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 Clapp circuit operating over a range of 3370 to 4000 kc., split into three bandspread ranges, tuned by C_1 which is fitted with a calibrated dial. These ranges, selected by proper setting of C_2, are 3500 to 3750 kc., 3370 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 6C4 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.

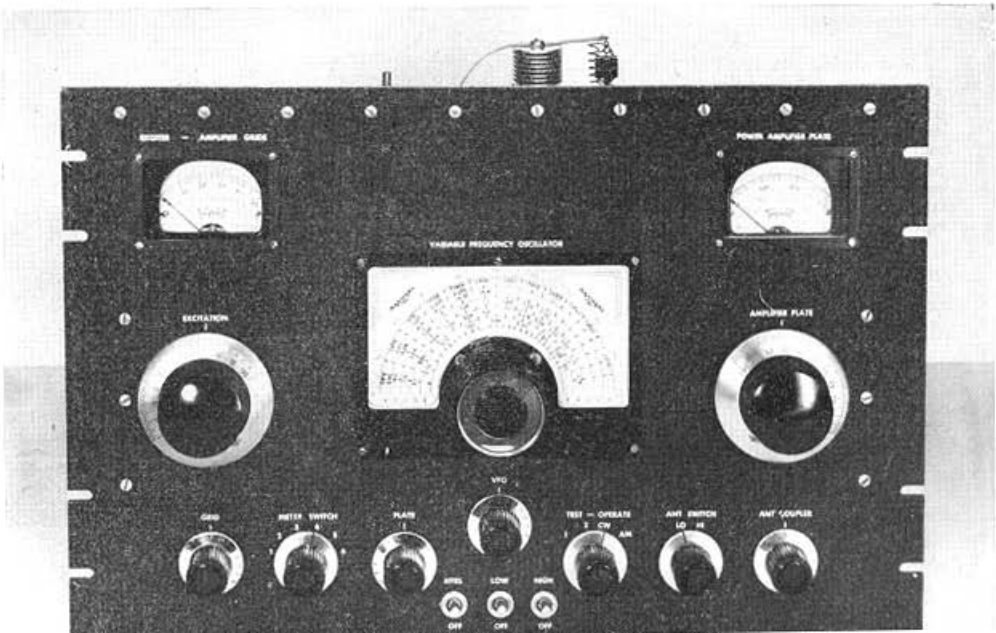
The 813 in the final amplifier also uses a multiband tuner to cover all bands. This stage is always operated as a straight amplifier and a neutralizing circuit is provided. The only switching necessary is in the output link circuit in changing between high- and low-frequency bands. Loading is adjusted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

V_8 and V_9 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_9, 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 ½-ohm resistor in the 6146 high-voltage lead multiples the meter-scale reading by three, while the 1-ohm shunt in the 813 screen lead increases 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 screens of the 6146 and 813 negative while tuning up the preceding stages and setting

Fig. 6-63 — The standard-rack panel is 12¼ inches high. Controls (National HRS) along the bottom, centers spaced at intervals of 2⅛ inches either side of center, are, left to right, for C_4, S_3, C_5, C_2, S_1 (Centralab 1405), S_2 and C_{10}. Power toggles are below at the center, spaced 1 inch apart. The calibrated v.f.o. dial (National SCN) for C_1 is at the center, with the excitation control to the left, and the dial for C_9 to the right (both National type AM). National CFA chart frames outline the rectangular openings for the recessed meters, 50-ma. to the left, 500-ma. to the right. The shielding enclosure is built up using aluminum angle, perforated sheet (also used for the bottom plate), and sheet-metal screws.



