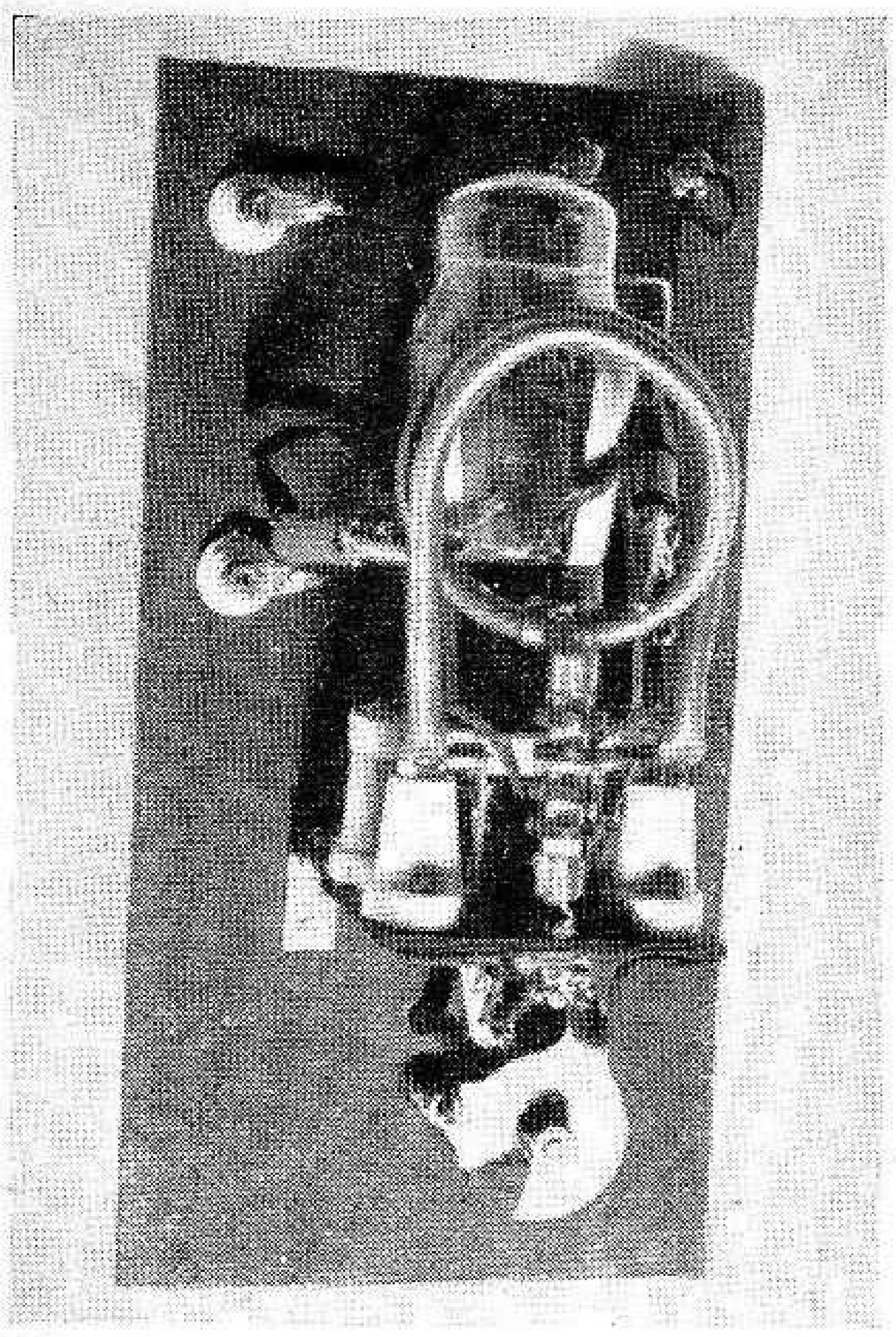
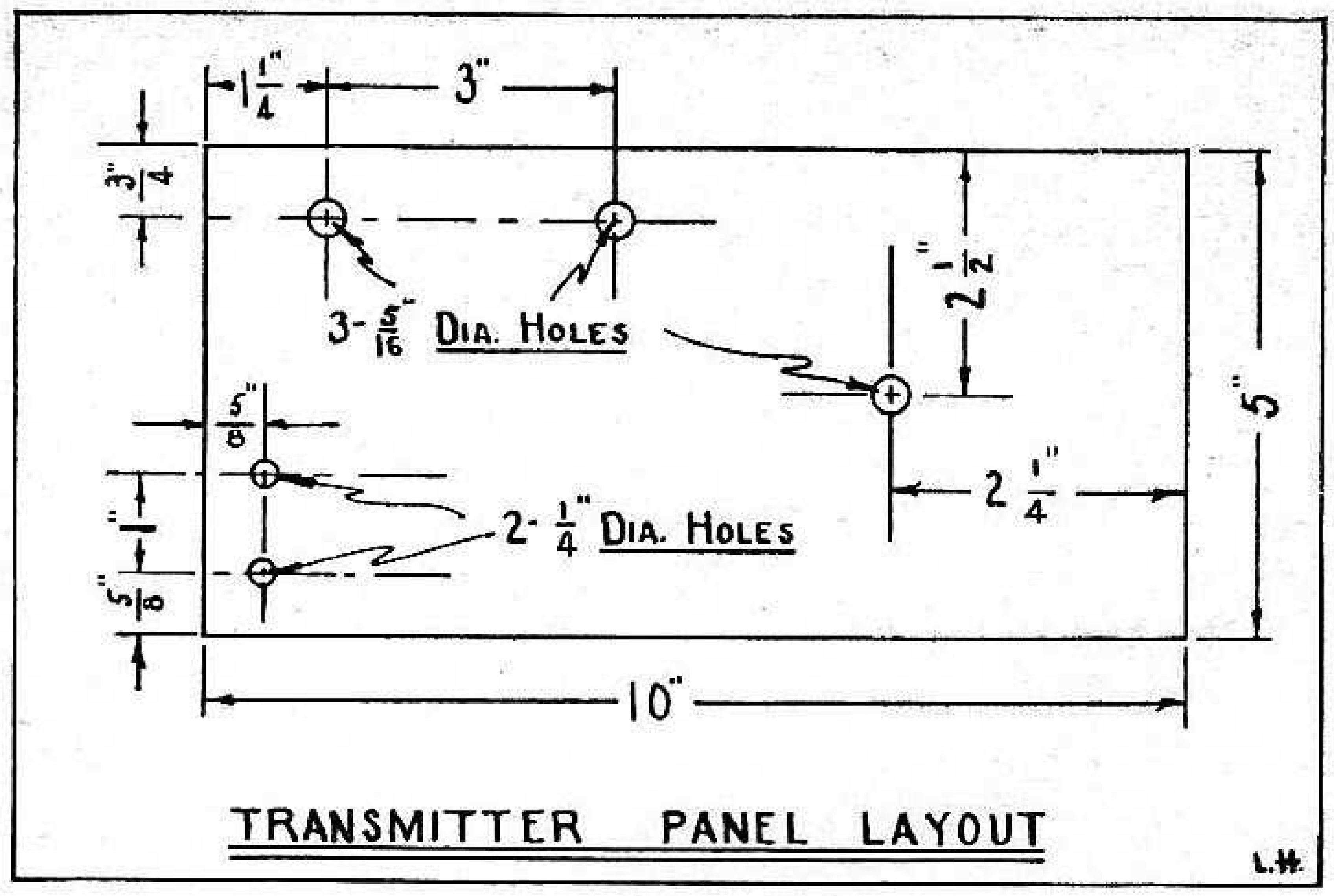


