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MODEL FS-23

23 CHANNEL

CITIZENS BAND TRANSCEIVER

SONAR RADIO CORPORATION ..... BROOKLYN, NEW YORK 11207

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## FS-23 TRANSCEIVER

### SECTION 1 - SERVICE

#### 1 - 1. WARRANTY

SONAR RADIO CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument which is returned to the factory for that purpose and to replacing any defective parts thereof. This warranty on all parts is effective for one year after delivery to the original purchaser, and for free labor and servicing for ninety days after delivery to the original purchaser, provided that all instructions as to installation, use and operation are followed and the fault has not been caused by misuse, accidents, negligence, alteration, unauthorized repairs or has been damaged by excessive input power, lightning or water-flooding. Warranty of parts shall not include pilot lamps.

#### 1 - 2. SERVICE POLICY

If it is necessary to return an FS-23 to the factory, a letter should first be sent describing the basic trouble. If an authorized service and sales agency is close to the customer, the customer will be so informed; otherwise, the unit will be returned to the factory. Do not return the unit without factory authorization.

#### 1 - 3. CHANGES

Sonar Radio Corporation reserves the right to modify or change any design or equipment, mechanically or electrically, to any degree as is necessary without Sonar Radio Corporation being liable to modify, change or exchange previously delivered equipment.

### SECTION 2 - FCC

- 2 - 1. FCC Regulations state that the owner of any Citizens Band equipment must have in his possession a current copy of Part 95 of the FCC Rules and Regulations in addition to a Citizen's Band License to operate the same before transmitting any signals.
- 2 - 2. The FS-23 has been tested prior to shipment to comply with the FCC Rules and Regulations regarding power input, receiver radiation, spurious signal attenuation and frequency stability.

### SECTION 3 - DESCRIPTION

#### 3 - 1 A. GENERAL

The FS-23 is a 23 channel crystal-controlled transmitter and receiver unit with a self-contained power supply. A frequency synthesizer using 12 crystals determines the frequency of operation of both transmitter and receiver. Output

of the synthesizer is mixed with a 6 mc oscillator output for transmitting or with a 5.545 mc oscillator output for receiving. Fine tuning control is provided on the front panel so that the frequency of the 5.545 mc oscillator may be shifted to accommodate the reception of transmitters operating within the tolerances provided by the FCC.

A channel indicator and meter are illuminated to facilitate mobile operation at night. A large front-mounted speaker provides an ample amount of audio. A rear speaker jack is provided for an external speaker. The rear panel controls are adjusted during initial installation and do not need any attention except during periodic maintenance. The meter reads both relative power output and received signal strength. ("S" Meter) Zero adjustment of the "S" meter is provided on the rear panel. Independent power plugs are provided for 120 VAC or 12 VDC operation. The unused plug is automatically covered as protection from possible shock. The 120 VAC line cord is a 3 line cord as an added protection by grounding the chassis.

The FS-23 is constructed of heavy gauge aluminum for heavy-duty operation. A carrying handle serves as a mobile mounting bracket or as a tilt bar for desk-top operation. The cabinet is adequately ventilated. The perforated top and bottom are easily removed for servicing when so required.

Voice operation of the transmitter is accomplished with the plug-in Vox unit (an accessory). Merely speaking into the microphone will automatically turn the transmitter on. The transmitter turns off when the operator stops talking. Controls for the VOX unit are accessible from the side.

The FS-23 operation can be enhanced by eliminating all objectionable reception through the use of a Sonar-Call two-tone squelch (an accessory). The receiver will remain quiet and inoperative until the proper two tones are received by the FS-23. The use of Sonar-Calls provides a high degree of interference-free operation.

The transmitter is fully modulated by a Class "B" push-pull audio amplifier. The audio amplifiers are designed to restrict the audio to 300-3000 cycles. This provides maximum intelligibility under poor operating conditions.

When the optional VOX control and Sonar-Call are not installed, dummy plugs are provided to allow the FS-23 to operate normally.

### 3 - 1 B. SPECIFICATIONS

#### 1. RECEIVER:

<b>SENSITIVITY:</b>	0.4 microvolts for 10 db $\frac{S+N}{N}$
	1.0 microvolts for 20 db "
<b>SELECTIVITY:</b>	±2.5 kc @ -6 db
	±7.5 kc @ -60 db
<b>AGC:</b>	Output varies only 10 db @ inputs of 10 mv to 1 volt
<b>SQUELCH:</b>	Adjustable to open @ 0.5 to 300 microvolts

"S" METER: S9 denotes approximately 100 microvolts signal input  
NOISE LIMITER: Gated series type (switched)  
AUDIO OUTPUT: At least 2.5 watts @ 10% distortion  
AUDIO RESPONSE: 300 to 3000 cps @ -6 db  
HUM & NOISE: At least -60 db below full output  
IMAGE & SPURIOUS: Better than -60 db  
ADJACENT CHANNEL: Better than -80 db

## 2. TRANSMITTER:

R. F. INPUT POWER: 5 watts (FCC Regulations)  
R. F. OUTPUT POWER: 3.5 watts  
MODULATION: 100%  
R. F. OUTPUT IMPEDANCE: 35 - 70 ohms  
STABILITY: Better than .003% from -30 to +70° C and  
+10% input voltage variation  
PRIMARY POWER: 120 VAC @ 96 watts  
12 VDC @ 7.0 amp.  
SIZE: 11-3/4" W. x 5-3/4" H. x 11-3/4" D.  
WEIGHT: 15 lbs.

- NOTE: (1) All audio measurements are made with noise limiter off.
- (2) Sensitivity measurements are made with a 30% modulated signal source. The modulating frequency is 400 cycles.
- (3) Sensitivity measurements can vary 4 to 6 db due to production tolerances.

## 3 - 2. FRONT PANEL CONTROLS.

- a. Channel selector switches any one of 23 channels.
- b. Fine tuning allows the operator to "peak up" any received signal that is not exactly on frequency.
- c. Microphone jack accepts any ceramic microphone with a push-to-talk switch. (See 3 - 4)
- d. Volume controls the amount of audio output at the speaker. In the fully counter-clockwise position, the set is turned off.
- e. Squelch restricts the background noise until a signal is received. Maximum squelch requires a large signal to open the threshold.

- f. R. F. Gain adjusts the overall sensitivity of the receiver. This is necessary for reception of very strong signals that may have a tendency to distort.
- g. Panel space has been allotted for the installation of the Sonar-Call switch and light. A blank plate is normally supplied.

### 3 - 3. REAR PANEL CONTROLS.

- a. External Speaker: This jack allows an external permanent magnet speaker of 4 ohms impedance to be plugged in.
- b. Antenna: A UHF type connector is used. Any antenna system of 50 ohms impedance may be used.
- c. Antenna Loading: Makes up for any variation in antenna impedance from 35 to 70 ohms.
- d. Plate Tuning: Resonates the R. F. power amplifier to provide maximum output. (Usually adjusted on channel 10.)
- e. Noise Limiter: A switch to turn the noise limiter on and off, depending upon the need to do so.
- f. "S" Meter Zero: Adjusts "S" Meter to zero when antenna is disconnected.
- g. A pivoted plate between the two power plugs of the dual power supply version of the FS-23 will cover the unused plug and provide protection from voltage that appears at the unused plug.

