SPECIAL REPRINT

The Narco VTR-2A Series
OMNIGATOR MARK II

with ***narco*** VTR-1, V12MP-2A, V24MP-2A Schematics

MAINTENANCE MANUAL

MANUFACTURED BY

NARCO AVIONICS

DIVISION OF NARCO SCIENTIFIC INDUSTRIES

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Warranty

We have designed and constructed this equipment using the finest materials and components available. It has been thoroughly tested and inspected before leaving our factory.

NARCO warrants your new VTR-2A OMNIGATOR against all defects in workmanship or material on components and parts manufactured by us for a period of ninety (90) days from the date of original installation. We will replace any part of our manufacture which proves to be defective within this time under normal installation and operating conditions (except receiving-type tubes and fuses), provided the defective part is returned, transportation charges prepaid, either to the factory or to a NARCO Authorized Warranty Service Center.

To place your warranty in effect you must complete the enclosed Warranty Application Card and mail it to us within ten (10) days after your new installation is completed. By return mail you will receive your NARCO Warranty Certificate recognized by any NARCO Authorized Service Agency.

NARCO AVIONICS
Division of Narco Scientific Industries
FORT WASHINGTON, PA. 19034

Perfection in Electronics

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SECTION I . . OPERATION

A. RECEIVER

A-1. FUNCTION SWITCH

The five position rotary switch on the lower left part of the front panel turns the power to the entire set OFF and ON, and serves to select the desired type of operation. Its five positions are as follows:

1. OFF — All power to set and power unit shut off.
2. COM — For communication use.
3. CAL — For tuning receiver to transmitter frequency.
4. VOR — For Omni-Range operation.
5. LOC — For ILS localizer approach.

A-2. TUNING DIAL

The dial is calibrated directly in megacycles from 108.0 to 127.0. Stations are tuned in the customary manner. The tunable frequency band is divided as follows:

1.	108.1 to 111.9	Omni-Range Stations, VOR and TVOR I.L.S. Localizers.
2.	112.1 to 117.9	Omni-Range Stations. (VOR)
3.	118.1 to 121.3	Control-Tower Stations.
4.	121.5 and 121.6	Emergency Channel.
5.	121.7 to 121.9	Ground Control Stations.
6.	122.1 to 122.9	Private Aircraft Stations.
7.	122.8 (UNICOM)	Aircraft Advisory. (Airports without control towers).
8.	123.0 (UNICOM)	Aircraft Advisory (Airports with control towers)
9.	123.1 to 123.5	Flight Test; Flying School Stations.
10.	123.9 and 126.5	Approach Control Stations.
11.	124.1 to 126.3	Air Carrier Stations.
12.	126.7 and 126.9	INSAC Communications.

The voice channel of the localizer stations carries a frequent station identification and in some cases also the control-tower voice transmissions.

The voice channel of the omni-range stations carries a frequent station identification and also the usual range-station communications such as airways traffic control, weather information, etc.

The control-tower stations function in a manner similar to low frequency towers providing communications relative to take-offs, landings, etc.

A positive stop is provided at each end of the tuning range. Damage may result if the tuning crank is forced beyond the stops.

A-3 VOLUME CONTROL

The receiver volume control is used to set the desired loudness level of the voice signals. It does not affect the navigational functions, nor the loudness of the marker beacon tones.

A-4 MARKER BEACON RECEIVER

Operation of the 75-mc. marker beacon receiver is controlled by a push-pull switch combined with the volume control. Pull the volume control knob out about 1/8" from the panel to activate the marker receiver. The settings of the volume control and function switch (other than OFF) do not affect the operation of the marker receiver.

B. TRANSMITTER

B-1. CHANNEL SELECTOR

The channel selector is in the upper center part of the panel. It has 28 positions marked as follows:

LOW BAND SET		HIGH BAND SET	
INT	Interphone	INT	Interphone
118.1	mc Control Tower	121.5	mc Emergency
118.3	" "	121.7	Ground Control
118.5	" "	121.9	" "
118.7	" "	122.1	Airways Comm.
118.9	" "	122.5	Control Tower
119.1	" "	122.6	" "
119.3	" "	122.7	" "
119.5	" "	122.8	Unicom
119.7	" "	123.0	"
119.9	" "	123.7	Approach Control
120.1	" "	123.9	Centers
120.3	" "	124.1	"
120.5	" "	124.3	"
SPARE 1		124.5	"
120.9	" "	124.7	"
121.1	" "	124.9	"
121.3	" "	125.1	"
121.5	Emergency	125.3	"
121.7	Ground Control	125.5	"
121.9	" "	125.7	"
122.1	Airways Comm.	125.9	"
122.5	Control Tower	SPARE 1	
122.6	" "	126.3	"
122.7	" "	126.5	Approach Control
122.8	Unicom	126.7	Insacs
123.0	"	126.9	"
SPARE 2		SPARE 2	

NOTE: BAND (High or Low) can be determined by channel markings and by label inside set. Markings for channels not supplied with crystals are covered with segmented, black masking tape.

B-2 MODULATION

The push-to-talk switch which is part of the microphone serves to place the transmitting equipment in operation. The transmitter will operate in any (but OFF and CALIBRATE) position of the FUNCTION SWITCH, but the "COM" position is recommended for faster recovery after a transmission.

The front panel also includes a transmitter output lamp. This lamp is lighted by a portion of the transmitter output power and serves as a positive indicator of actual transmission. It will light whenever the transmitter is radiating, but will not respond when the selector switch is in the INT position or is set to an inactivated channel. This indicator lamp should flash somewhat brighter, in rhythm with the voice, when speaking into the microphone, and in so doing serves to inform the pilot that his microphone is functioning, and that he is speaking loud enough and sufficiently close to the microphone. Failure of the lamp to brighten when speaking indicates one or more of the following shortcomings:

1. Pilot not talking loud enough.
2. Microphone too far away from his mouth.
3. Microphone not functioning properly.

The range of reliable VHF radio transmission is limited by the approximate distance to the horizon. Therefore, the reliable range increases rapidly as higher altitudes are attained.

B-3. LICENSE NOTICE

The Federal Communications Commission requires that the operator of this transmitter hold a Restricted Radio-Telephone Operator Permit, or higher class license. This permit may be obtained by any U. S. citizen from the nearest field office of the F.C.C.; no examination is required.

The transmitter itself, as installed in the aircraft, requires a Private Aircraft Radio Station License. This license is obtained by filing FCC Form 404. Since this transceiver has been type-accepted by the FCC and entered on their list of type-accepted equipment as "Narco - VTR-2A," it must be identified as "Narco - VTR-2A," on your FCC Form 404 Station License Application.

B-4. SIMPLEX OPERATION

The CAL position of the FUNCTION SWITCH is provided to enable the pilot to use the transmitter crystals as tuning markers to precisely tune to the tower channels or to any channel for which a crystal is installed in the transmitter section).
To use this feature:

1. Set the transmitter channel switch to the desired frequency on which you want to both transmit and receive.
2. Set the FUNCTION SWITCH to "CAL" position.
3. Tune the receiver across the band until you hear the special tone produced by the transmitter oscillator. (DO NOT OPERATE THE MICROPHONE SWITCH FOR THIS PURPOSE).
4. Accurately center the receiver tuning control on the special tone, and then SET FUNCTION SWITCH TO "COM."
5. Your receiver is now precisely tuned to the selected transmitter channel, so you may hear any traffic using that particular channel, and transmit by using the mike and its push-to-talk button when the channel is clear.
6. BE SURE THE FUNCTION SWITCH IS SET TO "COM" WHEN TRANSMITTING.
7. Repeat the above procedure as needed for other channels.

C. OMNI-RANGE NAVIGATION (VOR)

C-1. COURSE SELECTOR and INDICATORS

The course selector dial is edge-operated and located at the lower part of the panel. It is calibrated every 5 degrees from 0° to 360°.

The LEFT-RIGHT meter is located in the upper left corner of the panel. The TO-FROM flag is near the center of the LEFT-RIGHT meter.

C-2. COURSE TO STATION (Homing)

1. Make sure that the FUNCTION SWITCH is set to VOR.
2. Tune to the desired omni-range station on the receiver dial. The identification will be heard in the headset or loudspeaker. Tune for maximum deflection of the TO-FROM flag (either up or down).
3. Rotate the COURSE SELECTOR dial until the LEFT-RIGHT (L-R) meter centers, and the TO-FROM (T-F) flag reads "TO." Two different COURSE SELECTOR settings will be found (which are 180° apart) where the L-R meter centers, but only one of these will cause the T-F flag to read "TO."
4. Turn the airplane until the magnetic compass reads the same as the COURSE SELECTOR dial. The omni indications do not depend upon the attitude or heading of the airplane, but only upon its bearing from the ground station, and so will not change as the airplane is turned to the magnetic heading which corresponds to the bearing to the ground station.
5. Fly the airplane along the course indicated by the COURSE SELECTOR making corrections to right or left as indicated by LEFT-RIGHT needle. The needle points to the selected track along the ground, so if the needle points LEFT, correct the airplane heading to follow a track somewhat to the left, and vice versa.
6. The difference between the course setting as indicated by the COURSE SELECTOR and the magnetic heading of the airplane necessary to keep the needle centered is the wind correction angle (plus any errors in the compass), which will be found useful in estimating the wind velocity and direction.
7. If, for some reason, the airplane gets very far off-course as indicated by the L-R indicator, the COURSE SELECTOR can be reset to center the L-R meter. This will establish a new track to the station which is a straight line from the off-course point to the station and is shorter than flying back to the original course.
8. When approaching close to the VOR station, the needle may become difficult to hold to center. Notice the compass heading you have been flying in the approach, and fly by compass until far enough beyond the station to make is easy to hold center again. Any off-course error will be indicated, along with the direction for the correction, after the station has been passed. The TO-FROM flag will reverse when passing the station.

C-3. COURSE FROM STATION

Any desired course outbound FROM the station may be set on the COURSE SELECTOR and followed by correcting the heading of the airplane to keep the L-R needle centered with the T-F meter reading "FROM."

As the distance from the station increases in flying out-bound, the signal will gradually grow weaker as indicated by a decreasing deflection of the T-F flag. When the signal gets so weak as to cause the red sector to fill the TO-FROM window (with the receiver properly tuned for maximum T-F deflection) it is no longer reliable, and another stronger omni station should be found.

C-4. ORIENTATION

The OMNI-RANGE system can be used for orientation (obtaining a "fix" when airplane's location is in doubt).

Bearings to ground stations do not depend upon the attitude or heading of the airplane, and hence can be taken easily and accurately in rough air. No heading correction is necessary.

To use the omni system for orientation, the following procedure is recommended.

1. Choose two omni stations for bearings, which are as near 90° apart as possible and which are within 50 miles of your probable location. (Longer distances can be safely used at higher altitudes).
2. Tune in No. 1 omni station and check its identification. Tune for maximum deflection of the T-F meter.
3. Rotate COURSE SELECTOR dial until L-R meter centers and T-F flag reads "FROM."
4. Record bearing, and draw line from omni station on chart in direction of bearing.
5. Tune to No. 2 omni station and repeat steps 2, 3 and 4 above, but for No. 2 station.
6. Location of airplane is at the intersection of the two lines drawn on the chart.
7. Add other bearing lines from other omni stations, as desired, to improve accuracy of "fix."

D. LOCALIZER OPERATION (ILS)

1. Set the FUNCTION SWITCH to LOC.
2. Tune in the localizer station. Refer to the AIRMAN'S GUIDE for frequencies, courses, and other pertinent data. Tune for max. TO deflection.
3. The Left-Right needle will center when on-course, and will point toward the track when approaching on the prescribed inbound localizer course, but will deflect in a reverse sense when flying an outbound localizer course, or when making an inbound approach from the BACK DIRECTION (normally used only when extreme wind conditions warrant). TO-FROM flag deflects in TO direction only, serving as tuning meter but not as a direction indicator.

SECTION II

INSTALLATION

A. VHF TRANSMITTER-RECEIVER UNIT (VTR-2A) (See Fig. 1)

1. Cut a rectangular hole in the instrument panel measuring 6-11/32 inches wide by 4-7/8 inches high.
2. Remove case from set and install the case in this cut-out using machine screws and stop-nuts in the holes provided in the flanges. Set is held in by single wing nut at rear.
3. Install a rear support strap between the rear surface of the case, and some nearby structural member. Be sure there is at least 2 inches behind the case to accommodate the various plugs and cables which connect to the rear of the set.
4. Slide the set into its case, and reattach rear wing nut and washer, tightening fully. Upper shock grommets are mounted in tongues to permit case fit adjustment.

B. MODULATOR-POWER UNIT (V(-)MP-2A) (See Fig. 2)

1. Fasten the power unit mounting plate to either a vertical or horizontal surface using four No. 10 machine screws and stop nuts.
2. Attach the two power unit mounting brackets to the top, rear, or bottom of the power unit, so as to place power unit upright when mounted.
3. Start the four power unit mounting screws (No. 10A) but leave about 1/8 inch between their heads and the U nuts in the mounting plate.
4. Slip the power unit into place, and push to the proper side to engage the mounting screws in the slots provided for them.
5. Tighten all four mounting screws.

C. OMNI RECEIVING ANTENNA (See Fig. 4)

The full range and accuracy of the VHF omni-range system can only be realized when the airplane is equipped with the proper type of antenna. A horizontal V-type is absolutely necessary; **a vertical whip is definitely not satisfactory,** although it may appear to be when tried. Vertically polarized components are not radiated by the ground stations, but are produced by reflections. Therefore a vertical antenna may receive strong signals, but not directly from the ground station, giving rise to very unreliable bearings.

The location of the antenna is likewise of paramount importance. It is advisable to place it on the top of the airplane behind the cockpit and well away from the engine(s) and propellor(s). Other antennas and wires located within two feet of the omni antenna may cause weak reception from some directions, and should be avoided.

Some very successful installations have also been made placing the antenna on the lower surface of the fusilage, and also on the top of the vertical stabilizer. The nose of the V should face directly forward or rearward, and the rods should be horizontal in level-flight attitude.

The antenna mast contains a matching balun which serves as both an impedance transformer and a means to connect coaxial line to a balanced V antenna. It is made of a special type of transmission cable cut to critical dimensions, and should not be disturbed. If the mast is not used, this balun must be installed between the antenna rods and the cable to the set. Be sure to ground all coax sheaths at the point where the balun connects to the set cable.

D. VHF TRANSMITTING ANTENNA (See Fig. 3)

The VHF transmitting antenna should be mounted on a metal plate measuring at least 18 inches square for best results. Such a mounting plate is often found directly in front of the windshield in fabric-covered ships, and at the center of the cabin roof in metal ships. Where no such surface is available, a piece of thin aluminum may sometimes be affixed flush with the fabric. This thin aluminum sheet or foil may be made to conform to the various curved surfaces to which it is mounted, but all cuts and seams should be along lines radiating from the center point. A 7/16 inch hole should be in the center of this sheet for mounting the antenna. It is recommended that where necessary a metal supporting plate be provided for the antenna to resist the bending load imposed by the slipstream. Do not lengthen or shorten the antenna. It has been cut the proper length for the most efficient radiation at the frequencies generated by this transmitter. Do not attach other wires or devices to it, and locate it at least 12 inches from the nearest projecting object or other wire. The method of attaching the transmission line to the antenna is illustrated in Fig. 3 and should be rigidly followed. Excess transmission line can be neatly coiled at any convenient point provided that at least a six-inch radius is used in coiling. All bends in the transmission line should be smooth and gradual, to prevent possible trouble later on.

E. MARKER BEACON ANTENNA (See Fig. 5)

The marker beacon antenna, which is not furnished with the equipment, should be fabricated from suitable antenna wire. It should be located under the fusilage and spaced about six inches away from it by a pair of suitable support masts. Note that the point where the lead-in is connected is five inches displaced from the center of the antenna wire. This dimension is important for proper matching.

A shorter (quarter wave) bent-rod, shunt-fed antenna mounted on the under surface of the airplane has been found to be satisfactory if the feed point is carefully adjusted for best reception.

The coaxial feed cable has its sheath connected to the metal skin or frame of the aircraft at a point opposite the connection to the wire. The center conductor is usually connected to a feed-thru insulator, which in turn is connected to the antenna wire.

It is well to locate the marker beacon antenna as far aft as possible, to reduce noise pick-up. It has been found that placing the tap forward or aft of the center can make a large difference in performance due to capacity unbalances, etc. It is therefore suggested that the tap be moved to the other side of center, if poor marker beacon reception is obtained.

F. CABLING (See Fig. 6)

F-1 INTERCONNECTING POWER CABLE (90514-101)

The cable which connects the TRANSMITTER-RECEIVER UNIT with the MODULATOR-POWER UNIT contains 11 wires including two No. 16 conductors. It is supplied in 8-foot lengths, and can be lengthened provided that heavier conductors are used to replace the two No. 16's, and a shielded wire is used for the No. 11 pin lead.

F-2. AUDIO CABLE (P90509-101)

This cable connects the mike and phone jacks as well as the speaker lead to the MODULATOR-POWER UNIT. The cable can be lengthened as needed. The No. 6 pin of the receptacle provided on the power unit is connected to the A+ lead so as to permit testing of the sets in test stands previously used on earlier models, and to accommodate the use of a VP-9 Switchmaster control unit.

F-3. ACCESSORY RECEPTACLE

This extra receptacle is provided in the power unit to enable various accessory items such as a low-frequency receiver attachment to be connected. The voltages available are:

Pin	Voltage	Maximum Load
1	Ground	—
2	A+ (12-volt units only)	1 amp.
3	Not Used	—
4	B+ 150 volts	30 ma.
5	Audio Lead	0.5 ma.
6	A+ (24-volt units only)	1 amp.

