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NOVEMBER, 1945

CQ

The Radio Amateurs' Journal

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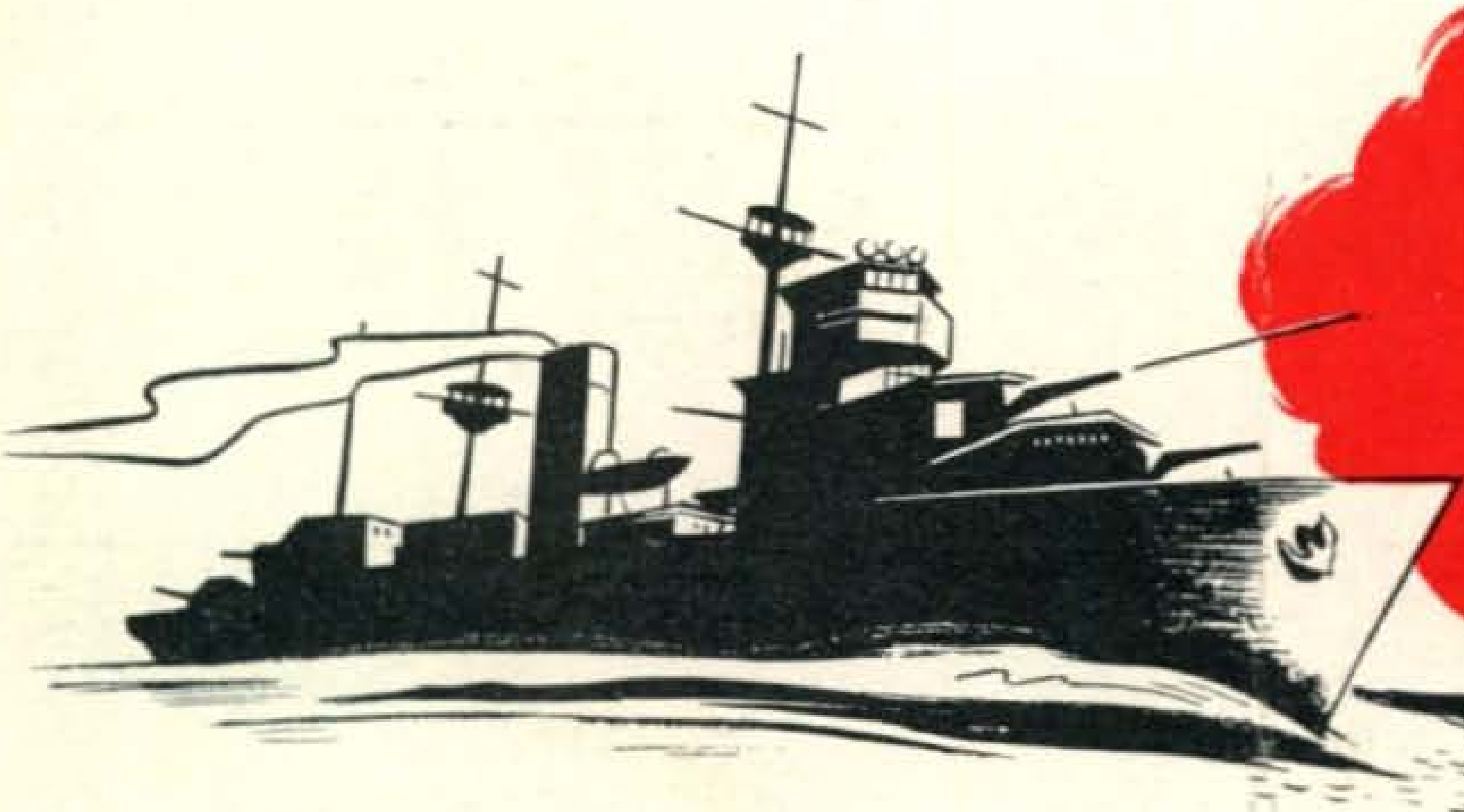

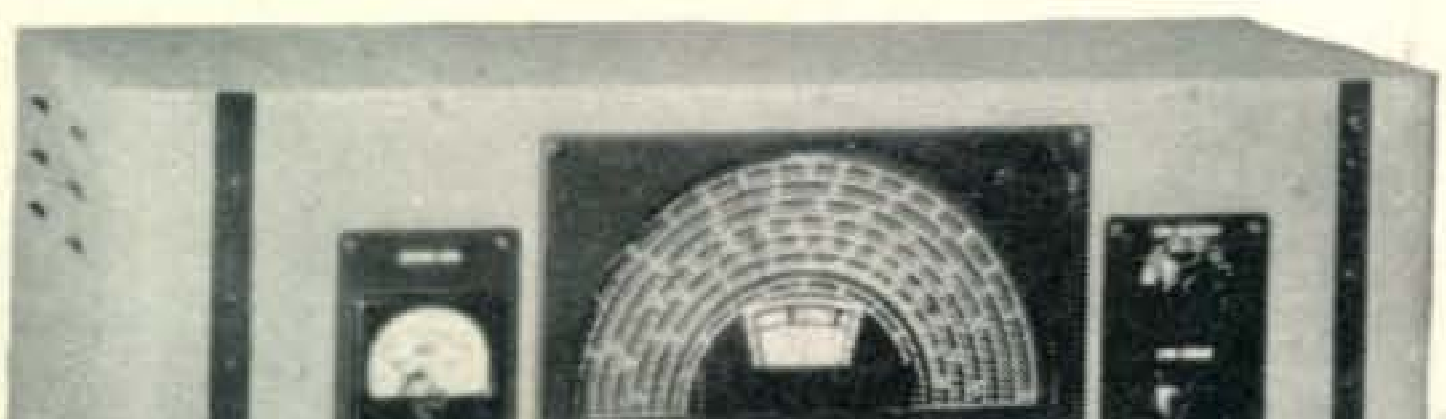

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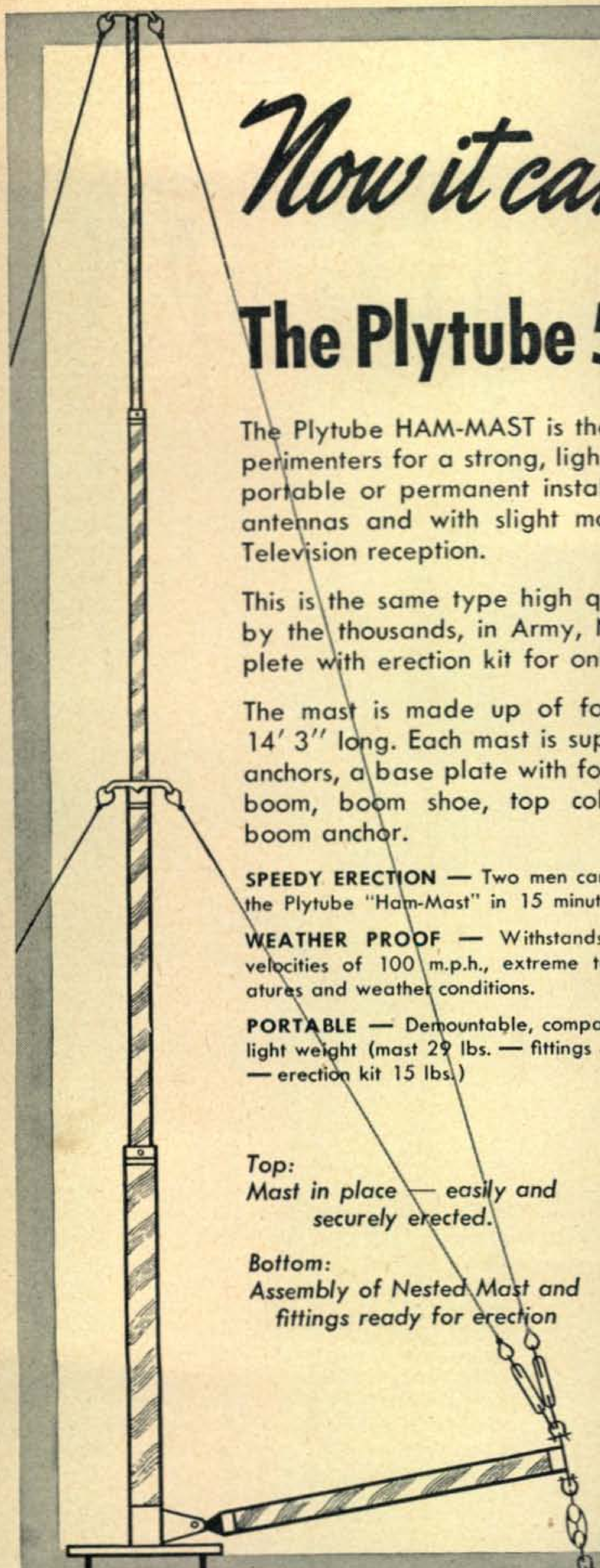

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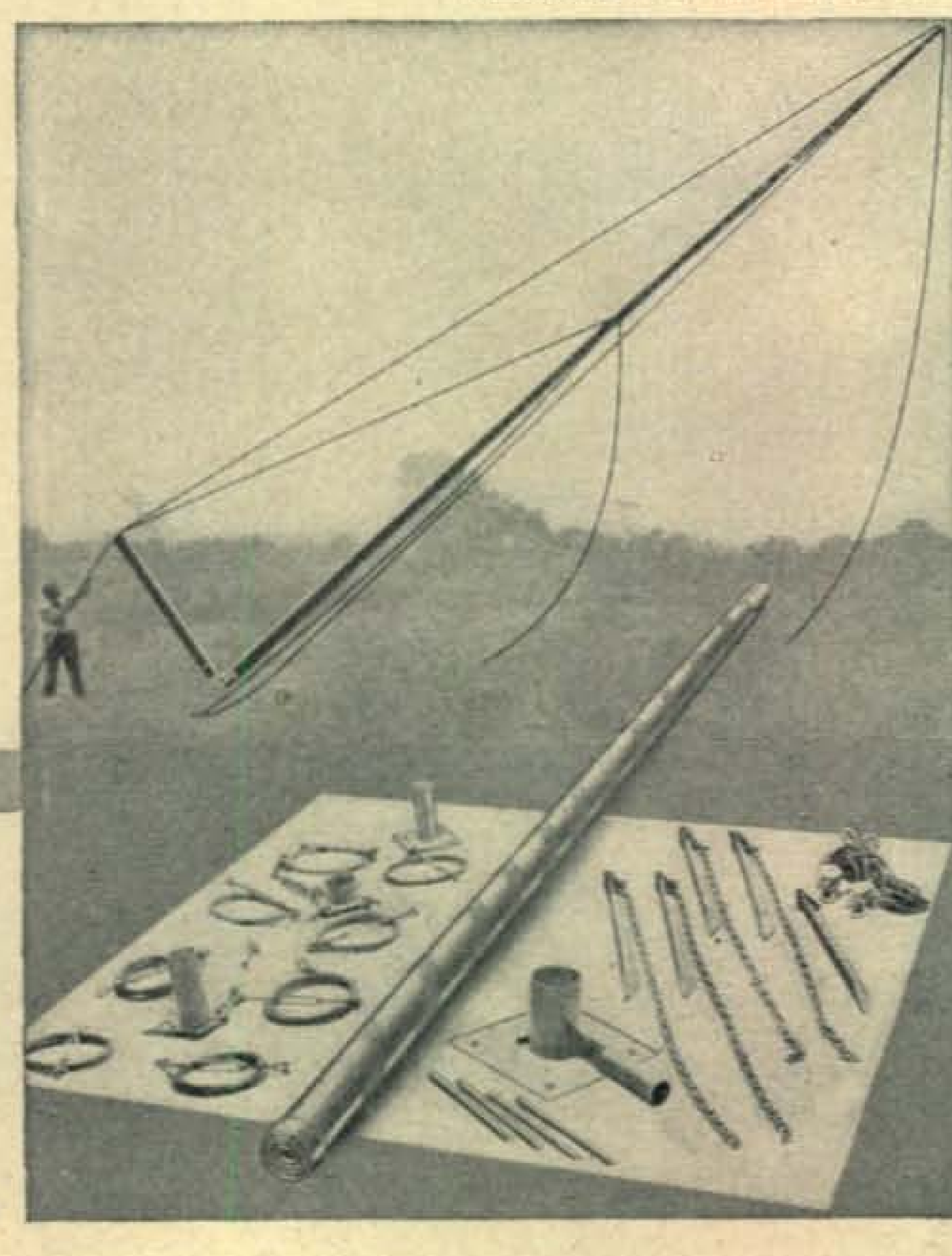

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VOL. 1, No. 11 **NOVEMBER, 1945**

CONTENTS

COVER

Checking the antenna system at the CAA inter-continental airways communications station, WSY. (*CAA photo*)

ARTICLES

MISCELLANEOUS


SA OM

ZERO BIAS

OSCILLATIONS OF considerable amplitude along the grapevine indicate that all proposed amateur bands above 28 megacycles will have been cleared by the Board of War Communications and the green light flashed by the FCC before this printers' ink is dry. In other words, we are really back on the air; and with a chance of making the most of 10-meter DX possibilities which are perhaps least erratic—sun spots, Aurora Borealis, earth currents and cosmic rays permitting—as late Fall merges into Winter. While foreign QSO's probably provided the most interesting contacts in the 28-megacycle region, "ten," when it could be worked at all, was always good for transcontinental hauls.

There may be some delay in consummating the shift from 112 to 144 megacycles—which is a matter of little consequence except insofar as it is indicative of red tape that still ties the lid on amateur frequencies below 28 megacycles. (Officially, the United States is still at war!) It appears unlikely that we shall be permitted to transmit on any of these DX bands until early in 1946—despite the priority argued for 3,500-4,000 kilocycles in disaster and emergency communications. Australia, Colombia, Switzerland and the USSR are already operating on all pre-war bands. That Colombia and Switzerland should be on the air is fairly logical, as these nations were lightly affected by such military considerations which, according to the Pentagon Building, are holding up the works here in the USA. However, Australia and Russia were fighting long before Pearl Harbor, and their communications set-ups could hardly have been less exacting and complicated than our own. The manner in which the return of amateur radio has been expedited in these allied countries would seem a commentary on the fact that we are (if you'll pardon a pun) still somewhat effectively hamstrung.

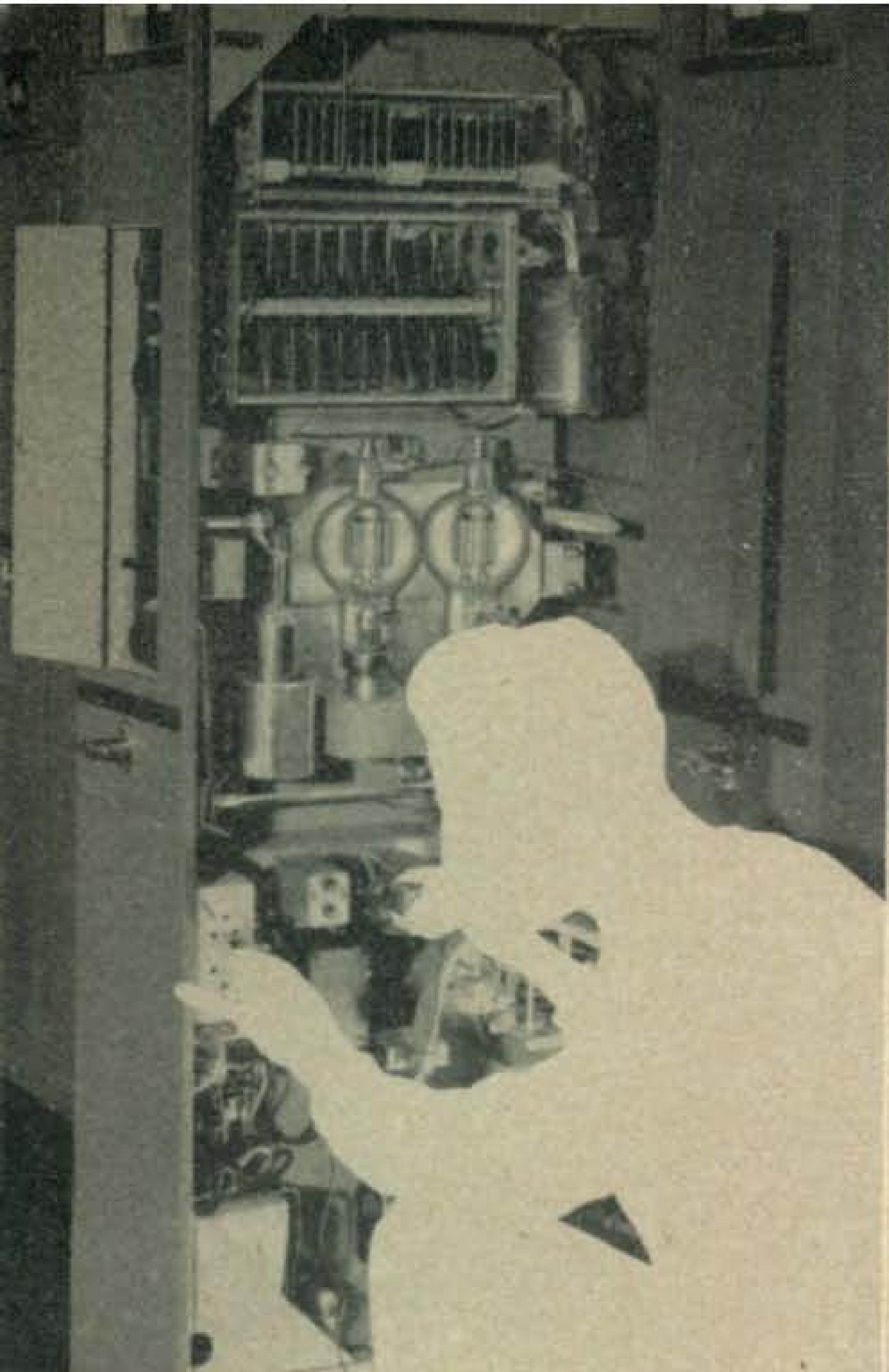
The Rio Conference

Amateur radio was well represented, both in backing and personnel, at the Third Inter-American Radio Conference held at Rio de Janeiro from the 3rd through the 27th of September. A. L. Budlong, veteran with the ARRL (and of the Santiago Conference in 1940), employed his best Portuguese and Spanish in spiking a Chilean and Cuban brainstorm that would split the 80-meter band with the amateurs squeezed between 3,500 and 3,750 kilocycles. South American amateurs in the delegations were—LU7BK, President of the Radio Club of Argentina; CP5EA, President of the Radio Club of Bolivia; CP5EB (ex-W3ATN); PY1AV and PY1AY of Brazil; CE1VA and CE2AK from Chile; Colombia's HK3CK; CO2WW of Cuba; HC1JW from Ecuador; ZP5AC, President of the Radio Club of Paraguay; Paraguay's ZP6AB; and OA4Z, Chairman of the Peruvian delegation.

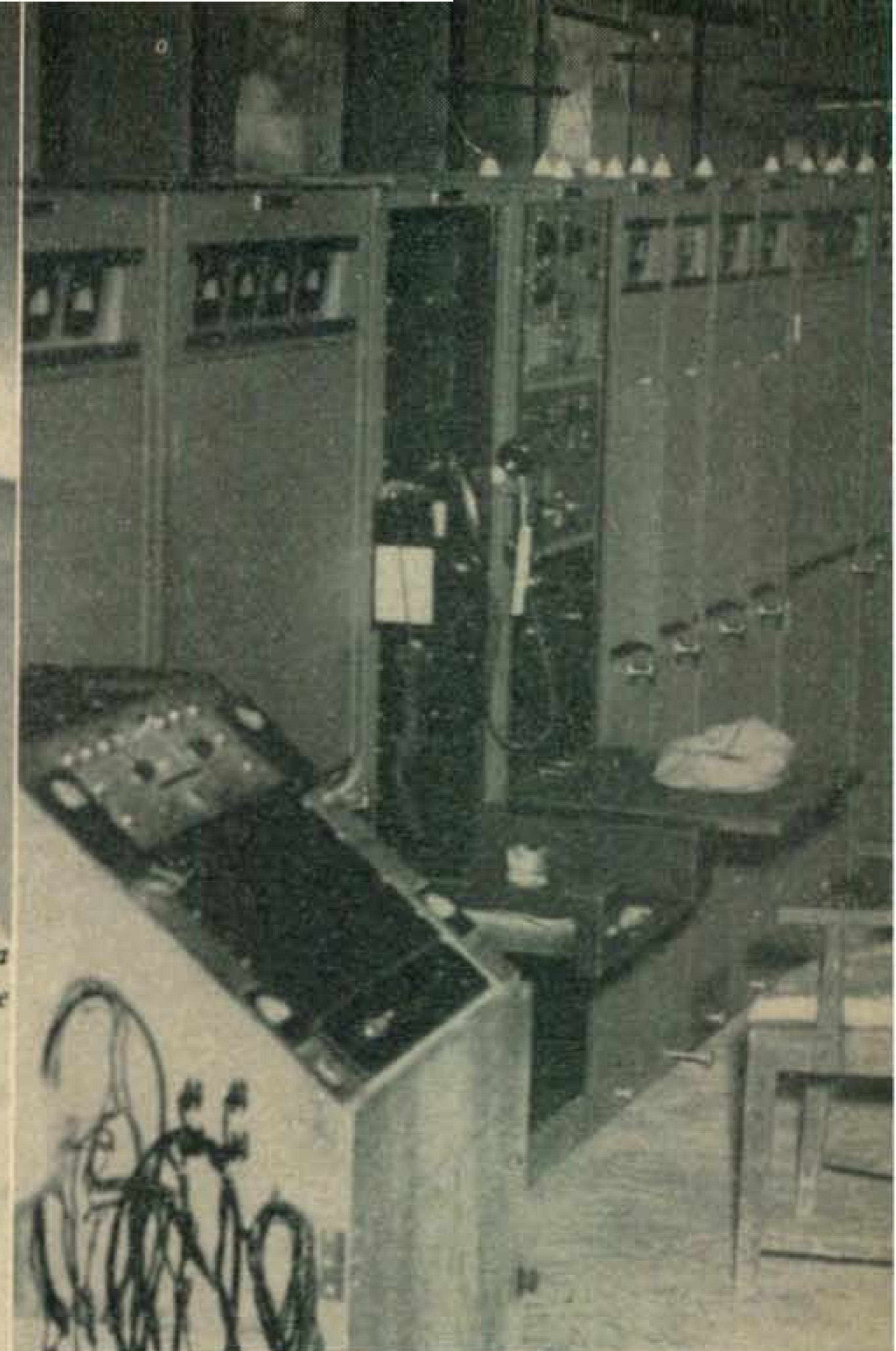
Conferences of this nature can have little direct effect on amateur regulations which are solely the matter of individual governments acting within the limits of world-wide agreement. What these "sub-conferences" accomplish, however, is an interchange of ideas and a solidification of policy so that nations (in this case the Americas) can act more or less cooperatively and in concert at the world get-together. This was effectively achieved at Rio, and the rest of the Americas are pretty much in agreement with the ideas of the United States concerning amateur radio (as expressed in the proposed FCC allocations) and will back us up at the next world conference.

Our "good neighbors" to the south are solidly sold on the 21-meter band, but, alas, equally convinced that "160" is no longer for the amateur and had best be written off with a gentle R.I.P. Only Argentina favored 1750-1800 kilocycles as an exclusive amateur band. Brazil would include these frequencies in a general allocation for Fixed, Mobile and Air Navigation services. Colombia and Mexico also want it for Air Navigation. Argentina, generous in the matter of 160 meters, favored a recommendation requiring previous amateur experience for operation on any DX band! In effect, this would make a Class A ticket prerequisite for working all frequencies lower than 50 megacycles. This monumental idea was eventually squelched, and the original U.S. recommendation—which limits phone operation in the 14-megacycle band to more experienced amateurs—stands.

The only trouble on the horizon blows in from Canada with the proposal that 220-225 mc and 420-450 mc should be used for Air Navigation rather than amateur operation as recommended by the United States. However, don't hold this against your VE friends, as the idea smacks of London rather than Ottawa. Unfortunately, it may be pressed by the British Empire at the next world conference.



AACS Domestic Station showing a pair of Eimac 450-T tubes



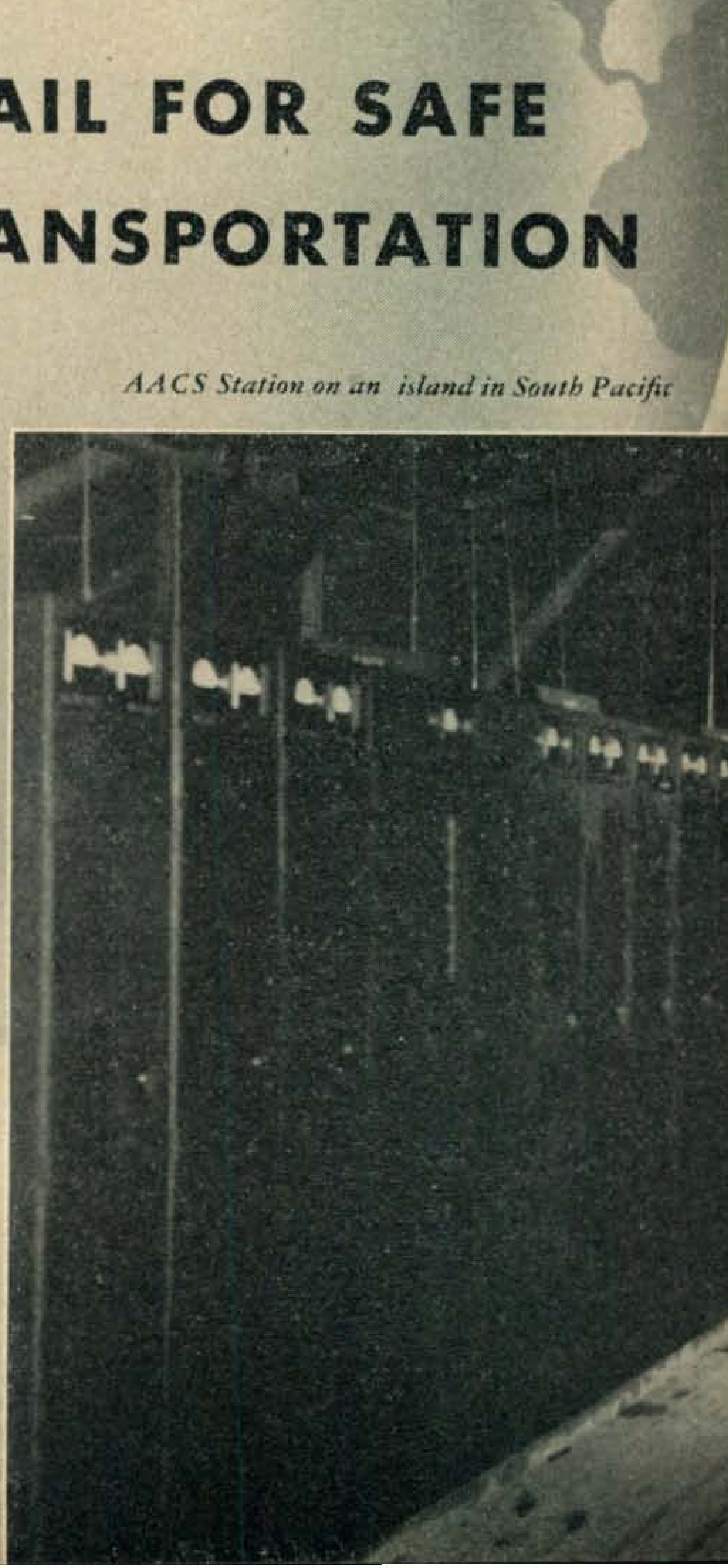
AACS Ground Station China-Burma-India Theatre

AACS* BLAZES THE TRAIL FOR SAFE FUTURE WORLD AIR TRANSPORTATION

World-wide aviation communications are an established fact today. Almost overnight a great radio network has been created. The actual physical difficulties involved were great enough, to say nothing of the variety of extreme operating conditions encountered and overcome. Needless to say, the equipment employed must be dependable, both from a standpoint of construction and performance capability.

The establishment of radio ground stations on every continent and in fifty-two different countries...overcoming the widest extremes in operating and climatic conditions (from 40 degrees below zero to 140 degrees above)...stations in jungles ...in deserts...in mountains and towns...and to have these stations constantly operating at near peak levels is a tribute to the equipment employed. On this page are shown three AACS Stations located at widely separated spots on the globe.

