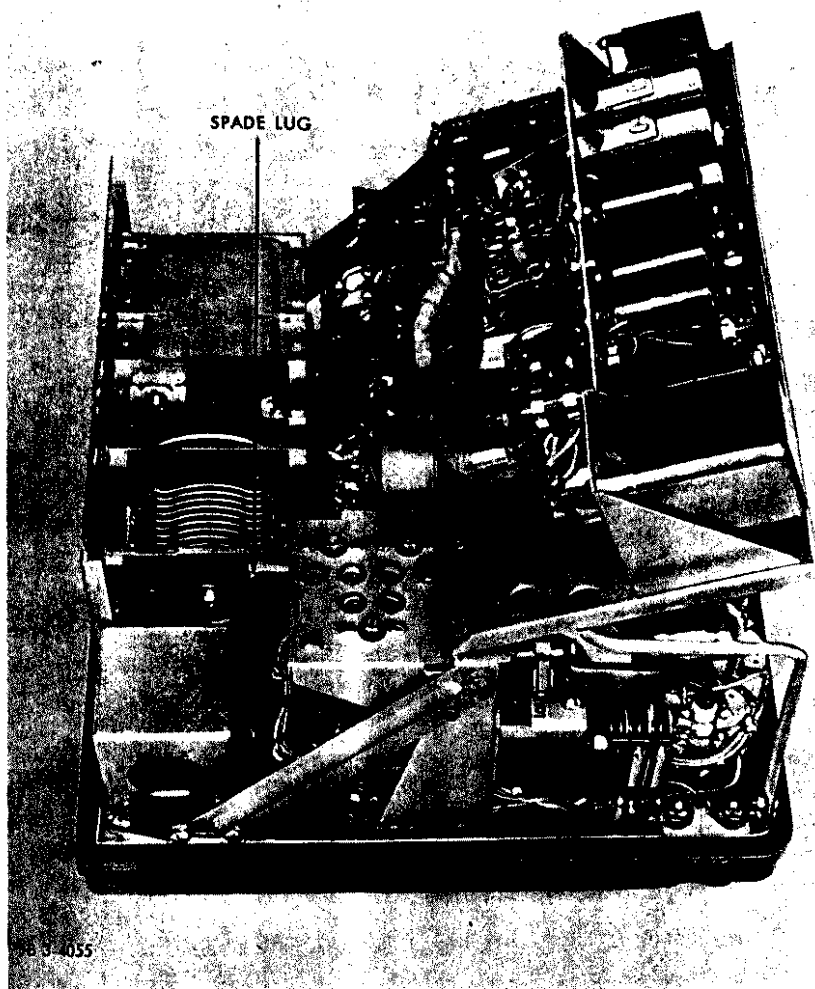


Figure 99. Back panel of transmitter shown swung up to expose tuning capacitor.

135. Localizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY

Symptom	Probable trouble	Correction
MASTER OSC 3A4 (V101): 1. Master oscillator does not oscillate on either MO or XTAL position. All d-c supply voltages are normal.	1a. Faulty tube V101 b. Grid coil between terminals 4 and 5 of transformer T101 is open. c. One of capacitors C146, C101A, C102, C129, and C106B may be shorted. d. Grid resistor R102 is open ... e. Capacitor C105 may be open . f. Capacitor C103 may be open . g. Capacitor C104 may be open .	1a. Replace tube V101. b. Check resistance between 4 and 5. Replace transformer T101. c. Check resistance between terminals 1 and 3 of transformer T101. d. Replace resistor R102. e. Momentarily, short capacitor C105 with one of equal capacity. f. Momentarily, short capacitor C103 with one of equal capacity. g. Momentarily, short capacitor C104 with one of equal capacity.

135. Localizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY - Continued

Symptom	Probable trouble	Correction
2. Oscillator does not oscillate on XTAL position only. All d-c supply voltages are normal.	2a. If oscillator does not oscillate for only one or two crystals, they are probably defective or switches S101D and S101E are dirty or open. b. Capacitor C103 shorted c. Oscillator plate coil in transformer T101 mistuned.	2a. Replace the crystals. Clean or replace the switch sections. b. Replace capacitor C103. c. Refer to paragraph 158 on alinement.
3. Incorrect d-c voltage on pin 3. All other voltages are normal.	3a. Resistor R101 open	3a. Check resistor, replace if defective.
4. Incorrect d-c voltage on pin 2 or 6. All other voltages are normal.	b. Capacitor C103 may be shorted 4a. Open plate coil for one or two bands. b. Switch S101A open or dirty .. c. Partially short one of capacitors C146, C101A, C129, and C106.	b. Replace defective capacitor. 4a. Replace faulty transformer. b. Clean or replace switch S101A. c. Replace shorted capacitor.
5. No voltage on pin 7	5a. Resistor R110 open	5a. Replace resistor R110.
DOUBLER 3A4 (V102):		
6. DOUBLER stage does not pass oscillator signal. D-c supply voltages to tube are normal.	b. Shorted regulator CR101 6a. Capacitor C109 or C110 open b. Doubler coil T104A, T104B, or T104C misaligned. c. Resistor R104 open	b. Replace regulator CR101. 6a. Momentarily, short capacitor C109 or C110 with one of equal capacity. b. See paragraph 158 on alinement. c. Replace resistor R104. d. Clean or replace switches.
7. Incorrect d-c supply voltage on pin 2 or 6.	d. Switch S101G or S101I open or dirty. 7a. Choke coil L101 open	d. Clean or replace switches. 7a. Replace choke L101.
8. Incorrect d-c supply voltage on pin 3. All other voltages are normal.	b. Resistor R105 open	b. Replace resistor R105.
9. Incorrect voltage on pin 7	c. Relay K101 contacts 9 and 10 defective. 8a. Resistor R120 open	c. Check and clean contacts. 8a. Replace resistor R120.
POWER AMPLIFIER 2E22, V103:		
10. Power amplifier does not pass signal. Tube d-c supply voltages are normal.	b. Capacitor C142 shorted c. Resistor R121 open	b. Replace capacitor C142. c. Replace resistor R121.
11. Excessive plate current, as indicated by abnormal voltage at terminals 2 and 8 on metering socket.	9. Resistor R110 open	9. Replace resistor R110.
12. Excessive signal grid current, as evidenced by abnormally high voltage from 5 to 7 on the metering socket.	10a. Switch S101J or S101L open .. b. Open circuit in one of p-a coils T104A, B, and C. c. P-a coils T107, T108, and T109 may be misaligned. d. Plate cap connection may be faulty. 11a. Antenna circuits or coils T107, T108, and T109 are misaligned. b. Insufficient d-c grid bias. Check terminals 5 and 7 of metering socket. If voltage is too low, resistors R106, R107, or relay coil K102A is open.	10a. Check switches and clean contacts. b. Check continuity of the three p-a coils. c. Refer to paragraph 158 on alinement. d. Repair plate cap connection. 11a. Refer to paragraph 158 on alinement. b. Replace defective component.
	12a. Screen grid supply voltage too low. Check voltage between 3 and 7 of metering socket on PHONE position of control D. If an abnormal reading is obtained, check resistors R124, R117, and R118. Capacitor C116 may be shorted.	12a. Replace defective components.

135. Localizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY - Continued

Symptom	Probable trouble	Correction
	<ul style="list-style-type: none"> b. Plate supply voltage may be too low. Check variable tuning capacitor C101C for leakage. Capacitor C121 may be leaking. c. Overload relay K102 contacts open. 	<ul style="list-style-type: none"> b. Clean capacitor C101C. Replace capacitor C121. c. Refer to symptom 28 of this chart.
13. Improper suppressor grid bias, as evidenced by voltage reading from pins 7 to 4 on metering socket, on PHONE and MCW.	<ul style="list-style-type: none"> 13a. Incorrect signal grid current. The suppressor grid receives its d-c bias from across relay coil K102A and resistor R107. b. Capacitor C117 may be shorted 	<ul style="list-style-type: none"> 13a. See symptom 13 above. b. Replace capacitor C117.
14. Incorrect voltage from plate cap of tube to ground. Caution: There are 500 volts to ground on the plate cap of tube V103 (2E22).	<ul style="list-style-type: none"> 14a. Resistor R108 open b. Capacitor C121 shorted c. One of coils T107, T108, and T109 may be open. 	<ul style="list-style-type: none"> 14a. Replace resistor R108. b. Replace capacitor C121. c. Check resistance of the coils.
15. Incorrect d-c supply voltage on pin 1 of tube.	<ul style="list-style-type: none"> 15a. If the condition is only at PHONE, contacts 14 and 15 of relay K101 are defective. b. Switch S105-3 is open or dirty c. Capacitor C115 is shorted 	<ul style="list-style-type: none"> 15a. Clean contacts of relay K101. b. Repair switch S105-3. c. Replace capacitor C115.
MODULATOR 3A4 (V105):		
16. No modulator voltage output. Tube d-c supply voltages are normal. No sidetone signal.	<ul style="list-style-type: none"> 16a. Resistor R111 or R112 open b. Open circuit in primary or secondary of transformer T112. c. Defective tube V105 d. Jack J104 defective 	<ul style="list-style-type: none"> 16a. Check resistor R111 or R112. b. Check for continuity of transformer T112. c. Replace tube V105. d. Repair and clean the jack.
17. Modulator inoperative on MCW position only of control D. Tube d-c supply voltages are normal.	<ul style="list-style-type: none"> 17a. Capacitor C143 defective b. Defective tube V105 	<ul style="list-style-type: none"> 17a. Replace capacitor C136. b. Replace tube V105.
18. No sidetone signal sent to receiver. Otherwise, modulator operates normally.	18. Potentiometer R115 (control G) open or dirty.	18. Replace potentiometer R115.
19. Incorrect d-c supply voltage on pin 3.	<ul style="list-style-type: none"> 19a. Resistor R113 open b. Capacitor C137 shorted c. Switch S3-3 in receiver is defective. 	<ul style="list-style-type: none"> 19a. Replace resistor R113. b. Replace capacitor C137. c. Inspect and repair switch S3-3.
20. Incorrect d-c supply voltage on pins 2 and 6.	<ul style="list-style-type: none"> 20a. Transformer T113 open between terminals 3 and 4. Choke coil L103 open. b. Capacitor C138 shorted. Capacitor C143 shorted. c. Relay K101 contacts 17 and 18 are defective. 	<ul style="list-style-type: none"> 20a. Check for continuity. b. Replace defective components. c. Repair and clean the contacts.
21. Incorrect d-c supply voltage on pin 7.	21. Resistor R110 open	21. Check resistor R110.
KEYING RELAY K101:		
22. Relay does not operate when key is depressed.	<ul style="list-style-type: none"> 22a. Relay coil is open b. Switch S101N defective c. Capacitor C133 shorted 	<ul style="list-style-type: none"> 22a. Disconnect one end of resistor R125 and test for continuity through coil of relay K101. b. Inspect and clean switch S101N. c. Replace capacitor C133.
23. Relay, contacts chatter	<ul style="list-style-type: none"> 23a. Contacts do not close in the proper sequence. b. Contacts defective 	<ul style="list-style-type: none"> 23a. Refer to section V of chapter 6. b. Refer to section V of chapter 6

135. Localizing Trouble in Transmitter Section of Radio Set AN/GRC-9-GY - Continued

Symptom	Probable trouble	Correction
ANTENNA SWITCHING AND TUNING CIRCUITS:		
24. No signal fed to antenna	Refer to figure 76.	
25. INDICATOR neon bulb will not light. Signal is known to be radiated	24. All continuity checks for each position of control A can be made with the aid of figure 76.	24. Replace or repair defective component.
	25a. Resistor R122 or R123 open .. b. Coil L104 open c. Defective neon indicator I101 .	25a. Check resistance and replace faulty unit. b. Check resistance of coil L104. c. Replace neon indicator.
OVERLOAD RELAY K102:		
26. Overload relay fails to open ..	26. Contacts jammed or bent	26. Replace relay K102.
27. Overload relay fails to close ..	27. Coil K102A open	27. Disconnect the lead from pin 1, and check resistance between terminals 1 and 2.
28. Relay chatters	28a. Contacts 15 and 16 of keying relay K101 are defective. b. Overload relay coil K102B is open	28a. Clean and repair the contacts. b. Turn control E to OFF. Turn control D to PHONE. Check resistance between pin 3 and ground. It should be 67 ohms; if not, coil K102B is open.

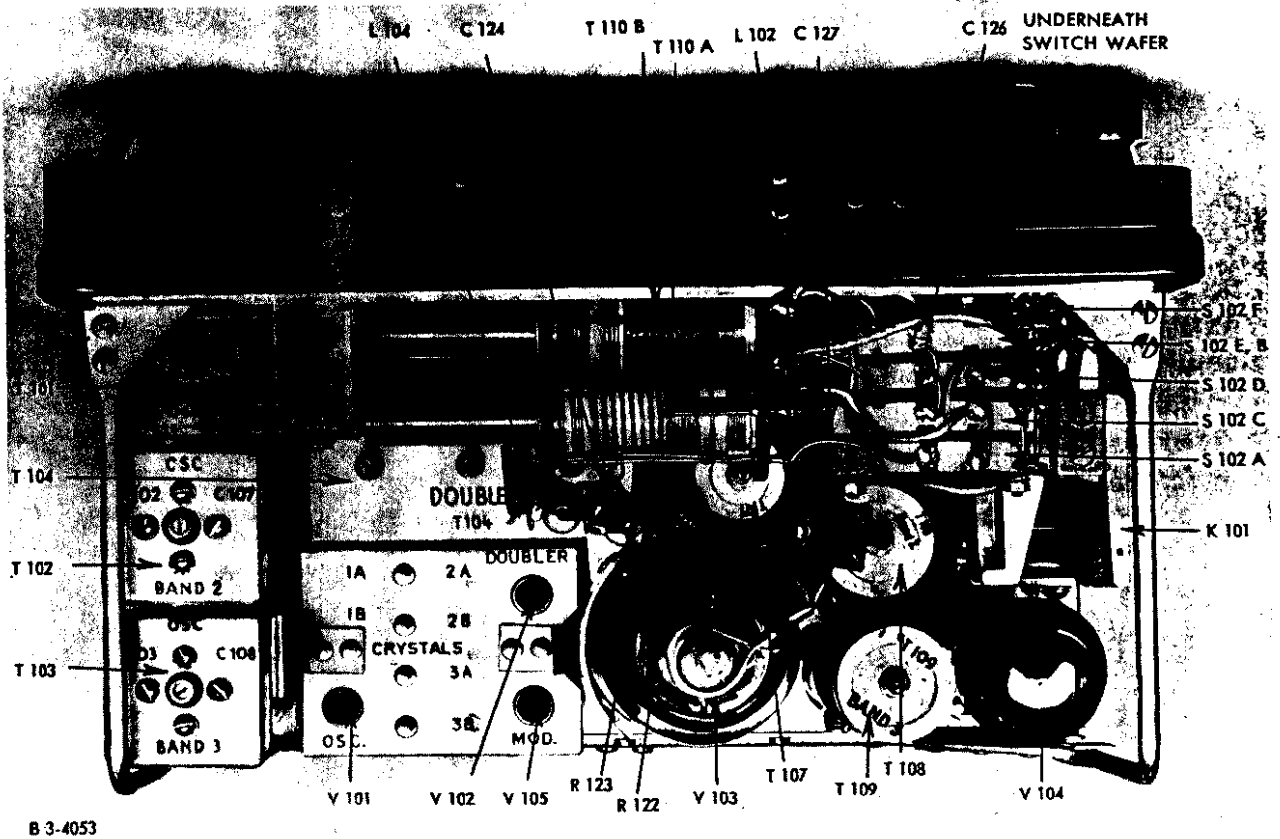


Figure 100. Transmitter parts location (top).