F-4. RECEIVING ANTENNA CABLE (P90512-102)

This coaxial cable should be a small size 52-ohm cable such as RG-58A/U. It is normally supplied in 8-foot lengths with a long type antenna connector on one end (for insertion in the rear of the transmitter-receiver unit) and a short type connector on the other end for insertion in the antenna base receptacle. A longer cable can be used, but splicing this type of cable is not recommended.

Any excess cable can be coiled in a convenient location. Shortening the cable is permissable, but this can be done only by persons thoroughly experienced in the special techniques required to properly handle polyethylene-insulated cables.

F-5. TRANSMITTING ANTENNA CABLE (P90512-101)

The transmitting antenna cable is similar to the receiving antenna cable except that the set end is terminated in a short type connector, and the antenna end is fitted with a lug for direct attachment to the transmitting antenna base, and a sheath grounding lug. The length of this cable is critical, and should not be changed. Excess cable can be coiled in a convenient location.

F-6. POWER LEAD

The fused lead extending from the rear of the transmitter-receiver unit should be connected to a point in the airplane's electrical system which can supply the required current, as shown below:

Set	Power Unit	Voltage	Maximum Current	Fuse Capacity
VTR-2A	V12MP-2A	13.5	6 amp.	15 amp.
VTR-2AB	V24MP-2A	27.0	3 amp.	10 amp.

G. 12/24V CHANGEOVER

The VTR-2A filament system is wired for 12 or 24 volt airplanes. A conversion plug (P-102) on the rear of the set need only be changed for operation on either voltage. (See figure 13).

H. EXTERNAL LIGHT DIMMER

Provision is made for use of an optional external light dimmer. Connections are made to the 12/24 volt conversion plug as shown in Figure 13. A separate 100 ohm 3 watt resistor is supplied with the VRP-45. This resistor must be installed in series with the external dimmer rheostat to limit the max. lamp current.

I. WEIGHT TABLE

UNIT	WEIGHT
Transmitter-Receiver, in case	7.0 lbs.
Power Unit (V12MP-2A)	6.9
Omni Receiving Antenna	1.9
Transmitting Antenna	0.2
Antenna Cables (both, 8 feet)	0.4
Audio Cable and Jacks	0.4
Power Cable	0.9
Total	17.7

