Three-Control Six-Band 813 Transmitter

Multiband Tanks in a 500-Watt High-Frequency Rig

BY C. VERNON CHAMBERS,* W1JFQ

The prime considerations in the design of the transmitter shown in the photographs were power, operating convenience, TVI, safety and appearance. Use of a 500-watt output stage leaves little doubt about the power angle. Operating convenience is placed at a nearly maximum level by the inclusion of a built-in VFO and the complete elimination of plug-in coils. To change bands, it is only necessary to retune three homemade multiband tuners and readjust the output coupler. There is only one r.f. switch and this need be thrown only when shifting between high- and low-frequency bands. Furthermore, the unit takes up no more space than the average receiver. In other words, it's a compact layout that can rest right on the operating table. TVI has been handled by employing all of the wiring, by-passing and shielding methods that have become standard practice during the last year or two. Safety is automatically taken care of by the elimination of plug-in coils, and the fact that the transmitter need never be opened during the normal course of operation. The neat commercial appearance is obtained by a carefully planned panel and chassis layout and the use of readily available panel markings.

Circuit

As the circuit of Fig. 1 shows, the VFO uses a 5763 in a Clapp circuit operating in the 3.5-Mc. region. The total usable frequency range of 3370 to 4000 kc. is split into three bands, spaced ranges, tuned by C4, which is fitted with a calibrated dial. These ranges are selected by proper setting of C2. The principal range covers 3500 to 3750 kc. This range is used for all operation except in the 11-meter band and the 75-meter 'phone band. By adjusting C2 to a higher capacitance, the frequency range is lowered to include 3370 kc. for 11-meter operation; with C2 set at a lower capacitance, the tuning range is shifted to cover 3750 to 4000 kc. for 75-meter 'phone work. The oscillator screen voltage is regulated by the 0A2 VR tube.

The oscillator circuit is followed by two isolating stages. The first is a 6C4 connected as a cathode follower, which is very effective in reducing reaction on the oscillator by subsequent stages. Good oscillator keying for break-in is a result, even at 28 Mc. 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,

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for reading 813 screen-grid current is also made. The 12-ohm resistor in the 6146 high-voltage lead multiplies the meter-scale reading by three. A separate 500-ma meter is used to check plate current to the 813.

The two-circuit rotary switch, S1, is used to bias the screens of the 6146 and 813 negative while tuning up the preceding stages and setting the VFO to frequency. In the first position, both screens are biased; in the second position, only the 813 screen is biased, while positive voltage from a voltage divider is applied to the screen of the 6146 so that this stage may be tuned up. In the third and fourth positions, positive voltage is applied to both screens, but in the last position it is applied to the 813 screen through an audio choke so that the stage may be screen-plate modulated.

Two 20-ma rectifiers are included in the unit, to supply fixed bias to the 6146 and 813, so that the plate currents will be cut off during keying intervals. Both rectifier systems operate from a single 6.3-volt filament transformer connected in reverse. The bias transformer, T2, is operated from the 6.3-volt winding of the filament transformer, T1.

Two a.c. outlets are provided for connecting the primaries of external high- and low-voltage supplies into the control circuit consisting of three toggle switches. B1 is the ventilating blower that starts operating as soon as the filament switch is closed. This is virtually a...
necessity with so much power confined in a small space. The jack, \( J_2 \), provides a means of keying the final amplifier, rather than the oscillator, or it may be used for the connection of an external cathode modulator.\(^1\)

**Construction**

Most of the constructional details will be evident from the photographs and their captions. However, construction will be simplified by doing the basic operations in logical order: Start with the layout of parts that mount on the front wall of the chassis. Do not remove the wrapping from the chassis for the time being, as the paper covering provides a convenient surface on which to make location marks. Start with a vertical line at the center of the front wall of the chassis, and then add three additional lines, each 2\(\frac{1}{2} \) inches apart, on each side of the center guide. Now, mark the positions of the ten controls that are chassis-mounted. The VFO handset control is directly above the center toggle switch, and is far enough down from the top of the chassis to permit use of a right-angle drive between the knob and the variable condenser (to be mounted later on). The spacing between toggle switches is 1 inch, and the six controls that flank the center line are centered on their guide lines already drawn. Next, drill a small hole—a No. 35 does very nicely—through each of the ten location points. This will permit the chassis to be used as a template during the panel-layout stages of construction.

