A 75- TO 120-WATT CW TRANSMITTER

The transmitter shown in Fig. 6-48 is designed to satisfy the cw requirements of either a Novice or higher-class licensee. The PA stage will operate at 75-watts dc input for the Novice. The rig provides station control and other operating features. Holders of General Class or higher licenses can run up to 120-watts dc input. A SPOT position is provided on the FUNCTION switch which permits identifying the operating frequency in a band. The transmitter has been designed for ease of assembly, with the beginner in mind.

The circuit diagram of the transmitter (Fig. 6-49) shows the oscillator tube, V_1, to be a 6GK6. This pentode works "straight through" on some bands while multiplying in its plate circuit on others. An 80-meter crystal will develop either 80- or 40-meter energy in the subsequent stage (6146B) grid circuit, depending on the setting of S_2 and C_1. Similarly, a 40-meter crystal will permit the oscillator to drive the final tube on 40, 20, 15 and 10 meters. The final amplifier is always operated straight through for maximum power output. Since the amount of excitation will vary with the degree of frequency multiplication, a screen-voltage-adjustment control, R_1, is included.

To insure stability, the 6146B amplifier is neutralized. This is done by feeding back a small amount of the output voltage, (out of phase) to the 6146B grid through C_2. The adjustment of this circuit is described later. Provision is included to measure the grid and cathode current of the amplifier stage. With the 6146B it is important to insure that the grid current is kept below 3 mA at all times; *high grid currents will ruin the tube in short order.* The meter, which has a basic 0-1-mA movement, uses appropriate multiplier and shunt resistors to give a 0-10-mA scale for reading grid current, and 0-250 mA for monitoring plate current.

The plate tank for the final amplifier uses the pi-section configuration for simple band switching. This network is tuned by C_3, and C_4 provides adjustment of the antenna coupling. The pi-network also assures excellent suppression of harmonics when properly terminated, typically 35 to 45 dB. All connection points to the transmitter are filtered to "bottle up" harmonic energy, which, if radiated, could cause television interference.

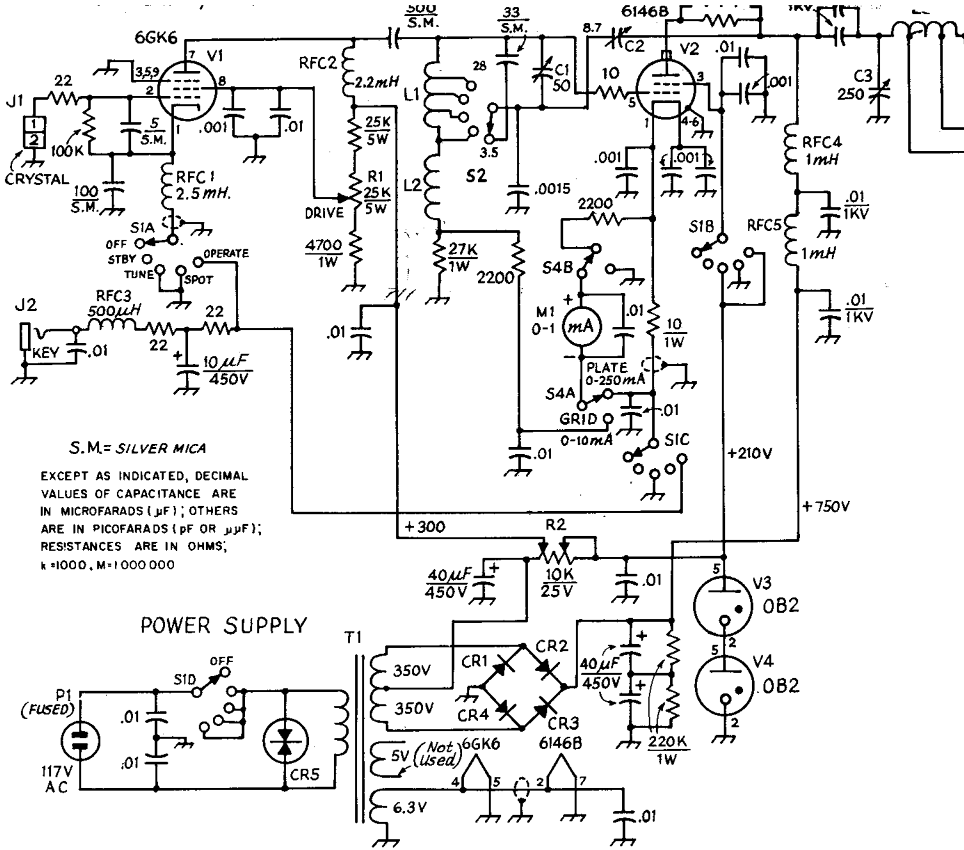
Silicon rectifiers are used in the "economy" power supply. A center-tapped transformer with a bridge rectifier provides all of the operating voltages for the transmitter. Depending upon the line voltage, the high-voltage supply will deliver about 750 volts, key up, dropping to about 700 volts under load. If the line voltage is above 120, these figures will be increased by about 50 volts. The screen supply to the 6146B is regulated by two OB2 VR tubes.

