CQ

APRIL, 1945

W2FX

The Radio Amateurs' Journal

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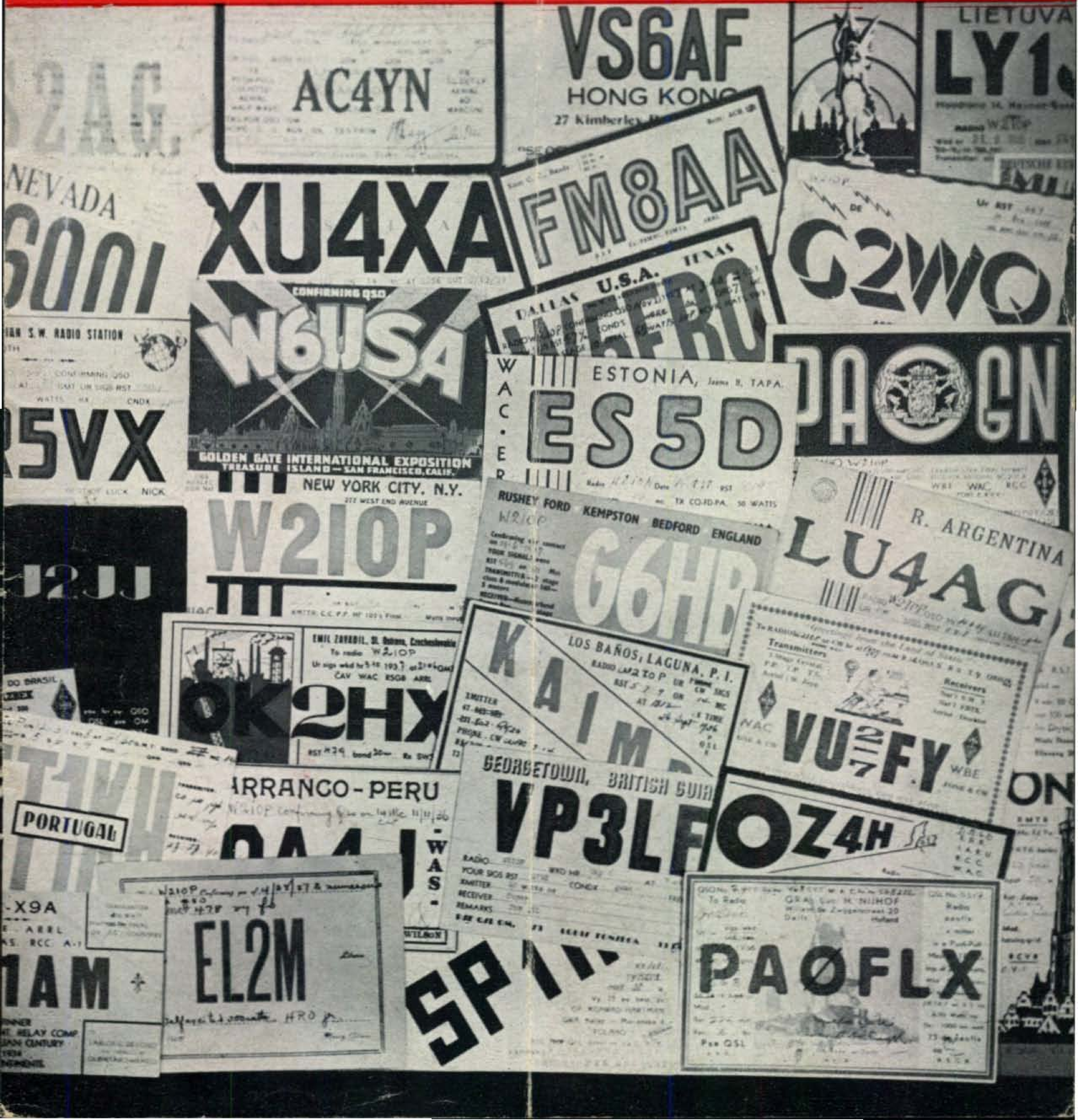

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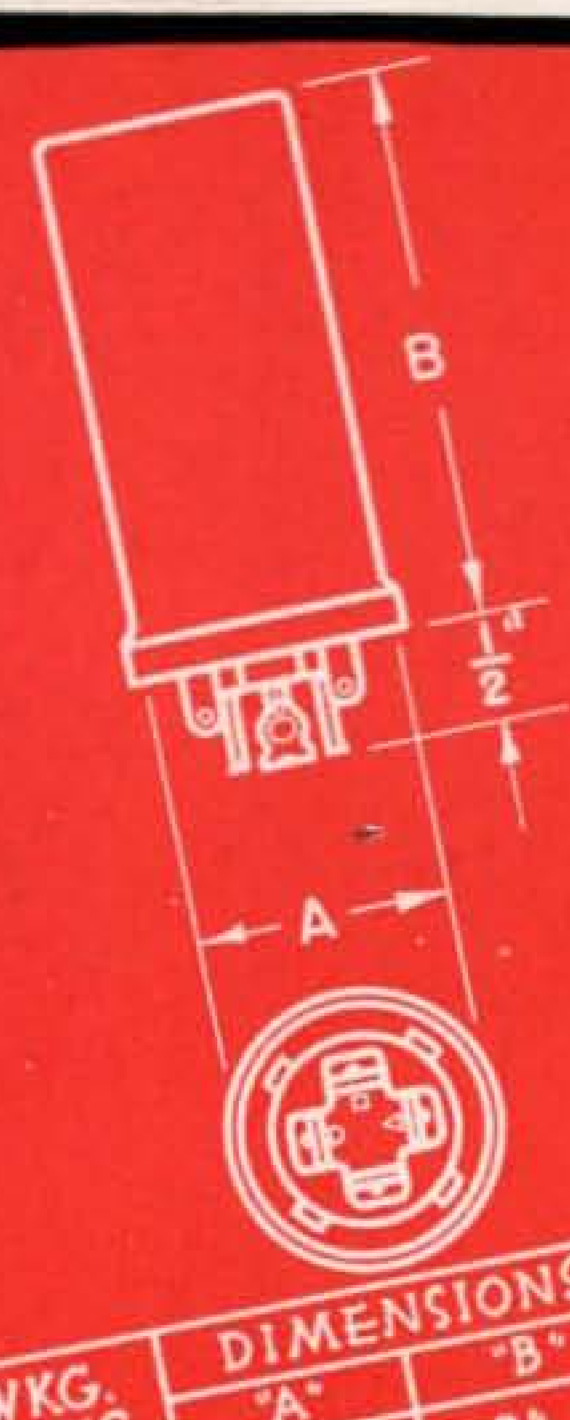

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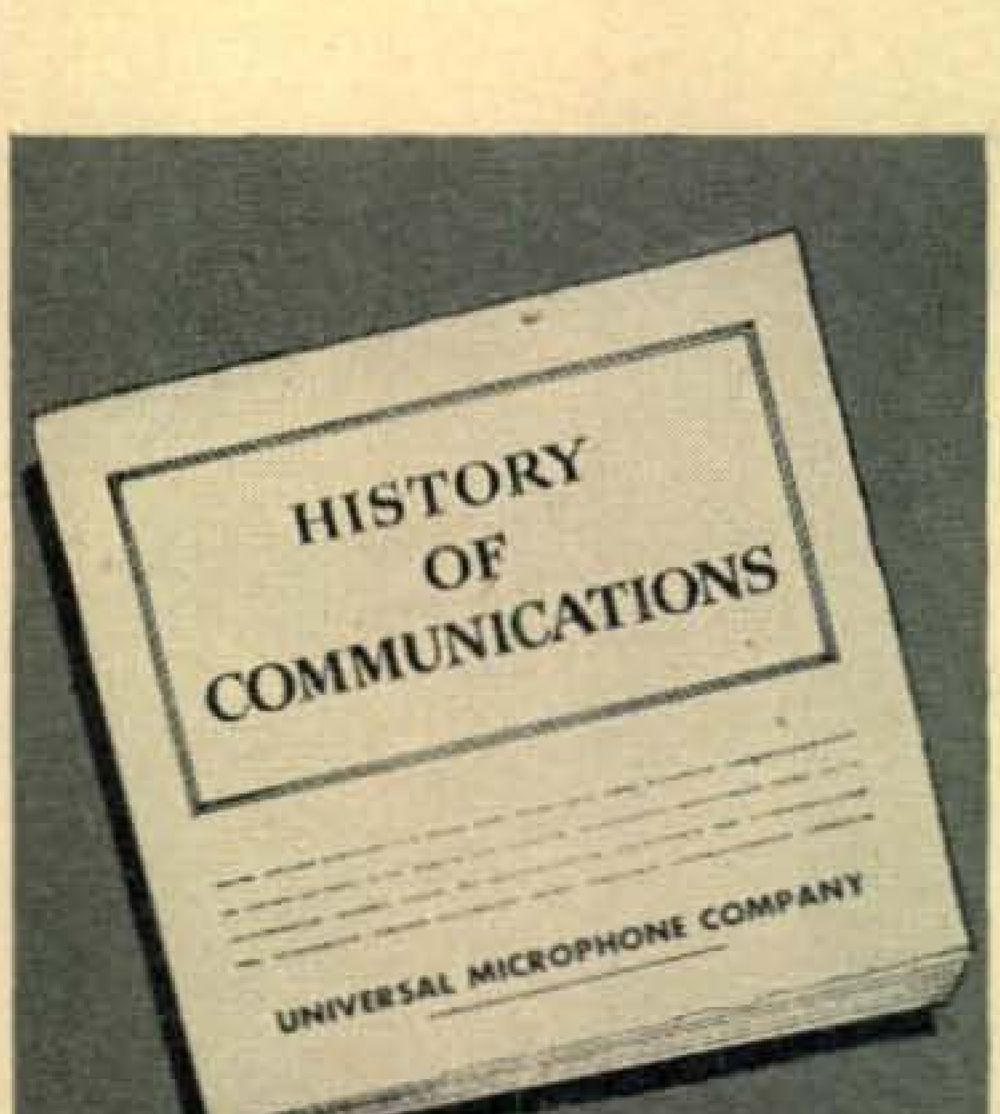

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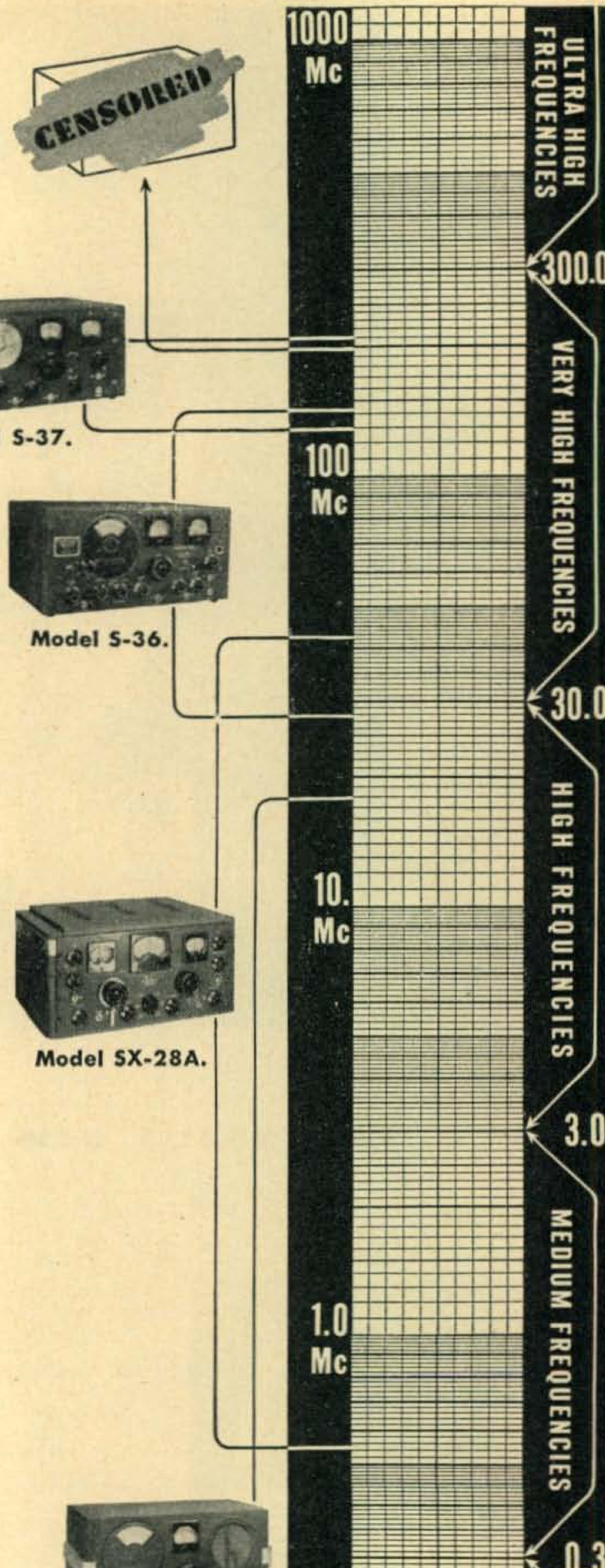

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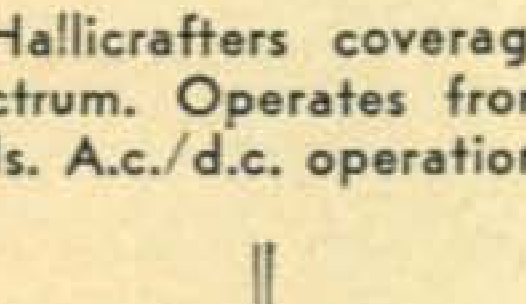

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CQ

The Radio Amateurs' Journal

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John H. Potts........Editor
Sanford R. Cowan....Publisher

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VOL. 1, No. 4 **APRIL, 1945**

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COVER

QSL cards at W2IOP's shack. (*See article, page 25*)

ARTICLES

MISCELLANEOUS

FOR MOBILE SHORTWAVE OPERATION
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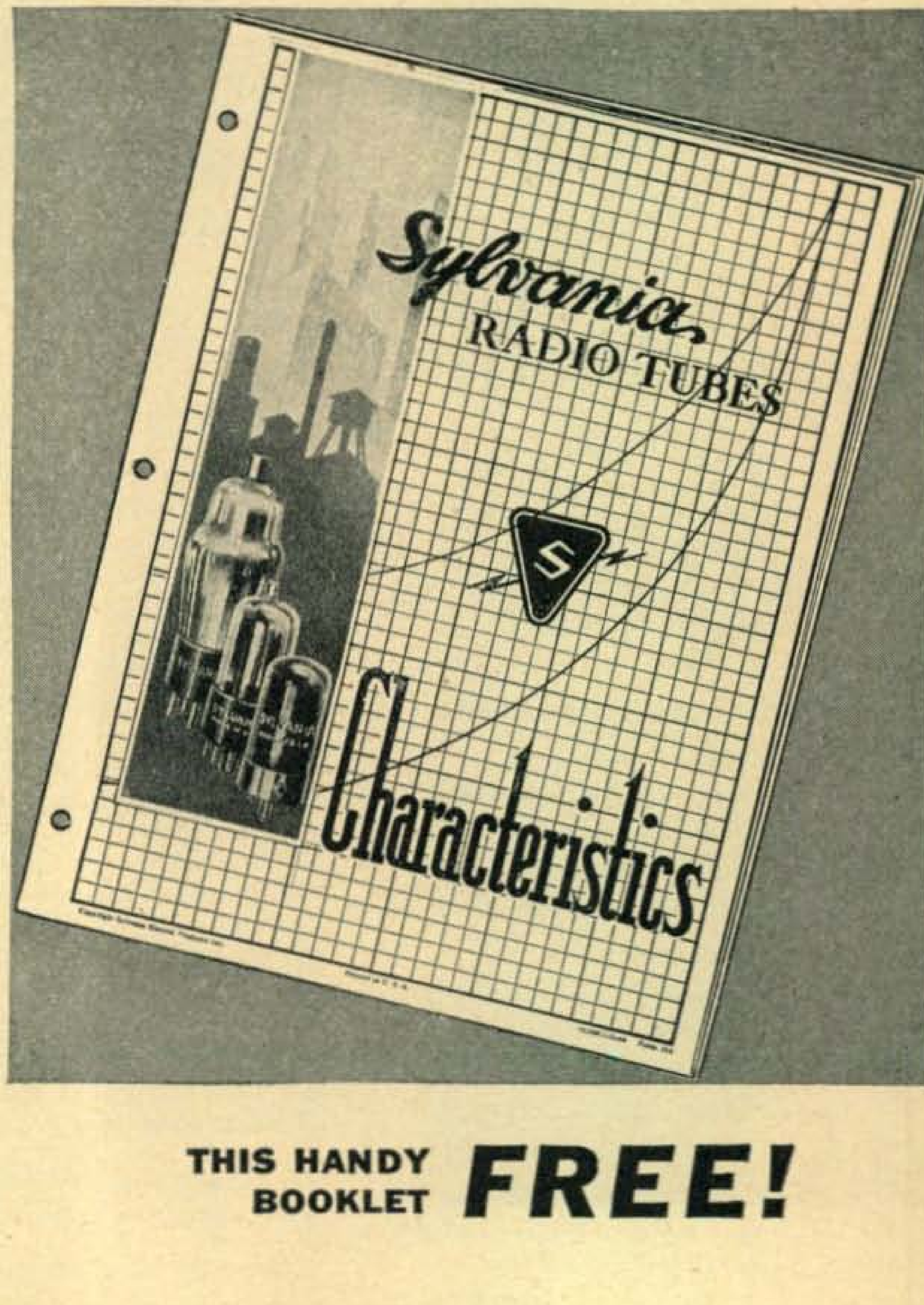

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ZERO BIAS

IT TAKES a lot of imagination to preview post-war amateur radio—and even with imagination a crystal ball would be of considerable assistance. Many amateurs consider the war as a simple hiatus — with the thought that after it's all over we shall take up again where we left off when we pulled the switches that Sunday night after Pearl Harbor. The FCC has proposed amateur-band allocations that look very familiar, and to perhaps most of us our reconversion problem appears a mere matter of dusting. This may be so for a short time — as it was following World War I, when the ham came back on the air with his pre-war spark transmitter. However, we venture the thought that could Marconi look in on amateur radio in 1950, the Father of Wireless would be as flabbergasted as Napoleon would have been waking up on Iwo Jima just as the Leathernecks landed.

War, for all its destruction, is the world's most potent catalytic agent in the chemistry of human progress. The flying machine entered World War I a box kite with a motorcycle engine. It emerged a modern airplane, and the 1918 DH-4 was still flying our mail some ten years later. Similarly with radio, the spark coil and crystal detector were metamorphosed by war into the tube transmitter, modern radiotelephone and the superheterodyne. At the beginning of the present war, the airplane was a relatively ambulatory proposition with a top practical speed not far from 300 miles an hour and a theoretical maximum of 750 m.p.h.—the velocity of sound. Jet-propelled planes have already exceeded this theoretical maximum, and the *temporary* limit now seems to be in the neighborhood of 1500 miles per hour, or 25 miles a minute. Progress is logarithmic. That is, the more we advance the more accelerated is our progress. As to just what's happened to radio during the past four years, no sizeable portion of the story can yet be told. We can only advise the old timer to hold on to his bug, the 1000-watter and his diversity receiver. They'll be worth something again, some day—to the Smithsonian.

Second Thoughts on the CRS

We've had time to chew the cud over the proposed FCC allocation of 460 to 470 megacycles for a Citizens Radiocommunication Service. As one who well remembers the efforts of this same citizenry over the past three decades to break into radiocommunication (by hook, crook and the Supreme Court) without passing an advanced examination in radio law, theory and code, we are particularly interested in the suggested license requirements. Quoting the FCC—"To procure such a license, an applicant need only show familiarity with the relevant portions of the Communcations Act . . . No technical knoweldge will be required."

