

NAVSHIPS 91457(A)

INSTRUCTION BOOK

for

RADIO TRANSMITTING SET
AN/FRT-5A

FEDERAL TELEPHONE AND RADIO CORPORATION

CLIFTON, NEW JERSEY

U. S. A.

BUREAU OF SHIPS

NAVY DEPARTMENT

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From: Chief, Bureau of Ships
To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Radio Transmitting Set AN/FRT-5A, NAVSHIPS 91457(A)

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H. N. WALLIN
Chief of Bureau

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GUARANTEE

The equipment, including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f. o. b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten percent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred percent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

INSTALLATION RECORD

Contract Number NObsr-49171

Date of Contract, 24 May 1950

Serial Number of equipment.....*Date of acceptance by the Navy*.....*Date of delivery to contract destination*.....*Date of completion of installation*.....*Date placed in service*.....

Blank spaces on this page shall be filled in at time of installation.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations using form NAVSHIPS NBS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures see Chapter 67 of the *Bureau of Ships Manual* or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Standard Navy stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of the *Bureau of Ships Manual* or superseding instructions on the subject of radio-safety precautions to be observed.

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

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

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casual-

ties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

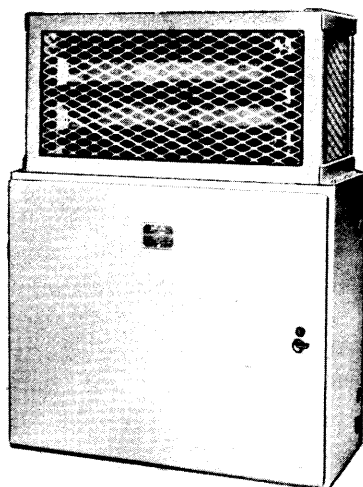
Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS:

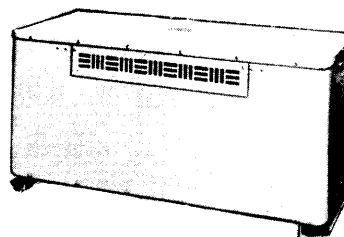
Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

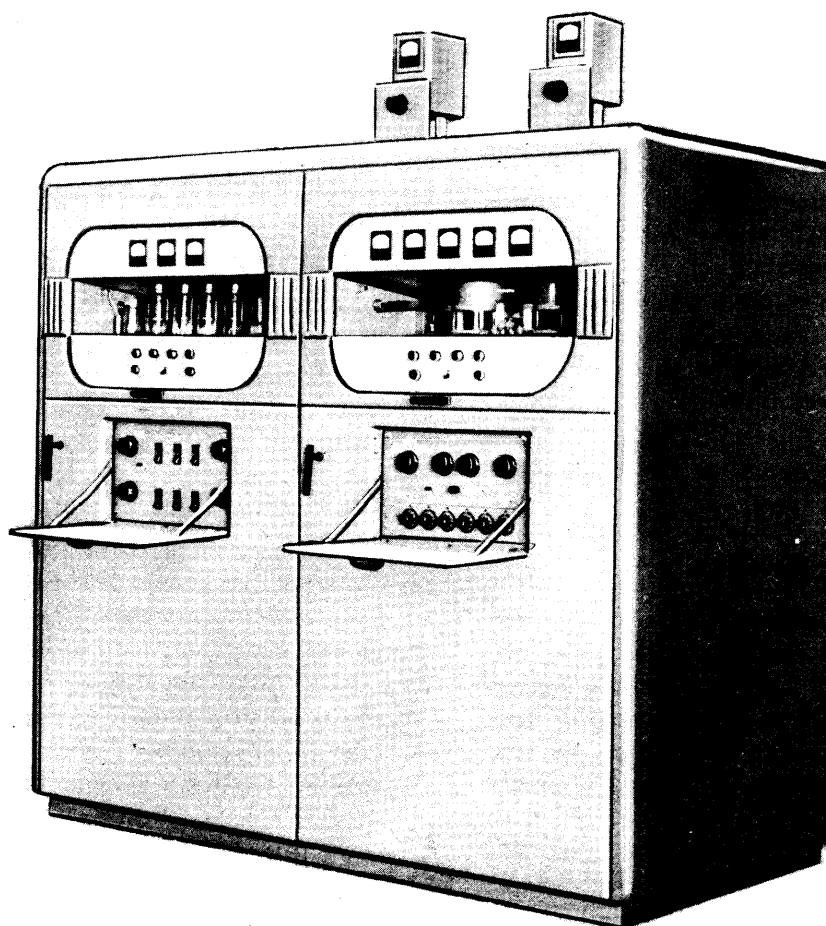
AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.



TRANSFORMER TF-122/U



POWER CONTROL C-587A/FRT-5



POWER SUPPLY
PP-490A/FRT-5

RF UNIT
T-225A/FRT-5

Figure 1-1. Frontispiece — Radio Transmitting Set AN/FRT-5A, Major Units

TABLE 1-1. EQUIPMENT SUPPLIED

QUAN- TITY PER EQUIP- MENT	NAME OF UNIT	DESIGNATION	OVERALL DIMENSIONS			VOLUME	WEIGHT
			Height	Width	Depth		
1	RF Unit	T-225A/FRT-5	91½	46⅝	37½	92.5	1942
1	Power Supply	PP-490A/FRT-5	91½	46⅝	37½	92.5	1780
1	RF Oscillator	O-92A/FRT-5	5¼	19	12	6.9	15
1	RF Oscillator	O-91A/FRT-5	10½	19	15⅝	1.7	35
1	Frequency Shift Keyer	KY-45A/FRT-5	10½	19	15⅝	1.7	29
1	Power Supply	PP-454A/FRT-5	8¾	19	15⅝	1.5	85
1	Power Transformer	TF-122/U	18½	36½	14¾	5.8	560
1	Power Control	C-587A/FRT-5	38¼	30¼	14¼	9.6	273
2	Instruction Book	NAVSHIPS 91457(A)	11	8½	1⅝	0.061	—

TABLE 1-2. EQUIPMENT AND PUBLICATIONS REQUIRED, BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NAVY TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	230-volt line	—	Operation of AN/FRT-5A	3-phase, 60-cps
1	115-volt line	—	Operation of ovens	Single-phase, 60-cps

NOTE: Unless otherwise stated, all dimensions are in inches, volumes in cubic feet and weights in pounds.

TABLE 1-3. SHIPPING DATA

SHIPPING BOX NO.	CONTENTS		OVERALL DIMENSIONS			VOLUME	WEIGHT
	NAME	DESIGNATION	Height	Width	Depth		
1	RF Unit	T-225A/FRT-5	93	62	59	197.0	3130
2	Power Supply	PP-490A/FRT-5	93	62	59	197.0	3150
3	Power Transformer	TF-122/U	47	25	29	20.0	790
4	Power Control	C-587A/FRT-5	54	44	24	33.0	496
5	Side Covers (2 units)	—	85	41	16	33.0	416
6	Top Covers	—	48	41	13	15.0	220
7	Capacitors & Xtal Oven	—	61	26	26	24.0	178
8	Accessories & SSB Conversion Kit	—	40	24	15	9.0	100
9	Tubes and Instr. Bks.	Tubes per list, & Navships 91457(A)	61	26	26	24.0	158
10	Installation Material	—	125	19	13	18.0	236
11	Spare Parts Chest #1	—	18	47	19	9.3	198
12	Spare Parts Chest #2	—	18	47	19	9.3	180
13	Spare Parts Chest #3	—	18	47	19	9.3	110

NOTE: Unless otherwise stated, all dimensions are in inches, volumes in cubic feet and weights in pounds.

TABLE 1-4. ELECTRON TUBE COMPLEMENT — QUANTITIES OF TUBES USED,
BY TUBE TYPES AND BY MAJOR UNITS

UNIT	TUBE TYPES																							T tal Number f Tubes
	2C51	3X2500A3	4-400A	5686	6AS6	6AK5	6AK5W	6BE6	6BA6	6AL5	6AL5W	6SJ7	6X4	6AG7	807	12AU7	12AX7	6C4	3B28	4B32	5R4GY	OA2	OB-3/VR-90	
RF Unit T-225A/FRT-5		2	1										5	1	2	7	6							24
Power Supply PP-490A/FRT-5																		4	6					10
RF Oscillator O-92A/FRT-5						1								1									2	4
RF Oscillator O-91A/FRT-5	8			5	1	8		4	1	2		2												31
Freq. Shift Keyer KY-45A/FRT-5							1	2	3		2				1	1	1	1						12
Power Supply PP-454A/FRT-5													1								3	2		6
Total Number of Each Type	8	2	1	5	1	9	1	6	4	2	2	2	6	2	3	8	7	1	4	6	3	2	2	87

SECTION 1 GENERAL DESCRIPTION

1. PURPOSE.

Radio Transmitting Set AN/FRT-5A, figure 1-1, is designed for shore-based communication service. The set is capable of providing an output of 15 kilowatts of continuous-wave radio-telegraph, frequency-shift-telegraph, or facsimile transmission on any frequency from 4.0 to 26.0 mc. The principal function of the equipment is to ~~effect~~ communication with reliability and precision from shore-to-ship or point-to-point. Due to its high r-f power output, the transmitter is intended primarily as a means of transmitting intelligence over long and difficult circuits.

2. BASIC PRINCIPLES OF OPERATION.

Operation of Radio Transmitting Set AN/FRT-5A is based upon the principle of generating, at an exact sub-multiple of the desired output frequency, a low energy radio-frequency signal, then multiplying the frequency, and amplifying the power of this signal to produce the desired radio-frequency carrier. This carrier is then interrupted, or the frequency shifted, in accordance with the intelligence to be transmitted. The resultant radio-frequency energy is then radiated from a suitable antenna.

The required low energy excitation is derived from one of two alternate exciter units incorporated within the transmitter, which may be further augmented by a frequency-shift keyer. These two units are RF Oscillator O-91A/FRT-5, which is a stabilized master oscillator, and RF Oscillator O-92A/FRT-5, which is a 10-channel crystal-controlled oscillator. This low energy signal is then passed through a buffer stage and thence into two frequency multiplier stages where the frequency of the signal is multiplied by a factor of 2, 4, 6, or 8. Following the two multiplier stages, the signal power is amplified to 15 kw in a power amplifier stage. The intelligence may be superimposed on the carrier wave in one of two ways, viz, off-on keying or frequency-shift keying. The former is produced by interrupting the carrier in the low energy buffer and 1st multiplier stages. Frequency-shift keying is accomplished by passing the signal through a frequency-shift keyer prior to its entering the buffer amplifier. The frequency-shift keyer then shifts the carrier frequency a small amount, linearly with respect to the keying signal.

Protection for operating and maintenance personnel, as well as protection against equipment damage caused by overloads or other normal equipment faults, is as complete as is possible with existing design methods.

3. GENERAL DESCRIPTION OF UNITS.

a. INTRODUCTION. — Radio Transmitting Set AN/FRT-5A is contained within two handsomely styled sheet metal cabinets, which bolt together to form a single unit, figure 1-2. In addition, there are two small sheet metal enclosures which house the required power transformer and the control unit.

Several features, new and unique to equipment of this power class, have made this a compact yet easily serviced equipment. A pair of medium power triodes is used in the power amplifier stage. The anode voltage requirements of this tube are relatively low, thereby allowing the use of intermediate voltage rectifier tubes and smaller-than-usual filter and power supply components. The tubes and tank circuit components are forced air cooled, thereby eliminating the customary bulky water cooling system.

The externally mounted plate transformer is of the dry type, air cooled and fully enclosed in a grounded sheet metal case. Connecting leads are brought in through grounded conduit and connected internally, thus eliminating the usual requirement for additional protective enclosures. The high current primary circuit is fed directly to the plate transformer through the external control unit, thereby eliminating the space and service problems presented by large high current wiring and control components located within the main enclosure.

All resonant circuits are continuously variable, motor driven, and servo positioned, thus eliminating the usual complication of switching or shorting and awkward mechanical drives. Servo positioning allows the controls to be grouped at a convenient and logical location while the resonant circuits are placed where it best suits the requirements of the electrical circuit and the mechanical design.

The upper front door of each cabinet has a large glass window which affords a continuous view of all of the tubes contained within the bay. The upper front door itself provides access to all of the tubes within the bay, as well as some of the adjustment controls not directly associated with tuning. These doors are hinged

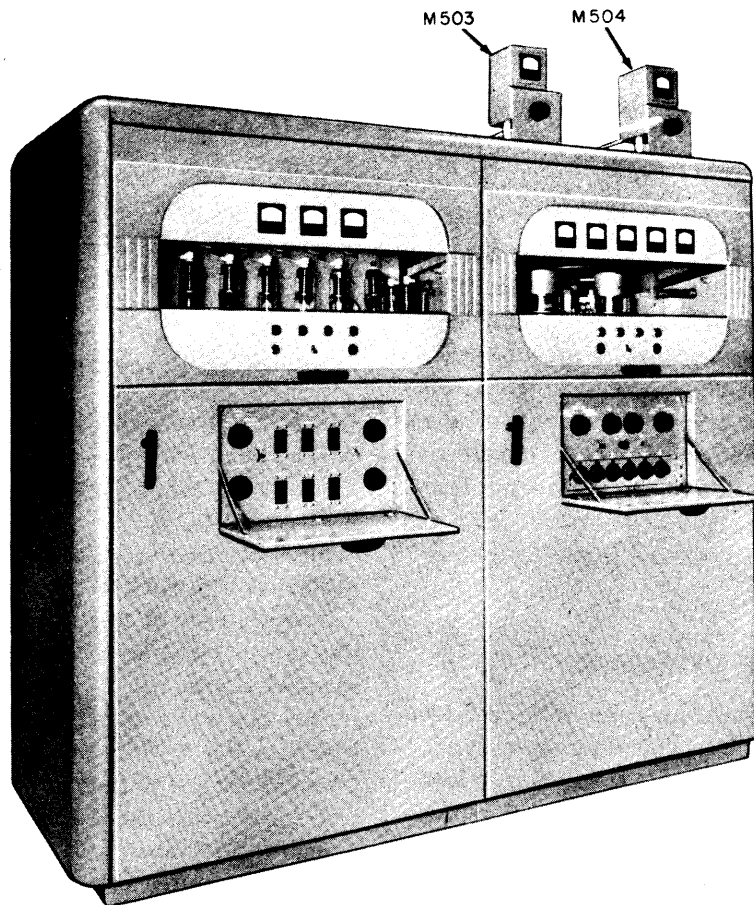


Figure 1-2. Radio Transmitting Set AN/FRT-5A, Front View

at the top and are counterbalanced for ease of operation. They are further provided with dual interlocks, one group electrical and the other mechanical in nature, which remove all dangerous voltages and ground the high potential circuits as soon as a door is opened. Status lights, illuminated meters, and the main control switches are mounted in these upper doors. Identical interlocks are also provided on the large double rear doors. All interlocks for all the units are wired in series so that opening any door immediately removes the high voltage from the circuits in all of the bays. The cabinets each have a non-interlocked lower front door which provides access to the control relays and timers and several infrequently used controls. The lower door of each bay also contains a small drop door which permits access to the control panel for that bay without opening the lower door.

b. LIST OF UNITS. — Radio Transmitting Set AN/FRT-5A may be thought of as consisting of the following major and minor units:

- (1) RF Unit T-225A/FRT-5, which contains:
 - (a) RF Oscillator O-91A/FRT-5
 - (b) RF Oscillator O-92A/FRT-5
 - (c) Frequency Shift Keyer KY-45A/FRT-5
 - (d) Power Supply PP-454A/FRT-5
 - (e) Servo amplifiers
 - (f) Servo power supply
 - (g) Patch panel
 - (h) Electronic keyer
 - (i) Control panel
 - (j) Buffer amplifier, frequency multipliers, and driver amplifier
 - (k) Power amplifier
 - (l) Coupling network
- (2) Power Supply PP-490A/FRT-5, which contains:
 - (a) Control circuits
 - (b) Low voltage supply
 - (c) High voltage supply
 - (d) Bias voltage supply

**GENERAL
DESCRIPTION**

**NAVSHIPS 91457(A)
AN/FRT-5A**

**Section 1
Paragraph 3 c**

c. MAJOR AND MINOR UNITS DETAILS. — In more detail, the major and minor units of Radio Transmitting Set AN/FRT-5A consist of the following:

(1) RF UNIT T-225A/FRT-5. — RF Unit T-225A/FRT-5 is the right-hand one of the two main bays. It contains, on a special mounting space, the units described under paragraphs (a), (b), (c), (d), (e), (f), and (g) below. This space is a pivoted, double-width, 25-inch high standard equipment rack. Pivoting this rack provides easy access to the rear of all the units mounted thereon. RF Unit T-225A/FRT-5 contains as permanent equipment the circuits and units described under paragraphs (b), (i), (j), (k), (l) and (m).

(a) RF OSCILLATOR O-91A/FRT-5. — (Refer to figure 1-3.) — RF Oscillator O-91A/FRT-5 is a stabilized variable-frequency oscillator which derives

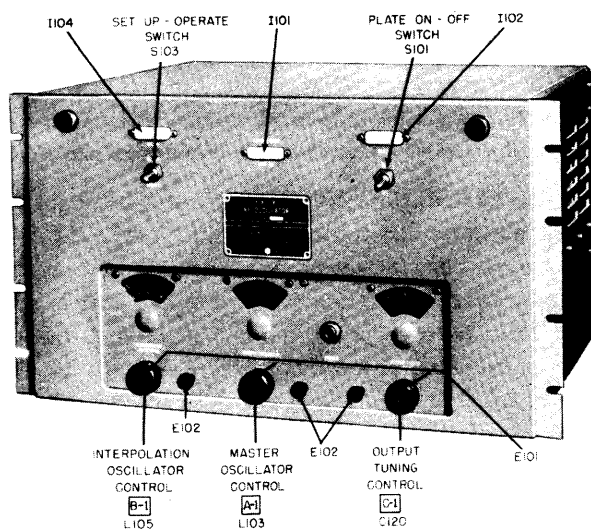


Figure 1-3. RF Oscillator O-91A/FRT-5, Front View

its stability from a 100-kc crystal standard. Utilizing a permeability tuned oscillator, it provides a frequency stabilized output in the range of 2-4.5 mc. It is mounted in the equipment rack which occupies the lower part of the r-f bay. Refer to table 1-1 for dimensions.

(b) RF OSCILLATOR O-92A/FRT-5. — (Refer to figure 1-4.) — RF Oscillator O-92A/FRT-5 is a crystal-controlled 10-channel oscillator. With proper crystals, the oscillator provides an output frequency of from 2-4.3 mc. Plate and filament voltages for this unit are derived from the main transmitter. It is mounted in the equipment rack of the r-f bay. Refer to table 1-1 for dimensions.

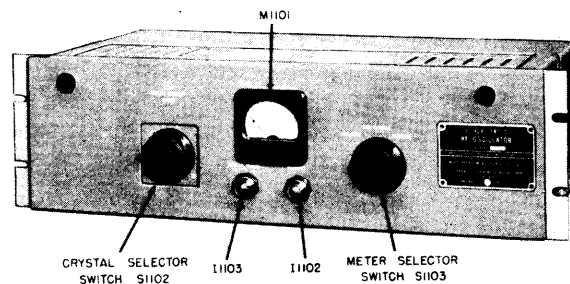


Figure 1-4. RF Oscillator O-92A/FRT-5, Front View

(c) FREQUENCY SHIFT KEYER KY-45A/FRT-5. — (Refer to figure 1-5.) — Frequency Shift Keyer KY-45A/FRT-5 is used to provide a frequency shift which is linear with respect to the keying voltage. In a telegraph system, it causes the transmitter to emit one frequency for a "mark" signal and another for a "space" signal. Because of its linearity with respect to the keying voltage or current, it may also be used for "photo" and teleprinter transmission. This unit is mounted in the equipment rack of the r-f bay. Refer to table 1-1 for dimensions.

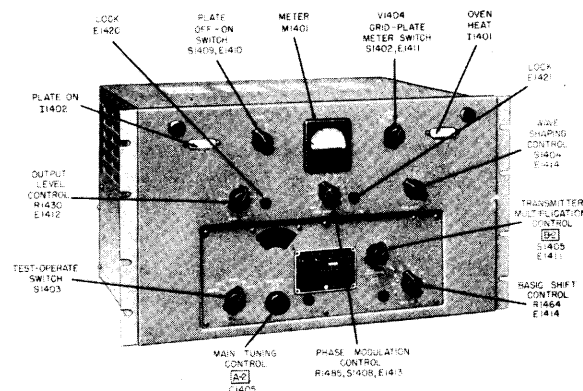
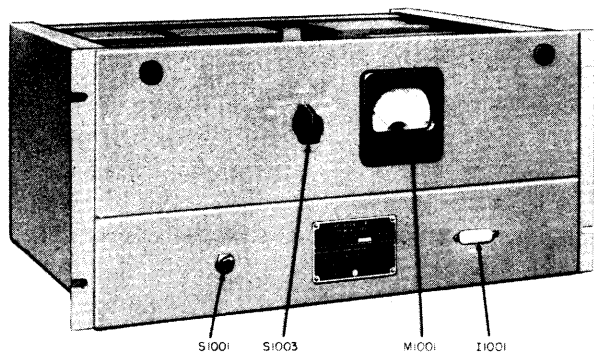


Figure 1-5. Frequency Shift Keyer KY-45A/FRT-5, Front View

(d) POWER SUPPLY PP-454A/FRT-5. — (Refer to figure 1-6.) — Power Supply PP-454A/FRT-5 is a dual supply furnishing plate and filament voltages to RF Oscillator O-91A/FRT-5 and Frequency Shift Keyer KY-45A/FRT-5. It also supplies a regulated bias to the keyer. It is mounted in the equipment rack of the r-f bay. Refer to table 1-1 for dimensions.

(e) SERVO AMPLIFIERS. — There are six identical interchangeable, plug-in servo control amplifiers mounted in a common enclosure on the equipment rack in the r-f bay. One of these units is associated with each of the six tuned servo-positioned circuits in

RF Unit T-225A/FRT-5. Each contains a voltage amplifier, a relay control tube, and a pair of motor-control relays.



Figur 1-6. Power Supply PP-454A/FRT-5, Front View

(f) SERVO POWER SUPPLY. — The servo power supply furnishes voltage to all of the servo amplifiers, and drive motors located in RF Unit T-225A/FRT-5. It is mounted on the lower left side of the equipment rack, immediately below the servo amplifier unit.

(g) PATCH PANEL. — The remaining unit in the equipment rack is the patch panel which contains the two oscillator output jacks, the keyer input and output jacks, the transmitter input jack and several spare jacks. Three cables with connectors on each end are supplied with the unit to facilitate setting up any desired type of excitation and keying.

(h) ELECTRONIC KEYER. — An electronic keyer is mounted on the right side of the control panel of RF Unit T-225A/FRT-5. It receives the keying impulses and accomplishes off-on keying of the transmitter proper. Provision has been made for keying of the transmitter by negative, positive, polar negative, or polar positive impulses for "mark."

(i) CONTROL PANEL. — The control panel carries the basic transmitter tuning and checking controls and is located behind the lower front door. Easy access to these controls is provided, however, by a small drop door located at the top center of the main lower door.

(j) BUFFER AMPLIFIER, FREQUENCY MULTIPLIERS, AND DRIVER AMPLIFIERS. — The buffer amplifier, frequency multipliers, and driver unit are contained within a subassembly which is mounted to the left of the control panel. The unit is hinged so that it may be tilted forward for easy access to the interior. Inside are located a broad-band buffer-

amplifier, and two frequency-multiplier stages. The driver tube is mounted on top of the assembly.

(k) POWER AMPLIFIER. — The power amplifier is located on the top deck of RF Unit T-225A/FRT-5. It is a push-pull, cross-neutralized, grounded-cathode amplifier with both grid and plate circuits resonant and continuously variable from 4 mc to 26 mc. The resonant grid circuit, which also provides the plate tank for the driver stage, is contained within an airtight enclosure located behind the control panel. The PA tube sockets are mounted on top of this enclosure. Cooling air for these tubes is forced into this enclosure by the blower in the lower rear of the cabinet, and flows upward through the tube sockets to cool the tube radiators. The resonant plate tank circuit is located directly behind the PA tubes and is readily accessible through the large double rear doors.

An alternate provision is made for operating the power amplifier as a linear amplifier driven by a single side-band suppressed-carrier exciter such as the Western Electric D-156000 twin-channel unit. The grid circuit of the power amplifier is arranged to be modified so that it presents a 200-ohm balanced load to the exciting single side-band transmitter. Approximately 500 watts of peak exciting power are required.

(l) COUPLING NETWORK. — The coupling network occupies the top of RF Unit T-225A/FRT-5. It is a resonant circuit continuously variable across the entire frequency range, and the complete unit is suspended from the top of the cabinet on rails or tracks. Magnetic coupling from the plate tank coils to the inductors of this coupling network is varied by the positioning of the coupler on its rails.

(m) GENERAL. — The upper front door of RF Unit T-225A/FRT-5 has a large glass window to provide continuous visibility of the PA tubes. All meters directly associated with tuning or adjusting the r-f stages in the bay are mounted above the window. The filament and d-c controls and the colored status lights are located below the window on the upper front door. A ventilating blower cooling the PA tubes is located on the floor of the unit. Dual interlocks for personnel protection are incorporated on all but the lower front door.

(2) POWER SUPPLY PP-490A/FRT-5. — Power Supply PP-490A/FRT-5 consists of the left-hand bay of Radio Transmitting Set AN/FRT-5A. It contains the following units and circuits:

(a) CONTROL CIRCUITS. — A vertical panel inside the lower front door of Power Supply PP-490A/FRT-5 mounts all of the control, overload and timer

relays which are associated with both Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5. The lower front door is not interlocked and may be opened at any time without exposing open or unguarded circuits. A small drop panel on this door provides convenient access to the controls most often used in connection with Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5.

(b) **LOW VOLTAGE SUPPLY.** — A d-c potential of 600 volts, positive to ground, for the operation of the frequency multiplier and buffer stages, the driver screen, and RF Oscillator O-92A/FRT-5 is provided by a common low voltage supply. The two type 3B28 xenon-gas-filled rectifier tubes used in this supply are grouped at the end of the rectifier shelf in Power Supply PP-490A/FRT-5.

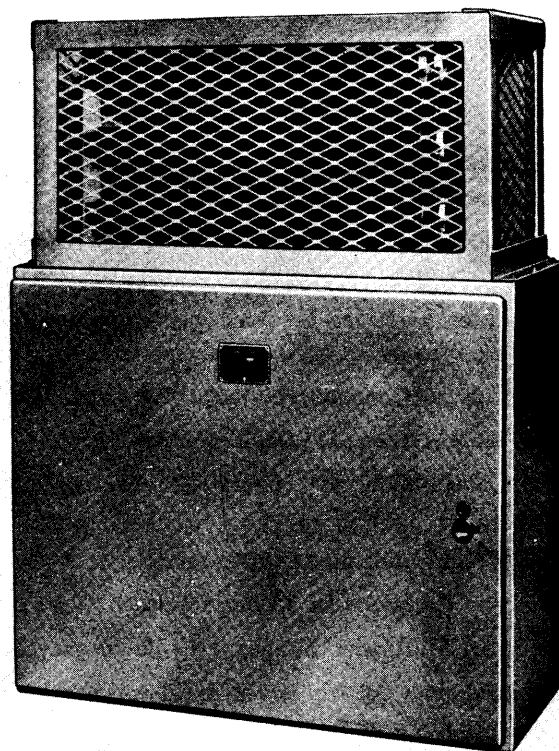
(c) **BIAS SUPPLY.** — A d-c potential of 400 volts, negative to ground, for biasing the frequency multipliers, the driver, the power amplifier, and the off-on keyer is provided by a common supply located in Power Supply PP-490A/FRT-5.

(d) **HIGH VOLTAGE SUPPLY.** — The six type 4B32 tubes mounted on the tube shelf are rectifiers for the power amplifier plate voltage supply. The high voltage transformer for this supply is mounted outside of the unit. The filter components are located on the floor of the bay and are readily accessible through the large double rear doors.

(e) **GENERAL.** — The upper front door with its large window provides access to and continuous visibility of the rectifier tubes. Meters associated with the high d-c voltage, the primary a-c voltage and the filaments of the PA stage are located above the window. Status lights and controls are mounted below the window. A blower for circulating air in the power bay is mounted on the floor of the unit and is readily accessible through the rear doors. No special cooling is required for the rectifiers since they contain the inert gas xenon and hence can operate efficiently and properly in spite of extremely wide temperature variations. All doors except the lower front one are provided with dual interlocks for the protection of personnel.

(3) **POWER CONTROL C-587A/FRT-5.** — (Refer to figure 1-7.) — Power Control C-587A/FRT-5 includes the line input terminals for the 230-volt power supplying all parts of the transmitter, except high voltage plate supply transformer T1701. It consists of a heavy-gauge sheet-metal cabinet with a large front access door, and includes the following components: a fused three-phase circuit to the transmitter for

filaments, blowers, etc., a combination overload protection breaker and start-stop contactor and a "delta-wye" switch for the PA stage plate transformer primary. Also included are a set of series line resistors for tune-up purposes with a shorting contactor for normal operation. The resistors are contained in a ventilated cage on top of the cabinet. The cabinet is stamped with a wide variety of knock-out discs for conduit connection of the wiring. It is provided with four large mounting holes in its rear corners so that it may be wall mounted and connected directly to the primary line bus by means of rigid conduit.

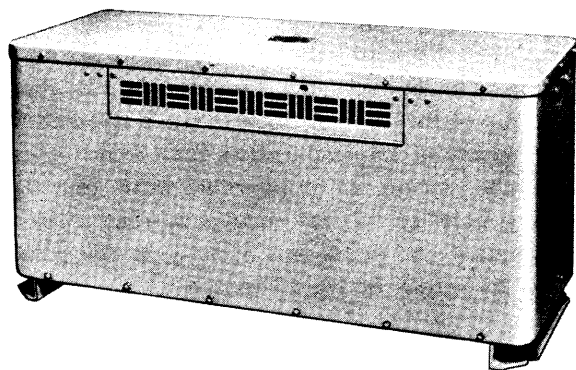


**Figure 1-7. Power Control C-587A/FRT-5,
Front View**

(4) **POWER TRANSFORMER TF-122/U.** — (Refer to figure 1-8.) — Power Transformer TF-122/U is a separate unit to be mounted on the floor apart from the cabinets. It is a three-phase, dry-type, air-cooled unit enclosed in a ventilated sheet metal case. It supplies the high voltage for the power amplifier plate voltage supply.

4. REFERENCE DATA.

Contract Numbers and Dates: NObsr-49171, dated 24 May 1950.



Figur 1-8. Power Transformer TF-122/U,
Front View

Contractor: Federal Telephone and Radio Corp.,
100 Kingsland Road, Clifton, N. J.

Cognizant Naval Inspector: AINM, 167 Prospect
St., Passaic, N. J.

Number of packages involved per complete ship-
ment of equipment, including spare parts: 13.

Total Cubical Contents (crated): 598 cubic feet.

Total Weight (crated): 9362 pounds.

Total Cubical Contents (uncrated): 240 cubic feet
(approx).

Total Weight (uncrated): 5043 pounds.

Frequency Range: 4 to 26 megacycles.

Frequency Multiplier Range: 4 to 26 megacycles.

First Frequency Multiplier: 4 to 13 megacycles.

Second Frequency Multiplier: 4 to 26 megacycles.
Type of Frequency Control: Crystal or stabilized
oscillator.

Type of Emission:

- a. A-1 (carrier on-off).
- b. Frequency shift.

Keying Speed: Up to 400 wpm for either off-on or
frequency-shift emission.

Nominal Carrier Output for each type of emission:

- a. 15 kilowatts for class A-1 emission into a fixed
600-ohm load with a maximum SWR of 2 to 1.
- b. 15 kilowatts for frequency-shift emission into a
fixed 600-ohm load with maximum SWR of 2 to 1.

Power Factor of Equipment:

- a. Starting: 98% (high voltage off).
- b. Standby: 95% (key open).
- c. Normal Operation: 98%

Power Source Requirements:

- a. Voltage: 207 to 253 volts; designed for a center
voltage of 230 volts.
- b. Frequency: 60 cps $\pm 5\%$.
- c. Number of Phases: Three.
- d. Input Power: (approx):

Key Down: 28kw.

Key Up: 5.4 kw.

High Voltage Off: 3 kw.

Crystal: Type AN/CR-27/U with fundamental fre-
quency between 2.0 and 4.2 mc required (not supplied
by contractor).

SECTION 2

THEORY OF OPERATION

1. GENERAL.

A thorough understanding of the block diagram of Radio Transmitting Set AN/FRT-5A is essential to the understanding of this section. As can be seen from the block diagram, figure 2-1, the equipment is divided into three major divisions. On the left, set off by a vertical dashed line, is the equipment designated as rack and panel type. This includes two oscillators, a frequency-shift keyer, a power supply for one of the oscillators and the keyer, and an input-switching panel for the selection of the oscillator to be used. In addition, this part of the diagram contains a group of servo amplifiers and a servo power supply which are part of the transmitter tuning system. The basic transmitter, which consists of a buffer amplifier, two frequency multipliers, a driver, and a power amplifier, plus the d-c power supplies necessary to operate these stages, occupies the remainder of the diagram. A set of equipment, designated as external equipment, occupies the lower righthand corner of the diagram. This includes the main power transformer and its primary control equipment.

The explanation that follows will be further aided by an understanding of the physical location of these

various units. The general physical location of the various parts of the transmitter was pointed out in Section 1. However, it will be well to review this information briefly.

The equipment is composed of the following four major units: RF Unit T-225A/FRT-5, Power Supply PP-490A/FRT-5, Power Transformer TF-122/U and Power Control C-587A/FRT-5.

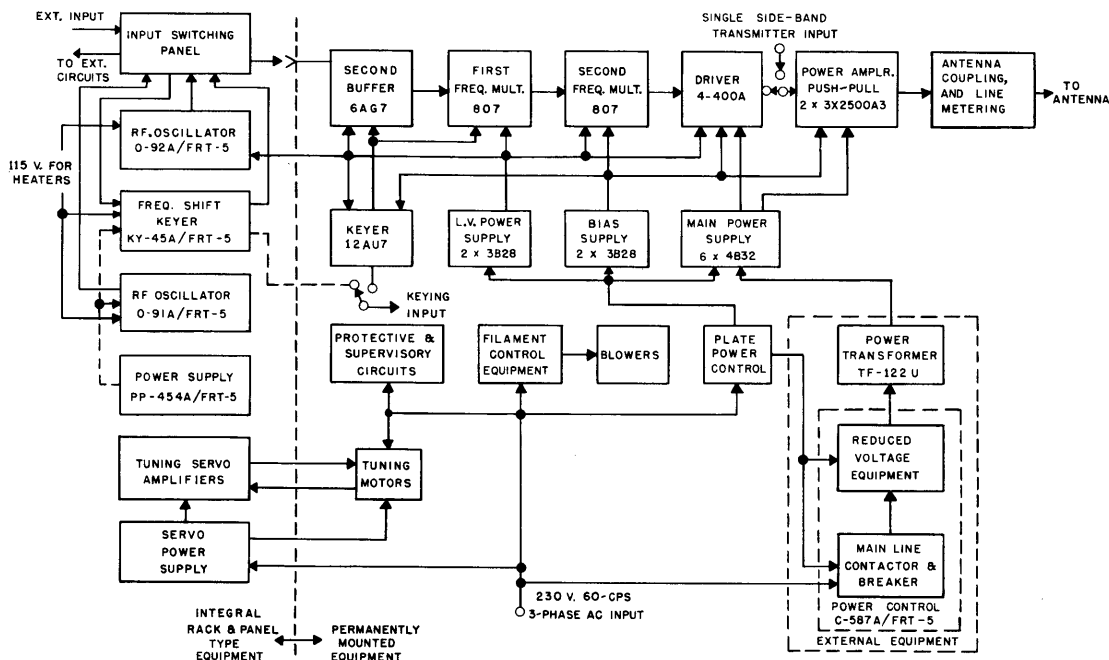
Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5, the two main enclosures, are installed side-by-side in one cabinet and constitute the main portion of the transmitter.

The other two units, which might be considered as auxiliaries, are to be located near, but outside of, the main transmitter enclosure.

RF Unit T-225A/FRT-5 contains, in addition to the basic 15-kilowatt section, several alternate exciters and interconnecting facilities which will be discussed under the heading of exciters and associated equipment.

In the discussion that follows the equipment will be considered under these four general headings:

a. EXCITER SYSTEM. — The exciter system is contained within RF Unit T-225A/FRT-5 and consists of the following:



Figur 2-1. Functional Block Diagram — Radio Transmitting S t AN/FRT-5A

(1) RF Oscillator O-92A/FRT-5. — A 10-channel crystal-controlled unit.

(2) RF Oscillator O-91A/FRT-5. — A variable-frequency unit employing automatic frequency stabilization.

(3) Frequency Shift Keyer KY-45A/FRT-5 whose output frequency alternates between two values in accordance with the applied keying impulses.

b. TRANSMITTER PROPER. — The transmitter proper consists of a buffer amplifier, a frequency multiplier, an electronic keyer, a driver, a power amplifier, a coupling network, a servo tuning system and special metering and monitoring circuits.

c. POWER SUPPLIES. — The power supplies contained in Power Supply PP-490A/FRT-5 consist of a low voltage power supply, a bias supply for the driver and power amplifier, and a power amplifier high voltage supply.

d. CONTROL CIRCUITS. — All switches, relays, and most contactors required for the control and supervision of the equipment are located in Power Supply PP-490A/FRT-5. All circuits are carefully cross-connected and interlocked to insure the proper operating sequence.

Start-stop contactors and circuit breakers for control of the primary power to the plate transformers are located in Power Control C-587A/FRT-5, which is external to the r-f unit.

2. DESCRIPTION OF CIRCUIT ELEMENTS.

a. EXCITERS AND ASSOCIATED EQUIPMENT. — There are three separate sources of excitation provided in this equipment, namely, crystal oscillator frequency control by means of RF Oscillator O-92A/FRT-5, master oscillator frequency control by means of RF Oscillator O-91A/FRT-5, and frequency-shift keying by means of Frequency Shift Keyer KY-45A/FRT-5 in conjunction with RF Oscillator O-91A/FRT-5 or RF Oscillator O-92A/FRT-5. A convenient means of selecting and interconnecting these exciters is provided by an input switching panel which consists of coaxial jacks with short coaxial jumper connectors which couple between these jacks.

The theory of operation of these units is given in more detail in the following paragraphs.

(1) RF OSCILLATOR O-92A/FRT-5. — (Refer to figure 2-2.) — RF Oscillator O-92A/FRT-5 is a 10-channel crystal oscillator capable of delivering 2 to 4 volts RMS into a 50-ohm to 80-ohm load over the frequency range of 2000 kc to 4300 kc. It utilizes a Pierce oscillator circuit and consists of an untuned

crystal-controlled oscillator followed by a broad-band buffer. The oscillator is conventional in that it utilizes the cathode, grid, and screen of the tube as a triode. The crystal is connected from grid-to-ground while the screen is at r-f ground potential. Therefore, the crystal operates as a parallel resonant circuit between the grid and screen. Feedback is provided by the voltage dividing action of capacitors C1111 and C1112. The input capacity of the oscillator tube is in parallel with C1111. This is an extremely stable oscillator circuit since the crystal itself is the only resonant element. Electron coupling to the plate, within the tube, provides the means of coupling to the cathode follower output stage. The output stage is operated as a cathode follower as the most effective means of operating into a low impedance transmission line. The load impedance presented by the line is increased slightly by autotransformer T1102, so that the cathode follower will operate into a more desirable load.

Voltage regulator tubes V1103 and V1104 maintain the oscillator and buffer operating voltages at 180 volts. Capacitors C1101 through C1110 are shunted across the crystal circuit as a means for obtaining exact adjustment of the crystal oscillator frequency. One of these capacitors is associated with each crystal position so that each crystal may be independently set at exactly the desired frequency. The 10 AN type AN/CR27-U crystals are mounted within a common, temperature-controlled oven. This oven temperature is controlled by a special heater and thermostat arrangement which requires approximately one ampere at 12 volts when the thermostat is closed. The presence of heater voltage is indicated by a pilot lamp (I1102) on the front panel, while proper functioning of the thermostat is indicated by intermittent operation of a second pilot lamp (I1103), also on the front panel. The crystal selector switch, which is operated from a front panel control, is special in that one of its wafers is an integral part of the plug-in crystal oven. This wafer is the one that actually selects the active crystal. By this means it is possible to provide a crystal oven with only one r-f output terminal even though it contains up to 10 crystals. Care must be exercised in inserting this crystal oven so that its switch wafer engages properly with its operating shaft. This is further explained in Section 4.

Power for this oscillator is derived from the low voltage d-c power supply of the transmitter proper. The oscillator is equipped with a self-contained meter for checking the oscillator and buffer cathode currents. A selector switch provides the means for inserting this meter into the desired circuit. In addition, there is a provision for externally metering these two stages. This provision is not carried beyond the output jack J1102 and its associated plug P1102. If external

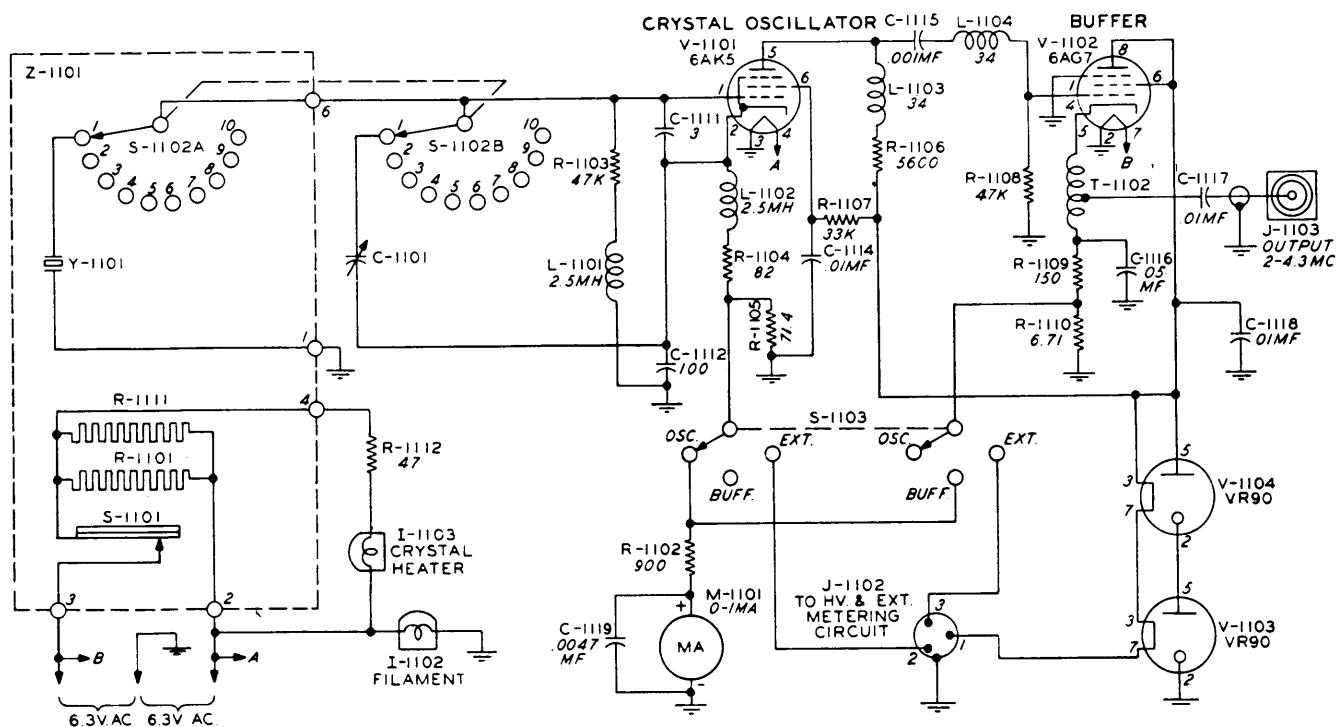


Figure 2-2. Simplified Schematic — RF Oscillator O-92A/FRT-5,
Crystal Oscillator

metering is desired, special provisions must be made to make connections at these points.

(2) RF OSCILLATOR O-91A/FRT-5. — RF Oscillator O-91A/FRT-5 is a very stable automatic frequency-controlled (AFC) oscillator which covers a frequency range of 2 mc to 4.5 mc. It employs a master oscillator and amplifiers in conjunction with automatic frequency control circuits which maintain the output frequency constant at any selected value within its range. The actual circuits that provide power output to drive the transmitter are marked with an orange arrow on the chassis and are the master oscillator (V131), multiplier (V112) and final amplifier (V114). The remainder of the circuits, with the exception of the 450-kc amplifier (V106) and the 100-kc amplifier (V107), are the frequency control circuits. The 450-kc amplifier and the 100-kc amplifier are both provided with external jacks so that the output of either one may be used on any external equipment requiring a frequency source of this type. Figure 2-3 is a block diagram of the oscillator.

The stability of RF Oscillator O-91A/FRT-5 is derived from a 100-kc standard, either external or internal. This 100-kc standard signal is subdivided by a divider circuit to 25 kc and then is passed into a harmonic amplifier circuit whose output is in the range of 9.125 mc to 21.625 mc.

This 9.125-21.625-mc signal is mixed with the fifth

harmonic of the output frequency (10-22.5 mc) to produce an intermediate frequency (IF) in the range of 875 kc to 900 kc. This IF is amplified and combined in a second mixer with a 75-100-kc signal which is obtained by subdividing the output from a 600-800-kc interpolation oscillator. The second IF is then a fixed frequency centered on 800 kc.

This 800-kc signal is then divided to 100 kc in a regenerative divider circuit. Any error involved in setting up the master oscillator will also appear in this 100-kc signal. This signal is then combined, in a pair of diode mixers, with a signal from the 100-kc standard to produce an output which is audible and is a definite measure of the frequency error. In one of the diode mixers, the 100-kc standard signal is shifted 90 electrical degrees, thus providing a two-phase audio output. This audio output from the mixers is passed into a pair of d-c amplifiers and thence into a pair of power amplifiers. The resultant two-phase output from the power amplifiers is fed to the AFC motor which rotates in such a manner as to adjust the master oscillator to the desired frequency.

In the following discussion of circuit details, the exciter circuits and frequency control circuits are discussed separately. While these circuits are interconnected, the excitation (magnitude) is not directly dependent upon the control circuits. In an attempt to clarify the explanation, the control circuits are ex-

plained by taking one signal and bringing it up to a mixer, returning and picking up the signal that it is to be mixed with and then proceeding with the discussion from the output of the mixer.

In more detail, the individual circuit theory is as follows:

(a) MASTER OSCILLATOR. — (Refer to figure 2-4.) — The oscillator assembly is a precision device which supplies output energy whose frequency is very stable under conditions of extreme temperature and humidity change. The circuit used is an electron-coupled type employing a type 6SJ7 tube (V131), and covering a frequency range of 1000 kc to 1500 kc. The output frequency of the oscillator is determined by the position of the tuning slug within grid inductor L103, and the capacity setting of C126 which is across the

grid coil. The tuning slug position is determined by the setting of the MASTER OSCILLATOR dial **A-1**. The setting of capacitor C126 is adjusted by the AFC motor which is linked to it mechanically, and which operates in response to the output of the frequency control circuit.

(b) MULTIPLIER V112. — (Refer to figure 2-5.) — The multiplier stage, V112, employs a type 6BE6 miniature pentagrid tube operating as a class "C" stage with cathode bias. The input voltage is fed to the #1 grid of V112 through R242 which is used to reduce the input voltage slightly so that the multiplier stage will not be overdriven. In the plate circuit of V112 is a tuned circuit composed of a slug-tuned inductor T104, a trimmer capacitor C128D and one section of a variable ganged capacitor C120D. This

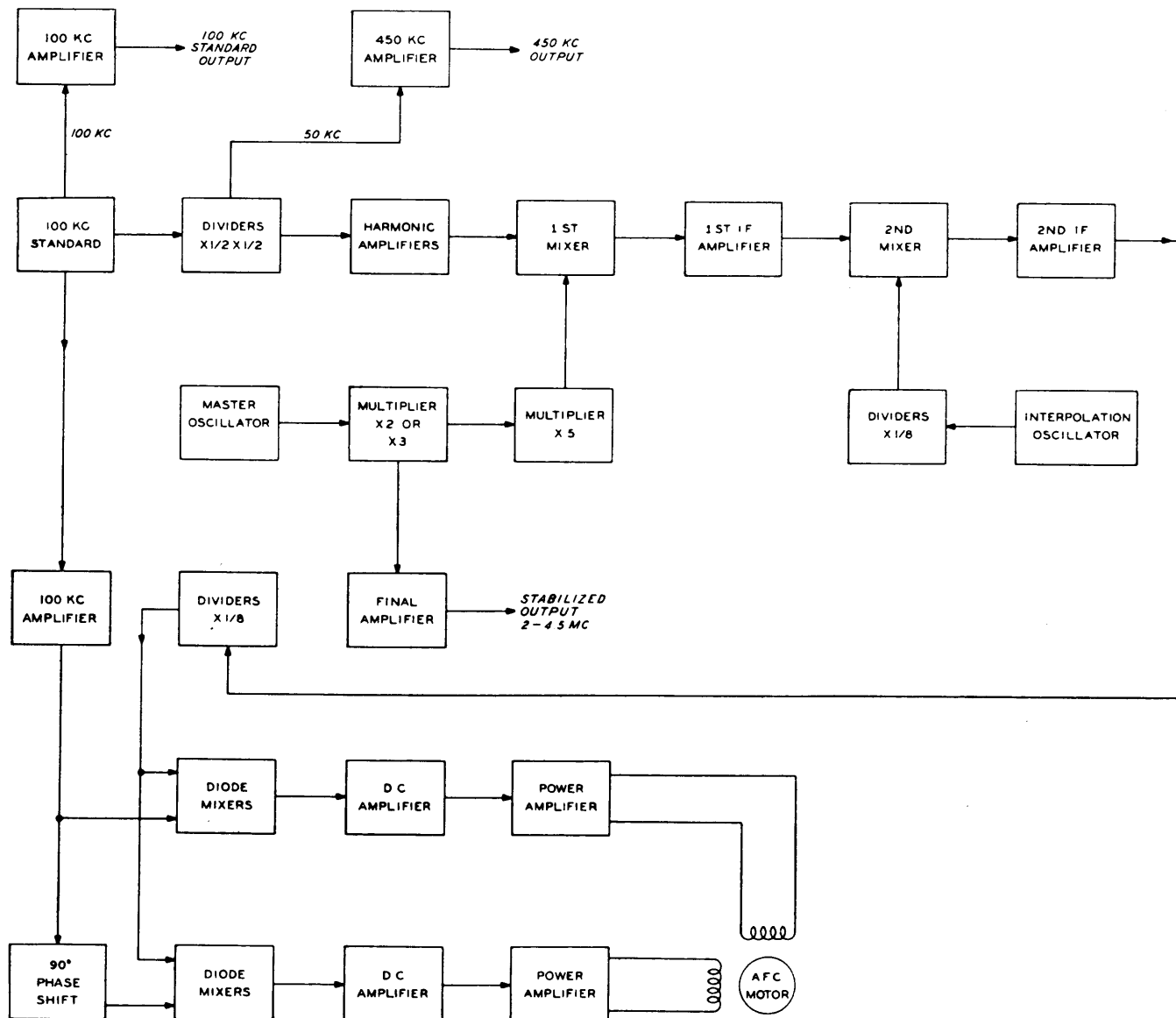


Figure 2-3. Functional Block Diagram — RF Oscillator O-91A/FRT-5

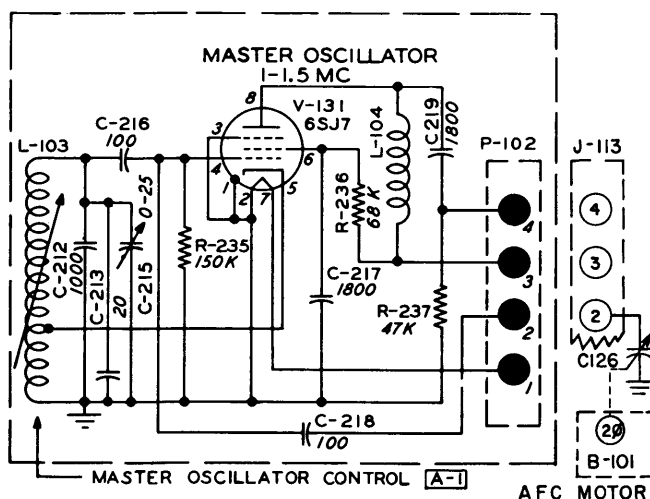


Figure 2-4. Schematic — RF Oscillator O-91A/FRT-5, Master Oscillator

tank circuit, T104, is tuned to twice the input frequency to produce an output frequency from the final amplifier of 2 mc to 3 mc, or tuned to three times the input frequency to produce an output frequency from the final amplifier of 3 mc to 4.5 mc. Tuning is accomplished by the OUTPUT TUNING dial **C-1** (C120D). The output of V112 is capacity coupled through C159 to the second multiplier grid, and through C154 to the final amplifier grid.

(c) FINAL AMPLIFIER. — (Refer to figure 2-5.) — The final amplifier is a class "A" stage operating as a straight amplifier and receiving its bias from cathode resistor R164. Input voltage is fed from the plate circuit of V112 through capacitor C154 to the control grid of V114. A voltage divider arrangement using a potentiometer, whose rider is connected to

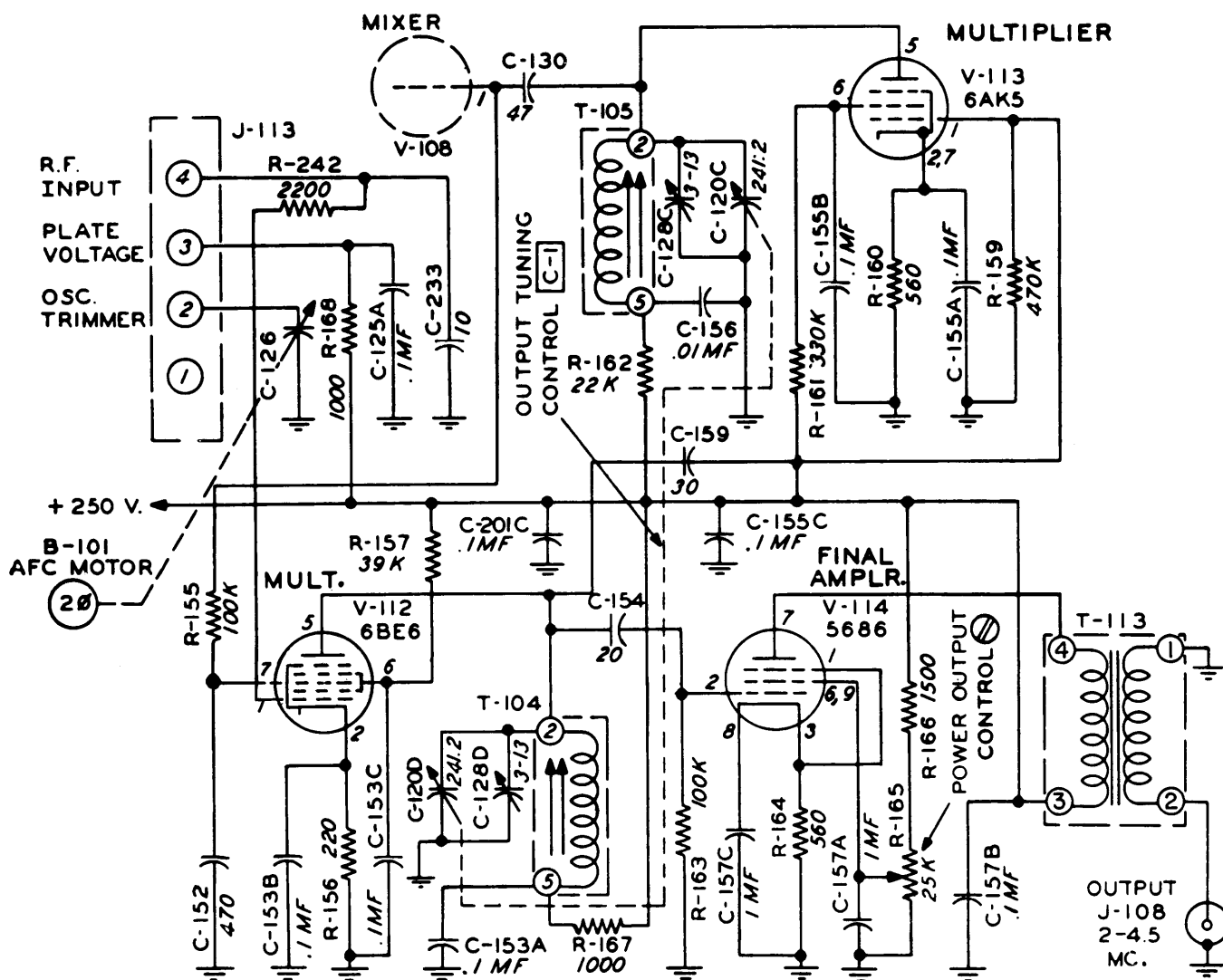


Figure 2-5. Schematic — RF Oscillator O-91A/FRT-5, Output Circuit and Multiplier

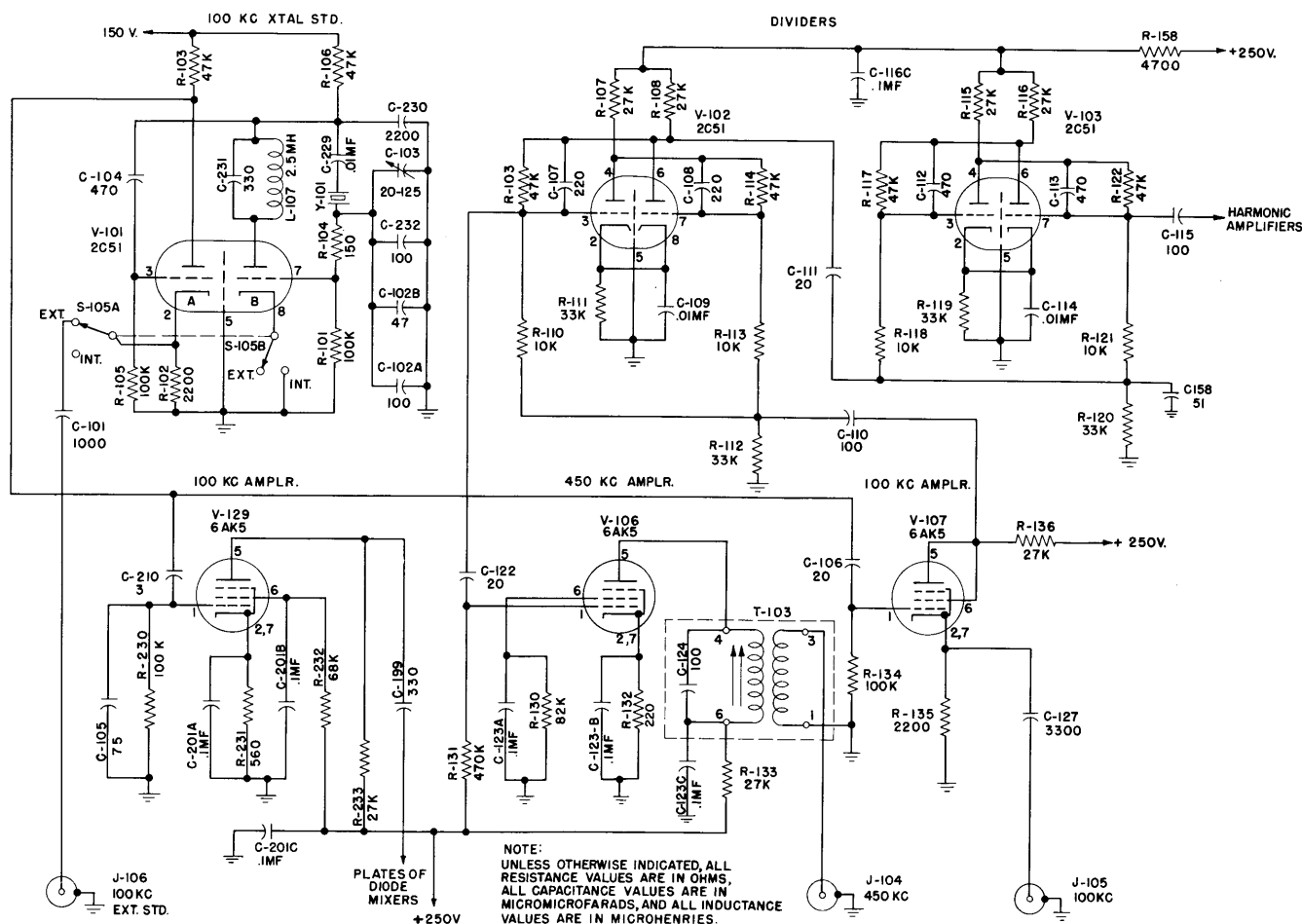
the screen of V114, provides a means of varying the screen voltage, which in turn varies the power output of the final amplifier stage. The plate circuit of V114 contains an untuned transformer, T113, whose output winding is coupled to the transmitter through a coaxial cable.

Note

The frequency control circuits consist of: 100-kc crystal standard, 100-kc amplifier, crystal divider, harmonic amplifiers, first intermediate frequency amplifier (875 to 900 kc), second intermediate frequency amplifier (800 kc), interpolation oscillator, buffer, interpolation dividers, regenerative dividers, diode mixers, d-c amplifiers and power amplifiers.

(d) 100-KC CRYSTAL OSCILLATOR AND AMPLIFIER. — (Refer to figure 2-6.) — The 100-kc oscillator and amplifier circuit employs a type 2C51 triode tube (V101A/V101B). This circuit is designed

so that either the 100-kc crystal supplied or an external 100-kc crystal can be used as a standard. When an external crystal oscillator is used, its output is fed to the cathode of amplifier V101A through jack J102, capacitor C101 and switch S105A/S105B which must be turned to its EXT position. In the EXT position one section of this switch opens the cathode circuit of V101B, thus disabling the internal 100-kc crystal oscillator. However, V101A continues to operate as an amplifier supplying a 100-kc signal to the 100-kc amplifiers, V107 and V129. When using the 100-kc crystal supplied with the oscillator, switch S105A/S105B is turned to the INT position, which closes the cathode circuit of section "B" of V101. Section "B" of V101 is the internal 100-kc oscillator. It employs a regenerative type circuit. The plate circuit of V101B is tuned to 175 kc by means of inductor L107 and capacitor C231. The end of the tank coil opposite the plate is connected to one end of capacitor C229, while the other end is connected between the crystal and capacitors C102A/C102B, C103 and C232. Capacitor C229 is used to provide additional feedback voltage



for better operation of the oscillator circuit. Capacitors C102A/C102B, C232 and C103 are connected in series with the 100-kc crystal to adjust the frequency to exactly 100 kc. The 100-kc crystal and the temperature-controlled oven in which it is located are contained in a sealed plug-in unit (Y101). When the 115-volt a-c power is applied to this oven, the pilot light (I101) designated as XTAL HEAT comes on, indicating that the heater resistors are energized to raise the temperature of the oven. The temperature is thermostatically controlled between 59° to 61°C (138.2°F to 141.8°F). When the temperature within the oven becomes stabilized, the heating cycle should be "heat on" for four or five minutes, then "heat off" for eight or ten minutes, provided the room temperature is constant. The required stability should be reached within one hour after power is applied. Capacitor C205 is connected across the thermostat contacts to prevent arcing.

The output of the crystal oscillator section is fed to the grid of section "A" of V101 through capacitor C104. Section "A" is operated as a class "A" amplifier and receives its bias from cathode resistor R102. There is no tuned circuit in the plate of V101A so the output of this amplifier is taken directly from the plate and fed to the grid of the 100-kc amplifier (V107) through capacitor C106, and to the grid of the other 100-kc amplifier (V129) through capacitor C210.

(e) 100-KC AMPLIFIER (V107). — (Refer to figure 2-6.) — The 100-kc amplifier, V107, employs a type 6AK5 pentode having its plate and screen tied together, and its suppressor grid and cathode also tied together, to make it operate as a triode. This stage is operated as a class "A" amplifier receiving its bias from cathode resistor R135, and serves as a buffer between the preceding amplifier (section "A" of V101) and the first crystal divider (V102). The output from V107 is taken from the plate and coupled to the grids of the first crystal divider, V102, through coupling capacitor C110. A second connection is made to the plate from J105 through coupling capacitor C127. J105, a coaxial connector mounted at the rear of the chassis, permits the supplying of any external source that may require a 100-kc signal.

(f) CRYSTAL DIVIDERS. — (Refer to figure 2-6.) — The crystal dividers and interpolation dividers are a type of trigger or "flip-flop" circuit. The purpose of this circuit is to divide the input frequency by two to supply an output frequency of one-half the input frequency. To explain the operation more thoroughly, consider the 50-kc divider V102 alone. The normal condition of the divider when no excitation voltage is being applied to the grids would be that one section of the tube, let us call it "A," would be draw-

ing plate current, and at the same time the plate current in section "B" would be zero. Now when a negative voltage is applied to the grid of section "A" it will decrease its plate current. This causes a decreased voltage drop across R107 because of the coupling from the plate to the grid through R114 and C108, which in turn makes the bias on the grid of section "B" more positive. Consequently, the plate current of section "B" increases, increasing the voltage drop across R108. This makes the grid of section "A" (as coupled from the plate of section "B" through R109 and C107 to the grid of section "A") more negative, causing a further decrease in the plate current of section "A" and a resultant further increase in plate current of section "B". The process continues until section "A" is cut off, and only section "B" draws plate current, a condition which will continue until the next negative pulse is applied to the grid of section "B", at which time the action will reverse. The resultant differential of the negative pulse causes the circuit to make an abrupt reversal. The positive pulses do not possess the required differential to make the divider reverse. Referring to the divider circuit (V102) the 50-kc output voltage is fed from the plate of section "B" to the next stage through capacitor C111. The function of divider circuit V103 is the same as for V102 with the exception that its output has a 25-kc fundamental. This is fed to the grid of the first harmonic amplifier.

(g) HARMONIC AMPLIFIERS. — (Refer to figure 2-7.) — The harmonic amplifiers employ a type 6AK5 tube (V104) for the first harmonic amplifier and a type 6AS6 tube (V105) for the second harmonic amplifier. Grid bias is provided by cathode resistor R124 in the 1st stage and cathode resistor R127 in the 2nd stage. The plate of V104 contains a tuned circuit consisting of C120B, which is the main tuning capacitor, C128B, a trimmer capacitor in parallel with C120B, and a slug-tuned inductor, T101. Capacitor C119 is inserted in series with C120B and C128B of the tuned circuit to make grounding the rotor of C120B possible. The capacity of C119 is sufficiently large so that its effect on the tuned circuit is negligible. Capacitor C120B is controlled by the OUTPUT TUNING dial **C-1** on the front panel. The plate circuit of V104 is coupled to the grid of V105 through coupling capacitor C117. Harmonic amplifier V105 contains a tuned circuit similar to V104, whose tuning capacitor (C120A) is also controlled by the OUTPUT TUNING dial **C-1** on the front panel. The tuned circuits of both V104 and V105 are designed to cover a frequency range of 9.125 to 21.625 mc. In order to obtain good performance from these amplifiers it is necessary to supply regulated voltage (+150v) to the plate of V104 and to the plate and screen of V105. The plate circuit of

harmonic amplifier V105 is coupled to the grid of mixer V108 through capacitor C129.

The first stage of the first i-f strip is a mixer (V108). The two signal voltages mixed in this tube are the output of the harmonic amplifier (V105) and the output from the multiplier (V113).

(b) MULTIPLIER V113. — (Refer to figure 2-5.) — The multiplier V113 receives its input voltage from the plate of multiplier V112 through coupling-capacitor C159. It operates as a class "C" amplifier and multiplies the input frequency 5 times. The tuned circuit of V113 consists of main tuning capacitor C120C, which is controlled by the OUTPUT TUNING dial [C-1] trimmer capacitor C128C, and a slug-tuned inductor, T105. Capacitor C156 is connected in series with C120C and C128C to make grounding of the rotor of C120C possible. C156 is sufficiently large so that it has a negligible effect on the tuned circuit. The plate of V113 is capacity coupled to mixer V108 through C130. Grid bias for V113 is supplied by grid resistor R159 and cathode resistor R160.

(i) FIRST IF (875 to 900 kc). — (Refer to figure 2-7.)

1. MIXER. — The mixer stage employs a type 6BE6 (V108) pentagrid converter. Bias for the mixer is supplied by cathode resistor R140. The output frequency of harmonic amplifier V105 is fed to the #3 grid of V108 and the output frequency of multiplier V113 is fed to the #1 grid of V108. These two injected signals are mixed and the plate tuned circuit is tuned to the difference frequency. In the plate of V108 and the grid of V109 is an i-f transformer T106. This transformer consists of two slug-tuned coils and two fixed capacitors, one capacitor being connected across each coil. It is also required to pass a frequency range of 875 kc to 900 kc. To do this, it is necessary to overcouple the tuned circuit, so as to flatten out the peak of the i-f curve enough to pass the required frequencies.

2. AMPLIFIER. — (Refer to figure 2-7.) — The i-f amplifier operates as a class "A" stage and employs a type 6AK5 (V109) pentode tube. Bias is

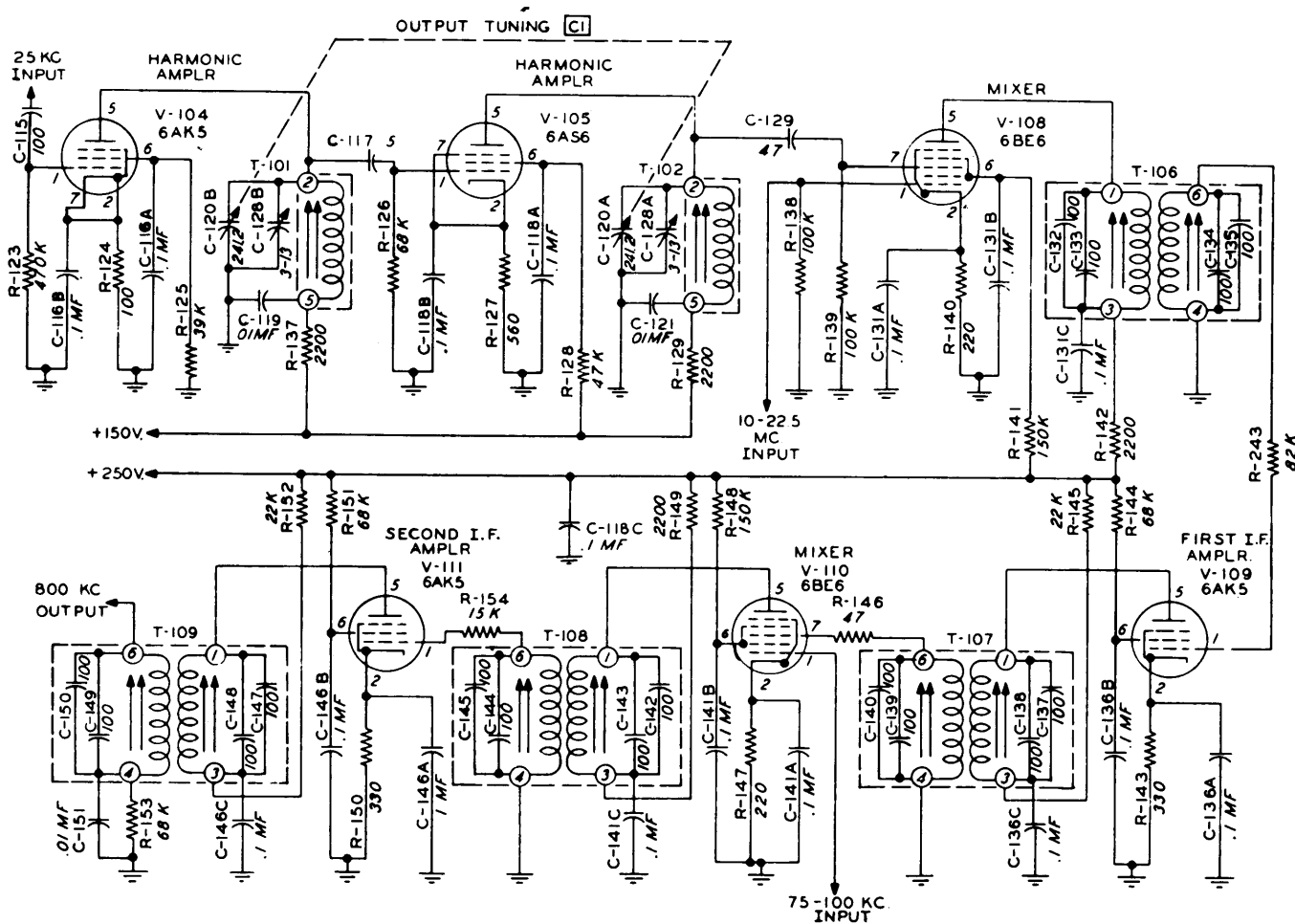


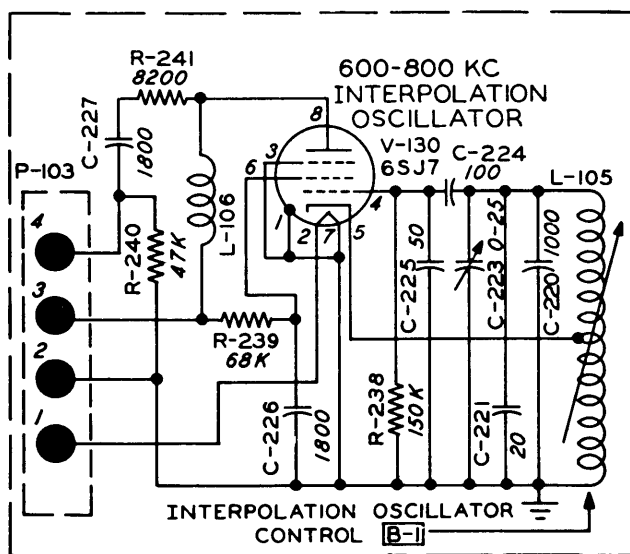
Figure 2-7. Schematic — RF Oscillator O-91A/FRT-5, IF Amplifier Strip

supplied by cathode resistor R143. The input voltage for V109 is supplied by i-f transformer T106. I-f transformer T107 is connected to the plate of V109 and the grid of V110. Transformer T107 is the same as T106, having two slug-tuned coils shunted by fixed capacitors and, like T106, is required to pass the frequency range of 875 kc to 900 kc. To do this it is necessary to overcouple the tuned circuit so as to flatten out the peak of the i-f curve enough to pass the required frequencies.

At this point we come to the mixer in the second i-f strip. One of the mixing voltages is that supplied by the first i-f strip, the other voltage is supplied by an interpolation circuit consisting of an interpolation oscillator, a buffer and three interpolation dividers.

(j) INTERPOLATION CIRCUITS.

1. INTERPOLATION OSCILLATOR. — (Refer to figure 2-8.) — The interpolation oscillator assembly is a precision device which supplies an output frequency that is extremely stable under conditions of extreme temperature and humidity change. The circuit used is an electron-coupled type employing a type 6SJ7 tube, V130, and covering a frequency range of 600 kc to 800 kc. The output frequency of the oscillator is determined by the tuned circuit made up of grid inductor L105 and the fixed capacity across the coil. The position of the tuning slug inside L105 is determined by the setting of the INTERPOLATION OSCILLATOR dial **B-1**. The plate circuit of interpolation oscillator V130 is untuned. The output of the interpolation oscillator is taken from the plate of the oscillator and fed to the grid of buffer V118 through coupling capacitor C227.



Figur 2-8. Schematic — RF Oscillator O-91A/FRT-5, Interpolation Oscillator

ORIGINAL

2. BUFFER. — The buffer operates as a class "A" amplifier employing a type 6AK5 (V118) pentode tube. Bias for this stage is supplied by cathode resistor R197. The plate and screen of V118 are tied together, as are also the suppressor grid and the cathode, to make it operate as a triode. The output voltage of V118 is capacity coupled to the grids of the first divider circuit V117 through capacitor C177. This buffer stage provides a means of isolation between the interpolation oscillator and the interpolation divider circuits.

3. INTERPOLATION DIVIDERS. — (Refer to figure 2-9.) — The interpolation dividers operate in the same way as the crystal dividers. Refer to the paragraph describing crystal dividers for the theory of operation (paragraph 2 a (2) (f), this section).

a. INTERPOLATION DIVIDER (300-400 kc). — The first interpolation divider, V117, has an input frequency of from 600 kc to 800 kc depending on where the INTERPOLATION OSCILLATOR dial is set. The output frequency of V117 is one-half of the input frequency, or 300 kc to 400 kc.

b. INTERPOLATION DIVIDER (150-200 kc). — The second interpolation divider, V118, has an input of from 300 kc to 400 kc. The output frequency of V118 is one-half the input frequency or 150 kc to 200 kc.

c. INTERPOLATION DIVIDER (75-100 kc). — The third interpolation divider, V119, has an input frequency of from 150 kc to 200 kc. The output frequency of V119 is one-half the input frequency or 75 kc to 100 kc. The output frequency of the interpolation divider (V119) is fed to the #1 grid of mixer V110, through coupling capacitor C163, and low-pass filter T110.

(k) SECOND IF (800 kc). — (Refer to figure 2-7.)

1. MIXER. — The mixer stage employs a type 6BE6 (V110) pentagrid converter. The output frequency of i-f amplifier V109 is fed to the #3 grid of V110 and the output of interpolation divider V115 is fed to the #1 grid of V110. These two injected signals are mixed and the plate circuit is tuned to the difference frequency. I-f transformer T108 couples the plate of V110 to the grid of V111 and is sharply tuned to pass only the band of frequencies centered on 800 kc. It consists of two slug-tuned coils and two fixed capacitors, one capacitor being connected across each coil.

2. AMPLIFIER. — The i-f amplifier operates as a class "A" stage and employs a type 6AK5 pentode tube (V111). The input voltage for V111 is supplied

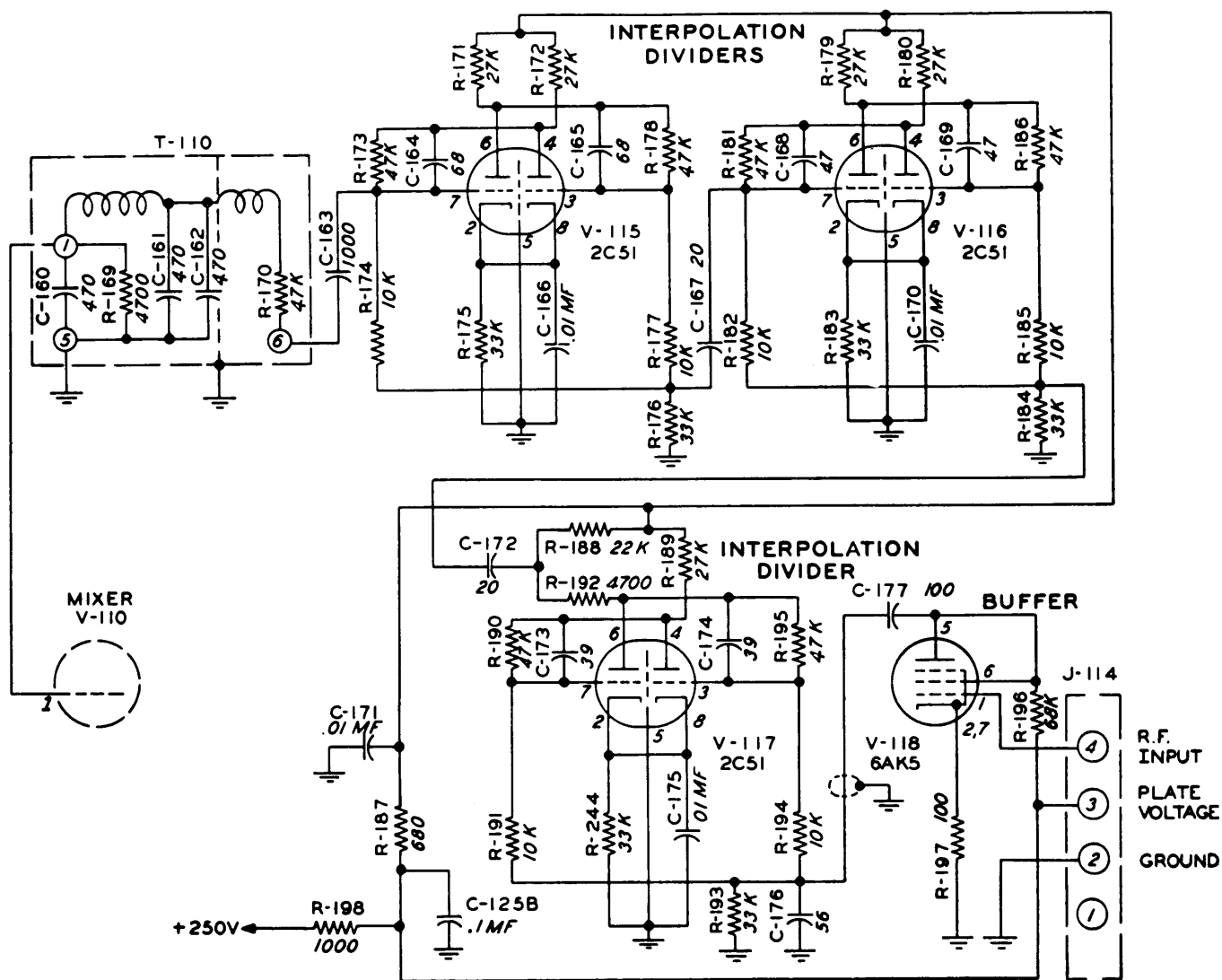


Figure 2-9. Schematic — RF Oscillator O-91A/FRT-5, Interpolation Oscillator Dividers

by i-f transformer T108. I-f transformer T109 connects the plate of V111 to the grid of V127 and is also sharply tuned to pass only the band of frequencies centered on 800 kc. This transformer consists of two slug-tuned coils and two fixed capacitors, one capacitor being connected across each coil.

(l) REGENERATIVE DIVIDERS. — (Refer to figure 2-10.) — The 800-kc output from T109 is fed to the #1 grid of V127. V127 is a mixer stage employing a type 6BE6 tube. A second voltage is applied to the #3 grid of V127 from the plate of V128. V128 employs a type 6BA6 tube in a regenerative oscillator circuit resonated to 700 kc. The tuned circuit in the plate of V128 consists of a slug-tuned coil with a fixed capacitor connected in parallel with it. The frequency is adjusted by varying the slug within the coil. In the mixer tube (V127) the 800-kc signal from the second i-f amplifier (V111) and the 700-kc signal from the

regenerative oscillator (V128) are mixed to produce a difference frequency of 100 kc. The tuned circuit in the plate of the mixer (V127), which consists of a slug-tuned coil in parallel with a fixed capacitor, is resonated to this difference frequency. The inductance of the coil is varied by means of the slug. A second coil is inductively coupled to the tuned coil of V127 and its output is fed to the cathodes of the diode mixers V125 and V126. The tuned circuits of both V127 and V128 are contained in a common container with a shield between and designated as T111.

(m) 100-KC AMPLIFIER (V129). — The 100-kc amplifier (V129) employs a type 6AK5 tube which is operated as a class "A" amplifier, receiving its bias from cathode resistor R231. This stage acts as a buffer between the amplifier section of tube V101 and the plates of diode mixers V125 and V126. The 100-kc input voltage for the grid of V129 is obtained from the

plate of V101A through coupling capacitor C210. The 100-kc output voltage is taken from the plate of V129 and fed to the plates of V125 and V126 through coupling capacitors C199 and C187.

(n) DIODE MIXER AND POWER AMPLIFIERS. — (Refer to figure 2-10.) — We must now compare the 100-kc voltage just mentioned with the crystal standard. This is done in the following manner: 100-kc voltage from the standard is taken from V101 and isolated by buffer amplifier V129. The output of V129 is coupled into the plate circuit of diode mixer V126 and one-half of T112. The regenerative divider output is coupled to the cathode circuit of V126 from the divider transformer, T111. All mixer products are attenuated by the low-pass filter network, R215, R216,

C181 and C182, except the difference frequency which is audible. This filter terminates on the grids of d-c amplifier V124 which drives power amplifiers V121 and V122. One phase of the AFC motor (B101) is supplied from these two tubes. The second phase of the AFC motor is supplied from a circuit identical to the one just described but displaced 90 electrical degrees. The circuit for the second phase consists of diode mixer V125, d-c amplifier V123, and power amplifiers V119 and V120. The 90° phase shift is accomplished by a loosely coupled resonant circuit in the diode mixer circuit. This resonant circuit is the other half of T112 and is coupled to the plate circuit of diode mixer V125.

(o) 450-KC AMPLIFIER. — (Refer to figure 2-6.) — The 450-kc amplifier employs a type 6AK5

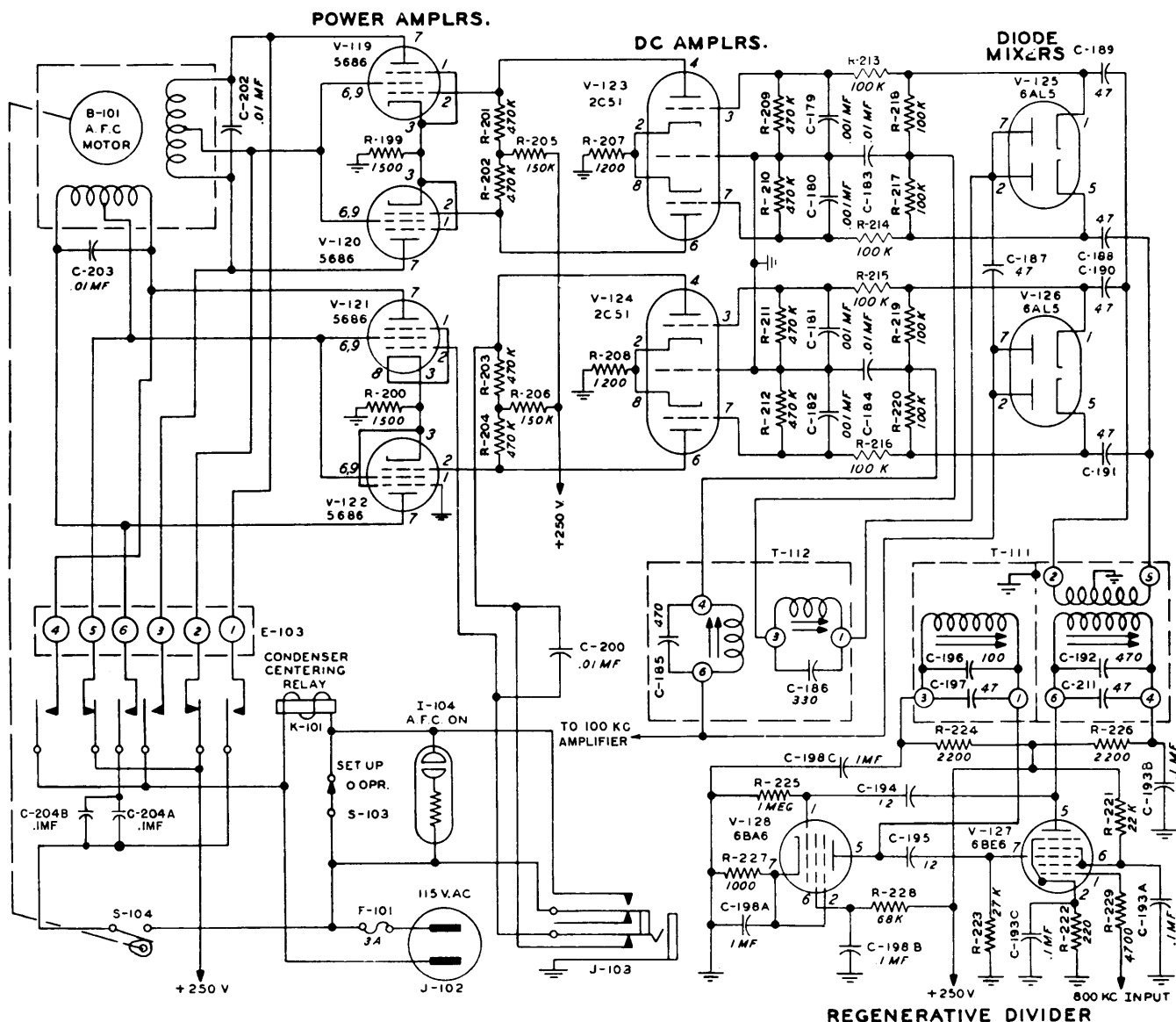


Figure 2-10. Schematic — RF Oscillator O-91A/FRT-5, Motor Control Circuit

tube (V106) which is operated as a class "A" amplifier and receives its bias from cathode resistor R132. A 50-kc voltage is supplied to the grid of V106 from the grid of the first crystal divider V102. The tuned circuit in the plate of V106 is resonated, by a variable slug, to the ninth harmonic of the 50-kc input voltage, thus creating a 450-kc output voltage. An output coil is inductively coupled to the plate coil of V106 with one end terminating at connector J104 and the other end going to ground. Both the plate coil and the output coil are placed in a common container and the assembly designated as T103.

(p) SET UP-OPERATE SWITCH (S103). — (Refer to figure 2-11.) — Turning the SET UP-OPERATE switch to the SET UP position energizes capacitor centering relay K101. The operation of this relay applies 115 volts ac to the automatic frequency

control motor, B101, and opens the plate circuit of amplifiers V119, V120, V121 and V122. The applied 115-volt ac causes the motor to rotate until S104, a cam-actuated switch, opens the a-c line to the motor. This cam is an integral part of AFC capacitor C126, and serves to effect the centering of the AFC capacitor which is prerequisite to "setting up" the desired frequency. The AFC ON light I104 glows when the SET UP-OPERATE switch (S103) is switched to the OPERATE position indicating that the AFC is in operation.

Phone jack J103 is wired so that when the phone plug is in the jack, and the SET UP-OPERATE switch is in the OPERATE position, the AFC circuit will not operate. This is due to the fact that the phone jack circuit keeps relay K101 energized. As soon as the phone plug is removed from the jack, relay K101 be-

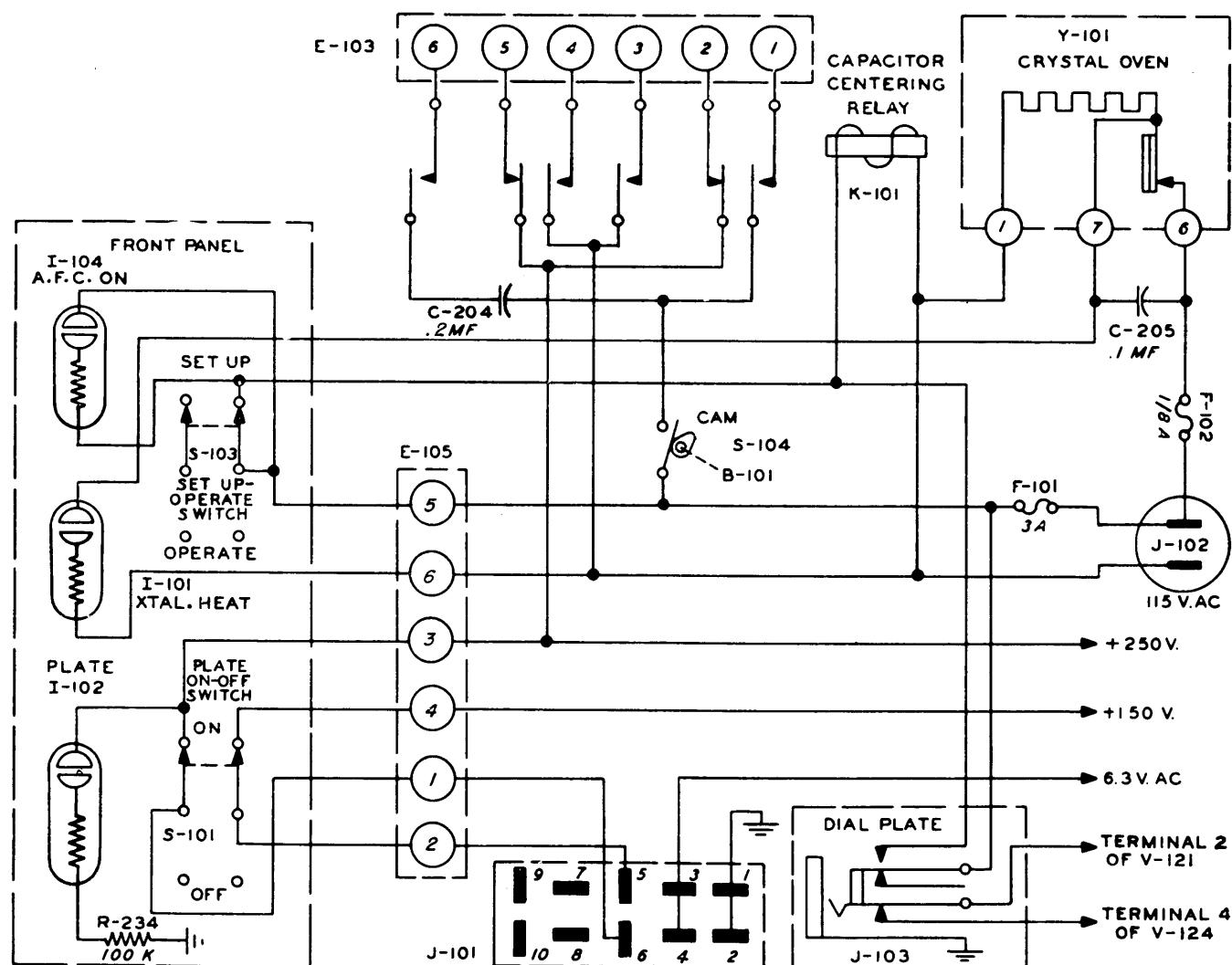


Figure 2-11. Simplified Sch matic — RF Oscillator O-91A/FRT-5, Contr I Circuit

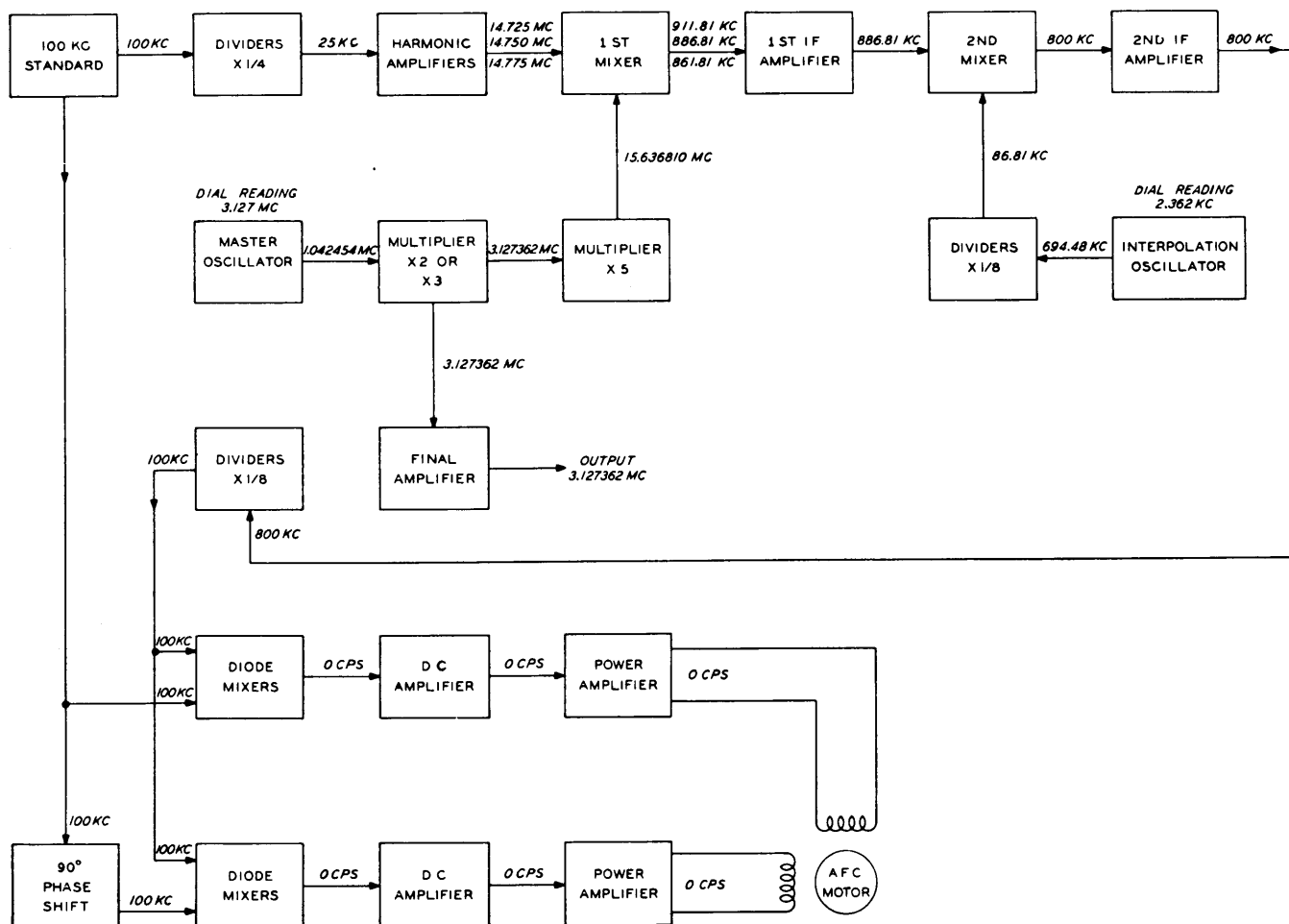


Figure 2-12. Block Diagram — RF Oscillator O-91A/FRT-5, Typical Frequencies During Operation, No Error in Master Oscillator Setting

comes de-energized and the AFC circuit then becomes operative.

(q) TYPICAL FREQUENCIES DURING OPERATION. — Figures 2-12 and 2-13 were included to tie together, in a more coherent fashion, the foregoing discussion of the individual circuits. Both charts were set up with the same output frequency, in this case, 3,127,362 cps, but figure 2-13 assumes that the master oscillator is set up with some error.

Figure 2-12 assumes that the master oscillator has no error in frequency, i.e., it was set up exactly on the desired frequency. The arrows indicating the frequencies involved should be quite clear; however, a short explanation may be required in the case of the harmonic amplifier and the 1st mixer. As seen in figure 2-12 only three frequencies are shown leaving the harmonic amplifiers, but in actuality a complete spectrum of frequencies, spaced 25 kc apart, is generated in this stage. For purposes of explanation, only the frequency used in this example and the one on either side of it are shown. In the same manner, three frequencies

are shown leaving the 1st mixer; however, the two outer frequencies, 911.81 kc and 861.81 kc, have suffered some attenuation in the plate circuit of the mixer. The 1st i-f amplifier having a pass band of 875-900 kc further attenuates the two side frequencies so that only the one frequency, 886.81 kc, suffers no attenuation in the mixer.

Some difficulty may be encountered in the apparent difference in the INTERPOLATION OSCILLATOR dial reading and its actual frequency. The dial is calibrated from 0-5000 cps while the actual oscillator range is 600-800 kc. Thus with a reading of "0" on the dial, the oscillator is actually working at 600 kc, while with a reading of "5000" on the dial, the oscillator frequency is 800 kc. Since the ratio of the dial calibration in units (5000) to the frequency range of the oscillator in kilocycles (200) is 25:1, each unit of change in the position of the dial will represent 1/25th of a kilocycle change in the frequency of the oscillator. Therefore, for an intermediate setting of the dial, the corresponding frequency of the oscillator in kilocycles

will be equal to the minimum frequency of the oscillator in kilocycles (600) plus 1/25th the reading on the dial (in units). In this example the dial reading is 2362, so the actual oscillator frequency in kilocycles would be $600 + (1/25 \times 2362)$ or 694.48.

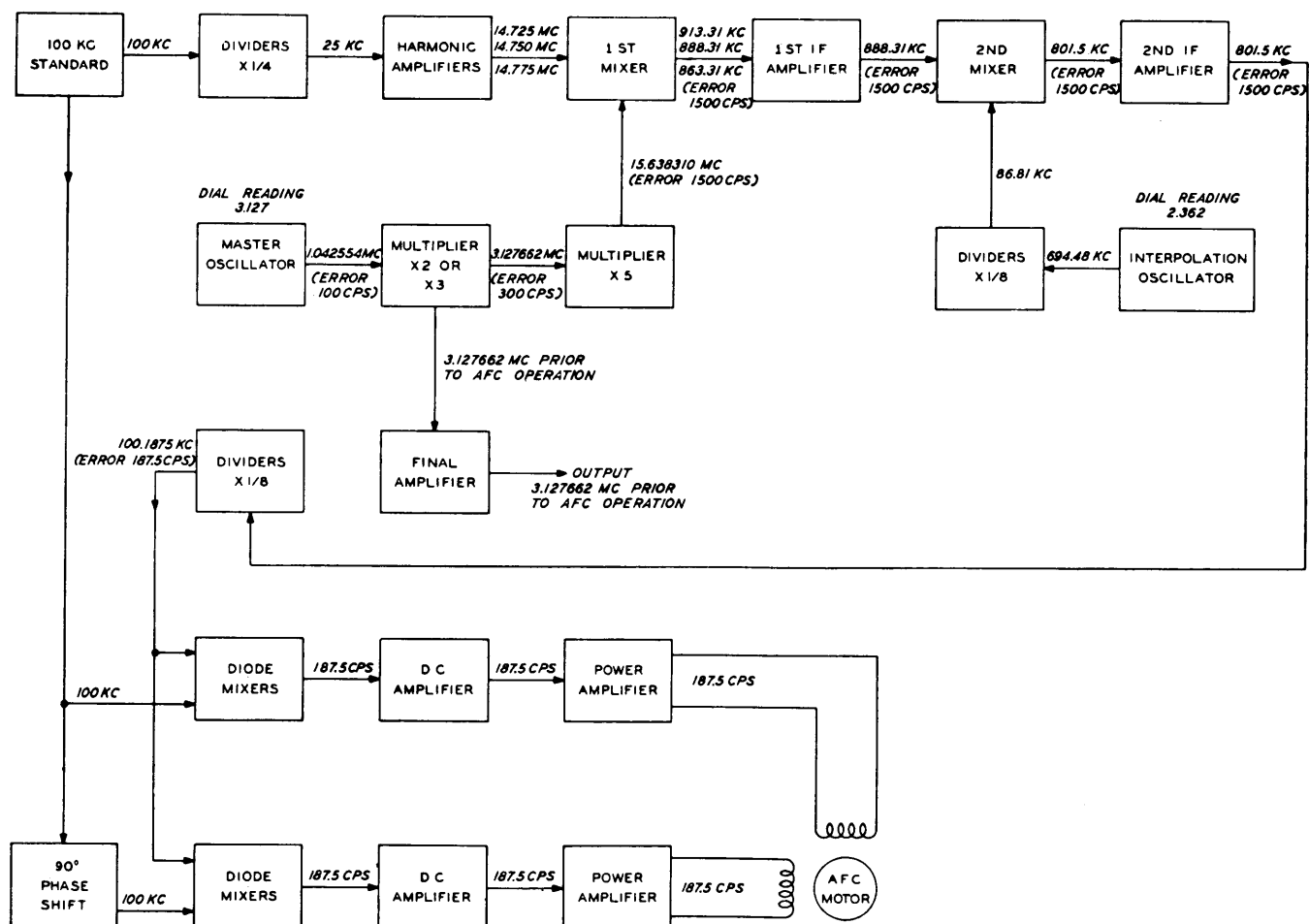
The remainder of the chart should be quite self-explanatory, with one exception. Take, for instance, a case where the output frequency is such that the 1st i-f amplifier would receive a frequency of 875 kc and also one of 900 kc. Since both of the frequencies lie in the pass band of the 1st i-f strip, both frequencies would be delivered to the second mixer with little or no attenuation. However, in any case of this sort, the output from the interpolation oscillator and interpolation dividers would be such that the output frequencies of the 2nd mixer would be 800 kc and 825 kc, and since the 2nd i-f amplifier will pass only a very narrow band of frequencies centered on 800 kc, the 825-kc signal would be attenuated in the 2nd i-f amplifier.

Figure 2-13 shows the frequencies which would result if the same output frequency (3,127,362 cps) were

desired but with the master oscillator setting being in error by, e.g., 100 cps. It is evident that an output of a frequency other than zero will be obtained from the power amplifiers which will cause the AFC motor to rotate and correct the master oscillator frequency. As the master oscillator frequency error becomes smaller, the output from the power amplifiers also decreases in frequency until the master oscillator is set up on the exact desired frequency. Then the output frequency from the power amplifiers will again be zero cps and the AFC motor will cease to rotate.

(3) FREQUENCY SHIFT KEYER KY-45A/FRT-5.

(a) GENERAL. — The frequency-shift keyer is ordinarily used at the transmitting station of a frequency-shift radio-telegraph circuit. Telegraph signals are generated at a control point equipped with teleprinter keyboards and tape recorder. Both the transmitting and receiving radio stations may be remote from the communication centers and they are ordinary-



Figur 2-13. Block Diagram — RF Oscillator O-91A/FRT-5, Typical Frequencies During Operation, 100-cps Error in Master Oscillator Setting

ly connected to the station by means of land lines. Figure 2-14 is a block diagram of the frequency-shift keyer.

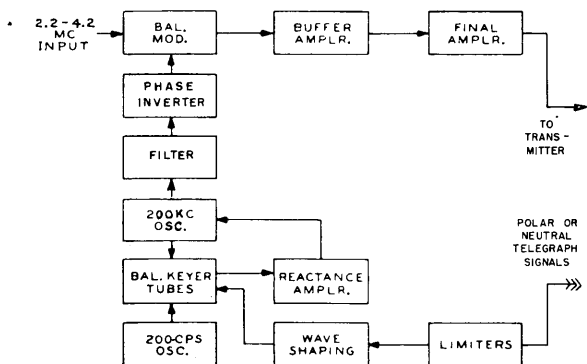


Figure 2-14. Functional Block Diagram — Frequency Shift Keyer KY-45A/FRT-5

(b) OPERATING FREQUENCY. — The keyer requires an injection voltage which is in the range of 2.2 mc to 4.2 mc, and 200 kc higher than the operating range. This injection voltage is mixed with a 200-kc frequency-shifted voltage from an internal source to produce an output voltage in the frequency range of 2 mc to 4 mc. The external injection voltage is ordinarily provided by RF Oscillator O-91A/FRT-5, but any stable injection voltage of good wave form in the range of 2.2 mc to 4.2 mc may be used.

(c) BALANCED MODULATOR, BUFFER AND FINAL AMPLIFIER. — A simplified schematic of the high frequency portions of the frequency-shift keyer is shown in figure 2-15. A radio-frequency source in the range of 2.2 mc to 4.2 mc is fed into J1401 and then to the #1 grids of V1401 and V1402 which con-

POWER AMPLIFIER

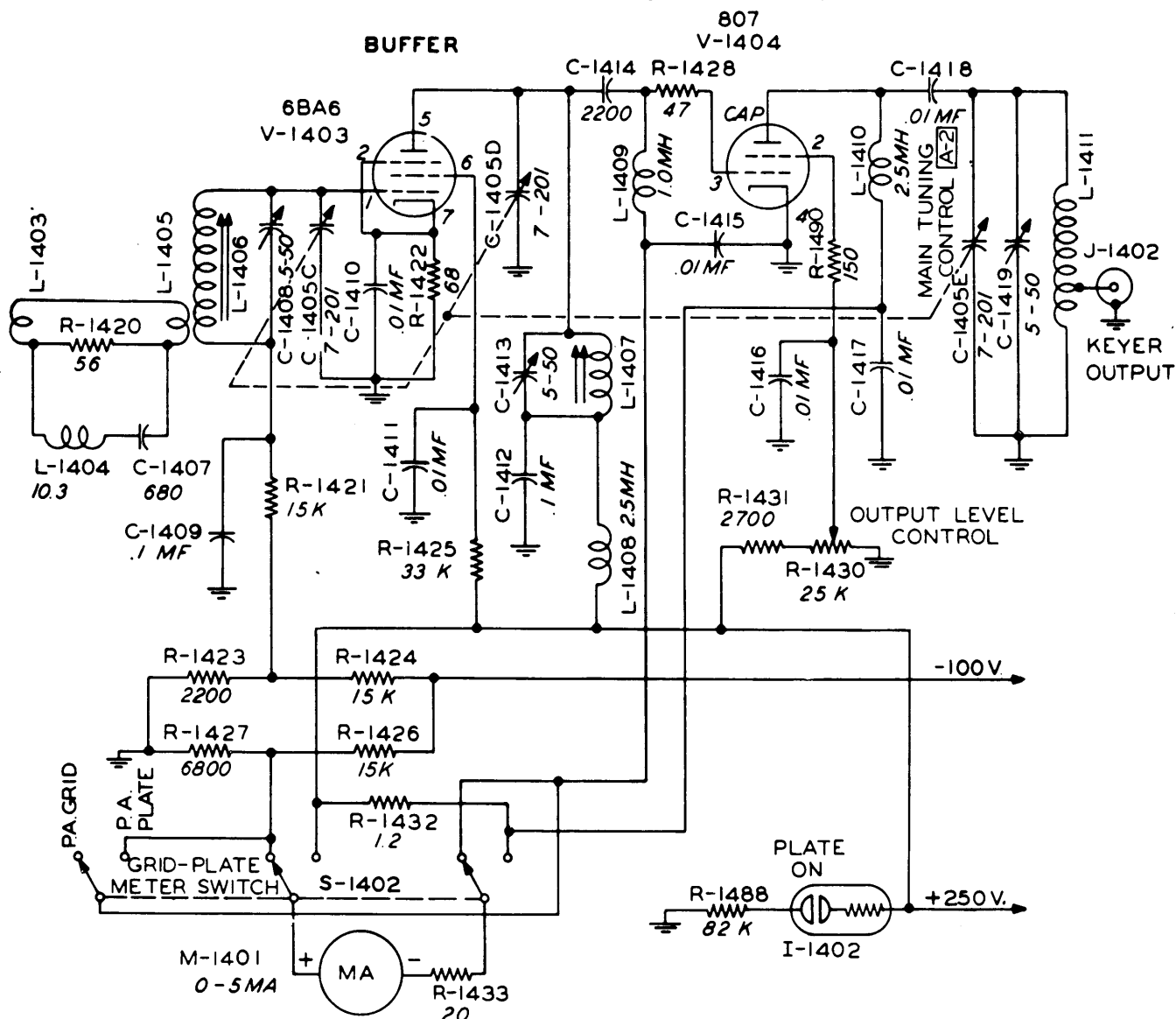


Figure 2-15. Simplified Schematic — Frequency Shift Keyer KY-45A/FRT-5 High Frequency Section

stitute the balanced modulator (refer to figure 2-18). The #3 grids of V1401 and V1402 are excited in push-pull from a 200-kc voltage derived from the frequency-shifted oscillator. Since the high frequency input is supplied to the #1 grids of these tubes in identical phase, this voltage is cancelled in the output circuit because of its push-pull arrangement. Complete cancellation of this voltage occurs when the balance potentiometer R1416 is adjusted so that the transconductance of the two tubes is identical. With the high frequency input cancelled, only the mixer products remain, the most important of these being the sum and difference frequencies produced by the mixing of the high frequency signals with the 200-kc frequency-shift voltage. This keyer operates on the lower difference frequency (200 kc below the injected signal) which is selected by the four gang-tuned circuits associated with the OUTPUT TUNING control. These gang-tuned circuits include the modulator plate circuit (L1402), buffer grid (L1406), the power amplifier grid (L1407) and the power amplifier plate circuit (L1411). These four circuits are provided with inductive and capacitive trimming to make possible exact tracking through-

out the 2-mc to 4-mc operating range. Because the tubes used in the buffer-amplifier and the final amplifier have effective screen grids, neutralization is unnecessary. A meter switch, S1402, provides a convenient means of measuring the grid and plate currents of the final amplifier.

(d) 200-KC OSCILLATOR, BALANCED KEYER AND REACTANCE AMPLIFIERS. — (Refer to figure 2-16.) — The portion of the frequency-shift keyer which produces the frequency-shifted signal consists of a 200-kc oscillator (V1411), a balanced keyer tube (V1408) and two phase-shifting amplifiers (V1409 and V1410). The operation of the circuit can be most easily explained by means of vector diagrams. In figure 2-16 is shown the simplified circuit and in figure 2-17 are shown the various vector diagrams which will be used in the course of this explanation. If we let the vector E_0 represent the voltage across the oscillator grid coil L1415, then vector $V1408G_1$ represents the voltage at one terminal of pick-up loop L1416 while $V1408G_2$ represents the voltage at the opposite terminal of the same loop (V1416). The two voltages

NOTE:
VALUE OF C1441 IS CHOSEN TO FULFIL
REQUIREMENTS OF INDIVIDUAL OSCILLATOR.

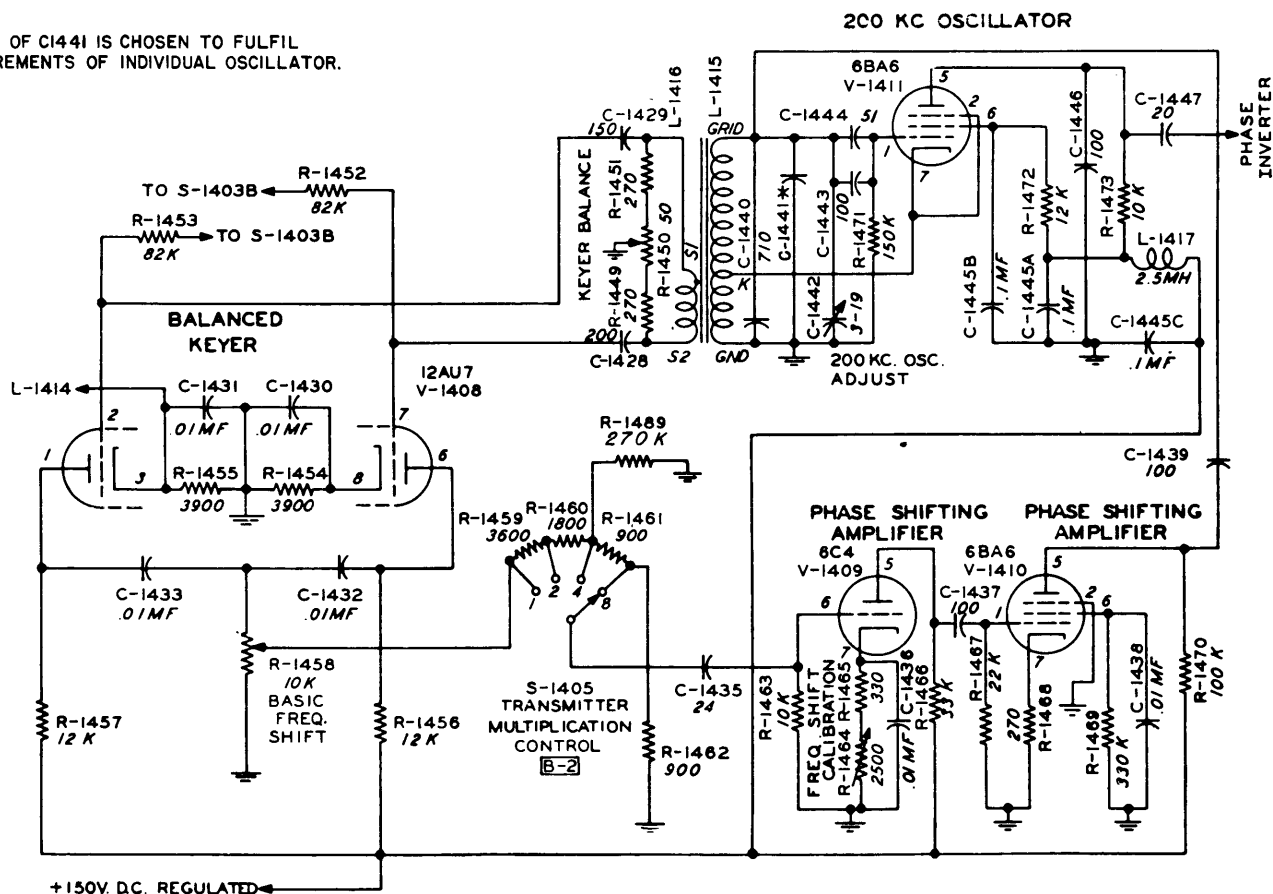


Figure 2-16. Simplified Sch matic — Fr equency Shift Key r KY-45A/FRT-5,
R actanc Tube Circuits

represented by vectors V_{1408G_1} and V_{1408G_2} are fed to the two grids of the keyer tube (V_{1408}). Each section of V_{1408} is a voltage amplifier; one section (section 1) operates at a fixed amplification and the other section (section 2) will have its grid more positive and, at this instant, the plate signal may be represented by vector V_{1408P_2} which is 180° out of phase. The resultant vector at the plate of the tubes is shown at "C" in figure 2-17. Because C_{1435} has a high capacitive reactance at 200 kc, a leading current flows through the

original oscillator vector, E_0 , it may be seen that a lagging 90° relationship exists between these two voltages and a leading or capacitive current flows in the oscillator tank producing an effect much as if an additional capacitor had been placed across L_{1415} , resulting in a lower frequency.

When the bias voltage applied to the grid of the section of V_{1408} , which is allowed to vary in amplification, is made more negative than that of the constant amplification section, the vector relationships are as shown at "F". Vector V_{1408P_2} is smaller than V_{1408P_1} and the resultant vector appears at "H". This vector encounters a phase shift through C_{1435} and R_{1463} so that the vector relationships exist as shown at "I". After passing through V_{1409} the voltages appear as shown at "J". Here the voltage V_{1410P} leads the oscillator voltage and a lagging current flows which adds to the inductive current in the oscillator tank, effectively reducing the circuit capacity and raising the frequency. The condition shown at "E" corresponds to a radio-telegraph "mark" because it is effective in lowering the frequency of the 200-kc oscillator (raising the final output frequency). The condition shown at "J" corresponds to a radio-telegraph "space" because it raises the frequency of the 200-kc oscillator. The circuit constants are so chosen that a linear change in keyer tube grid voltage produces linear frequency shift.

The magnitude of the reactive voltage (i.e., frequency shift) can be adjusted by potentiometer R_{1458} . Further division of this voltage is possible through the use of TRANSMITTER MULTIPLICATION switch S_{1405} , the function of which will be explained later.

Thus, under the control of the keyer tube, it is possible to produce either a leading or a lagging voltage at the plate of V_{1410} and this is equivalent to adding inductance or capacitance in its effect on the oscillator frequency. Control R_{1458} then provides a means by which the total amount of frequency shift can be adjusted. Because the amount of frequency shift which is present in the associated transmitter is dependent upon the degree of multiplication to which the output of this keyer is subjected, it is necessary to reduce the amount of frequency shift by means of control S_{1405} . This switch provides for full shift, one-half shift, one-quarter shift, and one-eighth shift to provide for multiplication by one, two, four, and eight in the associated transmitter. To calibrate the frequency-shift control, R_{1458} , an adjustment in the gain of the amplifier is provided by the cathode potentiometer R_{1464} . Because of slight differences in the keyer tube gain characteristics and in circuit wiring, a balancing control, R_{1450} , is provided to equalize the output of each section of the keyer tube when the d-c voltages

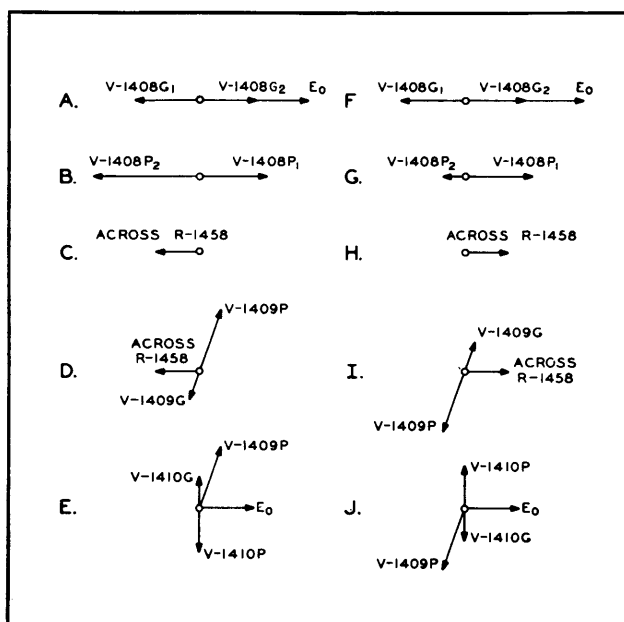


Figure 2-17. Vector Diagram - Frequency Shift
Keyer KY-45A/FRT-5

series circuit consisting of C_{1435} and R_{1463} . The values of C_{1435} and R_{1463} in this circuit are so selected that a phase shift of about 70° occurs and the leading vector shown at "D" results across R_{1463} . The magnitude of this voltage may be adjusted by changing the position of the arm of potentiometer R_{1458} and/or the setting of tap switch S_{1405} . This voltage is applied to the grid of V_{1409} . The output of this tube may be represented by the vector V_{1409P} which is 180° displaced from the voltage on the grid of V_{1409} . Another capacitor-resistor series circuit, C_{1437} and R_{1467} , brings about a 20° phase shift and the resulting voltage, represented by vector V_{1410G_1} , is applied to V_{1410} whose plate voltage is then represented by V_{1410P} . When this voltage is compared with the

applied to the two grids are identical. A small amount of adjustment of the oscillator frequency is possible through adjustment of C1442. Because of the tempera-

ture-controlled oven and the high inherent stability of the circuit, adjustment of this control is unnecessary for extended periods of time.

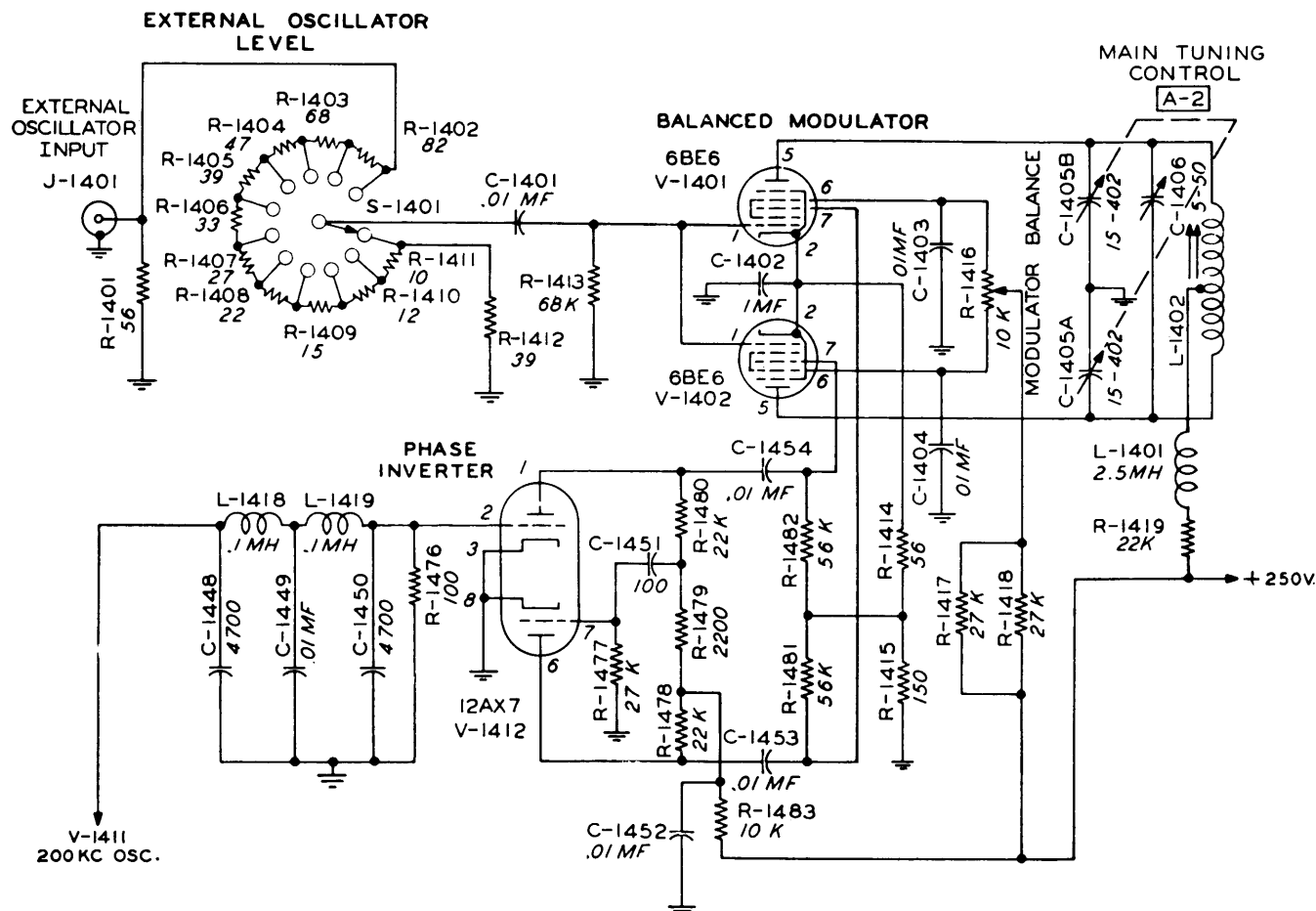


Figure 2-18. Simplified Schematic — Frequency Shift Keyer KY-45A/FRT-5, 200-Kc Filter and Phase Inverter Tube

(e) 200-KC FILTER AND PHASE INVERTER. — Figure 2-18 shows the 200-kc filters and the phase inverter in simplified form. Because harmonics of the 200-kc oscillator fall within the pass-band of the high frequency circuits of this keyer, these harmonics must be suppressed to eliminate spurious output. This is done with a low-pass filter consisting of C1448, C1449, C1450, L1418, and L1419. This filter passes the fundamental with very little attenuation but offers a high degree of rejection in the second and higher harmonics of the 200-kc oscillator. The phase inverter tube, V1412, serves to produce push-pull 200-kc voltage for application on the #3 grids of the balanced modulator tubes. This phase inverter employs a twin triode to secure the push-pull output voltages.

(f) LIMITERS AND WAVE-SHAPING FILTER. — (Refer to figure 2-19.) — Radio teleprinter

or picture transmission signals are applied to the keyer line input connector J1407. Teleprinter signals pass through a negative peak limiter (V1405) so that only positive keying impulses reach switch S1403A. With S1403A in the FSK position a positive peak limiter presents an essentially fixed voltage having square-wave characteristics to the wave-shaping filter. The wave-shaping filter is a low-pass pi-section circuit. By selecting the proper position of S1404 it is possible to apply the desired amount of wave shaping to the square wave delivered by the limiter tubes. Wave shaping at this point materially reduces the side-band frequency components which are present with square-wave keying.

The TEST-OPERATE switch, S1403, provides a means by which carrier, space, mark, FSK, or photo transmission of the keyer can be provided. In the CARRIER position the input line is disconnected and

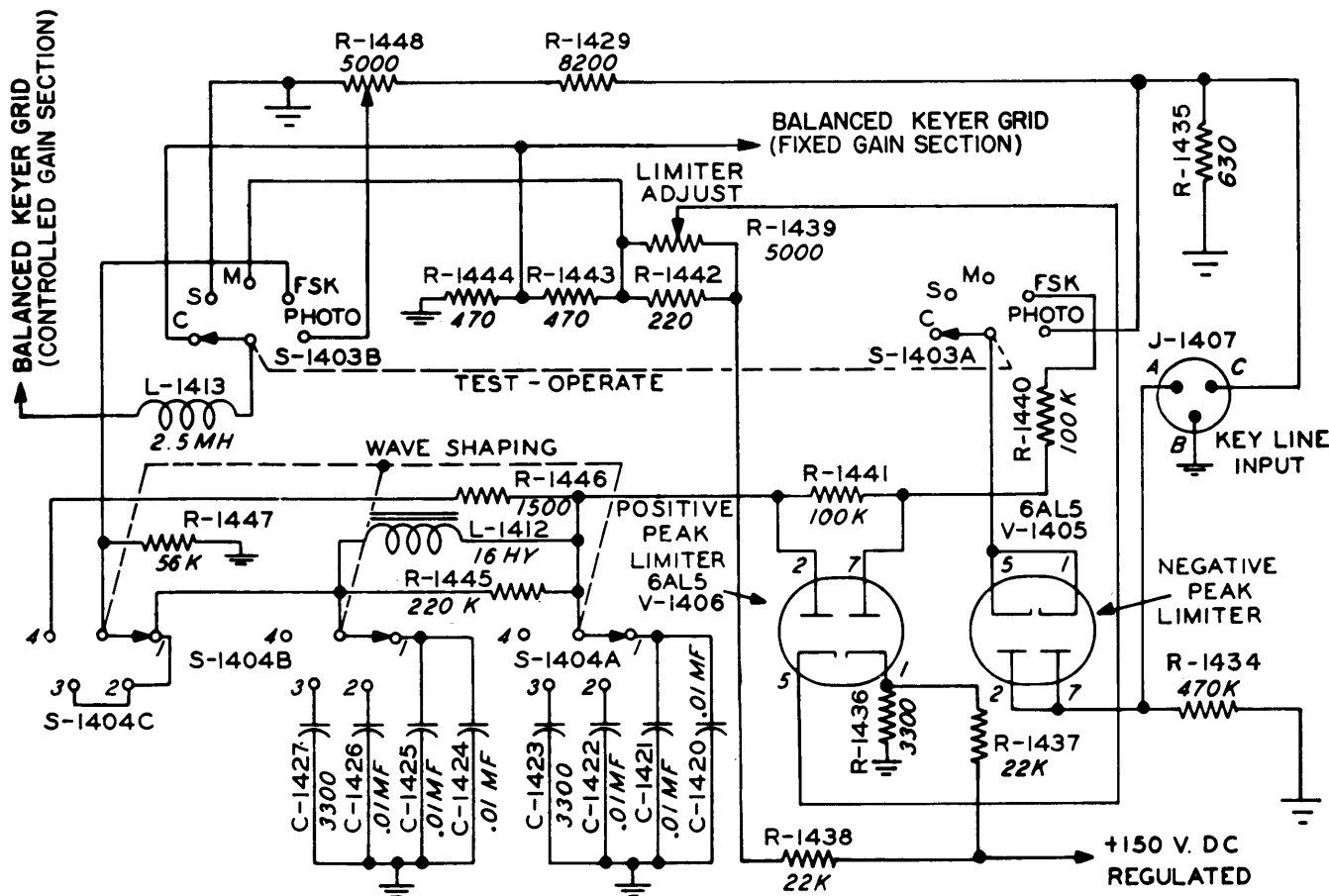


Figure 2-19. Schematic — Frequency Shift Keyer KY-45A/FRT-5, Input Circuit and Wave Shaping Filter

the same voltage is applied to both keyer tube grids. This results in voltages in phase opposition but of identical magnitude at the plates of the keyer tube so that essentially zero voltage appears across R1458, resulting in the natural frequency of oscillation for the 200-kc oscillator. In the MARK position a positive voltage is applied to the keyed grid of V1408 (pin #7) causing lower frequency of oscillation for the 200-kc oscillator, while in the SPACE position the input line is disconnected and zero voltage is applied to the keyed grid so that the 200-kc oscillator operates at a higher frequency. In the FSK position, the input line is connected through the positive peak limiter and into the keyed grid of V1408 through the wave-shaping filter. In the PHOTO position S1403 connects the input line without the wave shaping or positive peak limiting to the keyed grid of V1408. In photo transmission, the frequency of the 200-kc oscillator follows the keying voltage present on the line in a linear fashion. The key line input connector is arranged so that separate lines for photo and FSK may be left permanently connected. The proper line is then automatically selected by the TEST-OPERATE switch.

ORIGINAL

(g) PHASE MODULATION OSCILLATOR. — (Refer to figure 2-20.) — The phase modulation oscillator is a simple Hartley oscillator tuned to 200 cps. This 200-cps oscillator provides a voltage across R1455 such that up to one radian of phase modulation at 850-cps total shift is possible on the output signal. The use of phase modulation permits frequency diversity which is a decided advantage in the presence of severe multipath distortion in radio transmission.

(4) POWER SUPPLY PP-454A/FRT-5. — (Refer to figure 7-49.) — Power Supply PP-454A/FRT-5 provides the filament, bias, and plate potentials necessary for the operation of Frequency Shift Keyer KY-45A/FRT-5 and RF Oscillator O-91A/FRT-5. Figure 7-50 is a schematic diagram of Power Supply PP-454A/FRT-5. Two separate power supplies are incorporated.

One of the power supplies furnishes voltage for RF Oscillator O-91A/FRT-5. This power supply includes a full-wave rectifier using two type 5R4GY rectifiers. The filter system employs a choke input and utilizes two 10-mf capacitors on the output. A type OA2

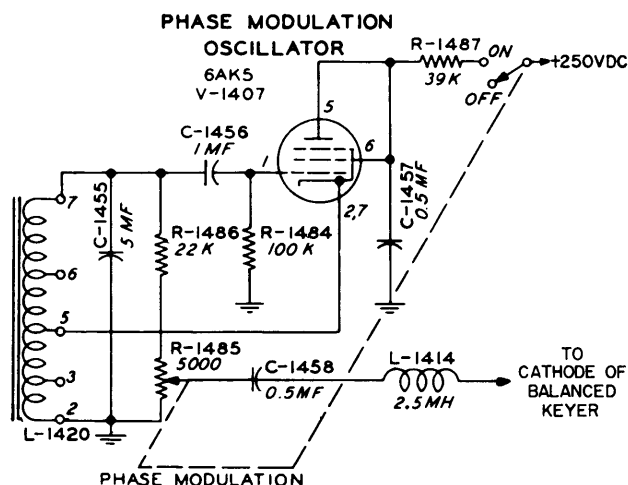


Figure 2-20. Schematic — Frequency Shift Keyer KY-45A/FRT-5, Phase Modulation Oscillator

voltage regulator tube is used for regulation. Potentials of 150 volts regulated and 250 volts unregulated are supplied to the RF Oscillator.

The other power supply furnishes the voltage for Frequency Shift Keyer KY-45A/FRT-5. This power supply is a full-wave type using a single type 5R4GY rectifier tube. The filter system for this supply has a choke input and uses two 4-mf capacitors. A type OA2 voltage regulator tube is used to improve the regulation. This unit has an additional voltage supply which uses a 6X4 rectifier tube and an RC filter network system. The voltage output from this winding is a negative 100 volts. Potentials of 150 volts regulated and 250 volts unregulated are supplied to the frequency-shift keyer.

Power Supply PP-454A/FRT-5 incorporates a voltmeter and switching arrangement for checking all voltages coming from within.

b. TRANSMITTER PROPER.

(1) GENERAL. — The RF Unit T-225A/FRT-5 consists of seven different sections which will be considered in more detail in the following order.

(a) MAIN COMPONENTS.

1. Buffer and frequency multipliers
2. Electronic keyer
3. Driver
4. Power amplifier
5. Coupling network

(b) AUXILIARY FEATURES.

1. Tuning system
2. Metering and monitoring circuits

(2) RF UNIT T-225A/FRT-5 — MAIN COMPONENTS.

(a) BUFFER AND FREQUENCY MULTIPLIERS. — (Refer to figure 2-21.) — The first stage in the transmitter proper is a broad-band buffer stage, V501, employing a type 6AG7 tube. This stage provides the necessary voltage gain and isolation between the exciters and the first frequency multiplier. Exciting input voltage is coupled to the buffer grid through a 50-ohm coaxial input line and autotransformer T501. The coaxial line is loaded by a group of four carbon resistors, R501 through R504, to provide a fixed load for the exciters while the autotransformer raises the voltage applied to the grid approximately 2 to 1. It will be noted that a second coaxial line is coupled through C501 to the buffer grid. The line extends to external jacks and provides a means of frequency monitoring.

The output circuit of the buffer contains only an r-f choke (L501) as its load, and is capacity coupled, through C507, to the grid of the first multiplier stage (V502).

The first multiplier uses a type 807 tube and has a tuned plate circuit consisting of L503 and C511. Both the capacitor and inductor are variable. They are mechanically coupled together and varied simultaneously by a tuning motor. These two components and their gearing are assembled as a small unit and will cover the frequency range of 4000 kc to 13,000 kc. Since the oscillator-buffer output is in the range of 2000 kc to 4000 kc, the first frequency multiplier is intended for doubling, tripling, or quadrupling the input frequency.

The output of the first multiplier is capacity coupled, through C512, to the grid of the second multiplier V503, also a type 807 tube. The plate tank of the second multiplier is composed of C517 and L506, and is identical to that of the first multiplier except for its frequency range, which is 4000 kc to 26,000 kc. This multiplier is designed for use as a doubler or as a straight amplifier.

The full r-f output of the second multiplier is capacity coupled, through C518, to the grid of the type 4-400A driver tube, V504. The magnitude of this voltage and therefore the grid current of the driver may be controlled, from the front panel, by means of the r-f excitation control, R519. This potentiometer varies the screen voltage and hence the output of the first multiplier tube, V502. A second drive control is also incorporated in the unit. This control, potentiometer R522, is mechanically linked to L506 and C517, the second multiplier tank, and is automatically positioned when the tank is tuned. It controls the second multi-

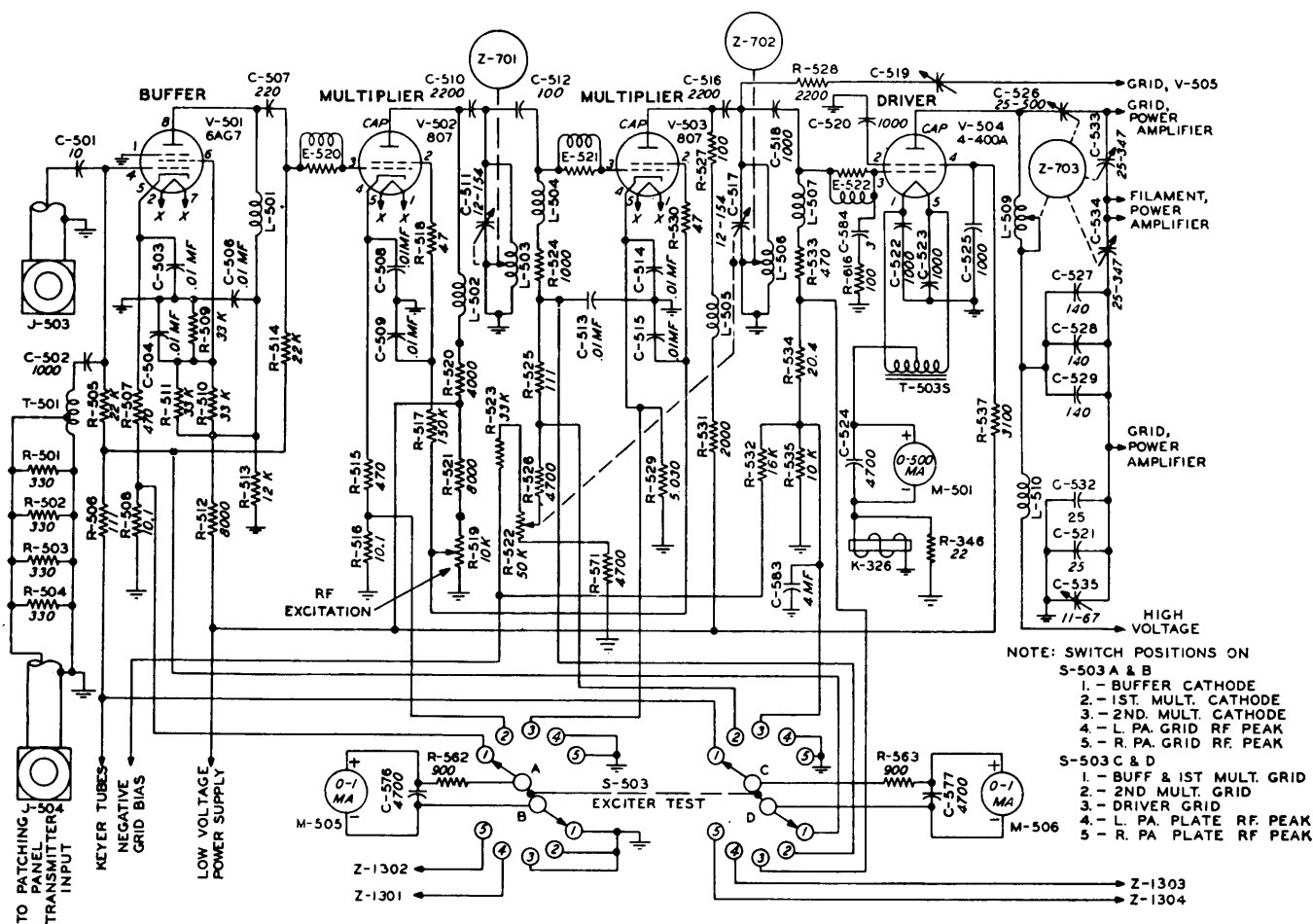


Figure 2-21. Simplified Schematic — RF Unit T-225A/FRT-5, Buffer, Multipliers and Driver

plier grid bias so that it is maximum at the lowest frequency and minimum at the highest frequency of operation.

