

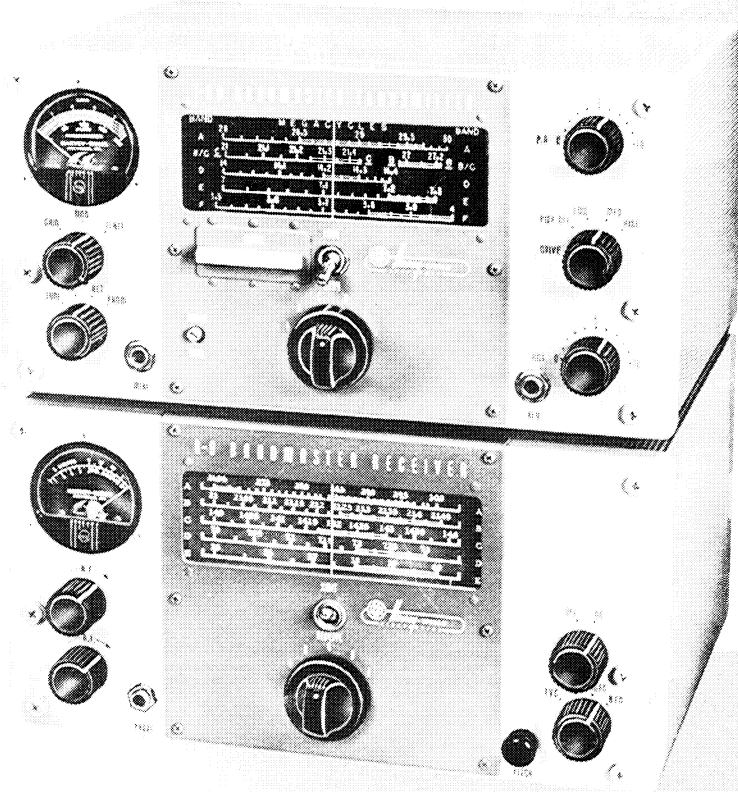
Harvey-WELLS proudly presents *A Complete Amateur Station*


**SYSTEM ENGINEERED FOR TOP
PERFORMANCE ON ALL BANDS**

INSTRUCTION MANUAL T-90

T-90
90 WATT
TRANSMITTER

R-9
9 TUBE
DOUBLE CONVERSION
RECEIVER



 **Harvey-WELLS**
ELECTRONICS, INC.
SOUTHBRIDGE MASS U.S.A.

INSTRUCTION MANUAL

T-90





IMPORTANT NOTICE

Before disposing of the carton in which the equipment is packed, look for small accessories such as connectors and plugs that may be included as part of the equipment. These small items are usually placed in a small paper bag which may easily be missed.

DAMAGED OR INOPERATIVE EQUIPMENT

This unit has been carefully inspected and was shipped from the factory in perfect operating condition. If the package has been damaged in transit, it is important that you file claim immediately with the carrier.

If the equipment does not function properly and the fault is not obviously apparent notify the factory. Return the unit by prepaid carrier only after receiving approval to do so from the factory.

When returning the unit, it is important that it be properly packed either in the original or a strong substitute carton. All surfaces should be protected by ample use of a soft packing material. Insure the equipment for its full value against damage or loss.

REMOVAL OF THE DUST COVER

Disconnect all external cables. Unscrew the four (4) large binder-head screws (#8-32) in the rear of the case. Stand the transmitter with its front panel up and remove the four (4) screws holding the rubber bumpers. These are the only screws which need be removed. Do not loosen front panel or other screws. Grasp the front panel edges and carefully lift the transmitter out of its case.

When replacing the unit in its enclosure, ascertain first that all tubes are solidly in their sockets. Then place the chassis in the dust cover so that the chassis connectors match the dust cover connector cutouts. Replace the four rear screws - lock and flat washers also - and then the rubber feet. Tighten all screws only after they have been properly placed in their respective positions.

Your attention is directed to the following revisions or additions:

SECTION II Page 8.

1. GENERAL

On later models, it is not necessary to remove the dust cover to change microphone position. A snap, plug-button on the cover allows access to this switch.

SECTION III Page 17.

b. Tuning Procedure

Set drive to "LOW" instead of "HIGH" position when initially tuning. When drive is set to HIGH position in some instances, the drive is sufficient to cut-off the clamp tube so that plate current of the PA is excessive even though the function switch is in the TUNE position.

SECTION III Page 19.

Figure 5.

L2, in the key click filter should have very low DC resistance, otherwise the oscillator may not start when keying due to excessive voltage drop in the oscillator cathode circuit.

HARVEY-WELLS ELECTRONICS, INC.

SOUTHBRIDGE, MASSACHUSETTS

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SECTION I

GENERAL DESCRIPTION

1. General.

The Harvey-Wells T-90 Bandmaster is a versatile VFO and crystal controlled, bandswitching transmitter designed for use in mobile, portable or fixed installations. It provides RF output on all amateur frequency bands from 3.5 to 29.7 mcs., inclusive. The maximum input to the PA stage is 90 watts, CW-ICAS, or it may be operated phone with an input of 75 watts maximum.

The RF section consists of an oscillator stage followed by two amplifier-multiplier stages which provide excitation to the final amplifier stage. The oscillator is of the variable frequency type but may be operated crystal controlled as an alternative. The VFO dial scale is calibrated to the output frequencies. A three position tap switch in the second multiplier stage permits adjustment of the PA grid drive by varying the screen voltage. A protective clamping circuit is provided to hold down the screen of the Power Amplifier should excitation fail. The PA plate is coupled to a Pi network output circuit which is designed to work into a wide range of antenna load impedances.

The modulator system includes a speech amplifier stage followed by an amplifier-driver stage which supplies driving voltage to push-pull modulators. An internally located two position slide switch modifies the speech input so that either carbon, crystal, or high impedance dynamic microphones may be used. When using carbon microphones, microphone button voltage is automatically developed in the speech tube cathode. The overall modulation system is designed for maximum response in the speech range for increased side-band power.

The T-90 Bandmaster is a complete transmitter, factory wired and tested, including tubes, less power supply.

Some of the special features are:

- a. TVI Suppression
- b. Receiver Muting or Disabling
- c. Remote Control Connections
- d. Push-to-Talk Operation
- e. Zero Beating without Carrier On
- f. Antenna Changeover Relay

The heater system of the T-90 is wired in a balanced series-parallel arrangement and filaments may be operated with either 6 or 12 volts AC-DC input simply by properly wiring the power input connector for the correct operating voltage.

SECTION I

2. Electrical Specifications.

- a. Frequency ranges:
(6 Bands - 5 dial scales)
- | | |
|--------|------------------|
| Band A | 28000 - 29700 kc |
| B | 26960 - 27230 |
| C | 21000 - 21450 |
| D | 14000 - 14350 |
| E | 7000 - 7300 |
| F | 3500 - 4000 |
- b. VFO or Crystal Frequencies:
- | | |
|--------|------------------|
| Band A | 3500 - 3712.5 kc |
| B | 3370 - 3403.75 |
| C | 3500 - 3575 |
| D | 3500 - 3587.5 |
| E | 3500 - 3650 |
| F | 3500 - 4000 |
- c. Frequency Control: Variable Frequency Oscillator or Crystal.
- d. Emission: Voice or CW
- e. RF Output Impedances:
- 20 to 400 ohms resistive, 3500 - 4000 kc
20 to 2000 ohms resistive all other bands.
- f. Tuning Controls:
- VFO Tuning
Bandswitch
PA Tuning
Antenna Tuning
- g. Other Controls:
- PWR and DRIVE Control Switch
Meter Switch
TUNE - CW - HET - PHONE Function Switch
XMIT - STBY Switch
AUDIO GAIN
- h. PA Input:
- | | |
|------------------------|--------------------|
| 90 watts CW - ICAS: | 75 watts CW-CCS |
| 75 watts VOICE - ICAS: | 45 watts VOICE-CCS |

SECTION I

i. Microphones:

Carbon, Crystal, or High Impedance Dynamic

j. Speech Frequency Response:

250 - 3500 cps at half-power points.

k. Power Supply Requirements:

6 or 12 Volts AC/DC at 7 or 3.5 A, respectively

6 or 12 Volts DC at 500 ma

300 VDC at 100 ma

500 to 600 VDC at 225 ma

l. Tube Complement:

V1	6CL6	VFO - Crystal Oscillator
V2	6AQ5	1st Amplifier-Multiplier
V3	6AQ5	2nd Amplifier-Multiplier
V4	6L46	Power Amplifier
V5	6AQ5	Clamp
V6	OB2	Regulator
V7	6AU6	Speech Amplifier
V8	6AQ5	Audio Driver Amplifier
V9	6AV5	Modulator
V10	6AV5	Modulator

3. Circuit Description.

a. Oscillator:

The VFO is a series-tuned Colpitts type circuit noted for its inherent frequency stability. A high Q, permeability tuned inductor, in conjunction with related trimmers and fixed padders, comprises the grid circuit components of the oscillator. One grid coil is used for all bands and capacitors only are switched to cover the necessary fundamental frequency range of each band. The grid circuit is compensated with negative coefficient capacitors to reduce frequency drift over wide ambient temperature changes. A small value resistor in the grid reduces tendency towards parasitic oscillation.

Since the oscillator is also used for crystal control, a shorting plug placed in the crystal socket completes continuity of the grid circuit for VFO operation. For crystal operation, this plug is removed and a

SECTION I

crystal is inserted in its place. Tuning of the VFO then allows rubbering of the crystal frequency over a limited range. Refer to Section III, Paragraph 5, for additional information.

Both plate and screen of V1 are supplied regulated voltage provided by a gaseous type regulator tube, V6 which is an OB2. The oscillator plate is broadly tuned to 40 meters by RFC 2 and the circuit distributed capacity to increase drive on harmonic frequencies, but useful output is also obtained at 80 meters. The oscillator plate is lightly loaded for maximum frequency stability and excellent keying characteristics, and is capacity coupled to the grid of the 1st amplifier-multiplier stage. The oscillator cathode may be keyed for break-in CW operation.

b. Amplifier-Multiplier Stages.

The 1st amplifier-multiplier is conventional and develops its operating bias across a cathode resistor. Plate circuit inductances are switched allowing this tube to function as a broad-band buffer on 80 and 40 meters; a resistor loaded fixed-tuned amplifier for operation on 20 and 15 meters; and as a doubler on 11 and 10 meters. The plate circuit of this stage is capacity-coupled to the grid of the 2nd multiplier-amplifier. This stage cathode is also keyed for CW operation.

The second amplifier-multiplier is also of the conventional type and has cathode bias. The screen voltage of this tube is supplied from a voltage divider circuit thru a 3 position switch to provide control of driving power to the power amplifier grid. Depending on the band in use, this tube functions as an amplifier on 80 and 40 meters; a doubler on 20, 11 and 10 meters; and as a tripler on 15 meters. The plate inductors are fixed-tuned on all bands to the output frequencies. One exception is the 11 meter band which uses the 10 meter coil complemented by another small inductor to bring it on frequency. The 10 meter coil remains in the circuit on all bands and is wired directly to the plate of V3.

c. Power Amplifier.

The plate of the 2nd exciter stage is coupled to the grid of the power amplifier thru a 20 mmfd capacitor. The grid circuit components of the 6146 include an RFC and grid resistor; a second low value resistor in series with the grid is for grid circuit metering. Other components in the grid circuit are related to the clamp tube functions described in paragraph d. The cathode of the power amplifier is essentially at ground through a very low value resistor, which is provided as a meter shunt for metering the PA cathode. The screen voltage is sup-

SECTION I

plied thru series resistors tied to the plate supply and to the clamp tube elements. The screen bypass capacitor is lower in value than normally used but allows optimum screen swing with modulation while adequately bypassing RF.

The power amplifier plate is connected for parallel feed thus eliminating DC from the tuning components. The plate of the PA is connected to the output circuit by means of a high voltage blocking capacitor with a series RFC for parasitic suppression. A single, air wound, high Q coil is utilized for operation in the 10, 11 and 15 meter bands. This coil remains in the plate circuit on all frequencies and is complemented with a similar coil when switched for 20 meter operation. An additional coil which is normally shorted out by the band switch on the higher frequencies is tapped, and provides the proper inductance for operation on the 40 and 80 meter bands. The total inductance of this coil is across one of the 20 meter coils when switched for operation on 20 meters, but its reactance is too high at that frequency to affect operation. An additional fixed mica padder is switched into the circuit on 80 meters to maintain optimum circuit Q and LC ratio. The overall plate tank circuit is a Pi network and performs very efficiently on all bands under a wide range of load impedances.

The Pi network load capacitor is a 300 mmfd variable capacitor which can be supplemented by up to eight additional fixed, 300 mmfd, capacitors. This is accomplished by mechanically coupling the variable capacitor to a nine position, internally located, progressively shorting switch to which the fixed capacitors are wired. The first position of this switch allows use of only the variable capacitor. Each succeeding 360 degree rotation of the variable capacitor trips the switch thereby adding fixed capacitors in parallel with the load circuit, resulting in continuous change of capacity in the Pi network of from the initial minimum capacity of the variable to a total of approximately 2700 mmfds. This load flexibility provides a means of balancing out considerable antenna reactance. The load circuit is then tied into the antenna change-over contacts of a relay.

d. Clamp Tube.

The clamp tube is connected in a modified circuit designed to hold down the screen of the power amplifier in event of excitation failure or during keying. The grid of this tube is tied into the grid of the 6146 thru a filter network. During operation, the rectified RF which is developed in the grid of the 6146, drives the clamp tube to cutoff. The plate and screen of the clamp tube draw zero current and normal screen voltage is supplied to the 6146 screen. When excitation fails, the clamp tube grid is at zero potential, causing its plate and screen to

SECTION I

draw heavy current which in turn increases the voltage drop across the 6146 screen resistors, thereby reducing the screen voltage to near zero and limiting the 6146 plate current. In order to protect the 6146 while tuning, the clamp tube grid voltage is reduced proportionally, allowing its plate and screen to draw some low value of current which limits the 6146 screen voltage so that just sufficient plate current flows. (NOTE: The plate current level will vary from Band to Band and is a function of RF Grid Drive.) This condition occurs only when the function switch is in the TUNE position.

e. Speech and Audio Drive Amplifiers.

The 6AU6 speech amplifier is essentially a grounded grid amplifier when used with carbon microphones and becomes a very high gain speech amplifier when operating with crystal or high impedance dynamic microphones. When the microphone change switch is in the carbon mike position, the carbon button is inserted in series with a by-passed cathode resistor to ground. A small capacitor from cathode to ground by-passes any possible RF which may be picked up by the microphone or cable. High impedance microphones are fed directly into the grid thru an LC filter network, which reduces the possibility of RF feedback through the speech system. The 6AU6 plate is coupled to the variable arm of the audio gain control which is the grid of the audio driver amplifier, a 6AQ5.

The driver amplifier plate is transformer coupled and provides push-pull drive to the modulator tubes. Negative feedback voltage is taken in the proper phase from one side of the secondary of the driver transformer and returned thru a resistor divider network to the grid of the driver tube. This provides essentially flat frequency response over the speech band, and stable, relatively low impedance drive to the modulators.

f. Modulators.

The modulator tubes are beam type power tubes which are connected as high mu triodes having very high power sensitivity and gain, drive requirements of which are easily satisfied. Drive voltage is applied directly to the screen grids instead of the control grids as with normal operation. The control grids, however, are driven at a reduced level thru resistor voltage divider networks designed for optimum operating conditions. This circuit allows operation of these tubes at zero bias. The tubes operate Class B and draw low, initial no-signal plate current, and relatively low, full signal average current. The modulator tubes operate within their rated plate dissipation and are capable of handling unusually high DC and transient voltages. The values of the

SECTION I

components of the overall modulating system were chosen to provide relatively narrow band speech response. The modulating transformer secondary is shorted out at all times except when the function switch is in the PHONE position.

SECTION II

INSTALLATION

1. General.

Prior to installation, it is recommended that the operator become thoroughly familiar with the circuit of the T-90. Operating procedure, as outlined in Section III, should be carefully read and followed. The T-90 enclosure should be removed and tubes checked to ascertain that they are solidly in their sockets. Components should be examined for breakage, and if none is evident, the dust cover should be replaced. First, however, the position of the microphone change switch should be checked to ascertain that it is in the proper position for the type of microphone to be used.

2. External Connections.

a. Power Connections.

The Harvey-Wells APS-90, which is a 115 VAC input fixed station supply, is provided with its own prewired shielded interconnecting cable terminated with appropriate mating plugs to match the T-90 and APS-90 chassis connectors. It is only necessary to plug in each end of this cable to the units and the transmitter is ready for operation. The Harvey-Wells VPS-T90 is a combination 6 or 12 VDC input mobile vibrator power unit which is also provided with a length of shielded cable and terminating plugs.