### 3 - 4. MICROPHONE.

The microphone as supplied with the FS-23 is the ceramic type having the ceramic element connected directly to the plug and is not switched into the circuit by the "push-to-talk" button. This is necessary for VOX operation.

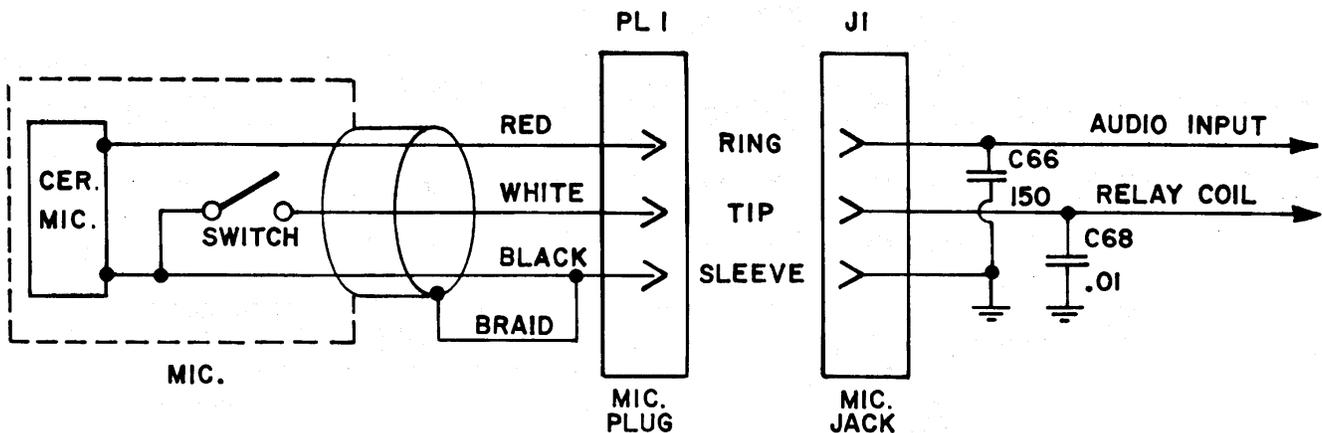
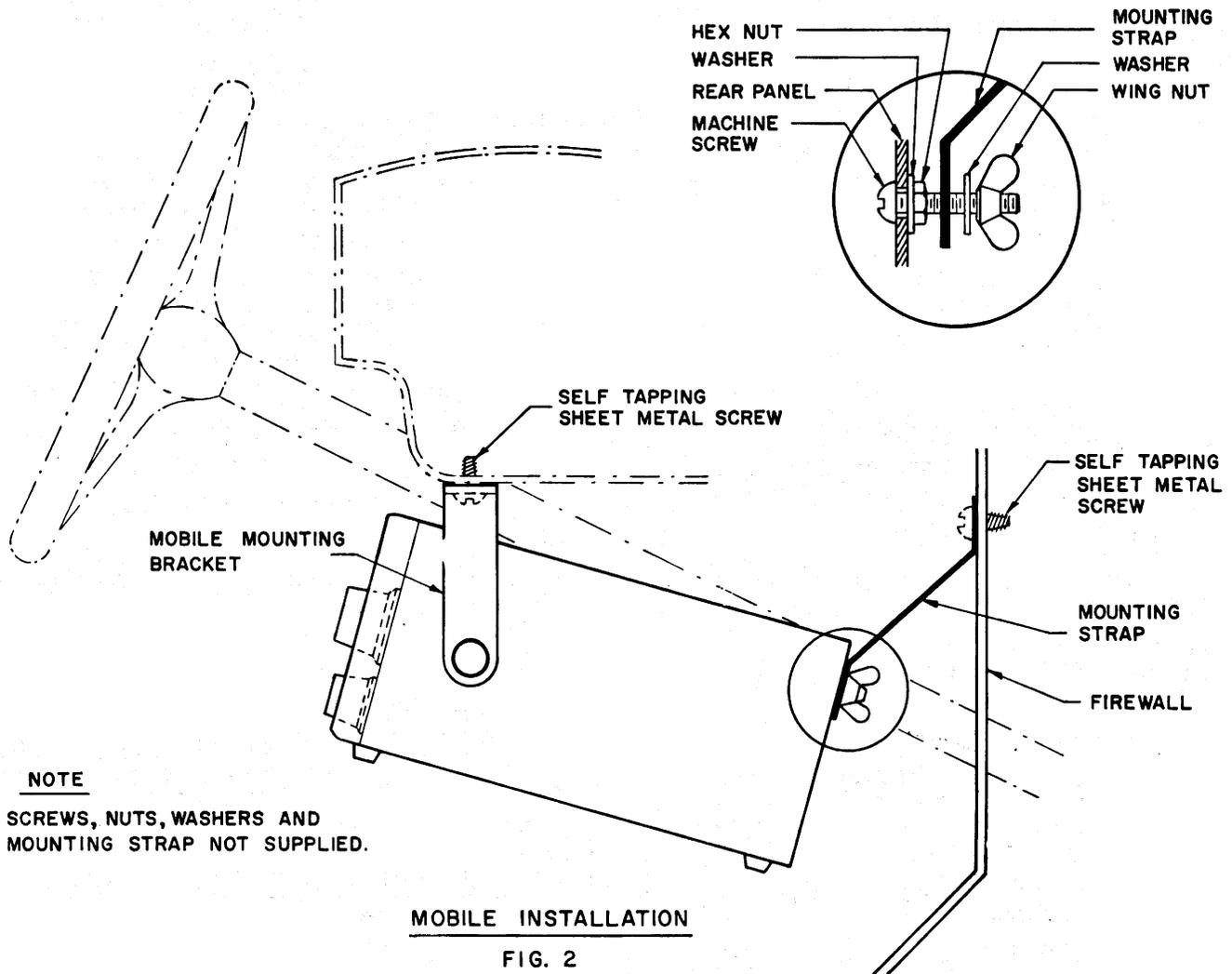


FIG. 1 MICROPHONE CIRCUIT

## SECTION 4 - INSTALLATION

### 4 - 1. MOBILE INSTALLATION

Mount the "U" bracket supplied with the FS-23 under the dash panel using the bracket itself as a location template. Drill holes for screws of the self-tapping type. If possible use bolt, nut and lockwasher. A hole is supplied on the rear panel of the FS-23 for an additional mounting strap. The use of a wing bolt on the rear will facilitate easy removal when servicing is necessary. Do not crowd the FS-23. Leave room for ventilation.



### 4 - 2. DC POWER - NEGATIVE GROUND ONLY!

The FS-23 power plug polarity must be carefully noted. The ground of the FS-23 is negative. Use No. 8 to 12 stranded wire for power leads. Be sure that voltage drops in the power leads are held to a minimum. Red designates the positive lead of the pre-wired DC power socket and cable. No. 12 wire is sufficient for 6 foot leads and No. 10 wire for 15 foot leads.

### 4 - 3. NOISE SUPPRESSION

The FS-23 Gated Noise Limiter is very effective in the reduction of noise, but this alone is not effective against all the different noises in a mobile installation. Particular attention is called to:

- a. Bonding. The use of 1" copper braid to interconnect parts of the automobile that can radiate noise such as:
  - (1) Hood to firewall
  - (2) Rear bumper to body and chassis
  - (3) Rear light fixtures to body
  - (4) Tailpipe to body
  - (5) Either side of muffler to body and chassis
  - (6) Chassis to body in several places
  - (7) Ignition coil body to firewall

When braid connections are made, be sure to clean the metal "bright" and coat with grease before tightening the connection. This will prevent contact corrosion which is the chief cause of noise.

