JULY, 1945

CQ

The Radio Amateurs' Journal

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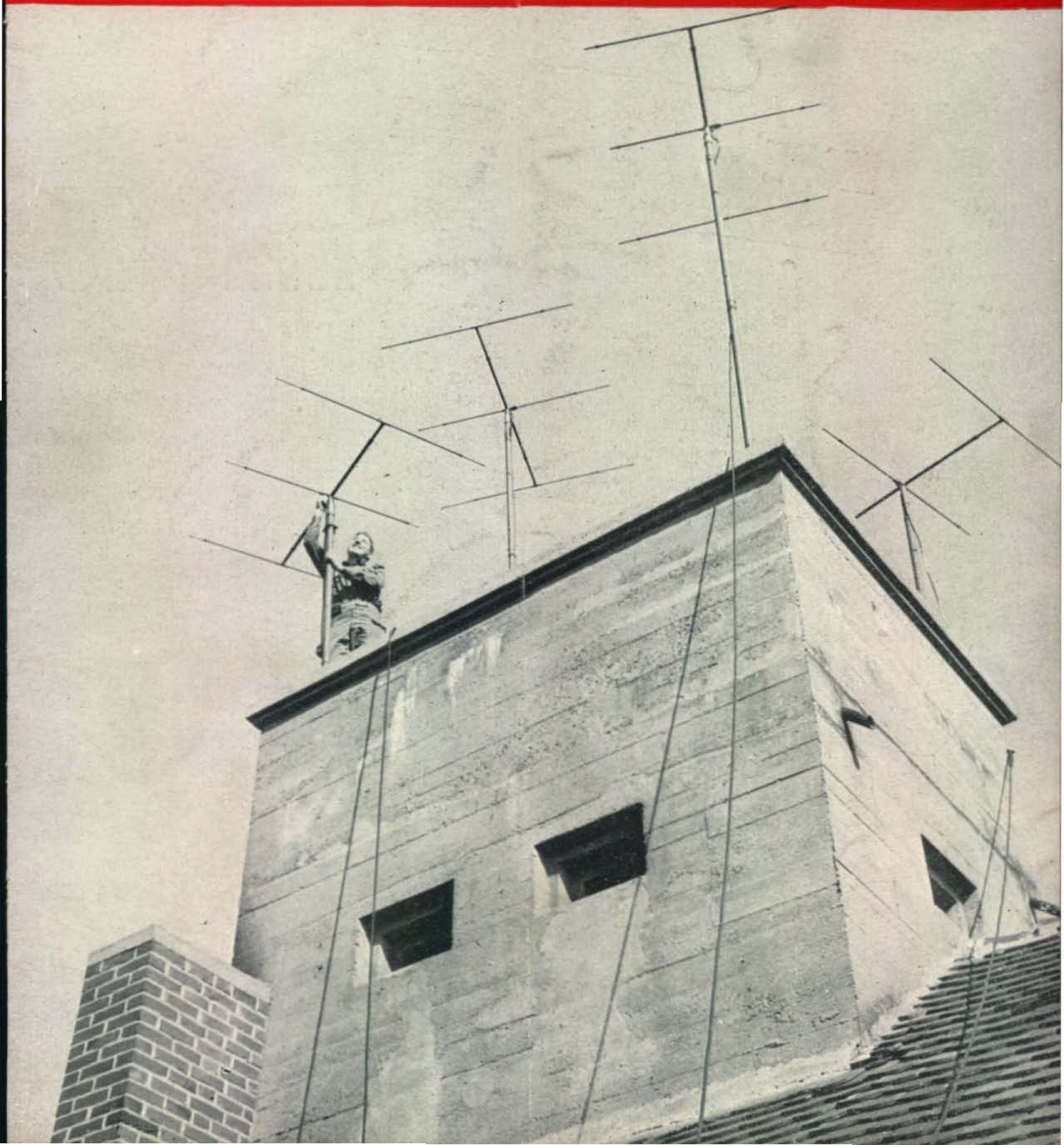

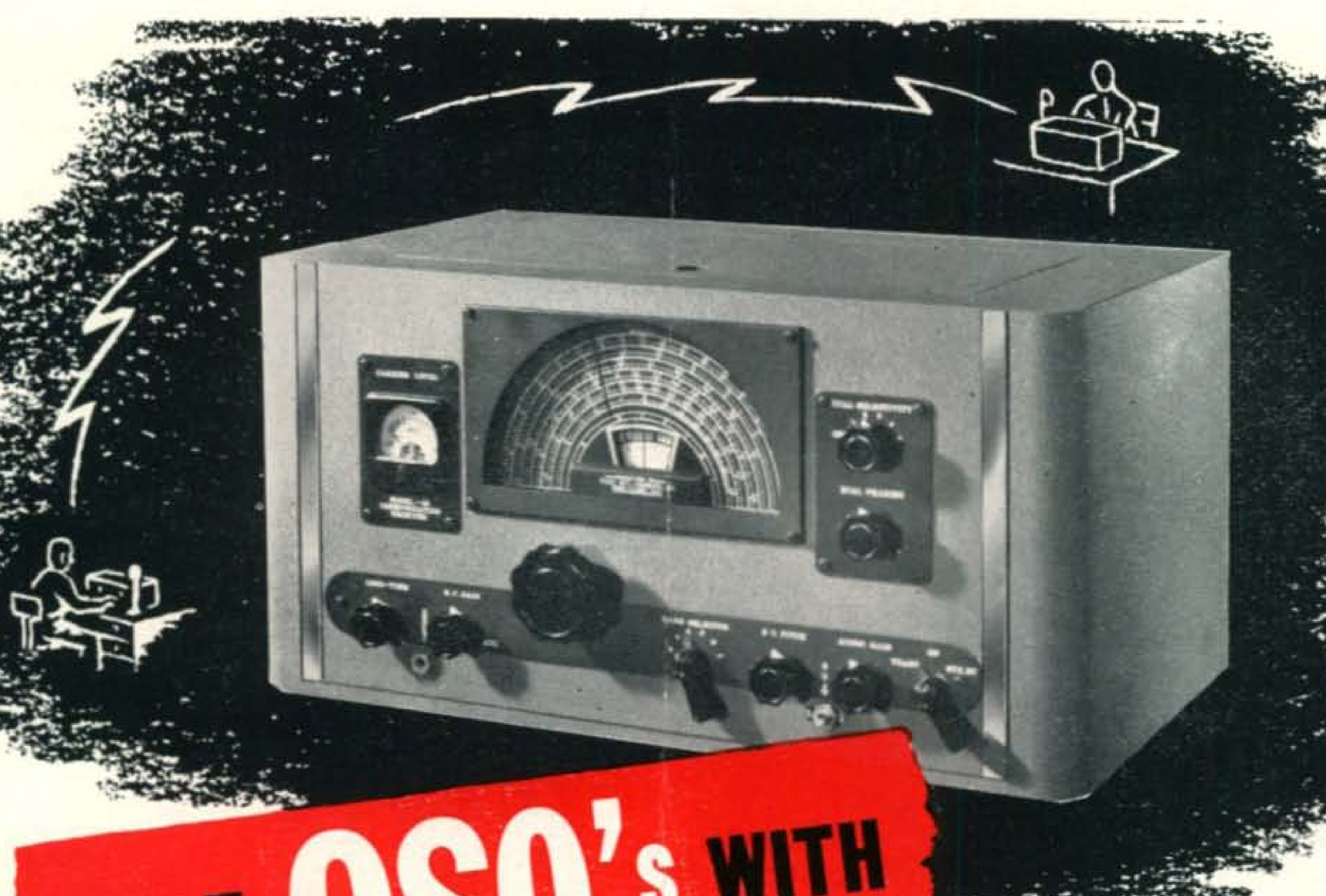

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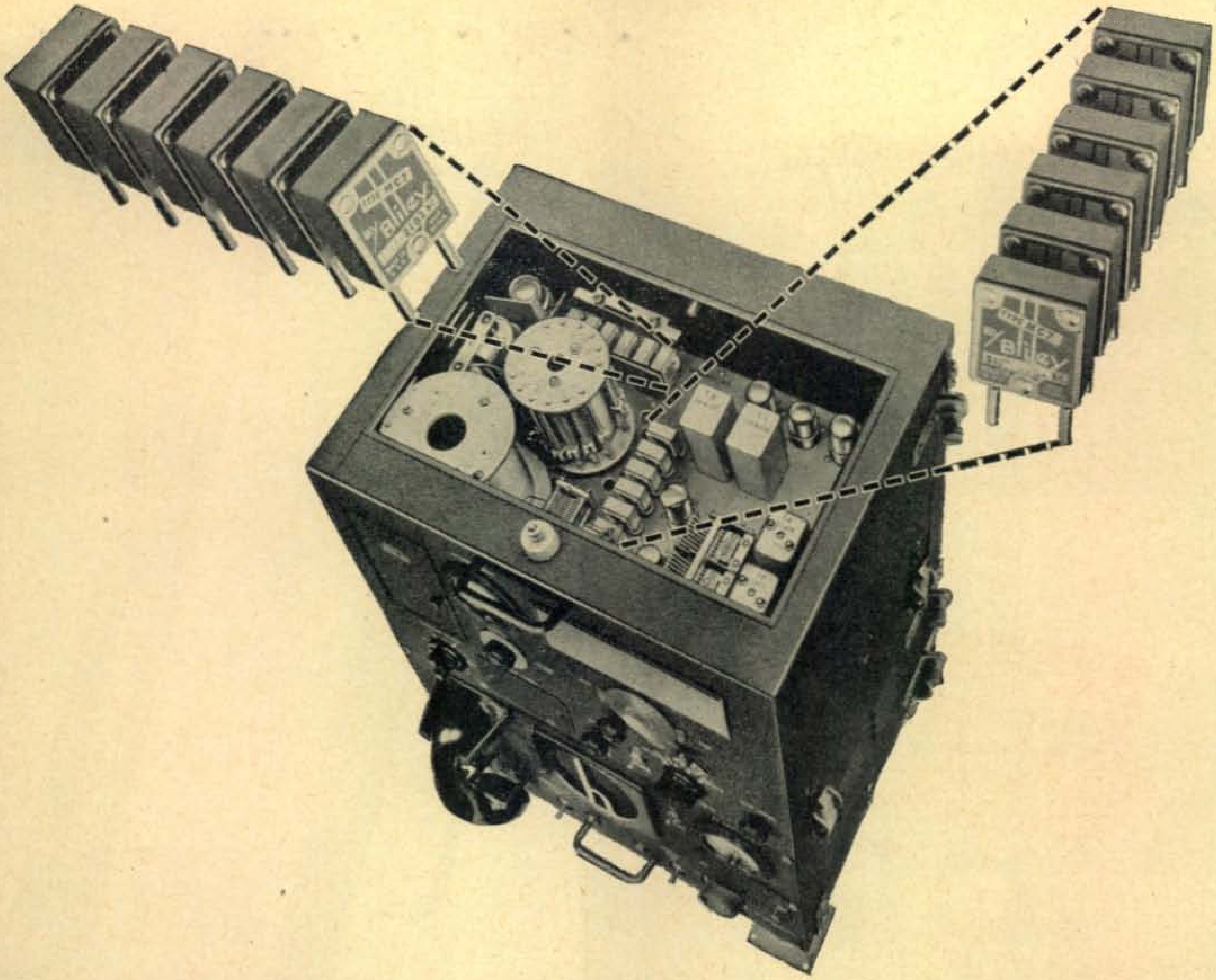

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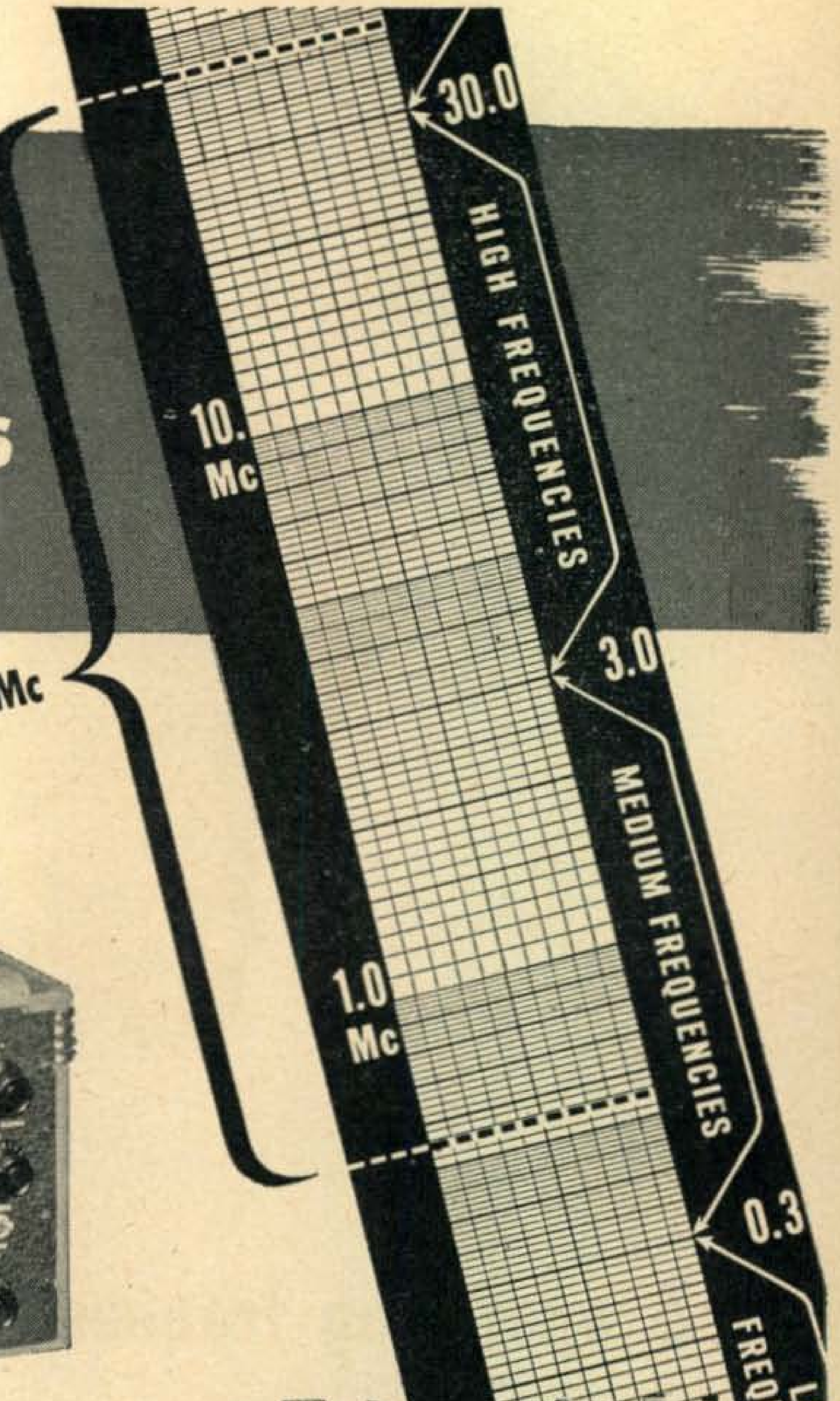

MODEL SX-28A — from 550 kc to 42 Mc

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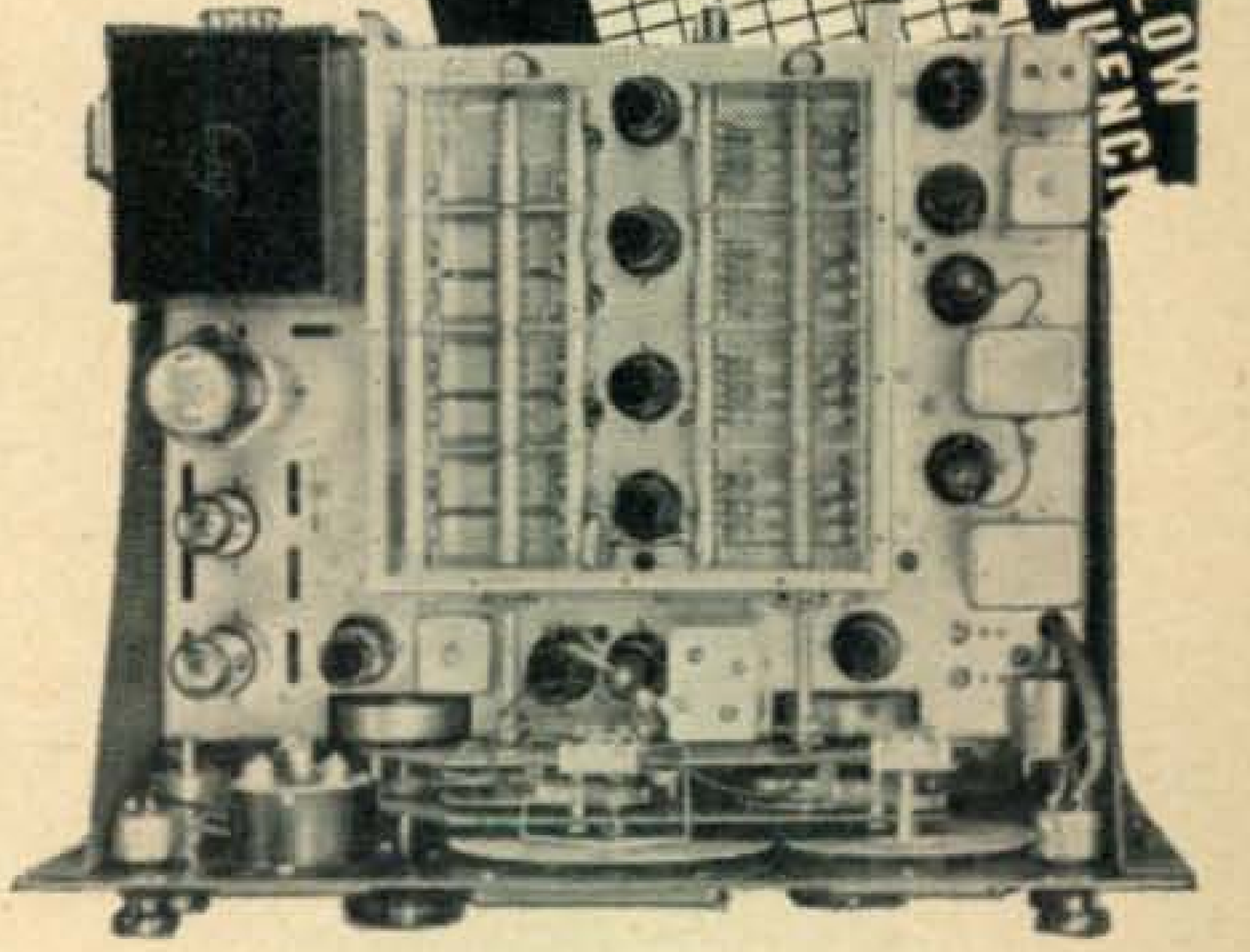

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VOL. 1, No. 7 **JULY, 1945**

CONTENTS

COVER

First voice communication with outside world on new communication line east of Rhine was made through these antennae. (*Signal Corps Photo*)

ARTICLES

MISCELLANEOUS

SA-OC

Want characteristics and diagrams of 400 types of RADIO TUBES?

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ZERO BIAS

THE FCC has announced its final frequency allocations above 25 megacycles following three months of oral discussion, by representatives of all services concerned, on the tentative band assignments proposed by the Commission last January. While the definite amateur allocations differ materially from those published in the March issue of CQ, the changes are academic rather than of vital importance, despite the loss of some 200 megacycles and "temporary" band-sharing with reduced power on one allocation.

The most serious frequency curtailment from the point-of-view of utility is undoubtedly the 15% cut of .3 megacycles from the 10-meter band, which now stands at 28 to 29.7 mc as against 28 to 30 megacycles recommended in January and available to amateurs prior to Pearl Harbor. If it's of any consolation, this portion of the band was wide open before the war to a hodge podge of c.w., amplitude-modulation and frequency-modulation phone.

No assignment has as yet been made between 44 and 108 megacycles to any service—pending the outcome of tests, scheduled for this summer, to determine just where the f-m broadcasting stations would be most effectively placed. The remaining services will then be juggled accordingly, with the hams slated for 44 to 48, 56 to 60 or 50 to 54 megacycles. In any event, we are practically guaranteed 4 megacycles in the familiar 5-meter region—perhaps the same 56 to 60-mc allocation enjoyed in days of yore.

The original recommendation of 144 to 148 megacycles remains unaltered, and provides a band-width of 4 mc—the same as in the pre-war and WERS 112 to 116-megacycle band. Similarly, the FCC retains the 220 to 225-mc allocation, which, however, is one megacycle short of the former 224 to 230-megacycle spectrum. Further comparison between pre-war and post-war assignments is fruitless because previous to Pearl Harbor no definite allocations were made above 230 mc, though from 300 megacycles up was considered pretty much free-for-all territory. Our losses in amateur bands between 28 and 230 megacycles total 1.3 megacycles or 8% of our pre-war additive allocations.

The ham allocation of 420 to 450 megacycles remains as originally recommended. However, it is to be shared "temporarily" with "special" air navigation aids, and during the period of sharing amateur transmitters will be limited to a power of 50 watts on this band. The band is to be exclusively amateur when no longer required for air navigation purposes—an assurance which may or may not hold any real significance.

An allocation of 1,145 to 1,245 megacycles replaces last winter's designation of from 1,125 to 1,225—but does not alter the band-width of 100 mc. However, in the 2,300 to 2,450-megacycle allocation, we are 50 mc short of the 2,500 to 2,700 megacycles proposed in January, and we find ourselves losing another 150 megacycles in the permanent 5,250 to 5,650 allocation as against the tentative assignment of 5,200 to 5,750 megacycles. The remaining allocations from 10,000 to 10,500 and from 21,000 to 22,000 megacycles are unchanged—until perhaps these nether regions of wavelength are developed by the radio amateur to the point where they are worth something to other services.

While these allocations are to be regarded more or less final and permanent, they may be subject to change in order to conform with future international agreements. However, in every instance, these proposed amateur bands will be recommended by the FCC to the State Department for world-wide allocation at the next international radio conference.

In summing up, our old 10-meter rigs can go on the air, as is, as soon as restrictions are removed. The same may hold true for the 5-meter band (if we obtain the 56 to 60-mc range); but, at most, conversion will mean only the addition or removal of an inch or two of wire plus a minor aerial adjustment. Operation on the two higher-frequency bands will necessitate no more than the stretch or squeeze of a coil with a correspondingly simple bit of tailoring to the antenna.

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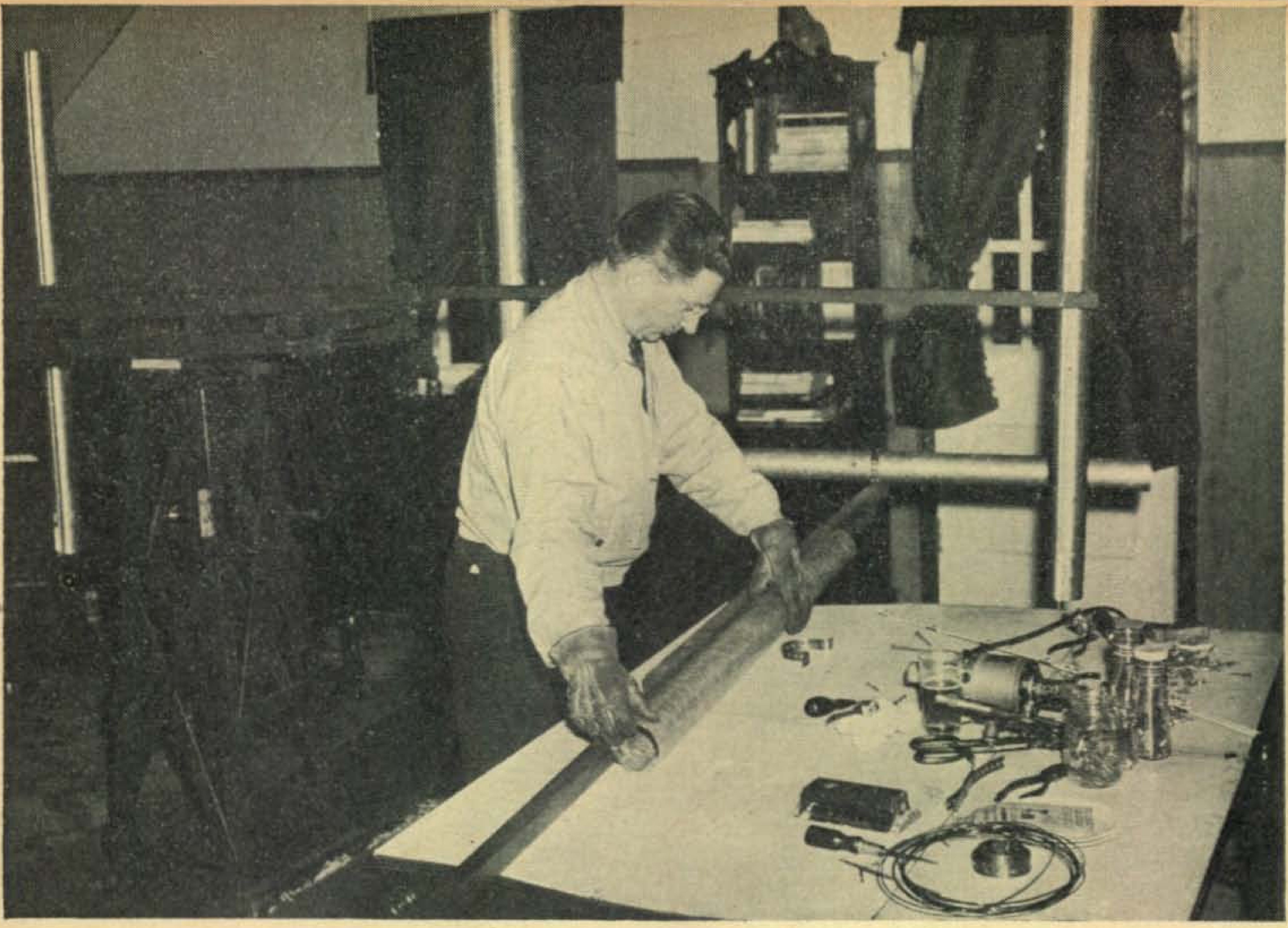

A GOOD POINT-TO-POINT ANTENNA

Designed for 112-116-mc Operation Over a 50-Mile Range With a Wide Frequency Spread for Civil Air Patrol Use

ARTHUR H. LYNCH, W2DKJ

NOT TOO MUCH information has been forthcoming concerning the radio activity of the Civil Air Patrol. A few introductory remarks to outline our interest in the CAP may be useful in giving the reasons for and the advantages to be obtained from so elaborate an antenna as the eight-element array to be described. This antenna was designed and constructed as part of a program to establish a satisfactory communication system for that portion of the Wing known as Group 11 covering Long Island, N. Y., east of the Queens County Line.

Group 11 has its headquarters in the armory at Hempstead, L. I., and does a lot of its flying from McArthur Field located at Lake Ronkonkoma—a distance of about forty miles. There are occasions when communication between the two locations is very desirable and when other than radio contacts are out of the question. So, with a limit of 25 watts for CAP operation, an antenna with reasonable gain was indicated to assure regular and reliable service. In addition to the direct path, between those two points, it was desirable to maintain communication with planes as far as ten miles east of the field, directly from Hempstead, or with

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The photo above shows antenna and reflector elements being cut to size by W2DKJ in accordance with the formulae given by the author in the May issue of CQ

[*Photos for this article contributed by Stanley P. McMinn, W2WD*]

(left). The radiator or antenna proper of the eight array antenna system—glorifying the gutter pipe

(below). Affixing strips for feeder connection on the lower ends of the proper antenna

one of the auxiliary stations, located within a short distance of the armory. In order to maintain our regular contacts with the various stations in the Nassau County WERS, we were of the opinion that the most suitable antenna would be one which would give us reasonable gain on the desired frequency, but which would not discriminate too much against the other frequencies, in that band.

Gain vs. Band Width

Arrays such as shown in *Fig. 2* provide high gain, but they do not lend themselves to operation over a wide frequency range. The introduction of the directors, with close spacing, alters the impedance at the center of the antenna, so that the feed method as shown, while not satisfactory if a really symmetrical pattern is desired, does eliminate the necessity of finding some form of very low impedance transmission-line, which today is very hard to obtain. It is also well-known that quarter-wave spacing of the elements, while not providing the gain to be had from close spacing, does enable us to do rather well with transmission lines of more common impedances. In addition, most of the "commercials" maintaining high-frequency links which operate over distances greater than "line-of-sight," recognize that much of the frequency shifts, fading and other undesired effects, noted when ordinary antenna elements are used, are greatly reduced when the diameter of the elements is increased.

What we wanted was good forward gain on an antenna cut for 115.5 mc, with reasonable efficiency when operated on any frequency within the 112-116-mc band. The results more than justified the work involved in making up the unit. On actual tests, with the antenna set up indoors on the second floor of our bungalow, actual contact was carried on with an airplane a sufficient distance the far side of our flying field to indicate that we would be safe in expecting the desired ten miles.