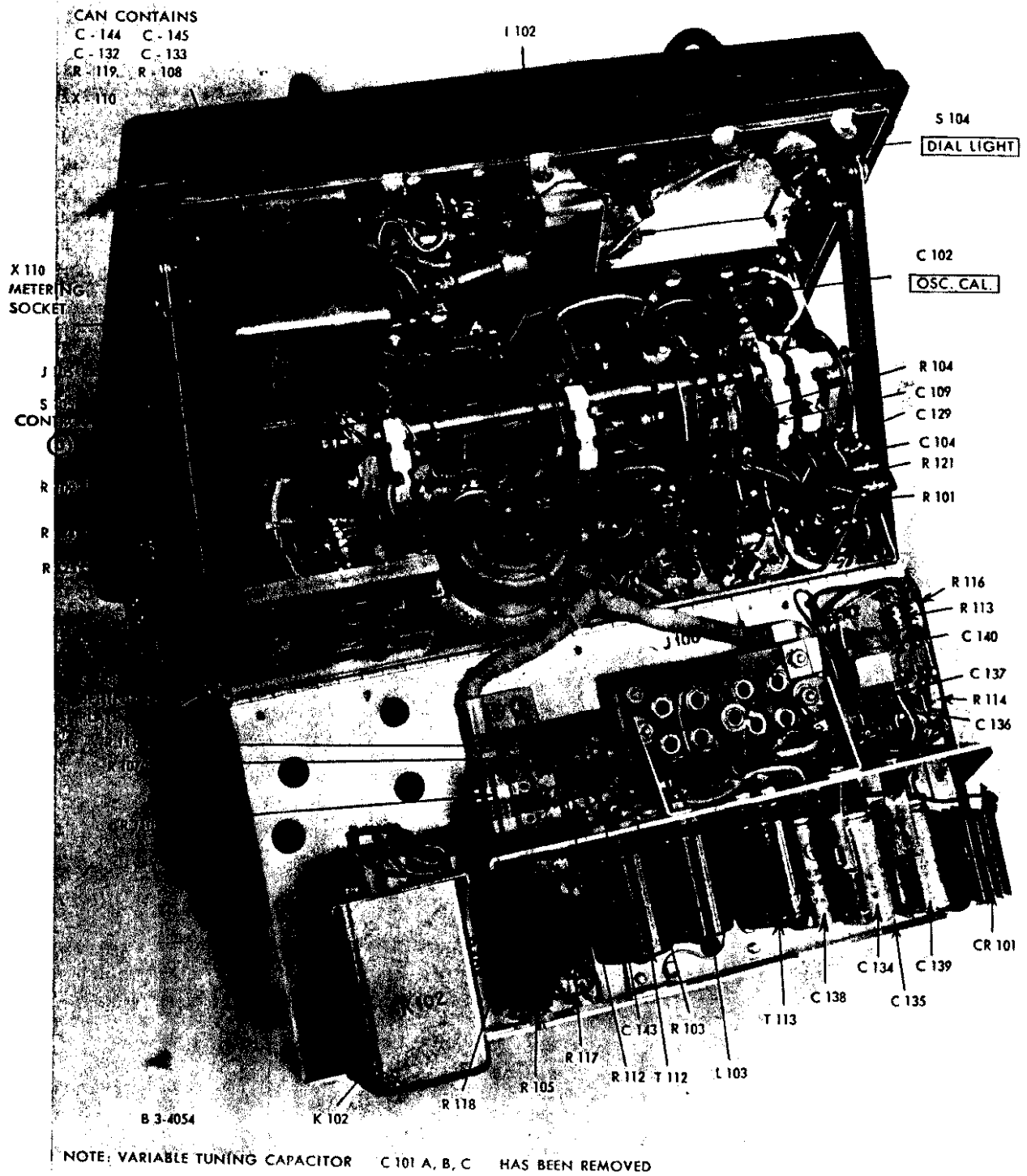
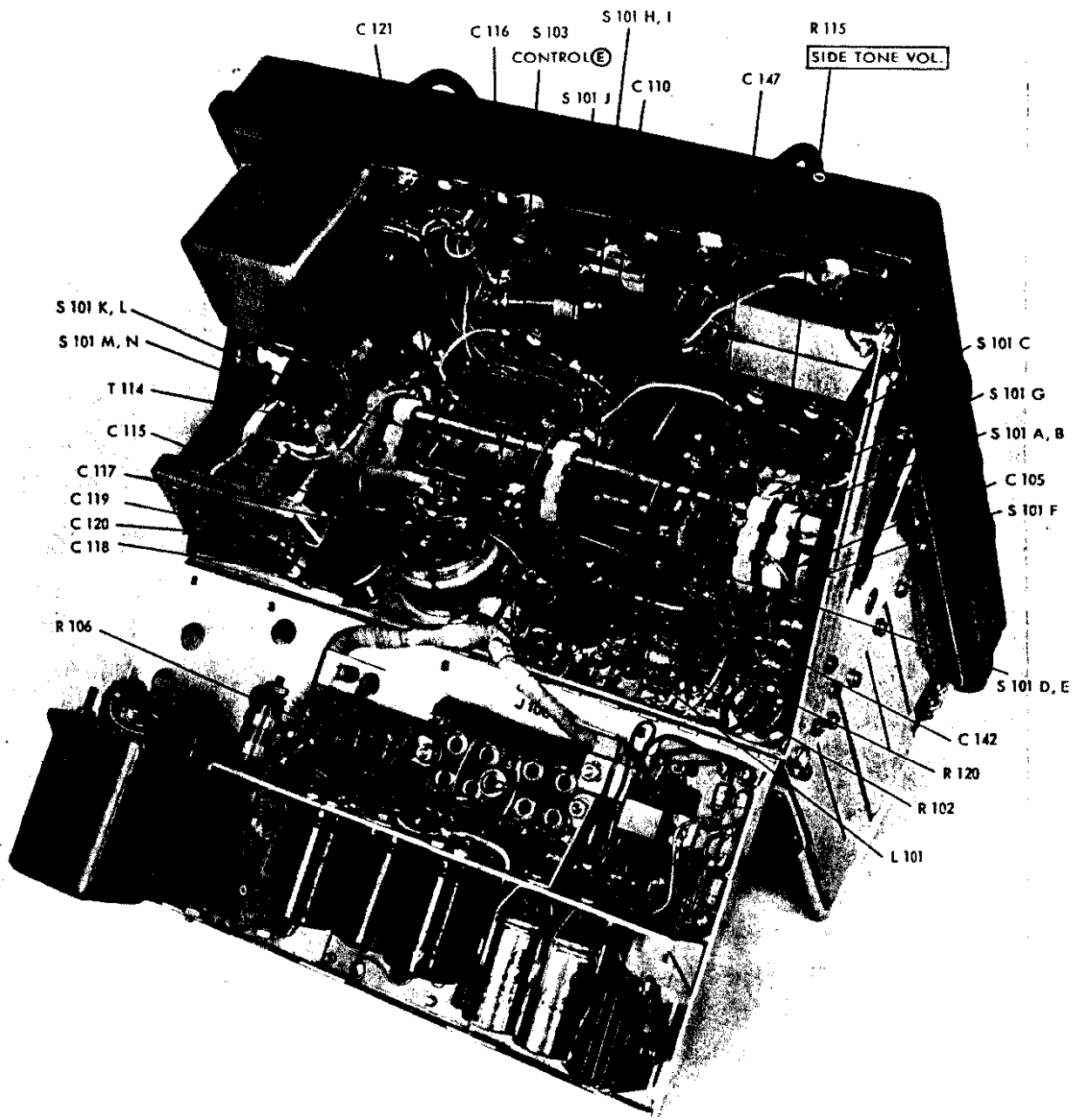


Figure 101. Transmitter parts location (bottom).



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NOTE: VARIABLE TUNING CAPACITOR C 101 A, B, C HAS BEEN REMOVED

Figure 102. Transmitter parts location (bottom).

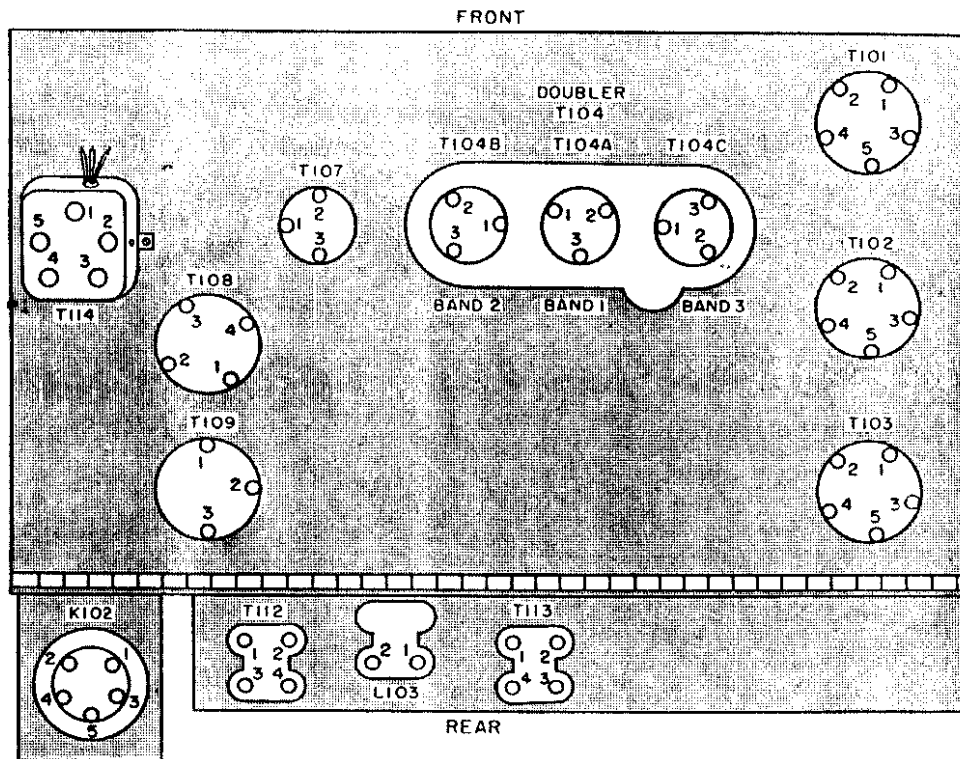


Figure 103. Transformer pin designation on transmitter.

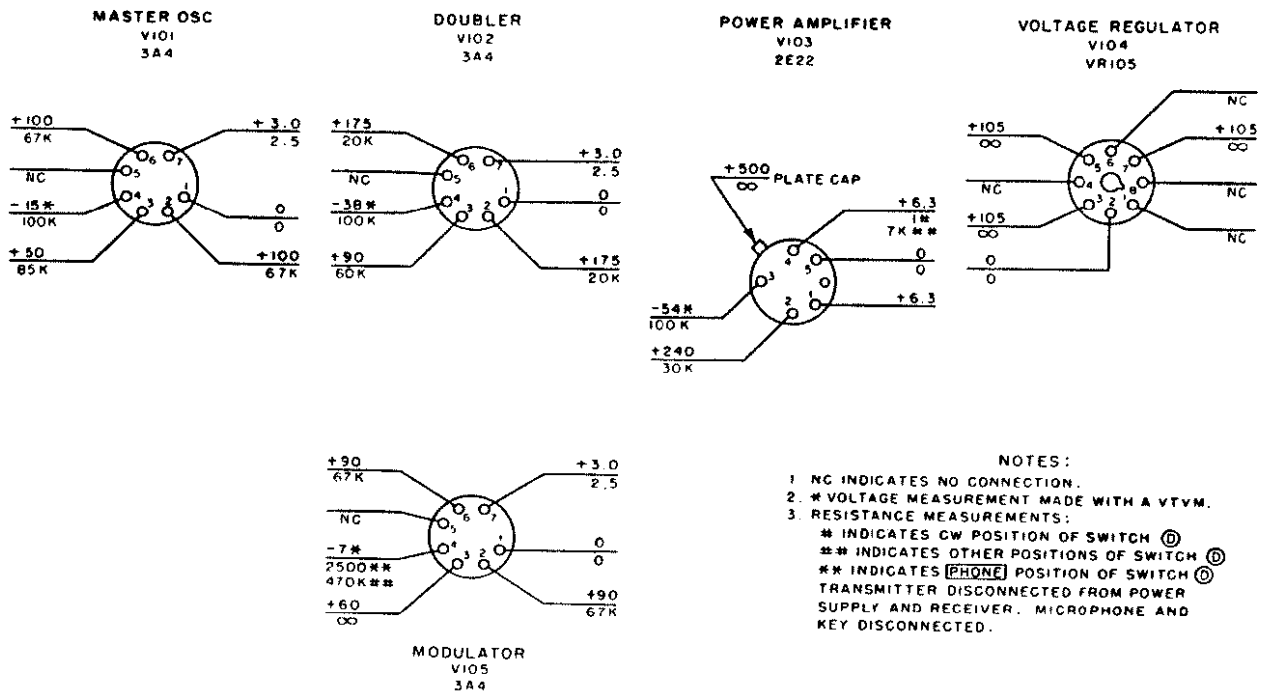


Figure 104. Transmitter tube socket voltage and resistance diagram.

136. Transmitter Tube Socket, Voltage, and Resistance Diagram
(fig. 104)

The d-c voltage values given in the following diagram were made with a 20,000-ohm per volt meter, except those readings marked with an asterisk (*) which are measured with a VTVM. The following control settings were used:

- a. Control F at BAND 2-MO.
- b. Control D at CW-HI.
- c. Control E at SEND.

d. Supply voltage 500 and 105 volts to the plates and screen grids, and 6.3 volts to the filaments.

e. Control A, at WHIP position, is tuned to the antenna being used. The resistance values given in the diagram were measured under the same switch conditions as the voltage charts except that the transmitter was disconnected from the receiver and power supply, and the MIKE and KEY were disconnected. Variations in switch positions are given in the chart at the bottom of figure 95.

