CHAPTER V—

SIDEBAND RECEPTION AND ADAPTERS—

THE SIGNAL SLICER

Four-Tube Receiver Adapter for Improved Reception of AM, NBFM, CW or SSB Signals

From July-August, 1951

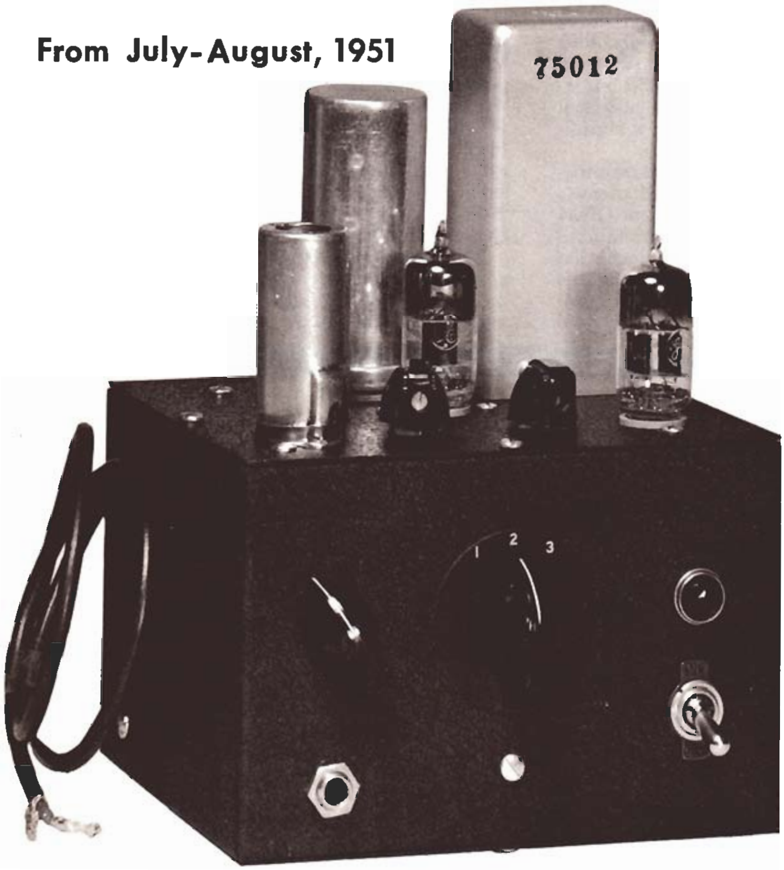


Fig. 1. Front view of the Signal Slicer. The input cable is at the left of the unit.

Ever since the SSB, Jr. transmitter appeared in the G-E Ham News *my readers have been asking whether it would be possible to design a simplified receiver adapter incorporating the same simple phase-shift network. The Signal Slicer described in this issue is W2KUJ's answer to those questions.*

—Lighthouse Larry

ANOTHER G-E HAM NEWS SSB SPECIAL

The Signal Slicer is a complete receiver adapter for converting the conventional communications receiver having 450–500 kilocycle I-F to a single-sideband receiver. The system utilized to obtain single-sideband response is of the phase-shift type, utilizing either a commercially made or a home-built phase-shift network of the type described for the SSB, Jr., transmitter (G-E *Ham News,* Vol. 5, No. 6). The name Signal Slicer has been applied to this adapter because of its ability to slice the selectivity curve of the conventional receiver in two, permitting one to listen at will to signals in either the upper or lower frequency portion of the receiver's normal I-F selectivity curve.

In contrast to the original SSB receiver adapter (G-E *Ham News,* Vol. 3, No. 6) the Signal Slicer requires no vacuum-tube probe, utilizes only four double-purpose tubes, and has no carrier synchronizing circuit. Notwithstanding a rather drastic reduction in its complexity, this adapter is a practical answer to the question, "Why not describe a simplified single-sideband receiver adapter?"

The Signal Slicer, when attached to a communications receiver, gives you a combination which permits you to do away with at least fifty percent of the QRM when receiving conventional AM or phase-modulated phone signals. The same holds true for the reception of CW signals, with the Signal Slicer supplying the heterodyning signal so that the BFO in the communications receiver is not required. True single-signal reception of CW signals is possible with this combination.

For reception of single-sideband signals, this adapter furnishes a carrier against which the sidebands may be demodulated. By selecting the proper sideband with a switch, the modulation may be read. Although it is now pretty well understood that a special adapter is not required for reception of single-sideband signals, many amateurs who have heard or used the original *Ham News* SSB receiver adapter appreciate the benefits of such a device.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Signal Slicer is shown in Fig. 2. As is the case for most equipment described in the *Ham News,* an effort has been made to utilize completely standard components wherever possible. The built-in power supply is a conventional voltage doubler with a selenium rectifier and a conventional resistance-capacitance filter. No further comment on this portion of the circuit is necessary except to point out that a transformer is used to isolate the circuits from the a-c line in order to prevent interconnection problems between the adapter and the communications receiver.

The phase-shift type of adapter consists basically of two detectors (demodulators) supplied by a signal to be received and signals from an oscillator which acts as a local carrier source. The outputs of the

Electrical Circuit

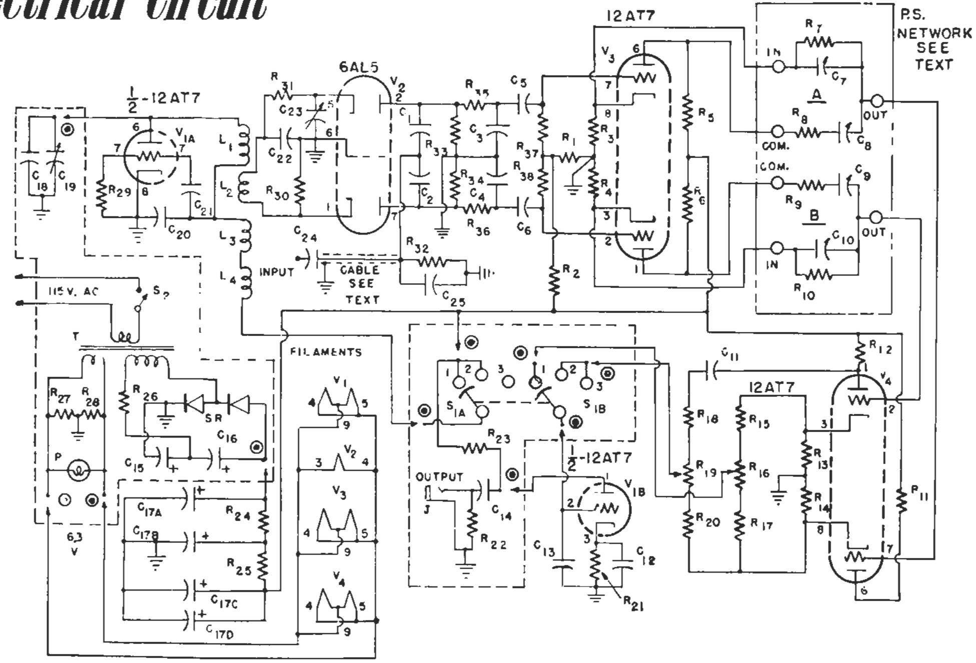


Fig. 2. Circuit diagram of the Signal Slicer.

separate demodulators are fed through a pair of phase shifters of such characteristics that the algebraic sum of their outputs consists of audio signals created by I-F signals which lie on one side of the local oscillator frequency, and the algebraic difference consists of audio signals created by I-F signals which are on the other side of the local oscillator frequency.

In the Signal Slicer half of the double triode V_1 is used as a Colpitts oscillator whose output is coupled into the two halves of the double-diode V_2 acting as the two demodulators. These demodulators are also supplied with signals from the I-F amplifier of the receiver with which the adapter is used. The demodulator outputs are supplied to the double triode V_3 which in turn feeds two phase-shift networks (Millen No. 75012 or a home-made equivalent).

The outputs of the phase-shift networks are then applied to the two triode sections of V_4 whose outputs are fed to the combining circuits (R_{15}, R_{16}, R_{17} and R_{18}, R_{19}, R_{20}). These, in turn, feed through a selector switch into an audio amplifier, the remaining section of V_1. The purpose of the selector switch is to permit choice of sideband and to permit conventional receiver operation. With reference to the circuit diagram, positions 1 and 2 of switch S_1 are the two sideband positions, and position 3 is the proper position for normal operation of the receiver.

CONSTRUCTIONAL DETAILS

The Signal Slicer is simple to build, especially if a commercial unit is used for the phase-shift networks. The entire unit is built into a standard four by five by six inch utility box. Most of the components are mounted on one of the five by six inch removable cover plates. This plate will be referred to as the "top."

Refer to the circuit diagram, Fig. 2. Note that two groups of components are shown inside dotted-line boxes. The components that are in these two boxes are those that are mounted on the utility box proper. All the other components are mounted on the top plate, including the phase-shift network assembly which has been indicated in the circuit diagram inside a dashed-line box. This box is marked "P.S. Network." Don't confuse this with the two dotted-line boxes in the diagram.

It may be seen that each of the two dotted-line boxes has connection points indicated by a circle with a large dot inside. There are ten of these points. These represent the connections that must be made when the wiring of the box is complete and the wiring of the top plate is complete, and you are assembling the two sections. The leads shown with the arrow at each of these points indicate a length of wire which is left long so that the connection may be made after assembly. The photograph of the top plate in Fig. 3 shows these ten wires clearly. The wires are longer

CIRCUIT CONSTANTS

(All resistors and capacitors ±20% tolerance unless specified otherwise)

C_1, C_2	*100 mmf mica or ceramic (matched within 5%)*
C_3, C_4	*100 mmf mica or ceramic (matched within 5%)*
C_5, C_6	0.01 mf mica, paper or ceramic
C_7	*2430 mmf (0.002 mf mica ±5% with 170–780 mmf trimmer in parallel)*
C_8	*4860 mmf (0.0043 mf mica ±5% with 170–780 mmf trimmer in parallel)*
C_9	*1215 mmf (0.001 mf mica ±5% with 50–380 mmf trimmer in parallel)*
C_{10}	*607.5 mmf (500 mmf mica ±10% with 9–180 mmf trimmer in parallel)*
C_{11}, C_{14}	0.1 mf 400 volt paper
C_{12}	0.5 mf 200 volt paper
C_{13}, C_{25}	470 mmf mica or ceramic
C_{15}, C_{16}	40 mf 150 volt electrolytic
$C_{17A, B, C, D}$	20—20—20—20 mf 450 volt electrolytic
C_{18}	*300 mmf mica ±5%, for 456 to 465 KC. (Use 240 mmf for 500 KC, I-F receivers)*
C_{19}	50 mmf variable (Hammarlund HF-50)
C_{20}	*0.003 mf mica ±10%*
C_{21}	1000 mmf mica or ceramic
C_{22}	*330 mmf mica ±5%*
C_{23}	5–50 mmf mica trimmer (El Menco T-52210)
C_{24}	10 mmf mica or ceramic
J	Open circuit jack
L_1, L_2, L_3, L_4	All made from one R-F choke (see text)
R_1	*10,000 ohm, ½ watt (±10%)*
R_2	*680,000 ohm, ½ watt (±10%)*
R_3, R_4	*2,000 ohm, ½ watt precision (±1%)*
R_5, R_6	*7,000 ohm, ½ watt precision (±1%)*
R_7, R_{10}	*133,300 ohm, ½ watt precision (±1)%*
R_8, R_9	*94,000 ohm (100,000 ohm ½ watt ±1% precision resistor in parallel with a 1.5 megohm ½ watt ±5% resistor)*
R_{11}, R_{12}, R_{13}, R_{14}	*3,000 ohm, ½ watt (±5%)*
R_{15}, R_{17}, R_{18}, R_{20}	*220,000 ohm, ½ watt (±10%)*
R_{16}, R_{19}	100,000 ohm potentiometer
R_{21}	*5,600 ohm, ½ watt (±10%)*
R_{22}	2.2 megohm, ½ watt
R_{23}	47,000 ohm, 1 watt
R_{24}, R_{25}	470 ohm, 1 watt
R_{26}	*400 ohm, 4 watt (±10%) (Two 200 ohm, 2 watt resistors in series)*
R_{27}, R_{28}	47 ohm, ½ watt
R_{29}, R_{32}	10,000 ohm, ½ watt
R_{30}	*1,000 ohm, 1 watt (±5%)*
R_{31}	*1,000 ohm, ½ watt (±10%)*
R_{33}, R_{34}	*1.0 megohm, ½ watt (±10%)*
R_{35}, R_{36}	*51,000 ohm, ½ watt (matched within 5%)*
R_{37}, R_{38}	*3.3 megohm, ½ watt (±10%)*
S_1	Double pole, three position shorting type rotary switch
S_2	SPST Toggle Switch
SR	Voltage doubler type selenium rectifier, rated 160 RMS volts at 100 ma (Federal 1008A)
P	6.3-volt pilot lamp
T	Power Transformer, 135-volt A-C RMS secondary at 75 ma, 6.3 volts at 1.5 amps (Thordarson R-22R12)
P.S. Network	Millen No. 75012 or home-made equivalent (see text)

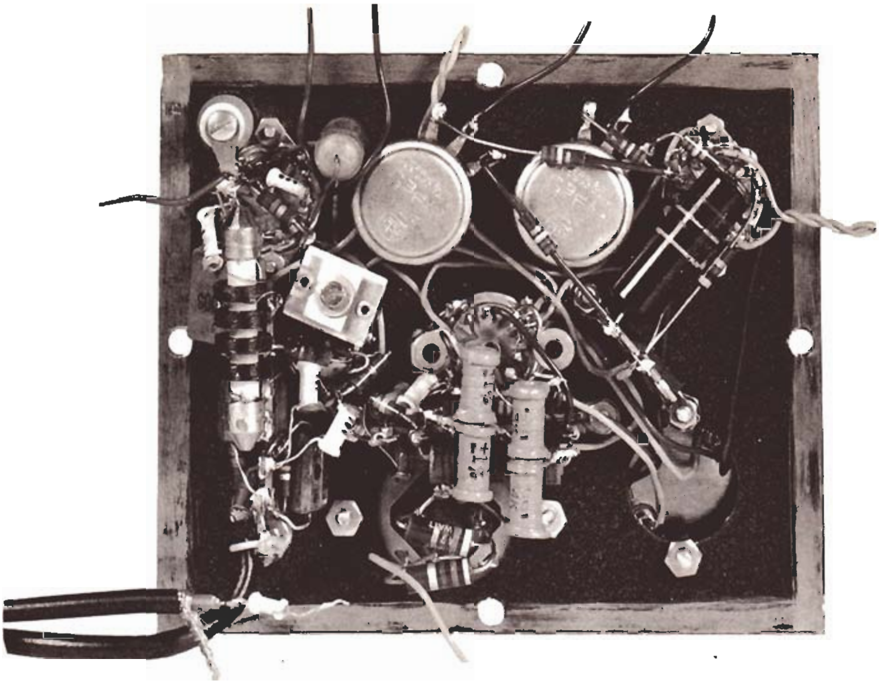


Fig. 3. Detail view of the wiring on the top panel of the Signal Slicer.

than the photograph shows. Make each one about 5 inches long, then cut them to length when assembling the adapter.

A drilling layout is shown in Figs. 6, 7 and 8 for those who wish to duplicate the original unit exactly. If another type of construction appeals to you, a reasonable duplication of the layout shown is suggested.

With reference to Fig. 4, the power transformer, the selenium rectifier, condensers C_{15}, C_{16} and resistor R_{26} are mounted on the rear apron of the utility box. This rear apron also has two grommets mounted on it to handle the a-c line and the input probe cable. On the front apron you mount the pilot light, power switch S_2, resistors R_{27}, R_{28}, oscillator tuning control C_{18}, C_{19}, output jack, selector switch S_1, condenser C_{14} and resistors R_{22} and R_{23}. All the wiring involved with these components can easily be completed if the two removable plates are not in place. Because of tolerances on certain components and the particular I-F of your receiver, it is well to mount C_{18} directly across C_{19} so that possible pruning operations may be done conveniently without removing the top plate.

The one inch diameter hole specified for the phase-shift network is used regardless of whether a Millen unit or a home-made unit is employed. Details of the home-made unit will be given later.

It is desirable to remove the paint from the top lip of the utility box, and from the four edges of the top plate, to ensure good electrical contact when the two parts are joined.

Coils L_1, L_2, L_3 and L_4 require explanation. All four coils are made by making some minor changes on a single National R-100 R-F choke. This choke has four pies, and each pie becomes a coil. To make the necessary changes, refer to Fig. 5, and proceed as follows. Examine the coil and the individual pies. You will note that one lead on each pie comes off the outside of the pie, and the other lead comes from the part of the pie nearest the ceramic support. Orient the choke in your hand until it is as shown in Fig. 5, that is, so that the lead from the right-hand end goes to the outside of the farthest-right pie, L_1.

Carefully loosen two turns on the outside of L_2 and then cut the wire to provide an inch or so of lead from the inside of coil L_1. Remove the insulation and the enamel from the end of this lead. The two connections to coil L_1 are now the original pigtail and the inch or so of wire removed from the outside of coil L_2.

Repeat this operation on coil L_3 to provide leads for coil L_2, as well as a connecting lead from L_3 to L_1. Continue as shown in Fig. 5 until you have L_1 in series with L_3 and L_4, with L_2 having separate, unconnected leads. Tin the ends of all wires and solder the connection between L_1 and L_3. Double-check to make certain that your leads are as shown in Fig. 5, that is, that the leads come from the top of the pie where so indicated and from the center of the pie, where so indicated. This is important, because this determines the direction of the winding on the form. The entire procedure probably will take less time to do than the time you have spent reading this. The inductance of each pie of the National R-100 choke is approximately 420 microhenries.

For wiring details of the top of the Signal Slicer, refer to Fig. 3. The coil assembly (L_1 through L_4) is mounted with the L_1 end fastened to a ceramic stand-off post and the other end connected to one lug of a terminal strip. The common connection of L_1 and L_3 should be made to the end lug of the terminal strip nearest V_1, and the two connections from L_2 to the next two lugs. Make certain that the coil will clear the lip on the box as the chassis is mounted. The remainder of the wiring is quite straightforward and should present no difficulty. Note that R_5 and R_6 are actually each made up of a 3000 and a 4000 ohm resistor in series, since 7000 ohm resistors were not immediately available.

Remember to leave several inches of hookup wire at each of the ten connection points, so that the final assembly consists in cutting these wires to length and

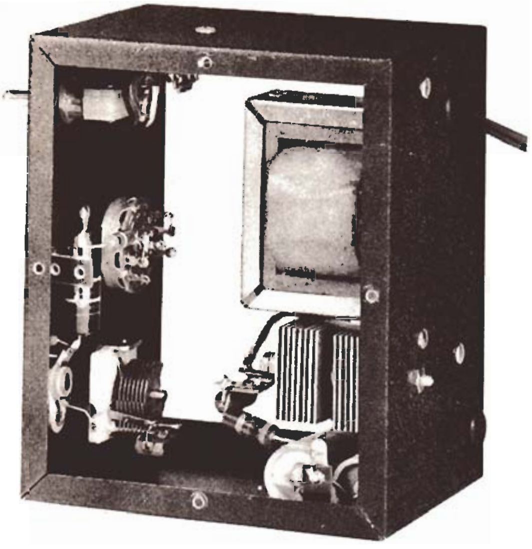


Fig. 4. Detail view of the completely wired interior of the Signal Slicer.

soldering them to the proper points on the box proper. Obviously, all wiring should be completed on the top plate before the final connections to the box are made. The probe cable should be made of approximately two feet of RG-58/U cable, and C_{24} soldered to the far end. The cable may be shorter or longer, but try to keep its length under six feet.

PHASE SHIFT NETWORKS

The Millen No. 75012 network is a complete and aligned pair of phase-shift networks. To use this unit in the Signal Slicer a slight modification is required to achieve optimum results. Each of the 100,000 ohm precision resistors (R_8 and R_9 in the circuit) should be paralleled with a 1.5 megohm five percent tolerance $\frac{1}{2}$ watt carbon resistor. To do this the can must be taken apart to permit access to the resistors. The photograph (Fig. 9) shows where these resistors have been added to the Millen unit. Make no other changes or adjustments, since these units are pre-aligned at the factory.

The change mentioned is beneficial in taking account of the effective source impedance presented by V_3 and associated circuits.

If desired, you may make your own phase-shift network unit. The home-made unit pictured in Figs. 10 and 11 is made in a Millen No. 74400 plug-in shield can. The octal base pictured is a part of this unit. The components are supported on a vertically-mounted piece of insulating material, such as bakelite, poly, etc. The size of this piece is $3\frac{5}{8}$ by $1\frac{3}{4}$ inches by $\frac{1}{16}$ inch thick. This is secured to the mounting posts by two small right-angle brackets. The suggested terminal arrangement is pictured quite clearly in Figs. 10 and 11. The fixed mica condensers are mounted on one side of the insulating material, and the adjustable trimmers and resistors on the other side. Mount, but do not solder these components in place until the phase-shift networks have been aligned.

The suggested pin connections for a home-made unit are as follows: Pin 1, ground; pins 2, 3 and 4, network "A"; and pins 6, 7 and 8, network "B."

Electrically the two networks in this can are identical to the ones used in the SSB, Jr., except for the modification noted above for the Millen unit. (For convenience, the symbol numbers indicated in Fig. 2 in this issue are the same as were used in Figs. 2 and 3A of the Vol. 5, No. 6, ***Ham News*** describing the SSB, Jr.)

After completing the phase-shift unit leave the can cover off until the adjustments are made and the two 1.5 megohm resistors added across R_8 and R_9. Run a wire from pin 1 on the phase-shift unit to one of the mounting posts inside the No. 74400 can to allow grounding. To prevent inadvertent short circuits, a stiff piece of insulating material (such as waxed Kraft paper) should be placed inside the can as is usually done in commercial I-F transformers.

If a home-made phase-shift network is used, an octal socket will be required on the top plate to accommodate the Millen No. 74400 unit. The alignment of the home-made phase-shift network will be discussed later.

COMPONENT PARTS

As is true with many equipment designs, there are some component parts in the Signal Slicer that must be chosen carefully. The precision resistors specified are important if optimum results are to be obtained. Continental "Nobleloy" 1% resistors were used in the original models of the Signal Slicer (where 1% resistors are specified) although any other make of equal quality should work equally well.

Some of the other resistors are specified with tolerances of 5% or 10%. This has been done to ensure a piece of equipment which will be capable of being tuned up properly after you complete it. If you desire, use 20% tolerance resistors which you have measured to make certain that they are within the required tolerance. Certainly one or two of these values may vary as much as 20%, but if all the resistors varied this much, in the wrong direction, you might have a much harder job getting the unit to work properly.

The adjustable mica trimmers used in the phase-shift networks may be any good grade of trimmer. Those actually used are El Menco: T52910 for C_7 and C_8; T52510 for C_9; and T52310 for C_{10}.

It is important that you use a National R-100 2.5 mh. choke for L_1, L_2, L_3 and L_4. Other chokes will undoubtedly work, but the National R-100 is universally available, and no attempt was made to check the suitability of other four-pie 2.5 mh. chokes.

Mica condensers should be used where mica only is specified. In the other cases the specifications call for "mica or ceramic" or "mica, ceramic or paper" condensers. In general, the ceramic condensers are smaller than either the mica or paper condensers and should therefore be used if feasible. Be certain to obtain condensers within the tolerances specified.

The selector switch, S_1, should be of the shorting type. Loud switching transients will be produced unless this precaution is observed.

The selenium rectifier specified is capable of handling 160 volts RMS. Most small selenium rectifiers are rated for only 130 volts RMS, and these were not specified because the transformer, unloaded, supplies more than 130 volts RMS, which would damage the lower-rated rectifier.

