SHORT WAVE CRAFT

Edited by
HUGO GERNSBACK

LATEST INVENTIONS and DEVELOPMENTS in SHORT WAVES.
HOW TO BUILD RECEIVERS.
NEWEST HOOK-UPS.
HANDY KINKS

FIRST SUMMER ISSUE

ARTICLES BY
Dr. Lee de Forest
Laurence M. Cockaday
Robert Kruse
John L. Reinartz
David Grimes
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Sylvan Harris
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Ever on the alert for new ways of helping our members make more money out of Radio, the Radio Training Association of America now offers ambitious men an intensified training course in Radio Service Work. By taking this training you can qualify for Radio Service Work in 30 days, earn $3.00 an hour and up, spare time; prepare yourself for full-time work paying $40 to $100 a week.

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AERO SHORT-WAVE Automatic TUNING UNIT

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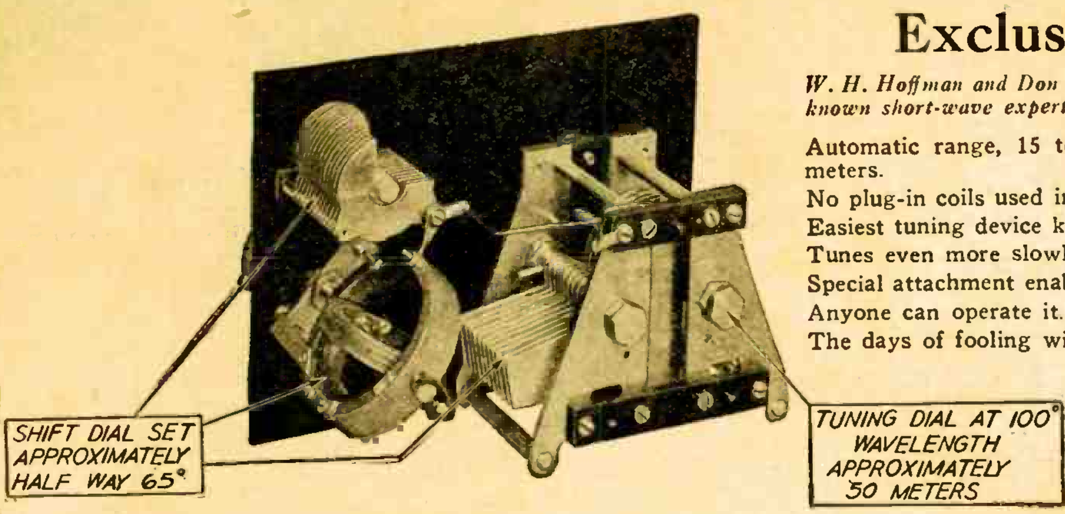

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Automatic range, 15 to 90 meters; full range, up to 200 meters.
No plug-in coils used in automatic range.
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Anyone can operate it.
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A Marvelous Improvement

NO PLUG-IN COILS

Range 15 to 90 meters. Easiest tuning short-wave receiver known. The tuning unit consists of two controls. The right-hand control, which will be termed the shift control, and the left-hand control, the actual tuning device. In addition to these two controls it will, of course, be necessary to have a regeneration control.

For those who desire to employ it for television or the upper phone band, a special attachment may be secured.

OPERATION

The tuner is operated in the following manner. As a specific example, with the right-hand dial set at nine degrees, revolving the left-hand dial through 180 degrees, you will cover from 19.1 to 22.6 meters. The next step will be to move the shift dial to 13 and tuning over 180 degrees, as before, this time covering from 21.9 to 25.7 meters. This process is continued through 180 degrees on the shift dial until you have reached the maximum automatic wave length, which is 90 meters.

You will note that the tuning dial, in the first instance when tuned through 180 degrees, covers only 3½ meters, whereas ordinarily when using plug-in coils your tuner, when passing through 180 degrees, generally covers at a minimum of 25 meters. This same speed of tuning is maintained throughout the entire short-wave spectrum, and it is for this reason that this tuning arrangement surpasses any known method.

This unit is furnished completely assembled to the amateur, and may be built into either a short-wave converter or receiver.

For those desiring to go from 90 *to* 200 *meters a special device may be had, making its range then from* 15 *to* 200 *meters. Net price of attachment,* $5.90 *extra.*

A general chart is furnished with each unit specifying the settings for the shift dial, which will enable you to approximate the wave length for each setting on the shift dial.

This tuner is not sold through the usual trade channels, but is sold to amateurs only direct from factory at special low net price. Be sure to send post office or express money order for $19.50 with your order. Shipments will be made in order received. Be first to order. Attach your money-order to coupon below and mail today — NOW!

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I want to be one of the first to secure the new Aero Short-Wave Automatic Tuning Unit. Enclosed is money order for $19.50 which is your low opening net price to amateurs only.

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Vol. I **SHORT WAVE CRAFT** No. 1

HUGO GERNSBACK, Editor H. WINFIELD SECOR, Managing Editor

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IF you're in Radio now spare time or full time - it will show you how my *improved training* can help you make *still more money*

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If you're not in Radio! this book will show you how you can get in quickly!

Radio's continued amazing growth and new uses of Radio principles is opening hundreds of fine jobs every year. Broadcasting Stations, Radio Dealers, Jobbers and Manufacturers, Shipping Companies, Aviation, Talking Movies, Research Laboratories and many other sources of good jobs need men well trained in Radio continually. Besides, there are almost unlimited opportunities for a profitable spare time or full time Radio business of your own. Many of my graduates have jumped from $25, $35 and $40 a week to $50, $60, $75 and even $100 a week within a year or less. My book proves this.

I Will Train You Inexpensively at Home In Your Spare Time

Hold your job until you are ready for another. Give me part of your spare time. I will give you the training that is raising hundreds of men's salaries every year. I feel so sure that I can satisfy you that I will agree in writing to refund every cent of your tuition fee if you are not satisfied with my Lessons and Instruction service when you finish my course.

Many Make $10 to $30 a Week Repairing Sets In Spare Time While Learning

The day you enroll I will show you how to do ten jobs common in most every neighborhood. Nearly every one of the twelve million Radio sets in use needs $2 to $10 servicing a year. Get some of this money for yourself. I will show you how to do it. I will give you the plans and ideas that are making $200 to $1.000 for many of my students while they are taking my course.

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Training in Radio's use in Talking Movie Apparatus, both Vitaphone and Photophone systems.

Training in Television and home Television experiments.

These are only a few improvements.

My book "Rich Rewards in Radio" tells you of many more. Write for it today.

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It tells you where the good Radio jobs are, what they pay, how you can fit yourself right at home in your spare time to get into Radio. It tells you about the many extra services and materials that the National Radio Institute gives its students and graduates: Lifetime Employment Service and other features. It shows you what others who have taken my course have done—are making—what they think of it. There is no obligation. Send the coupon today.

J. E. SMITH, Pres., Dept. OF90
National Radio Institute
Washington, D. C.

Have you read my new book giving an outline of National Radio Institute's improved training in Radio? If you haven't, send for your copy today. No matter what kind of a job you may have in the Radio industry now, unless you are at or near the top, I believe my training can help you get ahead—make still more money—get a still better job. However, I'll let you decide that for yourself after you have read my book—just let me show you what I have to offer. Many others in Radio—amateurs, spare time and full time service men, Radio dealers, fans, custom set builders—have found the way to more profit and more money through this course. You will find letters from them in my book.

See What I Offer Those Who Are Now or Who Want to Be Service Men

While my course trains you for all branches of Radio—I am also giving extensive, thorough and practical information on servicing different models and makes of A.C., D.C., battery operated and screen grid tube sets. Atwater-Kent models, Crosley, Zenith, Majestic, Stewart-Warner, Radiola, Eveready, and many other makes are covered. This information is of special help—of real money making value—to those who are now service men or those who want to be service men. This part of my training, however, is only one of 18 features that I am offering men and young men who want to get good jobs in the Radio industry—or who are in Radio and want to advance. Even though you may have received information on my course before, unless you have gotten my new book as pictured above, write to me again—see how N.R.I. has grown and improved too. While my training has been enlarged and revised—my course is not new or untried. Hundreds of men in Radio owe their success and larger income to it. Send the coupon today.

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J. E. SMITH, President,
National Radio Institute, Dept. OF90
Washington, D. C.

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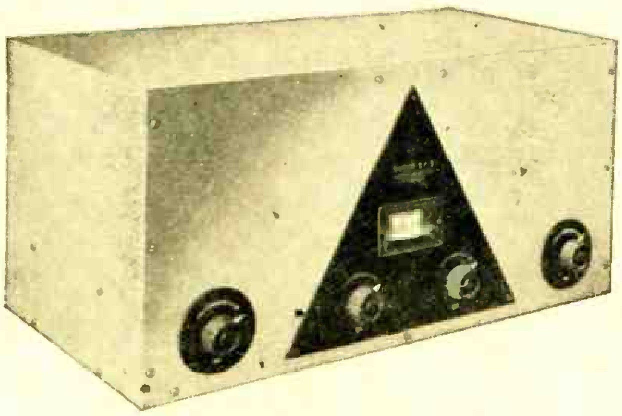

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HUGO GERNSBACK
EDITOR

SHORT WAVE CRAFT

H. WINFIELD SECOR
MANAGING EDITOR

JUNE - JULY
1930

VOLUME 1
NUMBER 1

96-98 Park Place, New York, N. Y.

The Short Wave Radio Field

By HUGO GERNSBACK

IT IS well-known, to the student of radio, that the history of this art tends to repeat itself. While radio was still young, in the era of the old spark coil and coherer, it was thought by many that its days were over as soon as this cycle had passed its height. Just then the vacuum tube came along and, overnight, radio took a tremendous impetus and a real radio industry was created. Towards the end of 1920, the cycle again declined and there were more pessimists to declare that the good days of radio were past. Then, suddenly, broadcasting started in 1920 and the whole country—the lay public then first included—became wild about radio, and a tremendous growth of radio activity ensued.

We are now in the upswing of a similar cycle, given its impetus by short-wave activities. There is nothing new about short waves; as a matter of fact, the original pioneer in radio, Heinrich Hertz, began with short waves over forty years ago.

But short-wave radio did not come into its own in a big way until very recently. Its present vogue is due particularly to the tremendous new developments and the many new amazing applications in this, the most marvelous and certainly the coming field of radio.

Today's widespread enthusiasm for the great and unlimited possibilities of short waves recalls, in many ways, the days of 1921-1922 when the first real boom in radio had arrived.

Just now, short-wave activities are certainly the hotbed of new radio developments. There are no longer revolutionary possibilities in the highly-standardized medium-wave broadcasting, or in the commercial receiving set of today, which has tended more and more to reduce radio to automatic reception of local stations.

But radio history, in the present cycle, is repeating itself. There are over 100,000 short-wave enthusiasts, in the United States and Canada alone, who are daily listening to short-wave voice and music broadcasts from England, Germany, Holland, France, Sweden, Central and South America, Africa, Japan, the East Indies, Australia—10,000 miles away and more. Short waves have encompassed the entire world and have made the Antipodes our next-door neighbors. Then, there are in this country alone some 20,000 radio amateurs who are in regular telegraphic communication with each other in all parts of the globe.

But short waves are very much more than just a hobby—they are important from a commercial standpoint. Television in the home, toward which our largest commercial laboratories are feverishly working, is possible by no other means than through the use of short waves. The trans-oceanic telephone, to Europe and to liners at sea, depends upon short waves; which are also relied upon to bring all sorts of international events to us for rebroadcasting over our American networks on the higher waves. Airplane radio cannot do without short waves today; for they are essential to make flights safe for passengers and property. Explorers in our days find it absolutely necessary to carry with them short-wave equipment. The success of Admiral Byrd cannot very well be imagined without short waves for his communication during his entire stay in the Antarctic.

The scientific value of short waves affords tremendous possibilities in every direction. Physicians are already using short waves to treat deep-seated diseases. Short waves are used to influence the growth and development of plants and animals, and very promising experiments have been made along these lines.

Short waves are employed in electric furnaces of great efficiency. Marconi, who has made possible picture transmission to the Antipodes with his short-wave beam radio, already talks of power transmission. One of our largest commercial radio laboratories is daily transmitting the impression of an entire newspaper, by short waves, from one end of the country to the other.

Lack of space forbids the cataloguing of all the short-wave activities, which today are legion; but it is safe to say that short waves have now arrived, in earnest, and they will play the dominant rôle in radio within the next twenty years. Even now, far-seeing radio authorities freely predict that in due time ALL broadcasting will be done below 200 meters.

I have felt for a long time the necessity of a periodical to be devoted in its entirety to the cause of short waves, and it is for this reason that SHORT WAVE CRAFT has been brought into life.

Having seen, during the past few years, the development of tremendous enthusiasm among radio readers for short waves, I feel certain that this, the initial issue of SHORT WAVE CRAFT, will be welcomed by every short-wave enthusiast in this country and elsewhere.

I have tried to make this a DIFFERENT radio publication, and I hope that I have succeeded. But I am by no means satisfied with the first effort, and you may rest assured that, with your cooperation, subsequent issues will far exceed the humble beginning which you now hold in your hands.

But what we need most today is your comment on the first issue; because only through intelligent cooperation with our readers can we give you the sort of publication you most desire. Not only are we trying to make this publication both authoritative and interesting, but we have already secured the cooperation of the best-known short-wave experts in this country and abroad, who will write for SHORT WAVE CRAFT right along.

It will please you to know also that we have made arrangements with European short-wave experts to present timely articles on what is being done abroad in short waves. Much of the material that we will publish hereafter will appear only in SHORT WAVE CRAFT; and you may always rest assured that the latest oversea developments, which are most important today in short waves, will be published exclusively in SHORT WAVE CRAFT.

Incidentally, I pledge my word that as long as the majority of you demand it, SHORT WAVE CRAFT will contain 100 per cent short wave material—*nothing else.*

SHORT WAVE CRAFT IS PUBLISHED ON THE 15th OF EVERY OTHER MONTH

THE NEXT ISSUE COMES OUT JULY 15TH

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Hoover, Jr., a Radio Expert

Herbert Hoover, Jr., son of President Hoover, has taken up his new position in Los Angeles, where he will be in charge of radio-telephones on planes operated by the Western Air Express. It is the desire of this company to make communication possible between passengers in planes and ground officials. Officials of the air line assert that under Mr. Hoover's direction, it is the intention of the company to provide such complete service that a passenger aboard the plane may be connected with any ground number, and a person at a ground station may put in an ordinary call for a passenger aboard the plane in flight. Herbert Hoover, Jr., has stated his belief that no airplane engine shielding at present has fully met the day-in-and-day-out grind of transport operations, and that it probably will develop for some time yet and will be evolved slowly. Engines were evolved gradually, he said, and he thinks that shielding experience will be very similar, particularly in regard to spark-plugs and the difficulties of standardizing connections between spark-plugs and harnesses, so that many different types will be interchangeable.

Miss Ruth Peiser Likes the "Short Waves"

The photo shows a California short-wave radio enthusiast, Miss Ruth J. Peiser. Miss Peiser is said to be the only girl in California having a licensed radio transmitting station. The transmitter used by Miss Peiser is shown at the right of the photo. The tuning inductances used in the short wave transmitter are shown in the apparatus resting on the table; variable condensers of the transmitting type, with well spaced plates, and a meter to assist in tuning the circuits to resonance are used. The receiving set used by Miss Peiser is shown at the left of the picture. High ratio vernier dials are used on the receiver to enable the operator to do very fine tuning. Miss Peiser has taken a great interest in amateur radio communication—and by the way, this is a mighty fine way to get acquainted. We have read of many courtships which started "via the ether". So girls, here's your chance to get acquainted with many he-males — become a short-wave fan!

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R. T. I. QUALIFIES YOU TO MAKE MONEY AND ITS SERVICE KEEPS YOU UP-TO-THE-MINUTE ON THE NEWEST DEVELOPMENTS IN RADIO, TELEVISION, AND TALKING PICTURES **R. T. I.**

R.T.I. Training Brings Big Jobs Like These!

Earned $500 Extra Money in Two Months

Your radio course has enabled me to earn over $600 in two months' spare time work. Understand that this is all spare time work, as I have a permanent position with my father in our store. I give you all the credit for the above and as I said before, I wish to finish the entire course as soon as I can.—Your student, J. NOFFSINGER, Greenville, Ky. R 1, Box 37.

Salary Raised 33 1-3% Since Enrolling

You may be interested to know that I am now Radio Service Manager for the H. N. Knight Supply Co. who are distributors for Eveready Radio Receivers in the State of Oklahoma, and Texas Panhandle, with an increase in salary of about 33 1-3%, since I enrolled with your school.

Thanking you for your interest you have shown in me, and your wonderful course, I am, EARL P. GORDON, 618 East 6th St., Oklahoma City, Okla.

Makes $25 a Day

Haven't forgotten you. How could I when I make as high as $25.00 per day and have made $600.00 in two months from Radio work. That's not so bad when I'm only 19 and in a small town. I just looked over the catalog you sent me before I enrolled, and you did about all you said you would and about as much more.—FLOYD KNISELY, R. F. D. 2, Box 91, St. Joe, Ind.

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RADIO-TELEVISION-*Talking Pictures*

BIG PAY JOBS! SPARE TIME PROFITS! A FINE BUSINESS OF YOUR OWN! They're all open to you and other live wire men who answer the call of RADIO. The fastest growing industry in the world needs more trained men. And now come Television and Talking Movies—the magic sisters of Radio. Will you answer this call? Will you get ready for a big pay job Now and step into a BIGGER ONE later on? You can do it EASILY now.

R. T. I. Home Training Puts You In This Big Money Field

Radio alone, pays over 200 MILLION DOLLARS a year in wages in Broadcasting, Manufacturing, Sales, Service, Commercial Stations and on board the big sea going ships, and many more men are needed. Television and Talking Movies open up other vast fields of money-making opportunities for ambitious men. Get into this great business that is live, new and up-to-date, where trained service men easily earn $40 to $50 per week, and "trained" men with experience can make $75 a week, and up.

FRED H. SCHNELL
Chief of R. T. I. Staff

Twenty years of Radio Experience. First to establish two-way amateur communication with Europe. Former Traffic Manager of American Radio Relay League. Lieut. Commander U.S.N.R. Inventor and Designer Radio Apparatus. Consultant Radio Engineer. Now in charge of R. T. I. Radio Training—and you will like his friendly manner of helping you realize your ambition.

Easy To Learn At Home—In Spare Time

Learning Radio the R. T. I. way with F. H. Schnell, the "Ace of Radio" behind you is EASY, INTERESTING, really FUN. Only a few spare hours are needed and lack of education or experience won't bother you a bit. We furnish all necessary testing and working apparatus and start you off on practical work you'll enjoy—you learn to do the jobs that pay real money and which are going begging now for want of competent men to fill them.

Amazingly Quick Results

You want to earn BIG MONEY, and you want some of it QUICK. R. T. I. "Three in One" Home Training—Radio-Television-Talking Movies—will give it to you, because it's easy, practical, and is kept right up-to-date with last minute information. In a few weeks you can be doing actual Radio work, making enough EXTRA MONEY to more than pay for your training. In a few short months you can be all through—ready to step into a good paying job or start a business of your own. A BIG JOB—BIG MONEY—A BIG FUTURE. There is no other business in the world like it.

Investigate—Send For R. T. I. Book Now

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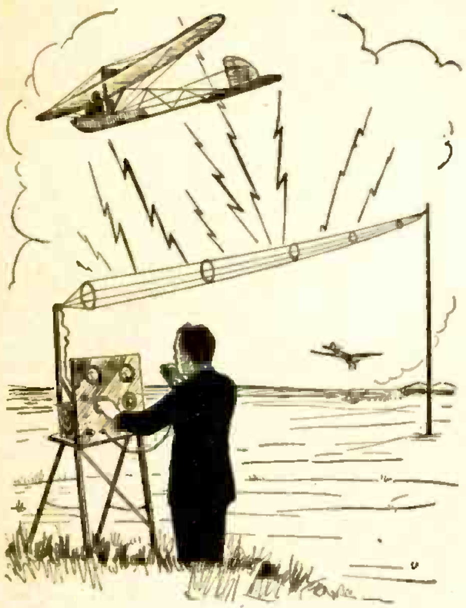
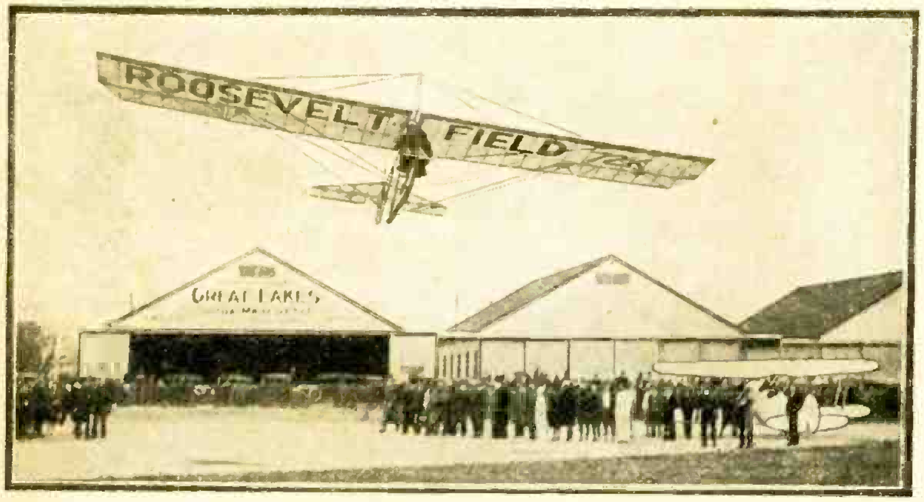


Ground operator talking into microphone of radio transmitter and giving orders to the glider pilot. Below: The glider just after launching at Roosevelt Field, Long Island.

IN a recent test at Roosevelt Field, Long Island, near New York City, orders were successfully given to a glider pilot after the glider had been launched. This method of giving orders to the pilot while in flight should prove a great boon in the future training of glider pilots everywhere. An instructor on the ground might note suddenly that the pilot had encountered peculiar air conditions, and a crash might be averted by telling the pilot just which way to move the control stick or the foot-operated rudder bar. The glider pilot who co-operated in this short-wave radiophone test was Mrs. Alicia Patterson Simpson, famous flying daughter of one of the owners of the Chicago Tribune. Mrs. Simpson holds a transport pilot's license for flying regular, engine-driven planes. The receiving set used on the glider comprised three tubes, with regeneration in the detector circuit. The current supply for the tubes in the receiver was furnished by batteries. The vacuum tube of the radiophone transmitter on the ground was connected with a suitable aerial and the transmitter and receiver worked in excellent fashion in the test at Roosevelt Field. The radio telephone is being widely experimented with in connection with aircraft, and tomorrow we will not only expect, but demand to talk from aircraft in flight to our land-bound friends and business associates.

Mrs. Alicia Patterson Simpson at the glider controls. Note short-wave radio receiver mounted just back of the fair pilot. Radiophone instructions were received through headphones worn by Mrs. Simpson.



A Two-Way Short Wave Portable Set for Aircraft

WHEN Colonel Lindbergh and the scientists of the Carnegie Institution of Washington were over the jungles of Yucatan on their recent Maya exploration trip, they were in constant touch with the outside world by way of this two-way, short-wave radio set.

The system was devised and developed entirely by the communications department of the Pan-American Airways, Inc., for use on all Pan-American planes in co-operation with the necessary ground stations. A new set, with refinements, was recently exhibited by Mr. H. C. Leuteritz. The photo at the right shows the short-wave receiver tilted downward with plug-in coil between the tubes, the extra coils for covering different wavelength bands resting in sockets on top of the cabinet.

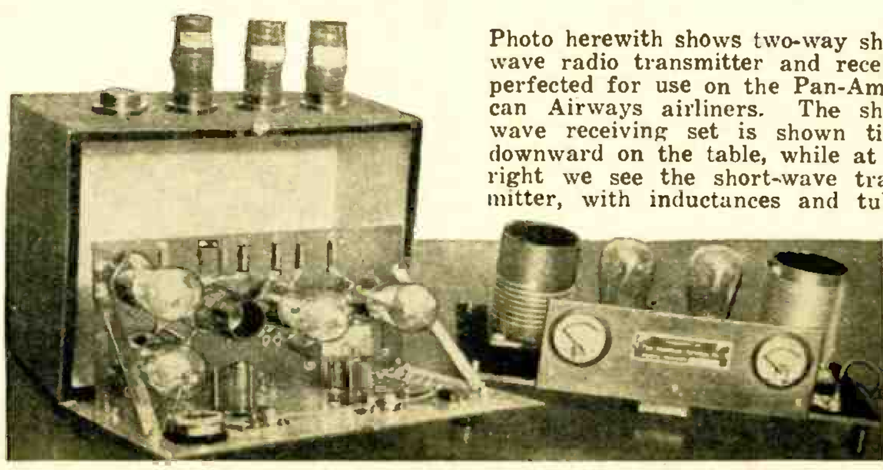


Photo herewith shows two-way short-wave radio transmitter and receiver perfected for use on the Pan-American Airways airliners. The short-wave receiving set is shown tilted downward on the table, while at the right we see the short-wave transmitter, with inductances and tubes.

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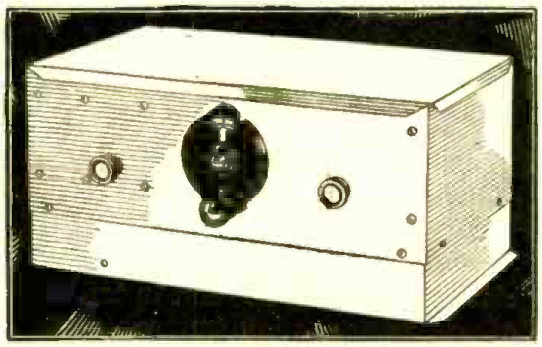
Don't Kid Yourself... An Up-to-Date Short-Wave Receiver *Must Have:*

All-A. C. Operation—and That Means *Built-In Power Supply!*
One-Dial Tuning—and That Means a *Real Gang Condenser!*
Screen-Grid Circuit—and That Means *At Least Two S. G. Tubes!*

There isn't any reason for not having these vitally important improvements in your short-wave receiver (you wouldn't look at a *broadcast* receiver that didn't have *all* of them) except that until now no *short-wave* manufacturer has offered them. From now on, *no short-wave set is modern without them!*

***For Performance* —the New S-M 737 Short-Wave Bearcat**



S-M 737 Double-Screen-Grid Bearcat

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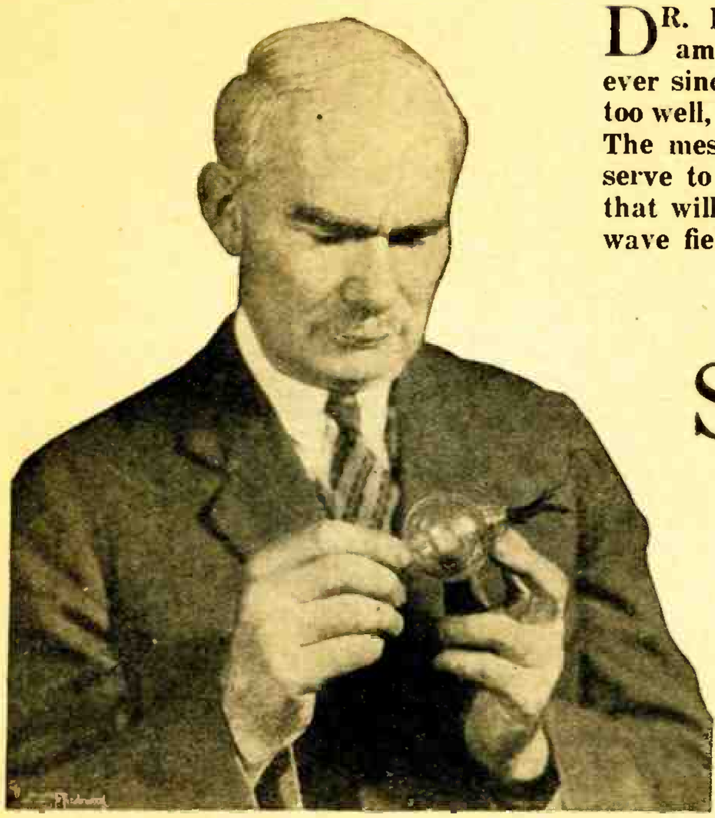

Dr. Lee de Forest examining an early type vacuum tube.

DR. LEE DE FOREST needs no introduction to the radio amateur. The famous inventor has been a radio amateur ever since the pioneer days, and as his present story shows only too well, he still has a soft spot in his heart for the radio amateur. The message which he gives the amateur in this issue should serve to inspire every short wave enthusiast. It is a message that will be long remembered by every true friend in the short wave field.

—Editor.

SHORT WAVE POSSIBILITIES *and* PROBABILITIES

By Lee de Forest, Ph.D.

THERE is nothing decidedly new about short waves. Strangely enough, the early experiments of Heinrich Hertz, who laid the theoretical groundwork for radio communication, were conducted with short waves and even ultra-short waves, which are now receiving considerable attention from advanced radio workers. In the archives of early radio history we come across many references to 5 and 10 centimeter waves—one-twentieth to one-tenth meter wave length. Hence our latest radio developments may be said to represent history repeating itself, but with the benefit of four decades of remarkable research, development and practical application as an invaluable guide.

How Short Is a Short Wave?

How short is a short wave? After all, this is purely a relative term. Compared with the work of Hertz and other pioneer experimenters, with their wave lengths of but a fraction of a meter, even our short waves below 5 meters would be considered relatively long waves. In terms of the early transoceanic radio experiments, our present broadcast band of 200 to 550 meters might be considered decidedly short waves. But in terms of our present radio art, wherein we cover the wave length spectrum from 5 meters or 59,960 kilocycles to well above 10,000 meters or 30 kilocycles, we consider anything below 200 meters, or 1,500 kilocycles, as short-wave radio. And below 5 meters, we refer to ultra-short waves.

It is well to take this opportunity of thanking the radio amateur for what he has done in the matter of short-wave developments, in addition to his other untold contributions to the radio science. Let us not forget that it was the radio amateur, forced to vacate the band now occupied to a large extent by radio broadcasters, who explored the possibilities below 200 meters. And as the radio amateur has been jostled along from one wave band to the next lower wave band, each time seemingly threatened with practical extinction, because of the unknown conditions existing in the virgin radio territory, he has gone ahead and blazed the trail so that others might follow. Usually the amateur's reward has been a "dispossess notice"! But when radio history comes to be written, a perpetual monument will be erected to him in many of the wave length bands, due to his wonderful pioneering efforts. Today, radio amateurs are making history on the 80-meter, 40-meter and 20-meter bands, and the more intrepid of their number are now exploring the uncertain region below 5 meters.

De-bunking Short Wave Radio

Due chiefly to the radio amateurs, short-wave radio has been de-bunked in late years to the point where the veriest layman can now enjoy short-wave thrills. We may recall the situation a few years ago, when short-wave radio was considered nothing short of black magic. Those desiring to invade this mystic territory were obliged to feel their way by the old cut-and-try method. Coils had to be individually wound for the purpose. Variable condensers were generally standard devices with some of the plates removed to reduce the capacity. The vacuum tubes had to be selected by the trial and error method, the bases removed and the terminals arranged in pig-tail fashion to reduce inter-capacity. Many a good tube, I fancy, was sacrificed on the altar of short-wave experimentation.

(*Continud on page* 79)

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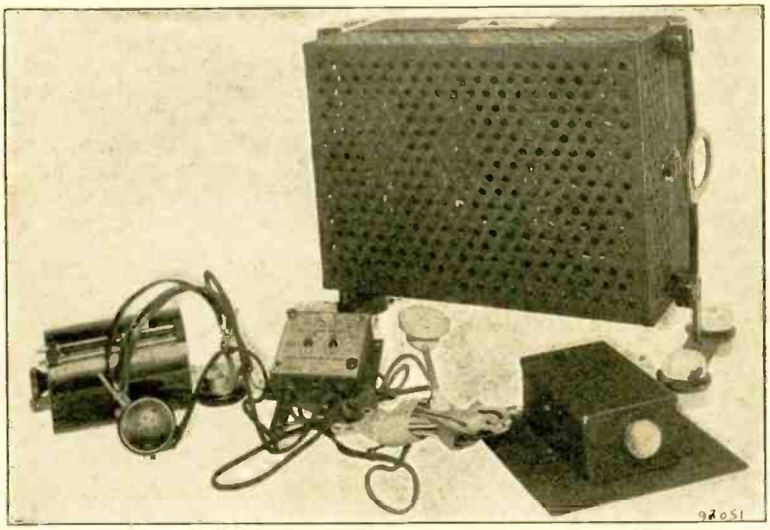
The experimental flying radio laboratory of the Radiomarine Corp., of America, is shown above. The black arrow shown near one of the landing struts indicates the wind-driven dynamo, which supplies the current for the radio transmitter.

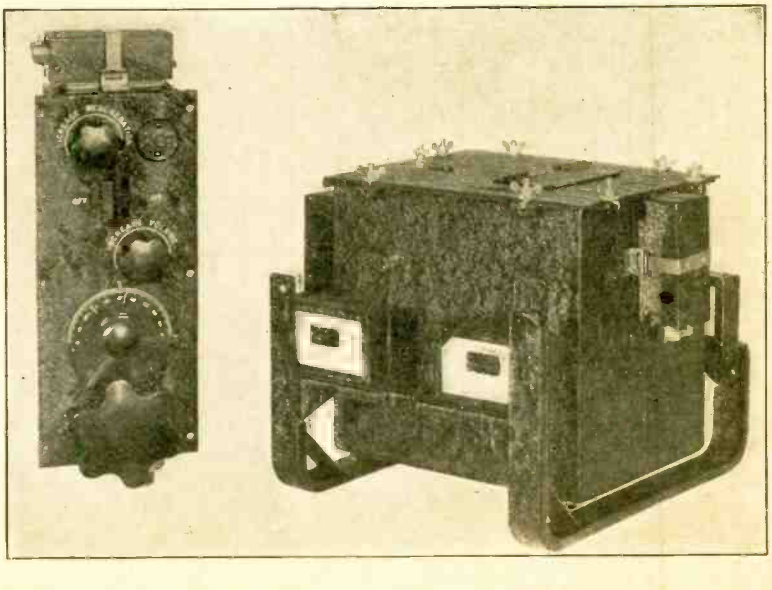


100 watt, short-wave R.C.A. transmitter for use on aircraft, comprising vacuum tube equipment in ventilated case with suitable mounting; microphone and headphone, together with switching keys.

When Radio Takes to the Air

SOME of the latest aircraft radio equipment is shown in the accompanying pictures. The picture at the top of the page shows the flying laboratory of the Radiomarine Corp., of America, with wind-driven dynamo which supplies the current for the transmitter, etc., indicated by the arrow just ahead of the landing strut. The receiving antenna is indicated just above the center of the fuselage by the figure 2. The photo in the center of the page shows the 100 watt transmitter, while the lower photo shows the aircraft receiver suitable for a range of 45 to 1200 meters. One of the interesting things about this aircraft radio receiving set is that it can be placed in any part of the plane out of the pilot's way, and the tuning and volume controls are taken care of by the small box with the dials on it, illustrated at the left of the picture. Flexible shafts connect the control dials with the receiver, which is resiliently mounted with rubber and other means of support, so as to minimize any shocks.

The arrangement of the transmitting antenna on the plane is shown in the photo at the top of the page, and the receiving aerial, of the latest type, is indicated by the figure 2 in the picture of the plane. This receiving aerial or mast, about 8 feet in length, comprises a spar or strut of streamlined shape, along which there is run a wire which forms the antenna. The streamlined strut cuts the air with minimum resistance and supports the antenna. Instead of a ground, the metal framework of the plane and the engine, etc., are all bonded together and form what radio operators term a counterpoise.



Short-wave R.C.A. aircraft receiver with remote control dials at left of picture. The set itself can be mounted in any part of the plane, and this receiver covers a wave band between 45 and 1200 meters.

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A Treatise on Short Waves

By
DR. H. BLEY
Consulting Engineer, Dresden, Germany

The author gives a brief history of short-wave development, then discusses the propagation of short waves versus long waves—the effect of the Heaviside layer—type of aerial best suited for short-wave operations—role of the quartz crystal to steady oscillation—newest short-wave receivers

AFTER the opening of the trial operation of the German international short wave transmitter at Königswusterhausen near Berlin, on the 26th of August, 1929, using a wave length of 31.38 meters, short wave reception has become the common possession of the great number of German radio listeners at home and abroad. At present the programs of this famous German station are reported daily in many papers. Since there are essential differences between short and long waves, relative to transmission, the construction of apparatus, etc., we shall accordingly go into some detail as to the peculiarities of short waves, for the purposes of installation and alteration.

Radio communication takes place, as is well known, by transversal electromagnetic oscillations. For distant communication there were formerly used only wave lengths from about 19 kilometers down to 11 kilometers, for radio those from 2650 meters down to 200 meters. An important supplement to both fields is now being formed by short waves, the field of which lies from 100 down to 10 meters. How the oscillations used for communication, more especially the short waves, are arranged in the scale of octaves of the other electromagnetic oscillations, may be observed from Fig. 1.

The only electromagnetic oscillations directly perceptible to our senses are the heat rays and the narrow band of visible light rays, while in the case of other oscillations, including accordingly short waves, we must for this purpose cause a transformation of energy by special technical apparatus.

Historical Development

The merit of having first given a practical proof of the significance of short waves for the bridging of great distances with slight

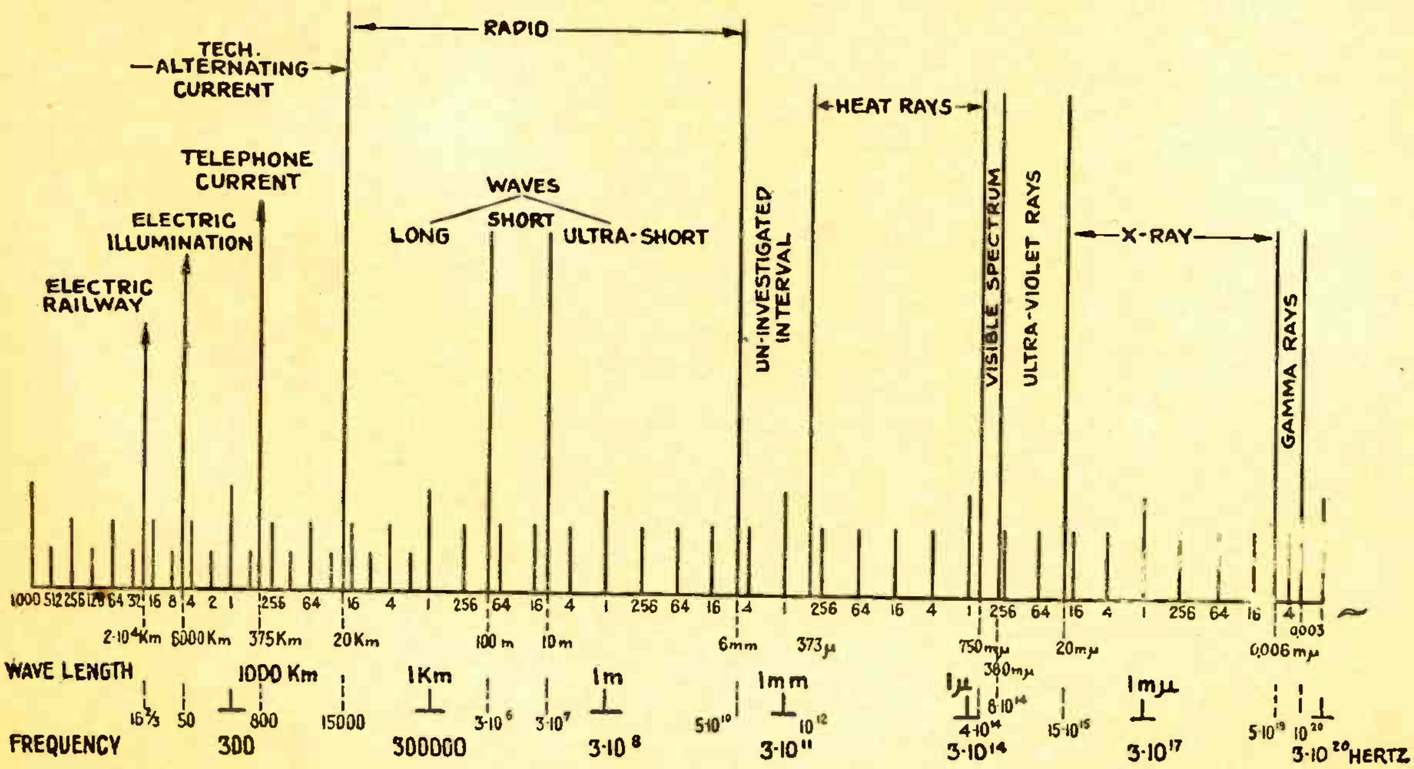

Fig. 1. The diagram above shows a comprehensive scale in octaves of electro-magnetic oscillations or vibrations. The frequency on the lower line is in cycles per second, the word "Hertz" at the end of the line being the German way of indicating vibrations per second. Note the considerable part of the spectrum of vibrations occupied by radio waves; also in contradistinction, the relatively small part of the spectrum occupied by the visible vibrations. The positions occupied by X-rays, heat rays, telephone currents, etc., in the vibration spectrum are also indicated.

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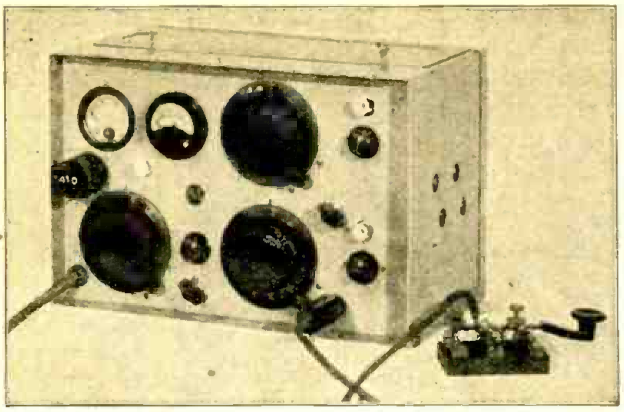

Fig. 2. This photograph shows the appearance of a German-built, 2 watt, short wave transmitter, this particular transmitter with operating key shown at right of the picture being the one used on the famous dirigible "Graf Zeppelin". The dials for tuning the condensers in the short wave transmitter are the usual type and necessary milliameters are incorporated on the panel, together with filament resistance controls, etc.

expenditure of power belongs to the radio amateurs, especially those in America. By a series of experiments, first in America, then from America across the Atantic to Europe, they demonstrated that even if permanent connections between distant places are not possible, still at times we can telegraph successfully with very slight amounts of energy.

Encouraged by these initial successes, in Germany particularly, Telefunken, Lorenz, and Aheno, in close cooperation with the Reichspost and the German Institution for Experimental Aeronautics, developed short wave technology to an important branch of communication, aided by the fundamental scientific researches of Prof. Esau of Jena, Prof. Barkhausen of Dresden, and others.

The Difference Between Long and Short Electromagnetic Waves

For a number of years very long waves were preferred for international communication. They make possible a dependable continuous communication during the entire day at all times of year. They also follow the curvature of the earth better than short waves. The long waves have, however, also very considerable technical and economic disadvantages. For example, the radiation of the transmitting aerial and consequently the economy of operation greatly decrease with increased wage length.

Thus in radio communication between Nauen and Buenos Aires, with a wave length of 20 kilometers, an effective antenna height of 150 meters, with 500 amperes antenna current; of 440 kilowatts input, only 22 kilowatts or 5% of the power applied to the antenna was radiated out. With a 75 meter wave length, an effective antenna height of 15 meters, with 5 amperes current strength, of 5 kilowatts about 1.6 kilowatts or approximately 30% of the power used resulted in actual radiation. As may be seen from the above illustrative figures, the chief advantages of short waves are these: that one can get along when using them with much less transmitter energy than in the case of long waves, and the antenna can be lower.

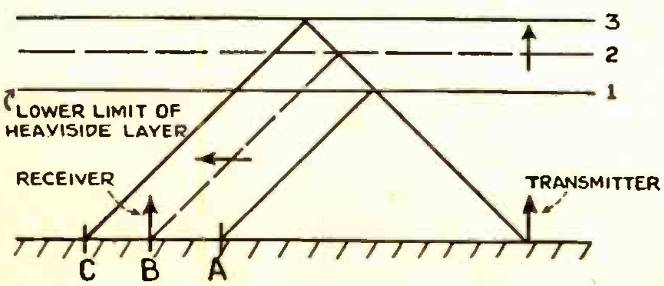

Fig. 4 shows the action taking place in the transmission of a short wave, the wave rising from the transmitter aerial striking the Heaviside layer and being reflected downward.

