The "Basic" 'Phone Exciter

Single or Double Sideband or P.M. from One Transmitter

BY BYRON GOODMAN,* W1DX

• While the gadget described in these pages is called a "basic" 'phone exciter, it is actually a single-sideband exciter, with p.m. and double-sideband a.m. thrown in at no extra cost. Also included is adjustable carrier injection, a necessary adjunct to the a.m. and p.m. and a big help in raising operators who don't recognize a carrierless single-sideband signal for what it is or whose receivers suffer from atrophy of the b.f.o.

The output of this unit is on 5.2 Mc., so that a subsequent mixer and a 9-Mc. oscillator will heterodyne the signal to either the 75- or 20-meter 'phone band without complication and with a minimum of adjustment.

If you have been waiting for a "how-many-turns" article on the phasing system of single-sideband generation, here it is.

The principles described by W2KUJ earlier this year [1] make it possible to build a single-sideband exciter unit that has just about everything in it. One three-position switch gives a choice of double-sideband a.m., p.m., or single sideband. Another switch flips the unit to one sideband or the other, when you are using single sideband. A third control governs the amount of carrier radiated, which can run anywhere from enough to avoid overmodulation on a.m. to something like 25 or 30 db. down from this value. Lacking only f.m. (but substituting p.m.), it can truly be called a "basic" 'phone exciter. This article will tell how to build and adjust such a device — the theory of operation was covered in the original disclosure.

You might wonder why we even bother with the other modes if they are so inferior to single sideband. There are two reasons, and they are both good ones. First off, the other modes are easily obtainable from the single-sideband exciter circuit, requiring the addition of only one switch to make them available, so you get them "for free." Second, they come in handy when you are testing the device, or comparing the various systems. Actually, you don't need the double-sideband position, but it's convenient if you want to prove to yourself (and others) that the "quality" doesn't suffer with single-sideband operation. The p.m. comes in handy if you have sporadic BCI trouble. The adjustable-carrier feature is a "must" until most operators recognize and know how to tune in a suppressed-carrier signal. With this exciter, all you have to do is to put in enough carrier to give a single-sideband-full-carrier signal and call in the usual manner. Then, after you raise the unsuspecting victim, you can explain to him that you have single sideband and how he can tune it in, if he doesn't already know. Then you reduce your carrier and hop up your single-sideband output (to make full use of your output stage), and you're in business. So, until such time as a large number of operators recognize single-sideband signals or use receivers that don't distinguish between single-sideband-reduced-carrier and normal a.m. signals,[2,3] adjustable carrier injection is a very desirable feature.

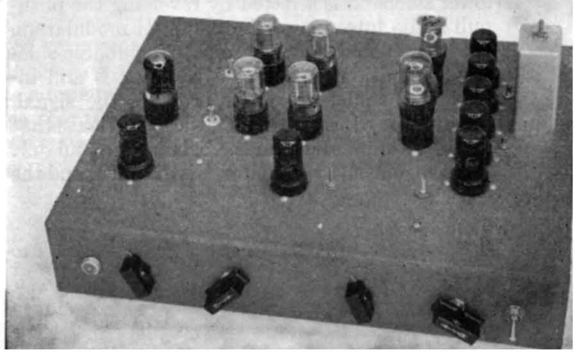
The basic unit uses receiving-type tubes throughout, and generates a 5.2-Mc. signal, at a low level. Having once generated the signal at this frequency, it is a simple matter to heterodyne to either 3.9 or 14 Mc. with a 9-Mc. oscillator. Hence following this exciter with a mixer and a 9-Mc. oscillator provides for 75- or 20-meter operation merely by using the proper coils in the output of the mixer and in the following amplifier stages. With the basic signal generated at 5.2 Mc., all you do to change bands is to change coils, and all you do to change frequency within a band

* Assistant Technical Editor, *QST*.

[1] Norgaard, "A New Approach to Single Sideband," *QST*, June, 1948.

[2] Norgaard, "Practical Single-Sideband Reception," *QST*, July, 1948.

[3] "Single-Sideband Reception," *GE Ham News*, November, 1948.



A "basic" 'phone exciter unit. The controls along the front, from left to right, are audio gain control, double-sideband / phase modulation / single-sideband selector switch, sideband selector switch, and carrier-amplitude control.

