Interest in SSB on the VHF amateurs bands -- principally 50 and 144 megacycles -- is growing rapidly. This two-part series in 6-Q-5 HAM NEWS has been prepared by two long-time experimenters with VHF SSB techniques -- and proven in hundreds of tests over a rugged 40-odd mile path between their stations. There's a wealth of good ideas in their circuits, choices of frequency conversion, and construction techniques. You'll find it's easy to modify or add to your present equipment and try VHF Single Sideband!

INTRODUCTION -- It is not necessary to extol the advantages of single or double sideband on the high frequency amateur radio bands, but on the VHF bands where there is no QRM, just steady receiver noise, many people do not realize the advantages of single or double sideband. These advantages can largely be summed up as follows:

1. In order to achieve high power output with an amplitude modulated signal, a large audio amplifier of at least one-half the total input power to the transmitter is required. For one kilowatt transmitter this audio power output is extremely difficult and costly to achieve. However, a single sideband exciter of only 6 watts output is capable of driving a pair of 500-watt class B pentode tubes in a linear amplifier to full 1200 watt peak effective input. If this same amplifier was used to amplify an amplitude modulated signal one finds that its efficiency is so poor that an amplifier which is capable of putting out 800 watts of SSB RF power delivers approximately 200 watts. Thus single and double sideband provide a simple means of producing a high power RF signal.

2. By theory and experimentation it has been shown that CW has a 17 db advantage over amplitude modulation. That is, a transmitter capable of transmitting one kilowatt input fully amplitude modulated has the same transmitter output range as a 20-watt transmitter on CW. This is all well and good if you want to use CW. However, it has also been shown that a single sideband emission is nearly as effective as CW. Actual tests on the 144-megacycle band show that, even though not exactly predicted by theory, a single sideband signal can be copied with the same ease as CW when the distance between stations is such that the signal strength of the received signal is very weak. Under these same conditions an amplitude modulated signal is indistinguishable. Therefore, single or double sideband do provide two very obvious advantages in the VHF bands: (1) equipment simplicity, and (2) talking power.

This article describes a 144-megacycle exciter which is capable of operating single sideband, double sideband, amplitude modulation and CW. It has a power output of approximately 6 watts which is adequate for local use or to drive a pentode-type kilowatt linear amplifier to full rated output. It also includes a tunable crystal oscillator with good stability and a voice operated control system. The exciter is a phasing type single sideband generator which provides good carrier suppression and unwanted sideband rejection.

CIRCUIT DESCRIPTION -- The Exciter consists of four basic circuits: (1) A phasing type single sideband generator operating on 25 megacycles; (2) a tunable crystal oscillator as the VFO; (3) a RF mixer and amplifier; and (4) a voice operated control circuit.

Each of the separate circuits which make up the Exciter are discussed in detail, and all instructions as to how to go to the schematic diagram, Figure 1.
TABLE 1 — PARTS LIST

<table>
<thead>
<tr>
<th>Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>8-100-pF variable, double bearings (Hammarlund HC-100-S)</td>
</tr>
<tr>
<td>C2</td>
<td>4.5-21-pF ceramic trimmer, NPO (Canfield 822-A2)</td>
</tr>
<tr>
<td>C3</td>
<td>7.45-pF ceramic trimmer, N-405 (Canfield 822-BN)</td>
</tr>
<tr>
<td>C4</td>
<td>27-10.8-pF per section miniature butterfly variable, 5/05-inch air gap (B. F. Johnson 160-211, type 11MB11)</td>
</tr>
<tr>
<td>C5</td>
<td>37-53-pF variable air (Hammarlund HP-50 or equal)</td>
</tr>
<tr>
<td>E1</td>
<td>3-terminal 3-watt filament type socket.</td>
</tr>
<tr>
<td>E2</td>
<td>12077</td>
</tr>
<tr>
<td>C17</td>
<td>.001 µf .01 µf, air bypass, 115-volt AC, 50000 ohm.</td>
</tr>
<tr>
<td>E3</td>
<td>double bearing (Hammarlund HC-100-S).</td>
</tr>
<tr>
<td>E4</td>
<td>single pole, single throw, single throw, 10000 ohm.</td>
</tr>
<tr>
<td>C5</td>
<td>25-watt type R550 or equal.</td>
</tr>
<tr>
<td>E5</td>
<td>Single layer coils, see TABLE I—COIL DATA. for details.</td>
</tr>
<tr>
<td>M</td>
<td>0.1 DC milliammeter, 15-turn dial. (G-E type DNN).</td>
</tr>
<tr>
<td>E6</td>
<td>300,000-ohm trimmer, audio taper.</td>
</tr>
</tbody>
</table>