In the case where power sources other than the above are used with the T-90, the Jones S-312-CCT plug normally supplied with the T-90 may be used for cable connections to the power supply. A shielded cable should be used and the braid wired to one of the ground terminals of the connector. Wiring of the cable to the connector should be made in accordance with the applicable wiring information indicated in Figures 1 and 2. A simplified diagram indicating T-90 filament, plate and control circuit termination at the power input connector is shown in Figure 4 and may be an aid in determining cable connections. A typical mobile supply is noted in Figure 3.

The T-90 power requirements are indicated in Section I, paragraph 2.k. It will be noted that in addition to the usual filament and plate voltages, 6 or 12 VDC is also required for relay control. This DC voltage may be obtained from the AC filament winding by using a 28 V .5 A half-wave selenium rectifier and a 1000 mfd 25 V filter capacity.

b. Antenna Connections.

SECTION II

The antenna input connector, which is a Jones type P-101-1/4", is also provided with the T-90. It is of the coaxial type, for small diameter cables. The shield of the coaxial cable should be soldered to the shell of the plug and the inner conductor to the pin. Since the connections are for unbalanced feed, refer to the Antenna Section for proper connections to balanced lines.

A plug is also provided for receiver antenna connections. This plug is a conventional friction type generally used for car radios. The pin is wired to the inner conductor and the split shell to the shield of the cable. If the antenna changeover facilities included in the T-90 are to be used for receiver antenna take-off, and the receiver antenna input connections are of the balanced type, one terminal should be grounded for unbalanced operation.

c. Microphone and Push-To-Talk Connections.

The microphone input and push-to-talk jack is of the three circuit type. The microphone plug is not provided with the transmitter but is available commercially. The high side of the microphone is connected to the ring and the shield to the sleeve, the push-to-talk wires are connected to the tip and the sleeve of the plug, sleeve is grounded. Shielded cables should be used for microphone input, regardless of the microphone type. The push-to-talk control leads should be heavy enough so as not to cause appreciable voltage drop in the circuit.

IMPORTANT NOTE: A two circuit phone plug should not be used for microphone input connections since it would short out the speech input.

d. Keying Connections.

The key jack is a standard two circuit jack. A plug is not provided with the T-90 but any phone type plug will suffice. No special treatment is required for wiring to the key. Two wires are required, one for the hot terminal and one for ground. Keying is accomplished by breaking the exciter cathodes.

e. Receiver Disabling.

Receiver disabling connections are available for use at the power input connector. These connections are tied into another set of contacts on the antenna changeover relay. When the transmitter is on standby, these contacts complete continuity of the circuit to ground, but

SECTION II

are open while transmitting. Consequently, the receiver muting or disabling circuit must be worked against ground unless an accessory relay is used. Muting connections are to Pin 10 and either Pin 2 or 5 which are grounds.

f. Ground Connections.

A good earth ground should be used and the wire should be as short as possible and of heavy copper. In the case where the transmitter position is such that a lengthy ground wire is necessary, it is good practice to cut the wire length so that it is a multiple of $1/2$ wavelength at the frequency of operation. The ground connection at the transmitter should be made to the bottom screw located under the antenna input connectors.

g. Auxiliary Relay Connections.

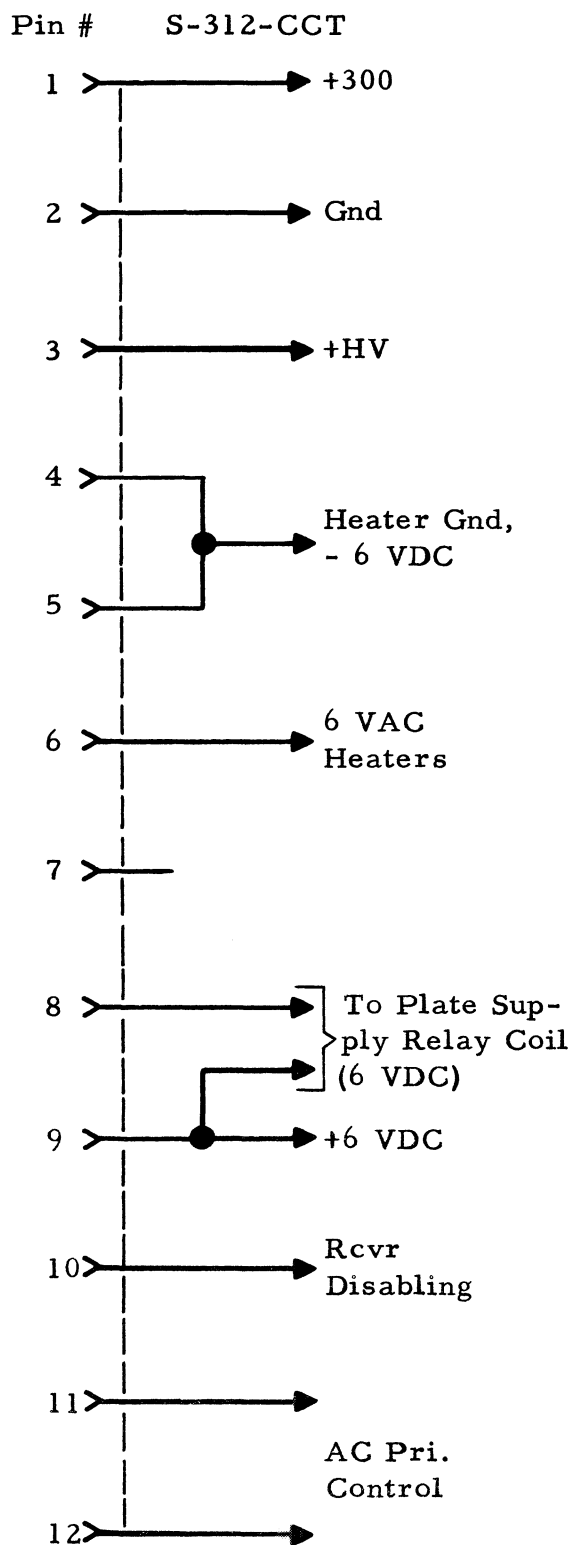
If an additional relay is required for some external function when using the APS-90 AC power supply, a 12 VDC relay with a coil resistance of approximately 100 ohms should be used. The coil terminals should be wired to pins 7 and 8 of the power input connector either at the transmitter or power supply end. The same connections apply when operating mobile with 12 VDC car systems. When the car system is 6 VDC, the relay coil should of course be for 6 VDC.

Relays used for mobile operation should have good pull-in characteristics. The coil resistance should be reasonably high, consistent with pull-in ability, and to keep system current drain low.

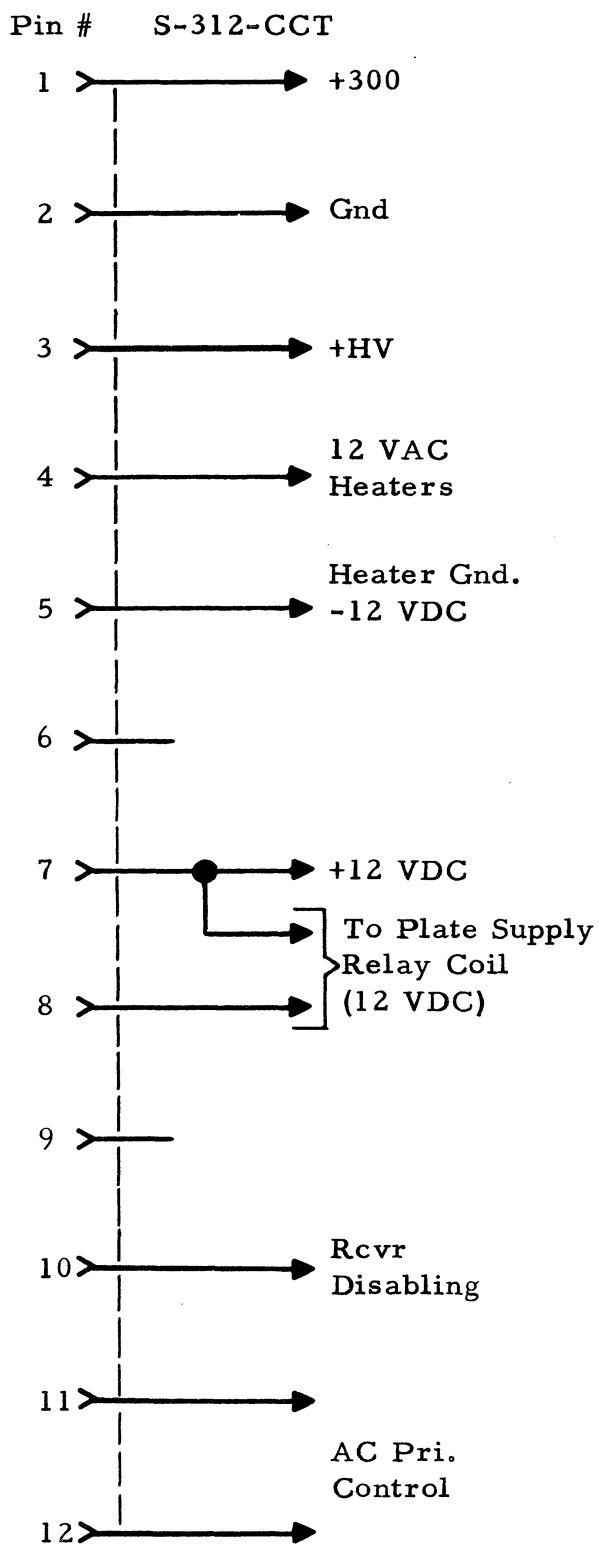
3. Installation.

When the T-90 is used at a fixed location, it may be placed on a desk, table or bench top. The transmitter should be conveniently placed for easy access to the controls. The only precaution necessary is that it be placed in a position allowing adequate air circulation to avoid excessive heating of the unit.

No two mobile installations being alike, it will be left to the operator as to where and how the T-90 will be mounted in the vehicle. Mounting brackets are not supplied with the T-90 because it is doubtful if they would be useful for more than 10% of the installations. The particular need of the amateur can best be served if he fashions his own mounting brackets. The basic prerequisites for proper installation are mechanical rigidity, accessibility of controls and ease of observation.

