

## CONVERTING THE SCR-522 (Transmitter-Receiver)

A popular piece of v.h.f. radio equipment that has been quite common on the surplus market is the SCR-522 (also SCR-542) communication transmitter-receiver. In the military service it was generally known as the v.h.f. communication set used in the larger aircraft for inter-aircraft and air-ground communication. The ground version of the SCR-522 included several additional components such as a power unit, antenna, and antenna mast.

Power requirements for the SCR-522 are 28 volts d.c., at 11.5 amperes (maximum), with the PE-94A dynamotor furnishing the required "B" supply. Identical to the SCR-522, the SCR-542 operates from 14 volts dc., at 23 amperes, and uses the PE-98A dynamotor.

This set, consisting of an automatically-tuned, four-channel, crystal-controlled transmitter-receiver, operates in the range of 100 to 156 Mc. The frequency channels are determined by the four sets of crystals used. This frequency range covers many of the important services including airport control, police, railroad, air navigation aids, facsimile, urban telephone, and of course the 144 to 148 Mc. amateur band.

The complete SCR-522 Radio Set consists of the following components:

Transmitter. . . . .	BC-625
Receiver. . . . .	BC-624
Dynamotor Unit . . . . .	PE-94A
Rack . . . . .	FT-224
Case . . . . .	CS-80
Control Box. . . . .	BC-602
Jack Boxes (for crew interphone). . . . .	BC-629, BC-630, and BC-631

The conversion of the SCR-522 for amateur use involves the two basic components, the transmitter, BC-625, and the receiver, BC-624. These will be discussed separately since it is generally preferable to use them as separate units for stationary operation. For mobile operation, the units may be replaced in their original case and operated from the original dynamotor, PE-94A.

### Transmitter, BC-625:

The conversion and modification of the BC-625 is discussed under the following section headings:

- (a) General Description and Operation
- (b) Circuit Changes
- (c) Power Supply
- (d) Mechanical Modifications

#### (a) General Description and Operation:

This transmitter with only slight modification makes an excellent low-

power transmitter for either stationary or mobile use. With the recommended power supply, it will deliver 12 to 15 watts to the antenna; or it may be successfully used to drive a large power amplifier on 144 Mc. where higher power is desired.

The transmitter tube complement consists of seven tubes, three of which comprise the modulator, and four in the RF section.

Beginning with the RF section, VT-198A (6G6-G) is a modified Pierce crystal oscillator which doubles its frequency in the plate circuit. For operation in the 144-148 Mc. range, it is necessary to use a crystal frequency in the range of 8.0 to 8.255 Mc.; the power amplifier output is the 18th harmonic of the crystal frequency.

The plate output of the crystal oscillator, which is at 16 Mc., is tripled in the next stage to 48 Mc. This stage is the VT-134 (12A6) and drives the third stage, VT-118 (832), which also is a tripler. This brings the frequency up to the final frequency of 144 Mc. The output of the second tripler is coupled into the final with the hair-pin type of tank tuned with a split-stator butterfly capacitor. The final power amplifier VT-118 (832) operates as a straight amplifier and is coupled to the antenna through a variable swinging link.

It will be noted upon inspection that all coils are of the silver-plated type. Another point worthy of mention, is that the antenna loading can be anything between 20 and 500 ohms. However, it will be most convenient to use 52 ohm coaxial cable which matches the receiver input impedance and which also is the most readily available on the surplus market.

In some models of the SCR-522, a VT-199 (6SS7) stage is used as an RF indicator. This stage is connected as a diode and coupled with a pick-up loop into the final tank circuit.

The modulator section of the transmitter consists of a speech amplifier, VT-199 (6SS7), which is driven by a carbon mike through the input transformer 158. This stage also acts as an audio oscillator when tone modulation is used. The speech amplifier in turn drives the push-pull modulators, VT-134's (12A6's), which modulate the plate and screen of the final RF amplifier and the screen of the driver stage through the modulation transformer 160.

#### (b) Circuit Changes:

Voice modulation with the existing modulator is accomplished with a single or double button carbon mike through input transformer 158. If a single button mike is used, only half of the transformer primary is used with the center-tap grounded as shown in fig. 1. If a crystal mike is considered, it will be necessary to add an additional pre-amplifier to the modulator input. This can be a conventional voltage amplifier using a high mu triode with a 12-volt heater such as the 12F5. An alternative approach is using the unnecessary RF indicator stage VT-199 (6SS7) rewired in the conventional manner as the pre-amplifier stage.

The T-17, which is readily available on the surplus market, will operate very satisfactorily with the transmitter as a carbon mike.

If modulated c-w operation is desired, in addition to voice, it can be easily obtained by keying the cathode circuit of the speech amplifier, 6SS7

(VT-199), when it operates as an audio oscillator. This is conveniently done by inserting a normally-closed-circuit keying jack in the cathode circuit as shown in fig. 1. It is also necessary to install a double-throw single-pole switch in the grid circuit of the 6SS7. This switch changes the operation of the normal speech amplifier to an audio oscillator, thus giving the audio tone necessary for ICW. This switch as shown in fig. 1 merely replaces the grid circuit contacts that formerly existed on relay No. 131.

Since the mechanical tuning arrangement is removed from the transmitter and discarded as discussed in section (d), it is necessary to provide a crystal selector switch in order to utilize the different crystals. This is accomplished by a four-position single-pole switch as shown in fig. 1. The switch is physically located on the front panel as shown in the panel layout, fig. 2.

To facilitate tuning and operation, it is necessary to meter the plate and grid circuits in the conventional manner. This was accomplished by a switching arrangement and metering leads which were brought out to jacks for a separate external meter. As shown in fig. 2, a O-1 d-c milliammeter can be mounted on the panel with the metering leads run directly to the meter. The selector switch shaft is then extended and controlled from the panel.

Since metering is practically a necessity for tuning up a transmitter, the added meter is a worth-while addition that will complete and dress-up the appearance of the converted transmitter.