The layout of components on the rear wall of the chassis is next on the list. Actual placement of parts is not critical, and easily can be duplicated after brief study of the rear and bottom views of the transmitter.

The VFO tank subassembly may be constructed at this time. Remove the top and bottom covers from the square box and then mark the mounting position for \( C_1 \) on the front wall—centered 2\(\frac{1}{2} \) inches up from the bottom. Screw the bottom cover in place and mark mounting-hole locations for \( C_2, C_3 \) and \( L_1 \). Do not drill any holes at the moment. \( C_2 \) should be centered in the bottom of the box with its shaft vertical, 1\(\frac{1}{8} \) inches back from the front edge. \( C_3 \) should be similarly mounted to the left of \( C_2 \). The 2-inch isolantite stand-off insulators that support \( L_1 \) should be located so as to allow the coil to be placed at the exact center of the bottom plate. The point where the RG-

![Fig. 2 - The 3-inch square meters are mounted on the covers of the boxes with four spacers.](image)

22/U cable will leave the compartment should be at the rear left-hand corner of the box.

The box is mounted on the chassis with machine screws around the bottom lip of the box and the bottom cover. When the transmitter was first constructed, screws were used only at the original cover-mounting holes. While no difficulty was encountered on higher-frequency bands, the keyed signal was chirpy with serious a.c. modulation on 80 meters caused, apparently, by feed-back from the adjacent final tank when

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tuned to the same frequency as the VFO. There was also considerable dragging of the oscillator frequency with tuning of the final stage and even the antenna coupler. This was entirely cleared up by adding screws at 1-inch intervals around the bottom. The bottom contact with the chassis seemed to be considerably more important than the tightness of the top cover, but it would be well to use the same screw spacing on top as insurance. These additional holes, as well as those for the condensers, coil and coax, should now be marked and drilled with a No. 35 drill. The box should then be centered on the chassis, with its front edge 1 5/8 inches back from the front edge of the chassis. Using the bottom cover as a template, the holes should be duplicated in the chassis. Draw a square around the box and then set it aside. This will remind you to keep that area clear while the rest of the chassis layout is being worked.

The interior and the bottom views of the transmitter show how the components for $V_1$ through $V_5$ have been grouped at one corner of the chassis. After the sockets for these tubes, and $L_3$, have been fitted into the layout, mounting holes should be provided for the amplifier tank capacitor, for $C_5$, $V_7$ and the feed-throughs for the h.v. and output-coupling leads. The shaft for $C_9$ should be aligned parallel with and 2 1/2 inches in from the left end (rear view) of the chassis, and the rear end plate of the capacitor should be 1 5/8 inches in from the back edge of the chassis. Feed-through insulators for the link circuit are located in between $C_9$ and the oscillator compartment. The h.v. feed-through is at the rear edge of the chassis, directly above the h.v. safety terminal. The socket of $V_7$ is centered 2 1/2 inches from the rear edge of the chassis, and 6 3/4 inches from the end.