A very good method for locating noisy fixtures is to put the FS-23 into operation and connect a 25' length of coaxial cable to the antenna connector on the rear of the FS-23. The other end of the coaxial cable should have the center conductor showing for about 1/2". This bare end of the coax will serve as a "noise probe." With the receiver volume turned up and noise limiter "off," touch the "noise probe" to all parts of the automobile (except the electrical system.) A large increase in noise will indicate a noisy section. This section should then be bonded and rechecked. Continue this process until a substantial reduction of noise is achieved. Remember, ungrounded metal parts can radiate noise.

- b. Ignition Radiation Suppression requires the use of resistor spark plugs, feed-thru capacitors and distributor suppressors. Of prime importance is a properly adjusted ignition system. The following steps will serve as a guide:
  - (1) Spark Plugs: Install resistor spark plugs or Belden IRS cable.
  - (2) Distributor cap: Install suppressor resistor or IRS cable between distributor cap and ignition coil.
  - (3) Generator: Install a 0.5 mfd coaxial capacitor (Sprague #48018 or equivalent) at the "A" terminal of the generator.
  - (4) Alternators: Require no attention except when the diodes become defective.
  - (5) Ignition Coil Primary: Install a 0.1 mfd coaxial capacitor (Sprague #48P9 or equivalent) in the lead from ignition switch to coil. Keep capacitor close to coil terminal. Brighten the metal around the coil mounting bracket to engine block, apply grease and retighten mounting screws.

- (6) (a) Regulator Field Terminal: Connect a 39 ohm resistor in series with a 0.01 mfd ceramic capacitor between the Field terminal and ground.
- (b) Armature Terminal: Insert 0.2 mfd coaxial capacitor (Sprague #48P18 or equivalent.)
- (c) Battery Terminal: Repeat (b).
- (7) Gauges: Install 0.5 mfd, 200 volt capacitors from terminals to ground.
- (8) Wheels and Tires: Inject special graphite powder into the tires available at automotive parts suppliers.

CAUTION: Do not connect any capacitor alone from the Field Terminal of the generator to ground. Read (6) (a) carefully.

#### 4 - 4. MOBILE ANTENNA.

The mobile antenna represents an electrical quarter wave-length at the operating frequency or physically represents 109". Shorter equivalents are the "loaded" type of antenna. This type of antenna can be bottom, center or top-loaded and is usually 5 feet in length. Another loaded type is the spiral-wound antenna.

The best type without a doubt is the 109" whip antenna. This is usually mounted on the rear bumper or low on the rear of the body. The shorter antenna is a compromise between efficiency and size, but in most cases can be relied upon to perform very well. It is very important that the coaxial antenna lead be between 14 to 18 feet to provide a low standing-wave ratio. RG-58A/U cable is recommended as a low-loss transmission line.

There are antenna mounts available to suit any installation. The most practical types are the swivel ball mount which is available for body mounting, and the coiled spring type which is used as a bumper mount. In certain instances, both the swivel ball and coil spring are used.

#### 4 - 5. MARINE ANTENNA.

The antenna system for a boat requires a ground plane antenna. The common name for such an antenna is "co-axial ground plane antenna." The boat ground system which usually consists of a ground plate is not efficient at 27 mc and therefore should not be relied upon for use with a simple whip antenna. This does not hold true if the boat is of all-metal construction.

The same bonding and ignition suppression techniques must be applied to a boat as to an automobile. In many cases a boat requires more work because the engine compartment is of wood, whereas an automobile has a hood and firewall to shield the engine. A boat's wooden engine compartment requires copper mesh shielding that is adequately connected to a bonded electrical system.

Bonding a boat's ground requires that all metal fittings that come in contact with the electrical system or water be continuously interconnected by 2" wide

copper "flashing" strips. The engine shaft will require a "wiper" resting on the shaft and connected to the bonded ground system. This "wiper" is usually a piece of spring steel resting on a cleaned portion of the shaft.

#### 4 - 6. BASE ANTENNA

The transmission line (antenna lead) of a Base installation may be lengthy even though the antenna is only 20' off a roof. In such an installation RG-8U cable (heavier than RG-58A/U) should be used to minimize the transmission line losses.

Base antenna falls into two categories:

- (a) Ground Plane types
- (b) Beam antenna types

Ground plane antennas are omni-directional. Beam antennas are uni-directional. If the FS23 is used in a restricted direction, a Beam will have a greater advantage since the antenna response will be concentrated in only one direction. The antenna should have an impedance of 50 ohms regardless of the type chosen.

#### SECTION 5 - OPERATION

After the FS-23 has been unpacked, inspected and connected to a power source, a suitable antenna of 50 ohm impedance should be connected through either RG-58 or RG-8 coaxial cable. RG-8 coaxial cable provides the least loss when a long antenna cable is necessary. (These cables and antennas may be ordered as an accessory from Sonar Radio Corporation.)

The FS-23 should be allowed to warm up for three minutes and the microphone button pressed. The meter will indicate R. F. output. The Antenna Loading and Plate Tuning controls should be carefully adjusted for maximum R. F. output. This adjustment is made on channels 9, 10 or 11. R. F. output on Channels 1 and 23 will be slightly lower, but this only represents a negligible amount of actual power.

The receiver should have controls set as follows:

Volume ----- 1/2 c. w.  
Squelch ----- full ccw (min)  
R. F. Gain ----- full cw (max)  
Fine Tuning ---- 1/2 c. w.

When a signal is received, conditions may be such that more than one station is transmitting on a channel. Reception can be improved by using the Fine Tuning and R. F. Gain control.

The setting of the Squelch control will vary, depending upon the noise conditions and location. Set the Squelch CW, when no signals are present, until the background noise disappears. The Squelch threshold will open when a signal is received.

Rotation of the Channel switch is continuous with no end stops from Channel 23 to 1 or from Channel 1 directly to 23. Signals from adjacent channels might be heard, but this is due to "sideband splatter" and is in no way a deficiency of the FS-23; in such cases the fault lies with the transmitter to which the operator is listening.

