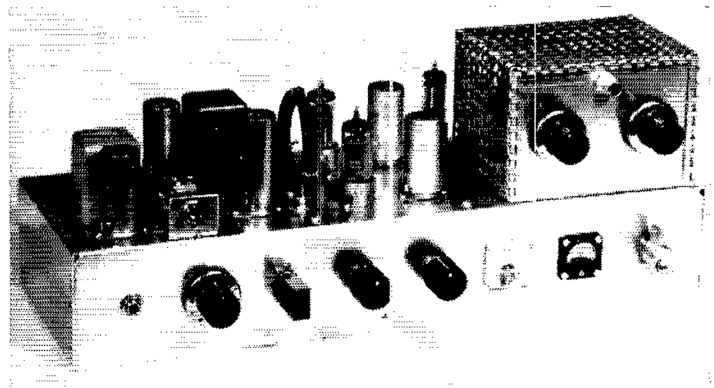


The complete 12-watt, 50-Mc. s.s.b. transmitter is shown on the 17 × 6 × 3-inch chassis. The 2E26 linear amplifier is enclosed in the shielding box on the right, with its tuning and loading controls on the upper right. The 6JH8 balanced-modulator tubes are to the right of the loop of coax, and are shown with tube shields removed. The small coil of coax provides 90-degree r.f. phase shift at 50 Mc. The left knob is the audio gain. The sideband-selection switch is directly above. Next to the audio gain control is the 8-Mc. crystal, and on its right are the two carrier-balance controls. On the extreme right is a meter switch that was little used and has been omitted from the schematic. Power requirements are 300 volts at 60 ma. and 600 volts at 90 ma. The −75-volt bias supply and the regulated 150-volt screen supply are included in this chassis.

The Single-Sideband Sixer

A 12-Watt Beam-Deflection-Tube Transmitter

BY JAY GOOCH,* W9YRV AND ESTIL CARTER,* WA9DNF

The applications of the unique balanced-modulator circuit used in this exciter aren't confined to 6-meters — the circuit is usable at any frequency. Combining beam-deflection mixing and cascode output coupling, it offers a high degree of stability in balance, along with enough output for driving small power tubes directly.

A simple, straight-through phasing type 6-meter s.s.b. exciter has been constructed and shows smooth, stable operation. New G.E. type 6JH8 beam deflection tubes,[1] V_4 and V_5, Fig. 1, are used as balanced modulators in a novel cascode circuit. Sufficient power is obtained from the balanced modulators along with two 12AT7s, V_6 and V_7, to drive directly a 2E26 linear amplifier which provides 12 watts p.e.p. output measured at the 50-ohm load.

The 50-Mc. suppressed carrier frequency, which provides the r.f. drive to the balanced modulators, is furnished from an 8-Mc. crystal, a triode third-overtone oscillator, V_{3A}, and a pentode frequency doubler, V_{3B}. The two sections of a 6AW8 are used. The 90-degree r.f. phase difference between the control grids of the two balanced modulators is obtained by a length of 75-ohm coax cable, W_1.

A speech amplifier, V_1, a 90-degree audio phase-difference network, Z_1, and two split-secondary audio transformers, T_2 and T_3, provide the required push-pull audio drive for the balanced modulators.

D.c. feedback, obtained from the balanced-modulator cascode-tube outputs, coupled through neon bulbs and the audio transformer split secondaries to the deflector elements, gives unusually good carrier-null balance stability.

The buffer amplifiers in the plates of the balanced modulators are cascode-connected, direct-coupled, and grounded-grid. These have advantages which include:

1. Some r.f. power gain.
2. Increased d.c. feedback gain, resulting in improved carrier-null balance stability.
3. Isolation between plates of the quadrature-driven beam-deflection tubes, resulting in less distortion due to intercoupling.
4. High-impedance output from the cathode driven amplifiers following the balanced modulators, which makes possible more ideal current addition of the two balanced-modulator channels.
5. Elimination of the need for special quadrature balance of the carrier null because of a large increase in the plate resistances shunting the two halves of the output tank circuit.

These advantages result *without requiring* additional tuned circuits.

The unit is operated from a TV transformer and bridge-rectifier power supply which furnishes +300 and +600 volts. A −75-volt d.c. bias

* Coordinated Science Laboratory, University of Illinois, Urbana, Illinois.

[1] *Description and Rating Sheet, 6JH8, ET-T3029.* General Electric Company, Receiving Tube Department, Owensboro, Kentucky.

