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SURPLUS RADIO

CONVERSION MANUAL

VOLUME I

Third Edition

by

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CONVERTING THE BC-348 RECEIVER

Introduction:

The BC-348 series of receivers was manufactured for the Armed Forces and was designed to operate from a 28-volt d-c supply. As these sets were used in aircraft, they are extremely compact and much smaller than their equivalent in present commercial cummunications receivers. The following conversion data will cover the changes necessary to adapt the unit to 115-volt a-c operation. Various circuit improvements will also be elaborated on as applicable to amateur radio use.

Many models of the BC-348 were built but, with the exception of the BC-348J, Q and N, they are electrically and mechanically similar. It is of special note that the B minus of the 348Q is not grounded. The BC-224 series is identical except for the heater circuits.

The receiver covers the frequency range of 1500 to 18,000 kc. and 200 to 500 kc. by means of a directly-calibrated vernier dial. It will be noted that the 10-meter amateur band as well as the standard broadcast band is neatly skipped. Converters will be necessary if these bands are desired.

The receiver has two r-f stages and three i-f stages. The intermediate frequency is 915 kc. A crystal filter is included in the circuit also.

The tube line up is as follows:

1st RF	6K7
2nd RF	6K7
RF Osc.	6C5
1st Det.	6J7
1st IF	6K7
2nd IF and CW Osc.	6F7
3rd IF and 2nd Det.	6B8
Audio	41

It is assumed that the reader would not attempt this conversion without enough technical knowledge to make unnecessary the tedious "wire by wire" descriptions generally encountered and, with the suggestions and conversions given here, satisfactory results should be easily obtained. It is important to bear in mind that, due to the numerous models, and circuit differences, common sense will be required in many of the operations as exact component symbols and wire movements have been eliminated in this article.

The following sections of the conversion procedure will be covered in detail:

(a) Power supply
(b) Filament circuit
(c) Speaker matching
(d) Operation
(e) Additional audio stage
(f) Noise silencer
(g) General notes

(a) Power Supply:

As the receiver was designed for operation from a 28-volt d-c source, it will be necessary to build a 115-volt a-c supply.

Since an external speaker and matching transformer will be required, and in order to keep heat out of the receiver compartment, it is advised that the power supply be built into the speaker cabinet along with the speaker matching transformer, and connections be brought out through a cable and plug system.

It should be possible to obtain, on the surplus market, the plug for power connections that was intended for use with the receiver. But if not, the present socket can be replaced with a standard octal tube socket by removing the present socket and filing the retaining bracket to take the octal tube socket.

The circuit shown in Fig. 1 will work nicely and, by referring to the plug connections given at the end of this article, the connecting cable can be made up.

(b) Filaments:

For 6.3-volt a-c operation, it will be necessary to rewire all tube filaments in parallel and to remove the balancing resistor which was used in the d-c system. Fortunately, all tubes are of the 6.3-volt type and no substitutions are required. The fixed and variable dimming controls associated with the pilot lamp circuit should be removed as this feature is not essential.

Fig. 2 is self-explanatory for the filament conversion, and careful examination will show the few actual wire changes necessary. The 6.3-volt lead should be brought out to pin 3 or pin 4 of the power plug. (These two terminals originally were the 28-volt input connections.)

(c) Speaker Matching:

The output of the receiver was originally designed for headphone operation and consisted of two output connections, for 500 ohms or 4500 ohms, depending upon the tap used on the output transformer. As most permanent magnet dynamic speakers are around 8 ohms, a matching transformer will be required to match one of the original outputs to the speaker. This transformer can be mounted in the speaker cabinet as discussed in the paragraph dealing with the power supply. An alternative is the replacement of the original output transformer with one designed to match the output tube to a PM dynamic speaker. However, the former is to be preferred as it does not necessitate circuit changes.

(d) Operation:

After completion of the previous steps, the receiver will function by merely applying power and connecting together terminals 2 and 6 of the output plug. Terminal 2 is the B plus connection and 6 is the screen-grid lead to the i-f's. These two terminals provide a very simple method of

adding an "S" meter to the set. Examination of Fig. 3 will show that this circuit can be inserted between terminals 2 and 6 with no other circuit changes being required. The meter can be mounted in the upper right hand corner of the front panel, providing a very small one is used. The adjustable pot should be of the screwdriver adjusting type and also mounted on the front panel for zero setting the "S" meter. Calibration of the meter in "S" units or in "DB's" will be necessary. This addition is not necessary for operation but will add considerably to the versatility of the receiver for amateur use.

(e) Additional Audio Stage:

The audio gain of the receiver is not quite adequate, and an additional stage is required for satisfactory results. Fig. 4 is a proven circuit consisting of a 6J5 tube in a simple resistance coupled stage to be inserted directly ahead of the 41 power amplifier. With this additional stage the gain will be sufficient.

It is suggested that this added stage be built onto the small removable chassis upon which the dynamotor was originally mounted. The terminal strip on the chassis can be used to bring out all necessary connections and will make a neat and compact unit.

(f) Noise Silencer:

On the higher frequency band of the receiver, and especially if higher frequency converters are to be used, the noise problem becomes one of importance. A shunt-type noise silencer circuit employing a small 1N34 crystal is shown in Fig. 3A. This circuit can be added easily to the receiver schematic. Addition of any noise silencer circuit will normally cause some distortion in the output and therefore should be used only when ignition noise, fluorescent lighting, etc. gives trouble. If properly connected, the silencer should have very little effect on the receiver gain when connected in the circuit and no effect when out of the circuit.

Difficulty may be encountered in using the added audio stage in conjunction with the noise silencer due to the common cathode resistor on the second detector and third i-f stages. This may be remedied by removing the wire between the two cathodes and shorting out "R105".

Note: In 348E, M and P this is not possible as the two stages are in the same tube.

(g) General Notes:

If desired, the audio and RF gain controls, which are originally on a common shaft, may be separated, especially for CW use. This will necessitate disconnecting one of the controls and running the leads to an added control of the same value but mounted elsewhere on the front panel.