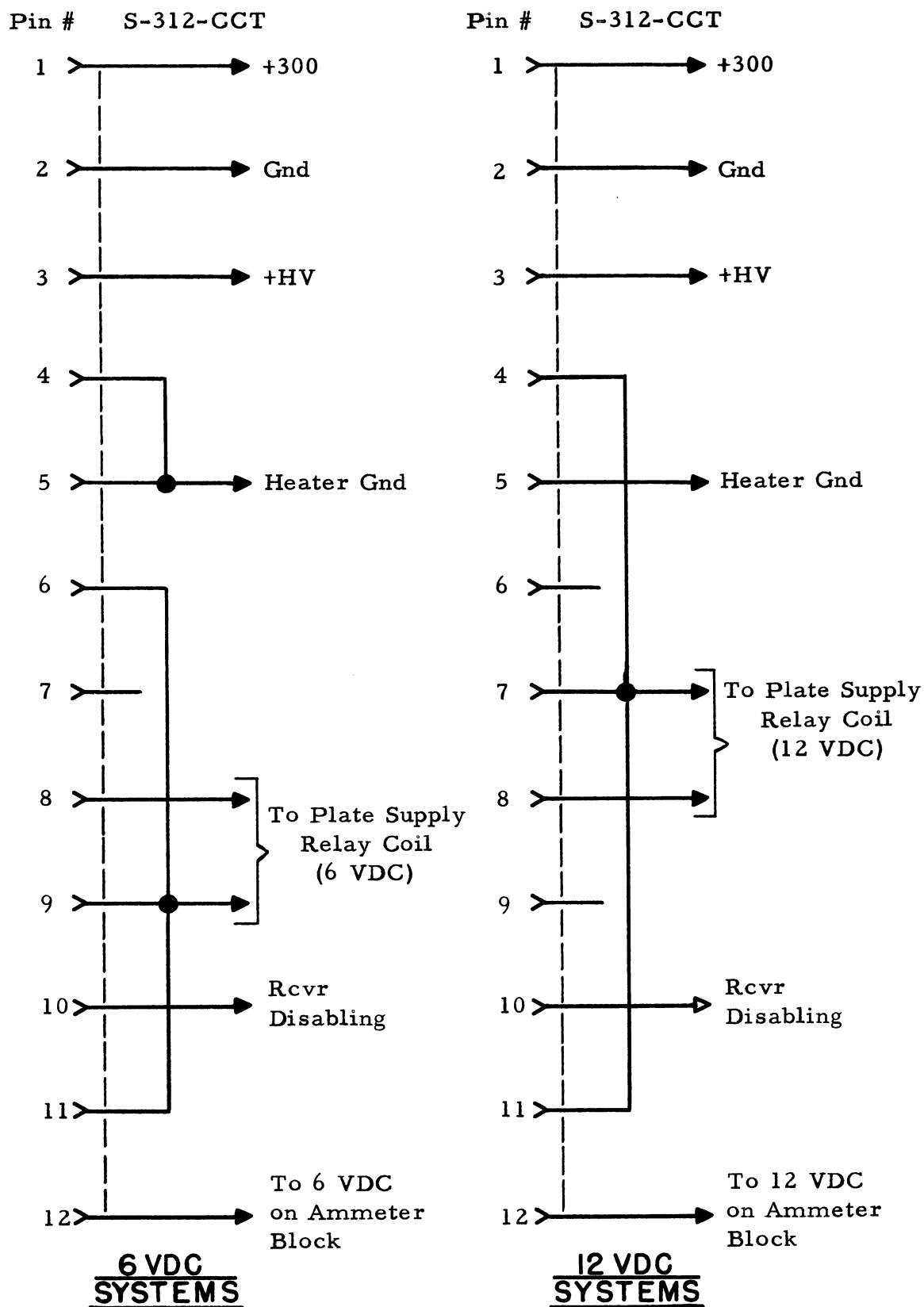


CONNECTIONS WHEN USING
6 VAC FOR HEATERS

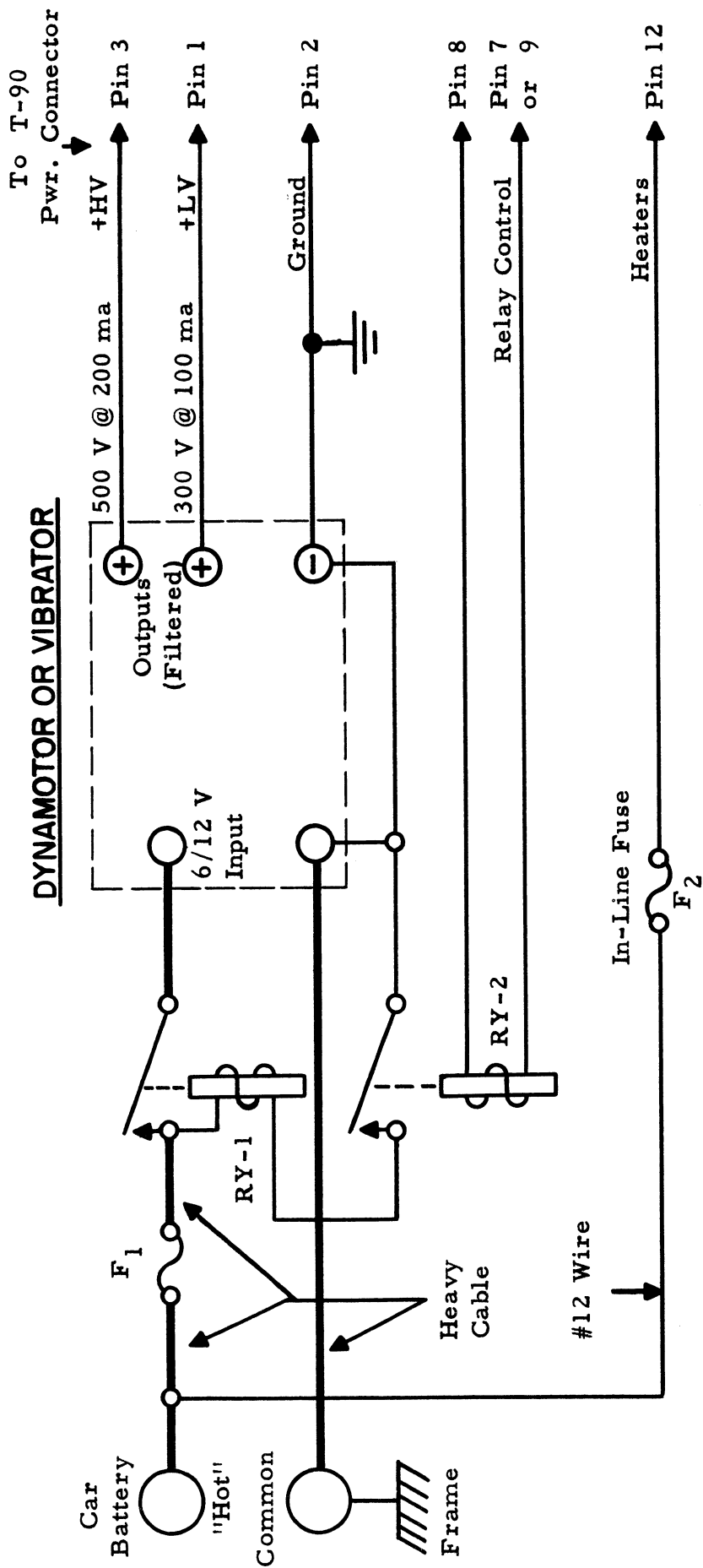


CONNECTIONS WHEN USING
12 VAC FOR HEATERS

POWER INPUT CONNECTOR WIRING FOR AC SYSTEMS
FIGURE 1



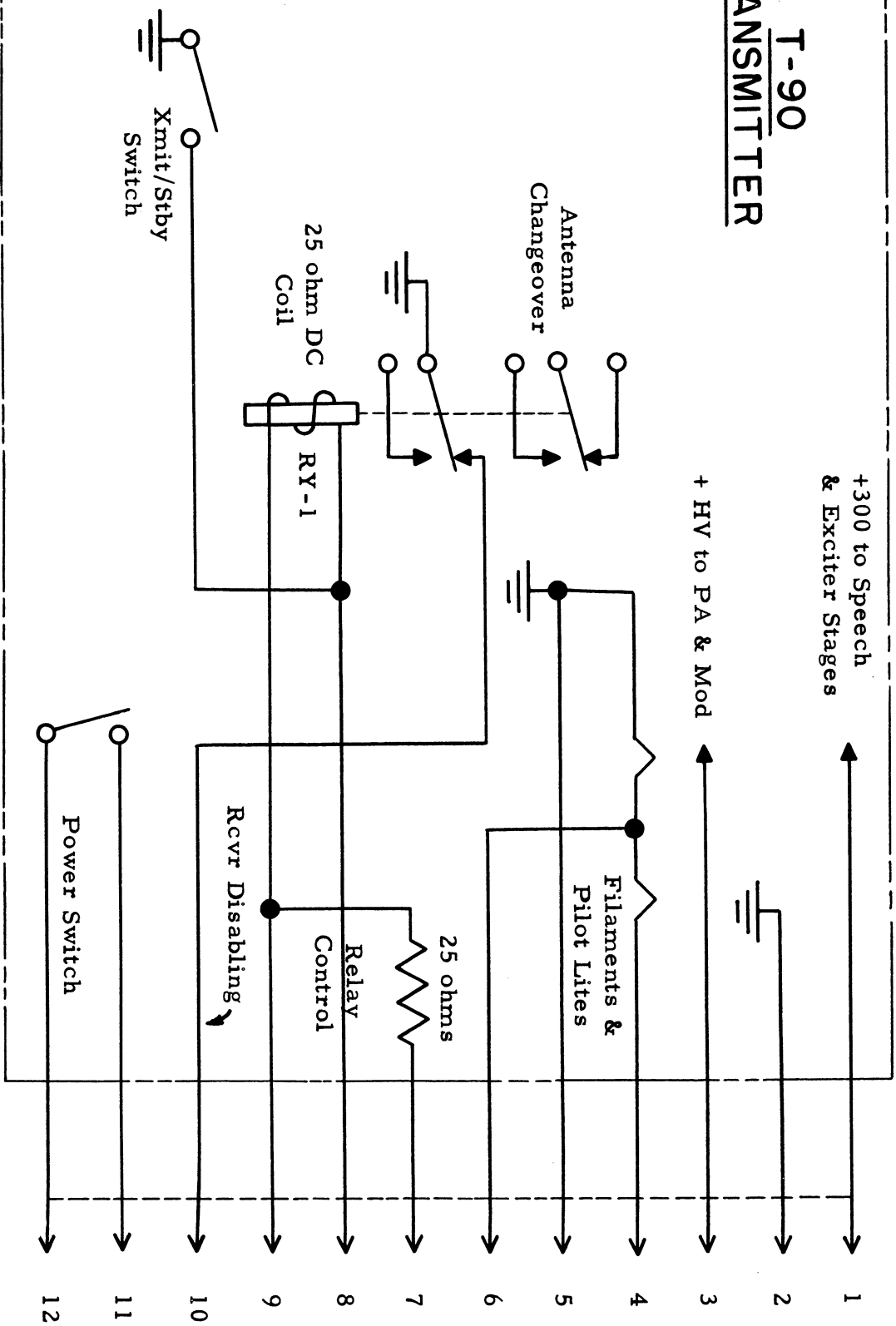
POWER INPUT CONNECTOR WIRING FOR DC SYSTEMS
FIGURE 2



Parts: F1 = 60/30 A Cartridge Fuse (6/12 V. Resp.)
 F2 = 10/5 A Cartridge Fuse (6/12 V. Resp.)
 RY-1 = 60 A Contacts SPST Relay (6 or 12 V. Coil)
 RY-2 = 5 A Contacts SPST Relay (6 or 12 V. Coil)

TYPICAL DYNAMOTOR OR VIBRATOR SUPPLY
FIGURE 3

T-90 TRANSMITTER



SIMPLIFIED WIRING OF TRANSMITTER POWER INPUT CONNECTOR

FIGURE 4

SECTION III

OPERATION

1. Panel Control Functions.

a. Power On and Drive Control Switch.

This control is a dual function, four position, rotary switch. Panel markings are PWR OFF, LOW, MED and HIGH. When the knob is in the full counter-clockwise position, the power input circuit is completely disabled. When turned to any one of the three remaining positions, power is supplied to the filaments and pilot lights and the circuit is ready for application of plate voltage. LOW, MED and HIGH apply to drive conditions to the power amplifier grid. The position chosen should be that which will give a meter reading of between 2 and 3 milliamperes on PHONE and 1 to 3 ma on CW when loaded.

b. Metering Switch.

This switch is a three position rotary switch with panel markings GRID, MOD and PLATE. When the switch is placed in the GRID position, the meter will read power amplifier grid current on the 10 ma scale. In the MOD position, the meter reads effective modulator plate current on the 200 ma scale. When the switch knob is placed in the PLATE position, the meter will read power amplifier cathode current, which is the combined plate, grid and screen current, on the 200 ma scale.

c. TUNE-CW-HET-PHONE Function Switch.

This is a four position rotary multi-function switch. When it is turned to the TUNE position, the circuit is modified so that the power amplifier may be tuned at reduced power and the modulators are disabled. When in the CW position, the transmitter may be keyed for break-in operation - the modulators remain disabled. In the HET position, the oscillator cathode is returned to ground and is not keyed. Keying may be accomplished in the first multiplier stage cathode except as noted in paragraph 4, this section. The oscillator remains on at all times. This position, however, is primarily used for zero beating (HETerodyning) the VFO against a received signal without carrier on.

If receiver disabling connections have been made to the transmitter terminals as noted in Section II, paragraph e, placing this switch in the HET position will automatically turn the receiver on. In the PHONE switch position, high voltage is applied to the modulator tubes and the modulator transformer secondary winding, which is shorted on all other switch positions, is properly connected for voice operation.

SECTION III

d. XMIT-STBY Switch.

This toggle switch locally controls application of plate voltages when push-to-talk or remote control connections are not used. When in the transmit position, the antenna and power supply plate relays are energized and the transmitter is on the air.

e. Audio Gain Control.

This control has a knurled, 1/4 inch shaft which protrudes slightly from the panel escutcheon. It may be adjusted with a screwdriver or finger tips, and sets the modulation level.

f. VFO Tuning Knob.

The VFO tuning knob is the outer of the two knobs on a concentric shaft and is located in the center of the panel under the XMIT toggle switch. This knob is used to tune the VFO.

g. Band Change Switch.

The inner of the two knobs on the concentric shaft is for selecting bands. The knob points to the Band identifying letters A through F.

h. PA Tuning.

The PA control tunes the power amplifier plate. The panel markings are in equal increments from zero to ten, over 180 degrees of rotation. When the knob is set at zero, the PA tank capacitor is at minimum capacity. Mechanical stops limit rotation of the condenser to 180 degrees.

i. ANT Tuning.

The knob marked ANT is the Pi network output load capacitor and is used to adjust the output impedance to match the antenna impedance. The panel markings are in equal increments from zero to ten, over 180 degrees rotation. It may be rotated continuously, however, thru 360 degrees to index the fixed load capacity switch, to which it is mechanically coupled.

2. Tuning and Operating.

a. General.

SECTION III

Assuming that all connections to power supply, antenna, ground, key or microphone have been made, the T-90 is now ready for tuning. The only circuits that require tuning are those associated with the VFO setting, power amplifier plate tuning capacity and the antenna load capacitor. The final amplifier should be loaded to CCS ratings initially. When operating in Band F, 3500 to 4000 kc., it is important that the antenna load be within the limits of the specified load resistance, i.e. 20 to 400 ohms, otherwise a current dip may not be evident when tuning the PA plate capacitor. Insufficient capacity in the antenna load circuit, on all bands, may also be the cause of not being able to locate a plate current dip. In general, as the frequency is increased, the antenna load capacity must be decreased. Normally, on Bands A, B and C, i.e. 28, 27 and 21 mc., only the variable load capacitor is required to cover a wide range of loads. On the other bands, usually one or more fixed capacitors should be switched into the load circuit. The antenna impedance also affects setting of the load capacity and in general, the lower its impedance, the higher the capacity required.

The following tuning procedure is typical for all bands except that tuning of the PA tank is critical on the higher frequency bands.

IMPORTANT NOTE: Dial Markings of Band B (27 mc.) and Band C (21 mc.) are combined on one scale. The variable oscillator frequency, however, will change continuously, extending the frequency range of the particular band in use beyond legal band limits, although scale markings indicate band edges only. It is important, therefore, to ascertain that both the band switch and VFO are properly positioned when operating on either of these bands. All other bands have separate scale markings. Phone band ranges are indicated by double lines.

b. Tuning Procedure.

Set band change switch to Band F (3500 - 4000 kc.). Tune the VFO to the desired output frequency. Switch power on and set drive to the HIGH position. Allow 30 second filament warm-up. Set Meter switch to PLATE position, and Function switch to the TUNE position. Tune ANT capacitor until four or five fixed capacitors are in the circuit. (NOTE: When all capacitors are in or out of the cir-

SECTION III

cuit, mechanical stops prevent any further turning. Do not force beyond this point.)

Apply plate voltage and quickly tune the PA knob for resonance, indicated by a sharp dip in plate current. If no dip is found, increase the antenna load capacity as required and again tune the PA circuit. Once the PA has resonated, switch off the plate voltage and set the function switch to the PHONE position. Reapply plate voltage and load the PA plate for a meter reading as indicated in the applicable Paragraph c. (1) or (2) of this section. In general, increase the antenna capacity to reduce loading and decrease it for heavier loading. Since any change in antenna capacity will reflect a change in PA tuning, alternate the tuning of both circuits until properly loaded.

After loading, check grid drive and if necessary set the DRIVE control to one of the three positions which will give between 2 and 3 ma of grid current for phone operation (1 to 3 ma for CW operation). A large change in grid current will affect PA plate loading. Retune PA if necessary.

c. PA Loading.

	<u>PHONE</u>	<u>CW</u>
CCS	110 ma (500 V)	125 ma (600 V)
ICAS	125 ma (600 V)	160 ma (600 V)

NOTE 1: When using the APS-90 power supply, 500 or 600 VDC output may be obtained by switching the "PA Voltage" to either the "LOW" or "HIGH" position. The supply also provides the additional current required by the modulators when operating phone.

NOTE 2: When using the VPS-T90 supply, either 300 or 500 VDC output may be obtained by changing transformer taps. Load PA to 110 ma in either case for phone operation.

NOTE 3: Since the PA cathode is metered instead of the plate, the above listed PA currents are the combined plate, grid and screen currents. The grid and screen currents are a small percentage of the plate current, running between 8 to 14 ma, but they cannot be completely neglected in loading.

SECTION III

3. Phone Operation.

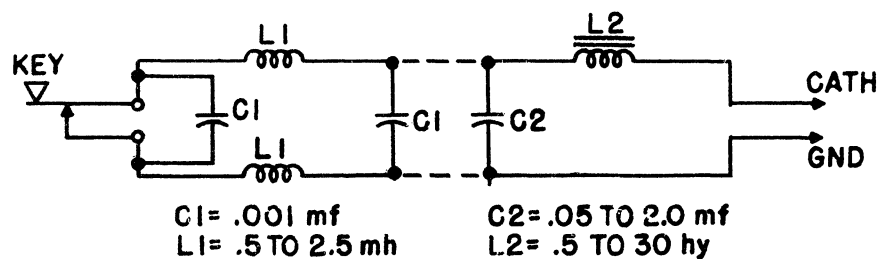
Plug in the microphone if not already in and switch on the plate voltage. Modulation level should then be adjusted by rotating the AUDIO GAIN control. Switch the meter to MOD position and set the audio level, while speaking, so that the meter reading increases to approximately that of the indicated PA plate current on voice peaks. For accurate modulation adjustment to reduce the possibility of over-modulation, use of an oscilloscope, carrier shift meters, etc. is recommended. In general, however, the PA current will remain essentially constant during modulation if the audio level is correct and the PA plate voltage excursions are not excessive.

Should the microphone be equipped with push-to-talk and is wired as noted in Section II, paragraph 2.c., the plate voltage may be applied by use of this switch instead of the XMIT/STBY switch which should remain in the STBY position.

4. CW Operation.

Insert plug into key jack if not already in and turn function switch to the CW position. Switch on plate voltage and depress key. Check loading and retune PA circuit if necessary. The transmitter may now be keyed. This provides complete break-in keying with both the oscillator and 1st buffer stages being keyed. When the function switch is in the HET position, the 1st buffer tube only is keyed and the oscillator remains on. The principal function of this position, however, is to allow HETerodyning the oscillator against a received signal without carrier for spot or net frequency settings. This holds for all bands except 7 mc. and possibly 14 mc. where there may be sufficient leakage thru stray coupling allowing some carrier output.

Although keying transients have been minimized by an LC filter in the cathodes of the keyed tubes, under certain conditions, further treatment may be required to reduce key clicks. A suitable filter is noted in Figure 5.



KEY CLICK FILTER
FIGURE 5

SECTION III

5. Crystal Control Operation.

When it is desired to operate crystal control, remove the crystal access door and then the circuit shorting plug from the socket, and replace with a crystal. (The crystal frequency should be within the ranges listed below to give the desired output frequency.) Replace the crystal door and tune the VFO to the approximate output frequency and tune the transmitter as described in paragraph 2 of this section. Since the crystal becomes a part of the VFO grid circuit, tuning the VFO will rub the crystal over a relatively narrow frequency range. This allows adjustment of the output frequency to a precise network frequency. Relatively low activity crystals may be used in this circuit. The oscillator starts well during nominal keying speeds. For high speed keying, the intermediate stage only should be keyed. If the crystal does not oscillate during initial tune-up, readjust the VFO towards the high frequency side.

IMPORTANT NOTE: The frequencies of the crystals used for operation in the various bands should be as listed below only. Oscillator circuitry is such that crystals of 1/2 or 2X the listed crystal frequencies will not oscillate or will be erratic in operation.

BAND	CRYSTAL FREQ.	MULTIPLIER	OUTPUT FREQ.
A	3500-3712.5 kc	X8	28000-29700 kc.
B	3370-3403.75	X8	26960-27230
C	3500-3575	X6	21000-21450
D	3500-3587.5	X4	14000-14350
E	3500-3650	X2	7000- 7300
F	3500-4000	X1	3500- 4000

SECTION IV

ALIGNMENT AND SERVICE

1. General.

VFO calibration has been factory adjusted against secondary frequency standards and the RF circuits have been tuned for optimum drive. No further adjustments are normally required, however, due to replacement of tubes, normal ageing of components, and other causes, realignment may be required. The following paragraphs fully detail proper step-by-step procedure. It should be noted that the alignment is accomplished by monitoring the transmitter output frequencies and not the VFO fundamental frequencies.