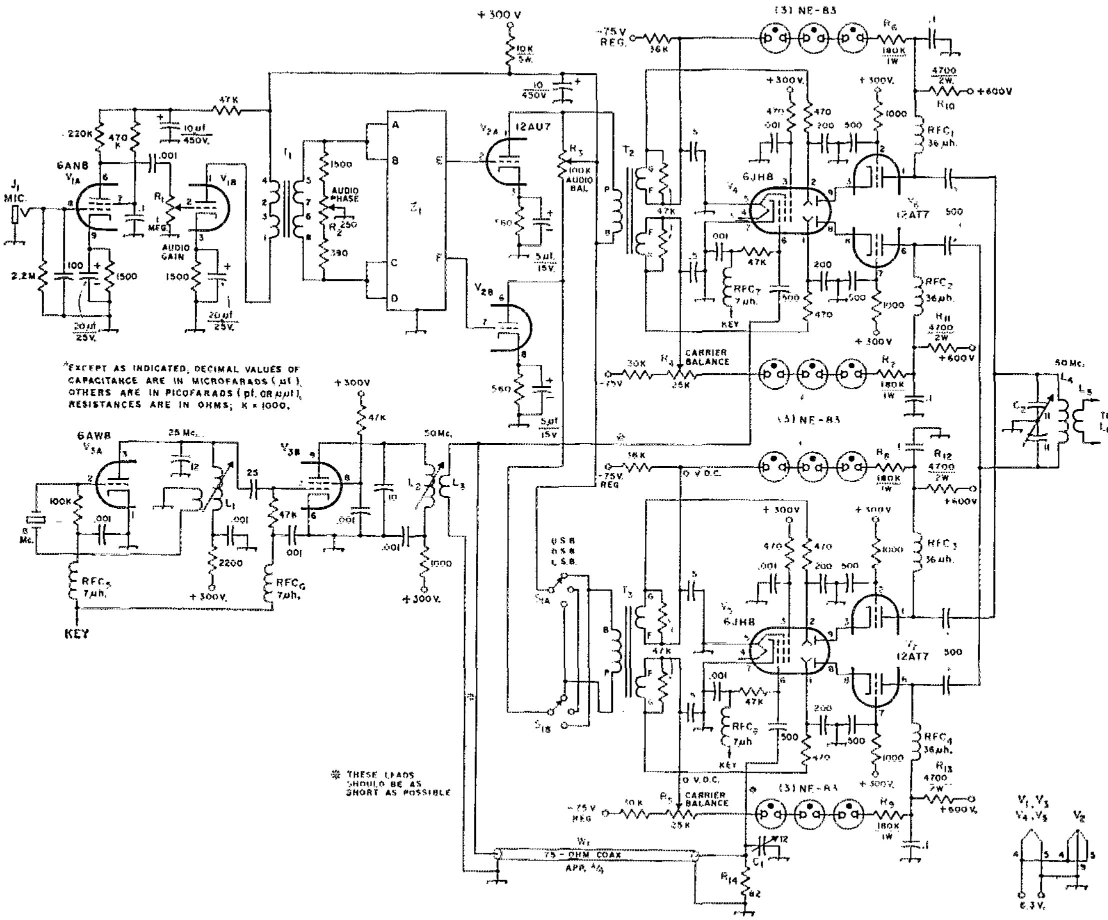


Fig. 1—Circuit diagram of the s.s.b. exciter for 6-meter operation. Except as indicated, resistors are ½-watt composition; fixed capacitors above 0.001-µf. are paper, 0.001-µf. capacitors are ceramic, those with polarity marked are electrolytic, others are mica. See text on heater supply for V_6 and V_7.

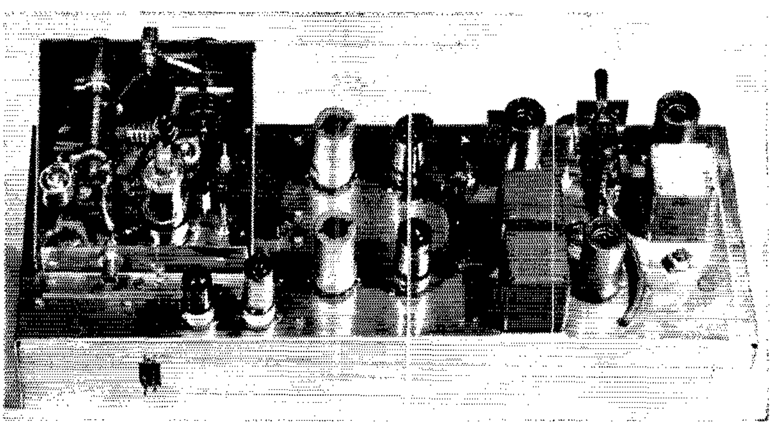
C_1—Ceramic piston, 1.5-12 pf. (Cambion CST-50 or equivalent).
C_2—10.8 pf. per section, butterfly (Johnson 11MB11 or equivalent).
J_1—Open-circuit jack (or microphone connector).
L_1—3-5.5 µh., slug-tuned (North Hills 110B, Miller 4504 or equivalent). Feedback coil 5 turns No. 24 close-wound at cold end.
L_2—7 turns No. 24 close-wound on ⅜-inch diam. slug-tuned form (CTC PLS5-2C4L/N or Miller 4400 form).
L_3—3 turns No. 24, diam. ¾ inch, close-wound at cold end of L_2.
L_4—8 turns No. 20, diam. ¾ inch, 16 turns/inch (B & W Miniductor 3011); see L_5.
L_5—Center turn of L_4, cut to form link; inner ends of remaining two sections of L_4 connected together.
R_1—Audio-taper control.
R_2, R_3, R_4, R_5—Linear-taper control.
R_6-R_{14}, incl.—For text reference.
RFC_1-RFC_4, incl.—Single-pie choke (Miller 6176-TV peaking coil or equivalent).
RFC_5-RFC_8, incl.—V.h.f. choke (Ohmite Z-50 or equivalent).
T_1, T_2, T_3—See text and photo captions.
W_1—See text.
Z_1—Audio phase-shift network; see Table I and Footnote 9.

supply is built into the transmitter.

The beam-deflection tube is attractive as a balanced modulator since it (1) operates well at frequencies as high as 50 Mc., (2) gives moderate power output without excessive distortion, (3) has good inherent carrier-null balance stability due to its single cathode and control grid associated with two anodes, and (4) has separate high-impedance inputs for r.f. and for audio drive.