On its first crossing of the Atlantic Ocean the giant dirigible "Graf Zeppelin" had on board an experimental short wave transmitter of only two watts power (see Fig. 2). This little transmitter was heard by the DVL station at Adlershof, near Berlin, up to a distance of about 6,000 kilometers (about 3,600 miles), that is, almost up to the time the dirigible reached the American coast.

By increasing the short wave power up to a few kilowatts, it is easy to encircle the earth several times, as is shown in the oscillogram, taken in Geltow near Berlin, of the short wave transmitter in Rio de Janeiro (see Fig. 3).

In the short wave field atmospheric disturbances are much less pronounced, and are of essentially shorter duration, than in the case of long waves. Furthermore the speed of telegraphy may be increased to twice or thrice what it used to be, whereby for the first time a practical step has been taken toward telegraphic typewriting and television. The fact that in the band of short waves the wave spectrum can be occupied much more closely with waves than in the bands of the medium or even the long waves, is a point in favor of the introduction of short waves in radio. Likewise much simpler sets suffice for the production and reception of short waves than in long wave communication.

On the other hand the short waves also have certain disadvantages. First of all comes the great difference in the reception strength by day and by night in the case of

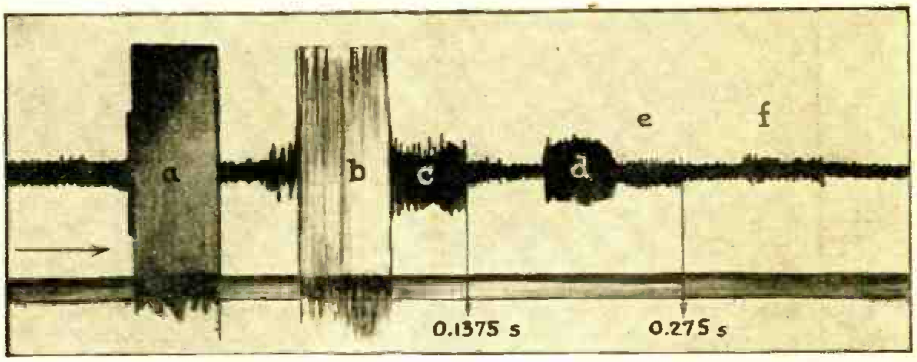

Fig. 3. A most astonishing oscillogram or graphic curve showing the actual record of a radio signal which has encircled the earth not only once, but twice! In the illustration, a and b indicate the signals arriving over the shortest path; c and d indicate the signals which went around the earth once; while e and f are the records of the radio signals which went around the earth twice!

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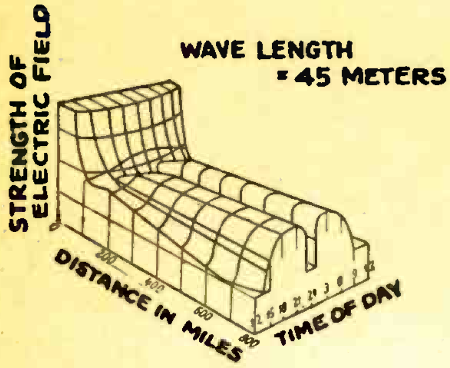

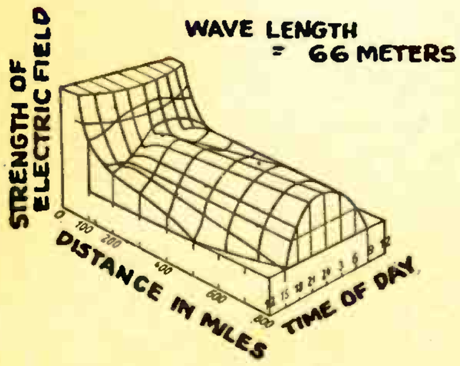

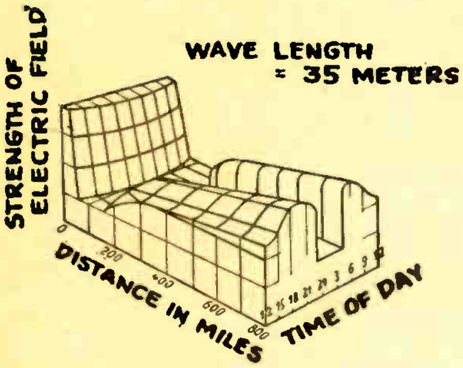

Figs. 5, 6 and 7 above, reading from top to bottom, show the variation in strength of electric field, together with distance in miles range, for different hours of the day, the day being based in this case on a clock dial numbered from one to twenty-four.

one and the same wave length, which in many wave lengths is unpleasantly noticeable, and is sometimes so great, that the sound strength sinks to inaudibility, once daylight prevails in only a part of the space which is being bridged. By a proper choice of wave lengths and by increasing the energy, one can, however, in great measure, eliminate the differences in loudness between daytime and night time, in a given instance by changing from the shorter "day wave" (10 to 30 meters) to the longer "night wave" (30 to 70 meters).

A further disadvantage of short wave communication is this: that it demands very sharp tuning and a much greater regularity of wave length, than long wave communication. While with a wave length of 15,000 meters (the frequency being 20 kilocycles), clear reception is possible with frequency variations up to .5%; this limit in the case of work with a 30 meter wave length (the frequency being 1.10^4 kilocycles) amounts only to .001%. Such a high degree of regularity can, of course, only be attained by special means.

Short wave transmitters cannot have their direction determined, a point which is to be regarded as partly advantageous, partly disadvantageous.

The Propagation of Short Waves

For the propagation of short waves other laws hold good than in the case of long waves. The formula given by Dr. L. W. Austin for the strength of the field of the oscillation arriving at the point of reception, which is a general truth for any long waves, is no longer true in the case of short waves. In the communication between Nauen and Buenos Aires on a wave length of 70 meters, it has been determined that the strength of field measured in Buenos Aires, for instance, is about 10^{24} times as great as it would have had to be according to the Austin formula. How is this amazing difference to be explained?

According to a theory generally recognized as valid, the waves radiated from an antenna may be divided into so-called *ground* waves and *space* waves; that is, part of the waves follow the surface of the earth, while part on the contrary go out from the transmitting antenna into space. The division of ground waves and space waves at the attainable limit of distance is dependent on the wave length, the form of the antenna, and the excitation of the latter. *In the case of long waves, ground radiation is predominant; in the case of short waves, space radiation.*

The absorption of the waves in the ground increases with increas-

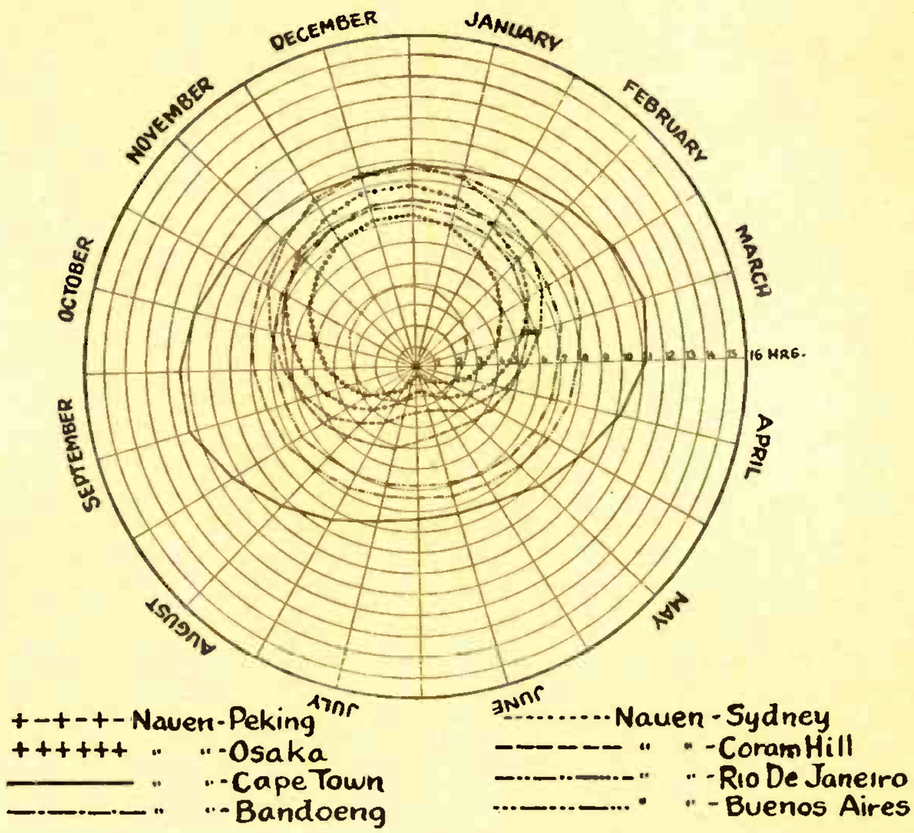

Fig. 8 above shows in very interesting fashion how strongly dependent distant communication by short waves is upon the time of year and the circumstances of whether the stretch lying between the transmitter and the receiver is simultaneously illuminated as bright as day, or whether it is in darkness. This diagram indicates the number of hours daily possible for communication without change of wave length, in the case of some short wave, long distance communication systems. The best result is obtained between Nauen and Cape Town, South Africa, since both these stations have day and night at almost the same time.

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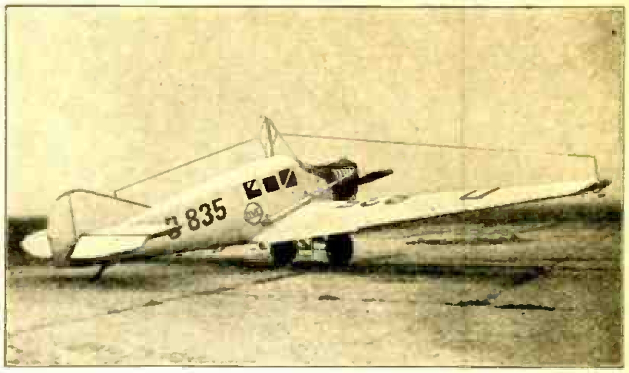
ing frequency. Short waves are accordingly subject to an especially strong absorption in the ground. The range of the ground radiation therefore decreases with decreasing wave length.

Furthermore, the curvature of the earth's surface and the conductivity of the ground exert a pronounced influence upon the effectiveness of the ground wave. The shorter the wave is, the greater its difficulty in following the curvature of the earth. Mountains strongly screen off the ground radiation of short waves. On the other hand, good conductivity of the ground favors the ground radiation, especially if the conductor lies in the direction of the receiving station (telegraphy along conductors). Good conductors (including rivers) which lie across the direction of propagation have, however, a strongly damping effect.

Fig. 9 at right shows a Junkers airplane fitted with a dipole antenna for carrying on short wave communications. A great amount of work is being carried on by engineers with short waves for both aircraft transmission and reception in this country as well as abroad. The latest idea is toward the elimination of the trailing antenna.



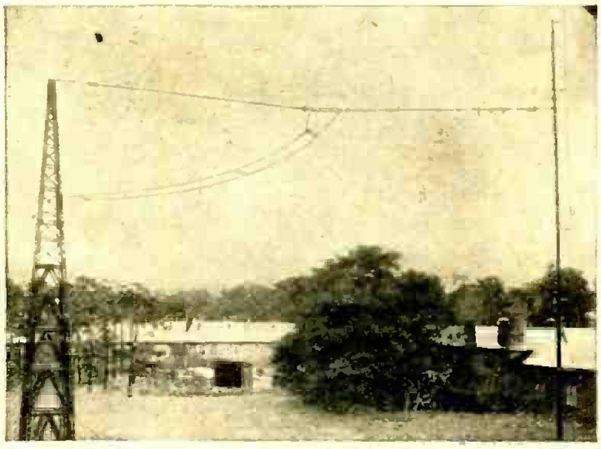


Fig. 10 at left shows a short wave ground station, with dipole antenna and feeder line connecting the right and left limbs of the antenna proper, to the short wave station apparatus. Wood masts are preferred for short wave antennae.

That besides the ground radiation there is also a space radiation present was satisfactorily proved by measurements on airships (DVL). The bridging of immense distances with very low power can only be explained by the fact that the waves on their way between the transmitter and the receiver, as long as they move in space, are subject to extremely slight absorption. Space radiation, however, can only strike an antenna located on the ground if at least a part of the waves are directed off toward the earth.

It is assumed that the waves radiated forth below a sometimes limited angular field, are bent back to earth from a layer located some 90 to 130 kilometers above the earth. This layer, called the *Heaviside layer*, is higher by day and in the summer than by night and in the winter. The waves leaving almost perpendicularly to the surface of the earth go out into space and are lost for reception on earth. For the sake of simplicity reflection instead of divergence is shown in Fig. 4. The waves reaching the earth again describe on it more or less spherical zones, concentric to the transmitting antenna; we call these distant zones. Between the first distant zone and the ground radiation of the transmitting antenna lies the first dead zone, in which no radiation, or only an extremely weak one can be demonstrated.

Since the shorter wave lengths are bent less than the long ones, the diameter of the dead zones depends on the wave length. The transition from the ground radiation to the dead zone and thence to the distant zone is, of course, gradual, since for one thing waves cannot be radiated from an antenna at a sharp angle, and for another thing the Heaviside layer possesses a certain depth. This is also the reason why the distant zones show a certain breadth.

Once space radiation is again deflected back to the earth, which is demonstrable with waves from 1,000 meters down to 10 meters, we must count on the occurrence of the fading effect. These disappearance phenomena can be completely checked by the use of short wave transmission. Apparently there are rays which, repelled from the antenna at various angles, reach the earth on paths of different length. If their difference in course on reaching the receiving antenna amounts to 180 degrees, an extinguishing of the field takes place at the receiving antenna. The disturbance is especially strong at the boundary line between the dead zone and the distant zone (this being called the fading zone), because there the possibility of the formation of fading phenomena is especially great, in consequence of sudden changes in the height of the Heaviside layer.

Extensive experiments for the investigation of the dead zones were commenced in recent years by the DVL, using a Junker plane. The strength of sound reception was determined, once at a constant distance (500 kilometers) during the course of 24 hours; the other time only during the day at varying distances, for various wave lengths. A two watt airplane sender was used in this experimentation.

The investigation of the reception relations at still greater distances, showed that there are alternately several dead zones and reception zones. A ship with a transmitter operating on a 12 meter wave length found the following zones: the first distant reception zone, 1,100 to 4,500 miles; second dead zone, 4,500 to 5,000 miles; third distant reception zone, beyond that. (A mile is 1.6 kilometers.) One can explain the

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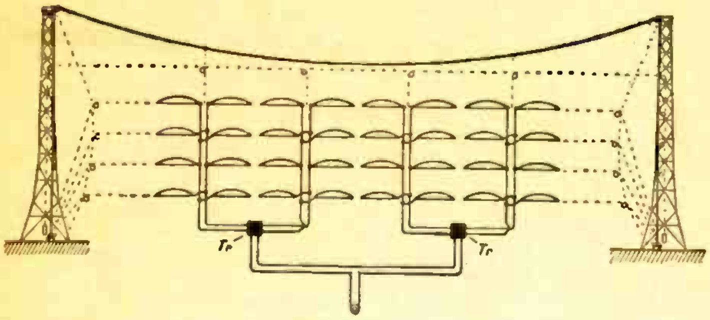

Fig. 11. This interesting diagram of an aerial shows the Telefunken short wave antenna used at Nauen, Germany. The connection of the feeder or transmission line to the two limbs of the antenna, is clearly shown. The dotted lines are non-radiating supports.

SHORT WAVES IN GERMANY

Some of the most interesting researches imaginable are being made with short waves in Germany. SHORT WAVE CRAFT will report these experiments and results right along. You cannot afford to miss these timely and valuable articles.

manifold alternation of dead zones and reception zones only by assuming a manifold deflection in the Heaviside layer and reflection back to the earth. The breadth of the dead zone increases with increasing distance from the transmitter, which agrees well with what was said above and the observations made.

There is exemplified an extraordinarily striking indication of the dependence of the loudness of reception on the distance and the time of day in Figs. 5, 6, and 7, for three different wave lengths.

The strong absorption of the ground radiation, which alone is effective up to about 100 miles (with wave length 33 meters) or 200 miles (with wave length 66 meters), is expressed in the initial strong sinking of the sound strength. A pronouncedly dead zone (weak in reception) is first demonstrable in the case of the 33 meter wave. The first dead zone begins the sooner and is the wider, the shorter the wave length is. Once the space radiation alone is effective, within the individual zones of distant reception the distance has practically no more influence on the loudness of the reception. It was furthermore determined that the strength of the distant reception is independent of whether the radio work is done over land or over water.

From Fig. 8 we perceive how strongly dependent distant communication by short waves is upon the time of year and the circumstance of whether the stretch lying between the transmitter and the receiver is simultaneously illuminated as bright as day or is in darkness.

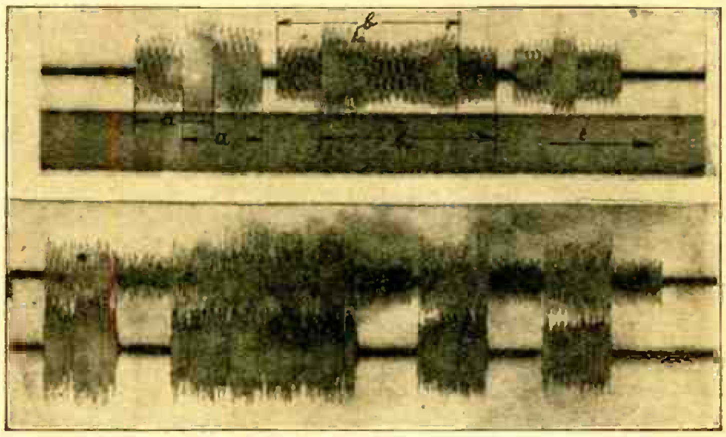

Fig. 12. In the case of an antenna radiating in all directions, the earth is encircled forward and backwards as well, so that at the point of reception the identical signals can modulate and disturb each other. In the graph at the right, the signals arriving by the shortest path are designated by a and b. the signals coming in backward by a_1 and b_1.

This indicates in a polar diagram the number of hours daily possible for communication without change of wave length in the case of some short wave, long distance communication systems. The best result is obtained in the communication between Nauen and Cape Town, which is almost right along a degree of longitude of the earth, since both these stations have day and night at almost the same time. On the contrary, in the stretch from Nauen to Osaka (Japan), which is in the direction of a degree of latitude, satisfactory radio communication is only possible for very few hours a day. For another thing, with just this line of communication, which runs in the northern hemisphere, it appears that in the dark winter months the daily hours of communication are much greater in number than in the summer. As was already mentioned above, the number of daily hours of operation may be increased by change of wave length within certain limits.

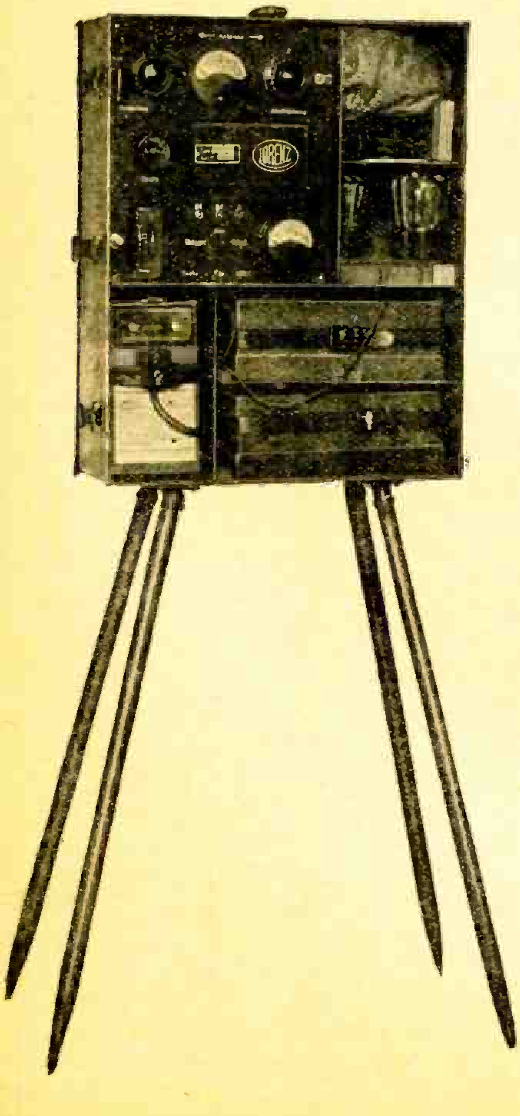

Fig. 13, at the left, shows a Lorenz 2-watt, short-wave portable transmitter. In this apparatus, which is shown here with demountable legs, the transmitter and the sources of power are all combined into a single container. The ground radiation of this transmitter permits telegraphy up to about eighteen miles. After bridging first dead zone, they can be heard by space radiation, up to several hundred miles.

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For every short wave there is a definite angle whch the waves leaving the transmitting antenna form with the horizontal, above which there can be no deflection at all. (Compare ,in optics, the case of the diver under water.) The consequence is that not only outside the short wave band (from 100 meters down to 10 meters) but also above a definite angle of radiation, different for each wave, there is no possibility at all of short wave distant transmission to stations on the ground.

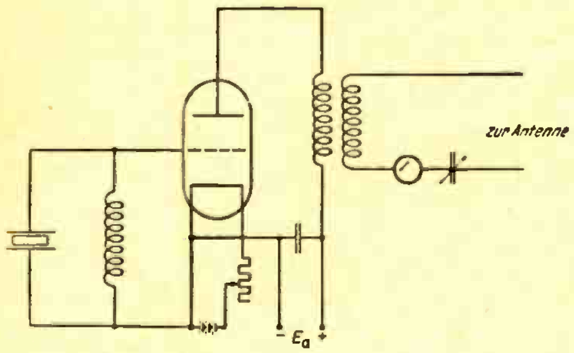

Fig. 14 at the left shows hookup of quartz crystal to vacuum tube, for the purpose of stabilizing the oscillations. In this diagram as well as the one below, zur antenne means "to antennae". For technical reasons these quartz crystals can be used only down to a natural oscillation of 40 meters.

Aerials

In the case of the first short wave experiments, there were used as aerials the same types of antenna (T-antenna, L-antenna, etc.) as in ordinary radio with continuous waves, and thereby astonishingly great distances were bridged. When a more exact investigation of the propagation of short waves had been made, preference was given to forms of antenna with predominantly high space radiation, thus arriving at the *dipole antenna*, which is now used almost exclusively for short wave transmitting and receiving stations.

The *dipole* is a symmetrical form of antenna, in which antenna and counterpoise consist of a straight wire, the length of which is made about *equal to half the wave length*, and which is also oscillated in a half wave length. Accordingly, for low power, the short wave antennas are small and simple to construct. They may be put on airplanes and airships and are essentially superior to the antennas previously used and which were towed after the ships. (See Fig. 9.)

One must exercise special care in building and making the connections to the antenna, having the best of insulation and placing the aerial sufficiently far away from any grounded conductors; since otherwise, with the extraordinarily high frequency of the short waves, the electrical losses will mount to a prohibitive degree.

Likewise the dipole and the connection must be under good tension, since variations in capacity in the case of the extraordinarily sharp tuning of the short wave transmitter, would render operation free from disturbance impossible.

If to increase the range one wants to put the dipole at a great distance from the earth, to avoid energy losses, one must provide two connection wires running about 10 centimeters apart, of the Lecher wire type, in such a manner that vertical waves arise in them. The supporting of these wires must take place at the points of junction (see Fig. 10). The simultaneous feeding of several dipoles, according to the scheme of Fig. 11, affords a further increase of energy.

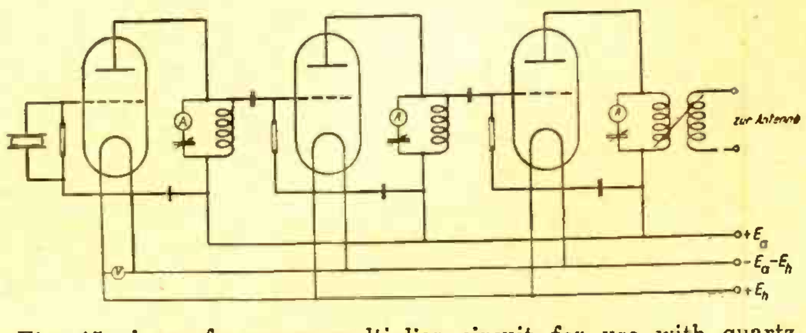

Fig. 15 shows frequency multiplier circuit for use with quartz crystal. In this the fundamental frequency of the crystal stage is doubled, by using the over-oscillations in the first intermediate circuit, when this is tuned to the double frequency. In the second intermediate circuit, there doubling is again resorted to.

As was mentioned earlier, by using a few kilowatts of power, one can encircle the earth several times. In the case of an antenna radiating in all directions, the earth is encircled forwards and backwards as well, so that at the point of reception the identical signals can modulate and disturb each other. In Fig. 12, at the top the signals arriving by the shortest path, are designated by a and b, the signals coming in backward by a^1 and b^1. This concerns the short wave transmitter at Buenos Aires, S. A., the signals of which have been recorded oscillographically in Geltow, near Berlin. These echo-like disturbances have been successfully eliminated by means of reflecting antennas. As reflectors there are used for this purpose reflector wires, which are stretched behind the antenna at a definite distance depending on the wave length; and they possess the same dimensions as the antenna itself. These reflector wires, for one thing, screen off the backward radiation almost completely; and for another they intensify the forward radiation, as in the case of light, as may be seen from the lower part of Fig. 12. If one imagines the plan of the Telefunken antenna of Fig. 11, as drawn with another one close behind it, one gets a representation of the very complicated antenna construction of a large short wave station.

The Transmitter

The undamped tube transmitter exclusively dominates the field of short waves. The short wave transmitters have essentially smaller coils and condensers, corresponding to their smaller wave length, and are therefore simpler and lighter than the long wave radio transmitters. In small transmitters one can use ordinary receiver tubes as transmitter tubes; for sources of current, one may use

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small storage batteries to heat the filaments; and dry cells for the anode current. This makes the entire sending apparatus easy to move about. Fig. 13 shows such a station, in which the sender and the sources of power are all put into one single container.

The ground radiation of this station permits telegraphy up to about 30 kilometers (18 miles). After bridging the first dead zone, such transmitters, in consequence of the then effective space radiation, can be heard well up to many hundred kilometers (several hundred miles).

The supreme demand for maintaining a constant frequency on the short waves can only be attained by the aid of quartz crystals. These crystals have the property of oscillating, according to their lamellar strength, with a natural frequency which is regular and constant to a high degree, once they are given a little electric potential (this is an example of applying piezo-electricity).

Fig. 14 gives the hook-up of a transmitter with quartz crystal control.

For reasons of solidity and of the technology of operation, such quartz crystals can be used only down to a natural oscillation of 40 meters. To produce still shorter waves one uses multiplication of frequency, according to diagram 15. In this the fundamental frequency of the crystal stage, is doubled by using the over-oscillations in the first intermediate circuit, when this is tuned to the double frequency; in the same way in the second intermediate circuit, there doubling is again resorted to, relative to the first intermediate circuit, and so forth. Thus for example with a wave length of 40 meters in the crystal stage, one already has the wave length of 10 meters, by the second intermediate circuit. The tubes coming after that are then mostly used to increase the power.

The great short wave stations and the newest short wave transmitters are built on this principle.

Since the transmitter tubes of the individual stages and the tubes for telephonic modulation, require different potentials of filament, anode, and grid, while at the same time there is mostly used as anode potential rectified alternating current, the transformers requisite for supplying a great short wave station, along with the switchboard, take up many times as much space as the actual transmitter itself.

Receivers

Likewise the short wave receivers are simpler and lighter than the long wave and regular radio receivers, since the requisite tuning devices (coils, condensers, etc.), become smaller with the wave length. Fig. 17 shows the

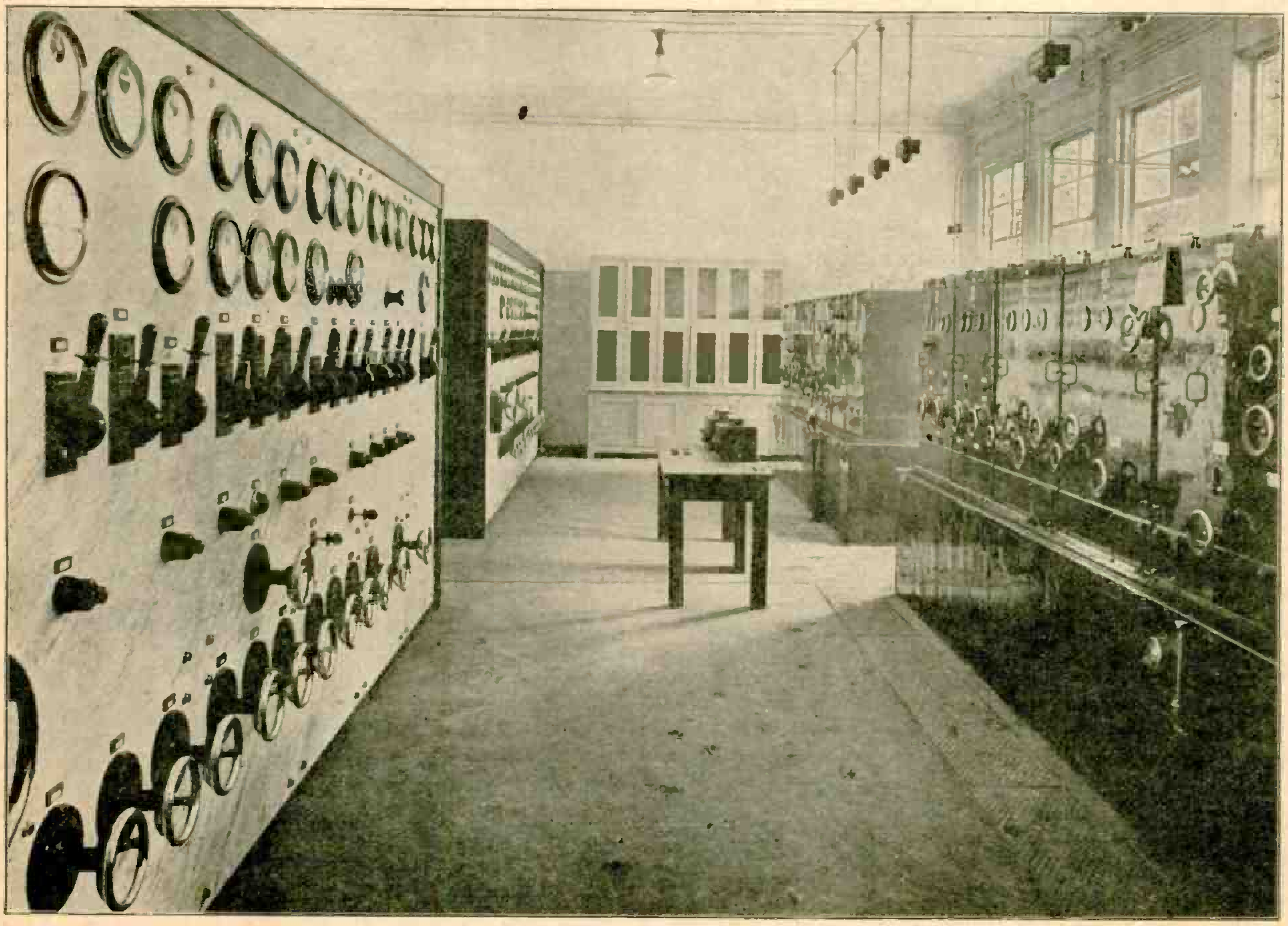

Fig. 16. One of the most powerful "short-wave" transmitting stations in the world—that connected with the radio system at Nauen, Germany.

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receiver corresponding to the transmitter shown in Fig. 13. Together they make up the Lorenz (German make) short wave, two-compartment set.

This receiver is a three tube set with audion (vacuum tube) and two low frequency stages, a hook-up which, because of its simplicity and power has proved best for receiving short waves, both from the listener's viewpoint and that of home construction as well. The fine adjustment of the capacitive tuning apparatus is of great advantage, with the sharply defined transmitter wave. High frequency amplification is avoided as much as possible, using rather the intermediate frequency stages. Thus the Beelitz short wave receiver for large stations, which is used in the communication between Nauen (Germany) and Buenos Aires (S. A.), has four high frequency stages, As receiver tubes there is no question about the suitability of the normal radio tubes usual in the trade.

In the case of low power, one can easily put transmitter and receiver, along with the sources of power, all in one container; as is the case with the one-compartment set designed and built by Lorenz (Germany), (Fig. 18).

This little set, with only two watts antenna power, permits the bridging of distances up to 30 kilometers (18 miles), in the case of telegraphy, by means of ground radiation; while in the case of telephony, conversation can be carried on up to the range of 4 kilometers. (This must be done alternately, taking turns at using the transmitters.)

Communication directly back and forth and dialogue by telephone (as in the ordinary manner) demands, to be sure, the separation of the transmitter from the receiver; still, in the case of rather low power, as with the two-compartment set shown in Figs. 13 and 17, a distance of a few meters (1 meter 3.2 ft.) is enough. The sender operates with the normal dipole aerial, while the receiver is advantageously connected with a loop antenna. If the difference in wave length between the sending and the receiving is kept greater than 2 meters, separating the apparatus merely 2 meters (6½ ft.) is sufficient to permit regular conversation in the usual manner.

AUTHORS—ATTENTION!

The Editors will welcome all sorts of articles on short wave transmission and reception, whether designed for radiophone or code. All articles accepted and published will be paid for at regular space rates. We particularly desire articles describing how to build sets, accompanied by good photographs and diagrams.

Address all communications to The Editor, Short Wave Craft.

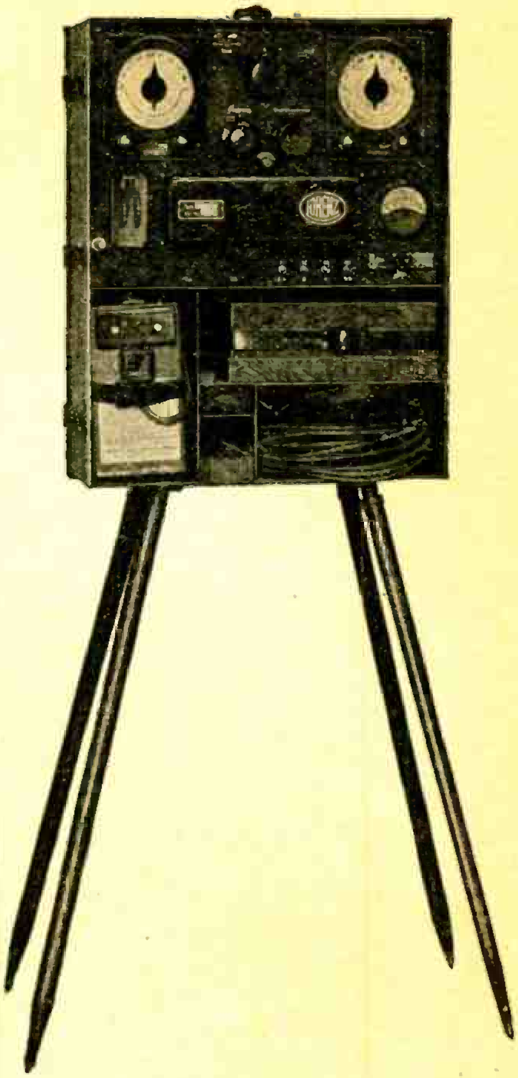

Fig. 17. Short-wave radio receiver, built in two compartments, by the famous Lorenz concern of Germany. This set works with the transmitter shown in Fig. 13.

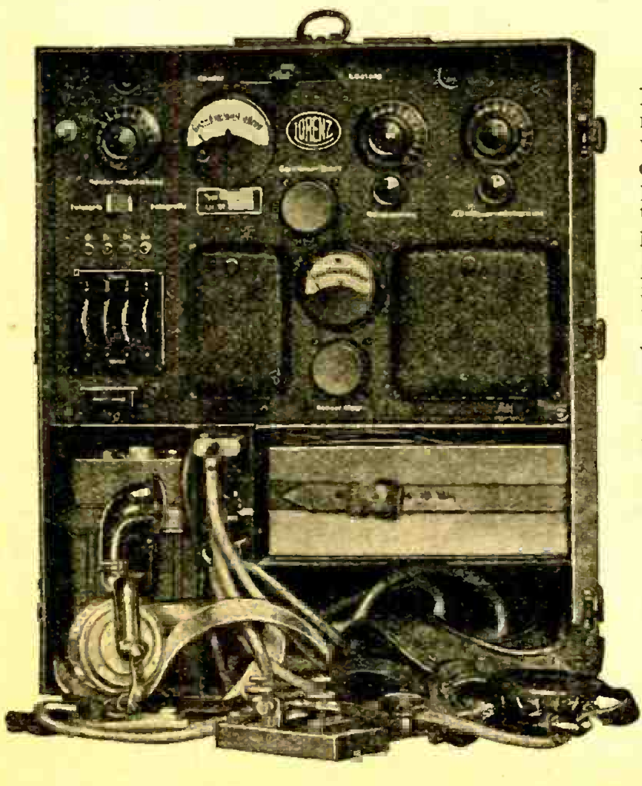

Fig. 18 at left shows remarkably compact short-wave transmitter and receiver, all combined in one portable case, as built by the Lorenz company. This portable cabinet contains all the sources of power for the tubes, including high voltage plate current. The transmitter is fitted with telegraphic signalling key and also a microphone for transmitting the voice when desired. Necessary milliammeters for reading the vacuum tube currents are mounted on the instrument panel, as well as the tuning dials for the receiver. This portable set with but 2-watts antenna power permits the bridging of distances up to eighteen miles by ground radiation alone.

Fields of Use

Short waves have reached their greatest practical significance in *long distance communication*. All the larger countries, especially those with many colonies, have provided permanent short wave communication lines, both for tactical and economic purposes, within their own borders and also to communicate with their most distant colonies. Besides. international short wave radio, provides that every person away from his native land can stay in close contact with his country.

In the case of scientific expeditions in pathless lands, a small short wave station often provides the only connection with the base.

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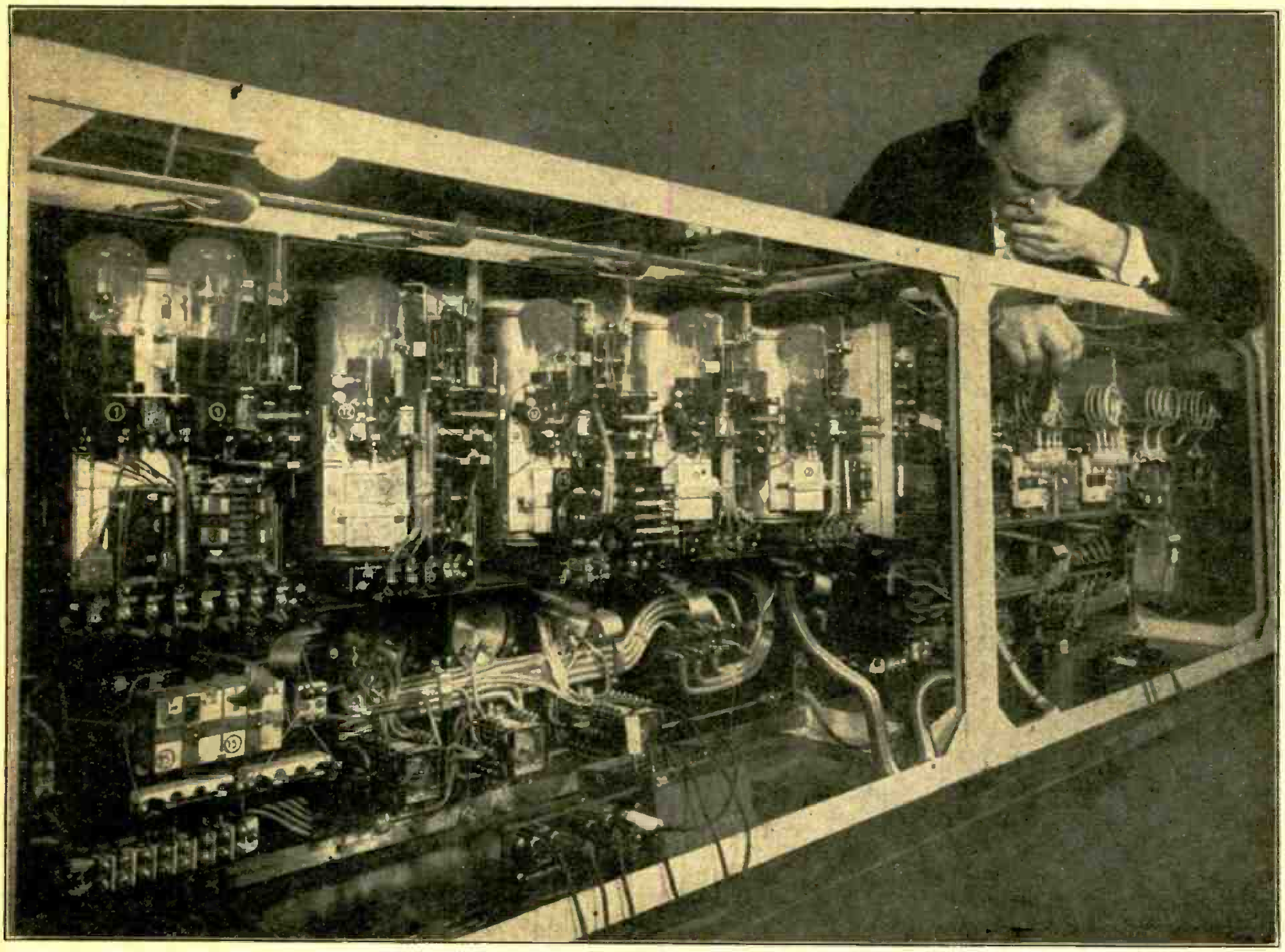

HOW WOULD YOU LIKE TO OWN THIS SHORT-WAVE RECEIVER?

Well, radio enthusiasts, we have to admit here's the short wave radio receiver we have always dreamed about! It employs 12 vacuum tubes and it is used in listening to short wave stations all over the world by Dr. Reissner in his laboratory located at Zehlendorf, Germany, near Berlin. The short wave tuning stages are observed at the extreme right, while the audio frequency amplifier is shown at the left. Loops are used a great deal for short wave reception.

Short Wave News from Germany

Giant Short Wave Receiver

DR. REISSNER'S radio station in Zehlendorf, Germany, is reputed to be the most complete experimental laboratory in the world. The entire equipment is contained in the basement of a small house and every effort has been made to produce ideal conditions and facilities of every variety installed. Special materials have been employed to make the floor, ceiling and walls sound proof. Here broadcasts from every point, trans-Atlantic included, are received in a profusion of languages. German broadcasting stations receive relays of important messages from Zehlendorf.

A New Short Wave Transmitter in Prague

WE have just been informed that a new short wave transmitter is to be put in operation in Prague. The wave length will be 60 meters (corresponding to 4997 kilo-cycles); transmitting will take place between the hours of 17 and 22 o'clock (hours numbered 1 to 24).

More Than Five Hundred Amateur Senders in Russia

The Russian government is reported to have become very friendly to the amateur transmitting station movement. It is encouraging all the lovers of radio to establish amateur stations. Consequently the number of such stations has greatly increased in the last few months. It is now said to be over 500.

On a Wave Length of 7 Centimeters!

Prof. Protoff has been making successful experiments in the Russian government laboratories at Nizhni-Novgorod on waves of 7, 12, and 19 centimeters (1 inch = 2.54 cms.). It is reported that he has been successful in communicating thousands of kilometers

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(1 km. = .6 mile), on these extremely short wave lengths, with an energy of only 20 watts. It seems as though one might well append a question-mark to the last part of this new item.

18,000 Kilometer Amateur Communication

The Argentine amateur station LU2CA succeeded in maintaining for about an hour a conversation (back and forth) with the expedition recently engaged in seeking the survivors of the "Italia" north polar expedition. The distance bridged was about 18,000 kilometers.