There are several reliable methods that may be used for circuit alignment of the T-90. The use of a receiver only in conjunction with its BFO is not generally recommended for calibration purposes if band edge accuracy is desired. The better types of communication receivers usually have self-contained 100 and 1000 kc. crystal calibrators that may be used. The method of alignment herein described is predicated on the use of a reliably calibrated receiver in conjunction with a frequency standard having 100 and 1000 kc. outputs. A wavemeter or grid dip oscillator should also be used to check the exciter stages to preclude the possibility of off-frequency alignment.

Prior to actual adjustment, the high voltage plate supply should be disabled or the high voltage rectifier should be pulled out of the socket. Filament, relay and exciter plate voltage should be supplied. Place the function switch to the TUNE position and meter switch to GRID. Turn the power switch ON and to the HIGH drive position and allow 15 minute warm-up. Loosely couple the frequency standard to the receiver antenna post, or if self-contained in the receiver, turn it on. Hook up a short piece of wire to the receiver antenna post and place the other end anywhere near the transmitter exciter section. Throw switch to XMIT position.

Refer to Figures 6 and 7 for location of trimmers and tuning slugs and proceed with alignment as per the following steps:

2. VFO Alignment.

a. Switch to Band F.

Set receiver to 4000 kc. and locate harmonic of 1000 kc. standard.

Set VFO to 4 mcs. and carefully adjust oscillator trimmer C7 to zero beat.

SECTION IV

Set receiver to 3500 kc. and locate harmonic of the 100 kc. standard.

Tune VFO to 3.5 mcs. and adjust the slug of L1 for a zero beat at this frequency.

Alternate tuning of trimmer C7 at 4000 kc. and slug L1 at 3500 kc.

b. Switch to Band D

Set receiver to 14 mcs. and locate harmonic of 1000 kc. standard.

Set VFO to 14 mcs. and adjust C2 to zero beat.

c. Check Band C at 21 mcs. and Band E at 7 mcs. Frequencies should fall in.

NOTE: A single trimmer, C2, is initially adjusted on Band D on 14 mcs., but it is also common to Bands C and E. Oscillator adjustment is therefore not required on the latter two bands.

d. Switch to Band B

Tune receiver to 27 mcs. and locate harmonic of the 1000 kc. standard.

Tune VFO to 27 mcs. and adjust trimmer C4 to zero beat.

e. Switch to Band A

Tune receiver to 28 mcs. and locate harmonic of the 1000 kc. standard.

Tune VFO to 28 mcs. and adjust trimmer C5 to zero beat.

f. Repeat steps a. to e. inclusive and make slight readjustments if necessary.

g. Oscillator adjustment is now complete but 100 kc. points on each band should be checked to ascertain that the frequencies along the band are falling in.

3. Exciter Stage Alignment.

NOTE: It is important that all exciter coils be checked with a wavemeter or GDO for output on frequencies noted in the following. This is because these coils, which are permeability tuned, can be varied over a

SECTION IV

relatively wide range of inductance and can be tuned off frequency. The receiver is not required for these adjustments.

- a. Switch transmitter to Band A and tune VFO to approximately 29.2 mc. Adjust slugs of L3 and L5, in that order, for maximum indicated grid drive. L3 will be tuned to approximately 14.6 mcs. and L5 to 29.2 mc.
- b. Switch to Band B and set VFO to approximately 27 mcs. Adjust grid drive for maximum by squeezing or spreading L6 with an insulated tool. Output at L3 will be approximately 13.5 mcs. and L5 or L6 at 27 mcs.

NOTE: Inductors L3 and L5 are common to Band A and Band B but are peaked on Band A. When switched to Band B additional series inductors L4 and L6 are tied to L3 and L5 respectively. L4 is fixed and requires no adjustment; while L6 is peaked as indicated above.

- c. Switch transmitter to Band C and set VFO to approximately 21.3 mcs. Peak L2 and L7 in that order for maximum grid drive. L2 will be peaked to approximately 7.1 mcs. and L7 to 21.3 mcs.
- d. Switch transmitter to Band D and set VFO to approximately 14.2 mcs. Peak L8 only for maximum grid drive and output at 14.2 mcs.
- e. Switch transmitter to Band E and set VFO to approximately 7.2 mcs. Peak L9 only for maximum grid drive at 7.2 mcs.
- f. Set Band switch to Band F and VFO approximately to 3.9 mc. Peak L10 only for maximum grid drive at 3.9 mcs.

4. Service.

In the event of transmitter operating failure, which is not corrected by replacement of tubes, conventional ohmmeter and voltmeter tests should be made to determine if resistors, capacitors or other components are normal. A defective component can usually be found by a point-to-point continuity test, although a visual inspection may often indicate a defective component, such as a burnt resistor, etc.

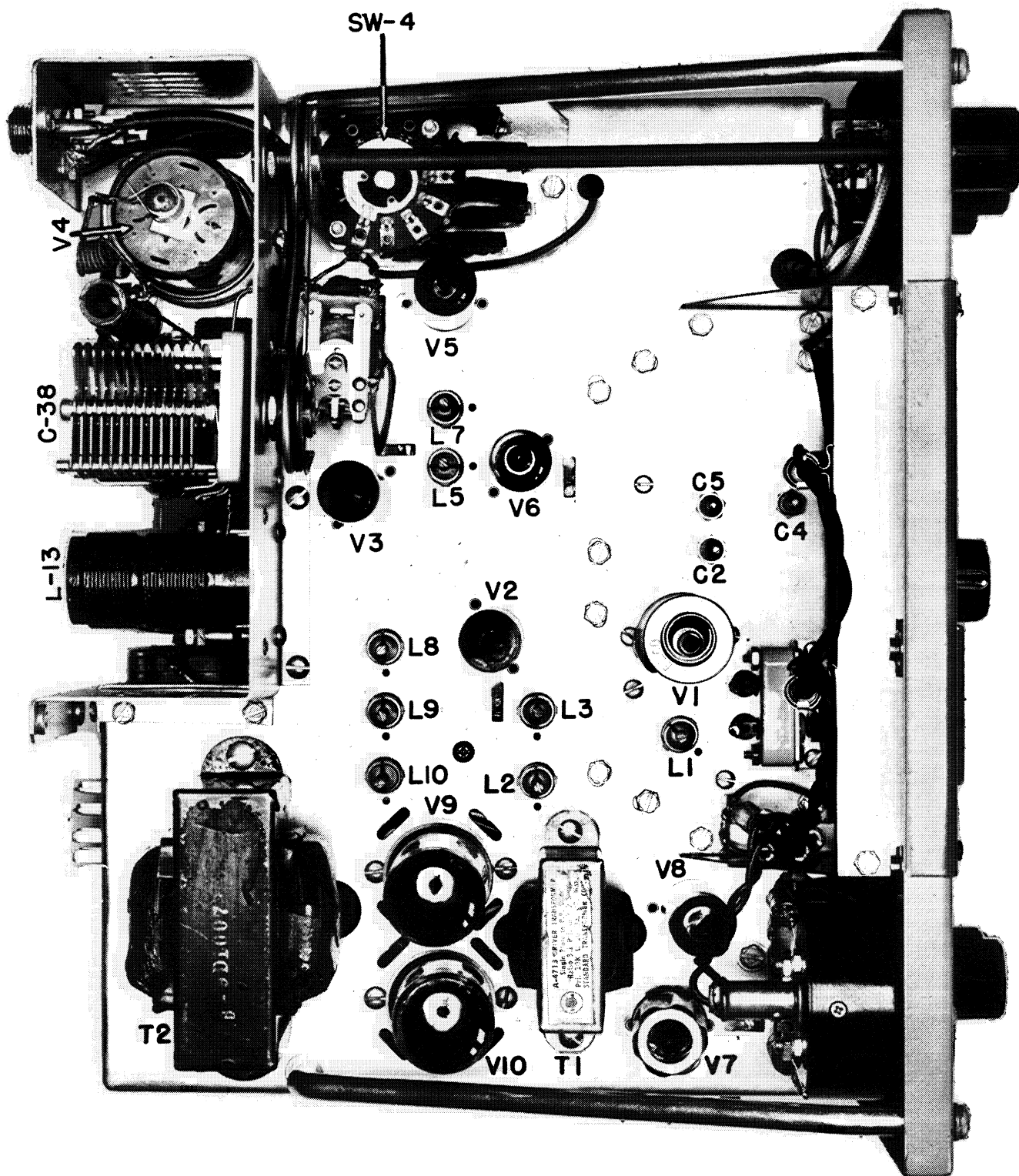
The voltage and resistance charts indicated in Figures 8 and 9 will

SECTION I V

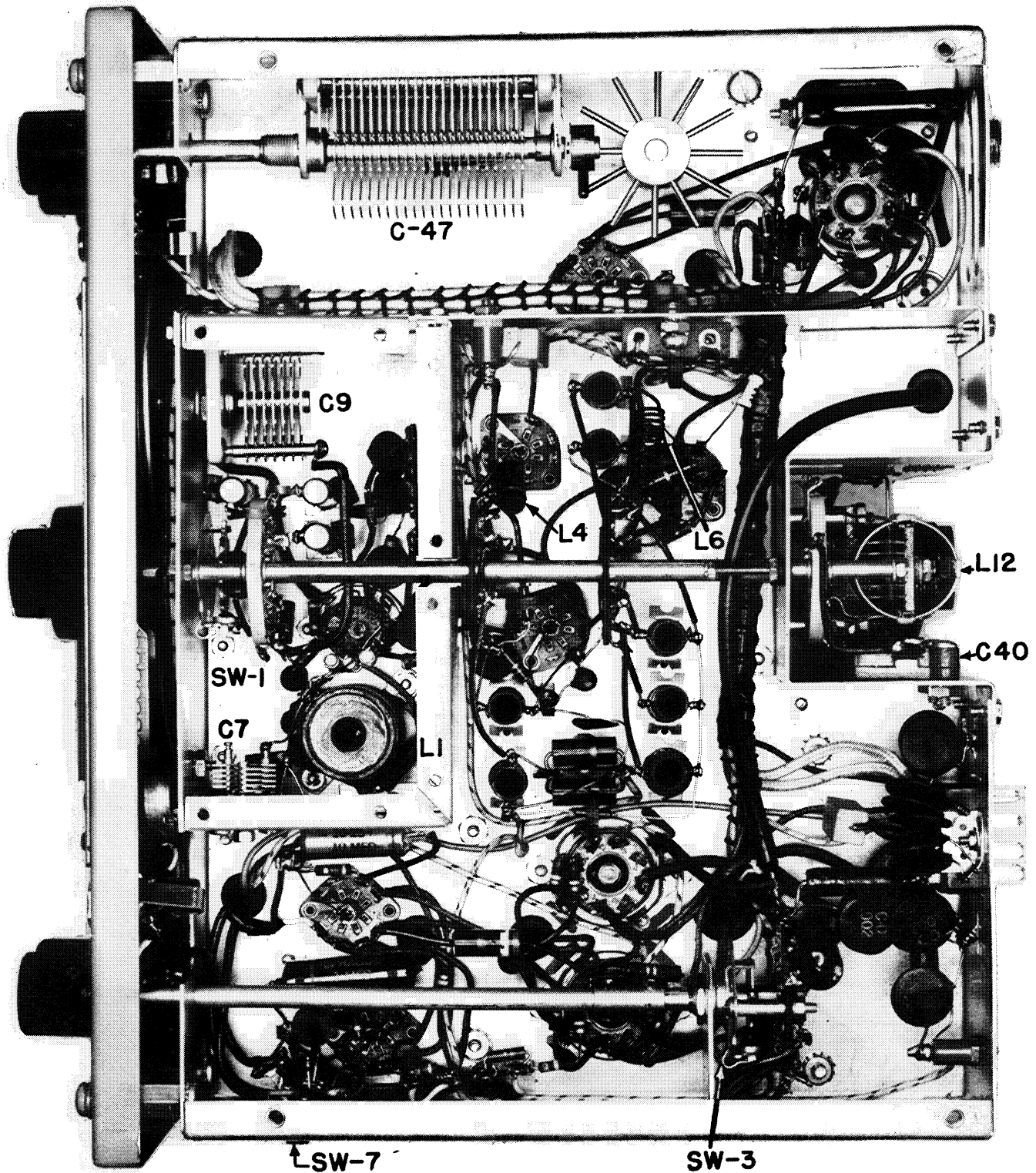
be an aid in checking circuitry. Defective components which are replaced should be within the values and tolerances indicated under the parts list. When resistors used in circuits carrying RF are defective, it is important that they be replaced with non-inductive types only.

When checking tubes, mark them as they are removed from the transmitter so that they may be returned to their original sockets. This applies especially to the two 6AQ5 multiplier tubes. When a tube change is made in any of the exciter stages, realignment of the RF circuits may be necessary.

Failure of the transmitter to operate may also be due to power supply defects. Replace defective line fuses or other components as required.



TOP VIEW OF CHASSIS
FIGURE 6



BOTTOM VIEW OF CHASSIS
FIGURE 7

Tube	Tube Socket Pins								
	1	2	3	4	5	6	7	8	9
V1 6CL6	.25	-4.4	80	0	6.3 vac	105	0	80	-4.4
V2 6AQ5	-20	2.4	0	6.3 vac	300	105	-22		
V3 6AQ5	-8	3	0	6.3 vac	300	90	-8		6146
V4 6146	0.2	6.3 vac	180	0.2	-70	0.2	12.6 vac	0	Cap 500
V5 6AQ5	-70	0	6.3 vac	12.6 vac	180	225	-70		
V6 OB2	105	0	0	0	105	0	0		
V7 6AU6	0	0	0	6.3 vac	35	70	1.75		
V8 6AQ5	0	24	6.3 vac	12.6 vac	290	190	0		
V9 6AV5	-0.6	6.3 vac	0	0	500	0	12.6 vac	0	
V10 6AV5	-0.55	0	0	0	500	0	6.3 vac	0	

Conditions of Measurements:

- 1.) AC Input - 115 vac Using APS-90 Power Supply (PA Voltage in "LOW" Position).
- 2.) Controls set as follows:
 - a.) Band switch & tuning - Band F - 3.9 mc.
 - b.) Function Switch - Phone
 - c.) Meter Switch - Plate
 - d.) Audio Gain - Full Clockwise
 - e.) Drive Switch - Low
 - f.) Xmit/Stby - Xmit
 - g.) Mike Switch - Crystal Position
- 3.) Power to Load = 30 watts.
- 4.) Plate & Grid Voltages taken through RF Choke (25 ohms approximately).
- 5.) All voltages measured with respect to ground with VTVM.

Note: Voltages may vary $\pm 10\%$.

T-90 TUBE VOLTAGE DATA
FIGURE 8

Tube	Tube Socket Pins								
	1	2	3	4	5	6	7	8	9
V1 6CL6	Inf.	50 k	210 k	0	.3	200 k	0	210 k	50 k
V2 6AQ5	82 k	Inf.	0	.3	190 k	240 k	82 k		
V3 6AQ5	60 k	270	0	.3	190 k	240 k	60 k		6146
V4 6146	.5	.3	Inf.	.5	27 k	.5	.5	0	Cap
V5 6AQ5	120 k	0	.3	.5	Inf.	Inf.	120 k		Inf.
V6 OB2	200 k	0	Inf.	0	200 k	Inf.	0		
V7 6AU6	900 k	0	0	.3	650 k	1.0 meg	2.2 k		
V8 6AQ5	750 k	500	.3	.5	190 k	300 k	750 k		
V9 6AV5	50 k	.3	.5	Inf.	Inf.	Inf.	.3	400	
V10 6AV5	50 k	0	.5	Inf.	Inf.	Inf.	.3	400	

Conditions of Measurements:

- 1.) No external connections to transmitter.
- 2.) All resistances measured from tube pins to ground.
- 3.) Controls set as follows:
 - a.) Function Switch - Phone
 - b.) Meter Switch - Plate
 - c.) Audio Gain - Full Clockwise
 - d.) Drive Switch - High
 - e.) Mike Switch - Crystal Position

Notes:

Resistance is in Ohms. K' = X1000.
Resistance Tolerance $\pm 20\%$.