Fig. 1

Left—top, Fig. 1, rear view of unity coupled transmitter; center, Fig. 2, front view of radio control transmitter; bottom, Fig. 3, atuned plate tuned grid oscillator. Right, Fig. 4

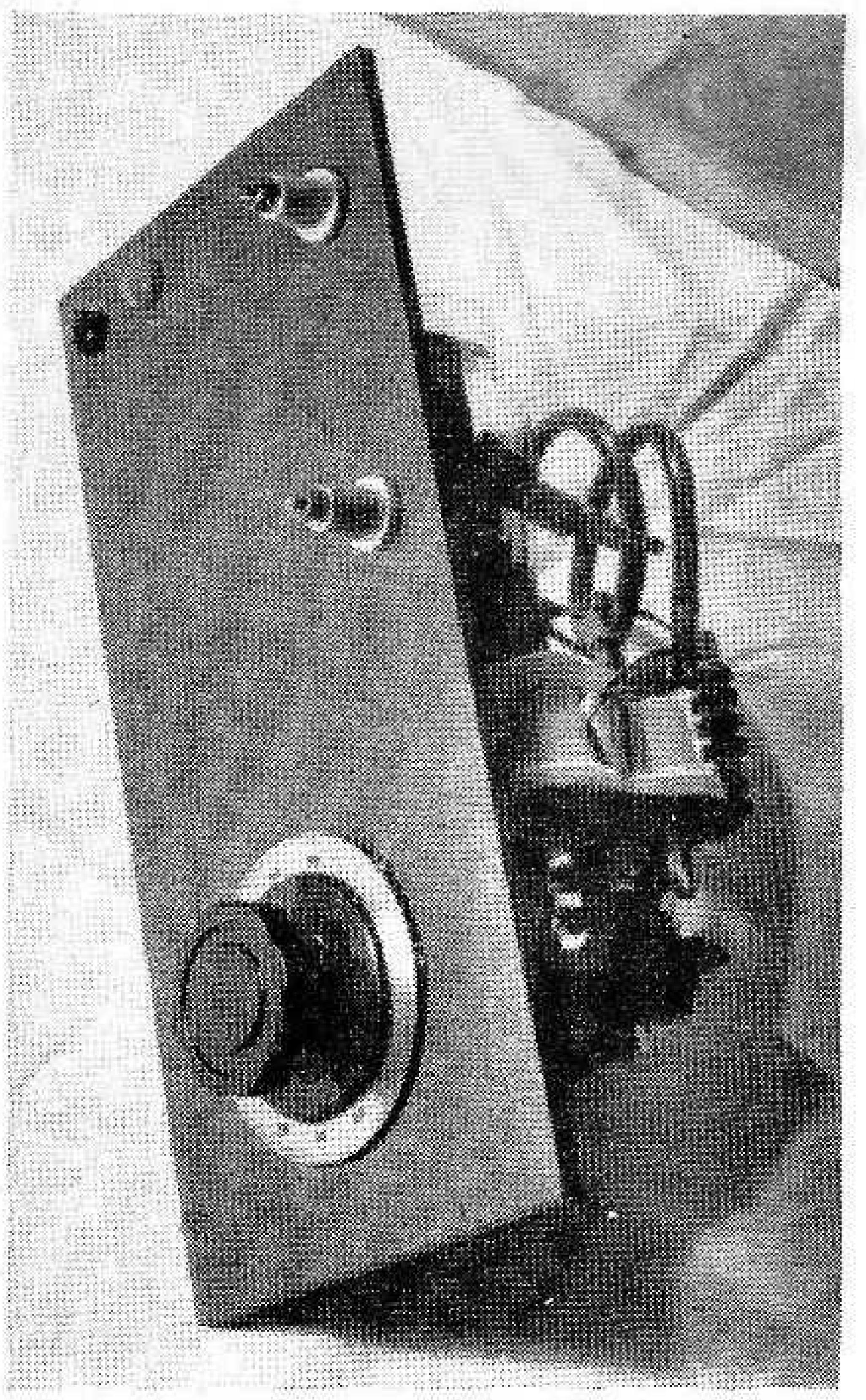


RADIO REMOTE CONTROL

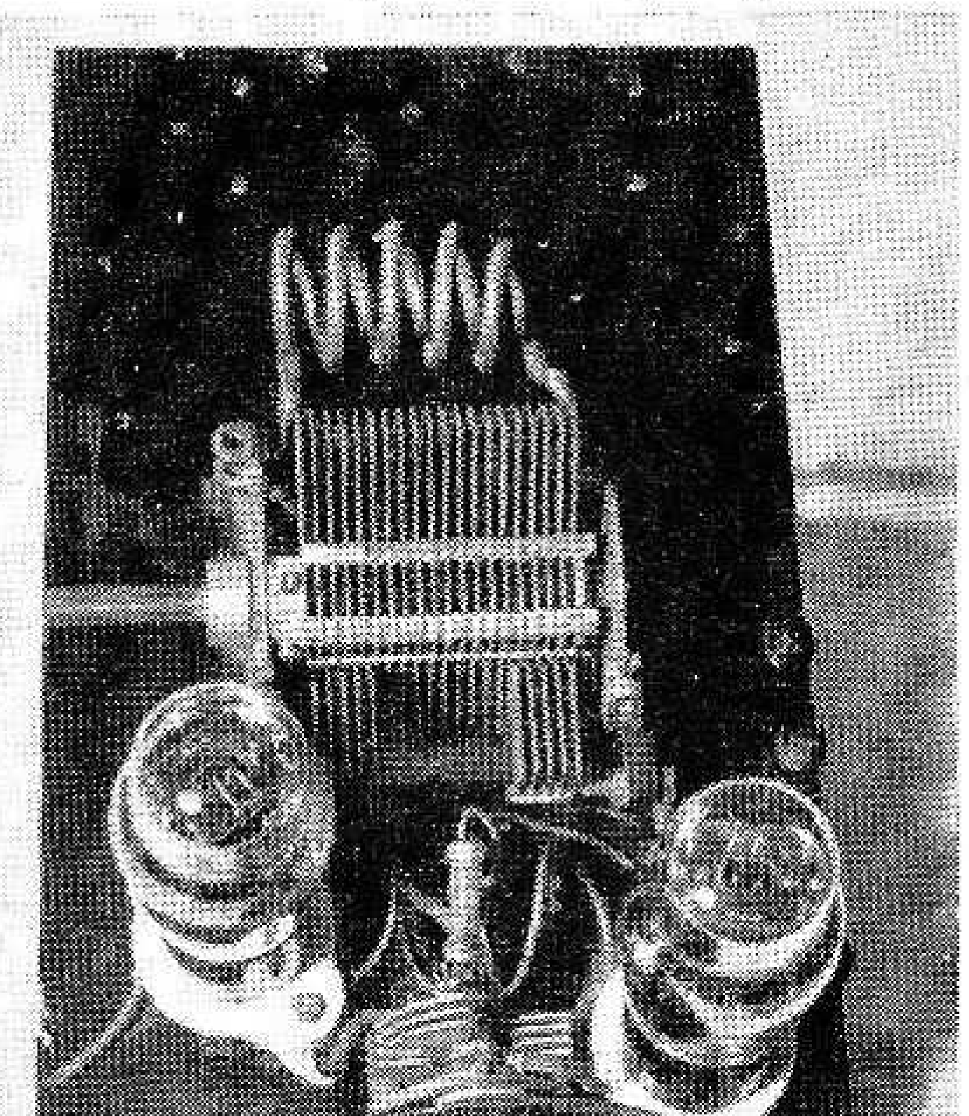
How various types of radio control transmitters are built and operated

