



HAM TIPS



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A NUVISTOR CONVERTER FOR 432 MEGACYCLES

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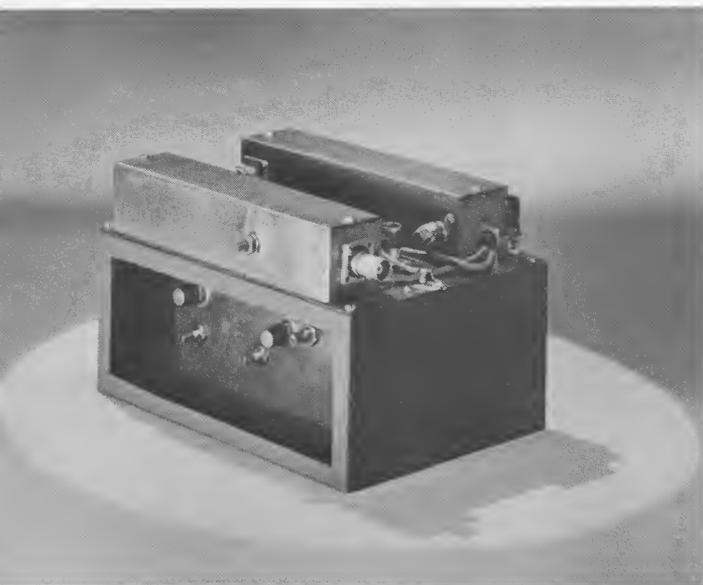
New performance possibilities in the field of amateur receiver equipment resulting from the introduction of RCA nuvistors have led increasing numbers of hams to explore the various frequencies which might fully utilize the wide capabilities of these unique tubes. After achieving notable successes in one area, the author—like many of his fellow hams—was encouraged to proceed with experimentation in another. Excellent results with nuvistors converters for 144 and 220 megacycles in the VHF band soon prompted him to investigate designs for the UHF band. In the following article, he reports on a nuvistors converter for 432 megacycles—a highly dependable unit which “. . . has produced many hours of enjoyable QSO's.”

Description

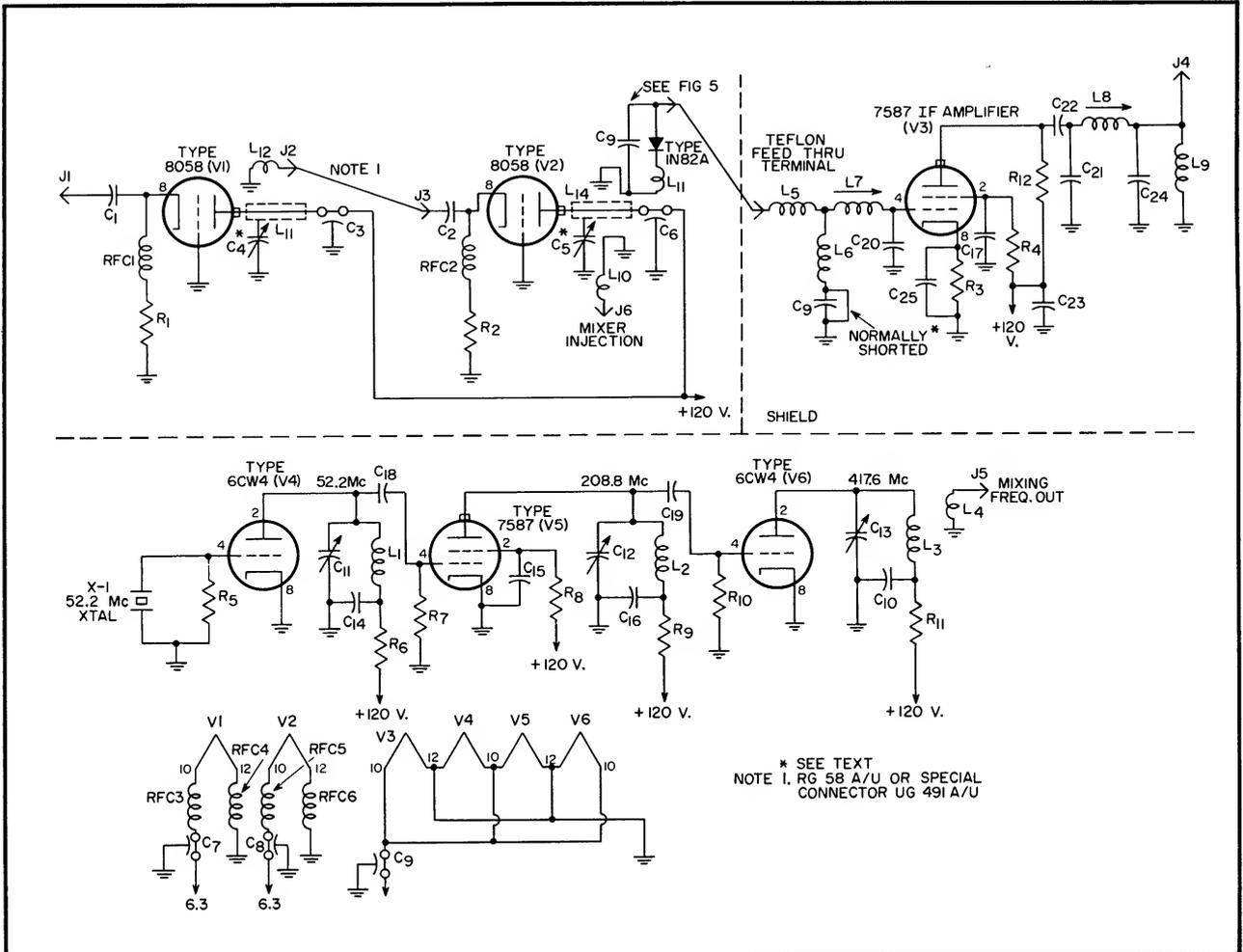
This article describes a nuvistors converter for the 432-megacycle UHF band. As shown in the schematic diagram (Figure 1), the converter has two rf amplifier stages. Both stages employ the RCA-8058, a double-ended high-mu nuvistors triode which was announced commercially early in 1962.