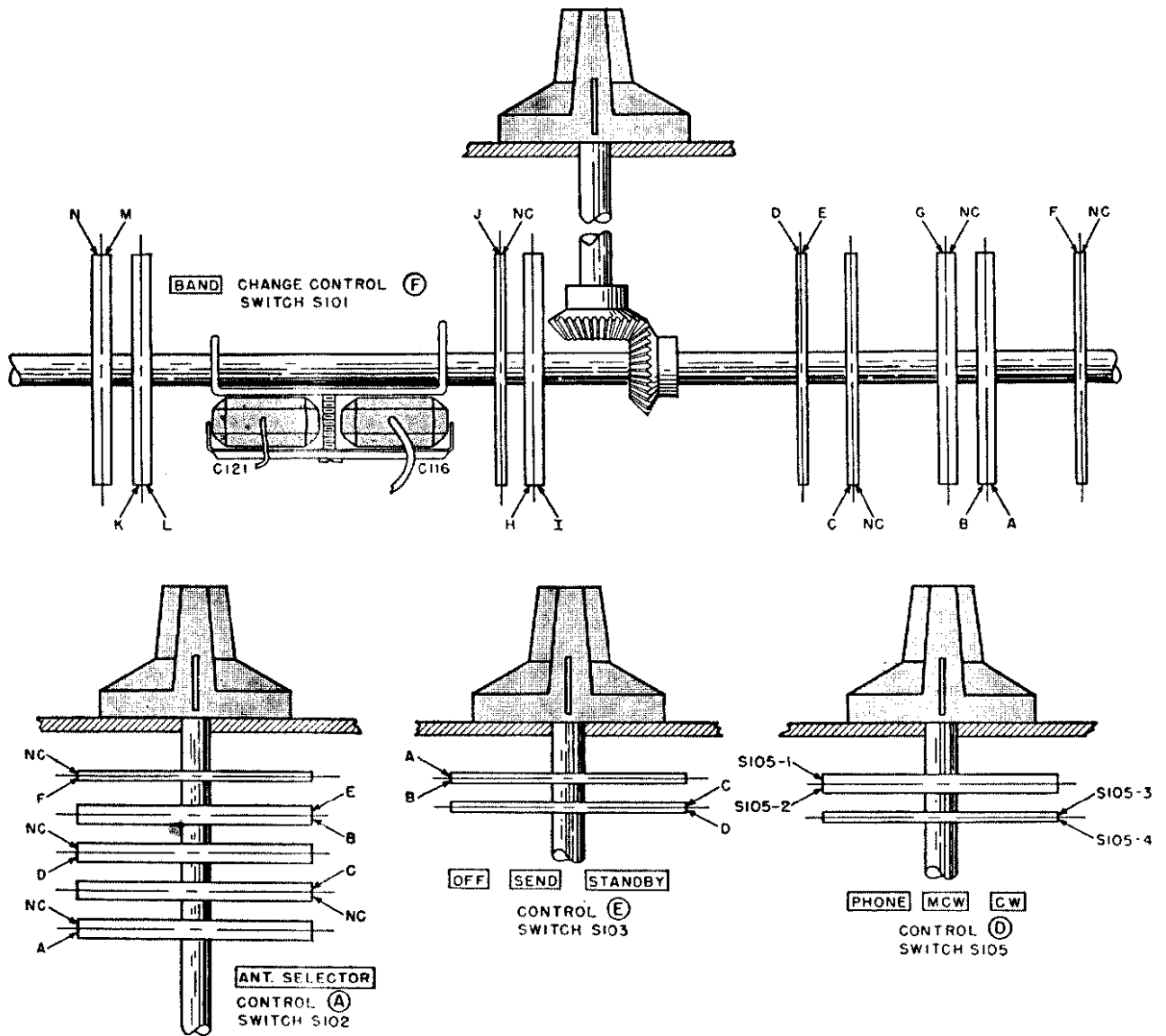


Figure 105. Transmitter wafer switch sections.

137. D-c Resistance of Transmitter Coils and Transformers

In order to measure the resistance between several of the contacts listed, first it will be

necessary to perform the steps given in the column headed "Condition". If these steps are not performed before the reading is taken, the value found will be in error.

Transformer or coil	Terminals	Ohms	Condition
T101 ...	1-3	.5 or less	Control F in BAND
	4-5	.5 or less	1 position.
T102 ...	1-3	.5 or less	Control F in BAND
	4-5	.5 or less	2 position.
T103 ...	1-3	2.0 or less	Control F in BAND
	4-5	.5 or less	3 position.
T104A	1-3	.5 or less	Control F in BAND
BAND 1			1 position.
T104B	1-3	.5 or less	Control F in BAND
BAND 2			2 position.
T104C	1-3	.5 or less	Control F in BAND
BAND 3			3 position.
T107 ...	1-3	.5 or less	Control F in BAND
			1 position.
T108 ...	1-2	.5 or less	Control F in BAND
			2 position.
	3-4	.5 or less	Control F in BAND
			2 position.
T109 ...	1-2	.5 or less	Control F in BAND
			3 position.
	3-2	.5 or less	Control F in BAND
			3 position.
T110A ..	1-2	.5 or less	
	3-4	.5 or less	
	1-3	.5 or less	
	5-6	.5 or less	
	6-7	.5 or less	
	5-8	.5 or less	
T112 ...	1-2	30	Remove microphone
	3-4	1,100	plug from MIKE
			jack.
T113 ...	1-2	725	Unsolder all leads to
	3-4	425	terminal 1.
T114 ...	1-5	.5 or less	Control A turned to
	3-4	2.0	position 11.
L101 ...	.....	10	
L102 ...	1-2	.5 or less	
L103 ...	1-2	600	
L104 ...	.....	1.0	
K101 ...	.....	11	Disconnect the lead to
			one of the K101 coil
			terminals.
K102A ..	1-2	5,400	Disconnect the lead to
			terminal 1 of relay
			K102.
K102B ..	3-chassis	67	Control E at OFF po-
			sition.
			Control D at PHONE
			position.

138. Sectionalizing Trouble in Generator GN-58-A-GY

In order to test the Generator under load conditions, it will be necessary to remove the top part of the housing. To accomplish this, remove the cover clamp lock screws which fasten the cover clamps to the side of the housing. After opening the cover clamps, the top of the housing should come off easily when lifted straight up. Figure 106 shows the generator with the cover removed. Next, loosen the screw which

holds the terminal strip insulating cover in front of panel board 239. This will expose the terminal board, and all voltage measurements can be made at full load, using the contacts on the board. The measurements are from each terminal to ground.

Caution: Some of the voltages in the generator are of the order of 500 volts. Do not touch any of the exposed terminals or other connections with both hands. Keep one hand completely away from the generator.

138. Sectionalizing Trouble in Hand Generator GN-58-A-GY

Symptom	Probable trouble	Correction
1. Incorrect voltages from terminals 32 and 21 to terminal 24. All other voltages are normal. Caution: There are 500 volts across these two terminals.	1a. Brushes on h-v armature are worn, and springs have lost their tension. b. Choke coil 228-1 open c. Capacitor 233-1 or 233-2 shorted d. Choke coil 228-2 open	1a. Check brushes and springs. Replace defective components. Be sure to fit new brushes (par. 139). b. Remove the brush to which coil 228-1 is connected and check the resistance of the coil. c. Further disassembly of generator is necessary. See paragraph 139. d. Further disassembly is necessary. See paragraph 139.
2. Incorrect voltage from terminals 21 through 24. Other voltages are normal.	2. Resistor 229 open	2. Check resistance of resistor 229.
3. Incorrect voltage between terminals 20 and 24.	3. Check the h-v circuits (symptoms 1 and 2 above). If they check normal, then the l-v circuits is defective, and further disassembly is necessary.	3. Refer to paragraph 139.
4. Incorrect voltage between terminals 23 and 24. All other voltages are normal.	4. Choke coil 225 open	4. Refer to paragraph 139.
5. No voltage output from any of the terminals.	5a. Field coil 237-2 or 237-1 open .. b. Voltage regulator is defective . c. Resistor 245 open d. Resistor plaques 1 and 2 may be open.	5a. Remove voltage regulator and then check for continuity of field coils. Further disassembly is necessary. b. See paragraph 139. c. Check resistance of resistor 245. d. See paragraph 139.
6. Voltage output varies within wide limits.	Voltage regulator defective	See paragraph 139.

139. Disassembly of Hand Generator

To determine which component in the hand generator is at fault, it may be necessary to remove the generator and chassis from the bottom half of the housing. The procedure is as follows:

a. Remove the crank handles and take the generator off its leg supports.

b. Remove the seven screws located around the flange of the right crankshaft coupling housing (fig. 107).

c. Insert the tip of an old worn screw driver between Generator GN-58-A-GY housing and the coupling housing flange. Pry the assembly away from the housing.

d. Pull the crankshaft coupling through the hole in the housing.

e. Remove the six screws around the flange of the left crankshaft coupling housing.

f. Repeat step c above.

g. The hole in the housing is not large enough for the left crankshaft coupling to be passed through it and out of the housing.

h. Remove the terminal strip insulating cover, shown in figure 106, from in front of panel board 239, exposing the spade lug connections on the board.

i. Loosen the screws and remove the spade lugs completely from the board. Make a written

note on the color coding of the wires connected to the terminals so that correct reconnection can be effected.

j. Next remove the seven chassis retaining screws around the top of the lower half of the housing (fig. 106).

k. Again, with the screw driver, pry the chassis away from the sides of the housing. The generator and filter assembly then can be lifted out and away from the housing as seen in figure 107. With the generator removed from the housing, all the components are easily located.

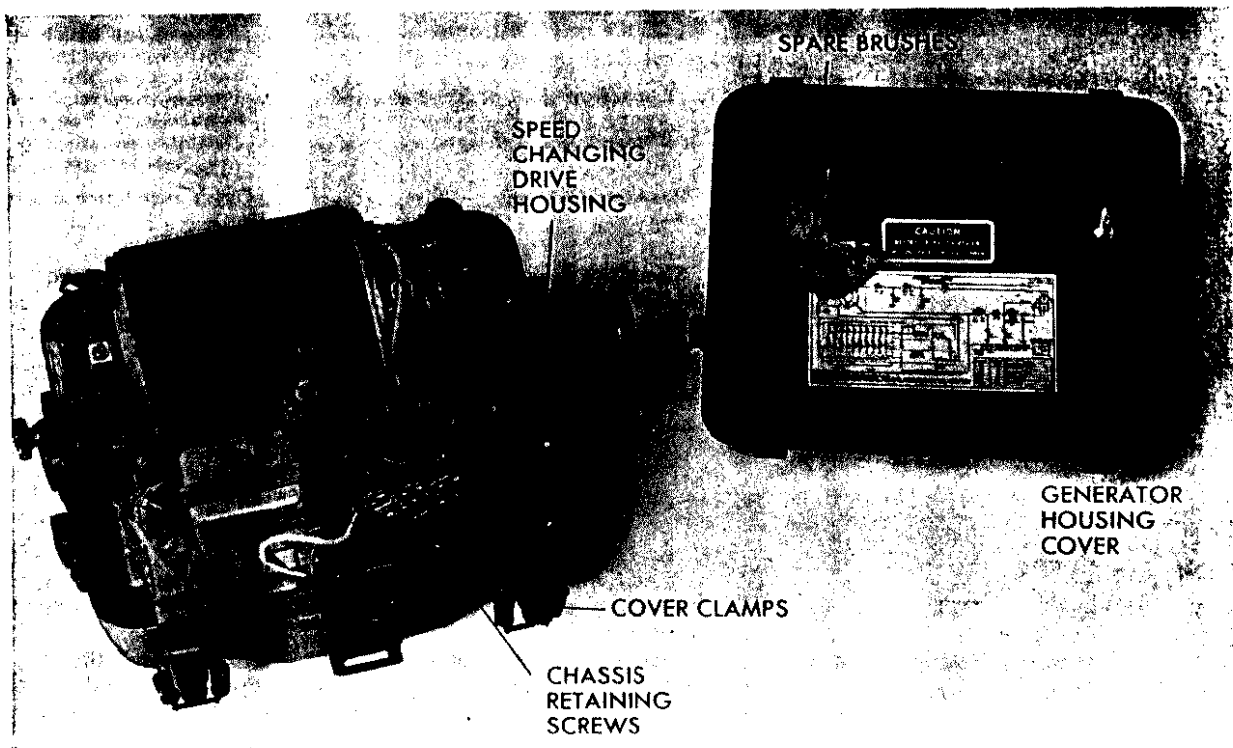


Figure 106. Generator GN-58-A-GY, disassembly illustration.

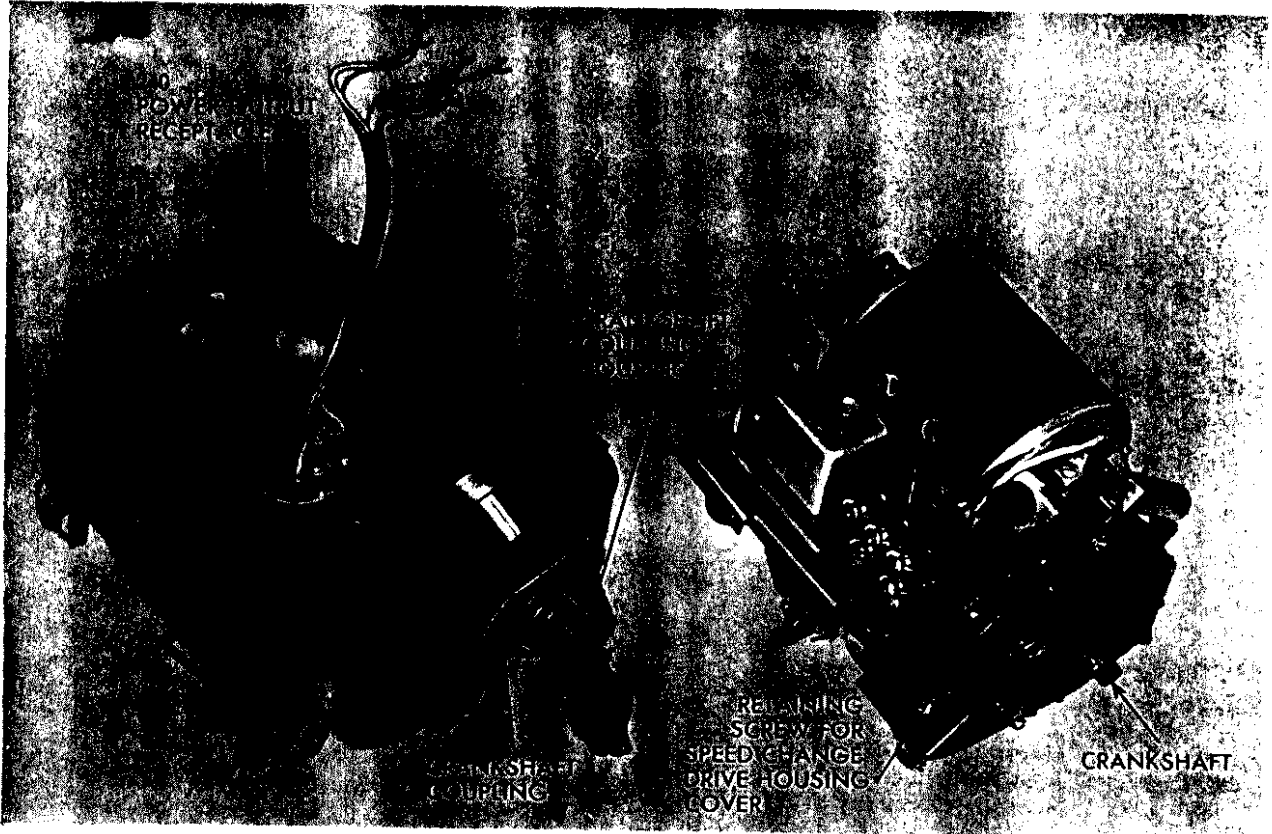


Figure 107. Generator GN-58-A-GY, removed from bottom half of housing.