Berlin Radio Amateur Sentenced

In the Charlottenburg court the Berlin amateur, Walter Scheibner, who had been sentenced to five hundred marks fine and the confiscation of his set, had a technical hearing. In the first trial the president of the German Society of Radio Engineers had petitioned this hearing on the ground of the slight offense (interference). It actually came out that the radio disturbances attributed to Scheibner did not come from him at all, but from another amateur who had called up Scheibner. Various experts were invited to the hearing, among them Director Haanemann of the C. Lorenz Co. and the physicist, Dr. Max Arndt. Haanemann and Arndt were in accord in stating that only the work of amateur transmitters had directed science and industry to the field of short waves. Both considered the inclination of German radio amateurs toward such experiments extremely important from the technical angle. To justify his transmitting experiments Scheibner pointed out that he had discovered a great improvement in an existing method of modulation. For obvious reasons he declined to answer the query of the judge regarding the nature of this improvement. The prosecution considered proper a fine of 50 marks and the seizure of the set. The court decreed a fine of 20 marks and confiscation of the transmitting apparatus. There is a highly remarkable sentence in the decision: This decree is to have a warning effect, and therefore one must suffer for all!—Scheibner, through his attorney, entered an appeal against the sentence. We shall later report the outcome.

IN THE NEXT ISSUE:

German short wave advances:

Short wave reception with super-heterodynes and neutrodynes, by Fr. Scheuermann.

The influence of the earth's atmosphere upon the propagation of short waves, by J. Fuchs.

A three-meter transmitter and receiver, by Dr. Karl Stoye.

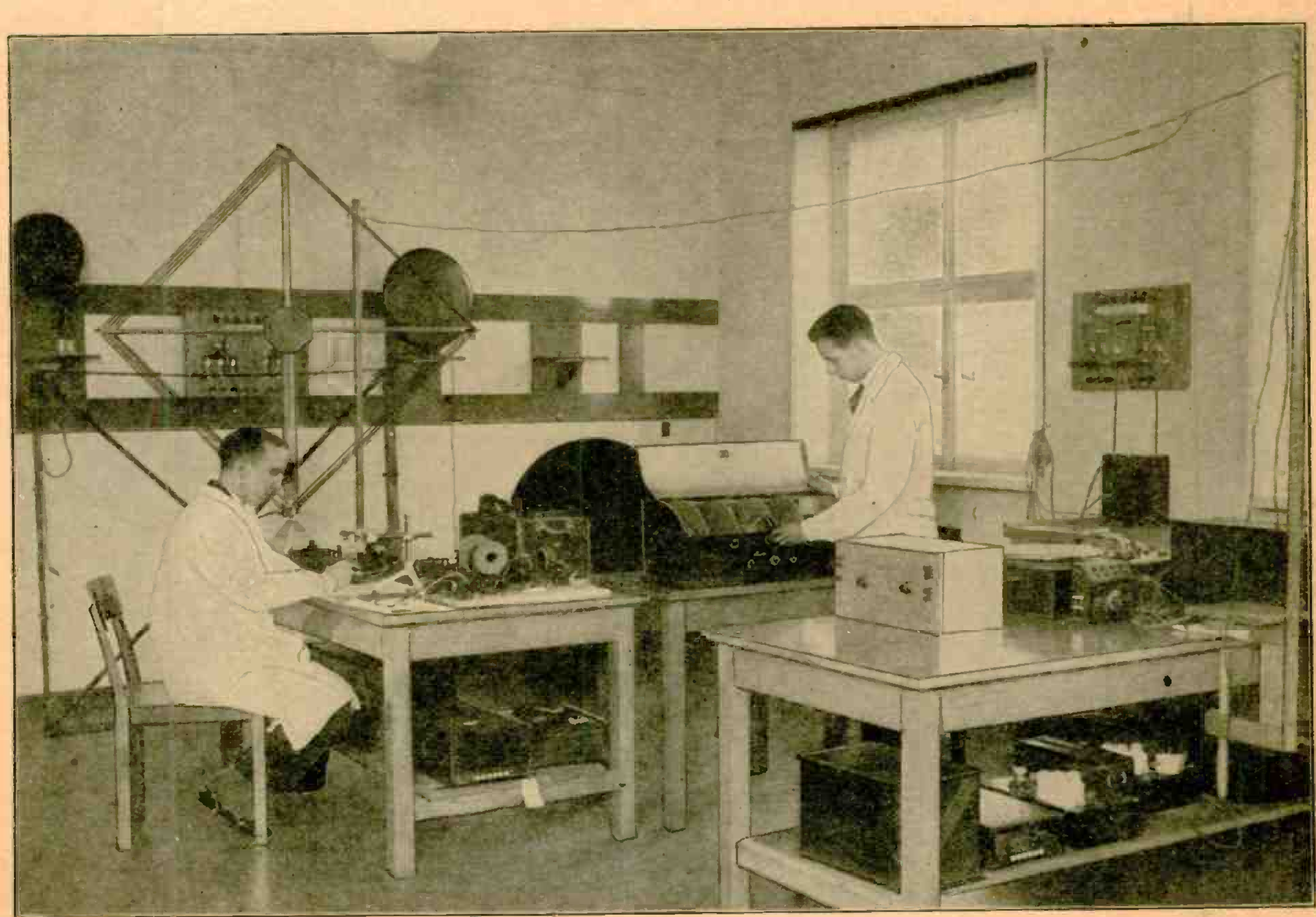

Photo above shows two German physicists in one of the leading German laboratories, where research is carried out on short wave reception. As one may see from the picture the Germans frequently use loops for short wave reception. A great deal of the German short wave receiving tests are carried on by means of loops—a hint to we Americans.

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Effect of Magnetic Storms on Trans-Oceanic Short Waves

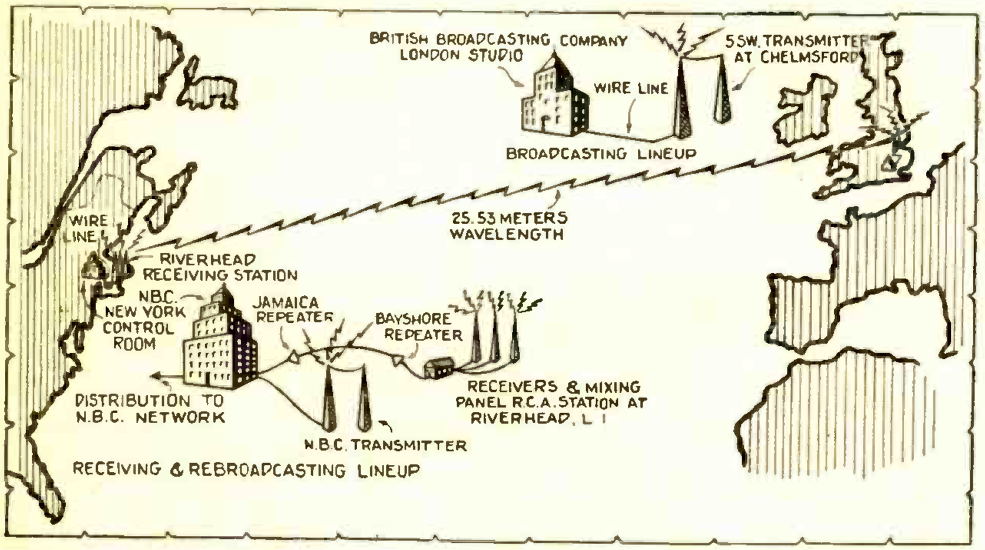
Peculiar Phenomena Observed by

C. W. HORN,

General Engineer, National Broadcasting Company

▼▼▼

Mr. C. W. Horn, general engineer of the National Broadcasting Company, gives us in the following article some very illuminating information on the difficulties of short-wave transmission across the Atlantic Ocean. Mr. Horn discusses magnetic storms, the advantages of short waves for long distance operations and other vital factors which all of us want to know about.



The photo-diagram above shows the general plan of short wave operation as carried out by the National Broadcasting Company between London and New York. Different short wave lengths are used for different seasons and different hours of the day, the wave length being chosen to fit changes of season and time. A certain wave length which operates very well for a number of hours during the day time, may not come through well at all at night time, or even at a different time of the day.

AN enemy more difficult to cope with than static confronts radio engineers when they venture into the field of international program exchanges, according to C. W. Horn, general engineer of the National Broadcasting Company. The new enemy is the so-called magnetic storm, an effect known to electrical engineers for years.

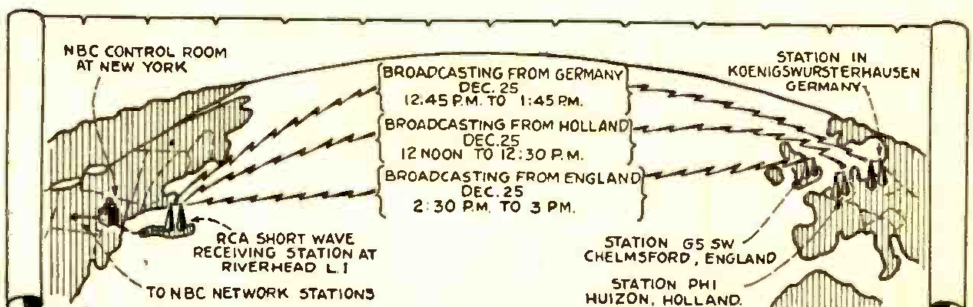
"We have known for many years that the magnetic storms affect land-line communications to quite an extent and influence delicate instruments, such as ships' compasses," said Mr. Horn. "However, it is only in recent years, since the advent of long-distance radio communication, particularly on short waves, that we have noticed any great effect from this source.

"It is a peculiar fact that the magnetic disturbances act differently in the case of long waves. Dr. L. W. Austin, of the Bureau of Standards, who has been making measurements for many years on long waves, reports a general increase in signal strength at about the time that magnetic disturbances take place.

"We have found that these disturbances react in just the opposite manner on short waves. That is, they reduce the signal strength very greatly and seem to offer an impedance to the passage of the wave."

The uncertainty as to when magnetic storms may be expected makes it difficult to plan trans-Atlantic program exchanges in advance, Horn explained. Twice last winter the National Broadcasting Company's attempts to relay European programs in this country were defeated by magnetic storms, which attacked the programs coming from England and Germany, and made it impossible to pick them up on this side of the ocean.

Static is an enemy which engineers believe can be partially conquered. Static does not reduce the strength of the signals, but is an interference, manifesting itself in the form of noise. It is conceivable that programs might be broadcast at such high power that the interference from static might be reduced to a point where it would not be objectionable. In other words, static might not be eliminated, but it might possibly be weak in ratio compared with the signal strength.



The diagram above shows how the broadcasting was picked up on short waves across the Atlantic Ocean from Germany, Holland and England on December 25 and 26, 1929, during the inauguration of international broadcasting by the National Broadcasting Company.

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No one really knows much about the causes of magnetic storms, according to Horn, but there seems to be a general belief among scientists that the sun spots, of which so much has been heard in the last few years, are responsible to a large degree. During the periods of greatest sun spot activity the earth is bombarded by streams of electrons, which react upon the magnetic lines of force surrounding the earth. The aurora borealis is believed to be associated in some manner with these phenomena.

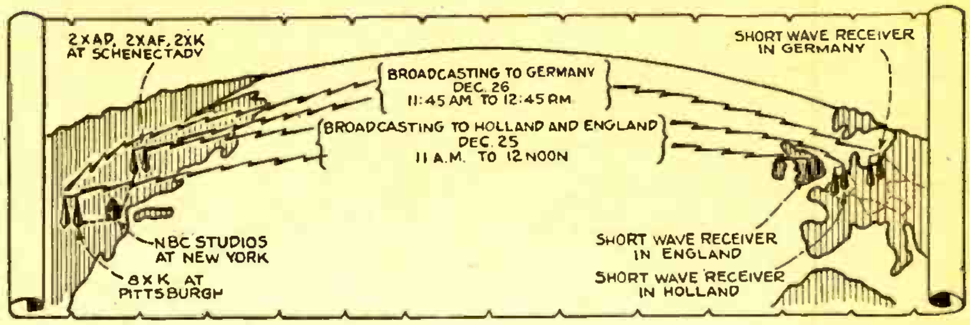
During the last several years, during which very high sun spot activity has been noticed, there has also been a large number of these magnetic storms. Astronomers' records, according to Horn, show that the periods of greatest sun spot activity evidently run in cycles of approximately eleven years. The activity is now on the decline, and for the next five or six years improved conditions in radio reception are to be expected.

"This gives us a great deal of hope," said Horn, "and a breathing spell during which scientists and engineers will actively pursue their investigations, and perhaps find a way of over-coming some of Nature's eccentric and irresponsible behavior."

The United States Coast and Geodetic Survey, at its observatory at Cheltenham, Md., has made many studies of the magnetic storms, and their reports on these and other natural phenomena have been widely used by NBC engineers in working up their plans for international broadcasts.

Whatever knowledge can be gained in this field is much more valuable than reports of probable weather conditions, Horn points out, for the worst that can be expected of the weather is sharp electrical storms, resulting in static. Observations of the weather are of value only, insofar as variations in weather may possibly be caused by the same agency that affects long-distance radio transmission—the sun spots.

Failure of programs originating on the other side of the Atlantic, and transmitted to this country on short waves, to arrive at a high enough volume-level to permit re-



This picture shows short wave broadcasting circuits from the National Broadcasting Company's studios in New York City, to Germany, Holland and England, as carried out on December 25 and 26, 1929, at the time the N. B. C., inaugurated international broadcasting.

broadcasting, is less likely during the next few years than in the year just past, according to Horn, although such attacks by magnetic storms are not likely to cease entirely.

SHORT WAVE HINTS

THE editors shall be pleased to hear from all short wave experimenters and set builders who have some practical hints on the construction and operation of short wave receivers and also transmitters. Sketches and photographs are greatly desired with a brief description of the hint or wrinkle. Address all sketches and manuscripts to Editor, Short Wave Craft.

QUESTIONS ANSWERED

By C. W. HORN,
General Engineer, National Broadcasting Company, at the Request of "Herald Tribune"

Question 1—Do you think the short-wave is the solution, as a link, for international broadcasting and what are the main advantages of short waves for long distance transmission and reception?

Answer—The greater penetration of short wave transmissions per unit of energy, as compared with the longer waves, and the greater freedom from static or atmospherics make the use of the higher frequencies desirable for long distance radio circuits. These are the two main advantages. By using a reasonable amount of power, such as 40,000 watts, and the proper wave length, which depends on the time of the day and the year, reliable signals can be received.

In radio as in other cases, one seldom receives such a wonderful gift without some strings attached to it. On short wave transmissions these restrictions consist of distortion due to rapid fading and other causes. These are the problems which the engineer must solve before he can take full advantage of the remarkable carrying power of short waves. Progress is being made along these lines, and some hopeful results have been obtained after exhaustive tests, which would indicate that the problem can be solved in the near future.

Question 2—Is time difference an impasse that will prevent successful world hook-ups?

Answer—The difference in time between various parts of the world is a handicap, particularly at present, as we are more interested in furnishing each other (various nations) with important happenings which are of world wide interest. There is a difference of six hours between New York and Berlin and a difference between New York and Sydney, Australia, of 15 hours. It is obvious that events cannot very well be timed to satisfy even the majority of listeners in the world. The United States has one advantage over Europe in that any event that takes place in England or on the Continent during the afternoon will be either an early afternoon or late morning period in this country. Similarly, the evening events in Europe will be our afternoon features. In the reversed direction our evening events take place after midnight or very early in the morning, which is past the average time for the listeners. Our afternoon programs would come in in the evening, which means that as far as Europe is concerned they will have to depend on happenings which take place during the day in this country.

The international exchange of programs is slowly being im-

(*Continued on page* 83)

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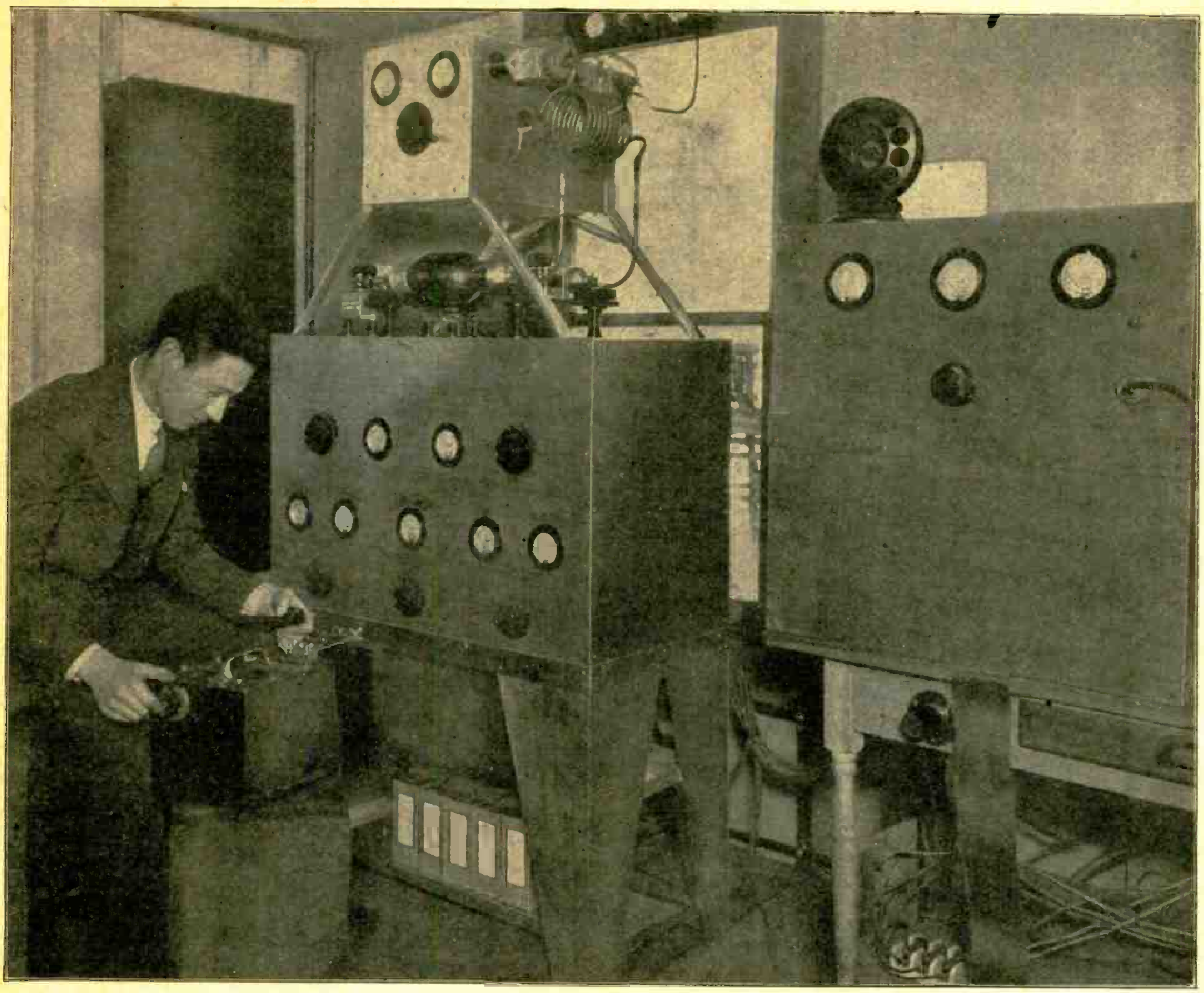

The short wave transmitter at station W2XAL. This beautifully built short wave apparatus was designed and constructed by Mr. J. L. McLaughlin, who is shown using the wave meter at the left of the picture.

The Latest Push-Pull Short Wave Transmitter

By
LAURENCE COCKADAY
New York University

How to Prevent Swinging of the Frequency in Short-Wave Transmitters by Special Design of Circuits Here Described.

RADIO transmission and reception at ultra-high frequencies, better known by the simple term "short-waves," is now quickly becoming looked upon as one of the most important phases of radio communication, rather then the plaything of amateur experimenters and fans. And it is to the amateur, largely, to whom the world owes its gratitude for a development that in the future may dwarf all other forms of communication, and control, at a distance.

The rapid strides that have been made in the apparatus for receiving short-wave transmissions over great distances is known, and it is not this subject that we are to discuss in this article. Rather let us study something of the methods of transmission that have been in the process of development and that have not been so well understood by the majority of experimenters.

Of course, it is common knowledge that with relatively tiny

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amounts of power the short-wave signal travels over great distances with an amazing facility. It is also known that one of the early troubles with short-wave transmission is the phenomenon of fading. Another queer and little understood thing about the short waves is known as "skip distance". This latter effect is believed to be the result of the waves bouncing back and forth between the surface of the earth and a layer of ionized gases high up in the atmosphere that surround the earth up to a distance of three or four hundreds of miles. On the waves bouncing upwards, to the layer, during their flight around the earth's curvature, they skip over bands or regions of the earth's surface and little or no signal is picked up in these regions. But when the waves go further and bounce downwards again they come in at a more distant point with great strength and clarity.

It has been found, by experiment, that this effect can be eliminated for any distance by using a number of wavelengths, each one for a given distance where reception is wanted. It is for this reason that each transmitting station, for short waves, is alloted more than one wavelength, so that good results, day and night, may be gotten for any distance of transmission.

Crystal Oscillators

Another effect that has been found extremely important for short-wave transmission is frequency swinging. This is caused, sometimes by changes in antenna capacity, and sometimes by changes in capacity or temperature in the circuits of the transmitter itself. It has been largely overcome by using a master-oscillator system of frequency generation which includes a crystal frequency control. Another thing that has helped to overcome this effect is the use of push-pull radio-frequency amplification for increasing the power of the original oscillatory current before it is fed into the antenna system.

This is the general method employed by the great short-wave transmitters that have been broadcasting from European countries during the last year and that of the larger American stations which are heard all around the world.

Some of the more advanced and progressive amateurs have used these types of transmitters, but the ordinary experimenter has not always had the "dope" on these circuits or has not believed that he could build a station of this seeming complexity. But really, there is not so much difficulty in making a transmitter of this kind if the amateur is experienced in transmitter work of any kind at all.

A Push-Pull Transmitter

Let us see what the problem resolves itself into and how it would be possible to build up such a transmitter.

Referring to the diagram in Figure 1, at the extreme left is the shielded quartz crystal and temperature control circuit. These units can be obtained from a number of instrument makers and mounted in a metal can-type shield. The frequency of the crystal should preferably be one-half that of the frequency transmission for the best results. In this case this is imperative for the complete circuit utilizes a frequency doubler for obtaining the transmitter frequency.

Connecting to the two terminals of the crystal are the two grid circuits of the two oscillator valves, which are type 210 tubes connected in push-pull circuit. Connected also across the grid circuit is a push-pull filter circuit for the oscillator C bias voltage and consisting of two R.F. chokes and a condenser. The constants of the chokes and the condenser should be suitable for operation at the frequency of transmission employed. Also notice that the filament circuits of all of the amplifier and frequency-doubler tubes are by-passed with suitable condensers. The A.C. wiring of the filament circuits has not been shown, for the sake of clarity.

The output circuit of the oscillators is tuned by a coil and a transmitting condenser and connects to the next two 210 tubes,

MR. LAURENCE COCKADAY, the author of the present article, is well known as a radio expert and as the designer of the famous Cockaday receiving circuit. Mr. Cockaday, who is at present connected with the faculty of New York University, here presents the newest push-pull circuit for short-wave transmitters, which every short-wave enthusiast will find most valuable and interesting, as it eliminates swinging of the frequency.

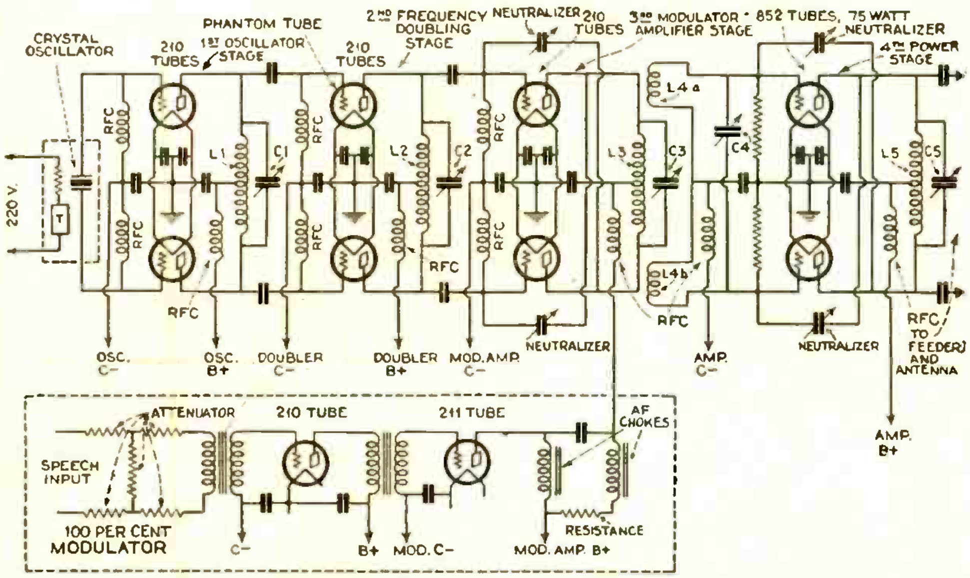

Fig. 1. Complete circuit diagram for the push-pull short wave transmitter with crystal control and frequency doubler circuit, as well as 100 per cent modulator circuit.

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through a second push-pull filter, similar to that used in the oscillator input, except that two isolating condensers are used to keep the plate voltage of the first tubes off the grid circuits of the second tubes. Notice that the output of the second set of valves is exactly the same as for the first tubes, and that the plate voltages are fed to the tubes through another choke coil, connected to a center tap on the tuning coils. The frequency of tuned circuit L2-C2 is set at half the frequency of circuit L1-C1.

A Frequency Doubler

This second stage is used as a frequency-doubling stage and *only one tube is used with the filament lit!* In this way the amplification in this stage is unsymmetrical and second harmonics are set up in the circuit L2-C2, and that is the reason for it being tuned to pick up these higher-frequency signals. The use of a phantom tube for this purpose is a very satisfactory method of frequency doubling and the output of this combination is exceedingly constant.

The next stage following this is similar in circuit layout except that two neutralizing condensers are used to prevent self-oscillation to make the circuit a pure amplifier. The tuned output circuit is tuned to the same frequency as L2-C2 and the modulation is introduced into the plate circuit by the 100 per cent modulation scheme used in all of the more modern broadcasting stations. The general circuit of the modulator is given in the lower part of the diagram, enclosed in the dotted lines, and is similar to that used by most amateurs. A 210 tube and a 211 tube are employed herein. The control of volume in this circuit is taken care of by means of a potentiometer-attenuator that does not distort by frequency selection, having constant output and input impedances for all settings. The modulation is almost never used at values of more than 75 to 80 per cent in order to make sure of little or no distortion.

Inductive Coupling

It will be noticed that the output circuit of the third stage is inductively coupled; the coil L3 and condenser C3 forming the primary circuit while the split coil L4a and L4b and the condenser C4 form the secondary circuit. This method gives an isolated circuit for the grid of the two power amplifiers

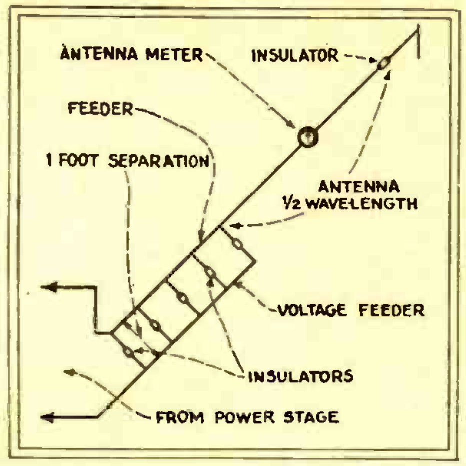

Fig. 3 above shows the feeders and the half-wave antenna which have been found suitable for use with the push-pull transmitter circuit here described by Mr. Cockaday. The antenna meter may be read by means of a small telescope or by opera glasses, while someone is making adjustments on the transmitting apparatus for maximum radiation.

which are type 852 valves, neutralized as are the two preceeding tubes. In this case, however, high resistances are used across the grid

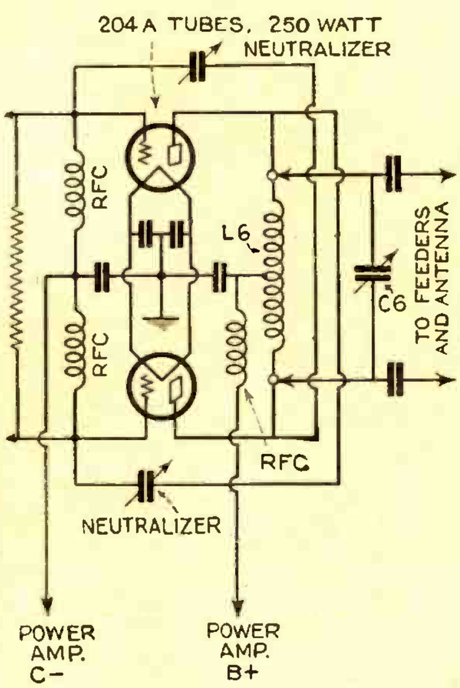

Fig. 2 above, showing an additional power stage employing 250 watt tubes, the same as utilized at W2XAL. By placing this hook-up to the right of the large one at Fig. 1, it becomes clear how this power stage can be added when desired.

circuit to produce a small amount of damping in order to get good stability from the transmitter when it is in operation. These values will have to be determined by experiment, according to the type of antenna that the transmitter is used with.

The output tuning arrangement is similar to that used for the previous stages and the coupling to the feeder type of antenna is accomplished through two high-voltage type condensers. The coupling coils for both the input and output circuits of the last power stage described should be made with copper tubing with the coils wound in diameters of approximately four or five inches. Of course the number of turns will depend on the wavelength allocation, but this can easily be gotten around by sliding clips for making the initial connections to the coils.

Great Distances Covered

With a transmitter of this type verifications and congratulations have been received from many foreign countries, both as to the steadiness and clarity of signals and the quality of reception has been called admirable.

This is the same type of circuit as used by experimental station W2XAL, the aviation radio station, except that this station employs one more power stage employing 250 watt tubes. This may be added to the circuit shown in Figure 1 and consists of the arrangement in Figure 2. Notice that there is a loading resistance shunted across the input circuit to the grids and that there are also two radio-frequency chokes used here. The output tuning is taken care of by the coil L5 and condenser C5 and all of the apparatus in this circuit must be able to withstand the high voltages that are necessary with these tubes. Otherwise the general circuit is the same as previously used and neutralization is employed for preventing self-oscillation. The whole circuit shown in the photograph was designed and built by J. L. McLaughlin, the design engineer of the station and well-known for his earlier work in both transmitting and reception apparatus.

(*Continued on page 89*)

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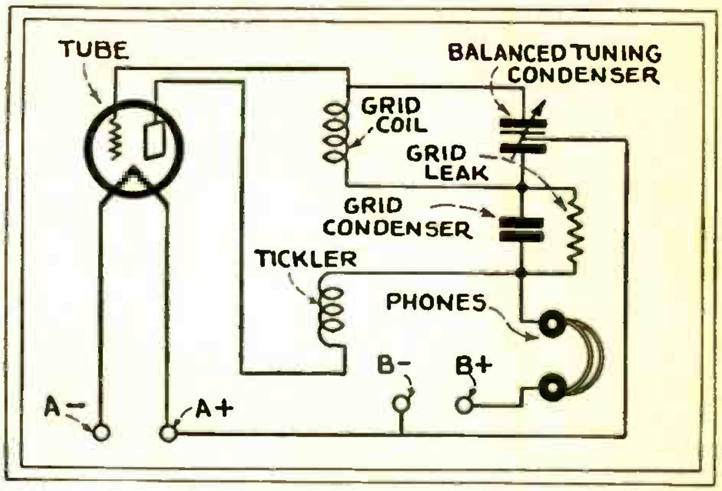
The short wave enthusiasts who are at all concerned with transmission of code or voice signals, will be interested in this description of a simple frequency meter for measuring short waves. The author is well known as an expert in short waves. The parts required for building this frequency meter are inexpensive and few in number.

A SIMPLE *Short Wave* FREQUENCY METER

By JOHN L. REINARTZ



Schematic diagram showing connections of the few, yet highly important instruments employed in building the short wave frequency meter here described by John Reinartz.

JOHN L. REINARTZ needs no introduction to the short wave fraternity—his name has been outstanding in the radio field for many years. We might almost say that the name Reinartz is practically synonymous with short waves. The well-known "Reinartz circuit" is one that every radio experimenter has encountered at one time or another in his work.

THE one thing which should be built first when you have decided to build and operate a radio transmitting station is a good frequency meter. This may take any one of the many forms in use today; of these the heterodyne meter is to be preferred. The following description will be of one of that type, and we will mount it in a good looking case and make it serve as a monitor as well.

To make this frequency meter simple we will build it around a circuit which will readily allow a plug-in type of coil, using the UX type of socket, in which the filament connection will be for the tickler coil, and the plate and grid connections for the tuning coil. Old burned-out tube bases are used to wind the coils on for the various tuning ranges, it only being necessary to change plug-in coils, when a different range is desired.

In addition to the socket used for the plug-in coils it will be necessary to have a socket for the type of radio tube you will use; this is supposed to be the UX 199 type, as this tube is easy on the filament supply and will work for a long time from a 4.5 volt C battery, while the plate supply is furnished by a 22.5 volt C battery; this can be raised to 45 volts if desired, but is not necessary.

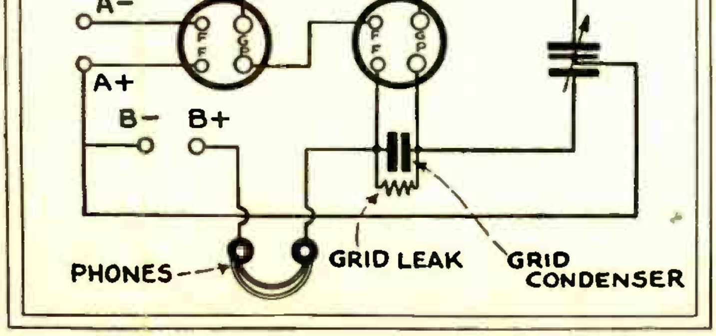
Apparatus Required

The circuit requirements are quite simple and inexpensive; they are, one Sangamo grid condenser, grid leak mounting and grid leak, and whatever kind of balanced receiving condenser you may have on hand. The Sangamo grid condenser should be .001 mf., at least and may be as large as .01 mf., while the grid leak may be anywhere from 1 to 5 megohms in value. The balanced condenser should not be larger in capacity than 250 mmf., for each half of the condenser, and preferably but 100 mmf., for each half. After you have made the meter and find the tuning range too great, you may wish to remove some of the plates.

The coils are wound on the bases of broken tubes of the UX 201-A size. The writer has wound them so small, that they fit into the tube base and are then sealed in with wax, effectually preventing any physical changes thereafter.

The tuning coil for the range from 3,300 to 4,300 kilocycles (kc.) is made up from number 28 or 30 dcc. wire, there being 50 turns in the grid coil and 15 turns in the tickler coil, wound at such a diameter that both coils will just fit into the tube base. The tuning coil connections are soldered to the plate and grid pins, and the tickler coil connections are soldered to the filament pins. Before sealing the coil into place, it is well to plug it into the meter and see if the circuit will oscillate; if it should not, it may be found that the tickler coil needs to be turned over, when this is done the circuit should work OK.

(*Continued on page* 85)



The diagram at the left shows connection of balanced variable condenser, together with grid condenser, grid-leak and phones, and V-T sockets; the socket at the extreme left being used for the tube and the one at the right for the inductance, which is fitted with an old tube base or its equivalent.

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PRACTICAL Receiver

The author, who is prominently known in short wave research, discusses the general design of short wave receivers, as well as the best forms of inductances to use and why some fixed as well as variable condensers are better than others for short wave work. Shielding is also discussed.

ROBERT S. KRUSE

TO those who have followed the development of radio in this country, the name of Robert S. Kruse is definitely identified with those that have given radio to the amateur. Mr. Kruse was educated at Kansas State University and received the degrees of Electrical Engineer and B. Sc. in 1917. In the following year he joined the U. S. Signal Corps as radio instructor, and from 1919 to 1921 was affiliated with the radio division of the Bureau of Standards. After an interval of two years, during which he was connected with private laboratory enterprises, Robert Kruse became technical editor of Q. S. T. magazine. Through this medium he gave considerable impetus to citizen radio by stimulating interest in engineering principles and in experimental investigations. Mr. Kruse is an associate member of the American Institute of Electrical Engineers and the Institute of Radio Engineers.

THE following material is in the nature of working information. The conclusions given are based on numerous tests and measurements, details of which are omitted for brevity. As a result some of the statements will appear dogmatic, but this is

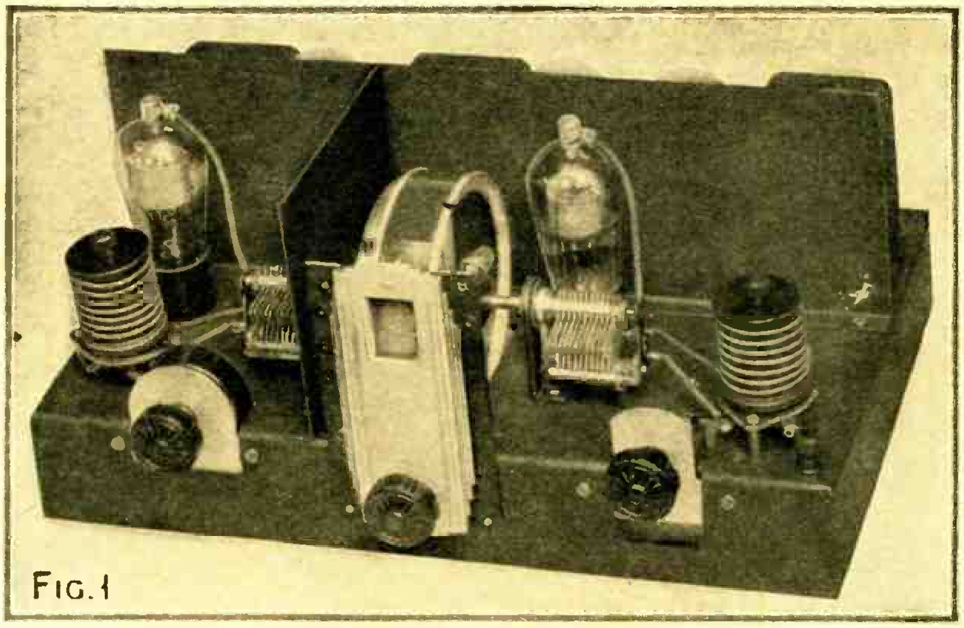

Fig. 1. A modern short wave receiver chassis utilizing screen-grid tubes and drum dial with inter-stage shielding.

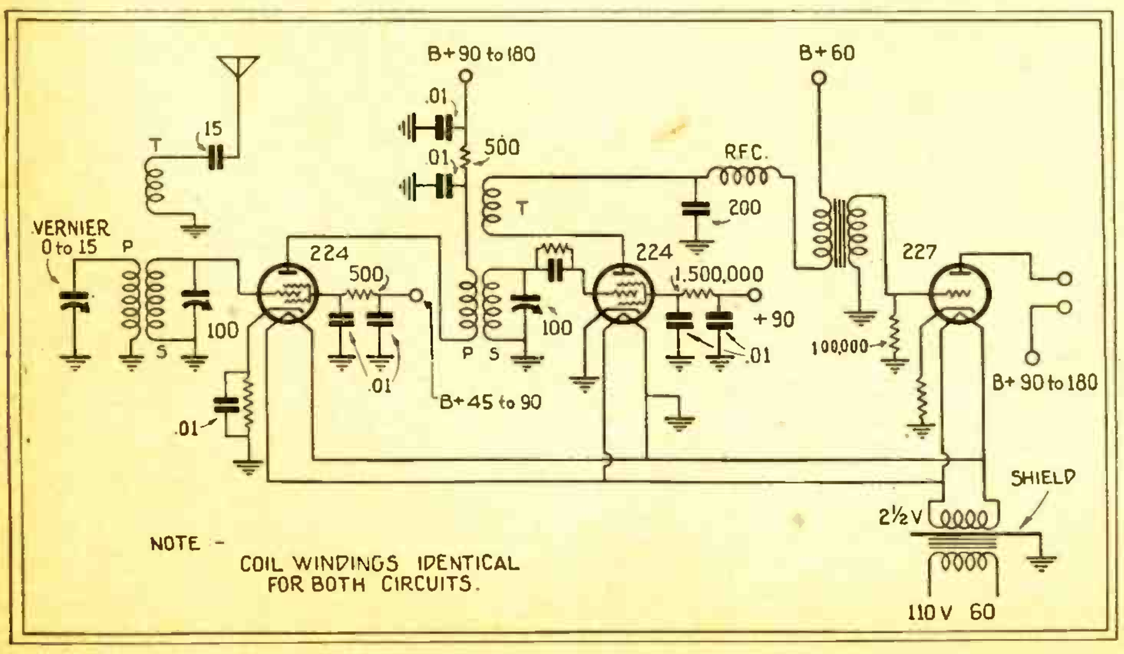

Fig. 2. A representative short wave receiver with shield-grid radio frequency stage, shield-grid detector stage, and 227 tube used in the audio stage. This circuit is highly recommended by Mr. Kruse, the author of the present article, as one which will provide maximum sensitivity with a high degree of selectivity. This is one of the best short wave hook-ups that the editors have seen in some time and they recommend a thorough reading of Mr. Kruse's article by all those interested in short wave receivers, whether intended for reception of broadcast or code signals.

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SHORT WAVE Design

By ROBERT S. KRUSE, E.E.

not to be avoided without lengthy discussion.

What Is Wanted

The most useful high-frequency receiver is one having a continuous range from 3,500 to 17,000 kc., which is about 85 to 18 meters. To extend the range toward the usual broadcast band (i. e., to 200 meters) adds nothing but complexity; the 85-200 meter territory is singularly barren of anything interesting. In the opposite direction nothing is to be found but routine commercial signals, some experimental signals and a few lonesome amateurs cautiously prodding the 10 meter band.

Since the range of 3,500 to 17,000 kc. cannot be covered comfortably in less than 3 steps, each tuned circuit of the receiver requires at least 3 coils. Thus the number of tuned circuits must be limited to avoid many loose coils or a very complex switch. The one way to avoid this difficulty is to employ a special type of "superheterodyne," in which the intermediate amplifier is fixed as usual, but the oscillator and mixer inductances are changeable. The commercial appearance of such a receiver is hampered by the irrational patent situation, which prevents others from making a device in which the patent owner has no interest. The employment of the circuit at high frequencies (especially with an oscillating detector) offers some special difficulties for even the "home builder," unless he has available a good design—and I

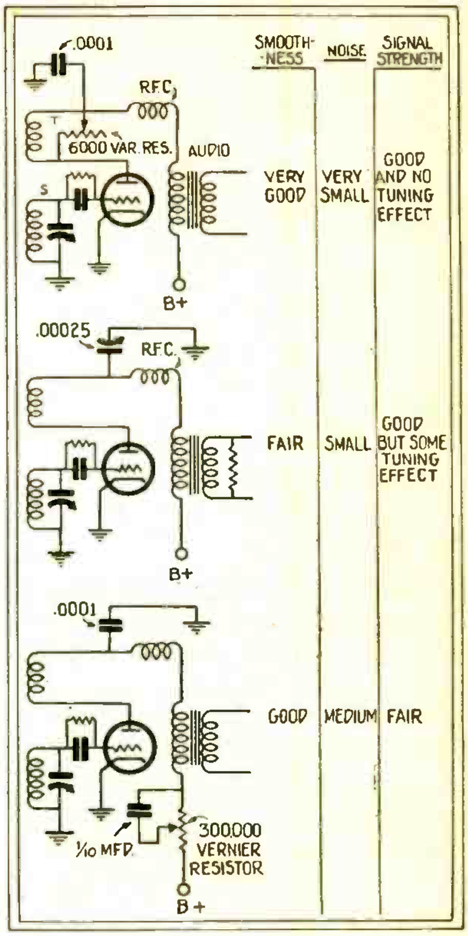


Fig. 4. This diagram shows the various features of different short wave receiver circuits as tried out by the author.