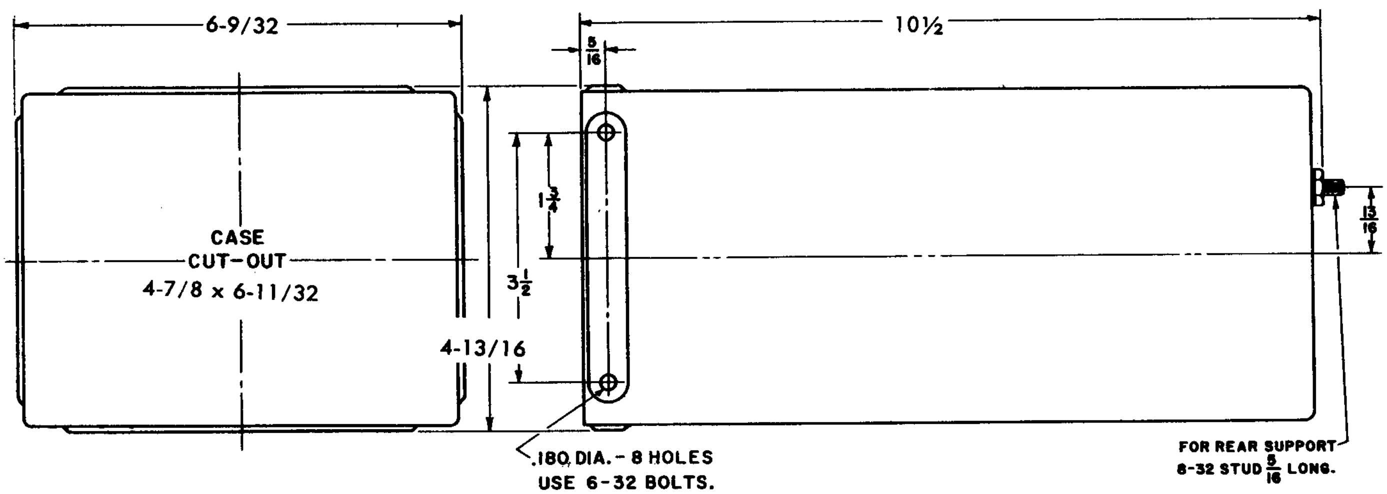


Figure 1. VHF TRANSMITTER-RECEIVER UNIT—MOUNTING DIMENSIONS

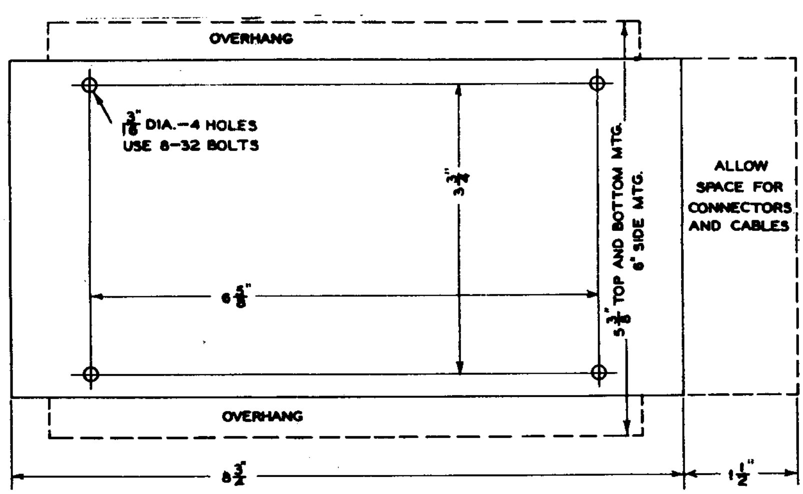


Figure 2. MODULATOR-POWER UNIT—MOUNTING DIMENSIONS

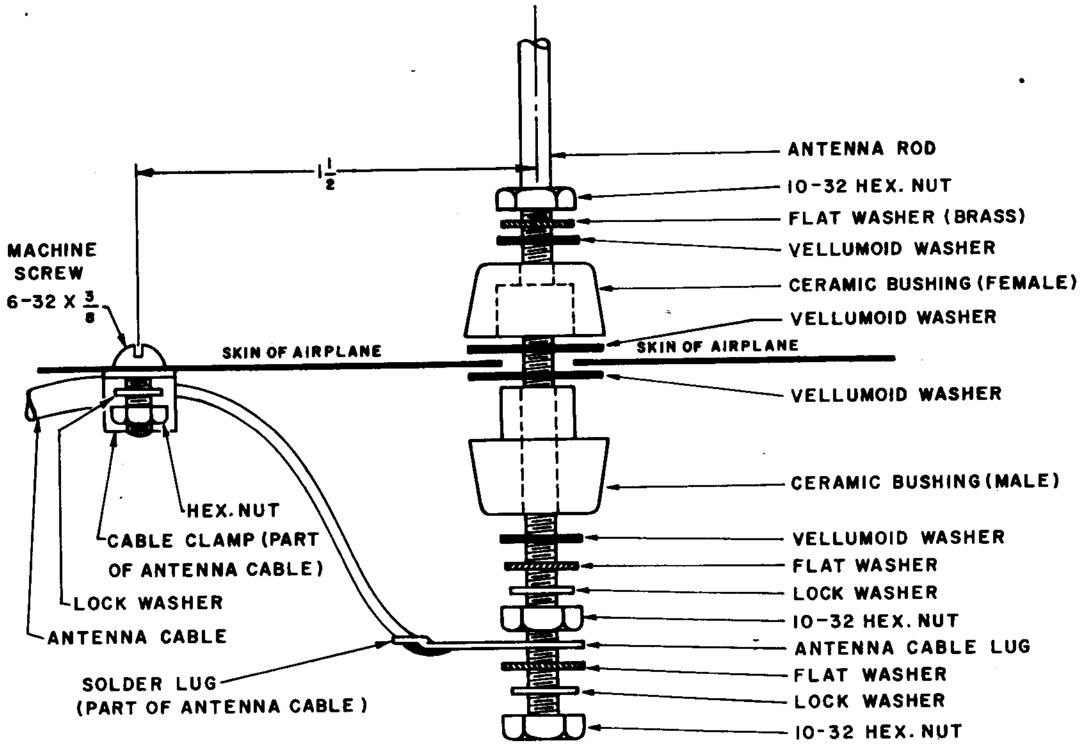


Figure 3. TRANSMITTING ANTENNA—MOUNTING DIAGRAM

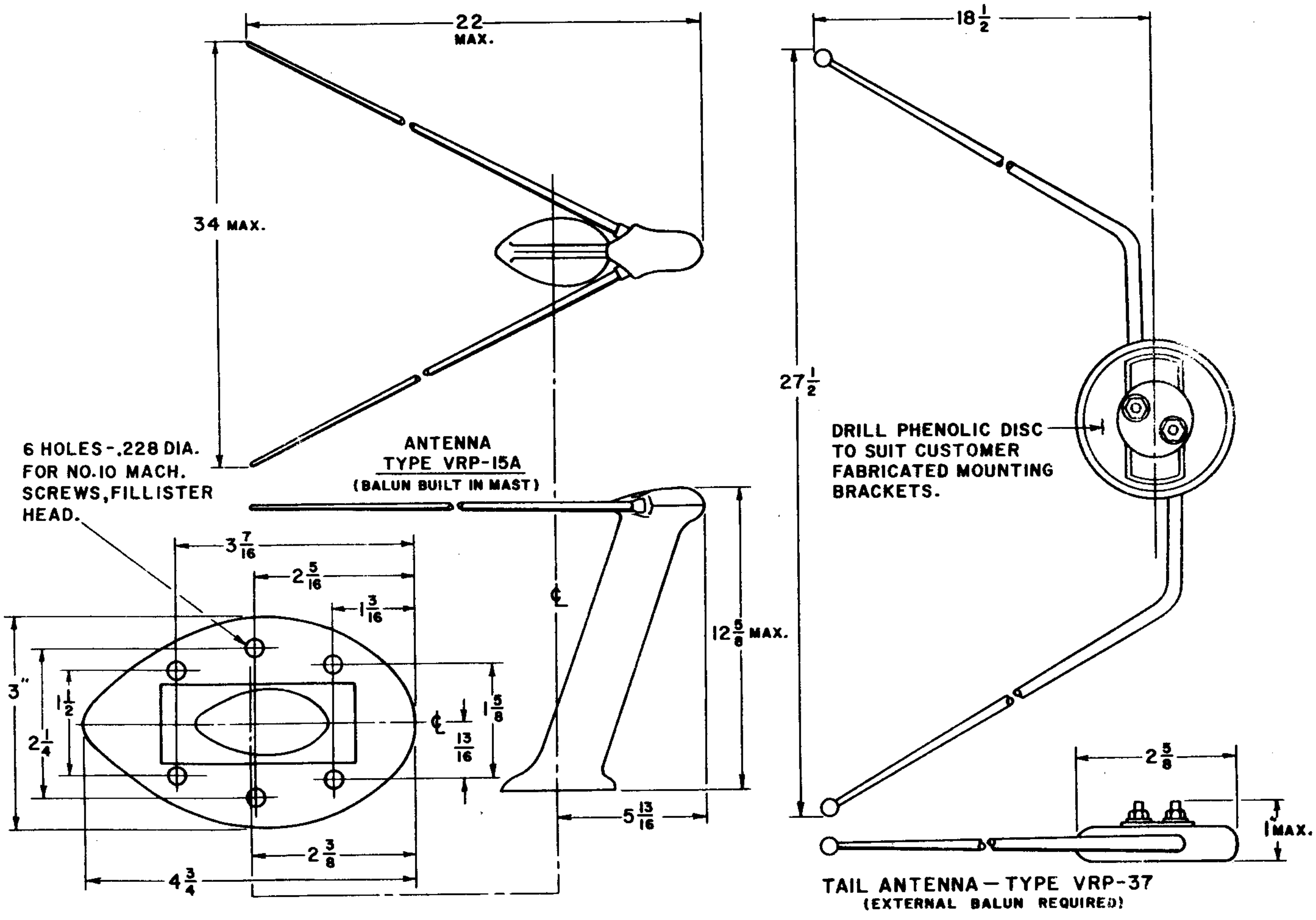


Figure 4. RECEIVING ANTENNA—MOUNTING DIAGRAM

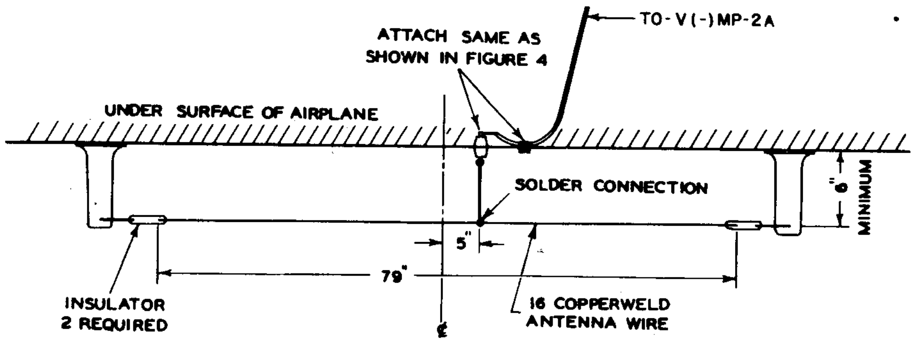


Figure 5. MARKER BEACON ANTENNA—DIAGRAM

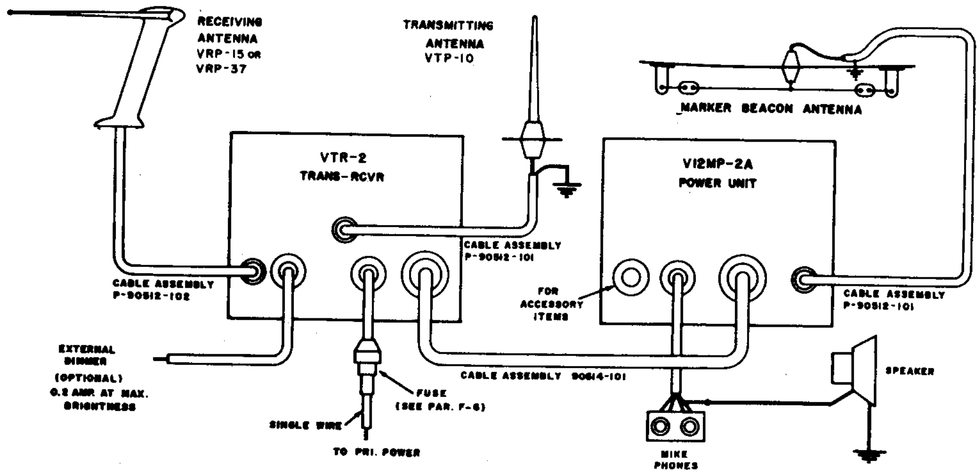


Figure 6. SYSTEM DIAGRAM—VTR-2A & V12MP-2A

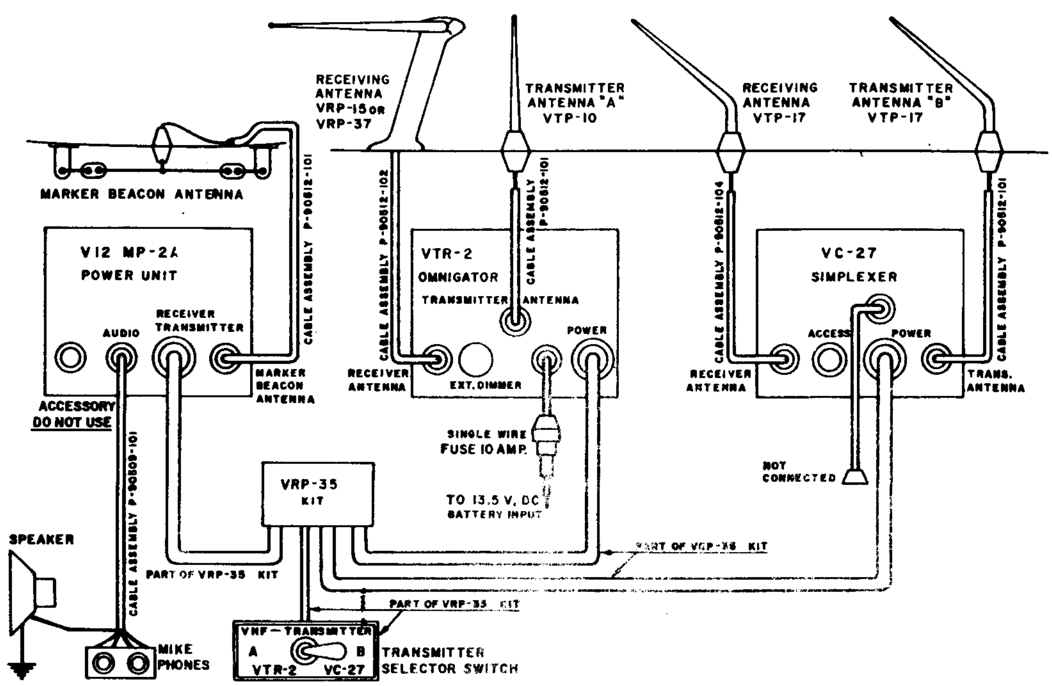


Figure 7. SYSTEM DIAGRAM—VTR-2A & V12MP-2A
(SEPARATE ANTENNAS: 54 CHANNELS: DUAL RECEIVER

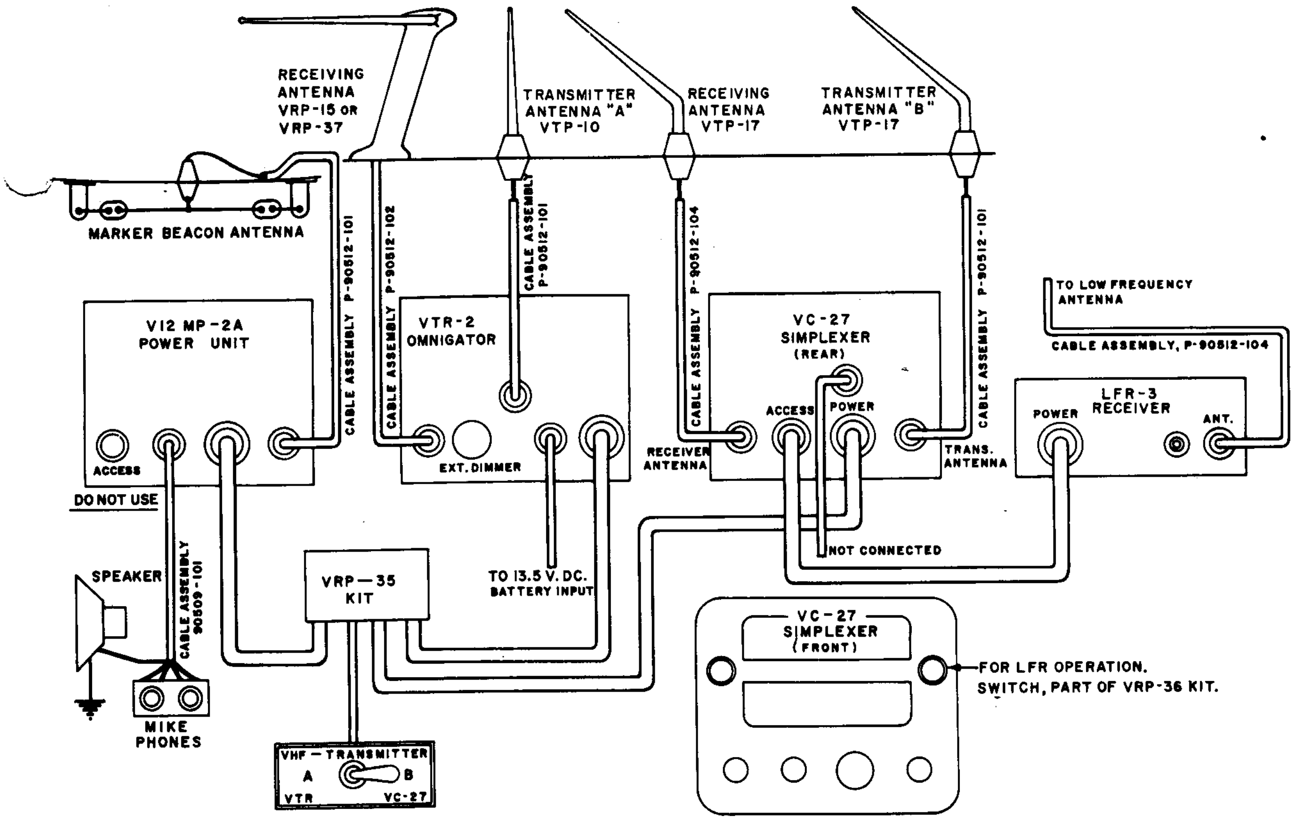


Figure 9. SYSTEM DIAGRAM—VTR-2A, VC-27a AND LFR-3 (54 CHANNELS: DUAL RECEIVERS)

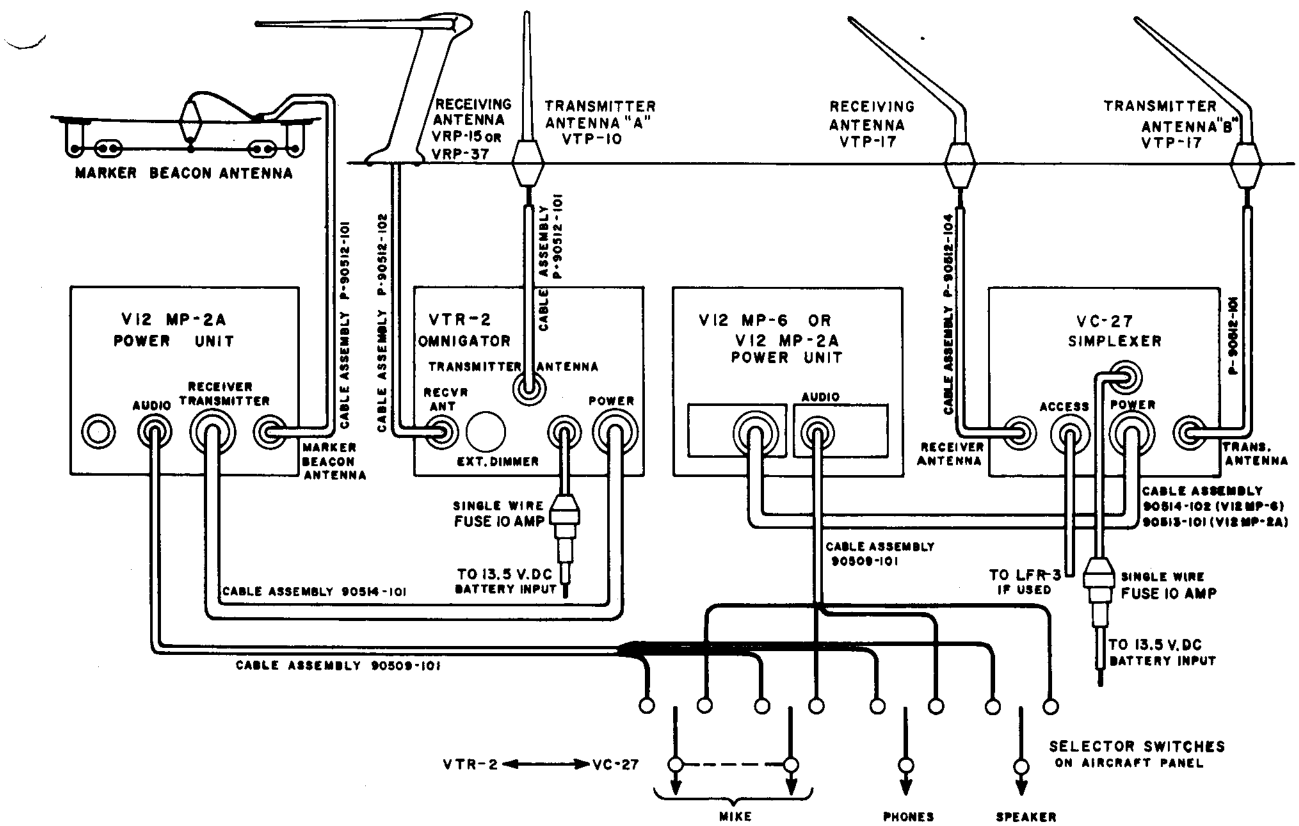


Figure 10. SYSTEM DIAGRAM—VTR-2A & VC-27a (DUAL POWER SUPPLIES: 54 CHANNELS: DUAL RECEIVERS)

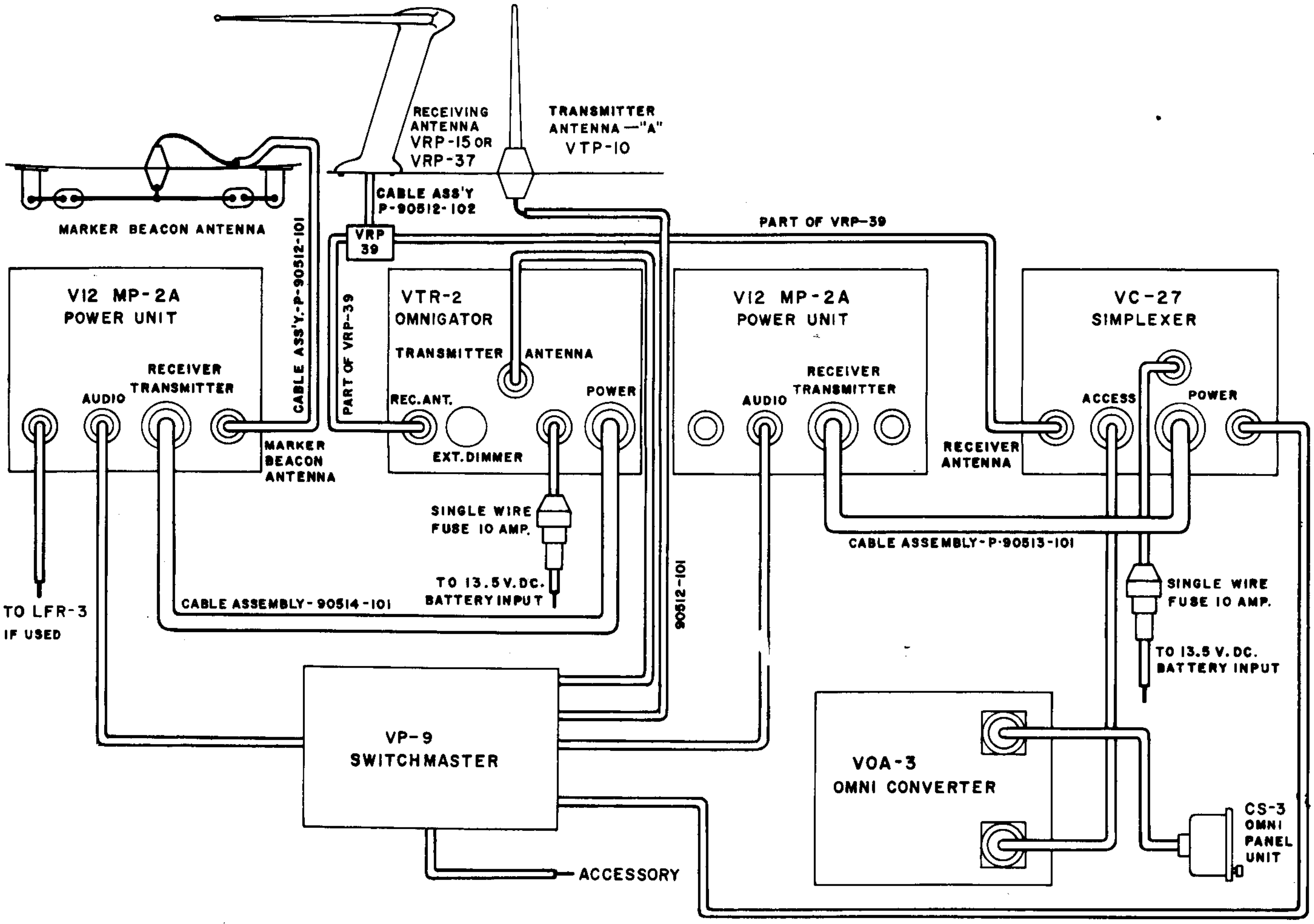


Figure 11. SYSTEM DIAGRAM—VTR-2A, VC-27a, VOA-3
(DUAL OMNI: 54 CHANNELS: DUAL RECEIVERS)

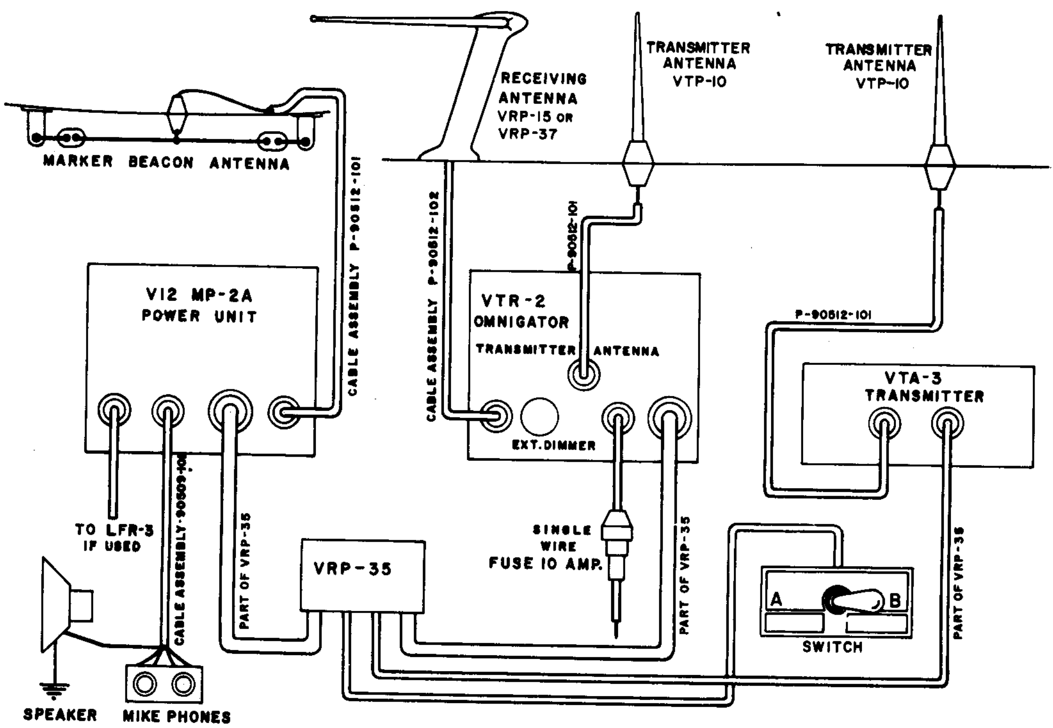


Figure 12. SYSTEM DIAGRAM—VTR-2A & VTA-3
(54 CHANNELS: ONE RECEIVER)

SECTION III . . CIRCUIT DESCRIPTION

A. VHF RECEIVER (See Fig. 16)

A-1. PRE-SELECTOR

The VHF pre-selector section includes a tuned R.F. amplifier stage with three resonant circuits between the antenna line and the converter tube grid, providing high rejection of unwanted image and other spurious interferences. Two of these resonant circuits form a capacitively-coupled, double-tuned coupling network between the R.F. amplifier plate, and the converter grid. The coupling is set somewhat below critical.

A separate local oscillator is used and injected into the converter grid circuit. Temperature compensation is used to stabilize the oscillator frequency. The tuning system is a four-gang permeability mechanism with a reduction gear drive. Positive stops are provided at each end of the range, arranged to prevent damage to the gears thru excessive pressure at the ends of the tuning range. The trimmer capacitors are mounted on the coil assembly, which is mounted on the chassis in such a manner as to reduce drift resulting from chassis strains, etc.

A-2. I.F. AMPLIFIER—DET—AVC

Three stages of I.F. amplification are used employing eight resonant circuits to secure high sensitivity and selectivity. The coupling within the I.F. transformers has been chosen to provide a broad, blunt nose for ease of tuning, along with steep sides for separation of adjacent channel stations.

The I.F. amplifier is peaked at 10.7 megacycles. A high-level diode detector is used to insure adequate linearity for use with the VHF omni-range system. The omni-range output signal is taken directly from the detector diode load.

An extremely flat AVC is obtained by using a separate, highly delay-biased AVC diode in conjunction with the proper type of controlled amplifier tubes. The AVC voltage is applied to the grid of the R.F. stage and the first two I.F. stages. No AVC is applied to the converter tube in order to improve oscillator stability, nor to the third I.F. stage. The time constant of the AVC is switched by the FUNCTION SWITCH so as to provide rapid AVC for communication purposes (switch set to "COM") and slow AVC as required for accurate omni- range bearings when switched to "VOR."

A-3. NOISE LIMITER—AUDIO

In the aural channel between the detector diode load and the first audio stage are interposed the compound peak noise limiter, and the audio volume control. The noise limiter includes two diodes arranged to combine both series and shunt-type peak limiting in a circuit in which the clipping levels automatically follow slow variations in carrier strength.

The first audio stage is a high gain pentode in a cathode-biased circuit. The plate of the first audio stage is connected through the power cable to its load resistor, which is located in the power unit, along with the second audio stage and its associated components.

The modulator tube is used also as the receiver audio power output tube. The plate lead from the first audio stage is coupled to the modulator grid through a combining network. The circuits are arranged so as to remove the screen voltage from the speech amplifier except when transmitting, and when the marker beacon receiver is on.

The modulation transformer also contains output windings designed to match a 150 to 600-ohm headset load, a 3-ohm speaker voice coil. Simultaneous operation of speaker and headset is possible, but at somewhat reduced output. Relay contacts are arranged to remove the transmitter load when receiving, and to remove the loudspeaker and reduce the headset load when transmitting.

B. MARKER BEACON RECEIVER (See Fig. 15)

The marker beacon receiver circuits are located in the power unit. It comprises a tuned R.F. stage and detector-audio amplifier. The resonant circuits are peaked at 75 megacycles providing considerable audio output for a 2.5 millivolt .narker type signal (modulated 100% at 3000 cycles). Plate power to the R.F. stage is controlled by a push-pull switch combined with the volume control.

C. VHF TRANSMITTER (See Fig. 16)

The VHF transmitter employs three tubes. V-301 is used as a third overtone crystal oscillator on 30.5 mc. 27 crystal sockets are provided which are selected by means of a rotary switch. The plate circuit of V-301 is broad-band coupled to the grid of V-302 passing all frequencies from 59 to 61.5 mc. Low band (or 60.7 to 63.5 mc., high band).