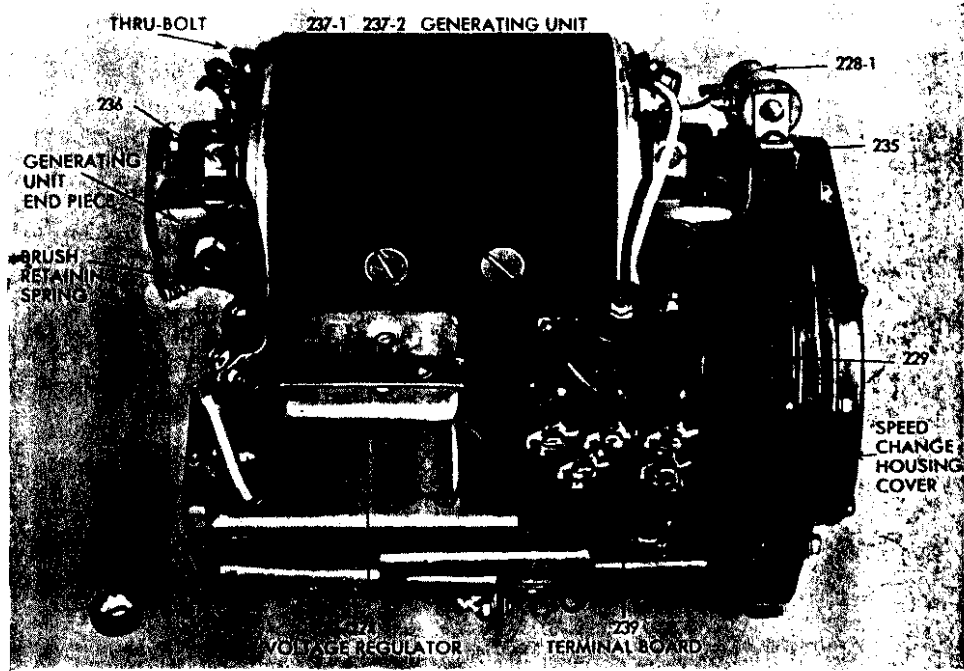


Figure 108. Generator GN-58-A-GY, parts location (top).

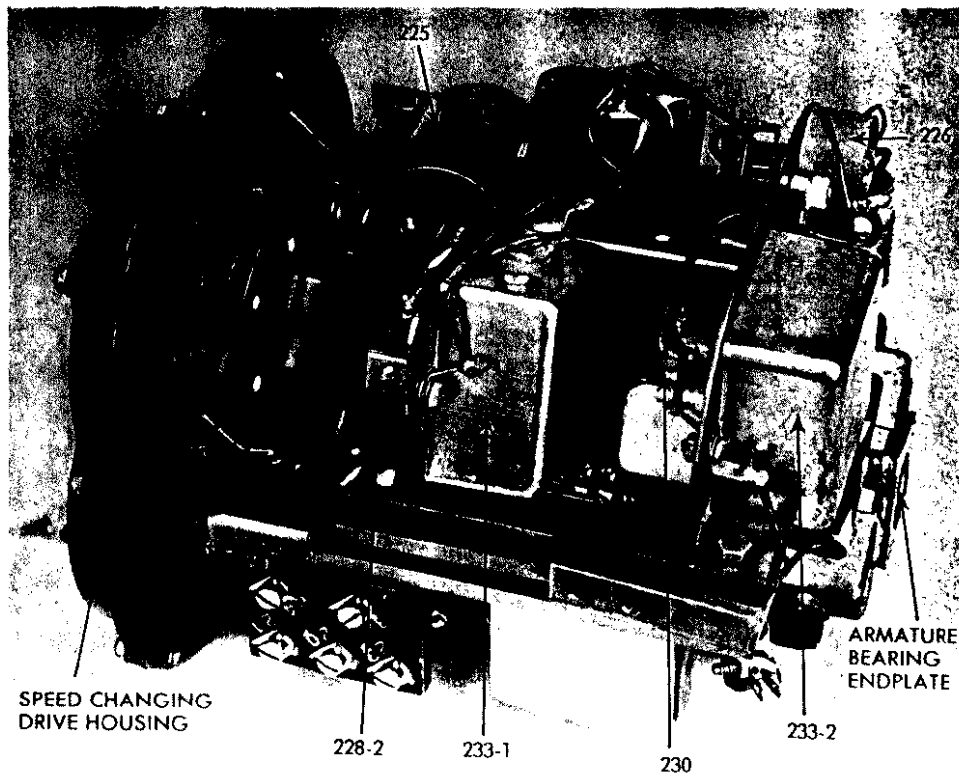


Figure 109. Generator GN-58-A-GY, parts location (bottom).

140. Localizing Trouble in Generator GN-58-A-GY

Symptom	Probable trouble	Correction
1. H-v circuit defective	1a. Choke coil 228-1 or 228-2 is open	1a. Remove the positive h-v brush.
	b. Capacitor 233-1 or 233-2 is shorted	b. Replace capacitor.
2. L-v circuit defective	2a. Choke coil 225, 226, or 227 is open	2a. Remove the positive low voltage brush. Check resistance of these coils.
	b. Capacitor 230 or 231 is shorted	b. Replace capacitor.
3. Excessive sparking under brushes.	3. Worn, dirty, or cracked brushes	3. Replace defective bushes, being sure to fit new brushes to commutator. See figure 113.
4. Both high and low output voltages vary within wide limits.	4a. Resistor 245 defective	4a. Replace resistor 245.
	b. Voltage regulator defective ..	b. Replace voltage regulator.

141. D-c Resistances of Generator GN-58-A-GY Choke Coils

Note. Remove Cord CD-1086-GY from power output receptacle 240 before taking resistance readings.

Coil	Ohms
225	10.5
226 .....	.03
227 .....	.12
228-1	7.
228-2	7.

142. Trouble-shooting Chart for Dynamotor-Power Supply DY-88/GRC-9-GY

In order to trouble shoot the dynamotor power supply, it is necessary to remove the power supply from the case. Connect the power supply to a radio set known to be good. Set voltage selector switch control H206 (fig. 111) to the proper setting corresponding to the voltage of the battery to be used. Check the DYN FUSE. Be sure it corresponds to the voltage of the battery to be used as shown in paragraph 43 a. Note that the terminals on output receptacle J202 are numbered (fig. 111). These terminals are to be used to check the output voltage of the dynamotor power supply.

142. Trouble-shooting Chart for Dynamotor-Power Supply DY-88/GRC-9-GY

Symptom	Probable trouble	Correction
1. No voltage from any terminal of power output receptacle J202.	1a. Fuse F202 open. b. S203 open. c. Power input cable open.	1a. Replace fuse. b. Check switch S203. c. Check input cable.
2. No voltage at terminal 20. Control E in SEND position.	2a. C214 shorted. b. R208 and R209 open.	2a. Replace C214. b. Replace R208 and R209.
3. No voltage at terminal 32. Dynamotor runs. Control E in SEND position.	3a. Choke L201 open. b. H-v brushes defective.	3a. Check for voltage at each end of L201. If open, replace L201. b. Check brushes. If worn, replace with new ones.
4. No voltage at terminal 33. Control E in STANDBY position. Vibrator hums.	4a. Resistor R213 open. b. Resistor R212 open. c. Capacitor C230 shorted.	4a. Check resistance of R213. b. Check resistance of R212. c. Replace capacitor C230.
5. No voltage at terminal 33. Control E in STANDBY position. Vibrator does not hum.	5a. Vibrator defective. b. Contacts 2 and 3 of relay K202 defective. c. Contacts 3 and 7 of relay K203 open.	5a. Replace vibrator. b. Check for voltage at contacts 2 and 3 of relay K202 for continuity. c. Check for voltage at contacts 3 and 7 of relay K203.
6. No voltage at terminal 34. Control E in SEND position.	6a. Resistor R201 open.	6a. Check for voltage at each end of resistor R201.
7. No voltage at terminals 22 and 23. Control E in STANDBY position.	7a. Ballast resistor R210 open. b. Capacitor C216 shorted. c. Capacitor C215 shorted.	7a. Check ballast resistor R210 for continuity. b. Replace capacitor C216. c. Replace capacitor C215.
8. No voltage at terminal 21. Control E in SEND position.	8a. Capacitor C231 shorted. b. Contacts 3 and 4 of relay K202 open. c. Resistor R212 open. d. Capacitor C229A or C229B shorted.	8a. Replace capacitor C231. b. Check for voltage at terminals 3 and 4 of relay K202. c. Check for voltage at each end of resistor R212. d. Replace capacitors C229A and C229B.
9. Low voltage at terminal 33. Control E in STANDBY or SEND position.	9a. Secondary of transformer T201 open between terminals 1 and 2 or between terminals 2 and 3. b. Choke L203 open. c. Choke L206 open. d. R213 increased in value.	9a. Check continuity between terminals 1 and 2 and terminals 2 and 3 of transformer T201. b. Check continuity of choke L203 with vibrator removed from socket. c. Check continuity of choke L206 with vibrator removed from socket. d. Check R213. Replace if defective.
10. High voltage at terminal 20. Receiver-transmitter in PHONE-SEND position. Microphone button released.	10a. Resistor R211 open. b. Contacts 3 and 5 of relay K204 open.	10a. Replace resistor R211. b. Check for voltage at terminals 3 and 5 of K204.
11. No voltage at terminals 22, 23, and 33. Control E in STANDBY position.	11a. K203 relay coil open. b. Ballast resistor R210 is open.	11a. Check K203 coil for continuity. b. Replace ballast resistor R210.
12. No voltage at terminals 20, 32, and 34. Control E in SEND position. Dynamotor does not run.	12a. Fuse F201 is open. b. K201 relay coil open. c. Contacts 11 and 12 of K202 are open. d. K202 relay coil is open.	12a. Replace fuse F201. b. Check K201 coil for continuity. c. Replace K202 if defective. d. Check continuity of K202 coil.
13. No voltage at terminal 21 with control E in SEND position. No voltage at terminal 33 with control E in STANDBY position.	13a. Vibrator F201 is defective.	13a. Replace vibrator E201.
14. Fuse F201 keeps blowing control E in SEND position.	14a. Capacitor C201, C202, C204, C207, C208, C209, C210, C211 or C212 shorted. b. Fuse F201 not the correct value for the voltage used.	14a. Check for shorted capacitor and replace. b. Replace fuse F201 as follows: 30 amp for 6-volt operation, 20 amp for 12-volt operation, and 10 amp for 24-volt operation.

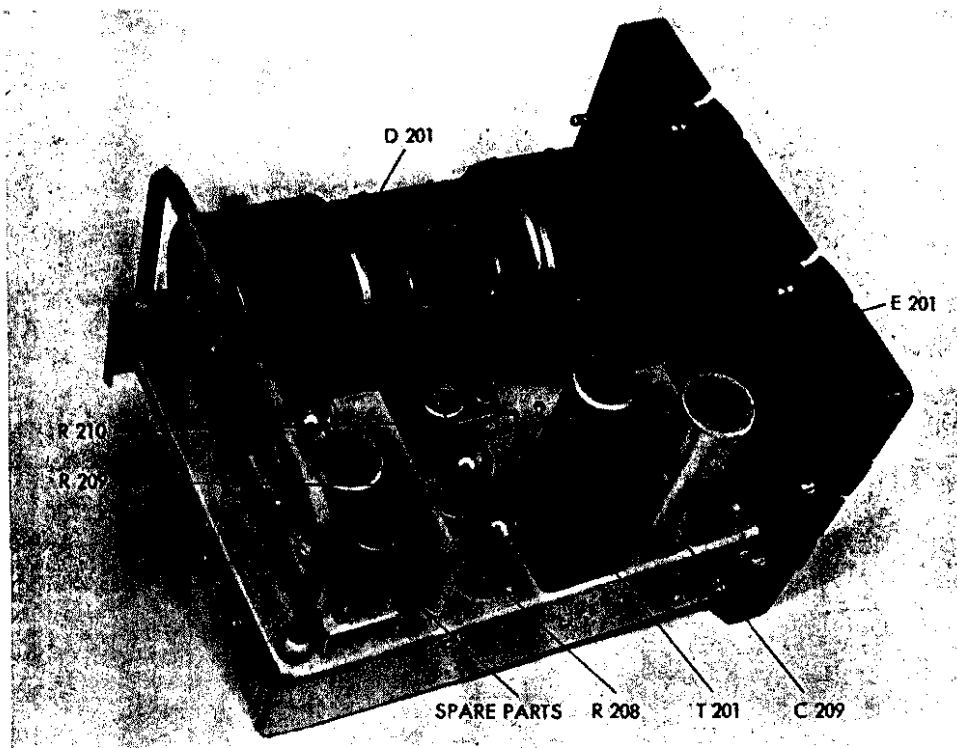


Figure 110. Dynamotor-Power Supply DY-88/GRC-9-GY, cover removed, top view.



Figure 111. Dynamotor-Power Supply DY-88/GRC-9-GY, cover removed, bottom view.

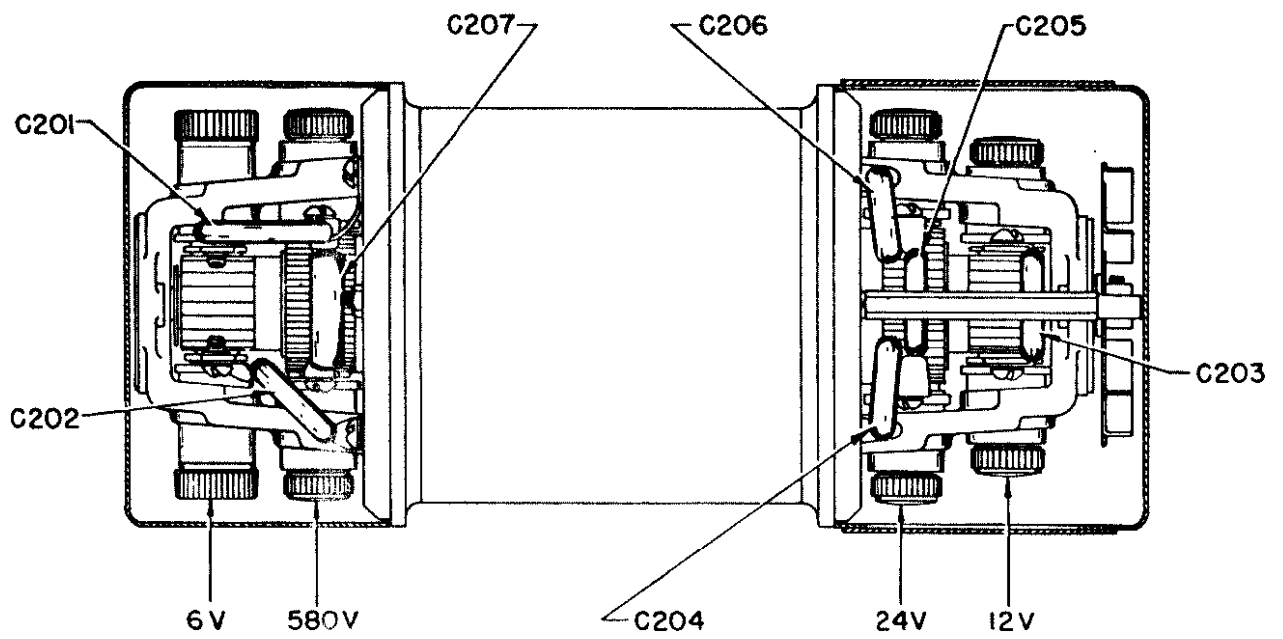


Figure 112. Dynamotor D201 manufactured by AEG Germany.

