A 100-Watt Transmitter Using a Pair of VT1625s

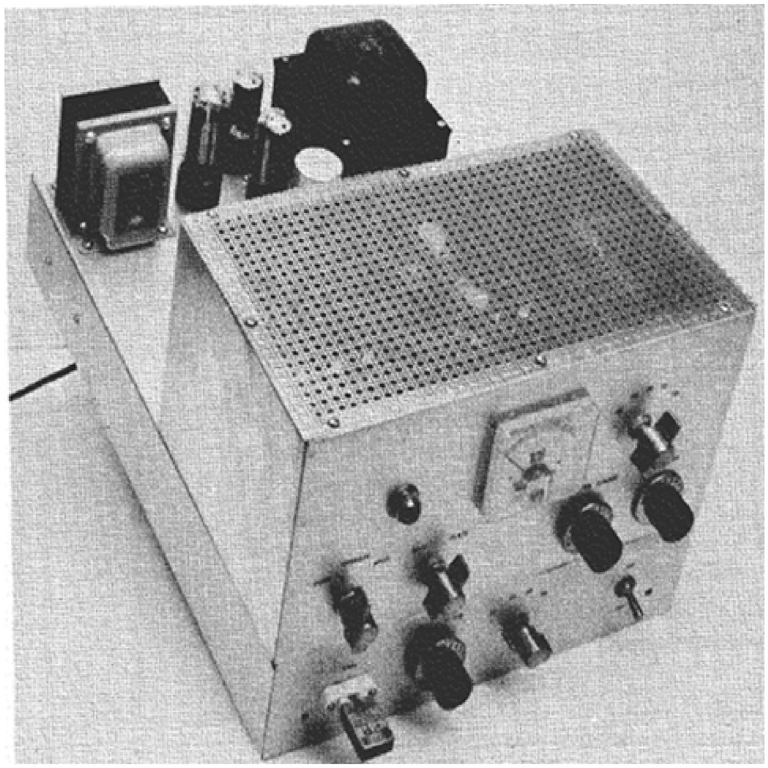


FIG. 10.6 — A 100-watt transmitter for five bands, using salvaged TV power transformer and surplus 1625 amplifier tubes.

Across the bottom on the front of the chassis are the

- crystal
- amplifier grid (or oscillator plate) tuning capacitor
- oscillator band switch, and
- power switch

On the box panel, from the left, are the

- tune- operate-spot switch
- meter switch and
- amplifier plate tuning and loading controls.

The amplifier band switch is at the upper right.

At the rear of the chassis are

- L_8
- the 5U4 and 6DE4s (see Fig. 10.7) and
- the power transformer

The key jack, not visible in this view, is mounted on the rear chassis wall.

Circuit Details

The transmitter can be operated on any band from 3.5 MHz through 28 MHz at inputs up to 100 watts. It uses a 6AG7 crystal oscillator driving a pair of 1625s. Either 80- or 40-meter crystals are used, depending on the band.

The plate circuit of the oscillator is tuned by the combination of C_3 and L_1L_2, Fig. 10-7. The correct inductance for each band is selected by using S_1 to short out part of L_2. The oscillator can be operated either straight through, doubling, or tripling, depending on the crystal used. An 80-meter crystal is used for 3.5-MHz operation, and the same crystal will provide more than enough excitation for 40 meters with the oscillator working as a doubler. However, the grid drive to the amplifier on 14 MHz is not great enough when the oscillator is operated as a quadrupler from a 3.5-MHz crystal. Adequate 14-MHz excitation is obtained with the oscillator working as doubler from a 7-MHz crystal, and also on 21 MHz working as a tripler; the 7-MHz crystal, of course, also can be used for 40-meter work with the oscillator working straight through. For 28-MHz work, a 7-Mc. crystal is used with the oscillator doubling to 14 Mc., and the amplifier also works as doubler.

The parallel 1625s are operated as a straight-through amplifier on all bands except 28 Mc. The amplifier tank circuit is a pi network designed primarily to work into 50- or 70-ohm loads. C_5 is the plate tuning capacitor. The variable loading capacitor, C_6, is a two-gang broadcast type consisting of two sections of approximately 375 pF each. These two sections are connected in parallel to provide 750 pF at maximum. In addition, a 680-pF mica fixed capacitor is switched into the circuit on the 80-meter band. This, with C_6, provides the approximately 1450-pF capacitance required for 50-ohm loads at 80 meters.