(b) ELECTRONIC KEYSER. — (Refer to figure 2-22.) — On-off keying is accomplished by controlling the bias of the first buffer, V501, and the first frequency multiplier, V502, in accordance with the keying impulses. Bias for these two tubes is obtained from a tap near the electrical zero voltage point of a voltage divider connected between the negative 400-volt bias supply and the positive 600-volt low voltage supply. This divider circuit is so proportioned that the voltage from its center resistance, R560, to ground is essentially zero. R560 is a potentiometer mounted on the control panel of the electronic keyer and is designated as **KEYER OUTPUT**. This control allows an exact adjustment of the zero voltage output from this divider which corresponds to "carrier-on" condition. A keyer tube, V507, which is a type 12AU7 dual triode, is connected to a tap on the positive side of this divider in such a manner that current drawn by one section will upset the dividing ratio and consequently cause

the voltage at the tap to become negative with respect to ground. This will become clear on close inspection of the schematic diagram. Note that the voltage divider consists of R558, R559, R560, and R561 in series. Current flowing to plate of the second section of V507 will add to any current that was already flowing in R558 and therefore cause the junction of R558 and R559, which is also the applied plate voltage, to shift in the negative direction. This results in a negative voltage being applied to the keyed tubes which causes plate current cut-off and therefore a "carrier off" condition.

This keyer is arranged to accept keying impulses that are negative, positive, polar negative, or polar positive for mark. Since a negative voltage applied to the grid (pin #7) of the second section will produce "carrier on" condition, only this section is used for negative or polar negative keying. The only difference between these two types of keying is that for polar negative, a cathode resistor, R557, is inserted to produce a positive cathode bias. This allows the tube to operate in a class "A" condition so that the grid is affected by voltage swings in both directions. In order to accept positive

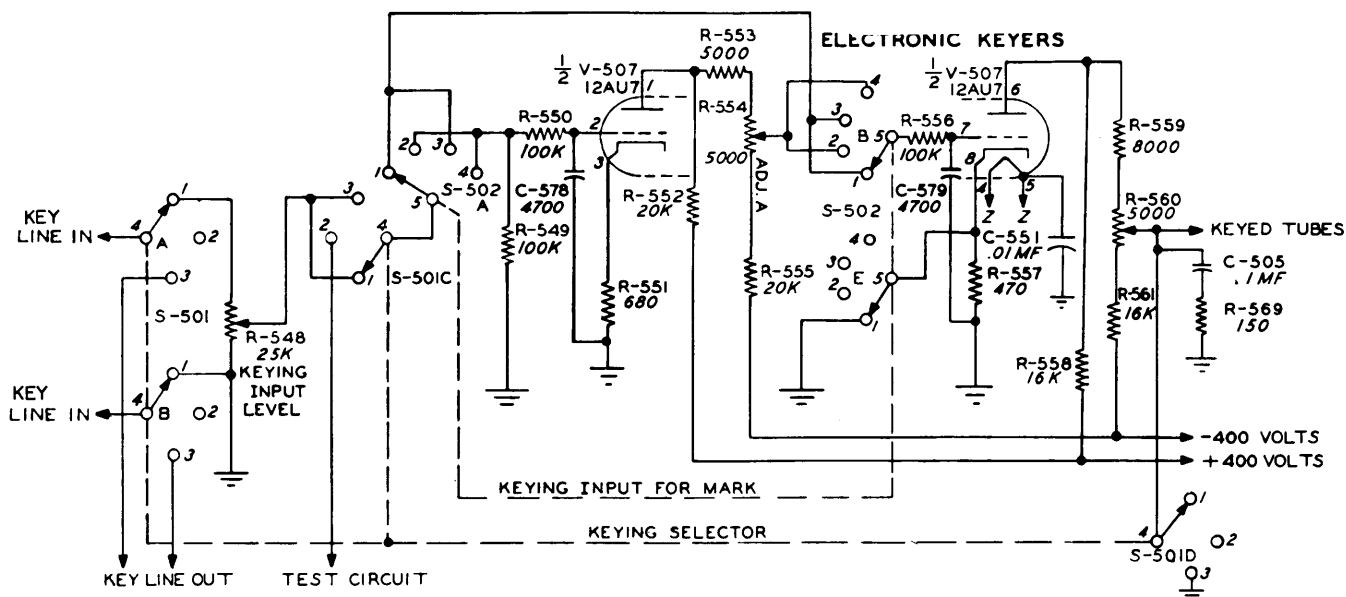


Figure 2-22. Simplified Schematic — RF Unit T-225A/FRT-5, Electronic Keyer

keying impulses, a phase inversion stage is inserted ahead of the keyer. This stage is the first half of V507 and has a voltage gain which is adjusted to unity. The entire keyer is direct coupled. A variable resistor, R554, is required in the output section of the first or phase inverter half of this keyer to allow adjustment of the average d-c voltage applied to the second section of the keyer by the phase inverting section. The procedure for making this adjustment is very simple and is explained in detail in a later section.

Although it would be possible to key the transmitter manually by utilizing test keys to ground the output of this keyer and thus turn on the carrier, this would give no assurance that the keyer itself was functioning properly. A keying test voltage is therefore developed and applied to the keyer input through the contacts of the test keys for manual keying. Since there are four choices of keying impulses that will operate this keyer, the test keying circuit must deliver voltage to suit the requirements of each. The circuit shown in figure 2-23 consists of a network of resistors connected as voltage dividers between the negative 400-volt and the positive 600-volt power supplies. By appropriate choice of resistance values, 50 volts for mark with the required polarization is made available at the test key terminals. The required test keying voltage is automatically set up by the selector switch which sets up the keyer itself for a given type of keying impulse. This switch is operated from the front panel of the keyer.

(c) DRIVER. — (Refer to figure 2-21.) — The driver stage, V504, employs a type 4-400A high gain tetrode tube. It amplifies the signal from the second multiplier a sufficient amount to drive the

push-pull amplifier. Although V504 is a well-shielded screen grid tube, some neutralization is nevertheless required. To provide this neutralization, C519 feeds back a small amount of out-of-phase voltage.

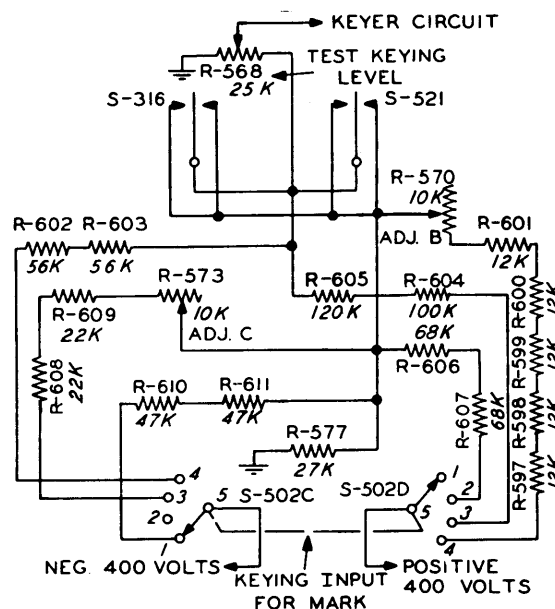


Figure 2-23. Schematic — RF Unit T-225A/FRT-5, Keyer Test Circuit

A single coupling circuit provides a high impedance load for the driver and delivers push-pull excitation voltage to the low impedance grids of the intermediate power amplifier. A constant voltage ratio of about 5 to 1 is maintained between the driver swing and the intermediate amplifier grid swing. These functions are performed simultaneously and uniformly over the full 4000-26,000-kc range by a single coupling circuit. The

tuning is done by a single motor which drives all of the components.

To better explain the method of obtaining push-pull excitation from this circuit, figure 2-24 will be used. For this discussion, only the equivalent r-f circuit is necessary so that the d-c block capacitors designated as C527, C528 and C529 may be considered as being short-circuited. It is then seen that the inductive branch of

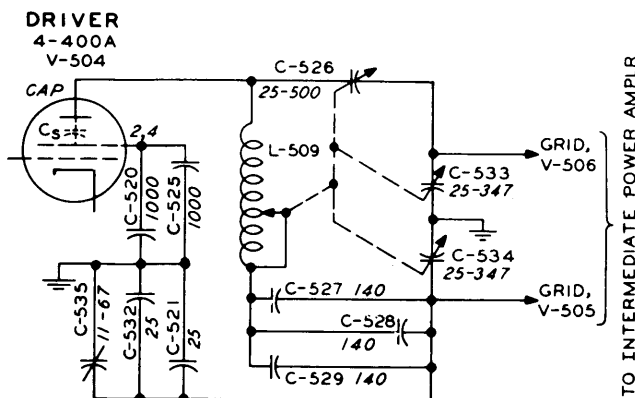


Figure 2-24. Schematic — RF Unit T-225A/FRT-5,
Driver to PA Coupling Circuit

the tank may now be thought of as consisting of L509 and C534 in series, and that the capacitive branch may be thought of as C526 and C533 in series. Because C533 and C534 are equal the voltages developed across them will be equal provided the current through them is equal, and, since the tank current flows through them in the opposite directions, the voltages developed will be 180° apart. To insure the equality of these voltages, balancing capacitors C521, C532 and C535 are connected in parallel and to ground from one side of C534. This balancing capacitance provides a return path for the current which flows to ground through the driver tube output capacitance.

Variable inductor L509, variable capacitor C526, and variable loading capacitors C533 and C534 are geared together and positioned simultaneously by a servomotor drive which tunes the circuit across the frequency range.

(d) POWER AMPLIFIER. — (Refer to figure 2-25.) — The power amplifier is a grounded cathode, cross-neutralized push-pull class "C" amplifier. It utilizes two type 3X2500A3 air-cooled triodes, V505 and V506. A preventable oscillation is inherent in this stage in the vicinity of 50 mc. At this frequency the neutralization circuit feedback can be excessive because of the series inductance of the neutralizing capacitor and its leads. For this reason, the neutralizing leads of the power amplifier contain oscillation suppressors

composed of C539, C540, E523, E524, and two shunting copper straps. These suppressors are made resonant at the frequency to be suppressed. This effectively reduces the excessive neutralizing feedback at the undesired frequency and hence prevents oscillation.

The plate tank of the power amplifier consists of a push-pull, balanced, parallel-resonant circuit composed of capacitors C569 and C570 and inductors L516 and L517. These inductors and capacitors are continuously variable and simultaneously driven with the proper gear ratio by a tuning motor. The circuit is variable over the entire frequency range of 4000 kc to 26,000 kc, with an essentially constant "Q". Because of tube and circuit capacity, the "Q" does rise slightly at the higher frequencies.

1. PA CONVERSION FOR LINEAR AMPLIFICATION. — The circuit that is normally employed at the grids of the power amplifier is designed to present a high impedance load to the type 4-400A driver tube and to deliver balanced push-pull voltage to the relatively low impedance grid circuit of the PA. This is not a suitable circuit for accepting drive from an external exciter such as the Western Electric type D-156000 single side-band suppressed carrier transmitter. Therefore the power amplifier must be modified slightly for such operation. Figure 2-26 is a simplified schematic of the power amplifier input circuit following conversion for linear amplifier operation.

It is necessary to operate the PA as class "B" stage in order to obtain the required linear amplification with reasonable efficiency. Ordinarily the power amplifier is operated as a class "C" stage and is biased to about twice the cut-off voltage which is negative 280 volts. With class "B" operation, however, plate current must flow for 180° or for one-half of a cycle; thus the power amplifiers must be biased just to cut-off. This condition is met after the modification is complete. Under these conditions, and with no grid signal, the static plate current is almost zero. With excitation, the plate signal will be an exact replica of the input or grid signal.

A careful adjustment of the drive voltage and loading is required in order to produce this linear relationship. The tuning procedure for single side-band operation, given in Section 4, assures that these conditions will be met. However, a short explanation of what is to be accomplished during tuning may help to clarify both the theory and the tuning procedure.

In any amplifier the maximum peak r-f plate voltage that can be developed is always less than the applied plate voltage. Conventional triodes usually develop between 80 percent and 90 percent of the applied plate voltage when operated as class "C" amplifiers.

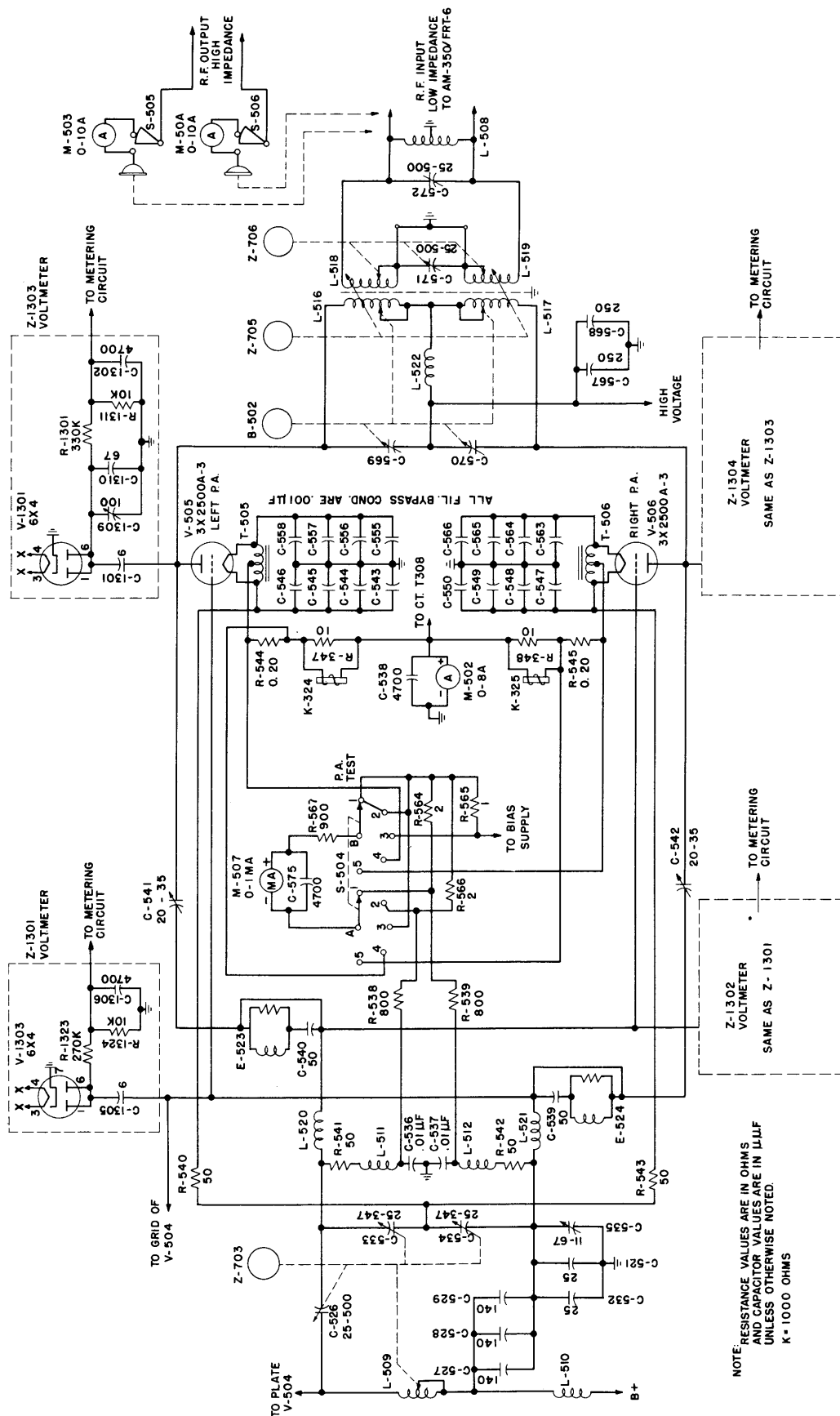


Figure 2-25. Simplified Schematic — RF Unit T-225A/FRT-5, Power Amplifier

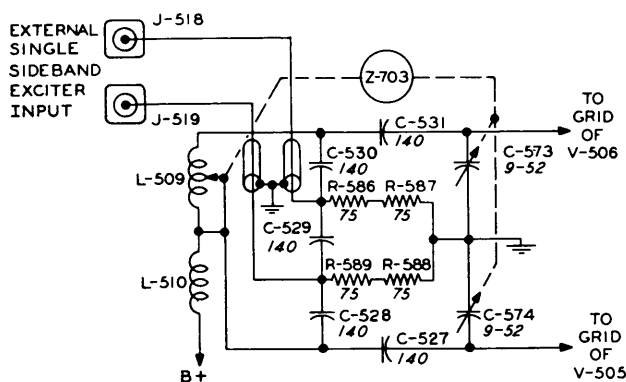


Figure 2-26. Simplified Schematic — RF Unit
T-225A/FRT-5, Single Side-band Excitation Input

For linear amplifier operation the plate current and therefore the peak r-f plate voltage must be linearly related to the peak r-f grid voltage. Plate load resistance, r-f drive voltage, and bias must be carefully balanced to obtain this linear condition while at the same time delivering a maximum of useful output power. Since the peak r-f plate voltage swing is pretty well established regardless of operating conditions, any variation of the load resistance must be accompanied by an equal variation in the r-f plate current in order to maintain this voltage. This means that for linear operation a range of linear grid voltage plate current conditions must be found and utilized. The low or zero voltage point is determined by the operating bias which in the case of a class "B" linear amplifier is slightly above plate current cut-off. Departure from linearity at the maximum voltage end is usually the result of a grid voltage that is positive and approaching the instantaneous value of the plate voltage, thus deflecting many of the electrons from their intended destination at the plate to a new destination, the grid. This of course increases the grid current and requires considerable power from the driving source. A limit of maximum grid swing must be chosen that is sufficiently lower than this so that the linear grid-voltage to plate-current relation still exists. At this operating condition maximum r-f grid swing, maximum r-f plate swing and maximum r-f plate current occur simultaneously. Steady operation under this condition is usually not possible because of excessive plate dissipation so actual adjustments requiring a steady carrier must be made at reduced operating conditions. Usual practice in AM service is to adjust for one-half the value of both grid and plate swings, so that the full range of the tube's capabilities will be utilized at 100 percent modulation when all voltages double. This is accomplished by actually setting the grid voltage to a value which is predetermined to be one-half of the linear swing capability, and adjusting

the plate load until one-half of the maximum plate r-f swing exists. Power output under this condition is then one-quarter (since voltages are one half and power varies as square of voltage) of the peak available power.

A similar reasoning can be made in the case of the single side-band adjustment, except there is no good reason for choosing the factor of one half. It might just as well be one sixth or some other fraction as long as the plate load is adjusted for a swing that is the same fraction of the maximum plate swing. A value of one half is suggested because the same settings can also be used for AM linear amplifier adjustments.

Peak reading r-f voltmeters are permanently installed on the r-f tank circuits to facilitate these adjustments.

It is very important that the values given in Section 4 under tuning procedure be properly set up. If the grid swing is set to less than the recommended value, the plate swing could still be easily adjusted to the value shown and thus keep within the dissipation rating of the tube. In order to do so, however, the power amplifiers would have to be underloaded which would result in an increase in efficiency, but at the same time a decrease in power output. On the other hand, if the peak grid swing were made more than the recommended value it would be necessary to load the PA more heavily, by decreasing the load resistance, which would in turn result in increased power output but decreased efficiency for the stage. Optimum power output at a reasonable value of efficiency will be obtained if the grid and plate swings are properly adjusted as described.

Peak power output under these conditions should be 8 kw. This value corresponds to an AM carrier power level of 2 kw.

(e) OUTPUT COUPLING CIRCUIT.—Coupling between the PA stage and the 600-ohm transmission line is effected by a parallel-resonant circuit consisting of two oppositely wound inductors, L518 and L519, and two variable capacitors, C571 and C572. These units are mounted on a platform which is suspended from rails in the top of RF Unit T-225A/FRT-5. The position of this platform, as varied by a chain drive and motor, governs the amount of magnetic coupling between the plate tank inductors (L516 and L517) and the inductors of the coupling network. When operating into a 600-ohm transmission line, capacitor C571 must be removed at the lower frequencies (see figures 2-25 and 4-12). This is accomplished by shorting each end of the capacitor to ground by means of the shorting straps provided.

At the higher frequencies (above 10 mc), the inductance of the leads becomes appreciable and it becomes difficult if not impossible to obtain the proper loading because of the low circuit "Q". To correct this condition, C571 is inserted in the circuit by pulling out the shorting strap. This allows the circuit to be properly loaded by virtue of its higher "Q".

(3) RF UNIT T-225A/FRT-5 — AUXILIARY FEATURES.

(a) TUNING SYSTEM. — (Refer to figure 2-27.) — All variable resonant circuits are motor operated and servo positioned from front panel controls. A small reversible a-c motor is mechanically coupled to each of the variable circuits, and is in turn controlled by a pair of relays, K801 and K802, located

within a servo amplifier chassis. The servo positioning system is basically an a-c bridge circuit in which one branch consists of a variable voltage divider or potentiometer mounted on the control panel and set by the operator, while the other arm consists of a variable voltage divider mechanically coupled to the motor-driven circuit. The arrangement is such that the bridge will always seek a balance by closing the appropriate motor relay until the balance is obtained.

In order to increase the bridge sensitivity, and therefore the setting accuracy, and also to give "sense" to the bridge, a vacuum tube amplifier is used as a detector. This is referred to as the servo amplifier. This amplifier consists of a push-pull voltage amplifier, V801, followed by a push-pull relay control stage, V802. The operating voltage for this bridge is approxi-

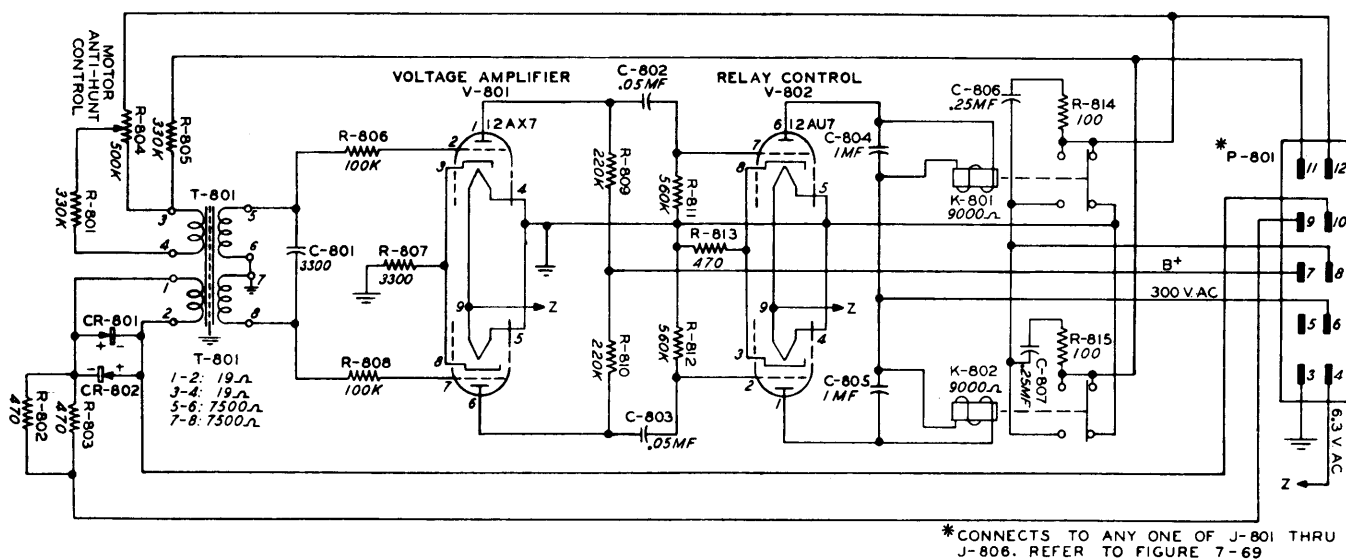


Figure 2-27. Schematic — RF Unit T-225A/FRT-5, Servo Amplifier

mately 30 volts, 60 cps. This voltage is applied simultaneously to both the front panel control and the motor positioned control. Since both of these controls are voltage dividers, the divider ratios will be alike when the controls are identically positioned, and there will be no voltage difference between the variable arms. If, however, they are not identically positioned, the divider ratios will be different, and a voltage will be developed that is proportional to the difference in the position of the arms. The first stage of the servo amplifier, V801, has this difference voltage applied to its grids, and it in turn applies amplified push-pull voltage to the grids of the relay control tube V802. This relay control tube operates with 60-cps a-c plate voltage. Both plates of V802 are supplied from the same

source so that their plate voltages are in phase. Since the grids are fed push-pull, only one of the two sections will have its grid and plate positive at the same time. Therefore only one section will draw current at any given time. The particular section of V802 which draws current and therefore closes the motor relay depends on the phasing of the voltage fed into the amplifier from the bridge. Because of this arrangement, the appropriate relay will operate to bring the bridge into balance and therefore position the associated transmitter component to coincide with the control dial setting.

Power for the six servo amplifier units in RF Unit T-225A/FRT-5 is obtained from a special power supply (Z901) which employs a type 6X4 tube (V901) in

a single-phase full-wave rectifier circuit together with a three-section RC filter network. In this power supply transformer T901 supplies filament voltage to all servo amplifier tubes, as well as the rectifier tube in the power supply itself. Transformer T902 has three windings. The first supplies 250 volts which is rectified, filtered, and fed to the plates of the voltage amplifier tubes. The second supplies 300 volts and is connected to the plates of the push-pull relay control stage through their associated relay coils. The third supplies 30 volts to operate the bridge circuit. Transformer T903 has one tapped winding which supplies voltage to operate the drive motors. All transformer primaries are equipped with fuses, and indicator lights to indicate when fuses are blown.

(b) **METERING AND MONITORING PROVISIONS.** — Provisions are made for metering the cathode current of all of the r-f tubes in the equipment. Eight permanently mounted diode voltmeters are also included in the equipment for use in measuring the peak r-f voltages. These are a valuable aid when tuning the equipment, as well as when setting it up for single side-band operation.

A continuous check of the cathode current of the driver amplifier, and the total plate current of the power amplifiers is maintained by meters M501 and M502. These meters have 0-500 ma and 0-8 amp ranges, respectively, and are located on the upper front door of RF Unit T-225A/FRT-5.

Two 0-1 ma meters, M505 and M506, are mounted on the upper front door of RF Unit T-225A/FRT-5 and are labeled EXCITER TEST #1 and EXCITER TEST #2, respectively. Each monitors five different circuits. The two meters are switched into the various circuits simultaneously by means of a single selector switch, S503. Their scales are arbitrary, the full-scale reading for each position of the switch being indicated opposite the switch pointer. Meter M505 (EXCITER TEST #1) checks the buffer amplifier cathode current, the 1st multiplier cathode current, the 2nd multiplier cathode current, and the peak r-f voltages in the grid circuits of the left and right power amplifier tubes. Meter M506 (EXCITER TEST #2) checks the combined buffer and 1st multiplier grid current, the grid current of the 2nd multiplier, the grid current of the driver, and the peak r-f voltages in the plate circuits of the left and right power amplifier tubes.

The meter designated PA TEST (M507) is a 0-1 ma meter mounted on the upper front door of RF Unit T-225A/FRT-5. This provides metering of the individual cathode and grid currents of the power amplifier tubes, as well as the total grid current for the stage, according to the setting of selector switch

S504. Meter M507 has arbitrary scales, the proper full-scale reading for the various circuits being indicated opposite the pointer on selector switch S504.

Antenna current is measured by meters M503 and M504 located on top of RF Unit T-225A/FRT-5. These meters have switches (S505 and S506) which allow them to be inserted or removed from the lines at the will of the operator, but are normally left out.

A sample of the r-f voltage applied to the grid of the 1st buffer, which is between 2000 kc and 4000 kc, is fed to an external frequency monitoring circuit through coaxial jacks and plugs and designated as J503, P503, J506 and P506.

c. POWER SUPPLIES.

(1) **GENERAL.** — This portion of Radio Transmitting Set AN/FRT-5A consists of a main power supply unit and a power distribution system whose primary function is to supply and control the operating power of the r-f unit.

(2) **PRIMARY (230 VOLTS) DISTRIBUTION SYSTEM.** — All 230-volt three-phase primary power is brought in from the main bus through three 50-amp fuses (F403, F404 and F405) located in Power Control C-587A/FRT-5.

This power is distributed to the various sections of the transmitter through automatic over-current breakers. Six of these breakers are located on the control panel of Power Supply PP-490A/FRT-5, and one in Power Control C-587A/FRT-5. They distribute the 230-volt power as follows:

(a) 230 volts, single phase, to —

1. Servo power supply for RF Unit T-225A/FRT-5.
2. Bias and low voltage supply for RF Unit T-225A/FRT-5.
3. Power amplifier filament transformers.
4. Control circuits for Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5.

(b) 230 volts, three phase, to —

1. Filament transformers for RF Unit T-225A/FRT-6, excluding power amplifiers.
2. Blowers for RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5.
3. Power Control C-587A/FRT-5.

(3) **POWER SUPPLY PP-490A/FRT-5.**

(a) **BIAS SUPPLY.** — (Refer to figure 2-28.) — The bias supply for the r-f tubes in RF Unit T-225A/FRT-5 develops 400 volts, negative to ground.

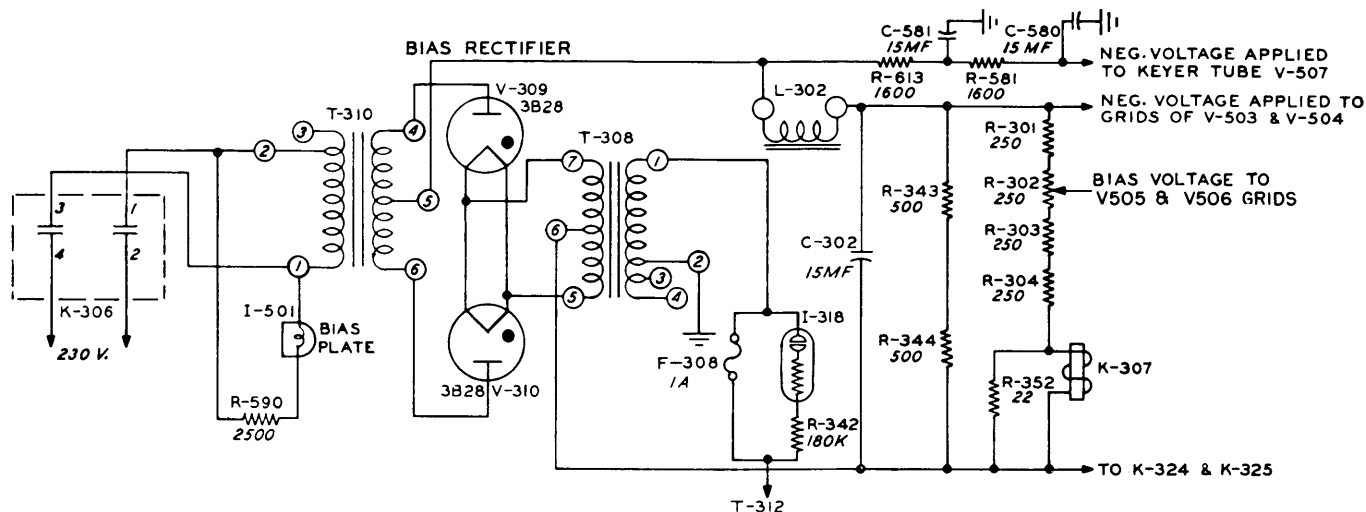


Figure 2-28. Simplified Schematic — Power Supply PP-490A/FRT-5, Bias Supply Section

When no grid current is being drawn by any stage it is loaded to 0.8 ampere by bleeder resistors R301, R302, R303, R343 and R344. Bias for the power amplifier is obtained from the tap on variable resistor R302. This tap permits adjustment for class "B" operation and is an aid to the control of keyed wave shape. Since the final amplifier grid current is in opposition to the bias bleeder current, the load on this supply drops to about 200 ma during "carrier on" conditions. All other r-f stages are provided with cut-off bias from this supply.

This supply is a conventional single-phase full-wave circuit utilizing two type 3B28 xenon-gas-filled rectifiers and a single-section choke-input type filter. Bias interlock relay K307 and its shunt R352 are in series

with the bleeder resistors so that a portion of the previously mentioned bleeder current must flow through them. Since this relay must be closed before either the low voltage d-c or the high voltage d-c power supplies can be energized, it serves as an effective bias interlock.

(b) LOW VOLTAGE D-C SUPPLY. — (Refer to figure 2-29.) — A d-c potential of 600 volts to operate the crystal oscillator and frequency multiplier stages, and to supply screen voltage for the driver, is developed by the low voltage d-c supply. This supply is a conventional single-phase full-wave circuit utilizing two type 3B28 rectifier tubes. A single-section choke-input filter and a moderate bleeder constitute the remainder of the supply.

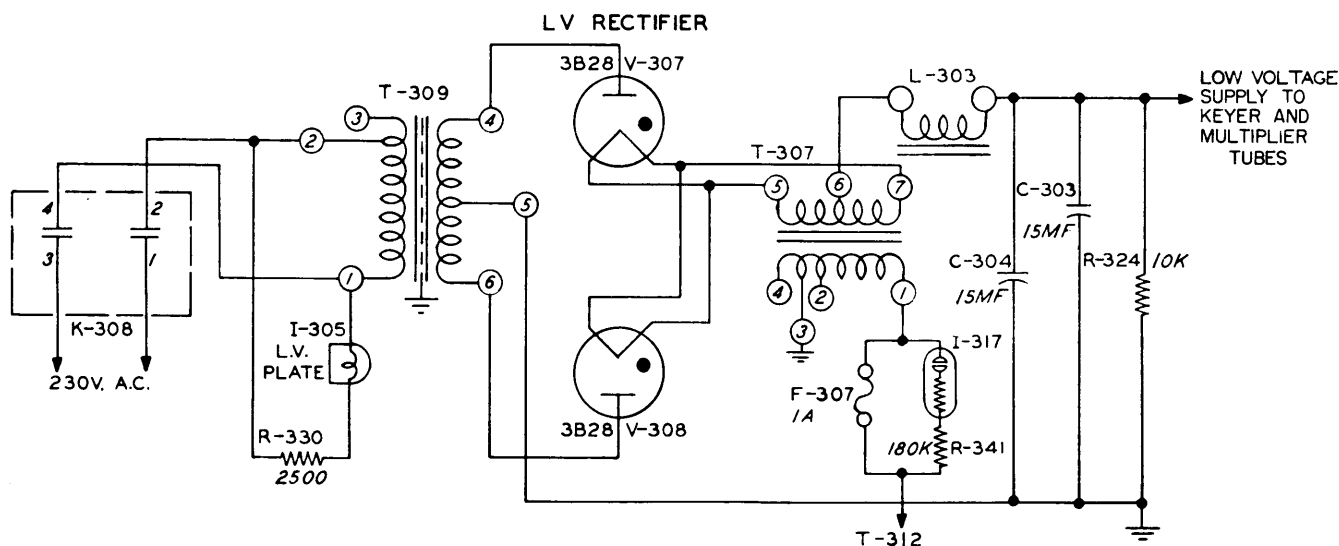


Figure 2-29. Simplified Schematic — Power Supply PP-490A/FRT-5, Low Voltage Supply Section

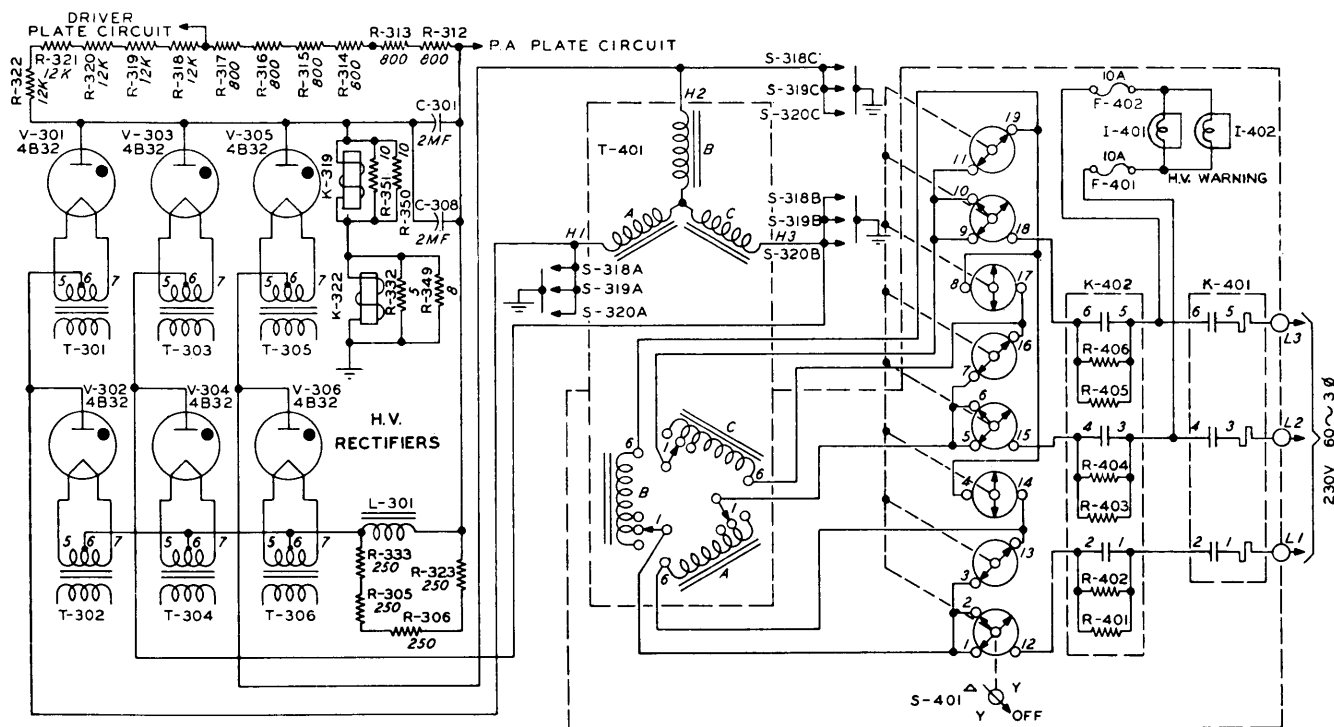
(c) HIGH VOLTAGE D-C SUPPLY. — (Refer to figure 2-30.) — A d-c potential of 5500-6000 volts for operation of the power amplifier is supplied by the high voltage supply. This supply utilizes a three-phase full-wave rectifier circuit which requires six type 4B32 xenon-gas-filled rectifier tubes. The filter consists of a single reactor followed by two 2-mf capacitors in parallel. A heavy bleeder which dissipates approximately 600 watts is used to help maintain constant voltage during keying. As a further effort to minimize the transient voltage dip during keying, the filter reactor is shunted by 1000 ohms of resistance consisting of R305, R306, R323, and R333. These resistors prevent the very high voltage from building up across the filter reactor during sudden current changes such as occur when the key is opened or closed. Without these resistors a voltage equal to 50 percent or more of the supply voltage might momentarily be developed at the moment of key closing. Such voltage would subtract from the available supply voltage and produce a transient modulation of the keyed pulse. These resistors minimize this transient modulation so that it does not exceed 20 percent to 25 percent at its worst condition. For single side-band operation or frequency-shift keying operation, better filtering is obtained with these resistors removed.

Resistors R308 and R309 constitute a series resistance of 42 ohms in the d-c line to the power amplifier.

They are inserted to minimize the current surge in the event of an amplifier tube arc-back or any d-c arc-over in the power amplifier. Without these resistors such arc-overs or flash-backs would have almost unlimited peak currents because they would be discharging the filter capacitors directly.

This power supply is capable of delivering approximately 4.5 amperes at its rated voltage. This would appear to be beyond the normal rating of a three-phase full-wave rectifier using type 4B32 tubes, according to published and standard information which gives a rating of 3.75 amperes. However, the filament emission rating of any gas vapor rectifier can be doubled by operation with the filament voltage 60°, 90° or 120° out of phase with the plate voltage. This simply allows the plate current pulse to flow during the time that there is very little difference in voltage between the ends of the filament, and thus allows a uniform distribution of the emission current over the length of the filament. With normal in-phase operation, on the other hand, plate current flows at a time when the voltage difference between ends of the filament is maximum, in which case the majority of the emission takes place at the negative end of the filament.

This doubling of average current rating is not often attainable in small size mercury-vapor tubes because the gas temperature rise, which aggravates flash-backs, becomes too great long before double current is reached.



Figur 2-30. Simplified Schematic — Power Supply PP-490A/FRT-5,
High Voltage Supply Section

Xenon gas, however, is very stable over a wide range of temperatures and therefore is not as severely affected by the increase in current as is mercury.

This rectifier has been very carefully phased so that all tubes are operating with either 120° or 60° phasing between filament and plate voltages. Therefore it is actually operating quite conservatively at 4.5 amperes.

The high voltage fed to the rectifier tubes is obtained from external Power Transformer TF-122/U. The primary circuit of this transformer (T401) has a manually operated DELTA-WYE-OFF switch for changing the transformer primary connections or opening them completely. Also located in the primary line are contactor K402 and a set of tune-up resistors. Contactor K402 is operated by the TUNE-OPERATE switch located on the control panel of Power Supply PP-490A/FRT-5. When the TUNE-OPERATE switch is in the HV TUNE position, contactor K402 is open and tune-up resistors R401 through R406 are in series with the primary line, thus dropping the voltage to the power transformer. When the TUNE-OPERATE switch is turned to OPERATE position, contactor K402 is operated, shorting out the tune-up resistors, and full voltage is applied to the primary of power transformer T401. Filament voltage for the power supply rectifier tubes is provided by transformers T301 through T306 inclusive.

(d) METERING PROVISIONS. — Three meters mounted on the upper front door of Power Supply PP-490A/FRT-5 provide metering of all important voltages connected with RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5. Meter M301 (P.A. PLATE VOLTAGE) is a 0-8 kv meter which monitors the plate voltage of the power amplifiers at all times. The other two, A.C. LINE VOLTAGE meter M302 and P.A. FILAMENT VOLTAGE meter M303, are simultaneously cut into the desired circuits by a two-gang five-position selector switch (S314). Meter M302 is a 0-300 v voltmeter which checks the three phases of the primary line voltage in the first three positions of selector switch S314, and indicates the output voltage of the regulating transformers (T311 and T312) in positions #4 and #5. When the switch is in positions #4 and #5, meter M303, a 0-10 v voltmeter, simultaneously indicates the filament voltages on the left and right power amplifier tubes, respectively.

d. POWER CONTROL CIRCUITS.

(See figure 2-31.)

(1) RF UNIT T-225A/FRT-5 AND POWER SUPPLY PP-490A/FRT-5. — The power control circuits of RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5 are divided into two parts, viz, the

filament and blower control circuits and the d-c control circuits. In more detail, they are as follows:

(a) FILAMENT STARTING SEQUENCE. —

The normal filament starting sequence can be accomplished with only the filament and blower circuit breakers S301, S304, and S305 closed, and all other circuits de-energized. Starting is accomplished by throwing the front panel toggle switches, S307 and S510, which are in series, to their FILAMENT positions. These toggle switches have red handles and are also marked as EMERGENCY OFF switches. They are so marked because they control the primary relays, and therefore provide the best possible "emergency off" circuit. Further, since both switches must be in the ON position for the equipment to be operating, either switch when thrown to the OFF position will cause a complete shutdown.

If the LOW LEVEL FILAMENT circuit breaker (S304) is closed, the LOW LEVEL FILAMENT contactor, K301, may be operated through the front panel toggle FILAMENT ON-OFF switch (S307). This circuit will function even though all other circuit breakers are open. Next, if the BLOWER circuit breaker (S301) is closed, or has previously been closed, the blower will start up through BLOWER contactor K302. Contactor K302 receives its power from the blower circuit, but requires that the LOW LEVEL FILAMENT contactor (K301) be closed before it can close to start the blowers. Once closed, however, the BLOWER contactor (K302) will remain closed for a set time interval after the filament contactor has been released as determined by BLOWER HOLD ON TIME delay relay K305. Once the blowers have started, all other circuit breakers in the transmitter can be opened without shutting down the blowers themselves. The blowers will continue to run until the set time has elapsed or until the BLOWER circuit breaker is thrown off. If the P.A. FILAMENT circuit breaker (S305) is closed or has previously been closed, the filament transformers will be energized through the P.A. FILAMENT contactor (K303). Although K303 receives its power from the P.A. FILAMENT circuit breaker, it is interlocked through an air interlock, S511, in the blower air stream, and an auxiliary contact on the LOW LEVEL FILAMENT contactor, K301. An auxiliary contact on P.A. FILAMENT contactor K303 interlocks with the plate voltage control circuit, preventing application of plate voltage if the contactor is not closed.

It will be noted from the schematic that the low level filament circuit consists of 10 separate filament transformers. The primary voltage to these transformers is maintained constant by voltage regulating transformers T311 and T312. These are special transformers in that

they are tolerant of a 5 percent frequency variation. Their regulating ability, in the face of primary line voltage changes, is excellent. Their design, however, is such that the secondary voltage, which becomes the line voltage for connected loads, is greatly dependent on the magnitude and power factor of the connected load. The load on these transformers has been set as close as is practical to the required load value. If any of these loads is disconnected, it is normal for the transformer voltage to rise. However, this is not a normal operating condition and therefore is not a matter for concern.

The filament voltages on the power amplifier tubes are manually controllable over a 10 percent range by means of four primary taps on the filament transformer and a series line resistor in the primary of each filament transformer (T505 and T506). The resistors, designated as R326 and R327, are located on the power bay control panel, while the primary tap switches, designated as S512 and S513, are located on the front of RF Unit T-225A/FRT-5 directly above the vacuum tube keyer.

The filament pilot lamps, which are the left-hand lamps on each of the upper front doors, are valuable status indicators. It will be noted that the pilot lamp on the power bay is connected across the load side of the voltage regulating transformer, thereby indicating that power is present on the primaries of the low level filament transformers. However, the filament pilot lamp on RF Unit T-225A/FRT-5 is connected across the coil of the power amplifier filament contactor so that it indicates definitely that this contactor is closed, that the blowers are operating, and that the power amplifier filament breaker is closed.

(b) PLATE POWER SEQUENCE. — Low voltage and bias voltages are obtained through a common breaker, S302, while the high voltage is supplied through a special motor-operated circuit breaker, K401, located in Power Control C-587A/FRT-5. Circuit breaker K401 doubles as a plate start-stop contactor. Control voltage for operation of these d-c supply controls is fed through CONTROL CIRCUIT breaker S303. The control circuits are interlocked through PA FILament contactor K303. An energized control circuit is indicated by the lighting of the meter lights. Arrangements have been made so that the control circuit will not be energized until CONTROL CIRCUIT breaker S303 and P.A. FILament contactor K303 are closed. Alternatively, failure of either circuit breaker or contactor will de-energize the control circuit and remove all plate and bias voltages. In addition the circuit is arranged so that a bias voltage must exist before the low or high voltage contactor will close, while the LOW VOLTAGE supply contactor, K308, must be

energized before the high voltage contactor will remain closed. All contactors directly controlling the d-c supply voltages are interlocked with the cabinet doors through a series-connected door interlock circuit incorporated in the control circuit.

The BIAS voltage contactor, K306, is energized automatically at the end of the filament heating time delay by the closure of the FILament TIME DELAY relay, K304, provided that the CONTROL CIRCUIT and LOW VOLTAGE AND BIAS circuit breakers are closed, that the BLOWER, LOW LEVEL FILament and P.A. FILament contactors are energized, and that all interlocked doors are closed. Low voltage dc will be applied instantly when the PLATE ON button, which energizes the LOW VOLTAGE contactor (K308), is depressed, provided that the bias voltage is adequate to energize BIAS interlock K307.

A BIAS pilot lamp on RF Unit T-225A/FRT-5 and a LV pilot lamp on Power Supply PP-490A/FRT-5 indicate when primary voltage is present at these supplies.

High voltage dc will be applied approximately one-third of a second after depressing the PLATE ON button, provided all the interlock circuits are closed. Red pilot lamps on both units indicate that high voltage should be present. The interlocked components, in addition to the one already mentioned, are the d-c overload circuits and the manual TUNE-OPERATE SWITCH. The d-c overload relays consist of a left PA overload (K324), a right PA overload (K325), a H.V.D.C. OVERLOAD (K319) and a DRIVER OVERLOAD (K326). Their respective contacts are connected in series with each other and in series with the under-voltage release coil (K401A) of the high voltage circuit breaker (K401).

The circuit breaker for the high voltage supply is a high-speed, high-interrupting-capacity unit with motor operation and the above-mentioned under-voltage release coil. It serves as a high voltage on-off contactor and, at the same time, provides a-c overload protection through the use of both thermal and magnetic trip units. The thermal trip unit is set at 125 amperes and will allow continuous operation at up to 20 percent overload and five seconds of operation at 800 percent overload. The magnetic trip unit is adjustable from 400 to 1250 amperes and is accessible for adjustment when the front cover of the circuit breaker is removed. The normal recommended setting is 400 amperes. In the circuit diagram, the complete circuit breaker is designated as K401. The motor is shown as a circle and the under-voltage release coil as a winding. With this breaker, the under-voltage release coil must be continuously energized in order to hold the circuit closed. Opening this under-voltage circuit causes in-

stantaneous trip-out of the breaker. Since this coil receives its energy from the control circuit through the d-c overload contacts, the interlocking contacts on both the bias voltage supply and low voltage supply contactors and all of the door interlocks, opening of any of these contacts will cause instantaneous trip-out of the breaker. The circuit is arranged so that if the main circuit breaker under-voltage release coil is de-energized and the TUNE-OPERATE SWITCH is in the LOW VOLTAGE TUNE position, the circuit breaker starting motor will run the circuit breaker to the reset position and stop without closing the main contacts when the PLATE ON button is depressed. If, however, the TUNE-OPERATE SWITCH is in either the HIGH VOLTAGE TUNE or the OPERATE position, and the under-voltage release coils are still de-energized, the circuit breaker starting motor will continue to run but still will not close the main contacts while the PLATE ON button is depressed. In other words, the under-voltage release coil must be energized before the main circuit breaker contacts will close, even though the motor may appear to function normally.

The manual TUNE-OPERATE SWITCH, previously mentioned as an additional interlock on the high voltage, is a three-position switch. In the first position, LOW VOLTAGE TUNE, the main circuit breaker motor circuit is opened for the closing direction so that the circuit breaker can run to the reset position, but no farther. Only low voltage dc can be applied in this position. The second position, HIGH VOLTAGE TUNE, allows the main circuit breaker to close, applying high voltage but leaving resistors in the primary line of the high voltage transformer for tuning purposes or reduced power output. The third position, OPERATE, activates the HIGH VOLTAGE STEP-STARTER INTERVAL timer, K318, through the contacts of the MAIN BRKR AUXiliary K311, which in turn activates the TUNE RESISTOR SHORTING contactor, K402, thus shorting the tuning resistors and providing normal operation. The TUNE-OPERATE switch can be operated from the LOW VOLTAGE TUNE position to HIGH VOLTAGE TUNE or OPERATE position without shutting down the plate voltage. Once the high voltage supply has been turned on, the TUNE-OPERATE SWITCH will not shut it off. This supply can be switched back and forth between the "high voltage tune" and the "operate" conditions at the will of the operator, but a return of the low voltage tune condition requires that the d-c voltages be manually shut down and restarted by means of the momentary push buttons with the tune operate switch in the LOW VOLTAGE TUNE position.

(c) AUTOMATIC RESTART CIRCUIT. — This circuit incorporates a complete automatic restart-

after-overload feature. For a short interval of time after manual start up, adjustable from 0 to 30 seconds on NON-AUTOMATIC RESTART INTERVAL timer K312, any overload will cause the low voltage and power amplifier voltage supplies to shut off and stay off. During this interval the NON-AUTOMATIC RESTART AUXiliary contactor K320 completes the circuit to the reset coil (K315B) of RESTART CYCLE COUNTER (K315) to prevent the counter from stepping to any other than the first contact. At the end of this interval, the NON-AUTOMATIC RESTART AUXiliary relay is de-energized, allowing recycling to take place in the event of subsequent overloads.

The number (adjustable from 0-8) of automatic recycles which may take place before the transmitter locks out can be preset by manual operation of the selector switch on RESTART CYCLE COUNTER S317. However, these consecutive overloads must occur within an adjustable time interval of 0-15 minutes, as determined by the AUTOMATIC RESTART INTERVAL timer, K316, in order to cause the power supplies to lock out.

If an overload occurs after the initial "non-automatic restart" period following manual start, it energizes the RESTART INTERVAL TIMER AUXiliary K313, which locks up through the contacts of AUTOMATIC RESTART INTERVAL timer, K316, resulting in the lighting of the automatic restart indicators, which are designated OVERLOAD on the front of each bay. Timer K313, in turn, energizes the LOCK-OUT ALARM AUXiliary, K321, and the AUTOMATIC RESTART INTERVAL timer, K316. The occurrence of this overload also energizes the stepping coil (K315A) of RESTART CYCLE COUNTER K315 causing the counter to move to the next contact. If no more overloads occur within the interval of time determined by the AUTOMATIC RESTART INTERVAL timer, the reset coil (K315B) of RESTART CYCLE COUNTER K315 is energized, resetting the RESTART CYCLE COUNTER to its initial position, the same as after manual start. If, however, the overloads and automatic restarts continue to occur within this interval of time, the RESTART CYCLE COUNTER is stepped to the contact that opens the circuit to the NON-AUTOMATIC RESTART INTERVAL timer, K312. This results in the LOW VOLTAGE contactor, K308, being de-energized causing the power supplies to lock out and the LOCK-OUT ALARM horn, I310, to sound an audible warning.

(d) AUTOMATIC SHUT-DOWN CIRCUIT. —An automatic shut-down circuit is incorporated in the control circuits of this transmitter. It consists of a thermal relay, K322, located in the cathode circuit of

the power amplifier and an AUTOMATIC SHUT-DOWN TIME DELAY timer, K323, that is adjustable from 0 to 30 minutes. The thermal relay contacts are normally closed. The energizing coil in this relay is a heater which controls the temperature of a bimetallic strip upon which the moving contact is mounted. Therefore, when the power amplifier is drawing current, either continuously or intermittently, the heater causes the contacts to part after a few seconds delay. When the current through the heater is interrupted, the bimetallic element starts to cool so that in the event the interruption continues for 60 seconds or more, the contacts again close. These contacts are in

series with the operating coil of AUTOMATIC SHUT-DOWN TIME DELAY relay K323 so that any time they are closed, this timer is energized. This timer in turn has its normally closed contacts in series with the coil of LOW VOLTAGE contactor K308, so that in the event this timer is allowed to complete its cycle, power to K308 will be interrupted, thus shutting down the low voltage, and consequently the high voltage, d-c power. This circuit can be rendered inoperative, if so desired, by manual operation of a toggle switch located on the front panel of the power bay and designated AUTO SHUT-DOWN.

SECTION 3

INSTALLATION AND INITIAL ADJUSTMENTS

1. GENERAL.

The entire AN/FRT-5A equipment, including equipment spare parts, is packed in 13 wooden shipping cases. The large transmitter and power supply cabinets, the power control unit and the large power transformer are each packed in a separate case. The two top panels and two end panels used to make the two large units into a finished assembly are packed in two other cases. The accessories and the parts required for single side-band conversion fill a whole case; the equipment installation materials fill another case, and the spare parts chests, three cases. The two remaining cases contain such fragile items as the vacuum capacitors and electron tubes.

The several cases involved are identified, and their numbers, weights and dimensions summarized, in table 1-3 of this book. The contents of the individual cases are listed in detail in the packing sheets shipped with the equipment.

Components within the major units which are not rigidly mounted, or which would be subject to shifting during shipment due to their individual masses, have been blocked up and either braced with wooden shoring or tied with strips of tape. Items such as the large ferrule-mounted resistors, which snap into place, have been secured with tape. Only the very fragile items, such as the electron tubes and vacuum capacitors, have been removed and separately packed.

2. UNPACKING PROCEDURE.

To uncrate the two large units the following procedure should be followed, and the precautions observed.

a. Place the packing case near the position in which the equipment is to be installed.

CAUTION

USE EXTREME CARE WHEN MOVING
THE EQUIPMENT TO AVOID DAMAGE
TO THE CABINETS OR COMPONENTS.

b. Remove the steel straps used to reinforce the corners of the packing case.

c. Remove the nails from the case using a nail puller.

d. Remove the sides and top of the packing case, but

leave the skid, which is integral with the bottom of the case, in place until the unit is moved to its final location.

CAUTION

PRYING OFF THE SIDES MAY RESULT
IN DAMAGE TO THE EQUIPMENT. USE
CARE!

e. When the exact position for a unit is known, the skid may be removed by lifting the unit from the skid and setting it down in position, or by putting the skid in position and then lifting the unit while the skid is slid out from under it. A hoist of 1½ tons capacity, or equivalent manpower, will be required for this operation.

f. Remove the bags of dessicant which have been distributed throughout the transmitter for moisture absorption.

g. Many of the components within the large cabinets have been blocked in place by means of wooden supports and in some cases padding has been used to protect the equipment from damage. Remove all of this excess material. Untie all of the components that have been bound with tape.

b. Carefully remove the smaller units from their packing cases but do not install them until they have been thoroughly checked.

i. While inspecting the equipment visually for damage, check all the units and components received against the master packing list.

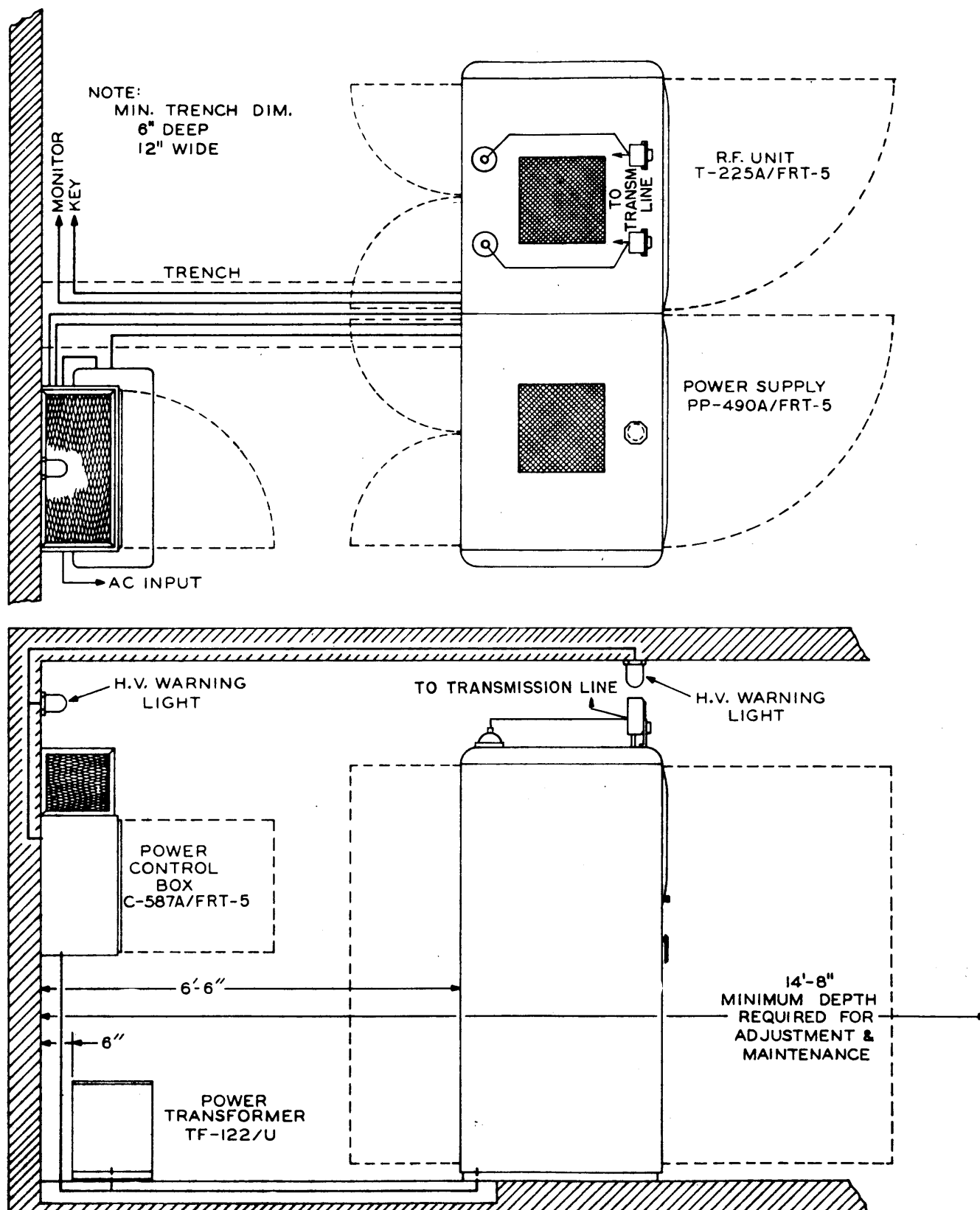
3. INSTALLATION.

a. LOCATION. — Before selecting a permanent location for the transmitter, the following factors should be taken into consideration:

(1) The structure of the building should be checked to make sure that the added weight of the equipment will not strain the floor. The weights of the various units are given in table 1-1.

(2) The room must be large enough so that sufficient space around the transmitter is available, in the event that repairs must be made.

(3) Adequate ventilation must be available.



Figur 3-1. Typical Installation Layout — Radi Transmmiting Set
AN/FRT-5A

TABLE 3-1. CONDUIT AND WIRE SIZES

CONNECTION	CONDUIT	RECOMMENDED WIRE
Station power line switch to Power Control C-587A/FRT-5	2"	#000 Underwriter's Code RH
Power Control Unit to Power Supply Unit	1"	#8 Underwriter's Code RH
Power Control C-587A/FRT-5 to Power Transformer TF-122/U Primary	2"	#8 Underwriter's Code RH
Power Transformer TF-122/U to Power Supply PP-490A/FRT-5	1 1/4"	#14 High Voltage Wire such as Neon Sign Cable
Power Control C-587A/FRT-5 to Power Supply PP-490A/FRT-5	1"	#14 Underwriter's Code RH
Power Control C-587A/FRT-5 to high voltage warning lights	1/2"	#14 Underwriter's Code RH

(4) The transmitter should be placed in a level position to insure smooth working of the control shafts. It must not be subject to vibration from external sources.

A typical installation layout is shown in figure 3-1. If an arrangement similar to this is decided upon, mount Power Control C-587A/FRT-5 on the wall, with Power Transformer TF-122/U directly below, or nearby. Leave a six-inch clearance between the transformer and the wall for ventilating purposes. Mount one of the red HV warning lamps on the wall above Power Control C-587A/FRT-5, and one on the ceiling above the transmitter. Set the transmitter six and one-half feet in front of the wall that mounts the power control unit. The conduit and wires which connect the power control unit and the power transformer to the transmitter should be laid in a trench. Conduit and wire for making most of the connections required for this installation are included with the equipment. If the installation arrangement deviates from the typical arrangement shown, it may be necessary to procure additional wire and conduit.

b. EXTERNAL CONNECTIONS. — Refer to table 3-1 for conduit and wire sizes required for the power and control lines.

Note

With the exception of the radio-frequency transmission lines which are connected to the antenna meters at the top of RF Unit T-225A/FRT-5, all of the external connections are brought through the bottom of the cabinets to terminal boards.

(1) PRIMARY POWER CONNECTIONS. — Connect two three-phase three-wire 230-volt a-c lines from the station distribution panel to Power Control

C-587A/FRT-5. Figure 3-3 shows the primary power terminals to which these lines will be connected. It will be noted that the three lines are connected directly to the top or line terminals of the motor-operated breaker (K401). Also note that these terminals are already wired to fuses F403, F404 and F405. Do not remove these wires. Interconnect RF Unit T-225A/FRT-5, Power Supply PP-490A/FRT-5, Power Transformer TF-122/U and Power Control C-587A/FRT-5, as indicated on the inter-cabinet cabling schematic (see figure 3-3). Using #14 wire run a separate 115-volt line into RF Unit T-225A/FRT-5 and connect it to terminals #111 and #112 on terminal board E512. Figure 3-3 and the notes included thereon indicate whether cable or bulk wire is supplied. The notes in table 8-7 pertaining to hook-up wire designations will aid in selecting the proper wire from the bulk wire furnished.

(2) KEYING AND MONITORING LINES. — Using shielded wire, feed the keying and monitoring lines out through the bottom of the transmitter and lay them in the trench along with the conduit. Connect the monitoring line to terminals #108 and #109 of terminal board E512, with the shield, or grounded, side of the line on terminal #109. Connect the keying line to terminals #110 and #111 of E512 with the shield of grounded side on terminal #111.

(3) GROUND CONNECTIONS. — The transmitter enclosure should be connected to a good ground system which should include, as a minimum, all of the metal parts of the building in the vicinity of the equipment. These metal areas should be well bonded together and connected to the base of the transmitter at as many places as is practical using wide copper strap or heavy wire. Any connections made of flexible copper braid should be kept as short as possible because this material is not a particularly satisfactory conductor of high frequency currents.

c. INSTALLATION OF COMPONENTS
REMOVED PRIOR TO SHIPMENT.

(1) GENERAL. — The only items removed from the major units for separate packing are the fragile electron tubes and vacuum capacitors, and certain accessories such as the antenna meters. However, the re-installation procedure will also be given for certain other items which may have been removed for re-shipment of the equipment, or for other special reasons.

(2) ELECTRON TUBES. — When restoring these to their proper places in the equipment the circuit symbols stamped on the cabinet adjacent to their sockets can be used to look up identifying descriptions in the table of replaceable parts. The tubes used are listed in table 1-4 of this book and on the shipping list.

(3) FERRULE-TYPE RESISTORS. — The large ferrule-type resistors are shipped in place in their respective clips, but are secured with strips of tape which must be removed. If dislodged, or disarranged for any reason, the circuit symbols stamped on the cabinet adjacent to the clips can be used to locate identifying descriptions in the table of replaceable parts. The JAN type number is stamped on the ferrule of each resistor. There are several of these in each of the r-f units and in each of the power supply units.

(4) VARIABLE VACUUM CAPACITORS. — These large glass units are used in the power amplifier and output section of RF Unit T-225A/FRT-5. They are terminal-mounted by tightening a clamping band around the three-inch diameter annular contact surface at each end.

Note

Variable vacuum capacitors require special installation procedure. See details in Section 7 for specific circuits.

The fixed vacuum capacitors used in the voltmeter assemblies (C1301 and C1305) should be installed so that the inner anode of each capacitor is connected to the plate or grid, as applicable. The outer anodes of the capacitors should be connected to the internal circuits of the voltmeter assemblies. Care should be taken to avoid breaking off the glass tip of the capacitor when inserting it through the rubber grommet.

(5) BOWL-TYPE INSULATORS. — The bowl-type transmission line feed-through insulators are mounted on the roof of RF Unit T-225A/FRT-5 (see figure 3-1). They are secured by bolts inserted in holes provided in the roof area.

(6) ANTENNA METERS. — These box-like units (M503 and M504) are installed on the roof of RF Unit T-225A/FRT-5 by means of bolt holes provided. They are shown in figures 1-1, 1-2, 3-1 and 3-2.

(7) COUPLING NETWORKS. — This unit is located in the uppermost portion of RF Unit T-225A/FRT-5. It is heavy enough to require the efforts of two, or preferably three, men to handle it, and must be installed or removed through the rear doors.

Note

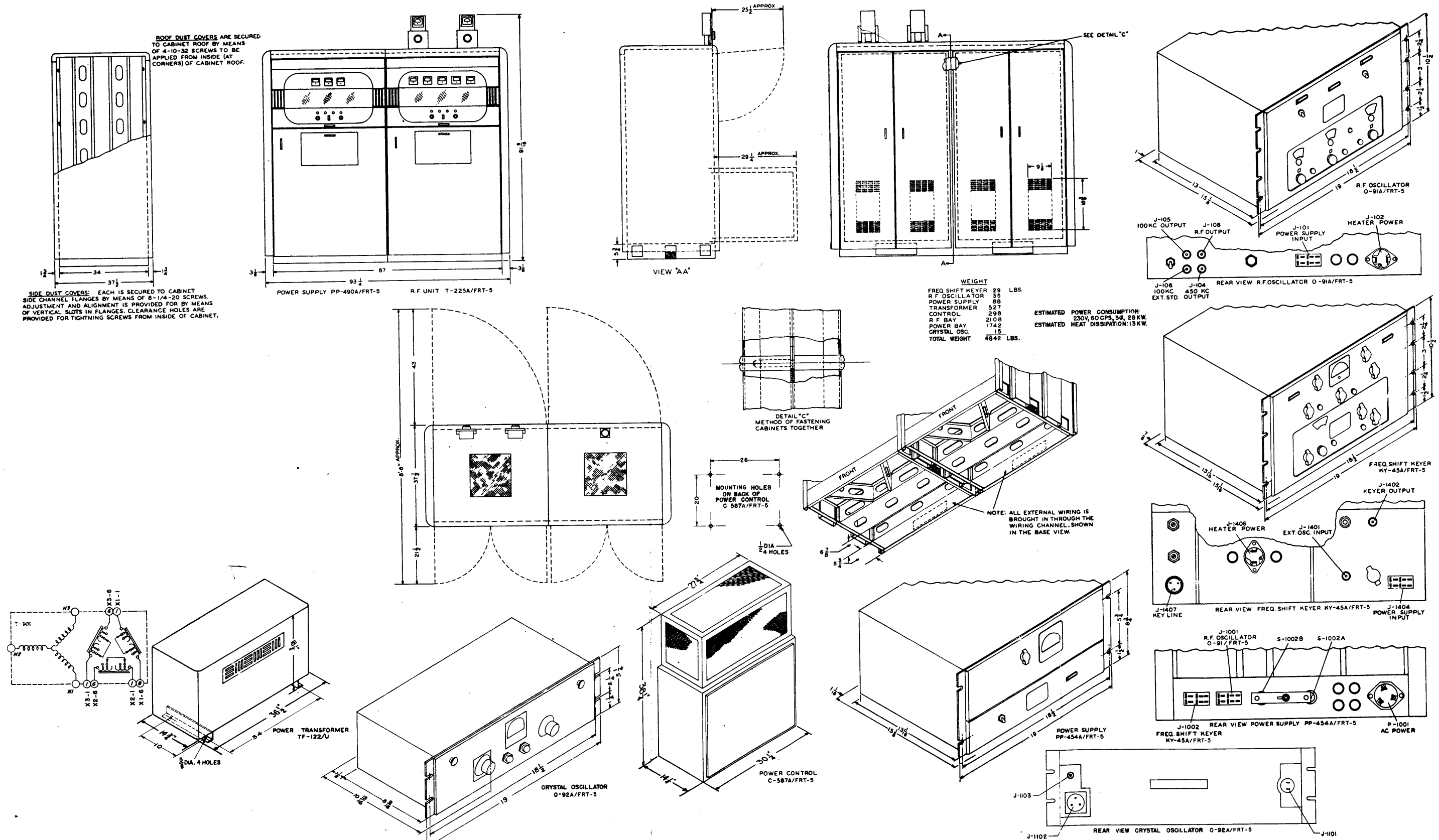
The procedure outlined below should be carefully followed or trouble will be encountered when attempting to install this unit.

Make certain that the stop screw at the rear end of the right-hand rail is removed. This screw is inserted from the bottom and used to prevent the coupling unit from rolling off its rack after it is in place. It must be replaced following installation of the coupling network.

Figures 3-8 and 7-28 show the unit, and figures 7-29 and 7-32 its placement. Note that the driving motor and its gearing are located on the right-hand end as viewed from the rear of the cabinet. The motor and lead screw assembly shown in figures 3-14 and 7-32 must be removed in order to insert this antenna network. This assembly is held in place by means of four rows of screws at the top of the cabinet. It will be necessary to lift the rear edge or remove completely the top cover over this unit to gain access to these screws. Before attempting to lift the coupler to the top of the cabinet and roll it on to its tracks, make certain that it is properly oriented and that the three small wheels have not been damaged. After this unit is in place on its tracks, immediately reinsert the stop screw at the rear end of the right-hand rail. This is important as it is very easy to roll this unit too far to the rear and allow it to drop.

A cable will be found hanging over the upper edge of the right-hand plate tank shield. This cable is to be connected to the coupling unit servo drive motor. There is a small double ring wire hook at the extreme right end near the center of the coupling network platform. The drive motor cable is to be slipped into this ring before being connected to the motor. This insures that the cable does not become entangled in the gearing.

Replace the drive motor and lead screw assembly that was removed in order to insert the antenna unit. Remove the drive chain from this unit, however, and lay it aside for the time being. When the assembly has been



Figur 3-2. Outlin s and Dim nsions — Major Units f Radio
Transmitting S t AN/FRT-5A

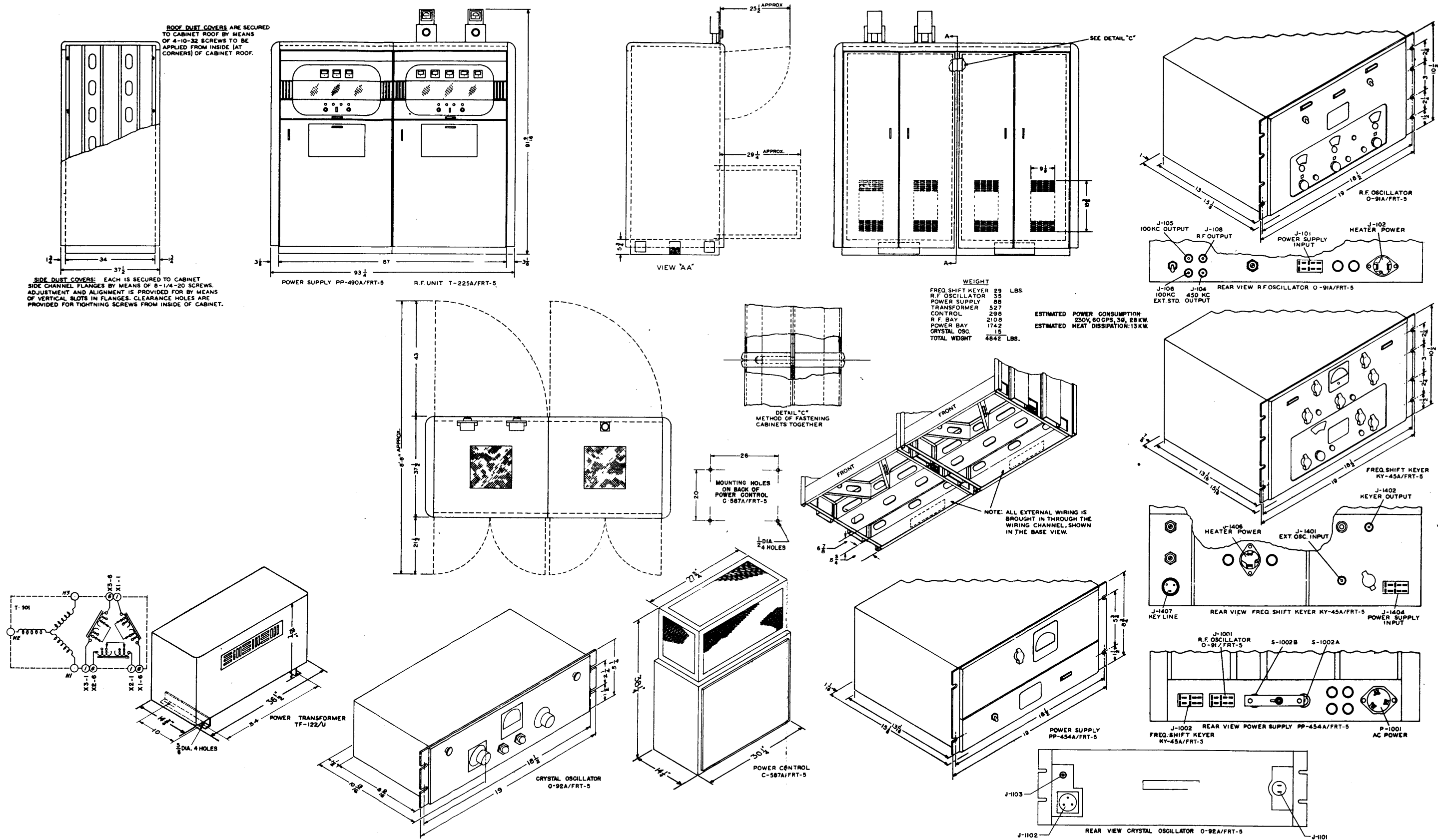
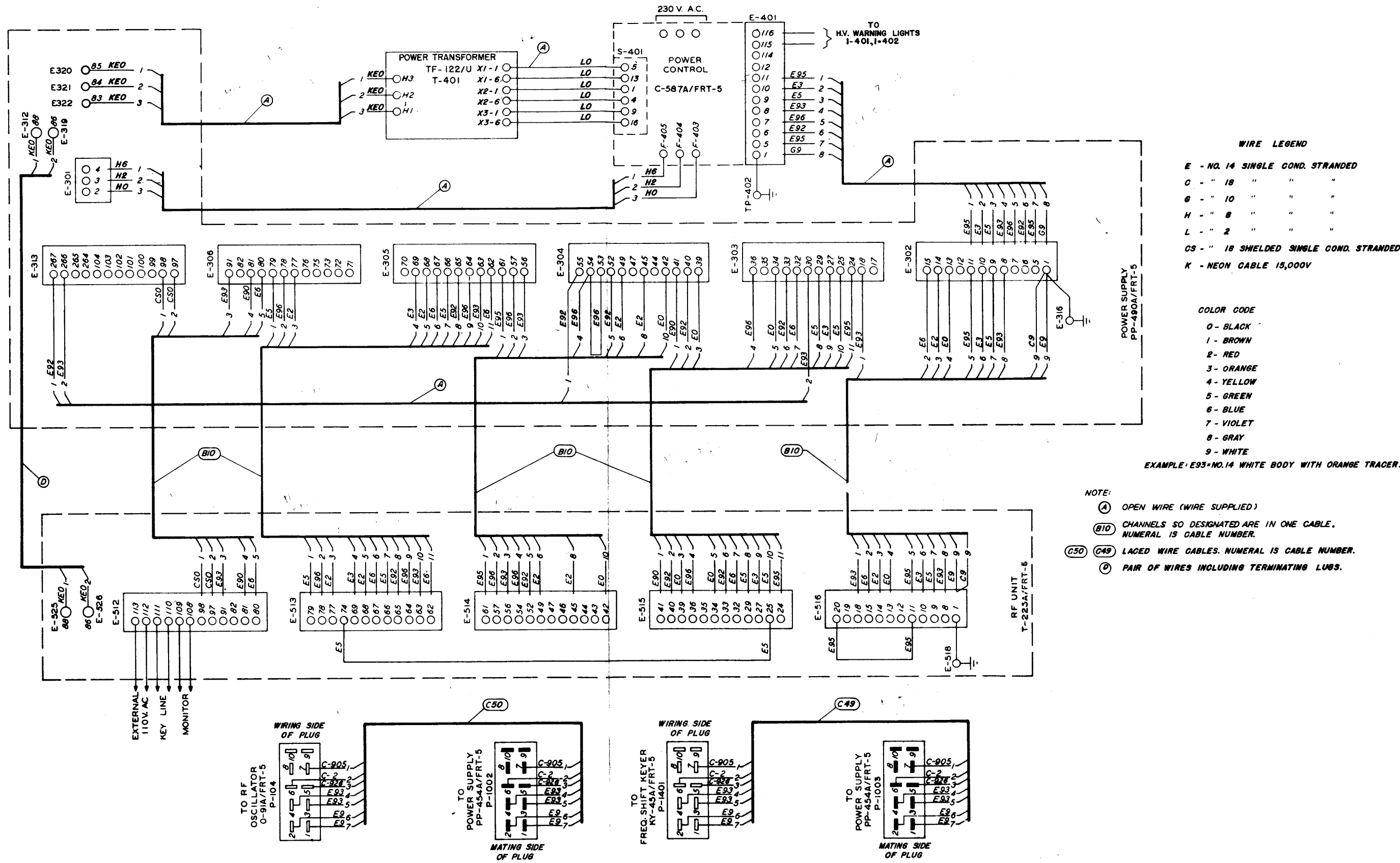


Figure 3—2. Outlines and Dimensions — Major Units of Radi Transmitted Set AN/FRT-5A



Figur 3-3. Inter-Cabinet Cabling Diagram — Radio Transmitting Set
AN/FRT-5A



properly secured, thread the lead screw into the floating bearing on the antenna rack and, turning the lead screw by hand, operate it until the antenna platform is at its extreme rear position.

(8) PA FILAMENT TRANSFORMERS T505 AND T506. — These transformers are mounted on the floor of RF Unit T-225A/FRT-5 (see figure 7-31). The wires connecting to them are clearly marked to identify proper connections.

(9) FUSES. — The fuses used in various locations in the equipment are listed in table 5-3, together with their circuit locations, their voltage and current ratings and the manufacturer's catalog numbers. Further data is given in the table of replaceable parts. The circuit symbol of each fuse is stamped on or near the fuse clip in which it belongs.

d. R-F CONNECTIONS.

(1) R-F FEED LINES. — R-f output energy from the power amplifier stage of RF Unit T-225A/FRT-5

is fed to the antenna meters (M502 and M504) on top of the unit by means of two preformed copper tubing conductors installed between the bowl insulators (see figures 3-1 and 3-2), also on top, and the meters. In-

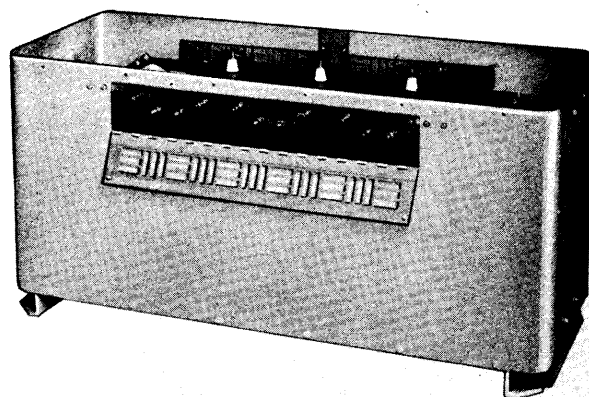


Figure 3-4. Power Transformer TF-122/U,
Front View, Cover Removed and
Hinged Panel Lowered

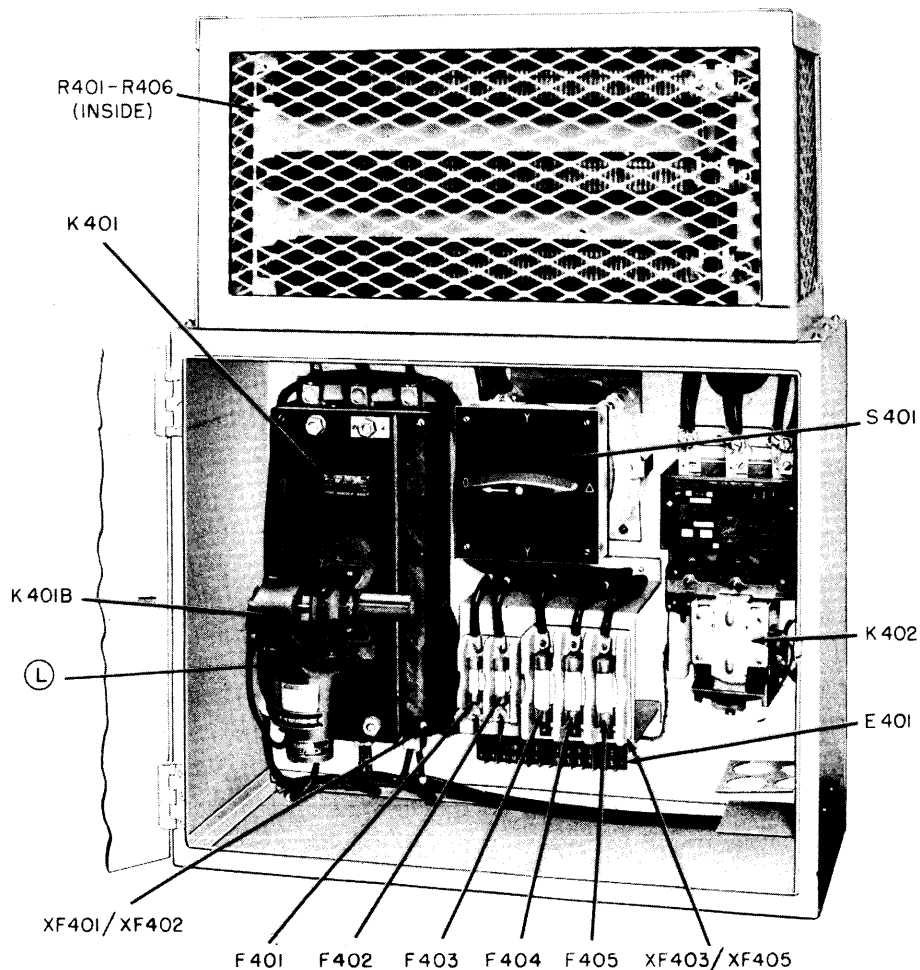


Figure 3-5. Power Control C-587A/FRT-5, Front View, Door Open

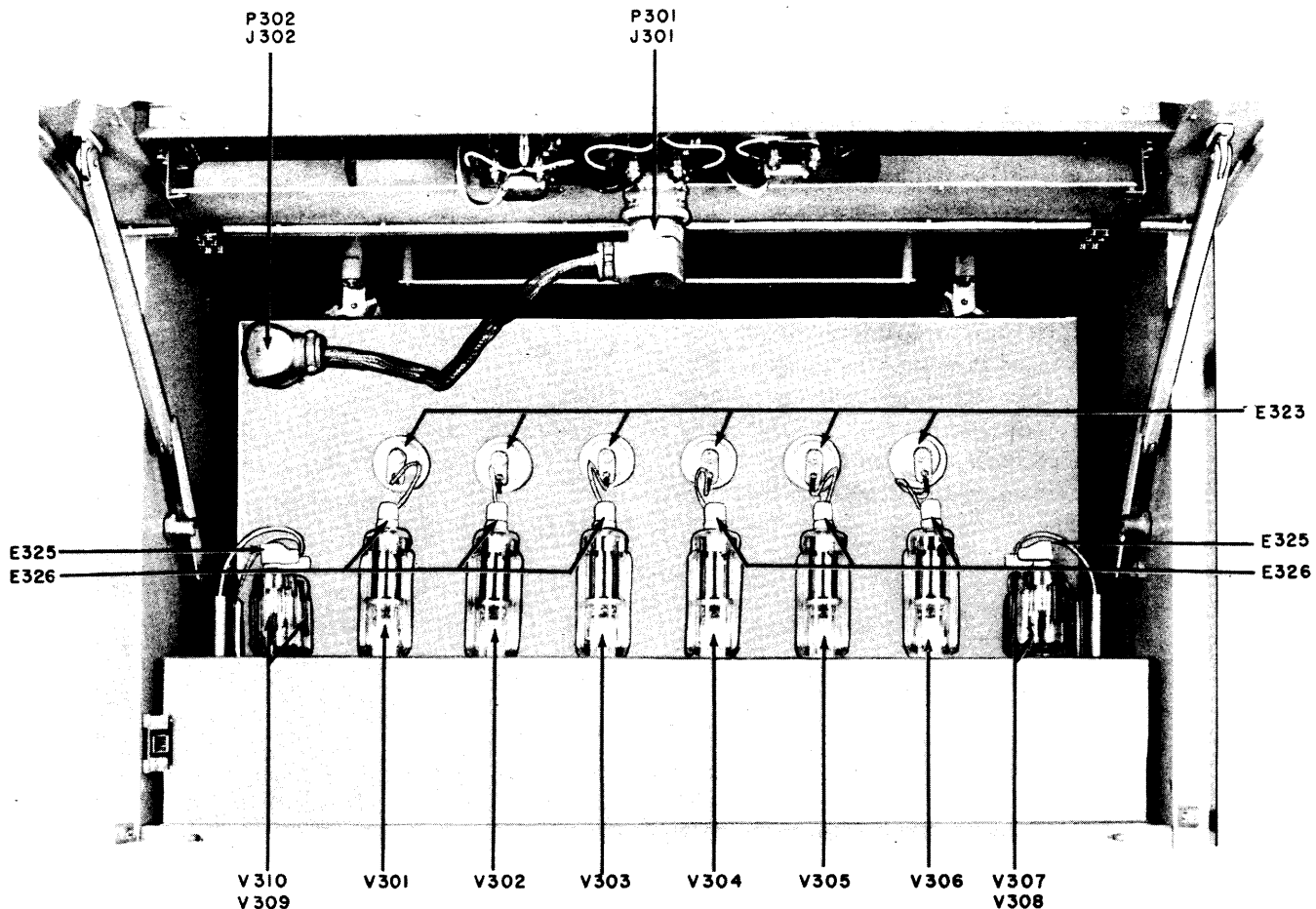


Figure 3-6. Power Supply PP-490A/FRT-5, Rectifier Tube Component

side the unit the lower ends of the bowl insulator center studs are connected to the rear ends of the coupling network rails by short lengths of #6 AWG or larger copper wire.

(2) TRANSMISSION LINE TO ANTENNA.

(a) Connect the r-f transmission line to the terminals of meters M503 and M504 located on the top of RF Unit T-225A/FRT-5.

(b) Use #6 hard drawn wire for the transmission lines, and space the two wires on 12-inch centers to obtain the required 600-ohm transmission line impedance.

(c) Maintain a clearance of at least three feet between the transmission lines and the top of the transmitter cabinets.

(d) Use feed-thru bowl-type insulators when transporting the line through building walls.

(e) If more than one antenna is to be used, arrange a system of switches or other means of transfer at some convenient point in the transmission line.

Maximum values of line currents and voltages should be kept in mind if this is done.

e. INTERCONNECTIONS BETWEEN UNITS IN RF UNIT T-225A/FRT-5.

(1) PATCH PANEL. — The interconnection or patch panel illustrated in figure 3-9 is used to inter-connect the various exciters, and/or to connect them to the transmitter input, as required. It is mounted in the upper left corner of the equipment rack as shown in figure 3-11. Connectors J1201 and J1206 on the patch panel should be connected to J504 and J507, respectively, on the r-f unit.

(2) RF OSCILLATOR O-92A/FRT-5. — (Refer to figure 1-4.) — Mount this crystal-controlled oscillator unit in the upper right-hand corner of the mounting rack in RF Unit T-225A/FRT-5, as shown in figure 3-11. Use the cables that are mounted behind the rack to connect the output connector (J1103) on the oscillator to J1202 on the patch panel, and to connect the high voltage connector (J509), located behind the rack, to J1102 on the oscillator. Connect J513

to J1101 on the oscillator to supply 115-volt a-c power for the crystal heater and for the primary of the oscillator and buffer filament transformer.

This oscillator is supplied less crystals. It is equipped with an oven which will mount as many as 10 type CR-27/U crystals. These crystals must be within the range of 2000 kc to 4000 kc, and must be ground for an exact sub-multiple ($1/2$, $1/3$, $1/4$, $1/6$ or $1/8$) of the desired output frequency.

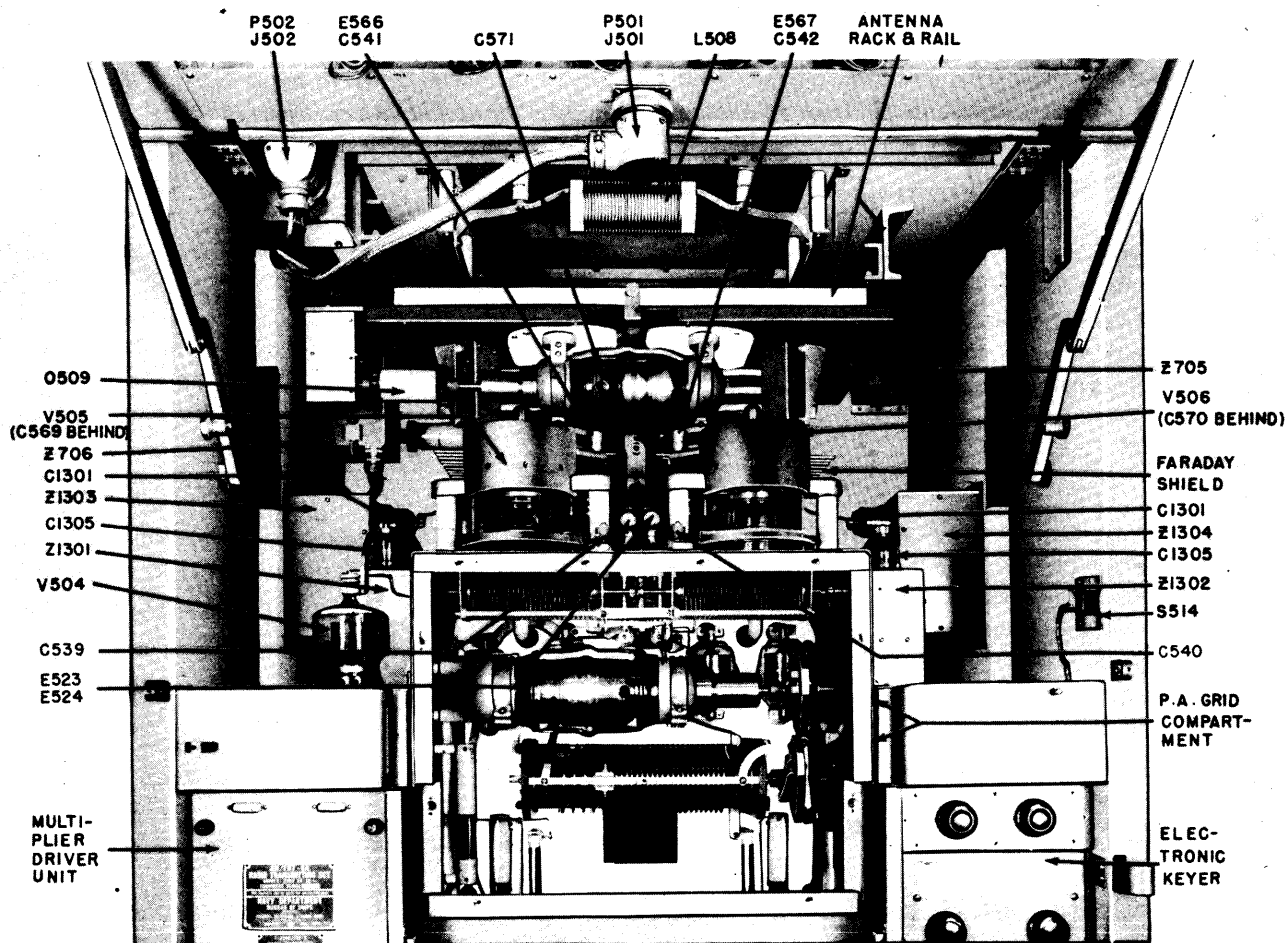
To place crystals in the crystal oven, open the front panel of the oscillator and remove the crystal oven by pulling it directly forward. Before doing so, however, it is wise to set the crystal selector knob to position #1. This must not be changed until the oven has been replaced. One will note, after the crystal oven has been withdrawn, that a flatted shaft extends into the crystal oven. This shaft operates the crystal selector switch deck which is inside the oven proper. The shaft and the selector switch deck must be carefully fitted together when this oven is replaced or the selector switch is likely to be damaged.

Remove the four corner screws from the oven and

gently lift off the oven cover. This will expose a smaller inner box with the oven heater wrapped around it. Gently lift this box and let it hinge on the heater and thermostat wires at one end. The crystal sockets will be visible when this inside cover is hinged open. After placing the crystals in their appropriate places, make certain that the identifying chart on the front of the oven is marked with the frequency of the crystal in each position. Use care in reassembling and replacing the oven.

(3) SERVO POWER SUPPLY (Z901). — Mount the servo power supply (figures 7-18 thru 7-21) in the lower left-hand corner of the mounting rack in RF Unit T-225A/FRT-5, as shown in figure 3-11. There are no connections to be made to this unit until the servo amplifier unit is installed.

(4) SERVO AMPLIFIER MOUNTING CABINET (Z807). — This unit (figures 3-12 and 7-14) is installed just above the servo power supply in the rack, as shown in figure 3-11. The six servo amplifier units (Z801 thru Z806) are slid into this cabinet as shown



Figur 3-7. RF Unit T-225A/FRT-5, P w r Amplifi r Plat Circuit C mp nents

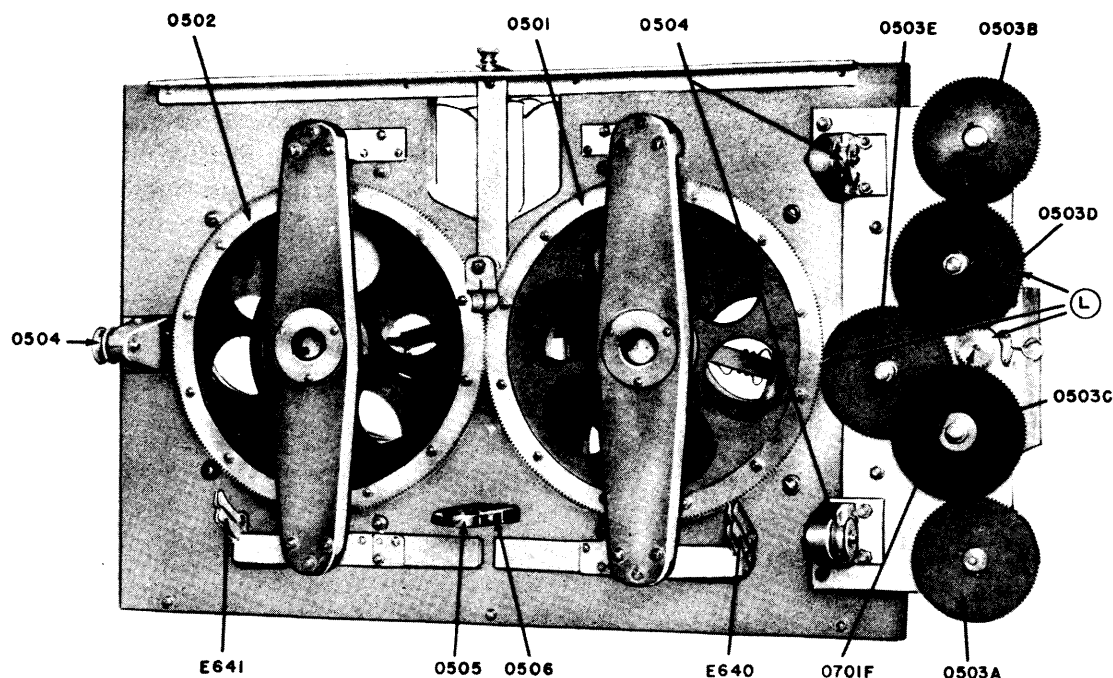


Figure 3-8. RF Unit T-225A/FRT-5, Antenna Coupling Network Assembly, Top View

in figure 3-12. Connectors P901 and P802 on the cables from the servo cabinet connect to J901 on the servo power supply and J517 on the r-f unit, respectively.

(5) POWER SUPPLY PP-454A/FRT-5. — (Refer to figures 1-6 and 3-11.) — Mount this power supply in the lower right-hand side of the rack. It supplies filament and plate voltages for both RF Oscillator O-91A/FRT-5 and Frequency Shift Keyer KY-45A/FRT-5. Using the power cable supplied, connect P1001 on this power supply to J516 on the r-f unit.

(6) RF OSCILLATOR O-91A/FRT-5. — (Refer to figures 1-3 and 3-11.) — Mount this r-f oscillator in the space just above Power Supply PP-454A/FRT-5. Connect J101 on the oscillator to J1001 on the power supply using the cable supplied. The r-f output of the oscillator is connected to the patch panel through J108 on the oscillator and J1203 on the patch panel. J106 on the oscillator is available for connecting an external 100-kc crystal if one is used. J105 is for 100-kc output. J104 is available for 450-kc output. A cable is supplied to connect the 115-volt a-c supply from connector J512 on the r-f unit to connector J502 on the oscillator.

(7) FREQUENCY SHIFT KEYER KY-45A/FRT-5. — (Refer to figures 1-5 and 3-11.) — Mount the frequency-shift keyer on the left-hand side just above the servo amplifier unit. A power cable is sup-

plied to connect J1404 on the keyer to J1002 on Power Supply PP-454A/FRT-5. Connect J1401 on the keyer to J1205 on the patch panel. With this method of connection, either RF Oscillator O-92A/FRT-5 or RF Oscillator O-91A/FRT-5 may be patched into the frequency-shift keyer. The r-f output of the keyer is connected from J1402 on the keyer to J1204 on the patch panel. An a-c cord is provided to connect the 115-volt a-c supply for the crystal oven, from J511 on the r-f unit to J1406 on the keyer. An external keying line connects between J1407 and J510.

4. INITIAL ADJUSTMENTS.

a. GENERAL. — The following adjustments are to be made after the equipment is completely installed. It is assumed that the equipment has been properly connected with other units of the system. If difficulty is experienced in obtaining the results specified in these procedures, refer to the adjustments and corrective procedures included in Section 7.

b. MECHANICAL INSPECTION. — After completing the setting up of the transmitter and the making of external connections, make a thorough inspection of the equipment and its associated wiring.

WARNING

TURN OFF ALL POWER BEFORE ATTEMPTING THE PROCEDURES LISTED IN PARAGRAPHS 4c(1) and 4c(2).

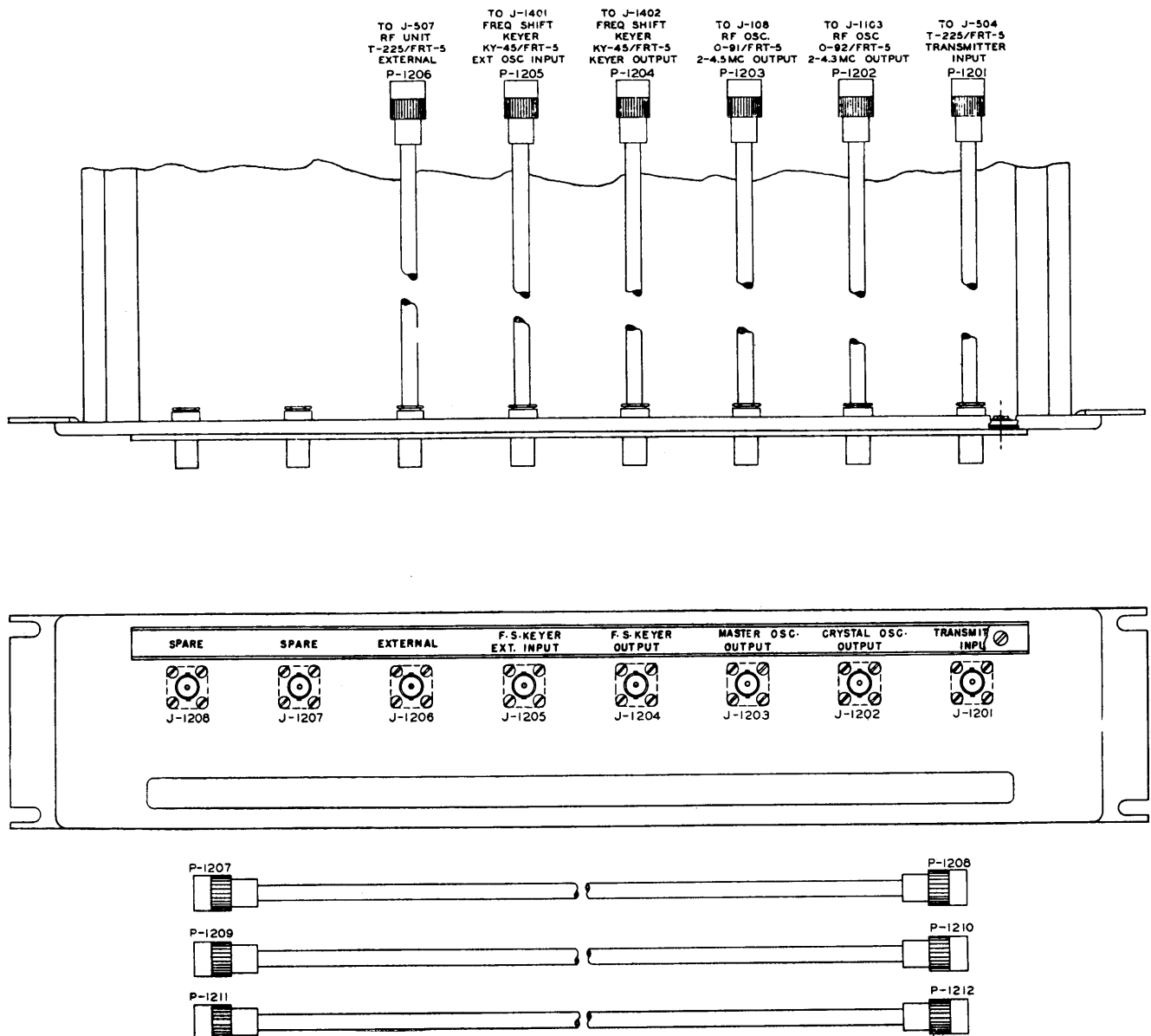


Figure 3-9. Outline Drawing — RF Unit T-225A/FRT-5, Patch Panel Showing Interconnecting Cables and Patch Cords

c. TEST AND SET-UP PROCEDURE. — Carefully check the primary line and the plate transformer connections to make certain that the phasing is exactly as shown in the wiring and schematic diagrams. This is very important as life of the rectifier tubes can be materially shortened by improper phase relationship between plate and filament voltages. Test and set-up procedure should be as follows:

(1) TIME DELAY AND OVERLOAD SETTINGS.

(a) Set the FILAMENT TIME DELAY timer, K304, at 30 seconds.

(b) Set the BLOWER HOLD ON timer, K305, for 5 minutes.

(c) Set the NON-AUTOMATIC RESTART INTERVAL timer, K312, for 30 seconds.

(d) Set the AUTOMATIC RESTART INTERVAL timer, K316, for 10 minutes.

(e) Set the AUTOMATIC SHUT-DOWN TIME DELAY timer, K323, for 15 minutes.

(f) Set selector switch S317 on RESTART CYCLE COUNTER K315 at position #3. This is located under the snap-on relay cover on the front panel, below the time delay relays.

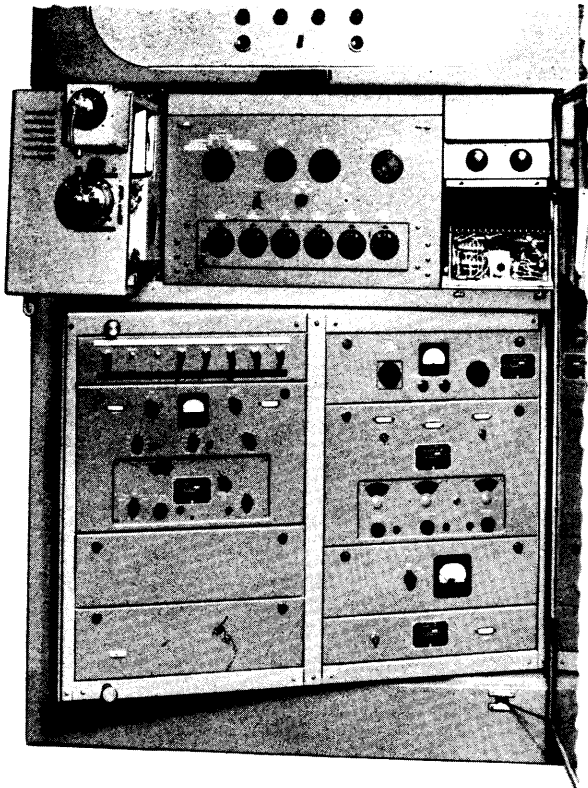


Figure 3-10. RF Unit T-225A/FRT-5, Front View of Lower Portion, Door Open, Multiplier-Driver and Electronic Key Assemblies Lowered Forward on Hinges and Rack Assembly Partially Rotated

(g) Check the adjustment of the PA d-c overload relays (K324 and K325) to make certain that they are set for 2.5 amperes.

(h) Check the high voltage d-c overload relay (K319) to make certain that it is set for five amperes.

(i) Check the driver d-c overload relay (K326) to make certain that it is set for 0.4 ampere.

(j) Check the BIAS INTERLOCK relay K307 to make sure that it is adjusted for 0.25 ampere.

Note

The trip setting of these relays is determined by the distance the iron plunger projects below the bottom surface of the coil — the greater the projection the higher the current rating of the trip setting. To adjust the setting, the plunger is rotated about its axis until the index mark on its surface is aligned with the desired calibration mark on the plunger guide tube.

(2) FILAMENT AND BLOWER CHECK-OUT.

(a) Start with all circuit breakers on the control panel of Power Supply PP-490A/FRT-5 in their down or open position and the red FILAMENT — EMERGENCY OFF toggle switches on the lower edge of the upper front doors in their OFF positions and then proceed to check as follows:

(b) Turn on the 230-volt a-c power to the transmitter.

(c) Close the LOW LEVEL FILAMENT breaker, S304, and operate both the red FILAMENT — EMERGENCY OFF control toggle switches to their ON position. This will turn on all rectifier filaments and all other filaments except the power amplifier. Line or regulated bus voltages may now be checked on the 300-volt a-c voltmeter by operating S314 to pick out the circuit to be measured.

(d) Close BLOWER CONTROL breaker S301 and make sure that the blowers in both the power supply and the r-f unit operate, and that they rotate in the proper direction. Note also whether the BLOWER HOLD-ON timer, K305, is operating. At the end of the time setting (5 minutes if the preceding procedure was followed) the blowers should shut off automatically. To restart the blowers switch the red FILAMENT — EMERGENCY OFF toggle switches off momentarily, then back on again.

(e) Close the POWER AMPLIFIER FILAMENT breaker, S305, and note that the power amplifier tubes light up. Check the filament voltages of these tubes by means of the 10-volt a-c meter on the upper front panel of the power unit and the METER SELECTOR switch, S314, on the control panel of Power Supply PP-490A/FRT-5. Adjust these filaments to 7.5 volts by means of the left and right FILAMENT controls on the power unit control panel, and by means of the FILAMENT controls to the right of the control panel on the r-f unit. Adjust the voltage first above and then below the required setting as a check to make certain that the controls are functioning properly. Make sure that the controls are finally returned to 7.5 volt setting.

(f) Open the BLOWER CONTROL breaker, S301, and observe the power amplifier filaments. They should go off before blower B501 in the r-f unit and blower B301 in the power supply cease turning. This procedure checks the operation of the air interlock, S511. Throw BLOWER CONTROL S301 on again.

(3) CONTROL CIRCUIT CHECK-OUT.

(a) Set the DELTA-WYE-OFF switch, S401, located inside of Control Unit C-587A/FRT-5, to the OFF position. Nothing will happen. Make certain that

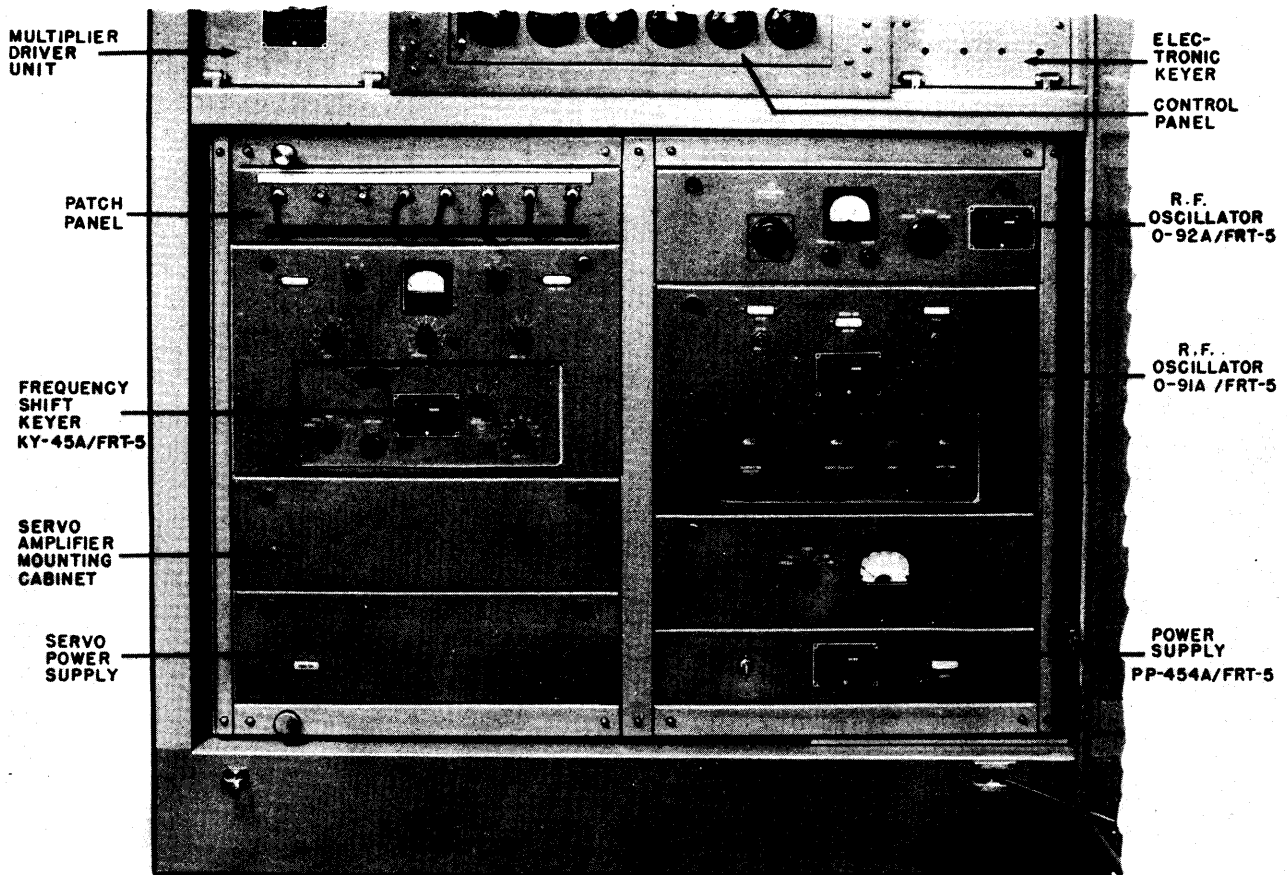


Figure 3-11. RF Unit T-225A/FRT-5, Front View of Lower Portion, Door Open, Showing Rack-Mounted Equipment

BIAS & LV breaker S302 is open. Then, using a piece of paper, cardboard, or other convenient material, block BIAS INTERLOCK relay K307 with its plunger in the raised position.

(b) Close the CONTROL CIRCUIT breaker, S303. Note that all meter lights become illuminated. Check both upper front doors and all four rear doors, making certain that they are tightly closed. Locate relay K306 on the power unit control panel and see

that it is closed. Open an upper front door and note whether this relay opens immediately. Reclose this door and proceed to check the operation of the plate control circuit as follows:

Set TUNE-OPERATE switch S310 in the LV TUNE position and depress the PLATE ON button, S309 or S519, on either of the front doors. Locate relay K308 and note that it closes when this button is depressed. Move the TUNE-OPERATE control to the HV TUNE position and again depress the PLATE ON button in case plate power is not already on. This time listen for the audible sound of the main circuit breaker closing. This is a motor operated breaker which makes a rather peculiar and easily recognized sound as it operates. Immediately following the depression of the PLATE ON button, a whirring and clicking noise will be heard for a brief interval, followed by a pronounced thud, and then silence. If the whirring noise continues or if there is no silence following the thud when one holds the plate button depressed, it is an indication that the breaker is not properly adjusted and should be checked according to the procedure outlined in Section 7. Assuming that the breaker operated properly, rotate the

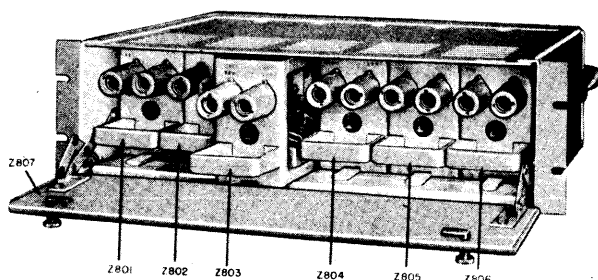


Figure 3-12. RF Unit T-225A/FRT-5, Servo Amplifier Mounting Cabinet, Front View, Hinged Panel Lower Portion Showing Six Plug-in Units

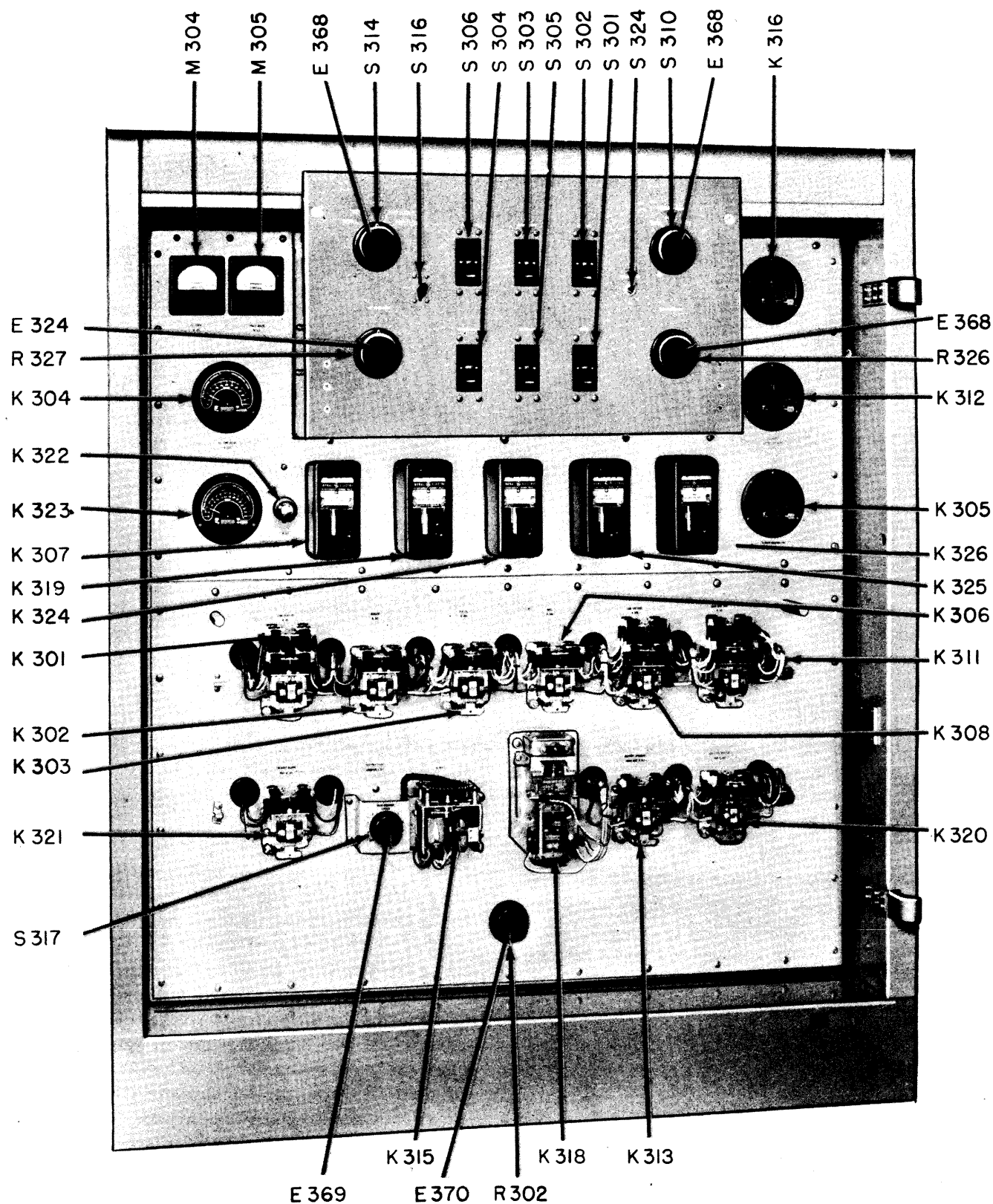


Figure 3-13. Power Supply PP-490A/FRT-5, Control and Relay Panels,
Relay Dust Cover Removal

TUNE-OPERATE switch to the OPERATE position and listen for the closing of a rather large contactor after a brief interval. This is the contactor which shorts the tune resistors in Power Control C-587A/FRT-5, and sets up the equipment for regular operation. Operate this switch several times between the HV TUNE and the OPERATE positions, noting whether or not the contactor responds. Two or three other checks should be made before it is assumed that this circuit is properly adjusted. Remove the cover from one of the overload relays (K319, K324, K325, or K326) and using a pencil or other insulated object, lift the armature until the contacts part to simulate an overload. The main breaker should release and the overload pilot lights on the transmitter panels should come on. Then one of two things may happen. If the plate power control has been in operation for less than 30 seconds, this mock overload will cause a complete lock-out, and the transmitter will have to be restarted by manually depressing the PLATE ON button. On the other hand if the control circuit has been in operation for more than 30 seconds, the automatic restart feature will become effective. In this event, Power Control C-587A/FRT-5 will drop out momentarily following this simulated overload, but will immediately return to the ON condition.

Now operate the overload relay as before, two more times, and note that on the fourth attempt the equipment, instead of turning back on, will stay off and a warning alarm will be sounded. To silence the alarm, depress either one of the two PLATE OFF buttons. These checks should be sufficient to indicate that the control circuit is functioning normally.

(4) TUNING SYSTEM CHECK-OUT.

(a) SET UP. — Close the SERVO CONTROL breaker, S306. This applies power to the servo tuning system. The pilot light on the front panel of the servo power supply mounted on the equipment rack in the r-f unit should be illuminated to indicate that power is present. Within a few seconds after closing this breaker, several control motors may be heard to start operation simultaneously. These should stop, however, within a maximum of about 60 seconds.

(b) FIRST MULTIPLIER PLATE TUNING. — The operation of the 1ST MULTIPLIER PLATE TUNING control [A] should be checked by rotating the control and noting whether the motor-driven circuit follows properly. This circuit is located inside of the frequency multiplier chassis and is accessible after tilting this chassis forward as illustrated in figure 3-10. If this unit is operating properly, variable capacitor C511 will be completely meshed when the control dial is reading zero and there will be a smooth change as

the dial is rotated. Any "hunting" by the motor or severe relay chattering can be eliminated by adjusting the "anti-hunting" control (R804) on the servo amplifier. This control is a slotted shaft potentiometer located directly behind a small hole in the front panel, just above the withdrawing handle. The servo amplifiers are aligned in their rack in the same way that the controls are aligned across the front panel, that is, the first frequency multiplier plate tuning is the left-hand unit in each case, and so on. Adjust this "anti-hunting" control to produce smooth operation of the motor-driven positioning mechanism.

(c) SECOND MULTIPLIER PLATE TUNING. — The 2ND MULTIPLIER PLATE TUNING control [B] is adjusted in exactly the same manner as described in paragraph 2 above.

(d) DRIVER PLATE TUNING. — The DRIVER PLATE TUNING control [C] should operate smoothly and freely in the same manner previously described. In order to observe the driver circuit, however, the cover panel must be removed from the power amplifier grid enclosure. To remove this, tip the control panel of RF Unit T-225A/FRT-5 forward, turn all of the thumbscrews one quarter turn counter-clockwise, then lift the cover completely out of the transmitter. This is illustrated in figure 7-30, which shows the transmitter with the cover removed. Operate the driver plate tuning control to the "1000" position. Proper adjustment of the variable components inside of this grid housing is indicated when the slider on inductor L509 is on the second turn from the left end, when the two variable air capacitors in the top, C533 and C534, are adjusted for almost minimum capacity (in position shown in figure 7-30) and when the vacuum variable capacitor, C526, is at its minimum capacity. Operate the driver control over its full range once or twice and make sure that the mechanical operation within the enclosure is free of sticking and chattering.

(e) POWER AMPLIFIER TUNING. — The control marked POWER AMPLIFIER PLATE TUNING (control [D] on RF Unit T-225A/FRT-5) should be checked for proper operation of the PA plate tank circuit. If the adjustments are correct, when this control is set at "1000", the copper cylinders and the contact crossbar inside of the plate tank coils, L516 and L517, will be near the top of the two coils with the top contact on the last turn at the rear side. Both cylinders will be at the same level, and they will be symmetrically positioned. If the variable vacuum capacitors, C569 and C570, were removed for shipment and have been replaced, it will be necessary to check their setting in accordance with the procedure outlined in paragraph 3 c (6) of Section 7. Check the

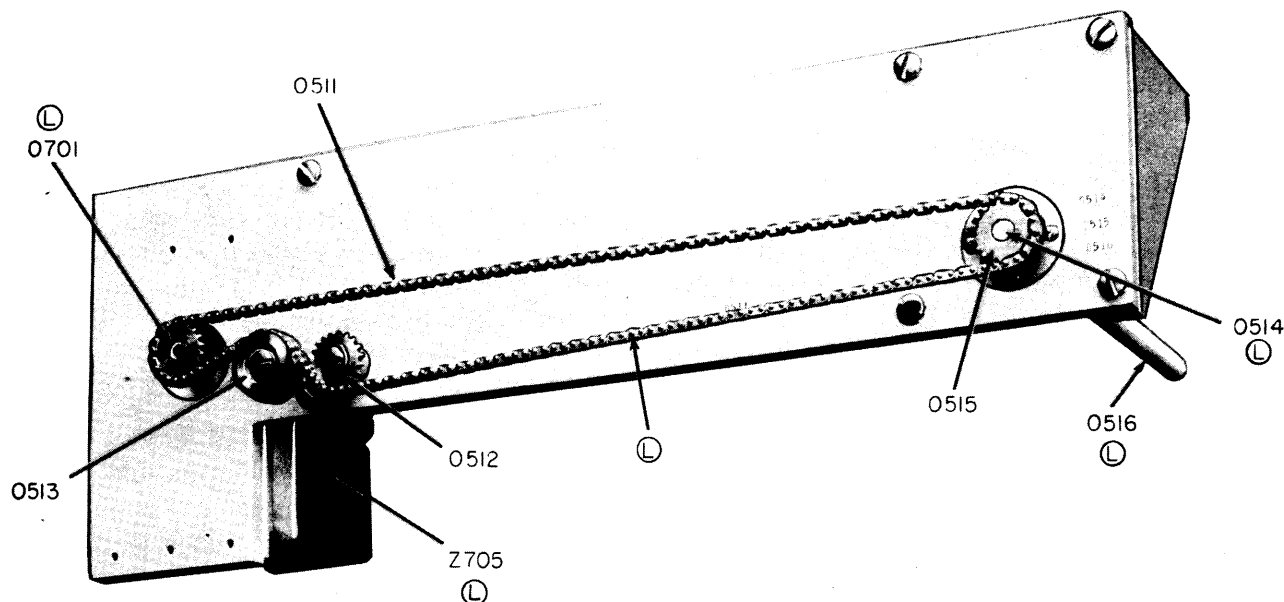


Figure 3-14. RF Unit T-225A/FRT-5, Servo Motor, Drive Sprockets and Chain for Positioning Antenna Coupling Network Assembly

operation of the servo amplifier (PA PLATE tuning control) and adjust its "anti-hunting" control (R804) for smoothness of operation, in a manner similar to that outlined under paragraph 2 above.

Note

The left and right power amplifier grid and cathode currents should be balanced at 20.8 mc during installation of the equipment. The PA cathode currents should remain reasonably well balanced throughout the frequency range of the transmitter. If not, they should be rechecked in accordance with the procedure outlined in Section 7, paragraph 3 c (14) (k). The grid currents, however, will probably not remain balanced over the entire frequency range. A difference of up to 110 ma between the left and the right PA grid currents is not abnormal at the lower frequencies provided that the currents are balanced at 20.8 mc. If such is not the case, refer to Section 7, paragraph 3 c (13) (b), for the balancing procedure.

(f) **LOADING.** — The **POWER AMPLIFIER** **LOADING** adjustment **[E]** controls the position of the output coupling network (L518/L519) relative to the PA plate tank circuit (L516/L517) through a servo positioning system. The procedure for align-

ment of this adjustment is as follows: With the coupling platform in its maximum coupling position, which is with the lead screw turned clockwise to the end of its run, turn the control dial to the "1000" position and note that the motor operates. After the motor drive has stopped of its own accord, replace the chain, which was previously removed, in the position shown in figure 3-14. Slack in the chain may be taken up by shifting the position of the idler pulley (O513). The chain should not be tight but snug enough so that the upper part does not touch the idler sprocket or idler gear or the lower part of the chain. Check the operation of this circuit by rotating the **LOADING** control between its limits and noting whether the coupling platform operates smoothly over its range.

(g) **OUTPUT TUNING.** — The output tuning control **[F]** of RF Unit T-225A/FRT-5 is marked **ANTENNA TUNING**. It operates the driving motor which varies the resonant frequency of the output coupling network (L518, L519, C571 and C572) through a servo positioning system. If it is operating properly, the sliding contacts on coils L518 and L519 will be in the positions representing maximum inductance, and the two variable vacuum capacitors, C571 and C572, will be adjusted for maximum capacity, when the tuning dial is set at zero. This control should be operated several times to be sure that the circuit is operating smoothly without sticking or binding.

The sliding contacts used in the plate and output network inductors consist of several chromium

plated beryllium copper springs. Chrome plating is used to provide a hard surface, which, wearing against the copper, produces a highly polished track on the copper coil. If for some reason the chromium plating is damaged or broken, this contact may roughen the copper coil surface instead of producing a highly polished contact line, and thus aggravate sticking. Therefore, the condition of the coil contact surface and the chromium contact spring should be checked often. Any roughening or burring of the copper should immediately be sanded and polished to a smooth surface. Occasionally some of the contact springs will have been made up with too much arch. This produces too great a clamping action between the top and bottom contacts and makes it nearly impossible for the driving motor to operate against the load. If this is the case, remove the contact springs and, using a pair of flat-jawed pliers, remove some of the arch from the spring. There should be just enough arch so that the springs fit snugly, but not tightly, when the cross-bar is in place inside of the coil.

(5) RF OSCILLATOR O-92A/FRT-5.

(a) Close circuit breaker S302 and rotate the DELTA-WYE-OFF switch, S401, to the WYE position. Remove the blocking cardboard from K307. Set the keying selector switch, S501, to the LOCAL position and open both test keys by operating them to their center position.

(b) With the 115-volt a-c power connected to the oscillator, the CRYSTAL HEATER light I1103 should come on, indicating that the oven heater is working.

(c) Filament voltage for the oscillator and buffer tubes in RF Oscillator O-92A/FRT-5 is supplied from the same transformer, T1101, that supplies the crystal heater voltage. The FILAMENT pilot, I1102, should come on as soon as the 115-volt a-c line is connected.

(d) Set the TUNE-OPERATE switch, S310, to the LV TUNE position and depress the PLATE ON button. This turns on the low voltage d-c power which should start the crystal oscillator functioning. Bias voltage should already be present provided all of the doors were closed.

(e) If this oscillator is connected to the transmitter input through the patch panel, there will be a buffer and 1st multiplier grid current indication of between 1 and 2 milliamps.

(f) The frequency of the crystals may now be checked by means of an external frequency monitor connected to the monitoring output jack, J506. If it is desired, the crystals can now be set to the exact frequency specified, by means of trimmer capacitors

C1101 through C1110 which are located in the oscillator unit. They are located behind switch S1102B and are readily accessible when the front panel on this oscillator is swung downward as shown in figure 7-10. An insulated screw driver should be used to adjust these trimmers.

(6) POWER SUPPLY PP-454A/FRT-5.

(a) Turn ON-OFF switch to the ON position. The POWER lamp (I1001) should light. This unit is shown in figure 1-6.

(b) Rotate the voltage switch (S1003A) to each position and check the readings on meter M1001 against the figures indicated opposite the pointer on the switch. The actual readings should be a little high if the supply is not loaded.

(7) RF OSCILLATOR O-91A/FRT-5. — Perform the following checks carefully, keeping alert to any evidence of an irregularity which might provide an indication of possible trouble.

(a) Connect 115-volt a-c power (P1101/J1101) to the oscillator. The CRYSTAL HEAT ON light should come on indicating that the oven heater is working.

(b) Operate the plate ON-OFF switch to the ON position. This should turn on the PLATE pilot light.

(c) Operate S105, 100-kc standard switch, located on the rear of the unit, to the INT position.

(d) Determine the frequency which is to be set up for the check, for example, 2,439,224 cps. Throw the SET UP-OPERATE switch to the SET UP position and insert the headphone connector into the JACK on the front panel. Set the MASTER OSCILLATOR dial to the approximate frequency, in this case, "24" on the outer dial and "39" on the inner dial.

(e) Set the INTERPOLATION OSCILLATOR to the difference between the MASTER OSCILLATOR dial reading and the 5-kc check point immediately below it. In the above case, this would be "42" on the outer dial and "24" on the inner dial.

Note

A frequency check point is provided at each 5000-cps interval. The reading on the INTERPOLATION OSCILLATOR control dial **B-1** is added to the value of the check-point immediately below the reading on the MASTER OSCILLATOR control dial **A-1**. In the above case, the check point immediately below the master oscillator dial setting would be 2,435,000 cps; thus the interpolation oscillator dial would be set for the difference be-

tween 2,435,000 cps and 2,439,224 cps, or 4224 cps.

The desired oscillator output frequency will be most accurately obtained if the required settings of the interpolation oscillator control dial and the master oscillator control dial are approached while rotating these dials in their clockwise direction.

(f) Set the OUTPUT TUNING control as close as possible to the desired frequency. A steady tone should be heard in the headphones.

(g) Readjust the MASTER OSCILLATOR dial for a low pitched tone (50-100 cps), then readjust the OUTPUT TUNING control for loudness and clarity of tone.

(b) Now, to determine if the AFC motor and associated circuits are working properly, remove the headphone connector plug and place the SET UP-OPERATE switch in its OPERATE position. The AFC motor should be heard going into operation.

(8) FREQUENCY SHIFT KEYS KY-45A/FRT-5. — It is assumed that the total frequency shift is 850 cps (frequency raised by 425 cps for a mark signal and lowered 425 cps for a space signal). The procedures are, of course, identical for a different over-all shift of frequency (for example 800 cps) except for the slightly different numerical values which apply. With the 115-volt supply connected to the keyer, the OVEN HEAT pilot light should come on, indicating that the oven heater is working.

(a) R-F TUNING.

1. Set the EXT. OSC. ATTENUATOR (S1401) on the rear of the unit to 0 db. The setting of this control is tentative and will be selected more accurately during the following procedure.

2. Rotate the METER switch (S1402) to the GRID position, and provide a suitable carrier from one of the two r-f oscillators.

3. Starting at position "0", rotate the MAIN TUNING dial (C1405) slowly and note that two successive peak values of current are indicated on the meter (M1401). These two current peaks correspond to the two resonant peaks for the lower and upper side bands respectively. The current peak at the lower frequency indicated on the main tuning dial corresponds to the lower side band and is the one to be used.

4. Rotate the MAIN TUNING dial **A-2** (C1405) to a position which corresponds to the lower side-band resonant peak.

5. Set the OUTPUT LEVEL control (R-1430) in a position which provides the most favorable driving power to the first amplifying stage of the transmitter proper (1 to 2 milliamps buffer and 1st multiplier grid current).

6. Rotate the meter switch to the PLATE position.

(b) CHECK OF FREQUENCY. — The r-f output of the keyer must be checked to be sure that its frequency is accurate and stable. This output stability is derived from both the 200-kc oscillator and the external r-f injection stability.

1. Rotate the BASIC SHIFT control (R-1458) to position zero.

2. Make certain that the external oscillator is adjusted for a frequency exactly 200 kc above the desired keyer output frequency.

3. Adjust the station frequency-measuring equipment to the desired keyer output frequency.

4. Trim the 200-kc OSC. ADJUST control (C1442 — in front of oven) on the keyer for zero beat with the monitor.

(c) FREQUENCY SHIFT.

1. Determine the multiplication factor which is to be used. It must be either 2, 4, or 8 as required to multiply the 2-mc to 3-mc keyer output to the desired transmitter operating frequency.

2. Set the TRANSMITTER MULTIPLICATION switch **B-2** (S1405) at the position corresponding to the chosen multiplication factor.

3. Set the BASIC SHIFT dial for the desired basic frequency shift as indicated on the calibration chart, figure 4-13.

4. Set the TEST-OPERATE (S1403) switch to the SPACE position. The output frequency will be slightly lowered for this, the space frequency.

5. With the frequency monitor still connected and adjusted as it was for step 2 d above, compare the audio beat signal that is now obtained with an adjustable audio oscillator to determine its frequency. This beat should have a frequency equal to one-half the total required shift divided by the multiplication factor. For example, if the basic shift were to be a total of 850 cps, and the multiplication factor were four, the audio beat signal should have a frequency equal to $(850/2)$ times $(1/4)$, or 106.25 cps. A slight adjustment of the BASIC SHIFT control may be necessary to obtain the exact degree of shift required.