CIRCUIT ADJUSTMENTS

With the exception of alignment of the phase-shift networks (if you build your own) very few adjustments are required in the Signal Slicer. The two

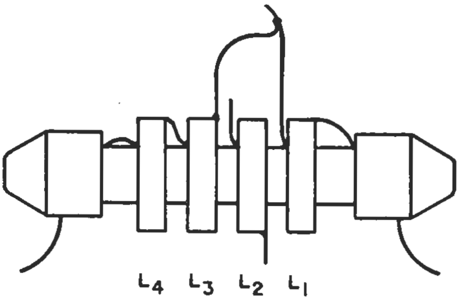


Fig. 5. Sketch of the altered R-100 choke

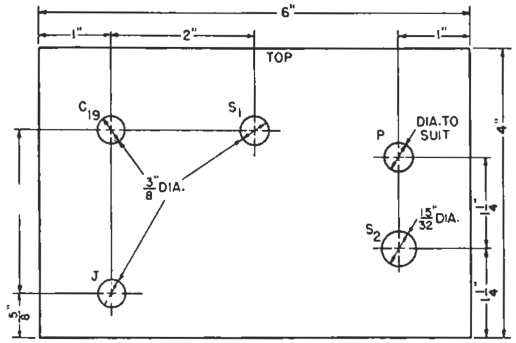


Fig. 6. Layout dimensions for the front of the Signal Slicer. The dimension on the left which is blank should be 1 5/8 inches. Note also that the holes for C_{19} and S_1 are not shown in true perspective, because they are actually closer to the bottom of the panel than the hole for the panel light. The dimensions shown are correct.

methods for alignment of the home-made phase-shift networks are identical to those described for the SSB, Jr. The simpler method is to use accurately measured parts (R_7 through R_{10} and C_7 through C_{10}). The more exact method involves four test frequencies which enable one to adjust each of the four capacitors, C_7 through C_{10} for perfect alignment.

The adjustment procedure using the test frequencies is as follows. First, determine that the resistors R_7 and R_8 (as well as R_{10} and R_9) bear the ratio of 133,333 to 100,000, that is, 4 to 3, as closely as can be determined. If there is any doubt about the value of the resistors, double-check their values on an accurate bridge. Next procure the two necessary instruments, which are an audio oscillator capable of providing output frequencies in the range between 300 and 2000 cycles per second, with good waveform, and an oscilloscope. The oscillator may be calibrated by the method described later. Connect the oscillator output through a step-down transformer (a conventional audio transformer run "backward" will do nicely) into a 1000 or 2000 ohm potentiometer with the arm of the potentiometer grounded. See Fig. 12.

Adjust the arm position so that equal (but opposite) voltages appear on each half of the potentiometer. A steady audio frequency signal of any convenient frequency may be used with an oscilloscope acting as a convenient voltmeter for this job. Swing the vertical deflection lead from one end of the potentiometer to the other and adjust the arm to obtain equal voltages (a true center-tap). Set up a temporary double cathode-follower circuit using a 12AT7 with 500 ohms from each cathode to ground and connect as shown in Fig. 12. (It will be convenient to provide leads M, N, and 1 and 2 with clips at the ends to facilitate checking.) The horizontal and vertical plates of the oscilloscope should be connected to the 12AT7 cathodes as shown in Fig. 12 and the 'scope common connection should go to the arm of the potentiometer.

Now, refer to the circuit diagram, Fig. 2, and disconnect the elements in your home-made phase-shift network as follows. Disconnect the left-hand end of

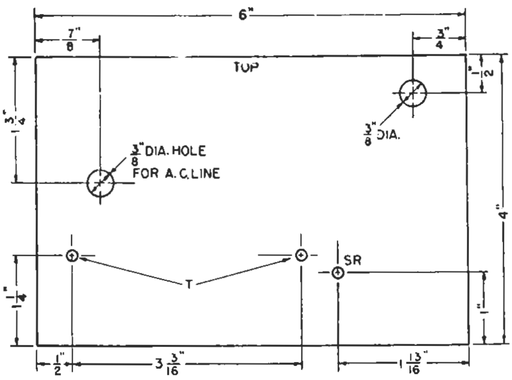


Fig. 7. Layout dimensions for the rear of the Signal Slicer.

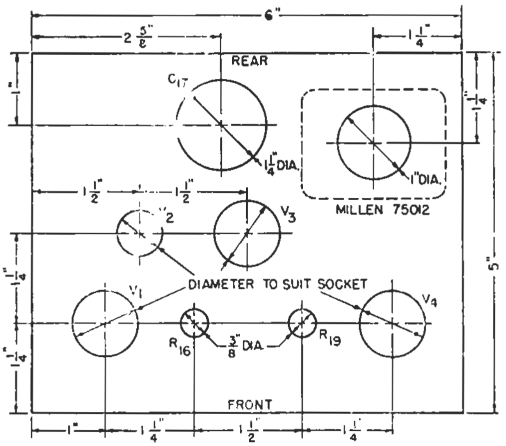


Fig. 8. Layout dimensions for the top panel of the Signal Slicer.

R_7 from C_7. Disconnect the left-hand end of R_{10} from C_{10}. You are now ready to proceed with the alignment.

Connect lead M (Fig. 12) to the left-hand end of R_7 and connect lead N to the left-hand connection of C_7. Connect leads 1 and 2 (Fig. 12) to terminal M. Adjust the horizontal and vertical gains on the oscilloscope to produce a line about 1½ inches long slanted at 45 degrees when the oscillator is set to a frequency of 490 CPS. If the oscilloscope has negligible internal phase shift the display will be a straight line instead of a narrow slanting ellipse. If the latter display appears it is necessary to correct the oscilloscope phase shift externally by using an adjustable series resistance (a 50,000 ohm potentiometer) mounted at either the vertical or horizontal input terminal, depending on what correction is necessary.

At any rate, the objective here is to get a straight line at 490 CPS. In some cases a series capacitor may be needed to provide the necessary correction. Try values from 0.05 to 0.0005 mf. Now shift lead 1 from the left-hand end of R_7 to the junction of R_7 and C_7. Adjust the trimmer of C_7 to obtain a circle on the oscilloscope. It will be noted that as this adjustment is made the display will shift from an ellipse "leaning" to one side through a circle or ellipse (with axes parallel to the deflection axes) to an ellipse which leans the other way. If desired or necessary, the appropriate gain control on the oscilloscope may be changed so that a circle instead of a "right" ellipse is obtained at the point of correct adjustment. After changing the gain control on the oscilloscope, check (and correct, if necessary) the phase shift in the oscilloscope by moving lead 1 back to the left-hand end of R_7, and then repeat the setting of C_7 with lead 1 back again on the junction of R_7 and C_7.

In general, always make certain that the oscilloscope is used in a phase-corrected manner. As a double-check (if the deflection plates in the 'scope are skewed, for instance) connect lead 2 to the left-hand end of C_7. If the circle changes to a slanting ellipse, readjust C_7 to produce an ellipse half-way between the ellipse (obtained by switching lead 2) and a circle. Changing lead 2 from the left-hand end of C_7 to the left-hand end of R_7 and back again should give identical skew to the display when C_7 is set correctly. Failure to get symmetrical ellipses (egg-shaped, or other display) is due to distortion, either in the oscilloscope, the oscillator, the transformer, or the cathode follower. Conduct the test at as low a signal level as possible to avoid distortion.

Next, connect lead M to the left-hand end of R_{10} and lead N to the left-hand end of C_{10}. Connect leads 1 and 2 to lead M, set the oscillator frequency to 1960 CPS, correct 'scope phase-shift as before, and move lead 1 to the junction of C_{10} and R_{10}. Adjust C_{10} for a circle as was done for C_7, using the precautions outlined for that case.

Now connect lead M to the left-hand end of R_9 and lead N to the right-hand end of C_9. Connect leads 1 and 2 to lead M, set the oscillator frequency to 1307 CPS, correct 'scope phase-shift as before, and move lead 1 to the junction of R_9 and C_9. Adjust C_9 to obtain a circle on the oscilloscope, as before.

Repeat the above procedure for the remaining R-C pair, R_8 and C_8. Use an oscillator frequency of 326.7 CPS. This completes the alignment of the phase-shift network. None of the preceding alignment instructions need be carried out if a Millen No. 75012 network is used.

Re-connect the phase-shift units, connecting the left-hand end of R_7 to C_7, and the left-hand end of R_{10} to C_{10}. Connect the phase-shift units to the base pins of the plug-in can assembly and solder all connections. Shunt R_8 and R_9 with the 1.5 megohm resistors previously mentioned, then place the cover on the plug-in assembly. Remember to use some insulating material inside the can as mentioned previously.

AUDIO OSCILLATOR CALIBRATION

It will be noted that the frequency ratios are such that the 12th harmonic of 326.7 CPS, the 8th harmonic of 490 CPS and the 3rd harmonic of 1306.7

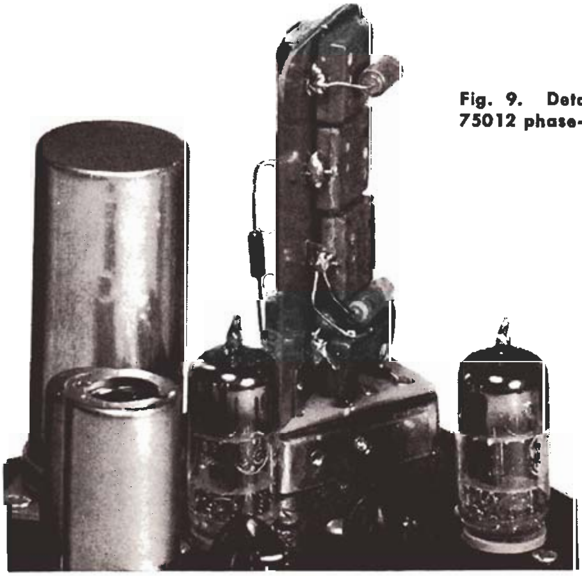


Fig. 9. Detail view of the Millen No. 75012 phase-shift network.

CPS are all the same as the 2nd harmonic of 1960 CPS, namely, 3920 CPS. Thus, if a stable source of 3920 CPS frequency (such as a thoroughly warm audio oscillator) be used as a reference, the frequency of the test oscillator can be set very closely to one-half, one-third, etc., of this reference frequency if both oscillators feed an oscilloscope and the resulting Lissajous figures observed.

Use of a calibrating frequency in this manner assures that the frequency ratios used are correct, even though the exact frequencies used are unknown. The frequency ratios (just as the resistance ratio previously mentioned) are far more important than the actual values of frequency (or resistance) used.

CONNECTION TO RECEIVER

After completion of the wiring and a thorough wire-check you are ready to connect the adapter to the receiver. The connection from the "hot" side of the I-F transformer to the diode plates of the detector in the receiver should be removed, and the audio connection from the detector output to the A-F gain control should be opened. The shield of the adapter cable connects to ground on the receiver, and the 10 mmf capacitor connects to the hot side of the I-F transformer, in place of the diode plates.

The output of the adapter may be used directly on headphones, or an audio lead may be plugged into the output jack of the adapter (J) and wired into the audio input of the receiver. It can be seen that the Signal Slicer essentially replaces the detector normally used in the receiver. The AVC action in most receivers so altered will now be completely out of service, as will the S-meter. (Even if the AVC is not disabled, it should not be used when using the Signal Slicer.) The RF gain control will be the main gain control of the receiver. It is difficult to give specific information for connection of the Signal Slicer to all receivers, but the above information covers most cases that will be encountered.

Some receivers have an accessory plug in the rear. Find out whether the amount of power available from this plug is ample to supply the requirements of the Signal Slicer if you contemplate borrowing the power from the receiver instead of using a built-in power supply. The heater power required is 6.3 volts at 1.2 amperes and the high voltage required is 250 to 300 volts at approximately 25 ma. It is recommended that the filter section consisting of R_{24}, R_{25} and C_{17} be retained regardless of the power supply used.

FINAL ADJUSTMENTS

Turn on both the receiver and the Signal Slicer and allow a few minutes warm-up time. The R-F gain control of the receiver should be all the way to zero and the AVC switch set for "manual" or "RF." Plug headphones into the output jack (J) on the adapter, set the selector switch to normal (position 3), advance the R-F gain until the receiver sounds "live" and tune in an AM station, governing the output with the R-F gain control. Keep this output reasonably low. Be certain to *tune* the receiver to maximum output (remember, there is no AVC and no S-meter) with minimum I-F bandwidth, if the receiver is so equipped, but do not use the crystal filter at this time. Trim the secondary of the last I-F transformer to compensate for any shift of its tuning caused by connection of the Signal Slicer input circuit. Set the two balance potentiometers (R_{16} and R_{19}) about midway and turn the selector switch on the adapter to one of the sideband positions (position 1 or 2). This actuates the oscillator in the Signal Slicer.

Tune the oscillator (with C_{19}) to zero beat with the received carrier, at which point good, clean audio reproduction should result. If the oscillator will not tune to zero beat within the range of C_{19}, replace C_{18} with different values of capacitance until zero beat can be obtained with C_{19} near mid-range.

Now, detune the *receiver* until a beat note of about 1000 CPS is heard. Try detuning first on one side, and then on the other, leaving the receiver set for the *weaker* heterodyne. Adjust the appropriate resistor (R_{16} or R_{19}, depending on the selector switch position) for a *minimum* heterodyne. Then detune the receiver to the other side of the signal, switch to the other sideband with the selector switch, and adjust the other potentiometer for a minimum heterodyne. Quite possibly neither minimum will be a complete null at this time.

Adjust C_{23} for a further reduction in heterodyne strength (readjusting the oscillator frequency with C_{19} if necessary to maintain the same beat note). Adjust the potentiometer (R_{16} or R_{19}) for still further reduction of heterodyne strength, switch to the other sideband position, retune the *receiver* for a beat note of 1000 CPS on the other side of zero beat, and adjust the other potentiometer for a minimum heterodyne signal strength. You will find that the sharpness of the minimum becomes more pronounced each time the above process is repeated until C_{23} is set at the optimum point, just as in balancing a bridge.

Throughout the above adjustment procedure it is assumed that the Signal Slicer is in working order other than for the correct settings of the few adjustments just covered. If no signal is heard at any time, or if excessive hum or other evidence of trouble appears, a thorough trouble-shooting routine is indicated.

OPERATING INFORMATION

After a short time of familiarization the user of the Signal Slicer will find that he listens almost exclusively to one or the other of the sideband positions, rarely ever going back to normal reception. In most cases reception of AM, NBFM, CW and Single-Sideband signals will be greatly improved over conventional reception methods. If interference appears when listening to one sideband of an AM or NBFM signal, simply switch to the other sideband to dodge the problem. Do not try to "tune out" interference—switch it out instead. Sometimes, even then, the going is rough, as we all know. That's the time to switch to normal reception to find out how rough it really is. At least, with the Signal Slicer, you can always get rid of the interference that appears on any one side of the received signal.

Since extremely close tuning (within 100 CPS) is generally necessary, the receiver should have a good bandspread arrangement, and should, therefore, have excellent stability. Some signals will be found where the Signal Slicer is of no advantage whatever because the signals themselves are characterized by excessive drift, syllabic instability, or other obvious faults. Then too, some receivers exhibit faults quite similar to those mentioned for transmitters. Do not expect the Signal Slicer to cure either a "rotten" signal or a receiver that, for instance, makes *all* CW signals sound rough, or one that has excessive drift.

In general, operate the receiver with the lowest R-F gain control setting that gives comfortable audio output. An overloaded receiver is just as bad as an overloaded transmitter (perhaps worse) as far as the listener is concerned. The crystal filter in the receiver may be used in the conventional manner.

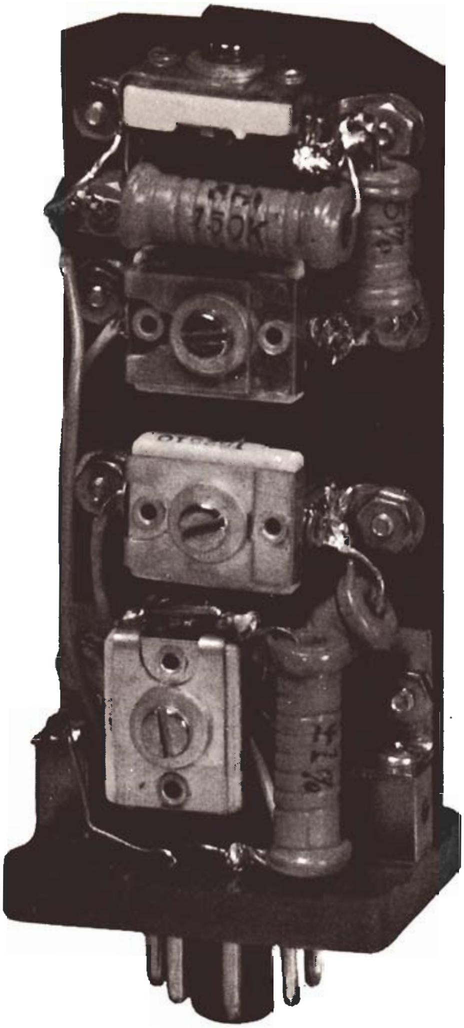


Fig. 10. Internal view of the front of the home-made phase-shift network.

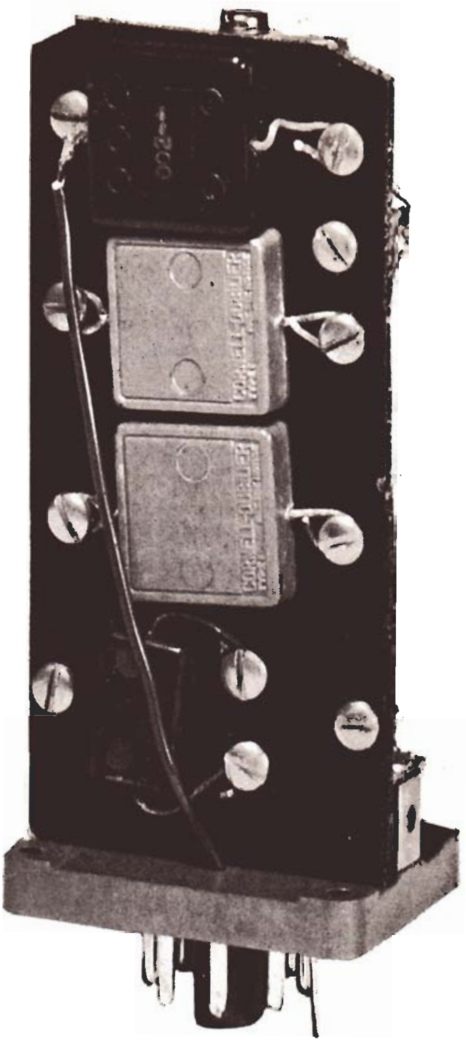


Fig. 11. Internal view of the rear of the home-made phase-shift network.

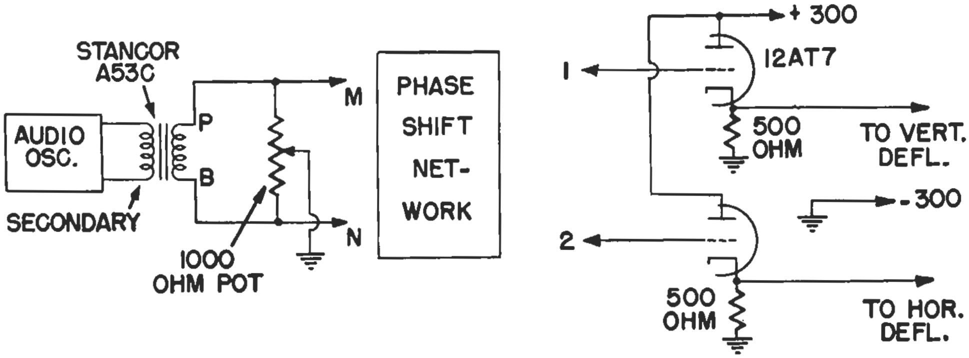


Fig. 12. Temporary layout required to test phase-shift networks.

Designers' Corner—Notes on the Application of the Signal Slicer

Many hams who do not operate single-sideband 'phone stations feel that a single-sideband receiving system would be of no use to them. The fact is, it is probably more useful to them for receiving CW and AM 'phone signals than it would be to a SSB enthusiast for receiving SSB signals (although the SSB ham has long since learned the usefulness of such a receiving system).

In other words, if the Signal Slicer is good for SSB 'phone reception (I can assure you it is—Ed.) it should be dandy for CW, especially traffic nets, where one or more of the stations may slip away from the crystal filter and turn up missing on a few receivers.

Going a bit further in our thinking, an AM 'phone station is just like two single-sideband stations (at the same carrier frequency) that just happen to be transmitting identical signals on opposite sidebands. Therefore, one isn't missing anything if he doesn't listen to one of the signals. The Signal Slicer allows the receiving operator to select which one of the signals he doesn't want to hear. This sounds ridiculous on the face of it, until you consider that one of these "stations" is liable to be severely heterodyned, which is a polite way of saying that the QRM on that station is terrible.

If this QRM situation exists, the operator can flip a switch and hear the same transmission on the other side, where no heterodyne exists. Obviously, the operator isn't choosy about which side he listens to, as long as he can hear the same thing on either side. This is what is known as broad-nosed selectivity with extremely steep side-slope—a rather valuable asset in many situations.

The Signal Slicer, however, goes one step beyond providing just usable selectivity as such. The demodulator is made as nearly distortionless as one could pray for, because *all* incoming signals are smaller by a factor of some 200 or better than the carrier signal that is supplied by the built-in oscillator to the detector system. This is exalted carrier operation with a vengeance, but it certainly pays handsome dividends.

One dividend is the elimination of "mushing up" when receiving a fading signal; another is in reduction of the apparent volume range of a fading signal—so much so that loss of the AVC function in a receiver using the Signal Slicer is actually a distinct gain. But, don't take my word for it—try it yourself.

A word about the demodulator circuit is in order at this point. You might be tempted (even as I was) to use germanium diodes in place of the 6AL5 diode tube, and thus end up with a three-tube Signal Slicer. If you like to listen to noise this simplification is recommended. However, if you want a good SSB receiver adapter, use the 6AL5 or some other thermionic diode tube. My physicist friends tell me that the effective noise resistance of germanium diodes is extremely high, compared to a tube like the 6AL5, when you operate at low frequencies with only a few microamperes of d-c flowing in the circuit. My friends were correct. The tube is as quiet as a tomb lined with rock wool compared to the germanium diodes. For this particular application, a tube works out better than germanium diodes.

Somebody (perhaps it was Aesop or Confucius, I don't recall) said that the merit of a radio receiver was not in what it would receive, but in what it *wouldn't* receive. Of course, receivers have on-off switches, but what I mean is, doesn't your present receiver receive too much?

I am certain that you will agree that many, many times, on a single frequency, you have received more signals than you knew what to do with.

So, if these ancient philosophers were right, the Signal Slicer is a merit improver, although it's not perfect. The frequency range over which you can expect to get at least 40 db. signal rejection is controlled by the phase-shift network, and its range is 225 to 2750 cycles per second. This, of course, more than covers the region of most acute hearing, but what about the audio frequency range outside these limits?

At 4000 cycles the signal rejection due to the phase-shift network is between 36 and 37 db., and at 8000 cycles it is about 30 db. The audio amplifier in the Signal Slicer is deliberately designed to have a response which is down 3 db. at 4000 cycles, 9 db. down at 8000 cycles, etc. (This is at a rate of about 6 db. for each octave.) Thus, at the slight sacrifice of high fidelity it is fair to say that the signal rejection is about 40 db. all the way along, because the audio response has been tailored in an identical way on the low-frequency end of the spectrum.

Add to all of this the I-F selectivity curve of your receiver and you may begin to see why we think the Signal Slicer is really about as good as anyone might want when you consider the practical aspects of reception.—W2KUJ

—*Lighthouse Larry*

Added Information on the Signal Slicer

These comments should answer the many requests for information on substituting components and changing the operating frequency of the original G-E HAM NEWS SIGNAL SLICER.