L_3 and L_4, in the plate leads of the 1625s, are for suppressing parasitic oscillations. The 1625 plates are parallel fed. Either of the two chokes specified in the parts list for RFC_5 will work satisfactorily. RFC_6 serves as a safety precaution in the event that C_7, the plate blocking capacitor, should break down, in which case the DC plate voltage would be shorted to ground through RFC_6 rather than appearing on the antenna circuit.

Note that the cathodes of the 1625s are individually bypassed, as are also the screens. The bypass capacitors, 0.01 pF, should be installed right at each tube socket, using the shortest possible path to chassis.

Keying System

A feature of the circuit is the differential keying system. A keyed oscillator usually has either clicks or chirps. The chirp is a slight change in the oscillator frequency as it is keyed.

Chirp can be eliminated, or much reduced, in a two-stage transmitter by letting the oscillator run continuously during a transmission and doing the keying in the following stage. However, break-in operation is not possible when this is done, and it is necessary to have a send-receive switch to turn off the oscillator at the end of each transmission. In "differential" keying, the oscillator does not actually run all the time but is turned on just before the power is applied to the amplifier and turned off shortly after power is taken off the amplifier. Only the amplifier keying is heard on the air, and this keying can be shaped as desired, to eliminate key clicks, without affecting the oscillator frequency.

In the system used here, the keying circuit can be adjusted so that the oscillator "hangs on," even at slow speeds. In fact, it can be set to turn off as much as a second or two after the key is opened, thus eliminating the need for manual switching even though the oscillator runs continuously while the operator is sending at ordinary keying speed.

A "Tune-Operate-Spot" switch, S_2, is included in the circuit:

- In the "Spot" position, the oscillator is turned on and, if desired, can be left on continuously while keying is done entirely in the amplifier stage.

The system as shown also eliminates key clicks by shaping the keyed signal.

The differential keying circuit uses a 6-volt AC relay, single-pole, double-throw. In the key-up position a negative voltage is applied to the screens of the 1625s through the contacts of K_1, thus cutting off the plate current. The same voltage is applied to the 0A3/VR75, causing it to conduct and thereby applying negative voltage as a bias to the 6AG7 grid through one diode of a 6H6 (the other half of the 6H6 is used as a rectifier for the negative supply).

In this condition the 6AG7 plate current is cut off and the circuit does not oscillate. When the key is closed, a positive voltage is applied to the circuit, through the contacts on K_1. The positive voltage does not reach the grid of the oscillator because it cannot get through the 6H6, and since the negative biasing voltage has been removed the oscillator comes on. Meanwhile, the positive voltage has gradually been overcoming the negative charge left on C_4, so the amplifier screens come up to the normal positive operating voltage relatively slowly. The slow rise in voltage – actually, it takes place in just a small fraction of a second – eliminates the click on closing the key. On opening the key the negative voltage is again applied to the

1625 screens through K_1, but must overcome the positive charge left on C_4 before cutting off the amplifier. This slow change in voltage eliminates the click on ”break”, and also delays the application of negative bias to the oscillator, so the oscillator holds on for a while after the key is opened.