Several phasing-type beam-deflection-tube exciters have been described.[2,3,4] These generally have been lower-frequency, lower-power units which require additional amplifier or heterodyne stages for v.h.f. use. This unit, although simple, is attractive as a complete transmitter for a

[2] Vance, "S.S.B. Exciter Circuits Using a New Beam-Deflection Tube," *QST*, March, 1960, p. 33.
[3] "A Phased Single-Sideband Exciter," *The Radio Amateur's Handbook*, ARRL, 38th edition (1961), pp. 307–312.
[4] Evans, "Another Phasing-Type S.S.B. Exciter Unit," *QST*, September, 1962, p. 28.



The 2E26 compartment can be seen on the left, with perforated metal cover removed. On the extreme left is the pi-network loading capacitor, and to its right is the 2E26 plate tuning capacitor. The piston-type 2E26 neutralizing capacitor is near the rear right corner of the tuning capacitor. It is mounted on top of a 500-pf. feed-through capacitor which is the partial bypass for the bottom end of L_7, the 2E26 grid coil. T_2 and T_3, the audio transformers for driving the deflectors, are UTC type A-19 but can be replaced by less expensive Chicago-Stancor type A-4774. T_2 and T_3 furnish 12 volts of peak-to-peak audio (4.2 volts r.m.s.) to each deflector element of each 6JH8.

6-meter station.

50-Mc. Carrier Generation

An 8-Mc. crystal is used in a third-overtone oscillator with its output on 25 Mc. This is followed by a pentode frequency doubler. The two sections of a 6AW8 are used in a circuit similar to that in *Handbook* v.h.f. transmitters.[5] A link, L_3, on the output coil, L_2, of the doubler is connected to two paralleled loads. One is the control grid of the first balanced modulator. The other is a length of 75-ohm coax cable which provides 90-degree phase shift to the 50-Mc. signal and feeds the grid of the second balanced modulator.

R.F. Phase Shift

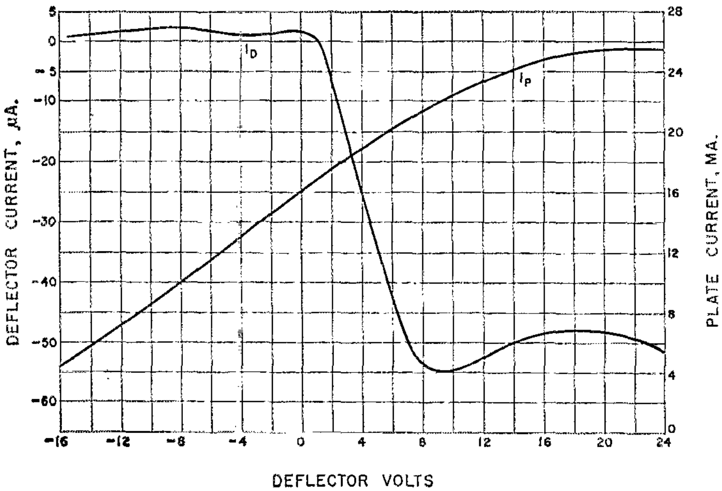
This phase shift is accomplished by an approximate quarter wavelength of 75-ohm coax cable. Both subminax, 21-579, and RG-59/U were tried with no noticeable difference.

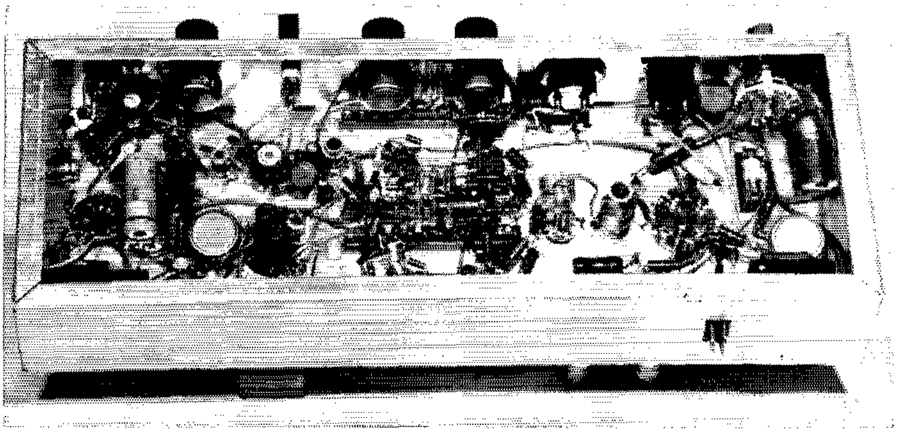
The amount of phase shift furnished by the coax depends on its length, its characteristic impedance, and its terminating impedance. Here the 75-ohm characteristic impedance cable is terminated in approximately 8 pf., the capacitance of the 6JH8 control grid input. An 82-ohm resistor, R_{14}, is added to lower the v.s.w.r. on the coax. This avoids the large change in phase shift which accompanies a very small length change in a cable operated at a high v.s.w.r.

Simplest construction if operation near 50.2 Mc. is intended is to omit C_1, the 1.5- to 12-pf. trimmer capacitor, and to cut the total length of coax to 31¾ inches. This is estimated to give phase shift of 90 ± 1 degrees over about a ½-Mc. frequency range. Lengths for other spot frequencies in the 6-meter band, where the cable is terminated in the 6JH8 control grid capacitance, can be calculated from

[5] "Simple Transmitters for 50 and 144 Mc.," *The Radio Amateur's Handbook*, 38th edition (1961), p. 437, and 39th edition (1962), p. 442.

Fig. 2—Deflector current and plate current as a function of deflector voltage, 6JH8 beam-deflection tube.