T-90 TUBE SOCKET RESISTANCE DATA
FIGURE 9

SECTION V

ANTENNA INSTALLATION

1. General.

The ability of the T-90 output Pi network to tune over a wide range of antenna impedances would suggest that it could load into almost any piece of wire used as a radiator. Actually, it will load into a wide range of antenna impedances and is capable of balancing out a considerable amount of reactance. However, in order to obtain maximum radiation efficiency, it is recommended that the antennas used be at least a quarter wavelength at the operating frequency. Circuit criteria, when operating at the extreme ranges of the 80 meter band, dictates that antenna impedances should be within the ranges specified under RF Output Impedances in Section I, otherwise a plate current dip may not be found. There is also the problem of TVI when operating fixed station in those locations where television signals are received. For this reason the antennas suggested for use with the T-90 transmitter are those having feeders capable of being matched to the characteristic impedance of a low pass filter by using an antenna coupler, so called baluns or L-type networks. Since the Pi network output is of the unbalanced type, means should be provided, in case of use of balanced lines, to modify the feed to the unbalanced type. In the case where coax fed antennas are used, no additional treatment is required. In any case, the standing wave ratio of the feed lines should be at a minimum.

The Harvey-Wells Bandmaster Z Match, available as an accessory, is ideally suited for use with the T-90 transmitter. It will match a 50 ohm transmitter output into antenna loads ranging from 10 to 2500 ohms, reactive, non-reactive, balanced or unbalanced. Refer to Figure 15 for connections. For complete details and features, refer to the article "Z Match - The Easy Way" in QST, May 1955.

a. Antennas for Fixed Station Locations.

Several antennas are suggested and are outlined with details as noted in Figures 11 thru 14. Other types of antennas may be used to conform with requirements peculiar to a particular installation. For information on various other types of antennas, matching systems, feed lines, low pass filters, etc., it is suggested that the amateur refer to the various published manuals dealing with the respective problem.

b. Antennas for Mobile Operation.

The whip antenna, having provisions for center or bottom

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loading, is generally accepted universally for mobile operation. In general, the whip is cut to a quarter wavelength for operation on the highest frequency range, usually 30 mcs. For operation on the lower frequencies, inductances are inserted at the bottom or center of the whip to electrically lengthen it to a quarter wavelength. There are available commercially a variety of whips which have provisions for loading coils. Some of the whips are set up so that they may be used throughout the entire frequency range of 3.5 to 27.9 mc. simply by moving a tap on the loading coil, or by a simple tuning arrangement.

Amateurs will have a personal preference with regard to mobile antennas. The antennas noted in Figure 10 are typical for mobile use, but there are many other types which will function just as efficiently.

Center loading versus bottom loading of whips is very controversial at best. However, generally speaking, center loading is usually accepted as giving a higher gain in antenna efficiency because the radiation resistance is approximately double that of bottom loading. The ground loss resistance remains the same in either case, but the increased radiation resistance becomes a greater portion of the total circuit resistance, thereby increasing radiation efficiency. Bottom loaded whips usually have a base feed resistance of approximately 10 to 36 ohms as compared with 20 to 36 ohms for center loaded whips, in the range from 3.5 to 29.7 mcs.

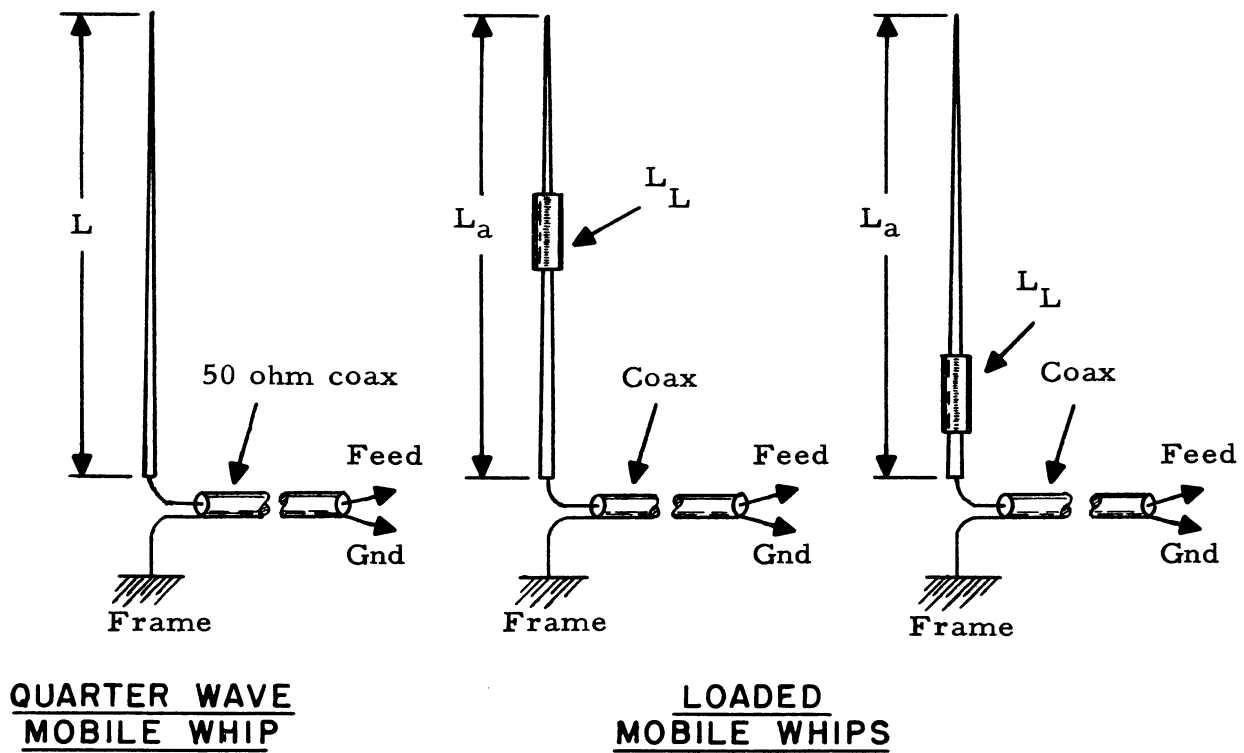
Feeding a mobile whip is not much of a problem because the length of cable required between transmitter and antenna is usually short. However, some attempt should be made to match impedances to obtain maximum radiation. The most popular method of feed is by use of coaxial cable. RG-58/U and RG-8/U have a nominal characteristic impedance of approximately 50 ohms, and RG-59/U and RG-11/U run about 70 ohms, which is appreciably higher than the radiation resistance of the antenna. When short lengths are used, either of these cables may be used and the Pi network output circuit of the T-90 will balance out the slight reactance. If a closer impedance match is desired, especially when using longer lines, two lengths of coaxial cables may be paralleled. This is more practical when using the smaller diameter cables such as RG-58/U and RG-59/U, and impedances of 26 and 36 ohms, respectively, may be obtained. Of course, there is the alternative of raising the base antenna impedance to 50 or 70 ohms by use of variable inductors and capacitors, but this is not generally recommended for quick QSYing from band to band, unless automatic means are employed.

If individual loading coils are used with mobile whips, pruning of these coils should be done in accordance with the manufacturer's

SECTION V

instructions. In lieu of such information, a GDO may be used and coupled to a one or two turn link temporarily inserted between the base of the whip and ground. The frequency at which a dip in current of the GDO meter is indicated is the resonant frequency of the whip. Each coil may be pruned or tuned as required. When using all-band type loading coils, the initial adjustment of the tap should be made as noted above. Once the tap has been properly placed it should be marked for the various bands and the tap set at these marks when QSYing. Many other types of loading coils are available such as dual-band types, etc. In each case, the manufacturer's instructions should be followed as to the method of tuning and loading.

In lieu of a GDO, a field strength meter may be used to resonate the whip. This should be placed outside of the direct field of the transmitter and the whip tuned for maximum radiation. An antenna impedance meter, used in conjunction with the GDO is an aid in determining antenna base feed impedance. The physical location of mobile whips on vehicles is a matter of personal preference. The greater percentage of amateurs install them at the rear of the car, at some clear space near the trunk opening or on the rear bumper. The general considerations for whip mounting, regardless of the physical location, are to mount it as high on the car body as possible, mindful of the fact that the vehicle may have to pass under low bridge structures; and that the whip should be kept away from the car's metal body. The antenna feed line should be grounded as close to the base of the antenna as possible. In order to keep the ground-loss resistance at a minimum, it is important that a good electrical ground connection be made to the vehicle frame.



$$L \text{ (ft.)} = \frac{234}{f \text{ (mc)}}$$

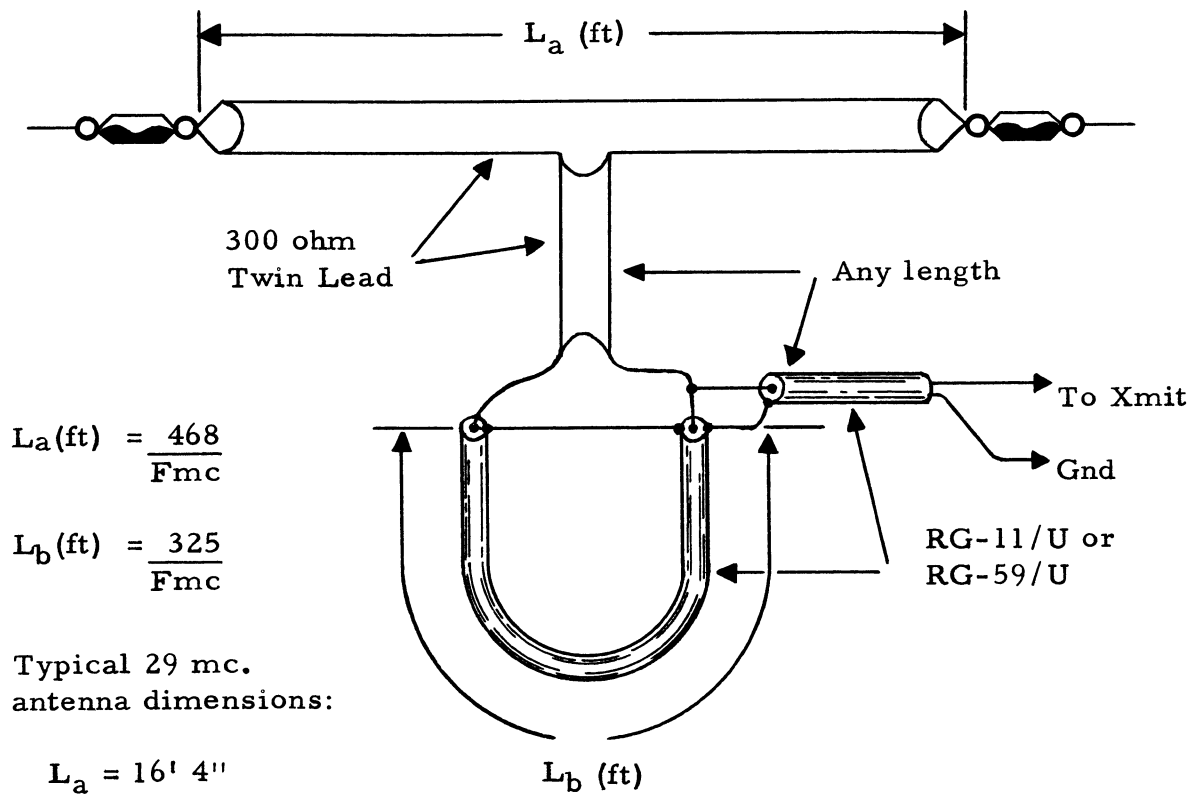
$$L_a \text{ (ft.)} = \frac{234}{f \text{ (mc)}}$$

L_a = Approximately a quarter wave long on highest frequency of operation with loading coil shorted out.

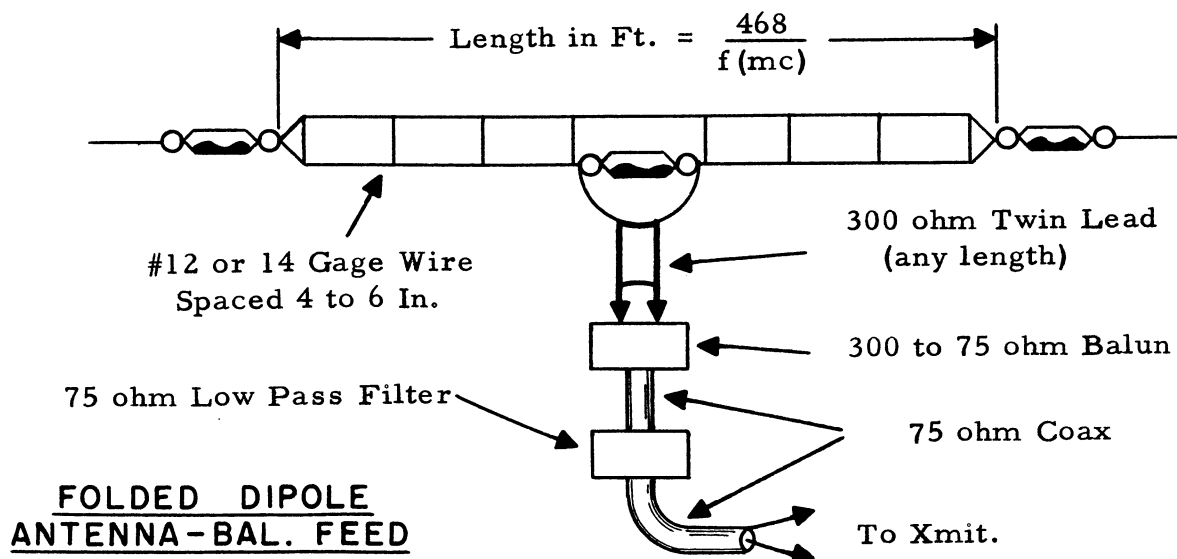
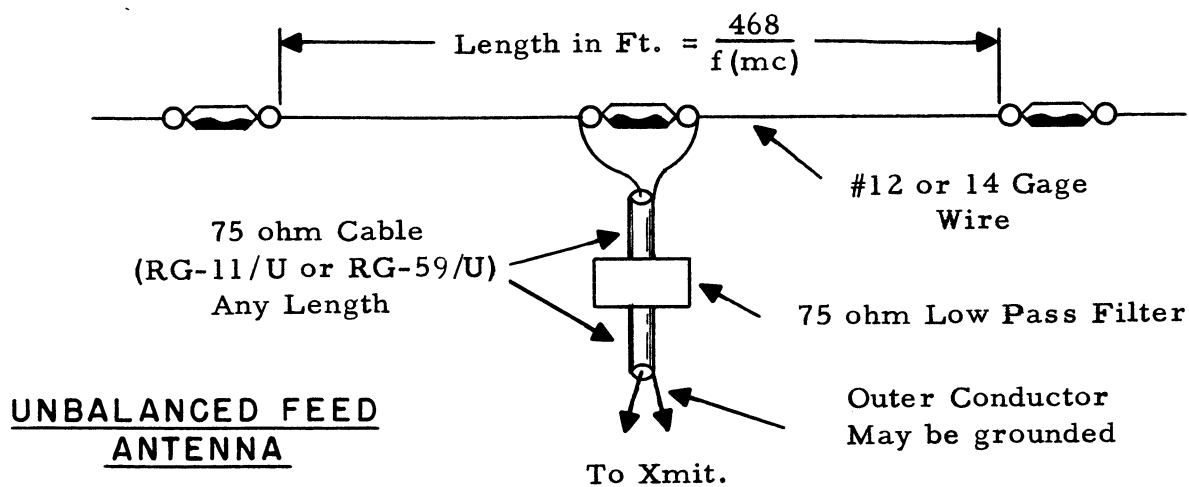
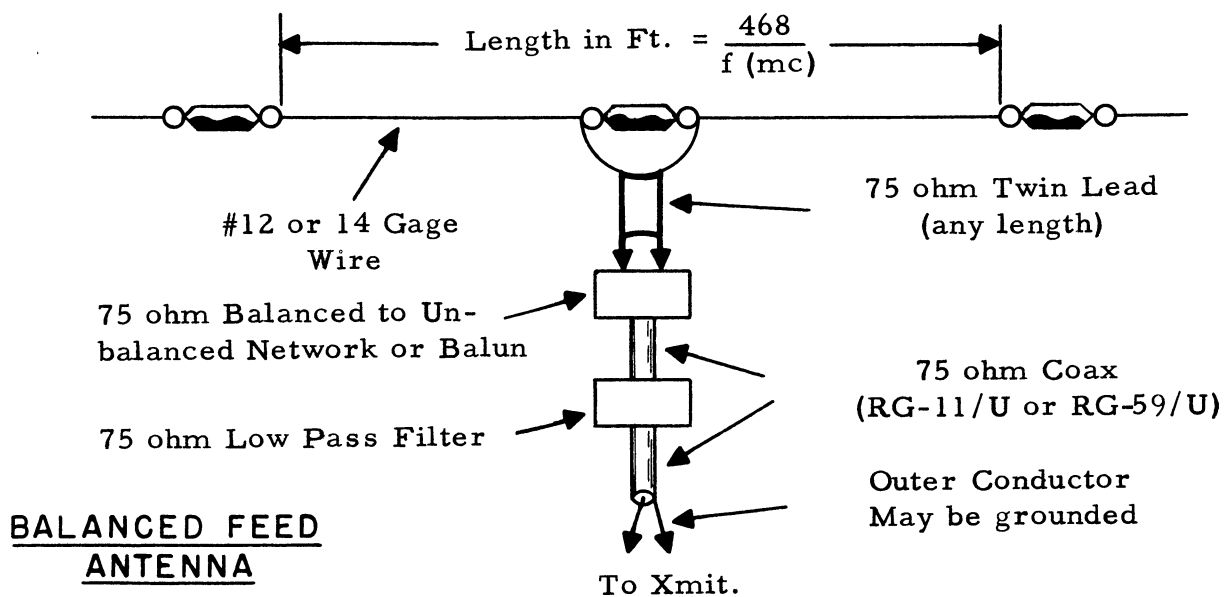
L_L = Loading coil. May be plug-in, tapped or tuned.