This nuvistors type has been used successfully in cathode-drive amplifier service at frequencies up to 1200 Mc. Although its cost is somewhat higher than other nuvistors types, it is inexpensive when compared with other industry vacuum tubes capable of operating up to 1200 Mc.

Demonstrating excellent stability over a wide range of frequencies, the 8058 is designed to provide high gain with low noise in cathode-drive amplifier service. It is particularly suited to such service because the peripheral lugs used for indexing are also used as the connections to the grid. Further-



Front view of K2BTM's 432-Mc nuvistors converter. (Note how portion of chassis has been removed to facilitate final adjustments and additional cooling of oscillator-multiplier section.)



- C₁, C₂—100 pf, ceramic tubular (Centralab TC2 or equiv.)
- C₃, C₆, C₇, C₈, C₉—1,000 pf, feed-thru (Erie 2404)
- C₄, C₅—See Figure 3
- C₁₀—500 pf, silver button (Erie 370CB-501K or equiv.)
- C₁₁—20 pf, miniature (E. F. Johnson 20M11)
- C₁₂—15 pf, miniature (E. F. Johnson 15M11)
- C₁₃—5 pf, miniature (E. F. Johnson 5M11)
- C₁₄, C₁₅, C₁₆, C₁₇—500 pf, disc ceramic (Centralab DD501 or equiv.)
- C₁₈, C₁₉—5 pf, ceramic tubular Centralab TCN or equiv.)
- C₂₀—5 pf, N.P.O. ceramic (Centralab DT2 or equiv.)
- C₂₁—15 pf, N.P.O. ceramic (Centralab DT2 or equiv.)
- C₂₂, C₂₃—1,000 pf, disc ceramic (Centralab DD102-G or equiv.)
- C₂₄—100 pf, silver mica (Arco Electronics CM-15 or equiv.)
- C₂₅—,003 disc ceramic (Centralab DD302 or equiv.)

- J₁, J₂, J₃, J₄—BNC-type connector (UG290AU)
- J₅, J₆—RCA-type phono connector
- L₁—6 turns of No. 20 on ½-inch diameter (B&W 3003)
- L₂—1 turn of No. 18 enamelled wire on ½-inch diameter
- L₃—See Figure 3
- L₄—Hairpin loop, No. 16 enamelled wire cut to ½-inch length
- L₅, L₉—9 turns of No. 26 enamelled wire, close wound on ¼-inch diameter poly form
- L₆—18 turns of No. 26 enamelled wire, close wound on ¼-inch diameter poly form
- L₇—28 turns of No. 26 enamelled wire, close wound on ⅜-inch diameter slug-tuned form (CTC-PLST or equiv.)
- L₈—20 turns of No. 26 enamelled wire, close wound on ⅜-inch diameter slug-tuned form (CTC-PLST or equiv.)
- L₁₀—Hairpin loop, No. 18 enamelled wire cut to ½-inch length