AACS Station on an island in South Pacific



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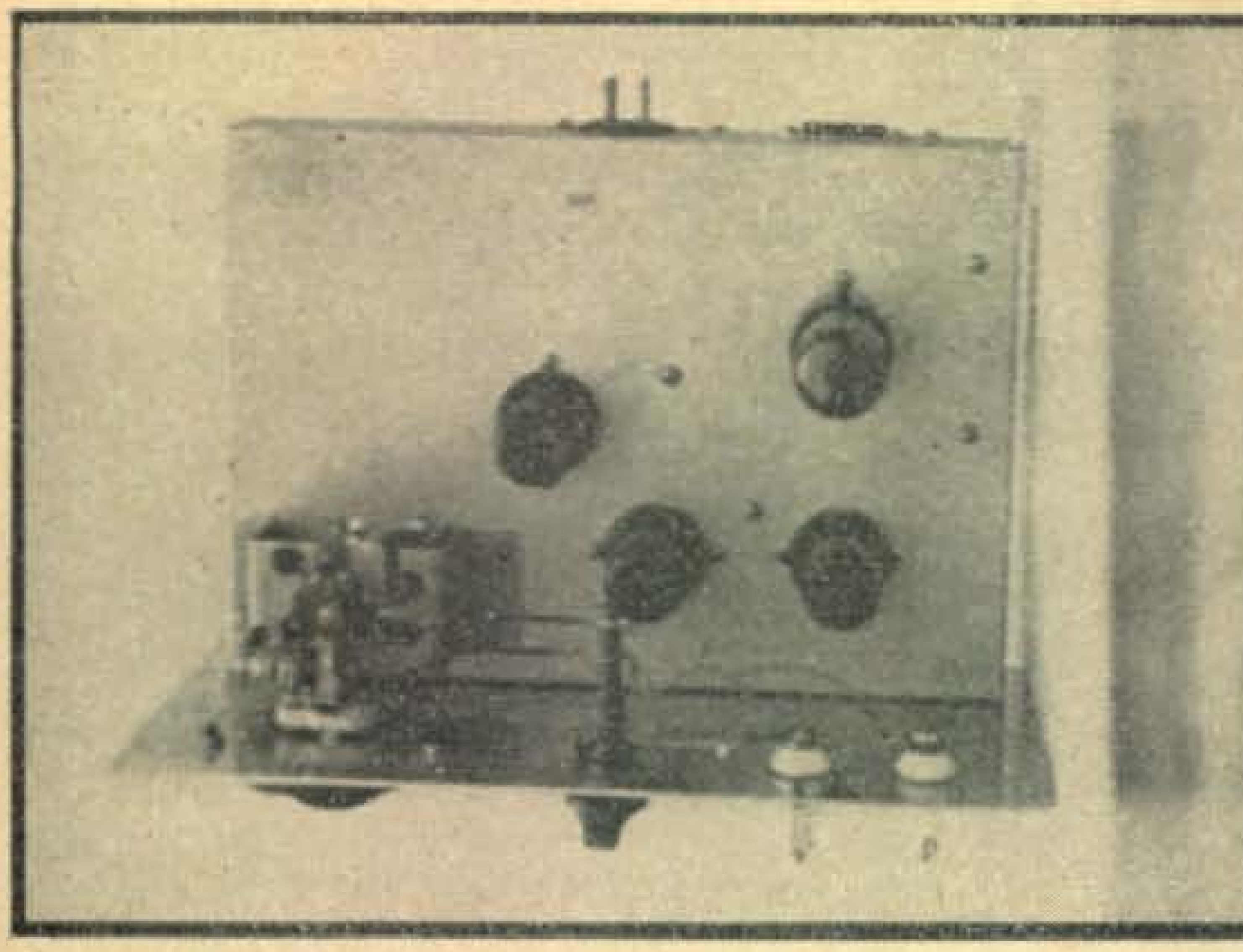


Fig. 3. The mixer is mounted upside-down on an inverted U-shaped strip of aluminum. The tuning capacitor is grounded only at the tube socket. A shielded lead runs to the first i-f stage

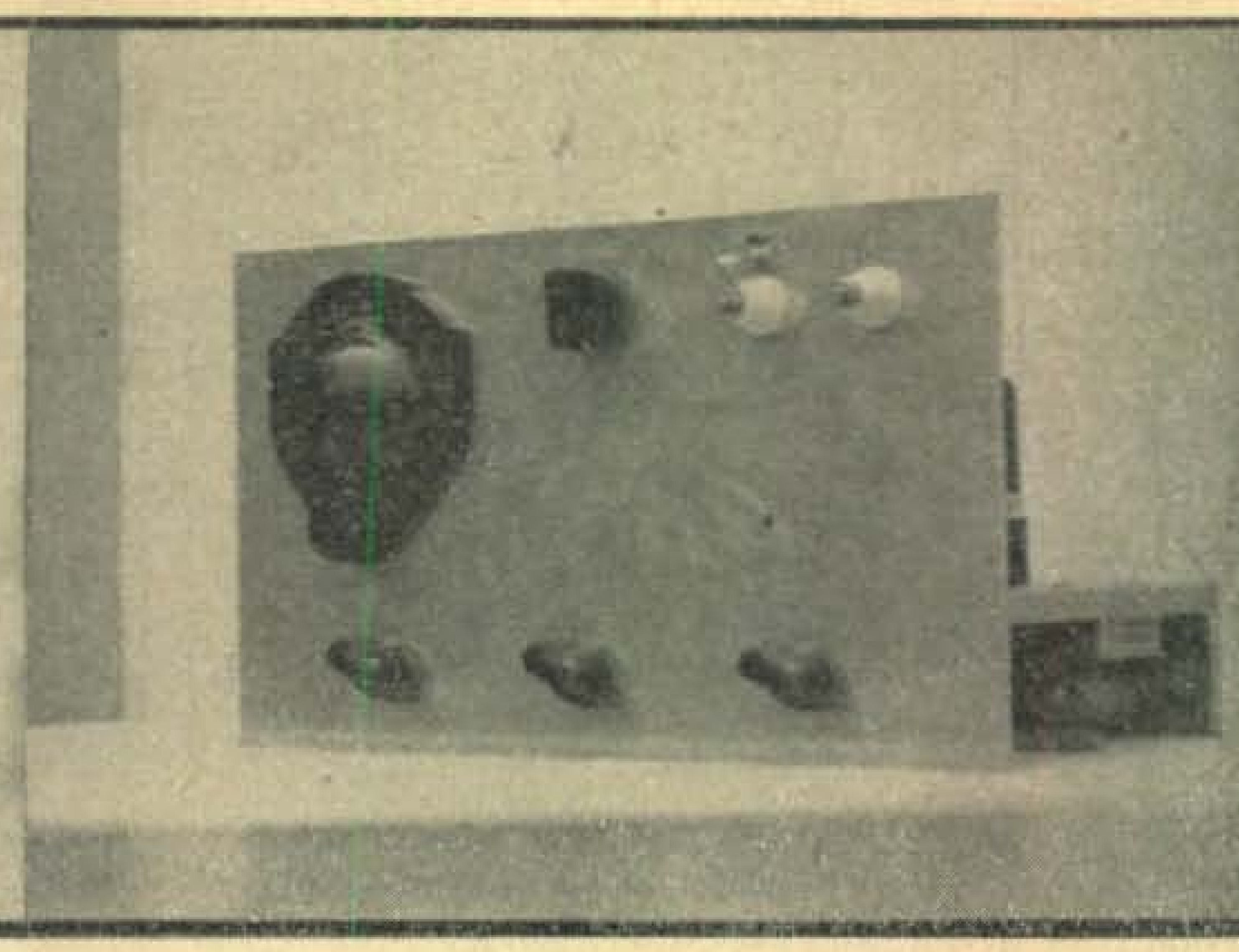


Fig. 4. Front view of the R-C super. Controls are— antenna coupling (top center) and left to right, tuning, super-regeneration, i-f gain (later discarded) and audio gain

AN R-C SUPERHET FOR THE ULTRA-HIGHS

A RESISTANCE-COUPLED SUPERHET FOR 144 MC WITH A SUPER-REGENERATIVE FIRST DETECTOR

HOWARD A. BOWMAN, W6QIR

THE EARLY PART of the WERS era found the super-regenerative receiver quite effective. There weren't too many stations in operation, nor were those on the air so close to each other as to cause trouble by either strong signal blocking or receiver radiation. As the WERS grew, however, the situation became progressively worse. Ultimately we reached a point at which over three hundred stations were licensed to four major networks here in the Los Angeles metropolitan area. Obviously some order had to be brought from this chaos, and conferences among Radio Aides resulted in frequency allocations which the various licensees attempted to observe with greater or less success. Even so, the average super-regenerative was still unsatisfactory because of its tendency to "lock-in" with a strong signal, lack of selectivity, and radiation to nearby receivers. Further efforts to rectify the situation suggested the superheterodyne. Several were constructed (or re-constructed), but this proved only a stop-gap available to a small minority of the operators. There is no denying the advantage of the broad-band AM superhet or a combined FM and AM job. The great difficulty lay in obtaining the i-f transformers, plus the high-frequency tubes necessary to make the front end of the receiver operate with acceptable efficiency.

It was obvious that most operators were going to be reduced to something less than a true superhet, and many adopted some evolution of the super-regenerative receiver. In the mobile job we described in *CQ* some months ago, we employed a 7G7/1232 as a non-radiating pentode super-regenerative detector. This circuit is still the best super-regenerative we've heard in operation. There is one further and obvious improvement, however,—in the direction of the resistance-coupled superhet.

Resistance-coupled supers have been used for many years, but chiefly on frequencies lower than the 112-115.5-mc band. Articles on how to build and operate them have appeared for many years, but the idea never seemed attractive to us for 5 or 10-meter work. On 112-mc however, and for the new band in the 140-mc region, we have concluded that the R-C super offers a worth-while field for experimentation.

Principle of Operation

The resistance-coupled superhet operates much the same as any other superheterodyne receiver. That is, the received signal is converted by means of a mixer tube to a lower frequency, known as the intermediate frequency. It is amplified at this frequency, and the characteristics of the amplifier increase the overall selectivity of the unit. The signal is then rectified by a second detector and proceeds through the audio channel in the customary manner. The resistance-coupled superhet derives its name from the fact that the intermediate-frequency amplifier employs resistance-capacity coupling rather than transformer coupling. The resistors and capacities are chosen to pass a band of frequencies in the neighborhood of 50 or 100 kilocycles. The mixer, or first detector, is an oscillating circuit tuned to one side or the other of the incoming signal by an amount equal to the i. f., thus heterodyning the signal to the intermediate frequency.

Construction

We constructed our first unit on a 7″ x 10″ x 2″ chassis with an external speaker and power supply. Later we built another super with the speaker mounted on the front panel. We do not particularly recommend this latter procedure, however, unless the overall construction is made extremely rigid. Speaker vibrations are likely to set up microphonics in the mixer stage, resulting in a low pitched howl. Most of the available data on R-C super construction has appeared in past issues of *Radio*, the *Jones Radio Handbook* and in its successor, the *Radio Handbook*. We used this information as a basis for our experiments, but arrived at some slightly different conclusions, particularly in the operation of the first detector, or mixer.

The wiring of the receiver is entirely below the chassis, with the exception of the mixer unit, which was mounted separately above chassis so as to shorten the tuning leads. One of the two receivers built employs a 7V7 as mixer. This is a loktal pentode with somewhat better characteristics than the 7G7/1232, and performs well in this circuit. The other receiver used an 1852 mixer. With the 7V7, variable antenna coupling supplemented the screen potentiometer as a control, but on the 1852 we decided to use fixed coupling. Results differ little, so either system may be employed. In any event, provision should be made for single or two-wire feed to the antenna coupling coil.

All available data on R-C supers stresses the importance of operating the mixer as a weak oscillator—never forcing it into the region at which it commences to super-regenerate. Conversations with pre-war builders indicated that

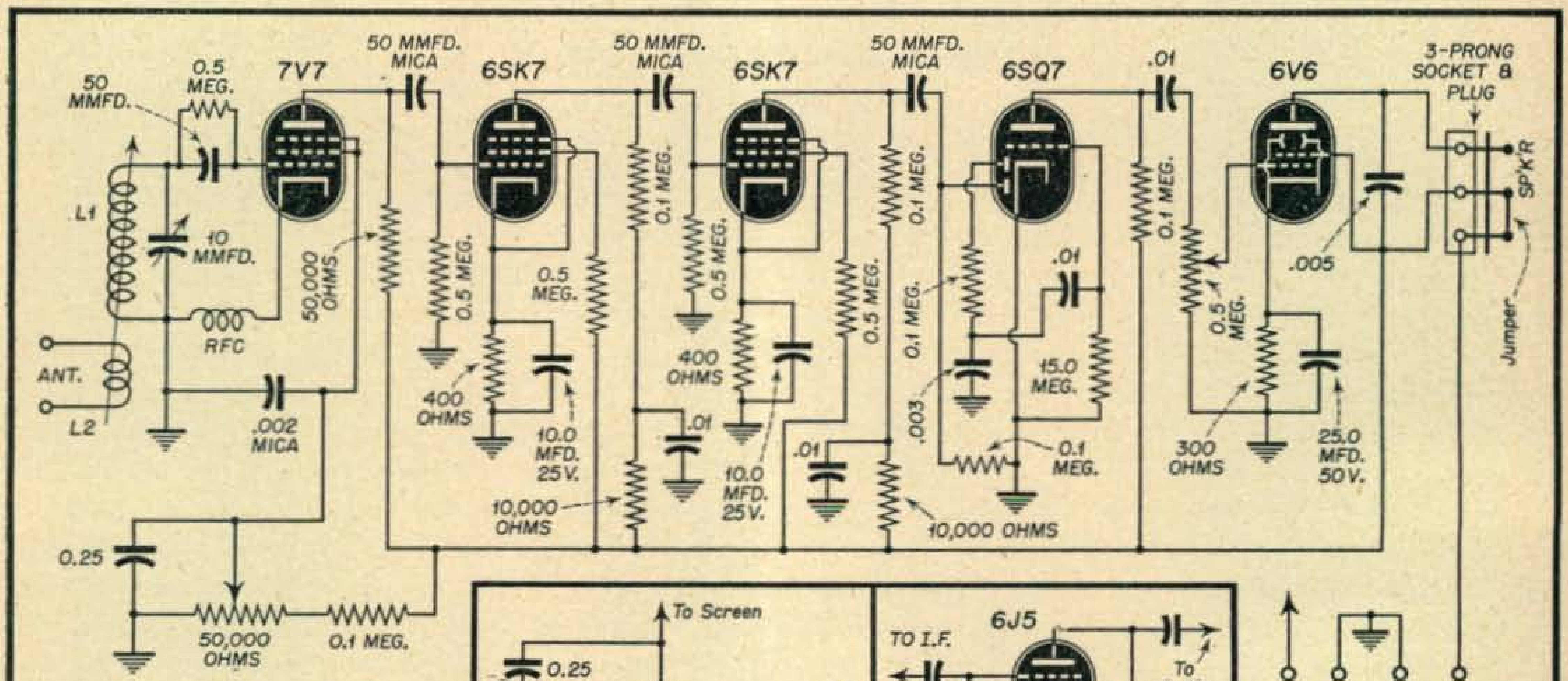


Fig. 1. Circuit diagram with alternatives for the resistance-coupled 144-mc superheterodyne. Parts values not indicated are—

All resistors are 1/2 watt excepting in the 6V6 cathode circuit where 1 watt is required
L_1—4 turns #16 1/2″ dia. 1/2 long
L_2—2 turns #16 at ground end of L_1
RFC—15 turns #24 DSC 1/4″ dia. close-wound self-supporting

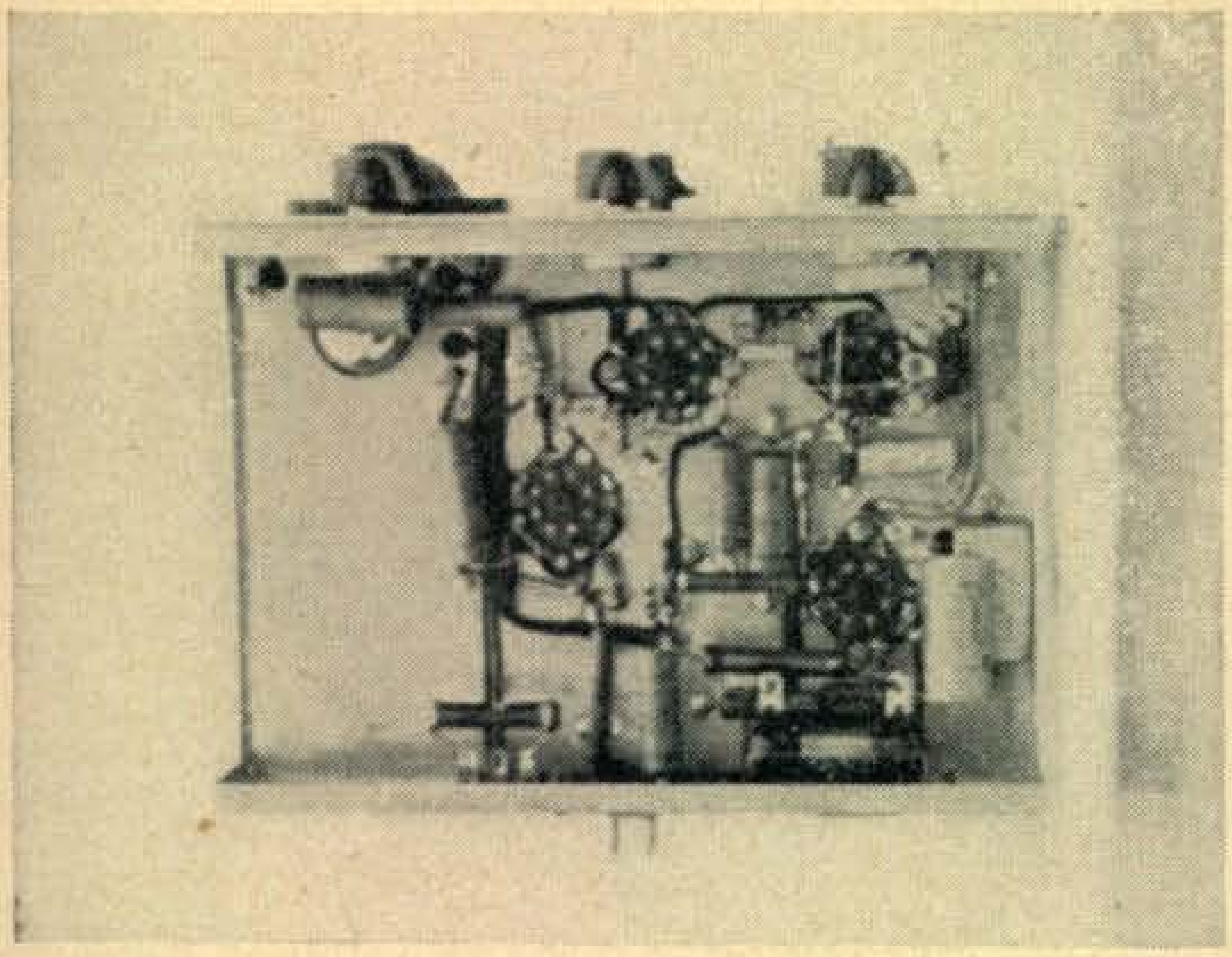


Fig. 2. Under view of chassis shows the parts placement and emphasizes the liberal use of tie points. The large resistors are part of the voltage-dividing network

perhaps this might be accomplished and still retain fair gain at 112-mc if one of the high-frequency tubes were employed. One receiver (which we didn't build) used a 954 for a while; and this operated identically with ours—that is, the first detector functioned in a super-regenerative condition.

With this in mind, we tried both methods of operation. The result was, to all practical purposes, that no signals were received if the detector was oscillating weakly. As soon as the mixer was edged over into a super-regenerative condition, the signals came in very well. With the type of circuit we are employing, this is immaterial so far as radiation is concerned, because the radiation is heard over only an extremely small area. (As a matter of fact, we were able to operate this receiver alongside an Abbott TR-4. The TR-4 picked up no radiation until both were tuned very nearly to the same frequency.)

We have arrived at the conclusion that the usual run of tubes is simply not very effective at our operating frequencies. For this reason, neither the 7V7 nor the 1852 gave normal results when employed as a simple oscillator. When the tubes were permitted to super-regenerate, however, sensitivity increased many fold, with the result that the conversion gain of the mixer went to a relatively high figure. The hiss level is not too objectionable. Selectivity and sensitivity are considerably better than with the usual super-regenerative—so much so that there is really no comparison in operation.

Super-regeneration is controlled with the potentiometer in the screen circuit of the mixer, and is rather critical. The mixer appears to operate best at one particular position—just barely in the super-regenerative range. This led to the belief that we may be able to achieve somewhat of a vernier action on this control by using the alternative circuit shown. (We haven't worked around to trying it yet, but it appears to have possibilities. It is possible that the optimum performance region of the control could be spread so as to cover say, 45 to 90 degrees of rotation instead of one or two degrees.)

The i-f Amplifier

At a casual glance, the i-f amplifier resembles a high gain audio amplifier. Closer examination of *Fig. 1* reveals the small-value coupling capacitors, and the resistor values chosen to resonate at the correct frequency. One receiver uses 100,000-ohm resistors in the plate circuits and 500,000 in the grids with 50 $\mu\mu$f coupling capacitors. The other employs 50,000, 250,000 ohms and 100 $\mu\mu$f. Either set of values may be used. It may be necessary to take the precaution of decoupling the i-f stages. Decoupling is employed in one of our receivers only—but both supers work equally well. We originally included decoupling because other amateurs had found it necessary to eliminate squeals, howls and general instability. Constructional details are suggested in the photos, *Figs. 2, 3* and *4*.

Second Detector

Almost any kind of a second detector will work. Most circuits examined recommended a detector biased so that detection took place in the plate circuit of a triode. The net result in one super we checked was that a single 6V6 used as an audio amplifier did not supply enough gain. It was therefore necessary to insert a 6J5 audio stage ahead of the 6V6. We determined to include both second detector and first-audio stage in the same tube.

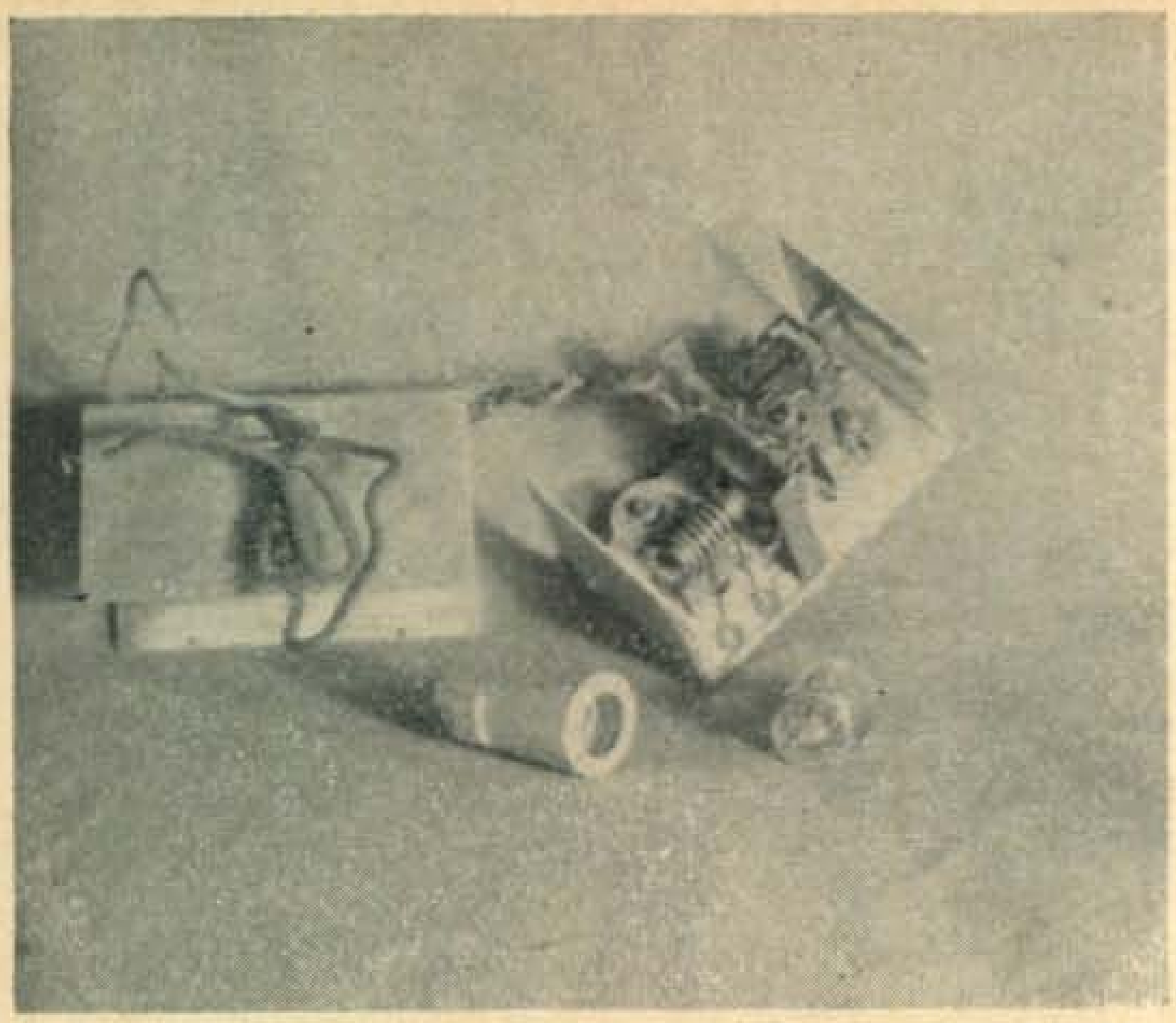
We could have used a double triode, but it didn't appear that there would be much, if any, advantage over a diode-triode. The diode rectifies the signal, which is fed to the triode section of the 6SQ7 through an r-f filter. The gain control is in the grid circuit of the 6V6 output amplifier. Note the connections for the speaker plug, which prevent operation of the receiver unless the speaker is plugged in. (Many a power pentode has gone down the river without this protection.)

Operation

The controls on receiver No. 1 are antenna coupling, tuning, super-regeneration, and audio gain. On receiver No. 2 they are the same except for the elimination of the variable antenna coupling.

The screen potentiometer is advanced to the point at which super-regeneration commences, and the tuning capacitor rotated for stations. If

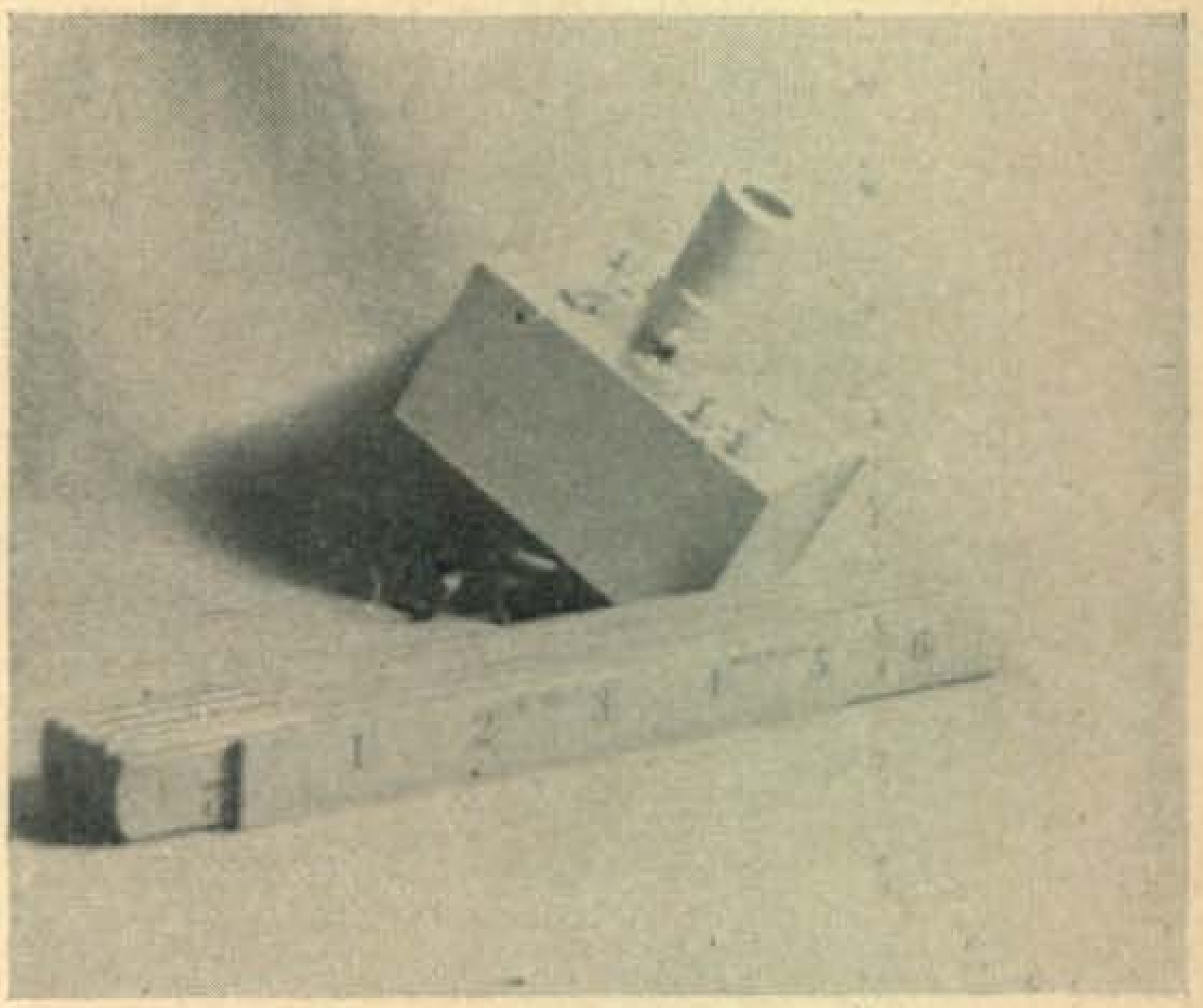
[*Continued on page 46*]



The r-f amplifier with cover and tube removed. The center shield is not aluminum as it must accommodate soldering

R-F UNIT

JOHN WONSOWICZ, W9DUT
AND
HERBERT S. BRIER, W9EGQ



Providing an idea of size. The 112-144-megacycle r-f unit completely assembled with tube

With the reopening of the VHF's for amateur use, operators in crowded areas are again learning the disadvantages of straight super-regenerative receivers. (A "crowded area" is any place where there are two or more hams within a mile using super-regens! The receivers often cause more mutual interference than their transmitters.) Trick circuits, claimed to be non-radiating, do not always cure the trouble, because, as soon as an antenna is coupled to the detector, they often radiate. The interference can be reduced by using loose antenna coupling, but as this practice lowers receiver sensitivity, it is neither very practical nor popular.

A properly adjusted r-f stage will eliminate radiation, but is often impossible to install in an existing receiver. However, the fixed-tuned, wide-band r-f amplifier shown in the accompanying diagram and pictures is small enough to fit into almost any receiver. When installed, it is peaked in the center of the band and, thereafter, left untouched. It provides a gain of at least six db over a range of more than one megacycle on each side of the center frequency—with a gradual drop-off as the receiver is tuned to the edge of the band. Even at the band edges, the sensitivity of the combination is greater than with the receiver alone. Wide bandwidth is obtained by tight coupling to both the input and output circuits. The comparatively high gain is the result of using a HF tube and very short leads. Tuning is accomplished with screw-driver adjusted, 10 $\mu\mu$f midget variable capacitors. The grid circuit is broad, but the plate capacitor peaks sharply.

Construction

All parts are mounted on a piece of aluminum 3″ by 1 7/8″—which is the top of the box. The tube socket mounts in the exact center, and the shafts of the tuning capacitors are on diagonally opposite corners, 5/8″ from the end, and ½″ from the side. Miniature banana plug jacks for the input and output leads are located on the other corners. Each end piece is 1 7/8″ by 1½″, while the sides and bottom are made from a piece of aluminum 3″ by 5″ bent to form an open ended trough, 3″ by 1½″ by 1 7/8″, inside dimensions. These pieces are fastened to the top with small screws.

After drilling all holes and checking parts for clearance, mount the tube socket with the control grid terminal (pin #1) and the plate terminal (pin #5) on opposite sides of the vertical shield which goes directly across the socket. It is important that this shield is soldered to the metal insert in the center of the socket, as well as grounded to the top plate by means of the mounting screws. The socket should be made of a low-loss material, preferably ceramic, so that soldering the shield to the insert will not soften or char it.