MOBILE ANTENNAS

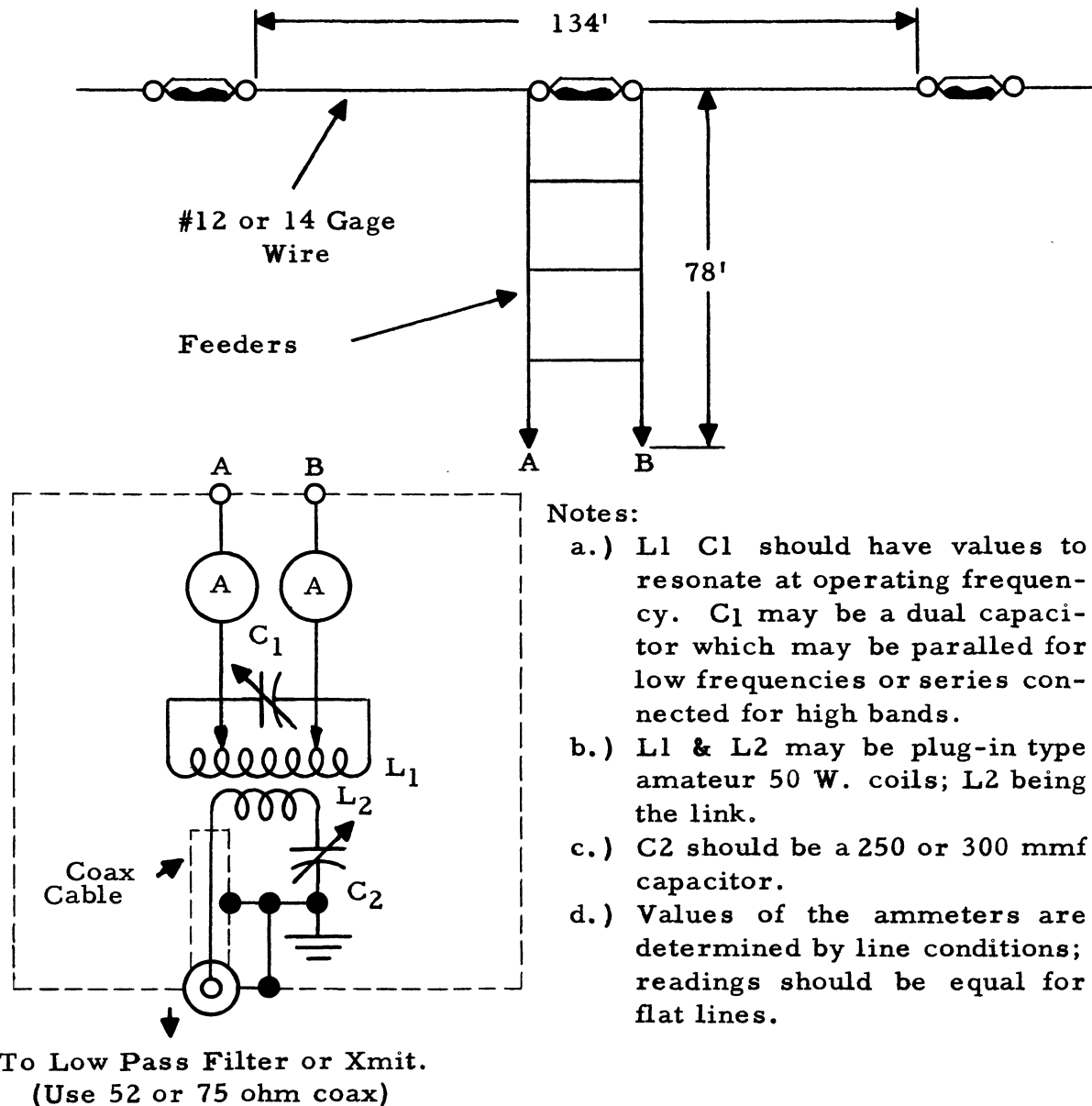
FIGURE 10



300 TWIN LINE ANTENNA
WITH BALANCED TO UNBALANCED TRANSFORMER
FIGURE 11



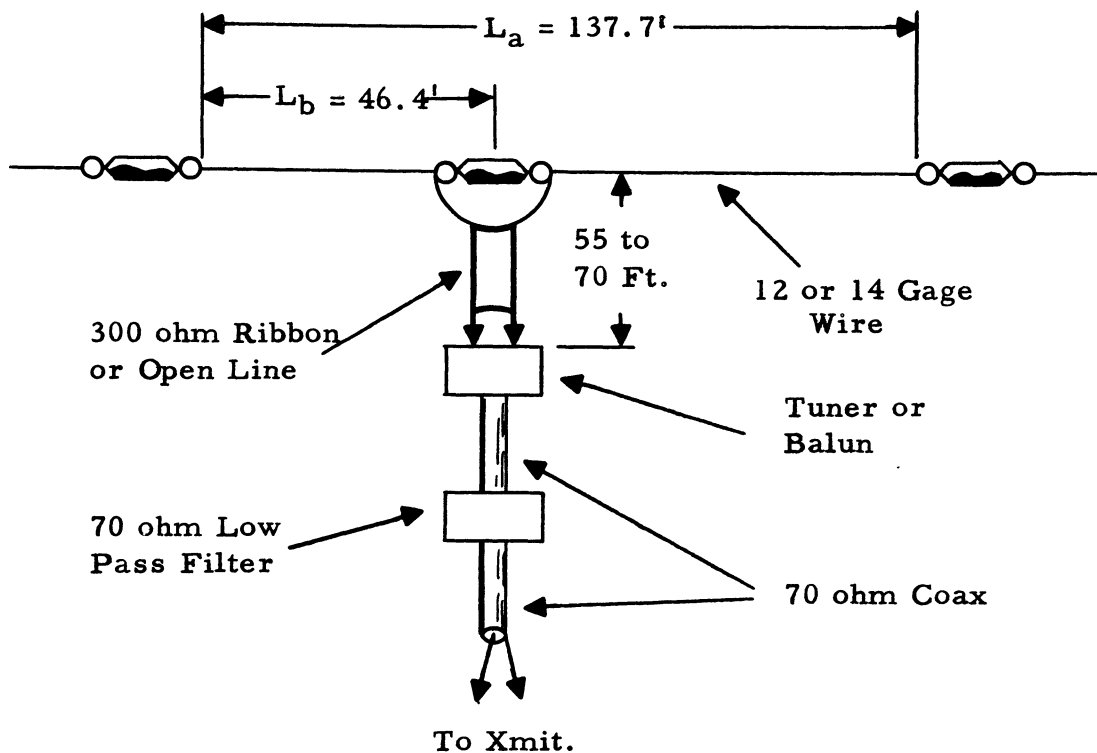
**CENTER-FED HALF WAVE ANTENNAS
FOR SINGLE BAND OPERATION
FIGURE 12**



General:

With antenna and feeder lengths shown, parallel tuning is used on all bands from 3.5 to 28 megacycles. In general, taps on L₁ are moved closer to center as frequency is increased. Feeders may be open line or 300 ohm twin line; open line having the least attenuation. For alternatives in antenna and types of tuning circuits, consult antenna manuals.

CENTER-FED MULTI-BAND RESONANT LINE, ANTENNA FIGURE 13



$$L_a \text{ (ft.)} = \frac{492 (N - .05)}{F_{mc}}$$

$$L_b \text{ (ft.)} = L_a \times .3375$$

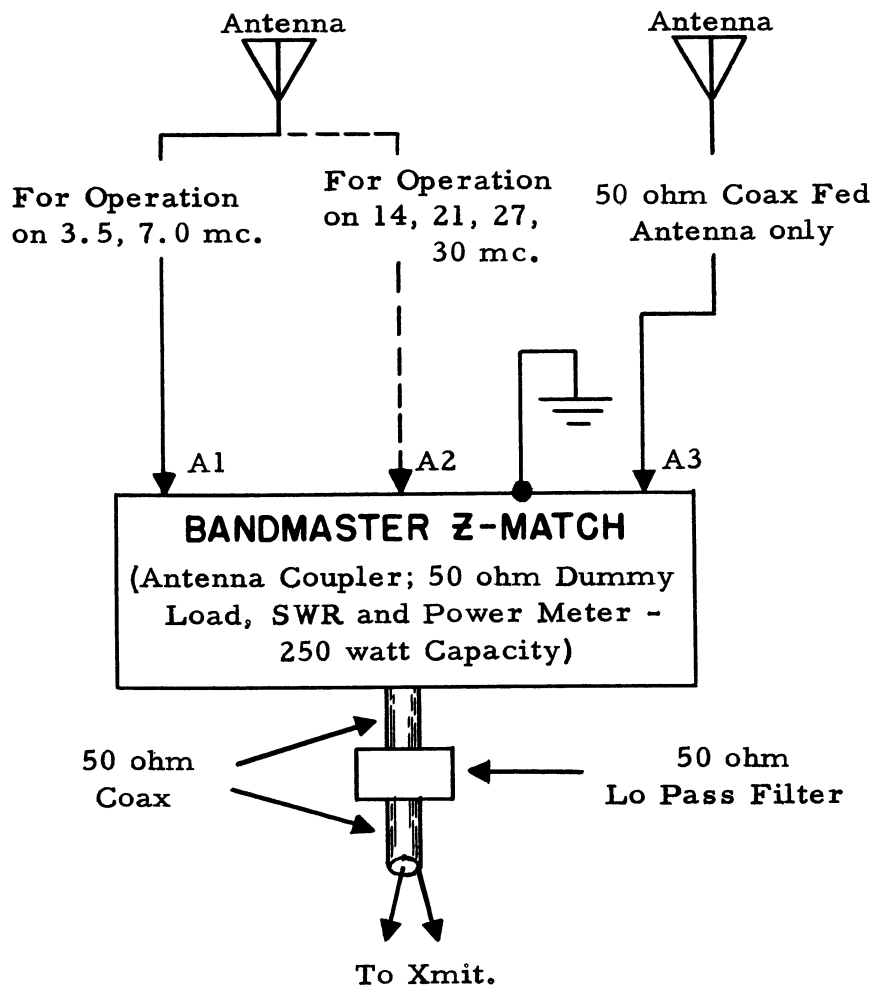
N = Number of halfwaves at highest frequency of operation.

F_{mc} = Highest frequency of operation.

Design Frequency = 28.4 megacycles.

The antenna noted above is a harmonic-type, off center fed, multi-band antenna. It is included herewith because of its popularity and wide acceptance by amateurs. It will purportedly load into the 3.5, 7, 14, and 28 megacycle bands. However, no claims are made herewith as to its radiation efficiency; nor to the flatness (low VSWR) of the 300 ohm line on all bands. This is because harmonic frequencies of a long wire are not precise integral multiples due to end effects as indicated by the formula.

OFF CENTER-FED HARMONIC ANTENNA FIGURE 14



- Notes:
1. Antenna feeders connected to A1 or A2 may be of the balanced, unbalanced, or single wire feed type. The Z-Match will tune feed impedances from 10 to 2500 ohms, reactive or non-reactive.
 2. Any beam or other type antenna fed with 50 ohm coax line may be connected to A3.
 3. Antennas may be connected to A1 or A2 but not to both at the same time. If an antenna is tied to A3, it may remain in position even though an antenna connected to A1 or A2 is in use.
 4. The coupler or balun denoted in Figures 12, 13, 14 may be replaced with the Z-Match which provides simpler tuning and better overall efficiency. Adjustment of the Z-Match is accomplished by tuning out reflected power thereby minimizing the SWR of the system.

BANDMASTER Z-MATCH
FIGURE 15

SECTION VI

MISCELLANEOUS INFORMATION

1. Car Systems.

When using the T-90 in vehicles having either 6 or 12 VDC systems, current demands on the battery, when taking advantage of the relatively high output capabilities of the T-90 transmitter, are very severe. For this reason, it is recommended that the car battery be augmented with an auxiliary battery or that a special generating system such as the Leece-Neville, or other, be used to provide the necessary additional current. The method of obtaining the required current is left to the discretion of the amateur. However, the T-90 may be operated at reduced power with conventional car systems if the on-the-air time is not abnormal and the generator charging rate is increased. The VPS-T90 power supply available as an accessory, requires approximately 35 A under full load using a 6 volt system and draws approximately 17 A with a 12 volt input. These ratings are exclusive of the current required for the T-90 heaters, which is 8 and 4 A, for 6 and 12 V systems, respectively, the receiver, and other equipment which may be drawing current from the battery.

2. The Use of the T-90 as an Exciter.

The T-90 was designed for use as a complete transmitter. Should it be used as an exciter to drive a high power RF Amplifier, the Pi network output will easily load in a link. It is suggested that, depending on the drive requirements of the external RF amplifier, the voltage of the 6146 plate be reduced proportionally so as not to over drive the external amplifier grid and to allow proper loading of the 6146 plate. The modulators of the T-90 operate Class B and cannot be used to drive another Class B stage. It is therefore necessary to use a completely independent speech amplifier and modulators if high level modulation is to be used for the new PA.

3. TVI.

The usual precautions have been taken to suppress TVI in the T-90. All the power input receptacle leads have been filtered with ceramic disc capacitors and low inductance RF chokes. The meter terminals, dial lights, microphone and keying jacks also have filters to minimize possible radiation from these sources. Other networks are used to suppress spurious frequencies at their sources.

Nevertheless, there are many contributing causes of TVI beyond the control of the equipment manufacturer since they cannot predict the effects caused by loading into reactive lines; front end overload

SECTION VI

and direct IF feedthru in the TV set; rectification, direct or due to faulty antenna connections; and many other causes of TVI peculiar to the location; affinity of the particular type of TV set to radiated frequencies; etc. These problems will have to be rectified by the individual as best he can.

Comprehensive treatment of TVI is beyond the scope of this manual. The amateur, however, can take the usual basic measures to initially reduce TVI by using coaxial fed antennas and a low pass filter having good attenuation characteristics. These filters are available commercially or can be made up by the amateur. It is important of course that the feed lines have low standing wave ratio and that the characteristic impedance of the filter be that of the line. At the TV receiver end, a 300 ohm high pass filter may be installed as close as possible to the front end input, or a $1/4$ wave 300 ohm line may be used for suppression of TVI at specific frequencies.