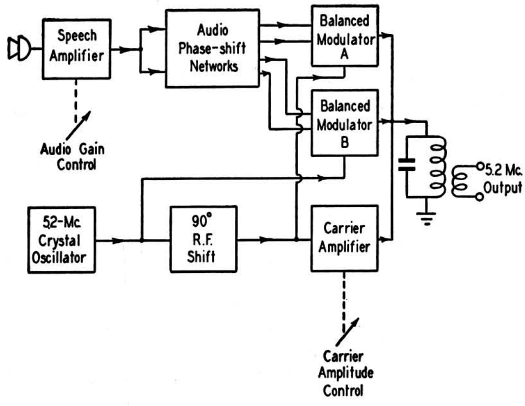


Fig. 1 — **A block diagram of the basic exciter. As shown, a single-sideband signal is generated, and any amount of carrier can be added through the "Carrier Amplifier." Reversing the push-pull audio input to either of the balanced modulators shifts to the other sideband. Disabling "Balanced Modulator A" and injecting sufficient carrier results in a double-sideband (a.m.) signal. With "Balanced Modulator A" operating, "B" disabled, and carrier inserted, a phase-modulated signal is obtained in the output.**

is to shift the 9-Mc. oscillator to some other frequency. VFO operation is a cinch. While the exciter to be described could be built for direct 3.9- or 14-Mc. output, it would be capable of covering only a small frequency range without some readjustment. This other system seems much more attractive.

The Circuit

Basically, the circuit is as outlined by W2KUJ. It is shown in block diagram in Fig. 1. A speech amplifier builds up the crystal-microphone input to a usable level. The output of the speech amplifier is then passed through the phase-shift networks described by W2KUJ, which offer two sources of push-pull audio, with a 90-degree phase difference between these two sources. Each of these sources feeds a balanced modulator. The r.f. drive for the balanced modulators is obtained from a crystal oscillator, and there is a 90-degree difference in the r.f. to the two balanced modulators. There appears in the combined output of the balanced modulators only a single-sideband signal, with substantially no carrier. To reintroduce the carrier, a *"Carrier Amplifier"* with adjustable gain feeds the desired amount of r.f. to the common output circuit.

In the single-sideband condition, the upper or lower sideband is selected by reversing the push-pull audio into one of the balanced modulators. (It doesn't matter which one.) For double-sideband operation, disabling Modulator B and introducing sufficient carrier provides the signal, because the r.f. is returned in the same phase that it had before removal in the balanced modulator. For p.m. output, Modulator A is disabled, and the carrier is combined with a pair of sidebands originally related to a carrier different by 90 degrees.

The audio phase-shift networks and the balanced modulators used in this exciter were described by W2KUJ, and you can refer to the earlier article for explanations of them. The r.f. circuit in this unit was devised by W2KUJ but not described, so a few of the salient points will be mentioned. The circuit is shown in Fig. 2. Two similar tanks are link-coupled and both tuned to resonance, resulting in a 90-degree difference in r.f. at the two circuits. Low-impedance push-pull output to drive the balanced modulators is obtained across the 680-$\mu\mu$fd. condensers. Equal-amplitude r.f. at *A* and *B* is obtained by adjusting the link coupling between L_1 and L_2, and the over-all magnitude of the r.f. is controlled by the plate and screen voltage on the 6SJ7. Phase and amplitude adjustments are provided at the grids of the balanced modulators, so that the carrier can be balanced out easily.

The detailed audio circuit is shown in Fig. 3. If you don't want to include the 3000-cycle low-pass filter you don't have to, of course, but it's easy to incorporate and doesn't add much to the cost. However, you should have something in your audio amplifier to attenuate frequencies above 5000 cycles, because the audio phase-shift network used in this unit begins to fall down above 5500 or 6000 cycles. If you already have a speech amplifier capable of a few volts output, you can use it instead of the one shown in the diagram. But notice that, in this exciter, the speech amplifier plus the audio phase-shift networks represent *all* of the speech equipment. You can