6. Operate the TEST-OPERATE switch to the MARK position. In this position the frequency

should be approximately as much higher than the zero shift frequency as it was lower in the SPACE position. The monitor beat note should be nearly the same as it was for space. In any event the frequency-shift calibration control should be adjusted until the desired total shift, e.g., 850 cps, is obtained. This may mean a shift of minus 400 cps for space and plus 450 cps for mark, etc.

(d) KEYING SIGNAL INPUT.

1. Operate the TEST-OPERATE switch to the FSK position.

2. With a mark keying signal applied, adjust the LIMITER ADJUST control, located on the rear of the unit, until the same beat frequency is obtained as was obtained in steps 3 e and 3 f above. This insures that the FSK mark and space correspond to those obtained from the TEST-OPERATE mark and space.

(e) WAVE SHAPING. — The setting of the WAVE SHAPING switch depends on the keying speed. The relation between the switch positions and the keying speed is as follows:

SWITCH POSITIONS	KEYING SPEED (DOT-CYCLES PER SECOND)
1	0 to 23
2	23 to 60
3	60 to 120
4	120 to 240

Position #4 provides minimum wave shaping.

5. NEUTRALIZATION AND PA GRID AND CATHODE CURRENT BALANCE PROCEDURE.

Refer to paragraphs 3c(12) through 3c(16) of Section 7 for the neutralization procedure, the PA grid current balance procedure and the PA cathode current balance procedure.

6. TUNING FOR INITIAL OPERATION.

The equipment is now ready for operation. Installation personnel should place the set into operation as a final check. Refer to Section 4 for tuning procedures applicable to the final check.

7. MODIFICATION OF PA INPUT TO EFFECT LINEAR AMPLIFICATION FOR SINGLE SIDE-BAND SUPPRESSED-CARRIER OPERATION.

a. GENERAL. — A kit of parts for converting the input circuit of the power amplifier stage to accept balanced drive voltage from an external driving source

is supplied with each AN/FRT-5A equipment.

The circuit that is normally employed at the grids of this PA stage is designed to present a high impedance load to the type 4-400A driver tube (V504) and to deliver balanced push-pull voltage to the relatively

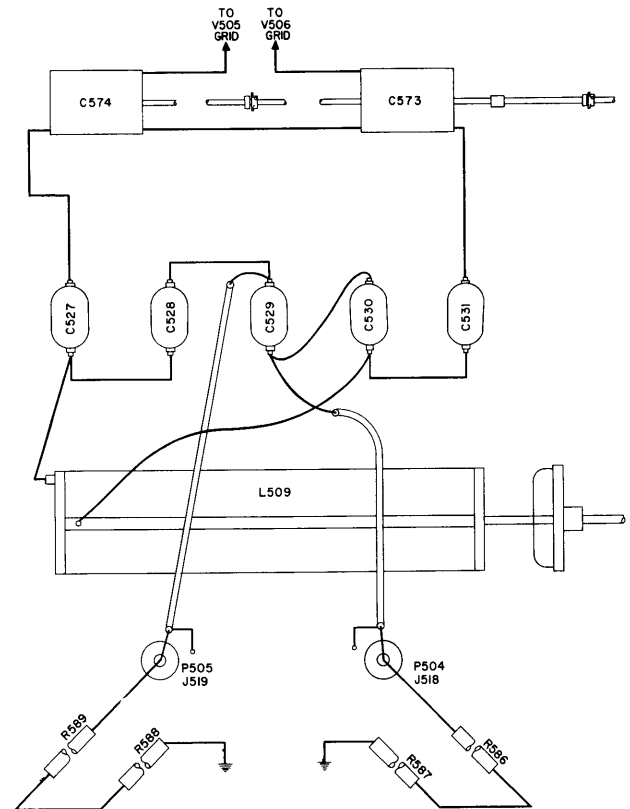


Figure 3-15. Wiring Diagram — RF Unit T-225A/-FRT-5, Conversion of PA Input Circuit for Single Side-band Excitation

low impedance grid circuits of the PA tubes (V505 and V506). However, such a circuit is not suitable for accepting drive from an external exciter such as the Western Electric type D156000 single side-band suppressed-carrier transmitter and therefore it must be modified slightly for such operation.

After modification, the transmitter input is approximately 200 ohms balanced to ground, and requires between 400 and 500 watts peak drive power. The two input terminals are coaxial connectors designed to be used with JAN type RG-8/U coaxial cables fitted with JAN type UG-59A/U male connectors. The connectors, but no cable, are supplied with the conversion kit. These input terminals are located on the rear side of the power amplifier grid circuit enclosure in RF Unit T-225A/FRT-5 and are accessible through the rear doors. The coaxial cables are to be inserted through the cable openings in the bottom of the cab-

inet and connected directly to these jacks. The cable may be tied to existing transmitter wiring at convenient places for support.

b. POWER AMPLIFIER GRID CIRCUIT CONVERSION. — A wiring diagram for the single side-band conversion is shown in figure 3-15.

(1) Remove the variable vacuum capacitor C526 and lay it aside.

(2) Remove the 25-347 mmf variable air capacitors C533 and C534 and replace them with 9-52 mmf variable air capacitors C573 and C574 from the modification kit. Note that mounting holes are provided for these capacitors. Leave balancing capacitor C535 disconnected.

(3) Remove the three 140-mmf fixed vacuum capacitors, C527, C528 and C529, but save them for replacement.

(4) Reconnect the circuit consisting of C527, C528, C529, C530, C531, C573, C574 and L509 as shown in figure 2-26 using the copper connectors supplied in the modification kit. These connectors are all supplied as flat straps and must be bent as necessary in installation. Be very careful to place these connectors exactly as shown in the installation drawing supplied with the modification kit.

(5) Connect load resistors R586, R587, R588 and R589 in series between the input jacks as shown.

(6) Use short lengths of JAN type RG-8/U coaxial cable to make the connections from the input jacks to the terminals of C527. Ground the shields of these coaxial cables to the cabinet wall by installing a grounding lug under one of the input jack mounting screws on each side and making connection thereto. This coaxial cable is to be slipped down between the back wall of the cabinet and the support rods of coil L509. Make certain that the two lengths of cable are cut the same length even though one must be coiled up a bit in fastening it to the capacitor terminal.

(7) Reinsert the 140-mmf fixed vacuum capacitors in the three center positions.

(8) Insert the 140-mmf fixed vacuum capacitors into the outside clips. It may be necessary to loosen the capacitor terminal bushings from their leads and slide them outward a bit to make the units fit the mounting clips. These terminal bushings are held in place by small set screws.

(9) After the wiring is complete, adjust the variable elements as follows:

(a) Turn on the servo control system by the procedure previously outlined under initial adjustment and set the DRIVER PLATE TUNING control "C" to "1000" on the scale.

(b) Loosen the set screws on the shaft of capacitor C573/C574 and rotate it to the point of minimum capacity (with the plates just ready to mesh on the front side). Tighten the set screws.

(c) Slip the flexible coupler on the drive for inductor L509 off of the splined inductor shaft by pushing the splined collar to the right. Rotate the coil until the slider is positioned at the extreme left end of the coil at the end of the last turn. Slip the flexible coupler splines back together.

(d) Check the operation throughout the dial range to make certain that the variable circuits are operating smoothly.

(10) Disable the frequency multipliers and driver by removing the following links or connections:

(a) Remove the plate cap connector from the type 4-400A tube and lay it aside.

(b) Disconnect the driver plate voltage by removing the jumper wire connecting terminal #86 on E314 with the junction of R317 and R318 in Power Supply PP-490A/FRT-5.

(c) Disable the low voltage supply by removing the jumper between terminals #59 and #60 on E310 in Power Supply PP-490A/FRT-5.

(11) Add a 15-mf, 1000-volt capacitor (C309) to the PA bias supply to improve the filtering. Connect the capacitor from the arm of the bias adjustment potentiometer R302 to ground, either by making a direct connection to the potentiometer arm or by connecting to terminal #34 on E303. No special mounting provisions have been made for this capacitor.

(12) Remove one resistor from the filter reactor shunt resistor group (R305, R306, R323 and R333) in Power Supply PP-490A/FRT-5.

c. TUNING PROCEDURE. — With the modification complete and the input coaxial cables connected to the output of the Western Electric type D156000 or other suitable transmitter, the tuning and set-up procedure given in Section 4, paragraph 3 e, should be followed to put the set in operation.

SECTION 4 OPERATION

1. INTRODUCTION.

Radio Transmitting Set AN/FRT-5A is a 15-kilowatt unit designed for off-on keying, frequency-shift keying or teleprinter operation over the frequency range of 4000 kc to 26,000 kc. The tuned circuits are motor-driven and servo-positioned by means of a simple servo-positioning system. Each tuning control varies a single tuned circuit continuously over the entire band. This arrangement provides a simple method of rapidly and accurately changing frequencies.

The transmitter proper contains a buffer amplifier, frequency multipliers, a driver and a power amplifier, and is designed to be preceded by any one of several types of exciter. The required excitation from the exciter is approximately 2 volts across a 50-ohm transmission line in the frequency range of 2000 kc to 4000 kc.

Three alternate forms of excitation are provided. They are a 10-channel crystal oscillator, a stabilized master oscillator and a frequency-shift keyer. The unit or units to be used at any given time will be determined from the transmitting schedule, and are to be set up by means of the coaxial interconnecting patch panel.

Protection against equipment damage caused by overloads or other normal equipment faults is completely in accordance with modern practice. Caution must be exercised, however, in the tuning and adjusting of this equipment as damage may result from improper operation. Before attempting to adjust this equipment, each operator should familiarize himself with all of the controls, their functions and their locations. He should also have reasonable knowledge of the fundamental circuit theory and details of the equipment.

2. OPERATIONAL PROCEDURES.

a. LOCATION OF CONTROLS. — In the following discussion of the location of the controls, it is assumed that the equipment has been in operation, in which case all of the breakers on all of the control panels will be in the ON position. This is the normal operating condition, and therefore only one switch need be thrown to energize all circuits except the d-c plate supplies. It is with this fact in mind that the operator should familiarize himself with the location and function of controls. For a detailed explanation of

the individual breakers, refer to paragraphs 2*b* through 2*d* below.

(1) GENERAL. — There are four principal control locations on the two units designated as RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5. In each unit these are located (a) on the upper front doors, and (b) on the control panels.

(2) UPPER FRONT DOORS. — Each of the upper front doors contains three controls which are identical on each door. They are:

(*a*) FILAMENT — EMERGENCY OFF SWITCHES. — These are red toggle switches (S510 and S307) labeled FILAMENT — EMERGENCY OFF. They control filament power and all incidental equipment in the two units, excluding the d-c supply, and are wired in series so that both must be thrown to the FILAMENT position before the equipment can be operated. Conversely, the whole unit may be shut down in an emergency by throwing either one of the switches to its EMERGENCY OFF position.

(*b*) PLATE ON. — These are black push buttons located one on each upper front door and labeled PLATE ON. They control the application of d-c voltage and are wired in parallel so that depressing either button will turn the equipment on.

(*c*) PLATE OFF. — These are red push buttons located to the right of the black buttons and labeled PLATE OFF. They remove the d-c voltage from the equipment and are wired in series so that, like the filament toggles, only one must be depressed to turn the equipment off.

(3) CONTROL PANELS. — Each cabinet contains a small control panel behind a horizontally hinged door in the lower front door of the main cabinet. These panels contain controls as follows:

(*a*) RF UNIT T-225A/FRT-5. — All of the r-f operating controls are located either on or adjacent to the control panel of RF Unit T-225A/FRT-5. The panel is shown in figure 4-1. It contains the six variable controls required for tuning plus an excitation control, a keying input level and a test key. Located to the right of the panel are four more controls. They are the left and right power amplifier filament voltage coarse adjustment controls, the keyer output level control, and a keying input selector switch.

(b) POWER SUPPLY PP-490A/FRT-5. — A fourth control point is located on the control panel of Power Supply PP-490A/FRT-5. This panel is shown in figure 4-2. It contains all of the 230-volt power distribution switches and breakers associated with Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5 except for the high voltage supply main breaker (K401). It also contains the vernier controls (R327 and R326) for the power amplifier filaments, a meter selector switch (S314), a TUNE-OPERATE switch (S310) and a hand-operated test key (S316).

(4) RACK-MOUNTED EQUIPMENT. — An equipment rack is provided behind the lower front door of RF Unit T-225A/FRT-5. This rack contains the two exciter units, RF Oscillator O-91A/FRT-5 and RF Oscillator O-92A/FRT-5, Frequency Shift Keyer KY-45A/FRT-5, Power Supply PP-454A/FRT-5 which is

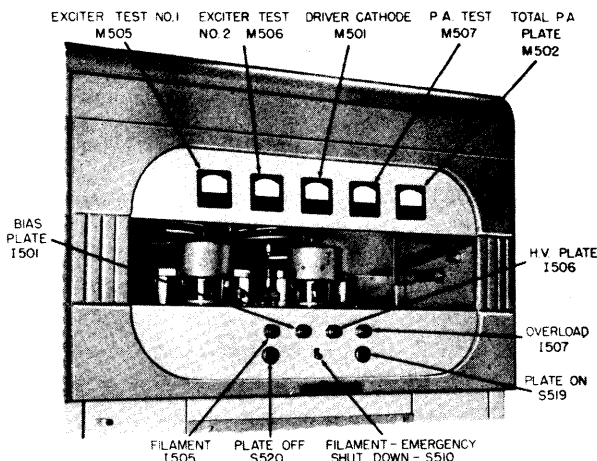


Figure 4-1A. RF Unit T-225A/FRT-5, Upper Front Panel

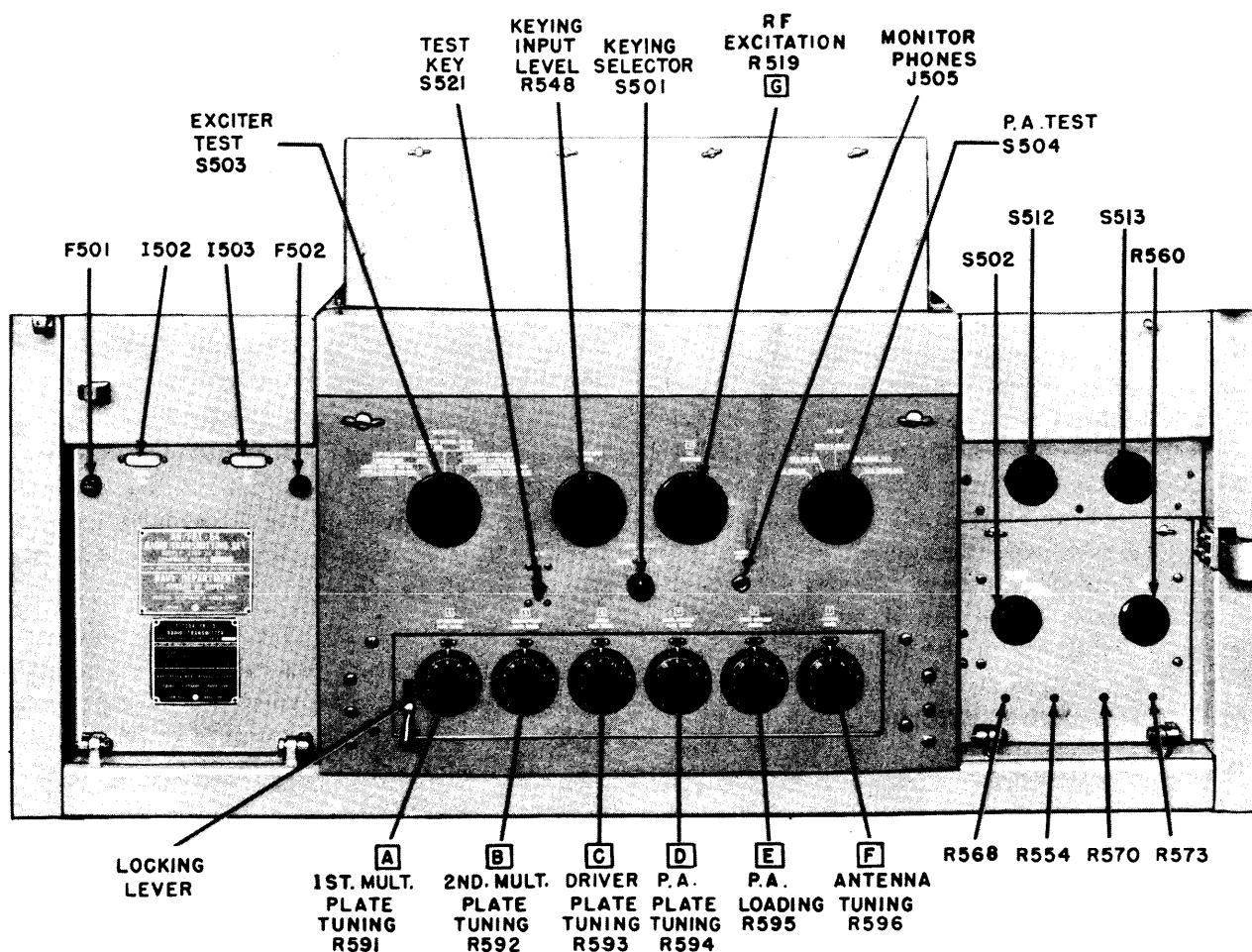


Figure 4-1B. RF Unit T-225A/FRT-5, Control Panel and Front Panels of Multiplier-Driver and Electronic Keyer Assemblies

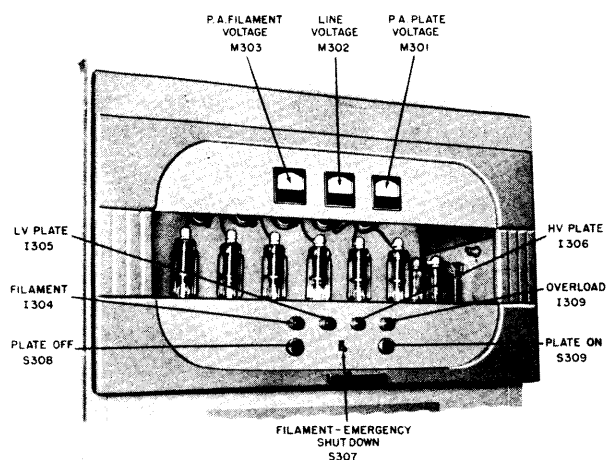


Figure 4-2A. Power Supply PP-490A/FRT-5,
Upper Front Panel

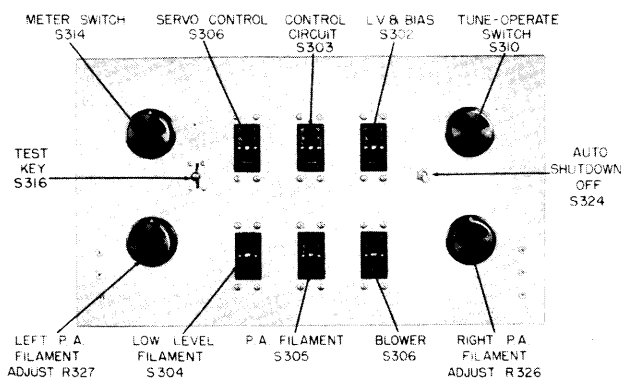


Figure 4-2B. Power Supply PP-490A/FRT-5,
Control Panel

associated with RF Oscillator O-91A/FRT-5 and Keyer KY-45A/FRT-5, and a set of servo amplifiers and their associated power supply. A patch panel for convenience in interconnecting any of the exciting units is also mounted on this rack. The rack is pivoted on one end so that it may be swung outward to provide access to the rear of the equipment mounted on it. All connections from the rack-mounted equipment to the transmitter are made through flexible cables which terminate at a junction box or jack panel at the left end of the wall behind the rack.

b. POWER CONTROLS. — Power for the basic transmitter is controlled through two independent although interconnected systems. One system controls all of the filaments, blowers, and miscellaneous items whereas the other system controls the primary power to the d-c supplies.

(1) **FILAMENTS AND BLOWERS.** — The filament and blower control system in RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5 is the starting point of the controls. Three breakers, designated as **LOW LEVEL FILAMENT**, **PA FILAMENT** and **BLOWERS**, distribute power to this portion of the control system.

The term low level filaments includes all filaments except the power amplifiers. The individual filament transformers are supplied through voltage regulating transformers (T311 and T312), and each is protected by a separate fuse which is shunted by a neon lamp. These lamps light up when the corresponding fuse is blown or absent, and are readily visible on inspection after opening the enclosure doors. The breaker labeled **PA FILAMENT** (S305) and located on the control panel of Power Supply PP-490A/FRT-5 supplies 230-volt power to the two PA filament transformers. There is an air interlock (S511) in this circuit so that the PA filaments cannot be energized unless the blowers are delivering the required amount of cooling air. Means for adjusting the voltage of these PA filaments are provided in the primary of each transformer. Each primary is equipped with four taps to provide coarse voltage steps, while a series rheostat provides for vernier adjustments. The primary taps are selected by tap switches S512 and S513, located inside of the lower front door and near the upper right-hand corner of the r-f bay.

The blowers, controlled by blower circuit breaker S301 which is designated as **BLOWER** on the panel, are provided with a delayed shut-down feature following the regular equipment shut-down. A **BLOWER HOLD ON** timer (K305), which is adjustable for 0 to 5 minutes, causes the blowers to remain in operation for a selected interval after the filament circuits have been de-energized.

Pilot or status lamps are located on the upper front doors immediately above the push buttons. The left-hand or filament light on the power unit indicates when the low level filaments are energized whereas the filament pilot on the r-f unit indicates that the PA filament transformer primaries are energized. Operation of the latter light is proof that the blowers are in operation and that the air interlock is closed.

(2) **D-C SUPPLIES.** — The d-c power control portion of the primary control circuits affects the bias, low voltage and high voltage power supplies. This control circuit is interlocked with the PA filaments supply so that plate power can never be applied to the power amplifier in the absence of filament power. The control circuit breaker, S303, on the power unit control panel distributes the 230-volt power for operation of all the relays associated with the d-c control circuit.

Since all of the meter lights are also fed through this control circuit breaker, they serve to indicate whether it is closed.

(a) **BIAS SUPPLY.** — The bias supply and the d-c low voltage supply obtain their primary power through breaker S302, designated as LV & BIAS and located on the power unit control panel.

Between the breaker and the supply transformers are two separate contactors, K306 and K308, which obtain their operating power from the d-c control circuit. The bias contactor is automatically closed at the end of the filament time delay which follows initiation of filament heating, provided all interlocked doors are closed. These interlocked doors include both upper front doors and all the rear doors. The presence of primary voltage in the bias supply is indicated by the green pilot lamp (I501) on the upper front door of RF Unit T-225A/FRT-5. When d-c bias voltage is present, an interlocking relay (K307) operates to permit further operation of the d-c power control circuits. This relay, K307, is located inside of the lower door of the power unit at the right-hand end of a row of overload relays. An orange flag appearing behind the glass window indicates that the relay is closed and that bias voltage is present.

(b) **LOW VOLTAGE SUPPLY.** — The low voltage d-c power supply is controlled either by itself or simultaneously with the high voltage supply. Independent control is accomplished by setting the TUNE OPERATE switch to the LV TUNE position and depressing the PLATE ON button. A green pilot lamp (I305) on the power unit indicates presence of primary power in this supply. Both the bias and the low voltage supplies are protected against damage from overload or short circuit by the control panel breaker, S302, which trips out when excessive current is drawn by either supply.

(c) **HIGH VOLTAGE SUPPLY.** — The high voltage supply is controlled by a special motor-operated combination start-stop contactor and overload breaker (K401). It is located in Power Control C-587A/FRT-5 which is mounted outside of the main transmitter housing. This breaker is controlled by the PLATE ON push button (S519 or S309) on the upper front door in the same manner as the low voltage supply except that the TUNE OPERATE switch must now be in the HV TUNE or OPERATE position. The difference between these two positions is that in the HV TUNE position, series resistors are inserted in the primary line to the high voltage plate supply transformer whereas in the OPERATE position these resistors are short-circuited.

Indication that the high voltage d-c supply is ener-

gized is given by red pilot lamps (I306 and I506) on the upper front doors of the individual cabinets and by two 50-watt warning lamps in ruby globes mounted outside of the cabinets. All light up when the control circuit is set up for high d-c voltage. The warning lamps are connected directly across the primary lines to the plate transformer and are mounted, one (I402) above the transmitter and the other (I401) near the external plate transformer. Plate voltage is also indicated on HV DC meter M301.

The high and low voltage d-c supplies are disabled simultaneously by depressing either of the PLATE OFF buttons (S520 and S308) on the two upper doors. A manual switch is located in the external power control, C-587A/FRT-5, to provide a means for connecting the primary of the plate power transformer (T401) in delta or wye arrangement, or disconnecting it from the line entirely. Normally operation is with this switch in the DELTA position. Reduced voltage (58 percent of normal) is obtained in the WYE position. The high voltage plate power control circuit may be checked without fear of high voltage power being applied accidentally by setting this switch to the OFF position and proceeding to turn on the transmitter. In this case, the red HV ON lamps (I306 and I506) on the transmitter will be illuminated but the 50-watt red globes (I401 and I402) will remain unlighted.

Note

The plate supplies in the entire transmitter may be disabled by depressing either of the PLATE OFF buttons on the front of the units.

c. **TUNING SYSTEM.** — The six resonant circuits in this transmitter are remotely positioned through a system of motor drives and servo positioners. Power for these circuits is distributed through a breaker designated SERVO CONTROL (S306) and located on the control panel of Power Supply PP-490A/FRT-5. All six of the circuits are similar. A typical system consists of a 10-turn front panel control potentiometer, a servo amplifier, a driving motor assembly and a second 10-turn potentiometer used for "follow-up" control. The "follow-up" potentiometer is coupled to the driving motor and is automatically rotated to a position corresponding to the manually set position of the front panel control. A motor-driven tuning system of this nature operates at fixed speed. It is therefore possible to rotate the tuning dials faster than the tuning motors can operate the driven circuit. This results in a slightly unusual feel to the tuning of the equipment but an operator soon becomes accustomed to this. It must be remembered that the motor-tuned circuit will

position itself in accordance with the setting of the front panel control, automatically, and at a fixed speed, regardless of whether the panel control is moved a very slight or a very large amount. These circuits require from 30 to 60 seconds to travel over the entire range from the position corresponding to 4000 kc to that corresponding to 26,000 kc.

An alternate tuning procedure is to disable this circuit by opening the SERVO CONTROL breaker and preset all of the control knobs according to previously recorded set-up data, then to close the SERVO CONTROL circuit breaker so that all of the servo-operated systems will reset to their new positions simultaneously. Plate power must be removed during the travel time.

d. OVERLOADS.

(1) GENERAL. — A complete overload protecting system is incorporated in this transmitter. Primary overloads in the filament and blower circuits have already been covered and some mention made of the overload features.

The power amplifier tubes and the driver tube each have a d-c overload relay associated with their cathode circuits. These three relays trip the primary circuit breakers of the high voltage supplies, and are normally set to trip at approximately 125 percent of normal current. In addition, a single d-c overload relay (K319) is located in the ground return of the PA high voltage supply to protect this supply against overloads other than those caused by the three tubes previously listed. These four relays are located behind the lower front door of Power Supply PP-490A/FRT-5. All are housed in black Bakelite cases with glass windows. An orange flag becomes visible through the glass window when a relay is tripped. These flags are provided to facilitate location of the circuit in which an overload occurs and can be reset (dropped out of sight) by lifting a small plunger which protrudes from the bottom of the case near the front edge. The operator should check these relays following any overload and note on the log book which ones were tripped.

The overload and trip-out sequence in this transmitter is designed to keep the transmitter in operation, if at all possible, provided it has been properly adjusted initially. There are two types of restart operations, the automatic restart and the non-automatic restart. They function as follows:

(2) NON-AUTOMATIC RESTART. — During the first 30 seconds after manual start-up, any overload will cause the transmitter to lock-out. In this case, it will be necessary to manually start it up again. If it should lock-out once again, it is wise to find the

cause of the overloads before attempting to put the transmitter on the air again. If there is no overload within the 30-second period after manual start-up the auto-start feature becomes operative.

(3) AUTOMATIC RESTART. — It is the function of the automatic restart circuits to close the primary circuit breakers immediately after they have been tripped out by an overload. This means there will be a momentary interruption of the transmitter carrier. If the overload was caused by a flashover, the chances are that this same flash-over will not recur immediately and therefore the equipment will continue to operate following such restarting. On the other hand, it may be that an overload will occur several times in succession before clearing. To provide for such situations, the automatic circuit is designed to produce a maximum of 8 successive reclosures before final lock-out. This number of reclosures is adjustable to any number from 0 to 8 by means of selector switch S317. It is normally set for three successive reclosure cycles.

A second feature of this overload circuit is that the over-all time interval, during which the selected number (0 to 8) of overloads must occur to produce a lock-out, is adjustable from 0 to 15 minutes. This means that if the selected number of overloads occurs within the over-all time interval (0-15 minutes) following the first overload, the transmitter will lock-out. If, on the other hand, the selected number of overloads does not occur within the over-all time interval, the circuits will automatically clear themselves as if no overload had occurred. A pilot lamp is located on the front panel of each unit to indicate that an overload has occurred and that the 0-15 minute time interval just described is timed out.

An audible alarm is provided to give warning that the transmitter is off the air and has locked out. This warning is produced by a horn (I310) located in the top of Power Supply PP-490A/FRT-5. It can be quieted by depressing any of the PLATE OFF buttons.

Another form of overload which has not been mentioned, but which may occur, is a rectifier arc-back. Such an arc-back will produce a short circuit on the plate transformer secondary which will increase the primary current enough to trip the a-c over-current breakers. If none of the overload relays is showing its flag when the power trips out, it is probable that an a-c overload has occurred. This may or may not be due to a faulty rectifier tube. However, it can be checked very quickly by observing the rectifier tubes while the transmitter is operating. The xenon-gas-filled tubes normally show little if any internal glow, because of

their shielding. Arc-backs, however, produce easily visible light flashes within the glass envelope of the tube.

e. AUTOMATIC SHUT-DOWN. — Provision has been made to shut down the main d-c power supply automatically in the event that no keying impulses are applied to the input circuit for a period of 15 minutes. This automatic shut-down feature can be disabled at will by the operator by throwing the AUTO SHUT-DOWN switch, S324, located on the control panel of Power Supply PP-490A/FRT-5, to the OFF position.

f. METERS.

(1) RF UNIT T-225A/FRT-5. — This r-f unit has five meters located above the window on the upper door. Two of these meters, EXciter TEST #1 (M505) and EXciter TEST #2 (M506), have arbitrary scales, their full scale reading depending on the circuit being metered. A common selector switch, S503, simultaneously switches both meters into the various circuits. The circuit being monitored by each meter in each position of the switch, together with the true values of the corresponding full-scale meter readings for that position, is indicated opposite the switch pointer on the control panel. Each of these two meters checks five circuits. EX. TEST #1 meters the buffer cathode current, the 1st multiplier cathode current, the 2nd multiplier cathode current, and the peak r-f voltages on the grids of the left and the right PA tubes. EX. TEST #2 meters the buffer and 1st multiplier grid current, the 2nd multiplier grid current, the driver grid current, and the peak r-f voltage on the plates of the left and right PA tubes.

The third meter, designated DRIVER CATHODE (M501), is located in the center of the r-f unit and is permanently connected into the driver cathode (V504) circuit. The meter immediately to the right of this center meter is marked PA TEST (M507) and is used in conjunction with the right-hand selector switch (S504) on the control panel. It meters the individual PA grid currents, the total PA grid current and the individual cathode currents of the PA tubes. As in the case of switch S503, the true values of the full-scale meter readings for each position of switch S504 are indicated on the control panel opposite the switch pointer. The fifth and end meter of the group, designated as TOTAL PA PLATE, is permanently connected in the cathode circuit of the power amplifier. It is so connected, however, that the PA grid current does not flow through it; therefore it is a true indication of the total PA plate current.

Output current is measured by two other meters, M503 and M504, located on top of RF Unit T-225A/FRT-5.

(2) POWER SUPPLY PP-490A/FRT-5. — There are three meters located above the window on the upper front door of Power Supply PP-490A/FRT-5. A 300-volt a-c LINE VOLTAGE meter (M302) and a 10-volt a-c P.A. FILAMENT VOLTAGE meter (M303) are switched simultaneously by a common meter selector switch so that the appropriate meter will be used to check the three-phase primary voltage, the output voltage of the regulating transformers, and the PA filament voltages. The third meter (M301) is a high voltage d-c voltmeter which indicates the P.A. PLATE VOLTAGE applied to the power amplifier.

g. OTHER FEATURES. — There are several more features of this equipment with which the operator must be familiar. The following listing makes no attempt to put them in their order of importance. They are:

(1) DELTA-WYE-OFF SWITCH. — This switch is located in Power Control C-587A/FRT-5 and provides a means for connecting the PA plate supply transformer primary in delta or wye arrangement, or disconnecting it entirely. The delta connection provides the highest secondary voltage and is the normal adjustment. The wye connection provides a voltage that is approximately 58 percent of normal. This voltage is provided for use while making initial adjustments, and for use by operating personnel who are learning to adjust the equipment. It may also be used to keep the transmitter on the air when, for some reason, it will not operate at full voltage.

(2) INTERLOCKS. — The upper front doors and all of the rear doors are equipped with automatic mechanical grounding switches. These switches operate the instant any of these doors is opened, to short-circuit all potentials greater than that of the 230-volt primary line. These are in addition to the normal interlock switches which interrupt the primary circuits to the d-c power supplies. Normally, the interlocking circuits will shut off the power supplies ahead of the operation of the grounding switches so that no arcing or flashing occurs. In case of failure or slowness of this electrical control system, these grounding switches, short-circuiting the supplies as they do, will trip out the primary breakers and thus prevent possible accidental injury to operating personnel. It is a wise precaution for the operator to form a habit of momentarily operating and releasing the plungers of these interlocks each time he opens a door, in order to assure himself that they are operating properly. This habit may sometime save his life.

(3) TEST KEYS. — There is one test key (S521) on the control panel of RF Unit T-225A/FRT-5, and another (S316) on Power Supply PP-490A/FRT-5.

These keys simulate off-on keying and are normally open (when the handle extends straight out from the panel). They are arranged to lock closed in the upper position, but to make only momentary contact in the down position. This makes it possible for the operator to manually key the transmitter for test purposes.

(4) PA BIAS ADJUST. — The PA bias adjusting control (R302) is located at the bottom of the relay panel behind the lower front door of the power unit. This control is normally adjusted to its extreme counterclockwise position and left there. It is used for careful adjustment of the bias when the amplifier is adjusted for linear operation, as is required for single side-band suppressed-carrier transmission.

(5) OFF-ON KEYS. — The off-on keyer has two controls which are to be adjusted for best keying waveform. One of these controls (R548) is the KEYING INPUT LEVEL control. This is located on the main control panel of the RF Unit T-225A/FRT-5 and is simply a variable voltage divider across the keying line. In order to retain any wave shaping that may have been applied to the original pulse and to prevent changing the relative spacing of the mark-to-space signals, this input level should be operated at as low a value (counterclockwise direction) as will produce constant keying. The other control, OUTPUT LEVEL control R560, is located on the front panel of the on-off keyer unit itself, which is to the right of the main control panel of the r-f unit. This control primarily adjusts the value of the biasing voltage when the key is open and the carrier is off. This bias voltage is increased or made more negative as the control is rotated counterclockwise. For normal general operation, the control is to be set in middle position. If means are available for observing the keying waveform, this control may be varied to obtain the best result.

On the front panel of the keyer is a selector switch (S502) marked KEYING INPUT FOR MARK. This is a set-up switch. It sets the vacuum tube keyer so that it will accept one of the four types of keying that are indicated. When the nature of the key line signal is known, this switch is set accordingly.

A control, marked KEYING SELECTOR (S501), is located in the middle of the control panel on RF Unit T-225A/FRT-5. Its middle position is marked LOCAL. In this position the test keys on the control panels are the only source of keying voltage, external circuits being disconnected. To the left is a REMOTE position. This connects the external incoming key line directly to the off-on keyer for normal keying. The right side is marked FSK. In this position the off-on

keyer is by-passed and the carrier is locked on. The input keying line is also shunted from the off-on keyer to the key line input of the frequency shift keyer mounted on the rack.

(6) PATCH PANEL. — A patch panel, otherwise known as an input-switching or interconnecting panel, is provided in the upper left-hand corner of the equipment rack behind the lower front door of RF Unit T-225A/FRT-5. This is shown in figures 3-9 and 3-11. The r-f input to the transmitter appears at one of the coaxial jacks (J201) on this panel, while the outputs of the crystal oscillator, the master oscillator and the frequency-shift keyer appear on separate coaxial jacks (J1202, J1203 and J1205). Jumper or patch cables are provided for interconnecting the frequency-shift keyer and either of the two oscillators. Several external and spare circuits are also available.

b. CRYSTAL OSCILLATOR O-92A/FRT-5. — This is a 10-channel crystal oscillator which has no tuning controls. A 10-position CRYSTAL SELECTOR SWITCH **[K]** (S1102) on the front panel allows the selection of the particular crystal required to provide the desired output frequency. The only other adjustments are the frequency trimming capacitors across the individual crystal positions. These are internal adjustments and not to be touched except by qualified personnel.

A second switch on the control panel (S1103) inserts the small test meter into either the OSCILLATOR CATHODE or the BUFFER CATHODE for current checks. The third position of this selector, marked REMOTE, provides for remote metering if the remote equipment is available. This transmitter does not include such equipment.

i. MASTER OSCILLATOR O-91A/FRT-5. — This is a continuous coverage oscillator delivering output from 2000 kc to 4500 kc. Its front panel controls include a MASTER OSCILLATOR TUNING dial, an INTERPOLATION OSCILLATOR TUNING dial, an OUTPUT TUNING dial and a SET UP — OPERATE switch (S103). The master oscillator and output tuning are calibrated in kilocycles and are set up as close to the desired frequency as possible. The interpolation oscillator dial is calibrated directly in cycles-per-second and is used in conjunction with the automatic frequency correcting circuit within this unit to bring the master oscillator to the desired frequency. Refer to the detailed operating instructions further on in this section for the exact procedure to be followed in adjusting this and other controls.

j. FREQUENCY SHIFT KEYS KY-45A/FRT-5. — Frequency Shift Keyer KY-45A/FRT-5 contains a

TABLE 4-1. CONTROL LOCATION AND FUNCTION

FUNCTIONAL DESIGNATION	LOCATION	LETTER DESIGNATION	TYPE OF COMPONENT	SYMBOL	PURPOSE OF CONTROL
PLATE—ON-OFF	KY-45A/FRT-5 (Front Panel)	—	Switch	S1401	Controls connection of 250 volts and 150 volts from power supply to components of the F. S. Keyer. The PLATE ON pilot lamp comes on when the switch is in the ON position.
METER— GRID-PLATE	KY-45A/FRT-5 (Front Panel)	—	Switch	S1402	Permits switching of M1401 to either the GRID or PLATE circuit of the POWER AMPLIFIER, V1404.
OUTPUT LEVEL	KY-45A/FRT-5 (Front Panel)	—	Potentiometer	R1430	Controls the r-f output level of the keyer.
PHASE MODULATION	KY-45A/FRT-5 (Front Panel)	—	Potentiometer and Switch	R1485 S1408	Connects the 250-volt plate supply to phase-modulating oscillator V1407 with switch S1408 and with potentiometer R1485, modifies the magnitude of the phase modulation.
WAVESHAPING	KY-45A/FRT-5 (Front Panel)	—	Switch	S1404	Modifies the output wave shape of the keying tube by connecting different combinations of series inductance and bridged capacitance.
TEST-OPERATE	KY-45A/FRT-5 (Front Panel)	—	Switch	S1403	Permits selecting CARRIER - SPACE - MARK - FSK or PHOTO operation.
MAIN TUNING	KY-45A/FRT-5	A	Capacitor	C1405A through C1405E	Tunes the output circuits of the BALANCED MODULATORS, the BUFFER and the POWER AMPLIFIER.
TRANSMITTER MULTIPLICATION	KY-45A/FRT-5 (Front Panel)	B-2	Switch	S1405	Sets the magnitude of the frequency shifts in ratios corresponding to the frequency multiplication factor of the transmitter.
BASIC SHIFT	KY-45A/FRT-5 (Front Panel)	—	Potentiometer	R1458	Adjusts the magnitude of the frequency shift.
KEYER BALANCE	KY-45A/FRT-5 (Behind Front Panel)	—	Potentiometer	R1450	Equalizes the magnitude of the balanced keyer output voltage. This condition is reached only when the TEST-OPERATE switch is in the CARRIER position.
200-KC OSC. ADJUST.	KY-45A/FRT-5 (Behind Front Panel)	—	Capacitor	C1442	Adjusts frequency of frequency-shifted signal (200 kc oscillator).
FREQUENCY SHIFT CALIBRATION	KY-45A/FRT-5 (Behind Front Panel)	—	Potentiometer	R1464	Adjusts the gain of phase shifting amplifier V1409 which in turn calibrates the BASIC SHIFT control (R1458).
PHOTO ADJUST	KY-45A/FRT-5 (Rear of Unit)	—	Potentiometer	R1448	Limits the amount of photo signal to the balanced keyer tube.
LIMITER ADJUST	KY-45A/FRT-5 (Rear of Unit)	—	Potentiometer	R1439	Adjusts the bias on the balanced keyer and limiter tubes.
MODULATOR BALANCE	KY-45A/FRT-5 (Rear of Unit)	—	Potentiometer	R1416	Equalizes the output of the balanced modulator.
EXT. OSC. ATTENUATOR	KY-45A/FRT-5 (Rear of Unit)	—	Switch	S1401	Permits adjusting the level of the r-f input from the external oscillator.
PLATE ON-OFF	O-91A/FRT-5 (Front Panel)	—	Switch	S101	Controls connection of 250-volt and 150-volt outputs from power supply to components of the r-f oscillator. The PLATE ON pilot comes on when the switch is in the ON position.
TEST-OPERATE	O-91A/FRT-5 (Front Panel)	—	Switch	S103	Controls the AFC motor. When the switch is in the OPERATE position the AFC ON pilot comes on.
INTERPOLATION OSCILLATOR	O-91A/FRT-5 (Front Panel)	B-1	Inductance	L105	Interpolates within the 0-5000 cps range between adjacent points of M.O. dial.
MASTER OSCILLATOR	O-91A/FRT-5 (Front Panel)	A-1	Inductance	L103	Determines the output frequency as indicated on the dial.
OUTPUT TUNING	O-91A/FRT-5 (Front Panel)	C-1	Capacitor	C120	Tunes the output circuit of V112, the output circuit of V113 and the plate circuits of the two harmonic amplifiers V104 and V105.

TABLE 4-1. CONTROL LOCATION AND FUNCTION (Continued)

FUNCTIONAL DESIGNATION	LOCATION	LETTER DESIGNATION	TYPE OF COMPONENT	SYMBOL	PURPOSE OF CONTROL
100 KC EXT. INT.	O-91A/FRT-5 (Rear of Unit)	—	Switch	S105	To connect the internal 100-kc crystal in the circuit, or to connect an external 100-kc crystal in the circuit.
OUTPUT CONTROL	O-91A/FRT-5 (Rear of Unit)	—	Potentiometer	R165	Changes the r-f output level of the r-f oscillator.
CRYSTAL SELECTOR SWITCH	O-92A/FRT-5 (Front of Unit)	K	Switch	S1102 A&B	Selects one of the ten crystals for the oscillator circuit.
OSC. CATH., BUFF. CATH., EXTERNAL	O-92A/FRT-5 (Front of Unit)	—	Switch	S1103	Inserts front panel meter in oscillator cathode or buffer cathode, or connects meter shunts to external metering circuits.
ON-OFF	PP-454A/FRT-5 (Front Panel)	—	Switch	S1001	Controls connection of 230-volt a-c power to the primaries of power transformers T1001 and T1002.
METER SWITCH	PP-454A/FRT-5 (Front Panel)	—	Switch	S1003 A&B	Switches the output voltages to the meter circuit for reading.
METER SWITCH	PP-490A/FRT-5 (Control Panel)	—	Switch	S314	Simultaneously inserts A-C LINE VOLTAGE and P. A. FILAMENT VOLTAGE voltmeters into indicated positions for checking. Provides switching to each of the three phase lines, REG. BUS 1 & L PA FIL. and REG. BUS 2 & R PA FIL.
SERVO CONTROL	PP-490A/FRT-5 (Control Panel)	—	Switch	S306	Controls application of 230-volt a-c power to the servo power supply and provides a-c cover-load protection.
CONTROL CIRCUIT	PP-490A/FRT-5 (Control Panel)	—	Switch	S303	Controls application of 230-volt a-c power to the relays and timers which control the high voltage, low voltage and bias d-c power supplies and provide a-c overload protection.
L. V. AND BIAS	PP-490A/FRT-5 (Control Panel)	—	Switch	S302	Controls application of the 230-volt a-c power to the primary windings of the low voltage and bias supply plate transformers and provides a-c overload protection.
TUNE OPERATE SWITCH	PP-490A/FRT-5 (Control Panel)	—	Switch	S310	Permits the selecting of L. V. TUNE, H. V. TUNE or OPERATE circuits.
TEST KEY	PP-490A/FRT-5 (Control Panel)	—	Switch	S316	Applies a test keying voltage to the keyer tube and thus turns on the carrier.
AUTO SHUT-DOWN	PP-490A/FRT-5 (Control Panel)	—	Switch	S324	Completes the circuit to AUTO SHUT-DOWN TIMER when in AUTO SHUT-DOWN position. Disables automatic shut-down feature when in OFF position.
LEFT PA FILAMENT	PP-490A/FRT-5 (Control Panel)	—	Potentiometer	R327	Gives a vernier voltage adjustment between the taps selected by S512.
LOW LEVEL FILAMENT	PP-490A/FRT-5 (Control Panel)	—	Switch	S304	Controls application of 230-volt a-c power to the primaries of all the rectifier, buffer, multiplier and driver filament transformers and provides a-c overload protection.
FILAMENT — EMERGENCY SHUT-DOWN	PP-490A/FRT-5 (Control Panel)	—	Switch	S307	In series with switch S510. Applies 230-volt a-c primary power to low level filaments contactor K301.
PA FILAMENT	PP-490A/FRT-5 (Control Panel)	—	Switch	S305	Controls application of 230-volt a-c power to the primaries of the PA filament transformers, and provides a-c overload protection.
BLOWER	PP-490A/FRT-5 (Control Panel)	—	Switch	S301	Controls application of 230-volt a-c power to the blower motors, and provides overload protection.
RIGHT PA FILAMENT	PP-490A/FRT-5 (Control Panel)	—	Potentiometer	S326	Gives a vernier voltage adjustment between the taps selected by S513.

TABLE 4-1. CONTROL LOCATION AND FUNCTION (Cont'd)

FUNCTIONAL DESIGNATION	LOCATION	LETTER DESIGNATION	TYPE OF COMPONENT	SYMBOL	PURPOSE OF CONTROL
EXCITER TEST	T-225A/FRT-5 (Control Panel)	—	Switch	S503	Inserts EXCITER TEST meters No. 1 and No. 2 simultaneously into the following circuits, with the indicated meter range: #1 Buffer Cathode — 100 ma. #2 Buffer and 1st Mult. Grid — 10 ma. #1 1st Mult. Cathode — 100 ma. #2 2nd Mult. Grid — 10 ma. #1 2nd Mult. Cathode — 200 ma. #2 Driver Grid — 50 ma. #1 L PA Grid RF Peak — 1000 V. #2 L PA Plate RF Peak — 10 KV. #1 R PA Grid RF Peak — 1000 V. #2 R PA Plate RF Peak — 10 KV. Note: { #1 is read on meter M505 { #2 is read on meter M506
FILAMENT — EMERGENCY SHUT-DOWN	T-225A/FRT-5 (Control Panel)	—	Switch	S510	In series with switch S307. Applies 230-volt a-c primary power to low level filaments contactor K301.
KEYING INPUT LEVEL	T-225A/FRT-5 (Control Panel)	—	Potentiometer	R548	Controls the amount of input voltage from the incoming keying line being applied to the keyer tube.
RF EXCITATION	T-225A/FRT-5 (Control Panel)	G	Potentiometer	R519	Controls screen voltage of the multiplier tubes and is used to set PA grid current level.
P.A. TEST	T-225A/FRT-5 (Control Panel)	—	Switch	S504	Inserts PA TEST meter in the following circuits with the indicated meter range: L. PA GRID — 0.5 amp R. PA GRID — 0.5 amp TOTAL GRID — 1 amp L. PA CATHODE — 0.5 amp R. PA CATHODE — 0.5 amp
TEST KEY	T-225A/FRT-5 (Control Panel)	—	Switch	S521	Applies a test keying voltage to the keyer tube when KEYING SELECTOR Switch is in LOCAL position.
KEYING SELECTOR	T-225A/FRT-5 (Control Panel)	—	Switch	S501	Permits the selecting of REMOTE, LOCAL or FSK operation.
MONITOR PHONES	T-225A/FRT-5 (Control Panel)	—	Jack	J505	Provides for aural checking of the frequency monitor output from the front panel of the transmitter when the monitor output is connected to the transmitter terminals provided.
1st MULTIPLIER PLATE TUNING	T-225A/FRT-5 (Control Panel)	A	Potentiometer	R591	Varies the resonant frequency of the plate tank circuit for V502 through a servo positioning system.
2nd MULTIPLIER PLATE TUNING	T-225A/FRT-5 (Control Panel)	B	Potentiometer	R592	Varies the resonant frequency of the plate tank circuit for V503 through a servo positioning system.
DRIVER PLATE TUNING	T-225A/FRT-5 (Control Panel)	C	Potentiometer	R593	Varies the resonant frequency of the plate tank circuit for V504 through a servo positioning system.
POWER AMPLIFIER PLATE TUNING	T-225A/FRT-5 (Control Panel)	D	Potentiometer	R594	Varies the resonant frequency of the plate tank circuit for V505 and V506 through a servo positioning system.
POWER AMPLIFIER LOADING	T-225A/FRT-5 (Control Panel)	E	Potentiometer	R595	Varies the position of the output coupling network relative to the PA plate tank circuit through a servo positioning system.
ANTENNA TUNING	T-225A/FRT-5 (Control Panel)	F	Potentiometer	R596	Varies the resonant frequency of the output coupling network through a servo positioning system.

TABLE 4-1. CONTROL LOCATION AND FUNCTION (Continued)

FUNCTIONAL DESIGNATION	LOCATION	LETTER DESIGNATION	TYPE OF COMPONENT	SYMBOL	PURPOSE OF CONTROL
SHORTING BAR	T-225A/FRT-5 (Above IPA)	L	Strap	—	Shorts out C571.
LEFT P.A. FIL.	T-225A/FRT-5 (Inside Front Lower Door)	—	Switch	S512	Selects the primary taps on PA filament transformer T506.
RIGHT P.A. FIL.	T-225A/FRT-5 (Inside Front Lower Door)	—	Switch	S513	Selects the primary taps on PA filament transformer T505.
KEYING INPUT FOR MARK	T-225A/FRT-5 (Inside Front Lower Door)	—	Switch	S502	Sets up on-off keyer for operation from keying input pulses that are negative to ground for mark, positive for mark, polarized to ground negative for mark, or polarized positive for mark.
OUTPUT LEVEL	T-225A/FRT-5 (Inside Front Lower Door)	—	Potentiometer	R530	Adjusts the amplitude of the keying pulse applied to the keyed stages in the transmitter.
TEST KEYING LEVEL	T-225A/FRT-5 (Inside Front Lower Door)	—	Potentiometer	R568	Adjusts the amplitude of the d-c voltage applied to the keyer input through the test key.
ADJ. A	T-225A/FRT-5 (Inside Front Lower Door)	—	Potentiometer	R554	Adjusts voltage gain of phase inverter portion of keyer.
ADJ. B	T-225A/FRT-5 (Inside Front Lower Door)	—	Potentiometer	R570	Adjusts ratio of positive and negative test voltages for polarized positive keyer set up.
ADJ. C	T-225A/FRT-5 (Inside Front Lower Door)	—	Potentiometer	R573	Adjusts ratio of positive and negative test voltages for polarized negative keyer set up.

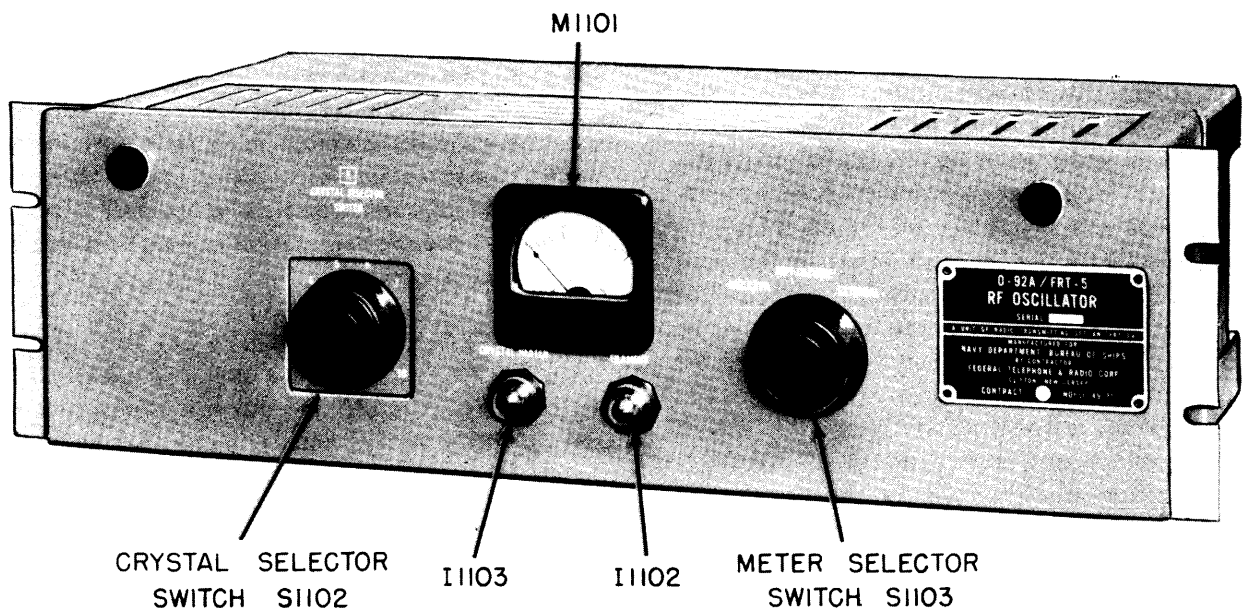


Figure 4-3. RF Oscillator O-92A/FRT-5, Front View

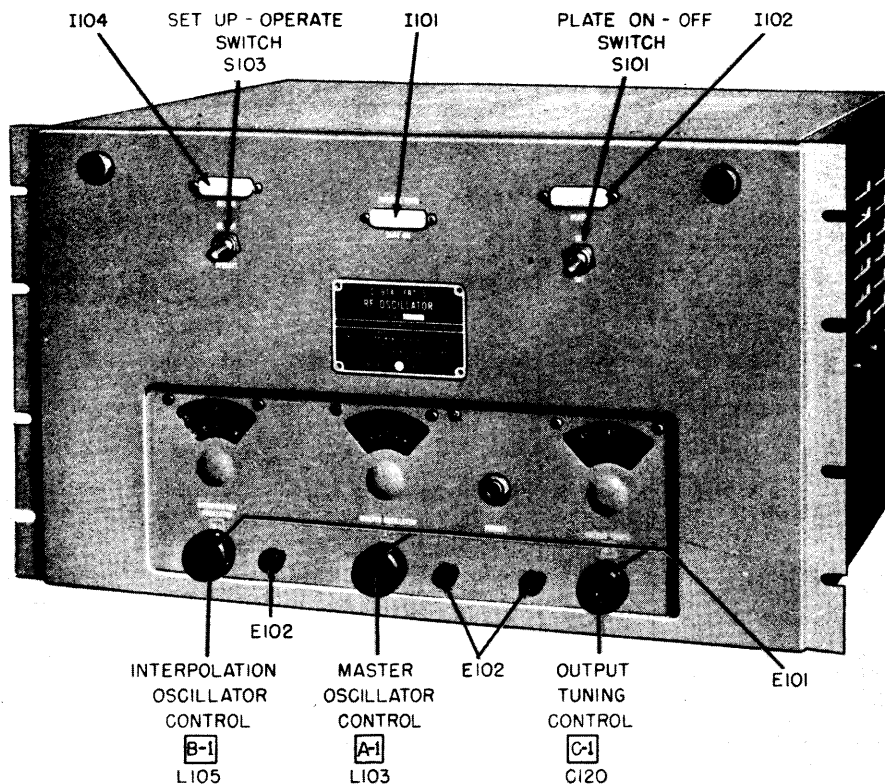


Figure 4-4. RF Oscillator O-91A/FRT-5, Front View

number of special front panel controls. These are listed in table 4-1, and illustrated in figures 4-5 and 7-46. Instructions for operation of the frequency-shift keyer are given in paragraph 3 d below. These should be thoroughly understood before any attempt is made to use the unit.

Briefly, its front panel controls are as follows. There is a MAIN TUNING control which is calibrated in kilocycles. It is to be set at an exact fraction of $\frac{1}{2}$, $\frac{1}{4}$, or $\frac{1}{8}$ of the desired transmitter output frequency along with a second switch marked TRANSMITTER MULTIPLICATION, which is to be set to the same factor. An OUTPUT LEVEL control is provided for adjusting the voltage applied to the transmitter input. This should be set to produce between 1 and 2 ma of buffer and first multiplier grid current. A TEST-OPERATE switch, a BASIC SHIFT control, a WAVE SHAPING switch, and a PHASE MODULATION control constitute the remainder of the front panel controls. Their use is carefully explained in the portion of this section dealing with the actual tune-up procedure.

3. OPERATION.

a. GENERAL. — Since the tuning of this equipment involves a rather complex procedure, it has been

deemed advisable, for the purpose of explanation, to assume an arbitrary set of operating conditions. It will be assumed that conventional "on-off" keying is to be used and that the transmitter frequency is to be 26,000 kc.

It should be understood that the procedures set forth below will apply to actual operating conditions, as well as to the example chosen. Tuning charts are included in this section to aid the operator in the tuning and adjusting of this transmitter. The operator is referred to table 4-1 for the explanation of panel designations, location and functions.

b. PROCEDURE USING CRYSTAL OSCILLATOR O-92A/FRT-5. — Tables 4-2 and 4-3, and the tuning charts shown in figures 4-6 through 4-13, provide initial or typical setting data. It should not be assumed that the settings of the individual transmitter being tuned will coincide exactly with those shown in these charts.

(1) On Power Supply PP-490A/FRT-5 place the circuit breakers marked SERVO CONTROL (S306), CONTROL CIRCUIT (S303), LV & BIAS (S302), LOW LEVEL FILAMENT (S304), PA FILAMENTS (S305) and BLOWER (S301) in their ON positions.

(2) Connect the output of RF Oscillator O-92A/-FRT-5 to the transmitter input. This is accomplished by attaching one end of one of the patch cords (short lengths of RG-58/U coaxial cable) to the CRYSTAL OSC. OUTPUT jack (J1202) on the patch panel, and the other end of the cable to the TRANSMITTER INPUT jack (J1201) on the patch panel.

(3) Operate the FILAMENT EMERGENCY SHUT-DOWN switches on both cabinets (S510 and S307) to their FILAMENT ON positions.

(4) Operate the TUNE OPERATE switch to the LV TUNE position.

(5) Operate the CRYSTAL SELECTOR SWITCH **K** to the position which will give the desired transmitter output frequency. In this case, the desired output is 26 mc, hence the 3250-kc crystal should be used.

Note

Referring to figure 4-6, multiplication factors of 2, 4, 6, or 8 may be used, the only criteria being that the oscillator frequency be between 2.0 to 4.0 mc.

(6) Refer to the calibration curves, figures 4-8 through 4-18, and set up controls **A**, **B**, **C**, **D**, **E**, **F**, and **G**, on the control panel of RF Unit T-225A/FRT-5 to the settings indicated by the curves. In this example, the frequency is being multiplied by four in the 1st multiplier and by two in the 2nd multiplier resulting in a total multiplication of eight.

(7) Check the position of shorting strap **L**. It should be open for frequencies above 15 mc, and closed for frequencies below 15 mc. Strap **L** is located above the power amplifiers and is accessible through the upper front door of RF Unit T-225A/FRT-5.

(8) Operate either one of the two TEST KEY controls to the upper or locking position.

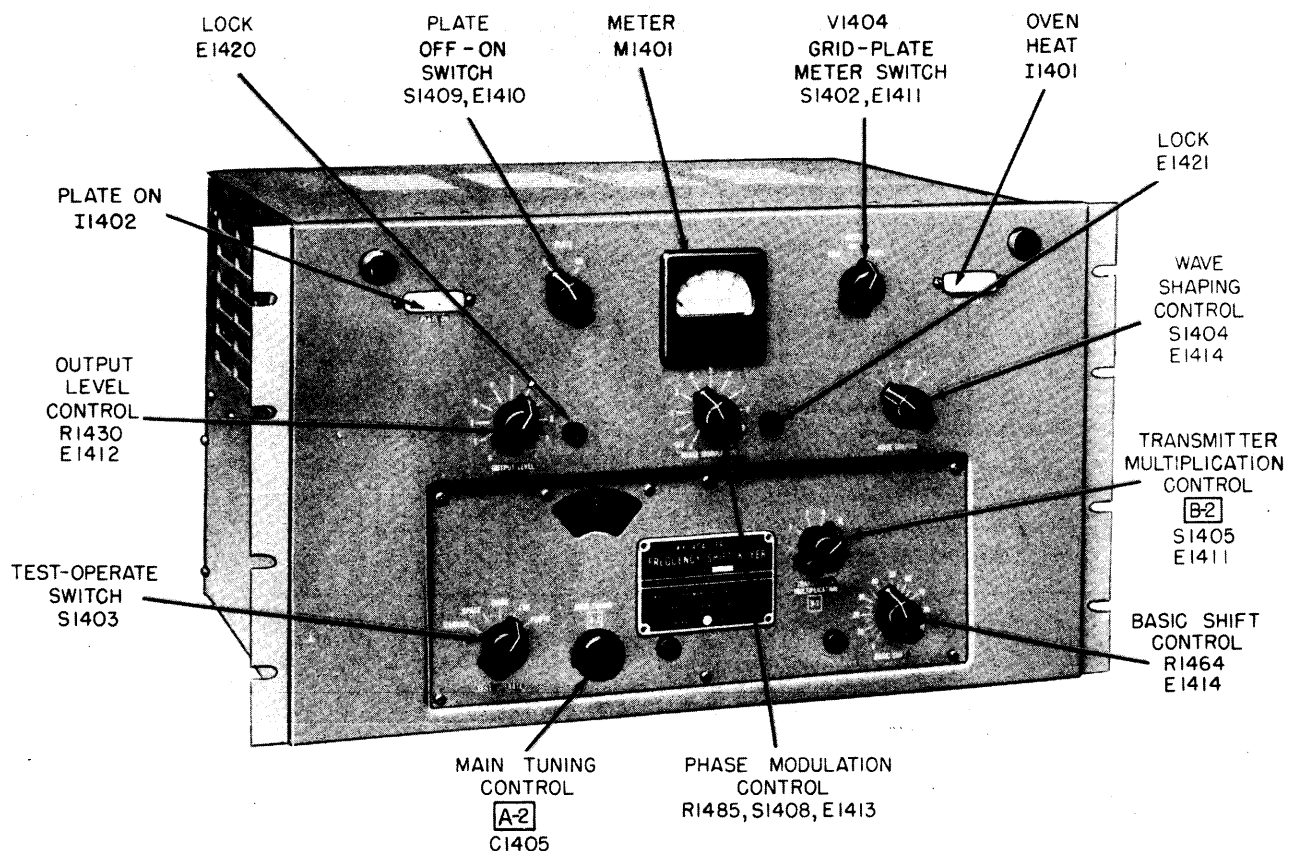
(9) Set the KEYING SELECTOR switch, S501, on RF Unit T-225A/FRT-5 to the LOCAL position.

(10) Rotate the EXCITER TEST switch, S503, on RF Unit T-225A/FRT-5 to the first position marked:

#1 — BUFFER CATHODE — 100 MA.

#2 — BUFFER AND 1ST MULT. GRID — 10 MA.

The EXCITER TEST #1 meter indicates the buffer



Figur 4-5. Fr qu ncy Shift K y r KY-45A/FRT-5, Fr nt Vi w

NAVSHIPS 91457(A)
AN/FRT-5A

OPERATION

TABLE 4-2. TYPICAL DIAL SETTINGS

Channel Identification	Antenna Identification	Output Frequency (Kc)	Excitation Frequency (Kc)	Type of Excitation at Transmitter Input	RF UNIT T-225A/FRT-5													XTAL OSC. 0-92A/FRT-5	MASTER OSC. 0-91A/FRT-5 (SET-UP OPERATE SWITCH must be thrown to SET-UP during change)				FREQUENCY SHIFT KEYS KY-45A/FRT-5	NOTES OR COMMENTS	
					1st Multiplier	2nd Multiplier	Driver Plate Tuning	PA Plate Tuning	PA Loading	Antenna Tuning	Antenna Capacitor	Shorting Strap	Excitation Level PA Grid (Amps)	Xtal Selector Position	Master Oscillator	Interpolation Oscillator	Output Tuning		Output Tuning	Transmitter Multi- plication Factor					
CONTROL DESIGNATION																			K	A-1	B-1	C-1	A-2	B-2	
		4000	2000	MO	A	B	C	D	E	F	L	G													
					173	68	84	21	950	164	ON	0.50	EXT.	2.2	0	2.2	2.0	2							
		6000	3000	XTAL	538	392	454	356	762	408	ON	0.47	5				3.0	2							
		8000	4000	XTAL	170	547	611	521	600	548	ON	0.45	3				4.0	2							
		10000	2500	XTAL	395	644	704	627	438	667	ON	0.42	2				2.5	4							
		12000	3000	XTAL	540	707	763	700	359	731	ON	0.40	5				3.0	4							
		14000	3500	MO	642	750	806	756	603	792	ON	0.40	EXT.	3.7	0	3.7	3.5	4							
		15000	3750	XTAL	679	768	825	776	613	827	ON	0.42	7				3.75	4							
		18000	2250	XTAL	780	850	873	830	300	735	OFF	0.45	5				2.25	8							
		20000	2500	XTAL	829	835	895	861	681	781	OFF	0.49	2				2.5	8							
		22000	2750	MO	870	851	913	887	681	784	OFF	0.49	EXT.	2.95	0	2.95	2.75	8							
		24000	3000	XTAL	901	867	927	911	490	806	OFF	0.48	5				3.0	8							
		26400	3300	XTAL	933	880	943	938	379	849	OFF	0.50	6				3.3	8							

*At 23 megacycles, and above, strap "L" must be on, but inverted, so that it does not ground.

Note: When Keyer KY-45A/FRT-5 is used, the master oscillator (RF Oscillator 0-91A/FRT-5) or the crystal oscillator (RF Oscillator 0-92A/FRT-5) should be adjusted for a frequency 200 kc higher than the excitation frequency required.

TABLE 4-3. METER DATA AND TYPICAL METER READINGS

METER	SELECTOR SWITCH (& POSITION)	METERED CIRCUIT	METER RANGE	METER READINGS AT TYPICAL OPERATING FREQUENCIES											
				4000 Kc	6000 Kc	8000 Kc	10000 Kc	12000 Kc	14000 Kc	15000 Kc	18000 Kc	20000 Kc	22000 Kc	24000 Kc	26000 Kc
M506	S503(1)	Buffer and 1st Multiplier Grid Current	0-10 ma	1.7	1.4	2.0	1.3	1.5	1.0	2.1	1.5	1.3	1.4	1.4	1.6
M505	S503(1)	Buffer Cathode Current	0-100ma	14	16	9	19	17	10	8	18	20	20	19	15
M505	S503(2)	1st Mult. Cathode Current	0-100ma	10	12	11	9	11	14	15	12	14	17	28	27
M506	S503(2)	2nd Mult. Grid Current	0-10 ma	0.4	2.4	2.4	2.1	3.7	5.2	5.4	2.8	2.2	19	1.7	0.9
M505	S503(3)	2nd Mult. Cathode Current	0-200ma	10	36	28	20	40	38	60	32	38	40	80	64
M506	S503(3)	Driver Grid Current	0-50 ma	10	19	20	11	15	20	12	10	9	10	7	3
M501	—	Driver Cathode Current	0-500ma	245	270	250	230	275	300	290	295	285	305	355	300
M507	S504(3)	Total PA Grid Current	0-1 amps	0.57	0.57	0.57	0.52	0.50	0.50	0.47	0.50	0.50	0.50	0.46	0.39
M502	—	PA Plate Current	0-8 amps	1.9	2.0	2.0	2.2	2.0	2.1	2.0	2.3	2.5	2.5	2.3	2.0
M301	—	PA Plate Voltage	0-8 kv	5.65	5.65	5.70	5.65	5.65	5.65	5.65	5.75	5.7	5.8	5.7	5.7
M503	S505	Transmission Line Current	0-10 amps	—	—	—	—	—	—	—	—	—	—	—	—
M504	S506	PA Grid Current	0-10 amps	—	—	—	—	—	—	—	—	—	—	—	—
M507	S504(1)	PA Grid Current	Left	330	290	285	250	240	240	230	235	240	240	210	170
	S504(2)	PA Cathode Current	Right	240	270	285	270	260	250	240	265	260	265	260	230
	S504(4)	PA Cathode Current	Left	1.4	1.4	1.4	1.2	1.25	1.3	1.47	1.3	1.7	1.4	1.3	1.3
	S504(5)	PA Cathode Current	Right	1.1	1.2	1.2	1.1	1.1	1.4	1.5	1.4	1.4	1.5	1.7	1.7
	S503(4)	PA Grid RF Peak Voltage	Left	800	770	800	740	740	750	690	720	800	740	720	660
M505	S503(5)	PA Plate RF Peak Voltage	Right	620	670	700	680	650	680	650	720	800	780	720	700
M506	S503(4)	PA Plate RF Peak Voltage	Left	4.8	4.9	5.0	4.9	5.2	5.0	5.1	6.1	4.8	4.9	4.8	5.7
	S503(5)	PA Plate RF Peak Voltage	Right	4.9	5.1	5.2	5.1	5.2	5.2	5.3	5.6	5.0	4.8	5.2	5.3

cathode current and the EXCITER TEST #2 meter indicates the buffer and 1st multiplier grid current.

(11) Press the PLATE ON button, S519, on the upper door of RF Unit T-225A/FRT-5 or Power Supply PP-490A/FRT-5. Check the readings on EXCITER TEST meter #1 (M505) and EXCITER TEST meter #2 (M506).

Note

Check the meter readings obtained against the typical readings given in table 4-3. Minor variations from the readings given in this table are to be expected.

(12) Rotate the EXCITER TEST switch, S503, to the second position, marked:

#1 — 1ST MULTIPLIER CATHODE — 100 MA.

#2 — 2ND MULTIPLIER GRID — 10 MA.

(13) Tune **[A]**, the 1ST MULTIPLIER PLATE TUNING control (R591), for maximum reading of EXCITER TEST #2. This meter indicates the 2nd multiplier grid current.

(14) Rotate the EXCITER TEST switch, S503, to the third position, marked:

#1 — 2ND MULTIPLIER CATHODE — 200 MA.

#2 — DRIVER GRID — 50 MA.

(15) Tune **[B]**, the 2ND MULTIPLIER PLATE TUNING control (R592), for maximum reading on EXCITER TEST #1 meter M506. If there is no indication on EXCITER TEST meter #2, check control **[G]** and set for center of tuning range.

(16) Rotate the EXCITER TEST switch, S503, to the fourth position.

#1 — L. PA GRID RF PEAK — 1000 V.

#2 — L. PA PLATE RF PEAK — 10 KV.

(17) Tune **[C]**, the DRIVER PLATE TUNING control (R593), for maximum indication on EXCITER TEST #1 meter. This tunes the driver plate to near resonance.

(18) Rotate the PA TEST switch, S504, to the TOTAL PA GRID — 1.0A position. This total PA grid current is indicated on the P.A. TEST meter, M507.

(19) Rotate the TUNE-OPERATE switch, S310, to the HV TUNE position.

CAUTION

As soon as the TUNE-OPERATE switch is turned to the HV TUNE position, the POWER AMPLIFIER TUNING control should be adjusted for minimum plate current to prevent possible damage to the PA tubes.

(20) Recheck the DRIVER PLATE TUNING control **[C]** to make certain that it is adjusted to produce maximum PA grid current and simultaneously minimum driver cathode current. Check the driver for proper neutralization by carefully noting that as the DRIVER PLATE TUNING control is varied through resonance the driver grid current and the PA grid current reach their respective peaks simultaneously. If this is not the case, recheck the driver neutralization by the procedure outlined in paragraph 3 c (13) of Section 7.

(21) Check the power amplifier for neutralization. This is accomplished by tuning the POWER AMPLIFIER PLATE TUNING control **[D]** (R594) on RF Unit T-225A/FRT-5 and observing the grid current and the plate current. If the stage is neutralized the plate current will reach the minimum at the same time that the grid current reaches its maximum. If this does not occur, the stage needs neutralization. Refer to paragraph 3 c (14) of Section 7 for the correct procedure for neutralizing the power amplifier.

Note

The left and right PA grid and cathode currents should have been balanced at 20.8 mc during installation of the equipment. The PA cathode currents should remain reasonably well balanced throughout the frequency range of the transmitter. If not, they should be rechecked in accordance with the procedure outlined in paragraph 3 c (14) (k) of Section 7.

The grid currents, however, will probably not remain balanced over the entire frequency range. A difference of up to 110 ma between the left and right PA grid currents is not abnormal at the lower frequencies, provided that they are balanced at 20.8 mc. If such is not the case, refer to paragraph 3 c (13) (b) of Section 7 for the balance procedure.

(22) Operate the ANTENNA TUNING control **[F]** (R596) until a noticeable increase in PA plate current is indicated on the TOTAL P.A. PLATE meter (M502), but do not tune for a peak reading; it is pre-

ferable to tune this control to the low number side of resonance. At the same time adjust the P.A. PLATE TUNING control **[D]** (R594) for a minimum total PA plate current, simultaneously increasing or decreasing the LOADING control **[E]** (R595) as necessary to maintain the PA grid current between 1 and 2.5 amperes.

Note

If the equipment is being tuned to a new or uncharted frequency, or if the operator has had no previous experience with tuning this equipment, it is advisable to reduce the PA plate voltage to a minimum. This is done by rotating the DELTA-WYE-OFF switch (S401) to the WYE position.

(23) Check the transmitter for stability or keying ability by operating the TEST KEY to the down position and manually keying the transmitter for a few seconds. With this TEST KEY in the center position all tube currents should drop to very low values. If they do not drop as they should, it is an indication of oscillation in one of the stages probably resulting from improper neutralization. If the neutralization is good, and the oscillation still persists, a slight detuning of the SECOND MULTIPLIER PLATE TUNING control **[B]** will completely eliminate it.

(24) With the transmitter tuned and loaded as indicated above, switch the KEYING SELECTOR switch (S501) to the REMOTE position and proceed with the transmission in the normal manner using "on-off" keying.

Note

To turn off the transmitter, the normal procedure is to first depress the red P.A. PLATE — OFF button on either RF Unit T-225A/FRT-5 or Power Supply PP-490A/FRT-5, and then to throw the red FILAMENT — EMERGENCY OFF toggle switch on one of the same units to the OFF position. To resume transmission on the same frequency, throw the same toggle switch (both must be ON) back to the ON position, wait for the filament time-delay relay to operate, and then depress the black P.A. PLATE — ON button on either RF Unit T-225A/FRT-5 or Power Supply PP-490A/FRT-5. With power on trim up the tuning controls as necessary. If the transmitting frequency is to be changed

from what it was before shut-down, it will be necessary to set the TUNE-OPERATE switch to the LV TUNE position and proceed as described in paragraphs 3 b (4) through 3 b (24) above.

c. PROCEDURE USING OSCILLATOR O-91A/FRT-5. — The above procedure assumed that it was desired to use crystal control. If it is desired to use RF OSCILLATOR O-91A/FRT-5, the master oscillator, for frequency control, the same procedure will apply, but it will first be necessary to connect the output of this oscillator to the transmitter input. This is accomplished by use of the patch panel shown in figure 3-9 and one of the type RG-58/U jumper cables furnished with the equipment. One end of this jumper cable must be connected to the MASTER OSCILLATOR OUTPUT connector (J1203) on the patch panel, and the other end to the TRANSMITTER INPUT connector (J1201), on the patch panel. It will also be necessary to perform the following steps prior to performing the procedure given in paragraph 3 b above.

(1) SETTING UP ON A FREQUENCY NOT PREVIOUSLY RECORDED.

(a) Insert the headphones cord plug into the jack on the front panel of the oscillator unit.

(b) Set SET UP-OPERATE switch to SET-UP position.

(c) Choose an oscillator frequency lying between 2.0 and 4.0 megacycles which when multiplied by 2, 4, 6, or 8 will produce the exact desired output frequency. Figure 4-6 can be used as an aid in selecting this frequency and the multiplying factor. However, the exact oscillator frequency used should be derived by actual longhand division of the exact output frequency by the multiplication factor.

(d) Set OUTPUT TUNING, control **[C-1]**, to the frequency determined by step (c) above.

(e) The frequency control circuit provides check points 5 kc apart over the 2-mc to 4.5-mc output frequency range. Set the INTERPOLATION OSCILLATOR, control **[B-1]**, to indicate the exact difference between the desired output frequency and the nearest check point frequency below it. For example, a required frequency of 2866.375 kc is 1375 cycles above the nearest check point frequency, so the outer dial of **[B-1]** should be set to 1.3 and the inner dial to 75.

(f) Set the MASTER OSCILLATOR, control **[A-1]**, as close as possible to the required frequency. In the example just given above, set the outer dial to 2.8 mc and the inner dial to 66.

Note

The desired oscillator output frequency will be most accurately obtained if the required settings of the INTERPOLATION OSCILLATOR control **B-1** and the MASTER OSCILLATOR control dial **A-1** are approached while rotating these dials in their clockwise direction.

(g) At this point, a steady tone should be audible in the headphones.

(h) Readjust the MASTER OSCILLATOR, control **A-1**, until a low pitched tone (50 to 100 cps) is heard in the headphones.

(i) This tone should be made as loud and as clear as possible by slight readjustment of the OUTPUT TUNING, control **C-1**.

(j) Remove the headphones cord plug and set the SET UP-OPERATE switch in the OPERATE position.

(k) Record the dial readings of each control for this frequency for future reference.

(l) Refer to the foregoing procedure and follow steps 3 b (5) through 3 b (22) to complete tuning of the transmitter.

**(2) SETTING UP ON A FREQUENCY
PREVIOUSLY RECORDED ON
TUNING CHARTS.**

(a) Throw SET UP-OPERATE switch on RF OSCILLATOR O-91A/FRT-5 to SET-UP position.

(b) Set the MASTER OSCILLATOR, control **A-1**, to the setting previously recorded for that control.

(c) Set the INTERPOLATION OSCILLATOR, control **B-1**, to the setting previously recorded for that control.

(d) Set the OUTPUT TUNING, control **C-1**, to the setting previously recorded for that control.

(e) Insert headphone cord plug in jack and recheck final settings of INTERPOLATION OSCILLATOR and OUTPUT TUNING dials as described in paragraphs 3 c (1) (e) through 3 c (1) (j) above.

(f) Refer to the procedure given in paragraph 3 b above and follow steps (5) through (22) to complete tuning of the equipment.

**d. PROCEDURE USING FREQUENCY SHIFT
KEYER KY-45A/FRT-5.** — Whether this keyer is in use or not, keep a-c power connected to the oven

(J1406) so as to maintain correct operating temperatures. In order to use the keyer it will be necessary to provide it with an r-f carrier from some external source and to connect its output to the transmitting input. This is done on the patch panel shown in figure 3-16 by means of two jumper cables. Connect one end of one of the cables to the patch panel jack marked EXTERNAL (J1206), CRYSTAL OSCILLATOR OUTPUT (J1202), or MASTER OSCILLATOR OUTPUT (J1203), depending upon which one is to be used to provide the r-f carrier for the keyer, and connect the other end of the same cable to the jack marked FS KEYER INPUT (J1205). Connect another jumper cable from the FS KEYER output jack (J1204) to the TRANSMITTER INPUT jack (J1201).

Note

The r-f carrier which is provided to the keyer must be 200 kc higher than the desired keyer output (input to the transmitter). Since the transmitter has provision for multiplication by factors of 2, 4, 6, and 8, these will have to be considered when determining the transmitter input frequency corresponding to a desired transmitter output frequency.

(1) SETTING OF CONTROLS.

(a) Set operating control MAIN TUNING **A-2** to the output frequency of the keyer as determined above. This is equal to the transmitter output frequency divided by the particular multiplying factor at which the transmitter is operating. Set the TRANSMITTER MULTIPLICATION control **B-2** on the keyer to the same multiplying factor. (See table 4-2 for typical settings.) No provision is made for operation of the keyer with a transmitter multiplying factor of 6, but if it is necessary to do so, the required shift may be obtained by using the BASIC SHIFT control. Merely adjust the BASIC SHIFT to a point where the shift at the keyer is equal to the desired final shift divided by the transmitter multiplication factor.

(b) Turn the METER SWITCH to the GRID position.

(c) Turn the OUTPUT LEVEL control to full output (position 10).

(d) Readjust the MAIN TUNING control **A-2** slightly until maximum grid current indication is obtained, as indicated on meter M1401.

(e) Turn the METER SWITCH to the PLATE position (average reading between 35 ma and 75 ma.)

(f) Adjust the output control to supply between 1 ma and 2 ma buffer and 1st multiplier grid current.

(2) CHECK OF FREQUENCY.

(a) Set TEST-OPERATE switch to CARRIER position.

(b) Tune a receiver to the transmitter frequency.

(c) Adjust the radio-frequency measuring equipment to the transmitter output frequency.

(d) Adjust the 200-kc OSCILLATOR ADJUST control until a zero-beat condition is obtained between the r-f measuring equipment and the transmitter output.

(3) ADJUSTMENT OF FREQUENCY SHIFT.

(a) Set the TEST-OPERATE switch to the CARRIER position.

(b) Using a receiver as a mixer, beat an accurate external frequency standard, set at the transmitter output frequency, against the keyer output. Assuming

the keyer is exactly on the carrier frequency (step 2), a zero-beat condition will be obtained in the receiver.

(c) Set the TRANSMITTER MULTIPLICATION switch **B-2** to the position indicating the desired transmitter multiplication factor.

(d) Connect the output of an audio oscillator to the receiver audio system and adjust the audio oscillator for a frequency corresponding to one-half the final shift required (for example, one-half of 850 cps or 425 cps).

(e) Set TEST-OPERATE switch to the SPACE position.

(f) Compare the audio output of the receiver with the audio oscillator and adjust the BASIC SHIFT until the two audio frequencies produce a zero beat.

(g) Set the TEST-OPERATE switch to the MARK position, and make sure that a near zero beat is also produced in this position.

e. TUNING PROCEDURE FOR SINGLE SIDEBAND OPERATION. — With the single side-band modification complete, as described in paragraph 7 of

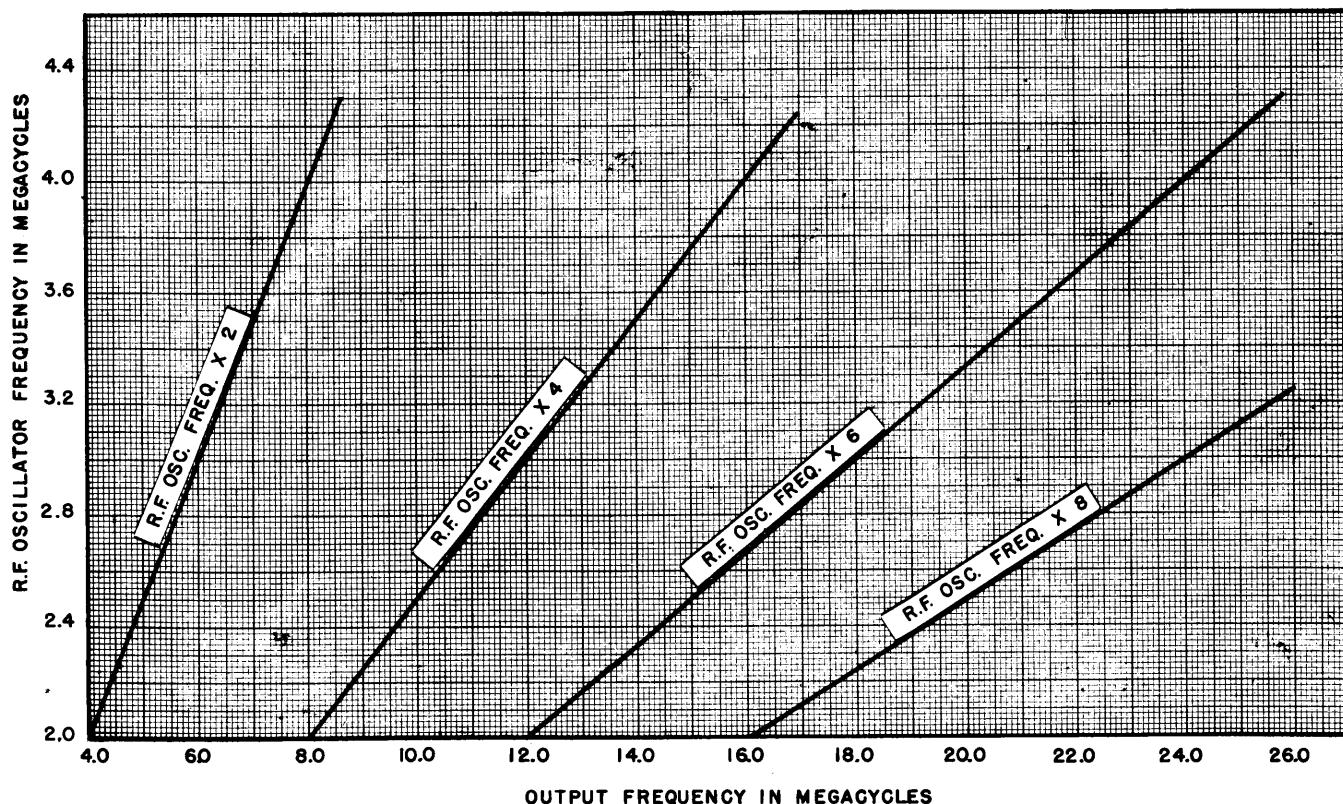


Figure 4-6. Tuning Chart — Oscillator Output Frequency vs Transmitter Output Frequency

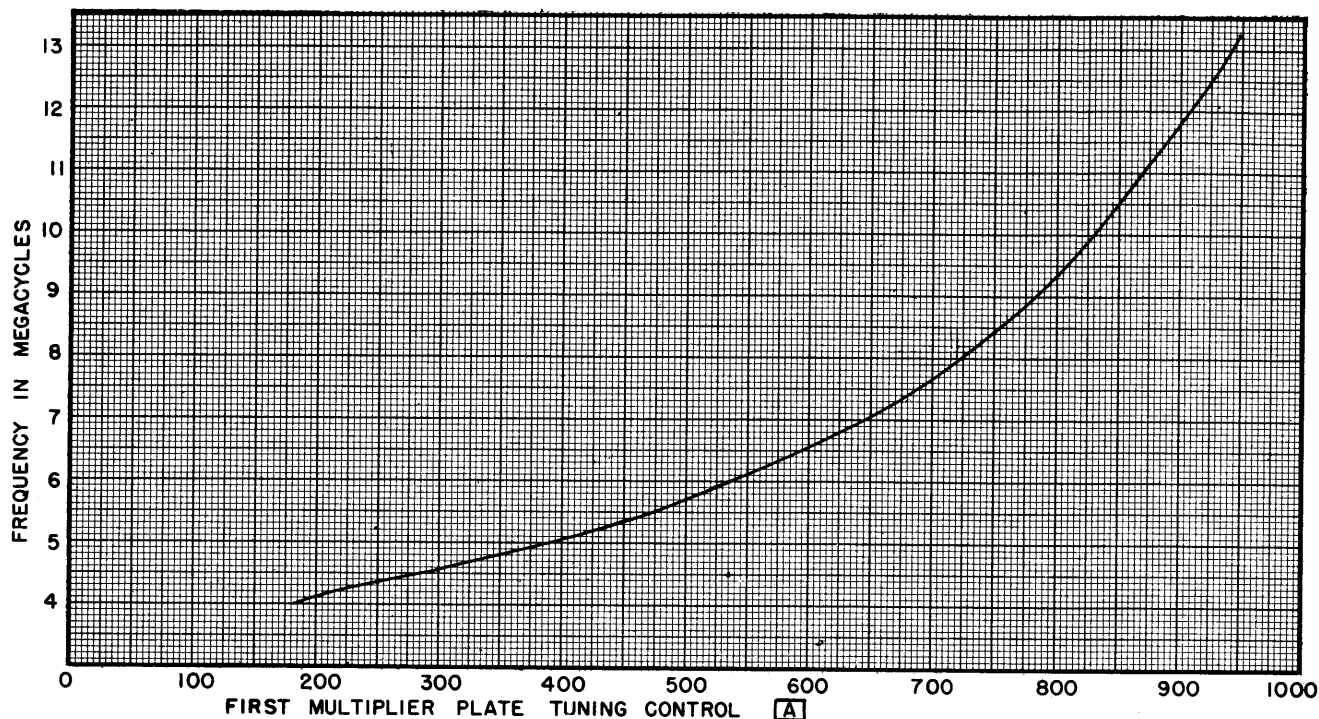


Figure 4-7. Tuning Chart — 1st Multiplier Plate Tuning vs Frequency

Section 3, and the input coaxial cables connected to the output of the Western Electric type D156000 or other suitable transmitter, the following tuning and set up procedure should be followed:

(1) If a single side-band transmitter is being used as the exciter, modulate the transmitter with an audio tone and set a level corresponding to $\frac{1}{2}$ peak voltage or 25 percent peak power.

(2) If a double side-band amplitude-modulated exciter is used, no modulation is required. In either case, the procedure from here on is the same.

(3) Turn on all transmitter filaments and proceed to adjust the driving transmitter tuning and loading. Set the EXCITER TEST meter selector switch for left or right PA peak r-f grid voltage and note the voltage reading on EXCITER TEST #1 meter. Adjust the drive for a reading of 120 to 140 volts.

(4) Set the TUNE-OPERATE switch to the HV TUNE position and turn on high voltage by depressing either the PLATE ON button on the r-f unit or the corresponding button on the power supply.

(5) Adjust the P.A. PLATE TUNING control **[D]** for minimum plate current. Note that a voltage reading probably in the neighborhood of 5000 volts

has appeared on EXCITER TEST #2. This is peak r-f plate voltage, and should be maximum when the plate current is minimum, while the grid voltage should remain constant if the stage is properly neutralized.

(6) Proceed to resonate the coupler ANTENNA TUNING adjustment **[F]** in the normal manner.

(7) Turn the TUNE-OPERATE switch to the OPERATE position.

(8) Adjust the coupling until the peak r-f plate voltage has dropped to approximately 2500 volts. Carefully check the plate circuit resonance as this adjustment is made.

(9) Recheck the peak r-f grid voltage and re-adjust if necessary to maintain it between 120 and 140 volts.

(10) Check the power input. It should be approximately 6.5 kw, and the corresponding carrier power output should be approximately 2 kw.

(11) Modulate the exciter with various degrees of modulation and check for linearity by means of an oscilloscope, modulation monitor, or other means available.

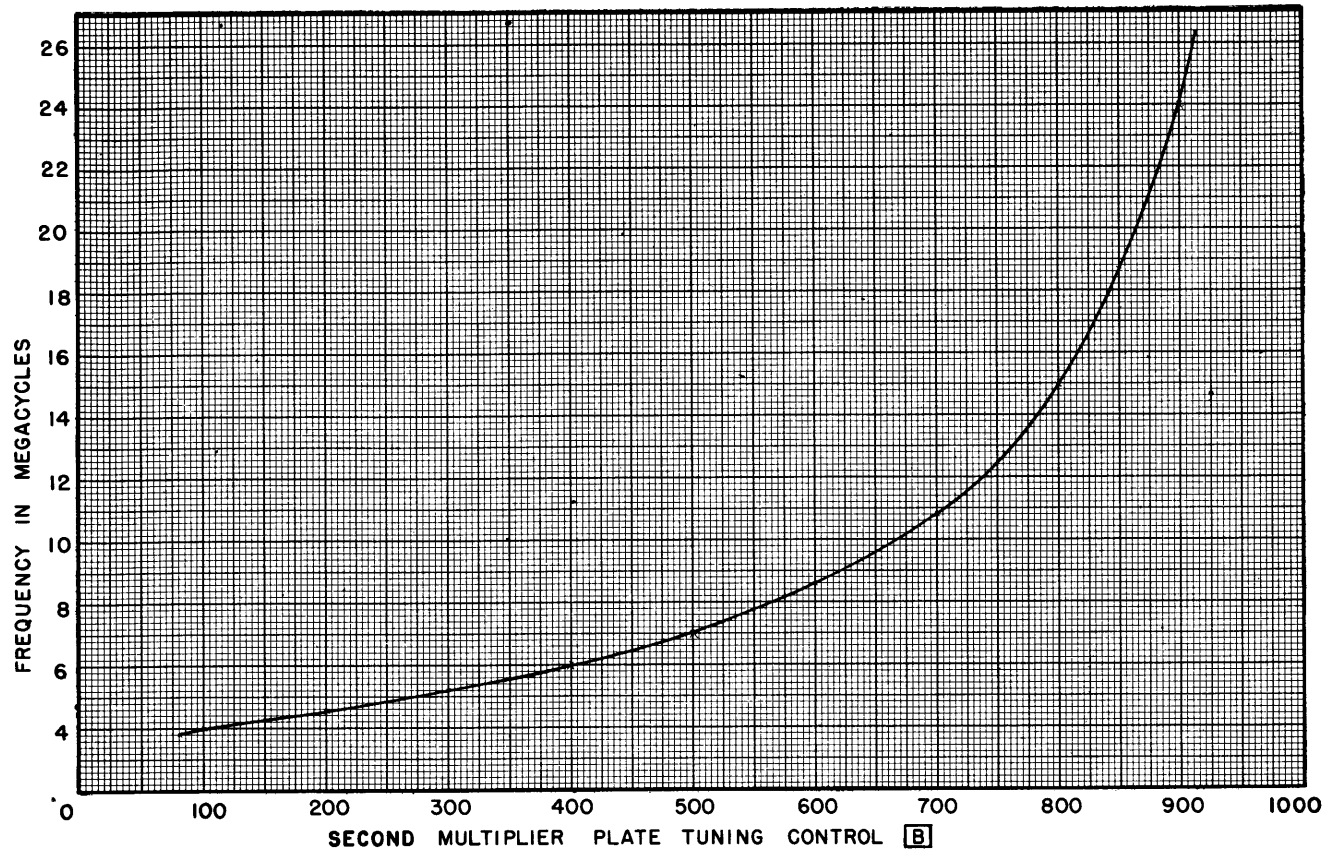


Figure 4-8. Tuning Chart - 2nd Multiplier Plate Tuning vs Frequency

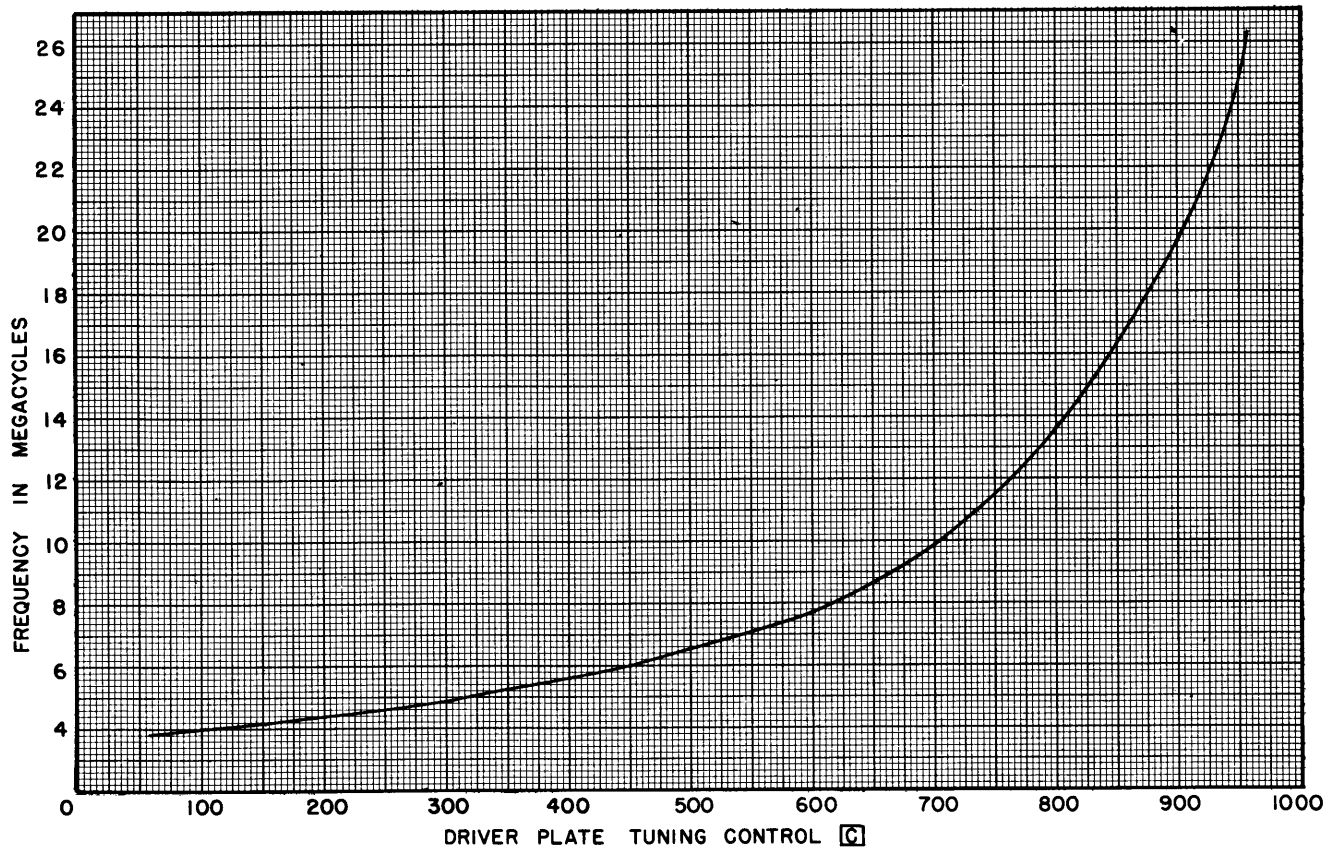


Figure 4-9. Tuning Chart - Driver Plate Tuning vs Frequency

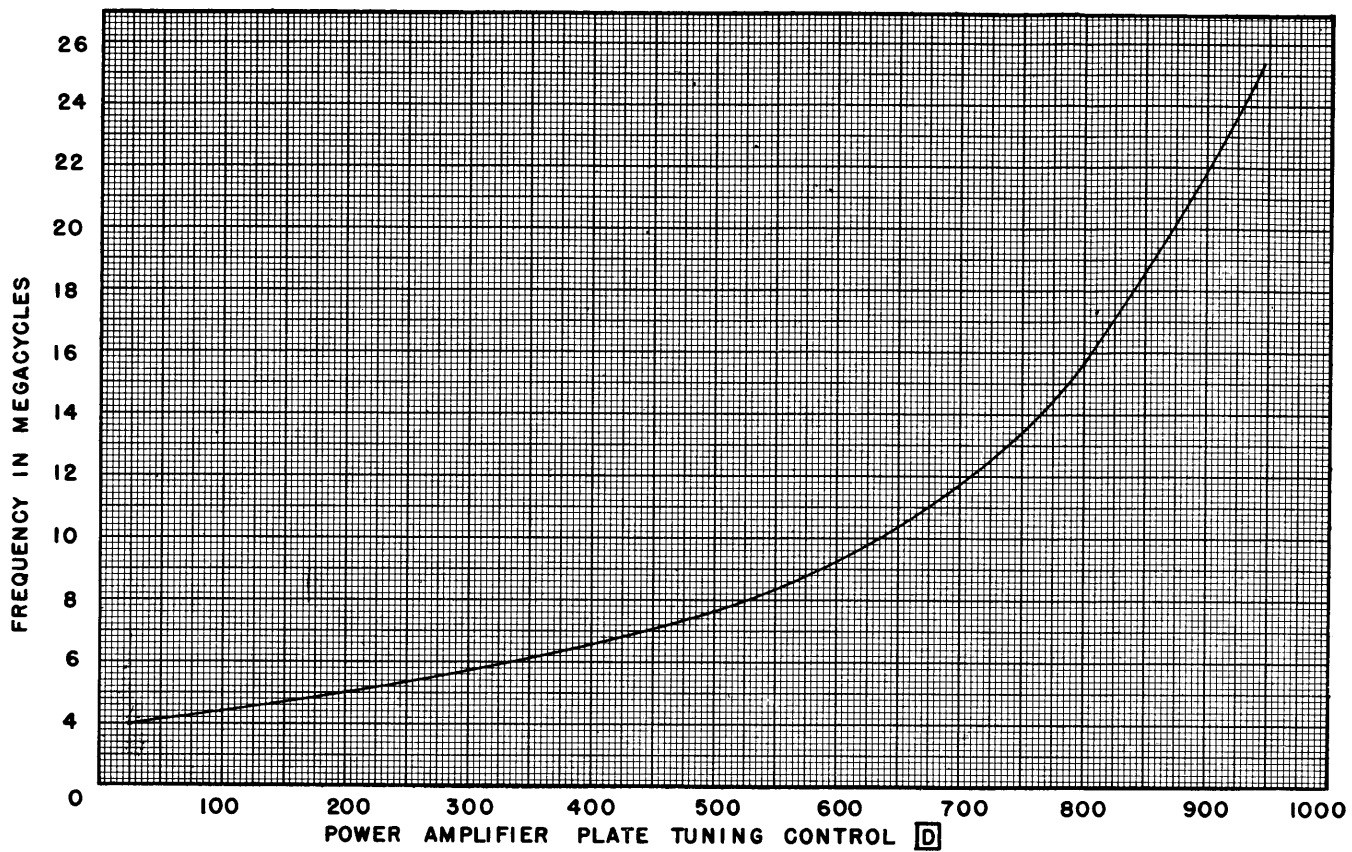


Figure 4-10. Tuning Chart — PA Plate Tuning vs Frequency

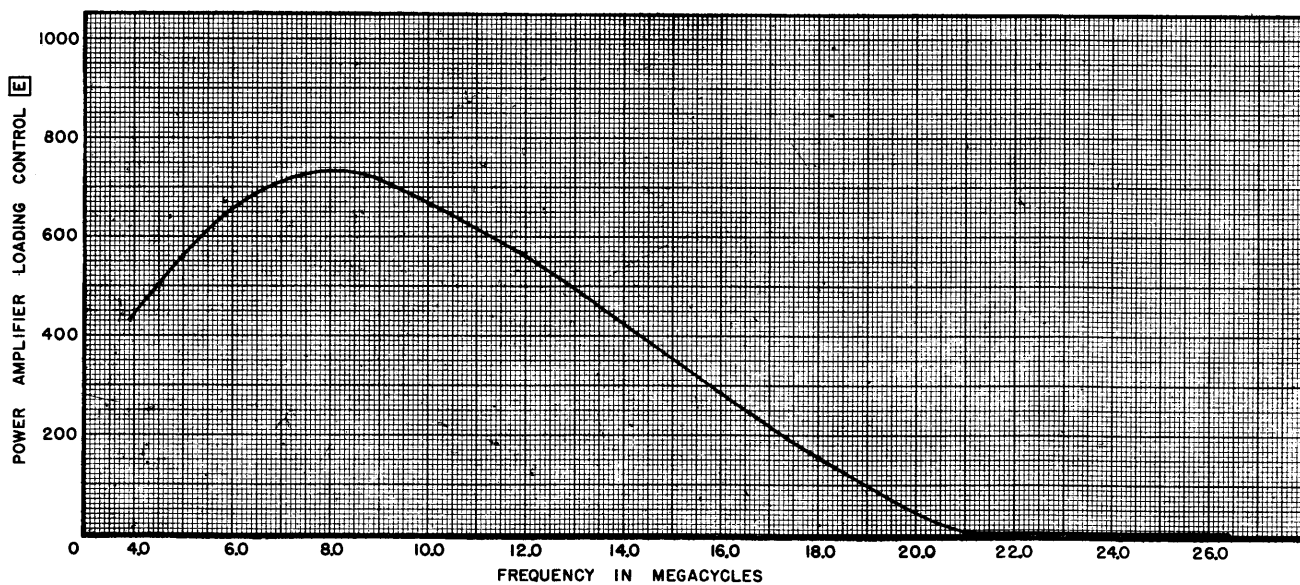


Figure 4-11. Tuning Chart — Typical PA Loading vs Frequency

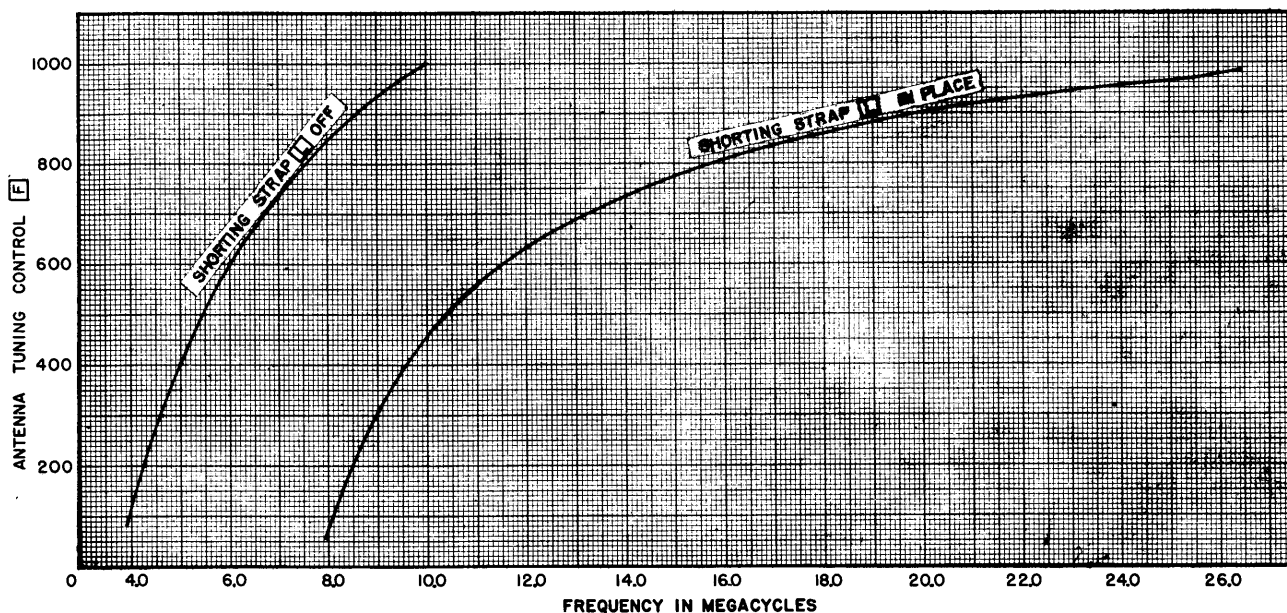


Figure 4-12. Tuning Chart - Typical Antenna Tuning vs Frequency

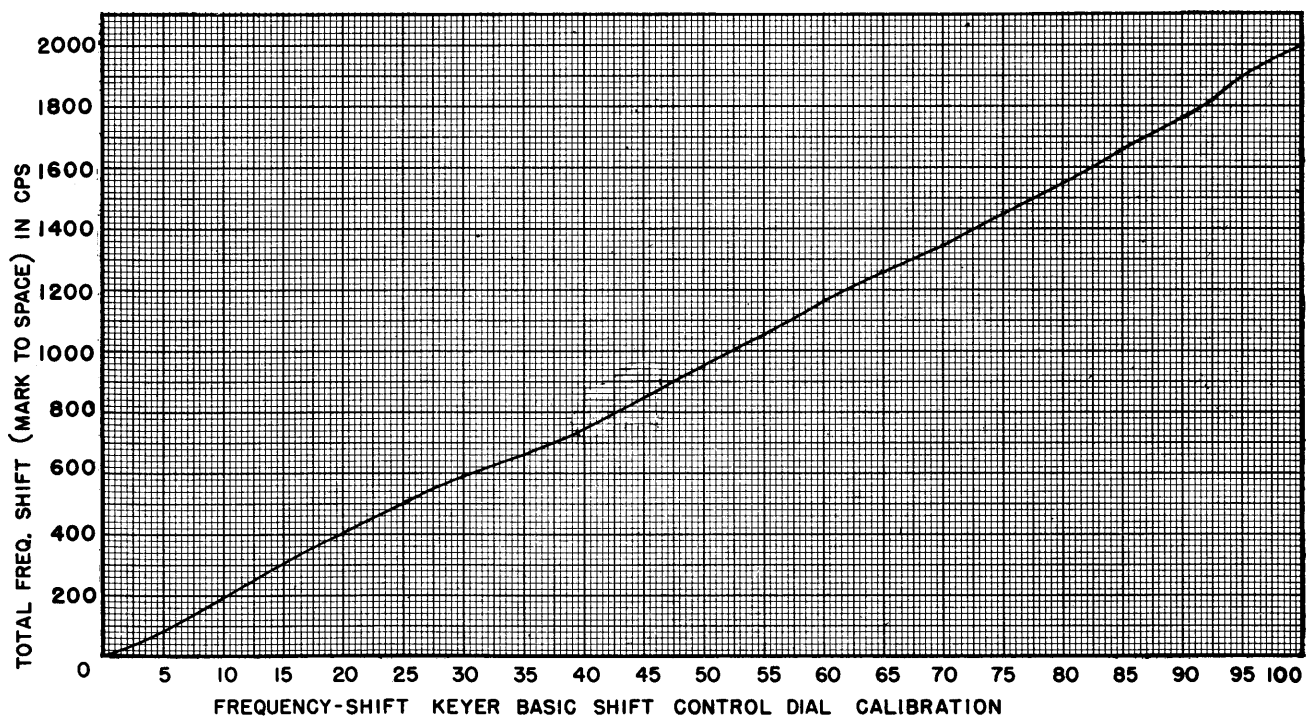


Figure 4-13. Tuning Chart - Frequency Shift vs Dial Calibration
(Frequency Shift Keyer KY-45A/FRT-5)

SECTION 5 OPERATOR'S MAINTENANCE

1. INTRODUCTION.

To maintain peak performance of the equipment it will be necessary that the operator perform a routine check when coming on watch and during each period that he is responsible for the operation of the equipment. Minor defects may develop during operation which may be rectified without difficulty by the operator. Correction of these minor troubles will pre-

vent the occurrence of major troubles at a later date. The operator should be sufficiently familiar with the technical details of the equipment to service minor defects that may develop when trained technical aid is not available.

2. OPERATOR'S CHECK CHART.

The following check chart and service information are offered for the guidance of the operator.

TABLE 5-1. OPERATOR'S CHECK CHART

LOCK KEY POSITION — EACH WATCH		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
1. Information from previous operator.	a. Review history in log-book. b. Receive verbal instructions.	a. Verify reported abnormal operation during your watch.
2. Transmitter tuning.	a. Meter readings. b. Minor adjustments of tuning controls to verify proper tuning.	a. Be familiar with tuning procedure. b. PA and driver plate tuning must be correct to prevent tube damage.
3. Observe all meters.	a. Observe and record meter readings. b. Observe and record temperature readings. c. Compare with normal readings.	a. Be alert for abnormal or subnormal readings. b. Be alert for erratic or jumpy meter readings.
4. Operating frequency of transmitter.	a. Use a frequency meter or other stable frequency monitoring device.	a. Frequencies must not drift. b. Check position of crystal switch. c. If frequency is instable make note if only one or all crystals act the same.
5. Color of all tubes.	a. Visually inspect for abnormal color (white or bright red) of the type 4-400A amplifier tube. b. Visually inspect for flash-over in the type 4B32 rectifier tubes.	a. Prolonged operation at abnormal color will eventually ruin tube or circuit components. b. Abnormal color may be indicative of improperly tuned stages.
6. Indicator lights on master control panel.	a. Observe indicator light. b. All should be lighted except overload pilot lights when transmitter is in full operation.	a. Unlighted indicator lights may be indicative of inoperative stage. b. Check meter readings.
7. Keying characteristic.	a. Keying monitor or communication receiver.	a. Make certain that keying monitor or receiver are adjusted properly. b. Make certain that keying input level and keying output controls are properly set.
ON STANDBY — EACH WATCH		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
1. Information from previous operator.	a. Review history in log-book. b. Receive verbal instructions.	a. Note if transmitter is to go on the air during watch.
2. Control circuit operation.	a. Manually operate transmitter OFF and ON with key open if the frequency is in use while checking control circuit operation.	a. Report any inoperative circuit immediately. Be alert for slippage in switches.

TABLE 5-1. OPERATOR'S CHECK CHART (Continued)

ON STANDBY — EACH WATCH		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
3. Overall operation.	<ul style="list-style-type: none"> a. Tune transmitter completely in accordance with instructions in Section 4. b. Check color and operation of tubes. c. Check meter readings. 	<ul style="list-style-type: none"> a. Be alert for any inoperative or erratic stage or component.
4. Electronic keyer.	<ul style="list-style-type: none"> a. Key the transmitter. 	<ul style="list-style-type: none"> a. If the transmitter will not key when the KEYING INPUT FOR MARK switch is in the polar positive or positive positions, section 1 of V507 may not be drawing any current. b. If the transmitter will not key regardless of the position of the KEYING INPUT FOR MARK switch, section 2 of V507 may not be drawing any current. c. If the carrier will not come on under the conditions of a. above, section 1 of V507 may be shorted or is drawing excessive current. d. If the carrier will not come on under the conditions of b. above, section 2 of V507 is shorted and/or drawing excessive current.
5. Filament voltages.	<ul style="list-style-type: none"> a. Visually check meters. b. Manually check operation of filament voltage controls. 	<ul style="list-style-type: none"> a. If transmitter is to remain off the air for more than two hours, shut down completely.
6. Temperature of components and cabinets.	<ul style="list-style-type: none"> a. Immediately after shut down visually inspect all units for evidence of heating. b. Cautiously touch components with your hand as a check for heating. 	<ul style="list-style-type: none"> a. Normal operating temperatures of some components are high enough to produce severe burns. Become familiar with these components, and use caution.
7. Operation of all tubes.	<ul style="list-style-type: none"> a. Observe rectifier tubes. b. Observe current readings for power amplifier tubes. c. Observe cathode current of driver tube. d. Observe grid drive readings of buffer multiplier and driver stages. e. Check to see if servo system will run in both directions. f. Check to see if servo system is sluggish, i.e., if the backlash is bad. 	<ul style="list-style-type: none"> a. Be alert for visible internal flashing. No visible glow should be observed under normal conditions. b. Check for abnormally low current in one tube. Reverse tubes to make sure it is not a defective circuit. Raise filament voltage of the tube with low current. If the current increases, it indicates low emission in the tube. c. If cathode current will not rise to 350 ma or more when the grid current is normal and the circuit is off resonance, the tube may be defective. d. If drive is low to any of the stages, it may indicate a defective tube in the preceding stage. e. If system only runs in one direction, and will not reverse, the servo amplifier output tube may be defective. f. If the backlash is bad, it may indicate a bad servo amplifier input tube.
8. Operation of relays.	<ul style="list-style-type: none"> a. Remove relay covers and observe operation of relays. 	<ul style="list-style-type: none"> a. Report any relays which have excessive sparking or operate sluggishly.
9. Main circuit breaker.	<ul style="list-style-type: none"> a. Check to see if main breaker is working properly. 	<ul style="list-style-type: none"> a. If breaker is in the habit of cycling several times before closing, report it immediately.

TABLE 5-1. OPERATOR'S CHECK CHART (Cont'd)

ON STANDBY — EACH WATCH		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
10. Meter switch contacts.	a. Observe meter switch contacts and the meter readings as the meters are switched into the various circuits.	a. Report any dirty contacts or intermittent operation immediately.
11. Sliding or moving coil contacts.	a. Visually and manually inspect all sliding or moving coil contacts.	a. Replace any contacts that are worn, dirty, bent or broken.
12. Set screws and other parts.	a. Inspect all set screws and parts for looseness.	a. Tighten all loose parts, components and set screws.

3. REPLACEMENT OF FUSES AND RESETTING OF CIRCUIT BREAKERS.

All fuses in the AN/FRT-5A equipment, with the exception of the ones located in Power Control C-587A/FRT-5 (F401, F402, F403, F404 and F405), are equipped with indicator lamps. When any of the fuses blow, with the exception of those mentioned above, the indicator lamps will glow. This gives the operator a rapid means of locating the blown fuse. For fuse data see tables 5-2 and 5-3.

All other circuits are protected by circuit breakers. In the event a circuit breaker has tripped, it is easily reset by moving the tumbler type operating handle first to the OFF position as far as it will go, and then to the ON position.

CAUTION

Never replace a fuse or a circuit breaker with one of a higher rating unless continued operation of the equipment is more important than probable damage. If a fuse burns out immediately after replacement, do not replace it a second time until the cause of the trouble has been corrected. If a circuit breaker trips after resetting, do not reset a second time until the cause of trouble has been corrected.

4. ELECTRON TUBE MAINTENANCE.

a. PROPER MAINTENANCE. — For satisfactory tube operation and normal tube life, filament voltages must be correct to within 5 percent of the rated value. Permitting the tubes to draw current for more than a few seconds while the stage is out of resonance will shorten the life of the tubes.

The type 3B28 and 4B32 rectifier tubes are xenon filled. They have the same current and voltage ratings as type 866A and 872A tubes and are directly interchangeable therewith. However, the latter are more

sensitive to changes in ambient temperature and therefore should not be used for replacement, except in an emergency.

The xenon-gas-filled rectifier tubes used in this equipment are the four type 3B28 and six type 4B32 tubes in Power Supply PP-490A/FRT-5.

5. ELECTRON TUBE REPLACEMENTS.

WARNING

ALLOW TUBES TO COOL BEFORE HANDLING. IF IMMEDIATE REPLACEMENT IS REQUIRED USE AN ASBESTOS GLOVE AND HANDLE CAREFULLY.

Before replacing an electron tube determine the proper location from table 5-4. When removing octal type vacuum tubes, use a gentle rocking motion. When inserting the replacement tube into the socket, first align the tube guide and socket slot, then use a steady pressure and push straight downward until the tube is seated properly. Do not force a tube, as damage to the socket terminal clamp and wiring may result. Use the same procedure and precautions when removing any four-prong or five-prong tubes.

When removing tubes such as the JAN types 3B28 and 4B32, and similarly constructed tubes, the tube should be grasped firmly and rotated counterclockwise until the guide pin is in line with the tube socket slot. The tube may then be lifted out of the socket without any difficulty. When inserting a new tube into this type socket, align the guide pin with the socket slot; push the tube straight down; rotate clockwise until the guide pin is stopped.

a. REMOVAL OF POWER AMPLIFIER TUBES. — Removal of a PA tube calls for considerable caution and care. When removing these tubes, use the following procedure:

(1) A pulling device for removing the type 3X-2500A3 PA tubes is supplied with the equipment.

TABLE 5-2. SYMPTOMS OF FUSE FAILURE

SYMPTOMS	FUSE (Fuse indicator lights will glow when fuse is blown)
RF Oscillator O-91A/FRT-5 AFC ON pilot does not light.	F101
RF Oscillator O-91A/FRT-5 CRYSTAL OVEN HEAT ON Pilot does not light.	F102
Rectifier V301 filament does not light.	F301
Rectifier V302 filament does not light.	F302
Rectifier V303 filament does not light.	F303
Rectifier V304 filament does not light.	F304
Rectifier V305 filament does not light.	F305
Rectifier V306 filament does not light.	F306
Rectifier V307 and V308 filament does not light.	F307
Rectifier V309 and V310 filament does not light.	F308
External HV ON lamps do not light.	*F401 *F402
Complete transmitter dead.	*F403 *F404 *F405
I502 on the multiplier chassis lights.	F501
I503 on the multiplier chassis lights.	F502
Impossible to tune the RF stages with controls A, B, C, D, E and F.	F901 F902 F903
POWER lamp on Power Supply PP-454A/FRT-5 does not light when OFF-ON switch is in the ON position.	F1001 } for 115-volt F1002 } operation. F1003 } for 230-volt F1004 } operation.
RF Oscillator O-92A/FRT-5 CRYSTAL HEATER lamp does not light.	F1101
Frequency Shift Keyer KY-45A/FRT-5 OVEN HEAT lamp does not light.	F1401 F1402

*These fuses do not have indicator lights.

Hook the jaws of this device onto the metal cap on top of the tube and hook the other end of it over the front edge of the antenna coupler platform (or form a hook with thumb of one hand, while fingers are hooked over edge of the coupler platform behind the

power amplifier tubes). Then push upward on the front end of the tool.

(2) When the PA tube is loosened from its socket, the puller is removed from the tube, and the tube can then be removed from the equipment by hand.

TABLE 5-3. FUSE LOCATIONS AND DATA

SYMBOL	PROTECTS	AMPS	VOLTS	MANUFACTURER'S PART NUMBER
RF Oscillator O-91A/FRT-5 (at rear of unit)				
F101	AFC motor and K101	0.5	125/250	CLF#313.500
F102	Crystal oven	1/8	125/250	CLF#313.150
Power Supply PP-490A/FRT-5 (at rear of unit)				
F301	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F302	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F303	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F304	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F305	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F306	HV rectifier filament transformer primary	1	125/250	CLF#313001.
F307	LV filament transformer primary	1	125/250	CLF#313001.
F308	Bias filament transformer primary	1	125/250	CLF#313001.
Power Control C-587A/FRT-5				
F401	HV ON lamp (external)	10	250	CFA#NFA-10
F402	HV ON lamp (external)	10	250	CFA#NFA-10
F403	Primary wiring to transformer enclosure	50	250	CFA#NFA-50
F404	Primary wiring to transformer enclosure	50	250	CFA#NFA-50
F405	Primary wiring to transformer enclosure	50	250	CFA#NFA-50
RF Unit T-225A/FRT-5 (on multiplier unit, or on servo pwr. supply cabinet)				
F501	Exciter filament transformer primary	1	125/250	CLF#313001.
F502	Driver filament transformer primary	1	125/250	CLF#313001.
F901	Servo filament transformer primary	1/4	125/250	CLF#313.250
F902	Servo plate transformer primary	3/8	125/250	CLF#313.400
F903	Servo motor power	2	125/250	CLF#313002.
Power Supply PP-454A/FRT-5 (on rear of unit)				
F1001	Power transformer primary	3	125/250	CLF#312003.
F1002	Power transformer primary	2	125/250	CLF#312002.
F1003	Power transformer primary	1 1/2	125/250	CLF#31201.5
F1004	Power transformer primary	1	125/250	CLF#312001.
RF Oscillator O-92A/FRT-5 (inside front panel)				
F1101	Crystal heater	1/4	125/250	CLF#313.250
Frequency Shift Keyer KY-45A/FRT-5 (on rear of unit)				
F1401	Oven heaters	1	125/250	CLF#312001.
F1402	Oven heaters	1	125/250	CLF#312001.

TABLE 5-4. REPLACEMENT OF ELECTRON TUBES

SYMBOL DESIG- NATION	TUBE TYPE NUMBER	REFER TO FIGURE NO.	SYMBOL DESIG- NATION	TUBE TYPE NUMBER	REFER TO FIGURE NO.	SYMBOL DESIG- NATION	TUBE TYPE NUMBER	REFER TO FIGURE NO.
RF Oscillator O-91A/FRT-5			Power Supply PP-490A/FRT-5			Frequency Shift Keyer KY-45A/FRT-5		
V101	2C51	7-36	V305	4B32	3-6	V1401	6BE6	7-43
V102	2C51	7-36	V306	4B32	3-6	V1402	6BE6	7-43
V103	2C51	7-36	V307	3B28	3-6	V1403	6BA6	7-43
V104	6AK5	7-36	V308	3B28	3-6	V1404	807	7-43
V105	6AS6	7-36	V309	3B28	3-6	V1405	6AL5W	7-43
V106	6AK5	7-36	V310	3B28	3-6	V1406	6AL5W	7-43
V107	6AK5	7-36	RF Unit T-225A/FRT-5			V1407	6AK5W	7-43
V108	6BE6	7-36				V1408	12AU7	7-43
V109	6AK5	7-36	V501	6AG7	7-24	V1409	6C4	7-43
V110	6BE6	7-36	V502	807	7-24	V1410	6BA6	7-43
V111	6AK5	7-36	V503	807	7-23	V1411	6BA6	7-43
V112	6BE6	7-36	V504	4-400A	7-24	V1412	12AX7	7-43
V113	6AK5	7-36	V505	3X2500A3	3-7			
V114	5686	7-36	V506	3X2500A3	3-7			
V115	2C51	7-36	V507	12AU7	7-27			
V116	2C51	7-36	*V801	12AX7	7-17			
V117	2C51	7-36	*V802	12AU7	7-16			
V118	6AK5	7-36	V901	6X4	7-19			
V119	5686	7-36	Power Supply PP-454A/FRT-5					
V120	5686	7-36	V1001	5R4GY	7-40			
V121	5686	7-36	V1002	5R4GY	7-40			
V122	5686	7-36	V1003	6X4	7-40			
V123	2C51	7-36	V1004	5R4GY	7-40			
V124	2C51	7-36	V1005	OA2	7-40			
V125	6AL5	7-36	V1006	OA2	7-40			
V126	6AL5	7-36	RF Oscillator O-92A/FRT-5					
V127	6BE6	7-36	V1101	6AK5	7-10			
V128	6BA6	7-36	V1102	6AG7	7-10			
V129	6AK5	7-36	V1103	OB3/VR-90	7-10			
V130	6SJ7	7-36	V1104	OB3/VR-90	7-10			
V131	6SJ7	7-36	RF UNIT T-225A/FRT-5					
Power Supply PP-490A/FRT-5			**V1301	6X4	3-7			
V301	4B32	3-6	**V1303	6X4	7-23			
V302	4B32	3-6						
V303	4B32	3-6						
V304	4B32	3-6						

*P/o Z801-Z806.
**P/o Z1301-Z1302.

SECTION 6

PREVENTIVE MAINTENANCE

1. INTRODUCTION.

The maintenance of radio equipment does not begin when the equipment fails to operate in a normal manner. Maintenance must begin weeks or even months before, when the equipment is first placed in operation. Regular care and inspection, known as preventive maintenance, are just as important as corrective maintenance. Hence, if a regular schedule of preventive maintenance is adhered to, most of the common faults and breakdowns will never occur. Only a few minutes each day are needed to be sure that the equipment is kept entirely free from dirt, dust, sand, excess moisture, vermin, or insects; that all cables and plugs of the equipment are clean and tight-fitting; and that no part of the equipment is being abused or neglected.

It is extremely important that personnel become very familiar with normal operating conditions so that

abnormal conditions can be quickly detected. The equipment should be carefully studied during operation to locate all detectable symptoms of trouble. Valuable time can be saved by a careful analysis of the situation and formulation of several possible theories about the trouble. This approach is preferable to waiting for the trouble to become so serious that it causes a shut-down, even though the source of the difficulty may be, by then, quite obvious.

2. MAINTENANCE SCHEDULE.

An outline of the important items to be inspected is listed in table 6-1.

Note

The attention of maintenance personnel is invited to the requirements of chapter 67 of the *Bureau of Ships Manual* of the latest issue.

TABLE 6-1. MAINTENANCE SCHEDULE

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS AND REMEDIES
HOURLY		
1. Crystal oven temperature.	a. Check the oven indicator lamps and see if they cycle.	a. Verify oven lamp lights for about two or three minutes, then goes out for about ten or twelve minutes.
2. Transmitter tuning.	a. Meter readings. b. Minor adjustment of tuning controls to verify proper tuning.	a. Be familiar with tuning procedure. b. PA and driver plate tuning must be correct to prevent possible tube damage.
3. Meter readings.	a. Record in appropriate chart and compare for irregularities.	a. Improper meter readings indicate trouble. Refer to Corrective Maintenance, Section 7.
4. Color of tubes and tube operation.	a. Observe the type 4-400A tube for abnormal color (white or bright red). b. Visually check for flash-over in rectifiers. c. Observe rectifier tubes. d. Observe current readings of power amplifier tubes. e. Observe cathode current of driver tube. f. Observe grid drive readings of the buffer, multiplier and driver stages.	a. To prevent circuit or tube damage, condition must be corrected immediately. b. Abnormal color may be indicative of improperly tuned stage. c. Be alert for visible internal flashing. No visible glow should be observed under normal conditions. d. Check for abnormally low current in one tube. Reverse tubes to make sure it is not a defective circuit. Raise filament voltage of the tube with low current. If the current increases, it indicates low emission in the tube. e. If cathode current will not rise to 350 ma or more when the grid current is normal and the circuit is off resonance, the tube may be defective. f. If the drive is low to any of the stages, it indicates that the preceding stage may be defective.

TABLE 6-1. MAINTENANCE SCHEDULE (Continued)

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS AND REMEDIES
	g. Check to see if the servo system will run in both directions. h. Check to see if the servo system is sluggish, that is if the backlash is bad.	g. If the system only runs in one direction, and will not reverse, the servo amplifier output tube may be defective. h. If the backlash is bad, it may indicate a bad servo amplifier input tube.
5. Indicator lights on control panel.	a. Observe indicator lights. b. If transmitter is in full operation, all indicators, pilots except OVERLOAD pilots should be lighted.	a. Unlighted bulb shows particular circuit inoperative. Refer to Section 7, Corrective Maintenance.
DAILY		
1. Transformer, chokes, capacitors, etc.	a. Visually and manually inspect all parts in the transmitter for over-heating and damage.	a. Remedy any signs of breakdowns, over-heating, or breakage by repairing or replacing the part.
2. Sliding or moving coil contacts.	a. Visually and manually inspect all sliding or moving coil contacts.	a. Replace any contacts that are worn, bent or broken.
3. Major connections such as tight caps, wire connections, lock nuts and set screws.	a. Feel connections for possible looseness.	a. Tighten where necessary.
4. Zero setting of all transmitter meters.	a. With transmitter completely shut down, all meters should read zero.	a. Erratic readings will result if meters are not zeroed. b. Small screw below glass allows adjustment.
5. Tuning servo positioner operation.	a. Manually operate tuning dials and note that the variable circuit operates without chattering or sticking.	a. Make certain that the anti-hunting control is set properly. b. Substitute a spare servo amplifier unit as a check. c. Make certain the gears and chains are clean, in good condition, and properly lubricated.
6. Accumulation of dust and dirt.	a. Notice deposits of dust and dirt in the various compartments.	a. Remove by best means available. b. Take care not to strike tube envelopes with cleaning equipment.
7. Blower motor.	a. Feel motors for over-heating. b. Visually inspect rotating parts for wear.	a. Lubrication may be necessary. b. Refer to lubrication chart, table 6-2.
8. Relay contacts.	a. Visually inspect contacts for pit marks, unevenness, or corrosion.	a. Use carbon tetrachloride and burnishing tool to remedy.
9. All door interlocks.	a. Manually operate.	a. Repair if inoperative.
WEEKLY		
1. Rotary contacts and switch contacts.	a. Visually inspect switches and contacts for loss of tension, poor contacts, or pitting.	a. Clean, repair, or replace as necessary. b. Crocus cloth and carbon tetrachloride may be used for cleaning.
2. Components enclosed in dust covers.	a. Remove dust cover from particular component and inspect for dust, dirt, or possible failure.	a. Clean with equipment available. b. Use care when cleaning to prevent damage to components.
3. Automatic shut-down, time delay, and safety devices.	a. Operate each one and know if proper operation takes place.	a. If inoperation is discovered, refer to Section 7, Corrective Maintenance.
4. Operation of circuit breakers.	a. Manually throw ON and OFF.	a. Be alert for faulty operation of switch.
5. Check air-filters.	a. Inspect each filter for excessive accumulation of dust and dirt.	a. There are two types of air-filters used: <ol style="list-style-type: none"> 1. Spun-glass—non removable: replace with new filter. 2. Permanent "Air Maze": clean in degreasing solution periodically and re-oil. See paragraph 4 c of Section 7 for servicing procedures.

TABLE 6-1. MAINTENANCE SCHEDULE (C nt'd)

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS AND REMEDIES
MONTHLY		
1. Main tuning shafts and gears.	a. Rotate each to maximum and minimum settings, note any binding, looseness or unevenness.	a. Apply lubricant when necessary. b. Refer to lubrication chart, table 6-2.
2. Tube sockets and connections.	a. Remove plate connections from tubes. b. Examine socket contacts. c. Visually inspect sockets for cracks, breaks, etc. d. Visually examine tube pins or contact area for cleanliness and surface pitting.	a. Remove any coating or dullness with crocus cloth. b. Replace cracked or broken sockets or contacts.
3. All nut and screw connections.	a. Carefully look for signs of corrosion, dullness or poor contacts.	a. Use crocus cloth or #0000 sand paper for cleaning.
4. Blower and motor lubrication.	a. Examine shafts and motor bearings, etc., to see that they are properly lubricated.	a. Refer to lubrication chart, table 6-2.
5. General lubrication.	a. Examine all moving parts for binding or dry surfaces.	a. Refer to lubrication chart, table 6-2.
QUARTERLY		
1. Bearings.	a. Rotate bearings within their retainers and note any unevenness or binding.	a. Oil when necessary. b. Refer to lubrication chart, table 6-2.
2. Tube life and time in use.	a. Review past and present tube time meter readings.	a. Replace as necessary.
3. Motor drive units.	a. Carefully remove motor drive units and inspect them thoroughly, being alert for parts which need lubrication.	a. Lubricate necessary parts, especially the single tooth gear and the notched counting gear.
ANNUALLY		
1. Transmitter overhaul.	a. Disassemble and clean every component possible. b. Replace parts where necessary.	a. Experienced technician should be present for reassembly.

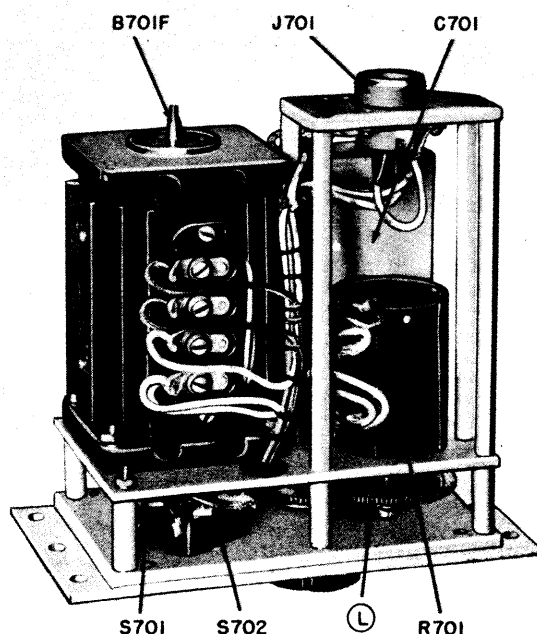


Figure 6-1. RF Unit T-225A/FRT-5, S rvo Driv for Ant nna Coupling Network

3. LUBRICATION.

Lubrication in the AN/FRT-5A equipment is applicable to:

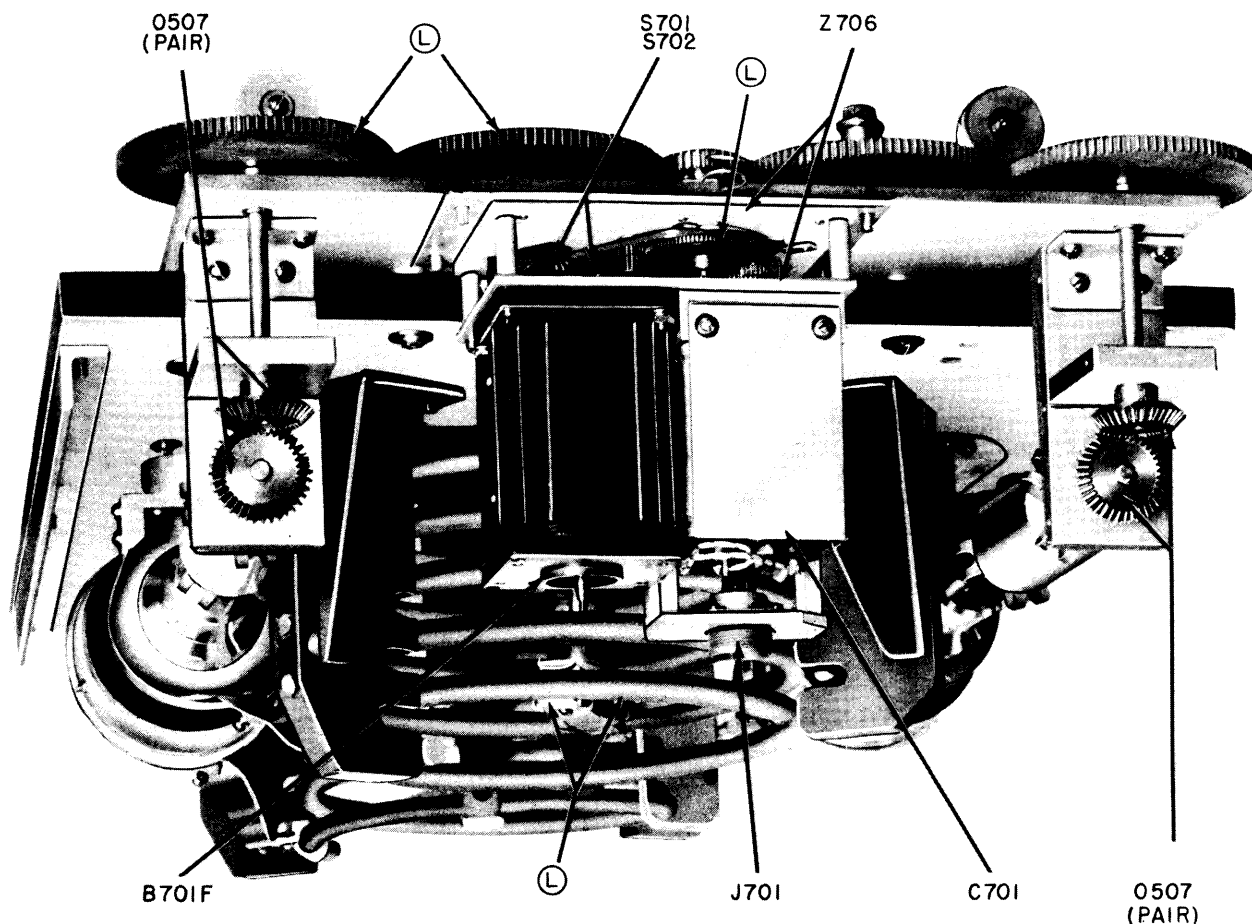
- a. The motor-driven blowers and circuit breaker reclosers.
- b. The servo drive units and associated drive chains and/or gear trains.
- c. The sliding contacts on the plate tuning and output tuning inductors.
- d. The oscillator and keyer tuning drive assemblies.
- e. The hinges and stops.

