Gene Klein W4BRS
6814 Criner Road, S.E.
Huntsville, Alabama

A Toroidal VFO

Gene has made an excellent VFO using a toroidal inductor. This VFO has many interesting construction ideas.

Many advantages can be gained by using toroids in amateur radio equipment. Their small size and high-Q head the list of reasons why they are seeing more and more applications today.

No longer is it necessary to use a four or six inch square box to house the big ceramic coil in the home-made VFO. No longer does the circuit stop oscillating when we attempt to reduce the box size, now that we have toroids. One of these ⅜-inch-diameter gems can be mounted right on a printed circuit board along with the transistors and capacitors which make up a VFO circuit.

A transistorized VFO employing a toroid coil was described by Jo Emmet Jennings W6EI in 1963.[1] Del Crowell, K6RIL sparked current enthusiasm with this recent excellent article[2] from which our circuit (and several cores) were borrowed. In this article is described a practical approach to the construction of a very compact and dependable VFO. The mechanical work required to fabricate the aluminum housing can be done with the simplest hand tools available in most ham workshops.

[1] The Transistor Radio Handbook—Editors & Engineers Ltd.

[2] A Stable VFO or VHF or HF—73 Magazine, November, 1966.

Circuit

A conventional Clapp oscillator is used, feeding an emitter-follower buffer stage (Fig. 1.) High frequency NPN transistors such as the 2N697 are used for the oscillator and buffer stages. Temperature compensation is provided by the 75 pF NPO type ceramic capacitor. The relative values of this capacitor and the 100 pF silver mica capacitor may be varied experimentally to provide flexibility in achieving optimum compensation.

An rf probe and vacuum tube voltmeter are indispensable when substituting transistors and making circuit adjustments for optimum output. Approximately 0.3 to 0.5 volts rf should be measured at the emitter of