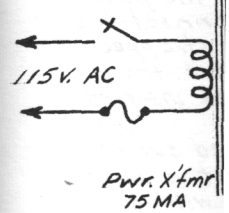
The antenna and ground connections may be extended to the rear of the set and terminals added for convenience.

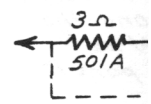
The AVC-OFF-MVC switch has several contacts which were originally used in the 28-volt d-c circuit and which are now useless. These

contacts may be used as a standby switch breaking the B minus lead when the switch is in the OFF position and applying it again when in AVC or MVC positions. Careful circuit tracing will be necessary here in order not to disconnect the wrong wires on the switch. An alternative is the use of a simple SPST toggle switch mounted on the front panel and wired in accordance with Fig. 1.

Connections to the output plug (original) are as follows:

1- Output (phones or speaker)
2- B plus
3- 28 volts plus
4- 28 volts plus
5- Output
6- Screen grid voltage to IF
7- Ground (B minus, filament common)





BC-348 Power Supply & Filament Circuit

fig 1

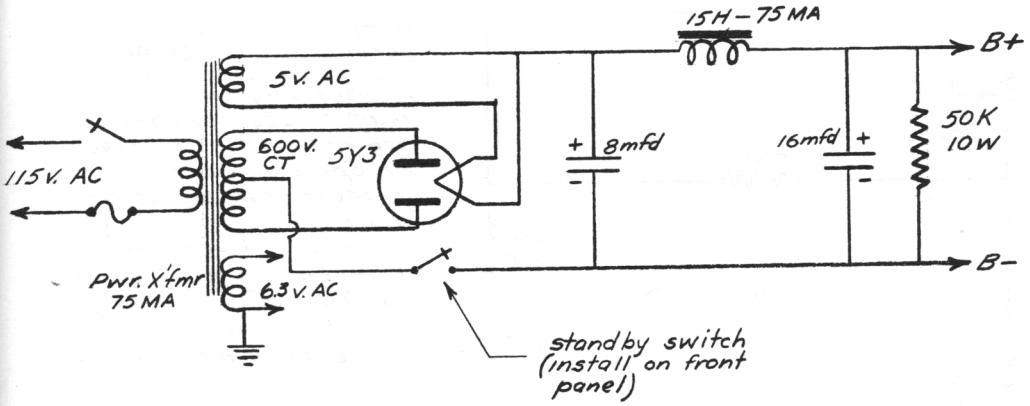
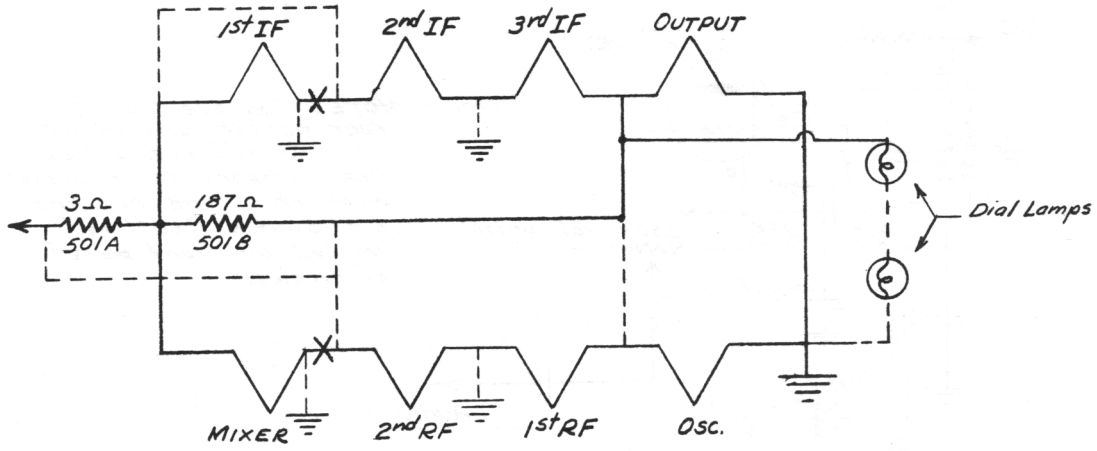


fig 2



Solid lines — Original Circuit
Dotted lines — Added Circuit (modification)
X — Places to break original circuit
NOTE: Osc. can need not be opened.

S-METER CIRCUIT

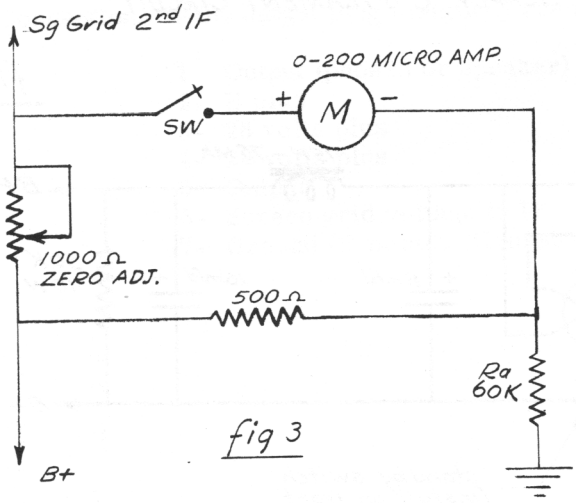


fig 3

NOTE: B+ connection & screen lead to IF Amp are terminals 2 & 6 respectively on the power plug. These connections are normally strapped for operation but the S-Meter can be inserted instead.

For desired swing of meter adjust value of Ra. This value will vary with the sensitivity of the meter movement used.