It is imperative that lubrication of the motor-driven blowers be given careful attention, since these units

are fast-moving and continuously in operation. Other lubrication requirements, while less critical, are nevertheless important and not to be postponed unnecessarily.

In the table which follows the points to be lubricated in each major unit, and the location of each, are listed in the first two columns, the number of the instruction book illustration in which they are shown is given in the third column, the type of lubricant in the fourth, the frequency of lubrication in the fifth and special instructions, where required, in the last.

In the instruction book illustrations referred to the points where lubrication is required are designated by the symbol **L**.



Figur 6-2. RF Unit T-225A/FRT-5, Antenna Coupling Network Assembly,
Left End View, Covers Removed from Servo Drive Unit (Z706) and from
Gear Boxes

TABLE 6-2. LUBRICATION CHART

Lubrication Point	Location	Figure Reference	Lubricant	Frequency of Lubrication	Remarks
RF UNIT T-225A/FRT-5					
Blower B501 Motor Bearings Fan Bearings	On base of cabinet	7-32 7-32	MS-3065 MS-3065	Monthly Monthly	
1st Frequency Multiplier Plate Tank Assembly Sleeve Bearings Gear Train Servo drive Z701 - gears Servo drive Z701 - motor Ball Bearings	Left side of driver-multiplier unit	7-24 7-24 6-1, 7-26 7-24	MIL-L-644 MIL-G-3278 Lubriplate 105V 14-L-3C MIL-G-3278	Monthly Monthly Monthly Monthly Monthly	
2nd Frequency Multiplier Plate Tank Assembly Ball Bearings Gear Train Servo drive Z702 - gears Servo drive Z702 - motor Sleeve Bearings	Right side of driver-multiplier unit	7-23 7-23 6-1, 7-26 7-23	MIL-G-3278 MIL-G-3278 Lubriplate 105V 14-L-3C MIL-L-644	Monthly Monthly Monthly Monthly Monthly	
Driver Plate Tank Tuning (L509) Ball Bearings Coil Turns and Sliding Contacts Gear Plate Assembly - Gears Servo drive Z703 - gears Servo drive Z703 - motor Sleeve Bearings	Center of front of cabinet	7-29 7-29 7-29 6-1, 7-29 7-29	MIL-G-3278 Graphite MIL-G-3278 Lubriplate 105V 14-L-3C MIL-L-644	Monthly Monthly Monthly Monthly Monthly Monthly	
PA Plate Tank Tuning Assembly Chain Motor B502 Gears Coil Turns and Sliding Contacts Ball Bushing Ball Bearings Sleeve Bearings	In center of cabinet; access from rear	7-32 7-32 7-32 7-32 7-32 7-32 7-32	Lubriplate 105V 14-L-3C MIL-G-3278 Graphite MIL-G-3278 MIL-G-3278 MIL-L-644	Monthly Monthly Monthly Monthly Monthly Monthly Monthly	
Output Coupling Platform Drive Bearing Chain Lead Screw Gears Servo drive Z705 - gears Servo drive Z705 - motor	Upper left corner (viewed from rear)	3-14 3-14 3-14 3-14 6-1	MIL-L-644 MIL-G-3278 MIL-G-3278 MIL-G-3278 Lubriplate 105V 14-L-3C	Monthly Monthly Monthly Monthly Monthly Monthly	
Output Tuning Drive Assembly Bearing Bevel Gears Gears Coil Turns and Sliding Contacts Servo drive Z706 - gears Servo drive Z706 - motor	Top of cabinet; left side of coupling network assembly	6-2 6-2 3-8 7-28 6-1, 6-2	MIL-L-644 MIL-G-3278 MIL-G-3278 Graphite Lubriplate 105V 14-L-3C	Monthly Monthly Monthly Monthly Monthly Monthly	
RF Oscillator O-91A/FRT-5 AFC centering motor B101 Tuning Drive Gears	Rack-mounted unit in lower rt front panel	7-35 7-36	14-L-3C Lubriplate 105V	Monthly Monthly	
RF Oscillator O-92A/FRT-5 Tuning Drive Gears at Rear	Rack-mounted unit in lower rt front panel	7-13	Lubriplate 105V	Monthly	
Frequency Shift Keyer KY-45A/FRT-5 Tuning Drive Gears	Rack-mounted unit in lower left front panel	7-44	Lubriplate 105V	Monthly	
POWER SUPPLY PP-490A/FRT-5					
Blower B301 - motor bearings	On base of cabinet	7-33	MS-3065	Monthly	

TABLE 6-3. LUBRICANT FEDERAL STANDARD STOCK NUMBERS

LUBRICANT			STANDARD NAVY STOCK NUMBER						
Specification	Class	Symbol	1/2 oz	1 oz	2 oz	4 oz	1 qt	5 gal	55 gal
		Lubriplate 105V	R14-G-611-50	R14-G-611-70	R14-G-612	R14-G-612-100			
MIL-L-644*						W14-O-2833-994	W14-O-2834-10	W14-O-2834-15	
MIL-L-15016	3	MS-3065						W14-O-2879-25	WW14-O-2663-3
Specification	Class	Symbol	8 oz	1 lb	5 lb	25 lb	35 lb	100 lb	
MIL-G-3278**			R14-G-984-500	R14-G-982-20	R14-G-984-520	R14-G-984-540	R14-G-984-550	R14-G-984-560	
SS-G-659		Lubricating Graphite			W14-G-570	W14-G-575			W14-G-565
14-L-3C	—			R14-L-84-900	R14-L-84-910				

*Formerly AN-O-6

**Formerly AN-G-25

SECTION 7 CORRECTIVE MAINTENANCE

WARNING

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES (6000 VOLTS) WHICH ARE DANGEROUS TO LIFE. OBSERVE SAFETY REGULATIONS AT ALL TIMES. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE ON. DO NOT DEPEND ON DOOR INTERLOCK SWITCHES FOR PROTECTION BUT ALWAYS THROW THE RED "FILAMENT — EMERGENCY OFF" SWITCH TO THE "OFF" POSITION. UNDER NO CIRCUMSTANCES SHOULD INTERLOCKS BE SHORT-CIRCUITED, REMOVED OR TAMPERED WITH, UNLESS SERVICING IS REQUIRED FOR THOSE PARTICULAR PARTS. TO AVOID INJURY ALWAYS GROUND CIRCUITS BEFORE TOUCHING THEM. DO NOT SERVICE ALONE.

1. INTRODUCTION.

In the normal service life of any piece of equipment, faults and breakdowns will develop. In order that the necessary repairs may be carried out in a reasonably short time, a logical testing routine must be followed. The twofold purpose of any corrective maintenance procedure is, first, the localization of the faulty circuit or stage and, second, the location of the faulty component or part. The trouble must be determined as quickly and as accurately as possible. The maintenance technician should familiarize himself with the circuitry and the component make-up of the equipment prior to the occurrence of trouble. Reference to schematics and wiring diagrams, figures 7-47 through 7-69, should be made frequently as an aid to servicing.

When repairs are necessary it is recommended that this servicing be done whenever possible by competent radio technicians, supplied with suitable tools and equipment.

Before proceeding with any extensive repair be reasonably sure that performance of this repair will eliminate the trouble. Do not waste time in needless probing or replacement of parts. When trouble is encountered, be logical.

In all repairs and replacements, every attempt should

be made to duplicate the original condition of the equipment. Standard replacement parts, such as supplied in the spare parts accompanying this equipment or taken from stock, should be used. Particular care should be taken to run any replacement wiring in the same position and manner as the original wiring. Only resin-core solder should be employed and only the minimum amount required should be applied. Do not permit excess solder to drop on other components, or remain within the chassis.

In the event of emergency repairs, where it is impossible to make exact replacement of parts, the same care and workmanship must be taken. The temporarily repaired equipment should be conspicuously marked or tagged to indicate the temporary nature of the repair, and restored to its original condition at the first possible opportunity.

2. LOCALIZING OF TROUBLE.

In servicing the equipment, the defective components which caused operation failure should be localized as quickly and efficiently as possible. The transmitter is divided into several stages to facilitate localization.

Full use should be made of the schematic and wiring diagrams contained in this section. Also provided as an aid to servicing are a trouble-shooting chart (table 7-1), a table of resistance measurements (table 7-2) and a table of tube operating voltages and currents (table 7-3). It is suggested that the procedure used in trouble shooting be as follows:

Observe all meters for abnormal or subnormal readings; observe indicator lights on upper front doors, to determine the affected stage. Also, note any other visual or aural indications that may help to isolate the stage at fault. For example, assume that all indications are normal through the second frequency multiplier stage, that the transmitter is operating on a frequency of 18 mc and that the second frequency multiplier cathode meter reads "0". It can be assumed that the trouble lies somewhere in the second frequency multiplier stage, or in the power supply connected with it.

Before proceeding to any intricate servicing, check such accessible components as vacuum tubes which are a major source of electronic troubles. If it is determined that the tubes are not at fault, the defective circuit and its associated components should be

FAILURE REPORTS

A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause

of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from the nearest district publications and printing office.

FAILURE REPORT—ELECTRONIC EQUIPMENT
NAVSHIPS (NBS) 383 (REV. 8-45)
(FORMERLY NAVSHIPS (NBS) 383 AND NAVSHIPS (NBS) 384)
SHIP NUMBER AND NAME OR STATION

NOTICE—Read notes on reverse side. Add Social forms and envelope may be obtained from nearest RMO.

NAME OF PERSON MAKING REPORT _____ DATE _____

CHECK ONE: ☐ RADIO

EQUIPMENT MODEL DESIGNATION _____

TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED _____

THIS _____

TUBE TYPE, INCLUDING PREFIX LETTERS _____

TUBE MANUFACTURER _____

FAILURE OCCURRED IN:

☐ STORAGE ☐ OPERATION

☐ HANDLING ☐ OTHER (SPECIFY)

☐ INSTALLING

NATURE OF FAILURE AND REMARKS _____

ELECTRONIC EQUIPMENT FAILURE REPORT (SIG)
NAVSHIPS (NBS) 383 (REV. 11-45)

NOTICE—Read notes on cover prior to preparing this form.

*REPORT NO. _____ DATE _____

ORGANIZATION PERFORMING MAINTENANCE _____ NAME AND RANK OF OFFICER ACCOUNTABLE FOR MAINTENANCE _____

EQUIPMENT INVOLVED

☐ Navy ☐ Army ☐ USMC ☐ JAG ☐ Commercial ☐ Other _____ (Specify)

☐ Radio ☐ Radar ☐ Sonar ☐ Wire ☐ Test ☐ Test ☐ Power ☐ Sound ☐ Other _____ (Specify)

EQUIPMENT MODEL DESIGNATION _____ SERIAL NUMBER OF EQUIPMENT _____ NAME OF CONTRACTOR _____ CONTRACT NO. _____

TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED _____ SERIAL NUMBER OF UNIT _____ CONTRACT OR PO DATA OF UNIT _____ DATE EQUIPMENT RECEIVED _____

ITEM WHICH FAILED

THIS SIDE FOR TUBES

TUBE TYPE, INCLUDING PREFIX LETTERS _____ SERIAL NO. (NOTE 8) _____ NAME OF PART _____ NAVY TYPE NO. _____

TUBE MANUFACTURER _____ CONTRACT NO. (NOTE 8) _____ SERIAL NO. _____ *CONTRACT DATA _____ *DATE RECD. _____ *ARMY STOCK NO. _____

FAILURE OCCURRED IN

☐ Storage ☐ Operation

☐ Handling ☐ Other (Specify in remarks)

☐ Installing

GUARANTEED HOURS (NOTE 8) _____ DATE OF ACCEPTANCE (NOTE 8) _____

ACTUAL HOURS _____ DATE OF FAILURE _____

TYPE OF FAILURE (NOTE 1) _____ TUBE CIRCUIT SYMBOL _____

NATURE OF FAILURE AND REMARKS (NOTE 8) (CONTINUE ON BACK) _____

BRIEF DESCRIPTION AND CAUSE OF FAILURE, INCLUDING APPROXIMATE LIFE (CONTINUE ON BACK) _____

CONCLUSION:

☐ Normal replacement ☐ Shortage ☐ Modification ☐ Failure ☐ Transportation breakage ☐ Other _____ (Specify)

*NOT REQUIRED FOR REPORTS SUBMITTED BY NAVAL ACTIVITIES.

16-46481-1 U. S. GOVERNMENT PRINTING OFFICE

Figur 7-0. Failure R ports Form, NBS-383

TABLE 7-1. TROUBLE SHOOTING CHART

TROUBLE	PRIMARY CHECK	SECONDARY CHECK	PROBABLE CAUSES
Low level filaments not on.	Pilot lamp not lighted.	Low level filament contactor K301 not pulled up.	1. FILAMENT-EMERGENCY-OFF switches not both in the ON position. 2. LOW LEVEL FILAMENT circuit breaker S304 not in ON position. 3. Coil of LOW LEVEL FILAMENT contactor open.
	Pilot lamp lighted but low level filaments not lighted.	Low level filament contactor K301 is pulled up.	1. Fuse blown (F501 or F502). 2. LOW LEVEL FILAMENT contactor contacts dirty. 3. Filament transformers' windings open.
Servo amplifiers not on.	Servo motors do not run when tuning controls are turned.	Servo power supply pilot lamp not lighted.	1. Low level filaments not turned ON position. 2. Servo circuit breaker S306 not in ON position.
		Servo power supply pilot lamp is lighted.	1. Fuse blown (F903). 2. Servo amplifier chassis not plugged in. 3. Servo power supply rectifier tube filaments burned out. 4. Wrong voltages on plug P801. These should be approximately the same as those given on the servo amplifier schematic.
Blowers not functioning properly.	Air movement not audible.	Blower contactor K302 not pulled up.	1. Blower hold-on timer, K305, not set properly. 2. Low level filaments not turned ON. 3. Blower circuit breaker S301 not in ON position. 4. Coil of blower contactor open.
	Air movement audible but power amplifier filaments can not be turned ON.	Blower contactor K302 is pulled up.	1. Blower contactor contacts dirty. 2. Blower not rotating in the proper direction.
PA filaments not on.	Pilot lamp not lighted.	No reading on the PA filament voltage meter (M303).	1. Blower not rotating in the proper direction. 2. Low level filaments not turned ON. 3. PA filament circuit breaker S305 not in ON position.
	Pilot lamp lighted but PA filaments not glowing.	PA filament contactor K303 not pulled up.	1. Coil of the PA filament contactor K303 open.
		PA filament contactor K303 is pulled up.	1. PA filament contactor contacts dirty. 2. PA filament controls R326 and R327 (on the power supply unit) open. 3. PA filament controls S512 and S513 (on the r-f unit) not functioning properly.

NOTE: In all cases it is assumed that the preceding circuits are trouble free.

TABLE 7-1. TROUBLE SHOOTING CHART (Cont'd)

TROUBLE	PRIMARY CHECK	SECONDARY CHECK	PROBABLE CAUSES
No bias voltage on power amplifier.	Pilot lamp not lighted.	Bias voltage contactor K306 not pulled up.	<ol style="list-style-type: none"> 1. Doors not all closed. 2. FILAMENT TIME DELAY timer K304 not set properly. 3. PA filaments not turned ON. 4. CONTROL circuit breaker S303 not in the ON position. 5. LOW VOLTAGE AND BIAS circuit breaker S302 not in the ON position. 6. Coil of K306 open. 7. Contacts of K306 dirty. 8. Terminals #20 and #11 on terminal board E516 not jumpered together.
	Pilot lamp lighted but low voltage can not be turned on.	Bias voltage contactor K306 is pulled up, but bias interlock contactor K307 is not operated ("flag" not showing).	<ol style="list-style-type: none"> 1. Bias voltage power transformer (T310) winding open. 2. Bias voltage rectifier tube (V309 or V310) faulty.
No low voltage d-c power.	Pilot lamp not lighted but bias voltage is ON.	Low voltage supply contactor K308 not pulled up.	<ol style="list-style-type: none"> 1. Automatic shutdown timer K323 not set properly. 2. Contacts on the non-automatic restart auxiliary contactor K320 dirty. 3. Contacts on bias interlock relay K307 dirty. 4. Contacts on low voltage supply contactor K308 dirty. 5. Terminal #74 on terminal board not jumpered to terminal #25 on terminal board E515.
	Pilot lamp lighted.	Low voltage supply contactor K308 is pulled up.	<ol style="list-style-type: none"> 1. Low voltage rectifier tube (V307 or V308) faulty. 2. Low voltage power transformer (T309) open winding.
No high voltage for power amplifier.	No reading on PA PLATE VOLTAGE meter (M301), and pilot lamps on RF Unit T-225A/FRT-5 not lighted.	Circuit breaker motor runs continuously with TUNE-OPERATE switch S310 in either the H. V. TUNE or OPERATE position, but will not close breaker.	<ol style="list-style-type: none"> 1. Circuit breaker under-voltage release coil not pulled up. (The sound of this relay operating can be heard when switch S310 is in the L.V. TUNE position and one of the overload relays is operated.) 2. Overload relays not all operative and/or not all properly adjusted. 3. Terminal #55 on terminal board E304 not jumpered to terminal #267 on terminal board E313. 4. Motor mounting plate not properly centered.
	No reading on PA PLATE VOLTAGE meter, but pilot lamps lighted.	Circuit breaker operates properly. Main breaker auxiliary K311 is pulled up.	<ol style="list-style-type: none"> 1. DELTA-WYE-OFF switch in the OFF position.
	High voltage present but 10% to 20% low.	Resistors R305, R306, R323 and R333 (in power supply unit) very hot.	<ol style="list-style-type: none"> 1. Rectifier tube faulty. Plate caps can be removed one at a time and high voltage turned on until tube is found where removal of cap produces no variation in high voltage value.

NOTE: In all cases it is assumed that the preceding circuits are trouble free.

TABLE 7-1. TROUBLE SHOOTING CHART (Continued)

TROUBLE	PRIMARY CHECK	SECONDARY CHECK	PROBABLE CAUSES
Automatic shutdown inoperative.	Transmitter will not turn off automatically after not having been keyed for a preset time interval.	Automatic shutdown switch S324 on the control panel of the power supply unit not in ON position.	1. AUTOMATIC SHUTDOWN thermal relay K322 defective. 2. AUTOMATIC SHUTDOWN timer K323 not set properly.
Recycling circuit inoperative.	Transmitter will not recycle.	NON-AUTOMATIC RESTART INTERVAL timer (K312) not set properly, or at the end of its timing period.	1. RESTART CYCLE COUNTER selector switch S317 not set properly. 2. Contacts on the RESTART CYCLE COUNTER K315 dirty. 3. Terminal #266 on terminal board E313 not jumpered to terminal #30 on terminal board E303.
	Transmitter will not lock-out after preset number of recycles has occurred.	RESTART CYCLE COUNTER K315 should be stepped to two more contacts than the number of automatic recycles that the restart cycle counter selector switch S317 is set for.	1. Restart cycle counter stepping coil K315A not properly adjusted. 2. Restart cycle counter reset coil K315B not properly adjusted. 3. Non-automatic restart auxiliary K320 not pulled up. 4. Restart interval timer auxiliary K313 not pulled up. 5. Restart interval timer K316 not set properly. 6. Contacts on the restart interval timer auxiliary K313 dirty.
	Overload pilot lamps do not light.	Restart interval timer auxiliary K313 not pulled up.	1. Restart interval timer K316 not set properly. 2. Contacts on the restart interval timer auxiliary dirty. 3. Contacts on the non-automatic restart auxiliary K320 dirty.
	Recycle counter will not reset.	Restart cycle counter reset coil K315B should pull up when the restart interval timer K316 completes its timing interval.	1. Restart cycle counter reset coil K315B not adjusted properly.
		Restart cycle counter reset coil K315B should pull up for the initial starting interval.	1. Non-automatic restart auxiliary K320 not pulled up. 2. Non-automatic restart timer K312 not set properly. 3. Contacts on non-automatic restart auxiliary K320 dirty.
Lockout alarm does not sound.	No audible indication.	Lock-out alarm auxiliary K321 should be pulled up.	1. Contacts on lock-out alarm auxiliary K321 dirty. 2. Contacts on restart interval timer auxiliary K313 not clean.
Tuning resistors in primary of high voltage transformer not shorted out.	Voltage reading on P. A. PLATE VOLTAGE meter M301 is in the order of 3 kilovolts when PA stage is loaded. Power supply regulation is very poor.	Contactor K401 (shorts R401-R406) in Power Control C-587A/FRT-5 should be pulled up. (Operation is audible and should occur when TUNE OPERATE switch is turned from H.V. TUNE to OPERATE position.)	1. High voltage step-start interval timer K318 not set properly.

NOTE: In all cases it is assumed that the preceding circuits are trouble free.

TABLE 7-1. TROUBLE SHOOTING CHART (Continued)

TROUBLE	PRIMARY CHECK	SECONDARY CHECK	PROBABLE CAUSES
Low d-c voltage readings.	Low readings on d-c meters.	Check filter reactor shunt resistors (R305, R306, R323 and R333) for over-heating.	1. Faulty rectifier tube. 2. Poor connections.
Filament reactor shunt resistors very hot with on-off keying.	Shunt resistors hot to touch.	D-c plate voltages will be low.	1. Faulty rectifier tube. Check by removing plate caps one at a time until tube is found whose removal from circuit has no effect on output voltage.

NOTE: In all cases it is assumed that the preceding circuits are trouble free.

TABLE 7-2. RESISTANCE MEASUREMENTS

CONDITIONS OF MEASUREMENTS:

1. All measurements were made with a Simpson model 303 meter. They were taken with the plate switch OFF and with all tubes in their sockets.

2. Resistance measurements in RF Oscillator O-91A/FRT-5, in Frequency Shift Keyer KY-45A/FRT-5 and in Power Supply PP-454A/FRT-5 were taken from terminal to ground with all

power cables disconnected. The TEST-OPERATE switch (S103) was in its OPERATE position and the 100-KC EXT-INT switch (S105) was in its INT position.

3. Resistance measurements in RF Unit T-225A/FRT-5 and in Power Supply PP-490A/FRT-5 were taken from terminal to ground, with all power turned off and with the HV shorting switches blocked open.

CIRCUIT SYMBOL	PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
RF Oscillator O-91A/FRT-5									
V101	0	2.2K	100K	INF.	0	INF.	100K	INF.	H
V102	0	33K	27K	28K	0	28K	27K	33K ¹	H
V103	0	33K	27K	28K	0	28K	27K	33K	H
V104	470K	100	H	0	INF.	39K	100		
V105	68K	560	H	0	INF.	INF.	560		
V106	470K	220	H	0	35K	92K	INF.		
V107	100K	2.2K	H	0	35K	35K	INF.		
V108	100K	220	0	H	12K	160K	100K		
V109	82K	330	0	H	32K	76K	INF.		
V110	4.7K	220	0	H	12K	78K	53		
V111	15K	330	0	H	32K	78K	INF.		
V112	49.2K	220	H	0	11K	49K	200K		
V113	470K	560	H	0	32K	340K	560		
V114	560	100K	560	H	0	10K ²	10K	560	10K ²
V115	0	33K	27K	28K	0	28K	27K	33K	H
V116	0	33K	27K	28K	0	28K	27K	33K	H
V117	0	33K	27K	28K	0	28K	27K	33K	H
V118	47K	100	H	0	78K	78K	100		
V119	1600	630K	INF.	0	H	10K	10K	1600	10K
V120	1600	630K	INF.	H	0	10K	10K	1600	10K
V121	1600	630K	INF.	H	0	10K	10K	1600	10K
V122	1600	630K	INF.	H	0	10K	10K	1600	10K
V123	H	1200	300K	630K	0	630K	300K	1200	0
V124	H	1200	300K	630K	0	630K	300K	1200	0
V125	327K	335K	0	H	327K	0	335K		
V126	327K	335K	0	H	327K	0	335K		
V127	72.7K	220	0	H	12.2K	32K	27K		
V128	1 MEG	1000	0	H	12.2K	78K	1K		
V129	100K	270	0	H	35K	78K	560		
V130	0	H	0	150K	70	78K	0	10K	
V131	0	0	0	150K	70	78K	H	10K	
RF Unit T-225A/FRT-5									
V501	0	0	12K	40K	500	13K	0	4.5K	
V502	0	150,000	40K	550	0				
V503	0	5K	15K	5	0				
V504	6.5	3K	6.7K	3K	6.5				
V505 ³									
V506 ³									
V507	15K	220,000	700	Gnd	Gnd	13K	110,000	Gnd	Gnd
V801	400,000	110,000	3.5K	Gnd	Gnd	380,000	110,000	3.4K	Gnd
V802	9.5K	550,000	500	Gnd	Gnd	10K	550,000	500	Gnd
V901	300	INF.	0	0	INF.	300	150,000		

See footnotes at end of table, page 7-8.

TABLE 7-2. RESISTANCE MEASUREMENTS (C nt'd)

CIRCUIT SYMBOL	PIN NUMBERS								
	1	2	3	4	5	6	7	8	9
Power Supply PP-454A/FRT-5									
V1001	NC	90K	NC	18	NC	19	NC	90K	
V1002	NC	90K	NC	18	NC	19	NC	90K	
V1003	30K	NC	4	4	NC	30K	40		
V1004	NC	110K	NC	40	NC	42	NC	110K	
V1005	NC	0	NC	NC	85K	NC	NC		
V1006	NC	0	NC	NC	100K	NC	NC		
RF Oscillator O-92A/FRT-5									
V1101	50K	200	Gnd	Gnd	12.8K	42K	INF.		
V1102	Gnd	Gnd	INF.	50K	150	6.5K	Gnd	6.5K	
V1103	INF.	Gnd	13 meg		INF.		6.5K	INF.	
V1104	INF.	INF.	13 meg		INF.		6.5K	INF.	
RF Unit T-225A/FRT-5 (Voltmeters)									
V1301	350,000	INF.	0	0	INF.	350,000	0		
V1302	350,000	INF.	0	0	INF.	350,000	0		
V1303	300,000	INF.	0	0	INF.	300,000	0		
V1304	300,000	INF.	0	0	INF.	300,000	0		
Frequency Shift Keyer KY-45A/FRT-5									
V1401	68K	206	H	0	35K	26K-37K ¹	56K		
V1402	68K	206	H	0	35K	26K-37K ¹	56K		
V1403	17.2K	68	0	H	13K	46K ²	68		
V1404	H	150- 12.5K ³	5.6K	0	0				
V1405	00 ⁴ 256K ⁷	470K	0	H	00 ⁴ 256K ⁷		470K		
V1406	3K	56K	0	H	1K		156K		
V1407	100K	25	0	H	00 ⁸ 51K ⁹	00 ⁸ 51K ⁹			
V1408	25K	82K	3.9K	0	0	25K	82K	3.9K	H
V1409	46K		H	0		10K	330- 2.8K ¹⁰		
V1410	22K	0	0	H	113K	343K	270		
V1411	150K	0	0	H	23K	25K	1.2		
V1412	47K	100	0	0	0	45K	27K	0	H

CIRCUIT SYMBOL	TERMINAL NUMBERS														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
J1001	0	0	H	H	85K	85K	NC	NC	NC	NC					
J1002	0	0	H	H	100K	100K	100K	NC	NC	NC					

¹Value depends on position of switch S105.²Value depends on position of variable resistor R165.³These tubes do not have contact pins. In each, the resistances from the filament, grid and plate contacts to ground are 0.6, 1300 and 60,000 ohms, respectively.⁴Depends on setting of R1416.⁵Depends on setting of R1430.⁶S1403 in CARRIER position.⁷S1403 in FSK position.⁸S1407 open.⁹S1407 closed.¹⁰Depends on setting of R1464.

TABLE 7-3. TUBE OPERATING VOLTAGES AND CURRENTS (KEY CLOSED)

CONDITIONS OF MEASUREMENTS:

(a) RF Unit T-225A/FRT-5 (except low level circuits on multiplier chassis), Power Supply PP-490A/FRT-5, RF Unit AM-350A/FRT-6 and Power Supply PP-515A/FRT-6.

- 230 volts a-c input.
- Circuit breakers marked SERVO CONTROL, CONTROL CIRCUIT, L.V. & BIAS, LOW LEVEL FILAMENTS, PA FILAMENT and BLOWER, on RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5, in ON position.
- Circuit breakers marked SERVO CONTROL, CONTROL CIRCUIT, BIAS RECT FILAMENT, PA FILAMENT, and BLOWER, on RF Unit AM-350A/FRT-6 and Power Supply PP-515A/FRT-6, in ON position.
- TUNE-OPERATE switch on Power Supply PP-490A/FRT-5 in OPERATE position.
- RF EXCITATION control on RF Unit T-225A/FRT-5 set for 8 ma grid current on driver V504.
- OUTPUT LEVEL control on RF Unit T-225A/FRT-5 set for 50 volts negative with TEST KEY open.
- PA BIAS ADJUSTMENT on Power Supply PP-490A/FRT-5 set at maximum.
- Bias adjustment on Power Supply PP-515A/FRT-6 set at a maximum.
- All grid voltages were taken with a 2½ mh choke in series with the test lead.
- All voltage measurements were taken from the terminal indicated to ground, with a Weston model type 772, #6 meter (unless otherwise indicated).

(b) RF OSCILLATOR O-91A/FRT-5

- All tubes in place.
- Power Cable connected from RF Oscillator O-91A/FRT-5 to Power Supply PP-454A/FRT-5.

- 115 volt a-c input to Power Supply PP-454A/FRT-5.
 - Power Supply PP-454A/FRT-5 OFF-ON switch in ON position.
 - 100-kc EXT. INT. crystal switch S105A and S105B in EXT. position.
 - Output Control (R165) full on.
 - PLATE switch in ON position.
 - TUNE-OPERATE switch in OPERATE position.
- (c) FREQUENCY SHIFT KEYER KY-45A/FRT-5
- All tubes in place.
 - Power cable connected from Frequency Shift Keyer KY-45A/FRT-5 to Power Supply PP-454A/FRT-5.
 - Power Supply PP-454A/FRT-5 OFF-ON switch in ON position.
 - EXT. OSC. ATTENUATOR at "O".
 - KEY LINE disconnected.
 - KEYER OUTPUT line disconnected.
 - PLATE switch in ON position.

(d) POWER SUPPLY PP-454A/FRT-5

- All tubes in place.
- 115-volt a-c input to Power Supply PP-454A/FRT-5.
- Power Supply PP-454A/FRT-5 OFF-ON switch in ON position.
- RF Oscillator O-91A/FRT-5 and Frequency Shift Keyer KY-45A/FRT-5 power cables disconnected.

Note

ALL VOLTAGE MEASUREMENTS WERE MADE WITH A HICKOK TYPE #125 VTVM.

JAN TUBE TYPE	FUNCTION AND CIRCUIT SYMBOL		PLATE (VOLTS)	PLATE (MA)	SCREEN (VOLTS)	SCREEN (MA)	SUPPRESSOR (VOLTS)	CATHODE (VOLTS)	GRID (VOLTS)	HEATER (AC VOLTS)
Power Supply PP-490A/FRT-5										
4B32	IPA high voltage supply rectifier	V301-V306								¹ 5.0
3B28	Low voltage rectifier	V307 V308								¹ 2.5
3B28	IPA bias supply rectifier	V309 V310								¹ 2.5
RF Unit T-225A/FRT-5										
6AG7	1st buffer	V501	278	18.8	211	3.2	0.75	0.75	—31.8	¹ 6.1
12AU7	(1) Keyer (6)	V507	95 160	12 12				1.9	0	¹ 6.1
807	1st frequency multiplier	V502	583	27.3	345	0.7		0.1	—31.5	¹ 6.1
807	2nd frequency multiplier	V503	480	87.2	350	12.8		0	—185	¹ 6.1
4-400A*	Driver	V504	4600	268	620	11.3		0.2	—152.5	² 5.0
3X2500-A3*	Intermediate power amplifier	V505 V506	³ 5900	¹ 1400				1.25	—620	¹ 7.5

*Not a JAN type.

¹Measured between proper terminals on secondary of respective filament transformers with iron vane type meter. (See figure 7-62 for terminal numbers.)

²Measured from pin #1 to pin #5 on XV504 with iron vane type meter.

³D-c meters on equipment used for measurement.

⁴Average values per tube.

TABLE 7-3. TUBE OPERATING VOLTAGES AND CURRENTS (KEY CLOSED) (Continued)

JAN TUBE TYPE	FUNCTION AND CIRCUIT SYMBOL	PLATE (VOLTS)	PLATE (MA)	SCREEN (VOLTS)	SCREEN (MA)	SUPPRESSOR (VOLTS)	CATHODE (VOLTS)	GRID (VOLTS)	HEATER (AC VOLTS)
Servo Amplifier									
12AX7	Amplifier V801	147 147					1.6	0	6.1
12AU7	Amplifier V802	147 147					1.6	0	6.1
Servo Power Supplies									
6X4	Rectifier V901	250 250	20				200	0	6.3
RF Oscillator O-92A/FRT-5									
6AK5	Oscillator V1101	146	6.6	108	1.9		1.45	1.45	6.6
6AG7	Buffer V1102	185	35	185		8	8	0	6.1
OB-3/ VR-90	Osc voltage stabilization V1103 V1104	90	30						
RF Oscillator O-91A/FRT-5									
2C51	Crystal oscillator and amplifier V101A V101B	+100(4) +150(6)					+2.6(2) +76(8)	0 0	6.3 (1 & 9)
2C51	Divider V102	+120(4) +185(6)					+95(2) 0	+88(3) +120(7)	6.3 (1 & 9)
2C51	Divider V103	+120(4) +115(6)					+90(2) +90(8)	+82(3) +83(7)	6.3
6AK5	Harmonic amplifier V104	+145		12		+0.5	+0.5	-4.1	6.3
6AS6	Harmonic amplifier V105	+145		+96		+1.8	+1.8	0	6.3
6AK5	450 KC amplifier V106	+92		+105			+1.6	0	6.3
6AK5	100 KC amplifier V107	+185		+185			+8	0	6.3
6BE6	(First IF) mixer V108	+226		+39			+0.4	-110(1) 0(7)	6.3
6AK5	(First IF) amplifier V109	+135		+125			+2.2	0	6.3
6BE6	(Second IF) mixer V110	+260		+22			+5	0(1) 0(7)	6.3
6AK5	(Second IF) amplifier V111	+130		+120			+2.2	0	6.3
6BA6	Multiplier V112	+260		+82		+1.2	-2.9	-11	6.3
6AK5	Multiplier V113	+220		+75			+1.3	0	6.3
5686*	Final amplifier V114	+260		+240		0	+14	0	6.3
2C51	Interpolation circuit V115	+140(4) +140(6)					+95(2) +95(8)	+89(3) +88(7)	6.3
2C51	Interpolation circuit V116	+135(4) +140(6)					+97(2) +97(8)	+86(3) +90(7)	6.3

TABLE 7-3. TUBE OPERATING VOLTAGES AND CURRENTS (KEY CLOSED) (Continued)

JAN TUBE TYPE	FUNCTION AND CIRCUIT SYMBOL	PLATE (VOLTS)	PLATE (MA)	SCREEN (VOLTS)	SCREEN (MA)	SUPPRESSOR (VOLTS)	CATHODE (VOLTS)	GRID (VOLTS)	HEATER (AC VOLTS)
2C51	Interpolation circuit V117	+120(4) +135(6)					+92(2) +92(8)	+86(3) +84(7)	6.3
6AK5	Buffer V118	+42		+42			+3	-4	6.3
5686*	Power amplifier V119	+255		+260		+63	+63	+79	6.3
5686*	Power amplifier V120	+255		+260		+60	+60	+38	6.3
5686*	Power amplifier V121	+255		+260		+80	+80	+50	6.3
5686*	Power amplifier V122	+255		+260		+72	+72	+50	6.3
2C51	DC amplifier V123	+48(4) +43(6)					+0.75(2) +0.75(8)	0(3) 0(7)	6.3
2C51	DC amplifier V124	+48(4) +48(6)					+0.75(2) +0.75(8)	0(3) 0(7)	6.3
6AL5	Diode mixers V125	-0.6(2) -0.6(7)					0(1) 0(5)		6.3
6AL5	Diode mixers V126	-0.75(2) -0.75(7)					0(1) 0(5)		6.3
6BE6	Dividers V127	+260		+105			+2.2	0(1) 0(7)	6.3
6BA6	Dividers V128	+255		+135		+5.4	+5.4	—	6.3
6AK5	100 KC amplr V129	+130		+140			+3.4		
6SJ7	Master oscillator V131	+250		+155		0	0	-7	6.3
6SJ7	Interpolation oscillator V130	+250		+140		0	0	-3	6.3
Frequency Shift Keyer KY-45A/FRT-5									
6BE6	Balanced modulator V1401								
6BE6	Balanced modulator V1402								
6BA6	Buffer V1403	+290		+190		+75	+0.75	-7.6	6.3
807	Power amplifier V1404			+260			0	-65	6.3
6AL5	Limiter V1405	-0.5(2) -0.5(7)					0(1) 0(5)		6.3
6AL5	Limiter V1406	0(2) 0(7)					+20(1) +7(5)		6.3
6AK5	Phase modulation oscillator V1407	+100		+100			+0.4	-7.8	6.3
12AU7	Balanced keyer V1408	+125(1) +130(6)					+8.7(3) +8.7(8)	+3.2(2) +3.2(7)	6.3
6C4	Phase shifting amplifier V1409	+65					+1.5	0	6.3
6BA6	Phase shifting amplifier V1410	+50		+20		0	+0.4	0	6.3
6BA6	200 KC oscillator V1411	+100		+125		0	0	-8.7	6.3
12AX7	Phase inverter V1412	+150(1) +163(6)					0(3) 0(8)	0(2) -0.45(7)	6.3

TABLE 7-3. TUBE OPERATING VOLTAGES AND CURRENTS (KEY CLOSED) (CONT'D)

JAN TUBE TYPE	FUNCTION AND CIRCUIT SYMBOL	PLATE (VOLTS)	PLATE (MA)	SCREEN (VOLTS)	SCREEN (MA)	SUPPRESSOR (VOLTS)	CATHODE (VOLTS)	GRID (VOLTS)	HEATER (AC VOLTS)
Power Supply PP-454A/FRT-5									
5R4GY	Rectifier V1001	355AC(4) 355AC(6)							5
5R4GY	Rectifier V1002	355AC(4) 355AC(6)							5
6X4	Rectifier V1003	-465(1) -465(6)					363 AC		6.3
5R4GY	Rectifier V1004	363AC(4) 363AC(6)							5
OA2	Voltage regulator V1005	+160						0	
OA2	Voltage regulator V1006	+157						0	

checked systematically for continuity, defective resistors, shorted capacitors, loose connections, etc. An ohmmeter or a volt ohmmeter should be available for making these tests.

When performing circuit continuity checks, or resistance measurements, take into account other components which may be in parallel with the part under test. For accurate results, disconnect one lead of the part being checked before proceeding with measurements. Manually close contacts which are normally open when the transmitter is not operating. This will prevent errors occurring in continuity checks.

3. ELECTRICAL ADJUSTMENTS AND ALIGNMENT.

a. RF OSCILLATOR O-91A/FRT-5.

(1) TEST EQUIPMENT REQUIRED.

- Ohmmeter — Simpson #260, or equal.
- A 115-volt and a 230-volt 60-cps a-c power source.
- Power Supply PP-454A/FRT-5.
- Voltage regulator — T313 (Sola #6090) or "Transtat".
- R-f signal generator — Boonton Model 65-D, or equivalent.
- Two vacuum-tube voltmeters — Simpson model #303 with r-f probe, or equivalent. Note: Use the probe for all r-f measurements.
- Oscilloscope.
- Headphones.
- Frequency meter — Bendix type IF-12, or equal.
- Secondary frequency standard.
- Audio signal generator.

- Two 50-ohm 5-watt carbon resistors.
- One 220-mmf mica capacitor.
- One 1000-mmf mica capacitor.
- One 10,000-ohm 2-watt resistor.
- One 10,000-mmf 600-volt capacitor.
- Five feet AN type RG-58/U coaxial cable.

(2) GENERAL SET-UP.

- Connect 10,000-ohm resistor to J105.
- Connect 50-ohm resistor to J104.
- Connect 50-ohm resistor to J108, at the end of five-foot length of RG-58/U coaxial cable.
- Install all tubes and crystal oven (Y101).

(3) POWER INPUT CHECK.

- Throw the PLATE ON-OFF switch (S101) to ON position; leave power plug P101 disconnected.
 - Measure resistance from pin #5 of J101 to ground; reading should be infinity.
 - Measure resistance from pin #6 of J101 to ground; reading should be 10,000 ohms, ± 5 percent.
 - Turn PLATE ON-OFF switch OFF.
- Connect the 115-volt a-c line to J102.
 - The CRYSTAL OVEN — HEAT ON indicator (I101) should light indicating that the thermostat in the 100-kc crystal oven has closed.
- Set switch S103 in SET-UP position.
 - The AFC ON indicator (I404) should be dark.
 - Relay K101 should operate.
 - The AFC motor (B101) should rotate capacitor C126.
 - When C126 is centered, cam on shaft should open switch S104 and stop B101.
- Set switch S103 in OPERATE position.

1. The AFC ON indicator (I404) should light.

(e) Insert plug P104 in receptacle J101.

1. All filaments should light.

(f) Turn PLATE ON-OFF switch ON.

1. PLATE ON indicator I102 should light.

2. Potential from pin #5 of J101 to ground should be approximately +150 volts.

3. Potential from pin #6 of J101 to ground should be approximately +250 volts.

4. Turn PLATE ON-OFF switch OFF.

(4) 800-KC I-F ALIGNMENT (2nd IF).

(a) SET-UP.

1. Remove tubes V108, V109 and V128 from sockets.

2. Connect the r-f signal generator to pin #1 of V111.

3. Adjust the r-f signal generator frequency for exactly 800 kc.

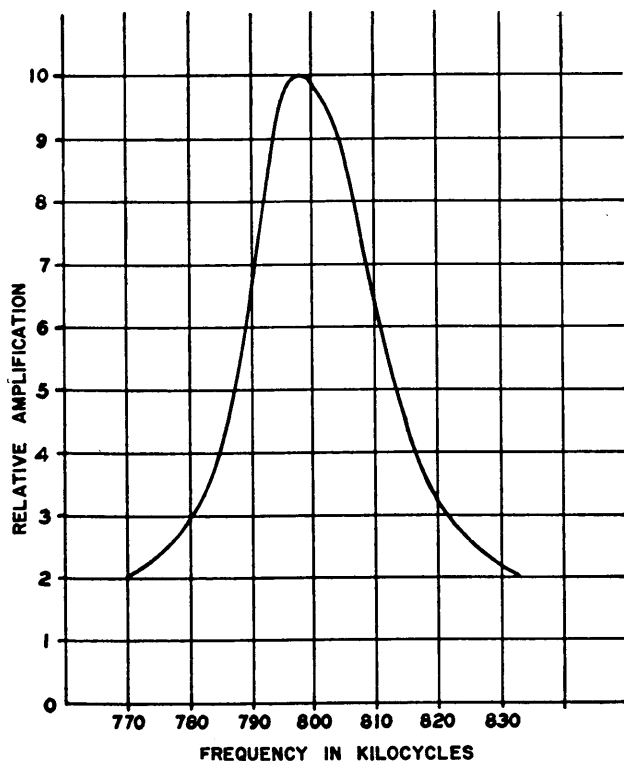
4. Connect the VTVM to terminal #4 of T109 and set for "-15 v d-c" range.

(b) PROCEDURE.

1. Connect the 220-mmF capacitor across secondary (terminals #4 and #6) of T109.

2. Turn PLATE ON-OFF switch ON.

3. Tune primary of T109 for maximum read-



**Figure 7-1. Selectivity Curve - RF Oscillator
O-91A/FRT-5, 2nd IF Stage**

ing on VTVM, by adjusting top slug. Reduce signal input level enough to keep output below -15 v dc.

4. Turn PLATE ON-OFF switch OFF.

5. Transfer 220-mmF capacitor to secondary (terminals #1 and #3) of T109.

6. Turn PLATE ON-OFF switch ON.

7. Tune secondary of T109 for a peak reading on VTVM by adjusting bottom slug.

8. Turn PLATE ON-OFF switch OFF. Transfer 220-mmF capacitor to secondary (terms #4 and #6) of T108.

9. Connect the r-f signal generator to pin #7 of V110.

10. Turn PLATE ON-OFF switch ON.

11. Tune primary of T108 for a peak reading on VTVM by adjusting top slug.

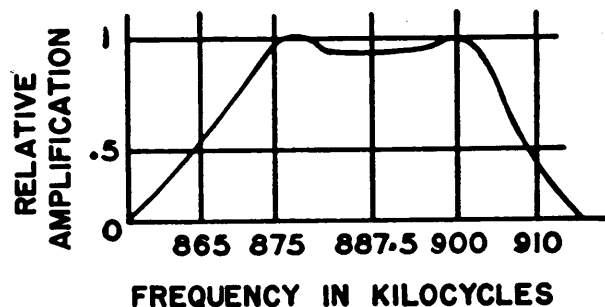
12. Turn PLATE ON-OFF switch OFF. Transfer the 220-mmF capacitor to the secondary (terms #1 and #3) of T108.

13. Turn PLATE ON-OFF switch ON.

14. Tune secondary of T108 for a peak reading on the VTVM by adjusting bottom slug.

15. Turn PLATE ON-OFF switch OFF.

16. Remove the 220-mmF capacitor.



**Figure 7-2. Selectivity Curve - RF Oscillator
O-91A/FRT-5, 1st IF Stage**

17. Turn PLATE ON-OFF switch ON.

18. Adjust the r-f signal generator output for a VTVM reading of -10 volts.

19. Reduce the r-f signal generator frequency until VTVM reading is -5 volts, but NOT BELOW 781 kc.

20. Increase the r-f signal generator frequency until VTVM reading is -5 volts, but NOT ABOVE 825 kc.

21. Turn PLATE ON-OFF switch OFF.

(5) 900-KC I-F ALIGNMENT (1st IF).

(a) SET-UP.

1. Insert tubes V108, V109 and V128 in sockets.

2. Remove tubes V113, V105 and V115.

3. Connect the r-f signal generator to pin #1 of V109.

4. Connect the VTVM to pin #5 of V110, or to terminal #1 of T108.

5. Connect the 1000-mmf capacitor across secondary (terms #4 and #6) of T107.

(b) PROCEDURE.

1. Adjust the r-f signal generator frequency for exactly 887.5 kc. Check this frequency.

2. Turn PLATE ON-OFF switch ON.

3. Tune primary of T107 for a peak reading on VTVM by adjusting top slug.

4. Turn PLATE ON-OFF switch OFF.

5. Transfer the 1000-mmf capacitor to the primary (terms #1 and #3) of T107.

6. Turn PLATE ON-OFF switch ON.

7. Tune secondary of T107 for a peak reading on VTVM by adjusting bottom slug.

8. Turn PLATE ON-OFF switch OFF.

9. Transfer the 1000-mmf capacitor to the secondary (terms #4 and #6) of T106.

10. Connect the r-f signal generator to pin #7 of V108, and the VTVM to pin #7 of V110, or to terminal #6 of T107.

11. Turn PLATE ON-OFF switch ON.

12. Tune primary of T106 for a peak reading on VTVM by adjusting top slug.

13. Turn PLATE ON-OFF switch OFF.

14. Transfer the 1000-mmf capacitor to primary (terms #1 and #3) of T106.

15. Turn PLATE ON-OFF switch ON.

16. Tune secondary of T106 for a peak reading on VTVM by adjusting bottom slug.

17. Turn PLATE ON-OFF switch OFF.

18. Remove the 1000-mmf capacitor.

19. Connect the VTVM to pin #5 of V110, or to terminal #1 of T108.

20. Turn PLATE ON-OFF switch ON.

21. Adjust the r-f signal generator output level for a VTVM reading of exactly two volts.

22. Reduce the signal generator frequency until the VTVM reads one volt, but NOT BELOW 840 kc.

23. Increase the signal generator frequency until the VTVM reads one volt, but NOT ABOVE 915 kc.

24. The frequency response in steps #22 and #23 should be relatively flat between 875 kc and 900 kc and should drop off sharply above and below this range.

25. Turn PLATE ON-OFF switch OFF.

(6) REGENERATIVE DIVIDER
ALIGNMENT.

(a) SET-UP.

1. Remove tube V110 from its socket and insert tubes V105, V113 and V115 in place.

2. Connect the r-f signal generator to pin #1 of V127.

3. Adjust the r-f signal generator for a frequency of 100 kc and an output level of one volt, unmodulated.

4. Connect the VTVM of pin #1 of V128.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust top slug of T111 for a peak reading on VTVM.

3. Turn PLATE ON-OFF switch OFF.

4. Connect the r-f signal generator to pin #1 of V128.

5. Adjust the r-f signal generator for a frequency of 700 kc and an output level of 0.1 volt, unmodulated.

6. Connect the VTVM to pin #7 of V127.

7. Turn PLATE ON-OFF switch ON.

8. Adjust bottom slug of T111 for a peak reading on VTVM.

9. Turn PLATE ON-OFF switch OFF.

10. Connect signal generator to pin #1 of V111.

11. Adjust the r-f signal generator frequency for exactly 800 kc.

12. Connect the VTVM to terminal #4 of T109, and adjust for "-15 v d-c" range.

13. Connect headphones to jack J103, and set the EXT-INT switch (S105) in the INT position.

14. Turn PLATE ON-OFF switch ON.

15. The VTVM reading should be at least -15 v dc.

16. Vary the signal generator frequency over the range from 750 kc to 850 kc and note the frequencies at which the divider tone first becomes audible, as the frequency is varied toward 800 kc.

17. The divider should function between 780 kc and 820 kc.

18. If the divider does not function at 820 kc, set the signal generator for 820 kc and adjust the top slug of T111 until a smooth note is audible.

19. If the divider does not function at 780 kc, set the signal generator for 780 kc and adjust the bottom slug of T111 until a smooth note is audible.

20. Repeat steps #19 and #20, alternately, until alignment is obtained. One or two repetitions should suffice.

21. Turn PLATE ON-OFF switch OFF.

(7) 100-KC PHASE SPLITTER ADJUSTMENT.

(a) SET-UP.

1. Connect terminal #2 of V122 to the VERTICAL INPUT terminal of the oscilloscope, and terminal #2 of V119 to the HORIZONTAL INPUT terminal.

2. Connect the r-f signal generator to pin #1 of V111, or to terminal #6 of T108.

3. Adjust the r-f signal generator for a frequency of 800 kc and an output level of +0.10 volt, unmodulated.

4. Connect the VTVM to pin #2 of V122. (Use the a-c probe.)

(b) PROCEDURE.

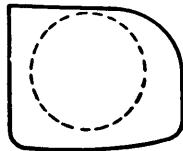
1. Turn PLATE ON-OFF switch ON.

2. Shift the signal generator frequency slightly away from 800 kc until a 400-cps (approximately) tone is heard in the headphones. Disconnect headphones.

3. The VTVM reading should be between 15 volts and 20 volts.

4. The oscilloscope should indicate a 90° phase relationship between the two audio phases; the patterns should be similar to those shown below. Check the balance of the oscilloscope amplifiers to make certain that the vertical and horizontal traces are equal.

**SOLID CURVE
LOW FREQ
0-150 CPS
APPROX.**



DOTTED CURVE 150 TO 1000 CPS APPROX.

**Figure 7-3. Oscillograms — RF Oscillator
O-91A/FRT-5, 100-Kc Phase Splitter Circuit
Phase Relations**

5. If the patterns obtained are not similar to those shown, adjust the top and bottom slugs of T112.

6. Turn PLATE ON-OFF switch OFF.

(8) MOTOR CONTROL CIRCUITS CHECK.

(a) SET-UP.

1. Remove cover plate from capacitor C126 to permit observation of its rotation.

2. Connect pin #2 of V122 to the VERTICAL input terminal of oscilloscope.

3. Connect audio signal generator to HORIZONTAL input terminal of the oscilloscope.

4. Connect r-f signal generator to pin #1 of V111.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust the r-f signal generator for 800 kc. Capacitor C126 (driven by motor B101) should not rotate. If it does, a slight adjustment of the r-f signal generator frequency should stop it.

3. Slowly reduce the r-f signal generator frequency; the audio signal on the oscilloscope should increase in frequency. Check the highest and the lowest frequencies at which the motor (B101) will operate. Limits: 750 cps and one cps.

4. Repeat step #3, this time increasing the r-f signal generator frequency.

5. Turn PLATE ON-OFF switch OFF.

6. Replace tube V110.

**(9) MASTER OSCILLATOR END POINTS
CALIBRATION.**

(a) SET-UP.

1. Loosen the set screw in the shaft coupling between the dial drive assembly and the master oscillator assembly (Z102).

2. Couple the frequency meter to pin #1 of V112.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust the master oscillator (Z102) for exactly 1.25 megacycles, by turning end of shaft with fingers.

3. Set the MASTER OSCILLATOR dial **A-1** to exactly 2.5 megacycles (on red scale).

4. Tighten the set screw in the shaft coupling, being careful not to disturb either the dial setting or the adjustment of Z102.

5. Check the end points of the dial calibration. At the 3.0-megacycle setting (red scale) the oscillator output should be 1.5 megacycles, and at the 2.0-megacycle setting (red scale) it should be 1.0 megacycle.

6. Turn PLATE ON-OFF switch OFF.

(10). MULTIPLIER ALIGNMENT (TRACKING).

(a) SET-UP.

1. Remove tube V105.

2. Set switch S105 in EXT position.

3. Set the MASTER OSCILLATOR dial **A-1** for 2.2 mc (red scale).

4. Connect one VTVM across the 50-ohm load resistor which was installed across J108 in step 3 a (2) (c), and the second to pin #1 of V108.

5. Set the OUTPUT TUNING dial **C-1** at 2.2 megacycles.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust slug in T104 for a maximum reading on first VTVM.

3. Adjust slug in T105 for a maximum reading on second VTVM.

4. Re-adjust T104 for a maximum reading.

5. Set the MASTER OSCILLATOR dial **A-1** for 4.2 megacycles (white scale).

6. Adjust the OUTPUT TUNING dial **C-1** for 4.2 megacycles.

7. Adjust trimmer capacitors C128C and C128D for maximum readings on the second and first VTVM, respectively.

8. Return the MASTER OSCILLATOR and OUTPUT TUNING dials to 2.2 megacycles.

9. Repeat steps #4 through #8.

10. Check tracking at each 100-kc interval from 2.0 to 4.5 megacycles. Track by means of the split end plates of variable capacitor sections C120C and C120D, if necessary.

11. Turn PLATE ON-OFF switch OFF.

12. Replace tube V105.

(11) INTERPOLATION OSCILLATOR END POINT CALIBRATION.

(a) SET-UP.

1. Loosen the set screw in the shaft coupling between the dial drive assembly and the interpolation oscillator assembly (Z101).

2. Couple the frequency meter to pin #1 of V118.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust the interpolation oscillator (Z101) for exactly 700 kc by turning the end of the shaft with the fingers.

3. Set the INTERPOLATION OSCILLATOR dial **B-1** to exactly 2.5 kc.

4. Tighten the set screw in the shaft coupling, being careful not to disturb either the dial setting or the adjustment of Z101.

5. Check the end points of the dial calibration. At "0" on the dial the interpolation oscillator output should be 600 kc, and at 5 kc on the dial it should be 800 kc.

6. Turn PLATE ON-OFF switch OFF.

(12) SPECTRUM GENERATOR ALIGNMENT (TRACKING).

(a) SET-UP.

1. Remove tube V103.

2. Connect the r-f signal generator to pin #7 of tube socket XV103 through a 10,000-mmF capacitor.

3. Adjust r-f signal generator for exactly 10.125 megacycles.

4. Connect the VTVM to terminal #4 of T109.

5. Set the INTERPOLATION OSCILLATOR

B-1 at the "0" position.

6. Set the OUTPUT TUNING dial **C-1** and the MASTER OSCILLATOR dial **A-1** at 2.2 megacycles.

(b) PROCEDURE.

1. Turn the PLATE ON-OFF switch ON.

2. Adjust the slug in T101 for maximum (approximate) reading on the VTVM (output from term #4 of T109).

3. Adjust the slug in T102 for maximum output.

4. Always reduce the r-f signal generator output enough so that the input to the VTVM is less than 15 volts.

5. Repeat steps #2 and #3.

6. Adjust the r-f signal generator output for exactly 19.125 megacycles.

7. Set the OUTPUT TUNING dial **C-1** and the MASTER OSCILLATOR dial **A-1** at 4.0 megacycles.

8. Adjust trimmer capacitors C128B and C128A for maximum signal.

9. Change the signal generator frequency to 10.125 megacycles and repeat steps 3 a (12) (a) 4 through 3 a (12) (b) 8.

10. Check tracking at each 100-kc interval from 2.0 to 4.5 megacycles. Track by means of the split plates on variable capacitor sections C120A and C120B, if necessary.

11. Turn PLATE ON-OFF switch OFF.

12. Replace tube V103.

(13) 100-KC CRYSTAL STANDARD ADJUSTMENT.

(a) SET-UP.

1. Allow at least one-half hour for crystal to warm up.

2. Set the EXT-INT switch S105 in the INT position.

(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.

2. Adjust capacitor C103 to bring the crystal frequency to exactly 100 kc.

3. Check the frequency at J104; it should be 450 kc. Adjust T103 for maximum output at J104.

4. Set the EXT-INT switch S105 in the EXT position; this should reduce the voltage at J104 to zero.

5. Connect the r-f signal generator to J106, and adjust for 100-kc output.

6. Check for a 100-kc signal at J104.

7. Turn PLATE ON-OFF switch OFF.

**(14) POWER OUTPUT CHECK AND
CALIBRATION ADJUSTMENT.**

(a) SET-UP.

1. Set the EXT-INT switch S105 in the INT position.
2. Turn AFC control on; AFC ON indicator I404 should light.
3. Rotate POWER OUTPUT control R185 to its maximum clockwise position.
4. Connect one VTVM across the 50-ohm load resistor installed across J108 in step 3 a (2) (c), above.

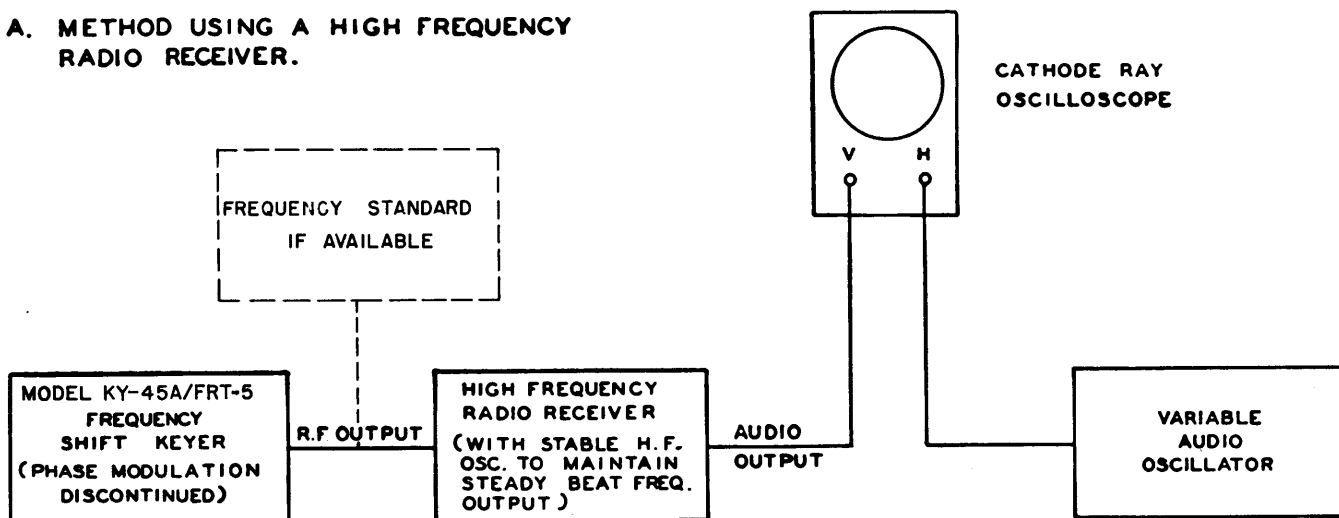
5. Connect the second VTVM to terminal #4 of T109.

6. Make sure all tubes are in their respective sockets.

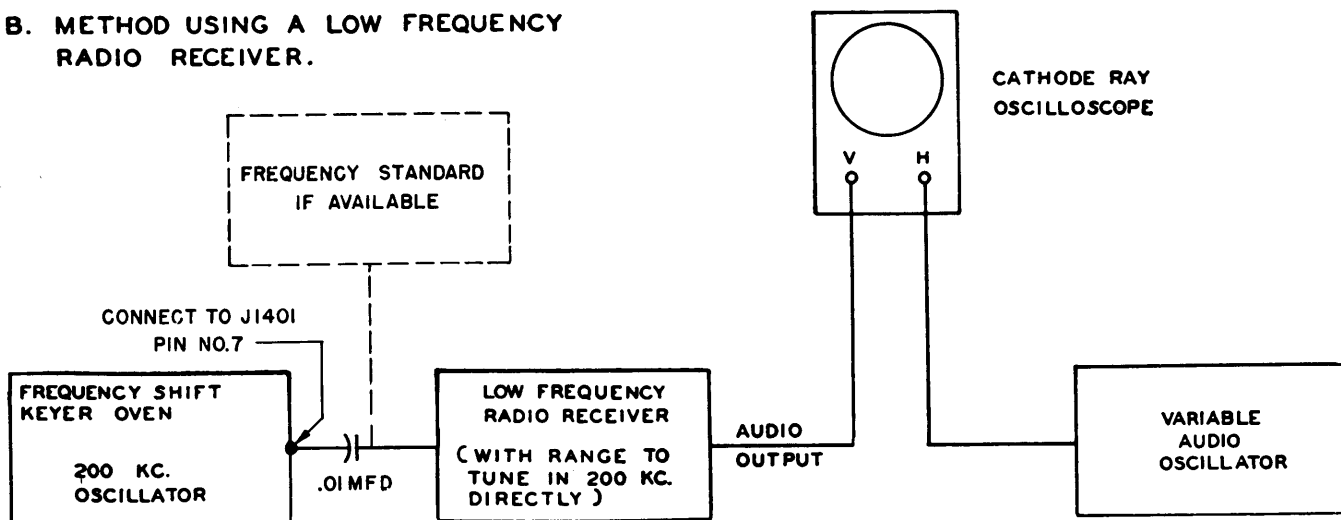
(b) PROCEDURE.

1. Turn PLATE ON-OFF switch ON.
2. Measure the output voltage and frequency for each of the following combinations of settings of MASTER OSCILLATOR dial **A-1** and OUTPUT TUNING dial **C-1**. Limits: minimum voltage, 2 volts; maximum frequency error, 30 cps.

**A. METHOD USING A HIGH FREQUENCY
RADIO RECEIVER.**



**B. METHOD USING A LOW FREQUENCY
RADIO RECEIVER.**



**Figure 7-4. Test Set-Up Diagram — Frequency Shift Keyer KY-45A/FRT-5,
Method of Connecting Oscilloscope to Display Patterns of Different
Frequency Shifts**

MASTER OSCILLATOR dial A-1	OUTPUT TUNING dial C-1
2.0	2.0
2.5	2.5
3.0 (doubling)	3.0
3.0 (tripling)	3.0
3.5	3.5
4.0	4.0
4.5	4.5

3. Minimum voltage over the band should be 4.0 v dc, as read on VTVM (output from term. #4 on T109).

4. Turn PLATE ON-OFF switch OFF.

**b. ALIGNMENT OF FREQUENCY SHIFT
KEYER KY-45A/FRT-5.**

**(1) TEST EQUIPMENT NEEDED FOR
ALIGNMENT.**

- (a) Signal generator, General Radio type 805C.
- (b) Secondary frequency standard.
- (c) Oscilloscope.
- (d) Square wave generator.
- (e) Audio oscillator.
- (f) Dummy load, 50 ohms.
- (g) VTVM, Ballantine type 300A.
- (h) Keying relay, Western Electric type 215A.
- (i) Discriminator (refer to figure 7-7).

(2) EQUIPMENT SET-UP.

(a) Interconnect Frequency Shift Keyer KY-45A/FRT-5 and Power Supply PP-454A/FRT-5 with the power cable.

(b) Connect the line cord to a 115-volt 60-cps power source.

(3) RF ALIGNMENT.

(a) EQUIPMENT SET-UP.

1. Connect the power cable between J1002 on Power Supply PP-454A/FRT-5 and J1404 on Frequency Shift Keyer KY-45A/FRT-5.

2. Connect the 115-volt a-c line at J1406. Allow oven temperature to stabilize for 60 minutes.

3. Remove the 200-kc oscillator tube, V1411.

4. Set RF TUNING dial at 4.0 mc.

5. The METER SWITCH (S1402) should be in PA GRID position.

6. Connect the signal generator, tuned to 4.0 mc with an output of approximately two volts, to EXT. OSC. INPUT, J1401. THE EXT. OSC. ATTENUATOR should be at zero db.

7. Adjust all variable ceramic capacitors so that their plates are approximately five degrees engaged and all tuning cores half way in.

8. Place MODULATOR BALANCE control R1416 in either maximum or minimum position.

(b) ALIGNMENT PROCEDURE.

1. Place POWER switch in ON position.

2. Adjust capacitors C1406, C1408 and C1413 so that maximum grid current is indicated on M1401.

3. Change signal generator frequency and RF TUNING to 2.2 mc and adjust cores of inductors L1402, L1406 and L1407 for a maximum grid current indication.

4. Repeat steps #2 and #3, alternating between 4.0 and 2.2 mc until no further increase is noted.

5. Place METER SWITCH in PA PLATE position. Turn OUTPUT CONTROL R1430 to maximum.

6. Tune signal generator to 4.0 mc and adjust C1419 for a minimum plate current indication.

7. Return signal generator to 2.2 mc and adjust core in L1411 for minimum plate current. Repeat steps #6 and #7 until no retuning is required to bring plate current to minimum. Connect 50-ohm load at J1402.

8. Replace the 200-kc oscillator tube, V1411.

(4) MODULATOR BALANCE ADJUSTMENT.

(a) Connect the signal generator, tuned to 3.0 mc, to the EXT. OSC. INPUT jack (J1401). The EXT. OSC. ATTENUATOR should be set at zero db.

(b) Turn RF TUNING dial to approximately 2.8 mc. Grid current and output should be indicated.

(c) Turn RF TUNING dial to approximately 3.0 mc. Grid current and output should be indicated. Adjust MODULATOR BALANCE control R1416 to obtain minimum plate current.

(d) Turn RF TUNING dial back to 2.8 mc and check output and grid current. Output should be five watts with 2.0 volts input to J1401, and with EXT. OSC. ATTENUATOR at zero db.

**(5) TEST OPERATE FUNCTION SWITCH
SET-UP.**

(a) Adjust BASIC SHIFT control to "0", TEST OPERATE SWITCH to carrier position, TRANSMITTER MULTIPLICATION FACTOR switch to "1" and PHASE MODULATION DEGREES control to "0" (off).

(b) Using the three-beat method, adjust the 200-kc oscillator until an exact zero beat is obtained. Use signals taken from the keyer, the frequency standard and the BFO.

Measure the 200-kc frequency by coupling the output from the terminal #7 of tube V1401 through a 0.01-mf capacitor to a radio receiver capable of tuning to this frequency.

The measuring technique for steps #6, #7 and #8 is the same as that used in step #5 except that the receiver BFO is not used and the audio output from the receiver is compared, instead, with the audio frequency of a calibrated audio oscillator.

If a radio receiver capable of being tuned to 200 kc is not available, a high frequency receiver may be used, provided it covers the frequency range from 2 mc to 4 mc. In this case a sample of r-f voltage taken from the KEYSER OUTPUT jack (J1402) must be coupled to the receiver input along with the output of the frequency standard, and it will be necessary to apply an injection voltage at the EXT. OSC. INPUT jack (J1401) of the keyer. With this method, if the frequency of the signal generator used to supply the injection voltage is known, the setting of the 200-kc oscillator and the adjustments to be made in steps #6, #7 and #8 may be made at the keyer output frequency which, after completion of step #5, will be 200 kc lower than that of the injection voltage.

(6) FREQUENCY SHIFT CALIBRATION.

(a) Begin with the equipment adjusted as in paragraph 3 b (5) (b) above. Turn the FREQUENCY SHIFT control to the maximum position.

(b) Adjust KEYSER BALANCE control R1450 to return signal to zero beat. Place the TEST OPERATE switch in the SPACE position, and adjust the FREQ. SHIFT CALIBRATION control for a 1000-cps shift. Then place the switch on MARK. The frequency should increase to approximately 1000 cps.

(c) If a 1000-cps shift is not obtained, adjust FREQ. SHIFT CALIBRATION control and recheck. Correct adjustment is obtained when the total shift is 2000 cps, e.g., 1000 cps for mark and 1000 cps for space.

(d) Put the TEST OPERATE switch in the FSK position and apply a mark signal on key line J1407A. Adjust LIMITER ADJUST R1439 until a note is heard which is the same frequency as that obtained with the TEST-OPERATE switch in the MARK position. The frequency should increase as in step (b). Next apply a space signal. The frequency should now decrease producing a total shift of 2000 cps.

(7) "TRANSMITTER MULTIPLICATION FACTOR" CONTROL ACCURACY. — Place the TRANSMITTER MULTIPLICATION FACTOR control in position #1, and the TEST OPERATE switch in the CARRIER position, and adjust the FREQ. SHIFT CALIBRATION control for maximum shift. Keyer balance must be correct as in paragraph 3 b (6) above. Rotate TEST OPERATE switch to either MARK or SPACE; either will produce a 1000-cps beat note. Adjust the audio oscillator to produce a 1:1 oscilloscope pattern. Successively greater ratios of oscil-

loscope pattern should be obtained as the TRANSMITTER MULTIPLICATION FACTOR control is rotated clockwise.

"Transmitter Multiplication Factor" Control Position	Oscilloscope Pattern
1	1:1
2	2:1
4	4:1
8	8:1

The foregoing ratios shall be obtained by varying the audio oscillator not more than ± 20 cps at each position.

(8) CARRIER SHIFT LINEARITY FOR PHOTO INPUT. — Place TEST-OPERATE switch in PHOTO position. Adjust PHOTO-ADJUST R1448 so that an input of 15 ma into the photo key line (pin "C" of connector J1407) yields zero cps shift from carrier. Vary the line current from 30 ma to 0 ma five ma steps. The amount of resultant shift should be within the following limits:

Line Current	Required Shift	Tolerance
30.0	+1000 cps	+5%
25.0	+ 667 cps	± 50 cps
20.0	+ 333 cps	$\pm 33\text{-}1/3$ cps
15.0	+ 0 cps	$\pm 16\text{-}2/3$ cps
10.0	— 333 cps	0 cps
5.0	— 667 cps	$\pm 16\text{-}2/3$ cps
0	—1000 cps	$\pm 33\text{-}2/3$ cps

(9) PHASE MODULATION OSCILLATOR. — Turn the BASIC SHIFT control to give 850 cps shift (425 cps above and below) carrier.

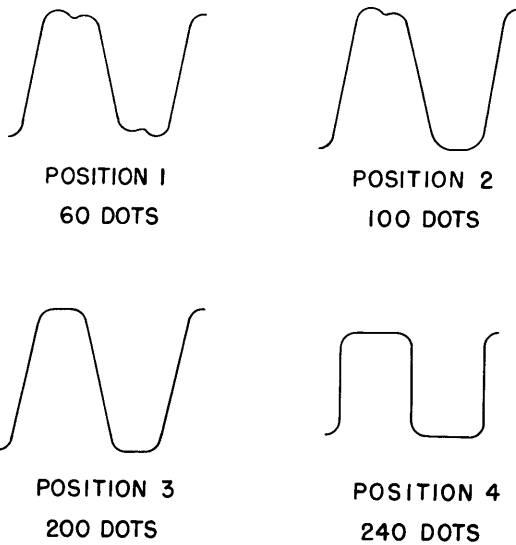
(a) Turn PHASE MODULATION control to ON position.

(b) Compare the output of the 200-cps oscillator at terminal #2 of J1403 with an audio oscillator, using an oscilloscope to check its frequency.

(c) Set WAVE SHAPING switch on position #3.

(d) Connect a 20-dot-cycle signal to key line input.

(e) Connect a discriminator (figure 7-7) and oscilloscope to keyer output jack J1402. This should be terminated with a 50-ohm load.



WAVE FORMS OF DISCRIMINATOR OUTPUT FOR DIFFERENT POSITIONS OF WAVE-SHAPING SWITCH S1404, AND FOR DIFFERENT DOT SPEEDS.

Figure 7-5. Oscillograms — Frequency Shift Keyer KY-45A/FRT-5, Wave Forms of Discriminator Output for Different Positions of Switch S1404, and for Different Dot Speeds

(f) Adjust the PHASE MODULATION dial to obtain one radian of phase modulation as indicated by the oscilloscope pattern. (Refer to figures 7-6 and 7-8.)

(10) WAVE SHAPING.

- (a) Adjust keyer for 3.5 mc output.
- (b) Connect square wave generator to the keying line at J1407A.
- (c) View waveform on the oscilloscope.
- (d) Check waveforms of r-f output for different positions of wave shaping switch, S1404, and for different dot speeds as shown in figure 7-5.

c. RADIO TRANSMITTING SET AN/FRT-5A ALIGNMENT.

(1) TEST EQUIPMENT NEEDED FOR ALIGNMENT.

- (a) Dummy load.
- (b) Secondary frequency standard.
- (c) Vacuum tube voltmeter.
- (d) Q-meter, Boonton Radio type 200A.
- (e) Audio oscillator, Hewlett-Packard #200 BR or equivalent.
- (f) A-C voltmeter, 0-10 volt, 1/2% accuracy.

(2) EQUIPMENT SET-UP.

(a) Interconnecting cables are to be installed between the cabinets for RF Unit T-225A/FRT-5

and Power Supply PP-490A/FRT-5 and the external units, namely, Power Control C-587A/FRT-5 and Power Transformer TF-122/U.

(b) The 230-volt 3-phase line is to be connected to Power Control C-587A/FRT-5.

(3) ADJUSTMENT OF FIRST MULTIPLIER PLATE TUNING COIL AND CAPACITOR.

(a) Plug in servo amplifier Z801 and allow it to warm up.

(b) The multiplier chassis should be tipped forward so that the type 807 tubes (V502 and V503) and their associated tank circuits are readily accessible. Refer to figure 3-10. The first multiplier is the one to the left. Turning the FIRST MULTIPLIER PLATE TUNING control **A** on the front panel should cause the associated plate tuning circuit, C511, and L503, to follow. If the circuit is wired properly the rolling coil contact will move toward the top of the exciter chassis as the control is rotated clockwise. The servo drive motor should operate only when the control is turned and should stop a short time after rotating the control.

(c) Adjust the "anti-hunting" control, R804, so that the servo motor starts and stops smoothly. This control is screw driver adjustment located on the front of each amplifier.

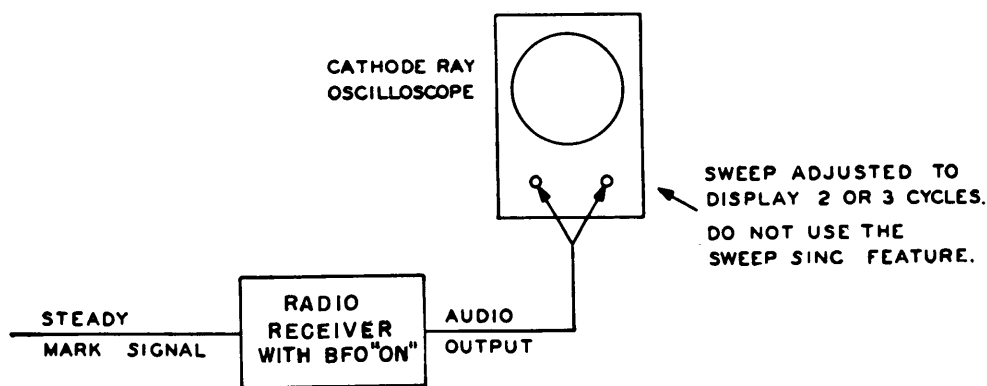
(d) If it is impossible to make the motor follow the control **A** in accordance with the above outlined procedure it may be an indication that the motor field is reversed. This can be checked by reversing the leads on terminals #11 and #12 on the backside of the connector, J806, mounted in the common servo amplifier enclosure. Refer to figure 7-69.

(e) After the servo control has been checked and found to operate properly, carefully adjust variable air capacitor C511 for maximum capacity. At this capacity setting, place the rolling contact of coil L503 on the last turn at the bottom (nearest the drive unit) end of the coil. Remove the servo drive unit by loosening the two hold-down screws, then turn the front panel control **A** counterclockwise to zero on its scale. This sets the servo drive motor at its low frequency limit.

(f) Replace the drive unit and check the operation to see that the circuit operates properly throughout its range.

WARNING

THE FUSE MOUNTS LOCATED ON EITHER SIDE OF THIS MULTIPLIER UNIT ARE ENERGIZED DURING THESE TESTS AND ACCIDENTAL CONTACT



CONNECTION OF OSCILLOSCOPE
TO DISPLAY WAVEFORM WITH
PHASE MODULATION.

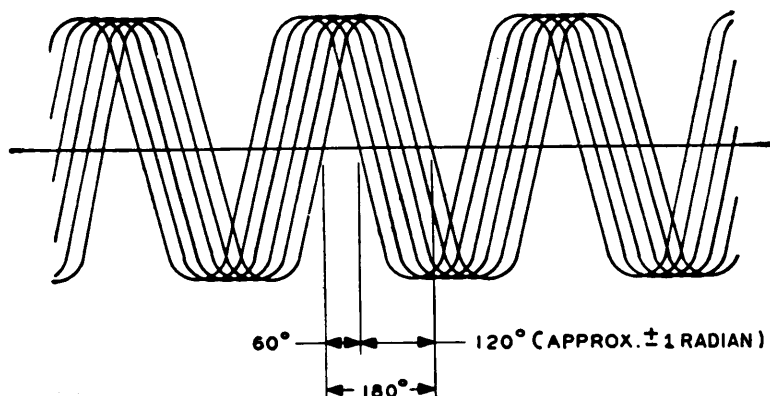


Figure 7-6. Test Set-Up Diagram — Frequency Shift Keyer KY-45A/FRT-5,
Method for Checking One Radian of Phase Modulation, Using a Radio Receiver;
and Oscillogram of Wave Shape

WITH THEIR TERMINALS WILL CAUSE
AN UNPLEASANT, AND POSSIBLY DAN-
GEROUS, SHOCK.

(4) ADJUSTMENT OF SECOND MULTIPLIER PLATE TUNING COIL AND CAPACITOR.

(a) Plug in servo amplifier Z802 and wait for it to warm up.

(b) This circuit is on the right side of the frequency multiplier chassis. Follow the same procedure as that outlined in paragraph 3 c (3) above, except for subparagraphs (e) and (f).

(c) After the servo control has been checked and found to operate satisfactorily, carefully set the variable air capacitor C517 to near minimum capacity so that the tips of the rotor blades and the stator blades

are just ready to start meshing. At this capacitor setting set the roller contact of coil L506 on the top (end away from the drive unit) turn.

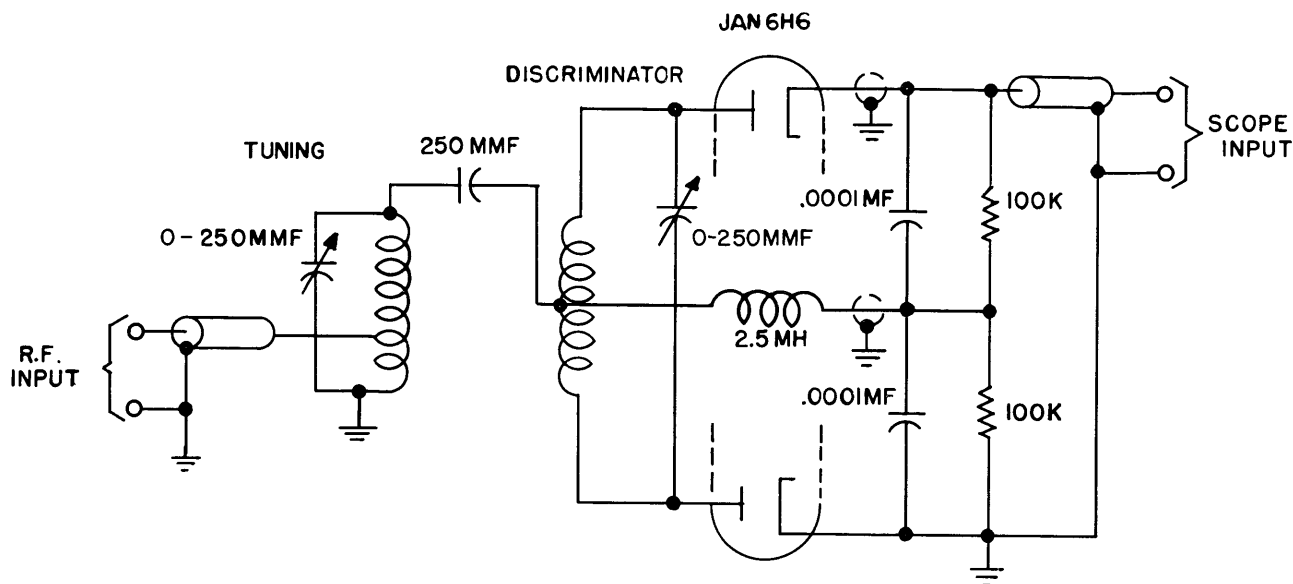
(d) Remove the servo drive unit by loosening the two hold-down screws, then turn the front panel control **B** completely clockwise to the "1000" mark on its scale. This sets the servo drive motor to its high frequency limit.

(e) Replace the servo drive unit and check the operation to see that the circuit operates properly throughout its range.

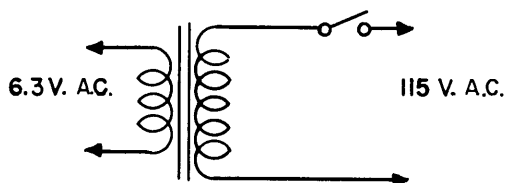
(5) ADJUSTMENT OF DRIVER PLATE TUNING COIL AND CAPACITOR.

(a) Plug in servo amplifier Z803 and allow it to warm up.

(b) Check operation of the servo drive unit in accordance with the procedure outlined in sub-



COILS ARE WOUND ON A 1 1/2 INCH DIAMETER FORM, SIDE BY SIDE, AND SINGLE LAYER CLOSE WOUND. DISCRIMINATOR COIL IS CENTER TAPPED.



FREQ. MC	TURNS TUNING	TAP TUNING	TURNS DISCRIMINATOR	SPACING BETWEEN COILS	SIZE WIRE
1.78 - 4.95	28	2	28	5/16 IN.	26 D.C.C.

Figure 7-7. Schematic — Frequency Shift Keyer KY-45A/FRT-5, Discriminator Circuit for Checking Wave Shapes

paragraphs (b), (c), and (d) of paragraph 3 c (3) above.

(c) Remove the variable vacuum capacitor C526 from the assembly.

(d) Rotate the tuning control counterclockwise until the slider on the variable inductor, L509, is at the extreme right end. The dial reading should be "0".

(e) Loosen the set screws on the shaft at the right end of the dual-coupled variable air capacitor assembly (C533 and C534) and adjust this capacitor carefully for maximum capacity. Retighten the set screws.

(f) Run the servo drive unit to its extreme high frequency position by rotating the DRIVER PLATE TUNING control **C** clockwise to the "1000" mark.

(g) Operate the circuit from the front panel control **C** to see that it is functioning properly. The

vacuum capacitor C526 is still out.

(b) Set the SERVO CONTROL **C** so that there is exactly one turn of the variable inductor L509 between its left end and the slider.

(i) Using a Q-meter or other equally accurate means set the vacuum variable capacitor C526 to 40.7 mmf, and replace it in the circuit.

(j) Again check the operation of the circuit, readjusting the anti-hunt control, R804, if necessary, to obtain smooth starting and stopping.

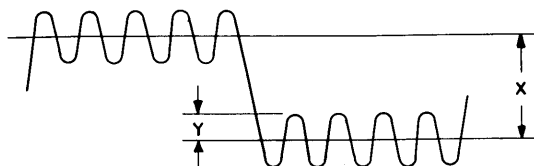
(6) ADJUSTMENT OF PA PLATE TUNING COILS AND CAPACITORS.

(a) Plug in amplifier Z804 and allow it to warm up.

(b) Check operation of the servo drive unit in accordance with the procedure outlined in subparagraphs (b), (c) and (d) of paragraph 3 c (3) above.

(c) Remove the variable vacuum capacitors

(1) WAVE FORM (APPROX. $\frac{1}{4}$ RADIAN OF PHASE MODULATION.



(2) APPROXIMATE DETERMINATION OF PHASE MODULATION.

$$\text{PHASE MODULATION (RADIAN)} = \frac{\frac{Y}{X} \times \text{FREQUENCY SHIFT}}{\text{FREQUENCY OF PHASE MODULATING OSCILLATOR}}$$

MULTIPLY BY $\frac{360}{2\pi}$ TO CONVERT RADIAN INTO DEGREES.

EXAMPLE :

FREQUENCY SHIFT = 850 CYCLES
FREQUENCY OF PHASE MOD. OSC = 200 CYCLES
FROM ABOVE WAVE FORM $Y/X = 1/4$ APPROX.

$$\begin{aligned} \text{PHASE MODULATION} &= \frac{\frac{1}{4} \times 850}{200} \\ &= 1.06 \text{ RADIAN OR } 60.7 \text{ DEGREES} \end{aligned}$$

Figure 7-8. Diagram — Frequency Shift Keyer KY-45A/FRT-5, Method of Checking Phase Modulation, Using Discriminator; and Oscillogram of One Radian of Wave Shape

C569 and C570 by opening the top and bottom clamp bands and sliding them up and outward.

(d) Disengage the drive coupling to the slider contacts of plate tank coil L516 and L517 by removing the two screws on each coupler. Block up the top section of the couplers to prevent them from making contact.

(e) Rotate the POWER AMPLIFIER PLATE TUNING control **D** clockwise to the "1000" position. Note that the plate tank drive mechanism follows properly, and that its limit switch stops its operation at or just before the dial reaches the "1000" mark. Turn the control to zero and note that the mechanism follows and that the limit switch operates at or near zero on this end also. Reset the system to the "1000" mark.

(f) Manually set sliding contacts one-quarter of a turn from the top of the tank coils L516 and L517. In this position the slider bars will be parallel and the top contact will be at the extreme rear of the coil.

1. With the sliders in this position and the servo drive dial set at the "1000" mark, the tank coil drive couplings should be lined up so that the top section could be lowered into place without rotating either top or bottom section. If this is not the case the

chain sprocket wheels of the drive unit must be rotated to produce alignment. This is accomplished as follows:

a. Note the number of sprocket teeth and direction that each of the two large sprockets must be moved — write this down.

b. Turn the front panel control **D** to some position near the middle of the scale and when the drive has positioned itself shut off the SERVO POWER breaker.

c. Loosen the chain tightener on the drive unit and carefully move the sprockets with respect to the driving chain, the number of teeth and direction previously noted.

d. Retighten the chain and turn on the SERVO POWER breaker.

e. Again set the front panel control **D** at the "1000" mark; if you have been careful the coupler will be lined up ready to slip together.

2. Reassemble the drive couplers and operate the tank drive through its range two or three times to see that everything is operating smoothly. Reset control **D** at the "1000" mark and proceed to the next step.

(g) Using a Q-meter and a 15-mc frequency set the capacitance of the two variable vacuum capacitors C569 and C570 at approximately 100 mmf, being careful to set them alike.

(b) Manually rotate the splined nut clockwise (toward minimum capacity), carefully keeping track of the starting point and number of turns until the stop is reached. Select the unit which required the least number of turns from its 100-mmf setting to the top and set the other capacitor to the same number of turns, or part turns, from its 100-mmf position.

(i) Rotate both capacitor nuts one-quarter turn counterclockwise to make certain that they never hit the stops in operation and replace them in the transmitter, being careful not to turn the shaft in the process.

(j) Rotate the POWER AMPLIFIER PLATE TUNING control **D** counterclockwise to the zero position, noting that everything operates smoothly and properly.

(7) ADJUSTMENT OF COUPLING RACK IN RF UNIT T-225A/FRT-5.

(a) Plug in amplifier Z805 and allow it to warm up.

(b) The carriage should move to the rear of the cabinet as the POWER AMPLIFIER (PA) LOADING control **E** on the front panel is rotated clockwise toward the "1000" position.

(c) Check operation of the servo drive in ac-

cordance with the procedure outlined in subparagraphs (c) and (d) of paragraph 3 c (3) above.

(d) Remove the drive chain.

(e) Manually set the loading carriage approximately one-quarter of an inch from the limit screw located on the rear of the right track.

(f) Set CONTROL dial **E** at the "1000" mark.

(g) Replace the drive chain.

(h) Rotate the CONTROL dial to the zero position to obtain a minimum coupling, noting that carriage follows smoothly.

(i) Plug in amplifier Z806 and allow it to warm up.

(j) The coil contacts should move to the top of coil as the ANTENNA TUNING coupling control **F** on the front panel is turned counterclockwise toward the zero position.

(k) Check operation of the servo drive unit in accordance with the procedure outlined in subparagraphs (c) and (d) of paragraph 3 c (3) above.

(l) Remove the variable vacuum capacitors C571 and C572 by opening the clamp bands and sliding them out.

(m) Adjust the capacitors to one-quarter turn above minimum capacity.

(n) Set the coil slider contacts so that they just touch the straps at the bottom of the coils. The control dial **F** should read "1000." If necessary, remove the servo motor, set dial **F** at the "1000" mark and re-insert the motor.

(o) Replace capacitors C571 and C572 and turn dial **F** counterclockwise to zero, making sure that the sliding contacts do not jam against the top of the coil.

(8) CHECKING OPERATION OF CONTROL CIRCUITS AND INTERLOCKS.

(a) Set the DELTA-WYE-OFF switch (S401) in Power Control C-587A/FRT-5 in the OFF position and close the CONTROL CIRCUIT breaker (S303).

(b) Turn on the LV AND BIAS circuit breaker (S302).

1. If the doors are closed the bias supply will come on. This is indicated by the green light on the front of RF Unit T-225A/FRT-5.

2. Open each of the doors and the keyer control panel, one at a time, checking each time to see that the bias pilot light goes out when the door is opened but comes on again immediately when the door is reclosed.

3. Check the bias voltage at terminal #33 on terminal strip E303 with an external voltmeter. It should be approximately 400 volts negative to ground.

(c) Set the TUNE-OPERATE switch, S310, on Power Supply PP-490A/FRT-5 to the LV TUNE position.

1. Make certain there is no r-f connection to the transmitter input coaxial connector J1201 and as a further precaution see that the RF EXCITATION control **G** on the r-f bay is turned completely counterclockwise. Also, unless the oscillator is known to be all right, disconnect the d-c supply to the oscillator by disengaging P509 (the single conductor Cannon type connector on the connector board behind the relay rack).

2. Push the PLATE ON button on the upper front door of either RF Unit T-225A/FRT-5 or Power Supply PP-490A/FRT-5 and note that the LV PLATE pilot light on the rectifier bay comes on. The jewel is green. If nothing happens check the BIAS INTERLOCK relay, K307, to see that it has closed properly before testing in the control circuit.

3. Assuming the pilot light comes on and goes off as the PLATE ON and OFF buttons are operated, check the low voltage with an external voltmeter at terminal #36 on terminal strip E303. It should be approximately 600 volts, positive to ground.

4. Manually operate the plunger in any of the overload relays and listen for the sound of a relay opening and closing inside the motor-operated main circuit breaker K401. Repeat this check with all four overload relays, K326, K319, K324 and K325.

(d) Turn the TUNE-OPERATE SWITCH to the HV TUNE position. The sound of the motor-operated main circuit breaker closing will be clearly audible.

(e) Turn the high voltage on and off a few times by means of the PLATE ON and OFF buttons to be sure that the circuit breaker operates every time. Notice the front panel HV PLATE lights on RF Unit T-225A/FRT-5 and Power Supply PP-490A/FRT-5. The jewels are red.

(f) Turn the TUNE-OPERATE SWITCH to the operate position. An audible indication of the operation of the tuning resistor shorting contactor, K402, should be heard within one-half second. If not, adjust the high voltage step-starter interval timer, K318, until this condition is met.

(9) ADJUSTMENT OF THE CRYSTAL OSCILLATOR.

(a) Make certain that the oscillator filament voltage is on. This is indicated by an amber-jeweled FILAMENT pilot lamp. Again turn on the d-c voltage. Using the self-contained meter on the oscillator check the oscillator cathode current. It should be approximately 10 ma. Then check the buffer cathode current.

It should be approximately 35 ma. Switch the CRYSTAL SELECTOR switch to a blank position or in between positions and note that the oscillator cathode current is higher when there is no oscillation. Check each crystal switch position and note that oscillator cathode current is lower than for no oscillation. Check for proper operation of the crystal oven thermostat. The amber-jeweled CRYSTAL HEATER indicator lamp should be lighted periodically while the oscillator is in operation. All 10 crystal sockets in the oven should be tried as a check for proper wiring.

(b) If possible, terminate the output of the crystal oscillator with a 50-ohm carbon resistor and measure the r-f voltage developed across the resistor with a vacuum tube voltmeter. This should be more than 2 volts rms with crystal ranging from 2.0 to 4.3 mc.

(10) ADJUSTMENT OF TIMING RELAYS.

(a) Set the AUTOMATIC SHUTDOWN TIME DELAY timer, K323, for 15 minutes and actuate the AUTOMATIC SHUTDOWN switch, S324, located on the front panel of the power bay. This timer will cause the transmitter to shut off at the end of this period if the transmitter is left turned on but with the key open for the period.

(b) Check that PLATE HOUR meter M305 is operating correctly.

(c) Push the PLATE OFF button and set the NON-AUTOMATIC RESTART INTERVAL timer, K312, for 30 seconds and the AUTOMATIC RESTART INTERVAL TIMER K316 for 10 minutes.

(d) Depress the PLATE ON button and manually operate the plunger in any of the overload relays while the timer K312 is running. The transmitter should go off and lock out.

(e) Set the selector switch of automatic RESTART CYCLE COUNTER S317 to position #3. Depress the PLATE ON button and wait for the NON-AUTOMATIC RESTART INTERVAL TIMER K312 to complete its cycle. Manually operate the plunger in any of the overload relays two times in succession, noting that the plate control circuit recloses after each overload. Check the RESTART CYCLE COUNTER K315 to see if it has stepped to the third contact. The amber OVERLOAD indicator lamps located on the front of each bay should be lighted.

(f) Manually operate the plunger in any of the overload relays once more. The transmitter should shut down and the ALARM horn, I310, should sound. This horn can be turned off by depressing the PLATE OFF button. The NON-AUTOMATIC RESTART INTERVAL timer (K312) should reset.

(g) Push the PLATE ON button and wait 45

seconds; then manually operate the plunger of any of the overload relays twice. The OVERLOAD indicator lamps should be lighted and remain lighted for 10 minutes, the AUTOMATIC RESTART INTERVAL timer (K316) should be running during this time and the RESTART CYCLE COUNTER (K315) should be on the third contact. After 10 minutes have elapsed, the OVERLOAD indicator lamps should extinguish and the RESTART CYCLE COUNTER (K315) should reset.

**(11) ADJUSTMENT OF THE ELECTRONIC
KEYER.**

(a) Connect an external voltmeter to the slider terminal of the TEST KEYING LEVEL control, R568, so that the polarity is negative to ground.

(b) Rotate the INPUT LEVEL and OUTPUT LEVEL controls, R548 and R560 respectively, to their extreme clockwise positions and set the KEYING INPUT FOR MARK control, S502, for NEGATIVE. One of the TEST KEYS (S316 and S521) should be in the closed (up) position.

(c) Set the transmitter for LV TUNE and turn on the d-c supplies. Set the KEYING SELECTOR, S501, to LOCAL.

(d) Adjust the TEST KEYING LEVEL control, R468, with a screwdriver to obtain a reading on the voltmeter of 40 volts dc negative to ground.

(e) Reverse the leads of the external voltmeter and set the KEYING INPUT FOR MARK control, S502, for POSITIVE. The voltmeter should read approximately 30 volts dc positive to ground.

(f) All TEST KEYS should be opened, the KEYING INPUT FOR MARK control, S502, set for POLAR NEGATIVE, and the voltmeter reading noted. It should be positive with respect to ground.

(g) A TEST KEY should be closed, the external voltmeter leads reversed and the reading noted. This reading should be negative with respect to ground and equal in magnitude to the reading with the TEST KEY open.

(b) If the voltages are not equal, steps (f) and (g) should be repeated while the control marked ADJUST C (R573) is adjusted with a screwdriver to equalize the magnitudes of the two readings.

(i) With the voltmeter connected negative to ground, the KEYING INPUT FOR MARK control should be set to POLAR NEGATIVE and the voltmeter reading noted with all TEST KEYS open.

(j) The voltmeter leads should be reversed, the TEST KEY closed and the voltmeter reading noted. This reading should be positive with respect to ground, and equal in magnitude to the reading obtained with the TEST KEY open in step (i), above.

(k) If these voltages are not equal, adjustment of ADJUST B (R570) should be made with a screwdriver while steps (i) and (j) are repeated until the magnitudes of the two readings are equal.

(l) The voltmeter should be connected to the slider terminal of OUTPUT LEVEL control, R560, so that the polarity is negative to ground. The TEST KEY should be in the open position and the KEYING INPUT FOR MARK control set to NEGATIVE. Adjust the OUTPUT LEVEL control until the reading on the voltmeter is 50 volts dc. Closing the key should cause this voltage to drop to approximately zero.

Turn the KEYING INPUT FOR MARK control to POSITIVE. Adjustment of ADJUST A (R554) should be made with a screwdriver to obtain a voltmeter reading of 50 volts dc (key open).

(m) The voltmeter should now read the same for all four positions of the KEYING INPUT FOR MARK control.

(12) TUNING THE TRANSMITTER SO AS
TO PERMIT NEUTRALIZATION OF
THE DRIVER AND PA STAGES.

(a) Through the use of one of the jumpers supplied with the patch panel connect the CRYSTAL OSCILLATOR OUTPUT to the TRANSMITTER INPUT. Turn the DELTA-WYE-OFF switch to WYE position. Place TEST KEY S521 or S316 in the locked key position.

(b) With only the low voltage turned on, with the TUNE-OPERATE switch in the L.V. TUNE position and with the RF EXCITATION control **[G]** turned completely counterclockwise, check the BUFFER and 1st MULTIPLIER GRID current using the EXCITER TEST selector and EXCITER TEST NO. 2 meter. This should be between one and two ma for any crystal frequency between 2.0 mc and 4.3 mc.

(c) Set the transmitter on 26 mc, or the highest frequency at which it will be required to operate, and set up the oscillator and servo tuning system for the frequency. Use the tuning charts supplied for setting up these servo-controlled circuits.

1. Set the EXCITER TEST switch to read 1ST MULTIPLIER CATHODE and 2ND MULTIPLIER GRID.

2. Turn up the RF EXCITATION control **[G]** until either a grid current is indicated or the first multiplier cathode current is in the neighborhood of 20 ma.

3. Tune the 1ST MULTIPLIER PLATE TUNING for maximum 2ND MULTIPLIER GRID current.

4. Set the EXCITER TEST selector to read

2ND MULTIPLIER CATHODE and DRIVER GRID currents.

5. Tune the 2ND MULTIPLIER PLATE TUNING for maximum driver grid current.

6. Set the RF EXCITATION control **[G]** for 6-8 ma driver grid current.

7. Set the EXCITER TEST selector to PA GRID RF PEAK and PA PLATE RF PEAK.

8. Tune the DRIVER PLATE TUNING **[C]** for maximum reading on the PA GRID RF PEAK meter. The maximum indication will be small and may be easily missed so be careful.

(13) NEUTRALIZING THE DRIVER
AMPLIFIER (V504).

(a) Remove the link between terminal #88 on terminal board E312 and terminal #88 on terminal board E318 to disconnect the high voltage from the final amplifier stage. These terminal boards are located on the left-hand wall of the power bay.

(b) Turn the TUNE-OPERATE switch to the HV TUNE position.

(c) Recheck the DRIVER PLATE TUNING **[C]** to make certain that it is adjusted to produce maximum PA grid current and, simultaneously, minimum driver cathode current.

(d) Check for proper neutralization by carefully noting that as the driver PLATE TUNING **[C]** is varied through resonance, the driver grid current and the PA grid current reach their respective peaks simultaneously. If the stage is improperly neutralized note the approximate difference between the dial position at which PA grid current reaches its peak, and that at which the driver grid current reaches its peak. The meter selector switch should be in the EXCITER TEST #2 position.

(e) Open the upper front door of RF Unit T-225A/FRT-5 and adjust the neutralizing control, C519, which is located directly behind the driver tube. There is a lock nut on it which will have to be loosened during the adjustment and tightened again after the adjustment. Close the upper front door.

(f) Once again check for proper neutralization as in step (d) above. Note particularly whether the adjustment has improved the neutralization or not.

(g) If the neutralization has improved, the control was adjusted in the right direction. If the neutralization has become worse, the control was adjusted in the wrong direction. With this as a guide, repeat steps (d) through (f) until the stage is properly neutralized, i.e., until the PA grid current and the driver grid current reach their respective peaks simultaneously.

(h) Adjust the PA BALANCE control located

between the PA tubes, towards the front of the grid box, until the grid voltages are equal in magnitude. Normal grid currents should also be equal.

(i) Recheck the driver neutralization. If it has been upset, repeat steps (d) through (f) until the stage is again properly neutralized.

**(14) NEUTRALIZING THE POWER
AMPLIFIER (V505 and V506).**

(a) With the transmitter still tuned up on 26 mc, as above, and the link disconnecting the high voltage still removed, remove neutralizing capacitors C541 and C542.

(b) Adjust the capacity of each of them to 25 mmf by means of a Q-meter or other equally accurate capacity measuring device.

(c) Replace the capacitors, being careful not to change their adjustment. Both of the indicator scales above the capacitor mounts should be set to the same position.

(d) With TOTAL PA GRID CURRENT between 250 ma and 500 ma, tune the PA plate circuit through resonance by means of the POWER AMPLIFIER PLATE TUNING control and note the effect on the PA grid current. A dip in current will probably be noticed.

(e) Carefully adjust neutralizing capacitors, varying both by the same amount. A counterclockwise adjustment will probably be necessary. Adjust in small increments, each time rechecking for decreasing magnitude of grid current dip. When neutralization is accomplished, the dip will be negligible.

(f) Replace the link which reconnects the PA plate voltage (removed in paragraph 3 c (13) (a)).

(g) Recheck the neutralization with the PA stage lightly loaded, i.e., with about 750 ma of grid current. This is accomplished by turning the POWER AMPLIFIER LOADING control **[E]** to near zero.

(h) Make certain that all stages are resonated, and then turn the DELTA-WYE switch, located in Power Control C-587A/FRT-5, to the DELTA position.

(i) Tune the DRIVER PLATE TUNING control **[C]** for maximum PA grid current. Adjust the POWER AMPLIFIER PLATE TUNING control **[D]** for minimum PA plate current.

(j) Adjust the POWER AMPLIFIER LOADING control **[E]** for approximately 3.4 amps of power amplifier TOTAL PLATE CURRENT. Make certain that the PA plate circuit is tuned to resonance, i.e., for minimum plate current.

(k) Check the individual grid currents of the PA stage for balance, and correct any unbalance by means of the PA BALANCE control. Then check the

individual cathode currents. If the latter are 10 percent or more out of balance, proceed to correct the unbalance as follows:

Interchange the PA tubes (V505 and V506) and again note the direction of unbalance. If the unbalance is reversed from the previous condition it can either be neglected or different tubes may be substituted to effect a closer balance. If, however, this interchanging of the PA tubes has no effect on the cathode current balance, it will be necessary to adjust the plate tank capacitor C569 or C570 for balance. To do this, loosen the clamps on the plate tank vacuum capacitor (C569 or C570) associated with the tube that had the lowest cathode current. Rotate the vacuum capacitor counterclockwise, but not over one-third of a turn, and retighten the clamps. Be careful not to hit the seal-off tip on the glass envelope of the capacitor during this process. Then recheck the balance and repeat the process as many times as it is necessary to bring the cathode into balance.

(15) SUPPRESSION OF 50-MC PARASITIC OSCILLATION. — Although this transmitter when properly adjusted is completely free of parasitic and other forms of spurious oscillations, several measures have been taken to eliminate or prevent their occurrence. The failure or misadjustment of these preventive circuits can, therefore, allow oscillation to occur.

A final amplifier parasitic oscillation and its stabilizing circuit were briefly mentioned in Section 2. This is an oscillation which is in the neighborhood of 50 megacycles. It occurs when excitation is removed with full plate voltage present, as when the key is opened during off-on keying, and may or may not be indicated by high values of plate and grid current. Its presence is indicated by a strong corona discharge emanating from the heads of the screws which fasten the plate tank coil to its Mycalex support. Since these screws are recessed quite deeply into the counterbored holes in the Mycalex, the discharge appears, when seen, to be shooting out from the holes.

This oscillation takes place at 50 megacycles because at this frequency the PA plate tank circuit becomes, in effect, an inductive reactance which balances the capacitive reactance of the PA tubes to form a parallel-resonant circuit equivalent to a 50-megacycle tank. At this frequency plate coils L516 and L517 can be considered as nothing more than r-f choke coils feeding dc to the plates. The capacitive branch of the PA plate tank, however, consists of variable vacuum capacitors C569 and C570 and their lead inductances in series from plate to plate. At 50 megacycles the inductive reactance of this series circuit is greater than the capacitive reactance so that the entire circuit is a plate-to-plate inductive reactance which resonates with

the tube capacity at 50 megacycles. Since the neutralizing circuit is not properly balanced at this frequency because of its series inductance, the feedback through the neutralizing capacitors C541 and C542 exceeds the feedback through the grid-to-plate capacity which was being neutralized so that in effect the stage is over-neutralized, and oscillation inevitably results.

In order to prevent this type of oscillation, an anti-resonant circuit is inserted in series with the neutralizing lead to reduce the neutralizing feedback in the vicinity of 50 megacycles. Parts of these circuits are designated as E523 and E524 in the schematic diagram. They consist of a 63-mmfd ceramic capacitor (C539 or C540) in series with a two-turn coil shunted across a portion of the neutralizing capacitor lead. The "Q" of this circuit is made very low by shunting the two-turn coil with a 50-ohm carbon resistor. To be effective this circuit must be resonant at the same frequency as the previously described circuit in the plate. Unfortunately, however, this plate-to-plate circuit through the tank capacitors varies in frequency as the plate tank tuning capacitors are varied. It covers a frequency range that is approximately 48 to 58 megacycles. This trap circuit in the neutralizing leads must, therefore, be effective across this full frequency range. It has been found by experiment that if the fundamental resonance of the trap is approximately 50 megacycles it will be quite effective. Occasionally, however, due to minor variations in components, the trap circuit may be too high or too low in frequency so that this type of oscillation may occur at either the four-megacycle or the 26-megacycle end of the frequency range of the transmitter. Generally speaking, trouble is most likely to occur at the four-megacycle end. If this happens, it simply means that the resonant frequency of these trap circuits must be lowered slightly. This can be done either by increasing the inductance of the two-turn coil by closing the spacing between turns or by increasing the capacity in series with this coil by a small amount.

There are no other forms of parasitic oscillation which are not the result of improper neutralization. Operation should be very carefully observed during manual keying after tuning up to make certain that when the key is opened there is a clean, smooth interruption of the carrier. Pips or other spurious emissions during this interval are indications that something is wrong and should be corrected, as the transmitter when properly adjusted is absolutely free of such emissions. The off-on keying circuit is subject to a minor form of transient operation which can produce a small pip following interruption of the carrier if the damping circuit is not effective. This circuit consists of R569 and C505 in series across the keyer output to

ground. If such pips are observed, it is wise to check resistor R569 to make certain that it is the proper value and has not failed.

(16) ADJUSTMENT OF VACUUM TUBE VOLTMETERS (Z1303 and Z1304).

(a) Tune the transmitter for four-mc operation.

(b) Turn POWER AMPLIFIER LOADING control **[E]** on RF Unit T-225A/FRT-5 to minimum coupling.

(c) With the power amplifier unloaded, voltmeters Z1303 and Z1304 are adjusted so that the meter readings are alike, and so that each is equal to about 90 percent of the d-c voltage applied to the plates of the PA tubes. This adjustment is made by varying the capacitor C1309 in each of the voltmeter circuits.

(d) By operating the POWER AMPLIFIER LOADING control **[E]**, adjust the drive to the antenna for optimum value.

4. MAINTENANCE AND ADJUSTMENTS.

a. RELAYS AND CONTACTORS. — Before servicing relay or contactor contacts, clean the exterior with a dry or slightly damp lintless cloth. If it is very dirty, clean it with a cloth or brush dipped in carbon tetrachloride. Then wipe the surface with a dry cloth to remove the white deposit left by the solvent when it dries. If loose connections are found, they should be inspected. If inspection shows them to be dirty or corroded, they should be removed and cleaned, and then carefully replaced.

Hard alloy contacts are cleaned by drawing a strip of clean wrapping paper between them while holding them together. It may be necessary, in some cases, to moisten the paper or paper strips if it is used for polishing. Corroded, burned or pitted contacts should be dressed with a crocus cloth strip or a burnishing tool.

CAUTION

Never use highly abrasive materials, such as emery cloth, coarse sandpaper or carborundum paper, for surfacing relay contacts. They will damage the surface.

Solid silver contacts are easily cleaned with a rag or brush dipped in carbon tetrachloride. After being cleaned, the contacts are polished with a dry cloth. Dress corroded contacts first with crocus cloth, using either a stick or a strip of the material. When all of the corrosion has been removed, wipe with a clean cloth moistened with carbon tetrachloride and polish

with a piece of folded cloth. Make certain that the shape of the contact has not been altered from the original. Dress burned or pitted contacts, if necessary, with #000 sandpaper, making certain that the shape of the contact is not changed. Then smooth the surface with crocus cloth. After a high polish is obtained, wipe thoroughly with clean cloth, using carbon tetrachloride when necessary.

Note

The brown discoloration found on silver and silver-plated contacts is silver oxide and is a good conductor. It should be left alone unless the contacts must be cleaned for some other reason. It can be removed at any time with a cloth moistened with carbon tetrachloride.

Clean silver-plated contacts with a cloth or brush dipped in carbon tetrachloride. After cleaning, polish the contacts with a dry cloth. Dress corroded contacts first with crocus cloth. The work must be done very carefully so as not to remove an excess amount of silver plating. When all the corrosion has been removed, polish with cloth. Make certain that the shape of the contact has not been changed. Dress contacts after burned or pitted spots are removed. This may require an appreciable amount of time, but is preferable to the use of a file or sandpaper. If crocus cloth does not remove the burns or the pits, use a sandpaper tool very carefully. If sandpaper is used, follow with crocus cloth to polish the contacts, wipe thoroughly with a cloth moistened with carbon tetrachloride and dry with a clean cloth.

Note

The pole faces of the undervoltage release magnet in circuit breaker K401 must be kept clean.

Accumulated foreign matter on these faces may cause them to stick together and so prevent release of the breaker when the PLATE POWER-OFF button is pushed. This condition would be revealed by continued burning of the external red indicator lamp after the front panel lamps are extinguished. If the relay should stick, a slight jarring of the breaker will usually release it. However, the pole faces should be inspected immediately and cleaned with carbon tetrachloride.

An alternate means of tripping the breaker is provided by the over-current trip coils. These are energized by mechanical interlocks

which short-circuit the high voltage supply to ground when either power supply door is opened.

b. MAIN CIRCUIT BREAKER (K401).

(1) GENERAL. — Type AB "De-ion" circuit breakers (figure 7-9) are small, completely enclosed devices equipped with "De-ion" arc chambers and interchangeable trip units. The "De-ion" chambers permit interruption of short circuit currents without outward disturbance due to arcing.

The trip units are calibrated at the factory for a certain current rating and will carry 100 percent of this rating continuously. They will permit small over-currents to continue for short periods of time, but will positively trip out on sustained over-currents of 125 percent of the rating or more. On short-circuit currents they will trip out instantaneously. The current above which instantaneous tripping will occur is adjustable by means of lever "L" located on the trip unit inside the breaker.

The power amplifier breaker (K401) is adjustable from 400 to 1200 amperes.

Generally speaking, these adjustments are to be set to as low a value as will allow the power supply to be turned on the majority of the time without being tripped out immediately by the inrush current. An occasional trip-out due to inrush current is to be expected and is, in fact, a good indication that the breaker is working properly. The trip-out point for the PA breaker (K401) should therefore be adjusted for a value at or near the low current (400 amperes) rating. This breaker is motor-operated and functions when one of the PLATE ON buttons is depressed. It also contains an undervoltage release coil which causes the breaker to trip out as soon as the applied voltage becomes too low.

(2) DISASSEMBLY. — To gain access to the interior of one of these motor-operated breakers, it is necessary to remove the three nuts (two at the top and one at the bottom) which hold the motor mounting plate on the breaker. The metal projection, which engages the motor and is attached to the trip handle, is detached by removing the two screws which secure it to a bakelite projection from the breaker unit. Once these have been removed, the bakelite cover must be removed by removing the four screws located one in each corner. Complete access may then be gained to the inside of the breaker.

(a) TO REMOVE TRIP UNITS. — Throw breaker to the open position, take off the bakelite cover as described above, and then remove the load

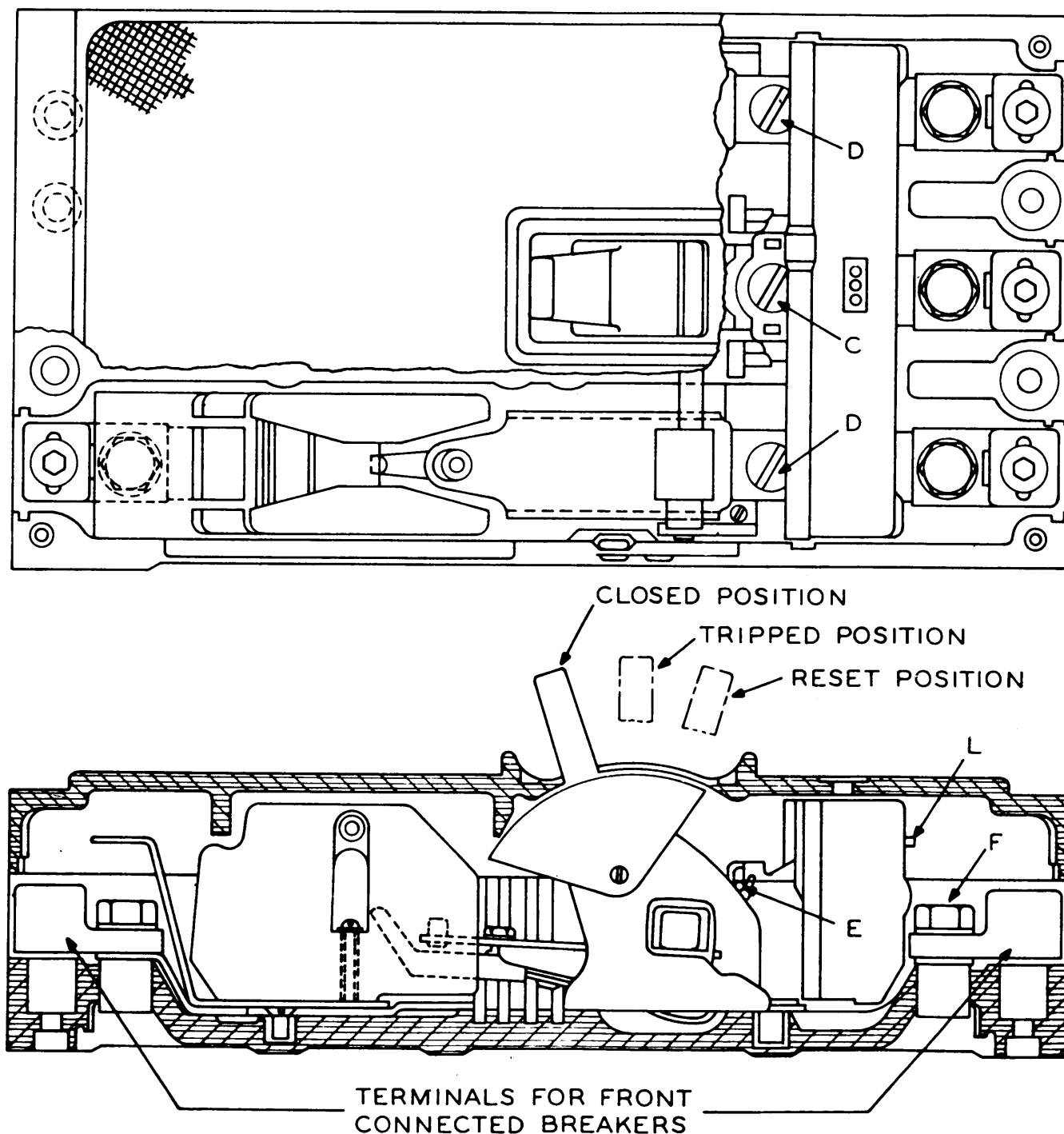
terminal studs "F" and screws "C" and "D", after which the trip unit can be lifted out of the frame.

(b) **TO INSTALL TRIP UNITS.** — Place trip unit in the frame as shown in figure 7-9, making sure that the ends of the pin in the trip unit bracket sit in the slots on the mechanism at "E". First screw "C" and then "D" firmly in place. Screw "C" is provided with a plain and a lock washer and is removable.

(c) **TO REMOVE AND INSTALL UNDERVOLTAGE RELEASE COIL.** — Before attempting to

remove the undervoltage release coil, the cover plates must be removed as described above. The undervoltage release coil is seen on the right-hand side of the breaker. It is removed by taking out the two screws which extend upward through part of the frame of the breaker into the undervoltage release coil assembly. The coil is then slipped straight out.

(3) **ADJUSTMENT OF MAIN CIRCUIT BREAKER.** — Circuit breaker K401 operates in the same manner as all "De-ion" breakers in that once the



Figur 7-9. Outlin Drawing — Motor Operated Circuit Br ak r, K401

mechanism is tripped, it is necessary to operate the handle to a position beyond the OFF position in order to reset them. Since these breakers are motor-operated, the mechanism is designed to move the breaker handle past the normal OFF position before throwing it to the ON position, which means that, in this installation, the resetting operation will take place every time the equipment is turned on.

c. **SERVICING THE AIR FILTERS.** — The filters on the rear of Power Supply PP-490A/FRT-5 and RF Unit T-225A/FRT-5 cannot be cleaned and must be replaced when they become too dirty to operate properly.

5. REPLACEMENT OF COMPONENTS.

a. **GENERAL.** — The replacement of the majority of components in this equipment requires no special treatment; however, there are a few components which are included in the spare parts and which do require a short explanation. These parts are listed in the parts list (table 8-4) with a letter following their symbol designation, e.g., K301A, L516B, etc. The following paragraphs explain briefly the procedure for replacement of these particular parts.

b. **BLOWER ASSEMBLIES.** — The spare parts associated with the blowers include extra V-belts, spare motors, and spare sleeve bearings for the impeller shaft. To replace the V-belt, it is necessary to remove the two screws holding one of the bearing assemblies, and slip the bearing off of the shaft. It is then possible to remove the old belt and replace it with the new one. To replace one of the blower motors, it is necessary to remove the entire blower assembly from the cabinet. This assembly is taken out by removing the four nuts holding it to the floor of the unit, and slipping the entire assembly out of the cabinet. The motor may then be removed by taking out the four bolts holding it to the blower assembly.

c. **CAPACITORS.** — There are a number of capacitors which have end caps, a lead screw assembly and bearings fastened to them. These include C526, C569, C570 and C571. When replacing one of these parts, remove the defective one and take off the end cap, the lead screw assembly and the bearing. Fasten these components on the replacement part and install the latter in the unit.

d. **RELAY COILS AND CONTACTS.** — The spare parts include spare contacts and coils for nearly all of the relays in the equipment. The relays are all quite similar and an explanation of the procedure to be followed in replacing the contacts and the coil on one of the relays should suffice for all of them. As an example,

take relay K301. This particular relay has four normally open contacts mounted on one bakelite strip, and three normally open contacts mounted on another bakelite strip, both strips being mounted on the left-hand side of the relay. These bakelite strips are mounted by means of two screws which extend through the strips downward into the relay frame. Should the contacts on one of these strips become damaged to the extent that replacement is indicated, take out the two mounting screws and remove the bakelite strip which mounts the defective contacts. Insert the replacement part in its place and secure it to the relay frame. The center contacts on the relay are held in place by a spring loading arrangement. They may be removed by twisting them a quarter turn in either direction and then lifting upward.

To replace one of the relay coils, first remove the wires which connect to it. Next take out the screw which is located on the upper part of the plunger immediately above the core of the coil and then remove the spring from the back of the plunger. This allows the plunger to drop out. Remove the screw located immediately above the relay coil, and slip the coil out. To insert the new coil reverse the procedure given above.

e. **COIL CONTACTS AND SHORTING BARS.** — The spare parts include the shorting bar for the PA plate tank coil and the "U" and "C" shaped coil contacts.

To replace the "U" and "C" shaped contacts on either the PA plate tank or the PA coupling coils, it is necessary first to remove the shorting bar. This may be done by rotating the bar to the very top of the coil and then removing the single screw which holds the shorting bar to the rotating center post. When this is done, rotate the bar the remainder of the distance until it is free of the coil. The upper "U"-shaped contact is connected to the bar by means of a flat strap pigtail. The lower "U"-shaped contact can be removed with a pliers or other suitable tool. The "C"-shaped contacts are removed by putting a screwdriver or other instrument underneath the flange of the contact and prying it off of the shorting bar.

f. **CHAIN REPAIR.** — Chain repair kits are provided in the spare parts box. There are two types of chains in the equipment and the chain repair kits contain material for the repair of either type. To remove a defective link or section of chain, the heads of the pivot pins at each end of that link, or section, must be ground off. Because this process usually damages the side plates, extra side plates are included. The replacement link or length of chain is to be taken from the long lengths of chain which are contained in the repair kit. After locating the replacement link, or length of

chain, in its place in the original chain, substitute new side plates wherever the old ones have been damaged and insert new pivot pins to complete the assembly. Finally, head up the ends of the pins so they will not slip out.

g. ANTENNA METER IN-OUT SWITCH. — Spare stators for switches S505 and S506 are included in the spare parts. When the stator of any of these switches is in need of repair or replacement, it is removed by taking out the two screws which hold it in place. The new stator is then put in place and secured by means of the same two screws.

b. MAIN CIRCUIT BREAKER BRUSHES. — Contained in the spare parts are replacement brushes for the reclosing motor on breaker K401. To change these brushes unscrew the small black knobs which are located on either side of the breaker motor. This will reveal a small spring which is attached to the brush. Remove the defective brush by pulling this spring from the hole. Insert the replacement brush, and then replace the small black bakelite knob.

6. DISCARDING ELECTRON TUBES.

In the course of shooting trouble in the equipment, it may be necessary to replace a defective or inoperative electron tube. It should be borne in mind, however, that the tube is a vital part of the equipment and that, often, no field substitute is available. Therefore, before discarding any electron tube, the technician should make very sure that replacement is the only remedy for the trouble. The tube should be checked in a standard tube tester or in actual operation, and should be discarded only if it shows one or more of the following faults:

- a.** Low emission: sufficient to prevent minimum efficient operation.
- b.** No filament continuity.
- c.** Microphonics: noise interference with operation.
- d.** Shorted element.
- e.** Intermittent shorts: erratic operation and interruption of transmission.

When it is definitely ascertained that the tube is valueless and requires replacement, observe the following rule: "ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK."

7. TUBE CHARACTERISTICS.

The operating characteristics of all tube types used in the AN/FRT-5A equipment are summarized in table 7-4 below.

8. CRYSTAL DATA.

a. RF OSCILLATOR O-91A/FRT-5.

(1) 100-KC CRYSTAL (Y101).

(a) CIRCUIT RANGE: (Refer to figure 2-6.) — The r-f oscillator crystal circuit is designed for 100-kc crystal operation only.

(b) STABILITY. — The crystal frequency variation over a temperature range of -20°C to $+60^{\circ}\text{C}$ (-4°F to $+140^{\circ}\text{F}$) will not exceed ± 0.0003 percent.

(c) OVEN TEMPERATURE: The 100-kc crystal operates in an oven temperature of $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$).

(2) 100-kc HOLDER AND OVEN.

(a) CRYSTAL MOUNTING: The crystal is metal-plated and suspended on wires in the holder. A conductive bonding material is applied at the point of contact of the suspension wire to the plating on the crystal plate.

(b) DIMENSIONS OF OVEN.

- 1. Diameter 3.750 inches
- 2. Length, less mounting pins 4.625 inches
- 3. Length, including mounting pins 5.4375 inches

(c) NUMBER OF MOUNTING PINS 7

(d) PIN CONNECTION:

- 1. heater
- 2. ground
- 3. crystal
- 4. no connection
- 5. crystal
- 6. thermostat
- 7. thermostat and heater junction

b. RF OSCILLATOR O-92A/FRT-5.

(1) JAN TYPE CR-27/U CRYSTAL (Y1101-Y1110).

(a) CIRCUIT RANGE: (Refer to figure 2-2.) — The r-f oscillator crystal circuit is designed to operate over a frequency range of 2000-4300 kilocycles.

(b) INITIAL ACCURACY: ± 0.0005 percent of nominal frequency at 70° ($\pm 1^{\circ}$) C ($+158^{\circ}\text{F}$).

(c) OVEN TEMPERATURE: 70° ($\pm 1^{\circ}$) C ($+158^{\circ}\text{F}$).

(d) FREQUENCY TOLERANCE: ± 0.0002 percent of nominal frequency when measured at 70° ($\pm 1^{\circ}$) C ($+158^{\circ}\text{F}$).

(2) JAN TYPE CR-27/U CRYSTAL HOLDER.

(a) CRYSTAL MOUNTING: The JAN TYPE CR-27/U crystal is a metal-plated crystal wire-mounted in a metal holder. A conductive bonding material is applied at the point of contact, of the suspension wire to the plating on the crystal plate.

(b) DIMENSIONS OF HOLDER:

1. Depth 0.340 inch
 2. Width 0.750 inch

3. Length 0.982 inch
 4. Number of mounting pins 2
 5. Pin spacing 0.486 inch

TABLE 7-4. TUBE CHARACTERISTICS

JAN TUBE TYPE	FILAMENT VOLTAGE (VOLTS) (NORMAL)	FILAMENT CURRENT (AMPS) (NORMAL)	PLATE VOLTAGE (VOLTS) (MAXIMUM)	GRID BIAS (VOLTS)	SCREEN VOLTAGE (VOLTS) (MAXIMUM)	PLATE CURRENT (MA) ¹	SCREEN CURRENT (MA)	AC PLATE RESISTANCE (OHMS)	VOLTAGE AMPLIFICATION FACTOR (MU)	TRANSCON- DUCTANCE (MICROMHOS)
OA2			150			30				
OB-3/VR-90			90			40				
2C51	6.3	.3	300			10.5			44	6500
3B28	2.5	5	5000 ³			2000 ⁴				
3X2500A3*	7.5	48	5000 ²	—400		2000 ²		1,000	20	20,000
4B32	5.0	7.5	10000 ³			5000 ⁴				
4-400A*	5	14.5	4000 ²	—500 ²	600 ²	350 ¹	45			4000
5R4GY	5	2	2800 ³			650 ⁴				
5686*	6.3	.35	250	—15	250	40	15			
6AG7	6.3	.45	330	—0.2	330	10	2.5	75,000	6750	9000
6AG7	6.3	.45	300	—0.2	150	10	2.5	75,000	6750	9000
6AK5	6.3	.175	200		155	20 ¹	4	420,000	1800	5100 ¹
6AK5 (W)	6.3	.175	180		140	7.7	2.4	690,000	3500	5100
6AL5 (W)	6.3	.3	420 ³			54 ⁴				
6AS6	6.3	.19	200		150	9	6			4500
6BA6	6.3	.3	300	—20	125	11	4.2	1.5 meg		4400
6BE6	6.3	.3	300	—1.5	100	3	7.1	1.0 meg		475
6C4	6.3	.45	300	—40 ²		15 ²				
6SJ7	6.3	.3	300	—3	125	3	0.8			1650
6X4	6.3	.6	1250 ³			210 ⁴				
807	6.3	.9	600	—90	300	100	6.5	50,000		6000
807	6.3	.9	600 ²	—200 ¹	300 ²	500 ²	6.5 ²	50,000		
12AU7	6.3	.3	330	—8.5		10.5		7,700	17	2200
12AX7	6.3	.3	300	—50 ¹		1.2		62,500	100	1600

* Not a JAN type.

¹ Maximum values.² C.W. telegraphy only.³ Maximum peak inverse plate voltage.⁴ Maximum peak value.