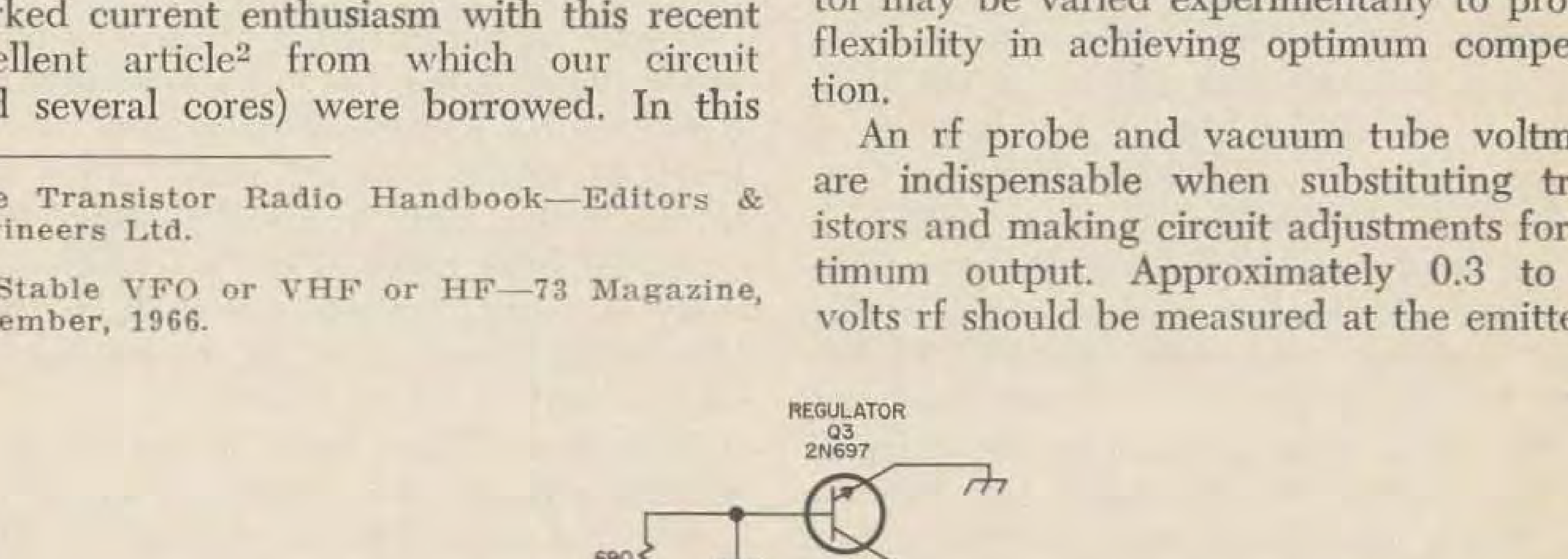
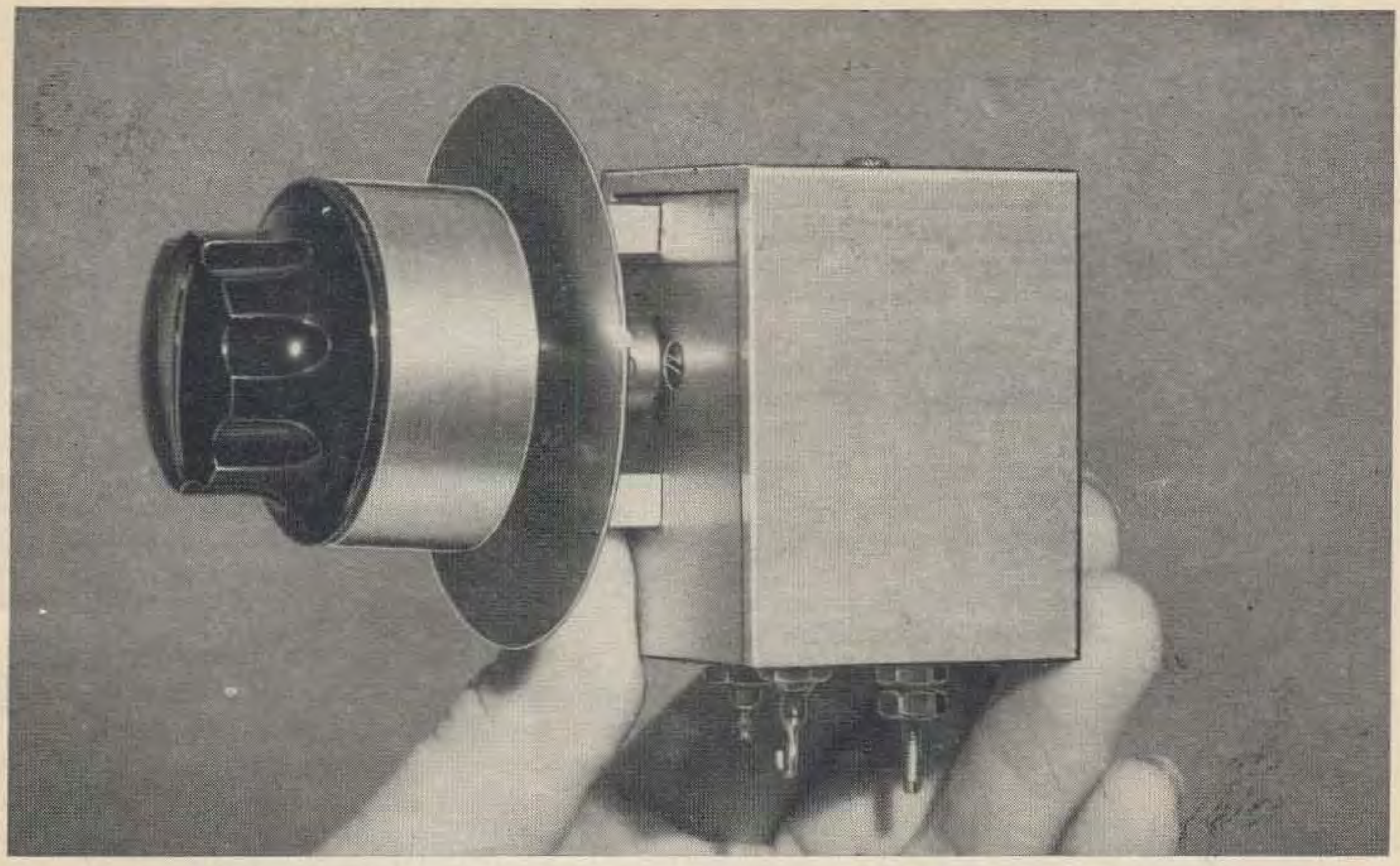


Fig. 1. Schematic of the VFO and power supply. Regulation is provided for both the oscillator and buffer. If more rf output is required, a tuned circuit (toroid, of course) can be installed in the emitter of Q2 in lieu of the 100 ohm resistor.