SERIES TYPE NOISE SILENCER

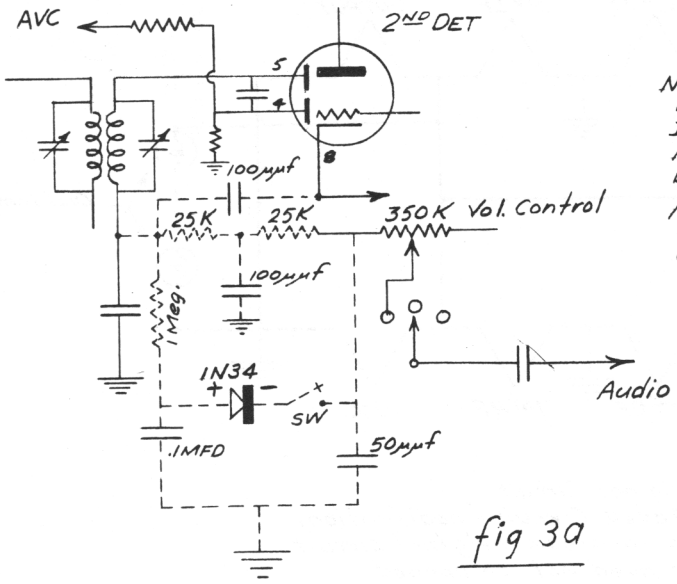


fig 3a

NOTE: Remove lead from rear pot (the one to 4th IF) and add the dotted line components in series with this lead and the pot. Switch should be located on front panel of receiver

ADDED AUDIO STAGE FOR BC-348

ADDED AUDIO STAGE FOR BC-348

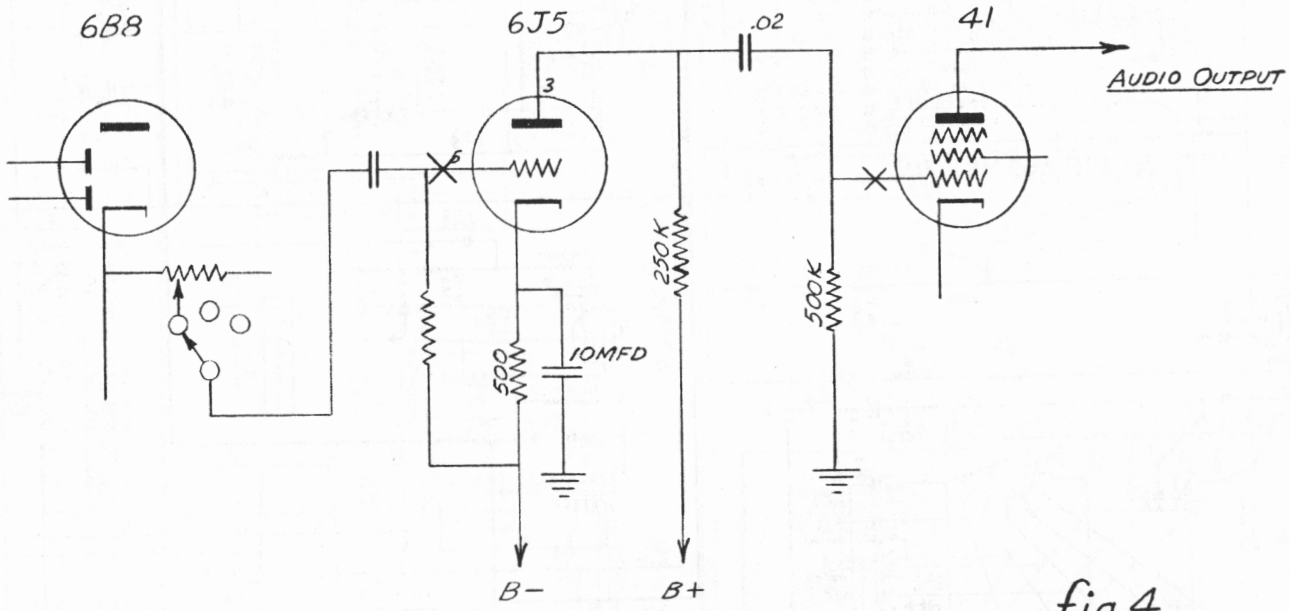
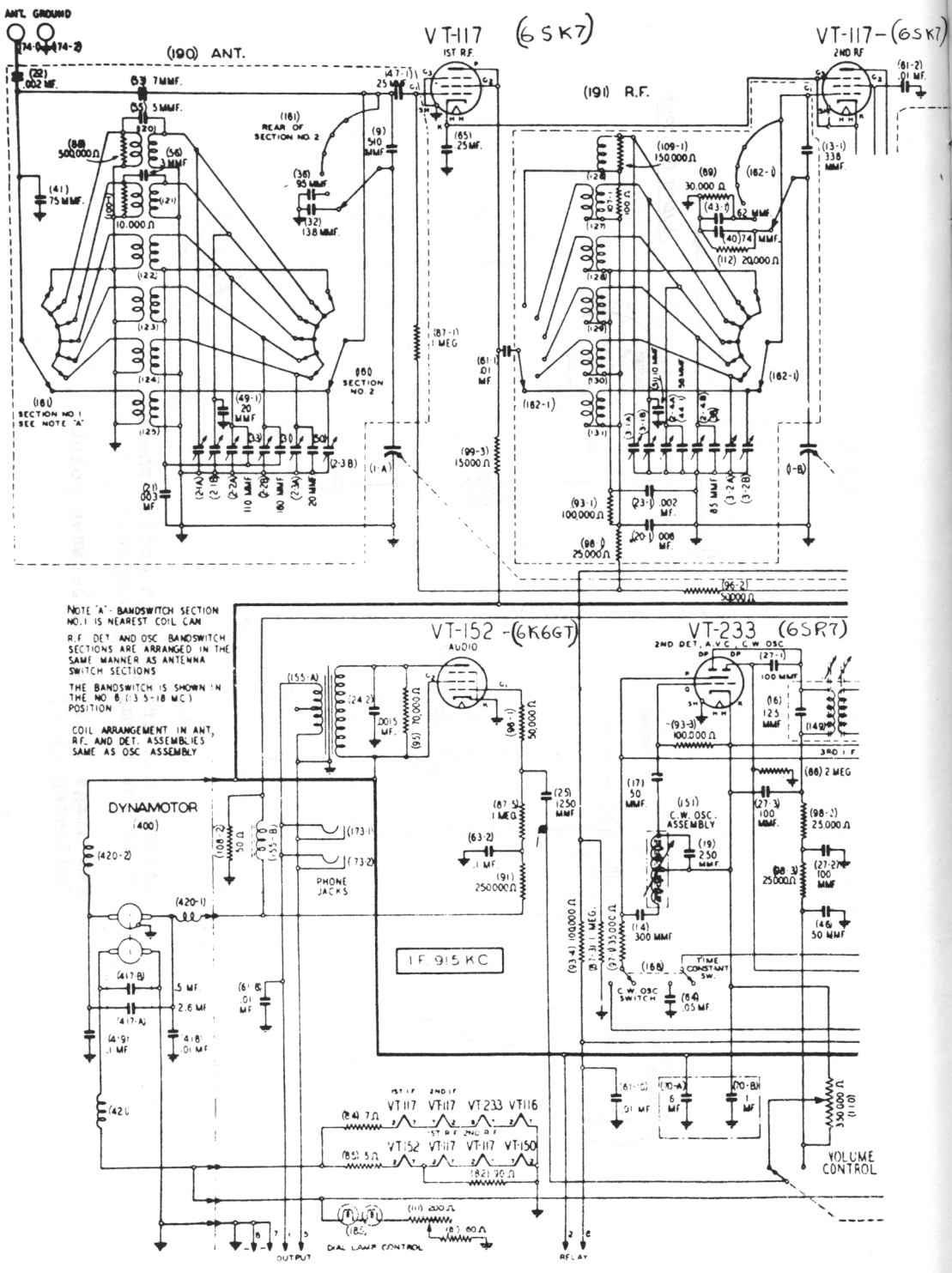