Field-strength Tests

Some of the comparative figures, developed over a long period of testing between our own station and a callibrated receiver located a half mile distant, shown in the accompanying table. Incidentally, all the figures corresponded closely with similar measurements, made with an Erco, type MW-60, resonance indicator set up some twenty-five feet *behind* the array. (It is doubtful that the same accuracy could have been expected, had the resonance indicator been set the same distance, ahead of the array). For all the measurements, identical conditions were maintained, insofar as possible without making the set-up too complicated. A crystal-controlled transmitter was employed with the output at a constant level. The same low-impedance transmission-line was used in all comparisons, and adjustment of the length of the matching stub, as well as the point of contact between the stub and the transmission-line, was always optimum. The frequency range, from 112.064 to 116.0 megacycles was covered with 12 crystals, ranging in fundamental frequency from 3502 to 3712 kc.

The various types of antennas used in the comparative tests are indicated in *Figs. 1* to *4* and the results are shown in the following table, where the numerals indicate the level, indicated by an "S" meter, on a Hallicrafter, h-f superhet.

	Fig. 1			*Fig. 2*	*Fig. 3*	*Fig. 4*
	(a)	(b)	(c)			
112 mc	2+	3+	4	6+	5	8+
113 mc	3	4	4+	7	5+	8+
114 mc	3	4	4+	8+	6	9
115 mc	3	4	5	7	6+	9+
116 mc	2+	3+	4+	6	6	9

The author wishes to express his appreciation to Capt. William Allen, Communications Officer of the Nassau County Police, for the painstaking manner in which he made the observations, which, by the way, took many hours. In order to avoid the likelihood of error, several sets of tests, covering the various forms of antennas, were made at different times and they checked very well.

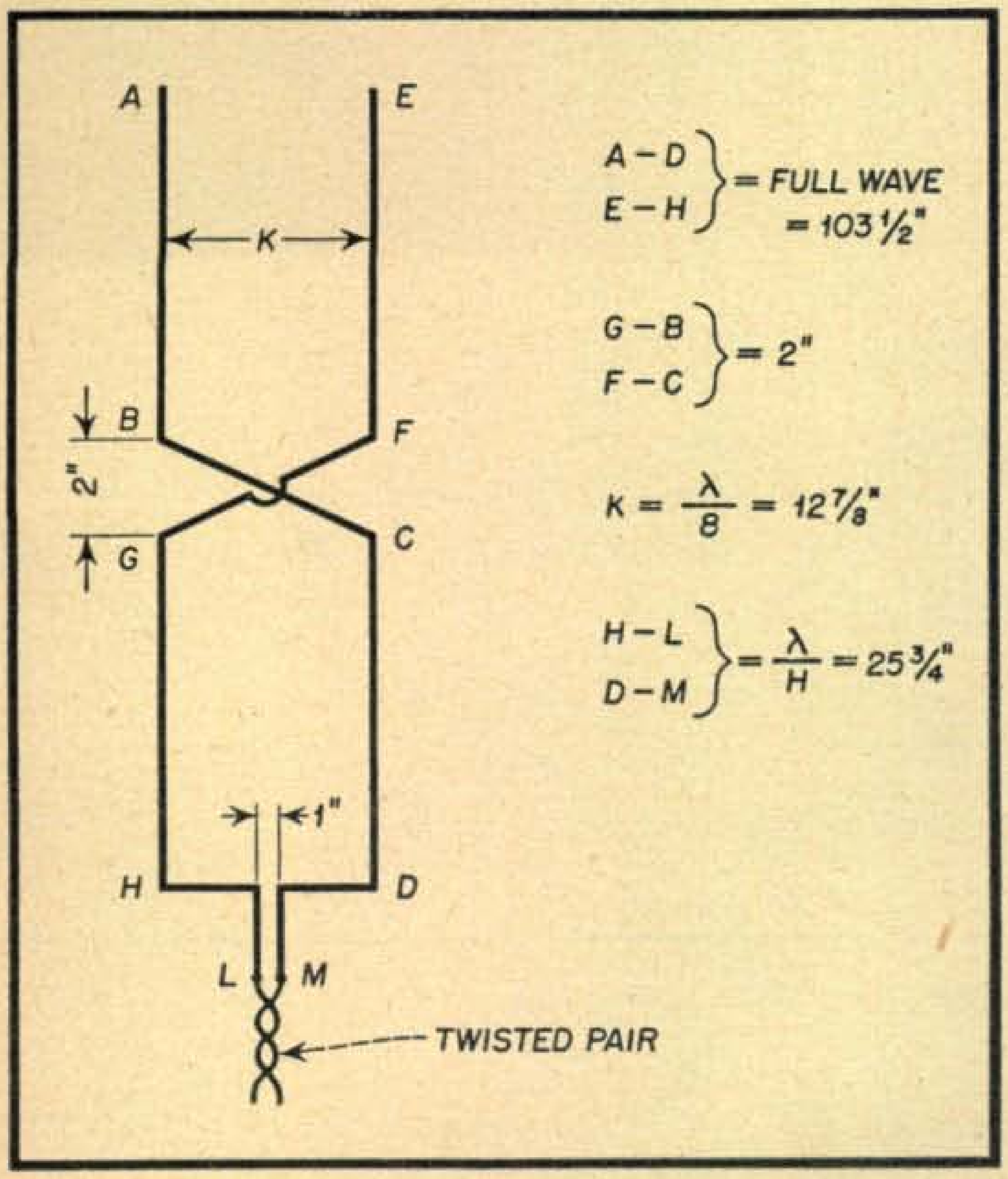


Fig. 2. Dipole with reflector and directors also checked against the more elaborate CAP array—and found wanting

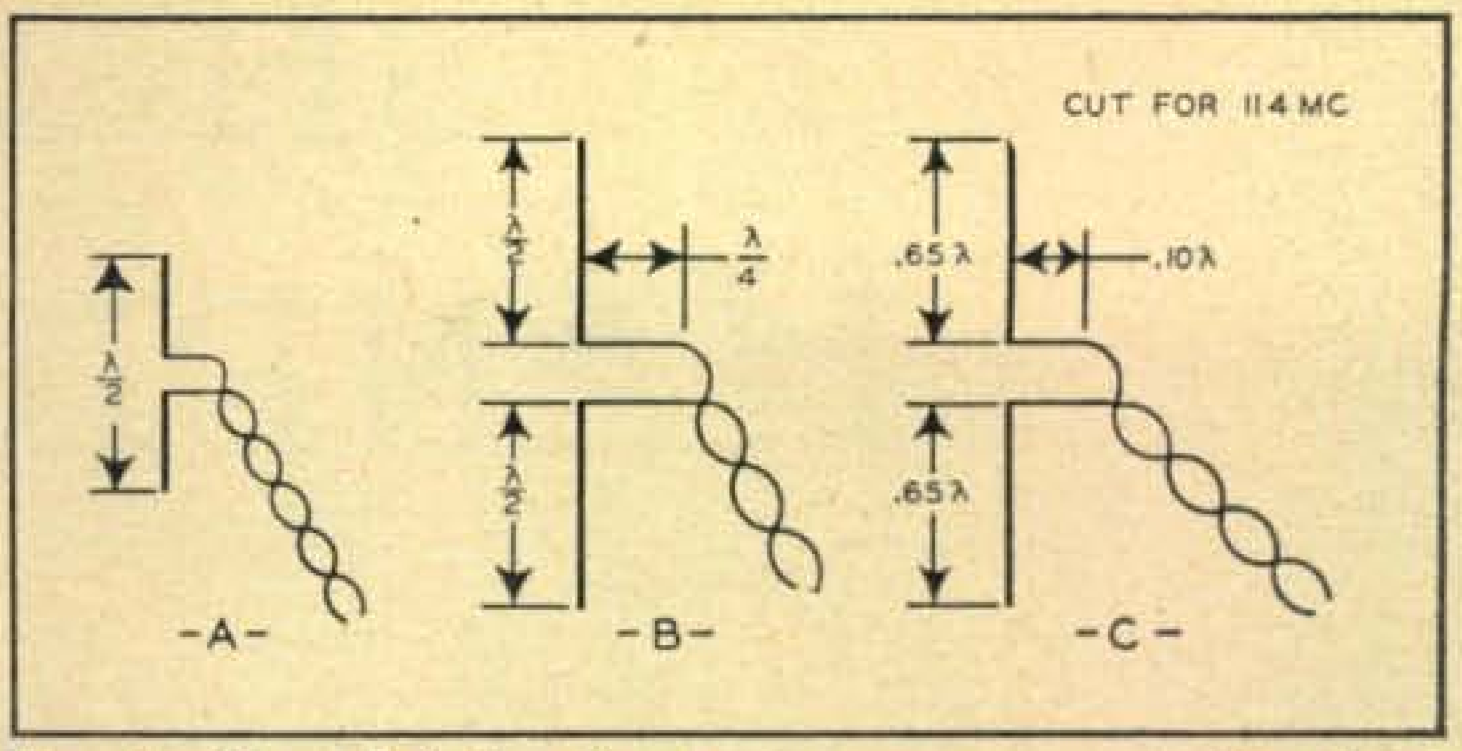


Fig. 1. Three of the five antenna arrangements which were compared with the eight-element array described in this article

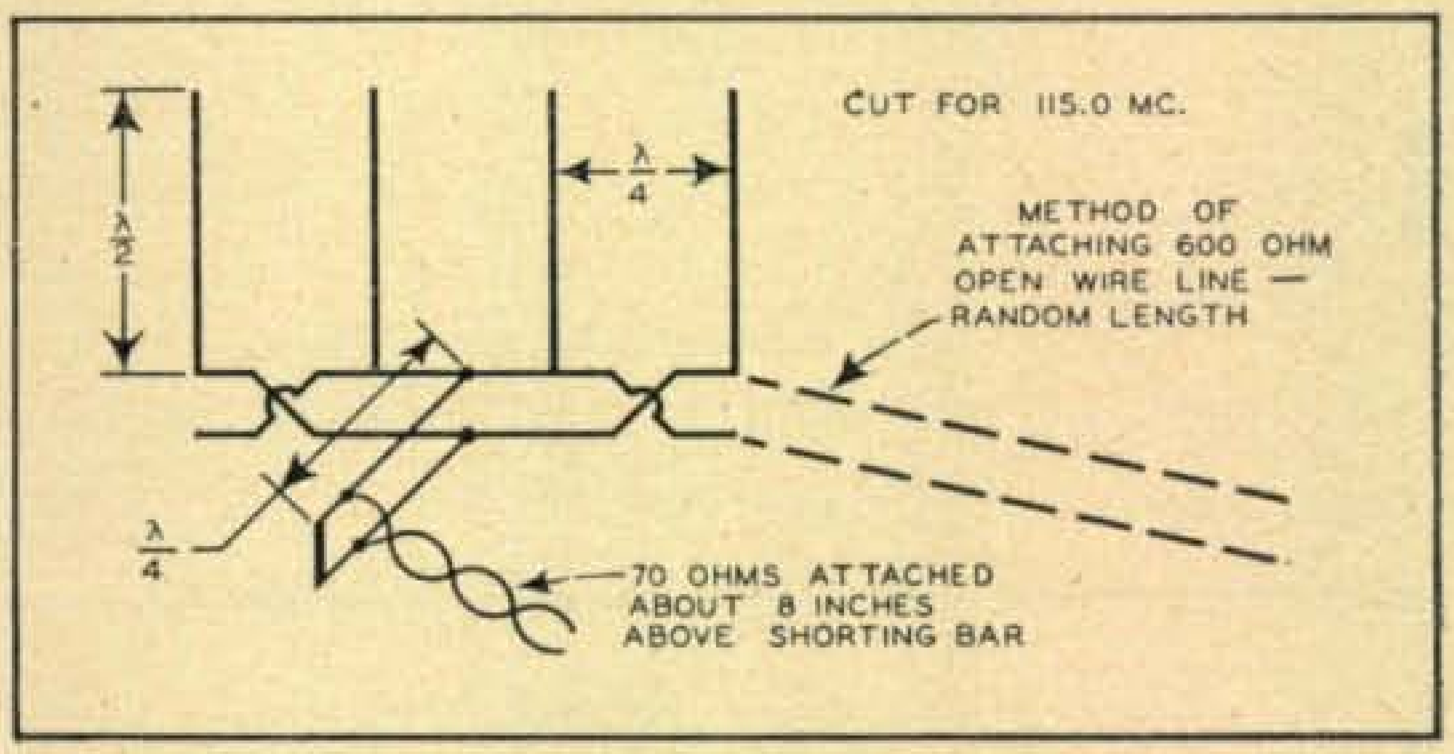


Fig. 3. Antenna number five which proved inferior to the eight-element gutter-pipe arrangement

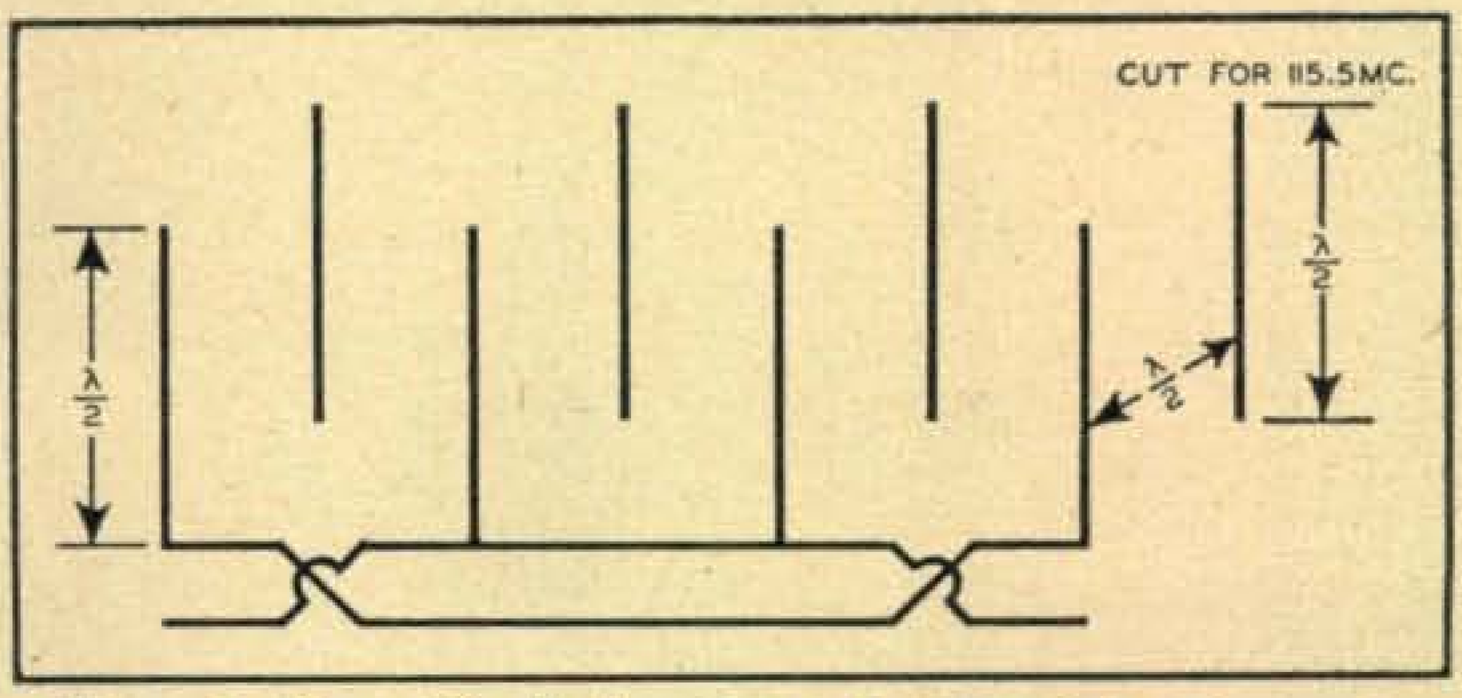


Fig. 4. Simplified drawing of the eight-element array. Exact dimensions are given in the text

Constructional Details

So much for the results. Now for a few words about making the antenna. Almost any plumbing supply house will be able to provide ten foot lengths of galvanized "down-spouting," which we found to be light, reasonably simple to cut and not too expensive. It comes in ten foot lengths, of which four are required. Copper pipe, the same size, would cost several times as much and there would be no difference in the signal delivered to the receiving station. It is a good idea to shop around. We found the price in one place more than double what they asked for the same material in another store a few blocks away

The Civil Air Patrol, in our territory, operates on 115.5 mc, so our antenna was out to 115 megacycles, using the data which appeared on page 23 of CQ for May. Therefore the reflectors are 4 feet, 2 inches long, while the antennas, proper, are just 4 feet. The spacing between all adjacent elements is 4 feet, 2 inches, center-to-

[*Continued on page 38*]

PUSH-TO-TALK HANDIE-TALKIE

ATHAN COSMAS, Engineer, WQXR

THERE HAS BEEN much wild speculation and not a little starry-eyed dreaming about the vest pocket transmitter-receiver for the projected Citizens Radio Communication Service.

[*Photos by Robert E. Cobaugh, W2DTE*]

Some manufacturers' advertisements, written around the military "handie-talkie" have fascinated the general public and certainly interested radio men. More recently, a few trade publications ran pictures of the rigs, showing the relative

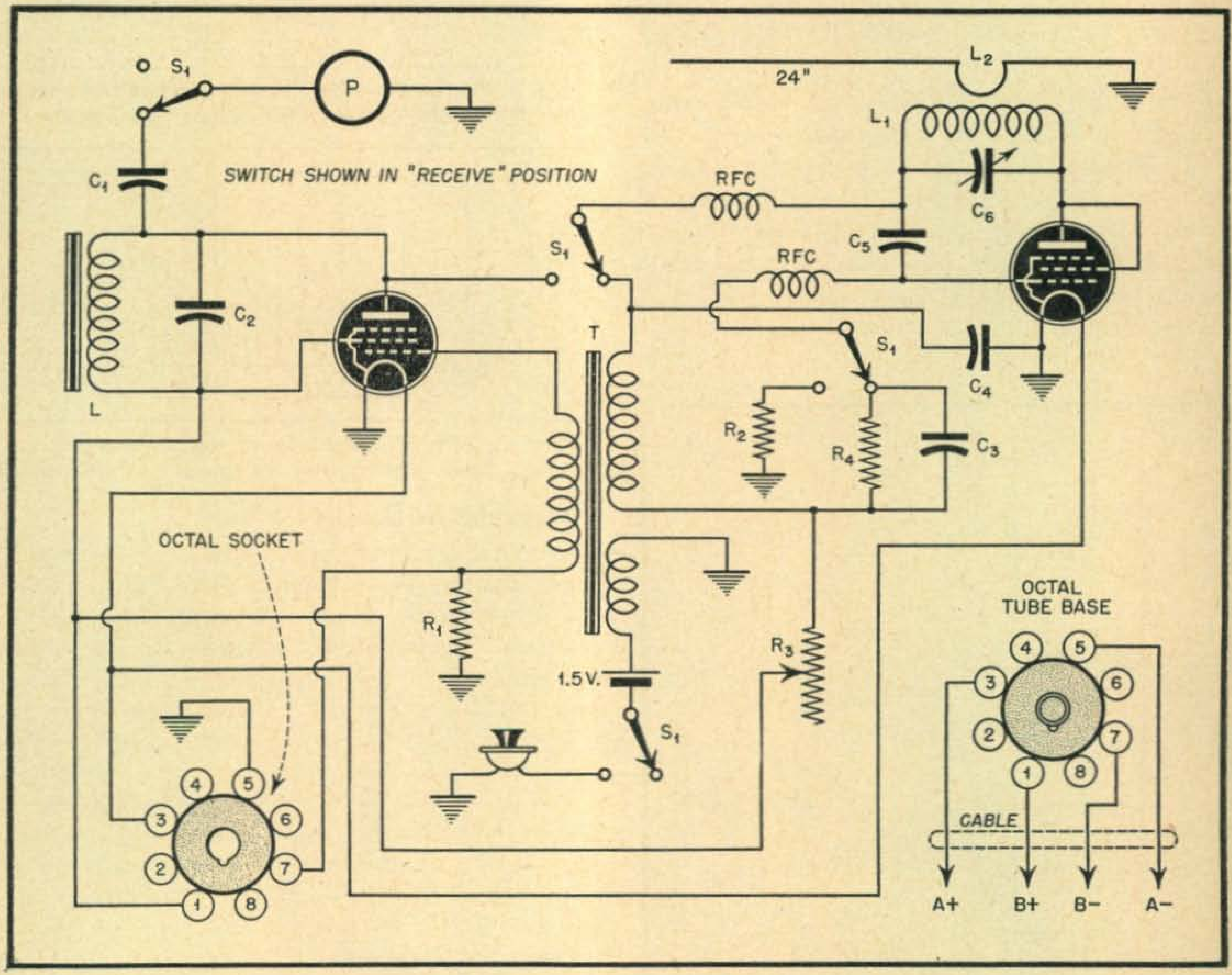


Fig. 1. Schematic diagram of WNYJ-312. Parts as follows:

C_1—.01 μf
C_2—.001 μf midget mica
C_3—.005 μf midget mica
C_4—.003 μf midget mica
C_5—.00005 μf midget mica
C_6—8 μμf midget variable

L—Midget a.c.-d.c. choke
L_1—4 turns No. 12, ½ inch i.d. spaced to band
L_2—One-half turn No. 12, ½" i.d.
R_1—750 ohms, ½ watt
R_2—25,000 ohms, ½ watt

R_3—100,000 ohms. (pot.) regeneration control
R_4—10 megohms, ½ watt
RFC—Ohmite v-h-f or equiv.
S_1—4-pole-double-throw
T—Transceiver transformer (see text)

Designed for the WERS, WNYJ-312 Constructional Details Can Be Used to Make a Good Handie-Talkie for the Citizens Radiocommunication Service.

size of specially constructed batteries and conveyed a hint about the self-contained telescoping antenna. For security reasons, little has been said about frequencies, circuits or tube types used. At the proper time, we will not only have the information—but also the opportunity to buy the components. [Handie-talkie frequency 3,900 to 5,500 kilocycles, crystal controlled. Walkie-talkie, 30 to 40 megacycles, frequency modulated.—*Ed.*]

For The WERS

Meanwhile, many of us felt the need for this type of equipment in the War Emergency Radio Service. An emergency communications set-up would not be complete without means of contact from an otherwise inaccessible point at a scene of disaster—fire, cave-in, explosion, etc.—through associated pack and mobile units to the communications traffic control center. The handie-talkie is ideally suited for this purpose.

The problem was approached from many constructional viewpoints, notable examples being Frederick A. Long's (*QST* February 1944) "multi-tube" job, operated from a storage battery-vibropack supply, and Charles T. Haist, Jr.'s W6TWL (*QST* June 1944) light-weight self-contained unit, powered by dry batteries.

The Power Supply

The rig herein described (WNYJ 312) is a modification of W6TWL's rig. While a completely self-contained unit is ideal, we felt that flash-light cells are an inadequate source of filament supply for sustained operation. Further, designing the rig for use with "Minimax" batteries placed too great a restriction in these times, as this type of battery has been unobtainable without priority. To avoid the hampering and sometimes costly limitation of a particular size battery, the power supply is contained in an over-the-shoulder photographic carrying case, feeding the voltages through a cable and plug to an octal socket mounted in the bottom of the unit. Filament battery drain is 200 ma. When the push-to-talk switch is in the receive position the B battery current is 10 ma, and about 15 ma on the transmit side. Audio-frequency bias is provided by the voltage drop across R_1 (*Fig. 1*). Although only four leads are required in the battery cable, the octal socket was chosen to circumvent the possibility of inexperienced operators inadvertently plugging in from the standard four-prong power source usually available.

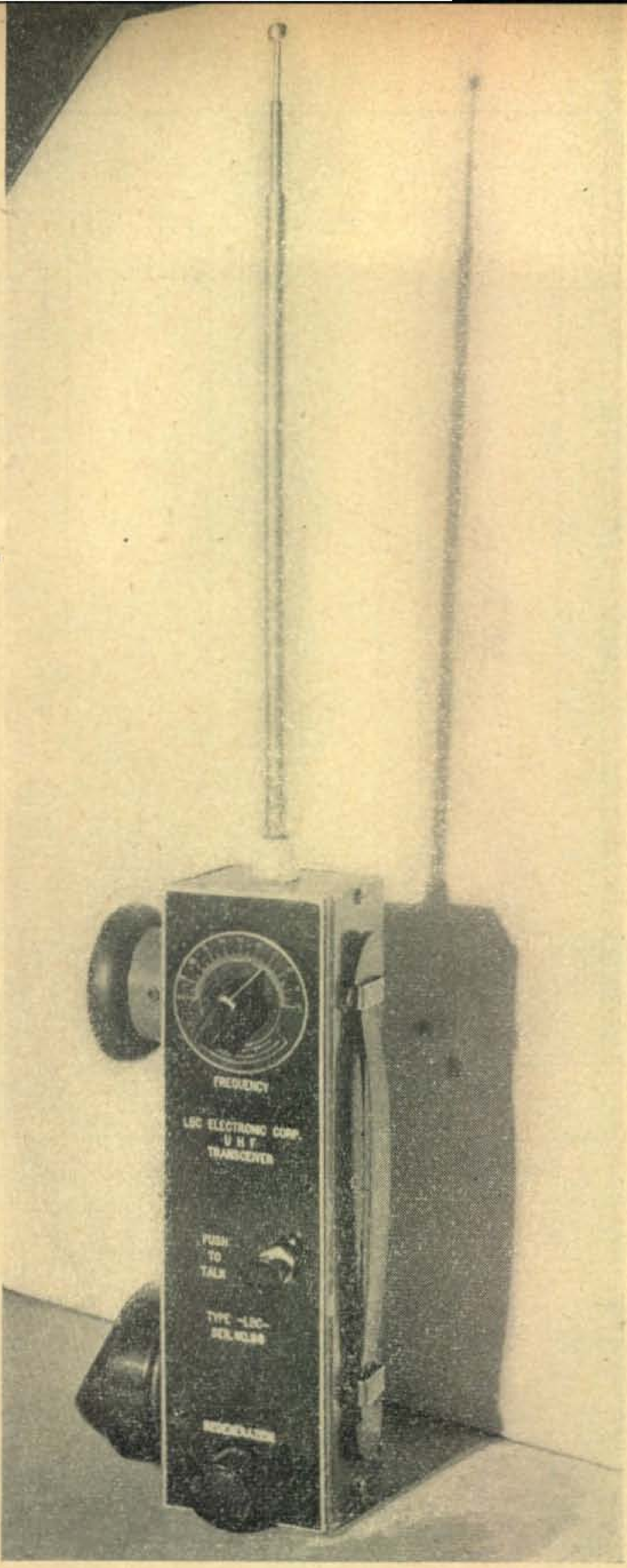


Fig. 4. Antenna attached, WNYJ-312 is ready for WERS or any other communications chore in the 112-mc band

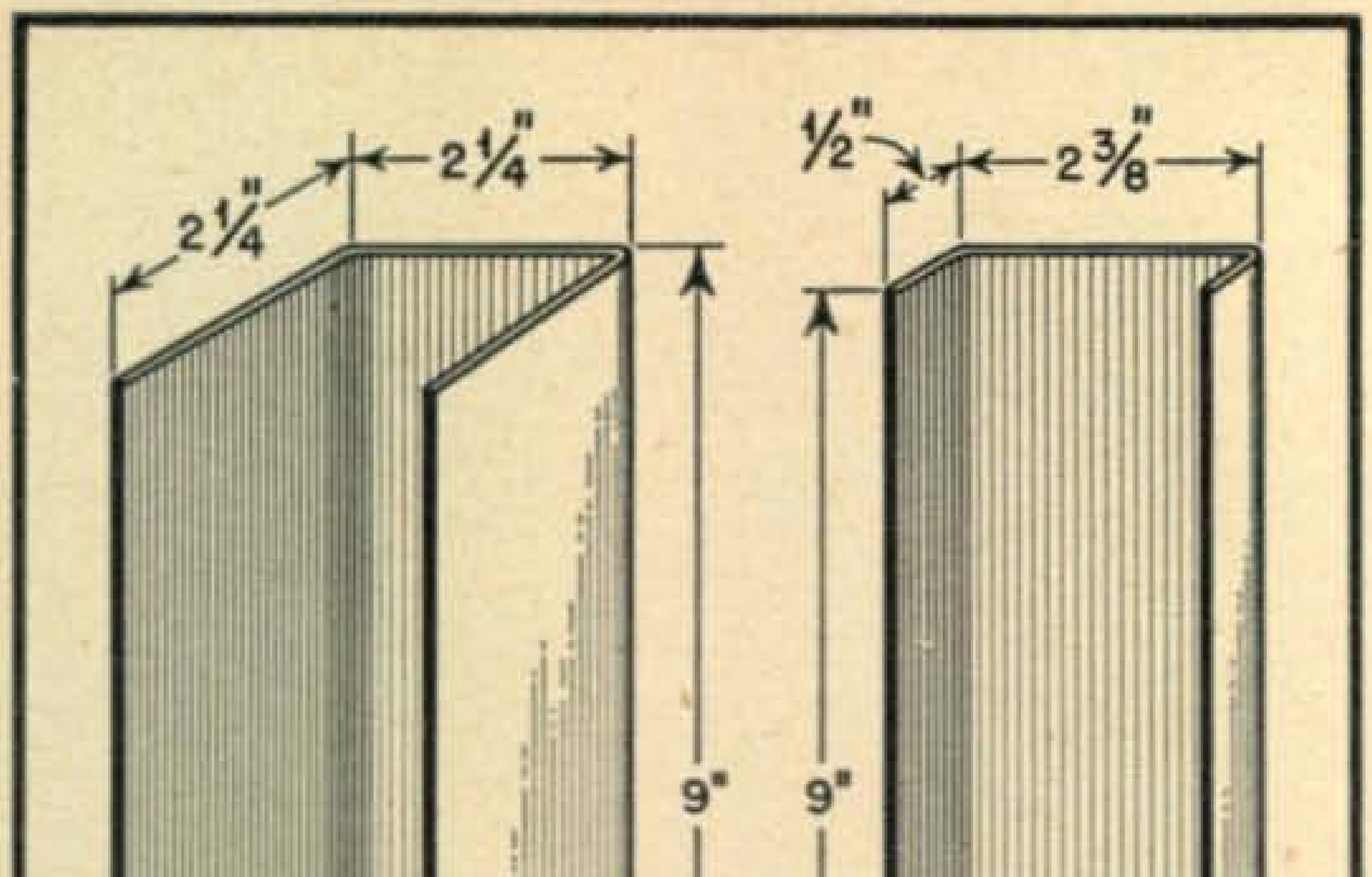


Fig. 2. Mechanical details of the "cabinet." Dotted lines in *B* will vary with the gauge (thickness) of the aluminum sheeting.