The plate circuit of V-302 is broad-band coupled to the grid of V-303 passing all frequencies from 118 to 123 mc. Low band (or 121.5 to 127 mc., high band.) V-303 is the modulated final amplifier. Its plate circuit is broad-band coupled to the 50 ohm antenna.

The DC mike current is obtained from the modulator bias through a load resistor. The omission of the usual mike transformer has several advantages particularly in reducing weight, and in avoiding the damage which is done to many carbon button microphones by the inductive "kick" which would occur each time the transformer primary circuit is interrupted by the mike switch.

A high-gain pentode speech amplifier is used in which the low audio frequencies are purposely suppressed so as to reduce engine rumble effects which would be particularly bothersome in a high-gain clipping system.

The modulator is transformer-coupled to the transmitter load in order to obtain optimum match. The winding polarities of this transformer are important and must be preserved because the DC currents in the primary and secondary are phased in opposition so as to avoid saturating the core. This permits the use of a lighter transformer than would otherwise be required.

Side-tone signal is supplied to the headsets by inserting a dropping resistor in series with the phone jack and its transformer winding, in the "TRANSMIT" operation.

D. OMNI-RANGE SECTION (See Fig. 16)

D-1. OMNI SIGNAL DESCRIPTION

No attempt will be made here to describe in detail the technology of the VHF omni-range system. Briefly the ground station sends out one continuous VHF carrier wave with three simultaneous, but non-interfering amplitude modulations. These are:

1. Voice modulation. 200 to 2500 cycles. 35% max. mod.).
2. Reference phase signal. (30% mod.) 9960 cycles subcarrier frequency — modulated between 9480 and 10440 cycles with a 30 cycle fixed phase.
3. Variable phase 30 cycles (30% mod.) produced by effectively rotating a limacon antenna pattern 30 times per second at the station.

The variable phase signal is thus a 30-cycle sine wave modulation whose phase angle relative to the 30-cycle FM on the 9960-cycle subcarrier depends upon the bearing of the airplane's receiving antenna to the station. The station is adjusted so that the variable phase signal is "in phase" with the reference phase at a bearing due magnetic north (0° mag.) from the station.

Thus the audio signal developed across the detector load resistor in the receiver contains the above three separate and distinct audio components which are mixed together in simple addition. It is the purpose of the omni circuits to separate these components, and to indicate by means of a course selector dial, and some indicating meters, the relative phase angle between the variable phase signal and the reference phase signal, as received, and to thus indicate the bearing to the station.

D-2. REFERENCE PHASE CHANNEL

The 9960-cycle subcarrier component of the audio signal, which is frequently modulated at a 30-cycle rate is passed through a two-section RC type high-pass filter to the grid of the limiting amplifier tube (V-205). This filter prevents the 30-cycle variable phase and voice components from passing into the reference channel amplifier.

The limiting amplifer tube is operated at reduced plate and screen voltages, and with no fixed grid bias, so as to saturate readily and thereby remove any amplitude modulation of the 9960-cycle subcarrier (propeller modulation, etc.). It drives a ratio detector (V-206) through a discriminator transformer (T-202).

The ratio detector demodulates the FM component of the signal, but is relatively unresponsive to any amplitude modulation which remains in the output of the limiting amplifier. The 30-cycle ratio detector output voltage is developed across R-247.

A pi-section RC-type low-pass filter is used to remove the residual subcarrier component. This filter causes a phase shift of about 25° in the 30-cycle signal, and is used to compensate for the accumulated phase shift variation throughout both channels. A variable resistance (R-248) is included which provides a vernier adjustment of about ±2°. Larger compensations are made by selecting the fixed series resistor R-249.

The output signal from the low-pass filter is amplified in a high-gain pentode stage (V-207) and fed into the output stage (V-208).

The reference channel output amplifier (V-208) provides two independent output signals. One of these is obtained across the cathode resistance and fed through a very high capacity electrolytic capacitor (C-231) to the L-R metering circuit. The plate output is fed to a differentiating transformer which shifts the phase of this voltage by 90° with respect to the grid voltage. This shifted phase signal is used to drive the TO-FROM metering circuit.

D-3. VARIABLE PHASE CHANNEL

The 30-cycle variable phase component of the audio signal is fed through an RC-type, parallel-T, band-rejection filter tuned to 60 cycles, and thence through an RC-type band-pass filter tuned to 30 cycles, to the grid of the first voltage amplifier stage (V-201A). The purpose of the 60-cycle rejection filter is to prevent 60-cycle components which are generated by propeller modulation at certain critical engine speeds (usually 1800 RPM) from causing errors in the readings and slow oscillations of the indicators. The 30-cycle band-pass filter removes voice frequency and 9960 subcarrier components along with very low frequency fluctuations, arising in the VHF propagation, which would cause the meters to fluctuate erratically.

The output of the first voltage amplifier stage (V-201A) is fed to the input of the phase-splitter stage (V-202A) through another 30-cycle band-pass filter to further remove the undesired components. This tube has both plate and cathode resistors, which are equal in value, and thereby generates two output voltages equal in amplitude but 180° apart in phase (phase inverter).

Coupled to these two outputs is an RC-type phase-dividing bridge (C-210, C-211, R-221, R-222) in which the resistors and capacitors have been selected to produce four equal voltages (to ground) at each of the four bridge corners, but spaced at exact 90° phase intervals. For this condition to obtain, the capacitive reactances must exactly equal the resistances (at 30 cycles). The component parts of this bridge are therefore very critical, and are held to very close tolerances.

The four output voltages from the corners of the bridge are fed into four cathode follower sections (V-203 and V-204) which serve as impedance transformers to drive the relatively low impedance phase shifter (course selector).

The course selector is a continuously-variable phase shifter which produces a 30-cycle output which can be set to any desired phase relative to the input signal. The phase angle between the output voltage (movable arm to ground) and the zero phase input voltage is indicated directly on the hand-calibrated course selector dial.

The tapped potentiometer course selector is essentially uniform in resistance (linear taper) having a total loop resistance of about 10,000 ohms with taps at 2500, 5000 and 7500 ohms.

The output of the course selector potentiometer feeds into a high-pass RC-type filter which further reduces low-frequency fluctuations, and partially compensates for the phase shift at 30 cycles produced by the 60-cycle parallel-T network described earlier.

The output of this filter is the input to the second voltage amplifier stage (V-201B) which drives the variable phase output amplifier tube (V-202B). The output of V-202B is fed into the primary of a specially designed audio stepdown transformer to drive the metering circuits with a balanced push-pull signal. The DC plate current is kept out of this transformer by a parallel feed circuit.

Negative voltage feedback is employed from the primary of the transformer to the cathode of V-201B to stabilize the shift in phase with changes in signal level.

D-4. METERING CIRCUITS

The output signals from the reference phase and variable phase channels are combined in the metering circuits to indicate certain relative phase relationships.

The metering circuits are in effect AC wattmeter circuits.

For small deviations from 90° and 270° phase angles the meter deflection will be approximately proportional to the amplitude and direction of the deviation angle.

Both the L-R meter and TO-FROM flag use similar circuits, but the T-F metering circuit is driven from the differetiating transformer coupled plate circuit of the reference phase output amplifier stage (V-208) in which the phase of the plate circuit output voltage is shifted about 90° from the grid excitation voltage. This causes the T-F flag to deflect to its maximum degree when the L-R meter is centered (zero deflection), and in a direction (up or down) which depends on whether the two phase channels are 90° or 270° apart in relative phase.

A very large electrolytic capacitor (C-215) is connected across the L-R meter to add to the meter damping, and help to smooth out rapid fluctuations which arise from many sources.

E. ILS LOCALIZER (See Fig. 16)

The audio output from the receiver is also connected to the input of V-110. When a LOCALIZER station is being received, the audio signal comprises a mixture of 90 and 150-cycle components, plus voice. These signals are amplified by V-110 and fed into two resonant circuits tuned to 90 and 150 cycles. The two audio tones are thereby separated.

They are rectified by the crystals XT-101 and XT-102, and the DC currents mixed and fed through the Left-Right meter when the FUNCTION SWITCH is set to LOC. A balancing potentiometer (R-137) is provided to compensate for variations in filter response and crystal efficiency, and is set so as to cause the meter to read zero when equal amounts of 90 and 150-cycle components are fed into it.

F. POWER SUPPLY (See Fig. 15)

The vibrator system is of the non-synchronous interrupter type. Every precaution has been taken in the design to provide the utmost in dependability and long life.

The primary input circuit includes a hash filter primarily to prevent interference in cases where the VHF equipment is used in conjunction with a low-frequency receiver, and a high-capacity electrolytic capacitor to aid in supplying the peak currents required by the vibrator system.

The vibrator was specifically designed for this equipment, so it is absolutely necessary that any replacement be identical to the original. No substitute can be expected to provide the same performance or life. The vibrator transformer is somewhat larger than is customary in aircraft radio equipment to provide better reliability. Again, any replacement must be made with the identical part.

The buffer or timing capacitor is divided between the primary and secondary of the transformer. This placement of a substantial part of the timing capacitance across the primary winding is very beneficial to a 12-volt vibrator system. It prevents the usual starting difficulties, and short vibrator life, that have characterized such vibrator systems in the past.

Replacements for either timing capacitor should be identical to the originals, and preferably obtained from the factory.

The rectifier system comprises four selenium stacks arranged as a full wave voltage doubler. Thus a 280-volt output is obtained for the modulator and transmitter operation, and a 140-volt output for the receiver and omni-range circuits.

SECTION IV . . MAINTENANCE

A. OPENING SET

Access to the inner parts of the transmitter-receiver unit is accomplished as follows:

1. Remove the four screws which hold the sub-chassis to the main chassis. See Figure 21.
2. This will permit the rear of the sub-chassis to be lifted away from the main chassis.
3. Lay sub-chassis assembly to one side as shown in Figure 22. Reverse the above process when reassembling set. Be sure wiring cables are tucked in so as to clear the case.

B. ALIGNMENT PROCEDURE

B-1. VHF RECEIVER

1. Open set as described in A above.
2. Connect a signal generator between V-104 pin 1 and ground. Keep leads very short to prevent oscillation.
3. Connect audio output meter to PHONES output jack.
4. Set signal generator to 10.7 megacycles and reduce output until audio meter reads conveniently with volume fully advanced.

   CAUTION—10 kc. Ratio Det. Coil in RED CAN should not be disturbed during I.F. alignment.

5. Peak the tuning screws on the three rear I.F. transformers using an insulated tool. Do not peak the front I.F. transformer at this time. See Figures 19 and 22.
6. Remove the I.F. signal generator, and connect an R.F. signal generator set to 118 mc. to the receiving antenna receptacle J-101. See Figure 18.
7. Tune in the signal, and peak the front I.F. transformer, and the three rear R.F. trimmers. See Figure 22.
8. Reset the oscillator trimmer only if dial is in error, and signal source of known accuracy is available.

B-2. MARKER BEACON RECEIVER

The marker beacon receiver is located in the modulator-power unit.

1. Connect a signal generator set to 75.0 megacycles to the marker beacon antenna receptacle. See Figure 24. (2.5 millivolts, modullated 100% at 3000 cps)
2. Connect an audio output meter to the PHONES output jack.
3. Pull the marker beacon switch (volume control) on the front panel of the transmitter-receiver unit to its ON position.
4. Peak the two marker beacon tuning screws. See Figure 24. A strong R.F. signal is normally required for marker beacon receivers. (2500μV)

B-3. VHF TRANSMITTER

CAUTION: Determine frequency band by reference to label inside set. THIS SET MUST BE ALIGNED AS FOLLOWS, for proper broad band operation.

It is not recommended that the VHF transmitter be realigned unless one or more tubes have been replaced, or unless there is a definite reason to believe that it is needed. If realignment is needed, proceed as follows:

1. Oscillator Screen Coil L-301.
   a) Connect VTVM probe to the free end of R-320. Set VTVM to indicate negative volts.
   b) Set Crystal Switch to 122.9 mc. (low band), 126.9 (high band).
   c) Tune L-301 for max. VTVM reading.
2. Oscillator Plate Coil, L-303, and Doubler Grid Coil, L-305.
   a) Connect VTVM as in 1(a) above.
   b) Set Crystal Switch to 118.3 mc. (low band), 121.7 (high band).
   c) Tune L-303 and L-305 for max. VTVM reading.
   d) Reset Crystal Switch to 122.7 mc. (low band, 126.7 (high band). VTVM should read about same as at 118.3 mc. (121.7). If reading is much lower, repeak L-303 and L-305 at 122.7 (126.7) and check at 118.3 mc. (121.7).
   e) Check symmetry of drive by observing VTVM readings over entire band. Retouch coils as needed to obtain symmetrical double-peaked curve.
3. Doubler Plate Coil, L-307, and Final Grid Coil, L-309.
   a) Connect VTVM to the free end of R-321.
   b) Use same procedure as in 2. above, but tuning L-307 and L-309.
4. Output Coils, L-310 and L-313.
   a) Connect VHF Power Output Meter to transmitter antenna receptacle, J-301.
   b) Set crystal switch to 121.5 mc (low band), 125.3 (high band).
   c) Starting with tuning slugs out (closest to chassis), tune L-310 and L-313 for max. output.
   d) Check uniformity of output over the entire band. Retune L-310 for max output on end of band having least output.
   e) Band edges should now be uniform.
   f) Channel to 121.5 mc (low band), 125.3 (high band), and tune L-313 for max. power output.
   g) Retune L-310 for max. power output.
   h) Recheck ends and middle of band. If power output is not uniform, decrease L-313 at point of highest output to balance power across band.
   i) Retune L-310 for max. power output for each change in L-313.

B-4. OMNI-RANGE SECTION

The only tuning adjustments in the omni-range section are the two iron cores which tune the ratio detector transformer coils. These are best aligned with the aid of an accurate AC voltmeter (Narco T-4 or equivalent), and a real or simulated omni signal fed into the unit. The AC VTVM should be connected to point E (Figure 21). The normal signal amplitude at this point is only .1 volt. Adjust first the bottom tuning screw (T-202, Figure 22) for maximum voltage reading and then the top tuning screw for maximum voltage. The To-From meter should read TO at the maximum AC VTVM voltage indication when the Course Selector and the Omni Simulator are set to the same course.

B-5. ILS LOCALIZER

The balance adjustment, R-137, is set at the factory, and should not be readjusted unless the proper test equipment is available, and there is reason to believe readjustment is needed.

Connect the receiver receptacle to the output jack of an ILS localizer simulator. Set up the test set for a "center course" on localizer. Tune in the signal, and set the FUNCTION SWITCH to "LOC." Set the balance control, R-137 (see Figure 19), to center the LEFT-RIGHT meter. Check localizer operation by setting blue and yellow courses.

C. ACTIVATION OF ADDITIONAL CHANNELS

There are sockets for 27 quartz crystals provided in the transmitter, but it is usually supplied with only 25 crystals. The remainder of the crystals may be procured at a later date to activate all channels. These crystals should be plugged in the sockets as shown in Figures 19 and 20. Alteration of the factory circuit alignment should not be necessary to accommodate the new crystals. It is well to check operation on all activated channels after installing crystals.

The transmitter frequency dial is marked with all of the frequency channels listed in par. B-1 (page 2) for the low or high band sets. These dial markings are covered by segmented black masking tape which has been peeled off exposing the markings corresponding to the crystals supplied with the set. As new crystals are added, it will be necessary to peel off additional segments of the black masking tape to expose dial numbers for the new channels.

The markings are in the order given on page 2. A particular marking can therefore be located by counting the segments in a counterclockwise direction starting from the INT segment.

Two spare channels are provided which are left blank on the dial, and are marked SPARE in Figures 19 and 20. They are indicated and numbered in the sequences on page 2, and also in Figures 19 and 20.

D. OMNI COMPENSATION

The omni circuits are carefully compensated at the factory, and should not require subsequent compensation unless certain critical components have been replaced. The following plan of compensation should be followed completely, and in the order given, should it be necessary to perform it, but it is strongly recommended that it not be tampered with unless absolutely necessary, and then only if all the necessary items of special and standard test equipment are used. All compensations must be made in the order shown below.

D-1. RECTIFIER BALANCE (XT-201 and XT-202)

The purpose of this compensation is to balance the two rectifier circuits which form a part of the L-R metering circuit. Unbalance which arises from the manufacturing tolerances of these components will cause a reciprocal error in the bearing readings. A reciprocal error is one which causes the two course selector readings for L-R meter centering to differ by not exactly 180° (±2°). The need for recompensating the rectifier balance is indicated by excessive reciprocal error when test signal is reversed, but not necessarily when the course selector dial is shifted 180°.

1. Inject a 500 μV R.F. signal from an Omni-simulator to the receiver antenna receptacle. Tune to the simulated omni signal.

2. Set the FUNCTION SWITCH on VOR, and the Simulator, to 270°.

3. Set the course selector dial of the VTR-2 to center the L-R meter near 270°.

4. Reset the Simulator azimuth dial to 90°. If L-R meter does not recenter between 88° and 92° on the Simulator dial, bridge R-236 or R-237 as needed with shunting resistors to bring this reciprocal test within limits. Repeat steps 3 and 4 for each shunt resistor test. Shunting resistors will usually lie between 5000 and 50000 ohms.