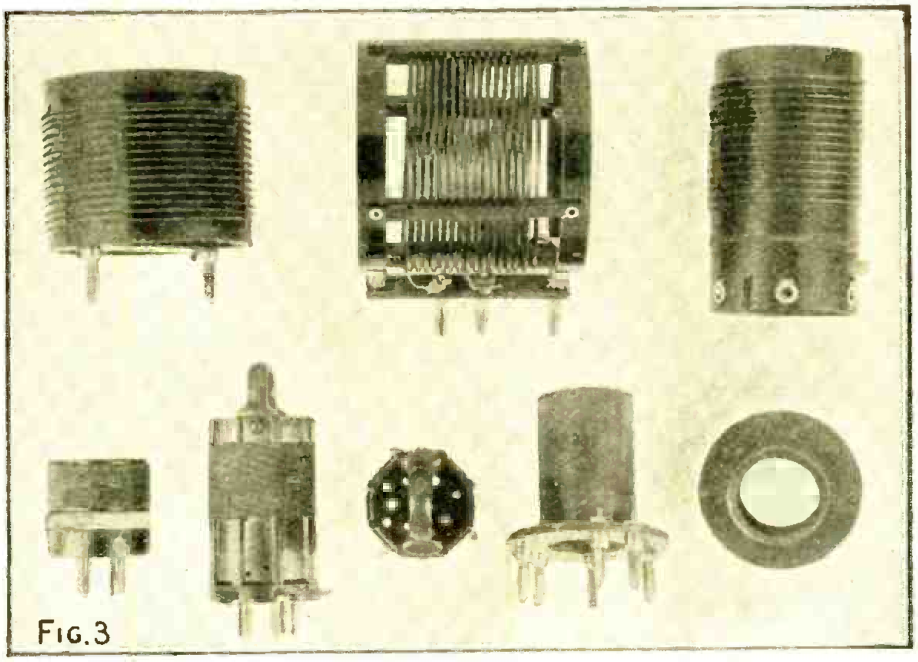
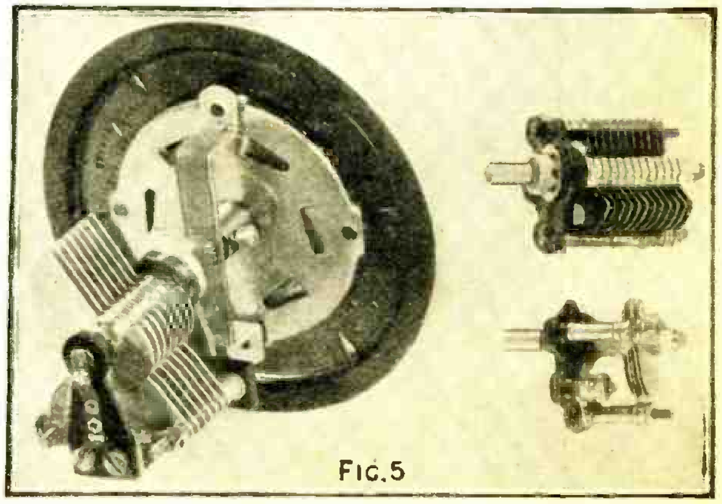


Fig. 3. Mr. Kruse discusses the various merits and demerits of the short wave inductances illustrated in the above picture. See if you can pick out the most efficient form of inductance shown and then read what Mr. Kruse has to say about them.

Fig. 5. Several styles of short wave tuning condensers are shown in the picture at right and the good and bad types of condensers are analyzed by the author.



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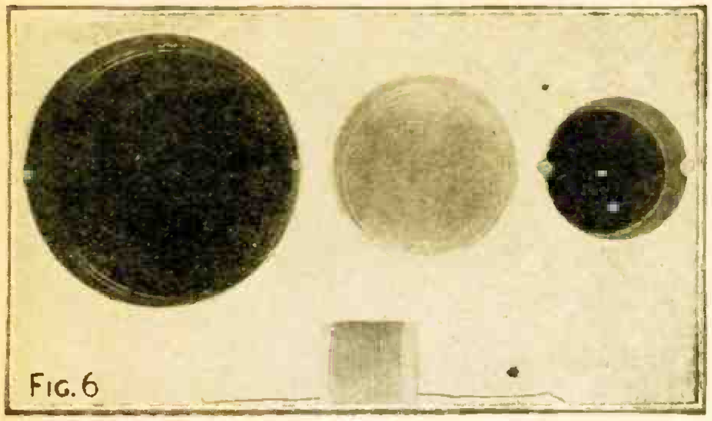


Fig. 6. Mr. Kruse discusses the various features and design of coil or inductance shields for use at various frequencies. The shields shown at the left are intended for use at 6,000 kilocycles.

know of only one, and that one has not been published in any periodical.

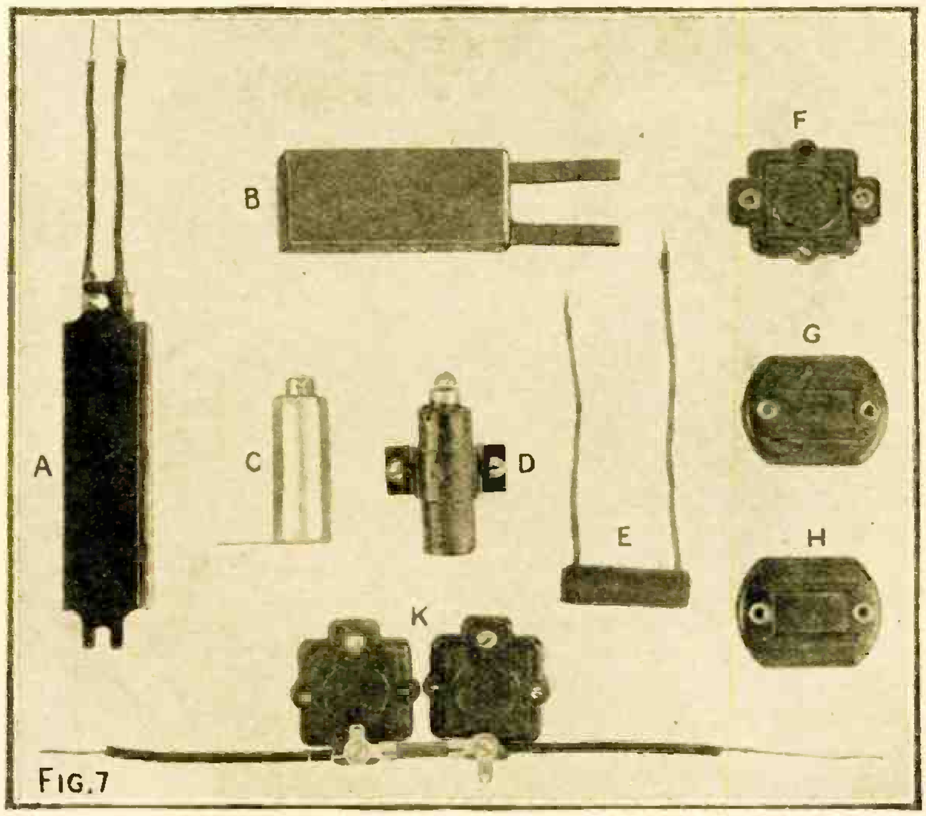
One is accordingly referred to the tunable r.f. amplifier and must take care to arrive at the desired amplification without too many tuned circuits. Both the representative chassis of Fig. 1 and the representative diagram (not of the same set) in Fig. 2, show that there is a considerable off-hand similarity to the simpler broadcast receivers. There is no intention to discuss Figs. 1 and 2 in particular, but rather to point out the general precautions to be observed, after which the application of these precautions to any circuit at high frequencies should be apparent.

Tuning Ranges

In dividing the 3,500-17,000 kc. range into sections to be covered by different coils, one must provide some overlap, as for example by making the ranges as follows:

Kilocycles		Meters	Kc Width	Tuning Ratio
3400 to 6200 kc	or	88 to 48 meters	2800	1.82/1
6000 to 10600 kc		50 to 28 meters	4600	1.77/1
10000 to 17600 ks		30 to 17 meters	7600	1.76/1

This combination splits no important bands, and does not create any impossible tuning since the tuning controls of high-frequency receivers are never permitted to be as stiff and rough as those of broadcast receivers. Instead they are smooth, high-ratio, friction or string-drive controls.



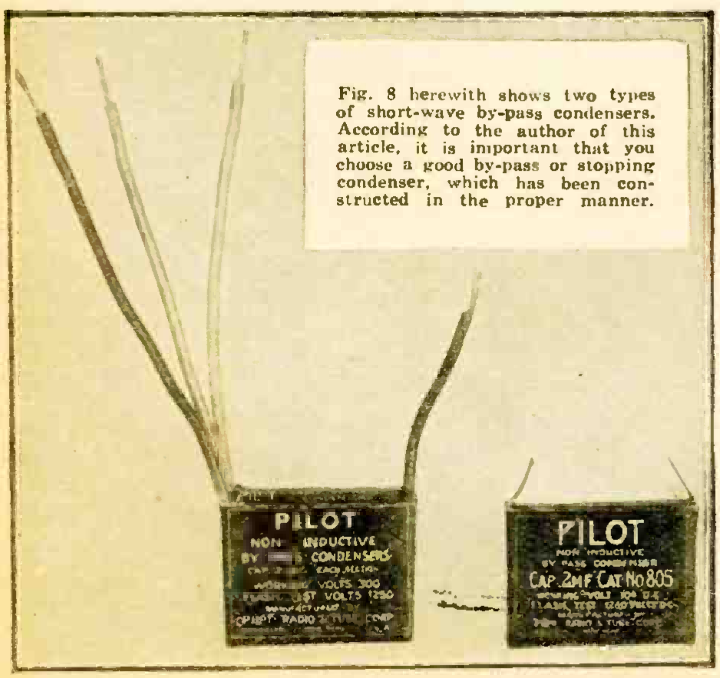


Fig. 8 herewith shows two types of short-wave by-pass condensers. According to the author of this article, it is important that you choose a good by-pass or stopping condenser, which has been constructed in the proper manner.

Fig. 7 above shows many different styles of fixed condensers, some of which are good, while others are objectionable for a number of technical reasons, which Mr. Kruse discloses in his article. For example, the condensers shown at A and B, each of a rated capacity of ¼ microfarad, acted as "inductive resistances" at 20 meters. The receiving set was improved by rejecting them and substituting condensers of better quality and workmanship. The paper condensers, C, D and E are wound non-inductively, which is important in short-wave work.

The ranges mentioned can be obtained nicely with a tuning capacity of 90 micro-microfarads maximum, if the fixed circuit capacities are carefully minimized, but the circuit is less affected by tube changes, etc., if the condenser minimum is run up a trifle and 100 micro-microfarads max. used. (For brevity the micro-microfarad will hereafter be referred to as the picofarad—abbreviated pfd.)

Building Up the Set

It is now necessary to look at the available parts, note their uses and then observe certain circuit precautions in fitting them into a circuit—as for instance that of Fig. 2.

The older types of high frequency coils appearing in the up-

(*Continued on page* 89)

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Short Wave Reception with Super-Regeneration

One of the most interesting circuits for radio reception ever invented was the super-regenerator. This circuit is here described in detail by Mr. Tanner, in his special adaptation of the principle involved to the reception of short-wave signals. This circuit is worth experimenting with

By
R. WM. TANNER
W8AD

VERY little, if anything, has been written on the subject of super-regenerative reception on the short-wave bands. This method is very desirable below about 150 meters; for the gain increases with a decrease in wavelength.

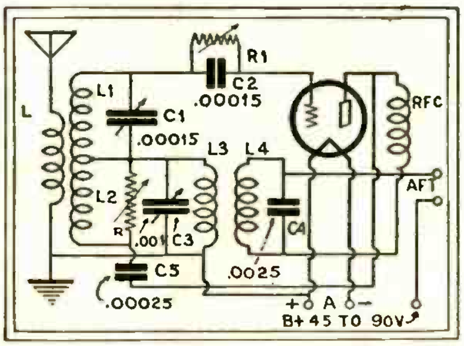
It is possible to employ a very low variation-frequency (approximately 10,000 cycles) and still obtain a great amount of amplification; for a super-regenerative detector gives a signal strength greater than is obtained with a screen-grid R.F. stage ahead of a straight detector. With proper tuning of the long-wave circuit and a correct adjustment of the grid leak, the quality of short-wave broadcast reproduction is excellent, with almost entire absence of the "mush" so prominent in the 200-600 meter super-regenerators of a few years back.

The only disadvantage is lack of selectivity. However, this desirable characteristic may be increased to a degree as high as (if not higher than) that obtained with the plain regenerative circuit; by mounting the short-wave components and tube in a shielded box and loose-coupling the antenna to the secondary.

A single-tube circuit is shown in the accompanying diagram. An '01A tube may be used successfully; but a '12A seems to give decidedly better results. The coils L1 and L2 are Silver-Marshall type-131 T, U and V; having a range of 17 to 110 meters when tuned by a variable condenser (C) with a maximum capacity of .00014-mf. The lower end (near the slot) of the grid coil and the finish of the slot winding are connected and made common to the filament.

Adjustments

The primary or antenna coil L is wound with 5 turns of No. 14 or 16 cotton-covered wire to a diameter of about 2½ inches, and tied with string in three or four places to insure rigidity. This is connected to the "A" and "G" binding posts and placed directly over the coil-mounting socket. Because of



The circuit of Mr. Tanner's short-wave superregenerator. Values and coil data are given in the accompanying text. A screen-grid stage may be added between L1 and the antenna.

the stiffness of the wire, it is easily held in place.

If a large antenna is employed, selectivity may not be good, and some points on the dial may be found where the tube will not oscillate with the 5-turn coupling coil. The number should then be cut down until the selectivity is satisfactory and the regeneration smooth over the entire range.

A higher degree of regeneration is required with this circuit; so the number of turns in the slot windings may not be sufficient when certain tubes are employed. If the set fails to function on the high end of the scale with any of the coils, it probably means that the tickler is too small and more turns will have to be added. Regeneration is controlled by means of a 50,000-ohm variable resistor (R) across the tickler.

The long-wave coils L3 and L4 may be 1250- and 1500-turn honeycombs respectively. An .001-mf. XL "Variodenser" (C3) is used to tune L3, and a .0025-mf. fixed condenser (C4) to tune L4. The coupling between the two coils should be variable over a comparatively wide range.

Some types of 45- or 30-kilocycle ironcore intermediate-frequency (superheterodyne) transformers may be used in place of honeycombs. The secondary will then be used as the primary, and vice versa; that is, the "G" terminal would go to "B+"; "F" to the plate; "P" to the center tap of L1-L2, and "B+" to the filament. It has been found that the Acme 30-kc. transformer functions perfectly; however, these are hard to procure as they are no longer manufactured.

In the beginning of the writer's experimental work with short-wave super-regenerators, a great amount of trouble was experienced from a loud continuous roar which drowned out the signals almost completely. No adjustments of the long-wave coils or coupling seemed to help in the least. This roar was finally eliminated by employing a grid leak of lower value. As the leak R1 is rather critical, a Standard Clarostat was installed and proved very effective.—*Courtesy Radiocraft.*

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How Short Differ From

MR. DAVID GRIMES is a leader in short-wave research and he here presents a clear explanation of some of the more interesting angles of short-wave receiver design. Mr. Grimes is the author of numerous radio articles.

Some of the interesting and practical reasons why we use plug-in coils in short-wave receivers; the relation between the size of the coil and the condenser with respect to the wavelength; tuning analogy with musical instruments; why regeneration is desirable in short-wave receivers; the grid-leak versus the "C"-bias detector.

IF THERÉ has ever been a definite time in the history of radio when a fertile field was wide open for the experimenter, that time is right now, and the field is short wave reception investigation. Just a few years ago, every wave below 200 meters was considered of little or no value. The amateurs were relegated to these bands by the large commercial stations—they investigated and found them to be full of unpredictable surprises. Yet, refinements have been few and far between. The short wave circuits of today, while quite satisfactory for a start, are far from the degree of perfection which we now find in the average broadcast receiver.

In fact, were it not for the extreme efficiency of the short waves in traveling through space, our present circuits could not be used. Think for a moment what we could do on low wave reception with a radio frequency amplifier equivalent to the sensitivity of the broadcast set, having a pick-up of a few microvolts per meter, instead of many hundreds of microvolts per meter. Our best present short wave sets have a regenerative detector and one stage of R.F. (radio frequency) amplification. In many designs this is not even tuned, but consists of an R.F. coupling tube to the antenna. We venture to predict that sooner or later the same design procedure must be followed in the low waves as has been so successfully applied to broadcast receivers.

Why Not Add R.F. Stages?

Well, why not add more R.F. amplification, is no doubt your first question? This is not so easily done, and herein lies the appeal to the pioneering experimenter. Many nuts await the cracking process. If the R.F. stages are to be tuned, the number of coil or condenser combinations runs up into a cost which is prohibitive. So far untuned stages have not proved satisfactory—the gain is not appreciable and the short wave circuits are already quite broad, due to other reasons discussed later.

Let us first view the general aspects of the situation. There has been a lot of mystery thrown about short waves which really doesn't belong there at all; yet there are several things that are quite different from the broadcast phenomena with which most of you are familiar. In this article we will attempt to clarify several of these points of difference, drawing upon mechanical comparisons wherever possible.

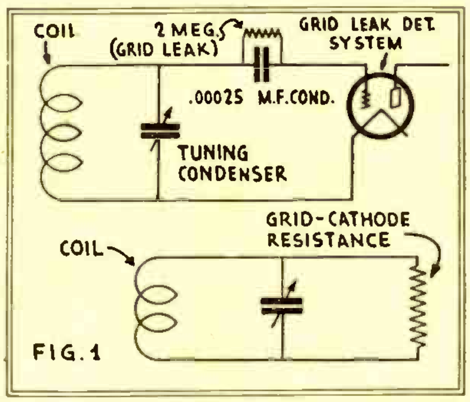

Fig. 1. Fundamental tuning circuit showing grid-leak and grid condenser; also grid-cathode resistance.

Figure 1 shows the standard conventional tuned input circuit for a grid-leak detector system. Such a circuit is in very common use in all broadcast receivers. The size of the tuning coil is chosen so the tuning condenser will enable the operator to tune in all broadcast stations from the low end of the band to the top. The grid leak system functions best with either a slight positive bias on the grid of the detector or no bias at all. The A.C. 227 heater type of tube requires no bias—the grid being returned directly back to the cathode. In either case the grid-cathode circuit acts like a resistance across the tuning circuit, as indicated in the sketch in Figure 1. This is an important point to remember in short wave work. The significance will become more apparent as you study further.

A Study of the Tuning Circuit

Now the next step in our short wave investigation is the consideration of this tuning circuit, and the changes necessary to convert it to the lower waves. First, we must appreciate that there are many combinations of tuning coils and condensers which will give us the desired broadcast station. For instance, it is possible to tune in the particular station under consideration with a very large coil and small condenser, or a small coil and large condenser. Considerable experience with broadcast waves (200 to 550 meters) has resulted in the adoption of a coil of about 250 micro-henries inductance. Such a coil tunes satisfactorily with the average .00035 micro-farad condenser. It is interesting to note that broadcast coils are wound somewhere in the neighborhood of 100 turns, irrespective of their diameter. This is because the smaller the diameter of the coil, which would cut down the inductance, the smaller the wire used, which increases the number of turns per inch—thereby increasing the inductance about the same amount. We are fairly safe if we refer to a broadcast coil having 100 turns.

The coil and condenser combinations just discussed are shown in Figure 2. Both of these circuits can be made to tune to the same wavelength. With this in mind, we can now proceed to the second step in designing our short wave set. Electrical vibrations follow the same general behavior as other more familiar forms. Those of us who have seen the

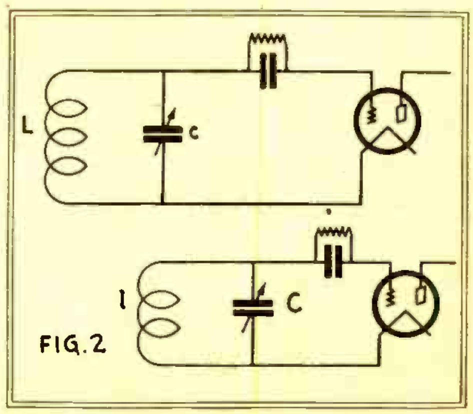

Fig. 2. Another representation of the fundamental tuning circuits which hold true for long and short waves.

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Wave Receivers Broadcast Sets

By DAVID GRIMES

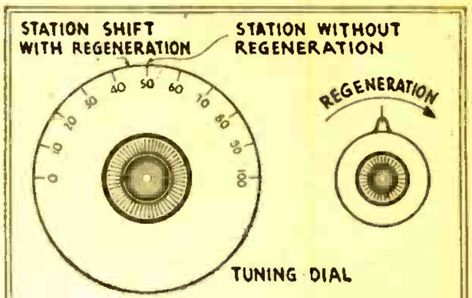

FIG. 5

Fig. 5. This diagram shows how, in tuning a short-wave set, one has to "follow the station" on the tuning condenser dial, as regeneration is changed to strengthen the signal. In other words, the change in the regeneration changes the tuning.

inside of a piano can readily visualize the whole design theory incorporated in radio receivers built for responding to various wavelength bands. The high notes at the upper octaves with their short, tightly strung wires, correspond to our coil and condenser design at the high frequency, short waves. The long, heavy bass wires of course correspond to our broadcast waves, which are of relatively low frequency. And if you are not on the best speaking terms with the piano, just take a glimpse at Figure 3. This shows the huge bass viol compared with the ordinary violin.

Violin and Bass Viol Analogy

The violin is somewhat comparable with the short wave set while the bass viol may be considered as the broadcast receiver. As a matter of fact, the difference in the dimensions of radio sets to cover the short as well as the broadcast range, varies even greater than the illustration above, as the number of electrical octaves is greater than the musical octaves covered with the violins. There are only about two musical octaves difference between the violin and the bass viol, while there are in our electrical range—well let's just count them up. Starting at 200 meters, the broadcast octave runs up to 550 meters. As a matter of fact this is about an octave and a half but it

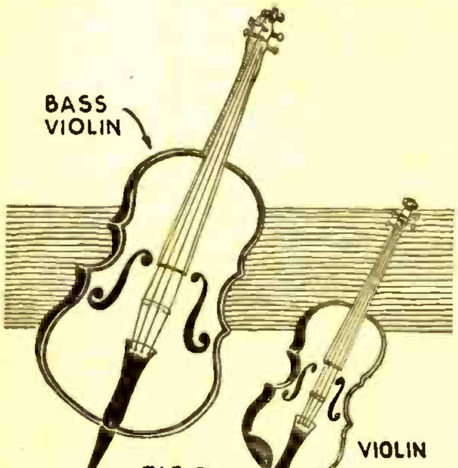

FIG. 3

Fig. 3. The bass viol and the violin produce musical vibrations or notes which bear a close analogy to the vibrations or oscillations set up in a radio circuit, as Mr. Grimes explains.

is referred to as the broadcast octave; so to simplify matters we will refer to it as such. Then we drop down to the next range from 100 to 225 meters. This is one octave lower in the radio scales. Then we have the next lower step from 50 to 110 meters. A total of three octaves has already been encountered and we are only down to 50 meters. Another jump takes us down to 25 meters, and still another down to 12.5 meters. Thus it is obviously necessary for the flexible radio receiver to accommodate itself to a measly five octaves—a considerably greater feat of acrobatic contortion than remolding a violin into the bass viol.

In the case of the piano there is a different string for every note desired. On the low frequency bass notes (cor-

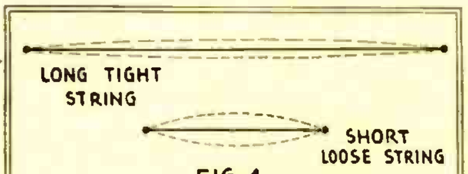

FIG. 4

Fig. 4. This diagram shows how musical vibrations are set up by a long, tight string, on the piano for example, while a short, loose string does not give what we would call musical vibrations, but will merely flop about without really vibrating.

responding to the broadcast frequencies in our mechanical analogy) the tuning is obtained by long, loosely strung wires; while on the highest notes the resonance is secured by short, tightly strung wires. The different length wires are similar to the different size coils in our radio circuits, and the extent to which they are tightened is illustrative of the amount of capacity we have connected across the coils. A different length wire with a predetermined amount of tension is used for every note in the piano. In other words, a separate tuned circuit is employed for every resonant frequency used. This would make a very complex radio set, just as it makes a somewhat cumbersome musical instrument.

The violin type of instrument should next be considered. Just a glance is sufficient to show that only four wires are employed—in other words, there are but four tuned circuits in this well known string instrument. When the player wishes intermediate frequencies he merely presses his finger down on one of the wires to shorten its length. This is equivalent to tapping it—he has only done what we would do in our broadcast receiver if we had a series of taps on our tuning coils. Many of the early wireless telegraph sets which were designed to cover several octaves on the still longer ranges were built with a series of taps on the tuning coil.

It is important to note in the case of both of these instruments the tension of the wires has been left alone. Then in the instance of the piano, various frequencies were played by different wires or "tuned circuits." In the case of the violin the complete range of desired tones was obtained by only four strings whose tensions are not changes, but whose lengths are variable by "tapping." It should be apparent that the tapping system makes the violin a much more simple instrument in construction than the piano. But in our principle of radio tuning we have gone to a more simple system than the violin. We employ only a single string for a given octave and then proceed to obtain all the intermediate frequencies through a change in tension—accomplished electrically by the tuning condenser. It is just as if we had a one string violin whose tones were changed by twisting the tuning key at the top of the finger board; that is one string for each octave of tuning. Such an instrument would require as many strings as the octaves of tuning desired. This rather rambling but simple comparison should show that a radio set designed to cover the five radio octaves from broadcasting down to the 12 meter band, mentioned above, should have at least five sets of tuning coils—one for each octave.

Why Not a Single Tuning Coil for All Wavelengths?

You might very naturally ask why more than this approximate octave cannot be covered by the one tuning coil, and thus simplify the operation of the set by cutting down the number of coils at least. Well there are certain very definite limits to the amount that a string can be tightened and loosened and still give music. By adhering to our comparison with the musical instruments, it should be obvious that if too high a note is attempted by tightening the string, there will be a limit beyond which the string will break. Similarly, if too low a note is attempted, the string will have to be loosened to such an extent that it will lose all its tension and will merely

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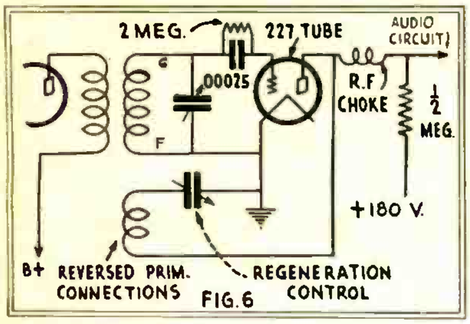

Hook-up for short-wave reception, showing variable condenser as a regeneration control, reversed primary connections at tickler, RF choke, and grid-leak detector set-up.

"flop" without vibrating. While we do not have these same limitations in the electrical tuning, we have others that prevent us covering too high or too low a range on any given single tuning coil. About one octave has been found to be the most practical for reasons which will here be given.

The description so far should fit us now for the next step. We are ready to start with the standard regenerative set for broadcast frequencies, and remodel it for operation on successively higher octaves of frequencies. By reference to the musical instruments, and to the electrical viewpoint of tuning displayed in Figure 2, we naturally wonder whether we should attempt to cover the octaves by several strings, or coils, with only one tension device (the tuning condenser) or whether we should try to cover the entire five octaves with only one coil and the single tension arrangement. A clue to this has been given above, but the substantiating facts are herewith given in Tables A, B, and C.

TABLE A

Wave Length Is Proportional to $2\pi\sqrt{LC}$

Wavelength Ranges	Tuning Inductance
200 to 550 meters	250 Micro-Henries
100 to 225 meters	62.5 Micro-Henries
50 to 110 meters	15.6 Micro-Henries
25 to 55 meters	3.9 Micro-Henries
12.5 to 28 meters	0.9 Micro-Henries

Same Tuning Condenser Throughout.

TABLE B

Wave Length Is Proportional to $2\pi\sqrt{LC}$

Inductance Proportional to Square of Turns.

Wavelength Range	Tuning Coil Turns
200-550 meters	100 Turns
100-225 meters	40 Turns
50-110 meters	18 Turns
25- 55 meters	8 Turns
12.5-28 meters	4 Turns

Same Tuning Condenser Throughout.

TABLE C

Wave Length Is Proportional to $2\pi\sqrt{LC}$

Wavelength Range	Capacity of Tuning Condenser
200-550 meters	.000350 micro-farads
100-225 meters	.000090 micro-farads
50-110 meters	.000022 micro-farads
25- 55 meters	.0000055 micro-farads
12.5-28 meters	.0000028 micro-farads

Same Tuning Coil Throughout.

How Condenser Capacity Varies With Wavelength

Table C shows what will happen if we attempt to cover the five electrical octaves between the 12 meter range and the broadcasting scale with one tuning coil only. We start off with the standard tuning condenser of .00035 mf. capacity. This is somewhere near the average 23 plate condenser. As you all know this tunes the broadcast octave very nicely. Dropping down one scale in wavelength, or up an octave in frequency, brings us to the band between 100 and 225 meters. For this range we must have only one-fourth the size of tuning condenser which we employed in the 200-550 meter scale. And while we continually try to avoid the use of mathematics in these radio articles, there are certain fundamental formulas which one should know. One of these mathematical relationships is that the wavelength of a tuned circuit is proportional to the square root of the product of the inductance of the coil and the capacity of the condenser. This is shown at the head of Table C. It can be seen from this that to reduce the tuning of a circuit to one-half its wavelength, it is necessary to divide the inductance by four, or the capacity by four, or both of them by two. What to do! But let's proceed.

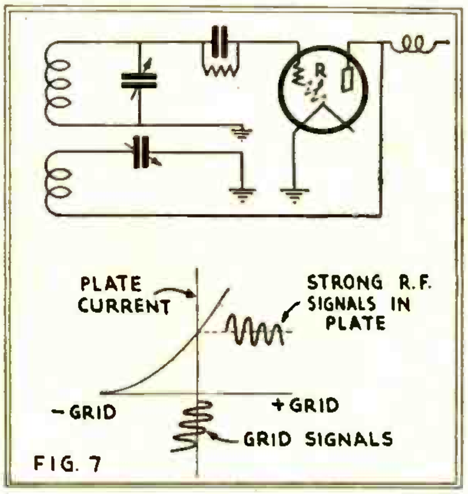

Fig. 7. Hook-up and graphic curve showing why grid-leak detector is preferred for short-wave reception; strong RF signals are manifested in the plate circuit when this circuit is used.

By leaving the coil alone and dividing the tuning condenser by four, we find we require a 90 micro-micro-farad condenser (1 micro-micro-farad is 1-1,000,000 of a micro-farad or 10^{-12} farad) instead of the usual 350 micro-micro-farad. This is not so unreasonable, even though this means a variable condenser having only five plates instead of the 23 plates in the broadcast range. But going on down the wavelength scale still further soon brings us to our senses. Suppose we take the 50-110 meter band. By previous definition, the tuning condenser must be cut once again to one-fourth its value, bringing it down to about 22 micro-micro-farads.

Such a tuning condenser would have barely two plates and would be only a little over twice the capacity of the vacuum tube across which it is connected. A tuning scheme of this nature becomes completely out of order on the next lower band. The 22 micro-micro-farads by virtue of the one-fourth cut to reach the 25-55 meter octave, becomes only a little over five micro-micro-farads—smaller than a neutralizing condenser and only one-half the inter-electrode capacity of the average vacuum tube. Of course following this same system, gives a mere 2 micro-micro-farads for the 12 meter scale. The condenser system is out of the question.

Changing Coil Turns With Same Condenser

Table A shows what may be expected with a system which employs a change of coils for each scale and uses the standard broadcast condenser for tuning all the way down to the 12 meter limit. Referring once more to the tuning formula, it is found that the inductance must be cut by one-fourth each time the wavelength is reduced by two—providing the tuning condenser remains the same value without reduction. The regular broadcast coil is approximately 250 micro-henries. Then proceeding by our one-fourth system, the value for the 100-225 meter range would be about 62 micro-henries. The 50-110 meter octave would call for a coil of only 15.6 micro-henries, while the 25-55 meter range requires a 3.9 value with just a mere 0.9 micro-henries for the bottom scale reaching down to 12 meters.

These values of inductances sound terribly small but they are practically quite possible. Let us look at these values from the standpoint of coil turns. Table B should be consulted here. If it is assumed that the broadcast coil is built with 100 turns, we can advance down the line with a fair amount of assurance that our approximations will be accurate within commercial limitations. Since the inductance values have to go down by one-fourth ratios for every octave, and

(*Continued on page 86*)

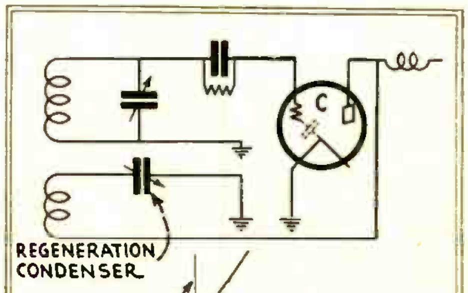

Fig. 8. This shows graphically and also in diagram why the "C"-bias detector is undesirable for short-wave reception; the tube here operates on the bottom of the plate current curve, with resultant weak RF signals in the plate circuit.

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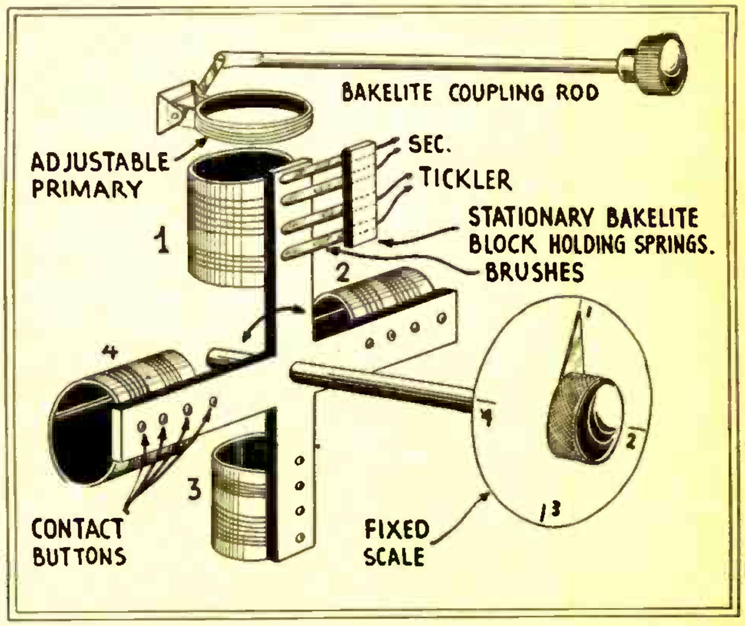
The Short Wave Experimenter

Changing Short Wave Coils With a Dial

How to switch Plug-in-Coils with a twist of the wrist—a great time and energy saver.

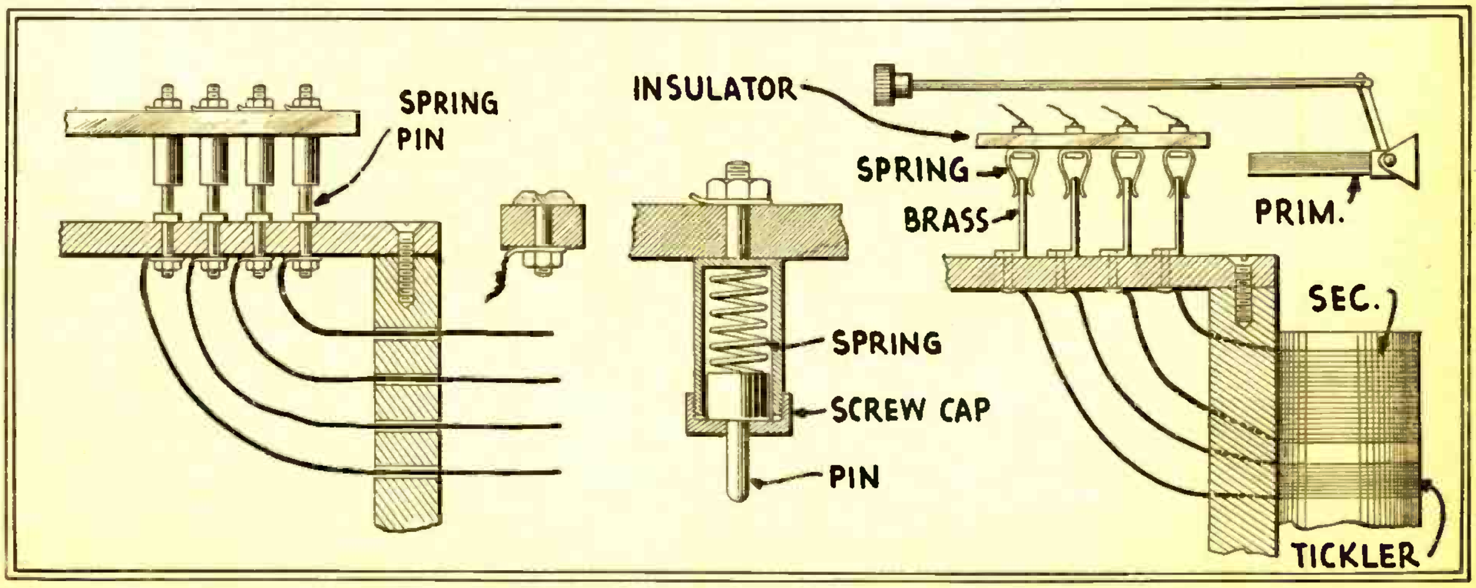


Simple yet effective design of short-wave inductance change-over switch. This gear switches the coils in and out of circuit without dead-end losses.

WE moderns, with all of our much vaunted pep and progressiveness, are nevertheless at times quite lazy. To obviate the necessity of opening a cabinet, which is sometimes necessary to remove plug-in coils and plug other coils in the sockets, the accompanying design of quick-changing switch for short wave coils is suggested.

There are many variations of this arrangement, of course, and more crossarms can be used in the event that more than four coils are to be switched into and out of circuit. Most everyone knows that the reason why we use plug-in coils for short-wave circuits is because tapped coils or coils with sliders leave a lot of inductance in a circuit, which due to its electrical capacity and also a certain inductive (reactive) effect of the turns left connected, through unipolar current conduction, the circuit causes a broadness of tuning and other undesirable features. In other words, the plug-in coils make a clean-cut job of changing the set from one band of frequencies to another. For that reason we must keep in mind in building the switch mechanism here illustrated, that the cross arms should not be less than ten to twelve inches long at least, although good results will be obtained with even shorter cross arms on which the coils are mounted. In other words, it will be seen that when the dial and shaft with its attached spider are rotated, the coils not in use are fairly well separated by a goodly air gap from the electrical field of the coil in actual use at a given moment.

There are any number of designs of switching mechanism which may be employed, and several suggestions are shown in the illustrations for good positive contact switches.—*Contrib. by H. W. Secor*



This drawing shows two ways of making the switch contacts for the coil change gear here described. Spring propelled pin contacts are shown at the left and knife-switch style contacts at right.

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Short Waves in Medicine

By DR. ERWIN SCHLIEPHAKE
(*University of Jena, Germany*)

Dr. Schliephake gives us an interesting discussion on the latest applications of short waves to the human body for the treatment of various ailments. The author carried on a large number of experiments, the important results of which he gives in this article. Some of these experiments were made with three-meter waves.

THE development of the electrical high frequency field has introduced a new medical application of extremely high frequency electrical oscillations. The body to be treated does not need to be in contact with any electrodes, as is the case with the process customary hitherto. The effect can be given in any desired amounts, especially by the use of the Esau oscillation circuit. Above all, it strikes the deep-seated inner organs, just as strongly, and with proper arrangement even more strongly, than the surface, and under certain conditions can produce considerable changes. Furthermore, every sensitive object in the reach of the field is exposed to the effect. In contradistinction to the diathermal current, which localizes in the organs of least resistance and thereby is often directed away from other organs, the electric field is to a great extent free from such factors as, for example, the different organic resistances of the individual organs.

A short discussion of the high frequency apparatus hitherto customary in medicine will make these differences clear. The most usual modes of application are *diathermy* and the so-called *high frequency* treatment by the Arsonval system.

While in diathermy relatively low tensions are used, with current strengths up to two or three amperes, the high frequency therapy works with higher voltage and lower current strengths. With both processes the oscillations are produced principally by the spark gap method.

The outstanding effect is the warming of the parts of the body in question, as is indicated in the case of diathermy, by its name. In it, corresponding to the great amounts of current used to operate the apparatus, the amount of heat produced in the body is relatively great. As to the conduction of energy I shall say more later.

With the much smaller and simpler high frequency medical apparatus the effect of the current is of course much less, but with application of the electrodes in opposite pairs, as has been recently done for treating the throat, a powerful local effect can nevertheless be obtained.

The frequency used in all apparatus thus far is of the order of one million cycles, corresponding therefore to a wavelength of about 300 meters. Besides the fundamental vibration there are always extra vibrations of higher frequency. In the modern diathermal apparatus of exact working they play hardly any part, however. Still, in the field of radiation of many apparatus of the d'Arsonval type, with proper arrangement of the electrodes, waves can be dem-

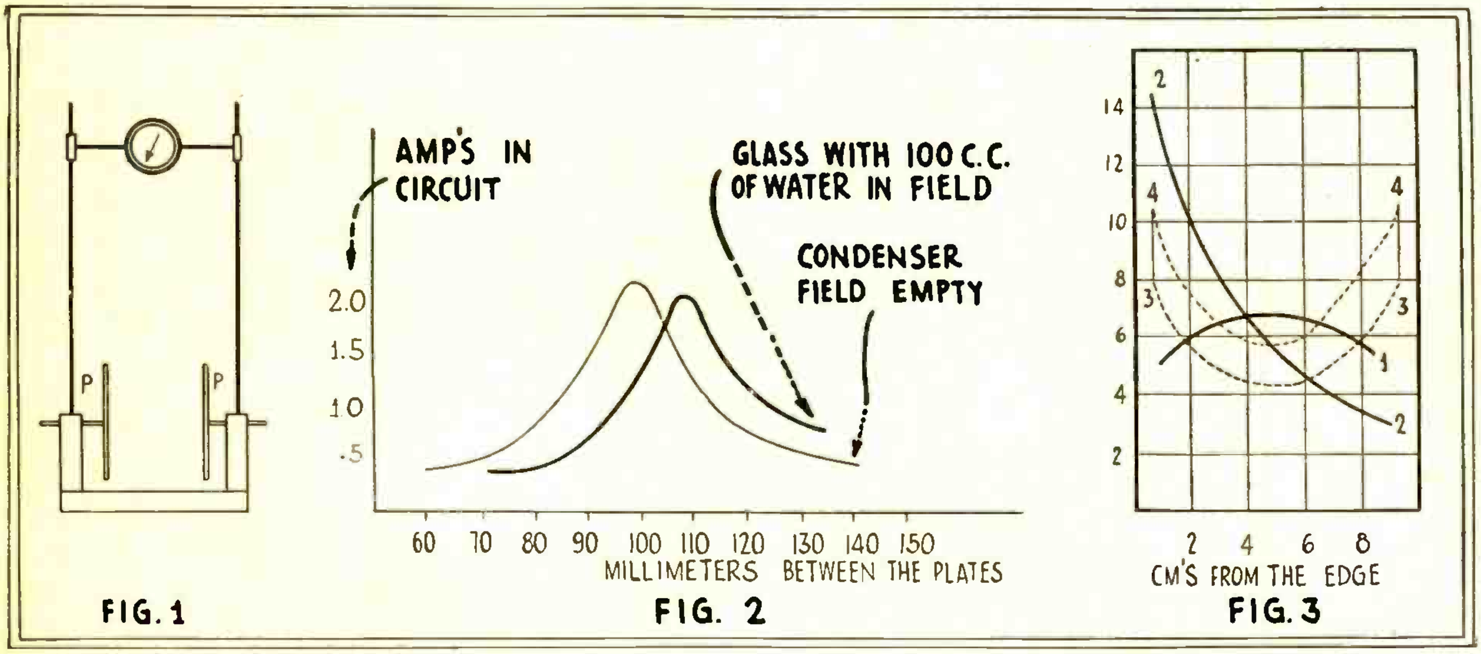

Fig. 1 shows Esau's short wave tuning arrangement for experiments on animal organisms, P representing the condenser plates. Fig. 2 shows change of resonance curve caused by changing the dielectric placed between the plates PP. Fig. 3 shows the division of the heat in a model (bread) placed between the condenser plates; curve 1, the plates placed 2 centimeters from the side surfaces; 2, the left plate brought into contact; 3, diathermy (contact on both sides); 4, same as 3, calculating the warmth which flowed away during the experiment.