by LEON HILLMAN

A HALT has been called on all radio controlled model airplane flights! This is a result of the ban on the use of radio transmitters imposed upon licensed radio amateurs. A challenge has been offered to work under handicapped conditions. It is now the duty of every model airplane technician and radio amateur interested in radio remote control not to throw up his hands, but continue to experiment, study and train so as to contribute his knowledge for the war effort when called upon. Knowledge of radio is a necessity for pilots and aeronautical men and constitute part of the training given to our country's flying personnel.



Above, Fig. 2; below, Fig. 3



There remains much work to be done: such as efficient and light mechanisms to operate control surfaces, motor speed control devices and numerous necessities for successful radio control. It is the purpose of this article to describe types and principles of operation of radio control transmitters and how they are built, that basic information concerning radio transmission will be part of the background of the growing specialized group of radio control technicians versed in aeronautics and radio.

Fundamentally a transmitter consists of: an oscillator to generate high frequency oscillation (in effect the radio signal), a power supply for the necessary current to operate the transmitter, and perhaps one or more radio frequency amplifier stages to strengthen the signal generated by the oscillator or change the oscillator frequency. An antenna is always necessary to radiate the generated radio signal. In transmitters for audio (sound) transmission and for some types of radio control apparatus based on the transmission of tone, a modulator is used to vary the radio signal in accordance with the audio signal to be transmitted. Since a model airplane radio control system requires easily portable and simple gear, the use of radio frequency amplifiers and modulators will be eliminated from the equipment design.

To select the type of transmitter circuit for radio control, several important accepted characteristics of different transmitter circuits must be analyzed. These considerations are: transmitter frequency, stability and power output.

Concerning operation wavelength of radio control transmitters there has been little dispute in acknowledging the use of ultra high frequency bands, usually the five meter amateur band. This is so because of the limited size of the parts that can be used in both receiver and transmitter, short antenna necessary for efficient operation, and minimum power necessary for coverage without interference, for model flights. Although fixed figures cannot be set for the power required for coverage—as so much depends on the local conditions such as height of antenna and surrounding terrain—nevertheless transmitter power necessary for ordinary coverage of model flights up to one-half mile, for reliable performance, should be at least two watts output. In some instances good results have been obtained with as little as one-quarter watt.

This assumes of course, in all cases, a reasonably sensitive receiver with efficient transmitting and receiving antennae. For successful coverage up to two miles, at least fifteen watts output power is desirable. Over two miles, to about ten miles, at least forty watts output power is required for consistent results. These figures have been obtained after extensive tests on the 56 megacycle (5 meter) amateur band with various transmitters and receivers at different altitudes using efficient antennae. The corresponding power input can be figured assuming the efficiency of transmitters at this frequency to be about sixty-five percent.