The FUNCTION switch turns the transmitter on and selects the spot, tune or operate modes. Leads from this switch are brought out to the rear deck of the transmitter to mute the station receiver and key the antenna relay. Thus, S_1 provides one-switch transmit-receive operation. In the OPERATE position, the oscillator and amplifier are keyed simultaneously by grounding the common cathode circuit. A *RC* network across the cathode line is included to shape the keying, thus preventing key clicks.

Fig. 6-41—This 120-watt cw transmitter can be operated at 75-watts dc input for Novice-band use. The slide switch puts the meter in the grid or cathode circuit of the 6146B amplifier. Directly to the right of the slide switch is the FUNCTION switch and crystal socket. Continuing at this level, farther to the right is the GRID TUNING, grid BAND SWITCH, and the DRIVE level control. The controls to the upper right are the final BAND SWITCH, FINAL TUNING, and FINAL LOADING.

Construction

An 11 × 7 × 2-inch aluminum chassis (Bud AC-407) is used as the base for the transmitter. A homemade aluminum U shield encloses the final amplifier. The chassis is fitted with a 11 × 7-inch front panel which is cut from sheet aluminum. The panel is held to the chassis by the switches and panel bushings common to both units. Correct placement of the various parts can be determined by viewing the photographs. Only an experienced builder should try to relocate the major components. The rf compartment has ¾-inch mounting lips bent along the back side and the ends to give a finished size of 5 × 8¾ inches. This rear housing is held to the chassis and front panel with 6-32 hardware, and a perforated metal cover is fastened to it with No. 6 sheet-metal screws.



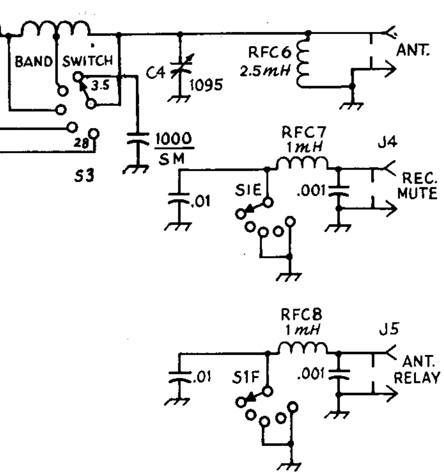


Fig. 6-42—Circuit diagram of the 6146B transmitter. Capacitors with polarity marked are electrolytic, others are disk ceramic. Resistors are ½-watt composition.

C_1—Air variable (Hammarlund APC-50B).

C_2—Air variable (Johnson 160-104).

C_3—Air variable (Hammarlund MC250M).

C_4—Three-section broadcast variable, 365 pF per section, all sections connected in parallel (Miller 2113).

CR_1-CR_4, incl.—100-PRV, 1-A silicon.

CR_5—Transient suppressor (GE 6RS20SP4B4).

J_1—Crystal socket.

J_2—SO-239-style connector, panel mount.

J_3, J_4—Phono connector, panel mount.