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onstrated (by the Lecher system) down to as low as about 40 meters in length, though to be sure with decreasingly small energy.

It is possible that the quieting effect upon pains of the nerves, which is often claimed in treatment with such apparatus, depends a specific effect of especially high frequencies upon the nervous system, as I have also observed with the short wave transmitter. This assumption is supported by the observation of Müller and Stiebock, who described the quieting effect of very high frequency vibrations of low energy in the case of neuralgia. These investigators produced oscillations by using apparatus with tubes, thus making possible changes of frequency within wide limits. Here, too, only a little current is actually used, being conducted to the body by contact electrodes, as in the processes previously customary.

The production of very high frequency vibrations and thereby of ultra-short waves of one kilowatt power, was only made possible by the hook-ups devised by Esau. The hook-up uses only the inner capacity of the tubes and the inner back-coupling, brought to the most favorable values by proper tuning of the anode chokes.

Influencing organisms and other organic objects by such a transmitter can be arranged in several ways: first, by free radiation from antennas; second, by the electromagnetic field prevailing within coils, and, third, by the electric field between the plates of a condenser.

Electrostatic Treatment

Since the last method has proved to be the most serviceable, let us discuss it first.

The strong effect upon the internal organs, such as we can now attain, has only been made possible through the use of closed oscillation circuits, in the Esau arrangement (Fig. 1). Like all oscillation circuits they have self-inductance and capacity. They can be tuned to a definite wave by change of these two values.

The variable self-inductance consists of a wire circuit, the upper horizontal part of which may be moved on the side parts, causing a change of the effective wire lengths. The capacity is produced by the two plates P, which are likewise adjustable (toward each other). In this way the secondary circuit is tuned to the sender. If now the object is placed between the two plates, it forms a part of the dielectric of the condenser. The capacity, which depends not only on the size and distance apart of the plates, but also on the dielectric constant, is strongly changed by the object inserted, as may be noted from the reduction of the current as shown by the ammeter. To obtain resonance again, tuning must be done by lessening the self-inductance or by moving the plates farther apart.

The resonance curve of the secondary oscillating circuit is not merely changed in position by the dielectric, but is also considerably flattened in form. (See Fig. 2.) That is the result of the increased damping in the circuit, which likewise depends on the nature of the dielectric. Various substances in the condenser field have very definite and characteristic damping curves.

To obtain good results it is also important to have the right coupling of the secondary circuit with the transmitter. On bringing the circuit closer, from a considerable distance, the current at first increases, only to decrease again, when a certain point is passed. The critical coupling is at this point; if it is passed, the back-effect of the secondary circuit upon

(*Continued on page* 88)

In Our Next Issue !

HOW the Byrd broadcast was carried out between Australia and America. The technical details of the short wave system, illustrated with photographs and diagrams, by H. Winfield Secor.

TELEVISION on the short waves — latest developments in television transmission and reception on high frequencies, with details of the apparatus used at the transmitting station, as well as at the receiver.

ANOTHER idea in short wave receivers for amateurs, by F. H. Schnell, famous short wave investigator. Article illustrated with photographs and diagrams.

ULTRA-SHORT waves speed plant growth, by Dr. Albert Neuburger.

EXPERIMENTING with short wave regenerative receiving circuits, by Clyde A. Randon.

AERIALS for short wave receivers. Various shapes and sizes of short wave receiving antennae and the action of the short waves on these antennae.

THEORY and construction of audio amplifiers, for both short wave code and broadcast reception, by A. R. Haidell.

PROFITS in short waves for the set builder—how to cultivate short wave trade in your locality, by Robert Hertzberg.

NEW observations in the short wave field, by Dr. Ernst Busse, of the Technical-Physical Institute, Jena, Germany.

A SIMPLE 5-meter transmitter, by E. T. Somerset, G2DT (England). Five meter transmission is being carried on by the author on a regular daily schedule, in an attempt to bridge the Atlantic Ocean.

THE next issue of SHORT WAVE CRAFT will contain numerous articles on all sorts of short wave transmitters and receivers, designed to operate on various wave lengths, including sets intended for radiophone as well as code operation.

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A New Magnifying Tuner for Short Wave Reception

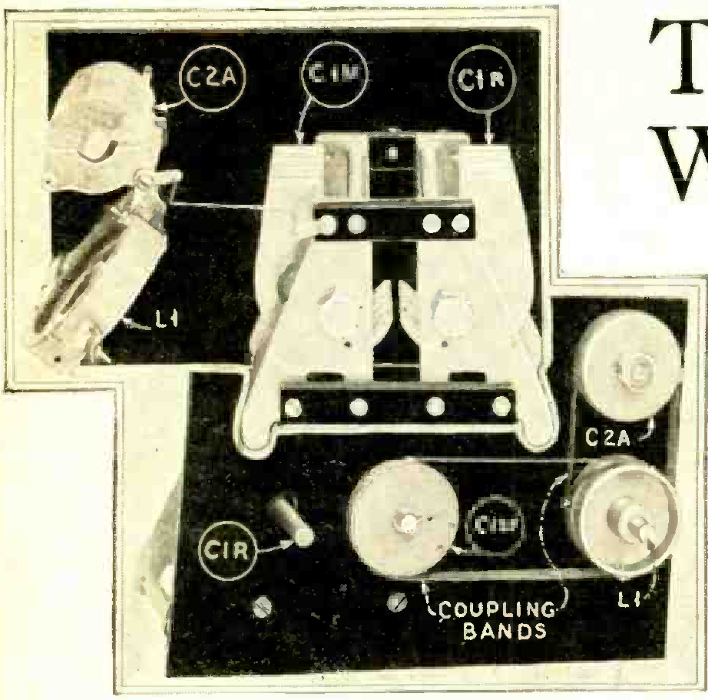

Fig. A (below)
Fig. B (above)
These two views show: below, the front of the new "Automatic Tuner," whose circuit is Fig. 2C; and, above, the components operated by the two controls, as they appear in the position of minimum setting (compare Fig. C) corresponding to a wavelength of from 15.25 up, as determined by the circuit and tube used.

SHARP tuning and plug-in coils have always been the two bugbears of short-wave reception and especially was this true for the average "broadcast listener" who had been used to fairly comfortable tuning, so far as broadness on the dial was concerned. This new and revolutionary short-wave receiver acts as a tuning magnifier. It also tunes from 15 to 100 meters, without the bother of changing plug-in coils, an extraordinary accomplishment in itself.

AUTOMATIC waveband shifting, obtained by the ingenious system of variable inductance and capacity units illustrated here, makes it possible to cover a tuning range up to five times the lowest frequency. This invention marks another milestone in the development of short-wave radio to the stage where it will be convenient for the public as long-wave broadcast tuning, and consequently of universal commercial value.

By the combination of variometer and dual condenser shown, which was worked out by W. H. Hoffman and D. H. Mix, and has now become available to the experimenter, it is possible to obtain an enormous tuning range by the use of two dials, entirely without the changing of coils which has hitherto been necessary and, with completely-shielded receivers, highly inconvenient.

The first, or "shift-frequency" dial, rotates the shaft designated as L1 in the front view (Fig. A) and operates, as will be seen, one set of plates (C1SF Fig. B) in the peculiar double-rotor condenser which is prominent in all rear views of the unit. By its motions, synchronized

THE DAWN OF A NEW SHORT-WAVE ERA

WE are happy to present to our readers one of the greatest (if not the greatest) recent developments in the evolution of short-wave receivers.

Heretofore short-waves were a sealed book to the public, because of the inability of the average man to tune a short-wave set. It took an expert to tune such a set successfully, and even he would frequently pass over many stations.

Imagine the following:

Take a wide rubber band and place across it a number of fine lines very close to each other—so close in fact that your eye can no longer separate them. This corresponds to the tuning dials of short-wave sets before the advent of this new tuner.

Now take the same rubber band and stretch it to about ten times its original length. Immediately, the former lines which ran into each other become widely separated and can easily be distinguished. A corresponding separation of stations is the accomplishment of the new short-wave receiver presented in this article.

It becomes now possible for anyone to tune-in on the short waves, just as easily as he tunes-in on his broadcast set.

No more passing over stations because the tuning, unbelievable as it seems, is so broad on one of the dials that it is well-nigh impossible to go over any station that comes in with any amount of audibility.

Nor is this all:

The second and greatest objection to short-wave receiving, at the present time, is the plug-in coil bugaboo. Heretofore, the average short-wave set has required at least four such coils to take in a range from 16 to 200 meters.

With the new receiver this is a thing of the past. In the new tuning unit described here, no plug-in coils whatsoever are used, yet the range of the set can be made from 16 to 200 meters.

It is certain that this evolutionary accomplishment will make it possible to interest the public at large in short-waves, just as broadcasting in 1921 created a wave of immediate popular enthusiasm.

No doubt, as time goes on, the present system will be improved, until it will take in all short waves from 3 meters up; and in years to come we will have a single-dial short-wave set of this range as well.

But the important point is that radio has taken a big leap forward, once more, and the seemingly impossible has been accomplished.

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with those of the rotors of the coil L1 and the condenser C2A, the desired wave band in which the receiver is to operate is selected.

The second dial, rotating shaft C1R, governs the other set of rotors of the large condenser; and thereby selects stations in the waveband to which the set is adjusted by the first dial. The shift-frequency dial, therefore, does not require continual adjustment; it produces an electrical change equivalent to that obtained, say, by moving a "fan" switch over a bank of condensers. The tuning range thus may be extended, for instance, from a minimum of 20 meters (15,000 kc.) to a maximum wavelength of 100 meters (3,000 kc.). By flipping a switch a built-in, fixed two-inductance coil of greater dimensions may be connected into circuit and higher wavelengths up to 200 meters may be then tuned in; a larger inductance unit would raise this maximum still more.

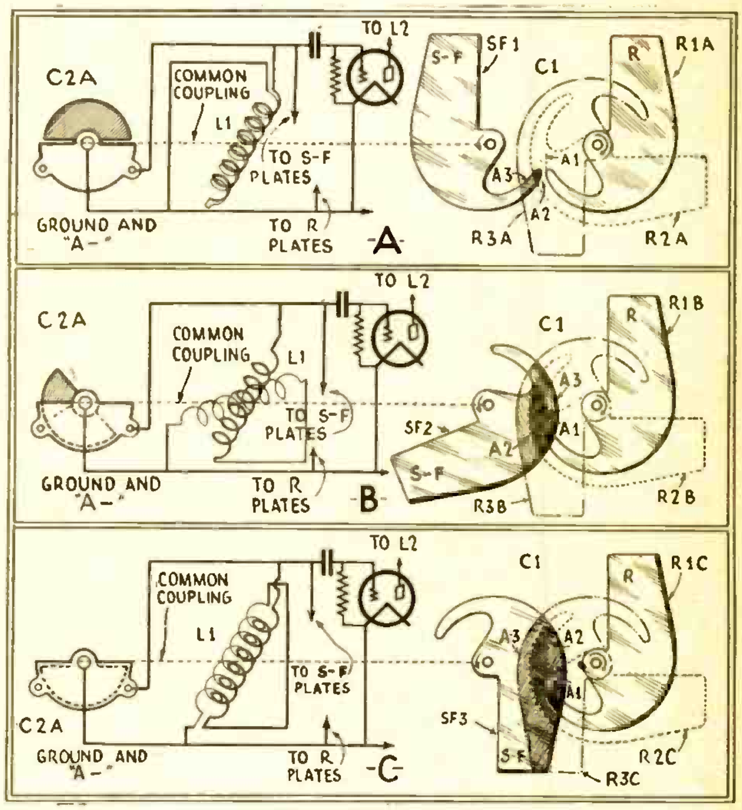
New Condenser Design

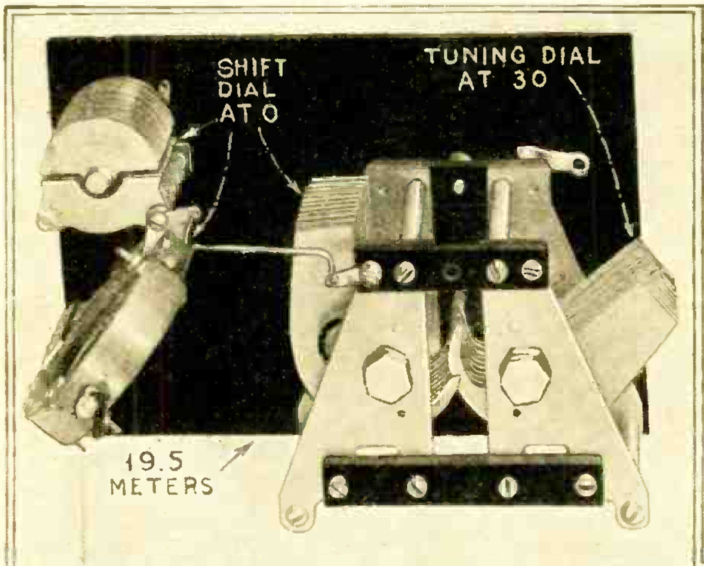
This extraordinary range is obtained by the fact that the variable

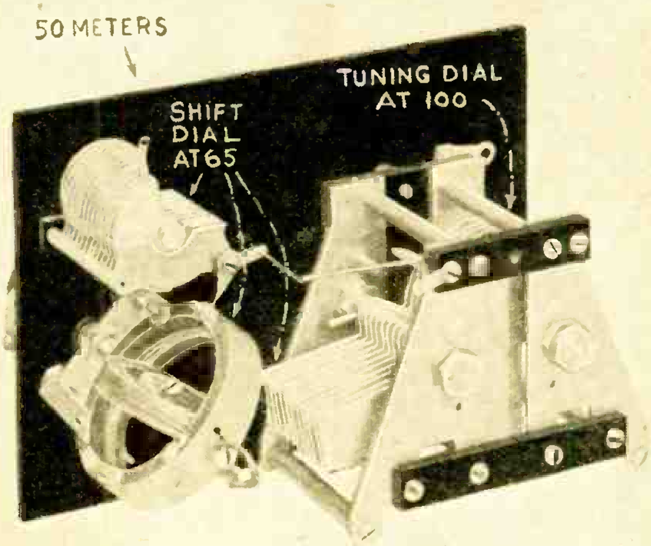
In Fig. 1, at the right, we see represented the effects of the dial settings pictured below. Fig. C (upper left) corresponds to Fig. 1A; the inductance and capacity controlled by the "shift-frequency" dial are at a minimum; consequently, the very small capacity change permitted by the tuning dial gives a sufficiently wide station channel. (The plates of the tuning rotor are between positions R1A and R2A.)

In Fig. D, as shown also by Fig. 1B, at the middle of "shift" dials range, the tuning dial also effects a correspondingly great capacity variation, with a frequency-band no wider. (Position R3B.)

In Fig. E the "shift" dial is at maximum, and, since the tuning dial is also at a 100, we have the top of the wavelength range. (This is position R3C in Fig. 1C.)







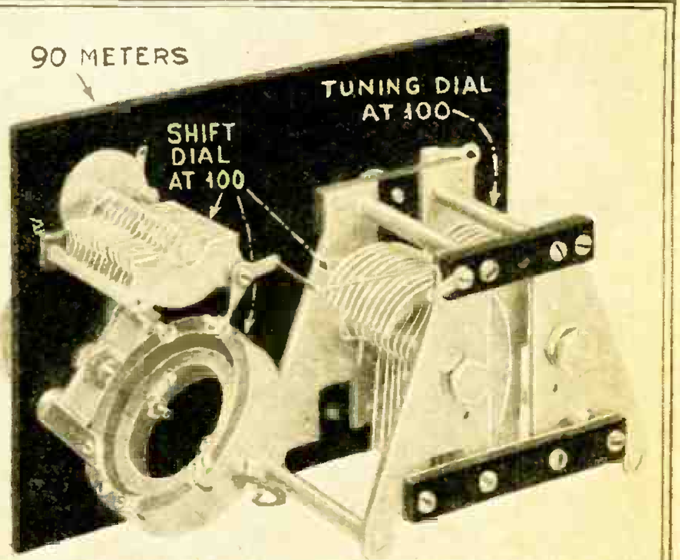


Fig. C (upper left) Fig. D (lower left) Fig. E (lower right)

The upper tuning condenser, the variometer rotor, and one set of plates of the large condenser are turned together by the shift dial, and left at any setting which the operator desires. This determines the band, say 1500 kilocycles wide, which the tuning dial covers over its full scale. The actual minimum and maximum, and consequently the calibration of the receiver (see Fig. 3, page 40), are determined by the hookup and the characteristics of the tube used. (*Photos courtesy Aero Products, Inc.*)

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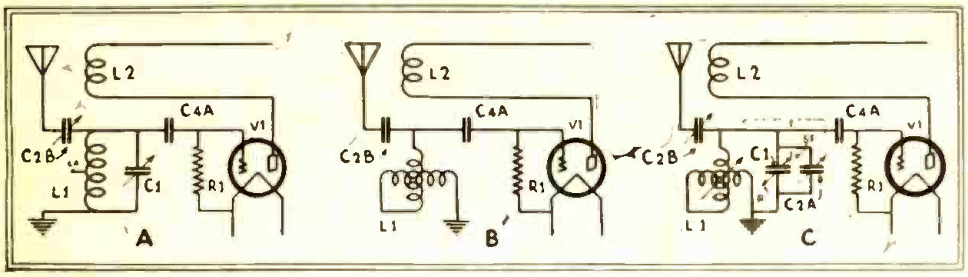


The first two diagrams show the usual variable-condenser tuning method, and the variometer much used in long-wave sets in the old days. By combining the two, we arrive at the finely-adjustable system indicated at C (Fig. 2).

inductance of the input circuit (the "variometer" shown as L1) is shunted across a variable capacity obtained from two condensers, one of which has an extremely low minimum value because of its unusual design. While one condenser (C1A) is of ordinary low-capacity type, the other has no stators, but two sets of rotors, operated by different dials, and separated completely by a considerable distance when unmeshed. Their position of minimum capacity is shown in Fig. B; Figs. C and D and Fig. 1 at A. B and C illustrate increased degrees of meshing at different adjustments, until a maximum is seen in Fig. E. Here the plates mesh to the extent of the largest shaded area in Fig. 1C.

By reference to Fig. A, it will be seen that a system of belts, such as are used in well-known makes of single-dial broadcast receivers, enables the right-hand dial (which we will call the "shift-frequency dial") to turn, not only the movable plates C1SF of the double condenser, to the shaft of which it is directly attached, but also the rotors of the variometer L1 and the standard 135-mmf. variable condenser C2A. The left-hand dial, on the other hand, turns only the set of plates C1R, and thereby, in effect, produces a vernier effect over the widened frequency-range. This dial, therefore, we shall call the "station selector."

Now that the somewhat intricate mechanical arrangement of this tuning unit has been considered, and found to be a combination of old and new elements to produce a system that is quite new, we may consider the electrical actions brought about by their interaction under their dual controls.

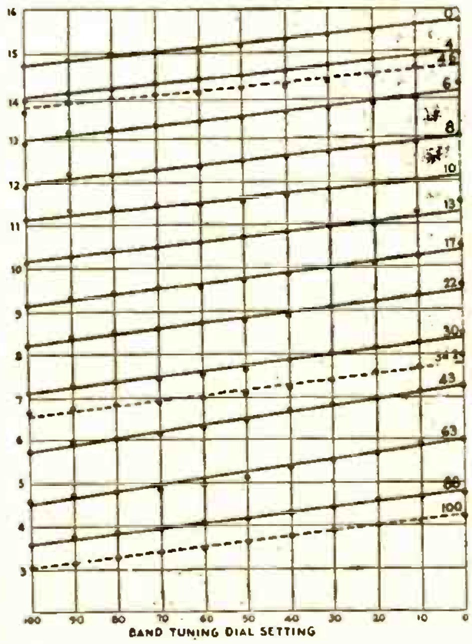
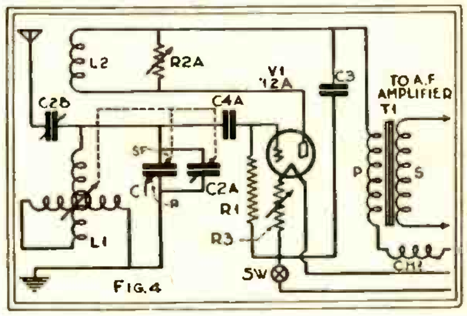


Fig. 3

This log shows how completely the short-wave bands may be covered. Each heavy sloping line represents the tuning range obtained with the "station selector" at one setting of the "shift-frequency" dial, the latter may be set, however, to give any intermediate range. (From QST.)

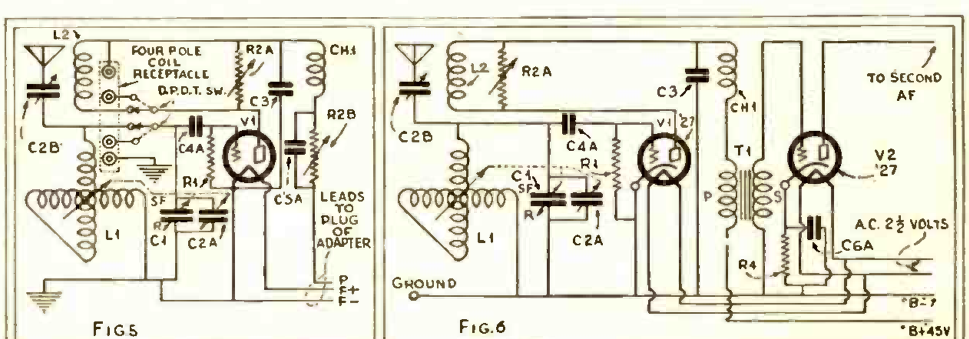
A Fundamental Circuit

Before we come to the application of the unit, let us consider a typical regenerative circuit, such as that shown at A in Fig. 2. Coils L1 and L2, of fixed inductance, may constitute the tuned "secondary" (grid) and the tickler (plate) windings and, in short-wave sets, are usually wound on one plug-in form. C1 is the standard variable tuning condenser, of any convenient design and capacity. In most short-wave receivers an aerial coupling condenser, C2B, is required to prevent direct con-



In this diagram, the simplest method of connecting the Automatic Tuner unit for short-wave reception; the details of the audio amplifier are purely optional.

ductive connection of the aerial with L1; for the latter would introduce a high damping effect, and cause erratic tuning and regeneration. Often this condenser (C2B) is connected to a tap on the tuned coil (as at LA) when a particularly long aerial is being used; its capacity is best determined by trial. For short-wave work a variable of 135-mmf. maximum capacity may generally be recommended. For short-wave reception, the grid condenser C4 may have a capacity of .00015-mf. or 150 mmf.; the grid leak, for this work, has usually a resistance between the values of 3 and 10 megohms. Whether the grid leak should return to the positive or negative side of the filament circuit depends upon the characteris-



At the left, the circuit of an adapter constructed with the "Automatic Tuner," for use with the audio channel of a broadcast receiver. A plug-in receptacle is provided for a 100-200 meter coil, switched in when desired. At right, a short-wave receiver, using the same tuner, with one or two A.F. stages as desired.

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tics of the tube V1, used as a detector. All simple short-wave receivers follow the general lines of this fundamental design.

Yet it is possible to tune-in different stations without resort to a variable condenser. Tuning-in is changing the resonance-peak, or fundamental frequency of the circuit, to correspond with that of the received wave. The formula for determining a circuit's frequency shows that this is inversely proportional to the square root of the product of the capacity by the inductance. In other words, whether we vary the inductance or the capacity, we affect equally the frequency and wavelength of the circuit. Therefore, in place of a variable condenser, a *variometer* may be used.

To explain this instrument, it may be said that when two coils, connected in series, are placed in such inductive relation that their magnetic fields act in the same direction, they "aid" each other, and the inductance of the combination is at a maximum. By changing their relation to each other, the fields are made to "oppose" or "buck"; and the inductance will be then at a minimum. The variometer is commonly made by rotating one winding within—and very close to—the other; and was a familiar device in the early days of radio.

A circuit arrangement whereby tuning is accomplished by substituting a variometer L1 in place of the L1-C1 combination, is given in Fig. 2 at B; the wavelength range remains the same.

The "Automatic" Tuner

Now, let us add a variable condenser across the variometer L1; in fact, let's add *two* variable condensers in shunt with this inductance. We thus rearrange the circuit as at C in Fig. 2. Two variable condensers (C1 and C2A) are used to obtain the desired tuning range in the most satisfactory manner, for a reason to be explained below.

SWAPPERS

SWAPPERS are swappers of correspondence. During the past few years we have noted that Short-Wave enthusiasts love to get acquainted with each other by mail, in order to swap experiences.

That's the reason we will open a department for them under the above heading in which we will print the names and addresses of all those who wish to correspond with others. As we know we will be deluged with requests, please be sure to follow these simple rules: Use a postcard only. Never write a letter. Address postcard as follows:

SWAPPERS
c/o SHORT WAVE CRAFT
96-98 PARK PLACE,
NEW YORK, N. Y.

On the blank side of the postal PRINT clearly your name, address, city and State. Don't write anything else on card. We will then understand that this is your request to publish your name and address and that you wish to enter into correspondence with other short-wave readers. There is no charge for this service.

—EDITOR.

In Fig. 2, at B and C, regeneration is obtained through the use of L2, a feed-back or tickler winding placed over the stator-coil of the variometer, L1. In the tuning unit pictured, the stator tube of the variometer, 1⅞ in. in diameter, is wound with 4¾ turns of No. 24 D.S.C. wire, and the rotor, 1 11/16 in. in diameter, with 4½ turns of the same wire. The tickler inductance consists of 5 turns of No. 28 D.S.C. wire.

(It is convenient to indicate here the new design for condenser C1, with its no-stator and two-rotor construction, by two arrowheads instead of only one.

The dotted lines at C (Fig. 2) show that variometer L1, the "shift-frequency" or SF half of the variable condenser C1, and the 135-mmf. variable condenser C2A are ganged together and operated by one dial; while the other dial controls the other rotor section R of C1, for station selection.

Turning the master dial (controlling C1SF, L1, and C2A) determines where, in the range between approximately 15 meters and 100 meters, stations may be tuned in. A wavelength frequency table for the tuning components described above is given herewith.

On a panel about 8½ in. x 5 in., an "Automatic Tuner" may be built comprising only L1, C1 and C2A, to tune approximately as follows (the degrees indicated the settings of the shift dial):

S. D. Degrees	*Wavelength Meters*	*Frequency Kilocycles*
0	15.25— 16.2	19672—18519
3	15.7 — 17.0	19048—17647
5	16.5 — 18.5	18182—16216
7	17.6 — 19.9	17045—15075
9	19.1 — 22.6	15707—13274
13	21.9 — 25.7	13699—11673
18	25 — 29.5	12000—10169
24	28.25— 34.1	10619—8800
32	32.9 — 40.5	9120—7407
45	39.4 -- 50.5	7610—5941
65	48.7 — 65.	6160—4615
85	59.3 — 79.	5059—3797
100	69.7 —100	4304—3000

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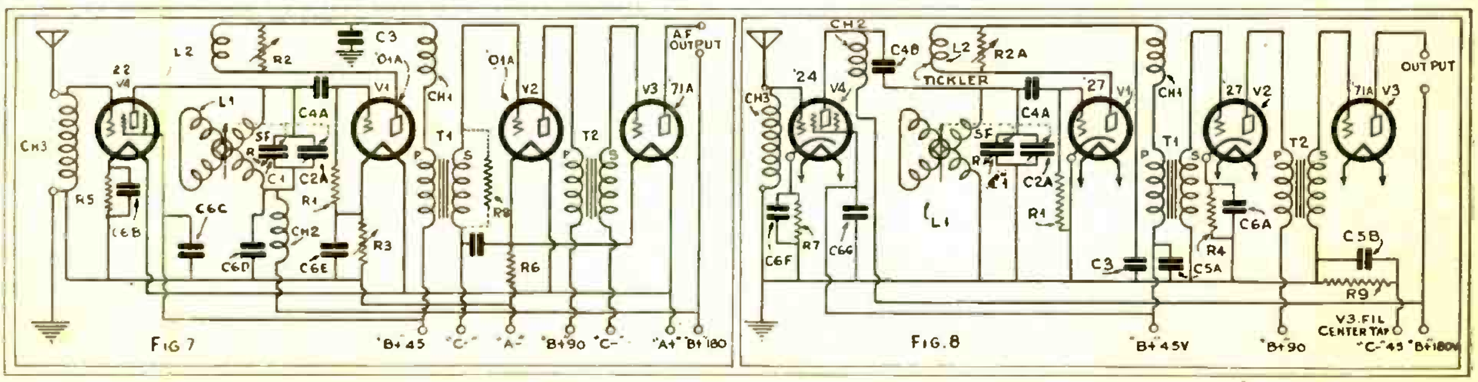

Above, alternative arrangements of four-tube short-wave receivers using the "Automatic Tuner" after an untuned or blocking stage of screen-grid amplification. The latter practice is coming into increasing vogue; as increasing short-wave reception makes it desirable to minimize possibilities of radiation.

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The Pilot "A. C. Super-Wasp" Short Wave Receiver

By
ROBERT HERTZBERG

This short-wave receiving set is outstanding for three reasons:—It operates without batteries on A.C., without hum. It can be used to listen-in on the regular broadcast wavelengths, by means of plug-in coils. Third, the editors know of several instances where European S-W stations are being received daily on this set—and on the loud speaker!

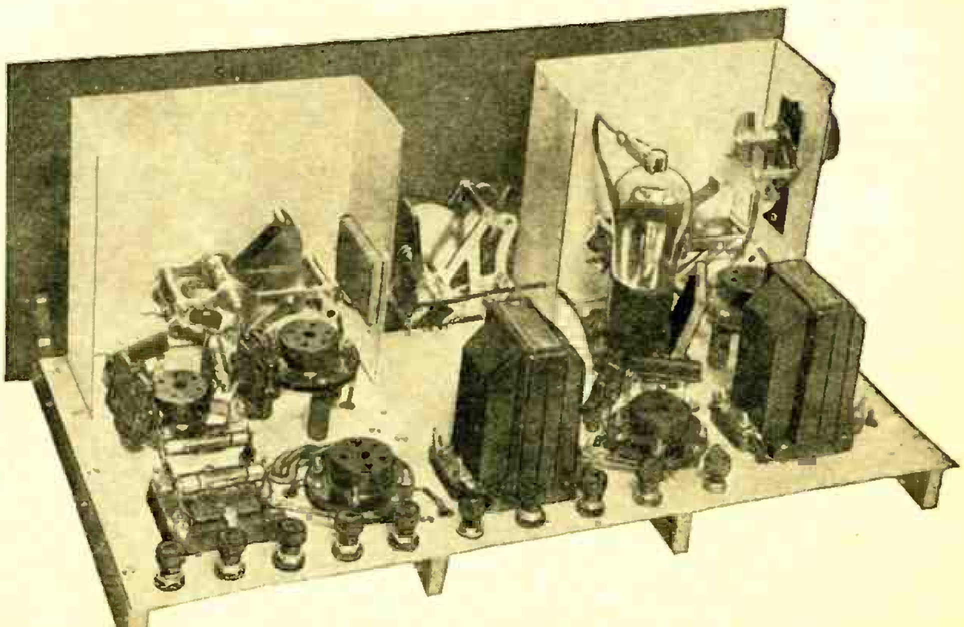
A front view of the neatly designed panel and dials of the Super-Wasp Short-Wave Receiver.

THERE is nothing in radio more thrilling than the short waves. Radio fans who have constructed the most expensive and complicated of broadcast receivers, and who think there is nothing left in the "game" to interest them, are discovering a new and fertile field of amusement in the regions below 200 meters, where hundreds of stations are now broadcasting at all hours of the day and night. Short waves have the peculiar habit of "skipping" over the earth's surface in such irregular fashion that even tiny transmitters deliver "walloping strong" signals at antipodal points, and owners of short-wave receivers enjoy truly phenomenal reception.

The writer wishes to distinguish distinctly between short-wave *broadcasting* and short-wave amateur *telegraphy*. The former is a comparatively recent development, and is of interest to broadcast fans because the announcements are made in voice. Amateurs have been telegraphing to each other all over the world for many years, but this work is done in the dots and dashes (short and long signals) of the Continental Code. It is much more difficult to pick up a distant short-wave *broadcast* station than a *telegraph* station, and therein lies most of the sport. If such reception were easy, there would be no "kick" to it.

Trans-Oceanic Reception Common

It is still an accomplishment, even in these days of high-power stations and super-sensitive receivers, for a man in Boston to hear West Coast broadcasting stations direct, even on a seven or eight-tube receiver. The owner of a good short-wave receiver, using only three or four tubes, considers



Rear view of Super-Wasp A.C. Short-Wave Receiver with shield cans removed to show tuning condensers and other parts. The shield grid tube used in the R.F. stage may be seen at the right. The layout of the instruments in this set is such that losses are reduced to a minimum.

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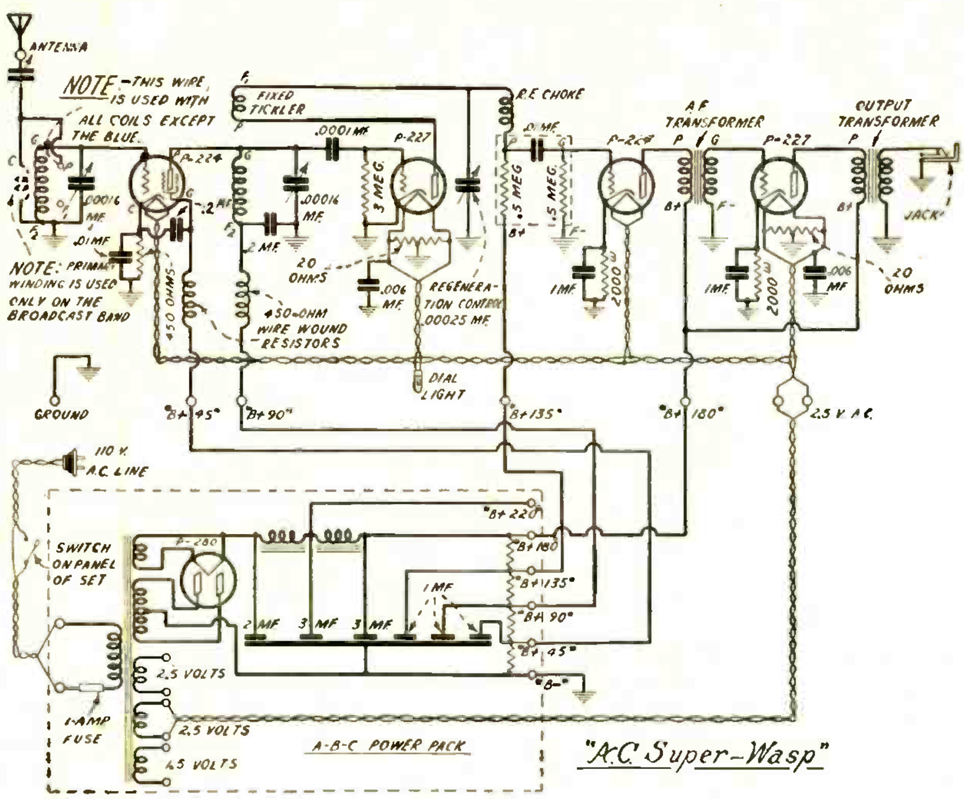

Schematic diagram of the Super-Wasp A.C. Receiving Set.

W6XN, in Oakland, California, a nuisance because of its strength, and reaches for Khabarovsk, Siberia, where the Soviet maintains a fine short-wave station, or for Bandoeng, on the island of Java, where the enterprising Dutch operate a whole string of short-wave transmitters. Thousands of fans who have "discovered" the short waves amuse their friends frequently by tuning in, on the loud speaker, mind you, station G5SW, in Chelmsford, England, which signs off at 7 o'clock in the evening, New York time; by broadcasting the midnight chimes from Big Ben in London; or station PCJ, in Holland, from which the announcements are made in six languages; or little NRH, in Costa Rica, Central America, over which the owner broadcasts the chirpings of his delightful two-year-old baby; or station VK2ME, in Sydney, Australia, which broadcasts football games in the best McNamee manner.

In a spirit of truthfulness, the writer does not want to create the impression that such reception can be accomplished at the mere flip of a switch. Short-wave work is still quite tricky, and it takes a few hours of practice to learn where the important stations come in on the dials. The usual difficulties with fading and signal distortion are experienced, but the short-wave channels are so active now that distant stations can be heard almost any time. The Australian, Javanese and other East Indian stations float in early in the morning, conveniently around breakfast time. The Dutch, English, French and German stations operate right through the afternoon. The Central American and South American stations put on special programs for the United States during the early evening hours, as do the Dutch stations. There are also plenty of American transmitters to make the air quite lively.

Short Wave Set at Last Electrified

To take advantage of the opportunities the short waves offer, radio fans until recently were forced to use critical, battery-operated, straight regenerative receivers, innocent of shielding or the benefits of tuned R. F. (radio frequency) amplification, and utterly lacking the conveniences of "lamp socket" operation. This situation discouraged many ex-broadcast fans who had disposed of their batteries with the advent of the A. C. broadcast receiver, and who naturally did not want to take a step backward by buying batteries all over again. Now, however, there is available, in kit form, a completely electrified A. C. short-wave receiver, having a *tuned* screen-grid R. F. stage, double shielding and a wavelength range of 14 to 500 meters. This kit was designed particularly for the man who wants

"Caught in the Act" of assembling a Super-Wasp Short-Wave Receiving Set, which is a simple matter even for the uninitiated. The simple details for connecting the various parts of the short-wave receiver are all clearly shown in the blueprint, which is tacked on the wall in front of the young radio set builder we see in the picture. A soldering iron, a pair of pliers and a screw driver are all that one needs to complete the job, plus solder and flux, of course.

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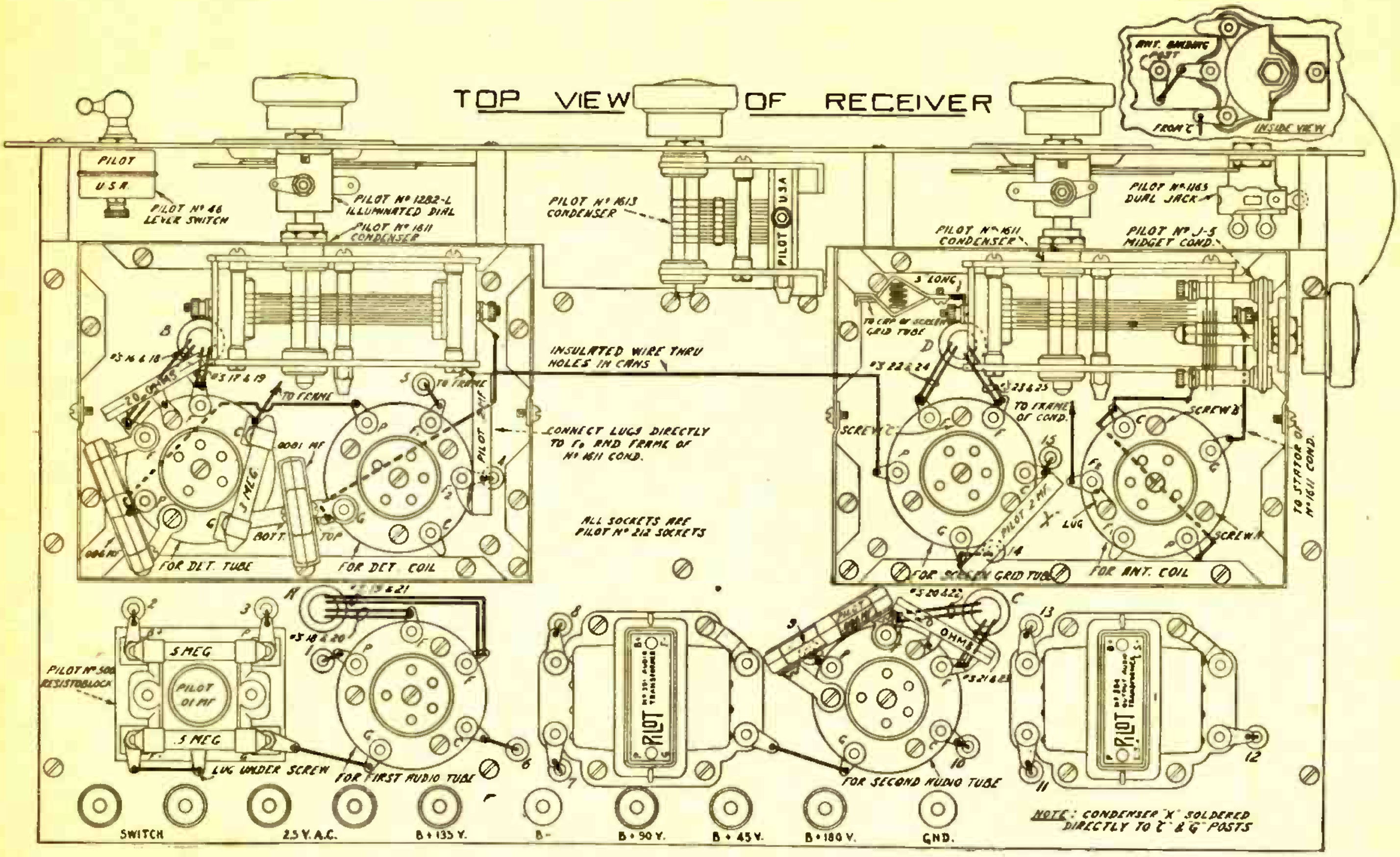

Top view of Super-Wasp A.C. Short-Wave Receiver.

to get into the short-wave game at little expense and with little trouble. The set can be assembled and wired in two evenings with the aid of a screw-driver, a Spintite wrench and a soldering iron, all necessary parts down to the last washer and lug being supplied. The front and sub-panels are accurately drilled, and everything goes in place with gratifying smoothness. This set, known as the Pilot A. C. Super-Wasp, has been on the market for about seven

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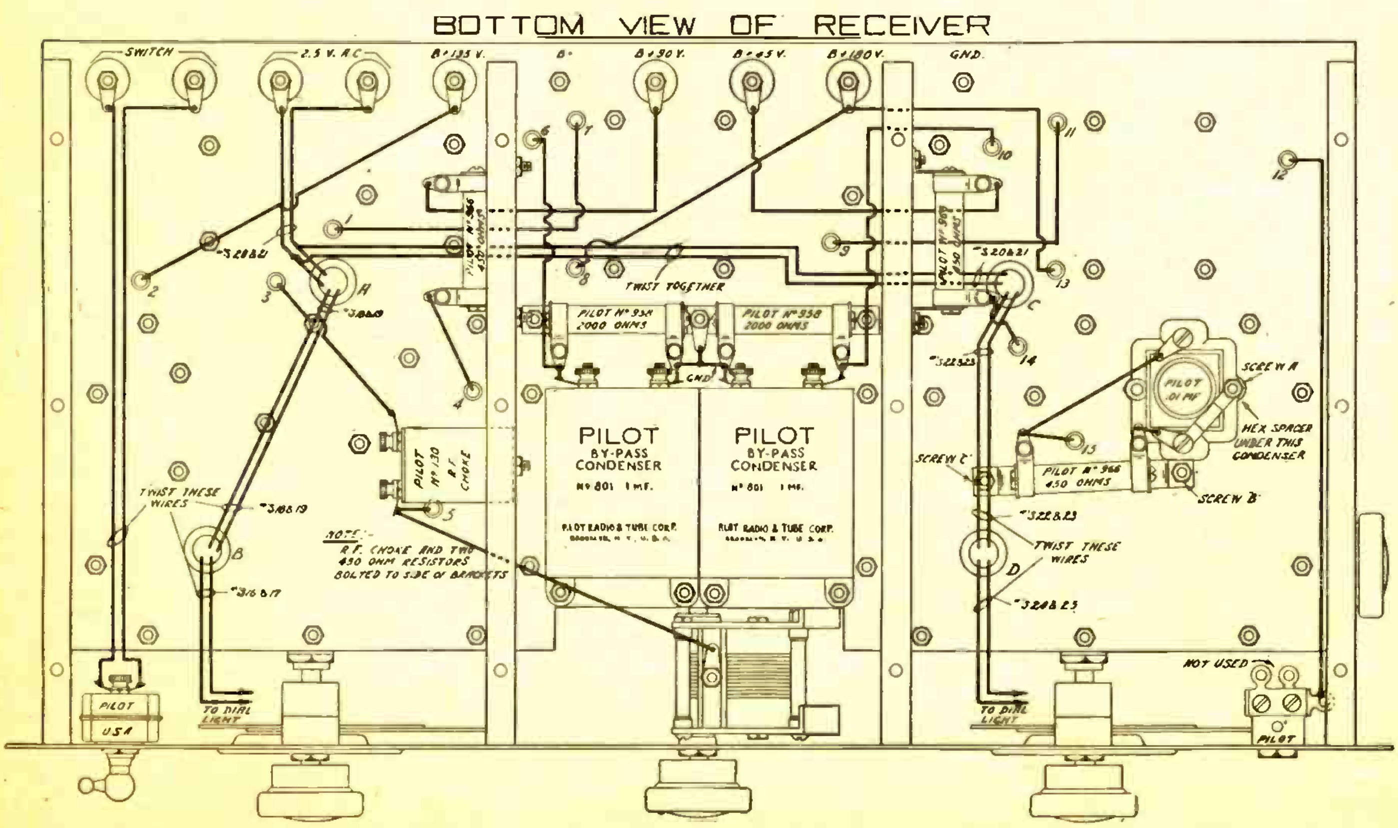

Bottom view of the Receiver, showing the very simple wiring.