- L₁₁—No. 18 insulated wire, ¾-inch length, bent into loop and coupled approximately ⅛-inch from L₁₄
- L₁₂—Same as L₁₁, except for coupling of loop to L₁₃
- L₁₃, L₁₄—See Figure 3
- R₁, R₂—56 ohm, ½ watt
- R₃—68 ohm, ½ watt
- R₄—47,000 ohm, ½ watt
- R₅—47,000-to-100,000 ohm, ½ watt (See text)
- R₆—4,700 ohm, ½ watt
- R₇, R₁₀—100,000 ohm, ½ watt
- R₈—120,000 ohm, ½ watt
- R₉—1,000 ohm, ½ watt
- R₁₁—22,000 ohm, ½ watt
- RFC₁, RFC₂, RFC₃, RFC₄, RFC₅, RFC₆—Ohmite Z460 rf choke
- Miscellaneous—One feed-thru Teflon insulator; crystal socket; one crystal 52.2-Mc overtone (International Crystal Company type FA5); six nuvistor sockets (Cinch No. 133 65 100.011); one chassis, aluminum, 5-by-7-by-3 inches (Bud AC429 or equiv.)

Figure 1: Schematic diagram and parts list of K2BTM's 432-Mc converter.

more, three base-pin connections for the cathode reduce lead inductance and provide flexibility in circuit layout.

The 8058 is especially useful in equipment which requires tubes having low drain and exceptionally high uniformity of characteristics. The double-ended construction of this nuvistor provides a high degree of isolation between the input and output circuits.

As indicated in the schematic, the second rf amplifier (V2) is identical to the first but is followed by a crystal mixer mounted on the chassis. Both stages use quarter-wavelength shorted plate lines. A noise figure of 7 db and a gain of 15 db at 450 megacycles have been measured for the first rf stage. In operation, signals which are generally hidden in the noise level of other converters are easily detected with this converter.

The output of the crystal mixer is link-coupled to a low-noise bandpass amplifier which uses the RCA-7587, a general-purpose sharp-cutoff nuvistor tetrode. This nuvistor type is designed for use in a wide variety of small-signal applications requiring compactness, low current drain, relatively low-voltage operation, exceptional uniformity of characteristics from tube to tube, and ability to withstand severe mechanical shock and vibration.

Performance and stability of this tetrode stage have been most satisfactory. The gain of the if amplifier is about 20, and its output is fed to a receiver which tunes from 14 to 18 megacycles. A 52.2-megacycle overtone crystal in the oscillator-multiplier circuit multi-

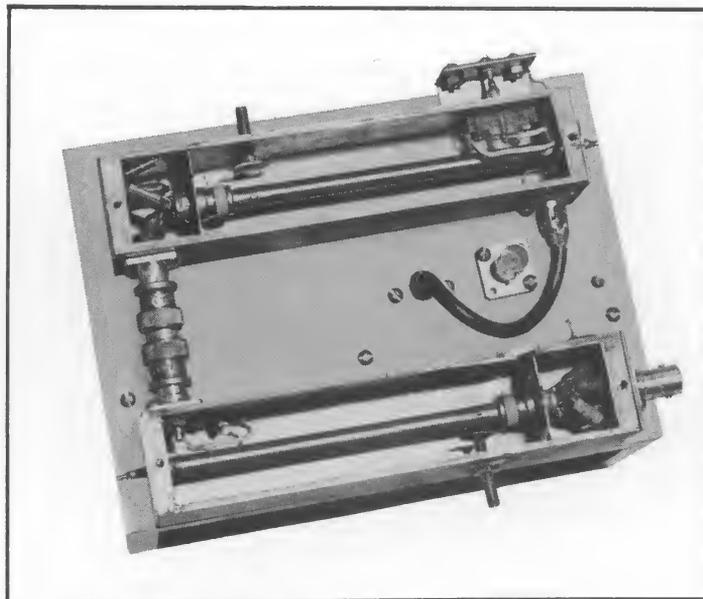


Figure 2b: Top view showing two rf amplifiers.

plies the signal frequency up to the final injection frequency of 417.6 megacycles.