SUBSTITUTING PHASE-SHIFT NETWORKS-Commercially-made phase-shift networks may be substituted for the network designed by Norgaard, shown on page 9 of the original article.

a. MILLEN No. 75012: This network is housed in an aluminum can having about the same dimensions as the original. The parts values are the same, but connections are made through terminals on a recessed insulating board on the bottom of the network, as shown in Fig. 13 below.

b. CENTRAL ELECTRONICS No. PS-1 and LAKESHORE INDUSTRIES No. PS-Jr.: Both of these networks are packaged in aluminum cans approximately the same size as the homemade network. Both have a special 9-pin octal type plug-in base. The matching socket for this plug is: Amphenol type 77MIP9; or 78RS9. Both of these networks have the same capacitance and resistance values as used in the original Norgaard network. Plug pin connections are shown in Fig. 14 below.

c. BARKER & WILLIAMSON Model 350, type 2Q4: This popular network is very compact and is housed in an 8-pin octal based metal tube envelope the size of a 6J5 tube. Since the resistance values are higher, and the the capacitance values are smaller, stray and other external circuit capacitances may have a greater effect on the performance of this network than on the above types. This is the opinion of Norgaard, designer of the G-E HAM NEWS SSB equipment. Basing connections are shown in Fig. 15.

CHANGING THE MECHANICAL LAYOUT--Although the original Signal Slicer was constructed in a 4 x 5 x 6-inch utility box, other sizes of chassis or boxes are equally suitable. The following precautions should be observed:

a. Components should be kept approximately in the same relationship to each other as in the original model. This will keep stray circuit capacitances and coupling about the same.

b. Since a portion of the Signal Slicer circuit operates at low audio level, it is best to keep the unit well away from components which have a strong magnetic field.

MODIFYING THE SIGNAL SLICER FOR OTHER INTERMEDIATE FREQUENCIES--The recent appearance of receivers having intermediate frequencies other than the 450--500 kilocycle range for which the Signal Slicer was designed, has created a demand for information on modifying the Signal Slicer to work at these frequencies.

a. Circuit constants in two tuned circuits must be changed, one circuit being formed by C_{18}, C_{19} and L_1; the other circuit consists of C_{22} and L_2. Values for these components should be scaled up or down according to the ratio of the original frequency to the new frequency.

b. For example, when shifting the Signal Slicer to 915 kilocycles (BC-348 receiver IF), values of the above components should be reduced by a ratio of 2:1; or, 1/2 the value specified for 455 kilocycles. Windings L_1 and L_2 on the 2.5-mh RF choke should have about 30-percent of their turns removed to reduce the inductance to one-half the original value. Capacitor C_{18} should be 150 mmf; C_{19}, a 25-mmf variable; and C_{22}, about 165 mmf, for this frequency.

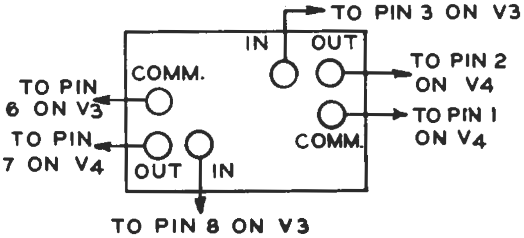


FIG. 1—CONNECTING DIAGRAM MILLEN NO. 75012 PHASE SHIFT NETWORK

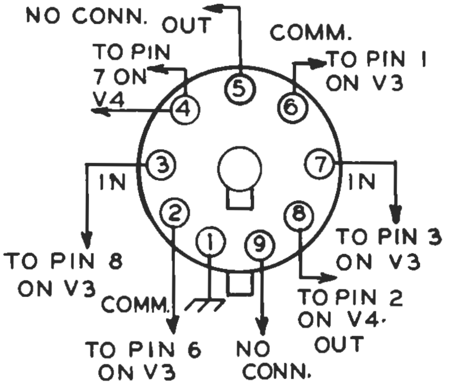


FIG. 2—CONNECTION DIAGRAM FOR CENTRAL ELECTRONICS PS-1 AND PS-JR. NETWORKS

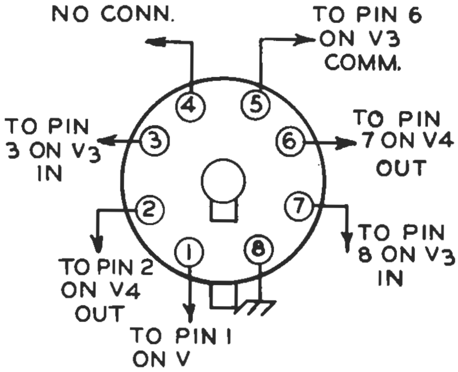


FIG. 3—CONNECTION DIAGRAM FOR B AND W MODEL 350, TYPE 2Q4 PHASE SHIFT NETWORK

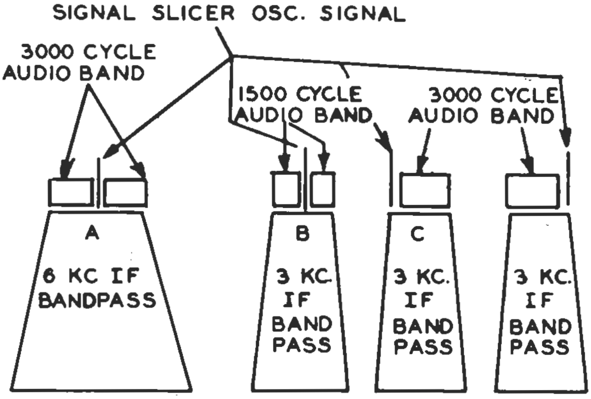


FIG. 4—DIAGRAM SHOWING RELATIVE POSITIONS OF OSCILLATOR SIGNAL AND AUDIO BANDS IF RECEIVER IF BANDPASS

c. The oscillator tank (C_{18}, C_{19}, L_1) and the RF phase shift network (C_{22} and L_2) should be hooked up temporarily according to the schematic diagram. Remove what looks like an estimated 20-percent of the turns from L_1, counting the number of turns removed. Check the resonant frequency of this circuit by listening for the oscillator signal on a broadcast receiver. Keep removing turns from L_1 until the oscillator tunes to 915 kilocycles with C_{19} about half meshed. Then remove the same number of turns from L_2.

80--85- KILOCYCLE IF AMPLIFIERS--Increase C_{18} to 1600 mmf, C_{19} to a 100-mmf variable, and C_{22} to 1650 mmf. Also increase C_{23} to a 15--130-mmf mica trimmer capacitor. Substitute a National R-100 10-mh RF choke for the 2.5-mh RF choke. Make the same connections, but it should not be necessary to remove any turns from the windings. If the oscillator frequency is too high, add small mica capacitors (50 to 100 mmf) across C_{18} until the oscillator is on the correct frequency.

OPERATING THE SIGNAL SLICER WITH NARROW-BANDWIDTH RECEIVERS--The original Signal Slicer was designed to operate with receivers having an IF bandwidth of 6 kilocycles or more. The tuning procedure calls for setting the oscillator to the center of the IF passband (Fig. 4A).

a. When using the Signal Slicer with receivers having a 2 to 3-kilocycle bandwidth, the oscillator frequency should be shifted when switching the sideband selector switch. If the oscillator in a Signal Slicer is set to the center of a 3-kilocycle IF passband, only audio frequencies below 1500 cycles will be heard, since the IF amplifier will pass only plus or minus 1500 cycles from the center frequency. This effect is shown in Fig. 4B.

b. By setting the oscillator to one edge of the IF passband, as shown in Fig. 4C, the full 3000-cycle speech range will be within the IF passband of the receiver. In order to change the oscillator frequency to the other side of the IF passband when shifting S_1 to receive the other sideband (Fig. 4D), a small fixed capacitor should be added across C_{18}. It will be necessary to add another section to S_1 to add this capacitance across C_{18}. This change is shown in Fig. 5. Just enough capacitance should be used for C_x to lower the oscillator frequency by 3 kilocycles. At 455 kilocycles, this will be about 5 to 10 mmf. It should be connected to both positions 1 and 2 on S_{1C}, to see which sideband position requires the lower oscillator frequency. This is best determined by experiment.

CRYSTAL CONTROLLED OSCILLATOR IN SIGNAL SLICER--The frequency stability of the oscillator in the Signal Slicer is sufficiently good for long-term operation without adjustment. However, amateurs who may wish to try crystal control of this oscillator can connect the crystal from control grid to ground in the 12AT7 tube, V_{1A}. Capacitor C_{21} (0.001-mfd) should be removed. Two crystals 3 kilocycles apart in frequency can be used if desired in the manner shown above.

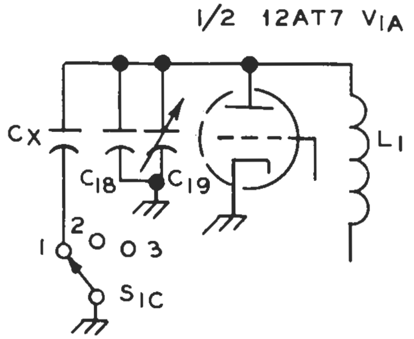
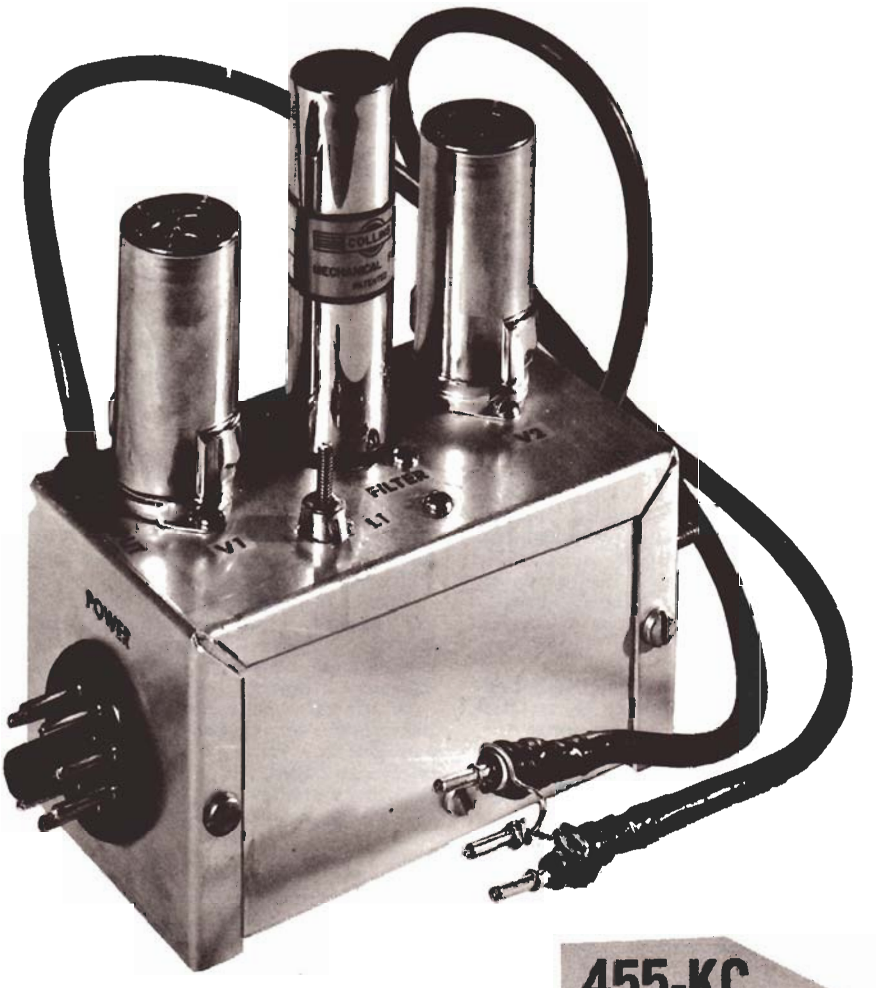


FIG. 5—DIAGRAM SHOWING CAPACITOR C_X AND EXTRA SWITCH ADDED TO OSCILLATOR IN SIGNAL SLICER. C_X IS 10 MMF AND SHOULD BE TRIED IN BOTH POSITIONS 1 AND 2 OF S_1C

PACKAGED SELECTIVITY

From March-April, 1957



455-KC MECHANICAL FILTER RECEIVER ADAPTER

Enjoy 1957-style selectivity and performance from your present receiver by plugging in this simple mechanical filter adapter that replaces the first IF amplifier tube.

—Lighthouse Larry

GENERAL INFORMATION

There are clear channels on today's crowded amateur bands even though you may not find them easily with your present communications receiver. Try tuning one of the new high-selectivity amateur receivers across a popular band and several clear channels usually will be found.

It is now possible to add this new order of selectivity to your present receiver—which otherwise may be quite satisfactory—by constructing a simple mechanical filter adapter unit that is substituted for the first 455-kilocycle intermediate-frequency amplifier tube (or the IF tube) without making any under-chassis changes in the receiver. Simply connect the adapter to a power source, remove an IF amplifier tube, and insert two short coaxial cables into the tube socket, as shown in Fig. 1. These cables carry the IF signal to and from the adapter, which may then be tucked away in an unoccupied corner of your receiver cabinet. An adapter that plugs directly into the tube socket could be constructed, but the available space is very restricted in many receivers.

The primary design and construction consideration of this adapter is to completely isolate the input and output circuits. Any stray coupling can cause signal leakage around the filter unit, thus impairing its effectiveness. For this reason, we recommend that the adapter be constructed as described.

Many modern medium-priced and older high-priced communications receivers now in general use are convenient to operate, have good frequency stability and sensitivity, but lack the necessary "skirt" selectivity to sufficiently reject strong signals that are only a few kilocycles higher or lower in frequency from a desired signal. The shaded area of curve "A" in Fig. 2 shows the typical selectivity characteristic of several popular medium-priced communications receivers. Although the peak, or "nose" of this curve is usually only a few kilocycles wide, the "skirt" selectivity 60 decibels down from the peak may be from 15 to 30 kilocycles broad! Small wonder that strong local signals a few kilocycles up the band from a station you are trying to copy may sometimes paralyze your receiver!

Incidentally, the curves at "A" are the bandwidth figures for a receiver with the selectivity control set for the sharpest bandwidth that does not utilize the crystal filter, if the receiver has one. Switching in the crystal filter will greatly sharpen the "nose" of the selectivity curve, but the width of the "skirts" may not be materially reduced.

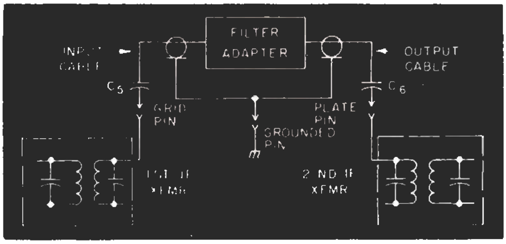


Fig. 1. Diagram showing how the mechanical filter adapter is connected to the first IF tube socket in the receiver.

When the "PACKAGED SELECTIVITY" adapter is installed in a receiver of this type, the crystal filter can then be utilized to reject, or "notch out" any heterodyne-type interference that may fall within the bandpass of the mechanical filter. Or, a "Q" multiplier may be connected into the receiver for this purpose. The mechanical filter has none of the characteristic "ringing" sound that sometimes results when a crystal filter is adjusted to produce an extremely sharp selectivity peak response curve. And lastly, the random noise output from the receiver will be reduced.

SELECTIVITY SYSTEMS

There are two systems generally used to obtain a bandpass characteristic that approaches the "ideal" communications receiver selectivity curve for voice-modulated signals, shown at "B" in Fig. 2. One system is the "packaged filter," including the mechanical filter as used in this adapter circuit, the crystal lattice filter, and certain toroidally-wound inductive filters. A good crystal lattice filter usually must be assembled from carefully matched war-surplus quartz crystals in this frequency range, while the toroidal filter operates at a lower frequency and requires a more complex frequency conversion adapter circuit.

The second method is to utilize a string of high "Q" circuits in the receiver's IF amplifier that are tuned to achieve the desired bandpass. This system can be space consuming, difficult to adjust and fairly expensive if quality components are employed.

Of the three packaged filters, the mechanical type has certain advantages. It is very compact, readily available in a variety of bandwidths, has an excellent selectivity curve, and is roughly equivalent in cost to the other systems having comparable selectivity. Curve "C" in Fig. 2 illustrates the selectivity of the 3.1-kilo-

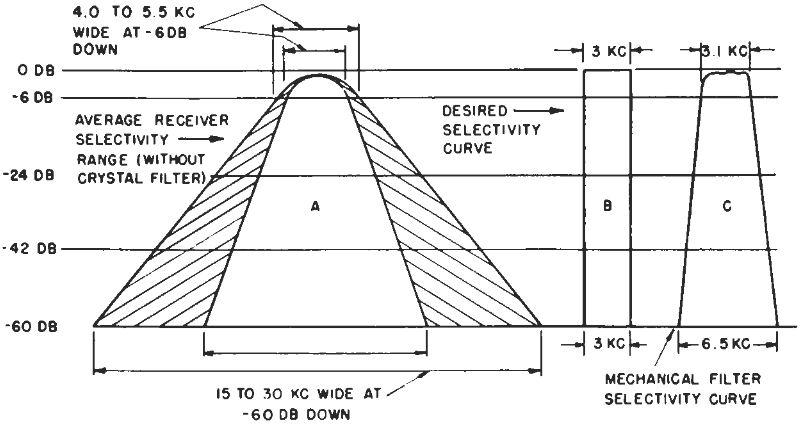


Fig. 2. Bandwidth curves showing: A—selectivity range of most medium-priced single-conversion receivers with crystal filter out of circuit; B—ideal selectivity curve for voice reception; and C—selectivity curve of a 455-kilocycle mechanical filter with a 3.1-kilocycle bandwidth.

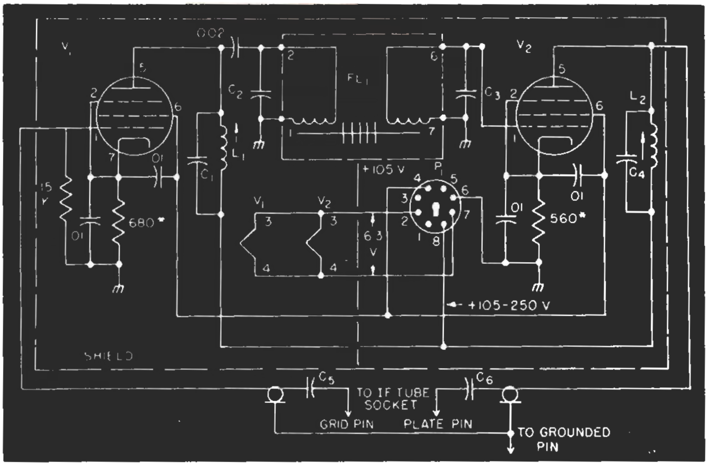


Fig. 3. Schematic diagram of the mechanical filter adapter.

PARTS LIST

C_1, C_4—600-mmf ceramic (270- and 330-mmf in parallel).

C_2, C_3—120-mmf ceramic.

C_5, C_6—10-mmf tubular ceramic (Aerovox Type CI-1 or Erie Type 315).

FL_1—455-kilocycle mechanical filter with 3.1-kilocycle bandwidth and 9-pin miniature plug-in base (Collins 455J-31).

L_1, L_2—200-uh iron slug-tuned coil (Grayburne or Superex Vari-loopstick Model VL, or Miller No. 6300).

P_1—male octal plug with retaining ring (Amphenol 86-PM-8).

V_1, V_2—6BA6 or 6BJ6 tubes.

cycle mechanical filter bandwidth suitable for AM and SSB reception. Compare this curve with "A," which is drawn to the same scale!

A mechanical filter is, as the name implies, a series of vibrating, mechanically resonant, disks tied together with small rods that transmit the vibrations from disk to disk. Small inductances coupled to the disks at both ends convert the electrical energy passing through them into mechanical vibrations at the input end and back into electrical energy at the output end. Each disk has a "Q" 20 times as high as an ordinary tuned circuit, so that several disks of slightly different resonant frequencies must be coupled together to achieve a nearly rectangular bandpass response curve.[1]

Since the filter characteristic determines the over-all intermediate frequency bandwidth, any other tuned circuits in the intermediate-frequency amplifier may utilize a low-cost, readily available coil, such as the vari-loopstick, instead of more expensive IF coupling transformers.

The adapter model pictured on the cover was assembled from parts that cost about five dollars (plus $45.00 for the Collins F-455J-31 filter). W2FZW, designer of the adapter, was so pleased with his station receiver's new-found selectivity (formerly about 30 kilocycles broad at the −60-db points) after testing the adapter that he promptly added "A4" to the receiver's model number!

Receivers with an intermediate-frequency amplifier on 465 kilocycles (mostly found in pre-World War II receivers) must be re-aligned to the 455-kilocycle center frequency of the mechanical filter, otherwise very little signal will be heard when the adapter is added. This change in the intermediate frequency will render the crystal filter practically inoperative unless a 455-kilocycle filter crystal is substituted for the original.

ELECTRICAL DETAILS

The adapter picks up the signal from the control grid of the receiver's first IF amplifier tube socket through coupling capacitor C_5, then feeds it to the grid of a pentode tube, V_1, in the adapter unit, as shown in the schematic diagram, Fig. 3. The plate circuit of V_1 is capacity-coupled to the input terminals on the mechanical filter to keep plate current from flowing through this coil. A much wider signal voltage range can be handled by the filter without distortion when no current flows through the coils. Both filter coils are tuned to resonance at the operating frequency by fixed capacitors C_2 and C_3.

The filter output terminals are connected directly to the control grid of V_2 and the chassis, since no grid current will flow in this stage. The output signal from V_2 is again capacity coupled back into the plate terminal of the receiver's IF tube socket. The tuned circuits connected to the plates of both V_1 and V_2 are composed of vari-loopstick coils, L_1 and L_2, shunted by fixed capacitors C_1 and C_4.

The input and output coaxial cables are 16-inch lengths of RG-58/U. This cable forms the 40-mmf ground leg of a capacitor voltage divider, C_5 being the other leg, that reduces the signal voltage applied to V_1 to about ¼ of the voltage across the secondary of the receiver's first IF transformer.

The over-all signal amplification of the adapter has been held down to a few decibels more than the 10-db loss through the filter through use of small input and output coupling capacitors and fairly large cathode bias resistors in both amplifier stages. This is suitable for receivers having two or more intermediate-frequency amplifier stages, but additional gain from the adapter may be obtained by reducing the value of one or both cathode resistors to 270 ohms. This may be desirable when the adapter is operated with a receiver having only one intermediate frequency amplifier stage. The capacity ratio in the input voltage divider may be reduced by shortening the input cable, or increasing C_5 to 25 mmf, for a further increase in gain, but the first IF transformer in the receiver may then have to be retuned to achieve maximum signal.

Power was brought into this unit through a male octal chassis plug, but a three- or four-wire cable may be substituted. The pin connections were made as shown so that this adapter could be plugged directly into the "NBFM" adapter socket on certain National receiver models. Most communications receivers have an accessory power socket on the rear of the chassis from which power may be obtained. If 6BJ6 tubes are used for V_1 and V_2, the power required (6.3 volts at 0.3 amperes, and 105 to 250 volts at 10 ma) may be

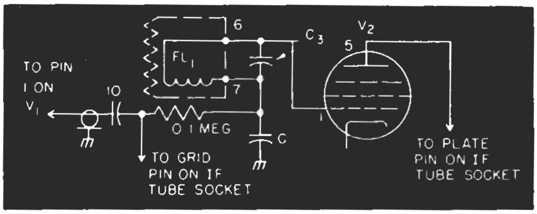


Fig. 4. Alternate output coupling and optional AVC connections in the adapter.

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[1] A comprehensive discussion of mechanical filters may be found in the following articles: *QST* magazine, "Mechanical Bandpass Filters for IF Ranges," February, 1953, page 22; *Proceedings of the IRE*, January, 1957, page 5; and in *Collins Application Bulletin No. 200.*

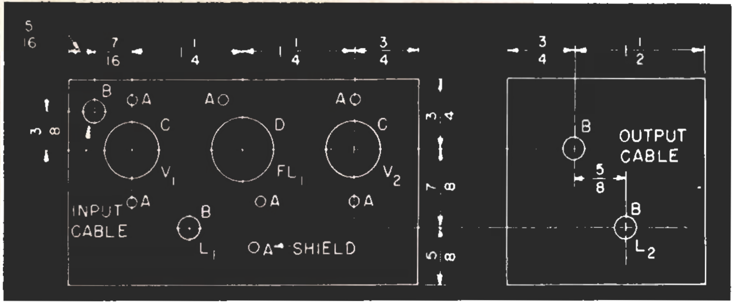


Fig. 5. Suggested parts layout for the adapter.