The degree of "familiarity" to be stipulated may well serve to restrict operation in this band, contrary to the FCC's avowed purpose of making it practically open territory. The Commission sees the utility of the CRS in civilian emergencies, and some interesting questions (as we recall past examinations) might be posed concerning priority of signals in distress communications. And there are other queries concerning basic radio law which also fall in the sixty-four-dollar category. Dispensing with technical qualifications brings up the problem of who will service these transmitter-receivers and make certain they do not spill over the edges of the band which, as matters now stand, is sandwiched between facsimile and air navigation aids. Certainly it is not a job for the regular radio serviceman, unless he possesses the specialized technical knowledge which the licensee himself has been permitted to eschew. Offhand it looks like a lucrative chore for the licensed amateur experienced in microwave technique. These are things, of course, which will be ironed out—and it's all probably still a long way off. The FCC observes—"The design of equipment for use in the citizens radiocommunication band should challenge the ingenuity of radio designers and engineers." It will!

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ELEMENTARY ANTENNAS for UHF TRANSMISSION

LOCATE YOUR SKY-HOOK AS HIGH AS YOU CAN — BUT KEEP YOUR THEORY CLOSE TO THE GROUND

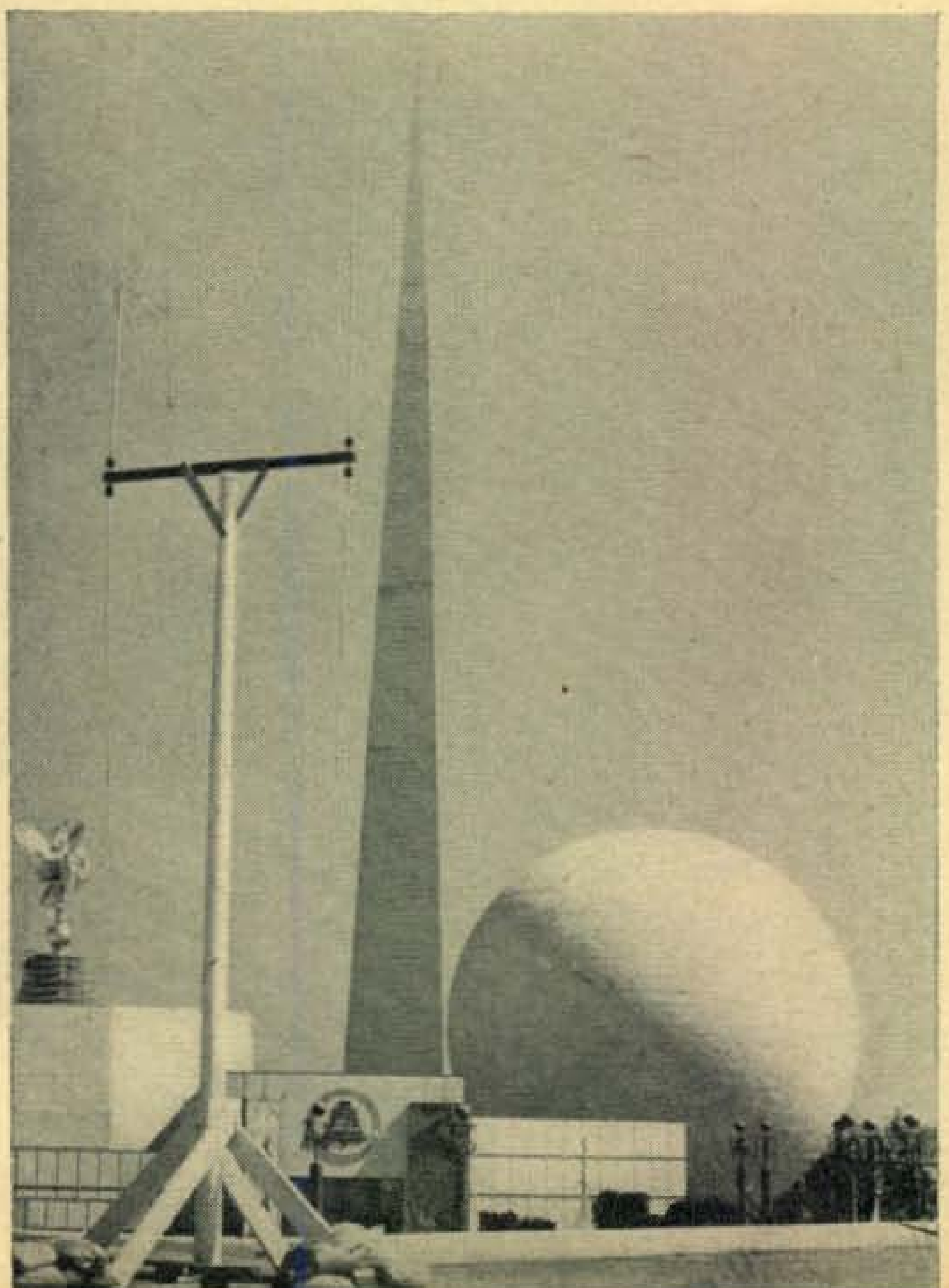
ARTHUR H. LYNCH, W2DKJ

IT HAS BEEN SAID that a little knowledge is a bad thing. It would be difficult to find a more complete example of the truth of this statement than is provided in the folk-lore of ultra-high-frequency operation. So much has been said and written that isn't so, the neophyte in the ultra-high-frequency field may well be led to believe the whole business is over his head. Nothing could be further from the truth. Ultra-high frequency, called u.h.f. by the sophisticates, is much easier to manage as a means of communication than any of the lower frequencies.

It will give me great personal satisfaction to point out a few short cuts and I welcome the opportunity to explode a lot of "do's and don'ts," apparently conceived by folks who have read about these things but have never taken the time to do them. Lest these remarks be construed as impugning the work done by some of the more serious antenna experts, I hasten to remark that one may learn much, in a practical way, from such as A. A. Alford. Nor should his practicality be considered in the light that he does not back it up with

W2DKJ

The author is an old timer whose original license was a first-class commercial ticket issued in 1912. Antennas are his specialty, and his pet diversion is the commission of mayhem and high treason against many sacred notions concerning antennas and transmission lines. But what he says is backed up with DX records on the air.



A full-wave 10-meter beam designed by the author for operation at the New York World's Fair station W2USA. The transmission line (which gave the "experts" heart failure) was ordinary twisted lightning cord, No. 14 weather-proof, 300 feet long!

One of the author's pre-war rigs. The transmitter on the left and the National "I-10" receiver were operated on $2\frac{1}{2}$ meters with antennas similar to those described in the article

mathematical analysis of a very complex variety. He does, and how!

Antenna Theory

You may, if you choose, begin your investigation of antennas (the correct word is antennae, but who cares?) by studying the performance of electrical wave motion in space and on wires. It is not a bad idea, but it takes time and you may be sure that a lot of very capable engineers and investigators have covered the ground before and that the formulas (formulae, for the purists) they have evolved really have some foundation in fact. You will find that antenna dimensions are often not too critical, unless it is necessary to squeeze out the very last milliwatt of radiation. Also, no matter what you do, some "wise guy" will tell you how much better it could have been done another way. Don't let that disturb you, for you will find, in a great many cases, that your adviser has not even tried the system he recommends.

For most practical purposes, there is agreement that the simplest form of antenna is one-half wave length long. The practical operating length of such an antenna (in inches) is obtained by dividing the figure 492 by the frequency in magacycles. For instance, the WERS stations are permitted to operate on the frequencies between 112 and 116 megacycles, which is roughly called the two-and-one-half meter band. Taking the upper limit, the center of the band and the lower limit of this frequency spectrum, we divide 492 by 112, 114 and 116, and arrive at 4.39, 4.31 and 4.23, respectively. There is not too much difference, so a good compromise, particularly if we would like to operate anywhere between the extremities of the bank, is the middle figure, which, when changed from the decimal, measures four feet, three and three-quarter inches. This length does right well, under most conditions, up to 116 and down to 112 mc. If doesn't make a bit of difference how much power our transmitter is getting to put out. It may be a flea-power walkie-talkie or a powerful television station. If we're going to operate on 112-116 megacycles, the length of the antenna will be the same. The same size antenna will be suitable for receiving as well as transmitting.

For the sake of this discussion, let us consider our $51\frac{3}{4}$ inch antenna as our "fundamental" half wave. If all our operation is to be done with such a simple radiator (as is the case in u-h-f work), it is worth while to consider how we can best get the power from our transmitter into the antenna, and the siggnals we desire to hear from the antenna, which then is the pickup device, into our receiver. In certain forms of operation, such as the "walkie-talkie, it is more convenient to employ only half the "fundamental" length. The combination transmitter and receiver then functions as the other half of the antenna, and is called a "Marconi" or quarter-wave antenna. This may well be the subject of another discussion but has no practical bearing on present considerations. While it is common practice to provide a whip-type antenna or a tubular rod somewhat less than a half inch in diameter for operation on the frequencies and with the power we are considering (WERS stations being limited to 25 watts input), there is a lot to be said in favor of other radiators we shell describe.

Transmission Lines

The matter of getting the most power into the half-wave rod as well as the convenience with which we are able to do it are the two most important considerations which merit our attention. If the system is efficient for transmitting, it will be good for receiving, other essential elements being the same which is the reason that most of the information about this subject appearing in print is concerned with transmitting aerials.

While antennas are on the agenda of nearly every radio gathering and lead to discussions which might, in many instances, be described more correctly as brawls, it is the related subject of transmission - lines and impedance - matching which really enables the boys to hold forth.

Where the distance from the point of operation to the antenna is more than a few feet, it is doubtful that any form of transmission line is superior or even equal to a line formed of two wires suitably spaced, insulated and impedance matched to the transmitter or receiver on one end, and to the antenna, on the other. We hope, later, to enlarge upon such a line, which has given great satisfaction to those who have the space, facilities and the ability to get the thing going well. It is not an easy job. One or two false moves and the whole works is worth much less than some of the more simple arrangements which follow.

The Average Installation

There is little gained in considering an ideal case, so let us think of an installation, which, except for minor differences, represents an average fixed-location figure. Portable and mobile stations will be studied at another time. We live, let us say in a typical two or three story building in the suburbs, or, in an apartment, not more than three floors from the roof. Such a condition is covered by *Fig. 1.* The following suggestions serving as a guide, may be altered to suit circumstances. For ultra-high operation the height of the antenna, above ground as well as above surrounding objects, is the most important consideration. Therefore, all other conditions being equal, the higher we can place the cross-arm and the taller we can make the supporting mast, the better off we are going to be.

Pole *A* is a self-supporting (un-guyed) wooden mast conveniently made from an ordinary 2 x 4, say ten feet long. The manner of securing it to the roof is left to the ingenuity of the ham. The stand-off arm is also a 2 x 4, long enough to permit the transmission-line *I*, to be run for about three feet at right angles to *C* before starting to descent. Antenna support *C* is a piece of well-seasoned wood, 1″ x 2″ x 18″ mounted edgewise. The spacing of the insulators is unimportant, though room should be left in the center to separate the two inside ends of antenna, *E* and E_1 by one inch.

Our 51¾″ rod has been cut in two, at the center, thus giving us a half-wave antenna, made of two quarter-wave rods. (Other arrangements will be shown, wherein the rod will remain in one piece; but this will suffice as a starter. Aside from the matter of convenience, it will be found that there is room for little to recommend one type over another. We shall consider several, so that the most readily adaptable may be employed).

Transmission line *I*, a twisted pair, runs from the antenna connection on the transmitter through a suitable lead-in insulator, *H*, and the porecelain-insulated screw-eyes, F_1, F_2, F_3 and F_4, to the inside terminals of antenna rods E_1 and E_2. Where the distance from the shack to the radiator (aerial) is three floors or less, losses in the transmission line are not too important. Therefore almost any kind of twisted pair can be used—such as No. 14 electric-light wire having a weather-resistant insulation, or any good rubber-covered cord. The bet-

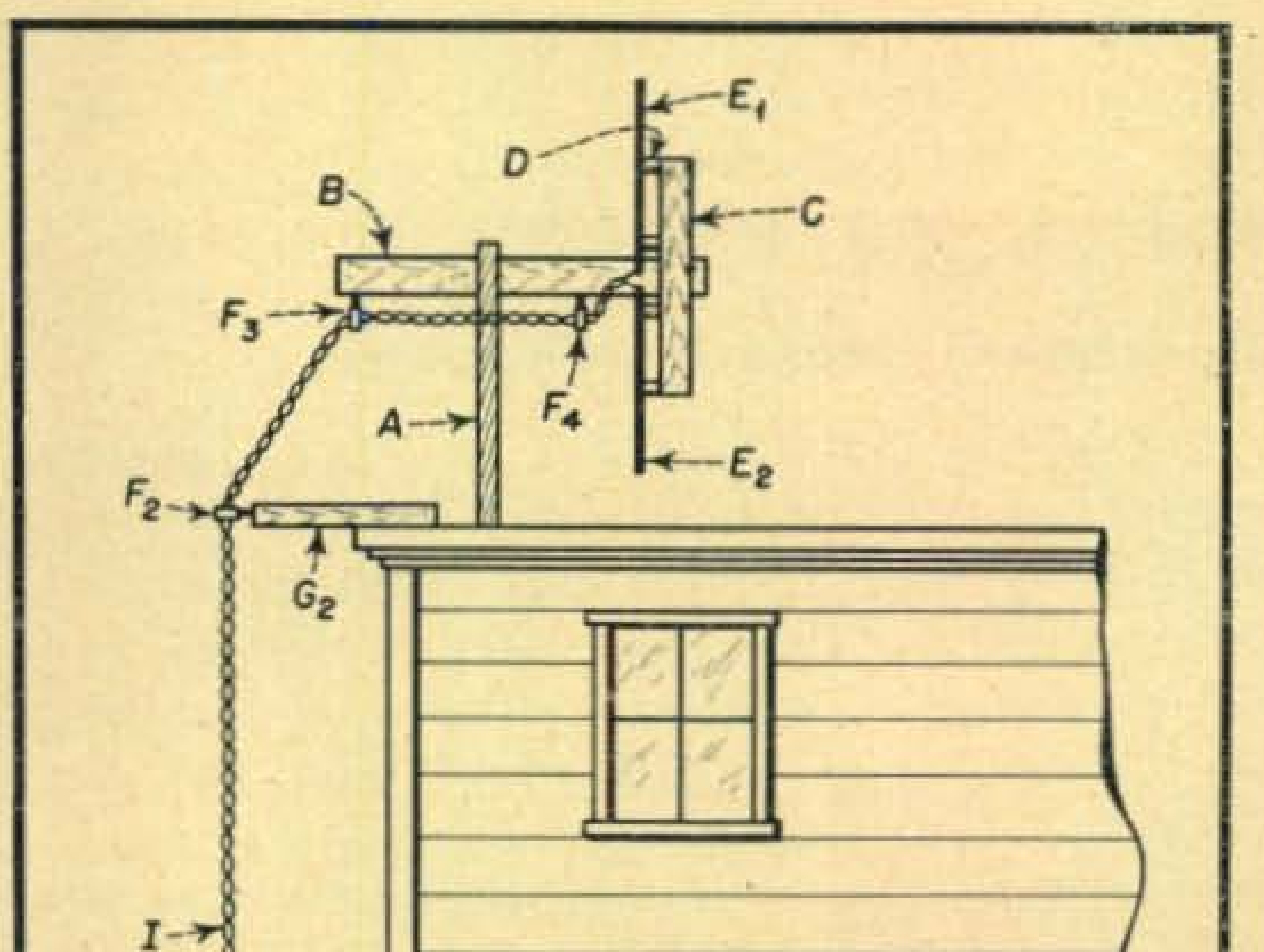


Fig. 1. The basic di-pole antenna. A simple, reliable radiator on its own, it is the starting point for other antennas and arrays of higher efficiency. Outside of the actual length of the rods, the most important dimension is, how high can you get it.

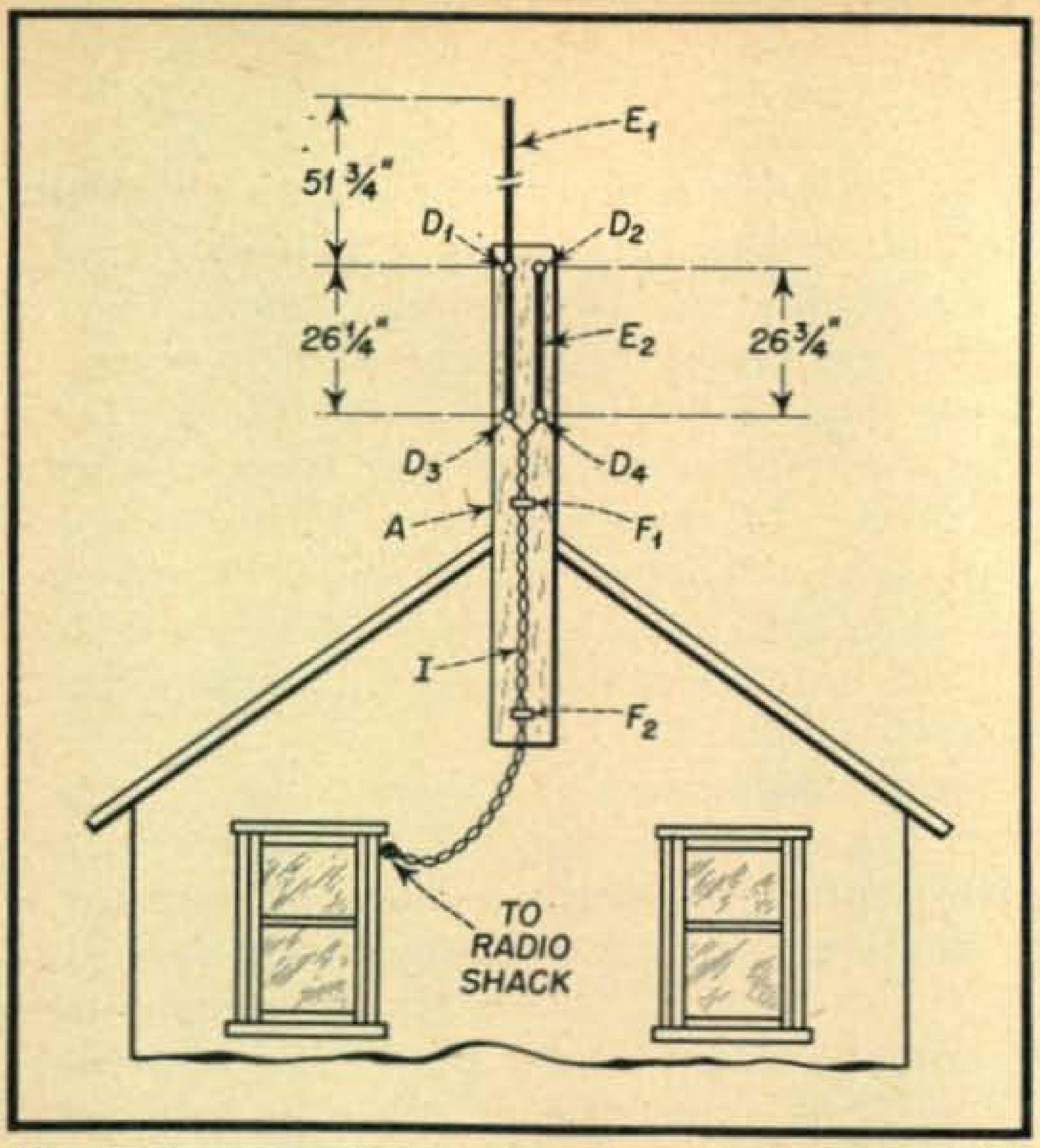


Fig. 2. A voltage-fed version of our fundamental half-wave antenna. The lower portion of the radiator and E_2 form a matching stub which permits efficient transfer of energy to and from the aerial via the twisted pair transmission line

ter the quality of the transmission line, the better the results, but reasonable efficiency can be expected even with an inferior conductor. If the antenna and transmission line are both indoors, as in attic installations, weather-proofing is less important.

Apartment House Installations

If the installation is made in a steel-girder apartment house, wooden supports, such as G_1 and G_2, should be used as stand-offs to reduce the loss which would occur if the lead-in, *I*, were run close to the building. These supports should be from two to three feet long. Where the building is frame, brick or stone, and the transmission line does not closely parallel the electric-light wiring, the porcelain-insulated screw-eye, F_1, F_2, etc., can be affixed to any convenient part of the structure so long as the lead-in is spaced a few inches from the building. Good tension joints should be made at points of strain.