Circuit

The circuit (*Fig. 1*) is conventional. One 1S4, triode connected, serves as an oscillator in the transmit position and as a self-quenched super-regenerative detector when receiving. The other 1S4 is used as a modulator and audio amplifier. In the receive position the small "AC-DC" choke provides the plate load for the audio tube. During transmission it functions as a Heising modulation choke.

One improvement over W6TWL's rig is the push-to-talk switch. Since no r.f. appears at the switch, almost any type will do, provided it does not take up too much room, and in the rig described was made up from some old Yaxley switches. No battery switches are needed since the power plug is removed when the unit is not in use. Details on the coils and condenser are given in the circuit diagram and parts list. There is nothing unusual about the transceiver transformer. A midget interstage transformer with an additional winding of 30 to 50 turns of No. 28 wire will work very satisfactorily.

Constructional Details

Batteries offering no problem, the dimensions of the case are reduced to the minimum necessary to provide six and one-half inches, center to center, between the 2000 ohm phone and the single button mike. The case is made of sheet aluminum, held together by self-tapping screws. Dimensions are shown in *Fig. 2.* The phone and mike are mounted on the left side of (A) while the pencil cell mike battery is clamped to a fuse clip on the inside. All leads are cabled over to the cover of the case. Two pieces, shown in (B) are permanently mounted on (C). The bottom piece mounts the octal socket, while the top section contains the antenna feed-through insulator.

The transceiver is designed to operate in the 112-116 megacycle band. The tank coil is soldered directly to the condenser. As can be seen from the photograph, (*Fig. 3*), the audio and r-f tubes are mounted on a small plexi-glass shelf. All r-f leads are kept short. The completed rig is shown in *Fig. 4.* The 24″ antenna is a home-made telescoping affair consisting of two lengths of copper tubing, the larger being ¼″ outside diameter plus a length of No. 10 wire. When not in use the telescoped antenna is tightly clamped in small fuse clips on the side of the case.

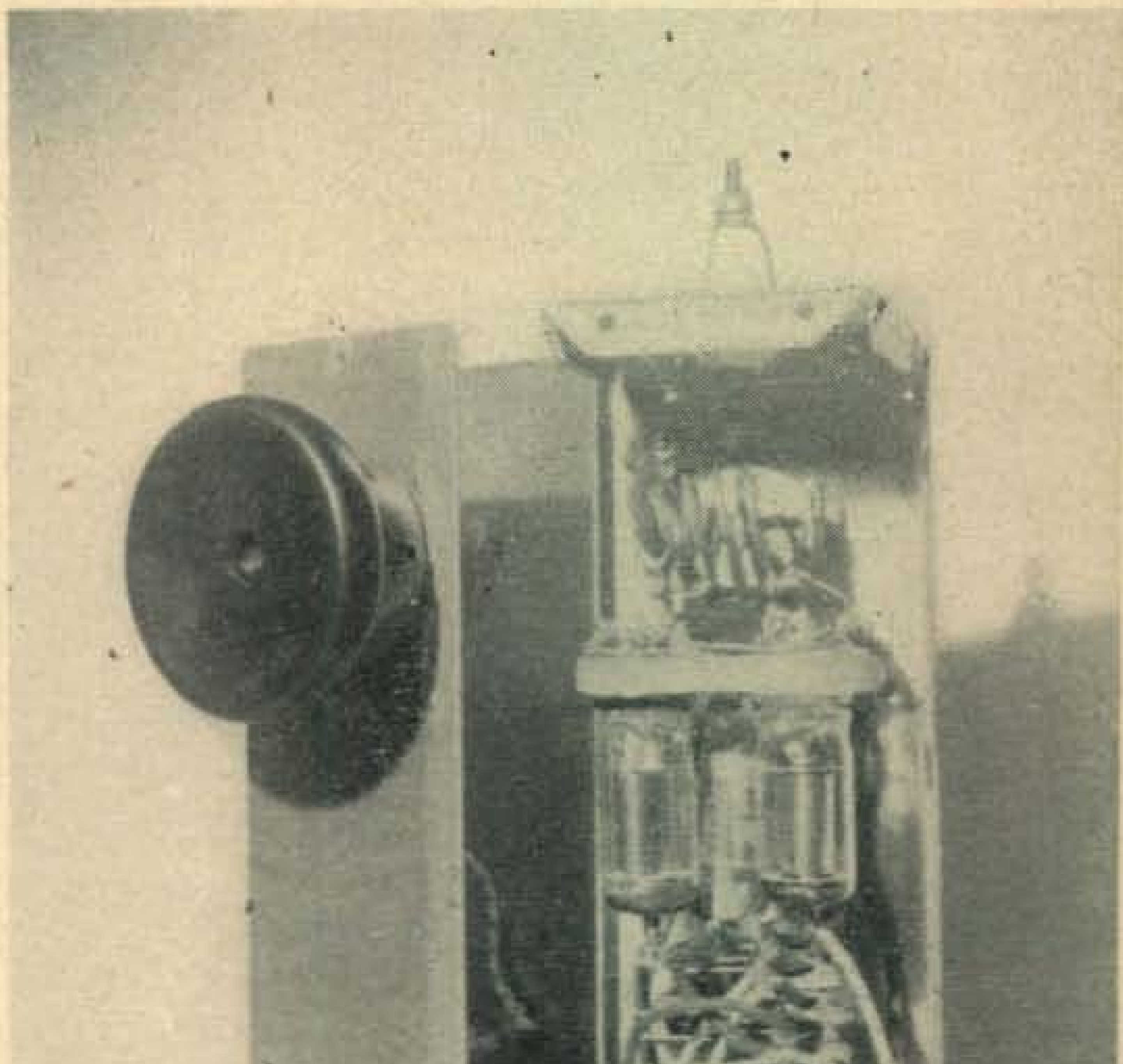


Fig. 3. A lot of ham radio crammed into nine inches of space with a professional touch

A MATTER OF TIME

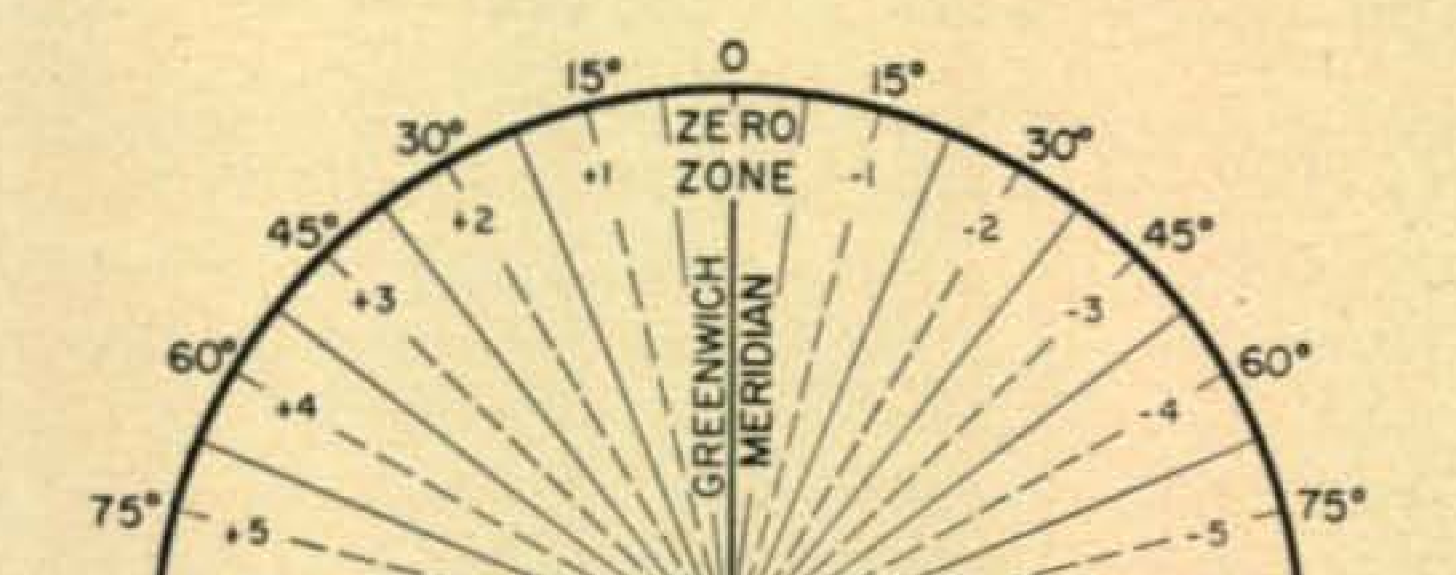
Translating Local, Zone, Standard, Daylight and War Times into GMT for Ham Working and Logging

LAWRENCE LeKASHMAN, W2IOP

Just as the average amateur in the United States must confine his operating to available hours of leisure, the DX stations cannot be expected to be transmitting at any and all hours of the day. Thus it follows that the best hours to work any particular foreign country are those which coincide with the leisure hours at the DX station. For example, when it is 10:00 P.M. Eastern War Time, it is 4:00 A.M. British War Time—a mighty poor hour to expect many of the English stations to be operating. Normally there is 5 hours difference in time between the east coast and the United Kingdom. Today, however, the east coast is on war time (plus 1 hour) and the United Kingdom is on double war time (plus 2 hours) making a difference of 6 hours. On the other hand, if the English hams are looking for United States west coast contacts, the hour of 4:00 A.M. in Britian, corresponding to 7:00 P.M. Pacific War Time, would be ideal. (We refer to War Time as a matter of expediency. It demonstrates the idea. Naturally, there are no QSOs during "War Time.")

One of the confusing things in DX work is the difference in time—especially when expressed in terms of local hour only. The adoption of the Greenwich Civil Time (GCT) system would simplify the problem to a great degree. The radio amateur is primarily concerned with four kinds of time—Greenwich Civil Time, standard time, zone time, and daylight and war saving time, the latter two being considered together.

Greenwich Civil Time or Greenwich Mean Time (GMT), as it is sometimes called, is used almost exclusively for navigation tables, for checking time on aircraft or shipboard, and anywhere else where a standard is required. On a plane flying three hundred miles-per-hour from New York to London, it would be virtually impossible to keep an intelligible set of records in zone time, since it would be constantly changing. Starting out on GCT, there is always an immediate point of reference.

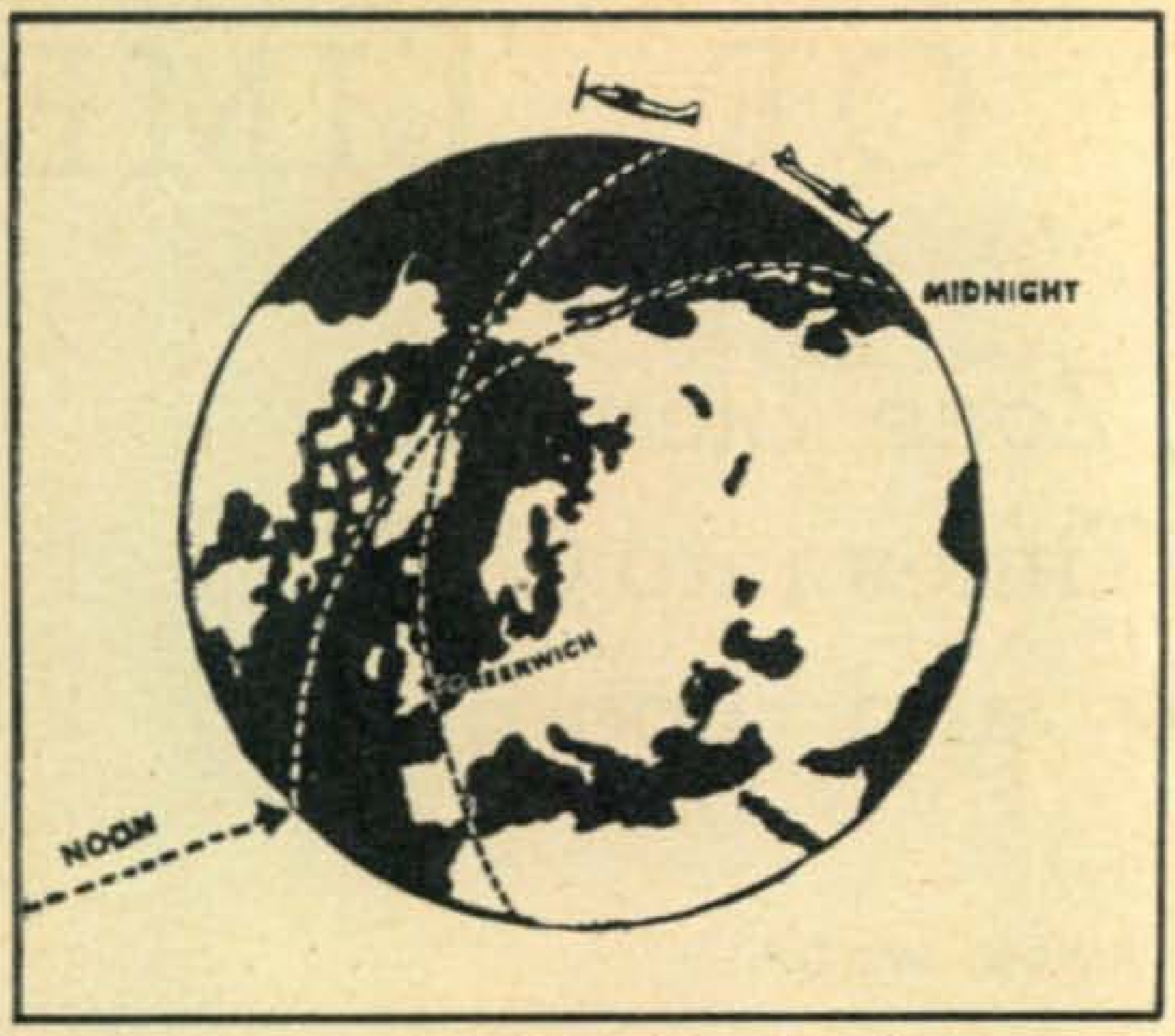


Time zones described in a polar diagram. Eastern Standard Time is 75 degrees and five hours west of Greenwich

Navigation tables and charts are tabulated in such a way that information may be found for any instant of Greenwich Civil Time. Obviously, it would be impractical to tabulate all these data for each meridian of the world, and so the zero degree meridian of Greenwich, England, is chosen as standard. Since Greenwich is on the 0 degree meridian, its local civil time, standard time, and zone time are all identical. GCT is often referred to as "universal time" because time in most parts of the world is derived from GCT, which thus serves as a standard for the times of different places.

Twenty-four-hour Time

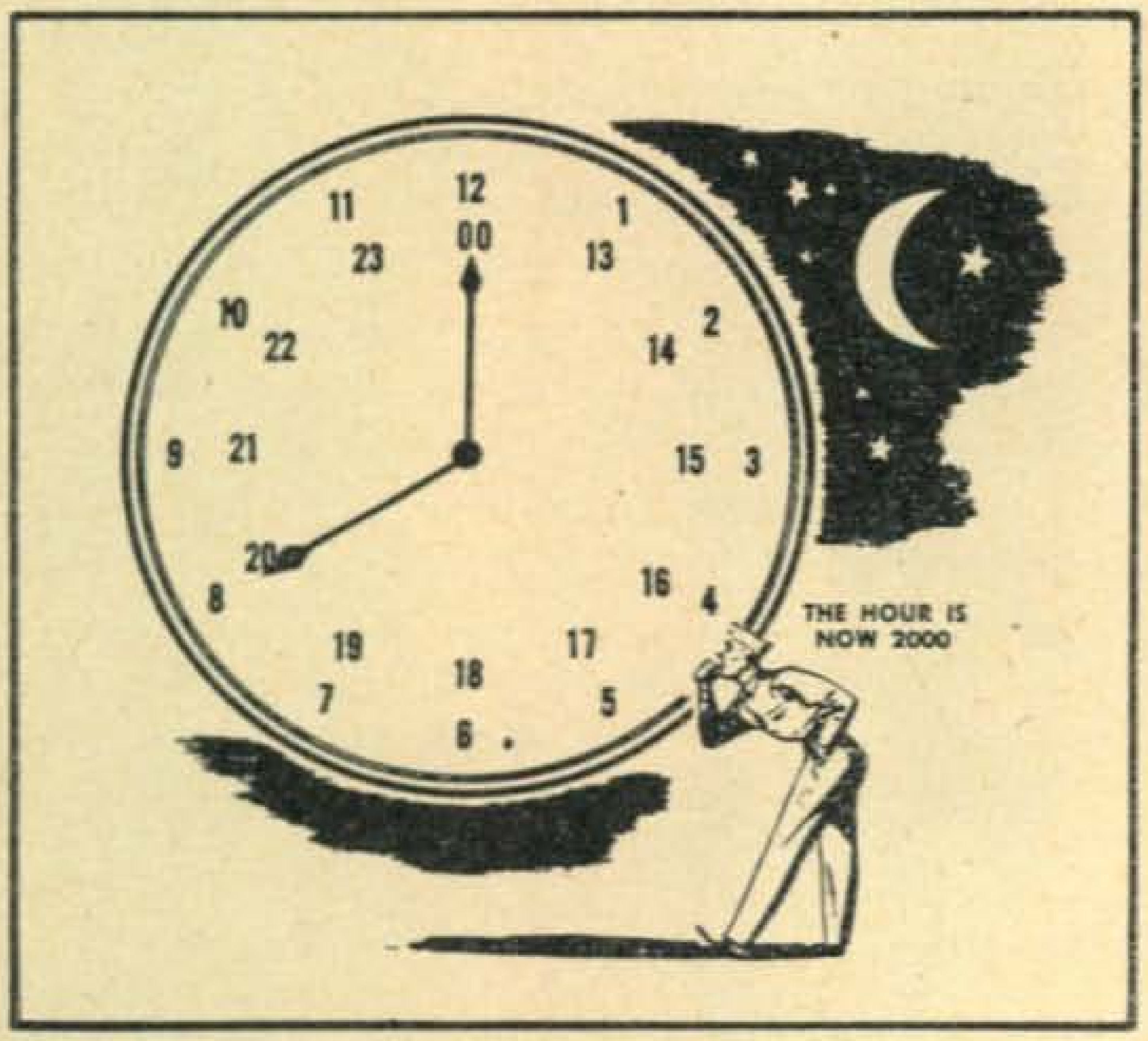
GCT is expressed from 0 hour to 24 hour. Since the everyday clocks and watches in this country are marked only up to 12 hours, a Greenwich Civil Time of more than 12 hours, for example 18



Crossing the International Date Line. Traveling east, subtract one day. Going west, add a day—*Courtesy AAF*

hours, cannot be indicated directly except on special time pieces. In the instance of 18 hours, the face of the regular clock would read 6 hours. In addition, the clock does not give the Greenwich date, which may be the same as the local date, or the day before or after. There need be no trouble or ambiguity if the rules of time are carefully applied, bearing in mind that continuous practice and daily use is the only way to become familiar with GCT.

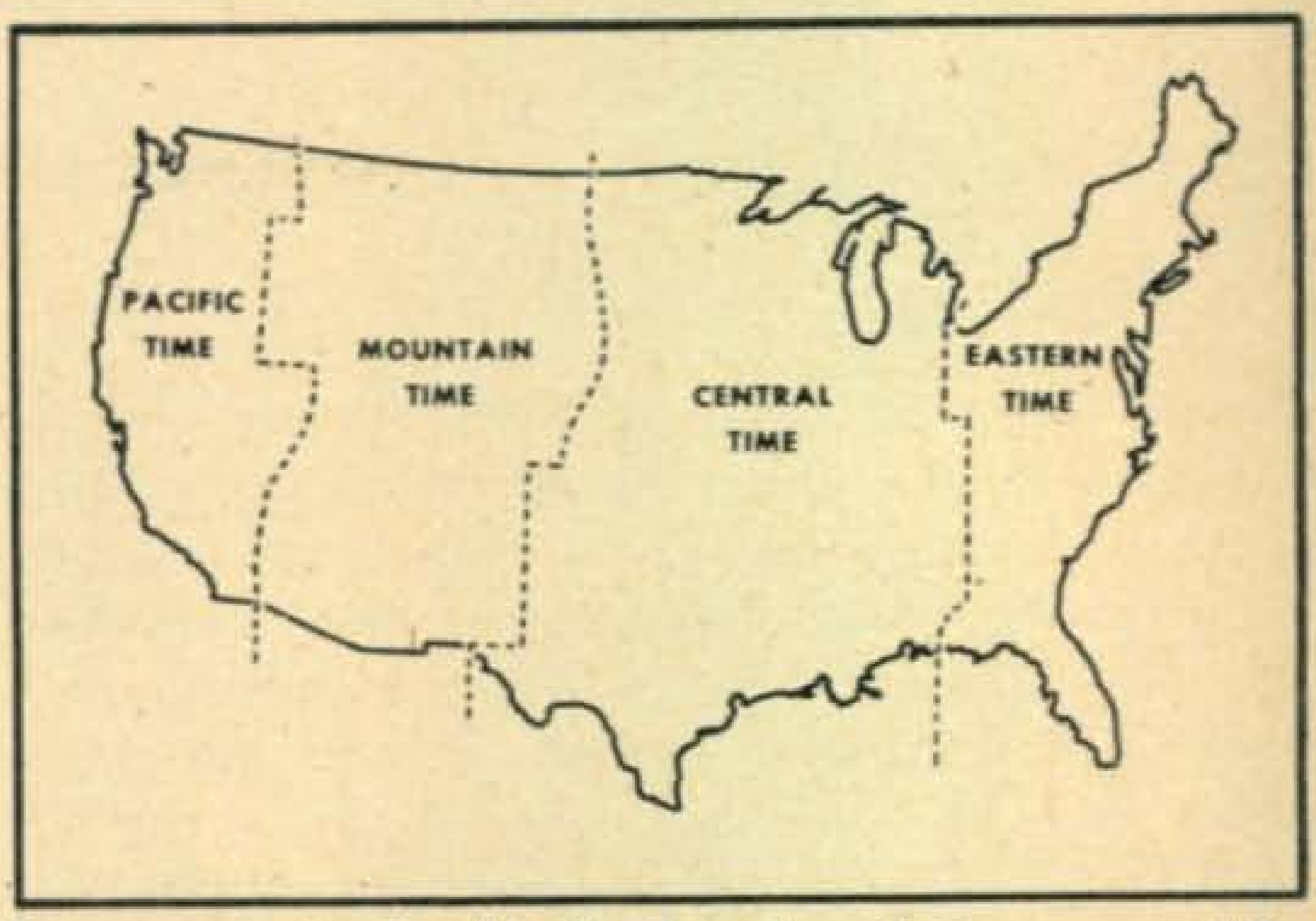
Zone time is derived directly from GCT. If you start at a given place, and travel around the world eastward, setting your watch one hour ahead for every 15-degree (24 hours for 360 degrees) change in longitude as you should do, when you get back at your starting point, you will find that you are one day ahead of the day there. If you travel westward, instead of eastward, then you will be one day behind the date when you return to your starting point. In going around the world, the date must be changed enroute on crossing the 180th meridian, by subtracting one day from the date when sailing eastward, or adding one day when sailing westward. The instant of GCT noon is the only time during a day that the same date prevails throughout the world.



Twenty-four-hour time is standard in parts of Europe. Above is a conventional twelve-hour dial with an inner circle adding up to twenty-four-hour time —*Courtesy AAF*

Zone Time

Each of the time zones is 15 degrees wide, making the total of 24 zones. The first two zones of 15 degrees has the 0 degree meridian, Greenwich, as a bisecting line. Traveling east, the zones are plus. Traveling west, the zones are minus. It is important to remember the GCT hour is the same all over the world. But the zone or "standard" time is local.



Time zones in the U. S. A. Local time may differ from the four standard times—*Courtesy AAF*

In the United States local civil time prevails in belts or zones extending as nearly as practicable, 7.5 degrees on either side of a "standard" meridian, making each zone 15 degrees wide. Such time is designated "standard time." With the meridian of Greenwich taken as the initial starting point, others are assigned at every 15 degrees of longitude. Thus in the United States the standard meridians are the 75th, 90th, 105th, and 120th west, and in Alaska the 135th, 150th and 165th west. All the people of the same meridian, regardless of the latitude, have the same time.

The local civil time of the 75th meridian is called Eastern Standard Time. Similarly, that of the 105th meridian is Central Standard Time, etc. Eastern Standard Time (75th meridian time) differs from Pacific Standard Time (120th meridian) by 3 hours because the two standard meridians differ by 45 degrees of longitude. PST is 3 hours behind EST because the sun, our timekeeper, rises in the east, and thus becomes visible in New York 3 hours before it rises in San Francisco, which is west of New York. For the same reason, the sun crosses New York's meridian about 3 hours before crossing San

Francisco's. In other words, when it is noon in New York it is 9:00 A.M. in San Francisco.

Civil Time

The local civil times of two places differ as their exact longitudes. Their standard time varies as the longitudes of their standard meridians. This simply means that standard time invariably differs by one or more whole hours, since the standard meridians are always one hour apart in longitude. For example, local civil time, between New York and San Francisco, which are 48 degrees 30 minutes apart in longitude, would differ by 3 hours and 14 minutes.

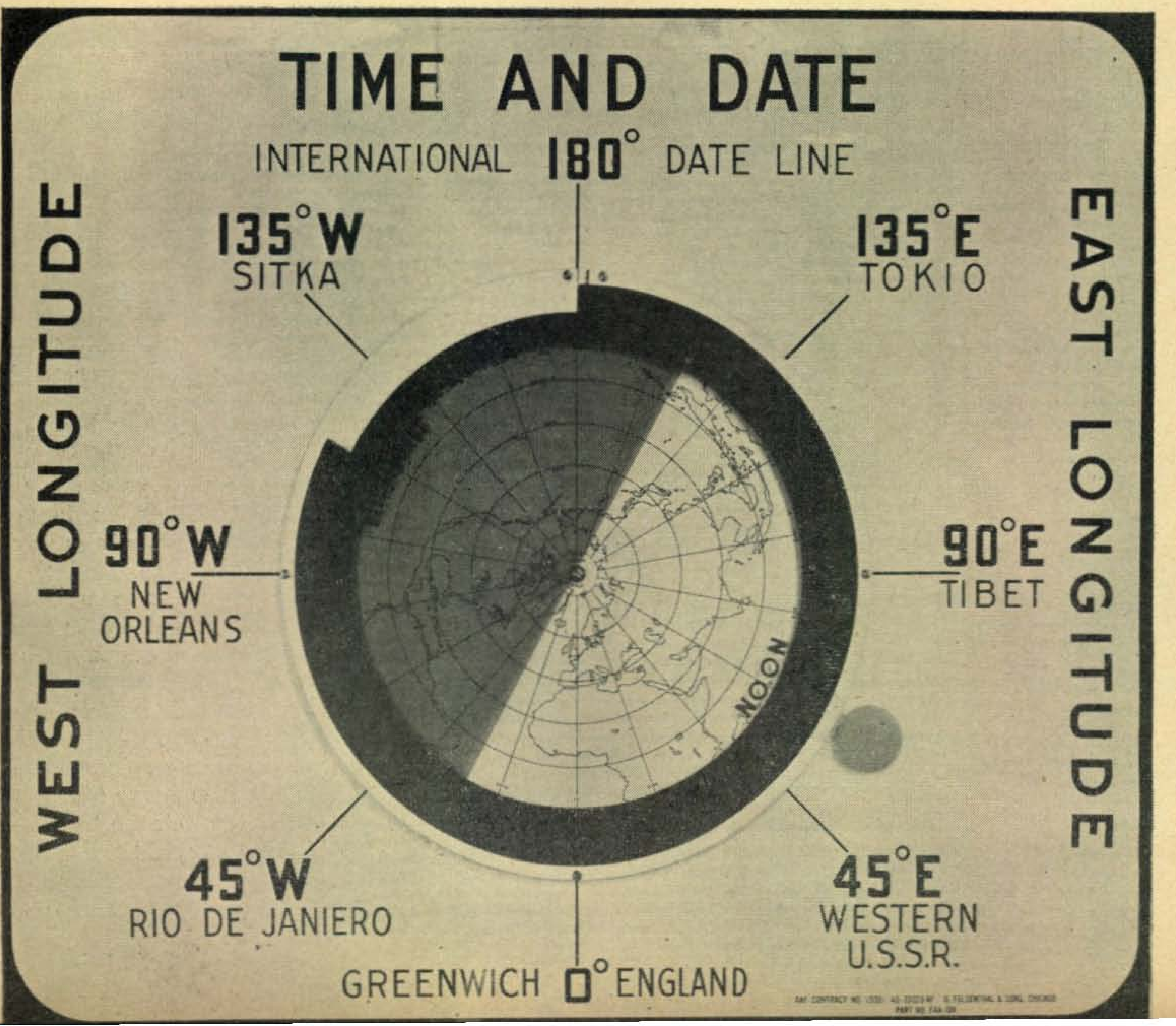
Many irregularities have crept in, as communities decided to keep the standard time of some large city nearby. Daylight and War Saving time have introduced further complications. During the spring and summer months, when there are more hours of daylight than of darkness, many localities adjust their standard time so as to "save" or utilize daylight to the greatest extent, by advancing clocks and watches at a specified time, so that they keep the time of the next standard meridian eastward. During the daylight-saving time period, New York City which usually keeps Eastern Standard (75th meridian) time, keeps 60th meridian standard time instead.