fig 4

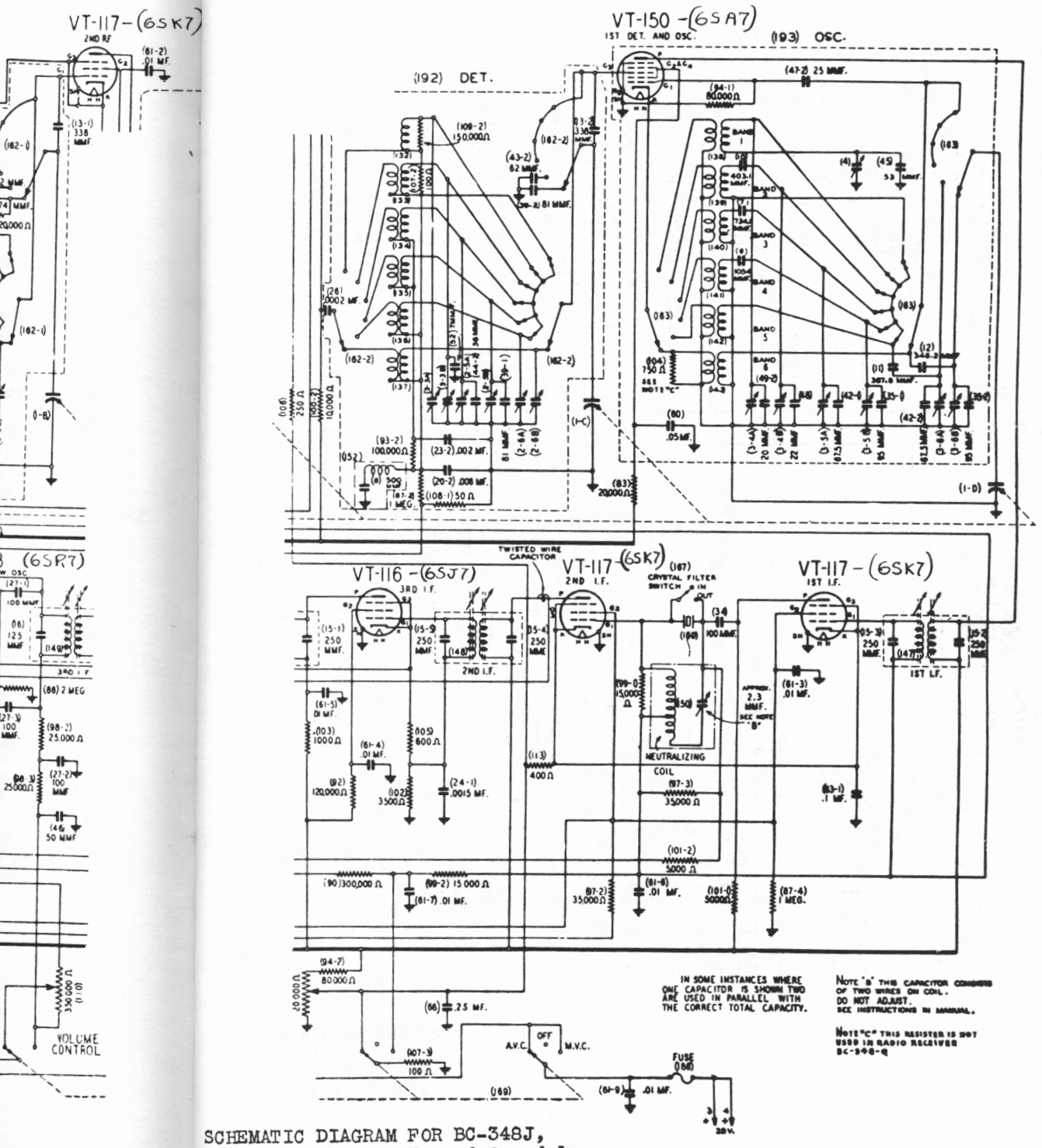
NOTES:

Cathode not grounded in models where B- is not normally grounded.