The completed VFO with dial ready for calibration. One screw holds the cover in place. Trimmer capacitor and feed-throughs are used to secure the VFO to a chassis.

Q1. Decreasing the 560 ohm emitter resistor will increase the output up to 1½ to 2 volts whereupon oscillation will stop. The oscillator Q1 should be operated at the lowest emitter current consistent with obtaining approximately 1½ volts output at the emitter for Q2.

The regulator transistor, Q3 is an audio type NPN in a shunt regulator configuration. In the author's circuit, a 2N697 rf transistor was used because it was available. The zener diode clamps the base-to-collector voltage of Q3 to the value selected for VFO operation; in this case 12 volts. This diode may be of the inexpensive ¼ to 1 watt variety. Power for the VFO was obtained from a 6.3 volt transformer and a conventional voltage doubler circuit which provides a peak voltage of about 18 volts.

This VFO configuration may be used at any frequency from 1 to 10 MHz by selecting proper values for L1 and its associated frequency determining capacitors. However, in the author's application, the frequency range of 3.5 to 3.65 MHz was required for doubling to the 40 and 20 meter bands.

Assembly

The various parts of the VFO are shown in the photos. Four #4-40 screws hold the component board in place. The piston-type trimmer capacitor to the right is a Cambridge Thermionic Corp. CS6-50. It is externally adjustable and is used for band setting as well as for securing the VFO housing to a chassis. Positive 18 volts enters via the feed-through capacitor. Centralab Type FT-1500, which aids in mounting the VFO, as does the rf bushing, USECO #1433, to the left in the photograph.

A frequency spread of 150 kHz is achieved with a Hammerlund Type MAPC-50 tuning capacitor. The type capacitor having a ¼ inch shaft extension should be used.

Component Board

A phenolic or glass-epoxy board, 1/16 inch thick is used to mount the components. **Fig. 3** shows the position and identification of the parts. In the VFO illustrated, a prepunched phenolic board was employed. Transistor sockets are used to provide greater flexibility in experimenting with different transistors. No deterioration in frequency stability was experienced when using sockets for the oscillator stage due to the "swamping effect" of the large 3000 pF silver mica voltage dividing capacitors.