War Time in the United States has added an hour to the standard time of each zone—so what was formerly 9:00 P.M. Eastern Standard Time becomes 10:00 P.M. Eastern War Time. England has double war time, or two hours "off" their standard time. Thus 0800 GCT is 8:00 A.M. throughout the British Isles. However, double war time makes 0800 GCT actually equal to 10:00 A.M. during the present emergency.

A very few communities prefer to be precise, and differ from GCT by the exact latitude and longitude. An example of this would be the city of Stephenville in Newfoundland, which is minus 2½ hours from GCT on their local time. Thus when it is 1900 GCT it is 1630 hours, or 4:30 P.M. Stephenville War Time. Stephenville is located in approximately the center of the fourth time zone west of the Greenwich meridian, giving them a precise time zone of minus 3½, but they have

[*Continued on page 33*]

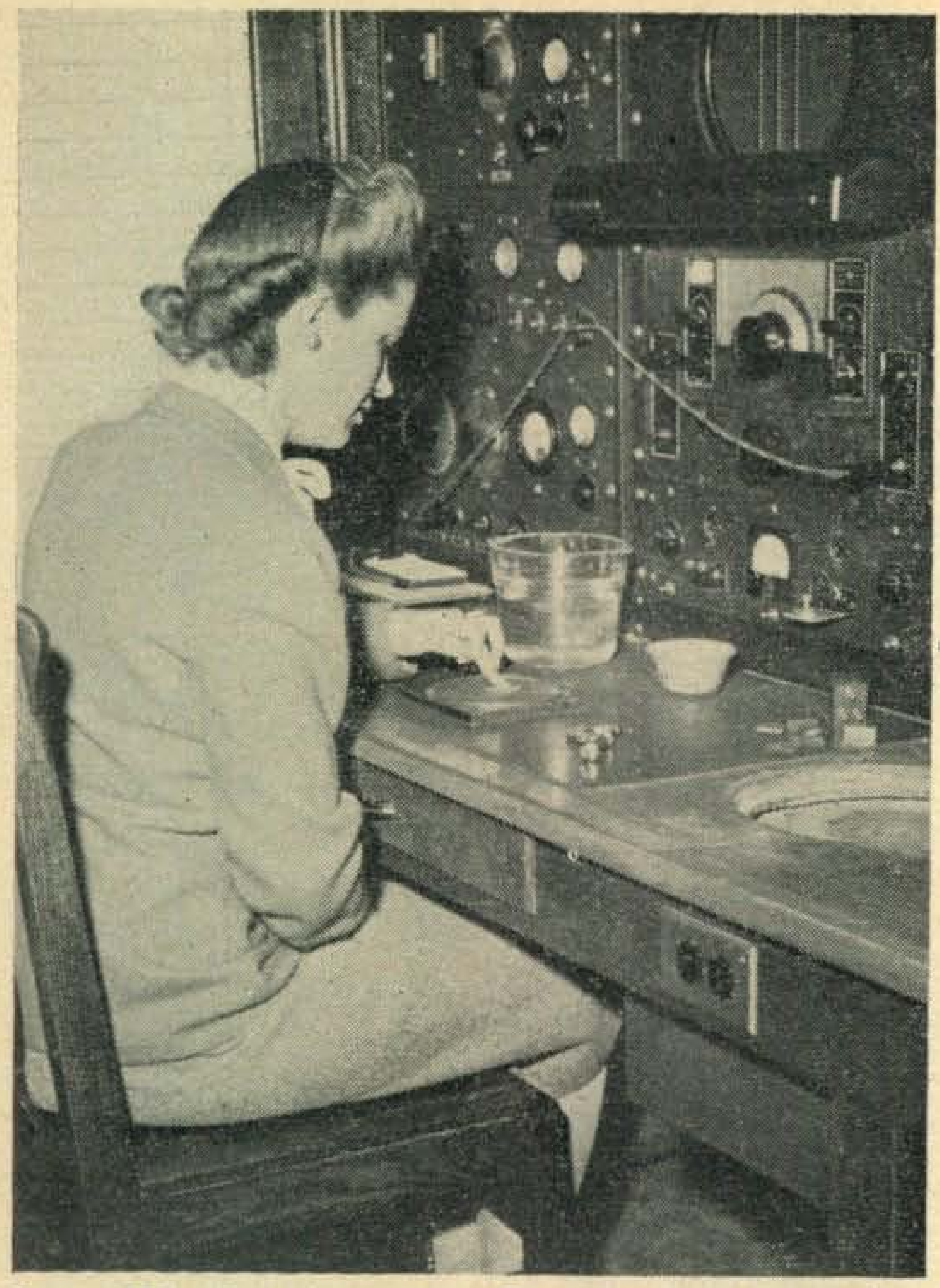
"Time and Date" panel illustrates the function of the International Date Line. This device demonstrates that crossing the International Date Line does not change watch time—only calendar date.
[*Courtesy AAF, Technical Aids Division*]



QUARTZ

RICHARD E. NEBEL, W2DBQ-WLNB

Little detailed information has been published describing methods employed in finishing quartz crystals, which desiderata have given rise to the impression among many amateurs that the manufacturers have been hoarding state secrets. However, the main reason why such data have not been abundant is the fact that crystal grinding is a job for the expert. Post-war considerations have altered the picture to some extent, and we consider W2DBQ's article one of the most informative CQ has been privileged to publish.



Typical finishing position. Operator is using surface ground iron alloy lap instead of glass. Motor-driven edging lap may be seen at right. Rack at left holds frequency standard, test oscillator and interpolation oscillator.

Crystal finishing is a skilled art and, like comparable techniques, mastery can only be attained through extensive practice. However, the situation is somewhat altered in the case of an amateur radio station owner, primarily interested in turning out a crystal for use in his own transmitter. In practically all instances he will start with a manufactured crystal that he wishes to up in frequency—perhaps a kilocycle or even a few hundred. If the crystal used was made by a reputable concern it can be assumed to be a perfect crystal. It must be kept in mind that the instant it is ground on its major faces or edges, even the slightest bit, *it is no longer a finished crystal.* It becomes a "blank". Of course, it may not have been harmed in the least but it cannot be regarded as a finished crystal unless the proper equipment is available to check its operation and prove it to be "finished." The lack of this type of equipment has been one of the serious drawbacks in amateur crystal-grinding experiments.

In attempting to move the frequency of a crystal with no crystal-finishing experience, the odds are against the ham's success. If the crystal stops oscillating completely, the loss is his alone. However, if it seems to oscillate fairly well, he will probably use it in his transmitter—but perhaps with an unstable signal, off-frequency operation, etc. Reasons of economy dictate that the amateur use the crystal, if he possibly can, even if it oscillates poorly, and annoys the fraternity in general. The manufacturer makes every effort to turn out as perfect a crystal as the development of the art will permit, and takes pride in the quality of his product.

His understandable reluctance to have someone with no experience and inadequate equipment attempt to regrind one of his crystals, bungle the job and replace the crystal in the holder bearing his name, is one of the reasons why crystal-grinding information has not been more generally circulated.

War Surplus Stocks

However, war brings many changes and it is the writer's belief that the amateur should be shown how he can shift the frequency of a quartz crystal by a desired and reasonable amount. Many thousands, perhaps millions, of quartz crystals will be available from military surplus after the war. The largest part of these will undoubtedly gravitate to the ham bands.

The majority will be kilocycles distant from the amateur allocations. However, appreciating the tenacity of purpose and pioneering spirit of the radio amateur, the writer (an amateur himself) decided it would do no good to tell the ham he could not successfully regrind a crystal. He'd try

CRYSTAL FINISHING FOR HAMS

it anyway; and so with tongue-in-cheek, the following information is presented. The methods, implements and equipment are adapted especially to amateur use and are not to be construed as representing those employed in mass production, outside of incidental similarities.

Test Oscillator

The main requirement of a crystal from the amateur viewpoint is activity. Temperature coefficient is important but it is assumed that a crystal of low drift cut is at hand. It is further assumed that a perfect crystal is used to begin with—that is, one with high activity, free from all electrical and mechanical flaws and with its frequency stamped on the holder. The activity of a crystal is a measure of its flatness. The higher the frequency (the thinner the crystal) the less unevenness can be tolerated if the crystal is to come up to standard activity. The word "standard" is used relatively as there is no general standard for all quartz oscillators. The military sets a certain standard for a type and frequency of crystal taking into consideration ,only the characteristics peculiar to the piece of equipment in which the crystal is to be used.

For amateur use a compromise standard of activity may be determined with the test oscillator diagrammed in *Fig. 1*. It is important that the component values used be exactly as specified if the instrument is to be of value as a standard. Table I indicates the acceptable maximum and minimum milliammeter readings for the various frequency ranges. Maximum values are read with the load condenser, C_1, set for minimum capacity. Minimum values are read with C_1 set at maximum capacity. It is important to note that, as C_1 is slowly rotated from maximum to minimum capacity, the meter reading (relative activity) should increase evenly and smoothly. Dips or hesitation at any point indicates the generation of spurious frequencies due to uneven or non-parallel surfaces, or coupling of other modes of vibration in the plate. Surface trouble is remedied by face grinding (which raises the frequency), and the latter effect by edge grinding. The apparent performance of a crystal in the transmitter oscillator stage is an inadequate indication of its activity. Also the rectified grid current of the following buffer stage is by no means a satisfactory criterion, especially if the crystal oscillator is keyed.

The test oscillator shown in *Fig. 1* is of the Pierce type. This is particularly suitable for a standard that is to cover a wide range of frequencies as there are no tuning controls. A tuned-plate oscillator would require a separate calibration curve of activity for each range due to the varying L/C ratio between extremes. However, the Pierce oscillator will make the frequency of the crystal appear higher than it actually is in a tuned circuit, so the final frequency must be measured in the oscillator stage of the transmitter. Use the test oscillator for *activity* checks and the transmitter oscillator for final *frequency* determination. The frequency need be measured in the transmitter only when the crystal reaches a point about one kilocycle below the desired frequency as measured in the test oscillator.

Determining Crystal Cuts

It is important to know the cut of a crystal in order to finish it with the proper contours for greatest activity. Provided the frequency is known it is a simple matter to determine the cut by calculation. Every cut has a thickness factor which, divided by the thickness, will yield the frequency or, conversely, divided by the frequency will yield the thickness. Table II shows the thickness factor k for the AT and BT cuts as well as for the X and Y cuts of pre-war vintage which the amateur may attempt to regrind.

Equipment and Materials

Tools and materials are as important as the necessary knowledge to accomplish the desired results. All of the following items should be procured before any attempt is made to regrind a plate:—

1. A standard ½″ or 1″ micrometer reading in thousandths and equipped *with a lock* so that the spindle may be locked in position.
2. A few pieces of *plate* glass, not less than ¼″ thick (preferably thicker) and anywhere from four to seven or eight inches square.
3. A small amount of #600 silicon carbide grain (carborundum).
4. A few sheets of carborundum waterproof paper, #400A.
5. A few ounces of carbon tetrachloride (Carbona).
6. A pair of small tweezers.
7. Lint-free cloths.
8. Some small scraps of window glass.

In addition, a large bowl or basin of water is required as well as a small dish to hold the carborundum. The window glass is cut into small pieces exactly the size of the crystals to be ground—one piece for each size. These glass pieces are known as "protectors." The thick plate glass pieces are called "laps." The waterproof paper is cut into pieces about three or four inches square and the silicon carbide grain is mixed with water to form a thick paste. All of this material, along with a communications receiver, the test oscillator, transmitter and frequency-measuring apparatus, comprise the crystal-finishing layout, and, if you're game, we're now ready to start. The method described below can only be general as we do not know the type or size of crystal, its frequency or how far it is to be moved. It is recommended that initial attempts be made with low-frequency crystals in the largest size available.

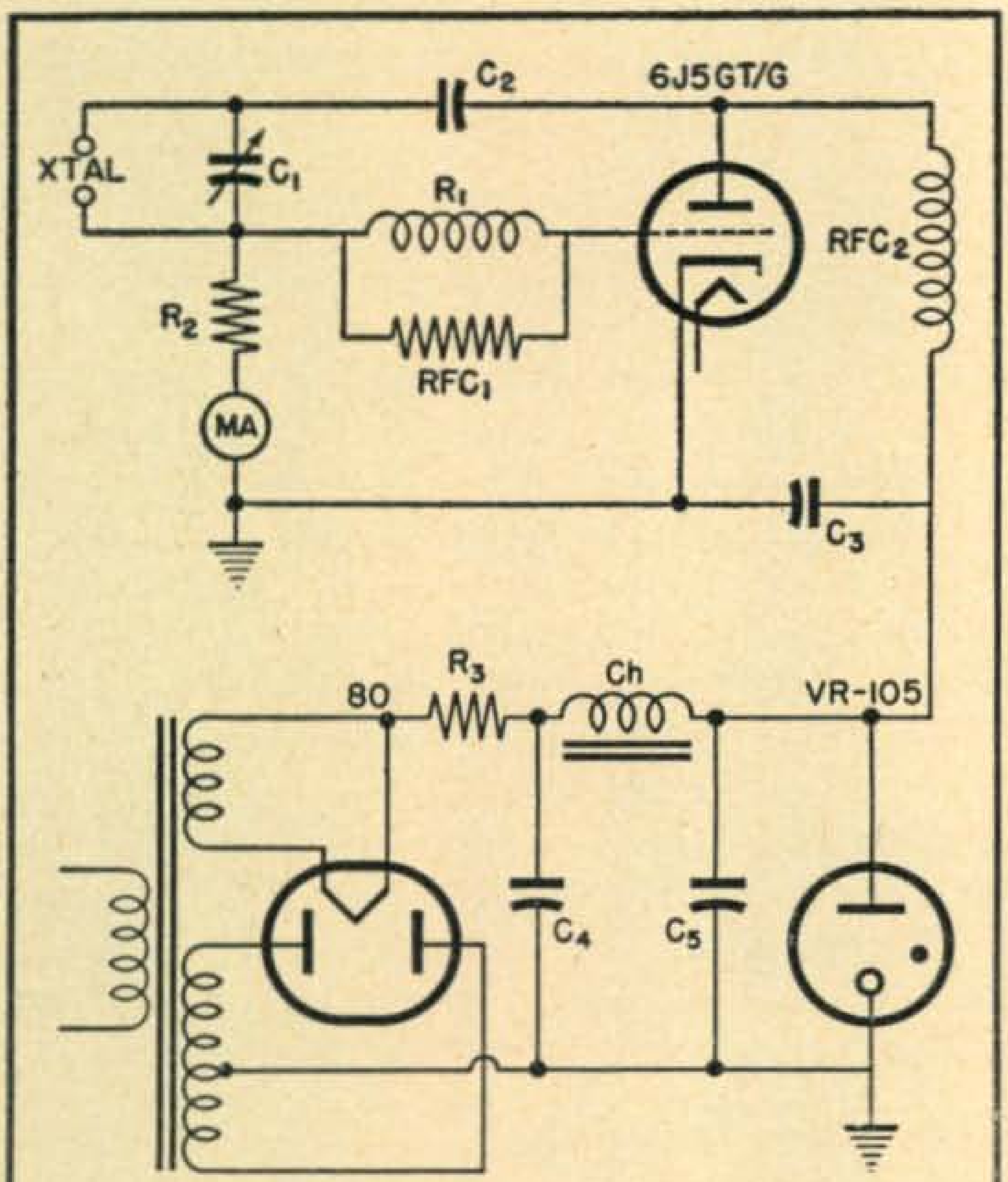


Fig. 1. Test oscillator for crystals—with power supply

R1—100 ohms, ½ watt
R2—30,000 ohms, ½ watt
R3—3000 ohms, 10 watts, wire-wound
C1—35 μμfd, variable
C2—.005 μfd, mica
C3—.005 μfd, mica
C4—8 μfd 450 working volts, d.c.
C5—8 μfd 450 working volts, d.c.
T—250-0-250, 5 and 6.3 volts
CH—2 H filter choke
RFC1—12 turns #14 wire, ¼-inch inside diameter, spaced ½ diameter wire and air-wound.
RFC2—2.5 MH choke
M—0—1 ma meter

FREQ. RANGE-KC/S	METER READING AT C1 MIN.	METER READING AT C1 MAX.
1700-3000	1.0	0.8
3000-4000	1.0	0.75
4000-5500	0.95	0.6
5500-6500	0.9	0.4
6500-7500	0.8	0.2

Table 1. Activity readings in test oscillator

Finishing Procedures

The method by which a crystal may be moved a kilocycle or two is so simple that the reader may question the above list of materials. It should be kept in mind, however, that the basic purpose of this paper is to describe a method whereby "war-baby" crystals can be converted to ham use, and in only a few cases will these be within one or two kilocycles of the amateur bands. They may be hundreds and even thousands of kilocycles too low—and in such instances the recommended inventory represents an absolute minimum.

Before beginning operation on any crystal it is suggested that it be put in the test oscillator and the reading noted. This reading will probably be quite low in accordance with Table I, if the crystal is of the amateur type produced before the war. There are numerous reasons for this, chiefly aging and the accumulation of foreign matter over a long period of non-use. Just to become familiar with the effect foreign matter can have on the crystal, dismount it from the holder and, grasping it in the tweezers, immerse the crystal in the carbon-tet and shake it around a bit. Grasp it in a different position and repeat the operation. Dry it quickly on one of the cloths, being careful not to touch any part of the crystal with the fingers except the edges. Then replace it in the holder and recheck the activity. In most cases you will be very much surprised. Performing this operation a number of times with various crystals will help develop the "feel" for handling them. The above procedure with the

F x T = K	CUT	K
WHERE	AT	66.2
F = FREQ. IN KC/S	BT	100.0
T = THICKNESS IN INCHES	X	112.6
K = THICKNESS FACTOR (A CONSTANT)	Y	77.0
EXAMPLE: F=3510 KC/S T=.0189 INCHES K=3510 X .0189=66.2 CRYSTAL IS AT CUT		

Table 2. Thickness factor and formula for determining crystal cuts

carbon-tet is the cleaning method referred to hereafter whenever we say "clean the crystal."

To begin with, let us move an 80-meter crystal a few kilocycles. Immerse a piece of the waterproof paper in water and stick it on one of the glass laps. Place the crystal on the surface of the paper and with the finger in the center of the crystal maintaining slight pressure, move it about three inches. Then rinse the crystal in the bowl of water, dry it on a cloth and replace in holder. Check frequency and activity. Be sure to keep track of which side of the crystal was abrased *and work only on that side.* Repeat this operation until the frequency is only a few hundred cycles below that desired. If the activity is not up to par it should be possible to increase it by edge grinding, as described later. The reason for stopping a bit low in frequency is that the edge grinding also may affect the frequency. If the activity is satisfactory, clean the crystal and measure the frequency to see if it was raised by cleaning. If not, another touch to the waterproof paper should properly finish it. Only experience can teach the amount of abrasion and pressure necessary to accomplish the desired result.

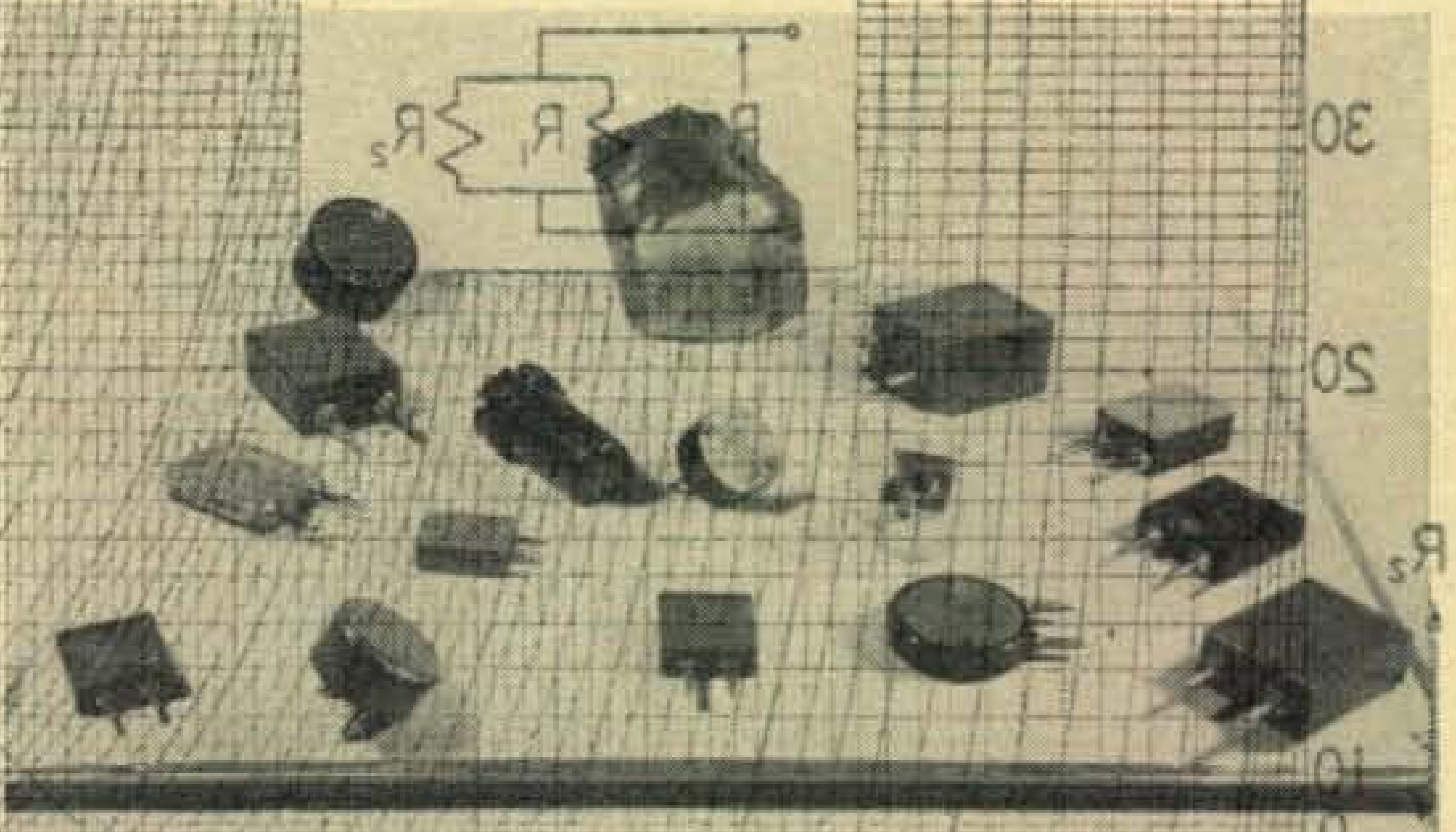
After a number of rubs the surface of the crystal will take on a polished appearance and it will be noted that the frequency is moved less and less with each treatment. A point is finally reached where the surface is quite polished and the frequency can no longer be raised no matter how hard the plate is rubbed. The micrometer has not been used so far as one need not be concerned with the crystal getting out of true. Only an infinitesimal quantity of quartz can be removed from the surface by this method, which amount is abraded evenly so the original contours are not disturbed. By polishing one face to the limit the frequency rise can be doubled by polishing the other face. The frequency shift that can be attained by this method depends on the cut of the crystal and its frequency. As a rough approximation, forty kilocycles can be removed at seven megacycles. CAUTION: *Keep the paper wet.*

We can now turn our attention to crystal grinding where it is necessary to move a crystal, say, two hundred kilocycles. Here the cut of the crystal must first be determined. For greatest activity the contours of the AT, BT, and Y cuts should be slightly higher in the center of the plate, that is, convex. In the X cut, the center must be slightly lower or concave.

Using the Micrometer

To become proficient in the use of the micrometer, it is well to practice a bit. This will also acquaint you with the contours of a commercially finished plate. Hold the crystal on the anvil of the micrometer and close the spindle so that it clamps the crystal very lightly. Then tighten the lock. There should be just enough pressure so that the crystal will not fall out of its own weight but not enough to prevent sliding it about with the fingers. The spindle may be adjusted slightly, even with the lock on. By sliding the crystal around it will be found to be loose in some spots and tighter in others. The tight spots of course indicate that the crystal is thicker at those points. It is said that a difference in thickness of a few hundred-thousandths of an inch can be detected, but the "feel" can only be acquired with practice.

Before starting to grind our crystal it is assumed that it has the proper contours on both faces. One face is then completely polished on the waterproof paper and will be hereafter known as the reference face. All grinding is done on the other face, the reference face not being touched again. The reason for polishing the reference face is so that it can be recognized. Polished faces also increase activity a bit and minimize aging effects.



Various types of crystal units, some of which may come into the hams' possession after the war. In the center background is a raw "mother" crystal

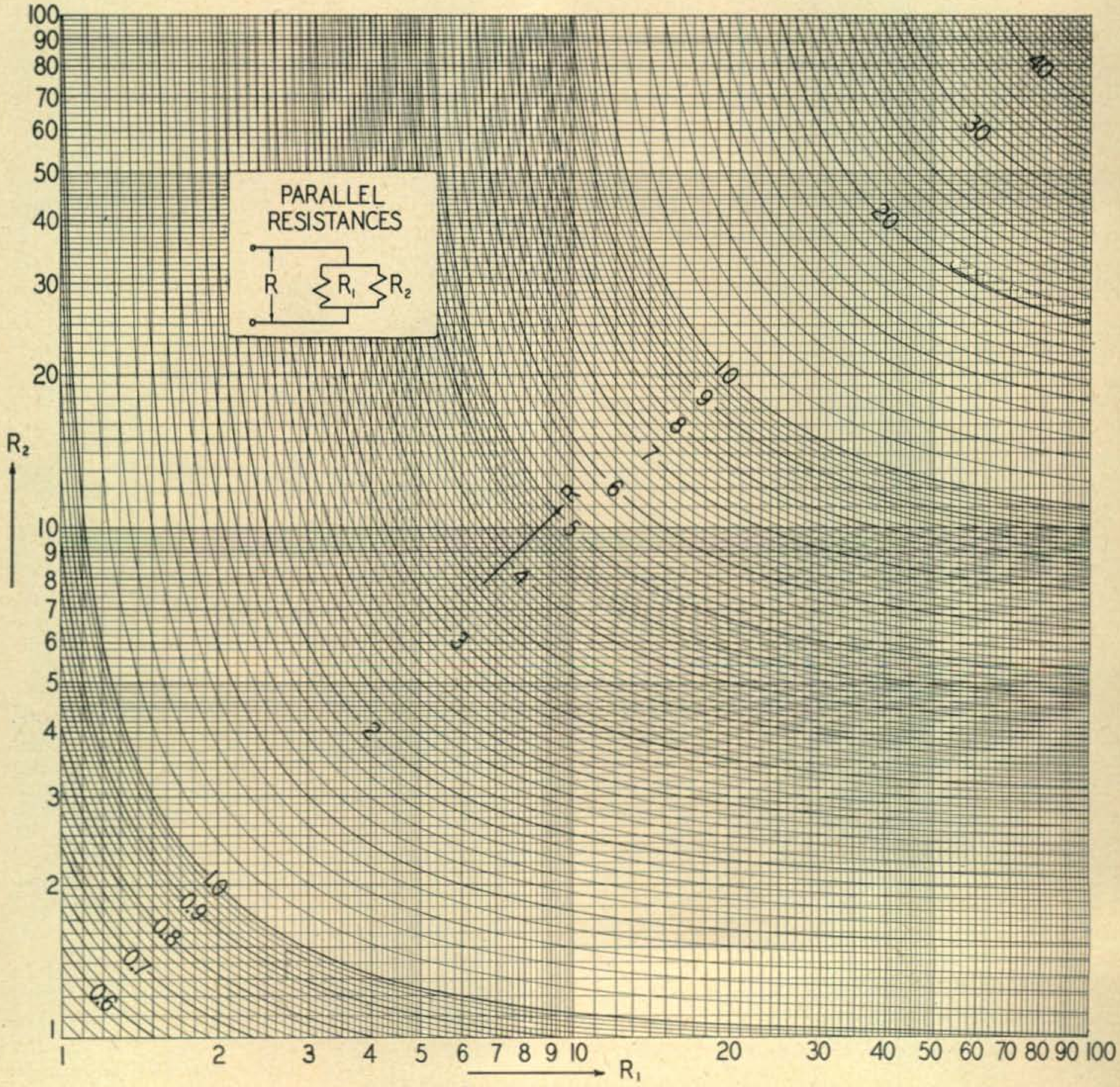
A bit of the silicon carbide grain is smeared over one of the laps and a glass protector the size of the crystal is ground on one face by placing it on the lap and with the finger in the center describing "figure eight" patterns. Be sure plenty of water is used with the abrasive. The protector is treated this way to provide a ground surface to which the crystal will adhere. With both the protector and the crystal washed and dried, the tip of the tongue is touched to the ground surface of the protector and to the reference face of the crystal. The crystal is slid on the protector

[*Continued on page 34*]

PARALLEL RESISTANCE CHART

C. J. MERCHANT
Brush Development Co.

THIS CHART GIVES CONSTANT PERCENTAGE ERROR WITHIN 1% FOR THE RESULTANT PARALLEL RESISTANCE



BENT ANTENNAS

Modifying the Horizontal Half-Wave Radiator Where Space Is Limited

DAVID M. SANDERS, W2HSY

Bent antennas will work and work well—often without any apparent rhyme or reason. The worst we ever saw was a compromise between a hair-pin and a wash-drier strung in some memory-defying manner between the garage and house at W4DVO-WLRB, Tampa, Florida. We doubt if any part of this sky-hook-or-by-crook was more than 25 feet above ground. It was end-fed on 80, 40 and 20 meters, and the shack was so plastered with cards that half the radiation went into the thumb tacks!—Ed.