5. Excessive rectifier unbalance results from poorly-matched rectifiers. Replacement matched rectifier pairs can be obtained from the factory. They mount on the terminals provided. Avoid excessive heat in soldering to rectifier terminals. It is best to remove the rectifier from the terminals to which any soldering is to be done, being careful to replace them exactly as they were.

D-2. PHASE ZERO (270°)

The phase zero adjustment shifts the phase of the reference signal to compensate for accumulated component tolerance errors which would cause a fixed error in the course reading. A fixed error is one which is independent of omni course. Small compensations (up to ±3°) are made by means of adjusting R-248 which is shown in Figure 21. Larger compensations (up to ±10°) if required, can be made by substituting other resistor values for R-249.

This resistor value has been selected at the factory to approximately center the adjustable resistor at the proper zero phase setting. This one adjustment permits compensation for most of the errors which arise as a result of component drifts (which are held to a practical minimum) and changes in tube characteristics. To make this compensation, proceed as follows:

1. Connect the LOW R.F. output jack of an Omni-Simulator to the receiver antenna receptacle. Tune to the simulated omni signal.
2. Set the Simulator azimuth dial to 270°.
3. Set the FUNCTION SWITCH to VOR, and the course selector dial to 270°.
4. Reset R-248 (and R-249 if necessary), to center the L-R meter.

D-3. PHASE INVERTER BALANCE (90°) (See Fig. 18)

The phase inverter balance is compensated after the phase zero is set at 270°. Proceed as follows:

1. Reset the Simulator azimuth dial to 90°.
2. Reset the course selector dial to 90°. If L-R meter will not center between 88° and 92°, the phase inverter balance needs correction.
3. Bridge terminals A and C with shunting resistors between 1 megohm and 50 megohms as needed to correct 90° readings.
4. If step 3 increases the error and in the same direction, repeat all steps using 90° to set phase zero, and then steps D-1 and D-2 using 270° as the course setting, but bridging terminals C and D as needed.

D-4. PHASE BRIDGE BALANCE (0°) (See Fig. 18)

1. Reset the Simulator azimuth dial to 0°.
2. Reset the course selector dial to 0°. If L-R meter will not center between 358° and 2°, the phase bridge needs compensation.
3. Bridge D to E with a resistor or A to E with a capacitor as needed to center the L-R meter at 0°. Resistor values should lie between 5 megohms and 50 megohms, and capacitor values between 100 MMF and 470 MMF.

D-5. PHASE BRIDGE BALANCE (180°) (See Fig. 18)

Repeat same procedure as in D-4, but set dials to 180°. Normal tolerance is ±2°.
Terminals to be bridged A and B or D and B.

E. CRITICAL COMPONENTS

E-1. TUBES

The various tubes used in this equipment are not selected, or critical, except that they must lie within ±20% of the rated transconductance if full performance is to be achieved.

The four sections of the two cathode follower tubes (V-203 and V-204) must be matched to within ±20% in transconductance in order to maintain the close balance between the four cathode output voltages. Most good tubes will lie well within these limits, but if excessive unbalance is evident from the tests outlined, replacement tubes should be tried, until a suitable one is found. It is well to check these four voltages for balance at the regular maintenance inspections, at which time any replacements can be made. In the event that a pair of tubes having transconductances lying within the above matching tolerance cannot be obtained locally, a properly matched pair can be obtained from the factory.

E-2. CAPACITORS and RESISTORS

The following capacitors and resistors have special characteristics, and should be replaced by identical units obtained from the factory.

C-113, 114, 201, 202, 203, 204, 205, 206, 207, 210, 211, 212, 215, 227.

R-201, 202, 203, 204, 205, 206, 207, 210, 211, 212, 213, 215, 216, 221, 222, 227, 228, 229, 236, 237, 238, 239, 248, 249.

CAUTION—Extreme care must be observed in replacing components to avoid damaging printed circuit boards.

E-3. OMNI OUTPUT TRANSFORMER

As mentioned in Sect. III, D-3, the audio output transformer employed in the variable phase channel is of unusually high quality as regards low-frequency performance (30 cycles). If replacement is required, use only the identical type of unit, which is available from the factory only.

After replacing this transformer, the rectifier balance compensation should be checked and recompensated if needed, as described in paragraph D-1, and also the phase zero setting as described in paragraph D-2.

E-4. RECTIFIERS

The crystal rectifiers used in the L-R metering circuit (XT-201 and XT-202) are carefully matched at the factory, so as to minimize the balance compensation. This matching is done with a special test bridge.

It is strongly recommended that any replacement rectifiers be obtained in matched pairs from the factory. The rectifier load resistors (R-236 and R-237) are matched to ±2%. Any replacements should be held to the same tolerance. After replacing a pair of these rectifiers, or one or more of the load resistors, the rectifier balance should be rechecked and recompensated, if necessary, as described in paragraph D-1.

E-5. COURSE SELECTOR

The course selector comprises a special wire-wound potentiometer with 5 accurately-located taps.

The dials are interchangeable, but after changing a dial or a potentiometer, the 180° tap must be aligned with the 180° dial mark as follows:

1. Connect a LOW-range ohmmeter to the center arm terminal, and to the 180° tap terminal of the course selector potentiometer. (Points F and G in Figure 22).
2. Set the potentiometer shaft for the lowest ohms reading using a screw driver in the slot provided in the shaft.

3. Holding the shaft in this position, rotate the dial until the 180° mark aligns with the index pointer.
4. Press dial firmly against the friction springs under it, and tighten the set screws.
5. Check proper setting by noting if point of lowest resistance as measured in 1. corresponds exactly to the 180° dial reading. If slightly in error, the two screws which hold the pointer can be loosened, and the pointer moved to accurately align it. Retighten screws after alignment.

   It is advisable to check the compensations in paragraphs D-2, D-4 and D-5, since these are also used to compensate for slight variations in course selector potentiometers.

F. T-4 FILTER VOLTMETER

The NARCO T-4 Filter Voltmeter consists of a very high input impedance (50 meg) VTVM with a 30 cycle RC feedback filter carefully designed for zero phase shift at 30 cycles. Information (description, schematic, and parts list) may be obtained from NARCO upon request.

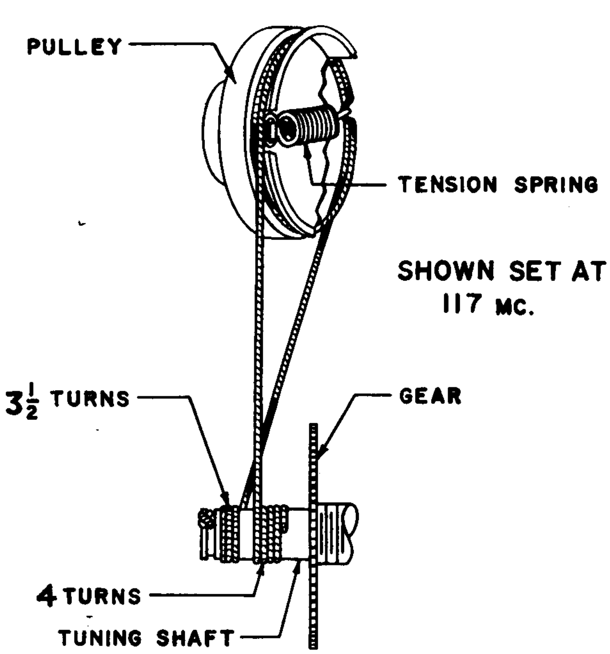
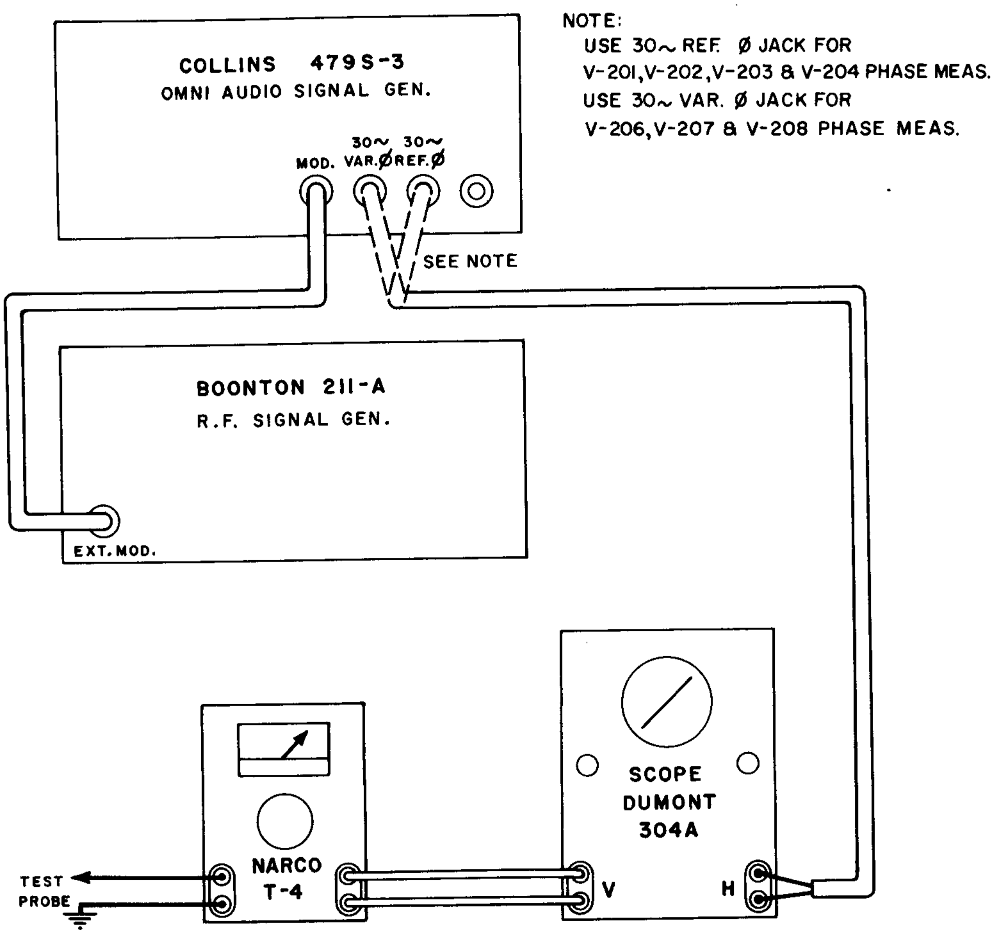
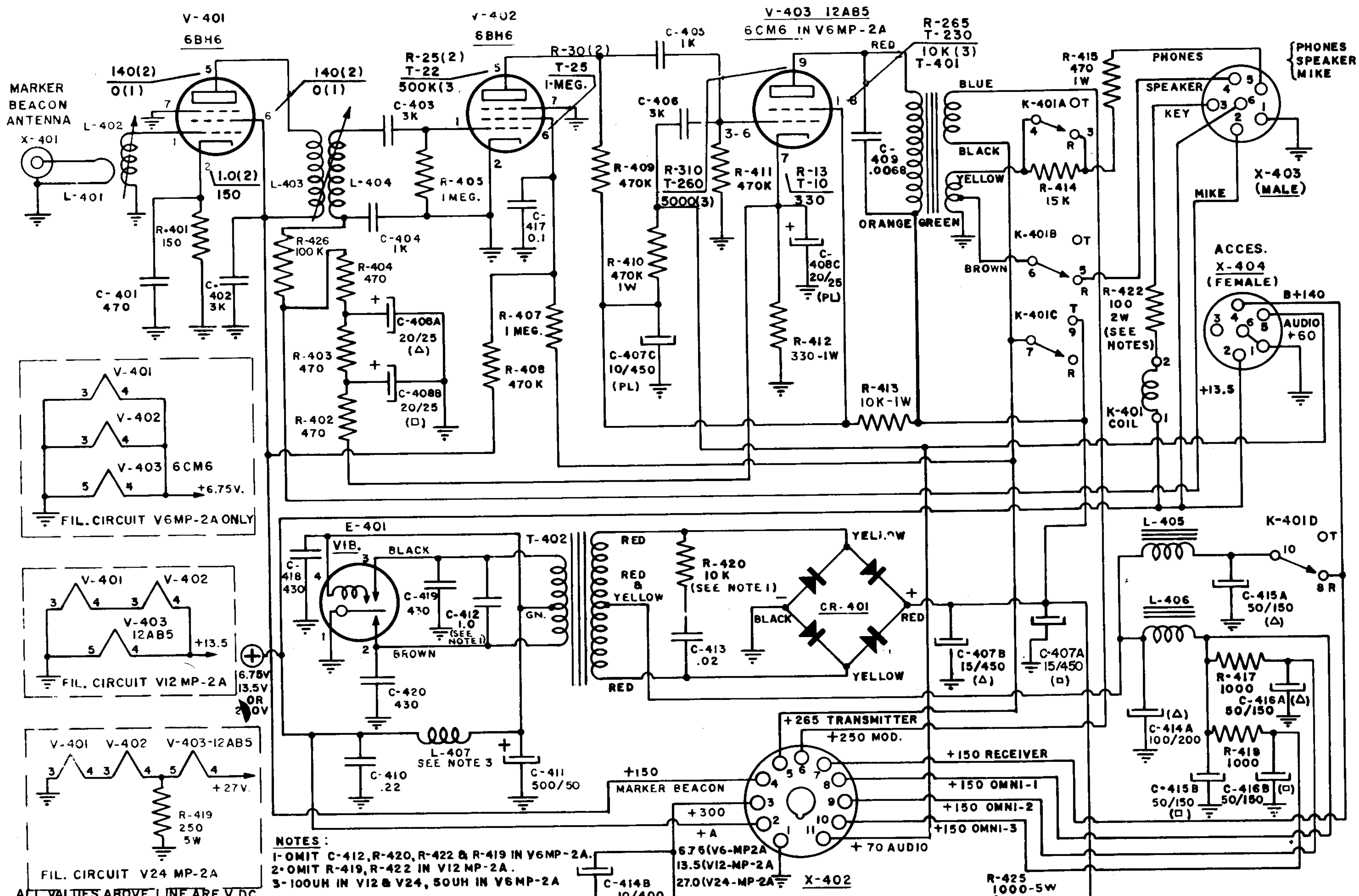


Figure 13. DIAL STRING DIAGRAM



PHASE ANGLE TEST SET-UP

Figure 14.



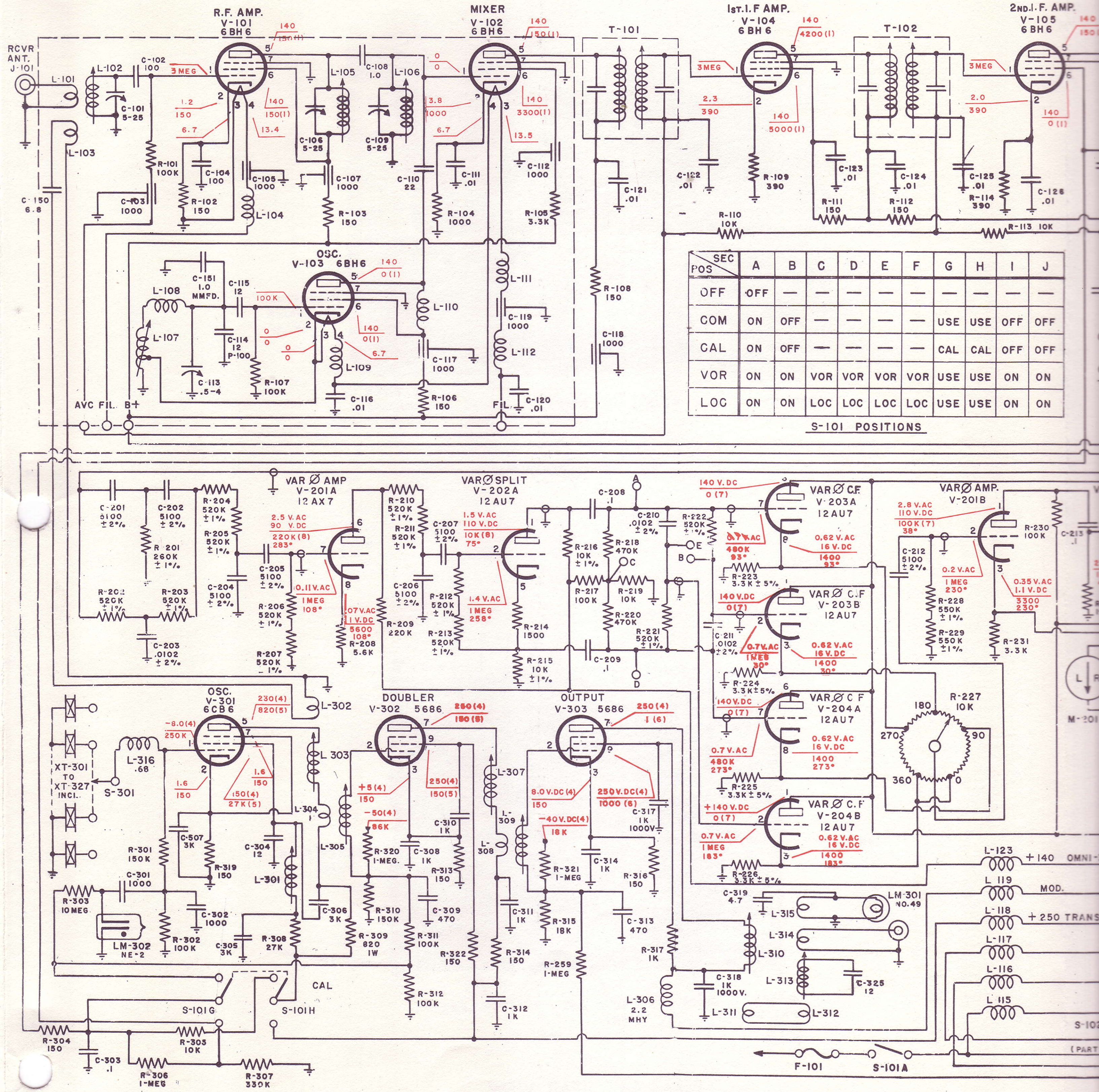
NOTES:
1-OMIT C-412, R-420, R-422 & R-419 IN V6MP-2A.
2-OMIT R-419, R-422 IN V12 MP-2A.
3-100UH IN V12 & V24, 50UH IN V6MP-2A

ALL VALUES ABOVE LINE ARE V.DC
ALL VALUES BELOW LINE ARE RESISTANCE; SHOWN IN RED.
NOTES: (1) MEASURED TO PIN 4 OF X-402
(2) MARKER BEACON SWITCH PULLED ON.
(3) MEASURED TO + TERMINAL OF CR-401.
MEASUREMENTS TAKEN SAME AS VTR-2.