Some question may arise (from the sophisticates) concerning our recommendation of the set-up illustrated in *Fig. 1*. This is a workable and *fundamental* design. In a future article we propose to show how the same mechanical assembly, with minor changes tn the antenna itself, can produce outstanding results. The common name of the radiator we have been considering is "a current-fed, half-wave di-pole." Its impedance at the center, where the transmission line connects, approximates 70 ohms — which is pretty close to the impedance of most twisted pairs. Hence we are providing a good impedance match between line and radiator—and without the use of calculus.

A Simple Alternate

Another simple antenna system with similar performance is shown in *Fig. 2*. It may be easier to use in some locations —particularly in the suburbs. Here again, the higher the mast the better the results. An ordinary telescopic automobile rod is used for the antenna E_1 as well as half of "matching stub." The other half of the stub, E_2, may be a similar piece of metal tubing, or even a short length of heavy wire held away from the mast by stand-off insulators. Insulators D_1, D_2, D_3 and D_4 may be of the type standard with automobile whip antennas. It will be noted that E_1 has been extended to an over-all length of 78 inches, while E_2 is 26¼ inches long (the difference being our familiar 51¾ inch rod). The space between E_1 and E_2 is approximately 2½ inches—and don't worry too much about it.

With this modification of our original design, that portion of I_1 extending beyond the upper end of E_2 remains our half-wave antenna. However, as it is fed at the end, (a point of high potential) it is termed "voltage fed," and the impedance at this point is very much higher than at the center of the di-pole. Considerable loss of power would result if one side of the twisted pair were connected to the end of the 51¾ inch length. The additional 26¼ inches and the extra rod or wire, E_2, form what is known as an impedance-matching transformer—or matching stub—which solves this problem. The transmission line, *I*, is run through stand-offs F_1 and F_2.

Good mechanical assembly, insulation and material, intelligently applied, are highly conducive to good results, but the difference between expert and poor construction is of much less importance than height. For the antennas just described, or any other types, especially when working within the low-power limitations of WERS communications, transmission line and impedance-matching losses should be minimized by common good sense. A good co-

[*Continued on page* 38]

LIFE-RAFT TRANSMITTER-RECEIVER

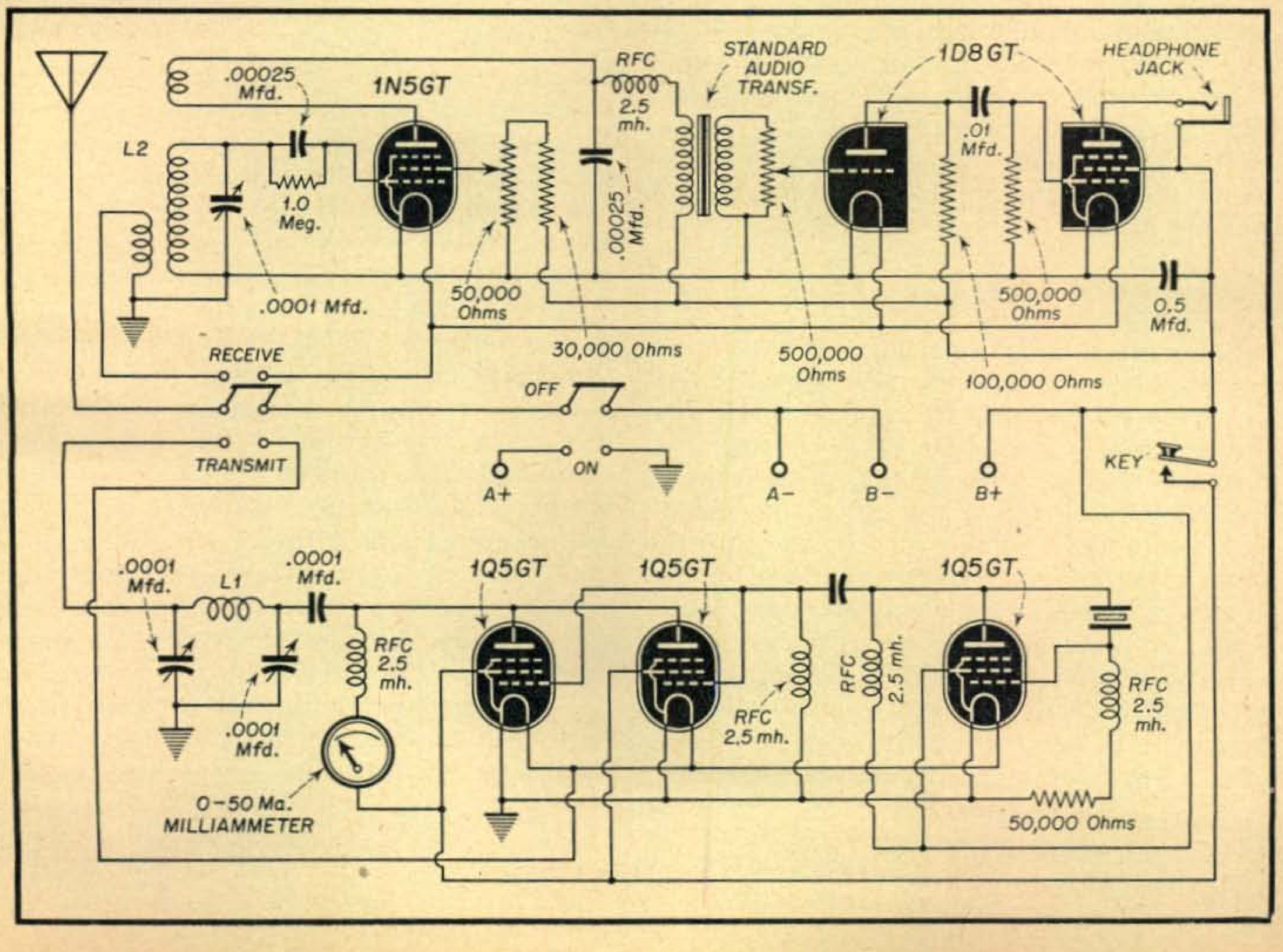
REQUIREMENTS OF THIS EMERGENCY SERVICE — AND A HAM PORTABLE DESIGN

PAUL L. RAFFORD, JR., W2GQM

IN LATE 1941 the author became interested in the development of a small transmitter for use aboard rubber life rafts which are standard emergency equipment aboard all commercial and military aircraft in over-ocean service. The transmitter-receiver herein described was not built as the ultimate in either circuit or mechanical design. The problems of water and shock proofing were ignored. The primary purpose of this unit was to demonstate that a light-weight transmitter and receiver of dependable characteristics could be constructed within stringent weight and size limitations. The result is a completely self-contained, battery-powered unit 9″ wide, 7½″ high, 7½″ deep, and weighing 10 pounds.

The transmitter-receiver, built along amateur lines, was intended to be tested on amateur frequencies and used as an auxiliary portable at the author's station,

Schematic diagram. L_1 — 4-prong, 1½″ form, 20 turns No. 16, close-wound. L_2 — 6-prong 1¼″, No. 26 wire; ant. coil, 3 turns on top of form; grid coil, ½″ below ant. coil, 15 turns spaced over ¾″; tickler, ¼″ below grid coil, 6 turns, close-wound.



Transmitting coil, L_1, is behind output condenser on extreme left. Crystal, with shield removed, is next to it. Audio transformer is in the center with the receiving coil unit, L_2, on the right

W2GQM. Construction was completed late in the evening on December 6, 1941. The 7-mc ham band was crowded that night. The transmitter was connected to a convenient receiving antenna approximately 15 feet high, running 60 feet alongside a frame house. A local station a few miles distant was immediately contacted and reported a strong, clear signal. The hour was late and it was decided to postpone further tests until the following evening. Needless to say, there never was a following evening for amateur transmission purposes. However, for the general interest of radio amateurs and those in particular considering the post-war construction of a small, portable, complete radio station, we present the constructional details at the end of this article.

"Gibson Girl" Features

It is interesting to discuss at this point the various features of the "Gibson Girl" and compare them with the features and advantages of this unit. The Gibson Girl has done its job well, saving of many lives in various theatres of war. It is now standard equipment aboard all U. S. aircraft that might possibly be forced down at ea. It can be operated by anyone with sufficient intelligence and strength to carry out the simple instructions. Either a kite or a balloon may be used to raise the antenna. It is powered by turning a crank, which also automatically keys the transmitter—or it may be keyed manually. It operates on the international distress frequency, 500 kc only. The range is approximately fifty miles under average conditions and reliable radio bearings have been taken at this distance. It is reasonable to assume that under certain sky-wave conditions the range would be greater.

However, there are certain disadvantages in the Gibson Girl. Using the same power on a high frequency, distances of several hundred miles might readily be covered. Amateurs have proved the ability of "flea power" transmitters to work over great distances with surprising consistency on high frequencies. A transmitter having at least one constantly monitored emergency frequency in the 5 to 10-mc band *in addition* to 500 kc would be of considerably increased in an emergency. At present, part of the disadvantage of short-range communication on 500 kc has been overcome by the elaborate monitoring procedure established on that frequency during the tow international distress periods each hour. Practically every ship, plane and ground station engaged in ocean transportation communications maintains these watches and the chances of being heard by a nearby station are fairly good and direction-finding facilities are also available on 500 kc.

Power

The term "strength" was used in conjunction with the ability to operate the Gibson Girl. Anyone who has cranked a Gibson Girl will agree that it requires no small amount of effort and it is questionable whether survivors after several days at sea, without adequate food and water, would have the strength necessary to crank it during each one of the silent periods. The only alternative is batteries. During the few years preceding the war the radio industry saw the development of portable broadcast receivers that were entirely self-contained and powered by batteries. The battery and radio tube industries developed components to meet the needs of the manufacturers of these portable receivers, and the transmitter-receiver herein described was designed around the best equipment available in late 1941.

The chief disadvantage of battery power in a transmitter is the relatively short life of the battery under operating conditions. However, within recent months a new type of storage battery has been announced, which is packed dry, maintains its charge indefinitely and may be filled by a simple, instantaneous process. This battery is available in a convenient "A" and "B" pack designed for small portable equipment and appears to be the answer to the battery problem.

Receiver Worth While

When the Gibson Girl was developed, it was intended to be operated by personnel without technical radio-operating training and so there was no need for a receiver to be included. However, if a high-frequency receiver is used in conjunction with a high-frequency transmitter, it would enable an operator, even of minimum skill, to maintain two-way cw communication with shore and rescue stations. Practically all over-ocean aircraft carry a competent radio operator and it has been the custom of commercial airlines, when flying any but very short over-sea routes, to employ two Radio Officers. In addition, most pilots are required by their organizations to have a minimum of radio-operating training which in most cases would be sufficient to operate an emergency transmitter of this type. It therefore is reasonable to assume that at least some of the survivors of a landing at sea would be capable of operating the equipment. In the event that there was no technically trained survivor, the equipment could be operated similarly to the Gibson Girl by a simple switching and crank system for sending the SOS automatically.

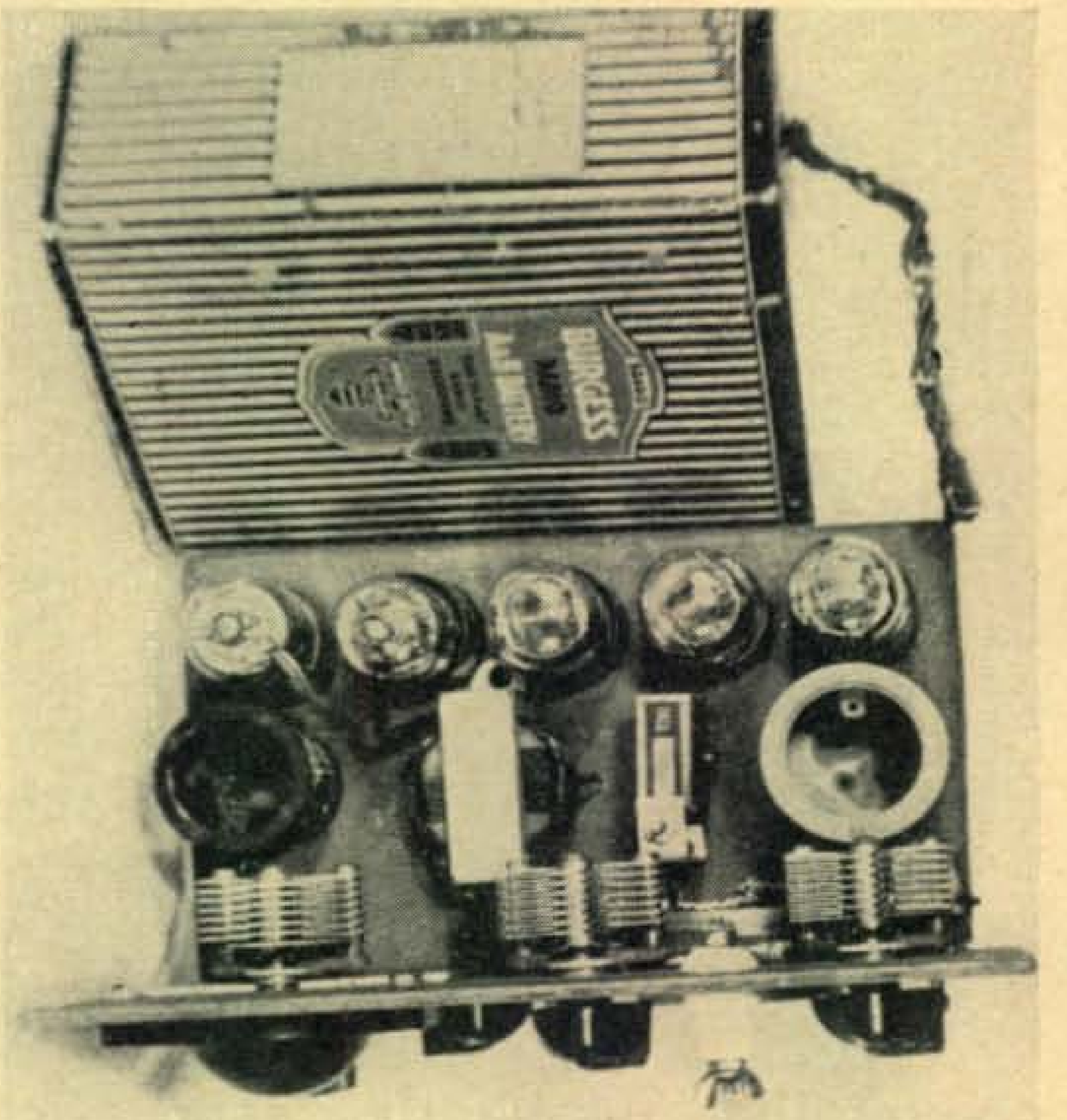
After several days at sea aboard a life raft, there might be considerable doubt as to the accuracy of the timepieces used for navigation. A knowledge of the exact time is essential for determining accurately latitude and longitude and also the start of the 500 kc silent period. if a simple receiver is available that will cover the 5, 10 or 15 mc broadcasts of the National Bureau of Standards radio station, WWV, near Washington, D.C., the exact time may be determined at practically any time of the day or night. Other stations also broadcast accurate time ticks at various hours and may be heard practically anywhere.

The Pre-Pearl Harbor Model

Plug-in coils were employed in this test model, for the sake of simplicity. A superheterodyne was considered, but the additional tubes, coils and space required outweighed the slight advantage of a superhet over a regenerative receiver. The receiver in this unit has been able to pick up every signal that was fairly readable on a 12-tube superhet. Most of the aeronautical ground and marine coast stations employ high power on relatively clear channels, so selectivity and sensitivity are no problems in a life-raft receiver. The regenerative detector is a IN5GT and covers 4.9 mc. to 9.6 mc. with a coil as shown. Oscillation is smooth over the entire range and although reception is best with an antenna approximately 60 feet long, the receiver will operate satisfactorily on much shorter lengths. The output of the detector is transformer coupled to a two-stage amplifier built around the triode and the pentode units of a 1D8GT. It is necessary to shield the grid leads to prevent audio oscillation. Hand capacity effects to the receiver tuning condenser are eliminated by means of a small sheet of aluminum mounted behind the main panel as can be seen in the photograph.

The Transmitter

The transmitter employs a 1Q5GT in a Pierce crystal oscillator with a pair of parallel 1Q5GTs as amplifiers. Use of the



Top view of transmitter-receiver with battery, giving a good idea of over-all compactness. Frequency range is from 4.9 to 9.6 mc with coil specifications as given

The complete transmitter-receiver unit with batteries enclosed — ten pounds of two-way radio, with a potential long-distance range, in a case 9" wide, 7½" high and 7½" deep

Pierce crystal oscillator eliminates oscillator tuning controls, and with a crystal of normally good activity operation is quite satisfactory. It is preferable to operate the output stage as a straight amplifier but doubling is possible with somewhat reduced ouput. For the purpose of battery economy, the use of a crystal oscillator by itself might seem advisable but the far more stable operation of an amplifier in tuning practically any length of antenna outweighs this advantage. Tuning is accomplished by means of the "pi" network and with the coil and condensers shown, almost any length of wire from 15 to 100 ft. can be matched. However, some difficulty may be experienced in the neighborhood of a quarter wave (33 feet in the case of 7 mc) as the loading or output condenser effect becomes nil, and the amount of amplifier loading is dependent on the ratio of the input or resonating condenser to the coil inductance at resonance. The recommended length of wire is anything between 60 and 80 feet for 7-mc band operation.

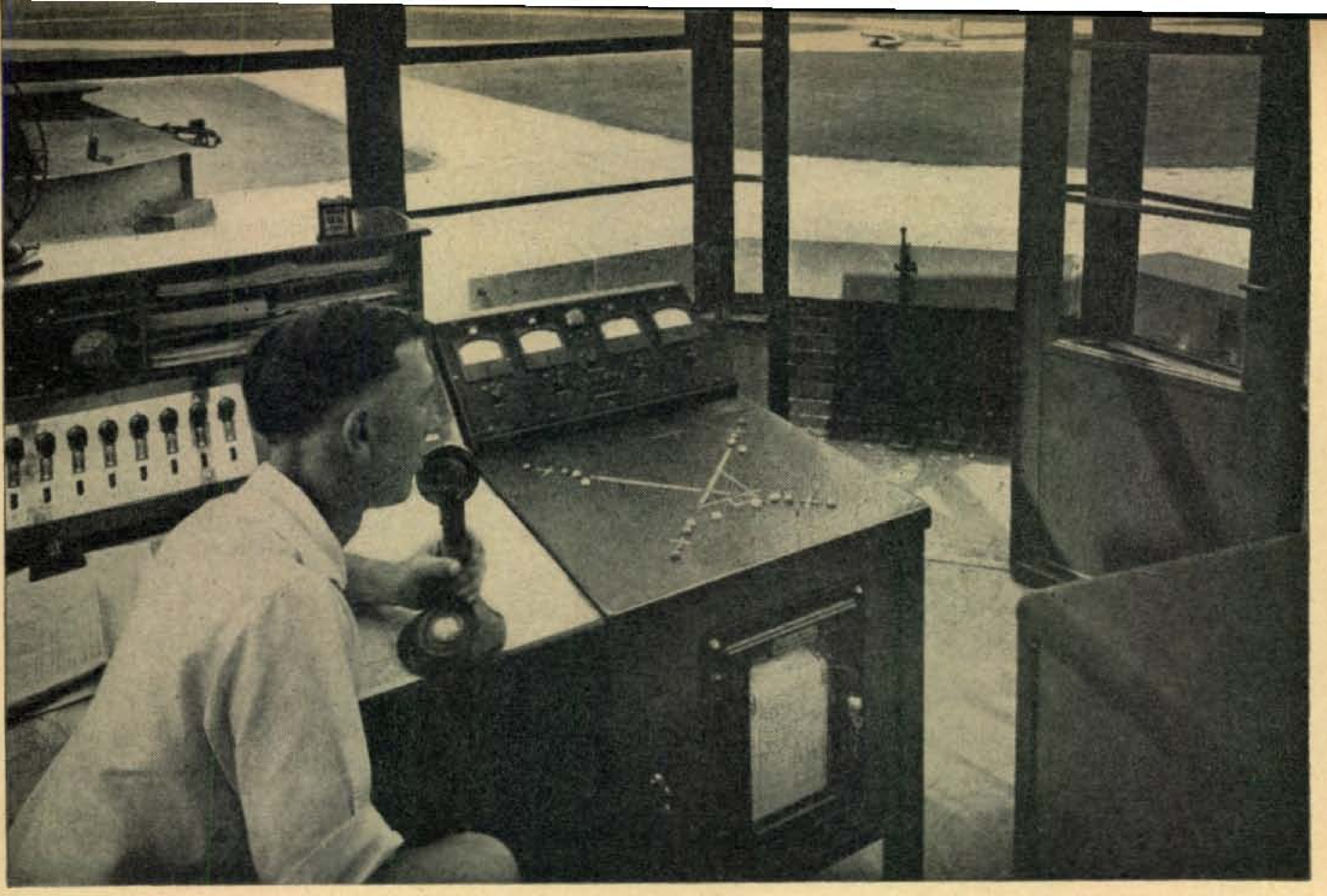
Operation

With the transmit-receive switch in the transmitting position, plate current is observed for minimum current as the input condenser is resonated for various settings of the output condenser. The tank condenser should be adjusted to provide a loading of approximately 25 ma. with the input condenser adjusted to resonance. The input power is slightly more than two watts and it may be assumed that somewhat over a watt is in the antenna. A fairly good ground connection should be used as this antenna system works against ground. It is necessary to shield the crystal as both holder plates are operated above ground, and amplified self-oscillation, due to capacity between the coil and crystal holder, may occur. The photograph of the rear of the transmitter shows the crystal holder with the shield removed.