This frequency multiplication is accomplished with two RCA-6CW4 high-mu nuvistor triodes and a 7587 tetrode. The 6CW4 features high-gain capabilities which are achieved by very high transconductance and excellent transconductance-to-plate-current ratio (12500 micromhos at a plate current of 8 milliamperes and a plate voltage of 70 volts). The design of the oscillator-multiplier insures an adequate amount of injection frequency free of unwanted frequencies.

Power requirements for the converter are 120 volts at about 40 milliamperes and 6.3 volts ac at 950 milliamperes for the heaters.

Circuit Design

The first and second rf stages use the 8058 nuvistor in a grounded-grid (cathode-drive) configuration. The 8058 is especially suitable for this operation because the ground connection to the grid is made when the tube is inserted into the socket. Optimum performance of both rf stages occurs at about 430 megacycles; only a slight drop in gain occurs at 420 and 450 megacycles. Coupling from the antenna is through C_1 to the cathode of V1. The heaters are isolated above ground by rf chokes to provide stable operation. Oscillation has not been experienced in either stage.

As previously mentioned, the plate lines are quarter-wavelength shorted lines tuned by a small copper disc capacitor at the plate end. Plate voltage is fed to the line at the rf ground end through a 1000-picofarad capacitor. The

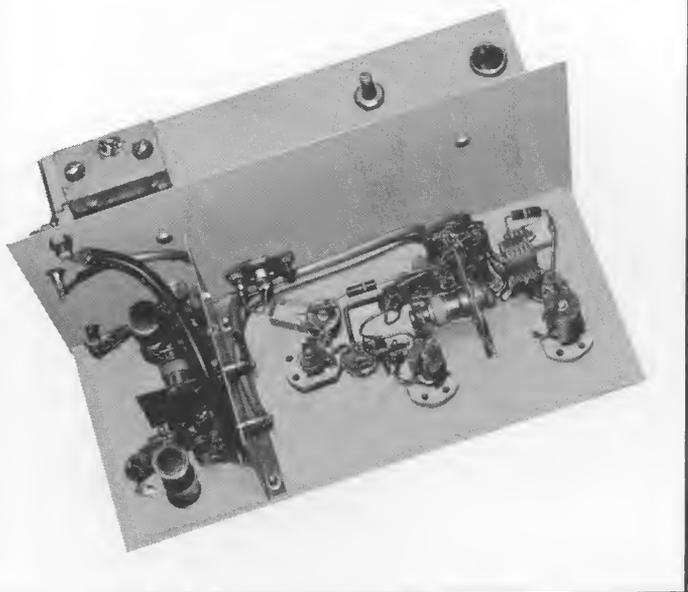


Figure 2a: Bottom view of converter showing if stage (left of shield) and oscillator circuits.

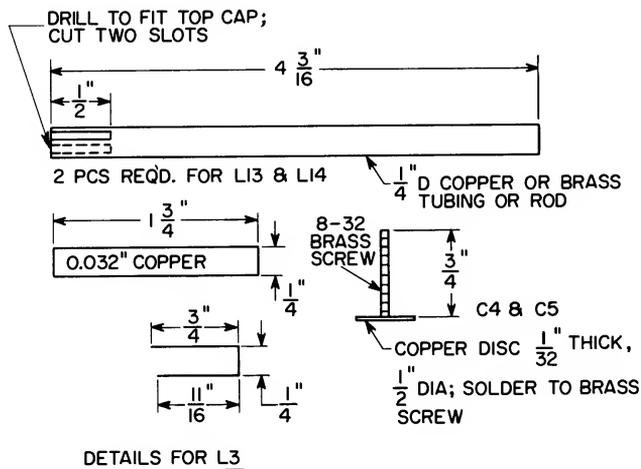


Figure 3: Detailed view of variable capacitors and inductors in rf stages.

two amplifiers are connected with a double BNC connector. Instead of this double connector, coaxial cable with conventional BNC fittings can be used.

The 1N82A crystal mixer is easy to construct, and was selected in preference to other types because it can take a considerable amount of rf voltage from the transmitter before burning out. Nevertheless, precautions should be taken for cutting off B+ during transmission to prevent damage to the rf circuits and the crystal mixer.