Aluminum brackets for the under-chassis construction should now be bent into shape. The one that supports $T_1$ and $T_2$ is 2 3/4 inches high, 4 3/4 inches long and has side and bottom lips for fastening to the chassis. The bracket for the 6146 has a 2 1/4-inch section for the socket, and a 5-inch member that serves as a shield between the grid and the plate circuits of the driver. This bracket has a 1 3/4-inch hole at the rear corner that passes the lead from the grid prong of the tube socket and the stator terminal of $C_4$. This bracket is placed with the long side 3 1/2 inches in from the right end (bottom view) of the chassis. A series of 1 1/4-inch ventilation holes for the 6146 should be drilled in the chassis before the bracket is bolted in place. The brackets for $C_4$, $C_{10}$ and $S_3$, and the tubular spacers used to raise $C_5$ off the chassis should all have dimensions which allow the shafts of the controls to line up with the holes already marked on the front wall of the chassis. Before $C_4$ is permanently installed, mount three feed-through insulators in the chassis, just directly over the stator and the rotor terminals of the capacitor. These insulators will be used to support $L_3$ and $L_4$ (in the 3 x 4 x 5-inch box in the interior view) and for feeding leads between the coils and $C_4$.

The next job is that of spotting mounting holes on the panel. Lay the panel face down on a bench or table, and then use the front walls of the chassis and the VFO shield as templates for marking holes for the condensers and switches. Allow the panel to overlap the bottom of the chassis by 3/16 inch during this operation. Now mark a hole for the shaft of $C_9$, remove the chassis, and then measure off locations for the meters and the excitation control. The excitation control should balance with the shaft position for $C_9$, and the centers of the meters should be above and in line with these last two controls. Now, drill mounting holes for the National SCN VFO and the National AM (used with $C_9$), and then cut windows for the meters. These cut-outs should match the inside dimensions of the National type CFA chart frames. The mounting hardware for the frames is used to hold the meter boxes against the rear of the panel. Fig. 2 shows a method of subassembly that provides both d.c. insulation and r.f. shielding for the meters.

The holes in the VFO compartment and the
top of the chassis may now be enlarged to the proper size for the mounting screws and oscillator components. The holes in the front wall of the chassis should also be enlarged to accommodate the control shafts, and the panel holes reamed correspondingly. When performing this operation, allow for the use of panel bushings with the right-angle drive and $C_{10}$. Panel-bearing shaft assemblies are to be used with $C_4$, $C_5$ and $S_2$. In the final assembly, insulated shaft couplers must be used between the panel bearings and shafts of $C_4$ and $C_5$.

Inductors $L_7-L_9$ and $L_9$ should be mounted on $C_9$ before the capacitor is secured to the chassis. $L_7-L_9$ is made from a length of B & W 3005-1 coil material. Clip the support bars at one end of the coil and unwind one full turn. Count off $10\frac{1}{4}$ turns and clip the winding without breaking the support bars. Bend the last quarter turn out from the body of the coil. This section of the assembly is $L_7$. Completely remove the next $\frac{3}{4}$ turn—watch the bars. This leaves a $\frac{1}{4}$-inch space between $L_7$ and the adjacent coil, $L_8$. Count off 10 turns, remove the excess material and unwind the last full turn. Now solder heavy wire leads, approximately 6 inches long, to the inside end, and to the first turn (counted from the open end) of $L_8$

Hold the coil assembly above the rear section of $C_9$ in a position similar to that shown in the rear view of the transmitter. Now adjust the length of the lead at the rear end of $L_7$ until it reaches the stator terminal at the back of $C_9$. Bend the inside lead of $L_7$ over to the tubular support rod that runs the length of the capacitor, mark the intersection and then drill and tap the rod for a 6-32 machine screw. Place $C_9$ on the chassis and cut to length the three leads from $L_8$ to the coupling-circuit feed-throughs. Remove the coil-condenser assembly from the chassis and mount $L_9$ on $\frac{1}{2}$-inch stand-offs, just to the front of $L_8$.