Frequency stability is the closeness to

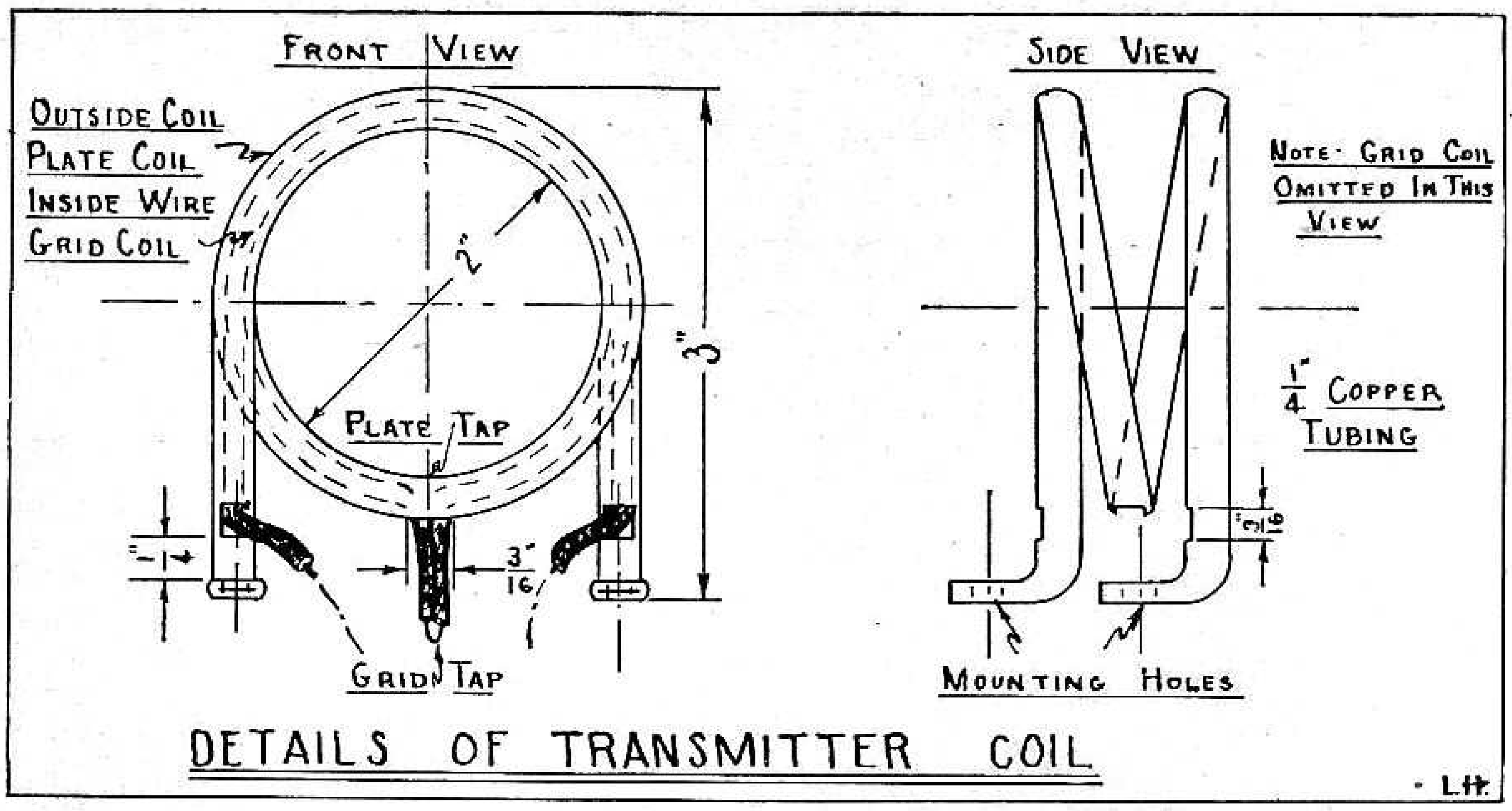


Fig. 5

which the transmitter adheres to its tuned frequency. In considering the frequency stability of the transmitter necessary, account should be taken of the stability of the receiver as well. Since radio control receivers usually tune very broad, it is a false notion to assume that an extremely high stable transmitter is necessary. However, highest possible stability without sacrifice should be attained, made possible by good mechanical design and circuit selection.

Of the basic types of transmitter oscillator circuits, most common are the Hartley, tuned-not-tuned, tuned-plate-tuned grid, electron coupled and crytal oscillator. The crystal oscillator—so named because it utilizes a specially ground quartz crystal as its frequency control—is highly stable but capable only of low output. Also, it cannot directly generate a 56 megacycle signal, and frequency multiplying stages are necessary. The other types of oscillators are known as self-excited oscillators. Of the self-excited type the electron-coupled is most stable but is a poor ultra-high frequency oscillator. The remaining types are capable of the greatest output, and although stability is not great the use of two tubes in the oscillator circuit to form what is known as a push-pull oscillator provides greatly improved stability.

