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OCTOBER, 1945

The Radio Amateurs' Journal

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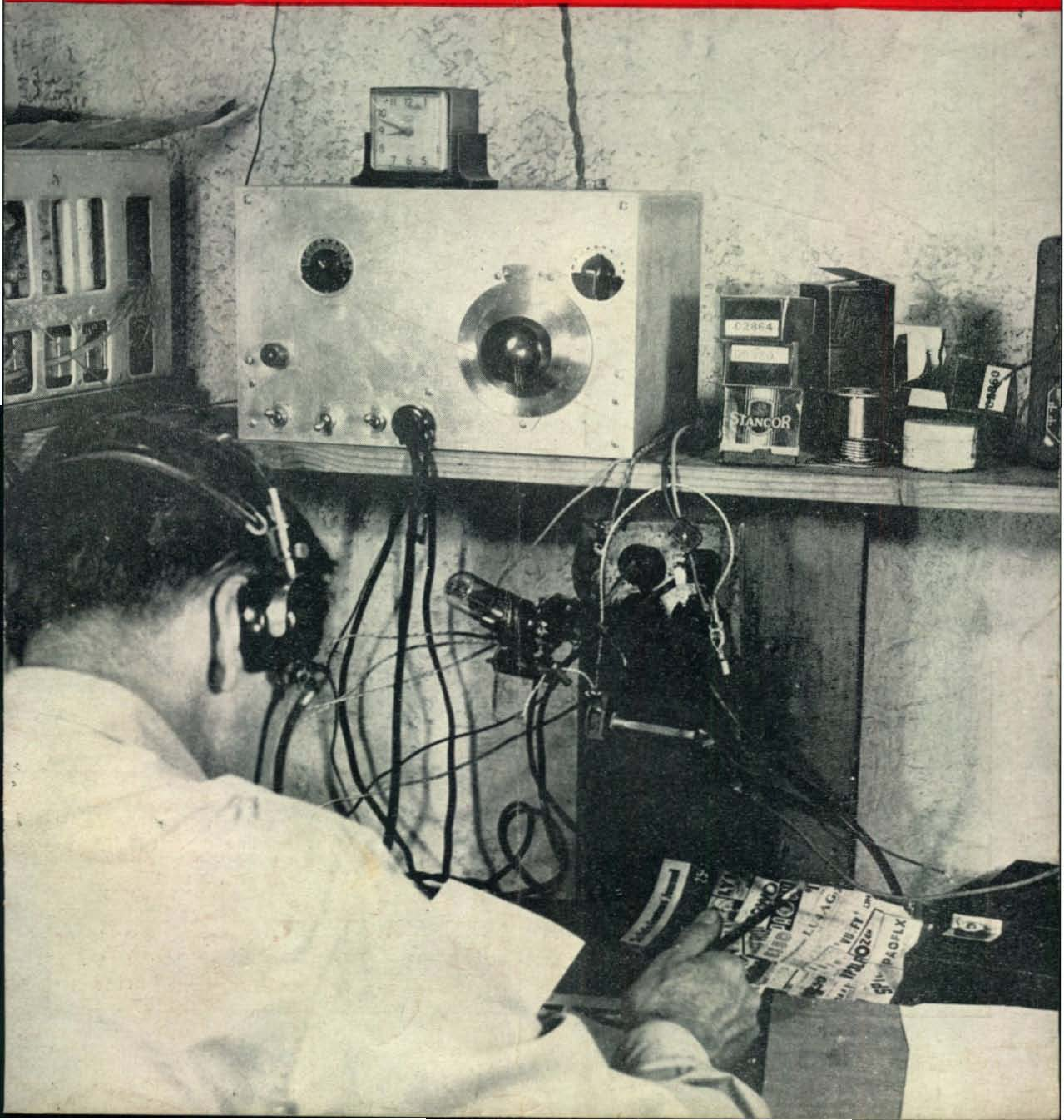
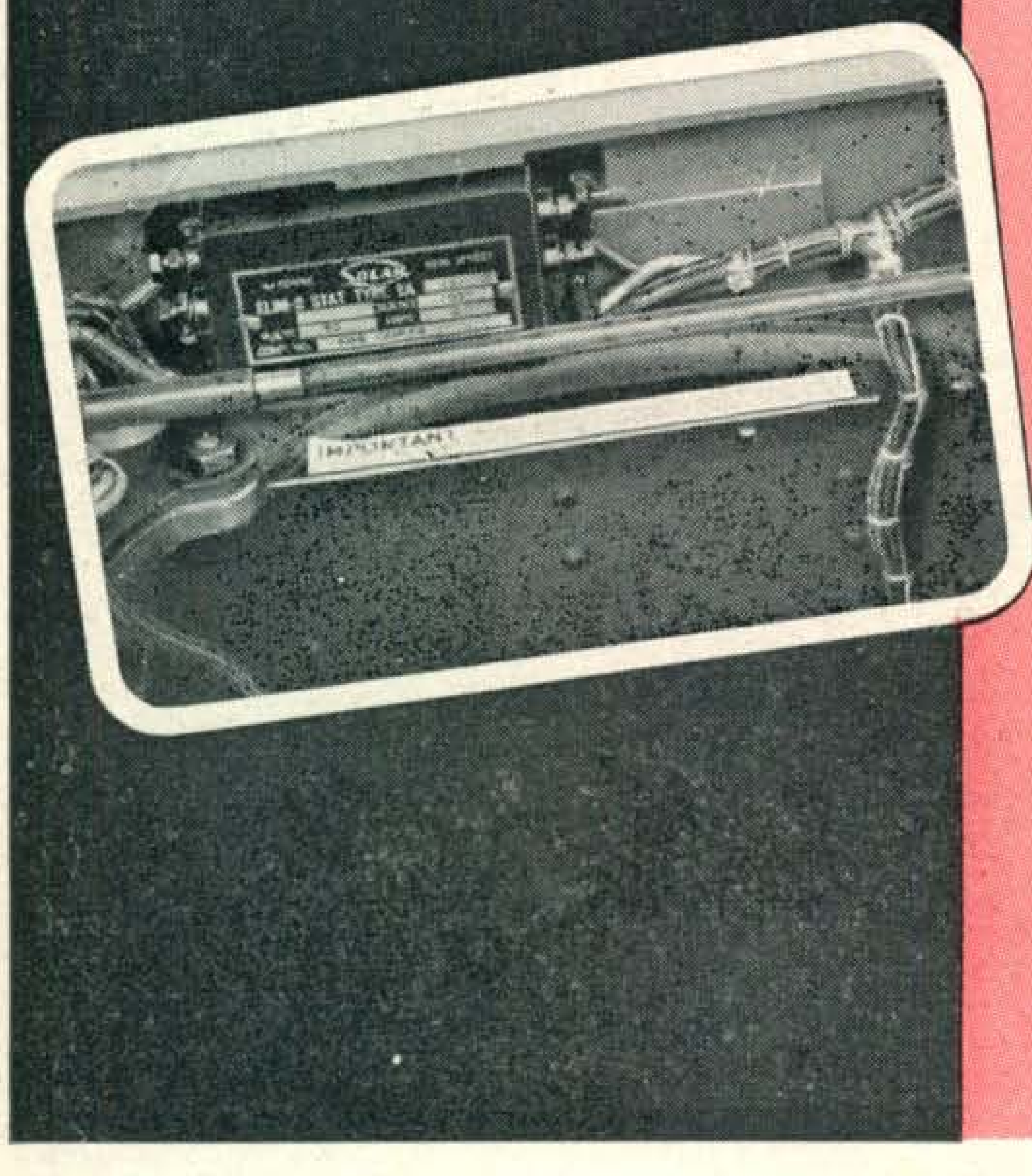


Quick as a wink the Fairchild Night Owl Camera records enemy movements intended to be hidden by darkness. Quick as a flash the radio of the photo-reconnaissance plane keeps touch with its base—and clearly – for Solar Elim-O-Stats are part of the electronic equipment of these highly perfected cameras. This is but one of many instances where Solar Elim-O-Stats are being used to absorb local interference and keep speech channels free. Let Solar advise you on radio-noise suppression.



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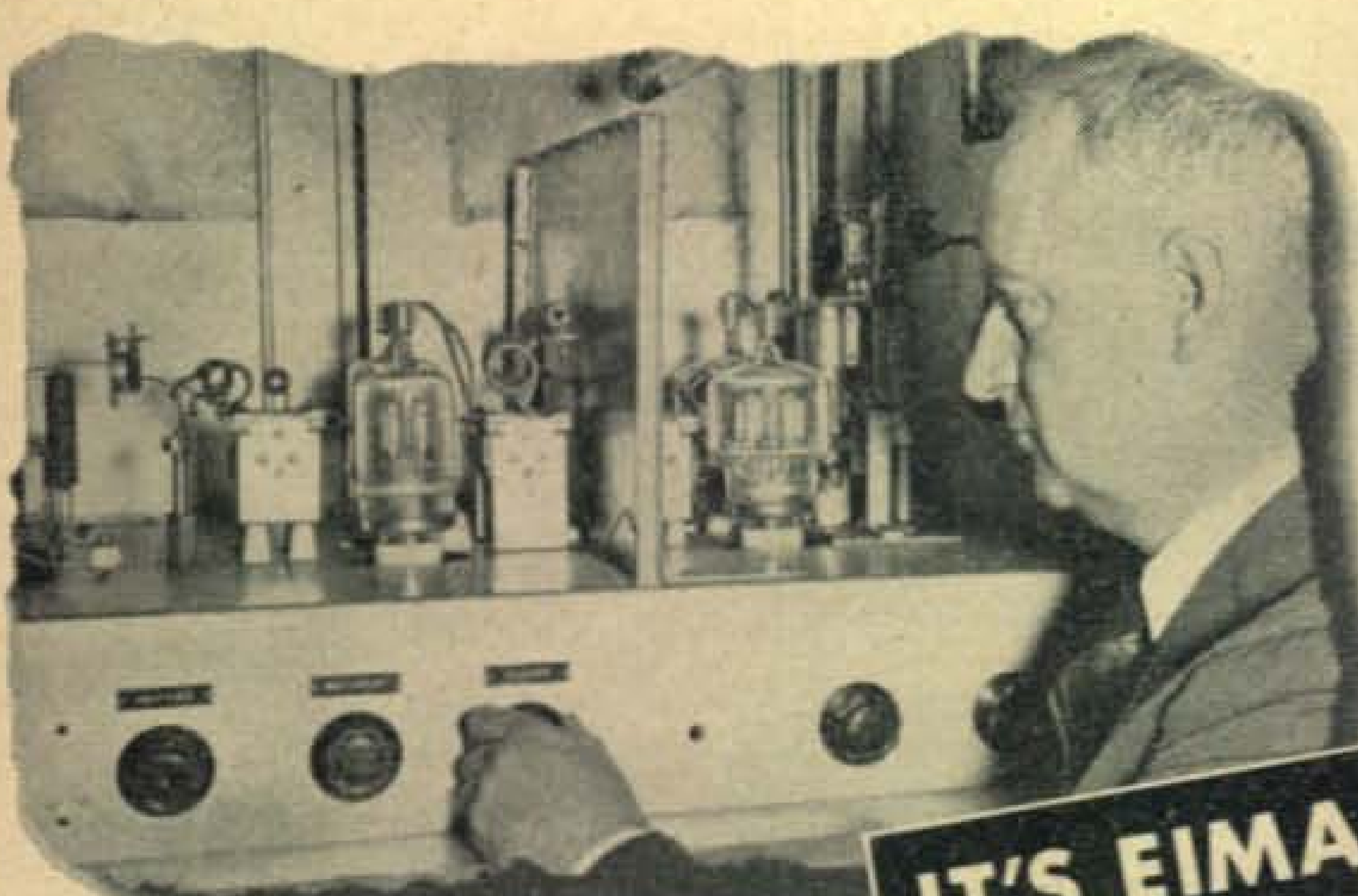
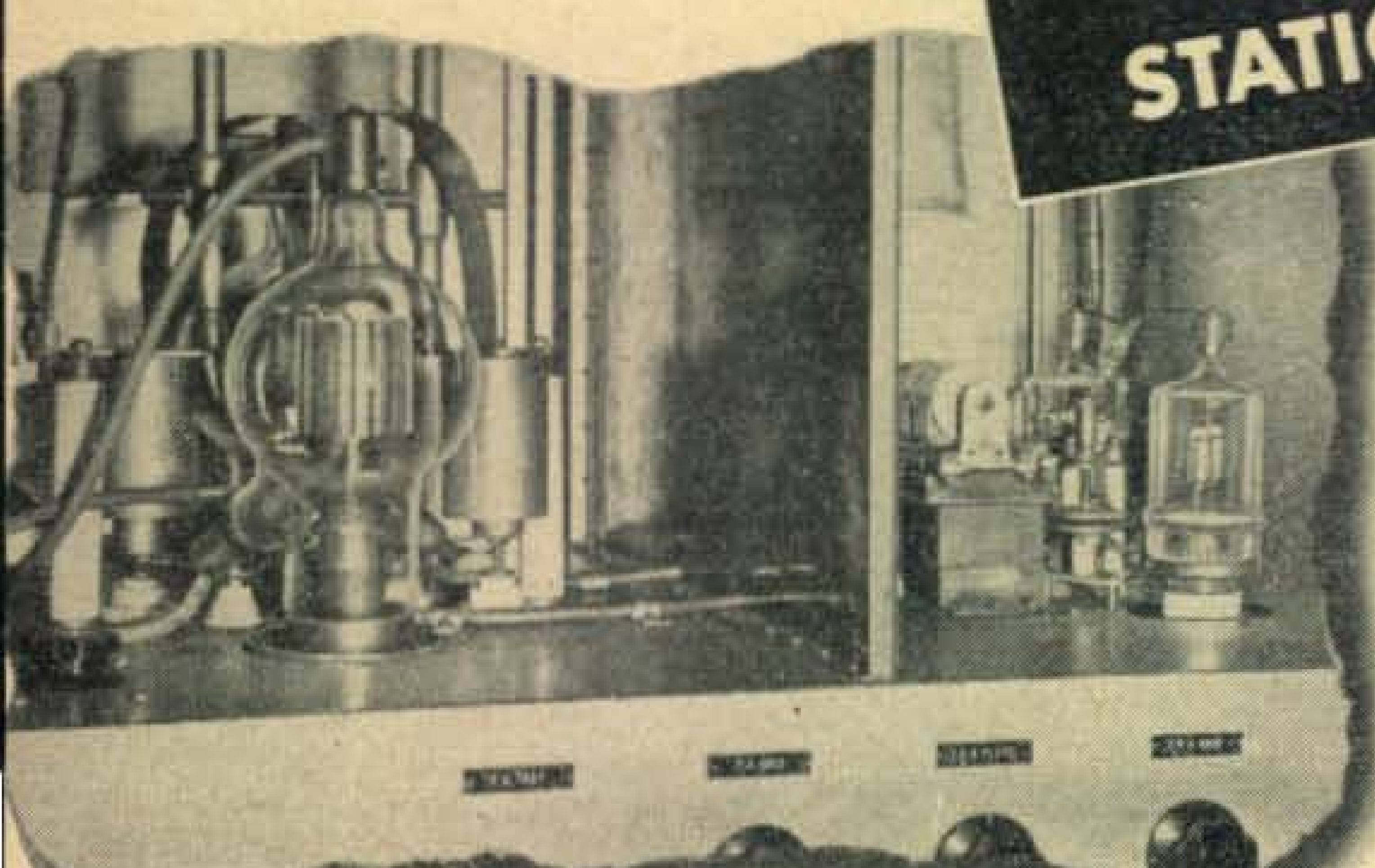


A. H. Brolly . . . *Chief Engineer of Television Station WBKB, Chicago, adjusts the grid circuit of the Eimac 304-TL's in the Class B linear stage of the video transmitter.*

IT'S EIMAC AGAIN! FIRST CHOICE FOR THE KEY SOCKETS AT TELEVISION STATION WBKB

Mr. Brolly calls attention to the Eimac 1000-T's in the final stage of the Audio FM Transmitter which operates at 65.75 megacycles. It is a very stable amplifier of good efficiency.



The video transmitter operates at 61.25 megacycles; peak power output is 4 KW which provides a television service throughout metropolitan Chicago and reaches suburbs out to 35 miles or more.

Eimac 152-T's are used in the modulated stage and 304-T's in the first Class B linear amplifier of the video transmitter.

Grid modulation is employed at WBKB and a broad band of frequencies must be passed in all stages following the modulated amplifier. Multiple-tuned resistance loaded coupling circuits are used between stages.

Performance, stability, dependability are good reasons why Eimac tubes are to be found in the key sockets of the outstanding new developments in Electronics. Balaban & Katz, owners of television station WBKB of Chicago, offer potent confirmation of the fact that Eimac tubes are first choice of leading Electronic Engineers the world over.

E. F. Cawthon and W. R. Brock are operating the station which has been broadcasting television programs with the present equipment since 1942 and began operation on a commercial schedule in October, 1943.

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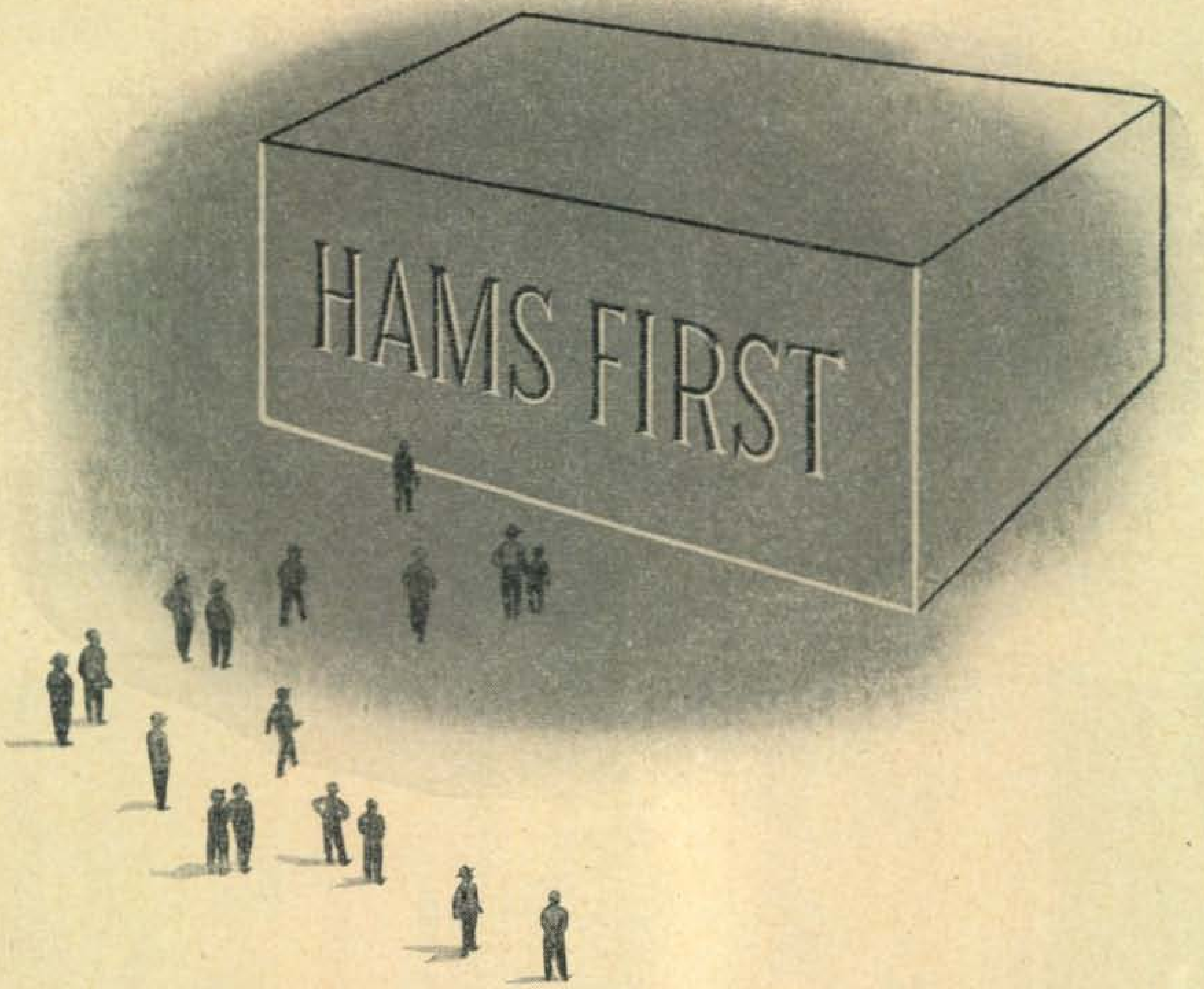
HAMS FIRST

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VOL. 1, No. 10 **OCTOBER, 1945**

CONTENTS

COVER

At work in the shack. Frequency meter on shelf is described on page 18

ARTICLES

MISCELLANEOUS

ZERO BIAS

THE RECENT series of catastrophic hurricanes that devastated many coastal areas from the Gulf to Hatteras, has placed grim emphasis on the necessity for amateur radio and the desirability of clearing adequate channels for such operation, not only in distress communications, but also for the amateur's regular work which keeps him on the air and insures his ubiquitous presence when and wherever disaster strikes. The pattern has been tragically monotonous, with communities and large areas isolated and "communications wiped out."

The amateur is now operating on 112-116 megacycles, and will probably shift over to his proper 144-148-mc band in the near future. The facilities of his station are available for emergency traffic. Much of the equipment is manned by WERS veterans, and close tie-ins are being organized with the Red Cross. However, the v-h-f bands alone provide a woefully unsatisfactory answer to the problems of disaster communication. We write this in full recognition of what has been accomplished on 112 and of the possibilities of these frequencies, particularly in reference to mobile installations. Admittedly, 112 or 144 is indispensable as a complementary disaster service. But definite limitations are imposed by distance and terrain, and nature's holocausts have no more respect for a target than a Nip balloon or a buzz-bomb. The inadequacy of the very high frequencies in many conceivable instances of emergency communication is recognized by the FCC in its proposal to establish amateur emergency networks somewhere between 1650 and 1800 kilocycles—in the neighborhood of our old and long-suffering 160-meter band.

Unless the complete restoration of the pre-war 1750-2050-kc allocation is contemplated in the near future (which is extremely dubious), we can see little sense in the proposed emergency allocation. Certainly it would not be so effective as an extra kilocycle or two on the fringe of our virtually assured 80-meter band. It will hardly spur the amateur's enthusiasm for emergency work if he must build special equipment for the job, and be permitted to use it only for occasional test transmissions while sitting around waiting for an earthquake. Of course, the Commission and others may point out that amateurs and the general citizenry did practically the same thing with the WERS. However, there were many shades of difference in the wartime situation. It was the patriotic thing to do. The emergency was always present, its grim potentiality reiterated with every newscast and headline. The WERS in many sections of the country were well disciplined. Last, and by no means least, it was the only way the amateur could stay on the air. Obviously, these arguments offer little incentive to the establishment of a 160-meter net (with general operation excluded), where the additional equipment may run anywhere from a set of coils, a special crystal and probably a globe-girdling antenna, to a complete extra rig.

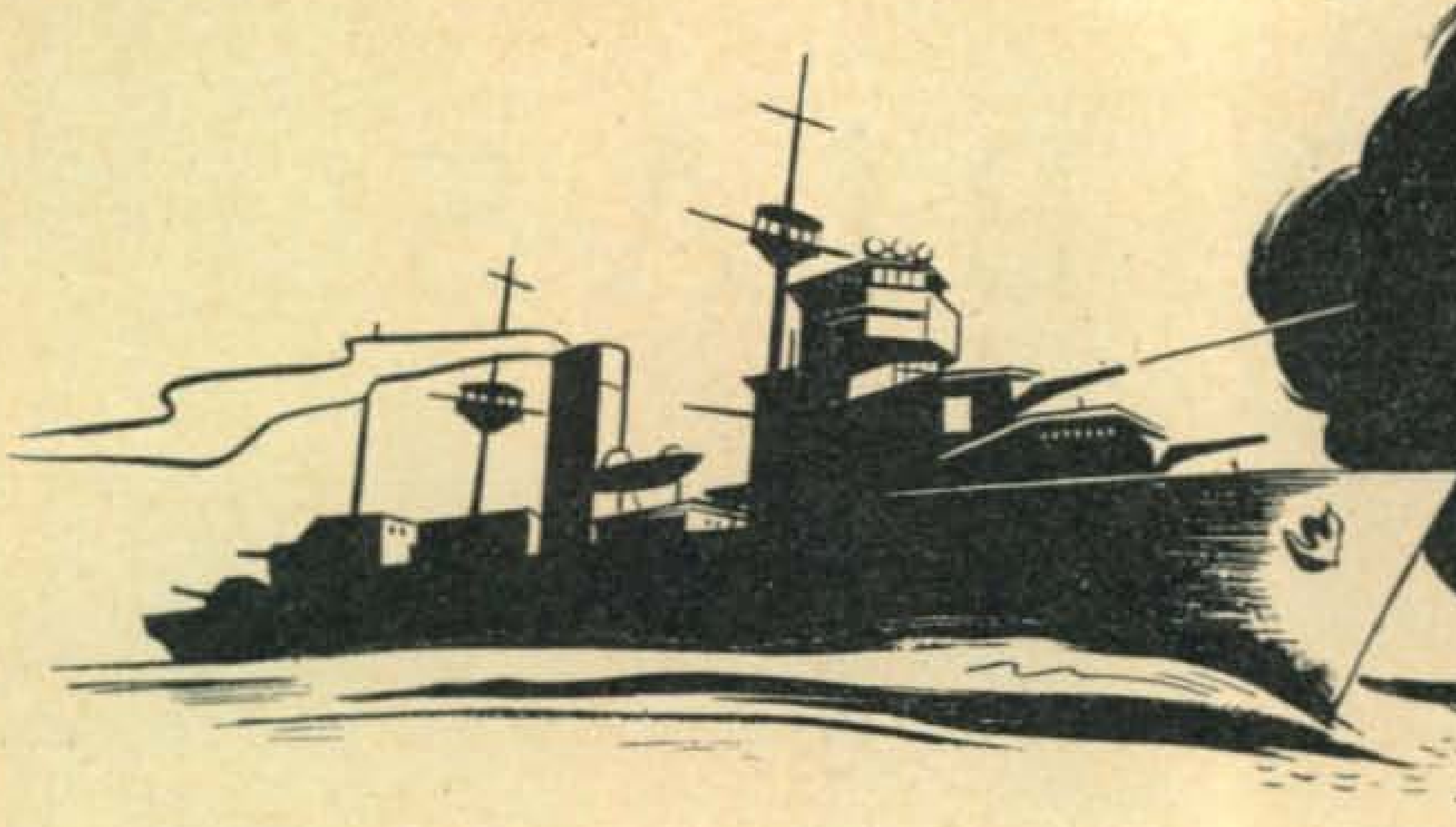
As we write this, a tropical hurricane has veered in from the Bahamas, and is cutting a hundred-mile-per-hour swath across the Keys and southern Florida. Prior to Pearl Harbor, Florida probably had the best organized disaster net of any state. (If we're stepping on some New England toes, just toss it off as the ravings of a Yankee who operated for several winters with the Florida net.) The net was on 80 cw, and was well disciplined by the Army Amateur Radio System. Six nights a week, it handled messages and rag-chewed, with one evening out of seven given over to drill and strictly AARS traffic. Similar setups, of course, existed in many other sections of the country.

The point is, the amateurs were operating *continuously* and *naturally* within a band that could be alerted for emergency at a moment's notice. This is the big argument (aside from the characteristics of the band) in favor of an emergency net working in or close to the 3500-4000-kilocycle allocation, where nothing more would be required than a flick of the ECO, or at the most, an extra crystal. If the FCC prefers to designate a narrow range of frequencies at either end of the 80-meter band for disaster communications (rather than intra-band operation), the amateur is hardly one to turn up his nose at an extra five or ten kilocycles.

The main thing now, if only from the emergency point-of-view, is to return the 80-meter channels to the amateur as quickly as possible. The Board of War Communications should be

[*Continued on page 46*]

A FAMILIAR NAME *with* OUR NAVY



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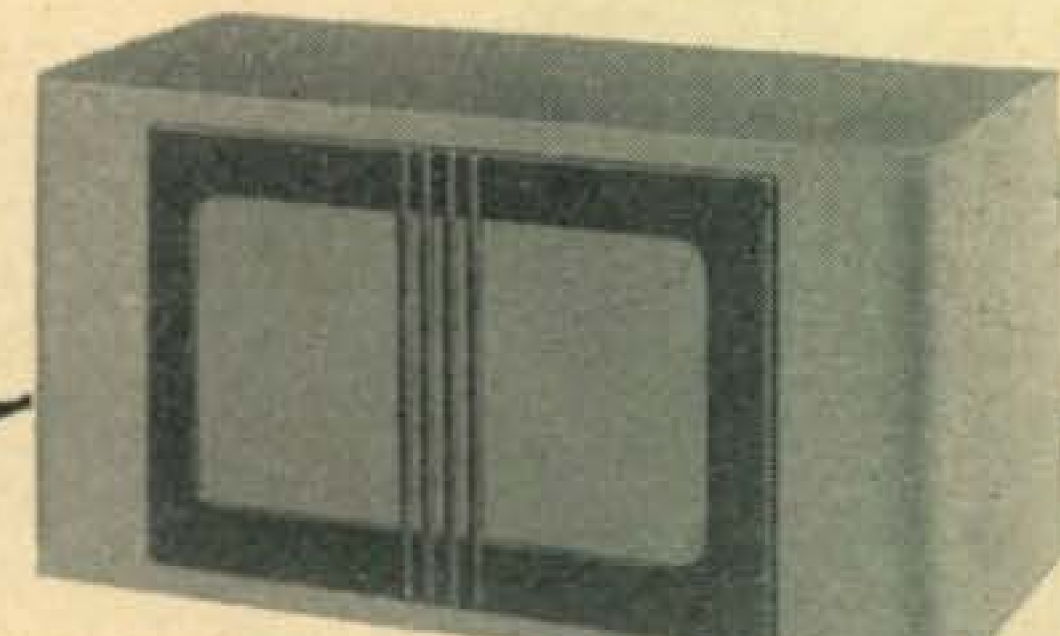

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EXCITERS FOR THE NEW AMATEUR BANDS

JUGGLING 80-METER CRYSTALS TO HIT 52.5-54 MC AND COVER THE REST OF THE BANDS UP TO 148 MEGACYCLES

HERBERT S. BRIER, W9EGQ

THE FACT THAT the new amateur bands are not all harmonically related has been a stumbling block to many amateurs in designing exciters. The following discussion and diagrams show how the job may be done quite simply.