All by-pass capacitors are then soldered between the proper pins on the socket and a central ground point on the vertical shield. Notice that both cathode terminals are by-passed to ground,

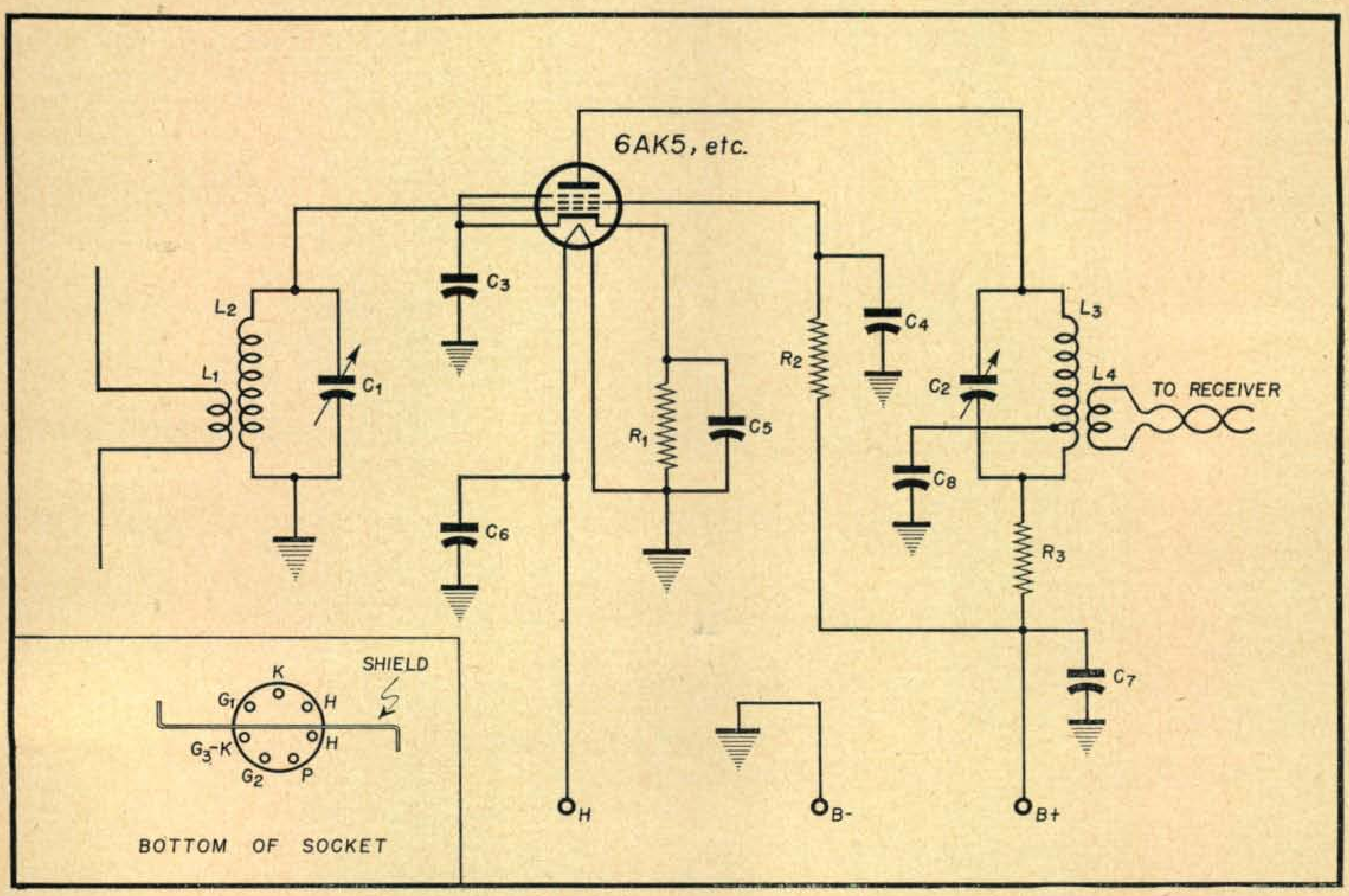
FOR THE V-H-F'S

WIDE-BAND AND GOOD GAIN ON 112 OR 144 MEGACYCLES WITHOUT RADIATION

which reduces the effects of lead inductance. Having made all necessary connections to the socket, including the screen dropping resistor, and the "hot" filament lead, mount and connect the variable capacitors. The plate and grid coils are then wound and soldered directly across the capacitors. The 100-ohm resistor in the plate circuit is used to isolate r.f. from the B supply. It is very effective, and takes up less room than a conventional r-f choke.

The position where C_8 is soldered to L_3 is

[*Continued on page 44*]



Wiring diagram for the 112-144-megacycle r-f amplifier. Note coil dimensions in the following parts list—

112 MC

L_1—5T #22 enameled interwound with L_2
L_2—6T #18 bare 1/4" dia. 1/2" long
L_3—8T #18 bare 1/4" dia. 5/8" long, tapped 2½ turns from B+ side
L_4—4T #22 enameled interwound with L_3

144 MC

L_1—3T #22 enameled interwound with L_2
L_2—4T #18 bare 1/4" dia. 1/2" long
L_3—5T #18 bare 1/4" dia. 5/8" long, tapped one T from B+ side
L_4—3T #22 enameled interwound with L_3

C_1, C_2—Sickles air-trimmers (or equivalent), 3 stator 2 rotor. Approximately 10 $\mu\mu$f (ultra midgets)
C_3, C_4, C_5—500 $\mu\mu$f midget mica
C_6, C_7—300 $\mu\mu$f midget mica

R_1—200 ohms 1/4 watt for 6AK5, 1100 ohms for 9001 and 300 ohms for 9003
R_2—60,000 ohms 1/4 watt for 6AK5, 100,000 ohms for 9001 and 9003
R_3—100 ohms 1/4 watt

WORKSHOP

A "Know How" of Shop Technique Contributes Professional Appearance and Efficiency to Amateur Rigs

TO THE VAST NUMBER of amateurs who have come into contact with commercial equipment during the war, the degree of dependability expected from such apparatus is often a distinct revelation. This is in no small degree consequent to the careful and solid constructional methods used, much of which can be made standard amateur practice. The extra dividend of good appearance also cannot be ignored.

Cut-outs

Presuming a conventional enclosed chassis is selected and the parts laid out, the first problem is making the necessary cut-outs for tube sockets, transformers, etc. By far the most convenient type of socket is the clamp-on design with a spring-like retainer ring underneath the chassis. The hole for this can be made with a 1 3/16″ chassis punch—preferably the kind that tightens together with a bolt rather than the "hammered" type. A 7/16″ hole is drilled in the chassis to pass the bolt, then the punch bolted on and tightened. It is often better to put the head of the bolt in a vise and turn the whole chassis rather than to try to secure the chassis and tighten the bolt. Use of the punch results in a clean hole with no burr around the edges.

Numerous methods may be employed for making transformer cut-outs. Cold-chisel cuts along the dimensions are satisfactory if the dimensions of the hole are laid out somewhat greater than required, to allow for the inevitable stretching of the metal along the cut. A preferred method (*Fig. 1*) consists of drilling a number of small adjacent holes all around the proposed cut. The center section is then knocked out and the edges filed down even. Note that the line of drill hole centers will be the radius of the drill inside the desired dimensions. In cases where this method would be too cumbersome, larger holes may be drilled in each corner, and then the straight sides cut with a keyhole hacksaw.

Mounting Parts

One of the inflexible rules of good construction is that *no connection or part shall be left floating mechanically*. In other words, all resistors and condensers must have both terminals connected directly to a tube socket or some solid support such as a terminal tie point (see *Fig. 2*). The reasoning behind this rule is simply that no component should be left free to vibrate, possibly resulting in its leads working loose or breaking off. Strips with up to eight lugs or so, are available and only a little planning will be required to make an adequate number of points available at the desired places, so as not to involve long interconnecting leads.

The next job normally encountered is that of drilling the mounting holes. The use of a center punch before drilling is mandatory. In order to obtain the highest degree of accuracy in positioning a hole, a very small pilot hole should be drilled first, followed by drills of larger diameters. For holes under 5/16″ or so, this is generally a needless refinement (unless great accuracy is desired) and the proper hole size may be made in the first operation. However, for the larger sizes from 3/8″ up, the position should be staked with about a 5/64″ drill. Follow with about a 3/16″ drill then the final size (or smaller steps may be taken if desired). Trying to keep the point of a ½″ drill in a punch prick is a rather trying experience and usually results in the hole being gnawed rather than drilled to a greater diameter than the drill.

If a flush surface is desired, flat-head machine screws should be used, after countersinking the holes to accommodate the heads. Countersink

Essential Shop Tools

100-watt soldering iron with radio tip
Breast drill (preferably up to ½ inch)
Assortment of drills (preferably high-speed): 7/64″ to pass #6-32 bolts; 9/64″ to pass #8-32; 3/8″ to pass volume control shafts; 15/32″ to pass toggle switches; and appropriate sizes if tapping is desired.
Countersink for flat-head screws
Center punch and cold chisel
12-inch steel rule and a small scriber
A 4-ounce hammer
½″ and 9/16″ wrenches (spanners); 5/16″ and 11/32″ socket-wrenches
Long-nose pliers and small diagonal cutters
Various screw-drivers including one with a very narrow blade for set-screws
Hacksaw
Files
Reamer

WRINKLES

W. H. ANDERSON, VE3AAZ

Ham Hardware

Machine screws: #6-32 by 3/8" and #6-32 by 1" round head. Also #8-32 by ½" round head. (The #6-32s are suitable for most mountings and the #8-32s for heavier work.) Flat-head screws as required.

#6-32 and #8-32 hex nuts

Inside star (shakeproof) washers Nos. 6 and 8

Assortments of grommets, 2 to 8-lug terminal tie points, closed-end lugs and spaghetti

Rosin-core solder

Lacing Twine. This can generally be obtained from most electrical supply houses. Any strong string such as fish line, drawn through a cake of beeswax or a soft candle, is an excellent substitute.

only until the top of the flat head is flush—a deeper countersink weakens the panel. If for any reason the end of a bolt must be sawed off, it is a good idea to run up a nut on the bolt before cutting. Removing this nut will straighten out the burred threads on the raw end.

The use of a shakeproof or lock-washer under the nut of every bolt is a prudent policy. This has the effect of binding the nut to whatever is under it, providing a good electrical contact and discouraging the nut from loosening. Such bolts should be tightened by turning the screw rather than by trying to tighten the nut, in order not to "pull" the connections under the bolt.

Wiring

The termination of wires under bolt heads and nuts is commonly called for. Merely twisting the end around the bolt and tightening is not good enough. The likelihood is too great that the bruised wire will break at the point of commencing its twist around the bolt. That's why lugs were invented! Lugs may be of two general types—closed and open end. The latter have advantages in experimental work as it is not necessary to take out a bolt in order to free a lug. But where more than one such lug is involved, tightening will often result in a lug being squeezed out. Accordingly, the closed type is generally preferred. Clamp some of the insulation in the jaws, and slide a length of spaghetti over the connection, as shown in *Fig. 3*. Spaghetti is of great value in strengthening as well as insulating. Anywhere it is used, it should fit snugly. If the spaghetti is a fairly close fit to start with, and is slipped over the soldered joint while still warm (not hot), a particularly solid job will result which will resist any tendency of the wire to break where it enters the lug.

Whenever wires have to pass *through* a panel, a rubber grommet should be used to prevent the raw edges from abrading the wire insulation. For the larger sizes, punches similar to the socket punch provide a convenient method of making the necessary hole in the panel.

As to hook-up wire for units such as receivers, exciter units, speech amplifiers, etc., both solid and stranded push-back are available. The solid wire makes the neater job and more ends can be placed in one terminal tie point lug. It is also handier in confined spaces, such as male cable plugs, etc. After the desired length has been cut, the ends should be bared by simply pushing back the insulation rather than trying to cut it off. Using a knife to remove insulation may nick the wire. With solid wire, one nick means eventual breakage while with stranded some of the strands will break off and weaken the connection.

Shielded Wire

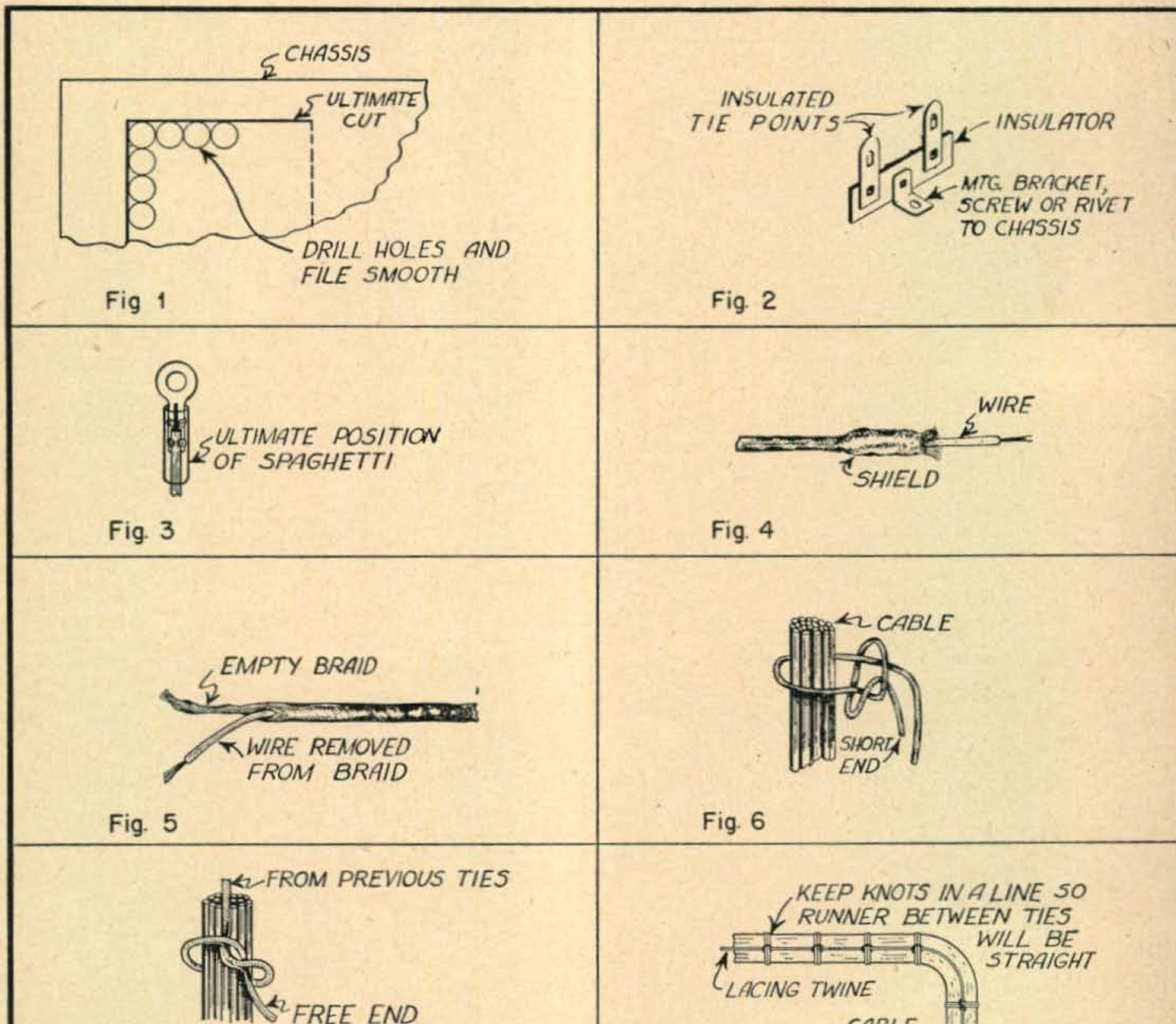
A method that eliminates much of the difficulty in removing the shield from shielded wire is shown in *Fig. 4*. The shield is gathered up and formed into a ridge around the wire. This ridge may then be clipped off, and the shield will part cleanly. If a connection is to be made to this shield, it is prudent to slide some spaghetti over the wire and under the shield, to prevent the sharp ends from piercing the insulation, and also to save the insulation from being burned in the soldering process. If the shield has to be separated from the other conductors for termination it is better to proceed as in *Fig. 5*. In this case the strands of the shield are spread apart and the insulated wire carefully drawn out through this hole with long nose pliers.

Lacing

Where wires naturally run close together and parallel for some distance, lacing or cabling contributes the final professional touch to the wiring job. While lacing offers the advantages of greater rigidity and improved appearance, it should not be overdone to the extent of introducing undesirable coupling effects, or when shorter direct leads may be mechanically and electrically preferable regardless of appearance.

To start lacing, a simple slip knot may be tied (*Fig. 6*) and brought tight; a fairly long loose end being left and laid in the grooves of the cable in the direction toward which the lacing is to proceed. Then ties are made as in *Fig. 7*, each one being tightened by pulling at right angles to the cable. Bringing the twine parallel to the cable clinches the previous knot. It will be noted that these are *not* merely half hitches. The number of knots tied together and the distance between the groups of ties depends largely on the type and size of cable and the rigidity of the wire. For a small, more or less flexible cable, single ties 1" to 1½" apart will be sufficient, while for large, fairly stiff cables, groups of three ties ¾" to 1" apart will be required. If the cable turns abruptly, ties are made at each side of the actual bend, being careful that the cable is formed to the correct angle before wrapping. The secret of successful lacing is pulling each tie very tight before forming the next.

Splicing in another piece of twine is effected by first laying it in the groove of the cable. After crossing it with a few ties, pick it up with the short end of the twine and make one wrap with them both. The short end is then laid in the groove and the long end used. Terminating the lacing is done by making a larger number of parallel ties and then simply cutting off the unused cord.



Figs. (1) Drilling transformer cut-out. (2) Terminal tie points. (3) Proper use of lug. (4) Method of removing shield braid. (5) Separating wire from braid. (6) Slip knot for start of lacing. (7) Lacing tie. (8) Laced cable, showing spacing of ties.

FUNDAMENTALS OF RADAR

THE ABCs OF HOW ULTRA HIGH-FREQUENCY LOCATION SYSTEMS WORK

FIRST LIEUT. ROBERT L. FINKELSTEIN, W2KVY

The fundamentals of Radar come first. No attempt has been made in this article to describe the more complex theory and circuits of "Pictorial Radar," in which the outlines and contours of certain type of "targets" are recognizable—a combination Radar and television. CQ will present data on these systems later.

WITH THE VEIL of secrecy being lifted, the basic principles of one of the war's greatest scientific developments, the science of Radio Location, or Radar, can now be told. In prewar years, these same principles, which now enable the detection and accurate positioning of objects far in space, were utilized in determining the heights of the various ionized layers of air above the earth's surface—critical factors in the prediction of high-frequency radio transmission reliability. Radar, or RAdio Detection And Ranging, enables our military forces to position accurately either aircraft or ships although the actual "targets" may be obscured by distance, fog, night, or rain. Aircraft, equipped with radar equipment, can observe the same types of targets as well as additional objects such as prominent ground features.

The Echo Principle

The theory of radar evolves from the familiar phenomenon we have all observed at one time or another. Shouting lustily toward a distant hill, we have heard our voice returned after a brief period at somewhat decreased amplitude. The more distant the hill, the longer the lapse of time between our shout (let us say "pulse" of sound) and the answer (or "echo" pulse) from the hill. The more observant may also have noticed that in order to hear an echo from a hill close by, the original shouted pulse must be crisp and brief. Otherwise, the weaker echo pulse will merge with the original sound and only the shout itself will be heard. Since sound waves under average conditions travel through air at a velocity approximating 1,100 feet per second, we can measure the distance to the reflecting hill simply by timing the period needed for the shouted pulse to travel out to the reflecting hill and return to the ear. This simple formula determines the distance to the hill:

$$S = \frac{vt}{2}$$

where S is the distance in feet to the hill, v equals 1,100 feet per second, and t is the time in seconds for the round-trip of the shout. We must divide by 2 in the above formula, since the time interval measured without this division is the time required for the shout to go out to the hill and return to the ear, whereas the time desired is one-half of the total "loop" time. As will be shown later, the formula above is used in determining radar ranges. The velocity of propagation of radio waves is substituted for the 1,100 feet-per-second velocity of sound.

In radar equipment a radio frequency "pulse" of energy is substituted for a sound pulse. Inasmuch as radio waves are propagated through space with a velocity of 186,000 miles per second, the measurement of time in the range determination becomes a matter of accurately measuring intervals as short as one-millionth of a second.

Sound ranging equipment has been discarded in favor of Radar, since the maximum range of sounding gear is very limited, and the accuracy of positioning a rapidly moving object by means of a relatively slow sound wave is low. Radar, however, can beam a brief, high-power pulse of radio frequency out to a target at great range and have a workable echo return before the target has moved a perceptible distance.

Since r-f pulses are to be used rather than sound pulses, some sort of radio transmitter is essential. The transmitter for this type work is designed to transmit a fixed number of pulses per second in the ultra-high or super-high frequencies. A highly directive beam antenna system is used to concentrate this energy in the general direction of the target. At the high frequencies usually employed in radar systems, the antenna is extremely small and compact inasmuch as antenna dimensions decrease with the wavelength.

The r-f pulses, upon striking any solid object, are re-radiated or "reflected" from the "target." The amount of energy reflected from any object is a function of the size of the target and the materials from which it is made. Metal targets are good reflectors, although working echoes may be obtained from wood and even water. In any case, enough energy is reflected from the average target to allow a sensitive radar receiver (placed alongside of the transmitter) to detect the resulting echo. The receiver, which is a component of the radar system, is tuned to the frequency of the radar transmitter.

In order to measure the time interval between the transmission of an r-f pulse and the return of the echo pulse at the receiver, a third component, known as the radar "indicator" is incorporated in the system. The heart of the indicator is one or more cathode-ray tubes (CRTs) of standard types. The fourth unit which provides timing and synchronizing functions for the entire radar system is known as the radar "synchronizer." Inasmuch as the transmitter and the receiver of the Radar are conventional, this discussion will deal mainly with the indicator and the synchronizer.

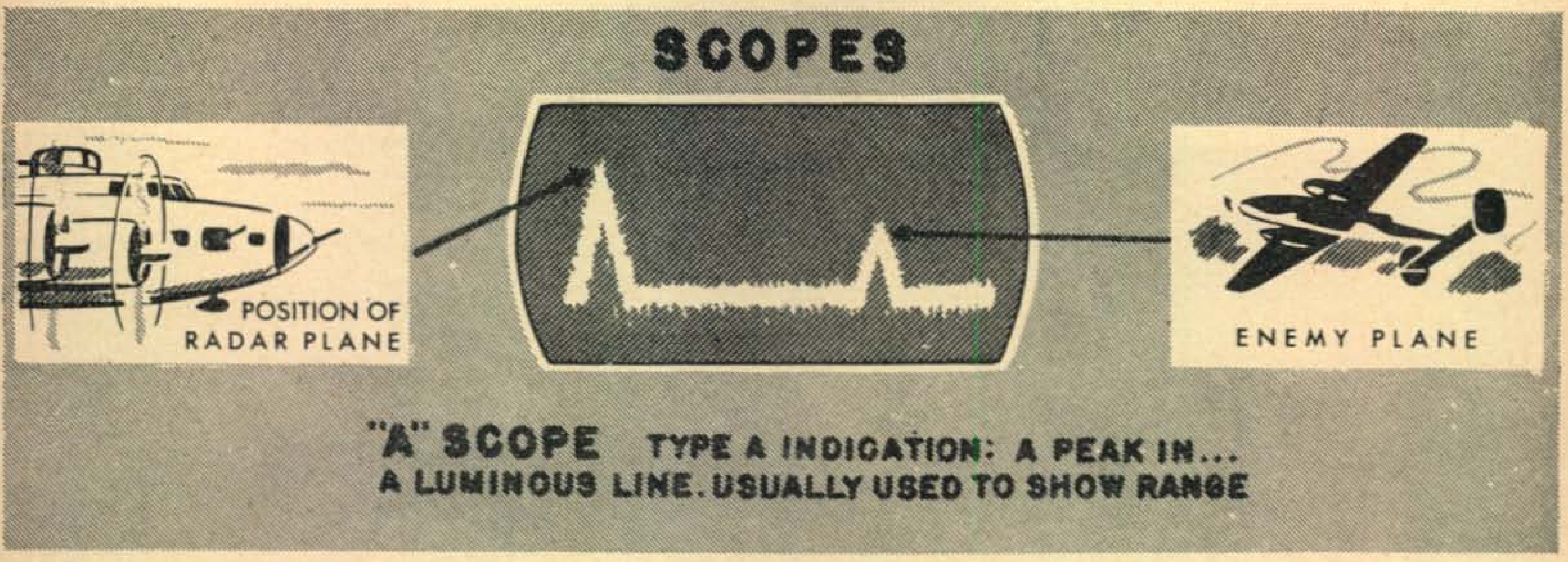
Radar Indicator

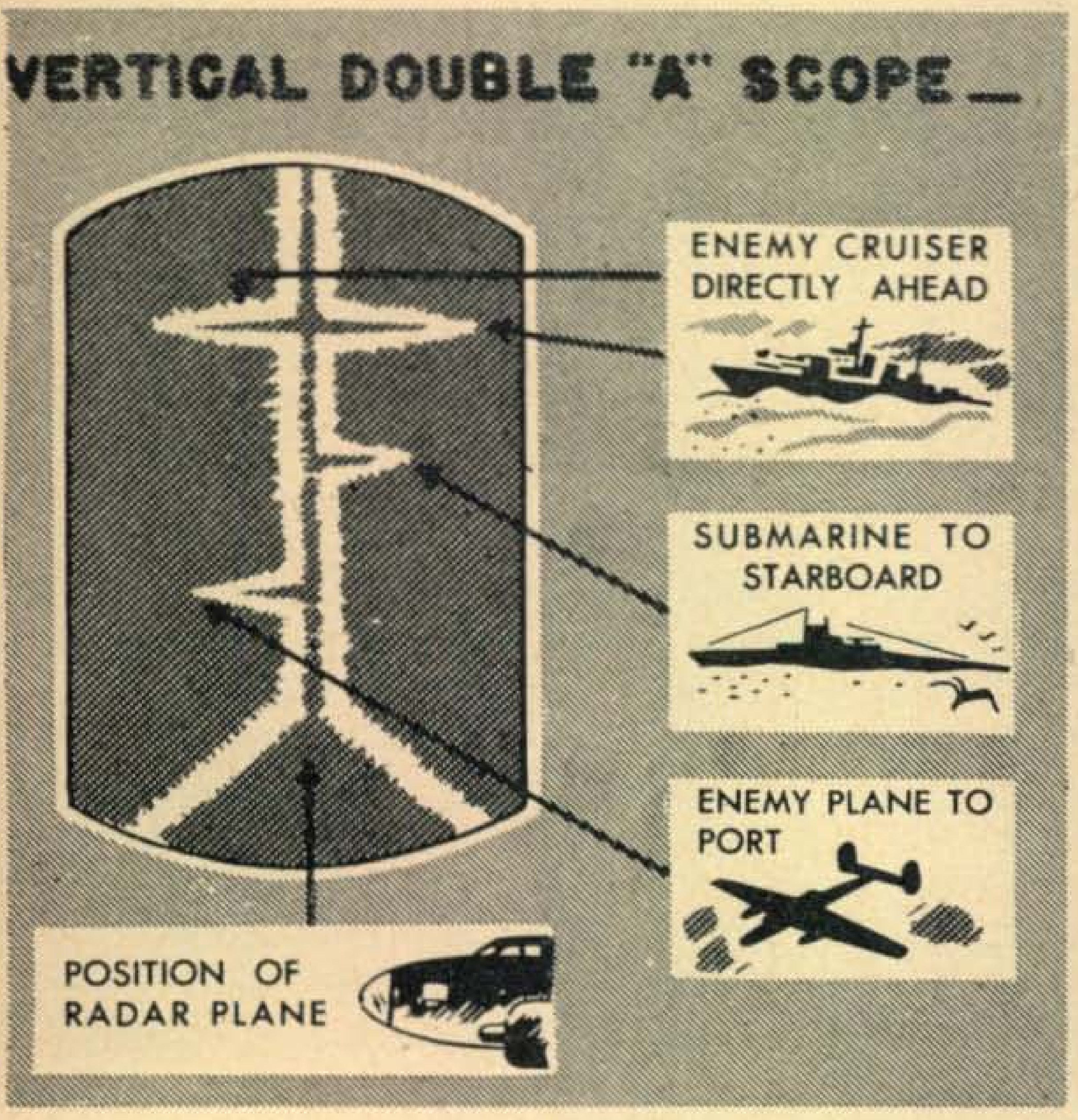
The most important component of every radar indicator is the cathode-ray tube, which measures the minute time intervals between transmission of radio-frequency pulses and the receipt of the corresponding echoes. Before proceeding further, it is well to be familiar with the actual units of time measurements used in radar. The standard time unit, corresponding to one-millionth of a second, is called the "microsecond" and is abbreviated "μsec." It is worthwhile in radar work to establish a relationship between time in microseconds and range in miles. Inasmuch as a radio wave is propagated through space at a velocity of 186,000 miles per second, in one microsecond the wave will have moved one-millionth of 186,000 miles or 0.186 miles. In the majority of radar equipments, ranges are measured in nautical rather than statute miles, so a conversion is made of 0.186 statute miles to 0.162 nautical miles. Therefore:

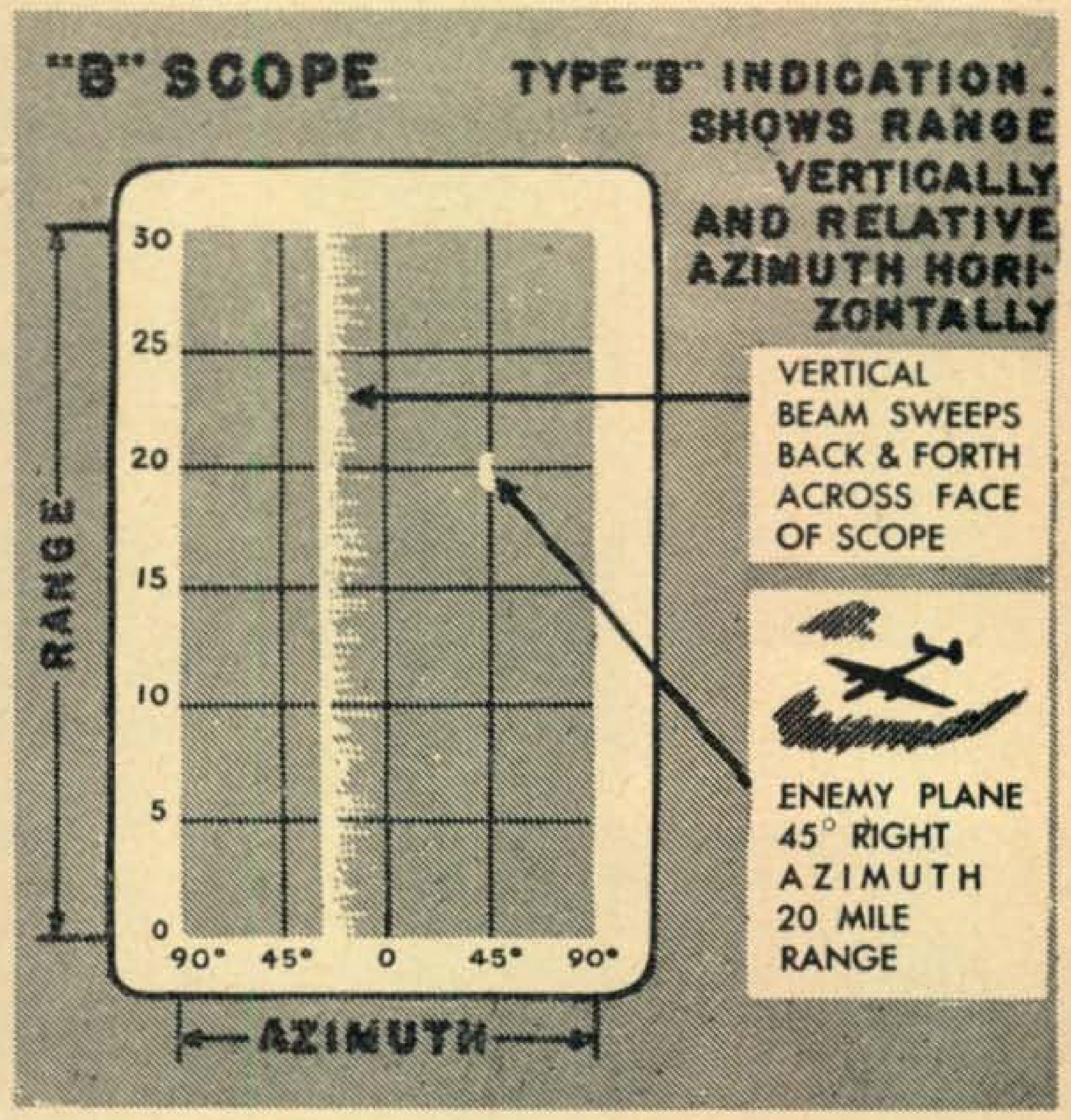
$$1\ \mu\text{sec} = 0.162 \text{ nautical miles, and—}$$
$$6.2\ \mu\text{sec} = 1.0 \text{ nautical mile.}$$

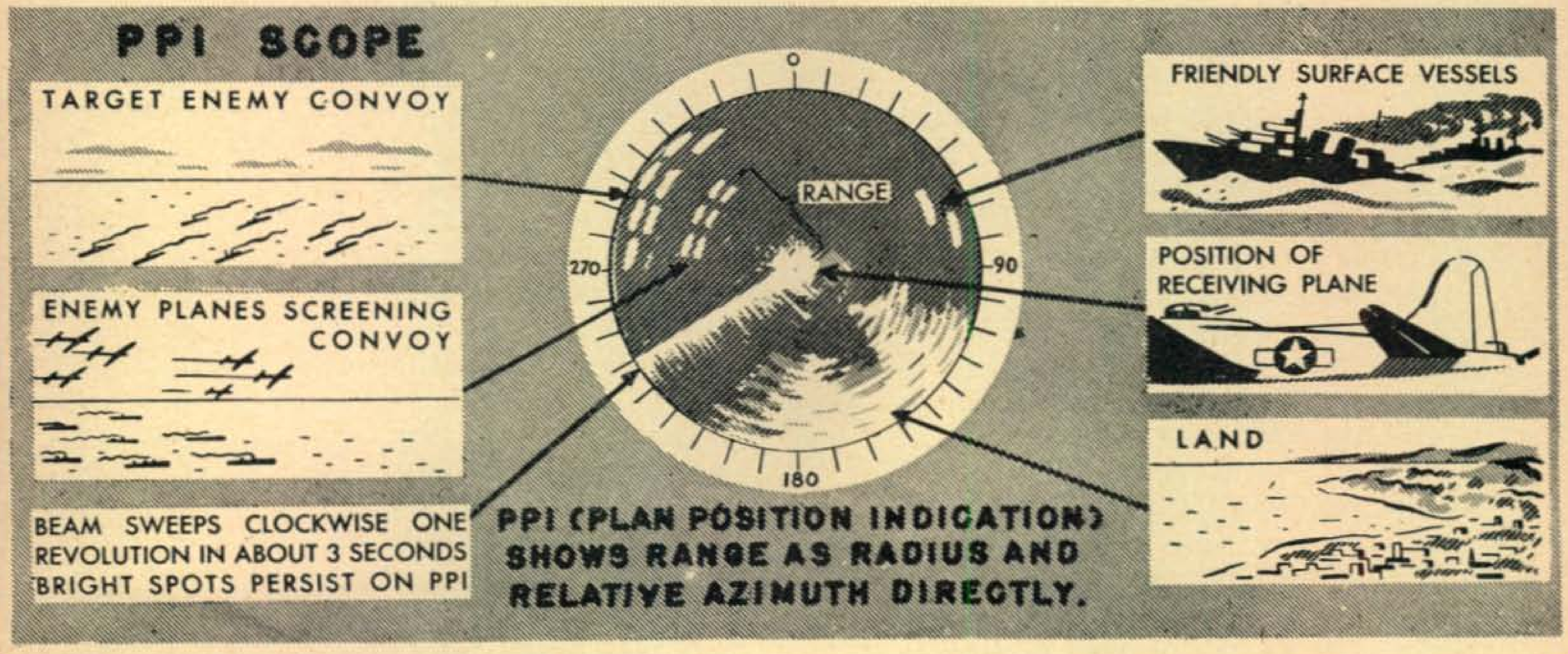
If a target is detected at one-nautical-mile range, the round trip time for the r-f pulse to go to the target and return as an echo will equal 12.4 μsec. This relationship between time and distance is the essence of radar work.