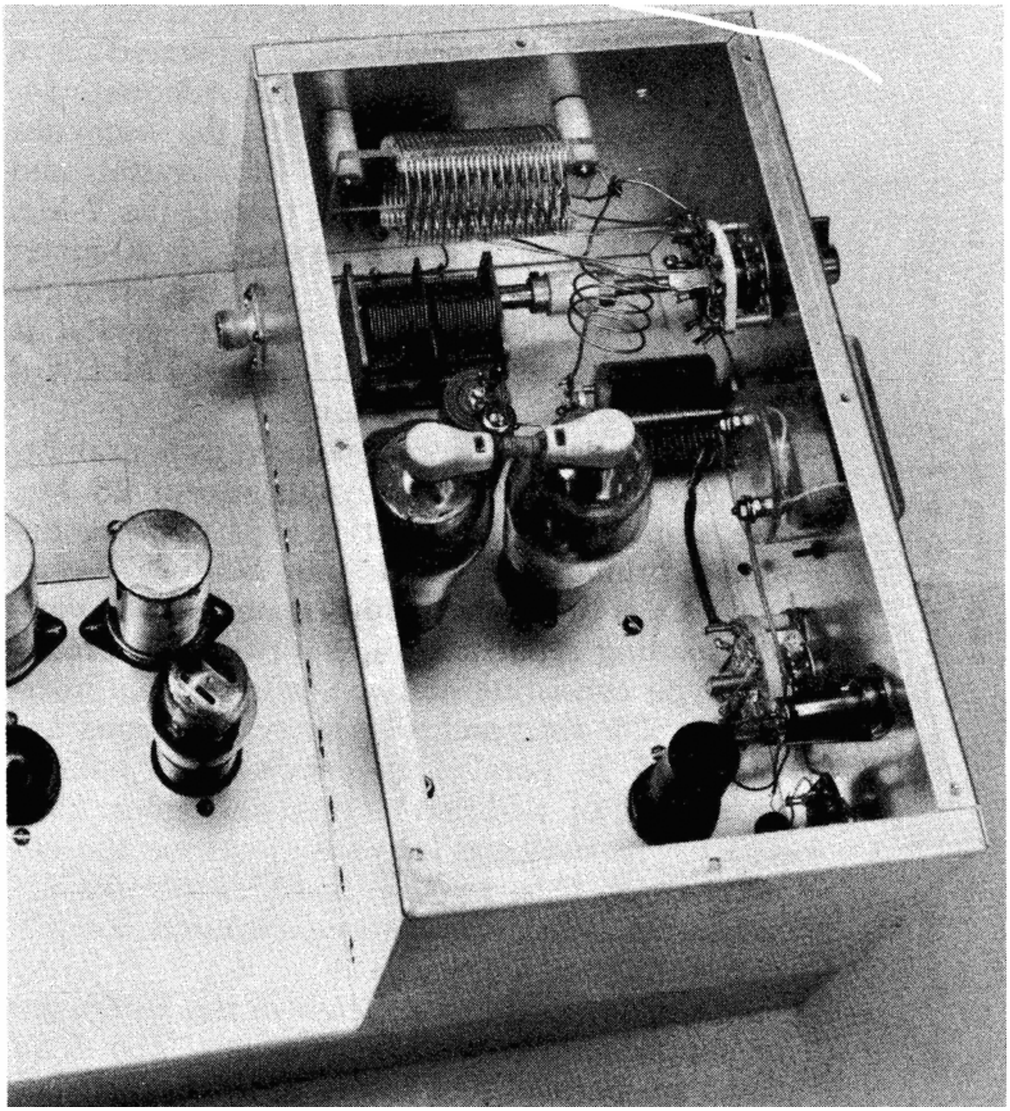


FIG. 1 0-8 — Arrangement of parts inside the 100-watt transmitter.

The loading capacitor, C_6, in the upper left-hand corner, is mounted at the rear of the box near J_2, the output connector.

A panel-bearing assembly (Allied 60 H 385) and a shaft coupler are connected to the rotor of C_6. (Some of the broadcast-type capacitors have 3/8-inch diameter rotor shafts. A 3/8-to-1/4-inch shaft coupler (Allied 60 H 362) can be used in such an installation.)

The 28-MHz coil, upper center in this view, is connected between the stator of C_5 and one end of L_6. Two steatite standoffs are used to support L_6 from the side of the box.

When placing the 1625 sockets be sure to allow sufficient clearance for installing and removing the tubes.

Control and Metering

- The first position of S_2 grounds the amplifier screens and turns on the oscillator. This allows tune-up at reduced amplifier plate current.
- The second position of S_2 permits the oscillator and amplifier to be keyed together, as described above.
- In the third position the oscillator is turned on but the amplifier is off until the key is closed. This position can be used for spotting your frequency. It also lets the oscillator run continuously, if plain amplifier keying is preferred.

The metering circuit uses a 0—1 milliammeter as a low-range voltmeter that can be switched, by S_5, across appropriate shunts to read either grid or cathode current of the 1625 amplifier.