The transmit-receive switch shifts the filament voltage and the antenna from one section to the other. This switching arrangement saves battery power and permits dual use of a single aerial. There is a few seconds delay after the switch is thrown before the filaments heat to operating temperature, but this is not a serious disadvantage. The transmitter is keyed in the "B" plus lead of the amplifier. Break-in operation was considered but the details involved, such as a keying relay or providing a separate receiving antenna, ruled this out. The power from the battery is controlled by means of a switch which breaks the plus A and B minus voltages.

Construction

The unit slips readily out of its plywood case, to which it is secured by means of four machine screws and wing nuts. The machine screws are mounted on angles which in turn are screwed to the inside of the case. Four holes, one in each corner of the panel, accommodate the screws. The washers and wing nuts are then fastened on the outside of the panel as can be seen in the front view photograph. The case itself is constructed of ¼" plywood. The front panel, made of ⅛" tempered masonite, is secured to the aluminum chassis by means of the two potentiometers and jacks mounted at the bottom. The chassis dimensions are 8" wide, 4½" deep and 1½" high. A handle is screwed to the top of the case to facilitate carrying. The battery originally used with this unit was a Burgess 5DA60, providing 1½ volts and 90 volts. Any similiar type may be employed providing the case dimensions will accommodate it. The chassis and panel are painted in a "Communications Gray" wrinkle finish, the case a smooth, glossy gray, while the inside is varnished.



CAA PHOTO

GET ON THE BEAM!

A PRIMER ON AVIATION RADIO

L. LeKASHMAN, W2IOP

AVIATION radio is playing an increasingly important part in our daily lives. The success of the airplane as a practical transportation device may be laid on the door-step of radio. Scheduled flying in all kinds of weather, traffic control involving hundreds of planes, landing with ceiling zero—are possible only because of radio. It is the purpose of this article to discuss briefly such major radio aids used in the domestic aviation field as are not restricted. Actually the list will be quite complete, because few of the secret wartime inventions will find immediate application in commercial flying. This is not a technical treatise, so we call it a primer on aviation radio.

The amateur has been familiar with aircraft transmitters and receivers for many years. Weight limitations has necessitated unusual mechanical and electrical circuits in commercial design, though basically they are straightforward receivers and transmitters. Band-switching, crystal switching, pre-tuned circuits, A1, A2, or A3 emission, built-in antenna loading, ease of servicing, anti-shock mounting and rigid mechanical specifications, are just some of the important considerations in airplane radio design. The receivers differ principally in that they may be required to perform multiple functions. For example, an automatic direction finder may also be used for communications on the range band. However, it is more common to find a separate receiver for every job. A completely equipped airliner will have at least one automatic direction finder (more likely two), a communications receiver for the low and medium frequencies, a very-high-frequency communications receiver, a VHF marker beacon receiver, a low-frequency range receiver; a VHF localizer and ranger receiver, and

Airport traffic control tower at CAA operated Washington National Airport
—*CAA Photo*

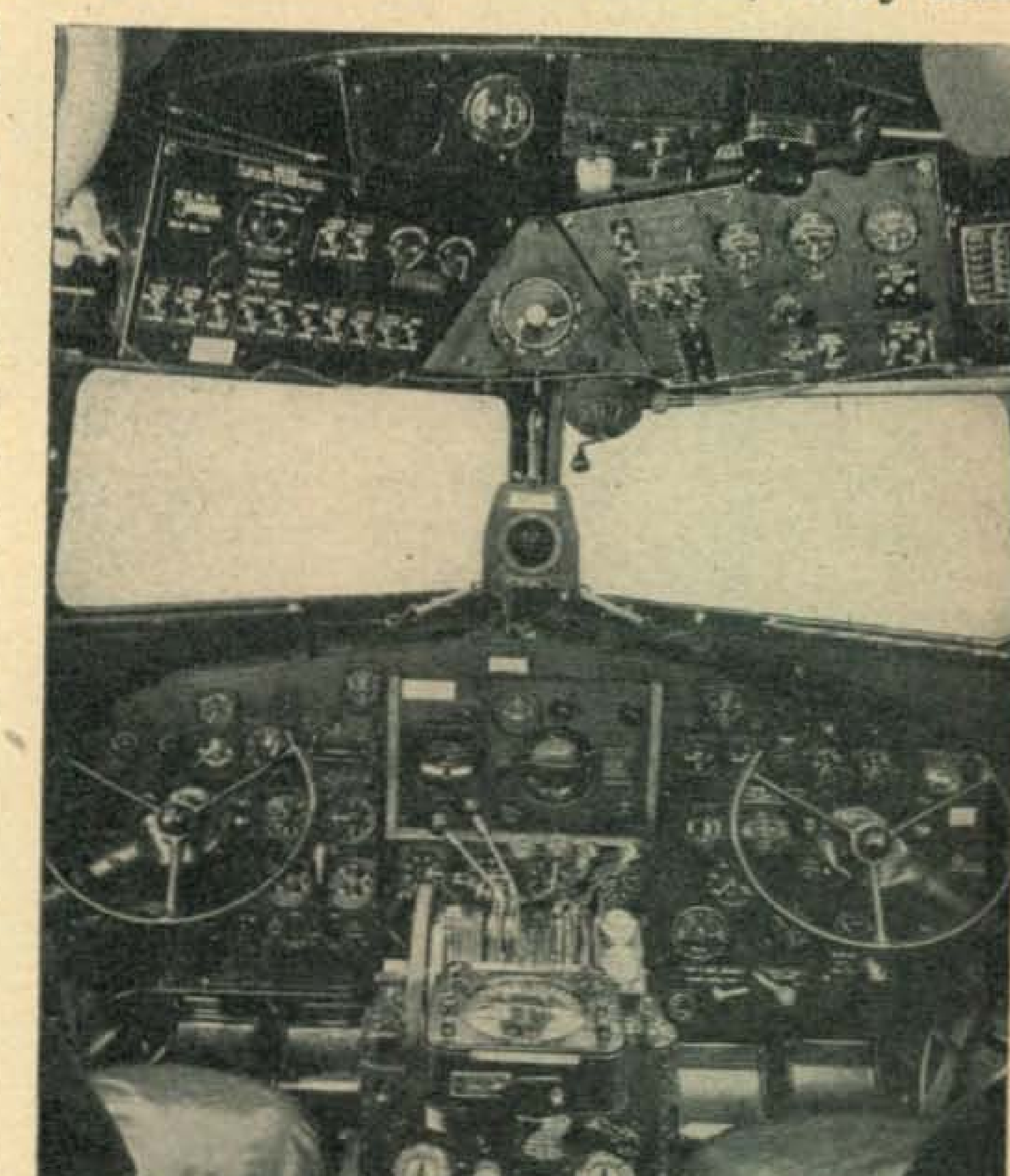
possibly a radio altimeter, as well as an interphone amplifier. There are, of course, many different classes of commercial planes. Those flying a domestic run will, as a rule, have installations quite different from planes on overseas routes. Aircraft flying outside of the United States usually have greater duplication of equipment to allow for possible failure in flight, and carry less equipment used only in conjunction with domestic radio aids.

The principal radio aid to fiying in the United States is the radio range. The four-course Adcock type of simultaneous range, is being rapidly replaced by ranges on the VHF. The loop-type range is used to far lesser extent, and while still frequently encountered, is also giving way to more modern developments. On the VHF there are a four-course aural range (similar in operation to the low-frequency prototype), a two-course aural range, the two-course visual, and the omni-directional range, which seems likely to supplant all the other types soon after the war.

Simultaneous Radio Range

The simultaneous radio range is the most common used in this country at the present time. It consists of five 125 foot towers on a 600 foot square, the odd tower being placed in the center. The two pairs of crossed Adcock antennas are 90 degrees in space with respect to each other. The station is a familiar sight along many American highways. Two transmitters are separated in frequency by 1,020 cycles. One transmitter, the weather and voice transmitter, is connected to the center tower. The other transmitter is keyed from one pair of towers to the other. The center tower transmits continually, except when interrupted for voice announcements. A filter prevents the 1,020-cycle tone from modulating the transmitter on speech. Planes are equipped with filters allowing the passage of only the 1,020 cycles for flying the beam, or eliminating this for monitoring speech. Course alignment is accomplished by a goniometer adjustment on the ground.

Each of the Adcock radiators has a marked directional characteristic and the pair forms a figure eight pattern. The two figure-eight patterns may be rotated in azimuth by employing a goniometer adjustment consisting of two primary and two secondary windings. The angle between the primary coils of the goniometer can be varied from 90 degrees, resulting in a varied course alignment. The course alignment may also be changed by inserting a resistance in the circuit, or by some

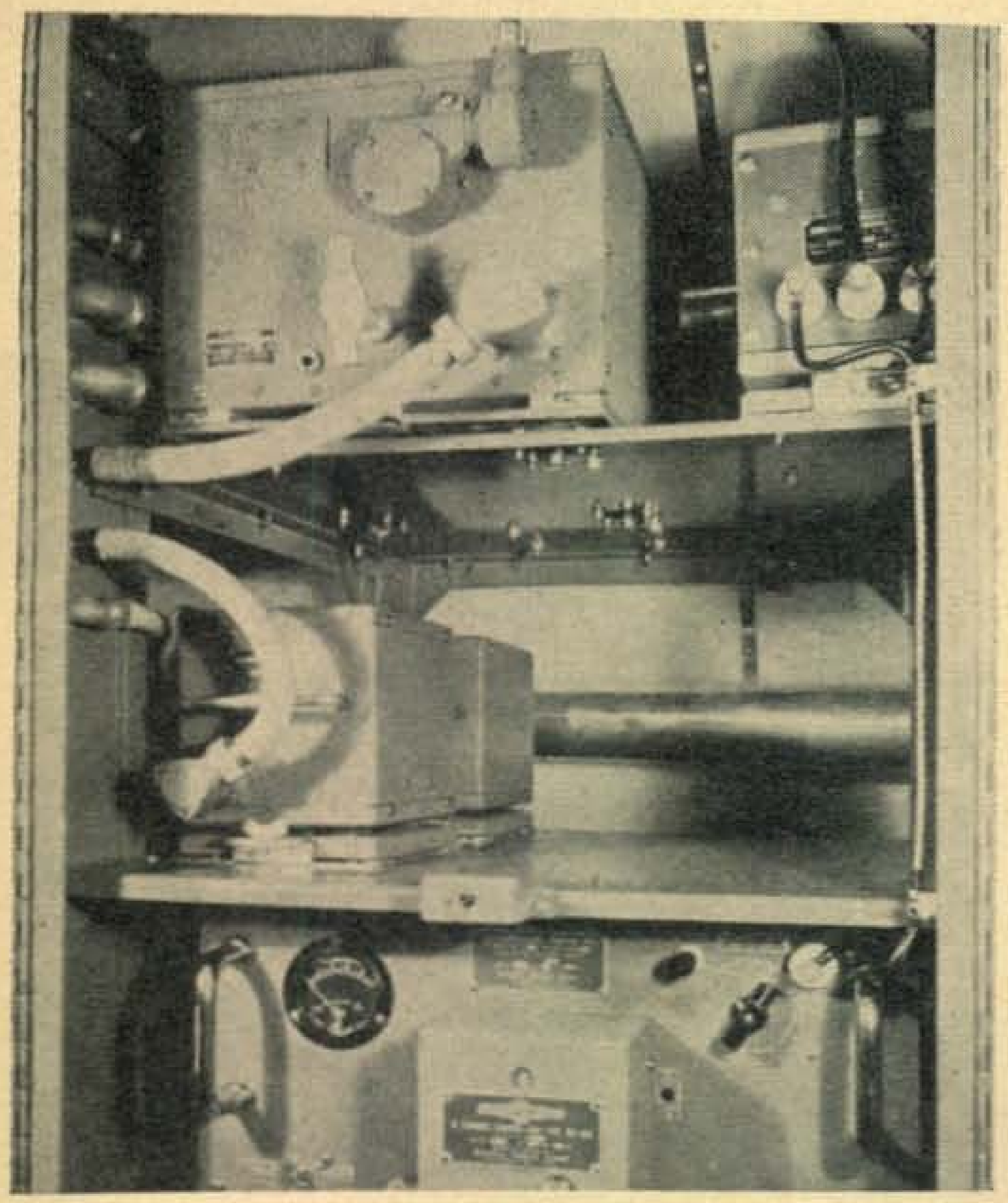


The "office" on a DC3 transport. Note the ADF and the mutiplicity of radio controls on the ceiling panel
—*American Airlines Photo*

other method so that the power delivered to one of the Adcock systems is less than the other. A phase-shifting network may be used to introduce a phase shift between the currents in the two towers comprising one of the Adcock antenna systems, so that they are no longer 180 degrees apart. Permitting the center tower to receive some excitation from the second r-f channel while it is switched to one of the Adcock systems will also cause a course shift in the same manner as a phase shift. These several methods can be combined for extreme flexibility.

Directional Loops

The loop-type range consists of two loops crossed at right angles. RF is fed to the loops alternately by a motor-driven switch. The signal is modulated at audio frequency and keyed at the same time to produce the character N in the field formed by one antenna, and the letter A in the field of the second antenna. The letters are so keyed that in the quadrant of an individual antenna either the A or N signal will be heard. The keyed signal for both quadrants is audible approaching the intersection of two lobes and finally, when on the bisecter of the intersection of two lobes, the A and N signals of the same intensity interlock, and form a steady (on-course) signal.



Bendix rack-mounted transmitting and receiving equipment on a DC3

VHF Range at Black Moshannon, Pa.
CAA Photo

Night Effects

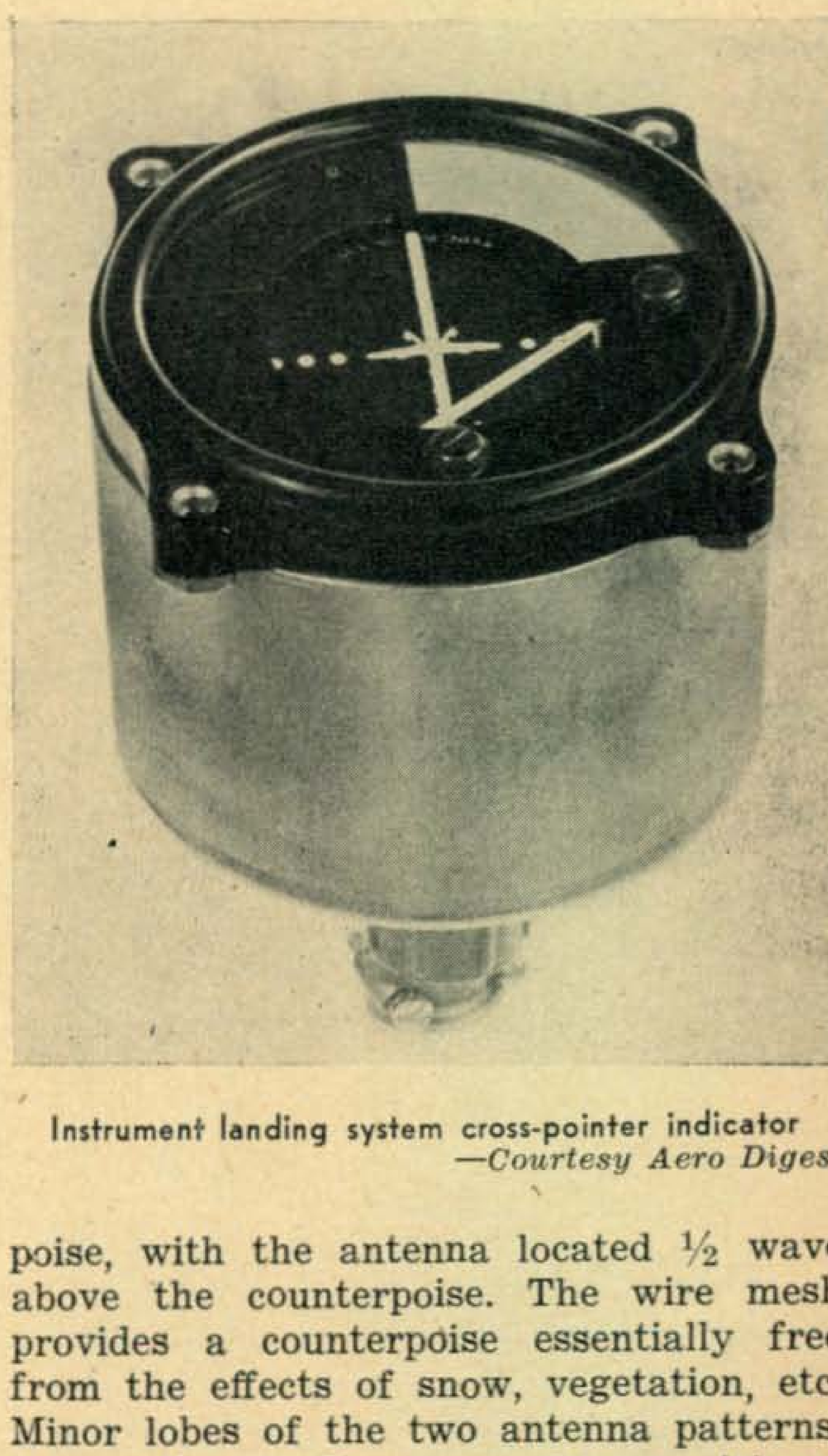
The loop type range is unsatisfactory for more than local work, from the hour immediately preceding darkness until some time after sunrise, due to "night effect." Both the vertical and horizontal portions of the loop radiate energy, but the horizontal component is reflected by the Heavyside layer and arrives at the receiving point out of phase with the vertically-polarized part of the signal. This tends to cancel the desired signal and produces false or unreadable courses. However, close in to the range (less than 30 miles or so), this effect is negligible at all hours. Another shortcoming of the loop range is that the keyed carrier must be interrupted for voice broadcasts or to communicate with aircraft. During instrument weather conditions this has proved very dangerous. However, because of their relatively low cost, loop type ranges are employed where purely local coverage is the principal requirement, as at airway intersections, emergency fields, or gaps along the airway not adequately covered by the regular range station. During night-time the loop type range should be used with extreme caution.