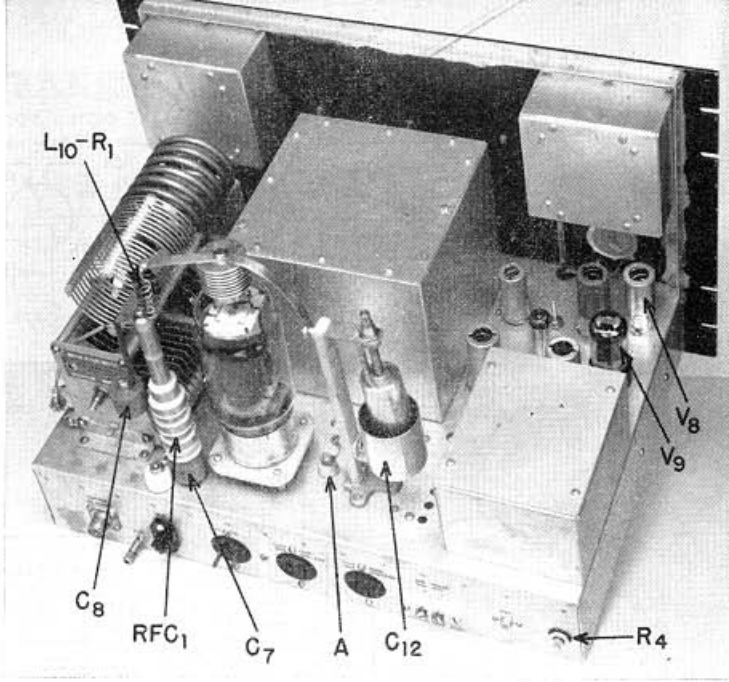


Fig. 6-64 — The components are assembled on a 17 × 12 × 3-inch aluminum chassis. The meters are housed in 4 × 4 × 2-inch boxes, the v.f.o. enclosure is 6 × 6 × 6 while the box enclosing L_3 and L_4, to the right, measures 3 × 4 × 5 inches. The National R-175A r.f. choke is threaded into C_7 (Sprague 20DK-T5). C_8 (also Sprague 20DK-T5) is mounted on a metal bracket fastened to a stator terminal of C_9. C_{12} (a Johnson N-250) connects to C_{13} via feedthrough *A*. V.h.f. parasitic choke L_{10} consists of 6 turns No. 16, ¼ inch diameter, 1¼ inches long. R_1 is made up of five 470-ohm 1-watt carbon resistors in parallel. It is connected across 3 turns of L_{10}. The 813 socket is mounted on ½-inch pillars over a 2¼-inch hole in the chassis. Along the rear apron are J_2, + h.v. (Millen 37001) and ground terminals, a.c. power-input connector, two a.c. outlets, low-voltage input terminals, key connector, and R_4.

♦

the v.f.o. to frequency. In the first position, both screens are biased; in the second position, only the 813 screen is biased, while positive voltage 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 bias rectifiers are included to supply fixed bias to the 6146 and 813, so that the plate currents will be cut off during keying intervals. Negative blocking voltage is also provided for the keying system. Both rectifiers operate from a single 6.3-volt filament transformer connected in reverse. The bias transformer T_2 is operated from the 6.3-volt winding of the filament transformer T_1.

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. B_1 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.

L_1 (35 μh.) is a B&W 80-BCL coil with the link and base removed. L_2 is described over Fig. 6-71. L_3 (2.6 μh.) is 31 turns of B&W 3003 Miniductor, while L_4 (5.3 μh.) is 30 turns of 3011. L_5 (1.5 μh.) consists of 11 turns of No. 16, ¾-inch diameter, 13/16 inch long. L_6 (8.9 μh.) has 29½ turns of B&W 3015 Miniductor. L_9 (1.6 μh.) has 6 turns of ¼-inch copper tubing, 2¼ inches inside diameter, 2¾ inches long.