FIG. 1. MAIN SCHEMATIC DIAGRAM for the exciter. The panel controls are identified with rectangular boxes around their names. Resistances are in ohms, 1/4-watt rating, unless otherwise marked. Capacitances are in picofarads (pf), or microfarads (μF), as marked. Parts reading further identification are described in TABLE 1—PARTS LIST, or TABLE II—COIL DATA. Circuits within dashed lines are in the upper sub-chassis section of the exciter.
The carrier generator is a transition oscillator (V1) operating on 25 megacycles. This oscillator is very stable. It uses the screen grid of a 6AS8 dual-triode as the plate of the oscillator, and the suppressor grid as the control grid. The suppressor grid, electrically follows the screen grid as the electron stream flows but yet controls the flow of electrons, materially contributing to the stability of the oscillator. The stability is also improved by forcing the crystal to run in a series resonant mode. Since this is a low impedance mode in 1 matching network (transform the low impedance crystal) to a higher impedance to develop more voltage at the screen and control grids.

The power output is limited therefore, it is necessary to follow the oscillator with a 40 megacycle 6AV6 amplifier. Its control grid is coupled very loosely to the transformer output by a 4.5 pf capacitor. The 4.5 pf capacitor, and the infinite impedance of the 6AV6 is a capacitor divider therefore by keeping the load of the small. The output of the buffer is coupled to the double balanced modulator by a four turn link (L0) tightly coupled to the plate tank circuit of 3.3-µf of the buffer, providing a low impedance output to drive the rf phase shift network.

The double balanced modulator consists of a pair of 5670 twin triodes (V2 & V3). Each of the balanced modulators suppresses the carrier and produces a double sideband suppressed carrier signal: output of each sideband. The carrier frequency.

In order that the balanced modulator can suppress the carrier, the carrier signal is fed to the base of each of the carrier generating transistors. It is the result that the output of one of the balanced modulators differs from the other balanced modulator by 90 degrees.

In addition, each balanced modulator is fed by two audio signals having a relative phase difference of 90 degrees. The output of the balanced modulators (V2 & V3) are fed to a common tank circuit (C3-L3) which combines the signals. This addition and cancellation in the output of the two balanced modulators whose carrier is phase shifted by 90° as well as a 90° phase shift of the audio input, produces a single sideband signal in the tank circuit.

Audio Amplifier and Phase shifter: the major problem with the phasing type single sideband generator is to produce a precise 90 degrees relative phase shift between the two audio signals required for each balanced modulator. This 90 degree phase shift which is precise across the voice range audio bandwidths. In order to produce this phase shift a complicated network must be used. Usually this network is made up of resistances and capacitance values that are not readily available. However, a special phase shift network was devised which consists of a shift out of standard resistor and capacitor values. Not only is it a 1500 ohm but it has a 5 percent tolerances. All other values are matched from a 4.7 pf capacitor. The suppression provided by this network is at least 90. To achieve the suppression as good as possible, the actual component units chosen should be close to the specified values.

The audio amplifier itself is straight forward. It consists of three twin triode tubes; a 12AX7 and two 12AT7's. The 12AX7 (V6) functions as a normal two stage triode amplifier. The output of the second section feeds the first section of the 12AT7 (V4) which is transformer coupled (by T1) to both the audio phase shift network and the VOX amplifier. The 600 ohm windings of T1 feeds the phase shift network and the 5200 ohm winding drives the VOX amplifier. The output of the phase shift network is a push-pull signal and is fed to an amplifier consisting of a 12AT7 (V5a) connected in push-pull with a balancing potentiometer (R5) in the cathodes, and the plate of each connected to a separate output transformer (T2 and T3). The 600 ohm windings of each drive the 5670 double balanced modulator tubes.