## SECTION 6 - CIRCUITRY

### 6 - 1. RECEIVER

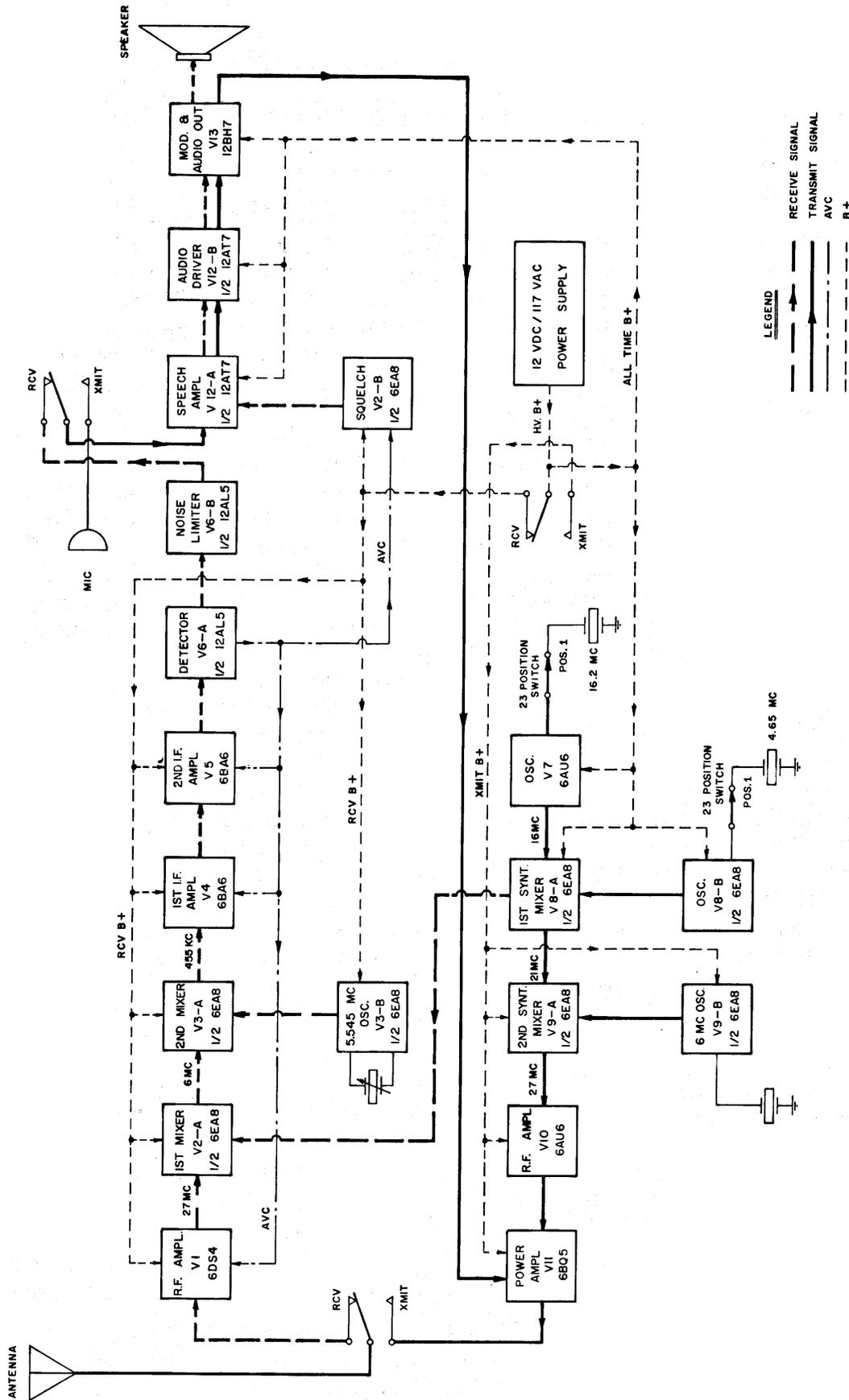
The received signal is fed through relay RY-1 to the R. F. Input coil L1. V1 (6DS4) is a low-noise neutralized triode amplifier. V1 is impedance coupled to V2-A (6EA8) where the signal is mixed with the output of the Frequency Synthesizer. F. S. injection is at pin 8 of V2-A from R43, C43 at T5 via C42. The resultant 6.0 mc IF signal is transformer coupled to V3-A (6EA8) where the output of V3-B (6EA8) mixes to produce the 455 kc IF. V3-B is a 5.545 mc crystal-controlled oscillator that is varied by the fine tuning control. D1 and D2 are diodes that act as variable capacitors when variable voltage is applied from the Fine Tuning control R12. Mixing takes place in the capacity coupled grids of V3. The 455 kc signal passes through a selective high gain amplifier system consisting of T2A, T2B, V4, T3, V5, and T4. The R. F. Gain controls the cathodes of V1 and V4. The amplified 455 kc signal is demodulated by V6A while V6B is a Gated Noise Limiter for the audio output that will appear at Volume Control R31.

### 6 - 2. TRANSMITTER

The Frequency Synthesizer is made up of a 16 mc oscillator V7-6AU6, a 4 mc oscillator V8B-6EA8, 1st synthesizer mixer V8A-6EA8 and 2nd synthesizer mixer V9A-6EA8. The output of T5 is 21 mc (as an example). V9B is a 6 mc crystal-controlled oscillator that mixes in V9A for a resultant signal of 27 mc (as an example). T6, L4 and L5 are tuned for 27 mc. V10-6AU6 is an R. F. Amplifier which raises the level of the 27 mc signal at T6 to drive the R. F. Power Amplifier V11-6BQ5 to full output. V11 is neutralized by C55. Neutralizing voltage is fed back from the plate of V11 via C55 to present an out-of-phase voltage at junction of L4, C54 and R51. L5 and C62 tune the plate of V11, while C63 matches the impedance of the antenna network for maximum transfer of power.

L6A suppresses harmonics and transfers a minute amount of power to L6B. D3 rectifies this R. F. energy and indicates relative power on M1. Mixing takes place at low impedance in the joined cathodes of V8 and V9.

R54 controls the screen voltage so that a plate input of 5 watts to V11 can be maintained. (FCC Regulations)



MODEL FS-23, BLOCK DIAGRAM

FIG. 3

### 6 - 3. AUDIO OUTPUT AND MODULATOR

V12A-12AT7 is a combination microphone amplifier and receiver speech amplifier. V12B is a speech amplifier which drives V13-12BH7. V13 is a push-pull Class B power amplifier with outputs either to drive a 4 ohm speaker or to modulate V11 to 100%.

V2B-6EA8 is an audio squelch tube operating with reference to AVC voltage. When no signal is received and no AVC voltage is present, R68 can be adjusted clockwise until V12A will not pass audio. When a signal is received and AVC voltage is applied to the grid of V2B, V12A will then pass audio to V12B.

### 6 - 4. CONTROL CIRCUITS

RY-1 is operated by grounding one side of the coil through the push-to-talk microphone switch.

The contacts of RY-1 switch:

- (1) High voltage B+ between transmitter and receiver.
- (2) Speech amplifier (V12A) between receiver output and microphone.
- (3) Speaker out during transmitting periods.
- (4) Antenna from receive to transmit.

### 6 - 5. POWER SUPPLY

The power supply can be operated from either a 117 VAC or 12 VDC source with negative ground. This is done by plugging either PL5 or PL4 into either SO5 or SO4. During 117 VAC operation, the Black and Brown leads of T9 supply filament voltage while the 117 VAC is fed to the two White leads of T9. During 12 VDC operation, Q1, Q2, T10 and T9 is a power oscillator operating at approximately 300 to 400 cycles. 12 volts is switched between the Green and Green/White leads to provide AC voltage for the secondary of T9.

## SECTION 7 - MAINTENANCE

### 7 - 1. ALIGNMENT

#### A. RECEIVER

- (1) Connect audio output meter to external speaker jack or connect VTVM to AVC line of V6A to measure negative AVC voltage (or use "S" meter).
- (2) Connect signal generator set at 6.0 mc to pin 2 of V3. The 6.0 mc signal should be checked for exact frequency using some standard.
- (3) Set controls:

Volume ..... 1/2 cw  
Squelch ..... ccw  
R. F. Gain ..... cw  
Fine Tuning ..... 1/2 cw (set at dot)  
Channel Switch ..... channel 10

- (4) Using just enough signal to give a reading of audio or AVC, align T2A, T2B, T3 and T4 for maximum indication. Always reduce signal input to that minimum which will give an indication.
- (5) Inject signal at Pin 9 of V2A. Adjust T1 for maximum indication.
- (6) Connect Signal Generator to antenna input and adjust to channel 10 such that maximum audio or AVC indication is observed.
- (7) Adjust L1 and L2 for further maximum indication.
- (8) Neutralization of V1. Unsolder B+ end of R4. Increase signal generator output for AVC indication. Adjust C4 for minimum AVC. Readjust L1 and L2 for maximum AVC. Resolder B+ end of R4. Decrease signal generator output to about 1 microvolt. Readjust L1 and L2. V1 is now neutralized.

