A 500-Watt Multiband V.F.O. Transmitter

Figs. 6-63 through 6-71 show the circuit and other details of a 500-watt transmitter with v.f.o. frequency control, capable of operation in any band from 3.5 to 28 Mc. It is completely shielded and all tuning adjustments, including band changing, may be done with the panel controls.

As the circuit of Fig. 6-66 shows, the v.f.o. uses a 5763 in a Chapp circuit operating over a range of 3370 to 4000 kc., split into three bands—ranges tuned by $C_4$ which is fitted with a calibrated dial. These ranges, selected by proper setting of $C_4$, are 3500 to 3750 kc., 3770 to 3405 kc. (for 11-meter operation); and 3750 to 4000 kc. for 75-meter phone work.

The oscillator circuit is followed by two isolating stages. The first is a 6C14 connected as a cathode follower, which is very effective in reducing reaction on the oscillator by subsequent stages. Since the output of the cathode follower is quite small, it is followed by a 5763 in an amplifier fixed-tuned in the 3.5-Mc. region.

Frequency multiplying to reach the higher-frequency bands is done in the next two stages, the first using a 5763 while the second employs the larger 6146 to drive the final amplifier. These two stages are tuned with multiband tuners—circuits which have a tuning range that includes all necessary bands. Thus no switching or plug-in coils are needed. Neither of these two stages is operated as a straight amplifier, except on 80 meters. Frequency is doubled in the 6146 stage for output on 40, 20 and 10 meters, and tripled for output on 15 meters. The 5763 stage is operated at 3.5 Mc. for 80- and 40-meter output, doubles to 7 Mc. for 20- and 15-meter output, and quadruples to 14 Mc. for 10-meter output. Excitation to the final is adjusted by the potentiometer in the screen circuit of this stage.

The 813 in the final amplifier also uses a multiband tuner to cover all bands. This stage is always operated as a straight amplifier and a neutralizing circuit is provided. The only switching necessary is in the output link circuit in changing between high- and low-frequency bands. Loading is adjusted by $C_{10}$.

$V_a$ and $V_b$ are used in a differential break-in keying system which automatically turns the v.f.o. on before the 5763 cathode is closed by the keyer tube $V_b$, and turns the v.f.o. off after the 5763 cathode circuit has been opened. This prevents any chirp in the oscillator from appearing on the output signal of the transmitter.

A 50-ma. meter may be switched to read plate current in the exciter stages, grid current in the driver and final-amplifier stages, or screen current to the 813. The 1-ohm resistor in the 6146 high-voltage lead multiplies the meter-scale reading by three, while the 1-ohm shunt in the 813 screen lead multiplies the full-scale reading to 100 ma. A separate 500-ma. meter is used to check plate current to the 813.

The two-circuit rotary switch, $S_1$, is used to bias the grids of the 6146 and 813 negative while tuning up the preceding stages and setting

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Fig. 6-63 — The standard rack panel is 12¾ inches high. Controls (National 1RS) along the bottom, centers spaced at intervals of 2¼ inches, are, left to right, for $C_4$, $S_4$, $C_6$, $S_6$ (Centralab 1305), $S_7$, and $C_9$. Power toggle switches are below at the center, spaced 1 inch apart. The calibrated v.f.o. dial (National SRT) for $C_4$ is at the center, with the excitation control to the left, and the dial for $C_6$ to the right (both National type AM). The smaller CFA chart frames outline the rectangular openings for the rear panel, meters, 560-60, to the left, 560-60, to the right. The shielding enclosure is built up using aluminum angle, perforated sheet (also used for the bottom plate), and sheet-metal screws.
Fig. 6-64 — The components are assembled on a 12 × 12 x 3-inch aluminum chassis. The meters are housed in four 4 × 4 x 2-inch boxes, the v.f.o. enclosure is 6 × 6 × 6 while the box enclosing L3 and L4, to the right, measures 8 × 4 × 5 inches. The National R-153A r.f. choke is threaded onto C4 (Sprague 20DK-15). Cs (also Sprague 20DK-15) is mounted on a metal bracket fastened to a stator terminal of Cs, C7 (a Johnson 8-2000F) elements to Cs via feed-through A. V.h.f. parasitic choke L0 consists of 6 turns No. 16, 1/8-inch diameter, 1/8 inches long. R1 is made up of five 170-ohm 1-watt carbon resistors in parallel. It is connected across 3 turns of L0. The 813 socket is mounted on three-inch pillars over a 1/4-inch hole in the chassis. Along the rear apron are L5, L6, L7, L9, and L10, and the power-input connector, two a.c. outlets, low-voltage input terminals, key connector, and R4.