The 6AN8 speech amplifier socket is in the upper left corner. The overtone crystal oscillator and doubler are adjacent to the crystal socket on the front panel. Two carrier-balance pots occupy the center position of the front panel. The left-hand miniature meter reads r.f. output voltage and the right-hand meter reads 2E26 plate current. The wafer switch at upper right permitted reading 2E26 plate, screen, or control grid current, but proved of little use and was omitted from the schematic. At center right is the 2E26 socket and, on its left, the 2E26 grid tank coil, with link coupling from the balanced modulator plate coil. The silicon bias rectifier is at the far right center, adjacent to the electrolytic bias-supply filter capacitor. The 6JH8 balanced modulator sockets with their short leads connecting to the coax cable are below the left carrier-balance pot. This photo shows that all coils and tuning capacitors except the 2E26 plate components are mounted below the chassis. The 2E26 plate circuit components are kept above the chassis for isolation. The output connection to the antenna is also above the chassis.

$$length,\ inches = \frac{1592}{freq.\ in\ Mc.}$$

This length was verified both for RG-59/U and Amphenol subminax 21-579, both of which have a velocity factor of 0.66. Alternate construction is to incorporate a 1.5-12 pf. piston capacitor (C_1) as an r.f. phase adjustment and cut the coax to 29 inches. This allows adjustment that will give a 90-degree phase shift on any frequency in the 50 to 54-Mc. band

The r.f. voltages measured at the control grids of the two 6JH8 tubes are nearly equal. They read 5.1 volts r.m.s. on the link and 5.3 volts r.m.s. at the terminated end of the coax.

Cascoded Balanced Modulators

The control grids of the two 6JH8 balanced-modulator tubes, V_4 and V_5, are fed 90-degree phase difference r.f. Likewise, each tube has its set of deflector elements fed 90-degree phased push-pull audio. Each tube has a push-pull double-sideband signal appear at its two anodes. When equal outputs from the two channels are added, single sideband results. Previous experiments, without the cascode amplifiers, indicated that a considerable amount of intercoupling was occurring between the two beam-deflection tubes when the anodes were tied directly together to add their outputs. Only small output was possible before distortion became large. With outputs in parallel, but inputs consisting of quadrature signals, it appeared that distortion was being caused by the first balanced modulator plate modulating the second, and vice versa.

A better understanding of the 6JH8, or any of the other beam deflection tubes, can be had by considering the following:

The 6JH8 deflector-anode characteristics, which are typical of most beam-deflection tubes, describe the portion of the tube beginning at the accelerator (screen grid) and including the deflectors and two anodes. If this part of the tube is considered to be analogous to a dual triode with common cathode, operating in class-A push-pull, the class-A characteristics of one triode section, which is analogous to half of the above portion of the 6JH8, would have an amplification factor (μ) of 6.3, a plate resistance of 9000 ohms, and a transconductance (g_m) of 700 micromhos.[6] The output circuit of the 6JH8 should be designed considering the equivalent of two of these triodes in class-A push-pull.

Distortion caused by intercoupling between the two balanced modulators with plates paralleled was attributed to the low plate-to-plate resistance of the 6JH8s (18,000 ohms) and to the low amplification factor (6.3) between the deflectors and anodes. The plate-to-plate resistance of the tube, when viewed as the equivalent generator internal resistance, is low compared with the usual tank-circuit load impedance. Therefore, the output tank does not load down the voltage swing of the plates appreciably. The low amplification factor of 6.3 means that a differential, or push-pull, voltage between the plates of 6.3 volts is fully as effective in deflecting the beam as would be a one-volt push-pull signal applied between the deflectors. A rather unfortunate situation exists whereby one tube can very effectively plate modulate the other. To avoid this intercoupling without undue circuit com-

[6] Private Correspondence: W. P. Kimker, Advanced Applications, General Electric Company, Owensboro, Kentucky.

plexity, cascode 12AT7 triodes, V_6 and V_7, were added in the plate leads of the 6JH8 tubes. The grids of V_6 and V_7 were connected to +300 volts and grounded for a.c. bypass capacitors. The 12AT7 plates were fed from the +600 volt supply. Since the d.c. cathode voltage of the 12AT7 follows the d.c. grid voltage very closely, this results in approximately 300 volts across each the 6JH8 and the 12AT7. The plate load of the 6JH8 is the low impedance looking into the 12AT7 cathodes. This makes a good high-frequency circuit. The comparatively high plate resistance of the driving 6JH8 plates, being in the cathode circuit of the 12AT7, acts to increase the effective plate resistance of the 12AT7 tubes by about 40 times. Thus paralleling the plates of the two 12AT7s to add the outputs of the two balanced modulators produces a nearly ideal current addition of the two balanced-modulator channels. The high effective plate resistance of the 12AT7 tubes results in very little resistive loading across the two halves of the push-pull plate tank circuit, C_2 and L_4. Unequal resistive loading of the two halves of the output tank circuit would cause out-of-phase currents in the two halves of the tank. This would make fairly critical "quadrature null balance" adjustment[7] necessary to achieve good carrier suppression.

[7] Quadrature balance is usually achieved by a differential capacitance or resistance connected across the plate tank circuit with the capacitor rotor or resistor arm grounded. Also see p. 285 of M. B. Knight, "A New Miniature Beam-Deflection Tube," *R.C.A. Review*, Vol. 21, No. 2 (June, 1960), p. 266.

However, the high effective plate resistance of the grounded-grid cascode tubes, V_6 and V_7, which results from being cathode-driven by the 6JH8 plate resistance, makes a quadrature balance control completely unnecessary. The resulting effect of all these considerations is a balanced modulator circuit that has excellent performance.