To many amateurs, especially those living in the city, the erection of a suitable antenna presents a major problem. Putting up a half-wave antenna in limited space is often impossible. Where sufficient room for a horizontal straight wire is not available, a compromise radiation system can be used. It is not claimed that the compromise will be as efficient as an antenna constructed "according to Hoyle," but if intelligently considered and built, good results can be expected.

Before erecting an antenna in restricted space it is well to consider first some fundamental antenna characteristics. Almost anything connected to a transmitter will radiate some energy. Even a dummy aerial or a very short piece of wire will radiate sufficient energy to be picked up at a near-by location. The main differences between antennas are efficiency and radiation pattern. For the ham without the room, the radiation pattern will usually have to be what it turns out, but the efficiency can be worked on and in most cases made reasonably good.

The Half-Wave Antenna

The fundamental antenna is a straight wire one-half wave long electrically. The formula for calculating such an antenna is —

$$\text{Length (in feet)} = \frac{468{,}000}{\text{frequency (in kilocycles)}}.$$

The antenna can be coupled to the transmitter at either end of the wire, which is known as voltage feed, or current-fed to the center. In both cases, as a characteristic of the half-wave antenna, maximum voltage occurs at either end of the wire and the current is maximum at the center. Theoretically, maximum radiation occurs at the point of the most current. It is therefore important in any antenna system to have the point of maximum current (the center in the instance

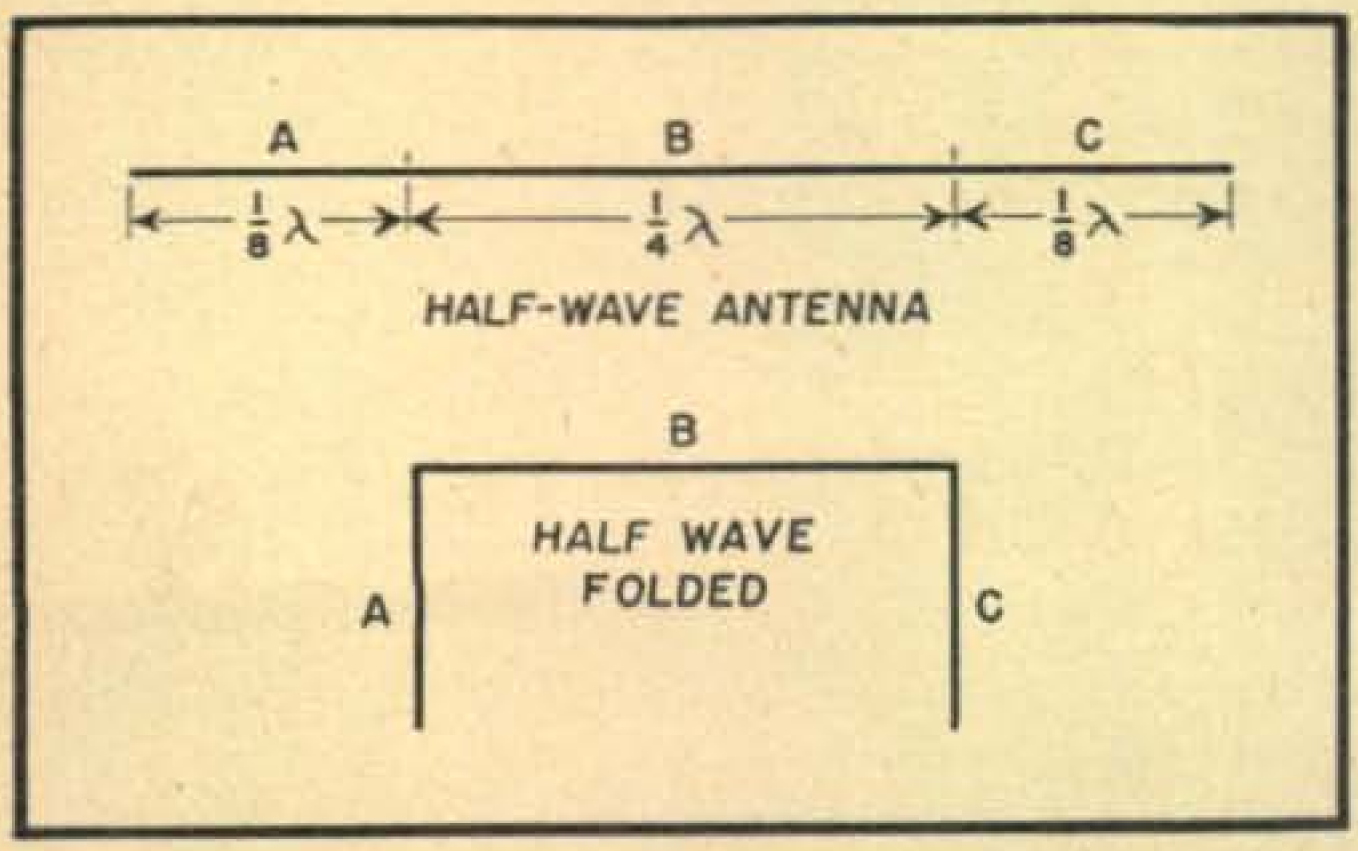


Fig. 1. the half-wave antenna, with the preferred dimensions for folding. Half the horizontal space is saved

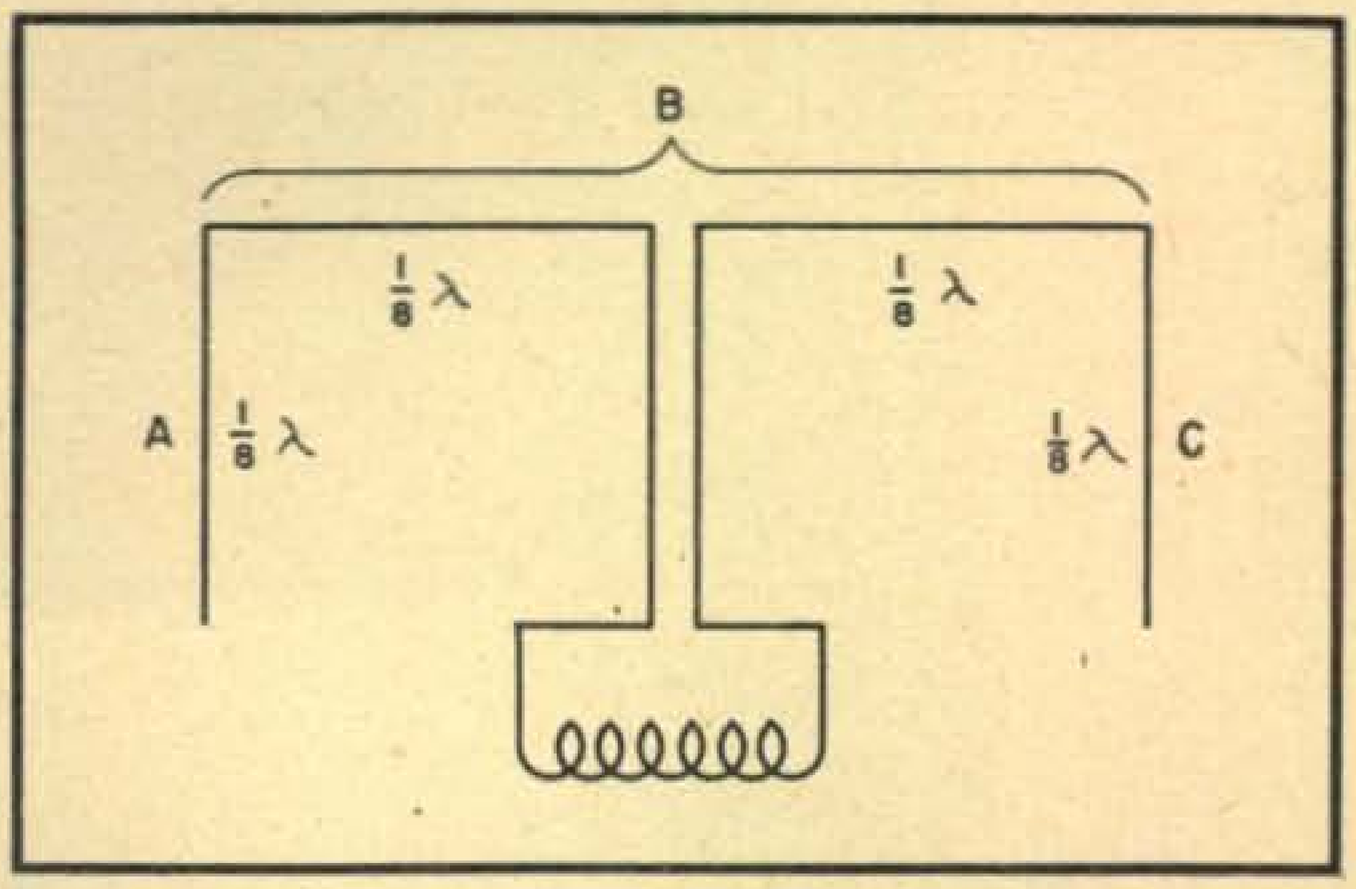


Fig. 2. Current feed to the bent half-wave antenna. Keep the center in the clear

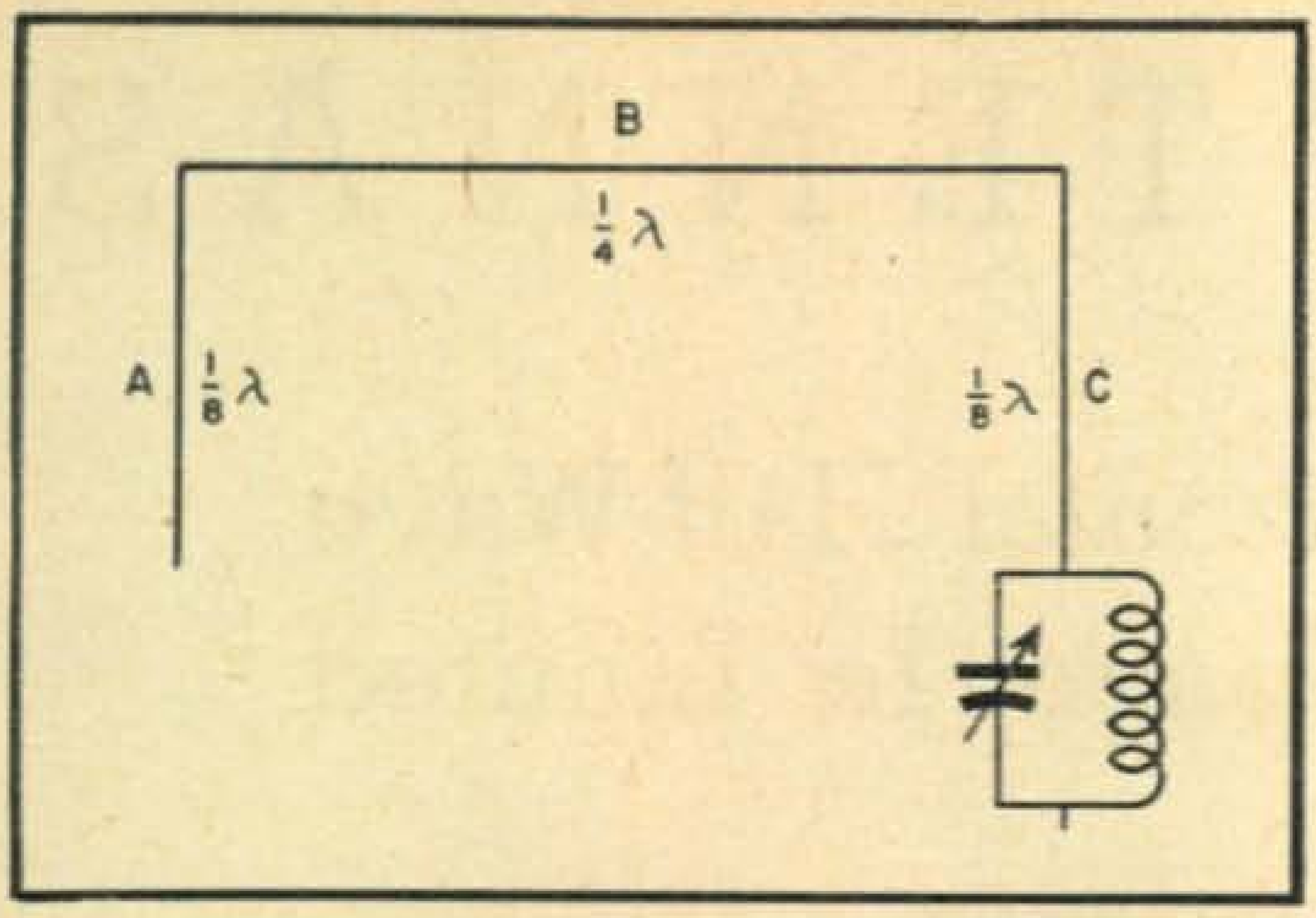


Fig. 3. End or voltage feed can also be employed with the bent antenna

of the half-wave) as much in the clear as possible. Should the point of maximum antenna current be close to surrounding objects, much of the radiation is absorbed and less energy will be available for its intended work.

The Bent Antenna

A half-wave bent antenna can be approximately as efficient as a straight wire and also have about the same radiation pattern. Where space will not permit a straight half-wave wire this is probably the most efficient type of antenna that can be constructed.

Generally, the best method of "folding" the wire is to bend both ends down, leaving the center section straight and horizontal. The bent antenna should be one-half wave long overall with the ends bent down. The folded ends are each one-quarter of the total length (or ⅛ wavelength) leaving the center section a quarter wave (*Fig. 1*). It can be seen that this antenna will only require half the horizontal space of a half-wave straight wire. Since this is a half-wave antenna, maximum current will occur in the center where the wire is straight and horizontal—thus the similarity of radiation patterns of the straight and bent antennas.

The transmitter can be connected to this antenna in any of the conventional methods (*Figs. 2* and *3*.) It may be possible to conserve more space by using end-feed—i.e., connecting the transmitter to one end of the radiator.

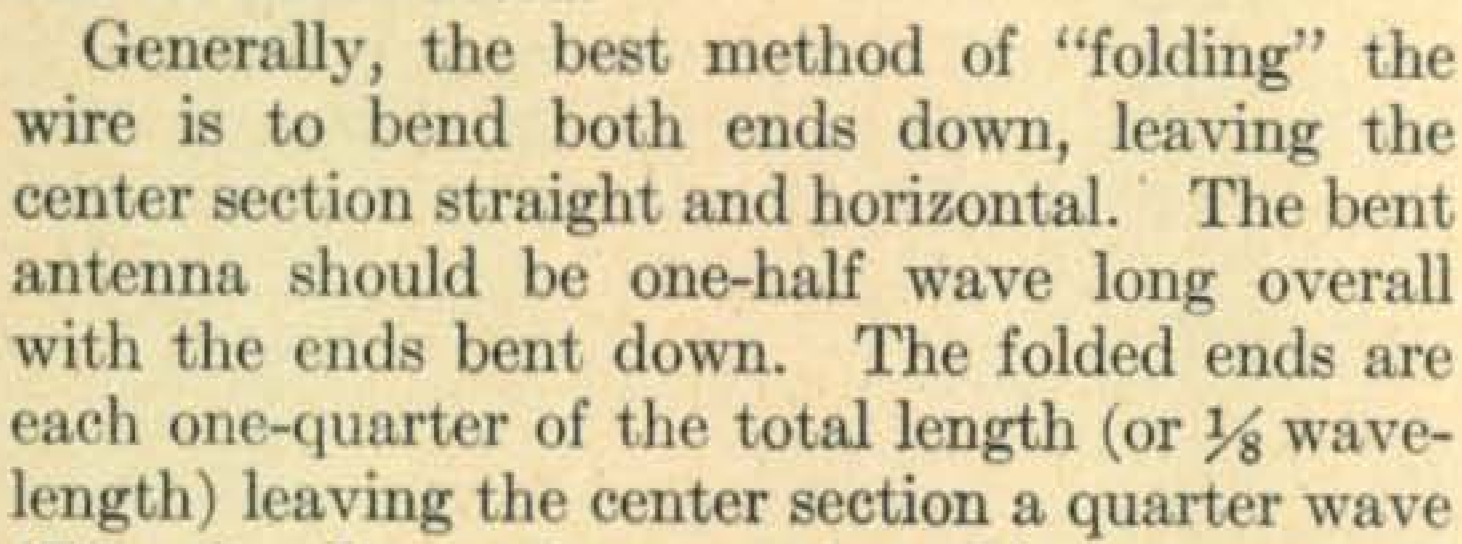


Fig. 4. The folding or bending pattern actually used at station W2HSY—with good results

If the bent antenna suggested will not fit into the available space, then the ends or the whole wire can be folded to conform with conditions. However, the radiation pattern will most likely be different and the efficiency may suffer as well, due to probable cancellation of radiation lobes. But in any case it would be difficult to predict the radiation pattern and only experimentation with any set-up would determine it.

In general, when bending an antenna, keep the center point of the half-wave wire straight and horizontal and as much in the clear as possible. Avoid sharp curves and do not fold the antenna back on itself and run portions of the wire parallel and close together. These precautions should be heeded to prevent field cancellation. The fields around two parallel a-c lines tend to cancel each other. If the half-wave antenna is strung out and then back on itself, this parallel condition will exist with limited radiation. As the two free ends are spread apart, cancellation becomes less and less. In some cases of bending an antenna, it might happen that radiation lobes would be additive instead of subtractive with somewhat the effect of a directional antenna. Only experimentation with a given case will determine its characteristics, and if found undesirable another method of folding the antenna must be tried.

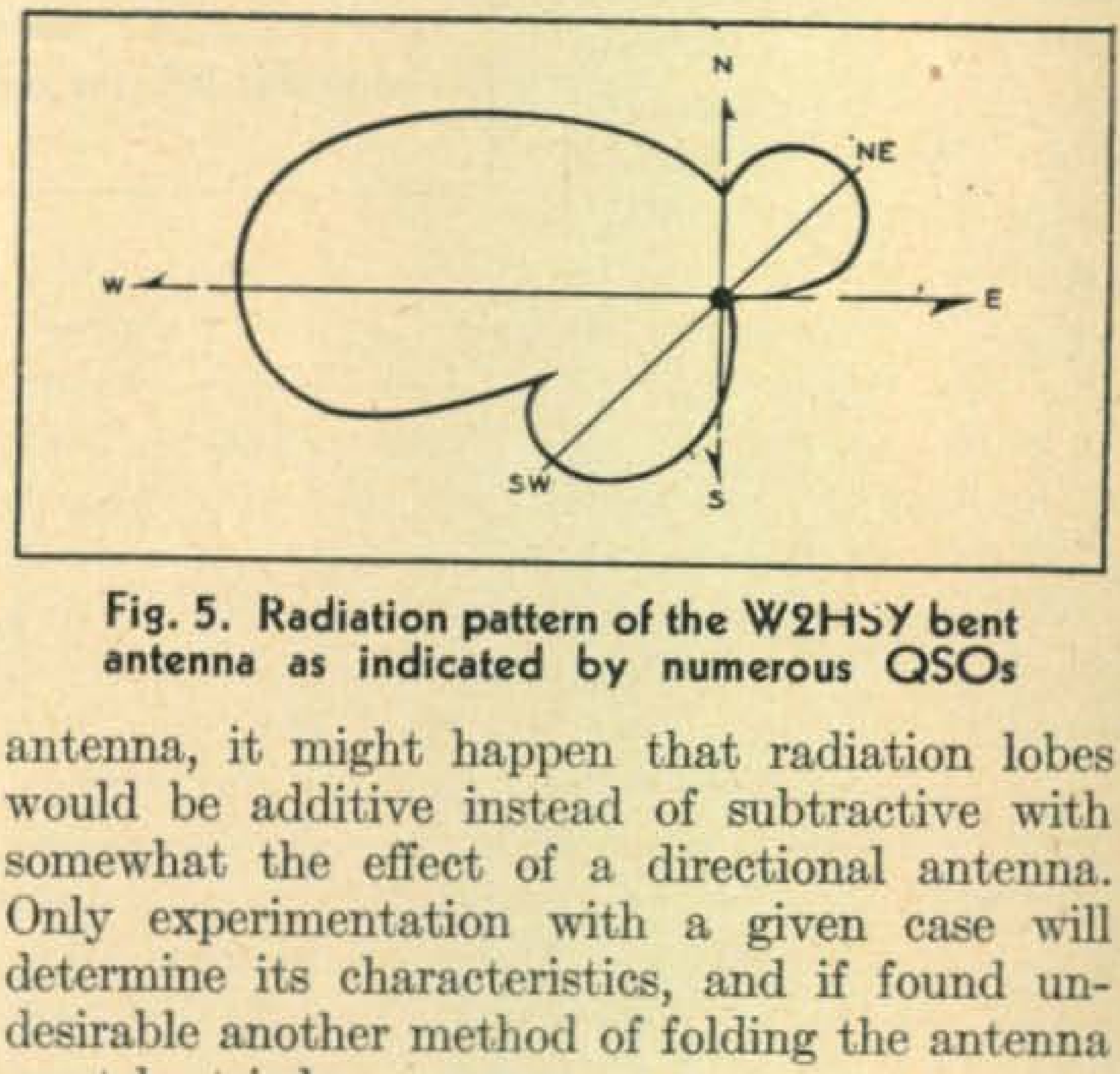


Fig. 5. Radiation pattern of the W2HSY bent antenna as indicated by numerous QSOs

Antenna at W2HSY

The writer's interest in bent antennas was the result of living in an apartment where there was not space for a conventional 40 meter half-wave wire in a straight line. Even a Marconi antenna was considered out, due to the ground connection. A 66-foot wire (*Fig. 4*) was finally strung out and with two bends in it to squeeze into the back yard. The antenna was coupled directly to the transmitter, as using feeders would have required additional and unavailable space in this case. The bending was as follows: From transmitter northerly 6 feet to first bend; thence 20 feet westerly to the second bend; and finally 40 feet southwesterly. Nowhere could any literature be found on the behavior of such a radiator—which

[Continued on page 40]

RADIO AMATEURS' WORKSHEET

No. 2. SUPER-REGENERATIVE RECEIVERS

A SUPER-REGENERATIVE receiver is one in which the regeneration is varied in such manners that the circuit is rendered oscillatory and non-oscillatory periodically. Consider the circuit of *Fig. 1*, which is a Hartley oscillator. Now, the coupling between the two sections of the tank coil may be reduced until, for a given plate voltage, the circuit does not oscillate. And for a given coupling, the plate voltage may be reduced until no oscillation occurs. The effect of increasing the plate voltage or coupling can be considered equivalent to introducing a negative resistance into the tank circuit. Now, the tuned circuit can be considered as having for any given frequency, a finite positive resistance. This is not constant under all conditions, however, due to the effect of the tube. To some degree the positive resistance of the circuit of *Fig. 1* is a function of the current flowing in the circuit.

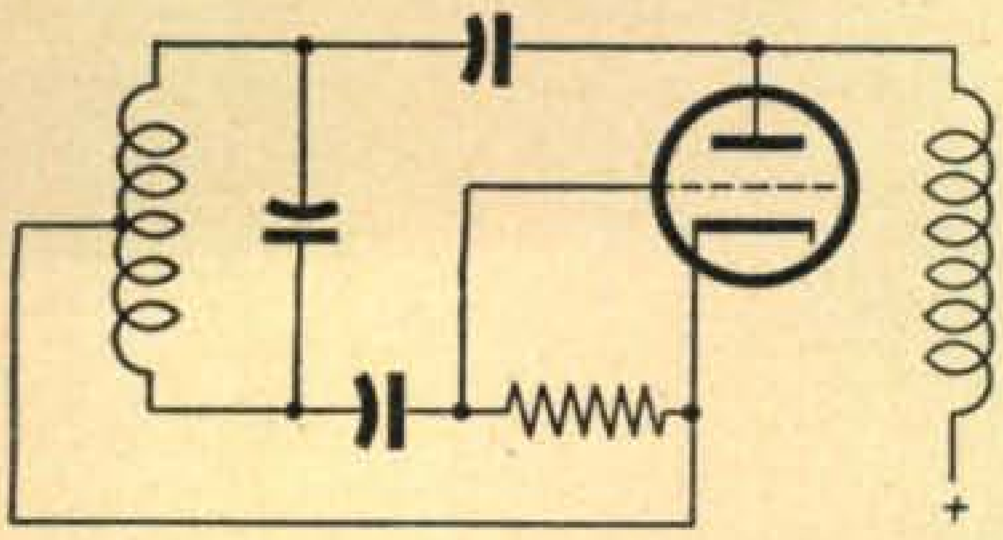


Figure 1

The negative resistance introduced into the circuit by regeneration subtracts directly from the positive resistance of the circuit. Thus, if the positive resistance of the circuit is 10 ohms and 2 ohms of negative resistance is introduced into the circuit the net or effective resistance will be 8 ohms. The negative resistance may be less than, equal to, or greater than the finite positive resistance. If the net resistance is positive and a voltage is suddenly impressed on the circuit the current flowing in the circuit as a result will be directly proportional to the impressed voltage and inversely proportional to the net or effective resistance. When the voltage is removed the oscillations will be damped out at a rate determined by the effective resistance of the circuit. See *Fig. 2*.

If the negative resistance introduced by regeneration is equal to the positive resistance of the tank circuit, the effective resistance will be zero. If a voltage is suddenly impressed on the tank circuit, the current in the circuit will build up at a rate directly proportional to the induced voltage, and to the square root of the ratio of the tank circuit capacitance, to the tank circuit inductance. When the impressed voltage is removed the tank circuit will continue to oscillate at the amplitude at which the impressed voltage was removed. Theoretically, if the impressed voltage were not removed the current would continue to build up to infinite amplitude. Actually it would build up until limited by the tube which would exert more damping as the amplitude of the oscillations increase. See *Fig. 3*.