In order to choose the desired sideband, the output of T2 and T3 is connected to a 4-pole 3-position tap switch (S6) as shown in Fig. 1. The lower sideband is chosen if transformer leads 1 and 2 from T2 are connected to modulator A and B, respectively, Note: if transformer leads Nos. 3 and 4 from T2 are connected to modulator grid C and D, respectively. To obtain lower sideband leads 3 and 4 are interchanged. To obtain double sideband the actual components used are in parallel and the leads Nos. 3 and 4 are connected.

Variable Crystal Oscillator — A stable but yet tunable oscillator can be achieved by placing a varactor diode in the tank circuit of a quartz crystal. As the value of the inductor is changed, the frequency of oscillation will change proportionally. However, since variable inductors are difficult to tune and particularly in a linear manner — the actual frequency will change quite proportionally by placing a variable capacitor (C5) in series with the inductor. A modified Pierce oscillator is achieved by placing the capacitors and inductor, and a temperature compensating capacitor, between the screen and control grid of the 6AJ4 pentode (V6). The feedback circuit is then provided by the variable capacitor (C5) and a zero temperature coefficient trimmer capacitor (C6).

An ideal crystal frequency for 144 megacycle band operation is 5065 kilocycles, since no harmonics fall in the 144 megacycle band the crystal will pull very nicely at least 100 kilocycles lower or higher. The 25th harmonic of this crystal is 119.10 megacycles. Mixing this frequency with 25 megacycle produces a frequency of 144.14 megacycles. To achieve the 25 megacycle shift, the output is taken from each of the tank circuit in the plate of the oscillator and coupled to the 5th harmonic (279.775 Mc). This frequency is doubled.
The mixer is stable since the cathode is grounded. Bias is provided by self-bias operation of the control grid, and the single sideband signal is fed to a completely separate element of the tube. By tuning the plate of the tube to 144 megacycles and coupling it through a double tuned circuit into the following amplifier stage, a very clean 144-megacycle output signal is produced from this mixer.

**RF AMPLIFIER** —The first amplifier stage is a 6AX6 VHF pentode (V3) operated as a Class A amplifier. Double-tuned circuits are used from the mixer into its control grid, and into the following stage. The 5666, even though operated in Class A, provides ample drive for the 6060 twin pentode (V1) output stage, operated class AB1 with a fixed bias of 21.5 volts. The 6060 is operated push-pull and requires no neutralization because of its internal neutralized construction. The output of the push-pull tank is link coupled to the RF output connector. The 6100 operating in class AB1 provides about 6 watts CW output.

To measure the RF output of the exciter, the diode CR4 and RF choke R8C are mounted in a coaxial cable RF connector, and then plugged into a "Tree" connector in the output cable line, as shown in the rear and top views. A DC connection then runs to the meter control switch, S3.

**VOICE OPERATED CONTROL CIRCUITS** —No single stage transmitter is complete without the voice control circuitry. In this exciter a familiar type voice control circuit is used. The output of the audio amplifier from the 2200 ohm tap of the audio transformer is fed to one-half of the 12AT7 triode (V1A). The output from the 0.05 ohm tap or loud speaker of the receiver is fed to the other half of the 12AT7 triode (V1B). The output of V1A from the audio channel is then rectified by diode CR3, and used to charge a 0.3 mfd capacitor with an adjustable discharge resistor of 2.5 megohms. This operates a control circuit.

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**FOOTNOTES**

1. Technical discussion along the lines of an article printed in the AARL transmission crystal controlled oscillator will appear in the A.R.C. Bulletin, October 1962 (Vol. 17, No. 3).

2. Three recent articles by articles on the VXO-Crystal Oscillator appeared in the A.R.C. Bulletin, October 1962 (Vol. 17, No. 3). The crystals were VXO-Crystal Oscillators, which were purchased at a reduced price from the Crystal Oscillator Co., 515 W. 36th St., New York, New York.