Section III. REPAIRS

143. Replacement of Parts

a. Most of the parts in Radio Set AN/GRC-9-GY are readily accessible and easily replaced if found defective. If the BAND change switches need replacement, mark the wires connected to the switch with tags or other devices to avoid misconnection when the new switch is installed. Follow this practice whenever replacement requires the disconnection of numerous wires.

b. When removing screws from the units try to keep the screws in individual groups corresponding to the components which they fasten to the chassis. This will speed up the reassembly process.

c. Be careful when resoldering not to allow drops of solder to fall onto other wiring and components. This may cause future trouble if care is not taken.

144. Refinishing

Instructions for refinishing badly marred panels on exterior cabinets are given in TM 9-2851.

145. Replacing Brushes in Generator GN-58-A-GY

a. There are standard replacement brushes for Generator GN-58-A-GY, which are already shaped to fit the contour of the armature. These brushes also have polarity markings on them. The brushes should be replaced so that the polarity markings face upward, in the normal operating position of the generator. If this is not observed, damage to the commutator may result.

b. Some brush replacements will necessitate a sand-in operation to allow the brush to make full contact with the armature. If the operation is not performed, excessive heating of the brush and commutator will occur, also, excessive sparking will ruin the commutator.

c. Sanding-in may be accomplished by using two strips of No. 00 sandpaper about 5 inches long and almost as wide as the h-v and l-v armatures. Wrap the strip of sandpaper around the commutator with the sand surface out. Insert the brushes in the brush holders, and replace the brush caps over the brush spring so that the brushes are pressed tightly against the sand-

paper. Holding the ends of the sandpaper so as to stretch it tightly against the commutator (fig. 113), rotate the armature back and forth until the full width of the brush face is making contact against the sandpaper, as indicated by the sanding marks or scratches on the contact surface of the brush when the brush is removed for inspection.

d. Never apply oil, grease, or any other lubricant to the brush, commutator, or brush holder.

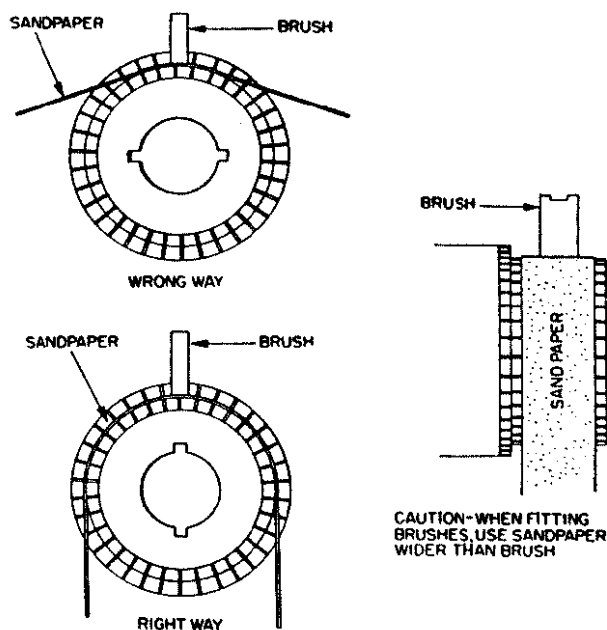


Figure 113. Correct and incorrect methods of fitting a brush to the commutator.

146. Replacing Brushes in Dynamotor-Power Supply DY-88/GRC-9-GY

There are standard replacement brushes furnished as spare parts with Dynamotor-Power Supply DY-88/GRC-9-GY. These brushes are already shaped to fit the contour of the armature. To replace the brushes, proceed as follows:

- Remove the power supply from its case.
- Remove the four screws holding each of the two access covers (fig. 110) to the dynamotor. The 12- and 24-volt brushes now are accessible.
- Remove the two screws holding the rear cover to the dynamotor. The 6- and 580-volt brushes now are accessible.



Figure 114.1. Speed change drive housing, gasket, and cover removed.

d. Unscrew the brush caps and remove the brushes.

Note. The commutator arrangement will vary according to the type of dynamotor used (fig. 112).

e. When replacing the brushes, be sure that the polarity markings on the brushes face upward, in the normal operating position of

the dynamotor. If this is not observed, the commutator may be damaged.

f. Replace the brush caps, access covers, and rear cover of the dynamotor.

Caution: Never apply oil, grease, or any other lubricant to the brush, commutator, or brush holder.



Figure 114.2. Generator GN-58-A-GY, sprocket gear, and sprocket chain removed.

147. Removal of Armature of Generator GN-58-A-GY

The armature is not to be repaired, except in a depot maintenance unit. This information is given for those units where the armature is to be replaced, in case they are defective. The procedure is as follows:

- a. Remove all brushes.
- b. Take off the speed change housing cover by removing the six screws around the edge of the cover (figs. 107 and 114.1).
- c. Remove the screw that secures the sprocket gear to the armature shaft (fig. 107).
- d. The sprocket gear is press-fitted to the shaft. Pry it off gently (fig. 114.2).
- e. Remove the two through-bolts from the left generating unit endpiece (fig. 115).
- f. Pry the left generating unit endpiece away from the generating unit, and slip it off the armature shaft bearing. Be careful not to damage any of the wiring. It may be necessary to remove the left bearing plate so that the endpiece can be forced off and away from the bearing which is press-fitted to the armature shaft.
- g. The armature now can be pulled out gently through the generating unit (fig. 116).

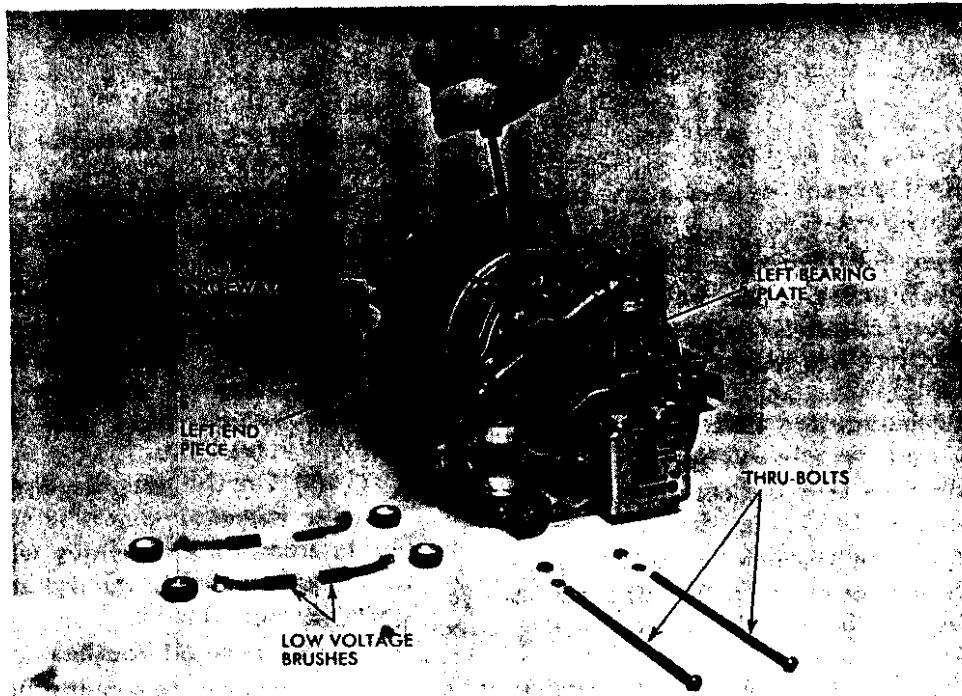


Figure 115. Generator GN-58-A-GY, prying off generating unit left endpiece.

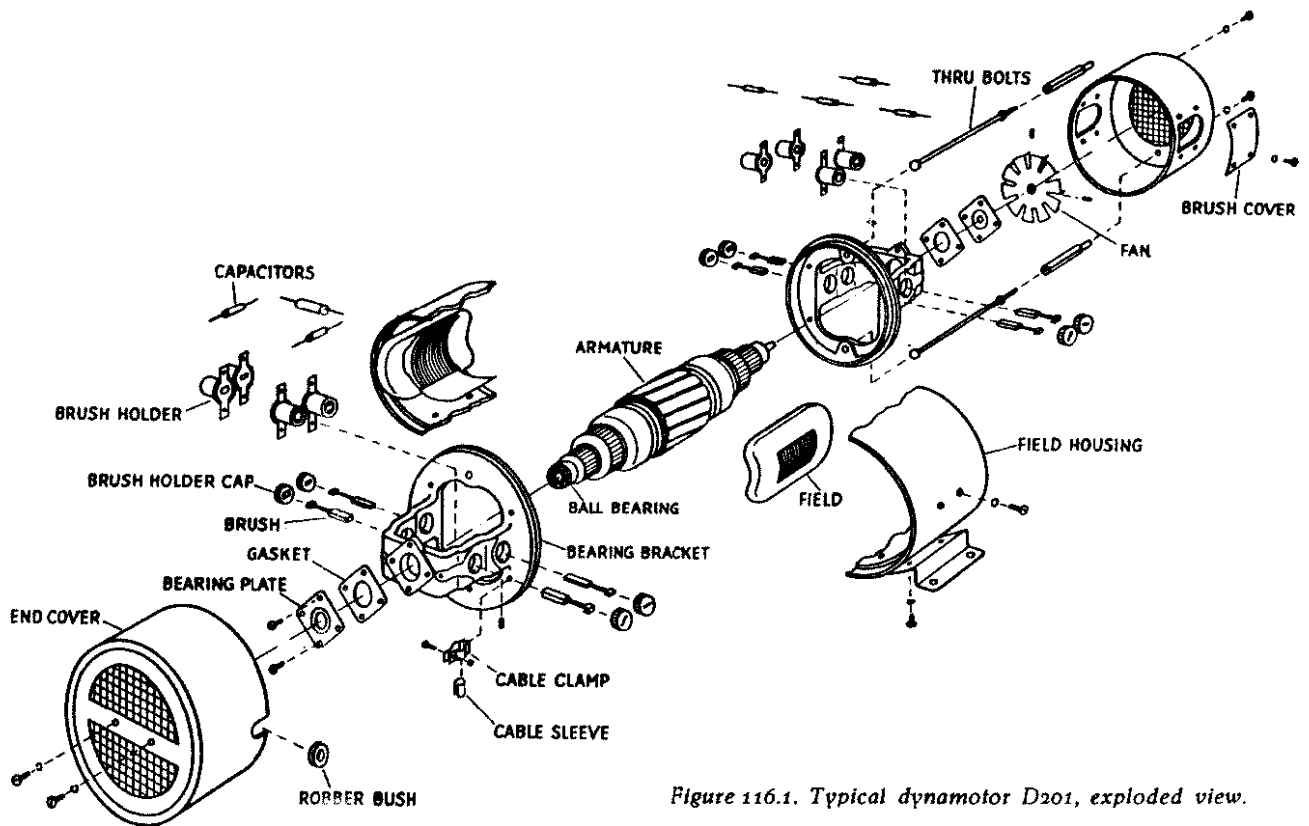


Figure 116.1. Typical dynamotor D201, exploded view.

148. Replacement of Armature of Generator GN-58-A-GY

Reverse the disassembly procedure in paragraph 147, being careful of the following:

- a. The bottom through-bolt passes through a connecting lug before it emerges from the generating unit. Before screwing on the nut to the bolt, be sure that the lug is around the bolt inside the generating unit.
- b. Be sure that the sprocket chain is fitted completely about the sprocket gear and is sufficiently lubricated.
- c. Do not forget to replace the gasket before screwing on the speed change housing cover.

149. Removal of Armature of Dynamotor D201

In general, repair or replacement of the armature is not recommended. If possible, replace the entire dynamotor. The armature is not to be repaired, except in a depot maintenance unit. This information is given for those units where the armature is to be replaced. Proceed as follows:

- a. Remove power supply from its case.

- b. Remove the dynamotor from the chassis.
 - (1) Disconnect the dynamotor wires at the under side of the chassis (fig. 111) by loosening the screws which hold the dynamotor wire spade lugs. Tag all wires before removal.
 - (2) Remove the four screws and nuts which hold the dynamotor to the chassis.
 - (3) Gently pull the dynamotor up off the chassis.
- c. Remove the screws which hold the front and rear covers to the dynamotor. Remove the covers (fig. 116.1).
- d. Remove all brushes.
- e. Remove the top through bolt.
- f. Before removing the bottom through bolt, loosen the cable clamp. Then, remove the bottom through bolt.
- g. Loosen and remove all wires at the terminals at the front (fan) end of the dynamotor. Be sure to tag all wires.
- h. Use an Allen wrench to remove the two screws holding the fan to the dynamotor. Remove the fan.

i. Pry the front end piece away from the dynamotor unit. Remove the front end piece by pulling it off the dynamotor unit. Be careful not to damage any of the wiring.

j. The armature now can be pulled out gently through the dynamotor unit.

150. Replacement of the Armature of Dynamotor D201

To replace the dynamotor armature, reverse the disassembly procedure given in paragraph 149. Be sure to connect all wires properly.

151. Adjustment of Apparatus

a. TRANSMITTER TUNING CONTROL I KNOB. Be sure that when replacing the tuning

knob, the setscrew in the knob is tightened up against the flat side of the tuning control shaft. If the setscrew should be tightened incorrectly on the round part of the shaft, the dial readings on the knob will not correspond to the frequency to which the tuning capacitor will actually be tuned.

b. TRANSMITTER KEYING RELAY K101.

Note. The adjustment of the relays in the radio set are to be made only in fixed depot maintenance centers by skilled personnel, and then only under extreme necessity.

- (1) The necessary sequence of operation of the relay is as follows: Contacts 3 and 4 shall close before contacts 9 and 10. This is important, otherwise p-a tube V103 may be ruined.



Figure 116.2. Armature removed from generating unit.

- (2) The air gap between contacts 4 and 5 and between 1 and 2 is .040 inch minimum when contacts 3 and 4 are closed. Contacts 9 and 10 are open with an air gap of .25 inch minimum when contacts 7 and 8 are closed.
- (3) The contact pressures of the relay contacts are 29 grams, plus or minus 3 grams.

c. **ADJUSTMENT OF VOLTAGE REGULATOR IN GENERATOR GN-58-A-GY.** A vibrating contact-type voltage regulator is incorporated in the hand generator. Adjust, only when necessary, with Signal Corps Gauge TL-127

(stock No. 6Q45127) according to directions inside the cover of the generator.

d. **ADJUSTMENT OF INDEX MARK OF TRANSMITTER MAIN TUNING CAPACITOR.** The flat of the main tuning capacitor shaft should be rotated to position for easy tightening up of setscrew of the frequency control dial after the assembly is replaced. The setscrew of the frequency control dial must be seated on the flat of the capacitor shaft, otherwise calibration will be inaccurate. To readjust dial lock, place lock in approximately the normal position, close clamp, and tighten mounting screws.