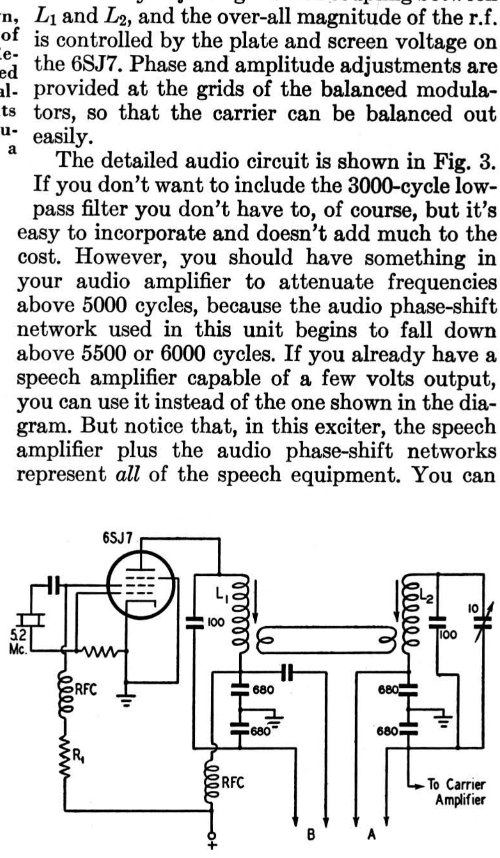


Fig. 2 — **Basic circuit of the crystal oscillator and 90-degree r.f. phase-shift circuit. The plate circuit of the 6SJ7 is tuned to resonance by adjusting the slug in L_1, and low-impedance push-pull r.f. is obtained at point *A*. The other tuned circuit is tuned close to resonance with the slug in L_2 and tuned carefully with the 10-$\mu\mu$fd. trimmer. When this circuit is tuned to resonance, push-pull r.f. appears at *B* that is different by 90 degrees to that at *A*. The amplitudes of the r.f. at *A* and *B* are made equal by adjustment of the coupling link between L_1 and L_2, and the over-all amplitude is controlled by the value of R_1.**

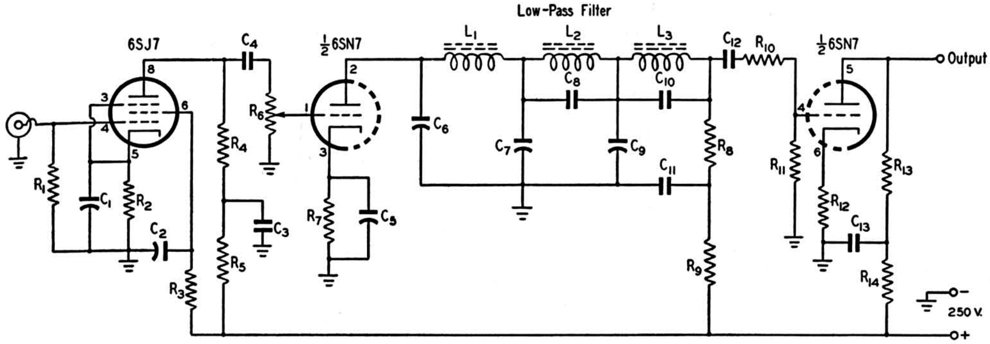


Fig. 3 — **Wiring diagram of the audio amplifier used in the basic exciter. The low-pass filter is not necessary for the proper generation of a single-sideband signal, but its use is recommended in *all* 'phone transmitters.**

C_1, C_5 — 10-μfd. 25-volt electrolytic.
C_2, C_3 — 0.5-μfd. 400-volt paper.
C_4 — 0.0022 μfd.
C_6 — 0.05-μfd. paper.
C_7 — 0.045-μfd. (0.025 + 0.02) paper.
C_8 — 0.005-μfd. paper.
C_9 — 0.035-μfd. (0.03 + 0.005) paper.
C_{10} — 0.03-μfd. paper.
C_{11}, C_{13} — 1.0-μfd. 400-volt paper.
C_{12} — 0.0068 μfd.
R_1, R_3 — 1.0 megohm.
R_2 — 820 ohms.
R_4 — 0.27 megohm.
R_5, R_{10} — 68,000 ohms.
R_6 — 0.25-megohm volume control.
R_7 — 1000 ohms.
R_8 — 2200 ohms.
R_9, R_{14} — 47,000 ohms.
R_{11} — 22,000 ohms.
R_{12} — 5600 ohms.
R_{13} — 0.22 megohm.
L_1 — 0.25 hy. (Millen 34400–250).
L_2 — 0.20 hy. (Millen 34400–200).
L_3 — 0.075-hy. (Millen 34400–75).

go from a watt to a kilowatt and only add r.f. amplifiers — you already have all of the audio gear you need!

The rest of the circuit is shown in Fig. 4. All of the components in this exciter are standard over-the-counter parts, with the possible exception of the low-tolerance resistors in the phase-shift networks. High-grade resistors are used here because of their greater stability over long periods of time, but they probably aren't an absolute "must." We know of several rigs that have been built with standard units, but here we stuck to the recommendation of W2KUJ and used precision units. The condensers in the phase-shift networks are mica units shunted by adjustable mica compression trimmers, since you will want to adjust the networks for best results. Here again you might cut corners, if you have access to a capacitance bridge (W6YX and W6DHG built their rigs without the adjustable feature), but being able to "tune" the networks is highly convenient.

How much trouble you take with the networks depends entirely on how good you want to make your rig. For example, you might use the network configuration described by W6DHG [4] and W6QYT [5] and, by carefully measuring the components beforehand, get a minimum attenuation of the undesired sideband of from 20 to 25 db., over a modulation-frequency range of 130 to 3600 cycles. Using the network in this unit and adjusting it carefully, you can get a minimum attenuation of around 30 db., from 70 to 5000 cycles. The latest network constants [3] with careful adjustment will give close to 40 db. minimum attenuation over the same range. One big advantage of the latter two networks is that they can be adjusted after wiring into the set — that used by the W6s cannot. The simpler network, while it cannot be adjusted, saves four tubes. This might be a factor in some cases, even though the tubes are only receiving types.