DRILLING LEGEND

"A"—No. 32-drill for socket and shield

"B"—$\frac{9}{32}$-inch-diameter drill

"C"—⅝-inch-diameter socket punch

"D"—¾-inch-diameter socket punch

little more than was drawn by the IF tube replaced by the adapter. A single plate and screen voltage lead will suffice when the supply voltage is 130 or less. A single 250-volt DC source will require that an 18,000-ohm, 12-watt screen voltage dropping resistor be connected between pins 4 and 8 on the power plug.

An alternate output coupling circuit, and a method of applying AVC voltage from the receiver to the second amplifier stage in the adapter are shown in Fig. 4. This circuit is mainly useful when the adapter is connected to a receiver that has few AVC-controlled stages. The AVC voltage is taken from the control grid connection on the IF tube socket and is applied to the grid of V_2 through the output coupling coil of the mechanical filter. The lead from the plate of V_2 to the IF tube socket should be the shortest possible length of RG-59/U coaxial cable. The primary of the receiver's second IF transformer should be returned after plugging in this cable.

MECHANICAL DETAILS

This adapter unit was constructed in a 2¼- x 2¼- x 4-inch Minibox (Bud CU-3003), a good compromise that is compact, yet not too small for easy wiring. A larger box may be required if a "B" or "C" type rectangular mechanical case filter designed for horizontal mounting is used instead of the "J" model. A somewhat smaller Minibox will suffice if the circuit in Fig. 4, eliminating L_2, is used.

For maximum isolation between input and output circuits, a parts layout similar to that shown in the drilling diagram, Fig. 5, should be followed. After drilling and punching all holes, the tube and mechanical filter sockets, power plug and rubber grommets may be assembled. Solder lugs were placed on all socket screws for ground connections. Then, a 3- x 3-inch piece of perforated sheet aluminum is formed into the shield shown in the bottom and oblique views, Figs. 6 and 7, respectively. A ⅜-inch-wide flange is formed along all edges of this shield except where it crosses the center of the 9-pin socket. A small notch is cut in the shield next to the socket for heater and plate power leads to V_2. The shield passes between the lugs for pins 3 and 4, and 8 and 9, then is bolted to a soldering lug that has been soldered to pin 2 on the socket. The upper flange on the shield also is bolted to the box directly above L_2, and two self-tapping screws are driven into the shield's side flanges when the other half of the box is assembled.

Assembling the two IF tube socket probes takes little more time than is required to explain it. First, cut two lengths of RG-58/U coaxial cable 17 inches long and remove 1½ inches of the vinyl cover on one end of each piece. Slide the braided shield back over the outer cover, then trim the center conductor and insulation so that ½ inch protrudes beyond the shield. Next, skin the insulation to expose ¼ inch of the center conductor, trim one lead of the 10-mmf capacitor, C_5, and solder it to the center conductor with a $\frac{5}{16}$ of an inch overlap. Cut narrow strips of plastic insulating tape and wrap them around this joint up to the body diameter of the capacitor as shown in Fig. 8.

Slide the braided shield over the capacitor, pull it

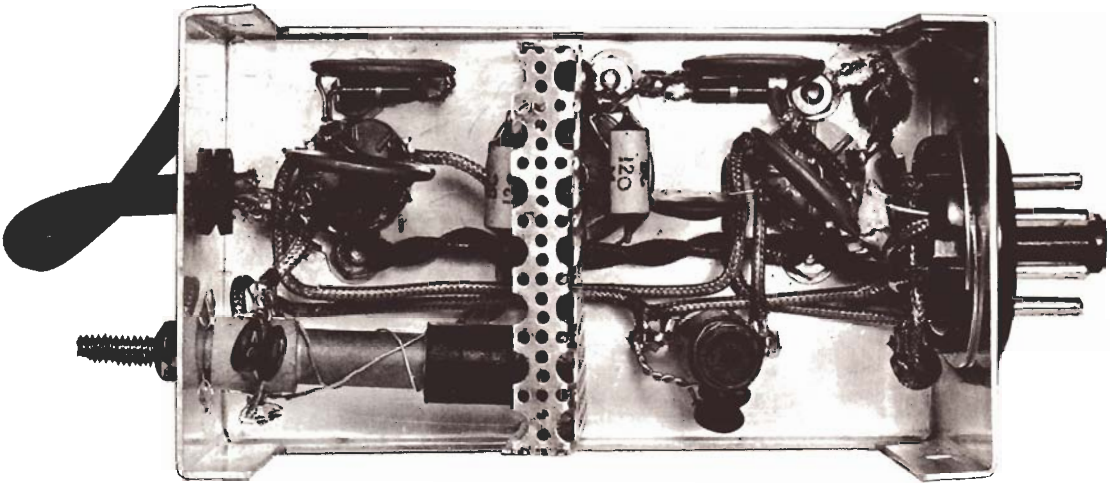


Fig. 6. Bottom view of the adapter showing locations of major parts.

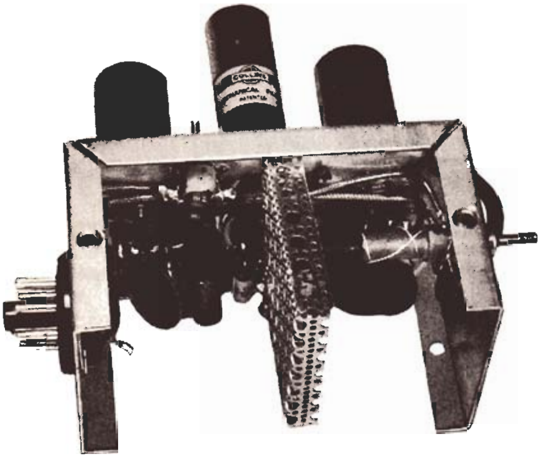


Fig. 7. Oblique view of the adapter.

tight and wrap a short length of tinned copper wire twice around the middle of the capacitor. Solder the wire to the shield and trim off the excess shielding. The tinned wires from each cable are then soldered to a pin from an octal tube base for a plug-in ground connection. Similar pins are also soldered to the capacitor leads, and the excess lead trimmed off. The exposed cable shield is then wrapped with plastic tape.

Capacitors C_5 and C_6 also may be soldered directly to a male octal plug, if desired, instead of making individual pin connections. If the receiver has a 7-pin miniature tube in the first IF amplifier, short lengths of No. 18 tinned wire may be used for the plug-in pins on the cables, or the capacitors and ground lead may be soldered to a special 7-pin miniature male adapter plug (Vector No. P-7).

For easy parts assembly, the shield may be temporarily removed, and replaced when wiring is completed. Heater, screen and plate power wires are next installed, keeping all such leads close to the box wherever possible to minimize stray signal pickup. Small parts, resistors and capacitors, are now soldered in place, after which the coaxial cable input and output leads are connected. About ⅝ of an inch of the outer vinyl jacket is skinned from these cables and the shield braid is twisted into a single conductor. These cable ends are then brought into the box through rubber grommeted holes. The cable shield is soldered to the closest ground lug and the center conductors are soldered to the correct tube socket pins. Finally, the vari-loopstick coils and capacitors C_1 and C_4 are assembled and wired.

OPERATION

The adapter is connected to a communications receiver as previously described, following a wiring and power check to insure that the correct voltages are applied to the various tube elements. The receiver should then be tuned to the center of a strong, steady local amateur or broadcast station signal. If the recevier has an "S" meter, the AVC may be left "ON" while tuning the slugs in coils L_1 and L_2 for maximum carrier strength on the meter. On a receiver that has no "S" meter; L_1 and L_2 are best adjusted by turning the RF gain down, the audio gain up, and tuning both coils for maximum audio output from a modulated signal. Tuning adjustments on the first and second IF transformers in the receiver also may be touched up for highest output, although no improvement in gain may be noted if C_5 and C_6 are only 10 mmf.

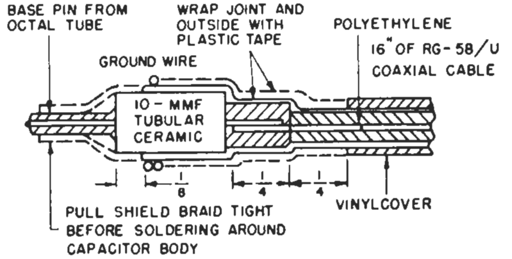


Fig. 8. Cross-section assembly view of signal cables.

TUNING TIPS

A somewhat different technique should be used for tuning AM and SSB signals on a receiver following installation of "PACKAGED SELECTIVITY." If any of your local hams have a receiver with built-in mechanical filters, you may wish to have him brief you on this subject. And it's also a good opportunity to compare the selectivity improvement you can expect from this adapter.

Modulated signals with carrier should be tuned in so that the carrier is placed on one edge, rather than the center of the IF passband shown in Fig. 1C. If you tune a bit too far, the carrier will drop off the edge and will be suppressed, and the modulation will sound like an SSB signal—practically unintelligible. Since only one sideband of a double-sideband signal will be heard at a time, the receiver tuning may be shifted so that the sideband on which a heterodyne is present may be "pushed off" the edge of the IF bandpass.

When receiving single-sideband, suppressed carrier signals—or for single-signal CW reception—the receiver's beat frequency oscillator is turned on and the "PITCH CONTROL" is adjusted so that the BFO carrier is near one edge of the IF passband. The proper pitch control setting may be determined by tuning the receiver across a carrier while adjusting the pitch control so that a beat note on only one side of zero beat is heard. After noting or marking this setting of the pitch control, again turn it so that the test signal on only the other side of zero beat is heard. Note this setting, then try tuning in an amateur SSB signal. If intelligible speech cannot be heard, shift the BFO pitch control to the first-noted setting and again carefully tune the receiver. Intelligible speech should now be heard.

As with the reception of 'phone signals with carrier, some interference can be removed from an SSB signal by shifting the BFO pitch control a small amount, then retuning the receiver so that the correct voice pitch is again heard.

This adapter will serve as a good signal slicer for SSB reception, especially if your receiver has strong BFO injection to the second detector circuit. When the usual diode second detector is replaced by a product detector, which can also be constructed as a plug-in adapter, a wide range of SSB signal strengths can be handled by the receiver without continually turning the RF gain control up and down. (See "CQ" magazine, November, 1956, page 19; and the ARRL's "Single Sideband for the Radio Amateur," page 86, for additional details on product detectors.)

In addition to the 3.1-kilocycle bandwidth filter previously mentioned, 455-kilocycle plug-in filters may be obtained in the following bandwidths: 0.5, 1.5, 2.1, 4.0, 6.0 and 12.0 kilocycles at the −6 db points.

The 2.1-kilocycle bandwidth model is ideal for reception of SSB and exalted-carrier reception of AM signals. The 0.5-kilocycle bandwidth model provides just about the maximum selectivity that is practical for CW reception. Devoted brass pounders may prefer this bandwidth, especially during DX and other contests. Samples of the 0.5- and 2.1-kilocycle filters were tested simply by plugging them into this adapter. The same shunting capacitors, C_2 and C_3, may be used with both filters.

If you still have a soft spot in your heart for that old receiver, enjoy 1957 selectivity from it by installing "PACKAGED SELECTIVITY" that meets your bandwidth needs.

MOBILE SSB RECEPTION

MOBILE SSB RECEPTION . . .

Successful reception of single and double sideband signals in a mobile radio system requires that the receiver have excellent frequency stability, on the order of cycles at several megacycles. Also, sufficient selectivity to attenuate signals on adjacent channels is highly desirable.

The double conversion superhetrodyne receiver circuit, when properly applied, will meet both of these major requirements. It makes possible using crystal control in the high frequency oscillator for the first frequency converter when a band only a few hundred kilocycles wide — such as an amateur band — will be tuned by the receiver.

The tunable portion of the receiver can then be operated much lower in frequency where tunable oscillators for the second converter can easily be built with a stability within a hundred cycles. Some top-performing amateur radio receivers utilize this principle.

The double conversion receiver principle has been applied by W8DLD and W8WFH to attain excellent stability and selectivity at low cost by using the BC-453 Command Set receiver, covering 190 to 550 kilocycles, as a tunable i.f. amplifier preceded by high-frequency converters with crystal-controlled oscillators. The selectivity and stability of the BC-453 are widely recognized in amateur radio circles.

CRYSTAL FREQUENCY CHART

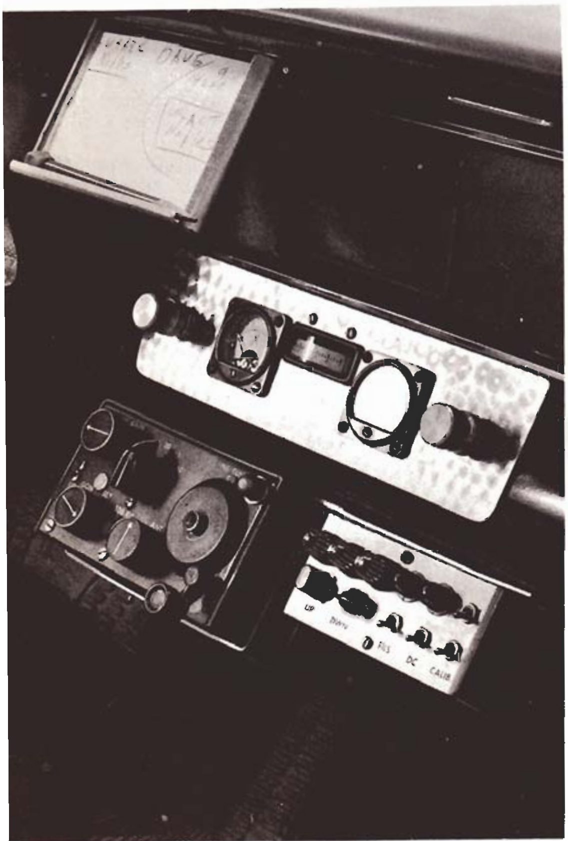
CRYSTAL FREQ. (MC)	HARMONIC	INJECTION FREQ. (MC)	BAND TUNED (MC)	BC-453 RANGE (MC)
3.2	Fund.	3.2	3.5- 3.85	0.2-0.55
3.5	Fund.	3.5	3.7- 4.0	0.2-0.5
6.8	Fund.	6.8	7.0- 7.3	0.2-0.5
6.9	2nd	13.8	14.0-14.35	0.2-0.55
4.6	3rd	13.8	14.0-14.35	0.2-0.55
6.933	3rd	20.8	21.0-21.35	0.2-0.55
5.2	4th	20.8	21.0-21.35	0.2-0.55
6.967	3rd	20.9	21.1-21.45	0.2-0.55
5.225	4th	20.9	21.1-21.45	0.2-0.55
6.975	4th	27.8	28.0-28.35	0.2-0.55
7.0	4th	28.0	28.2-28.55	0.2-0.55
7.075	4th	28.3	28.5-28.85	0.2-0.55
7.15	4th	28.6	28.8-29.15	0.2-0.55
7.225	4th	28.9	29.1-29.45	0.2-0.55
7.3	4th	29.2	29.4-29.75	0.2-0.55

The tunable oscillator in the BC-453 operates sufficiently low in frequency, and is mechanically rugged, to minimize the effects of temperature and power supply voltage variation, and shock and vibration upon its stability. Of course, the crystal-controlled oscillators in the amateur band converters have excellent stability too.

Incidentally, here is a more complete listing of crystal frequencies which can be used in the converters described herein than the crystals covered in the coil tables. The listing also shows the harmonic of the crystal oscillator required for injection to the mixer, the signal frequency ranges covered, and the tuning range of the BC-453 receiver for each crystal.

The BC-453 receiver will work fine with 150 volts on the plates. If 300 or more plate volts are applied, bypass capacitors may fail. W8DLD suggests using a VR-150 or 0A2 regulator tube to hold the plate voltage down to 150 volts. Use a power supply with at least 200 volts output and drop the voltage with a 10-watt adjustable resistor, set so that the VR tube is ignited at all times.

Try the converter/BC-453 receiving combination described in this issue. I'm sure you'll be pleased with its performance.



W8WFH's bandswitching converter, and the metering panel and power control box, all form a neat under-dash package in the above view. The tuning dial on the converter actually tunes the BC-453 receiver— tucked up on the firewall at the right side of the car—through a flexible shaft.

BANDSWITCHING MOBILE CONVERTER From September-October, 1960

By W. C. Louden, W8WFH

MOBILE OPERATION on several amateur bands requires that the transmitting and receiving equipment in the installation — as well as the antenna — be constructed to be switched readily to the band on which operation is desired at a particular time. A bandswitching converter with crystal controlled oscillator, designed to work into a receiver covering an established intermediate frequency tuning range, can be constructed in little more space than is needed to house a converter covering only a single band.

The converter used at W8WFH/M, however, also incorporates a remote tuning dial which simply drives a flexible shaft coupled to the receiver, mounted up under the right side of the dash in the car. Other controls for the i.f. receiver — r.f. gain, audio gain, AVC switch, and sideband selector switch — also were built into the converter, although these controls and the dial could easily have been located elsewhere.

SEPARATE COILS were used in each of the r.f. circuits of the converter shown in the schematic diagram, Fig. 1, to cover the five amateur bands from 3.5 to 30 megacycles. A 6CB6 sharp cutoff r.f. pentode functions as the r.f. amplifier, while the pentode section of a 6U8 (or 6U8-A) is the mixer. The triode 6U8 section is the crystal oscillator.

(continued on page 4)

TABLE I — PARTS LIST — BANDSWITCHING CONVERTER

C_1	5-35 mmf midget air variable.
C_2	5-140 mmf midget mica padder.
J_1, J_2	auto radio type antenna connectors; or, midget phono jacks.
L_1 to L_4	r.f., mixer and oscillator coils on CTC LS-6 iron slug-tuned coil forms; see COIL TABLE for details on windings.
RFC_1	0.5 millihenry pi-wound r.f. choke.
RFC_2	2.5 millihenry pi-wound r.f. choke, tapped between first and second pies.
S_1	(S_{1A} to S_{1E}) 5-pole, 5-position, 5-section midget rotory tap switch.
S_2, S_3, S_4	1-pole, 2-position midget slide switches.
X_1	Quartz frequency control crystals, 5 required; see COIL TABLE for frequencies.

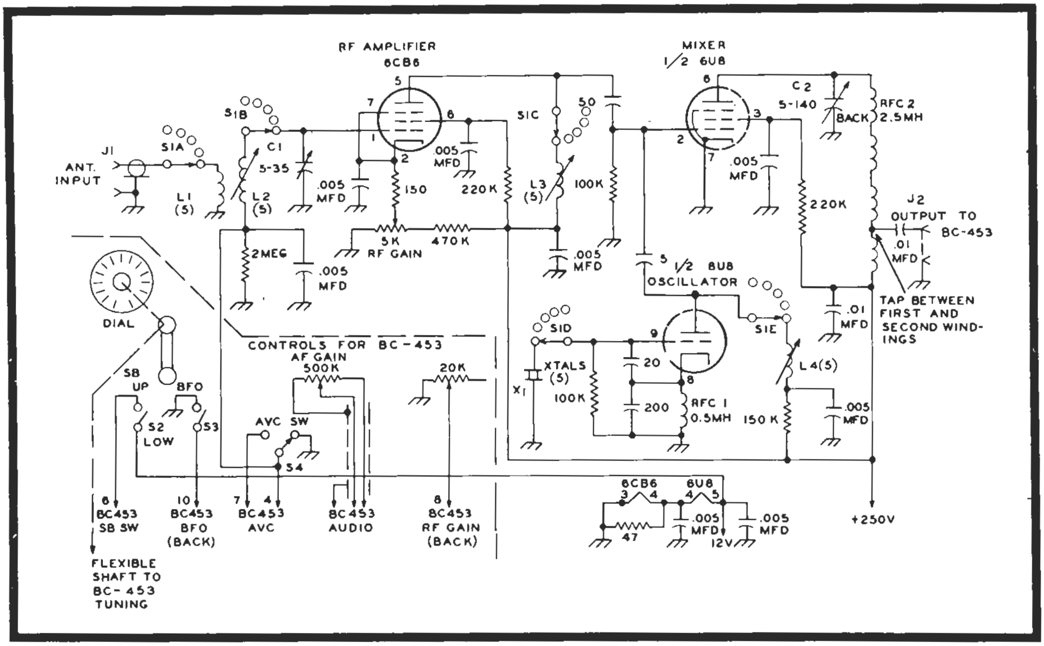


FIG. 1. **SCHEMATIC DIAGRAM** of the bandswitching mobile converter constructed by W8WFH. All resistances are in ohms, ½-watt rating, and capacitances are in micro-microfarads (mmf), unless otherwise marked. All controls at the lower left corner are for the BC-453 receiver with which this converter is used. Only one set of coils is shown for L_1, L_2, L_3 and L_4; actually there are five coils in each of these locations, each connected to a separate position on S_{1A} to S_{1E}.

PANEL VIEW PHOTO of the bandswitching converter. Only the controls marked "RF GAIN," "ANT.," and "80-40-20-15-10" (the bandswitch) actually control circuits in the converter.

(continued from page 3)

The crystal oscillator functions at the crystal fundamental frequencies to cover the 3.65-4.0 and 7.0-7.3 tuning ranges, as shown in TABLE II—COIL TABLE. For 14.0-14.35 megacycles, the second harmonic (13 megacycles) of the 6.9-megacycle crystal is the injection frequency, while the fourth harmonic of a 5.25-megacycle crystal (21.0 megacycles) is used to cover 21.10-21.45 megacycles. Five crystals in the range of 6.95 to 7.2875 megacycles are required for complete coverage of the 28-megacycle band. However, the fourth harmonic (28.3 megacycles) of a 7.075-megacycle crystal will give coverage of 28.5 to 28.85 megacycles where most sideband operation occurs on this band. Other crystal combinations are suggested in

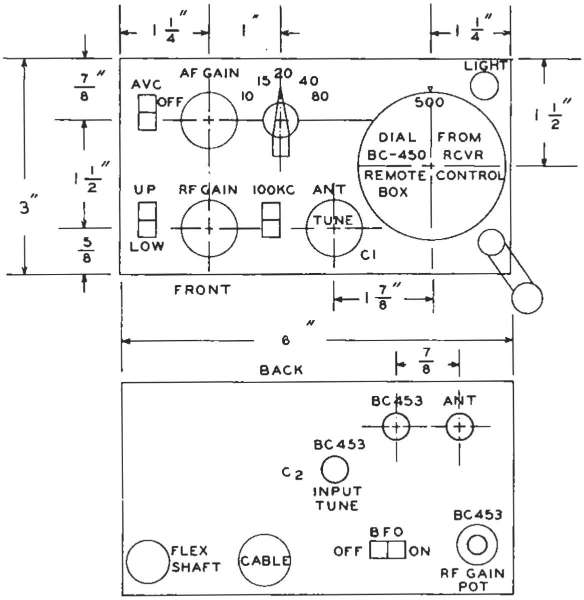
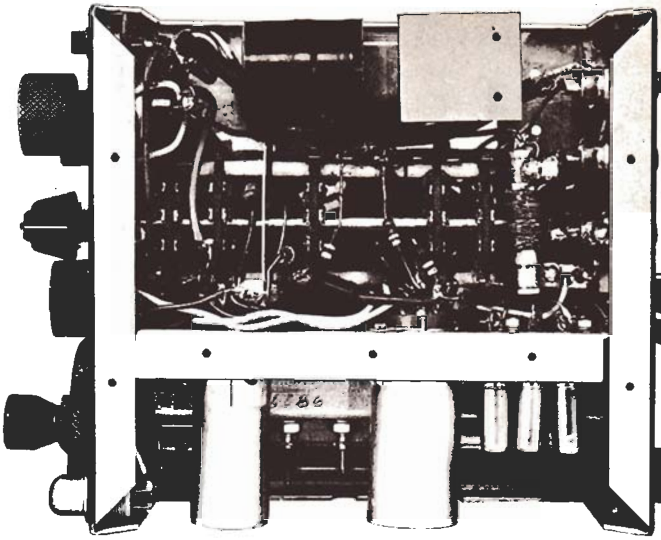


FIG. 2. FRONT AND REAR panel drilling diagrams for the bandswitching converter. The slide switch marked "100 KC" applies plate voltage to a 100-kilocycle crystal calibrator which the author included in his converter, but is not shown in the schematic diagram, Fig. 1. All the BC-453 controls could be mounted on a separate panel to reduce crowding in the converter, if desired.