Consider a standard electrostatic-deflection cathode-ray tube having as elements a heater, cathode, grid, two anodes known as the first anode and the second anode, and four deflection plates called the upper and lower vertical and right and left horizontal deflecting plates respectively. (In the case of the deflection plates, if one could see through the opaque coating, looking at the screen, the right horizontal deflecting plate appears at the right of the screen. This convention is observed in the discussion.) With a correct ratio of voltages applied to all electrodes and with zero voltages on the deflecting plates, a bright spot of light appears in the center of the screen. This spot is caused by a bombardment of the special chemical coating deposited on the inside face of the screen by a great number of electrons composing the electron beam. When the electron beam is moved across the screen of the CRT, the glow of light follows the path of the beam. However, due to a property of the chemicals in the coating, known as persistence, the glow will remain after the beam has moved from one area to another, and a path is traced on the face of the tube in accordance with the movement of the electron beam. The persistence is measured in seconds and varies with different types of "scopes" from fractions of a second to 20 or 30 seconds. The movement of the electron beam is achieved by varying the differences in voltages established across the pairs of deflection plates and occurs by virtue of the electrostatic lines of force set up by these potentials.


SCOPES
POSITION OF RADAR PLANE
ENEMY PLANE
"A" SCOPE TYPE A INDICATION: A PEAK IN... A LUMINOUS LINE. USUALLY USED TO SHOW RANGE


VERTICAL DOUBLE "A" SCOPE
ENEMY CRUISER DIRECTLY AHEAD
SUBMARINE TO STARBOARD
ENEMY PLANE TO PORT
POSITION OF RADAR PLANE


"B" SCOPE
TYPE "B" INDICATION. SHOWS RANGE VERTICALLY AND RELATIVE AZIMUTH HORIZONTALLY
30
25
20
15
10
5
0
RANGE
90° 45° 0 45° 90°
AZIMUTH
VERTICAL BEAM SWEEPS BACK & FORTH ACROSS FACE OF SCOPE
ENEMY PLANE 45° RIGHT AZIMUTH 20 MILE RANGE


PPI SCOPE
TARGET ENEMY CONVOY
ENEMY PLANES SCREENING CONVOY
BEAM SWEEPS CLOCKWISE ONE REVOLUTION IN ABOUT 3 SECONDS BRIGHT SPOTS PERSIST ON PPI
0
90
180
270
RANGE
FRIENDLY SURFACE VESSELS
POSITION OF RECEIVING PLANE
LAND
PPI (PLAN POSITION INDICATION) SHOWS RANGE AS RADIUS AND RELATIVE AZIMUTH DIRECTLY.

The great inherent advantage of the cathode-ray tube is the instantaneous reaction of the electron beam to changes in the deflection plate potentials. A rubber ball, on striking a wall, first slows down, stops, and accelerates in the bouncing direction. The electron beam, however, seems to eliminate the time-wasting slowing down and speeding up, and reverses direction practically instantaneously when new deflection potentials are applied to the CRT. This "inertia-less" property is due to the infinitesimal mass of the individual electron as contrasted to the large forces acting upon it.

By a selection of deflection plate potentials, the spot on the CRT is initially at rest at the left of the screen's horizontal center line. The glowing spot of light is synchronized with the radar transmitter in such a manner that spot movement commences horizontally and to the right the instant the transmitter emits a radio-frequency pulse out to a target in space. The spot moves in this manner because a steadily increasing positive potential is applied to the right horizontal-deflecting plate with respect to the left horizontal plate. No vertical movement occurs at this time, since no voltages are applied to the vertical deflecting plates.

The spot moving across the CRT will consume a total transit time from left to right equal to twice the time required for the r-f pulse to travel from the transmitter to a target at the maximum designed range of the radar set. If the maximum range of the Radar is say 100 nautical miles, the sweep will consume 1240 μsec. Upon reaching the extreme right of the screen the trace ends, and the electron beam is returned to the left of the scope (to await another "pulsing" of the transmitter) by means of a standard oscilloscope fly-back circuit.

The Echo Pulse

Whenever a target is encountered by the r-f pulse, the resulting echo, if strong enough, is detected by the radar receiver and applied as a voltage pulse to the upper vertical deflecting plate. This pulse causes the electron beam to veer momentarily from its horizontal path across the CRT to form a vertical trace, the height of which depends upon the amplitude of the signal fed in from the receiver. After the electron beam describes this echo or "pip" on the trace, the beam continues the horizontal path across the tube until additional echoes are encountered, which are similarly indicated. The width of the echoes equals the width or duration of the transmitted pulse in microseconds on small targets, and they are generally several microseconds long. If the sweep is 1240 μsec, as it is in this example, it is obvious that a pulse of several microseconds will yield an echo pulse on the trace which is narrow and rather difficult to observe unless the focus of the cathode-ray tube is well adjusted. The use of a narrow pulse is advantageous as the ability of a particular Radar to differentiate between two targets close together in range is a function of the radio-frequency pulse width. If the r-f pulse width is very narrow (a microsecond or so), several echoes can be observed on the CRT at about the same range whereas the use of an extremely wide pulse would create wide echoes on the CRT, obscuring the visual presentation.

A relationship exists between the time required for the r-f pulse to reach a target and return through the receiver to the CRT, and the longitudinal distance along the sweep from the start of the trace and the pip corresponding to the receipt of an echo pulse. Distances along the sweep are actual measurements of ranges to targets encountered. The sweep is usually arranged with zero range on the left and maximum range to the right, and a range scale is often glued on the face of the CRT just below the trace in order to facilitate range readings.

A Pictorial Description

The cycle described above is illustrated in *Fig. 1*. The range of the radar set in this example is again 100 nautical miles. In *Fig. 1*, at time = 0, the spot on the CRT is at the left of the tube the instant the transmitter begins pulsing. At time = t_1 the r-f pulse encounters a target 50 nautical miles from the Radar. However, the spot at time = t_1 has moved only 25 indicated nautical miles or 155 μsec. At time = t_2, the echo reflected to the radar by the target at 50 nautical miles range has returned to the receiver and indicator The spot on the CRT has now moved to an indicated 50 nautical miles in 310 μsec. At the instant the echo returns, the pip forms at exactly this point on the scale. The time required by the r-f pulse and the resulting echo to travel through space is 620 μsec.

In a radar system, the transmitted pulse is so powerful that it saturates the radar receiver to appear as a pulse on the CRT at the exact beginning of the sweep or at zero range. This "main bang," as it is familiarly called, is shown in *Fig. 1* at time = t_1 and time = t_2.

The radar transmitter will not pulse again until the previous radio-frequency pulse has traveled outwards past the maximum range of the set. The greater the range capabilities of a radar equipment, the fewer times per second the transmitter pulses. The number of pulses transmitted per second is known as the "pulse-recurrence frequency" or PRF of the particular Radar.

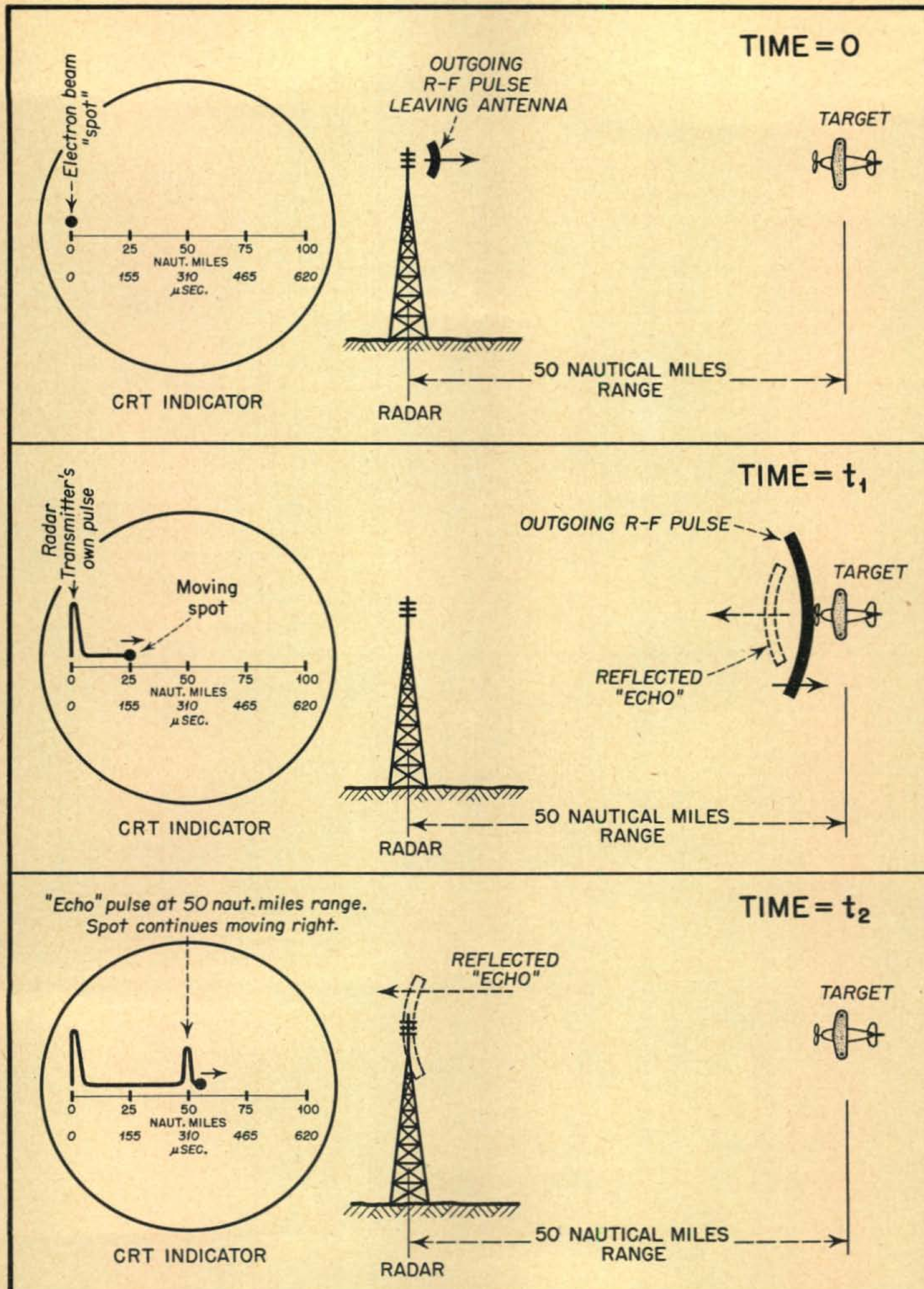


Fig. 1. Three progressive time periods in the transmission of a radar pulse, and the reception of the echo pulse. In practice the CRT is calibrated only in miles or yards.

The actual circuit used to generate the sweep is generally one which will produce a saw-tooth wave, causing the electron beam to move across the CRT linearly with time. The saw-tooth generator starts the production of a sweep upon the arrival at the generator of a timing trigger pulse or "start signal." The timing pulse is fed in either from the transmitter (in apparatus where the transmitter is "free-running" and controls its own pulsing) or from the synchronizer (or common timer) in later designs.

As in all radio systems, a certain amount of extraneous noise is always present in the receiver—due to ignition, tube noise, etc. Instead of being heard on Radar, however, this "noise" is seen as a large number of small vertical deflections known as "grass." The height of the grass, which represents the noise level of the receiver and the various pulse amplifiers, is adjusted by means of the receiver gain control to an amplitude of approximately ¼ inch. Target echoes of signal-to-noise ratio greater than one override the grass and are clearly visible.

Airborne Radars also pick up a direct echo from the ground below. This "ground return" is valuable to the air crews, who use it as an indication of absolute altitude or altitude above terrain below.

Radar Synchronizer

The radar synchronizer is the component of the radar system which produces a series of pulses to control the pulse-recurrence frequency of the transmitter and to synchronize the start of the CRT sweep in the indicator. These timing pulses are usually formed from the square waves output of a free-running multivibrator. Earlier equipment employed sine waves with a squaring amplifier to produce the square waves. Once a square wave is obtained, it is usually differentiated by a short time constant R-C (resistor-condenser) circuit to form a series of narrow pulses. The frequency of the multivibrator is generally the desired pulse-recurrence frequency of the radar transmitter.

The various timing pulses are utilized in the following manner. If it is only desired to generate a sweep at a certain instant, the sweep generator tube can be held past cut-off by placing a negative voltage on the grid. The timing pulse arriving at the sweep generator would probably be a positive pulse sufficient to lift the bias on the generator and make it operative. In an identical manner, the transmitter is held in check by a high bias until the timer arrives. Depending upon the type equipment, timing pulses vary in width and means of injection into the

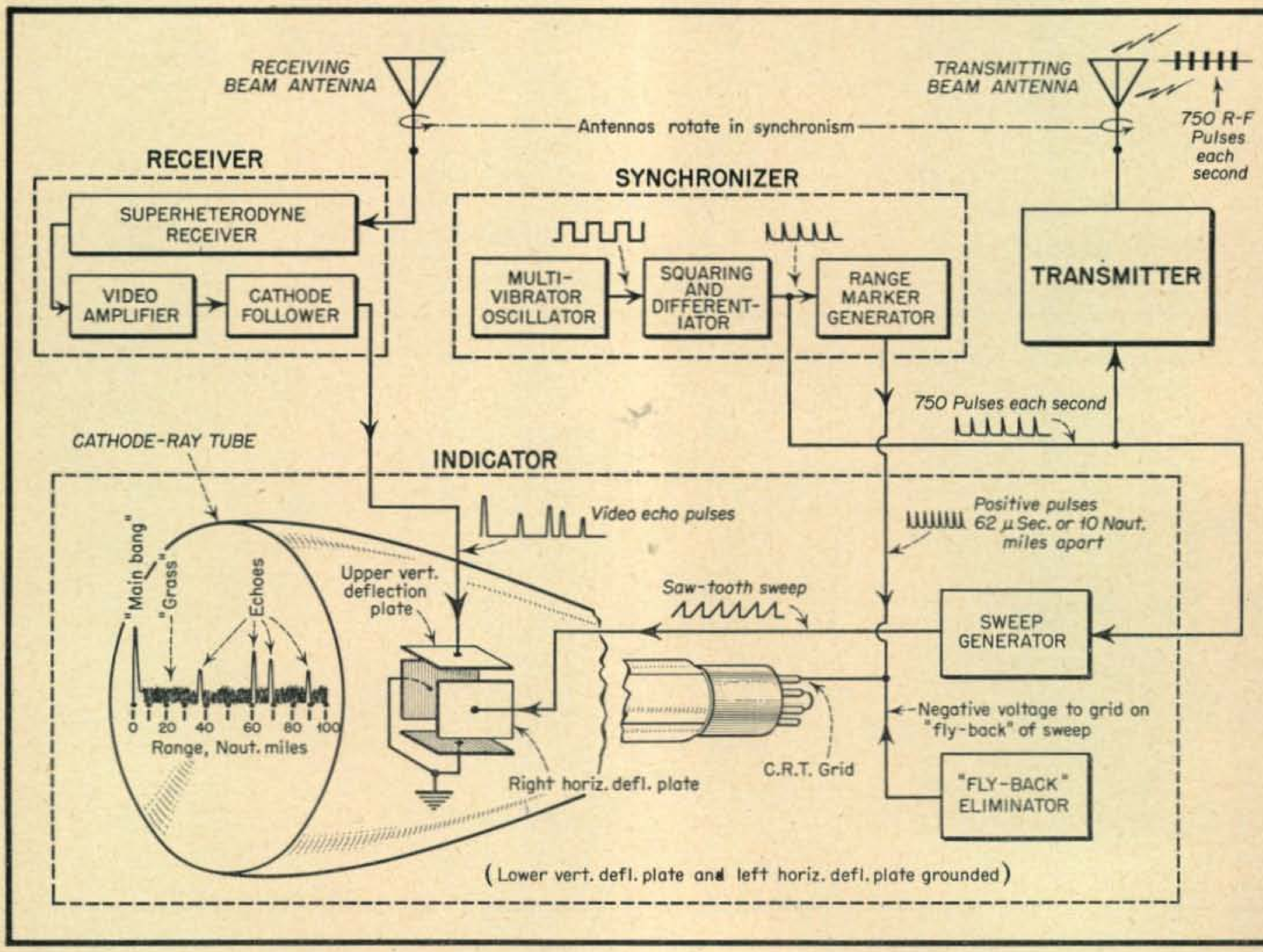


Fig. 2. Block diagram of a complete radar installation. Wave forms are not drawn to a common scale. Power supplies and some CRT elements have been omitted for clarity.

circuit; however, they are all used to control carefully the starting or stopping of a particular circuit.

Radar Receiver

Radar receivers are similar in design to a good amateur superhet. They are tuned to the frequency of the transmitter so as to receive the weak echo pulses reflected from the various targets. Following the receiver itself is a video amplifier. The video amplifier is a wide-band audio amplifier especially designed to preserve the wave shape of the echo pulses. The last tube in the video amplifier is generally a cathode follower, which efficiently matches an extremely high impedance to a low impedance and becomes valuable in passing the video signal from the last video amplifier to the deflecting plates of the CRT.

Radar Transmitter

The radar transmitter is also conventional except for the pulsing feature. Normally, with cut-off, either in the final amplifier or in one of the earlier buffer stages, the transmitter operates for only a brief interval upon the receipt of the trigger or timing pulse. Since the transmitter is off most of the time, the tube ratings can be vastly exceeded during the pulsing period without fear of damage. This characteristic of radar transmitters, which allows them to be overloaded, provides additional range by virtue of increased power output. Higher frequency equipment utilizes centimeter techniques of r-f generation and transmission, but they too are pulsed for but a short period of time each second.

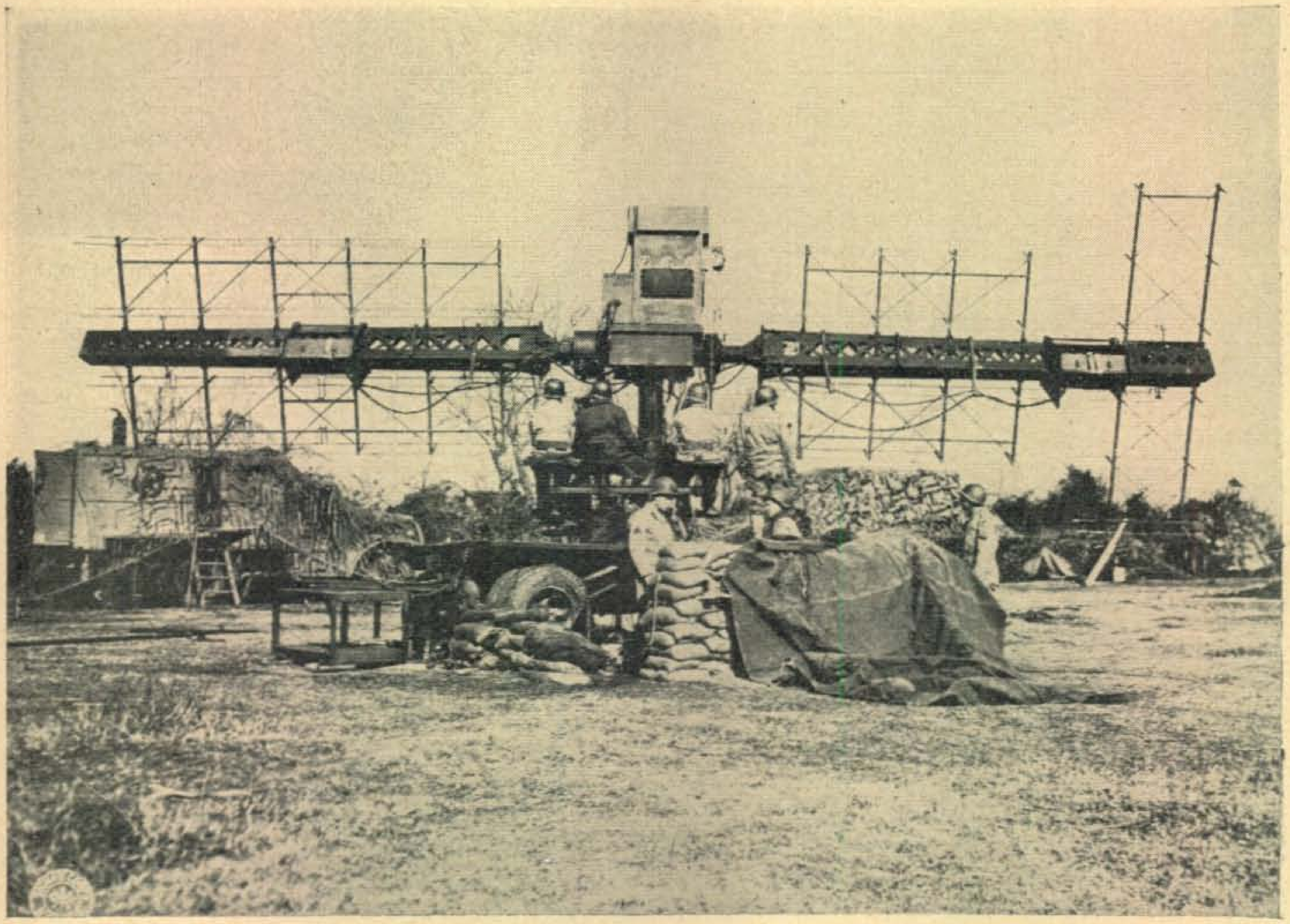
Antennas

Most modern radar systems now employ a common antenna for transmitting and receiving, isolating the two circuits by means of quarter-wave transformers. Weak echo pulses are directed to the receiver by these transformers, while powerful pulses from the transmitter have right-of-way to the antenna without blasting the receiver off the table. The space-saving is considerable, and a simplification results in eliminating the need for two antenna systems which much be synchronized so they point in the same direction. The basic principles governing the design of radar antennas are those used in pre-war ham designs on 2½ and 5 meters.

The Complete Layout

A block diagram of a typical system will prove of interest. In *Fig. 2*, the Radar is controlled

[*Continued on page 43*]



SCR-268 radar in action in Nettuno, Italy. As this picture was being made, A.A. guns began picking off Luftwaffe fighters. (*Western Electric photo*)

TELEVISION PICK-UP TUBES

THESE "BOTTLES" WILL PLAY A PART IN POST-WAR AMATEUR RADIO

B. W. SOUTHWELL, W6OJW

WITH AMATEUR TELEVISION looming on the not distant horizon, this article endeavors to acquaint the reader with the principles of television pick-up tubes. The first of these is the iconoscope. The word iconoscope comes from the combination of two Greek words "eikon," meaning image and "skopein," to observe. The iconoscope as shown in *Fig. 1*, is shaped somewhat like a household saucepan. The large pan-shaped part houses the most essential element of the tube known as the "mosaic."

The mosaic is a flat mica plate approximately .001 inch thick. Mica is used because of its uniform thickness, high electrical insulation and good surface. The mica is baked in an oven after being coated on one side with a thin, finely sifted silver oxide. The silver oxide is reduced to pure silver by the heating process, which causes it to congeal in the form of extremely minute globules of less than .001 inch in diameter. The globules are separate and insulated from each other. By passing a glow discharge through the tube in the presence of caesium vapor and oxygen, the globules are made photosensitive. Each globule becomes a miniature photoelectric cell and assumes a potential in proportion to the amount of light falling upon it.

Backing the Mosaic

Before being placed within the tube, a thin "signal coat" of colloidal graphite is applied to the reverse side of the mosaic, which serves during the process of scanning, as an electrode through which the external circuits receive transference of signal. Silver plating is sometimes substituted for the colloidal graphite. The mosaic is placed in the tube so that the beam from the electron gun in the neck (corresponding to the handle of the saucepan) strikes the photosensitive globules at an angle of 30 degrees. The optical image to be converted to electrical energy for transmission is focused on the mosaic through a lens system as in an ordinary photographic camera. When a scene is focused on the mosaic (which may be thought of as a vast number of minute photocells, each one coupled by a capacitor to a common signal lead) these globules are positively charged as photoelectrons are emitted from its surface, and the optical image is thereby translated into an *electrical* image.

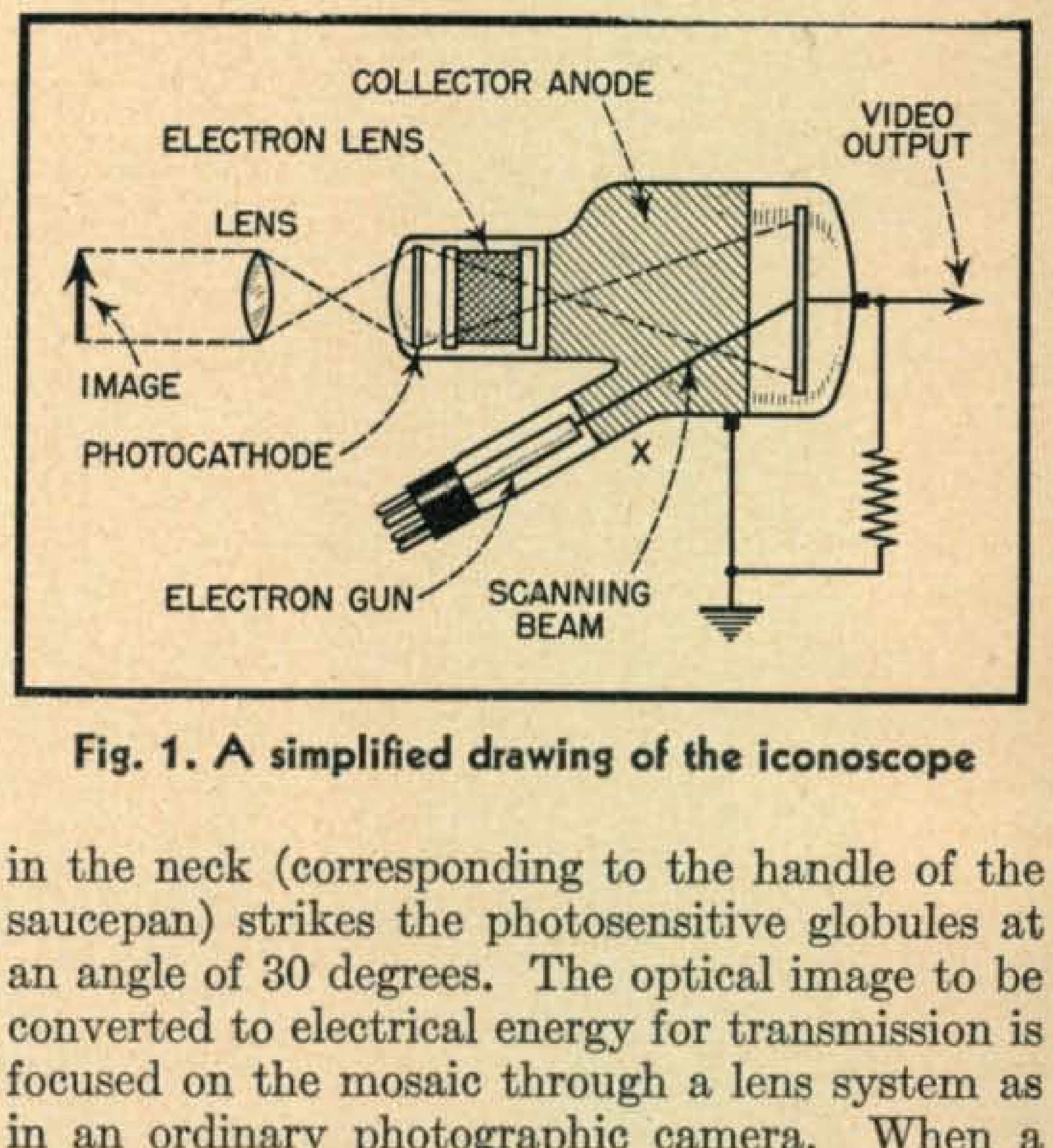


Fig. 1. A simplified drawing of the iconoscope

The electron gun contained in the neck of the tube produces a very narrow stream or beam of electrons (negative charges of electricity). To the tiny photocells on the mosaic, the beam serves as a commutator. Two electron "lenses" comprising the electronic optical system, are formed by cylindrically symmetrical electrostatic fields between the gun elements. The gun construction consists of an indirectly heated cathode placed at the bottom or socket end of the neck of the tube. The cathode cylinder has its emitting surface at the tip, a few thousandths of an inch in front of an aperture in the control grid. The first or accelerating anode is a long cylinder with three defining apertures, whose axis coincides with the cathode and control grid axes. This anode imparts the initial acceleration to the electrons emitted from the cathode. A second cylinder of somewhat greater diameter and coaxial with the first anode, serves as a second anode and from it the electrons receive their final velocity. The neck of the iconoscope is usually metalized to form the second anode, sometimes termed the "collector" anode, as it collects and concentrates the electrons into a very narrow beam. The electron beam is made to scan the image on the mosaic.