L_1—37 turns, No. 20, 16 tpi, ¾-inch dia., tapped at 4 turns from the tube end for 28 MHz, 6 turns for 21 MHz, 12 turns for 14 MHz, and using the entire coil for 7 MHz (B&W 3012).

L_2—28 turns, No. 20, 32 tpi, ¾-inch dia. (B&W 3011).

L_3—12 turns, No. 18, 8 tpi, 1-inch dia., tapped at 3 turns from the tube end for 28 MHz, 6 turns for 21 MHz, and using the entire coil for 14 MHz (B&W 3014).

L_4—21 turns, No. 20, 16 tpi, 1-inch dia., tapped at 9 turns in from the junction with L_3 for 7 MHz, and using the entire coil for 3.5 MHz (B&W 3015).

M_1—Milliammeter (Calectro D1-912).

P_1—Fused plug (use 3-A, 3AG fuses).

R_1—25,000-ohm, 5-W wirewound control (Mallory VW25K).

R_2—10,000-ohm, 25-W wirewound.

RFC_1, RFC_2—2.2 mH (Miller 73F223AF).

RFC_3—500 μH (Millen 34300-500).

RFC_4—1 mH (Miller 34107).

RFC_5, RFC_7, RFC_8—1 mH (Miller 4527).

RFC_6—2.5 mH (Miller 4532).

S_1—Ceramic rotary switch, 6 pole, 3 section, 6 position (5 used), non-shorting contacts (Centralab PA-2023).

S_2—Ceramic rotary switch, 2 pole (1 not used), 6 position (1 not used) 1 section, non-shorting contacts (Centralab PA-2003).

S_3—Ceramic rotary switch, 1 pole, 6 position (1 not used), non-shorting contacts (Centralab 2501).

S_4—Dpdt slide switch.

T_1—Power transformer, 117-volt primary, secondary 540 volts c.t. at 260 mA, and 6.3 volts at 8.8 A (Stancor P-8356).

Z_1—7 turns of No. 16 wire on a 100-ohm, 1-W composition resistor.

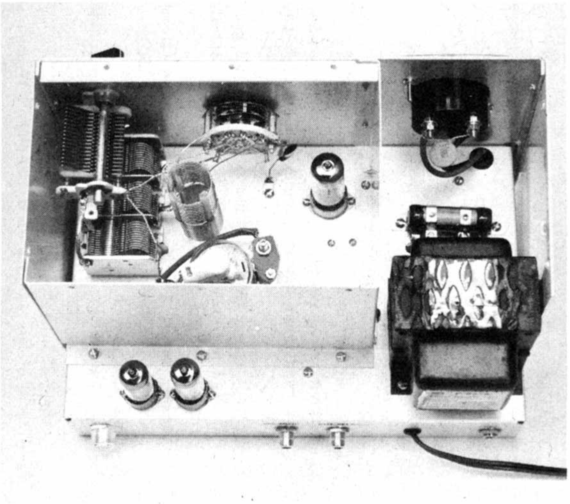


Fig. 6-43—Top view with the perforated metal cover removed. The small capacitor beside the 6146B provides the neutralizing adjustment. L_3 and L_4 are mounted one above the other. The smaller tube inside the rf compartment is the 6GK6 oscillator.

The lead to RFC_4 is routed through an insulated bushing. A small bracket supports a piece of Lucite which insulates C_2, the neutralizing capacitor, from ground. Another bracket supports C_1 and S_2. C_1 is above ground for rf and dc, so an insulated coupling (Millen 39016) is to be used on its shaft. Tie strips are used to support the small capacitors, resistors, and rectifier diodes.

The 5-volt winding of T_1 is not used. Therefore, these leads should be cut and taped to avoid accidental contact with the chassis. The filter capacitors and bleeder resistors are mounted on tie strips. Care should be used in making all high-voltage connections to prevent accidential shorts from occurring. Also, don't omit the "spike prevention" Thyrector diode, CR_5, as this unit protects the supply from transient voltage surges.