TABLE II — COIL TABLE — BANDSWITCHING CONVERTER

AMATEUR BAND (MC)	CRYSTAL FREQ. (MC)	INJECTION FREQ. (MC)	COILS (inductance in uh and CTC Part No.)			
			L_1 (turns)	L_2	L_3	L_4
4	3.5	3.5	10 of #30 enam.	16-30 + 30* (X2060-5)	61-122 (X2060-7)	61-122 (X2060-7)
7	6.8	6.8	7 of #30 enam.	10-18 (X2060-4)	16-30 + 30* (X2060-5)	28-63 (X2060-6)
14	6.9	13.8	5 of #30 enam.	3.4-7.0 (X2060-2)	3.4-7.0 + 10* (X2060-2)	16-30 (X2060-5)
21	5.25	21.0	3 of #30 enam.	2.0-3.7 (X2060-1)	2.0-3.7 (X2060-1)	2.0-3.7 (X2060-1)
28	7.075	28.3	2 of #30 enam.	17 turns of #24 enam.	22 turns of #26 enam.	22 turns of #26 enam.
			(Wind 28-MC coils on CTC LS-6 Forms)			

*Small ceramic capacitor across coil where indicated — otherwise only circuit capacitance.



TOP VIEW PHOTO of the bandswitching converter model. The 100-kilocycle crystal calibrator components are fastened to the small angle bracket in the upper portion of this view. The bandswitch was built up from a Centralab midget tap switch index assembly (PA-302), and five switch wafers (PA-31). Although this 6 x 6 x 3-inch box was fabricated by the author, the converter can easily be housed in a 7 x 5 x 3-inch Minibox if the BC-453 controls are not included.

the CRYSTAL FREQUENCY CHART for the converters on page 2 of this issue. Oscillator coils (L_4) tune to the crystal harmonic frequency being used.

A 2.5-millihenry r.f. choke, tapped between the first and second pies from the end to which plate voltage is applied, serves as the converter output circuit and is peaked at the desired frequency in the 190 to 550-kilocycle tuning range of the BC-453 receiver with C_2. An alternate output circuit, shown in Fig. 2 of the single band converter article on page 8, also is suitable for this converter.

CONSTRUCTION of the model shown in the photos was accomplished in a 6 x 6 x 3-inch home-fabricated box made in two sections. However, the converter can be constructed into a 7 x 5 x 3-inch Minibox (Bud CU-3008) if the remote tuning dial and BC-453 controls are not included in the box. Or, these controls can be included when the converter is constructed in a Minibox 8 x 6 x 3½ inches (Bud CU-3009) in size.

Dimensions are given in the panel layout diagram, Fig. 2, the box layout diagram, Fig. 3, and the subchassis layout diagram, Fig. 4, for the 6 x 6 x 3-inch box, but will serve as a guide for the larger standard Miniboxes suggested above. It is best to select the box size to fit into the space available in each individual mobile installation.

Major parts were mounted in the locations shown in the above diagrams, and should be kept in the same relative positions in the larger boxes. The subchassis has a ½-inch step, as shown in the side view, and was made with narrow flanges along the upper, lower and rear edges to facilitate rigid mounting.

Wiring should be handled in the usual manner for high-frequency circuits: Shortest possible grid, plate and coil leads; disc ceramic bypass capacitors soldered with shortest possible leads; power wiring run well away from r.f. coils; and short lengths of coaxial cable for the antenna input and output connections to the BC-453 receiver.

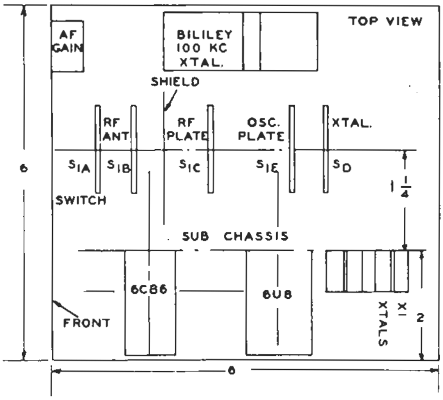


FIG. 3. TOP LAYOUT DRAWING of the converter. The subchassis should be trimmed to clear the top flanges on the box.

THE TUNEUP PROCEDURE is quite simple, once construction is completed and a check has been made of the heater and plate power circuits to ensure that the correct voltages appear on both tubes. Plate voltages will be the same as the power supply voltage, and screen voltages will range from 100 to 120 volts on both the 6CB6 and 6U8 tubes.

The crystal oscillator should be adjusted first. A general coverage receiver is helpful in checking to see that the oscillator works on all bands, and that the plate coils (L_4) are tuned to the correct harmonic frequency. Set S_1 to the 3.5-megacycle position, tune the receiver to 3.5 megacycles, and tune the 3.5-megacycle L_4 for maximum signal in the receiver.

Next, switch S_1 to 7 megacycles, set the receiver at 6.8 megacycles and tune the 7-megacycle L_4 for maximum signal. For 14

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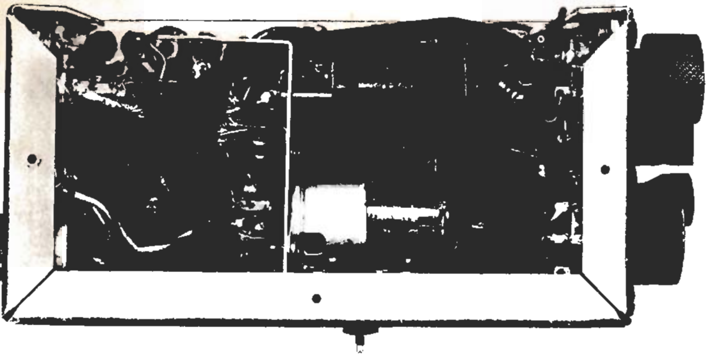


PHOTO SHOWING LEFT side of the converter. The crystal calibrator components—tube, crystal, tuning capacitor (extending out bottom) and angle bracket—are in the center. Flanges on box are 3/8 of an inch wide.

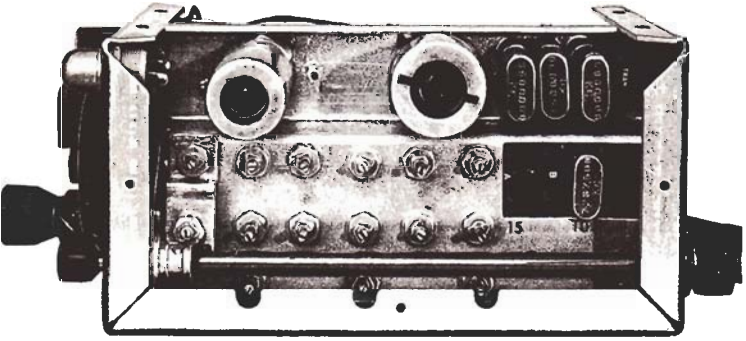


PHOTO SHOWING RIGHT side of the converter, with some crystals (X_1) removed to show double crystal sockets. Positions of the coils on the subchassis are shown in Fig. 4. The remote tuning dial shaft runs back through the converter just below the coils.

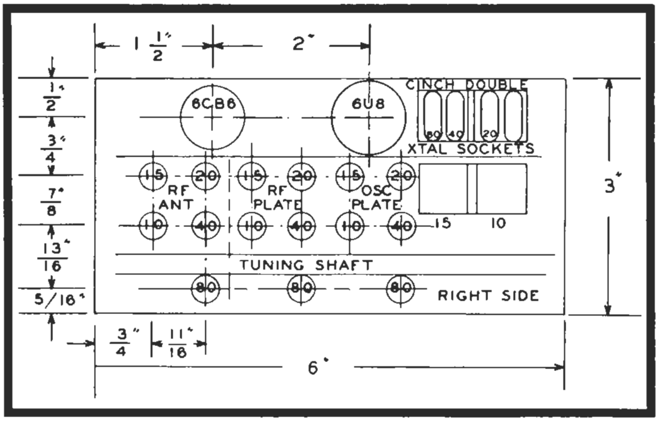


FIG. 4. LAYOUT DIAGRAM for the converter subchassis on which the tube sockets, coils and crystal sockets are mounted. Holes not marked for location and size should be drilled to suit the components used. The subchassis has a ½-inch step between the coils and tube sockets.

(continued from page 5)

megacycles, set S_1, tune the receiver to 13.8 megacycles, and tune the 14-megacycle L_4 for maximum signal. For 21 and 28 megacycles, calculate the correct harmonic frequency of the crystal being used, set the receiver at that frequency, and peak the proper L_4 coils.

FRONT-END ALIGNMENT consists simply of peaking the mixer grid (L_3) and r.f. amplifier grid (L_1-L_2) coils at the center of the tuning range for each band. The converter output should, of course, be connected to the BC-453 receiver, and a signal generator — or amateur band signals from an external antenna — should be fed into the converter input, J_1.

Set the BC-453 receiver at about 350 kilocycles and set C_1—the r.f. stage grid peaking capacitor — at mid-capacitance. Tune the mixer grid coils (L_3) first for maximum signal at these frequencies, and then peak the r.f. coils (L_1-L_2) for each band. Either the signal generator, or external signals close to the specified frequencies, may be used.

The alignment may be completed before the converter is "buttoned up" by installing the top half of the box, since the coils are sufficiently removed from it to have little effect on the inductance values.

Both converter power and remote control connections were made through a 12-pin plug and cable running to the BC-453 receiver. Length of this cable, and the flexible shaft for tuning, will be determined by the space available in the constructor's car, and probably will be from 24 to 36 inches long.

Single Band Mobile Converters

From September-October, 1960

By. A. F. Prescott, W8DLD

THE SINGLE BAND approach appeals to many mobile amateur radio operators who concentrate their operations mainly on one or two bands because of space limitations, or the nature of local activity. The equipment can be constructed easier because of the absence of a bandswitch and multiple sets of coils. Those amateurs who work two bands can construct plug-in r.f. units for the receiver front end — and transmitter too — and achieve optimum performance on each band.

At W8DLD/Mobile, five single-band converters were constructed to cover the amateur bands from 3.5 to 30 megacycles. All units have plug-in connections for easy changing, and follow the same basic circuit. Because of the fairly low frequency chosen for the tunable i.f. range — 200 to 550 kilocycles — four tuned circuits at the signal frequency were included in each converter for maximum rejection of image signals. These image signals will be twice the frequency to which the BC-453 is tuned away from the amateur band signal frequency: An image frequency 400 kilocycles below the signal frequency when the BC-453 is tuned to 200 kilocycles; and an image frequency 1,000 kilocycles below the signal frequency when the BC-453 is tuned to 500 kilocycles.

The triode section of a 6U8 pentode-triode functions as a grounded-grid r.f. amplifier, as shown in the schematic diagram, Fig. 1. The antenna input circuit is untuned, with only a 2.5-millihenry r.f. choke in the cathode DC return. Coils L_1 and L_2 form a bandpass coupler which feeds the pentode section of the 6U8 as a second r.f. amplifier, with an r.f. gain control in its cathode circuit.

TABLE I — PARTS LIST — SINGLE BAND CONVERTER

C_1	midget silvered mica or ceramic capacitor; try valves from 1 mmf to 5 mmf for optimum oscillator injection without excessive oscillotor harmonic signal input.
C_2	5-140 mmf midget air capacitor.
J_1	midget phono jack.
L_1 to L_5	Bandpass transformers made from Merit TV-104 or TV-108 shielded coils; see TABLE II—COIL TABLE, and text for details.
P_1	6-pin male chassis type power plug (Jones P-306-AB).
RFC_1	1 millihenry pi-wound r.f. choke (National R-50, 1 mh.).
RFC_2	2.5 millihenry pi-wound r.f. choke, tapped between first and second pies.
X_1	Quartz frequency control crystals; see TABLE II — COIL TABLE, for frequencies.

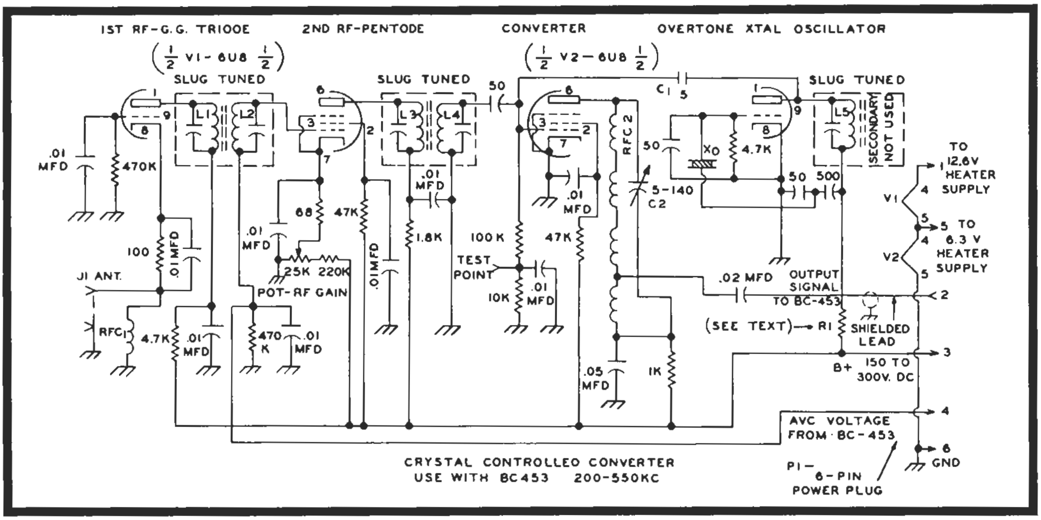


FIG. 1. SCHEMATIC DIAGRAM for the single band converters designed and constructed by W8DLD. All resistances are in ohms, ½-watt rating, and capacitances are in micro-microfarads, if not otherwise marked. The output signal runs through pin 2 on the power plug, P_1. Note that 6 volts DC should be applied to pin 5, and pin 1 grounded, for operation of the converter from 6 volts.

TABLE II — COIL TABLE — SINGLE-BAND CONVERTERS

AMATEUR BAND (MC)	PART NO. (MERIT)	ALTERATIONS TO BE PERFORMED ON COILS L_1 TO L_5, INCLUSIVE
4	TV-108 (4.5-MC TV IF)	Remove coils from forms. Reploce with single pies (same position) from 2.5-mh. r.f. choke. Remove turns from inside of pies until coils fit on forms ot original coil positions. Remove more turns until circuits tune to 4.3 MC with slug out and 25-mmf capacitors across each coil in place of original capacitors.
7	TV-108	Remove 50-mmf capacitors across TV-108 coils and replace with 20-mmf capacitors. Remove turns from original coils until each circuit tunes to 7.5 MC with slug all the way out.
14	FM-251 (10-5-MC FM IF)	Turn slugs nearly all the way out of coils ond remove turns from each coil until each circuit tunes to 14.8 MC. Use original capacitors across coils.
21	TV-104 (21-MC TV IF)	No alterations required in either coils or capacitors. Tune each circuit to 21-MC band to achieve proper bandpass.
28	TV-104	Turn slugs neorly all the way out of coils and remove turns from each coil until each circuit tunes to 30 MC.

(continued from page 7)

The second pair of coils, L_3 and L_4, couple the signal into the pentode section of a second 6U8, operating as a mixer. The triode section of this tube is the crystal oscillator, operating either on the fundamental or harmonics of the crystal, as described in the bandswitching converter. Oscillator signal injection is through a small coupling capacitor. Values from 2 to 5 mmf should be tried, to obtain optimum oscillator injection.

Plate circuit of the mixer is again a 2.5-millihenry r.f. choke (RFC$_2$), with the i.f. output signal tapped off between the first and second pies. An optional mixer output circuit, using a Miller No. 70-A broadcast receiver antenna coupling coil, is shown in Fig. 2. The antenna winding is used for the output link to the power plug, P_1.

THE CHASSIS on which all converters were constructed is a 5¼ x 3 x 2⅛-inch Minibox (Bud CU-3006) and provides plenty of room

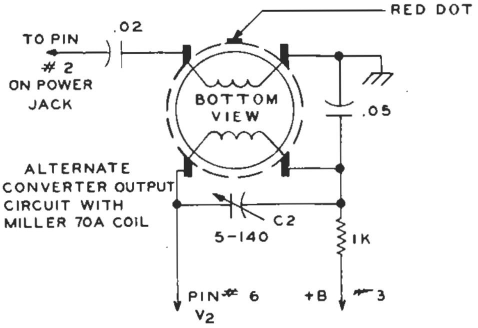


FIG. 2. **OPTIONAL OUTPUT CIRCUIT** for the converters, using a Miller 70A miniature broadcast receiver antenna coil with the primary as the output link coil. This circuit can be substituted for RFC$_2$ in either the bandswitching or single-band converters.

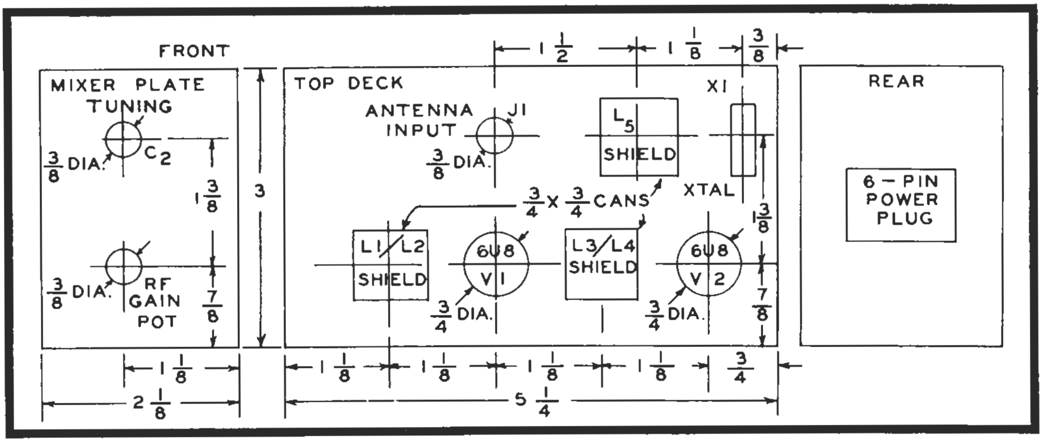
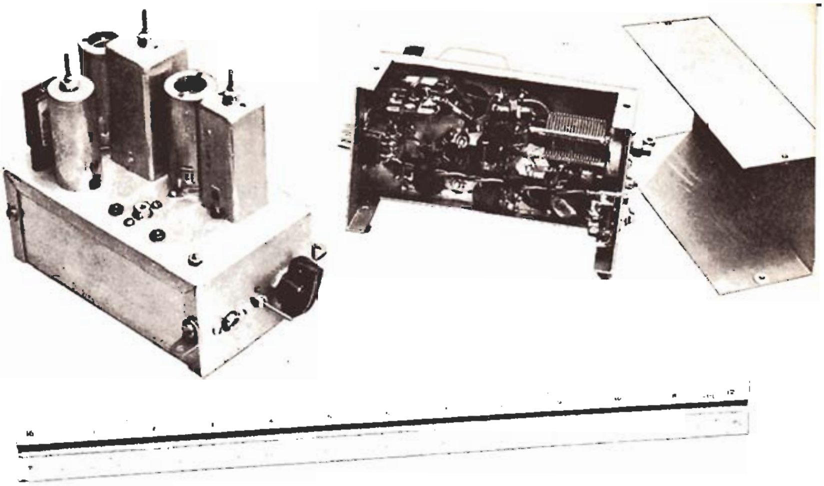
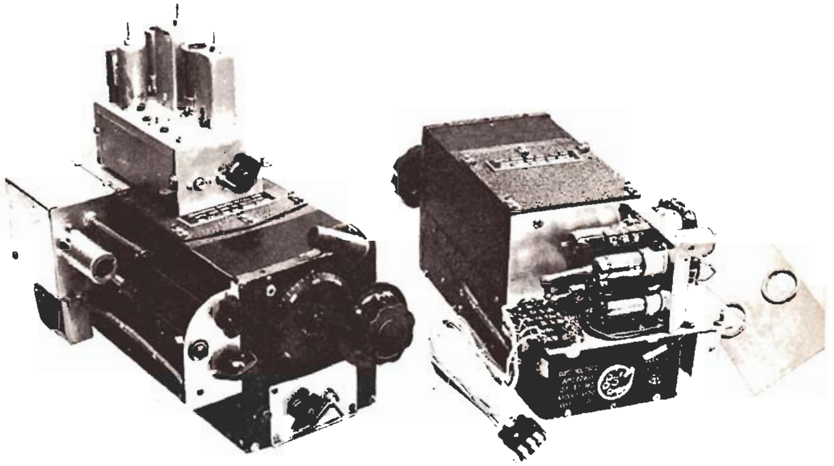


FIG. 3. **CHASSIS LAYOUT DIAGRAM** for the single-band converters. The chassis is a 5¼ x 3 x 2⅛-inch Minibox (Bud CU-3006). The same parts layout was used for all five of W8DLD's converters.



SINGLE-BAND converter views, with completely assembled model at left, and model with bottom cover removed at right. Placing all tuned circuits in shields above the chassis reduces interaction and leaves plenty of room for small components under the chassis.



COMPLETE RECEIVER, composed of BC-453, modified as described on pages 10 and 11, and the crystal controlled converter mounted on the top shield (at left). Rear view at right shows audio amplifier constructed on small plate, occupying space in which dynamotor mounts on original receiver.

for the components specified in TABLE I—PARTS LIST. The same general parts layout, shown in the drilling diagram, Fig. 3, was used for all converters.

The alterations necessary on coils L_1 through L_5 — as described in TABLE II — COIL TABLE, and the coils checked for proper frequency coverage with a grid-dip oscillator — should be made before the shield cans are fastened to the chassis.

The usual precautions regarding short r.f. wiring and bypass capacitor leads apply to all converters, and especially the 21 and 28-megacycle models. The tube heaters may be operated from either a 6 or 12-volt supply by making the proper connections when wiring the Jones cable jack which connects to P_1.

ALIGNMENT of the crystal oscillator stage consists simply of peaking L_5 for maximum signal in a receiver tuned to the proper harmonic frequency for the crystal and band in use. After coupling the BC-453 receiver to the output, and feeding in a signal of the proper frequency into J_1, the signal circuits, L_1 to L_4, may be aligned. Peak coils L_2 and L_4 (the bottom adjustments) about 50 kilocycles inside the high edge of the amateur band for which the converter is designed (3.95 megacycles on the 4-megacycle converter). Peak coils L_1 and L_3 from 100 to 200 kilocycles lower in frequency, so that the converter has nearly uniform gain across the portion of the amateur band most used. Coils L_1 and L_3 are made the top adjustments so that the converter bandpass can be easily changed for maximum performance either in the American phone, or CW assignments of the amateur bands.

The converters, when completed and aligned, may be mounted on top of the BC-453 receiver, as shown in the picture above.

At W8DLD/Mobile, the converters were mounted on top of the linear amplifier for the sideband transmitter in the rear of the station wagon (as shown in the view on the top left corner of page 7 in the July-August, 1960 issue). This permits a short connection to the antenna changeover relay — also on the linear amplifier — and changing converters when bands are switched in the amplifier. A coaxial cable feeds the i.f. output signal from the converter to the BC-453 receiver, mounted below the dash (see picture on page 4 of the July-August, 1960 issue).

Converters of this type have traveled over 120,000 miles in W8DLD's mobile installations, and the models described incorporate the lessons learned during this vast amount of "field testing."

Converting the BB-453 Receiver

From September-October, 1960

By A. F. Prescott, W8DLD, and W. C. Louden, W8WFH

CONVERSION DATA for the BC-453 Command Set Receiver has been widely published. However, here are suggestions for making the basic conversion, plus adding a more powerful audio amplifier, fast-acting AVC and S-meter circuit, and a sideband selector switch.

HEATER CIRCUIT—

To operate the BC-453 tube heaters from a 6-volt supply, rewire all heater connections to the sockets in parallel. Install 6-volt tubes: three 6SK7's, one 6K8, one 6SR7, and one 6J5 or 6C5 in the audio (V8), changing no socket connections other than tying pin 7 to pin 1.