3. A variable frequency crystal exciter was described in the A.R.C. NEWS, September 1959, page 37.


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**TABLE III** — **VOICE SIZE CHART**

- **A**-diode — No. 21 ferrite 4-6000.0000 scrn.
- **B**-diode — No. 24 ferrite 4-6000.0000 scrn.
- **C**-diode — No. 17 ferrite 6-6000.0000 scrn.
- **D**-diode — No. 7 ferrite 6-6000.0000 scrn.
- **E**-diode — 3-6000.0000 diameter.
- **F**-diode — 4-6000.0000 diameter.
- **G**-diode — 6-6000.0000 diameter.
- **H**-socket punch — 7-6000.0000 diameter.
- **I**-socket punch — 9-6000.0000 diameter.
- **J**-socket punch — 12-6000.0000 diameter.
- **K**-socket punch — 15-6000.0000 diameter.

**TABLE IV** — **FOOTPRINT**

- **Medallion** — 3/4-inch diameter.
- **Medallion** — 5-inch diameter.
- **Medallion** — 4-inch diameter.
- **Medallion** — 3-inch diameter.
- **Medallion** — 2-inch diameter.
- **Medallion** — 1-inch diameter.
relay tube, also one half of a 12AT7 (Vam) with a 1,500-ohm, 8 ma. plate relay. To provide anti-clip, the output of the receiver amplifier (V1a) is rectified by a negatively biased diode (C6) and also charges a long time constant circuit. This circuit PAR- is the audio amplifier (V1a) channel so that any output from the loud- speaker cancels the signal from the audio amplifier channel by not allowing diode C6 to conduct.

In addition to the choice of lower, upper and double sidebands on (R9), by adding a mode selector switch (R9), the exciter can be placed in an AM or CW mode of operation. To provide AM, one of the double balanced modulators is simply unbalanced. This increases the carrier from its normal cancellation amplitude. In this mode, the specific carrier level can be set, R1.

Bias one of the balanced modulator carrier balance potentiometers (R12) to a new potentiometer (R9), which is set at the desired AM carrier amplitude. In practice, only a small amount of carrier is required to make speech very intelligible. Therefore, if a high-power linear amplifier is used to follow this exciter most of the benefits of single sideband can be achieved by inserting a small amount of carrier so that the output modulation is 400 to 500 percent. The carrier output is then small enough to cause little increase in plate dissipa- tion in the linear amplifier tube, but will be very readable on those 144- megacycle receivers which cannot receive single sideband due to the lack of a R.F.O.

In the AM mode the use of only one sideband is not detrimental to reception. Normal AM can be obtained by inserting the mode selector switch (R9) to the exciter into the double sideband mode. Further, the biasing of the balanced modulators through R12 to an extreme to the left will cause the carrier to be reduced to full output provides a CW carrier. Keying the exciter in the cathode of the RF mixer (V3) through J2. In addition to unbalancing the carrier, it is also desirable in the CW mode to disconnect the output of the audio am- plifier. This eliminates the possibility of transmitting inadvertently modulated CW. The mode switch (R9) performs these functions.

**MICRO SUPPLY** Power requirements of the complete 144-megacycle SSB exciter is 6.3 volts at 5 amperes for heaters; plus 150 volts DC at 55 to 110 ma.; plus 200 volts DC at 25 ma.; plus 300 volts DC at 75 ma.; minus 22 volts for grid bias.

To assure optimum and stable performance of the exciter, the plus 150, 200 and 300-volt DC supplies should be regulated. A suitable power supply con- structed by the author for his exciter will be described in the following issue, September-October, 1962 (Vol.17, No. 2).

**Construction Details** Most of the con- struction of the exciter is self-explanatory through the pictures and mechan- ical layouts. However, some details may not be obvious and are explained in detail.

The upper chassis was fabricated with open sides from 18-gauge (0.040- inch thick) sheet aluminum 13\(\frac{1}{4}\)4 inches. It is trimmed and folded as shown in the upper chassis layout drawing, Fig. 2. Drill holes for the tube sockets and other parts at the locations marked. Make two end plates 3x1 3/4 inches from the same sheet stock and fasten them to the flanges on the ends with No. 8 sheet metal screws. Also make a shield partition and fasten it in place as shown in Fig. 2.