ELECTRICAL PARTS LIST

T-90 TRANSMITTER

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
C1	Capacitor, silver mica 18 mmf $\pm 2\%$ 500 VDC	1J(CM15E180G)	1
C2, C4, C5	Capacitor, tubular trimmer 12 mmf	B-2E1001-3	3
C3, C8, C11	Capacitor, silver mica 47 mmf $\pm 2\%$ 500 VDC	1J(CM15E470G)	3
C6	Capacitor, silver mica 10 mmf $\pm 5\%$ 500 VDC	1J(CM15E100J)	1
C7	Capacitor, air trimmer 25 mmf	A-2C1007-1	1
C9	Capacitor, air, variable 50 mmf	A-2B1016-1	1
C10	Capacitor, silver mica 68 mmf $\pm 5\%$ 500 VDC	1J(CM15E680J)	1
C12, C13 C27	Capacitor, negative coefficient 3.3 mmf 500 VDC	A-1K3024-1	3
C14, C15	Capacitor, silver mica .001 mf $\pm 5\%$ 300 VDC	1J(CM20D102J)	2
C19, C23	Capacitor, ceramic 47 mmf 600 VDC	A-1K3008-C47ZM	2
C21, C24, C32, C34, C35, C61	Capacitor, Disc .001 mfd 600 VDC	A-1K3023-13Z	6
C29	Capacitor, ceramic 20 mmf 600 VDC	A-1K3008-C21K	1
C36	Capacitor, ceramic 470 mmf 600 VDC	A-1K3025-471Z	1

ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
C37	Capacitor, mica .002 mmf 2500 VDC	A-1G4515-23Z	1
C38	Capacitor, air variable 150 mmf	A-2B1012-1	1
C39, C66, C68	Capacitor, disc .002 mf 2500 VDC	A-1K4001-23Z	3
C40	Capacitor, mica 150 mmf <u>+5%</u> 2500 VDC	A-1G4515-151J	1
C43, C44, C45, C46, C48, C49, C50, C51	Capacitor, silver mica 300 mmf <u>+5%</u> 500 VDC	1J(CM20D301J)	8
C47	Capacitor, variable, air 300 mmf	A-2B1013-1	1
C52	Capacitor, ceramic 100 mmf 500 VDC	A-1K3001-C12K	1
C16, C17, C18, C20, C22, C25, C26, C28, C30, C31, C33, C53, C56, C65, C69	Capacitor, disc .01 mf 600 VDC	A-1K3022-14Z	25
C54, C57, C58, C63, C64, C67, C80	Capacitor, disc .002 mf 600 VDC	A-1K3023-23Z	7
C55, C59	Capacitor, electrolytic 10 mf 25 VDC	A-1N1006-10R0	2
C60	Capacitor, paper .1 mf 400 VDC	A-1C3007-0R1	1

ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
C62	Capacitor, paper .01 mf 1600 VDC	A-1C4002-14	1
I1, I2, I3	Pilot Lamp, #47	A-42A1000-3	3
J1	Key Jack, 2 circuit	B-16A1009-1	1
J2	Antenna Connector	A-16E1002-1	1
J3	Socket, Jones #S-101	A-18E1005-1	1
J4	Mike Jack, 3 circuit	B-16A1009-6	1
J5	Jones Conn. #P-312AB	A-17E1001-12	1
L1	Oscillator Coil Assembly	B-12L1004-501	1
L2	Coil Assembly	C-12E1010-506	1
L3	Coil Assembly	C-12E1010-507	1
L4	Coil Assembly	B-12C1037-501	1
L5	Coil Assembly	C-12E1010-505	1
L6	Coil Assembly	B-12C1036-501	1
L7	Coil Assembly	C-12E1010-504	1
L8	Coil Assembly	C-12E1010-502	1
L9	Coil Assembly	C-12E1010-501	1
L10	Coil Assembly	C-12E1010-503	1
L11	Coil	A-12C1027-1	1
L12	Coil	A-12C1026-1	1
L13	Coil Assembly	B-12C1030-501	1
M1	Meter	C-69C1007-1	1

ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
R1	Resistor, fixed 27 ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-270K	1
R2, R9, R10, R11, R13	Resistor, fixed 47K ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-473K	5
R3	Resistor, fixed 12K ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-123K	1
R4	Resistor, fixed 82K ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-823K	1
R5	Resistor, fixed 270 ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-271K	1
R6	Resistor, fixed wirewound 8K ohm 10 W $\pm 5\%$	A-5C7000-83J	1
R7	Resistor, fixed 56K ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-563K	1
R8	Resistor, fixed 270 ohm 1 W $\pm 10\%$ Carbon	A-5A4001-271K	1
R12, R17, R30, R31, R32, R33, R34, R35	Resistor, fixed 100K ohm 1/2 W $\pm 10\%$ Carbon	A-5A3002-15K	8
R14, R20, R21	Resistor, fixed 4.7K ohm 2 W $\pm 10\%$ Carbon	A-5A5502-472K	3
R15	Resistor, fixed 27k ohm 1 W $\pm 5\%$ Carbon	A-5A4001-273J	1

ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
R16	Resistor, fixed 100 ohm 1/2 W Carbon	A-5A3002-12K	1
R18, R36	Resistor, fixed, wirewound .51 ohm 1/2 W <u>+10%</u>	A-5C3000-OR51K	2
R19	Resistor, fixed 27K ohm 1/2 W <u>+10%</u> Carbon	A-5A3002-273K	1
R22	Resistor, fixed, wirewound 30K ohm 10 W <u>+10%</u>	A-5C7000-34K	1
R23, R25	Resistor, fixed 1.0 megohm 1/2 W <u>+20%</u> Carbon	A-5A3002-16M	2
R24	Resistor, fixed 2.2K 1/2 W <u>+20%</u> Carbon	A-5A3002-222M	1
R26	Resistor, fixed 470K ohm 1/2 W <u>+10%</u> Carbon	A-5A3002-474K	1
R27	Resistor, variable 1 megohm Potentiometer special	A-6A4002-A16M	1
R28	Resistor, fixed 10K ohm 1/2 W <u>+10%</u> Carbon	A-5A3002-14K	1
R29	Resistor, fixed 470 ohm 1/2 W <u>+10%</u> Carbon	A-5A3002-471K	1
R37	Resistor, fixed, wirewound 25 ohm 7 W <u>+10%</u>	A-5C6513-250K	2
R38	Resistor, fixed 39 ohm 2 W <u>+5%</u> Carbon	A-5A5502-390J	1

ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
RFC1, RFC3, RFC4, RFC5, RFC8, RFC10	Choke Assembly 500 uh	B-12B1012-501	6
RFC2	Choke Coil Assembly 20 uh	B-12A1023-501	1
RFC6	Choke and Plate Cap Assembly	B-90D1097-501	1
RFC7	Choke Assembly 60 uh	B-12A1027-501	1
RFC9, RFC12, RFC13, RFC14, RFC15	Choke Assembly 7 uh	B-12A1032-501	5
RY1	Relay, 25 ohm coil 6 VDC	A-48A1016-1	1
SW1	Bandswitch	C-47F1029-1	1
SW2	Driveswitch	A-47F1039-1	1
SW3	Function Switch	B-47F1031-1	1
SW4	Load Switch	B-47F1030-1	1
SW5	Meter Switch	A-47F1040-1	1
SW6	Toggle Switch	C-47B1004-4	1
SW7	Mike Switch	A-47L1003-1	1
T1	Transformer, driver 10K ohm Primary Ratio Primary to 1/2 sec = 2:1	B-9K1002-1	1
T2	Transformer, modulation Special	B-9D1007-7	1

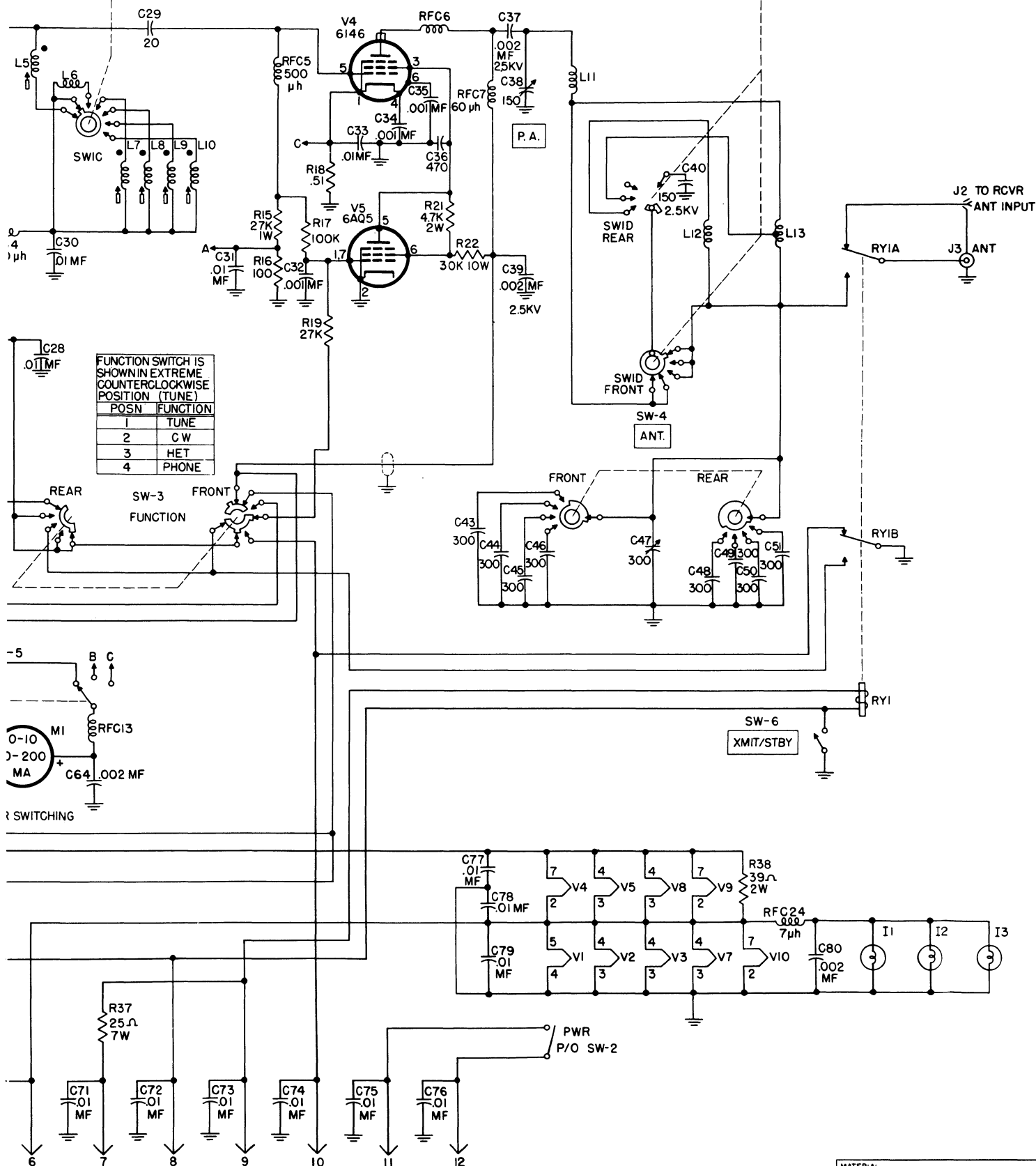
ELECTRICAL PARTS LIST (CONT'D)

SYMBOL	DESCRIPTION	H-W PART NUMBER	QTY
V1	6CL6 Tube		1
V2, V3, V5, V8	6AQ5 Tube		4
V4	6146 Tube		1
V6	OB2, Regulator Tube		1
V7	6AU6 Tube		1
V9, V10	6AV5 Tube		2

NOTES

NOTES

POWER AMPLIFIER



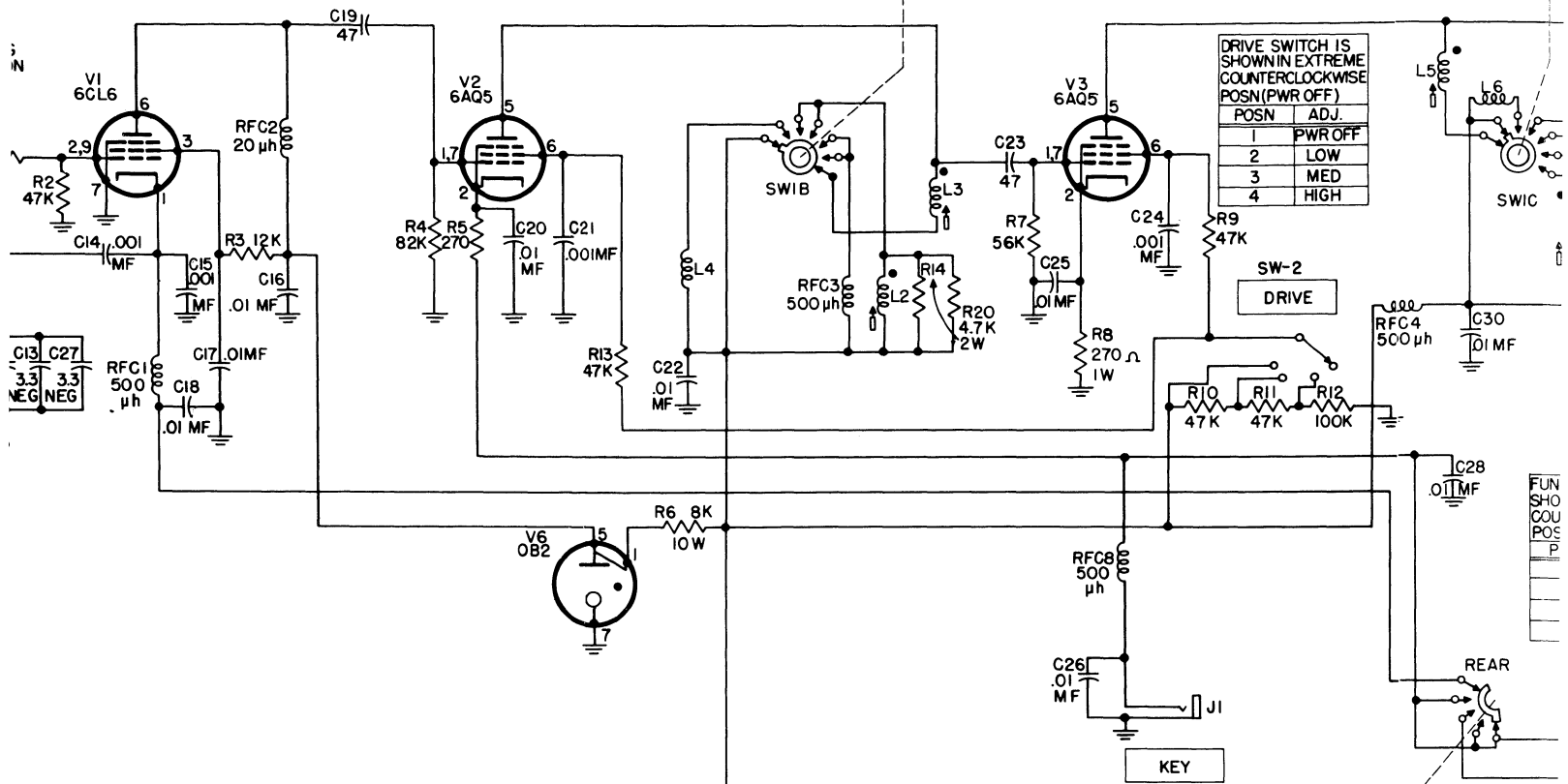
MATERIAL	
FINISH	
TOLERANCE EXCEPT AS OTHERWISE INDICATED	
FRACTIONS	1/8"
DECIMALS	0.001
ANGLES	1°
SCALE	
SCHEMATIC DIAGRAM	
T-90 AMATEUR TRANSMITTER	
FIRST MADE FOR X-199	
DRAWN	DATE 4-4-55
CHECKED	DATE 4-4-55
APPROVED	DATE 4-4-55
HARVEY WELLS ELECTRONICS, INC. SOUTHERS BAY, N.Y.	
E-91A1134	