The illumination on the subject to be televised is in the order of several hundred foot-candles, and with the use of the best optical lenses this provides a mosaic illumination of approximately one foot-candle (the light produced by a standard candle at a distance of one foot). A standard candle is a specified fraction of the visible light radiated by a group of carbon-filament lamps preserved in the U. S. Bureau of Standards. This illumination of one-foot candle on the mosaic of the iconoscope is only possible when the lens aperture is maximum or "wide open." The depth of focus in this adjustment is so severely restricted that the simultaneous focusing of near-by and distant objects is not possible. The simplest of studio presentations are the only type in which this is not a serious restriction. If the iconoscope were more sensitive, the lens aperture could be made smaller with improved depth of focus.

The Image Iconoscope

The "image iconoscope" pictured in *Fig. 2*

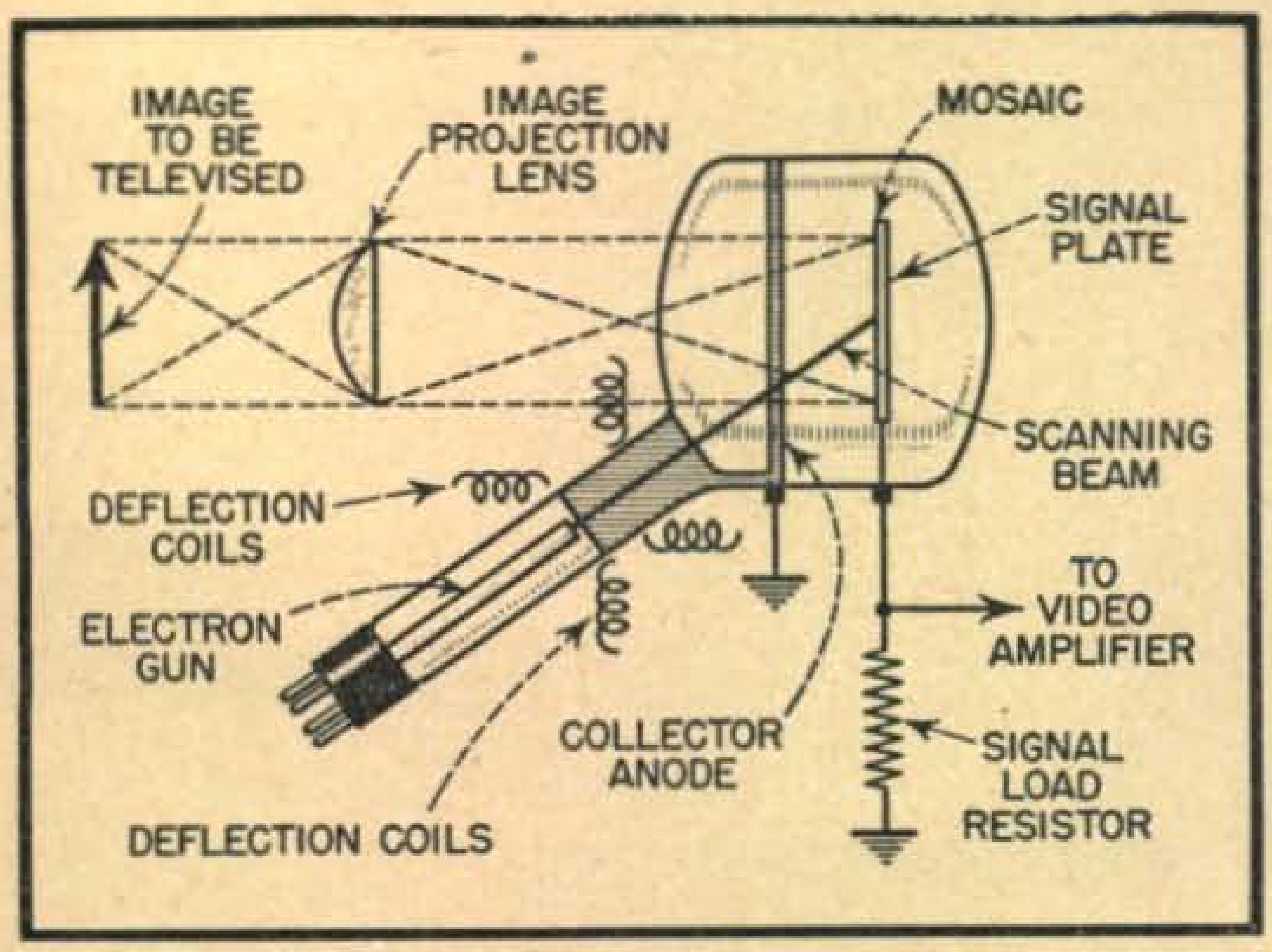


Fig. 2. The "image iconoscope" is more sensitive than the simple iconscope. Deflection coils fit around the neck of the "gun" at point X

is an improvement over the conventional iconoscope in that an additional sensitivity of approximately ten times is available. A transparent glass plate is photo-sensitized with a sputtered layer of silver caesium. This "photocathode" is inserted in the evacuated tube, and the object to be televised is focused on it through the usual optical lenses. The sensitized layer is located on the *inside* of the plate so that light from the projected image must pass through it to charge the photoelectrons. There is also located between the photocathode and the final mosaic a series of ring-like electrodes which constitute an electronic lens. When excited by the light from the projected image, the photoelectrons on the sensitized cathode emit an electron image which is drawn down the tube to the mosaic located directly opposite it at the far end. When the electrons strike the mosaic it causes a charge deficiency to occur due to the emission of secondary electrons. This second mosaic is then scanned as in the regular iconoscope and the signal transferred to the external circuits of the iconoscope preamplifier.

The advantage in the image iconoscope is that the electrical field drawing the photoelectrically emitted electrons from the photocathode is appreciable while that available in the conventional iconoscope is very small. The mosaic also has a higher secondary-emission ratio and emits five or more electrons for every one striking it. The image iconoscope has an approximate field of 5000 microvolts per foot-candle compared to about 500 microvolts for the conventional iconoscope.

The fact that the photocathode is close to the front wall is of optical advantage as a lens of shorter focal length can be used. The mosaic of the image iconoscope is not of the same construction as that in the conventional iconoscope. The mosaic plate may be mica or a flat metal plate covered with a film of china clay, and is capable of high secondary emission. The signal is readily transferred to the preamplifier if a capacitance exists between the metallic signal coat on the reverse side of the plate and the mosaic surface upon which the electron image is projected by the photocathode.

Only part of the electrons emitted from the mosaic as secondary emission are collected and transferred to the external signal circuits. The remainder falling back on the mosaic, produces a charge distribution resulting in a spurious (dark-spot) signal and uneven background shading. A compensating shading-correction generator must be used which produces sine, saw-tooth and parabolic wave shapes at horizontal and vertical scanning rates. These wave shapes are synchronized with the scanning beam from the electron gun, and are fed into the preamplifier.

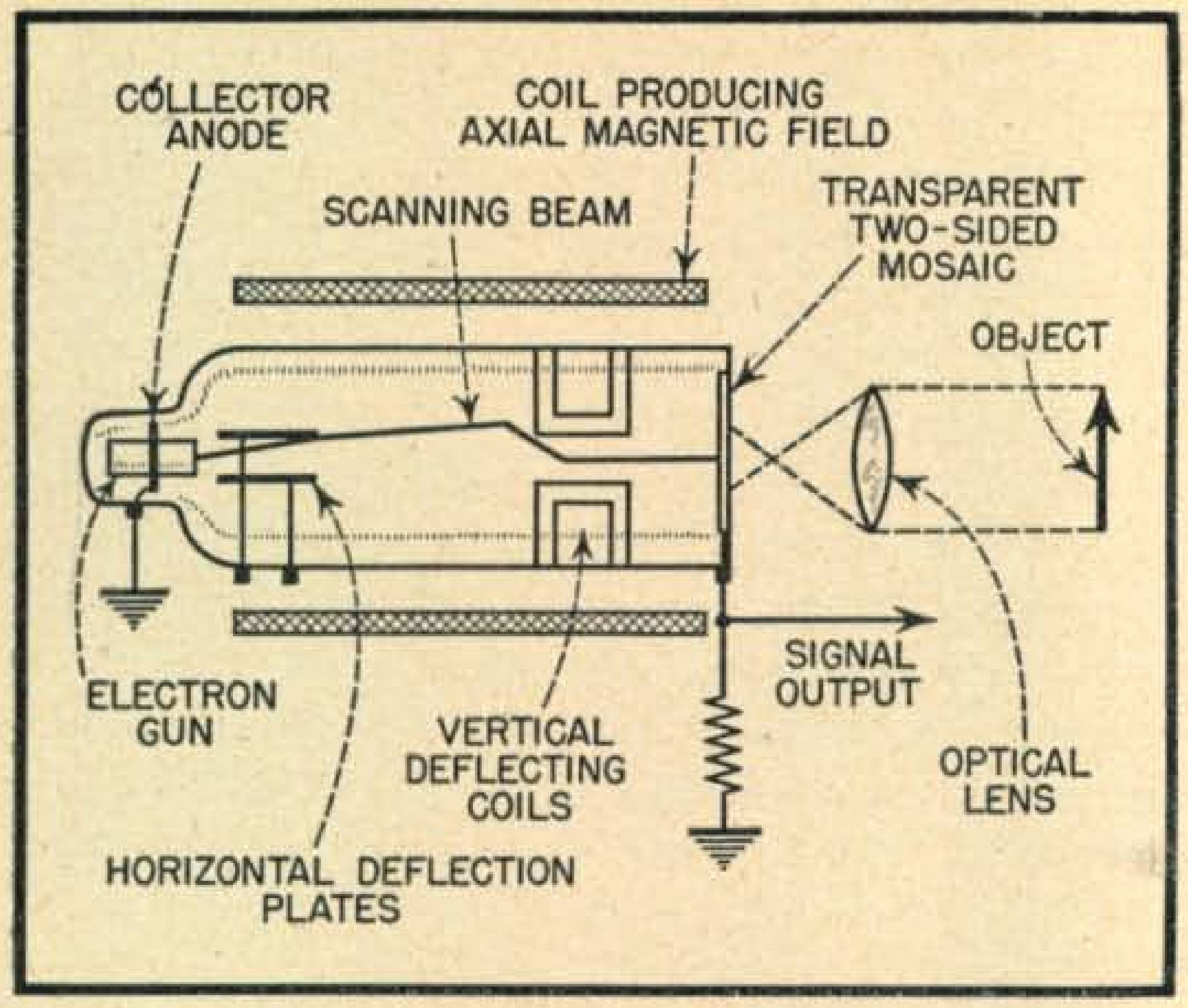


Fig. 3. Another variation of the iconoscope is the orthiconoscope or "orthicon"

The image iconoscope is more widely used in Great Britain than in the United States.

The "Orthicon"

The orthiconoscope, sketched in *Fig. 3*, derives its name from the fact that the output current-to-mosaic-illumination curve is a straight line (i.e., ortho meaning straight). It is a form of iconoscope, hence its full name orthiconoscope—usually shortened to orthicon. Compared with the iconoscope, the storage efficiency of the orthicon is in the order of 100 per cent. The velocity of the electron beam is slow and consequently no secondary emission is observed. This eliminates the spurious dark-spot signal and external shading compensation circuits are not required. Due to the elimination of secondary electrons no video signal can arise from an accumulation of such electrons as in the iconoscope. Instead, only the scanning electrons themselves are collected and the output of the orthicon is confined to useful current variations. In scanning the mosaic by a low-velocity electron beam, there arises the problem of producing and deflecting such a beam without defocusing and distorting the scanning raster. Adequate shielding is necessary to overcome stray electric and magnetic fields around the tube.

In order to assure the perpendicular scanning of the mosaic at all points, a combination of magnetic and electric fields is used to accomplish horizontal scanning. The magnetic field, supplied by surrounding the tube with a coil, tends to guide the scanning electrons to the mosaic. A traverse electric field is produced by the two deflection plates, and an electron passing through this region tends to travel toward the positive plate. The axial magnetic field acts on the electron causing it to execute a cycloidal motion deflecting it parallel with the deflecting plates. After emerging from the area between the deflecting plates, the electron is compelled by the magnetic field to straighten out and proceed on a forward course parallel with the axial magnetic field. The beam strikes the mosaic perpendicularly regardless of its point of impact on the mosaic. The vertical deflection is accomplished by employing a coil which acts on the beam after it emerges from the region of the horizontal deflection plates.

The televised subject is optically focused on the mosaic which is translucent and a stored image charge is set up. As in the iconoscope the scanning electrons restore the charge on each tiny photo-sensitized globule in the mosaic.

The current model orthicon is approximately 20 inches long and 4 inches in diameter. The mosaic is 2 by 2½ inches and is placed very close to one end of the evacuated tube. The short focal length and small diameter of the optical lens needed to focus the subject to be televised on the mosaic are points in its favor. In spite of the small area of the mosaic, the picture resolution varies from 400 to 700 lines. The maximum signal/noise ratio is about 500 times and the weakest signal/noise ratio is five to one. The orthicon is used with a rotating color filter drum by CBS for direct-color television pickup.

The Image-Dissector

The image-dissector or camera tube, *Fig. 4*, was invented by P. T. Farnsworth and is of the instantaneous electronic scanner type. The image to be transmitted is focused on a flat photo-sensitized surface also known as the photocathode. This cathode is placed at one end of a highly-evacuated cylindrical glass tube and faces a flat glass plate which comprises the opposite face or end of the cylindrical tube. An optical lens system exterior to the glass plate projects the image on the cathode. Electrons are released from the cathode in proportion to the light and dark areas

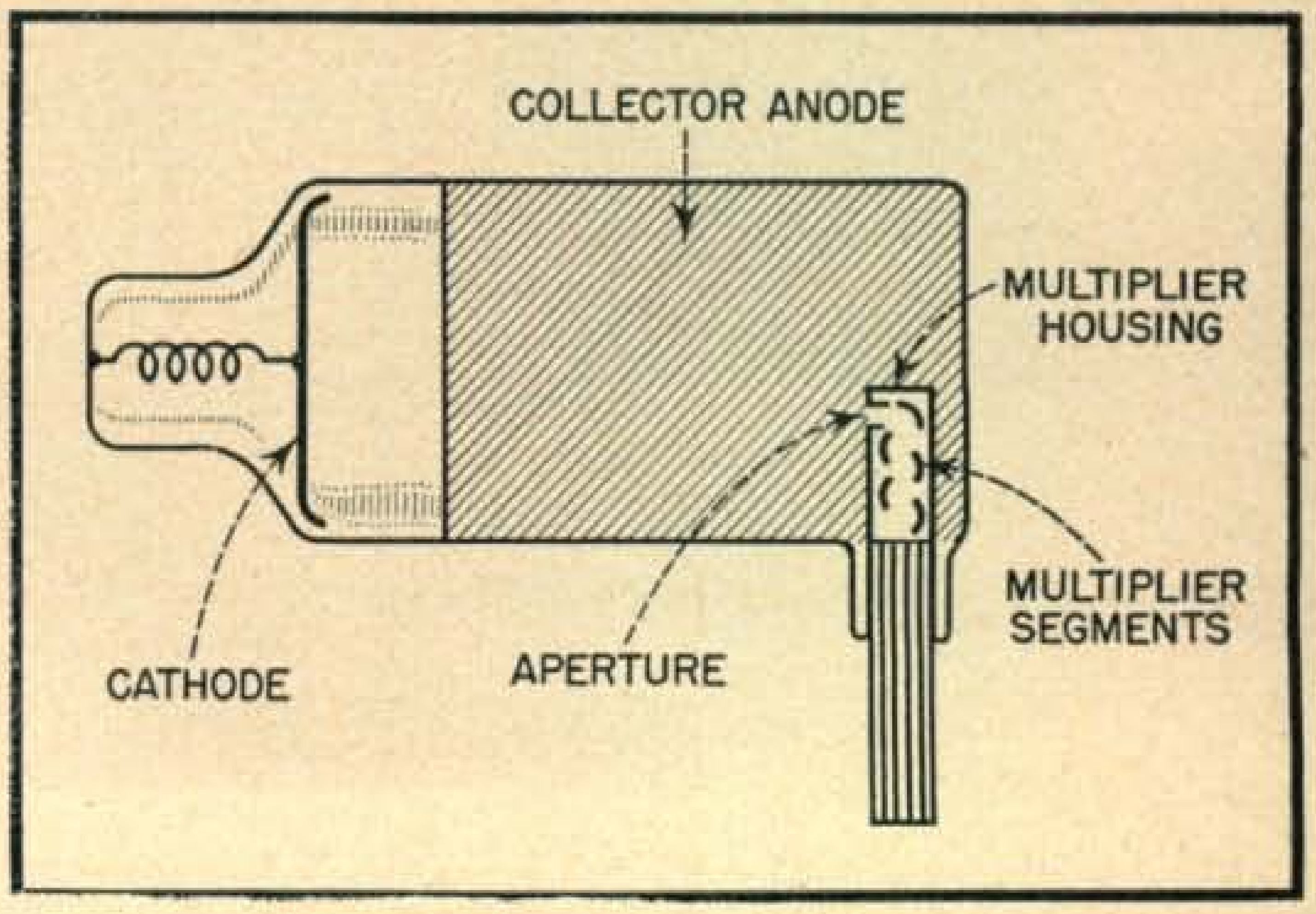


Fig. 4. The "image dissector" developed by Farnsworth. The magnetic deflection and focusing coils are external and surround the tube

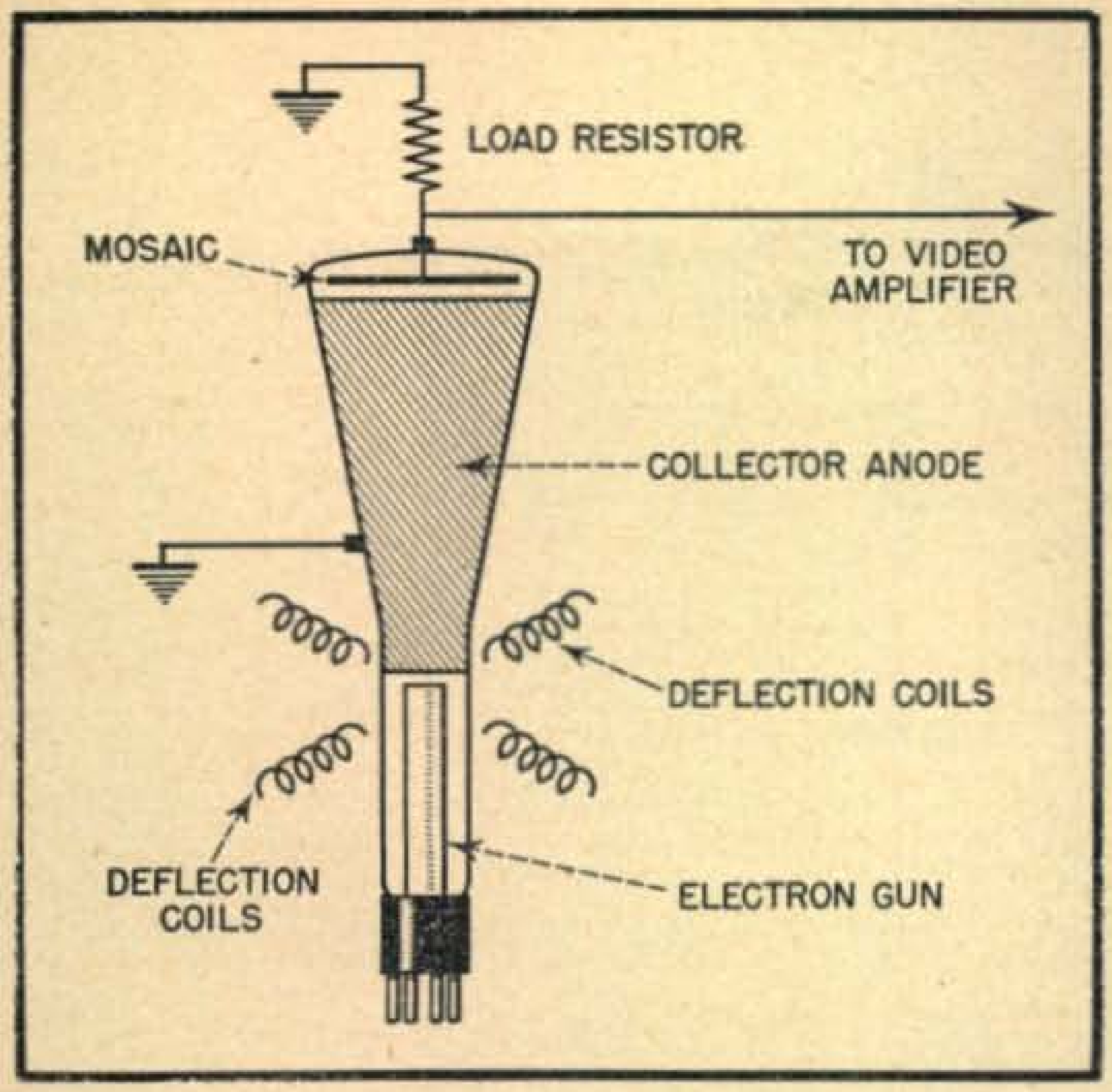


Fig. 5. The "monoscope" is used for televising prepared still pictures or "patterns"—largely for test purposes

of the image. This "cloud" of electrons or "electron image" is sped down the length of the tube by a field set up by an electrode at the same end of the tube as the glass plate. The mutual repulsions among the electrons themselves, which would tend to scatter the electron image, are neutralized by a focusing coil generating a magnetic field. This coil focuses the electrons on a "multiplier" structure with a small hole in its center. Electrons passing through this aperture impinge on a surface which emits 5 to 10 electrons for every electron striking it. This process of electron multiplication recurs several times within the multiplier structure and the augmented stream is collected in the form of a current impulse. As the scanning aperture is rigid and cannot be moved across the image, it is necessary to move the electrical image past the aperture so that the electrons are taken from it and pass through the hole in the multiplier in such a way as to form a succession of scanning lines. External control coils linked to horizontal and vertical saw-tooth sweep oscillators move the electron image past the multiplier structure. The electrons (or current) emerging at the bottom of the multiplier are passed through a resistor, the voltage variations across which are fed into an electronic voltage amplifier. High scanning speed is employed and an optical lens of large area is used to collect a considerable amount of light from the image. This tube is very useful for the scanning motion-picture films.

Still Images

The monoscope is a tube in which a signal is produced from a static image printed on the mosaic or signal plate. It is shown in *Fig. 5*, and is also known as the monotron and phasmajector. The mosaic consists of a .004 inch thick aluminum plate on which an image is printed with ordinary printer's ink. The ink is reduced to pure carbon as the tube is heated during manufacture. The secondary emission ratio of the carbon to the aluminum is in the order of 3 to 7. The electron beam therefore excites more electrons from the unprinted portions and the secondary emission variation is transferred by the collector anode to the external signal circuit. This type of tube is primarily employed to transmit a test signal, or pattern, which, due to the fact that the mosaic is not photosensitive, is the same regardless of illumination variations which would affect an ordinary iconoscope.

Color Pictures

The "Telechrome" is a tube used for color pickup and has a two-sided mosaic for two-color effect. One face of the mosaic is coated blue-green and the other orange-red. Each side of the mosaic is scanned by its own electron gun in conventional fashion. For three-color effect, the mosaic has a red screen on one side and a corrugated surface on the other which is coated green on one-half of each corrugation and blue on the

[*Continued on page 44*]

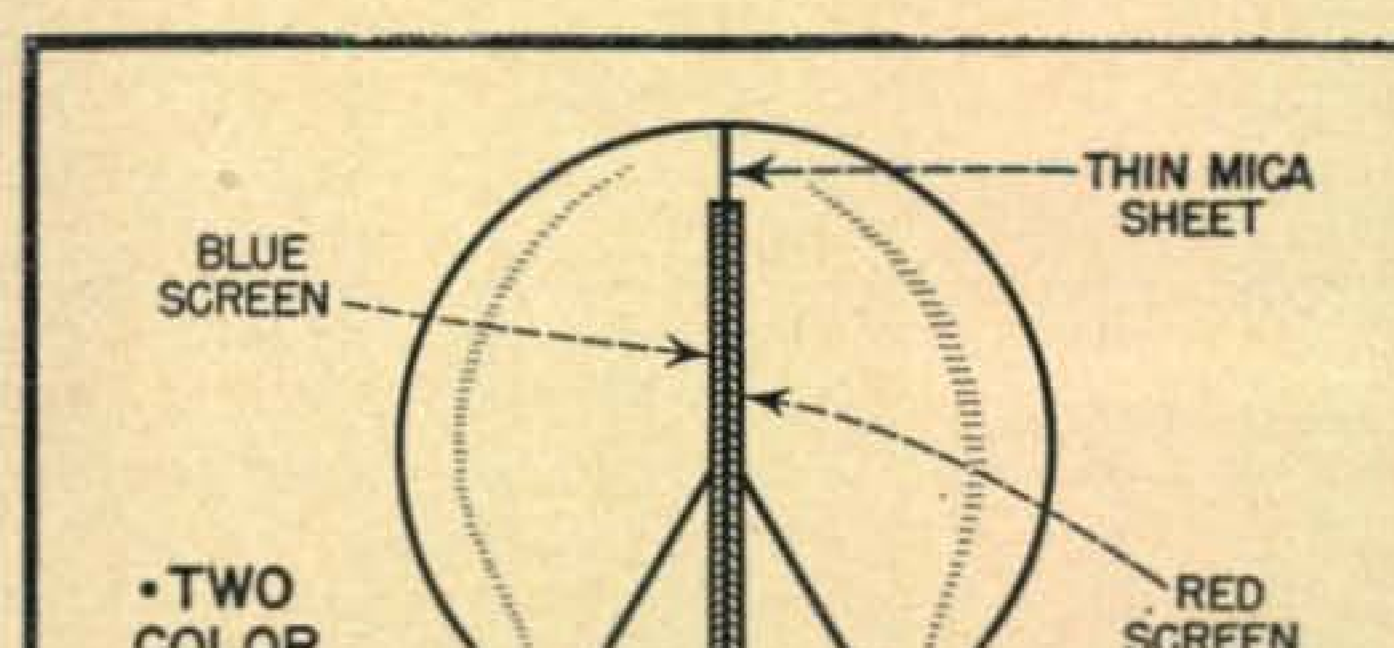


Fig. 6. The "telechrome" is the heart of one of the systems used for color television. Two and three-color tubes are shown

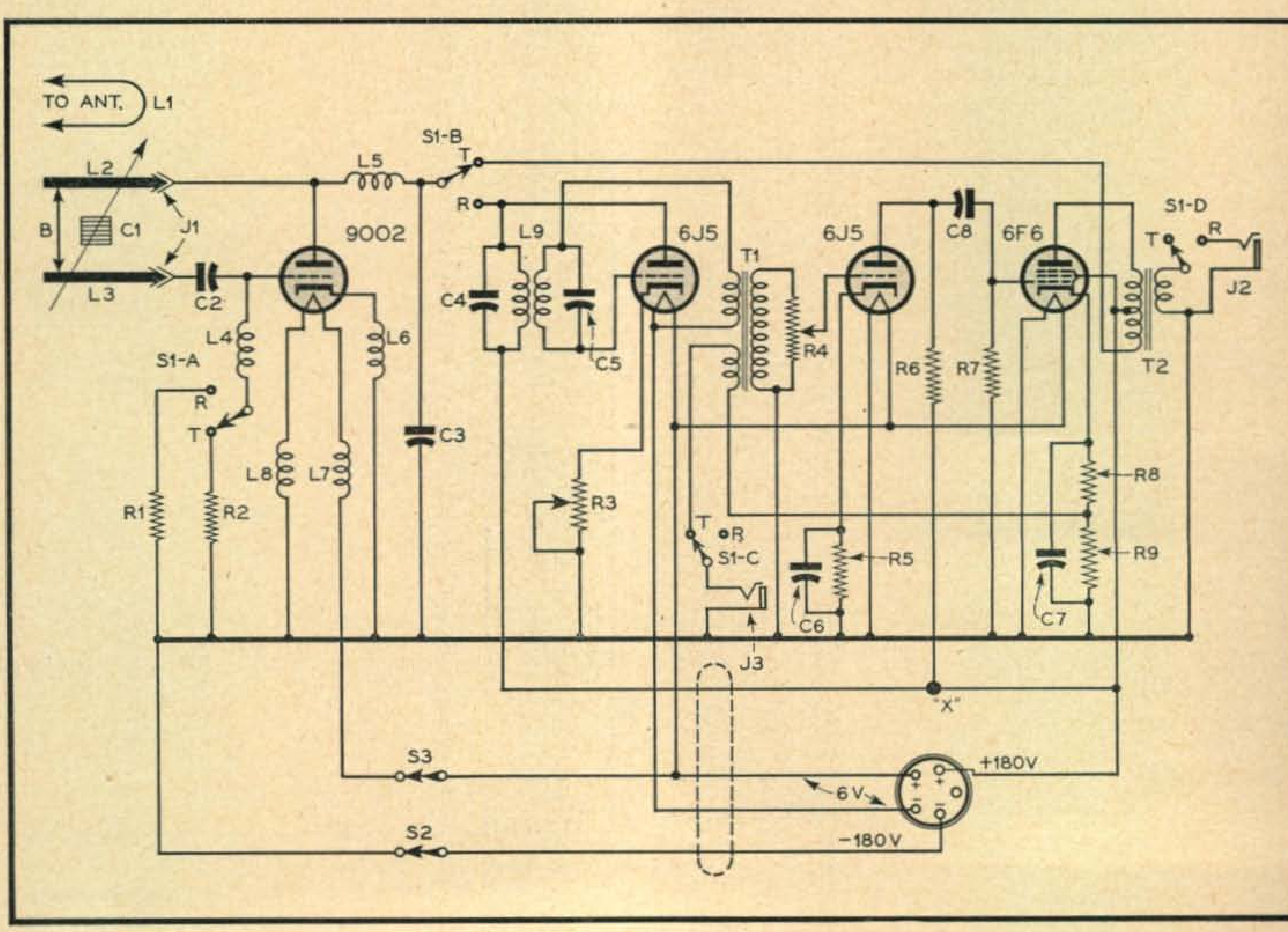
A 420-450 Megacycle TRANSCEIVER

J. D. POTTER, W3IKM

FEATURES IRON-CORE TUNING AND WILL COVER 224 AS WELL AS THE 460-470-MC CITIZEN'S RADIO BAND

WITH THE OPENING of the high-frequency amateur bands, it is probable that the experimentally-inclined amateur will concentrate his first serious efforts on the 420-450-mc sector which is practically adjacent to the proposed Citizens' Radio Service band of 460 to 470 megacycles. A transceiver (transmitter-receiver) covering both bands is a logical consideration, and the circuit of *Fig. 1* diagrams such a combination developed by the author.