The main chassis is a standard 7x2-inch type (Rad AC-406, or equiv- alent). Drill and punch the panel as shown in the layout diagram for it, Fig. 3. Make shield partitions from 18-gauge aluminum at the locations shown by the dashed lines in Fig. 3, and the bot- tom view photo. Fit the shields in place and fasten them with No. 8 sheet metal screws.

Drill the upper chassis down with No. 8 sheet metal screws driven up from the bottom side into the flanges on the bottom of the upper chassis. Also, punch the holes for the power sockets at the left rear corner.

The panel comes with the 8x12\(\frac{1}{4}\) inch deep cabinet (Rad C-1740, or equivalent) and is 8x10 inches in size. Drill and punch the panel as shown in the layout diagram of Fig. 4. The upper and lower chassis, the National MGN dial, and shields all should be assembled temporarily to check proper align- ment before beginning the mounting of parts and wiring.

**Upper Chassis** The upper chassis is divided into two sections. On the right hand side facing the front panel is the audio section separated by a shield from the variable crystal oscillator sec- tion. The audio section is constructed on Vector socket assemblies, with the exception of the phase shift networks. In the left side detail view on page 1, the entire audio section is shown as being con- structed on a Vector circuit board and con- nected to the Vector board (Vs). This was convenient since this tube feeds the output stage and the phase shift network. Behind the audio transformers is the plate relay (Rc) for the VOX. The entire VOX was built on a Vector socket assembly with a small terminal board attached to the base of the pot on the socket for V1, to hold these components which would not fit on the panel.

The sideband selector switch (S2) is mounted through the front of the audio section chassis and passes through the front panel. The mode selector switch (R9) is mounted directly on the front panel just above the top chassis. In the variable crystal oscillator section of the chassis was assembled from components mounted directly on the underside as is shown in the figure.

The National MCN dial is mounted on the side of the chassis and the shaft going through the front panel. The shaft is mounted to the chassis and the shaft holds three potentiometers for grid bias, receiver gain, for the anti-clip circuit (R9), the CW am- plitude (R60), and the AM amplitude (R60).

![FIG. 4. FRONT PANEL layout diagram. Location of the main and upper sub-chassis are shown by dashed lines. Hole for the meter should be bored to fit the case of the particular meter used in construction.](image-url)
MAIN CHASSIS — The main chassis has four shielded areas. These consist of the single sideband generator, the RF assembly, the control section and the power plug section. Construction of the single sideband generator is seen in the bottom view. The output from the single sidetable double balanced modulators (V6 and V7) passes through a feed-through terminal in the shield directly to the suppressor grid pin of the RF mixer tube (V8). The assembly of the 144-megacycle amplifier stages (V8 and V1) is detailed in the sketch of Fig. 5, in addition to the bottom view.

The control section in the middle of the main chassis contains the two relays, R1 and R2, plus the pilot light, control switches, key jack, and audio transformers. The power plug section compartment is filled with small RF Chokes (RF7) and 1000-pf. ceramic feed-through bypass capacitors mounted in the partition. These filters keep RF energy from leaking out through the power leads.

The variable crystal oscillator will only be as stable as the frequency of the crystals. Because the crystal is operated in a parallel mode in which it is pulled from its normal operating frequency, it is more temperature sensitive than a normal crystal. Therefore, in order to insure good frequency stability as the oscillator warms up two things must be done. The crystals must be mounted in an assembly as shown in the top view and preferably connected to the front panel by a metal strap in contact with the crystals to keep them at the temperature of the front panel.

This assembly is a simple aluminum frame. The terminals are soldered to the crystal holders thereby providing their mechanical support. The face panel and the aluminum frame reflects the radiant heat from the nearby tubes. Insulation around the crystal prevents additional heating. A metal strap which touches the metal portion of the crystal holder also helps keep the crystal at nearly constant temperature.