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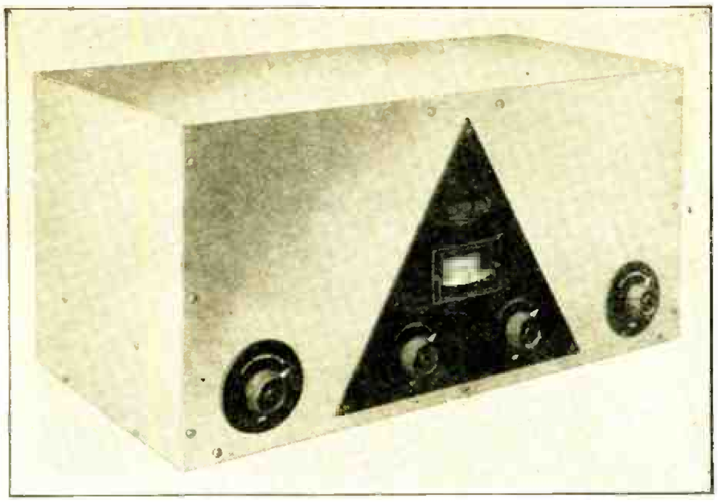


Front view of Norden-Hauck de Luxe short-wave receiver, known as the Super DX-5. It measures 9" by 18" by 10" and weighs 30 lbs. Wavelength range 20 to 205 meters and adaptable down to 10 meters, and as high as 2000 meters with extra coils.

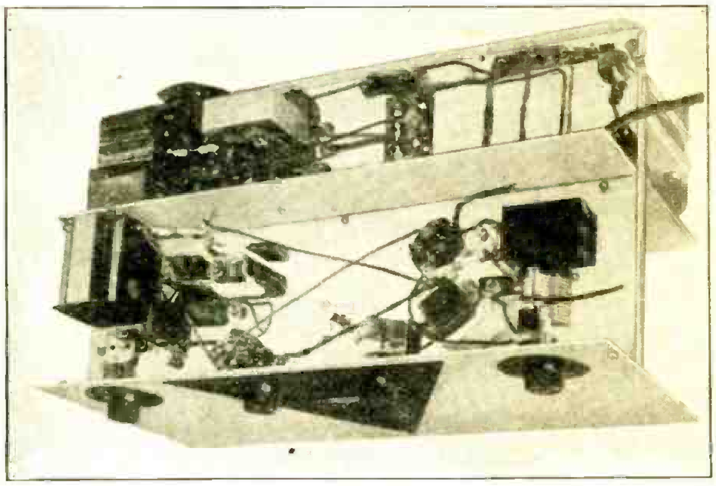
A de Luxe Short Wave Receiver

First short-wave receiver to use the new Pentode, high amplification tube. Range of set, 20 to 205 meters; output stage uses two 245 tubes; coils available for broadcast band and higher waves; receiver is supplied for AC or battery.

THE short wave receiving set illustrated in the accompanying photographs represents one of the finest pieces of workmanship yet produced. Not only is this short-wave receiver of excellent design and construction, but it also embodies some of the latest developments in radio engineering. Among other features, this receiver utilizes the newest vacuum tube, which has made such a stir in radio circles, the *pentode*, which provides tremendous amplification in a single stage. The pentode tube is used in the radio frequency amplifier stage, with 250 volts on the plate of the tube. This set is supplied in either the battery operated model or in the AC model for operation on 110 volt, 60 cycle, AC supply circuits.

So well designed is the filter and general balance of the circuits in this Norden-Hauck short-wave receiver that no hum is noticeable when receiving, and the residual hum is so low that earphones may be used with perfect satisfaction. The rectifier in this set uses a 280 type tube, and two 227 tubes are used for the detector and first audio stages. Due to the special design of the tuning circuits and the employment of the pentode tube, with its very high amplification factor, this set possesses unusual sensitivity, high selectivity and volume.

All of the radio frequency and detector circuits are tuned with vernier adjustments, affording the greatest volume, the highest degree of selectivity, together with really accurate calibration.



Bottom view of the Super DX-5 short-wave receiver, showing high class workmanship and excellent arrangement of parts.

The audio stages, in view of the fact that the output or second stage utilizes two 245 tubes connected in push-pull style, with 250 volts on the plates, provides four watts of undistorted power output; sufficient to operate a dynamic loud speaker in excellent fashion.

The wavelength range of the set runs from 20 to 205 meters, with the set of three coils regularly furnished with the Super DX-5 set. One other set of coils is needed to go down to about 10 meters, while coils wound to take care of the broadcast band and higher waves are also available when desired.

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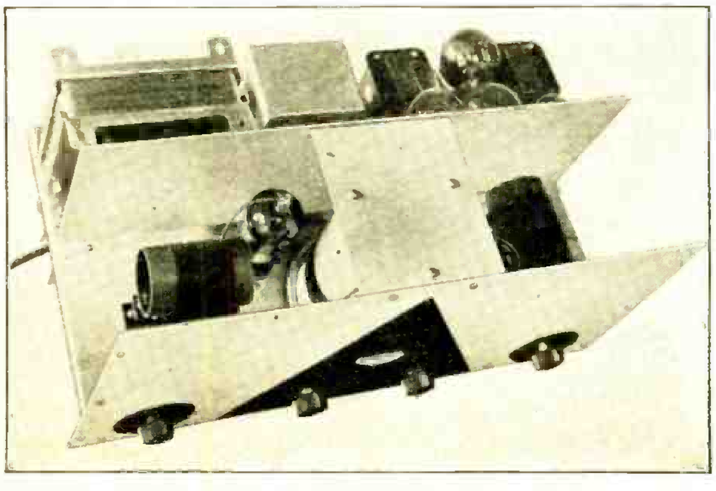

Interior view of Super DX-5 receiver, taken from the top, showing good design and arrangement of the parts. Power pack and audio amplifier are mounted in the rear and suitable shielding used wherever found necessary.

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Bringing Old S-W Receivers Up-to-Date

By
ROBERT (BOB) HERTZBERG

Get that old short-wave receiver out of the attic and bring it up to date with the addition of a few parts as specified by an expert. It is not so much the instruments you have, as how you connect and use them. How to improve the regeneration control and general reliability of the set are here discussed.

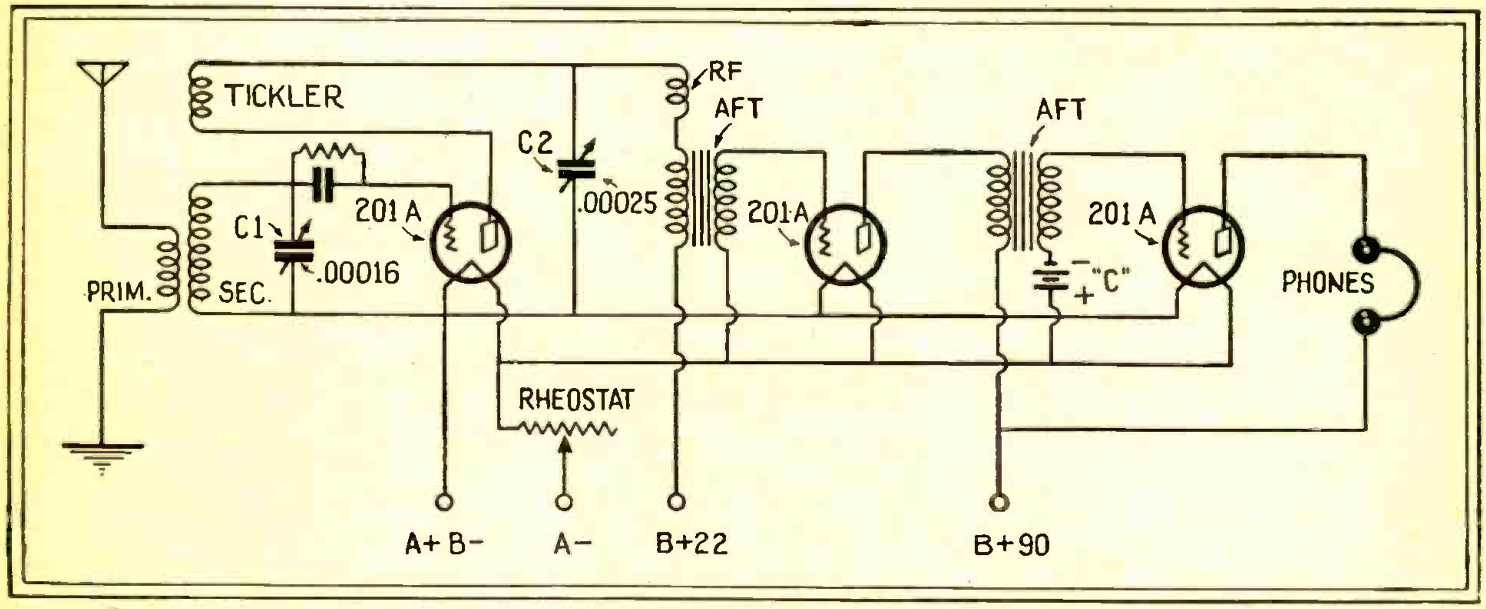

Fig. 1. This diagram shows short wave receiving circuit frequently used on the older sets. How to bring it up to date is explained by Mr. Hertzberg in this article.

WITH the interest in short-wave broadcasting rising to new and unprecedented heights, many people who first tried their hands at short-wave reception a few years ago are digging their old sets out of the cellar and the attic, and are planning to "get on the air" once more. When they get all the dust off the outfits they usually gaze at them rather speculatively and say, "Well, this thing is a bit out of date. Wonder how I can revamp it?"

Questions of this kind have been very common lately. Most of those three- and four-year-old receivers represent a considerable investment, and their owners naturally do not want to junk them in favor of brand-new sets, if they can help it. Fortunately, it is not difficult to revise them, as short-wave principles have not changed any. In this article the writer will offer a number of practical suggestions that have actually been tried and found to work satisfactorily.

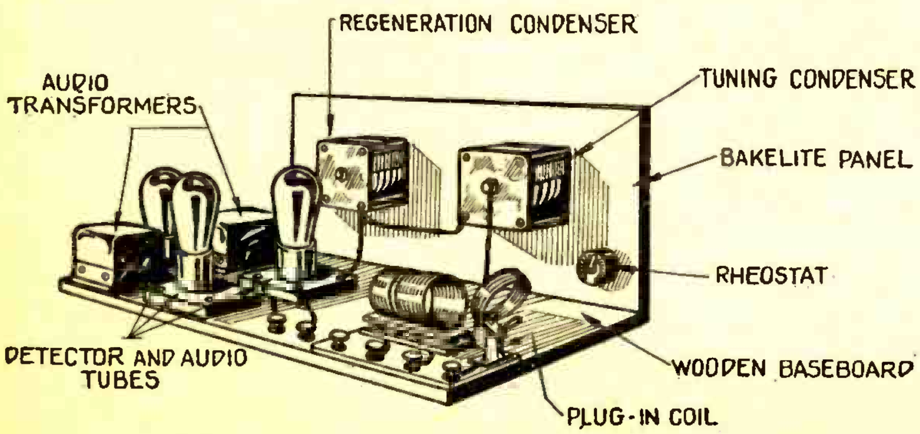

Fig. 2. A preferred arrangement of the short wave receiving set apparatus is indicated in the illustration above.

First let us study Fig. 1. This is a schematic representation of practically all the short-wave receivers sold two, three and four years ago. They all consist of a straight regenerative detector, followed by either one or two stages of transformer coupled amplification. Tuning is accomplished by means of plug-in coils, wound with heavy wire, with a shunt variable

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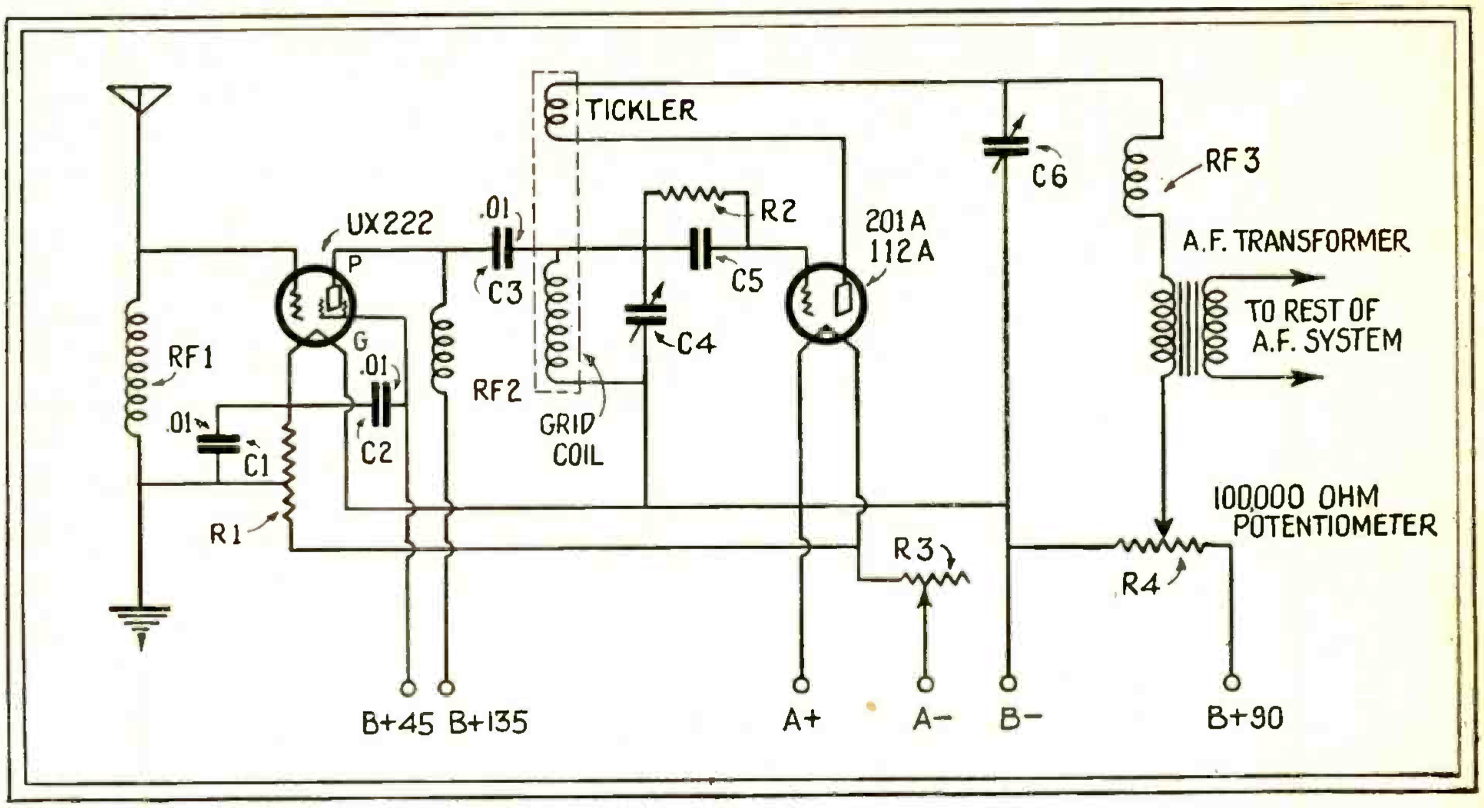

Fig. 3. The circuit above shows how to connect a 222 tube in an RF stage ahead of the regenerative detector; this simple addition to your old short wave set gives far greater stability and evenness of tuning.

condenser C1, usually of .00016 mf. capacity. A hinged primary is mounted at one end of the plug-in base, the secondary and tickler being the plug-in unit. Regeneration is controlled by another condenser, C2, usually about .00025 mf. The audio system is of the straight transformer type. The parts are usually arranged somewhat as shown in Fig. 2.

Now, the question is: "How much of this set can be saved?" The answer is: "All of it." You can use everything now in the outfit, merely adding an additional tube to give it increased sensitivity and to eliminate the "dead spots" that you undoubtedly experienced in the tuning.

Adding Screen Grid R. F. Stage

The revamped circuit is shown in Fig. 3. The additional tube is a UX-222 screen-grid amplifier, connected between the present detector and the antenna to act as an untuned radio-frequency amplifier. Study this hook-up carefully and it will become clear to you. Note that the primary coil is no longer used, the aerial being connected across the grid and filament of the 222 through a radio-frequency choke coil, RF1. The grid of the 222 tube is the cap electrode at the top of the glass; the G pin in the base is the connection to the screening grid, marked G, which receives a 45-volt positive charge from the "B" battery. This G lead is by-passed to the filament by condenser C2, of .01 mf.

The plate of the 222 is connected to the detector circuit through a blocking condenser, C3, of .01 mf., the detector circuit itself remaining substantially the way it was before. The plate of the 222 receives 135 volts of "B" through the R. F. choke, RF2. As the 222 filament is rated at only 3.3 volts, it must be connected to the rheostat through a series resistance, R1, of 15 ohms, which cuts down the six volts of the "A" battery to the correct value. This resistance is tapped at 10 ohms and the grid return lead from RF1 is brought to it; the grid is then biased about 1½ volts negative, which is required for the proper operation of the tube. Tapped resistances of this kind cost only a few cents and can be purchased in any radio store.

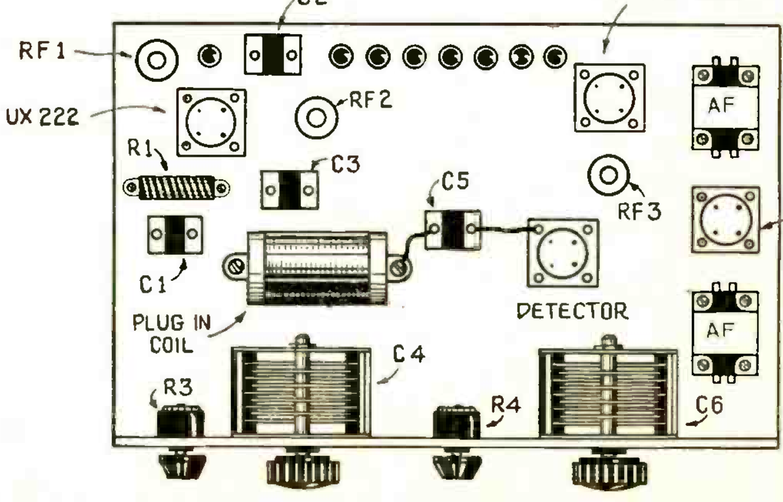

Fig. 4. Suggested arrangement of re-vamped short wave receiver, with screen grid tube stage added ahead of the detector.

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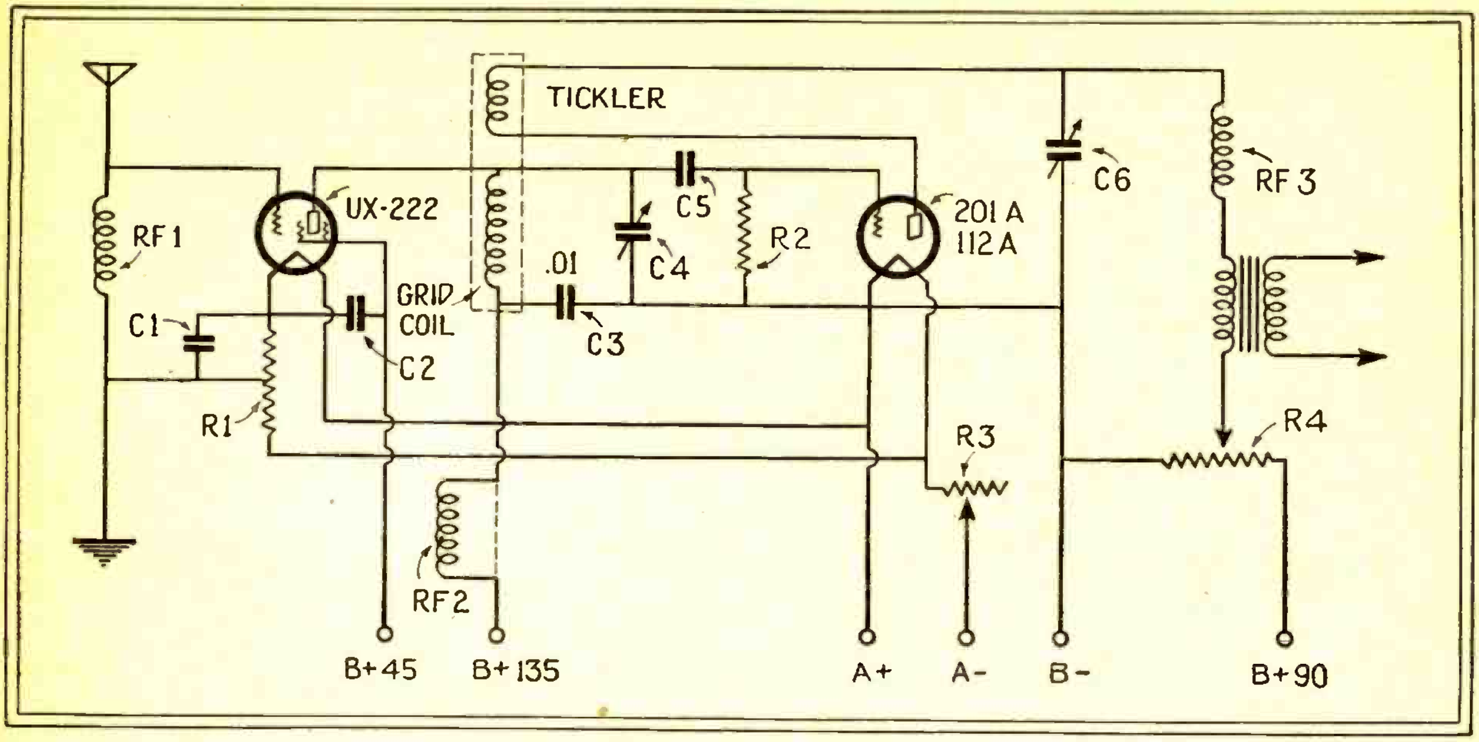

Fig. 5. Another method of coupling the untuned screen grid tube stage to the detector. Here the plate current of the 222 tube flows through the grid winding of the detector plug-in coil.

Operation of Circuit

The operation of the circuit is simple. All signals picked up by the aerial are impressed on the screen-grid tube and amplified by it. The choke RF1 provides a complete grid circuit, particularly for the biasing voltage, but because of its high impedance to the R. F. currents, forces the latter to flow to the grid, where they affect the tube in the usual manner. The amplified signals flow through condenser C3, which offers practically no opposition, and into the grid tuning circuit. The latter, of course, responds only to signals of one wavelength—the one to which it is adjusted. The amplified R. F. currents are forced into the detector through C3 because of the choke RF2. If this choke were absent, the R. F. current would merely flow back to filament through the "B" battery, and would not affect the detector at all.

The installation of an untuned screen-grid stage adds no controls to the receiver. The tuning and regeneration condensers remain the major adjustments, and the revamped set is tuned in exactly the same manner as before.

The actual physical placement of the screen-grid tube and its associated parts depends on the construction of the present set. Fig. 4 shows a simple arrangement that can be adapted to most sets. The 222 is put in the left corner of the baseboard, in front of the plug-in coil. There usually is plenty of room on the baseboard; in a pinch the present parts can be shifted around a bit. If this is necessary, place them so that the connecting leads will be as short as possible. The filament resistor, chokes, condensers, etc., are easily distributed, as they are small and occupy little room.

An incidental improvement can be effected in the detector circuit by the addition of a potentiometer, for accurate control of the detector plate voltage. This is helpful in obtaining smooth regeneration. This

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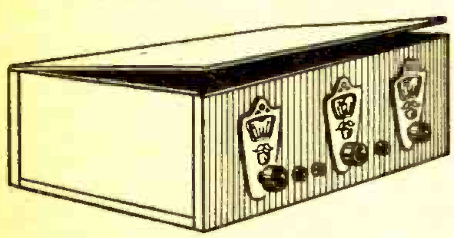
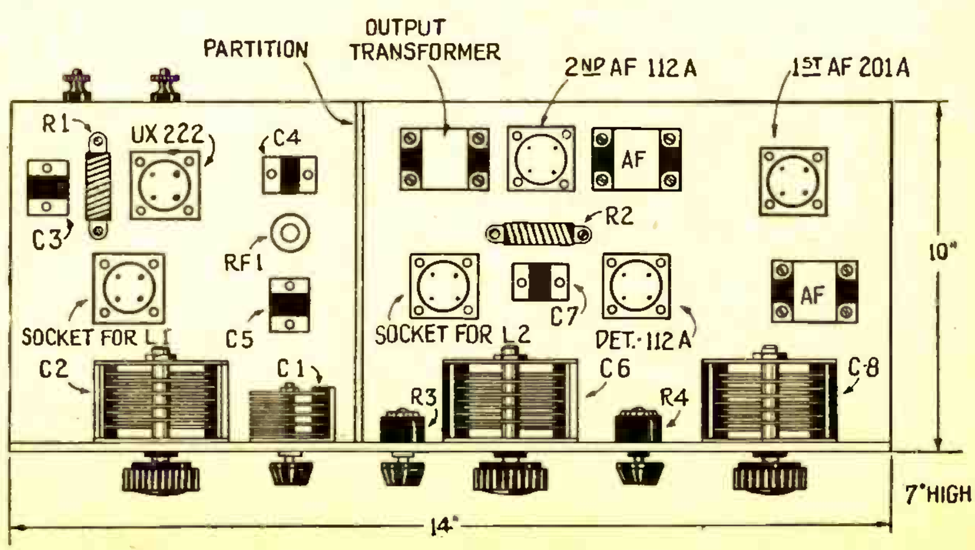


Fig. 7. If you feel real ambitious and want to build a new short wave receiver from your old parts, plus a few new ones possibly, here is a 1930 de Luxe receiver, diagram of connections for which appears in Fig. 6. This short wave receiver utilizes a stage of tuned, screen grid RF amplification, ahead of the detector. Shielding is both desirable and necessary; the cabinet may be made of aluminum, brass, or copper as shown above.



potentiometer should have a resistance of 100,000 ohms, and may be mounted in any convenient place on the front panel. It is adjusted only when the plug-in coils are changed.

The importance of good radio-frequency choke coils in the revamped receiver cannot be overestimated. It is worth while to discard the old ones and to buy new ones, of good make. Also, the condenser C3 must have excellent insulation, as it is subjected to the full voltage of the "B" battery.

connections, and buy new tubes and batteries. *Put up a small aerial —about 50 feet or so—just for the short-wave receiver*, so that you won't have to disturb the regular broadcast receiver in the living room. Wipe off the earphones, fill your pipe, and you are ready to *explore the ether once more!*

Another Method of Connecting Screen-Grid Stage

Another method of coupling the untuned screen-grid tube to the detector is shown in Fig. 5. Here

With the arrangement of Fig. 5 the grid leak R2 must be connected from grid to filament, instead of directly across the grid condenser. In the latter position it would allow the plate current of the 222 to bias the detector strongly, thus making it inoperative. The rest of the connections remain as they are in Fig. 3.

A Model 1930 S-W Receiver

If you feel ambitious, and want to build a new receiver using as many of the old parts as possible,

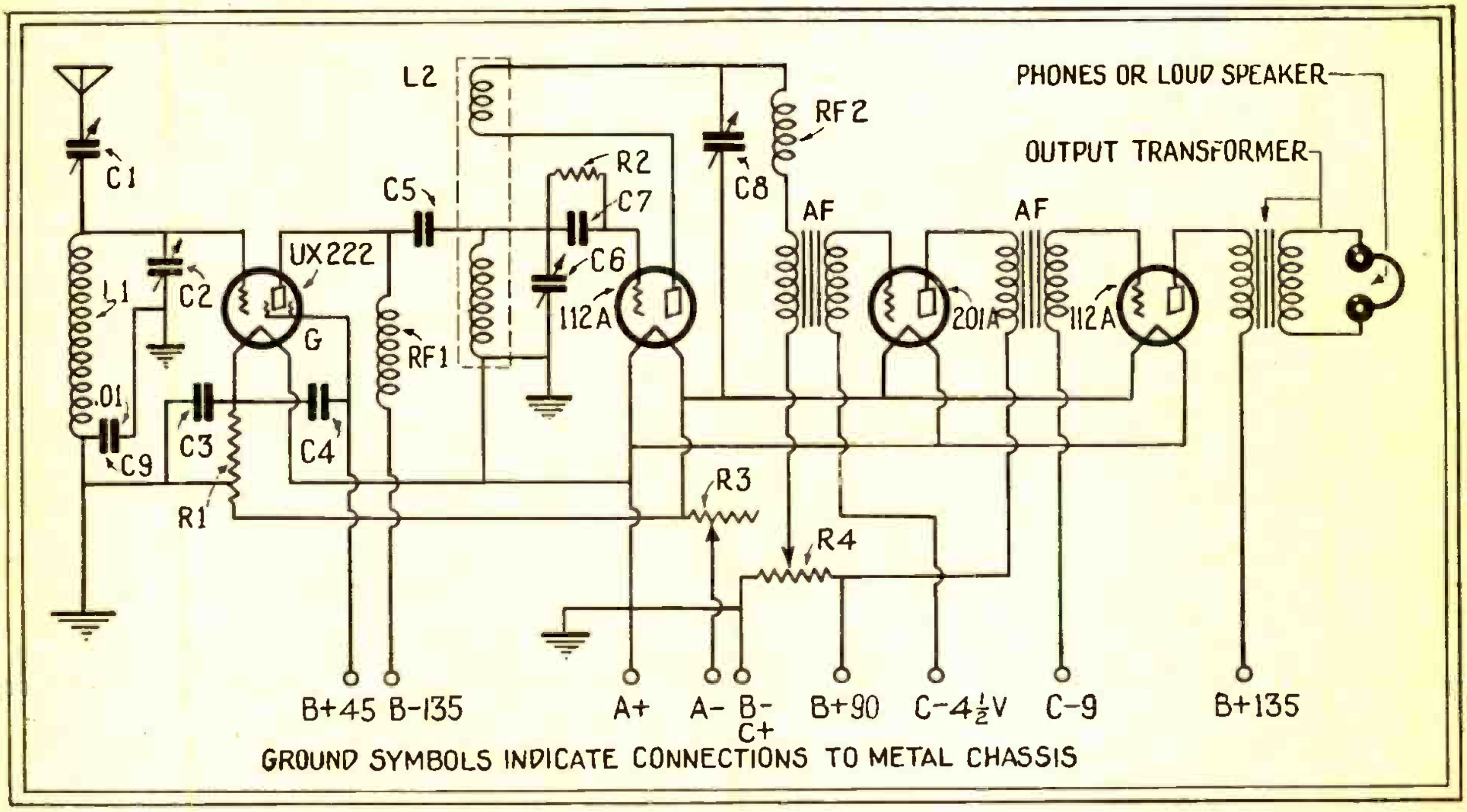


Fig. 6. Detailed wiring diagram for de Luxe 1930 short wave receiver illustrated in Fig. 7. As will be seen, this receiving set uses a stage of tuned RF, with screen grid tube, ahead of the regenerative detector; together with two stages of transformer-coupled audio.

The Audio Amplifier

The audio system need not receive much attention. Tone quality is not yet an important factor in short-wave reception, so even your old transformers will do. It is the thrill of the reception, not the actual programs themselves, that counts. When you tune in Siberia or Java you'll be too excited to worry about the high notes or the low notes. Tubes of the 201A type can be used throughout, though a 112A tube should be tried as the detector.

Of course it is advisable to clean up all the parts, go over all the the plate current of the UG-222 flows through the grid winding of the detector plug-in coil, being kept off the grid of the detector tube by the grid condenser, C5. It is prevented from short-circuiting back to the filament by the blocking condenser C3, of .01 mf. capacity. Although this latter condenser is directly in the tuning circuit, it is so large in comparison with the .00016 mf. of C4 that it has practically no detuning effect. A radio-frequency choke, RF2, connected in the "B" plus 135 lead, is sometimes helpful, though not necessary.

cast your eye over Figures 6 and 7. Fig. 6 shows the hook-up of a real snappy, Model 1930, short-wave receiver, using a stage of *tuned* screen-grid R. F. amplification ahead of the detector. The actual circuit differs only slightly from that of Fig. 3, but the mechanical construction of the set itself is more complicated than the simple layout of Fig. 2. Shielding is both desirable and necessary, and is best obtained by making the set in a box of aluminum, brass or copper, as shown in Fig. 7.

The box is divided into one small

(*Continued on page* 87)

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The Short Wave Beginner

How to Obtain Smooth Regeneration in S-W Receivers

By ROBERT (BOB) HERTZBERG

The author explains, in simple terms, how to connect the apparatus in short-wave receivers so that regeneration will be smooth over the entire dial. The cause of "dead spots" on the dial is explained, as well as the best hook-ups for the regenerative circuit.

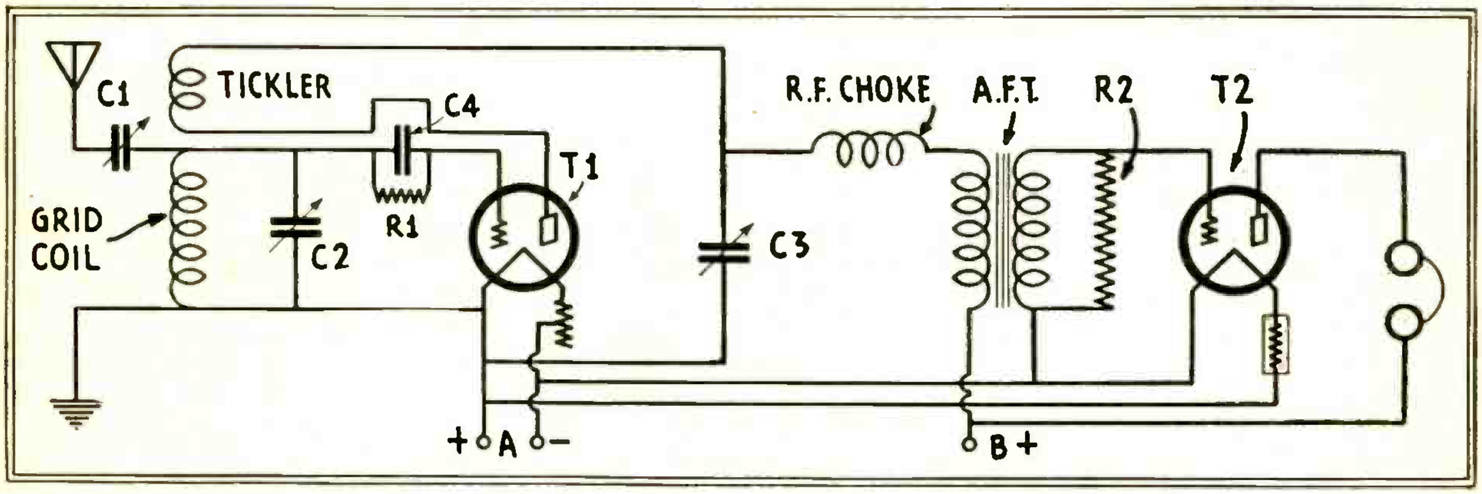

Fig. 1. The common regenerative circuit used for short wave reception is shown above. If the set breaks forth into a loud howl on the very point of oscillation, you should connect resistance R-2, of about 100,000 ohms value, across the secondary of the A. F. T.

CRITICAL, cranky regeneration controls are responsible more than any other single factor for the failure of short-wave receivers to produce satisfactory results. Many otherwise excellent sets are discarded in disgust by their purchasers when they show themselves to be difficult to operate, yet they can be adjusted properly without any trouble at all. An irregular regeneration control apparently makes the tuning unduly sharp, and even very high ratio tuning dials do not help.

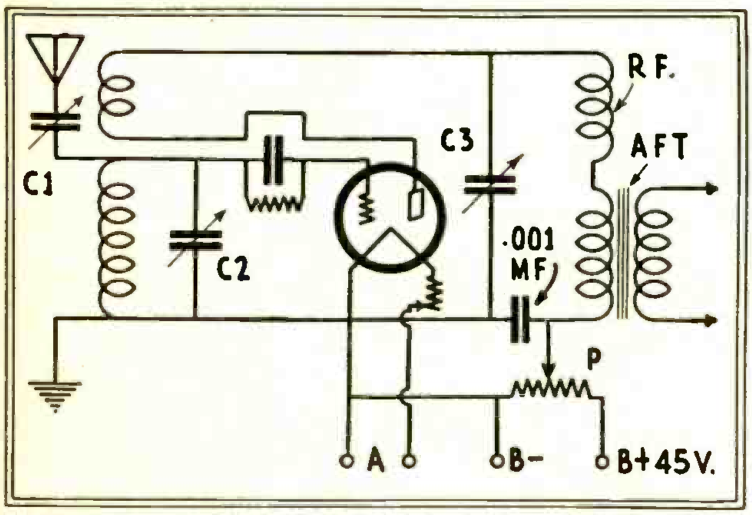

Fig. 2 above shows how to smooth up the regeneration control on short wave receivers—use a potentiometer at "P," to give fine control of the plate voltage.

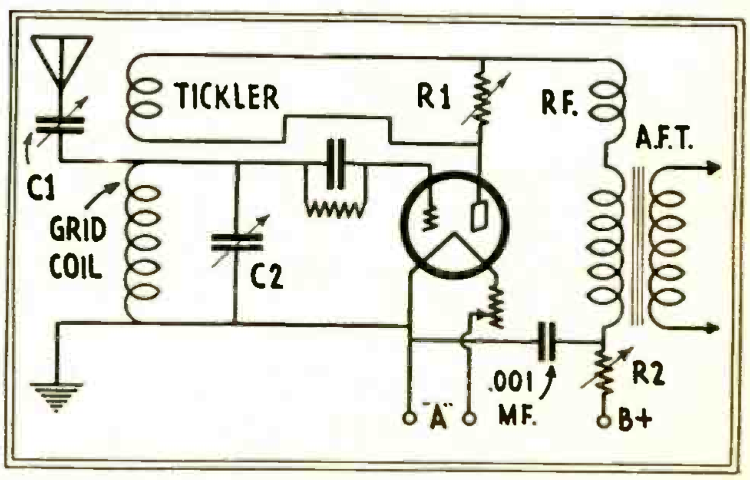

Fig. 3 shows still another way of controlling regeneration by varying the plate potential on the detector tube with a finely variable resistance R-2; and also by the variable resistor R-1.

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This article will attempt to explain a few methods for taming down a too-lively circuit and for making it work smoothly and easily. The suggestions apply to all types of short-wave receivers, as they all use a regenerative detector, with and without tuned or untuned R.F. amplification and with one, two or three stages of resistance or transformer coupled A.F. amplification.

First let us study the diagram of Fig. 1. This shows the usual straight regenerative short-wave circuit, with one stage of audio for headphone reception. The antenna is coupled to the grid coil through a small condenser C1, the grid coil being tuned by a variable condenser C2, usually of .00016 mf. Regeneration is secured by means of a tickler coil wound over the same form holding the grid coil. The regenerative action is controlled by another variable condenser C3, of about .00025 mf. The detector T1 is led to an audio amplifier tube T2 through a standard A.F. transformer, AFT. A grid condenser C4 of .0001 mf. capacity and a grid leak R1 of about 3 megohms are used.

Causes of Regeneration

Now the tendency of the detector tube to regenerate is determined by several factors: the size of the tickler coil and its proximity to the grid coil, the value of the detector plate voltage, the setting of condenser C3, the characteristics of the particular tube, and to a lesser extent the quality of the R.F. choke in the transformer primary circuit. Contrary to general opinion, the grid leak is not at all critical, three megohms being just about right for practically all types of both battery and A.C. detector tubes.

If the tickler is of the right size and the plate voltage correct, the detector should slide into regeneration and finally oscillation with a soft, hushing sound as the condenser C3 is turned in. Furthermore, when the set is tuned to the high end of its wave range, with any particular plug-in coil in place, oscillation should take place as the condenser C3 reaches maximum capacity. As the set is tuned to lower wavelengths less and less of the regeneration condenser is needed.

How to Eliminate Howling

After the hushing sound has given way to the gentle "plunk" that indicates oscillation, you should hear nothing more than a few faint tube noises. If the set breaks forth into a loud howl on the very point of oscillation, you will have to connect a resistance R2 (Fig. 1) across the secondary of the audio transformer. This "fringe howl" effect is exceedingly annoying, as it occurs at the very point where weak stations are generally heard. The resistance R2 should be about 100,000 ohms (.1 megohm). Sometimes, but not always, adjustment of the grid leak R1 helps to eliminate this very undesirable howl.

If you find that the set jumps suddenly into oscillation, with little or no preliminary hushing sound, and with only a degree or two of condenser C3 dial movement, don't waste your time trying to tune for foreign stations, as you won't be successful. To smooth out the control, first try reducing the "B" voltage, if it is not already low. Cut it down from 45 to 22½, and see if regeneration occurs more smoothly. If this reduction helps somewhat, but not enough, you must reduce it even more. It is quite surprising to see how easily most short-wave circuits oscillate with only eight or ten volts on the plate of the detector.

(*Continued on page 84*)

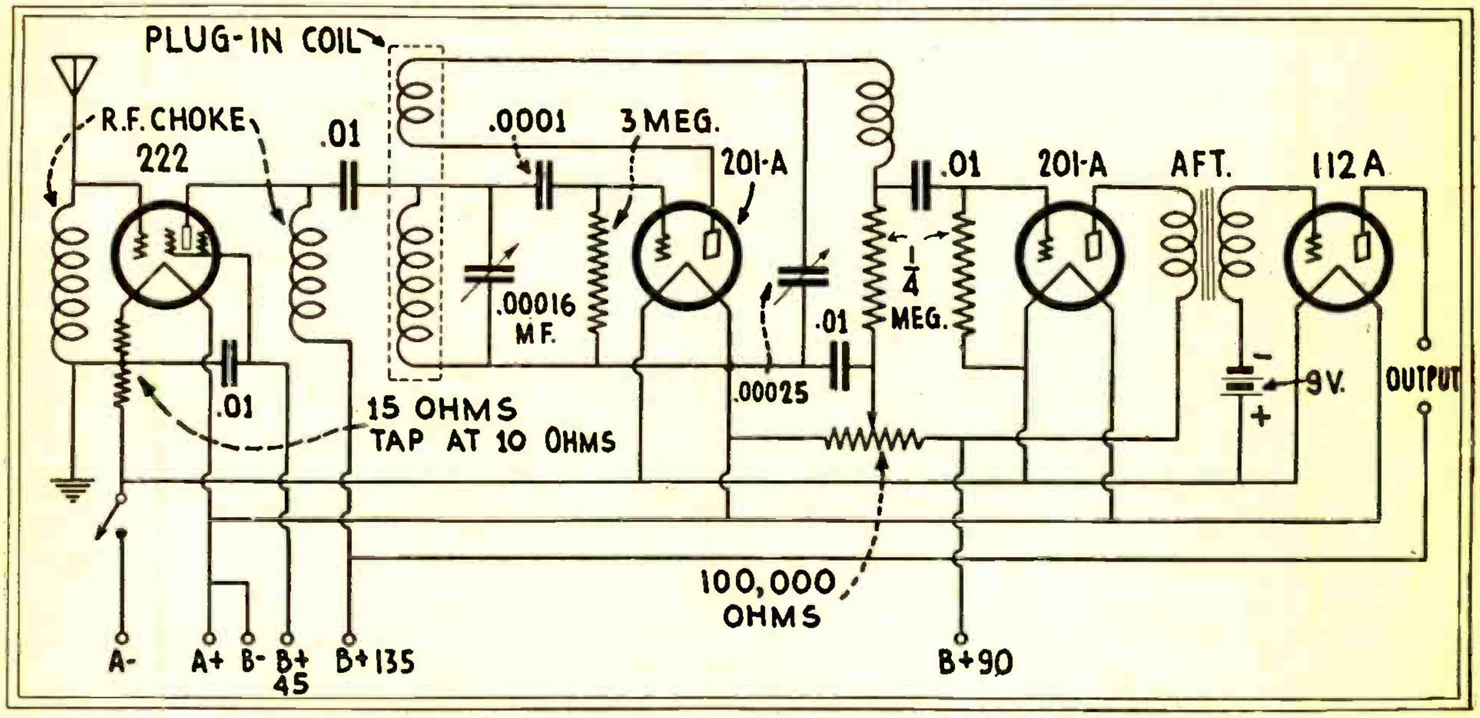

Fig. 4 above shows connection of a 222 tube in the RF circuit ahead of the detector, with detector feeding into a resistance-coupled stage of audio frequency amplification. The use of a screen grid tube eliminates dead spots on the tuning dial, and the resistance-coupled first audio stage eliminates the "fringe howl" frequently so troublesome in transformer-coupled first audio stages.