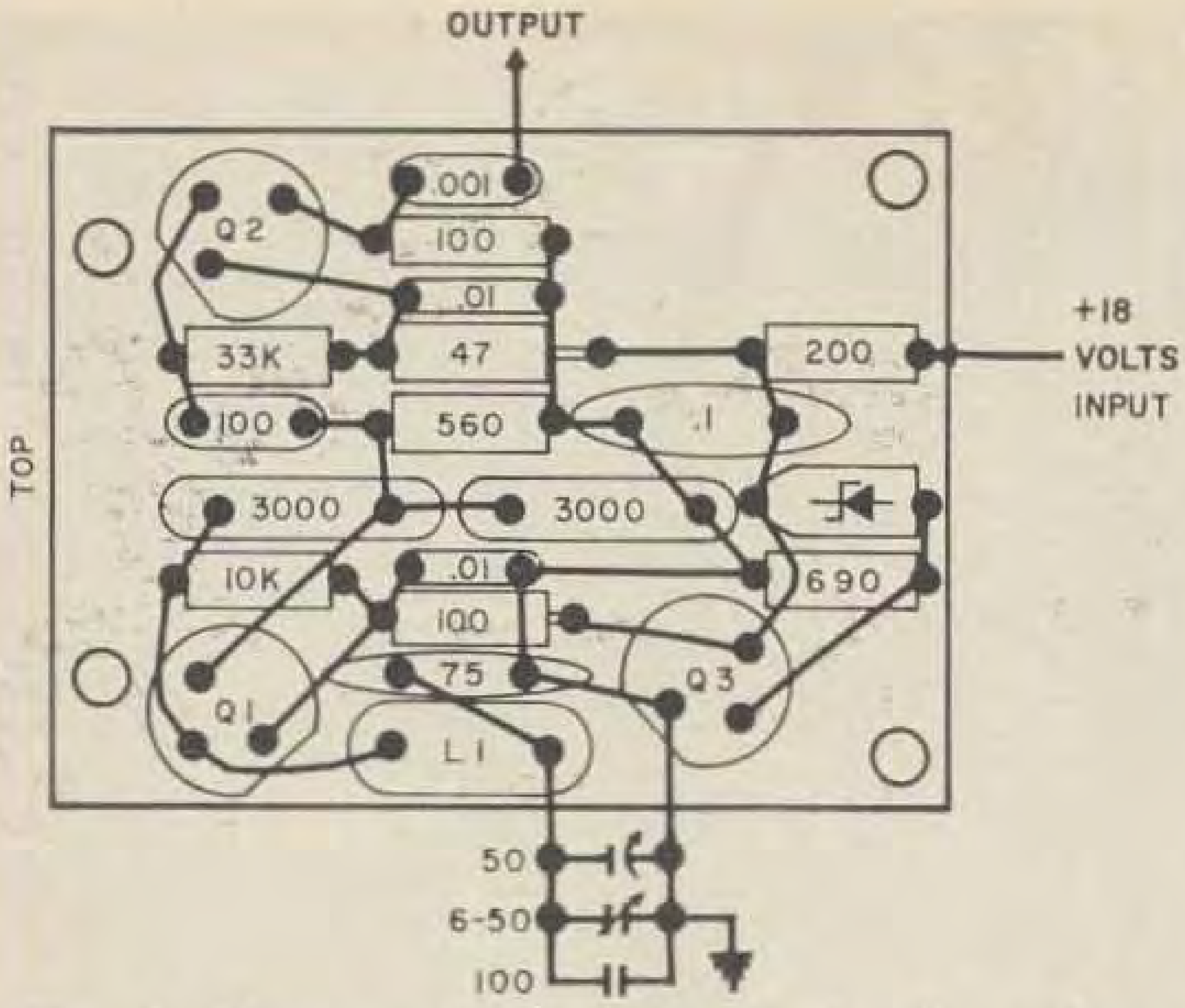