An alternate solution is to purchase a crystal oven and operate the crystal in this oven in place of the crystal sockets shown. Two crystal sockets are shown, but only one of the sockets, the one to the right, facing the front panel, is connected. The other socket is a dummy in which to store the space crystal at the same temperature. To change to the second crystal, simply reverse them in their sockets.

OPERATION AND ADJUSTMENT — Before applying power to the exciter, all tubes should be pulled out of their sockets. Since some stages are only biased by grid current, if the oscillator or amplifiers are not operating properly some of the stages could be drawing excess current. Place the tubes in their sockets one at a time as the adjustment proceeds.

First adjust the transition oscillator by removing the 3200-ohm resistor across the inductor (L3), removing the crystal and shorting out the socket. Set the variable capacitor (C12) to approximately one-half of maximum capacity; and, with a grid dip meter time the inductance to the 25-megacycle crystal frequency. Replace the 3200-ohm resistor and place the crystal in its socket. Connect a voltage tube meter (VTVM) to the control grid of the 6C66 buffer and tune the variable capacitor (C14) for maximum output voltage.

The next step is to adjust the plate coil (L4) of the 6C66 buffer by setting it to 25 megacycles with the grid-dip meter; it can then be tapped into position. Then balance the mixer and tank circuit. This can be done with a milliammeter and a galvanometer or by using a variable crystal oscillator. If the combination of grid and peaking can then be finished after the variable crystal oscillator and other BR stages have been adjusted. The final single sidetable adjustments are made after 144-megacycle output is obtained by listening to the signal on a receiver covering the 144-megacycle band.

RF ADJUSTMENTS — Adjustment starts with the variable crystal oscillator (V13). Insert the oscillator tube and the first doubler (V13), then connect a high impedance volt meter — preferably a vacuum tube volt meter — on the grid of the first doubler. Switch the oscillator to crystal position, turn the tuning capacitor (C17) to minimum capacitance and adjust the feedback capacitor (C18) for maximum negative voltage on the first doubler grid. Then switch the VXO into the variable position. Tune the inductance (L3) to minimum value and the negative temperature coefficient capacitor (C15) to approximately one-half its maximum value. With the VTVM on the grid of the first doubler, tune C4 across the band and determine if the oscillator is operating over its whole range. If not, adjust either L4 or C8 or both, until the oscillator delivers equal voltage at the grid of VXO nearly to that in the crystal position across the band. Adjustment of the oscillator's tuning range is made by listening on the 144 megacycle receiver after the remainder of the RF section is operating. Next, with the VXO in the crystal position, turn C4 to minimum capacitance, and place the second doubler tube (V14) in its socket. Connect the VTVM to the grid of the mixer stage (V15) and adjust L5 for maximum negative voltage. If the signal is still too low, adjust L3 and L4 until a signal is obtained on the mixer grid, then peak L8, L9, and L5. The VTVM on the grid of the mixer stage will probably affect the settings of L4 and L9, but this will be peaked again later. The high impedance volt meter and plate voltages to the 680Ω (V15) output tube. Connect the VTVM to the grid bias supply of the 680Ω. Then
insert carrier by turning the carrier balance controls off center (they prob- ably will be off before anyway) and with an insulated tool, adjust L2 by spreading the pair. This will allow the maximum negative voltage on the grid of the 6360. Since the other induc- tors must also be adjusted the signal at L9 may be large. Change the sett- ings of L1, L3 and L0 can be made. After the value of L2 has been pushed to a 60 m, try adjusting the coupling between L4, L1 and L3 and then bring to a maxi- mum DC voltage of 18 to 70 volts at the grid of the 6360.

Then apply the screen, plate and bias voltages (400 volt screen and connect the 6360 with C6 and connect the maximum RF signal out by adjusting the series leading capacitor (C3). This is best accomplished by calibrating the meter from plate current to RF voltage. The bias adjustment of the 6360 should be set to a no signal plate current of 20 Ma (CW Key Open), and with a maximum unbalance of the signal sideband generator a plate cur- rent of 50 to 60 ma, will be drawn by the 6360.