Supplies into the control circuit consisting of three toggle switches. R1 is a ventilating blower that operates when the filament switch is closed.

It is highly important that the v.f.o. box make good contact with the chassis; otherwise the v.f.o. may be adversely affected by feedback from the adjacent final tank when working on 80 meters. Mounting screws spaced an inch around the bottom lip of the box, and correspondingly in the top cover, should eliminate this completely.

L1 (35 µh.) is a B&H 80-BCL coil with the link and base removed. L2 is described over Fig. 6-71.

L3 (2.6 µh.) is 31 turns of B&H 3003 Miniductor, while L4 (3.6 µh.) is 30 turns of 3001. L5 (1.5 µh.) consists of 11 turns of No. 16, 1/4-inch diameter, 13/16 inch long. L6 (8.9 µh.) has 29 1/2 turns of B&H 3015 Miniductor. L9 (1.6 µh.) has 6 turns of 1/4-inch copper tubing, 2 1/2 inches inside diameter, 2 3/4 inches long.

L7 (4.8 µh.) and L8 (4.2 µh.) are made from...
Fig. 6-66 — All capacitances less than 0.001 μF are in μF. All unmarked by-passes are disk ceramic. All 100-
fixed capacitors are mica. All resistors are 1/2 watt unless otherwise specified. RFC₂ and RFC₃ are National R
C₁₁ is Sprague DD60-561. Rectifiers are selenium. R₂ is the excitation control. R₃ is the oscillator-lag adjust-
B₁ is the ventilating-fan motor.

Fig. 6-67 — Circuit of a suitable power supply for the 813 transmitter.
BkW 3005-1 strip coil as follows: Count off 9 1/4 turns, clip the wire without breaking the support bars. Bend the last quarter turn out. This portion is L7. Remove the next 3/4 turn to make a 3/4-inch space between L7 and L8. Count off 10 turns more, cut the remainder of the coil stock off. Unwind the last turn on L8 to make the necessary lead to the stator of C5. Tap L8 at the 8th turn from L7.

Adjustment

The diagram of a suitable power supply is shown in Fig. 6-67. The low voltage supply should deliver a full 400 volts under load, and R3 should be adjusted eventually so that the voltage to V1, V3, V4 and V5 is 300 volts under load.

The v.f.o. tuning ranges should be adjusted first. Set S1 to the first position. Adjust R2 to zero and turn on the filament low-voltage supply. Set C1 at 95 degrees on the dial (near minimum capacitance). Set C2 accurately at mid-scale. Listening on a calibrated receiver, adjust C3 until the v.f.o. signal is heard at 3750 kc. Tune the receiver to 3500 kc., tune C1 toward maximum capacitance until the v.f.o. signal is heard. This should be close to the lower end of the dial. By carefully bending the rearmost stator plate of C1 backward, it should be possible to adjust the range of 3500 to 3750 kc. so that it covers from 5 to 95 degrees on the dial. Some slight readjustment of C5 may be necessary during the plate-bending process to keep the band centered on the dial.

Now set C1 at about 15 degrees. Set the receiver at 3750 kc. and reduce the capacitance of C2 until the v.f.o. signal is heard. Then tune the receiver to 4000 kc., the v.f.o. signal should be heard when its dial is set at about 85 degrees. Mark this setting of C2 accurately. If it is desired to center the 11-meter band on the dial, set C1 at mid-scale. Increase the capacitance of C5 until the v.f.o. signal is heard at 3387 kc. Mark this setting of C2 also accurately.

When the v.f.o. frequency ranges have been set, tune the v.f.o. to 3.6 Mc. and adjust the slug of L2 for a maximum voltage reading across the 22K grid leak of V4. A high-resistance voltmeter should read about 25 volts.