The proposed 21-megacycle band intrigues most amateurs although it will probably be the last one authorized. A tritet oscillator, using active 7-megacycle crystals, with the plate circuit tuned to the third harmonic of the crystal frequency, will easily drive an 807 on this band. Using 3.5-megacycle crystals, there are two approaches to the problem—doubling in the oscillator and tripling in the next stage, or tripling in the oscillator and then doubling.

The circuit for a practical exciter is shown in *Fig. 1*. This circuit is interesting, because it allows all bands between 3.5 and 30 megacycles to be covered, using 3.5-megacycle crystals. It will deliver enough excitation to drive a quarter-kw modulated amplifier on each band. Coil L_2, of *Fig. 1*, with the 7 and 14-mc winding, is also used for 21-mc output from 3.5-mc rocks when the oscillator plate is tuned to 10.5 megacycles and the 807 functions as a doubler.

The 50-54-megacycle band presents the greatest difficulties. There is no practical way of working the entire band with in-the-band crystals, but *Fig. 2* shows how 52.5 to 54 megacycles can be covered with 3.5 to 3.6-megacycle crystals. The 6L6 oscillator has its plate circuit tuned to the fifth harmonic of the crystal, driving an 815 as a tripler. With active crystals the output from the oscillator will be sufficient to drive the 815. Coils L_2 and L_3 are center-tapped. The neutralizing capacitors C_5 and C_6 are small tabs of metal 1″ square, mounted on pieces of stiff wire and placed near the 815, parallel with the plates. Neutralization is not required if only 52.5-54-megacycle operation is desired. When C_4 is a 140 $\mu\mu$f per-section capacitor, coil L_3 is the same as L_2 with a 2-turn link wound around the center plus a special 52.5-54-megacycle inductor consisting of four turns of #10 wire wound with a 1¼″ diameter and 2½″ long.

Approximately 10 watts output should be available from the 815—sufficient to drive a

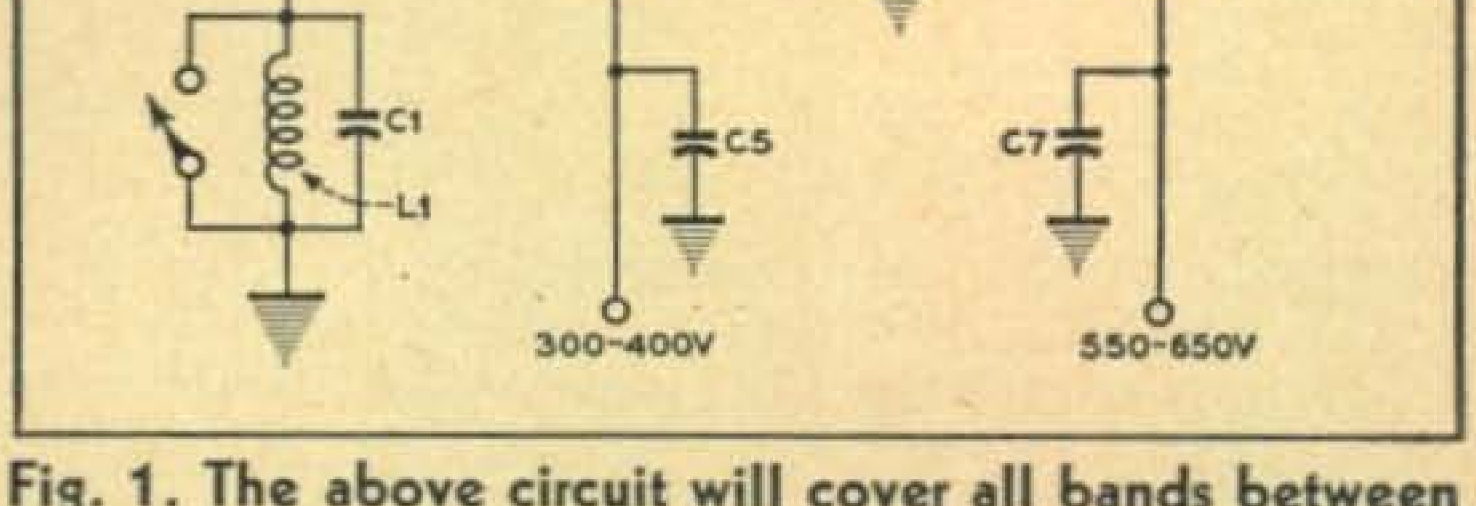
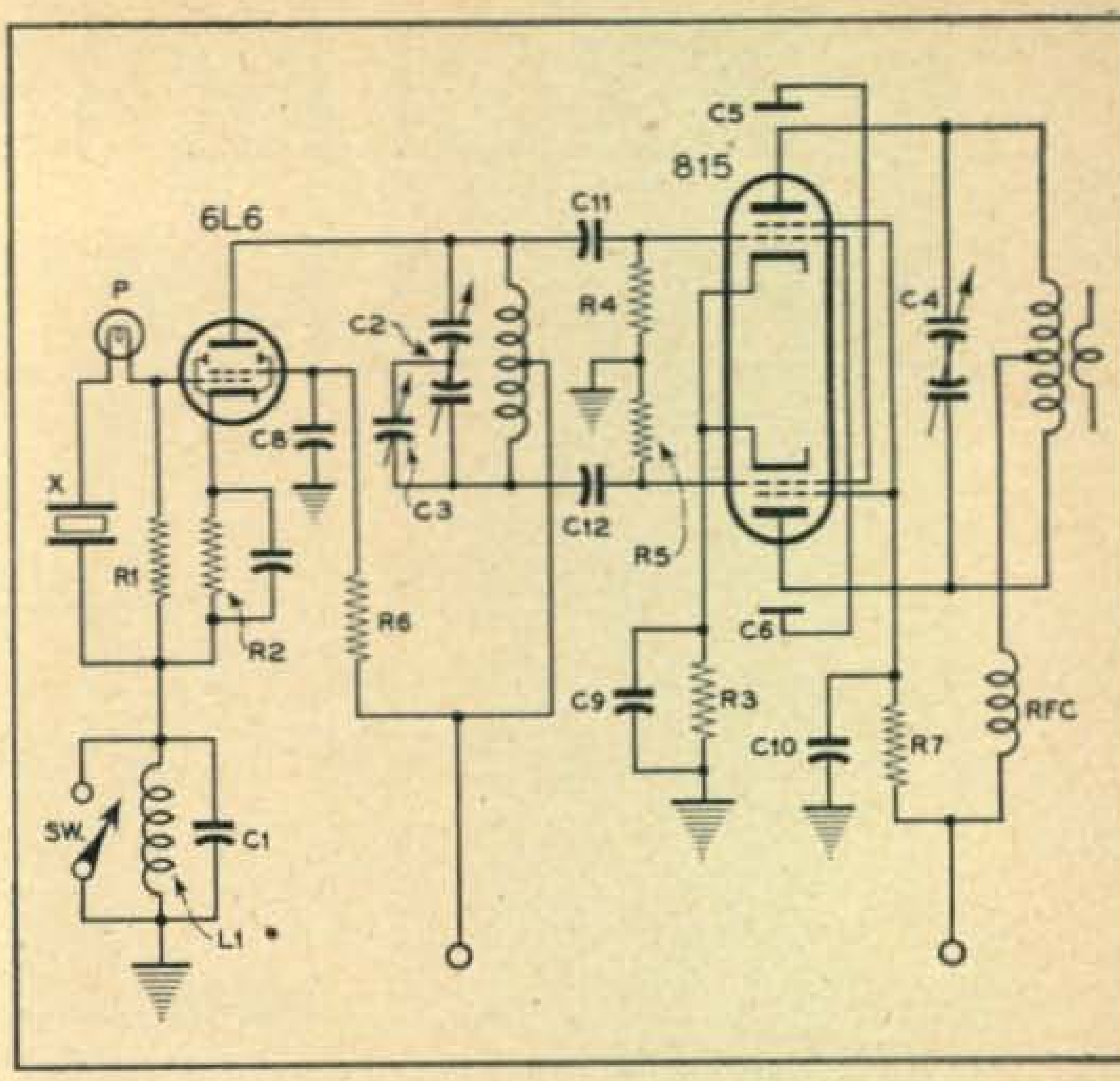


Fig. 1. The above circuit will cover all bands between 3.5 and 30 megacycles with 80-meter crystals. Parts and values are as follows:

C_1—200 $\mu\mu$f for 3.5-mc xtals, and 100 $\mu\mu$f for 7-mc xtals
C_2, C_3—150 $\mu\mu$f
C_4—50 $\mu\mu$f
C_5, C_6, C_7, C_8, C_9, C_{10}—.002 μf
L_1—10 turns #22 1½″ dia. 1″ long for 3.5-mc xtals
6½ turns #22 1½″ dia. 3/4″ long for 7-mc xtals
L_2—16 turns #18 1½″ dia. 1½″ long for 3.5 and 7 mc
7 turns #18 1½″ dia. 7/8″ long for 7 and 14 mc
4 turns #14 1½″ dia. 1″ long for 14, 21 and 28 mc
L_3—same as L_2 with 2-turn links added to the B+ end of each coil
P—60 ma pilot bulb
R_1—100,000 ohms
R_2, R_3—500 ohms
R_4—25,000 ohms
R_5, R_6—50,000 ohms
Sw—closed for operation on xtal frequency

Fig. 2. Hitting a good slice of the 54-megacycle band with an 80-meter xtal. Components and coil data as follows:

C_1—200 μμf for 3.5-mc xtals
100 μμf for 7-mc xtals
50 μμf for 14-mc xtals
C_2—140 μμf per section
C_3—15 μμf (to balance excitation to the 815)
C_4—35 μμf per section (use 140 μμf per section if all bands are to be tuned with this exciter)
C_5, C_6—neutralizing capacitors. See text
C_7, C_8, C_9, C_{10}—.002 μf
C_{11}, C_{12}—50 μμf
L_1—10 turns #22 1½″ dia. 1″ long for 3.5-mc xtals
6½ turns #18 1½″ dia. 3/4″ long for 7-mc xtals
6 turns #14 1″ dia. 3/4″ long for 14-mc xtals
L_2—40 turns #20 2″ dia. 2½″ long for 3.5 -mc
20 turns #18 2″ dia. 2½″ long for 7-mc
12 turns #14 2″ dia. 2½″ long for 14-mc
10 turns #14 2″ dia. 2½″ long for 21-mc (also used to tune to 18-mc when working the 6-meter band)
6 turns #10 2″ dia. 2½″ long for 28-mc
L_3—(with C_4-35 μμf per section)
14 turns #14 2″ dia. 2½″ long for 14-mc
10 turns #14 2″ dia. 2½″ long for 21-mc
8 turns #10 2″ dia. 2½″ long for 28-mc
4 turns #10 2″ dia. 2½″ long for 52.5-54-mc
P—60 ma pilot light
R_1—100,000 ohms
R_2, R_3—500 ohms
R_4, R_5—30,000 ohms
R_6—50,000 ohms
R_7—15,000 ohms
Sw—closed for fundamental xtal frequency operation



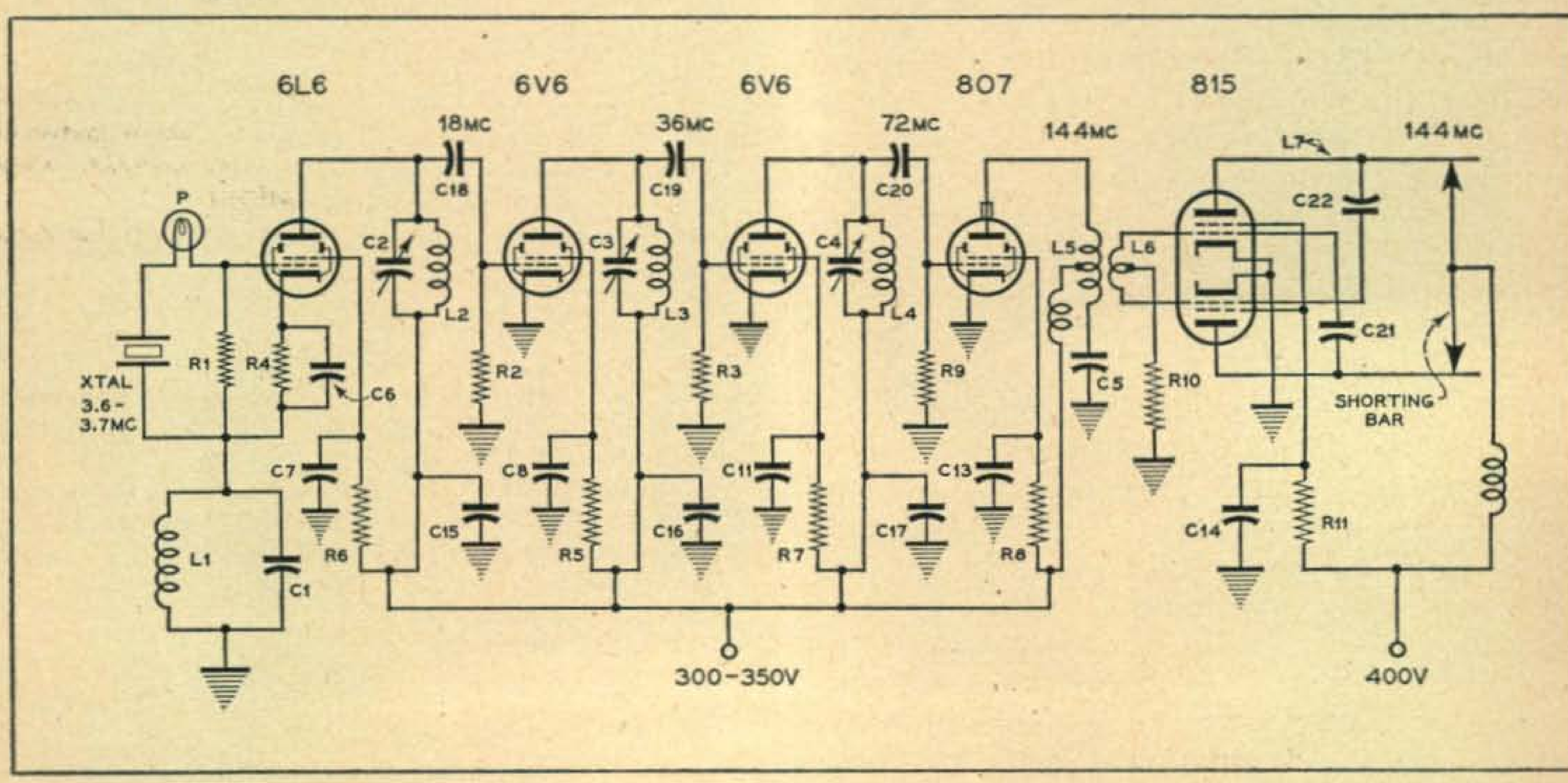
100-watt modulated triode in the final stage. By making all coils plug-in, and using three crystals, all bands between 3.5 and 54 megacycles can be tuned with this exciter.

The 144-148-megacycle band can be reached by using the fifth harmonic of crystals between 3.6 and 3.7 megacycles and a series of doublers, as shown in *Fig. 3*. Neutralizing capacitors C_{21} and C_{22} are similar to those described for *Fig. 2*. The square pieces of metal are mounted on

[*Continued on page 46*]

Fig. 3. This circuit covers the 144-148-megacycle band with the following parts and constants:

C_1—200 μμf
C_2—50 μμf
C_3—25 μμf
C_4, C_5—15 μμf
C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17}—.001 μf
C_{18}, C_{19}, C_{20}—100 μμf
C_{21}, C_{22}—See text
L_1—10 turns 1½″ dia. 1″ long
L_2—5 turns 1½″ dia. 1″ long
L_3—3 turns 1½″ dia. 1″ long
L_4, L_5—3 turns 3/4″ dia. 1″ long
L_6—2 turns 3/4″ dia. close-wound center-tapped
L_7—10″ lengths ½″ dia. tubing spaced 1″
P—60 ma pilot light
R_1, R_2, R_3—100,000 ohms
R_4—500 ohms
R_5, R_6, R_7, R_8—50,000 ohms
R_9—25,000 ohms
R_{10}, R_{11}—15,000 ohms



BALANCED R-F IMPEDANCE MEASURING SET

A VERSATILE INSTRUMENT FOR MEASURING THE IMPEDANCES OF TWO-WIRE FED ANTENNAS IN HIGH-FREQUENCY OPERATION

FRANK C, JONES, W6AJF

THE TWIN, or parallel-T, impedance bridge enables the user to obtain improved reception or transmission in the high-frequency region through better impedance matching of the transmitter or receiver to the antenna system. The net result is an appreciable reduction in losses due to impedance mis-match or standing wave effects.

With the aid of the Impedance Measuring Set it is a simple matter to determine definitely the correct operational adjustments for any single-wire or two-wire-fed antenna system in the frequency range of 2 to 20 megacycles, thus assuring optimum efficiency from the particular antenna system in use. Guesswork is no longer necessary.

The cost of the measuring equipment is very reasonable and the components are generally available from the experimenter's surplus stock of parts. Operation of the impedance measuring set requires two associated pieces of apparatus: 1.—a short-wave receiver and, 2.—a test signal oscillator or signal generator. Any conventional signal oscillator will prove suitable, although the technical details for constructing an instrument of this type will be described in a forthcoming article by the author.

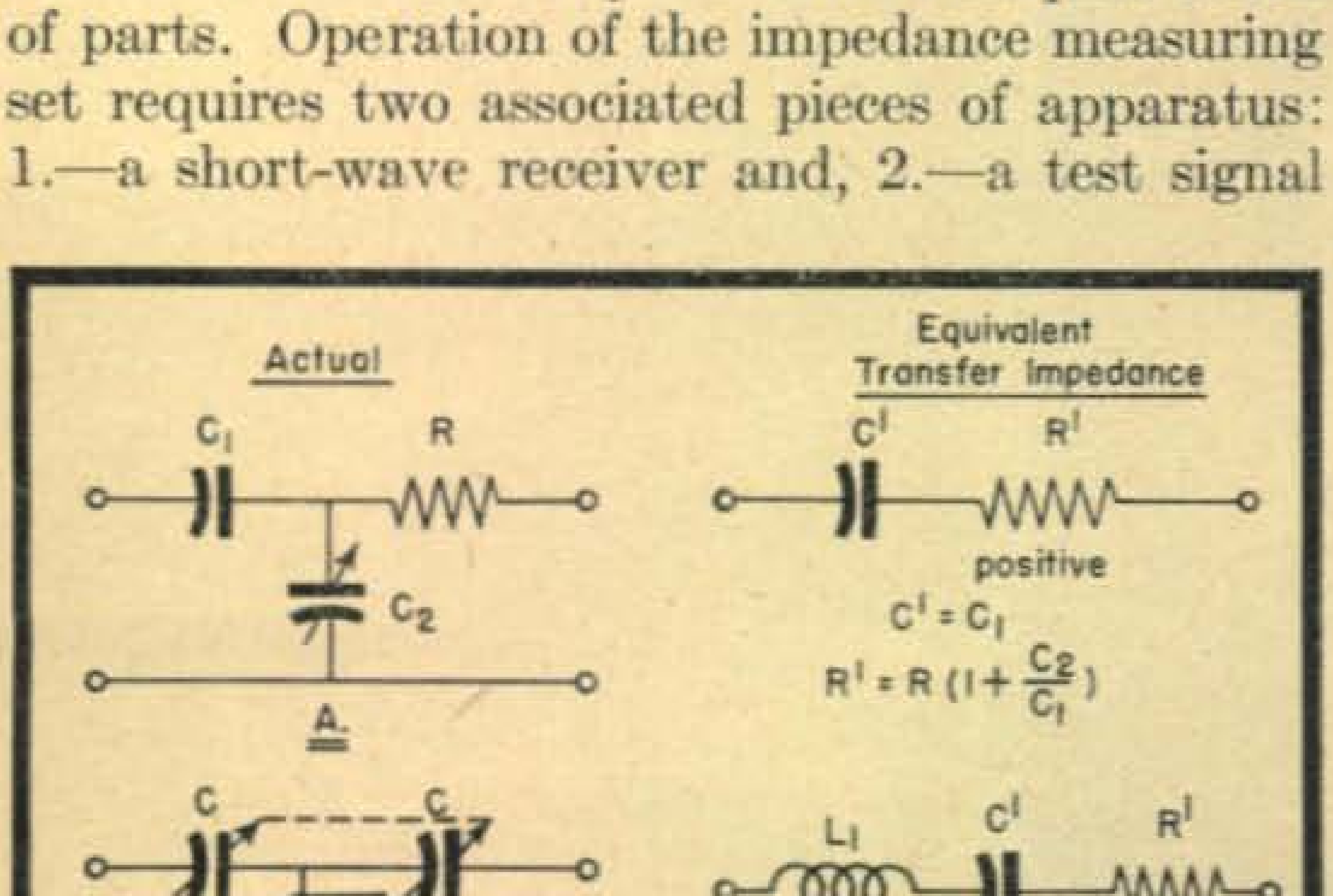


Fig. 1. Two T networks which, when combined, form a "Parallel T bridge"

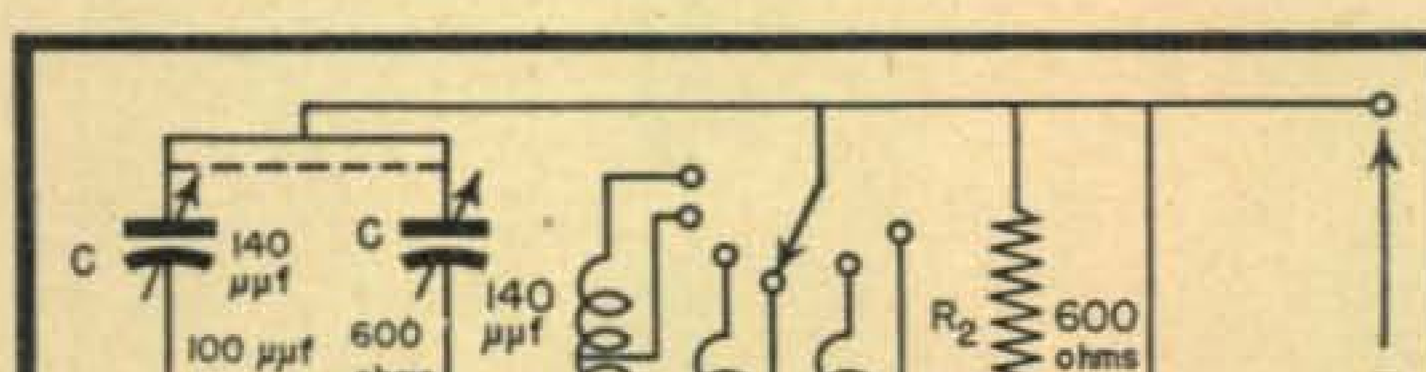


Fig. 2. Twin T impedance bridge for use with single-wire-fed antennas

Technical Description

Impedance bridges of the type described herein have been in use for several years for the purpose of measuring impedances throughout the range of 0.5 to 30 mc. The conventional instrument is useful for measuring impedance to ground if its resistive component is not less than 1,000 ohms. Lower values of resistance may be measured by changes in the constants of the bridge circuit, but with some sacrifice in accuracy. A more useful form of instrument was found desirable by the author, in order to measure balanced-to-ground impedances, such as rhombic and doublet antennas with two-wire feeders. For these purposes a balanced form of measuring set can be utilized to determine quickly proper impedance matching, antenna resonance, termination of rhombic antennas, and many other miscellaneous measurements.

The types of impedance bridges shown here may be constructed readily from available parts, and calibrated from an assortment of condensers and ½ or 1-watt resistors, if regular standards are unobtainable. A very few dollars invested in such measuring equipment will bring dividends in the form of increased antenna efficiency for both transmission and reception. The same bridge may be used to measure small inductances, and capacitances as low as a few μμf.

The impedance bridge is employed in conjunction with an r-f oscillator (an all-wave test signal generator is satisfactory), and a null detector

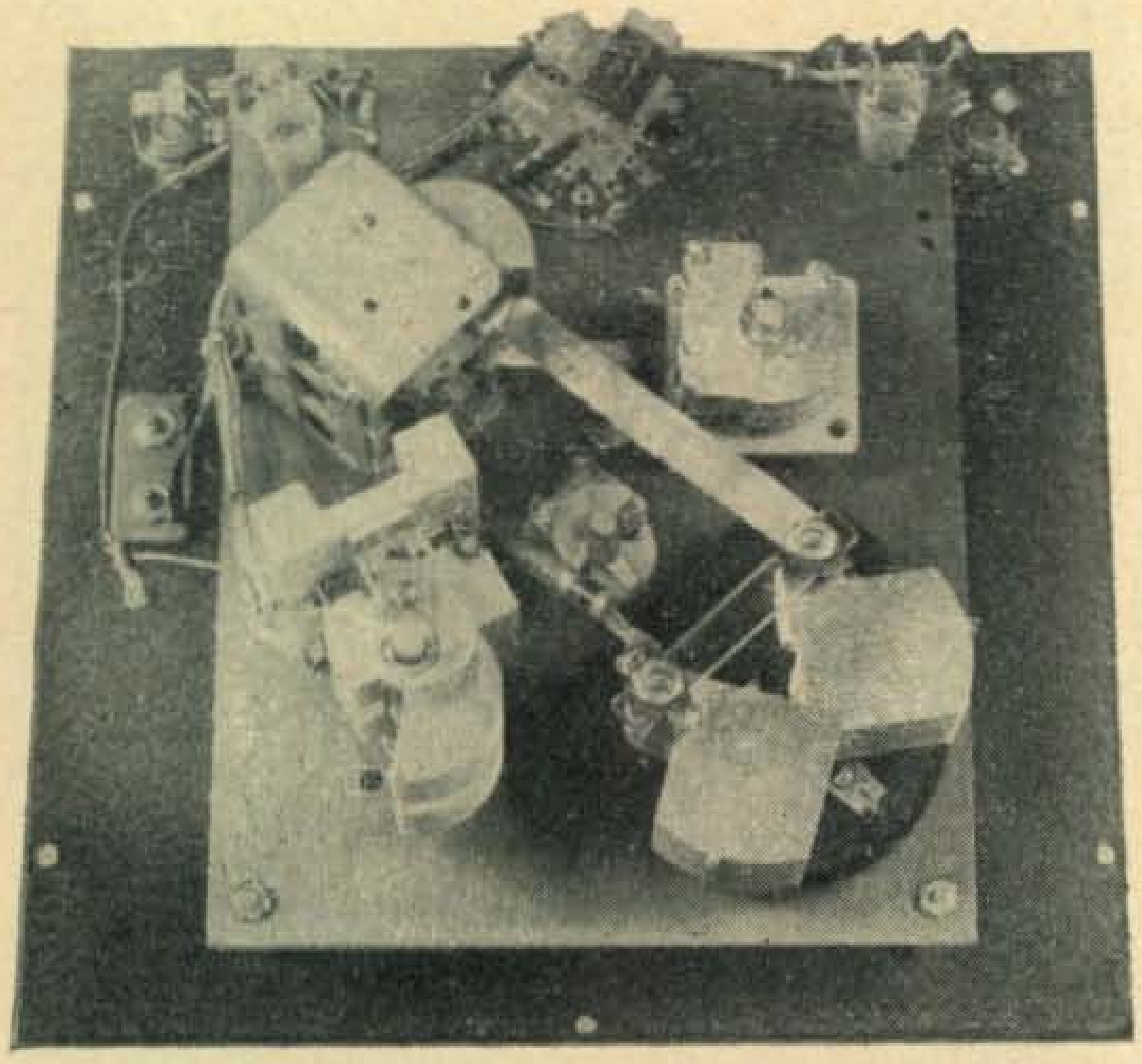


Fig. 4. Showing constructional details of the balanced r-f impedance bridge

such as a communications type radio receiver. A good v-t voltmeter with a sensitivity of .01 volt over a few megacycles range makes a very satisfactory null indicator. The unknown impedance is measured by connecting it across the bridge terminals and re-balancing the bridge for a null (no signal). Measurements over a wide range of frequencies at any desired points may be made in a few minutes, since the dials are calibrated directly in plus or minus μμf and the resistance is calibrated in ohms. The unknown impedance is measured as a resistance in shunt with an inductive or capacitive reactance.

Design of a Parallel-T Bridge

The parallel-T bridge, sometimes called the parallel twin-T bridge, consists in its most elementary form, of two T impedances in parallel, with nearly infinite impedance between its input and output terminals to a signal at one particular frequency. When two T networks of the type shown in *Fig. 1* are combined, the result will be

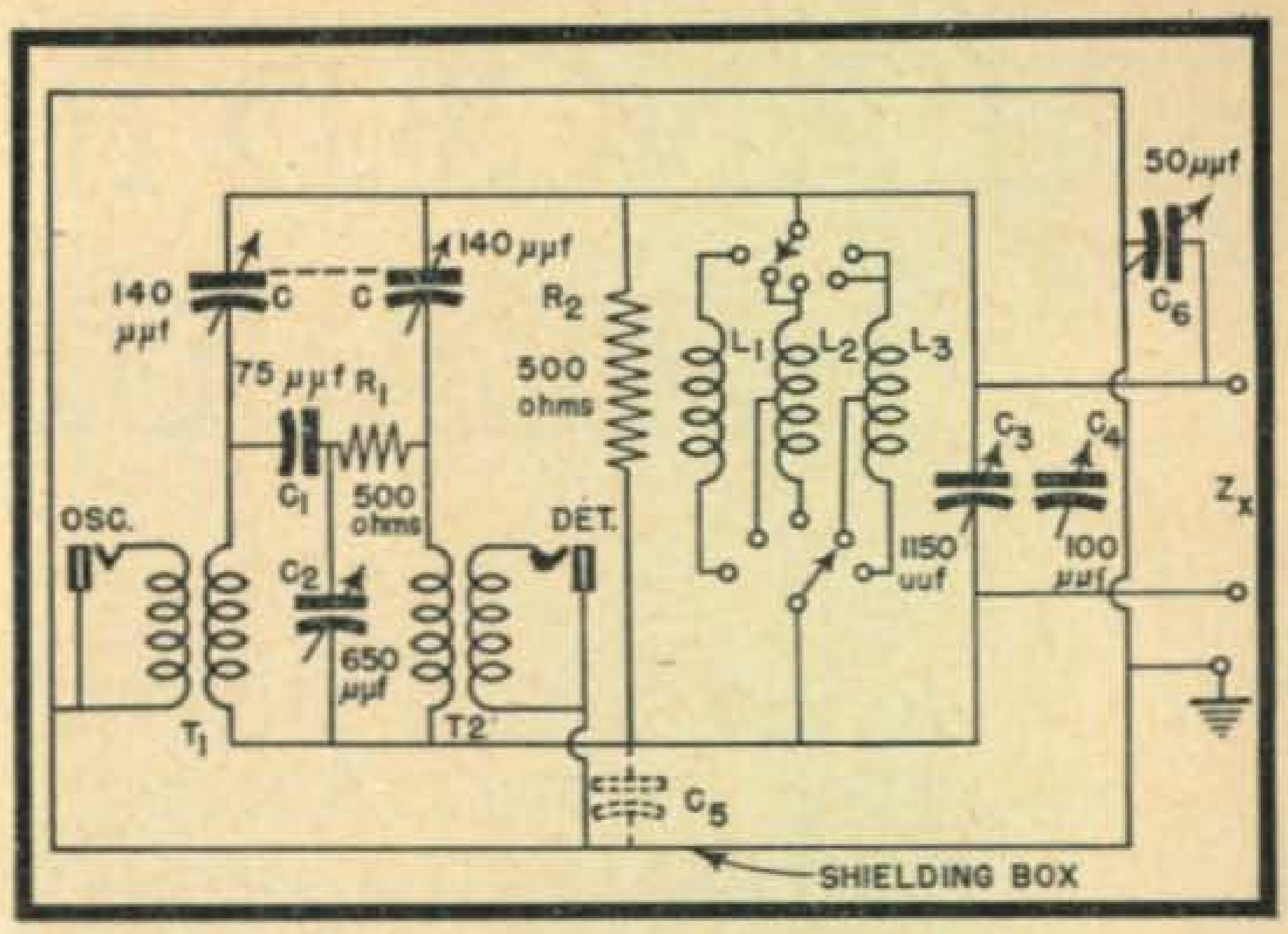


Fig. 3. The more versatile balanced r-f impedance bridge. Coil values may be the same as Fig. 2

an equivalent parallel tuned circuit with practically zero loss.