TABLE 7-5. WINDING DATA

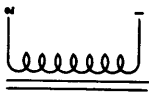
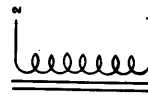
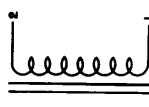
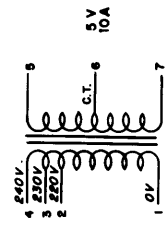
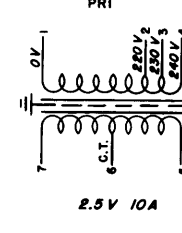
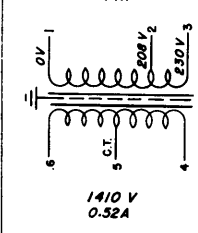
DESIGNATION SYMBOL	MANUFACTURER'S PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	IMPEDANCE RATIO	TEST VOLTAGE
L301	Federal Telephone and Radio FT-04-2380-12C		Single	#13 square DCC	900	3.84		12,000
L302	Chicago Transformer #12645-A		Single	#21	1501	18.95		
L303	Chicago Transformer #9825		Single	#22	1851	30.6		
T301 thru T306	Chicago Transformer #12635		Primary Filament #1	#27 #12 sq.	842 19	23.06 0.0226		2500 15,000
T307	Chicago Transformer #9753		Primary Filament #1	#31 #13	1350 16	70.3 0.026		2500 10,000
T309	Chicago Transformer #9754-A		Primary High Voltage	#17 #23	375 2360	1.35 50.4		2500 3000

TABLE 7-5. WINDING DATA (Cont'd)

DESIGNATION SYMBOL	MANUFACTURER'S PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	IMPEDANCE RATIO	TEST VOLTAGE
T310	Chicago Transformer #12634-A		Primary Secondary	#16 SCE #21	398 1684	1.4 17.7		2500
T311, T312,	Sola Electric #6040		Primary #1 Primary #2 Primary #3	#19 SVE #20 SVE #17 SVE	440 129 700			
T401	Westinghouse #SO-19-U-230		L.V. Winding H.V. Winding	0.102" x 0.365" rectangular copper strap 0.072" (#13) round copper	64 per phase 704 per phase	0.0857 (Total for 3 phase) 13.60 (Total for 3 phase)		

TABLE 7-5. WINDING DATA (C n't'd)

DESIGNATION SYMBOL	MANUFACTURER'S PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	IMPEDANCE RATIO	TEST VOLTAGE
T502, T901	Chicago Transformer #6504-A		Primary Filament #1	#28 #13 SCE	1320 36	38.8 0.048		2500 2500
T503	Chicago Transformer #9762		Primary Filament #1	#26 #13 SCE	760 17	18.5 0.013		2500 2500
T505, T506	Fed. Tele. & Rad. FT-04-2382-12C		Primary Filament #1	#14 E 2 x #6 sq. DCC	245 12	0.75 0.024		2500 5000
T801	Fed. Tele. & Rad. FT-07-2385-2C		Primary Secondary #1	#33 E #44 SF	2 x 475 2 x 6000	18.3 x 2 3740 x 2		1600 500

TABLE 7-5. WINDING DATA (Cont'd)

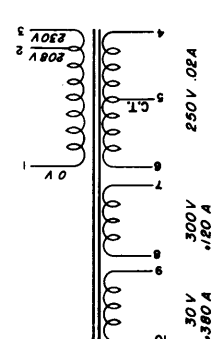
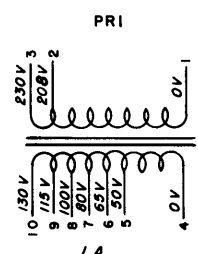
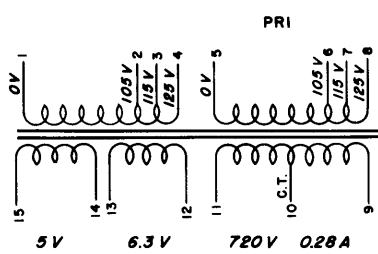
DESIGNATION SYMBOL	MANUFACTURER'S PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	IMPEDANCE RATIO	TEST VOLTAGE
T902	Chicago Transformer #12874		Primary	#27	974	29.33		2500
			Secondary #1	#38	1994	596		2500
			Secondary #2	#32	1403	111		2500
			Secondary #3	#27	142	4.9		2500
T903	Chicago Transformer #12875		Primary	#21	550	4.0		2500
			Secondary	#21	326	3.35		2500
T1001	Audio Development #A6522		Primary	#22 en	336	4.3		1500
			Secondary #1	#26 en	990 tapped at 495	39		1500
			Filament #1	#16 en	7	0.016		1500
			Filament #2	#15 en	9	0.016		1500

TABLE 7-5. WINDING DATA (Cont'd)

DESIGNATION SYMBOL	MANUFACTURER'S PART NO.	DIAGRAM	WINDING	WIRE SIZE	TURNS	DC RESISTANCE IN OHMS	IMPEDANCE RATIO	TEST VOLTAGE
T1002	Audio Development #A6523		Primary Secondary #1 Filament #1 Filament #2	#23 en #28 en #16 en #22 en	420 1280 tapped at 640 11 11	7.8 78 .022 .095		1500 1500 1500 1500
T1101	Chicago Transformer #11329		Primary Filament #1	#31 #27 #18	654 608 74	53.4 0.282		2500 2500

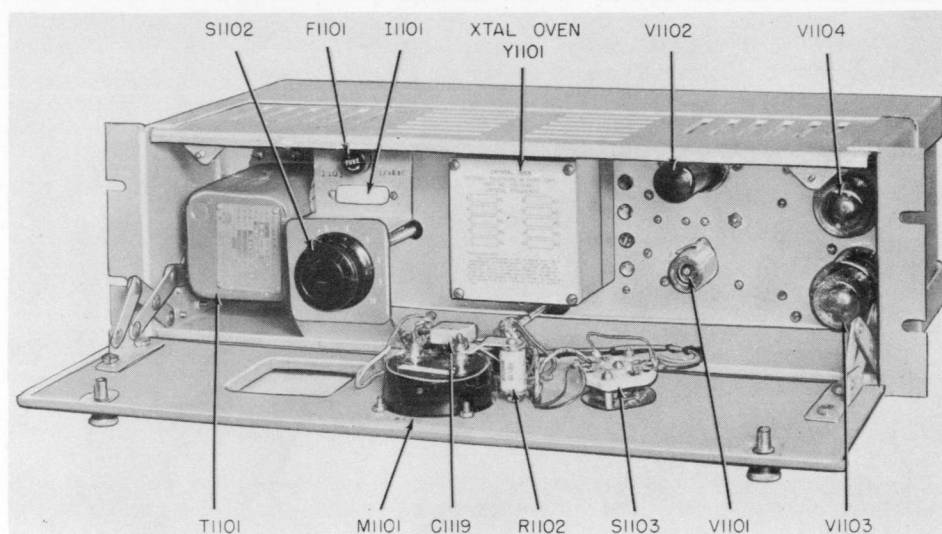


Figure 7-10. RF Oscillator O-92A/FRT-5, Front View, Hinged Panel Lowered

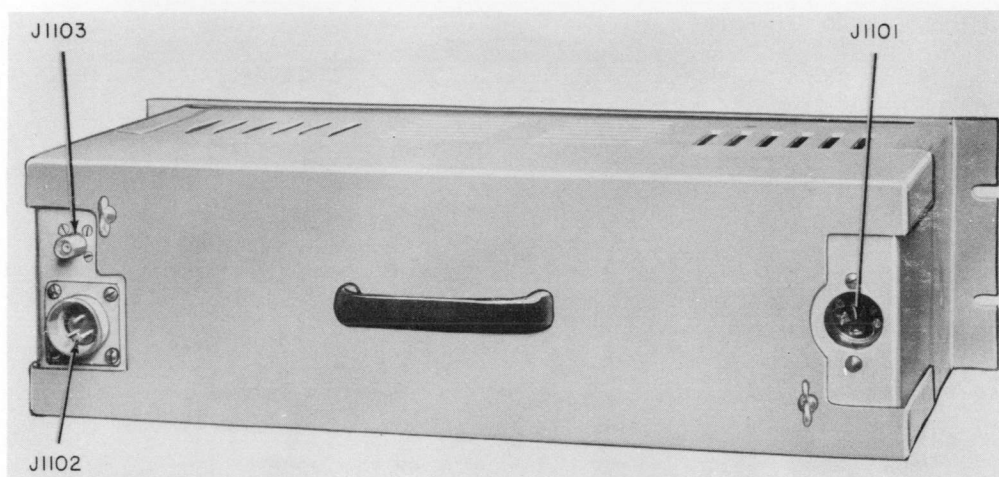


Figure 7-11. RF Oscillator O-92A/FRT-5, Rear View

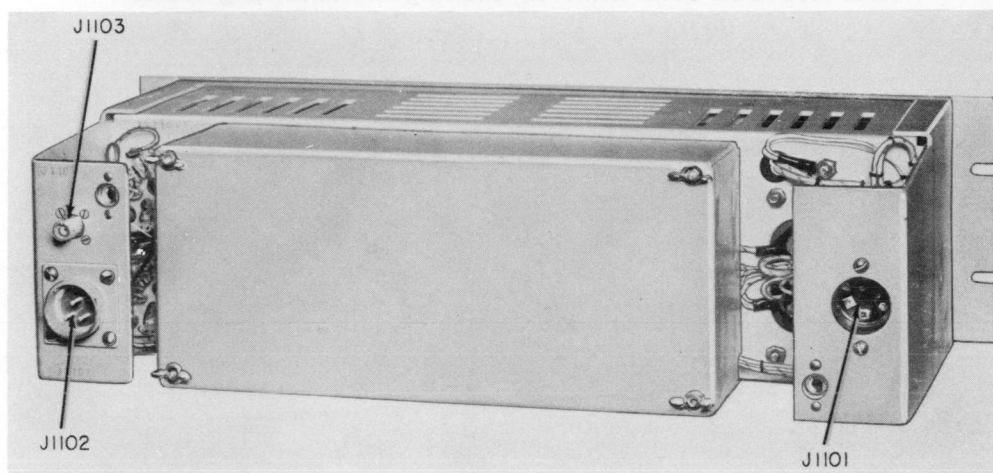


Figure 7-12. RF Oscillator O-92A/FRT-5, Rear View, Outer Dust Cover Removed

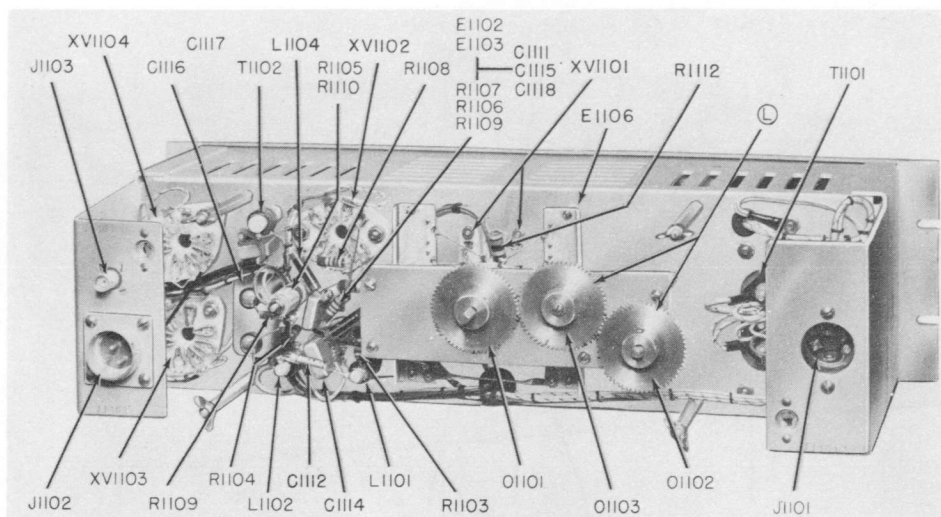


Figure 7-13. RF Oscillator O-92A/FRT-5, Rear View, Both Dust Covers Removed

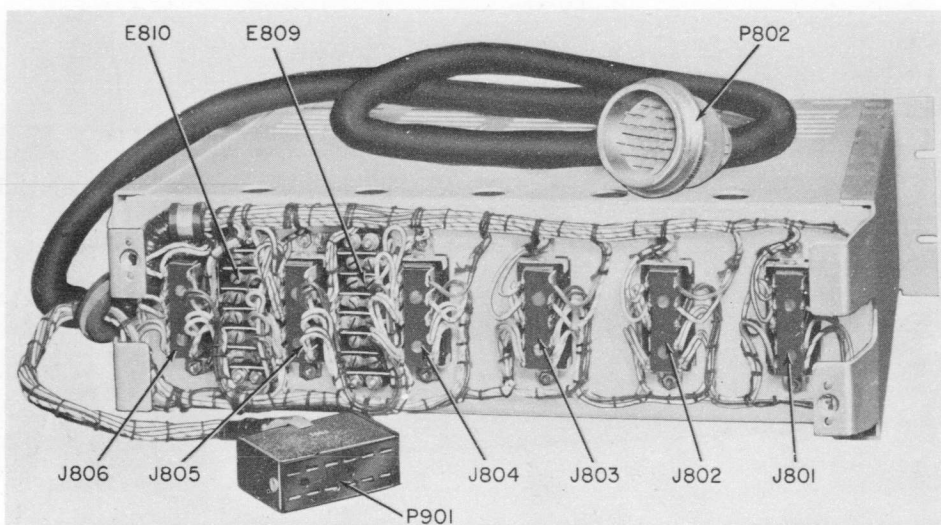


Figure 7-14. RF Unit T-225A/FRT-5, Servo Amplifier Mounting Cabinet, Rear View, Dust Cover Removed, Showing Interconnecting Cables

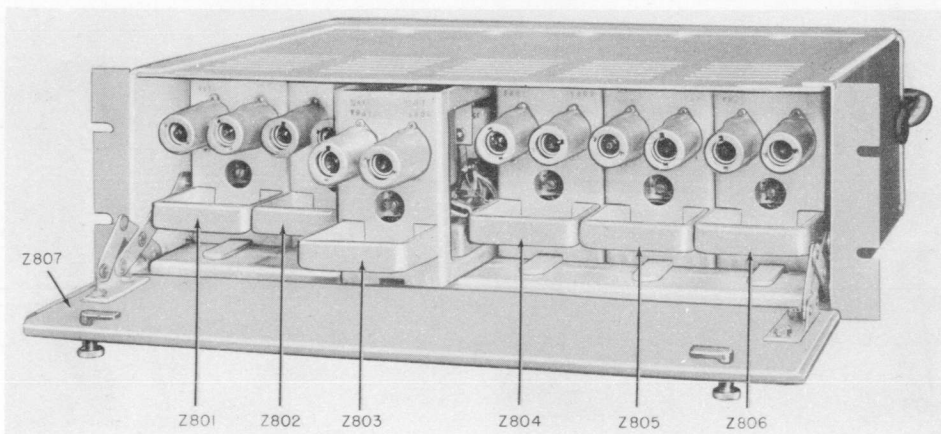


Figure 7-15. RF Unit T-225A/FRT-5, Servo Amplifier Mounting Cabinet, Front View, Hinged Panel Lowered to Show Six Plug-in Units

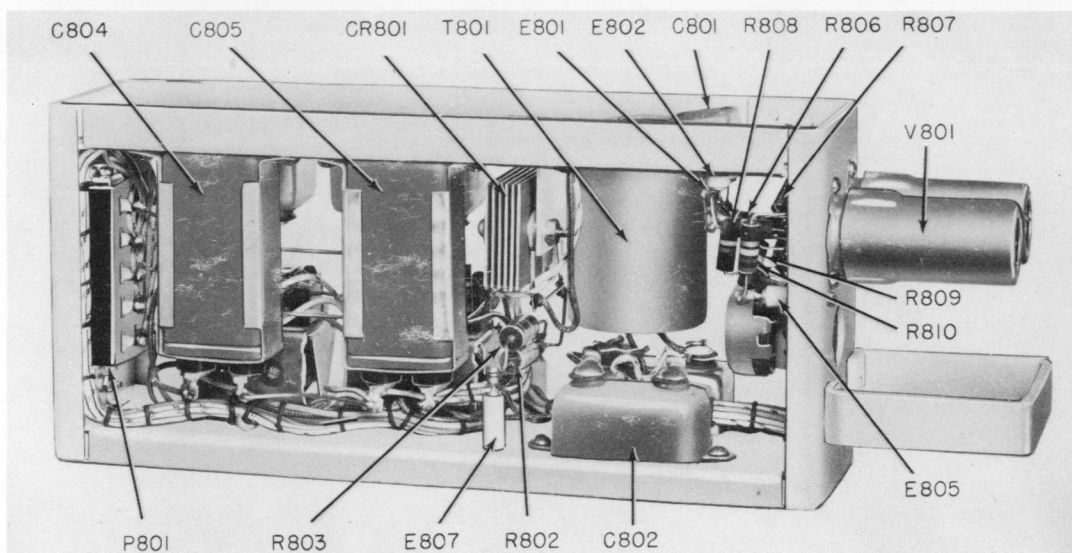


Figure 7-16. RF Unit T-225A/FRT-5, Servo Amplifier Unit, Left Side View

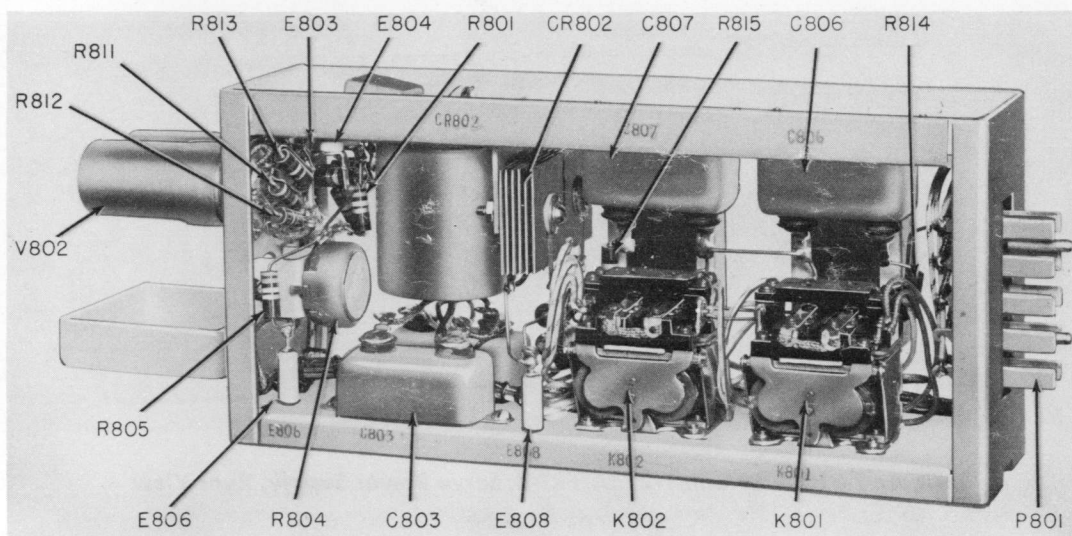


Figure 7-17. RF Unit T-225A/FRT-5, Servo Amplifier Unit, Right Side View

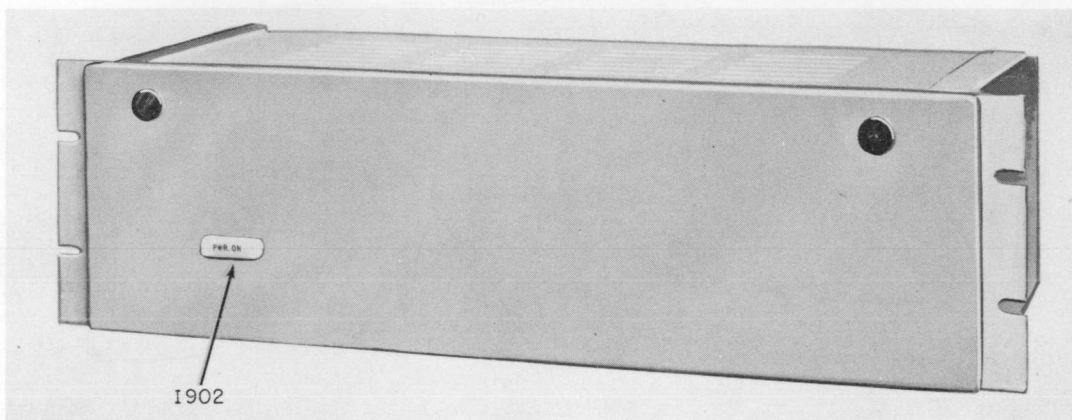


Figure 7-18. RF Unit T-225A/FRT-5, Servo Power Supply, Front View

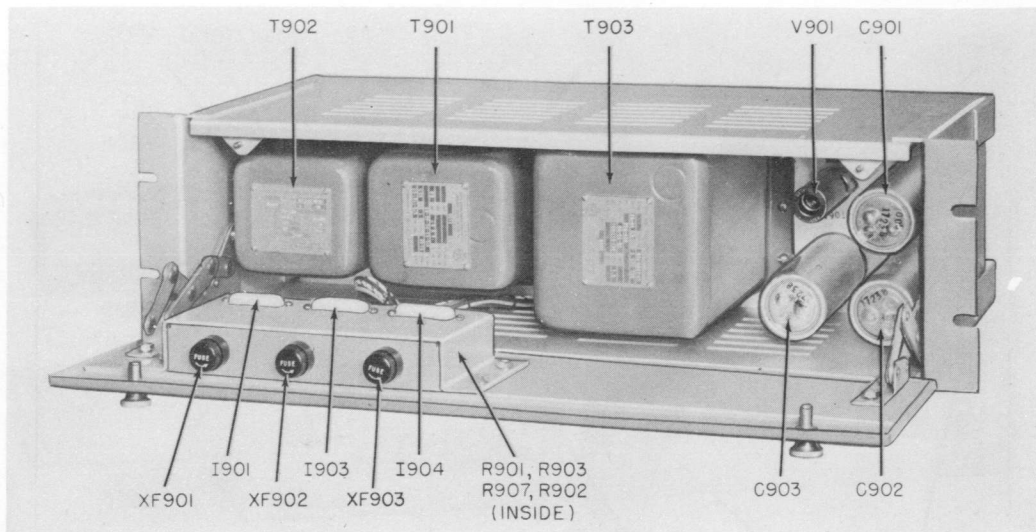


Figure 7-19. RF Unit T-225A/FRT-5, Servo Power Supply, Front View,
Hinged Panel Lowered

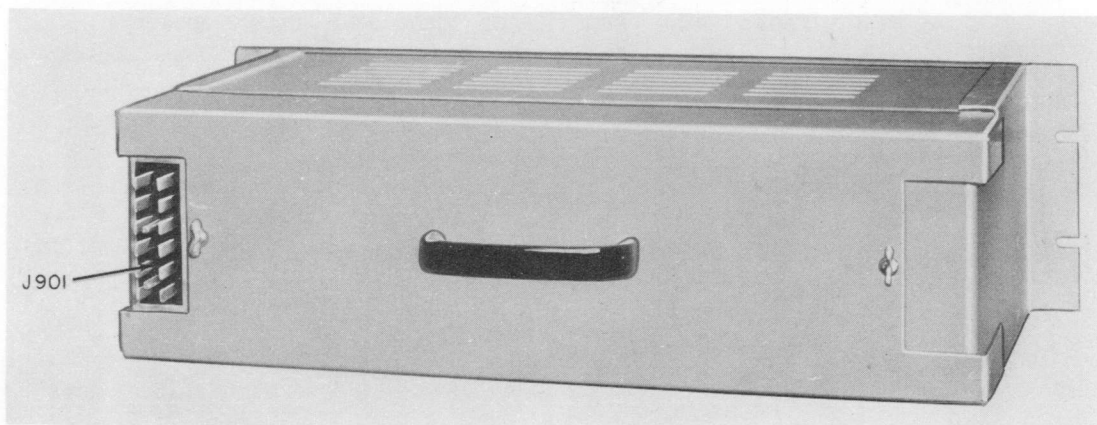


Figure 7-20. RF Unit T-225A/FRT-5, Servo Power Supply, Rear View

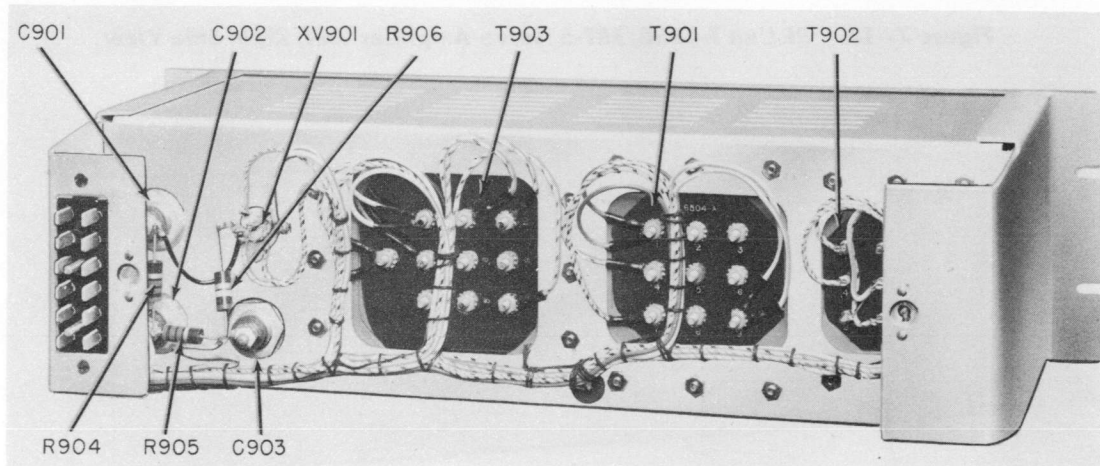


Figure 7-21. RF Unit T-225A/FRT-5, Servo Power Supply, Rear View,
Dust Cover Removed

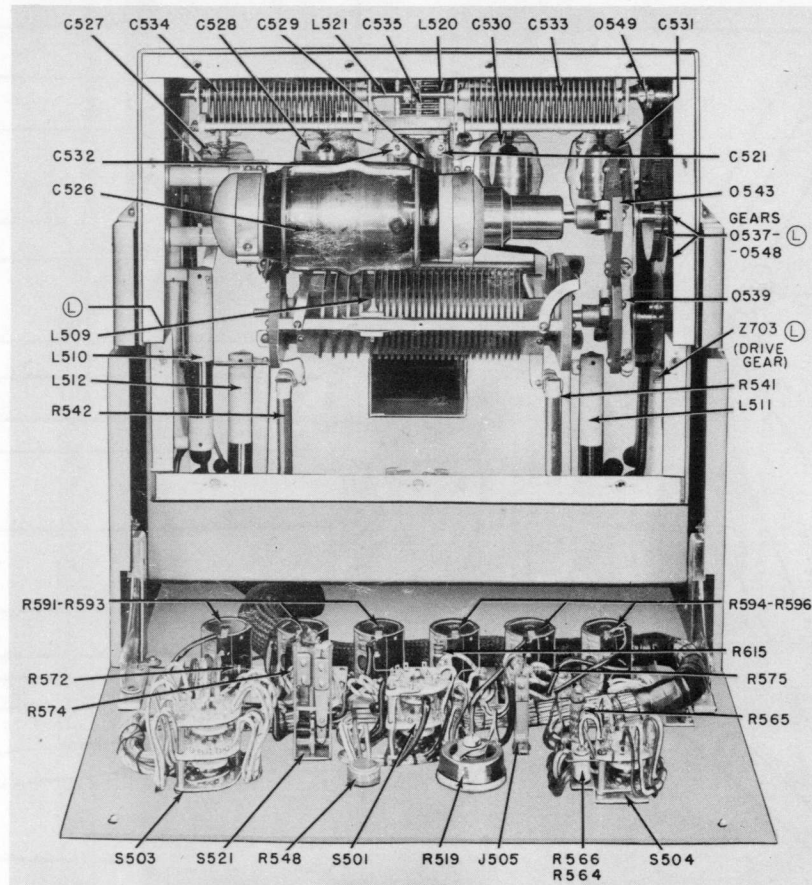


Figure 7-22. RF Unit T-225A/FRT-5, View of PA Grid Compartment and Control Panel, with Grid Shield Removed and with Panel Lowered forward on Hinges to Show Components on Rear

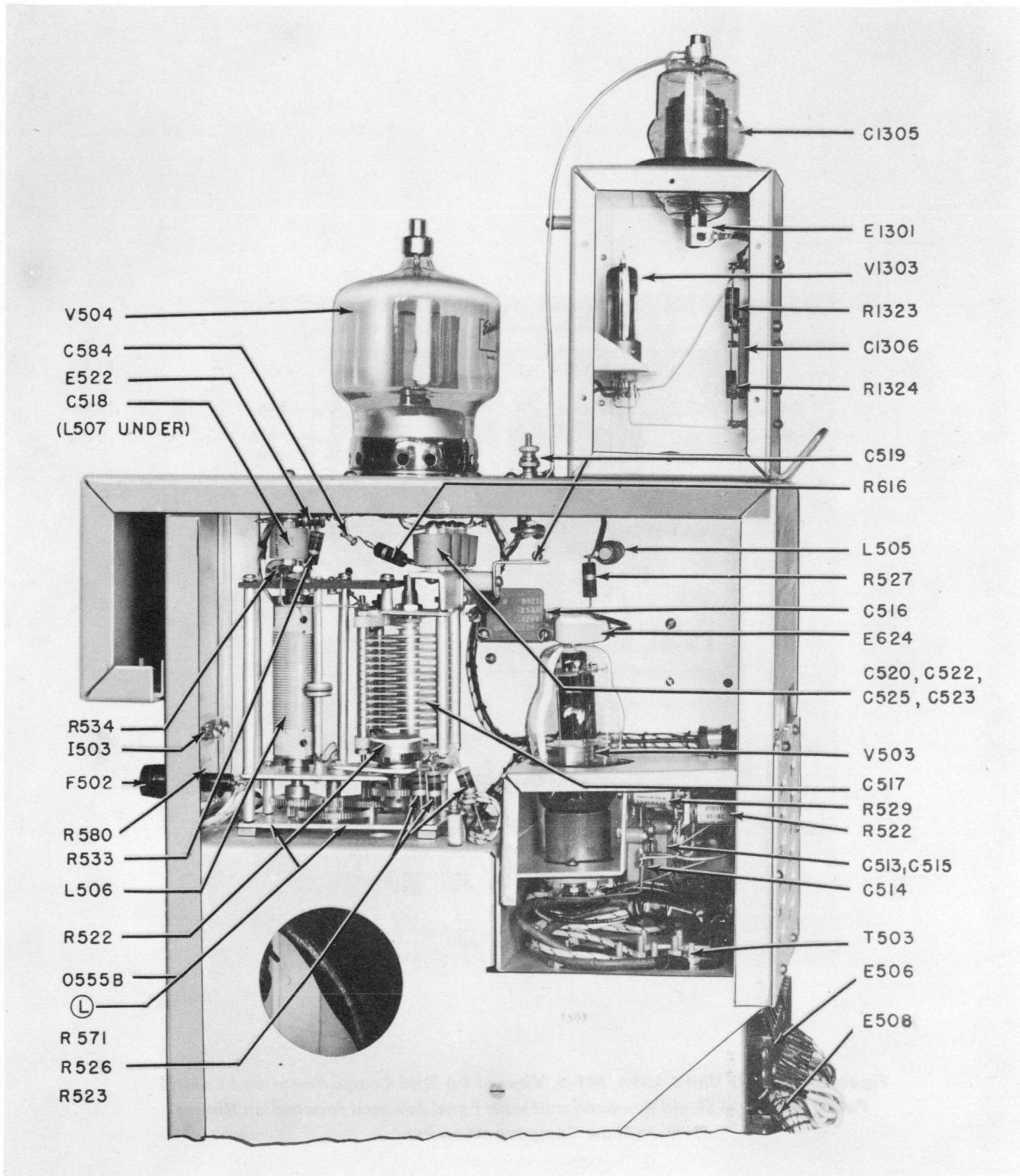


Figure 7-23. RF Unit T-225A/FRT-5, Multipliers and Driver Unit, Right Side View, Cover Plate Removed from P.A. Grid Voltmeter (Z1301)

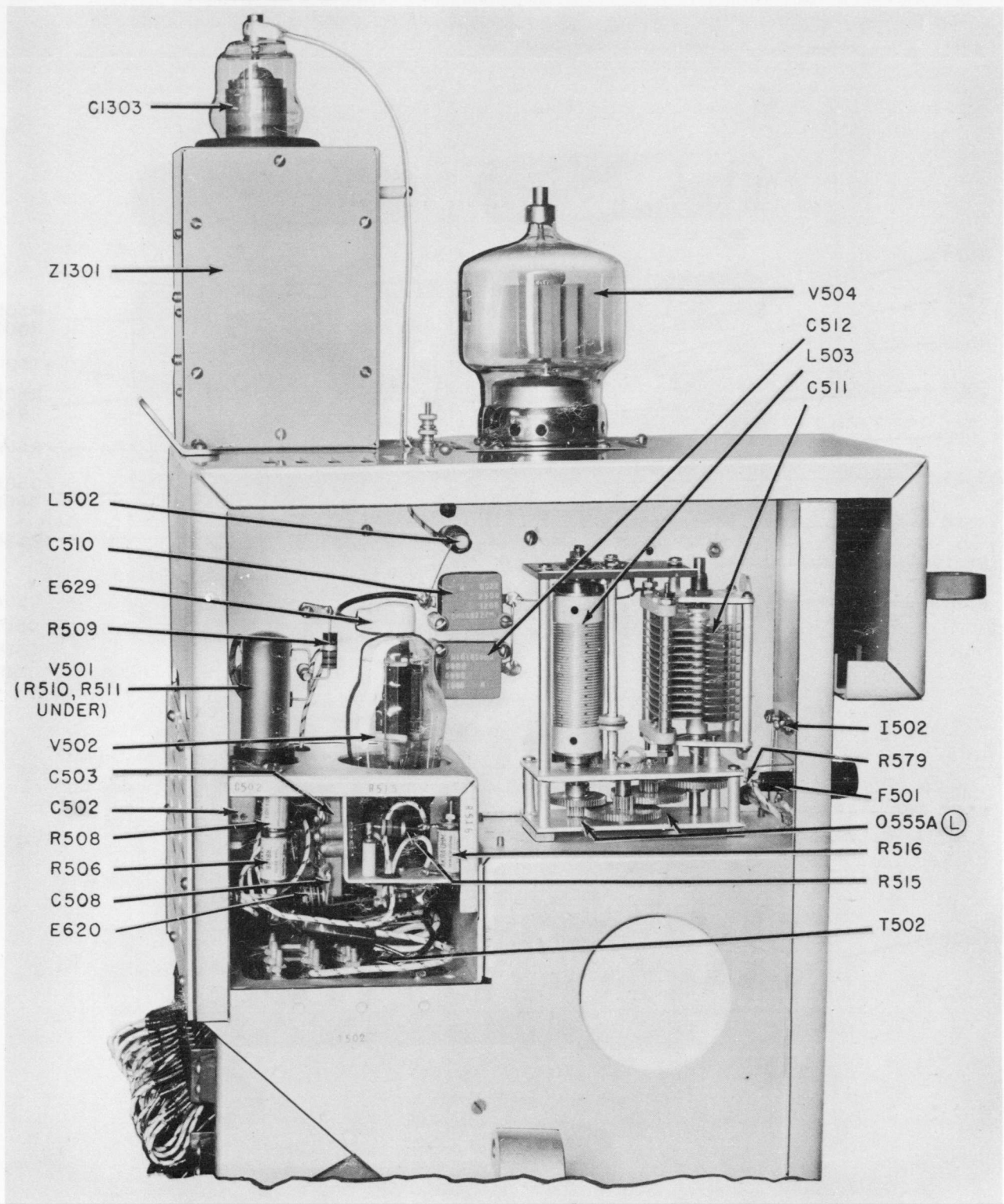


Figure 7-24. RF Unit T-225A/FRT-5, Multipliers and Driver Unit, Left Side View

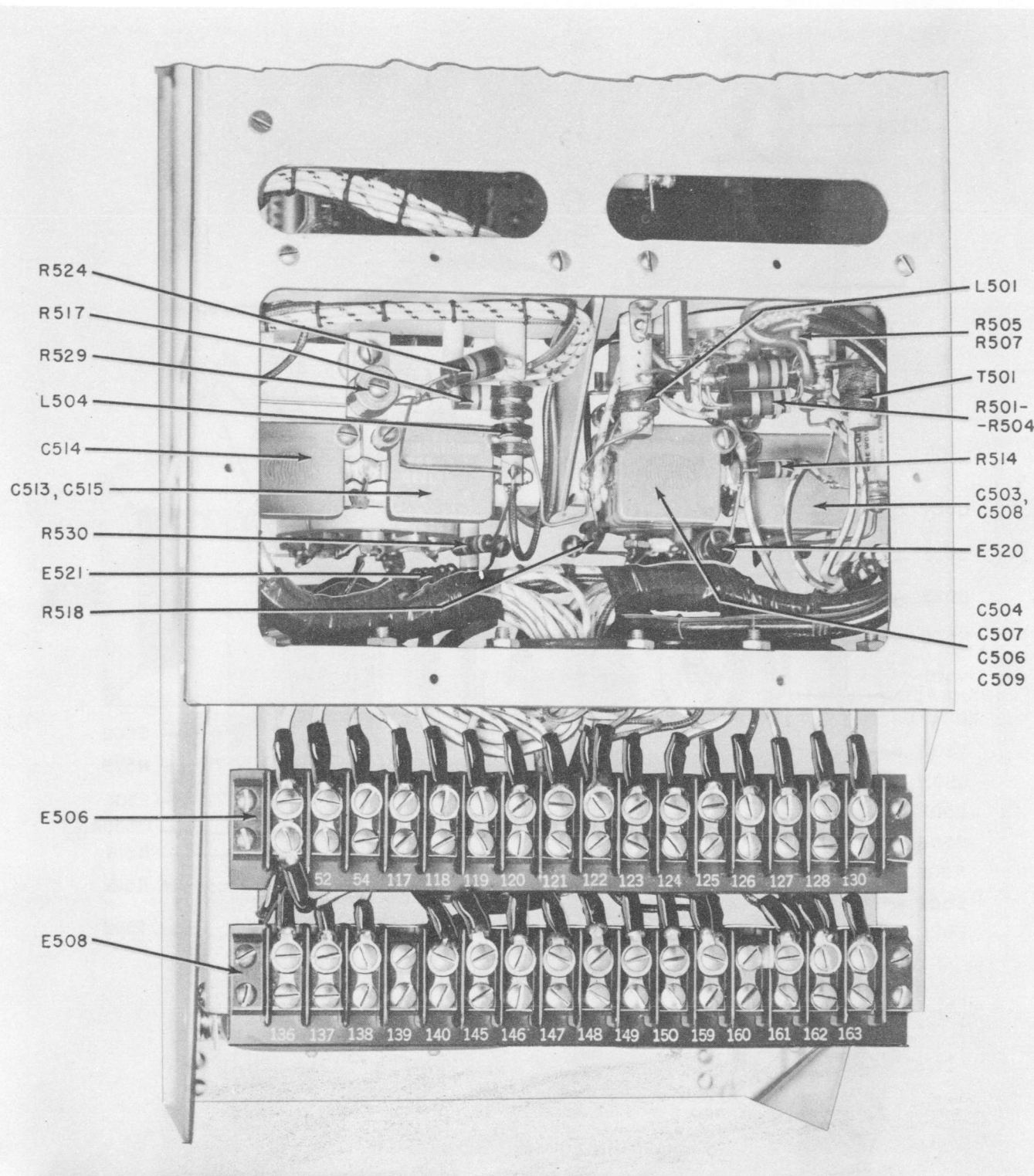


Figure 7-25. RF Unit T-225A/FRT-5, Multipliers and Driver Unit, Rear View,
Cover Plate Removed

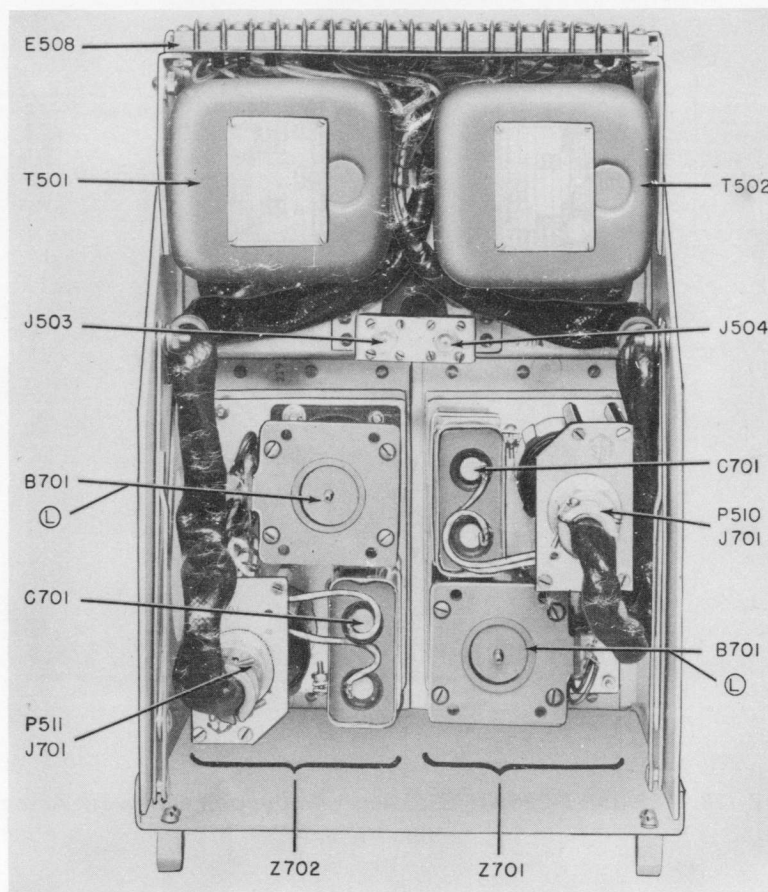


Figure 7-26. RF Unit T-225A/FRT-5, Multipliers and Driver Unit, Bottom View

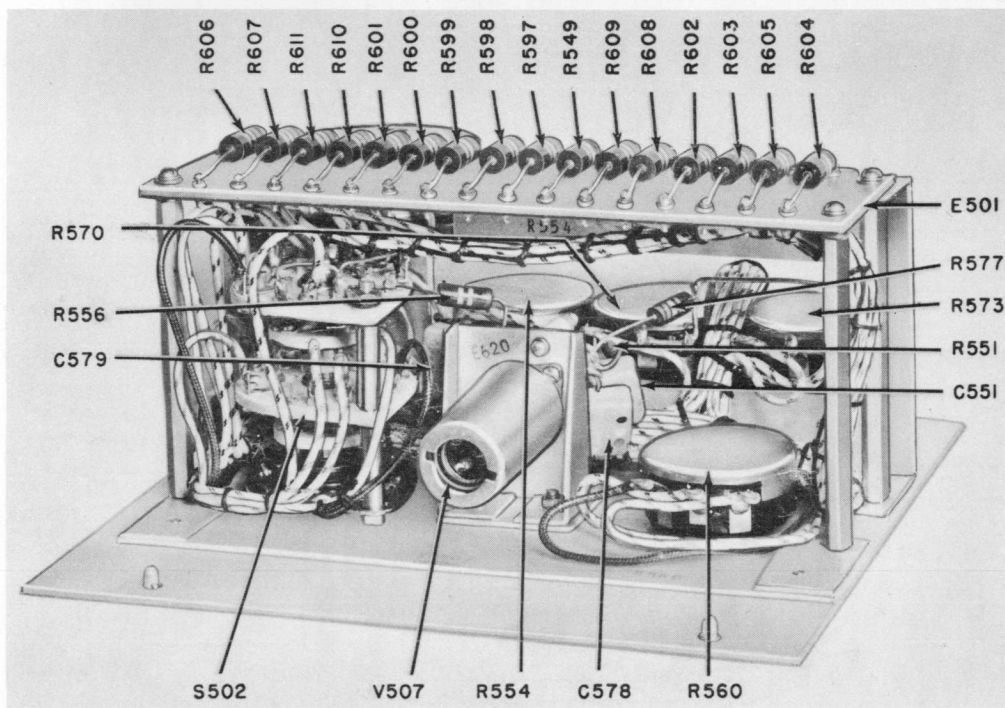


Figure 7-27. RF Unit T-225A/FRT-5, Electronic Keyer Assembly, Top Rear View

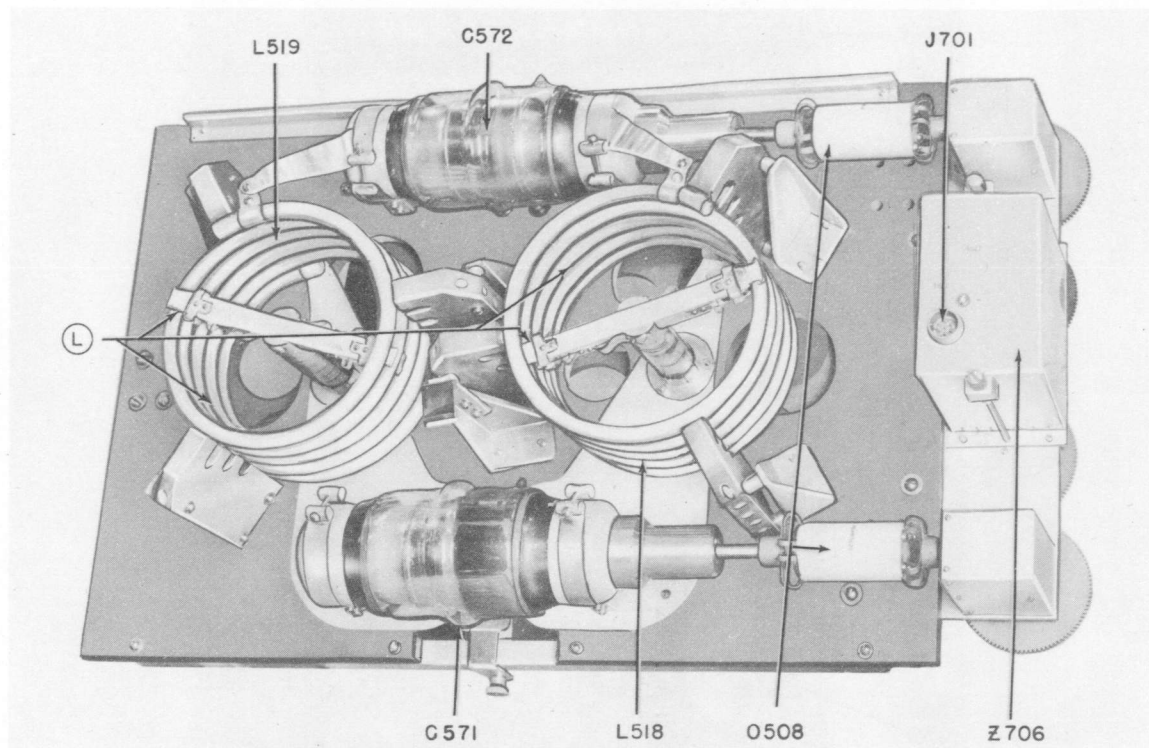


Figure 7-28. RF Unit T-225A/FRT-5, Antenna Coupling Network Assembly, Bottom View

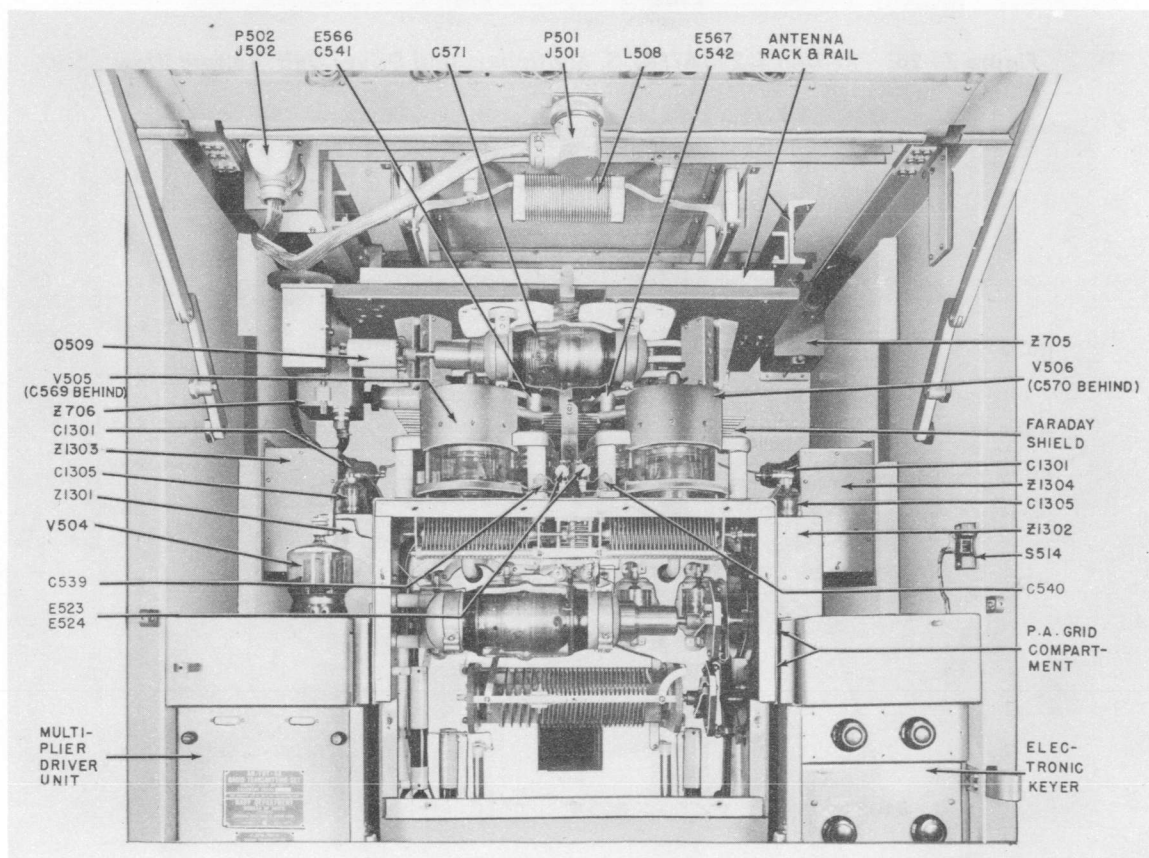
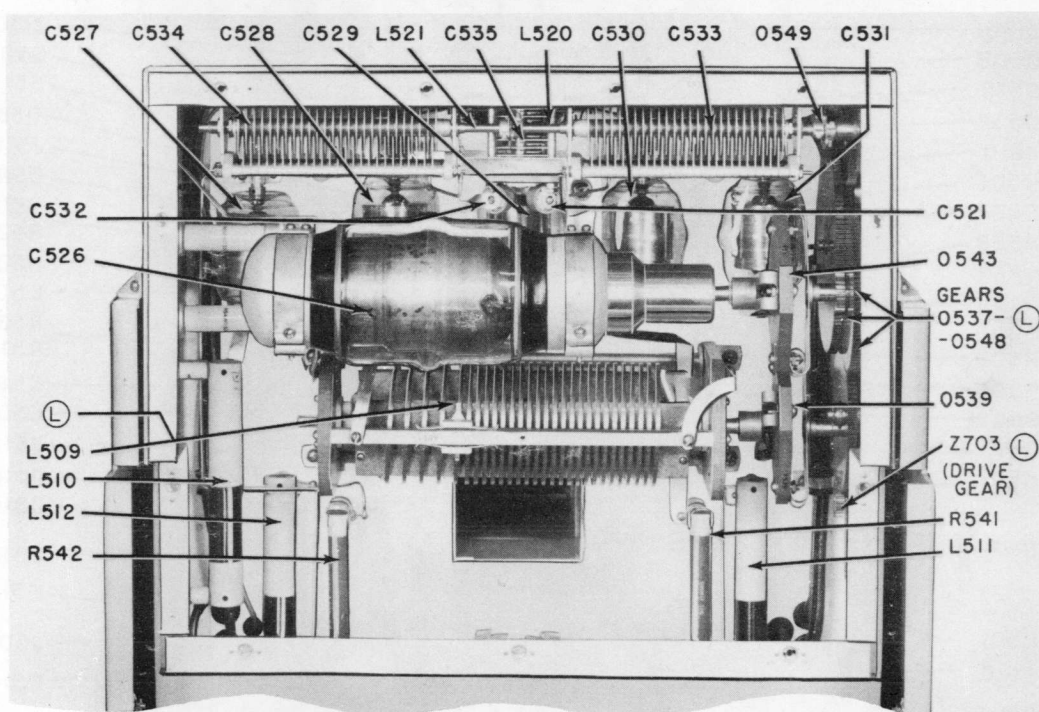


Figure 7-29. RF Unit T-225A/FRT-5, Power Amplifier Grid Circuit Components



**Figure 7-30. RF Unit T-225A/FRT-5, Front View of Upper Portion, with
Upper Front Panel Raised, Control Panel Lowered and Grid Shield Removed**

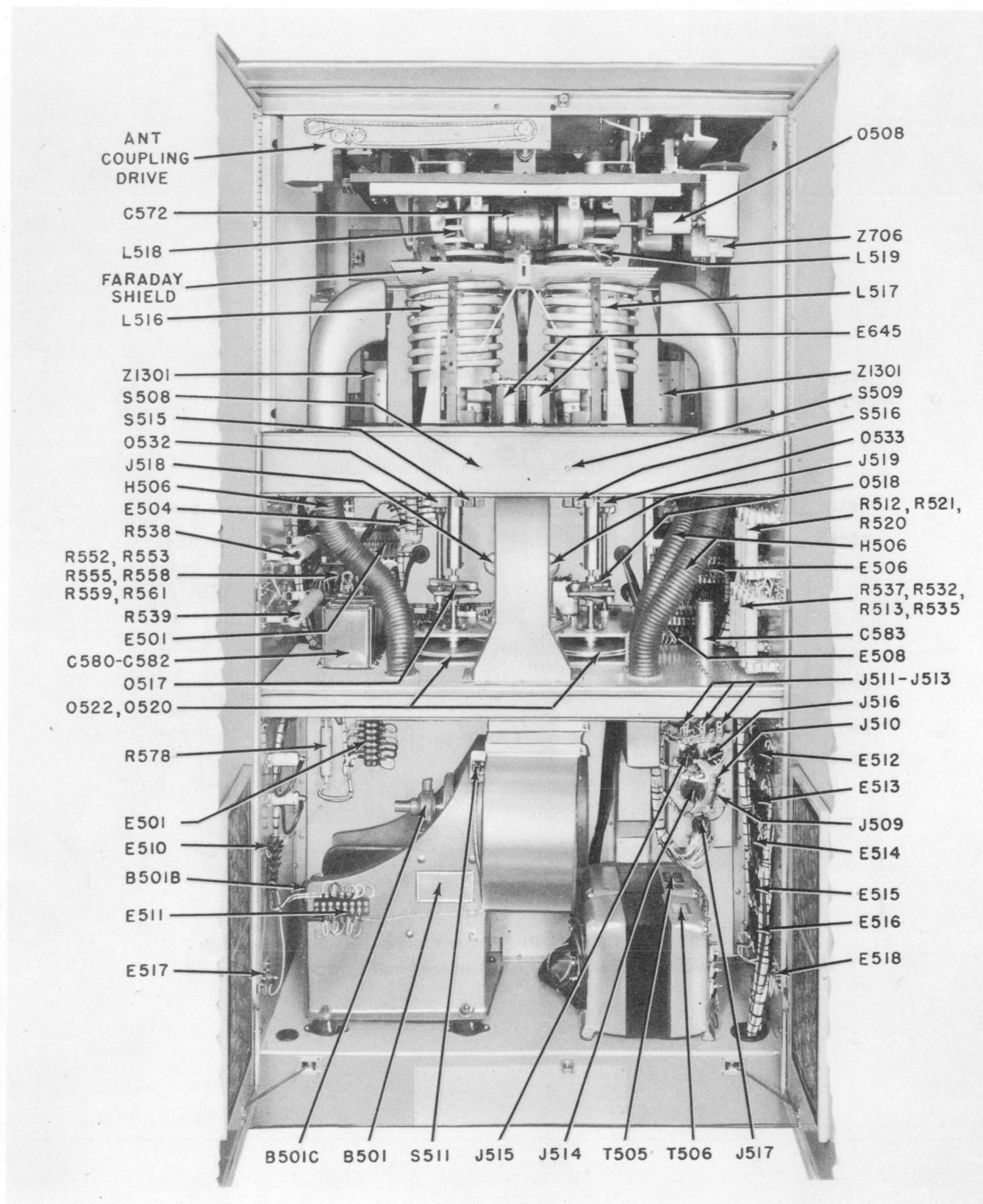


Figure 7-31. RF Unit T-225A/FRT-5, Rear View, Doors Open

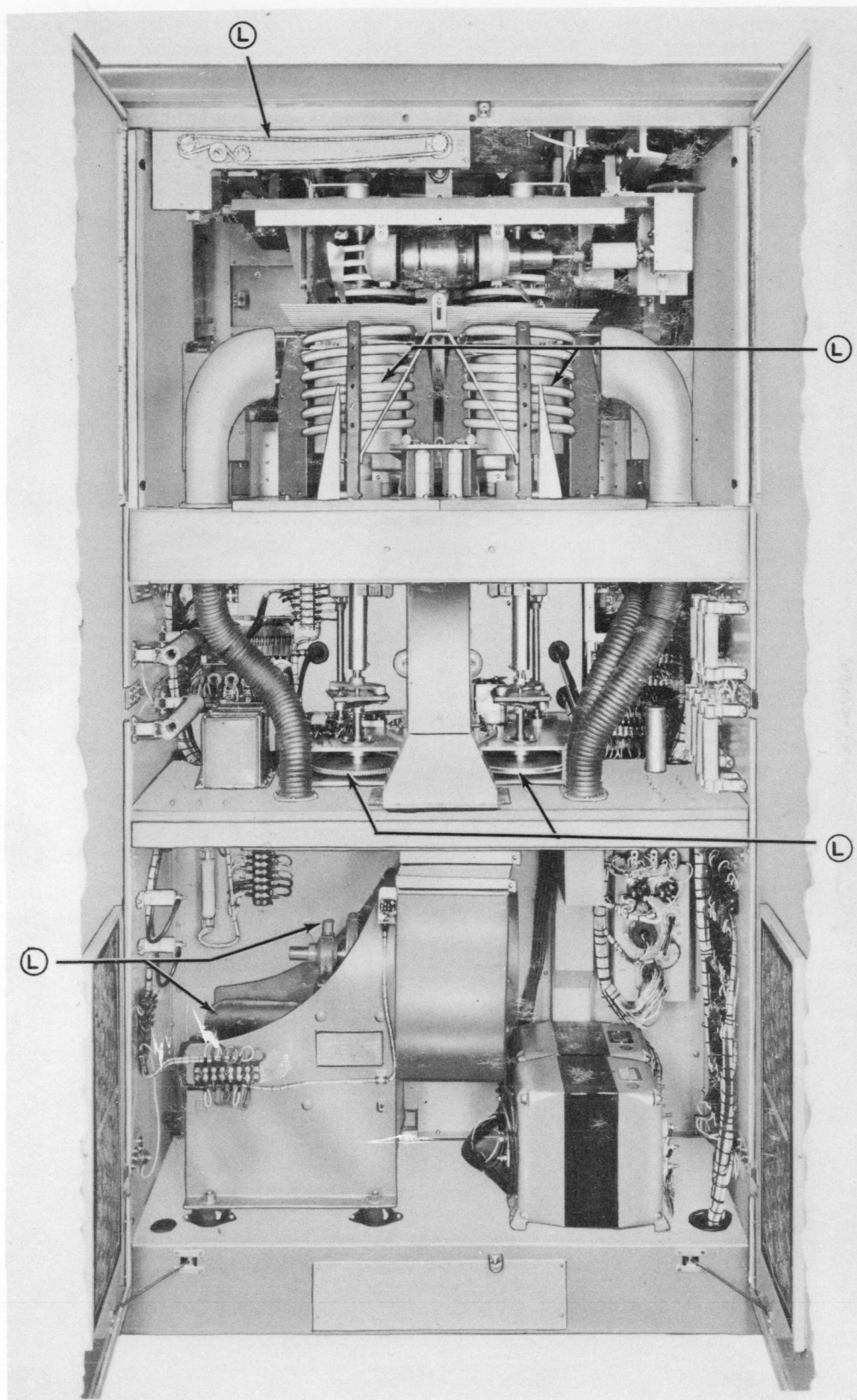


Figure 7-32. RF Unit T-225A/FRT-5, Rear View, Doors Open

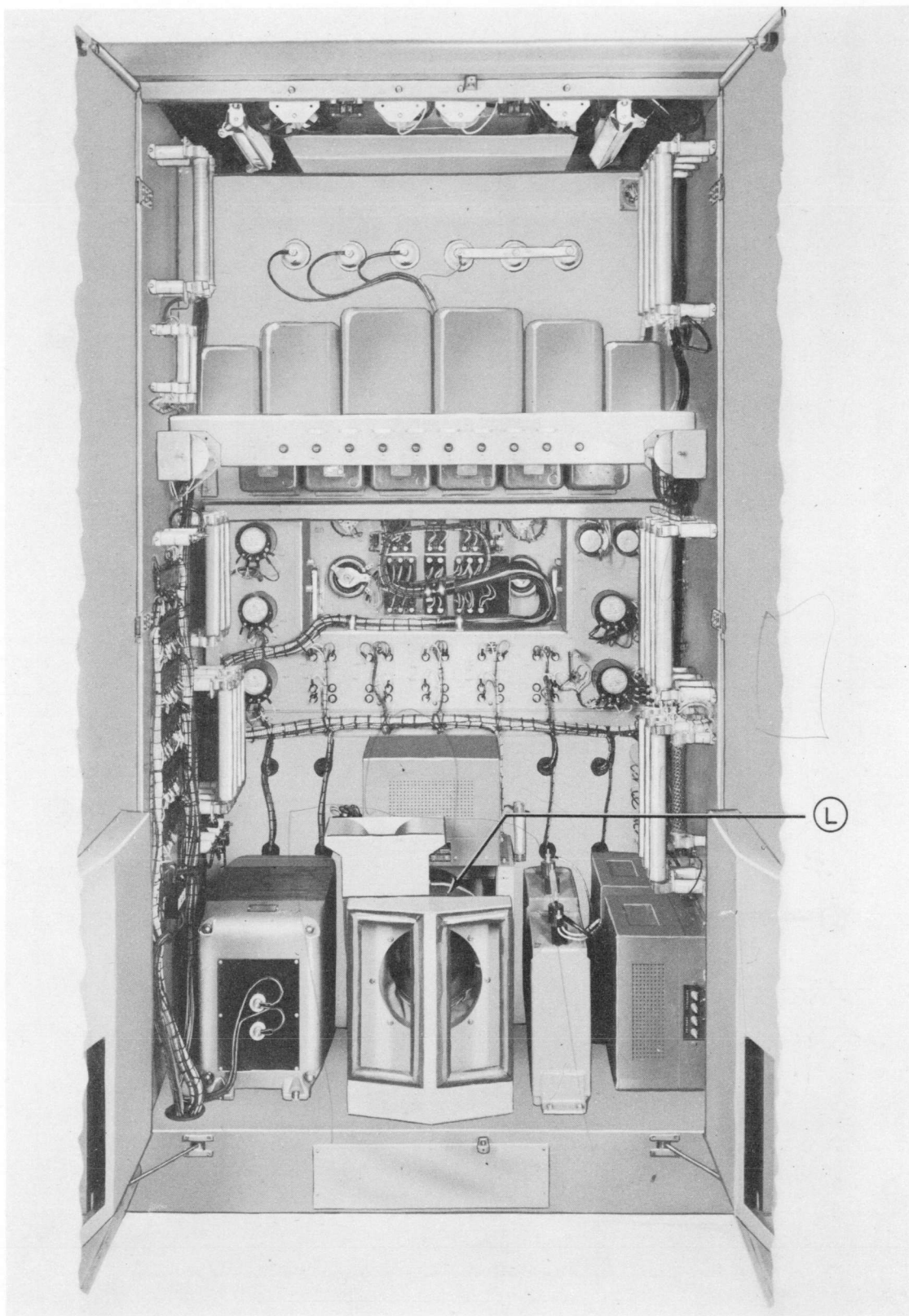


Figure 7-33. Power Supply PP-490A/FRT-5, Rear View, Doors Open

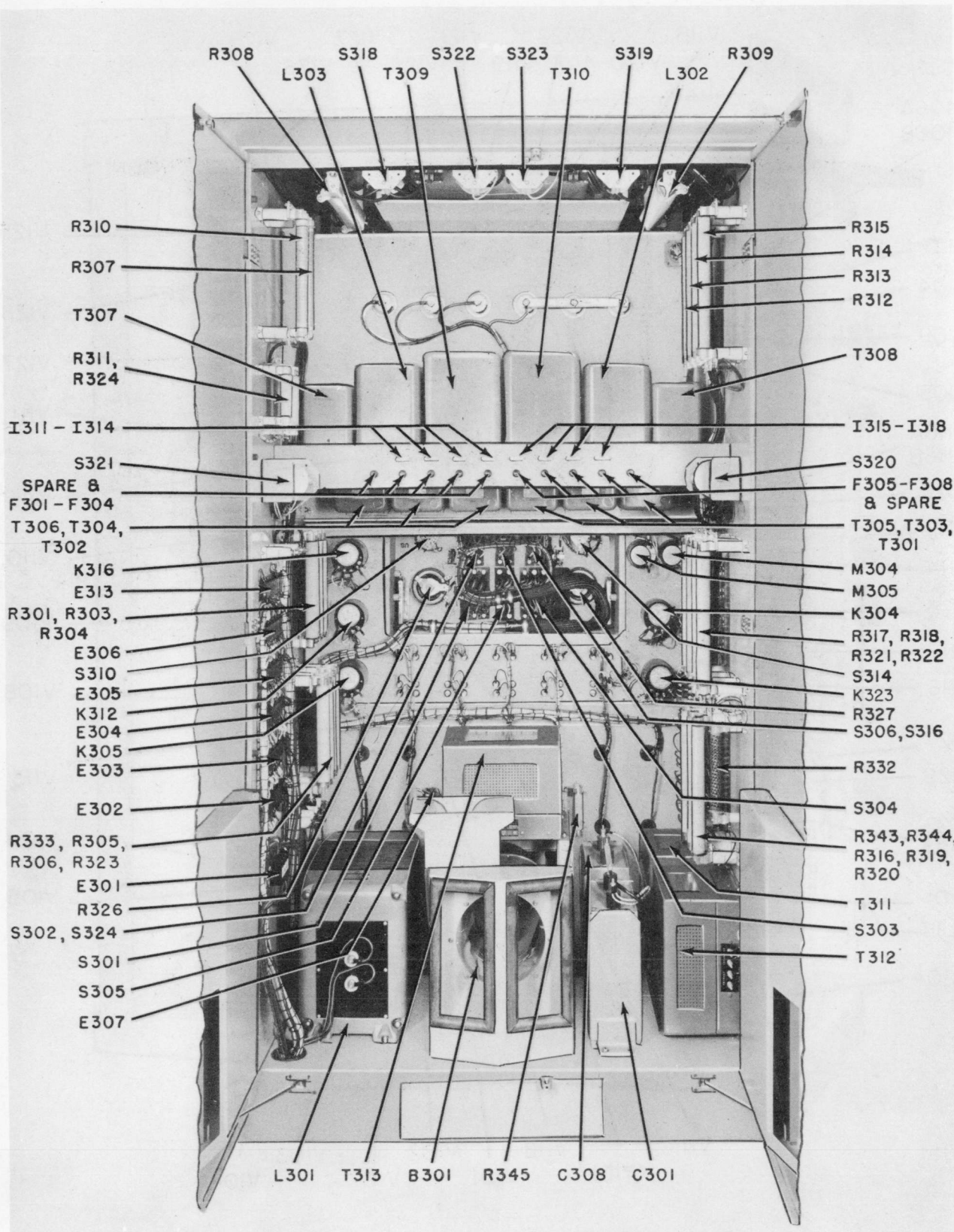


Figure 7-34. Power Supply PP-490A/FRT-5, Rear View, Doors Open

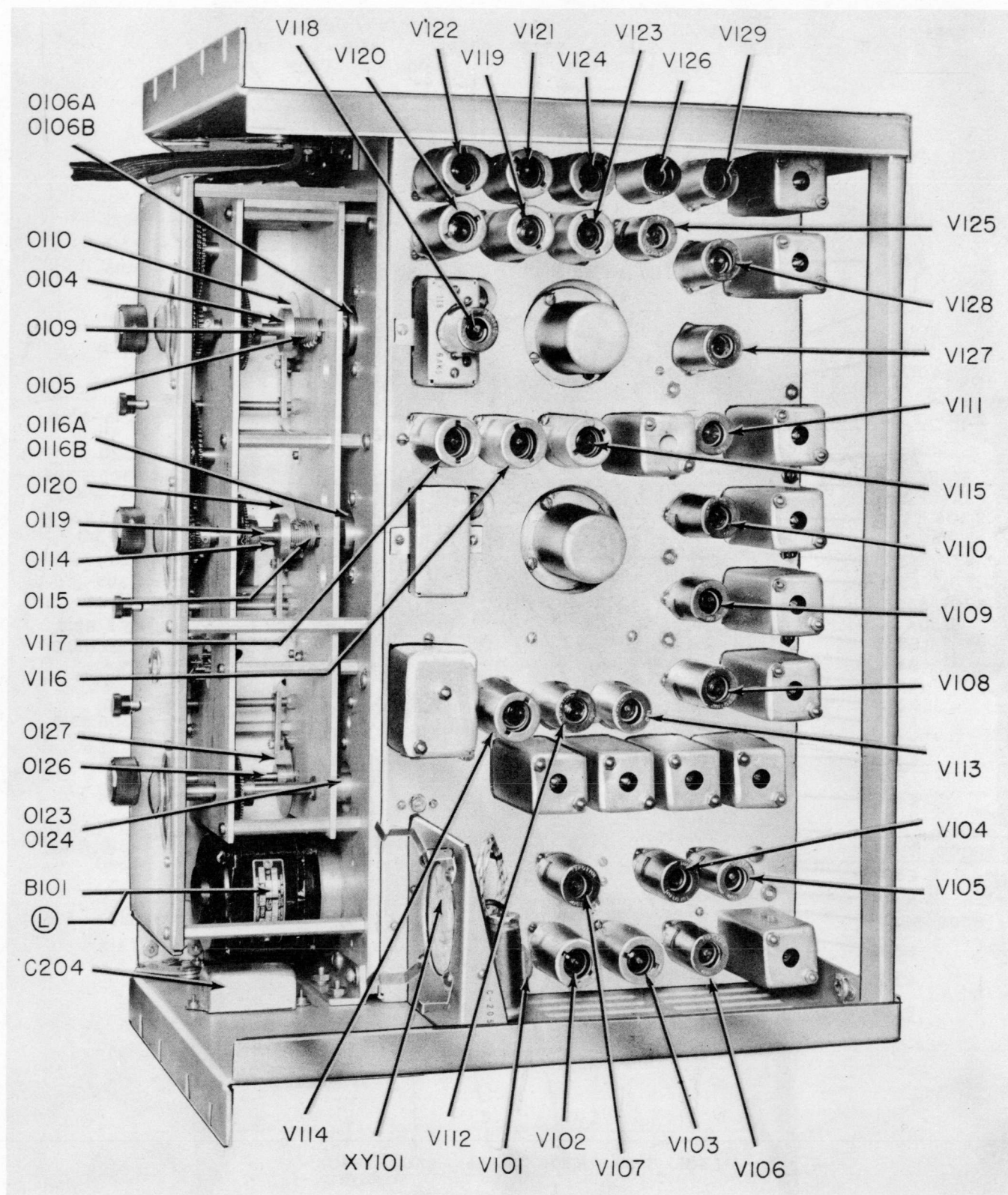


Figure 7-35. RF Oscillator O-91A/FRT-5, Top View with Dust Cover, Top Front Rail and Crystal Unit Removed, and with Front Panel Lowered

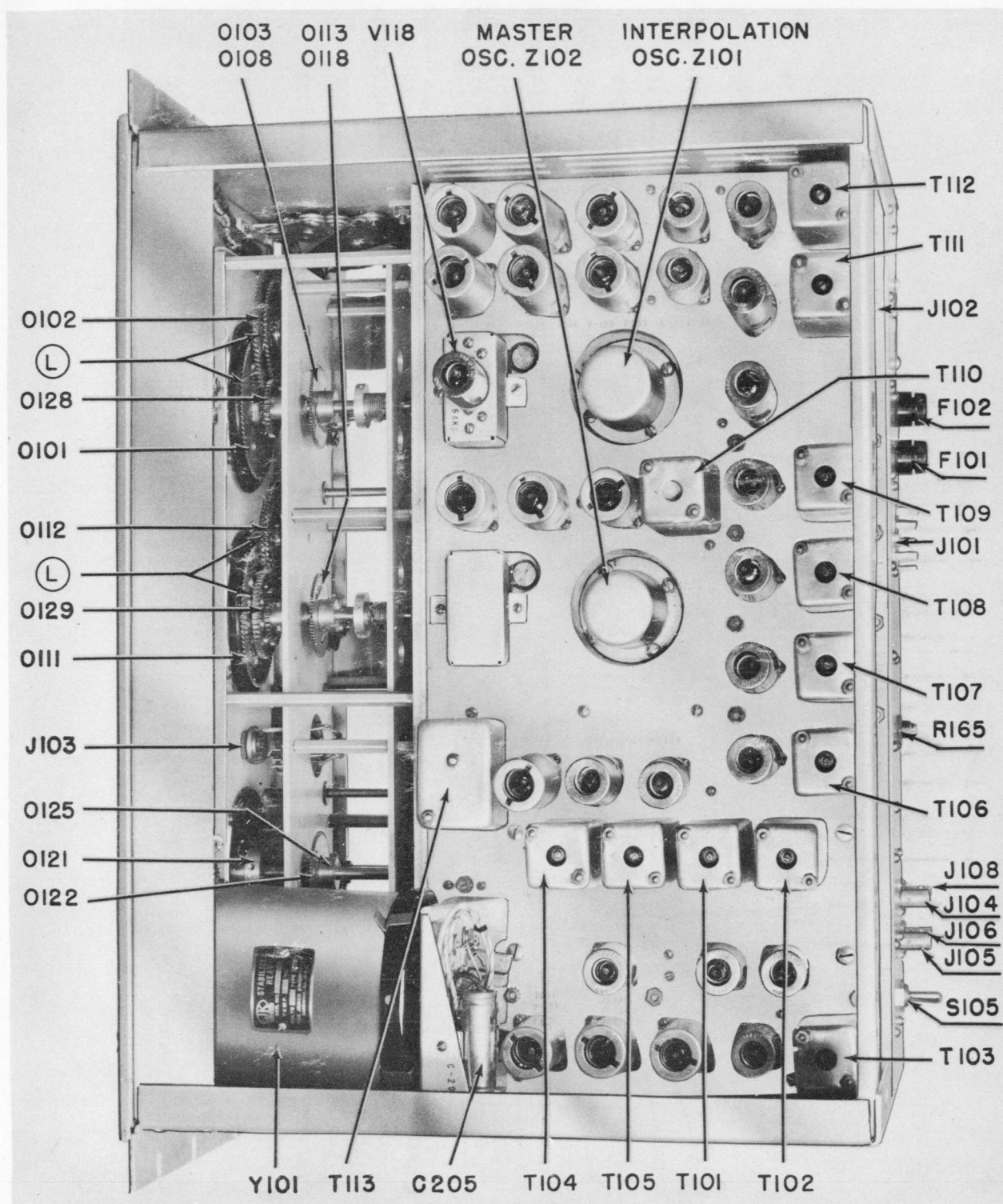


Figure 7-36. RF Oscillator O-91A/FRT-5, Top View, Dust Cover Removed

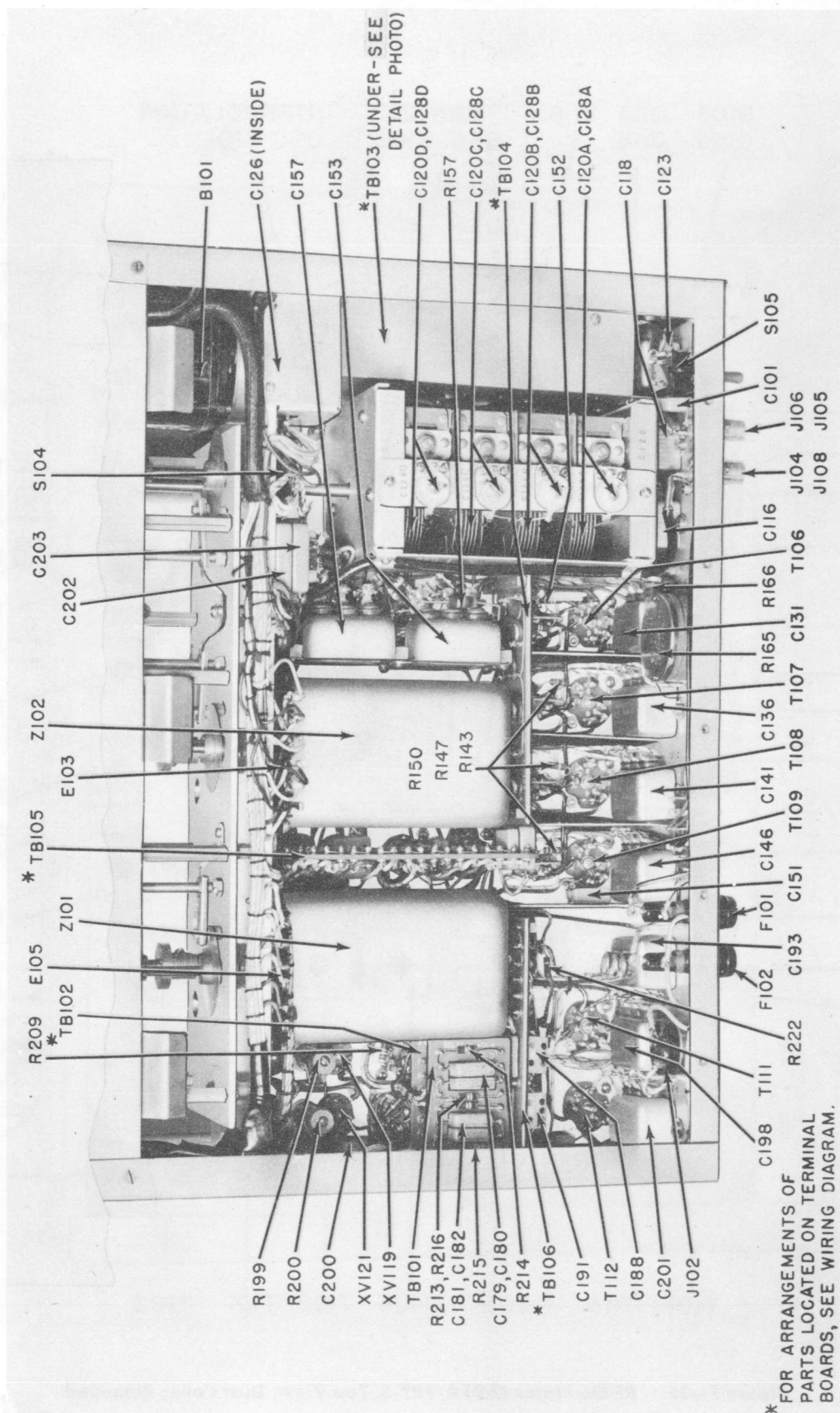


Figure 7-37. RF Oscillator O-91A/FRT-5, Bottom View, Dust Cover Removed

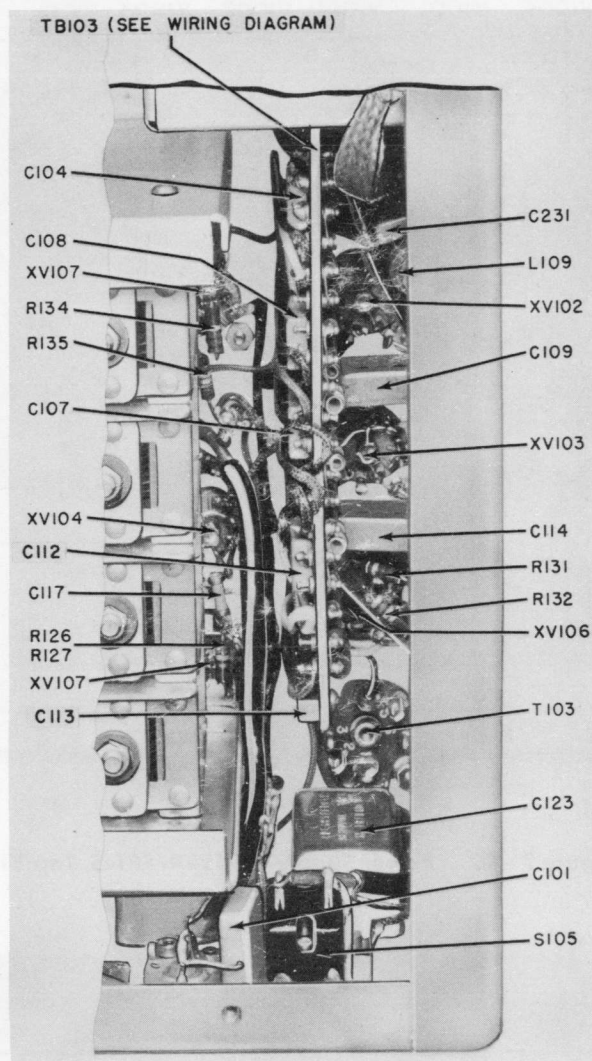


Figure 7-38. RF Oscillator, O-91A/FRT-5, Bottom View, Detail of Components under R-f Shield

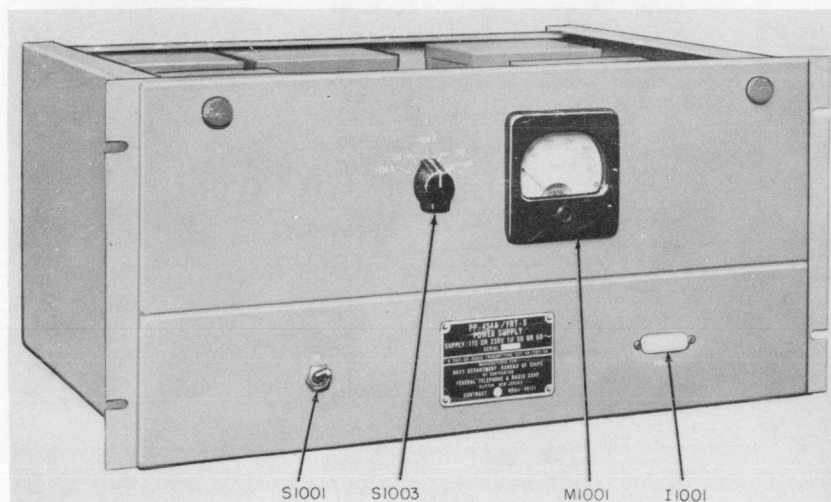


Figure 7-39. Power Supply PP-454A/FRT-5, Front View

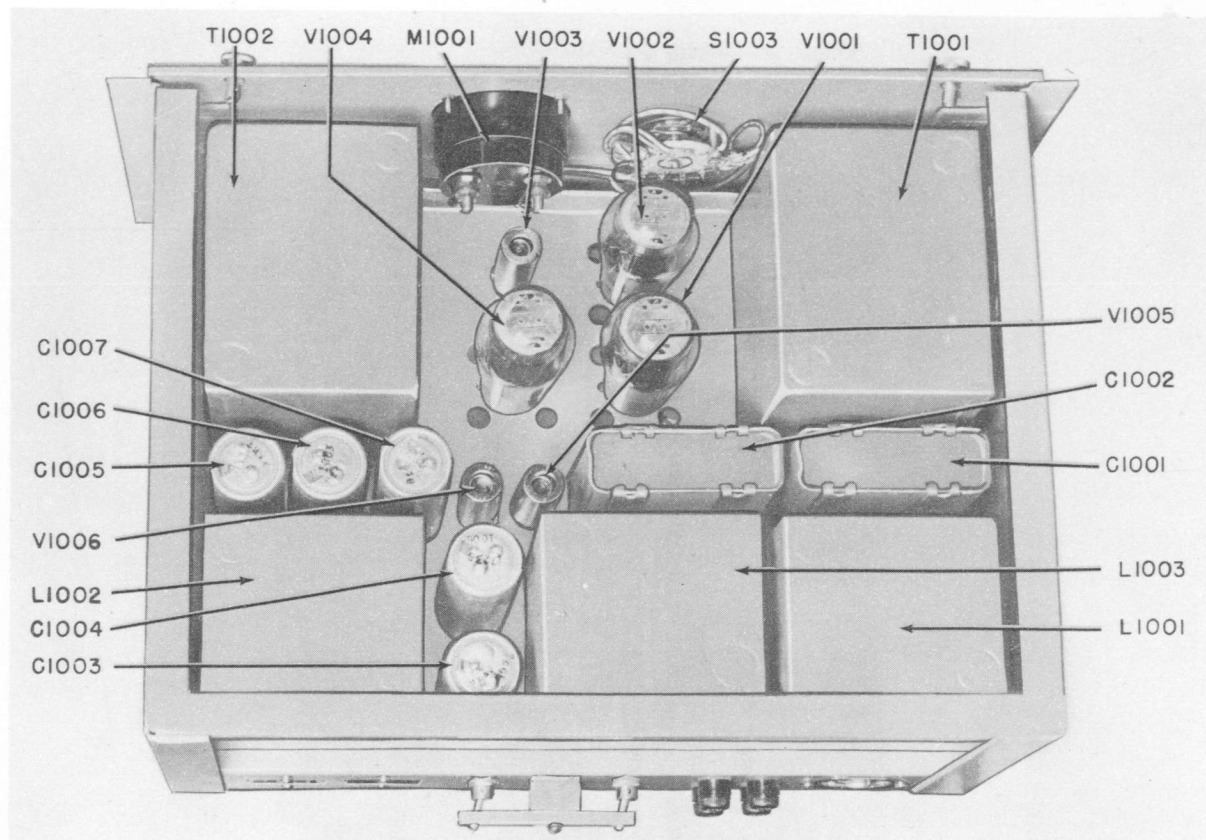


Figure 7-40. Power Supply PP-454A/FRT-5, Top View

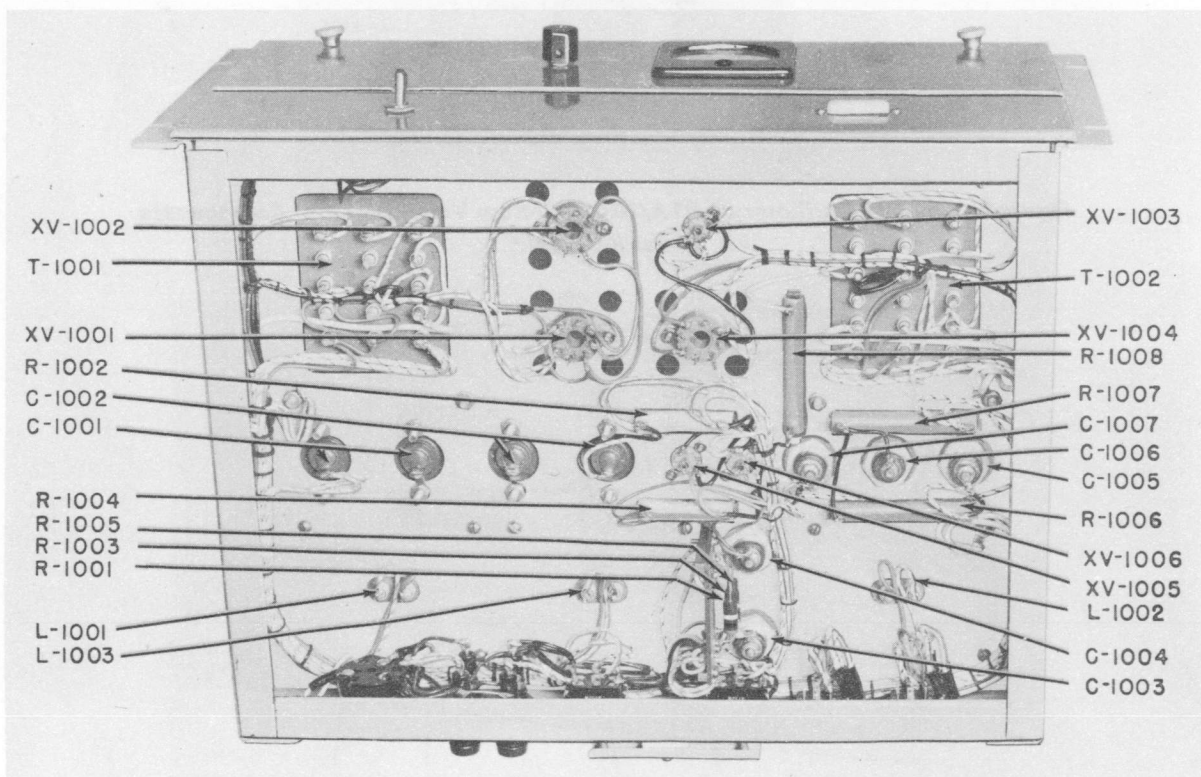


Figure 7-41. Power Supply PP-454A/FRT-5, Bottom View

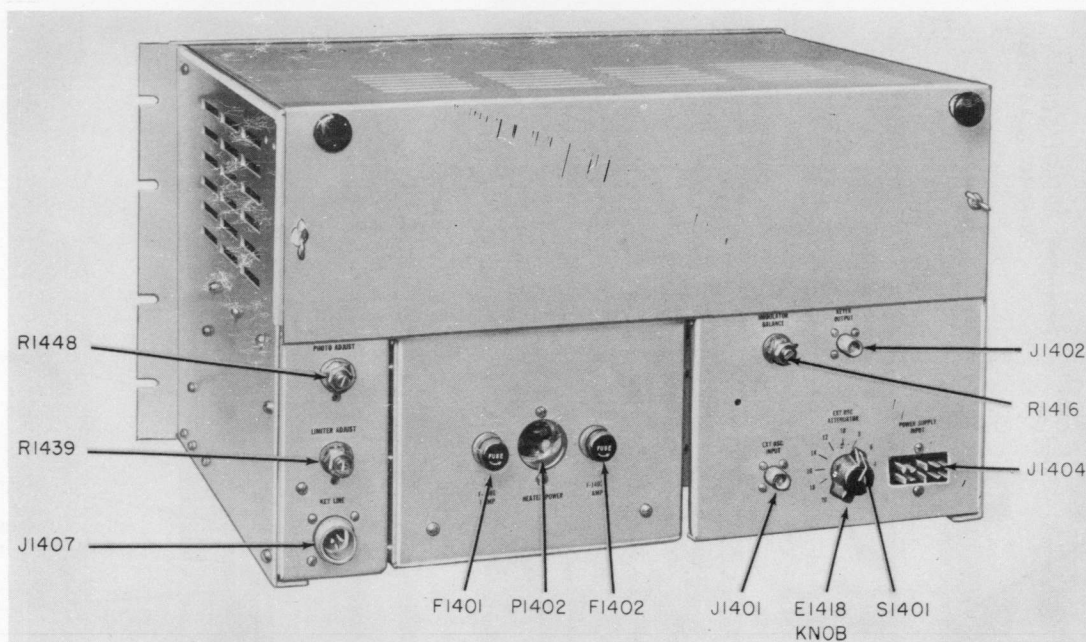
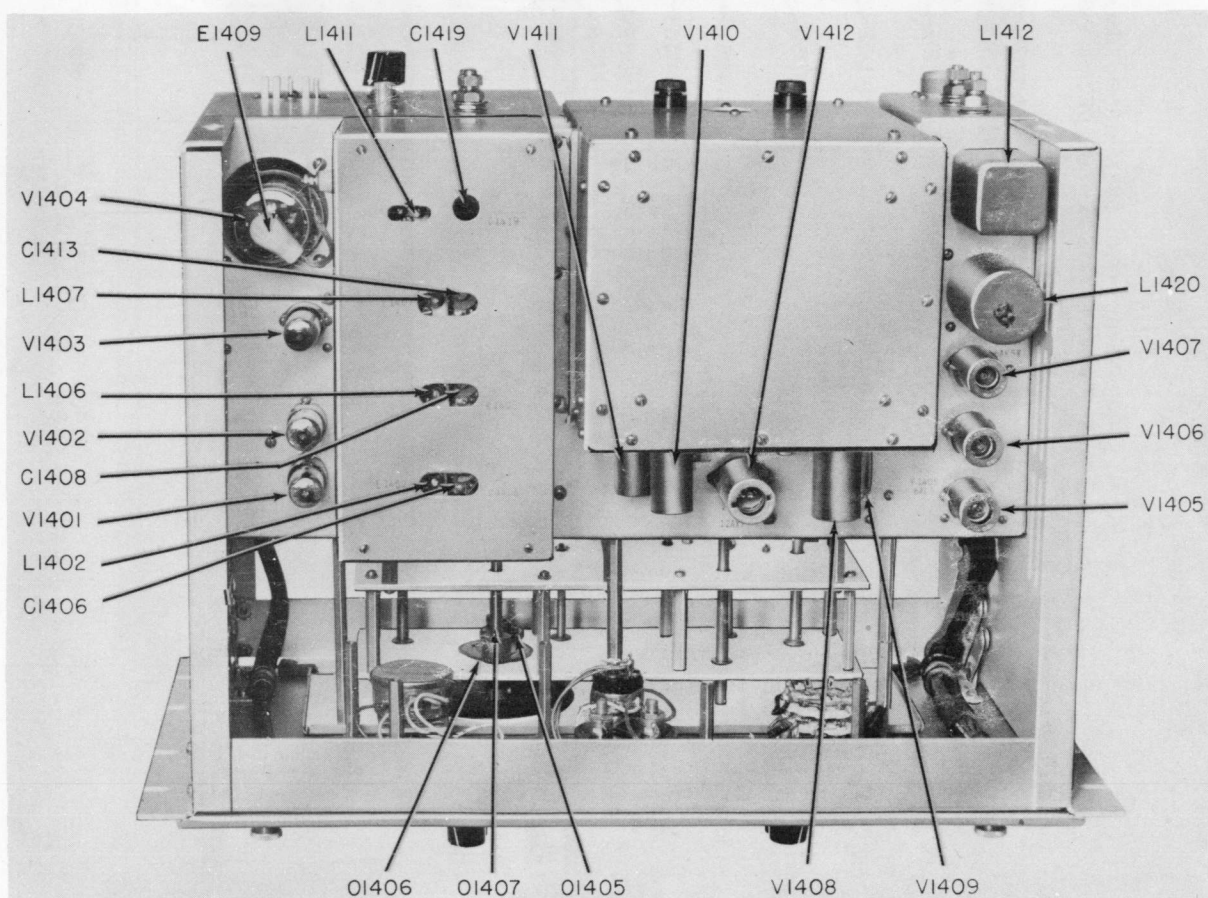


Figure 7-42. Frequency Shift Keyer KY-45A/FRT-5, Rear View



**Figure 7-43. Frequency Shift Keyer KY-45A/FRT-5, Top View,
Dust Cover Removed**

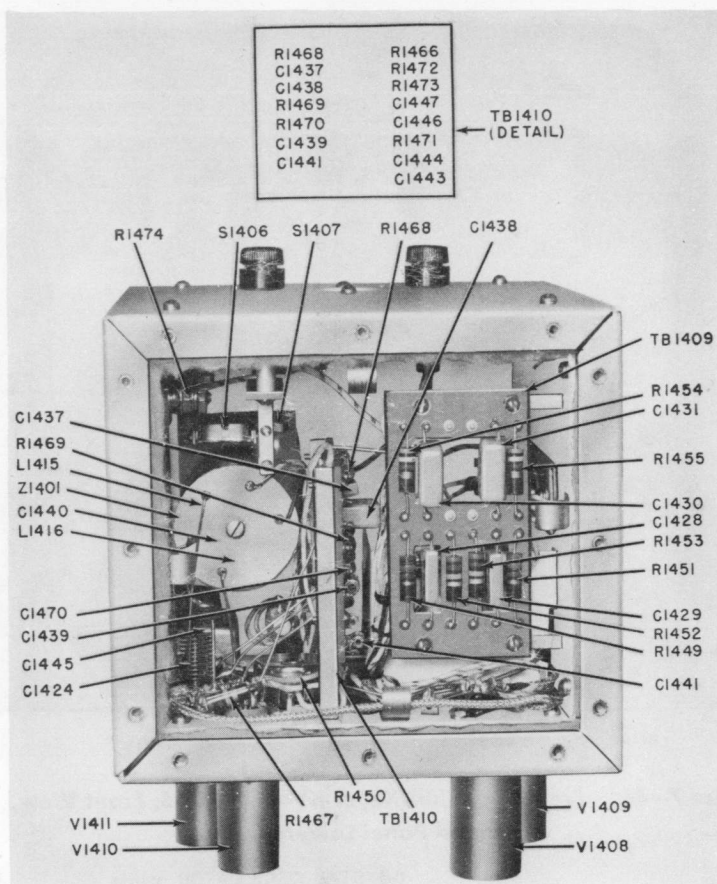


Figure 7-45A. Frequency Shift Keyer KY-45A/FRT-5, Top View of Oven, Cover Plate Removed

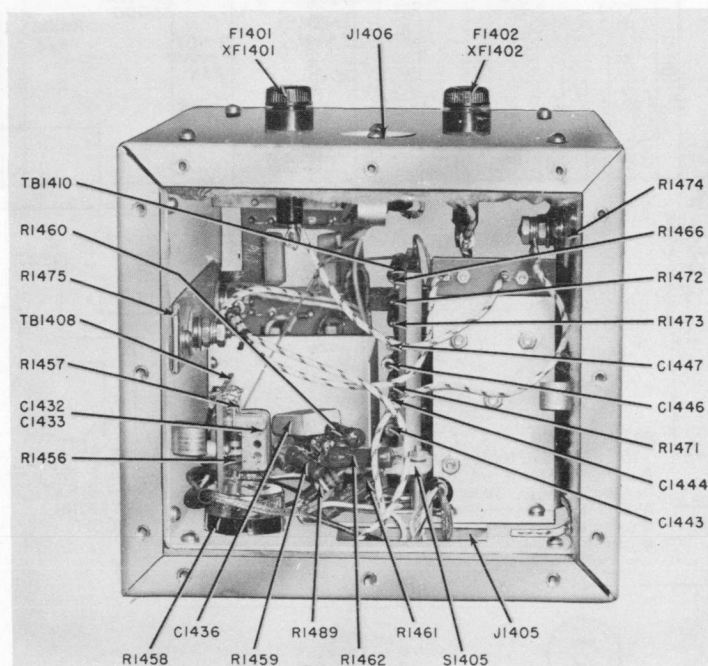


Figure 7-45B. Frequency Shift Keyer KY-45A/FRT-5, Bottom View of Oven, Cover Plate Removed

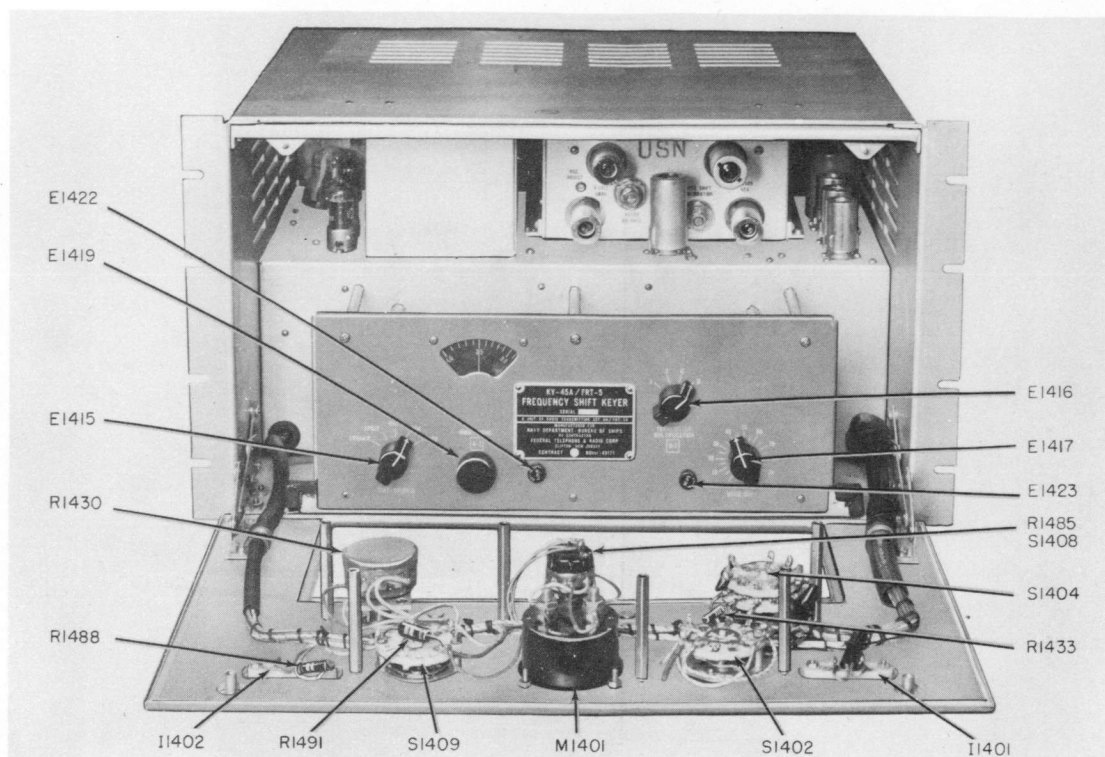


Figure 7-46. Frequency Shift Keyer KY-45A/FRT-5, Front View,
Hinged Panel Lowered

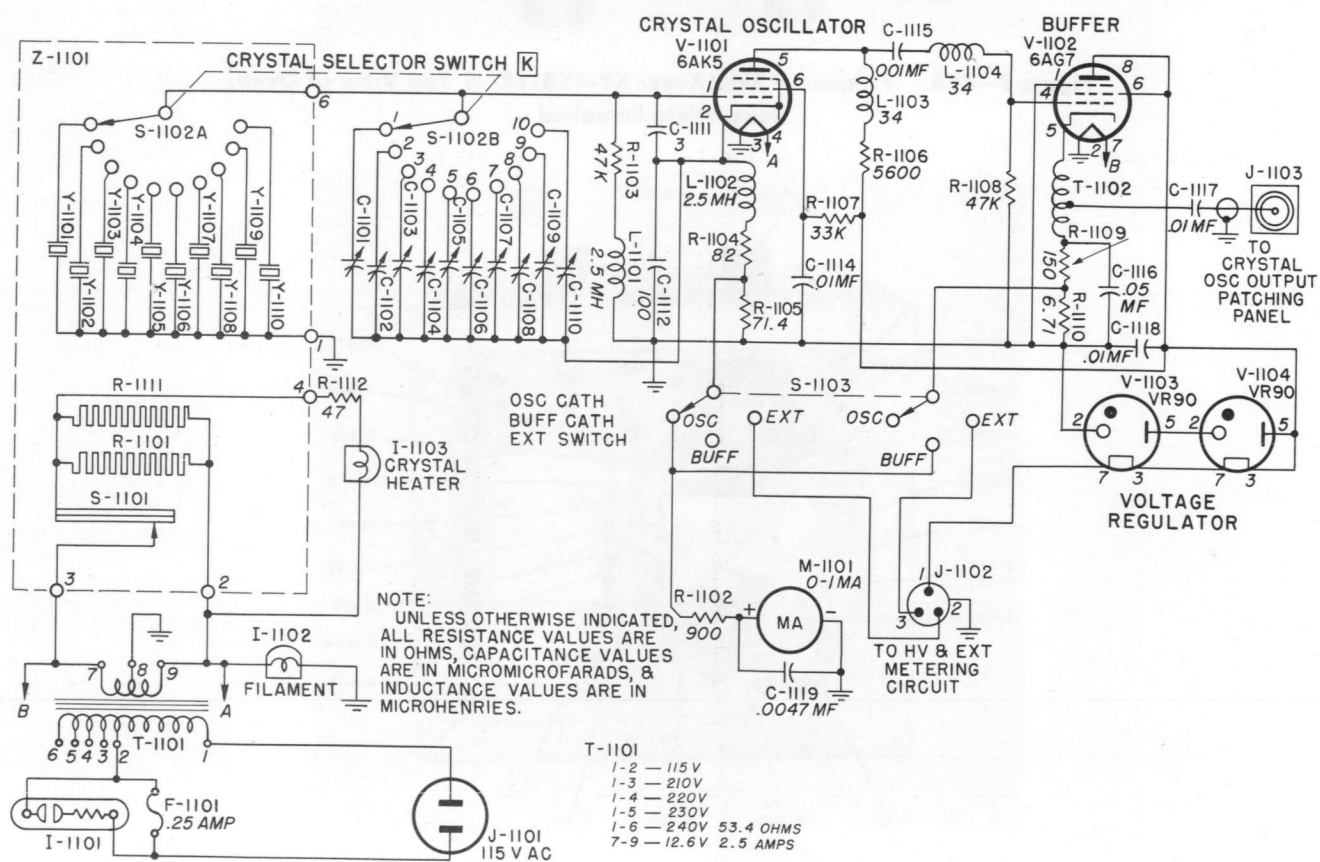
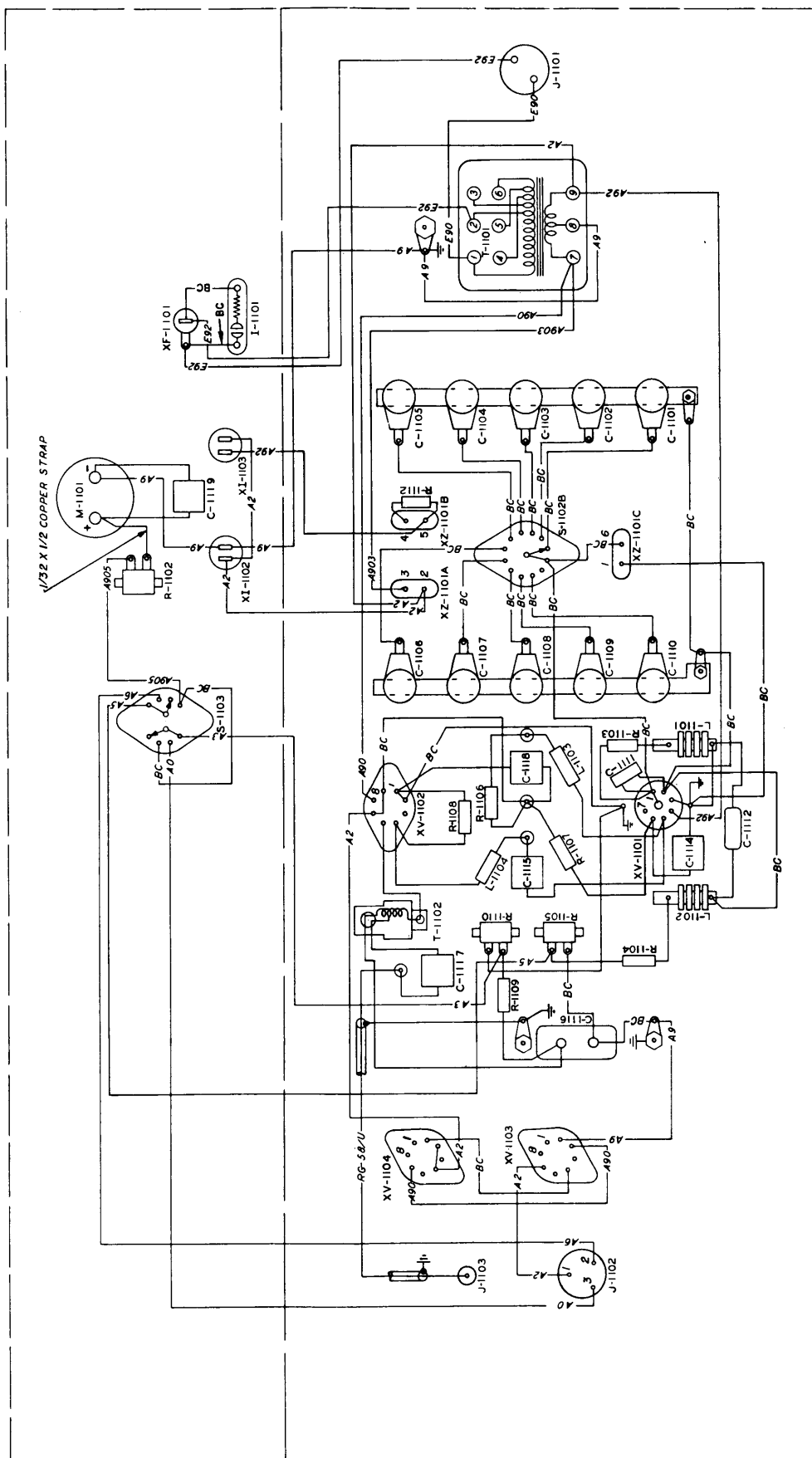


Figure 7-47. Schematic — RF Oscillator O-92A/FRT-5



Figur 7-48. Wiring Diagram — RF Oscillator O-92A/FRT-5

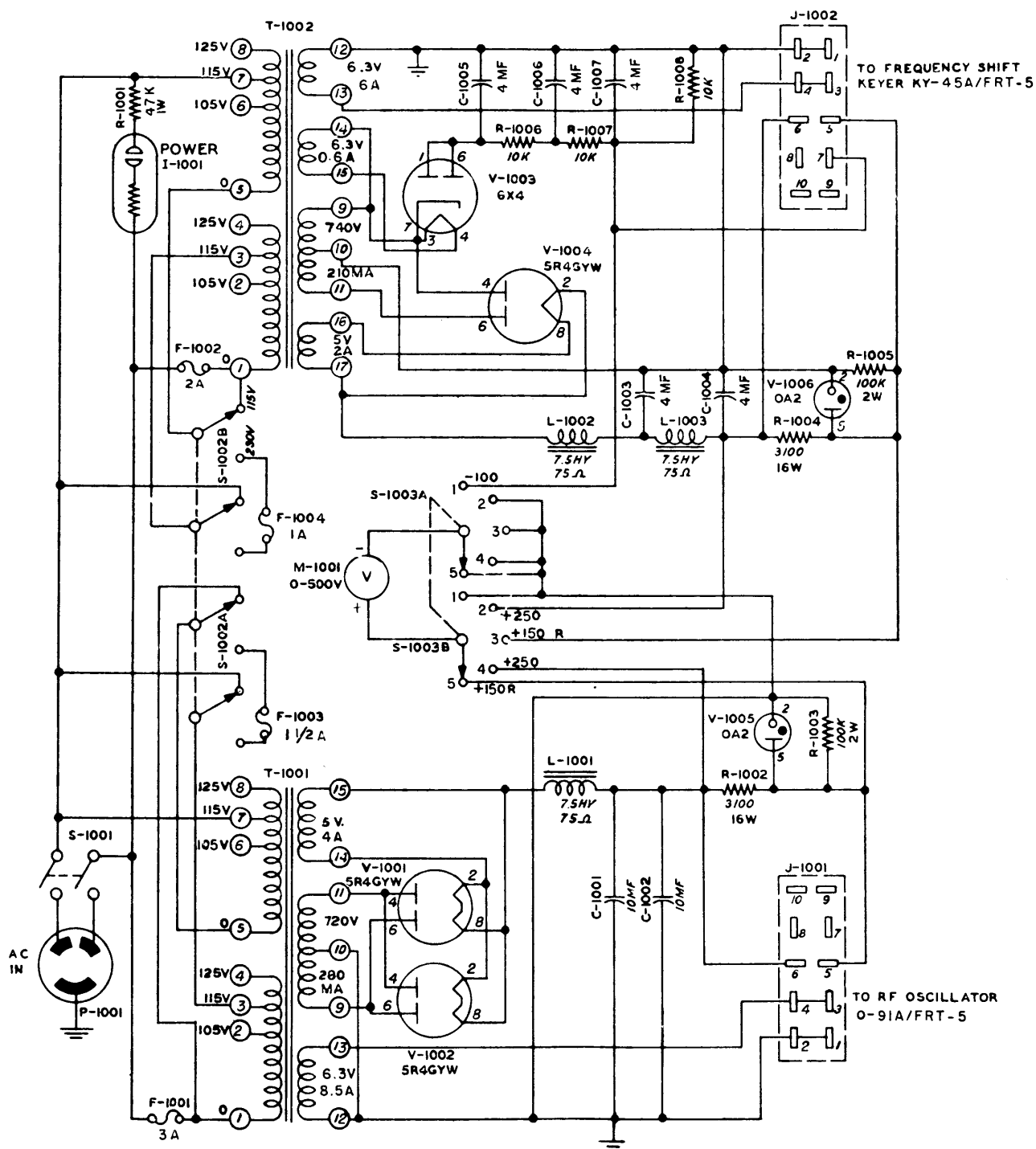


Figure 7-49. Schematic — Power Supply PP-454A/FRT-5

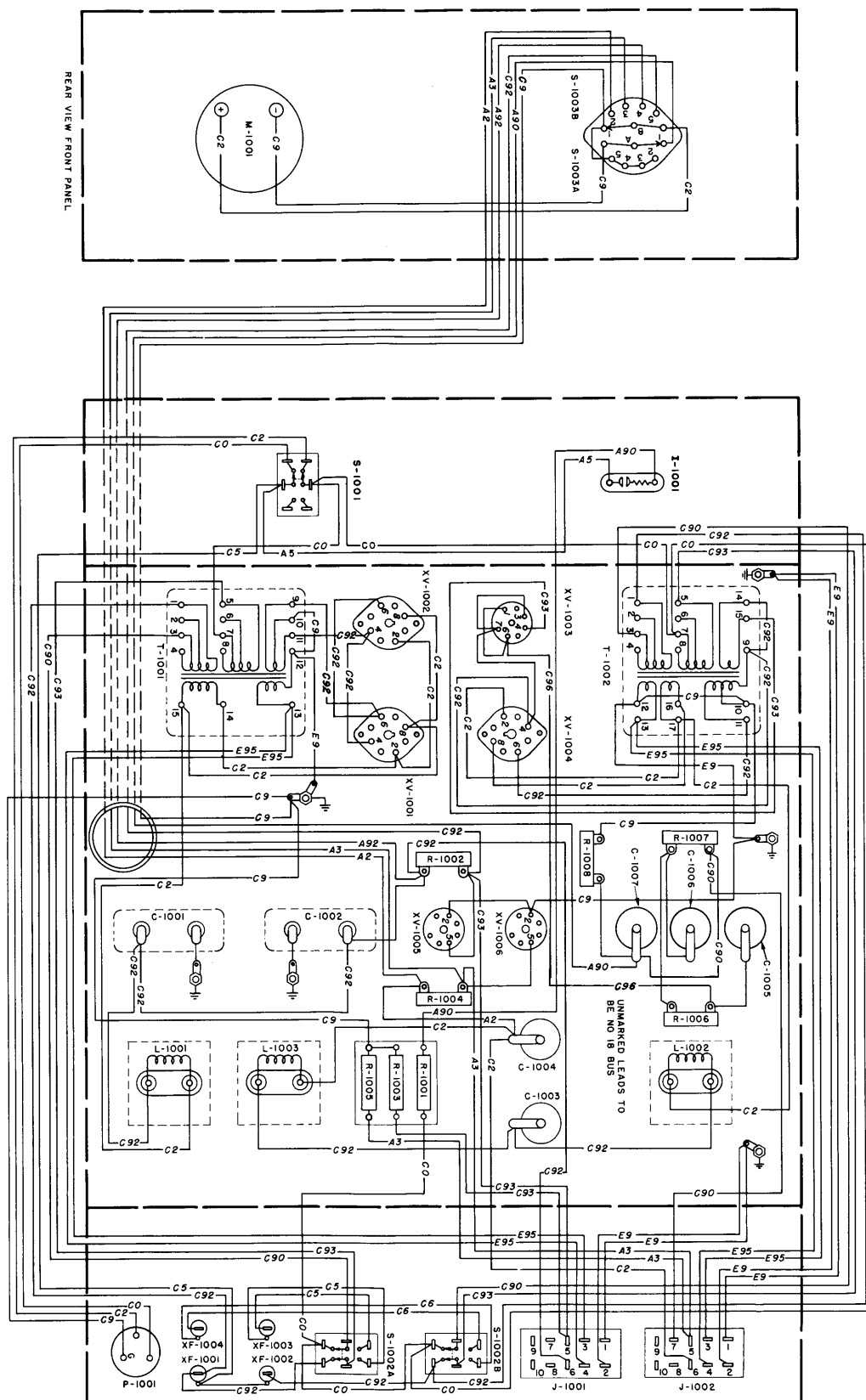


Figure 7–50. Wiring Diagram — P w r Supply PP-454A/FRT-5

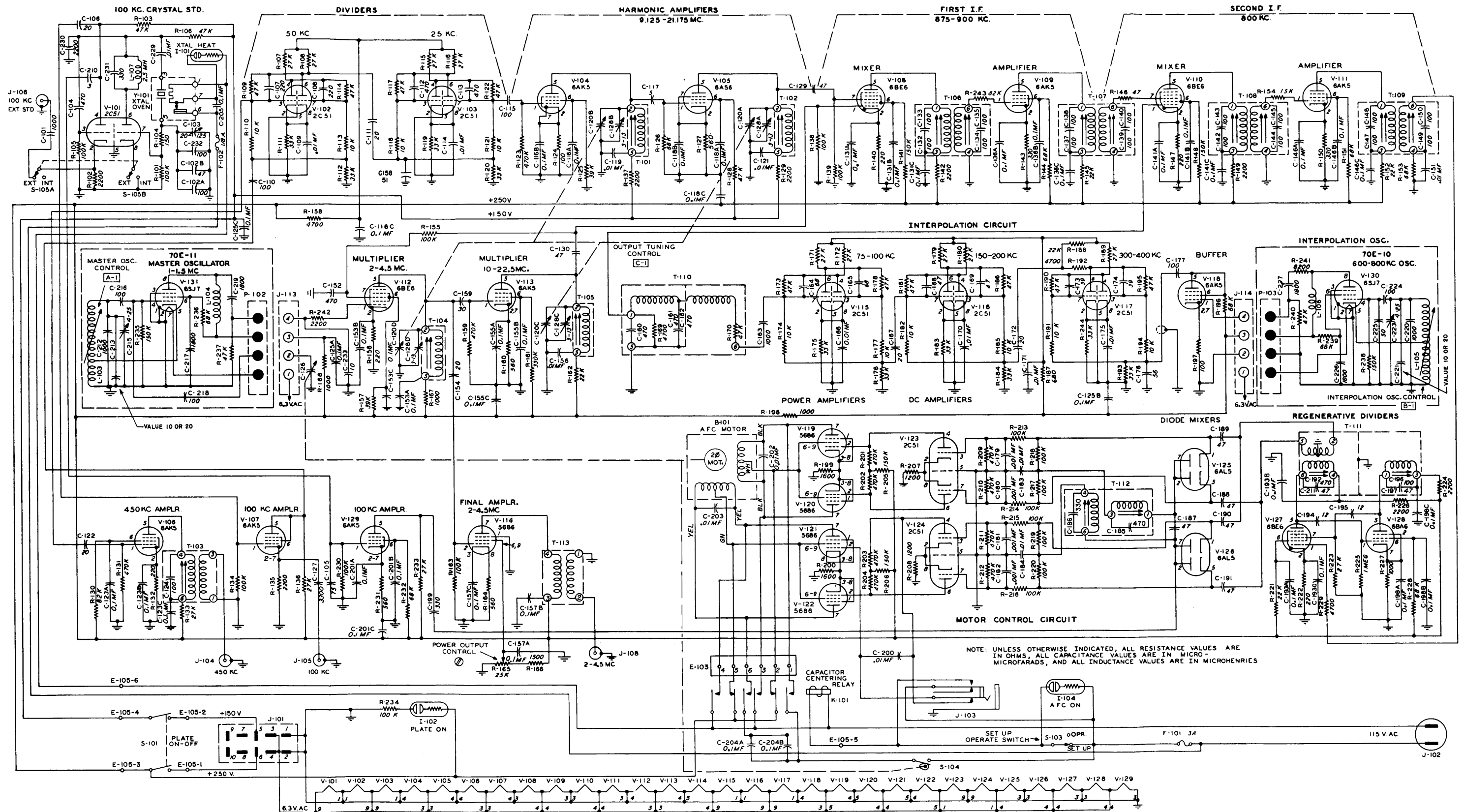


Figure 7-51. Schematic - RF Oscillator O-91A/FRT-5

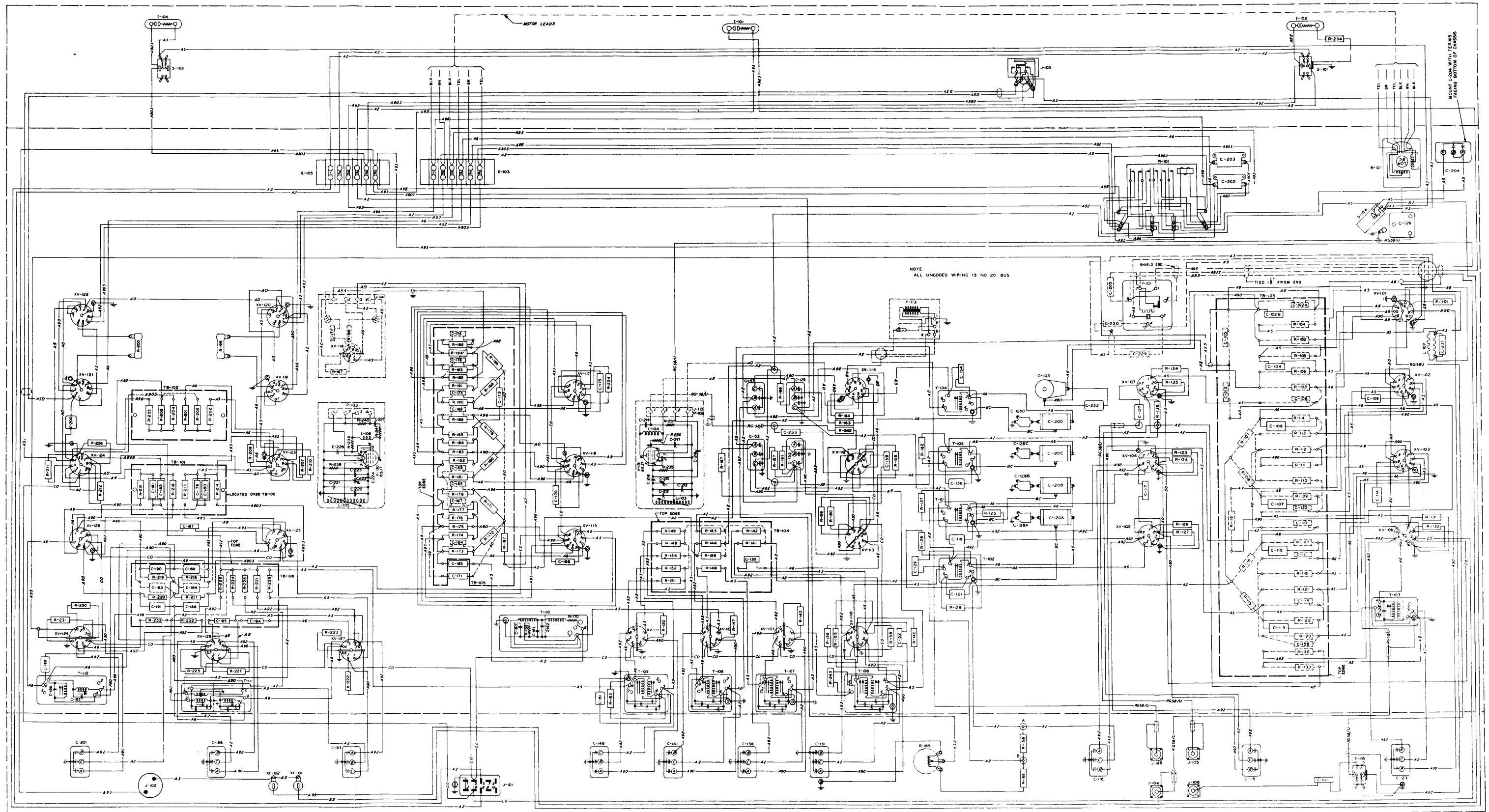


Figure 7-52. Wiring Diagram - RF Oscillator O 91A/FRT-5

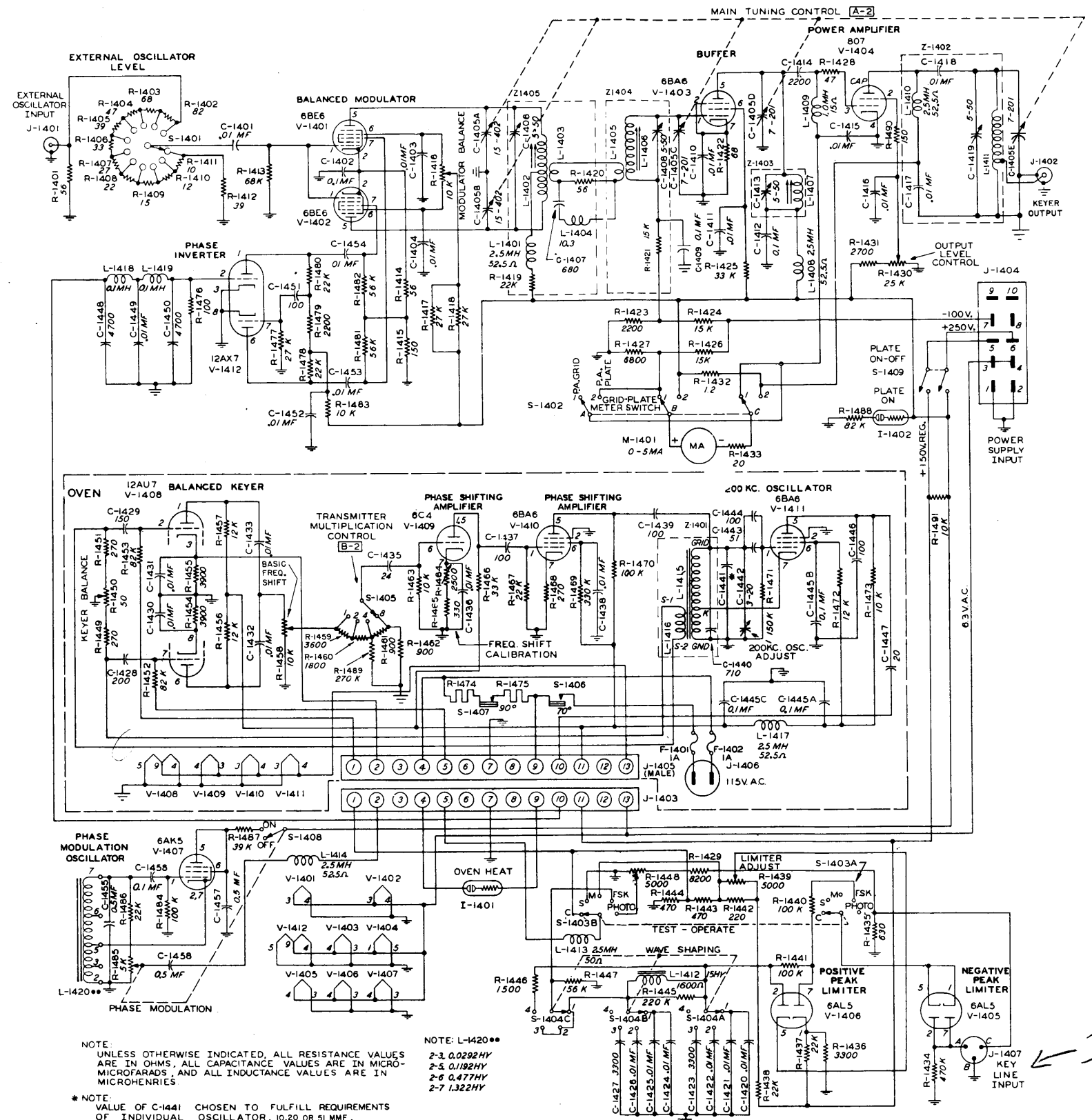
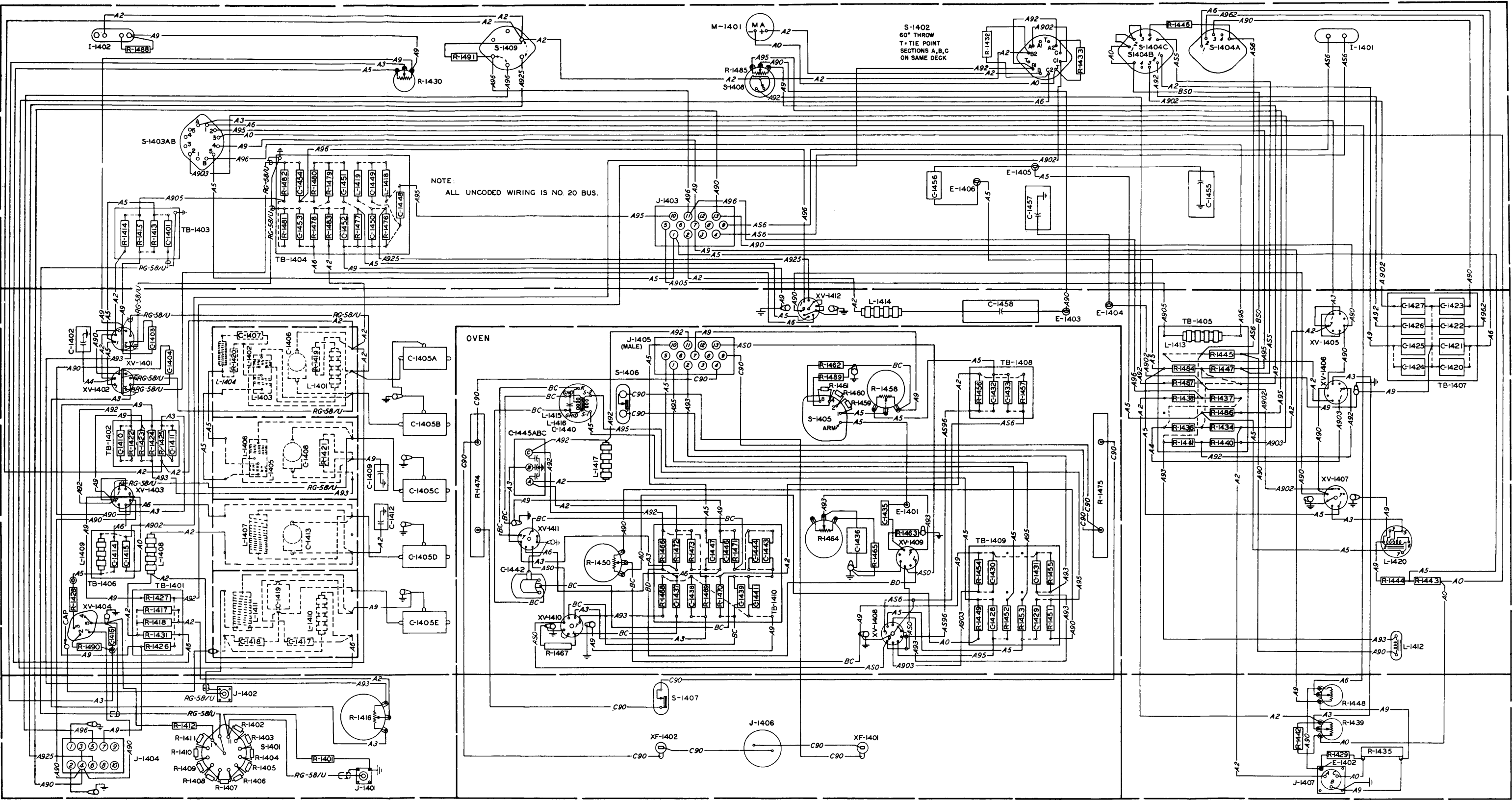
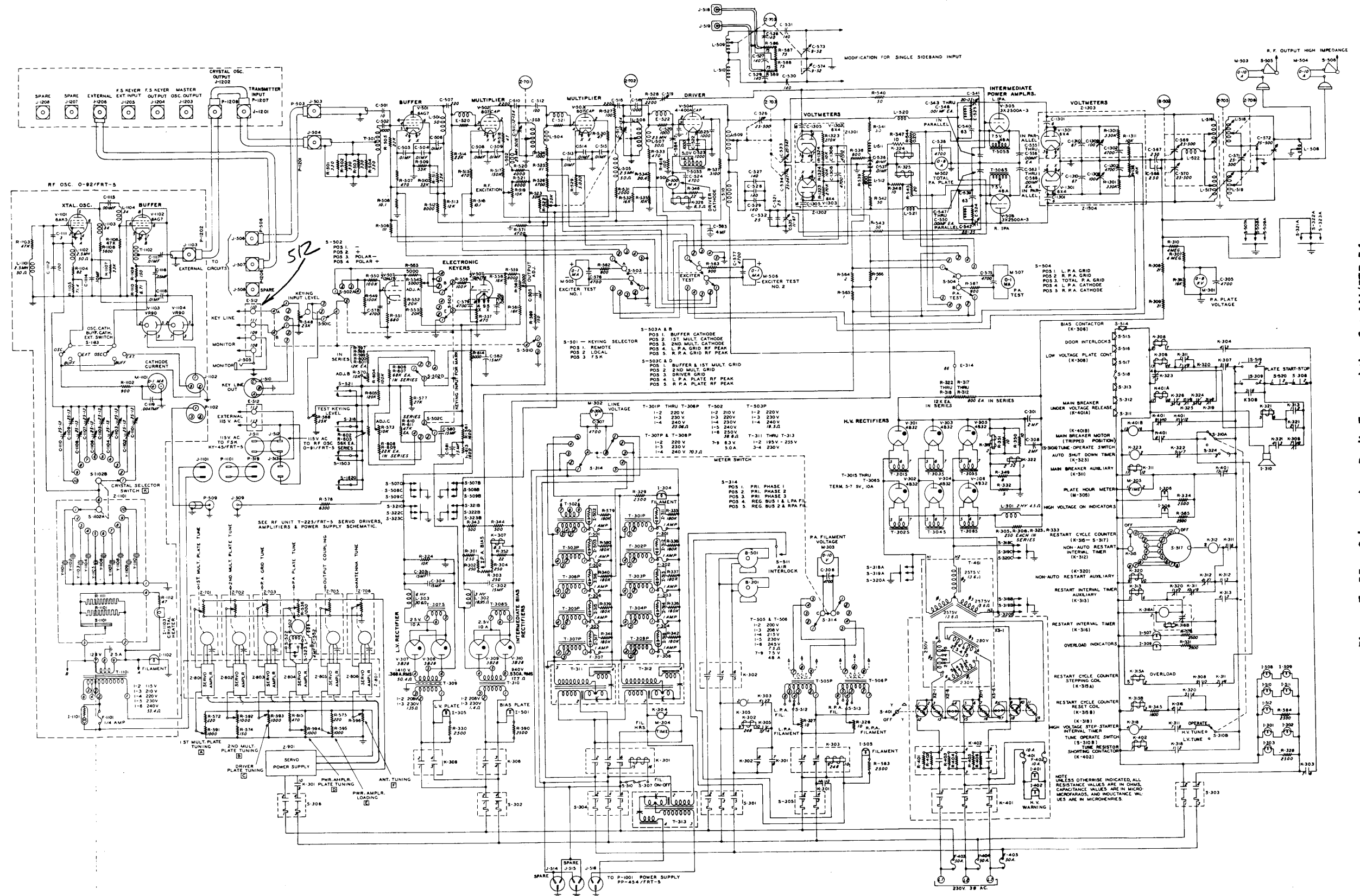


Figure 7-53. Schematic — Frequency Shift Keyer KY-45A/FRT-5





Figur 7-55. Schematic — Radio Transmitting Set AN/FRT-5A

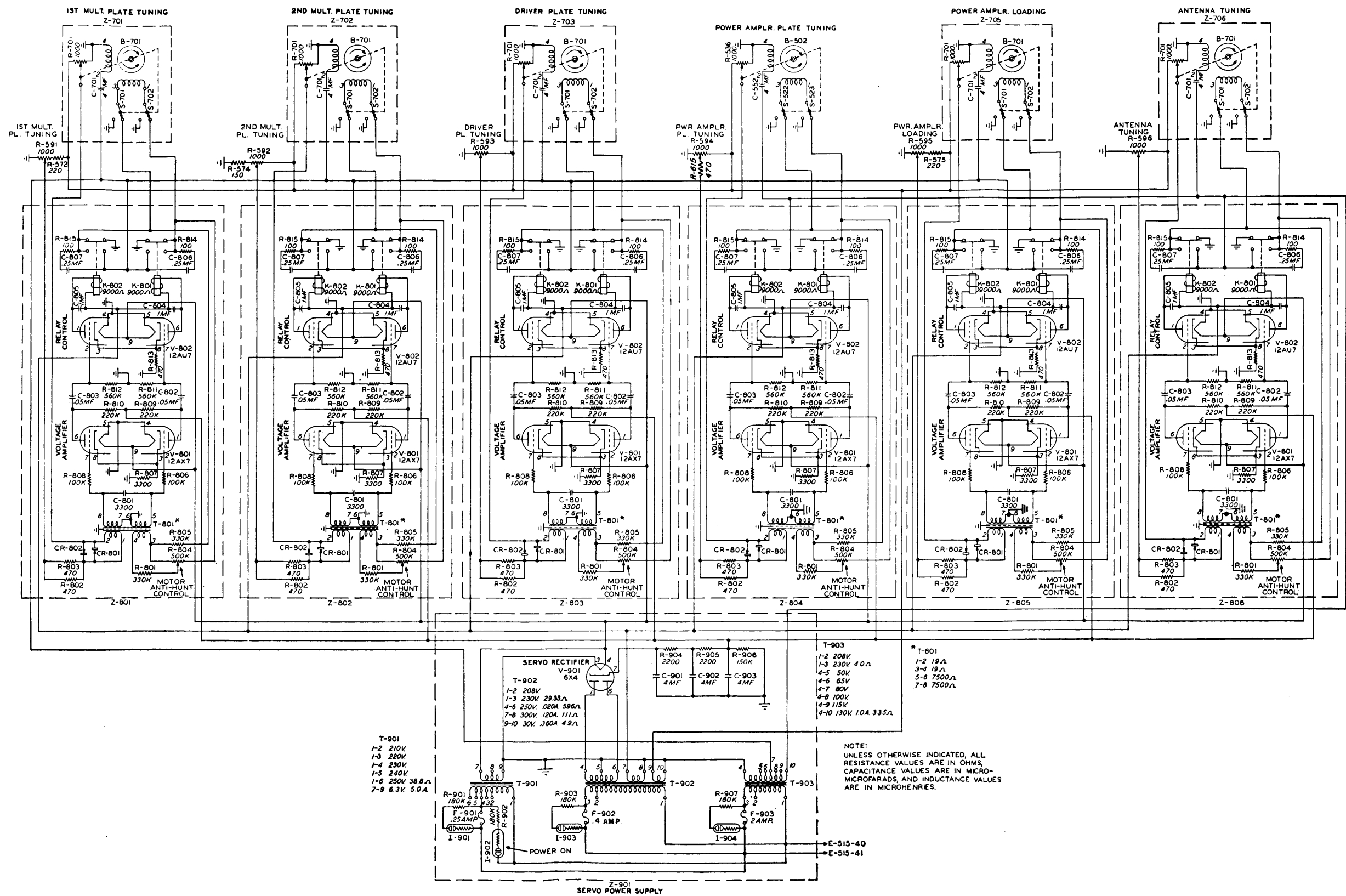


Figure 7-56. Schematic — RF Unit T-225A/FRT-5, Servo System Overall
(Servo Amplifiers, Drivers and Power Supply)

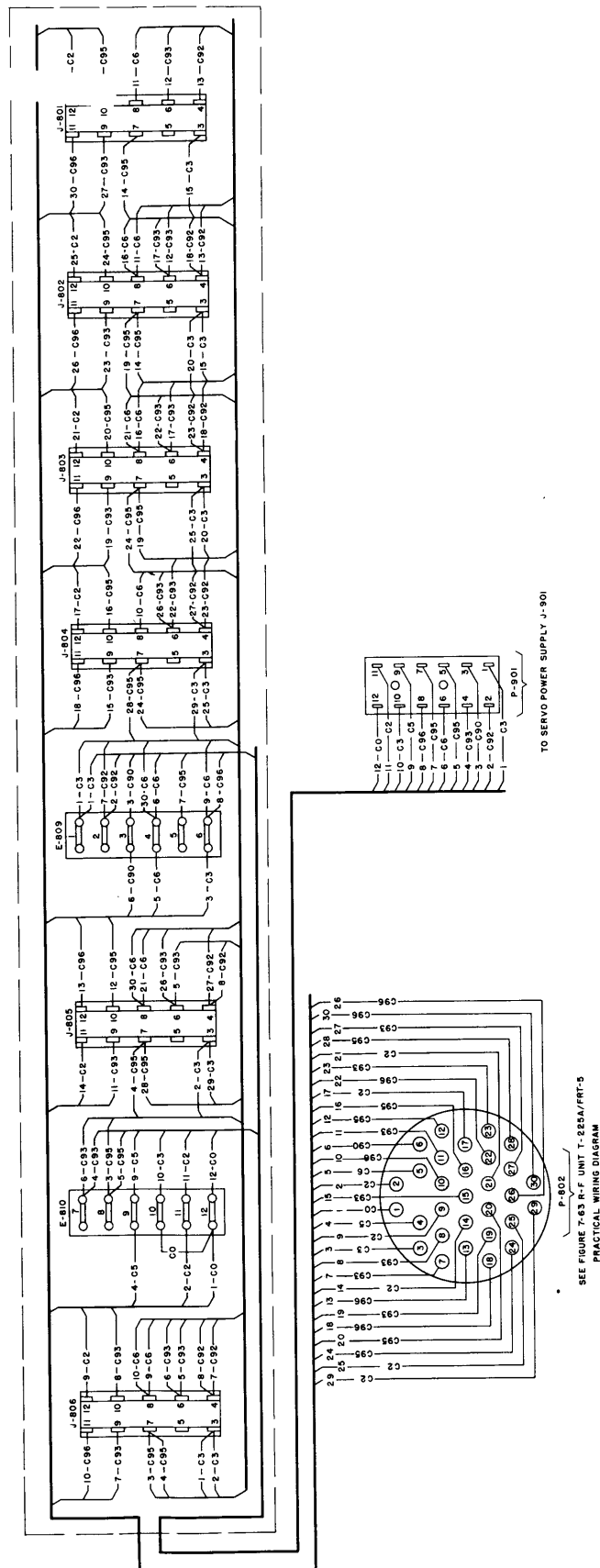


Figure 7-57. Wiring Diagram — RF Unit T-225A/FRT-5, Servo Amplifier Mounting Cabinet (Including Interconnecting Cables.)