L_7 (4.8 μh.) and L_8 (4.2 μh.) are made from

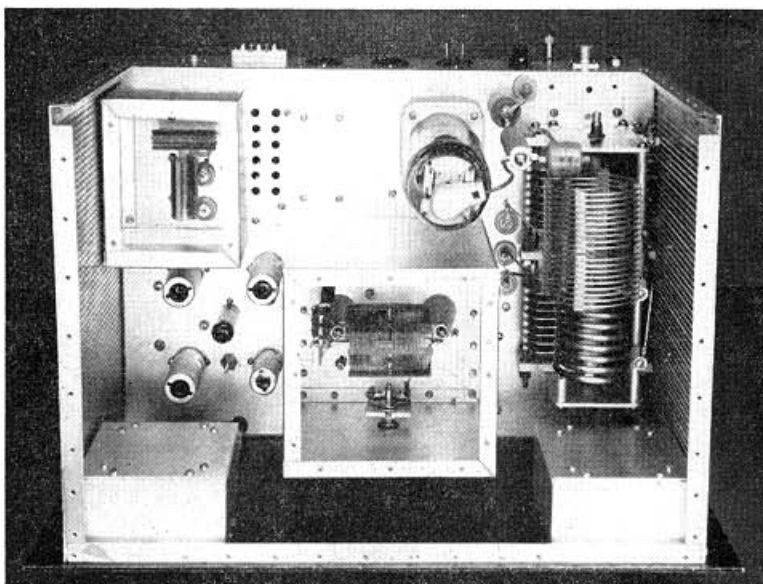


Fig. 6-65 — The v.f.o. box is placed with its front wall 1⅜6 inches back of the panel, central on the chassis. L_1 is mounted on 2-inch cones to center it in the box. The shaft of C_1 (Cardwell PL-6001 minus last rotor plate) is central on the box front, at a height to match that of C_9. C_2 (Cardwell PL-6002) is mounted, between C_1 and the coil, shaft downward, to engage the right-angle drive below. C_3 (Cardwell PL-6009) is similarly mounted, to the left of C_2. Grouped to the left are J_4, J_2, and J_3 in front, with J_5 and J_1 to the rear, and J_2 in the center. Feed-throughs in the bottom of the coil box to the rear connect L_3 and L_4 to C_4 below. The ventilating holes are over the 6146. C_9 (Johnson 200DD35) is placed with its shaft 2¼ inches from the end of the chassis, and its rear end plate 1⅝ inches in from the back edge. The three feed-throughs to the left connect L_8 to S_2. This photograph was made before the installation of C_{12}, the R-175A choke, V_8 and V_9.