The internal resistance of the meter used is approximately 50 ohms, and with the series and shunt values listed in Fig. 10-7 the full-scale readings are approximately 20 mA for grid current and 300 mA for cathode current.

Some of the lower-priced meters have internal resistances of 1000 ohms, and if such a meter is used the 4700-ohm series resistor, R_5, should be changed to 3900 ohms, the total of the meter resistance and R_5 should be approximately 5000-ohms, whatever the actual meter resistance.

Power Supply

To obtain as much voltage as possible from the TV-type transformer a bridge rectifier circuit is used in the power supply.

1. A pair of 6DE4 half-wave rectifiers and a full-wave 5U4G rectifier is used in the bridge.

2. The two 6.3-volt AC windings on the power transformer are connected in series to provide the 12.8 volts required for the heaters of the 1625s.

3. The power supply has two output voltages, approximately 600 and 300 volts. The actual voltages will depend on the particular type of power transformer used, but will be in this vicinity.

4. Choke-input filters are used in both the high- and low-voltage legs. Practically any TV power-supply choke will be usable for L_8, providing its current rating is at least 200 mA or more.

5. Two 16-pF 600-volt electrolytic capacitors, C_8 and C_9, are connected in series to provide 8 mF at 1200 volts for the filter capacitance in the high-voltage side of the power supply. Two 25,000-ohm, 10-watt resistors shunt these two capacitors, to help equalize the voltage drops across the two capacitors and to serve as a bleeder.

6. A 15,000-ohm, 10-watt resistor is used as a bleeder in the low-voltage leg of the supply.

7. The filter on the low B+ side of the supply consists of an 8.5-Hy choke (L_7) and a 16-mF 450-volt electrolytic capacitor.

8. One of the diode sections of the 6H6, V_{4B}, is used as a half-wave rectifier in the negative-voltage supply for the keying system. The secondary of T_1 has two windings, one at 250 volts, center-tapped, and the other at 6.3 volts. The center tap on the high-voltage winding is not used. When installing the electrolytic filter capacitor be sure that its positive side is connected to chassis ground.

Construction

1. A 17 x 12 x 3-inch aluminum chassis is used as the base and the RF components are housed in a 12 x 7 x 6-inch aluminum box (Premier AC-1276).

In laying out and mounting components inside the box be sure to allow clearance for the ½-inch lip around the bottom. It is a good idea to follow the general layout shown in the photographs.

2. L_6 is a length of Air Dux pi-network coil stock that comes mounted on a piece of plastic. Two steatite standoffs, ½ X 1 inch, are used to support the coil on the side of the box. The 28-MHz coil, L_5, is connected between one end of L_6 and the stator of C_5.

3. The output terminal, J_2, is mounted on the rear of the box just behind C_6.

The front-view photograph shows the layout of the panel controls.

1. Underneath the chassis, L_2 is mounted on a 1-inch cone insulator by cementing the coil support bars to the insulator with Duco cement.

2. L_1 is supported between the rotor of C_3 and the 21-MHz switch terminal.

3. The keying relay should be mounted on a rubber grommet to reduce the relay noise: the grommet size is ¼-inch diameter and a 3/8-inch hole is required.

The power-supply components are mounted at the rear of the chassis. The layout shown in the photographs can be followed if desired but the arrangement of parts is not critical. However, when mounting the rectifier sockets be sure to allow clearance for the tube envelopes when the tubes are inserted in the sockets.

In order to obtain the 12.6 volts required for the 1625 heaters, the two 6.3-volt windings on T_2 are connected in series. In the TV-type transformers there is usually one winding of 6.3 volts at 5 or more amperes and another winding of the same voltage at a little more than 1 ampere rating.
Connect the two windings in series and check the voltage at the outside ends with an AC voltmeter. If you don't have such a voltmeter, use the 1625 heaters instead: If the heaters light up the connections are correct: if they stay dark, reverse *one* of the 6.3-volt windings. You will get 6.3 volts between either lead *A* or B (Fig. 10-7), and chassis. The 6.3-volt winding with larger current rating (heaviest leads) will be your lead *A.* This is the one that will handle the heater current for the 6AG7, 6DE4s, the pilot light, and the keying relay.