The T network of *A* in *Fig. 1* has an equivalent transfer impedance consisting of a positive resistance controlled by capacitance ratio, and a fixed capacitance in series. The T network *B* has an equivalent transfer network consisting of a negative resistance in series with a capacitance and an inductance. When the two are combined in parallel the result is a means of obtaining a transfer impedance of zero resistance and zero reactance (equivalent to an infinite impedance).

In practice the inductance *L* of *B* in *Fig. 1* is shunted with a variable capacitor in order to provide a continuously variable control of the reactive arm. This capacitor dial can be calibrated directly in μμf, and will give reasonable accuracy at all radio frequencies in the range of the measuring set. The resistive factor is con-

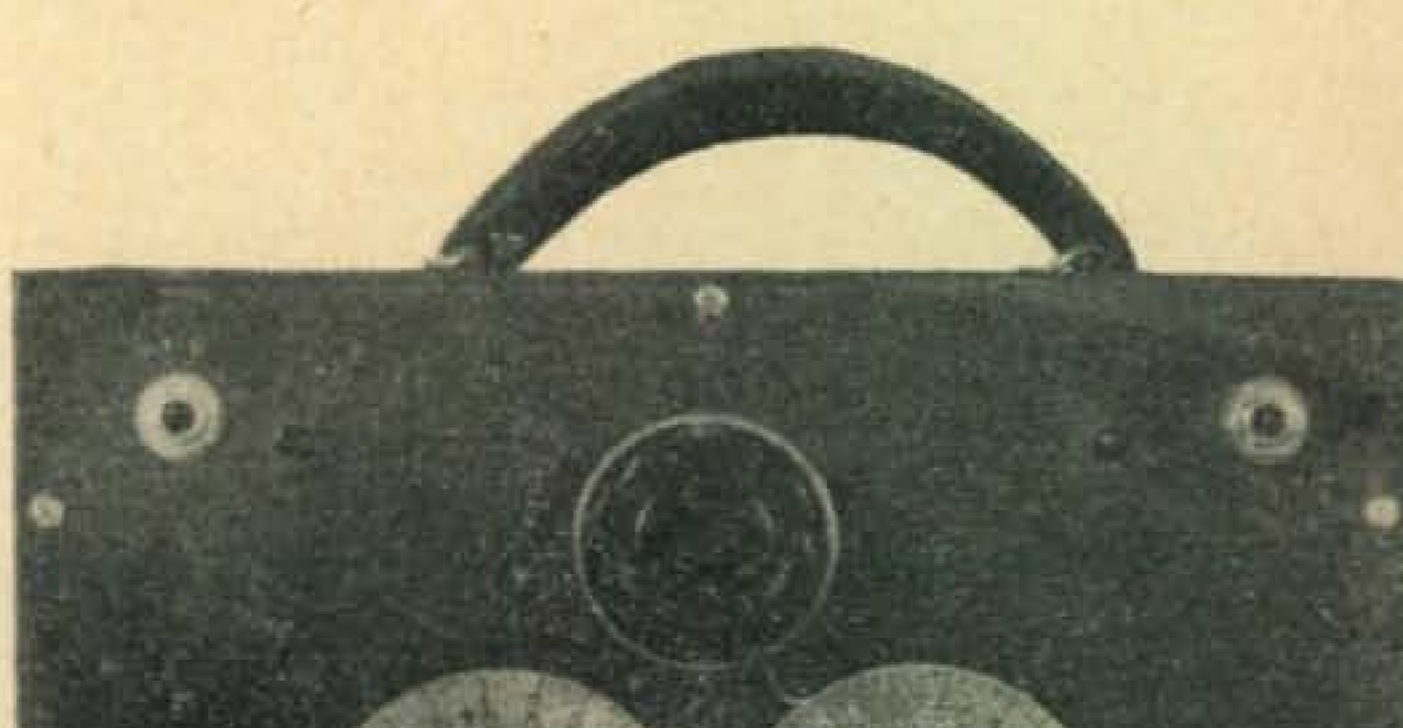


Fig. 5. Front view of the balanced r-f bridge

trolled by another variable capacitor which may have its dial calibrated directly in ohms. The bridge is balanced with its "Z" terminals in an open-circuited condition, then rebalanced by connecting the unknown impedance across these terminals, at each desired frequency. The resistive term is read directly from the dial, since the preliminary balance is always made with the dial set at the infinite resistance marking. The reactance is obtained as the difference in capacity readings from the capacitance dial.

A twin-T bridge, suitable for measuring single-wire-fed antennas, or other impedances to ground, is shown in *Fig. 2* while *Fig. 3* describes a balanced-to-ground bridge. This latter instrument has been used to measure two-wire feeder systems such as matched impedance doublets, or half-wave antennas and rhombics.

Electrical constants for the bridges can be calculated from the following formula:

$$R_2 = \frac{1}{\omega^2 C^2 R_2 \left(1 + \frac{C_2^1}{C_1}\right)}$$

where C_2^1 is always the initial capacitance setting of the *R* dial control.

The final balance becomes:

$$\frac{1}{R_x} + \frac{1}{R_2} = R_1 C^2 \omega^2 \left(1 + \frac{C_2}{C_1}\right)$$

This gives:

$$R_x = \frac{1}{\omega^2 C^2 R_1 \left(1 + \frac{\Delta C_2}{C_1}\right)} = \frac{C_1}{\omega^2 C^2 (C_1 + \Delta C_2)}$$

where ΔC_2 is the difference of capacities for the initial and final balance settings of C_2.

For initial balance

$$\frac{1}{\omega L} = \left(2C + \frac{C_2^1}{C_1} + C_3^1\right)\omega$$

For final balance:

$$\frac{1}{\omega L} + \frac{1}{X_x} = \left(2C + \frac{C_2^1}{C_1} + C_3\right)\omega$$

The difference between the foregoing equations becomes

$$\frac{1}{X_x} = \omega(C_3 - C_3^1) = \omega \Delta C_3$$

$$X_x = \frac{1}{\Delta C_3 \omega}$$

$$Z_x = \frac{R_x X_x}{\sqrt{R_x^2 + X_x^2}}$$

Small "x" of course indicates an unknown quantity in R (resistance) or X (reactance).

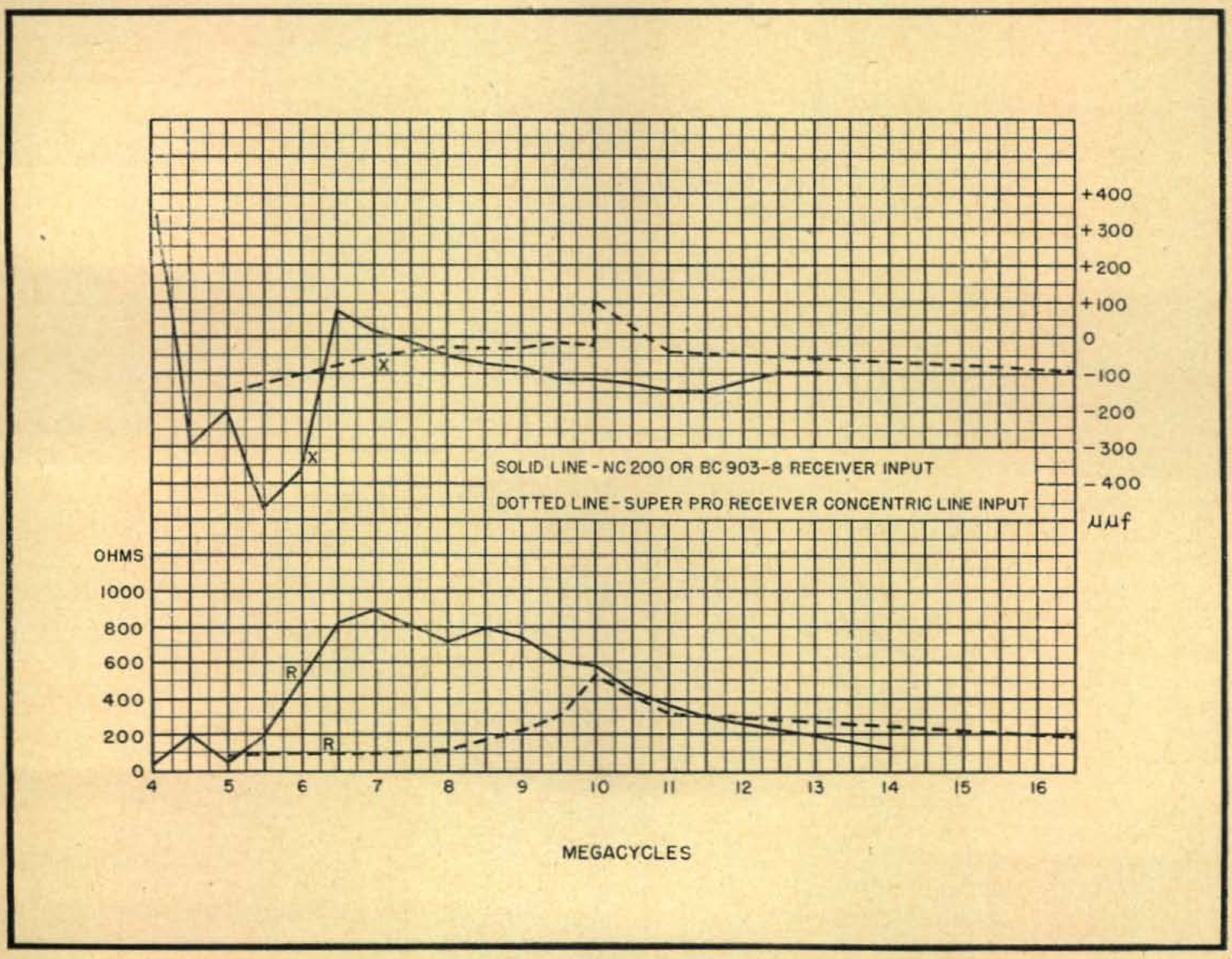


Fig. 6. Illustrating differences in receiver input impedance as checked with the bridge

The dial of capacitor C_2 can be calibrated directly in ohms if C is made variable and is set to obtain the initial balance at any given frequency.

The coil L does not enter into the calculations or measurements directly, since its effect is cancelled between the readings of initial and final balances. The initial reading of C_2 at a fixed point at or near minimum capacity actually results in a balance for the value of R_2, which should be much smaller than the parallel impedance of the internal circuit LC_3. If the parallel impedance of LC_3 is large enough, its variations for different frequencies will not appreciably affect the accuracy of the dial calibration of C_2 in ohms of resistance.

The reactance dials C_3 and C_4 should be calibrated in $\mu\mu$f in order that the calibration may function at all frequencies. Condenser C_4 provides a fine adjustment on C_3 for measurements of reactance in which the inductive or capacitive values correspond to only a few $\mu\mu$f.

The usual forms of parallel T Bridges, *Fig. 2*, are suitable for measuring impedances to ground, since one terminal is common to the radio-frequency oscillator and radio receiver null indicator. The circuit in *Fig. 3* has been modified so that measurements can be made on two-wire lines with a reasonable degree of accuracy. The r-f generator and receiver terminals are isolated by radio-frequency transformers from the internal parts of the bridge. All the stray capacities, C_5 in *Fig. 3*, of the parts to ground, are balanced by an equal capacity C_6 to the other side of the impedance connection terminals. The parts are mounted on a bakelite subpanel spaced approximately 1½ inches from the top panel which mounts the dial controls. The consistent use of insulated shaft couplings on the variable capacitors permits the grounding of all dials to the metal cabinet.

The two r-f transformers T_1 and T_2 in *Fig. 3* consist of 9 turns of No. 30 wire on a ½-inch diameter form, interwound to cover a length of ¾-inch. Nine turns in each winding proved satisfactory for covering the frequency range between 2 and 20 megacycles.

Short strips of copper were used for leads in making all connections in the bridge. By limiting the upper frequency range to 15 or 20 mc, conventional 2 and 3-gang "BCL"-type capacitors may be used with fairly good results. The

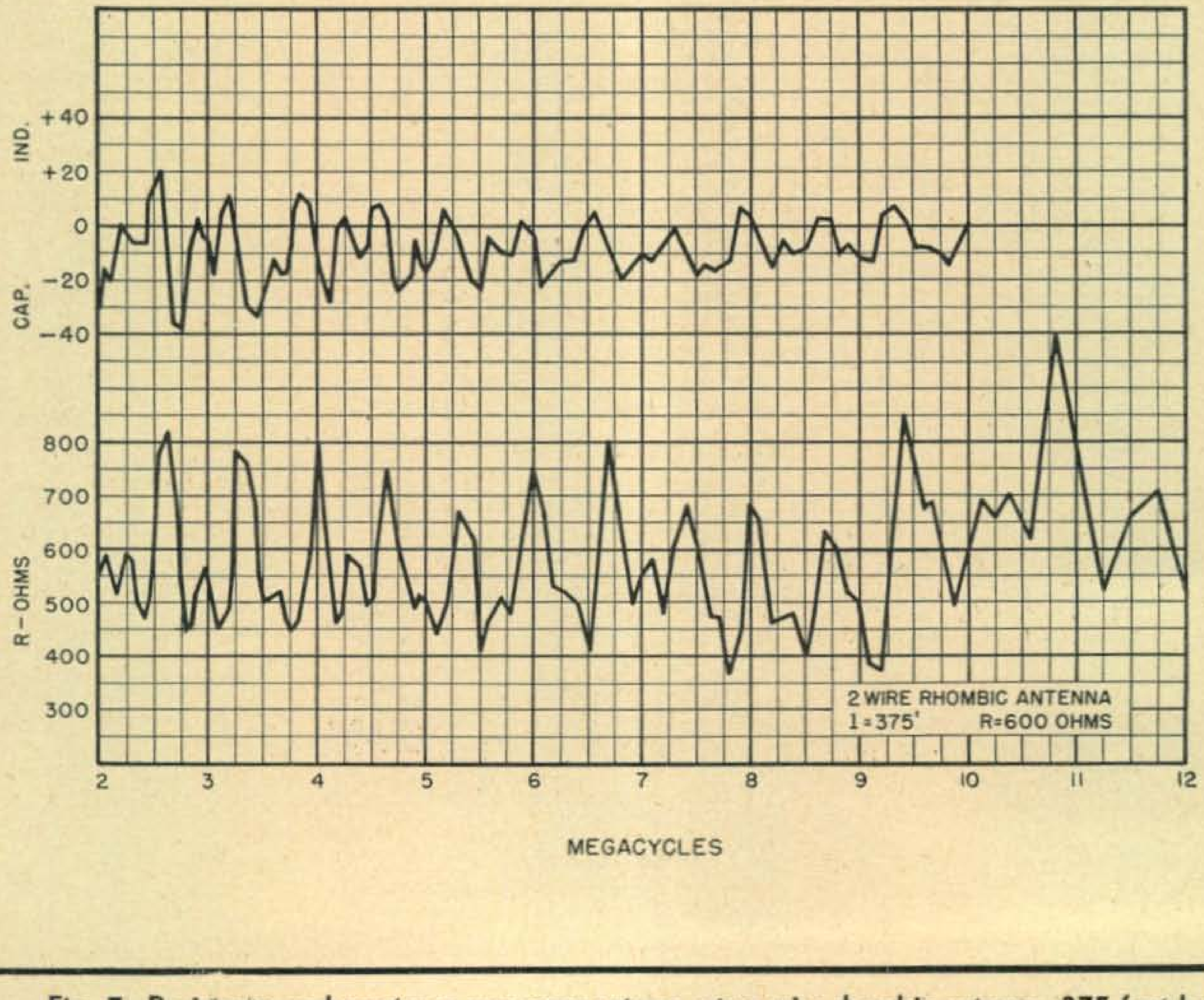


Fig. 7. Resistance and reactance measurements on a two-wire rhombic antenna, 375 feet long

coils in the reactive arm should be tapped in overlapping ranges in order to facilitate measurements of large or small values of external reactance. A desirable inductive range can be obtained with a set of 5 coils, tapped to give ten values of inductance covering from ¼ up to 15 microhenries. Constructional details of the bridge diagrammed in *Fig. 3* are suggested in the photograph of *Fig. 4* while a front view of the completed instrument is shown in *Fig. 5*.

Bridge Calibration and Operation

An arbitrary point at or near minimum capacity setting of capacitor C_2 was chosen as the point of initial balance. This setting of "infinite R" is always used when the unknown impedance is not connected to the bridge, and is marked with a heavy line on the "R" dial. The initial balance is made with an r-f carrier signal of some intensity less than 1 volt. The null detector (a short-wave communications receiver with BFO) is then tuned to pick-up the signal through the bridge. Shielded leads to the oscillator and from the receiver are essential, together with shielded plugs such as those used for microphone cables, in order to reduce direct radiation into the null indicator. As the bridge is balanced with C_2 on its initial line setting, the attenuation through the bridge will become very great and the signal will drop to a few microvolts in intensity when the bridge functions properly. Balance is obtained by selecting the proper coil tap while varying both C_3 and C. One particular setting of C_3 and C will provide the beat null for any given frequency, and thus the dial on C can be calibrated in terms of megacycles. The C_3 and C_4 dials can be calibrated by connecting a standard variable capacitor or known values of small fixed capacitors across the Z_x terminals, and thereupon balancing for a null.

The C_2 dial can be calibrated by connecting ½ or 1-watt resistors across the Z_x terminals. Carbon resistors with values of from 50 ohms to 10,000 ohms will provide a means for calibrating C_2 in ohms.

The dials for the instrument were made from ordinary metal plates, such as the reverse side of conventional control indicator plates. The calibration points, originally marked with pencil on the face of the dial, were later stamped into the metal with a punch set of the ⅛-inch lettering

[*Continued on page 44*]

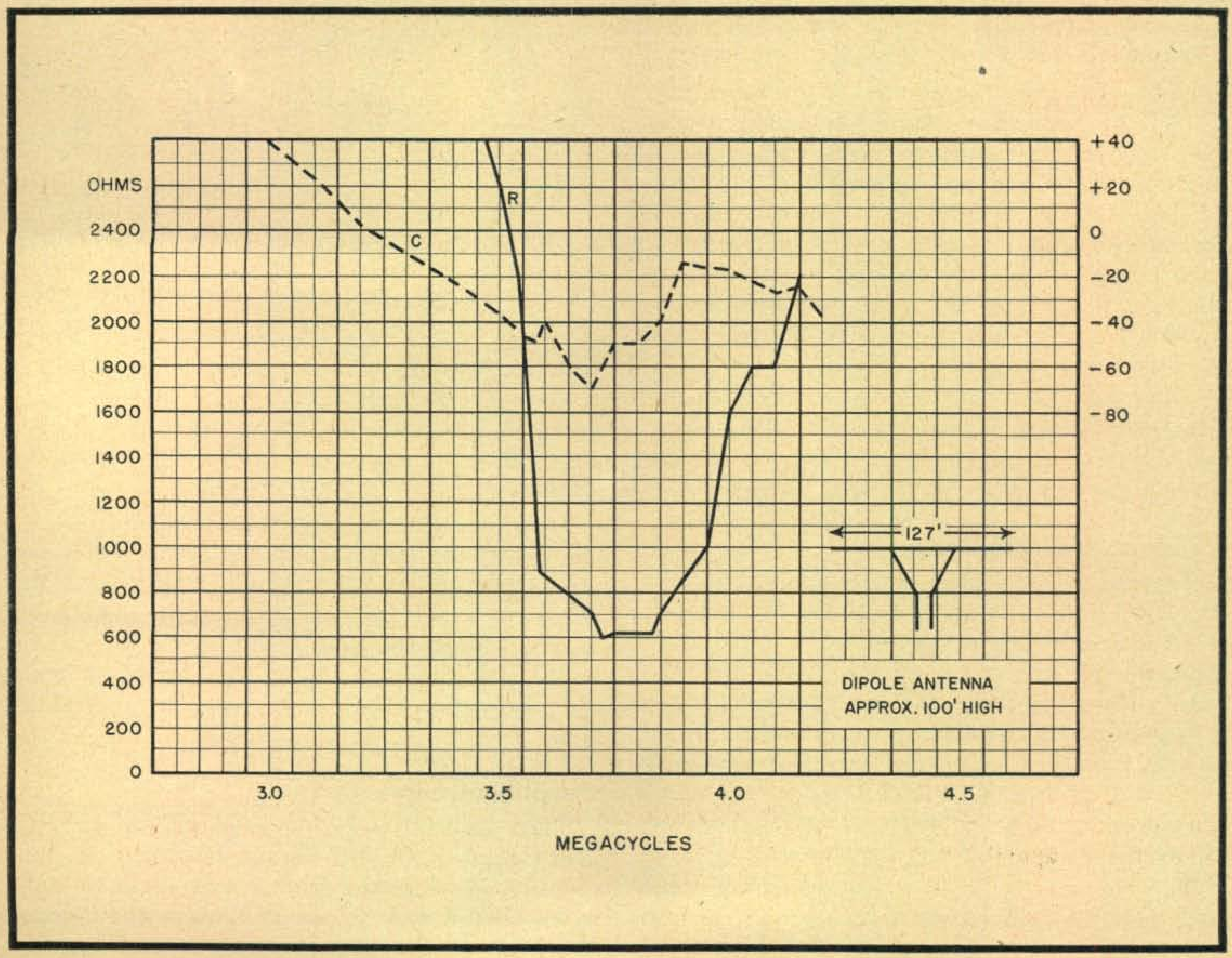


Fig. 8. Curves on a matched impedance half-wave antenna

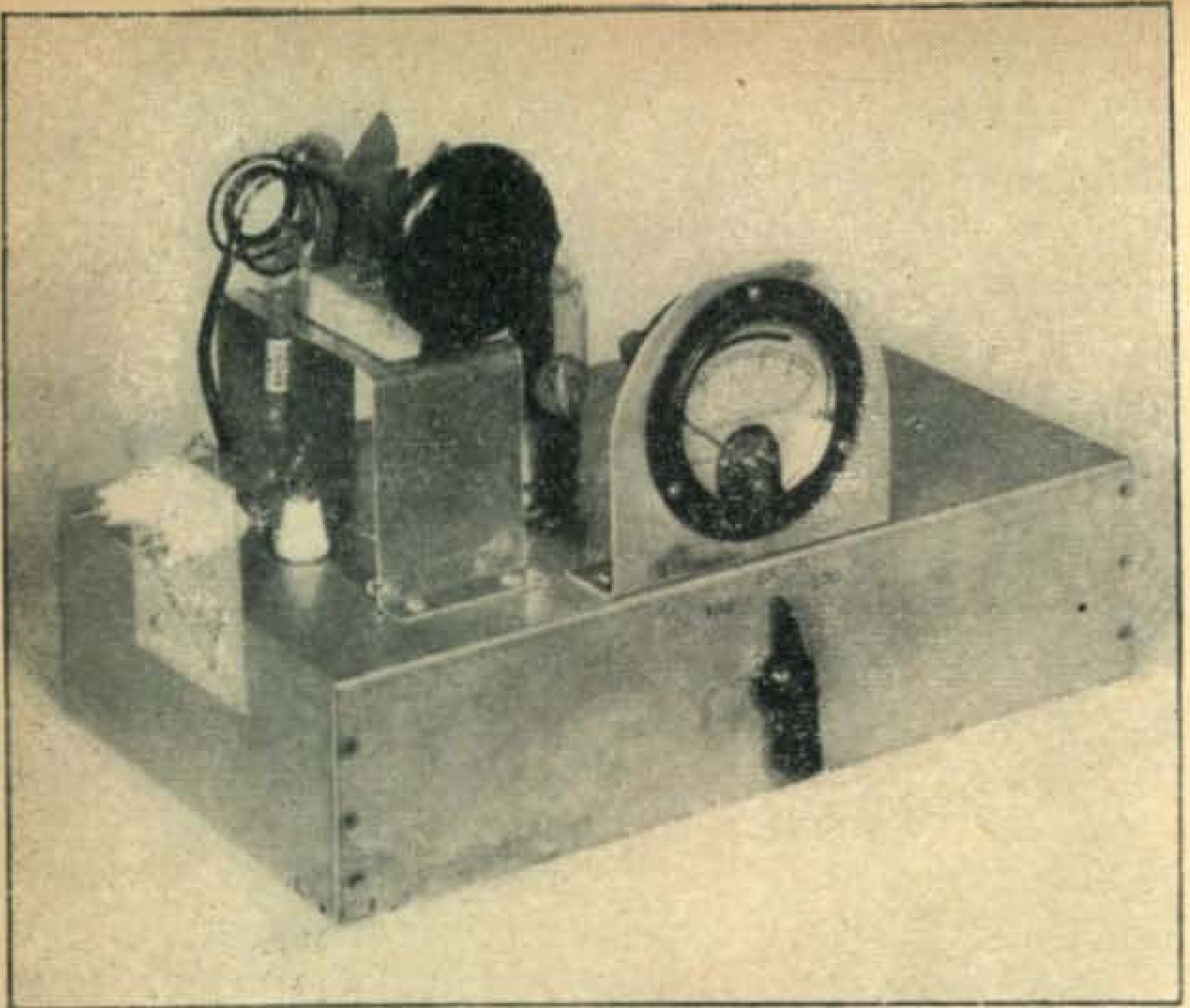


Fig. 2. Front three-quarter view showing capacitor and coil mounted on the inverted U bracket. Note one neutralizing capacitor next to the 815

GET ON

HOWARD A. BOWMAN, W6QIR

WHEN THE NEWS came through August 21st that we could open up on 112, we bravely ventured forth with our WERS mobile rig. But what worked on the relatively clear channels in war-time simply couldn't compete with the liberated QRM. A resistance-coupled superhet (which we shall tell you about in an early issue) helped matters a bit, but a transmitter with more wallop and stability was definitely in order.

In the first place, we wanted to get away from using just an oscillator, which has enough trouble as it is resisting frequency drift, without being modulated. When one appreciates that plate voltage stability is a principal contributing factor to oscillator stability, and then realizes in turn that modulation renders plate voltage stability just about nil, it is easy to see why modulating the oscillator is less desirable than modulating an amplifier.

Parts on hand, past experience and current experimentation decided us on an MOPA (master oscillator power amplifier) job, with an HY-615 driving the 815 from our old WERS rig.

Constructional Details

The entire r-f section is accommodated on a 7" x 12" x 3" chassis. A small bracket was constructed to mount the HY-615 horizontally beneath the chassis, with the plate and grid caps toward the 815. The tuning capacitor is a 15-$\mu\mu$f screwdriver-tuned affair, mounted by the two studs on the capacitor. The hexagonal adjustment stud protrudes through the chassis about a quarter of an inch. Of course there is no contact between the capacitor and the chassis.

The coil was soldered to the capacitor terminals and the associated r-f chokes and resistors were solidly mounted by means of tie lugs bolted to the chassis. The two flexible wire leads to the

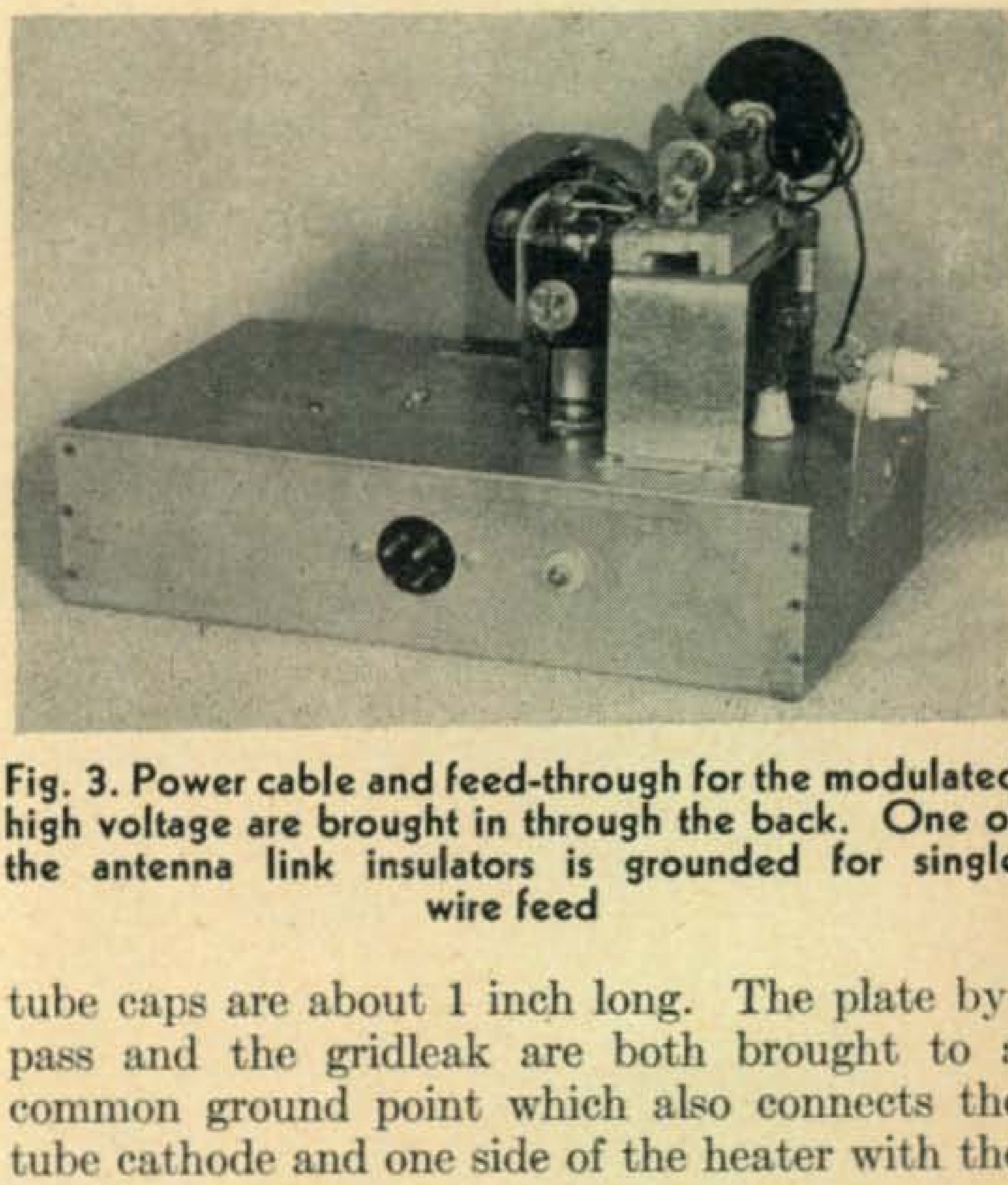


Fig. 3. Power cable and feed-through for the modulated high voltage are brought in through the back. One of the antenna link insulators is grounded for single wire feed

tube caps are about 1 inch long. The plate bypass and the gridleak are both brought to a common ground point which also connects the tube cathode and one side of the heater with the chassis.