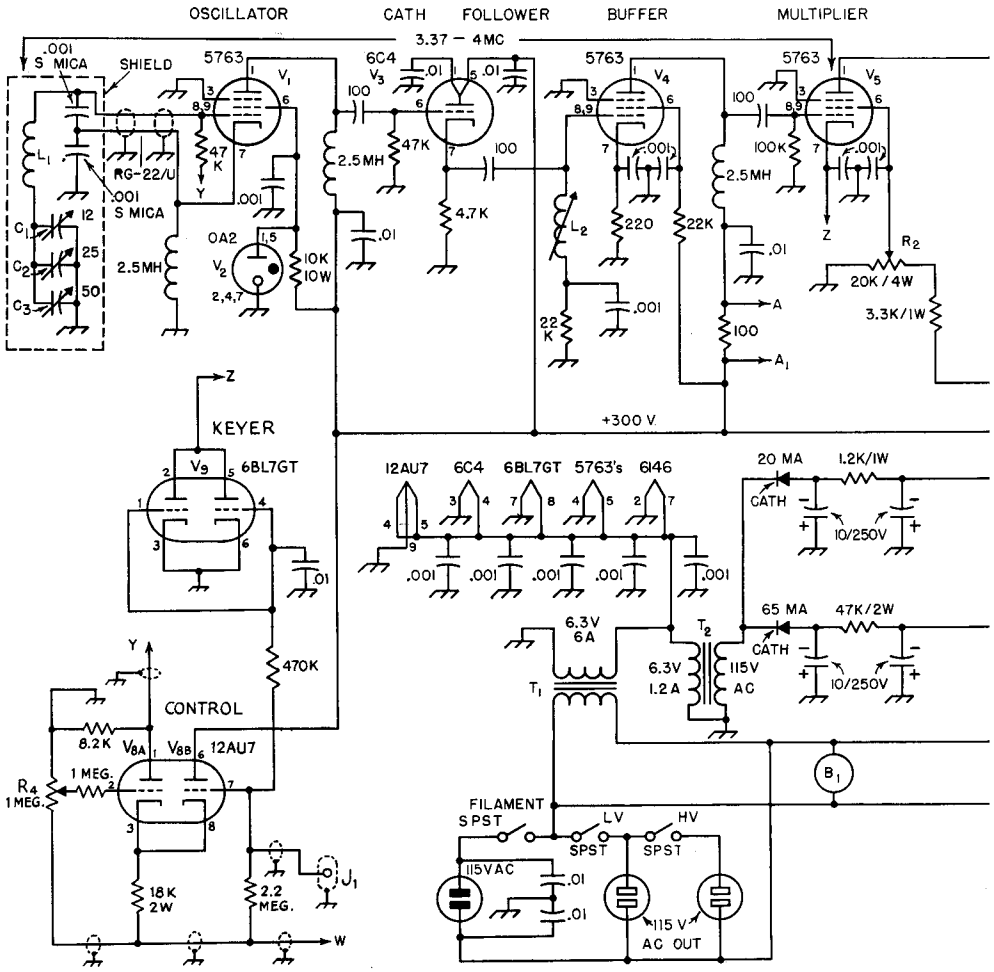
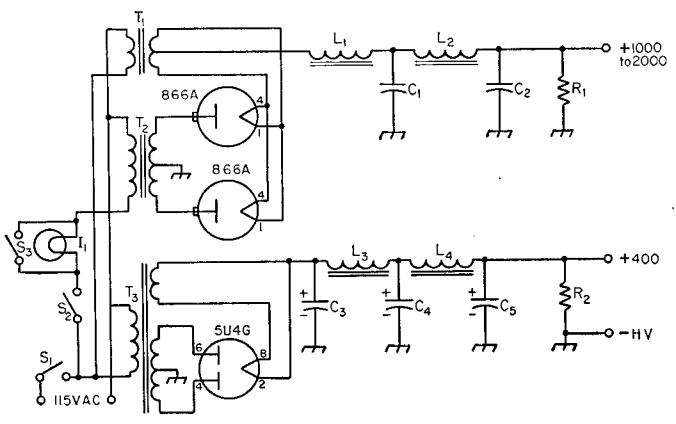
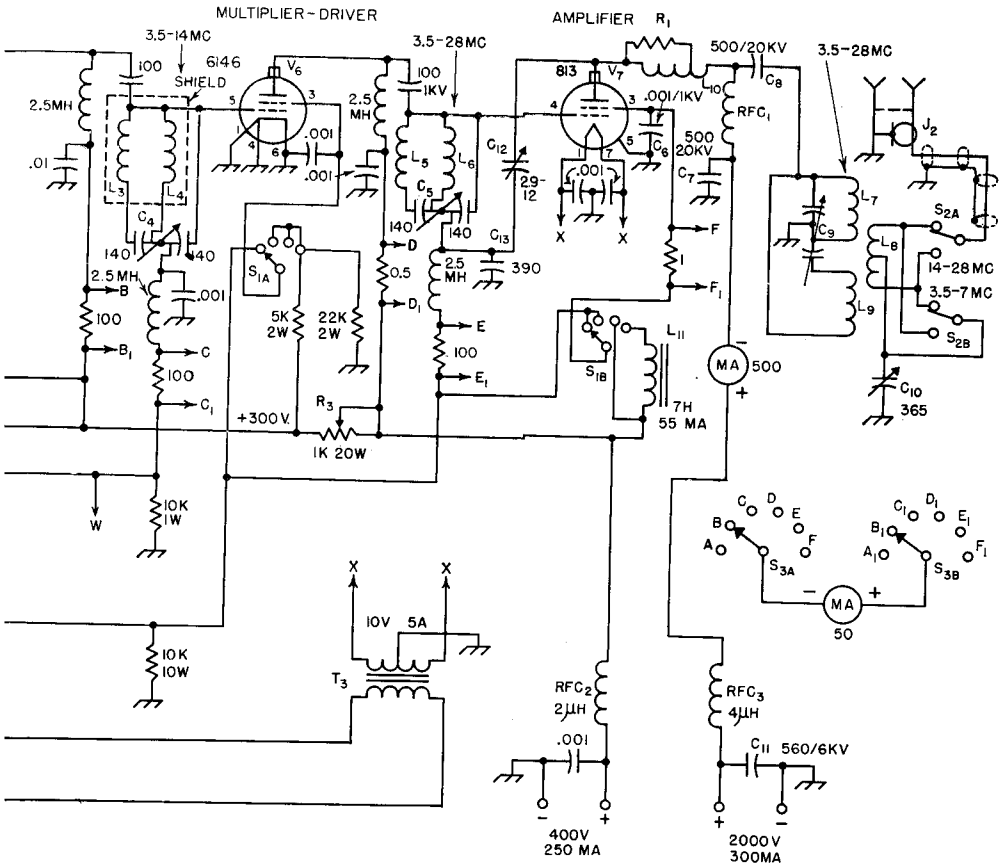