After the BC-625 is converted and connected to the power supply, described in section (c), it can be tuned up on the 144 Mc band in the conventional manner. The following chart gives the resonant conditions of the different stages, using the O-1 milliammeter in the respective circuit positions as selected by the metering selector switch:

Sw. Pos.	Circuit	Normal Meter Reading	Actual Current (ma)	Full Scale Represents
No. 1	1st freq. mult. plate	0.4	40	50
No. 2	2nd freq. mult. plate	0.5	50	100
No. 3	PA plate *	0.6 - 0.7	60-70	100
No. 4	Not used **			
No. 5	PA grid	0.5 - 1.0	1.0 - 2.0	2
No. 6	OFF (open position)			

\* Adjust antenna loading.

\*\* Used on some models in conjunction with RF indicator, full scale represents 1 ma.

The above data are the approximate values that can be expected when using a plate supply of 300 volts at approximately 260 ma. This represents approximately 20 watts input to the final which under normal conditions should give about 12 watts to the antenna.

(c) Power Supply:

The power supply required to operate the BC-625 has to supply 12 volts at 2.4 amperes for the heaters, and to supply a plate load of 260 ma. at 300 volts. A fixed negative bias of 150 volts is also required.

The easiest method for obtaining the bias voltage is from the bleeder which is tapped at ground thus giving the required bias voltage below ground potential. If this method is not convenient, the bias may be obtained from a battery source since the current drain is very low.

A power supply designed to meet the above requirements is shown complete in fig. 3, and should be self-explanatory. It will be noted that the recommended rectifier tube operates very near its upper limit; however for normal transmitter use, it will operate very satisfactorily.

(d) Mechanical Modifications:

The mechanical modifications primarily pertain to the added panel with its associated controls as shown in fig. 2. In order to add the necessary tuning controls, it is necessary to disconnect the tuning capacitor shafts from the ratchet tuning mechanism. It is not necessary to remove the ratchet assembly itself since the shaft extensions extend through this assembly.

The panel used is of standard relay rack dimensions and is mounted to the transmitter chassis with 3 inch brackets. It carries all of the designated controls as well as the O-1 milliammeter.

# CONVERTED BC-625 TRANSMITTER

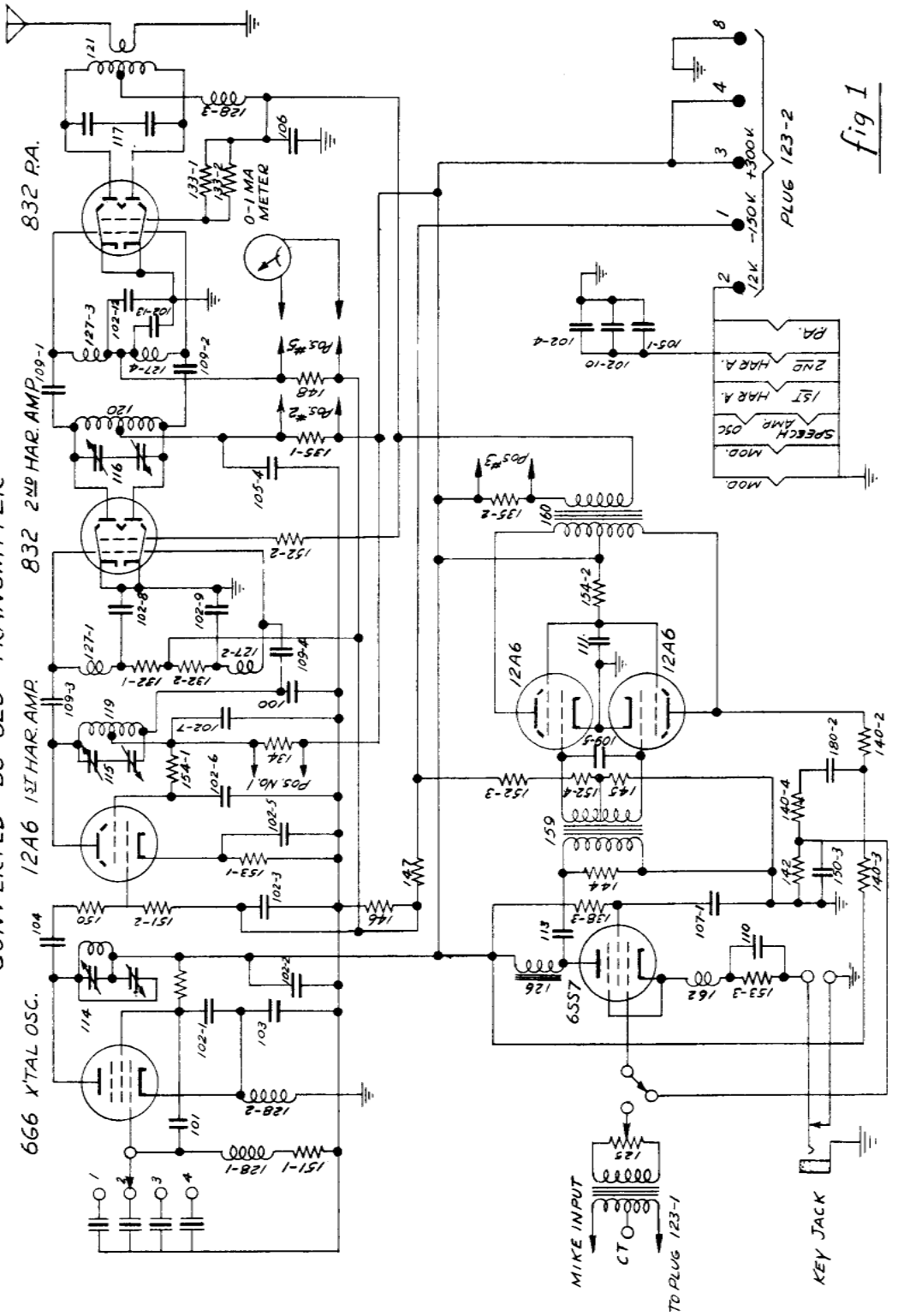
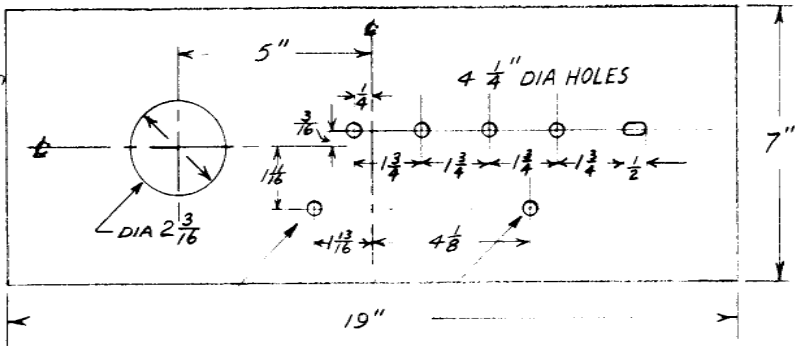