The transmitter whose construction will be described is a type of Hartley oscillator in push-pull circuit. This combination provides the desirable power output and frequency stability. To further increase stability, a special type of coil is used to create unity coupling between the grid and plate circuit. For this reason this type of oscillator is usually referred to as "unity coupled oscillator." To eliminate use of two tubes and still provide a push-pull circuit, a tube type is selected that contains two tube elements constructed in one glass envelope. The result is a one-tube oscillator-transmitter providing power output of two tubes and stability of the push-pull unity coupled circuit.

Power output is determined by power input and the efficiency of the oscillator. Naturally, greater efficiency means greater output, hence every effort is made to limit losses. Power input is determined by the type of tube selected for oscillator circuit, and power may be supplied from either batteries, vibrapack, genemotor or alternating current-rectifier-filter power supply. The unity coupled oscillator can be operated with any of these power sources and can be changed from one to the other with only slight modifications in the oscillator. For example, the unit can be built for low power battery operation and later the power stepped up by changing the tube type and using a rectifier filter power supply.

Because of the few parts necessary the oscillator costs only a few dollars and is easy to build and wire; but in laying it out several points must be kept in mind. It is important that the length of all the leads (wires) be kept as short as possible, especially those of the grid and plate circuits. It is also desirable to arrange everything mechanical as symmetrically as possible. That is, if one grid lead is one inch long, the other grid lead should be one inch long. This becomes apparent when actually laying out the parts. A view of Fig. 1 shows a suitable arrangement of the components.

Bus bar wire (size No. 14) has been used for grid and plate connections to insure low resistance, mechanically solid leads. The panel is masonite; layout is shown in Fig. 4. Note in Fig. 2 that the tuning condenser is not mounted directly on the panel but on a separate bracket located some distance behind the panel. The shaft of the variable condenser is turned by an insulated shaft protruding through the panel and fastened to the shaft of the condenser by a shaft coupler. These precautions have been taken for a very important reason. If the hand comes too close to the condenser, while tuning or otherwise, the capacity of the body alters the tuning.

An amateur once started to tune his transmitter to a receiver in his model and everything worked fine until he removed his hand from the tuning dial. Then no response in the plane. He put his hand back on the dial and it worked. Not wanting to glue his hand to the dial he set the tuning dial a little off tune and when he removed his hand he hoped to be tuned in.

By merely using a shaft extension and moving back the tuning condenser this trouble is neatly avoided. Note also that if the condenser is mounted under the chassis directly below the coil the leads can be made very short.

The coil is a simple item to make if done properly. Secure a 16" length of 1/4" diameter copper tubing. Obtain a solid round object such as an iron pipe, bottle or can with an outside diameter of 2", to be used as a coil form for bending the tubing. Bend the copper tubing around this form and make a coil of one and one-half turns as shown in Fig. 5. At the exact center of the coil, at the bottom, file a small opening about 3/16" wide. Also file two small openings 3/16" wide on either side as shown in Fig. 5. Hammer the ends of the coil flat and drill a hole to allow the coil to be mounted on small stand-off insulators. Feed a good grade of insulated wire, like rubber or cambric covered wire, through one of the end openings, push it through the inside