Adjustment

After the transmitter has been wired, check it a second time for possible wiring errors. Next, the two voltage-regulator tubes should be plugged in their sockets. With S_1 at off, plug the line cord into a 117-volt outlet. When S_1 is moved to STANDBY, the VR tubes should glow. The high voltage at RFC_4 should measure about 750 volts. The oscillator voltage, checked at pin 7 of the 6GK6, should be close to 300 volts. If it is not, move the tap on R_2 accordingly. *Make all measurements with care as these voltages are dangerous.* Then turn S_1 to off and make certain the voltage drops to zero at RFC_4, and at the 6GK6 socket. Normally, it will take at least a minute for the high voltage to drop to near zero (a fact which should be remembered during subsequent tests).

Remove the line cord from the outlet—*never work on a transmitter unless the ac power is disconnected.* Install the tubes and connect the plate cap to the 6146B. Insert an 80-meter crystal in J_1 and set both band switches to the 80-meter position. Set the FUNCTION switch to the tune position, and plug the power cord into the mains. After the tubes warm up, swing C_1 through its range. If the oscillator stage is working, grid current will be read on M_1. C_1 should be used to peak the grid current. The total current drawn should be kept below 3 mA. Use the DRIVE control, R_1, to set the drive level. Change S_2 to the 40-meter position and confirm that the second harmonic of the crystal frequency can be tuned. With a 40-meter crystal in J_1, it should be possible to obtain grid current with S_2 set for 7, 14, 21 and 28 MHz. The maximum grid current obtainable on the higher-frequency bands will be somewhat less than on 80 and 40 meters (about 2.5 mA on 21 MHz, and 1.5 mA on 28 MHz). The latter value is not enough for full drive on the 10-meter band. The dc input power to the 6146B should be limited to 90 watts on 10 meters, and this operating condition will provide approximately 50 watts output. On the other bands 60 to 70 watts output will be possible. If an absorption wavemeter is available, it is a good idea to check the setting of C_1 for each band to insure that the tuned circuits are operating on the proper harmonic frequency. It may be possible to tune to an incorrect harmonic frequency, *which can lead to out-of-band operation.* Once the proper setting of C_1 has been determined, mark the front panel so that this point can be returned to quickly when tuning up. Lacking a wavemeter, a receiver (with the antenna disconnected) can used to check output on the various bands.

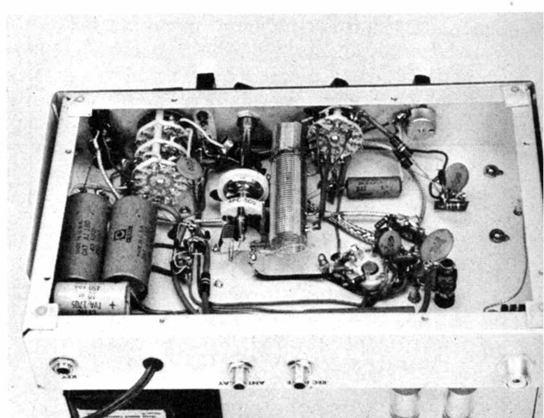


Fig. 6-44—Looking inside the bottom of the transmitter, L_1 and L_2 are located at the center, next to the grid-tuning capacitor. All of the output jacks are spaced along the rear wall of the chassis. The bottom cover has been removed in this photograph. It should be kept in place during operation.

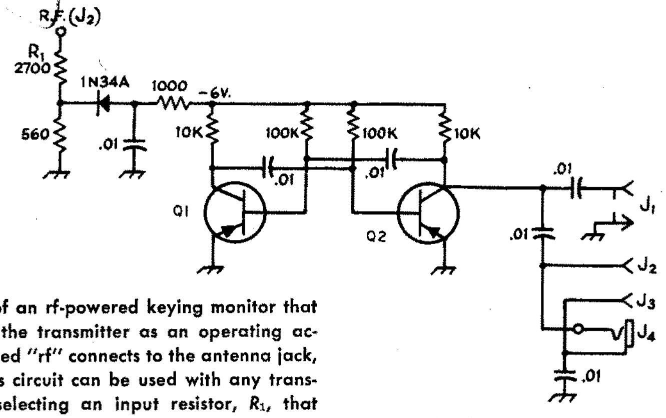


Fig. 6-45—Circuit of an rf-powered keying monitor that may be built into the transmitter as an operating accessory. Point marked "rf" connects to the antenna jack, J_3 in Fig. 6-42. This circuit can be used with any transmitter simply by selecting an input resistor, R_1, that gives about —6 volts at the point shown. Only the desired output jacks need to be included.