R = RECEIVE
T = TRANSMIT

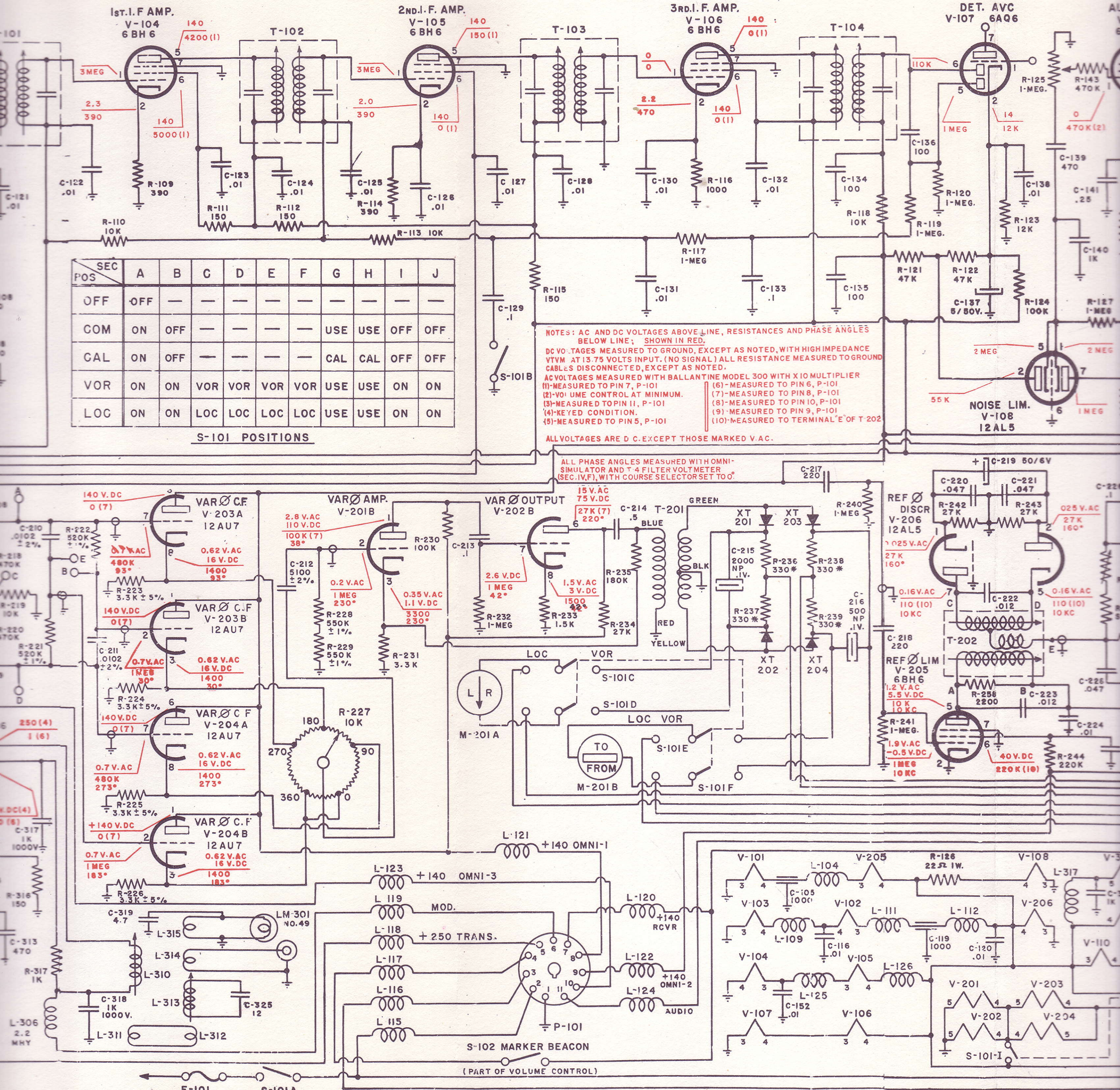
SCHEMATIC DIAGRAM V( )MP-2A

Figure 15.



POS \ SEC	A	B	C	D	E	F	G	H	I	J
OFF	OFF	—	—	—	—	—	—	—	—	—
COM	ON	OFF	—	—	—	—	USE	USE	OFF	OFF
CAL	ON	OFF	—	—	—	—	CAL	CAL	OFF	OFF
VOR	ON	ON	VOR	VOR	VOR	VOR	USE	USE	ON	ON
LOC	ON	ON	LOC	LOC	LOC	LOC	USE	USE	ON	ON

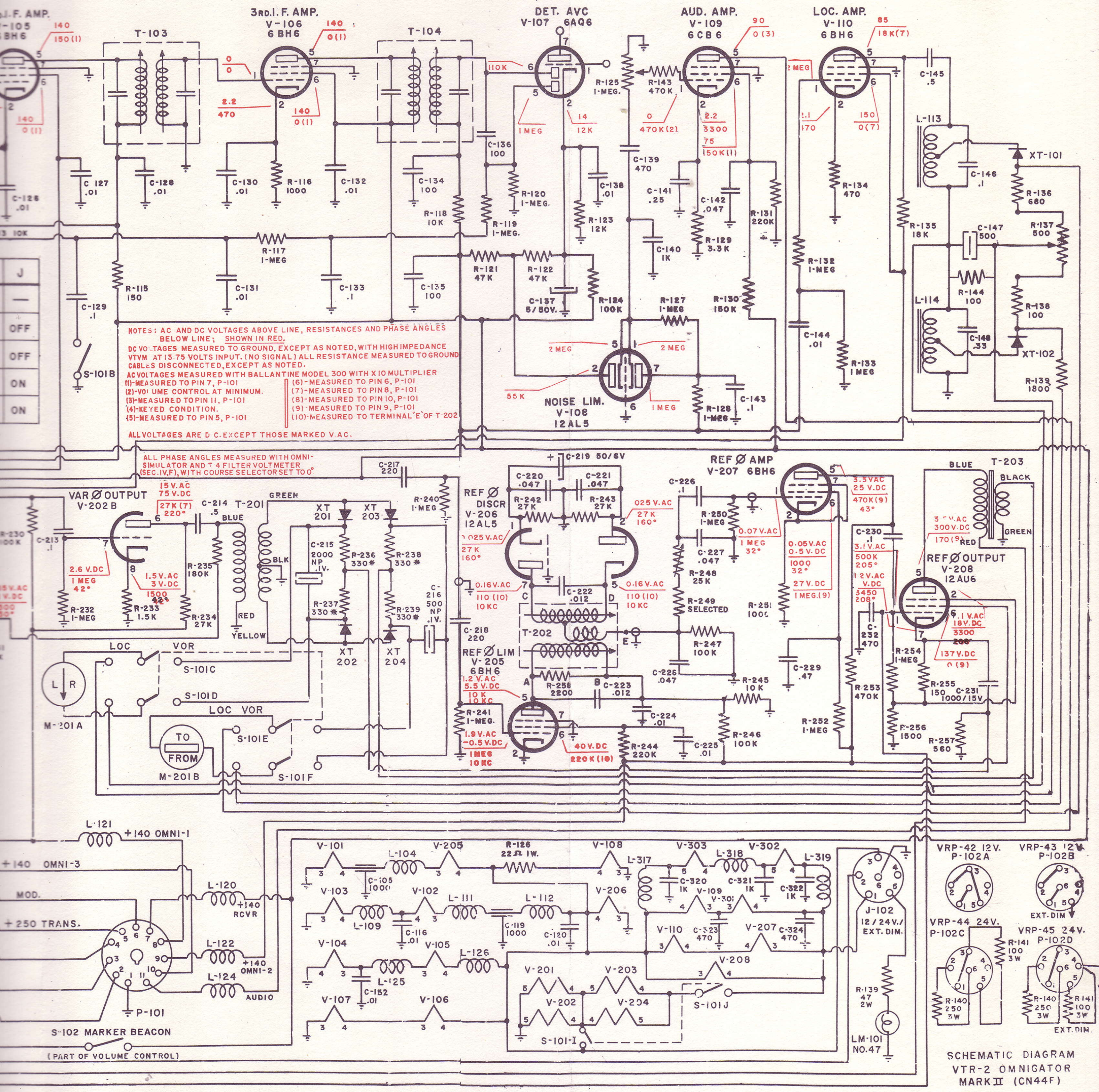
S-101 POSITIONS



SEC / POS	A	B	C	D	E	F	G	H	I	J
OFF	OFF	—	—	—	—	—	—	—	—	—
COM	ON	OFF	—	—	—	—	USE	USE	OFF	OFF
CAL	ON	OFF	—	—	—	—	CAL	CAL	OFF	OFF
VOR	ON	ON	VOR	VOR	VOR	VOR	USE	USE	ON	ON
LOC	ON	ON	LOC	LOC	LOC	LOC	USE	USE	ON	ON

S-101 POSITIONS

SCHEMATIC DIAGRAM — VTR-2A
Figure 16



SCHEMATIC DIAGRAM — VTR-2A

Figure 16

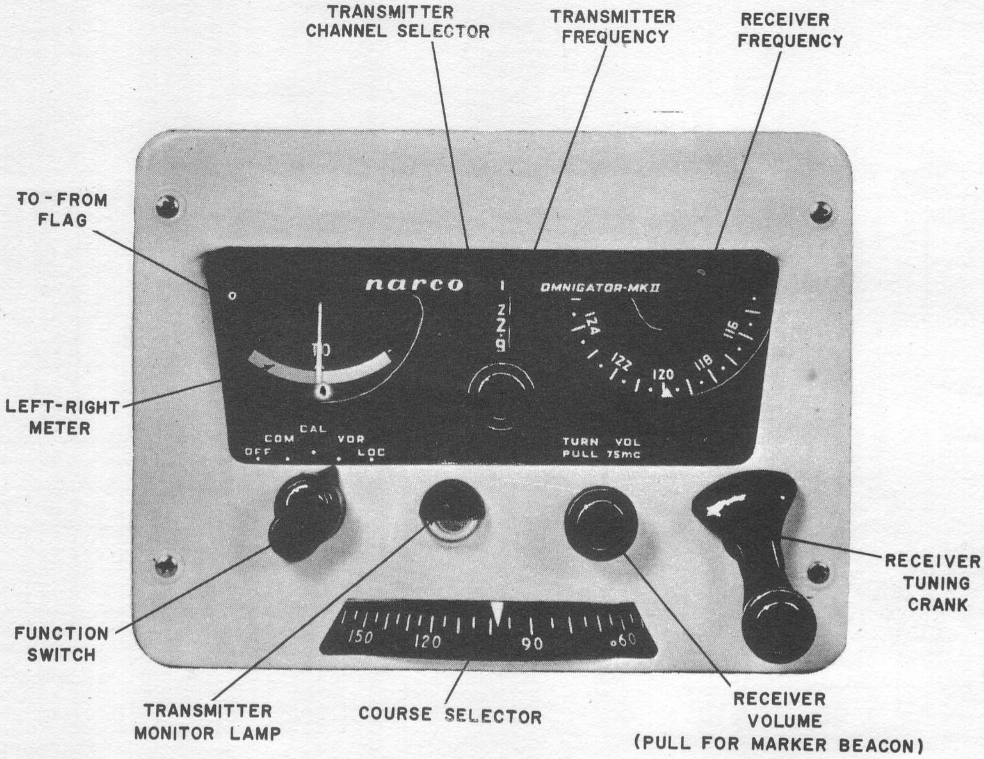


Figure 17. FRONT VIEW

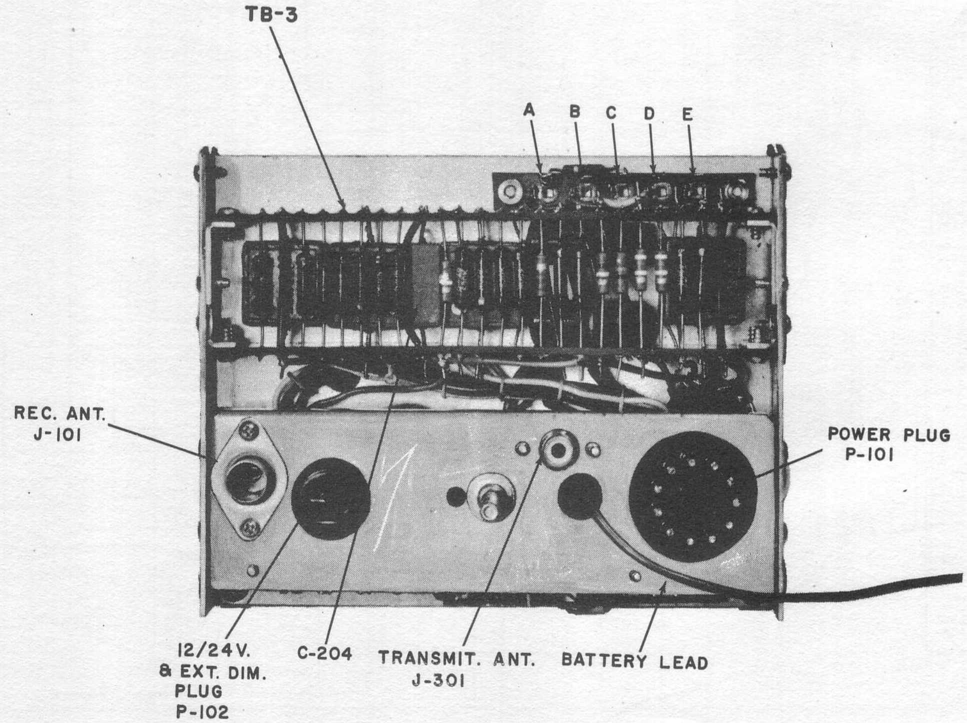


Figure 18. REAR VIEW

G. REPLACEMENT PARTS LIST, VTR-2

SYMBOL	PART No.	DESCRIPTION
C-113	22023-4	Capacitor, Glass Trimmer 0.5-4 mmf.
C-101, 106, 109,	22001-525	" Ceramic " 5-25 "
C-108, 151	24502-109	" " Tub. 500 volts 1.0 "
C-319	21201-479	" " " " " NPO 4.7 "
C-114	21282-4	" " " " " P-100, 5%, 12 "
C-115, 304, 325	21201-120	" " " " " " 12 "
C-110	21201-220	" " " " " " 22 "
C-102, 104, 134, 135, 136	21308-101	" " " " " GP 100 "
C-217, 218	21308-221	" " " " " " 220 "
C-232, 309, 313, 323, 324	21291-2	" " Disc " " " 470 "
C-139	21358-471	" " Tub. " " " 470 "
C-140, 301, 302	21308-102	" " " " " " 1000 "
C-308, 310, 311, 312, 314, 320, 321, 322	24506-110	" " Disc " " " 1000 "
C-103, 105, 107, 112, 117, 118, 119	21290-2	" " Feed-thru " " 1000 "
C-305, 306, 307	21291-4	" " Disc " " " 3000 "
C-317, 318	21291-12	" " " 1000 " " 1000 "
C-201, 202, 204, 205, 206, 207, 212	21117-512	" Mica 500 " 2%, 5100 "
C-203, 210, 211	24035-1022	" " 300 " 10200 "
C-144, 224, 225, 131	21171-103	" Paper, Tub. 400 " .01 mfd.
C-111, 116, 120, 122, 125 126, 130, 138, 152,	21291-5	" Ceramic Disc 50 " .01 "
C-121, 123, 124, 127, 128, 132	21291-6	" " " 500 " .01 "
C-222, 223	21170-123	" Paper, Tub. 200 " .012 "
C-142	21153-473	" " " 400 " .047 "
C-220, 221, 228	21170-473	" " " 200 " .047 "
C-227	21152-473	" " " 500 " .047 "
C-129, 133, 143, 146, 208, 209, 213, 226, 230	21170-104	" " " 200 " .1 "
C-303	21402-104	" " Metalized 500 " .1 "
C-141	21402-254	" " " 200 " .25 "
C-148	21170-334	" " " " " .33 "
C-229	21151-474	" " " " " .47 "
C-145, 214	21402-504	" " " 500 " .5 "
C-137	21524-20	" Electrolytic 50 " 5 "
C-219	21524-5	" " 6 " 50 "
C-147, 216	21524-21	" " .01 " NP 500 "
C-231	21524-23	" " 15 " 1000 "
C-215	21525-3	" " .01 " NP 2000 "
C-150	21201-689	" Ceramic Tub. 500 " NPO 6.8 mmf.
L-308, 309	11265-102	Coil, Amplifier Grid
L-301	11256-101	" Oscillator, Transmitter
L-302, 303	11263-101	" Oscillator, Plate, Transmitter
L-304, 305	11264-101	" Doubler Grid, Transmitter
L-307	11263-102	" Doubler, Plate
L-310, 311	11379-1	" Final
L-312, 313, 314, 315	11380-1	" Output
L-316	11138-6	R.F. Choke, 0.68 microhenry
J-101	41143-1	Receptacle, Receiver Antenna
J-102	41204-3	" 12/24v Ext. Dimmer
J-301	41110-2	" Transmitter Antenna
L-101, 102, 103, 105, 106, 107	11369-102	Tuning Coil Assembly (with trimmers)
L-104, 109, 110, 112, 125, 126, 317, 318, 319	11138-5	R.F. Choke, 0.47 microhenry
L-306	11138-9	" " 2.2 "
L-113, 114	11175-4	Audio Reactor
L-115	11349-101	R.F. Choke (High current)
L-116, 117, 118, 119, 120, 121, 122, 123, 124	Part of P-101	R.F. Choke
LM-101		Panel Lamp, Mazda No. 47
LM-301		Panel Lamp, Mazda No. 49
LM-302		Neon Lamp, G.E. NE-2
M-201A & B	76031-2	Combination Left-Right, To-From Indicator
P-101	41182-2	11 Pin male connector
R-102, 103, 106, 108, 111, 112, 115, 255, 304, 313, 316, 314, 319, 322, 142	31141-151	Resistor, carbon ½ watt, 150 ohms 10%
R-236, 237, 238, 239	31176-331	" " " 330 " matched 2%
R-114, 109	31110-391	" " " 390 " 10%
R-257	31110-561	" " " 560 " 10%
R-134	31110-471	" " " 470 " 10%
R-104, 251, 116, 317	31110-102	" " " 1K " "
R-126	31113-220	" " 1 watt 22 " "
R-136	31110-681	" " ½ watt 680 " "