**VFO FREQUENCY ADJUSTMENT**—Most 5000- kilocycle crystals will have a pulling range of 200 to 800 kilocycles at 144 megacycles. However, if L6 is set for maximum pulling, the frequency will not be very stable. Therefore, to make this adjustment, set the VFO to crystal position (L6) and, in the VFO circuit, the crystal detector. This will result in the highest frequency coming from the crystal. Now switch the oscillator to VFO position and note the frequency. The desired signal is slightly lower. Now tune C1 to a maximum of 200 Ma. After the value of L6 has been pushed to the desired value a check of the output voltages of the signals generator should then be made by placing a VTM on the grid of the 6360 mixer stage and tuning across the band. If the variation is greater than 100 Ma, adjust L6 to the frequency range, so it will be necessary to make a second fine tuning range and keep the mixer grid voltage at a minimum of 50 volts.

**SIDEBAND GENERATOR ADJUSTMENTS**—To insure that all of the circuits are working correctly, the entire RF adjustment procedure should be repeated with the tuning capacitor (C5) set to the center of the tuning band. The drive at the grid of the 6360 is best checked with the screen, plate and bias voltages removed.

Tune the oscillator to a convenient frequency on the receiver (set for CW reception) and adjust the carrier balance control (C1) to balance the potentials (R2) and (R6) for minimum output after placing the microphone switch in the suppressor carrier posit- ion. Use the suppressor control instead of the carrier balance and noting the frequency, set the sidetone controls to balance the upper or lower sideband, depending on which is the desired signal. Using an oscilloscope on upper sideband, insert a 1000-cycle audio tone into the audio input (F1) from an audio signal generator. With the re- ceiver still set for CW and maximum selectivity, carefully tune to both sides of the carrier. Hollow tones will appear as 10,000 cycles on either side of the carrier frequency before it was suppressed.

When adjusting for upper sideband, tune the receiver to the lowest frequency sideband, being careful to choose the first signal encountered on the low side of the carrier frequency. Other signals will appear which are second, third and fourth order harmonics of the previously suppressed, 10,000-cycle signal. These will be sup- pressed by adjusting the suppressor control to a maximum of 100,000 cycles of output. Then check the receiver to AM, learn- ing the selection in its simplest pos- ition and note it's value on the receiver. Carefully tune past the carrier toward the upper sideband and note its value on the S meter. If the receiver S meter is correctly calibrated the amount of suppression can be noted by comparing the relative readings of the upper and lower sidebands. Further adjustments are then made until the difference be- tween upper and lower sideband is ap- proximately 30 db, or 5 S units.

Now switch the sideband mode to lower sideband and tune the receiver — still in the AM position — from the lower to the upper sidebands. The lower sideband is now maximum and the upper sideband is suppressed. How- ever, sideband suppression may not be as great in this position. This is not a fault of construction or design — it is simply characteristic of a phasing type sideband rig. Next, switch the sideband generator to dual sideband and the sidebands should be approximately equal.

**VOICE OPERATED CONTROL ADJUSTMENTS**—When talking into the microphone, adjust the VFO control to normal level after making the previous adjustments on the signals generator. Increase suppression of the voice operated switch. Then with the microphone placed in the VFO operating position, adjust the VOX control to null the voice operated switch. Then adjust the VOX for normal amplitude. Then, if this occurs it is recommended that the VFO be switched to crystal position and then returned to variable. This will start the oscillator.

The spotting switch (R7) on the front panel applies power to exciter, with the exception of the RF amplifiers, therefore allowing the station receiver to hear the transmitter for zero-beat purposes.

Part II of this special report on VHF SSB will be covered in the next issue of "Ham Radio" and will include the second half of the mode and the complete construction details. A de- tailed discussion of the function of the transmitter will be covered as well as construction and data for the voltage input power supply for the exciter in this issue.

**DETAIL VIEW OF THE VFO connection is shown in the upper right with a slight magnification.**

Upon speaking into the microphone the input amplitude will then go up to its normal value or in other words the power of the signal and will be transmitted bearing the speech. This adjustment is approximately 400 percent over modu- lation but as previously mentioned is very readable by almost any receiver. If normal AM is desired then the car- rier should be increased by adjusting the setting of potentialmeter R9 until the final amplifiers are driving a plate current of two-thirds its maximum value. This pro- vides 100 percent modulation.