Physical size has been limited to permit either portable-mobile or fixed-station operation. This transceiver will also operate on the 220-225-mc band with the same tank coil, by using the parallel rods as one-quarter wave on 224 mc and one-half wave on 448 megacycles. For operation in the CRS band, a half-wave tank, approximately ½″ shorter than the 448-mc tank, is employed. Experimentation proved the worth of Mykroy insulation in the high-frequency detector-oscil-



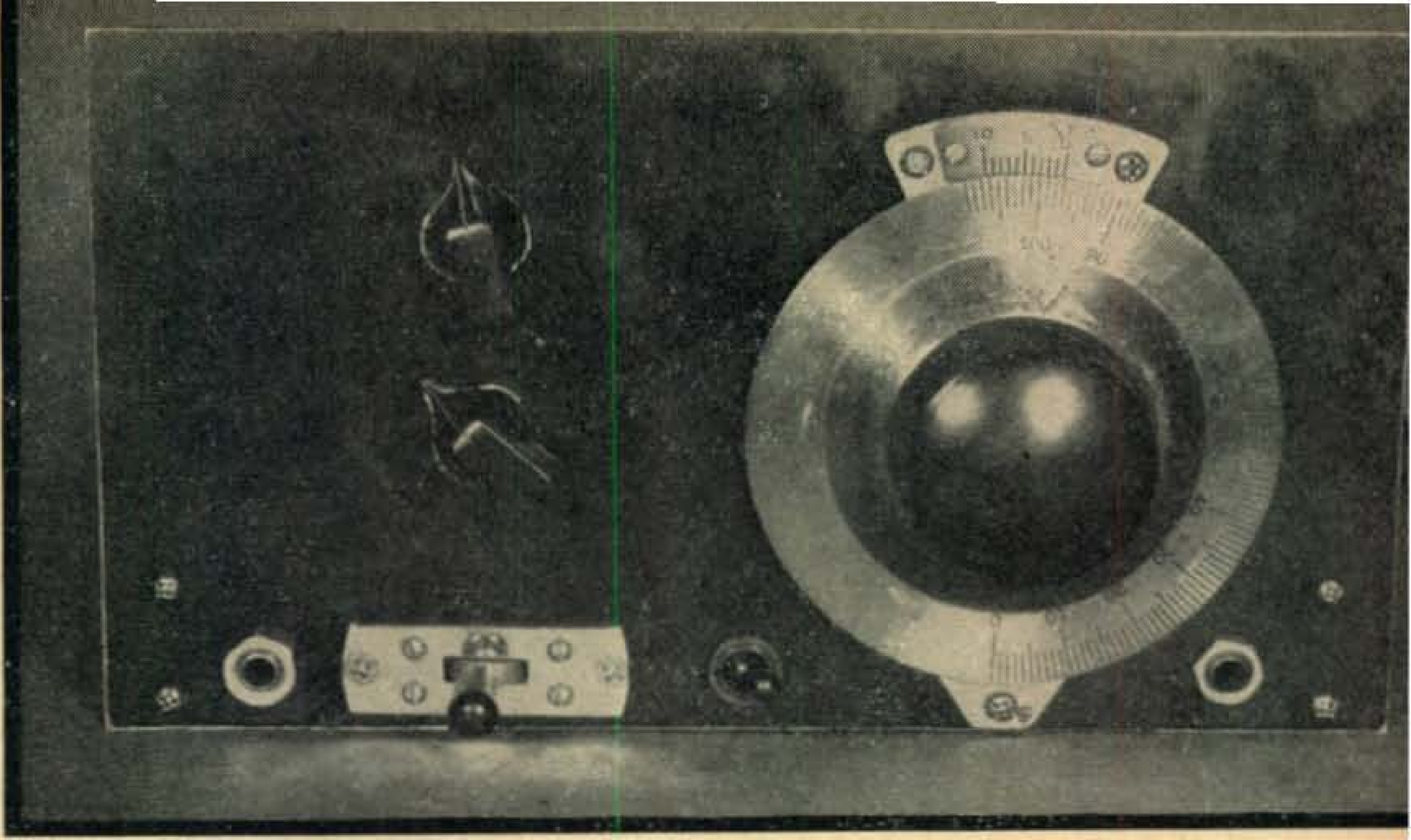


Fig. 2. Front view of the completed 450-mc transceiver showing panel arrangement

lator tank circuits. This material is easy to machine, and standard drilling practices may be used without gumming-up drills or dulling files and saws. Extremely satisfactory results have been obtained with Mykroy up to 600 megacycles in the rig described in this article.

The Circuit

The electrical design of this transceiver is shown in *Fig. 1*, and includes the following tube line-up: 9002 (oscillator-detector), 6J5 (interruption-frequency oscillator), 1st audio amplifier 6J5, and 6F6 (audio-output-modulator).

The 9002 detector-oscillator and the 6J5 interruption-frequency oscillator combination was adopted after numerous tests with acorn and other high-frequency tubes up to 600-mc. Self-quenched (super-regenerative) detectors were extremely erratic in operation and easily pulled out of oscillation when close antenna coupling was used. The 9002 was chosen after deciding to limit the upper operating frequency of this particular rig to 470 megacycles.

By using the 6J5 interruption-frequency oscillator resonant at 100 kc (this frequency is not critical and may be from 20 to 100 kc), and modulating the plate circuit of the 9002 when on the "receive" position, we obtain the same result as using a self-quenched super-regenerative detector without the disadvantages previously mentioned. In addition, the intensity of interruption-frequency oscillation may be controlled with potentiometer R_3 which adjusts the detector modulation for optimum reception conditions. The 9002-6J5 combination has been successfully used up to 600 mc in this transceiver. As shown in *Fig. 1*, the oscillator-detector tank circuit utilizes parallel rods equipped for plug-in operation. Four inch lengths of ¼" copper tubing are employed for both 224 and 448-mc operation.

Due to the effect of minor circuit changes on the parallel rod lengths it is impractical to state exact dimensions. However, it is imperative that accurate frequency be maintained and the line lengths precisely adjusted. The author has been using 5 foot Lecher wires for this purpose with

Fig. 1 (left). Getting a headstart on the 450-mc band! Parts as follows:

B—National Co. #8 grid clips (or equivalent) (see text)
C_1—iron-core plunger (see text)
C_2—10 μμf mica 400 volts
C_3—50 μμf mica 400 volts
C_4, C_5—2,500 μμf mica 400 volts
C_6, C_7—25 μf 25 volts d.c. electrolytic
C_8—.04 μf 600 volts paper
J_1—banana jacks and plugs
J_2, J_3—midget phone jacks
L_1, L_2, L_3—see text
L_4, L_5, L_6—50 T #34 D.C.C. ¼" dia. on polystyrene rod 7/8" long. Winding length 9/16"
L_7, L_8—27 T #20 D.C.C. 3/8" dia. on polystyrene rod 1¼" long. Winding length 1"
L_9—Meissner 175-kc osc. coil #14-3732 (or equivalent)
R_1—5.6 meg. ½ watt
R_2—18,000 ohms 1 watt
R_3/S_3—2,000 ohms pot. with switch
R_4—500,000 ohms pot.
R_5—2,000 ohms 1 watt
R_6—47,000 ohms 1 watt
R_7—470,000 ohms 1 watt
R_8—300 ohms 1 watt
R_9—100 ohms 1 watt
S_1—Federal "anti-capacity" key 4-pole double-throw #1424 (or equivalent)
S_2—toggle switch s.p.s.t.
S_3—see R_3/S_3
T_1—transceiver transformer Stancor #A-3833 (or equivalent)
T_2—universal output transformer
X—National Co. insulator #GS-10 (or equivalent)

excellent results. Possibly the simplest formula for practical operation is $F\text{mc} = 5906/\text{inches}$, which is easily applied by measuring the length (inches) of the standing half-waves on the Lecher wires and dividing into 5906 to obtain the operating frequency in megacycles. When properly coupled to the detector tank circuit, the Lecher wires will cause a noticeable drop in superregen hiss at each half-wavelength shorted out on the line.

Tuning

Frequency variation (tuning) was the major problem which confronted the author during preliminary experiments. Condensers or a variable shorting bar proved noisy or erratic in operation. The polyiron plunger tuning developed after much experimentation, works admirably and is easily constructed. As the plunger (shown in the photographs) is grounded and has no electrical connection to the tank circuit, the tuning is smooth and noiseless. When the polyiron plunger is engaged into the parallel rods, the capacity between the rods and the polyiron plunger increases. This effectively shortens the electrical length of the rods and raises the operating frequency. At 450 megacycles the frequency coverage is approximately 10 mc between the fully engaged and fully disengaged positions of the plunger. On 224 the plunger varies the frequency approximately 4 megacycles.

Mcehanical difficulties commonly experienced when using series-fed parallel rods have been eliminated by the use of shunt-fed plate and grid circuits. All tube elements in the detector-oscillator section are isolated by r-f chokes, mounted with the shortest possible connections. The interruption-frequency oscillator tank coil is a 175-kc i-f oscillator (Meissner #14-3732), shunted with two .0025 μf condensers to lower the operating frequency to around 100 kilocycles. Fixed capacitors across the primary and secondary of this coil eliminate variable condenser adjustments. The audio output of the detector circuit is obtained from the ground side of the interruption-frequency oscillator coil. This avoids the coupling condenser and r-f choke necessary if the output were taken from the plate inter-connecting line running between the 9002 and the 6J5 interrupter tube.

The balance of the circuit is conventional. The four-pole-double-throw "receive-transmit" switch (Federal anti-capacity No. 1424 or equivalent) is wired to receive at the left position. When operating on "transmit" (to the right) the 6F6 plate modulates the 9002 oscillator tube. The power supply must provide 6 a-c volts and 180-200 volts d.c. It is recommended that a voltage-regulated power pack be used to maintain frequency stability.

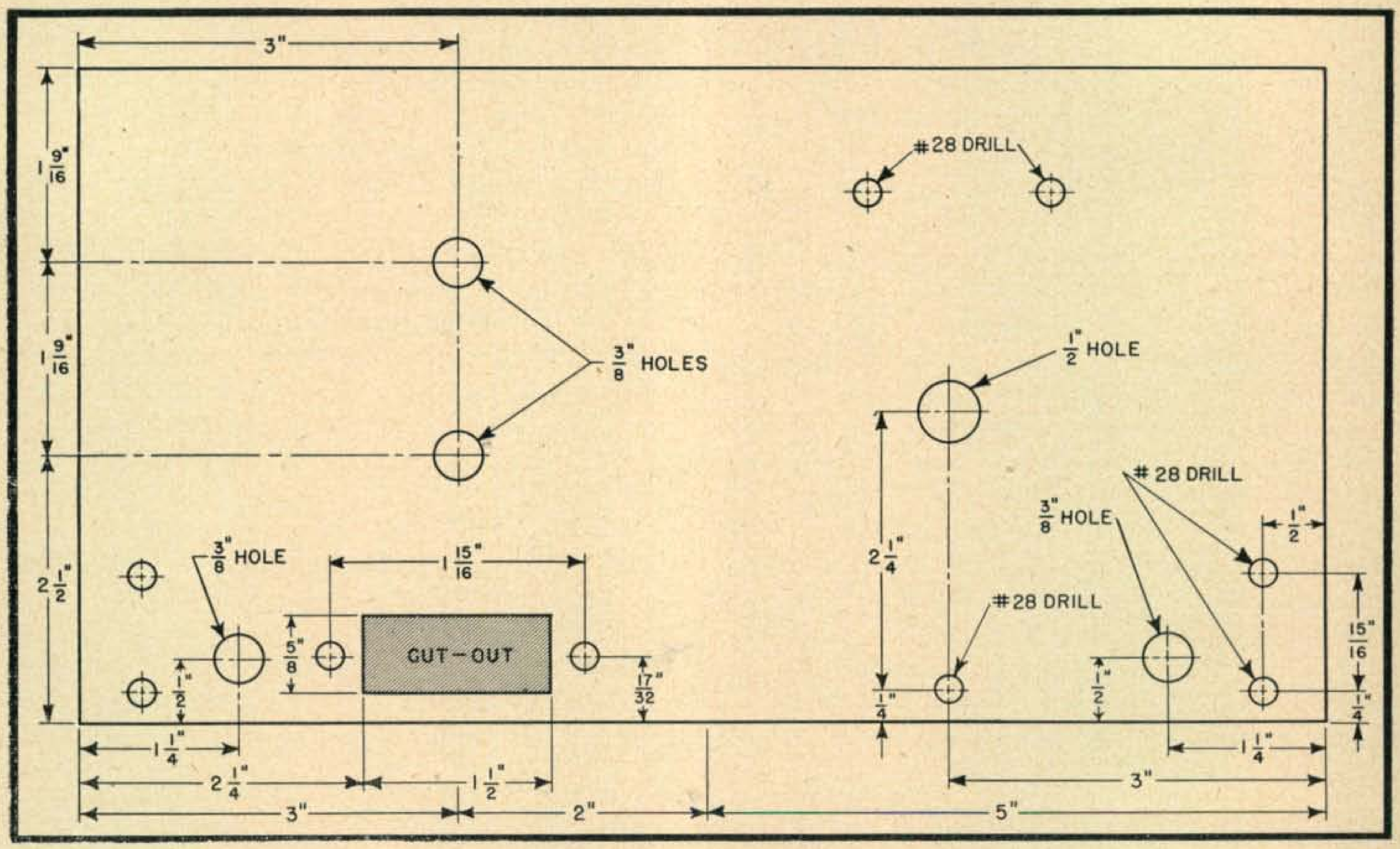
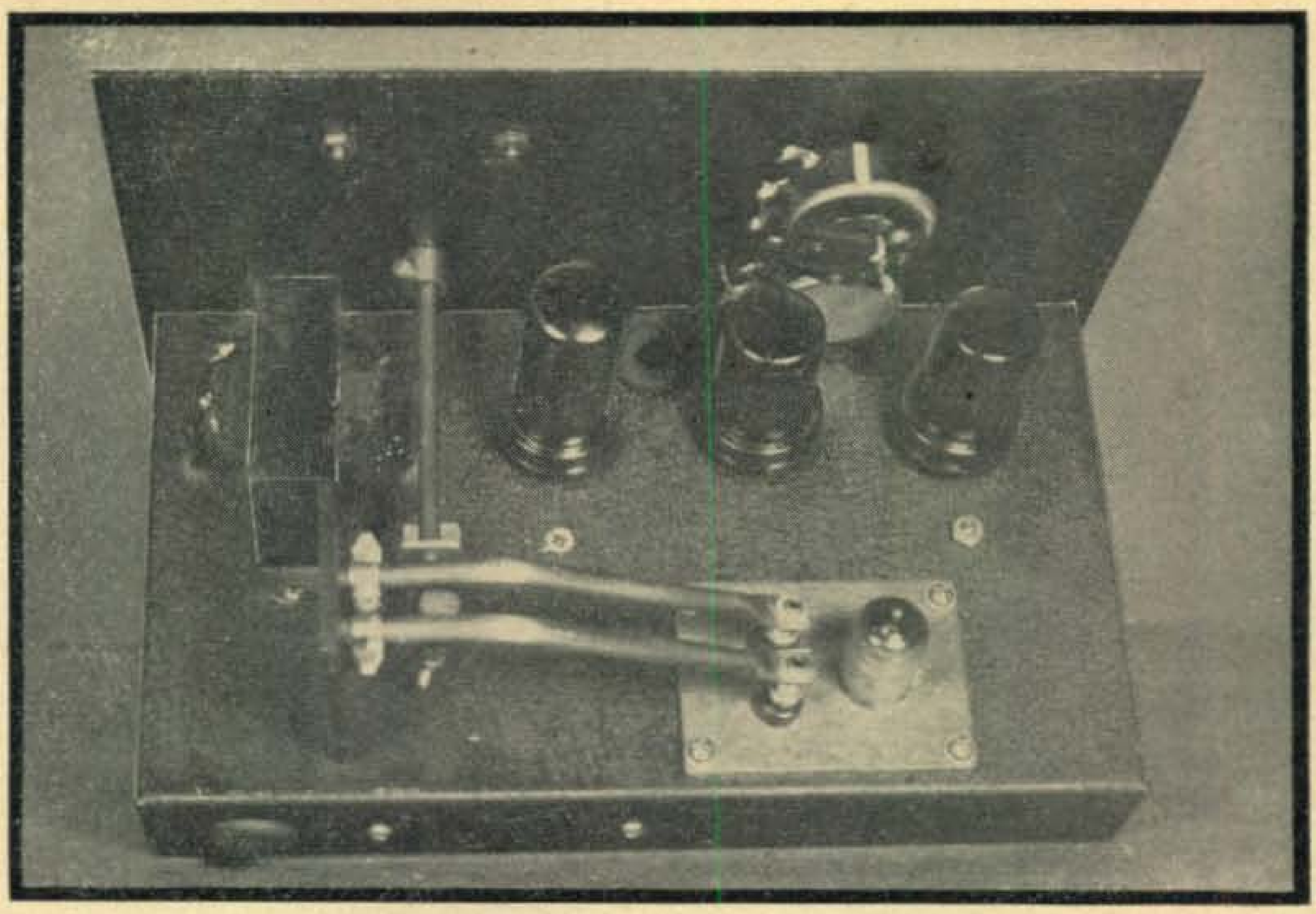


Fig. 3. Drilling template for the front panel

Mechanical Lay-out

The front view and panel lay-out (*Figs. 2* and *3*) show the locations of the microphone jack,

Fig. 4. Top view of the microwave transmitter-receiver, with shorting bar on the tank "coil" for 224-megacycle operation



receive-transmit switch, stand-by switch, headphone jack, volume control, interruption-frequency intensity control and tuning dial. The 6J5 interruption intensity control (cathode biasing) is located immediately above the volume control, which is over the receive-transmit switch. The entire panel has been designed with two main objectives—first to permit placing the r-f section toward the rear of the set, thus eliminating hand capacity, etc. Secondly, the controls have been grouped so that there is a minimum of lost motion in operating. The National Type N dial was used to provide a definite positioning device for the polyiron plunger, which is off-set from the tuning shaft. Other dials can be used, but a locking device must be incorporated to prevent the off-balance plunger from swinging the dial from set position.

The chassis as viewed from the top (*Fig. 4*) shows the parts locations with the output transformer (L_{10}), dial shaft, supporting bracket, 6F6 and the 6J5s to the front. The tank coil and 9002 detector-oscillator assembly are grouped at the rear of the chassis. The volume and interruption intensity controls are mounted on the panel. The wires to these controls are grouped and run together through a 5/16″ rubber grommet in the top of the chassis. The power cable, which is terminated in an octal male plug, is routed through another 5/16″ grommet located on the right rear edge of the chassis.

Subpanel Layouts

The bottom view of the chassis, *Fig. 5*, reveals the compactness and lack of hay-wire that has

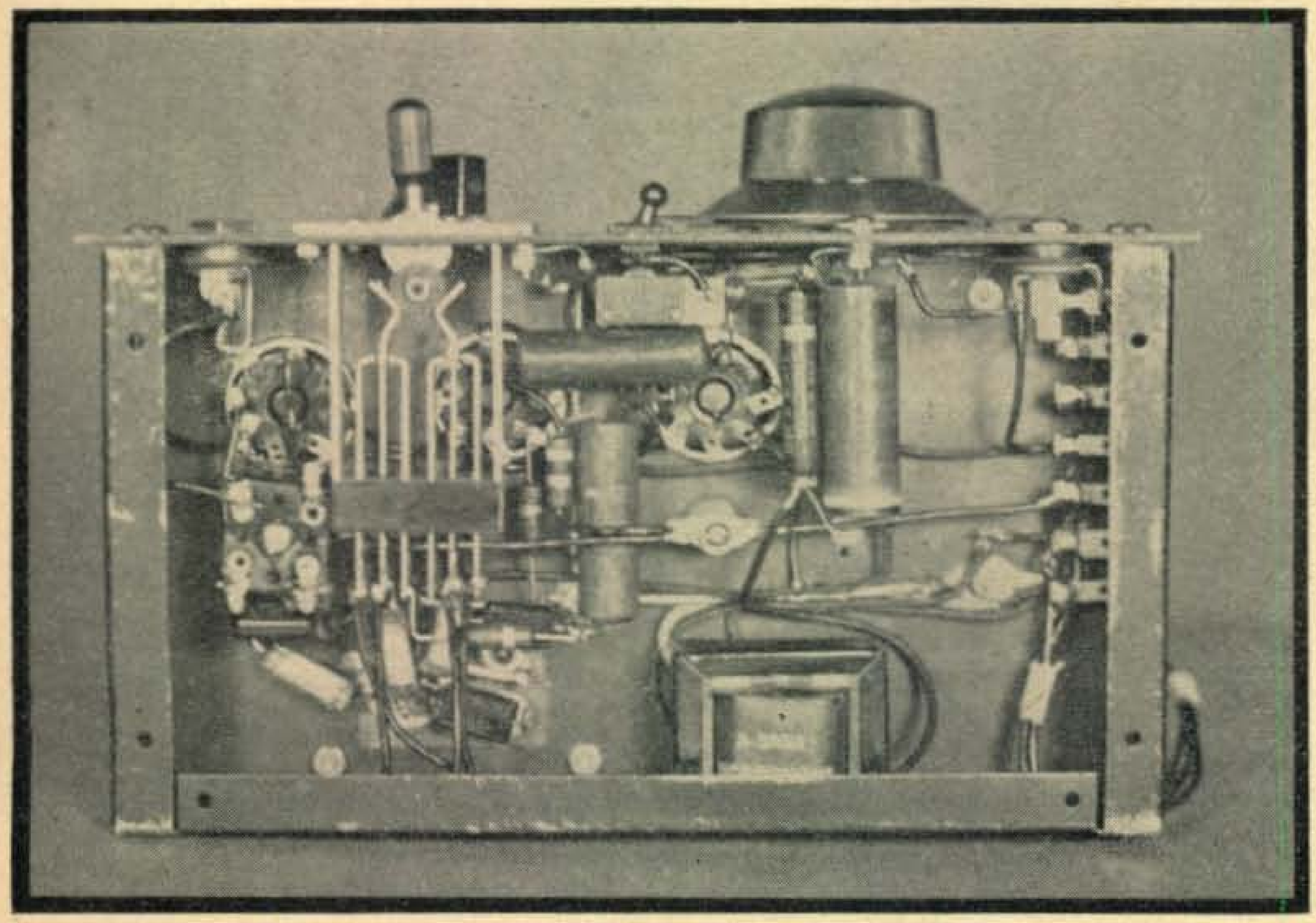


Fig. 5. Sub-chassis detail. The chassis is a Middletown product—#BS-591 (or equivalent)

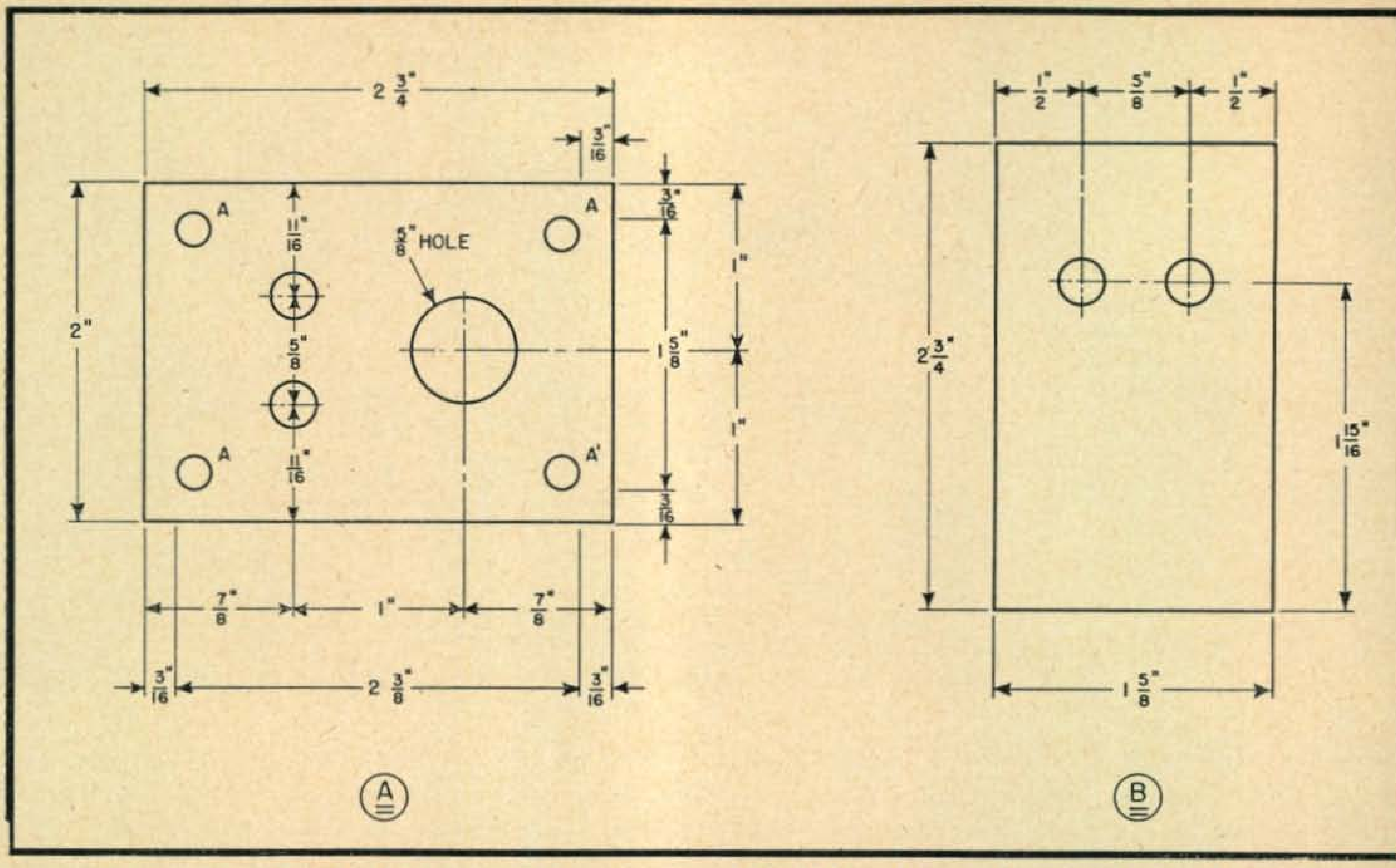


Fig. 6. Details of the detector-oscillator mounting plate (A) and the tank supporting insulator (B). Both are made of Mykroy

been attained by the proper placement of parts. The detector-oscillator mounting plate assembly has been located at the rear of the chassis in direct line with the receive-transmit switch. Soldered connections between this switch and the det.-osc. circuits are short and direct. All r-f chokes are soldered directly to the 9002 tube socket, the function switch or ground connections, and are self-supporting. The single-hole-mounting, 100-kc interruption-oscillator coil is

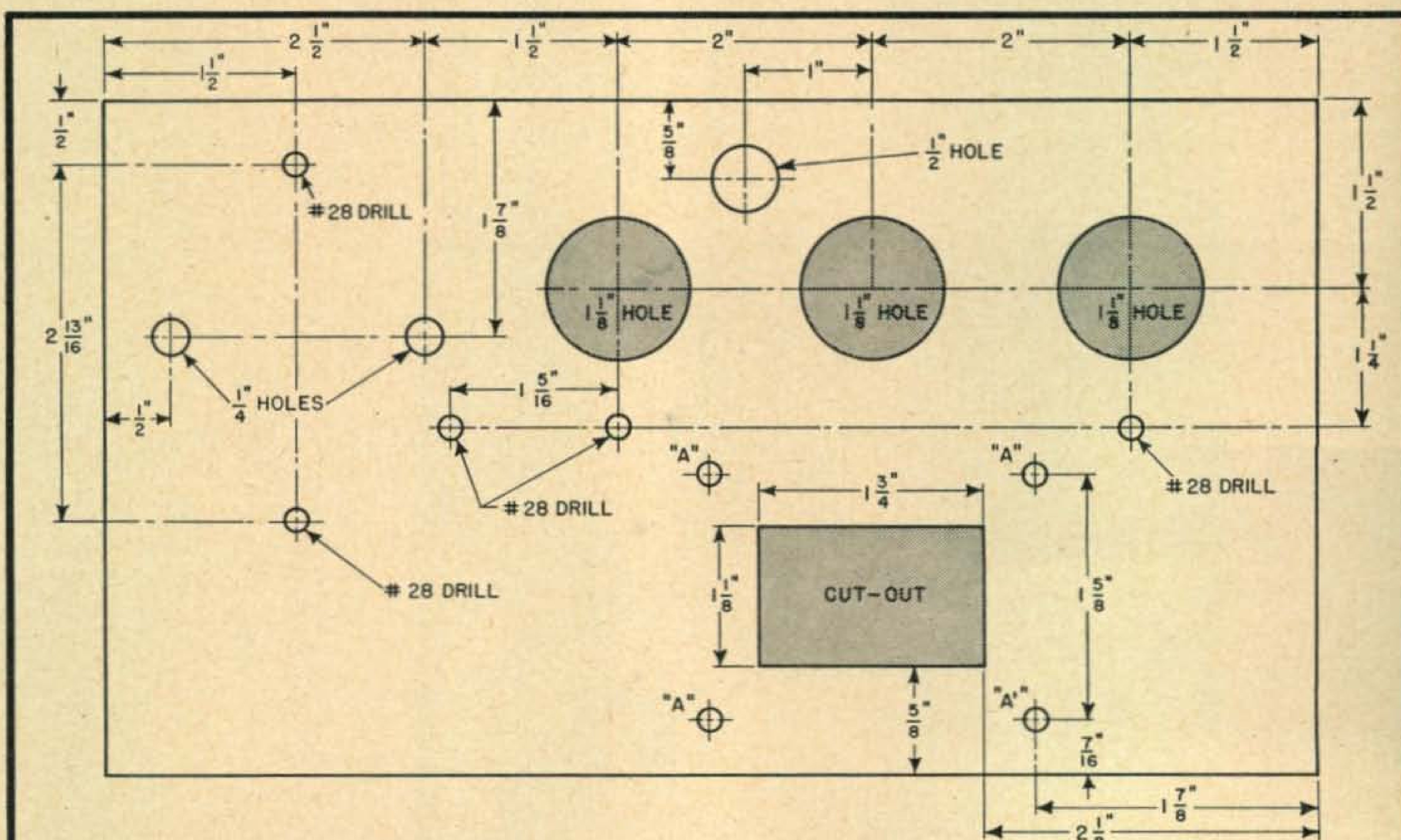


Fig. 7. Drilling template for the chassis which accommodates three Amphenol #78-58 sockets (or equivalent). The fourth socket, Amphenol #54-7P, (or equivalent), mounts on the Mykroy plate over the cut-out

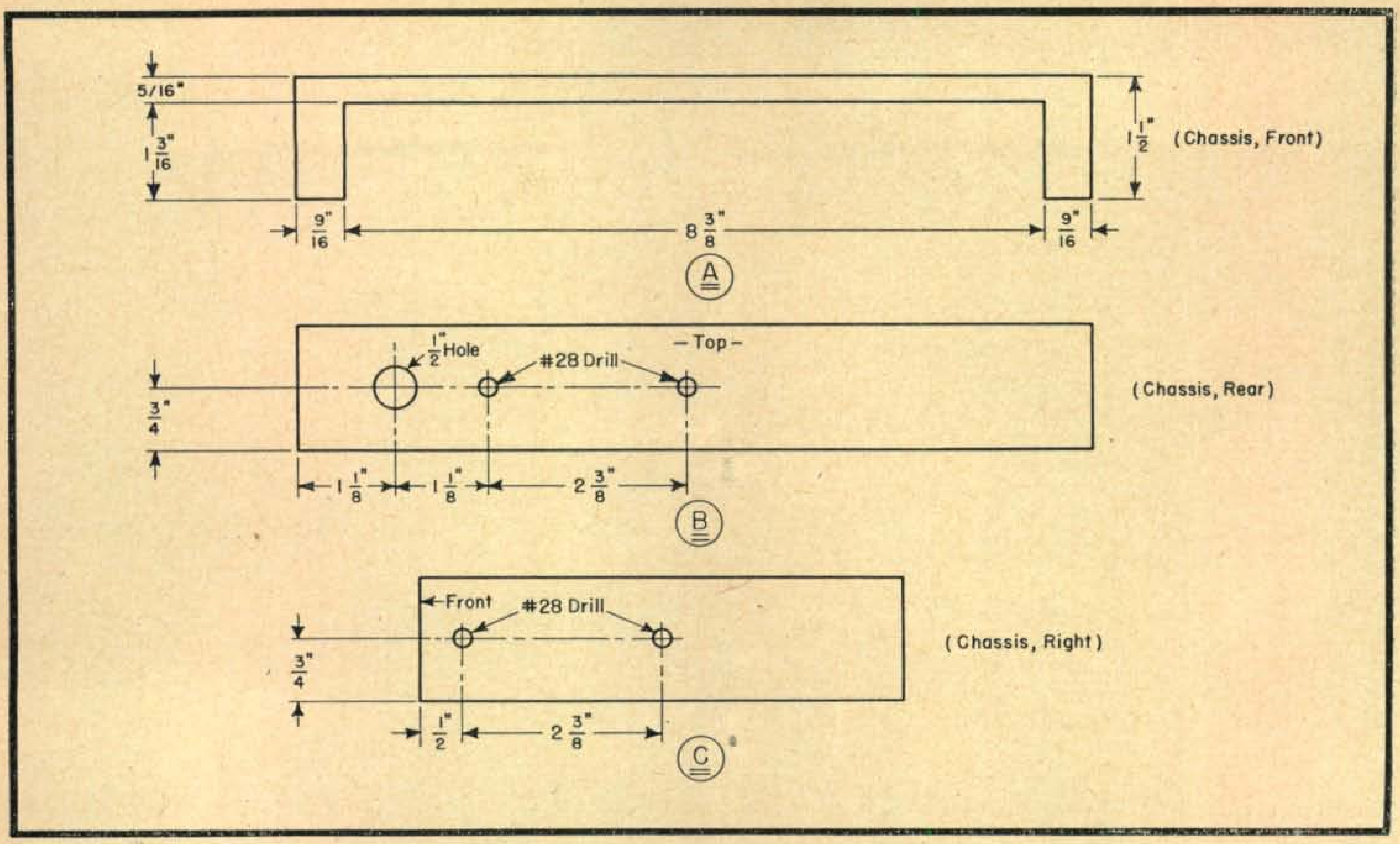


Fig. 8. Edge details for chassis cut-out and drilling

located in the center of the left-hand side of the chassis immediately next to the function switch. The detector-oscillator filament r-f chokes are located between the chassis and this switch. Grid, plate, and cathode chokes are grouped around the rear of the function switch. The 1st audio amplifier plate and cathode parts (R_5, R_6 and C_6) are to the right of the receive-transmit switch and between the tube sockets of the 6J5

[*Continued on page 38*]

Fig. 10. A professional-looking rig! Rear view shows how the tank rods are bent, and the mounting of the powdered iron frequency control

Post-War

By the CQ STAFF

[*Photographs by Robert Cobaugh, W2DTE*]

(Above) Two Presidents and a Chief Engineer at the NSRC festivities. S. A. Barone, Chief Engineer, Press Wireless (ex-2WO,) and Presidents Bailey (ARRL) and DiBlasi (NSRC).