Both types of low-frequency radio range have a number of inherent defects that are primarily a result of the operating frequency. Most serious of these is "night effect" (caused by ionosphere reflection) resulting in wandering legs, false courses and multiples. Sensitivity to static and terrain effects are also pronounced. In addition, because of lack of additional frequencies, station separation of 3 kc and geographic distribution have been inadequate to prevent skip interference between stations. The solution to the problem has been the adoption of the very high frequencies for an entirely new system of airway ranges. The VHFs have overcome almost all of the inconsistencies of the low-frequency range, while presenting fewer technical problems. Night effect and static are completely eliminated, multiples and course bending are reduced to a minimum, skip interference is non-existent, and a large number of frequencies are available. However, the VHFs are not a cure-all, especially on phone, where even line-of-sight transmissions are subject to severve interference, if only because of the activity on the band.

The VHF Range

The latest and most promising of the VHF ranges is the all-direction (or omnidirection range), which registers the bearing of an airplane on an instrument in the cockpit. The new range sends course signals in all directions from the station, in comparison with the four course standard range, and is equipped for simultaneous voice transmission. In actual flight, the pilot can select any desired compass course by setting a pointer on a 360 degree compass-type dial. So long as he maintains the course, the vertical pointer on another dial (usually the standard cross-pointer indicator used for instrument lands) remain centered. Deviations are indicated to right or left up to 10 degrees maximum on the dial. Should the pilot get far off course, despite continual instrument indication of his flight deviation, he can determine immediately his bearing to any station within receiving range by centering the vertical pointer and reading the bearing in degrees, on the scale. He can also take bearings on two or more stations for a radio fix. These VHF transmissions have a range of 50 miles at 1,000 feet, increasing to 100 miles at 10,000. The VHF ranges now being installed are all designed for conversion to the omnidirectional type. One of the most obvious advantages of this new system is that it makes it possible for the private pilot of a small airplane, with an inexpensive, lightweight radio receiver, to navigate by radio anywhere in the country.

The regular four-course, and two-course, aural VHF ranges are similar in many respects to the low-frequency range—except for antenna design. The small size of the physical layout makes the VHF stations much more economical to install. The antenna array in general use employs five horizontal Alford loops (not to be confused with Adcock) mounted on a tower over a coarse wire mesh approximately 30 feet off the ground. The most practical structure comprises a 30 to 45 foot counter-



Instrument landing system cross-pointer indicator
—Courtesy Aero Digest

poise, with the antenna located $\frac{1}{2}$ wave above the counterpoise. The wire mesh provides a counterpoise essentially free from the effects of snow, vegetation, etc. Minor lobes of the two antenna patterns, intersecting to form secondary equisignal zones, is the biggest problem encountered on the VHFs. It is also extremely important that changes in the altitude of a plane will have no effect on the equisignal course, a situation encountered in some VHF designs. It is interesting to note that while a decided increase in distance range can be obtained by increasing the height of the tower, the introduction of multiple lobes due to reflection from the ground, with the resulting surges, fades, course discontinuities, and false cones-of-silence, nullifies the usefulness of the range as an aid to aerial navigation. With the wide application of the VHF ranges to the civil airways it is expected that a variety of reflecting objects will be encountered. In extreme cases, specially shaped patterns may be required to reduce reflection and eliminate multiple courses.

Visual Indication

The visual radio range on the VHFs is a special application of the aural range. In the case of a four-course range, it is possible to have two visual and two aural legs. The visual range is succeeded by the

75 mc indicator lamp instrument
—Courtesy Aero Digest

omni-directional range, but since it is also of importance for instrument-landing-system localizers, it is likely that this form of range will be permanent. Modulation at 90 and 150 cycles is substituted for the quadrant letter (A and N) identification. This provides an equisignal course where the 90 and 150-cycle modulations are of equal intensity. The pair of antennas radiating the signals that register on the visual indicator are excited 180 degrees out of phase by side-band energy arising from modulation of the carrier frequency by 90 and 150 cycles simultaneously, but from which the carrier itself has been suppressed. The center element radiates the carrier frequency and also the 90-cycle and 150-cycle side bands. The side-band energy radiated from the center element combines vectorially with the radiation from the corner elements to produce a field pattern resembling two cardioids. At the point of intersection the 90 and 150 cycles are equal in field strength, forming an "on-course" signal. The aircraft receiver is conventional, except for two independent output circuits. The 90 and 150 cycles are separated by band-pass filters, the outputs from which are rectified, and the resulting d. c. applied in opposition to the zero-center meter. The predominance of one signal or the other will cause the pointer to deflect. When on course the pointer will remain in center position. The second output circuit of the receiver provides for the tone frequency and voice. When the visual and aural legs are combined, the same center element can be common to both systems. The aural legs are produced in exactly the same way, except that a single modulation tone of 1020 cycles is used and the courses are defined by keying an A and N.

Cone of Silence

The range systems alone, do not provide sufficient navigation information. To supplement them we have numerous aids. Over all radio ranges, and in fact over all vertical radiators, there is a no-signal area —commonly referred to as the cone-of-silence, since it theoretically appears as a cone with the apex on top of the radiator. This zone can be used for an orientation point (for example in an instrument let-down) if a certain course is to be steered after passing over the range station. However, the cone-of-silence is a negative rather than a positive indication. Because it is sharp, the cone often cannot be located. The cone-of-silence marker (or Z markers as they are commonly known) is a very low power 75 mc transmitter modulated by a 3000 cycle tone, exciting a directional array which produces a circular lobe in a vertical plane. The array is placed at the center of the radio range and is used to indicate flying over the point where the cone-of-silence should normally be. This Z marker signal may be monitored aurally, but visual indication is unusually available. When passing over the station, a relay is actuated in the receiver output lighting an indicator lamp on the instrument panel. The length of the indication is dependent upon the altitude of the plane, but a duration of 10 seconds is average.

High frequency "Z" marker
—*CAA Photo*

The cone-of-silence is much more clearly defined on the VHF ranges, which is an advantage not to be overlooked at a small airport where a minimum installation may be desired, or the special Z marker receiver is not carried.

The fan or FM marker derives its name from the fact it radiates a VHF signal in a fan-shaped directional pattern. These beacons are placed at strategic locations along the airways—such as the approach to an obstruction or the intersection of two ranges. The fan markers also operate on 75 mc, exciting a directional antenna having the desired pattern. The power required must provide an easily recognized signal up to about 20,000 feet, and the pattern must hold its elliptical shape. The cross-section at 5,000 feet altitude is approximately 12 by 3 miles in the horizontal plane. Larger patterns of proportionate dimensions are obtainable through the use of increased transmitter power or improved receiver sensitivity. A transmitter output between 100 and 150 watts covers all ordinary fan marker requirements. The key signal is customarily keyed in dashes to identify the particular leg of the range and to differentiate the FM from the Z marker. The use of 3000-cycle tone modulation for the marker transmitter makes it possible for both the marker and range signals to be heard simultaneously without bothersome cross interference. The marker receiver output also actuates a signal lamp indicator, as in the case of the Z marker. The FM marker antenna consists of four half-wave sections built in a line and operating in phase with each other. They are aligned with the direction of flight, on the center of the equisignal zone. A wire screen, or counterpoise, under the radiators serves to project the field pattern vertically.

Boundary Markers

Low-power marker signals are used to mark boundaries for airports with inner and outer markers on instrument landing systems. Signals are of about 5 watts output. The outer marker is modulated by a 400-cycle tone which lights a purple indicator lamp on the instrument panel. An auto signal will be heard approximately one second before the lamp lights. The inner marker, a 1300-cycle tone, will flash an amber light for approximately 1½ seconds when the plane passes over at a low altitude. While it is customary to use two of these markers in connection with an instrument landing system, they can be used in any number of combinations. However, standard receiving equipment on the VHFs makes provisions for only three indicator lamps—a white airways lamp and the inner and outer markers of purple and amber (all on 75 mc).

There are also low-frequency marker beacons located at intervals "on-course" of the regular low-frequency airways radio range. These stations operate on the same frequency as the particular radio range with which they are associated, and on frequencies not otherwise utilized by ranges. They are identified by coded letters. These markers should not be confused with non-direction beacons used for off-airways flying in conjunction with an ADF or the manual DF loop. At present they are largely restricted to type MHT beacons—medium-power homing beacons ratiating non-directional signals. They are located at secondary fields which are not sufficiently important to warrant ranges. In post-war plans the CAA is planning the installation of high-power beacons. Transcontinental planes will not be restricted to airways flights, but will go to high altitudes and make direct trips using such beacons for straight-line bearings.

Instrument Landings

The instrument landing system now most widely used consists of four essential parts

[*Continued on page* 39]

BIASING METHODS

Negative Bias Can Be Expensive — In Dollars, Cents and Plate Voltage. Sometimes You Can Get It For Nothing.

A. C. MATTHEWS, W3FWJ

IN THE DESIGN of radio receivers the matter of obtaining a satisfactory negative bias is an important consideration, since the use of extra components for this purpose increases the cost. This is a problem in battery powered receivers, where, in general, the tubes have no separate cathode connection.

Several possibilities present themselves and their advantages and disadvantages will be discussed. In the case of battery powered receivers where the filaments are connected either in series or parallel, two well-known methods are available as shown in *Fig. 1*. The most obvious, but least satisfactory method from a cost standpoint, is to supply a separate bias battery. This also requires additional space. Its use, however, does eliminate a source of common coupling since the battery has a fairly low internal resistance when new, and if properly bypassed, will cause no trouble as this resistance increases with age. Because the current requirements in this service are negligible, the operating life will be equal to the shelf life and replacements are seldom required. However, the disadvantages outweigh the good points, and a separate battery is rarely employed.

Series Dropping Resistor

Having decided against the "C" battery, the next logical step is the use of a series dropping resistor in the —B supply lead. Adequate bypassing must be provided to eliminate a source of common coupling or feedback, since the plate current for all tubes passes through the bias resistor. Bias voltage developed across this resistor is obtained at the expense of the plate voltage applied to the tubes. Decreasing the plate voltage when using battery type tubes is a serious matter because the tube capabilities are low to begin with, and any reduction will seriously affect the performance. It is therefore desirable to substitute some other method of bias supply.

C Bias Gratis

Fortunately, there is another source of voltage available for this purpose. Since practically all receivers are now superheterodynes, it is only necessary to utilize the d-c voltage developed across the oscil-

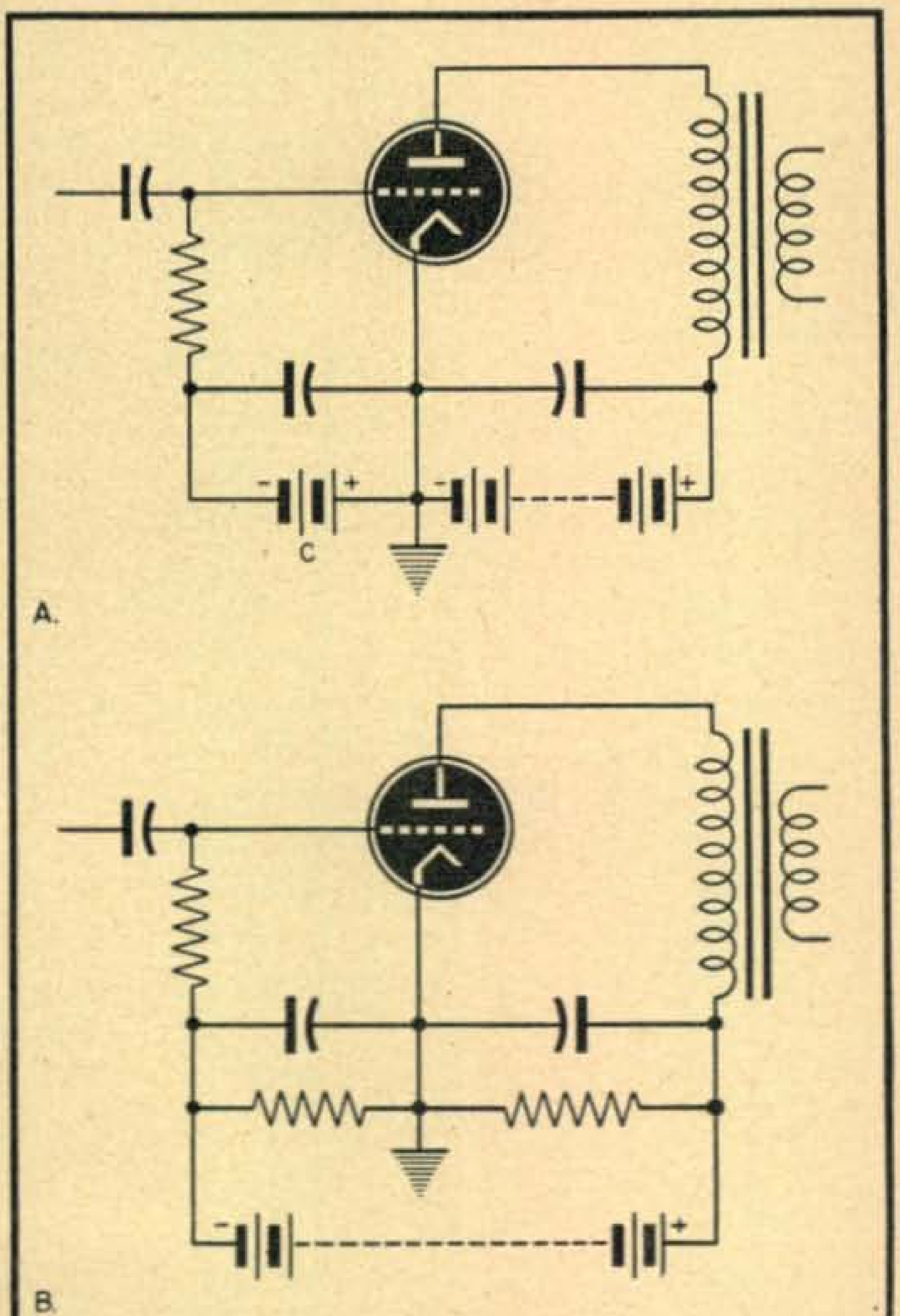


Fig. 1. In (A), separate bias battery and (B), bias across resistor in —B lead

lator grid leak to provide the required bias. *Fig. 2* shows a typical circuit arrangement. The d-c voltage developed should be reasonably constant throughout the tuning range of the receiver. This is necessary for uniform translation gain and therefore requires no special consideration when using the voltage for bias supply purposes. A resistance-capacity filter will be required between the d-c source and the output stage to minimize feedback, but the circuit constants are not critical. Should the developed bias be higher than required for normal operation (as is usually the case) the RC filter constants are so chosen that a fraction of the total voltage is obtained. In other words, the filter functions as a voltage dividing potentiometer and can be designed to suit the particular requirements at hand.

As can be seen from the schematic, this method of obtaining bias voltage does not reduce the effective plate potential to the output tube and therefore does not decrease the power output. Taking a typical battery operated receiver as an example, the use of the local superheterodyne oscillator as the source of bias voltage results in an increase in output of approximately 15 percent over the arrangement shown in *Fig. 1-B*. This is definitely where the designer must obtain the maximum in performance in the smallest possible space.

Other Uses

This method is not limited to battery operated receivers, although it is particularly useful in such designs since battery power is relatively expensive in both initial installation and upkeep. A possible application in line-powered receivers would replace the bias supply system shown in *Fig. 3*, where current flowing through a resistor in the negative high voltage supply lead is used to obtain bias for the output stage. This circuit requires that the first filter condenser and the center tap of the high-voltage transformer winding be below ground or chassis potential. Such

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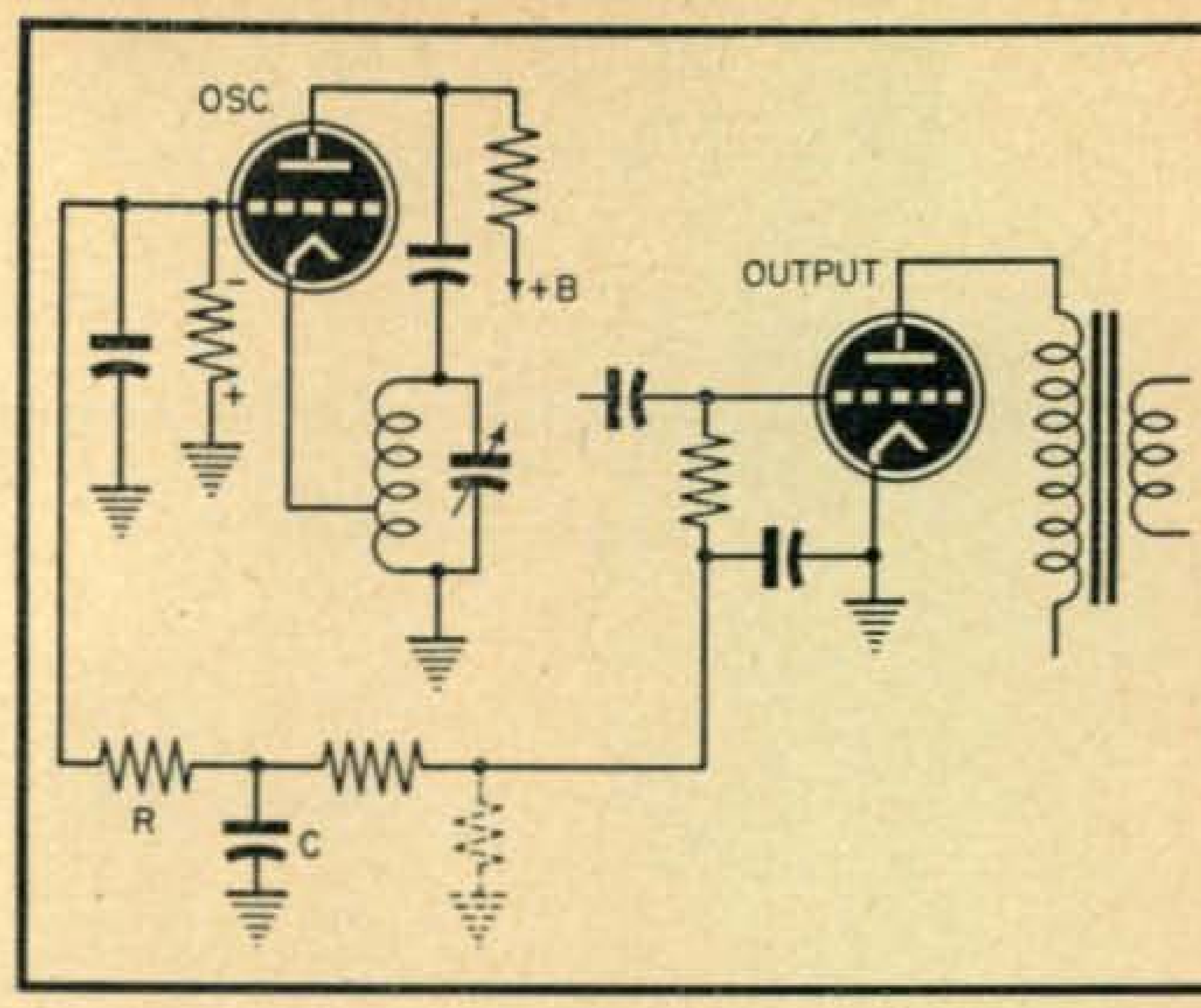