It should be noted that an isolated 6.3-volt filament supply, with the filament line connected to + 300 volts, should be used to supply the filaments of the cascoded 12AT7 tubes, V_6 and V_7.

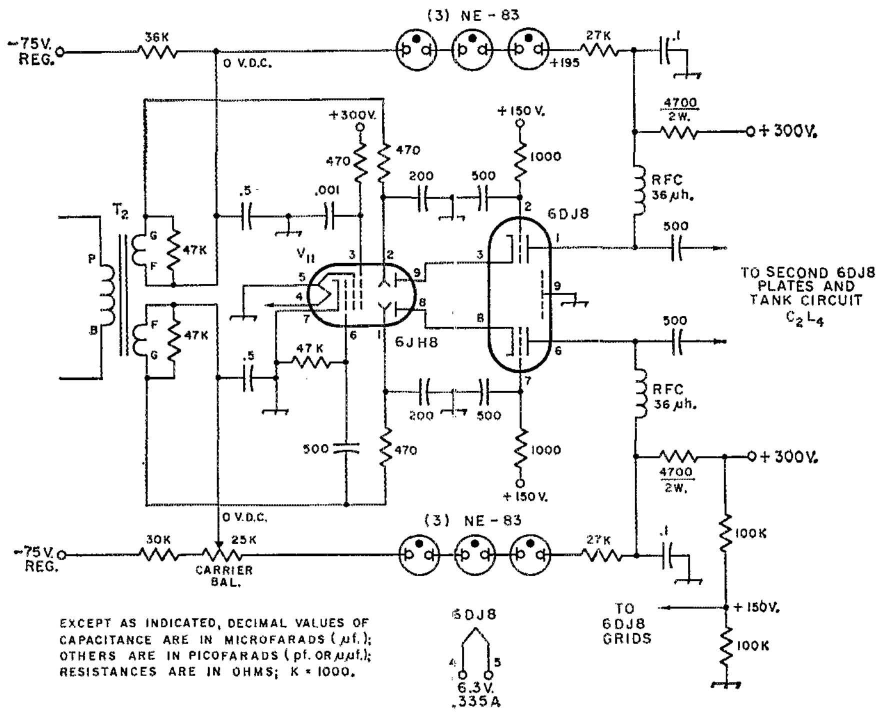
Audio System

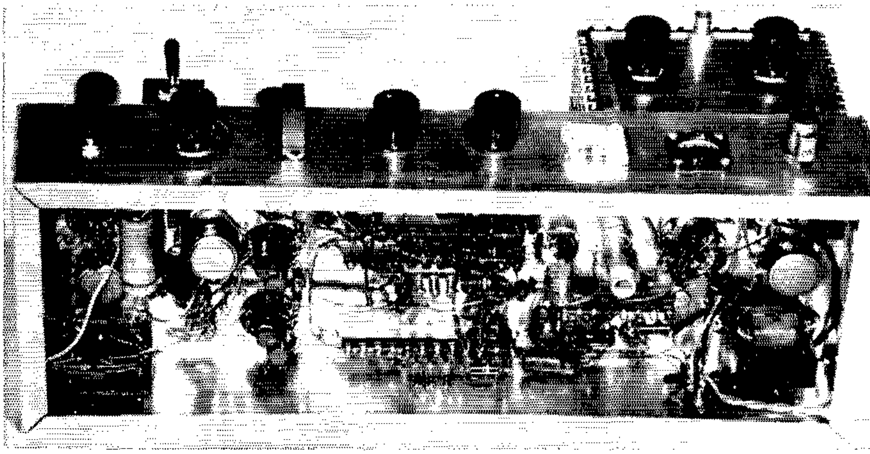
The speech amplifier is conventional, largely taken from the *Handbook*.[8] The triode second stage is, for convenience, transformer-coupled to the audio phase-difference network. Any plate-to-line transformer should be satisfactory for T_1. Connections for commercial audio phase-shift networks are shown in Table I. A comprehensive description of how to build such a network has been given[9]. The network used in the model shown in the photograph was homemade. The audio phase network outputs are connected to the grids of amplifiers V_{2A} and V_{2B}, the two halves of a 12AU7, which have the primaries of T_2 and T_3 as their plate loads. Better differential gain control was obtained by using a plate-load-

[8] "A 25-Watt Modulator Using Push-Pull 6BQ6GTs," *The Radio Amateur's Handbook*, ARRL, 39th edition (1962), p. 272.

[9] "S.S.B. Jr.," *G.E. Ham News*, Vol. 5, No. 6 (November-December, 1950).

Fig. 3—Alternative balanced-modulator circuit for 300-volt supply. Circuit designations and components same as in Fig. 1.





Another view inside the chassis. Mounted on the resistor board at left bottom is the homemade audio phase-shift network. A commercial audio phase network could plug into an octal socket mounted at this location. The NE-83 neon bulbs, identical in appearance to NE-2 types, are mounted on tie points near the center of the chassis. NE-2 bulbs can be substituted but have a shorter operating lifetime. The audio components, including the amplifier and deflector driving transformers, are located in the left one-fourth of the chassis. The balanced-modulator plate coil is mounted by its leads on the back of the vertical split-stator tuning capacitor, C_2, adjacent to the left wall of the 2E26 compartment. On the right rear is the backwards-operated filament transformer which is part of the −75-volt bias supply.

shunting audio balance control, R_3, than from the more usual cathode-bias control. To help realize maximum output with low distortion in the balanced modulators, push-pull audio from the secondaries of T_2 and T_3 was used to drive the deflectors. While single-ended audio drive to one deflector is simpler, lower distortion results from this push-pull drive.