For 12-volt heater supply operation, either rewire all heaters in parallel and use the original 12-volt tubes (three 12SK7's, one 12K8, one 12SR7, and substituting a 12J5 for the 12A6); or, use the original heater circuit and install 6-volt heater tubes which each draw 0.3 amperes (same 6-volt tubes as shown above).

AUDIO AMPLIFIER—

The original audio amplifier in the BC-453 may be sufficient for home-station operation under quiet conditions, but more volume is sorely needed to overcome the various noises encountered in mobile operation. A 5-watt amplifier and speaker in the 6 to 8-inch diameter range will provide plenty of sound.

A 3-stage amplifier circuit, shown in the schematic diagram, Fig. 1, was devised, and is easily driven by a 6J5 or 12J5, substituted for the original 12A6 pentode power audio amplifier in the BC-453. One section of a 12AX7 twin triode is a voltage amplifier; the other section functions as a phase inverter, driving the grids of a push-pull output stage with 12AQ5's (6AQ5's for a 6-volt heater supply).

The circuit constants shown provide good frequency response, but the higher audio frequencies will be accentuated if a 0.1-mfd capacitor is wired across the cathode resistor of the 12AX7 audio amplifier. A 0.006-mfd capacitor across the output transformer attenuates higher audio frequencies.

The audio amplifier was constructed on a small metal plate about 4 inches square with flanges on all sides for mounting. Wiring should follow the usual practices for audio amplifiers. Note that the audio output signal from the BC-453 was taken from pin 2 of the plug on the rear of the chassis, as shown in the view on page 9.

FAST-ACTING AVC/S-METER CIRCUIT—

The operation of this fast-acting AVC circuit which can be added to the BC-453 receiver must be heard to be appreciated. The S-meter was designed to work on CW, sideband or amplitude modulated phone signals. The two-tube package, added in a small box to the left side of the receiver in the view on page 9, is well worth its weight in operating convenience.

Note in the schematic diagram, Fig. 2, that the 85-kilocycle signal from the BC-453 is picked up at the control grid of the first i.f. amplifier (V_5) so that the AVC amplifier stage, a 12AU6 pentode, will be completely free of stray BFO voltage. The selectivity of this amplifier must be broader than the signal channel in order to reduce the gain of the receiver when strong adjacent channel splatter is present. The "Q" of L_1 should not be too high, or the 85-kilocycle tuned circuit formed by it and the 190-760-mmf padder will be too sharp. A 5.5-millihenry iron core r.f. choke (Bud CH-922W, or equivalent) should be used for L_1.

The AVC voltage is rectified by the 1N34 diode and applied through a decoupling network back into the BC-453 receiver at the lower end of L_9, the secondary of the interstage i.f. transformer which drives the second i.f. amplifier stage (V_6). The AVC voltage also is applied to one control grid of a 12AT7 twin triode in a vacuum tube voltmeter type S-meter circuit. An SPDT switch provides for full AVC voltage for higher "DX" S-meter readings, or lower AVC for "Local" S-meter readings from strong signals.

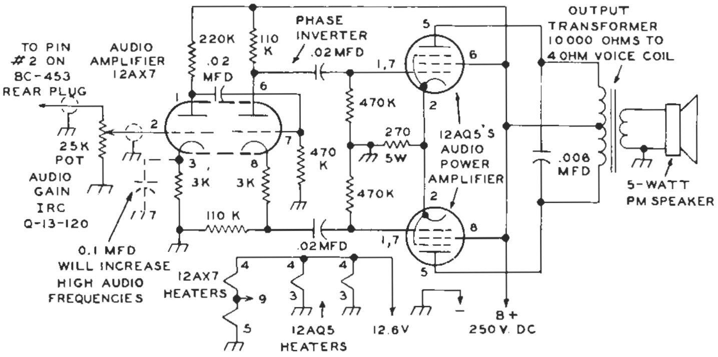
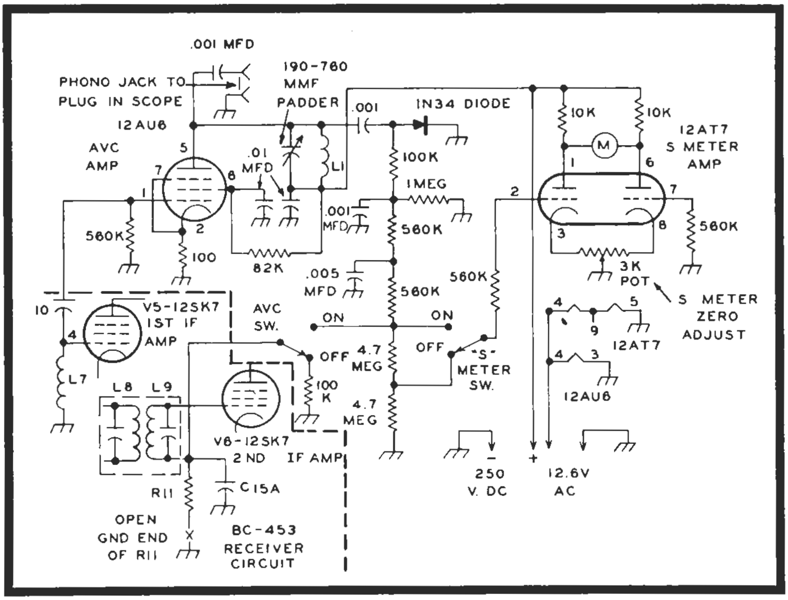


FIG. 1. SCHEMATIC DIAGRAM of a 5-watt audio amplifier for the BC-453 receiver. Audio output from the receiver is taken from the output transformer through pin 2 of the plug on the rear of the receiver chassis. Capacitances are in microfarads, and resistances are in ohms, ½-watt unless marked.

FIG. 2. FAST-ACTING AVC and S-meter circuit for the BC-453 receiver. Area inside dashed line at lower left corner of diagram shows points in the BC-453 circuit from which the i.f. signal is taken at pin 4 of the 12SK7 first i.f. amplifier; and connection to the lower end of L_9 into which AVC voltage from the AVC circuit is fed into the BC-453.



Note that a phono jack connection to the plate of the 12AU6 AVC amplifier provides a place to feed the i.f. signal to the vertical plates of an oscilloscope. By setting the horizontal sweep on the scope at 30 to 60 cycles, both incoming signals, and your own transmitter, may be checked for linearity.

The AVC/S-meter unit was constructed in a 4 x 2¾ x 2-inch Minibox (Bud CU-3015) and mounted on the left side of the BC-453. Extension shafts run from the controls to knobs, with the shafts supported on a small bracket. Exact arrangement of the AVC and S-meter circuit components will depend on the space available on each side of the BC-453 receiver in each mobile installation.

SIDEBAND SELECTOR SWITCH—

When properly aligned, the 85-kilocycle i.f. amplifier in the BC-453 has a bandwidth of about 2.5 kilocycles. This makes possible good SSB reception with considerable rejection of the unwanted sideband when the BFO signal is injected at either the upper or lower edge of the i.f. amplifier passband.

It is necessary only to install an SPST switch to add a 30-mmf capacitor across the BFO tuned circuit to change the frequency of the BFO so that it will provide the proper exalted carrier signal for reception of either upper or lower sideband signals. This addition, shown in the schematic diagram, Fig. 3, also includes increasing the plate voltage on the 12SR7 BFO tube by shunting R_{15} and R_{16} in the BC-453 with a 100,000-ohm, 1-watt resistor. This greatly increases the BFO injection for improved operation of the detector on SSB signals.

With the SPST switch open, adjust C_{28} in the BFO coil shield can so that upper sideband signals are properly received (BFO will be at upper edge of i.f. amplifier passband). Then, close the sideband selector switch and tune in a signal transmitting lower sideband, which also should sound normal.

When a station transmitting, say, lower sideband is properly tuned in, and the station shifts to upper sideband, the SPST switch should then be opened, and the BC-453 receiver dial be tuned 3 kilocycles higher in frequency to properly receive the upper sideband. A bit of practice in changing sidebands will allow this shift to be made in a matter of seconds.

The combination of the amateur band converters and BC-453 receiver modified as described herein is capable of providing excellent amateur radio mobile reception.

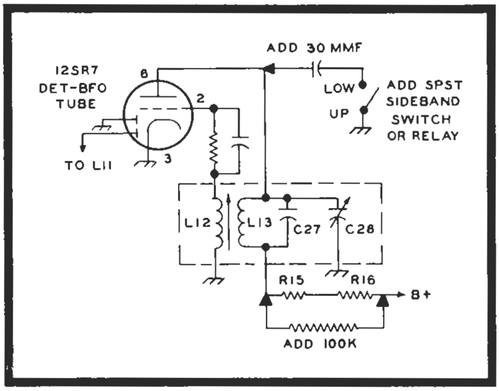


FIG. 3. SIDEBAND SELECTOR switch is added to BFO in BC-453 by adding a 30-mmf capacitor across BFO coil to shift BFO frequency. Locate switch and capacitor as close as possible to BFO tube to prevent radiation of signal from wiring.

12-TUBE ADAPTER FOR SINGLE SIDEBAND RECEPTION

AN ADAPTER TO CONVERT A SUPERHET INTO A TRUE SINGLE SIDEBAND RECEIVER

Materially Reduces QRM When Receiving AM, PM, CW or SSB Signals

From November-December, 1948

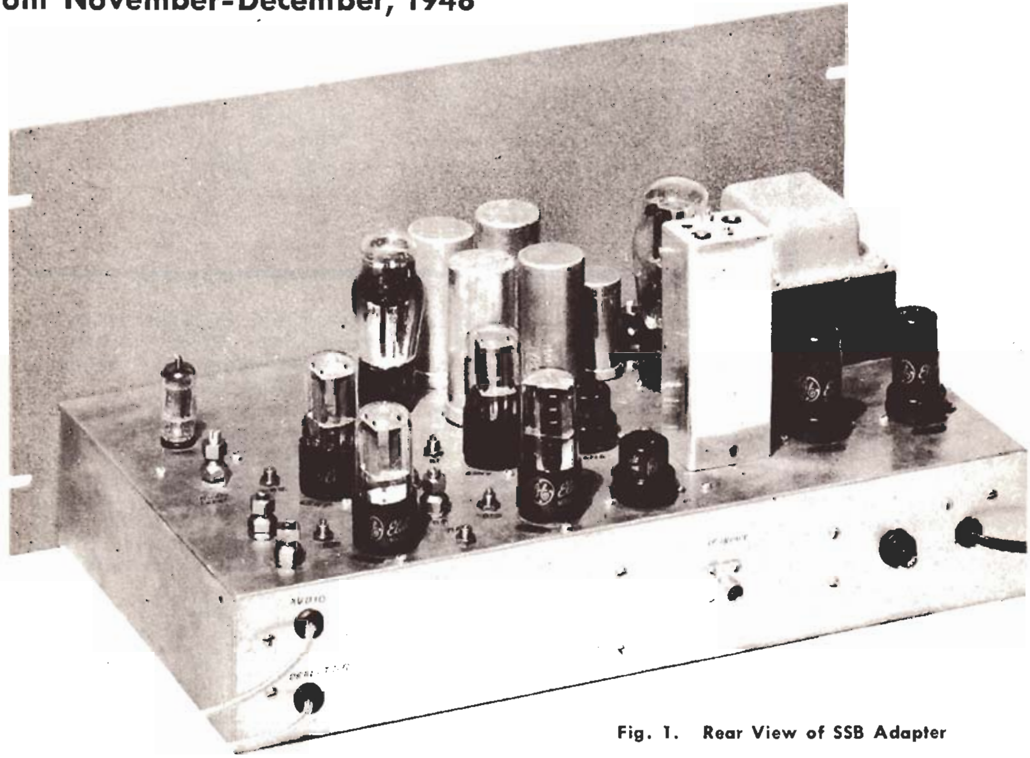


Fig. 1. Rear View of SSB Adapter

The single-sideband adapter, shown in Fig. 1 from a rear view, when attached to a superhet receiver will permit reception of single-sideband signals. Further, this combination will receive amplitude modulated phone signals, phase modulated signals, and c-w signals in a fashion which will enable the user to reduce the qrm on any frequency by at least fifty per cent.

In the case of reception of true single sideband signals with attenuated or suppressed carrier, the adapter furnishes a carrier against which the sidebands may be demodulated. By selecting the proper sideband with a switch, the modulation may be read. For reception of AM phone signals, this SSB receiver (adapter plus superhet) exalts the carrier component of the phone signal, making it effectively stronger than it would otherwise have been, and then allows reception of both sidebands, or either sideband singly. If qrm exists on one sideband, it can be avoided by receiving only the sideband on which the qrm does not exist. Where qrm exists on both sidebands, one is selected which is qrm'ed the least.

Phase modulated or NBFM signals may be received in the same manner as AM signals. No special detection equipment need be added to the SSB receiver. For the reception of c-w signals, the SSB receiver furnishes the hetrodyning signal so that the BFO in the superhet is not needed. True single-signal reception of c-w signals is achieved.

GENERAL PERFORMANCE

A single sideband receiver is not necessarily a "sharp" receiver, although the results obtained are usually superior to those obtainable with a receiver with steep-sloped IF curves. This means that if a signal has modulation with good audio fidelity, the SSB receiver will receive the full audio band, limited principally by the bandpass of the IF transformers in the superhet itself. Of course it is desirable to limit the audio range, both in transmission and reception,

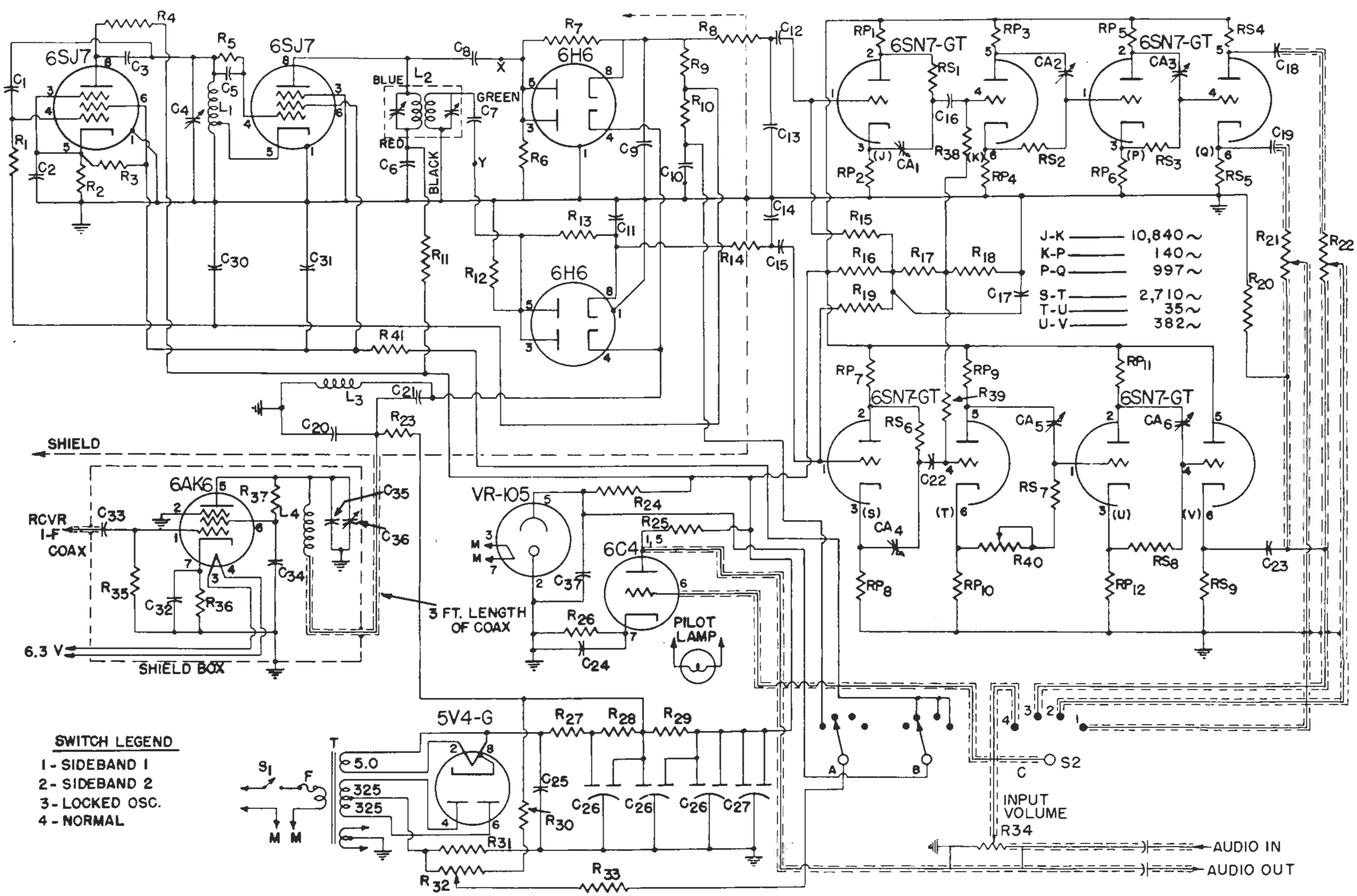


Fig. 2. Circuit Diagram of SSB Adapter

CIRCUIT CONSTANTS

C_1 =5 mmf mica or ceramic
C_2, C_{30}, C_{31}, C_{32} =0.1 mf 200 V paper
C_3 =0.001 mf 600 V mica or paper
C_4 =25 mmf variable
C_5 =100 mmf mica
C_6, C_{28}, C_{29} =0.01 mf 600 V paper
C_7, C_8, C_{13}, C_{14}, C_{33} =50 mmf mica (±5%)
C_9, C_{11} =500 mmf mica (±5%)
C_{10}, C_{17} =1.0 mf 200 V
C_{12}, C_{15} =0.05 mf 200 V
C_{16}, C_{21}, C_{22}, C_{34} =0.05 mf 400 V
C_{18} =0.5 mf 400 V
C_{19}, C_{23}, C_{37} =0.5 mf 200 V
C_{20} =0.006 mf mica
C_{24} =20 mf 25 V (part of C_{27})
C_{25} =20 mf 450 V electrolytic
C_{26} =40-40 mf 450 V electrolytic
C_{27} =40-40-20 mf 450-450-25 V electrolytic
C_{35} =750 mmf mica
C_{36} =150-500 mmf mica trimmer

CA_1 =300 mmf adjustable (see text)
CA_2 =2200 mmf adjustable (see text)
CA_3 =1600 mmf adjustable (see text)
CA_4 =600 mmf adjustable (see text)
CA_5 =9000 mmf adjustable (see text)
CA_6 =800 mmf adjustable (see text)

F =3 amp. fuse

L_1 =2.5 mH RF choke tapped at one pie
L_2 =456 KC IF Transformer (Millen No. 60456) (see text)
L_3 =1 pie of 2.5 mH RF choke
L_4 =1 pie of 2.5 mH RF choke with 100 turns removed (see text)

R_1 =470 ohm ½ watt
R_2 =820 ohm ½ watt
R_3 =33,000 ohm 1 watt
R_4, R_5, R_{33} =0.1 megohm ½ watt
R_6, R_7, R_{12}, R_{13}, R_{35} =0.22 megohm ½ watt (±5%)
R_8, R_{14} =47,000 ohm ½ watt (±5%)
R_9 =3.3 megohm ½ watt
R_{10}, R_{17} =10,000 ohm ½ watt
R_{11} =4700 ohm ½ watt
R_{15}, R_{19}, R_{20}, R_{38}, R_{39} =2.2 megohm ½ watt
R_{16}, R_{30} =0.33 megohm 1 watt
R_{18}, R_{25}, R_{37} =20,000 ohm ½ watt
R_{21}, R_{22} =200,000 ohm pot (linear taper)
R_{23} =7500 ohm 2 watt
R_{24} =10,000 ohm 10 watt
R_{26} =1800 ohm ½ watt
R_{27}, R_{31} =50 ohm 2 watt
R_{28}, R_{29} =300 ohm 5 watt
R_{32} =10,000 ohm pot
R_{34} =250,000 ohm pot
R_{36} =680 ohm 1 watt
R_{40} =100,000 ohm pot
R_{41} =500 ohm 1 watt
RP_1, RP_2 =4000 ohm ½ watt precision (±1%)
RP_3, RP_4 =3000 ohm ½ watt precision (±1%)
RP_5—RP_8 =4000 ohm ½ watt precision (±1%)
RP_9, RP_{10} =3000 ohm ½ watt precision (±1%)
RP_{11}, RP_{12} =4000 ohm ½ watt precision (±1%)

RS_1 =50,000 ohm ½ watt (±5%) (not wire wound)
RS_2, RS_7, RS_8 =0.5 megohm ½ watt (±5%) (not wire wound)
RS_3, RS_6 =0.1 megohm ½ watt (±5%) (not wire wound)
RS_4, RS_5 =5000 ohm ½ watt (±5%)
RS_9 =5000 ohm 1 watt (±5%)

S_1 =SPST toggle
S_2 =six pole four position shorting type rotary switch (see text)
T =Power Transformer, 325-0-325 V. at 150 ma, 5 V. at 3A, 6.3 V. at 5A (Thordarson T-22R06)

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to as narrow a range as possible, consistent with intelligibility. However, signals characterized by excessive frequency-modulated hum, carrier frequency drift, or overmodulated NFM will be immediately apparent. The amateur using a SSB receiver is thus able to spot difficulties of these sorts on any signal.

This SSB receiver does not cut out one sideband completely, but it attenuates it by approximately 40 db. This is the same as about 7 "S" points on the average receiver. Attenuation is such that signals which are no closer than 70 *cycles* and as far away as 5400 cycles from the carrier are attenuated at least 40 db. However, sufficient attenuation takes place between zero and 70 cycles so that unless an interfering signal is practically zero beat it can be eliminated in most cases sufficiently well to allow the desired signal to be copied.

The SSB receiver thus allows reception of all of the usual types of signals found on the ham bands, including single sideband signals. The principal advantage is that it allows the user to receive only one sideband at a time so that qrm is reduced by at least 50%.

ELECTRICAL DETAILS

The SSB adapter described here may be switched to any one of four types of reception by switch S_2 (see Fig. 2). Position 1 allows reception of one sideband of any type of signal described above. This will be either the upper or lower sideband, depending on which side of the received frequency the superhet oscillator operates. Position 2 permits reception of the other sideband. Position 3 is a locked-oscillator position. This means that the adapter is furnishing an artificial carrier (as it does also on positions 1 and 2) which augments (exalts) the carrier being received. This has the advantage of providing a strong non-fading carrier. The result is to reduce distortion on fading signals.

Position 4 of switch S_2 allows the receiver to function normally. The SSB adapter is not completely out of the circuit, since audio connections with the receiver require that audio be fed through the adapter. Experience has shown that position 4 is seldom used once the operator is familiar with the operation of a SSB receiver.

The circuit diagram (Fig. 2) follows the principles set forth by D. E. Norgaard in his article "Practical Single-sideband Reception" in the July 1948 *QST*.

With reference to Fig. 2, the second 6SJ7 is the oscillator which generates the artificial carrier. Its frequency is the same as that of the receiver IF. Coil L_1 and condenser C_4, along with the first 6SJ7 (reactance tube), are the frequency determining elements. Transformer L_2 is a 90 degree r-f phase shift circuit. The 6H6 tubes act as demodulators. The IF signal from the receiver is coupled through the 6AK6 tube (which functions as an impedance matching device) to both 6H6 tubes. The output of the 6SJ7 oscillator is also coupled to these 6H6 tubes. A portion of the output of the upper 6H6 is fed back through a low-pass RC filter (R_9, R_{10}, C_{10}, C_{30}) and acts on the 6SJ7 reactance tube so that automatic carrier synchronization is achieved.

The outputs from the two 6H6 demodulators are fed independently to two audio-frequency phase-shift networks. The upper two 6SN7-GT tubes with their associated components act as one network and the lower pair of 6SN7-GT tubes with their circuit components act as the other phase-shift network.

The audio outputs of these two networks are mixed by resistors R_{21} and R_{22} so that response from sideband 1, sideband 2 or both sidebands can be selected. The 6C4 is an audio amplifier tube.

The power supply circuit and the voltage regulator tube circuit are conventional. A large amount of capacitance is required because the two audio phase-shift networks must be supplied from a low impedance source of voltage.