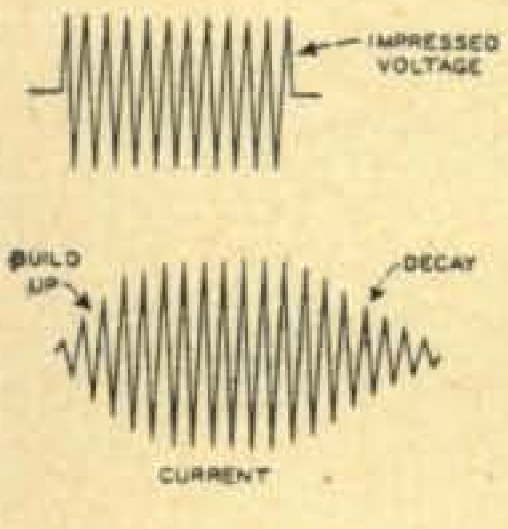


Figure 2

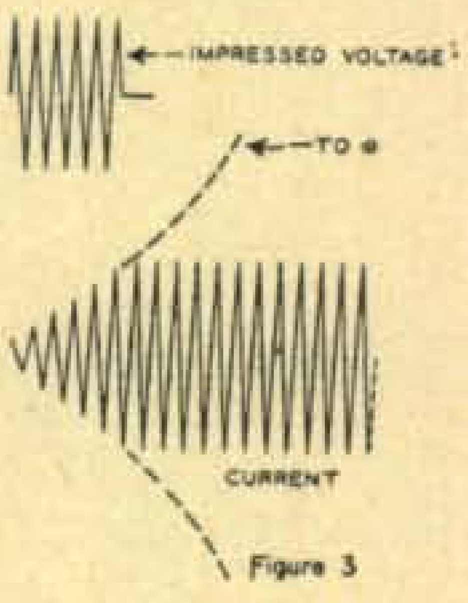


Figure 3

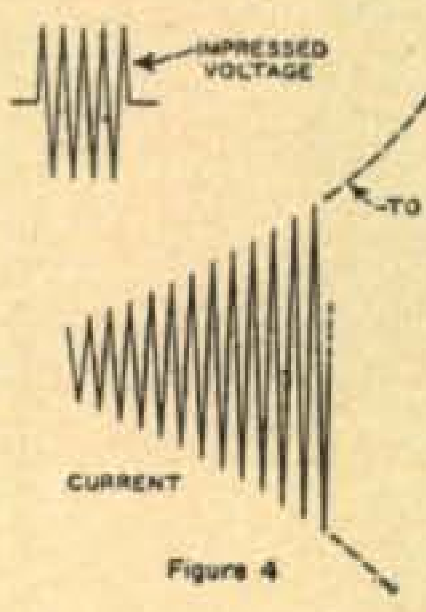


Figure 4

If a voltage is impressed on the tank circuit the net resistance of which is negative, the current starts at a value determined by the quotient of the impressed voltage and the circuit resistance, and theoretically builds up to infinity irrespective of when or whether the induced voltage is removed. See *Fig. 4*. Practically, the current in

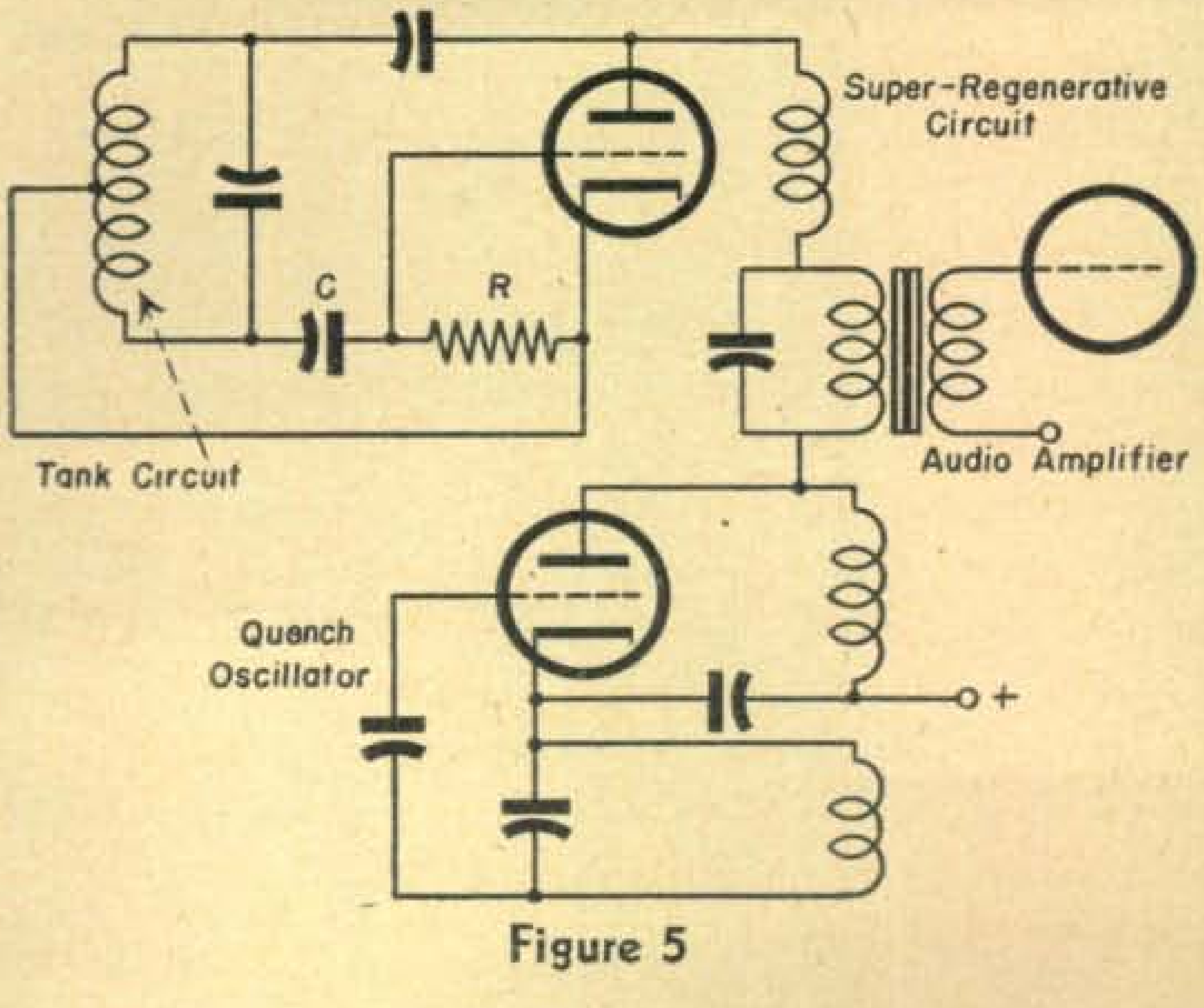


Figure 5

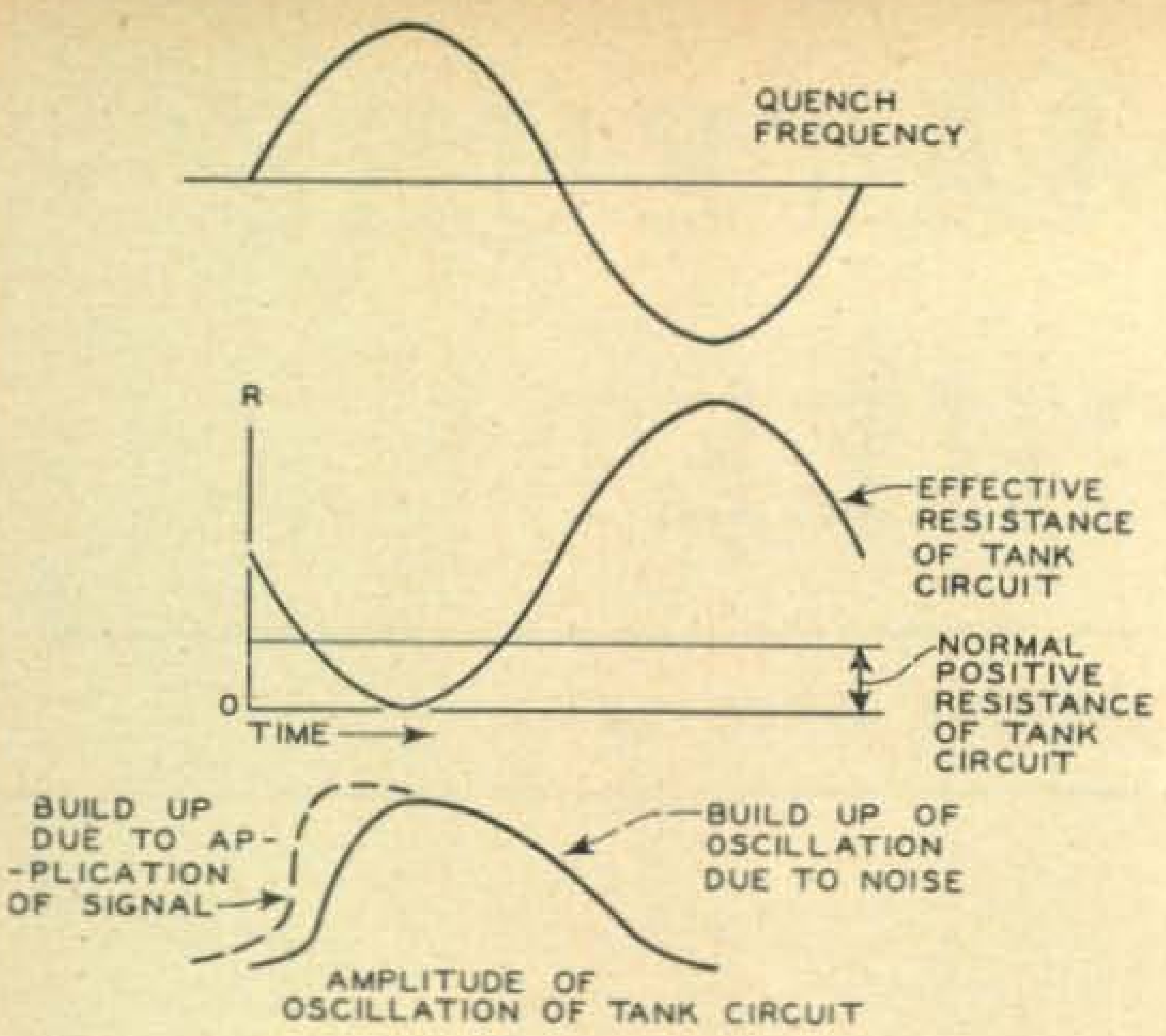


Figure 6

the tank circuit will build up until limited to some finite value by the damping of the tube.

The super-regenerative circuit takes advantage of this situation by increasing and decreasing the plate voltage (or by other means) so that the effective resistance of the tank circuit is first negative, then positive. This can be accomplished by introducing a low-frequency oscillation in the plate circuit of the super-regeneration tube. This oscillation is commonly called the quench frequency. See *Fig. 5*.

The quench frequency is generally above the audible range and below the signal frequency. As the positive half cycle of the quench oscillator increases the plate voltage of the super-regenerative circuit, the effective resistance of the tank circuit decreases through zero to a negative value. Oscillation then builds up in the tank circuit as shown in *Fig. 3* or *Fig. 4*. When the positive peak of the quench frequency is passed, the plate voltage of the super-regenerative circuit starts to decrease and eventually drops to a value at which the effective resistance of the tank circuit becomes positive and the oscillation is damped out. Then follows the negative half-cycle of the quench frequency, reducing the plate voltage of the super-regenerative circuit still further and the process starts over again.

If no signal is fed into the circuit, the thermal noise of the tank circuit or shot effect from the tube will shock the tank circuit, starting oscillation which gives rise to the "characteristic noise" of super-regenerative receivers. When the tank circuit effective resistance is zero or negative, the sensitivity of the receiver is very great, as is the selectivity. As a result, the succession of wave trains introduced above an audible rate gives rise to a series of high sensitivity periods producing what appears to be a continuous noise. This cycle of events is pictured in *Fig. 6*, in which it is shown that the oscillation builds up when the effective resistance of the tank circuit is sufficiently near zero. The build-up of oscillation does not start instantaneously, but builds up in accordance with the constants of the tank circuit.

If a signal is applied which is of higher amplitude than the noise of the tank circuit (i.e., thermal noise) or shot effect, then the oscillations start more promptly and build up at the same rate as if no signal had been applied. This is illustrated by the dotted line in *Fig. 6*. In general the stronger the signal the sooner the build-up process occurs. Since thermal noise and shot effect are random in nature and the desired signal is (or should be) at the resonant frequency of the tank circuit and is continuous in nature, the noise is masked by the signal and is not heard while the signal controls the oscillations of the tank circuit. The build up caused by the signal is exceptional. The curves of *Fig. 6* show that the signal advances the point at which oscillations start while the decay of oscillation is the same whether signal is present or not, and that decay is independent of the strength of the signal.

The Flewelling circuit, which is sometimes called the self-quenching type of super-regenerative circuit does not employ a separate quench oscillator. This circuit quenches by properly proportioning the grid condenser and grid leak (R and C of *Fig. 5*) to obtain interrupted oscillation. The Flewelling circuit is somewhat more critical to adjust than those employing a separate quench oscillator, but it is also much simpler and employs fewer components. The quench frequency of the Flewelling circuit is a function of the signal amplitude and is variable in operation rather than constant as contrasted with the type employing a separate quench oscillator. *Fig. 7* illustrates one form of the Flewelling circuit.

In general, it is considered good practice to use a relatively low quench frequency, say 20 to 50 kc. Most investigators have reported that low quench frequencies require less quench oscillator power, yield better sensitivity, reduce undesired responses, and make for a more stable circuit. It is usually preferable to use a high Q tank circuit rather than to overcome the effect of a high loss tank circuit by increased regeneration.

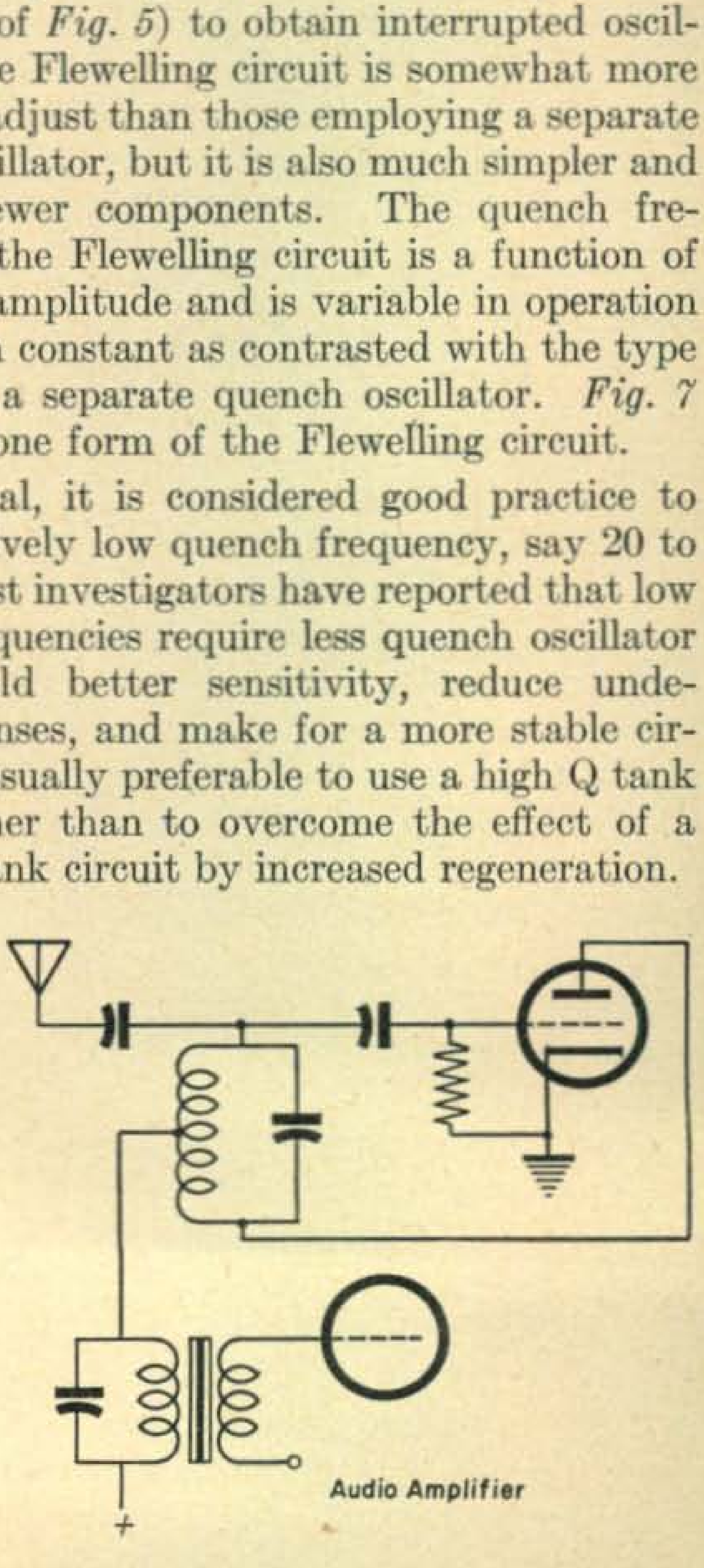


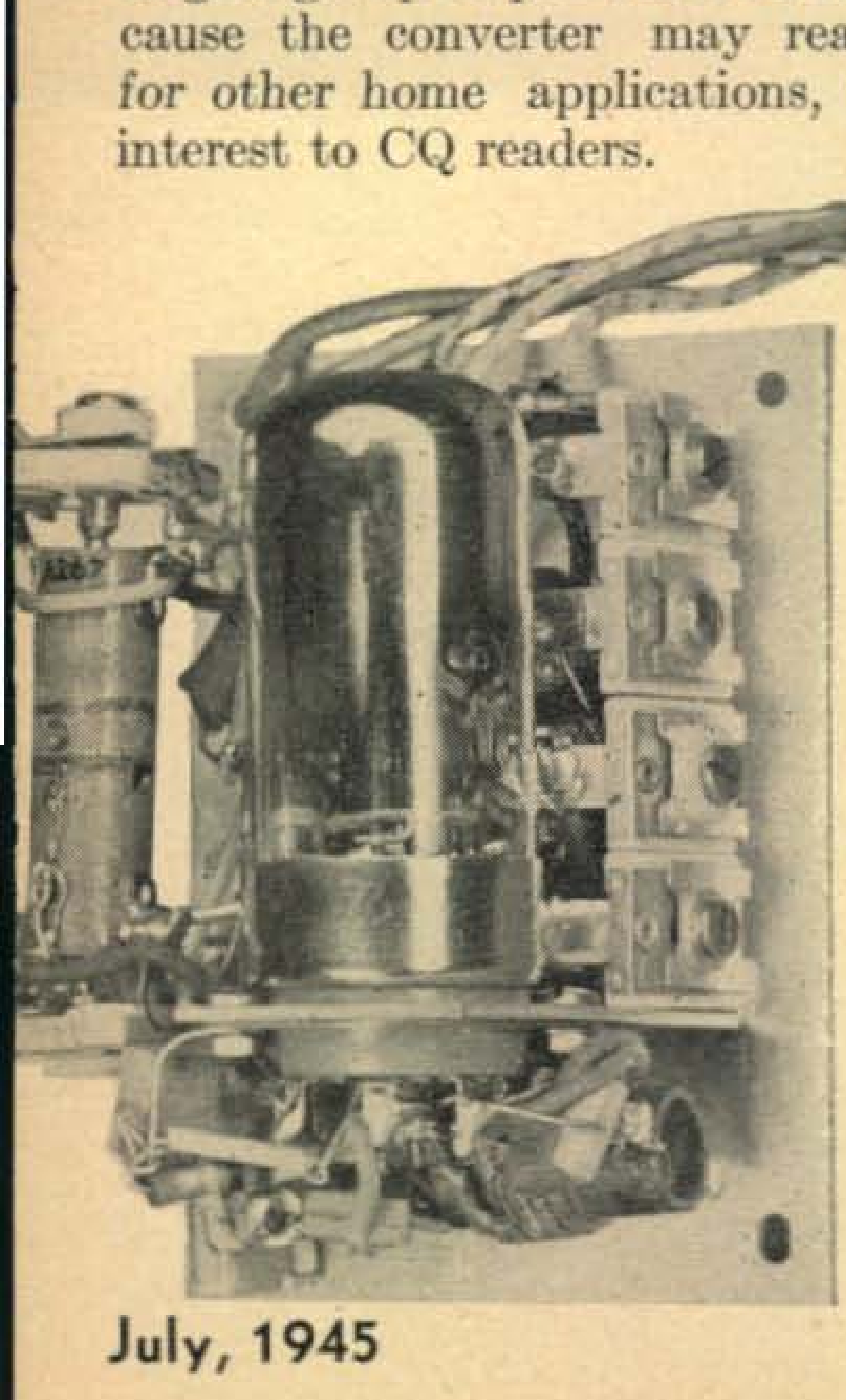
Figure 7

A SIMPLE CONVERTER FOR F-M RECEIVERS

This converter enables pre-war f-m receivers to bring in programs on the newly assigned f-m frequencies

ENGINEERING DEPT., HALLICRAFTERS COMPANY

A CONVERTER designed to permit the reception of FM stations in the proposed new band between 84 and 102 megacycles on pre-war FM receivers which were built for the old band of 42 to 52 mc, was recently demonstrated by the Hallicrafters' Company. The use of this converter will prevent obsolescence of pre-war sets in the event of a change of FM frequencies. Because amateurs are among the largest group of pre-war FM set owners, and because the converter may readily be modified for other home applications, this is of special interest to CQ readers.

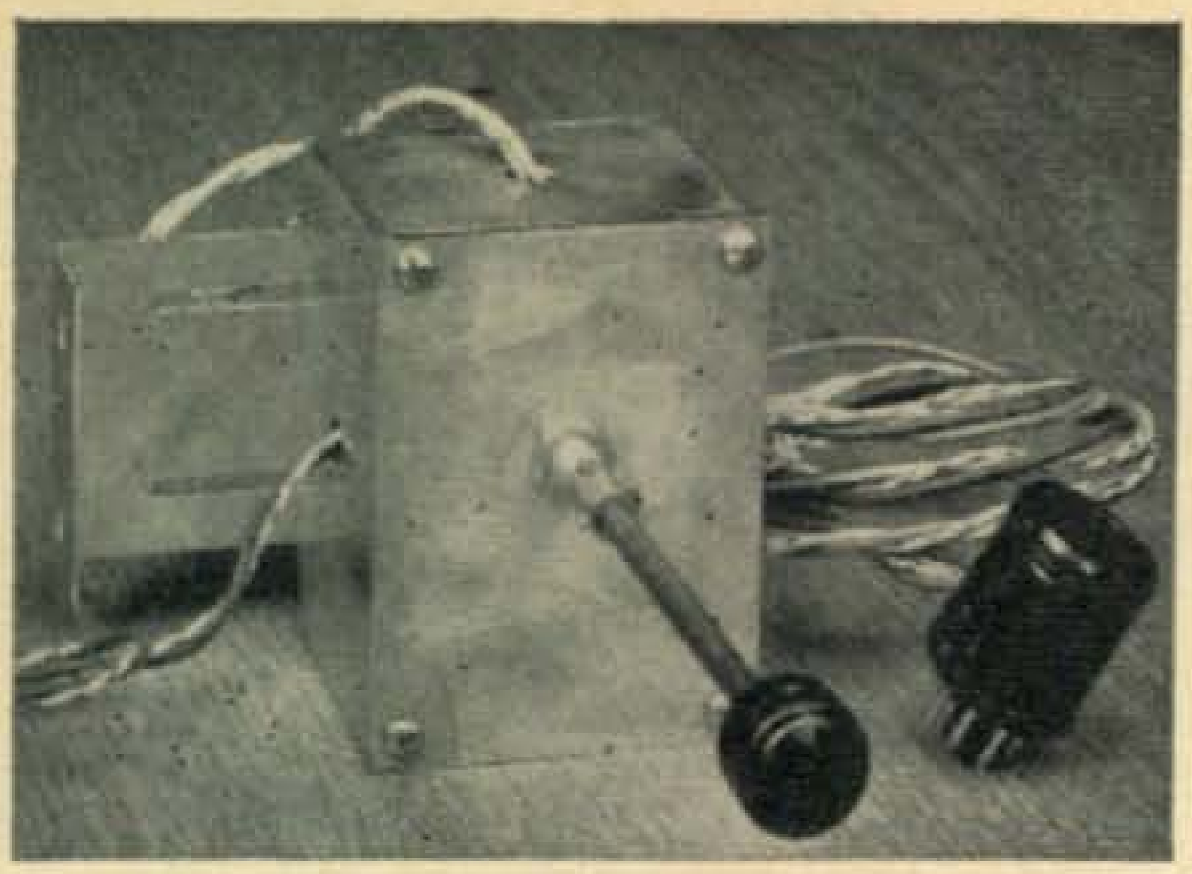


Chassis view of single-tube converter

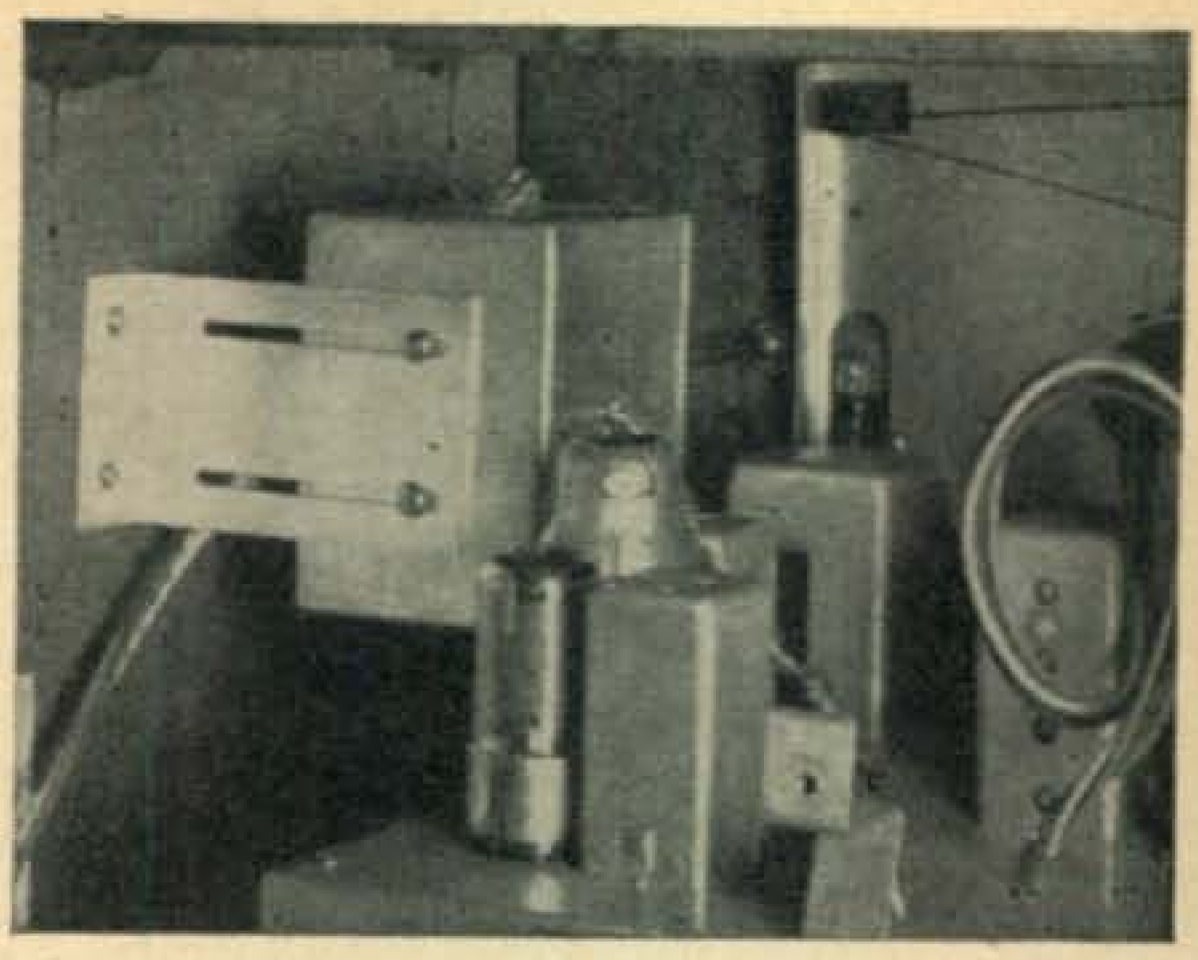
The single tube converter is designed for use in primary service areas where signal strength is high and the principal considerations are appearance and convenience. It is small enough to go inside the cabinet of practically any FM receiver and will not interfere in any way with normal operation. A switch on the front panel of the receiver permits the converter to be connected or disconnected and selects the two frequency ranges, 84-92 mc and 93-102 mc. All tuning is done with the regular receiver dial. During the period when the FM stations are being changed over to the new frequencies, a receiver provided with this converter will be able to bring in stations in both the new and old bands by merely switching the converter in or out.

This inexpensive converter uses a single 7N7 dual triode. The input circuit is a band-pass filter which permits approximately equal gain over the range to be covered; the oscillator is operated at a fixed frequency, and the FM receiver is used as a variable frequency i.f. Two settings of the oscillator and band-pass filter input are provided so that the FM receiver which was only designed to cover a band of 9 mc can cover the new 18 mc band between 84 and 102 mc in two ranges.