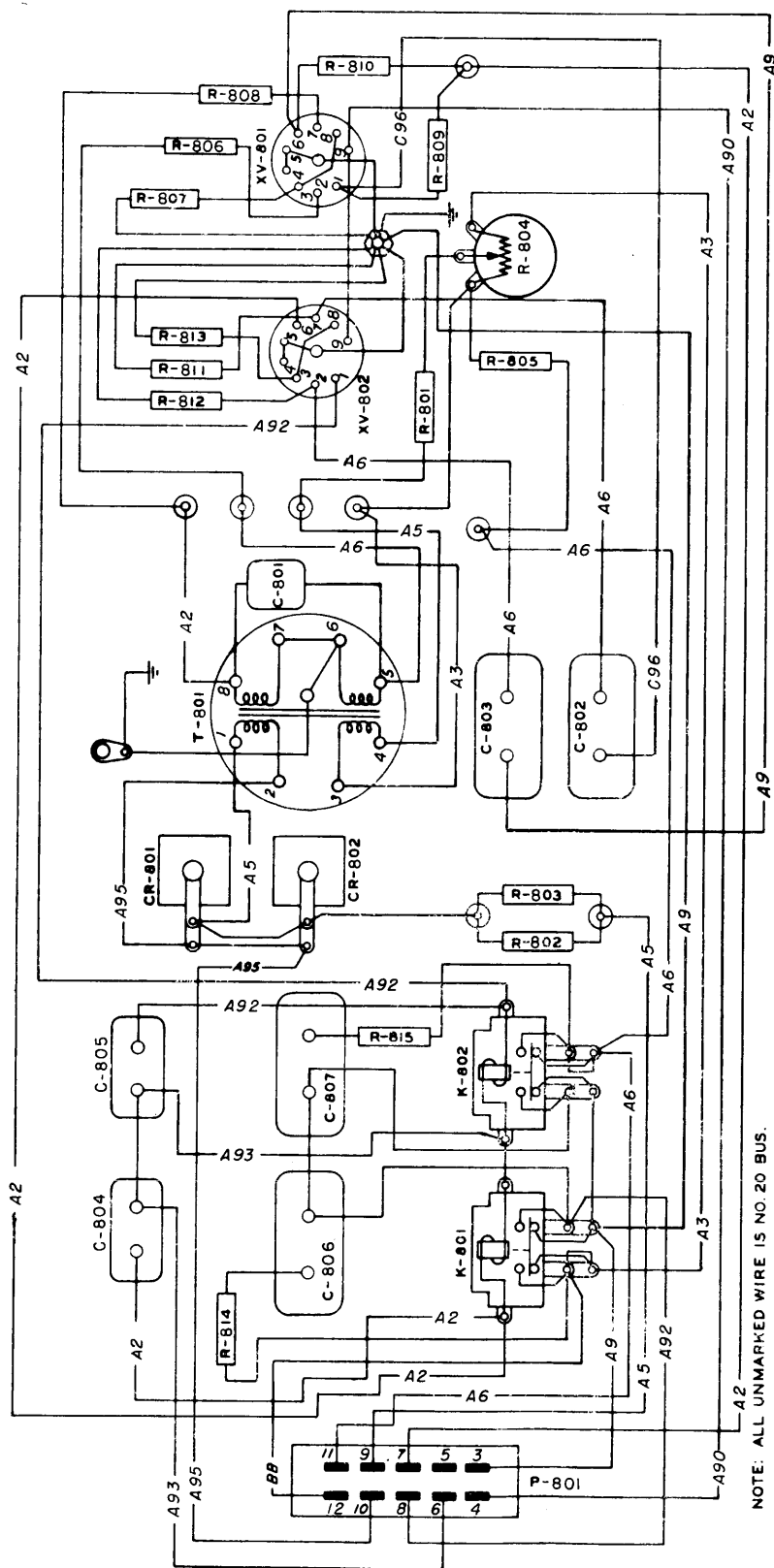


Figure 7-58. Wiring Diagram — RF Unit T-225A/FRT-5, Servo Amplifiers

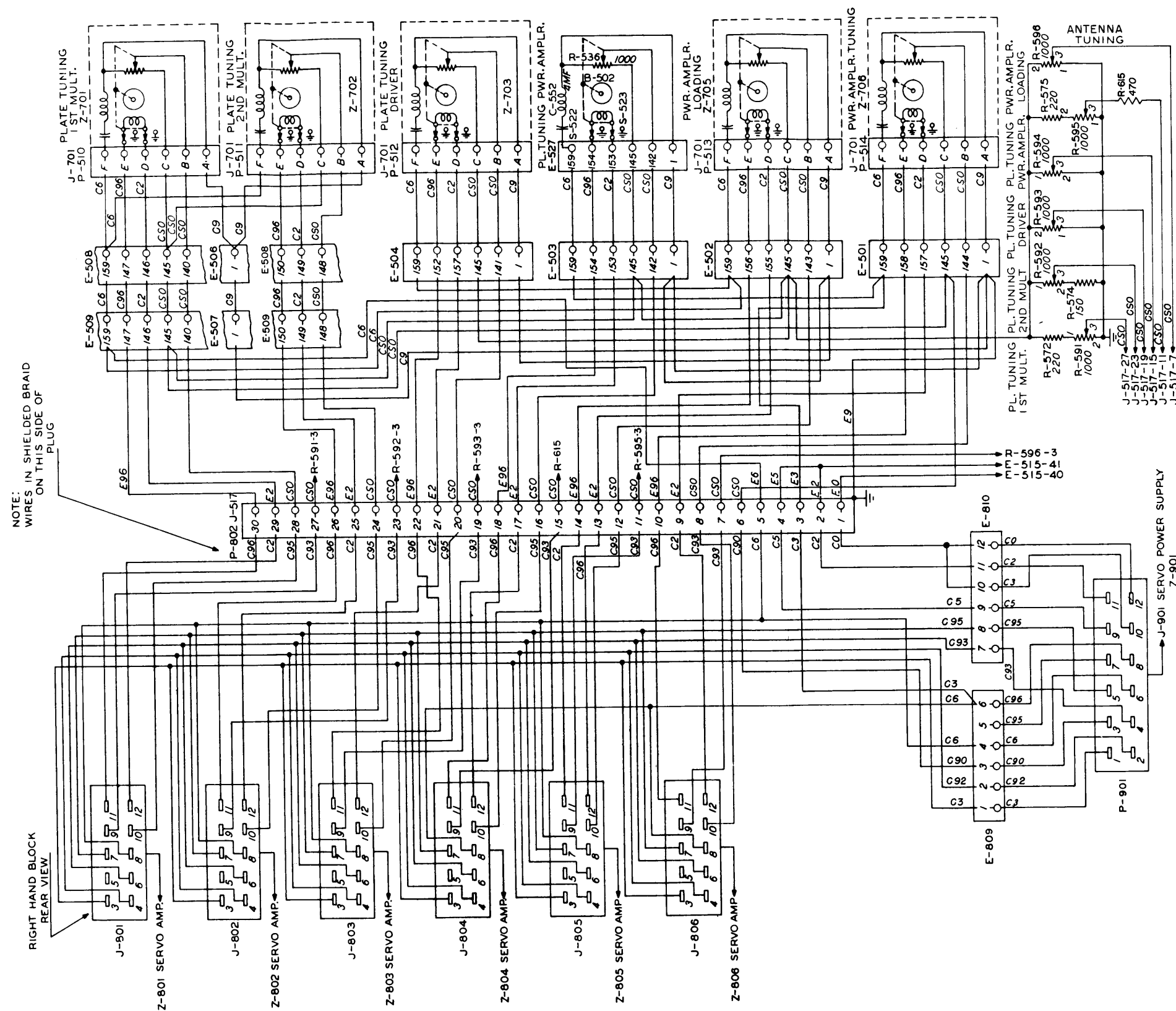


Figure 7-59. Cabling Scheme — RF Unit T-225A/FRT-5, Serv Amplifiers to S rvo Driv Units

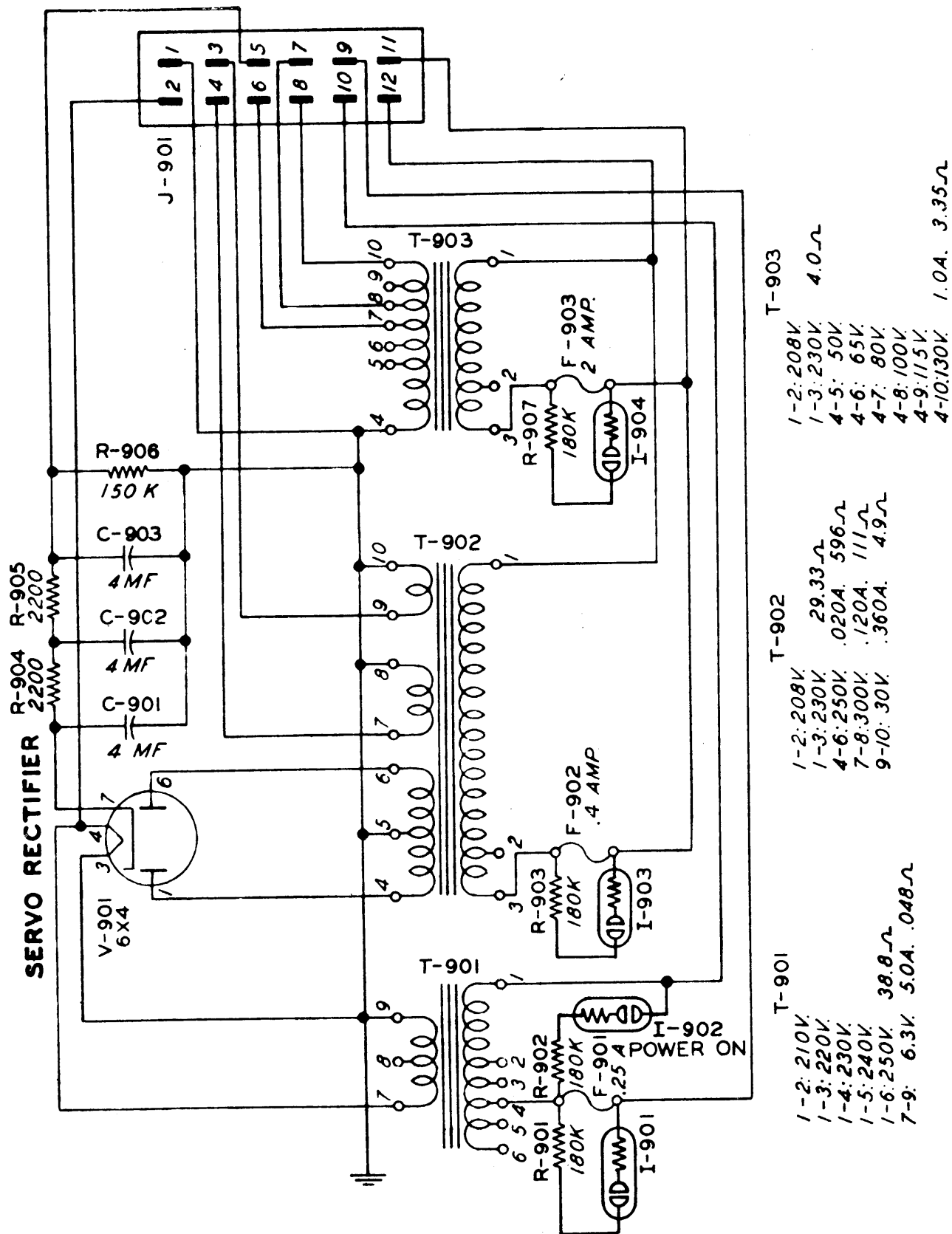
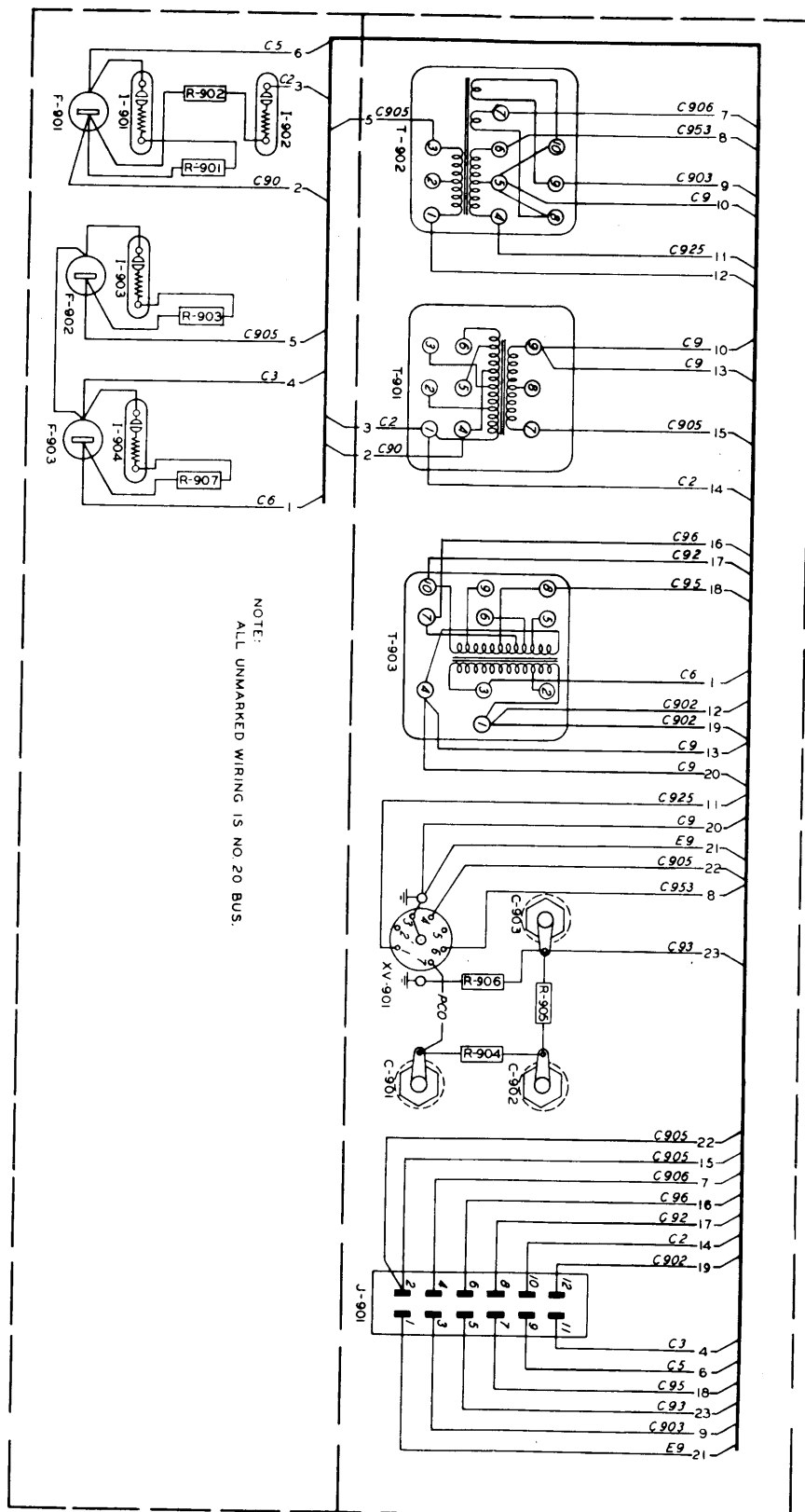
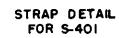


Figure 7-60. Sch matic — RF Units T-225A/FRT-5, Serv Power Supply



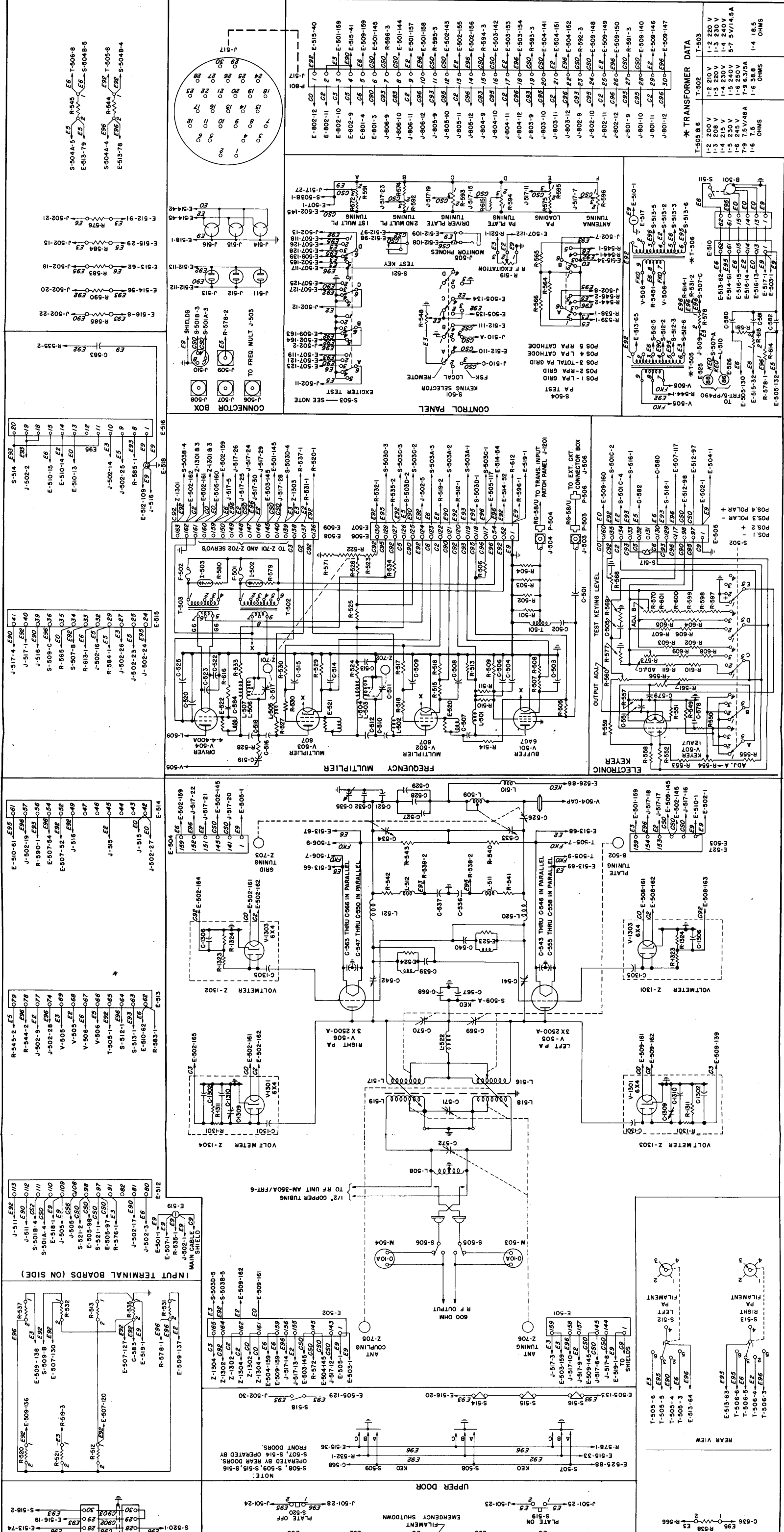
Figur 7-61. Wiring Diagram — RF Unit T-225A/FRT-5, Servo Power Supply

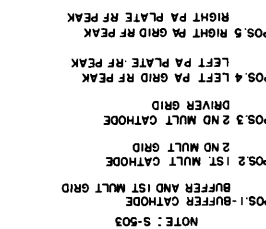


STRAP TERMS	DWG. NOS.
1-2	} FRB-32147-1A
5-6	
9-10	
2-3	} FRB-32145-1A
6-7	
10-11	
4-8	FRB-32149-1A
8-19	FRB-32146-2A
13-14	} FRB-32148-1A
16-17	

7-85
7-86

Figure 7-63. Cabling Schematic – RF Unit T-225A/FRT-5





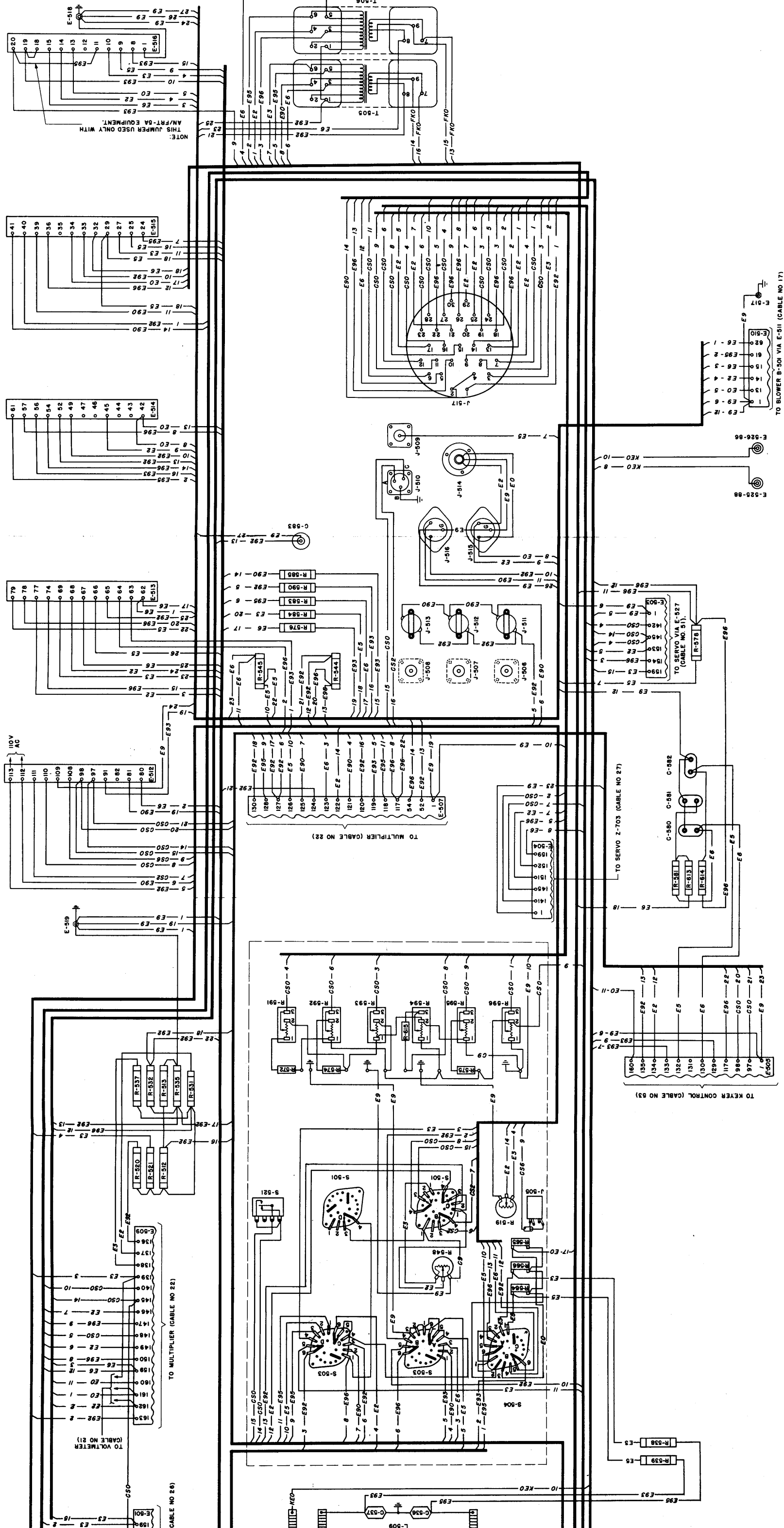
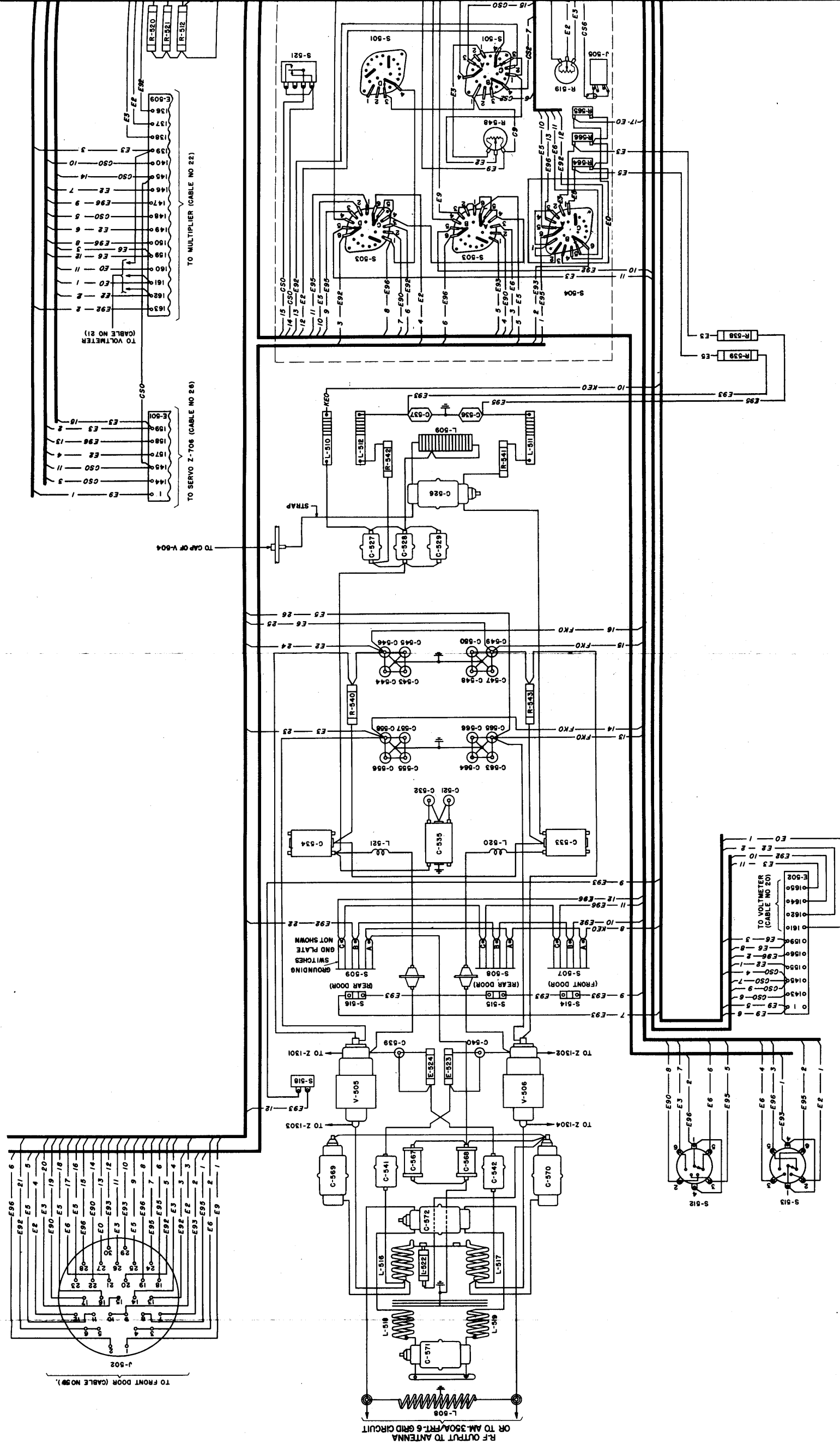


Figure 7-64. Wiring Diagram - RF Unit T-225A/FRT-5



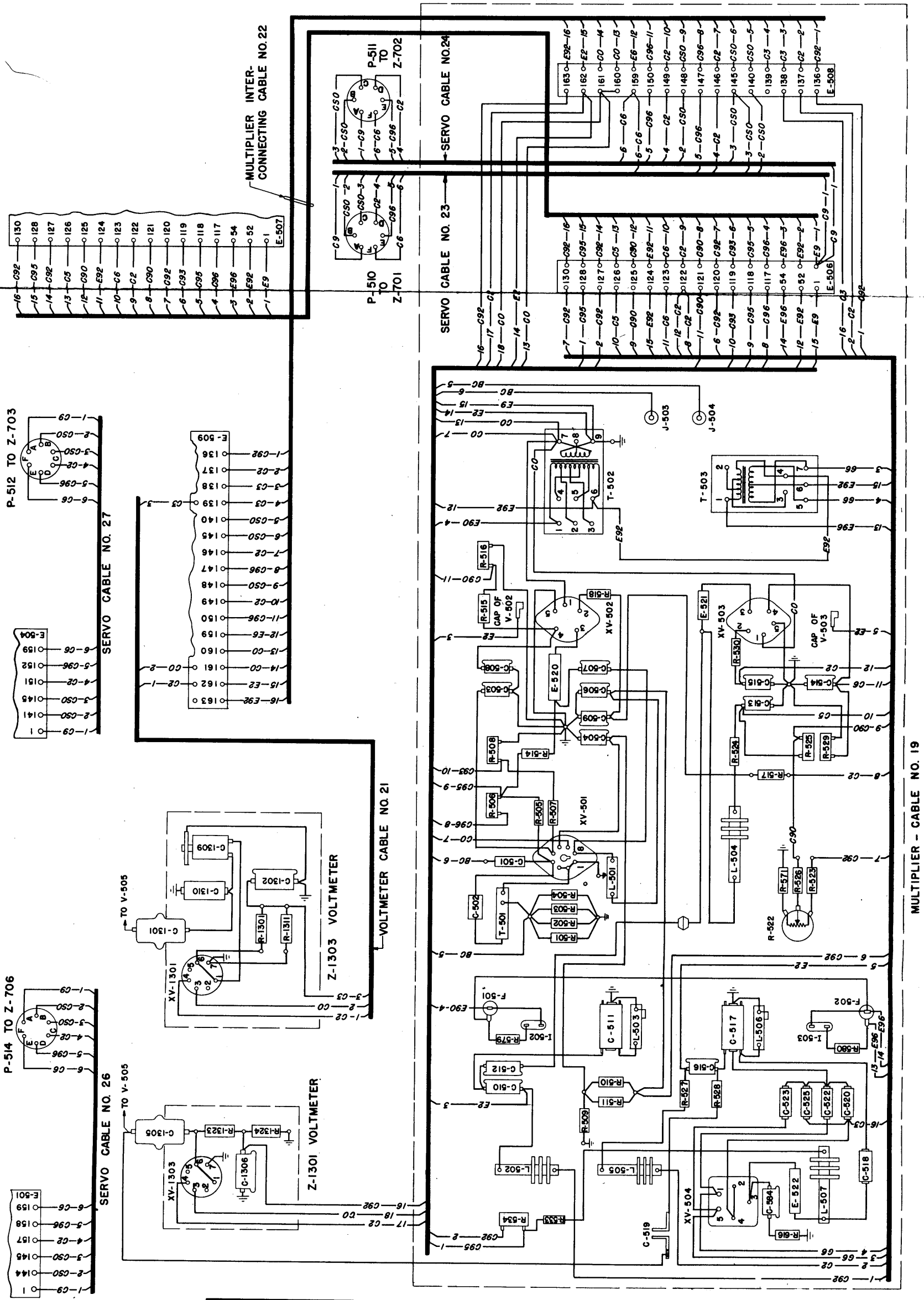


Figure 7-64. Wiring Diagram - RF Unit T-225A/FRT-5



Figur 7-65. Cabling Schematic - Power Supply PP-490A/FRT-5

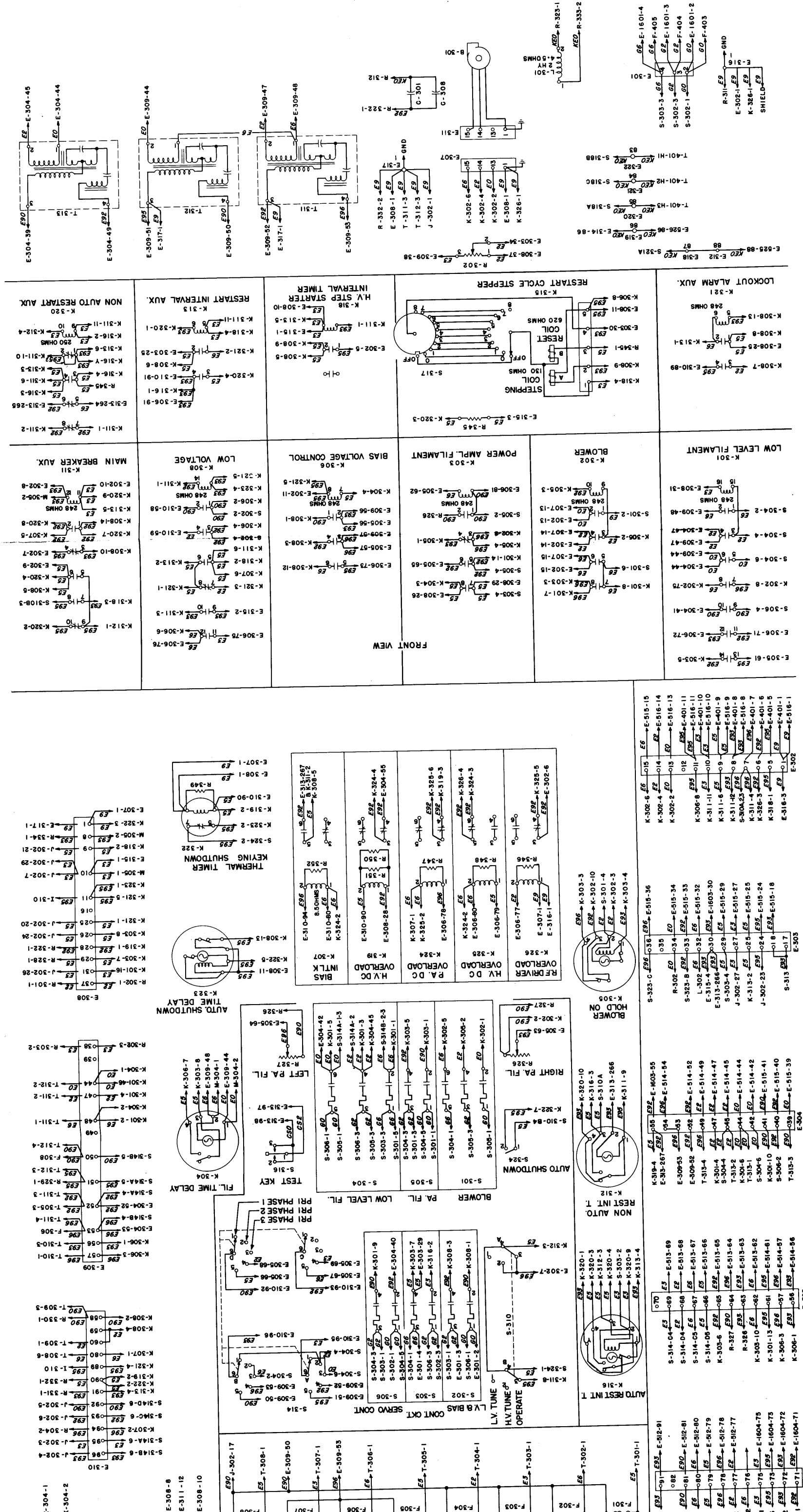
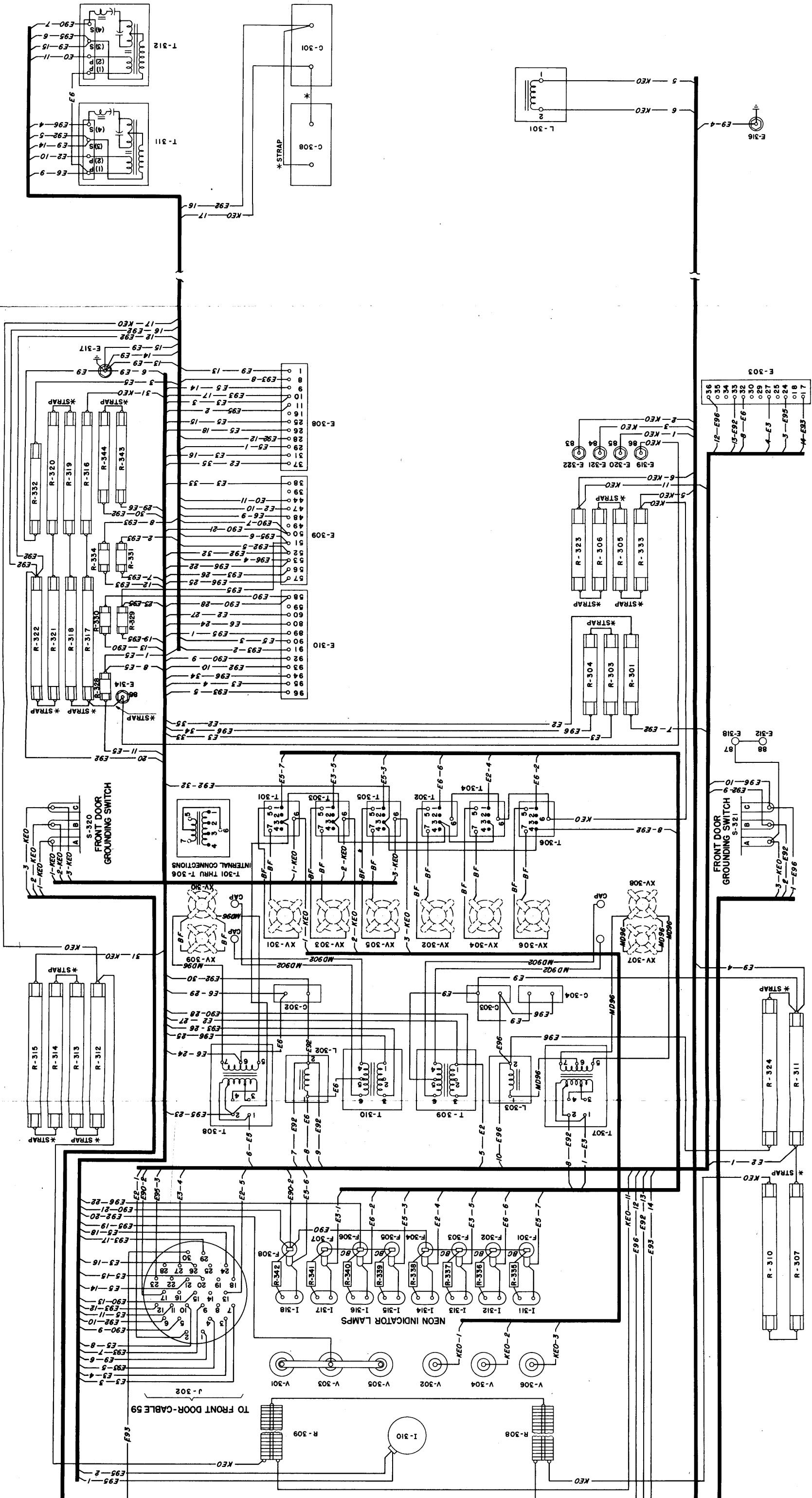


Figure 7-66. Wiring Diagram - P w r Supply PP-490A/FRT-5

MAIN CABLE PART I (CABLE NO.5)



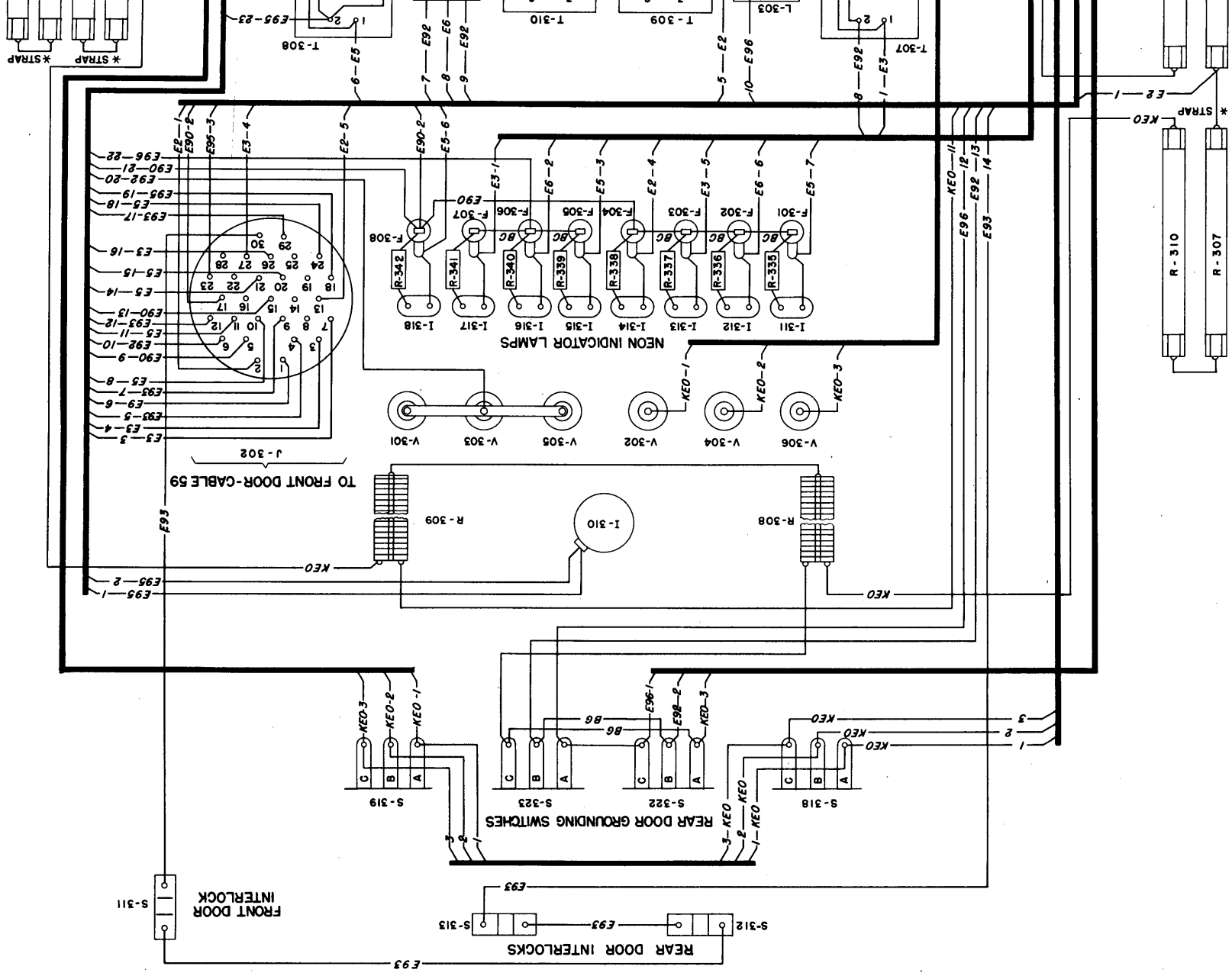
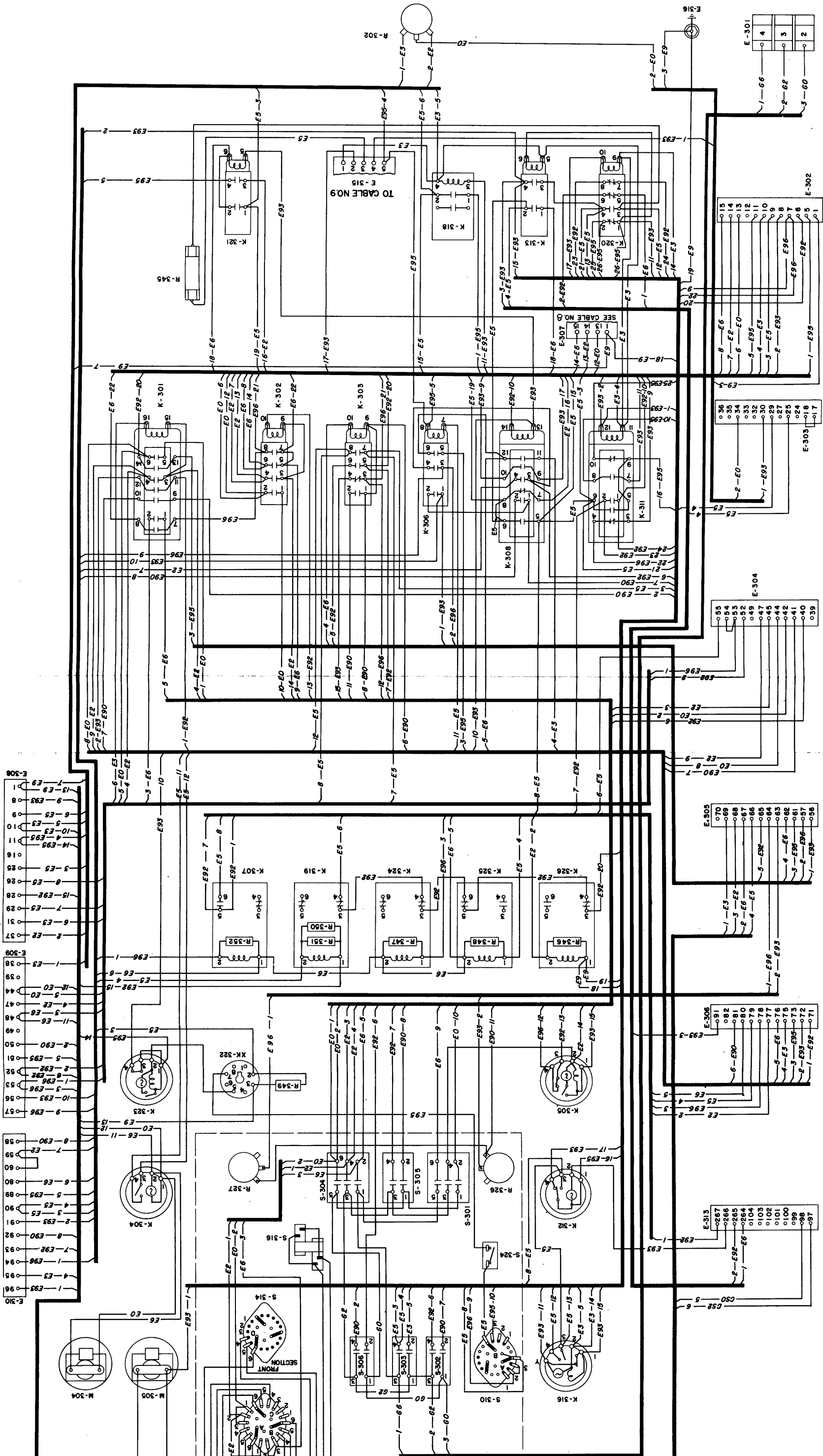
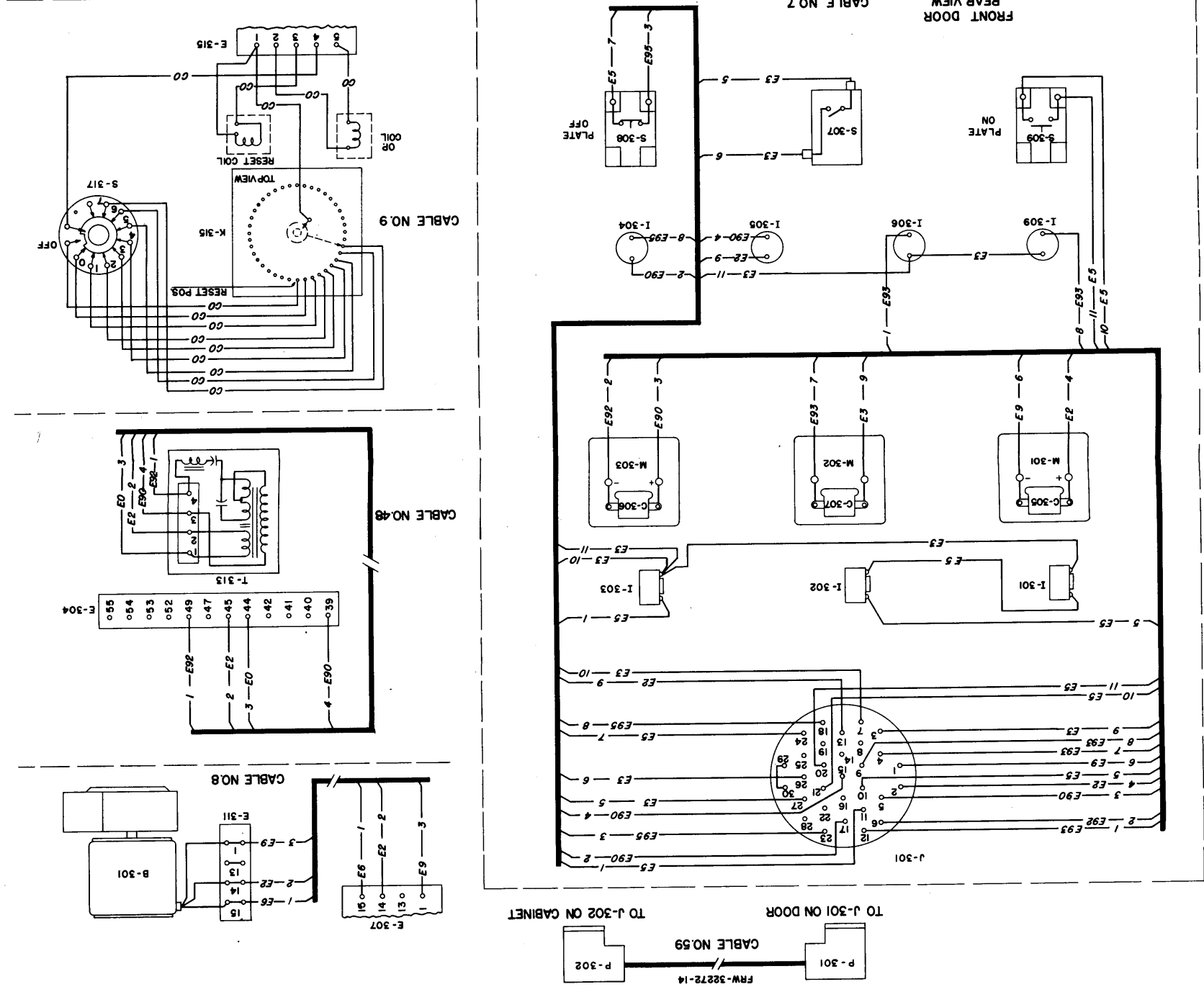


Figure 7-66. Wiring Diagram - P w r Supply PP-490A/FRT-5

MAIN CABLE, PART 2 (CABLE NO.6)





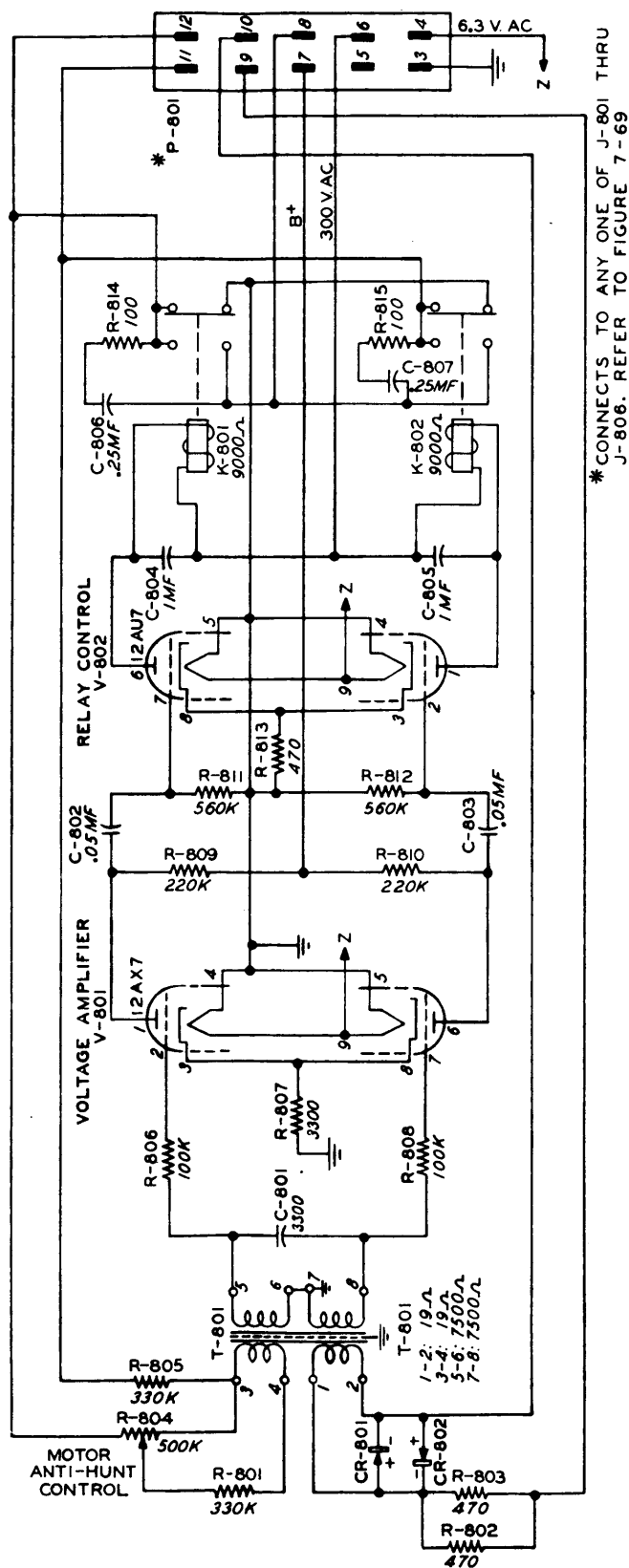
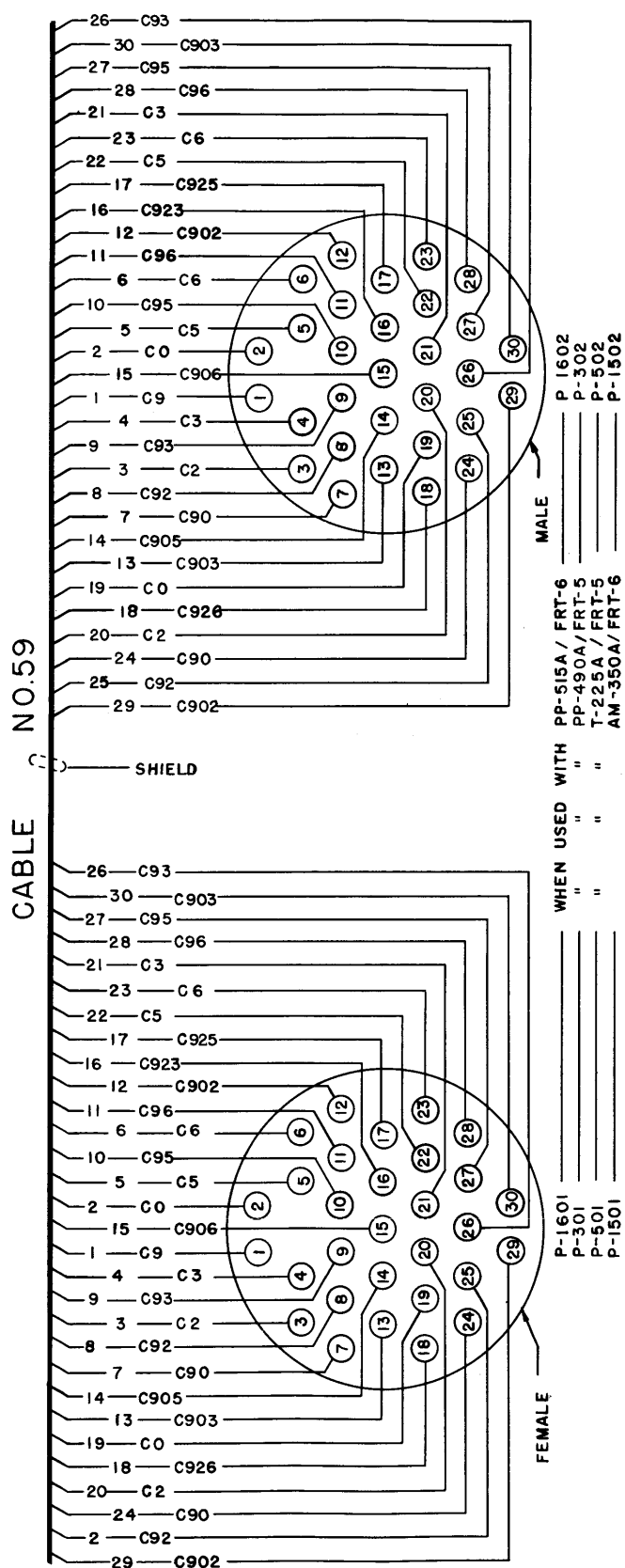
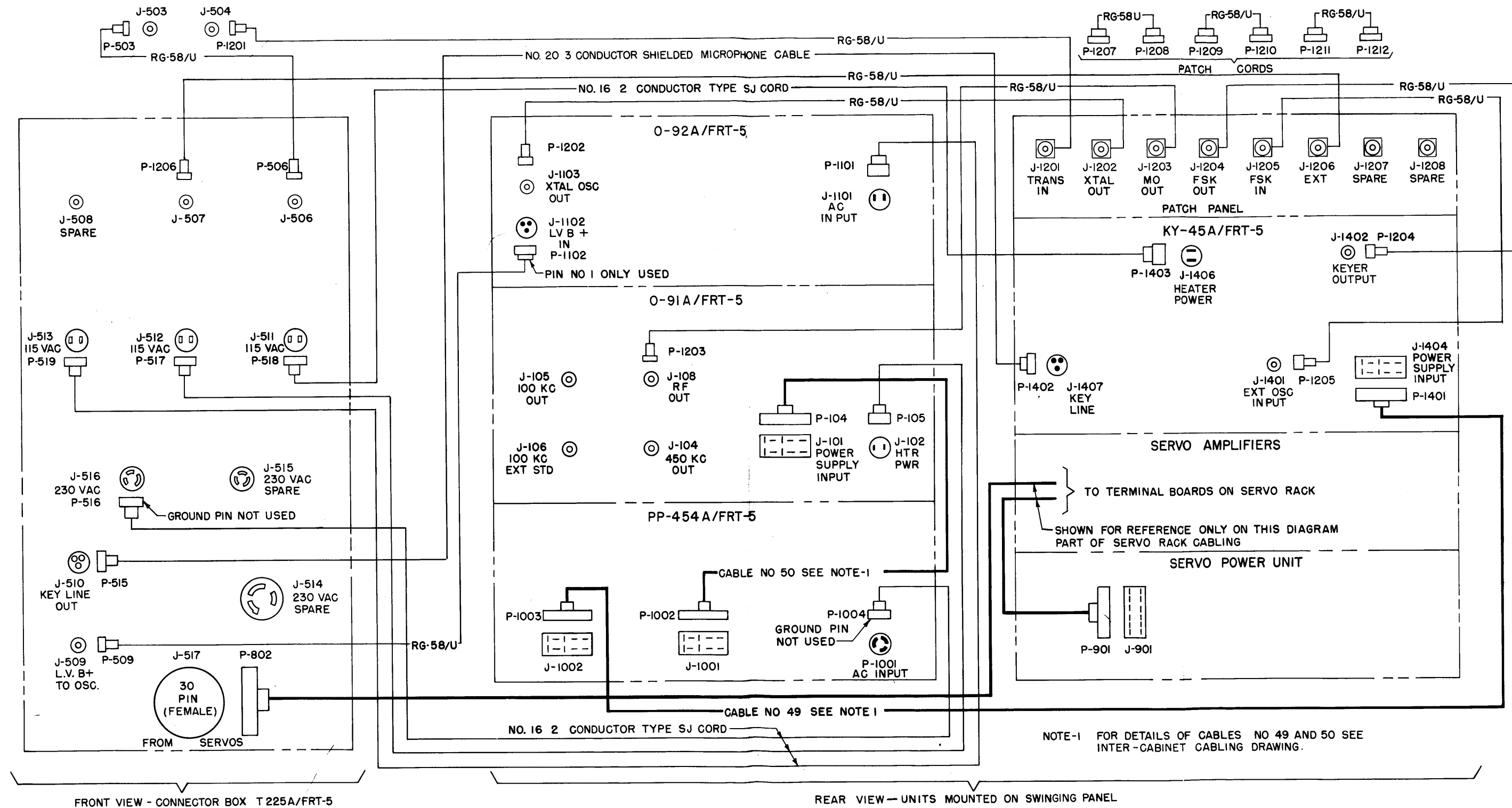


Figure 7-67. Schematic — RF Unit T-225A/FRT-5, Serv Amplifiers



Figur 7-68. Wiring Diagram - Front Door Hing Cabl , RF Unit
T-225A/FRT-5 and P wer Supply PP-490A/FRT-5



Figur 7-69. Interconnection Diagram - RF Unit T-225A/FRT-5, Swinging Panel I to Front

SECTION 8

PARTS AND SPARE PARTS LIST (AND MISCELLANEOUS TABLES)

LIST OF TABLES

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Table 8-4. Table of Replaceable Parts.

Table 8-5. Maintenance Parts Kit.

Table 8-6. Cross Reference Parts List.

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Table 8-8. List of Manufacturers.

TABLE 8-2. SHIPPING WEIGHTS AND DIMENSIONS OF SPARE PARTS BOXES (Including C nt nts)

EQUIPMENT SPARES				STOCK SPARES			
Shipping Box Number	Overall Dimensions			Shipping Box Number	Overall Dimensions		
	Height	Width	Depth		Height	Width	Depth
11	18	47	19	118	198	9.3	
12	18	47	19	180	9.3		
13	18	47	19	110	9.3		

NOTE: Unless otherwise stated, all dimensions are in inches, volume in cubic feet and weights in pounds.

TABLE 8-1. WEIGHTS AND DIMENSIONS OF SPARE PARTS CHESTS (Including C nt nts)

EQUIPMENT SPARES				STOCK SPARES			
Spare Parts Chest Number	Overall Dimensions			Spare Parts Chest Number	Overall Dimensions		
	Height	Width	Depth		Height	Width	Depth
1	15 1/8	43 1/8	16 3/8				
2	15 1/8	43 1/8	16 3/8				
3	15 1/8	43 1/8	16 3/8				

TABLE 8-3. LIST OF MAJOR UNITS

SYMBOL GROUP	QUANTITY	NAME OF MAJOR UNIT	STANDARD NAVY STOCK NUMBER	NAVY TYPE DESIGNATION
101—299	1	RF Oscillator	F17-T-78219-9001	O-91A/FRT-5
301—399	1	Power Supply		PP-490A/FRT-5
401—499	1	Power Control		C-587A/FRT-5
501—599	1	Power Transformer (T401)		TF-122/U
601—699	1	RF Unit		T-225A/FRT-5
701—799	1	Servo Drive Unit (Part of T-225A/FRT-5)		—
801—899	5	Servo Drive Unit (Part of RF Unit)		—
901—999	6	Servo Amplifiers (Part of RF Unit)		—
1001—1099	1	Servo Power Supply (Part of RF Unit)		—
1101—1199	1	Power Supply		PP-454A/FRT-5
1201—1299	1	RF Oscillator		O-92A/FRT-5
1301—1399	4	Patch Panel (Part of T-225A/FRT-5)		—
1401—1499	1	Voltmeter (Part of RF Unit)		—
		Frequency Shift Keyer		KY-45A/FRT-5

TABLE 8-4. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
B101	N17-M-56804-9871	MOTOR, AC: Navy type -212034; c/o motor and attached reduction gear box; 2-9/16" wd x 2-9/16" h x 2-15/16" lg excl shaft; motor: squirrel-cage type, 0.136 hp, 1150 rpm; closed frame; -20°C to +50°C (-4°F to +122°F) ambient, 200 v AC, 60 cps, 2-phase, 0.10 amp; FTRC dwg FRA-32933-1.	C126 centering (AFC)
B301	N17-B-21189-4245	BLOWER: Navy type -212036; centrifugal vane; electric motor oper; steel wheel with 52 blades; unguarded; motor; 1/6 hp, 1425/1725 rpm, at 50/60 cps, 1 ph, 230 v; 630 cfm free air delivery, single speed; direct drive; counter clockwise upblast discharge; steel housing; CATC#B-12.	Circulates cooling air through the power supply cabinet
B501	N17-B-21186-875	BLOWER: Navy type -212035; centrifugal vane; electric motor driven; 58 mild steel blades; 1410 cfm at 1 1/2" S.P. and 1642 rpm max; unguarded; motor (B501B) 3/4 hp, 1750 rpm, 60 cps, 3 ph, 220 v; adj outlet; speed adj to 1642 rpm max; belt (B501A) drive; motor sheave 4.0"/5.0" PD, fan sheave 5.2" PD; counter-clockwise upblast; steel housing; CCF #90-EP-CCWUBD.	Circulates cooling air through RF unit cabinet
B501A	2Z601-5 N33-B-4400 60-286223586	BELT, "V": composition; 0.3" wd inside x 0.5" wd outside x 9/32" thk x 28" lg inside x 30" lg outside; 5 cord, single row; Browning Mfg Co. type FHP-128.	Power transfer, motor to blower (B501) impeller
B501B	3H3000A75-6 N17-M-57281-5575 1760-348177618	MOTOR, AC: induction type; 3/4 hp, 1725 rpm; closed frame; continuous duty, 55°C temp rise; pulley not included, shaft 3/4" diam 2-5/16" from frame; sleeve bearings, 208-220 v AC, 60 cps, 3 ph, 2.4 amp per ph, 85% pf; G. E. Co. frame #73D; fixed base; CG#5K73DC2654.	Blower B501 drive power
B501C	2Z8552-67 N77-S-14909-3725 1760-295663248	BEARING, sleeve; graphited bronze; for 15/16" diam shaft; Randall Graphite Bearing Co. type SL-240.	For B501 impeller shaft
B502	3H3000-178 N17-M-56801-3647 1760-373734281	MOTOR, AC: Navy type -211454; induction type, low inertia; max power output 10 watts at 2000 rpm, no speed control; dustproof encl frame; 2 poles; -40°C to +55°C ambient, 65°C temp rise over 55°C ambient, continuous; no int protective devices, low alt use; no pulley; shaft 9/16" lg FMS with #6-40 NF-2 thrd, one end, and 3/8" lg FMS x 3/16" diam with 7/16" lg x 3/32" wd flat, other end; 115/115 v, 0.30 amps, 60 cps, 2 phase; horiz mtg; CDA #FPE-49-7.	Servo drive for tuning PA plate tank coils L516 and L517
B701A	N17-M-56846-1784	MOTOR, AC: Navy type -211052; induction type, low inertia; max power output 5 watts at 2000 rpm, no speed control dust-proof encl frame; 2 poles; -40°C to +55°C ambient, 65°C temp rise over 55°C ambient, continuous; no int protective devices; low alt use; no pulley; shaft 1/2" lg FMS with #4-48 NF-2 thrd, one end, and 1-3/16" lg FMS x 5/32" diam round with no flat, other end; 75/115 v, 0.11/0.16 amps, 60 cps, 2 phase; horiz mtg; CDA #FPE-25-11 modified (shortened shaft) per FTRC dwg #503-8632-002.	Servo drive motor for Z701
B701B	—	Same as B701A	Servo drive motor for Z701
B701C	—	Same as B701A	Servo drive motor for Z703
B701D	—	Not Used	
B701E	—	Same as B701A	Servo drive motor for Z705

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
B701F	—	Same as B502	Servo drive motor for Z706
C101	3K3010224 N16-C-31095-6644 3330-376120000	CAPACITOR, fixed: mica; JAN type CM30B102M; 1000 mmf, $\pm 20\%$; 500 vdcw; spec JAN-C-5.	Coupling, J106 to external-internal switch
C102A	3D9100-290 N16-C-17082-7801 3330-314693017	CAPACITOR, fixed: ceramic; JAN type CC35CH101K; 100 mmf $\pm 10\%$; neg temp coef 0 (tol plus 60 minus 110) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Padding for C103 in 100-kc crystal standard
C102B	3D9047-54 N16-C-16538-7801 3330-313430314	CAPACITOR, fixed: ceramic; JAN type CC35CH470K; 47 mmf $\pm 10\%$; neg temp coef 0 (tol plus 60 minus 110) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Padding for C103 in 100-kc crystal standard
C103	N16-C-64232-8500	CAPACITOR, variable: ceramic; JAN type CV12D121; rotary type, 20 to 125 mmf; 500 vdcw; rated temp coef neg 650 mmf/mf/°C; spec JAN-C-81.	Crystal calibration in 100-kc crystal standard
C104	3K2047124 F-16-C-30119-6756 3330-376035200	CAPACITOR, fixed: mica; JAN type CM20B471M; 470 mmf, $\pm 20\%$; 500 vdcw; spec JAN-C-5.	Coupling 100 kc crystal osc to grid #3 of V101
C105	3D9075-49 N16-C-16853-1562 3330-313664316	CAPACITOR, fixed: ceramic; JAN type CC30UK750J; 75 mmf $\pm 5\%$; neg temp coef 750 (tol +250, -510) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	By-passes harmonics of 100 kc at grid of V129
C106	3D9020-63 N16-C-16081-6531 3330-313162524	CAPACITOR, fixed: ceramic; JAN type CC30CK200J; 20 mmf, $\pm 5\%$; temp coef 0 (tol +250, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling output of V101 to grid of V129
C107	3K2022124 N16-C-29381-1556 3330-376016600	CAPACITOR, fixed: mica; JAN type CM20B221M; 220 mmf, $\pm 20\%$; 500 vdcw; spec JAN-C-5.	Part of time constant circuit V102
C108	—	Same as C107	Part of time constant circuit V102
C109	3K3510324 N16-C-35627-7705 3330-376144060	CAPACITOR, fixed: mica; JAN type CM35B103M; 10,000 mmf, $\pm 20\%$; 300 vdcw; spec JAN-C-5.	Cathode by-pass (V102)
C110	3D9100-230 N16-C-17077-1226 3330-313889957	CAPACITOR, fixed: ceramic; JAN type CC30UJ101J; 100 mmf, $\pm 5\%$; neg temp coef 750 (tol +120, -350) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling V107 to V108
C111	—	Same as C106	Coupling V102 to V103
C112	—	Same as C104	Part of time constant circuit V103
C113	—	Same as C104	Part of time constant circuit V103
C114	—	Same as C109	Cathode by-pass (V103)
C115	—	Same as C110	Coupling V103 to V104

C116	N16-C-54467-1572	CAPACITOR, fixed: paper; JAN type CP53B5FF104X, plus two #4-40 clinch nuts (E120) in mtg holes; 3 sect, 100,000 mmf per sect, +40% -13%; 600 vdcw; spec JAN-C-25, except clinch nuts; FTRC dwg #FRA-31570-1.	(See C116A, C116B, C116C)
C116A	—	(Part of C116)	By-pass cathode (V104)
C116B	—	(Part of C116)	By-pass screen grid (V104)
C116C	—	(Part of C116)	Decoupling in plate supply V102 and V103
C117	3D9005-121 N16-C-15628-1344 3330-312860723	CAPACITOR, fixed: ceramic; JAN type CC30CK050D; 5 mmf, $\pm 1/2$ mmf; temp coef 0 (tol +250, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling V104 to V105
C118	—	Same as C116	(See C118A, C118B, C118C)
C118A	—	(Part of C118)	By-pass V105 cathode
C118B	—	(Part of C118)	By-pass V105 screen grid
C118C	—	(Part of C118)	Decoupling on plus 250-volt line
C119	—	Same as C109	Plate decoupling in plate tank V104
C120	N16-C-63507-6401	CAPACITOR, variable: Navy type -484974; air; plate meshing, 4 sect; 241.2 mmf per sect; air gap .0185"; shaft $1/4$ " diam x 2-5/32" lg; FTRC dwg #920-0057-00.	(See C120A, C120B, C120C, C120D)
C120A	—	(Part of C120)	Tunes plate tank of V105
C120B	—	(Part of C120)	Tunes plate tank of V104
C120C	—	(Part of C120)	Tunes plate tank V113
C120D	—	(Part of C120)	Tunes plate tank V112
C121	—	Same as C109	Plate decoupling in plate tank V105
C122	—	Same as C106	Coupling V102 to V106
C123	—	Same as C116	(See C123A, C123B, C123C)
C123A	—	(Part of C123)	By-pass screen grid V106
C123B	—	(Part of C123)	By-pass cathode V106
C123C	—	(Part of C123)	Plate decoupling in plate tank V106
C124	—	Same as C110 (Part of T103)	Tuning T103 primary in plate of V106
C125	3DA100-804 N16-C-54467-1577 3330-317760029	CAPACITOR, fixed: paper; JAN type CP54B5FF104X; 3 sect; +40%, -15%; 100,000 mmf per sect; 600 vdc; spec JAN-C-25.	(See C125A, C125B, C125C)
C125A	—	(Part of C125)	Decoupling in screen lead #3 on J113
C125B	—	(Part of C125)	Decoupling in plus 250 volt line

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C125C	—	(Part of C125)	Decoupling in plus 150 volt line
C126	—	CAPACITOR ASSEMBLY: consists of C126A, C126B and hardware; as listed in FTRC dwg FRL-31042-1. NOT a replaceable part.	Motor driven tuning capacitor for master oscillator
C126A	N16-S-83701-1001	STATOR, capacitor: two plates mtd on two #4-40 standoffs; variable; 1½" lg x 1-1/16" wd x 1" h o/a; FTRC dwg FRA-30974-1.	Part of C126
C126B	N16-R-94402-1751	ROTOR, capacitor: two plates, assembled with hub and switch cam; variable; 1½" lg x 1" wd x 1½" d o/a; FTRC dwg FRA-30973-1.	Part of C126
C127	N16-C-32256-3244 3330-376134200	CAPACITOR, fixed: mica; JAN type CM30B332M; 3300 mmf, ±20%; 500 vdcw; spec JAN-C-5.	Coupling V107 to J105
C128A	3D9025V-82 N16-C-63965-2800	CAPACITOR, variable: ceramic; JAN type CV11B130; rotary, single sect; 3 to 13 mmf; 500 vdcw; rated temp coef minus 300 mmf/mf/°C; spec JAN-C-81.	Padder plate tank V105
C128B	—	Same as C128A	Padder plate tank V104
C128C	—	Same as C128A	Padder plate tank V113
C128D	—	Same as C128A	Padder plate tank V112
C129	3D9047-38 N16-C-16529-6533 3330-3113430288	CAPACITOR, fixed: ceramic; JAN type CC30CK470J; 47 mmf, ±5%; temp coef 0 (tol +250, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling V105 to V108
C130	—	Same as C129	Coupling V113 to V108
C131	—	Same as C116	(See C131A, C131B, C131C)
C131A	—	(Part of C131)	By-pass cathode V108
C131B	—	(Part of C131)	By-pass screen grid V108
C131C	—	(Part of C131)	Plate decoupling in plate tank V108
C132	—	Same as C102A (Part of T106)	Tuning T106 primary
C133	—	Same as C102A (Part of T106)	Tuning T106 primary
C134	—	Same as C102A (Part of T106)	Tuning T106 secondary
C135	—	Same as C102A (Part of T106)	Tuning T106 secondary
C136	—	Same as C116	(See C136A, C136B, C136C)
C136A	—	(Part of C136)	By-pass cathode V109
C136B	—	(Part of C136)	By-pass screen grid V109

C136C	—	(Part of C136)	Plate decoupling in plate tank V109
C137	—	Same as C102A (Part of T107)	Tuning T107 primary
C138	—	Same as C102A (Part of T107)	Tuning T107 primary
C139	—	Same as C102A (Part of T107)	Tuning T107 secondary
C140	—	Same as C102A (Part of T107)	Tuning T107 secondary
C141	—	Same as C116	(See C141A, C141B, C141C)
C141A	—	(Part of C141)	By-pass cathode V110
C141B	—	(Part of C141)	By-pass screen grid V110
C141C	—	(Part of C141)	Plate decoupling in plate tank V110
C142	—	Same as C102A (Part of T108)	Tuning T108 primary
C143	—	Same as C102A (Part of T108)	Tuning T108 primary
C144	—	Same as C102A (Part of T108)	Tuning T108 secondary
C145	—	Same as C102A (Part of T108)	Tuning T108 secondary
C146	—	Same as C116	(See C146A, C146B, C146C)
C146A	—	(Part of C146)	By-pass cathode V111
C146B	—	(Part of C146)	By-pass screen grid V111
C146C	—	(Part of C146)	Plate decoupling in plate tank V111
C147	—	Same as C102A (Part of T109)	Tuning T109 primary
C148	—	Same as C102A (Part of T109)	Tuning T109 primary
C149	—	Same as C102A (Part of T109)	Tuning T109 secondary
C150	—	Same as C102A (Part of T109)	Tuning T109 secondary
C151	—	Same as C109	By-pass bias resistor R153 grid V127
C152	—	Same as C104	By-pass suppressor grid V112
C153	—	Same as C125	(See C153A, C153B, C153C)
C153A	—	(Part of C153)	Plate decoupling in plate tank V112
C153B	—	(Part of C153)	By-pass cathode V112
C153C	—	(Part of C153)	By-pass screen grid V112
C154	—	Same as C106	Coupling V112 to V114
C155	—	Same as C125	(See C155A, C155B, C155C)
C155A	—	(Part of C155)	By-pass cathode V113

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C155B	—	(Part of C155)	By-pass screen grid V113
C155C	—	(Part of C155)	Decoupling on 250 volt line
C156	—	Same as C109	Plate decoupling in plate tank V113
C157	—	Same as C125	(See C157A, C157B, C157C)
C157A	—	(Part of C157)	By-pass screen grid V114
C157B	—	(Part of C157)	Plate decoupling in plate tank V114
C157C	—	(Part of C157)	By-pass cathode V114
C158	3D9051-42 N16-C-16595-1762 3330-313584268	CAPACITOR, fixed: ceramic; JAN type CC30PH510J; 51 mmf, $\pm 5\%$; neg temp coef 150 (tol $+60$, -140) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	By-pass grid V103
C159	3D9030-65 N16-C-16273-6532 3330-313330364	CAPACITOR, fixed: ceramic; JAN type CC30CK300J; 30 mmf $\pm 5\%$; temp coef 0 (tol $+250$, -340) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	Coupling V112 to V113
C160	—	Same as C104 (Part of T110)	Tuning T110
C161	—	Same as C104 (Part of T110)	Tuning T110
C162	—	Same as C104 (Part of T110)	Tuning T110
C163	—	Same as C101	Coupling T110 to V115
C164	3D9068-27 N16-C-16789-1562 3330-313625839	CAPACITOR, fixed: ceramic; JAN type CC30UK680J; 68 mmf, $\pm 5\%$; neg temp coef 750 (tol $+250$, -510) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	Part of time constant circuit (V115)
C165	—	Same as C164	Part of time constant circuit (V115)
C166	—	Same as C109	By-pass cathode V115
C167	—	Same as C106	Coupling V115 to V116
C168	—	Same as C129	Part of time constant circuit (V116)
C169	—	Same as C129	Part of time constant circuit (V116)
C170	—	Same as C109	Cathode by-pass (V116)
C171	—	Same as C109	Plate decoupling V116, V117, V118
C172	—	Same as C106	Coupling V116 to V117
C173	3D9039-40 N16-C-16401-6533 3330-313377192	CAPACITOR, fixed: ceramic; JAN type CC30CK390J; 39 mmf $\pm 5\%$; temp coef 0 (tol $+250$, -340) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	Part of time constant circuit (V117)

Part of time constant circuit (V117)			
Cathode by-pass (V117)	Same as C173	—	C174
By-pass V117 input	Same as C109	—	C175
Coupling V117 to V118	CAPACITOR, fixed; ceramic; JAN type CC30UK560K; 56 mmf, $\pm 10\%$; temp coef 750 (tol $+250$, -510) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	3D9056-36 N16-C-16670-6062 3330-313596161	C176
Part of low-pass filter in grids of V123	Same as C110	—	C177
Part of low-pass filter in grids of V123	Not Used	—	C178
Part of low-pass filter in grids of V124	Same as C101	—	C179
Part of low-pass filter in grids of V124	Same as C101	—	C180
Part of low-pass filter in grids of V123	Same as C101	—	C181
Part of low-pass filter in grids of V123	Same as C101	—	C182
Part of low-pass filter in grids of V124	Same as C109	—	C183
Part of low-pass filter in grids of V124	Same as C109	—	C184
Tuning T112	Same as C104 (Part of T112)	—	C185
Tuning T112	CAPACITOR, fixed; mica; JAN type CM20B331M; 330 mmf $\pm 20\%$; 500 vdcw; temp coef letter B; (part of T112); spec JAN-C-5.	3K2033124 N16-C-29723-9756 3330-376026000	C186
Couples plates of V125 and V126	Same as C129	—	C187
Coupling V125 to T111	CAPACITOR, fixed; mica; JAN type CM20B470M; 47 mmf, $\pm 20\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	3K2047024 N16-C-27587-4356 3300-376033400	C188
Coupling V125 to T111	Same as C188	—	C189
Coupling V126 to T111	Same as C188	—	C190
Coupling V126 to T111	Same as C188	—	C191
Tunes plate tank V127	Same as C104 (Part of T111)	—	C192
(See C193A, C193B, C193C)	CAPACITOR, fixed; paper; JAN type CP54B5FF104V; 3 sect; 100,000 mmf per sect, $+20\%$, -10% ; 600 vdcw; spec JAN-C-25, except clinch nuts in ea mtg hole; FTRC dwg FRA-30389-1.	N16-C-54460-4463 (plus clinch nuts)	C193
By-pass screen grid V127	(Part of C193)	—	C193A
By-pass cathode V127	(Part of C193)	—	C193B

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C193C	—	(Part of C193)	Plate decoupling in plate tank V127
C194	3D9012-72 N16-C-15953-6532 3330-313044153	CAPACITOR, fixed: ceramic; JAN type CC30CK120J; 12 mmf $\pm 5\%$; temp coef 0 (tol $+250, -340$) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	Coupling V127 to V128
C195	—	Same as C194	Feedback from V128 and V127
C196	—	Same as C110 (Part of T111)	Tuning plate tank V128
C197	—	Same as C129 (Part of T111)	Tuning plate tank V128
C198	—	Same as C116	(See C198A, C198B, C198C)
C198A	—	(Part of C198)	By-pass cathode V128
C198B	—	(Part of C198)	By-pass screen V128
C198C	—	(Part of C198)	Plate decoupling in plate tank V128
C199	—	Same as C186	Coupling V129 to V126
C200	—	Same as C109	Coupling V124 to V121
C201	—	Same as C116	(See C201A, C201B, C201C)
C201A	—	(Part of C201)	By-pass cathode V129
C201B	—	(Part of C201)	By-pass screen V129
C201C	—	(Part of C201)	Decoupling on 250 volt line
C202	3K4510324 N16-C-33628-1236 3330-376194800	CAPACITOR, fixed: mica; JAN type CM45B103M; 10,000 mmf, $\pm 20\%$; 600 vdcw; spec JAN-C-5.	Tuning AFC motor field
C203	—	Same as C202	Tuning AFC motor field
C204	3DA100-731 N16-C-53192-8194 3330-316777656	CAPACITOR, fixed: paper; JAN type CP53B4EF104L; 2 sect, 100,000 mmf per sect, $\pm 15\%$; 600 vdcw; spec JAN-C-25, except clinch nuts in ea mtg hole; FTRC dwg #FRA-30388-1.	Phase splitting in AFC motor field located between K101 and S104
C204A	—	(Part of C204)	
C204B	—	(Part of C204)	
C205	3DA100-471 N16-C-45807-7617	CAPACITOR, fixed: paper; JAN type CP29A1DF104M; 100,000 mmf, $\pm 20\%$; 600 vdcw; spec JAN-C-25.	Suppressor across thermostat contacts in Crystal Oven
C206	—	Not Used	
C207	—	Not Used	

C208	—	Not Used		
C209	—	Not Used		
C210	3D9003-47 N16-C-15532-1344 3330-31277/4209	CAPACITOR, fixed: ceramic dielectric; JAN type CC30CK030D; 3 mmf, $\pm 1/2$ mmf; temp coef 0 (tol ± 250 , -340) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	Coupling V101A to V129	
C211	—	Same as C129 (Part of T111)	Tuning plate tank V127	
C212	N16-C-18632-8164	CAPACITOR, fixed: ceramic dielectric; Navy type -484976-1; 1000 mmf $\pm 1\%$; neg temp coef 49.8 (tol ± 10) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA950-007.	Tuning V131 MO grid	
*C213	N16-C-15920-8853	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 0 (tol ± 30) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-001.	Padding V131 MO grid	
*C213	N16-C-15923-4258	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 200 (tol ± 30) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-009.	Padding V131 MO grid	
*C213	N16-C-15924-3401	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 400 (tol ± 60) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA934-010.	Padding V131 MO grid	
*C213	N16-C-15924-7558	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 600 (tol ± 90) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA934-008.	Padding V131 MO grid	
*C213	N16-C-15925-2220	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 800 (tol ± 120) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA934-009.	Padding V131 MO grid	
*C213	N16-C-15925-2360	CAPACITOR, fixed: ceramic; 10 mmf, ± 1.0 mmf; neg temp coef 1000 (tol ± 150) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA934-004.	Padding V131 MO grid	
*C213	N16-C-16080-8946	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 0 (tol ± 30) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-003.	Padding V131 MO grid	
*C213	N16-C-16083-4337	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 200 (tol ± 30) mmf/mf/ $^{\circ}$ C; 500 vdcw (p/o Z102; for maintenance replace complete Z102); CBN#DA933-004.	Padding V131 MO grid	
*C213	N16-C-16084-3439	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 400 (tol ± 60) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-002.	Padding V131 MO grid	
*C213	N16-C-16084-7558	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 600 (tol ± 90) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-006.	Padding V131 MO grid	
*C213	N16-C-16085-2220	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 800 (tol ± 120) mmf/mf/ $^{\circ}$ C; 500 vdcw; (p/o Z102; for maintenance replace complete Z102); CBN#DA933-007.	Padding V131 MO grid	

*Chosen to fulfill the requirements of each individual oscillator.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
*C213	N16-C-16085-2387	CAPACITOR, fixed: ceramic; 20 mmf, ± 1.0 mmf; neg temp coef 1000 (tol ± 150) mmf/mf/°C; 500 vdcw; (p/o Z102: for maintenance replace complete Z102); CBN#DA933-008.	Padding V131 MO grid
C214	—	Not Used	
C215	N16-C-59059-4601	CAPACITOR, variable: Navy type -483457; air; pl meshing; single sect; 4 to 25 mmf; air gap 0.0195"; shaft; 5/16" lg; locking; scdr adj; (p/o Z102: for maintenance replace complete Z102); CRK type #34.	Trimmer in grid of MO V131
C216	N16-C-17067-8295	CAPACITOR, fixed: ceramic; 100 mmf, ± 2.0 mmf; neg temp coef 0 (tol ± 30) mmf/mf/°C; 500 vdcw; (p/o Z102: for maintenance replace complete Z102); CBN#DA913-002.	Grid V131 blocking
C217	N16-C-31665-6528	CAPACITOR, fixed: mica; JAN type CM35B182J; 1800 mmf $\pm 5\%$; 500 vdcw; (p/o Z102: for maintenance replace complete Z102); spec JAN-C-5.	Screen V131 by-pass
C218	—	Same as C216. (p/o Z102: for maintenance replace complete Z102).	Series trimmer in AFC circuit. Grid of V131
C219	—	Same as C217. (p/o Z102: for maintenance replace complete Z102).	Coupling V131 output to P102
C220	—	Same as C212. (p/o Z101: for maintenance replace complete Z101).	Tuning grid of interpolation osc V130
*C221	—	Same as C213. (p/o Z101: for maintenance replace complete Z101).	Padding grid of interpolation osc V130
C222	—	Not Used	
C223	—	Same as C215. (p/o Z101: for maintenance replace complete Z101).	Padding grid of interpolation osc V130
C224	—	Same as C216. (p/o Z101: for maintenance replace complete Z101).	Grid V130 blocking
C225	N16-C-16555-8161	CAPACITOR, fixed: ceramic; 50 mmf, ± 1.0 mmf; neg temp coef 0 (tol ± 30) mmf/mf/°C; 500 vdcw; (p/o Z101: for maintenance replace complete Z101); CBN#DA931-001.	Padding grid of interpolation osc V130
C226	—	Same as C217. (p/o Z101: for maintenance replace complete Z101).	Screen V130 by-pass
C227	—	Same as C217. (p/o Z101: for maintenance replace complete Z101).	Coupling output V130 to P103
C228	—	Not Used	
C229	—	Same as C109	DC blocking plate of V101
C230	3K3022224 N16-C-31913-4044 3330-376129200	CAPACITOR, fixed: mica; JAN type CM30B222M; 2200 mmf, $\pm 20\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Plate by-pass V101
C231	3K2033121 N16-C-29718-7276 3330-376025600	CAPACITOR, fixed: mica; JAN type CM20B331K; 330 mmf, $\pm 10\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Part of wave trap plate V101

C232	—	Same as C102A	Padding C103 in 100-kc standard osc	
C233	3D9010-175 N16-C-15916-1331 3300-313004959	CAPACITOR, fixed: ceramic; JAN type CC30CK100D; 10 mmf, $\pm 1/2$ mmf; temp coef 0 (tol +250, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	V112 grid drive limiting	
C301	N16-C-49206-7483	CAPACITOR, fixed: paper; JAN type CP70D1FR205K; 2 mf $\pm 10\%$; 7500 vdcw; spec JAN-C-25; used with JAN type CP07FF4 mtg brkts	HV filter	
C302	3DB15-41 N16-C-52051-2305 3330-317470540	CAPACITOR, fixed: paper; JAN type CP70E1FG156K; 15 mf, $\pm 10\%$; 1000 vdcw; spec JAN-C-25; u/w JAN type CP07FF1 mtg bkt.	Bias supply filter	
C303	—	Same as C302	LV supply filter	
C304	—	Same as C302	LV supply filter	
C305	N16-C-32653-2258	CAPACITOR, fixed: mica; JAN type CM50B472M; 4700 mmf, $\pm 20\%$; 2500 vdcw; temp coef letter B; spec JAN-C-5; u/w meter mtg bkt.	Plate voltmeter by-pass	
C306	—	Same as C305	Power amplr fil voltmeter by-pass	
C307	—	Same as C305	Line voltmeter by-pass	
C308	—	Same as C301	HV filter	
**C309	—	Same as C302	Bias supply filter	
C501	3D9010-114 N16-C-15916-1328 3330-313004860	CAPACITOR, fixed: ceramic; JAN type CC20CK100D; 10 mmf $\pm 1/2$ mmf; temp coef 0 (tol +250, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling J503 to grid of V501	
C502	—	Same as C101	Coupling J504 to V501	
C503	—	Same as C202	Cathode by-pass V501	
C504	—	Same as C202	Screen by-pass V501	
C505	3DA100-1051 N16-C-45814-9330 3330-317760276	CAPACITOR, fixed: paper; JAN type CP33B1FF104X; 100,000 mmf, $\pm 40\%$, -15%; 600 vdcw; spec JAN-C-25.	Keying wave shaper in output load of V507	
C506	—	Same as C202	Plate by-pass V501	
C507	N16-C-29382-3597	CAPACITOR, fixed: mica; JAN type CM45B221M; 220 mmf, $\pm 20\%$; 2500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling V501 to V502	
C508	—	Same as C202	Cathode by-pass V502	
C509	—	Same as C202	Screen by-pass V502	
C510	3K4522224 N16-C-31913-9493	CAPACITOR, fixed: mica; JAN type CM45B222M; 2200 mmf, $\pm 20\%$; 1200 vdcw; temp coef letter B; spec JAN-C-5.	Coupling V502 to V503	
C511	3D9156V N16-C-61314-7907	CAPACITOR, variable; Navy type -484972; air: plate meshing; 12 to 154 mmf; SLC; air gap 0.045"; (p/o O555); CEJ #150 F20.	Plate tuning V502	

ORIGINAL

*Chosen to fulfill the requirements of each individual oscillator.

**For use in single sideband operation.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C512	3K4510124 N16-C-28564-6196	CAPACITOR, fixed: mica; JAN type CM45B101M; 100 mmf, $\pm 20\%$; 2500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling V502 to V503
C513	—	Same as C202	Grid by-pass V503
C514	—	Same as C202	Cathode by-pass V503
C515	—	Same as C202	Screen by-pass V503
C516	—	Same as C510	Coupling V503 to V504
C517	—	Same as C511 (Part of O555)	Plate tuning V503
C518	3DA1-299 N16-C-18660-2453 3330-314941529	CAPACITOR, fixed: Navy type -484975-20; ceramic; 1000 mmf, $\pm 20\%$; no fixed temp coef; 5000 vdcw; CBN#850-A.	Coupling V503 to V504
C519	—	DRIVER NEUTRALIZER ASSEMBLY: Consists of C519A, C519B and C519C.	Driver neutralization
C519A	*N16-R-94402-1435	ROTOR, capacitor: neutralizing assem; includes neutralizing plate, standoff and adj knob; $2\frac{1}{8}$ " lg x 3" wd x $1\frac{1}{4}$ " h approx o/a; 2 mtg holes in standoff $2\frac{5}{8}$ " c to c; FTRC dwg #504-1976-002.	Part of C519
C519B	*N17-S-690701-129	STRAP, connector: grounding; silver pl beryllium copper; rectangular; $1\frac{1}{8}$ " lg x $\frac{1}{4}$ " wd x 0.028" thk; 0.093" diam mtg hole at one end; FTRC dwg #504-2026-002.	Ground connection
C519C	*N16-P-401281-113	PLATE, capacitor: neut pl; "L" shape; c/o $\frac{5}{8}$ " wd x $1\frac{7}{8}$ " lg x 0.032" thk brass sheet; ends semi-circular; one 0.171" diam hole concentric with end in longer leg; one 0.062" diam hole $7/32$ " from first, c to c, on radius 45° from longer ctr line; FTRC dwg #504-2027-002.	Part of C519
C520	—	Same as C518	V504 screen by-pass
C521	3D9025-53 N16-C-16223-6759 3300-313250339	CAPACITOR, fixed: Navy type -481689-10; ceramic; 25 mmf, $\pm 10\%$; temp coef 0 (tol ± 30) mmf/mf°C; 2500 vdcw RMS at 2 mc, 1000 vdcw RMS at 16 mc; CBN#850-001.	Power amplr grid balance
C522	—	Same as C518	V504 fil by-pass
C523	—	Same as C518	V504 fil by-pass
C524	—	Same as C305	V504 cathode meter by-pass
C525	—	Same as C518	V504 screen by-pass
C526	N16-C-65875-4651	CAPACITOR, variable: vacuum; 25-500 mmf; 15,000 v test; for gear tuning; in sealed glass envelope, incl gear (C526B); nickel anode construction; FTRC dwg FRA-30375-2-1. (For replacement use C526A.)	Grid tuning V506
C526A	3D9500V-9 N16-C-65875-4865 3330-314576863	CAPACITOR, variable: vacuum; 25-500 mmf; 15,000 v test; in sealed glass envelope; term mtg; copper anode construction; CAZG #UXC-25-500, less tuning mechanism. (To use as replacement for C526 unscrew metal end from C526 and attach same to C526A.)	Partial replacement for C526

C526B	_____	GEAR, spur: commercial hard brass rod; c/o gear section plus hub; gear section 26 straight involute teeth, 48 D.P., hub $\frac{1}{2}$ " lg x $\frac{9}{16}$ " diam with $\frac{7}{16}$ " diam x $\frac{7}{16}$ " lg undercut (leaving $\frac{1}{16}$ " lg end flange); FTRC dwg FRD-30374-1-1.	Part of C526
C527	3D9140-6 N16-C-56789-4736 3330-313958032	CAPACITOR, fixed: Navy type -484980-10; vacuum; 140 mmf, $\pm 10\%$; 20,000 v RF peak; in sealed glass envelope; CAZG#W-140.	Grid of V505
C528	_____	Same as C527	Grid of V505
C529	_____	Same as C527	Grid of V505
C530	_____	Same as C527	Power amplr grid (supplied for single side-band modification)
C531	_____	Same as C527	Power amplr grid (supplied for single side-band modification)
C532	_____	Same as C521	Power amplr grid balance
C533	3D9350V-2 N16-C-61763-1675	CAPACITOR, variable: Navy type -484973; air; plate meshing; 25 to 347 mmf; SLC; air gap 0.075"; shaft $\frac{1}{4}$ " diam x $1\frac{1}{2}$ " lg from end plate one end, and $\frac{5}{8}$ " other end; scdr adj; CEJ#350E30.	V504 loading
C534	_____	Same as C533	V504 loading
C535	N16-C-60151-1740	CAPACITOR, variable: Navy type -484970; air; plate meshing type; 11 to 67 mmf; SLC; air gap 0.075"; shaft $\frac{1}{4}$ " diam x $1\frac{1}{4}$ " lg from end plate one end and $\frac{1}{8}$ " other end; scdr adj lg end; CEJ #75E30, dwg #155-9-2.	Power amplr grid drive balance
C536	N16-C-33623-9187	CAPACITOR, fixed: mica; JAN type CM60B103K; 10,000 mmf, $\pm 10\%$; 2500 vdcw; temp coef letter B; spec JAN-C-5.	RF by-pass in PA test metering circuit
C537	_____	Same as C536	RF by-pass in PA test metering circuit
C538	_____	Same as C305	Cathode meter by-pass for V505 and V506
C539	3D9063 N16-C-16741-7132 3330-313614900	CAPACITOR, fixed: ceramic; 63 mmf, $\pm 2\%$; temp coef 0 (tol ± 100) mmf/mf/ $^{\circ}$ C, 5000 vdcw; (u/w E523); CBN#850-019.	V506 parasite trap
C540	_____	Same as C539 (u/w E524)	V505 parasite trap
C541	3D9035V-56 N16-C-65829-3251 3330-313370559	CAPACITOR, variable: Navy type -484986; vacuum; 20-35 mmf, 15 amps max; 20,000 v test; sealed glass envelope; shaft tuning; shaft $\frac{1}{4}$ "; CAZG type ATC-20-35 (Special).	Neutralization of V505
C542	_____	Same as C541	V506 neutralization
C543	_____	Same as C518	V505 fil by-pass
C544	_____	Same as C518	V505 fil by-pass
C545	_____	Same as C518	V505 fil by-pass
C546	_____	Same as C518	V505 fil by-pass
C547	_____	Same as C518	V506 fil by-pass

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Continued)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C548	—	Same as C518	V506 fil by-pass
C549	—	Same as C518	V506 fil by-pass
C550	—	Same as C518	V506 fil by-pass
C551	—	Same as C109	By-pass fil V507
C552	3DB4-367 N16-C-49951-8325 3330-317643110	CAPACITOR, fixed: Navy type -484969-10; paper; 4 mf, $\pm 10\%$; 230 vdcw; used with CG #102 type 'L' footed bkt; CG#21F391.	Phase splitting for servo drive motor (B502)
C553	—	Not Used	
C554	—	Not Used	
C555	—	Same as C518	V505 fil by-pass
C556	—	Same as C518	V505 fil by-pass
C557	—	Same as C518	V505 fil by-pass
C558	—	Same as C518	V505 fil by-pass
C559	—	Not Used	
C560	—	Not Used	
C561	—	Not Used	
C562	—	Not Used	
C563	—	Same as C518	V506 fil by-pass
C564	—	Same as C518	V506 fil by-pass
C565	—	Same as C518	V506 fil by-pass
C566	—	Same as C518	V506 fil by-pass
C567	3D9250-117 N16-C-56804-7241 3330-314256299	CAPACITOR, fixed: Navy type -484977-10; vacuum; 250 mmf, $\pm 10\%$; 20,000 v RF peak; in sealed glass envelope; CAZG #VCC-250.	DC blocking plate tank V505 and V506
C568	—	Same as C567	DC blocking plate tank V505 and V506
C569	N16-C-65875-4813	CAPACITOR, variable: vacuum; 25-500 mmf; 15,000 v test; for gear tuning; in sealed glass envelope; incl gear (C569B); per FTRC dwg FRA-30375-2-3. (For replacement use C569A).	V505 plate tuning
C569A	—	Same as C526A	
C569B	—	Same as C526B	Partial replacement for C569 p/o C569
C570	—	Same as C569 (For maintenance use C570A)	V506 plate tuning

C570A	—	Same as C526A	Partial replacement for C570
C570B	—	Same as C526B	p/o C570
C571	N16-C-65875-4613	CAPACITOR, variable; vacuum; 25-500 mmf; 15,000 v test; for gear tuning; in sealed glass envelope; incl gear (C571B); copper anode construction; FTRC dwg FRA-30375-2-2. (For replacement use C571A).	Ant tuning
C571A	—	Same as C526A	Partial replacement for C571
C571B	N16-G-431414-390	GEAR, spur: commercial hard brass; c/o gear plus hub; 0.583" OD x 0.2506" ID x 2-1/16" lg o/a; gear section 26 straight involute teeth, 48 D.P., hub, 9/16" diam x 1-9/16" lg with 7/16" diam x 1 1/2" lg undercut (leaving 1/16" lg end flange); FTRC dwg FRB-30374-1-2.	p/o C571
C572	—	Same as C571 (for maintenance use C572A)	Ant tuning
C572A	—	Same as C526A	Partial replacement for C572
C572B	—	Same as C571B	p/o C572
C573	3D9051V-1 N16-C-60036-2299	CAPACITOR, variable: Navy type -484971; air; plate meshing; 9 to 52 mmf; SLC; shaft .249" diam x 1 1/2" lg one end, and 3/8" lg other end; scdr adj long end; CEJ#50F30.	Grid tuning (for single side-band suppressed carrier)
C574	—	Same as C573	Grid tuning (for single side-band suppressed carrier)
C575	—	Same as C305	Power amplr multimeter by-pass
C576	—	Same as C305	Exciter multimeter (M505) by-pass
C577	—	Same as C305	Exciter multimeter (M506) by-pass
C578	3K3547224 N16-C-32651-9288 3300-376151266	CAPACITOR, fixed: mica; JAN type CM35B472M; 4700 mmf $\pm 20\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Grid V507 limit high freq response
C579	—	Same as C578	Grid V507 limit high freq response
C580	—	Same as C302	Filter in plate supply V507
C581	—	Same as C302	Filter in plate supply V507
C582	—	Same as C302	Filter in plate supply V507
C583	3KB4-274 N16-C-49981-9983 3330-317643016	CAPACITOR, fixed: paper; JAN type CP40C2DF405V; 4 mf +20, -10%; 600 vdcw; spec JAN-C-25.	Filter in grid of V504
C584	—	Same as C210	Grid V504 suppressor circuit
C701	—	Same as C552	Phase splitting for servo drive motors (1 ea. 5 units)
C801	3K353322 N16-C-32256-3288 3330-376146200	CAPACITOR, fixed: mica; JAN type CM35B332M; 3300 mmf, $\pm 20\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Input transformer shunt (1 ea. 6 units)
C802	3DA50-384 N16-C-44257-3134 3330-316163519	CAPACITOR, fixed: paper; JAN type CP54B1FF503K; 50,000 mmf, $\pm 10\%$; 600 vdcw; spec JAN-C-25.	Coupling V801 to V802 (1 ea. 6 units)

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C803	—	Same as C802	Coupling V801 to V802 (1 ea. 6 units)
C804	3DB1-280 N16-C-48841-9594 3330-316958902	CAPACITOR, fixed: paper; JAN type CP61B1FF105V; 1 mf, +20%, -10%; 600 vdcw; spec JAN-C-25.	K801 coil shunt (1 ea. 6 units)
C805	—	Same as C804	K802 coil shunt (1 ea. 6 units)
C806	3DA250-372 N16-C-46347-3095	CAPACITOR, fixed: paper; JAN type CP54B1FF254K; 250,000 mmf, ±10%; 600 vdcw; spec JAN-C-25.	K801 spark suppressor (1 ea. 6 units)
C807	—	Same as C806	K802 spark suppressor (1 ea. 6 units)
C901	—	Same as C583	Filter in Z901 (1 ea. 2 units)
C902	—	Same as C583	Filter in Z901 (1 ea. 2 units)
C903	—	Same as C583	Filter in Z901 (1 ea. 2 units)
C1001	3DB10-233 N16-C-51881-9090 3330-317643344	CAPACITOR, fixed: paper; JAN type CP70B1DF106V; 10 mf, +20%, -10%; 600 vdcw; spec JAN-C-25. (Used with JAN type CP07FC4 mtg. bkt.).	Filter in MO B+ supply
C1002	—	Same as C1001	Filter in MO B+ supply
C1003	—	Same as C583	Filter in KY-45A/B+ supply
C1004	—	Same as C583	Filter in KY-45A/B+ supply
C1005	—	Same as C583	Filter in KY-45A/neg supply
C1006	—	Same as C583	Filter in KY-45A/neg supply
C1007	—	Same as C583	Filter in KY-45A/neg supply
C1101	3D9013V-12 N16-C-63960-2500 3330-313050140	CAPACITOR, variable: ceramic; rotary type, single sect; 3-12 mmf; 500 vdcw; temp coef 0 (tol ±100) mmf/mf/°C; scdr slot adj; CER#TS2A.	Frequency adjusting trimmer
C1102	—	Same as C1101	Frequency adjusting trimmer
C1103	—	Same as C1101	Frequency adjusting trimmer
C1104	—	Same as C1101	Trimmer
C1105	—	Same as C1101	Trimmer
C1106	—	Same as C1101	Trimmer
C1107	—	Same as C1101	Trimmer
C1108	—	Same as C1101	Trimmer

C1109	—	Same as C1101	Trimmer
C1110	—	Same as C1101	Trimmer
C1111	3D9003-48 N16-C-15531-9928 3330-31277/4210	CAPACITOR, fixed: ceramic; JAN type CC20CJ030D; 3 mmf, $\pm\frac{1}{2}$ mmf; temp coef 0 (tol ± 120 , -185) mmf/mf/ $^{\circ}$ C; 500 vdcw; spec JAN-C-20.	V1101 feedback
C1112	—	Same as C102A	V1101 feedback
C1113	—	Not Used	V1101 screen by-pass
C1114	—	Same as C109	Coupling V1101 to V1102
C1115	—	Same as C101	V1102 cathode by-pass
C1116	N16-C-45801-9618	CAPACITOR, fixed: paper; JAN type CP54B1EF104V; 100,000 mmf, $\pm 20\%$, -10% ; 600 vdcw; spec JAN-C-25.	
C1117	—	Same as C109	Coupling V1102 output to output jack
C1118	—	Same as C109	V1102 plate and screen by-pass
C1119	—	Same as C578	M1101 by-pass
C1301	3D9006-39 N16-C-56738-7241 3300-312886253	CAPACITOR, fixed: Navy type -484978-10; vacuum; 6 mmf, $\pm 10\%$; 20,000 v RF peak; in sealed glass envelope; CAZG#W-6.	Coupling; plate of V1301 in Z1303 and Z1304 (1 ea. 2 units)
C1302	—	Same as C305, less meter brackets	Filter in output line of Z1303 and Z1304 (1 ea. 2 units)
C1303	—	Not Used	
C1304	—	Not Used	
C1305	—	Same as C1301 (Part of Z1301)	Coupling; plate of V1303 in Z1301 and Z1302 (1 ea. 2 units)
C1306	—	Same as C1302 (Part of Z1301)	Filter in output line of Z1301 and Z1302 (1 ea. 2 units)
C1307	—	Not Used	
C1308	—	Not Used	
C1309	N16-C-60833-3479	CAPACITOR, variable: air; neut-disc type; 100.5 to 6.0 mmf; CBGB type A.	Part of low-pass filter in Z1303 (1 ea. 2 units)
C1310	N16-C-16774-7057	CAPACITOR, fixed: ceramic; 67 mmf, $\pm 5\%$; temp coef 0 (tol ± 100) mmf/mf/ $^{\circ}$ C; 5000 vdcw; CBN#850-022.	Part of low-pass filter in Z1303 (1 ea. 2 units)
C1401	—	Same as C109	Input coupling capacitor
C1402	3DA100-1024 N16-C-45807-7309 3330-317760249	CAPACITOR, fixed: paper; JAN type CP29A2DF104M; single sect; 100,000 mmf, $\pm 20\%$; 600 vdcw; spec JAN-C-25.	V1401 and V1402 cathode by-pass
C1403	—	Same as C109	V1401 screen by-pass

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C1404	—	Same as C109	V1402 screen by-pass
C1405	— N16-C-63665-7059	CAPACITOR, variable: air; 5 sects; sects #1, #2 each 402 mmf, $\pm 1\%$ ± 1 mmf; sects #3, #4, #5 each 201 mmf, $\pm 1\%$ ± 1 mmf; like sects all matched within 0.5%, ± 1 mmf; SLC; shaft $1/4$ " diam x $1 1/2$ " lg; COC#50.	Main tuning control
C1405A	—	(Part of C1405)	V1401 tuning capacitor
C1405B	—	(Part of C1405)	V1402 tuning capacitor
C1405C	—	(Part of C1405)	V1403 grid tuning capacitor
C1405D	—	(Part of C1405)	V1403 plate tuning
C1405E	—	(Part of C1405)	V1404 plate tuning
C1406	3D9050V-84 N16-C-64157-5249 3330-313580860	CAPACITOR, variable: ceramic; JAN type CV11D500; rotary type, single sect; 5.0 to 50.0 mmf; 500 vdcw; temp coef minus 650 mmf/mf/°C; (p/o Z1405); spec JAN-C-81.	Trimmer capacitor plate V1401 to plate V1402
C1407	3K3068122 N16-C-30531-4284	CAPACITOR, fixed: mica; JAN type CM30B681J; 680 mmf, $\pm 5\%$; 500 vdcw; temp coef letter B; (p/o Z1405); spec JAN-C-5.	p/o equalizing network between L1403 and L1405
C1408	—	Same as C1406. (p/o Z1404)	Grid trimmer V1403
C1409	—	Same as C1402	V1403 grid by-pass
C1410	—	Same as C109	V1403 cathode by-pass
C1411	—	Same as C109	V1403 screen by-pass
C1412	—	Same as C1402	V1403 plate by-pass
C1413	—	Same as C1406 (p/o Z1403)	V1403 plate trimmer
C1414	3K3022221 N16-C-31908-1564 3330-376128800	CAPACITOR, fixed: mica; JAN type CM30B222K; 2200 mmf, $\pm 10\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling capacitor V1403 to V1404
C1415	—	Same as C109.	V1404 grid by-pass
C1416	—	Same as C109	V1404 screen by-pass
C1417	—	Same as C109 (p/o Z1402)	V1404 plate by-pass
C1418	—	Same as C109 (p/o Z1402)	Coupling capacitor V1404 to Keyer output
C1419	— N16-C-59766-4781	CAPACITOR, variable: Navy type -483458; air; single sect; 4 to 50 mmf; SLC; air gap 0.0195"; scdr adj; (p/o Z1402); CHC type APC, special.	V1404 plate trimmer capacitor
C1420	—	Same as C109	Wave shaping capacitor

C1421	—	Same as C109	Wave shaping capacitor
C1422	—	Same as C109	Wave shaping capacitor
C1423	—	Same as C127	Wave shaping capacitor
C1424	—	Same as C109	Wave shaping capacitor
C1425	—	Same as C109	Wave shaping capacitor
C1426	—	Same as C109	Wave shaping capacitor
C1427	—	Same as C127	Wave shaping capacitor
C1428	3K2020122 N16-C-29265-2996 3330-376013000	CAPACITOR, fixed: mica; JAN type CM20B201J; 200 mmf, $\pm 5\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling capacitor 200 kc osc tank to V1408 grid
C1429	3K2015124 N16-C-28985-4556 3330-376008600	CAPACITOR, fixed: mica; JAN type CM20B151M; 150 mmf, $\pm 20\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling capacitor 200 kc osc tank to V1408 grid
C1430	—	Same as C109	V1408 cathode by-pass
C1431	—	Same as C109	V1408 cathode by-pass
C1432	—	Same as C109	Coupling capacitor V1408 to mixing resistor
C1433	—	Same as C109	Coupling capacitor V1408 to mixing resistor
C1434	—	Not Used	
C1435	3D9024-56 N16-C-16177-6532 3330-313184192	CAPACITOR, fixed: ceramic; JAN type CC30CK240J; 24 mmf, $\pm 5\%$; temp coef 0 (tol $+250$, -340) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling capacitor S1405 common to V1409
C1436	—	Same as C109	V1409 cathode by-pass
C1437	3K2010122 N16-C-28553-1196 3330-376002200	CAPACITOR, fixed: mica; JAN type CM20B101J; 100 mmf, $\pm 5\%$; 500 vdcw; temp coef ltr B; spec JAN-C-5.	Coupling capacitor V1409 to V1410
C1438	—	Same as C109	Screen V1410 by-pass
C1439	3D9100-305 N16-C-17073-3201 3330-314693032	CAPACITOR, fixed: ceramic; JAN type CC35CH101J; 100 mmf $\pm 5\%$; temp coef 0 (tol $+60$, -110) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	Coupling capacitor V1410 to V1411
C1440	N16-C-18437-4613	CAPACITOR, fixed: ceramic; 710 mmf, $\pm 1\%$; neg temp coef 100 (tol $\pm 10\%$) mmf/mf/°C; 500 vdcw; (p/o Z1401); CBN#DA950-000.	V1411 grid tuning capacitor
*C1441	3D9010-189 N16-C-15923-1762 3330-313004973	CAPACITOR, fixed: ceramic; JAN type CC30PH100F; 10 mmf, ± 1 mmf; neg temp coef 150 (tol $+60$, -140) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	V1411 grid tuning capacitor
*C1441	3D9020-56 N16-C-16083-1726 3330-313162517	CAPACITOR, fixed: ceramic; JAN type CC30PH200J; 20 mmf, $\pm 5\%$; neg temp coef 150 (tol $+60$, -140) mmf/mf/°C; 500 vdcw; spec JAN-C-20.	V1411 grid tuning capacitor
*C1441	—	Same as C158	V1411 grid tuning capacitor

*Chosen to fulfill requirements of individual oscillator. Use capacitor value found in equipment or as indicated on replacement Z1401.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
C1442	— N16-C-58716-3970	CAPACITOR, variable: air; single sect; 2.6 to 19.7 mmf; SLC; 750 v RMS at 2.0 mc, air gap 0.015"; shaft 0.188" diam x 1/4" lg beyond thd, 1/4"-32 NEF-2 x 1/4" lg, locking type; scdr adj; CEJ#160-110-15.	V1411 grid trimmer capacitor
C1443	—	Same as C1441 (51 mmf)	V1411 grid capacitor
C1444	—	Same as C1439	V1411 grid capacitor
C1445	—	Same as C125	(See below)
C1445A	—	(Part of C1445)	V1411 plate decoupling
C1445B	—	(Part of C1445)	V1411 screen by-pass
C1445C	—	(Part of C1445)	V1411 plate decoupling
C1446	—	Same as C1439	V1411 plate by-pass
C1447	—	Same as C1441 (20 mmf)	Output coupling capacitor
C1448	—	Same as C578	Part of lowpass filter, grid V1412
C1449	—	Same as C109	Part of lowpass filter, grid V1412
C1450	—	Same as C578	Part of lowpass filter, grid V1412
C1451	3K2010121 N16-C-28558-1676 3330-376002000	CAPACITOR, fixed: mica; JAN type CM20B101K; 100 mmf, $\pm 10\%$; 500 vdcw; temp coef letter B; spec JAN-C-5.	Coupling capacitor V1412 plate to other V1412 grid
C1452	—	Same as C109	V1412 plate by-pass
C1453	—	Same as C109	Coupling capacitor V1412 to V1401
C1454	—	Same as C109	Coupling capacitor V1412 to V1402
C1455	3DA500-792 N16-C-47327-9207 3330-319001365	CAPACITOR, fixed: paper; JAN type CP29A2DF504M; single sect; 500,000 mmf, $\pm 20\%$; 600 vdcw; spec JAN-C-25.	V1407 grid tuning capacitor
C1456	—	Same as C205	V1407 grid coupling
C1457	—	Same as C1455	V1407 screen by-pass
C1458	3DA500-791 N16-C-47327-9525 3330-319001364	CAPACITOR, fixed: paper; JAN type CP29A1DF504M; 500,000 mmf, $\pm 20\%$; 600 vdcw; spec JAN-C-25.	Coupling capacitor V1407 output
CR801	3H4860-153 N17-R-51401-8526 3300-375701577	RECTIFIER, metallic: selenium; input 130 v, 60 cps, single phase; output 125 vdc, 100 ma, half-wave; rectangular; FTTC part #1004.	Input limiter (1 ea, 6 units)
CR802	—	Same as CR801	Input limiter (1 ea, 6 units)

E101	N16-K-700296-586	<p>KNOB: round; black aluminum; for 1/4" diam shaft; two holes tapped #6-40 NF-2 at 90 deg; 15/16" diam x 9/16" thk; 1/4" diam x 7/32" d shaft hole; medium straight knurl; FTRC dwg #FRB-30947-1.</p>	Knobs (qty 3) RF osc tuning
E102	N16-K-700248-886 3320-292241463	<p>KNOB: round; black enamel aluminum; for 3/16" diam shaft; #6-32 thd hole through side; engraved arrow and word LOCK, 7/16" diam x 11/32" thk; 0.188" d shaft hole; straight knurl; CBY #7199.</p>	Knobs (qty 3) RF osc locking
E103	N17-B-77738-2769	<p>BOARD, terminal: general purpose; 6 brass screw term; term 3/8" c to c, with barriers; molded bakelite board; 2 7/8" lg x 7/8" wd x 13/32" thk o/a; four 0.160" diam mtg holes on 5/16" x 2 5/8" mtg/c; CJC #6-140.</p>	AFC motor relay board
E104	_____	Not Used	Terminal strip located in front of interpolation osc
E105	_____	Same as E103	
E106	_____	Not Used	
E107	_____	Not Used	
E108	_____	Not Used	Tie point for R194 and C177
E109	N17-T-28228-3181	<p>TERMINAL, stud: round post shape; molded melamine body; 1/4" diam x 9/16" lg o/a; #4-40 NC-2 thrd x 3/16" d hole one end, slotted solder lug other end, insert and term brass; Winchester Electronic Co. #756-1.</p>	
E110	_____	Same as E109	
E111	_____	Same as E109	
E112	_____	Same as E109	Tie point for R196 and R187 Tie point for C127 and J105 Tie point for R136, T105, R133 and C118 Tie point for XV116 and J114-1
E113	N17-T-28252-2575	<p>TERMINAL, stud: round post shape, style #55; molded melamine body; 1/4" diam x 27/32" lg o/a; #4-40 NC-2 thrd x 1/4" d hole one end, slotted solder lug other end; insert and term brass; Winchester Electronic Co. #750.</p>	
E114	_____	Same as E113	
E115	_____	Same as E113	
E116	_____	Same as E113	Tie point for R155, E116, R144 and K101 Tie point for R242 and J113 Tie point for R157, E114, C155C, C157A, T105 and R167 Tie point for XV114 and J513-1 Tie point for R158, T101 and C116C Tie point for R158, R166 and T102-4 Captive nuts for mounting capacitors
E117	_____	Same as E113	
E118	_____	Same as E113	
E119	_____	Same as E113	
E120	N43-N-99500-118	<p>NUT, clinch: SS type #303; 1/4" OD x 5/32" thk o/a; NC-2 thrd; FTRC dwg #FRB-30427-1-1.</p>	
E121	2Z8304.83 N16-S-34520-3862 3300-295578701	<p>SHIELD, tube: JAN type TSFOT101; nickel pl brass; cyl; 0.838" wd x 0.930" lg x 0.810" min ID x 1 3/8" h o/a, with 1/2" diam hole in top; conical spring inside; spec JAN-S-28A.</p>	Holddown shield for V104, V105-V107, V109, V111, V113, V118, V125, V126, V129

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E122	N16-S-34557-8350	SHIELD, tube: JAN type TSFOT102; nickel plated brass; cyl; 0.838" wd x 0.930" lg x 0.810" min ID x 1 3/4" h o/a, with 1/2" diam hole in top; bayonet mtg; conical spring inside; spec JAN-S-28A.	Holddown shield for V108, V110, V112, V127, V128
E123	2Z8304.136 N16-S-34532-8744 3300-295578959	SHIELD, tube: cad pl cold rolled steel; cylindrical with 19/32" diam hole in top; bayonet mtg; 0.950" ID x 1 1/2" lg; w/SS spring inside, CMG#16G12626.	Holddown shield for V101-V103, V115-V117, V123, V124
E124	2Z8304.137 N16-C-34576-6515 3300-295578960	SHIELD, tube: cold rolled steel, cad pl; cylindrical with 19/32" diam hole in top; bayonet mtg; 0.950" ID x 1-15/16" lg inside; w/SS spring inside; CMG-#16G12627.	Holddown shield for V114, V119, V120-V122
E125	N16-P-402241-110	PLATE, electrical shield: silver pl brass; irregular shape; mtd by tube socket with solder connection to socket ctr shield; 1 3/8" lg x 3/4" h o/a; 2 mtg holes #4-40 NC-2, 7/8" c to c; FTRC dwg #FRB-30967-1.	Gnd tiepoint and tube base shield for V106, V108-V113, V118, V127-V129
E301	N17-B-77590-1085	BOARD, terminal: general purpose; 3 solder lug term, 15/16" c to c with barriers; molded phenolic; CSZ #9080-T31, dwg #1828-C1, part G6.	3 ph line input term block in PP-490A/FRT-5
E302	N17-B-77990-6897	BOARD, terminal: general purpose, 12 brass screw term, 9/16" c to c, with barriers; molded bakelite; 7-23/32" lg x 1-5/16" wd x 5/8" thk o/a; CJC #12-142.	PP-490A/FRT-5 inter-cabinet connections
E303	—	Same as E302	PP-490A/FRT-5 inter-cabinet connections
E304	—	Same as E302	PP-490A/FRT-5 inter-cabinet connections
E305	—	Same as E302	PP-490A/FRT-5 inter-cabinet connections
E306	—	Same as E302	PP-490A/FRT-5 inter-cabinet connections
E307	N17-B-77639-1543	BOARD, terminal: general purpose; 4 screw term, 9/16" c to c, w/barriers; molded phenolic; 3-7/32" lg x 1-5/16" wd x 5/8" thk o/a; CJC#4-142.	PP-490A/FRT-5 Blower term block
E308	—	Same as E302	PP-490A/FRT-5 Relay and control terminal
E309	—	Same as E302	Relay and control terminal in PP-490A/FRT-5
E310	—	Same as E302	Relay and control terminal in PP-490A/FRT-5
E311	—	Same as E307	Blower term block PP-490A/FRT-5

E312	3G1250-32.24 N17-1-69231-9541 3320-332105217	INSULATOR, starfdoft: Navy type -61295; cyl pillar; JAN type NS4W0416; grade L-4 ceramic, white, glazed; 2" lg x 1" diam; spec JAN-1-8.	HV term PP-490A/FRT-5
E313	_____	Same as E302	PP-490A/FRT-5 inter-cabinet connections
E314	_____	Same as E312	PP-490A/FRT-5 inter-cabinet HV term
E315	N17-B-77690-5169 _____	BOARD, terminal: general purpose; 5 screw term, 9/16" c to c, with barriers; bakelite, 3-25/32" lg x 1-5/16" wd x 5/8" thk o/a; CJC #5-142; FTRC dwg #367-4040-00.	K315 term board in PP-490A/FRT-5
E316	N43-B-30001-5120 _____	STUD, brass: nickel pl; 1 1/4" lg; 1/4"-20 NC-2 thd entire length.	PP-490A/FRT-5 Gnd stud
E317	_____	Same as E316	PP-490A/FRT-5 Gnd stud
E318	_____	Same as E312	PP-490A/FRT-5 HV term
E319	_____	Same as E312	PP-490A/FRT-5 HV term
E320	_____	Same as E312	PP-490A/FRT-5 HV term
E321	_____	Same as E312	PP-490A/FRT-5 HV term
E322	_____	Same as E312	PP-490A/FRT-5 HV term
E323	3G3546-062 N17-1-47417-4211 3320-333772002	INSULATOR, bushing: JAN type NS4W4601; grade 4 steatite, white glaze; 2 1/2" OD max x 1-9/16" ID max x 1-43/64" lg o/a, with 7/16" diam ctr hole in top; spec JAN-1-8.	Feedthru for tube caps
E324	N16-K-700421-941 _____	KNOB: round; alum, black Alumilite finish; for 1/4" diam shaft; c/o knob plus dial; 2 1/2" diam x 59/64" lg o/a; 1/4" diam x 51/64" d shaft hole, two #8-32 third set-screw holes 90 deg apart, fine diamond knurl; dial 0.064" thk alum disc; 2 1/2" OD x 1-7/16" ID (to fit boss on knob) x 13/64" thk, small triangle index mark; FTRC dwg #FRA-30825-2C-1.	Knob for R327 power amplr fil rheostat
E325	2Z2712-41 N17-C-800956-126 3300-287222584	CLIP: electron tube; for connecting to tube term; spring brass, cad pl; 1 1/2" lg x 13/16" wd x 25/32" thk o/a; ceramic ins; CNA#SPP-9.	Plate cap ins for V307 to V310 incl
E326	_____	Same as E325	Plate cap ins for V301-V306
E327	_____	Not Used	
E328	_____	Not Used	
E329	_____	Not Used	
E330	_____	Same as E312	Mtg ins for R309
E331	_____	Same as E312	Mtg ins for R308
E332	_____	Same as E312	Mtg ins for R307
E333	_____	Same as E312	Mtg ins for R310

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E334	3G3503-08.1 N17-1-69210-9526 3320-333731401	INSULATOR, standoff: round post shape; JAN type NS4W0308; grade L-4 ceramic, white glaze; 1" lg x 3/4" diam o/a; #10-32 thrd x 3/8" d axial hole ea end; spec JAN-1-8.	Mtg ins for R311
E335	—	Same as E334	Mtg ins for R324
E336	—	Same as E334	Mtg ins for R328
E337	—	Same as E334	Mtg ins for R301
E338	—	Same as E334	Mtg ins for R303
E339	—	Same as E334	Mtg ins for R304
E340	—	Same as E312	Mtg ins for R333
E341	—	Same as E312	Mtg ins for R305
E342	—	Same as E312	Mtg ins for R306
E343	—	Same as E312	Mtg ins for R323
E344	—	Same as E334	Mtg ins for R330
E345	—	Same as E334	Mtg ins for R329
E346	—	Same as E312	Mtg ins for R315
E347	—	Same as E312	Mtg ins for R314
E348	—	Same as E312	Mtg ins for R313
E349	—	Same as E312	Mtg ins for R312
E350	—	Same as E312	Mtg ins for R322
E351	—	Same as E312	Mtg ins for R321
E352	—	Same as E312	Mtg ins for R318
E353	—	Same as E312	Mtg ins for R317
E354	—	Same as E334	Mtg ins for R332
E355	—	Same as E312	Mtg ins for R320
E356	—	Same as E312	Mtg ins for R319
E357	—	Same as E312	Mtg ins for R316
E358	—	Same as E334	Mtg ins for R334
E359	—	Same as E334	Mtg ins for R331
E360	—	Same as E334	Mtg ins for R344
E361	—	Same as E334	Mtg ins for R343

E362	—	Same as E334	Mtg ins for R345
E363	3G1250-32.2 N17-1-69215-9481 3320-332090000	INSULATOR, standoff: round post shape; JAN type NS4W0316; grade L-4 ceramic, white glaze; 2" lg x 3/4" diam o/a with #10-32 thrd x 3/8" d axial hole at ea end; spec JAN-1-8.	Mtg ins for XV307, XV308, XV309, XV310
E364	3G1250-24.3 N17-1-69213-9485 3320-332075300	INSULATOR, standoff: round post shape; JAN type NS4W0312; grade L-4 ceramic, white glaze; 1 1/2" lg x 3/4" diam o/a with #10-32 thrd x 3/8" d axial hole at ea end; spec JAN-1-8.	Mtg ins
E365	N17-C-804848-101	CLIP: fuse; for 1 1/8" diam cartridge fuse; phosphor bronze, silver pl; 1-9/32" lg x 1-5/32" wd x 23/32" thk o/a; 60 amp, 600 v; 1-1/16" max jaw opening; Multi-Electric Co. #2026-J.	Resistor clips
E366	N17-C-804783-901	CLIP: fuse; for 13/16" diam cartridge fuse; phosphor bronze; 1-5/32" lg x 3/4" wd x 23/32" thk o/a; 31-60 amp, 250 v; 13/16" max jaw opening; Multi Electric Co. #2022-J.	Resistor clips
E367	N17-C-804681-127	CLIP: fuse; for 9/16" diam cartridge fuse; phosphor bronze, silver pl; 13/16" lg x 5/8" wd x 19/32" thk o/a; 0-30 amp, 250 v; 9/16" max jaw opening; Multi Electric Co. #2020-J.	Resistor clips
E368	—	Same as E324	Knobs for S314, S310, R326
E369	N16-K-700374-866	KNOB: round; molded black phenolic; for 1/4" diam shaft; 2 radial holes tapped #10-32 NF-2; engraved white line; 1 3/4" diam x 7/8" thk o/a; brass insert; 5/8" d shaft hole; FTRC dwg #FRA-30847-1-1.	Knob for S317
E370	N16-K-700411-970	KNOB: round; molded black phenolic; for 1/4" diam shaft; 2 radial holes tapped #10-32 NF-2; engraved white line; 2 1/4" diam x 1-17/64" thk o/a; brass insert; 5/8" d shaft hole; FTRC dwg #FRA-30847-1-2.	Knob for R302
E401	—	Same as E302	C-587A/FRT-5 inter-cabinet connection
E501	N17-B-77741-8835	BOARD, terminal: general purpose; 6 screw term, 9/16" c to c, w/barriers; molded phenolic; 4-11/32" lg x 1-5/16" wd x 5/8" thk o/a; CJC#6-142.	Ant tuning servo motor term block
E502	N17-B-77939-3214	BOARD, terminal: general purpose; 10 screw term, 9/16" c to c, w/barriers; bakelite; 6 5/8" lg x 1-5/16" wd x 5/8" thk o/a; CJC#10-142.	Ant coupling servo motor term block
E503	—	Same as E501	Power amplr plate tuning servo motor term block
E504	—	Same as E501	Power amplr grid tuning term block
E505	—	Same as E502	Keyer connecting board
E506	N17-B-78086-8339	BOARD, terminal: general purpose; 16 screw term, 7/16" c to c; w/barriers; molded phenolic; 7 3/4" lg x 1 1/8" wd x 1/2" thk o/a; CJC #16-141.	Connector V503 tuning servo motor term board
E507	—	Same as E506	V503 tuning servo motor term board
E508	—	Same as E506	V502 tuning servo motor term board

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E509	—	Same as E506	V502 tuning servo motor term board
E510	—	Same as E501	Blower B501 connecting board
E511	—	Same as E501	Blower B501 connecting board
E512	—	Same as E302	T-225A/FRT-5 inter-cabinet connections
E513	—	Same as E302	T-225A/FRT-5 inter-cabinet connections
E514	—	Same as E302	T-225A/FRT-5 inter-cabinet connections
E515	—	Same as E302	T-225A/FRT-5 inter-cabinet connections
E516	—	Same as E302	T-225A/FRT-5 inter-cabinet connections
E517	—	Same as E316	T-225A/FRT-5 gnd stud
E518	—	Same as E316	T-225A/FRT-5 gnd stud
E519	—	Same as E316	T-225A/FRT-5 gnd stud
E520	3Z1891A-12.1 *N16-S-89857-1249 3330-399858030	SUPPRESSOR, parasitic: resistor and coil type; 1-13/32" lg x 15/32" OD; 5 turns #16 AWG wire; 47 ohms, $\pm 10\%$, 2 w resistor; uncased; 2 axial wire lead term; FTRC dwg #FRA-31071-1.	Parasitic suppressor grid V502
E521	—	Same as E520	Parasitic suppressor grid V503
E522	—	Same as E520	Parasitic suppressor grid V504
E523	3Z1891A-12.2 N16-S-89852-1406 3330-399858031	SUPPRESSOR, parasitic: resistor and coil type; 47/8" lg x 1-1/16" wd x 23/32" h o/a; 2 turns #14 AWG tinned copper wire; 50 ohms, $\pm 10\%$, 22 w resistor (R540); uncased: 2 screw term; FTRC dwg FRA-31081-1.	Parasitic suppressor in power amplr
E524	—	SUPPRESSOR: Interchangeable with E523 (includes resistor R543).	Parasitic suppressor in power amplr
E525	—	Same as E312	T-225A/FRT-5 HV term
E526	—	Same as E312	T-225A/FRT-5 HV term
E527	—	Same as E501	Power amplr plate tuning servo motor term block
E528	—	Same as E124	Hold-down shield for V507
E529	N17-I-69236-3501	INSULATOR, standoff: round post shape; JAN type NS4W0432; grade L-4 ceramic, white glaze; 4" lg x 1" diam o/a, with 1/4"-20 thrd x 5/8" d axial hole each end; spec JAN-1-8.	Plate cap support V505, V506
E530A	3G3541-04.1 N17-I-48719-7751	INSULATOR, bushing: JAN type NS4W4104; grade L-4 ceramic, white glaze; 1 1/8" OD x 0.2" ID x 1-5/16" lg o/a; spec JAN-1-8.	Feedthru for power amplr grid lead

E530B	3G3542-04.1 N17-1-47388-7521	INSULATOR, bushing; JAN type NS4W4204; grade L-4 ceramic, white glaze; $\frac{3}{4}$ " lg, $1\frac{1}{8}$ " to 1" OD; spec JAN-1-8.	Feedthru for power amplr grid lead
E531A	—	Same as E530A	Feedthru for power amplr grid lead
E531B	—	Same as E530B	Feedthru for power amplr grid lead
E532	3G350-127 N17-1-69154-6197 3320-331265931	INSULATOR, standoff: round post shape; JAN type NS4W0104; grade L-4 ceramic, white, glazed; $\frac{1}{2}$ " lg x $\frac{3}{8}$ " diam, with #6-32 thrd x $5/32$ " d axial hole each end; spec JAN-1-8.	Right hand parasitic suppressor support T-225A/FRT-5
E533	—	Same as E532	Left hand parasitic suppressor support T-225A/FRT-5
E534	3G3520-16.1 N17-1-68793-8901 3320-333751011	INSULATOR, standoff: conical shape; JAN type NS4W2016; grade L-4 ceramic, white glaze; 2" lg, $\frac{5}{8}$ " to $1\frac{1}{8}$ " diam, with #10-32 thrd x $\frac{3}{8}$ " d axial hole at end; spec JAN-1-8.	Support for C527
E535	—	Same as E534	Support for C528
E536	—	Same as E534	Support for C529
E537	—	Same as E534	Support for C530
E538	—	Same as E534	Support for C531
E539	—	Same as E534	Support for C527
E540	—	Same as E534	Support for C528
E541	—	Same as E534	Support for C529
E542	—	Same as E534	Support for C530
E543	—	Same as E534	Support for C531
E544	3G3503-24.2 N17-1-69218-9504 3320-333730802	INSULATOR, standoff: round post shape; JAN type NS4W0324; grade L-4 ceramic, white glaze; 3" lg x $\frac{3}{4}$ " diam o/a; with #10-32 thrd x $\frac{3}{8}$ " d axial hole ea end; spec JAN-1-8.	Term angle support, & support for C526
E545	—	Same as E534	Mounting
E546	3G3502-08.1 N17-1-69178-7151	INSULATOR, standoff: round post shape; JAN type NS4W0208; grade L-4 ceramic, white glaze; 1" lg x $\frac{1}{2}$ " diam o/a; with #8-32 thrd x $\frac{3}{8}$ " d axial hole ea end; spec JAN-1-8.	Support for L510
E547	—	Same as E546	Support for L510
E548	3G3501-05 N17-1-69156-6251 3320-333730610	INSULATOR, standoff: round post shape; JAN type NS4W0105; grade L-4 ceramic, white glaze; $\frac{5}{8}$ " lg x $\frac{3}{8}$ " diam o/a, with #6-32 thrd x $3/16$ " d axial hole ea end; spec JAN-1-8.	Support for L512
E549	—	Same as E534	Support for R542
E550	—	Same as E534	Support for R542
E551	—	Same as E534	Support for R541
E552	—	Same as E534	Support for R541

* Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E553	—	Same as E548	Support for L511
E554	—	Same as E334	Support for R586
E555	—	Same as E334	Support for R586
E556	—	Same as E334	Support for R588
E557	—	Same as E334	Support for R588
E558	—	Same as E334	Support for R587
E559	—	Same as E334	Support for R587
E560	—	Same as E334	Support for R589
E561	—	Same as E334	Support for R589
E562	—	Same as E334	Support for R538
E563	—	Same as E334	Support for R538
E564	—	Same as E334	Support for R539
E565	—	Same as E334	Support for R539
E566	N16-D-46420-9810	DIAL: drum: aluminum; for $\frac{3}{8}$ " diam max shaft; single $\frac{1}{4}$ "-28 NF-2 tapped hole through ctr; engraved numerals "1", "10", equally spaced; $\frac{7}{8}$ " diam x 1-7/32" d o/a; FTRC dwg #303-8939-002.	Knob for neutralizing capacitor on V505
E567	—	Same as E566	Knob for neutralizing capacitor on V506
E568	—	Same as E334	Support for R520
E569	—	Same as E334	Support for R521
E570	—	Same as E334	Support for R512
E571	—	Same as E334	Support for R520
E572	—	Same as E334	Support for R521
E573	—	Same as E334	Support for R512
E574	—	Same as E334	Support for R537
E575	—	Same as E334	Support for R532
E576	—	Same as E334	Support for R513
E577	—	Same as E334	Support for R535
E578	—	Same as E334	Support for R531

E579	—	Same as E334	Support for R537
E580	—	Same as E334	Support for R532
E581	—	Same as E334	Support for R513
E582	—	Same as E334	Support for R535
E583	—	Same as E334	Support for R531
E584	—	Same as E334	Support for R581
E585	—	Same as E334	Support for R581
E586	—	Same as E334	Support for R613
E587	—	Same as E334	Support for R613
E588	—	Same as E334	Support for R614
E589	—	Same as E334	Support for R614
E590	—	Same as E334	Support for R576
E591	—	Same as E334	Support for R584
E592	—	Same as E334	Support for R583
E593	—	Same as E334	Support for R590
E594	—	Same as E334	Support for R585
E595	—	Same as E334	Support for R576
E596	—	Same as E334	Support for R584
E597	—	Same as E334	Support for R583
E598	—	Same as E334	Support for R590
E599	—	Same as E334	Support for R585
E600	—	Same as E334	Support for R578
E601	—	Same as E334	Support for R578
E602	—	Not Used	Tie point for R572, R592
E603	3G350-128 N17-1-69152-1676 3320-331265932	INSULATOR, standoff: round post shape; grade L-5B ceramic; glazed; 5/8" lg x 1/4" diam, with #4-40 NC-2 thrd x 3/16" d csk axial hole ea end; FTRC dwg #FRG-30523-1.	Tie point for R574, R593, R591
E604	—	Same as E603	Tie point for R592, R593, E663
E605	—	Same as E603	Tie point for R575, R576, E663
E606	—	Same as E603	Tie point for R612, R595
E607	—	Same as E603	

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E608	—	Same as E334	Insulator for R559
E609	—	Same as E334	Insulator for R561
E610	—	Same as E334	Insulator for R558
E611	—	Same as E334	Insulator for R552
E612	—	Same as E334	Insulator for R553
E613	—	Same as E334	Insulator for R555
E614	—	Same as E334	Insulator for R559
E615	—	Same as E334	Insulator for R561
E616	—	Same as E334	Insulator for R558
E617	—	Same as E334	Insulator for R552
E618	—	Same as E334	Insulator for R553
E619	—	Same as E334	Insulator for R555
E620	—	Same as E603	Tie point for R549, R550, S502A-4
E621	—	Not Used	
E622	3G3501-06.1 N17-1-69158-6205 3320-333730613	INSULATOR, standoff: round post shape; JAN type NS4W0106; grade L-4 ceramic, white glazed; $\frac{3}{4}$ " lg x $\frac{3}{8}$ " diam, with #6-32 thrd x $\frac{1}{4}$ " d axial hole ea end; spec JAN-1-8.	Insulator for C518
E623	—	Same as E548	Insulator for C519
E624	2Z2712.1 N17-C-800645-401 3300-287222500	CLIP: electron tube; for connecting to tube term; spring brass cad pl; RSW; $1\frac{1}{8}$ " lg x $\frac{5}{8}$ " wd x $9/16$ " h o/a; ceramic ins; CNA#Spp.3.	Cap for V503
E625	—	Same as E603	Tie point for R523, E506, E136
E626	—	Same as E603	Tie point for R526, R515
E627	—	Same as E603	Tie point for R510, R511, C506
E628	—	Same as E603	Tie point for R513, R510, R511, C504
E629	—	Same as E624	Cap for V502
E630	—	Same as E603	Tie point for R515, XV502-4
E631	—	Same as E603	Tie point for C1305, C519
E632	—	Same as E366	Fuse and capacitor clips
E633	—	Same as E365	Fuse and capacitor clips
E634	—	Same as E603	Tie point for R517, TB506-122

E635	—	Same as E603	Tie point for R501-R504, T501, J504
E636	—	Same as E603	Tie point for C501, J503
E637	—	Not Used	Fuse and capacitor clips
E638	—	Same as E367	Fuse and capacitor clips
E639	N17-C-804618-727	CLIP: fuse; for 13/32" diam cartridge fuse; silver pl beryllium copper 0.733" lg x 0.398" wd x 0.464" thk o/a; 13/32" max jaw opening; CFA #4464.	Output network to ant line contact
E640	N17-C-82005-5172	CONTACT, switch: spring leaf type; 2-9/16" lg x 7/16" wd x 5/32" h o/a; 1/4" wd x 7/16" lg x 0.020" thk coin silver cont; two 0.154" diam mtg holes 7/8" from fixed end; 1-7/16" approx from cont to 1st mtg hole; FTRC dwg FRA-30477-1A.	Output network to ant line contact
E641	—	Same as E640	
E642	—	Not Used	
E643	—	Not Used	
E644A	N17-I-48679-2407	INSULATOR, bushing: JAN type NS4W4101; grade L-4 ceramic, white glaze; 1/2" OD max 0.143" ID x 5/8" lg o/a; spec JAN-1-8.	Feedthru from C512 to L504
E644B	N17-I-47363-4208	INSULATOR, bowl: JAN type NS4W4201; grade L-4 ceramic, white glaze; 3/8" lg, 1/2" OD tapering to 3/8"; spec JAN-1-8.	Feedthru from C512 to L504
E645	3G1250-48.8 N17-I-69233-9541 3320-332145560	INSULATOR, standoff: round post shape; JAN type NS4W0424; grade L-4 ceramic, white, glazed; 3" lg x 1" diam; spec JAN-1-8.	Support for S505, M503 and for S506, M504; also for shorting bar on L516, L517
E646	—	Not Used	
E647	—	Not Used	
E648	—	Not Used	
E649	—	Not Used	
E650	—	Not Used	
E651	—	Not Used	
E652	—	Not Used	
E653	—	Not Used	
E654	—	Not Used	
E655	3G350-135 N17-I-69175-7121 3320-331265939	INSULATOR, standoff: round post shape; JAN type NS4W0440; grade L-4 ceramic, white, glazed; 5" lg x 1" diam with 1/4"-20 x 5/8" d axial hole ea end; spec JAN-1-8.	Support for C526
E656	—	Same as E655	Support for C526
E657	3G3502-06.2 N17-I-69175-7121 3320-333730745	INSULATOR, standoff: round post shape; JAN type NS4W0206; grade L-4 ceramic, white glaze; 3/4" lg x 1/2" diam o/a, with #8-32 thrd x 1/4" d axial hole ea end; spec JAN-1-8.	Support for C541

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Continued)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E658	—	Same as E657	Support for C542
E659	—	Same as E548	Support for L512
E660	—	Same as E548	Support for L511
E661	3G1000-2 N17-1-47559-4201 3320-331735000	INSULATOR, bowl: glazed ceramic; 2 3/4" h x 3 1/8" ID x 5 3/8" OD max; six 9/32" diam holes equally spaced on 4 7/8" diam circle; CBU#306.	Antenna feedthru
E662	—	Same as E546	Mtg insul for R525
E663	—	Same as E603	Tie point for R594, E605, E606
E664	3G3540-03.1 N17-1-48707-8663 3320-333763021	INSULATOR, bushing: JAN type NS4W4003; grade L-4 ceramic; white glaze; 3/4" OD x 0.2" ID x 7/16" lg o/a; spec JAN-I-8.	Spacer and fil ring support for V505
E665	—	Same as E664	Spacer and fil ring support for V505
E666	—	Same as E664	Spacer and fil ring support for V505
E667	—	Same as E664	Spacer and fil ring support for V505
E668	—	Same as E664	Spacer and fil ring support for V505
E669	—	Same as E664	Spacer and fil ring support for V505
E670	—	Same as E664	Spacer and fil ring support for V505
E671	—	Same as E664	Spacer and fil ring support for V505
E672	—	Same as E664	Spacer and fil ring support for V505
E673	—	Same as E664	Spacer and fil ring support for V505
E674	—	Same as E664	Spacer and fil ring support for V505
E675	—	Same as E664	Spacer and fil ring support for V505
E676	—	Same as E664	Spacer and fil ring support for V506
E677	—	Same as E664	Spacer and fil ring support for V506