CONSTRUCTIONAL DETAILS

Before starting the constructional work, it is wise to have all the necessary components on hand. Some of these need explanation at this point. Resistors RP_1 through RP_{12} are specified as ½ watt precision resistors, with a resistance tolerance of ±1%. These are an important part of the SSB adapter. Quantities

Fig. 3. **Detail View of Probe with Cover Removed**

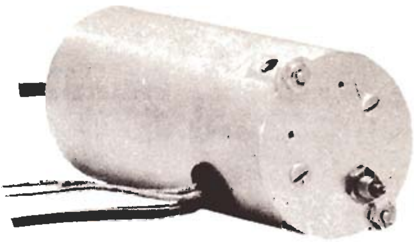


Fig. 4. **Detail View of Probe Shield Can**

of this type are available at low prices. Naturally, one watt resistors may be used if ½ watt ones are not available. It is possible to measure regular tolerance resistors until suitable values are found. This is not advisable unless the resistors chosen are certain to hold their measured values. A better alternative is to use stable resistors and pair them. For example, RP_1 and RP_2 need not be exactly 4000 ohms so long as they are the *same* value (within 40 or 50 ohms). Similarly, other pairs are RP_3, RP_4; RP_5, RP_6; RP_7, RP_8; RP_9, RP_{10}; and RP_{11}, RP_{12}.

Resistors RS_1 through RS_9 are listed separately because it is desirable for them to be very stable although their exact value is not important as long as they hold that value. Precision resistors are usually stable types, and for this reason they are recommended although not required. Ordinary resistors are suitable, although the performance of the unit may suffer if these resistors change value with time.

Condensers CA_1 through CA_6 are shown as single condensers, but except for CA_1, they are all multiple units. For example, CA_2 is listed as a 2200 mmf adjustable condenser. This made up by paralleling a 0.002 mf mica and a 150 to 500 mmf *mica* trimmer. Each of these specified condensers consist of a 150-500 mmf trimmer in parallel with mica condensers. CA_1 is simply a 100-500 mmf trimmer. The objective sought here is to permit adjustment of the RC products (RS_1 times CA_1, RS_2 times CA_2, etc.) to the proper value. This will be covered more thoroughly under "Tune-up Adjustments."

A Millen IF transformer is specified for L_2. Other types will undoubtedly work, although difficulty may be experienced in obtaining the correct coupling between the primary and the secondary windings. Generally speaking, high stability air tuned IF transformers of the proper frequency are suitable. Switch S_2 is specified as a shorting type switch in order to provide smooth switching action.

Inductance L_4 should be approximately 0.15 millihenrys, for use with receivers having 450-470 kc IF amplifiers. This value of inductance was obtained from a 4 pie 2.5 mh choke, by removing 3 of the pies, then taking 100 turns off the remaining pie. The particular choke used was a Millen No. 34100.

The SSB adapter is built on a 17 by 10 by 3 inch chassis and uses a 8¾ inch relay rack panel. The 6AK6 probe (Figs. 3 and 4) is built into a 2⅛ inch diameter by 4 inch long shield can (Millen No. 80006). It is desirable to follow the layout as shown. Fig. 1 indicates the general placement of parts, and Fig. 7 will serve as a drilling and layout guide. The rear of the chassis, referring to Fig. 1, is drilled for the two audio leads on the left, the coaxial connector on the right of center, and the fuse and a-c cord on the right. The front panel (Fig. 5) is drilled with four holes for the on-off switch, oscillator tuning control, control switch (S_2) and the pilot light. All holes are in a center line 1½ inches up from the bottom of the panel, and the side dimensions are three inches and five inches, respectively, in from either side of the panel.

The under-chassis view (Fig. 6) clearly shows the layout of parts. Note the shield which encloses the wiring for the two 6SJ7 and two 6H6 tubes. In order to better balance the layout in this shield compartment, the IF transformer could be moved toward the 6SJ7 oscillator tube.

It is necessary to make a small change in the IF transformer, assuming that the Millen No. 60456 is used. The blue lead should be unsoldered from the terminal point on the end of the coil form (which is a tap on the coil) and soldered instead to the stator of the primary tuning condenser. Also, the 24 mmf padding condenser across the primary coil should be removed.

The tune-up process will be simplified if a small piece of wire is soldered to the eight cathode connections of the four 6SN7-GT tubes. This wire should be about one inch long and arranged so that a clip lead may be attached to it.

The filaments of all the 6.3 volt tubes except the 6AK6 are wired to the 6.3 volt winding on the power transformer.

The 6AK6 tube is mounted in the probe chassis. The mounting piece is made of aluminum to fit the shield can. See Figs. 3 and 4. The coaxial lead which comes out the rear of this can connects to the receiver by means of a coaxial connector. The two filament leads and the coaxial line to the receiver are brought out the side of the can.

TUNE-UP ADJUSTMENTS

When the SSB adapter has been completed it is necessary to check the alignment carefully. In particular, the amount of attenuation obtainable on either sideband depends upon how well these adjustments are made.

Connect the adapter to the receiver in the following manner: The small can with the 6AK6 tube should be placed as close as possible to the last IF transformer in the receiver. The lead marked "receiver IF" should be soldered to the "hot" end of the secondary of the last IF transformer. Do not disconnect the lead from this point going to the second detector. The shielding braid on the coaxial cable should be stripped back only as far as necessary and then soldered to ground (receiver chassis). The 6.3 volt filament leads should be wired into a 6.3 volt a-c source in the receiver.

If the IF alignment of the receiver is questionable, it should be carefully realigned, following the manufacturer's directions. In any event, it is necessary to check the tuning of the secondary of the last IF transformer to compensate for the addition of the 6AK6 stage.

The other two connections are those marked "audio in" and "audio out." The audio connection to the input of the first audio amplifier must be opened. If the receiver has a phono input jack which accomplishes this, the two leads may be connected at this point. The "audio in" lead should be connected to the receiver connection which carries audio voltage from the second detector tube, and the "audio out" lead should be connected so that the audio signal on this lead is fed to the remainder of the audio system of the receiver. It is difficult to be specific about this because the adapter may be connected to a wide variety of receivers.

Turn on the receiver and the adapter. Allow both units to reach operating temperature. Turn off the avc on the receiver and set the adapter switch S_2 to position 4 (normal). Tune in a stable signal, such as a broadcast station. Adjust R_{34} and the receiver volume control until an adequate volume level is obtained. Change S_2 to position 3. Adjust condenser C_4, which tunes the oscillator, until a beat note is heard. Adjust for zero beat. If no beat is heard, the oscillator is either not oscillating or is not able to reach the correct frequency. With the constants shown, the oscillator will operate in the 450 KC to 465 KC IF range. For higher or lower frequencies it may be necessary to change L_1 and C_4.

Next, detune the receiver slightly so that a beat note is audible. Set the r-f gain on the receiver to ensure that no overloading is taking place. Adjust condenser C_{36} until this beat note is as loud as possible. If the receiver does not use a 450-465 KC IF, it may be necessary to change L_4, C_{20}, C_{35}, and C_{36} in order to achieve resonance.

Tune the receiver to a low frequency beat note. Inability to hold a low-frequency beat note indicates that the r-f gain control should be reduced. Insert a 0-1 mil d-c meter between resistor R_6 and ground. The positive connection on the meter should connect to ground. A 0-5 mil d-c meter may also be used if a 0-1 mil meter is not available. The 0-1 milliammeter becomes, in effect, a 0-200 volt voltmeter (approximately). Adjust the tuning condenser in the primary of L_2 for a maximum reading of this meter. This adjustment probably will cause the oscillator to change frequency slightly and the beat note will change frequency. If so, adjust C_4 to get the original low-frequency beat note. Recheck for maximum meter reading and repeat if necessary. Remove the meter and connect R_6 to ground again. Place the meter between R_{12} and ground in the same way. Adjust the tuning of the secondary of L_2 for maximum meter reading. If the beat note changes, adjust C_4 as before.

The IF transformer L_2 is now tuned approximately to the receiver IF. It is next necessary to adjust the coupling of L_2 so that approximately equal voltages are fed to the two 6H6 tubes. This condition is satisfied when the voltages from "x" to ground and "y" to ground are equal. (These voltages are those that were measured with the 0-1 milmeter.)

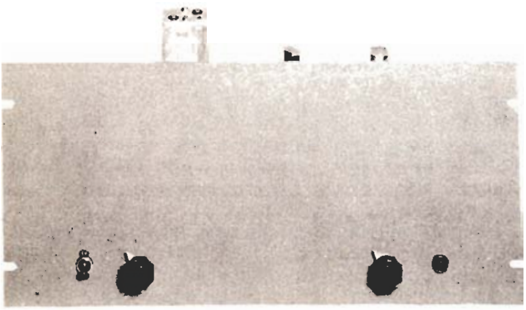


Fig. 5. Front View of SSB Adapter

It may be desirable to connect a closed circuit jack between R_6 and ground and R_{12} and ground. Inserting a 0-1 mil d-c meter in the jack between R_6 and ground reads voltage "x" and between R_{12} and ground reads voltage "y".

Therefore, measure voltage "x" and "y." Normally "x" will be greater than "y," indicating that there is not sufficient coupling between the primary and the secondary of L_2. Carefully heat the coil form of the Millen IF transformer with a soldering iron, through the large hole in the chassis, until the wax melts and the bottom coil can be pushed slightly toward the top coil. After this adjustment, retune C_4 to obtain the low-frequency beat note if this note changes frequency. Now measure voltages "x" and "y" by plugging the 0-1 mil meter into the two temporary jacks. Voltage "y" should increase as the coupling is increased. Several adjustments should be required as this process should be taken in easy steps to avoid too much coupling. Each time the coupling is adjusted the oscillator frequency should be adjusted to the low frequency beat with the signal in the receiver. Also the primary and secondary tuning condensers should be checked for proper tuning as indicated by a peak reading of the 0-1 mil d-c meter. (Peak the primary and read current in R_6 and peak the secondary by reading current in R_{12}.)

When voltages "x" and "y" are within ten per cent of one another the coupling adjustment may be considered complete. These voltages should normally be about 100 volts—half-scale on the 0-1 milliammeter.

The next step is to determine that transformer, L_2 is acting as a 90 degree phase-shift device. An oscilloscope is required for this and the following adjustments. The horizontal and vertical amplifiers in the scope may have differential phase shift, so first it is necessary to check for this condition.

Connect the "high" input leads of the horizontal and vertical amplifiers of the scope to pin 3 of the first 6SN7-GT tube (point J). The ground connections of the scope should be tied to the chassis of the SSB adapter. Detune the receiver so that a beat note of approximately 6000 cycles is obtained as heard in the speaker. Adjust the gain of the receiver (RF gain) until a relatively small signal is available. Adjust the horizontal and vertical amplifier gain controls on the scope until a straight line at a 45 degree angle is obtained. If the scope has no detrimental phase shift this line will be a thin straight line. If phase shift occurs, the line will be opened up, or split, so that it is in the form of a flat ellipse.

In order to correct this phase shift insert a 50,000 ohm potentiometer in the "high" lead of either the horizontal or vertical input at the scope. Adjust this potentiometer until the line becomes a solid line. If this is not possible, transfer the potentiometer to the other "high" lead. It should now be possible to adjust the resistance to give a straight line on the scope.

Next, remove one scope lead from point J and connect it to point S on the cathode of the first 6SN7-GT tube in the lower network. Do not remove the potentiometer and do not change the gain controls on the scope.

Change the receiver tuning to get a beat note of approximately 200 cycles. A circle should now appear on the scope tube. It may be lopsided, but it should resemble a circle. Adjust the condenser in the secondary of transformer L_2 until a perfect circle appears. If the best adjustment does not give a perfect circle then either the horizontal or vertical gain control should be adjusted to give equal horizontal and vertical deflections. This may upset the phase-shift compensation so check as before and readjust the 50,000 ohm potentiometer if necessary. Now repeat

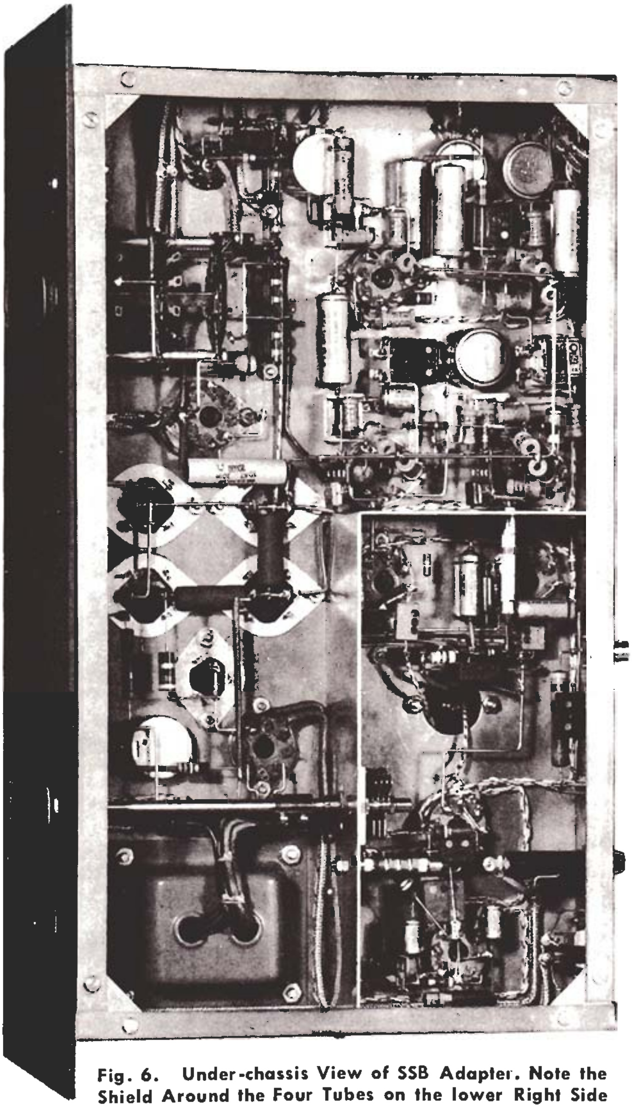


Fig. 6. Under-chassis View of SSB Adapter. Note the Shield Around the Four Tubes on the lower Right Side

the check for the circle by adjustment of the secondary tuning of L_2. Detune the receiver to provide a 6000 cycle beat note. The circle may change size but it should hold its shape reasonably well. If not, the fault will probably lie in condensers C_7, C_8, C_9, C_{11}, C_{13}, C_{14} or resistors R_6, R_7, R_8, R_{12}, R_{13}, R_{14}. Ideally C_7 and C_8 should be the same value, that is, equal in capacitance. Also, C_9 and C_{11} should be equal, and C_{13} and C_{14} should be equal. Further, R_6 and R_{12} should be equal, R_7 and R_{13} equal, and R_8 and R_{14} should be equal. It may be necessary to measure them in order to pair them in the way which makes them as close to equal values as possible.

The final tune-up adjustment concerns the two audio frequency phase shift networks. In addition to the scope, an audio oscillator is required. This oscillator should be as good an instrument as can be obtained, since accurate calibration and good waveform is required in order to permit adjustment of the audio-frequency phase shift networks for optimum performance. This audio oscillator is required to generate the six audio frequencies shown in the circuit diagram (Fig. 2).

If the available oscillator is not accurately calibrated, it is not too difficult to calibrate it for the six frequencies involved. This can be done by means of a piano, if the piano is in tune. Using the proper key on the piano it is possible to produce a frequency which may be used as a calibration point, or in some cases as a sub-multiple of a required calibration. Of course, any other calibration means which is accurate may also be used.

When the oscillator is ready for use, turn on the adapter and remove both 6H6 tubes and set S_2 to position 4. The receiver need not be turned on. Connect the audio oscillator output to pin 8 of the upper 6H6 tube with the ground lead on the audio oscillator output going to the adapter chassis. Connect the ground connections of the horizontal and vertical amplifier inputs of the scope to adapter chassis. Connect the "high" connections of both amplifiers to point J. Set the audio oscillator at 10,840 cycles and adjust its output to approximately one volt.

The scope tube should now show a line at a 45 degree angle, or the gain controls should be adjusted so that it does. If the line is thin and not split the phase compensation is correct. If not, adjust the 50,000 ohm potentiometer which should still be in series with one scope lead, as explained before. Next, move one lead from point J to point K. A figure which resembles a circle should now appear on the scope. Adjust the variable condenser CA$_1$ until a *perfect* circle is obtained. If this is not possible, then either the correct RC product (CA$_1$ times RS$_1$) is outside the range of adjustment or the gain controls on the scope are set in the wrong position. As before, adjust the gain controls so that equal horizontal and vertical deflection is obtained. Then check phase compensation again. This must always be done whenever the gain controls are changed. If the RC product is wrong change CA$_1$, RS$_1$ or both in order to obtain the required values.

The next five steps are repetitions of the above as follows. Remove the scope lead from J and place it on K. Adjust the oscillator to 140 cycles. The phasing adjustment to get a single line, if it is required, may call for a condenser in series with one of the scope leads rather than the 50,000 ohm condenser. Try values between 0.001 and 0.1 mf. When phase compensation is correct, move one lead from K and place it on P. Adjust CA$_2$ until a perfect circle is obtained.

Next, move the lead that is on K to point P. Adjust oscillator frequency to 997 cycles. Check for phase compensation by getting a single line as before. Move one of the leads on P to point Q. Adjust CA$_3$ until a perfect circle is obtained. This completes the upper network adjustment.

Change the oscillator output so that it connects to pin 8 of the lower 6H6 in the circuit diagram. Connect both scope leads to point S and set the audio oscillator to 2710 cycles. Check for phase compensation as before, using either capacitance or resistance as required. Move one lead from S and place on point T. Adjust CA$_4$ until a perfect circle is obtained.

Change oscillator to 35 cycles and move the lead from S to T. Check for phase compensation. Move one lead from T to point U. Adjust R$_{40}$ and CA$_5$ until a perfect circle is obtained. Usually adjustment of R$_{40}$ alone is all that is required, but if a perfect circle cannot be obtained, adjust CA$_5$ slightly and try again with R$_{40}$. Repeat until you get a perfect circle.

Change oscillator to 382 cycles and move the lead from T to point U. Check for phase compensation. Move a lead from U to point V. Adjust CA$_6$ until a perfect circle is obtained.

This completes the adjustment of the networks, and the balancing adjustments of R$_{21}$ and R$_{22}$ are next. Turn on the receiver, replace the 6H6 tubes in the adapter and allow the receiver to reach operating temperature. Set R$_{21}$ and R$_{22}$ to approximate mid-position. Connect the vertical input on the scope to the "audio out" lead. Set the horizontal plates to sweep frequency so that several sine waves will be visible on the scope screen after a 1000 cycle beat is obtained as described below. Tune in a steady signal, such as a broadcast station, while the adapter is in position 3. Set the r-f gain for a low signal level and make sure that the avc is turned off.

Tune the receiver slightly until the 1000 cycle beat note is obtained. Reduce the r-f gain until this heterodyne is just nicely audible with the audio gain opened most of the way. Now change S$_2$ to either position 1 or 2. On one of the positions the heterodyne will be weaker. This heterodyne will now be shown as a sine wave on the scope. Adjust the vertical gain until the sine wave covers about one-third of the screen. If the switch is in position 1, adjust R$_{21}$, or if in position 2, adjust R$_{22}$ until the heterodyne sounds as weak as possible to the ear. At the same time the scope trace will decrease in amplitude. Next, retune the receiver through zero beat, to the opposite side of the signal until a 1000 cycle heterodyne note is obtained. Change switch S$_2$ to the other of the two sideband positions. Then adjust the other potentiometer (which was not touched before) for a minimum, checking both by the scope and by ear.

Finally, very carefully adjust the secondary tuning condenser of L$_2$ in conjunction with the potentiometer for a further reduction in volume of the heterodyne. Now retune the receiver for a 1000 cycle note on the other side of the signal and change S$_2$ to the other sideband. Readjust the potentiometer which controls this sideband for minimum heterodyne

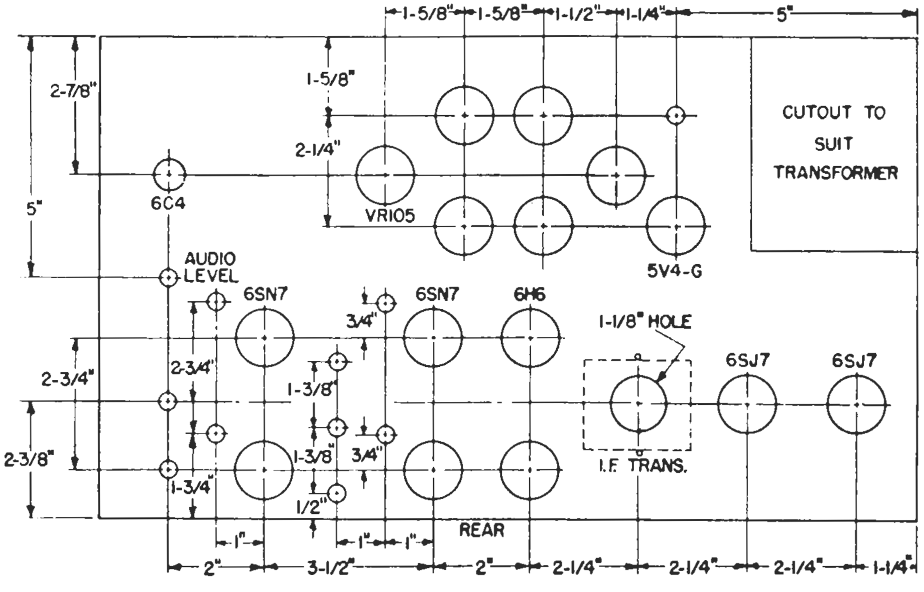


Fig. 7. Layout Guide for SSB Adapter

strength. If this is not as little as before, it will be necessary to go to the other sideband again and adjust L_2 secondary for equal rejection. It may be necessary to go back and forth several times to accomplish this. This rejection should be in the order of 40 db., which means a voltage ratio of about 100:1 as seen on the scope screen by switching S_2 back and forth between positions 1 and 2 while everything else is fixed.

Two more adjustments must now be made before the SSB receiver is really ready for use. Disconnect the scope. With S_2 in position 3, tune in a station. Be sure the input signal is small. Return to position 4. If the audio level changed, adjust R_{34} until no change in audio level is noted when going from position 3 to 4 or vice versa. (When in position 1 or 2 receiving AM signals the audio level will be lower by 6 db than the level observed in positions 3 and 4. This is normal.)

Lastly, tune in a signal zero beat in position 3 of S_2. Make sure the unit is at operating temperature. Reduce r-f gain as far as practical. Switch to position 4, wait five seconds and switch to position 3. If a sliding frequency change is heard as the oscillator is pulling in, R_{32} needs adjustment. Make a slight adjustment, return to position 4, wait five seconds, then switch to 3. If the frequency change is less continue the adjustment process in that direction until no change of frequency is heard. If the frequency change was worse, adjust R_{32} the other direction and follow the above steps until no frequency change is heard.

The SSB adapter is now completely aligned and adjusted. If it is to be used on another receiver at some future date some of the previous steps in adjustment will need to be repeated. Condenser C_4 will have to be set for the new IF of the receiver and transformer L_2 may similarly need touching up. Also, R_{34} and R_{32} will probably need re-adjustment. It might be desirable further to check the settings of R_{21} and R_{22} in the manner previously described. The two audio phase shift networks should not require any re-adjustment at any time unless the components change value. This might be a good place to mention that the adjustments which have been described may seem very complicated, but they are much easier to perform than to describe in writing.

USE OF THE SSB RECEIVER

A person using a SSB receiver for the first time will be in a position very similar to that of a young child taking his first steps. That is to say, the child does not know how to walk until he has learned, and the user of a SSB receiver will not be able to use the SSB receiver to full advantage until he has had some experience with it. (And he is due for as big a thrill as the child gets—Editor's note.) However, there are some basic rules to keep in mind. The *smaller* the r-f input, that is, the more the r-f gain can be turned down and still have a readable signal, the more certain one will be of obtaining maximum unwanted-sideband rejection. Always use the receiver with the avc off.