It will be observed that this method of mounting places the entire oscillator circuit below the chassis, except for the very small portion of the capacitor which projects through the chassis for tuning. Since the grid circuit of the 815 is also below the chassis, we held high hopes of being able to operate the amplifier without neutralization.

Amplifier Construction

There seemed to be no good reason why the grid circuit of the 815 should be tuned. A momentary check of the grid current available indicated that it rose to about 4 ma without load. When the oscillator was tuned lower in frequency than the 112–115.5-mc band the amplifier grid

THE AIR WITH AN MOPA

A 60-WATT RIG FOR 112 AND 144-MEGACYCLE OPERATION

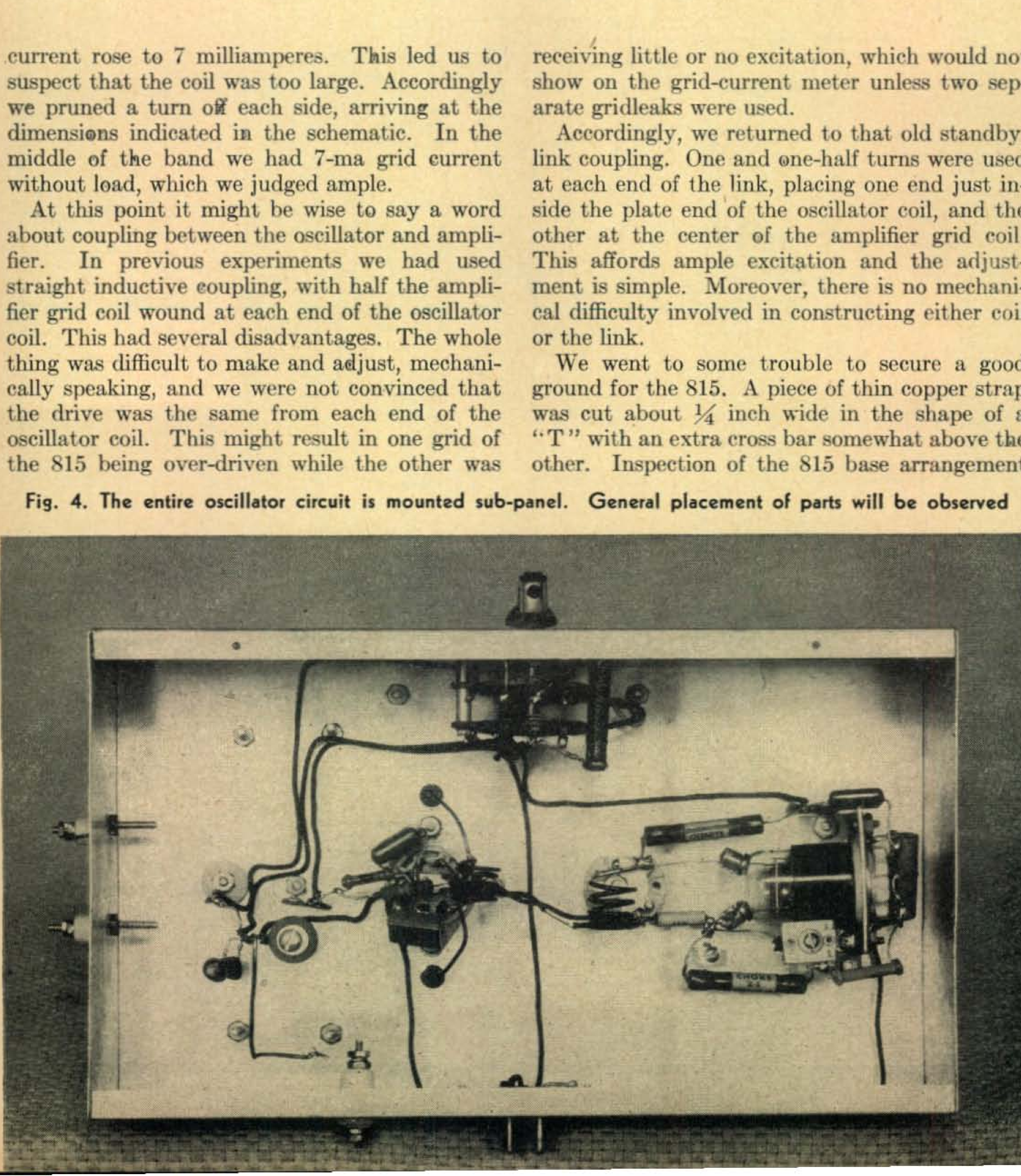
current rose to 7 milliamperes. This led us to suspect that the coil was too large. Accordingly we pruned a turn off each side, arriving at the dimensions indicated in the schematic. In the middle of the band we had 7-ma grid current without load, which we judged ample.

At this point it might be wise to say a word about coupling between the oscillator and amplifier. In previous experiments we had used straight inductive coupling, with half the amplifier grid coil wound at each end of the oscillator coil. This had several disadvantages. The whole thing was difficult to make and adjust, mechanically speaking, and we were not convinced that the drive was the same from each end of the oscillator coil. This might result in one grid of the 815 being over-driven while the other was receiving little or no excitation, which would not show on the grid-current meter unless two separate gridleaks were used.

Accordingly, we returned to that old standby, link coupling. One and one-half turns were used at each end of the link, placing one end just inside the plate end of the oscillator coil, and the other at the center of the amplifier grid coil. This affords ample excitation and the adjustment is simple. Moreover, there is no mechanical difficulty involved in constructing either coil or the link.

We went to some trouble to secure a good ground for the 815. A piece of thin copper strap was cut about ¼ inch wide in the shape of a "T" with an extra cross bar somewhat above the other. Inspection of the 815 base arrangement

Fig. 4. The entire oscillator circuit is mounted sub-panel. General placement of parts will be observed



reveals that four pins may be grounded—the two outside heater terminals, the cathode, and the shield. The socket is oriented so the grid pins face the HY-615. The piece of copper lies along the socket center line, with the four arms of the "double T" connecting to the four socket pins mentioned above. In each case the copper is folded over the socket pin and soldered firmly to it. About ⅜ inch at the end of the copper strap projects from the edge of the socket and this is bolted or soldered to the chassis. The whole matter of installing this is easier if the copper is first tinned. The two by-passes, heater and screen, connect to their respective terminals and to the grounding strip at its closest point. The heater supply is connected to the heater center tap terminal on the socket.

It was originally intended to employ resonant lines in the plate tuning circuit—which accounts for the length of the chassis. Upon placing the unit in operation, however, we speedily discovered that it isn't the simplest thing in the world to resonate the rods by means of a shorting bar. We could have capacity-tuned the rods by means of small discs, but this didn't particularly appeal, especially since listening to the band

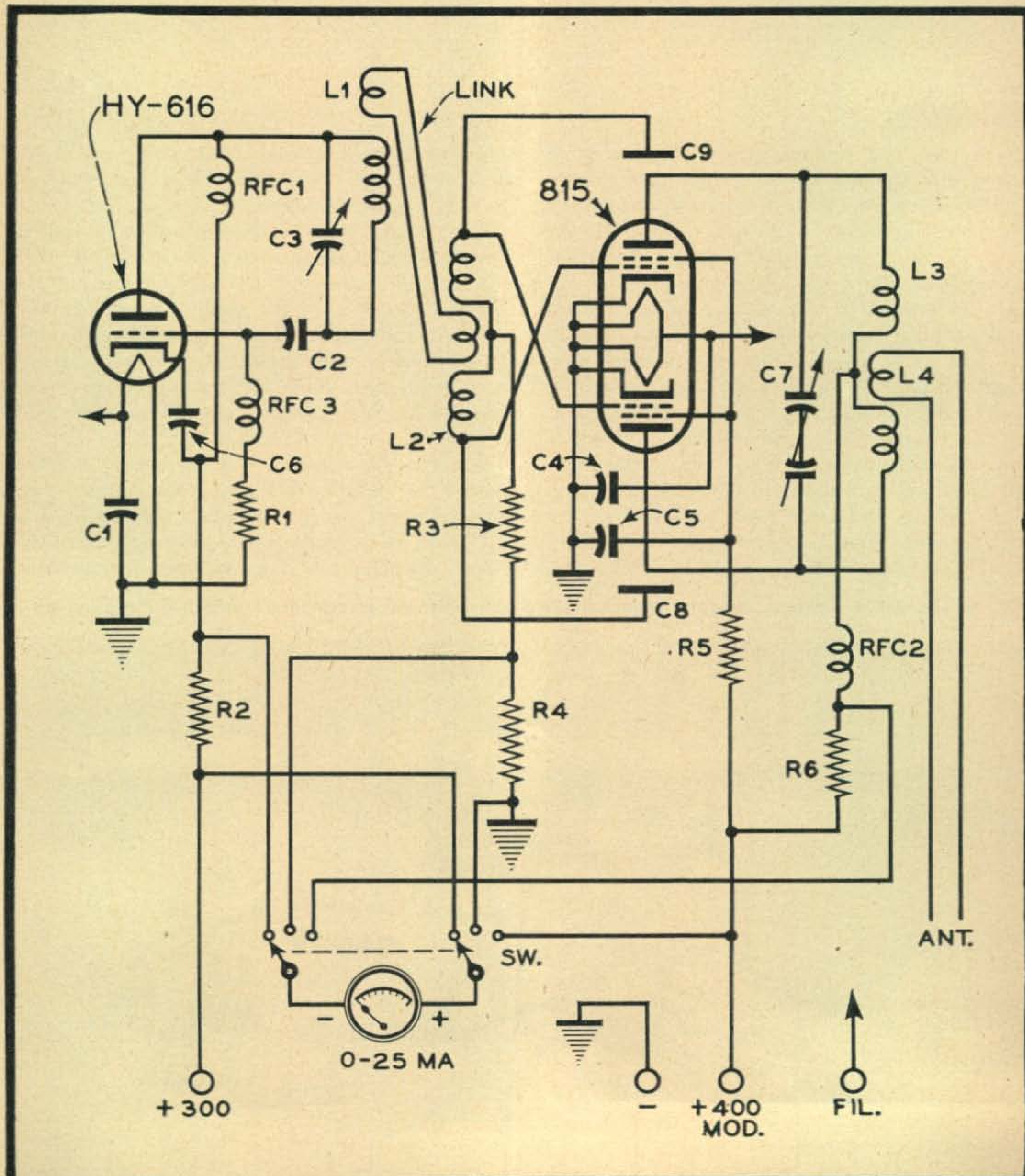


Fig. 5. The modulators, speech amplifier and power supplies. The large resistor lowers voltages for test purposes

had convinced us that some amount of QSY would be necessary.

Accordingly we substituted a dual 15-micro-microfarad variable capacitor and a two-turn coil. Our troubles about resonating the circuit vanished. No doubt the coil and capacitor circuit is rather inefficient in comparison with the resonant lines, but this is more than compensated by the ease of operation. Moreover, our pickup link for antenna coupling is easily adjusted. We mounted the coil and capacitor on an inverted "U"-shaped bracket close to the plate caps of the 815.

The wiring diagram of the radio-frequency section is shown in *Fig. 1*, while constructional details are suggested in the photographs, *Figs. 2, 3*, and *4*.

Our hope of operating the amplifier without neutralization was killed speedily when we put the rig on the air. True, there was a slight flicker of the grid meter when the rig was tuned through resonance. We then tried to make the 815 take off by itself, but with no success. This made us feel that the amplifier was probably neutralized fairly well, but a signal report quickly convinced us otherwise.

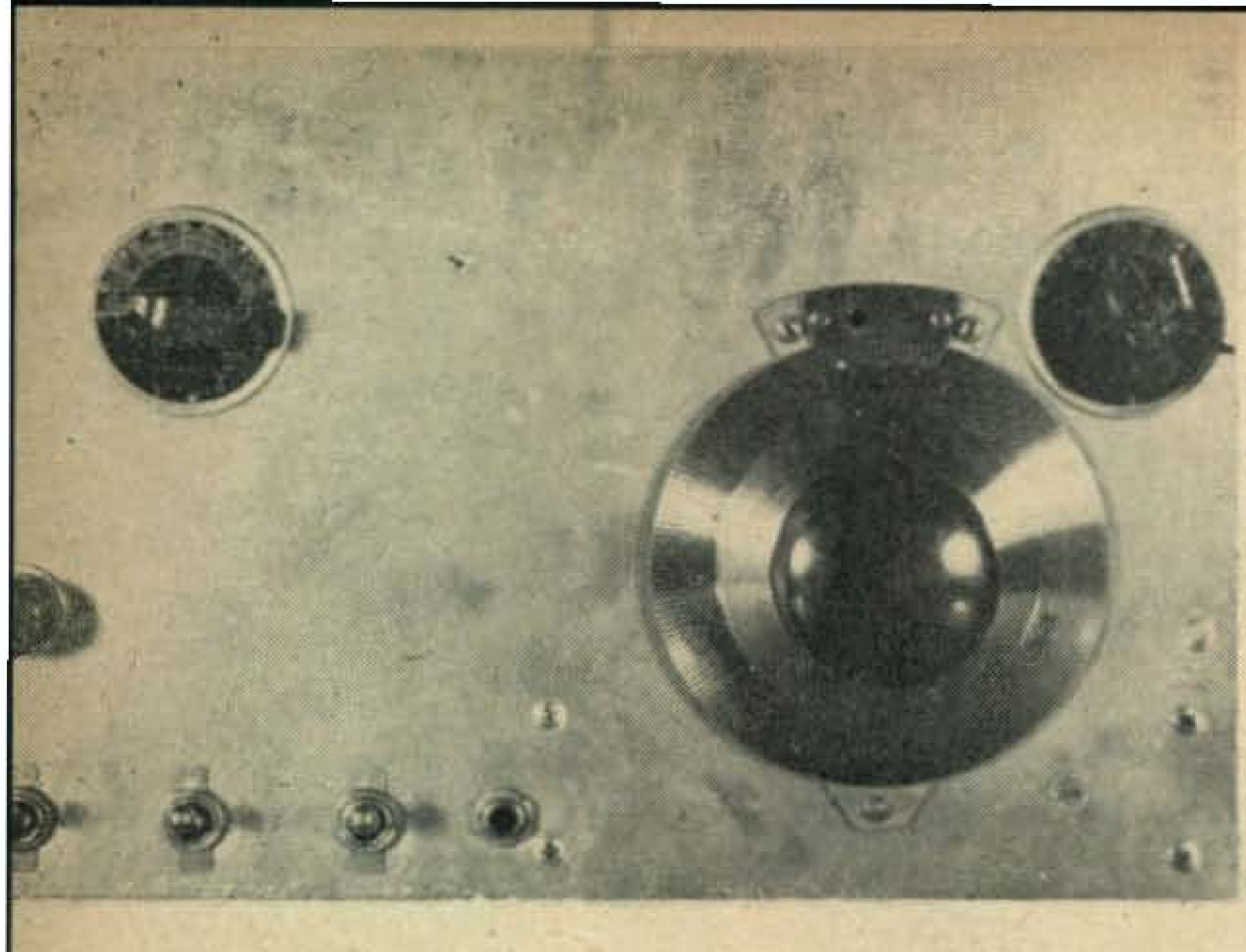
To one end of each of two pieces of #14 wire, we soldered a small copper disc, ⅝ inch in diameter. The wires were run through holes in the chassis and insulated with rubber grommets. The discs are positioned just opposite the tube plates, and the same distance from the chassis. The other end of each wire runs to an end of the grid coil. The grid coil had already been cross-connected to provide the proper phase relationship for neutralization if this should become necessary. The small disc acts as one half of the neutralizing capacitor and the plate of the tube as the other half. Neutralization is obtained by varying the positions of the discs with relationship to their respective plates, until no grid-current flicker is observed when the amplifier plate capacitor is tuned through resonance (with no plate voltage applied).

A single meter measures all circuits in the transmitter. The basic movement is 0 to 25 ma and simple shunts are applied to enable the meter to be inserted at various points as shown by the circuit diagram.

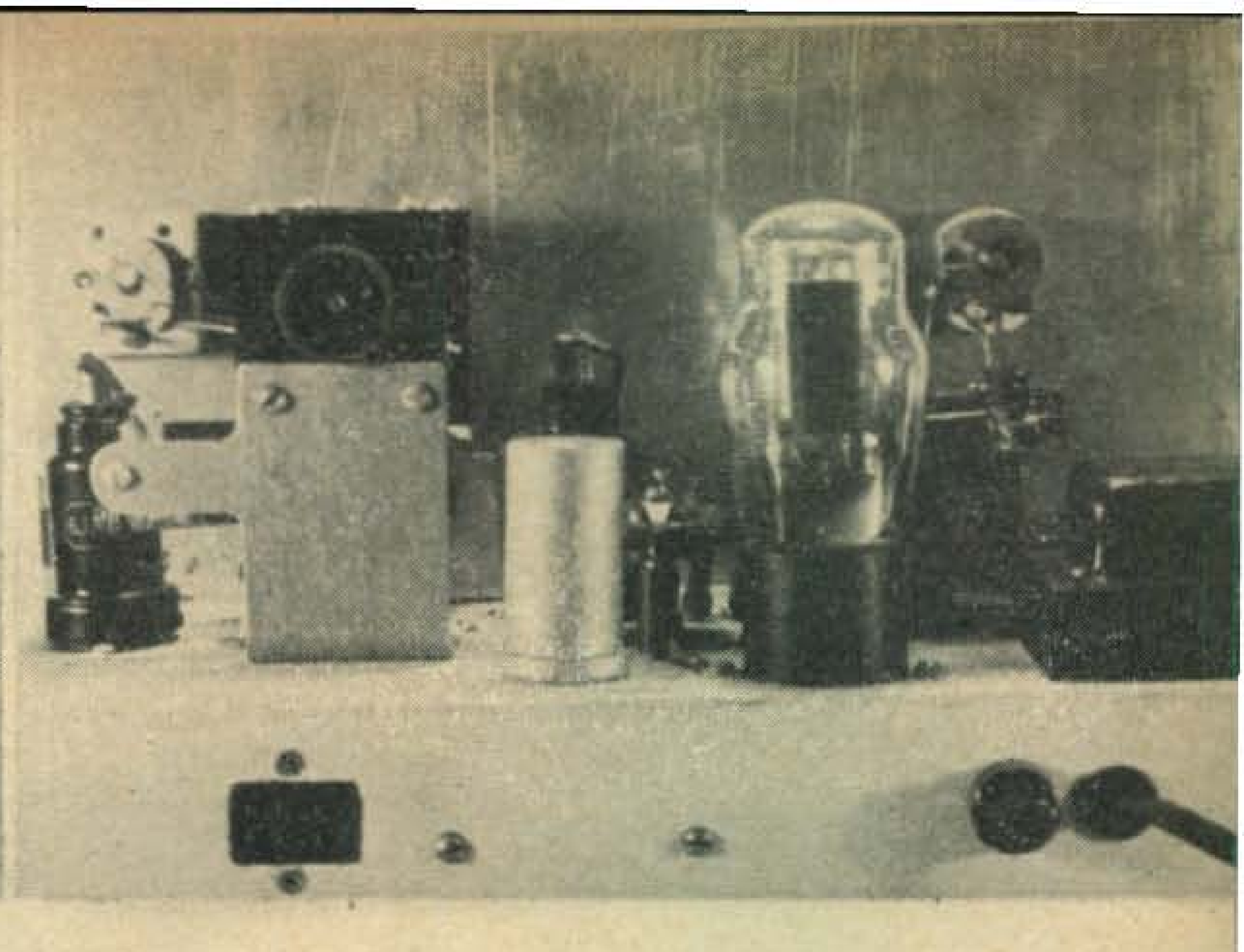
[*Continued on page 44*]

Fig. 1. (Left) Wiring diagram of the MOPA transmitter —less power supply and a-f section. The following parts are used in the r-f end:

C_1—.01 μf paper
C_2—.00005 μf mica
C_3—15 $\mu\mu$f variable
C_4, C_5, C_6—.002 μf mica
C_7—dual 15-15 $\mu\mu$f variable
C_8, C_9—neutralizing disks—see text
L_1—4 turns #14 enamel ½" dia. ½" long
L_2—4 turns #14 enamel ½" dia. 5/8" long ¼" center gap
L_3—2 turns #12 enamel 1" dia. 1 1/8" long
L_4—2 turns #12 enamel 3/4" dia.
R_1—7,500 ohms 1 watt
R_2—50 ma shunt
R_3—15,000 ohms 1 watt
R_4—100 ohms ½ watt
R_5—25,000 ohms 10 watts
R_6—250 ma shunt
RFC_1, RFC_2—Ohmite Z_1
RFC_3—Ohmite Z_0
Sw—2-pole 3-position rotary meter switch



Front view of frequency meter. Dial for calibration correcting condenser on left, main tuning dial on right



Rear view of frequency meter

FREQUENCY METER AND

A Versatile Unit with Excellent Design and Constructional Features Applicable to Post-War Equipment

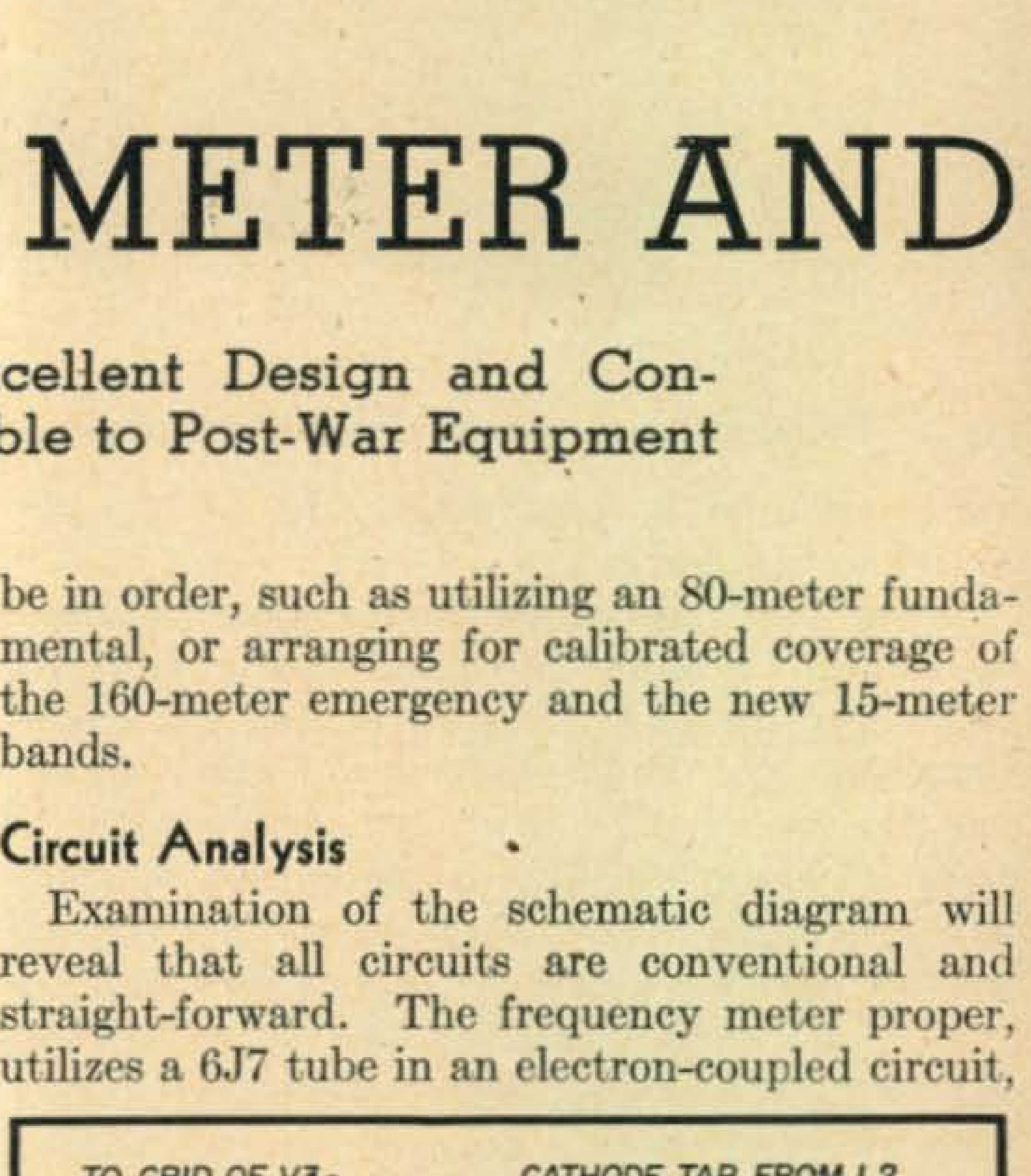
In the "Good Old Days" before Pearl Harbor, more and more amateurs were operating variable-frequency oscillators, the stability of which was both good and bad. When operating an oscillator of this type near either end of the band it was necessary to check constantly the output frequency in order that off-frequency operation did not result. Numerous operators throughout the country constructed frequency meters of one type or another, ranging from elaborate engineering projects to merely calibrated monitors.

Here at W2NYZ, several variable-frequency oscillators had been built and discarded without hitting upon a satisfactory combination, with the result that "Pearl Harbor" found this shack without a satisfactory frequency meter. With the banning of operations by the FCC, a gap in the normal routine had to be filled, and as a result considerable thought was given to the design and construction of a frequency meter for use when amateur operation was once more authorized.

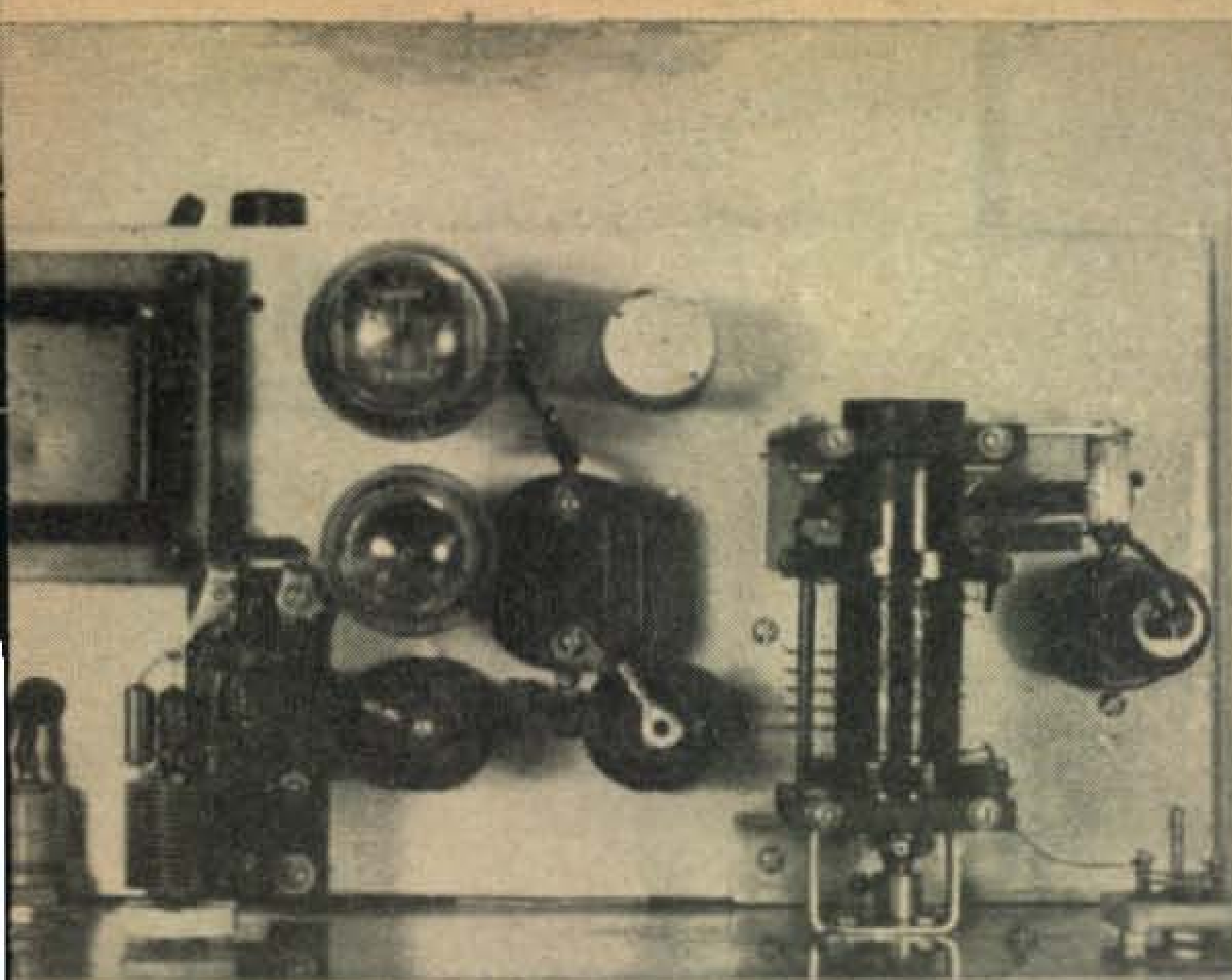
It was finally decided to construct a unit containing, in addition to the frequency meter proper, a 100-kc oscillator, simple modulation monitor and a regulated power supply. The resultant unit was of necessity (lack of priorities) constructed almost entirely from the ever-present junk-box, and the results obtained with regards to flexible operation, frequency stability and re-setability have been very satisfactory. The design features should be of interest to other amateurs contemplating construction of a frequency meter. Individual design variations may be in order, such as utilizing an 80-meter fundamental, or arranging for calibrated coverage of the 160-meter emergency and the new 15-meter bands.