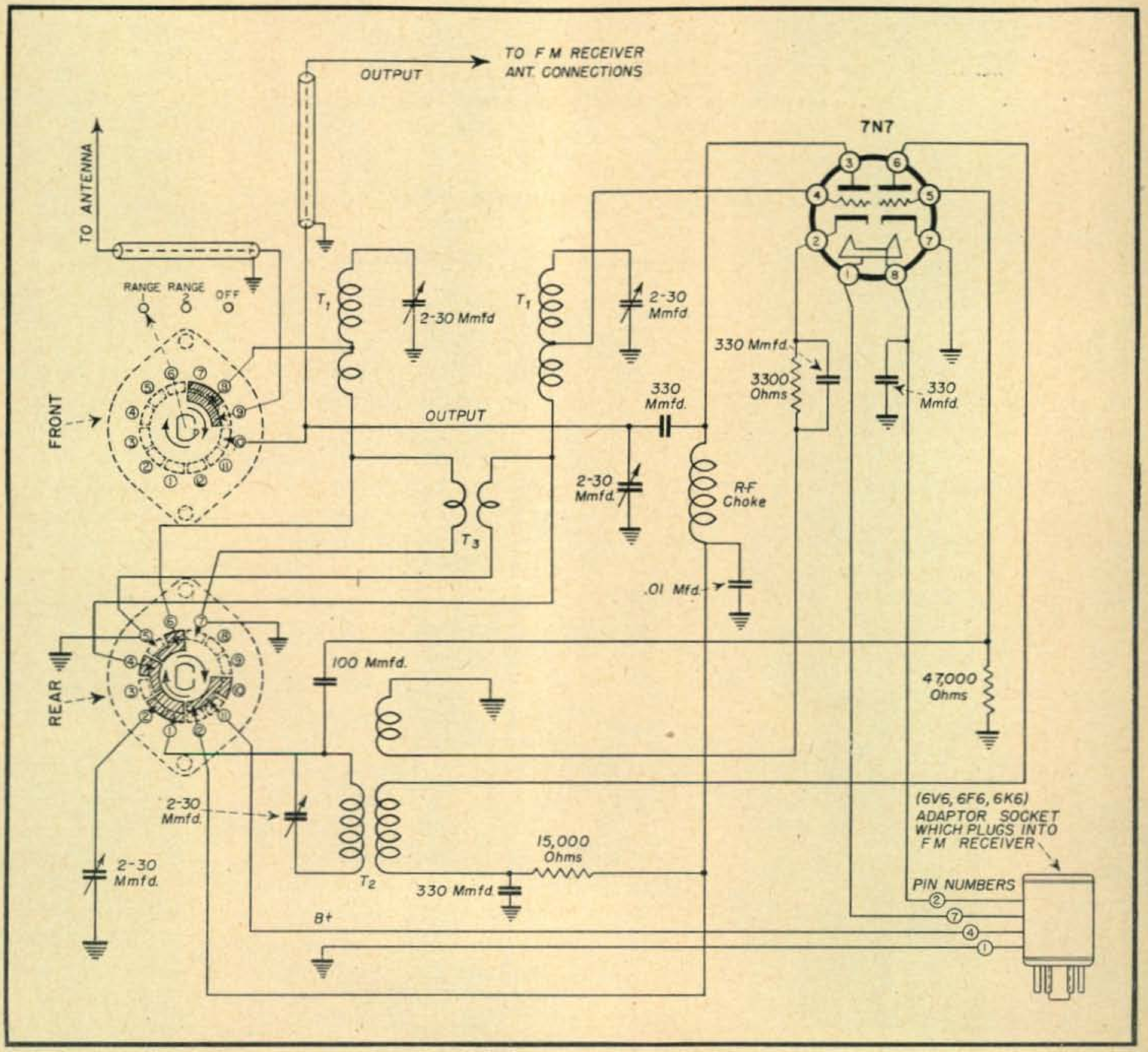
A three-position switch is provided by which the converter may be removed from the circuit for normal operation or may be set for either of the two ranges 84-92 mc and 93-102 mc. This



Left, experimental model of single-tube converter and (right) converter mounted in cabinet of console receiver



converter can be mounted inside practically any FM receiver. All that is necessary is to drill one hole in the panel for the range switch, mount the converter inside on its bracket, insert the power cable adapter plug under one of the receiver's output tubes, and connect the converter to the antenna and the input binding posts of the receiver.



Circuit diagram for Hallicrafters converter. Following are the coil specifications:

T-1-Wound on ½" form
Primary, 3½ turns, tapped 1 turn from bottom
Secondary, 2½ turns tapped 1¼ turns from bottom
T-2-Wound on ½" form
Primary (left side)—4 turns
Secondary—2½ turns
Tickler—1½ turns
T-3—Twisted pair No. 36 SCE, 2" long

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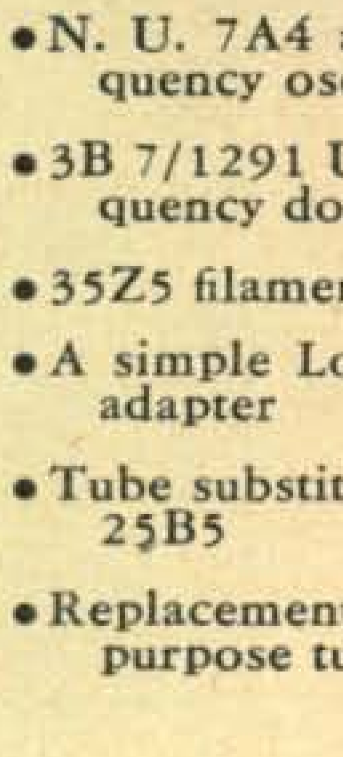

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SHOCK-PROOF MOUNTINGS

How to Shock-Mount Your Apparatus

L. W. LAWRENCE

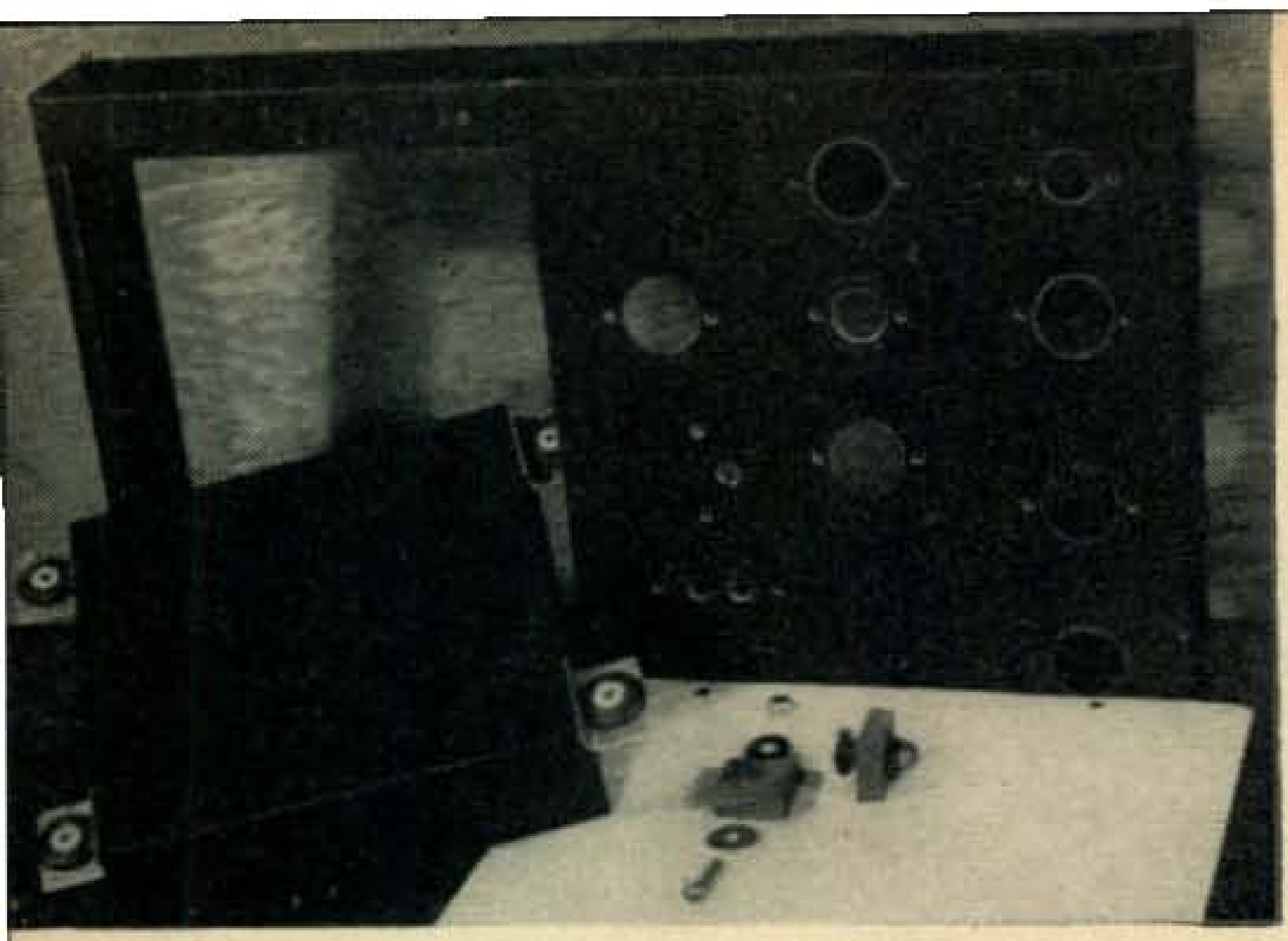


Fig. 3. Shock-mounted sub-chassis showing cut-out, hardware and shock mounts fastened to sub-chassis

SHOCK MOUNTING is top-notch protection for precision equipment. Shock mounting improves the stability of VFOs; it can be used to isolate circuits; it is a necessity in mobile or good portable equipment—and best of all it is simple and inexpensive to install. Two methods of mounting equipment to minimize shock or vibration are illustrated in *Figs. 1* to *5*.

Illustrated in *Fig. 1* is a simple suspended plate which has served admirably at W2GJR. In fact, the same principle has been applied commercially for protecting precision crystal circuits. Dimensions, materials, and tolerances are restricted only by the materials on hand. A cut-out of the desired size is made in the chassis. A flat plate, somewhat larger than the opening is then mounted and held by the four studs detailed in *Fig. 2*. In both shock mountings illustrated, elastic stop nuts are used to finish off the mounting bolts. They have the advantage of holding in place whether they are drawn up tightly or not. In the event elastic stop nuts are not available, a standard hex nut may be substituted. However, a cut or lap should be made on the bottom of the bolt to make certain the nut cannot work loose and fall free.

Rubber is used to provide resiliency to shock and vibration. In Fig. *2*, a rubber grommet, as thick as obtainable, serves as the shock absorber. Unfortunately, such grommets with a center hole small enough to grip the bolt snugly are now rare. Two methods of overcoming this problem are illustrated. In *Fig. 3*, it will be observed that there are what appear to be white centers in the rubber grommets. Actually these are wooden fillers which are a medium force fit—that is, they fit tightly, but do not push the grommet out of its normal shape.

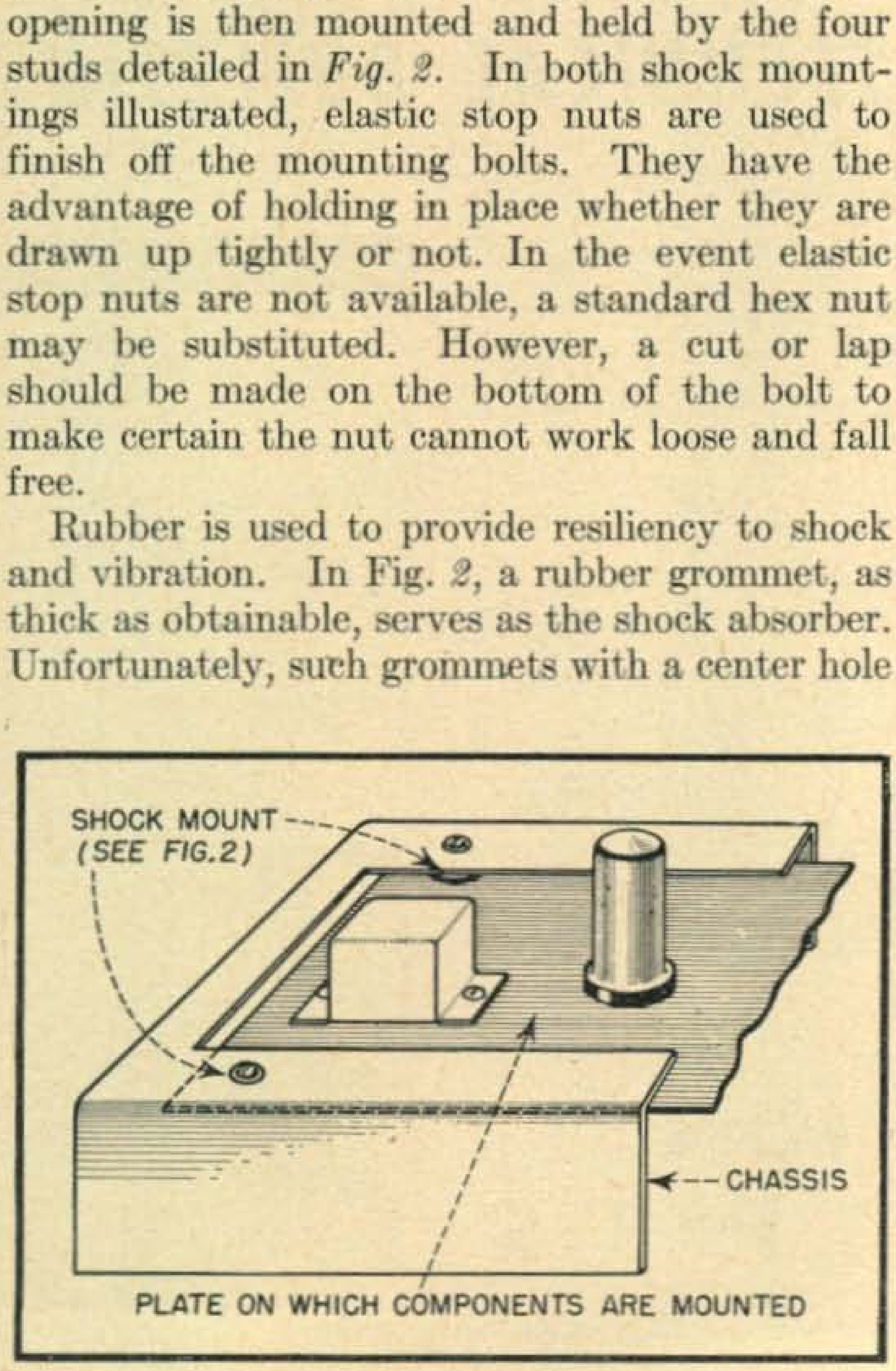
Sponge Rubber Substitute

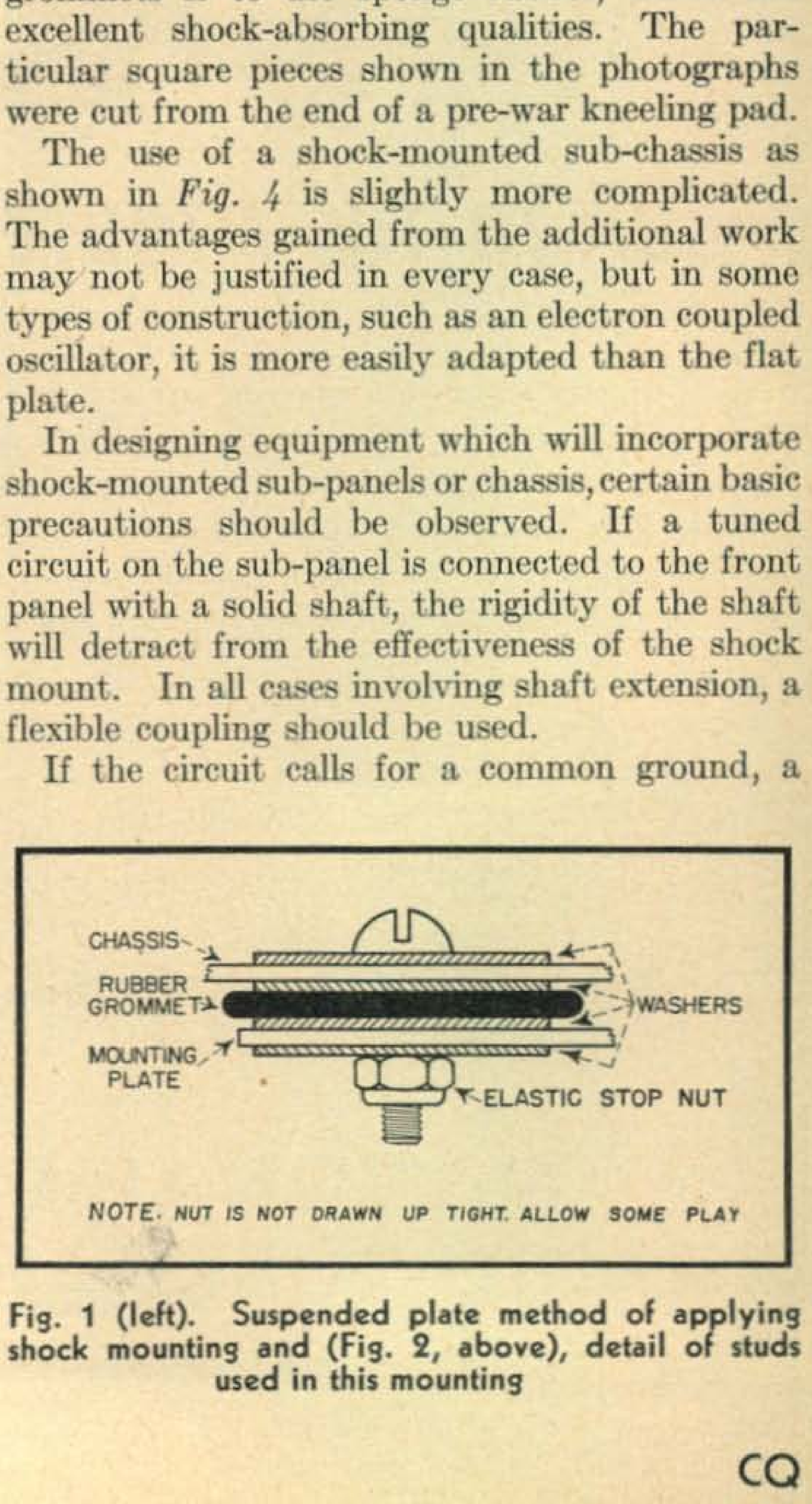
The second solution to securing proper size grommets is to use sponge rubber, which has excellent shock-absorbing qualities. The particular square pieces shown in the photographs were cut from the end of a pre-war kneeling pad.

The use of a shock-mounted sub-chassis as shown in *Fig. 4* is slightly more complicated. The advantages gained from the additional work may not be justified in every case, but in some types of construction, such as an electron coupled oscillator, it is more easily adapted than the flat plate.

In designing equipment which will incorporate shock-mounted sub-panels or chassis, certain basic precautions should be observed. If a tuned circuit on the sub-panel is connected to the front panel with a solid shaft, the rigidity of the shaft will detract from the effectiveness of the shock mount. In all cases involving shaft extension, a flexible coupling should be used.

If the circuit calls for a common ground, a





NOTE. NUT IS NOT DRAWN UP TIGHT. ALLOW SOME PLAY

Fig. 1 (left). Suspended plate method of applying shock mounting and (Fig. 2, above), detail of studs used in this mounting

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Eimac 1000T tubes in an amplifier stage of W6XAO transmitter, Hollywood

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Two young comedians, Robert Sweeny and Hal March, currently on transcontinental radio show, give a preview of their talents for television broadcast over W6XAO.

Work on television station W6XAO (Commercial station KTSL) began in November 1930; and thirteen months later, Dec. 23, 1931, it was on the air on the ultra high frequencies, the first present day television to operate on schedule. Today the station occupies elaborate copper sheathed studios which stand 1700 feet above Hollywood with an antenna on a 300-foot tower.

The program log shows almost every type of presentation. Highest in interest and achievement are the remote pick-ups and special event broadcasts made simultaneously or recorded on film for release later. Studio presentations, especially those directed to war activities, have become a duration standard.

Under the direction of Harry R. Lubcke, television station KTSL will be in daily schedule immediately after the war. Mr. Lubcke says: "We have been using Eimac tubes in our television transmitter since about 1938... We have found them good and reliable performers... their design is such that a favorable ratio of power output to tube and circuit capacitance is obtained... we look forward to using new Eimac tubes which may be forthcoming."

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flexible lead must be run between the sub-chassis and main chassis. All leads between the two chassis must be sufficiently long to allow freedom of action. From actual experience at W3IOP it has been found that it is a good idea to provide easily removable connections on the sub-chassis which are independent from the main chassis. This is not always practical and each specific application of shock mounting presents its own problem.

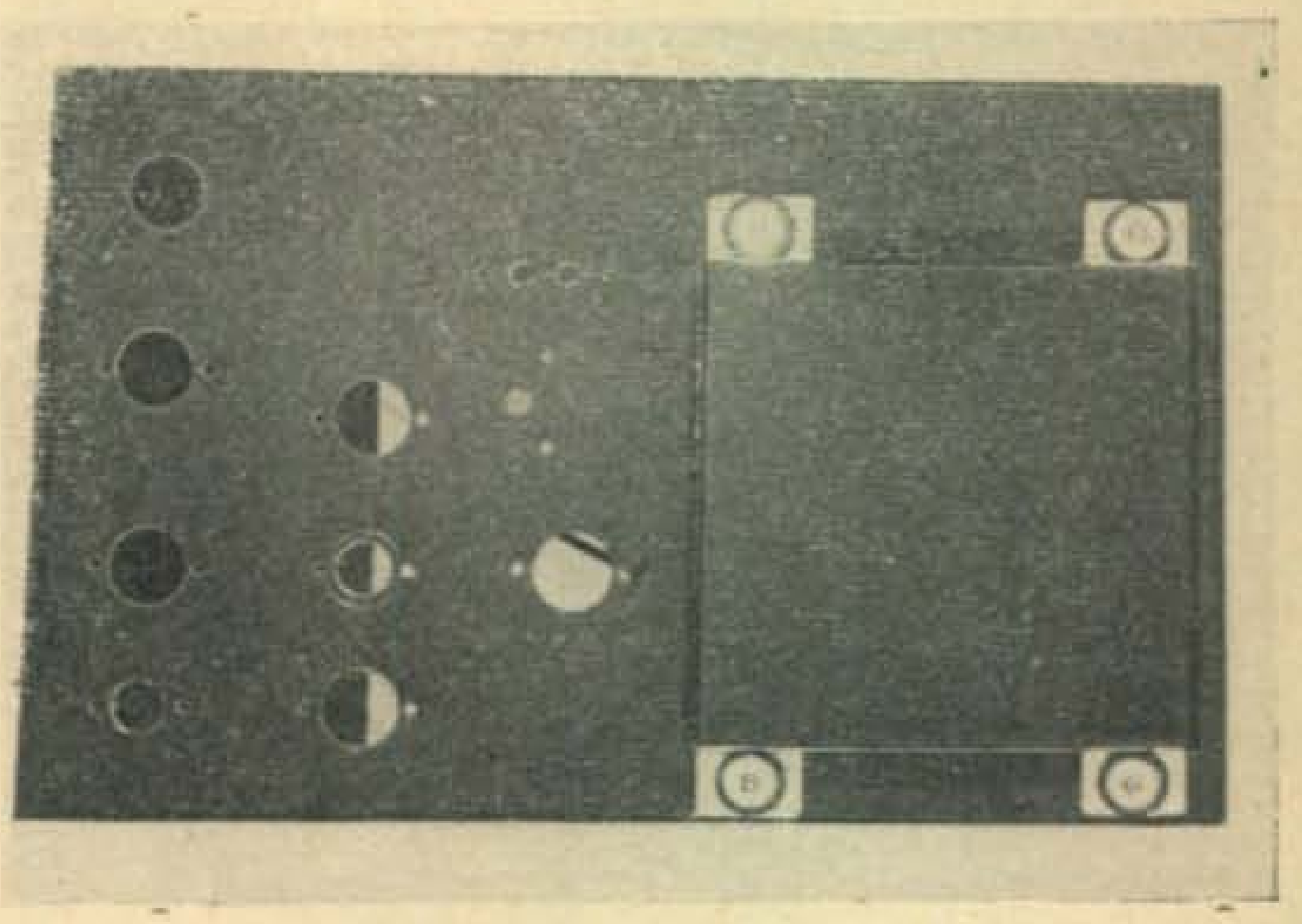


Fig. 4. Method of isolating vibrator power supply of a portable battery-operated communications receiver

Power-Pack Mounting

The shock-mounted chassis in *Fig. 4* is for a vibrator type power supply of a portable battery-operated communications receiver. This layout has been utilized to isolate the power supply from the receiver and still retain a compact design. Since there are relatively few connections to be made between the power supply and the main receiver unit, a single screw-type terminal strip is adequate. To remove the entire power supply the four shock-mount studs are loosened and four terminal connections removed.

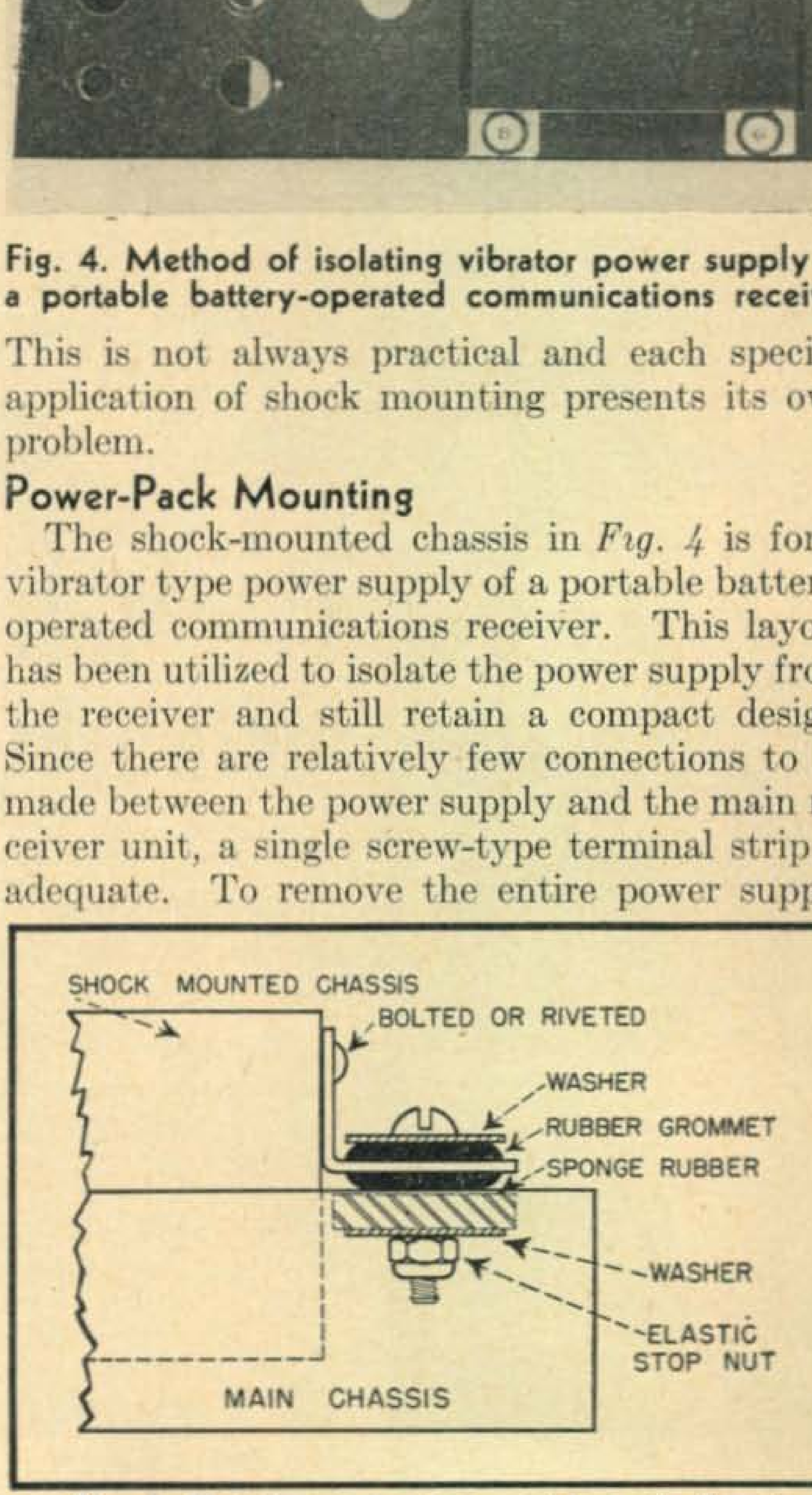


Fig. 5. Details on shock mount for sub-chassis

The detail sketch, *Fig. 5*, of the sub-chassis shock mount can also be applied where an entire unit is to be shock mounted. An example of this would be a receiver or transmitter built in the conventional manner and shock mounted off the floorboards in an automobile truck. In cases where equipment will be subject to more severe

IT'S FUN to live and work in MT. CARMEL, ILL.

Johnny Beauchamp, a supervisor at the Meissner factory in Mt. Carmel, is typical of Meissner's *precision-el.* The camera has recorded Johnny's day . . . a combination of work and play that's a big reason for the high quality you'll find in Meissner products —"precision-built by *precision-el.*"

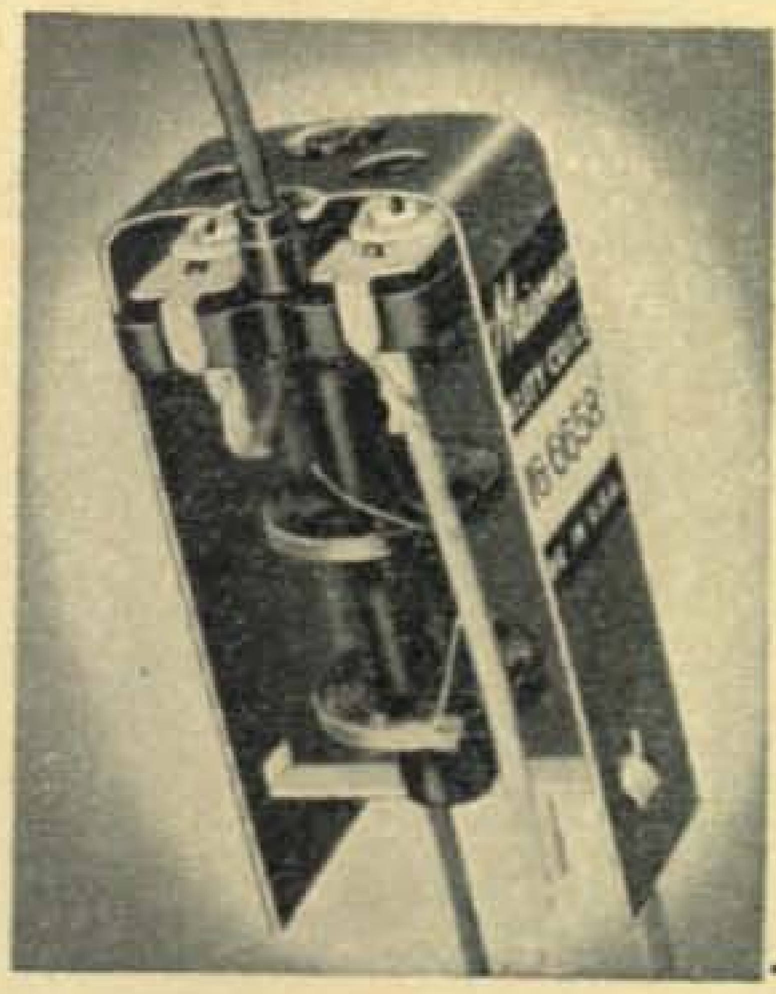
Here's Johnny at work. He's "tops" with subordinates because he's never too busy to give the other fellow a "lift" . . . help make the job easier.