Fig. 6-66 — All capacitances less than 0.001 μf. are in μμf. All unmarked by-passes are disk ceramic. All 100- fixed capacitors are mica. All resistors are ½ watt unless otherwise specified. *RFC*2 and *RFC*3 are National R *C*11 is Sprague DD60-561. Rectifiers are selenium. *R*2 is the excitation control. *R*3 is the oscillator-lag adjustm *B*1 is the ventilating-fan motor.



C_1, C_2 — 4-μf. 2000-volt oil-fil
C_3, C_4, C_5 — 4-μf. 600-volt e trolytic.
R_1 — 25,000 ohms, 200 watts.
R_2 — 15,000 ohms, 25 watts.
L_1 — 5/25-h. 300-ma. swinging.
L_2 — 20-h. 300-ma. smoothing.
L_3, L_4 — 8-h. 300-ma. filter ch
I_1 — 150-watt lamp (Tune up)
S_1, S_2 — 10-amp. switch.
S_3 — 3-amp. switch.
T_1 — 2.5 volts, 10 amp.
T_2 — 2000 volts d.c., 300 ma.
T_3 — 440-0-440 r.m.s., 200 ma volts, 3 amp. (Triad R-2

Fig. 6-67 — Circuit of a suitable power supply for the 813 transmitter.



B&W 3905-1 strip coil as follows: Count off 9¼ turns, clip the wire without breaking the support bars. Bend the last quarter turn out. This portion is L_7. Remove the next ¾ turn to make a ¼-inch space between L_7 and L_8. Count off 10 turns more, cut the remainder of the coil stock off. Unwind the last turn on L_8 to make the necessary lead to the stator of C_9. Tap L_8 at the 8th turn from L_7.

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 R_3 should be adjusted eventually so that the voltage to V_1, V_3, V_4 and V_5 is 300 under load.

The v.f.o. tuning ranges should be adjusted first. Set S_1 to the first position. Adjust R_2 to zero and turn on the filaments and low-voltage supply. Set C_1 at 95 degrees on the dial (near minimum capacitance). Set C_2 accurately at midscale. Listening on a calibrated receiver, adjust C_3 until the v.f.o. signal is heard at 3750 kc. Tune the receiver to 3500 kc., turn C_1 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 C_1 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 C_3 may be necessary during the plate-bending process to keep the band centered on the dial.

Now set C_1 at about 15 degrees. Set the receiver at 3750 kc. and reduce the capacitance of C_2 until the v.f.o. signal is heard. Then tuning 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 C_2 accurately. 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 v.f.o. signal is heard at 3387 kc. Mark this setting of C_2 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 L_2 for a maximum voltage reading across the 22K grid leak of V_4. A high-resistance voltmeter should read about − 25 volts.