The values of the network components are shown in Table I. Each pair of plate and cathode resistors (e.g., R_{17}, R_{18}) should be matched as closely as possible to each other, but they can depart from the "book" value by 1 per cent or so with no ill effects. Since they should stay matched over a long period of time, precision resistors of the types mentioned in the table are strongly recommended.

The resistance and capacity value for each stage (e.g., R_{19} and C_{15}) are adjusted so that the resistance is equal to the reactance of the condenser at the "check" frequency. This is done in this unit by making the capacity adjustable. This is no trick with the smaller values of capacity, but the larger ones may require some experimental paralleling of smaller condensers. The values in the table are the "book" values, and variations from the exact resistance are made up by adjusting the capacity value to match. The resistors dissipate no power, and it might be possible to get along with regular types, but the precision units are usually better protected against temperature and humidity effects.

[4] Dawley, "An S.S.S.C. Transmitter Adapter," *QST*, July, 1948.

[5] Villard, "A Simple Single-Sideband Transmitter," *QST*, November, 1948.

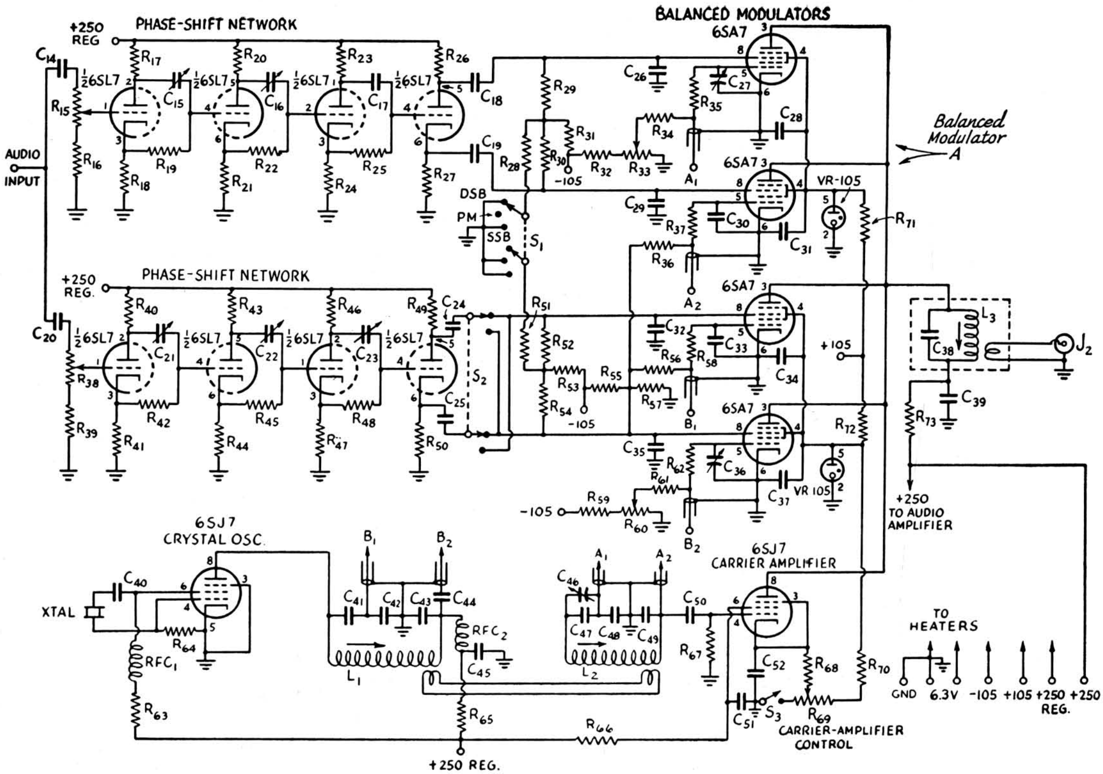


Fig. 4 **— Circuit diagram of the single-sideband exciter.**

C_{14}, C_{20} — 0.1-μfd. 400-volt paper.
C_{15}, C_{16}, C_{17}, C_{21}, C_{22}, C_{23} — See Table I.
C_{18}, C_{19}, C_{24}, C_{25} — 0.05-μfd. 400-volt paper.
C_{26}, C_{29}, C_{32}, C_{35}, C_{38} — 47-μμfd. mica.
C_{27}, C_{36} — 15-μμfd. midget variable (Johnson 160–107).
C_{28}, C_{31}, C_{34}, C_{37}, C_{39}, C_{42}, C_{43}, C_{48}, C_{49} — 0.0068-μfd. mica.
C_{30}, C_{33} — 10-μμfd. ceramic.
C_{40}, C_{44} — 470-μμfd. mica.
C_{41}, C_{47}, C_{50} — 100-μμfd. mica.
C_{45}, C_{51}, C_{52} — 0.0022-μfd. mica.
C_{46} — 9-μμfd. midget variable (Johnson 160–104).
R_{15}, R_{38} — 50,000-ohm volume control.
R_{16}, R_{39} — 0.47 megohm.
R_{17} through R_{27}, R_{40} through R_{50} — See Table I.
R_{28}, R_{51}, R_{57} — 4700 ohms.
R_{29}, R_{30}, R_{31}, R_{32}, R_{34}, R_{36}, R_{52}, R_{53}, R_{54}, R_{55}, R_{56}, R_{59}, R_{61}, R_{64}, R_{67} — 0.1 megohm.
R_{33}, R_{60} — 10,000-ohm wire-wound potentiometer.
R_{35}, R_{37}, R_{58}, R_{62} — 470 ohms.
R_{63} — 0.56 megohm. See text.
R_{65} — 47,000 ohms.
R_{66} — 68,000 ohms.
R_{68} — 270 ohms.
R_{69} — 5000-ohm wire-wound potentiometer.
R_{70} — 12,000 ohms, 1 watt.
R_{71}, R_{72} — 330 ohms, 1 watt.
R_{73} — 390 ohms, 1 watt.
L_1, L_2 — 34 turns No. 26 d.s.c. close-wound on National XR-50 form. Two-turn coupling loop on L_1, one-turn coupling loop on L_2. See text.
L_3 — 27 turns No. 24 d.s.c. close-wound on National XR-50 form; 3-turn coupling loop wound over "cold" end.
RFC_1, RFC_2 — 0.5-mh. r.f. choke (National R-50).
S_1 — Two-pole three-position rotary switch.
S_2 — D.p.d.t. rotary switch, shorting type (Mallory 3122J).
S_3 — S.p.s.t. toggle.
J_2 — Cable connector (Jones S-101).
Xtal — 5.2 Mc. (James Knight Co.).

Construction