Figure 2

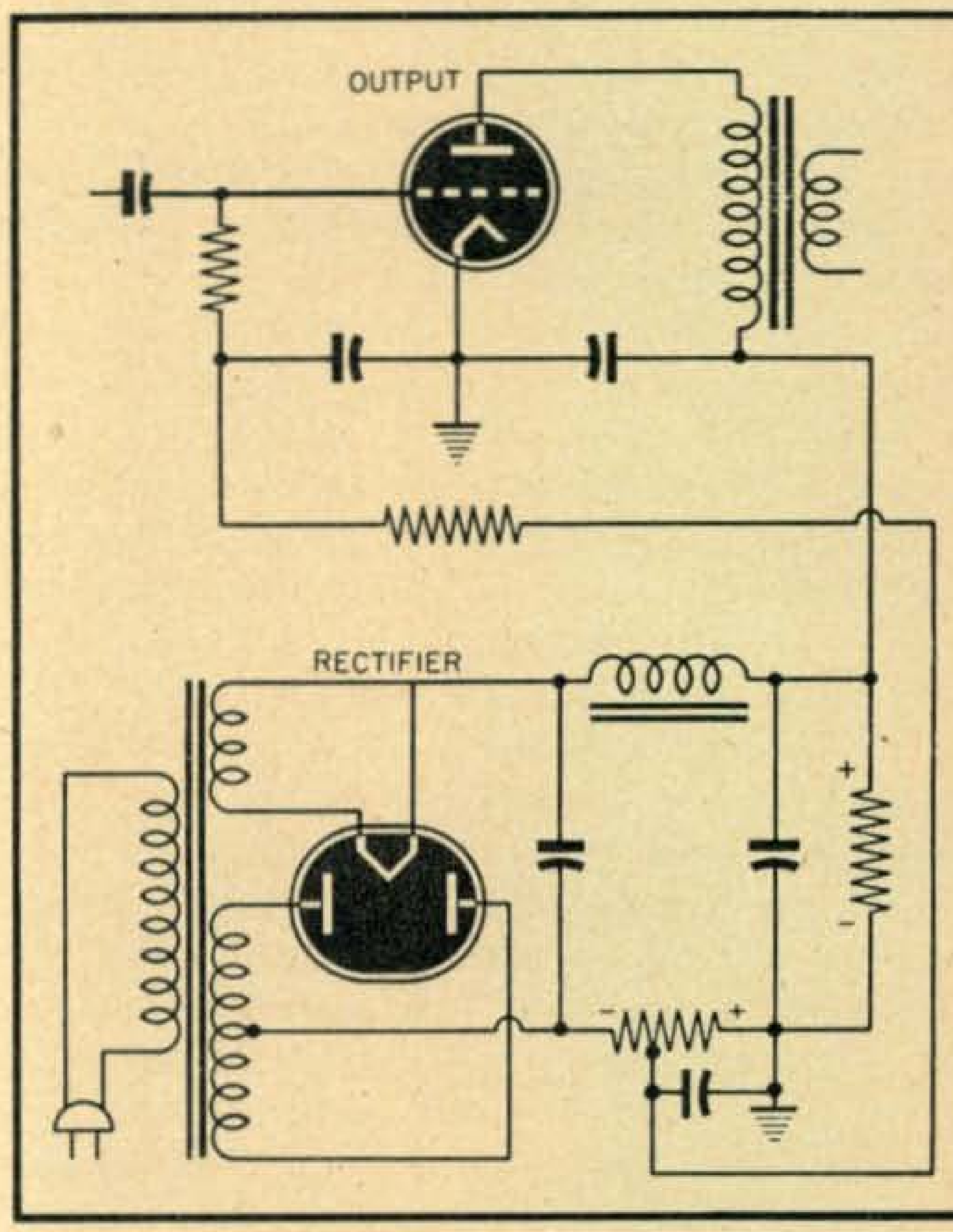

Figure 3

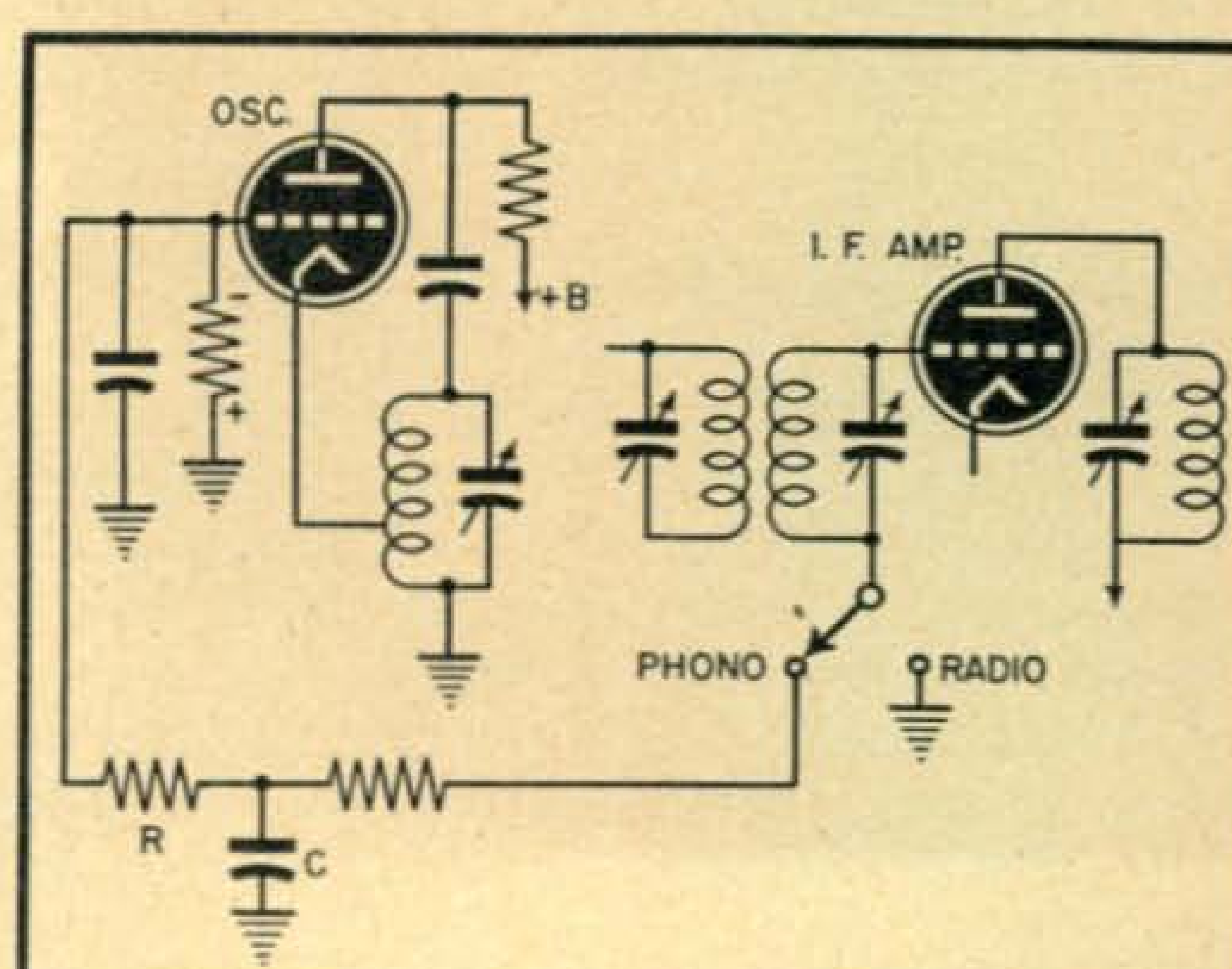

Figure 4

Fig. 2. Bias from d-c voltage across oscillator grid leak

Fig. 3. Bias across resistor in negative power supply lead

Fig. 4. Oscillator bias to cut off i-f amplifier in phono operation

STACKED CARDS

The Average Ham Has Them By The Hundreds — QSLs From All Over The World

L. W. LAWRENCE

QSL TO THE amateur has a special significance. QSL cards are a colorful and integral part of ham radio. On the list of definitions for international "Q" signals, QSL means "I acknowledge receipt." It was only natural that when amateurs started exchanging printed verification cards, that they should become known as QSL cards. The originator of the whole idea was 8UX. This custom was practiced (and we use the past tense only to indicate pre-war) by amateurs all over the world. QSL collections were proof of the pudding and highly-prized possessions.

Almost every station had a different card. The designs ranged all the way from simple typed post-cards, to elaborate engravings. Printers offered a large variety of designs which were both attractive and inexpensive. But most everyone had their own ideas as to what a QSL should look like—so originality was the keynote. DX men seemed to feel that a card should show up well on the wall of a foreign station. In this way, with pardonable pride, they could prove they worked that station every time a photograph of the same showed up in print. Many stations desired merely to convey information confirming a QSO, with little technical data, whereas, some cards read like engineering reports. Designs occasionally emphasized local attractions and those with any unusual call letters often capitalized on them. It was a rare card from Wyoming that didn't have a bronco buster tearing across it. From Montana, heart of the copper country, came a QSL printed on a thin copper sheet. Among the popular ideas was for entire clubs to utilize the same basic design, changing only call letters and descriptions of the individual station.

U. S. and Foreign Cards

The average QSL card contained at least the call, address, name of the station owner and operator, transmitter line-up, and receiver. If the receiver was home-brew, it was customary to include the tube complement. Affiliations and certificates were generally shown, as for example, membership in the ARRL, WAC for working, all continents, etc. (Certificates of achievement are awarded for a large number of amateur activities, and in the majority of cases QSL cards are required to substantiate claims.) In addition to the above data, there was space for the time of contact, signal reports, date, and pertinent remarks.

American cards were usually standard post-card size ($3\frac{1}{4}$ inches x $5\frac{1}{2}$ inches) which made for simple filing or mounting on the wall. Size was also somewhat re-

Wartime QSL of GM6WD, Glasgow, Scotland

stricted by postal regulations, which prohibits the one-cent rate on cards over standard dimensions. If you mailed out any great number of QSLs, postage was worth thinking about. Amateurs outside of the United States printed cards of every conceivable size. Some were double cards which containing a profuse amount of station and personal data. Europeans particularly went in for advertising the local town and its highspots. The New York City skyline made a beautiful background for many local QSLs, but seldom did a Pittsburgh mill, or California orange grove appear.

QSL Bureaus

Mailing cards a few at a time isn't much of a problem provided you have the full and correct address of your QSO. The Radio Amateur Call Book magazine was printed four times a year and contained an accurate list of the world's amateurs. While publication is temporarily suspended, this familiar aid to the ham may be expected to appear again. The nine American districts occupied most of the callbook, but the lists of foreign hams was lengthy and

QSL's from 35 different countries in every continent show the variety of designs used

constantly growing. Direct mailing of QSL's was always done inside the United States, but for DX, a more flexible and far less expensive method was worked out. Through the cooperation of the ARRL, foreign radio societies, and individual amateurs in the few small countries where no Organized Radio Clubs existed, "QSL bureaus" were established. Cards for hams in these countries were sent to the respective QSL bureaus, who then distributed them. This was particularly advantageous to foreign stations contacting thousands of W's. Ordinarily their postage bills would have been staggering, if not prohibitive.

In the U. S., each call number district had its own QSL manager. A station expecting foreign cards kept an envelope on file with his QSL manager and when several cards arrived they were mailed out. If a station worked a great deal of DX, it was only necessary to keep more envelopes on file. Foreign bureaus could send an entire batch to the ARRL by parcel post, for distribution to the district managers. In a like manner, a QSL for an Aussie, for example, could be sent to the Wireless Institute of Australia. The QSL service enables many W's to receive valuable DX cards which normally would not have been delivered. It reduced the chances of a card going astray because of an incorrect address, and served as a clearing house when the address was unknown. Volunteer QSL managers in a large district handled more mail than many a fair-size post office. The strange thing is that there were some hams who did not think enough of the cards to bother getting them from the bureaus. Thousands of uncalled for QSL's were destroyed annually. Yet every station was asked several times merely to send postage for mailing.

With all the effort expended in distributing cards and making QSL'ing easy, it is difficult to understand why some amateurs didn't acquire the QSL spirit. No one is compelled to mail out a QSL, but the least to be expected is a reply to a card received! This is merely common courtesy, but too many amateurs found it too much work filling out a card, a negligence that caused no little hard feeling, and, among DX men especially, many headaches. Extracting a QSL from a reticent foreign amateur became quite an art. The customary procedure, after two or three

[*Continued on page 37*]


ELECTRONIC ENGINEER'S
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"LINE-OF-SIGHT" TRANSMISSION

Putting A Signal Across "The Lost Horizon"

ZEH BOUCK, W8QMR-WLNG

THE DX GANG working below 30 megacycles has their problems in Great Circle distances and spherical trig, plus a few concessions to sunspots, night and day paths, time of year, geographical locations and frequency. As frequencies rise and we approach, or even enter, the microwave region above 300 megacycles, we run into a new set of considerations involving "line-of-sight" distances, diffraction, temperature inversion and several refractive effects. Climbing the spectrum ladder toward the frequency of light, it is only reasonable to suppose that the transmission characteristics of radio signals will approximate more and more the chacteristics of light, and that the line-of-sight limitation will be the most consistent factor in determining the average, reliable range of communication. You simply cannot see a terrestrial object beyond the actual horizon* (except for refraction, reflection and a negligible Einsteinian effect).

Figuring on the line-of-sight distance will provide a slight margin of safety in reliable day-in and day-out QSOs. The primary consideration then is how far can you see on a clear day from the average height of your antenna. The higher up you are, the farther away you can see, and over water or level ground, your limit of vision will be the theoretical horizon. Of course, a mountain range fifty miles away from this theoretical horizon may appear to be the horizon, which, with the observer at sea-level, would be only some four miles distant. In other words, a high antenna on the opposite end of the line-of-sight will also increase the range. For a given height of both antennas, the maximum optical range will be that distance at which the optical path (and perhaps the microwave radio beam) *just scrapes the horizon somewhere in between.*

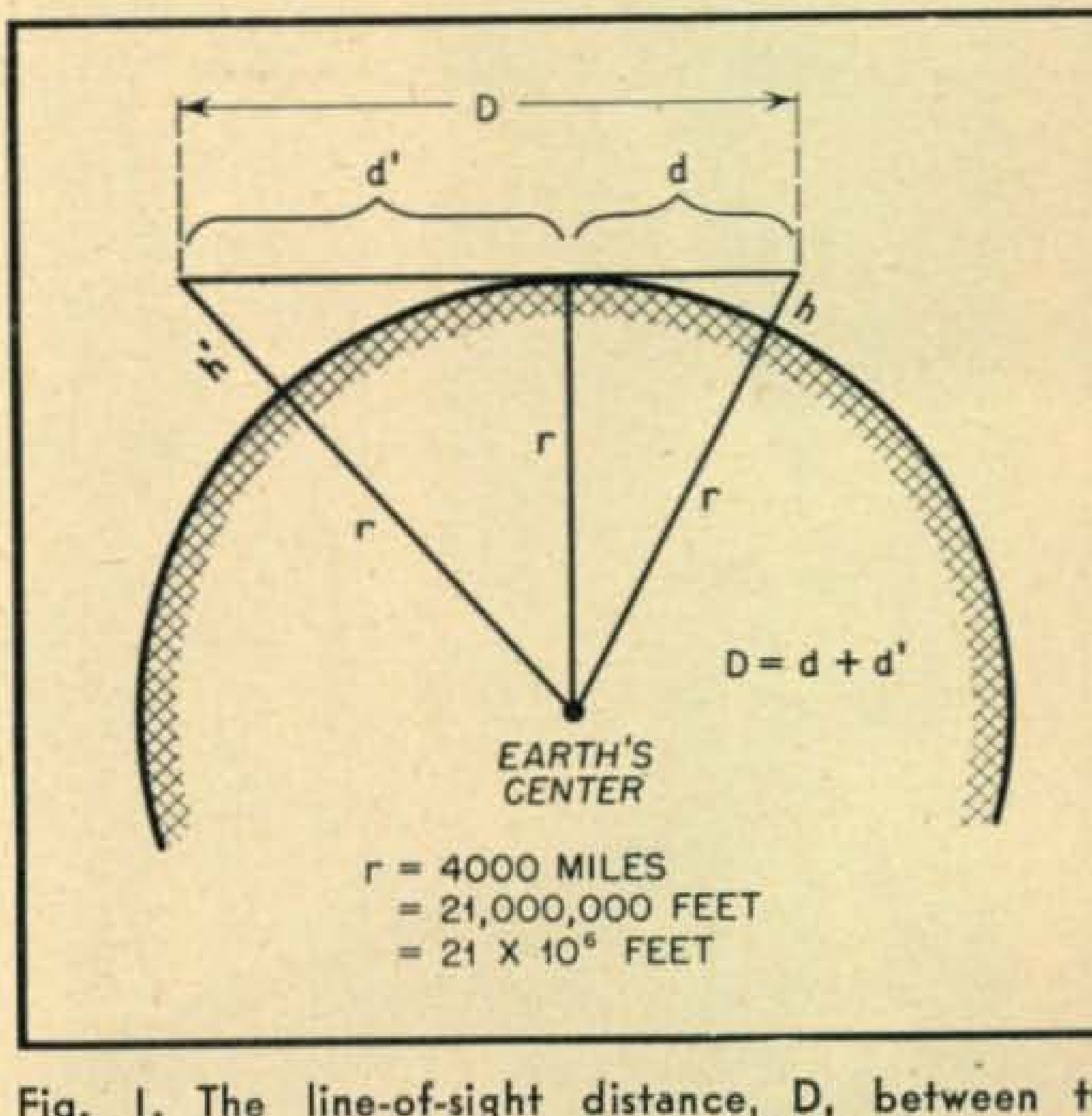
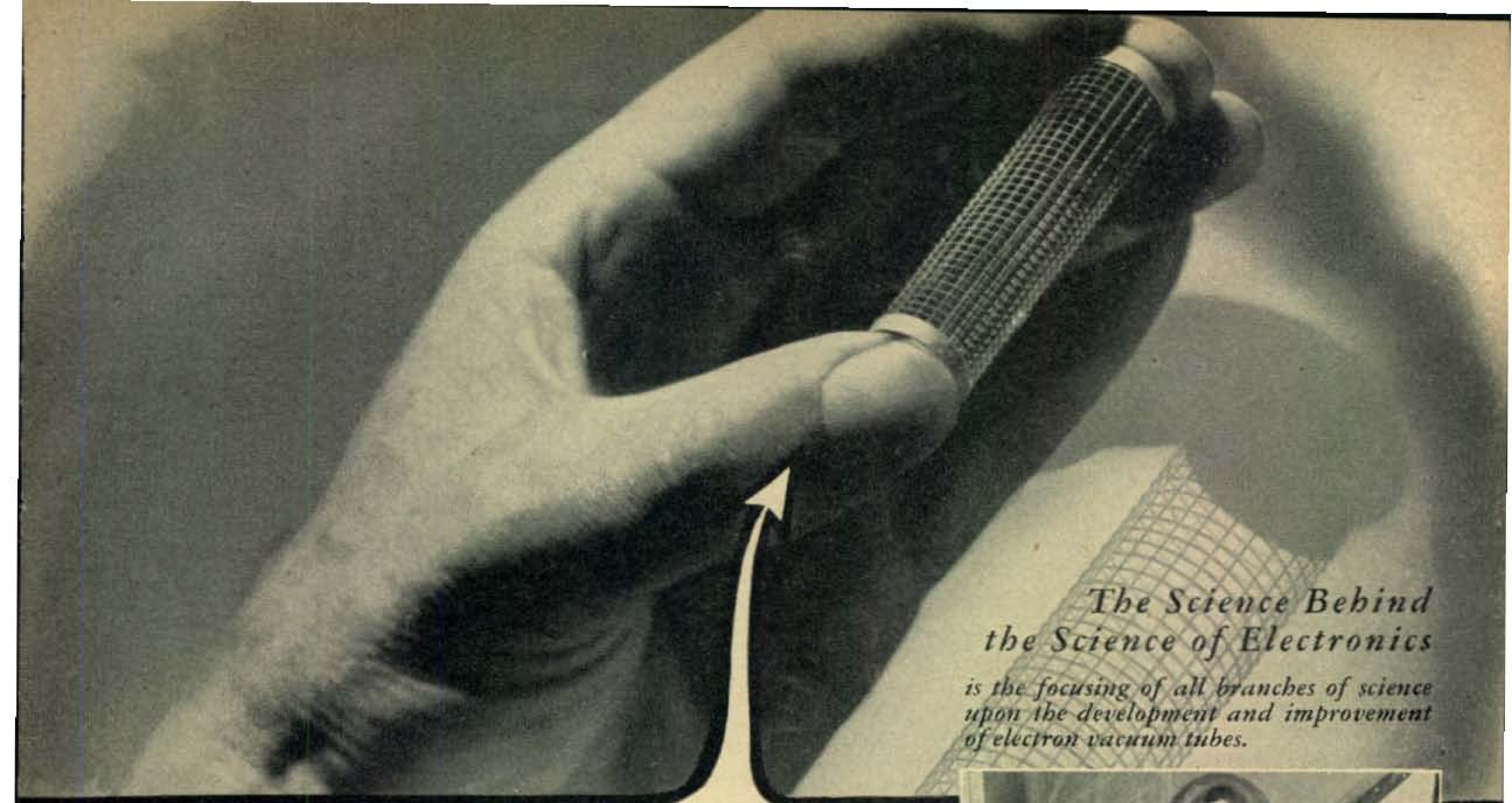


Fig. 1. The line-of-sight distance, D, between two antennas is the sum of the individual horizon distances, d' and d

There is a very simple equation by which this distance can be determined. However, in case one forgets the formula, anyone who remembers his school-days rule that the square of the hypotenuse equals the sum of the squares of the remaining sides of a right-angle triangle, can start from scratch and either pencil out the distance then and there or derive the simplified equation as a stimulus to memory (once you work it out yourself, you'll never forget it—which applies to many radio formulae).