Under conditions of high deflector d.c. return resistance, or high drive impedance, deflector secondary emission currents have been found to cause distortion.[10] D.c. return resistance through the transformers is low.

Deflector currents of the 6JH8 were measured under large drive conditions and were found to be lower than those of the 7360 or 6HW8. The measured 6JH8 deflector currents are shown in Fig. 2.

Deflector circuit d.c. return was made through the relatively low resistances of the secondaries of transformers T_2 and T_3, and the beam-centering d.c. voltages are series-fed through the appropriate split secondaries of the transformers. The sum of a d.c. and an audio voltage appears at each deflector.

D.C. Carrier-Null Feedback

Drift in the balanced-modulator tubes could necessitate frequent readjustment of the carrier-null balance controls. However, use is made of the fact that r.f. output from each half of the beam deflection tube is closely related to the amount of d.c. plate current drawn by that half tube. A sample of the plate current is obtained in each case by taking the proportional voltage drop across a plate decoupling resistor (R_{10}, R_{11}, R_{12}, R_{13}) and feeding this voltage back through neon bulbs where it is applied as a d.c. beam center stabilizing voltage on the deflector element. The burden of maintaining carrier balance is thus transferred from the active tube structure to the more stable d.c. divider chain. The direct-coupled 12AT7 tubes, neon bulbs, and divider return to the −75-volt supply result in excellent stabilization of carrier-null adjustment.

TABLE I

Connections for Commercial Audio Phase-Shift Networks

Terminal (Fig. 1)	Central Electronics PS-1	B & W 350-2Q4	Millen 75012
A	2	1	A-IN
B	6	5	B-IN
C	3	3	A-COM
D	7	7	B-COM
E	4	2	A-OUT
F	8	6	B-OUT
GND	1		Case

The nominal drop (constant 65 volts) across the NE-83 neon bulbs may vary from bulb to bulb and require trimming of resistors R_6, R_7, R_8 and R_9. This can be done by centering the carrier-balance pots and placing a d.c. voltmeter on the deflectors. The four resistors should be trimmed in value until each deflector is within a few volts of ground under no-signal conditions.

6JH8 Cascoded with 6DJ8

The alternative balanced-modulator circuit shown in Fig. 3 has been used with a 300-volt supply. Here, the plates of the cascode tubes are operated from 300 volts, and their grids are

[10] Technical Correspondence "7360 Deflector Currents and Large-Signal Operation," *QST*, March, 1962, p. 41.

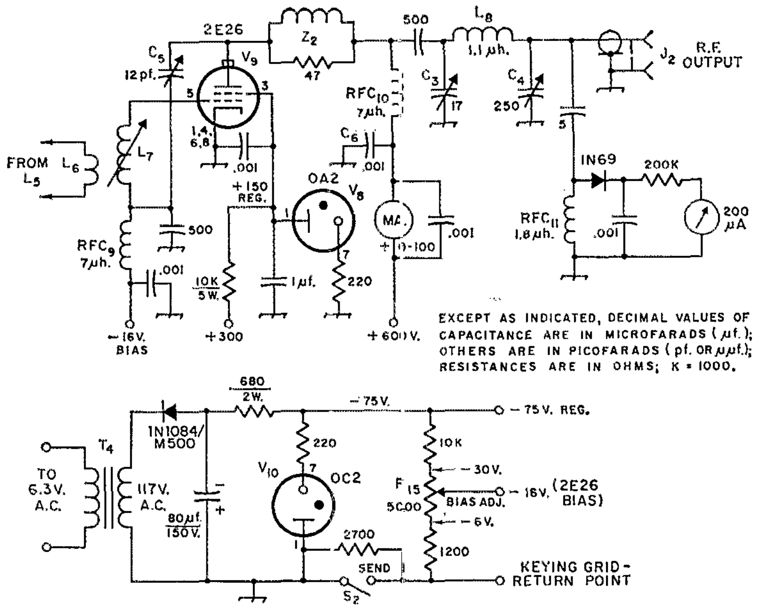


Fig. 4—Linear amplifier and bias supply. Except as indicated, resistors are ½-watt composition; 0.001-µf. fixed capacitors are ceramic, those with polarity marked are electrolytic, others are mica.

C_3—Approx. 17-pf. variable (Hammarlund HF-15 ro equivalent).

C_4—250-pf. variable (Hammarlund MC-250-M or equivalent).

C_5—Ceramic piston, 1.5-12 pf. (Cambion CST-50 or equivalent).

J_2—Coax receptacle, chassis-mounting.

L_6—2 turns No. 20 wound on form for L_7 (½ inch diam.) at cold end.

L_7—6 turns No. 20, diam. ¾ inch, 16 turns/inch (B & W Miniductor 3011) cemented on ½-inch diam. slug-tuned form (CTC PLS7-2C4L/Q or Miller 43A000CBI).

F_{15}—Linear-taper control.

RFC_9, RFC_{10}—7 µh. (Ohmite Z-50 or equivalent).

RFC_{11}—1.8 µh. (Ohmite Z-144 or equivalent).

T_4—Filament transformer, 6.3 volts, 1 amp.

Z_2—3 turns No. 18 wound on 47-ohm, 2-watt composition resistor.

pegged at +150 volts. Resistor values in the neon bulb-resistor divider chain are changed, so that the deflectors remain within a few volts d.c. of ground, under no-signal conditions, with the +300-volt power-supply voltage.