Readjust C_2 to midscale and turn the meter switch to read 6146 grid current, and turn up the

Tuning Chart for the 813 Transmitter

Output Band (Mc.)	C_4 *Dial*[1]	C_4 *Band (Mc.)*	C_5 *Dial*[1]	C_5 *Band (Mc.)*	C_9 *Dial*[2]
3.5	8.8	3.5	6.1	3.5	77
7	8.8	3.5	0.5	7	9
14	1.5	7	9.5	14	82
21	1.5	7	3.7	21	26
27-28	4.7	14	1.8	28	7

[1] 10-division dial — 10 max. capacitance.
[2] 100-division 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- and 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 wave meter 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, 1954; with modifications in the issues for June, 1954, June and October, 1956).

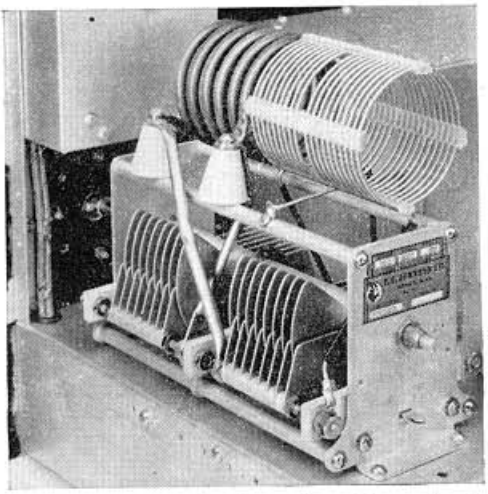


Fig. 6-68 — Close-up showing method of mounting L_7, L_8 and L_9. The stator rods of C_9 are tapped 6-32 for threaded studs by which the 1-inch cone insulators are attached. The bracket attaching C_8 to the stator of C_9 is at the lower right.

Voltage-Current Chart for the 813 Transmitter

Tube	Band (Mc.)	Grid 1 (volts)	Grid 1 (ma.)	Grid 2 (volts)	Grid 2 (ma.)	Cathode (volts)	Plate (volts)	Plate (ma.)
V_1	3.5	−16	—	150	—	0.6	300	—
V_2	3.5	—	—	—	—	39	300	—
V_4	3.5	−18	—	190	—	9	300	35
V_5	3.5	−64	—	115	—	27.5	300	5.5
V_5	7	−64	—	115	—	27.5	300	5.5
V_5	14	−58	—	170	—	34	300	8.5
V_6	3.5	−75	*	170	—	—	400	55
V_6	7	−76	*	170	—	—	400	63
V_6	14	−80	*	185	—	—	400	87
V_6	21	−80	*	195	—	—	400	90
V_6	28	−75	*	175	—	—	400	105
V_7	3.5	−165	17	400	40	—	2000	220
V_7	7	−185	18	400	40	—	2000	220
V_7	14	−190	19	400	35	—	2000	220
V_7	21	−190	20	400	35	—	2000	220
V_7	28	−190	19	400	40	—	2000	220

* Approximately 2 ma. Depends on setting of excitation control.