Circuit Analysis

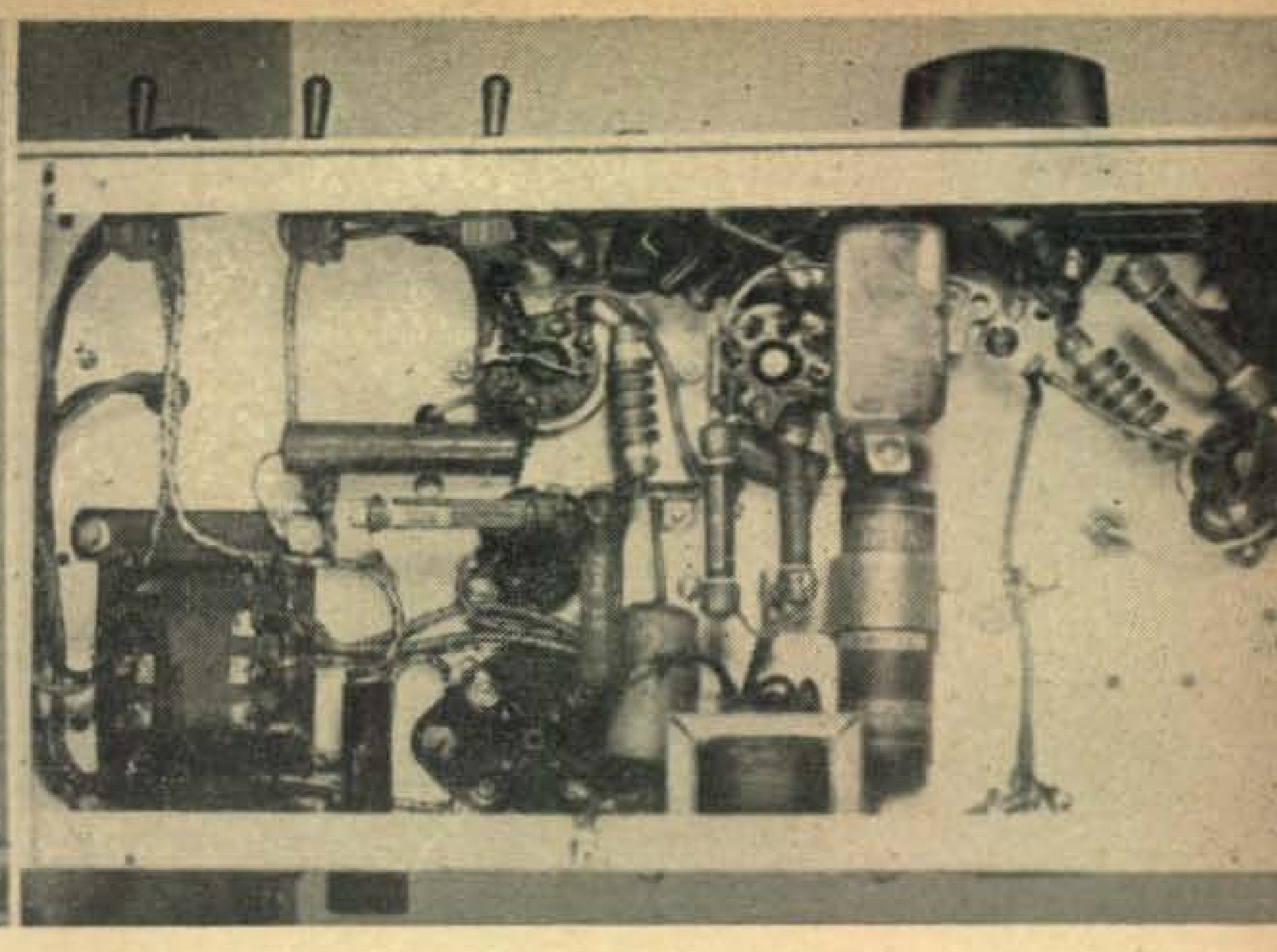
Examination of the schematic diagram will reveal that all circuits are conventional and straight-forward. The frequency meter proper, utilizes a 6J7 tube in an electron-coupled circuit,



Tank assembly of 100-kc oscillator



Top view of frequency meter. 100-kc oscillator on left end, modulation monitor in center, frequency meter on right end



Bottom view of frequency meter

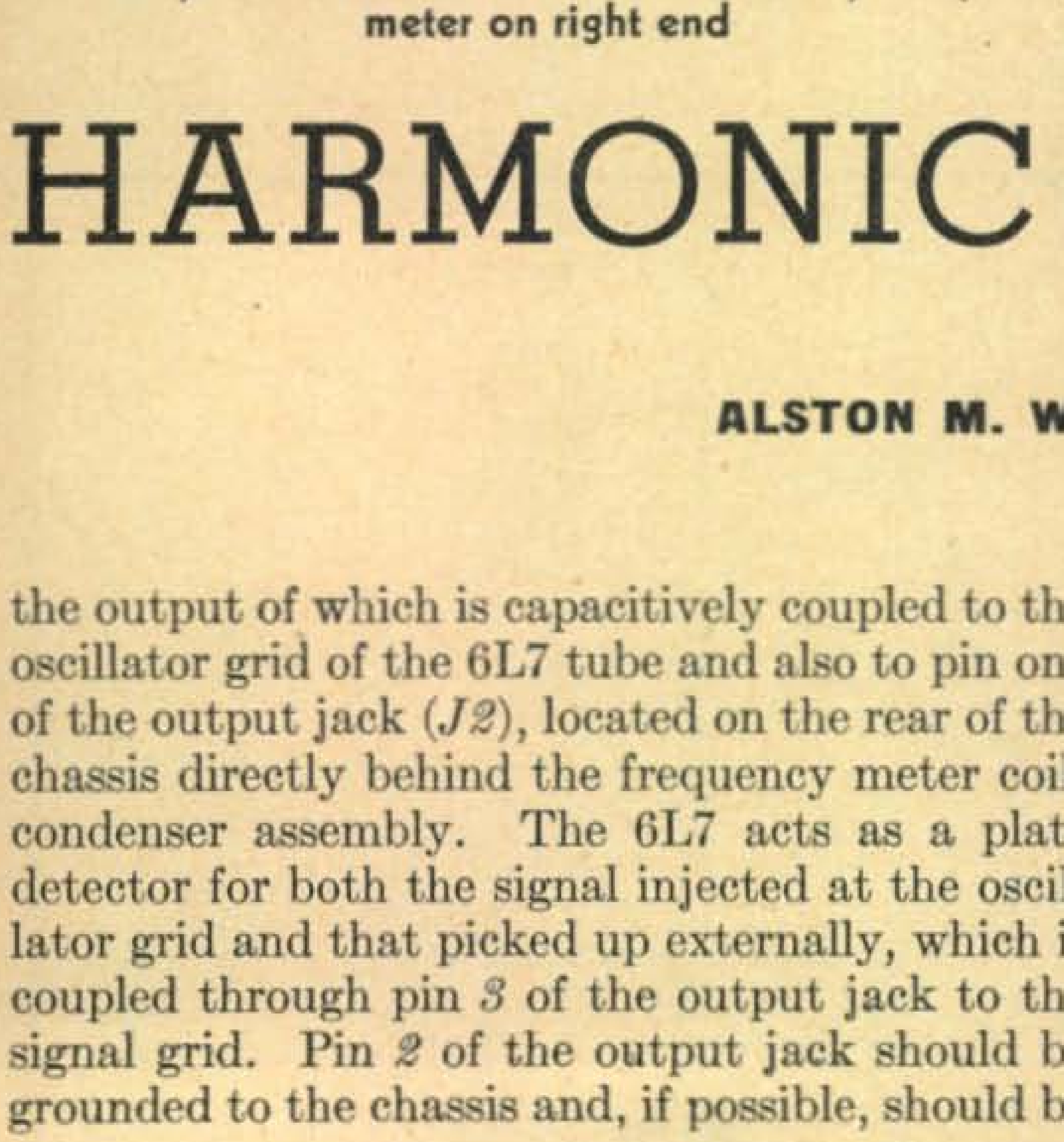
HARMONIC OSCILLATOR

ALSTON M. WHEELDEN, W2NYZ

the output of which is capacitively coupled to the oscillator grid of the 6L7 tube and also to pin one of the output jack (*J2*), located on the rear of the chassis directly behind the frequency meter coil-condenser assembly. The 6L7 acts as a plate detector for both the signal injected at the oscillator grid and that picked up externally, which is coupled through pin *3* of the output jack to the signal grid. Pin *2* of the output jack should be grounded to the chassis and, if possible, should be located between pins *1* and *3*, thereby shielding the two circuits from each other. The internal leads connecting to these two pins (*1* & *3*) should be carefully shielded and the shielding bonded to the chassis at both ends.

The 100-kc oscillator utilizes a 6K7 tube as an electron-coupled oscillator, the output of which is capacitively coupled back to grid #*3* of the 6L7. This allows the output of either oscillator to be coupled to a receiver through a common lead, the use of the 6L7 as a common detector or, when calibrating the unit, the injection of two frequencies simultaneously at the oscillator grid for zero-beat purposes.

The power supply is entirely conventional, with the regulated voltage being applied to both oscillators. The voltage for the modulation monitor is tapped from a point ahead of the voltage regulator tube. An extractor type fuse holder is located near the a-c line cord on the rear of the chassis and utilizes a 2-ampere type 3AG fuse for protection of the power supply.



Circuit of 100-kc multivibrator

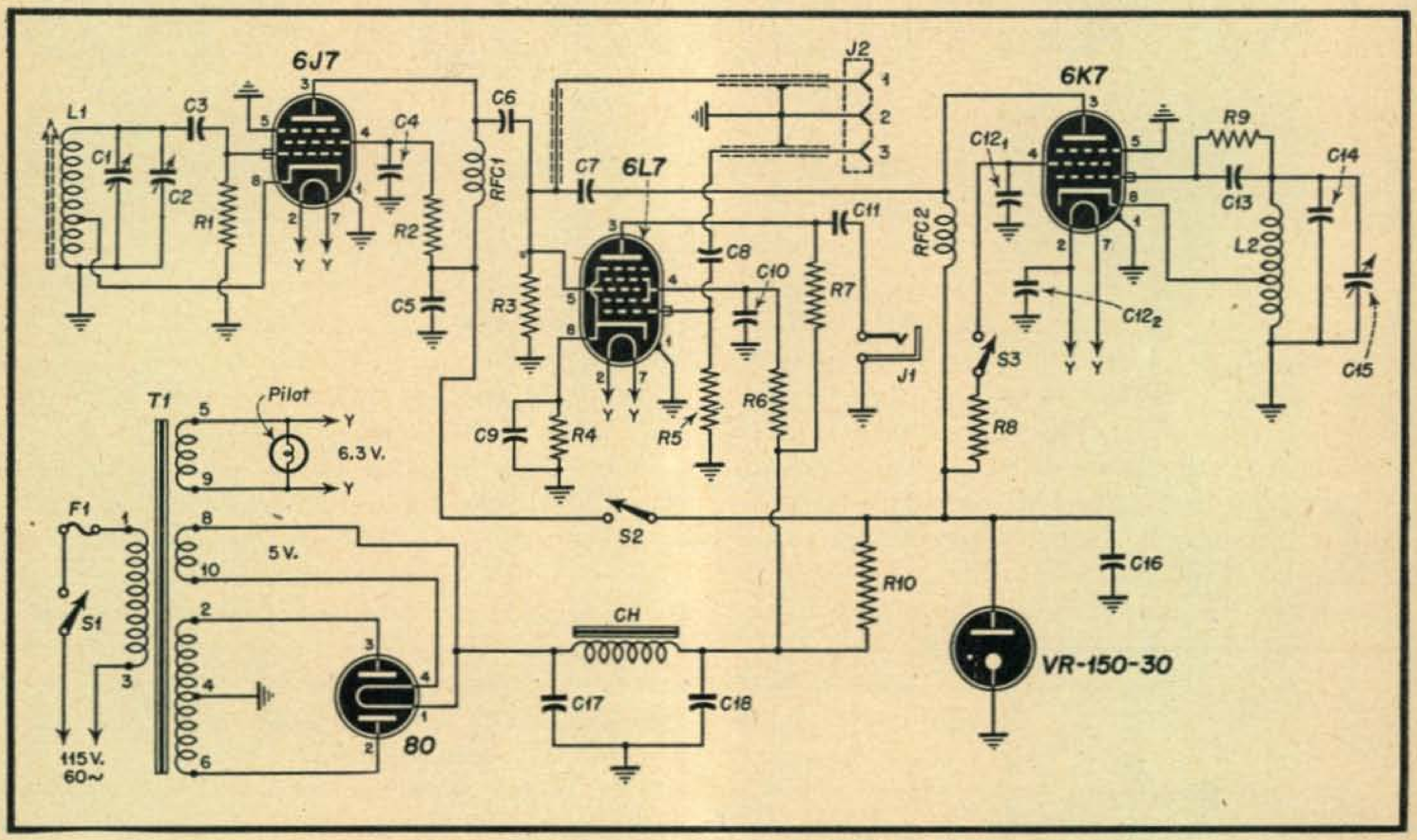
For Frequency Stability

To eliminate frequency instability in both of the electron-coupled oscillators, the various components comprising the respective oscillatory circuits were arranged in as compact and rigid assembly as possible. The support for the 100-kc oscillator components consists of two micarta stand-offs 3/8″ by ½″ by 1½″, tapped for 6-32 machine screws at both ends, and one micarta panel measuring 1¼″ wide, 3″ long and 1/8″

thick. The method of assembly can be seen in the various photographs, attention being called to the fact that the stand-offs are mounted flush with the "inboard" side of the panel. The purpose of this is to allow sufficient space for the two "L"-shaped copper strips used to support the tapped 2.5 mh r-f choke (L_2). A 3/16″ hole is drilled in each of the copper support strips permitting the metal ends of the choke to protrude, after which, the end of the choke and its associated lead is soldered to the strip.

Connections to these two mounting strips are brought out to the top side of the micarta panel by means of two 4-40 machine screws, ½″ long. A long solder lug is secured to the underside of the micarta panel in line with, and 5/8″ from, the front stand-off by another 4-40 machine screw and used as a termination for the cathode tap, which is taken off between the first and second windings on L_2 (from the ground end). The mounting of the grid blocking condenser, C_{13}, and associated resistor R_9 can be seen in the top view, across the rear end of the micarta panel. The screw holding the panel to the rear stand-off serves as a termination for one end of C_{13}, R_9 and the flexible lead to the control grid of the 6K7. The fixed capacity across L_2, (in this case, two small mica condensers of .001 and .0001 μf) is mounted parallel to the outboard edge of the panel, the condensers being in a vertical plane with respect to the chassis. With this arrangement, and using values of C and L as indicated, the small variable capacitor C_{15} varies the oscillator frequency from 97 to 101.5 kilocycles.

The calibrated oscillator was designed to have a fundamental frequency coverage of 1750-2050



Schematic of frequency meter. Parts list below:

C$_1$ | Freq. meter tuning cond. (*see text*)
C$_2$—Freq. corrector cond. (*see text*)
C$_3$—.0001 μf osc. grid blocking
C$_4$—.002 μf mica, 200 v. screen by-pass
C$_5$—.006 μf, 200 v. plate by-pass
C$_6$—.002 μf mica, freq. meter coupling
C$_7$—700 μμf mica, 100-kc osc. coupling
C$_8$—.002 μf mica, 200 v. grid blocking
C$_9$—25 μf, 25 v. cathode by-pass
C$_{10}$—.01 μf, 400 v. det. screen by-pass
C$_{11}$—.5 μf, 400 v. metal cased
C$_{12}$—.1 μf, 200 v. screen by-pass
C$_{12-2}$—.1 μf, 200 v. fil. by-pass
C$_{13}$—.00025 μf, mica, grid blocking
C$_{14}$—.0011 μf, mica, osc. tank (*see text*)
C$_{15}$—140 μμf var. (Hammarlund Type APC)
C$_{16}$—1 μf, 200 v. by-pass
C$_{17-18}$—15 μf, 300 v. filter
L$_1$—1700-2100 kc osc. inductance (*see text*)
L$_2$—2.5 mh RFC, tapped between 1st and 2nd pies

RFC$_1$, RFC$_2$—2.5 mh r-f chokes

(*All resistors ½ watt unless otherwise specified*)

R$_1$—1 megohm
R$_2$—100,000 ohms, 1 watt
R$_3$—25,000 ohms
R$_4$—500 ohms
R$_5$—20,000 ohms
R$_6$—40,000 ohms, 1 watt
R$_7$—50,000 ohms
R$_8$—100,000 ohms
R$_9$—300,000 ohms
R$_{10}$—10,000 ohms, 5 watts
S$_1$, S$_2$, S$_3$—SPST Toggle switches
T$_1$—Stancor power transformer, 250-0-250, 6.3, 5 volts, type 1473
CH—Ac-dc type filter choke
F$_1$—Type 3AG extractor type fuse holder, 2 A. fuse
J$_1$—Short type phone jack, single circuit open
J$_2$—Amphenol MC3M jack or equiv.

kilocycles, spread over as much of a 180-degree condenser rotation as possible. Thus, by use of the correct harmonic, the calibrated oscillator can be used for frequency measurements in the most popular amateur bands. As an example, a dial setting of 14.2 indicates a fundamental frequency of 1800 kc, a second harmonic frequency of 3600 kc, a fourth harmonic frequency of 7200 kc, an eighth harmonic frequency of 14,400 kc, etc. The correct values of L and C to accomplish this were determined by the cut-and-try method. The main tuning condenser, C_1, is a Hammarlund type MC-50, originally consisting of 10 stator and 9 rotor plates (double spaced). As modified, there remain 5 stator and 2 rotor plates (22.5-33 $\mu\mu$f). It was found during the cut-and-try process that removal of any additional stator plates prevented the desired capacity-rotation ratio mentioned above. The calibration corrector condenser C_2 is a Bud 15$\mu\mu$f variable, trimmed to one rotor and one stator plate. The permeability-tuned oscillator tank inductance, L_1, consists of 100 turns #32 DSC wire, close wound on a 1″-diameter tube, 3-5/8″ long. The cathode connection is tapped 6 turns from the ground end of the coil. The powdered iron core used to vary the inductance fits snugly inside the coil form and allows a variation in L of approximately 2.1 to 1.

Permeability Tuning

The oscillator coil described above has an inductance of approximately 130 μh with the core entirely removed and a maximum inductance of approximately 275 μh with the core full in. Inductance measurements with a Q meter indicate that in this particular unit the effective inductance in use is 265 μh. Permeability tuning is advantageous in that the coil dimensions can be kept small, distributed capacity and coupling reduced, with the Q of the coil relatively high (120). It also eliminates much of the labor involved in obtaining the correct LC ratio. However, an air-core type will produce satisfactory results.

Construction Memos

A metal chassis and panel were constructed for use with an available cast aluminum box 12 3/8″ x 6 5/8″ x 7¾″. The chassis, 2″ deep, 6-3/8″ wide and 12″ long was cut from galvanized sheet iron, approximately 1/32″ thick and the blank panel, measuring 7¾″ by 12-3/8″ was constructed of 24ST dural stock, 1/16″ thick. After all cut-outs for tube sockets, transformer, etc. were made in the chassis, the panel and chassis were securely fastened together with six 6-32 machine screws.

Regardless of allowable variations from the above dimensions, the unit must be well shielded. All-metal construction is therefore, necessary. All equipment, with the exception of the pilot light assembly, frequency meter calibration corrector condenser, 100-kc oscillator frequency setting condenser, phone jack and toggle switches should be securely attached to the chassis. Time and painstaking care spent in the layout and construction work have much to do with the reliability and frequency stability of the unit. Mount all component parts securely, avoid long sloppy leads, cold soldered connections, etc.

All related parts are grouped together on the chassis, the 100-kc oscillator occupying the left-hand end directly back of the panel with the modulation monitor between it and the frequency meter proper, which occupies the entire right-hand section of the chassis. The power supply is arranged along the rear of the chassis directly behind the 100-kc oscillator and modulation monitor.

The controls on the lower front of the panel as viewed from left to right are: a-c power ON/OFF switch (S1) with associated pilot light directly above, 100-kc oscillator ON/OFF switch (S3), frequency meter ON/OFF switch (S2) and phone jack (J1). The 100-kc oscillator frequency setting condenser is located in the upper left corner of the panel—the frequency meter calibration-corrector condenser occupying a similar position on the right with the main tuning dial below and left.

The photographs of the top, rear, and right end views, show the method of mounting the oscillator tank components, C_1, C_2, C_3, L_1 and R_1. The main tuning condenser C_1 is mounted above the chassis (stator plates upward) on two metal brackets, leaving sufficient clearance so that the rotary plates do not touch the chassis at any time. The front bracket is a simple "L"-shaped affair, 1¾″ wide, 1-7/16″ high and 7/8″ deep, constructed of 1/16″ material. A 3/8″ diameter hole, 5/8″ in from the right side of the bracket and 1″ up from the chassis is drilled for the front end of C_1. The rear bracket is a bit more elaborate, extending 2-5/8″ above the chassis with an extension on the right side, to which is fastened a stand-off insulator. This insulator is used as a support and termination for one end of C_3, R_1 and the flexible lead to the grid of the 6J7. A small bracket 11/16″ x 11/16″ x 1¾″ forms the rear support for C_1. (This bracket also serves to clamp the lower section of the rear coil clamp in position.)

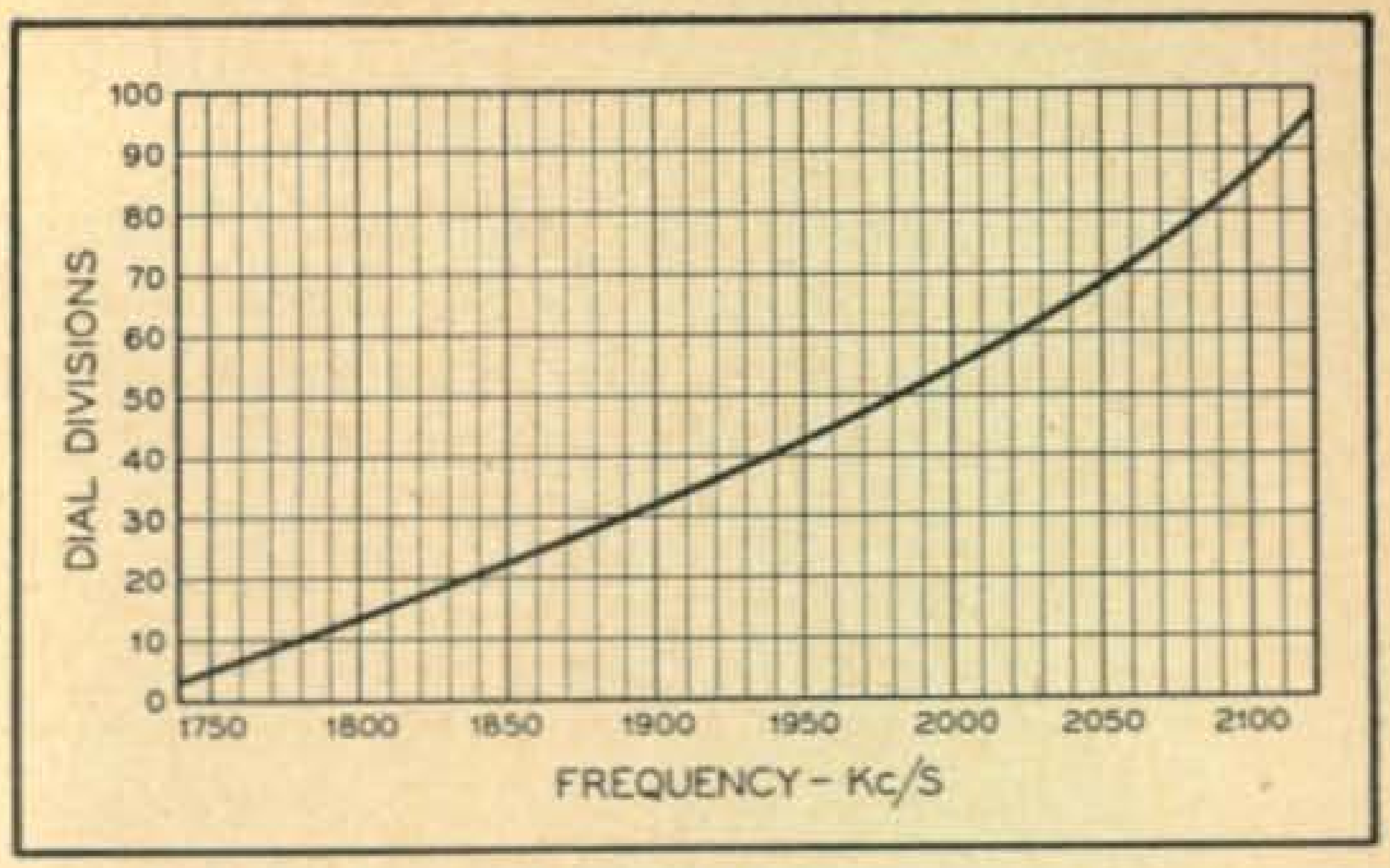
The oscillator coil is mounted directly above condenser C_1 by means of two bakelite clamps, each clamp measuring 1¾″ wide, 2″ high and ¼″ thick. A one-inch diameter hole, ¾″ down from the top, should be drilled in each clamp, after which the clamp is divided into two sections at the center of the 1″ hole. The lower section of the rear coil clamp is held in place by two 6-32 machine screws 5/8" long, passing through the rear mounting bracket, coil clamp and condenser mounting bracket. The lower section of the front coil clamp is secured to the front panel. The top section of each coil clamp is held in place by two 4-40 machine screws 1" long, passing through holes in the top section and threaded into holes in the lower section taped with 4-40 threads. On assembly, the top half of the coil clamps is removed, the completed coil placed in the lower clamps, top clamps replaced and securely fastened. This arrangement makes for a compact, rigid assembly with short, direct leads, well worth the extra time required for construction. It is desirable to use tie-lugs or small stand-off insulators freely when wiring the various components inside the chassis. This results in a much neater looking piece of apparatus as well as providing additional support for the various condensers and resistors on the underside of the chassis. The size of the chassis and the arrangement of components make any extensive cabling unnecessary.

Checking the Oscillator

Checking of the 100-kc oscillator for operation and frequency setting requires the use of a receiver equipped with a BFO, capaple of covering the broadcast band and preferably the short-wave band as well. If the receiver available is lacking a BFO, it is not at all difficult to haywire one together and connect it to the receiver long enough to complete the calibration checks. With the receiver and 100-kc oscillator in an operating condition (previously allowing a 20-minute warm-up period so that the frequency of the oscillator can become more or less stable) couple a lead from pin *1* of J_2 to the antenna lead of the receiver to increase the strength of the resultant beat note.

Select a broadcast station whose frequency is an exact multiple of 100 kc (such as WICC, Bridgeport, Conn. 600 kc) and tune the receiver to zero-beat with the station's carrier frequency. The 100-kc oscillator should now be turned on (S_3) and its frequency setting condenser C_{15} varied until the resultant beat note is exactly at zero-beat with the broadcast carrier frequency. This *may or may not* mean that the 100-kc oscillator is tuned exactly to 100 kc.

Without varying the setting of C_{15}, but with S_3 open, the receiver should be adjusted to zero-beat with some other BC or SW station operating on an exact multiple of 100 kc (such as WWRL, Woodside, L. I., N.Y. 1600 kc, or WWV on 2500 or 5000 kc). If the harmonic from the 100-kc oscillator is still zero-beat with the frequency of the newly selected station, it can be safely assumed that the oscillator *is* tuned to exactly 100 kc. *Do not* use zero-beat with *one* station only, as an indication of anything except that the



Calibration chart of frequency meter

oscillator is working. For the remainder of the pre-calibration checks, the broadcast receiver is used only to obtain periodical checks on the frequency drift of the 100-kc oscillator. Assuming that the unit is enclosed in a metal cabinet, it will be found that the frequency drift of the oscillator becomes negligible after approximately a half hour warm-up period.

With the 100-kc oscillator on frequency, the range of L_1, C_1 and C_2 should now be adjusted. Assuming the power switch *S1* is turned on, the closing of *S2* and *S3* will result in an audio beat produced by mixing the outputs of both the 100-kc oscillator and the calibrated oscillator (when the calibrated oscillator is tuned to any multiple of 100 kc) at the 6L7, which can be heard in the phones at J_1. The main problem with which we are concerned at the moment is the identification of the particular 100-kc harmonic to which L_1, C_1 and C_2 are adjusted. The use of a short-wave receiver is perhaps the most simple method of determining the above; or, if a signal generator is available, it can be used by coupling its output through pin 1 of *J2*. Positive identification is necessary.

Calibration

As an example, let us assume that 100-kc beat notes are heard when the vernier dial of the calibrated oscillator reads 1.7, 21.2, 40.1 and 64.8 and that the 64.8 point has been positively identified as 1900 kcs. Based on this assumption we calibrate as follows:

Dial	Freq. (kc)
1.7	1600
21.2	1700
40.1	1800
64.8	1900

From the above it is evident that we do not have the correct frequency coverage and that the value of L_1 must be adjusted. However, before changing L_1, the frequency corrector condenser, C_2, should be set at approximately its mid-capacity position and left there. To obtain a frequency coverage of 1750 to 2100 kc, it will be necessary to vary L_1 so that the 1900-kc check-point appears at approximately 32 on the vernier dial instead of the previous 64.8. When this has been accomplished, the 1600 and 1700-kc beat-notes will no longer be heard but beat-notes at 2000 and 2100 kilocycles will have made their appearance on the high frequency end of the dial, and we now have:

Dial	Freq. (kc)
14.2	1800
31.8	1900
52.5	2000
85.4	2100

The above dial-frequency relationship is entirely suited to our needs. However, there are not sufficient reference points with which to plot an accurate calibration curve for the oscillator. Occasional checking of the 100-kc oscillator for frequency drift assures us of a frequency standard, the accuracy of which will depend on the care used when adjusting its frequency to zero-beat with that of the broadcast station carrier used as a frequency standard. To obtain reference points at 10-kc intervals instead of 100-kc spots, a 10-kc multivibrator is employed, as sketched in the accompanying circuit. This does not have to be elaborately constructed, as will be appreciated from the photograph. Plate and filament voltages for the "multi" can be taken from the frequency meter power supply. To adjust the multivibrator, note the *exact* dial settings for any two of the 100-kc checkpoints. The multivibrator is then turned on, and its frequency control set at approximately half-scale. The number of separate audio beats *between* the two selected 100-kc reference points is then counted. If it is a number other than nine (indicating 10-kc intervals), readjust the frequency control in small increments until nine beats are obtained. At this setting of the frequency control there will be beat notes every 10 kc over the entire frequency range of the oscillator and the exact dial settings at which these beats occur should be logged, indicating which points are also 100-kc beats as well. It is now possible to draw a calibration curve for the oscillator that will be very accurate.