**OPERATION**—After completing the pre- vious adjustments the power output is controlled by the audio gain control. It may be found that for some crystals that the VFO will not oscillate if power is applied when the VFO is on variable tuning and the tuning capacitor (C5) is near the low end of the range. There- fore, if this occurs it is recommended that the VFO be switched to crystal position and then returned to variable. This will start the oscillator.
G-E COMPACTRONS IN HAM GEAR

General Electric's new compactron multi-function receiving tubes are appearing in the latest amateur radio equipment now coming on the market. One of the first such equipments is the new Hammerrhand HX-50 sideband transmitter. In it, a G610 triple-triode compactron (each section is similar to those in a 1A4X7-A miniature twin triode) is used as the input audio amplifier, audio modulator for the balanced modulator, and the carrier oscillator. The triode section performs each of these functions simultaneously.

This is a good example of how G-E's new compactrons can simplify electronic equipment through combining functions usually performed by two or three conventional tubes into one compact envelope. A list of compactron types was published on page 8 of the January-February, 1963 issue (Vol. 17, No. 1) of G-E HAM NEWS. A supplement to this list containing a number of new types will be published in the September-October, 1963 issue.

The HX-50 transmitter, incidentally, covers several 1-megacycle segments which include the 5.5, 7, 14, 21 and 28-megacycle amateur bands. It will run up to 120 watts P.E.P. input, and has all of the latest features.

G-E NEWS

NEW G-E COMPACTRONS
SIMPLIFY TV

Radio amateurs have a dramatic demonstration of how General Electric's new line of compactron receiving tubes can simplify electronic equipment in the industry trend toward "compactronized" television receivers.

The complements in these new TV sets is reduced about one third through substituting multifunction compactrons for conventional receiving tubes in most circuits. Amateurs can expect the same degree of simplification in amateur radio equipment using compactrons.

In the latest line of General Electric television receivers, an average of 7 or 8 compactrons per chassis replaces 11 to 13 conventional tubes used in preceding models. A total of 19 compactrons replaces 50 tubes in the three basic chassises which go into all 28-inch table and console TV's; in the 18-inch "Designer" series, the 18-inch portable "Century" and "Celebrity" models; and in the new lightweight, 25-pound 16-inch " Escort" model.

The photo below shows 8 compactrons and 1 standard tube (left) taking over the complement of the basic chassis of the HX-50 "Escort" portable TV. At the right are the 18 conventional tubes which comprised the tube complement in a typical TV basic chassis of several years ago.

Making the compact is Christopher D. McColl, Home Entertainment Products Design Engineering Manager of G-E's Receiving Tube Department, who spearheaded the compactron development program. Neither the power rectifier or tuner tubes are included in the examples.

The multifunction compactron types have many applications in equipment having a number of circuit functions - like the TV receivers described above. Amateurs receiving sideband exciters and transceivers can be simplified with multi-function compactrons in the small signal circuits. And, horizontal sweep type power compactrons are available

Available FREE from your G-E Tube Distributor

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G-E VHF FM GEAR AT K7USA

The VHF FM stations on the 50 and 144-megacycle bands at K7USA the amateur radio station at the Century 21 exhibition in Seattle have been furnished by General Electric's Communications Products Department located in Lynchburg Va.

The 80-watt deck-type basic stations, the same as supplied to hundreds of commercial VHF communications users, operate on the national amateur FM calling frequencies of 52.525 and 146.146.450 megacycles. In addition, frequencies of 146.080, 146.700 and 147.350 megacycles are available for casual operating to keep the calling frequencies clear.

If you are planning to attend the Century 21 exhibition in Seattle this summer, and have VHF FM mobile equipment in your car, be sure to take along crystals which cover the above channels so that you can contact K7USA to perform the tasks to which conventional sweep tubes are usually assigned in amateur radio gear.

G-E HAM NEWS plans to publish articles on "compactronized" equipment for the home constructor in coming issues. Watch for them!