The photographs show how the unit was built on a 13 × 17 × 3-inch chassis. We allowed plenty of room, and there is no doubt that the thing could be made smaller. However, the extra space makes working on the unit a simple matter. Usual practice was followed throughout, and there isn't anything tricky about the construction. The output circuit is mounted on a shield can above decks, but this is just a National XR-50 form wound with the proper coil and shunted by a fixed condenser. The tuning is done with the iron slug in the coil. The link coupling between L_1 and L_2 will require adjusting, so it should be left free to slide up and down until the adjustment is complete, after which it is made secure with a few drops of Duco cement. The trimmer condenser C_{46} is insulated from the chassis with a pair of fiber washers.

The wiring in the audio end of things is conventional, and no great pains need be taken, although you do want to keep the hum level down as low as possible. The main point to watch in wiring the audio phase-shift networks is to provide for ready access to the cathodes involved, because these are used as test points when aligning the set. In the r.f. end of things, make R_{63} easy to get to, because you may want to change it during the tune-up process. The "hot" r.f. leads from C_{42}, C_{43}, C_{48} and C_{49} to their respective modulator tubes are shielded wires, as indicated in Fig. 4.

Audio Alignment

It is possible that in the future means may be devised for aligning a unit of this type without an oscilloscope, an audio oscillator and a vacuum-tube voltmeter. For example, if 90-degree audio phase-shift networks were for sale "over the counter," you could do a fair job of checking the unit with just a receiver and a multimeter. But until such things are available (enterprising dealers please note!), it is best to rely on the instruments named above. You don't have to own them — you just have to know people who do.

The first step in getting the exciter working is to check the shift through the audio networks This requires an oscilloscope and an audio oscillator. The audio from the oscillator is fed in at the point marked "Audio Input" in Fig. 4, because one of the check frequencies wouldn't be passed by the audio filter. Connect the vertical and horizontal amplifiers of the 'scope across R_{18}, and set the audio frequency to 2710 cycles, the first "check" frequency. Adjust the gain of the 'scope amplifiers until you get a line that slants at an angle of 45 degrees. If it is a thin straight line, you have 'scope amplifiers with equal phase shifts, but if the best you can get is a thin ellipse, you will have to compensate one of the amplifiers. This generally means simply putting a resistor in series with one of the leads, and adjusting the resistor value until you get the single straight line. Or, it may be necessary to shunt a condenser across the amplifier input, in some cases. In any event when you have the straight line, you are ready to go ahead. Remove the lead from one of the amplifiers and connect it across R_{21}. If C_{15} is set properly, you will get a circular pattern on the 'scope, or rather an ellipse with one axis horizontal and the other vertical. If the ellipse is canted, a slight adjustment of C_{15} should bring it into line. If it is found impossible to correct the pattern, it indicates that the resistor is too far from the correct value and the condenser cannot be adjusted through the correct capacity. If the ellipse is not smooth all around, the audio level is too high and something is overloaded.