fig 1

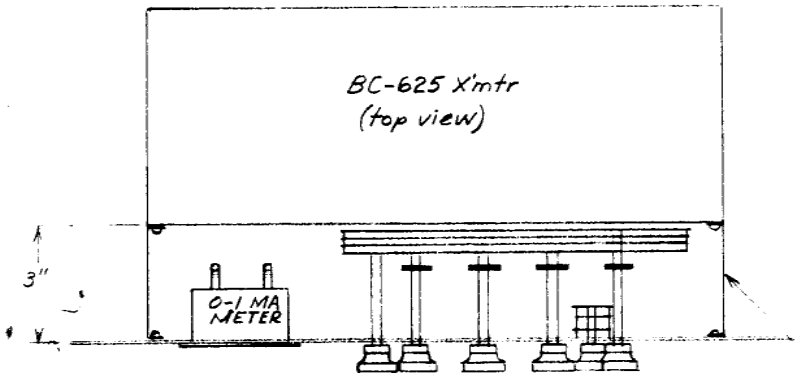
# BC-625 PANEL LAYOUT

Panel -  $\frac{3}{32}$ "  
sheet aluminum  
7-19" std  
relay rack  
dimensions



∠ Meter Sw.      — X'tal Sw.

fig 2



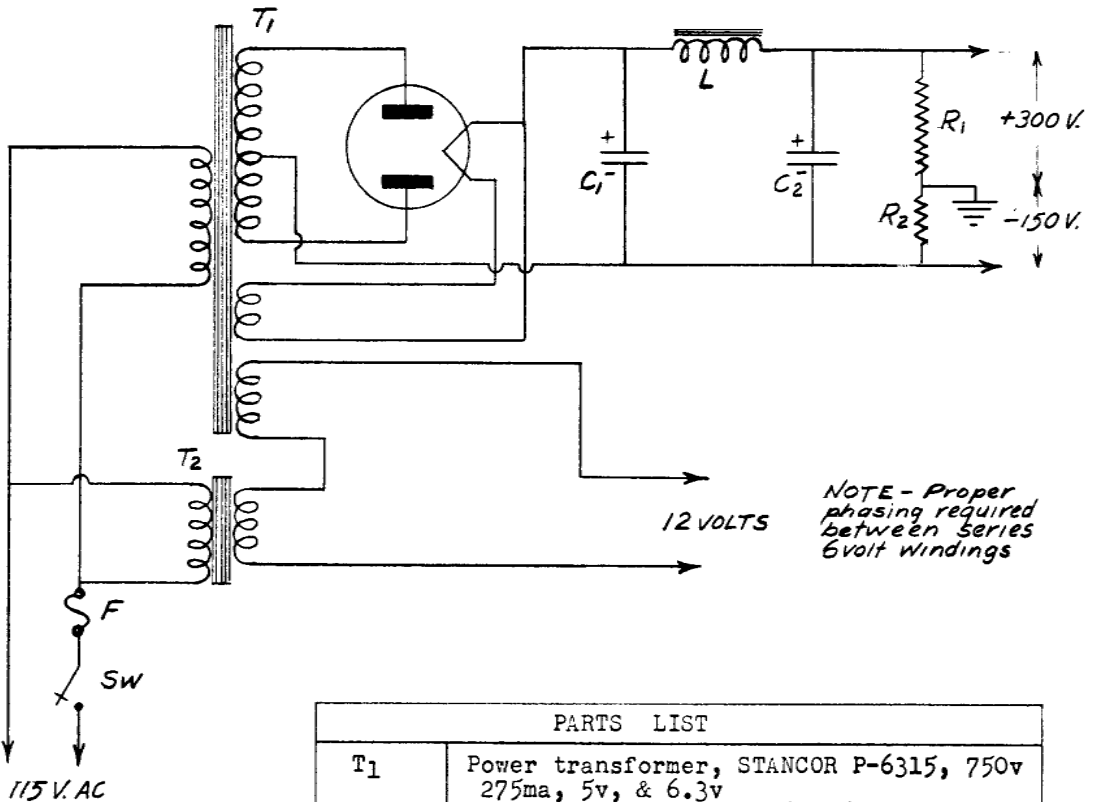
tuning shaft  
detail

8-32 thread

Mtg. brackets  
 $\frac{1}{16}$ " steel

# POWER SUPPLY FOR BC-625

fig 3



NOTE - Proper phasing required between series 6 volt windings

PARTS LIST	
T1	Power transformer, STANCOR P-6315, 750v 275ma, 5v, & 6.3v
T2	Filament transformer, 6.3v/2A
Rect.	5Z3 or 5U4
L	Filter Choke, 10 h., 250 ma.
C1	Filter Condenser, 8 mfd, 600 v.
C2	Filter Condenser, 16 mfd, 600 v.
R1	Resistor, 35,000 ohms, 10 watt.
R2	Resistor, 750 ohms, 5 watt.
F	Fuse, 2 amp.
SW	Switch, toggle

## Receiver, BC-624:

As the receiver component of the SCR-522, the BC-624 lends itself nicely to conversion for the two meter enthusiasts.

