A New Low-Cost Transmitter

A 75-watt, v.f.o.—controlled rig uses surplus parts to save money and gives excellent performance on 20-80 meters

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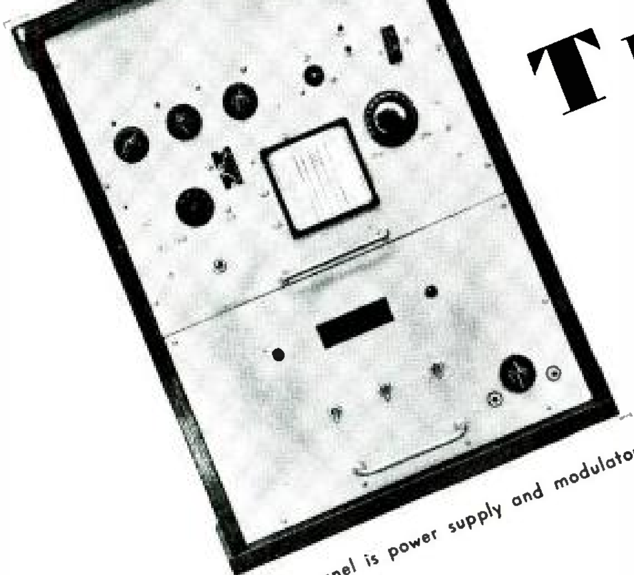


Lower panel is power supply and modulator.

THE woods are full of 75-watt, all-band transmitters using variable-frequency oscillators, but this one should be of special interest to those who don't have too much green stuff left over after paying for the pork chops. It is practically all war-surplus material of straightforward design, with no freak parts. It will do anything any other rig of like power will do and costs from a quarter to a half the usual price to build. The economy feature stems from the current low prices of the components, especially those which are surplus.

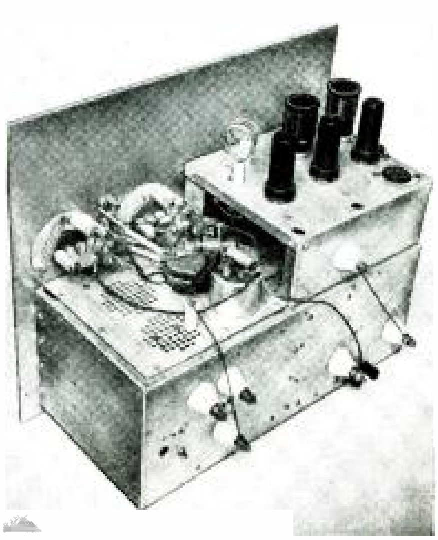
The foundation for the rig is the TU-5-B tuning unit (1500-3000 kc) from a BC-375 transmitter. It is full of the highest-quality parts, all usable. A TU-6-B unit was also bought, its oscillator tuning capacitor being just the right size for the final amplifier tank. The amplifier tuning capacitors in these two units are identical and, with the dials and other parts, make the foundation for a fine antenna tuning unit, using either series or parallel tuning. Another good buy, but not necessary, is the AM26/AIC intercom amplifier. At a low price it provides four needed tubes, sockets, a switch, a mike input transformer, and other small parts. The rest of the components can be purchased individually as needed. Type 1625 tubes are plentiful and very cheap, making a good final amplifier tube if 12 volts for the filament is available. They are the equivalent of 807's, except for their filaments and bases, which have seven prongs instead of the 807's five. They were widely used in military equipment.

Once committed to 12-volt tubes, the logical choice for the exciter stages and the output in the v.f.o. is the 12A6, an audio beam type with the right amount of power for this job. 12A6's are very cheap too. This leaves only the oscillator tube to be chosen, and any r.f. pentode will do—12SJ7, 12SK7, etc. The v.f.o. shown in Fig. 1 uses a 12C8 because the author happened to have one handy.

One way to get 12 volts for the filaments is to use two husky combination power transformers for plate and filament supply and hook the 6-volt windings in series. Depending upon the transformers, the high-voltage windings may be used in series or in parallel to obtain the required 600 to 750 volts at 250 ma. This will take care of the modulator current requirements also. Surplus transformers are usually conservatively rated. If the rig is not to be modulated, about 110 ma will be sufficient.