The output impedance of the crystal is matched to the input of the 7587 nuvistor (V3) by the coupling network (L_5 , L_6 , and L_7). Although this bandpass-coupling network is designed to operate at a frequency of 14 to 18 megacycles, slight retuning of coils (L_7 , L_8) is required when tuning 16 to 18 megacycles. During normal operation, the capacitor C_7 is shorted to ground. During initial operating adjustments of the converter, the short across C_7 is removed, and a milliamperemeter is placed in series with this point and ground. As a result, the crystal current can be measured and adjusted for normal operation. Noise measurements indicate that overall noise figure of the 7587 is less than other equivalent tubes.

Because the oscillator-multiplier circuit is of conventional design, no trouble should be encountered if good high-frequency wiring techniques are used. The 6CW4 (V4) oscillator stage is a harmonic overtone crystal circuit. Although slightly higher in cost than other crystals, overtone crystals are more accurate. Slight shifts in crystal frequency can be troublesome when multiplying to 417

megacycles. Because a number of receivers can tune below 14 megacycles and above 18 megacycles, a slight shift in the injection frequency can be compensated for.

When the 52.2-megacycle crystal in the grid circuit of the 6CW4 (V4) is oscillating, the plate circuit should be tuned to 52.2 megacycles. The high-value grid resistance (around 100,000 ohms) prevents excessive crystal current flow. Most active harmonic crystals oscillate readily with 100,000-ohm grid resistance. If this resistance is too high, however, it can be reduced to 47,000 ohms without causing excessive crystal current flow.

The next stage (V5)—a 7587 nuvistor tetrode—operates as a quadrupler and multiplies the frequency to 208.8 megacycles. The plate circuit is a single turn of #18 wire ($\frac{1}{2}$ -inch diameter). The Q of this coil is sufficiently high to reject unwanted frequencies. This stage and the next doubler stage require extreme care in layout so that short direct connections can be made. Figures 2a and 2b show the positions of the components in these two stages.

The next nuvistor triode stage doubles the frequency to 417.6 megacycles. The plate-circuit inductance (L_3) is a short piece of copper bent into the shape of a "U." Construction details of this tank circuit and the other coil assemblies are shown in Figure 3.

The 417.6-megacycle injection frequency is link-coupled to the mixer stage through a short piece of 50-ohm coaxial cable. The coupling loop L_{10} is about $\frac{1}{16}$ to $\frac{1}{8}$ of an inch from L_{14} .

Mechanical Description

A chassis measuring 5-by-7-by-3 inches is used as the enclosure for the converter. The circuit is constructed on a flat piece of flashing copper with a shield separating the oscillator-multiplier from the if amplifier. The top plate is also 5-by-7-by-3 inches and is fastened to the aluminum chassis which forms the base for the two rf lines. One side of the aluminum chassis is cut out to facilitate tuning of the oscillator-multiplier circuits as well as the coils in the if amplifier. Figure 2 shows the position of the shields.

Construction of Quarter-Wavelength Lines

The chassis is made of $1\frac{1}{4}$ -inch-square extruded brass. One side is cut out, except for two end ribs which are required for mounting the cover. The plate on which the socket is mounted is made of flashing copper and

soldered into position inside the brass extrusion. Position of components and dimensions for the lines are shown in Figures 2 and 4.

The crystal mixer is coupled to the line by means of coupling loop L_{11} , which is spaced $\frac{1}{8}$ to $\frac{3}{16}$ inch from the plate line. The ungrounded end of this loop is connected to a tube pin removed from an old octal tube. This pin is force-fitted into an insulating block mounted on the chassis. Details for this construction are shown in Figure 5. This arrangement does not require any soldering at either end of the crystal diode. The L-shaped bracket is made to a close tolerance, and permits electrical contacts to be made at either end of the crystal without soldering.

By the addition of another piece of copper and one layer of Teflon sheet 0.010-inch thick, the L-shaped bracket also becomes capacitor C_9 , having a capacitance of 45 picofarads. The mixing frequency is injected to the plate line of the second rf amplifier by the coaxial cable, both ends of which use a "phono-type" jack.

The size of the mixer-coupling loop (L_{10}) determines the amount of crystal current. A piece of wire, approximately $\frac{1}{2}$ -inch in length, should be formed into a small loop. One end of this loop is connected to the phono socket and the other end is soldered to the chassis. Adjustment of the distance of the loop to the plate line determines the amount of injection voltage to the mixer and also the mixer crystal current flow. Precaution should be taken because excessive injection voltage may result in reception of signals outside the band. Optimum adjustment of the mixer is required to eliminate unwanted frequencies.