Curves and Tables

For extreme accuracy, and also to facilitate speed in determining frequency-vs.-dial settings, it is recommended that tables be compiled listing the frequency for each .1 division over the entire dial—interpolating between each of the known 10-kc points. This represents quite a task in itself, resulting in 1000 calibrated dial settings. These should be made into a small book and indexed for reference. The following is copied, as an example, from the calibration book for the frequency meter shown in the accompanying photographs.

Dial	Fundamental Frequency	Second Harmonic	Fourth Harmonic
14.2 (10 kc)	1800.000 (100 kc)	3600.000	7200.000
14.3	1800.589	3601.178	7202.356
14.4	1801.178	3602.356	7204.712
14.5	1801.767	3603.534	7207.068
14.6	1802.356	3604.712	7209.424
14.7	1802.944	3605.888	7211.776
14.8	1803.532	3607.064	7213.128
14.9	1804.120	3608.240	7216.480
15.0	1804.708	3609.416	7218.832
15.1	1805.296	3610.592	7221.184
15.2	1805.884	3611.768	7223.536
15.3	1806.472	3612.944	7225.888
15.4	1807.050	3614.100	7228.200
15.5	1807.638	3615.276	7230.552
15.6	1808.226	3616.452	7232.904
15.7	1808.814	3617.628	7235.256
15.8	1809.402	3618.804	7237.608
15.9 (10 kc)	1810.000	3620.000	7240.000

Higher harmonics are similarly used for higher frequencies.

In order that the calibration of the frequency meter should be a permanent affair, provision was made in the form of the frequency corrector condenser, C_2 which is used to compensate small frequency changes due to aging of tubes, etc. In operation, the 100-kc oscillator is first checked for exact frequency setting and then the calibrated vernier dial set on any of the 100-kc reference point dial settings used at the time of calibration. If a beat note is present when switch *S2* is closed the frequency corrector condenser should be adjusted until a zero-beat is obtained between the two oscillators, at which time switch *S3* is placed in the OFF position and the frequency meter is ready for use.

To reduce drift as a result of temperature changes, it is reccmmended that the main power switch be left on at all times when there is any likelihood of using the frequency meter. The heat from the tubes will tend to hold the various components at a relatively stable temperature without the use of a separate heating element and thermostat.

Too much emphasis cannot be placed on the necessity for setting the 100-kc oscillator *exactly* on frequency and maintaining it there at all times during the calibration period; positive identification of the particular 100-kc harmonic employed as a reference point; always approaching zero beat with the vernier dial in the *same direction as when calibrated* (zero beat clockwise and counter-clockwise usually result in two different dial readings); and correctly interpolating between the various 10-kc reference points. Since broadcasting stations are required to stay within 20 cycles of assigned frequency, the maximum error will be less than 30 parts in one million, *if* you, the constructor, do your work thoroughly and accurately.

'ROUND-THE-WOR

SINGAPORE	MANILA	TOKYO	GUAM	WAKE IS.			HAWAII	PT. BARROW	SITKA	PACIFIC	MOUNTAIN	CENTRA
105°E	120°E	135°E	150°E	165°E	180°	165°W	157°W	150°W	135°W	120°W	105°W	-90°
0700	0800	0900	1000	1100	1200	1300	1330	1400	1500	1600	1700	180
0800	0900	1000	1100	1200	1300	1400	1430	1500	1600	1700	1800	190
0900	1000	1100	1200	1300	1400	1500	1530	1600	1700	1800	1900	200
1000	1100	1200	1300	1400	1500	1600	1630	1700	1800	1900	2000	210
1100	1200	1300	1400	1500	1600	1700	1730	1800	1900	2000	2100	220
1200	1300	1400	1500	1600	1700	1800	1830	1900	2000	2100	2200	230
1300	1400	1500	1600	1700	1800	1900	1930	2000	2100	2200	2300	000
1400	1500	1600	1700	1800	1900	2000	2030	2100	2200	2300	0000	010
1500	1600	1700	1800	1900	2000	2100	2130	2200	2300	0000	0100	020
1600	1700	1800	1900	2000	2100	2200	2230	2300	0000	0100	0200	030
1700	1800	1900	2000	2100	2200	2300	2330	0000	0100	0200	0300	040
1800	1900	2000	2100	2200	2300	0000	0030	0100	0200	0300	0400	050
1900	2000	2100	2200	2300	0000	0100	0130	0200	0300	0400	0500	060
2000	2100	2200	2300	0000	0100	0200	0230	0300	0400	0500	0600	070
2100	2200	2300	0000	0100	0200	0300	0330	0400	0500	0600	0700	080
2200	2300	0000	0100	0200	0300	0400	0430	0500	0600	0700	0800	090
2300	0000	0100	0200	0300	0400	0500	0530	0600	0700	0800	0900	100
0000	0100	0200	0300	0400	0500	0600	0630	0700	0800	0900	1000	110
0100	0200	0300	0400	0500	0600	0700	0730	0800	0900	1000	1100	120
0200	0300	0400	0500	0600	0700	0800	0830	0900	1000	1100	1200	130
0300	0400	0500	0600	0700	0800	0900	0930	1000	1100	1200	1300	140
0400	0500	0600	0700	0800	0900	1000	1030	1100	1200	1300	1400	150
0500	0600	0700	0800	0900	1000	1100	1130	1200	1300	1400	1500	160
0600	0700	0800	0900	1000	1100	1200	1230	1300	1400	1500	1600	170
0700	0800	0900	1000	1100	1200	1300	1330	1400	1500	1600	1700	180
105°E	120°E	135°E	150°E	165°E	180°	165°W	157°W	150°W	135°W	120°W	105°W	-90°

†Greenwich Civil Time   * Actual time used: 5 hrs. 53 min. +GCT

LD TIME CHART

EASTERN	PUERTO RICO	RIO DE JANIERO	AZORES	FR. W. AFRICA	#GCT - LONDON	ROME	CAIRO	ADEN		BOMBAY	*CALCUTTA	SINGAPORE
75°W	-60°W	-45°W	-30°W	-15°W	0	-15°E	-30°E	-45°E	-60°E	-75°E	-90°E	105°E
900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700	0800
100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900
200	2300	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000
300	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100
000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200
100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300
200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400
300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500
400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600
500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700
600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800
700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300
200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	0000
300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	0000	0100
400	1500	1600	1700	1800	1900	2000	2100	2200	2300	0000	0100	0200
500	1600	1700	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300
600	1700	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400
700	1800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500
800	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600
900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
75°W	-60°W	-45°W	-30°W	-15°W	0	-15°E	-30°E	-45°E	-60°E	-75°E	-90°E	105°E

Compiled by ATHAN COSMAS

ANTENNA CONSTRUCTION

ELEMENTS OF ANTENNA TECHNIQUE WHICH THE BEGINNER SHOULD KNOW—AND WHICH THE OLD TIMER OFTEN FORGETS

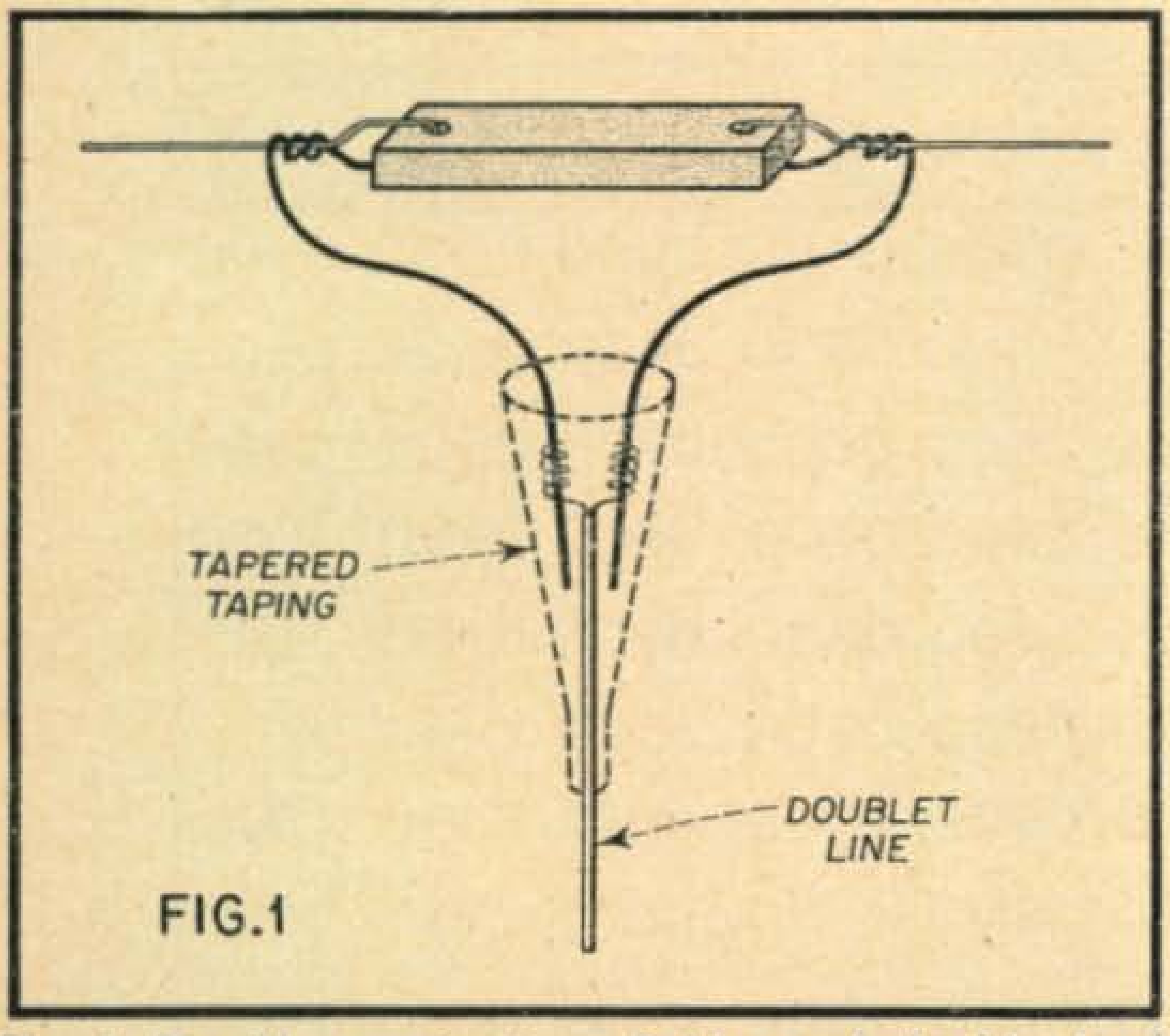


Fig. 1. Doublet termination. Solder each doublet lead to the surplus antenna ends. Tape individually, and then together in a long taper

A SOUNDLY CONSTRUCTED antenna will pay dividends in efficiency as well as present a respectable appearance to the passing world. Controversies have raged concerning skin effects, etc., as determining the choice of wire for a transmitting or receiving antenna. But from a strictly mechanical viewpoint, stranded wire is undoubtedly superior. Make a nick in any fairly hard solid conductor, flex it a few times and it is sure to break. A stranded wire therefore provides a greater margin of safety as the likelihood of accidental damage in handling to all the strands is very small. This difficulty with solid wire could be reduced somewhat by using softer material, but such wire will eventually stretch and sag, which is undesirable from both constructional and electrical viewpoints.

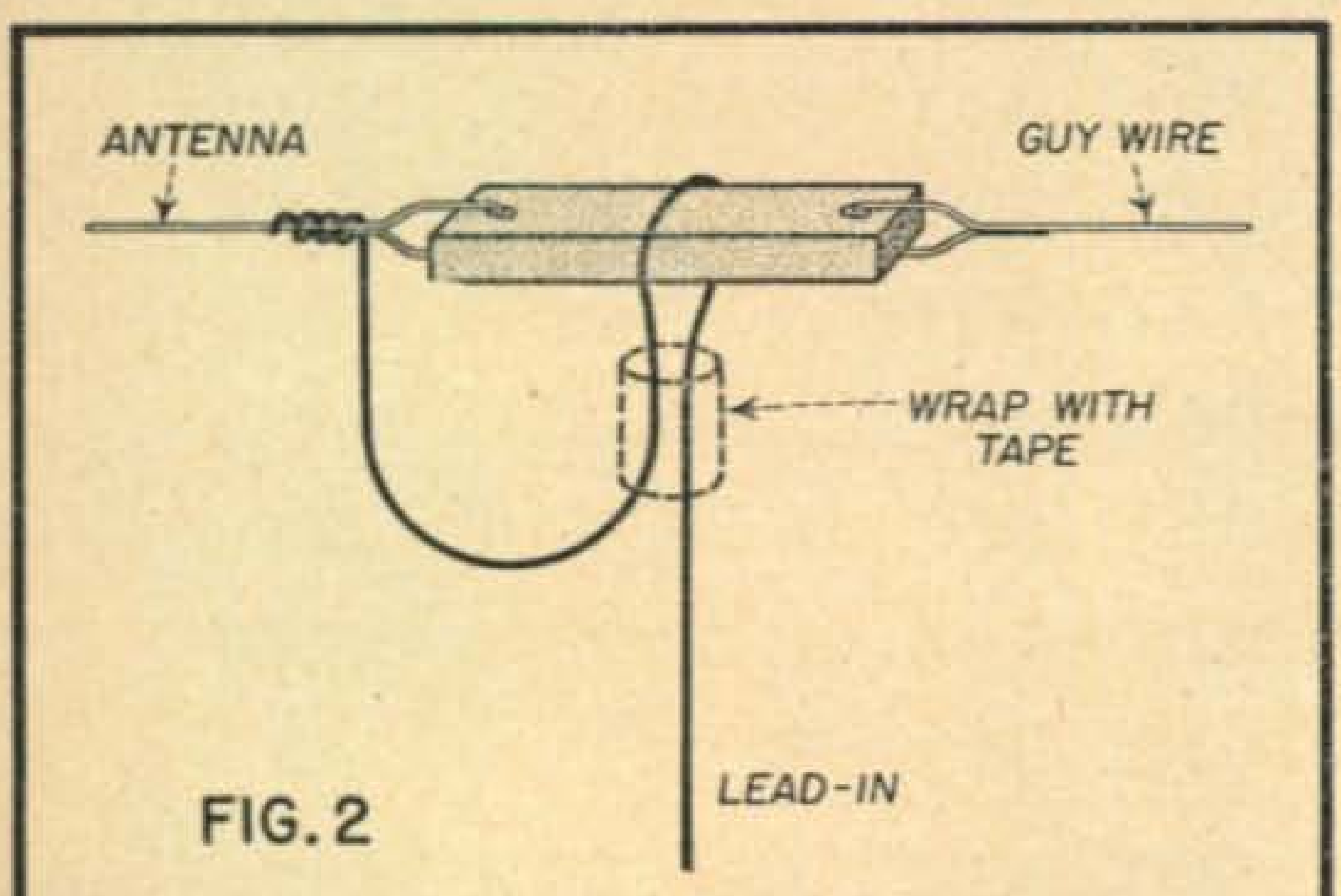


Fig. 2. Single-ended termination, designed to relieve strain on the soldered joint and the loop

Receiving Antennas

The conventional receiving aerial generally consists of a bare wire either center or end-fed by an insulated conductor. The trick in an ordinary doublet antenna is to join the line to the flat top. One method of accomplishing this, which largely eliminates the situation in which the feeder is supported by its soldered connection, and at the same time protects the doublet line from moisture, is shown in *Fig. 1.* The antenna wire is brought down through the centre insulator and the feeder connected above the ends. Each connection and its associated stub wire is then taped individually. Ordinary electrician's friction tape is often too wide for easy manipulation and under such circumstances should be torn down the middle into narrow strips which are easier to handle. The entire "throat" is then wrapped with rubber tape, followed by an application of friction tape—making as smooth a job as possible. The splice should then be coated with coil dope or some other

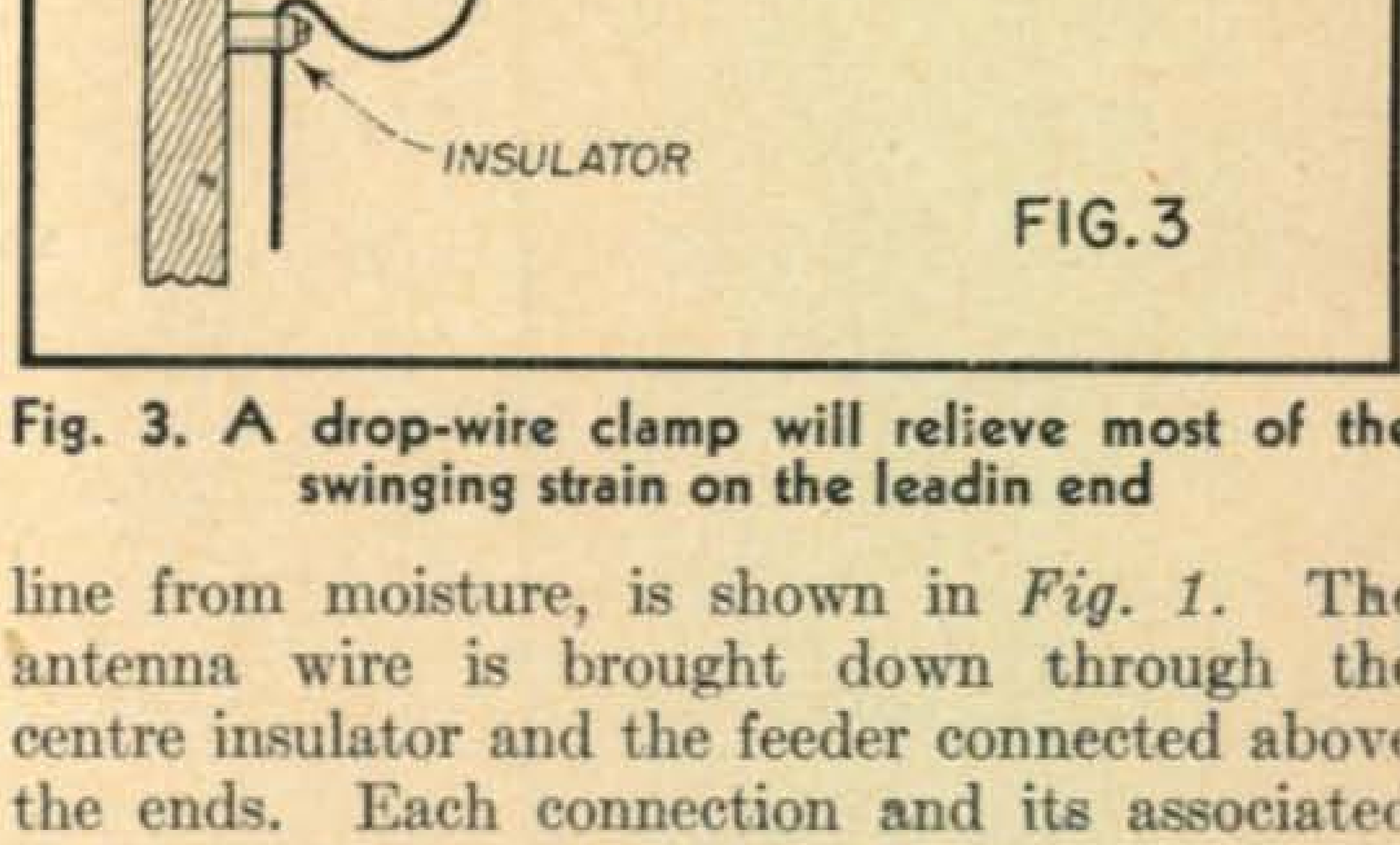


Fig. 3. A drop-wire clamp will relieve most of the swinging strain on the leadin end

HINTS

W. H. ANDERSON, VE3AAZ

moisture-repellent. The thickness of the tape covering should be tapered off down along the transmission line so as to prevent concentrating "whipping" of the feeder at the point where it emerges from the tape. In the case of the single-ended antenna, the feeder may be looped over the insulator as in *Fig. 2*, to relieve the soldered joint of the leadin weight.

When attaching an insulated leadin to its first rigid support, it is advisable to use a "drop-wire" clamp as in *Fig. 3*. This spreads the lead-in "swing" along a considerable length rather than concentrating it at one point.

Splicing and Dead-Ending

The accepted method of dead-ending a stranded wire is shown in *Fig. 4*. This consists of bringing the two wires together then separating one strand only of the loose ends and wrapping it around both wires, keeping the turns close together. Then separate each strand successively and wrap in the same manner. About four inches free end should be allowed to give adequate length for wrapping.

Dead-ending a solid wire should be effected as in *Fig. 5*. In fact, this policy of making a two-turn loop before dead-ending is a good idea

[*Continued on page 42*]

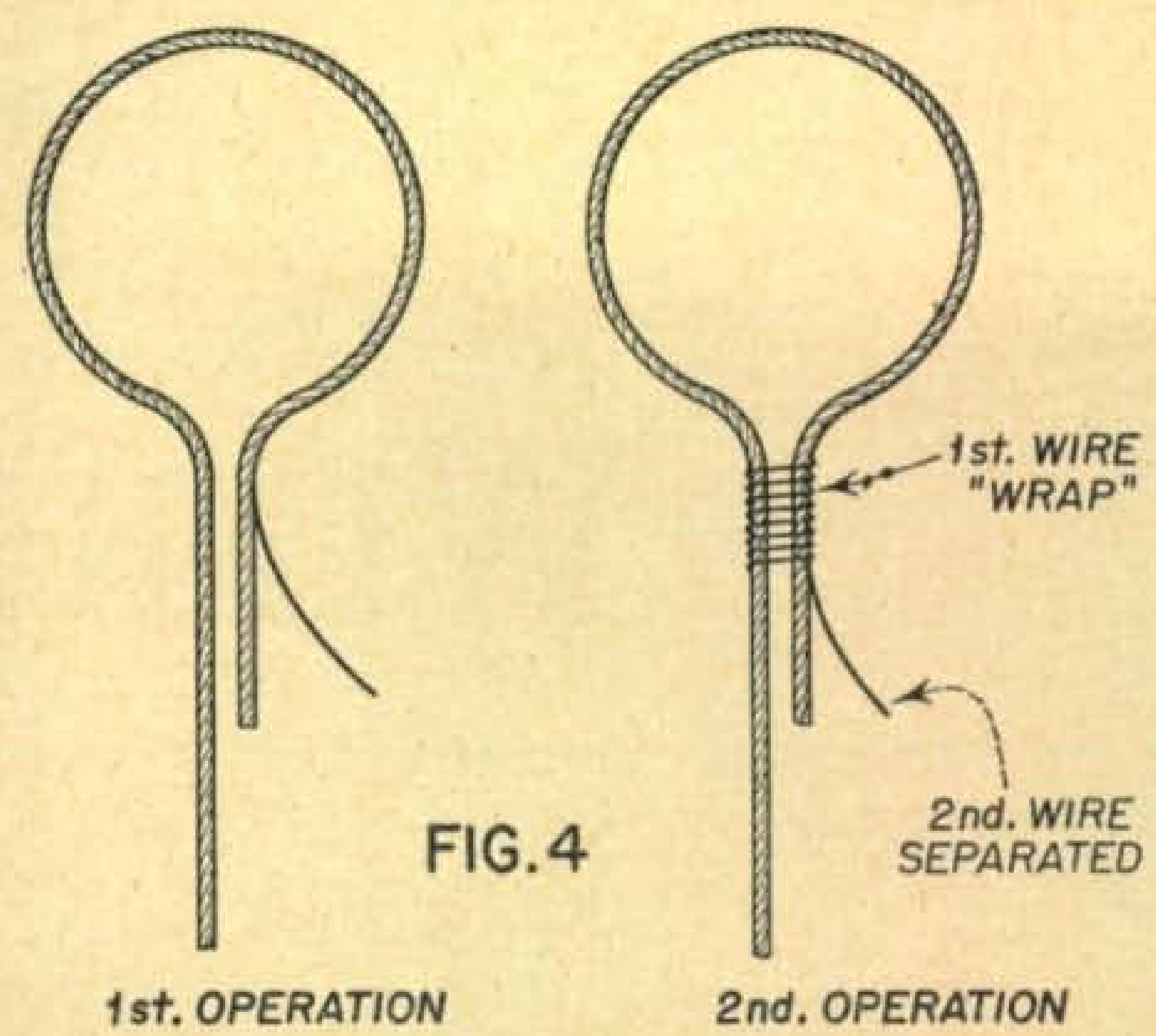


FIG. 4

Fig. 4. Dead-ending stranded wire. Individual wrappings of each strand are placed close together

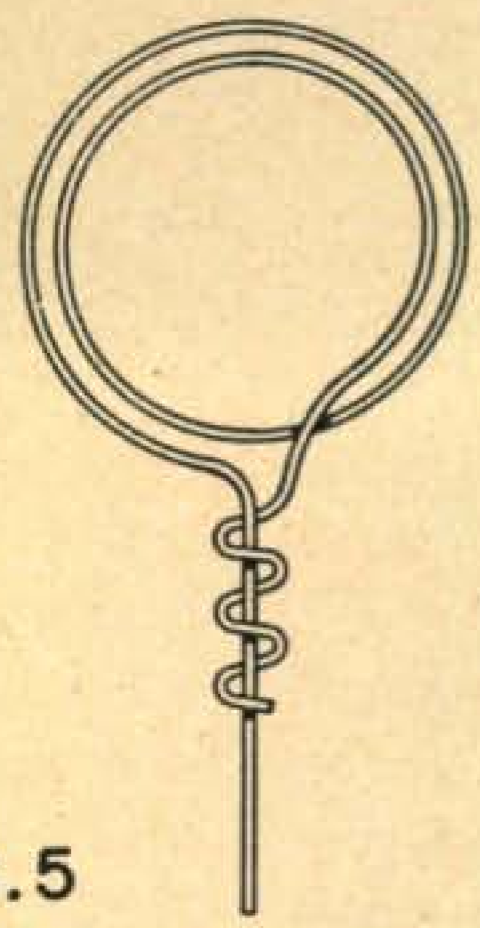


FIG. 5

Fig. 5. The double loop is a "must" in dead-ending solid wire

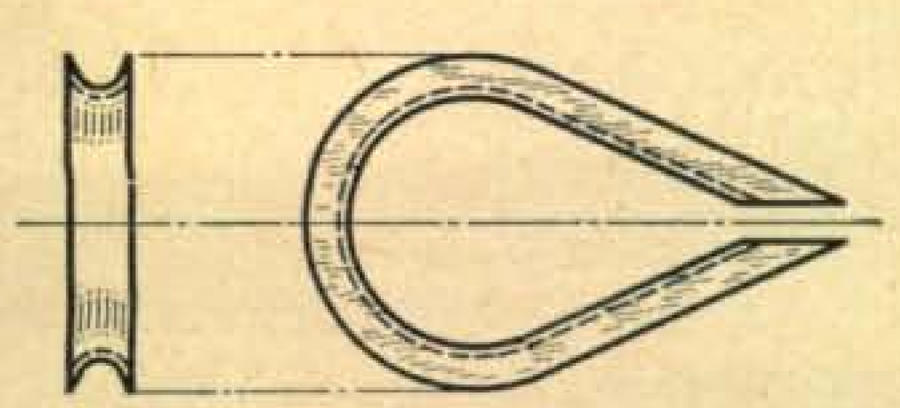


FIG. 6

Fig. 6. The "thimble," familiar to every line-man, is a stranger to many radio amateurs