New stage is inserted between points indicated by X's

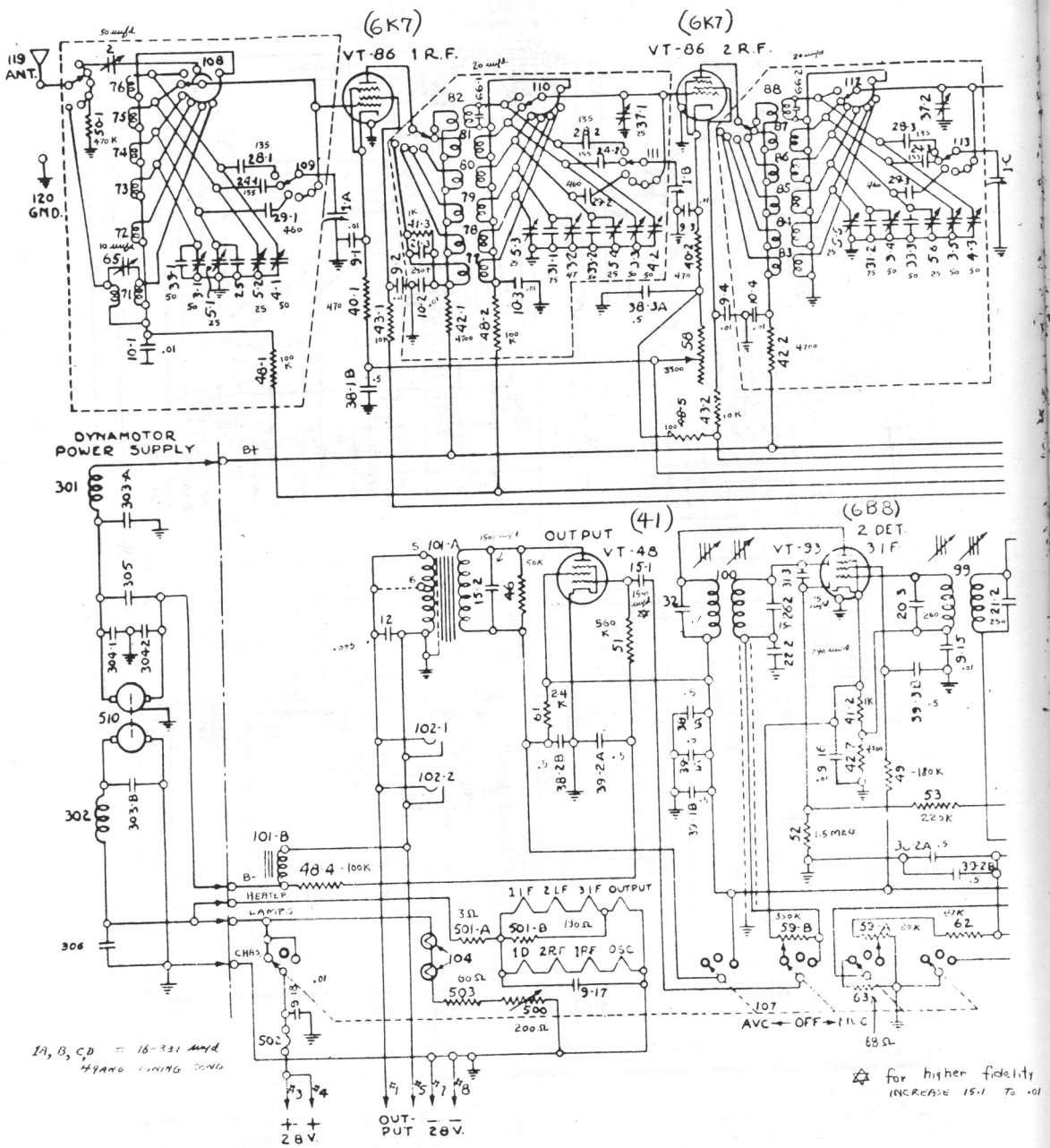


SCHEMATIC DIAGRAM FOR BC-348J, and will apply to N, and Q models.



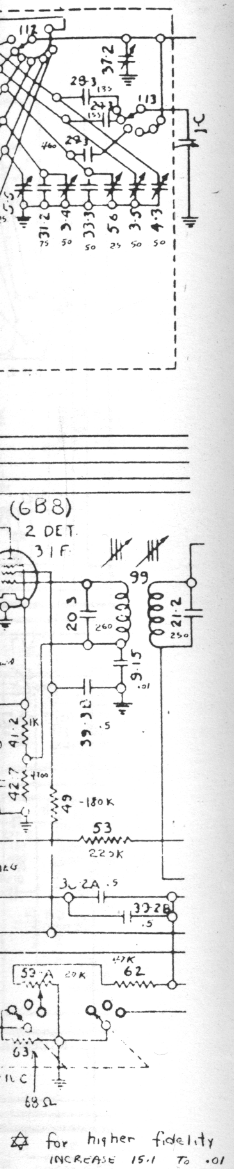
SCHEMATIC DIAGRAM FOR BC-348J,
and will apply to N, and Q models.

OR BC-348J,
, and Q models.