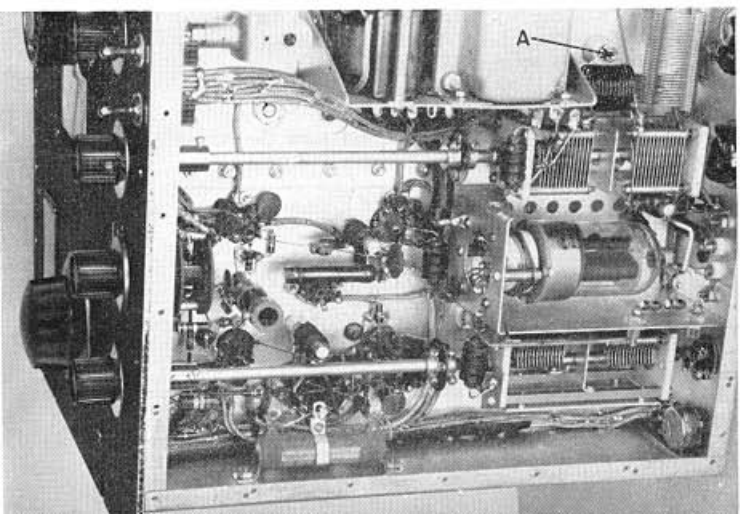


Fig. 6-69 — Detail view of the exciter section. The neutralizing lead from C_{12} comes through the chassis at feed-through *A*. R_4 in the keyer circuit is in the lower right corner. R_3 is near the lower left corner. Leads to the 6146 socket pass through a large clearance hole in the bracket.

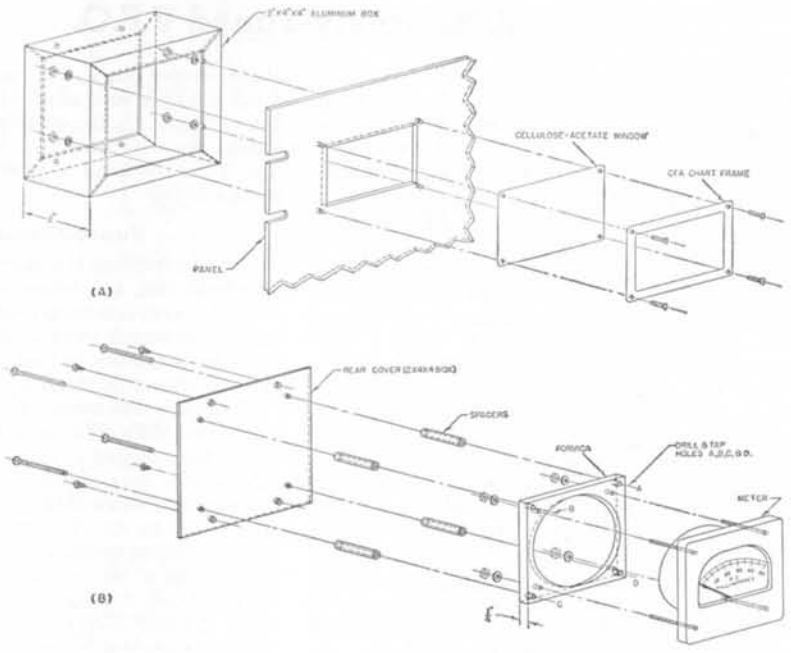


Fig. 6-70 — The chart frame, the panel and the aluminum box are held together, as show in A, by the hardware supplied with the CFA. B shows a meter (Triplett Model 327-T), its insulated mounting ring, and the rear cover of the box. The meter assembly is slipped into the metal box after the latter has 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 3/16 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 1½ 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 RR wafer on P-121 index assembly). The 6146 is mounted on a 5 × 2¼-inch bracket between C_4 and C_5, whose shafts are fitted with insulating couplings. C_5 is mounted on spacers, while C_4 is mounted on its side on a bracket. T_1 (Triad F-18A) and T_2 (Triad F-14X) are mounted on another bracket at the center. L_5 and L_6, at right angles, are soldered between the terminals of C_5 and Pin 4 of the 813 socket, seen through the 2¼-inch hole in the chassis. C_{10} and S_2 are mounted on small brackets. T_3 (Triad F-23U) and the blower (available from Allied Radio, Chicago, No. 72P715) are to the left. The screwdriver-slotted shaft of C_3 may be seen between the shaft of C_5 and the shielded power wires to the left. All power wiring is done with shielded wire (Belden 8656, Birnbach 1820, or shielded ignition wire for the 2000-volt line; Belden 8885 for the rest). L_2, behind S_3 (Centralab 1411), is a National XR-50 slug-tuned form close-wound with 93 turns No. 36 enameled wire.