A five-minute walk at noon takes Johnny home for lunch. Usually Connie Sue, his 6-year-old daughter, meets him at the corner. Johnny owns his own bungalow in this attractive section of Mt. Carmel.

There's a smile on his face as he leaves the factroy at 4 p. m., but smiles are the rule, *precision-el* . . . ten minutes later he's ready to apply Meissner precision to the golf game that has won him several trophies.

Flying is another of Johnny's hobbies. He and other members of Meissner's *precision-el* have organized the Mt. Carmel Flying Club, built a hangar, laid out the field. Here a group listens to a student being briefed before the takeoff.

Like most fathers, Johnny finds the baby more interesting than a tender morsel of chicken. After dinner, Johnny may go back to the plant to work out the following day's schedule.



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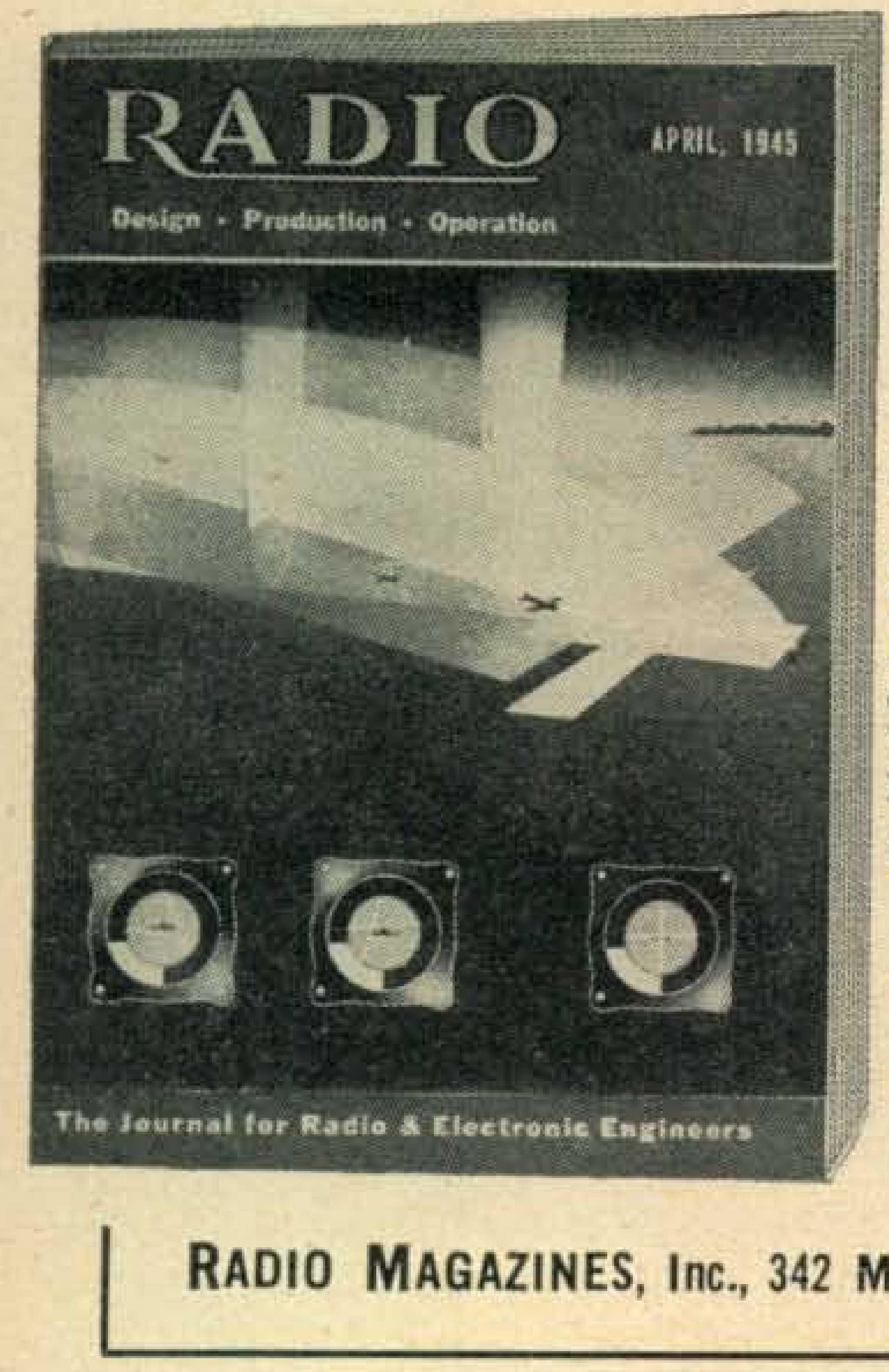

punishment than in average fixed operation, due consideration must be given to the physical size of the entire mount—including the bolts. Several rubber grommets can be used together for increased resiliency. Sufficient clearance must be allowed from the floor, or the unit will strike it during normal disturbances. Care in building equipment mechanically sound, and then providing the added protection of shock mounting, will pay dividends in more reliable, trouble-free operation of your gear.

Hamfest

The North Shore Radio Club of Long Island will sponsor the first "Hamfest" to be held in Greater New York since the war on Friday evening, August 24th, at the Community Gardens Ballroom, 215-32 Jamaica Avenue, Queens Village, Long Island, New York, it was announced today by John DiBlasi, president of the club.

This will be good news to radio amateurs in the Greater New York area, since the word "Hamfest" is the signal for all who follow amateur radio as an avocation to get together—convention-like—for the purpose of discussing their mutual interests and having a good time in general. The fraternal spirit of radio "hams" is an institution in itself and the pursuing of this hobby by the legions of radio amateurs has been directly responsible for many of the major developments in the art of radio communications.

The "Hamfest" will be open to all radio amateurs in the Greater New York and Long Island areas.

While the "Hamfest" program for August 24th will feature one prominent speaker on "What the Hams have done in the War Effort and what they can expect Post-War", the evening's program will be mostly informal and will include entertainment, movies, door prizes and an opportunity for all interested in the art to get together for exchange of ideas.

All radio amateurs are welcome at the "Hamfest" and tickets, nominal in price (50c), are available at Greater New York radio stores dealing in amateur radio equipment, from North Shore Radio Club members, and at the door.

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VOMAX

A new completely universal vacuum-tube volt-ohm-milliameter is announced by the McMurdo Silver Company, Hartford, Connecticut. Known as "VOMAX", it possesses a number of novel and original features. A total of 12 d-c voltage ranges cover .05 through 3000 volts — at the input resistance of 50 and 125 megohms. Six a-c voltage ranges cover .05 through 1200 volts, all effective at 6.6 megohms and $8\mu\mu$f. input loading. Three of these ranges are calibrated -10 through +50 db for power output measurements. Six direct current ranges facilitate measurements from 50 microamperes through 12 amperes. Six zero-left resistances ranges cover 0.2 ohms through 2000 megohms. Construction is rugged and decisively high quality, all switches being ceramic, tube sockets u.h.f. X2B, panel of 3/32″ aluminum, etc.

It is stated that all usual grid-and gas-current problems have been eliminated. A-c response is rated flat to 5% over the range of 20 cycles to above 100 megacycles. One zero-set knob serves for all ranges, and need be set but once for all 39 ranges. This multitude of usable ranges and functions requires only five different scales on the $4\frac{5}{8}''$ meter as a result of a newly-developed order of linearity between successive scales for this type of instrument. All circuits are dual-tube, automatically balanced against line voltage variation and tube aging. The removable diode r-f probe makes possible accurate r-f voltage measurements.

MATTER OF TIME

[*Continued from page 15*]

added an hour to their standard time to gain additional daylight.

Knowing the longitude of a place, the time at another place of known longitude may be found as follows: To the time of the first place apply the longitude difference, expressed in time units (15 degrees equals 1 hour). Add if the first place is westward, subtract it if eastward. The result will be the local time at the second place. Remember that the time at the eastern place will be later than at the western place.

Time and Longitude

As a further illustration, assume station A is at longitude 72°-00′ W; station B at 46°-00′ W. The difference in longitude is 26°-0′ degrees, which, expressed as time units, is one and eleven fifteenths, or, since the zone system avoids fractions, except in special cases, two hours. If the local time at A is 9:30 P.M., local time at B, which is west of A, is 9:30 – 2 = 7:30 P.M.

Another case: station C is at 12°-35′ E. Station D is 71°-46′ W, at which place it is 11:30 P.M. By adding the values, we get the difference in longitude. We must travel to 0° and back to 12°-35′ E. If the sun should exceed 180 degrees it is necessary to subtract 180 degrees. In this instance it is 84°-21′, and in time units 6 hours. The time 11:30 P.M. plus 6 hours, (since we are going from west to east) means the local hour at station C is 5:30 A.M. There is also a change in day, the easterly station being the later date. It is important to avoid confusing the changes in date as a result of a change in standard time as compared with GCT.

Watch Your Date

At midnight local time in NYC, which is also midnight for the entire zone, the calendar date changes. However, since NYC is located in zone 5, five hours behind GCT, if we are working on a GCT system, the calendar date changes at 7:00 P.M. Eastern Standard Time. This actually presents no problem if the records are kept constantly on the 24 hour GCT basis. When you advise a station of a schedule at 2230 GCT May 11th, there is less chance of confusion than to say 5:30 P.M. EST May 11th, since it may be a different date at the other station on the zone system.

To summarize and attempt to eliminate any confusion, remember these salient facts. The *Greenwich Civil Time* hour is the same all over the world at any instant of time. *Standard Time* and *Zone Time* are almost invariably the same. Each time zone is 15 degrees in width, extending 7½ degrees on either side of the standard meridian. The plus zones run west of the Greenwich meridian, the minus zones run east of the Greenwich meridian. GCT is converted into standard time by adding or subtracting the zone time difference from the zero Greenwich meridian. *Daylight* and *War Saving* time means the addition of one or more hours to standard time.

To avoid any possibility of error in computing differences of time, a simple diagram should be used. Reference to a map will serve as well. For local station use, there should be no more difficulty than following the present system. Operating pleasure will be materially increased when you can tell a fellow "QRX until 1545" without another thought of dates, A.M. or P.M.

CRYSTAL FINISHING

[*Continued from page 19*]

and squeezed with the fingers when in position. It will be found that they stick together tightly provided they were both clean before the tongue was applied. (This may not be the most sanitary method but a more convenient one is hard to find!) The purpose of the protector is to keep the crystal flat when grinding. If just the finger was used, hollows might be ground because even quartz (especially a thin crystal) bends. The protector, however, will not prevent the faces from being ground out of parallel, due to the difficulty of applying finger pressure to the exact center of the protector and of describing exactly uniform patterns in the grinding operation.

After a short grind on the lap (which has been wet by applying some water with the finger, rubbing it around until the abrasive grain is in complete suspension) the crystal and protector are separated, washed, dried and the crystal is again checked for frequency and activity. No concern need be shown if the activity has dropped as is probable. The micrometer is now employed and the high corners or areas are marked with pencil on the side of the crystal being ground. It is again replaced on the protector and ground, slight pressure being applied to the spots or sides that were found to be high. The object is to keep the crystal as flat and parallel as possible. The extent of each grind will have to be

Typical manufactured crystal unit—This model employs a quartz plate approximately .750" x .850", precision variable air-gap assembly, and is the prototype of Signal model DC-9, used extensively in frequency meter SCR-211, where high precision is mandatory.

determined by experience. The slower the better at first.

Proceed with Caution!

As the frequency comes within about 25 kilocycles of the target, extreme caution must be exercised—not that caution shouldn't be continually practiced. The plate should now be made as parallel as possible, taking only the slightest grind at each operation. The grind may consist of placing the finger on the protector over a high spot and perhaps pushing the crystal forward on the lap *only a distance of one inch.* If the sides and corners seem to be comparatively even but the middle is high, the center can be reduced by grinding on the edge of the lap (with about one-third of the crystal hanging off), describing tiny circles and reversing the position of the crystal every few revolutions. As noted before, the center must be kept slightly high for AT, BT and Y cuts. To put the hollow center in X cuts the crystal is ground extensively on the edge of the lap as outlined above. If necessary it may be hollowed by occasionally dispensing with the protector and grinding with a fairly heavy finger in the center of the crystal. The correct contours can be attained only with experience.

Edge Grinding

The reading will probably vary at every test of crystal activity. At times the crystal may stop oscillating altogether. Provided the plate is maintained flat and parallel, it can be made to oscillate again by grinding the edges. The explanation of the theory behind this is quite complex. Briefly, any crystal can oscillate by a number of different modes. For example, it might oscillate at a low frequency determined by its length or by its width. When the frequency of its thickness dimension (the one in which we are interested) equals one of the harmonics of a low frequency mode, certain phenomena take place which interfere with oscillation. Thus by changing the length or width we shift the low frequency harmonic out of the range of the thickness frequency. This is accomplished by edge grinding which, without extensive mathematical computation, is more or less a hit-and-miss proposition. It is accomplished commercially by a newly evolved system called predimensioning.

One glass lap should be kept for edge grinding only. A small amount of Carborundum paste is placed on the lap, spread around, and the crystal is held lightly between the fingers and beveled at various angles to its faces. This may be done on all eight edges or only two at a time. In the latter case *adjacent* edges should be ground, testing for activity between each grind. When the activity is in the neighborhood of that shown in Table I, the frequency is measured, and, if not high

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enough, face grinding is continued. When the frequency approaches a few kilocycles of that desired, it may be best to finish with the waterproof paper. Should the activity drop between any of these finish grinds, edge grinding must be resorted to in order to bring it up before the next face grind.

On paper the process appears to be cut and dried. Actually it is very tedious, and patience is the only qualification that will surmount arising obstacles. With some crystals a great deal of edge grinding may be necessary—in other cases only a little. It may be necessary to do some straight edge grinding particularly if the bevels become too severe. In any case edge grinding will not bring up the activity of a crystal that is out of true. *The plates must be flat and parallel.* The higher the frequency, the more difficult it becomes to keep them this way.

In reference to Table I, it must be kept in mind that the values given are only approximate and are averaged for the different sizes of crystals. Roughly, at the low frequencies large crystals will have much more activity than small ones. This should also hold true at the high frequencies but the statement must be modified considerably due to the greater difficulty encountered in keeping a large crystal flat, as it becomes thinner, compared with a small one. The amateur will find that compromises must necessarily be made throughout the entire process.

It must be emphasized again that this method has been evolved strictly for amateur application and in most part is not representative of the methods employed in modern commercial quartz crystal production.

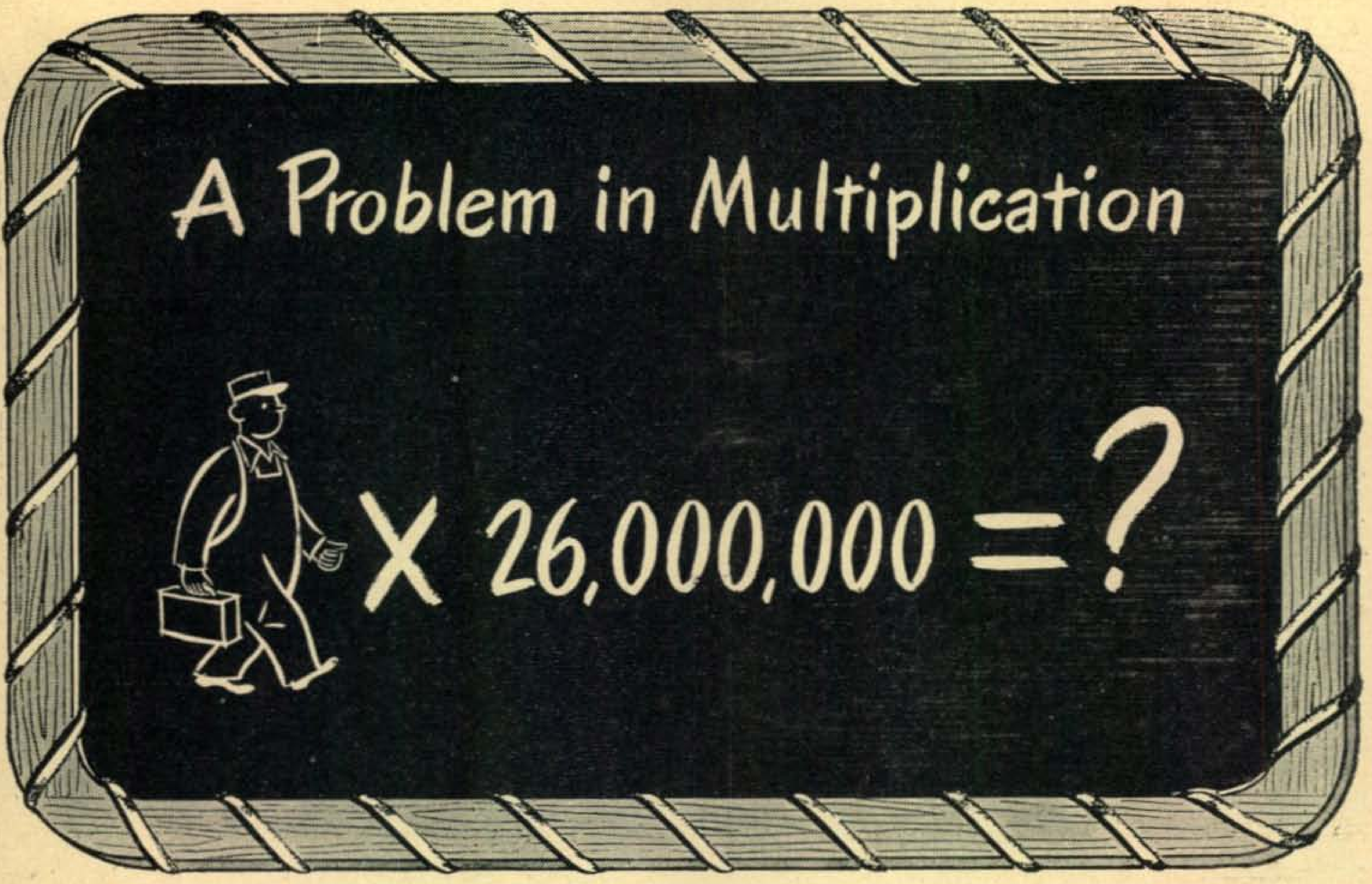
ANTENNA

[*Continued from page 9*]

center. Various spacing was tried between the antennas and the reflectors, but it was found to make but little change and the optimum point was found to be just about four feet.

A simple method of cutting the pipe to the desired length is to run a string around the correct point and then follow the string with a colored crayon. The crayon line is then cut with a hacksaw. It is a good idea not to saw all the way through until a fairly deep line has been cut clear around the pipe. Following the cutting, it is desirable to paint the rough edges with several coats of good varnish, especially if the pipes are to be used out doors. The bands which hold the pipes to the cross-members are made from "strapping" procurable in rolls from the plumbing-supply house. As it is not galvanized, several coats of varnish should be applied.

The wooden cross-members used in our set-up


A Problem in Multiplication
X 26,000,000 = ?

are 1″ x 1″ redwood. The sag, which may be noted in the photos, has no bearing on the performance of the array, but if it were to be used out of doors, it would be a good idea to make the cross-members not less than 2″ x 2″. Larger 2″ x 4″ spreaders, set in an upright position, would be better.

The insulators, for attaching the line between the four elements of the antenna proper, were made from the regular polystyrene spreaders, formerly used for a 600-ohm transmission line. For connection between the elements, number 14 tinned copper wire, spaced two inches and transposed as shown in *Figs. 3* and *4*, was used.

In passing, it may be of interest to note that our particular beam was rotary and that 15 degrees of arc resulted in the signal level dropping from S9 to S7, while a change of 30 degrees reduced it to S6; 45 degrees to S4; 90 degrees, to S3 and 180 degrees to zero.

BENT ANTENNAS

[*Continued from page 23*]

perhaps was part of the fun in trying it. While this antenna was not quite so successful as a conventional half-wave of a local ham who worked more states than I with an identical transmitter, it was certainly better than none (probably superior to a Marconi) and resulted in many enjoyable QSOs.

The radiation pattern plotted in *Fig. 5* gives an idea of how it actually worked out. However, as the Canadians and others were off the air at that time (in 1941) the northerly and easterly lobes may be somewhat smaller than complete field measurements would show.

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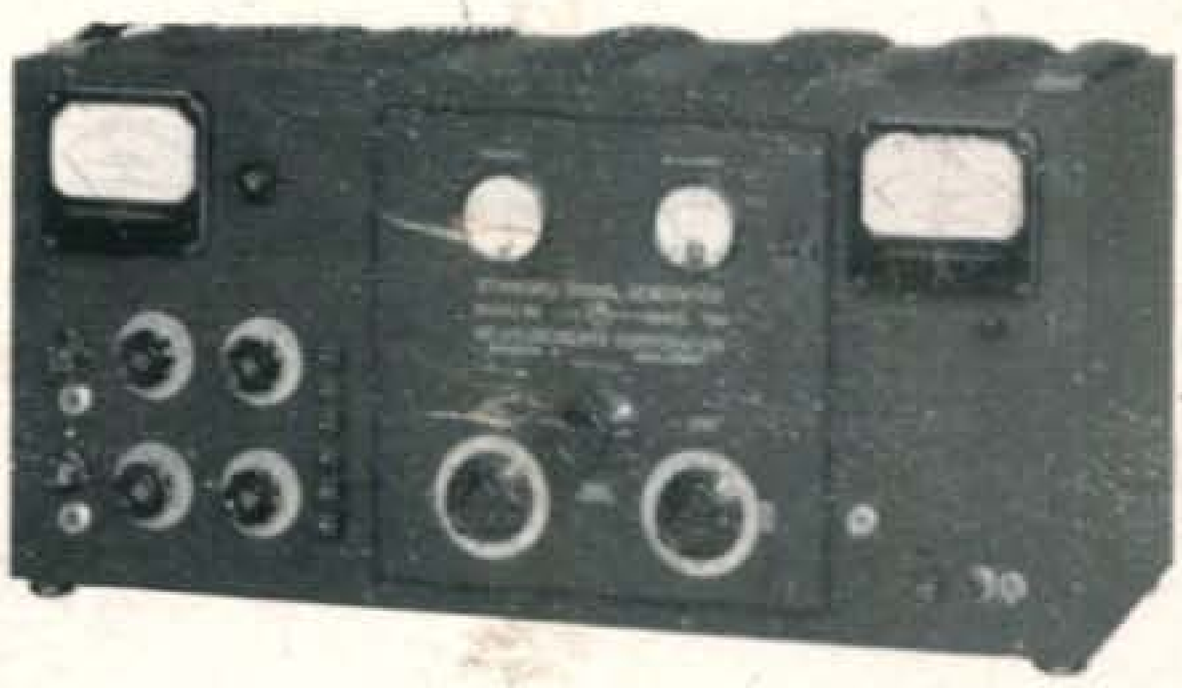

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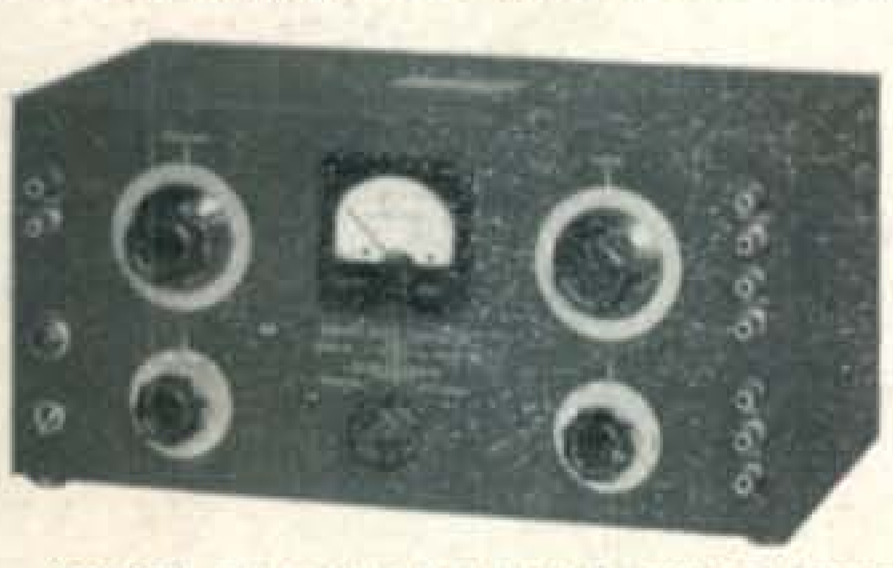

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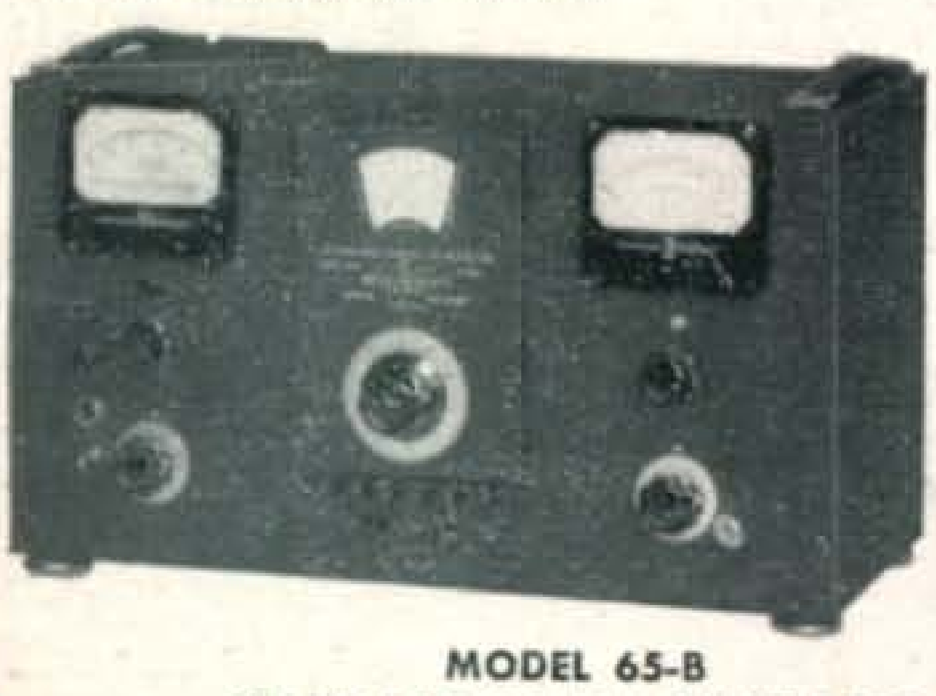

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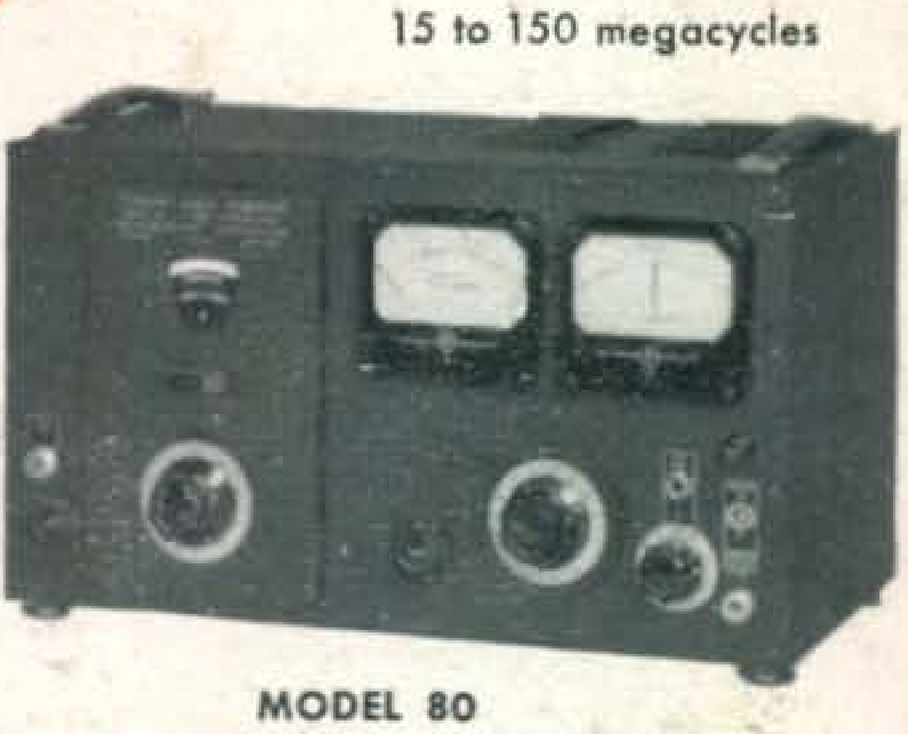

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