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The bottom cover is removed in this view of the 813 transmitter. $T_3$ and the $B_2$ are on the wall at the left end of the $3 \times 12 \times 17$-inch aluminum chassis. $C_{10}$, $S_2$ and the 7-hy. choke are at the lower left corner. Bias-circuit components for the final are to the left of the right-angle drive for $C_3$. An aluminum bracket at the center of the chassis supports $T_1$, $T_2$ and the 6L46 biasing components. $C_4$ is mounted on metal pillars to the left of $V_4$ and $C_4$ is bolted to a bracket at the right of the tube. Below $V_3$ are the tube socket and plate r.f. choke for the oscillator. $L_9$, located below the 6L43 socket, is flanked to the left and right by sockets and components for $V_5$ and $V_4$. The 20-watt resistor, multiplier plate choke and the socket for $T_3$ form a triangle just below $C_4$.
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Six-Band Rig

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The outside end of L9 (the end near the front of C9) is connected to the front terminal of the rear stator section. The inside end of L9 should connect straight down to the rear terminal of the front stator section of the condenser. Use lengths of 1/2-inch copper tubing for these two leads. The rear, or plate, end of L7 should go to the rear stator of C9 and the inside end of the coil can be attached directly to the condenser support bar with a machine screw. After the assembly has been bolted to the chassis, complete the wiring between L9 and the output switch, S2. The large section of L9 provides coupling at 3.5 and 7 Mc. and the 1-turn link takes care of coupling at 14 Mc. and above.

The panel and the chassis can now be fastened together by means of the panel-mounted components. National type P and IRS knobs are used with the excitation and the lower line of controls, respectively. Later on, the two will be rigidly held together by means of the shielding that encloses the transmitter. The various views of the transmitter show how perforated aluminum, 1/8-inch angle and self-tapping screws (except for the use of binder-head machine screws for fastening to the panel) have been used in the construction of the shielded enclosure.

Most of the power wiring is done with Belden No. 8885 shielded wire. A heavy-duty type of shielded wire (Belden 8566, Böhrn Bach 1820, or shielded ignition cable) should be used for the h.v. leads to the 813 circuit, and solid tinned wire is used for r.f. wiring.

Adjustment

A 400-volt 250-ma. supply is required for the exciter and the screen of the final amplifier. For full rated output from the 813, a supply delivering 2000 to 2200 volts at 300 ma. (including bleeder current) is needed. The amplifier may, of course, be operated at lower plate voltage with less power input.

The VFO tuning ranges should be first be adjusted. Set S2 to the first position, biasing the screen of the 6L46. Adjust the screen potentiometer in the 5763 multiplier stage to zero, and turn on the filament and the low-voltage supply. Set C3 at 95 degrees on the dial (near minimum capacitance). Set C2 accurately at midscale. Then, listening on a calibrated receiver, adjust C3 until the VFO signal is heard at 3750 kc.

Now, tune the receiver to 3500 kc, and turn C1 toward maximum capacitance until the VFO signal is heard. This should be close to the lower end of the dial. By carefully bending the rearmost rotor plate of C1 toward the rear, 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 C3 may be necessary during the plate-bending process to keep the band centered on the dial. Mark the setting of C2 accurately so that it may be reset easily.

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Now, set $C_1$ at about 15 degrees. Set the receiver at 3750 kc. and reduce the capacitance of $C_2$ until the VFO signal is heard. Then, tuning the receiver to 4000 kc., the VFO signal should be heard when its dial is set at about 85 degrees. Mark this setting of $C_2$.

If it is desired to center the 11-meter band on the dial, set $C_1$ at midscale. Increase the capacitance of $C_2$ until the VFO signal is heard at 3387 kc. Mark this setting of $C_2$ also accurately.

The next step can be done most easily with a high-resistance voltmeter connected across the grid leak of the 5763 buffer amplifier. Set $C_1$ and $C_2$ at minimum capacitance, and adjust the slug in $L_4$ for maximum grid voltage. Then watch the grid voltage as $C_2$ is swung through its range. If there is appreciable increase in grid voltage as $C_2$ is turned toward maximum capacitance, tune $L_4$ to a higher frequency by moving the slug out more. By correct adjustment of the slug, the grid voltage should remain essentially constant over the entire usable frequency range.