The cascode-tube type is changed to a 6DJ8.[11] This tube performs well in this lower-voltage circuit because its characteristics are such that it will handle the required 30 ma. peak plate current with as little as 75 volts across plate to cathode — and without the grid going positive with respect to cathode.

The circuit will not provide sufficient drive for the 2E26 at 50 Mc., a fact made clear by the condition of no excess drive for the 2E26 from the balanced modulators operating from a 600-volt supply. However, at lower frequencies where drive is easier, or when driving a smaller tube such as a 6BQ5 or 6CL6, the 6JH8 and 6DJ8 balanced modulators work well.

New Neon Bulbs

NE-83 neon bulbs were used.[12] These appear similar to NE-2 bulbs, but are an improved design, rated at 500 hours of life at 10 ma. current, and at greatly extended life at lower currents, such as the 2 ma. used here.

The NE-83 should prove useful in furnishing regulated voltages in multiples of 65 volts where currents under 10 ma. are required.

Survey of Beam Deflection Tubes

The 6JH8 beam deflection tube was picked for this unit after considering the 7360, 6AR8, 6JH8, 6HW8, and 7763. Its merits are a useful peak plate current which is approximately three times that of the 7360, and a higher plate dissipation. The large-signal deflector current is lower than that of the 7360 or 6HW8. Although the 6JH8 has a higher-current beam, it has a more elaborately-focused electron gun and the deflection linearity is better than that of the 7360 or 6HW8. The tube capacitances are about equal. More deflector drive voltage (audio in the present case) is required by the 6JH8. The 6AR8 is an early tube [13] and had poor internal anchoring of elements, causing a shift of carrier null under mechanical shock.

None of these has a screen grid between de-

[11] *Tube Data Sheet 6DJ8*, Amperex Electronic Company, 230 Duffy Avenue, Hicksville, Long Island, New York.

[12] *Glow Lamps as Circuit Control Components*, Miniature Lamp Department, General Electric Company, Cleveland 12, Ohio. Bulletin 3-1177.

[13] Adler and Heuer, "Color Decoder Simplifications Based on a Beam Deflection Tube," Trans. I.R.E., PGBTR (January, 1954), p. 64.

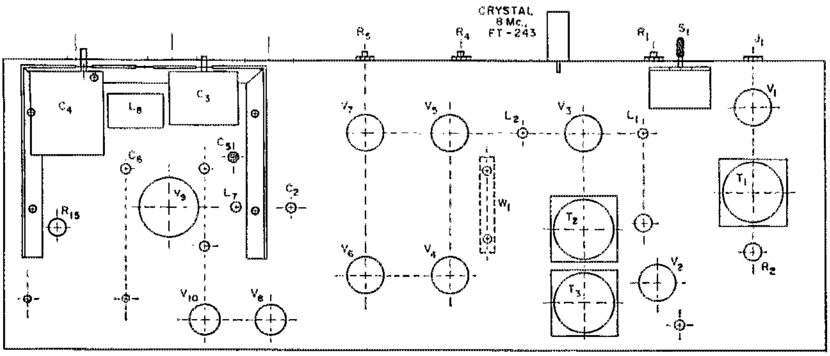


Fig. 5—Top-of-chassis layout of the 6-meter s.s.b. transmitter. This drawing is to scale and may be used for layout dimensioning; ¼ inch in the drawing above equals one inch of actual chassis size.

flectors and anodes, and a cascode circuit can sometimes improve performance. The 7763 has a screen grid between deflectors and anodes, but it is an experimental high frequency limiter tube and has no control grid.

Balanced modulators operate at lower efficiency than do linear amplifiers. For this reason, balanced modulators usually are operated at low levels followed by large amplification. However, for simplicity in this unit, the balanced modulators are operated at a high enough power level to be able to drive the 2E26. Fortunately, the 6JH8 is available to do this at low distortion.

Single-sideband power generation at 50 Mc. is more difficult than at lower frequencies, and there is no reserve of drive for the 2E26. For this reason, low-loss coils and capacitors and high *L*-to-*C* ratios should be used in the balanced modulator output and the linear-amplifier grid tuned circuits, consisting of L_4, C_2 and L_5.

2E26 Linear Amplifier

Straightforward design and construction were used for the linear amplifier, Fig. 4. The tube is operated with +150 volts regulated on the screen grid and 600 volts on the plate. This screen voltage is slightly less than is usually specified, but it results in a negative bias closer to zero (about −16 volts) than would be required with higher voltage; consequently, less r.f. drive voltage is required to overcome the bias and drive the grid up to the required peak of zero volts.

Bias is adjusted, under no signal conditions, by R_{15}, until plate current is about 20 ma. This adjustment places about −16 volts on the grid. At a plate voltage of 600 volts, the tube is at rated plate dissipation. During voice peaks the dissipation rating is exceeded slightly, but no ill effects resulted from prolonged single tone testing; and operation at this screen and bias voltage minimizes linear amplifier crossover distortion.

A parasitic suppressor was incorporated only in the 2E26 plate lead. Precautions were taken in layout to keep the balanced-modulator output tank and the 2E26 grid coil under the chassis, while the 2E26 plate coil and capacitor were kept above the chassis.

The bias supply, regulated at −75 volts, also is shown in Fig. 4. This supply also furnishes the −75 volts for the deflector d.c.-voltage-divider return point.