Readjust C2 to mid-scale and turn the meter switch to read 6146 grid current, and turn up the

### Tuning Chart for the 813 Transmitter

<table>
<thead>
<tr>
<th>Output Band (Mc.)</th>
<th>C5 Dial1</th>
<th>C5 Dial2</th>
<th>C6 Dial1</th>
<th>C6 Dial2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>8.8</td>
<td>3.5</td>
<td>6.1</td>
<td>3.5</td>
</tr>
<tr>
<td>7</td>
<td>8.8</td>
<td>3.5</td>
<td>0.5</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>1.5</td>
<td>7</td>
<td>9.5</td>
<td>14</td>
</tr>
<tr>
<td>21</td>
<td>1.5</td>
<td>7</td>
<td>3.7</td>
<td>21</td>
</tr>
<tr>
<td>27-38</td>
<td>4.7</td>
<td>11</td>
<td>1.8</td>
<td>28</td>
</tr>
</tbody>
</table>

1. 10-div. dial = 10 max. capacitance.
2. 100-div. dial = 100 max. capacitance.
excitation control to give a reading of 2 or 3 ma. Resonate the output tank circuit of the 5763 frequency multiplier at 80 meters (near maximum capacitance) as indicated by maximum 6146 grid current. Turn $S_1$ to the second position so that screen voltage is applied to the 6146 but not to the 813. Turn the meter switch to read 6146 plate current and resonate the 6146 output tank circuit as indicated by the plate current dip near maximum capacitance. Turning the meter switch to read 813 grid current, adjust the excitation control to give a reading of about 25 ma.

Before applying power to the 813, the neutralizing should be adjusted as described in an earlier section of this chapter. After neutralization, reduced plate voltage should be applied. Plate voltage can be reduced by inserting a 150-watt lamp in series with the high-voltage-transformer primary. A 300-watt lamp connected across the output connector can be used as a dummy load for testing. Make sure that $S_2$ is turned to the low-frequency position. This position is used for 3.5- to 7-Mc. operation. The other position is used for 14, 21 and 28 Mc. Turn $S_1$ to the third position to apply screen voltage to the 813, apply plate voltage and resonate the output tank circuit (near maximum capacitance) as indicated by a dip in plate current. Full plate voltage may now be applied and $C_{10}$ adjusted to give proper loading (220 ma. maximum). Adjust the excitation control to give an 813 grid current of 15 to 20 ma. Tuning up on the other bands is done in a similar manner, by adjusting the tuners in each circuit to the correct band to obtain the desired multiplication. The tuning chart shows the approximate dial setting for each band, but each should be checked with an absorption wavemeter and the setting logged for future reference. The voltage-current chart shows typical values to be expected. The output circuit is designed for a 50- or 70-ohm resistive load. For other loads, a link-coupled antenna tuner (see transmission-line chapter) should be used.

In the keyer circuit, turning $R_4$ toward ground causes the oscillator to cut off more quickly after the key has been opened.

(Originally described in QST for January, 1951; with modifications in the issues for June, 1954, June and October, 1956).
Fig. 6-70 — The chart frame, the panel and the aluminum box are held together, as show in A, by the hardware supplied with the CFA. If shows a meter (Triplet Model 327-T), its insulated mounting ring, and the rear cover of the box. The meter assembly is slipped into the metal box after the latter has been attached to the rear of the panel. Shielded meter leads enter the bottom of the box through a rubber grommet. The shield braid should be bonded to the outside of the aluminum case at the point of entry.

Fig. 6-71 — The panel drops 316 inch below the bottom edge of the chassis. The National RAD right-angle drive for $C_2$ is at the center. The other controls along the bottom are placed 112 inches up from the bottom edge of the chassis, and the corresponding components mounted so that their shafts line up with the controls. Panel bushings should be provided for the shafts of $C_{10}$ (Cardwell PL-7006), and the right-angle drive; panel-bearing shaft units for $C_4$ and $C_5$ (Cardwell PL-6043), and $S_2$ (Centralab R14 wafer on P-121 index assembly). The 6146 is mounted on a 5 x 21/4-inch bracket between $C_2$ and $C_5$, whose shafts are fitted with insulating couplings. $C_9$ is mounted on spacers, while $C_6$ is mounted on its side on a bracket. $T_1$ (Triad F-18A) and $T_5$ (Triad F-14X) are mounted on another bracket at the center. $L_3$ and $L_4$, at right angles, are soldered between the terminals of $C_6$ and Pin 4 of the 813 socket, seen through the 21/4-inch hole in the chassis. $C_{10}$ and $S_4$ are mounted on small brackets. $T_8$ (Triad F-23U) and the blower (available from Allied Radio, Chicago, No. 724715) are to the left. The screwdriver-slotted shaft of $C_5$ may be seen between the shaft of $C_7$ and the shielded power wires to the left. All power wiring is done with shielded wire (Belden 8666, Birnbach 8220, or shielded ignition wire for the 2000-volt line; Belden 8885 for the rest). $L_2$, behind $S_4$ (Centralab 1411), is a National XR-50 slug-tuned form close-wound with 93 turns No. 36 enameled wire.