(Right) At the North Shore Radio Club hamfest — left to right: Lieut. Leon A. Hansen, W2FIT, Sec'y. NSRC, John DiBlasi, W2LKC, Pres., George Bailey, W1KH, Pres. American Radio Relay League, Lt. Col. David Talley, W2PF-WLNA, Kurt Schoenfeld, W2BT, Treas. NSRC, and Milton Thompson, W2AYC, Vice President.

HAMFESTS ARE part and parcel of amateur radio, and over four hundred amateurs were on hand for the first such gathering since the end of World War Two and resumption of limited ham activity. Whether the North Shore Radio Club (L.I., N. Y.), sponsors of the affair, had advance information from General MacArthur or not, they couldn't have timed it any better—7:30 P.M., August 24th, 1945.

Normally there are so many of these meetings every year that it would be impossible to write about them all. But many readers of CQ have never even heard of this phase of amateur radio. Whether you call it a convention or hamfest, it's a get-together of amateurs—an opportunity to see and meet in person a lot of the fellows you have worked on the air. The individual programs vary. In general they provide entertainment, several or more prominent amateur speakers, eats and invariably the "door prizes."

Prizes Plentiful

Door prizes are distributed on the basis of numbered ticket stubs, or some other impartial method of selection. They range from standoff insulators to complete receivers. The ladies aren't forgotten either, although many a surprised OM has walked away with a pair of Nylons in days gone by! Usually the prizes are donated by radio dealers and parts manufacturers, but John DiBlasi, W2LKC, old timer and President of the North Shore Radio Club, hit upon a different idea—that of selling space in their souvenir program. The money realized from the programs paid for the 63 door prizes, ranging in value from $2.50 to $7.00 each. No expensive prize was given, on the assumption that the more prizes the fewer disappointed hams.

The North Shore Radio Club hamfest, held in Queens Village, Long Island, was a strictly informal affair—as are most hamfests. Some form of reorientation was needed after so long a break in the series of these get-togethers. Old acquaintances were renewed with fill-ins on four years of inactivity liberally exchanged. The principal speaker, George Bailey, W1KH, President of the American Radio Relay League, made a special trip from Washington to attend the meeting, and was introduced by John DiBlasi, Master of Ceremonies.

While it was already generally known that the FCC had permitted resumption of amateur activity on 2½, Mr. Bailey was able to confirm this officially. It was the first hamfest for W1KH since 1940. Mr. Bailey stated that due to the outstanding record of amateurs during

Hamfestivities

THE NORTH SHORE RADIO CLUB ON LONG ISLAND LEADS THE PARADE

the war, both in and out of uniform, the government had taken this unprecedented action of permitting limited activity without renewal of licenses. It was stressed that we carefully watch the 112-115.5-mc limits of our temporary assignment, because of the very important airport control service on 116.1 megacycles.

Amateurs have been assured that their bands will be reopened just as soon as they are vacated by the military and other wartime services. An extremely interesting point was brought out during Mr. Bailey's talk, concerning the apportionment of phone and c.w. channels in the respective amateur bands. It will be the democratic policy of the FCC to let the hams themselves decide what they want to do in this respect. Mr. Bailey said that the FCC has tremendous confidence in the amateur organization, because, in that black day in our history, December 7, 1941, the amateurs were off the air within 20 minutes of the FCC order. In general, the comments of Mr. Bailey were most optimistic. While he would not commit himself on what action is planned after November 1st, when FCC order number 127 expires, it is possible that additional bands may be opened for amateur operating at that time.

Lt. Col. Dave Talley, W2PF-WLNA, made a brief address in which he stressed the value of the AARS (Army Amateur Radio System). In addition, Colonel Talley remarked on the differences in attitudes between the English and American hams. The English amateur is somewhat more scientific about his work. The influence of the Ws is being increasingly felt in the United Kingdom, and the good will that can be created by proper use of our international DX bands was a point in Talley's informal chat.

Two splendid war pictures were shown, one dealing with the extraordinary capture of a German U boat intact, while the other featured many heretofore restricted combat shorts, including some captured from the Germans. Removed from fighter aircraft "camera guns," these shots were a sobering reminder that the

[Continued on page 43]

The YLs properly segregated and tabled at the North Shore Radio Club hamfest

RADIO AMATEUR'S WORKSHEET

No. 6 FM DISCRIMINATORS

A SINUSOIDAL WAVE may be modulated by operating on its amplitude, its phase, or its frequency. In amplitude modulation the instantaneous amplitude of the carrier is at all times proportional to the instantaneous amplitude of the modulating signal. Likewise in phase modulation, the phase of the modulated carrier is at all times proportional to the instantaneous amplitude of the modulating signal, the amplitude of the carrier wave not being altered in the modulation process. In frequency modulation the instantaneous amplitude of the signal current is employed to vary the instantaneous frequency of the carrier, while the amplitude remains constant.

Amplitude modulation results in side frequencies or sidebands on either side of the carrier displaced from it by an amount equal to the frequency of the modulating signal. Thus a one megacycle carrier modulated by a one kilocycle signal yields side frequencies of 999 kilocycles and 1001 kilocycles. In phase and frequency modulation there are many side frequencies for each modulating signal frequency and as in amplitude modulation they are symmetrically disposed on either side of the carrier. Hence the wide band of phase and frequency modulation compared to amplitude modulation. This is illustrated in *Figs. 1, 2,* and *3*. *Fig. 1* shows the disposition of the sidebands in an amplitude modulated wave. If the frequency of the modulating frequency is doubled, the side frequencies are displaced from the carrier by twice the frequency, but there are only two side frequencies for each modulating frequency.

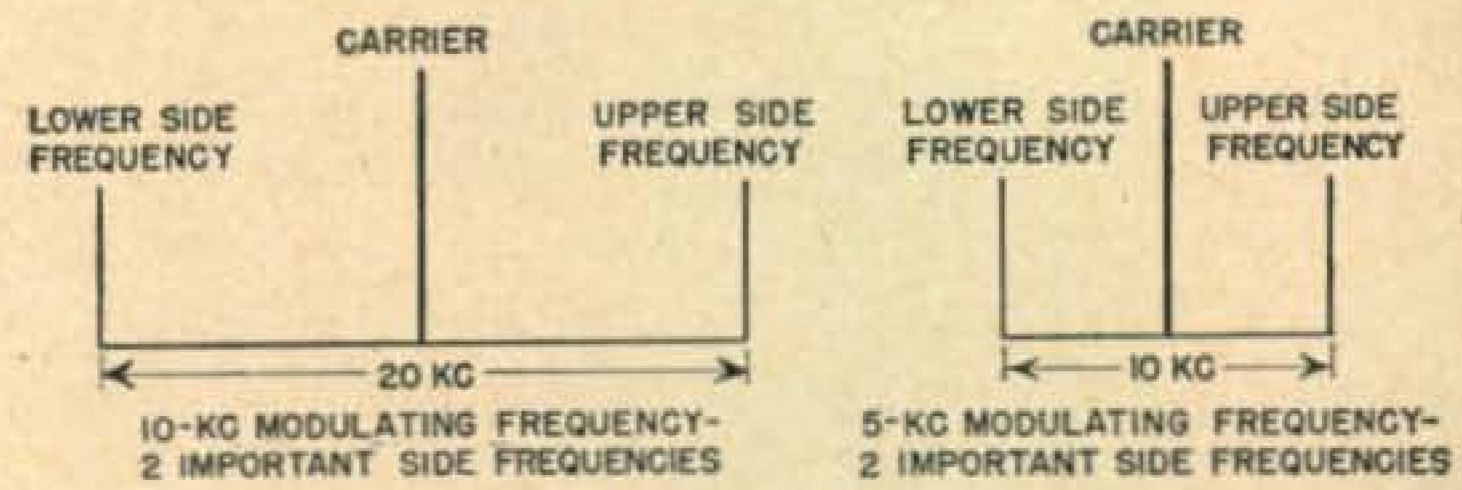


Figure 1

In a phase modulated wave, there are theoretically an infinite number of side frequencies, even though only one modulating frequency is used. Actually, as shown in *Fig. 2,* there are about 16 important energy bearing side frequencies for every modulating frequency. The

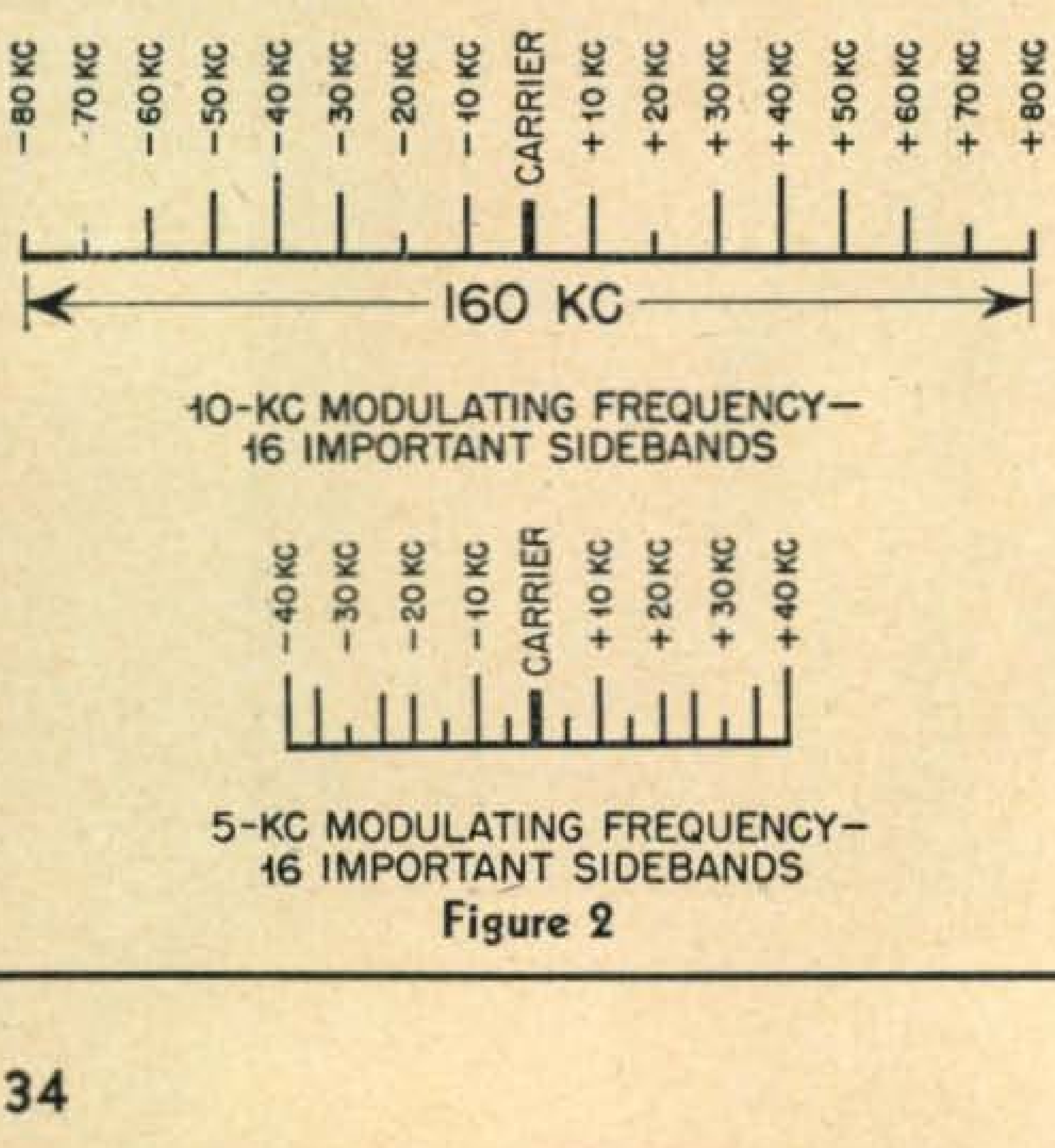


Figure 2

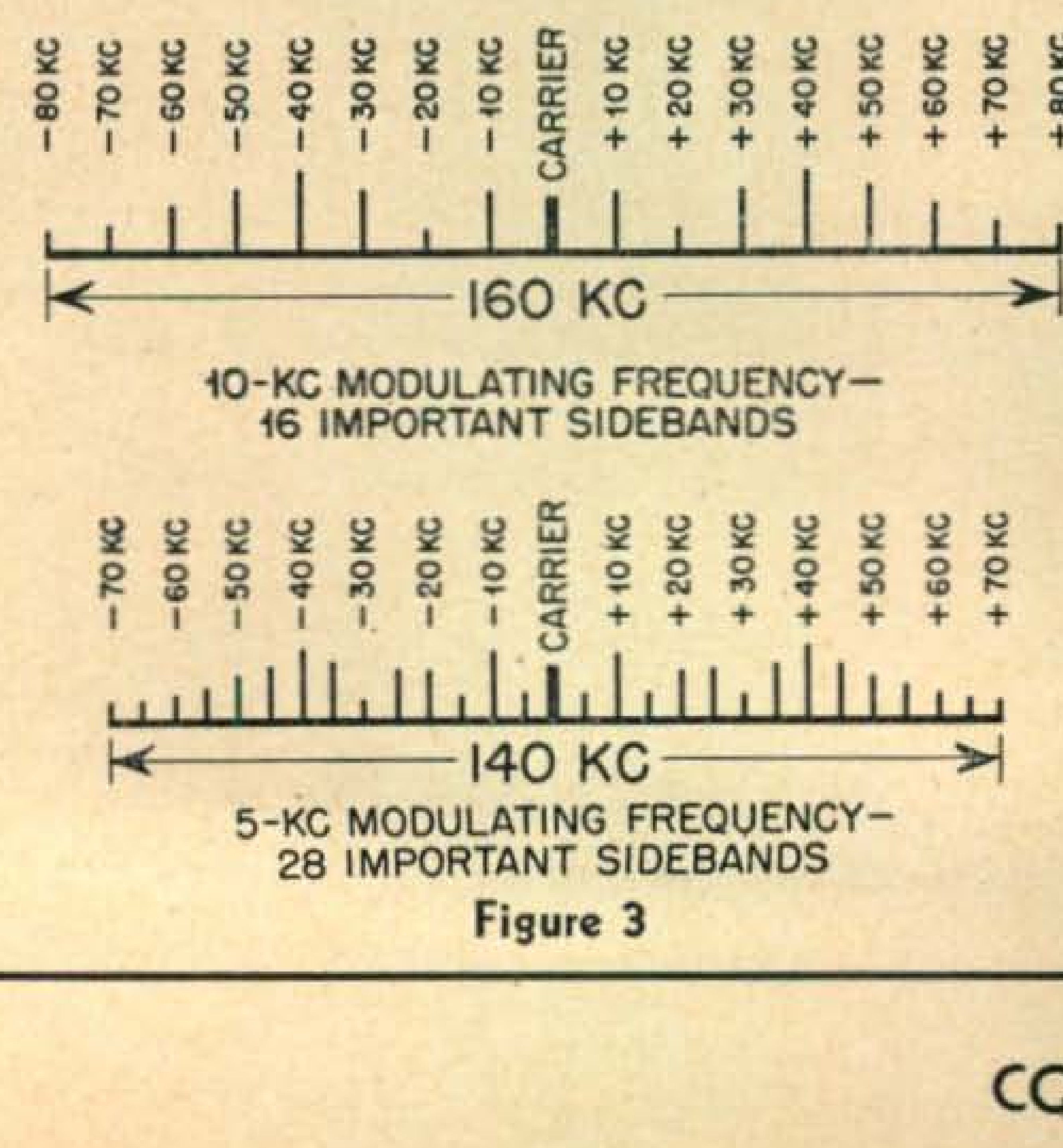
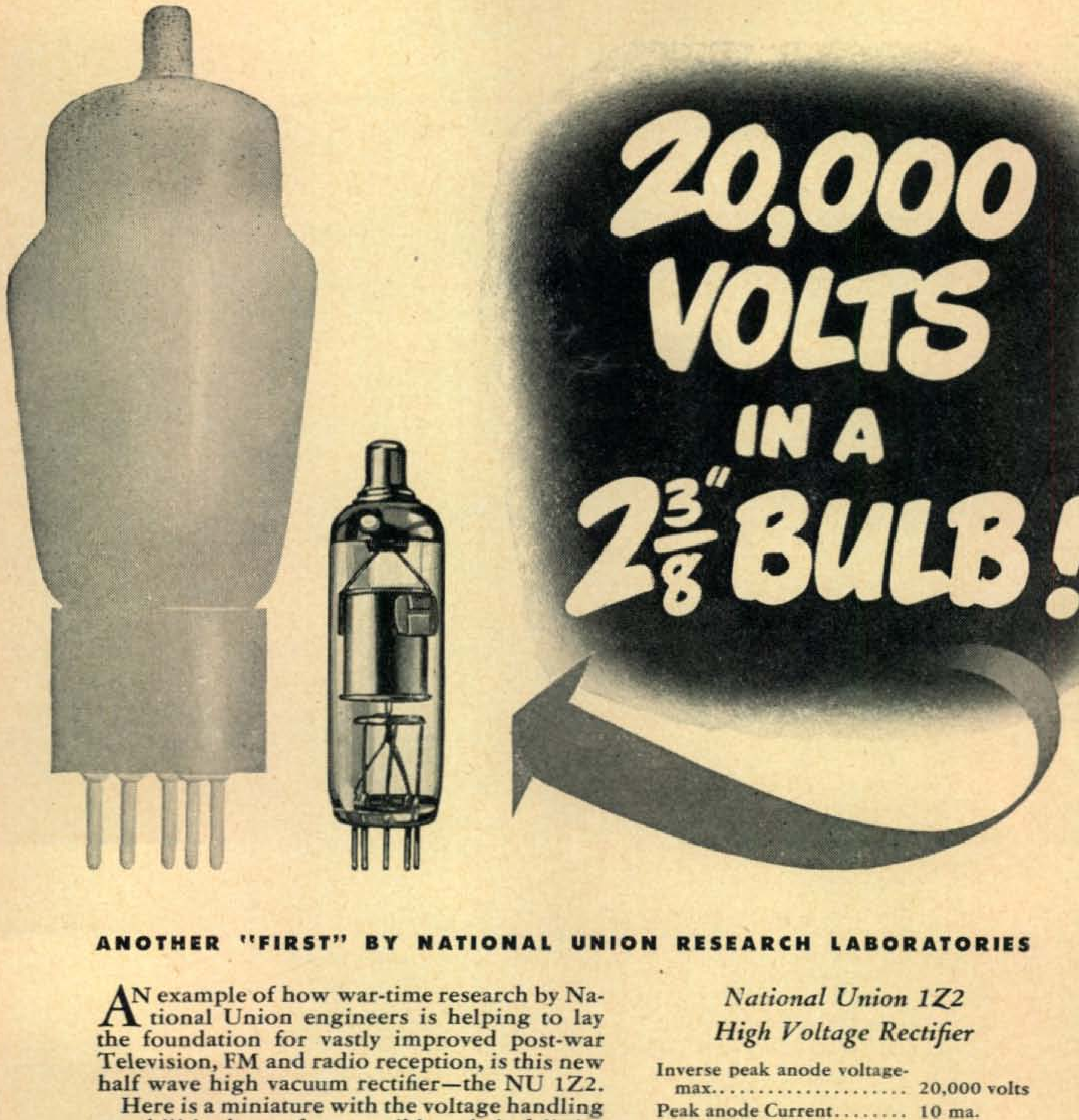


Figure 3



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AN example of how war-time research by National Union engineers is helping to lay the foundation for vastly improved post-war Television, FM and radio reception, is this new half wave high vacuum rectifier—the NU 1Z2.

Here is a miniature with the voltage handling capabilities heretofore possible only in full size tubes. For a high voltage rectified supply in the operation of radar and television equipment, the NU 1Z2 saves space—operates with increased efficiency—is exceptionally rugged. Its low filament power consumption suggests many new fields in circuit design and application, especially to the "ham" and experimenter.

For the distributor and service dealer, such original N. U. electron tube developments are creating new opportunities for profitable N. U. Tube replacement sales—today and in the future.

National Union 1Z2
High Voltage Rectifier

Inverse peak anode voltage-max.	20,000 volts
Peak anode Current	10 ma.
DC Output Current	2 ma.
Filament Voltage	1.5 volts
Filament Current	300 ma.

The NU 1Z2 is designed to withstand shocks in excess of 500 G's.

Maximum overall length	2.70"
Maximum seated height	2.37"
Maximum diameter	.75"
Bulb	T5½
Base Miniature Button	7 pin
Mounting position	Any

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number of important energy-bearing side frequencies is independent of the actual frequency of the modulating signal, as is the case with amplitude modulation. It will be observed also, as in the case of amplitude modulation, that the bandwidth is proportional to the frequency of the modulating signal. That is, an 80 kc band is required for a 5 kc modulating signal and 160 kc bandwith is required for a 10 kc modulating signal.

Fig. 3 illustrates the important energy bearing side frequencies in a frequency modulated wave and their symmetrical distribution about the carrier. In this case, the number of important side frequencies does depend on the frequency of the modulating signal. Moreover, the bandwidth is no longer proportional to the frequency of the modulating signal. Almost as wide a band is required for a 5 kc modulating signal (140 kc) as for a 10 kc modulating signal (160 kc). It is also pertinent that there are 16 important energy bearing side frequencies for the 10 kc modulating signal against 28 important energy bearing side frequencies for a 5 kc modulating signal.

In both phase and frequency modulation, the phase of the carrier frequency is displaced 90 electrical degrees (phase quadrature) from the carrier in an amplitude modulated wave, relative to the side frequencies. Hence, if the phase or frequency modulated wave is applied to an ordinary detector, no detection occurs. This is important, since amplitude modulated noise is not detected in a phase or frequency modulated system. If the phase of the carrier in an amplitude modulated wave is shifted from its normal position with respect to the sidebands, the output from an ordinary detector would decrease until the phase of the carrier had been shifted 90 electrical degrees, at which point the detector output would be zero. Beyond 90 degrees, the detector output would increase and again be a maximum at 180 electrical degrees.

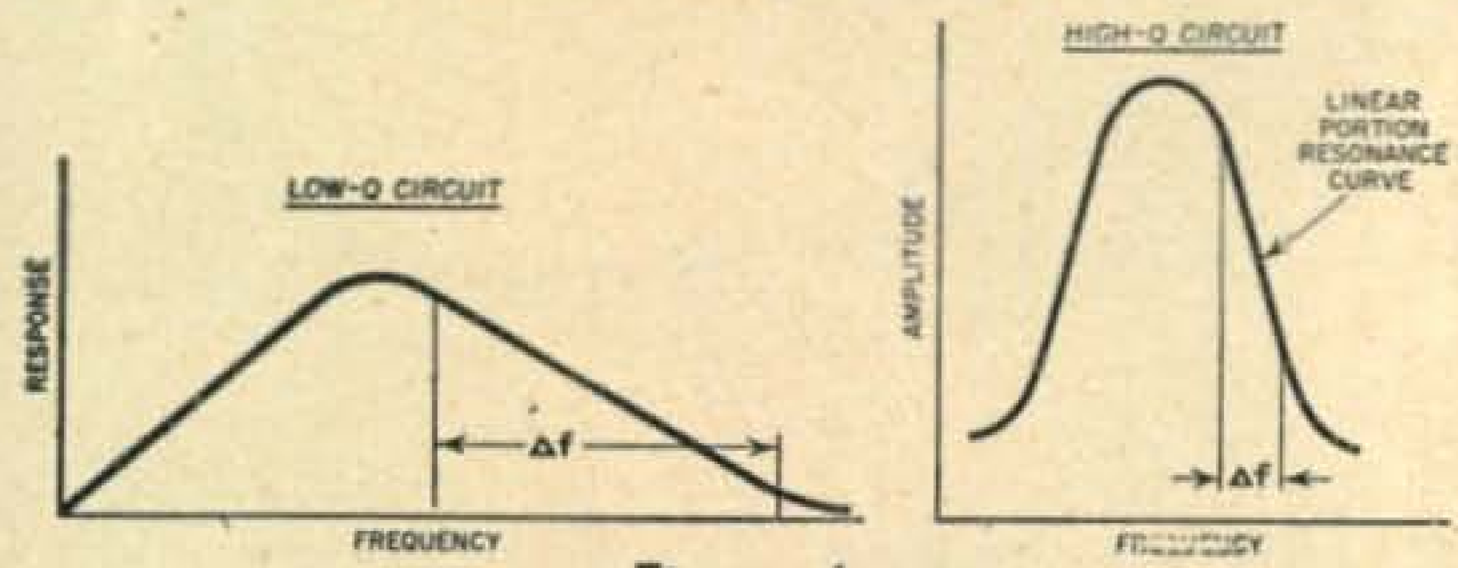

Figure 4

In most frequency modulation receivers, it is customary to convert the frequency variations to amplitude modulation before detection. This is accomplished by the discriminator. Perhaps the simplest method of converting frequency variation to amplitude variations is by detuning the tuned circuit immediately preceding the detector. This method is seldom used, however, because it has severe limitations. If a frequency modulated wave is applied to the side of a high "Q" tuned circuit as in *Fig. 4*, the amplitude variations are not directly proportional to the frequency variations, thus introducing nonlinear distortion. This is due to the fact that the resonance curve is not linear over any appreciable frequency band. This can be corrected by reducing the "Q" of the tuned circuit so that the side of the resonance curve is more nearly linear, but this in turn reduces the conversion efficiency.

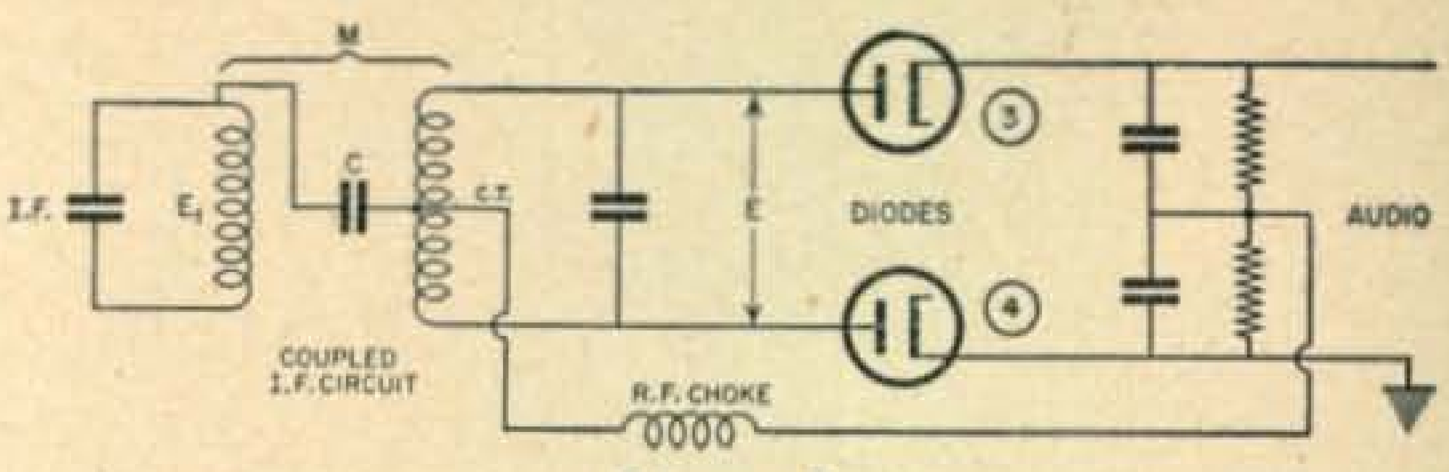

Figure 5

Fig. 5 illustrates a conventional frequency modulation discriminator. The primary of the last intermediate frequency transformer is coupled to the electrical center of the secondary by capacitor *C*. Ordinarily the electromagnetic coupling in this transformer is less than critical coupling. The primary voltage is thereby added vectorially to one-half of the secondary voltage applied to the diodes. Since the primary and secondary voltages differ in phase by 90 electrical degrees, the vector diagram of this condition is shown in *Fig. 6a*. As a result of the vector addition E_4 is applied to one diode in *Fig. 5* and E_3 to the other. The diodes of *Fig. 5* are connected differentially so that the audio voltages in the diode outputs are subtractive. *Fig. 6a* illustrates the condition at resonance. *Figs. 6b* and *6c* show the vector diagrams when the carrier swings below and above resonance respectively. When the carrier swings above or below resonance, the phase of the i-f transformer primary and secondary voltages no longer differ by 90 electrical degrees, as was the case in *Fig. 6a*.