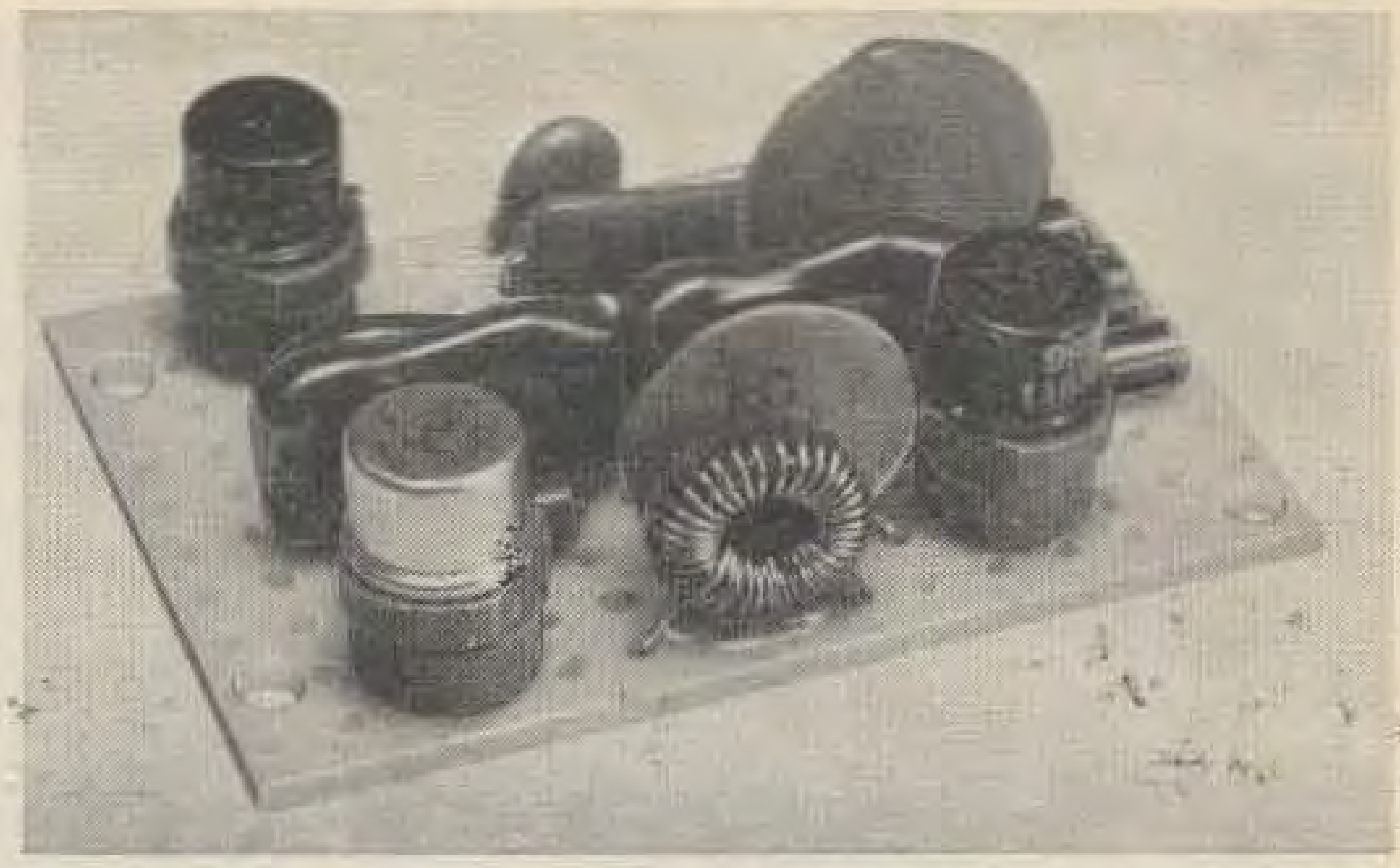