## B. TRANSMITTER

- (1) Before any attempt is made to align the transmitter, it must be assumed that no adjustments have been indiscriminantly changed from what was done at the factory.
- (2) With the Signal Generator set for channel 10, connect the Signal Generator output to Pin 2 of V9A. Connect a VOM or VTVM to the junction of R52 and R53 using the 3 - 5 volt scale. Signal Generator output should be between 0.5 and 1.5 V RMS.
- (3) Adjust T6 and L4 for maximum (approximately minus 2 V) indication at R52 and R53.
- (4) L3 is adjusted for maximum negative voltage VTVM indication at Pin 2 of V8A.
- (5) T5 is adjusted for maximum negative voltage VTVM indication at terminal "F" of T5.
- (6) Adjust plate tuning control (C62) and antenna loading control (C63) for maximum indication of front panel RF Indicator.
- (7) If any of the oscillators are disabled by shorting the grid to ground, both the P. A. grid current and the power output should fall almost to zero. If either the grid current or power output drops to only half, it is an indication that the transmitter is improperly aligned.
- (8) The oscillator trimmers C28, C38A and C47A should not be adjusted unless a very accurate means is available to check the oscillator frequencies. If an accurate method is available, then the output frequency on all channels should be checked first. Any channel exceeding a tolerance of plus or minus 750 cycles should be checked by first checking the individual oscillators on all channels.
- (9) Neutralization of V11. This operation should not be necessary unless V11 oscillates without any drive applied or C55 has been tampered with.

Disconnect the yellow lead of the modulation transformer (T8) from the terminal strip. Disconnect the antenna from SO1. Connect a VOM to junction of R53, R52 and C57 to measure minus 2 VDC. Connect an RF Probe and VTVM or H. F. Oscilloscope to SO1. Energize the transmitter and adjust C55 for minimum indication at SO1. L4 and C62 should be peaked for maximum indication at SO1. Continue adjustment of C55 for

minimum indication and adjustment of L4 and C62 for maximum until no further change is noted. Voltage at R53 should be about minus 2 VDC. V11 is now neutralized.

(10) Measurement of V11 plate current.

Insert 0-50 milliammeter between yellow lead of T8 and terminal to which it was connected as in (9). This measures both plate and screen current. To compute plate power input, first subtract the screen current from the reading on the 0-50 milliammeter. Screen current is computed by dividing the voltage drop across the screen resistor by the value of the screen resistor. This is about 2 ma.

(11) Adjustment of relative power meter.

In the event that the relative power meter reading is too high or low, it can be adjusted in the following manner: Remove the top cover of the FS-23. L6A is located on the rear panel center. By moving link L6B closer to the center of L6A, a higher reading can be obtained. Moving the link further away from the center will give a lower reading. A drop of Duco cement will secure the link.

## 7 - 2. REPAIRS AND REPLACEMENT

### A. FREQUENCY SYNTHESIZER

In the event that neither the transmitter nor the receiver is operative for a group of channels, then reference to the schematic will indicate the crystal representing these channels. A replacement can be ordered and plugged in directly.

Frequency checks and adjustment of C28, C38A and C47A should not be undertaken unless an accurate Frequency Meter is available. The trimmers C28 and C38A adjust the frequency of the respective crystals so that their frequency deviations fall equally to either side of "zero" deviation. C47A is adjusted so that V9B oscillates at 6.000 mc.

Although the transmitter is permitted plus or minus 1300 cycles from the assigned channel frequency, the FS-23 should not (as a safety factor) fall beyond plus or minus 750 cycles.

### B. TUBE REPLACEMENT

All of the tubes in the FS-23 may be replaced without readjustment of the associated circuits except for the R. F. Power Amplifier V11 (6BQ5). If V11 is replaced, re-neutralization may be required. Neutralization is necessary when V11 will oscillate with no grid drive applied and the antenna disconnected.

**VOLTAGE CHART**

NO.	TUBE	* * PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 12
V1	6DS4	T	—	—	—	—	—	—	—	—	—	6.3 VAC
		R	+100	—	-0.9	—	—	—	—	0	—	0
V2	6EA8	T	—	—	—	—	6.3 VAC	—	—	—	—	—
		R	+200	-1.0	+30	0	6.3 VAC	+0.3	0	+6.0	0	—
V3	6EA8	T	—	—	—	6.3 VAC	12.6 VAC	—	—	—	—	—
		R	+60	-1.2	+70	6.3 VAC	12.6 VAC	+70	0	0	-20	—
V4	6BA6	T	—	—	6.3 VAC	—	—	—	—	—	—	—
		R	-0.9	0	6.3 VAC	0	+275	+110	+0.9	—	—	—
V5	6BA6	T	—	—	6.3 VAC	—	—	—	—	—	—	—
		R	-0.9	0	6.3 VAC	0	+275	+125	+1.2	—	—	—
V6	12AL5	T	—	—	12.6 VAC	—	—	—	—	—	—	—
		R	+0.4	+0.1	12.6 VAC	0	+0.8	0	-0.1	—	—	—
V7	6AU6	T	-3.85 *	0	6.3 VAC	0	+280	+190	+3.25 *	—	—	—
		R	-3.85 *	0	6.3 VAC	0	+280	+190	+3.25 *	—	—	—
V8	6EA8	T	+225	-22 *	+160	6.3 VAC	12.6 VAC	+280	+0.2 *	+0.2 *	-27 *	—
		R	+225	-22 *	+160	6.3 VAC	12.6 VAC	+280	+0.2 *	+0.2 *	-27 *	—
V9	6EA8	T	+190	-20 *	+110	6.3 VAC	12.6 VAC	+280	+0.2 *	+0.2 *	-25 *	—
		R	—	-15 *	—	6.3 VAC	12.6 VAC	—	—	—	—	—
V10	6AU6	T	-8.0 *	0	12.6 VAC	6.3 VAC	+280	+200	0	—	—	—
		R	—	—	12.6 VAC	6.3 VAC	—	—	—	—	—	—
V11	6BQ5	T	—	-48 *	0	6.3 VAC	12.6 VAC	—	+275	—	+120	—
		R	—	—	—	6.3 VAC	12.6 VAC	—	—	—	—	—
V12	12AT7	T	+280	0	+3.8	0	0	+80	0	+5.3	6.3 VAC	—
		R	+280	0	+3.8	0	0	+270	+2.8	+23.5	6.3 VAC	—
V13	12BH7	T	+280	0	+9.0	0	0	+280	0	+12.0	6.3 VAC	—
		R	+280	0	+9.0	0	0	+280	0	+12.0	6.3 VAC	—

**LEGEND**

\* VOLTAGE MEASUREMENTS MADE WITH ADDITIONAL 1 MEG RESISTOR CONNECTED IN SERIES WITH D.C. PROBE. (KEEP RESISTOR LEADS AS SHORT AS POSSIBLE)  
 \*\* POSITION: T- TRANSMIT, R- RECEIVE