It is thus evident from *Figs. 6b* and *6c* that the audio output will vary in magnitude in accordance with the frequency swings of the frequency modulated signal. Thus the frequency variations are converted efficiently to amplitude variations. Direct proportionality (or linearity) between frequency variations and amplitude variations is extremely important for high fidelity. This is obtained by proper adjustment of coupling in the i-f transformer and proper choice of intermediate frequency.

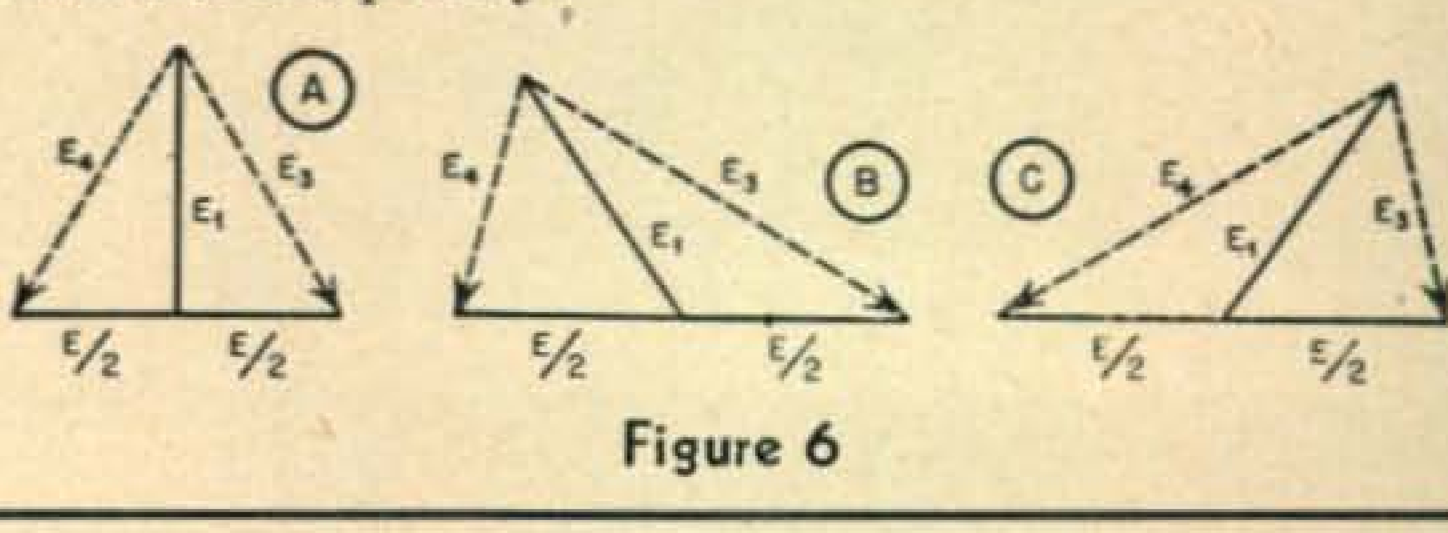

Figure 6

"VOMAX"

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"VOMAX" handles a wide range of d.c. and a.c. voltages at meter resistance so astronomically high that you can measure directly and accurately every such voltage. It goes far beyond conventional volt-ohm-ma-meters. For "VOMAX" will measure ***every*** a.f., i.f. and r.f. voltage from 20 cycles right up to beyond 100 megacycles.

This remarkable post-war instrument gives you vitally important visual dynamic signal tracing. Read the briefed specifications at right . . . practically a complete service station by itself . . . see how "VOMAX" makes you the master, no longer the victim, of tough service jobs. Imagine the time you'll save, the increased efficiency, the multiplication of your profits when you put "VOMAX" to work and can at last measure ***every*** voltage.

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3. Complete visual 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 51, and in 6 added ranges to 3000 volts at 126 megohms input resistance. Plus-minus polarity reversing switch.
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: ±3% on d.c.; ±5% on a.c.; 20∽ through 100 megacycles; ±2% of full scale, ±1% of indicated resistance value.
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TRANSCEIVER

[*From page 31*]

and 6F6 amplifier stages. A 3/4″ Isolantite stand-off insulator (or equivalent) located centrally on the bottom of the chassis is a common distribution point for B+ circuits. The 6F6 cathode bias and microphone voltage divider components are placed to the right of the output-modulator tube socket. A seven-stud terminal strip, mounted on the right-hand edge of the chassis, connects with the power supply cable. The microphone transformer is located on the rear of the chassis.

Constructional Notes

For those desiring to duplicate this transceiver the following constructional sequence is suggested:

1.—Cut the detector-oscillator mounting plate and the tank coil support from 1/8″ sheet Mykroy as indicated in *Fig. 6*, A and B respectively. Jig-drill the "A" holes in the top of the chassis, using the detector-oscillator mounting plate as a guide.

2.—Make the cut-out for the mounting plate in the chassis as shown in *Fig. 7*. Drill or punch tube socket and other holes in the chassis top.

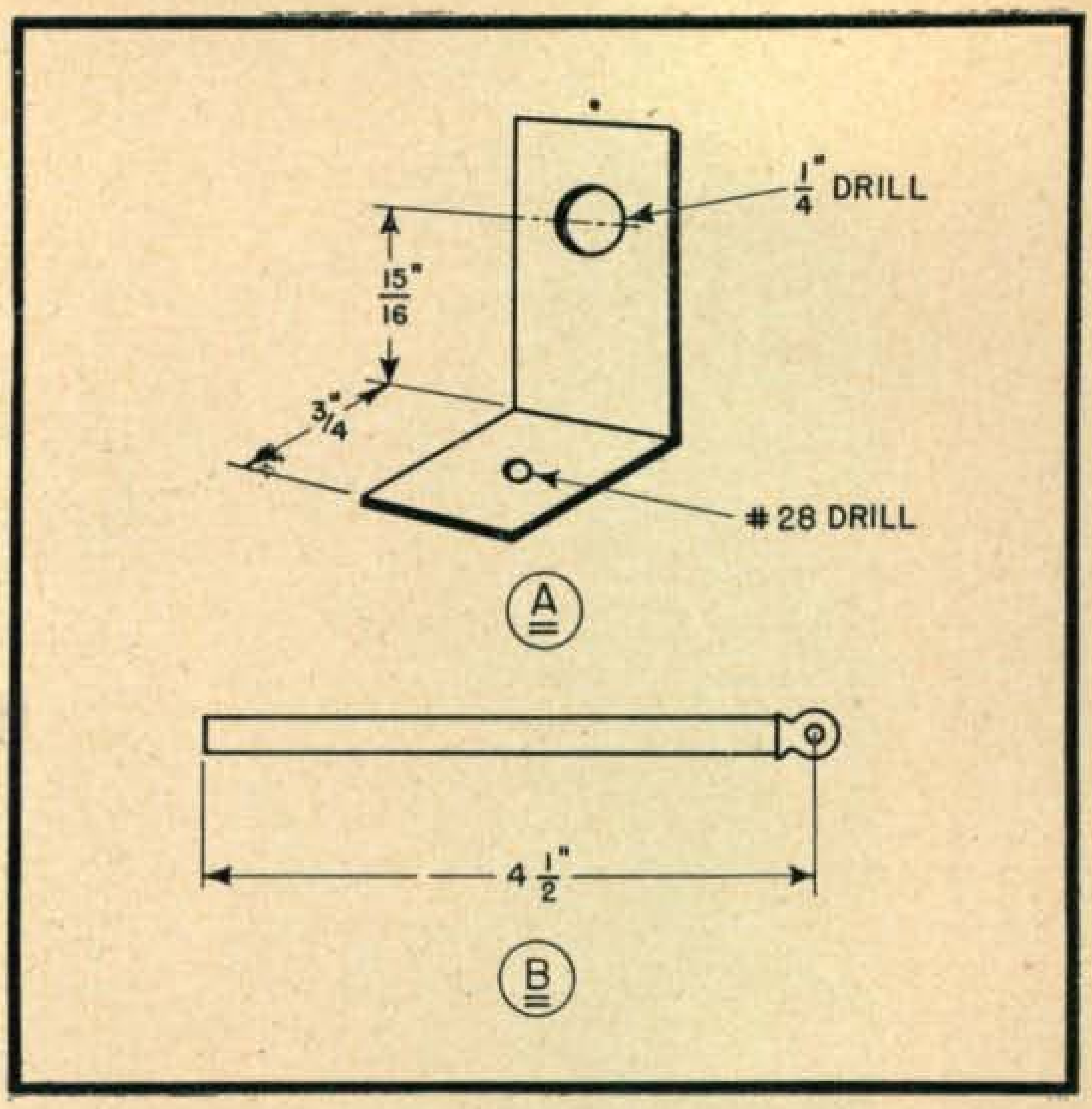

Fig. 9. The simple bracket, A, and curtain-rod shaft, B, support the powdered iron tuning element

3.—Referring to *Fig. 8*, cut out a section in the front edge of the chassis (A) to clear all parts located on the lower portion of the panel. Drill the transceiver transformer mounting holes in the rear chassis edge (B), and the power-line grommet hole.

[*Continued on page 40*]

WORLD'S FASTEST PLANE *uses* ANDREW COAXIAL CABLES!

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.

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4.—Manufacture the tuning shaft bracket and the tuning shaft as shown in *Fig. 9.* The shaft is a section of curtain rod.

5.—Drill the front panel in accordance with *Fig. 3,* and mount to the front edge of the chassis. Assemble and mount all major parts with the exception of the transmit-receive function switch. Use #6-32 machine screws for units with #28 drill holes.

6.—Wire a #10 tinned copper grounding bus line between the rear mounting bolt for the output transformer and the 100-kc oscillator mounting bolt. Use soldering lugs for securing the common line, and scrape paint from the chassis around the grounding studs. Run a similar bus to the front panel and terminate it under the left mounting nut for the function switch assembly.

7.—Wire the filament circuits with short, direct connections. The detector-oscillator filament chokes, L_7 and L_8, are located immediately next to the chassis and connect to the 6J5 (1st audio) filaments. Wire the interruption-oscillator, 1st audio and audio-output-modulator stages—leaving extra length on the leads that will run to the transmit-receive function switch. Install the function switch and the detector-oscillator assembly.

8.—Make up the power-line cable to the length required for your particular installation, and solder to the power-supply terminal strip. Wire the remaining circuits—jacks, switches, etc.

9.—Cut two ¼″ copper tubes 4¼″ long. Flatten one end of each tube and drill for the banana jack stud. Shape the copper tubes as shown in the photograph, *Fig. 10,* using the tank coil insulating support as a guide.

10.—Check all connections against the wiring diagram, *Fig. 1.*

Operating Notes

We suggest that preliminary operating tests be made on 224 megacycles, using two National #8 grid clips (or equivalent), secured together after they are slipped over the copper tank rods. This clip serves as a shorting bar which is easily shifted to obtain 224-mc operation.

Always warm-up the filaments for 20 to 30 seconds before switching on the B negative circuit. Advancing the interrupter intensity control to mid-point should cause a normal super-regen "rush" in the headphones. Lightly couple the Lecher wires to the tank circuit and adjust the tank shorting bar to the desired frequency. Upon familiarization with 244 mc, remove the shorting bar and measure the frequency with the open (one-half wave) line. The tank circuit may now be adjusted to any frequency in the 430-450-mc band by gradually shorting the length of the copper rods. These adjustments should be made with the polyiron plunger fully disengaged from the tank as the frequency will increase as the plunger is engaged.

Antenna coupling may be either inductive or capacitive. Inductive coupling is obtained by using a 2″ hair-pin of #10 tinned copper wire spaced approximately ½″ from the tank rods. This pick-up may be secured through the tank supporting insulator by drilling holes at the locations found most suitable for optimum performance. The antenna can be capacitively coupled to the plate tank rod through a series condenser of from 5 to 10$\mu\mu$f. A half-wave antenna for 440 mc will measure 13.4 inches. With such dimensions beam antenna arrays are in order.

HAM NEWS

ALL AMATEUR TRANSMITTER CONTEST

The 1st Annual All Amateur Transmitter Contest is being inaugurated by Taylor Tubes, Inc., of Chicago, Illinois, together with nine other radio-component manufacturer-participants as an expression of appreciation for the outstanding work done by the thousands of servicemen in the Communications Branches of the military, and the many amateur radio operators, or "hams."

The prizes consist of two transmitters, designed by the contestants, complete from microphone to antenna post, plus $1125 in Victory Bonds, furnished by the participating manufacturers. Two prizes will be awarded: one in final power input classification up to 250 watts, and the other in power input classification of from 251 watts to 1,000 watts.

The participating radio-component manufacturers, who are donating the $2250 in Victory Bonds ($1125 to the winner in each class) are: Aerovox Corp., New Bedford, Mass.; American Phenolic Corp., Chicago, Ill.; Barker & Williamson, Upper Darby, Pa.; Bliley Electric Co., Erie, Pa.; Gothard Mfg. Co., Springfield, Ill.; International Resistance Co., Philadelphia, Pa.; E. F. Johnson Co., Waseka, Minn.; Solar Mfg. Corp., New York, N. Y.; and United Transformer Corp., New York, N. Y.

Eight well-known men in radio are acting as judges. They are: Fred Schnell, W9UZ (Former Communications Manager of ARRL and now Chief of Radio Dep't., Chicago Police), Oliver Read, W9ETI (Editor, RADIO NEWS), Cyrus T. Reed, W9AA (Former Asst. Secretary ARRL), John H. Potts (Editor, CQ and RADIO), Lewis Winner (Editor, COMMUNICATIONS), Frank J. Hajek, W9ECA (President, Taylor Tubes, Inc.), Rex Munger, W9LIP (Sales Manager, Taylor Tubes, Inc.), and Karl A. Kopetzky, W9QEA (Former Managing Editor, RADIO NEWS).

Official Entry Blanks are available from any radio parts jobber or distributor. The contest opens November 1, 1945 and will close February 15, 1946. The contest is being managed by Magazines, Incorporated of Chicago, Illinois.

CRYSTAL CHIRPS

Due to a draftman's error, a line joining the plate and grid coil leads appears in *Figs. 10* and *14* of the article entitled "Don't Let It Phase You!" in our September issue. And, on page *5* of our October issue, the present ham band for 2½ meters is mentioned as 112-116 mc. This should be 112 to 115.5 mc.

Sorry these errors got by us.

HAMFESTIVITIES

[*From page 29*]

amateur's return to the air has been made possible by the sacrifice of many whose keys will be forever silent.

The North Shore Radio Club, is a small fraternity of limited membership. Organized in 1938, with emphasis on the social side, its members reside in the neighboring communities of Jackson Heights, Flushing, Bayside, Douglaston and Little Neck. Monthly meetings gather in the homes of members—from which the YLs and XYLs are by no means excluded. An annual picnic is celebrated by members and their families—with baseball, races, horse-shoe pitching and a wiener roast.

RADAR

[*From page 21*]

by a synchronizer which furnishes all timing pulses. It also furnishes a series of positive pulses spaced an indicated 10 nautical miles or 62 μsec apart which are applied to the grid of the cathode-ray tube. These pulses brighten up the sweep every "ten miles" and furnish an accurate guide to ranges measured along the trace. The synchronizer commences the generation of these "range marker" pulses upon the receipt of its own timing pulse so that the range marker circuit will be synchronized with the sweep generator circuit.

The indicator generates a sweep for the CRT the instant the timing pulse arrives. It also places a negative bias on the grid of the CRT for the short instant the electron beam is resetting itself at the left of the tube after a full sweep. This blanks out the CRT during fly-back and eliminates this useless trace.

The transmitter and receiver units are fundamentally the same from one equipment to the next. The 750-pulse-per-second PRF of the transmitter has been selected, since the range of the equipment in the illustration is 100 nautical miles. If the PRF were higher, more than one pulse would be making the round trip out to 100 miles and back at the same time. This situation would cause false and confusing echoes to appear on the CRT. Although many advanced circuits are incorporated in radar equipment increasing the accuracy of target determinations, the basic principles are those employed in earlier sound ranging.

The amateur may wonder to what extent his post-war station will be affected by war developments in radar work. Since security on Radar is still binding, specific devices and circuits can be discussed only lightly. It is possible that the development of Radar was more influenced by pre-Pearl Harbor amateur radio experience and experimentation on the shorter wavelengths, than post-war amateur work will be affected by radar. But regardless of how the post-war amateur may use Radar itself, he cannot help but benefit greatly from the techniques developed and the parts that will be available to him—components especially designed for frequencies from 60 megacycles up.

PICK-UP TUBES

[*From page 25*]

other half. An additional electron gun is employed so that each color has it own scanning beam. The telechrome shown in *Fig. 6* is capable of producing a good picture of 600 lines in natural color, and the aid of intermediate filters is not necessary to obtain stereoscopic depth.

In television pickup tubes the diameter of the scanning beam which serves as the commutator is of prime importance. As the diameter determines the size of the picture element, the narrower the beam, the higher the definition that can be obtained.

R-F UNIT

[*From page 11*]

rather critical. It should be as close to the B+ end of the coil as possible without the stage going into oscillation. The positions shown in the diagram will serve as logical starting points. The section of the coil between the tap and B+ acts as a trap circuit closely coupled to the rest of the coil, and absorbs enough power to squelch oscillation. There are several other methods of eliminating oscillation, including tapping the plate down on the coil, or connecting a resistor across it. The resistor arrangement tends to broaden the resonant peak a trifle more, if this should be considered desirable.

A 6AK5 tube is shown in the diagram, but either a 9001 or 9003 works equally well, if proper values of bias and screen dropping resistors are used. Correct values are shown in the parts list.

Adjustment and Operation

After the wiring has been completed, the output terminals are connected to the antenna coil in the receiver, using the shortest possible leads. The approximate setting for C_2 is then found by tuning it through its range. The setting that tends to pull the detector out of super-regenera-

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tion is approximately where C_2 will peak when the r-f stage is in operation. If this should occur with the capacitor at minimum capacity, reduce the inductance of L_3 slightly.

Leads for the filament and high voltages are then wired to appropriate points in the receiver (such as screen and filament terminals of the output tube socket), and the antenna is connected to the radio-frequency stage.

As stated before, C_1 tunes rather broadly. It might be eliminated by increasing the inductance of L_2 slightly, and peaking the grid circuit by spreading or squeezing the turns of the coil.

Once the r-f amplifier is installed it can be forgotten, and all tuning is done on the receiver as it was before. The additional sensitivity is quite helpful, and if the unit is installed without the knowledge of the fellow across the street, it is very amusing to note his reaction the first time you give him a call. He won't believe it, because he can't hear your receiver!

SUPERHET

[*From page 9*]

a low-power transmitter is available in the shack, it may be turned on momentarily to check whether the receiver hits the band. Coil turns are spread or compressed to give the correct coverage.

Most published data indicate that the usual R-C super tunes with a double signal. That is, each signal appears on the dial twice, once higher than its true frequency by an amount equal to the i-f frequency of the receiver, and once lower by the same amount, a condition that is not true with this super. With the super-regenerative action of the first detector, the signal is spread out sufficiently so that it sppears only once. It will be observed that, even with the i-f at 100 kc, the signal need cover but 200 kc to accomplish this. Most modulated oscillators appear to spread considerably more than this anyhow, so the width is of little moment.

The receiver is sufficiently selective to separate stations between which there is a reasonable frequency difference. Moreover, it does not appear to "lock-in" with strong signals as does an ordinary super-regenerator. It is possible to receive readable signals on the sidebands of a strong station.

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And after these fellows get home—these men who have fought and won the toughest war America has ever known—what then?

We want to take care of the injured ones, of course. We want to see that the young fellows who went off to fight get a chance to finish their education. We want to see that there are jobs—plenty of decent jobs—for the men who've been doing the world's meanest job at army pay.

How much are we willing to help?

If we're really serious about wanting our men to get what they have so richly earned, we'll buy *extra* Bonds in the Victory Loan.

Now's the time. Let's have a show of hands—with wallets—to prove how much we really want to hear that old familiar step and that familiar voice yelling "It's *me!*" Let's prove, with pocketbooks, that we can do our job as well as they did theirs.

THEY FINISHED THEIR JOB—
LET'S FINISH OURS!

VICTORY LOAN

CQ MAGAZINE

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Shown above are a few of the many types of micro-switches, toggle switches, knife switches, rotary switches, band switches, etc., now available through the Hallicrafters Co., Chicago, agent for the Reconstruction Finance Corporation under contract SIA-3-24.

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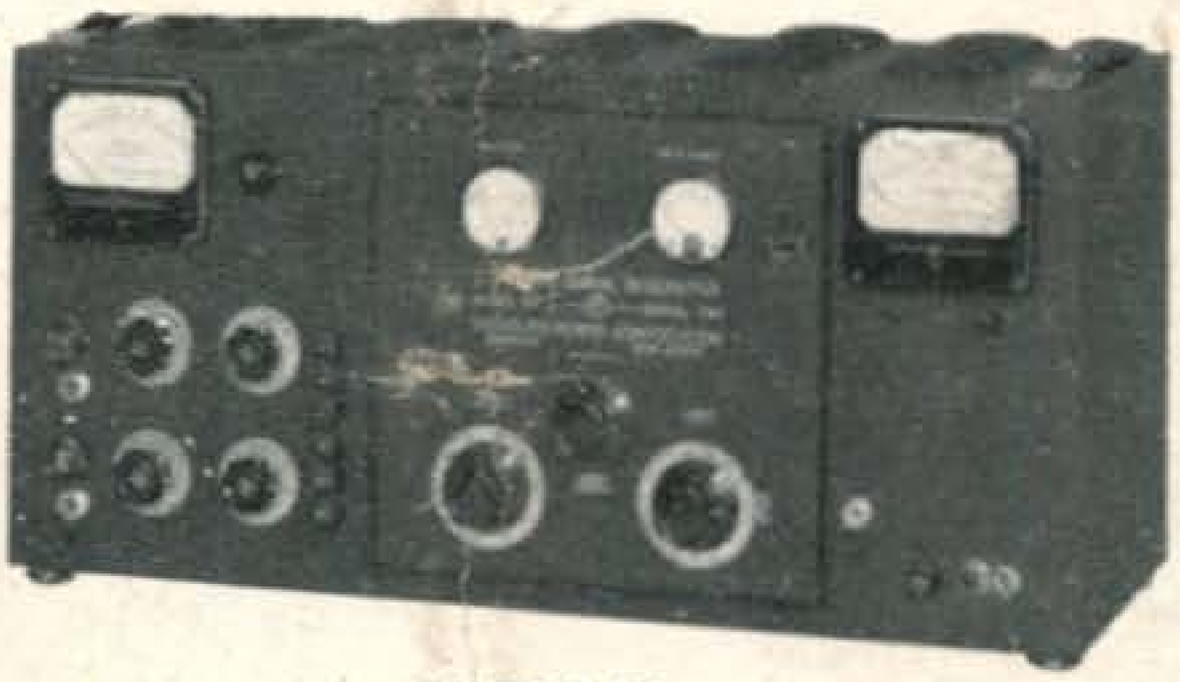

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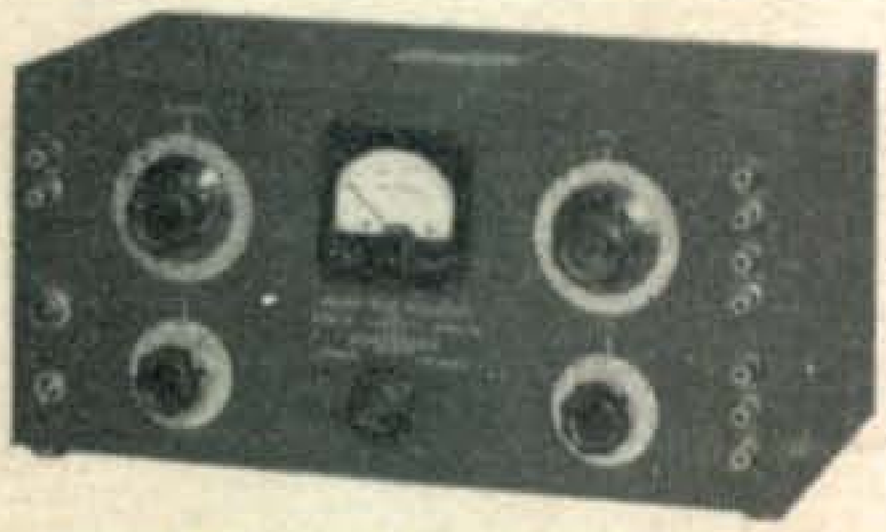

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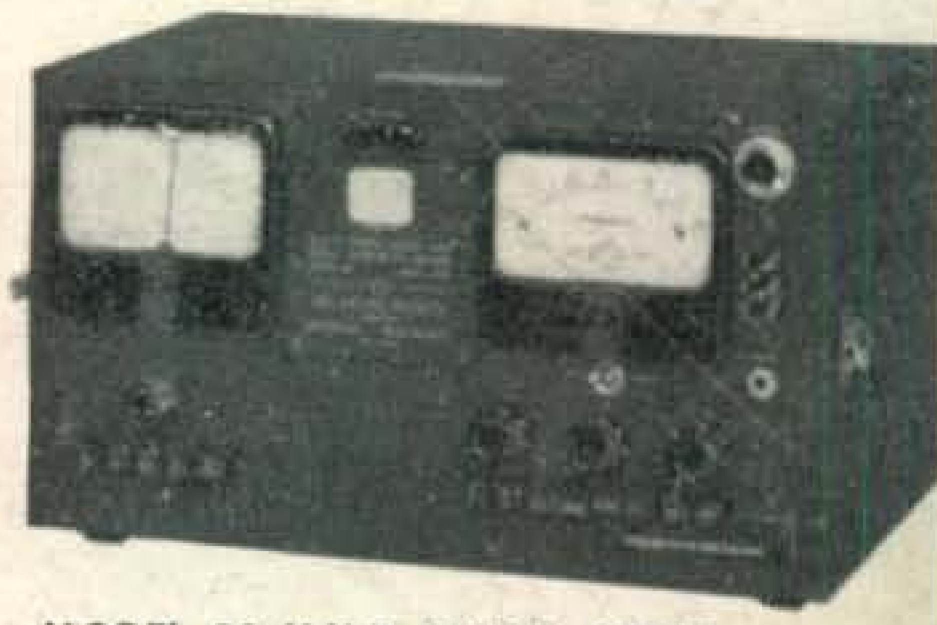

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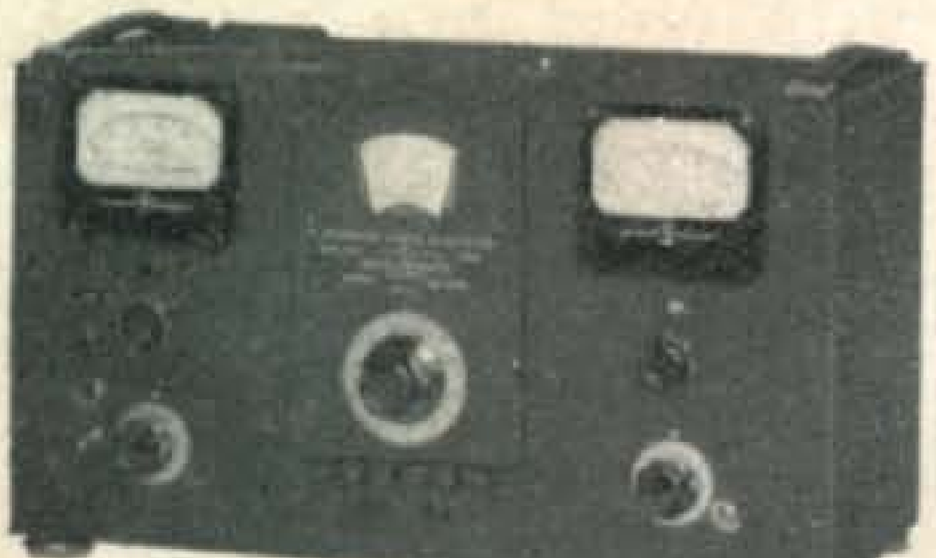

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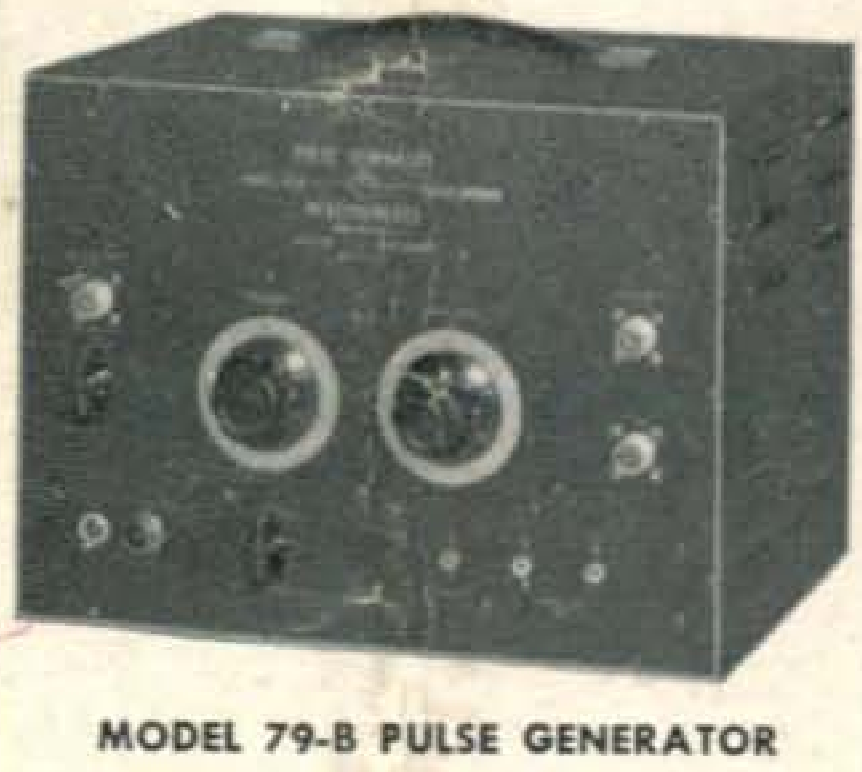

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Standards are only as reliable as the reputation of their maker.

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