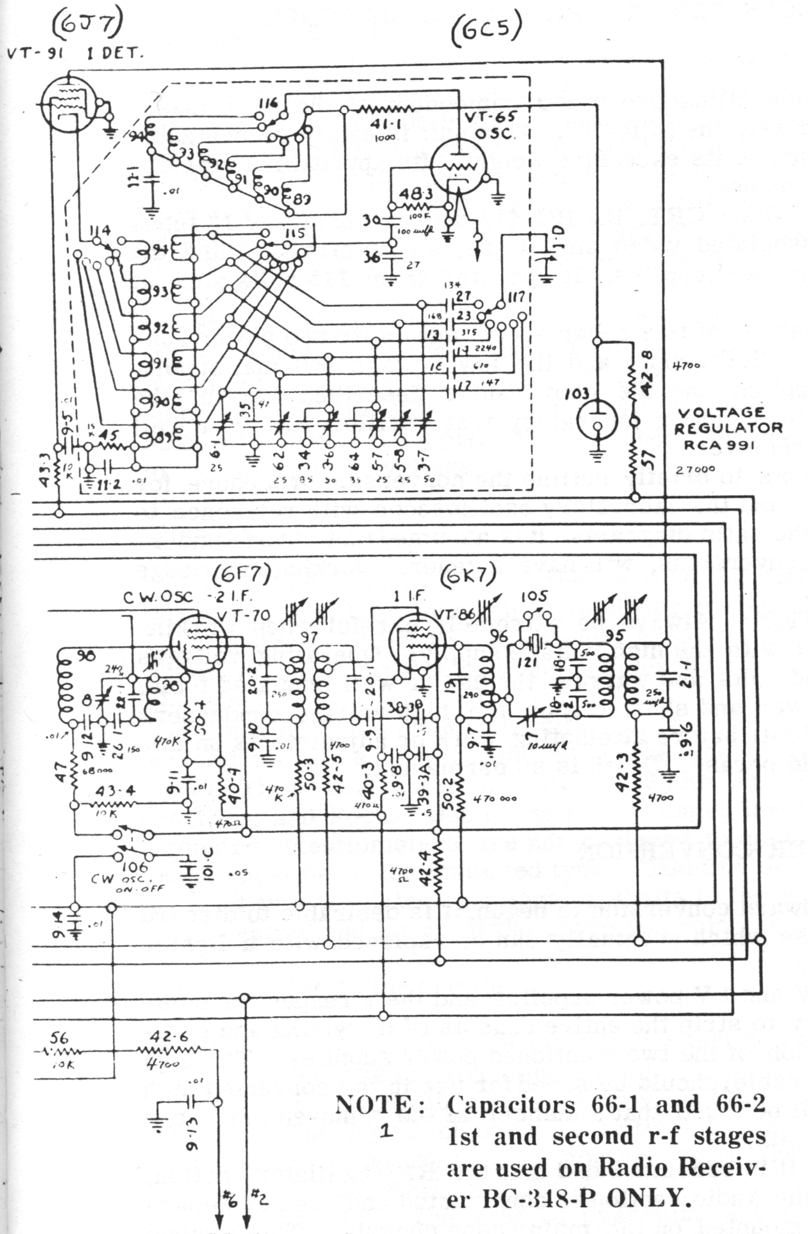


SCHEMATIC DIAGRAM
FOR BC-348E,M,P,
(and will apply to,
C,K,L,R,H,).

SCHEMAT
FOR BC-
(and w
C,K,L,



ATIC DIAGRAM
C-348E,M,P,
will apply to,
,R,H,).



NOTE: 1 Capacitors 66-1 and 66-2 1st and second r-f stages are used on Radio Receiver BC-348-P ONLY.

NOTE 2 These contacts are normally shorted for recieve operation. They should be opened for Transmit.

SCHEMATIC DIAGRAM
FOR BC-348E,M,P,
(and will apply to,
C,K,L,R,H,).

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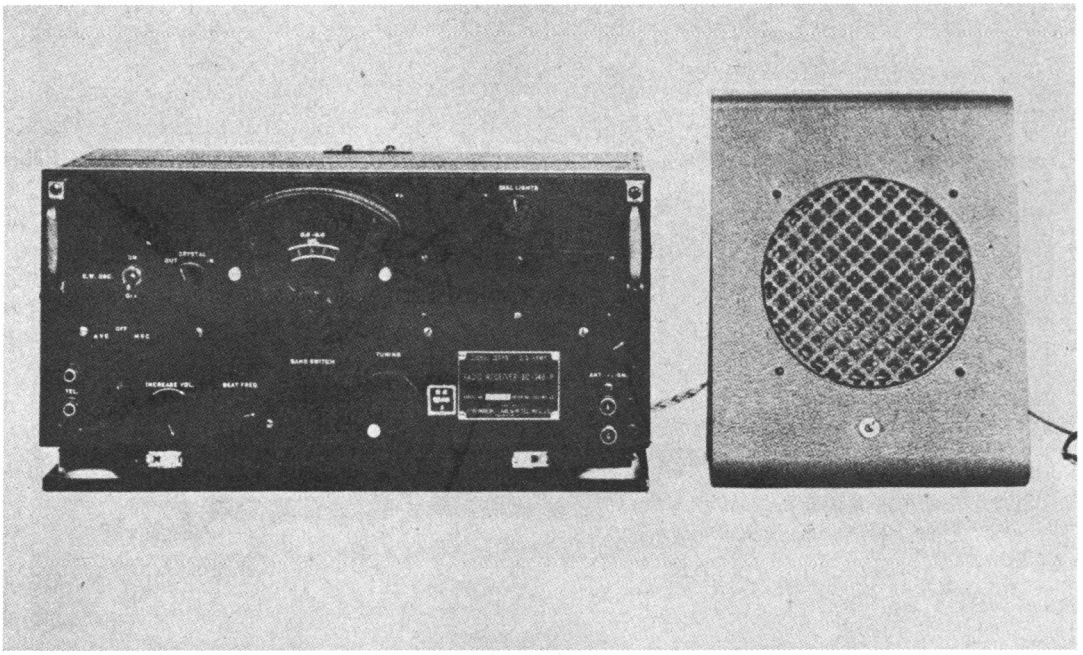

Figure 81.
BC-348P RECEIVER, SPEAKER AND POWER SUPPLY
The power supply is mounted in the speaker housing.

Noise Silencer The noise silencer shown in Figure 80 has been found to be very effective on the 14-Mc. band, and on the 28-Mc. and 50-Mc. bands when a converter is used ahead of the receiver. One half of a 7A6 tube has been used, and since this tube draws only 150 ma. of heater current the heater may be fed with a balance to ground by means of two 22-ohm 2-watt carbon resistors from the 12.6-volt heater line. Or, if desired, the heater may be placed in parallel with the 6V6-GT heater as discussed in the previous paragraph. One half of a 6H6 or 6AL5 tube could also be used for the noise limiter, but these latter tubes require 300 ma. of heater current. It is possible that a 12H6 could also have been used, but one has not been tried. Make sure that the return for the noise limiter (the bottom end of C_1, R_5 and R_4) is made to the *cathode* of the 6B8 and not to ground—if the return is made to ground proper noise-limiting action will not be obtained. A switch S_1 has been provided to take the noise silencer out of the circuit, since the circuit does introduce a detectable amount of distortion on a short-wave broadcast program.