Current for the 6H6 heater can be taken from the 6.3-volt winding on T_1.

F_1 and F_2 mount in a fuse-type line plug.

Testing and Adjustment

Before applying power to the transmitter, carefully check your wiring for errors.

1. Measure the resistance between the low-voltage B+ line and chassis. Before using the ohmmeter make sure the filter capacitor is discharged, by shorting the positive side of the electrolytic to chassis. Connect the negative

lead of your test instrument to chassis and make your test with the positive lead.

2. The resistance should be approximately 15,000 ohms, the value of the bleeder in the low-voltage supply.
3. On the high-voltage side the resistance will be about 50,000 ohms. These tests will show whether there are any shorts or opens in the B+ circuits.

A 100-watt lamp can be connected to J_2 to be used as a dummy load.

1. Put J_2 in the "Tune" position, thus grounding the screens of the 1625s.
2. Plug in a 3.5-MHz crystal and set S_1 and S_3 for the 3.5-MHz band. Turn on the power and allow about two minutes for the tubes to warm up.
3. With the meter switch in the grid-current position you should get a reading when C_3 *is* tuned. Adjust C_3 so that the grid current is about 7 mA.
4. Next, set C_6 near maximum capacitance (plates fully meshed). Set S_5 to read cathode current, and adjust C_5 for a dip in the reading. The current will be small because the screens of the amplifier are grounded.
5. Then turn S_2 to "Operate," close the key, and adjust C_5 and C_6 to cause the lamp dummy load to light.

Reducing the capacitance of C_6 will increase the lamp brightness if C_5 is readjusted for the dip in plate current each time the setting of C_6 is changed. Eventually a point will be reached where decreasing the capacitance of C_6 further will give no more output, although the plate current may continue to increase. The best loading adjustment is the one that gives maximum output with the least plate current. The plate current itself should be in the neighborhood of 175 to 200 mA at this point.

Go through the same procedure on the other bands to familiarize yourself with the controls. On each band, S_1 and S_3 should be set to the same frequency, with the exception of 28 MHz; on this band, set S_1 to 14 Mc. and S_3 to 28 Mc. Remember, also, that 7-MHz crystals should be used for 14, 21 and 28 MHz.
When testing the setup on 21 MHz, adjust C_1, the oscillator feedback capacitor, so that the grid current is no more than 7 mA. This adjustment should be made with C_3 at the position that gives maximum drive.

Typical voltage readings, with a TV power transformer having a 700-volt center-tapped winding, are:

- high voltage, 570 volts with the amplifier plate current at 170 ma.;
- low voltage, 260 (screens of 1625s and plate of 6AG7),
- 6AG7 screen, 150 volts.

Your transformer may give slightly higher or lower voltages, depending on the type. However, practically all TV power transformers will be suitable.

If you're a Novice licensee you must not run more than 75 watts input. If you know what your plate voltage is, Ohm's Law will give the plate current you can run on the amplifier to get 75 watts input. For example, if the plate voltage is 570 and the amplifier plate current is 130 mA, the input is 74 watts.

If you can't measure the plate voltage, the simplest thing to do is to assume that it will be 600 volts, a round figure that is not likely to be exceeded by a power supply of the type described here when the amplifier is loaded to a plate current of 125 mA. Thus a plate current of 125 mA should be on the safe side, for an estimated 73 watts input.

To load the amplifier to the Novice limit, first set the output capacitance, C_6, to maximum and "dip" the final by adjusting C_5. Note the current reading and, if you can measure the plate voltage, calculate your input. You'll probably find it to be considerably less than 73 watts. Decrease the capacitance of C_6 a little and redip the final, then repeat until the input is brought up to the 75-watt point. Alternatively, follow the same tuning process until the dipped plate current is 125 mA, as suggested above.

The negative grid voltage and current for the 1625s at normal operating conditions are -45 volts and 7 mA. The 6AG7 gives more than enough output, being capable of developing over 100 volts bias on the 1625 grids on 80, 40, and 20, and about 70 volts on 15 meters. However, the drive on 15 should be adjusted as outlined above, to minimize crystal heating. If the grid current is too high on the lower bands adjusting C_3 can reduce it.