From the general description it becomes apparent that there is more required in converting the BC-624 than its companion component, the BC-625 transmitter. Even though the conversion appears difficult, it is generally considered a rather easy and interesting one to the average ham.

It will also be apparent that some of the described refinements are optional and not essential for putting the set into operation. However, in most instances, these optional features are incorporated as well as a number of the personal touches. This is not out of line in doing justice to a well designed receiver such as the BC-624 which will perform with best of them.

The following topics of conversion will be discussed in detail with references to the schematic diagrams and drawings:

- (a) General Description and Operation
- (b) The HF Oscillator Circuit
- (c) Revamping the Second Detector and Adding the Noise Limiter
- (d) The First Audio and Addition of the "S"-Meter
- (e) Adding the Second Audio, Power Amplifier Stage
- (f) Power Supply for the BC-624
- (g) Tuning Mechanism
- (h) Mechanical Modifications and Panel Layout
- (i) Performance Information

### (a) General Description and Operation

This receiver is a 10-tube superhet with an intermediate frequency of 12 Mc. In its military form it is a 4-channel receiver which has a preset tuning arrangement and a crystal-controlled high-frequency oscillator.

The three principal models of the BC-624 are the BC-624A, the BC-624AM, and the BC-624C. The "A" model is the earlier model with the "AM" being the modified "A" model. This modification was the military improvement and consisted of an additional tube (12H6) installed under the chassis which functioned as a noise limiter and delayed AVC. The latest model is the "C", which incorporates several modifications over the earlier sets. These changes consist of an added "squelch" circuit and an extra audio stage.

From the above information, it is apparent that the later models are the preferable ones since the addition of the noise limiter and AVC is an important improvement toward the receiver's operation. This modification was later made by the Army on almost all of the earlier sets.

The existing tube line-up with their respective functions are as follows:

- 9003 (VT-203) First RF Amplifier
- 9003 (VT-203) Mixer (first detector)
- 12AH7GT (VT-207) Crystal Osc. and Audio Squelch

9002	(VT-202)	Harmonic Generator
9003	(VT-203)	Harmonic Amplifier
12SG7	(VT-209)	First IF Amplifier
12SG7	(VT-209)	Second IF Amplifier
12SG7	(VT-209)	Third IF Amplifier
12C8	(VT-169)	Second Det., AVC, and First Audio
12J5	(VT-135)	Second Audio Amplifier

(b) The HF Oscillator Circuit:

The existing crystal oscillator operates on four preset crystal frequencies in the range of 8.0 to 8.7 Mc. The harmonic generator selects the desired harmonic, (11th to the 18th) while the harmonic amplifier amplifies the relatively weak harmonic frequency to usable strength for the mixer stage.

To obtain continuous coverage of the band, it is obvious that the oscillator must be changed from the crystal controlled type to the variable tuned type. This is accomplished by eliminating the existing crystal oscillator stage and converting the harmonic generator to the variable-tuned HF oscillator. This becomes an easy matter since the harmonic generator tuning capacitor, 217B now becomes the new oscillator tuning capacitor.

All four crystal circuits and the former oscillator circuit are eliminated in this change and can be removed to provide additional space. The circuit modification is self-explanatory from the before and after circuit diagrams in fig. 4\* and fig. 5 respectively.

For the required mechanical tuning arrangement of the oscillator, refer to section (g).

(c) Revamping the Second Detector and Adding the Noise Limiter:

As mentioned before, the later models of the BC-624 have the modification that incorporates the 12H6 (duo-diode) as the Second detector and the noise limiter. This stage is mounted on a bracket under the chassis. To add this modification to the earlier models, should it be necessary, it should be noted that the 12H6 replaces the original 12C8 tube. From the modified schematic diagram, one half of the 12H6 serves as the detector and also furnishes AVC voltage in the conventional manner. The other half of the duo-diode serves as the noise limiter with its respective circuit and may be manually switched in or out. This stage should be wired as per the modified circuit as shown in fig. 5.

(d) The First Audio and Addition of the "S"-Meter:

The former 12C8 tube location is used for the 12AH7, dual triode, one section of which serves as the first audio amplifier. This stage is coupled to the second detector output in the conventional manner through a .5-meg. volume control.

An optional feature which is frequently added to facilitate tuning and to estimate signal strength, is the "S"-Meter. The circuit includes a 0-1 milliamper meter which can be attractively added to the panel of the

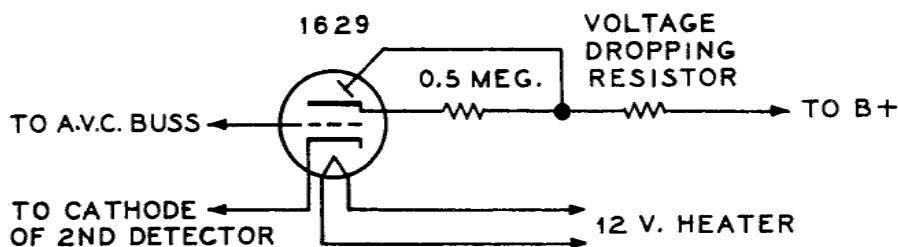
\*For Fig. 4 - see pg. 66.

receiver as shown in the panel layout. This "S"-Meter differs from the more conventional type since it utilizes the AVC voltage for its operation. The AVC voltage controls the meter bridge circuit through the triode amplifier, 12AH7 (second section). For manual adjustment of the meter deflection, a 0.25-meg. potentiometer in the 12AH7's grid circuit is used to obtain the proper amount of the AVC voltage. A switch is provided in this circuit for switching the "S"-Meter in or out as desired.