Fig. 2. Component identification is shown here. Because of the small size of the assembly, component leads may be simply bent over and used as indicated, instead of a printed circuit.



The VFO component board. Pre-punched phenolic material is convenient for the amateur constructor, however, a printed circuit board would improve appearances and provide a little more freedom in making the most desirable component spacing.

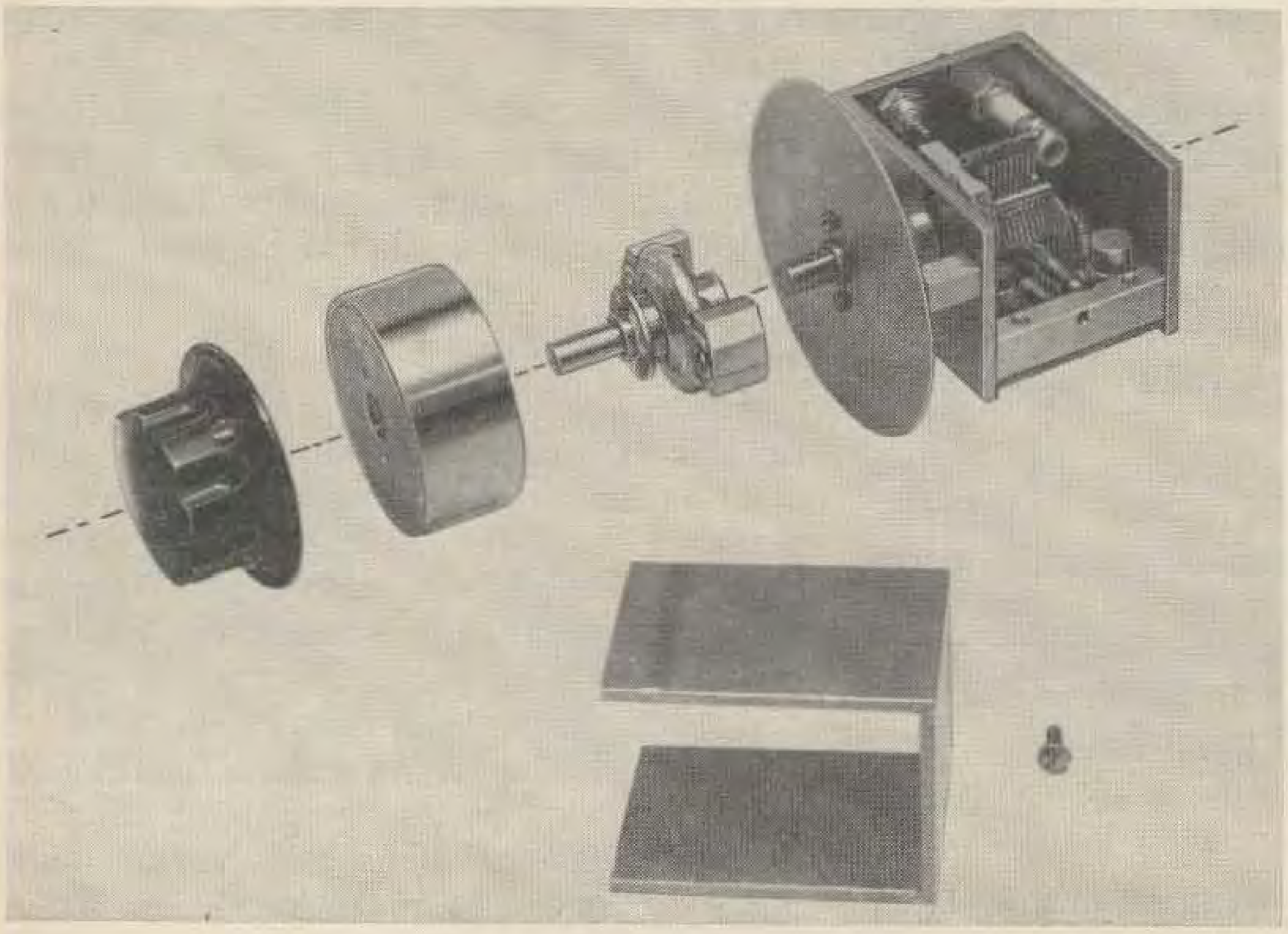
Housing

The objective of our VFO design was small size and simple mounting. For these reasons, a special housing had to be built because no commercial box or chassis was found suitable. The scrap pile of a local window glass shop provided rectangular aluminum tubing measuring 1-¾ inches by 4 inches outside. Two "U" shaped pieces were cut from the rectangular tubing so that they precisely "nest" together. One #4-40 machine screw holds the cover in place.

Brackets for mounting the component board were cut from aluminum scraps and glued in place using epoxy cement. While epoxy provides a valuable fabrication technique, one should not depend on cemented joints for electrical connections. The ground lead from the component board should be brought out and soldered directly to the tuning capacitor terminal as well as to a lug under the piston-type trimmer.

Tune Up

When using a toroid coil core it is impossible to use a grid dip meter in the conventional manner for verifying the frequency of a tuned circuit. This is because the flux of the coil is almost entirely contained within the closed core. Therefore, prior to ce-



Exploded view of the VFO and dial drive mechanism. Two Jackson Bros. planetary-vernier drives provide a 36:1 ratio. Leads to the tuning capacitor and feed-throughs are soldered after installing the component board.

menting the coil in place on the component board, it should be suspended by its leads which are left about 1½ inches long. These leads and the coil form a loop to which the grid-dipper may then be coupled.

After verifying the proper frequency of the tuned circuit, power should be applied with the regulator transistor Q3 only in place. Positive 12 volts dc will be measured at the collector of Q3. A check of the regulator under load can then be made by temporarily placing a 150 ohm resistor between the emitter and collector terminals of the buffer socket. This resistor, together with the 47 and 100 ohm resistors in the circuit, will present a total load of 300 ohms which will draw 40 milliamperes from the regulator, simulating about 100% overload conditions. The regulated 12 volts should show no discernable change under these conditions.

On the Air Tests

Excellent signal tone and stability are obtained from this VFO. The construction techniques used provide maximum immunity from mechanical shock and electrical transients. Long term stability is also achieved by negligible component heating and superior dissipation afforded by the sturdy housing.

A new era of VFO refinement is made possible by the toroid coil. The amateur constructor is well advised to include toroids in his present day projects.