Adjustment Procedure

The oscillator-multiplier is adjusted first for normal operation. A grid-dip meter is a very useful instrument and is considered a necessity when building converters such as the one discussed here. Insert V4 (the 6CW4 oscillator) into its socket. Temporarily connect a milliammeter (10 milliamperes full scale) in series with the 4700-ohm resistor in the oscillator plate circuit. Apply 120 volts B+ and tune C_3 until a sharp "kick" in current on the milliammeter indicates that the circuit is oscillating. Couple the grid-dip meter near L_1 and read the frequency (which should be the frequency marked on the crystal, i.e., 52.2 megacycles). The stage should oscillate readily with an active crystal; if it does not, reduce the value of the grid resistor

until oscillation is obtained. It is not advisable to go lower than 47,000 ohms because too much crystal current flow may cause the crystal to heat and, as a result, drift in frequency.

Remove the milliammeter and solder the 4700-ohm resistor back into the circuit. Insert V5 (7587 quadrupler) into its socket. Apply B+ and couple the grid-dip meter near L_2 and adjust C_4 for maximum output at 208.8 megacycles. Place V6 (6CW4 doubler) into its socket. (This stage may present an adjustment problem because most grid-dip meters used by ham operators do not cover frequencies above 220 megacycles.) If a grid meter is not available to measure 418 megacycles, adjust C_5 for maximum mixer crystal current (1.0 to 1.5 milliamperes maximum).

After a signal generator or antenna system with a characteristic impedance of 50 ohms is connected to the first rf stage and the receiver is tuned to 15 megacycles, tune C_4 and C_5 for maximum noise and crystal current. If the crystal current is more than 1.0 milliamperes, bend the injection loop (L_{10}) toward the chassis until the crystal current measures between 0.6 and 0.8 milliamperes. At this time, trim the oscillator-multiplier circuits for maximum noise signal.

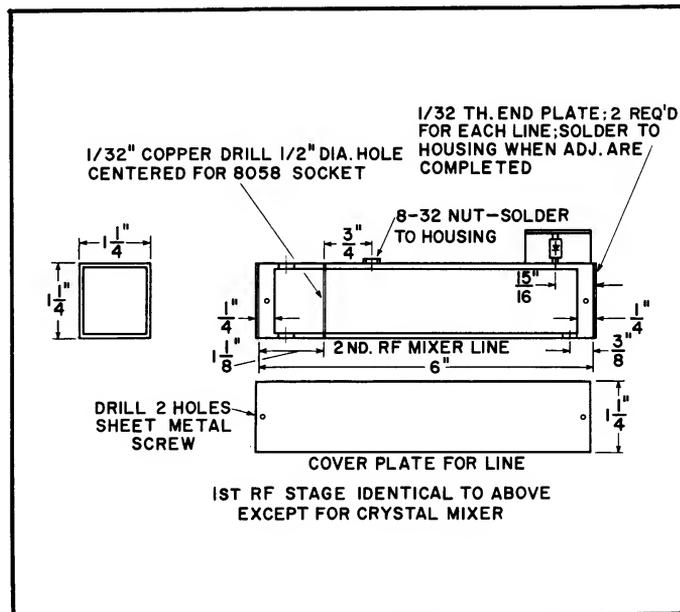


Figure 4: Construction details for two rf amplifiers.

The if amplifier can now be checked for operation and performance. Remove the connection to the crystal and connect a signal generator to the grid of the 7587 mixer. Response should be fairly flat over the 14-to-16-megacycle range. Tuning of the generator over the 14-to-18-megacycle range requires

some peaking of the if coils (L_7, L_8). If no generator is available, noise from the rf amplifier and the mixer can be used to peak the coils.

No oscillation should be observed when a

properly matched antenna is connected to the first rf stage and C_1 and C_2 are tuned for maximum noise. If oscillation does occur, the coupling loops (L_{12}, L_{11}) in the rf amplifier probably are coupled too loosely.