Another version of the above described "S"-Meter circuit incorporates the tuning-eye instead of the 0-1 millampere meter and the meter bridge circuit. This is primarily a tuning indicator and involves fewer parts and less expense if parts have to be purchased.

The 12-volt version of the 6E5 (magic eye tube) is the 1629 (VT-138) and is readily obtainable on the surplus market. It can be conveniently mounted at the rear of the receiver panel projecting through the panel in the approximate location shown for the meter in fig. 6.

Operation of the tuning-eye is directly controlled by the AVC voltage; however, due to the relatively low AVC voltage, the circuit shown below is recommended for optimum operation.



(e) Adding the Second Audio, Power Amplifier Stage:

In order to obtain sufficient audio volume for speaker operation, the power output stage, 12A6, is added with the conventional plate-to-voice-coil output transformer. In the later models this stage would replace the existing second audio stage, (12J5). In the earlier models this stage can be located in place of the squelch transformer 295. The "squelch" circuit is generally not considered practical and is completely removed from the receiver to make room for added modifications.

The audio power amplifier is coupled to the first audio amplifier (12AH7) in the normal R-C manner. Output transformer, 296, intended for headphone use (50, 300, and 4000 ohms) is replaced with a conventional plate-to-voice-coil output transformer. The impedance match for the 12A6 from the PM speaker voice coil should be approximately 7500 ohms.

It may be desired to add a closed circuit jack in the grid circuit of the power amplifier, 12A6, for headphone operation. Both jacks, first audio phones and second audio speaker, can be brought out to the panel of the receiver as shown in the panel layout.

(f) Power Supply for the BC-624:

The power requirements for this receiver are a plate potential of 300 volts at 60 ma., and a 12-volt heater supply at approximately 1.7 amperes. A power supply for these requirements can be conveniently constructed as shown in fig. 5. A 70-ma. power transformer is used with the 5 and 6 volt windings connected in series, and using the 6X5 (cathode type) rectifier. Polarity of the two filament windings must be observed in order to avoid phase cancellation. This can be determined by experiment so as to obtain the correct additive voltage. The conventional filter is used with a stand-by switch placed in the center tap lead for use with the transmitter.

Even though it is possible to build the power supply inside the receiver with careful layout of parts, it is considered preferable to keep it as a separate component with a connecting cable and plug to the receiver. If desired, the power supply OFF-ON switch may be located on the receiver panel with the leads brought out to the above mentioned power supply connecting plug.

(g) Tuning Mechanism:

The manual tuning capacitor controls of the converted receiver involve the two-ganged capacitor which tunes the oscillator and the harmonic amplifier, and the three-ganged, RF amplifier grid, the RF amplifier plate, and Mixer grid tuning capacitor.

The original preset ratchet selector and tuning mechanism is not particularly adaptable for ham operation and should be completely removed from the receiver chassis. This then makes available both shafts of the above mentioned tuning capacitors.

Due to the highly compressed 2-Meter band, as appearing on the capacitor shafts, it is quite necessary to use considerable mechanical reduction for manual tuning. This is particularly true for the oscillator tuning, since the band appears in a very narrow sector of its 90 degree rotation.

For the three-ganged capacitor, the National velvet vernier dial, such as found in the surplus BC-375 tuning units, is quite satisfactory. This type of dial is quite compact and easy to use, being well appearing on the receiver panel.

Due to the very narrow section in the oscillator tuning, it is apparent that even the National vernier dial is not sufficient reduction to afford practical tuning or dial calibration. For this problem there has appeared a variety of tuning arrangements that include both the electrical band spread method as well as the various mechanical methods.

The electrical method is probably the most desirable but does involve considerable effort for installation. This is generally accomplished by using a separate two-ganged condenser having only two or three plates per section, and connecting it in parallel with the existing condenser.

Of the different mechanical reduction arrangements, this one as described below, is probably the most straight forward and fool-proof. It consists of the national, type "A", vernier dial used in conjunction with a belt (dial cord) driven reduction. The dial cord and pulley arrangement is

supported between a frame-work consisting of two metal plates. This assembly is mounted directly on the receiver chassis, positioned to couple the drum to the oscillator capacitor shaft and to locate the tuning knob in a symmetrical position on the panel. The drawing in fig. 2 shows this assembly in detail.

The described tuning assembly gives very satisfactory and smooth tuning reduction. This reduction will be such that the 144-Mc. band will be approximately 50 divisions on the 100 division vernier dial. Parts for the dial cord and pulley arrangement are easily made or readily available.

(h) Mechanical Modifications and Panel Layout:

After the removal of the slider-ratchet tuning mechanism from the front of the receiver, brackets are made to support the panel approximately 3 inches from the front of the receiver. The 3-inch space between the panel and chassis is ample for the tuning reduction assembly and all of the other controls.

If all the modifications listed herein are contemplated, the front panel will carry the two National dials, the "S"-Meter or tuning indicator, volume control, AVC switch, send-receive switch, "S"-Meter" switch (if used) noise limiter switch, and the power OFF-ON switch.

(i) Performance Information:

As was originally true in the military version of the BC-624, the converted receiver should have a signal sensitivity of approximately 3 microvolts for an audio signal to noise ratio of 10 db.

The receiver input is designed to operate from a 50-ohm antenna circuit. Should higher impedance lines be used, it will be necessary to increase the number of turns on the antenna coupling coil. The increase of turns is small, being approximately 2-1/2 turns (total) required for a 600-ohm line.

Should a balanced antenna input be desired, the grounded side of the coupling coil should be lifted.

It will be found that the modified high-frequency oscillator can be tuned either 12 Mc above or below the incoming signal. After becoming experienced with the tuning characteristics of the receiver, the operator should be able to use the preferable frequency (above or below) without difficulty.