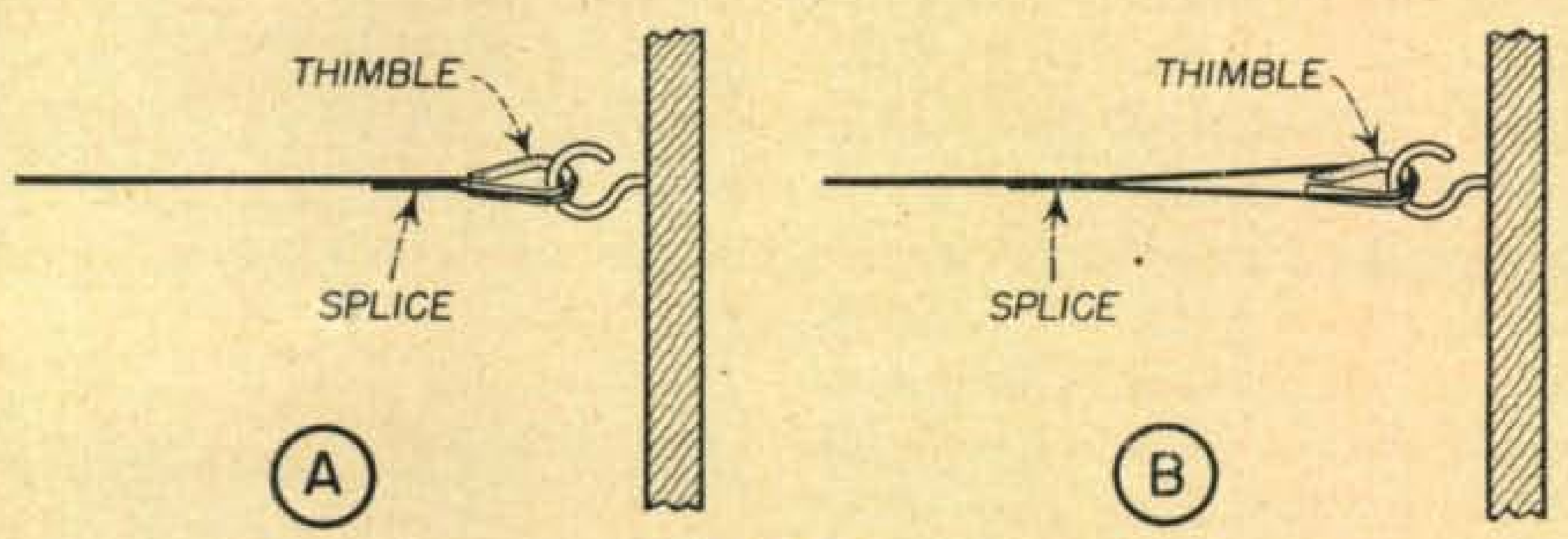


FIG. 7

Fig. 7. Right and wrong ways of splicing to a thimble

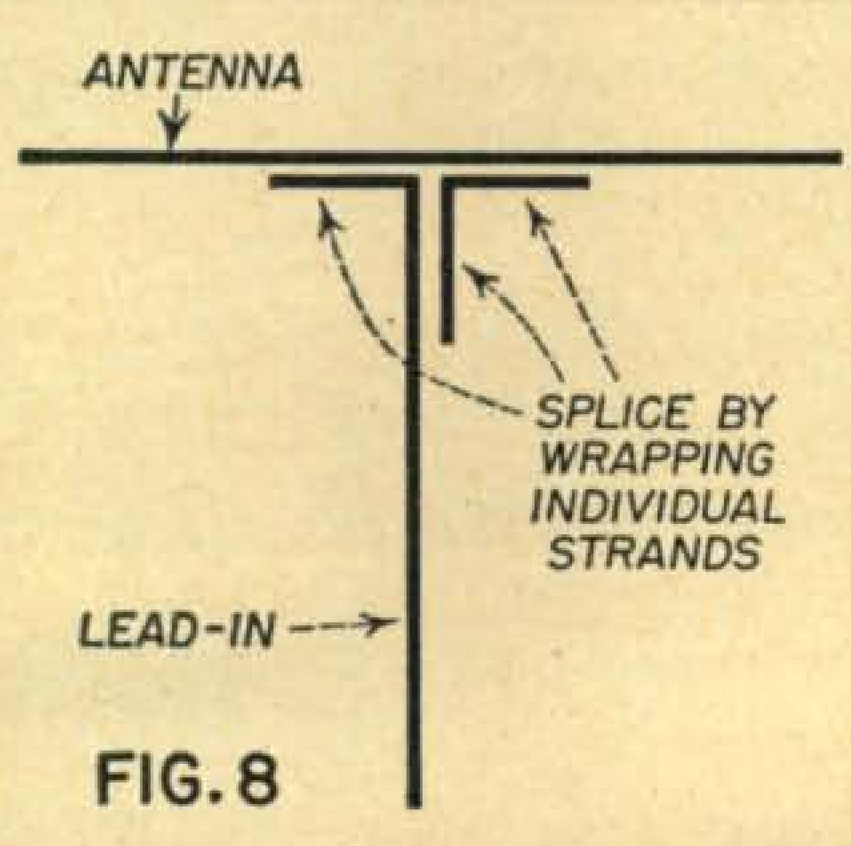


FIG. 8

Fig. 8. Good antenna construction technique dictates strengthening the tapped splice

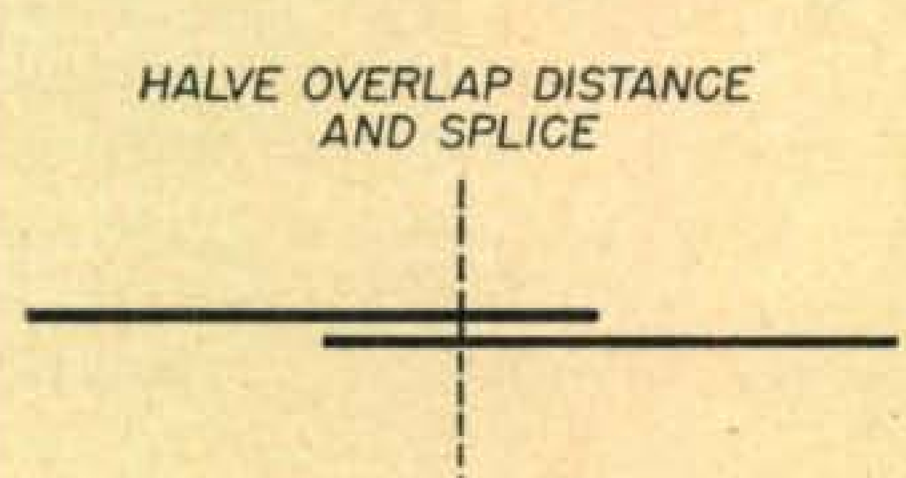


FIG. 9

Fig. 9. Each side of a running splice should be strand-wrapped as shown in Fig. 4

Radio Amateurs' Worksheet

No. 5. AUTOMATIC FIDELITY CONTROL; COUPLING OF TUNED RADIO FREQUENCY CIRCUITS

AUTOMATIC FIDELITY CONTROL

A NUMBER OF ingenious circuits have been devised to control automatically the audio bandwidth of radio receivers in proportion to the strength of the radio-frequency signal received. These circuits are usually referred to as automatic tone control or automatic fidelity control circuits. A representative circuit of this sort is illustrated schematically in *Fig. 1.* The action of this device is to reduce the audio bandwidth when weak signals are received, and to increase it when strong signals are received.

For the circuit depicted here the grid of the control triode (of course, it need not be a triode) is connected to the negative end of the diode load circuit, which in this case also supplies A-V-C voltage. The control tube acts as a variable capacitor shunt across the audio circuit of the detector; the capacitance increasing with a decrease in signal. This is precisely the action required in high fidelity broadcast receivers, the wide bandwidth of which can only be used to advantage on strong signals.

If the received signal amplitude is large, the total capacitance shunting the detector load circuit is *C* plus the input capacitance of the control tube. When the signal decreases, the dynamic capacitance of the control tube rises. For very weak signals the change in capacitance may be as much as .005 μf (*C* is normally about .00025 μf) in broadcast receivers. The action of the circuit of *Fig. 1* is more or less obvious from inspection and is due to the fact that the input capacitance of a triode varies with its mutual conductance and is governed by grid to plate capacitance. In the case of some triodes the grid-to-plate capacitance

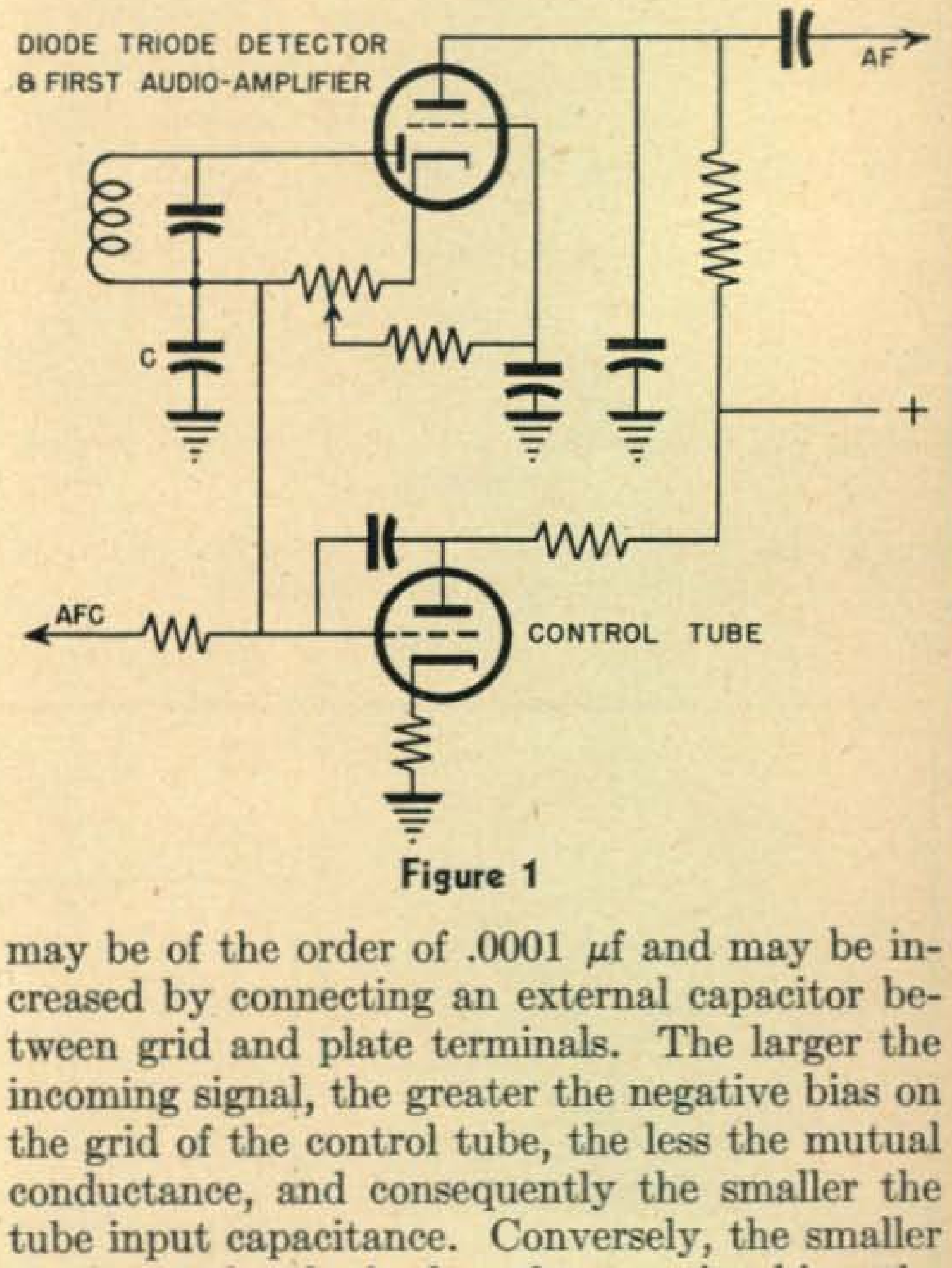


Figure 1

may be of the order of .0001 μf and may be increased by connecting an external capacitor between grid and plate terminals. The larger the incoming signal, the greater the negative bias on the grid of the control tube, the less the mutual conductance, and consequently the smaller the tube input capacitance. Conversely, the smaller the input signal, the less the negative bias, the larger the mutual conductance, and hence the larger the input capacitance.

COUPLING OF TUNED RADIO FREQUENCY CIRCUITS

IT IS FREQUENTLY necessary in radio receivers with wide pass bands to use more than critical coupling between successive tuned circuits in the intermediate frequency amplifier. If the tuning is fixed (the usual case) it is not im-

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Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs portant whether capacitive or inductive coupling is used. If the pass band is adjustable in steps, it is usually more convenient to use capacitive coupling. If the pass band is to be adjustable in many small steps or is to be continuously variable, inductive coupling is generally used. Intermediate frequency amplifiers usually employ identical tuned circuits coupled to each other, which are adjusted to the same frequency.

If K represents the coefficient of coupling, and M, the mutual impedance, we have at critical coupling:

$$\omega M = \sqrt{R_1 R_2}$$

$$K = \frac{M}{\sqrt{L_1 L_2}} = \frac{1}{\sqrt{Q_1 Q_2}}$$

where $\omega = 2\pi f$

and $Q = \frac{R}{\omega L}$

If $Q_1 = Q_2 = 100$

Then $K = 1\%$

As the coupling is increased beyond critical or "sufficient" coupling, the response decreases and the pass band separates into a two-humped curve. In general, the two humps begin to be apparent at about 1.5 times critical coupling. The relation between the frequency of unity power factor and the resonant frequency for the over-coupled circuit of *Fig. 2* is approximately:

$$\frac{F_1}{F_0} = \frac{1}{\sqrt{1 \pm K}}$$

where F_1 is the frequency at unity power factor and F_0 is the resonant frequency. The current in the secondary circuit at unity power factor (i.e., the frequency of the humps) is:

$$I_1 = \frac{E}{Z_1 + \frac{\omega^2 M^2}{Z_2}}$$

$$I_2 = \frac{-j\omega M I_1}{Z_2}$$

where:

$$Z_1 = R_1 + j(\omega L_1 - \frac{1}{\omega C_1})$$

$$Z_2 = R_2 + j(\omega L_2 - \frac{1}{\omega C_2})$$

When one of the tuned circuits is improperly aligned or when regeneration occurs the response curves shown in *Fig. 2* appear. The higher the Q of the circuits the more pronounced the humps of the response curve.

Bandwidth is sometimes defined as the distance (i.e. frequency difference) between the humps of the response curve. The ratio of pass

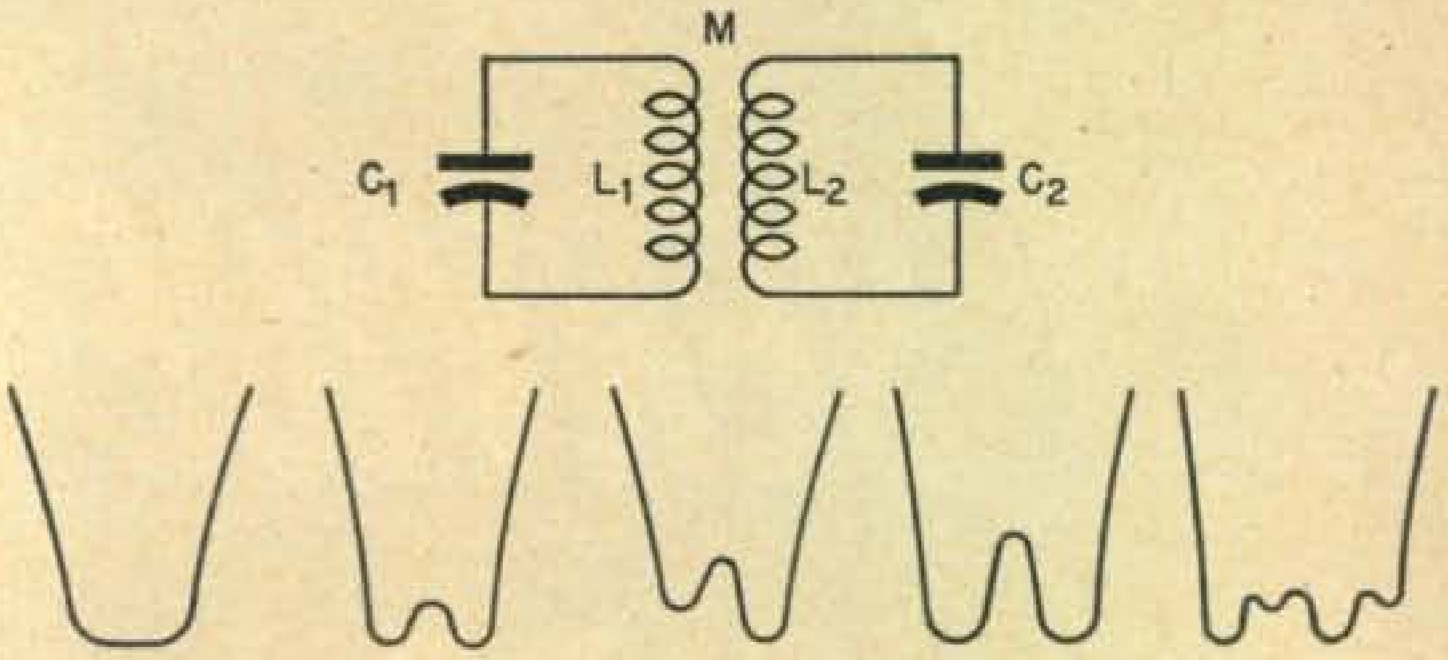

Figure 2

band width to resonant frequency may be expressed by:

$$\frac{\Delta F}{F_0} = \frac{\sqrt{1+K} - \sqrt{1-K}}{\sqrt{1-K^2}}$$

If K is very small, as is usually the case the above expression reduces to:

$$\frac{\Delta F}{F_0} = K$$

That is, the width of the pass band expressed as a percentage of midband frequency is approximately proportional to the coefficient of coupling. It is generally desirable that the response at the two humps and at the center of the pass band be approximately equal. This condition is realized to a first approximation when:

$$K = \frac{1.5}{\sqrt{Q_1 Q_2}}$$

If, as is usually the case:

$$Q_1 = Q_2$$

it appears that the value of Q required to yield nearly uniform response is inversely proportional to the coefficient of coupling, whence:

$$Q_1 = Q_2 = \frac{1.5}{K} = \frac{1.5\,F_0}{\Delta F}$$

Let E_1 be the voltage applied to the primary of the circuit of *Fig. 2* and E_2 the resulting voltage across the secondary condenser C_2, then for the condition of uniform response:

$$\frac{E_2}{E_1} = \frac{Q}{2}$$

In other words, the response at resonance is down 6 db over that of an identical single tuned circuit. This is equivalent to saying that the impedance facing the plate of the preceding tube is one-half that of a single identical tuned circuit. This in turn is equivalent to stating that the gain is reduced 6 db, since for r-f pentodes, the gain is given by:

$$A = \frac{G_m L}{CR}$$

SILVER

1. Brand new post-war design . positively not a "warmed-over" pre-war model.
2. **More** than an "electronic" voltmeter, **VOMAX is a true vacuum tube voltmeter** in every voltage/resistance/db. function.
3. Complete signal tracing from 20 cycles through over 100 megacycles by withdrawable r.f. diode probe.
4. 3 through 1200 volts d.c. full scale in 6 ranges at 50, and in 6 added ranges to 3000 volts at 125 megohms input resistance.
5. 3 through 1200 volts a.c. full scale in 6 ranges at honest effective circuit loading of 6.6 megohms and 8 mmfd.
6. 0.2 through 2000 megohms in six easily read ranges.
7. -10 through $+50$ db. (0 db. $=1$ mw. in 600 ohms) in 3 ranges.
8. 1.2 ma through 12 amperes full scale in 6 d.c. ranges.
9. **Absolutely stable**—one zero adjustment sets all ranges. No probe shorting to set a meaningless zero which shifts as soon as probes are separated. Grid current errors completely eliminated.
10. Honest, factual accuracy: $\pm3\%$ on d.c.; $\pm5\%$ on a.c.; 20~ through 100 megacycles; $\pm2\%$ of full scale, $\pm$ 1% of indicated resistance value.
11. Only five color-differentiated scales on 4⅝" D'Arsonval meter for 51 ranges (including d.c. volts polarity reversal) eliminate confusion.
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Created by a world-famous receiver design engineer specifically for post-war receiver servicing . . . that's why "VOMAX" will do more for you . . . make you the boss, not the victim, in servicing complex post-war receivers.

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It's no wonder "VOMAX" is sold out for 1945 on advance jobber orders. But though the factory is sold out, jobbers still have a few left. May we suggest that you follow the lead of America's top-flight service organizations . . . manufacturers . . . engineering laboratories . . . and place your order immediately? Service-station-originated AA-5 priority does the job. But only fast action will bring you "VOMAX", the key to post-war service profits, this year.

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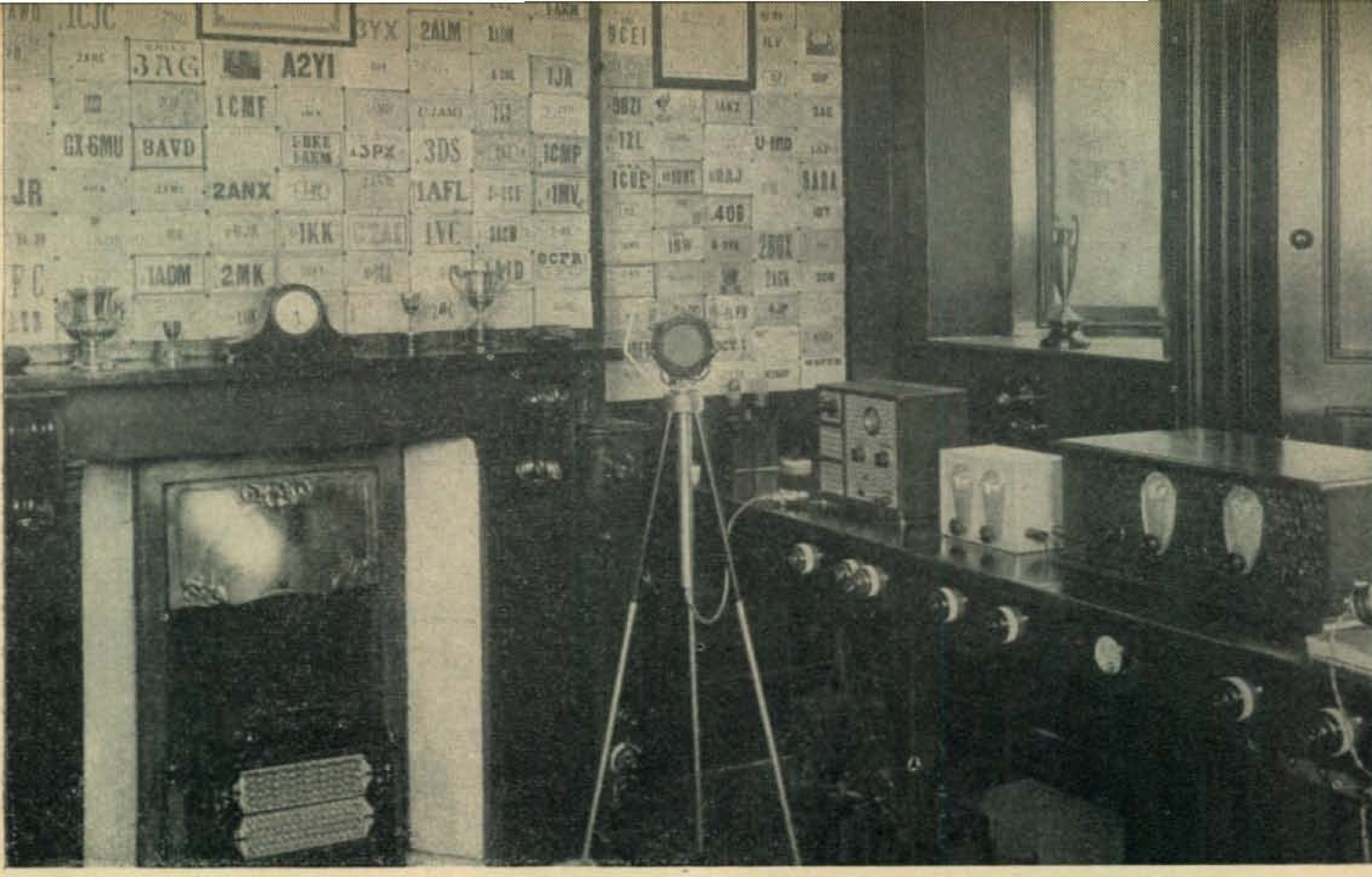

That G5BY is an old timer is testified by his cards from the States with the prefix U (before international agreement assigned the W) and those with no prefix at all

Hasta La Vista!

Some Ham Stations We May All Be QSOing Soon Again

COURT MATTHEWS, Lieut., USNR, W6EAK

IT HAS ALWAYS been our opinion that the yardstick for measuring a "successful" amateur station included many more factors than just high power and a super antenna. Sure, it's nice to dream of that "California kilowatt" and an "ideal" location. But is it really necessary? Looking back on more than a decade of hamming, it seems to us that the calls that stick in our memory had a little something more behind them. Maybe it was the personality of the operator; perhaps it was a contagious enthusiasm; maybe it was just that certain "feel" for his hobby that put an operator on the right band at just the right time. Whatever the reason there are certain calls that stand out.

Thumbing through our photos and logs, we

G5BY—and there's no mistaking that British key. You really had to *pound* brass on them

VS6AG in Asia—whose signals came first and faded last

Electrical Characteristics of Type 2B25

Filament Voltage (AC or DC)	1.4 volts
Filament Current	110 amps.
Maximum Peak Inverse Voltage	2800 volts
Maximum Peak Plate Current	9.0 ma.
Maximum Average Plate Current	1.5 ma.

TYPE 2B25
AVERAGE CHARACTERISTICS

A recent development for the expanding Raytheon miniature tube line is the type 2B25 high-voltage, high-vacuum rectifier. This tube requires approximately 0.15 watts filament power, yet can deliver 1000V DC at 1.5 ma.

These characteristics make it applicable to various forms of electronic equipment in which its small size and rugged construction may be very desirable features. Furthermore, with proper precautions, the low filament power can easily be supplied from an oscillator if it is desired to rectify low radio frequency to obtain direct current power within the 2B25 voltage and current ratings. Plate and filament potentials can be turned on simultaneously without damage and heating is practically instantaneous — thus making this tube suitable for intermittent usage.

Other possible applications include operation as the rectifier in battery vibrator power supplies designed to supply the high voltage DC for small portable cathode ray oscilloscopes or special test equipment.

Raytheon type 2B25 and the many other types in Raytheon's complete line are precision-engineered and quality-built for utmost efficiency and maximum dependability. Look to Raytheon for the *best* in tubes for your postwar products!

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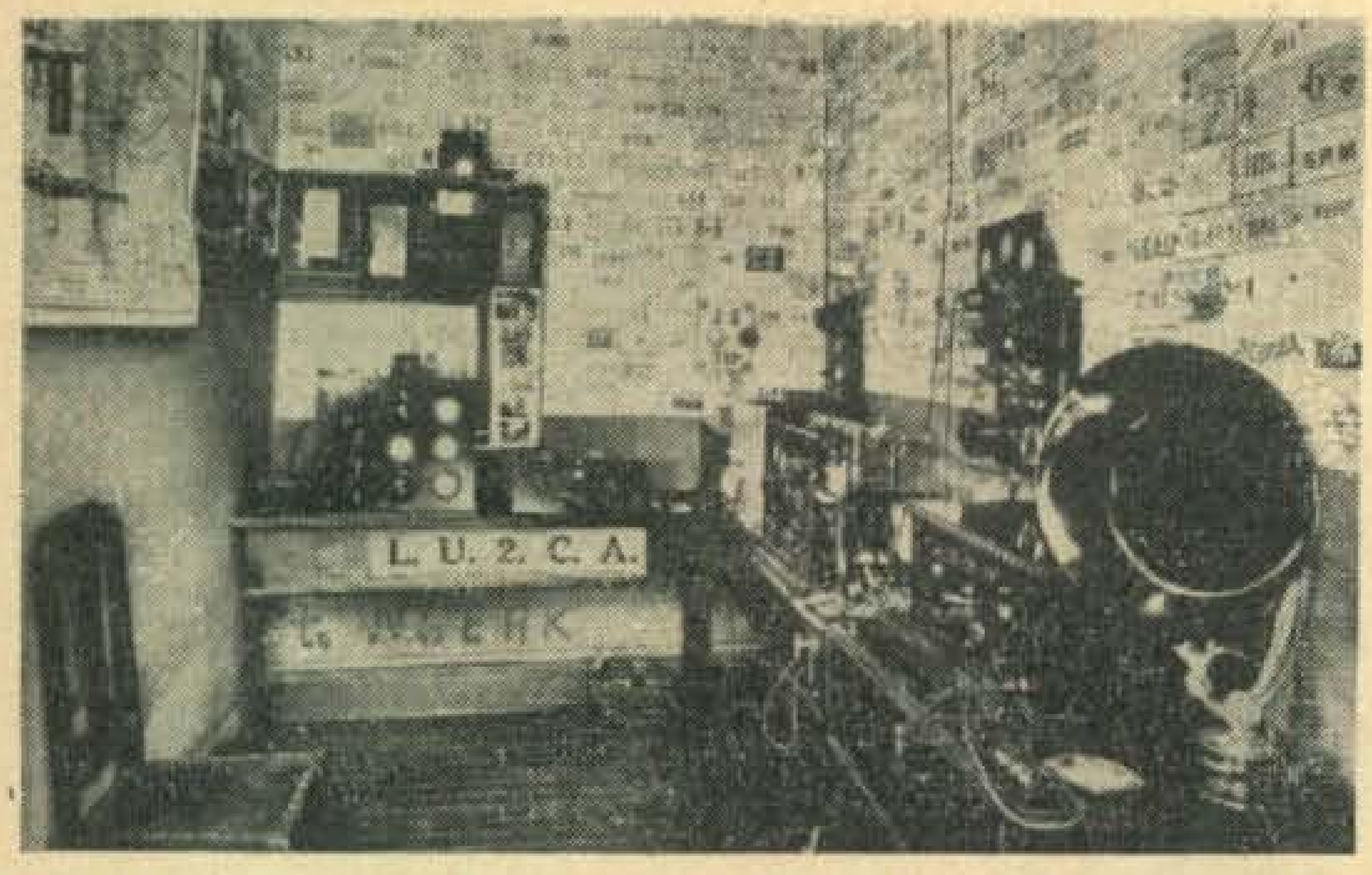

Father and son kept LU2CA on almost a 24-hour sked

A breadboard layout at W8CRA that apparently went places

can't help reminiscing a bit. Calls come back to us that had an extra something that made them outstanding. We present our selections for a sort of all time W.A.C. "Hit Parade"—our favorite station from each continent.

From Europe

Here's an old timer for you! Certainly G5BY must head any list of the "greats" in ham radio. Yes, we have heard louder European signals than G5BY's, but his signal was *always* in there—even when the band was otherwise dead. Maybe it was sheer British bull-dog perseverance that pushed that signal through, or perhaps it was Hilton's boundless enthusiasm for his hobby. Whatever it was—Europe for us will always bring to mind G5BY.

ZS5U—an African signal of pre-war fame

Africa

DX for almost any American ham, ZS5U must have been for many years the most called station on the African continent. Always operating with very moderate power, ZS5U put through amazingly consistent signals. We particularly remember his 40-meter wallop in the early DX days on the west coast when African signals were as rare as nylons in war-time. Up at dawn for that pre-breakfast DX, the first signal we would hear as the old blooper "shooshed" into oscillation was ZS5U. Pounding in until well after sun-up over some 14,000 miles (the long way around) he caused us to be late for school on many occasions. Then after dinner we would get on the air again, and presto, there would be ZS5U—this time coming in the other way around. That was real globe girdling. Always ready for a rag-chew, tests, or whatever the fellow at the other end wanted, ZS5U is our choice—not only as Africa's most consistent signal, but also its most congenial operator.

KA1HR from Oceania

Our nomination of KA1HR for top honors in Oceania is challenged by several fine Australian and New Zealand stations. However, KA1HR wins out on sheer consistency and service. An Army station of many operators and many prefixes (PI, OP, K, and KA), 1HR seemed nevertheless to develop a distinctive "personality." One outstanding memory of some seventeen years ago is the jolt our eardrums received the first time we tuned through the forty cycle rock crusher signal that identified KA1HR in those days. We just couldn't believe that a trans-Pacific signal could be that loud. KA1HR was for years almost the only link with home available to our GIs in the Philippines, and a QSO was usually the beginning of an hour or so of *fast* traffic handling. A compilation of 1HR's traffic totals from the first

[*Continued on page 36*]


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Company
GLENVIEW, ILLINOIS

trans-Pacific message up through December 7, 1941 should reach astronomical figures. Thousands of messages were handled and almost every one of them over seven thousand or more miles of ether. Some record!