Section IV. RECEIVER ALINEMENT PROCEDURES

152. Test Equipment Used for Alinement of Receiver Section of Receiver-Transmitter RT-77/GRC-9-GY

a. **SIGNAL GENERATOR.** The signal generator should be accurately calibrated instrument producing modulated r-f signals, such as Signal Generator I-72-(*). In addition to 456 kc, the unit must have a range of from 2 mc to 12 mc, covering the three bands of the

receiver. The signal generator should have an output of impedance of approximately 100 ohms for best results when the r-f and h-f oscillator circuits are alined. For i-f alinement, these values are not critical. The frequency calibration of the signal generator is extremely important in order that the receiver dial calibration be correct.

b. **OUTPUT METER.** The output meter in Test Set I-56-(*) is satisfactory.

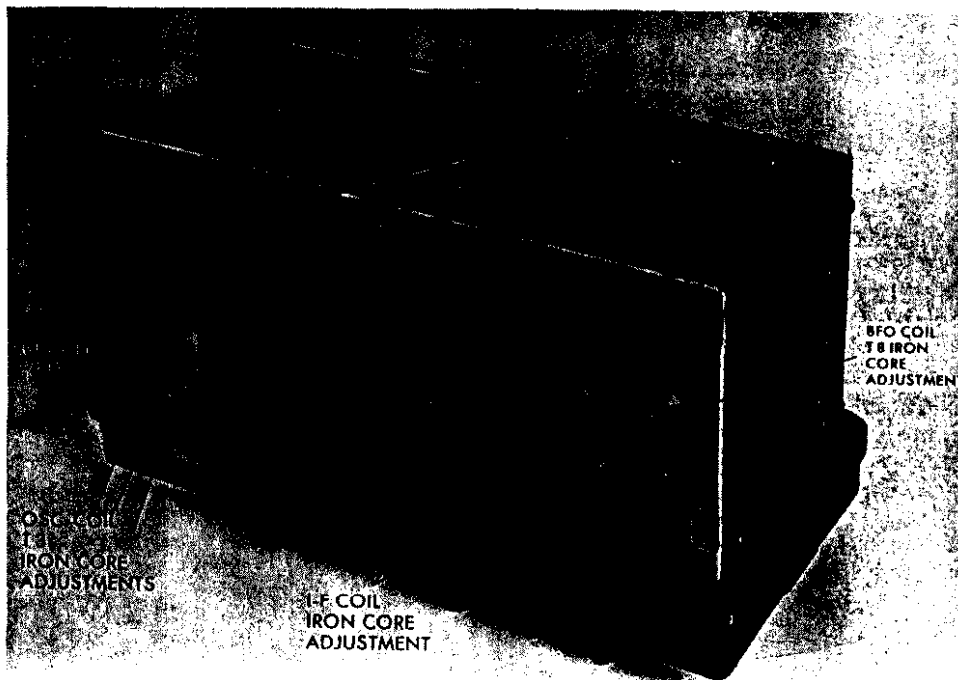


Figure 117. Receiver top, alinement points.

c. OTHER EQUIPMENT. Additional test equipment necessary are Headset HS-30-(*), a 110-uuf and .05-uf capacitors, and an alinement tool.

153. Preliminary Alinement Procedures

a. Turn on the signal generator and allow it to reach a stable operating temperature (approximately 15 minutes). Using the instruction book furnished with the signal generator, see that it is accurately calibrated.

b. Stand the receiver on its right side; connect the output meter by attaching the two wires from it to Plug PL-55, and insert the plug in one of the PHONES jacks. Plug the headset into the other phone jack.

c. Any of the usual power supplies may be used, but the battery power is recommended, because it is a more constant power source. If battery power is available, attach Cord CD-1119-GY to the BATTERY receptacle on the transmitter and to Battery BA-48.

d. Turn control E to STANDBY if Battery BA-48 or Dynamotor-Power Supply is used. If Generator GN-58-A-GY is used, turn control E to SEND.

e. Allow the receiver and signal generator to warm up for about 15 minutes before any attempt is made at alinement.

154. I-f Alinement

(figs. 117 and 118)

Remove the bottom cover of the receiver and refer to figure 91 for the placement of the i-f transformers. Proceed with the following:

a. Loosen the tuning slug locknuts on the top and bottom of i-f transformers T4, T5, and T6.

b. Turn A. F. GAIN control O clockwise to the maximum position. Turn R. F. GAIN control P clockwise to the maximum position. Set control L to PHONE. Set the output IMPEDANCE switch in the back of the receiver chassis for 250 ohms.

c. Cut out the avc voltage. This can be done most easily by connecting a shorting wire from the terminal board lead of resistor R1 to the chassis. The receiver will function normally except that the avc voltage will be shorted to ground.

d. Set the output meter for an impedance of 250 ohms.

e. Set the signal generator at 456 kc. Set the modulation at 30 percent at 400 cycles.

f. Connect the ground side of the signal generator to the receiver chassis.

g. Connect the hot lead of the signal generator output to the signal grid, pin 6 of the second i-f amplifier tube V4, through a .05-uf capacitor.

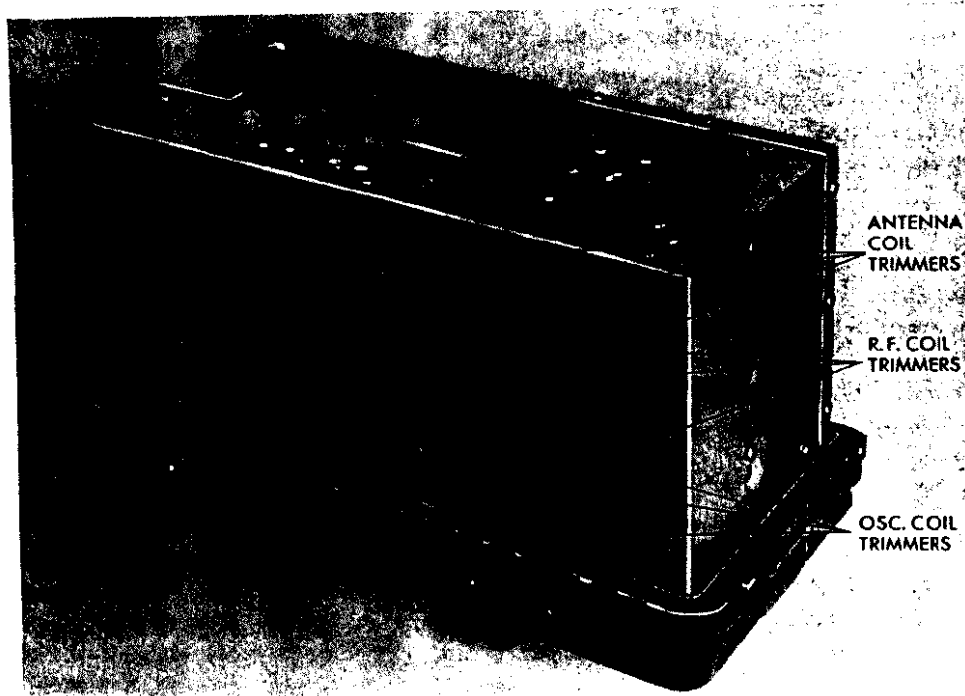


Figure 118. Receiver bottom, alinement points.

h. Adjust the signal generator attenuator to produce an approximate midscale reading on the visual indicating output meter.

Note. As alinement progresses, it may be necessary to reduce the signal generator output to keep the output meter on scale.

i. Adjust the top and bottom screws on i-f transformer T6 until a maximum reading is obtained on the visual indicating output meter.

j. Tighten the locknuts slightly, maintaining the peak output.

k. Repeat steps g, h, i, and j above for each of the other two i-f transformers. For transformer T5, connect the hot lead of the signal generator to pin 6 of tube V3. For transformer T4, connect the hot lead to pin 6 of the converter tube V2.

l. When the hot lead is on pin 6 of the converter tube, recheck the settings on all the i-f transformers and then tighten the locknuts snugly, being careful to maintain maximum reading on the output meter.

155. Bfo Alinement

To aline the bfo, use the following procedure:

- a. Set the TUNING dial control N at 2 mc.
- b. Set control L at C.W.
- c. Turn A. F. GAIN control O clockwise to its maximum position.
- d. Set the signal generator at 456 kc with no modulation.
- e. Clip the hot side of the signal generator output to pin 6 of tube V2.
- f. Loosen the locknut on the top of the bfo coil T8 and adjust the tuning slug screw for a zero beat.
- g. Tighten the locknut, being careful to maintain zero beat after the nut is tightened.

156. R-f Alinement

a. PRELIMINARY ADJUSTMENTS. For the r-f alinement on each of the three bands, the following steps apply:

- (1) Set the visual indicating output meter at 250 ohms.
- (2) Set the IMPEDANCE switch on the receiver chassis at 250 ohms.
- (3) Set control L to PHONE.
- (4) Modulate the signal generator output 30 percent at 400 cycles.
- (5) Connect the hot lead of the signal generator output to the ANT. binding

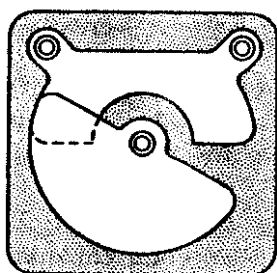
post through a 110-uuf capacitor. Connect the ground lead to the receiver chassis.

- (6) Control A in the transmitter must not be set at position 9, 10, or 11.
- (7) Disable the avc voltage supply as in paragraph 154c.

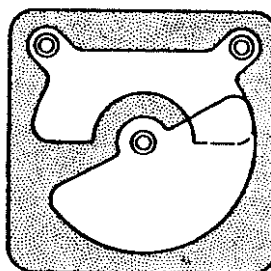
b. BAND 1 ALINEMENT.

- (1) To aline the receiver at the l-f end of BAND 1, proceed as follows:
 - (a) Set the signal generator at 6.6 mc.
 - (b) Turn control M to BAND 1.
 - (c) Set the receiver TUNING dial to exactly 6.6 mc.
 - (d) To aline the BAND 1 coil of r-f transformer T2, carefully adjust the coil 1 tuning slug screw (on the top of the receiver chassis) for a maximum deflection on the output meter.
 - (e) To aline the BAND 1 coil of ANT. transformer T1, carefully adjust the coil 1 tuning slug screw (on the top of the receiver chassis) for a maximum deflection on the output meter.
 - (f) To aline the BAND 1 coil of OSC. transformer T3, carefully adjust the coil 1 tuning slug screw (on the top of the receiver chassis) for a maximum deflection on the output meter.
- (2) To aline the receiver at the h-f end of BAND 1, proceed as follows:
 - (a) Set the signal generator at 12 mc.
 - (b) Set the receiver TUNING dial at exactly 12 mc.
 - (c) Carefully adjust OSC. BAND 1 trimmer capacitor C27 (on the bottom of the chassis) for a maximum deflection of the output meter.

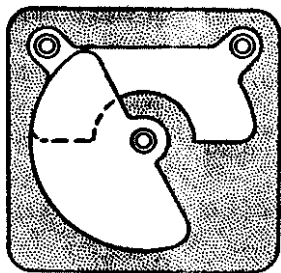
Caution: It may be found that there are two positions of the OSC. trimmer capacitor C27 which will give a maximum reading on the output meter. In this situation, the trimmer setting which has less capacity, is the correct one. Referring to figure 119, a capacitor setting at A gives the same capacity as at A' because of the circular construction of the trimmer, and either setting may be used. If the capacitor adjustment, however, results in the out-



SETTING A



SETTING A'



SETTING B

EITHER ONE OF SETTINGS A AND A' MAY BE USED IF MAXIMUM DEFLECTION IS OBTAINED AT THOSE SETTINGS. IF MAXIMUM DEFLECTION IS OBTAINED WITH SETTINGS A, A' AND ALSO SETTING B, USE ONLY SETTING A OR A' SINCE THESE SETTINGS WILL GIVE MINIMUM CAPACITY. SETTING B IS INCORRECT.

Figure 119. Determination of the correct settings for OSC. trimmer capacitors C25, C26, and C27.

put meter indicating a peak at two points such as at A and B, the correct setting is at A, which gives the minimum amount of capacity.

- (d) Adjust the R. F. GAIN BAND 1 trimmer capacitor C17 (on the bottom of the receiver chassis) for maximum deflection of the output meter.
 - (e) Adjust the ANT. BAND 1 trimmer capacitor C6 (on the bottom of the chassis) for a maximum deflection on the output meter.
- (3) Repeat the entire procedure from step (d) above of the l-f alinement to correct any errors due to interaction of adjustments. It may be necessary to repeat these operations twice. This depends on the initial degree of mis-alinement.
- c. BAND 2 ALINEMENT.
- (1) To aline the receiver at the l-f end of BAND 2, proceed as follows:
 - (a) Turn control N to BAND 2.
 - (b) Set the signal generator at 3.6 mc.
 - (c) Set the receiver TUNING control N to exactly 3.6 mc.
 - (d) To aline the BAND 2 coil of r-f transformer T2, carefully adjust the coil 2 tuning slug screw (on the top of the receiver chassis) for a maximum deflection on the output meter.
 - (e) To aline the BAND 2 coil of ANT. transformer T1, carefully adjust the coil 2 tuning slug screw (on the top of the chassis) for a maximum deflection on the output meter.
 - (f) To aline the BAND 2 coil of OSC. transformer T3, carefully adjust the coil 2 tuning slug screw (on the top of the chassis) for a maximum deflection on the output meter.
 - (2) To aline the receiver at the h-f end of BAND 2, proceed as follows:
 - (a) Set the signal generator at 6.6 mc.
 - (b) Set the receiver TUNING dial to exactly 6.6 mc.
 - (c) Carefully adjust OSC. BAND 2 trimmer capacitor C26 (on the bottom of the chassis) for a maximum deflection on the output meter. Refer to figure 119.
 - (d) Adjust the R. F. GAIN BAND 2 trimmer capacitor C16 (on the bot-

tom of the chassis) for a maximum deflection on the output meter.

(e) Adjust the ANT. BAND 2 trimmer capacitor C5 (on the bottom of the chassis) for maximum deflection on the output meter.

(3) Repeat steps (d) and (e) above of the l-f alinement of BAND 2 to correct any errors due to interaction of adjustments.

d. BAND 3 ALINEMENT.

(1) To aline the receiver at the l-f end of BAND 3, proceed as follows:

(a) Turn control M to BAND 3.

(b) Set the signal generator at 2 mc.

(c) Set the receiver TUNING control to exactly 2 mc.

(d) To aline the BAND 3 coil of r-f transformer T2, carefully adjust the coil 3 tuning slug screw (on the top of the receiver chassis) for a maximum deflection on the output meter.

(e) To aline the BAND 3 coil of ANT. transformer T1, carefully adjust the coil 3 tuning slug screw (on the top of the chassis) for a maximum deflection on the output meter.

(f) To aline the BAND 3 coil of OSC. transformer T3, carefully adjust the coil 3 tuning slug screw (on the top of the chassis) for a maximum deflection on the output meter.

(2) To aline the receiver at the h-f end of BAND 3, proceed as follows:

(a) Set the signal generator at 3.6 mc.