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A Complete Portable Transmitter and Receiver for Short Waves

Mr. Lawrence B. Robbins, W-1AFQ, here describes in detail just how to build a complete short-wave transmitting and receiving set. The set is light and thoroughly portable, suiting it to airplane or motor-boat

TO BE actually portable, a transmitter should be so constructed that it can be carried about in the hand if necessary. (This portable weighs only 30 pounds.) This is only possible with short wave transmitters because communication over any distance cannot be carried on, on the higher bands, with the low power such a transmitter would be able to offer. It was with this in mind that the portable transmitter shown in the photographs, together with its twin, a three tube receiver, was constructed.

Features

While, of course, not the last word in short wave outfits, it is entirely practical. The transmitter is a 40 meter affair operating on 67½ volts plate current and a "C" battery to light the filament of its tube, which is a 199. The hookup used has a known record of 2,000 miles per watt under good conditions and from 500 to 1,000 miles can be attained by this transmitter under as good conditions with this power supply, which delivers in the vicinity of .4 of a watt. It is thus excellent for so-called local work but may often surprise the user by making contact over unbelieved distances.

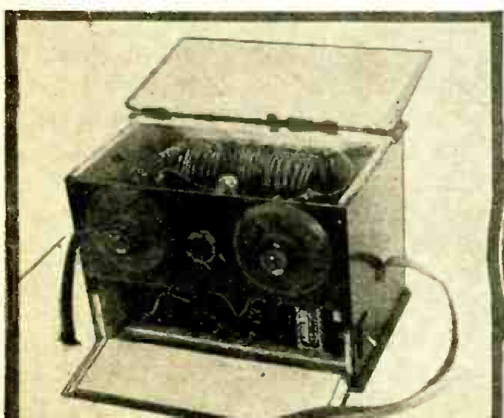
The receiver is a conventional Schnell circuit with two stages of audio amplification contained in a case of identically the same size. This uses 199 type tubes also and operates from three dry cells and a small 22½ volt "B" battery.

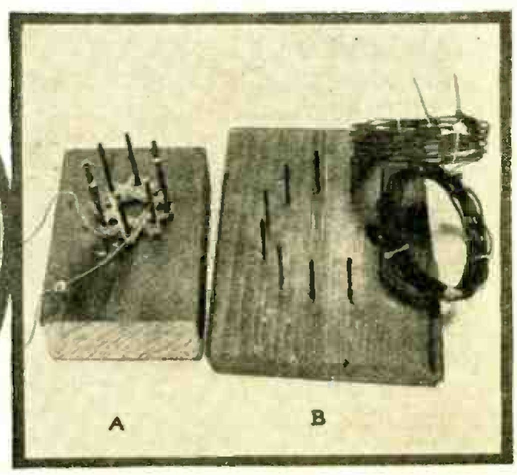
The filaments of both transmitter and receiver are controlled by 125 ohm rheostats; which makes it possible to light the tubes direct from a car battery if so desired. In other words the sets can be operated from a three, four or six or even an eight volt source if the contained "A" batteries fail for any reason. An extra "B" battery block can also be carried along if desired for boosting up the plate current of the transmitter, although this is optional. Even a Ford spark coil can be used for plate current by connecting top side contact to "A" plus, (bottom side contact is the "B" plus line) and the bottom contact of coil to the key and the other key lead to "A" minus. Besides the two units there are in addition the key, headset and antenna — counterpoise wires—all of which can be stuffed in a couple of pockets.

The transmitter is known as the Split Colpitts circuit having tuned plate and grid and a consequent absence of clips to adjust. Only two are included and are used to connect the outer end of each tuning coil.

Transmitter Details

The base is a thin board 11 inches long by 7 inches deep. The panel is of hard rubber 11½ inches long by 4½ inches high. Two .00025 mfd. variable condensers are used for tuning and are mounted at each end of the panel. The rheostat is mounted in the center. The tube socket is mounted on the base just back of the rheostat. Back of that comes a .001 mfd. fixed condenser and back of each tuning condenser is placed a choke





The transmitting unit is pictured at the left. The author is shown in the center picture, operating the completed station; the barrel is necessary for keeping the units away from the ground. The coil winding jig is shown in the picture on the right. The photographs show slight differences in the panel sizes, etc., of the two sets due to the use of discarded material, such as dials, etc., and the panels made to fit.

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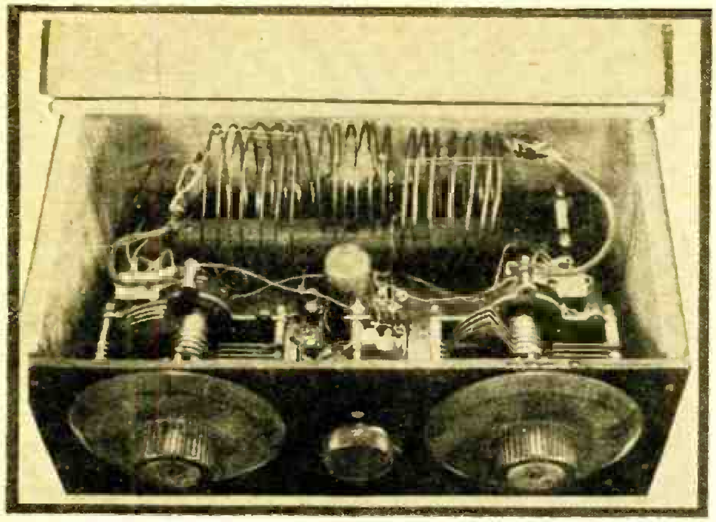
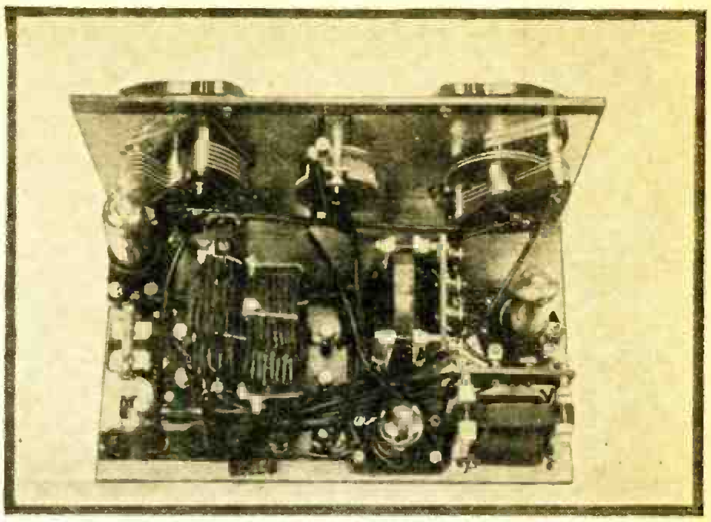


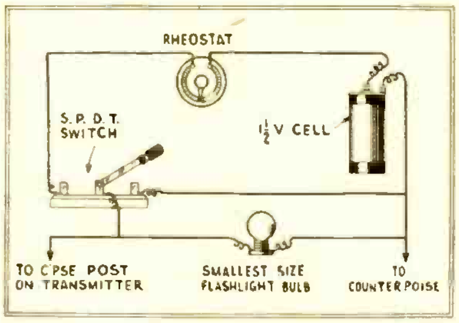
This close-up of the transmitting unit illustrates the general arrangement of the short wave coils and condensers. Note the antenna (middle) coil coupling.



A close-up showing the arrangement of the parts which constitute the receiver. The basket wound "bell wire" coils will not absorb moisture very appreciably in damp localities.

coil. A 5,000 ohm transmitter-type grid leak of good quality is then mounted at the back right hand corner of the base and then the tuning coils occupy the space parallel with the rear edge of the base.

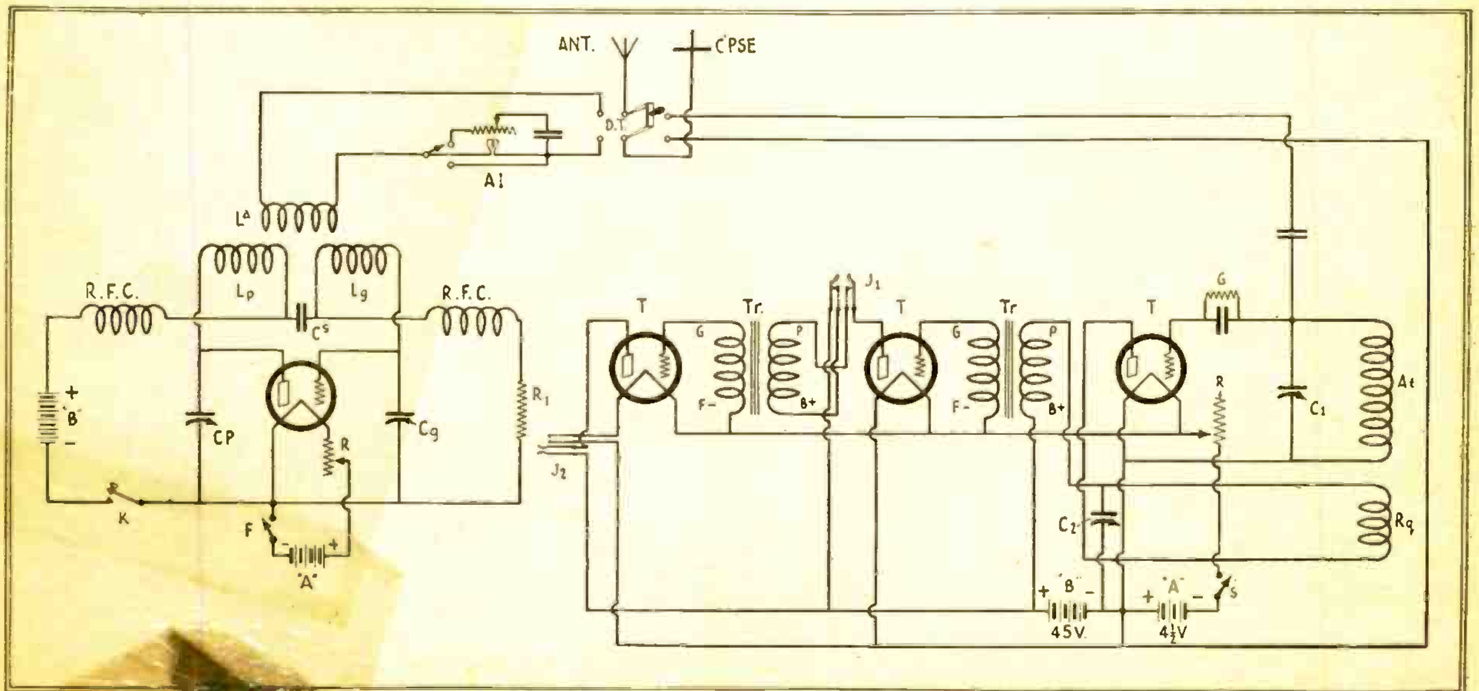
The transmitter coils consist of two separate air windings of No. 12 or No. 14 bare copper wire of seven turns each. Their mountings consist of two hardwood sticks; one 8½ inches long and the other 7½ inches long. The shortest one is notched underneath at ¼-inch intervals and arranged to leave 2 inches between the coils. Coils are then set in position on the long stick and the short one placed through the coils and screwed down to the bottom one, the notches bearing down on the coils and holding them vertical and rigid. Then the ends of the bottom stick are screwed to the base as shown.



Schematic circuit of the resonance indicator designed for the 30-lb. portable transmitter.

The antenna coil consists of five turns of the same gauge wire arranged as shown in the sketch. This is placed between the two main inductances and their ends are clipped into two Fahnestock clips fastened to the baseboard.

The form for winding the chokes is shown in both sketch and photograph. Eight long, headless wire nails are driven, in a 1¾ inch circle, in a board. Then, 40 turns of No. 22 DCC. copper wire are wound around them to form an eight-pointed star. This is done by winding around one nail, then



Schematic circuit of the complete portable transmitting and receiving radio set designed by Mr. Robbins. The antenna coil is not tightly coupled to the transmitter, the antenna coil being in adjustable relation to the oscillator coils.

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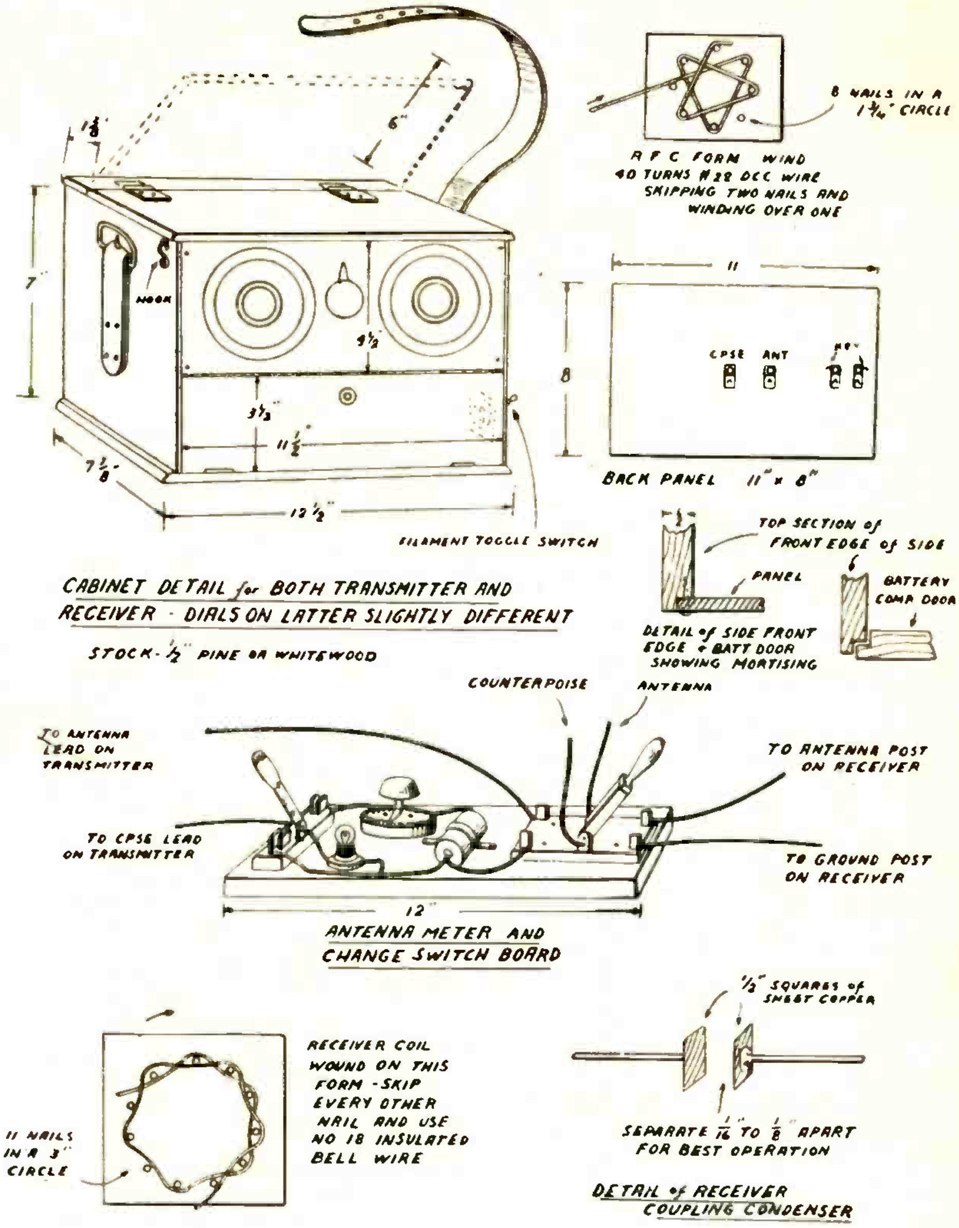
skipping inside two, around the fourth nail and so on until 40 complete turns have been made. Their hold-downs consist of a little piece of thin wood placed over them and held to the base by a match stuck in a hole in the base. This is shown in detail sketch. By following the schematic diagram and the accompanying photographs all constants will be found and the layout and wiring are fully explained. All battery connectors consist of Fahnestock clips fastened to the base with flexible wire leads of sufficient length.

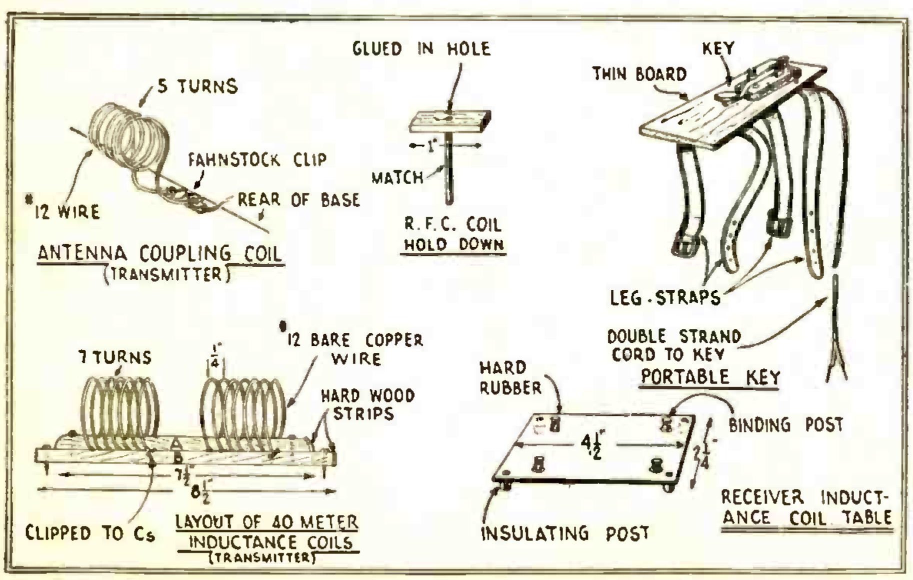
The key is attached to a piece of thin board 10 inches long with two straps underneath for strapping it around the leg of the operator. Two leads of insulated flexible wire serve to connect it to the clips in the back of the transmitter.

For the transmitter three blocks of "B" battery 5¼ x 2½ x 3 inches, totalling 67½ volts, and one or two "C" batteries furnish the power. The "B" batteries are wired direct to the clips above on the base board and the "C" batteries are wired to the usual "A" battery posts through the toggle switch.

It must be remembered that the "A" power of the transmitter is small and the latter should be turned off at the end of each transmission but, notwithstanding that, a single "C" battery will furnish power for upward of 100 operating hours. The small "B" batteries should last for 3 to 5 months with average use depending upon the quality and size used.



Arrangement of parts for the antenna and radiation controls, and construction details of the cabinet which is similar for the receiver and the transmitter.



Mechanical details of the transmitter and receiver components. This is a very inexpensive radio design.

Receiver Assembly

Assembly of the receiver should offer no serious difficulties. The base and panel are the same size as used for the transmitter. Variable condensers and rheostat are mounted in the same relation. The antenna coupling condenser consists of two little plates of brass or copper ½ inch square and separated a sixteenth to an eighth of an inch. A stiff wire soldered to one plate allows it to be slid through a binding post hole and proper adjustment thus made. The inductance coils are wound of common

(Continued on page 82)

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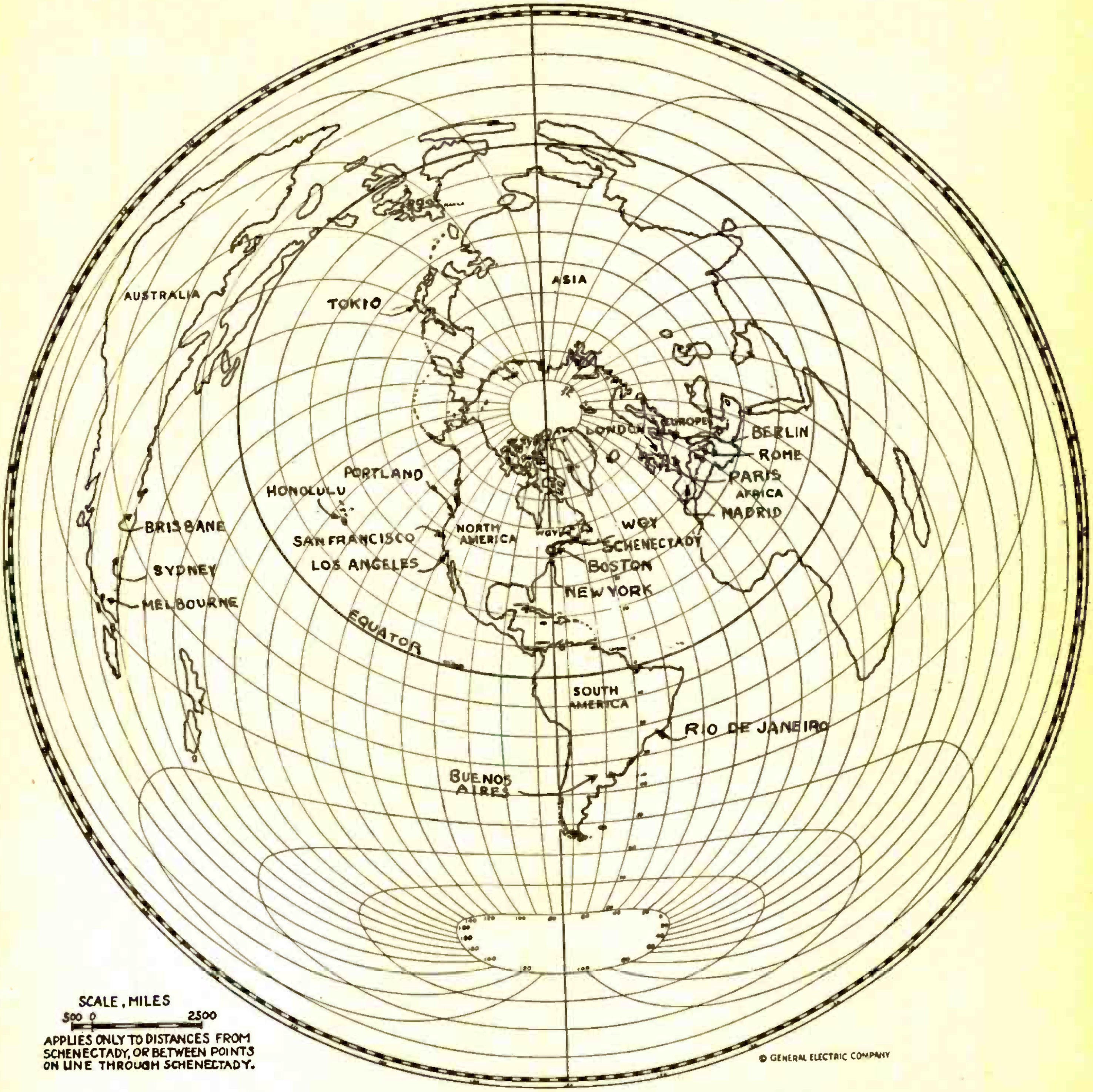
A Straight-Line Radio Distance Map of the World



By means of the straight-line, world distance map reproduced above, through the courtesy of the General Electric Company, one can determine the distance of a foreign radio station in a straight line from WGY, Schenectady, New York, by simply measuring the distance between that point and the foreign station on a piece of paper, and then refer this measure to the scale found in the lower left-hand corner of the map. At a later date we hope to furnish some more of these maps with different cities as the center point.

ARE YOU A MEMBER OF THE S.W.P.H.?

You haven't heard of this great and growing society? No? Bet you a layer of Heaviside that you are a S.W.P.H. yourself. What's its meaning? Must we spell it for you? Alright.

SHORT-WAVE PHONE HOUND

The S.W.P.H. is that sort of a doggone hound who hounds every distant-country station imaginable and then gets acknowledgment cards by the bushel—maybe.

But most important, when he has hounded his quarry to his lair, he promptly writes the Editor of S.W.C. all about it; and he, poor sap, not knowing better, prints the letter for the benefit of all other S.W.P.H.

So therefore, all you S.W.P.H., be sure to join the society PRONTO and report all the queer happenings at once if not sooner.

M. U. FIPS, Secretary, Society of S.W.P.H.

P.S.:—And the less you fib, the better!

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How to Build a 2 in 1 Receiver

A most novel arrangement, permitting double-band reception without need for changing coils (in the usual sense). A switching system changes from one range to the other. This is a practical scheme. Additional bands may be provided by the exercise of a little ingenuity

By
LOUIS B. SKLAR

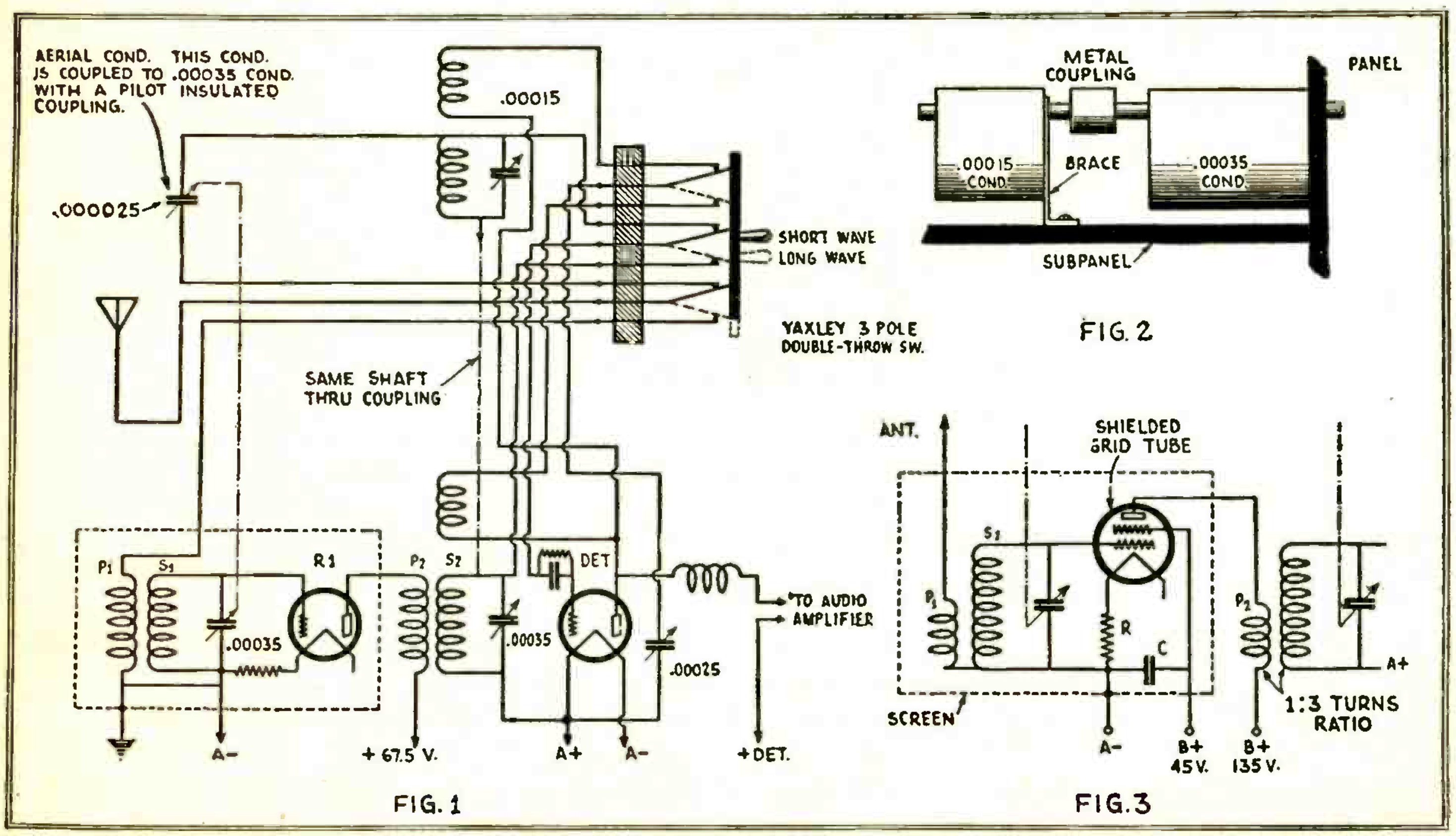
THE radio set to be described is a combination short-wave and broadcast wave receiver. (The range of this particular receiver was from thirty to five hundred fifty meters.)

This radio receiver differs radically from all other types. There are no adapters and no extra tuning dials. The change over from the broadcast wave to short wave and *vice versa* is accomplished by the turn or movement of a three pole double throw switch. Of course when you want to get the full range of the short wave channels, it will require changing the plug-in type coils for the various wave lengths. The radio fan will soon find, however, that a few of his favorite short-wave stations will come in on one and only seldom on two coils. In this case, he will leave a particular coil permanently in the set.

The same two tuning dials used for the operation on the broadcast wave channels are used on the short waves; the same tickler or regeneration control is used for all wave lengths.

I have constructed this set and had it in operation for several months with excellent results. It was satisfactory as a short-wave receiver, enabling me to reach distant stations, which I could not get with the regular broadcast receiver. It was also a sort of pleasure that this was obtained without any extra attachments and with the least effort.

Many times when my friends listened to distant stations coming from the loud speaker of this radio set they wondered how such great distance could be received with an ordinary four-tube set. There wasn't anything different in the method of tuning to lead my friends to suspect that a short-



Schematic circuit of the dual-range receiver described by Mr. Sklar. Fig. 3 illustrates the circuit to be used if a screen (shielded) grid tube is used as *R*1. It will be necessary to use particular care when shielding the parts associated with this tube, as indicated by dotted lines. This receiver will function very differently on different antennas, during short wave reception.

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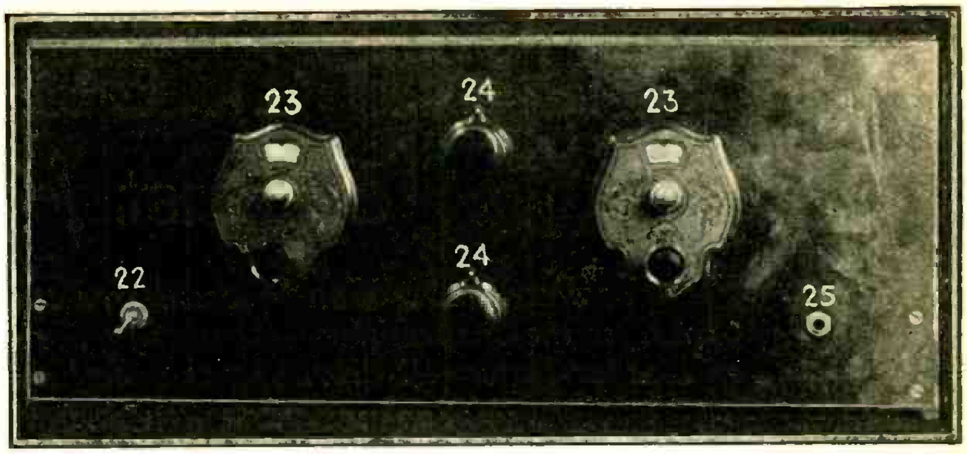
wave receiver was hidden somewhere in the console in which the radio set is housed. When signals faded only an expert would suspect "short waves."

The use of short waves has long been advocated for reception during the summer months when static is most prevalent. (In the countries of the torrid zone, short-wave operation is the only satisfactory means of communication with distant points.) If broadcast reception on the short waves is distorted, it will almost certainly be due to heterodyning between the short-wave fundamental and the harmonic of some higher wave station, or to its being one of the harmonics and not the fundamental frequency of the station to which you are listening.

Method of Construction

The construction of this Two-in-One Receiver is extremely simple. Anyone who knows how to handle a soldering iron and can follow a radio schematic diagram will have little trouble in building it.

The schematic diagram shown in Fig. 1 illustrates the way in which the set is changed from a long-wave to a short-wave receiver. Fig. 2 shows the mounting of the short wave condenser and how it is coupled to the shaft of the long-wave condenser. The coupling used on the first or radio frequency stage condenser is an insulating type coupling; the one used on the detector circuit tuning condenser is a metallic coupling. The two photographs and list of materials should enable anyone to get the proper parts and arrange them on the front and sub-panel for best results.



At right (above), panel arrangement of the "Two-in-One" receiver. The dials are of the illuminated type. If operation of the circuit-change switch is desired at the panel, one additional control knob will require to be provided for.

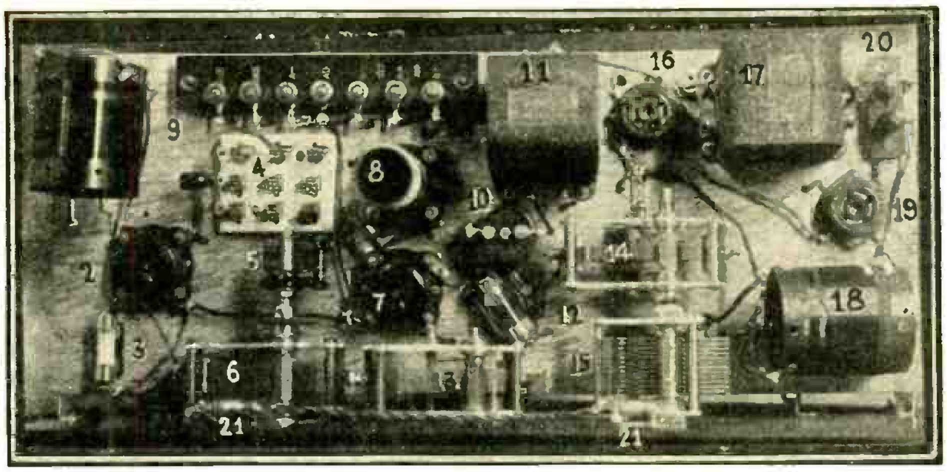
The three-pole double-throw switch can be of the "jack" type. When this type switch is used the change over can be made by shifting the small knob on the front panel; or, an ordinary blade type disconnecting switch as shown in the photograph can be used. In the latter case it will be necessary to "get inside the set" (to use a colloquialism) to make the change over.

Method of Tuning

I believe that there is no need of explaining how to tune the regular broadcast receiver. As to the short-wave part of the receiver, the method of operation is somewhat similar to any regenerative type of radio set. To tune in short wave transmissions the tuning operation must be done very slowly. A little patience and a few days' practice will enable you to tune this set instinctively and you will be able to tune in the short-wave stations without any difficulty.

The radio enthusiast building this two-in-one receiver will find that he will be amply repaid for his effort.

Anyone having a four-tube set similar to the long-wave part of the receiver herein described can very easily change it to a two-in-one radio set by making the necessary changes and additions.



⁂

At left: Parts layout of the 2-band receiver. The porcelain-base switch shown may be replaced by a good make of low-capacity, panel-operated switch. It may be advisable to make special mountings to hold the variable condensers rigidly. At the shorter wavelengths any undesirable motion of the variable condensers will make tuning difficult.

⁂

List of Materials

1. Radio Frequency Stage Transformer.
2. Radio Frequency Stage Socket.
3. Fixed Resistor for R.F. and 2 Audio Tubes.
4. 3 Pole Double Throw Switch.
5. .000025 Variable Condenser.
6. .00035 Variable Condenser.
7. Detector Tube Socket.
8. Short-wave Plug-in Coil Socket. (4 coils required.)
9. Binding Post Strip.
10. R.F. Choke.
11. First Audio Stage Transformer.
12. Grid Leak and Condenser.
13. .00025 Variable Condenser.

(Continued on page 81)

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Five Meters or Bust!

By CLYDE A. RANDON

Peculiar circuit conditions encountered at five meters—how to adjust the transmitter—measuring the wavelength with Lecher system—calibrating the oscillator wavelength

SEVERAL years' experience of the wavelengths below twenty meters has resulted in a wealth of practical information which is of unusual interest; because these frequencies are practically unexplored and are fertile ground for experimenters and amateurs interested in extraordinary effects. Ordinary apparatus can be used for work at five meters and, with the description of a receiver and transmitter which are easily constructed at small cost, in this article, anyone interested can successfully operate here.

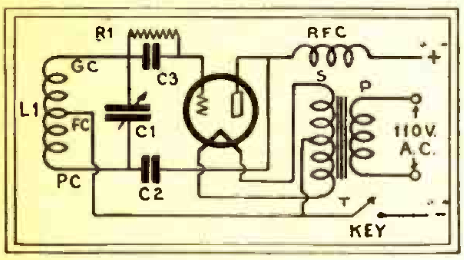

Fig. 1
The original Hartley circuit as used at, say, twenty meters before starting to overhaul it for five-meter work.

The ordinary experimenter, when attempting operation for the first time at the extremely short wavelength of five meters, usually makes several mistakes. In the first place, the existing transmitter and receiver in the station are dismantled, partly at least, and entirely new outfits are hooked up. Needless to state, they do not operate at once, and the experimenter is at a loss to explain why.

The reason is not difficult to see. An automobile designed to have a maximum speed of sixty miles an hour simply will not go eighty; and the ordinary tubes and equipment designed for low frequencies simply will not operate successfully at higher frequencies. The conditions are so very different that special

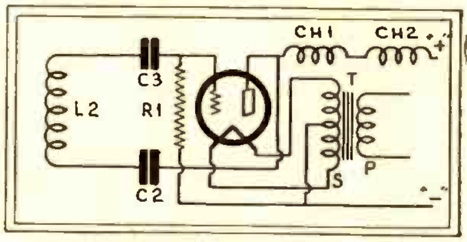

Fig. 2
Now the circuit of Fig. 1 has been cut down to about half the former wavelength, with only a couple of turns in L2.

precautions must be taken. One should go about the work, at extremely high frequencies, in a systematic manner and gradually working from known to unknown conditions—and that's sufficient excuse for the following instructions.

Not Too Fast

Take it easy. Your present transmitter and receiver probably operate at forty meters; but the procedure applies equally well to a twenty- or even an eighty-meter transmitter. First, gradually reduce the number of turns in the inductor (the popular Hartley circuit shown in Fig. 1 will be used for an example). Each time, reset the filament clip properly and readjust the set for proper oscillation, testing for this with the station wavemeter. If none is available for use at the very high frequencies, shunt a 5-plate condenser (or some other convenient size) across a small coil in series with a flashlight-lamp, as in the usual "ham" wavemeter. Each time, light the flashlight-bulb by coupling it to the transmitter.

If at any time the set will not oscillate, retrace your steps carefully, making one change at a time, until oscillation is again produced. In the vicinity of fifteen meters, it will probably be discovered that changing the R.F. choke in the transmitter to a couple of small coils Ch1, Ch2 (described later) connected in series, as shown in Fig. 2, will again restore oscillation. When oscillation is again produced, the number of turns can be reduced still further, while allowing the set to operate properly.

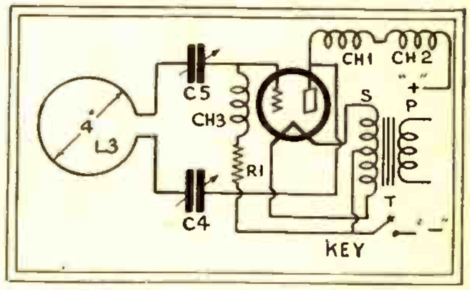

Fig. 3
Our final five meter-circuit, with midgets at *C4* and *C5*, and a single four-inch loop *L3* for an inductance.

It will be at last found that the tuning condenser across the oscillating circuit can be removed, because the distributed capacity of the coil is sufficient for oscillation.

No filament clip is necessary. In fact, operation is often extremely erratic when a filament clip is used; and oscillation can be produced, under these conditions, only by inserting in the filament-clip lead a small condenser or choke

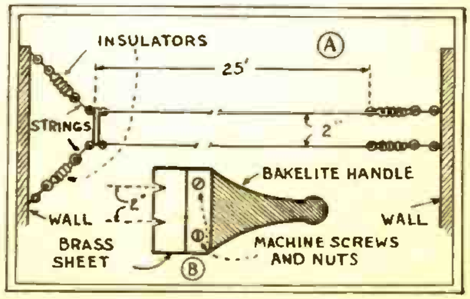

Fig. 4
On the Lecher wires, shown at A, "standing waves" may be set up. The bridge B determines the dimensions of the oscillating circuit.

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coil. But operation is better without any filament clip at all, as shown in Fig. 2.

Short, Short Waves

At this point (about ten meters), it will be found that reducing the number of turns (which are now two or three, and small in di-

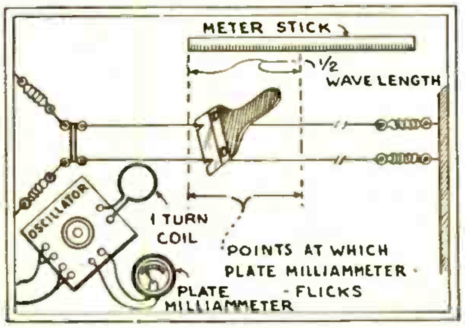

Fig. 5
Use of the Lecher wires enables us to measure the wavelength of a transmitter, with a very good degree of accuracy.

ameter) will not give strong oscillation. The next step is to shorten the length of the plate and grid leads. This will result in a surprising decrease in wavelength, with the same size inductor. At this point, it will be necessary to remove the plate and grid-blocking condensers (which have a value in the order of 100 mmf. in the usual forty-meter transmitter) and replace these with small midget variable condensers of about 32 mmf. (seven plates, or so), C4 and C5 in Fig. 3. The grid leak should be connected to the filament, and a small 30-turn basket-weave coil Ch3 (about one inch in diameter) placed in series, to confine the R.F. currents to their proper paths. It will be found that the wavelength is controlled easily, by varying the capacity of the blocking condensers. The coil is now replaced by a single four-inch loop of copper tubing L3, and the transmitter will be operating at approximately five meters; but one can never be sure unless the wavelength is accurately measured, as described later. The final circuit is shown in Fig. 3.

Since the operator has gradually reduced the wavelength, much has been learned as to the practical differences between a forty- and a five-meter set. The latter is slightly harder to adjust, since any small changes also affect the frequency; but the experimenter will find real enjoyment in trying various tests at these extreme frequencies.

Measuring Short Waves

The wavelength of the transmitter must be known accurately, if one is to operate "on the air;" it is easily measured with Lecher wires. These are simply two parallel wires spaced about two inches apart, left "open" at one end and "shorted" at the other, as shown in Fig. 4A.

For five-meter measurements, the wires should be about twenty-five feet long and spaced about two inches apart; although this separation is not critical. Since the waves are measured along the wires, it is necessary to have them of sufficient length; twenty-five feet is approximately correct. Details of the "bridge" or shorting handle are shown in Fig. 4B; the two triangular cuts in the bridge fit over the wires, and the brass piece slides along them while measurements are being taken.

The wires are supported by strong cords fastened to them, and must be well-insulated from surrounding objects, if good results are to be obtained.

The set-up for measuring the length of the waves impressed on the wires is shown in Fig. 5.