The sketch in *Fig. 1* represents a cross-section of half the earth. The radius of the earth is shown as r, while h, in exaggerated proportion, is the height of an aerial above sea-level or flat terrain (which height, of course, represents the sum of all local ele-



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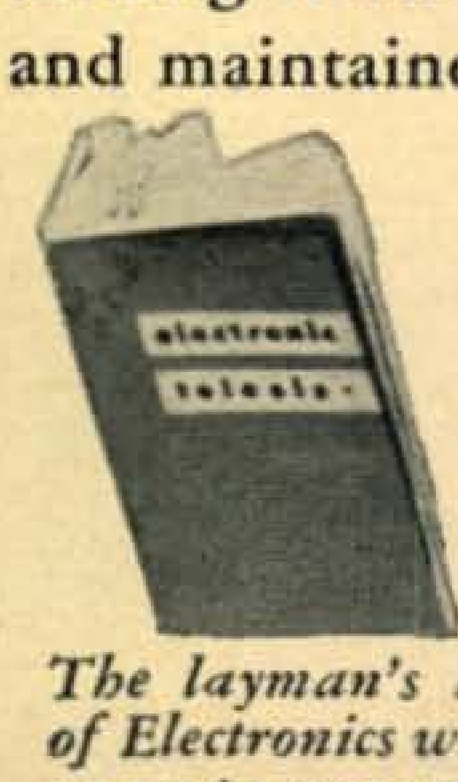

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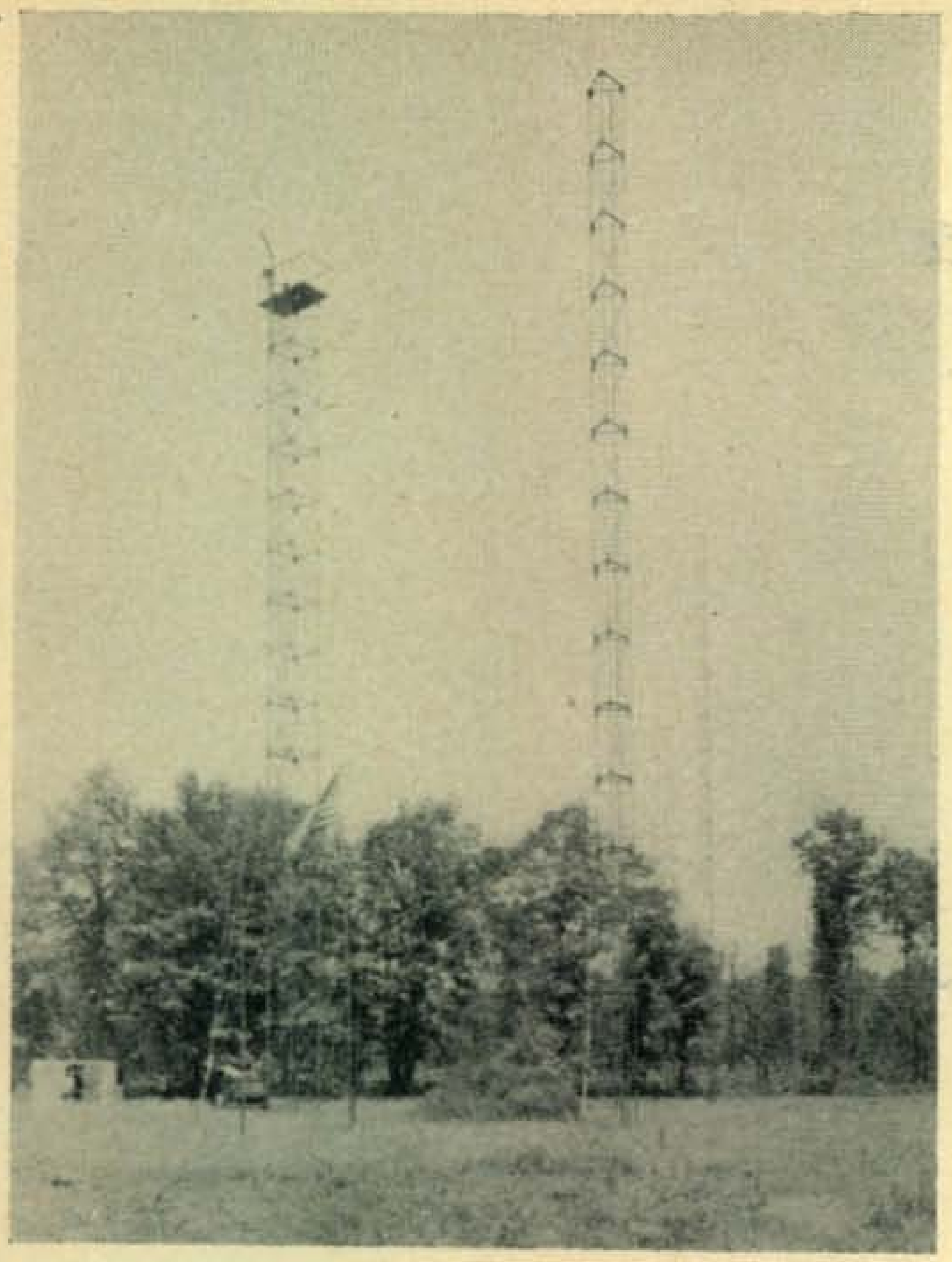


Sky-hooks which push out

vations). We desire to find the distance d —the number of miles from the antenna to the horizon. We obviously have a right-angle triangle, in which d and r form two sides, and $(r + h)$ the hypotenuse. Solving for d, the equation follows, *with all dimensions in feet.*

$$d^2 = (r + h)^2 - r^2$$
$$d = \sqrt{(r + h) - r^2} \qquad (1)$$

From equation (1) you can compute distance d—knowing h, the height of the antenna, and aproximately the earth's radius as 21,000,000 or 21 x 10^6 feet. That's the simple arithmetic of it, but the process may be somewhat laborious, and the equation admits of considerable simplification. Squaring $(r + h)$—

$$\begin{aligned} d &= \sqrt{r^2 + 2rh + h^2 - r^2} \\ &= \sqrt{2rh + h^2} \\ &= \sqrt{h\ (2r + h)} \qquad (2) \end{aligned}$$

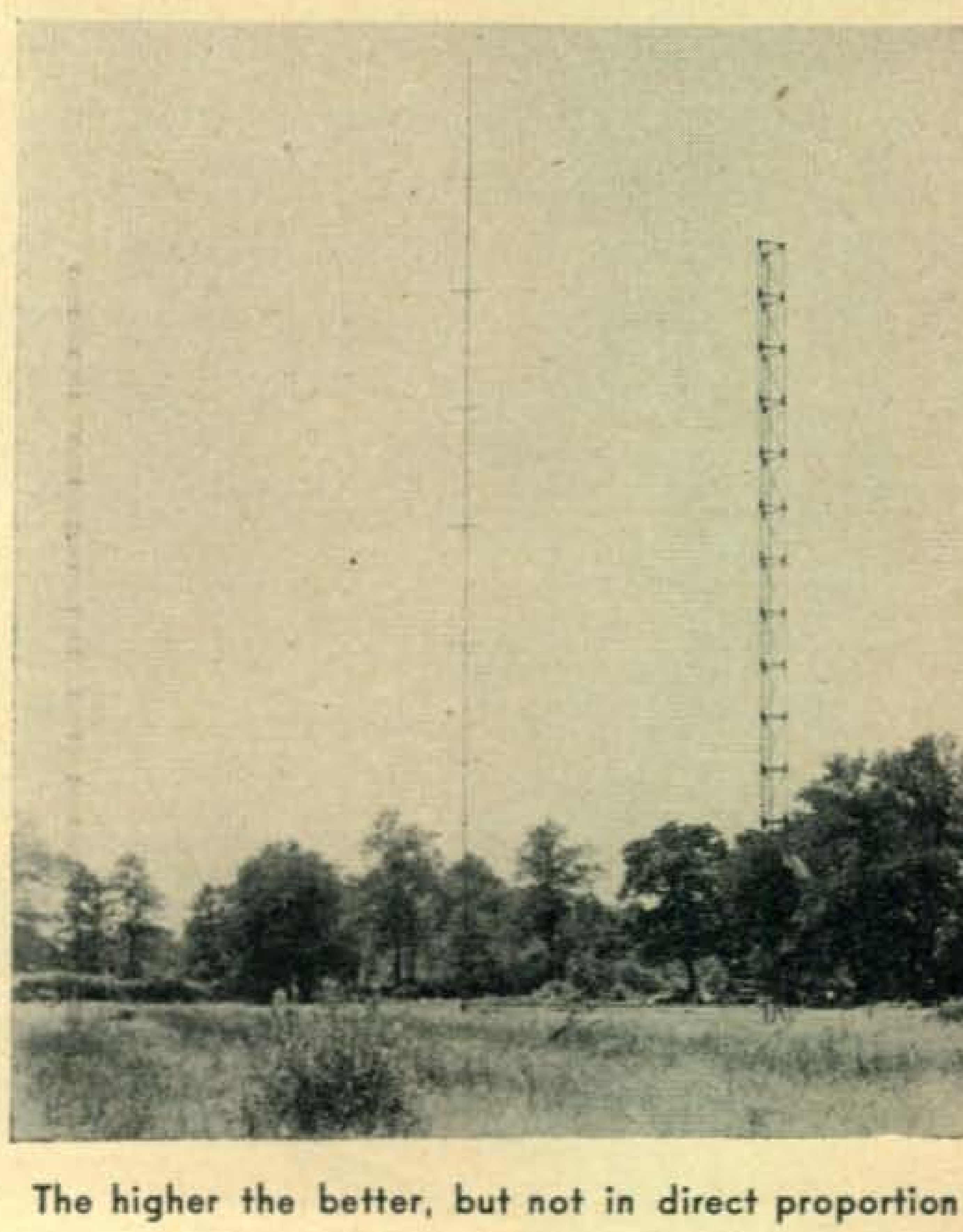
The height of the antenna, h, is negligible within the parenthesis even if, erected on top of a mountain, it may be several thousand feet high, because $2r$ (some 42,000,000 feet) is so much greater; and h, here, can be eliminated. (However, h is very important as a *multiplying factor* outside of the brackets.) Thus we can simplify equation (2)—

$$d = \sqrt{2rh} \qquad (3)$$

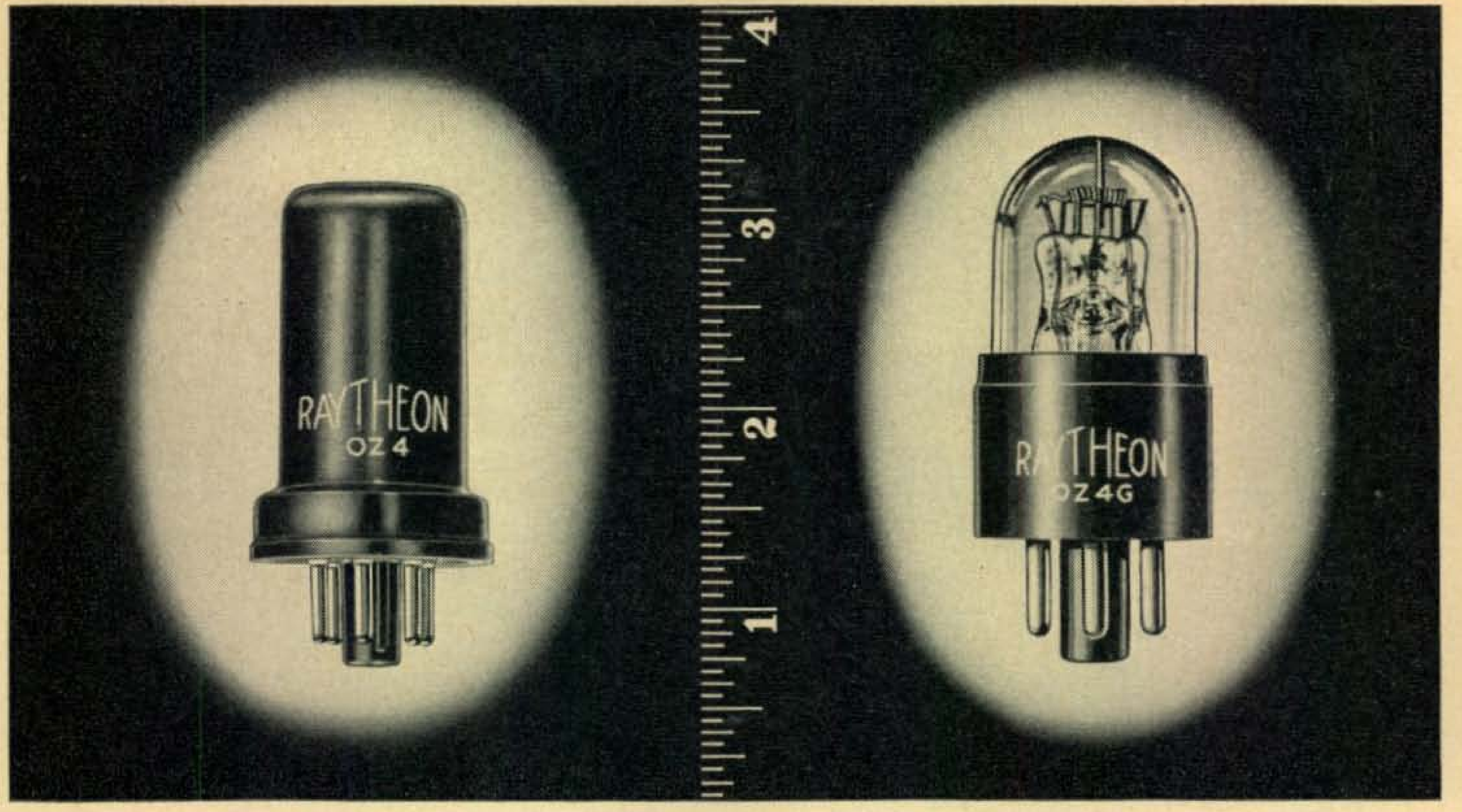
Equation (3) is obviously simplified and quite workable. However, its solution remains burdened with cumbersome arithmetic, and we can still boil it down to more essential ABCs. With the knowledge that *twice* the radius of the earth $(2r)$ *equals* 42 x 10^6 feet, we have—

$$\begin{aligned} d &= \sqrt{42 \times 10^6 \times h} \\ &= 10^3 \sqrt{42 \times h} = 10^3 \times \sqrt{42} \times \sqrt{h} \\ &= 10^3 \div 6.5 \times \sqrt{h} \\ &= 6500 \sqrt{h} \qquad (4) \end{aligned}$$

We now have our feet on firm ground K and, we trust, our antenna in the air. Unfortunately, we also have *feet* in the solution to formula (4). To change d (distance) to miles, divide the right-hand portion of equation (4) by 5300. (We realize that a mile is 5280 feet long. But a fundamental rule in engineering mathematics postulates that it's a waste of time and energy to be more accurate than physical tolerances justify. There is no sense in computing current microamperes if the equipment available and the probability of human error make accuracy dubious above the milliampere range. The radius of the earth, r, varies from 3963.399 miles at the equator to a polar semi-diameter of 3949.922 miles—a difference of



The higher the better, but not in direct proportion



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Many manufacturers realize the advantages of small ionically heated cathode gas rectifiers which require no heater power, can be used under any atmospheric condition, and yet operate with very low internal power losses. Convincing evidence is the widespread use of such tubes in automobile radios and other equipment where maximum performance must be obtained with minimum power input.

Millions of Raytheon OZ4 and OZ4G tubes have given reliable and efficient service in such equipment . . . service which will prompt engineers to incorporate them in numerous postwar products.

First developed by Raytheon as a refinement of the BH to obtain internal drops comparable to the larger directly heated cathode types, these tubes are now further improved to the point where the output rating has been increased from 75 ma to 90 ma when functioning as a full wave rectifier. Hence, it can be used to advantage in supplying the extra "B" drain imposed by larger receivers or low-power mobile transmitters.

The OZ4 and OZ4G are examples of Raytheon's ability to design and produce *better* tubes . . . tubes which will be in great demand in the postwar radio and electronics industry.

Specifications of OZ4 and OZ4G

	OZ4	OZ4G
Maximum Overall Length	2-5/8 in.	2-5/8 in.
Maximum Seated Height	2-1/16 in.	2-1/16 in.
Maximum Diameter	1-5/16 in.	1-3/64 in.