(b) Set the receiver TUNING dial to exactly 3.6 mc.

(c) Carefully adjust OSC. BAND 3 trimmer capacitor C25 (on the bottom of the receiver chassis) for a maximum deflection on the output meter (fig. 119).

(d) Adjust the R. F. GAIN BAND 3 trimmer capacitor C15 (on the bottom of the chassis) for a maximum deflection of the output meter.

(e) Adjust the ANT. BAND 3 trimmer capacitor C4 (on the bottom of the chassis) for a maximum deflection on the output meter.

(3) Repeat steps (d) and (e) above of the l-f alinement of BAND 3 to correct any errors due to interaction of adjustments.

157. Crystal Calibrator Oscillator Alinement

The adjustment of the iron slug in transformer T7 is made by the manufacturer and the necessity of its being reset is very unlikely. The position of the slug will not change the frequency output of the crystal oscillator to any extent, therefore, do not attempt to adjust the crystal oscillator output.

Section V. TRANSMITTER ALINEMENT PROCEDURES

158. Test Equipment Used for Alinement of Transmitter Section of Receiver-TRANSMITTER RT-77/GRC-9-GY

To aline the transmitter, use the following equipment:

a. Frequency Meter Set SCR-211-(*).

b. A voltmeter with an internal resistance of 1,000 ohms per volt or more. Correct metering socket voltages are found on the back panel of the transmitter (par. 134).

c. A power source for operation of the transmitter. A stable source should be used such as Dynamotor-Power Supply DY-88/GRC-9-GY, although Generator GN-58-A-GY can be used if necessary.

d. Dummy antenna load of 72 ohms or 5,000 ohms noninductive resistance with a rating of 20 watts or higher.

159. Transmitter Alinement Procedure

(figs. 120 and 121)

a. Remove the power cable from the transmitter.

b. Unfasten the catches and remove the transmitter from its case. Be careful not to damage the p-a tube.

c. Attach the power cable to the power receptacle on the front of the panel.

Caution: Be careful, since the top cap of the output tube and many other points carry approximately 500 volts when the power is turned on.

d. Set switch D to PHONE-HI.

e. Set switch F to BAND 1-MO.

f. Turn the ANT. SELECTOR switch A to WHIP position 4, and adjust the ANTENNA

OSC
COIL
TRIM

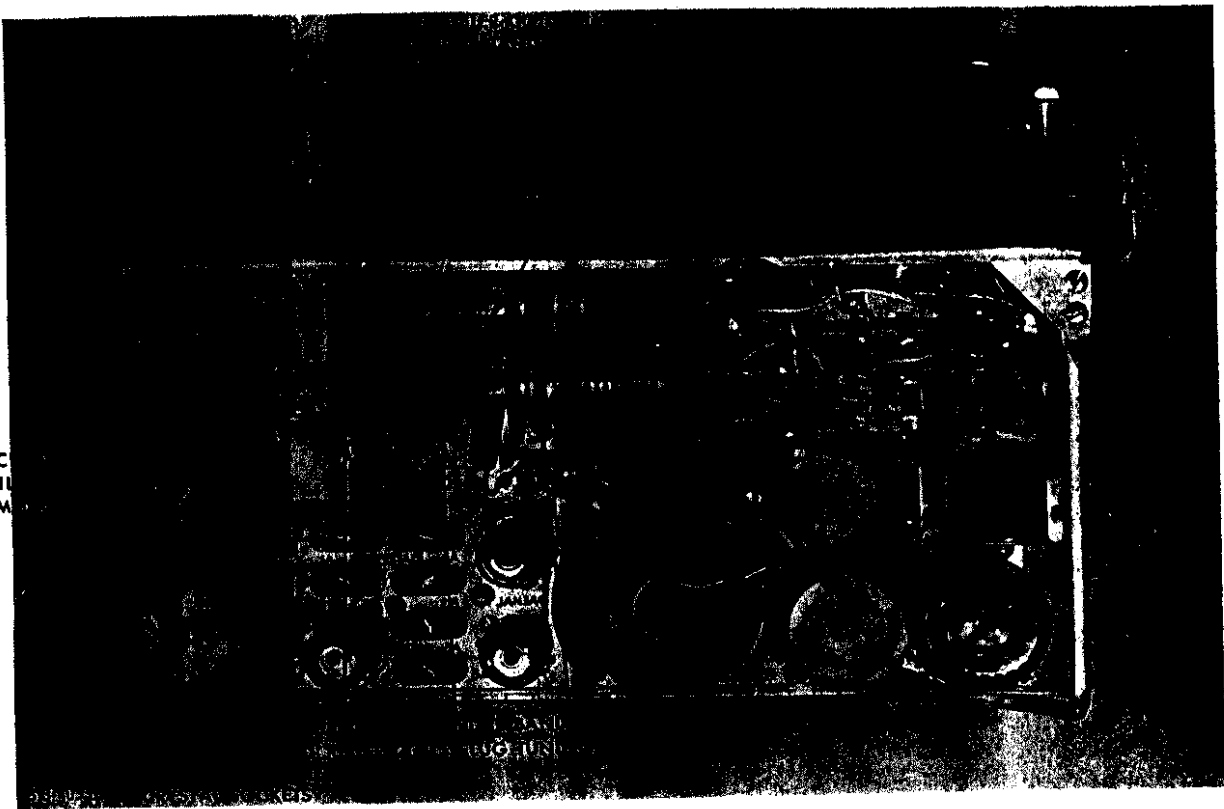


Figure 120. Transmitter alignment points, top of chassis.

TUNING control C to 10. Do not use any position lower than 10, since misalignment will result.

g. Set the frequency meter to 11,200 kc.

h. Set control H (OSC. CAL. control) to midposition.

i. Set the FREQ. CONTROL I knob on the transmitter to the setting indicated on the calibration chart for 11,200 kc.

j. Press the microphone button and listen in the phones connected to the frequency meter for the signal from the transmitter. Adjust the mo BAND 1 (MO) trimmer (C106B) to exactly zero beat. If the 200-kc crystal in the receiver is used instead of the frequency meter, proceed as instructed in paragraph 53.

Note. Since Frequency Meter SCR-211-(*) can give beat notes between harmonics of the transmitter and frequency meter, measurements of the transmitter frequency should be taken at several points on the dial to be sure that the transmitter has been aligned to the correct frequency, and that it has calibrated closely over its entire range. If a check is made at several points and it is found that only the one at which the adjustment has been made is closely on frequency and that the other points checked are considerably in error, it is probable that the wrong beat note was used in the

frequency meter and that none of the frequencies are correct.

k. Connect the negative lead of the 1,000-ohm per volt meter to point No. 5 on the metering socket and connect the positive lead to the chassis or pin 7, using the 100-volt scale on voltmeter.

l. Adjust the doubler trimmer (C111) BAND 1 for maximum output indication on the meter.

m. Using approximately a 3-volt scale of the meter, connect the positive lead of the meter to point No. 2 and the negative lead to point No. 8 of the metering socket.

Caution: Be careful, since both ends of the meter connected in this way are approximately 500 volts above the chassis.

n. Adjust the power amplifier trimmer (C118) BAND 1 for MINIMUM indication on the meter.

o. Set the FREQ. CONTROL I knob on the transmitter to the setting indicated on the calibration chart for 6.6 mc. Using the 100-volt scale, connect the negative meter lead to pin 5 and the positive lead to pin 7 of the metering socket. Adjust the BAND 1 DOUBLER screw

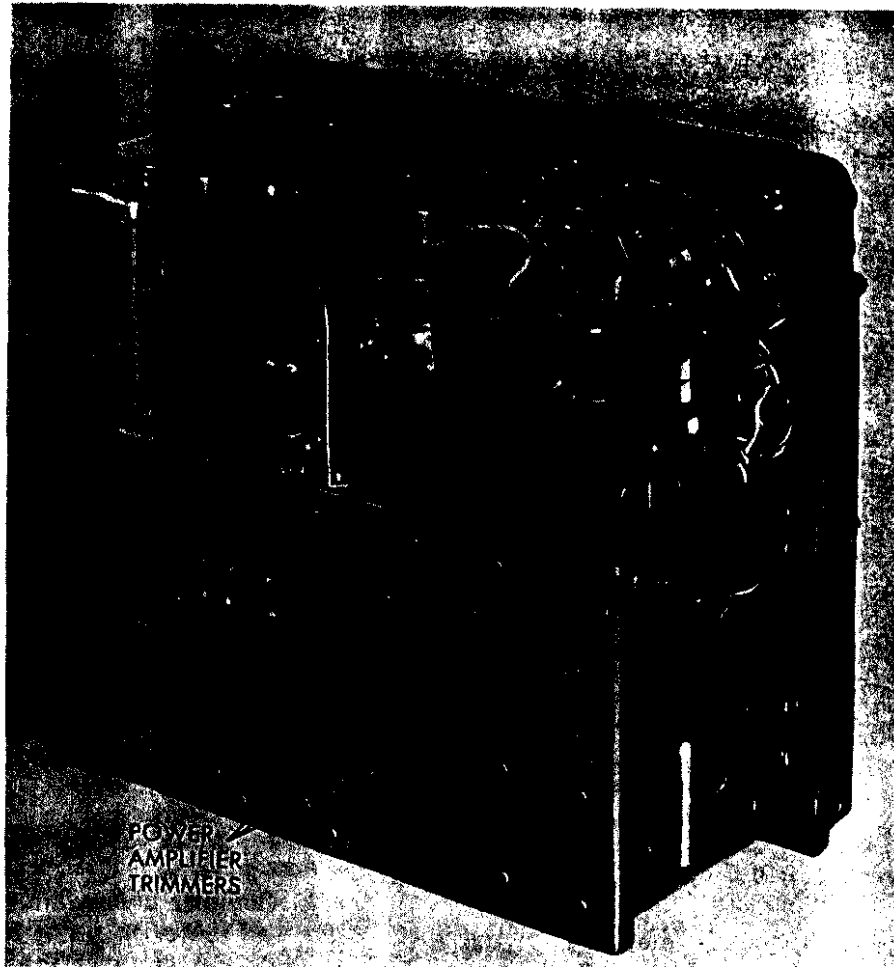


Figure 121. Transmitter alignment points, back of chassis.

on coil T104 (core) for MAXIMUM voltage and tighten the locknut.

p. Using the 3-volt scale, connect the negative meter lead to pin 8 and the positive meter lead to pin 2 at the metering socket. Adjust BAND 1 (PA) iron core for MINIMUM voltage on the meter and tighten the locknut.

q. Repeat operations as described in subparagraphs k, l, m, and n above in their proper sequence.

r. Connect the 5,000-ohm carbon resistor from the ANT. post on the transmitter to some bare metal part of the chassis of the transmitter. Turn the ANT. SELECTOR switch A to REEL 5, 6, 7, or 8, whichever will resonate. Rotate ANTENNA TUNING knob (control C) until INDICATOR glows brightest.

s. As a final check to insure proper alignment,

the transmitter should be tuned at one end of the frequency band and then at the other. At the same time, adjust knobs A and C at each end of the band. This is done to make the indicator glow at normal brilliance and assures that the antenna coupling circuits can be tuned to resonance at each end of the band.

t. The alignment of the transmitter is now complete on BAND 1. The same procedure will be carried out for BANDS 2 and 3 using alignment frequencies of 6,100 kc and 3,600 kc for BAND 2 and 3,300 kc and 2,000 kc for BAND 3.

u. Remove the power cable as a safety measure.

v. Replace the transmitter in its case.

Note. Transmitter alignment without test equipment is virtually impossible. Never attempt to align the transmitter without a voltmeter.

Section VI. FINAL TESTING OF RECEIVER SECTION

160. General

Sections VI and VII are intended as a guide to be used in determining the quality of a repaired Radio Set AN/GRC-9-GY. The minimum test requirements outlined in paragraphs 163 through 188 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

161. Test Equipment Required for Final Testing of Receiver Section

The instruments needed for testing the repaired equipment are listed below:

a. Signal generator with a frequency range from 2 mc to 12 mc. It should be capable of producing a signal modulated 30 percent at 400 cycles. Signal Generator I-72-(*) is suitable.

b. A vacuum-tube microvoltmeter if there is none available in the signal generator. It should be capable of reading from 0 to 500 microvolts.

c. Output meter having a range of at least 90 mw (milliwatts) and should be sensitive enough to have one midscale reading for 10 mw. It also should have a 4,000-ohm input impedance.

162. Receiver Section Preliminary Adjustments

All receiver measurements are made under the test conditions listed below, unless otherwise indicated:

Dummy antenna	. .110 uuf
Standard output	. .10 mw or 6.3 volts in a 4,000-ohm noninductive load
Load impedance	. .4,000 ohms noninductive
Power ratio	. . . . .Signal-plus-noise to noise ratio (10:1)
Modulation	. . . . .30 percent at 400 cycles

Controls **O** and **P** . .Set at maximum

The signal generator is connected to the ANT. binding post on the transmitter through the dummy antenna specified above. The output

meter should be connected to one of the PHONES jacks. Then the receiver is tuned to resonance at each of the test frequencies. The transmitter control **C** is set at the approximate center of its range, and the antenna selector switch (control **A**) is set to WHIP position 1.

163. Sensitivity Test

a. GENERAL. Sensitivity test input is expressed in microvolts and is the least input signal which, when modulated 30 percent at 400 cycles and fed into the receiver, will produce the standard output of 10 mw with controls **O** and **P** at maximum settings. The test is conducted to give a signal-plus-noise ratio of 10 to 1. The sensitivity is measured at the following test frequencies:

Band	High	Medium	Low
1	12 mc	9.3 mc	6.6 mc
2	6.6 mc	5.1 mc	3.6 mc
3	3.6 mc	2.8 mc	2.0 mc

b. C-W SENSITIVITY TEST. The procedure is as follows:

- (1) Turn control **L** to C.W.
- (2) Adjust TUNING control **N** to the test frequency.
- (3) Set the signal generator to the same unmodulated test frequency.
- (4) Adjust the A. F. GAIN control **O** and the signal generator output control until the output meter reads 10 mw.
- (5) Detune the signal generator to at least 20 kc away from resonance and adjust the R. F. GAIN control **P** until the output meter reads 1 mw.
- (6) It is probable that when the signal generator is set again at the resonant frequency, the output meter no longer reads 10 mw. Readjust the volume controls until it has the correct reading.
- (7) Repeat steps 5 and 6 above until the condition is maintained where the output meter reads 10 mw with the signal generator on resonance and 1 mw with the generator detuned, for the same setting of receiver and signal generator volume controls.
- (8) The sensitivity is then the signal voltage input to the receiver when the out-

put meter records 10 mw after the conditions in step 7 is found.

c. **PHONE SENSITIVITY TEST.** The procedure is as follows:

- (1) Turn control **L** to **PHONE**.
- (2) Adjust **TUNING** control **N** to the test frequency.
- (3) Set the signal generator to the same frequency, modulated 30 percent at 400 cycles.
- (4) Adjust the **A. F. GAIN** control **O** and the signal generator output control until the output meter reads 10 mw.
- (5) Remove the modulation from the signal input and adjust the **R. F. GAIN** control **P** until the output meter reads 1 mw.
- (6) When the modulation is removed, the output is no longer 10 mw. Readjust the volume controls until it is 10 mw.
- (7) Repeat steps 5 and 6 above until the condition is maintained where the output meter reads 10 mw with the signal generator modulated and 1 mw with the generator unmodulated, for the same setting of receiver and generator volume controls.
- (8) The sensitivity is then the signal voltage input to the receiver when the output meter records 10 mw and when the condition in step 7 is found.

d. **SENSITIVITY VALUES.** For a receiver output of 10 mw at a signal-plus noise to noise ratio of 10, the sensitivity figure of the receiver should be not more than 3 microvolts for c-w reception, and not more than 10 microvolts for phone reception.