Gain Control Changes It is a convenience in a communications receiver to have a separate control for audio and r.f. gain. To accomplish this in the series of receivers under discussion it is suggested that the dual control at the top of the panel be replaced by a single ½-megohm audio-taper potentionmeter. C_{81} and R_{32} are removed, and the low-potential end of the audio gain control is returned to ground. The r.f. gain control leads can be pulled down to the underside of the chassis and connected to a separate 15,000-ohm r.f. gain taper rheostat which can be placed either in the position formerly occupied by the MIKE jack or just to the right of the SEND-RECEIVE switch. The a.v.c. position of the switch will still short out the r.f. gain control in the conventional manner.

Control Circuits In the case of the BC-312 receiver as shown the 9-terminal power-connection strip was removed and the somewhat unsightly multi-connection receptacle on the front panel was removed and replaced by the "i.f. output" coaxial receptacle. Power and control connections were brought out to a 12-contact Jones P-312-RP connector which was mounted by means of a bracket to the rear of the chassis. The receptacle was aligned with the hole which already exists on the rear of the cabinet housing. The connector on the end of the power cable is a Jones S-312-FHT. The key, shorting relay, and switch inside the receiver were then rewired to connections on the connector on the rear of the cabinet as shown on Figure 80. The switch is connected so that it is in series with the center tap of the power transformer. Since a 12-volt keying relay is used on the transmitter, the antenna-shorting relay inside the receiver was wired so that it closed every time the transmitter keying relay closed.

In modifying the BC-342 series of receivers the external control circuit connections for the transmitter can be brought out of the front panel by replacing the connector which is installed on the front panel by an Amphenol MIP-8 octal socket, which fits the same mounting holes.

Hints on the BC-348 Series Receivers

The BC-348 series of receivers are quite satisfactory for communications use in the amateur station, but as in the case of the BC-312/BC-342 series, there

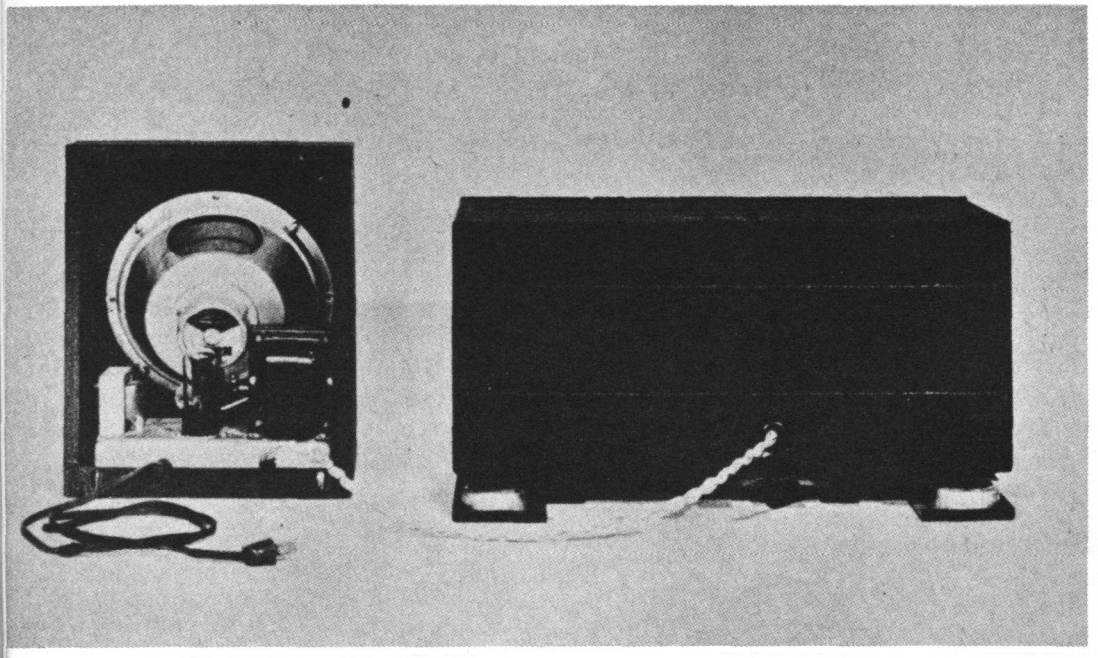

Figure 82.
REAR VIEW OF THE BC-348P ASSEMBLY.
Showing the power supply mounted in the speaker housing and the octal power plug on the receiver.

are several minor modifications which may be made to improve the performance and flexibility of the equipments.

BC-348Q General Information The BC-348 series of receivers may be operated with the heater circuits unchanged from a 26-volt a.c. supply. But a power transformer with such a filament winding is not readily available (although the C-228 transformer mentioned in connection with the BC-312 may be used with the filament windings in series) so it is in most cases best to rewire the heaters for operation from 6.3 volts. This means that one side of the heater of each tube should be grounded and the other side should be brought out as a common for feeding from the 6.3-volt line. In many cases the original "seriesing" wires between tube sockets may be used either for the grounded side or the hot side of the heater circuit, requiring addition of fewer wires and a solution to the problem of working in cramped spaces.

The a.c. power supply for the receiver may be mounted in the space formerly occupied by the dynamotor if space considerations and portability are very important. However, this procedure is not desirable from the standpoint of ventilation since an a.c. power supply dissipates a great deal more heat than the dynamotor originally installed. The space is more useful for additions to the receiver such as a noise limiter, an extra audio stage, or a broad-band converter.

The external a.c. operated power supply may be made somewhat oversize for operation of a frequency meter or a converter or an additional station accessory. In this event it is desirable to be able to ground the negative lead of the plate supply, which is not done on the BC-348Q. It is necessary to change the bias circuits of the 6K6-GT audio stage and the 6SA7 converter to accomplish this. The first step is to ground the B minus and remove connections to choke 155-B and resistor 108-2. This leaves both the above stages unbiased. A 470-ohm 2-watt resistor should be placed in series with the cathode terminal of the 6K6-GT audio stage. A 25-volt 25-μfd. electrolytic capacitor should be placed across this cathode resistor.

About 1.8 volts of bias is used on the grid of the 6SA7 converter stage. To obtain this, resistor 108-1 in the oscillator can should be clipped out of the receiver. The contact at the junction of this resistor and resistor 87-2 is available as a projecting lug. Upon this lug may be mounted a standard miniature bias cell with the positive side grounded and the negative side to the lug.