From Asia

A difficult choice between several outstanding old timers finally brings up Johnny Alvares of VS6AG as our blue ribbon winner in the Asiatic sector. Sometimes eclipsed in signal strength by other Asian stations when conditions were good, still VS6AG had one of those signals that was the first to come through and the last to fade. Year in and year out our log shows VS6AG as the most consistent signal from the Asiatic continent. If Johnny survives the tribulations that beset the VS gang at the present time, we are sure that his fine signal will once again make VS6AG a familiar call on the ham bands. Good luck, VS6AG!

South American LU2CA

Here's a father and son combination that really clicked. We never could figure out how the Radaelis managed to find time for such trivia as eating and sleeping and keep that signal so constantly on the air. LU2CA was our constant check on how the twenty-meter signals were coming through. If LU2CA wasn't booming, we didn't bother even to warm up the transmitter. One of our most pleasant ham memories is the long afternoon chats with LU2CA and his help in giving us Spanish lessons. That took a lot of good-natured forbearance on his part! Any ham who has ever participated in an international DX contest will remember the crisp efficiency and solid wallop behind LU2CA's signal. He put South America on the map for us.

Home Territory W8CRA

At the risk of offending some of our West Coast brethren we are forced to dig into the hat and pull out W8CRA. A DXer and rag-chewer de-luxe, Frank Lucas kept the ether buzzing in the far corners of the globe for years. First achieving prominence for his ability to work scores of Asiatic stations when nobody else in the eastern U.S.A. could even hear 'em, Frank proved his versatility by laying down an outstanding signal all over the world. Starting modestly with the old faithful 210, W8CRA finally worked up to the high-power class, but he could always do better with ten watts than we could with a kw—much to our envy. We're looking forward to the day when we can get that post-war dream rig on the air and give Frank some real competition. But we know it won't be easy. W8CRA had that "extra" push that's hard to beat.

PRECISION
is a hobby
in MT. CARMEL, ILL.

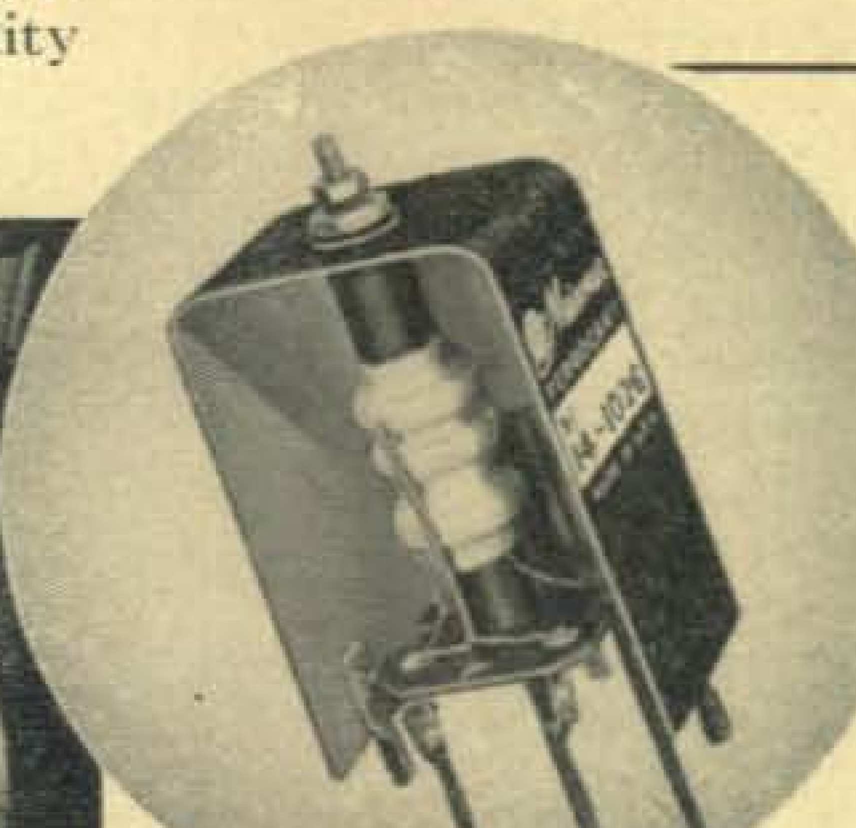
Yes, precision is the hobby of the men and women who make up Meissner's famed "*precision-el.*" The high quality electronic equipment that their skilled fingers produce each day is proof enough that they enjoy the work as thoroughly as they enjoy their after-hours hobbies. You'll find more proof in the photographs on this page.

It could be a new grandson or a 3-pound bass that brings a smile like this, but it's not! It's pride in a precision electronic job well done. It's a reason for higher quality in Meissner products.

This "precisioneer" takes the same interest in his work at Meissner as he does in his home. He proves it with a smile that is typical of *precision-el*—as typical as the precision quality of Meissner products.

Baseball broadcast? Not on your life. But it's a "homer" for this member of Meissner's laboratory staff. The satisfied smile means that the instrument he's testing is "on the Meissner quality beam."

Here's a member of Meissner's *precision-el* whose smile is contagious. Delicate adjustments properly made are the reason. Higher quality in Meissner electronic equipment is the result!



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These Adjustable-Inductance Ferrocart (iron core) coils will replace Antenna, RF or Oscillator coils without the trouble of locating "exact duplicates" because they are continuously variable in inductance over a wide range. The inductance of the old coil is easily matched by simple screwdriver adjustment. Ferrocart iron cores add gain and selectivity to the receiver. Available shielded or unshielded, shipped with complete instructions. Order by number. 14-1026 Univ. Ant. Coil; 14-1027 Univ. R.F. Coil; 14-1028 Univ. Osc. Coil. Price $1.50 each.

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MORE ON TIME

[*See Time Chart on pages 24 and 25*]

Editor, *CQ:*

Lawrence LeKashman's very interesting article "A Matter of Time" published in the July issue of *CQ* reminded me of my own experiences. For over ten years I was Radio Officer aboard vessels of the Isthmian Steamship Company, engaged in round-the-world service. With ship's time changing twenty or more minutes per day it was convenient, if not essential, to keep the radio room on some standard time. International time ticks, weather and press schedules were always given in GCT, so this was the obvious choice for "Radio Room" time. It was a simple matter to convert local time to GCT with the aid of the accompanying chart.

I happened to be among the first to test low-cost, low-power short-wave equipment for fleet communications. In selecting schedules for various frequencies (18, 24, and 36 meters) the signal path, day or night, had to be considered. With this chart, the type of path—between two communication points—was instantly evident for any hour of any local time. For example, if the path between two communication points was shaded, or night, it suggested that best results would be obtained by use of a night frequency, (36 meters). Likewise if the path was all unshaded, or day, a daytime frequency (18 meters) would produce best results. If the path went from "night" just into "day," or vice-versa, experience recommended 24 meters for best results. The chart was a great help in selecting frequencies for time signals, etc. Since most of these broadcasts were transmitted on several frequencies, it was a simple matter to select the optimum frequency for the path involved.

Some of the best DX was accomplished on 36 meters. For example, in the Indian Ocean, south of Calcutta and east of Colombo, it was possible to work stations on the Pacific coast in the early evening and the east coast during the early morning hours. At 1800 local time, the path eastward from 90° East to 120° West is a night path. Westward from 90° East to 120° West is mostly a day path, but since 90° East is in darkness, the 18 meter signal would not get through. The chart shows that for a little over two hours (or before the west coast moves on into local daylight) it is possible to effect communications on 36 meters. Similarly the early morning hour 0500 at 90° East indicates a night path, westward from 90° East to 75° West.

From the foregoing, it is obvious that it was

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Lockheed's sensational new jet-propelled super fighter, the P-80 "Shooting Star," is the world's fastest and highest flying plane.

★ It is highly significant that Andrew coaxial cables were chosen for the vital radio and radar equipment installed in the P-80. They were selected because they are much more resistant than ordinary solid dielectric cables to the high temperature encountered in the tail of the plane.

Andrew Co. is a pioneer manufacturer of antenna tuning and phasing equipment, including a complete line of ceramic insulated coaxial cables and all necessary accessories. *Write for catalog.*

ANDREW CO.

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CHICAGO 19, ILLINOIS

possible to communicate directly with the east or west coasts of the United States for a period of about four hours out of twenty-four from the vicinity of 90° East. (This was all accomplished with low power equipment. What can be done with higher power and specially designed antennas, is something else again.)

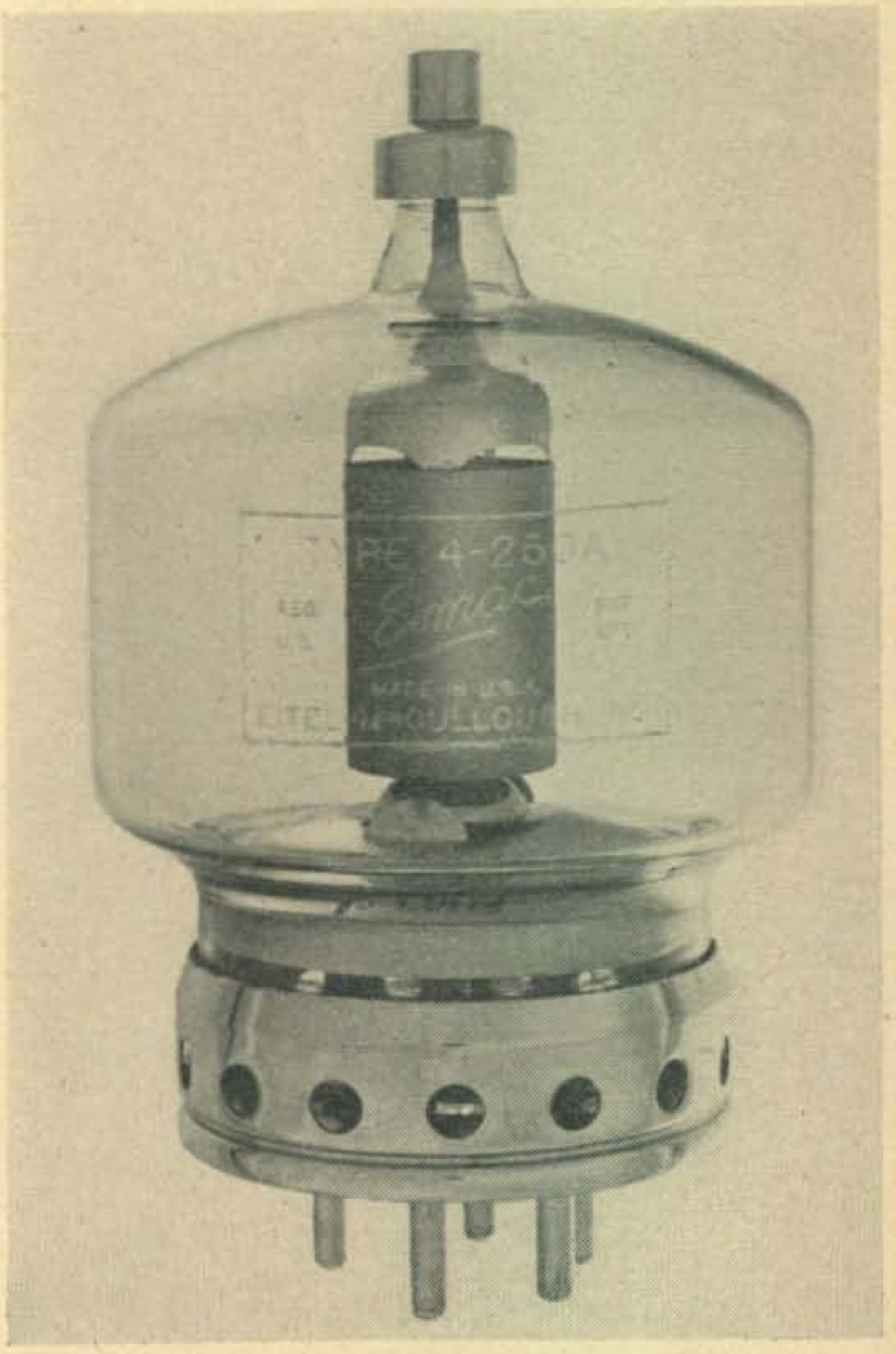
The confusion sometimes resulting from Daylight Saving Time is also eliminated by use of this chart. For example, to convert any Standard Time Daylight Saving Time, just move over one column to the right. Thus, 60th Meridian Standard Time is the same as 75th Meridian Eastern Daylight Saving Time.

The chart arbitrarily takes 6:00 A.M. and 6:00 P.M. as the time for sunrise and sunset. This, is of course, not true for all seasons, nor for all latitudes. However, a little careful listening will quickly determine the best frequencies to use in overlapping cases.

This chart, under glass on the desk in front of the receiver, ought to prove useful in the hamshack. Particularly so when applied to our forty, twenty and proposed fifteen meter bands.

Forest Hills, L. I. ATHAN COSMAS
Aug. 20th, 1945

NEW PRODUCTS



EIMAC TYPE 4-250A POWER TRIODE

Eitel-McCullough, Inc., of San Bruno, California, announces the new Eimac 4-250A transmitting tetrode tube. This new tetrode, which has a maximum plate dissipation rating of 250 watts, incorporates many of the features of the 125 watt 4-125A announced in February, 1945, and is a result of 18 months of extensive test and development work.

Preliminary class-C amplifier data obtained thus far have shown that at 3000 plate volts a single 4-250A is capable of a power output of 640 watts with a driving power of less than 3 watts. Due to the low grid-plate capacitance (0.11 $\mu\mu f$) neutralization has been found unnecessary at frequencies below 40 mc.

GENERAL CHARACTERISTICS

Electrical

Filament: Thoriated Tungsten	
Voltage....................	5.0 volts
Current	14.5 amperes
Maximum Plate Dissipation.....	250 watts
Maximum Plate Voltage...	4000 volts
Maximum Screen Voltage.......	600 volts
Maximum Plate Current........	350 ma.

ANTENNA HINTS

[*Continued from page 27*]

where space permits with *any* type of wire and should always be used when wrapping around masts, attaching guy wires to stays, etc.

Just as a wire with indefinite flexing at one point will break, similarly no wire with a pulling stress on it can stand being doubled back on itself around a short radius. Eventually the wire will cut through. If a wire must be dead-ended for instance, on a ring, it is advisable to use a "thimble" (*Fig. 6*) to carry the wire. In such a case the splice should be made right at the entrance to the thimble (*Fig. 7a*) *not* as in *Fig. 7b*.

Transmitting Antennas

Transmitting antennas pose problems quite similar (though on the hefty side) to those considered above. In the case of a tapped antenna, an extra piece of stranded wire is often spliced into the joint (*Fig. 8*), to provide added strength —then the entire splice is soldered. Avoid splices in any straight section of wire if possible; but if they are necessary, they should be made as in *Fig. 9*. Such splices are a derivation of the dead-end termination (with individual strands) described above, only in this case each wire is spliced to the other.

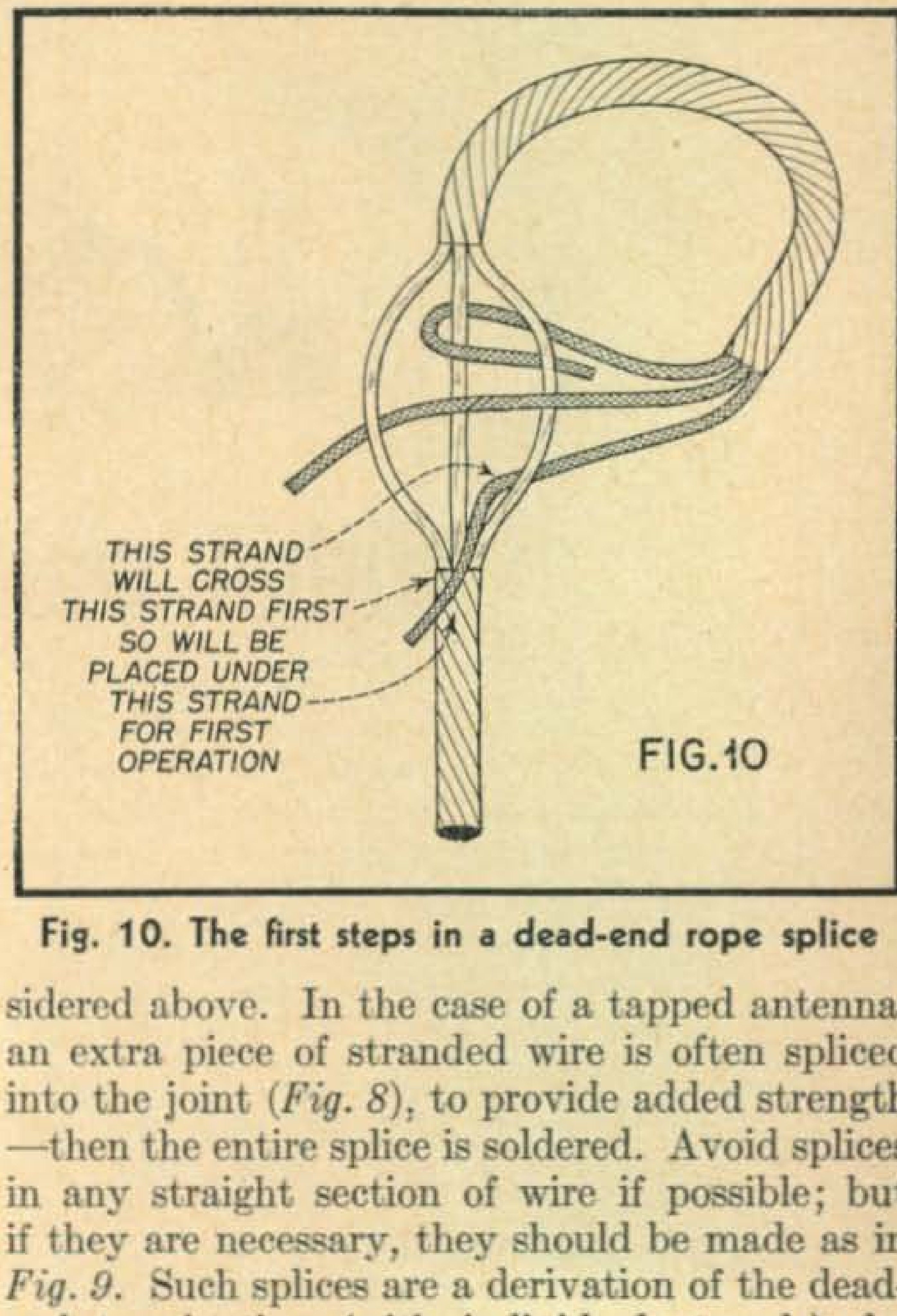


Fig. 10. The first steps in a dead-end rope splice

Soldering

It is almost superfluous to add that soldered connections should be given special consideration. As with all soldering, sufficient heat must be applied so that the solder runs freely. If the solder does not adhere solidly to the wire, either more cleaning or a more efficient flux must be used. Corroded stranded wire should be separated and *each strand individually scraped clean* before soldering is attempted. You may have to use old-fashioned muriatic acid or soldering paste rather than depending on resin-core solder. Over-heating should also be guarded against as it tends to make the wire brittle. Employing less heat and a more active flux is the better plan. Two 100-watt soldering irons working together generally provide sufficient heat. Blow-torches naturally have a tendency to overheat the wire. If possible, the soldering and splicing work should be done indoors where heating and cooling are more readily controlled.

Rope Splicing

Wire or hemp ropes are often used for halyards, and splicing or dead-ending them presents an awkward problem. For dead-ends a thimble should always be used to prevent cutting. While the technique of rope-splicing is rather difficult to put on paper, the basic ideas of one method may be gleaned from *Fig. 10*. First of all, the ends (generally three) are fanned out to the desired length. Since these ends weave back and forth in the splice, they should be made con-

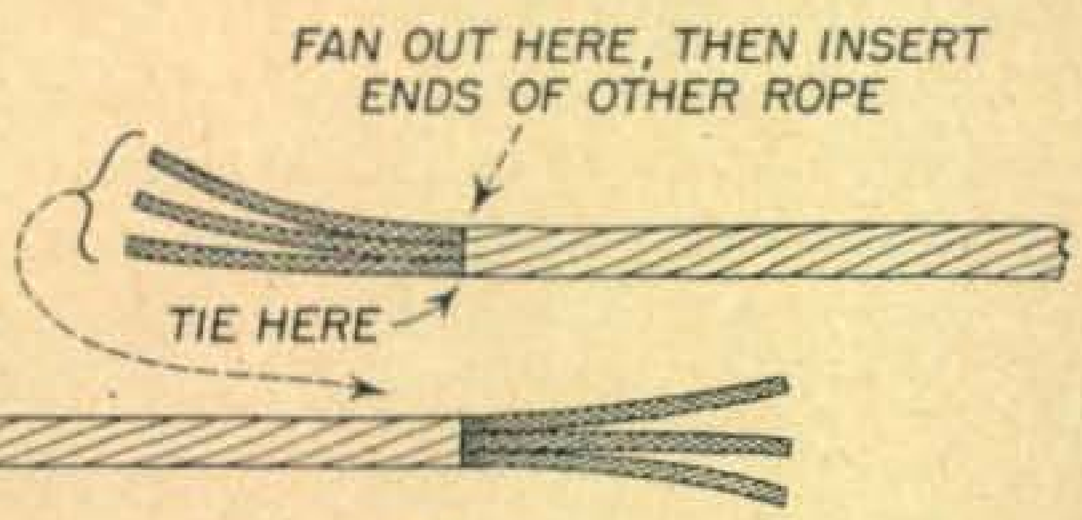


FIG.11

Fig. 11. Two ropes prepared for a running splice

siderably longer than the proposed splice. Anyway it's better to have some ends left over which can be cut off, than to find the splice going short on you. To be on the safe side, splices in ordinary halyards should be about 6″ long at least.

The point of contact with the main rope where the splice is going to be started, is then fanned out by twisting backwards, and the loose ends are placed *under* each one of these strands with the end pointing in the opposite direction to the normal twist of the rope. In other words, the loose ends should lie at approximately 90° to the grooves in the rope—not *in* the grooves. Each end in turn is then threaded under the second strand which it crosses, without changing this original direction. But don't attempt to finish up one end in a single operation. Work around the rope, performing one function on each end at a time, proceeding to the next in a regular sequence. If two ends come out exactly parallel, something is wrong and the splice should be undone to the point where this is no longer the case. (Better get a Boy Scout Manual or a book on ropes and splicing. Your skyhook'll stay up longer.—*Ed.*)

This method will be seen to bring each end strand into as great a contact as possible with the rope proper, resulting in a strong, even and pliable splice. Two such operations will be necessary for a running splice. The two ends should be opened out as far as required, then tied so that the remaining solid rope will not become unravelled. (See *Fig. 11.*)

Rope with a greater number of strands may be similarly handled if care is taken to have the ends initially placed one under each strand and pointing *across* the strands of the rope proper as above.

MOPA

[*Continued from page 17*]

Modulator and Power Supply

The speech amplifier, modulators, and power supply are mounted on a 12″ x 17″ x 2″ chassis (*Fig. 5*). There is no point in describing them as they are conventional in every respect. Any modulator capable of supplying thirty watts of audio to modulate the sixty watt input to the 815 is suitable. The power supply for the modulators delivers 400 volts at 200 ma to power the class AB_1 6L6Gs we use together with their 6N7 phase inverter and speech amplifier. The power supply for the radio-frequency section delivers 400 volts at 300 milliamperes. A dropping resistor is employed to lower the voltage to the HY-615.

The HY-615 runs 20 ma at 300 volts, while the 815 will draw 150 milliamperes at 400 volts, plate modulated. Incidentally, when the amateurs climb to the 144-mc region in future operations, we don't expect to encounter too much difficulty in putting this rig up there.

R-F IMPEDANCE

[*Continued from page 13*]

size. The dial graduations were made in like manner, using the numeral 1 engraving tool.

Dials C_3 and C_4 were calibrated so as to read differences of reactance in such a manner that an increase in dial reading gave capacitive reactance values, and a decrease gave inductive reactance values. The actual *inductive* or *capacitive* reactance in ohms can be calculated with a reactive slide-rule, or from the expression:

$$X_x = \frac{1}{\omega \triangle C_3} \quad \text{or} \quad X_x = \frac{1}{2\pi f \triangle C_3}$$

[*Continued on page 46*]

where ΔC_3 is the difference in capacity between initial and final balance readings.

Some typical impedance curves (*Figs. 6* and *7*) in terms of reactance in plus and minus $\mu\mu$f and resistance in ohms are shown for doublet and rhombic antennas fed by so-called 600-ohm feeder systems. Feeders which were terminated with 600-ohm resistors were found to be satisfactorily flat, but are usually far from such an ideal condition when connected to an antenna. A curve can be made of antenna measurements in a few minutes' time, then followed by making the necessary changes in the antenna so as to make it non-reactive at the desired frequency or frequencies, with the assurance that it will function properly for either transmitting or receiving.

Radio receivers are usually anything but uniform in their input impedance values, as can be seen from a typical curve (*Fig. 6*) taken from two differenct types of receivers. These curves are useful when an attempt is made to minimize local noise conditions. Substantial reduction in noise, with a consequent increase in the readability of weak signals, will result when the impedances of the antenna system and the receiver input are carefully matched for the desired operating frequency.

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Advertising n this section must pertain to amateur or experimentation radio activities. Rate—20c. per word per insertion. Remittance in full must accompany copy. No agency or term or cash discounts allowed. No display or special typographical ad setups allowed. "*CQ*" does not guarantee any product or service advertised in the Classified Section.

EXCITERS

[*Continued from page 8*]

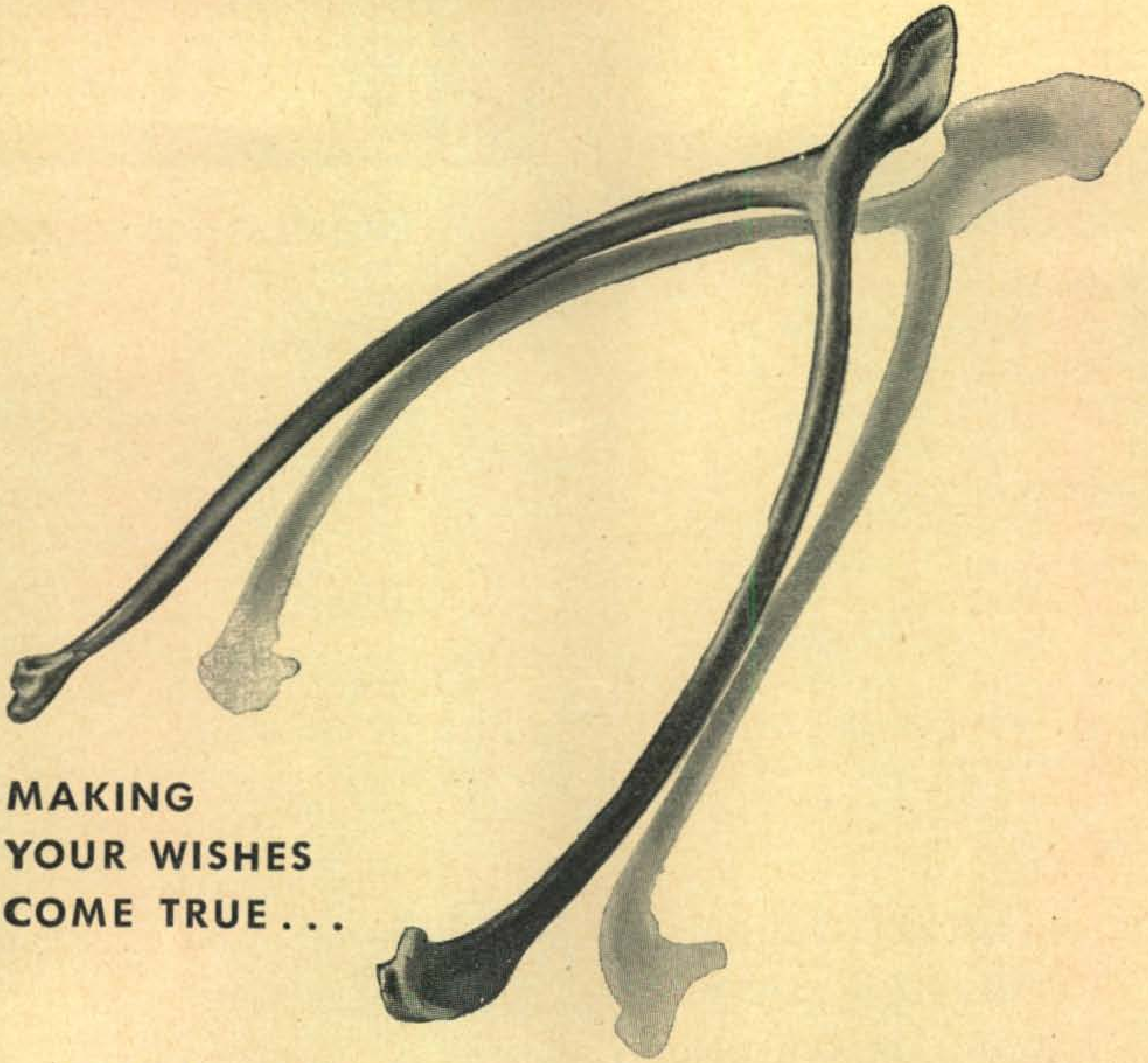
lengths of #10 wire, and again placed near the 815, parallel with the plates. Inductor L_7 is tuned by adjusting the position of the shorting bar.

There is little interest in crystal controlled transmitters on 228 megacycles, although it is possible to build them. The trick in obtaining usable output from the fourth and fifth harmonics of the crystal frequency, lies in using active crystals, and carefully adjusting the cathode coil for maximum output consistant with reasonable crystal current.

ZERO BIAS

[*Continued from page 5*]

convinced of this necessity immediately, so that it may make such a recommendation to the FCC without further delay. There is little activity on the band at present, day or night. Sparsely spread over 500 kilocycles, what communications there are could be accommodated in a much narrower range if we had to share the band temporarily. How important the traffic handled may be, we cannot say, as much of the transmission is in cipher. We might comment, however, that sloppy operating seems to be the rule, with crystal chirps no amateur would own, and that on September 14th we copied a message originated on August 19th! We venture a guess that the amateur could make better use of the band, and the ever-present possibility of emergencies make it imperative that 3500 to 4000 kilocycles be turned over to him pronto.



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