With the component values specified for R_4 and C_4, the oscillator tends to stay on for two or three seconds after opening the key. You can adjust the circuit so that the oscillator stays on for longer or shorter times by changing the value of R_4. A higher value, such as 220K or 330K, holds the oscillator on for longer periods. This also tends to soften the keying.

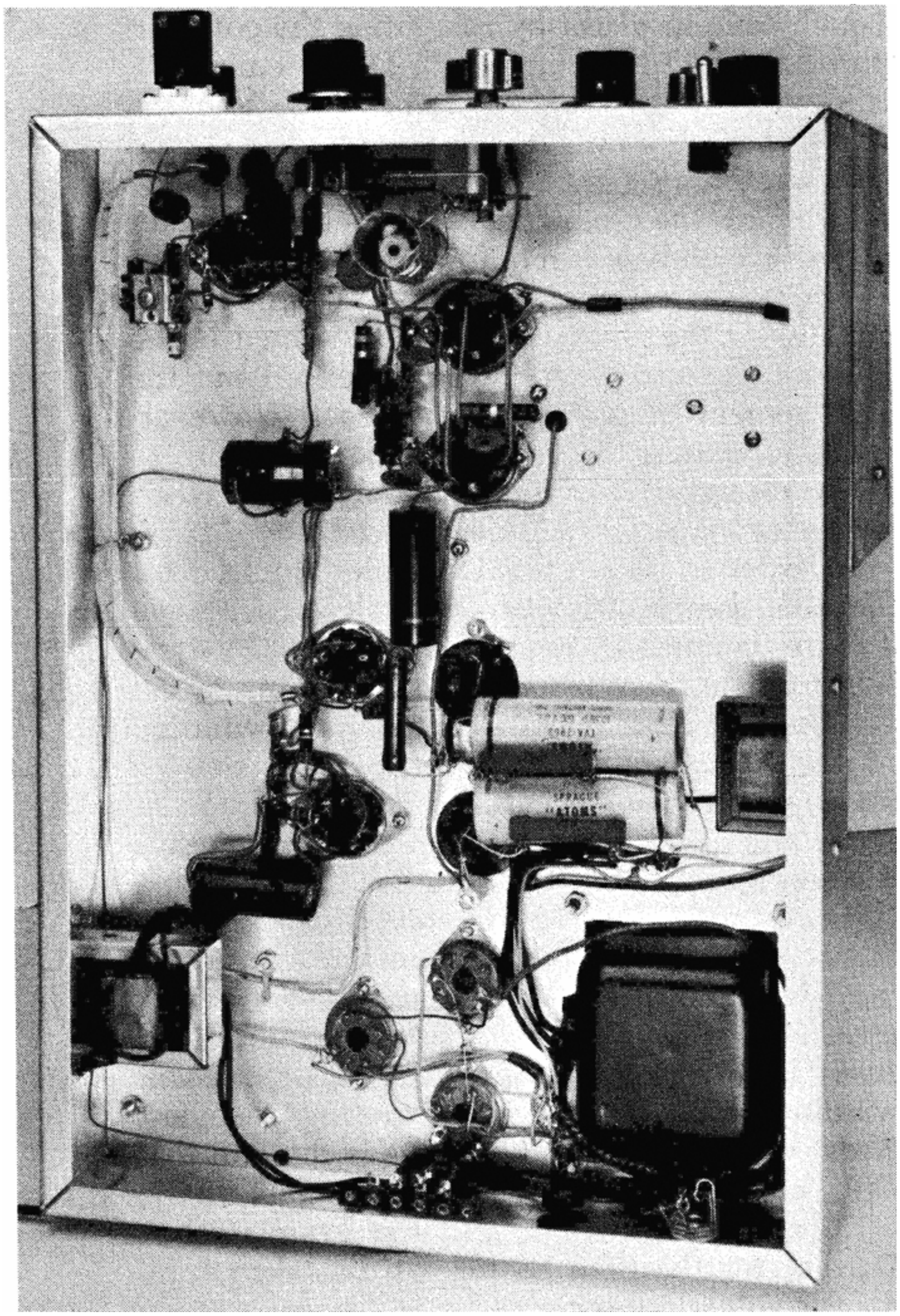
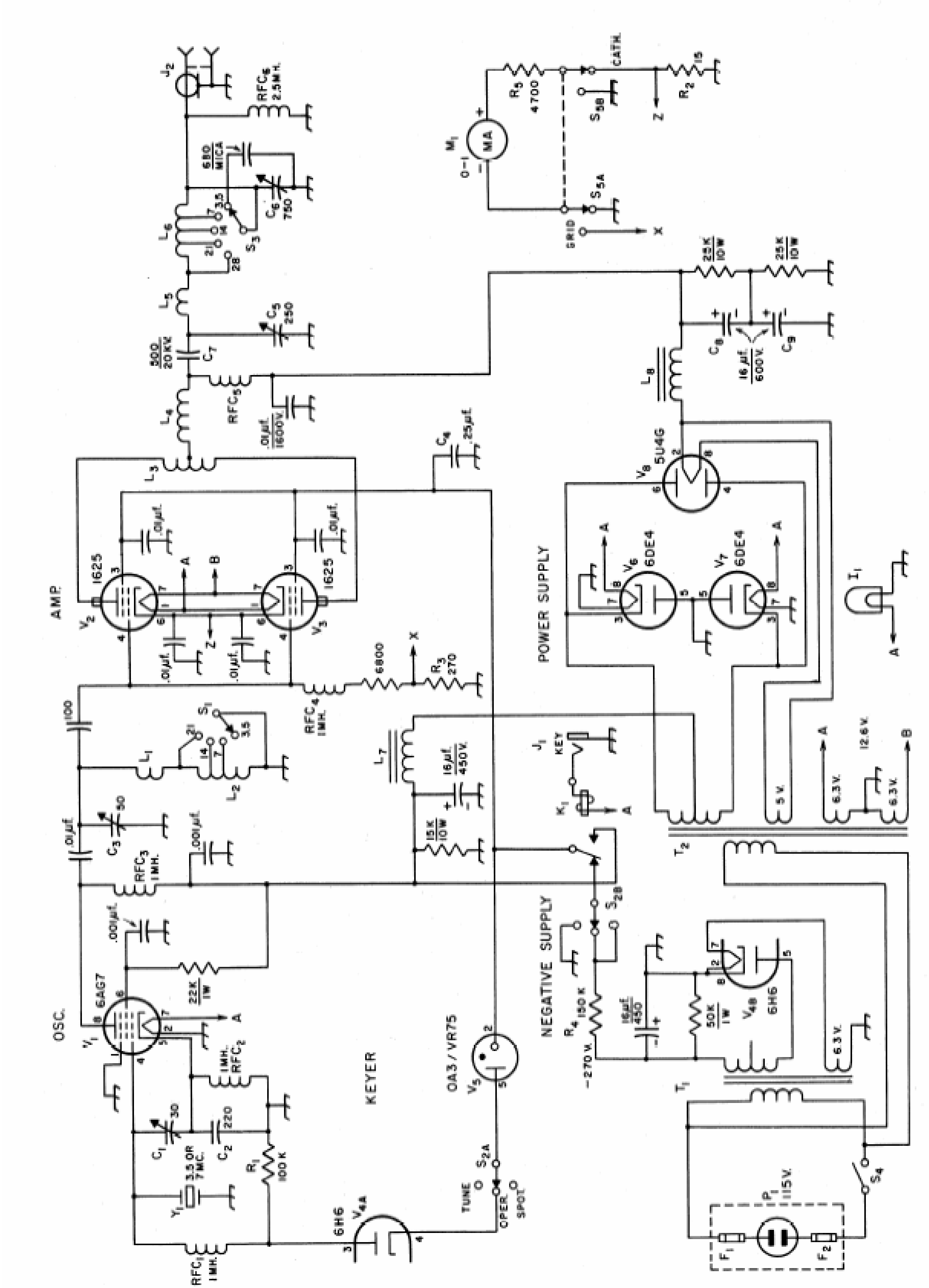