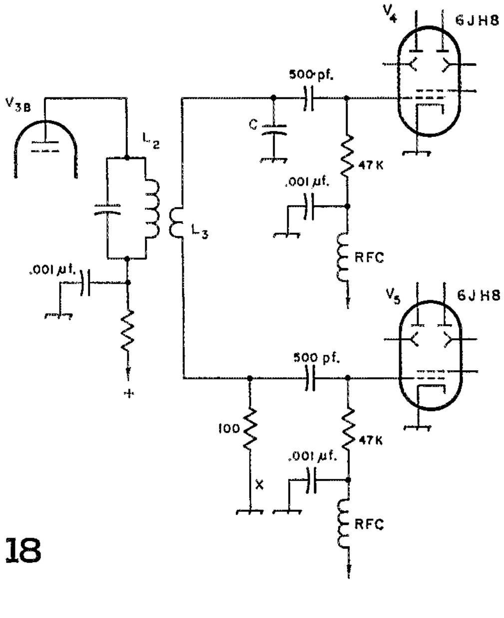


Fig. 6—Ninety-degree r.f.-phasing network for use on lower frequencies where transmission-line elements are impracticably large. L_2 and L_4, Fig. 1, must be replaced by tuned circuits appropriate for the frequency used. L_3 and its leads should have low capacitance to ground. Values for capacitor C are given below:

Freq. Mc.	Capacitance, pf.
3.9	400
7.2	210
14.3	100
21	65
29	46

A conventional pi network is used in the 2E26 plate circuit to match to a 50- or 75-ohm coax line to the antenna.

Adjustment for SSB Output

With an audio oscillator and oscilloscope, adjustment for sideband and carrier suppression is fairly routine. The procedure for phasing-type exciters has been well covered.[14,15] Adjustment of the 2E26 linear amplifier includes neutralizing and loading.

Additional features and accessories can certainly be added, but the mission of this article is accomplished if it is an aid to you in generating an s.s.b. signal on v.h.f.

It has been suggested that this balanced-modulator circuit might also be useful on lower frequencies. This has indeed been the case in this area, where Jack Washburn, W9IVB, and Lou Goodman, W9DCZ, are using this circuit on 4 Mc. with excellent results. Drive power on 4 Mc. is more plentiful than at 50 Mc., and the balanced modulators are used to drive a 6146 in one case and a pair of 6DQ6Bs in the other.

The quarter-wave coax is impractical for r.f. phase shift at lower frequencies, and the circuit shown in Fig. 6 is used. The value of C is selected for the frequency band used from the table in Fig. 6. The link, L_3, should have a minimum of capacitance to ground. Circuit calculations show that an inductance of about 0.08 μh. should be used at point X in Fig. 6, but experimentally no improvement could be found, probably because the distributed inductance of the 100-ohm resistor is near this value.

[14] Erlich, "How to Adjust Phasing-Type S.S.B. Exciters," *QST*, November, 1956; or *Single Sideband for the Radio Amateur*, ARRL, 2nd edition, p. 107.

[15] *The Radio Amateur's Handbook*, ARRL, 38th edition (1961), p. 310.

25 Years Ago this month

October 1938

. . . The new Maxim Memorial station, W1AW, was visited for *QST* readers. Although much of the gear and furnishings are gone now, still with us are the 65-foot wooden masts and author F. E. Handy, W1BDI.

. . . George Grammer, W1DF, described a low-cost, double-regenerative receiver featuring improved image rejection and i.f. selectivity.

. . . W2IXY and VR6AY were awarded Public Service certificates for radio contact work in connection with the threatened isolation due to epidemic of Pitcairn Islanders; and W6CUH/W4DHZ, W2GOQ and W2UK were commended for their radio work with Howard Hughes record-breaking round-the-world flight by aeroplane.

. . . W6EI described a compact kilowatt for all bands, 160 through 5 meters; RCA's J. B. Sherman wrote about construction of television receivers; and W1LJI discussed "Refinements in Combination Exciters." Other technical features were "sky-wave" propagation de W9BOE, W2DKJ and some thoughts on rotary beam antennas, a speech amplifier by W6AAR and W6ABF, and a follow-up on September's model-airplane article by ARRL's W1CBD.

. . . And George Hart, W1NJM, National Emergency Coordinator, who has just celebrated his 25th anniversary with the League, was introduced to *QST* readers.

Strays

Who d'ya suppose broke in while K3RJX and K8RJX were in QSO recently? Sure — K1RJX!

Hams on the staff of the Los Angeles Herald-Examiner include W6MLZ, K6GEF, K6HTI, WA6IPA, WA6SKC, WB6BGF, and WN6FNZ.

Strays

The Society of Radio Operators, one of Chicago's oldest amateur radio clubs, will hold an open house October 12 at the Edgebrook Field House, Chicago. Space will be provided for swapping ham gear, refreshments will be served, and there'll be demonstrations of advanced and unusual amateur equipment. The Project Oscar satellite exhibit which has been displayed around the world, will be displayed.

The purpose of the open house is to provide personal transistor radios (and, later, replacement batteries) to needy persons in the Chicago area who have suffered a hearing loss. For further information, contact Al Rutherford, 729 N. Delphia Avenue, Park Ridge, Illinois, or phone HU 9-2172. Mention "Lend an Ear Day."

Lee Bergren, WØAIW, received the May 1963 *QST* Cover Plaque award from Midwest Director Denniston (left) at the August 8 meeting of the Kansas City DX Club. The award is presented each month to the author of the article *adjudged best by the ARRL Board of Directors;* OM Bergren's winning entry was "The Multielement Quad." The central feature of the Cover Plaque Awards is the actual engraver's plate used in printing the cover, suitably chromed and mounted on a walnut plaque.