BANDSWITCH

VFO-CRYSTAL
OSCILLATOR

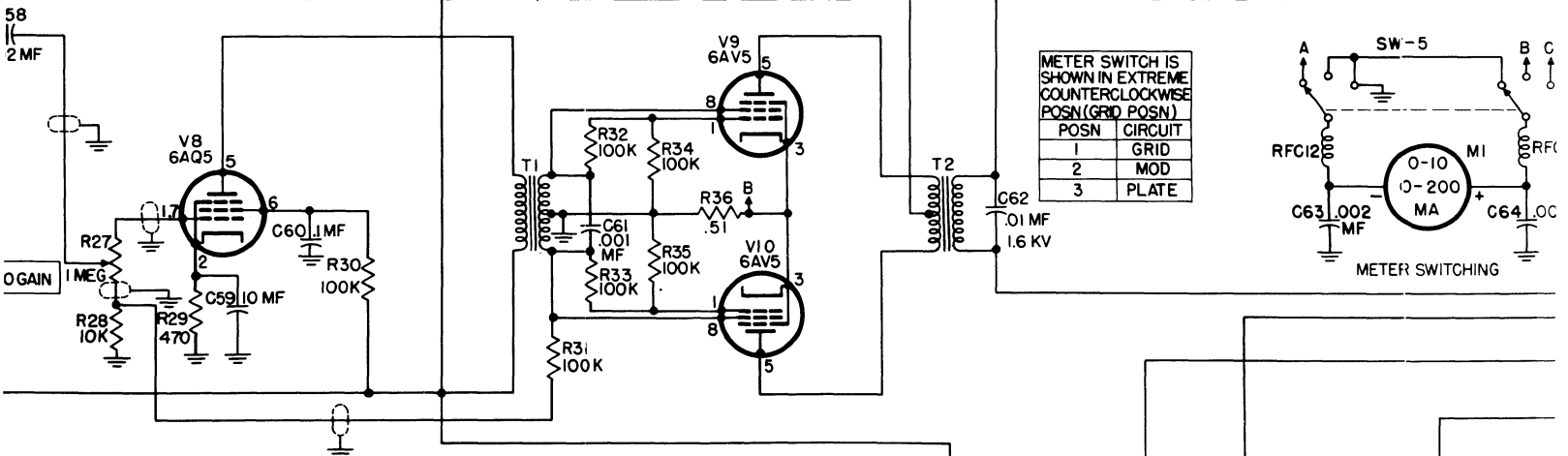
1ST AMPLIFIER/ MULTIPLIER

2ND AMPLIFIER/MULTIPLIER

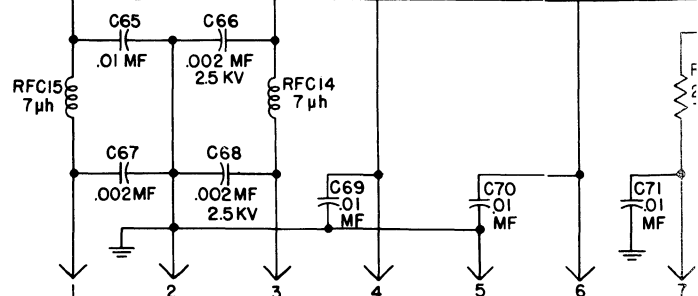


DRIVER AMPLIFIER

MODULATORS

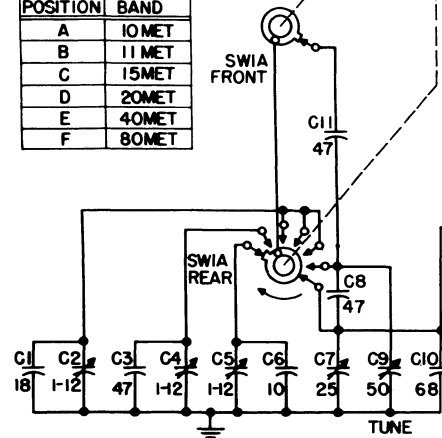


INDICATOR VALUES ARE IN MMF UNLESS
 OTHERWISE SHOWN
 RESISTOR VALUES ARE IN OHMS & 1/2
 UNLESS OTHERWISE SHOWN K=X1000
 18 & C42 ARE NOT USED
 IN SCHEMATIC ALSO RFC9
 HAS RED DOT MARKING ON COIL



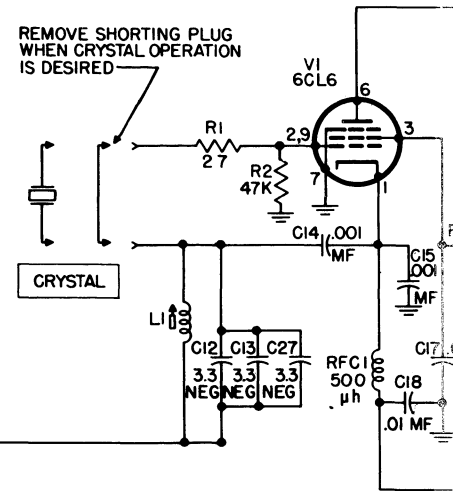
BANDSWITCH SHOWN
IN 10MET (EXTREME
COUNTERCLOCKWISE
POSITION)

POSITION	BAND
A	10MET
B	11MET
C	15MET
D	20MET
E	40MET
F	80MET



VFO-CRYSTAL OSCILLATOR

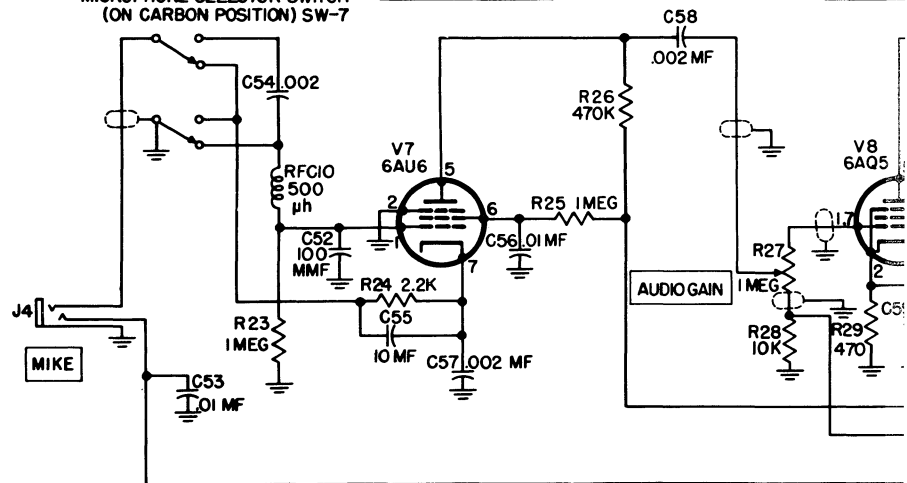
REMOVE SHORTING PLUG
WHEN CRYSTAL OPERATION
IS DESIRED



MICROPHONE SELECTOR SWITCH (ON CARBON POSITION) SW-7

SPEECH AMPLIFIER

DRIVER



NOTES

1. ALL CAPACITOR VALUES ARE IN MMF
OTHERWISE SHOWN
2. ALL RESISTOR VALUES ARE IN OHMS
WATT UNLESS OTHERWISE SHOWN K
3. RFC11, C41 & C42 ARE NOT USED
IN THIS SCHEMATIC ALSO RFC9
4. • DENOTES RED DOT MARKING ON COI

BANDMASTER Accessories

BANDMASTER POWER SUPPLIES

APS-90 AC POWER SUPPLY

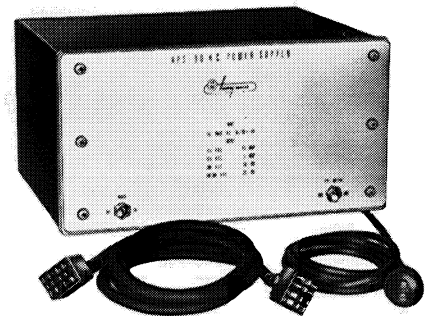
The APS-90 Supply was designed specifically for use with the T-90 Bandmaster Transmitter for fixed station operation. It operates with a nominal line voltage input of 115 VAC, 60 cycle, single phase, and provides all the necessary operating and control voltages for the T-90.

The APS-90 is completely contained in a perforated enclosure which is identical in size and appearance to that of the T-90. Two operating switches are on the front panel. One switch is for power "ON" and the other switch is for the primary taps of the high voltage transformer. The S-312-AB connector is located on the rear chassis apron.

A single filament transformer supplies heater voltages to a 5Y3GT, full-wave low voltage rectifier; and a 5R4GY, full-wave high voltage rectifier, both contained in the APS-90. Another winding on this transformer supplies filament power for the T-90 transmitter. This voltage source, in conjunction with a selenium rectifier and filter is also used to provide DC relay control voltage. Separate transformers are used to supply the low and high operating plate voltages, the outputs of which, after rectification, are well filtered and contain bleeder resistors. The high voltage plate transformer has a tapped primary which may be switched thus allowing operation of the T-90 at CCS or ICAS ratings. A low voltage DC relay is used to switch the primaries of both plate transformers.

A 6-foot length of shielded, multiconductor cable, completely wired and terminated with appropriate plugs is supplied with the APS-90. One end of this cable has a P-312-CCT Jones connector for mating with the APS-90 chassis connector and the other end has a S-312-CCT connector for plugging into the T-90 chassis connector.

Since the power switch of the APS-90 is series connected in the line as a safety precaution, completion of the circuit must be made externally. The interconnecting cable ties in the transmitter control circuits and the power switch is normally left in the "ON" position. All functions, with the exception of the high voltage change, are then controlled at the transmitter end.



SPECIFICATIONS

All operating voltages and control circuits are terminated to a Jones S-312-AB chassis connector. Voltages available at this connector are as follows:

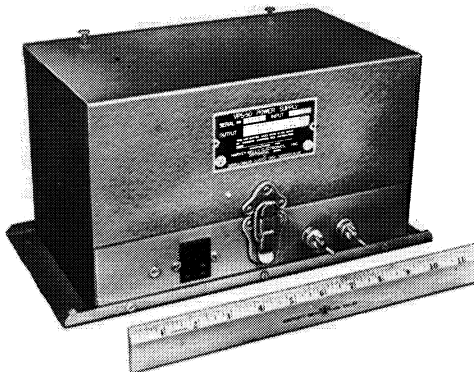
Volts	Current	Function
12.6 VAC	3.5 A	Transmitter Filaments
		Pilot Lights
12.6 VDC	.5 A	Relay Control
300 VDC	100 ma	Exciter & Speech Plates
500 or 600 VDC	225 ma	Power Amplifier and Modulator Plates

NOTE: When used as a separate supply for other equipment, the filament and relay voltages may be dropped to 6.3 volts by use of suitable external series resistors.

Dimensions: 12 $\frac{3}{8}$ " wide, 10 $\frac{1}{4}$ " deep, 6 $\frac{3}{4}$ " high — same as T-90 Transmitter.
Weight: 35 lbs.

\$79⁵⁰*

VPS-T90 6/12 VOLT DC SUPPLY



A vibrator power supply designed specifically for the T-90 Bandmaster Transmitter. Provides all necessary voltages. May be used with either 6 or 12 volts D.C. by changing jumpers. Comes complete with 10 foot shielded multiconductor output cable and connectors.

Designed for easy installation and service. Cover removable from front by means of snap latch, input and output connections on same face. Mounts on convenient mounting base.

SPECIFICATIONS

- Input: 6.3 VDC Nominal
Output: A. 300 VDC at 100 ma
B. 300 VDC at 200 ma
or 500 VDC at 200 ma
- Input: 12.6 VDC Nominal
Output: A. 300 VDC at 100 ma
B. 300 VDC at 200 ma
or 500 VDC at 200 ma
- Output Ripple: A. .5% or under
B. 1% or under
- Vibrator Frequency 60 CPS
- Lowest Input Voltage at which supply will operate
A. 5 VDC
B. 10 VDC

DIMENSIONS: 11" wide, 6 $\frac{5}{8}$ " deep, 6 $\frac{5}{8}$ " high.
WEIGHT: 20 lbs.

\$89⁵⁰*

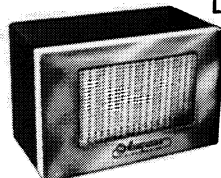
PRICE

VPS-R9 VIBRATOR SUPPLY

Designed for use with R-9 Bandmaster Receiver when operating mobile. 6 or 12 VDC input, outputs as required by R-9 Receiver. Mounts on either bottom or back of case. Input and output leads on same face. Complete with shielded multiconductor interconnect cable and connector. (No modification required to R-9 Receiver, just plug in the cable).

DIMENSIONS: 7 $\frac{1}{2}$ " wide, 6 $\frac{1}{2}$ " high, 4 $\frac{3}{4}$ " deep.
WEIGHT: 10 lbs. **\$28⁵⁰*** (Plus Federal Excise Tax)

BANDMASTER SPEAKERS

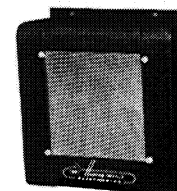


FS-1 FIXED STATION SPEAKER

Designed to match the T-90 and R-9. Incorporates high quality oval speaker 6" x 9". Overall dimensions 12 $\frac{3}{8}$ " wide, 6 $\frac{1}{4}$ " deep, 8" high. Impedance 3.2 ohms.

PRICE

\$10⁵⁰* (Plus Federal Excise Tax)



MS-1 MOBILE SPEAKER

A six inch speaker designed for mounting in automobile or cabin. Impedance 3.2 ohms. Dimensions 8" high, 4 $\frac{3}{4}$ " deep, 6 $\frac{5}{8}$ " wide.

PRICE

\$7⁵⁰* (Plus Federal Excise Tax)

*Price Subject to change without notice

PRINTED IN U. S. A.

Harvey-WELLS
ELECTRONICS, INC.
SOUTHBRIDGE MASS. U.S.A.

THE *Harvey*-WELLS BANDMASTER Z MATCH

Physically identical to other units in the complete "System-Engineered" Bandmaster Station.

12 $\frac{3}{8}$ " wide x 6 $\frac{3}{4}$ " high x 10 $\frac{1}{2}$ " deep.

Only
\$89⁰⁰*



THE *Antenna Coupler* THAT COMBINES 4 INSTRUMENTS IN ONE UNIT

1. A PRECISION ENGINEERED ANTENNA MATCHING UNIT
2. A FORWARD-REFLECTED POWER WATTMETER
3. AN R.F. WATTMETER
4. A DUMMY LOAD

Although originally designed for use with the Harvey-Wells T-90 Bandmaster Transmitter, this antenna coupler may be used with any transmitter for matching into a variety of load impedances ranging from 10 to 2000 ohms. Terminals are provided for line or coaxial antenna feeders. Tuning is continuous from 10 to 80 meters without band-switching. It will conservatively handle a transmitter input of 500 watts.

In addition to its features as an antenna coupler, the Bandmaster Z-Match has a built-in forward-reflected power wattmeter, an R.F. wattmeter, and a dummy load. Curves are supplied to enable the forward-reflected power readings to be converted to VSWR information. The R.F. Wattmeter is in the circuit at all times, and the dummy load may be used to check your transmitter before going on the air.

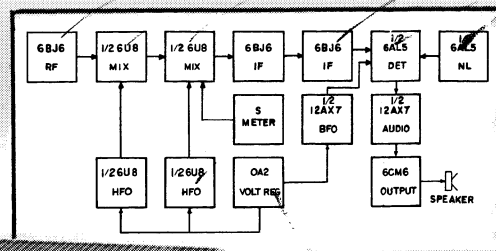
*PRICE SUBJECT TO CHANGE WITHOUT NOTICE



And a Companion Receiver to Complete the Station

R-9

**9 TUBES
DOUBLE
CONVERSION
MOBILE OR FIXED**



R-9

**DIMENSIONS
(overall)**
12 3/4" wide
10 1/2" deep
6 3/4" high
weight 18 lbs.

PRICE
\$149.50*

(Plus Federal Excise Tax)
complete with tubes

Matching Speaker
available
(See Back Page)

Harvey-WELLS R-9 BANDMASTER RECEIVER

In our further studies of amateur requirements, we found that the ultimate desire of all was to have equipment which "went together". The difficulty of installing odd sizes of cabinets has always been a source of irritation to the neat and efficient operator. The R-9 is physically an identical twin to the T-90. Now at last, without any reservation, you can have fixed station performance either in your shack or in your car. This highly stable all-band double conversion receiver has a versatility and a number of refinements which have never before been offered in such small space.

FEATURES

1. Double conversion on all bands
2. Three tuned circuits on each band, in R.F. section
3. All coils slug tuned, providing high "Q" circuits
4. Separate oscillator coils for each band (no spurious response)
5. Bandwidth:
Four kilocycles wide at the 6 db point
6. Complete with tubes and built-in AC power supply. 6/12 volt DC power supply available
7. Crystal filter and crystal calibrator available as accessories.
8. Approximately 6" of dial spread on all bands. Accurately calibrated
9. Rigid Steel construction (Vibration-Proof)
10. 6 3/4" height enables easy under dash mounting for mobile installation

SPECIFICATIONS

Frequency Ranges: (5 bands)

80 Meters	3.5 to 4.0 Mcs.
40 Meters	7.0 to 7.3 Mcs.
20 Meters	14.0 to 14.4 Mcs.
15 Meters	21.0 to 21.45 Mcs.
10-11 Meters	26.9 to 30.00 Mcs.

Sensitivity:

10 db. S/N on all bands measured with 2 microvolt signal input, 30% modulation, and 500 milliwatts output into a 4 ohm load.

Intermediate Frequency: 1600 and 260 Kc.

Output Impedance:

(1) Speaker	3.2 ohms
(2) Earphones	600 ohms

Input:

Nominal 50 ohm over all frequency ranges

Tube Complement:

- 1 — 6BJ6 R.F. Amplifier
- 1 — 6U8 Mixer-Oscillator
- 1 — 6A2 B + Regulator for H.F. Osc.
- 1 — 6U8 Second Mix/Osc.
- 2 — 6BJ6 I.F. Amplifiers
- 1 — 6AL5 Det. and N.L.
- 1 — 12AX7 1st Audio and B.F.O.
- 1 — 6CM6 Audio Output (5-6 watts)
- 1 — 5Y3GT Rectifier

*PRICE SUBJECT TO CHANGE WITHOUT NOTICE