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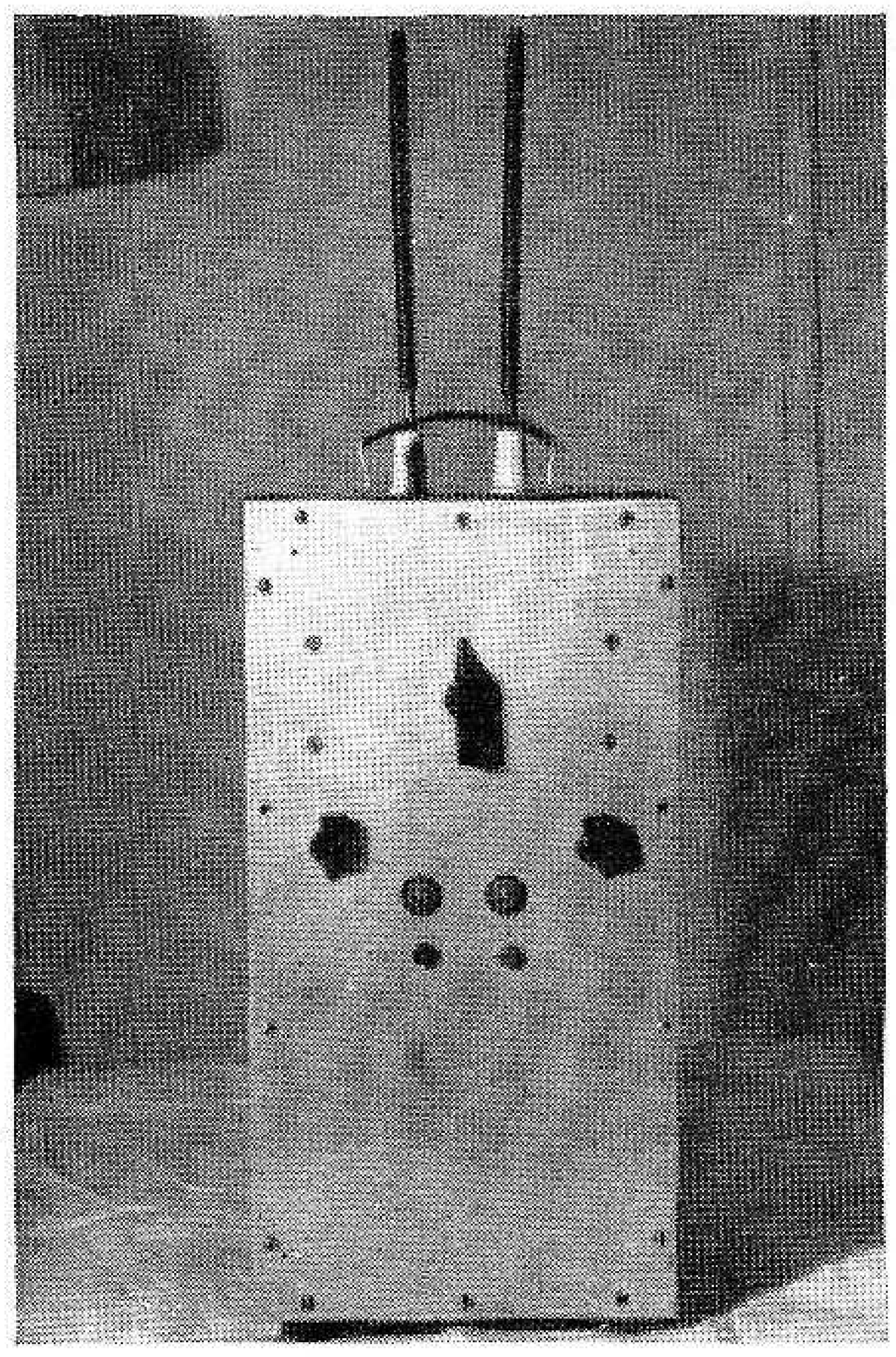
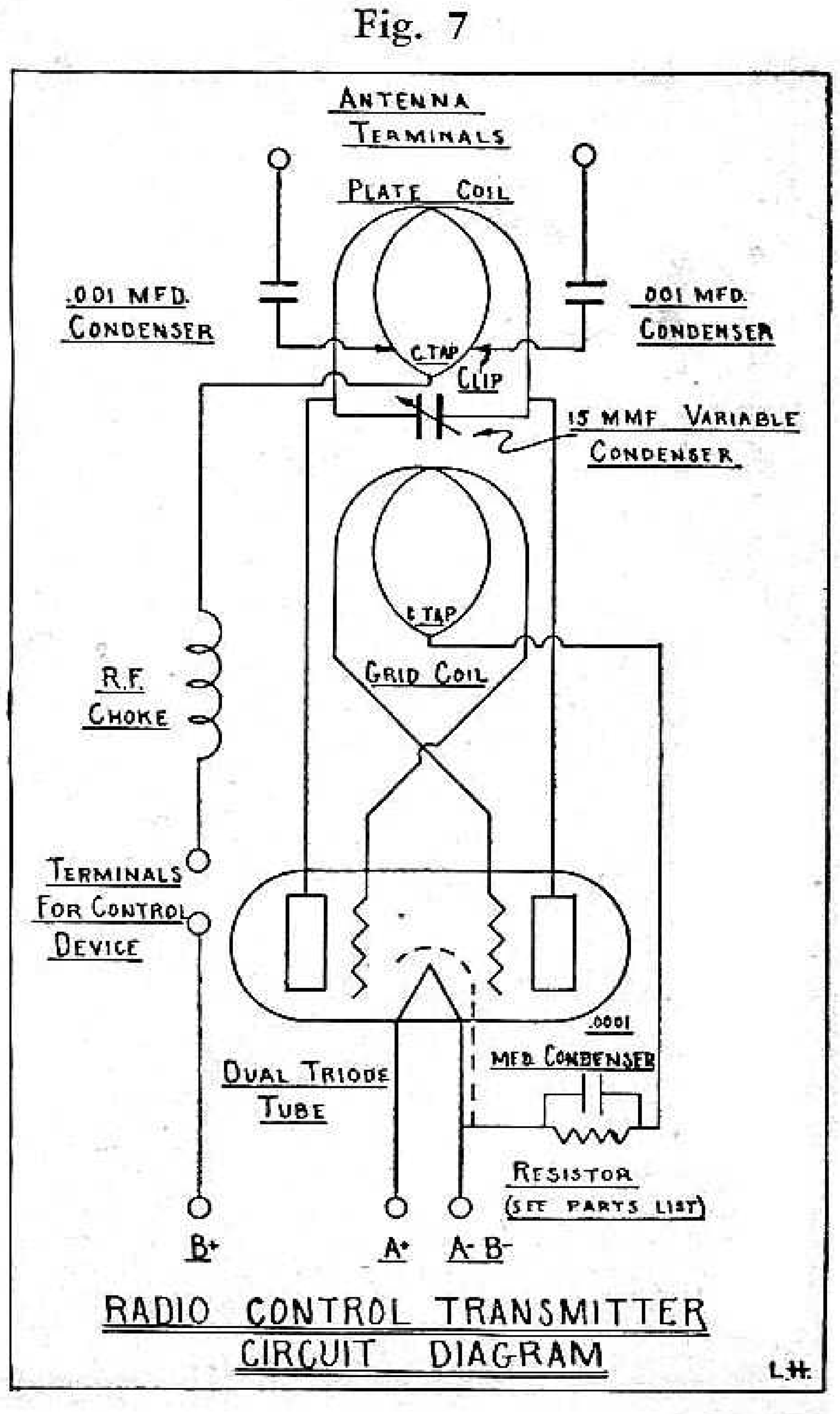