Typical Operation Ratings as a Full Wave Condenser Input Rectifier:

Heater Power	None
Minimum DC Output Current	30 ma
Maximum DC Output Current	90 ma
Maximum Peak Anode Current	270 ma
Minimum Starting Voltage—Peak (P to K)	320 volts
Average Dynamic Voltage Drop	24 volts
Maximum Peak Inverse Voltage	880 volts

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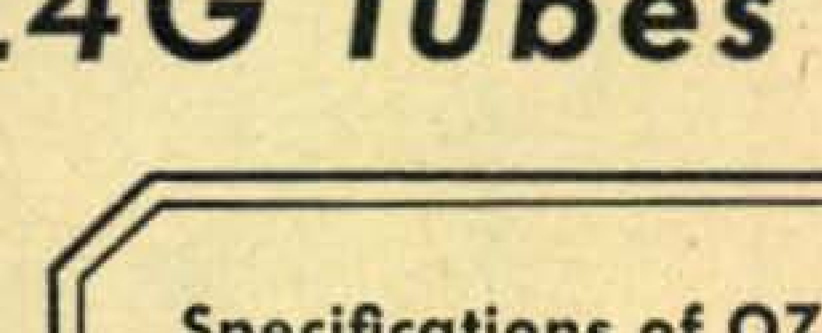

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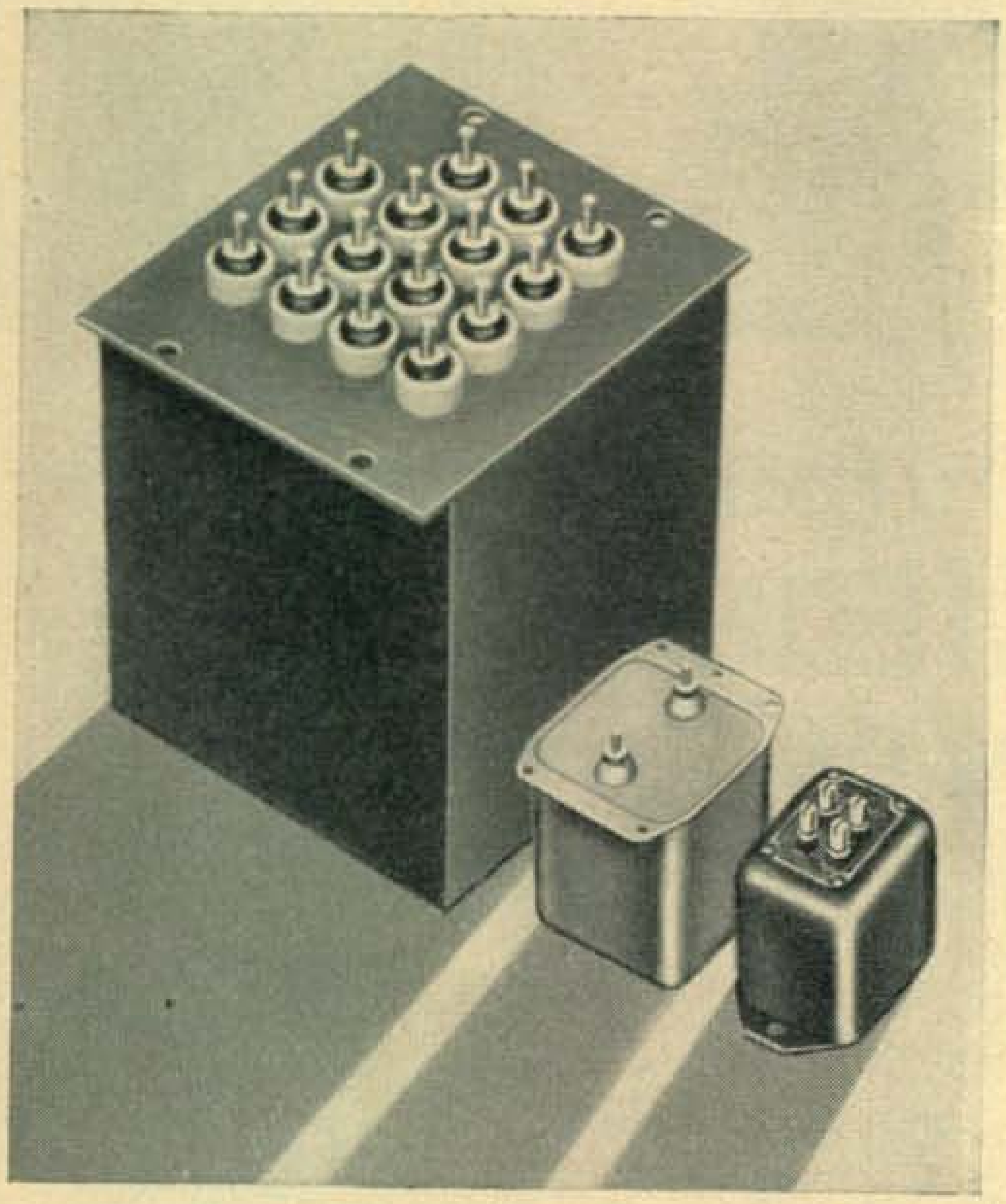

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70,470 feet.) Following up with this division, we obtain—

$$d = \frac{65}{53} \times \sqrt{h}$$
$$= 1.23 \sqrt{h} \qquad (5)$$

Equation (5) is the way we want it—with distance, *d,* in miles, and antenna height, *h,* in feet. Let's see how it works out—and we'll pick an easy one. Assume an installation on fairly level terrain. It doesn't make any appreciable difference (in *r*) whether this flat area is at sea-level or not. (Remember, the mean radius of the earth varies from equator to pole by more than twice the altitude of our highest mountain peaks.) We'll take advantage of a small hill about 50 feet high, put up a 50-foot pole, and call *h* 81 feet. Then—

$$d = 1.23 \sqrt{81} = 1.23 \times 9 = 11.07$$
$$= 11 \text{ miles}$$

Eleven miles is then the line-of-sight distance from the antenna to horizon, and, eliminating refraction consideration (which may or may not exist for certain frequencies at different times) is the communication range between the 80-foot aerial and an operator, sitting on the ground, with a handy-talkie.

If the second station is also elevated, say by h^1 feet, we encounter the second right-angle triangle shown in *Fig. 1,* and the total maximum distance *(D)* is the sum of d and d^1.

$$D = d + d^1$$
$$= 1.23 \sqrt{h} + 1.23 \sqrt{h^1}$$
$$= 1.23 \times (\sqrt{h} + \sqrt{h^1}) \qquad (6)$$

In passing, we should like to emphasize that (Vh + Vh¹) is not the same as the expression Vh + h¹, as was recently stated in another radio publication, and which erroneous implication so pricked our curiosity and respect for the verities, that we finally took pencil, typewriter and slide-rule in hand, and wrote this little article.

In applying equation (6), let's erect a second antenna 100 feet high (again for an easy square root). We have—

$$D = 1.23 (\sqrt{h} + \sqrt{h^1}) \qquad (6)$$
$$= 1.23 (\sqrt{81} + \sqrt{100})$$
$$= 1.23 (9 + 10)$$
$$= 1.23 \times 19 = 23\tfrac{1}{2} \text{ miles}$$

This, of course, gives you the antenna-to-antenna line-of-sight distance. The horizon lies at some undetermined point

[*Continued on page 38*]

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Post-War Jobs

That goal of postwar jobs for everyone is no pipe-dream.

This is borne out by what is probably the first postwar employment survey of a large industry, conducted by the Radio Manufacturers' Association. If other industries equal the radio makers' estimate of a 68.6 per cent increase in workers over 1940, full employment should be well within reach, R. C. Cosgrove, president of RMA, said today.

"Significantly, RMA survey figures showing an estimated employment of 145,266 persons in the first full year of peacetime production represent a decline of only 39.9 per cent from wartime employment in the July-September period last, despite the tremendous rise over 1940," Mr. Cosgrove declared.

"The drop in factory job estimates from wartime peaks should not create undue concern, since factories will not provide the only postwar employment. In the radio field as in other industries, resumption of peacetime production will reopen and add innumerable jobs in servicing, in warehouses, and in distribution. These will absorb many workers who have acquired special skills in war production."

RMA's president noted that as frequency modulation broadcasting and television develop across the country, many more jobs will be created in manufacture of transmitters, receivers and parts. Expansion of FM and television also will mean countless new positions in the allied fields of broadcasting and program production, he pointed out.

Hot Pants

A charming YL from St. Paul
Wore a newspaper dress to a ball—
The dress caught on fire
And scorched her entire
Front page, sports section and all.

Masts and Towers

The man-hour problem as well as constructional angles have been considered in the new Harco catalog describing nine different types of masts and towers, from 20 to 500 feet high, the shortest of which can be erected by one man in fifteen minutes flat. Mobile and portable units are illustrated as well as permanent installations. Featured is the exceptionally rigid "Bantam King," lending itself particularly to radar and to such applications as may require 500 or more pounds of top loading on an eight-by-four-foot platform. Guyed and self-supporting, square, triangular and tapered towers are described in this generously illustrated catalog which can be obtained by writing to the Harco Steel Construction Co., Inc., 1180 East Broad Street, Elizabeth, 4, N. J.

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Due to paper restrictions, CQ will not be sold on newsstands for the duration. A selected list of Ham Distributors will have a limited number of copies on sale at 25c each.

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City .... State .... Zone ....

What is your occupation or profession? ....

"Oh, she's OLD! Almost thirty!"

At twenty, thirty seems ancient.

At thirty, forty is distant middle age.

At forty, well, it'll be a long time before you're fifty.

The point is that ten years *ahead* always seems like a long time. Yet, actually it passes "before you know it" . . . and you find yourself face to face with problems, opportunities, needs, that once seemed very far in the future.

This is a good thing to remember today, when you buy War Bonds to speed the winning of the war.

In ten years—*only* ten years—those bonds will bring you back \$4 for every \$3 you put into them today.

Think of what that money may mean to you in 1955. An education for your children . . . a home . . . maybe even retirement to the place and the life of your heart's desire.

All this your War Bonds can mean to you . . . if you buy all you can today and hold them to maturity.

It won't be long till 1955. Not half as long as you think.

CQ

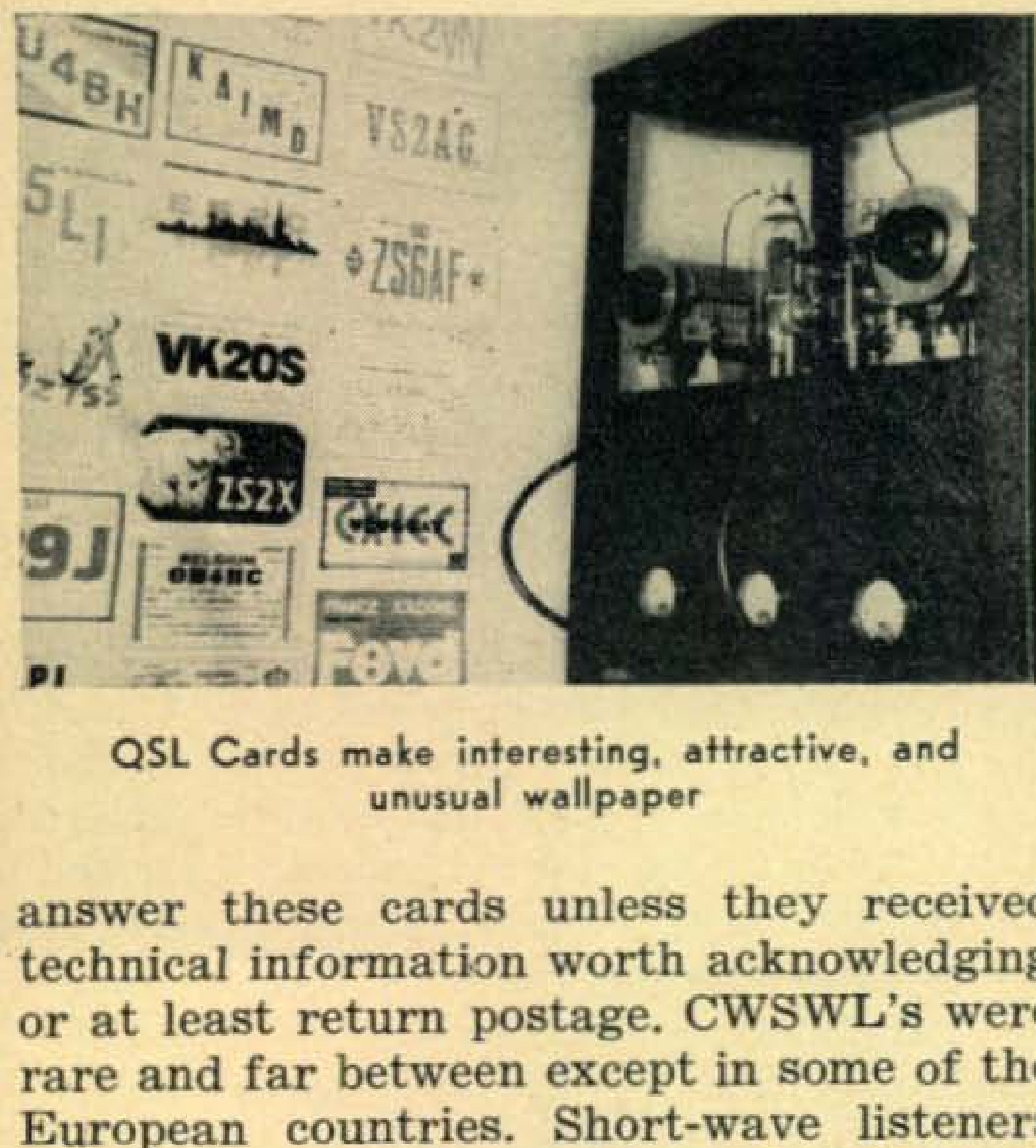
This is an official U.S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council

STACKED CARDS

[*Continued from page 26*]

cards failed to secure an answer, was to send an international reply coupon, which is valid for postage in most countries. Finally, moved to desperation, many hams drew up cards by hand, secured the proper return postage from the local stamp dealer, and sent the whole thing to be filled out and returned. Unfortunately, just as many W's were offenders, making it difficult for DX stations to verify all states.

QSL'ing is not confined to active amateurs since a large number of short-wave listeners sent out cards to both ham and BC stations. Unfortunately, the SWL in latter years stopped serving the useful function of suplying data on signals and quality, and became instead a collector of cards. Many amateurs were unwilling to



QSL Cards make interesting, attractive, and unusual wallpaper

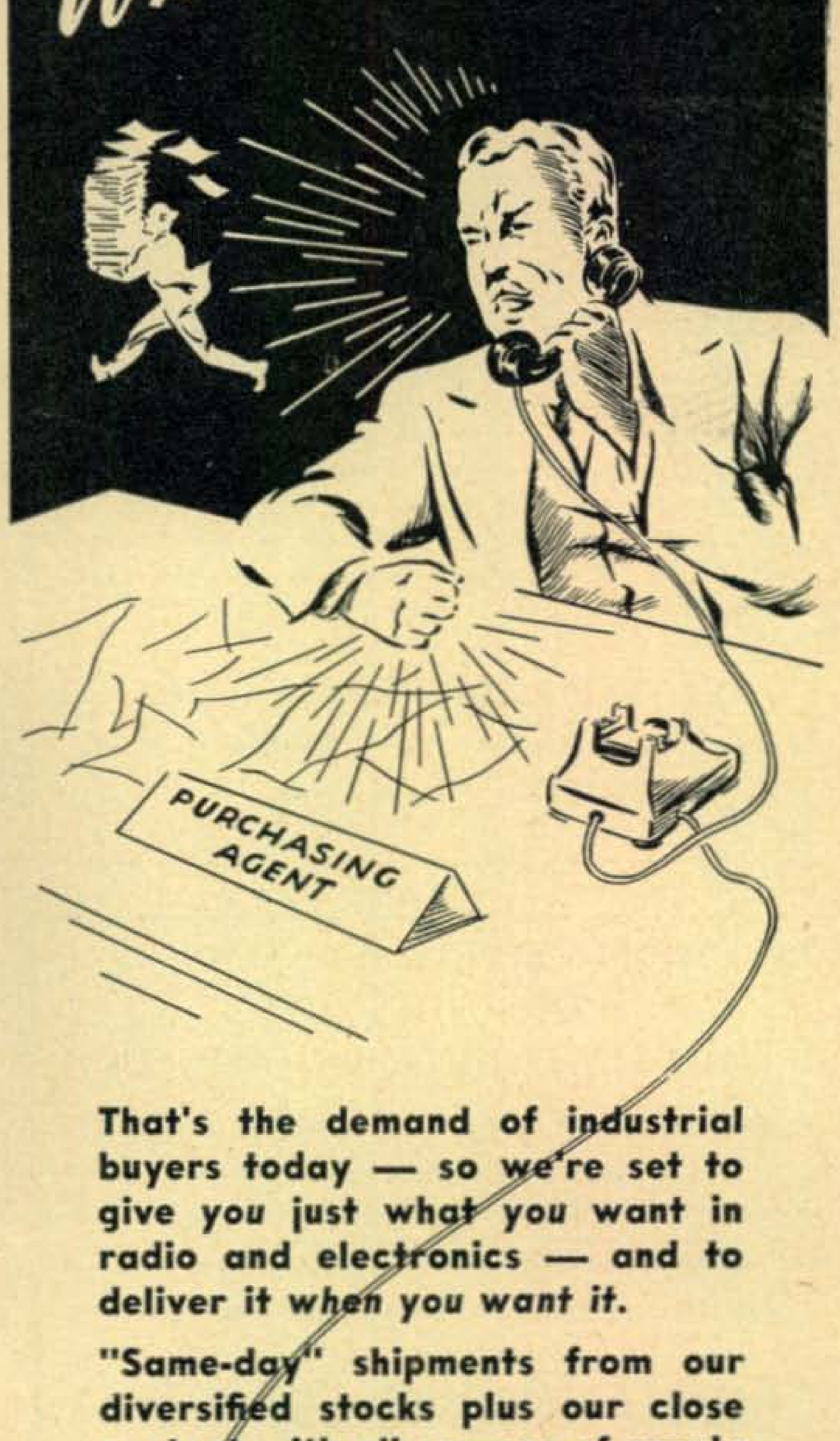
answer these cards unless they received technical information worth acknowledging or at least return postage. CWSWL's were rare and far between except in some of the European countries. Short-wave listeners expecting a high percentage of replies will do well to supply as many possible details on the signal, with no flattery as bait.

Amateurs who send out a lot of cards after the war should maintain a file system. This can serve the double purpose of avoiding duplication and will show if replies have been received. The same card file might contain pertinent data on the contact; but there is danger here of running into elaborate memoranda. A box

[*Continued on page 39*]

I WANT WHAT I WANT

When I Want It



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The RADIO SHACK
167 WASHINGTON ST., BOSTON, MASS., U.S.A.

UHF ANTENNAS

[*Continued from page* 12]

axial line is better than a twisted pair, and a well-designed spaced line would be even better. But for all practical purposes such losses can be largely counteracted by very simple mechanical changes in the antenna itself. It is that approach we shall outline in a future article.

To All Amateurs!

★ We are proud of the splendid showing our amateur friends and old customers are making today. We will be ready to serve you again as soon as you are through with your job and we are through taking care of military requirements. May we have a happy reunion soon.

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CQ Circulation Dep't.

RADIO MAGAZINES, INC.

342 Madison Ave., New York 17, N.Y.

BIASING METHODS

[*Continued from page* 24]

circuits often present hum problems and require extra insulation.

While we have been mainly interested in obtaining a source of bias which does not reduce the effective plate voltage, it is obvious that this arrangement can be used for other purposes where a fairly constant negative voltage is required, such as the delay voltage for AVC, or the biasing of an amplifier stage to cut-off to prevent signal break-through in a radio-phonograph combination as suggested in *Fig. 4*. This is an ideal way to utilize an otherwise unused voltage in a radio-phonograph combination. In providing an effective means for blocking out radio interference when operating the unit as a phonograph, it also eliminates the necessity for critical shielding and dressing of leads to eliminate radio cross-talk when the receiver is tuned to a strong local station.

"LINE-OF-SIGHT"

[*Continued from page* 32]

in between, and if this is of interest, equation (5) should be used. Obviously, if h and h^1 are the same, the horizon is halfway between the two stations.

An average or normal amount of refraction or bending of the radio wave can be expected on frequencies between 224 and 30 megacycles, which increases the radio range over the optical distance by about 15%. Substituting the constant 1.41 for 1.23 in the above equations will take care of this in computing ranges in the V. H. F. spectrum, but to what extent such modification is justifiable in the microwave region remains to be seen.

Occasional refractive phenomena increase the range of the very-high-frequency signals far beyond the 15% boost of average refraction. It is not impossible that something like this may happen as we approach a trifle closer to the frequency of light in the microwaves. After all, the mirage is a result of refraction. However, while waiting for a mirage, just keep in mind that distance equals height multiplied by 1.23.

STACKED CARDS

[*Continued from page* 37]

with 3″ x 5″ cards serves well. Cards can be allotted for districts and countries. When a QSL is sent out, the mailing is jotted down on the proper card. In a locality where numerous QSL's are sent, an alphabetical breakdown can be made, putting say W9AAA to W9MZZ on one card, and W9MZZ to W9ZZZ on another.

About the only time you shouldn't QSL is at the specific request of a station not to do so. Several foreign countries prohibited hams from operating—a **verboten** that was not always effective. Sending cards in the open would be a dead give away, so QSLs went under cover, or were not mailed at all.

GET ON THE BEAM

[*Continued from page* 22]

—the localizer, outer marker, inner marker, and the glide path. The localizer is, in effect, a VHF radio range, so placed that it provides lateral guidance over the center of the runway. In isolated cases the airways range may double as the runway localizer, but this is not the accepted practice due to a possible conflict in traffic. The glide path (not a new idea, but only recently perfected) provides vertical guidance enabling the aircraft to maintain the proper rate of descent. In operation, the glide path is similar to the localizer turned on edge. The path to be flown is the equisignal zone which will cause the horizontal pointer to remain in a horizontal position. An excess of 90-cycle modulation will cause a downward deflection, indicating the aircraft should fly down, and vice versa if the plane is too low.

Countless new radio aids are being developed and applied daily to flight problems. The principal instruments used at present on our domestic airways have been reviewed to prepare the amateur for an eventual introduction of more radical postwar changes, which, however, will to a large degree reflect the influence of existing equipment and facilities.

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Remember, we have available almost everything in electronics and Ham radio gear fer immediate delivery. "NO PRIORITY REQUIRED", and if by sum accident it's not in stock we'll get it fer u.

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