When the SSB receiver is used for the reception of c-w signals, it is not necessary to use the receiver BFO, as the necessary beat note is supplied by the oscillator in the adapter. Of course, when switch S_2 is in position 4 the BFO is used as usual with the receiver. Tuning is usually done in the locked oscillator position when the receiver is first in use, although with experience a c-w man will develop his own tuning patterns. For example, if the receiver is set to reject the high frequency sideband, and tuning is done from a low to a high frequency, then signals are not heard (unless they are very strong) until you have passed them frequency-wise.

For AM reception, the oscillator in the adapter will produce a heterodyne when tuning acrosss phone signals, when in position 1, 2, or 3. This beat note disappears when the received signal is tuned to zero beat. It thus acts as a signal locater and is a real tuning aid.

For phase-modulated signals and narrow-band f-m signals reception is carried out in positions 1 or 2, assuming that the frequency swing is not excessive. It is not necessary to tune to one side of the signal to receive it. It might be well to emphasize that reception of PM and NBFM signals requires only the SSB adapter and a regular superhet—no special limiting device or FM adapter is necessary, or desirable, on the receiver. Merely tune in the signal to zero beat in position 3, and switch to either sideband (position 1 or 2) for reception.

Reception of single-sideband signals is obviously possible, whether the signal is transmitting a carrier or not. If a carrier is transmitted the SSB receiver will lock on it provided the carrier is of sufficient amplitude. If this is not true, it is only necessary to ensure that the receiver is kept properly tuned. After tuning in the signal, make certain that you listen on the sideband being transmitted.

The user of a SSB receiver will find that he switches back and forth between positions 1 and 2 rather often, during a QSO, in order to dodge QRM which comes up. (Unless he is listening to a single-sideband signal.) In addition, he will find that whatever interference is heard may also be further reduced by means of the crystal filter, assuming that the superhet has such a device.

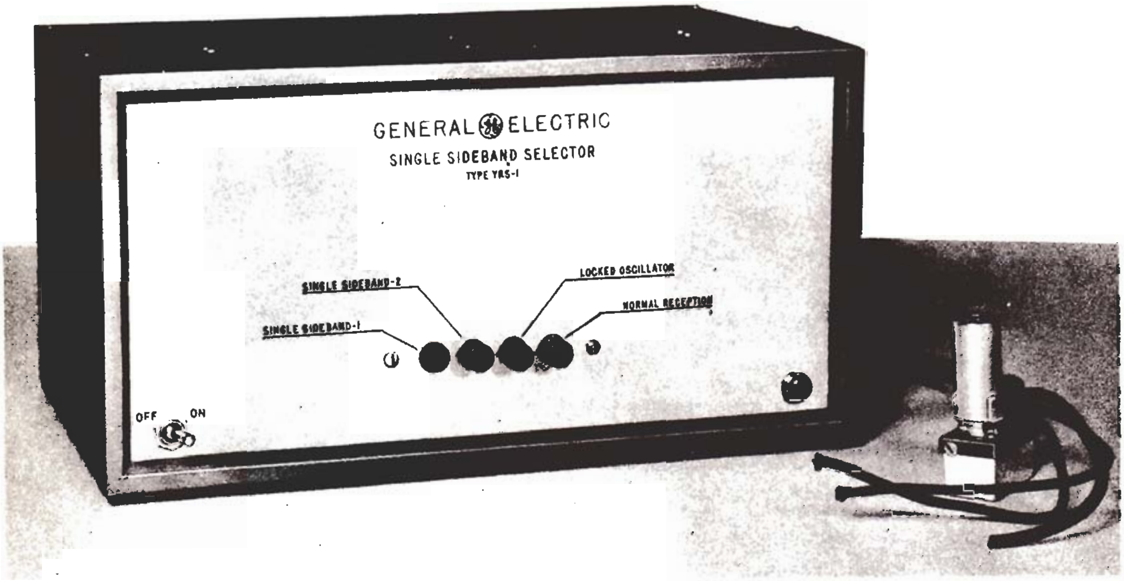
For best results, the receiver to which this adapter is connected and the signals which are tuned, should have reasonably good frequency stability. The more perfect the receiver, the better the results will be.

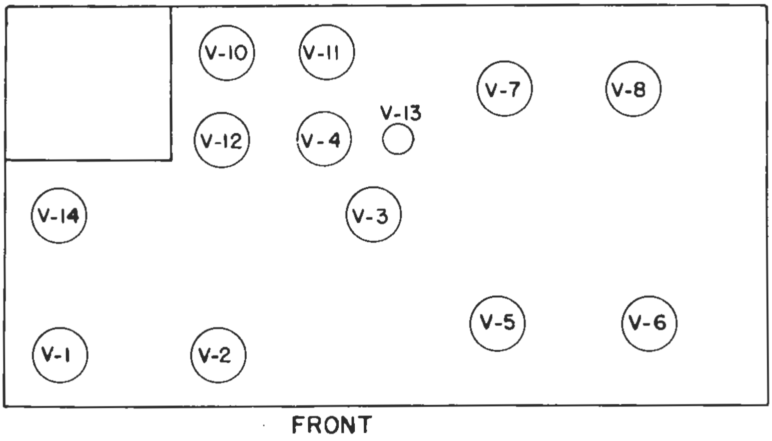
THE G-E MODEL YRS-1 ADAPTER

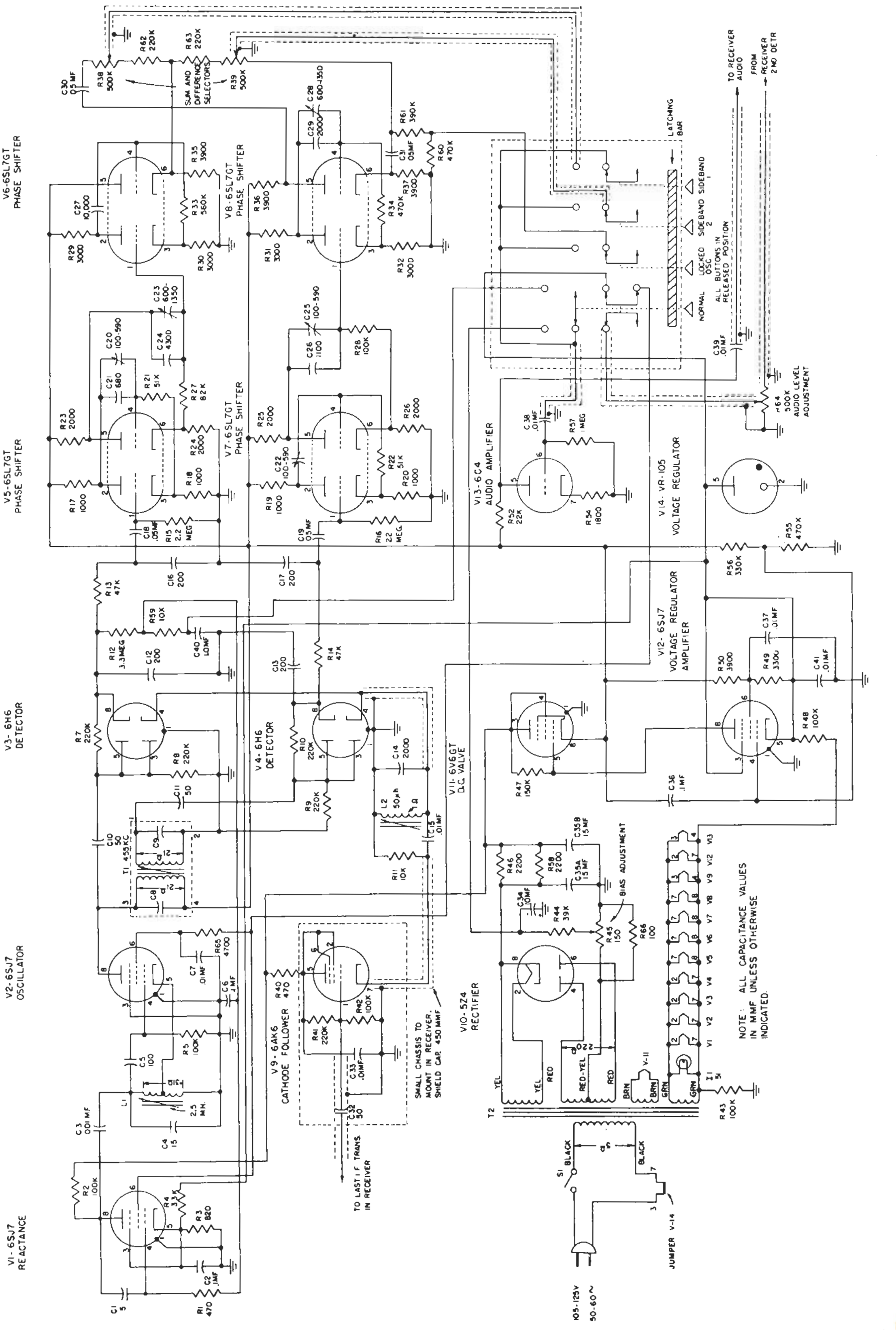
FOR SINGLE SIDEBAND RECEPTION

The General Electric YRS-1 Single Sideband Adapter is a 14-tube unit which permits the single sideband reception of either modulated or unmodulated signals. It is designed to be used with any receiver having an intermediate frequency of approximately 455 kilocycles.

The YRS-1 functions essentially similar to the 12-tube single sideband adapter described in the November-December, 1948 issue of G-E HAM NEWS, which is repeated in this chapter on pages V-28 to V-35. The YRS-1 adapter has an additional 2-tube voltage regulating circuit to improve stability. Since instruction books for the YRS-1 are no longer available, the circuit and other essential details are repeated here.






V1-6SJ7 REACTANCE
V2-6SJ7 OSCILLATOR
V3-6H6 DETECTOR
V4-6H6 DETECTOR
V5-6SL7GT PHASE SHIFTER
V6-6SL7GT PHASE SHIFTER
V7-6SL7GT PHASE SHIFTER
V8-6SL7GT PHASE SHIFTER
V9-6AK6 CATHODE FOLLOWER
V10-5Z4 RECTIFIER
V11-6V6GT D.C. VALVE
V12-6SJ7 VOLTAGE REGULATOR AMPLIFIER
V13-6C4 AUDIO AMPLIFIER
V14-VR-105 VOLTAGE REGULATOR
SUM AND DIFFERENCE SELECTORS
R38 500K
R39 500K
R62 220K
R63 220K
C30 .05MF
C28 600-1350
C29 2000
R61 390K
R60 470K
C31 .05MF
R37 3900
R34 470K
R35 3900
R33 560K
R36 3900
C27 10,000
R29 3000
R30 3000
R31 3000
R32 3000
LATCHING BAR
SIDEBAND 1
SIDEBAND 2
LOCKED OSC
NORMAL
ALL BUTTONS IN RELEASED POSITION
TO RECEIVER AUDIO
FROM RECEIVER 2ND DETR
C39 .01MF
R64 500K AUDIO LEVEL ADJUSTMENT
C23 600-1350
C24 4300
C20 100-590
C21 680
R21 51K
R27 82K
R23 2000
R24 2000
R18 1000
R17 1000
C18 .05MF
R15 2.2 MEG
C25 100-590
C26 1100
R28 100K
R25 2000
R26 2000
C22 100-590
R22 51K
R20 1000
R19 1000
C19 .05MF
R16 2.2 MEG
C38 .01MF
R57 1MEG
R52 22K
R54 1800
R55 470K
R56 330K
C16 200
C17 200
R13 47K
R59 10K
R12 3.3MEG
C12 200
C40 1.0MF
C13 200
R14 47K
C37 .01MF
R50 3900
R49 3300
C41 .01MF
R48 100K
R7 220K
R8 220K
R10 220K
C14 2000
C11 50
R9 220K
L2 50μh
C15 .01MF
R11 10K
C10 50
T1 455KC
C9
C8
R47 150K
C36 .1MF
R46 2200
R58 2200
C35B 15MF
C35A 15MF
C34 10MF
R44 39K
R45 150
R66 100
BIAS ADJUSTMENT
R65 4700
C7 .01MF
C6 .1MF
R5 100K
C5 100
L1 2.5 MH.
C4 15
C3 .001MF
R40 470
R42 100K
R41 220K
C33 .01MF
C32 50
SMALL CHASSIS TO MOUNT IN RECEIVER. SHIELD CAP. 450 MMF
TO LAST I.F. TRANS IN RECEIVER
R2 100K
R4 33K
R3 820
C2 .1MF
R1 470
C1 5
YEL
RED
RED-YEL
BRN
GRN
V-11
T2
I1
R43 100K
S1
BLACK
JUMPER V-14
105-125V 50-60~
V1 V2 V3 V4 V5 V6 V7 V8 V9 V12 V13
NOTE: ALL CAPACITANCE VALUES IN MMF UNLESS OTHERWISE INDICATED.

Parts List for YRS-1 SSB Adapter

ELECTRONICS

PART	DESCRIPTION
C_1	Capacitor, ceramic, 5 mmf., 500v., 10%
C_2	Capacitor, paper, .1 mf., 200v.
C_3	Capacitor, paper, .001 mf., 600v.
C_4	Capacitor, ceramic, 15 mmf., 500v. 10%
C_5	Capacitor, ceramic, 100 mmf., 500v., 20%
C_6	Capacitor, paper, .1 mf., 200v.
C_7	Capacitor, paper, .01 mf., 600v.
C_{10}, C_{11}	Capacitor, ceramic, 50 mmf., 500v., 10%
C_{12}, C_{13}	Capacitor, ceramic, 200 mmf., 500v., 10%
C_{14}	Capacitor, mica, 2000 mmf., 500v., 5%
C_{15}	Capacitor, paper .01 mf., 600v.
C_{16}, C_{17}	Capacitor, ceramic, 200 mmf., 500v., 10%
C_{18}, C_{19}	Capacitor, paper, .05 mf., 200v.
C_{20}	Capacitor, trimmer, 100-590 mmf.
C_{21}	Capacitor, mica, 680 mmf., 500v., 10%
C_{22}	Capacitor, trimmer, 100-590 mmf.
C_{23}	Capacitor, trimmer, 600-1350 mmf.
C_{24}	Capacitor, mica, 4300 mmf., 500v., 5%
C_{25}	Capacitor, trimmer, 100-590 mmf.
C_{26}	Capacitor, mica, 1100 mmf., 500v., 5%
C_{27}	Capacitor, mica, 10000 mmf., 300v., 5%
C_{28}	Capacitor, trimmer, 600-1350 mmf.
C_{29}	Capacitor, mica, 2000 mmf., 500v., 5%
C_{30}	Capacitor, paper, .05 mf., 600v.
C_{31}	Capacitor, paper, .05 mmf., 200v.
C_{34}	Capacitor, electrolytic, 10 mf., +100%, -10%, 25 WVDC
C_{35}	Capacitor, electrolytic, 15 mf., + 100%, -10%, 450WVDC
C_{36}	Capacitor, paper, .1 mf., 200v.
$C_{37, 38, 39}$	Capacitor, paper, .01 mf., 600v.
C_{40}	Capacitor, paper, 1.0 mf., 200v.
C_{41}	Capacitor, paper, .01 mf., 600v.
I_1	Lamp, GE51 6-8v., .2 amp.
L_1	Coil, oscillator
L_2	Coil, choke
R_1	Resistor, carbon, 470 ohms, 1/2w., 10%
R_2	Resistor, carbon, 100K., 1/2w., 20%
R_3	Resistor, carbon, 820 ohms, 1/2w., 10%
R_4	Resistor, carbon, 33K, 1/2w., 10%
R_5	Resistor, carbon, 100K, 1/2w., 20%
$R_{7, 8, 9, 10}$	Resistor, carbon, 220K, 1/2w., 20%
R_{11}	Resistor, carbon, 10K, 1/2w., 20%
R_{12}	Resistor, carbon, 3.3 meg., 1/2w., 20%
$R_{13, 14}$	Resistor, carbon, 47K, 1/2w., 20%
$R_{15, 16}$	Resistor, carbon, 2.2 meg., 1/2w., 20%
$R_{17, 18, 19, 20}$	Resistor, precision, 1000 ohms, 1/2w., 1%
$R_{21, 22}$	Resistor, precision, 51K, 1/2w., 1%
$R_{23, 24, 25, 26}$	Resistor, precision, 2000 ohms, 1/2w., 1%
R_{27}	Resistor, precision, 82K, 1/2w., 5%
R_{28}	Resistor, precision, 100K, 1/2w., 5%
$R_{29, 30, 31, 32}$	Resistor, precision, 3000 ohms, 1/2w., 1%
R_{33}	Resistor, precision, 470K, 1/2w., 5%

PART	DESCRIPTION
$R_{35, 36, 37}$	Resistor, carbon, 3900 ohms, 1/2w., 5%
$R_{38, 39}$	Potentiometer, carbon, 500K 1/2w., 10%
R_{40}	Resistor, carbon, 470 ohms, 1/2w., 10%
R_{43}	Resistor, carbon, 100K, 1/2w., 20%
R_{44}	Resistor, carbon, 39K, 1/2w., 10%
R_{45}	Potentiometer, carbon, 150 ohms
R_{46}	Resistor, carbon, 2200 ohms, 2w., 10%
R_{47}	Resistor, carbon, 150K, 1/2w., 10%
R_{48}	Resistor, carbon, 100K, 1/2w., 20%
R_{49}	Resistor, carbon, 300 ohms, 2w., 20%
R_{50}	Resistor, carbon, 3900 ohms, 2w., 10%
R_{52}	Resistor, carbon, 22K, 1/2w., 10%
R_{53}	Resistor, carbon, 100 ohms, 1/2w., 20%
R_{54}	Resistor, carbon, 1800 ohms, 1/2w., 10%
R_{55}	Resistor, carbon, 470K, 1/2w., 10%
R_{56}	Resistor, carbon, 330K, 1/2w., 10%
R_{57}	Resistor, carbon, 1 meg., 1/2w., 20%
R_{58}	Resistor, carbon, 2200 ohms, 2w., 10%
R_{59}	Resistor, carbon, 10K, 1/2w., 20%
R_{60}	Resistor, carbon, 470K, 1/2w., 10%
R_{61}	Resistor, carbon, 390K, 1/2w., 10%
$R_{62, 63}$	Resistor, carbon, 220K, 1/2w., 20%
R_{64}	Potentiometer, carbon, 500K, 1/2w., 20%
R_{65}	Resistor, carbon, 4700 ohms, 1/2w., 20%
R_{66}	Resistor, carbon, 100 ohms, 1/2w., 20%
S_1	Switch, toggle, SPST
S_2	Switch, pushbutton
T_1	Transformer, I. F., with trimmer capacitors, 455Kc.
T_2	Transformer, power

* Universal obtainable from any radio parts jobber.

All percentages shown are plus and minus.

Modifications to the YRS-1

I have been modifying my YRS-1 single-sideband adapter,[1] and some may be interested in certain changes I have made in this truly wonderful gimmick.

First, I replaced the toggle-type power switch on the panel with a gain-control-and-rotary-switch combination. The variable resistance is connected into the cathode circuit of the reactance modulator to control the frequency of the

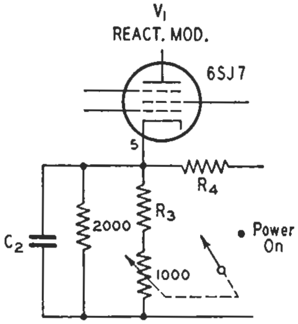


Fig. 1 — Wiring diagram of the modified YRS-1 reactance modulator to allow panel control. C_2, R_3 and R_4 refer to original components that are unchanged.

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[1] The YRS-1 is the commercial adaptation of the selectable-sideband adapter designed by W2KUJ. See Norgaard, "Practical S.S.B. Reception," *QST*, July, 1948.

YRS-1 Modifications and Experiments

reinserted carrier (Fig. 1). This provides panel control for oscillator readjustment and for tuning s.s.b. stations, but, more important, it allows for compensation of warm-up drifts. After initial alignment, any drift in either the receiver or the adapter requires (otherwise) that the receiver be detuned. Oscillator frequency control further permits deliberate detuning of the receiver when desired, in order to favor the outer sideband frequencies or as an aid in avoiding interference.

Secondly, I provided a panel switch in the audio circuitry to permit normal operation of the receiver without turning on the 14 tubes in the YRS-1. This switch merely connects the audio from the receiver detector directly back into the receiver audio system.

Most interesting of all, I have rewired the 6C4 audio output stage to take a 6J6, with the grids connected to the phasing networks, and the plates connected to two 'phone jacks (Fig. 2). This enables one to hear the sidebands separately on headphones, in addition to the operation through the receiver. With separate cords connected to each of the 'phones, the left ear hears the upper sideband, and the right ear hears the lower sideband.

This modification not only aids reception, but provides a certain "sense of direction." A heterodyne and the accompanying monkey-chatter associated with an interfering signal which appears on the right side of the panoramic adapter is heard in the right ear. Another interference on the left side may reach only the left ear. The brain tends to ignore the one-ear signals and favors the information from both ears. (Don Norgaard has mentioned this psychological effect.) With exalted-carrier reception, as you tune across a signal, the heterodynes seem to move right straight through your head. You know by "feel" which way to turn the tuning knob for oscillator lock-in.

With this binaural system, there seems to be a new realism. Voices (and music, too) seem to come to life. It is almost like walking into a broadcasting studio. Friends concur with me on this. I cannot understand why the difference should be so great nor why the binaural way is more pleasant. Adjusting the level of the 'phones independently proves nothing. Tests made with both 'phones on show a marked difference in "realism" when one 'phone is switched from one sideband to the other, yet tests with only one 'phone show no difference when that 'phone is switched in the same manner.

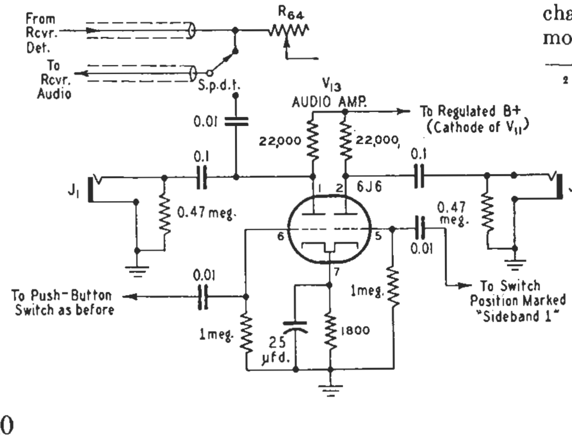

Fig. 2 — Wiring diagram of the modified audio amplifier to allow the use of split headphones. V_{13} is a 6C4 in the original unit — the connections to Pin 6 of the socket remain unchanged. With most receivers, J_2 will provide the upper sideband. The sideband from J_1 is selectable.

Properly operated, the YRS-1 with exalted carrier greatly reduces the harmonic distortion normally heard on foreign 'phones, and makes listening to music from such stations much more pleasant. However, the selective fades on such stations, which affect the sidebands separately and produce dissimilarities between them, give a very interesting "three-dimensional effect" when heard this new way. It is very difficult to describe. Perhaps you have heard it. I don't mean to convey the impression that I am a dramatic type, but there is something mesmerizing about it. I have observed some interesting reactions and comments. Some people can't get enough of it; others seem to be a little frightened by the eerie sounds.

This new venture into "three-dimensional music" is startling, at first. The sound seems to flow around inside your head. There is a tendency at times to turn as though looking for the source of music. Choral music is weirdly beautiful and exciting. Pipe organ recitals reverberate mysteriously, and make you feel you are sitting high up in the belfry of a cathedral. To quote E.T. Canby,[2] switching from one to both sidebands gives "an impression of a tremendous bursting-outward into space." Sound suddenly "jumps away in all directions as though the performers had leaped into the air. Suddenly they are more than room distance away and fully sized, alive."

The usual question is, will it work with two loudspeakers? The answer is "yes and no." The effect is not nearly so interesting with speakers because both ears hear both speakers. However, I do often use the receiver speaker on the left side and a separate amplifier and speaker on the right side, and find it an improvement. I would like to get some more opinions and expressions from others who have tried dual single-sideband reception, or can be induced to make the simple changes (it took about half an hour) to add one more feature to the YRS-1.

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[2] *Audio Engineering*, January, 1952.