**NOTES**

- |   |  |
|---|--|
| <ol style="list-style-type: none"> <li>1. VOLUME, SQUELCH AND R.F. GAIN AT FULL CW ROTATION.</li> <li>2. FINE TUNING AT MID RANGE (KNOB POINTER ALIGNED WITH DOT ON PANEL)</li> </ol> | <ol style="list-style-type: none"> <li>3. NOISE LIMITER SWITCH ON</li> <li>4. VOLTAGE MEASUREMENTS MADE WITH A VTVM (11 MEGOHM INPUT)</li> <li>5. ALL VOLTAGE MEASUREMENTS MADE FROM SOCKET PIN TO GROUND (CHASSIS)</li> <li>6. OPERATING PRIMARY VOLTAGE IS 117 VAC</li> <li>7. ALL VOLTAGES D.C. UNLESS OTHERWISE INDICATED.</li> <li>8. VOLTAGE MAY VARY ±15%.</li> </ol> |
|---|--|

**RESISTANCE CHART**

NO.	TUBE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 12
V1	6DS4		70 K		3.6 MEG.				0		FIL.	FIL.
V2	6EA8	73 K	3.7 MEG.	73 K	FIL.	FIL.	400 K	0	2.2 K	100 K		
V3	6EA8	96 K	100 K	73 K	FIL.	FIL.	73 K	0	0	12 K		
V4	6BA6	2.6 MEG.	0	FIL.	FIL.	41 K	90 K	62				
V5	6BA6	2.6 MEG.	0	FIL.	FIL.	41 K	62 K	62				
V6	12AL5	1.2 MEG.	1.3 MEG.	FIL.	FIL.	1.1 MEG.	0	47 K				
V7	6AU6	100 K	0	FIL.	FIL.	40 K	87 K	470				
V8	6EA8	44 K	100 K	140 K	FIL.	FIL.	41 K	14	14	100 K		
V9	6EA8	INF	100 K	INF	FIL.	FIL.	INF	14	14	100 K		
V10	6AU6	100 K	0	FIL.	FIL.	INF.	INF.	0				
V11	6BQ5	I.C.	28 K	0	FIL.	FIL.	INF.	INF.	INF.	INF.		
V12	12AT7	40 K	470 K	1 K	FIL.	FIL.	500 K	2.5 MEG.	15 K	FIL.		
V13	12BH7	40 K	150	220	FIL.	FIL.	40 K	110	220	FIL.		

**NOTES**

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. POWER SWITCH - "OFF".</li> <li>2. VOLUME, SQUELCH, R.F. GAIN AND "S" METER ZERO AT FULL CW ROTATION.</li> <li>3. FINE TUNING AT MID RANGE (KNOB POINTER ALIGNED WITH DOT ON PANEL)</li> </ol> | <ol style="list-style-type: none"> <li>4. NOISE LIMITER SWITCH ON.</li> <li>5. ALL RESISTANCE MEASUREMENTS MADE FROM SOCKET PIN TO GROUND. (CHASSIS)</li> <li>6. ALL RESISTANCE VALUES ARE IN OHMS.</li> <li>7. RESISTANCE MAY VARY ±15%.</li> <li>8. I.C. = INTERNAL CONNECTION</li> </ol> |
|---|---|