With both 'scope leads on R_{21}, recheck the 'scope amplifiers at 382 cycles for the single straight line canted 45 degrees. If a thin ellipse is obtained, correct one of the amplifiers as described above. Then transfer one lead to R_{24}, and adjust C_{16} for the correct ellipse.

With both 'scope leads on R_{24}, check the amplifiers at 35 cycles, transfer one lead to R_{27} and check the ellipse. Since C_{17} is a large condenser, it is best to bring it to the right value by adding additional mica units across it, or by making minor corrections in R_{25}.

The same alignment procedure is repeated in the other phase-shift channel, starting at R_{41} and a frequency of 10,840 cycles. Once you find your way around in these networks, the actual alignment procedure takes very little time, unless one of your values is in error quite a bit and you have to scurry around to correct it.

If you are using a 'scope in which the amplifiers have similar phase shifts regardless of the gain-control settings, another way to align the networks is to connect one amplifier across R_{18} (for example) and, at the check frequency of 2710 cycles, adjust for a deflection of, say, 10 divisions. Then disconnect this amplifier and connect the other amplifier across R_{21} and set it for the 10-division deflection. Then when you reconnect the first amplifier across R_{18} you can adjust C_{15} for a perfectly *circular* pattern. And so on down the line. This is a more accurate alignment method, but it does require good 'scope amplifiers.

When you are finished, confirm the action of the two networks over the range by connecting one amplifier across R_{27} and the other across R_{50}, after first setting the amplifiers to equal gains. Then, over a range from 70 to 5000 cycles, you should get a pattern that deviates very little from a true circle. If you find a point where it does, check the phase shift of the 'scope amplifiers, and you will probably find the trouble is in

TABLE I

Audio-Network Components and Check Frequencies

Component	*Check Freq. (cycles)*
C_{15} — 588 $\mu\mu$fd. (680 adjustable)	2710
R_{19} — 0.10 megohm	
C_{16} — 745 $\mu\mu$fd. (470 + 580 adjustable)	382
R_{22} — 0.56 megohm	
C_{17} — 8140 $\mu\mu$fd. (8200 ± 5%) *	35
R_{25} — 0.56 megohm.	
C_{21} — 288 $\mu\mu$fd. (380 adjustable)	10,840
R_{42} — 51,000 ohms.	
C_{22} — 1600 $\mu\mu$fd. (1200 + 680 adjustable)	997
R_{45} — 0.10 megohm	
C_{23} — 2040 $\mu\mu$fd. (1800 + 680 adjustable)	140
R_{48} — 0.56 megohm.	

R_{17}, R_{18} — 1000 ohms.	R_{40}, R_{41} — 1000 ohms.
R_{20}, R_{21} — 2000 ohms.	R_{43}, R_{44} — 2000 ohms.
R_{23}, R_{24} — 3000 ohms.	R_{46}, R_{47} — 3000 ohms.
R_{26}, R_{27} — 4000 ohms.	R_{49}, R_{50} — 4000 ohms.

Resistors are ±2% values, ½-watt rating (Continental Carbon "Nobleloy" or IRC BTS).

Fixed condensers are mica ±5 or ±10% values. Adjustable mica padders are El-Menco Type 46 trimmer condensers.

* May require several smaller mica condensers in parallel.