An interesting note in connection with the exceptional oscillator tuning range is, that by squeezing the RF and mixer coils slightly, the receiver will tune down to the 88-108 Mc. FM band. By utilizing the above and below tuning of the oscillator, as mentioned above, the FM band can be covered without sacrificing any of the 144-Mc. band, thus a total coverage from 88 to 148 Mc. Since the IF band pass is approximately 150kc., it can be made to operate nicely on FM by incorporating a limiter and discriminator circuit.

From the above information, the 2-meter enthusiast should be able to have, at a very nominal cost, a smooth operating and attractive receiver. The performance of this unit will be found to compare favorably with the best receivers of this type.

BC-624 (converted)

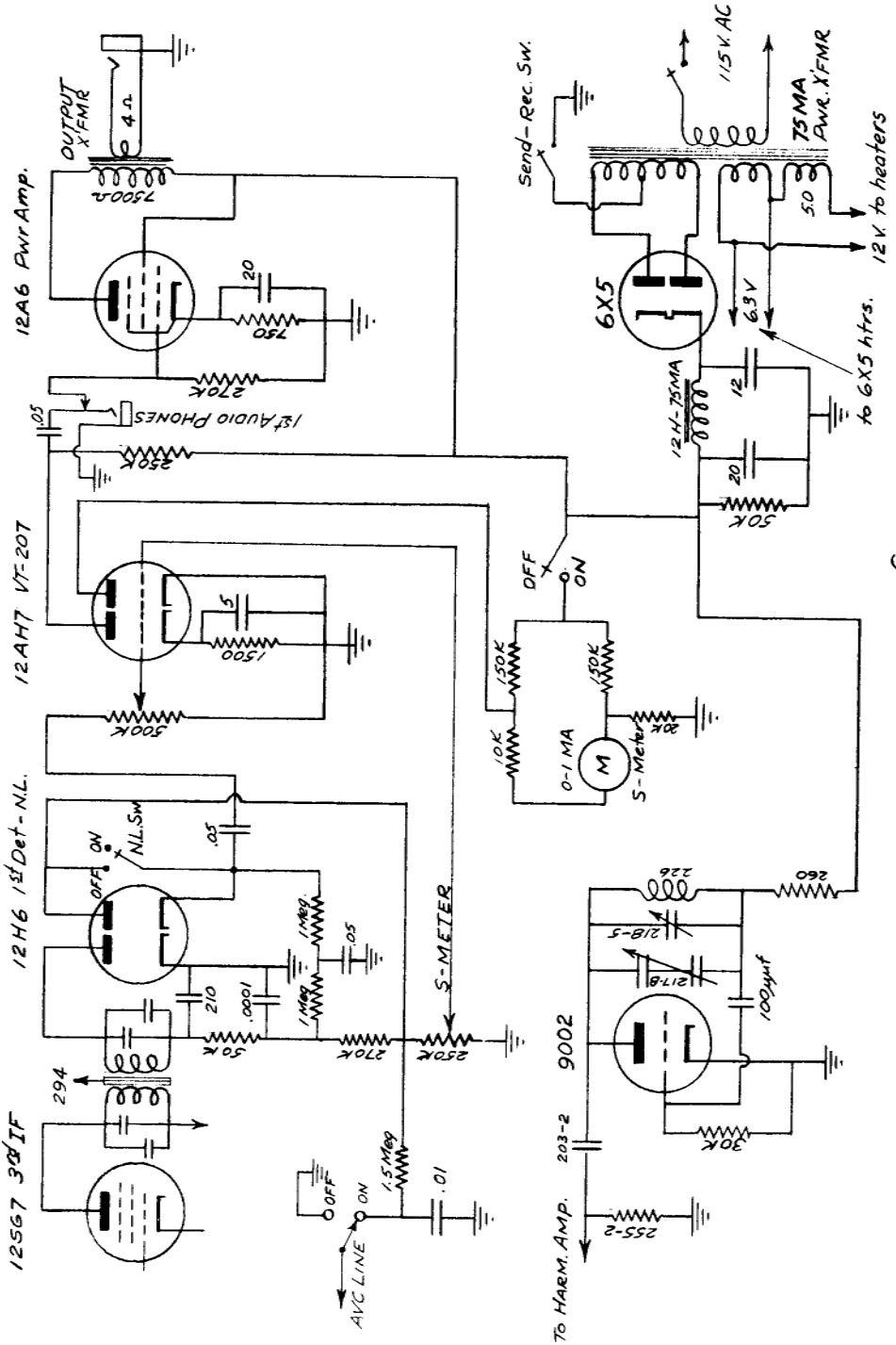


fig 5

# PANEL & MECHANICAL LAYOUT FOR BC-624

"5" METER OR TUNING-EYE, SEE TEXT

PANEL  $\frac{3}{32}$ " ALUM.  
STD RELAY RACK  
DIMENSIONS

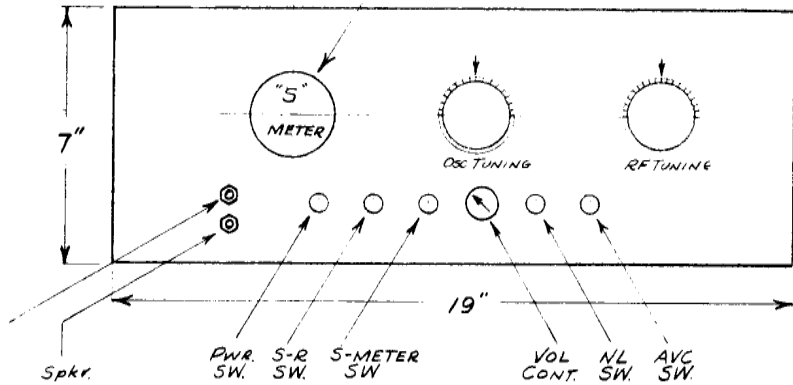
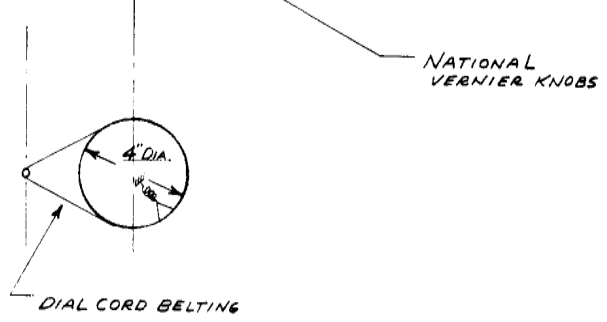
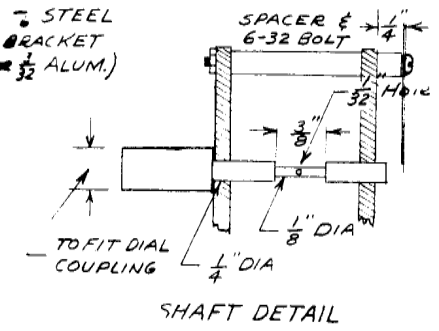
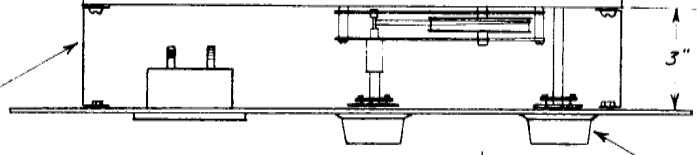
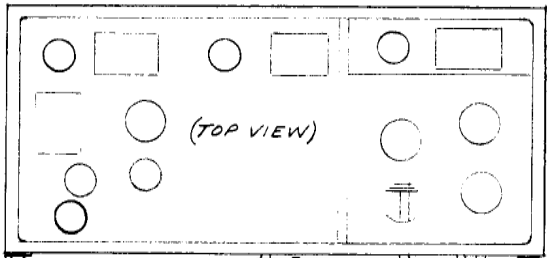
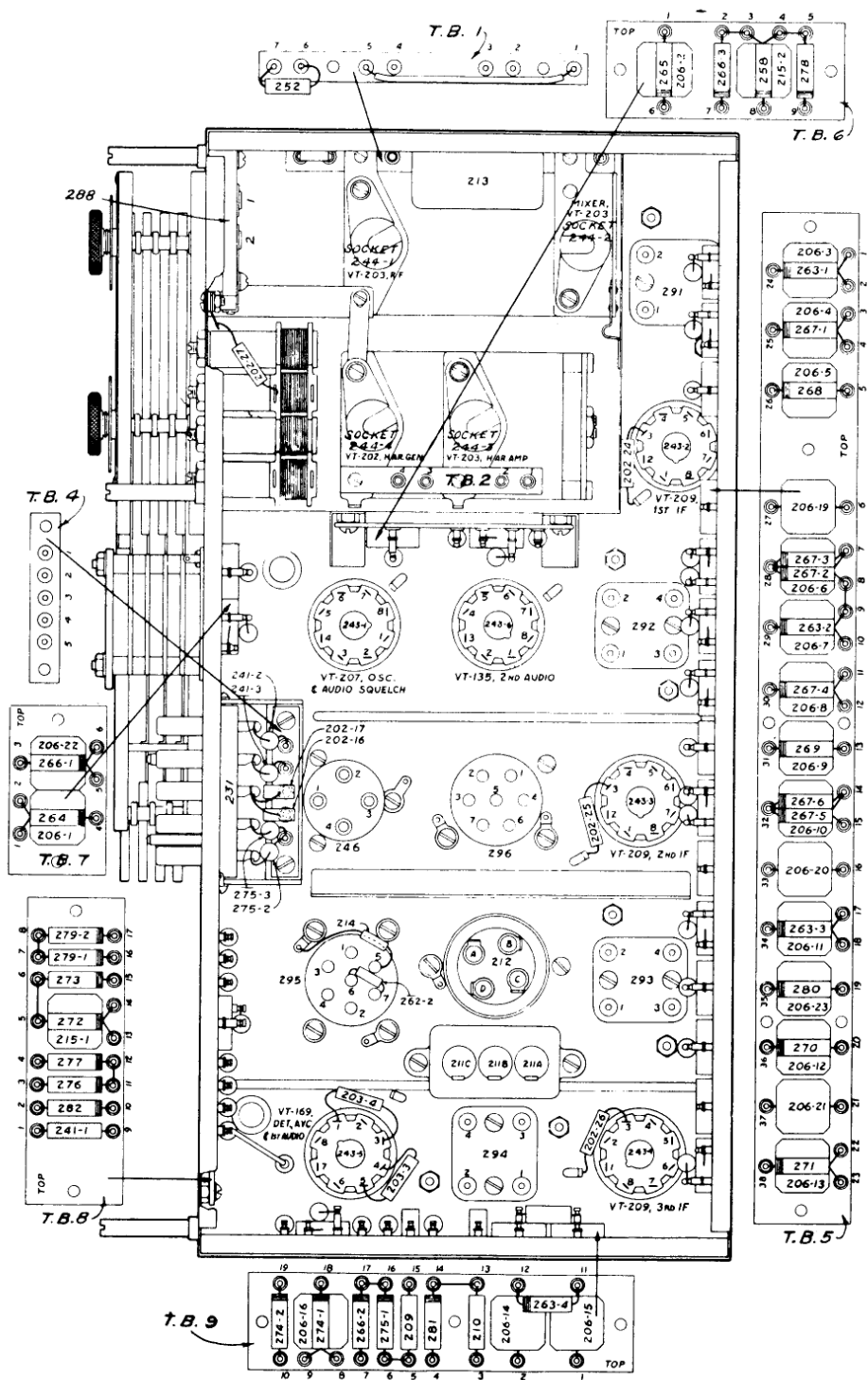
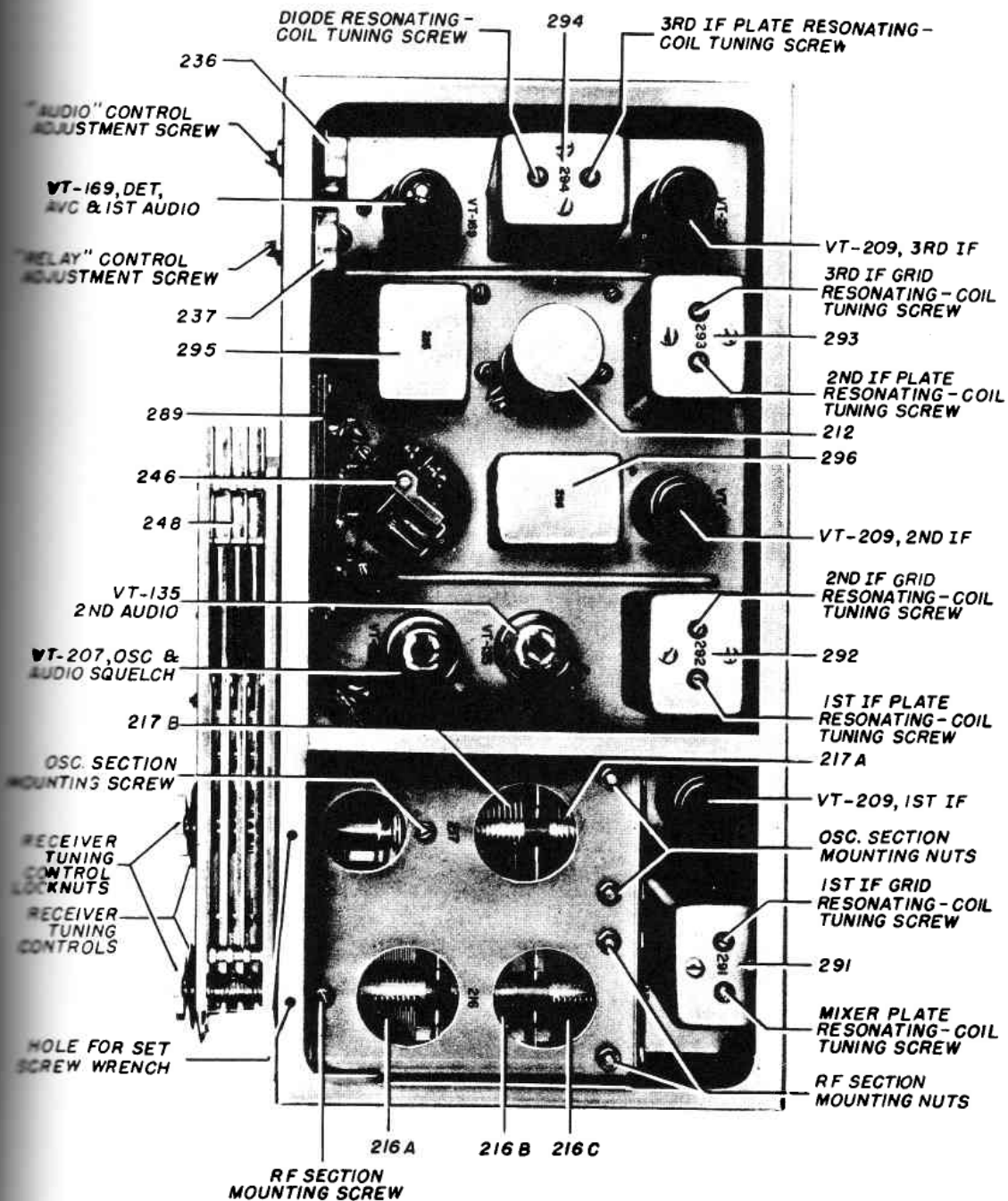