Section 8 Parts Identification

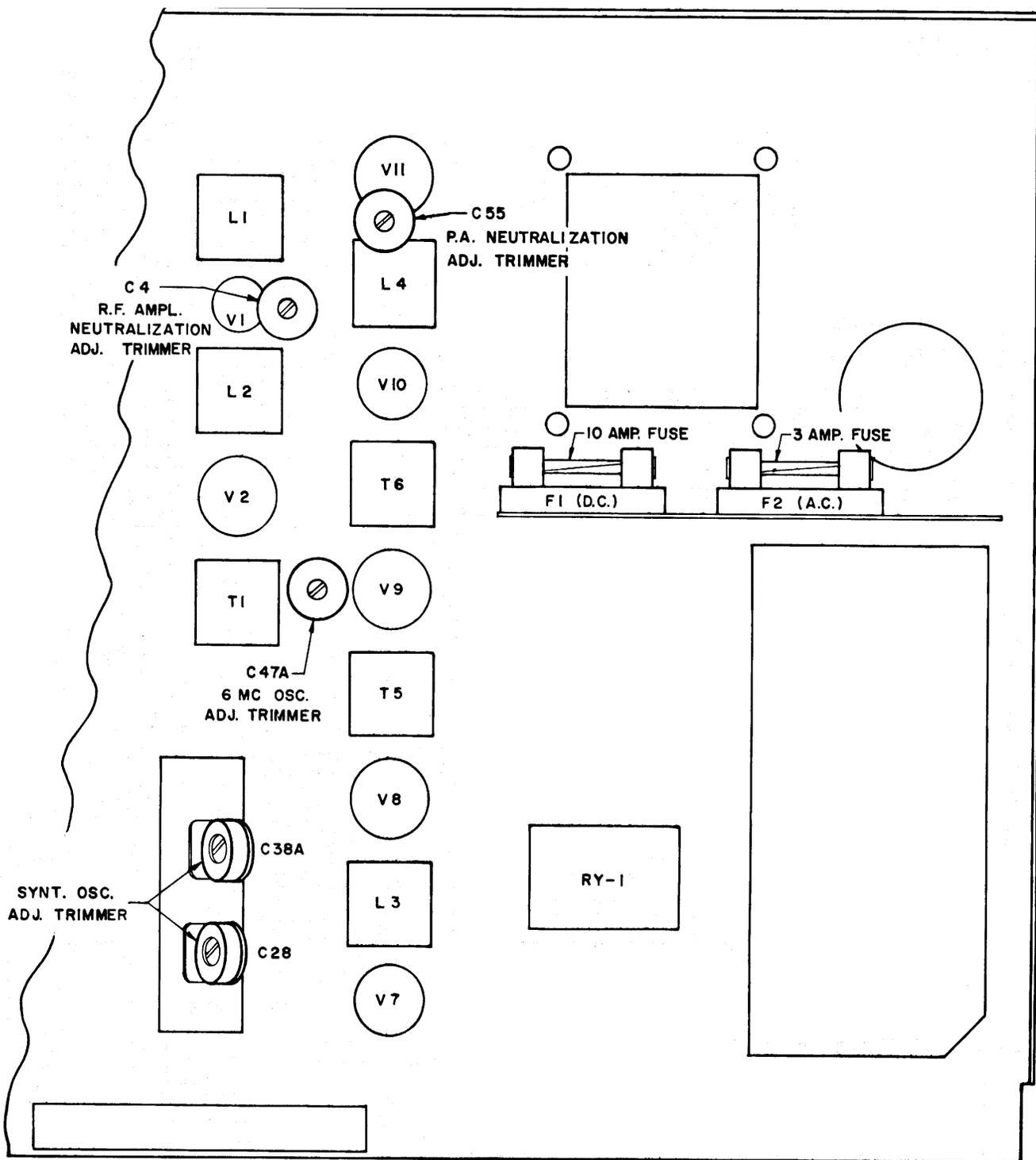


FIG. 4 NEUTRALIZATION & FREQUENCY ADJUSTMENT

BOTTOM VIEW



MODEL FS-23 PARTS LIST

DIAGRAM NO.	DESCRIPTION	SONAR PART NO.	*LIST PRICE
V1	Electron Tube, 6DS4 (Navistor)	19-010-053	\$ 4.40
V2, V3, V8, V9	Electron Tube, 6EA8	19-010-026	2.75
V4, V5	Electron Tube, 6BA6	19-010-010	1.90
V6	Electron Tube, 12AL5	19-010-022	1.80
V7, V10	Electron Tube, 6AU6	19-010-012	2.00
V11	Electron Tube, 6BQ5	19-010-052	2.30
V13	Electron Tube, 12BH7	19-010-005	2.85
D1, D2	Electron Tube, 12BH7	19-010-020	2.90
D3	Diode, Silicon, 600 PIV	19-040-002	1.00
B1	Bulb, Pilot, #1892	19-050-001	0.75
	Crystal, 4.765 mc	40-010-005	5.00
	Crystal, 4.775 mc	40-010-006	5.00
	Crystal, 4.785 mc	40-010-007	5.00
	Crystal, 4.805 mc	40-010-008	5.00
	Crystal, 16.200 mc	40-010-009	5.00
	Crystal, 16.250 mc	40-010-010	5.00
	Crystal, 16.300 mc	40-010-011	5.00
	Crystal, 16.350 mc	40-010-012	5.00
	Crystal, 16.400 mc	40-010-013	5.00
	Crystal, 16.450 mc	40-010-014	5.00
	Crystal, 6.000 mc	40-010-015	5.00
	Crystal, 5.545 mc	40-010-016	5.00
M1	Meter, 0-1 mA	32-010-010	10.00
L1	Coil, Antenna	22-030-013	3.00
L2	Coil, Receiver R. F. Plate Tuning	22-070-005	3.00
L3	Coil, 16 mc Osc. Plate Tuning	22-070-007	3.00
L4	Coil, R. F. Ampl. Plate Tuning	22-070-008	3.00
L5	Coil, P. A. Plate Tuning	22-070-001	2.00
L6A	Coil, Low Pass Filter	22-090-003	1.00
L6B	RF Indicator Link		
T1	(1 turn of wire lead on L6A)		
T2-A, T2-B, T3, T4	Transformer, I. F., 6 mc	22-050-018	3.00
T5	Transformer, I. F., 455 kc	22-010-020	3.00
T6	Transformer, Mixer, 21 mc	22-050-017	3.00
T7	Transformer, Driver	22-050-016	3.00
T8	Transformer, Modulation	14-020-001	5.00
RFC 1	Choke, Radio Frequency 1.8 UH	14-050-009	7.50
RFC 2	Choke, Radio Frequency, 1 UH	22-060-022	0.75
RFC 3	Choke, Radio Frequency, 21 UH	22-060-023	0.75
RFC 4, 5	Choke, Radio Frequency, 134 UH	22-060-005	1.00
RY-1	Relay, 4PDT, 110 VDC	22-060-004	1.00
SP 1	Speaker, Oval	16-010-011	7.50
SW-1	Frequency Synthesizer Assembly	36-042-608	5.00
R12	Switch, Slide, SPST, Noise Limiter	51-010-004	20.00
R68	Resistor, Variable, Composition 500 K Ohm, Fine Tuning Control	10-020-005	1.00
R31	Resistor, Variable, Composition 500 K Ohm, Squelch Control	03-504-003	2.00
SW-2	Resistor, Variable, Composition 500 K Ohm, Volume Control	03-504-037	2.50
R18	Resistor, Variable, Composition 5 K Ohm, R. F. Gain Control	03-502-036	2.00
R56	Resistor, Variable, Composition 100 K Ohm, "S" Meter Zero Control	03-104-028	2.00

DIAGRAM NO.	DESCRIPTION	SONAR PART NO.	*LIST PRICE
R1, 34, 72, 31A	Resistor, Fixed, Composition 47 K Ohm, ±10%, 1/2 w	01-473-531	\$ 0.25
R2, 5, 8, 11, 14, 16, 22, 32, 37, 38, 41, 43, 46, 48, 29	Resistor, Fixed, Composition 100 K Ohm, ±10%, 1/2 w	01-104-531	0.25
R3, 21, 25, 35, 42, 47, 51, 53, 71	Resistor, Fixed, Composition 1 K Ohm, ±10%, 1/2 w	01-102-531	0.25
R6, 17, 23	Resistor, Fixed, Composition 62 Ohm, ±10%, 1/2 w	01-620-531	0.25
R6A, 37A	Resistor, Fixed, Composition 2.2 K Ohm, ±10%, 1/2 w	01-222-531	0.25
R33	Resistor, Fixed, Composition 470 Ohm, ±10%, 1/2 w	01-471-531	0.25
R13, 44, 59, 67	Resistor, Fixed, Composition 220 K Ohm, ±10%, 1/2 w	01-224-531	0.25
R26	Resistor, Fixed, Composition 2.2 M Ohm, ±10%, 1/2 w	01-225-531	0.25
R36, 63, 65	Resistor, Fixed, Composition 10 K Ohm, ±10%, 1/2 w	01-103-531	0.25
R64	Resistor, Fixed, Composition 4.7 K Ohm, ±10%, 1/2 w	01-472-531	0.25
R49	Resistor, Fixed, Composition 10 Ohm, ±10%, 1/2 w	01-100-531	0.25
R52	Resistor, Fixed, Composition 27 K Ohm, ±10%, 1/2 w	01-273-531	0.25
R50, 61, 28	Resistor, Fixed, Composition 1 M Ohm, ±10%, 1/2 w	01-105-531	0.25
R62	Resistor, Fixed, Composition 390 K Ohm, ±10%, 1/2 w	01-394-531	0.25
R69, 70	Resistor, Fixed, Composition 470 K Ohm, ±10%, 1/2 w	01-474-531	0.25
R27	Resistor, Fixed, Composition 56 K Ohm, ±10%, 1/2 w	01-563-531	0.25
R10	Resistor, Fixed, Composition 12 K Ohm, ±10%, 1/2 w	01-123-531	0.25
R12A	Resistor, Fixed, Composition 18 K Ohm, ±10%, 1/2 w	01-183-531	0.25
R39	Resistor, Fixed, Composition 4.7 K Ohm, ±10%, 1 w	01-472-631	0.35
R45	Resistor, Fixed, Composition 10 K Ohm, ±10%, 1 w	01-103-631	0.35
R50, 57	Resistor, Fixed, Composition 33 K Ohm, ±10%, 1 w	01-333-631	0.35
R55	Resistor, Fixed, Composition 15 K Ohm, ±10%, 1 w	01-153-631	0.35
R20	Resistor, Fixed, Composition 100 K Ohm, ±10%, 1 w	01-104-631	0.35
R73	Resistor, Fixed, Composition 220 Ohm, ±10%, 1 w	01-221-631	0.35
R4	Resistor, Fixed, Composition 27 K Ohm, ±10%, 2 w	01-273-731	0.50
R19, 24	Resistor, Fixed, Composition 47 K Ohm, ±10%, 1 w	01-473-631	0.35
R30	Resistor, Fixed, Composition 180 K Ohm, ±10%, 1/2 w	01-184-531	0.25
R66	Resistor, Fixed, Composition 100 K Ohm, ±10%, 2 w	01-104-731	0.50
R7, 15	Resistor, Fixed, Composition 33 K Ohm, ±10%, 2 w	01-333-731	\$ 0.50
R13A	Resistor, Fixed, Composition 56 K Ohm, ±10%, 2 w	01-563-731	0.50
C62	Capacitor, Variable, Air Plate Tuning, 3.9 - 31.9 mmfd	08-150-012	3.00
C63	Capacitor, Variable, Compression Mica, Antenna Loading, 100-500 mmfd	09-210-001	1.50