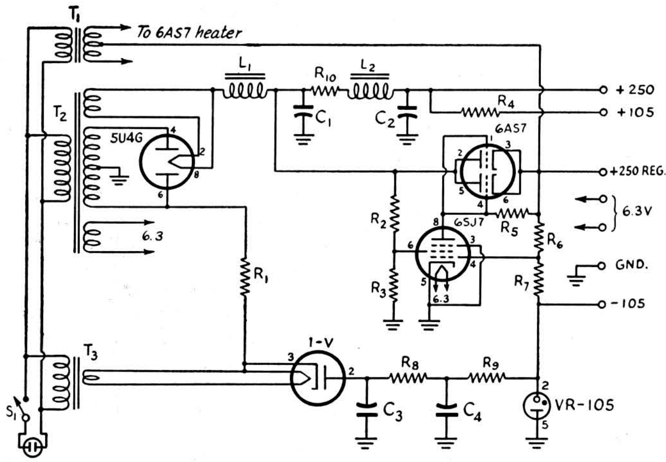


Fig. 5 — **Wiring diagram of the regulated power supply.**
C_1, C_2, C_3, C_4 — 16-μfd. 450-volt electrolytic.
R_1, R_4, R_8, R_9 — 2500 ohms, 10 watts.
R_2 — 47,000 ohms, 2 watts.
R_3 — 22,000 ohms, 1 watt.
R_5 — 0.47 megohm, ½ watt.
R_6 — 0.27 megohm, ½ watt.
R_7 — 0.1 megohm, ½ watt.
R_{10} — 1000-ohm wirewound, 10 watts.
L_1 — 8/30-hy. 150-ma. choke (Stancor C-1718).
L_2 — 30-hy. 100-ma. choke (Stancor C-1001).
T_1 — 6.3 volts, 3 amp. (Stancor P-5014).
T_2 — 375-0-375 volts, 150 ma.; 5 volts, 3 amp.; 6.3 volts, 5 amp. (Stancor P-6014).
T_3 — 6.3 volts, 1.2 amp. (Stancor P-6134).

the 'scope amplifiers and not in your network, if you have been careful in your procedure.

The R.F. Alignment

Most of the hard work is done now. The first step in the r.f. alignment is to adjust the output of the crystal-oscillator stage and the other tuned circuit to give about 1-volt r.f. signals at the grids of the 6SA7s. You can check that the oscillator stage is working by tuning in the signal on a receiver. Then adjust the slug in L_1 until a maximum r.f. voltage appears at the grids of Balanced Modulator B. If this voltage is too high above 1 volt, increase the value of R_{63}. You can measure the voltage with a vacuum-tube voltmeter, or by temporarily biasing the modulator tubes to 1.5 volts (with a dry cell) and checking to see if there is any grid current through R_{56} and R_{61}. (You are using the tube as a slide-back voltmeter.) Make the same check at R_{34} and R_{36}, with L_2 tuned for maximum signal at the grids. If the r.f. voltage at the grids of Balanced Modulator A is not within 5 per cent of that at B, move the links on L_1 and L_2 until you get what you want. Start out with too little coupling, to avoid any double-hump tuning. You won't be able to get all of the r.f. voltages to exactly the same value without trimming C_{42}, C_{43}, C_{48} and C_{49}, but don't worry about it if they are all within 5 per cent of each other.

Pull out the "Carrier Amplifier" tube, and connect the output at J_2 to your receiver. Set the receiver on a.v.c. and tune in the 5.2-Mc. signal that is coming through. Then tune the slug in L_3 to peak the signal. If you knock your S-meter off scale at this point, short your antenna input with a small resistor until you can get back on scale. With S_1 set for "SSB," adjust C_{27}, C_{36}, R_{33} and R_{60} for minimum signal in the receiver. You are now "balancing" the balanced modulators, and you will find that this works just like the book says. With no trouble at all, and in less time than it takes to read about it, you should find the setting where very little signal gets through to the receiver.

The next step can be done on a 'scope or on the receiver. Assuming you are using a receiver, leave it connected as described, with the a.v.c. on. Feed in the audio oscillator at a low level through the microphone circuit, at 1000 cycles or so. Your S-meter will go off scale as you increase the level, so short out the receiver input with 10 or 20 ohms and put a resistor in series to the "hot" side of J_2 until you get back on the S-meter scale. The audio output from the receiver will be an audio tone. Adjust C_{46} for minimum audio output from the receiver, and do the same for either R_{15} or R_{38}. (One of these is generally enough.) Now run the audio oscillator up and down the scale. You should hear little or no modulation on the signal, at any frequency.

The equivalent check on the 'scope requires that the output at J_2 be link-coupled to a tuned circuit connected directly to the vertical plates of the 'scope. With the 1000-cycle audio signal at the microphone jack, a pattern vaguely similar to an a.m. envelope should appear on the 'scope. As you adjust C_{46} and R_{16} (or R_{38}), the modulation should decrease, and you should minimize it for the correct adjustment. The correct pattern for a single-sideband signal (no carrier and a single modulation frequency) is what you are used to thinking of as an unmodulated carrier. If everything is perfect, no trace of modulation will appear, but everything won't be perfect, rest assured of that! However, over the entire audio range (limited by your audio filter, of course), the ripple should be small. Since this ripple can be introduced by harmonics generated in the audio amplifier, harmonics present in your audio signal generator, carrier leaking through or past the balanced modulators, and incorrect audio and r.f. phase and amplitude, you can see why we aren't too afraid that it will all be perfect.

The pattern should be the same for either position of S_2. If it isn't, it indicates that your audio network isn't perfect, but you know that the network isn't *exactly* right except at a few frequencies. If the ripple has the same order of magnitude at either setting of S_2, you are doing quite well.

All that is left to do now is to plug in the "Carrier Amplifier" tube and retune L_3, to compensate for the output capacity of the added 6SJ7. The tube was left out during the alignment procedure to avoid the chance of some carrier leaking through the tube. Even with S_3 open you may get a little more carrier leaking through than you do with the tube out of the socket, but it isn't enough to bother anyone on the air. On p.m. and double sideband, you have to insert carrier sufficient to prevent distortion and overmodulation, and your 'scope will help you to determine these levels.