164. Selectivity Test

The selectivity test gives an indication of the shape of the bandwidth or band-pass characteristics of the tuned circuits in the receiver. The selectivity is measured at 6,600 kc (BAND 2).

a. The signal generator is set at 6,600 kc, modulated 30 percent at 400 cycles, and has an initial input of 10 microvolts.

b. Receiver volume controls **O** and **P** are adjusted so that a 10-mw output is indicated

on the output meter. These controls are not changed for the remainder of the test.

c. The input voltage from the signal generator is successively increased to 2, 10, 100, and 1,000 times its initial value and, at each value of signal strength, the signal generator is detuned on each side of 6,600 kc so that the receiver will produce exactly a 10-mw output.

d. The selectivity of the receiver is within the following limits, using the above steps.

Signal generator input	Total bandwidth (kc)	
	Minimum*	Maximum
2 x initial setting	3.5	—
10 x initial setting	—	12
100 x initial setting	—	20
1000 x initial setting	—	30

*Minimum indicates that for a signal generator input of 2 x initial setting there should not be less than 3.5 kc between the two points (on either side of 6,600 kc) at which the power output will be equal to the 10-mw prevailing at the initial input of 10 microvolts.

165. Image Frequency Rejection Ratio

This is defined as the ratio of signal input voltage at the image frequency to the signal input voltage required at the desired frequency, with the receiver power output being the same for both frequencies. The image frequency rejection ratios for the receiver should be—

Band	Ratio
1	Greater than 50 to 1
2	Greater than 250 to 1
3	Greater than 1000 to 1

The image frequency rejection ratio is determined at the high, middle, and low end of each band. Proceed as follows:

a. Set the output voltage of the signal generator at 10 microvolts with a 400-cycle signal modulated 30 percent.

b. The receiver volume controls are adjusted to produce a 10-mw output indication on the output meter.

c. Tune the signal generator to the image frequency of the resonant frequency to which the receiver **TUNING** control **N** is set. The image frequency is 912 kc plus the resonant frequency. Image ratio is obtained by dividing the microvolts necessary to procedure a 10-mw output at image frequency (912 kc plus resonant frequency) by the microvolts required for the same 10-mw output at the resonant frequency, the volume control being in the same position for the two measurements.

166. I-f Rejection Ratio

The i-f rejection ratio should be greater than 100 db at all frequencies within the 2 mc to 12 mc bandwidth of the receiver. It is measured at the low end of each band, 2 mc, 3.6 mc, and 6.6 mc. The input voltage of the signal generator is 10 microvolts at resonance. The receiver volume controls are adjusted to produce 10-mw output. The ratio is obtained by dividing the microvolts necessary to produce 10-mw output at the i.f. (456 kc), by the microvolts required for the same output at the resonant frequency, the receiver volume controls being in the same position for the two measurements.

167. A-f Output

a. The maximum power output of the receiver should not be less than 90 mw at all frequencies from 250 to 2,500 cps (cycles per second) for both 250- and 4,000-ohm output impedances. Also, for these impedances, the maximum undistorted output (less than 10 percent distortion) should be not less than 75 mw at all frequencies from 250 to 2,500 cps.

b. The input level of the test signal is set to 500 microvolts at 5,100 kc modulated at 30 percent, and the receiver is tuned to resonance. The af is varied, and receiver volume control O is adjusted to maximum undistorted output at each af. Maximum undistorted power output is defined as the maximum power output which contains less than 10 percent total harmonic distortion (root-mean-square voltage).

168. Audio Fidelity

a. With both 250- and 4,000-ohm output impedances, the maximum undistorted output at all frequencies from 250 to 2,500 cps should be within +2 db or -5 db (decibel) of the output at 400 cps.

b. The input level of the test signal is set to 500 microvolts at 6,600 kc (BAND 2) and modulated at 30 percent at 400 cps. The receiver is tuned to 6,600 kc and the receiver volume controls are set to produce an output meter reading of 10 mw. The volume controls should not be touched for the remainder of the test. The a-m frequency is varied, while the modulation remains at 30 percent for all modulation frequencies.

169. Calibration Accuracy

a. The dial calibration should be accurate to within 30 kc on BANDS 2 and 3 and 50 kc on BAND 1.

b. The calibration accuracy of the receiver is checked at 200-kc intervals over the entire frequency range of each band, starting at 2,000 kc. The dial is turned in the direction of the increasing frequency for each check point.

c. See paragraph 48 for calibration operation.

170. Crystal Calibrator Circuit

a. With the receiver set to CAL. and the volume controls set at maximum, the power output of the receiver is measured at each crystal check point as the receiver is tuned through the entire frequency range. The power output indicated by the output meter should be a minimum of 10 mw.

b. The crystal calibrator oscillator circuit should have an accuracy of plus or minus 20 cps at 200 kc when using standard Crystal Unit CR-2/U-GY which is calibrated to plus or minus 18 cps.

c. The spurious response should have a rejection ratio of more than 27 db compared to the crystal check points on either side of the particular spurious response. With the receiver set to CAL. and volume controls set to maximum, the receiver is tuned over the entire range and spurious responses are noted. The receiver is tuned to the weaker of the crystal check points on either side of each spurious response, and the R. F. GAIN control P is reduced so that the receiver output is 50 mw. The receiver then is tuned to the spurious response without disturbance of the volume control. The spurious response power output reading should be less than .1 mw.

171. Beat Frequency Oscillator

The bfo is checked at 6,600 kc (BAND 2). The volume controls are adjusted to produce an output of 50 mw at a signal input of 500 microvolts when left in this position. Using Headset HS-30-(*), the audible beat note is distinct, without slurring as the signal input voltage is increased to 500 millivolts.

172. Resettability

The resettability is a measure of the backlash in the tuning gears. The resettability is checked at the h-f end of each band. Each test frequency is approached from the clockwise and counter clockwise directions, and the difference in readings is recorded. There should not be more than 5 kc difference in the dial reading when the test frequency is approached from the clockwise and counterclockwise directions.

173. Spurious Responses

Spurious responses caused by harmonics of the h-f oscillator and bfo should have a rejection ratio of more than 50 db over the entire tuning range. Spurious responses are measured at the h-f end of each band. With 10 microvolts input at the receiver signal frequency, the volume control is adjusted to give a 10-mw output. The input is then adjusted to 10,000 microvolts, and the signal generator frequency is adjusted over the frequency range of plus or minus 2 mc of the test frequencies. If spurious responses are encountered, the input should be reduced to give an output of 10-mw. The voltage ratio of this input to the resonant frequency input is recorded as the spurious response ratio.

174. Current Drain

The receiver current drain is measured with the receiver set for c-w operation, using a 0- to 50-ma meter in series with the B supply and a 0- to 1-ampere meter in series with the A supply. At 105 volts and 1.4 volts input, the B drain

should be less than 20 ma and the A drain should be less than 500 ma, respectively, under conditions of maximum current consumption.

175. Sidetone

The receiver should provide clear monitoring when the transmitter is operating on C.W. or MCW or PHONE. With the SIDE TONE VOL. control G set at maximum, the sidetone output at the receiver jack should be a minimum of 10 mw.

176. Receiver Section Tests at Reduced D-c Supply Voltage Input

a. SENSITIVITY. With a 1.2-volt filament voltage, a plate voltage of 75 volts and an output of 10 mw, the sensitivity should be not less than 50 microvolts for voice reception and not less than 25 microvolts for c-w reception.

b. CALIBRATOR OUTPUT. The crystal calibrator output under l-v conditions are measured by use of headphones at the receiver output jacks. With 1.2 volts filament voltage and a plate voltage of 75 volts, the calibrator output should be audible over the frequency range within two consecutive crystal check points.

c. FILAMENT VOLTAGE REGULATION. The filament voltage is measured at a tube socket when operating the filaments through a 10.6-ohm dropping resistor in series with a 6-volt source and an 8-volt source in turn. The filament voltage should be greater than 1.2 volts for a 6-volt source and less than 1.7 volts for an 8-volt source.

Section VII. FINAL TESTING OF TRANSMITTER SECTION

177. Test Equipment Required for Final Testing Transmitter Section

The instruments needed for final testing of the transmitter are listed below:

R-f meter . . . . .	.0 to 2 amperes
D-c voltmeter	20,000 ohms per volt
Oscilloscope	BC-1060-(*)
Test Set	TS-505/U
Frequency Meter	SCR-211-(*)

178. Transmitter Section, Preliminary Adjustments

Unless otherwise specified, all transmitter measurements are made under the following test conditions:

a. Dummy antenna: Use a 20-ohm noninductive resistor in series with a 70-uuf capacitor and 0- to 2-ampere r-f meter. This is equivalent to a 15-foot whip antenna. Connect the meter end to the chassis or ground side.

Note. A 5,400-ohm noninductive resistor is equivalent to a half-wave antenna (control A in REEL position).

b. Control D is set to PHONE-HI position unless otherwise stated.

179. Power Output

With input voltages of 6.3 volts filament and 500 and 425 plate voltages at the POWER receptacle, the power outputs should not be less

than those listed in the table below. The ANTENNA TUNING control C is adjusted to maximum meter deflection for each frequency. The power output is: (ANTENNA CURRENT) (20 ohms). The input power to the transmitter is obtained by measuring the total d-c plate and screen currents of the p-a tube. The input power to the transmitter should be less than the input powers listed in the following table.

Operating voltages	Plate and screen input power (watts)	Position of control D	Tower output (watts)	Frequency (kc)	Frequency band
500	100	CW HI	7	2,000	3
500	80	PHONE HI	2	2,000	3
500	70	CW LO	3	2,000	3
500	50	PHONE LO	.3	2,000	3
500	100	CW HI	12	3,600	3
500	80	PHONE HI	3	3,600	3
500	100	PHONE HI	10	3,600	2
500	80	CW HI	3.5	3,600	2
500	100	PHONE HI	12	6,600	2
500	80	CW HI	3	6,600	2
500	100	PHONE HI	7.5	6,600	1
500	80	CW HI	3	6,600	1
500	100	PHONE HI	12	12,000	1
500	80	CW HI	5	12,000	1
425	60	CW LO	2	2,000	3
425	40	PHONE LO	.2	2,000	3

180. Microphone Input Voltage

In phone operation for audio-modulation frequencies between 250 and 3,000 cps, 100 percent modulation should be obtained for an input of less than .5 volt to the primary of microphone transformer T112.

181. Mcw Operation

a. The frequency of the modulating tone in mcw operation should be between 600 and 850 cps. The transmitter should be modulated from 70 to 100 percent.

b. The transmitter is set up for normal operation and the sidetone control is adjusted for maximum output. The percentage of modulation, as viewed on an oscilloscope, is checked for both high and low power mcw operation at 8 mc.

182. Netting Operation

a. At all frequencies in the range of the transmitter, it should be capable of netting

with another radio transmitter within plus or minus 1,000 cps.

b. The transmitter is set up for high-power, mo, and c-w operation (HI-MO-CW). The receiver of the radio set is zero-beat to a frequency meter adjusted to 12 mc. The transmitter then is adjusted to zero beat with the receiver in the NET position. Then the transmitter is set to normal c-w operation and the frequency of the beat note in the frequency meter should be checked.

183. Overload Relay K102

a. The overload relay in the p-a circuit should open during crystal operation when mistuning of FREQ. CONTROL I exceeds 7 percent of the operating frequency. The overload relay should cut out before the grid voltage drops below 10 volts.

b. The transmitter is set up for CW-HI-XTAL operation for frequencies in the middle of each band. The transmitter tuning dial is set to the crystal frequency, and is tuned above

and below until the overload relay opens. The dial readings and the p-a grid voltage should be recorded.

184. Metering Socket Readings

a. The transmitter is set for high-power, mo, and c-w operation with a 20-ohm, 70-uuf dummy antenna load on the antenna circuit. The plate

supply should be adjusted to 500 volts and the filament supply to 6.3 volts. The antenna circuit should be resonated, and the voltages at the metering socket should be recorded for c-w operation. The measurements are made by using a 20,000-ohm per volt d-c meter. Plate current (with no load) measurements are made with the dummy antenna removed.

b. The following readings should be obtained:

Metering socket pins		Circuit	Value
1+	7—	P.A. filament voltage	+6.3 volts
2+	7—	P.A. plate voltage	+500 volts
2—	8—	P.A. plate current (loaded)	BANDS 1, 2, and 3, 110 ma; maximum
		P.A. plate current (unloaded)	Less than 30 ma on all bands
3+	7—	P.A. screen grid voltage	275 volts maximum on all bands
4+	7—	P.A. suppressor grid bias-CW	+6.3 volts
4—	7+	P.A. suppressor grid bias-PHONE	—40 volts
5—	7+	P.A. signal grid bias	—45 to —70 volts
6+	7—	Master oscillator plate voltage	+105 volts
		Modulator plate voltage	
7+	7+	Terminal 7 is grounded to the transmitter chassis...	0 volt

185. Keying

It should be possible to key the transmitter at speeds up to 25 words per minute either in the MO or XTAL position of control F.

186. Frequency Stability Versus Input Voltage

a. The transmitter is connected to the dummy antenna and is fully loaded for high-power c-w operation.

b. The transmitter is tuned to 12,000 kc and is allowed to warm up for 5 minutes at input voltages of 5.4 and 400 volts. The frequency is checked by a frequency meter and the transmitter is set to zero beat with the frequency meter. The supply voltages are increased to 7.5 and 700 volts. The frequency meter is then zeroed to the transmitter. The difference in readings is considered the drift.

c. The frequency drift of the mo should not exceed .02 percent for a variation from 5.4 volts filament and 400 volts plate to 7.5 volts filament and 700 volts plate.

187. Dynamotor-Power Supply DY-88/GRC-9-GY, Voltage Output Test

With a 6-, 12-, or 24-volt battery connected to the input of the dynamotor power supply, the voltage outputs are as follows:

Terminals (ground)	Circuit	Value in volts
20 to 24	Transmitter filaments	6.5
21 to 24	Receiver plates (SEND)	105
22 to 24	Receiver filaments	1.5
23 to 24	Receiver filaments	1.5
32 to 24	Transmitter plates	580
33 to 24	Receiver plates (STANDBY)	105
34 to 24	Keying relay K101	6.9

Note. These measurements are made at output receptacle J202 (fig. 111) with the receiver-transmitter connected to the dynamotor power supply. The terminals on J202 are numbered (fig. 111). Figure 127.

188. Generator GN-58-A-GY, Voltage Output Test

With the hand generator being driven at approximately 60 rpm, the voltage outputs should be the same as those given in the VOLTAGE CHART on the main schematic diagram (fig. 124). Refer to paragraph 138 for disassembly of the generator so that it may be checked under load.