Now turn the meter switch to read 6146 grid current, and turn the excitation control to maximum. Resonate the output tank circuit of the 5763 frequency multiplier at 80 meters (near maximum capacitance) as indicated by maximum 6146 grid current. Reduce the excitation control to give a 6146 grid current of 2 or 3 ma.

Next, 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. With this portion of the transmitter lined up, it is to be expected that the plate current for tubes $V_4$, $V_5$, and $V_6$ will be approximately 35, 15, and 50 ma., respectively.

The 813 should be tested initially at reduced plate voltage. Plate voltage can be reduced by inserting a 150-watt lamp in series with the high-voltage transformer primary. A 300-watt lamp bulb connected across the output connector can be used as a dummy load for testing. Turn $S_1$ to the third position to apply screen voltage to the 813, set $S_2$ at the low-frequency position, 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 $C_{1b}$ adjusted to give proper loading (220 ma., maximum). Adjust the excitation control to give a final-amplifier grid current of 15 to 20 ma. Screen currents for the 813 should be approximately 40 ma., when the excitation and loading are properly adjusted.

Tuning up on the other bands is done in a similar manner, by adjusting the tunes in each circuit to the correct band to obtain the desired multiplication. Plate current in the multiplier and driver stages will increase to values of 35 and 90 ma., respectively, when these

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circuits are used as frequency multipliers. The table shows the approximate dial setting for each band, but each should be checked with an absorption wavemeter and the setting logged for future reference.

Naturally, an antenna tuner will be required if the transmitter is to be worked into an antenna system using anything other than coaxial feed. The rig has been coupled through conventional tuners during the testing and on-the-air operating periods, and we are quick to admit that these run-of-the-mill tuners slow down the bandchanging operation. In fact, when they take more time to make frequency changes in a simple coupler circuit than it does in a 500-watt rig—well, it’s high time to do something about the situation. We can’t make any promises at the moment other than to say that the very next project will be some sort of wide-range, get-therin-a-hurry tuner. Naturally, we’ll pass the good word along if this idea pans out.

Correspondence
(Continued from page 68)

experimenting with A5 omission, may use the suffix "TV" in announcing his station call sign.

"The use of any prefix, suffix, or other innovation (except phonetic aids to identify the station call sign as provided by Section 12.282(d) of Part 12) is prohibited by Section 12.189 of Part 12."

This letter was signed by Wm. P. Massing, Acting Secretary.

As I said above, I do not know if anyone has ever transmitted the "TV" suffix; but, for the benefit of any who might contemplate doing so, I have one word of advice: DON'T.

By the way, I hope that there will be more articles on ham TV.

—James C. Grube, W3GRT

PUBLIC RELATIONS HELPS

29 High St.
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Editor, QST:

I wish to express my thanks for your fine help in helping me make my speech on amateur radio. The Lions Club here enjoyed it very much and the booklet you sent were passed out to all the members. From the prepared speech you sent, I had at my fingertips very good information to tell them. It was very helpful and has been asked to speak at the local schools because of your fine help. I wish not only to thank you, but the League in backing me up.

—C. Burns Robinson, W1SOD

STOLEN EQUIPMENT

3108 Waco Ave.
Waco, Texas

Editor, QST:

Recently someone broke into the Civil Defense building and stole the following amateur equipment which was the property of the Central Texas Amateur Club: one Johnson Viking-I transmitter, with four holes drilled in the top near the center for mounting the Johnson VFO (the VFO was of course taken along), and one National 183-D receiver with four holes drilled in the bottom for mounting on a board. Both the transmitter and receiver were mounted on a large board for easy transportation in case of emergency.

If possible, we would like for you to insert a small notice in QST so that others may be on the lookout for this equipment.

—C. J. McCaulay, Secy., W5TV, Central Texas Am. Radio Club