FIG. 10-9 — Below chassis view of the 100-watt transmitter.

- The oscillator components are in the upper left corner.
- The amplifier grid circuit components, C_3, L_1, L_2, and S_1, are at the top center.
- Directly below are the sockets for the 1625s.
- Lower left, on the chassis side is T_1, the negative-supply transformer.
- T_2, the power transformer, is visible In the lower right hand corner. Just above it, on the chassis wall, is L_7.


OSC.
6AG7
AMP.
1625
POWER SUPPLY
6DE4
5U4G
NEGATIVE SUPPLY
6H6
KEYER
OA3 / VR75
KEY
GRID
CATH.
TUNE
OPER.
SPOT
115 V.
6.3 V.
12.6 V.
5 V.
−270 V.
MA
0–1
4700
6800
270
150 K
100 K
22K 1W
50K 1W
15K 10W
25K 10W
16 µf. 450 V.
16 µf. 600 V.
500 20KV
.01µf. 1600V
2.5MH.
580 MICA
750
250
3.5 OR 7MC.

Parts List

Coil Data for the 100-watt Transmitter

L_1—13 turns No. 20, ½-inch diam., 16 turns per inch (B & W Miniductor 3003).

L_2—46 turns No. 24, 1-inch diam.; 14-Mc. tap 5 turns from junction of L_1L_2, 7-Mc. tap 17 turns from junction of L_1L_2 (B & W Miniductor 3016).

L_5—4 turns No. 16, 1-inch diam., 1 inch long.

L_6—28 turns No. 16, 1½ inch diam., 12 turns per inch; 21-Mc. tap 1½ turns from junction of L_5L_6, 14-Mc. tap 5½ turns from junction of L_5L_6, 7-Mc. tap 17½ turns from junction of L_5L_6 (Pi Air Dux 1212A with 4 turns removed).

C_1—3–30-μμf. mica trimmer.

C_2—220-μμf. mica.

C_3—50-μμf. variable (Hammarlund HF-50).

C_4—0.25-μf. paper, 400 volts.

C_5—250-μμf. variable (Hammarlund MC-250-M).

C_6—Approx. 750-μμf. variable, dual-section broadcast type, with stators connected in parallel (Allied 60 H 725).

C_7—500-μμf., 20,000-volt, TV "doorknob."

C_8, C_9—16-μf., 600-volt electrolytic.

F_1, F_2—5 amp., type 3AG.

I_1—Dial lamp, 6 volts, type 47.

J_1—Phone jack, open circuit.

J_2—Coax chassis receptacle, SO-239.

K_1—Keying relay, s.p.d.t., 6-volt a.c. coil (Potter Brumfield KA5A).

L_1, L_2, L_5, L_6—See coil table.

L_3—18 turns No. 22 enam., wound on a 1-watt resistor (any value over 1000 ohms) as a form, tapped at center.

L_4—12 turns No. 22 enam. on same type form as L_3.

L_7—8.5-hy. 50-ma. filter choke (Allied 62 G 136).

L_8—Filter choke, current-carrying capability over 200 ma. (see text).

M_1—0–1 d.c. milliammeter.

P_1—Fuse-type line plug.

R_1—0.1 megohm, ½ watt.

R_2—15 ohms, ½ watt.

R_3—270 ohms, ½ watt.

R_4—0.15 megohm, 1 watt (see text).

R_5—See text.

RFC_1–RFC_4, inc.—1 mh. (National R-50, Millen 34300-1000).

RFC_5—1 mh. (Millen 34107) or 120 μh. (Raypar RL-102).

RFC_6—2.5 mh. r.f. choke.

S_1—Ceramic rotary, 1 pole, 11 positions (4 used), 1 section (Centralab 1001).

S_2—Phenolic rotary, 2 poles, 3 positions, 1 section (Centralab 1473).

S_3—Ceramic rotary, 1 pole, 6 positions (5 used), 1 section (Centralab 2501).

S_4—S.p.s.t. toggle.

S_5—Phenolic rotary, 2 poles, 3 positions (two used), 1 section (Centralab 1473).

T_1—250 volts, center-tapped, 25 ma.; 6.3 volts, 1 amp.; h.v. center tap not used (Allied 62 G 008).

T_2—App. 700 volts center-tapped, 200–300 ma.; 6.3 volts, 5 amp.; 6.3 volts, 1 amp.; 5 volts, 3 amp. (from old TV receiver; see text).

Y_1—Crystal, 3.5- or 7-Mc. band as required.