Audio Considerations in the BC-348Q Addition of a noise-limiter (see *Radio Handbook*) will improve operation in the presence of ignition interference on the 14-Mc. band and is almost a necessity for use of the receiver with a converter on the 28-Mc. or 50-Mc. bands. The addition of an extra stage of audio is also desirable, especially for use with the crystal filter on 14-Mc. c.w. The added tube may be a 6SF5 triode with conventional circuit values (see any standard reference), or a 6SJ7 stage with feedback may be added.

Difficulty may be encountered with the audio system of the receiver after the addition of the audio stage and the noise limiter due to the common cathode resistor on the second detector and the third i.f. stage. This trouble may be avoided by isolating these two cathode circuits. The lead between the two cathodes is removed and resistor 105 is either removed or short-

ed. This leaves the third i.f. stage with resistor 102 and capacitor 61-4 in its cathode circuit to ground. The cathode of the second-detector tube is now grounded to the chassis. The large capacitor can 70-A and 70-B may now be removed to make additional room inside the equipment. The 6-μfd. section is ideal as a portion of the filter capacitance in the external power supply. The lead at the low-potential side of the third i.f. transformer should be opened and the noise limiter inserted at this point. Capacitor 27-3 should be left to by-pass the secondary of the transformer. The on-off switch for the noise silencer may be placed in a panel position in place of one of the headphone jacks.

Mechanical Considerations If a plug to fit the rear connector block cannot be secured, an octal socket may be fitted into the set by liberal use of a round file and then by drilling and tapping mounting holes for the socket. If the cast aluminum guide box is removed from the case it will not be necessary to enlarge the rectangular hole in the case to pass an octal power plug.

A socket punch may be used to make two holes in the back of the case. One hole is used to pass the plug for the speaker connection, and the other hole to reach a two-post terminal strip which is wired to the receiver silencing circuit (terminals 2 and 6 in the circuit diagram). These two terminals may then be shorted or wired into the transmitter control circuit in such a manner that the receiver is disabled whenever the transmitter is on the air.

The seriesed dial lamps should be parallel and connected to the 6.3-volt heater circuit with the dial light control resistors 111 and 81 out of the circuit.

BC-348E, M, and P Receivers Changes in this series of receivers are generally the same as in the (J), (N), and (Q) series of 348's, except that only the power audio stage must be modified when grounding the negative lead of the power supply. Also, the second detector and third i.f. stage cannot be isolated since they are in the same tube envelope.

Figures 81 and 82 show a convenient method whereby the power supply for a BC-348 series receiver may be mounted in the housing for the loudspeaker.

A 120 to 140 Watt Modulator from the BC-375 or BC-191

One way in which to solve the problem of making good use of the BC-375E or the BC-191 is to disassemble the tuning drawers for components, use the housings for the tuning drawers as cabinets for accessory pieces of test equipment, and use the main housing of the transmitter along with the audio transformers and miscellaneous other components to assemble a modulator. Figures 83 and 84 show one such assembly which operates quite satisfactorily.

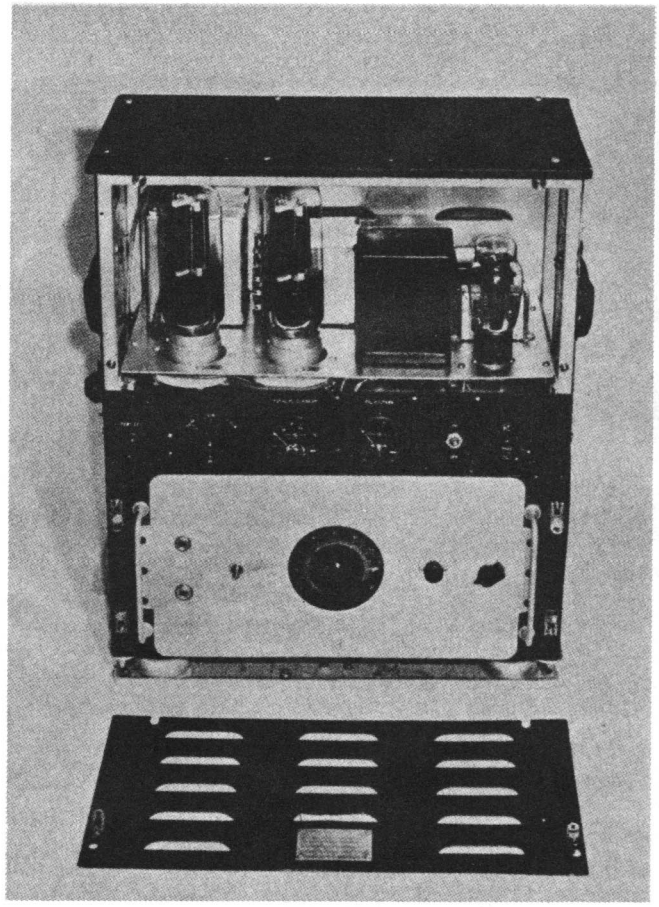

Figure 83.
MODULATOR AS MADE FROM A BC-375E.
The front cover has been removed to show the placement of components on the new chassis.

All components on the upper deck were removed, including the chassis, and a new chassis was bent from sheet aluminum to hold the components shown in Figure 85. The end of the main housing which held the antenna tuner was sawed off as unnecessary, but it might be retained to house the power supply for the modulator if components of the proper dimensions should be obtainable. The components mounted on the upper deck of the chassis include the power supply for the speech amplifier, a simple regulated bias circuit for the negative 100 volts on the 211 grids, and the audio transformers.

The clipper-filter audio amplifier and driver is mounted in the housing for one of the tuning drawers after all the r.f. components had been removed. The circuit for the speech amplifier is shown in Figure 86. An additional panel was placed in front of the original panel to cover the multitude of holes that had been left by removal of the r.f. components. The clipper-filter speech amplifier is quite conventional, ending in a single-ended 6B4-G which acts as driver for the 211's. Provision has been made in the input circuit of