Fig. 6, a transceiver converted for radio control use

Fig. 7



Radio Remote Control

(Continued from page 21)

of the copper tubing until it appears at the other end opening, and pull it out a few inches. With a hook pull about 2" of length of wire from the center opening. This inside wire is the grid coil, which should be carefully watched in wiring that the ends of this grid coil cross and go to opposite grid terminals on the tube socket as shown in the wiring diagram of Fig. 7. The antenna is coupled to the outside copper plate coil by tapping directly to the coil with alligator clips. Condensers are connected in series with the antenna leads to the feed-through insulators, as shown in the diagram of Fig. 7, to prevent any high voltage direct current from appearing at the antenna—this is a precaution taken for protection against shock.

Tube type determines the socket; however, in all cases a low loss type socket, such as isolantite, should be installed. For battery operation use type RK43, but if this type is not available or if a type 19 tube is at hand it can be used with addition of an extra dry cell in the filament circuit and a four ohm, one watt, fixed resistor connected in series with one of the filament wires.

Both type RK43 and 19 require a standard six contact socket. Types 53, 6A6, 6N7 or 6N7G can be used with higher power inputs. The 6A6, 6N7 and 6N7G tubes are good where a storage battery supplies filament voltage. The 6A6 and 53 require a seven contact (.855 inch pin-circle diameter) socket, and the 6N7 and 6N7G type tubes require standard octal sockets. Type 53 is useful where an alternating current power supply is available, its filament voltage being two and one-half volts. When using the 53, 6A6, 6N7, or 6N7G the cathode is connected directly to the negative filament, shown by the dashed line in Fig. 7. For the advanced radio amateur interested in higher power input type 815 should be considered.

Connected in series with the B plus lead are two pin jacks; these are used for connecting to the two pin jacks of the conjulator or other control switch or a milliameter for observing the plate current.

A complete discussion of antennae, power supplies for radio control transmitters and the procedure for tuning will be presented in a near future issue of MODEL AIRPLANE NEWS.

PARTS LIST

1 15 Micromicrofarad midget variable condenser
2 .001 Microfarad mica fixed condensers
1 .0001 Microfarad mica fixed condenser
1 Resistor—5 watts-5000 ohms for 6N7, 6N7G, 6A6 or 53 type tube
  10,000 ohms for 19 and RK 43
1 2.5 Millihenry radio frequency choke coil
1 Radio tube (see article for type)
4 Stand-off insulators—one inch high
2 Feed-thru insulators—one and one-half inches high