E678	—	Same as E664	Spacer and fil ring support for V506
E679	—	Same as E664	Spacer and fil ring support for V506
E680	—	Same as E664	Spacer and fil ring support for V506
E681	—	Same as E664	Spacer and fil ring support for V506
E682	—	Same as E664	Spacer and fil ring support for V506
E683	—	Same as E664	Spacer and fil ring support for V506
E684	—	Same as E664	Spacer and fil ring support for V506
E685	—	Same as E664	Spacer and fil ring support for V506
E686	—	Same as E664	Spacer and fil ring support for V506
E687	—	Same as E664	Spacer and fil ring support for V506
E688	—	Same as E324	Knob for S503
E689	—	Same as E324	Knob for R548
E690	—	Same as E324	Knob for F519
E691	—	Same as E324	Knob for S504
E692	N16-K-700285-346	KNOB: round; black anodized aluminum; for 1/4" diam shaft; two #6-32 NF-2 thrd radial holes, 9/16" lg white arrow; 13/16" diam x 3/4" lg o/a; 1/2" d shaft hole; medium diamond knurl; FTRC dwg #FRB-30894-1-2.	Knob for S501
E693	—	Same as E369	Knob for S512
E694	—	Same as E369	Knob for S513
E695	—	Same as E369	Knob for S502
E696	—	Same as E369	Knob for R560
E697	N16-K-700271-903	KNOB: Same as E692, except also has 1/4" lg white line on side; FTRC dwg #FRA-30894-1-1.	Knob for C535
E698	—	Same as E370	Knob for S505
E699	—	Same as E370	Knob for S506
E801	N17-1-59611-5521	INSULATOR, feedthru: round; grade L-5B ceramic; 0.400" diam x 0.854" lg o/a, incl 17/32" lg solder lug; body 0.281" diam x 0.323" lg with 0.400" diam x 1/8" wd fl at 0.109" from fixed end; fl and fixed end nickel plated copper jacket; FTRC dwg #FRA-30442-1-1.	Feedthru to T801 (4 ea, 6 units)

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E802	—	Not Used	Tie point for R810 and P801 (1 ea, 6 units)
E803	—	Not Used	Tie point for R805 and K802 (1 ea, 6 units)
E804	—	Not Used	Tie point for R802, R803 and P801 (1 ea, 6 units)
E805	—	Same as E603	Tie point for R802, R803 and P801 (1 ea, 6 units)
E806	—	Same as E603	Tie point for R802, R803 and CR801 (1 ea, 6 units)
E807	—	Same as E603	Connects servo amplr and drive units of T-225A/FRT-5 to servo power supply
E808	—	Same as E603	Used with E809
E809	N17-B-77739-5038	BOARD, terminal: connector strip; 6 screw term, 7/16" c to c, w/barriers; bake- lite; 3 3/8" lg x 1 1/8" wd x 1/2" thk o/a; CJC #6-141.	Hold-down shield for V801 (1 ea, 6 units)
E810	—	Same as E809	Hold-down shield for V802 (1 ea, 6 units)
E811	—	Same as E124	Hold-down shield for V802 (1 ea, 6 units)
E812	—	Same as E124	Hold-down shield for V901
E901	N16-S-34404-1051	SHIELD, tube: 0.0253" thk alum, etched; cyl fl mtd; 2-5/16" ID x 11/16" d x 2-29/32" OD; four radial mtg slots 90° apart; CEJ #16.100-1.	
E1001	—	Not Used	Clip for R1006
E1002	N17-C-814613-110	CLIP; resistor; nickel pl beryllium copper; "U" shape; 3-1/16" lg x 1/4" wd x 5/8" h o/a; two 0.110" diam mtg holes spaced 2 1/2" c to c; FTFC dwg #FRB- 30545-1-1.	Clip for R1007
E1003	—	Same as E1002	Clip for R1008
E1004	—	Same as E1002	Clip for R1002
E1005	N17-C-804971-101	CLIP; resistor; nickel pl beryllium copper; "U" shape; 2-1/16" lg x 1/4" wd x 5/8" h o/a; two 0.110" diam mtg holes spaced 1 1/2" c to c; FTFC dwg #FRB- 30545-1-2.	Clip for R1004
E1006	—	Same as E1005	Hold-down shield for V1003
E1007	—	Same as E901	Hold-down shield for V1005
E1008	—	Same as E901	Hold-down shield for V1006
E1009	—	Same as E901	

E1101	—	Same as E603	Tie point for J1103, C1117
E1102	—	Same as E603	Tie point for C1115, L1104
E1103	—	Same as E603	Tie point for term #8, XV1102, C1118, R1106, R1107
E1104	—	Same as E603	Tie point for R1106, L1103
E1105	—	Same as E603	Bkt support for C1106-C1110
E1106	—	Same as E603	Bkt support for C1106-C1110
E1107	—	Same as E603	Bkt support for C1101-C1105
E1108	—	Same as E603	Bkt support for C1101-C1105
E1109	—	Same as E369	Knob for S1103
E1110	—	Same as E369	Knob for S1103
E1111	—	Same as E121	Hold-down shield for V1101
E1301	—	Same as E603 (Part of Z1301)	Tie point for C1305, R1323, XV1303-6 (1 ea, 2 units)
E1302	—	Same as E603 (Part of Z1301)	Tie point for R1323, R1324, C1306 (1 ea, 2 units)
E1303	—	Same as E603	Tie point for R1311, XV1301-1 (1 ea, 2 units)
E1304	—	Same as E603	Tie point for R1301, R1311, E509 (1 ea, 2 units)
E1305	—	Same as E603	Tie point for R1311, R1301, C1302 (1 ea, 2 units)
E1401	—	Same as E109	Tie point for S1405, C1435
E1402	—	Same as E109	Tie point for R1429, R1448
E1403	—	Same as E109	Tie point for C1458, R1485
E1404	—	Same as E109	Tie point for C1457, V1407
E1405	—	Same as E109	Tie point for C1455, C1456, R1486
E1406	—	Same as E109	Tie point for C1456, R1484
E1407	—	Same as E644A	Feedthru for plate lead from L1410 to plate cap V1404
E1408	—	Same as E644B	Part of E1407 feedthru for plate lead from L1410 to plate cap V1404
E1409	—	Same as E624	Plate cap of V1404
E1410	N16-K-700061-474	KNOB: center round, RH projection rectangular, LH projection triangular; black bakelite; for 1/4" diam shaft; two #8-32 NF-2 holes spaced 90 deg; arrow marking; 1/8" lg x 3/4" wd x 21/32" h o/a; 7/16" d shaft hole in brass insert; FTRC dwg #FRB-30606-1.	Knob for S1409

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n't'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
E1411	—	Same as E1410	Knob for S1402
E1412	—	Same as E1410	Knob for R1430
E1413	—	Same as E1410	Knob for R1485, S1408
E1414	—	Same as E1410	Knob for S1404
E1415	—	Same as E1410	Knob for S1403
E1416	—	Same as E1410	Knob for S1405
E1417	—	Same as E1410	Knob for R1458
E1418	—	Same as E1410	Knob for S1401
E1419	—	Same as E101	Knob for C1405
E1420	—	Same as E102	Lock knob for R1430
E1421	—	Same as E102	Lock knob for R1485
E1422	—	Same as E102	Lock knob for C1405
E1423	—	Same as E102	Lock knob for R1458
E1424	—	Same as E122	Hold-down shield for V1401- V1403, V1409-V1411 (qty 6)
E1425	—	Same as E122	Hold-down shield for V1405- V1407 (qty 3)
E1426	—	Same as E124	Hold-down shield for V1408, V1412
E1427	—	Same as E125	Hold-down shield for V1401- V1403
E1428	N16-C-692001-104 —	NUT: miniature socket mtg strap; cad pl brass; not threaded; "C" shape with two hot tin dipped solder lugs at term; 1 1/8" lg x 0.064" thk x 25/32" wd o/a, 11/32" ID, 15/32 OD; one mtg hole 0.104" diam; CMG#1031.	Mtg ring and tie point for XV1405- XV1407, XV1409-XV1411 (qty 6)
F101	3Z2595.7 N17-F-14310-360 8800-360976	FUSE, cartridge: Navy type -28053-1 1/2; 1/2 amp; blowing time: life at 110%, 1 hr at 133%, 5-60 sec at 200% rated load; 125/250 v; one time; CLF #313.500.	Fuse all power except crystal oven
F102	N17-F-14310-320 —	FUSE, cartridge: Navy type -28053-15/100; 0.15 amp, blowing time: life at 110%, 1 hr at 133%, 5-60 sec at 200% rated load; 125/250 v; one time; CLF #313.150.	Fuse, crystal oven
F301	3Z2601.16 N17-F-14310-380 8800-360978	FUSE, cartridge: Navy type -28053-1; 1 amp; blowing time: life at 110%, 1 hr at 135%, 5-60 sec at 200% rated load; 125/250 v; one time; CLF #313001.	HV rect fil transf pri
F302	—	Same as F301	HV rect fil transf pri
F303	—	Same as F301	HV rect fil transf pri

F304	—	Same as F301	HV rect fil transf pri
F305	—	Same as F301	HV rect fil transf pri
F306	—	Same as F301	HV rect fil transf pri
F307	—	Same as F301	LV fil transf pri
F308	—	Same as F301	Bias fil transf pri
F401	G17-F-14635 8800-343000	FUSE, cartridge: 10 amp; blowing time: life at 110%, 1 hr at 135%, 5-60 sec at 200% load; 250v; one time; Navy spec 17F2; CFA #NFA-10.	HV on lamp (ext)
F402	—	Same as F401	HV on lamp (ext)
F403	G17-F-14680 8800-344200	FUSE, cartridge: Navy type -28079-50; 50 amp; blowing time: life at 110%, 1 hr at 135%, 5 to 60 sec at 200% load; 250 v; one time; Navy spec 17F-2; CFA #NFA-50.	Pri wiring to transf encl
F404	—	Same as F403	Pri wiring to transf encl
F405	—	Same as F403	Pri wiring to transf encl
F501	—	Same as F301	Exciter fil transf pri
F502	—	Same as F301	Driver fil transf pri
F901	3Z2587.1 N17-F-14310-335 8800-356107	FUSE, cartridge: Navy type -28053-1/4; 1/4 amp; blowing time: life at 110%, 1 hour at 135%, 5-60 seconds at 200% load; 125/250 v; one time; CLF #313.250.	Fil fuse (1 ea, 2 units) in Z901
F902	N17-F-14310-350 8800-360975	FUSE, cartridge: Navy type -28053-4/10; 4/10 amp; blowing time: life at 110%, 1 hour at 135%, 5-60 sec at 200% load; 125/250 v; one time; CLF #313.400.	Plate fuse (1 ea, 2 units) in Z901
F903	N17-F-16320-200 8800-360982	FUSE, cartridge: Navy type -28053-2; 2 amp; blowing time: life at 110%, 1 hour at 135%, 5-60 sec at 200% load; 125/250 v; one time; CLF #313002.	Servo motor pwr fuse (1 ea, 2 units) in Z901
F1001	3Z1950 N17-F-16302-120 8800-361212	FUSE, cartridge: Navy type -28032-3; 3 amp; quick acting; 125/250 v; one time; CLF #312003, type 3AG.	For 110-volt line
F1002	3Z1927 N17-F-16302-100 8800-361210	FUSE, cartridge: Navy type -28032-2; 2 amp; quick acting; 125/250 v; one time; CLF #312002, type 3AG.	For 110-volt line
F1003	3Z2601.5 N17-F-16320-100 8800-360913	FUSE, cartridge: Navy type -28032-1R5; 1 1/2 amp; quick acting; 125/250 v; one time; CLF #31201.5, type 3AG.	For 230-volt line
F1004	3Z1826 N17-F-16302-80 8800-361200	FUSE, cartridge: Navy type -28032-1; 1 amp; quick acting; 125/250 v; one time; CLF #312001, type 3AG.	For 230-volt line
F1101	—	Same as F901	Crystal heater fuse
F1401	—	Same as F1004	115-volt line fuse
F1402	—	Same as F1004	115-volt line fuse

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
H301	N16-H-150001-250	HANDLE: symmetrical "T" shape; steel; 5½" lg x 1" wd x 3¾" d o/a, incl shaft extension; 1⅝" d from mtg surface; FTRC dwg #503-1929-002.	Upper front door of cabinet
H302	N16-H-150001-249	HANDLE: offset "T" shape; C. R. steel; 5½" lg x 1" wd x 2¾" d o/a, incl shaft extension; 1⅝" d from mtg surface; FTRC dwg #503-0320-002.	Lower front door of cabinet
H303	N16-H-150001-247	HANDLE: modified "T" shape; cut from cold drawn #53S aluminum extrusion, anodized; 4½" lg x 1⅝" d x ⅝" wd o/a; rounded "E" shape; 0.3720" diam x 1⅓/16" d mtg hole in center leg; FTRC dwg FRB-30713-2-2.	Rear door of cabinet (right)
H304	N16-H-150001-246	HANDLE: same as above, except #10-32 NC-2 thrd x ⅝" d tapped hole and 0.062" diam x 3/16" d hole for pin 5/16" apart in center leg; FTRC dwg FRB-30713-2-1.	Rear door of cabinet (left)
H305	N16-H-150001-248	HANDLE: "U" shape; black plastic molded over aluminum or zinc core; 4-5/32" lg x ⅝" wd x 1-11/64" h o/a; mtd by two #10-32 thrd x ⅝" d tapped holes spaced 3.640" c to c in ends; FTRC dwg #015-1110-00.	Access door on front of cabinet
H501	—	Same as H301	Upper front door of cabinet
H502	—	Same as H302	Lower front door of cabinet
H503	—	Same as H303	Rear door of cabinet (right)
H504	—	Same as H304	Rear door of cabinet (left)
H505	—	Same as H305	Access door on front of cabinet
H506	N33-H-124-600	HOSE: air; rubberized fabric; 2" ID x 2¼" OD x 23¼" lg o/a; American Ventilating Hose Co. "Flexaust" type CWS.	Air duct (qty 2)
I101	N17-L-6806-460 7700-530118	LAMP, glow: 110 to 120 v AC or DC, 1/10 w; bulb rectangular translucent white; burn any position; CAYS #110.	Pilot, indicates crystal oven heaters on
I102	—	Same as I101	Pilot, indicates 250 volts on
I103	—	Not Used	
I104	—	Same as I101	Pilot, indicates AFC on
I301	G17-L-3916 8800-501190	LAMP, incandescent: 120 v, 6w; bulb S-6 clear; 1⅞" lg o/a; double contact bayonet candelabra base; burn any position; CG#S-6.	Meter light for M301
I302	—	Same as I301	Meter light for M302
I303	—	Same as I301	Meter light for M303
I304	—	Same as I301	Fil pilot
I305	—	Same as I301	LV pilot

I306	—	Same as I301	HV on pilot
I307	—	Not Used	
I308	—	Not Used	
I309	—	Same as I301	Overload pilot
I310	N17-H-85100-1201 7700-414290	HORN, electrical: Navy type -10737; electric motor driven; 230 v, 60 cps, 0.15 amp; 3 3/8" lg x 6 1/4" diam o/a; painted steel housing; four 1/4" diam mtg holes spaced 90° apart on 1 1/2" radius; CVY type 2, #127.	Overload lockout alarm
I311	—	Same as I101	Fuse failure indicator for F301
I312	—	Same as I101	Fuse failure indicator for F302
I313	—	Same as I101	Fuse failure indicator for F303
I314	—	Same as I101	Fuse failure indicator for F304
I315	—	Same as I101	Fuse failure indicator for F305
I316	—	Same as I101	Fuse failure indicator for F306
I317	—	Same as I101	Fuse failure indicator for F307
I318	—	Same as I101	Fuse failure indicator for F308
I401	N17-L-4413-40 8800-521530	LAMP, incandescent: 240 v, 50 w; bulb inside frosted; 3-15/16" lg o/a; medium screw base; burn any position; CG#50A21.	Ext HV on lamp
I402	—	Same as I401	
I501	—	Same as I301	Ext HV on lamp
I502	—	Same as I101	Bias pilot
I503	—	Same as I101	Fuse failure indicator for F501
I504	—	Not Used	Fuse failure indicator for F502
I505	—	Same as I301	
I506	—	Same as I301	Power amplr fil pilot
I507	—	Same as I301	HV on pilot
I508	—	Same as I301	Overload pilot
I509	—	Same as I301	Meter light for M502
I510	—	Same as I301	Meter light for M507
I511	—	Same as I301	Meter light for M501
I512	—	Same as I301	Meter light for M506
I901	—	Same as I101	Meter light for M505
I902	N17-L-6806-470	LAMP, glow: 110-120 v AC or DC, 1/10 w; bulb 1-7/32" x 9/16" x 9/32", translucent white plastic; solder lug term base; burn any position; black filled engraved letters "PWR ON"; (for replacement use I101); CAYS #110.	F901 failure indicator
			Indicator fil on

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
I903	—	Same as I101	F902 failure indicator fil on (1 ea, 2 units)
I904	—	Same as I101	F903 failure indicator on (1 ea, 2 units)
I1001	—	Same as I101	Pilot lamp
I1101	—	Same as I101	F1101 failure indicator
I1102	2Z5952 G17-L-6297 8800-444163	LAMP, incandescent: 6.3 v, 0.15 amp; bulb T-3¼ clear; miniature bayonet base; burn any position; CG#47.	Oscillator fil pilot
I1103	—	Same as I1102	Crystal heater indicator
I1401	—	Same as I101	Oven ON indicator
I1402	—	Same as I101	Plate ON indicator
J101	2Z7120.12 N17-C-73565-9015 8850-574411	CONNECTOR, receptacle: Navy type -491144; 10 rectangular male pol cont; straight: rectangular bakelite body; phenolic insert; CJC #P-310-AB.	Power input from power supply PP-454A/FRT-5
J102	6ZK7799-13 N17-C-73443-8438 8850-217220	CONNECTOR, receptacle: Navy type -49844; 2 rectangular male non pol cont; straight; 10 amp at 250 v, 15 amp at 125 v; cyl textalite body; molded phenolic insert; CG#2711, dwg K-5440592.	115-volt a-c input
J103	2Z5581-16 N17-J-39256-2751	JACK, telephone: Navy type -491973; for 3 cond plug; ¼" diam; J3-1C cont arrangement; ⅝"-32 NFF-2 thrd x ⅝" lg mtg bushing; CMA #705, class A.	Headphone
J104	2Z7390-290 N17-C-73108-1267	CONNECTOR, receptacle: AN type UG-290-U; single round female pol cont; straight; cyl metal body; phenolic insert; cable opening 0.330" diam; Navy dwg RE-49F331H; CARO #2700.	450-kc output
J105	—	Same as J104	100-kc output
J106	—	Same as J104	100-kc input from external source
J107	—	Not Used	
J108	—	Same as J104	2 to 4.5 mc output
J109	—	Not Used	
J110	—	Not Used	
J111	—	Not Used	
J112	—	Not Used	
J113	N17-C-71190-6437	CONNECTOR, plug: 4 female lug type cont; pol brass banana socket, w/0.105" diam holes; 3/32" thk phenolic plate type LTS-E-2; cable connects to solder lugs on back; FTRC dwg FRA-31050-1.	Master oscillator jack

J114	N17-C-73196-5137	CONNECTOR, receptacle: female lug type cont pol brass banana jacks with 0.105" diam holes; 3/32" thk phenolic plate, cable connects to solder lugs on rear; FTRC dwg #FRA-31049-1.	Interpolation oscillator jack
J115	N17-C-68293-3011	CONNECTOR, adapter: double ended male; four round male cont, 4 banana type cont; straight; connects 4 prong receptacle to 4 prong term board; rectangular phenolic body; (Part of Z102: for maintenance replace complete Z102).	Adapter in master oscillator
J116	—	CONNECTOR: Same as J115; (Part of Z101: for maintenance replace complete Z101).	Adapter in interpolation oscillator
J301	N17-C-73643-5360	CONNECTOR, receptacle: 30 round male pol cont; straight; cont 10 amp; round metal body; phenolic insert; CED#1K-30-32S.	Upper front door cable jack
J302	N17-C-73340-1933	CONNECTOR, receptacle: Navy type -491977; 30 round female pol cont; straight; cont 10 amp; round metal body; phenolic insert; CED#RIK-30-31SL.	Upper front door panel jack
J501	—	Same as J301	Upper front door panel jack
J502	—	Same as J302	Upper front door panel jack
J503	N17-C-73108-1262 8850-654440	CONNECTOR, receptacle: AN type UG-291/U; single round female cont; straight; cyl brass body; Navy dwg RE-49F-246; CARO #5000.	RF output to frequency monitor
J504	—	Same as J503	RF input from crystal osc to xmtr
J505	N17-J-39528-2090 8850-742620	JACK, telephone: Navy type -49021-A; for 2 cond plug 1/4" diam; J7 cont arrangement; 5/32" diam mtg hole; CMA #49021-A.	Phone jack for frequency monitor
J506	—	Same as J503	For external circuit
J507	—	Same as J503	For external circuit
J508	—	Same as J503	For external circuit
J509	N17-C-73110-8501	CONNECTOR, receptacle: Navy type -491979; single round cont; straight; cont 10 amp; round metal body; phenolic insert; CED#RWK-MI-31SL.	300-volt supply to RF oscillator O-92A/FRT-5
J510	2Z8673.20 N17-C-72240-1332 8850-532925	CONNECTOR, receptacle: AN type AN-3102-14S-1S; three round female pol cont; straight; cyl metal body, threaded 7/8"-20 NEF-2 for lockings; molded phenolic insert; 1/2" cable opening; spec MIL-C-5015.	Key line output for freq shift keyer
J511	6Z7788 N17-C-73127-5790 8850-512940	CONNECTOR, receptacle: Navy type -491453; double T slots; straight; cont 10 amp, 250 v, 15 amp 125 v; round black comp body; 1 3/8" c to c; CHU-#7255.	115-volt AC supply to freq shift keyer KY-45A/FRT-5
J512	—	Same as J511	115-volt AC supply to RF oscillator O-91A/FRT-5
J513	—	Same as J511	115-volt AC supply to RF oscillator O-92A/FRT-5
J514	6Z7811-10 N17-C-73171-9070 3300-697947142	CONNECTOR, Navy type -49809; 3 female pol cont; straight; 20 amp, 250 v AC or DC; 10 amp 575 v AC; round black comp body, twist lock; cable opening 5/8" diam; CHU #7328-G.	230-volt AC spare outlet

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
J515	N17-C-73175-3819 3850-514217	CONNECTOR, receptacle: Navy type -491014; 3 female pol cont; straight; cont 10 amp, 250 v, 15 amp, 125 v; round black bakelite body, twist lock; CHU#7557-G.	230-volt AC spare outlet
J516	—	Same as J515	230-volt AC primary power to power supply PP-454A/FRT-5
J517	—	Same as J502	Servo amplifier interconnections
J518	N17-C-73410-2751 8850-489600	CONNECTOR, receptacle: 1 round male cont; straight; cyl metal body; teflon insert; cable opening 23/32" diam; CARO#9450.	Single side-band excitation input
J519	—	Same as J518	Single side-band excitation input
J701	N17-C-72623-6977 8850-560158	CONNECTOR, receptacle: AN type AN-3102-16S-1P; 7 round male pol cont; straight; cyl metal body; molded bakelite insert; spec MIL-C-5015.	Connects power cable to servo drive unit (1 ea, 5 units)
J801	N17-C-73284-4143	CONNECTOR, receptacle: Navy type -491134A; 10 rectangular female pol cont; straight; black finish; molded bakelite insert; CJC #S-410-AB.	Connector for Z801
J802	—	Same as J801	Connector for Z802
J803	—	Same as J801	Connector for Z803
J804	—	Same as J801	Connector for Z804
J805	—	Same as J801	Connector for Z805
J806	—	Same as J801	Connector for Z806
J901	N17-C-73581-2457	CONNECTOR, receptacle: Navy type -49994; 12 rectangular male pol cont; straight; black finish; bakelite insert; CJC #P-412-AB-1/16.	Chassis connector (on Z901) to cable
J1001	N17-C-73281-9536 8850-574290	CONNECTOR, receptacle: Navy type -491982; 10 rectangular female pol cont; straight; rectangular bakelite body; CJC #S-310-AB.	Power supply to RF oscillator O-91A/FRT-5
J1002	—	Same as J1001	Power supply to freq shift Keyer KY-45A/FRT-5
J1101	—	Same as J102	115-volt AC input
J1102	N17-C-73465-6315 8850-528500	CONNECTOR, receptacle: Navy type -491978; 3 round male pol cont; straight; 15 amp cont; cyl metal body; molded phenolic insert; CED#GK-M3-32SL.	DC input, and external metering
J1103	—	Same as J503	RF output
J1201	—	Same as J503	Transmitter input
J1202	—	Same as J503	Crystal osc output connector

J1203	—	Same as J503	Master osc output connector
J1204	—	Same as J503	FSK output connector
J1205	—	Same as J503	FSK external input connector
J1206	—	Same as J503	External connector
J1207	—	Same as J503	Spare connector
J1208	—	Same as J503	Spare connector
J1401	—	Same as J104	External osc input
J1402	—	Same as J104	Keyer output
J1403	N17-C-73299-8312	CONNECTOR, receptacle: 13 solder lugs; straight; for banana type plug; rectangular; FTRC dwg FRE-30865-2-2.	Connector to heater oven
J1404	—	Same as J101	Power input from power supply PP-454A/FRT-5
J1405	N17-C-73299-8314	CONNECTOR, receptacle: 13 banana plugs; straight; silver pl copper and brass; rectangular; FTRC dwg FRE-30865-2-1.	Connector on oven heater
J1406	—	Same as J102	115-volt AC input for heater power
J1407	2Z3023-5 N17-C-72604-1516 8850-525756-52	CONNECTOR, receptacle: AN type AN-3102-14S-7P; 3 round male cont; straight type; cylindrical metal body; 0.682" diam cable openings; spec MIL-C-5015.	Keying line input
K101	2Z7599-107 N17-R-64197-5661 3300-294920165	RELAY, armature: Navy type -291774; cont arrangement 2B1A3A; cont: 2 amps 110 v 125 w non-inductive load rating, 3/32" diam x 0.015" thk fine silver; coil: single wnd, 115 v AC, ins; not polarized; RSW; solder lug term for coil and cont; fast acting; fungus resistance; CAU #R45-1040.	Capacitor centering for AFC
K301	N17-R-70651-2391	RELAY, solenoid: Navy type -291773; 7PST cont normally open; cont rating 10 amp, 600 v AC; cad pl silver cont; single wnd coil, 226 AC, inrush va 101, sealed va 23; not pol, ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul 700, type B700.	Fil voltage contactor
K301A	2Z3197A-63 N17-C-84197-7789 3380-287400563	CONTACT ASSEMBLY, relay: four normally open, L.H. contacts mtd on strip; cad plated silver cont; 10 amp; CBZ #X-137704.	Part of K301
K301B	2Z3197A-64 N17-C-84197-7799 3380-287400564	CONTACT ASSEMBLY, relay: four normally open R.H. contacts mounted on strip; cad plated silver cont; 10 amp; CBZ #X-137705.	Part of K301
K301C	2Z3197A-51 N17-C-84197-7729 3380-287400551	CONTACT ASSEMBLY, relay: three normally open L.H. cont mounted on strip; cad pl silver cont; 10 amp; CBZ #X-137714.	Part of K301
K301D	2Z3197A-52 N17-C-84197-7739 3380-287400552	CONTACT ASSEMBLY, relay: three normally open R.H. cont mounted on strip; cad pl silver cont; 10 amp; CBZ #X-137715.	Part of K301
K301E	2Z7684/13 N17-C-81588-7830 3380-295307530	CONTACT, relay: movable type; 2 cad pl silver cont. round, 1/4" diam; straight, CBZ #X-68996.	Part of K301

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
K 301F	2Z7593-5/2 N17-C-60707-1450 3380-294917193	COIL, relay: enam copper wire covered; 220 v, 60 cps, 272 ohms DC resistance; two 1/4" lg screw term and lugs on top; CBZ #RC2-3306.	Part of K301
K 302	2Z7684 N17-R-70651-2125	RELAY, solenoid: Navy type -29964; 4PST, cont normally open; cont rating 10 amp, 600 v AC; cad pl silver cont; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not pol, ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul. 700, type B-400.	Blower contactor
K 302A	—	Same as K301A	Part of K302
K 302B	—	Same as K301B	Part of K302
K 302C	—	Same as K301E	Part of K302
K 302D	—	Same as K301F	Part of K302
K 303	N17-R-70651-3725	RELAY, solenoid: Navy type -291770; 4PST, three normally open, 1 normally closed; contacts, 10 amp, 600 v AC, cad plated silver; single wnd coil, 220 v AC, inrush va 101, sealed, va, 23, not pol, ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul. 700, type B-310.	Power amplr fil contactor
K 303A	2Z3197A-45 N17-C-84197-7759 3380-287400545	CONTACT ASSEMBLY, relay: 4PST; three normally open, one normally closed L.H. contacts mtd on strip, cad plated silver, 10 amp; CBZ #X-137722.	Part of K303
K 303B	2Z3197A-50 N17-C-84197-7769 3380-287400550	CONTACT ASSEMBLY, relay: 4PST, three normally open, one normally closed R.H. contacts mtd on strip, cad plated silver, 10 amp; CBZ #X-137723.	Part of K303
K 303C	—	Same as K301E	Part of K303
K 303D	—	Same as K301F	Part of K303
K 304	N17-R-68422-9546	RELAY, motor driven: Navy type -291777; cont arrangement 1A; cont rating 10 amp 110 v AC, 5 amp 230 v AC, 3 amp 440 v AC; silver cont; 230 v, 60 cps single ph motor; 4 screw term on cont; fast acting; adj 6 to 120 sec delay; CCX #TE-120S, dwg #A50-25.	Fil heating time delay
K 305	N17-R-68418-4291	RELAY, motor driven: Navy type -291776; cont arrangement 1B; cont rating 10 amp 110v, 5 amp 230 v, 3 amp 440 v AC; silver cont; 230 v, 60 cps, single ph motor; 4 screw term on cont; 120 deg apart on 1.687" rad; fast acting; adj 15 sec to 5 min delay; CCX #TEC-5M (motor #SX-R63Z), dwg #A50-22.	Blower hold-on time delay
K 306	N17-R-70651-1915	RELAY, solenoid: Navy type -291769; 3PST cont normally open; cont rating 10 amp, 600 v AC; cad plated silver cont; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not pol; ins; screw type term on coil and cont; fast acting; CBZ #Bul 700, type B-300.	Bias contactor
K 306A	—	Same as K301C	Part of K306
K 306B	—	Same as K301D	Part of K306
K 306C	—	Same as K301E	Part of K306

K306D	—	Same as K301F		Part of K306
K307	N17-C-51769-6001	CIRCUIT BREAKER: Navy type -291784; magnetic; cont arrangement 1 normally open, 1 normally closed; AC non-inductive: 115 v 5 amp, 230 v 2 amp, 460 v 1 amp; DC non-inductive: 24 v 5 amp, 48 v 2 amp, 125 v 1 amp, 250 v 0.3 amp; calibration range 0.2 to 0.8 amp, 0.5 amp continuous; molded phenolic case, glass cover; instantaneous action, manual reset; impr coil for tropical use; CG #12PJC11A8TF.		Bias DC voltage interlock
K307A	2Z3189-15 N17-C-81466-8822 3380-287384030	CONTACT, relay: stationary type; single, conical; silver cont; cont 5 amp 115 v AC or 2 amp 230 v AC, non-inductive load; "L" shape; CG #6174439-G1.		Part of K307
K307B	2Z3189-15 N17-C-81446-1526 3380-287385490	CONTACT, relay: movable type; 1/32" thk L-shape alum plate with two 1/4" diam x 1/16" thk silver contact buttons located on oppos. sides; 2 1/4" lg tinned copper lead; CG #6174440-G1.		Part of K307
K308	N17-R-70651-4331	RELAY, solenoid: Navy type -291772; 6PST, five normally open, 1 normally closed; contacts 10 amp, 600 v AC rating; cad plated silver; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not poli; ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul. 700, type B510.		LV DC contactor
K308A	—	Same as K303A		Part of K308
K308B	—	Same as K303B		Part of K308
K308C	2Z3197A-49 N17-C-84197-7699 3380-287400549	CONTACT ASSEMBLY, relay: 2 normally open, left hand contacts mounted on strip; cad pl silver cont; 10 amp; CBZ#X-137716.		Part of K308
K308D	2Z3197A-48 N17-C-84197-7709 3380-287400548	CONTACT ASSEMBLY, relay: 2 normally open, right hand contacts mounted on strip; cad pl silver cont; 10 amp; CBZ#X-137717.		Part of K308
K308E	—	Same as K301E		Part of K308
K308F	—	Same as K301F		Part of K308
K309	—	Not Used		
K310	—	Not Used		
K311	N17-R-70651-3929	RELAY, solenoid: Navy type -291771; 5PST contacts: 3 normally open, 2 normally closed, rating 10 amp, 600 v AC, cad pl silver; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not poli; ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul. 700, type B-320.		Main breaker auxiliary
K311A	2Z3197A-47 N17-C-84197-7810 3380-287400547	CONTACT ASSEMBLY, relay: 2 normally open, 2 normally closed left hand cont mtd on strip; cad plated silver cont; 10 amp; CBZ #X-137706.		Part of K311
K311B	2Z3197A-43 3380-287400543	CONTACT ASSEMBLY, relay: 2 normally open, 2 normally closed right hand cont mtd on strip; cad plated silver cont; 10 amp; CBZ #X-137707.		Part of K311
K311C	2Z3197A-44 N17-C-84197-7669 3380-287400544	CONTACT ASSEMBLY, relay: one normally open left hand cont mounted on strip; cad pl silver cont; 10 amp; CBZ#X-137732.		Part of K311
K311D	2Z3197A-46 N17-C-84197-7679 3380-287400546	CONTACT ASSEMBLY, relay: one normally open right hand cont mounted on strip; cad pl silver cont; 10 amp; CBZ#X-137733.		Part of K311

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
K311E	—	Same as K301E	Part of K311
K311F	—	Same as K301F	Part of K311
K312	N17-R-68422-9544	RELAY, motor driven: Navy type -291775; contact arrangement 1C; cont rating 10 amp 110 v, 5 amp 230 v, 3 amp 440 v AC; silver cont; 230 v, 60 cps, single ph motor; 4 screw term on bottom; fast acting, adj 0-30 sec delay; CCX part #TE-30S, dwg #A50-25.	Non-automatic restart timer
K313	N17-R-70651-1549	RELAY, solenoid: Navy type -291768; 2PST, cont normally open; cont rating 10 amp, 600 v AC; cad pl silver cont; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not pol; ins; screw type term on coil and cont; fast acting; impr coil for tropical use; CBZ Bul. 700, type B-200.	Restart interval timer auxiliary
K313A	—	Same as K308C	Part of K313
K313B	—	Same as K308D	Part of K313
K313C	—	Same as K301E	Part of K313
K313D	—	Same as K301F	Part of K313
K314	—	Not Used	
K315	N17-R-69516-1226	RELAY, rotary: Navy type -291787; single disc, single row, 38 cont; shorting type cont arm; 0.5 amp at 230 v AC; silver cont; single wnd; 230 v, $\pm 10\%$, 60 cps; ins coil; solder lug term on coil and cont; varnish impr CGE series R, #53305-A.	Restart cycle counter
K316	N17-R-68408-5321	RELAY, motor driven: Navy type -291778 cont arrangement 1A; cont rating 10 amp 110 v, 5 amp 230 v, 30 amp 440 v AC; silver cont; 230 v, 60 cps, single ph motor; 4 screw term on cont; fast acting, adj 45 sec to 15 min delay; CCX part TEC-15M, dwg #A50-22.	Restart interval timer
K317	—	Not Used	
K318	N17-R-70714-3143	RELAY, solenoid: Navy type -291781; cont arrangement SPDT; cont rating 10 amp 125 v AC, 5 amp 250 v AC; 3/16" diam silver cont; single wnd coil, 230 v AC, 160 va inrush, 30 va holding, 175 ohms DC resistance; not pol; ins; screw type term on coil and cont; pneumatic time delay continuously adj 0.2 sec to 3 min, $\pm 10\%$; impr coil for tropical use; CSZ type RO-5E, #9050 special (coil #1861-S1-R32B).	Tune resistor shorting contactor auxiliary
K318A	—	COIL: CSZ #1861-S1-R32B	Part of K318
K319	N17-C-51769-8201	CIRCUIT BREAKER: Navy type -291785; magnetic; cont arrangement 1 normally open, 1 normally closed; AC non-inductive rating; 115 v 5 amp; 230 v 2 amp, 460 v 1 amp; DC non-inductive ratings; 24 v 5 amp, 48 v 2 amp, 125 v 1 amp, 250 v 0.3 amp; 6 amp continuous; moulded phenolic case, glass cover; instantaneous action; manual reset; CG #12PJC11A3TF.	HV DC overload
K319A	—	Same as K307A	Part of K319

K319B	—	Same as K307B	Part of K319 (qty 2)
K320	N17-R-70651-2925	RELAY, solenoid: cont arrangement 1 normally open, 3 normally closed; cont rating 10 amp, 600 v AC; cad pl silver cont; single wnd coil, 220 v AC, inrush va 101, sealed va 23; not pol, ins; screw type term on coil and cont; CBZ Bul 700, type B-130.	Non-automatic restart timer auxiliary
K320A	—	CONTACT ASSEMBLY, relay: rigid type, fixed, left hand; c/o three normally closed and one normally open (#2) contacts on bakelite block; CBZ #X-137738.	Part of K320
K320B	N17-C-84197-7749	CONTACT ASSEMBLY, relay: same as K320A, except right hand; CBZ #X-137739.	Part of K320
K320C	—	Same as K301E	Part of K320 (qty 4)
K320D	—	Same as K301F	Part of K320
K321	—	Same as K313	Lockout alarm auxiliary
K321A	—	Same as K308C	Part of K321
K321B	—	Same as K308D	Part of K321
K321C	—	Same as K301E	(qty 2) Part of K321
K321D	—	Same as K301F	Part of K321
K322	2Z7598-144 N17-R-72536-6968 3380-294814451	RELAY, thermal: Navy type -291782; cont arrangement SPST, one normally closed; cont rating 6 amp, 250 v AC; tungsten cont; single wnd coils, heater cur 500 ma; pol; ins; eight 9/16" cont pins; oper time 10 sec, +20%, -50%; CEE model #501.	Thermal timer for keying shutdown
K323	N17-R-68418-4296	RELAY, motor driven: Navy type -291779; cont arrangement 1B; cont rating 10 amp 110 v, 5 amp 230 v, 3 amp 440 v, AC; silver cont; 230 v, 60 cps single ph motor; 4 screw term on cont; fast acting; adj 30 sec to 30 min delay; CCX #TEC-30M, dwg #A50-22.	Automatic shutdown timer
K324	N17-C-51769-7801	CIRCUIT BREAKER: Navy type -291783; magnetic; DPST, 2 normally closed cont; AC non-inductive rating: 115 v 5 amp, 230 v 2 amp, 460 v 1 amp; DC non-inductive rating: 24 v 5 amp 48 v 2 amp, 125 v 1 amp, 250 0.3 amp; calibration range, 1 to 4 amp, 3 amp continuous; molded phenolic case, glass cover; instantaneous action; manual reset; impr coil for tropical use; CG #12PJ11A2TF.	Power amplr DC overload
K324A	—	Same as K307A	Part of K324 (qty 2)
K324B	—	Same as K307B	Part of K324 (qty 2)
K325	—	Same as K324	Power amplr DC overload
K326	—	Same as K307	Driver DC overload
K401	N17-C-51585-2006	CIRCUIT BREAKER: thermal armature; 3 pole; 125 amps at 600 v AC or 250 v DC at 25°C; 15,000 amps interrupting capacity; phenolic case; instant action; magnetic trip setting adjustable 400-1250 amps; undervoltage coil releases at 40-60% full voltage on 60 cps (or at 30-50% on 50 cps); 3 term ea end; attachment for motor (K401B) operation; interchangeable trip unit; CAY-#SO-6-E-5209, dwg #25B4439.	HV primary start-stop contactor and breaker (motor operated)

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
K401A	3C2200B N17-C-53795-1001 3340-308720350	COIL, circuit breaker: under voltage release; 4100 turns #37 AWG wire; 630 ohms resistance; 250 v; CAY part #1,019, 680 and dwg #79-D-253.	Under voltage release (p/o K401)
K401B	N17-M-59080-3750	MOTOR, AC/DC: series wound; 1/4 hp, 2500 rpm; closed frame, 2 poles; rotor brake spring set when power off; 50°C temp rise for rated duty cycle; plain shaft 5/16" diam x 1-21/32" lg beyond bearing shoulder; incl cut-off switch; 220 v DC, or 220 v, 60 cps, 1 phase AC; ball bearings; CAY frame #287, motor part #1172289-A, dwg #21-B-5199.	Breaker reset power (p/o K401)
K401C	N17-B-86434-6779	BRUSH SET, electrical contact: c/o two HV commutator brushes; grade AC-18 carbon; rectangular, 3/4" lg x 0.279" wd x 0.216" thk; 1-1/16" lg shunt; cont end concave on 1-1/16" radius; CAY style #1394062, except grade AC-18.	Part of K401B
K402	N-17-R-70651-2177	RELAY, solenoid: 3PST, double break, all normally open (plus one SPST normally open aux contact); 100 amp non-inductive load at 600 v; 11/16" diam silver-to-silver cont; single wnd, 220 v 60 cps, ins coil; 5.5 ohms DC resistance; 0.475 amp seal-in current; screw terms on cont, eyelet terms on coil; fast acting; impr for tropical use; CAFB#502U-31306-06.	Tune resistor shorting
K402A	N17-C-81617-1051	CONTACT, relay: moving block type; two round silver cont, 1/8" h; cont rating 100 amps, 220 v AC; oval shape, no term; mtd with pressure spring; CAFB #85225, dwg #AD-252.	Moving contact for K402 (qty 3)
K402B	N17-C-81618-5688	CONTACT, relay: rigid type, fixed, L.H.; one round silver cont, 1/8" h; cont rating 100 amps at 220 v AC; "L" shaped; CAFB #85217, dwg #AD-250.	Line contact and terminal (qty 3)
K402C	N17-C-81618-5686	CONTACT, relay: Same as K402B, except R.H. CAFB #85216, dwg #AD-250.	Load contact and term (qty 3)
K402D	N17-C-60726-8001	COIL, relay: single wdg, 220 v, 60 cps, 5.5 ohms DC resistance; enam copper wire; rectangular, mounts on 1-5/16" x 1 3/4" pole piece; two flexible wire leads with solder lug term; CAFB #CA-306, dwg #D-5029-B.	Operating coil for K402 (qty 1)
K801		RELAY, armature: SPDT, double break; contacts 8 amps 24 v DC, 3/16" diam, silver plated; single wdg, twin coils, 10-12 ma oper, 5.5-7 ma release, 9000 ohms \pm 10% total DC resistance; non-polarized; gnd coil; solder lug term on coil and cont; fast acting; tropicalized; CBER #27QA62A2.	Servo motor control (1 ea in 6 units)
K802		Same as K801	Servo motor control (1 ea in 6 units)
L101		Not Used	
L102		Not Used	
L103	N16-C-72590-8822	COIL, RF: Navy type -472510; osc; single layer wdg; unshielded; 41 turns #26 ga wire; phenolic form; adjustable powdered iron core; 2 solder lug term (Part of Z102; for maintenance replace complete Z102).	Grid tank of master oscillator
L104	N16-C-73926-8935	COIL, RF: Navy type -472512; choke; 1 pie universal wdg; unshielded; 180 μ h; 158 turns #30 ES wire; 3/8" lg phenolic coil form; single hole mtg; 3 clip term (Part of Z102; for maintenance replace complete Z102).	RF choke plate of master oscillator

L105	N16-C-72666-4402	COIL, RF: Navy type -472508; osc; single layer wnd; unshielded; 73 turns #33 ga wire; phenolic form; adj powdered iron core; 2 solder lug term (Part of Z101: for maintenance replace complete Z101).	Grid tank of interpolation oscillator
L106	N16-C-74209-7869	COIL, RF: Navy type -472511; choke; 1 pie universal wnd; unshielded; 600 μ h; 300 turns #32 ES wire; phenolic form, powdered iron core; single hole mtg; 2 clip term (Part of Z101; for maintenance replace complete Z101).	RF choke plate interpolation oscillator
L107	3C341-19 N16-C-74715-1017 3390-307775442	COIL, RF: choke; 1 wnd 4 pies, universal wnd; 2.5 mh, $\pm 20\%$, 250 DC ma; 52.5 ohms DC resistance; ceramic coil form; single CJA #K34102, modified to meet humidity requirements of JAN Spec 16-C-38.	RF choke in plate of V101
L301	N16-R-28996-9557	REACTOR: Navy type -304898; filter choke; 2 hy at 4 amps at 350 v RMS 60 cps; 3.84 ohms DC resistance; 12 kv test; semi-encl type; vacuum varnish impr, asphalt potting compound; two 1/4"-20 NC-2 thrd x 1 1/4" lg term studs with ceramic bushings, 2" c to c; FTRC dwg FT-04-2380-12C.	HV supply filter
L302	N16-R-29027-7966	REACTOR: Navy type -304892; filter choke; 3 hy, 0.80 amp; 25 ohms max DC resistance; 5000 v test; semi-sealed drawn steel case; two #8-32 thrd x 1 3/16" lg screw terms with 9/16" diam ceramic bushings spaced 5/8" c to c on bottom; moisture resistant; CTR spec #12645, dwg #MD-4138.	Bias supply filter
L303	N16-R-29126-2359	REACTOR: Navy type -304888; filter choke; 6 hy, 0.5 amp; 40 ohms max DC resistance at 25°C; 3500 v RMS test; semi-sealed metal case; two 1" lg screw terms with 7/16" diam ceramic bushings spaced 3/4" c to c on bottom; moisture resistant; CTR spec #9825, dwg #MD-4133.	LV supply filter
L501	3C1084K-119 N16-C-73555-5815 3340-310025586	COIL, RF: Navy type -472506; 1 pie universal wnd; unshielded; not turning coil; 50 μ h, 1 amp. 1.2 ohms DC resistance; 73 turns #30 SSE copper wire; ceramic rod form; CAI #7-801.	V501 plate choke
L502	3C326-100.4 N16-C-74714-8543 3340-307672023	COIL, RF: choke; single wnd 4 pie, duo-lateral wnd; unshielded; 2.5 mh, $\pm 10\%$, 0.125 amp, 50 ohms DC resistance; 1.5 mmf max distributed capacity; ceramic form; fungus resistant; CNA #R-100S.	V502 plate choke
L503	N16-C-72543-5597	COIL, RF: Navy type -472513; tuning; single layer wnd; unshielded; 36 turns #18 AWG wire; Isolatite form, air core; inductance varied by rotating cont; (Part of O553; order O555 for maintenance).	V502 plate tuning
L504		Same as L502	V503 grid choke
L505		Same as L502	V503 plate choke
L506		Same as L503 (Part of O555)	V503 plate tuning
L507		Same as L502	V504 grid choke
L508	*N16-C-72473-2961	COIL, RF: ant grounding choke; single wnd, single layer wnd; unshielded; 30 right hand turns, CT, #12 bus wire; glazed ceramic form, air core; form; term mtg; three solder lug term; FTRC dwg FRA-31019-2.	Antenna gnd choke
L509	N16-C-76635-1354	COIL, RF: Navy type -472509; tank; left hand wnd; unshielded; 22.5 μ h, 10 amp RF; 27 1/2 turns, 1/4" x 1/8" edgewise copper strip, silver pl; air core; main winding rotates, cont carriage slides along rod; 3 screw type term on top; CEJ #226-1.	V504 plate inductance
L509A	2Z3191-321 N17-C-78168-1001 3380-287387888	CONTACT, coil: irregular shape; c/o 1/8" thk brass strip bent into squared-U shape with (1) three 3/8" wd spring cont extending 13/16" ea end and (2) two triangular springs at 45° angle on top with fine silver cont; springs beryllium copper, all silver pl; 15 amps rating; CEJ #23-274-1.	Part of L509

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
L510	3C1084K-120 3340-310025587	COIL, RF: choke; single wdg, single layer wnd, unshielded; 47.5 μ h, 0.5 DC ohms, 1.0 amps; 70 turns #24 AWG enam copper wire on thrd ceramic form; air core; 1 solder lug term ea end; FTRC dwg FRA-31158-2A.	V504 plate choke
L511	—	Same as L510	V506 grid choke
L512	—	Same as L510	V505 grid choke
L513	—	Not Used	
L514	—	Not Used	
L515	—	Not Used	
L516	N16-C-71877-6583 —	COIL, RF: plate tank; single wdg, single layer space wnd; unshielded; 5-23/24 turns $\frac{5}{8}$ " diam soft copper rod R.H. wnd at $1\frac{1}{4}$ " pitch on $6\frac{3}{4}$ " ID; radial lug screw; FTRC dwg #FRB-30987-2-1.	V505 plate
L516A	—	BAR, shorting: silver pl brass; 8" lg x $\frac{7}{8}$ " wd x $1\frac{1}{16}$ " h o/a; 4 holes #4-40 NC-2 x $\frac{1}{4}$ " d, 9/32" c to c on top and bottom; 4 holes #4-40 NC-2 x $\frac{1}{4}$ " d, 9/32" c to c on opposite sides; one $\frac{3}{16}$ " diam hole through bar from side; FTRC dwg #A1003702.	Used with L516
L516B	—	CONTACT, coil: cont plug spring, flexible; chromium pl beryllium copper; U-shape; 1" lg x 0.421" wd x $1\frac{1}{16}$ " d o/a; FTRC dwg #504-1483-001.	Used with L516
L516C	2Z3191-323 N17-C-78267-6601 3380-287387890	CONTACT, coil: top and bottom; chromium pl beryllium copper; "C" shape; 0.427" wd bent at $1\frac{1}{16}$ " ID; FTRC dwg. #504-1488-003.	Used with L516 (qty 4)
L516D	—	CONTACT, coil: flexible wiper type; U-shaped beryllium copper spring with one external coin silver contact each end, all hard chromium plated; $\frac{3}{8}$ " lg x $\frac{3}{8}$ " wd x $1\frac{1}{8}$ " h o/a; FTRC dwg #A1003649.	Used with L516 (qty 1)
L516E	2Z3191-325 N17-C-78202-8901 3380-287387892	CONTACT, coil: inside; silver pl brass; "U" shape; $1\frac{1}{3}$ / 16 " lg x $\frac{7}{8}$ " wd x 0.615" d o/a; with tantung contact; FTRC dwg. #A1003704.	Used with L516 (qty 2)
L516F	2Z8877-366 N17-S-46768-5969 1760-296470140	SPRING: flat type; shorting bar; #28 ga silver pl beryllium copper; FTRC dwg. #504-1485-001.	Used with L516 (qty 2)
L516G	2Z8877-367 N17-S-46768-3201 1760-296470141	SPRING: flat type; shorting bar; #28 ga silver pl, beryllium copper; FTRC dwg #504-1484-001.	Used with L516 (qty 4)
L517	N16-C-71877-6578 —	COIL, RF: same as L516, except L.H. wound; FTRC dwg #FRB-30987-2-2.	V506 plate tank coil
L517A	—	Same as L516A	Part of L517
L517B	—	Same as L516B	Part of L517 (qty 2)
L517C	—	Same as L516C	Part of L517 (qty 4)

L517D	_____	Same as L516D	Part of L517 (qty 1)
L517E	_____	Same as L516E	Part of L517 (qty 2)
L517F	_____	Same as L516F	Part of L517 (qty 2)
L517G	_____	Same as L516G	Part of L517 (qty 4)
L518	N16-C-71832-9549	COIL, RF: antenna; single wnd, single layer wnd; unshielded; 5½ left hand turns ⅝" diam soft copper rod; FTRC list FRL-30506-1-2 and dwg #503-9270-003.	Left (antenna) coupling coil
L518A	N16-B-23536-9670	BAR, shorting: silver pl brass; 8" lg x 11/16" wd x 11/16" h o/a; 4 holes #4-40 NC-2 x ¼" d, 5/16" c to c on top and bottom, 8 holes #4-40 NC-2 x ¼" d, 9/32" c to c, 4 on each side; one 3/16" diam hole through bar from side; FTRC dwg #FRB-30509-2A.	Part of L518
L518B	2Z3191-326 N17-C-78152-3001 3380-287387893	CONTACT, coil: spring type chromium pl beryllium copper; "U" shape; FTRC dwg #FRB-30456-1.	Part of L518
L518C	2Z3191-327 N17-C-78141-2025 3380-287387894	CONTACT, coil: top and bottom; chromium pl copper; "C" shape 0.343" wd bent at 11/16" ID; FTRC dwg #FRB-30455-1.	Part of L518 (qty 4)
L518D	2Z3191-328 N17-C-78288-8701 3380-287387895	CONTACT, coil: inside; one surface, silver pl brass; "U" shape; FTRC dwg #FRB-30457-1.	Part of L518 (qty 2)
L518E	2Z3191-329 N17-C-78152-4001 3380-287387896	CONTACT, coil: spring type; silver pl beryllium copper, irregular shape; FTRC dwg #FRB-30486-1.	Part of L518 (qty 2)
L518F	_____	Same as L516G	Part of L518 (qty 4)
L519	N16-C-71832-7712	COIL, RF: antenna; single wnd, single layer wnd; unshielded; 5½ right hand turns ⅝" soft copper rod; coil fastened to Mycalex bars; FTRC list FRL-30506-1-1 and dwg #B1001967.	Right (antenna) coupling coil
L519A	_____	Same as L518A	Part of L519
L519B	_____	Same as L518B	Part of L519 (qty 2)
L519C	_____	Same as L518C	Part of L519 (qty 4)
L519D	_____	Same as L518D	Part of L519 (qty 2)
L519E	_____	Same as L518E	Part of L519 (qty 2)
L519F	_____	Same as L516G	Part of L519 (qty 4)
L520	*N16-C-71665-6162	COIL, RF: choke; single wnd, unshielded; 2 turns #14 wire; air form and core; ⅜" ID coil; term mtg; 1 solder lug term on ea end; FRA-31014-1.	RF choke coil in grid of V505
L521	_____	Same as L520	RF choke coil in grid of V506
L522	N16-C-72306-8233	COIL, RF: choke; single wnd; unshielded; 21 right hand turns #12 bus wire; less term; air core; term mtg; two 55/64" lg lug term, 1 ea end, FTRC dwg FRA-31013-1.	V505, V506 plate choke
L1001	N16-R-29174-5623	REACTOR: Navy type -304883; filter choke; 7.5 hy; 280 ma. 10 v. 60 cps; 75 ohms DC resistance; 1500 v ins; HS gray metal case; two solder terms on bottom of case; CUD #A-6526.	Filter choke in master oscillator pwr supply

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C nYd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
L1002	—	Same as L1001	Filter choke in B+ supply for FS keyer
L1003	—	Same as L1001	Filter choke in B+ supply for FS keyer
L1101	—	Same as L502	RF choke, grid V1101
L1102	—	Same as L502	RF choke, cathode V1101
L1103	N16-C-73445-5821	COIL, RF; choke; single layer wnd; unshielded; 34.0 μ h at 1 kc; 130 max turns #36 AWG E copper wire; phenolic rod form, axial wire leads; term mtg; fun- gus resistant; CAU7 dwg #10005.	RF choke, plate V1101
L1104	—	Same as L1103	RF choke, grid V1102
L1401	—	Same as L107 (p/o Z1405)	RF choke plate supply to V1401 and V1402
L1402	N16-C-72595-5545	COIL, RF; mixer plate; single wdg, single layer wnd; unshielded; 42 turns #32 DE copper wire at 47 TPI, CT; wdg ends 5/32" from one end; ceramic form, air core; 3" lg wire-of-coil lead each end; part of Z1403; CAI #7-819.	RF coil for V1401 and V1402
L1403	(NOT a replaceable part)	COIL, RF; coupling; single wdg; c/o 4" lg #18 AWG bare tinned copper wire in Voltron sleeving wnd 1 1/4 turns on 1 3/16" ID; wire-end terms; term mtg; mounts concentric outside L1402.	Link to L1402 (part of Z1405)
L1404	N16-C-73129-2867	COIL, RF; equalizer, 4950 kc \pm 3%; single wdg, single layer wnd; unshielded; 10.3 μ h, 100 mmf approx distributed capacity; approx 90 turns #32 DE copper wire close wnd, excl leads; Bakelite rod coil form; coaxial wire lead ea end; term mtg; p/o Z1405; CAI#7-803.	P/o equalizing network in line between L1403 and L1405
L1405	—	COIL, RF; Same as L1403, except 7" wound 2 1/4 turns and mtd outside L1406.	Link to L1406 (part of Z1404)
L1406	N16-C-72595-5547	COIL, RF; Same as L1402, except no center tap; part of Z1404; CAI#7-820.	Grid coil of V1403
L1407	—	Same as L1406 (p/o Z1403)	Plate coil of V1403
L1408	—	Same as L107	RF choke in V1403 plate supply
L1409	3C341-5 N16-C-74381-4123 3340-307775400	COIL, RF; choke; 1 wnd, 3 pies, universal wnd; 1 mh, \pm 20%, 250 DC ma; 13.5 ohms \pm 20% DC resistance; ceramic rod form; one #18 tinned copper radial wire lead, 2 1/8" lg from ea end; term mtg; CJA#K34108.	RF choke grid V1404
L1410	—	Same as L107 (p/o Z1402)	RF choke plate V1404
L1411	N16-C-72595-5549	COIL, RF; same as L1402, except tap at 33.5 turns from start, and no CT; CAI#7-821.	Plate coil of V1404 (part of Z1402)
L1412	N16-R-29317-4166	REACTOR; Navy type -302715; filter choke; 15 hv, 600 ma, \pm 20%; 0-60 cps; 1600 ohm max; 1500 v test; HS metal case, finished in flat gray lacquer; 2 sol- der lug term on bottom; CTR # spec #89988.	Part of wave shaping circuit

L1413	3C341-1 N16-C-74721-3586 3340-307775350	COIL, RF: choke; 1 wnd, 4 pies, universal wnd; 2.5 mh, $\pm 20\%$, 250 DC ma; 50 ohms DC resistance, ceramic form and core; term mtg; one #18 tinned copper radial lead from ea end; CJA #K34103, modified. Same as L107	RF choke
L1414	—	Same as L107	RF choke output V1407
L1415/L1416	N17-T-87064-3711	TRANSFORMER, RF: osc; 2 wdg, single layer wnd; unshielded; wdg #1 (secd—L1415) 200 turns #36 DE copper wire with tap at 15th turn, wdg #2 (pri—L1416) 11 turns #36 SSE copper wire superposed on wdg #1 so $5\frac{1}{2}$ turns on ea side of tap on latter; tubular pwd iron form; natural coil leads; CAI #49-177.	Grid coil of V1411 (osc.)
(L1416)	—	COIL, RF: Integral with L1415. (Part of Z1401).	Link on L1415/L1416
L1417	—	Same as L107	RF choke plate supply V1411
L1418	N16-C-73742-1485	COIL, RF: choke; single wdg, 3 pie universal wnd; unshielded; 0.1 Mhy $\pm 5\%$; each pie 30 turns #12x40 SSE Litz wire; pies $\frac{1}{8}$ " wd, spaced $\frac{1}{16}$ " apart; pwd iron form and core, tinned copper axial wire lead ea end; term mtg; CAI #7-806.	Part of low-pass filter in V1412 input
L1419	—	Same as L1418	Part of low-pass filter in V1412 input
L1420	N16-R-29649-1238	REACTOR: audio; 0.0292, 0.1192, 0.477 and 1.322 hy, $\pm 5\%$; 77.3 DC ohms; 500 v RMS; HS metal case; 5 solder lug term on bottom; CUT #D8836; spec JAN-T-27.	Grid coil for V1407
M301	N17-M-35890-2701	METER, voltmeter: DC; range 0 to 1 ma; rectangular, flush, black bakelite case; body $2\frac{3}{4}$ " h x $2\frac{7}{8}$ " wd x 1.46 " d behind flange; flange 3 " x 3.13 " x $3/16$ " thk; 2% accuracy for full scale reading; sensitivity approx 1000 ohms per v; calibrated for $3/32$ " thk steel panel; 40 scale divisions, black markings on white background, window in top of case for illumination; self-contained; scale marked 0 to 8 kv; CV model 731.	HV DC voltmeter
M302	N17-M-34277-3851	METER, voltmeter: AC, 25 to 125 cps; range 0 to 300 v; rectangular, flush, black bakelite case; body $2\frac{3}{4}$ " h x $2\frac{7}{8}$ " wd x 1.46 " d behind fl; fl 3 " x $3\frac{1}{8}$ " x $3/16$ " thk; 2% accuracy for full scale reading; 50,000 ohms int resistance; 0.84 va at 25 or 60 cps; 30 scale divisions, black markings on white background, window in top of case for illumination; self-contained; two mtg lugs; CV model 734.	Primary AC voltmeter
M303	3F8010-27 N17-M-33903-3851 3300-328214226	METER, voltmeter: AC, 25 to 125 cps; range 0 to 10 v; rectangular, flush, black bakelite case; $2\frac{3}{4}$ " by $2\frac{7}{8}$ " body, 1.46 " d behind fl; 3 " x $3\frac{1}{8}$ " x $3/16$ " fl; 2% accuracy for full scale reading; 140 ohms resistance, 0.84 va at 25 or 60 cps; calibrated for $3/32$ " thk steel panel; 50 scale divisions; black markings on white background; window in top of case for illumination; self-contained resistor; CV model 734.	Power amplr filament voltmeter
M304	3F3359-1 N17-M-32915-3951	METER, time: Navy type -22375; elapsed time indicator; sync self-starting clock motor; direct reading; automatic start and stop; 3 " lg x $3\frac{1}{8}$ " wd x 3 " d o/a; five rotating drum counters, ea calibrated 0 to 9, w/window opening face, tenths digit red; operates from 230 v 60 cps power supply; rectangular, flush mtg (fl) black bakelite case; CCX type E3H, dwg #A50-58.	Filament hour counter
M305	—	Same as M304	Plate hour counter
M501	N17-M-19828-9101	METER, ammeter: DC; range 0 to 500 ma; rectangular black bakelite flush mtg case; 2.75 " x 2.88 " body, 1.46 " d behind fl; 3 " x 3.13 " x $3/16$ " fl; 2% accuracy for full scale reading; approx 100 mv drop; calibrated for $3/32$ " thk steel panel; 50 scale divisions, black markings on white background, window in top of case for illumination; self-contained; CV model 731.	V504 cathode current meter

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
M502	— N17-M-20205-9101	METER, ammeter: DC; range 0 to 8 amp; rectangular, flush, black bakelite case; 2.75" x 2.88" body, 1.46" d behind fl; 3" x 3.125" x 3/16" fl; 2% accuracy for full scale reading; calibrated for 3/32" thk steel panel; 40 scale divisions, black markings on white background, window in top of case for illumination; self-contained; CV model 731.	V505 and V506 plate current
M503	— N17-M-18260-3851	METER, ammeter: thermo RF; range 10 RF amp; rectangular, black phenolic flush mtg case; 2.75" x 2.88" body, 1.46" d behind fl; 3" x 3.13" x 3/16" fl; 2% accuracy up to 65 mc; power consumption 0.2 to 0.4 w per amp from 1 to 4 amp, 0.15 w per amp for 5 amp and above; calibrated for non-magnetic panel; 35 scale divisions, black markings on white background; self-contained; CV model 733.	RF line current
M504	—	Same as M503	RF line current
M505	3F891-95 N17-M-21878-2341 3300-325260864	METER, ammeter: DC; full-scale sensitivity 1 ma; rectangular, flush, black bakelite case; 2.75" x 2.88" body, 1.46" d behind fl; 3" x 3.13" x 3/16" fl; 2% accuracy for full scale reading; 55 ohms resistance; calibrated for 3/32" thk steel panel; 50 scale divisions, black markings on white background; window in top of case for illumination; self-contained; scale marked 0 to 100; CV model 731.	Exciter multimeter "A"
M506	—	Same as M505	Exciter multimeter "B"
M507	—	Same as M505	Power amplr multimeter
M1001	— N17-M-35614-8251	METER, voltmeter: DC; range 0 to 500 v; rectangular, flush, black bakelite case; 2.75" diam body x 2 1/2" diam sub base x 1.665" d behind fl; 3" x 3.120" x 0.20" fl; 2% accuracy for full scale reading; sensitivity 1000 ohm per v; calibrated for non-magnetic panel; 50 scale divisions, black markings on white background; self-contained; scale marked "0 to 500"; CV model 301.	Multimeter for monitoring power supply voltages
M1101	— N17-M-21878-2346	METER, ammeter: DC; range 0-150 ma; rectangular black phenolic flush mtg case 2.20" diam barrel x 1.02" d behind fl; 2 3/8" lg x 2 3/8" wd x 5/32" thk flange; 2% accuracy; D'Arsonval movement, 1 ma for full scale deflection; calibrated for nonmagnetic steel panel; 30 scale divisions, black markings on white background; self-contained; CV model #506.	V1101 and V1102 cathode current
M1401	— N17-M-19681-3426	METER, ammeter: DC milliammeter; range 0 to 5 ma; round; phenolic, flush, panel mtg case; barrel 2-1/16" diam x 1.317" d; flange 2 1/4" lg x 2-11/32" wd x 7/32" thk; 2% accuracy for full scale reading; 3.7 ohms \pm 10%; calibrated for non-magnetic panel; 50 scale divisions, black markings on white; self-contained; CAY model RX-33.	Plate and grid meter V1404
O101	— N16-D-46381-9251	DIAL: tuning; includes hub, gear and dial; round; 3-5/16" diam x 1/2" thk o/a; 5/16" shaft hole in hub; FTIRC dwg #504-0634-002.	Dial and gear for interpolation osc
O102	— N16-G-500001-211	GEAR ASSEMBLY: idler, includes four gears staked to hub; 3/4" diam x 17/32" thk o/a; 3/16" diam shaft hole in center; FTIRC dwg #504-0628-002.	Idler for interpolation osc tuning drive

O103	N16-G-500001-212	GEAR ASSEMBLY: drive; includes 2 gears assembled to dial shaft hub; 1-11/16" x 7/16" thk o/a; FTRC dwg #504-0782-002.	Drive for interpolation osc tuning
O104	N16-D-350641-111	DISC, driving: pinned to gear to act as hub; aluminum, round; 1/4" lg groove pin pressed through 1-1/16" diam hole; FTRC dwg #504-0773-001.	Collar for interpolation osc tuning drive shaft
O105	N43-W-7590-15	WASHER, flat: SS; round, 1/4" ID, 1/2" OD, 1/25" thk; 3/32" x 3/32" projection bent at 90 deg x 120"; FTRC dwg #503-0643-001.	Stop washer stock for interpolation osc
O106	—	COUPLING, flexible: consists of 2 hubs and 1 spider, O106A and O106B.	Interpolation oscil drive
O106A	N17-C-98611-1015	HUB: SS; cyl, 7/8" diam x 3/8" thk o/a; 1/4" diam coaxial hole; one face milled to leave 0.1550" wd x 1/16" d diametral key; other face milled to leave 0.344" wd x 7/32" d diametral projection parallel to key; FTRC dwg #FRB-31039-1A.	Part of O106 (qty 2)
O106B	N17-C-98611-1016	SPIDER, rotor: SS, cyl, 7/8" diam x 5/32" thk o/a; 5/32" wd x 0.078" d milled diametral keyway in one face; like keyway milled at 90° to first in opposite face; 9/32" diam coaxial hole; FTRC dwg #FRB-31056-1.	Part of O106 (qty 1)
O107	—	Not Used	
O108	N16-G-431796-237	GEAR, spur: brass and SS; idler; 45 straight teeth; diametral pitch 48, pitch diam 0.937"; 1" OD x 13/32" thk o/a; straight face; hub 0.406" diam x 0.390" lg; 0.188" diam hole in center of hub; FTRC dwg #504-0772-001.	Idler for interpolation osc drive
O109	N16-S-21126-1039	SHAFT ASSEMBLY: for knob; includes shaft and pinion; 3-13/16" lg x 1/4" diam shaft, 3/8" x 3/8" pinion; FTRC dwg #504-0783-002.	Knob, shaft and pinion for internal oscillator
O110	*N16-D-351301-101	DISC, shaft locking: brass; c/o disc fastened to collar with 3 drive screws; disc 1 5/8" OD x 3/16" ID x 0.159" thk; collar 1/2" OD x 3/16" thk x 3/16" diam shaft hole; FTRC dwg #504-0771-001.	Disc-lock for internal oscillator
O111	N16-D-46381-9796	DIAL: tuning; includes two gears and dial; round; 3-11/32" diam x 1/2" thk o/a; 11/32" shaft hole; 4 scale markings; FTRC dwg #504-0633-002.	Master osc dial and gear
O112	N16-G-500001-205	GEAR ASSEMBLY: drive; five gears and groove pin; 2-3/16" diam x 17/32" thk o/a; 3/16" shaft hole; FTRC dwg #504-0627-002.	Idler gear for master osc tuning drive
O113	—	Same as O103	Drive for master osc tuning
O114	—	Same as O104	Pinned collar for master osc tuning
O115	—	Same as O105	Stop washer stack for MO
O116	—	COUPLING, flexible: Consists of 2 hubs (O116A) and 1 spider (O116B).	Master oscillator drive
O116A	—	Same as O106A	Part of O116 (qty 2)
O116B	—	Same as O106B	Part of O116 (qty 1)
O117	—	Not Used	
O118	•	Same as O108	Idler for master osc drive

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
O119	—	Same as O109	Knob, shaft and pinion for master osc drive
O120	—	Same as O110	Disc-lock for master osc drive
O121	N16-S-117101-307	SCALE: tuning; includes dial and hub; aluminum; 3-5/16" diam x 3/8" thk o/a; single mtg hole in center; 27 scale divisions marked 4.5 to 2.0; FTRC dwg #504-0774-001.	Dial for output tuning
O122	—	Same as O103	P/o output tuning control
O123	N16-O-65501-1010	OSCILLATOR SUBASSEMBLY: consists of shaft mtg block with radial non-lash jaws to grip off-center pin of dog (O123B); all beryllium copper; block has central hole for 1/4" shaft with single #4-40 x 1/2" lg fil hd brass clamping screw; FTRC dwg #FRA-31038-1A.	Part of non-lash flexible coupling (used with O124) for output tuning control
O124	N17-C-98611-1019	COUPLING, flexible: consists of hub, disc and driving pin; 1 1/4" diam x 1-3/32" lg o/a with 1/4" diam shaft hole; all nickel pl brass; FTRC dwg #FRA-31036-1A.	Part of non-lash flexible coupling (used with O123) for output tuning control
O125	—	Same as O108	Idle in output tuning drive
O126	—	Same as O109	Knob, shaft and pinion for output tuning drive
O127	—	Same as O110	Disc-lock for output tuning
O128	N17-S-46666-3850	SPRING: helical compression type; 0.150" ID x 7/16" free length x 1/4" min working length; 7 1/2" RH turns 0.028" diam SS wire; FTRC dwg #504-0777-001.	Releases disc lock
O129	N16-A-700001-193	ARM: actuator; SS type #302; 2 1/8" lg x 13/32" h x 0.360" wd o/a; 15/16" diam hole 3/16" from one end; 0.171" diam hole 13/16" c to c from first hole; 0.140" diam hole 5/32" from other end; FTRC dwg #504-0769-001.	Actuates disc
O130	N16-S-20998-2001	SHAFT: disc-lock; SS type #303; 3-15/16" lg o/a x 3/16" diam; one end flattened 3/16", other end #6-32 NC-2 thd for 3/4", 1/8" plain; 0.046" diam hole 1/8" from threaded end; FTRC dwg #504-0788-002.	Disc-lock
O131	N17-A-25801-1006	ARM: actuator; c/o side mtg bkt, hinged roller leaf, two #2-56 x 3/4" lg screws and two nuts per screw; steel cad pl bkt, phosphor bronze cad pl leaf; 1-31/32" lg x 1-15/32" h x 5/16" thk o/a; four 3/32" diam mtg holes on 5/8" x 1" mtg/c; CATK #A-18-M.	Actuates S104 (used with S104)
O301	3H955-20 N17-C-793001-120 1760-373060957	CLEANER, air: spun glass dust stop; cartridge type; metal frame; 10" x 20" x 2"; flange mtg; Owens-Illinois Glass Co. "Dustop" #2.	Dust filter replaceable element (qty 2)
O501	N16-G-434872-107	GEAR, spur: aluminum gear, Mycalex ins ring, phosphor bronze hub; 276 straight teeth, 11.5" PD, 24 DP; straight face; hub 3 1/4" max OD x 1.755" max ID; hub mtg; FTRC dwg #503-9232-003.	Turns shorting bar in L519
O502	—	Same as O501	Turns shorting bar in L518

O503	N16-D-900081-133	DRIVE, antenna: antenna tuning gear plate assem; inc four spur gears; double spur gear, motor servo assem, plate bearing, three bearing plate assem, roller guide, plate and gear covers, flexible coupling, nine shafts, angle and block supports, gear bevel; 17 1/2" lg x 9 1/2" wd x 8 3/4" d o/a (includes O503A, O503B, O503C, O503D, O503E, O504, O507, O508); FTRC dwg #504-5176-005.	Drives O501 and O502 to tune L519 and L518
O503A	2Z4878-1186 N16-G-432807-131 1760-291632814	GEAR, spur: c/o bakelite gear on brass hub; 4.083" OD x 5/8" lg o/a; gear, 24 DP, 96 straight teeth, 4" PD, flat face; hub, 0.314" ID with two 1/16" diam radial holes 90° apart; hub mtg; FTRC dwg #FRA-30490-2-3.	Part of O503
O503B	—	Same as O503A	Part of O503
O503C	N16-G-500001-233	GEAR ASSEMBLY: spur; c/o two gears on brass hub; 4.333" OD x 35/64" lg o/a; bakelite gear 24 DP, 102 straight teeth, 4 1/4" PD, flat face; brass gear 24 DP, 42 straight teeth, 1 3/4" PD, flat face, hub 0.438" ID x 35/64" lg; hub mtg; FRA-30490-2-1.	Part of O503
O503D	2Z4878-1184 N16-G-432927-242 1760-291632812	GEAR: spur; c/o bakelite gear on brass hub; 4.333" OD x 1" lg o/a; gear 24 DP, 102 straight teeth, 4 1/4" PD, flat face, hub 0.501" ID; with two 1/16" diam radial holes 90° apart; hub mtg; FTRC dwg #FRA-30490-2-2.	Part of O503 drive gear
O503E	—	Same as O503D	Part of O503
O504	N16-R-751251-106	ROLLER, guide: phosphor bronze, bright alloy finish; 1 3/4" diam x 1/2" lg o/a, with 1/2" lg x 3/8" ID bearing pressed into 1/2" diam hole in center, FTRC dwg #503-9110-002.	Guides antenna network into rack (qty 3) (p/o O503)
O505	N16-S-900001-102	SWIVEL: guide; includes 1-5/16" diam gimbal ring mounted on "C" shaped block; SS; 2-1/16" lg x 1-13/16" wd x 1/4" thk o/a; 1/2" diam shaft hole; FTRC dwg #504-1760-002.	Guides lead screw on antenna network
O506	N16-B-600961-123	BLOCK, support: gimbal nut; 1/2 hd brass, bright alloy pl; rectangular; 1 7/8" wd x 1/2" d x 1-13/32" h o/a; two 0.290" diam ("L" drill) vert holes centered 1 1/4" c to c on ctr line; FTRC dwg #FRB-30463-1A.	Supports lead screw guide swivel
O507	N16-G-402607-126	GEAR SET, miter: matched pair; each gear, integral hub, brass, 24 DP, 36 straight teeth, 1 1/2" PD, 1/4" wd straight face; hub 0.314" ID, with two 1/16" diam radial holes 30° apart; FTRC dwg #FRB-30487-1.	2 sets (4 gears) drive C571 and C572 (p/o O503)
O508	N16-C-98380-2368	COUPLING ASSEMBLY, flexible: includes 2 flexible couplings separated by 3" ceramic standoff insulator; 5" lg x 2 1/4" diam o/a; FTRC #503-9084-002.	Connects O507 to C571 (part of O503)
O509	—	Same as O501	Dust filter (qty 2)
O510	—	Not Used	
O511	*N17-C-480881-569	CHAIN: silent type; 3/16" pitch; SS; 3.2' lg, 97 links, 194 pitches; ends riveted together; (for repair use chain repair kit O511A); FTRC dwg #504-1758-002.	Drive chain for antenna platform drive assem
O511A	2Z5727-142 N41-K-96-1225 1760-292083198	CHAIN REPAIR KIT: for Link-Belt #S-1807 silent chain; consists of 50 coupling pins and 10 side flanges; FTRC dwg #233-0033-00.	Drive chain repair
O512	*N17-S-500811-101	SPROCKET ASSEMBLY, chain: c/o SS sprocket and hub with bronze Oilite bearing, pressed in; 1 1/4" OD x 15/32" lg x 3/8" ID o/a; sprocket, 19 teeth, 3/16" pitch, 1.139" PD, 0.138" wd face; FTRC dwg FRA-31008-1A.	Idler in antenna platform drive assem
O513	*N16-R-751371-104	ROLLER, idler: bronze Oilite bearing pressed into SS roller; 5/8" lg x 1" OD x 3/8" ID o/a, with 1-3/16" diam x 1/16" wd flange one end; FTRC dwg #FRA-30603-1.	Idler in antenna platform drive assem

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
O514	*N17-S-500853-101	SPROCKET, chain; SS; sprocket and hub; 1 1/4" diam x 17/32" lg o/a; sprocket 19 teeth, 3/16" pitch, 1.139" PD .0138" wd; hub 9/16" OD by 3/8" ID with two 0.063" (52 dr) diam radial holes 90° apart; FTRC dwg. FRB-30712-1A-1.	Drives antenna coupling lead screw
O515	3H304-11 G77-B-115-00619-2008 3400-412712	BEARING, ball; single row radial; shielded, two plates; extra light duty; 3/8" bore x 7/8" OD x 9/32" wd; 7 balls; packed with WS-429 (Standard Oil of N.J.); std fit; CGM#77-R-6.	Ball bearing for O514
O516	N16-S-21226-1123	SHAFT ASSEMBLY: brass rod, nickel pl; 1/2" diam x 10 3/4" lg o/a, with 1/2"-13 class 2 thrd for 9/8" from one end; chamfered 1/32" x 45° at end; FTRC dwg FRB-30716-2.	Lead screw for antenna coupling servo drive unit
O517	3G320-164 N17-I-64340-9997 1760-331250765	INSULATOR, plate; square; glass bonded mica; 4.078" sq x 1/4" thk; 4 mtg holes on 2.828" mtg/c; FTRC dwg #504-3276-001.	Part of L516 shorting bar drive coupler
O518	—	Same as O517	Part of L517 shorting bar drive coupler
O519	*N17-C-480882-976	CHAIN: link, silent duplex; 3/16" pitch, cad plated steel; 5.6' lg x 5/16" wd; 354 pitches; lock construction for bushing and pin; incl coupler link and pin; (to repair use chain repair kit O519A); Link Belt Co. #D-1810; FTRC dwg #233-0015-00.	Power amplr plate tuning drive chain
O519A	2Z5727-145 N41-K-96-1250 1760-292083201	CHAIN REPAIR KIT: for Link Belt #D-1810; silent duplex chain; c/o 10' chain, 100 coupling pins, 20 side flanges; FTRC dwg #233-0038-00.	Drive chain repair
O520	*N17-S-500963-436	SPROCKET, chain: cad pl carbon steel; 110 teeth, 3/16" circular pitch, 6.566" PD; 16.77 DP; 0.5905" diam shaft hole; FTRC dwg #504-3286-003.	Drives shorting bar of L516
O521	*N17-S-500921-101	SPROCKET, chain: cad pl carbon steel; 55 teeth, 3/16" circular pitch, 3.283" PD, 16.77 DP; 0.590" diam shaft hole; FTRC dwg #504-3279-002.	Drives R536
O522	*N17-S-500963-427	SPROCKET, chain: cad pl carbon steel; 110 teeth, 3/16" circular pitch, 6.566" PD, 16.77 DP; 0.590" diam shaft hole; FTRC dwg #504-3287-003.	Drives shorting bar for L517
O523	*N17-S-500816-301	SPROCKET, chain: cad pl carbon steel; 20 teeth, 3/16" circular pitch, 1.198" PD, 16.77 DP; 0.590" diam hole through center; FTRC dwg #504-3262-001.	Drives C569
O524	*N17-S-500816-101	SPROCKET, chain: cad pl carbon steel; 20 teeth, 3/16" circular pitch, 1.198" PD, 16.77 DP; 0.590" diam hole through center; FTRC dwg #504-3261-001.	Drives O519
O525	N16-G-432807-116	GEAR, spur: linen base phenolic gear, SS hub; 96 straight teeth; diametral pitch 24, PD 4"; straight face; 0.590" diam shaft hole; FTRC dwg #504-3283-003.	Drives C570

O526	N16-G-500001-214	GEAR, spur: dual; c/o 2 gears plus hub; 2.586" diam x 2" lg o/a; large gear, SS, 60 straight teeth, 2.5" PD, 24 DP, 5/16" wd straight face; small gear, linen base phenolic, 24 straight teeth, 1" PD, 24 DP, 3/8" wd straight face, integral with hub; FTRC dwg #504-3281-002.	Idler gear in power amplr plate tuning drive assem
O527	N16-G-500001-213	GEAR, spur: dual; c/o 2 gears plus hub; 4.582" diam x 2" lg o/a; large gear, SS, 144 straight teeth, 4.5" PD, 32 DP, 5/16" wd straight face; small gear, linen base phenolic, 24 straight teeth, 1" PD, 24 DP, 3/8" wd straight face, integral with hub; FTRC dwg #504-1797-003.	Idler gear in power amplr plate tuning drive assem
O528	*N17-S-500816-201	SPROCKET, chain: cad pl carbon steel; 20 teeth, 3/16" circular pitch; 1.198" PD; 1-3/16" OD x 1.015" thk o/a x 0.590 diam hole through center; FTRC dwg #504-3263-001.	Drive chain idler sprocket
O529	N16-G-431170-332	GEAR: spur; SS; 14 straight teeth; 32 diametral pitch, 7/16" PD; straight face; 0.188" shaft hole through center; FTRC dwg #504-1566-001.	Drive gear for motor B502
O530	G77-B-143-01532-2004	BEARING, ball: double row radial; two shields; light duty; 0.5906" bore x 1.3780" OD x 5/8" wd; 20 balls; CGM #55502; FTRC dwg #309-0178-00.	Bearing in power amplr drive assem (qty 6)
O531	G77-B-143-01032-2004	BEARING, ball: double row radial; two shields light duty; 0.3937" bore x 1.1811" OD x 9/16" wd; 18 balls; CGM #55500; FTRC dwg #309-0177-00.	Bearing in power amplr drive assem (qty 2)
O532	_____	Same as O508	Part of coupler to C569
O533	_____	Same as O508	Part of coupler to C570
O534	N16-C-125001-171	CAM: SS; 11 notches covering 100 deg of cam angle with ten 0.093" diam holes mid way between notches on 1.002" radius; irregular shape; 1-3/16" radius x 0.060" thk o/a; 0.220" diam shaft hole in center; FTRC dwg #FRB-30631-1.	Operation of S522 and S523
O535	*N16-L-300001-128	PAWL: irregular shape; 2-3/16" lg x 3/8" wd x 3/16" h o/a; 5/32" mtg hole in approx center; FTRC dwg #504-1697-002.	Transmits motion from cam (O534) to S522 and S523
O536	_____	Not Used	Grid box drive assem
O537	N16-D-905001-111	GEAR ASSEMBLY: plate gear; includes 10 gears assembled on gear plate; aluminum plate; gears, 24 teeth 1" PD, 89 teeth 3.708" PD, 24 teeth 1" PD, 104 teeth 4.333" PD, 143 teeth 5.958" PD, 104 teeth 4.333" PD, 24 teeth 1" PD, three 55 teeth 2.292" PD, all 24 pitch; (includes O538, O541, O542, O545, O546, O547, O548); FTRC dwg #503-9449-004.	Part of O537
O538	N17-C-98379-3926	COUPLING, flexible: coil drive gear and coupler assem; flexible coupler assem attached to gear with groove pin; glass bonded mica plate, copper spring, fabric base bakelite gear, brass gear and hub; brass gear 24 teeth, 24 DP 1" PD; bakelite gear, 89 teeth, 24 DP, 3.708" PD; FTRC dwg #503-9001-002.	Part of O538
O539	N17-C-98379-3651	COUPLING, flexible: includes gear spring and coupler shaft fastened to glass bonded mica plate; 3/8" sq x 2 3/4" lg o/a; FTRC dwg #503-8978-002.	Part of O538
O540	N16-G-50001-206	GEAR: spur; fabric base bakelite; straight teeth; 89 teeth and 24 teeth; diametral pitch 24, PD 1" and 3.708"; straight face; 3/8" shaft hole through center; FTRC dwg #503-8983-002.	Part of O537 grid box drive
O541	N16-G-432967-262	GEAR: spur; fabric base bakelite; 104 straight teeth, 24 diametral pitch, 4.333" PD; hub mtg; FTRC dwg #503-8984-002.	

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TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
O542	N17-C-98379-4001	COUPLING, flexible: coil drive gear and coupler assem; flexible coupler assem attached to gear with groove pin; glass bonded mica plate, copper spring, fabric base bakelite gear, brass gear and hub; brass gear 24 teeth, 24 DP, 1" PD; bakelite gear 104 teeth, 24 DP, 4.333" DP; FTRC dwg #503-9002-002.	Part of O537
O543	—	Same as O539	Part of O542
O544	N16-G-500001-207	GEAR: double spur; fabric base bakelite; straight teeth; 104 teeth and 24 teeth; diametral pitch 24; PD 4.333" and 1"; 0.625" ID; straight face; hub mtg; FTRC dwg #503-8985-002.	Part of O542
O545	N16-G-500001-208	GEAR: double spur; fabric base bakelite; straight teeth; 143 teeth and 24 teeth; diametral pitch 24; PD 5.958" and 1"; 3/8" ID; straight face; hub mtg; FTRC dwg #503-8986-002.	Part of O537
O546	N16-G-431986-968	GEAR: spur; fabric base bakelite; 55 straight teeth, diametral pitch 24, PD 2.292"; 3/8" ID; straight face; hub mtg; FTRC dwg #503-8987-002.	Part of O537 grid box drive
O547	—	Same as O546	Part of O537
O548	N16-G-431986-973	GEAR: spur; fabric base bakelite; 55 straight teeth, diametral pitch 24, PD 2.292"; 3/8" ID; straight face; hub mtg; FTRC dwg #503-8988-002.	Part of O537 grid box drive
O549	N17-C-98378-4007	COUPLING, flexible: bakelite and brass; bright nickel finish on brass sections; 1.094" diam x 0.672 thk o/a; 1/4" shaft hole through ctr; COG #6432-032.	Flexible coupling to C533
O550	—	Same as O549	Flexible coupling to C534
O551	2Z3723-260 N16-D-46552-2126 3320-291396312	DIAL: molded black phenolic; 100 scale divisions, marked "O" to "90" in units of 10; round; for 3/16" diam shaft; two #8-32 thrd holes spaced 90 deg; FTRC dwg #503-8082-002.	Servo control knobs (R591-R596) (qty 6)
O552	2Z3723-261 N16-S-117101-216 3320-291396313	SCALE: aluminum; 10 spaces 32.4 deg ea, 1 space 36 deg, scale marked "0-9"; round; 0.408" diam mtg hole in center; FTRC dwg #503-8973-002.	Used with O551 (qty 6)
O553	N16-G-432096-116	GEAR, spur: bright alloy finish brass; 48 DP, 60 straight teeth, 1 1/4" PD, flat face; 1 1/4" OD x 1/4" ID x 0.494" thk; hub 7/8" diam x 0.494" thk o/a; hub mtg; FTRC dwg #503-9082-002.	Drives O552 (qty 6)
O554	N16-G-500001-210	GEAR, double spur: brass; 48 DP, 60 straight teeth and 18 straight teeth, 1 1/4" PD and 3/8" PD, flat face; 1/4" ID; hub mtg; FTRC dwg #503-9078-002.	Idle gears between O553 and motor (qty 6)
*O555A	2C6920-225-1 N16-T-43276-1057 1760-223155236	TRANSMITTER SUBASSEMBLY: exciter tank; c/o coil L503 and variable capacitor C511; gear driven; includes 4 gear assemblies, bearings, mtg plates and hardware, 5-9/16" lg x 2" wd x 4-13/16" h o/a; FTRC dwg #503-9468-004.	1st multiplier plate tuning; driven by Z701 (qty 1)
*O555B	N16-T-43276-1095	TRANSMITTER SUBASSEMBLY: Same as O555A except (1) includes variable resistor R522 with pinion gear and mtg plate, and (2) coil and capacitor are marked L506 and C517; FTRC dwg #B1003656.	2nd multiplier plate tuning; driven by Z702 (qty 1)

O556	2Z4878-1187 N17-G-431009-101 1760-291632815	GEAR, spur: special; CRS, cad pl; 13/32" OD x 0.252" ID x 17/32" lg o/a; gear and hub integral; gear, 48 DP, single straight tooth (18 teeth normal), 0.3750" PD; 3/16" wd flat face; hub 0.252" ID; mtd by brazing to adjoining part; FTRC dwg #FRB-30627-1B.	Servo drive revolution integrator
O557	N17-T-910993-101	TUBING, air: Raybestos "Curv-flex" rubber; 2" ID x 2 1/4" OD max x 23" lg; FTRC dwg #504-1998-002.	Directs air flow (qty 3)
O701A	N16-G-431256-406	GEAR, spur: SS; c/o gear integral with hub one side and with stub shaft other side; gear 48 DP, 18 straight teeth, 14 1/2° PA, 3/8" PD, hub 7/16" OD x 1/4" ID x 17/32" lg with one 1/16" diam radial hole; shaft 0.249" diam x 9/16" lg; FTRC dwg FRB-30705-1A.	Output coupling for motor on Z701
O701B		Same as O701A	Output coupling for motor on Z702
O701C	N16-G-43166-997	GEAR, spur: brass; c/o gear with integral hub; 1.083" OD x 5/8" thk o/a; gear 24 DP, 24 involute straight teeth, 20° PA, 1" PD, flat face; hub 1/4" ID with two 1/16" diam radial holes 90° apart; FTRC dwg FRB-30824-1.	Output coupling for motor on Z703
O701D		Not Used	Output coupling for motor on Z705
O701E	N17-S-500813-189	SPROCKET, chain: SS; consists of sprocket and hub; sprocket 3/16" pitch, 19 teeth, 1.139" PD, 0.138" wd; hub 9/16" OD x 1/4" ID with two 0.063" (#52 drill) radial holes 90° apart; FTRC dwg FRB-30712-1A-3.	Output coupling for motor on Z706
O701F	N17-G-431463-371	GEAR: spur; brass; c/o gear with integral hub; 1.290" OD x 5/8" thk o/a; gear 24 DP, 29 straight teeth, 20° PA, 1.208" PD, flat face; hub involute 1/4" ID with two 1/16" diam radial holes 90° apart; FTRC dwg FRB-30646-1.	Servo drive revolution integrator gear (1 ea, 5 units)
O702		Same as O556	Drive gear for S1102B
O1101	**N16-G-432090-318	GEAR: spur; bright alloy finished brass; 60 straight teeth; diametral pitch 32, 1 7/8" PD; straight face; hub mtg with two #8-36 tapped holes 90 deg apart; FTRC dwg #FRB-30962-1-1.	Drive gear for S1102B
O1102		Same as O1101	Idle gear between O1101 and O1102
O1103	**N16-G-432090-410	GEAR: spur; bright alloy finished brass; 60 straight teeth; diametral pitch 32, 1 7/8" PD; straight face; hub 1/4" ID; FTRC #FRB-30962-1-2.	Coupler for S1403
O1401	2Z3270-8 N17-C-98378-3896 1600-287654775	COUPLING, flexible: brass body, phosphor bronze disk; 1.094" diam x 0.648" thk o/a; 1/4" diam shaft hole through center; COC #6422-008.	Coupler for C1405
O1402		Same as O1401	Coupler for S1405
O1403		Same as O1401	Coupler for R1458
O1404		Same as O1401	Drive jacking
O1405	**N16-D-905001-109	DRIVE SUBASSEMBLY: knob shaft with pinion and locking disc attached; 3-7/16" lg x 1 5/8" diam o/a; FTRC dwg #504-3425-002.	Idle gear assembly
O1406	**N16-G-431796-126	GEAR: spur; idler; brass gear, SS post; 45 straight teeth; diametral pitch 48, 15/16" PD; straight face; hub 3/32" ID; FTRC dwg #504-3429-002.	

*This item should be returned to supply depot for repair.

**Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
O1407	_____ *N16-G-432396-760	GEAR: spur type; SS shaft and spring, brass hub, 2 bright nickel finish brass gears; ea gear 75 straight teeth, 48 DP, 1.562" PD, straight face, shaft 1/4" diam x 3 3/8" lg; mts by shaft to dial; FTRC dwg #504-3428-002.	Dial drive gear
O1408	_____ N16-S-20990-2501	SHAFT: lock; type #303 SS; cylindrical; 3-7/16" lg o/a; one end 3/16" diam x 2-11/16" lg, flatted 3/16"; other end #6-32 NC-2 x 3/4" thrd w/0.046" diam hole 1/8" from end; FTRC dwg #504-3424-002.	Drive for C1405
O1409	_____	Same as O129	Drive for C1405
O1410	_____	Same as O1405	Drive for C1405
O1411	_____	Not Used	
O1412	_____	Same as O1408	Drive for R1458
O1413	_____	Same as O129	Drive for R1458
O1414	_____ N16-S-21026-4550	SHAFT: control; type #303 SS; cylindrical 6-7/16" lg x 1/4" diam, flatted 1/4" ea end; 0.028" wd grooves, 1.625" and 3.425 from end; FTRC dwg #504-3375-001.	Drive for R1458
O1415	_____	Not Used	
O1416	_____	Not Used	
O1417	_____	Not Used	
O1418	_____ N16-C-600001-183	COLLAR, spacing: SS, cylindrical; 0.4985" OD x 0.250" ID x 0.375" thk; two holes tapped #8-36 NF-2 90° apart; FTRC dwg FRB-30945-1.	Locks R1430
O1419	_____	Same as O1418	Locks R1485
O1420	_____	PLATE, lock: aluminum alloy; flat; 1-15/16" lg x 11/16" wd x 0.094" thk; 0.469" shaft hole with 0.094" wd x 1-15/16" lg slot; FTRC dwg #FRB-30946-1.	Locks R1430
O1421	_____	Same as O1420	Locks R1485
O1422	_____ N16-E-300057-426	ECCENTRIC: pinned; c/o eccentric cam and 1/16" x 3/8" groove pin; SS; 0.375" diam x 0.541" lg o/a; FTRC dwg #FRB-30942-2.	Locks R1430
O1423	_____	Same as O1422	Locks R1485
P101	_____	Not Used	
P102	_____ N17-C-73197-7866	CONNECTOR, receptacle: Navy type -49197/4; four rectangular female pol cont; straight; rectangular bakelite body; (Part of Z102: for maintenance replace complete Z102).	Input connector for master oscillator
P103	_____	Same as P102 (Part of Z101: for maintenance replace complete Z101)	Input to interpolation osc
P104	_____ 2Z8680-5 N17-C-71281-3423 8850-336170	CONNECTOR, plug: Navy type -49277; 10 flat parallel female cont; polarized; straight; 45 v at 5 amp max; rectangular metal cap, 1/2" diam cable opening; includes cable clamp; CJC#S-310-CCCT.	Pwr input cable from power supply PP-454A/FRT-5

P105	2Z4063-120 N17-C-71129-5727	CONNECTOR, plug: Navy type -49903; 2 rectangular female pol cont; straight; 10 amp 250 v, 15 amp 125 v; cylindrical brown phenolic body; phenolic insert 13/32" diam cable opening; CG#2716.	115-volt AC power input cable
P301	N17-C-70901-2639	CONNECTOR, plug: Navy type -491976; 30 round female pol cont; 90 deg angle; cont 10 amp; right angle metal body; phenolic insert; 1-3/16" cable opening; CED#IK-30-23C-11/8.	Upper front door cable plug; mates with J301
P302	N17-C-71037-5180	CONNECTOR, plug: 30 round male pol cont; 90 deg angle; cont 10 amp; right angle metal body; phenolic insert; 1-3/16" cable opening; CED#RIK-30-24C-11/8.	Upper front door cable plug; mates with J302
P501	_____	Same as P301	Upper front cable plug; mates with J501
P502	_____	Same as P302	Upper front cable plug; mates with J502
P503	2Z7390-88 N17-C-71408-3241 8850-468450	CONNECTOR, plug: AN type UG-88/U; single round male cont; straight; 52 ohm impedance; cyl metal body; Teflon insert; cable opening 0.212" diam; Navy dwg RE-49F-246B; CARO#1200.	RF output to frequency monitor
P504	2Z7390-59A N17-C-71418-8250	CONNECTOR, plug: AN type UG-59A/U; single male cont; straight; cyl brass body; cable opening 7/16" diam; for use with RG-8/U cable.	Single side-band excitation input
P505	_____	Same as P504	Single side-band excitation input
P506	_____	Same as P503	RF output line to frequency monitor
P507	_____	Not Used	
P508	_____	Not Used	
P509	N17-C-71416-7001	CONNECTOR, plug: single round male cont; pol; straight; cont 10 amp; cyl metal body; molded phenolic insert; 11/32" cable opening; includes cable clamp; CED#RWK-MI-22C-5/16".	300-volt supply line to RF oscillator O-92A/FRT-5
P510	2Z8677-14 N17-C-70347-6977 8850-310593	CONNECTOR, plug: AN type AN-3106-16S-1S; 7 round female pol cont; straight; cyl metal body, threaded 7/8"-20 EF-2 for locking; molded bakelite insert; knurled coupling ring; spec MIL-C-5015. Also incl one type AN-3057-8 strain relief.	Connector for Z701
P511	_____	Same as P510	Connector for Z702
P512	_____	Same as P510	Connector for Z703
P513	_____	Same as P510	Connector for Z705
P514	_____	Same as P510	Connector for Z706
P515	2Z7113-16 N17-C-70588-1327 8850-263585	CONNECTOR, plug: AN type AN-3106-14S-1P; 3 round male pol cont; straight; cyl metal body; phenolic insert; 0.526" cable opening; spec MIL-C-5015.	Freq shift keyer key input line
P516	N17-C-71460-4878	CONNECTOR, plug: 3 curved "twist-lock" male cont, pol; straight; cont 10 amp 250 v, 15 amp 125 v; round rubber body; hard rubber insert; 1/2" diam cable opening; incl cable clamp; CHU#7567.	230-volt AC primary power cable to power supply PP-454A/FRT-5
P517	N17-C-71438-7453	CONNECTOR, plug: two spring-action male cont; straight; black rubber body; 3/8" diam cable opening; Allied Elec. Prods #102.	115-volt AC line to RF oscillator O-91A/FRT-5

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
P518	—	Same as P517	115-volt AC line to freq shift keyer
P519	—	Same as P517	115-volt AC line to RF oscillator O-92A/FRT-5
P801	N17-C-73568-3857	CONNECTOR, receptacle: Navy type -49664; 10 rectangular male pol cont; straight; cont rated 10 amps at 110v; rectangular brass body, black xtal finish; molded bakelite insert; CJC#P-410-AB-1/16.	Servo amplifier inter-connection cable (1 ea, 6 units)
P802	N17-C-71644-7058	CONNECTOR, plug: 30 round male cont, pol; straight; 2-9/16" diam x 2-13/16" lg o/a; 10 amp cont; round metal body; phenolic insert; 29/32" diam cable opening; integral mtg clamp; CED#RTK-30-22C-7/8.	Servo amplifier connector
P901	N17-C-71295-8635	CONNECTOR, plug: 12 rectangular female pol cont; straight; 2-13/16" lg x 2-3/8" wd x 1-1/8" d o/a; rectangular molded bakelite body; molded black bakelite insert; special cable opening 9/16" diam; incl cable clamp, and cover; CJC#S-12-CCT.	Servo power supply output cable
P1001	6Z7813-2 N17-C-73471-6407 8850-514868	CONNECTOR, receptacle: Navy type -49749A; 3 curved rectangular male pol cont; straight, 2-5/16" lg x 1-3/4" wd x 1-1/4" d o/a; cont rated 10 amp 250 v, 15 amp 125 v; cyl brass body, polished nickel finish, twist-lock; black bakelite insert; incl gnd shunt; CHU#7556.	230-volt primary power input
P1002	2Z7120-3 N17-C-71565-2109 8850-336510	CONNECTOR, plug: 10 flat male cont, pol; straight; 1-9/16" lg x 1-1/16" wd x 1-1/8" h less cont, incl clamp; 45 v at 5 amp max; rectangular metal cap, black crinkle finish; molded bakelite insert; 1/2" diam cable opening; incl cable clamp; CJC#P-310-CCT.	Power supply cable to RF oscillator O-91A/FRT-5
P1003	—	Same as P1002	Pwr supply cable to freq shift keyer
P1004	6Z7591-3.1 N17-C-71168-1306 8850-247226	CONNECTOR, plug: three curved twist-lock female cont, pol; straight; 1-1/2" diam x 2-5/32" lg incl cable clamp; cont 10 amp 250 v, 15 amp 125 v; black bakelite body; 1/2" diam cable opening; incl cable clamp; CHU#7559.	230-volt AC primary power input cable
P1101	—	Same as P105	115-volt AC input cable
P1102	N17-C-71174-2580	CONNECTOR, plug: Navy type -491980; 3 round female pol cont; straight; 2-3/16" lg x 1-23/64" diam o/a; 15 amp cont, cyl metal body; molded phenolic insert; 17/32" diam cable opening; CED#GK-M3-21C-1/2.	DC input and external metering
P1201	—	Same as P503	Patch cord plug
P1202	—	Same as P503	Patch cord plug
P1203	—	Same as P503	Patch cord plug
P1204	—	Same as P503	Patch cord plug
P1205	—	Same as P503	Patch cord plug
P1206	—	Same as P503	Patch cord plug
P1207	—	Same as P503	Patch cord plug

P1208	—	Same as P503	Patch cord plug
P1209	—	Same as P503	Patch cord plug
P1210	—	Same as P503	Patch cord plug
P1211	—	Same as P503	Patch cord plug
P1212	—	Same as P503	Patch cord plug
P1401	—	Same as P104	Power input cable from power supply PP-454A/FRT-5
P1402	N17-C-70040-1516 8850-254558-540	CONNECTOR, plug: AN type AN-3108-14S-7S; 3 round female cont, pol; 90° angle; 2 1/8" lg x 1 5/8" h x 1 1/8" wd max o/a; cylindrical metal body; phenolic insert; cable opening 3/4" diam; 3/4"-20 thread; spec MIL-C-5015.	Keying line input cable connector
P1403	—	Same as P105	115-volt AC input cable plug
R101	3RC20BF104K N16-R-50633-811 3300-381166220	RESISTOR, fixed: comp; JAN type RC20BF104K; 100,000 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V101 grid
R102	3RC20BF222K N16-R-50012-811 3300-381168060	RESISTOR, fixed: comp; JAN type RC20BF222K; 2200 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V101A cathode
R103	3RC20BF473K N16-R-50480-811 3300-381168800	RESISTOR, fixed: comp; JAN type RC20BF473K; 47,000 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V101 plate voltage dropping
R104	3RC20BF151K N16-R-49625-0811 3300-381167020	RESISTOR, fixed: comp; JAN type RC20BF151K; 150 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V101B cathode
R105	—	Same as R101	V101B cathode
R106	—	Same as R103	V101B grid
R107	3RC20BF273K N16-R-50399-811 3300-381168540	RESISTOR, fixed: comp; JAN type RC20BF273K; 27,000 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V102 plate load
R108	—	Same as R107	V102 plate load
R109	—	Same as R103	Part of V102 time constant circuit
R110	3RC20BF103K N16-R-50282-811 3300-381166160	RESISTOR, fixed: comp; JAN type RC20BF103K; 10,000 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V102 grid
R111	3RC20BF333K N16-R-50417-811 3300-381168960	RESISTOR, fixed: comp; JAN type RC20BF333K; 33,000 ohms, ±10%; 1/2 w; characteristic letter F; spec JAN-R-11.	V102 cathode
R112	—	Same as R111	V102 grid
R113	—	Same as R110	V102 grid
R114	—	Same as R103	Part of V102 time constant circuit
R115	—	Same as R107	V103 plate load

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n't'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR C RPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R116	—	Same as R107	V103 plate load
R117	—	Same as R103	Part of V103 time constant circuit
R118	—	Same as R110	V103 grid
R119	—	Same as R111	V103 cathode
R120	—	Same as R111	V103 grid
R121	—	Same as R110	V103 grid
R122	—	Same as R103	Part of V103 time constant circuit
R123	3RC20BF474K N16-R-50822-811 3300-381169860	RESISTOR, fixed: comp; JAN type RC20BF474K; 470,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V104 grid
R124	3RC20BF101K N16-R-49580-811 3300-381166040	RESISTOR, fixed: comp; JAN type RC20BF101K; 100 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V104 cathode
R125	3RC20BF393K N16-R-50444-811 3300-381169380	RESISTOR, fixed: comp; JAN type RC20BF393K; 39,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V104 screen dropping
R126	3RC20BF683K N16-R-50552-811 3300-381170640	RESISTOR, fixed: comp; JAN type RC20BF683K; 68,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V105 grid
R127	— N16-R-49805-811	RESISTOR, fixed: comp; JAN type RC20BF651K; 560 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V105 cathode
R128	—	Same as R103	V105 screen voltage dropping
R129	—	Same as R102	V105 plate voltage dropping
R130	3RC20BF823K N16-R-50588-811 3300-381171060	RESISTOR, fixed: comp; JAN type RC20BF823K; 82,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V106 screen voltage dropping
R131	—	Same as R123	V106 grid
R132	3RC20BF221K N16-R-49661-811 3300-381680000	RESISTOR, fixed: comp; JAN type RC20BF221K; 220 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V106 cathode
R133	3RC30BF273J N16-R-50398-751 3300-381318520	RESISTOR, fixed: comp; JAN type RC30BF273J; 27,000 ohms, $\pm 5\%$; 1 w; char- acteristic letter F; spec JAN-R-11.	V106 voltage dropping
R134	—	Same as R101	V107 grid
R135	—	Same as R102	V107 cathode

R136	—	Same as R107	V107 screen and plate volt dropping
R137	—	Same as R102	V104 plate voltage dropping
R138	—	Same as R101	V108 grid #1
R139	—	Same as R101	V108 grid #2
R140	—	Same as R132	V108 cathode
R141	3RC20BF154K N16-R-50678-811 3300-381167200	RESISTOR, fixed: comp; JAN type RC20BF154K; 150,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V108 screen voltage dropping
R142	—	Same as R102	V108 plate decoupling
R143	3RC20BF331K N16-R-49706-811 3300-381168-840	RESISTOR, fixed: comp; JAN type RC20BF331K; 330 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V109 cathode
R144	—	Same as R126	V109 screen voltage dropping
R145	3RC20BF223K N16-R-50372-811 3300-381168-180	RESISTOR, fixed: comp; JAN type RC20BF223K; 22,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V109 plate voltage dropping
R146	3RC20BF470K N16-R-49427-811 3300-381169-620	RESISTOR, fixed: comp; JAN type RC20BF470K; 47 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Parasitic suppressor grid #2 of V110
R147	—	Same as R132	V110 cathode
R148	—	Same as R141	V110 screen volt dropping
R149	—	Same as R102	V110 plate decoupling
R150	—	Same as R143	V111 cathode
R151	—	Same as R126	V111 screen voltage dropping
R152	—	Same as R145	V111 plate voltage dropping
R153	—	Same as R126	V127 grid #1
R154	3RC20BF153J N16-R-50335-0431 3300-381167620	RESISTOR, fixed: comp; JAN type RC20BF153J; 15,000 ohms, $\pm 5\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Parasitic suppressor V111 grid
R155	—	Same as R101	V112 suppressor grid dropping
R156	—	Same as R132	V112 cathode
R157	—	Same as R125	V112 screen voltage dropping
R158	3RC42BF472K N16-R-50130-469 3300-381604459	RESISTOR, fixed: comp; JAN type RC42BF472K; 4700 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Decoupling in plates of V102 and V103
R159	—	Same as R123	V113 grid
R160	—	Same as R127	V113 cathode

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	L CATING FUNCTION
R161	3RC20BF334K N16-R-50759-811 3300-381169020	RESISTOR, fixed: comp; JAN type RC20BF334K; 330,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V113 screen voltage dropping
R162	3RC30BF223K N16-R-50373-231 3300-381168180	RESISTOR, fixed: comp; JAN type RC30BF223K; 22,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V113 plate voltage dropping
R163	—	Same as R101	V114 grid
R164	3RC30BF561K N16-R-49806-231 3300-381170-140	RESISTOR, fixed: comp; JAN type RC30BF561K; 560 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V114 cathode
R165	3Z7425-101 N16-R-91406-1635 3300-394384138	RESISTOR, variable; WW; 25,000 ohms, $\pm 10\%$; 4 w at 100°C continuous operating temp; linear taper; no off position; Amalgamated Electronics type #PRA-30.	V114 screen voltage control
R166	— N16-R-49968-521	RESISTOR, fixed: comp; JAN type RC42BF152K; 1500 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V114 screen
R167	3RC30BF102K N16-R-49923-231 3300-381316100	RESISTOR, fixed: comp; JAN type RC30BF102K; 1000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V112 plate decoupling
R168	—	Same as R167	V113 plate decoupling
R169	3RC20BF472K N16-R-50129-811 3300-381169740	RESISTOR, fixed: comp; JAN type RC20BF472K; 4700 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; (Part of T110) spec JAN-R-11.	Part of 100-kc filter T110
R170	—	Same as R103 (Part of T110)	Part of 100-kc filter T110
R171	—	Same as R107	V115 plate load
R172	—	Same as R107	V115 plate load
R173	—	Same as R103	Part of time constant circuit V115
R174	—	Same as R110	V115 grid
R175	—	Same as R111	V115 cathode
R176	—	Same as R111	V115 grid
R177	—	Same as R110	V115 grid
R178	—	Same as R103	Part of time constant circuit V115
R179	—	Same as R107	V116 plate voltage dropping
R180	—	Same as R107	V116 plate voltage dropping
R181	—	Same as R103	Part of time constant circuit V116

R182	—	Same as R110	V116 grid
R183	—	Same as R111	V116 cathode
R184	—	Same as R111	V116 grid
R185	—	Same as R110	V116 grid
R186	—	Same as R103	Part of time constant circuit V116
R187	3RC30BF681K N16-R-49842-231 3300-381320520	RESISTOR, fixed: comp; JAN type RC30BF681K; 680 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Plate decoupling V116, V117 and V118
R188	—	Same as R145	V117 plate voltage dropping
R189	—	Same as R107	V117 plate voltage dropping
R190	—	Same as R103	Part of time constant circuit V117
R191	—	Same as R110	V117 grid
R192	—	Same as R169	V117 cathode
R193	—	Same as R111	V117 grid
R194	—	Same as R110	V117 grid
R195	—	Same as R103	Part of time constant circuit V117
R196	3RC30BF683K N16-R-50553-231 3300-381320640	RESISTOR, fixed: comp; JAN type RC30BF683K; 68,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V118 plate voltage dropping
R197	—	Same as R124	V118 cathode
R198	N16-R-49923-531	RESISTOR, fixed: comp; JAN type RC42BF102K; 1000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Decoupling for V118 and V130
R199	3RW25509 N16-R-66085-3846 3300-385255090	RESISTOR, fixed: WW; JAN type RW31G162; 1600 ohms, $\pm 5\%$; 10 w at 275°C max continuous oper temp; spec JAN-R-26A.	V119 and V120 cathode
R200	—	Same as R199	V121 and V122 cathode
R201	—	Same as R123	Plate load for V123
R202	—	Same as R123	Plate load for V123
R203	—	Same as R123	Plate load for V124
R204	—	Same as R123	Plate load for V124
R205	—	Same as R141	Voltage dropping V123
R206	—	Same as R141	Voltage dropping V124
R207	3RC20BF122K N16-R-49940-811 3300-381166620	RESISTOR, fixed: comp; JAN type RC20BF122K; 1200 ohms $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Cathode for V123
R208	—	Same as R207	Cathode for V124
R209	—	Same as R123	Part of low pass filter V123 input

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R210	—	Same as R123	Part of low pass filter V123 input
R211	—	Same as R123	Part of low pass filter V124 input
R212	—	Same as R123	Part of low pass filter V124 input
R213	—	Same as R101	Part of low pass filter V123 input
R214	—	Same as R101	Part of low pass filter V123 input
R215	—	Same as R101	Part of low pass filter V124 input
R216	—	Same as R101	Part of low pass filter V124 input
R217	—	Same as R101	Part of low pass filter V123 input
R218	—	Same as R101	Part of low pass filter V123 input
R219	—	Same as R101	Part of low pass filter V123 input
R220	—	Same as R101	Part of low pass filter V124 input
R221	N16-R-50373-421	RESISTOR, fixed: comp; JAN type RC42BF223K; 22,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V127 screen voltage dropping
R222	—	Same as R132	V127 cathode
R223	—	Same as R107	V127 grid #2
R224	—	Same as R102	Decoupling V128 plate
R225	3RC20BF105K N16-R-50975-811 3300-381166280	RESISTOR, fixed: comp; JAN type RC20BF105K; 1.0 megohm, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V128 grid
R226	—	Same as R102	V127 plate decoupling
R227	3RC20BF102K N16-R-49922-811 3300-381166100	RESISTOR, fixed: comp; JAN type RC20BF102K; 1000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	V128 cathode
R228	—	Same as R126	V128 screen
R229	—	Same as R169	V127 grid
R230	—	Same as R101	V129 grid
R231	—	Same as R127	V129 cathode
R232	—	Same as R126	V129 screen dropping
R233	—	Same as R107	V129 plate voltage dropping
R234	—	Same as R101	Voltage dropping for I102

R235	N16-R-50677-591	RESISTOR, fixed: comp; JAN type RC21BF154J; 150,000 ohms, $\pm 5\%$; $\frac{1}{2}$ w; characteristic letter F. (Part of Z102: for maintenance replace complete Z102) spec JAN-R-11.	Master oscillator grid (V131)
R236	N16-R-50551-591	RESISTOR, fixed: comp; JAN type RC21BF683J; 68,000 ohms, $\pm 5\%$; $\frac{1}{2}$ w; characteristic letter F. (Part of Z102: for maintenance replace complete Z102) spec JAN-R-11.	Screen voltage dropping (V131)
R237	N16-R-50479-591	RESISTOR, fixed: comp; JAN type RC21BF473J; 47,000 ohms, $\pm 5\%$; $\frac{1}{2}$ w; characteristic letter F. (Part of Z102: for maintenance replace complete Z102) spec JAN-R-11.	Grid V112
R238	—	Same as R235 (Part of Z101: for maintenance replace complete Z101).	Grid interpolation osc (V130)
R239	—	Same as R236 (Part of Z101: for maintenance replace complete Z101).	Screen voltage dropping (V130)
R240	—	Same as R237 (Part of Z101: for maintenance replace complete Z101).	Grid V118
R241	N16-R-50237-811	RESISTOR, fixed: comp; JAN type RC20BF822K; 8200 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; (Part of Z101: for maintenance replace complete Z101) spec JAN-R-11.	Coupling V130 output to P103
R242	3RC20BF222M N16-R-50014-291 3300-381168080	RESISTOR, fixed: comp; JAN type RC20BF222M; 2200 ohms, $\pm 20\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Drive limiting grid V112
*R243	—	Same as R125	Drive limiting grid V109
*R243	—	Same as R130	Drive limiting grid V109
*R243	3RC20BF153K N16-R-50336-811 3300-381167140	RESISTOR, fixed: comp; JAN type RC20BF153K; 15,000 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Drive limiting grid V109
R244	—	Same as R111	Cathode V117
R301	3RW20701 N16-R-61580-9495 3300-385207010	RESISTOR, fixed: WW; JAN type RW11F251; 250 ohms, $\pm 5\%$; 116 w at 275°C max continuous oper temp; spec JAN-R-26A.	Power amplr bias divider
R302	3RP6310 N16-R-90336-1446 3300-383063100	RESISTOR, variable: WW; JAN type RP301FE251KK; 250 ohms, $\pm 10\%$; 150 w; at 390°C continuous oper temp. 0.077 amp max; linear taper; no off position; spec JAN-R-22.	Power amplr bias divider
R303	—	Same as R301	Power amplr bias divider
R304	—	Same as R301	Power amplr bias divider
R305	—	Same as R301	HV filter reactor shunt
R306	—	Same as R301	HV filter reactor shunt
R307	3RMP1 N16-R-77621-3741	RESISTOR, fixed: WW; JAN type MFA 405; 4.0 meg, $\pm 5\%$; 85°C continuous oper temp; spec JAN-R-29.	Plate voltmeter multiplier
R308	N16-R-65409-6697	RESISTOR, fixed: Navy type -637312-20; WW; 21 ohms, $\pm 20\%$; power rating 5.8 amp continuous; CG #CR9033B21E.	Power amplr plate surge limiting
R309	—	Same as R308	Power amplr plate surge limiting
R310	—	Same as R307	Plate voltmeter multiplier

*Use resistor of the same value as original component.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'y'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R311	3RW31515 N16-R-62122-7135	RESISTOR, fixed: WW; JAN type RW14F163; 16,000 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	Plate voltmeter shunt
R312	3RW23734 N16-R-61735-7715 3300-385237340	RESISTOR, fixed: WW; JAN type RW10F801; 800 ohms, $\pm 5\%$; 140 w at 275°C max continuous oper temp; spec JAN-R-26A.	HV divider
R313	—	Same as R312	HV divider
R314	—	Same as R312	HV divider
R315	—	Same as R312	HV divider
R316	—	Same as R312	HV divider
R317	—	Same as R312	HV divider
R318	3RW30924 N16-R-62095-5295 3300-385309240	RESISTOR, fixed: WW; JAN type RW10F123; 12,000 ohms, $\pm 5\%$; 140 w at 275°C max continuous oper temp; spec JAN-R-26A.	HV divider
R319	—	Same as R318	HV divider
R320	—	Same as R318	HV divider
R321	—	Same as R318	HV divider
R322	—	Same as R318	HV divider
R323	—	Same as R301	HV filter reactor shunt
R324	3RW30303 N16-R-62072-5515	RESISTOR, fixed: WW; JAN type RW13F103; 10,000 ohms; $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	LV bleeder
R325	—	Not Used	
R326	3RP3311 N16-R-89693-7785 3300-383033110	RESISTOR, variable: WW; JAN type RP301FD100KK; 10 ohms, $\pm 10\%$; 150 w; at 390°C continuous oper temp; spec JAN-R-22.	Power amplr fil rheostat
R327	—	Same as R326	Power amplr fil rheostat
R328	3RW26734 N16-R-61865-6595 3300-385267340	RESISTOR, fixed: WW; JAN type RW16F252; 2500 ohms, $\pm 5\%$; 14 w at 275°C max continuous oper temp; spec JAN-R-26A.	I303 voltage dropping
R329	—	Same as R328	I304 voltage dropping
R330	—	Same as R328	I305 voltage dropping
R331	—	Same as R328	I309 voltage dropping
R332	N16-R-61101-7355	RESISTOR, fixed: WW; JAN type RW12F5RO; 5 ohms, $\pm 5\%$; 86 w at 275°C max continuous oper temp; spec JAN-R-26A.	Automatic keying shutdown timer (K322) shunt

R333	—	Same as R301	HV filter reactor shunt
R334	—	Same as R328	I306 voltage dropping
R335	3RC30BF184K N16-R-50697-231 3300-381317680	RESISTOR, fixed: comp; JAN type RC30BF184K; 180,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	I311 voltage dropping
R336	—	Same as R335	I312 voltage dropping
R337	—	Same as R335	I313 voltage dropping
R338	—	Same as R335	I314 voltage dropping
R339	—	Same as R335	I315 voltage dropping
R340	—	Same as R335	I316 voltage dropping
R341	—	Same as R335	I317 voltage dropping
R342	—	Same as R335	I318 voltage dropping
R343	3RW22515 N16-R-61661-9795	RESISTOR, fixed: WW; JAN type RW11F501; 500 ohms, $\pm 5\%$; 116 w at 275°C max continuous oper temp; spec JAN-R-26A.	Bias voltage supply bleeder
R344	—	Same as R343	Bias voltage supply bleeder
R345	3RW25528 N16-R-61822-5075 3300-385255280	RESISTOR, fixed: WW; JAN type RW14F162; 1600 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	K315B voltage dropping
R346	N16-R-49320-491	RESISTOR, fixed: comp; JAN type RC42BF220K; 22 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Relay shunt K326
R347	N16-R-49239-421	RESISTOR, fixed: comp; JAN type RC42BF100K; 10 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Relay shunt K324
R348	—	Same as R347	Relay shunt K325
R349	3RW11708 N16-R-65272-3536	RESISTOR, fixed: WW; JAN type RW33F8RO; 8 ohms, $\pm 5\%$; 18 w at 275°C max continuous oper temp; spec JAN-R-26A.	Relay shunt K322
R350	—	Same as R347	Relay shunt K319
R351	—	Same as R347	Relay shunt K319
R352	—	Same as R346	Relay shunt K307
R401	N17-H-60166-2001	HEATING ELEMENT, electrical: Navy type -637317; fin type; 73.5 v, 1500 w; single sect; chrome steel strip sheath; voltage dropping; CVV type SEF-240VW52.	Primary line series for tuning
R402	—	Same as R401	Primary line series for tuning
R403	—	Same as R401	Primary line series for tuning
R404	—	Same as R401	Primary line series for tuning
R405	—	Same as R401	Primary line series for tuning

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R406	—	Same as R401	Primary line series for tuning
R501	3RC42BF331K N16-R-49707-499 3300-381604327	RESISTOR, fixed: comp; JAN type RC42BF331K; 330 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Input line load
R502	—	Same as R501	Input line load
R503	—	Same as R501	Input line load
R504	—	Same as R501	Input line load
R505	—	Same as R162	V501 grid
R506	3RB4-1110 N16-R-78917-8199 3300-380411100	RESISTOR, fixed: WW; JAN type RB12B1110F; non-inductive; 111 ohms, $\pm 1\%$; $\frac{1}{2}$ w at 85°C max continuous oper temp; spec JAN-R-93.	Buffer and 1st multiplier grid meter shunt
R507	N16-R-49770-516	RESISTOR, fixed: comp; JAN type RC42BF471K; 470 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V501 cathode
R508	3RB3-1010 N16-R-78702-1024 3300-380310100	RESISTOR, fixed: WW; JAN type RB12B10R10F; non-inductive; 10.10 ohms, $\pm 1\%$; $\frac{1}{2}$ w; spec JAN-R-93.	V501 cathode meter shunt
R509	N16-R-50418-457	RESISTOR, fixed: comp; JAN type RC42BF333K; 33,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V501 screen divider
R510	—	Same as R509	V501 screen divider
R511	—	Same as R509	V501 screen divider
R512	3RW29704 N16-R-62028-3625	RESISTOR, fixed: WW; JAN type RW14F802; 8000 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	V501 plate divider
R513	3RW30903 N16-R-62093-8055 3300-385309030	RESISTOR, fixed: WW; JAN type RW14F123; 12,000 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	V501 plate divider
R514	—	Same as R162	V502 grid
R515	—	Same as R507	V502 cathode
R516	—	Same as R508	V502 cathode meter shunt
R517	N16-R-50679-520	RESISTOR, fixed: comp; RC42BF154K; 150,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V502 screen
R518	3RC30BF470K N16-R-49428-231 3300-381319620	RESISTOR, fixed: comp; RC30BF470K; 47 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V502 screen

R519	3RP9306 N16-R-91294-6980 3300-383093060	RESISTOR, variable: WW; JAN type RP151FE103 KK; 10,000 ohms, $\pm 10\%$; 50 w, at 340°C continuous oper temp, 0.07 amp max; linear taper; no off position; spec JAN-R-22.	Excitation control screen grids V502 and V503
R520	3RW27903 N16-R-61925-6165	RESISTOR, fixed: WW; JAN type RW14F402; 4000 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	V502 plate voltage dropping
R521	—	Same as R512	V502 and V503 screen divider
R522	3Z7450-157 N16-R-87852-1950 3300-399809102	RESISTOR, variable: comp; 50,000 ohms, $\pm 20\%$; 2 w at 85°C continuous oper temp; linear taper; no off position; CBZ #JU-5032-SD4056.	V503 bias divider
R523	—	Same as R509	V503 bias divider
R524	—	Same as R198	V503 grid
R525	—	Same as R506	V503 grid meter shunt
R526	—	Same as R158	V503 grid
R527	N16-R-49581-461	RESISTOR, fixed: comp; JAN type RC42BF101K; 100 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V503 plate series
R528	N16-R-50013-461	RESISTOR, fixed: comp; JAN type RC42BF222K; 2200 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Driver neutralizing
R529	N16-R-78644-9099	RESISTOR, fixed: WW; JAN type RB12B5RO30F; non-inductive; 5.030 ohms, $\pm 1\%$; $\frac{1}{2}$ w at 85°C max continuous oper temp; spec JAN-R-93.	V503 cathode meter shunt
R530	—	Same as R518	V503 screen
R531	3RW26106 N16-R-61836-2395 3300-385261060	RESISTOR, fixed: WW; JAN type RW16F202; 2,000 ohms, $\pm 5\%$; 14 w at 275°C max continuous oper temp; spec JAN-R-26A.	V503 plate series
R532	3RW31502 N16-R-62123-1655	RESISTOR, fixed: WW; JAN type RW13F163; 16,000 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	V504 bias divider
R533	—	Same as R507	V504 grid
R534	3RB3-2040 N16-R-78772-1522 3300-380320400	RESISTOR, fixed: WW; JAN type RB12B20R40F; non-inductive; 20.40 ohms, $\pm 1\%$; $\frac{1}{2}$ w at 85°C max continuous oper temp; spec JAN-R-93.	V504 grid meter shunt
R535	3RW30304 N16-R-62072-1995	RESISTOR, fixed: WW; JAN type RW14F103; 10,000 ohms, $\pm 5\%$; 40 w at 275°C max continuous oper temp; spec JAN-R-26A.	V504 bias divider
R536	—	RESISTOR, variable: Same as R591 except shaft is $\frac{7}{8}$ " lg FMS. (For replacement use spare part for R591 and cut shaft to proper length).	Servo positioning pot (motor driven by B502)
R537	3RW27302 N16-R-61887-8997 3300-385273020	RESISTOR, fixed: WW; JAN type RW13F312; 3100 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	V504 screen
R538	—	Same as R312	V506 grid bias

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	FUNCTION
R539	—	Same as R312	V505 grid
R540	3Z6005-62 N16-R-45555-4930 3300-390023420	RESISTOR, fixed: Navy type -634098-20; carborundum; 50 ohms, $\pm 20\%$; 22 w free air; CAZB type CX.	Parasitic suppressor V505 filament
R541	—	Same as R540	Parasitic suppressor V506 grid
R542	—	Same as R540	Parasitic suppressor V505 grid
R543	—	Same as R540	Parasitic suppressor V506 fil
R544	3Z5992-81 N16-R-78452-1508 3300-389610676	RESISTOR, fixed: WW; 0.2 ohms, $\pm 1\%$; 12 w at 275°C max continuous oper temp; CAO #TDC-57462; spec JAN-R-26A (type RW32FR20) except $\pm 1\%$ tolerance.	V505 cathode meter shunt
R545	—	Same as R544	V506 cathode meter shunt
R546	—	Not Used	
R547	—	Not Used	
R548	N16-R-87752-5475	RESISTOR, variable: comp; 25,000 ohms, $\pm 20\%$; 2 w at 85°C continuous oper temp; linear taper; no off position; CBZ #JU-2532-SD4056.	Keying input level control
R549	N16-R-50634-501	RESISTOR, fixed: JAN type RC42BF104K; 100,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V507 grid leak
R550	3RC30BF104K N16-R-50634-231 3300-381316220	RESISTOR, fixed: comp; JAN type RC30BF104K; 100,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V507 grid series
R551	—	Same as R187	V507 cathode
R552	3RW32104 N16-R-62137-5695 3300-385321040	RESISTOR, fixed: WW; JAN type RW13F203; 20,000 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	V507 plate load
R553	3RW28505 N16-R-61955-4245	RESISTOR, fixed: WW; JAN type RW13F502; 5000 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	V507 bias divider
R554	3RA6908 N16-R-91031-2010 3300-380069080	RESISTOR, variable: WW; JAN type RA25A1SA502AK; 5000 ohms, $\pm 10\%$; 3 w at 100°C continuous oper temp; spec JAN-R-19.	V507 bias divider
R555	—	Same as R552	V507 bias divider
R556	—	Same as R550	V507 grid series
R557	3RC30BF471K N16-R-49770-231 3300-381319680	RESISTOR, fixed: comp; JAN type RC30BF471K; 470 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V507 cathode

R558	—	Same as R532	V507 plate load
R559	3RW29703 N16-R-62028-7145	RESISTOR, fixed: WW; JAN type RW13F802; 8000 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	V507 output divider
R560	3RA6942 N16-R-91031-1950 3300-380069420	RESISTOR, variable: WW; JAN type RA25A1FD502AK; 5000 ohms, $\pm 10\%$; 3 w at 100°C continuous oper temp; linear taper; no off position, spec JAN-R-19.	V507 output adjust
R561	—	Same as R532	V507 output divider
R562	3RP4-9000.3 N16-R-79083-3764 3300-380490003	RESISTOR, fixed: WW; JAN type RB12B900ROF; non-inductive; 900 ohms, $\pm 1\%$; $\frac{1}{2}$ w; spec JAN-R-93.	M505 multiplier
R563	—	Same as R562	M506 multiplier
R564	3RB2-2000.1 N16-R-78602-4019 3300-380220001	RESISTOR, fixed: WW; JAN type RB12B2ROOF; non-inductive; 2 ohms, $\pm 1\%$; $\frac{1}{2}$ w at 85°C max continuous oper temp; spec JAN-R-93.	V505 grid meter shunt
R565	3Z5991-121 N16-R-78569-1508 3300-399669878	RESISTOR, fixed: WW; 1 ohm, $\pm 1\%$; 12 w at 275°C max continuous oper temp; CAO #TDC-57460; spec JAN-R-26A (type RW32FIRO) except $\pm 1\%$ tol.	Power amplr total grid meter shunt
R566	—	Same as R564	V506 grid meter shunt
R567	—	Same as R562	V505 and V506 multimeter series
R568	N16-R-91406-6598	RESISTOR, variable: WW; 25,000 ohms, $\pm 10\%$; 4 watts at 100°C max cont oper temp; linear taper; no off position; CMA type "E" class "A".	Test keying input potentiometer
R569	3RC42BF151K N16-R-49626-501 3300-381601997	RESISTOR, fixed: comp; JAN type RC42BF151K; 150 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Keying wave shaper in output of V507
R570	N16-R-91291-6160	RESISTOR, variable: WW; JAN type RA25A1SA103AK; 10,000 ohms, $\pm 10\%$; 3 w at 100°C continuous oper temp; linear taper; no off position; spec JAN-R-19.	Test keying divider
R571	—	Same as R158	V503 bias divider
R572	N16-R-49662-506	RESISTOR, fixed: comp; JAN type RC42BF221K; 220 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Z801 tuning servo limit
R573	—	Same as R570	Test keying divider adj
R574	—	Same as R569	Z802 tuning servo limit
R575	—	Same as R572	Z805 tuning servo limit
R576	—	Same as R328	I507 voltage dropping
R577	N16-R-50400-231	RESISTOR, fixed: comp; JAN type RC30BF273K; 27,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Test keying divider
R578	3RW29102 N16-R-61995-9775 3300-385291020	RESISTOR, fixed: WW; JAN type RW13FG32; 6300 ohms, $\pm 5\%$; 50 w at 275°C max continuous oper temp; spec JAN-R-26A.	Osc series dropping

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	L CATING FUNCTION
R579	—	Same as R335	I502 voltage dropping
R580	—	Same as R335	I503 voltage dropping
R581	—	Same as R345	Filter resistor for V507 output
R582	—	Not Used	
R583	—	Same as R328	I505 voltage dropping
R584	—	Same as R328	I512 voltage dropping
R585	—	Same as R328	I506 voltage dropping
R586	N16-R-61448-5920 —	RESISTOR, fixed: WW; non-inductive; 75 ohms, $\pm 5\%$; 116 w at 275°C max continuous oper temp. CAO type RFD, #M-11-SN (75 ohms); spec JAN-R-26A (type RW11F750) except non-inductive.	Single side-band loading
R587	—	Same as R586	Single side-band loading
R588	—	Same as R586	Single side-band loading
R589	—	Same as R586	Single side-band loading
R590	—	Same as R328	I501 voltage dropping
R591	3Z7310-109 N16-R-90751-2932 3300-394352551	RESISTOR, variable: Navy type -637318-V5; WW; 1000 ohms, $\pm 5\%$; 2 watt; linear taper; no off position; CAQM #M13-H13, dwg #4135-A.	Z801 servo panel potentiometer
R592	—	Same as R591	
R593	—	Same as R591	Z802 servo panel pot
R594	—	Same as R591	Z803 servo panel pot
R595	—	Same as R591	Z804 servo panel pot
R596	—	Same as R591	Z805 servo panel pot
R597	N16-R-50310-480 —	RESISTOR, fixed: comp; JAN type RC42BF123K; 12,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Z806 servo panel pot Test keying divider
R598	—	Same as R597	Test keying divider
R599	—	Same as R597	Test keying divider
R600	—	Same as R597	Test keying divider
R601	—	Same as R597	Test keying divider
R602	N16-R-50517-475 —	RESISTOR, fixed: comp; JAN type RC42BF563K; 56,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Test keying divider
R603	—	Same as R602	Test keying divider

R604	—	Same as R549	Test keying divider
R605	N16-R-50652-506	RESISTOR, fixed: comp; JAN type RC42BF124K; 120,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Test keying divider
R606	N16-R-50553-506	RESISTOR, fixed: comp; JAN type RC42BF683K; 68,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Test keying divider
R607	—	Same as R606	Test keying divider
R608	—	Same as R221	Test keying divider
R609	—	Same as R221	Test keying divider
R610	N16-R-50481-457	RESISTOR, fixed: comp; JAN type RC42BF473K; 47,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Test keying divider
R611	—	Same as R610	Test keying divider
R612	—	Same as R572	Z806 servo limit
R613	—	Same as R345	Filter and decoupling in V507 output
R614	—	Same as R553	Decoupling V507 plate supply
R615	—	Same as R507	Z804 servo limit
R616	—	Same as R527	P/o parasitic suppressor in grid of V504
R701	—	Same as R536	Servo positioning potentiometer. Used with Z701, Z702, Z703, Z705 and Z706 (1 ea)
R801	3RC30BF334K N16-R-50760-231 3300-381319020	RESISTOR, fixed: comp; JAN type RC30BF334K; 330,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Feedback series (1 ea, 6 units)
R802	—	Same as R507	Input limiting (1 ea, 6 units)
R803	—	Same as R507	Input limiting (1 ea, 6 units)
R804	N16-R-88182-5495	RESISTOR, variable: comp; 500,000 ohms, $\pm 20\%$; 1 w at 85°C max continuous oper temp; linear taper; no off position; CBZ type U.	Feedback adjustment for anti-hunt control (1 ea, 6 units)
R805	—	Same as R801	Feedback series (1 ea, 6 units)
R806	—	Same as R550	V801 grid series (1 ea, 6 units)
R807	3RC30BF332K N16-R-50067-231 3300-381318900	RESISTOR, fixed: comp; JAN type RC30BF332K; 3300 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V801 cathode (1 ea, 6 units)
R808	—	Same as R550	V801 grid series (1 ea, 6 units)

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R809	3RC30BF224K N16-R-50715-231 3300-381318180	RESISTOR, fixed: comp; JAN type RC30BF224K; 220,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V801 plate (1 ea, 6 units)
R810	—	Same as R809	V801 plate (1 ea, 6 units)
R811	3RC30BF564K N16-R-50859-231 3300-381320260	RESISTOR, fixed: comp; JAN type RC30BF564K; 560,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V802 grid (1 ea, 6 units)
R812	—	Same as R811	V802 grid (1 ea, 6 units)
R813	—	Same as R557	V802 cathode (1 ea, 6 units)
R814	3RC30BF101K N16-R-49581-231 3300-381316040	RESISTOR, fixed: comp; JAN type RC30BF101K; 100 ohms, $\pm 10\%$; 1 w; char- acteristic letter F; spec JAN-R-11.	K801 spark suppressor (1 ea, 6 units)
R815	—	Same as R814	K802 spark suppressor (1 ea, 6 units)
R901	—	Same as R335	I901 voltage dropping
R902	—	Same as R335	I902 voltage dropping
R903	—	Same as R335	I903 voltage dropping (2 units)
R904	—	Same as R528	Filter
R905	—	Same as R528	Filter
R906	—	Same as R517	Bleeder
R907	—	Same as R335	I904 voltage dropping
R1001	— N16-R-50482-611	RESISTOR, fixed: comp; JAN type RC30BF473M; 47,000 ohms, $\pm 20\%$; 1 w; characteristic letter F; spec JAN-R-11.	I1001 voltage dropping
R1002	3RW27323 N16-R-66167-8988 3300-385273230	RESISTOR, fixed: WW; JAN type RW32F312; 3100 ohms, $\pm 5\%$; 12 w at max continuous oper temp 275°C; spec JAN-R-26A.	Volt dropping in master osc 150-volt reg supply
R1003	— N16-R-50635-886	RESISTOR, fixed: comp; JAN type RC42BF104M; 100,000 ohms, $\pm 20\%$; 2 w; characteristic letter F; spec JAN-R-11.	Bleeder in master oscillator B+ supply
R1004	—	Same as R1002	Volt dropping in freq shift keyer B+ supply
R1005	—	Same as R1003	Bleeder in freq shift keyer B+ supply

R1006	3Z6610-334 N16-R-62071-2580 3300-392371772	RESISTOR, fixed: WW; 10,000 ohms, $\pm 5\%$; 18 w at max continuous oper temp 275°C; CAO #3"-0, 10,000 ohms; spec JAN-R-26A (Class RW33) where applicable.	Filter resistor in 100-volt neg supply to freq shift keyer
R1007	—	Same as R1006	Filter in 100-volt neg supply to freq shift keyer
R1008	—	Same as R1006	Bleeder in 100-volt neg supply to freq shift keyer
R1101	N17-W-237981-121 —	WIRE, electrical: consists of 3.5 ft #28 single Fiberglas covered Nichrome "Y" resistance wire; 4,090 ohms per ft at 20°C.	Crystal oven heater (part of Z1101)
R1102	—	Same as R562	M1101 multiplier
R1103	3RC30BF473K N16-R-50481-231 3300-381319800	RESISTOR, fixed: comp; JAN type RC30BF473K; 47,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1101 grid
R1104	3RC30BF820K N16-R-49536-231 3300-381320940	RESISTOR, fixed: comp; JAN type RC30BF820K; 82 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1101 cathode
R1105	3RB3-7140 N16-R-78877-9164 3300-380371400	RESISTOR, fixed: WW; JAN type RB12B71R40F; non-inductive; 71.40 ohms, $\pm 1\%$; $\frac{1}{2}$ w; spec JAN-R-93.	M1101 shunt
R1106	N16-R-50166-508 —	RESISTOR, fixed: comp; JAN type RC42BF562K; 5600 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V1101 plate load
R1107	3RC30BF333K N16-R-50418-231 3300-381318960	RESISTOR, fixed: comp; JAN type RC30BF333K; 33,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Screen V1101 drooping
R1108	—	Same as R1103	Buffer grid (V1102)
R1109	3RC30BF151K N16-R-49626-231 3300-381317020	RESISTOR, fixed: comp; JAN type RC30BF151K; 150 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Buffer cathode (V1102)
R1110	3RB2-6710 N16-R-78670-7243 3300-380267100	RESISTOR, fixed: WW; JAN type RB12B6R710F; non-inductive; 6.710 ohms, $\pm 1\%$; $\frac{1}{2}$ w; spec JAN-R-93.	M1101 shunt
R1111	N17-H-60001-5445 —	HEATING ELEMENT, electrical: WW; consists of approx 1.5 ft #35 Nichrome "Y" wire cut to 27.5 ohms and close-wound on 0.032" diam mandrel then stretched to fit installation; natural wire terms; wire 20.72 ohms/ft at 20°C (68°F); FTRC dwg FRB-31425-1.	Crystal oven heater (part of Z1101)
R1112	N16-R-49428-496 —	RESISTOR, fixed: comp; JAN type RC42BF470K; 47 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	I1103 voltage drooping
R1301	N16-R-50758-941 —	RESISTOR, fixed: comp; JAN type RC42BF334J; 330,000 ohms, $\pm 5\%$; 2 w; characteristic letter F; spec JAN-R-11.	Output voltage divider in Z1303 and Z1304 (1 ea, 2 units)
R1302	—	Not Used	
R1303	—	Not Used	

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R1304	—	Not Used	Output voltage divider in Z1303 and Z1304 (1 ea, 2 units)
R1305	—	Not Used	
R1306	—	Not Used	
R1307	—	Not Used	
R1308	—	Not Used	
R1309	—	Not Used	
R1310	—	Not Used	
R1311	3RC30BF103K N16-R-50283-231 3300-381316160	RESISTOR, fixed: comp; JAN type RC30BF103K; 10,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	
R1312	—	Not Used	
R1313	—	Not Used	
R1314	—	Not Used	
R1315	—	Not Used	Output voltage divider in Z1301 and Z1302 (1 ea, 2 units)
R1316	—	Not Used	
R1317	—	Not Used	
R1318	—	Not Used	
R1319	—	Not Used	
R1320	—	Not Used	
R1321	—	Not Used	
R1322	—	Not Used	
R1323	N16-R-50741-126	RESISTOR, fixed: comp; JAN type RC42BF274J; 270,000 ohms, $\pm 5\%$; 2 w; characteristic letter F; spec JAN-R-11.	
R1324	—	Same as R1311	Output voltage divider in Z1301 and Z1302 (1 ea, 2 units) J1401 terminating resistance
R1401	3Z6005E6-11 N16-R-65364-2046 3300-396501511	RESISTOR, fixed: WW; non-inductive; 56 ohms, $\pm 10\%$; 10 w; CL1#1 3/4 ENI.	
R1402	3RC20BF820K N16-R-49535-811 3300-381170940	RESISTOR, fixed: comp; JAN type RC20BF820K; 82 ohms, $\pm 10\%$; 1/2 w; characteristic letter F; spec JAN-R-11.	