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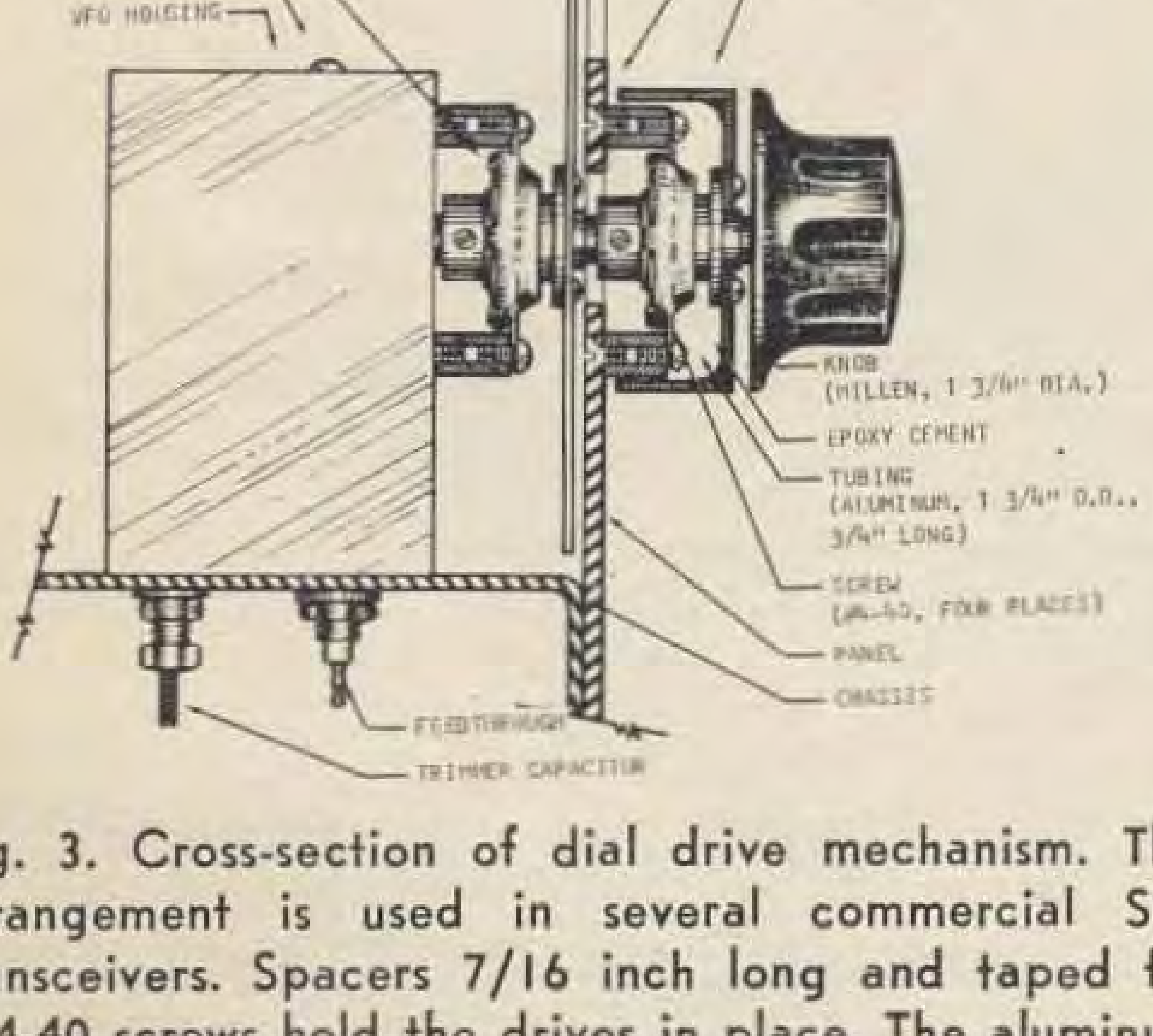

Fig. 3. Cross-section of dial drive mechanism. This arrangement is used in several commercial SSB transceivers. Spacers 7/16 inch long and taped for #4-40 screws hold the drives in place. The aluminum knob nearest the panel provides fast rotation (6:1 ratio) while the conventional knob provides slow speed (36:1 ratio).