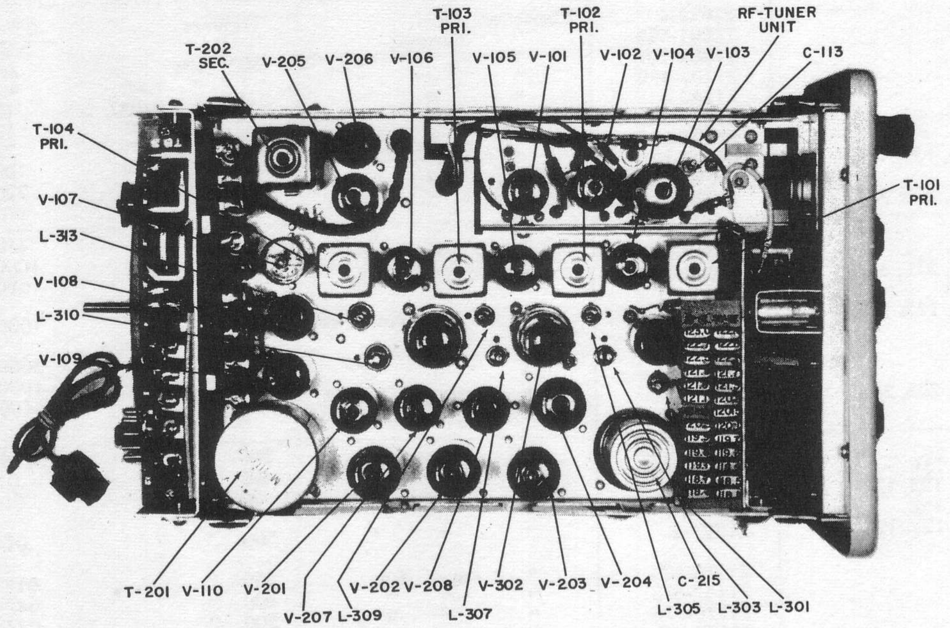


Figure 19. TOP VIEW—LOW BAND SET

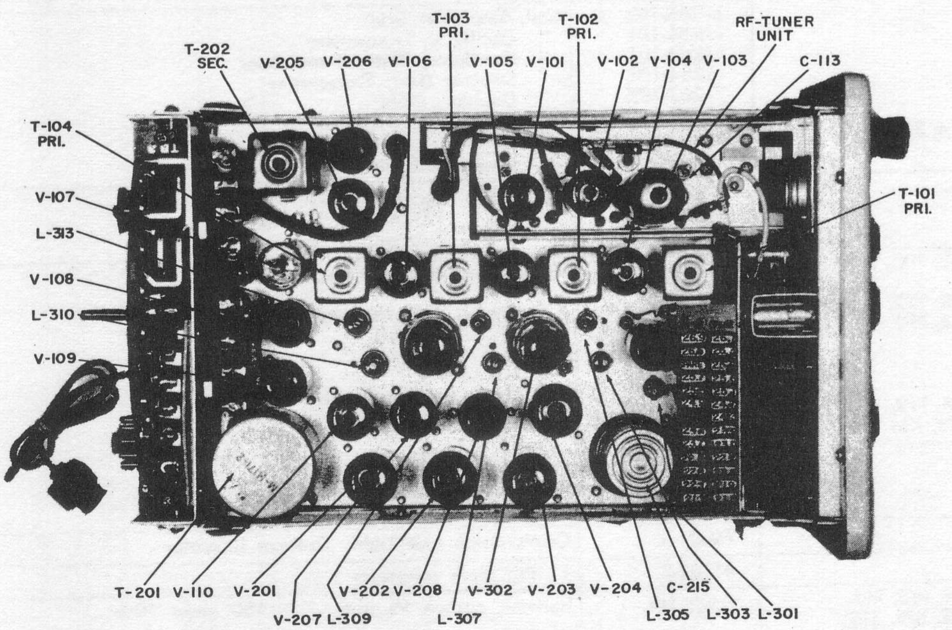


Figure 20. TOP VIEW—HIGH BAND SET

SYMBOL	PART NO.	DESCRIPTION
R-138 144	31110-101	" " " 100 " "
R 139	31110-182	1800
R-214, 233, 256	31110-152	" " " 1500 " "
R-105, 129, 231	31110-332	" " " 3300 " "
R-223, 224, 225, 226	31115-332	" " " 3300 " 5%
R-208	31110-562	" " " 5600 " 10%
R-110, 113, 118, 123, 219, 245, 305	31110-103	" " " 10K " "
R-215, 216	31177-103	" boron-car. " 10K " 1%
R-315, 135	31110-183	" carbon " 18K " 10%
R-234, 242, 243, 308	31110-273	" " " 27K " "
R-121, 122	31110-473	" " " 47K " "
R-101, 107, 124, 217, 230, 246, 247, 302, 311, 312	31110-104	" " " 100K " "
R-130, 301, 310	31110-154	" " " 150K " "
R-235	31110-184	" " " 180K " "
R-131, 209, 244	31110-224	" " " 220K " "
R-307	31110-334	" carbon " 330K " "
R-220, 253, 143, 218	31110-474	" " " 470K " "
R-202, 203, 204, 205, 206, 207, 210, 211, 212, 213, 221, 222, 228, 229, 201	31177-524	" boron-car. " 520K " 1%
R-117, 119, 120, 127, 128, 132, 133, 232, 240, 241, 252, 254, 306, 259, 320, 321, 250	31110-105	" carbon " 1 meg " 10%
R-303	31110-106	" " " 10 meg " "
R-309	31135-821	" " 1 watt, 820 " "
R-141	31161-1	" wire 3 watt, 100 " "
R-140	31161-4	" " " 250 " "
R-139	31121-3	" wire 2 watt, 47 " "
R-137	32007-5	Potentiometer, wire-wound, 500 " linear
R-227	32004-4	" " 10K " courseselector
R-248	32006-2	" " 50K " linear
R-125	32001-4	" carbon 1 meg " audio taper (includes push-pull switch)
T-101, 102, 103	11206-1	Transformer, I.F., 10.7 mc. (interstage)
T-104	11266-1	" " 10.7 " (output)
T-201	11171-2	" Omni Output
T-202	11365-1	" Ratio Detector
T-203	11183-1	" To-From Output
V-101, 102, 103, 104, 105, 106, 110, 205, 207		Tube, 6BH6
V-107		" 6AQ6
V-108, 206		" 12AL5
V-109, 301		" 6CB6
V-201		" 12AX7
V-202, 203, 204		" 12AU7
V-208		" 12AU6
V-302, 303		" 5686
VRP-15A	05020	Antenna Assy., Horizontal Vee, Pedestal Mount
VRP-37	71126	" " " " Tail Mount
VTP-17	71110-103	" " Bent Whip
VRP-35A	52212-102	Junction Box and Cable Assy. (VTR-2 and VC-27)
VRP-39	90525	Antenna Junction Box and Cable Assy.
VTP-31	90533-101	Matching Network, Switch and Cable Assy.
	53408-107	Case Assy., Omnigator
	88004-106	Tuning Crank Assy., black
	88009-7	Volume control knob
	88010-4	Function Switch Knob
	88089-101	Knurled Frequency Selector Knob
	88084-101	Dial Assy., Course Selector
	88098-2	" " Receiver Tuning
	88075-109	" " Transmitter Channel Selector (low band)
	88075-111	" " " " " (high band)
	88081-2	Dial Pointer, Course Selector Dial
	88082-2	" " Receiver Tuning Dial
	41207-101	Socket Assy., Crystal (14 pos.)
	41142-1	Connector, Receiver Antenna
	41130-2	" Transmitter Antenna
	41115-11F	" Power Cable (11 Pin female)
P-101	53841-101	Connector Bridge Assy., (incl. P-101, L-115 to 124, J-101, 102, 301)
P-102A	VRP-42	Dummy Plug—12 volt—no external dimmer
P-102B	VRP-43	" " 12 volt—for external dimmer
P-102C	VRP-44	" " 24 volt—no external dimmer
P-102D	VRP-45	" " 24 volt—for external dimmer
	41148-102	Fuse Connector Assy.

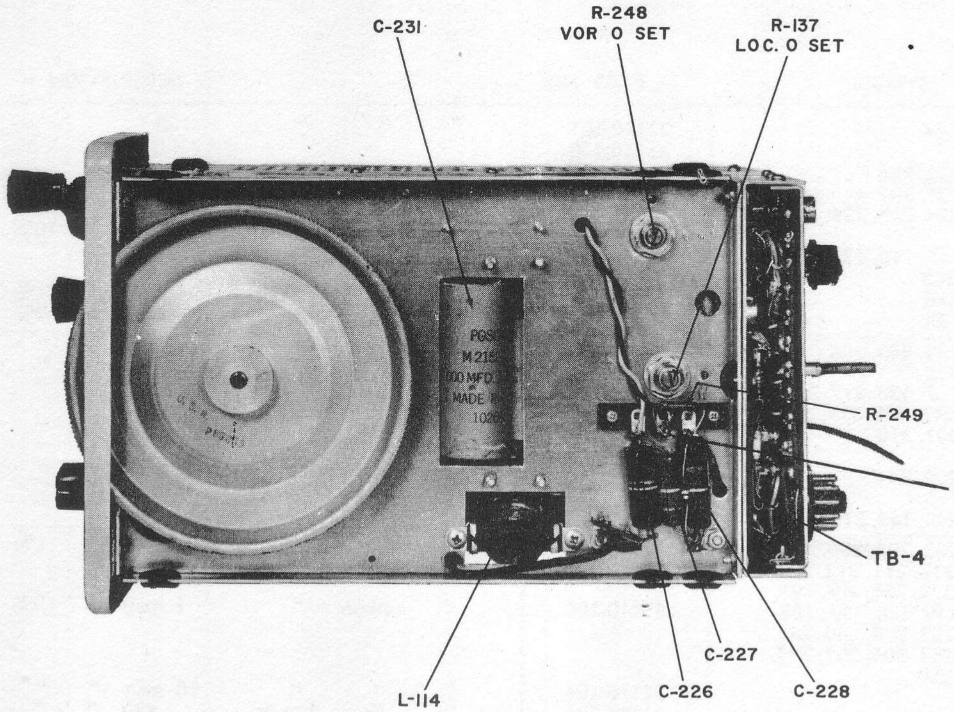


Figure 21. BOTTOM VIEW

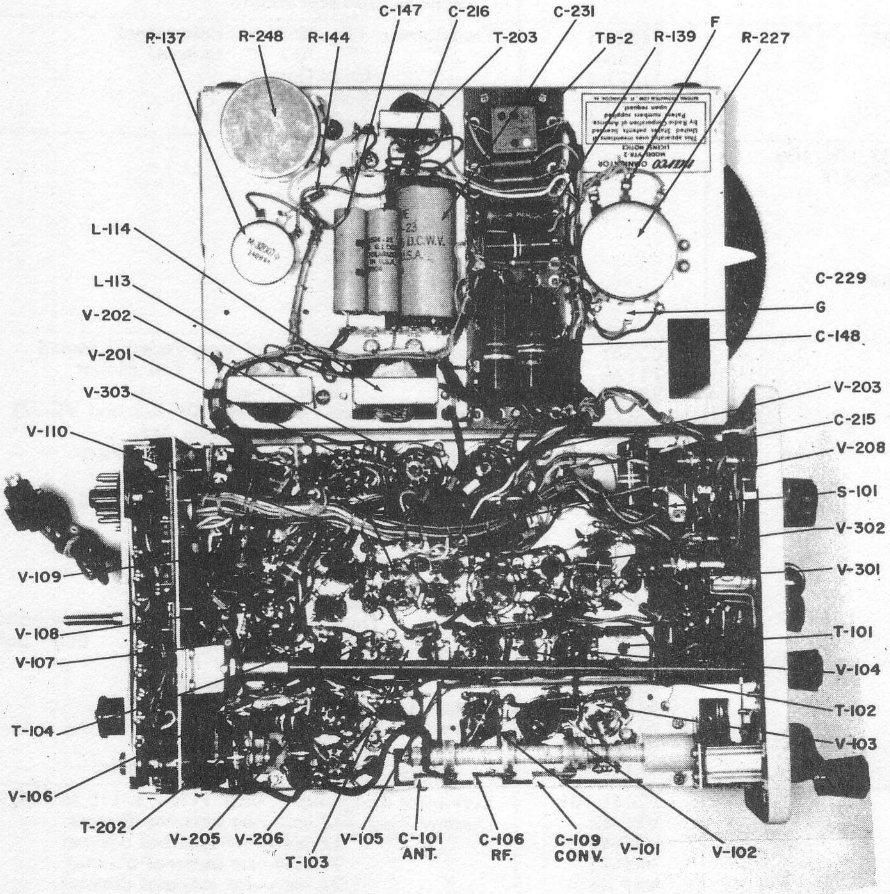


Figure 22. OPENED VIEW

	53836	Front Trim Panel (Specify color)
	53803	Front Masking Panel
	53809-103	R.F. Tuner, complete unit assy. incl. V-101, 102 and 103
	88019-104	Tuning Pinion and Stop Washer Assy.
	81654-2	Transmitter Monitor Lamp Cap (plastic)
	81192-3	Retainer Ring for Lamp Cap
	51773-2	Volume Control Extension Shaft
	81611-2	Dial Spring
	88031-3	Dial Cord, Dacron (non-stretch) (bulk)
	61241-6	Function Switch
	61240-1	Transmitter Channel Switch
XT-201, 202, 203, 204	75014-1	Crystal Rectifiers, see Section E-4
XT-301 to	K-72006-48	Crystal, Freq. Control, for 117.9 mc. Order K-117.9 mc.
XT-327	K-72006-101	" " " " 118.0 " " K-118.0 mc.
	K-72006-1	" " " " 118.1 " " K-118.1 mc.
	K-72006-102	" " " " 118.2 " etc.
	K-72006-2	" " " " 118.3 "
	K-72006-103	" " " " 118.4 "
	K-72006-3	" " " " 118.5 "
	K-72006-104	" " " " 118.6 "
	K-72006-4	" " " " 118.7 "
	K-72006-105	" " " " 118.8 "
	K-72006-5	" " " " 118.9 "
	K-72006-106	" " " " 119.0 "
	K-72006-6	" " " " 119.1 "
	K-72006-107	" " " " 119.2 "
	K-72006-7	" " " " 119.3 "
	K-72006-108	" " " " 119.4 "
FOR USE IN	K-72006-8	" " " " 119.5 "
LOW BAND SET ONLY	K-72006-109	" " " " 119.6 "
	K-72006-9	" " " " 119.7 "
	K-72006-110	" " " " 119.8 "
	K-72006-10	" " " " 119.9 "
	K-72006-111	" " " " 120.0 "
	K-72006-11	" " " " 120.1 "
	K-72006-112	" " " " 120.2 "
	K-72006-12	" " " " 120.3 "
	K-72006-113	" " " " 120.4 "
	K-72006-13	" " " " 120.5 "
	K-72006-114	" " " " 120.6 "
	K-72006-14	" " " " 120.7 "
	K-72006-115	" " " " 120.8 "
	K-72006-15	" " " " 120.9 "
	K-72006-116	" " " " 121.0 "
	K-72006-16	" " " " 121.1 "
	K-72006-117	" " " " 121.2 "
	K-72006-17	" " " " 121.3 "
	K-72006-118	" " " " 121.4 "
	K-72006-18	" " " " 121.5 "
	K-772006-119	" " " " 121.6 "
	K-72006-19	" " " " 121.7 "
	K-72006-120	" " " " 121.8 "
	K-72006-20	" " " " 121.9 "
	K-72006-121	" " " " 122.0 "
	K-72006-21	" " " " 122.1 "
FOR USE IN	K-72006-49	" " " " 122.2 "
LOW OR HIGH BAND SET	K-72006-22	" " " " 122.3 "
	K-72006-122	" " " " 122.4 "
	K-72006-23	" " " " 122.5 "
	K-72006-123	" " " " 122.6 "
	K-72006-24	" " " " 122.7 "
	K-72006-25	" " " " 122.8 "
	K-72006-26	" " " " 122.9 "
	K-72006-124	" " " " 123.0 "
	K-72006-27	" " " " 123.1 "
	K-72006-125	" " " " 123.2 "
	K-72006-28	" " " " 123.3 "
	K-72006-126	" " " " 123.4 "
	K-72006-29	" " " " 123.5 "
	K-72006-127	" " " " 123.6 "
	K-72006-30	" " " " 123.7 "
	K-72006-128	" " " " 123.8 "
	K-72006-31	" " " " 123.9 "
	K-72006-129	" " " " 124.0 "
	K-72006-32	" " " " 124.1 "
	K-72006-130	" " " " 124.2 "