MINIMUM ORDER - \$5.00. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

MODEL FS-23 PARTS LIST

DIAGRAM NO.	DESCRIPTION	SONAR PART NO.	*LIST PRICE
J1	Jack, Microphone	15-010-001	\$ 0.75
J2	Jack, External Speaker	15-010-003	0.75
SO1	Connector, Antenna, SO-239	15-120-001	1.50
	Front Panel	11-020-043	7.50
	Left Side Cover	11-080-028	5.00
	Right Side Cover	11-080-027	5.00
	Top or Bottom Cover	11-080-006	5.00
	Mobile Mount (Gimbal)	28-070-006	5.00
	Instruction Manual	44-010-020B	2.00

117 VAC/12 VDC POWER SUPPLY

DIAGRAM NO.	DESCRIPTION	SONAR PART NO.	*LIST PRICE
T9	Transformer, Power	14-010-032	\$ 15.00
T10	Transformer, Transistor Oscillator	14-110-002	5.00
Q1, Q2	Transistor, Power, MSP-1161-1	19-020-018	5.00
CH 1	Choke, Filter, 0.5 Henries	14-100-001	4.00
CH 2	Choke, Hash	22-100-002	1.00
CH 3	Choke, Hash	22-100-003	1.00
F1	Holder, Fuse	42-020-003	0.50
F2	Fuse, 3AG, 10 AMP	42-010-008	0.25
D4, D5, D6, D7	Fuse, 3AG, 3 AMP	42-010-012	0.25
C84	Diode, Silicon, 600 pIV	19-040-002	1.00
	Capacitor, Fixed, Electrolytic	06-140-015	2.00
	40 mfd, 450 VDC		
	Capacitor, Fixed, Electrolytic	06-450-037	5.00
	Can, 4 Sections		
C81	1500 MFD, 15 VDC		
C82	30 MFD, 350 VDC		
C83	30 MFD, 350 VDC		
C85	20 MFD, 200 VDC		
R74	Resistor, Fixed, Wirewound	02-181-422	0.50
	180 Ohm, ±10%, 1 w		
R75	Resistor, Fixed, Composition	01-221-631	0.35
	220 Ohm, ±10%, 1 w		
R76	Resistor, Fixed, Composition	01-479-531	0.25
	4.7 K Ohm, ±10%, 1/2 w		
R77	Resistor, Fixed, Composition	01-472-631	0.35
	4.7 K Ohm, ±10%, 1 w		
PL5	Plug, Power, 8 contacts	13-070-001	0.75
PL4	Plug, Power, 11 contacts	13-070-002	0.50
	Shell, Power Plug	26-080-001	0.50
	Cable, Power, 117 VAC	Assembly	7.95
	Cable, Power, 12 VDC	Assembly	5.95
SO 5	Socket, Power, 8 contacts	13-030-001	0.50
SO 4	Socket, Power, 11 contacts	13-080-001	0.50
	Power Socket Cap w/ Cable Clamp	26-040-001	0.50
	Line Cord, #18 S J3	38-150-008	2.00
	3 Wire Line Cord Adapter	15-014-001	1.00

DIAGRAM NO.	DESCRIPTION	SONAR PART NO.	*LIST PRICE
C4, 28, 38A, 47A, 55	Capacitor, Variable, Ceramic	09-610-017	\$ 1.50
	Trimmer, 3-12 mmfd		
C14	Capacitor, Fixed, Ceramic	04-396-001	0.50
	3.9 mmfd, 1 KV, NPO		
C1, 1A, 2, 7, 12	Capacitor, Fixed, Ceramic	04-255-001	0.50
	25 mmfd, 1 KVDC, NPO		
C3, 31, 49A, 51, 58, 59, 67, 74, 79, 80, 84	Capacitor, Fixed, Ceramic	04-103-004	0.50
	.001 mfd, 500 VDC		
C5, 20, 23, 42, 69A, 78	Capacitor, Fixed, Ceramic	04-102-014	0.50
	.01 mfd, 100 VDC		
C6, 11, 14A, 17, 18, 21, 22, 24, 25, 33, 36, 37, 40, 45, 46, 49, 52, 68, 69, 71	Capacitor, Fixed, Ceramic	04-102-012	0.50
	.01 mfd, 600 VDC		
C26	Capacitor, Fixed, Ceramic	04-502-003	0.75
	.05 mfd, 100 VDC		
C29, 38, 39, 41, 47	Capacitor, Fixed, Ceramic	04-165-001	0.50
	16 mmfd, 1 KVD, NPO		
C32, 34, 53	Capacitor, Fixed, Ceramic	04-105-001	0.50
	10 mmfd, 1 KVD, NPO		
C48, 50	Capacitor, Fixed, Ceramic	04-305-001	0.50
	30 mmfd, 1 KVD, NPO		
C57, 11A	Capacitor, Fixed, Ceramic	04-503-003	0.50
	.005 mfd, 100 VDC		
C60, 76, 77	Capacitor, Fixed, Ceramic	04-103-016	0.50
	.001 mfd, 1400 VDC		
C19, 25A	Capacitor, Fixed, Ceramic	04-226-007	0.50
	(Ghimnicke) 2.2 mmfd		
C43, 27A	Capacitor, Fixed, Ceramic	04-474-010	0.50
	470 mmfd, 1 KVDC		
C8, 56	Capacitor, Fixed, Dipped Mica	07-505-002	0.50
	50 mmfd, 500 VDC		
C35, 44	Capacitor, Fixed, Dipped Mica	07-124-002	0.50
	120 mmfd, 500 VDC		
C66	Capacitor, Fixed, Ceramic	04-154-002	0.50
	150 mmfd, 1 KVDC		
C70, 81, 82	Capacitor, Fixed, Ceramic	04-101-003	0.50
	0.1 mfd, 100 VDC		
C9, 13, 15, 16, 27	Capacitor, Fixed, Dipped Mica	07-204-002	0.50
	200 mmfd, 500 VDC		
C54	Capacitor, Fixed, Dipped Mica	07-344-008	1.00
	340 mmfd, 500 VDC		
C10	Capacitor, Fixed, Dipped Mica	07-264-002	0.75
	260 mmfd, 500 VDC		
C26A	Capacitor, Fixed, Ceramic	04-203-016	0.50
	.002 mfd, 1 KVDC		
C30	Capacitor, Fixed, Dipped Mica	07-855-007	0.50
	85 mmfd, 300 VDC		
C20A, 72	Capacitor, Fixed, Electrolytic	06-530-043	1.00
	5 mfd, 64 VDC		
C75	Capacitor, Fixed, Electrolytic	06-950-038	3.00
	Can, 3 Sections		
C73	5 MFD, 50 VDC		
C86	10 MFD, 350 VDC		
	40 MFD, 250 VDC(Used in Power Supply)		
	Microphone Assembly	57-010-006	17.95
	Knob, Control	33-010-010	0.75
	Knob, Channel Selector	33-020-005	1.50

MINIMUM ORDER - \$5.00. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