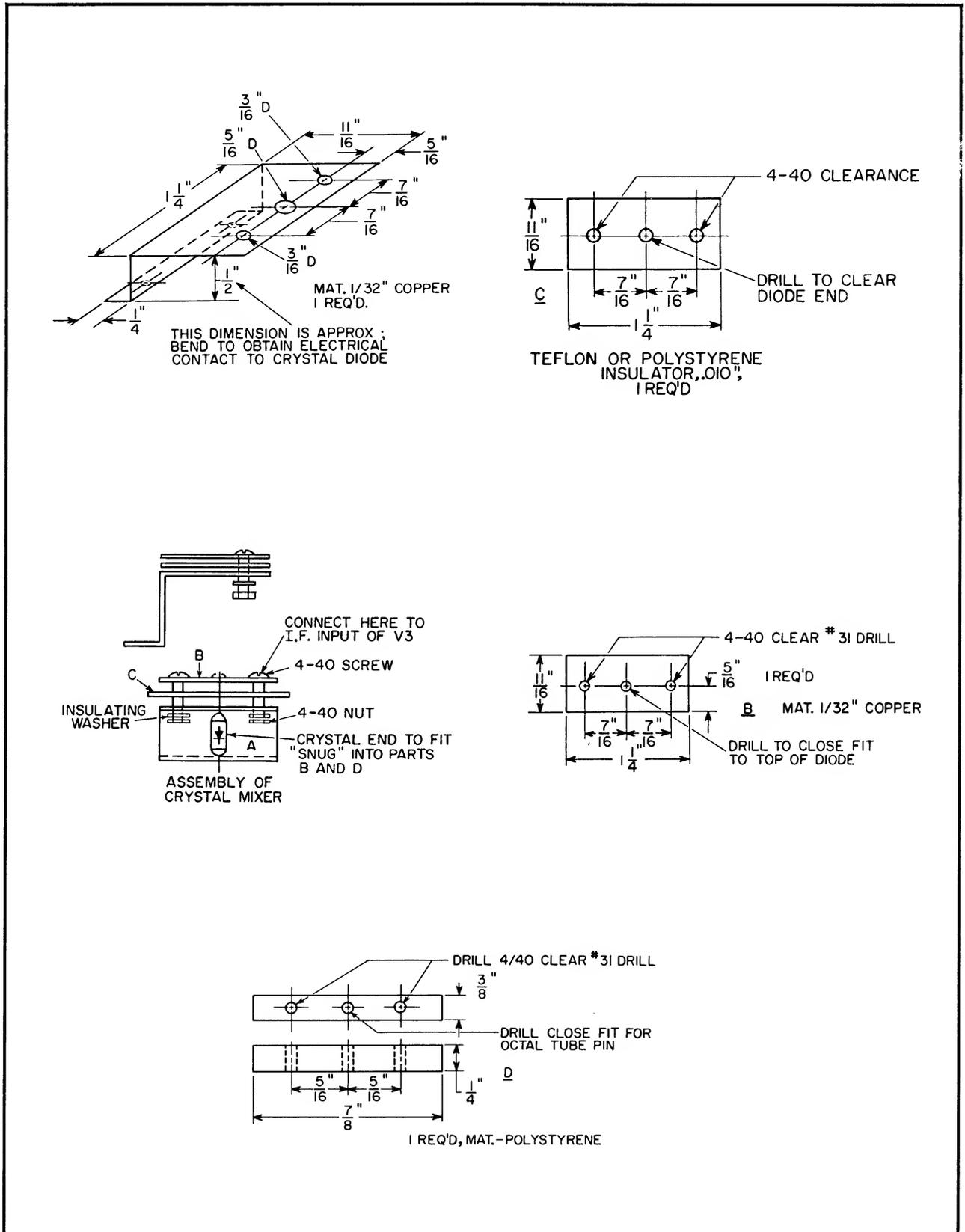
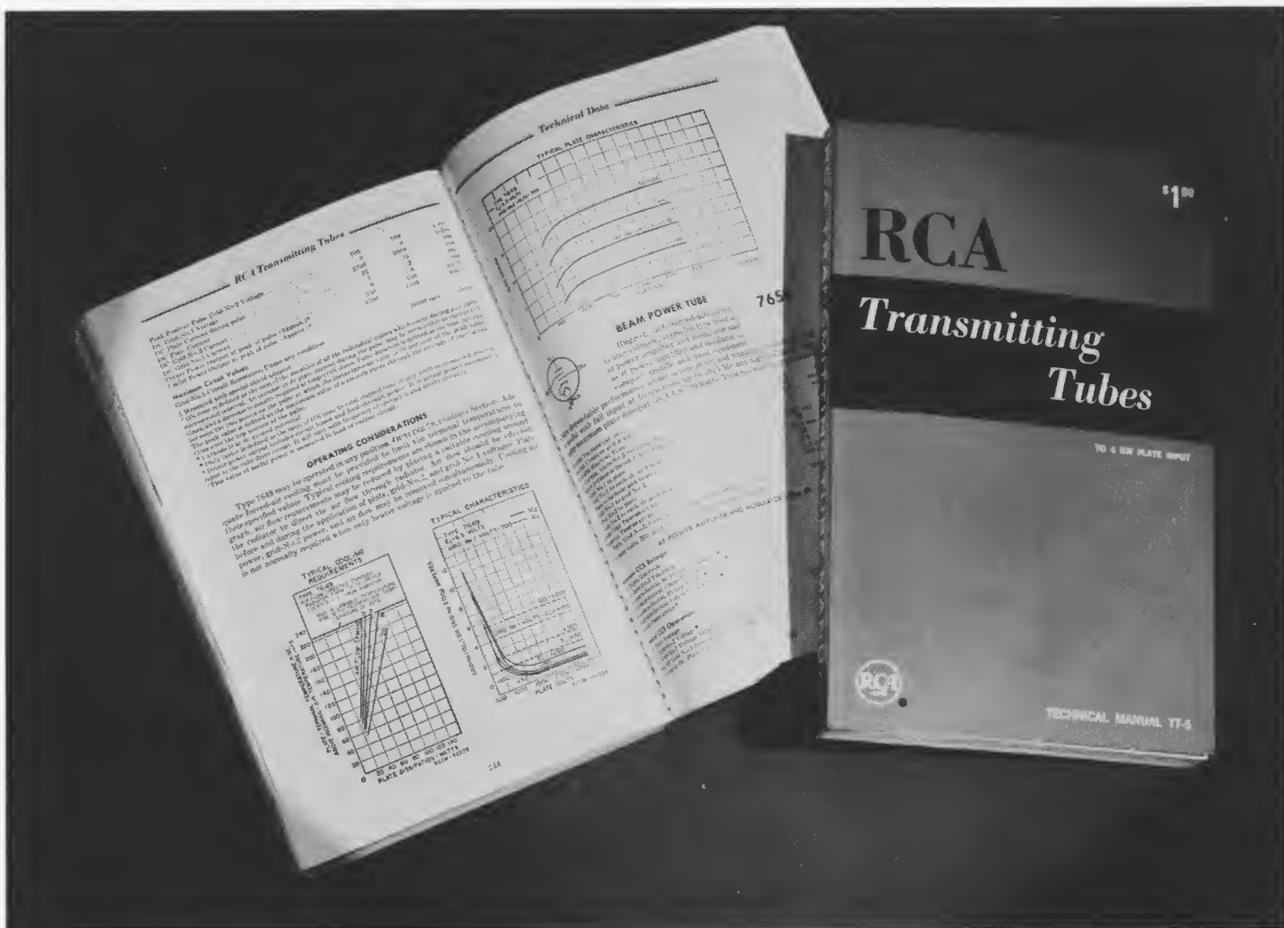


Figure 5: Construction for crystal mixer circuit.



Every ham will want a copy of RCA's new, 320-page transmitting tube manual. This edition is the largest to date and has been thoroughly revised and updated to keep pace with advances in power-tube technology.

Of tremendous value to radio amateurs, engineers, and others technically concerned with transmitting tubes, the new TT-5 manual provides information for the latest RCA types, including the new cermolox family of ceramic-metal tubes. Coverage of single-sideband information has been considerably increased and includes new single-sideband ratings; discussions of linear power amplifier design; and sample calculations of operating conditions for two-tone modulation.

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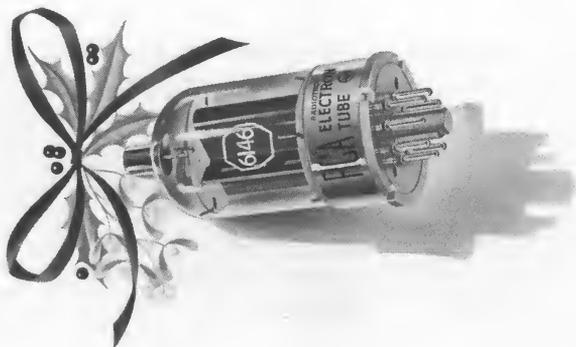
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