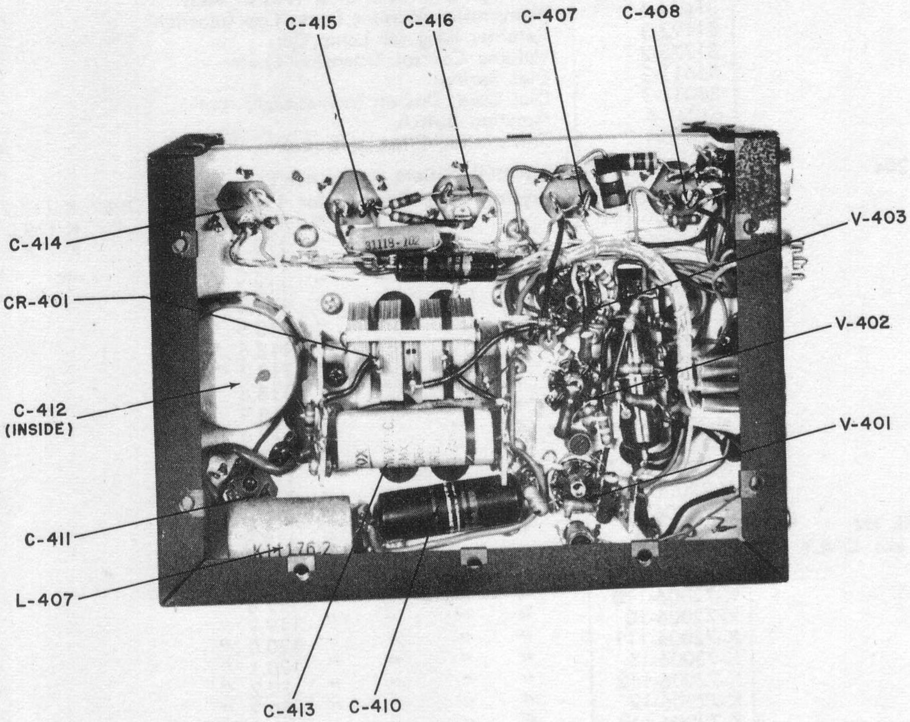


Figure 23. POWER UNIT—BOTTOM VIEW

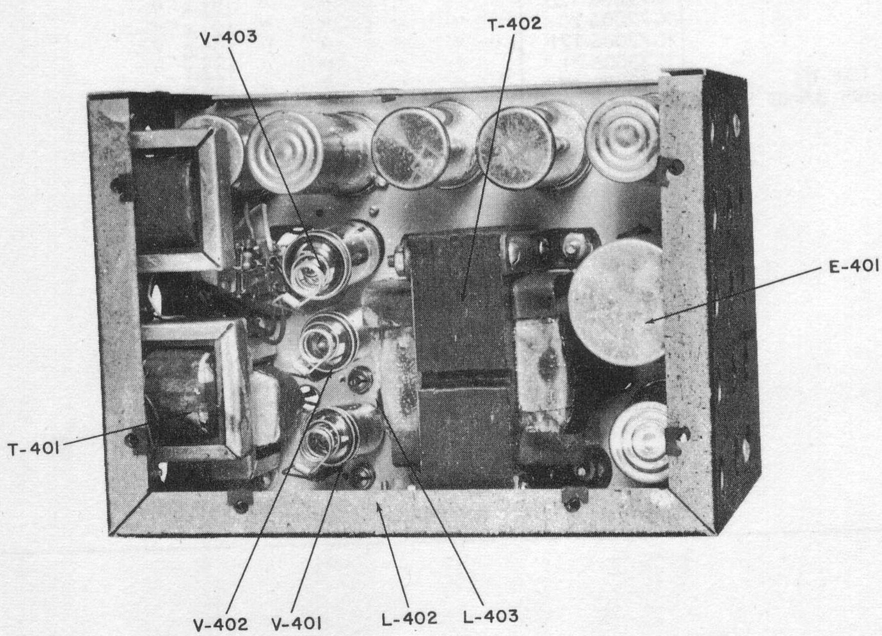


Figure 24. POWER UNIT—TOP VIEW

	K-72006-33	" " " " 124.3 "
	K-72006-131	" " " " 124.4 "
	K-72006-34	" " " " 124.5 "
	K-72006-132	" " " " 124.6 "
	K-72006-35	" " " " 124.7 "
	K-72006-133	" " " " 124.8 "
	K-72006-36	" " " " 124.9 "
	K-72006-134	" " " " 125.0 "
	K-72006-37	" " " " 125.1 "
	K-72006-135	" " " " 125.2 "
	K-72006-38	" " " " 125.3 "
	K-72006-136	" " " " 125.4 "
	K-72006-39	" " " " 125.5 "
FOR USE IN	K-72006-137	" " " " 125.6 "
HIGH BAND SET ONLY	K-72006-40	" " " " 125.7 "
	K-72006-138	" " " " 125.8 "
	K-72006-41	" " " " 125.9 "
	K-72006-139	" " " " 126.0 "
	K-72006-42	" " " " 126.1 "
	K-72006-140	" " " " 126.2 "
	K-72006-43	" " " " 126.3 "
	K-72006-141	" " " " 126.4 "
	K-72006-44	" " " " 126.5 "
	K-72006-142	" " " " 126.6 "
	K-72006-45	" " " " 126.7 "
	K-72006-143	" " " " 126.8 "
	K-72006-46	" " " " 126.9 "
	K-72006-47	" " " " 126.18 "

H. REPLACEMENT PARTS LIST, V(-)MP-2A

SYMBOL	PART No.	DESCRIPTION
C-418, 419, 420	M-2129-1	Capacitor, Ceramic Disc 500V HIK 430 mmf.
C-401	21308-471	" " " " " 470 "
C-402, 403, 406	21319-302	" " " " " 3000 "
C-405, 404	21308-102	" " " " " 1000 "
C-409	21155-682	" Tubular 600V 0.0068 mfd.
C-413	M-21191-4	" Oil 1600V 0.02 "
C-417	21153-104	" Tubular 400V 0.1 "
C-410	21170-224	" " 200V 0.22 "
C-412	21173-105	" Metallized " 1.0 "
C-407	M-21525-2	" Electrolytic 450V 15-15-10 "
C-408	M-21525-4	" " 25V 20-20-20 "
C-415, 416	M-21525-6	" " 150V 50-50 "
C-414	M-21525-15	" " 200-400V 100-10 "
C-411	M-21525-18	" " 50V 500 "
L-401, 402	K-11204-101	Marker Beacon Input Coil Assy.
L-403, 404	K-11205-101	" " Output " "
L-405, 406	K11173-1	Filter Choke, 4Hy
L-407 (V12MP-2A and VT4MP-2A)	K-11176-2	Hash Choke
L-407 (V6MP-2A)	K-11176-3	" "
R-401	31110-151	Resistor, Carbon ½ watt 150 ohms ±10%
R-402, 403, 404	31110-471	" " " 470 " "
R-414	31110-153	" " " 15,000 " "
R-417, 418	31110-102	" " " 1,000 " "
R-420	31110-103	" " " 10,000 " "
R-426	31110-104	" " " 100K " "
R-408, 409, 411	31110-474	" " " 470,000 " "
R-405, 407	31110-105	" " " 1 megohm "
R-412	31135-331	" 1 watt 330 ohms "
R-413	31136-472	" .. 2 watt 4,700 " "
R-415	31135-471	" " " 470 " "
R-422 (V24MP-2A)	31155-101	" " 2 watt 100 " "
R-410	31135-474	" " 1 watt 470K " "
R-419 (V24MP-2A)	31118-251	" " 5 watt 250 " "
R-425	31118-102	Resistor, Wire, 5 watt 1,000 " "
CR-401	M-75118-1	Rectifier,Selenium
K-401 (V12MP-2A and V24MP-2A)	M-65114-1	Relay, 4 pole D.T., 12 volt coil
K-401 (V6MP-2A)	M-65126-15	" " " 6 " "
T-402 (V12MP-2A)	M-11167	Transformer, vibrator, 12 volts input
T-402 (V24MP-2A)	M-11169	" " 24 " "
T-402 (V6MP-2A)	M-11168	" " 6 " "
T-401	M11166-2	" audio output

V-401, 402		Tube, 6BH6
V-403 (V12MP-2A) and 24MP-2A)		" 12AB5
V-403 (V6MP-2A)		" 6CM6
E-401 (V12MP-2A)	M-64007-3	Vibrator, 115 cycles, 12 volts
E-401 (V24MP-2A)	M-64007-7	" " 24 "
E-401 (V6MP-2A)	M-64007-5	" " 6 "
X-401	K-41110-2	Connector, Marker Beacon Antenna
X-402	K-41126-1	" 11 pin, Female
X-403	K-4112-2	" 6 pin, Male
X-404	K-4112-1	" 6 pin, Female
	K-41127-1	Jack, Phones
	K-41128-1	" Microphone
	K-42033-2	Tube Socket, 7 pin miniature, phenolic
	K-42034-1	" " 9 " " "
	K-42004-5	" " 4 " wafer (vibrator)
	K-42045-1	Vibrator socket shield assembly
	P-51403-2	Cover, L plate
	M-51404-3	" top plate
	K-52086-1, 2	Mounting brackets (right and left)
	M-51809	Mounting base

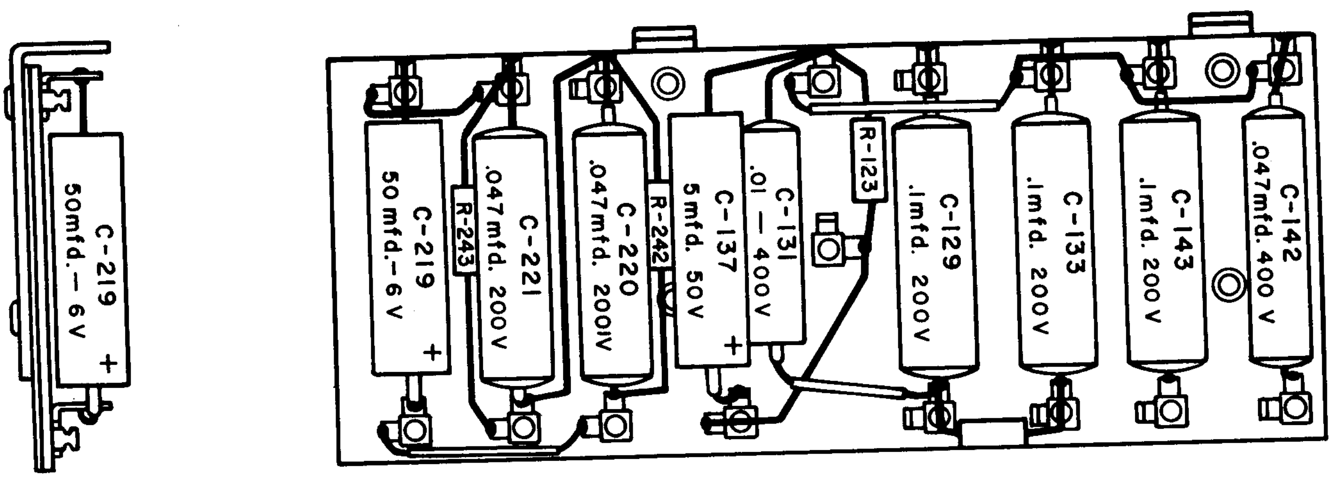
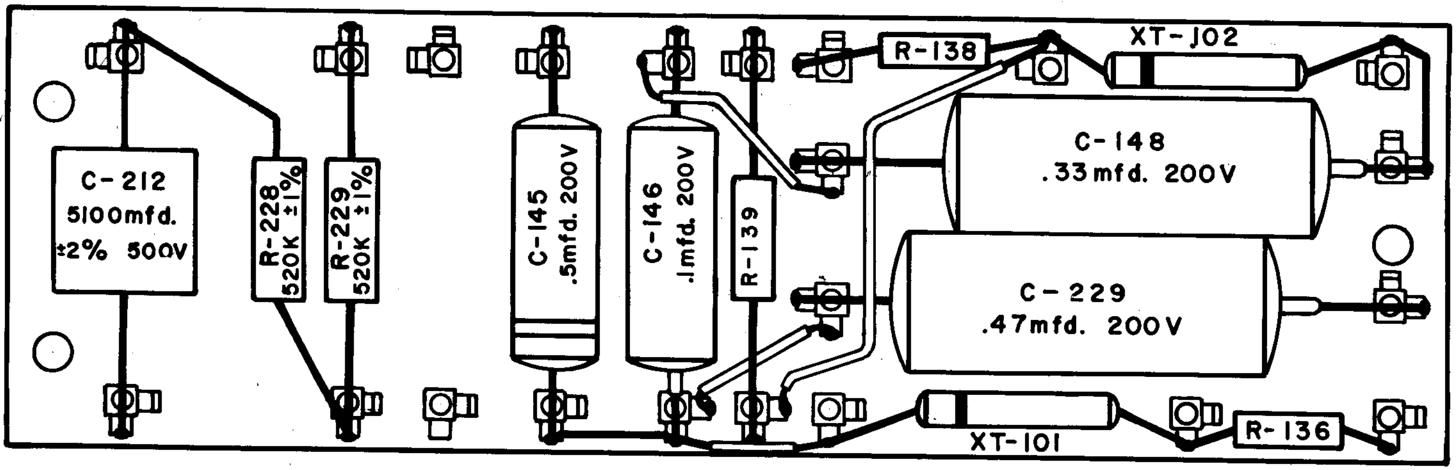
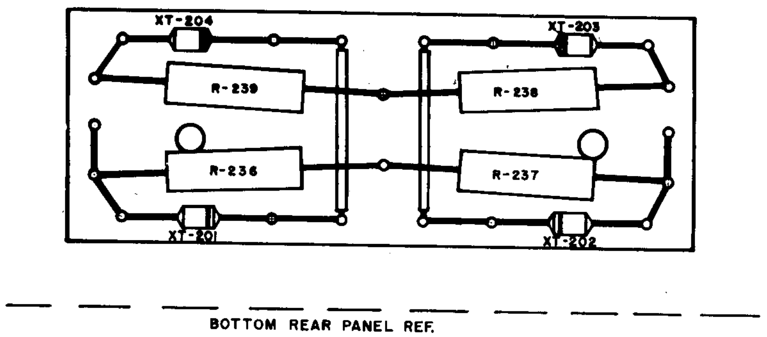


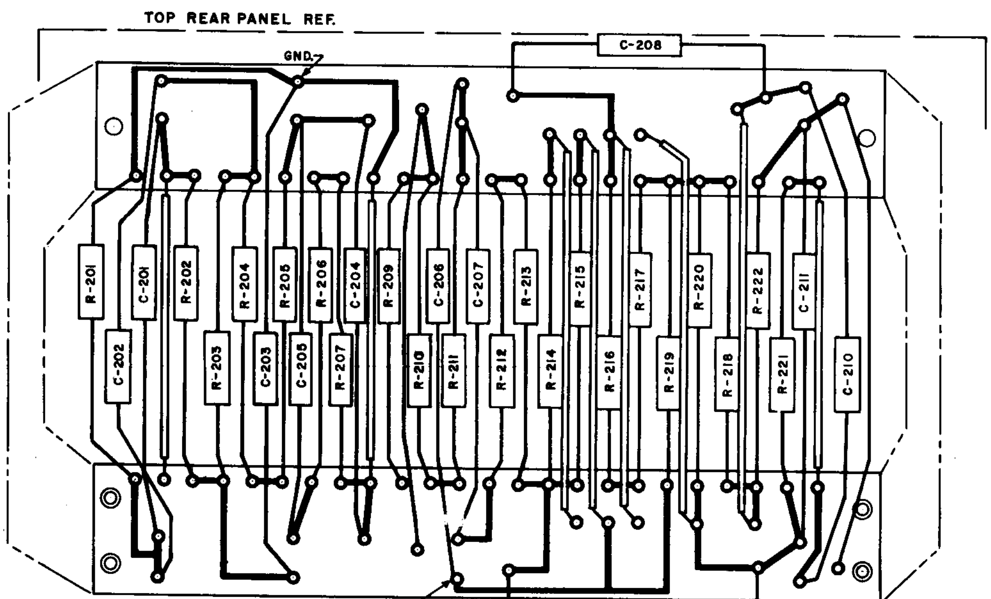
Figure 25. TB-1

TB-2





TB-4 VTR-2



TB-3 MODULE

Figure 26.