Power Supply

We haven't mentioned the power supply up to this point, but it is an important part of the system. The B+ side of the phase-shift network has to be "stiff," and the best way to keep it this way is with an electronically-regulated supply.[6] The supply we used furnishes 250 volts regulated, 250 volts unregulated, −105 regulated (for the various biases), and a lead to the two VR-105s across the screens of the balanced modulators. The diagram is shown in Fig. 5.

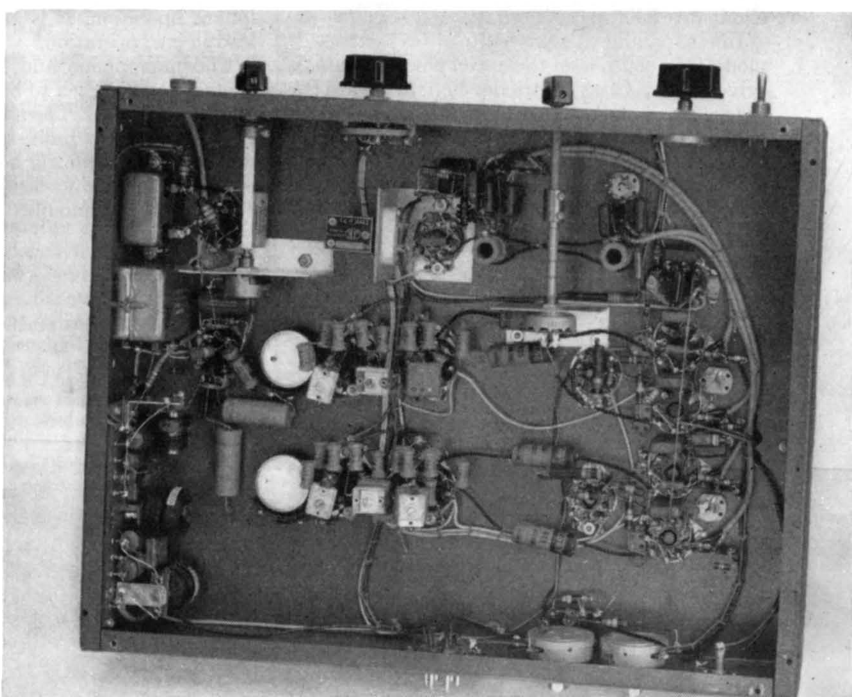
General

While the description of this unit may seem long and involved, it is only the result of trying to make the description as complete as possible. Naturally, questions will crop up that have been left unanswered, but we feel that anyone with a little familiarity with the use of a 'scope and an understanding of what he is trying to do will have no trouble with his single-sideband exciter. As mentioned earlier, if prealigned audio networks were available the exciter could be set up using only a receiver and perhaps a vacuum-tube voltmeter. Using the later type of network, one could dispense with the electronically-regulated power supply.

On single-sideband with single-tone modulation, the output at J_2 is about 0.1 volt across 300 ohms, and working into a tuned circuit will give about 20 volts. This is more than enough, of course, to drive any small mixer tube. The combination used at W1DX consists of a pair of 6K8s in a balanced mixer circuit, followed by a neutralized Class A 6AG7 driving a Class B 829-B. On a.m. the 829-B will comfortably handle a carrier output of about 20 watts, and on p.m. the carrier output can run close to 80 watts. In single-sideband operation, the 829-B will *loaf* along at a peak sideband output of 80 watts, but this gives a signal equivalent to an a.m. 'phone with 160 watts carrier output (about 225 watts to the modulated stage). As an amplifier for a single-sideband signal, the 829-B is the equivalent of a quarter-kilowatt a.m. 'phone.

Because of space limitations (and the fact that this article is plenty to chew over at one sitting), nothing has been said about the design and adjustment of the converter and output stages. But it is in the works and will be presented in the near future. The important thing to know is any and all converters and amplifiers following this exciter unit should be linear, which means using Class A or Class B amplifiers. The general practice seems to be to use Class A amplifiers at low levels (receiving tubes) and Class B when running powers above 10 or 20 watts.

[6] The audio phase-shift network described in footnote 3 is a later development and does not require quite such a "stiff" power supply. — *Ed.*



The 3000-cycle low-pass filter, at the lower left, is made from standard components mounted on a small resistor board. The components for the audio phase-shift networks are mounted on the tube sockets just to the left of center. The crystal-oscillator components are grouped around the tube socket, and the crystal socket is mounted on an aluminum bracket.

The two balancing potentiometers, R_{33} and R_{60}, are at the lower right.