R1403	3RC20BF680K N16-R-49499-811 3300-381170460	RESISTOR, fixed: comp; JAN type RC20BF680K; 68 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1404	—	Same as R146	Part of external osc input attenuator
R1405	3RC20BF390K N16-R-49391-811 3300-381169260	RESISTOR, fixed: comp; JAN type RC20BF390K; 39 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1406	3RC20BF330K N16-R-49364-811 3300-381168780	RESISTOR, fixed: comp; JAN type RC20BF330K; 33 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1407	3RC20BF270K N16-R-49346-811 3300-381168420	RESISTOR, fixed: comp; JAN type RC20BF270K; 27 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1408	3RC20BF220K N16-R-49319-811 3300-381167940	RESISTOR, fixed: comp; JAN type RC20BF220K; 22 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1409	3RC20BF150K N16-R-49283-811 3300-381166960	RESISTOR, fixed: comp; JAN type RC20BF150K; 15 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1410	3RC20BF120K N16-R-49256-811 3300-381166540	RESISTOR, fixed: comp; JAN type RC20BF120K; 12 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1411	3RC20BF100K N16-R-49238-811 3300-381165980	RESISTOR, fixed: comp; JAN type RC20BF100K; 10 ohms, $\pm 10\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	Part of external osc input attenuator
R1412	—	Same as R1405	Part of external osc input attenuator
R1413	—	Same as R196	V1401 and V1402 grid
R1414	3RC30BF560K N16-R-49464-231 3300-381320100	RESISTOR, fixed: comp; JAN type RC30BF560K; 56 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1401 and V1402 cathode
R1415	—	Same as R1109	V1401 and V1402 cathode
R1416	3RA7519 N16-R-91291-4935 3300-380075190	RESISTOR, variable: WW; JAN type RA20A1SD103AK; 10,000 ohms, $\pm 10\%$; 2 w at 100°C max continuous oper temp; spec JAN-R-19.	V1401 and V1402 modulator screen balance
R1417	N16-R-50400-499	RESISTOR, fixed: comp; JAN type RC42BF273K; 27,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V1401 and V1402 screen dropping
R1418	—	Same as R1417	V1401 and V1402 screen dropping
R1419	—	Same as R221 (Part of Z1405)	V1401 and V1402 plate voltage dropping
R1420	—	Same as R1414 (Part of Z1405)	Part of equalizing network between L1403 and L1405

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R1421	3RC30BF153K N16-R-50337-231 3300-381317140	RESISTOR, fixed: comp; JAN type RC30BF153K; 15,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; (p/o Z1404) spec JAN-R-11.	V1403 grid
R1422	3RC30BF680K N16-R-49500-231 3300-381320460	RESISTOR, fixed: comp; JAN type RC30BF680K; 68 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1403 cathode (p/o Z1404)
R1423	3RC30BF222K N16-R-50013-231 3300-381318060	RESISTOR, fixed: comp; JAN type RC30BF222J; 2200 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1403 bias divider
R1424	3RC30BF153J N16-R-50335-751 3300-381317120	RESISTOR, fixed: comp; JAN type RC30BF153J; 15,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1403 bias divider
R1425	—	Same as R1107	V1403 screen
R1426	—	Same as R1424	V1404 bias divider
R1427	3RC30BF682J N16-R-50200-751 3300-381320560	RESISTOR, fixed: comp; JAN type RC30BF682J; 6800 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1404 bias divider
R1428	—	Same as R518	Parasitic suppressor grid V1404
R1429	N16-R-50238-231 —	RESISTOR, fixed: composition; JAN type RC30BF822K; 8200 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Photo input divider
R1430	3Z7425-102 N16-R-91406-1650 3300-394384139	RESISTOR, variable: WW; 25,000 ohms, $\pm 10\%$; 4 w at 100°C max continuous oper temp; linear taper; no off position; Amalgamated Electronics type PRA-30.	V1404 screen potentiometer
R1431	N16-R-50040-511 —	RESISTOR, fixed: comp; JAN type RC42BF272K; 2700 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	V1404 screen
R1432	N16-R-68275-6956 —	RESISTOR, fixed: WW; JAN type RU3B1R2K; 1.2 ohms, $\pm 10\%$; $\frac{1}{2}$ w at 110°C max continuous oper temp; spec JAN-R-184.	M1401 meter shunt
R1433	3RC20BF200J N16-R-49309-431 3300-381167780	RESISTOR, fixed: comp; JAN type RC20BF200J; 20 ohms, $\pm 5\%$; $\frac{1}{2}$ w; characteristic letter F; spec JAN-R-11.	M1401 multiplier
R1434	3RC30BF474K N16-R-50823-231 3300-381319860	RESISTOR, fixed: comp; JAN type RC30BF474K; 470,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Key line input termination
R1435	3RW23135 N16-R-65935-3621 3300-385231250	RESISTOR, fixed: WW; JAN type RW30F631; 630 ohms, $\pm 5\%$; 7 w at 275°C max continuous oper temp; spec JAN-R-26A.	Photo input termination

R1436	3RC42BF332J N16-R-50066-121 3300-381604330	RESISTOR, fixed: comp; JAN type RC42BF332J; 3300 ohms, $\pm 5\%$; 2 w characteristic letter F; spec JAN-R-11.	Bias divider, cathode V1406
R1437	3RC30BF223J N16-R-50371-751 3300-381318100	RESISTOR, fixed: comp; JAN type RC30BF223J; 22,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	Bias divider, cathode V1406
R1438	_____	RESISTOR, fixed: comp; JAN type RC42BF223J; 22,000 ohms, $\pm 5\%$; 2 w; characteristic letter F; spec JAN-R-11.	Voltage dropping in +150 volt line
R1439	_____	RESISTOR, variable: WW; JAN type RA20A1SD502AK; 5000 ohms, $\pm 10\%$; 2 w at max continuous oper temp 100°C; linear taper; no off position; spec JAN-R-19.	Limiter adjustment, cathode V1406
R1440	3RC30BF104J N16-R-50632-751 3300-381316200	RESISTOR, fixed: comp; JAN type RC30BF104J; 100,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	Wave shaping (V1406)
R1441	_____	Same as R1440	Wave shaping, V1406 plate to plate
R1442	_____	RESISTOR, fixed: comp; JAN type RC30BF221K; 220 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Bias resistor, across R1439
R1443	_____	RESISTOR, fixed: WW; JAN type RB11B470R0F; 470 ohms, $\pm 1\%$; 1/3 w at 85°C max continuous oper temp; spec JAN-R-93.	V1408 bias
R1444	_____	Same as R1443	V1408 bias
R1445	3RC30BF224J N16-R-50713-751 3300-381318160	RESISTOR, fixed: comp; JAN type RC30BF224J; 220,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	Wave shaping
R1446	3RC20BF152J N16-R-49966-431 3300-381601999	RESISTOR, fixed: comp; JAN type RC20BF152J; 1500 ohms, $\pm 5\%$; 1/2 w; characteristic letter F; spec JAN-R-11.	Wave shaping
R1447	3RC30BF563J N16-R-50515-751 3300-381320200	RESISTOR, fixed: comp; JAN type RC30BF563J; 56,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	Terminating resistor for wave shaping
R1448	_____	Same as R1439	Photo adjustment
R1449	3RC30BF271J N16-R-49687-751 3300-381318430	RESISTOR, fixed: comp; JAN type RC30BF271J; 270 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	Voltage divider in 200-kc input to V1408
R1450	3RA3018 N16-R-89956-7050 3300-380030180	RESISTOR, variable: WW; JAN type RA20A1SG500AK; 50 ohms, $\pm 10\%$; 2 w at 100°C max continuous oper temp, linear taper; no off position; spec JAN-R-19.	Keyer bal control in 200-kc input to V1408
R1451	_____	Same as R1449	Voltage divider in 200-kc input to V1408
R1452	3RC30BF823K N16-R-50589-231 3300-381321060	RESISTOR, fixed: comp; JAN type RC30BF823K; 82,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1408 grid

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
R1453	—	Same as R1452	V1408 grid
R1454	3RC30BF392J N16-R-50092-751 3300-381319320	RESISTOR, fixed: comp; JAN type RC30BF392J; 3900 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1408 cathode
R1455	—	Same as R1454	V1408 cathode
R1456	3RC30BF123J N16-R-50308-751 3300-381316640	RESISTOR, fixed: comp; JAN type RC30BF123J; 12,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1408 plate load
R1457	—	Same as R1456	V1408 plate load
R1458	3Z6610-333 N16-R-87679-4293 3300-292371771	RESISTOR, variable: WW; JAN type RA20AIRH103AK; 10,000 ohms, $\pm 10\%$; 2 watts at 40°C; linear taper; no switch; spec JAN-R-19.	Frequency BASIC SHIFT control
R1459	3Z6360-19 N16-R-73030-9545 3300-391772260	RESISTOR, fixed: comp (deposited carbon); 3600 ohms, $\pm 1\%$; 1 w; 500 v varnish ins; temp coef 0.049% (-55°C) to 0.038% ($+105^{\circ}\text{C}$) for 25°C reference; CIR type DCF, (3600).	Part of xmtr multiplication control
R1460	3Z6180-77 N16-R-73008-7011 3300-391429328	RESISTOR, fixed: comp (deposited carbon); 1800 ohms, $\pm 1\%$; 1 w; 500 v varnish ins; temp coef 0.049% (-55°C) to 0.038% ($+105^{\circ}\text{C}$) for 25°C reference; CIR type DCF, (1800).	Part of xmtr multiplication control
R1461	3Z6090-40 N16-R-72986-4145 3300-391106275	RESISTOR, fixed: comp (deposited carbon); 900 ohms, $\pm 1\%$; 1 w; 500 v varnish ins; temp coef 0.049% (-55°C) to 0.038% ($+105^{\circ}\text{C}$) for 25°C reference; CIR type DCF (900).	Part of xmtr multiplication control
R1462	—	Same as R1461	Part of xmtr multiplication control
R1463	3RC30BF103J N16-R-50281-751 3300-381316140	RESISTOR, fixed: comp; JAN type RC30BF103J; 10,000 ohms $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1409 grid
R1464	3RA6329 N16-R-90868-3015 3300-380063290	RESISTOR, variable: JAN type RA20A1SG252AK; WW; 2500 ohms; $\pm 10\%$; 2 w; at 100°C max continuous oper temp; linear taper; no off position; spec JAN-R-19.	FREQUENCY SHIFT CALIBRATION (cathode V1409)
R1465	3RC30BF331K N16-R-49707-231 3800-381318840	RESISTOR, fixed: comp; JAN type RC30BF331K; 330 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1409 cathode
R1466	—	Same as R1107	V1409 plate voltage dropping
R1467	—	Same as R1437	V1410 grid
R1468	—	Same as R1449	V1410 cathode
R1469	—	Same as R801	V1410 screen
R1470	—	Same as R550	V1410 plate

R1471	3RC30BF154J N16-R-50677-751 3300-381317180	RESISTOR, fixed: comp; JAN type RC30BF154J; 150,000 ohms, $\pm 5\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1411 grid
R1472	3RC30BF123K N16-R-50310-231 3300-381316660	RESISTOR, fixed: comp; JAN type RC30BF123K; 12,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1411 screen dropping
R1473	—	Same as R1463	V1411 plate dropping
R1474	6Z5054-18 N17-H-60018-5001 1760-696943818	HEATING ELEMENT, electrical: strip type; 115 v, 100 w; single sect; metal sheath; air heater; CAYF #CA-20.	Heating element for oven
R1475	—	Same as R1474	Heating element for oven
R1476	—	Same as R814	V1412 grid
R1477	—	Same as R577	V1412 grid
R1478	—	Same as R162	V1412 plate load
R1479	—	Same as R1423	V1412 plate load
R1480	—	Same as R162	V1412 plate load
R1481	3RC30BF563K N16-R-50517-231 3300-381320220	RESISTOR, fixed: comp; JAN type RC30BF563K; 56,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	V1402 mixer grid #2
R1482	—	Same as R1481	V1402 mixer grid #2
R1483	—	Same as R1311	V1412 plate voltage dropping
R1484	—	Same as R1440	V1407 grid resistor
R1485	3RA6941 N16-R-91027-9295 3300-380069410	RESISTOR, variable: W/W; JAN type RA20B1RH502AJ; 5000 ohms, $\pm 5\%$; 2 w at 100°C max continuous oper temp; linear taper; no off position; spec JAN-R-19.	Phase modulation control
R1486	—	Same as R1437	V1407 grid
R1487	N16-R-50443-945 —	RESISTOR, fixed: comp; JAN type RC42BF393J; 39,000 ohms, $\pm 5\%$; 2 w; characteristic letter F; spec JAN-R-11.	V1407 plate and screen resistor
R1488	—	Same as R1452	I1402 voltage dropping
R1489	N16-R-50742-231 —	RESISTOR, fixed: comp; JAN type RC30BF274K; 270,000 ohms, $\pm 10\%$; 1 w; characteristic letter F; spec JAN-R-11.	Part of xmtr multiplication control
R1490	—	Same as R1109	V104 screen
R1491	3RC42BF103K N16-R-50283-529 3300-381600106	RESISTOR, fixed: comp; JAN type RC42BF103K; 10,000 ohms, $\pm 10\%$; 2 w; characteristic letter F; spec JAN-R-11.	Power supply regulation
S101	3Z9863-26N F17-S-74139-7130 3360-395853262	SWITCH, toggle: DPDT; JAN type ST26N endurance test cur values (ea pole) 5 amp 125 v resistive load, 3 amp 125 v inductive load, 6 amp continuous; spec JAN-S-23.	Plate ON and OFF
S102	—	Not Used	

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
S103	—	Same as S101	Set up-operate
S104	3Z9823-7.14 F17-S-69145-1898 3360-399840154	SWITCH, sensitive: Navy type -241431; SPDT; 10 amp, 115 v AC; bakelite case; 1-13/64" lg x 53/64" wd x 9/32" thk o/a; 0.070" x 0.094" plunger extending 0.071" out of side of case; oper pressure 3-6 oz; travel of actuating mechanism 0.007"; pre-travel 0.040" max; over-travel 0.025" min; momentary action; lug type term; four 3/32" diam mtg holes on 1" x 5/8" mtg/c; CATK #1MD-1A.	Stops B101 when C126 is centered; cam operated (used with O131)
S105	—	Same as S101	100 kc EXT-INT
S301	N17-C-51514-6810	CIRCUIT BREAKER: Navy type -291793; magnetic; three pole; 230 v, 5.0 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#3363-S, time-overload curve #1.	Blower (B301) protection
S302	N17-C-51472-8249	CIRCUIT BREAKER: Navy type -291792; magnetic; double pole; 230 v, 5 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#2263-S, time-overload curve #2.	LV and bias rectifier circuits protection
S303	3H900-15-46 N17-C-51473-4652 3360-337315361	CIRCUIT BREAKER: Navy type -291791; magnetic; double pole; 230 v, 15 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#2263-S, time-overload curve #2.	Control circuits protection
S304	3H900-6-3-1 N17-C-51514-7821 3360-337294101	CIRCUIT BREAKER: Navy type -291794; magnetic; three pole; 230 v, 6.3 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#3363-S, time-overload curve #2.	Low power filaments circuit protection
S305	N17-C-51472-9899	CIRCUIT BREAKER: Navy type -291789; magnetic; double pole; 230 v, 8.0 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#2263-S, time-overload curve #1.	Power amplr filaments circuit protection
S306	N17-C-51472-5974	CIRCUIT BREAKER: Navy type -291790; magnetic; double pole; 230 v, 2 amp AC, 250 v DC; bakelite case; 5 sec time delay; toggle action, manual reset; CHN#2263-S, time-overload curve #2.	Servo control power supply protection
S307	3Z9858-3.4 N17-S-73766-5076 3360-395812043	SWITCH, toggle: Navy type -241426; DPST; 30 amp 250 v 5 amp 600 v; CGT-#2228-S.	Filaments on-off and emergency shut-down
S308	3Z9824-50.17 N17-S-56597-7094 3360-397501695	SWITCH, push: Navy type -241428; cont arrangement 1B; 40 amp 110 v, 20 amp 220 v, 13 amp 440 v; normally closed; CAE#10250-H-376A10.	HV off
S309	3Z9824-50.16 N17-S-56597-7089 3360-397501694	SWITCH, push: Navy type -241429; cont arrangement 1A; 40 amp 110 v, 20 amp 220 v, 13 amp 440 v; normally open; CAE#10250-H-375A11.	HV on
S310	N17-S-62141-3296	SWITCH, rotary: 3 pole, 3 position, 1 section; 7 1/2 amp at 115 v, 60 cps; solid silver cont; seatite stator and rotor; non-shorting cont; CBN#V-9209.	Tune-operate selector
S311	—	SWITCH: Navy type -24067; consists of S311A and S311B.	Door interlock
S311A	3ZK9570-2 N17-S-91941-1004 3360-395048840	SWITCH, push-pull: male cont; bakelite body; 1 7/8" lg x 1 1/16" wd x 1-13/32" h o/a; momentary action; CG#7760014-3.	Door Interlock

S311B	N17-S-91941-1005	SWITCH, push pull: 2 female cont; bakelite body; 2-5/16" lg x 11/16" wd x 15/16" h; momentary action; CG#7760014-2.	Door Interlock
S312	—	Same as S311	Door Interlock
S313	—	Same as S311	Door Interlock
S314	N17-S-65228-6947	SWITCH, rotary: 6 pole 5 positions, 2 sections; 7 1/2 amp at 115 v, 60 cps; solid silver cont; steatite stator and rotor; non-shorting cont; CBN#2V-10318.	Circuit Selector for M303
S314A	—	(Part of S314)	
S314B	—	(Part of S314)	
S314C	—	(Part of S314)	
S314D	—	(Part of S314)	
S315	—	Not Used	
S316	N17-S-54549-8695	SWITCH, lever: Navy type -241425; 1 locking position (35°) and 1 non-locking (18°); position #1-left 1A, position #2-right 1A; 10 amps, 110 v AC non-inductive; 3/16" diam fine silver contacts; 1/2" diam x 7/8" lg (special) black phenolic knob; CDM #DP-4101 (knob shortened).	Test Key
S317	N17-S-60523-1305	SWITCH, rotary: 1 pole 10 position; solid silver contacts; steatite ceramic stator and rotor; shorting type cont; locking action; shaft 1/4" diam x 7/8" lg FMS; COC#36823-DH1C.	Reclosure cycle selector
S318	N17-S-56382-9001	SWITCH, push: Navy type -241443; 3 contacts normally closed by spring-loaded shorting disc; momentary; 5/16" diam x 8" lg shaft; FTRC dwg #503-1938-003.	Grounds secd wnd of T401; door operated
S318A	—	(Part of S318)	
S318B	—	(Part of S318)	
S318C	—	(Part of S318)	
S319	—	Same as S318	Grounds secd wnd of T401; door operated
S319A	—	(Part of S319)	
S319B	—	(Part of S319)	
S319C	—	(Part of S319)	
S320	*N17-S-56382-9051	SWITCH, push: 3 contacts normally closed by spring-loaded shorting disc; momentary; (for replacement use spare part for S318 and shaft from S320); FTRC dwg #503-8466-003.	Grounds secd wnd of T401; door operated
S320A	—	(Part of S320)	
S320B	—	(Part of S320)	
S320C	—	(Part of S320)	
S321	—	Same as S320.	DC grounding; door operated
S321A	—	(Part of S321)	Gnds HV DC line

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
S321B	—	(Part of S321)	Gnds bias DC line
S321C	—	(Part of S321)	Gnds LV DC line
S322	—	Same as S318	DC grounding; door operated
S322A	—	(Part of S322)	Gnds HV DC line
S322B	—	(Part of S322)	Gnds bias DC line
S322C	—	(Part of S322)	Gnds LV DC line
S323	—	Same as S318	DC grounding; door operated
S323A	—	(Part of S323)	Gnds HV DC line
S323B	—	(Part of S323)	Gnds bias DC line
S323C	—	(Part of S323)	Gnds LV DC line
S324	329863-42A N17-S-70412-4406 3360-395853395	SWITCH, toggle: SPST; JAN type ST-42A; 125 v AC 15 amp, 0.75 amp DC; 250 v AC 6 amp, 0.5 amp DC; 30 v DC 20 amp; locking; 15 amp momentary; spec JAN-S-23.	Automatic shutdown on-off
S401	N17-S-67096-7382	SWITCH, rotary: 8 pole, 4 position, 4 throws, 8 decks; 100 amp. 500 v AC; 19 phosphor bronze cont; stator and rotor phenolic; non-shorting cont; 63/4" square black phenolic front escutcheon plate with symbols "Δ", "Y", "O" and "Y" engraved in white at 3, 6, 9 and 12 o'clock positions, respectively; CBKO #9013-A.	Delta-wye switch
S401A	N17-R-95021-1046	ROTOR, switch: phosphor bronze, phenolic ins; 100 amp, 500 v cont; 3 pos; CBKO#9013-2.	Part of S401
S401B	N17-R-95021-1047	ROTOR, switch: phosphor bronze, phenolic ins; 100 amp, 500 v cont; 2 pos; CBKO#9000-32.	Part of S401
S401C	N17-C-82137-5001	TERMINAL, lug: straight flat type; spring temper phosphor bronze; T shape, 23/8" lg x 15/8" wd x 13/64" h o/a; 11/32" hole for lug and wire; CBKO #9004-3.	Part of S401
S501	N17-S-65209-6221	SWITCH, rotary: 6 pole, 3 position, 2 sections; 71/2 amp at 115 v, 60 cps; solid silver cont; seatite stator and rotor; non-shorting cont; CBN#2V-10487.	Keying selector
S501A	—	(Part of S501)	
S501B	—	(Part of S501)	
S501C	—	(Part of S501)	
S501D	—	(Part of S501)	

S502	N17-S-65221-1901	SWITCH, rotary: 6 pole, 4 position, 2 sections; 7½ amp at 115 v, 60 cps; solid silver cont; steatite stator and rotor; non-shorting cont; shaft ¼" diam x 7/8" lg; CBN#2V-10488.	Keying input
S502A	—	(Part of S502)	
S502B	—	(Part of S502)	
S502C	—	(Part of S502)	
S502D	—	(Part of S502)	
S502E	—	(Part of S502)	
S503	—	Same as S314	Circuit selector for M505 and M506
S503A	—	(Part of S503)	
S503B	—	(Part of S503)	
S503C	—	(Part of S503)	
S503D	—	(Part of S503)	
S504	N17-S-62279-2731 3360-395390004	SWITCH, rotary: 3 pole, 5 position; 7½ amp at 115 v, 60 cps; solid silver cont; steatite stator and rotor; non-shorting cont; shaft ¼" diam x 7/8" lg; FTRC dwg #259-0129-00.	Circuit selector for M507
S505	N17-S-59672-7761	SWITCH, rotary: SPDT; silver pl cont; aluminum case; 9½" lg x 5¾" wd x 5¼" d o/a; shorting type cont; flexible coupling, 9/32" diam shaft; FTRC dwg #504-2087-004.	RF line meter (M503) shorting
S505A	3Z7585-5 N17-R-95021-1045 3360-394400970	ROTOR, switch: silver pl brass; fan shaped; 2" lg radius x 60 deg; single 0.252" diam mtg hole; FTRC dwg #504-2078-002.	Part of S505
S505B	—	Same as E640	Part of S505 (qty 6)
S505C	2Z8202.21 N16-C-92356-8064 1760-295558608	COUPLING, flexible: insulated; for ¼" shafts ea end; c/o cyl ceramic spacer with phosphor bronze disc spring and brass cross-arms and hub ea end; 1-1/16" diam x 3-7/32" lg o/a; ea hub 2 fil hd set screws 90° apart; CNA #TX-2 mod per FTRC dwg #015-0130-00.	Part of S505
S506	—	Same as S505	RF line meter (M504) shorting
S506A	—	Same as S505A	Part of S506
S506B	—	Same as E640	Part of S506
S506C	—	Same as S505C	Part of S506
S507	*N17-S-56382-8351	SWITCH, push: Navy type -241433, 3 cont normally closed by shorting disc; momentary, normally closed cont; (for replacement use Std Navy Stock Number N17-S-56382-9001 (S318) and shaft from switch being replaced); FTRC dwg #503-9281-003.	DC grounding; door operated
S507A	—	(Part of S507)	Gnds HV DC line
S507B	—	(Part of S507)	Gnds bias DC line
S507C	—	(Part of S507)	Gnds LV DC line

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
S508	— *N17-S-58044-5501	SWITCH, push: 3 cont normally closed by shorting disc; momentary normally closed cont; (for replacement use Std Navy Stock Number N17-S-56382-9001 (S318) and shaft from switch being replaced; FTRC dwg #504-1271-003.	DC grounding; door operated
S508A	—	(Part of S508)	Gnds HV DC line
S508B	—	(Part of S508)	Gnds bias DC line
S508C	—	(Part of S508)	Gnds LV DC line
S509	—	Same as S508	DC grounding; door operated
S509A	—	(Part of S509)	Gnds HV DC line
S509B	—	(Part of S509)	Gnds bias DC line
S509C	—	(Part of S509)	Gnds LV DC line
S510	—	Same as S307	Emergency shut-down and fil on-off
S511	3Z9823-25.2 N17-S-69556-6901 3360-395304602	SWITCH, sensitive: Navy type -241432; SPDT; 5 amp, 250 v AC; oper torque 4 gram-inches; momentary action; CMU#V4-14.	Air interlock'
S512	N17-S-63648-8151	SWITCH, rotary: 6 contacts, 4 positions; 10 amps, 125 v AC; zinc pl copper contacts and rotor blades; shaft 1/4" diam x 29/32" lg FMS; non-shorting cont; CBKO#8407-C.	T505 primary tap selector
S513	—	Same as S512	T506 primary tap selector
S514	—	Same as S311	Door interlock
S515	—	Same as S311	Door interlock
S516	—	Same as S311	Door interlock
S517	—	Same as S311	Door interlock
S518	3Z9558-39.3 N17-S-69036-1610 3360-395033170	SWITCH, sensitive: SPDT; JAN type SSO5A10; 6-8 v at 20 amp, 12-14 v at 20 amp, 24-30 v at 2 amp, 110-115 v at 0.4 amp, 220-230 v at 0.2 amp; spec JAN-S-63.	Exciter interlock
S519	—	Same as S309	HV on
S520	—	Same as S308	HV off
S521	—	Same as S316	Local test key
S522	3Z9823-25.1 N17-S-69524-3501 3360-395304601	SWITCH, sensitive: SPDT; 15 amp 125 v, 5 amp 250 v, 3 amp 460 v, 2 amp 600 v; locking action, one cont normally closed, one normally open; CUM #MB-317.	Limit motor travel B502
S523	—	Same as S522	Limit motor travel B502
S701	3Z9823-25.3 N17-S-68271-6101 3360-395304603	SWITCH, sensitive: Navy type -241444; SPDT; 1/2 HP at 115 or 230 v AC; cont rated 10 amp; normally open; CG#CR1070C130-J4.	Limit motor travel (1' ea, 5 units); Used with Z701, Z702, Z703, Z705 and Z706.

S702	—	Same as S701	Limit motor travel (1 ea, 5 units); Used with Z701, Z702, Z703, Z705 and Z706.
S1001	3Z9863-52N N17-S-73959-1025 3360-395853615	SWITCH toggle: DPDT; JAN type ST52N; 30 amp continuous rating; spec JAN-S-23.	AC primary pwr ON-OFF
S1002	—	SWITCH ASSEMBLY: Consists of switches S1002A and S1002B mechanically coupled by metal bar.	Changeover from 115v to 230v operation
S1002A	—	Same as S1001	Part of S1002
S1002B	—	Same as S1001	Part of S1002
S1003	N17-S-61497-1459	SWITCH, rotary: 5 position; 2 ckt; silver plated brass term; ceramic body; non-shorting; shaft 1/4" diam x 3/8" lg; COC#39654-HIC.	Circuit selector for M1001
S1003A	—	(Part of S1003)	
S1003B	—	(Part of S1003)	
S1101	3Z9695-17.3 N17-S-69906-5356 3300-395246953	SWITCH, thermostatic: open at 82°C, ±2°C; closing differential 6°C min below; 2 amps at 12.5 v AC or DC, 0.75 amps at 115 v AC or DC; metal housing; bimetallic; Steven Co #CM Special.	Crystal oven thermostat (Part of Z1101)
S1102A	N17-S-91897-8769	SWITCH SECTION, rotary: single steatite wafer, and rotor; for 1/4" wd x 3/16" thk shaft; 1 pole, 11 positions; silver pl brass cont, non-shorting; oval shape, FTRC dwg #FRE-30814-1B. Per USN spec #16-S-19.	Crystal selector (Part of Z1101)
S1102B	N17-S-91697-1054	SWITCH SECTION, rotary: Isolantite wafer, spring silver alloy cont; single ckt, 11 positions; FTRC dwg #FRE-30814-1B.	Crystal trimmer selector (Part of Z1101)
S1103	N17-S-61164-9229	SWITCH, rotary: 2 pole 3 position; silver pl brass cont; stator and rotor ceramic; non-shorting cont; shaft 3/4" lg x 7/32" diam; COC#24270-HIC.	Metering osc & buffer cathodes (M1101)
S1401	N17-S-60581-1901	SWITCH, rotary: 1 pole, 11 position, single sect; spring brass silver pl cont; ceramic stators and rotors; shorting type cont; 1/4" diam x 7/8" lg shaft; COC-#40478-HIC.	Ext osc input attenuator switch
S1402	N17-S-62011-1461	SWITCH, rotary: 3 pole, 2 position; single section; spring silver alloy cont; ceramic rotor and stators; shorting type cont; 1/4" diam x 7/8" lg shaft, FTRC dwg #259-0368-00.	Metering grid-plate of V1404 (M1401)
S1403	—	Same as S1003	Test-operate switch
S1403A	—	(Part of S1403)	Test-operate switch
S1403B	—	(Part of S1403)	Test-operate switch
S1404	N17-S-64847-9401	SWITCH, rotary: 3 pole, 4 position; 2 sect; spring brass silver pl cont; ceramic stators and rotors; non-shorting type cont; 1/4" diam x 7/8" lg shaft; FTRC dwg #259-0366-00.	Wave shaping switch
S1404A	—	(Part of S1404)	Wave shaping switch
S1404B	—	(Part of S1404)	Wave shaping switch
S1404C	—	(Part of S1404)	Wave shaping switch
S1405	N17-S-60129-3161	SWITCH, rotary: 1 pole, 4 throws 4 position; single sect; spring silver alloy cont; ceramic stators and rotors; non-shorting type cont; 1/4" diam x 1 1/2" lg shaft; COC#40480-HIC.	Transmitter multiplication switch

* Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n't'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
S1406	3Z9695-17.4 N17-S-69906-5256 3300-395246954	SWITCH, thermostatic: SPST; opens at 71°C, $\pm 2^\circ\text{C}$; closing differential 6° min below; 0.75 amps, 115 v AC or DC, 2 amps 12.5 v AC or DC; Stevens Co. #CM.	Limits oven temp to 70°C
S1407	3Z9695-17.5 N17-S-69906-5456 3300-395246955	SWITCH, thermostatic: SPST; opens at 90°C, $\pm 2^\circ\text{C}$; closing differential 6° min below; 0.75 amp, 115 v AC or DC, 2.0 amp 12.5 v AC or DC; Stevens Co. #CM.	Limits oven temp to 90°C if S1406 fails to operate
S1408	—	SWITCH: (Part of R1485)	Phase modulation switch
S1409	N17-S-59272-7049	SWITCH, rotary: 3 pole, 2 position; spring silver alloy cont; ceramic body; shorting type cont; COC#39823-HIC.	Plate ON-OFF switch
T101	N16-C-76321-1586	COIL, RF: variable; 10-22.5 mc IF; single wdg, single layer wnd; rectangular alum shield can; phenolic form, powdered iron core with scdr adj through top of can; 11 turns #26 H.E. copper wire; CAI #41-463.	Plate tank V104
T102	—	Same as T101	Plate tank V105
T103	N17-T-81731-1167	TRANSFORMER, IF: variable Navy type -472516; 450 kc IF; 2 pie universal wnd; rectangular alum shield can; phenolic form, powdered iron core in top (pri) wdg, with scdr adj through top of can; primary pie 300 turns, sec'd pie 150 turns, both #36SSE copper wire; incl capacitor C124 across pri wdg; CAI #41-464.	450-kc output in plate of V106
T104	N16-C-76635-4341	COIL, RF: variable 2-4.5 mc IF; single wdg, single layer wnd; rectangular alum shield can; 23.4 μh ; pwd iron core with scdr adj thru top of can; 75 turns #30 DE copper wire at 86 T.P.I.; CAI #41-465.	Plate tank V112
T105	—	Same as T101	Plate tank V115
T106	N17-T-81716-1167	TRANSFORMER, IF: variable; Navy type -472517; 875-900 kc RF; 2 pie universal wnd; rectangular alum shield can; phenolic form; separate pwd iron cores with scdr adj in pri (top) and sec'd wdg, pri adjust thru top of can, sec'd at bottom; pri and sec'd wdg ea 100 turns #38 SSE wire in 1 pie; incl capacitors C132 and C133 in parallel across pri wdg and C134, C135 in parallel across sec'd; CAI #41-466.	Interstage coupling V108 to V109
T107	—	Same as T106 (includes C137, C138, C139, C140).	Interstage coupling V109 to V110
T108	N17-T-67710-4267	TRANSFORMER, IF: Same as T106, except tuned to 800 kc, and incl capacitors C142 and C143 across pri, and C144, C145 across sec'd; CAI #41-467.	2nd IF interstage coupling V110 to V111
T109	—	Same as T108 (includes C147, C148, C149, C150).	Coupling V111 to V127
T110	N16-F-44278-4358	FILTER, low pass: Navy type -53560; 100 kc cut-off; high input and output impedance; rectangular alum shield can; incl capacitors C160, C161, C162, R169 and R170; CAI #37-262.	Low-pass between V115 and V110

T111	2Z9629-308 N17-T-81731-1383 3340-296950808	SUBASSEMBLY: Navy type -472515; c/o two 100 kc tuned IF output wdg, plus one coupling wdg; in rectangular alum shield can; wdg ea 1 pie #36 SSE copper wire universal wdg; wdg #1 500 turns, wdg #3 150 turns, coupling (#2) 300 turns with grnd CT; wdg #1 and #2 on phenolic form with pwr iron core and scdr adj thru top of can; wdg #3 on second phenolic form with pwr iron core and scdr adj at bottom; capacitors C192 and C211 across wdg #1, and C196, C197 across wdg #3; CAI #41-468.	Plate tanks for V127 and V128; also coupling V127 to V125 and V126
T112	N17-T-81749-1011	TRANSFORMER, variable IF: Navy type -472514; 100 kc double tuned; 2 pie universal wdg; rectangular alum shield can; pri pie 500 turns #36 SSE copper wire on phenolic form with powdered iron core and scdr adj thru bottom of can; scd pie same except separate form and core and adj thru top of can; capacitor C185 across pri (terms 1 and 3), C186 across scd (terms 4 and 6); electrostatic shield ea wdg; CAI #41-469.	Phase shift for driving V123 and V124
T113	N17-T-81320-1103	TRANSFORMER, IF: 2-4.5 mc IF output; 2 wdg, ea single layer wdg; rectangular alum shield can; inner wdg (terms #3 and #4) 45 turns #30 DE copper wire on tubular Bakelite form (0.560" OD x 0.593" lg); outer wdg (terms #1 and #2) 6 turns #30 DE copper wire; 0.005" Fiberoil between wdg; form and wdg encased in pwr iron half shells; CAI #41-470.	RF Output coupling V114 to J108
T301	2Z9600-162 N17-T-72970-2302 3340-296833751	TRANSFORMER, power: Navy type -304891; fil type; input 220 v, 230 v, 240 v, 50/60 cps, single ph; one output wdg; scd 5 v at 10 amp CT; pri 2500 v test; scd 15KV test; CTR spec #12635, dwg #MD-4137.	HV rectifier (V301) filament
T302	_____	Same as T301	HV rect (V302) fil
T303	_____	Same as T301	HV rect (V303) fil
T304	_____	Same as T301	H rect (V304) fil
T305	_____	Same as T301	HV rect (V305) fil
T306	_____	Same as T301	HV rect (V306) fil
T307	N17-T-72969-4323	TRANSFORMER, power: Navy type -304886; fil type; input 220 v, 230 v, 240 v, 50/60 cps, single ph; one output wdg; scd 2.5 v at 10 amp CT; compound filled; pri test 2500 v, scd test 10 KV; CTR spec #9753, dwg #MD-4130.	LV rectifier (V307, V308) filaments
T308	_____	Same as T307	Bias rect (V309, V310) fil
T309	N17-T-78160-1001	TRANSFORMER, power: Navy type -304889; plate type; input 208 v, 230 v, 50/60 cps, single ph; one output wdg; scd 1410 v at 0.520 amp CT; compound filled; pri test 2500 v, scd test 3000 v; semi-sealed metal case; CTR spec #9754-A, dwg #MD-4131.	LV rectifier (V307, V308) plates
T310	N17-T-78159-6001	TRANSFORMER, power: Navy type -304890; plate type; input 208 v, 230 v, 50/60 cps, single ph; one output wdg; scd 940 v at 0.800 amp CT; compound filled; pri and scd test ea 2500 v; CTR spec #12634, dwg #MD-4136.	Bias supply rectifier (V309, V310) plates
T311	N17-T-76695-4703	TRANSFORMER, power: Navy type -304896; fixed autotransformer; input 195-255 v, 57-63 cps, single ph; single output 230 v $\pm 3\%$, 0.958 amps; 0.25 kva at 84% load P.F.; 1500 v test; CSY #6040.	Regulation of AC primary voltage for T305-T307, T502, T503
T312	_____	Same as T311	Regulation of AC primary voltage for T301-T304 and T308
T313	N17-T-76695-4725	TRANSFORMER, power: 1 phase; pri 195-255 v, 57-63 cps; scd 230 v $\pm 3\%$, 1.2 amps, PF 95%, 275 VA; 1500 v test; air cooled to permit cont operation with pri energized and no load in scd; encl metal case; CSY #6090.	Regulation of AC primary voltage for Pwr Supply PP-454A/FRT-5

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'y'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
T401	N17-T-78219-9001	TRANSFORMER, power: AN type TF-122/U; Navy type -304900; rectifier plate type; input 215-230-245 v, 57-63 cps, 3 phase, delta connected; single output, 4450 v at 3.26 amps RMS, wye connected; 8.66 kv ins test; CAY # S.O. 19-U-230, dwg #11-C-4260.	HV Plate Supply
T501	N16-C-74031-6453	COIL, RF: Navy type -472507; choke; single wdg, 1 pie universal wnd; unshielded; 280 μ hy tapped at 152 μ hy; 200 turns #30 SSE copper wire with leads brought out at 50th and 100th turns and reconnected so wdg starts at turn #50; ceramic rod form and core, CAI #7-800.	V501 grid RF choke
T502	2Z9604-17 N17-T-72780-8493 3340-296848000	TRANSFORMER, power: Navy type -302298; fil type input 210 v, 220 v, 230 v, 240 v, 250 v, 50/60 cps, single ph; one output wnd; sec'd 6.3 v at 5.0 amp CT; 2500 v; varnish impr, compound filled; pri and sec'd test ea 2500 v; HS metal case; CTR spec #6504-A, dwg #MD-4128.	V501, V502, V503 and V507 filaments
T503	N17-T-72970-3154	TRANSFORMER, power: Navy type -304887; fil type input 220 v, 230 v, 240 v, 50/60 cps, 2500 TV, 72.5 va; 1 output wnd; sec'd 5.0 v CT, 14.5 amp, 2500 TV, 72.5 va; vacuum impr, compound filled, semi-sealed metal case; CTR spec #9762, dwg #MD-4132.	Driver (V504) filament
T504	—	Not Used	
T505	N17-T-69142-6801	TRANSFORMER, power: Navy type -304897; fil type; input 245 v, 60 cps, tapped for 22v, 200v, 215v, 230v and 245v; 681 va at 60% PF; 1 output wdg, 7.5 v CT, 48 amps (100 amps max short circuit); pri wdg 245 turns #14E copper wire, 0.75 ohms DC resistance, 2500 v test; sec'd wdg 12 turns 2 x #6 sq DCC copper wire, 0.024 ohms DC resistance, 5000 v test; FTRC dwg #FT-04-2382-12C.	PWR amplr (V505) filament
T506	—	Same as T505	Pwr-amplr (V506) filament
T801	N17-T-61003-7001	TRANSFORMER, AF: Navy type -304899; input type; c/o two identical transformers on same core in humbucking arrangement; each pri 475 turns #33 E wire, 18.3 ohms DC resistance, 1600 v RMS test, 125 ohms impedance; pri wdg in series 20 hys max at lv RMS, 60 cps; each sec'd 6000 turns #44SF wire, 3740 ohms DC resistance, 500 v RMS test; sec'd wdg in series 100,000 ohms CT; FTRC dwg FT-07-2385-2C.	Servo amplr Input (1 ea, 6 units)
T901	—	Same as T502	Fil pwr for Z901
T902	2Z9600-166 N17-T-76099-1001 3340-298833755	TRANSFORMER, power: Navy type -304893; fil type; input 208 v, 239 v, 50/60 cps, single ph; 3 output wnd; sec'd #1, 250 v at 20 ma, CT; sec'd #2, 300 v at 120 ma, sec'd #3, 30 v at 360 ma; pri and sec'd test ea 2500 v; vacuum impr, compound filled; encl drawn steel case; CTR spec #12874, dwg #MD-4139.	Plate pwr for Z901
T903	N17-T-72726-6501	TRANSFORMER, power: Navy type -304894; fil type; input 208 v, 230 v, 50-60 cps, single ph; 1 output wnd; sec'd 50, 65, 80, 100, 115, 130 v at 1.0 amp; pri and sec'd test ea 2500 v; CTR spec #12875, dwg #MD-4140.	Motor supply for Z1401
T1001	2Z9612-333 N17-T-73673-8517 3340-296889447	TRANSFORMER, power: Navy type -304884; plate; input 2 pri wnd both rated 125 v tapped to operate at 105 v, 115 v, 125 v, 210 v, 230 v or 250 v, 50/60 cps, single ph; 3 output wnd; sec'd #1, 720 v CT, 280 ma, sec'd #2, 6.3 v, 8.5 amps, sec'd #3, 5 v, 4 amps; 1500 v insulation; CUD #A6522; spec JAN-T-27A. 27A.	Master oscillator power supply

T1002	N17-T-73674-9077	TRANSFORMER, power: Navy type -304885; plate; input 2 pri wnd, ea rated 125 v, tapped to operate at 105 v, 115 v, 125 v, 210 v, 230 v & 250 v, 50/60 cps single ph; 4 output wnd; sec'd #1, 740 v CT, 210 ma, sec'd #2, 6.3 v 0.6 amp, sec'd #3, 6.3 v, 6.0 amp, sec'd #4, 5 v 2 amp; 1500 v insulation; CUD #A6523; spec JAN-T-27A.	Power supply for Freq. Shift Keyer KY-45A/FRT-5
T1101	N17-T-70758-8001	TRANSFORMER, power: Navy type -304975; fil type; input 115 v, 210 v, 220 v, 230 v, 240 v, 50/60 cps, single ph; 1 output wnd; sec'd 12.6 v at 2.5 amp CT; pri and sec'd test ea 2500 v; CTR spec #11329, dwg #MD-4134.	Crystal heater and fil supply
T1102	—	Same as T501	RF output, cathode V1102
TB101	*N17-B-78082-8082	BOARD, terminal: general purpose; 16 feed-thru solder lug term staked to phenolic board, and spaced 17/64" c to c; 2 3/8" lg x 1 5/8" wd x 7/16" thk o/a; FTRC#dwg FRP-30858-14-17.	Mtg board for C179, C180-C182, R213-R216
TB102	*N17-B-77983-9890	BOARD, terminal: general purpose; 12 feed thru solder lug term staked to phenolic board and spaced 9/32" c to c; 2 3/8" lg x 1 5/8" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-13.	Mtg board for R201-R206
TB103	*N17-B-78327-7617	BOARD, terminal: general purpose; 55 feedthru solder lug term staked to phenolic board; term irregularly spaced; 6 3/4" lg x 1 7/8" wd x 7/16" thk o/a; FTRC #FRP-30858-14-12.	Mtg board for C102A, & B, C104-C108, C110-C113, C115, C122, R102-R122, R130, R133
TB104	*N17-B-78178-4669	BOARD, terminal: general purpose; 24 feedthru solder lug term staked to phenolic board; term irregularly spaced; 4-13/16" lg x 1-13/16" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-16.	Mtg board for C130, R142, R144-R146, R148, R149, R151, R152, R154, R198, R141
TB105	*N17-B-78292-5235	BOARD, terminal: general purpose; 44 feedthru solder lug term staked to phenolic board; term irregularly spaced; 5-7/16" lg x 2 1/2" wd (incl 1/2" lugs) x 7/16" thk o/a; 2 spade lugs riveted to board for mtg; FTRC dwg #FRP-30858-14-14.	Mtg board for C163-C165, C-167-C169, C171-C174, C176, R171-R195
TB106	*N17-B-78207-2421	BOARD, terminal: general purpose; 27 feedthru solder lug term staked to phenolic board; term irregularly spaced; 4 5/8" lg x 1 7/8" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-15.	Mtg board for C183, C184, C188-C191, C194, C195, R217-R221, R224, R226, R228, R229, R232, R233
TB501	*N17-B-78232-9870	BOARD, terminal: mts resistors; 32 feedthru lug term staked to phenolic board; term 7/16" between ctr; 7 7/8" lg x 2 3/8" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-11.	Mtg board for R549, R597, R598, R599-R609, R611
TB1001	*N17-B-77738-2903	BOARD, terminal: mts resistors; 6 feedthru solder term staked on 3/4" thk lam phenolic board, 3 term ea side, on 1-11/16" x 3/8" ctrs; 2 7/8" lg x 1 3/4" wd x 7/16" thk o/a; FTRC dwg #FRP-30550-1.	Mtg board for R1001, R1003, R1005
TB1401	*N17-B-77933-7078	BOARD, terminal: resistor mtg; 10 feedthru solder lug terms staked to phenolic board; terms irregularly spaced; 2-5/16" lg x 2" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-5.	Mounts R1417, R1418, R1426, R1427, R1431
TB1402	*N17-B-77984-2249	BOARD, terminal: component mtg; 12 feedthru solder lug terms staked to phenolic board; 2 rows of 6 terms, rows spaced 1 1/4" c to c, terms 5/16" c to c; 2 1/2" lg x 1 3/4" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-6.	Mounts C1410, C1411, R1422-R1425
TB1403	*N17-B-77835-8913	BOARD, terminal: component mtg; 2 rows of 4 feedthru solder lug terms staked to phenolic board, rows spaced 1 1/4" c to c, terms 5/16" c to c; 2" lg x 1 3/4" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-7.	Mounts C1401, R1413, R1414, R1415
TB1404	*N17-B-78241-8205	BOARD, terminal: component mtg; 34 feedthru solder lug terms staked to phenolic board; terms irregularly spaced; 3-3/16 lg x 3-1/16" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-2.	Mounts C1448-C1454, L1418, L1419, R1476-R1483

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
TB1405	_____ *N17-B-78138-2456	BOARD, terminal: component mtg; 20 feedthru solder lug term staked to phenolic board; term irregularly spaced; 4-5/16" lg x 3" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-4.	Mounts L1413, R1434, R1436-R1438, R1440, R1441, R1445, R1447, R1484, R1486, R1487
TB1406	_____ *N17-B-77737-9088	BOARD, terminal: component mtg; 6 feedthru solder lug term staked to phenolic board; term irregularly spaced; 2 3/4" lg x 1 5/8" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-9.	Mounts C1414, C1415, L1409
TB1407	_____ *N17-B-77985-5227	BOARD, terminal: component mtg; 12 feedthru solder lug term staked to phenolic board; 3-9/16 lg x 3" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-1.	Mounts C1420-C1427
TB1408	_____ *N17-B-77836-1287	BOARD, terminal: component mtg; 8 feedthru solder lug term staked to phenolic board; 2 rows of 4 terms; rows spaced 1 1/4" c to c; terms 3/8" c to c; 2" lg x 1 5/8" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-10.	Mounts C1432, C1433, R1456, R1457
TB1409	_____ *N17-B-78177-7790	BOARD, terminal: component mtg; 24 feedthru solder lug term staked to phenolic board; 6 rows of 4 terms; rows spaced 5/16" c to c; terms irreg spaced; 3-9/16" lg x 1-15/16" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-6.	Mounts C1428-C1431, R1449, R1451-R1455
TB1410	_____ *N17-B-78232-1304	BOARD, terminal: component mtg; 32 feedthru solder lug term staked to phenolic board; 8 rows equally spaced, 4 term irregularly spaced per row; 4 1/8" lg x 2-9/16" wd x 7/16" thk o/a; FTRC dwg #FRP-30858-14-3.	Mounts C1437-C1439, C1441, C1443, C1444, C1446, C1447, R1466, R1468-R1473, R1488
V101	2J2C51 N16-T-52351 3300-234190475	TUBE, electron: JAN-2C51; twin triode; spec JAN-1A.	100-kc crystal osc and amplr
V102	_____ _____	Same as V101	50-kc divider
V103	_____ _____	Same as V101	25-kc divider
V104	2J6AK5 N16-T-56191 3300-234450000	TUBE, electron: JAN-6AK5; pentode; spec JAN-1A.	1st harmonic amplifier
V105	2J6AS6 N16-T-56201 3300-234454100	TUBE, electron: JAN-6AS6; pentode; spec JAN-1A.	2nd harmonic amplifier
V106	_____ _____	Same as V104	450-kc amplifier
V107	_____ _____	Same as V104	100-kc amplifier
V108	2J6BE6 N16-T-56211-50 3300-234473050	TUBE, electron: JAN-6BE6 pentagrid; spec JAN-1A.	Mixer in 1st IF
V109	_____ _____	Same as V104	Amplifier in 1st IF
V110	_____ _____	Same as V108	Mixer in 2nd IF

V111	—	Same as V104	Amplifier in 2nd IF
V112	—	Same as V108	Buffer amplifier
V113	—	Same as V104	10 to 22.5-mc multiplier
V114	2J5686 N16-T-75686 3300-235793506	TUBE, electron: pentode; CRP#5686.	2 to 4.5-mc multiplier
V115	—	Same as V101	75 to 100-kc divider
V116	—	Same as V101	150 to 200-kc divider
V117	—	Same as V101	300 to 400-kc divider
V118	—	Same as V104	Interpolation buffer
V119	—	Same as V114	Power amplifier
V120	—	Same as V114	Power amplifier
V121	—	Same as V114	Power amplifier
V122	—	Same as V114	Power amplifier
V123	—	Same as V101	DC amplifier
V124	—	Same as V101	DC amplifier
V125	2J6AL5 N16-T-56195 3300-234452000	TUBE, electron: JAN-6AL5; twin diode; spec JAN-1A.	Diode mixer
V126	—	Same as V125	Diode mixer
V127	—	Same as V108	Regenerative Divider
V128	2J6BA6 N16-T-56211 3300-234473000	TUBE, electron: JAN-6BA6; pentode; spec JAN-1A.	Regenerative Divider
V129	—	Same as V104	100-kc amplifier
V130	N16-T-56665	TUBE, electron: JAN-6SJ7; triple-grid detector amplr (Part of Z101: for maintenance replace complete Z101); spec JAN-1A.	600 to 800-kc oscillator
V131	—	Same as V130 (Part of Z102: for maintenance replace complete Z102).	Master oscillator
V301	2J4B32 N16-T-54232 3300-234310015	TUBE, electron: JAN-4B32; rectifier; spec JAN-1A.	HV rectifier
V302	—	Same as V301	HV rectifier
V303	—	Same as V301	HV rectifier
V304	—	Same as V301	HV rectifier
V305	—	Same as V301	HV rectifier
V306	—	Same as V301	HV rectifier

*Not furnished as a maintenance part. In event of failure, this item should be repaired or a new part fabricated.

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
V307	2J3B28 N16-T-53228 3300-234240600	TUBE, electron: JAN-3B28; rectifier; spec JAN-1A.	LV rectifier
V308	—	Same as V307	LV rectifier
V309	—	Same as V307	Bias rectifier
V310	—	Same as V307	Bias rectifier
V501	2J6AG7 N16-T-56177 3300-234445000	TUBE, electron: JAN-6AG7; video power amplifier; pentode; spec JAN-1A.	2nd buffer
V502	2J807 N16-T-68070 3300-235425000	TUBE, electron: JAN-807; transmitting type beam power amplifier; spec JAN-1A.	1st frequency multiplier
V503	—	Same as V502	2nd frequency multiplier
V504	2J4-400A N16-T-54067 3300-234275135	TUBE, electron: tetrode; 400 w plate dissipation; CIM#4-400A.	Driver
V505	2J3X2500A N16-T-53990 3300-234275115	TUBE, electron: triode; CIM#3X2500-A.	Power amplr #1
V506	—	Same as V505	Power amplr #2
V507	2J12AU7 N16-T-58241 3300-234982300	TUBE, electron: JAN-12AU7; twin triode; spec JAN-1A.	Keyer
V801	2J12AX7 N16-T-58241-60 3340-234924400	TUBE, electron: JAN-12AX7; twin triode; spec JAN-1A.	Input stage (1 ea, 6 units)
V802	—	Same as V507	Output stage (1 ea, 6 units)
V901	2J6X4 N16-T-56840 3300-234804500	TUBE, electron: JAN-6X4; twin diode; spec JAN-1A.	Rectifier for Z901
V1001	2J5R4GY N16-T-55444 3340-234355000	TUBE, electron: JAN-5R4GY; rectifier; spec JAN-1A.	Rectifier
V1002	—	Same as V1001	Rectifier
V1003	—	Same as V901	Rectifier
V1004	—	Same as V1001	Rectifier
V1005	2J0A2 N16-T-52001 3300-234005100	TUBE, electron: JAN-OA2; voltage regulator; spec JAN-1A.	Voltage regulator

V1006	—	Same as V1005	Voltage regulator
V1101	—	Same as V104	Crystal oscillator
V1102	—	Same as V501	Buffer
V1103	2JOB3/VR-90 N17-T-53040 3300-234006300	TUBE, electron: JAN-OB3/VR-90; spec JAN-1A	Voltage regulator
V1104	—	Same as V1103	Voltage regulator
V1301	—	Same as V901	Rectifier for Z1303 and Z1304 (1 ea, 2 units)
V1302	—	Not Used	Rectifier for Z1301 and Z1302 (1 ea, 2 units)
V1303	—	Same as V901	Balanced modulator
V1401	—	Same as V108	Balanced modulator
V1402	—	Same as V108	Buffer
V1403	—	Same as V128	Power amplr
V1404	—	Same as V502	Limiter
V1405	2J6AL5W N16-T-56195-50 3300-234452100	TUBE, electron: JAN-6AL5W; double diode; spec JAN-1A.	Limiter
V1406	—	Same as V1405	Phase osc modulation
V1407	2J6AK5W N16-T-56191-50 3300-234450100	TUBE, electron: JAN-6AK5W; pentode; spec JAN-1A.	Balanced keyer
V1408	—	Same as V507	Phase shifting amplr
V1409	2J6C4 N16-T-56214 3300-234475000	TUBE, electron: JAN-6C4; triode; spec JAN-1A.	Phase shifting amplr
V1410	—	Same as V128	200-kc osc
V1411	—	Same as V128	Phase inverter
V1412	—	Same as V801	Holder for F101
XF101	N17-F-74267-5075 8800-619660	FUSEHOLDER: extractor post type; for single 3AG cartridge fuse; bakelite; 5 amp, 125 v; threaded body for panel hole mtg; CFA type HKP.	Holder for F102 Mounts F301 Mounts F302 Mounts F303 Mounts F304
XF102	—	Same as XF101	
XF301	—	Same as XF101	
XF302	—	Same as XF101	
XF303	—	Same as XF101	
XF304	—	Same as XF101	

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
XF305	—	Same as XF101	Mounts F305
XF306	—	Same as XF101	Mounts F306
XF307	—	Same as XF101	Mounts F307
XF308	—	Same as XF101	Mounts F308
XF401/ XF402	— N17-F-7379-2201 8800-574993-45	FUSEHOLDER: block type; for two 9/16" diam x 2" lg cartridge fuses; white porcelain; 250 v 30 amp; CBGZ#2965-30.	Single socket mounts both F401 and F402
XF403/ XF404/ XF405	— N17-F-73810-2991 8800-574993-48	FUSEHOLDER: block type; for three 13/16" diam x 3" lg cartridge fuses; white porcelain base w/6 #31-60 nat'l std clips; 250 v, 60 amp; CBGZ #2165-60-SP.	Single socket mounts F403 to F405 incl
XF501	—	Same as XF101	Mounts F501
XF502	—	Same as XF101	Mounts F502
XF503	—	Same as XF101	Mounts F503
XF901	—	Same as XF101	Mounts F901
XF902	—	Same as XF101	Mounts F902
XF903	—	Same as XF101	Mounts F903
XF1001	—	Same as XF101	Holder for F1001
XF1002	—	Same as XF101	Holder for F1002
XF1003	—	Same as XF101	Holder for F1003
XF1004	—	Same as XF101	Holder for F1004
XF1101	—	Same as XF101	Holder for F1101
XF1401	—	Same as XF101	Mounts F1401
XF1402	—	Same as XF101	Mounts F1402
XI301	— N17-L-51711-1936 8850-772400	LAMPHOLDER: double cont candelabra bayonet base socket; phenolic body; CAYZ#9S-4634-L46.	Mounts I301
XI302	—	Same as XI301	Mounts I302
XI303	—	Same as XI301	Mounts I303
XI304	— N17-L-76673-3807 7700-530062	LIGHT, indicator; without lens; for double cont candelabra bayonet base bulb; open frame; polished chrome; 11/16" max panel thk; horizontal mtg; lamp replaceable from front of panel; CAYZ#51702-1.	Mounts I304
XI304A	— N17-L-250065-560	LENS, indicator light: amber; threaded type; 1 1/8" OD x 3/4" lg o/a; lens, smooth glass rear frosted, 1" effective diam; bezel, brass, CAYZ #51-11-3.	Part of XI304

XI305	—	Same as XI304	Mounts I305
XI305A	—	LENS, indicator light: green: threaded type; 1 1/8" OD x 3/4" lg o/a; lens, smooth glass rear frosted, 1" effective diam; bezel, brass; CAYZ #51-11-2.	Part of XI305
XI306	N17-L-250389-501	Same as XI304	Mounts I306
XI306A	N17-L-250738-526	LENS, indicator light: red; threaded type; 1 1/8" OD x 3/4" lg o/a; lens, smooth glass, rear frosted, 1" effective diam; bezel brass; CAYZ #51-11-1.	Part of XI306
XI307	—	Not Used	
XI308	—	Not Used	
XI309	—	Same as XI304	Mounts I309
XI309A	—	Same as XI304A (amber)	Part of XI309
XI401	—	LIGHT, indicator: without lens or guard, medium screw base for 10 to 60 w lamp; open; galvanized iron base; vertical mtd; CASR #BOUZ-15-S.	Mounts I401
XI401A	N17-F-45361-1651	GLOBE, lighting fixture: glass body; for use with 10-60 w lamp; ruby globe only; cyl shape; CASR#BO-15-R.	Part of XI401
XI402	N17-G-76457-2281	Same as XI401	Mounts I402
XI402A	—	Same as XI401A	Part of XI402
XI501	—	Same as XI304	Mounts I501
XI501A	—	Same as XI305A (green)	Part of XI501
XI502	—	Not Used	
XI503	—	Not Used	
XI504	—	Not Used	
XI505	—	Same as XI304	Mounts I505
XI505A	—	Same as XI304A (amber)	Part of XI505
XI506	—	Same as XI304	Mounts I506
XI506A	—	Same as XI306A (red)	Part of XI506
XI507	—	Same as XI304	Mounts I507
XI507A	—	Same as XI304A (amber)	Part of XI507
XI508	—	Same as XI301	Mounts I508
XI509	—	Same as XI301	Mounts I509
XI510	—	Same as XI301	Mounts I510
XI511	—	Same as XI301	Mounts I511
XI512	—	Same as XI301	Mounts I512
XI1101	—	Not Used	

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'td)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
X11102	2Z5883-213 N17-L-76689-3956	LAMPHOLDER: miniature bayonet, amber; metal body with bakelite ins; CAYZ #PLN-844.	Holder for I1102
X11103	—	Same as X11102	Holder for I1103
XK322	2Z8678-149 N16-S-63511-6425 8850-893710	SOCKET, tube: Navy type -491479-A; octal; above chassis fl mtg; round mica filled phenolic body; phosphor bronze contacts silver pl and hot tin dipped; CPH#88-8TM.	Mounts K322
XV101	N16-S-64063-6718	SOCKET, tube: 9 cont miniature; JAN type TSE9T101; one piece brass saddle mtg; 3/4" diam chassis cutout required; round phenolic body; incl 0.180" OD metal ctr shield; silver pl copper cont; spec JAN-S-28A.	Socket for V101
XV102	—	Same as XV101	Socket for V102
XV103	—	Same as XV101	Socket for V103
XV104	N16-S-62603-6692	SOCKET, tube: 7 cont miniature; JAN type TSE7T101; one piece brass saddle mtg; 5/8" diam chassis cutout required; round phenolic body; incl metal ctr shield; silver pl copper cont; spec JAN-S-28A.	Socket for V104
XV105	—	Same as XV104	Socket for V105
XV106	—	Same as XV104	Socket for V106
XV107	—	Same as XV104	Socket for V107
XV108	—	Same as XV104	Socket for V108
XV109	—	Same as XV104	Socket for V109
XV110	—	Same as XV104	Socket for V110
XV111	—	Same as XV104	Socket for V111
XV112	—	Same as XV104	Socket for V112
XV113	—	Same as XV104	Socket for V113
XV114	—	Same as XV101	Socket for V114
XV115	—	Same as XV101	Socket for V115
XV116	—	Same as XV101	Socket for V116
XV117	—	Same as XV101	Socket for V117
XV118	—	Same as XV104	Socket for V118
XV119	—	Same as XV104	Socket for V119
XV120	—	Same as XV104	Socket for V120
XV121	—	Same as XV104	Socket for V121
XV122	—	Same as XV104	Socket for V122

XV123	—	Same as XV104	Socket for V123
XV124	—	Same as XV104	Socket for V124
XV125	—	Same as XV104	Socket for V125
XV126	—	Same as XV104	Socket for V126
XV127	—	Same as XV104	Socket for V127
XV128	—	Same as XV104	Socket for V128
XV129	—	Same as XV104	Socket for V129
XV130	—	Same as XK322 (Part of Z101; for maintenance replace complete Z101); CPH#88-8T.	Socket for V130
XV131	—	Same as XK322 (Part of Z102; for maintenance replace complete Z102).	Socket for V131
XV301	2ZK8759.9 N16-S-60935-9301 8850-771036	SOCKET, tube: Navy type -49424; 4 prong bayonet lock socket for use with 50 W base tubes; above chassis base mtg; round ceramic body, phosphor bronze cont; CEJ#211.	Mounts V301
XV302	—	Same as XV301	Mounts V302
XV303	—	Same as XV301	Mounts V303
XV304	—	Same as XV301	Mounts V304
XV305	—	Same as XV301	Mounts V305
XV306	—	Same as XV301	Mounts V306
XV307	2Z8663 N16-S-60856-2987 3300-295890000	SOCKET, tube: Navy type -49345; 4 prong med; above chassis base mtg; round ceramic body; phosphor bronze cad pl cont; CEJ#209.	Mounts V307
XV308	—	Same as XV307	Mounts V308
XV309	—	Same as XV307	Mounts V310
XV310	—	Same as XV307	Mounts V310
XV501	—	SOCKET, tube: Navy type -49367; octal; under chassis wafer mtg; oval ceramic body; phosphor bronze cad pl cont; CEJ#228.	Mounts V501
XV502	2Z8678.29 N16-S-63471-2924	SOCKET, tube: Navy type -49363; 5 cont small; under chassis wafer mtg. oval ceramic body; phosphor bronze cad pl cont; CEJ#225.	Mounts V502
XV503	—	Same as XV502	Mounts V503
XV504	N16-S-61876-8870 8850-880675	SOCKET, tube: Navy type -491975; 5 prong giant; above chassis mtg; sq ceramic body; brass cad pl cont; CEJ#275.	Mounts V504
XV505	—	SOCKET tube: special assembly which includes XV505A thru XV505Q.	Mounts V505
XV505A	2Z3600B-1 N16-L-77441-1027 1760-291340586	LINE, air: heat-proof glass, grade L-4; 2-7/32" lg x 5.062" max OD x 4.75" min ID x 1/16" min wall thk x 5/32" max wall thk; FTRC dwg #192-1012-00.	Air duct, and upper supporting cylinder

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
XV505B	2Z10004 N16-L-77441-1022 1760-397775400	TUBING: heat-proof glass, grade L-4; 5-5/64" OD x 4-47/64 ID x 31/32" lg; ends ground; FTRC dwg #192-1011-00.	Air duct, and lower supporting cylinder
XV505C	2Z2712.193 N17-C-814801-101 3300-287222737	CLIP, plate: silver pl beryllium copper; 4-21/32" lg x 1-3/16" wd x 0.008" thk o/a; 17 fingers equally spaced; FTRC dwg #503-8952-002.	V505 plate contact (qty 3)
XV505D	2Z2712.192 N17-C-79661-9001 3300-287222736	CLIP, tube socket: c/o silver pl beryllium copper spring strip with 35 equally spaced radial fingers all soldered to circumference brass ring; FTRC dwg #503-8937-002.	V505 grid contact
XV505E	N17-C-79669-9001	CLIP, tube socket: c/o connector ring casting, cathode support ring, connector spring; all brass, silver pl; 3 spokes spaced 120° apart; FTRC dwg #FRA-31070-2-2.	Outer filament ring of tube socket
XV505F	N17-C-82700-1301	CONTACT, tube socket: c/o brass ring casting and contact spring, all silver plated, 5 3/4" OD x 1/2" diam bore x 1" thk o/a; FTRC dwg #FRA-31047-2-2.	Left inner filament contact ring
XV505G	—	Same as E664	Support (qty 12)
XV505H	—	Same as E530A	Support
XV505I	—	Same as E530B	Support
XV505J	—	Same as E548	Support
XV505K	—	Same as E546	Support
XV505L	—	Same as E334	Support (qty 5)
XV505M	—	Same as E544	Support
XV505N	—	Same as E534	Support (qty 5)
XV505O	—	Not Used	Support (qty 2)
XV505P	—	Same as E529	Support
XV505Q	—	Same as E655	Mounts V506
XV506	—	SOCKET, tube: special assembly; includes XV506A thru XV506Q.	Air duct, also support
XV506A	—	Same as XV505A	Air duct, also (qty 3) support
XV506B	—	Same as XV505B	Plate contact (qty 3) V506
XV506C	—	Same as XV505C	
XV506D	—	Same as XV505D	
XV506E	N17-C-79669-9001	CONTACT: Same as XV505E, except tapped holes cl'wise from vert ctr line. FTRC part #FRA-31070-2-1, and dwg #C1003161.	Right outer filament contact ring

Part Number	Description	Notes	Quantity
XV506F	CONTACT; Same as XV505F, except third tapped hole cl'wise from radius line. FTRC dwg #FRA-31047-2-1.		Right inner filament contact ring
XV506G	Same as E664		(qty 12)
XV506H	Same as E530A		
XV506I	Same as E530B		
XV506J	Same as E548		(qty 2)
XV506K	Same as E546		(qty 5)
XV506L	Same as E334		
XV506M	Same as E544		
XV506N	Same as E534		(qty 5)
XV506O	Not Used		
XV506P	Same as XV505P		(qty 2)
XV506Q	Same as XV505Q		
XV507	SOCKET, tube: 9 cont miniature: JAN type TSE9T102; one piece brass saddle mtg; 3/4" diam chassis cutout required; ceramic body incl metal ctr shield; silver pl copper cont; spec JAN-S-28A.		Mounts V507
XV801	Same as XV507		Mounts V801 (1 ea, 6 units)
XV802	Same as XV507		Mounts V802 (1 ea, 6 units)
XV901	SOCKET, tube: 7 cont miniature: JAN type TSE7T102; one piece brass saddle mtg; 3/8" diam chassis cutout required; ceramic body; incl metal ctr shield; silver pl copper cont; spec JAN-S-28A.		Mounts V901
XV1001	Same as XK322		Mounts V1001
XV1002	Same as XK322		Mounts V1002
XV1003	Same as XV104		Mounts V1003
XV1004	Same as XK322		Mounts V1004
XV1005	Same as XV104		Mounts V1005
XV1006	Same as XV104		Mounts V1006
XV1101	Same as XV901		Mounts V1101
XV1102	Same as XV501		Mounts V1102
XV1103	Same as XV501		Mounts V1103
XV1104	Same as XV501		Mounts V1104
XV1301	Same as XV901		Mounts V1301 (1 ea, 2 units)
XV1302	Not Used		
XV1303	Same as XV901		Mounts V1303 (1 ea, 2 units)
XV1401	Same as XV104		Mounts V1401

TABLE 8-4 TABLE OF REPLACEABLE PARTS (Cont'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
XV1402	—	Same as XV104	Mounts V1402
XV1403	—	Same as XV104	Mounts V1403
XV1404	—	Same as XV502	Mounts V1404
XV1405	—	Same as XV104	Mounts V1405
XV1406	—	Same as XV104	Mounts V1406
XV1407	—	Same as XV104	Mounts V1407
XV1408	—	Same as XV101	Mounts V1408
XV1409	—	Same as XV104	Mounts V1409
XV1410	—	Same as XV104	Mounts V1410
XV1411	—	Same as XV104	Mounts V1411
XV1412	—	Same as XV101	Mounts V1412
XY101	2Z8677.19 N16-S-62833-8849	SOCKET, tube: Navy type -49384; 7 cont "Jumbo"; under chassis wafer mtg; square steatite body; brass cad pl cont; Navy spec RE13A524; CEJ type #237.	Crystal holder for Y101
XY1101	N16-S-54287-5101	SOCKET: Navy type -492008; for type CR-27/U crystal; steatite body; 2 cad plated phosphor bronze contacts; oval body; above chassis mtg; CJA #K33302.	Mounts Y1101 (P/o Z1101)
XY1102	—	Same as XY1101	Mounts Y1102 (P/o Z1101)
XY1103	—	Same as XY1101	Mounts Y1103 (P/o Z1101)
XY1104	—	Same as XY1101	Mounts Y1104 (P/o Z1101)
XY1105	—	Same as XY1101	Mounts Y1105 (P/o Z1101)
XY1106	—	Same as XY1101	Mounts Y1106 (P/o Z1101)
XY1107	—	Same as XY1101	Mounts Y1107 (P/o Z1101)
XY1108	—	Same as XY1101	Mounts Y1108 (P/o Z1101)
XY1109	—	Same as XY1101	Mounts Y1109 (p/o Z1101)
XY1110	—	Same as XY1101	Mounts Y1110 (p/o Z1101)
XZ1101A	2Z8761-20 N16-S-54423-5573 8850-868040	SOCKET, crystal: Navy type -49584; ceramic body; beryllium copper contacts; for crystal with two 1/8" diam term spaced 1/2" c to c; above chassis mtg; CJA #33202.	For crystal oven mtg.
XZ1101B	—	Same as XZ1101A	For crystal oven mtg.
XZ1101C	—	Same as XZ1101A	For crystal oven mtg.

Y101	N16-C-96177-3001	CRYSTAL UNIT, quartz: Navy type -40346; single xtal pl; 100 kc; incl heater and thermostat; temp range minus 20°C to plus 60°C; stud 7 prong base, hollow pins; 2 pins 5/32" diam x 9/16" lg; 5 pins 1/8" diam x 5/8" lg; cyl body 3/8" diam x 5-7/16" h o/a; no air gap adj; oven temp 60°C at 110 v AC; J. Knights type JKO-7.	100-kc crystal for crystal standard
Y1101	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1102	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1103	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1104	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1105	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1106	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1107	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1108	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1109	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
Y1110	_____	CRYSTAL UNIT: Type CR-27/U	Frequency control
*Z101	2C2711-3 N16-O-55033-4765 1760-213575938	OSCILLATOR, RF: freq range 600 to 800 kc; not crystal controlled; 0.001 w output; integral coils; mounts in sealed metal case; (includes C220, C221, C223 through C227, J116, L105, L106, R238 through R241, V130, XV130, P103); FTRC part #FRL-31628-1-1.	Interpolation oscillator
*Z102	2C2711-4 N16-O-55036-7755 1760-213575939	OSCILLATOR, RF: freq range 1 to 1.5 mc; not crystal controlled; 0.001 w output; integral coils; mounts in sealed metal case; (includes C212, C213, C215 through C219, J115, L103, L104, R235 through R237, V131, XV131, P102); FTRC part #FRL-31628-1-2.	Master oscillator
Z701	N16-D-901161-152	SERVO UNIT: c/o motor (B701A, B701B, B701C, B701E or B701G), capacitor (C701), 2 switches (S701 and S702), connector (J701), resistor (R701), reduction gears and assembling hardware; 6-13/16" lg x 3-11/16" wd x 6 3/8" h o/a; FTRC part #FRL-30637-2-6 and dwg #B1002836.	1st freq. multiplier (V502) tuning. Used with gear O701A
Z702	_____	Same as Z701	2nd freq. multiplier (V503) tuning. Used with O701B
Z703	_____	Same as Z701	Driver (V504) tuning. Used with gear O701C
Z704	_____	Not Used	
Z705	_____	Same as Z701	
Z706	N16-D-901161-151	SERVO UNIT: Same as Z701, except includes gear O701F; FTRC part #FRL-30637-2-1 and dwg #B1002836.	Output coupling (L516/L517 to L518/L519) adjustment. Used with gear O701E
Z801	2C451-9 1760-211307537	AMPLIFIER, AF: 2.2 w; input 30 v, 60 cps, single ph; 1 input channel; output impedance 18,000 ohms pl to pl; metal cabinet; FTRC part #FRL-30413-1.	Tuning drive for output coils (L518 and L519)
Z802	_____	Same as Z801	Servo amplr for Z701 (V502 tuning)
			Servo amplr for Z702 (V503 tuning)

TABLE 8-4 TABLE OF REPLACEABLE PARTS (C n'y'd)

REFERENCE DESIGNATION	STOCK NOS. (1) SIGNAL CORPS (2) STANDARD NAVY (3) AIR CORPS	NAME AND DESCRIPTION	LOCATING FUNCTION
Z803	—	Same as Z801	Servo amplr for Z703 (V504 tuning)
Z804	—	Same as Z801	Servo amplr for B502 (PA plate tuning)
Z805	—	Same as Z801	Servo amplr for Z705 (output coupling adjust)
Z806	—	Same as Z801	Servo amplr for Z706 (L518 and L519 tuning)
Z807	N16-C-10606-5501	CABINET: for mounting and enclosing six servo amplifiers; empty; 8½" lg x 2-9/16" wd x 7¼" h approx o/a; FTFC part #FRL-30677-1.	Rack-mounted cabinet for Z801-Z806
Z901	N16-P-68114-8821	SERVO POWER SUPPLY: enclosed metal cabinet with rear dust cover, horizontally hinged front panel, and end flanges for std relay rack mtg; includes circuit items C901-C903, E901, F901-F903, I901-I904, J901, P901, R901-R907, T901-T903, V901; 230 v, 60 cps, 1 ph AC input; approx 200 v DC output, and 30 v, 6.3 v, 300v and 80-100 v AC outputs; FTFC part #FRL 30414-1 and dwg #B1002104.	Power for servo control circuit, for servo amplr plates, fils & relays and for servo drive motor.
Z1101	2Z6897-3 N16-C-95445-3721 1760-293399212	OVEN: crystal; includes two resistors, 1 rotary switch, 1 thermostat, 10 sockets for crystals; (includes R1101, R1111, S1101, S1102A, XY1101 to XY1110 incl); FTFC part #FRL-31421-1 and dwg #A1001731.	Crystal oven
Z1301	—	VOLTMETER: Consists of C1305, C1306, E1301, E1302, R1323, R1324, V1303 and XV1303.	Power amplr grid RF peak reading voltmeter
Z1302	—	Same as Z1301	Power amplr grid RF peak reading voltmeter
Z1303	—	VOLTMETER: Consists of C1301, C1302, C1309, C1310, E1303, E1304, E1305, R1301, R1311, V1301 and XV1301.	Power amplr plate RF peak reading voltmeter
Z1304	—	Same as Z1303	Power amplr plate RF peak reading voltmeter
*Z1401	N17-T-81314-3713	COIL, RF: osc; pri and secd wnd; shielded; 200 turns of #36 DE wire, 5½ turns ea side of tap of #36 SSE wire; air core; iron coil form; HS in can (includes C1440, L1415, L1416); FTFC part #FRA-31398-1.	200-kc oscillator
Z1402	N16-C-77650-7801	COIL ASSEMBLY, RF: c/o 2 coils (L1410 & L1411) 2 fixed capacitors (C1417 & C1418) and 1 variable capacitor (C1419) on common mtg; FTFC part #FRL-31179-1A.	PA plate
Z1403	N16-C-76478-5725	COIL ASSEMBLY, RF: c/o one coil (L1407) and one capacitor (C1413) on common mtg; FTFC part #FRL-31180-1A.	Buffer plate

Z1404	N16-T-43276-1093	TRANSMITTER SUBASSEMBLY, RF; c/o 2 coils (L1405, L1406), 1 capacitor (C1408) and 1 resistor (R1421) on common mtg; FTRC part #FRL-31181-1A and dwg. #B1001591.	Buffer grid
Z1405	N16-T-43276-1092	TRANSMITTER SUBASSEMBLY, RF; c/o 4 coils (L1401-L1404), 2 capacitors (C1406, C1407) and 2 resistors (R1419, R1420) on common mtg; FTRC part #FRL-31178-1A and dwg #B1001546.	Mixer plate

TABLE 8-5. MAINTENANCE PARTS KIT

KEY DESIG- NATION	BOX NO.	QUAN/ UNIT	KEY DESIG- NATION	BOX NO.	QUAN/ UNIT	KEY DESIG- NATION	BOX NO.	QUAN/ UNIT	KEY DESIG- NATION	BOX NO.	QUAN/ UNIT
B501A	1	1	E334	1	10	L518C	1	1	R1464	2	1
B501C	1	2	E364	1	2	L518D	1	1	R1485	2	1
B502	1	1	E523	1	1	L518E	1	1	S104	2	1
(B701F)			E529	1	2	L1103	1	1	S301	2	1
C102A	1	2	E532	1	2	M503	1	1	S302	2	1
C102B	1	1	E534	1	4	O123	1	1	S303	2	1
C105	1	1	E544	1	2	O124	1	1	S304	2	1
C106	1	1	E545	1	2	O131	1	1	S305	2	1
C110	1	1	E603	1	12	O301	3	4	S306	2	1
C117	1	1	E622	1	1	O511A	1	1	S307	2	1
C125	1	1	E645	1	2	O519A	1	1	S308	2	1
C129	1	1	E655	1	2	O551	1	1	S309	2	1
C159	1	1	E657	1	2	O552	1	1	S318	2	1
C164	1	1	E664	1	12	O556	1	2	S505B	2	6
C173	1	1	F903	1	3	O1401	1	1	S511	2	1
C176	1	1	H506	3	3	P503	1	1	S512	2	1
C194	1	1	I101	1	2	P510	1	1	S518	2	1
C204	1	1	I401	1	2	P515	1	1	S522	2	1
C210	1	1	J101	1	1	P801	1	1	S701	2	2
C233	1	1	J801	1	1	R165	1	1	S1101	2	1
C301	1	1	K301A	1	1	R199	1	1	S1102A	2	1
C302	1	1	K301B	1	1	R302	1	1	S1406	2	1
C501	1	1	K301C	1	1	R312	1	2	S1407	2	1
C505	1	1	K301D	1	1	R318	1	1	T801	2	1
C518	1	2	K301E	1	4	R326	1	1	V114	2	1
C526A	1	1	K301F	1	1	R506	1	1	V504	2	2
C527	1	1	K303A	1	1	R508	1	1	V505	2	3
C539	1	1	K303B	1	1	R519	1	1	XF401	2	1
C541	1	1	K307A	1	2	R522	1	1	XF403	2	1
C552	1	1	K307B	1	2	R529	1	1	XI301	2	1
C583	1	2	K308C	1	1	R534	1	1	XI304	2	1
C802	1	2	K308D	1	1	R537	1	1	XI401	2	1
C804	1	2	K311A	1	1	R541	1	1	XV101	2	2
C806	1	2	K311B	1	1	R544	1	1	XV504	2	1
C1001	1	1	K311C	1	1	R554	2	2	XV505A	2	1
C1101	1	1	K311D	1	1	R560	2	2	XV505B	2	1
C1111	1	2	K320A	1	1	R562	2	2	XV505C	2	6
C1301	1	1	K320B	1	1	R564	2	2	XV505D	2	2
C1310	1	1	K401C	1	1	R565	2	2	XV507	2	2
C1402	1	1	K402A	1	1	R591	2	2	XV1301	2	1
C1435	1	1	K402B	1	1	R1002	2	2	XZ1101A	2	1
C1439	1	1	K402C	1	1	R1006	2	2	Z101	2	1
C1441 ¹	1	1	K801	1	1	R1105	2	2	Z102	2	1
C1441 ²	1	1	L107	1	1	R1110	2	2	Z801	3	1
C1441 ³	1	1	L501	1	1	R1401	2	2	Z1101	2	1
C1455	1	1	L509A	1	1	R1430	2	2	Spare	1	1
C1458	1	1	L516B	1	4	R1432	2	2	Parts	1	1
CR801	1	1	L516C	1	8	R1435	2	2	Boxes	3	1
E120	1	36	L516D	1	1	R1450	2	2			
E121	1	12	L516E	1	2	R1458	2	2			
E312	1	5	L516F	1	4	R1459	2	2			
E325	1	2	L516G	1	8	R1460	2	2			
E326	1	2	L518B	1	4	R1461	2	2			

10 µf. 20 µf. 51 µf.

TABLE 8-6. CROSS REFERENCE PARTS LIST

STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL
N16-A-700001-193	O129	N16-C-29718-7276	C231	N16-C-65875-4613	C571	N16-G-431366-997	O701C		
N16-B-23536-9670	L518A	N16-C-29723-9756	C186	N16-C-65875-4651	C526	N16-G-431414-390	C571B		
N16-B-600961-123	O506	N16-C-30119-6756	C104	N16-C-65875-4813	C569	N16-G-431796-126	O1406		
N16-C-10606-5501	Z807	N16-C-30531-4284	C1407	N16-C-65875-4865	C526A	N16-G-431796-237	O108		
N16-C-125001-171	O534	N16-C-31095-6644	C101	N16-C-692001-104	E1428	N16-G-431986-968	O546		
N16-C-15531-9928	C1111	N16-C-31665-6528	C217	N16-C-71665-6162	L520	N16-G-431986-973	O548		
N16-C-15532-1344	C210	N16-C-31908-1564	C1414	N16-C-71832-7712	L519	N16-G-432090-318	O1101		
N16-C-15628-1344	C117	N16-C-31913-4044	C230	N16-C-71832-9549	L518	N16-G-432090-410	O1103		
N16-C-15916-1328	C501	N16-C-31913-9493	C510	N16-C-71877-6578	L517	N16-G-432096-116	O553		
N16-C-15916-1331	C233	N16-C-32256-3244	C127	N16-C-71877-6583	L516	N16-G-432396-760	O1407		
N16-C-15920-8853	C213	N16-C-32256-3288	C801	N16-C-72306-8233	L522	N16-G-432807-116	O525		
N16-C-15923-1762	C1441	N16-C-32651-9288	C578	N16-C-72306-8233	L508	N16-G-432807-131	O503A		
N16-C-15923-4258	C213	N16-C-32653-2258	C305	N16-C-72543-5597	L503	N16-G-432927-242	O503D		
N16-C-15924-3401	C213	N16-C-33627-9187	C536	N16-C-72595-5545	L1402	N16-G-432967-262	O541		
N16-C-15924-7558	C213	N16-C-33627-7705	C109	N16-C-72595-5547	L1406	N16-G-434872-107	O501		
N16-C-15925-2200	C213	N16-C-33628-1236	C202	N16-C-72595-5549	L1405	N16-G-500001-205	O112		
N16-C-15925-2360	C213	N16-C-34576-6515	E124	N16-C-72666-4402	L1411	N16-G-500001-206	O540		
N16-C-15953-6532	C194	N16-C-44257-3134	C802	N16-C-73129-2867	L1404	N16-G-500001-207	O544		
N16-C-16080-8946	C213	N16-C-45801-9618	C1116	N16-C-73445-5821	L1103	N16-G-500001-208	O545		
N16-C-16081-6531	C106	N16-C-45807-7309	C1402	N16-C-73555-5815	L501	N16-G-500001-210	O554		
N16-C-16083-1726	C1441	N16-C-45807-7617	C205	N16-C-73742-1485	L1418	N16-G-500001-212	O102		
N16-C-16083-4337	C213	N16-C-45814-9330	C505	N16-C-73926-8935	L104	N16-G-500001-213	O103		
N16-C-16084-3439	C213	N16-C-46347-3095	C806	N16-C-74031-6453	T501	N16-G-500001-214	O526		
N16-C-16084-7558	C213	N16-C-47327-9207	C1455	N16-C-74209-7869	L106	N16-G-500001-233	O503C		
N16-C-16085-2220	C213	N16-C-47327-9525	C1458	N16-C-74381-4123	L1409	N16-G-500001-246	H304		
N16-C-16085-2387	C213	N16-C-48841-9594	C804	N16-C-74714-8543	L502	N16-H-150001-247	H303		
N16-C-16085-2537	C1435	N16-C-49206-7483	C301	N16-C-74715-1017	L107	N16-H-150001-248	H305		
N16-C-16177-6532	C521	N16-C-49951-8325	C552	N16-C-74721-3586	L1413	N16-H-150001-250	H302		
N16-C-16223-6759	C159	N16-C-49981-9983	C583	N16-C-76321-1586	T101	N16-K-700285-346	E697		
N16-C-16273-6532	C173	N16-C-51881-9090	C1001	N16-C-76478-5725	Z1403	N16-K-700285-451	E697		
N16-C-16401-6533	C129	N16-C-52051-2305	C302	N16-C-76635-1354	L509	N16-K-700296-586	E101		
N16-C-16529-6533	C225	N16-C-53192-8194	C204	N16-C-76635-1354	L509	N16-K-700374-866	E369		
N16-C-16538-7801	C225	N16-C-54460-4463	C193	N16-C-76635-4341	T104	N16-K-700411-970	E370		
N16-C-16555-8161	C1441	N16-C-54467-1572	C116	N16-C-77650-7801	Z1402	N16-K-700421-941	E324		
N16-C-16595-1762	C176	N16-C-54467-1577	C125	N16-C-92356-8064	S505C	N16-L-300001-128	O535		
N16-C-16670-6062	C539	N16-C-56738-7241	C1301	N16-C-92356-8064	Z1101	N16-L-300001-128	XV505B		
N16-C-16741-7132	C1310	N16-C-56789-4736	C527	N16-C-95445-3721	Y101	N16-L-77441-1022	XV505A		
N16-C-16774-7057	C164	N16-C-56804-7241	C567	N16-C-96177-3001	O508	N16-L-77441-1027	Z101		
N16-C-16789-1562	C105	N16-C-58716-3970	C1442	N16-C-98380-2368	O104	F16-O-55023-4765	Z102		
N16-C-16833-1562	C216	N16-C-59766-4781	C215	N16-D-351301-101	O110	F16-O-55036-7755	O123		
N16-C-17073-3201	C1439	N16-C-60001-183	O1418	N16-D-46381-9251	O101	F16-O-65501-1010	C519C		
N16-C-17077-1226	C110	N16-C-60036-2299	C573	N16-D-46381-9796	E566	N16-P-401281-113	E201		
N16-C-17082-7801	C102A	N16-C-60151-1740	C535	N16-D-46420-9810	O551	N16-P-401281-113	L301		
N16-C-18437-4613	C1440	N16-C-60833-3479	C1309	N16-D-46552-2126	O503	N16-P-402241-110	L302		
N16-C-18632-8164	C212	N16-C-61314-7907	C511	N16-D-900081-133	Z706	N16-P-68114-8821	L303		
N16-C-18660-2453	C518	N16-C-61763-1675	C533	N16-D-901161-151	O1405	N16-R-28996-9557	L1001		
N16-C-27587-4356	C188	N16-C-63507-6401	C120	N16-D-905001-111	O537	N16-R-29126-2359	L1412		
N16-C-28553-1196	C1437	N16-C-63665-7059	C1405	N16-D-905001-111	O1422	N16-R-29174-5623	L1412		
N16-C-28558-1676	C1451	N16-C-63960-2500	C1101	N16-E-300057-426	T110	N16-R-29317-4166	L1420		
N16-C-28564-6196	C512	N16-C-63965-2800	C128A	N16-F-44278-4358	O507				
N16-C-28985-4556	C1429	N16-C-64157-5249	C1406	N16-G-402607-126	O529				
N16-C-29265-2996	C1428	N16-C-64232-8500	C103	N16-G-431170-332	O701A				
N16-C-29381-1556	C107	N16-C-65829-3251	C541	N16-G-431256-406					
N16-C-29382-3597	C507								

TABLE 8-6. CROSS REFERENCE PARTS LIST (C n't)

STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL
N16-R-45555-4930	R540	N16-R-50200-751	R1427	N16-R-50715-231	R809	N16-R-78917-8199	R506
N16-R-49238-811	R1411	N16-R-50237-811	R241	N16-R-50741-126	R1323	N16-R-79031-3259	R1443
N16-R-49239-421	R347	N16-R-50238-231	R1429	N16-R-50742-231	R1489	N16-R-79083-3764	R562
N16-R-49256-811	R1410	N16-R-50281-751	R1463	N16-R-50758-941	R1301	N16-R-87679-4293	R1458
N16-R-49283-811	R1409	N16-R-50282-811	R1110	N16-R-50759-0811	R161	N16-R-87752-5475	R548
N16-R-49309-431	R1433	N16-R-50283-231	R1311	N16-R-50760-231	R801	N16-R-87852-1950	R522
N16-R-49319-811	R1408	N16-R-50283-529	R1491	N16-R-50822-811	R123	N16-R-88182-5495	R804
N16-R-49320-491	R346	N16-R-50308-751	R1456	N16-R-50823-231	R1434	N16-R-89693-7785	R326
N16-R-49346-811	R1407	N16-R-50310-231	R1472	N16-R-50859-231	R811	N16-R-89956-7050	R1450
N16-R-49364-811	R1406	N16-R-50330-480	R597	N16-R-50975-811	R225	N16-R-90336-1446	R302
N16-R-49391-811	R1405	N16-R-50335-751	R1424	N16-R-61101-7355	R332	N16-R-90751-2932	R591
N16-R-49427-811	R146	N16-R-50337-231	R1421	N16-R-61448-5920	R586	N16-R-90868-3015	R1464
N16-R-49428-231	R518	N16-R-50335-0431	R154	N16-R-61580-9495	R301	N16-R-91027-9295	R1485
N16-R-49428-496	R1112	N16-R-50336-811	R243	N16-R-61661-9795	R343	N16-R-91031-1140	R1439
N16-R-49464-231	R1414	N16-R-50371-751	R1437	N16-R-61735-7715	R312	N16-R-91031-1950	R560
N16-R-49499-811	R1403	N16-R-50372-126	R1438	N16-R-61822-5075	R345	N16-R-91031-2010	R554
N16-R-49500-231	R1422	N16-R-50372-811	R145	N16-R-61836-2395	R531	N16-R-91291-4935	R1416
N16-R-49535-811	R1402	N16-R-50373-231	R162	N16-R-61865-6595	R328	N16-R-91291-6160	R570
N16-R-49536-231	R1104	N16-R-50373-421	R221	N16-R-61887-8997	R537	N16-R-91294-6980	R519
N16-R-49580-811	R124	N16-R-50398-751	R133	N16-R-61925-6165	R520	N16-R-91406-1635	R165
N16-R-49581-231	R814	N16-R-50399-811	R107	N16-R-61955-4245	R553	N16-R-91406-1650	R1430
N16-R-49581-461	R527	N16-R-50400-231	R577	N16-R-61995-9775	R578	N16-R-91406-6598	R568
N16-R-49625-0811	R104	N16-R-50400-499	R1417	N16-R-62028-3625	R512	N16-R-91406-6598	C519A
N16-R-49626-231	R1109	N16-R-50417-811	R111	N16-R-62028-7145	R559	N16-R-94402-1435	C126B
N16-R-49626-501	R569	N16-R-50418-231	R1107	N16-R-62071-2580	R1006	N16-R-94402-1751	O552
N16-R-49661-811	R132	N16-R-50418-457	R509	N16-R-62072-1995	R535	N16-S-117101-216	O121
N16-R-49662-231	R1442	N16-R-50443-945	R1487	N16-R-62072-5515	R324	N16-S-20990-2501	O1408
N16-R-49662-506	R572	N16-R-50444-811	R125	N16-R-62093-8055	R513	N16-S-20998-2001	O130
N16-R-49687-751	R1449	N16-R-50479-591	R237	N16-R-62095-5295	R318	N16-S-21026-4550	O1414
N16-R-49706-811	R143	N16-R-50480-811	R103	N16-R-62122-7135	R311	N16-S-21126-1039	O109
N16-R-49707-231	R1465	N16-R-50481-231	R1103	N16-R-62123-1655	R532	N16-S-21226-1123	O516
N16-R-49707-499	R501	N16-R-50481-457	R610	N16-R-62137-5695	R552	N16-S-34404-1051	E901
N16-R-49770-231	R557	N16-R-50482-611	R1001	N16-R-65272-3536	R349	N16-S-34520-3862	E121
N16-R-49770-516	R507	N16-R-50515-751	R1447	N16-R-65409-6697	R308	N16-S-34532-8744	E123
N16-R-49805-811	R127	N16-R-50517-231	R1481	N16-R-65564-2046	R1401	N16-S-34557-8350	E122
N16-R-49806-231	R164	N16-R-50517-475	R602	N16-R-65935-3621	R1435	N16-S-54287-5101	XY1101
N16-R-49842-231	R187	N16-R-50551-591	R236	N16-R-66085-3846	R199	N16-S-54423-5573	XZ1101A
N16-R-49922-811	R227	N16-R-50552-811	R126	N16-R-66167-8988	R1002	N16-S-60856-2987	XV307
N16-R-49923-231	R167	N16-R-50553-231	R196	N16-R-68275-5206	R1439	N16-S-60935-9301	XV301
N16-R-49923-531	R198	N16-R-50553-506	R606	N16-R-68275-6956	R1432	N16-S-61700-1481	XV502
N16-R-49940-811	R207	N16-R-50588-0811	R130	N16-R-72986-4145	R1461	N16-S-61876-8870	XV504
N16-R-49966-431	R1446	N16-R-50589-231	R1452	N16-R-73008-7011	R1460	N16-S-62603-6692	XV104
N16-R-49968-521	R166	N16-R-50632-751	R1440	N16-R-73030-9545	R1459	N16-S-62603-6693	XV901
N16-R-50012-811	R102	N16-R-50633-811	R101	N16-R-751251-106	O504	N16-S-62833-8849	XV101
N16-R-50013-231	R1423	N16-R-50634-231	R550	N16-R-75137-104	O513	N16-S-63471-2924	XV501
N16-R-50013-461	R528	N16-R-50634-501	R549	N16-R-77621-3741	R307	N16-S-63511-6425	XK322
N16-R-50014-291	R242	N16-R-50635-886	R1003	N16-R-78452-1508	R544	N16-S-63511-6461	XV130
N16-R-50040-511	R1431	N16-R-50652-506	R605	N16-R-78569-1508	R565	N16-S-64063-6717	XV507
N16-R-50066-121	R1436	N16-R-50677-591	R235	N16-R-78602-4019	R564	N16-S-64063-6718	XV101
N16-R-50067-231	R807	N16-R-50677-751	R1471	N16-R-78644-9099	R529	N16-S-83701-1001	C126A
N16-R-50092-751	R1454	N16-R-50678-811	R141	N16-R-78670-7243	R1110	N16-S-89852-1406	E523
N16-R-50129-811	R169	N16-R-50679-520	R517	N16-R-78702-1024	R508	N16-S-89857-1249	E520
N16-R-50130-469	R158	N16-R-50697-231	R335	N16-R-78772-1522	R534	N16-S-90001-102	O505
N16-R-50166-508	R1106	N16-R-50713-751	R1445	N16-R-78877-9164	R1105	N16-T-43276-1057	O555A

TABLE 8-6. CROSS REFERENCE PARTS LIST (Continued)

STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL
N16-T-43276-1092	Z1405	N17-B-78292-5235	TB105	N17-C-73465-6315	J1102	N17-C-84197-7789	K301A	N17-C-73465-6315	J1102
N16-T-43276-1093	Z1404	N17-B-78327-7617	TB103	N17-C-73471-6407	P1001	N17-C-84197-7799	K301B	N17-C-73471-6407	P1001
N16-T-43276-1095	O555B	N17-B-86434-6779	K401C	N17-C-73565-9015	J101	N17-C-84197-7810	K311A	N17-C-73565-9015	J101
N16-T-52001	V1005	N17-C-480881-274	O511	N17-C-73568-3857	P801	N17-C-98378-3896	O1401	N17-C-73568-3857	P801
N16-T-52351	V101	N17-C-480882-976	O519	N17-C-73581-2457	J901	N17-C-98378-4007	O549	N17-C-73581-2457	J901
N16-T-53040	V1103	N17-C-51472-5974	S306	N17-C-73643-5360	J301	N17-C-98379-3651	O539	N17-C-73643-5360	J301
N16-T-53228	V307	N17-C-51472-8249	S302	N17-C-78141-2025	L518C	N17-C-98379-3926	O538	N17-C-78141-2025	L518C
N16-T-53990	V505	N17-C-51472-9899	S305	N17-C-78152-3001	L518B	N17-C-98379-4001	O542	N17-C-78152-3001	L518B
N16-T-54067	V504	N17-C-51473-4652	S303	N17-C-78152-4001	L518E	N17-C-98379-4001	O106A	N17-C-78152-4001	L518E
N16-T-54232	V301	N17-C-51514-6810	S301	N17-C-78154-4501	L516B	N17-C-98379-4001	O106B	N17-C-78154-4501	L516B
N16-T-55444	V1001	N17-C-51514-7821	S304	N17-C-78168-1001	L509A	N17-C-98379-4001	O124	N17-C-78168-1001	L509A
N16-T-56177	V501	N17-C-51585-2006	K401	N17-C-78190-9176	L516D	N17-C-98379-4001	F102	N17-C-78190-9176	L516D
N16-T-56191	V104	N17-C-51769-6001	K307	N17-C-78202-8901	L516E	N17-F-14310-320	F901	N17-C-78202-8901	L516E
N16-T-56195	V125	N17-C-51769-7801	K324	N17-C-78267-6601	L516C	N17-F-14310-335	F902	N17-C-78267-6601	L516C
N16-T-56195-50	V1405	N17-C-51769-8201	K319	N17-C-78288-8701	L518D	N17-F-14310-350	F101	N17-C-78288-8701	L518D
N16-T-56201	V105	N17-C-53795-1001	K401A	N17-C-78324-9601	L516A	N17-F-14310-360	F301	N17-C-78324-9601	L516A
N16-T-56211	V128	N17-C-60707-1450	K301F	N17-C-793001-120	O301	N17-F-14310-380	F401	N17-C-793001-120	O301
N16-T-56211-50	V108	N17-C-60726-8001	K402D	N17-C-79661-9001	XV505D	N17-F-14635	F403	N17-C-79661-9001	XV505D
N16-T-56214	V1409	N17-C-68293-3011	J115	N17-C-79669-9001	XV505E	N17-F-16302-80	F1004	N17-C-79669-9001	XV505E
N16-T-56665	V130	N17-C-70040-1516	P1402	N17-C-800645-401	E624	N17-F-16302-100	F1002	N17-C-800645-401	E624
N16-T-56840	V901	N17-C-70347-6977	P510	N17-C-800785-308	E325	N17-F-16302-100	F1003	N17-C-800785-308	E325
N16-T-58241	V507	N17-C-70588-1327	P301	N17-C-800956-126	E326	N17-F-16320-200	F903	N17-C-800956-126	E326
N16-T-58241-60	V801	N17-C-70901-2639	P302	N17-C-804681-127	E639	N17-F-16320-200	X1401	N17-C-804681-127	E639
N16-T-68070	V502	N17-C-71037-5180	P105	N17-C-804681-127	E367	N17-F-16320-200	X1401	N17-C-804681-127	E367
N16-T-75686	V114	N17-C-71168-1306	P1004	N17-C-804971-101	E366	N17-F-16320-200	X1401	N17-C-804971-101	E366
N17-B-21186-875	O131	N17-C-71170-6437	P1102	N17-C-804971-101	E365	N17-F-16320-200	X1401	N17-C-804971-101	E365
N17-B-21189-4245	B501	N17-C-71281-3423	P104	N17-C-81446-1526	K307B	N17-F-16320-200	X1401	N17-C-81446-1526	K307B
N17-B-77590-1085	E301	N17-C-71295-8635	P901	N17-C-814613-110	E1002	N17-F-16320-200	X1401	N17-C-814613-110	E1002
N17-B-77639-1543	E307	N17-C-71408-3241	P509	N17-C-81466-8822	K307A	N17-F-16320-200	X1401	N17-C-81466-8822	K307A
N17-B-77737-9088	E315	N17-C-71418-8250	P504	N17-C-81488-3834	K301E	N17-F-16320-200	X1401	N17-C-81488-3834	K301E
N17-B-77738-2769	TB1406	N17-C-71438-7453	P517	N17-C-81488-3844	K402A	N17-F-16320-200	X1401	N17-C-81488-3844	K402A
N17-B-77738-2903	E103	N17-C-71460-4878	P516	N17-C-81617-1051	K402C	N17-F-16320-200	X1401	N17-C-81617-1051	K402C
N17-B-77739-5038	E809	N17-C-71565-2109	P1002	N17-C-81618-5686	K402B	N17-F-16320-200	X1401	N17-C-81618-5686	K402B
N17-B-77835-8913	E501	N17-C-71644-7058	P802	N17-C-82005-5172	E640	N17-F-16320-200	X1401	N17-C-82005-5172	E640
N17-B-77836-1287	TB1403	N17-C-72240-1332	J510	N17-C-82137-5001	S401C	N17-F-16320-200	X1401	N17-C-82137-5001	S401C
N17-B-77933-7078	TB1408	N17-C-72604-1516	J1407	N17-C-82700-1301	XV505F	N17-F-16320-200	X1401	N17-C-82700-1301	XV505F
N17-B-77939-3214	E502	N17-C-72623-6977	J701	N17-C-82700-1303	XV506F	N17-F-16320-200	X1401	N17-C-82700-1303	XV506F
N17-B-77983-9890	TB102	N17-C-73108-1262	J503	N17-C-84188-3834	K320A	N17-F-16320-200	X1401	N17-C-84188-3834	K320A
N17-B-77984-2249	TB1402	N17-C-73110-8501	J104	N17-C-84188-3844	K320B	N17-F-16320-200	X1401	N17-C-84188-3844	K320B
N17-B-77985-5227	TB1407	N17-C-73127-5790	J511	N17-C-84188-3914	K320C	N17-F-16320-200	X1401	N17-C-84188-3914	K320C
N17-B-77990-6897	E302	N17-C-73171-9070	J514	N17-C-84188-3924	K320D	N17-F-16320-200	X1401	N17-C-84188-3924	K320D
N17-B-78082-8082	TB101	N17-C-73171-9070	J515	N17-C-84197-7669	K311C	N17-F-16320-200	X1401	N17-C-84197-7669	K311C
N17-B-78086-8339	E506	N17-C-73196-5137	J114	N17-C-84197-7679	K311D	N17-F-16320-200	X1401	N17-C-84197-7679	K311D
N17-B-78138-2456	TB1405	N17-C-73197-7866	P102	N17-C-84197-7699	K308C	N17-F-16320-200	X1401	N17-C-84197-7699	K308C
N17-B-78177-7790	TB1409	N17-C-73281-9536	J1001	N17-C-84197-7729	K308D	N17-F-16320-200	X1401	N17-C-84197-7729	K308D
N17-B-78207-4621	TB104	N17-C-73289-4143	J801	N17-C-84197-7739	K301C	N17-F-16320-200	X1401	N17-C-84197-7739	K301C
N17-B-78232-1304	TB106	N17-C-73299-8314	J1405	N17-C-84197-7749	K320A	N17-F-16320-200	X1401	N17-C-84197-7749	K320A
N17-B-78232-9870	TB1410	N17-C-73340-1933	J302	N17-C-84197-7751	K320B	N17-F-16320-200	X1401	N17-C-84197-7751	K320B
N17-B-78241-8205	TB501	N17-C-73410-2751	J518	N17-C-84197-7759	K303A	N17-F-16320-200	X1401	N17-C-84197-7759	K303A
	TB1404	N17-C-73443-8438	J102	N17-C-84197-7769	K303B	N17-F-16320-200	X1401	N17-C-84197-7769	K303B

TABLE 8-6. CROSS REFERENCE PARTS LIST (C n't)

STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	JAN (OR AWS) DESIGNATION	KEY SYMBOL
N17-L-69218-9504	E544	N17-R-95021-1045	S505A	N17-S-91941-1005	S311B	CC30CK470J	C129		
N17-L-69223-9541	E645	N17-R-95021-1046	S401A	N17-T-28228-3181	E109	CC30PH100F	C1441		
N17-L-69231-9541	E312	N17-R-95021-1047	S401B	N17-T-28252-2575	E113	CC30PH200J	C1441		
N17-L-69236-3501	E529	N17-S-46666-3850	O128	N17-T-61003-7001	T801	CC30PH510J	C1441		
N17-L-69237-9516	E655	N17-S-46768-3201	L516G	N17-T-67710-4267	T108	CC30UJ101J	C110		
N17-J-39256-2751	J103	N17-S-46768-5969	L516F	N17-T-69142-6801	T505	CC30UK560K	C176		
N17-J-39528-2090	J505	N17-S-50081-1101	O512	N17-T-70758-8001	T1101	CC30UK680J	C164		
N17-L-250065-560	XI304A	N17-S-500813-189	O701E	N17-T-72726-6501	T903	CC30UK750J	C105		
N17-L-250389-501	XI305A	N17-S-500816-101	O524	N17-T-72780-8493	T502	CC35CH101J	C1439		
N17-L-250738-526	XI306A	N17-S-500816-210	O528	N17-T-72969-4323	T307	CC35CH101K	C102A		
N17-L-3619	I301	N17-S-500921-101	O523	N17-T-72970-2302	T301	CC35CH470K	C1437		
N17-L-4413-40	I401	N17-S-500853-101	O514	N17-T-72970-3154	T503	CM20B101J	C1451		
N17-L-51711-1936	XI301	N17-S-500921-101	O521	N17-T-73673-8517	T1001	CM20B101K	C1429		
N17-L-6297	I1102	N17-S-500963-427	O522	N17-T-73674-9077	T1002	CM20B151M	C1428		
N17-L-6806-460	I101	N17-S-500963-436	O520	N17-T-76099-1001	T902	CM20B201J	C107		
N17-L-6806-470	I902	N17-S-54549-8625	S316	N17-T-76695-4703	T311	CM20B221M	C231		
N17-L-76673-3807	XI304	N17-S-56382-8351	S507	N17-T-76695-4725	T313	CM20B331K	C186		
N17-L-76689-3956	XI1102	N17-S-56382-9001	S318	N17-T-78159-6001	T310	CM20B331M	C188		
N17-M-18260-3851	M503	N17-S-56382-9051	S320	N17-T-78160-1001	T309	CM20B470M	C104		
N17-M-19681-3426	M1401	N17-S-56597-7089	S309	F17-T-78219-9001	T401	CM20B471M	C101		
N17-M-19828-9101	M501	N17-S-56597-7094	S308	N17-T-81314-3713	Z1401	CM20B102M	C1414		
N17-M-20205-9101	M502	N17-S-58044-5501	S508	N17-T-81320-1103	T113	CM30B222K	C230		
N17-M-21878-2341	M505	N17-S-59272-7049	S1409	N17-T-81716-1167	T106	CM30B222M	C127		
N17-M-21878-2346	M1101	N17-S-59672-7761	S1405	N17-T-81731-1167	T103	CM30B332M	C109		
N17-M-32915-3951	M304	N17-S-60129-3161	S1405	N17-T-81731-1383	T111	CM30B681J	C1407		
N17-M-33903-3851	M303	N17-S-60523-1305	S317	N17-T-81749-1011	T112	CM35B103M	C217		
N17-M-34277-3851	M302	N17-S-60581-1901	S1401	N17-T-82064-3711	L1415	CM35B182J	C801		
N17-M-35614-8251	M1001	N17-S-61164-9229	S1103	N17-T-910993-101	O557	CM35B332M	C578		
N17-M-35890-2701	M301	N17-S-61497-1459	S1003	N17-W-237981-121	R1101	CM45B101M	C512		
N17-M-56801-3647	B502	N17-S-62011-1461	S1402	N33-B-4400	H506	CM45B103M	C507		
N17-M-56804-9871	B101	N17-S-622141-3296	S310	N33-H-124-600	O511A	CM45B221M	C510		
N17-M-56846-1784	B701A	N17-S-62279-2731	S504	N41-K-96-1225	O519A	CM50B223M	C1534		
N17-M-57281-5575	B501B	N17-S-63648-8151	S512	N41-K-96-1250	E316	CM50B472M	C536		
N17-R-51401-8526	K401B	N17-S-65209-6221	S501	N43-B-30001-5120	E120	CP29A1DF104M	C205		
N17-R-64270-5661	K101	N17-S-65221-1901	S502	N43-N-99500-118	O105	CP29A2DF104M	C1402		
N17-R-65474-2063	K801	N17-S-65228-6947	S314	N43-W-7590-15	O515	CP29A2DF504M	C1455		
N17-R-68408-5321	K316	N17-S-67096-7382	S401	G77-B-115-00619-2008	O531	CP40C2DF405V	C583		
N17-R-68418-4291	K305	N17-S-68271-6101	S701	G77-B-143-01032-2004	O530	CP53B1FF104X	C505		
N17-R-68418-4296	K323	N17-S-69036-1610	S518	G77-B-143-01532-2004	B501C	CP53B4EF104	C204		
N17-R-68422-9544	K312	N17-S-69036-1610	C519B	N77-S-14909-3725		CP53B5FF104X	C1116		
N17-R-68422-9546	K304	N17-S-690701-129	S104			CP54B1FF104V	C806		
N17-R-69516-1226	K315	N17-S-69145-1898	S522			CP54B1FF503K	C802		
N17-R-70651-1549	K313	N17-S-69524-3501	S511			CP54B5FF104V	C193		
N17-R-70651-1915	K306	N17-S-69556-6901	S1406			CP54B5FF104X	C125		
N17-R-70651-2125	K302	N17-S-69906-5256	S1101			CP61B1FF105V	C804		
N17-R-70651-2177	K402	N17-S-69906-5456	S1407			CP70B1DF106V	C1001		
N17-R-70651-2391	K301	N17-S-70412-4406	S324			CP70D1FR205K	C301		
N17-R-70651-2925	K320	N17-S-73766-5076	S307			CP70E1FG156K	C302		
N17-R-70651-3725	K303	N17-S-73959-1025	S1001						
N17-R-70651-3929	K311	N17-S-74139-7130	S101						
N17-R-70651-4331	K308	N17-S-91697-1054	S1102B						
N17-R-70714-3143	K318	N17-S-91897-8769	S1102A						
N17-R-72536-6968	K322	N17-S-91941-1004	S311A						

TABLE 8-6. CROSS REFERENCE PARTS LIST (Continued)

JAN (OR AWS) DESIGNATION	KEY SYMBOL	JAN (OR AWS) DESIGNATION	KEY SYMBOL	JAN (OR AWS) DESIGNATION	KEY SYMBOL	JAN (OR AWS) DESIGNATION	KEY SYMBOL
CP07FC4	C1001	RA25A1SA502AK	R554	RC30BF104J	R1440	RC42BF222K	R528
CP07FF1	C302	RB11B470ROF	R1443	RC30BF104K	R550	RC42BF223J	R1438
CP07FK4	C301	RB12B10R10F	R508	RC30BF123J	R1456	RC42BF223K	R221
CV11B130	C128A	RB12B111ROF	R506	RC30BF123K	R1472	RC42BF272K	R1431
CV11D500	C1406	RB12B2R00F	R565	RC30BF151K	R1109	RC42BF273K	R1417
CV12D121	C103	RB12B20R40F	R534	RC30BF153J	R1424	RC42BF274J	R1323
JAN-2C51	V101	RB12B5R030F	R529	RC30BF153K	R1421	RC42BF331K	R501
JAN-3B28	V307	RB12B6R710F	R1110	RC30BF154J	R1471	RC42BF332J	R1436
JAN-4B32	V301	RB12B71R40F	R1105	RC30BF184K	R335	RC42BF333K	R509
JAN-5R4GY	V1001	RB12B900ROF	R562	RC30BF221K	R1442	RC42BF334J	R1301
JAN-6AG7	V501	RC20BF100K	R1411	RC30BF222K	R1423	RC42BF393J	R1487
JAN-6AK5	V104	RC20BF101K	R124	RC30BF223J	R1437	RC42BF470K	R1112
JAN-6AK5W	V1407	RC20BF102K	R227	RC30BF223K	R162	RC42BF471K	R507
JAN-6AL5	V125	RC20BF103K	R110	RC30BF224J	R1445	RC42BF472K	R158
JAN-6AL5W	V1405	RC20BF104K	R101	RC30BF224K	R809	RC42BF473K	R610
JAN-6AS6	V105	RC20BF105K	R225	RC30BF271J	R1449	RC42BF562K	R1106
JAN-6BA6	V128	RC20BF120K	R1410	RC30BF273J	R133	RC42BF563K	R602
JAN-6BE6	V108	RC20BF122K	R207	RC30BF273K	R577	RC42BF683K	R606
JAN-6C4	V1409	RC20BF150K	R1409	RC30BF274K	R1489	RP151FE103	R519
JAN-6S17	V130	RC20BF151K	R104	RC30BF331K	R1465	RP301FD100KK	R326
JAN-6X4	V901	RC20BF152J	R1446	RC30BF332F	R807	RP301FE251KK	R302
JAN-807	V502	RC20BF153J	R154	RC30BF333K	R1107	RU3B1R2K	R1432
JAN-12AU7	V507	RC20BF153K	R243	RC30BF334K	R801	RW10F123	R318
JAN-12XA7	V801	RC20BF154K	R141	RC30BF392J	R1454	RW10F801	R312
JAN-OA2	V1005	RC20BF200J	R1433	RC30BF470K	R518	RW11F251	R301
JAN-OB3/VR-90	V1103	RC20BF220K	R1408	RC30BF471K	R557	RW11F501 (N.L.)	R343
MFA-405	R307	RC20BF221K	R132	RC30BF473K	R1103	RW12F5RO	R586
NS4W0104	E532	RC20BF222K	R102	RC30BF473M	R1001	RW13F103	R332
NS4W0105	E548	RC20BF222M	R242	RC30BF474K	R1434	RW13F163	R324
NS4W0106	E622	RC20BF223K	R145	RC30BF560K	R1414	RW13F203	R532
NS4W0206	E657	RC20BF270K	R1407	RC30BF561K	R164	RW13F203	R552
NS4W0208	E546	RC20BF273K	R107	RC30BF563J	R1447	RW13F312	R537
NS4W0308	E334	RC20BF330K	R1406	RC30BF563K	R1481	RW13F502	R553
NS4W0312	E364	RC20BF331K	R143	RC30BF564K	R811	RW13F632	R578
NS4W0316	E363	RC20BF333K	R111	RC30BF680K	R1422	RW14F103	R559
NS4W0324	E544	RC20BF390K	R1405	RC30BF681K	R187	RW14F103	R535
NS4W0424	E645	RC20BF393K	R125	RC30BF682J	R1427	RW14F123	R513
NS4W0432	E529	RC20BF470K	R146	RC30BF683K	R196	RW14F162	R345
NS4W0440	E655	RC20BF472K	R169	RC30BF820K	R1104	RW14F163	R311
NS4W2016	E534	RC20BF473K	R103	RC30BF822K	R1429	RW14F402	R320
NS4W4003	E664	RC20BF474K	R123	RC30BF823K	R1452	RW14F802	R512
NS4W4101	E644A	RC20BF561K	R127	RC42BF100K	R347	RW16F202	R531
NS4W4104	E530A	RC20BF680K	R1403	RC42BF101K	R527	RW16F252	R328
NS4W4201	E644B	RC20BF683K	R126	RC42BF102K	R198	RW30F631	R1435
NS4W4204	E530B	RC20BF820K	R1402	RC42BF103K	R1491	RW31G162	R199
NS4W4601	E323	RC20BF822K	R241	RC42BF104K	R549	RW32FR20 (±1%)	R544
RA20AIRH103AK	R1458	RC20BF823K	R130	RC42BF104M	R1003	RW32FIRO (±1%)	R565
RA20A1SD103AK	R1416	RC21BF154J	R235	RC42BF123K	R597	RW32F312	R1002
RA20A1SD502AK	R1439	RC21BF473J	R237	RC42BF124K	R605	RW33F8RO	R349
RA20A1SG252AK	R1464	RC21BF683J	R236	RC42BF151K	R569	SS-05A10	S518
RA20A1SG500AK	R1450	RC30BF101K	R814	RC42BF152K	R166	ST-26N	S101
RA20BIRH502AJ	R1485	RC30BF102K	R167	RC42BF154K	R517	ST-42A	S324
RA25A1FD502AK	R560	RC30BF103J	R1463	RC42BF220K	R346	ST-52N	S1001
RA25A1SA103AK	R570	RC30BF103K	R1311	RC42BF221K	R572	TSE7T101	XV104

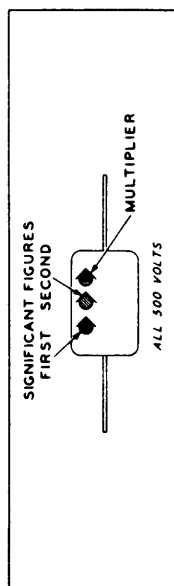
TABLE 8-6. CROSS REFERENCE PARTS LIST (CONT)

JAN (OR AWS) DESIGNATION	KEY SYMBOL	NAVY TYPE NUMBER	KEY SYMBOL	NAVY TYPE NUMBER	KEY SYMBOL	BUSHIPS DWG NUMBER	KEY SYMBOL
TSETT102	XV901	291789	S305	484986	C541	RE-49F-246 RE-49F-331H	J503
TSE9T101	XV101	291790	S306	49021A	J505		J104
TSE9T102	XV507	291791	S303	491014	J515		
TSFOT101	E121	291792	S302	491134A	J801		
TSFOT102	E122	291793	S301	491144	J101		
		291794	S304	491453	J511		
		29964	K302	491479	XK322		
		302298	T502	491973	J103		
		302715	L1412	491974	P102		
		304883	L1001	491975	XV504		
		304884	T1001	491976	P301		
		304885	T1002	491977	J302		
		304886	T307	491978	J1102		
		304887	T503	491979	J509		
		304888	L303	491980	P1102		
		304889	T309	492008	XY1101		
		304890	T310	49277	P104		
		304891	T301	49345	XV307		
		304892	L302	49363	XV502		
		304893	T902	49367	XV501		
		304894	T903	49384	XY101		
		304896	T311	49424	XV301		
		304898	L301	49584	XZ1101A		
		304899	T801	49664	P801		
		304975	T1101	49749A	P1001		
		40346	Y101	49809	J514		
		472506	L501	49844	J102		
		472507	T501	49903	P105		
		472508	L105	49994	J901		
		472509	L509	53560	T110		
		472510	L103	61295	E312		
		472511	L106	634098-20	R540		
		472512	L104	637312-20	R308		
		472513	L503	637317	R401		
		472514	T112	637318-V5	R591		
		472515	T111				
		472516	T103				
		472517	T106				
		472518	T101				
		472519	T104				
		481689-10	C521	AN-3102-14S-1S	J510		
		483457	C215	AN-3102-14S-7P	J1407		
		483458	C1419	AN-3102-16S-1P	J701		
		484969-10	C552	AN-3106-14S-1P	P515		
		484970	C535	AN-3106-16S-1S	P510		
		484971	C573	AN-3108-14S-7S	P1402		
		484972	C511	CR-27/U	Y1101		
		484973	C533	P-412-AB-1/16	J901		
		484974	C120	S-310-AB-1/16	J1001		
		484975-20	C518	TF-122/U	T401		
		484976	C212	UG-59A/U	P504		
		484977-10	C567	UG-88/U	P503		
		484978-10	C1301	UG-290/U	J104		
		484980-10	C527	UG-291/U	J503		

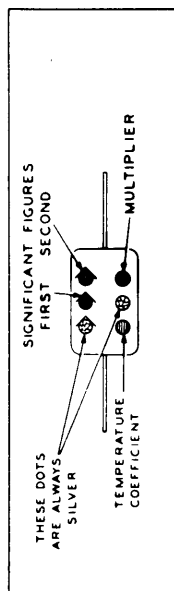
TABLE 8-7. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

CAPACITOR COLOR CODES

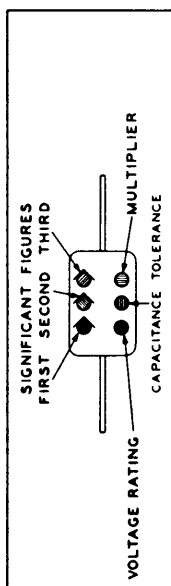
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



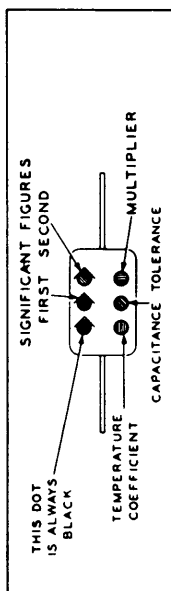
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



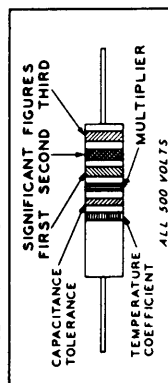
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



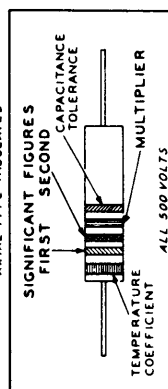
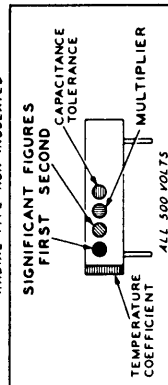
JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



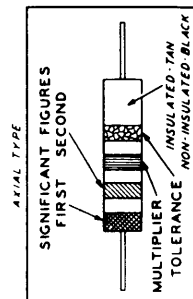
JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

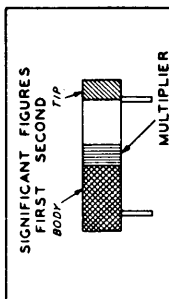
RESISTORS				CAPACITORS			
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING
1	1	0	BLACK	1	1	1	A
1	10	1	BROWN	10	10	10	B
1	100	2	RED	100	100	100	C
1	1000	3	ORANGE	1000	1000	1000	D
1	10000	4	YELLOW	10000	10000	10000	E
1	100000	5	GREEN	100000	100000	100000	F
1	1000000	6	BLUE	1000000	1000000	1000000	G
1	10000000	7	VIOLET	10000000	10000000	10000000	
1	100000000	8	GRAY	100000000	100000000	100000000	
1	1000000000	9	WHITE	1000000000	1000000000	1000000000	
5	0.1		GOLD	0.1	0.1	0.1	900
10	0.01		SILVER	0.01	0.01	0.01	1000
20			NO COLOR				2000
							500

RESISTOR COLOR CODES

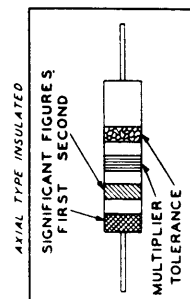
RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS



RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS



RADIAL TYPE NON-INSULATED

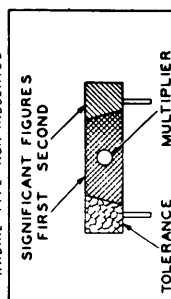


TABLE 8-7. (Cont'd) — HOOK-UP WIRE DESIGNATIONS

1. GENERAL

The hook-up wires used in the equipment are identified on the practical wiring diagrams by standard designations derived from the type, size and color codes given below. These codes are similar to those indicated in most Joint Army-Navy specifications.

2. DESIGNATIONS

Each designation is made up of a pair of letters indicating the type of wire and the size of wire, followed by one or more numerals indicating the body color and the colors of any tracers present.

a. TYPE OF WIRE CODE

LETTER	TYPE OF WIRE
A	
B	Busbar Round Tinned Copper
C	JAN Type WL (600 volts)
D	
E	
F	
G	General Electric Deltabeston
H	
J	Rockbestos Stranded, 1000v, type ACA
K	Neon Sign Cable (15,000 volts)
L	
M	Single Conductor, Stranded, 3000v
N	Single Conductor Stranded (Not Rubber)
P	Single Conductor Stranded (Rubber Covered)
Q	
R	JAN Type SRIR (1000 volts)
T	
V	JAN Type SRHV (2500 volts)

b. SIZE OF WIRE CODE

LETTER	SIZE	LETTER	SIZE
A	#22AWG	J	#6AWG
B	#20AWG	K	#4AWG
C	#18AWG	L	#2AWG
D	#16AWG	M	#1AWG
E	#14AWG	N	#0AWG
F	#12AWG	P	#00AWG
G	#10AWG	Q	#000AWG
H	#8AWG	R	#0000AWG

c. SHIELDING

When a wire is shielded this fact is indicated by insertion of the letter "S" between the alphabetical and numerical portions of the designation, as shown in the example in paragraph 3.

d. BODY COLOR AND COLORS OF TRACERS

The body color of the cover layer on insulated wires, and the colors of any tracers woven into it, are designated by standard RMA (also spec JAN-C-76) color code numerals, as follows:

0 Black 3 Orange 6 Blue
2 Red 5 Green 9 White

The six most contrasting colors have been used, and the others omitted, because of the difficulty of distinguishing similar colors in close quarters.

The following is a list of the combinations of body and tracer colors used in the equipment. Certain other color combinations are available, but have been omitted for clarity.

Body Color	First Tracer	Second Tracer	Color Cod Numerals
Black			0
Red			2
Orange			3
Green			5
Blue			6
White			9
White	Black		90
White	Red		92
White	Orange		93
White	Green		95
White	Blue		96
Green	Black		50
Green	White		59
Orange	Black		30
Orange	Green		35
Orange	White		39
Red	Black		20
Red	Orange		23
Red	Green		25
Red	White		29
Black	Red		02
Black	Orange		03
Black	Green		05
Black	White		09
White	Black	Red	902
White	Black	Orange	903
White	Black	Green	905
White	Red	Orange	923
White	Red	Green	925
White	Red	Blue	926
White	Orange	Green	935

3. EXAMPLES

Two examples of hook-up wire designations made up from the above codes are listed below: Note: When only one letter (not including an "S") appears in a designation prefix, it is assumed to indicate "wire size", and the "wire type" is assumed to be JAN type WL (600 volts).

a. Unshielded Wire, JAN Type WL, #22 AWG,
White with Red and Green Tracers

C	A	9	25
Type of Wire	Size of Wire	Color of Body	Colors of Tracers

b. Shielded Wire, JAN Type WL, #22 AWG,
White with Red and Green Tracers

C	A	S	9
Type of Wire	Size of Wire	Shielded	Color of Body
25			
Colors of Tracers			

Tabl 8-8. List f Manufacturers

MFR'S PREFIX	NAME	ADDRESS
CABU	Superior Electric Co.	32 Harrison St., Bristol, Conn.
CAE	Cutler Hammer Inc.	1333 West St. Paul Ave., Milwaukee, Wis.
CADI	Knight, James	Wells & Church Sts., Sandwich, Ill.
CAFB	Federal Electric Products Co.	50 Paris St., Newark, N. J.
CAI	Aladdin Radio Industries, Inc.	501 West 35th St., Chicago, Ill.
CAO	Ward Leonard Co.	6 South St., Mt. Vernon, N. Y.
CAOX	Automatic Electric Mfg. Co.	10 State St., Mankato, Minn.
CAQM	Gibbs & Co., Thomas B. (Division of George W. Borg Corp.)	Delavan, Wisconsin
CARO	Industrial Products Co.	Brookfield St., Danbury, Conn.
CAS	American Lava Corp. ("Alsimag")	Cherokee Blvd., Chattanooga, Tennessee
CASR	Pyle-National Co.	1340 West Kostner Ave., Chicago, Ill.
CATC	I L G Electric Ventilating Co.	2855 No. Crawford Ave., Chicago, Ill.
CATK	Acro Electric Co.	1305 Superior Ave., Cleveland, Ohio
CAUZ	Jeffers Electronics Co.	DuBois, Pa.
CAVS	Mepco, Inc.	78 Main St., Madison, N. J.
CAY	Westinghouse Elec. & Mfg. Corp.	East Pittsburgh, Pa.
CAYS	Drake Mfg. Co.	1713 W. Hubbard St., Chicago, Ill.
CAYF	Watlow Electric Mfg. Co.	2256 Dickson St., St. Louis, Mo.
CAYZ	Dial Light Corp. of America	900 Broadway, New York, N. Y.
CAZB	Globar Div. Carborundum Co.	Knupfer Bldg., Niagara Falls, N. Y.
CAZG	Jennings Radio Mfg. Co.	1098 East William St., San Jose 12, Calif.
CAZV	Aeronautical Radio Mfg. Inc.	Roosevelt Field, Mineola, N. Y.
CBGB	Sarkes Tarzian Co.	537 South Walnut St., Bloomington, Ind.
CBER	Phillips Control Co.	612 No. Michigan Ave., Chicago 11, Ill.
CBGZ	Kolton Electric Mfg. Co.	123 N. J. Railroad Ave., Newark 5, N. J.
CBI	Corning Glass Works	1945 Crystal St., Corning, N. Y.
CBJG	Cyclehm Motor Co., (Division of Howard Industries)	Racine, Wisconsin
CBKO	Electro-Switch Corp.	South Weymouth, Mass.
CBN	Central Radio Lab. ("Centralab")	900 East Keefe Ave., Milwaukee, Wis.
CBU	Isolantite, Inc.	343 Courtland St., Belleville, N. J.

Table 8-8. List of Manufacturers (Cont.)

MFR'S PREFIX	NAME	ADDRESS
CBY	Aircraft Radio Corp.	Boonton, N. J.
CBZ	Allen Bradley Co.	118 West Greenfield Ave., Milwaukee, Wis.
CCF	American Blower Corp.	6001-9 Russell St., Detroit, Mich.
CCX	Cramer, R. W., Inc.	Centerbrook, Conn.
CDA	Diehl Mfg. Co.	80 Trumbull St., Elizabethport, N. J.
CDM	Mossman, D. P. Co.	6021 No. Northeast H'way, Chicago, Ill.
CEB	Eby, Hugh H.	4700 Stenton Ave., Philadelphia, Pa.
CED	Cannon Elec. Devel. Corp.	3291 Humboldt St., Los Angeles 31, Calif.
CER	Erie Resistor Corp.	644 W. 12th St., Erie, Pa.
CEE	Edison, Thomas A. Inc.	West Orange, N. J.
CEJ	Johnson, E. F. Co.	Waseca, Minn.
CEP	Amperex Electronics Prods.	79 Washington S., Brooklyn, N. Y.
CFA	Bussman Mfg. Co.	2538 West University St., St. Louis, Mo.
CFT	Federal Telephone & Radio Corp.	100 Kingsland Road, Clifton, N. J.
CG	General Electric Co.	1 River Road, Schenectady, N. Y.
CGE	Guardian Electric Mfg. Co.	1623 West Walnut St., Chicago, Ill.
CGM	General Motors Co.	Detroit, Michigan
CGT	Trumbull Elec. Mfg. Co.	1936 Woodford St., Plainsville, Conn.
CHC	Hammarlund Mfg. Co.	460 West 34th St., New York City, N. Y.
CHH	Arrow-Hart & Hegeman Elec. Co.	102 Hawthorne St., Hartford, Conn.
CHN	Heinemann Circuit Breaker Co.	939 Plum St., Trenton, N. J.
CHU	Hubbel, Harvey, Inc.	447 Concord Ave., Bridgeport, Conn.
CIM	Eitel-McCullough	San Bruno, California
CIR	International Resistance Corp.	401 No. Broad St., Philadelphia, Pa.
CJA	Millen, James, Mfg. Co.	150 Exchange St., Malden, Mass.
CJC	Jones, H. B.	2300 West Wabansia Ave., Chicago, Ill.
CJE	Jefferson Electric Co.	910-25th Ave., Bellwood, Illinois
CLF	Littelfuse, Inc.	4765 Ravenswood Ave., Chicago, Ill.
CLI	Lectrohm, Inc.	5133 West 25th Place, Cicero, Ill.
CMA	Mallory, P. R. Co., Inc.	1941 Thomas St., Indianapolis, Ind.
CMG	Cinch Mfg. Co.	2339 West Van Buren St., Chicago, Ill.

Tabl 8-8. List of Manufacturers (Cont.)

MFR'S PREFIX	NAME	ADDRESS
CML	Meissner Mfg. Co.	Mt. Carmel, Ill.
CMU	Micro Switch Corp.	Freeport, Illinois
CNA	National Co., Inc.	61 Sherman Ave., Malden, Mass.
COC	Oak Mfg. Co.	1200 West Clybourne Ave., Chicago, Ill.
COL	Collins Radio Co.	Cedar Rapids, Iowa
COM	Ohmite Mfg. Co.	4835 West Fluornoy St., Chicago, Ill.
CPH	American Phenolic Corp.	1830 So. 54th Ave., Chicago, Ill.
CRK	Radio Condenser Co.	Camden, N. J.
CRP	Raytheon Mfg. Co.	190 Willow St., Waltham, Mass.
CSL	Solar Mfg. Corp.	588 Ave "A", Bayonne, N. J.
CSY	Sola Electric Co.	2525 Clybourne Ave., Chicago, Ill.
CSZ	Square-D Co.	6060 Rivard St., Detroit, Mich.
CTH	Thordarson Elec. & Mfg. Co.	500 West Huron St., Chicago, Ill.
CTR	Chicago Transformer Corp.	3501 Addison St., Chicago, Ill.
CUD	Audio Development Co.	28-33 So. 13th Ave., Minneapolis, Minn.
CUM	Mu Switch Corp.	863 Washington St., Canton, Mass.
CUT	United Transformer Corp.	148 Varick St., New York City
CV	Weston Elect., Instrument Co.	619 Frelinghuysen Ave., Newark, N. J.
CVV	Wiegand, Edwin L., Co.	7500 Thomas Blvd., Pittsburgh, Pa.
CVY	Faraday Electric Co.	Adrian, Michigan
CW	Western Electric Co.	120 Broadway, New York 5, N. Y.
CYA	Alden Products	117 North Main St., Brockton, Mass.
	Allied Electric Products	Irvington, N. J.
	Amalgamated Electronics Assoc.	Clinton Corners, N. Y.
	Driver-Harris Corp.	Harrison, N. J.
	Link Belt Co.	307 North Michigan Ave., Chicago, Ill.
	Multi Electric Mfg. Co.	1840 West 14th St., Chicago, Illinois
	Owens-Corning-Fiberglas (Dustop)	Toledo, Ohio
	Stevens Manufacturing Co.	1850 West Henderson St., Chicago 13, Ill.
	Winchester Electronic Co.	6 East 46th St., New York 17, N. Y.
	Rohden Co.	4739 Montrose Ave., Chicago 41, Ill.
	Waldes Koh-i-noor Inc.	4716 Austell Place, Long Island City, N. Y.

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