J_1—Phono jack for audio output from the receiver.
J_2, J_3—Tip jacks for headphones or receiver.
J_4—Phone jack for headphone connection.
Q_1, Q_2—2N406 or equivalent (pnp).

With S_2 and S_3 set for 15 meters, tune C_1 for maximum grid current. Then, set the indicated value to about 2 mA with the DRIVE control. Set C_4 at half scale, and slowly tune C_3 while watching the grid-current meter. At the point which C_3 tunes the tank through resonance, a dip in grid current will be seen, unless by chance the amplifier is already neutralized. A slow rate of tuning is required, as the indication will be quite sharp. When the dip has been found, adjust C_2 until no dip can be noted, or, at least, the dip is less than 0.1 mA. All preliminary tests should be made as quickly as possible, as the transmitter is operating without a load, and extended operation can damage the final-amplifier tube.

When neutralization has been completed, and all circuits appear to be operating normally, connect a load to the transmitter. Preferably, this should be a 50-ohm dummy load, but a 100-watt light bulb will do. If an output indicator or SWR bridge is available, it should be connected between the transmitter and the load. The lamp is a fair output indicator on its own. Adjust the transmitter as outlined above for 2 mA of grid current on the desired band. With a key plugged in at J_2, set C_4 at full mesh, and switch S_4 to read plate current. Watching the meter, close the key and adjust C_3 for a plate-current dip. The dip indicates resonance. If the plate current dips below 150 mA, decrease the capacitance setting of C_4, and again tune C_3 for a dip. This dip-and-load procedure should be repeated until a plate current of 170 mA is reached at resonance. If the Novice 75-watt input limit is to be observed, the plate current at resonance must be held to 100 mA. This can be accomplished by using additional capacitance at C_4.

If extended operation is planned at 75 watts or less input, it is advisable to reduce the screen voltage on the 6146B to insure that the rated screen dissipation rating of this tube is not exceeded. This can be done by using an OA2 in place of one OB2, jumpering the other VR-tube socket, and readjusting R_2 so that the single VR tube draws about 25 mA. The OA2 will deliver 150 volts, regulated.

A HIGH-OUTPUT TRANSISTOR VFO

If a solid-state VFO is to be used with tube-type transmitters, it must have sufficient output to drive a crystal-oscillator stage as a doubler or tripler. Most of the Novice-class transmitters require 10-25 volts of rf to produce sufficient drive to succeeding stages. The VFO shown in Fig. 6-46 serves as a "crystal replacement" for the type of transmitter that uses a 6GK6, 6AG7, 12BY7 or similar tube in the oscillator. To provide sufficient output level, a two-watt amplifier is added to the basic transistor VFO. To reduce harmonic output and eliminate tuning of the amplifier stage, a fixed-value half-wave tank is used as the output circuit, followed by broadband rf step-up transformers. The VFO will develop 20 volts or more across a 5000- to 50,000-ohm load.

The basic VFO design was originally described in *QST*, June, 1970.

Circuit Data

In the circuit of Fig. 6-48 are two completely separate tuned circuits — one for 3.5 to 4.0 MHz, and one for 7 to 7.35 MHz. A split-stator broadcast-type variable, C_3, is employed so that there is no need to switch a single tuning capacitor from one tuned circuit to the other. Also, the arrangement shown places the tuning-capacitor sections in different parts of the circuit for the two bands. The 7-MHz tuned circuit uses C_{3A} from the junction of the feedback capacitors (C_1 and C_2) to ground. This gives the desired amount of bandspread for 40-meter operation, but, when hooking the 80-meter tuned circuit up the same way, only 200 kHz could be covered with C_{3B}. So, for 3.5 to 3.8-MHz operation, C_{3B} is con-