In the rig shown, a 12-volt filament transformer of the type now being marketed as surplus equipment is used to heat the tubes. A separate receiver-type power supply is used for the v.f.o. and doublers. From 250 to 300 volts is right for the 12A6's. The VR-150 which regulates the 150 volts applied to the v.f.o. is necessary because the current drain on this power supply varies widely as doublers are switched into or out of the circuit. The maximum current drain is just under 110 ma with all circuits at resonance and loaded to the correct point.

In the front-panel photograph the three pointer knobs in a row at the upper left tune the 12A6 amplifier-doubler stages (Fig. 1). Below these is the dial for the v.f.o. At the upper right are the band-change switch and the closed-circuit meter jacks in the



Transmitter is built on converted TU-5 base.

grid and cathode circuits of the final amplifier. Below the jacks is the tuning dial for the final tank circuit. In the bottom panel at the right are the microphone input jacks and speech gain control. The left panel light shows green when the small power supply is turned on, and the right panel light contains a 500-ma dial lamp which is in the high-voltage center-tap lead of the power supply and serves as a fuse for the plate circuit. It glows at about half brilliance with the rig turned on and modulated.

Construction

The v.f.o. is constructed entirely within the left-hand compartment of the TU-5-B tuning unit case, using the original dial, capacitor, and coil. This coil (L1 in Fig. 1) has a number of taps fastened to the wire. All connections are unsoldered from these taps and the coil is left in place undisturbed, with new connections made to one end, to the tap located five turns from that end, and to the tap 19 turns from that end. The other end floats, with no connection at all.

A row of fixed mica capacitors with temperature-compensating plates is located under the tuning capacitor. The two nearest the rear, plainly marked .00003 and .0001, are left in place, and all the others are removed. This fixed capacitance, using the 19 turns of the coil, gives just the right amount of coverage on the tuning capacitor, with the 80-meter band taking up about 2,000 of the 2,500 divisions on the vernier dial.

There is plenty of room to mount the tubes and small parts, the main idea being to keep heat away from the coil and other frequency-determining components. The only definite precaution that must be observed is to use dissimilar r.f. chokes RFC1 and 2 in the v.f.o. The tuning units contain two each. One, with resistor attached, is needed for the final grid circuit—RFC3-R1. One, but only one, of the other chokes can be used in the v.f.o. If two are used, the 12A6 amplifier will take off by itself all over the dial. An additional r.f.c. of a different type must be obtained. The common pie-wound, 2.5-mh type is excellent. A liberal slurping with Duco cement after the wiring is completed will hold the leads rigidly in place.

As the rear-view photograph shows, the amplifier-doubler stages are built on an additional chassis mounted atop the tuning unit, on the left side directly above the v.f.o. The ventilated cover plate separates and shields the two sections. The output of the v.f.o. is fed through switch S1 into the first tuned stage, which serves either as a straight amplifier on 80, a doubler to 40, or a crystal oscillator (by opening the switch and plugging a crystal into the socket). This crystal feature was included in the original design and so is shown here, but could very well be eliminated, switch and all; it has never been used by the author except for testing, the v.f.o. being so satisfactory for use under almost any set of conditions.

The doubler stages are conventional, using plug-in coils, except for the last one, with its 28-mc output, where the coil is fixed. Three plug-in coils are needed, one each for 80, 40, and 20 meters, with a maximum of two in use at any time.

L2 and L3 are wound on 1¼-inch forms. The 80-meter coil is 30 turns; the 40-meter, 14 turns; and the 20-meter, 7 turns. L4 is a permanent 10-meter coil made of 4 turns of heavy wire or tubing, self-supported, 1 inch in diameter. The final uses 75-watt plug-in coils with end links, one being necessary for each band, 20, 40, and 80 meters.

Any combination of doubling or quadrupling seems to work equally well, as the 12A6's provide ample drive. The output tube always works as a straight amplifier. The v.f.o. output will not drive the final directly, so the first exciter tube is always used, with an 80-meter coil for 80-meter output. Series plate feed is used, with the tuning capacitors insulated from the chassis. Hardwood ¼-inch dowel makes an effective insulated shaft for these capacitors.

The right-hand compartment of the tuning unit contains the output circuit of the final stage. The 1625 hangs upside down in a socket mounted high enough above the tuning unit's ventilated cover so that half the tube projects through the cover into the compartment, with the tuning and bypass capacitors and the 75-watt plug-in coil

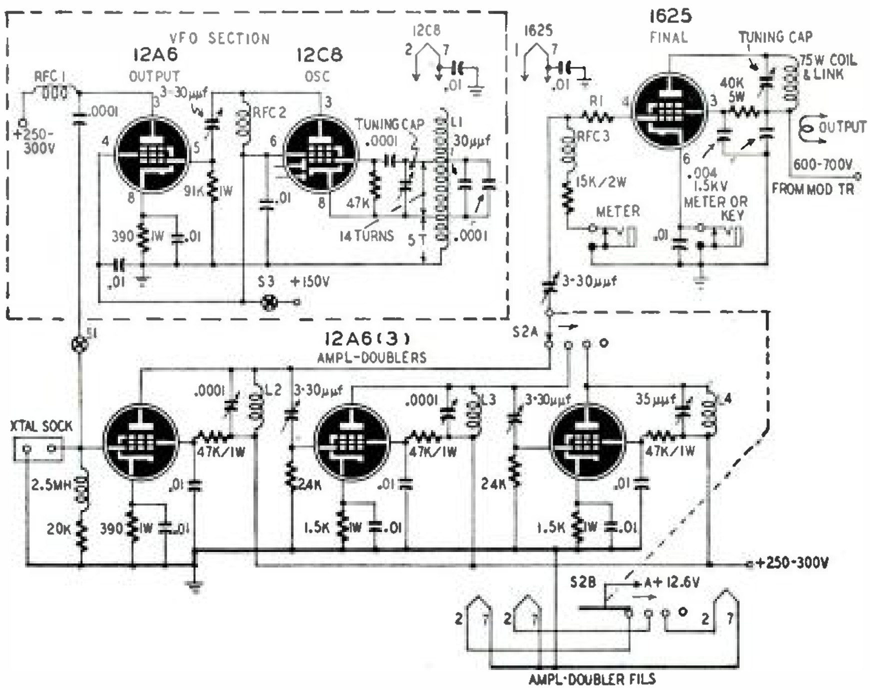
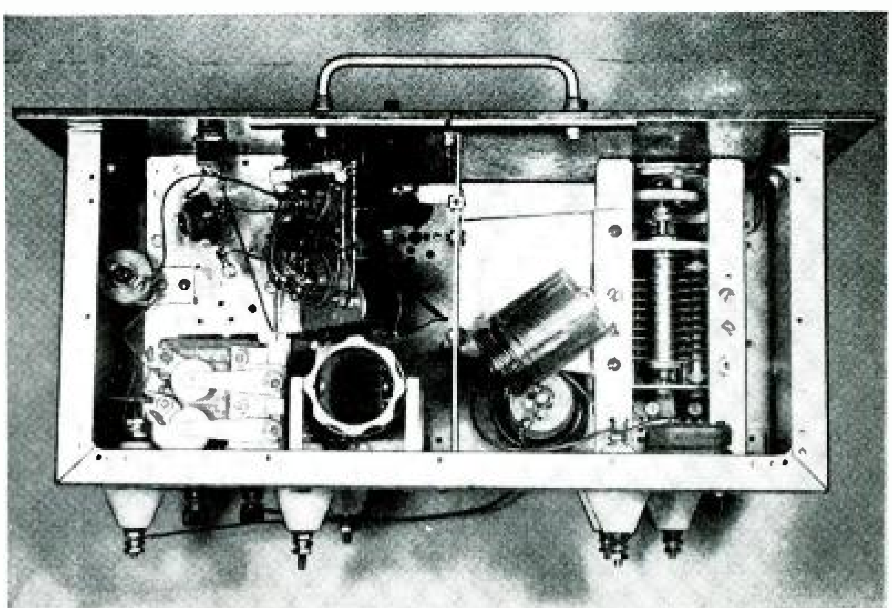


Fig. 1—The r.f. section. S2 is a special switch found in the TU-5-B. It must be modified.



Under-chassis view of completed r.f. section shows 1625 mounted upside down, right center.

inside. This arrangement permits short leads and provides thorough shielding, resulting in a perfectly stable amplifier. The coil plugs in from the bottom of the set (this seems awkward but actually has not proved to be so). For coil changing, the transmitter slides forward like a drawer. It takes no longer to pull downward than upward to remove a coil. A suitable hole is cut in the bottom plate. The link output is at the two close-spaced feedthroughs at the rear. The tuning capacitor was taken from the left compartment of the TU-6-B and fits perfectly in place. The 1625 tube socket shown was sawed out of the BC-456-B modulator unit in the 274-N series. (There is no less painful method of removing it.)

The band-change switch S2 taken from the tuning unit is modified slightly by making a shorter arm, using the original for a pattern, to connect the two sections so they will fit side by side on the right half of the panel. Just enough space is left between them to mount the grid and cathode meter jacks. The switch section nearest the edge (S2-b) is used as is, turning on the filaments as the doublers are connected into the circuit. The other section (S2-a) is altered to a tap switch, instead of the shorting type, by breaking off all but one of the rotor contacts, which selects the output of the proper doubler as required. The contacts snap off readily with a twist of the pliers.

The rig is keyed by plugging the key into the final cathode jack. For tuning, a meter with at least a 0-150-ma range plugs into the same jack. The capacitor bypassing this jack must be able to withstand the full plate voltage when the circuit is open (with the key up). The oscillator runs continuously and is no bother except when working a station directly on one's own frequency. Then it may be turned off while receiving, by the switch S3 mounted below its tuning dial.

The doublers are tuned by watching for maximum grid current on a meter inserted in the final grid jack. Doubler tuning is not critical and ordinarily need not be touched when shifting frequency within a band. It is necessary only to set the oscillator on the desired frequency, guided by the calibration chart on the panel, and then tune the final for cathode-current dip. A minimum of 6 to 8 grid ma is available, which is approximately twice the rated requirement. High-sensitivity beam tubes like the 1625 can be damaged by too much grid drive. A little detuning of the doubler stages will eliminate this possibility.

The modulator

The entirely conventional modulator circuit (Fig. 2) also uses 12-volt tubes. Most modulators in this power range terminate in 6L6's. It seemed reasonable that a 1625 will do anything a 6L6 will do, and perhaps do it better. Experience has proved this to be true. The 1625 is capable of much greater output than is necessary with this transmitter, and several 1625's cost less than one 6L6.

To avoid wasteful excess power input, the screen voltage is reduced through a dropping resistor to only 275. The original model uses a 12-watt potentiometer (surplus) to accomplish this, but any adjustable resistor of 10 watts or more and 20,000 ohms will do. At this screen voltage the plate input to the two tubes is about 120 ma when idling. A 12SJ7 and 12J5 provide adequate sensitivity for a crystal or dynamic mike.

A small PM dynamic speaker makes a good microphone. The original model also will accommodate a T-17 carbon mike, which is adequate and eliminates the need for the 12SJ7, at a slight decrease in tone quality. Using either mike, the gain control adjusts the output power for the correct modulation. If only the carbon mike is used, the entire 12SJ7 circuit may be eliminated; if the dynamic mike is used, then the microphone input transformer and battery are not needed. The battery is three flashlight cells wired in series. The built-in switch on the T-17 mike shuts off the battery current when not in use. If the modulator is turned off only by the filament switch and plate voltage remains on, then C1, C2, and C3 must be able to withstand the full plate voltage, as there will be no voltage drop in the resistors when the tubes are not drawing current.

There are a number of small surplus modulation transformers that are suitable for use in this transmitter. One of these, used in some ARC-5 transmitters, was designed to match class AB 1625's or 807's to a single-ended r.f. amplifier using a pentode or beam-power amplifier tube. This transformer has three secondary windings. One modulates the plate and another the screen grid of the r.f. amplifier. The third is a low-impedance winding used for monitoring the output of the modulator. The screen grid of the 1625 must be fed from a 300-volt supply with this transformer.

The mechanical work is not difficult. The tuning units and most other surplus equipment is made of aluminum. A small Allen wrench is needed for the setscrews. It is useless to try, as the author did, to pull and pry a knob off after loosening one setscrew; there are always two of them. The panel of the r.f. section measures 17 inches wide by 14 inches high, with an additional 9 inches of height in the lower panel, which covers the power supply and modulator. For stability in the v.f.o. the panel must be rigid. A sheet of Presdwood or Masonite ⅛ inch thick with a very thin galvanized sheet-steel backing meets all requirements and is easily worked. The two sheets can be glued into a sandwich with Miracle adhesive, available in dime stores. This forms a panel which may be pushed, twisted, or thumped upon without any effect whatever upon the oscillator. All the preliminary construction can be done with the original panel in place, and any necessary new holes drilled in it. It is then a simple matter to use it as a template in marking out the new panel, eliminating measurements or mistakes upon the latter.

Operation

When finished, this rig won't drown out the 900 watts in the next block or the next town. But even on the 75-meter phone band there is generally room between a couple of big ones to sneak a signal through. On the higher frequencies, particularly 10 meters, results are very good indeed, with plenty of dx. Even higher-frequency operation might be possible by doubling in the output circuit. The v.f.o. and the various doubler combinations provide maximum flexibility; the rig can be quickly set to any amateur frequency up through the 10-meter band—and when so set, it stays there. After the first initial heating of the tubes, there is no detectable drift. On c.w. the note is always given a 9X tone report and is assumed to be crystal-controlled. Results of phone operation are also excellent, with complimentary reports received. The whole unit makes a very satisfactory transmitter from any angle.

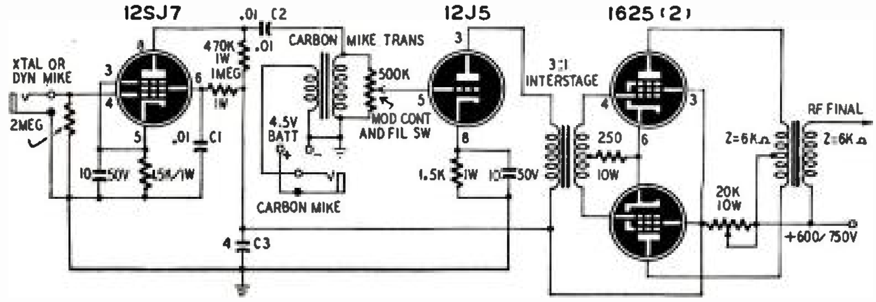


Fig. 2—This modulator is designed for carbon or crystal microphones. Be sure to ground the junction of the 250-ohm cathode resistor and the center tap of the interstage transformer.

MATERIALS FOR TRANSMITTER

Resistors: 1—20,000, 2—24,000, 1—47,000 ohms, 1—2 megohms, ½ watt; 2—390, 4—1,500, 3—47,000, 1—91,000, 1—470,000 ohms, 1—1 megohm, 1 watt; 1—15,000 ohms, 2 watts; 1—40,000 ohms, 5 watts; 1—250 ohms, 1—20,000 ohms, adjustable, 10 watts; 1—500,000-ohm potentiometer with switch.

Capacitors: 1—100 μμf, mica; 2—10 μf, 50 volts, electrolytic; 11—.01 uf, 600 volts, paper; 1—.01, 1—4 μf, 1,000 volts, paper; 1—.004 μf, 1,500 volts, mica; 4—3-30 μμf trimmers; 1—35, 2—100 μμf, variable.

Tubes: 4—12A6, 1—12J5, 1—12SJ7, 3—1625, 1—12C8.

Miscellaneous: 1—TU-5-B; 7—octal, 3—7-prong tube sockets; 2—s.p.s.t. toggle switches; 1—2.5-mh r.f. choke; 1—carbon microphone to grid, 1—3-1 ratio interstage audio, 1—6,000-to 6,000-ohm modulation transformers; power supplies; 1-TU-6-B; necessary insulators, hardware, etc.