fig 6





RECEIVER CONTINUITY TEST DIAGRAM



RADIO RECEIVER BC-624-A, REAR VIEW

# CONVERTING THE TBY TRANSCEIVER FOR CRYSTAL CONTROLLED OPERATION ON THE 10 AND 6 METER AMATEUR BANDS

## Introduction:

The model TBY transmitter receiver was designed for the US Navy's landing operations. It is an ultra-portable unit, weighing less than 50 pounds complete and comes equipped with a canvas carrying case that may be strapped to the back if desired.

The unit is excellent for mobile or portable operation and has a nominal power output of 1/2 watt.

The frequency range is from 28 to 80 Mc. and, as originally used, was continuously variable over this range. However, the frequency stability, along with the fact that the tuning dials are not calibrated directly in frequency, makes it necessary to convert the unit to a crystal-controlled circuit.

The unit was built to operate from either a special battery pack or a combination vibrator-storage battery pack which clips onto the bottom of the Transmitter/Receiver unit. The special pack of batteries is not available (at least not with fresh batteries) leaving the vibrator pack for practical use. This supply consists of a 4-volt leak proof storage battery and a vibrator unit supplying 2.35, 3.3, 4.2, 8.6, and 158 volts. The storage battery will last about 15 hours and can be recharged from any standard 6 volt charger or from a car battery.

Upon purchase of the unit, the following accessories should be obtained:

1. Combination vibrator-storage battery pack
2. Whip Antenna (9 ft)
3. Mike and Phones plus cables

The original tube line up is as follows:

Transmitter	(2) 958A's	--	PP self excited oscillator
	(1) 30	--	Tone generator
	(1) 1E7	--	PP modulators
Receiver	(1) 959	--	RF stage
	(1) 958A	--	Super Regenerative Detector
	(1) 30	--	1st audio (Same tube acts as tone generator in xmtr.)
	(1) 1E7	--	PP audio (Same tube acts as modulator in xmtr.)

Crystal Calibrator (1) 30

Spare tubes usually come with the set, and a complete set of accessories will come in handy if available.

Conversion Procedure: