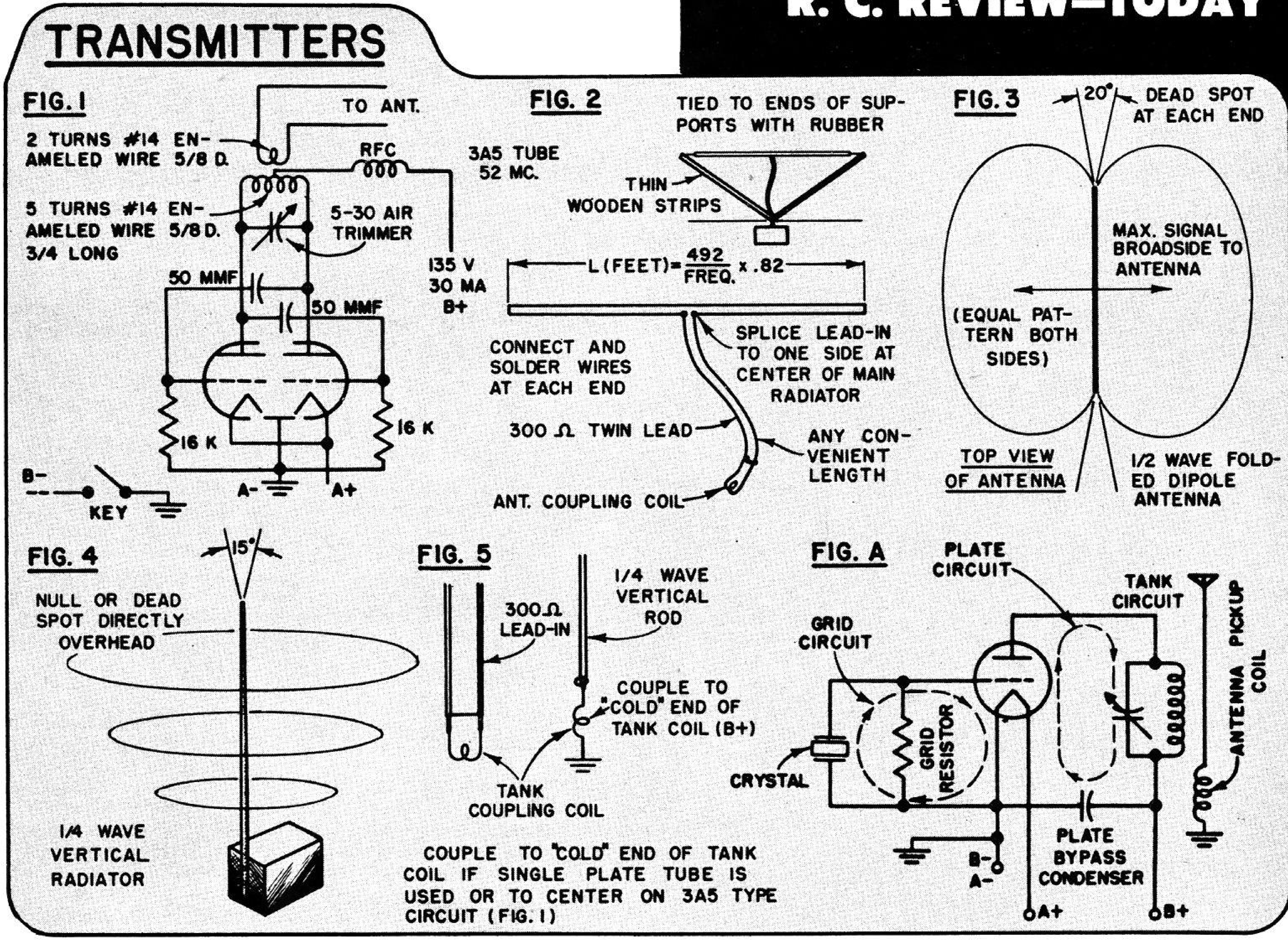
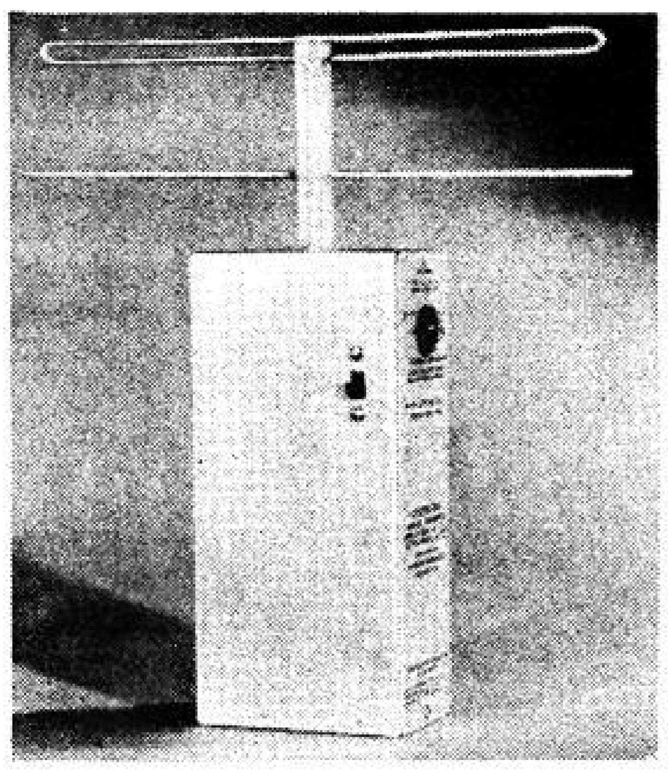
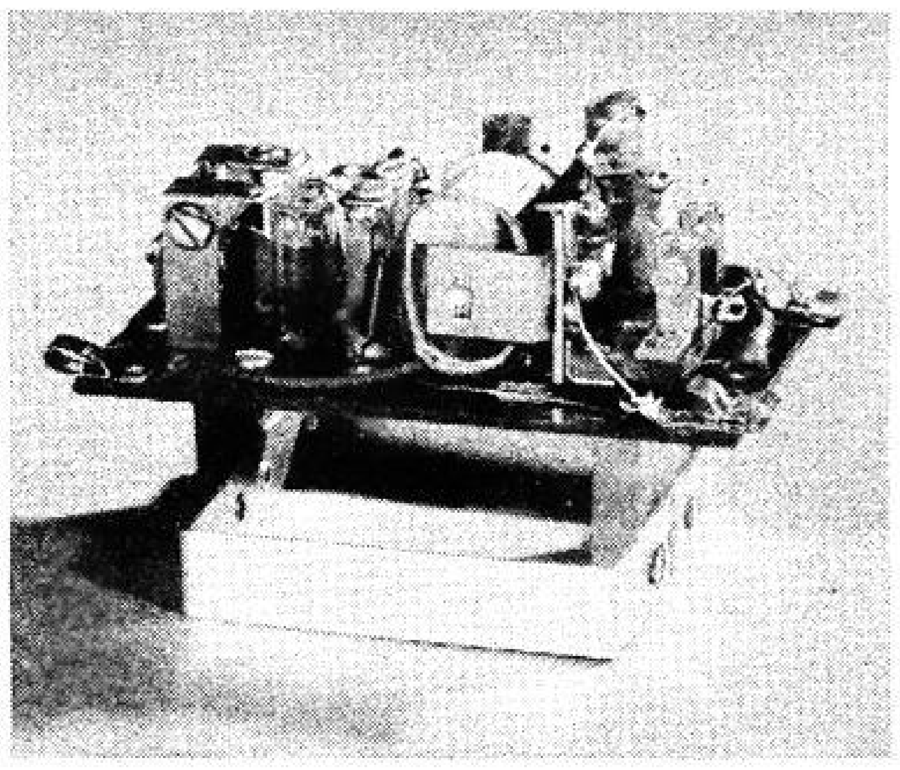






First license-free radio, MacNabb X-mitter, left; and receiver, right.

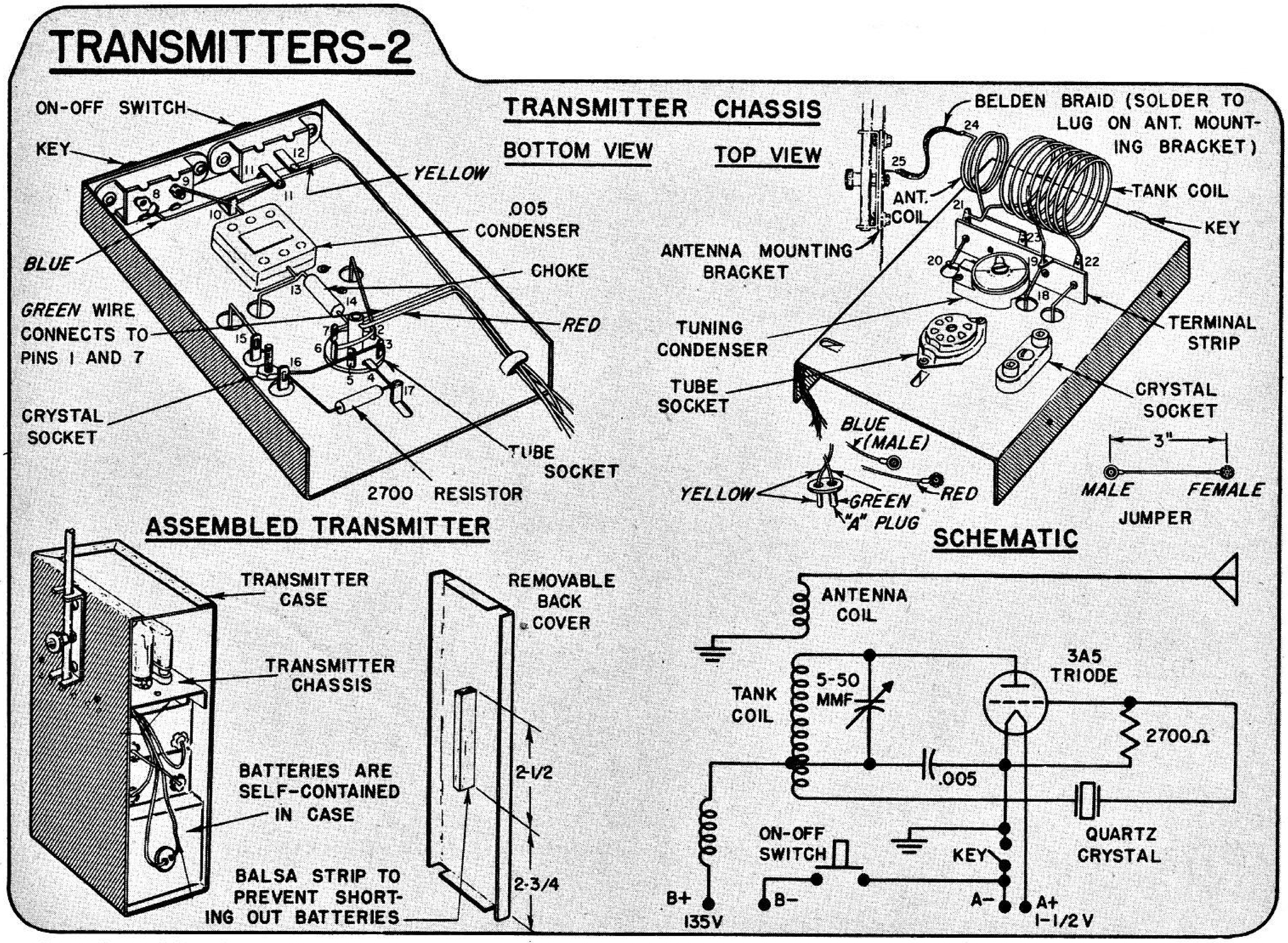
TRANSMITTERS

This crystal-clear, on-the-beam discussion of antennas, folded dipole and vertical, goes a long way to dissipate the mysteries of transmitter operation. There's a cargo job load of valuable tips for the beginner, explanation of wave patterns, tubes, tuning, and a rundown on a crystal control X-mitter.

In the early days of radio control, the transmitter was usually a multi-tube unit with a power output of from five to ten watts. Present day transmitters are practically all one-tube units with a power output of from one to two watts. The sensitivity of the Hivac and RK-61 tubes for receiver use made this low power for transmitters possible. Figure 1 shows the circuit for the type of transmitter most commonly used for operation on 52mc (not license-free).

Practically every large contest held during the past five years has been won with a transmitter having a power output of less than two watts, which is easily furnished by battery supply. If the transmitter is putting out about 1½ watts, the antenna efficient, and the receiver properly tuned, this is sufficient for reliable operation, Remember that the average five foot model is practically out of sight at a distance on one-half mile. In order to double the distance covered by a given power output, the power must be squared. For example, if three watts are used to operate a receiver at a distance of one-half mile range, nine watts would be needed to obtain the same results at one mile range.

Inasmuch as the modeler will buy either a ready-built transmitter, a kit from a reliable manufacturer, or build one himself from reliable plans, the antenna is the one item which he may change or try to make more portable. Therefore, a word about antennas, how their length is determined, and their characteristics. On practically all transmitters in use on 52mc, the half-wave folded dipole antenna is employed, due to its excellent loading and radiating characteristics. It is, however, a little large for the new 27.255mc frequency. The formula for calculating the length of such an antenna is: Length in feet equals $\frac{492}{\text{fqcy in megs.}}$



Parts of typical hand-held transmitter. Such units vary widely and this one is shown only to familiarize the reader with sample parts arrangement.

times .82. It is constructed of 300 ohm twin lead, as per Figure 2. Most antennas used for model radio control work have dead spots or nulls, areas of little or no signal. The radiation pattern of the folded dipole antenna is shown in Figure 3 and the null effects from the ends are most noticeable at a distance in excess of 500 to 800 feet. When this type antenna is used, it should be turned broadside to the model so that the maximum signal is directed toward the model. A half-wave dipole should be supported by a light wood frame and may be given a shallow "V" shape. This eliminates dead spots near the horizon. Figure 2 shows how the half-wave folded dipole antenna may be constructed to take up less space and be more portable.

If desired, the modeler may use a vertical antenna, which has a concentric radiation pattern. This eliminates all nulls in a horizontal plane, although a dead spot will be had overhead (see Figure 4). When a plane is flying overhead and a vertical antenna is employed, tipping the antenna mount so that the tip is about 30 to 40 degrees away from the plane will overcome this difficulty. The formula for determining the length of a vertical antenna is: Length in feet equals $\frac{246}{\text{fqcy in megacycles}}$ times .98. This is for a quarter-wave vertical "auto" type antenna. If desired, 300 ohm twin lead may be used, the same formula applying except that the first section is multiplied by .82 instead of .98. A strip of wood may be used for support. Figure 5 indicates the accepted method of coupling, or bringing the antenna coil near the end of the tank coil, when using either twin lead wires or a quarter-wave vertical rod.

The basic principle of loading an antenna for maximum efficiency is coupling the antenna coil to the tank circuit so that a maximum transfer of energy is accompuished. Using the correct range meter, usually 0-50ma DC, inserted in the "B-plus" lead, this transfer of energy can be noted; the DC plate current rises as the coupling between the antenna coil and the tank coil is increased. With a crystal-controlled transmitter the DC plate current is minimum, from five to fifteen milliamperes, when the set is tuned to resonance. As the antenna coupling is increased, this current should rise to the maximum value permitted for the type of tube used. When this point has been reached, the tuning condenser is adjusted to give a minimum reading again, of just a few mils under the maximum. For those familiar with radio theory, this information can be obtained from tube charts, but the novice radio model builder will do best to follow explicitly the directions given with the equipment he is building.

Since we are limited to a power input to the final tube of the transmitter on 27.255mc, a careful choice of tubes is essential. Tubes are made either with a directly heated emitter (for sending electrons toward the plate), such as filament types, or with a cathode heater, where an oxide-coated sleeve heated by a filament is used for the emitter. Generally, for our use, the filament type tubes have a one and a half or three volt filament drawing 100 to 220 milliamperes from the supply battery. The plate voltage is usually between 135 and 180 volts with a current of 15 to 30ma. The power output of the tube is primarily determined by the power emission characteristics of the filament itself. Cathode type tubes operate with a heater voltage of six volts on up to 117 volts and draw from 100 to 800ma. As you can see, the power consumed by a cathode tube in the filament circuit is much more than that consumed by a filament tube. With batteries (Continued on page 53)

R. C. Transmitters

(Continued from page 23)

as the source of supply, the filament type tube is most commonly used. The Burgess type 4F battery is popular for this work. If a cathode tube is used, six volts must be supplied and the battery must be capable of supplying the necessary current. One, or preferably two, Burgess type F4P1 batteries in parallel should be used. The author's experimental work on 27mc indicates the 3A4 to be the most suitable tube. The 3A5, 3B7, or 3D6 also may be used, depending upon the circuit. In the cathode type, the 6C4 and 6AK6 were found to be satisfactory. The power output of a transmitter may vary with the particular tube used, even though it be of the same type. Frequency also may change slightly. The frequency may be adjusted correctly by means of the tuning condenser, but power output can be changed only by trying other tubes. The 3A5 and 3B7 tubes as used in 52mc transmitters, often had an output varying as much as 50 per cent between tubes.

In the past few years, the trend has been toward building the transmitter unit into a case which is large enough to contain also the needed batteries. This, allows the transmitter to be placed on the ground and due to its weight, may be used as a support for the antenna. A six to ten foot two-wire cable is brought out from the box and terminated in a keying switch. This arrangement allows greater freedom of movement. Although favored by some of the more experienced model builders, a hand-held battery-contained transmitter is apt to be on the heavy side and if an extra length antenna is used it may be unwieldy.

It is advisable to build a meter into the transmitter box to assure the modeler at all times that the unit is properly tuned. If, in a crystal transmitter, the circuit is allowed to become detuned, off resonance, the crystal and tube may be damaged and batteries may run down.

Following is a typical crystal circuit which we shall use to explain the operation of a crystal transmitter. Figure A is a simple crystal oscillator. In order for a tube to become an oscillator and furnish power into the tank circuit, it is necessary that a small amount of the power circulating in the tank circuit be fed back to the grid circuit. The grid circuit (input of the tube), the tube itself, and the tank circuit (output of the tube), are similar to a circulating water pump system. As long as the output of the pump is fed through the external piping, back to the input of the pump, fluid will flow and we have a circulating action. In a tube circuit, current flows from the filament to the plate, through the tank circuit and back to the battery or power supply. Part of this current, in passing the grid of the tube, sets up a circulating current in the grid circuit, in which the crystal is placed. A voltage placed on the crystal will cause it to vibrate. The frequency of vibration is dependent upon the thickness of the quartz crystal. These vibrations, being in the grid circuit, will affect the circulating currents in the plate circuit, since the path from filament to grid is also common to the plate. Thus the plate current has vibrations or oscillating currents set up in it. The tank circuit, consisting of the tuning condenser and coil, is then adjusted to resonate at this frequency. The bypass condenser is used to channel the RF currents past the battery and back to the filament. There are various crystal oscillating circuits for radio control use, employing various methods of feedback. Different circuits are used because crystals vary in the amount of feedback needed to make them oscillate properly.