The oscillator is coupled loosely to the shorted end of the wires, and the bridge is moved along the wires, to short them at the other end. In certain positions, the plate milliammeter in the transmitter will show an abrupt change. When one of these positions is discovered, a mark should be made on the wires. The bridge is then moved along them until another such position is located. The distance between any two such positions is just half a wavelength. This distance should be accurately measured, preferably with a meter-stick (obtainable at any store dealing in drawing supplies). Suppose that the distance between two such positions is found to be 2.65 meters. The actual wavelength of the oscillator is then obtained by multiplying this value by two. The transmitter is thus operating on a wavelength of 5.30 meters.

(If a meter-stick is not available, inches multiplied by .0254 will give the meters.—*Editor.*)

Calibration

The wavelength of the oscillator may now be reduced, and other wavelengths determined. These values may be marked on the oscillator scale; but it is preferable to transfer them to a small wavemeter constructed of a 4-inch loop of copper tubing and a 32-mmf. (7-plate) midget variable condenser. Thus, one can always refer back to the wavemeter, in case some alteration is made in the transmitter which changes its dial settings.

To calibrate the wavemeter, simply measure the wavelength as described above; then, before changing anything, couple the wavemeter's coil to the oscillator and vary its condenser until the plate current in the oscillator shows an abrupt change. The wavemeter is then tuned to the oscillator's wavelength.

Since the wavemeter, the oscillator and wires are all tuned to the same wavelength, and this wavelength is known, from the Lecher-wire measurements, this value may be marked on the wavemeter scale. Other points are obtained by changing the wavelength of the oscillator, measuring the new distance on the wires, and marking a new point on the wavemeter's scale, as before.

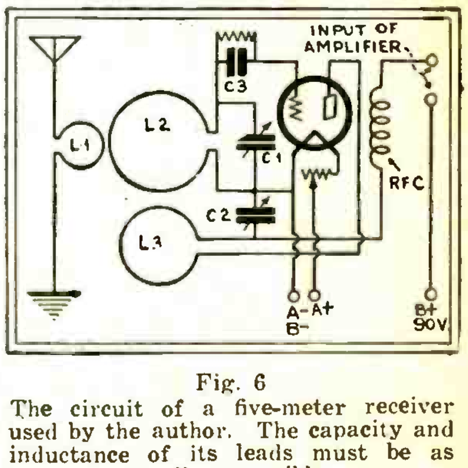

Fig. 6
The circuit of a five-meter receiver used by the author. The capacity and inductance of its leads must be as small as possible.

With a calibrated oscillator in operation in the five-meter band, it is extremely simple to build a receiver (Fig. 6) and adjust it to receive on the transmitter's wavelength. There are, however, certain important factors which must

(*Continued on page* 82)

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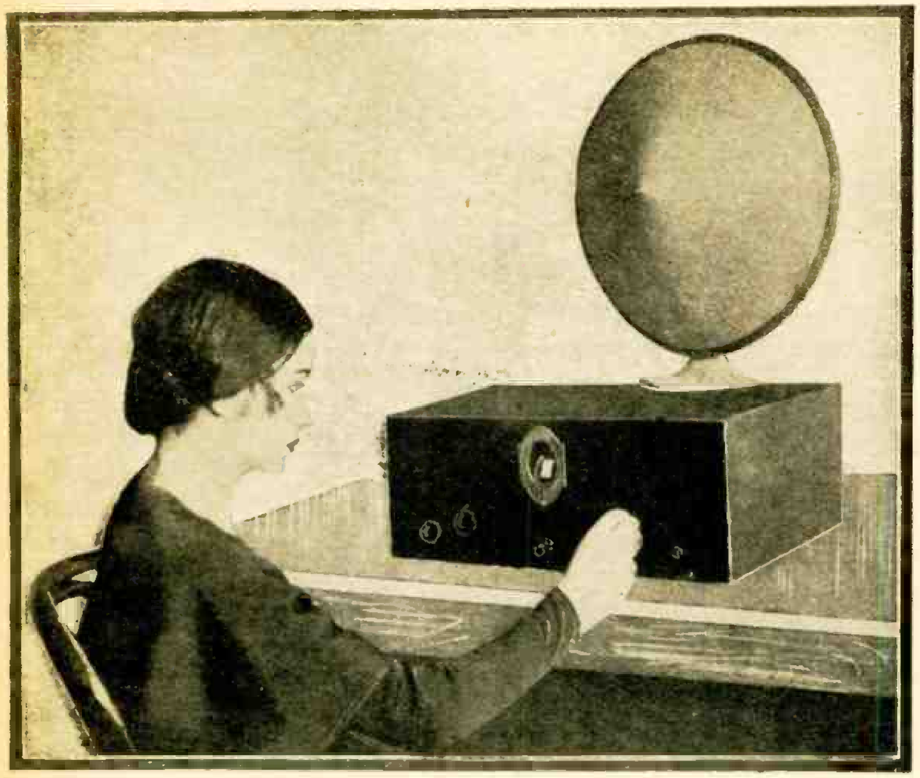


Miss Ann Seeley tuning in a short-wave station, on loud speaker, on the "Find-All Four."

The Short Wave Find-All Four

By
H. G. CISIN, M.E.

This article will interest all beginners in the short-wave art, as the assembly and wiring stages are all numbered and detailed A B C fashion. This is really a kindergarten lesson in building a short-wave receiver.

CAREFUL wiring is essential in a short-wave receiver. All wiring should be as short as possible, using Corwico Braidite flexible hook-up wire. It is desirable to keep radio frequency conductors away from each other, wherever possible, especially avoiding capacity coupling between grid and plate circuits. Extra careful attention should also be given to the making of soldered joints. These should be perfect, both mechanically and electrically and only a rosin core solder, such as Koster's should be used.

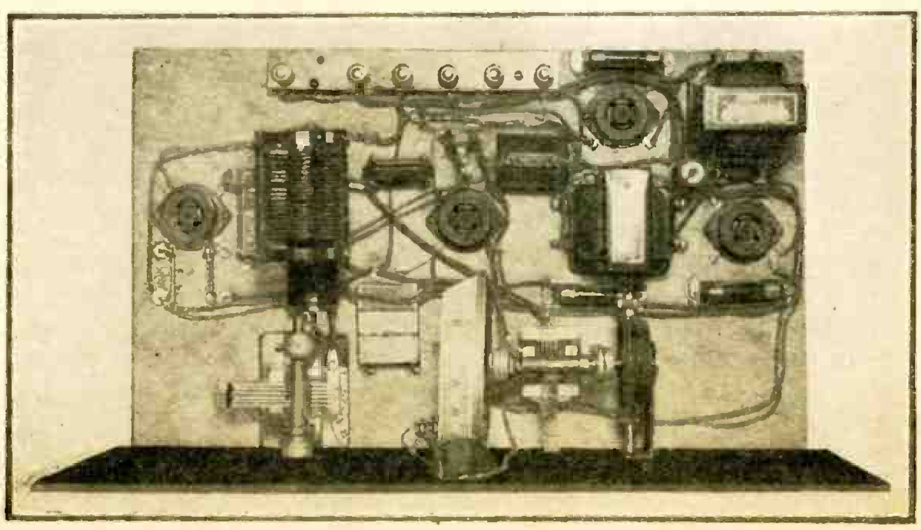
The wiring procedure is given below in eight steps:

1—Wire the positive filament circuit from the "A" plus binding post (29), through the filament switch (27) to the plus filament terminal of each socket. Solder one end of resistance (5A) to the filament terminal of socket (4), soldering the positive lead to the other end.

2—Wire the negative filament circuit from binding post (28) to one end of resistance (5) and also to one end of each of the amperites. The latter are shown grounded in the schematic diagram merely for the purpose of simplifying the diagram. The other end of resistance (5) is soldered to the negative terminal of socket (4), while the other ends of the amperites are wired to the negative terminals of their respective sockets.

3—Wire all grid circuits. Note that the connection from the antenna side of the Tonatrol (2) goes to the *cap* of the screen grid tube (4). For this connection, solder a screen grid clip to one end of a piece of flexible Braidite, fastening the other end to the Tonatrol. At this time, wire in grid condenser, grid leak, and also Electrad potentiometer (13A).

4—Wire in all plate circuits. Plate terminal of socket (4) is connected to the isolated terminal (that is, to the one away from the three grouped together), of the coil mounting (9) and thence is connected to the *stator* of the Hammarlund short-wave condenser (7). Connect the rotor to the other end of the coil winding—that is to the next adjacent terminal on the coil mounting. Wire in tickler coil, shunting it with variable resistor (11). Also wire in



Top view of "Find-All Four" Short Wave Receiver.

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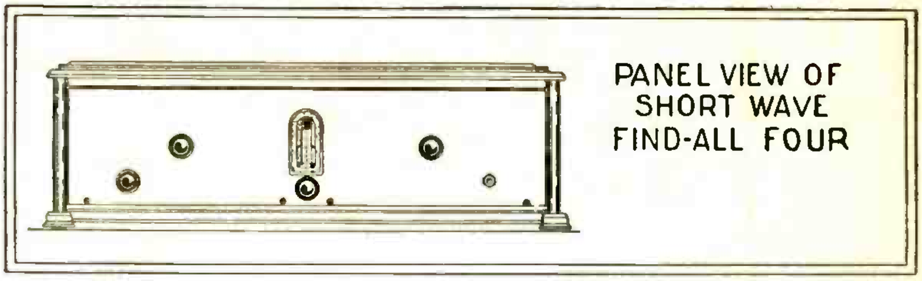

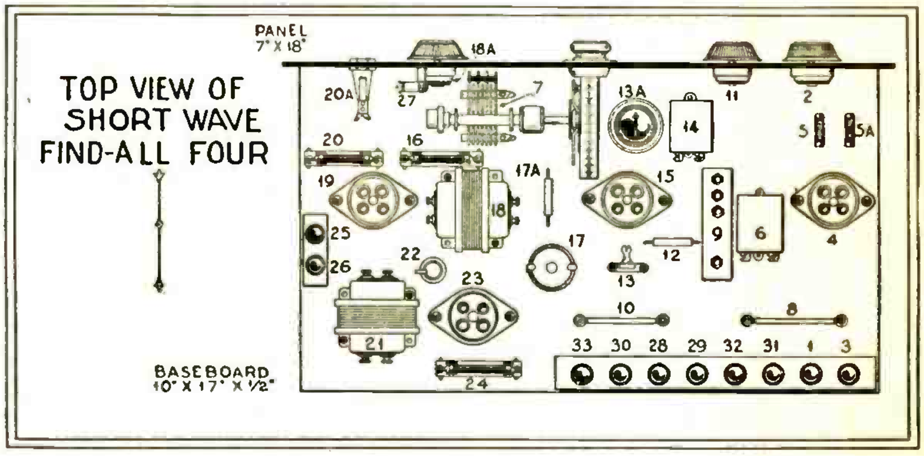

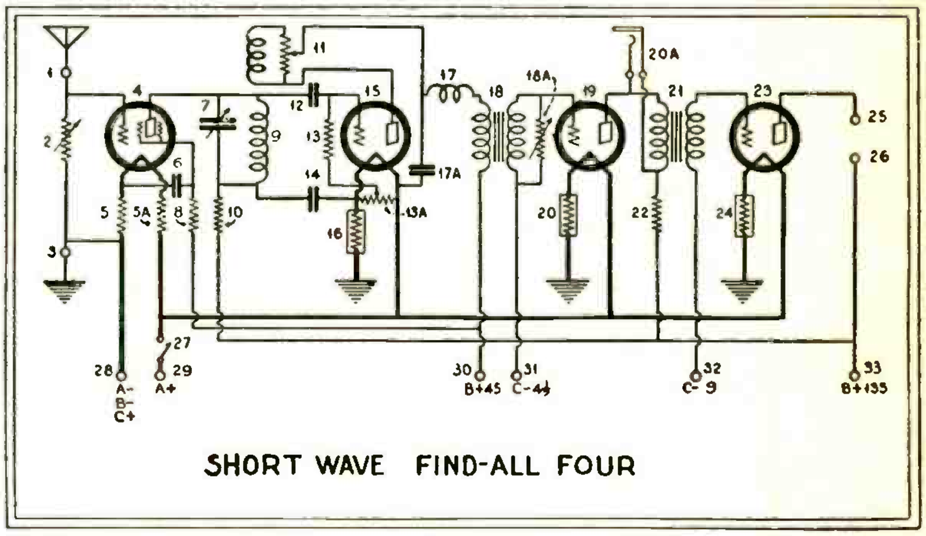

A baseboard layout, as well as schematic wiring diagram showing all the connections of the "Find-All Four" Short-Wave Receiver, are given above. Also a front view of the cabinet.

choke (17), jack (20A), and connection between plate terminal of socket (23) and post (25). Wire in all "B" plus and "C" minus returns.

5—Wire the double grid circuit, from grid terminal of socket (4), through flexible resistance (8) (which is soldered in place) and thence to "B" plus 45 line.

6—Wire in all three Polymet by-pass condensers.

7—Wire in Tonatrols (18A) and (2).

8—Complete connection from ground post (3) to the "A" minus post (28).

Assembly Details

The assembling details are given below in fourteen easy steps. Note that all mounting directions are given with observer facing panel or panel edge of baseboard.

1—Mount the Silver-Marshall drum dial on the center line of the baseboard, at the panel edge.

2—Mount the .00014 mfd. Hammarlund condenser (7) to the *left* of the dial. This is shown at the right of the dial in the "top view" illustration, but it has been found preferable to place the potentiometer (13A) and the by-pass condenser (14) on the right of the dial, in order to bring the tuning condenser nearer the short wave coil (9). The condenser (7) will have to be raised about 5/8", by means of long screws or by washers, so that its shaft will pass through the center of the drum dial.

3—Mount the four Eby sockets, the amperite mountings and the Hammarlund short wave coil mounting, as shown in the top view illustration.

4—Mount the Electrad potentiometer (13A) and the Polymet by-pass condenser (14) to the *right* of the drum dial.

5—Mount the two Thordarson transformers (18) and (21).

6—Mount the Electrad "B" type resistance (22) vertically, as shown—also mount the Silver-Marshall r.f. choke (17).

7—Mount the grid leak mounting (13) and the Polymet condensers (12) and (6). These two condensers are to be mounted flat, as shown.

8—Mount the eight Eby binding posts on a long composition strip and fasten this at the left rear of the baseboard. Also mount the two posts (25, 26) on a small composition strip and mount at the right side of the baseboard. The remaining parts (5, 5A, 8, 10, 17A) are soldered in place while wiring.

9—Prepare the panel for mounting, drilling the mounting holes for Electrad Tonatrols (2) and (18A); for the Royalty variable resistance (11) and for the small jack (20A). These parts are to be located symmetrically, as indicated on the "panel view." Parts (11) and (18A) are on the horizontal center line of the panel, each being about 4" from the vertical center line. The jack (20A) and Tonatrol (2) are mounted 2½" from the right edge and left edge respectively and 2" from the bottom of the panel.

10—Drill a large hole on the vertical line for the drum dial window. Use the escutcheon plate

(*Continued on page 68*)

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Solving Frequency, Wave-Length and Capacity Problems—Without Mathematics

By SYLVAN HARRIS

SYLVAN HARRIS is well known as a radio engineer, editor and writer and he here presents a series of simplified charts, whereby the radio student and set designer can ascertain the proper inductance and capacity to use in order to tune to certain wave lengths or frequencies. We are sure that our readers will find this article of extreme importance and value.

Mr. Harris has here provided easily read charts from which any one can determine what size condenser to use with a given inductance, or vice versa, when the wavelength or frequency is known—all without the use of mathematics, which are none too well liked by even the student of radio himself. With the directions and charts here presented and described by Mr. Harris, the exact relation between frequency, wavelength, capacity and inductance can be at once determined, without any tiresome calculations. Preserve these charts for future reference.

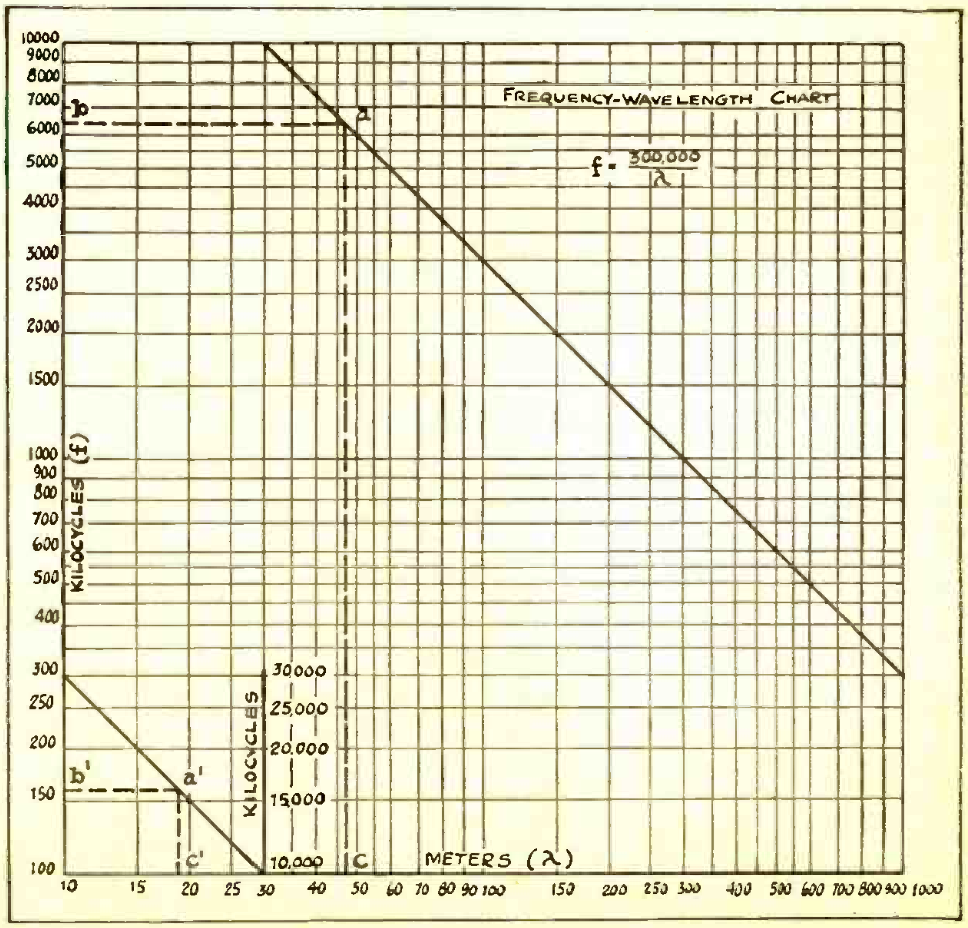
AS YOU are well aware, the need for staying on your wavelength is becoming more and more urgent every day, due primarily to the great number of stations which are now on the air, and which is increasing steadily. The problem of allocating all these stations in their proper places in the frequency spectrum is an enormous one, and a large amount of money, and a considerable amount of time is being spent by the government and large communication companies in the study of the problem.

It almost seems as if there are more communication channels required to handle the traffic of the world than there are channels available in the ether. And in the short-wave range of the spectrum the problem becomes more involved, due to the fact that when continued operation is required throughout the day it is necessary to change wavelengths or frequency at various times.

Transmission in certain directions and between certain stations requires operation at different frequencies at various times of the day. For example, reliable communication is possible between stations X and Z at a frequency of 7000 kilocycles in the early part of the night, whereas during the latter part of the night, or early in the morning, a frequency of, let us say, 4000 kilocycles is required for good communication.

We will not in this article discuss the reasons for this; many of you are already acquainted with the reasons. They include such things as the height of the Heaviside layer, the skip distance, the season of the year, the nature of the terrain over which communication is held, and many other things.

Just think what the problem means in connection with communication between ships or between ship and shore. During part of the ship's voyage the latter may be in daylight while the shore receiving stations may be in darkness.



This chart shows graphically the mathematical relations between frequency and wavelength. If we wish to check a frequency in kilocycles "b," we glance along the dotted line to the point "a", where it strikes the diagonal black line, and then look directly downward and read the equivalent meters wavelength at the point "c." Fig. 1.

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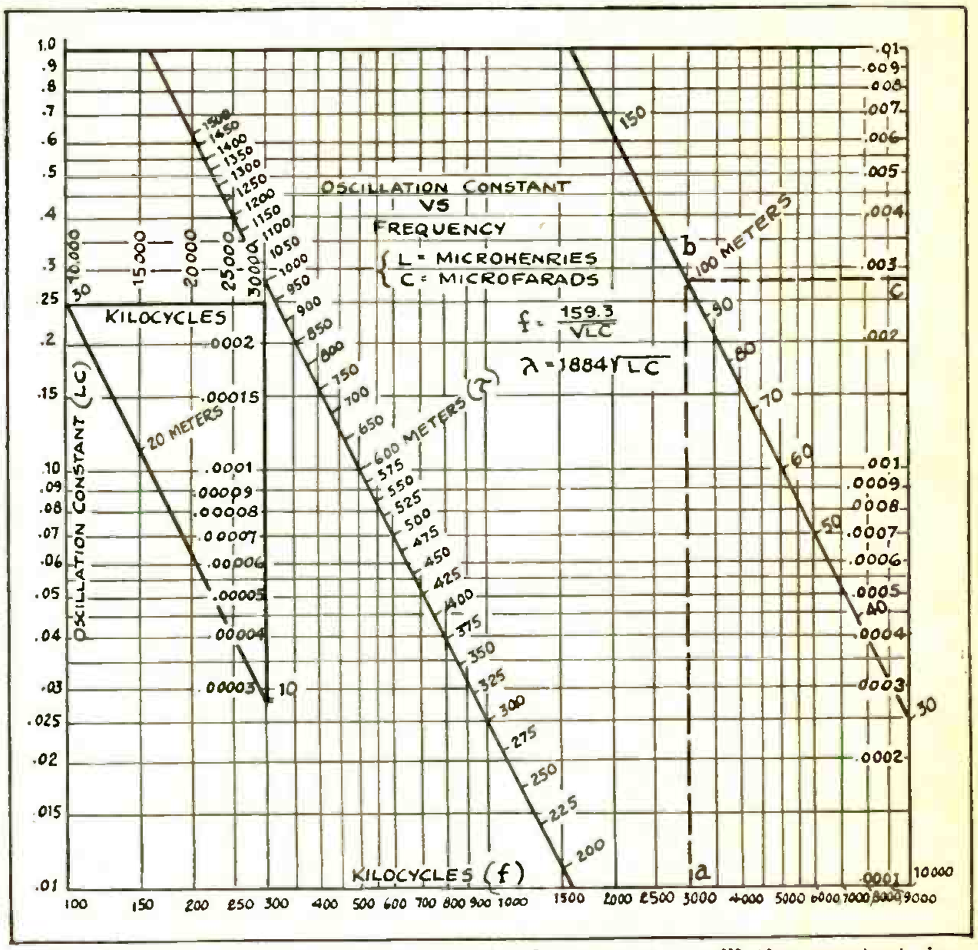
During another part of the trip the conditions may be reversed; the ship may be in darkness and the land stations in daylight.

Frequent Changes in Wavelength Necessary

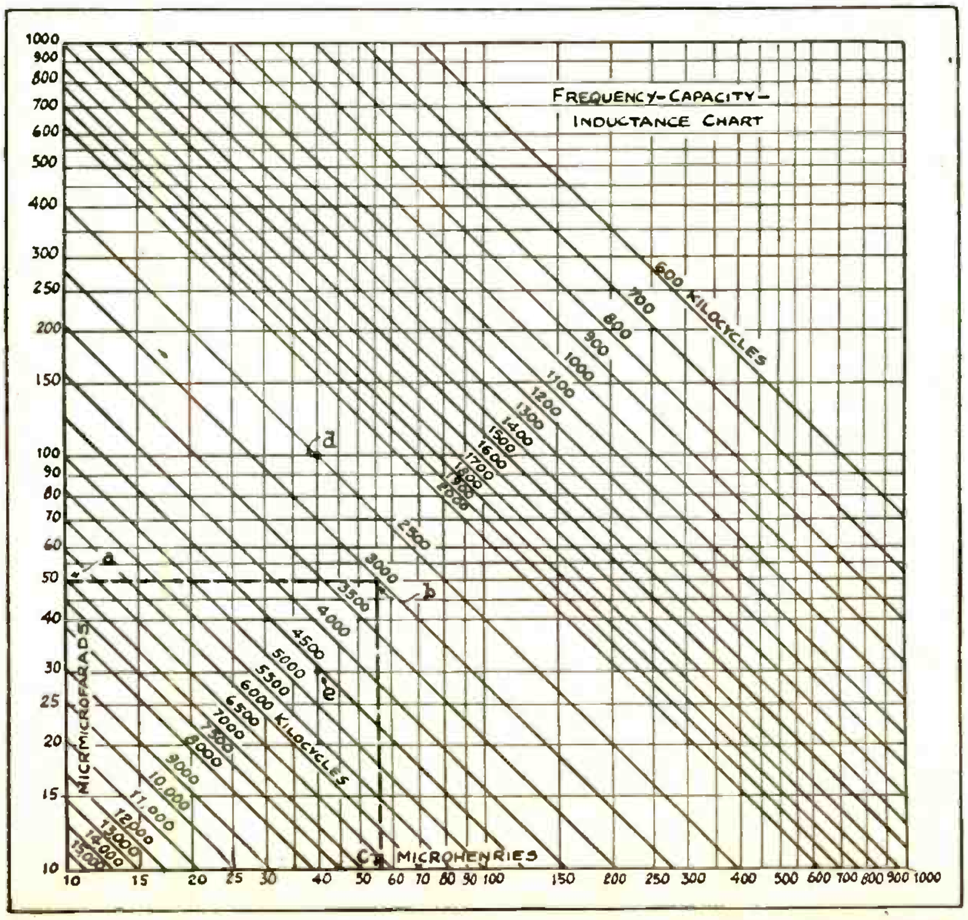
And between the conditions of darkness and daylight, all combinations of effects may be encountered. So, if continued communication between ship and shore is required, it is necessary to change wavelength or frequency several times during a trip. This means that commercial short wave stations require several communication channels, and these communication channels must be so chosen that no conflicts occur between stations of the same country or between stations of different countries.

At this point then, we see that in addition to the technical problems, there is involved also the matter of diplomatic relationship between the various countries. Try, then, to realize how many communication channels are required by each country of the world, and estimate what the sum total of all these might be. It is a difficult job, to say the least, and it is on this account that so much work is being done on the problem. Everybody wants to be satisfied, and yet there are only so many channels in the ether.

Recognizing the enormity of the problem, efforts have been made to utilize given channels for several simultaneous conversations or messages. So we have duplex communication, just as in wire telephony or telegraphy, we often have several conversations and telegraphs carried over the same wires simultaneously.



This chart shows graphically the relation between the oscillation constant, inductance multiplied by capacity, and the frequency in kilocycles. Its use is explained in the text. Fig. 2.



This chart shows the relation of three important radio quantities—the relations of frequency to capacity and inductance. Fig. 3.

Multiple Conversations On a Single Line

For example, over a given line we might have, and actually do have, a telephone conversation at ordinary audio frequencies, another telephone conversation transmitted by a carrier at one frequency, and another conversation transmitted by a carrier at another frequency; then we might have several telegraph messages going over the same wires. The arrangements are so made that no one channel of communication interferes with the other.

So we might go on and furnish many other instances to show how conservation of communication channels is a necessary and important thing, and we can go still further and show how it is just as important to amateurs as to commercial communication companies. One of the prime requisites for helping to conserve these channels is to keep on your wavelength or frequency. If your carrier wavers, even a trifle, you are likely to interfere with someone else's carrier, and cause trouble for both yourself and the other fellow. It is unnecessary to elaborate on this; you understand it fully already from your experiences in trying to separate the countless short-wave stations on the air every night.

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How to Adjust Your Wavelength Accurately

One way of maintaining your frequency constant is to use a crystal-controlled oscillator. But even this won't do any good if your crystal does not control at the proper frequency. So, perhaps the most important thing of all, or at least, the first thing of all, is to *know* what your wavelength is, or how to adjust your oscillator to the wavelength or frequency that is assigned to you.

There are several ways of measuring frequency or wavelength, with which you are undoubtedly acquainted. Perhaps the simplest and most reliable for your purposes, is that in which the wavelength is directly measured by means of a yardstick or meter stick, on a pair of Lecher wires.

In all this work, however, it is necessary to know what you are doing, and not to grope around in the dark. If you understand the principles of frequency adjustment, and are able to predict beforehand what your frequency will be, even if only approximately, you will save yourself a whole lot of work, and what is more important, a lot of uncertainty.

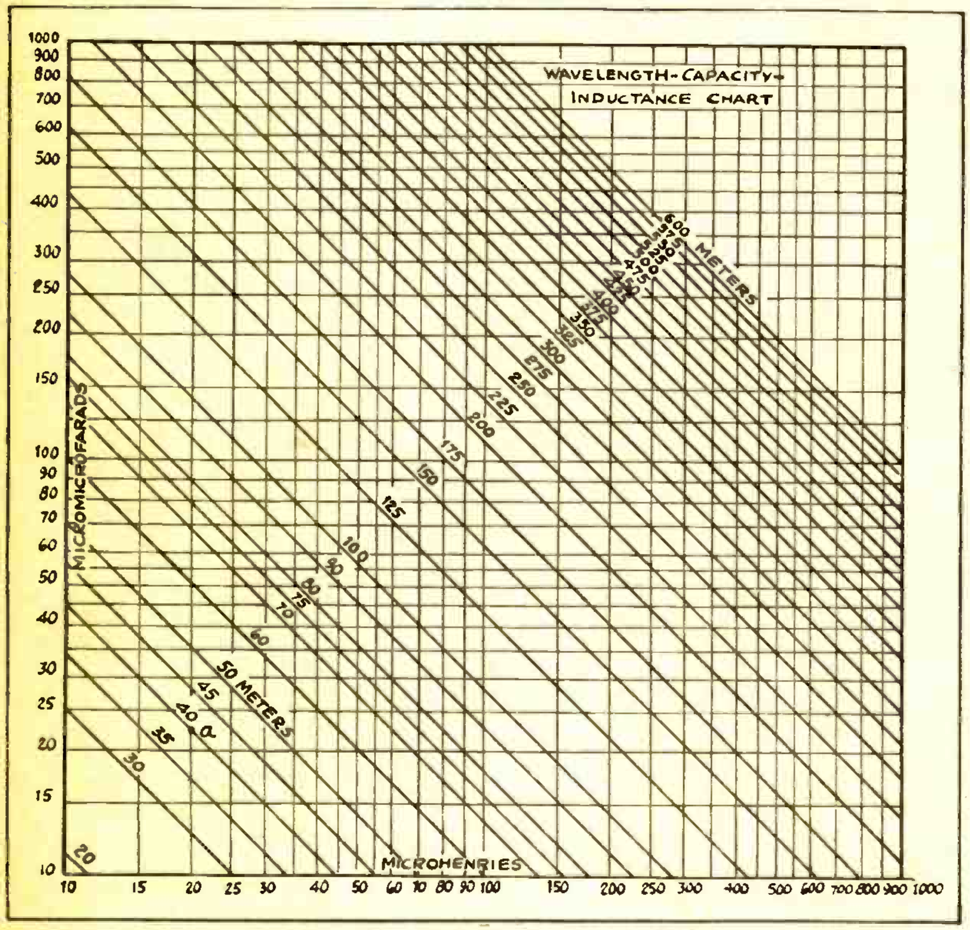
You are assigned to a certain frequency at which to operate your transmitter. You have next to consider the following problems in building it or in adjusting it:

(a) What values of inductance and capacity do I require in order to transmit on the assigned frequency?

(b) After obtaining the correct values of inductance and capacity, it is necessary to check the wavelength. Then, knowing the wavelength by the measurements on the Lecher wires, what is the corresponding frequency? Or, conversely, if my assigned frequency is so-and-so-much, what should the wavelength be, as measured on the Lecher system?

Solving Wavelength Problems Without Mathematics

There may be various other problems of similar nature involved in this work, and in order to simplify the problems, the charts shown in this article have been calculated. By means of these charts many problems of tuned circuits can be solved in a second, without having to bother with mathematics of any kind, even ordinary arithmetic.



This chart illustrates the relation between capacity in MMF and the inductance in microhenries, with respect to any given wavelength. Fig. 4.

Glance at Figure 1. When you find that your assignment is 6400 kilocycles, all you have to do is to look up 6400 on the vertical scale of Figure 1, as at the point b; then travel over to the curve, at the point a, and then drop down to the bottom to the point c. Immediately you know your wavelength is to be 47 meters. Or, to put the problem the other way, if Tommy Jones tells you his wavelength is 47 meters, start at the point c, at 47 on the horizontal scale, travel upward to the curve, at a, then over to the vertical scale, at b, and you know his frequency immediately.

The upper curve of the chart covers wavelengths from 1000 meters to 30 meters, and frequencies from 300 kilocycles to 10,000 kilocycles. The lower curve of the Figure 1 covers wavelengths from 30 meters to 10 meters. For example, a wavelength of 18.7 meters, indicated by the point a' indicates a frequency of 16,000 kilocycles, indicated by the point b'. You will find this chart a very simple one to use, and a very convenient one.

Now, in Figure 2 we have a means of calculating our inductance and capacity. You know that for any given wavelength or frequency the product of the inductance and capacity of a tuned circuit, or $L \times C$, has a certain value. This value is given by the equations

$$f = \frac{159.3}{\sqrt{LC}} \text{ or } \lambda = 1884 \sqrt{LC}$$

where f is the frequency in kilocycles and λ is the wavelength in meters. L and C are in microhenries and microfarads, respectively. These two equations are really the same equation expressed in two different ways.

Although we have given you these formulas, you don't need them. We show you them only to point out the fact that the product LC determines the wavelength or frequency. So, if we happen to know this product for any frequency we can easily find the capacity required if we know the inductance, or the inductance if we know the capacity. Let us try an example.

Determining Values of Capacity and Inductance From Charts

Glance at Figure 2. At the bottom we have plotted horizontally the frequency in kilocycles, and the product LC, which is known as the *Oscillation Constant*, vertically. Suppose the frequency we are considering is 3000 kilocycles. This is the point a in Figure 2. Travelling upward from this point to the curve, and then horizontally, we find at the point c that the oscillation constant, or LC, is .0028. In other words, we can use any combination of capacity and inductance whose product is equal to .0028. Suppose our tuning capacity is 50 micromicrofarads. Expressed in microfarads, this is .00005. The inductance we have to use is then, .0028 divided by .00005 or 56 microhenries. In other words, find the oscillation constant for the given frequency from the curve of Figure 2, and then divide it by the capacity to find the inductance or divide it by the inductance to find the capacity. This is simple enough, isn't it?

There are several curves on Figure 2. The two upper curves cover a range of 160 kilocycles to 1500 and 1500 to 10,000. The third curve, on the left, covers the range 10,000 kilocycles to 30,000 kilocycles. The corresponding wavelengths have been marked on the curves. The wavelength ranges are 1500 meters to 20, 200 to 30, and 30 to 10 meters.

Even though this is a very simple matter, we are all of us inclined to be a little lazy; at any rate, we all of us like speed, so if we can avoid even simple calculations we like to do so.

(*Continued on page* 78)

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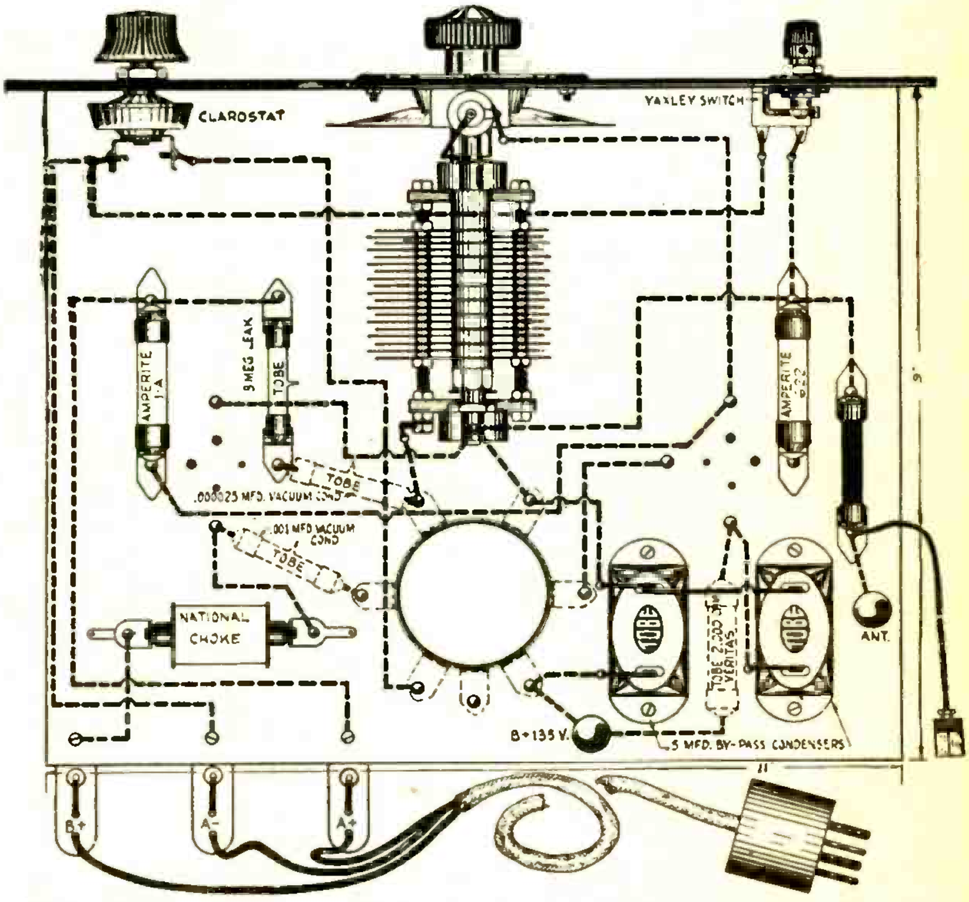
Short Waves for the Broadcast Listeners

An Improved Screen-Grid Short Wave Converter

The average broadcast listener is particularly interested in some method whereby he can readily and economically adapt his broadcast receiving set to the reception of short waves. The present article tells just how to build such a short-wave converter at reasonable cost.



Wiring diagram for screen-grid short wave converter here described. The cost of building this short wave converter is very small compared to the pleasure one will derive from it.

ALTHOUGH remarkable results have been obtained with the short-wave circuit including a screen-grid R.F. tube and a regenerative detector, the critical radio fans in many instances have sought something more refined for even better results. For one thing, the usual step-by-step resistor in the plate lead of the detector, which serves as a regeneration control, is not sufficiently precise to permit of the threshold regeneration adjustment that makes for maximum sensitivity. For another thing, the utmost performance cannot be had with the screen-grid tube in the absence of a critical voltage on the screen grid. With these requirements in mind, the refined circuit shown in the accompanying diagram has been developed.

As the one stage R.F. with regenerative detector rapidly became the outstanding circuit arrangement in home-built receivers during the great broadcast building era, so has a similar circuit won over the short-wave field. With this type of set just beginning to be appreciated, vast numbers of parts have been sold for these receivers.

The circuit used in short waves, however, uses an untuned input rather than a tuned antenna circuit, and in this way, differs from the accepted broadcast practice. The screen-grid tube serves several purposes. It permits the use of an antenna of any length without adjustment: it gives some amplification to the incoming signal; and, most important of all, it prevents

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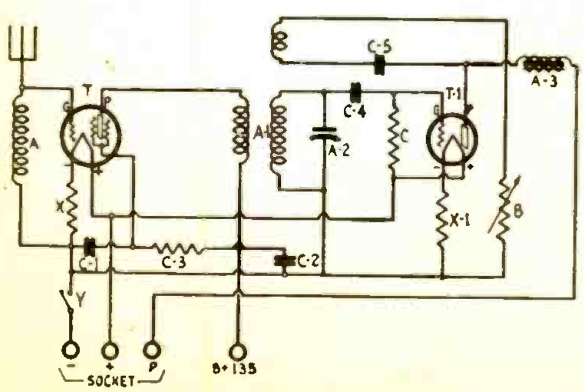

A: NATIONAL SHORT WAVE KIT INCLUDING FRONT PANEL AND SUB-PANEL, ALL PLUG IN COILS "A-1", TUNING CONDENSER "A-2", CHOKE "A-3"
B: GRIDLEAK CLAROSTAT
C: TOBE 8 MEG TIPON
C-1: TOBE BYPASS FILTER COND. 0.5 MFD.
C-2: " " " " "
C-3: " VERITAS 2000 OHMS
C-4: " .00025 VACUUM CONDENSER
C-5: " .001 " "
X: 622 AMPERITE
X1: 1-A "
Y: YAXLEY SWITCH

Schematic wiring diagram of the short wave converter here described, which utilizes a screen-grid tube in a radio frequency amplifying stage, together with a plug which fits into the detector socket of your set.

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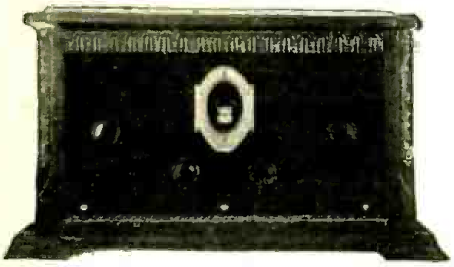


The adapter-receiver described in a small neat cabinet presents an appearance worthy of parlor use with a standard high-grade broadcast receiver.

The Hammarlund

By LEWIS WINNER

A particularly efficient short-wave receiver, which can also be used as an adapter to convert your broadcast receiver for the reception of short waves. This set uses a screen-grid R.F. stage.

BARRIERS of ice separated from jagged rock spotted with green and snow by streams, at some points a few feet, at others a mile—a portion of the frigid wastes never before seen by white man—hushed in silence, now and then upset by a wing flap of a strap penguin, the only inhabitant on this strange cold land.

A thickly wooded labrynth, here and there a patched hut with ravenous humans as inhabitants, swamps, snarling roving beasts—a lost world in the African or South American wilds.

A breathless group listens to the roar of an airplane motor, sees the chocks removed and a massive 'plane occupied by many people taxies down a long runway on the beginning of an epoch-making trip across the seas. Sight is soon lost of the 'plane, *but its progress is known—its mile by mile progress*—and almost instantly.

The events of the world at our window—thanks to short waves!

What are short waves? Why can they perform these paradoxical results? Why do they so overshadow long waves?

Well, wavelengths below 200 meters are arbitrarily called short waves; those below 5 meters being called ultra-short waves. They possess certain characteristics which enable them to travel great distances with low power.

Tremendous Range of Short Waves

The following table from an article entitled "Considerations Affecting the Licensing of High Frequency Stations," by S. C. Cooper, U. S. N., which appeared in the September issue of the *Proceedings of the Institute of Radio Engineers*, will illustrate the tremendous carrying power of short waves, a 1000-watt continuous wave transmitter and a receiver of moderate sensitivity being used:

Wavelength (Meters)	*Miles (Day)	*Miles (Night)
13.0-21.2	7000	Not useful
24.4-25.6	4000	Over 5000
27.3-31.6	2500	Over 5000
31.6-35.1	1500	Over 5000
41.2-45.0	1000	Over 5000
48.8-50.0	600	Over 5000
54.5-75.0	450	2500
75.0-85.7	300	1000
109.0-133.0	150	500
150.0-200.0	100	250

*Average distance.

The Short Wave Adapter Receiver

One of the newest short wave sets is known as the Hammarlund adapter receiver. As you will note, it uses that remarkable screen grid tube, in a highly efficient stage of radio frequency amplification, ahead of a super-sensitive regenerative detector, resulting in a short wave set that is stable as well as excellent on distance.

The positive, yet simplest, way to tune the antenna when the screen grid tube is used in the short wave band, is with a variable resistance in series with the antenna and ground. That method is here used.

Selectivity is maintained by coupling this screen grid tube to the detector tube with a tuned impedance, which is acknowledged to be the most effective way of coupling in this type of receiver.

In the detector circuit the parallel feed system is used. This permits the smooth oscillatory control so necessary in the short wave spectrum. With this method, oscillations do not come in with a "hang on" or "drag," when the regeneration condenser is reduced so as to stop oscillation. Instead there is that steady, velvety increase of feedback which enables even approach to the critical state of the tube, where the maximum sensitivity factor of the tube exists.

A midget variable condenser, C1, having a capacity of .0001 mfd. is used to control this feedback.

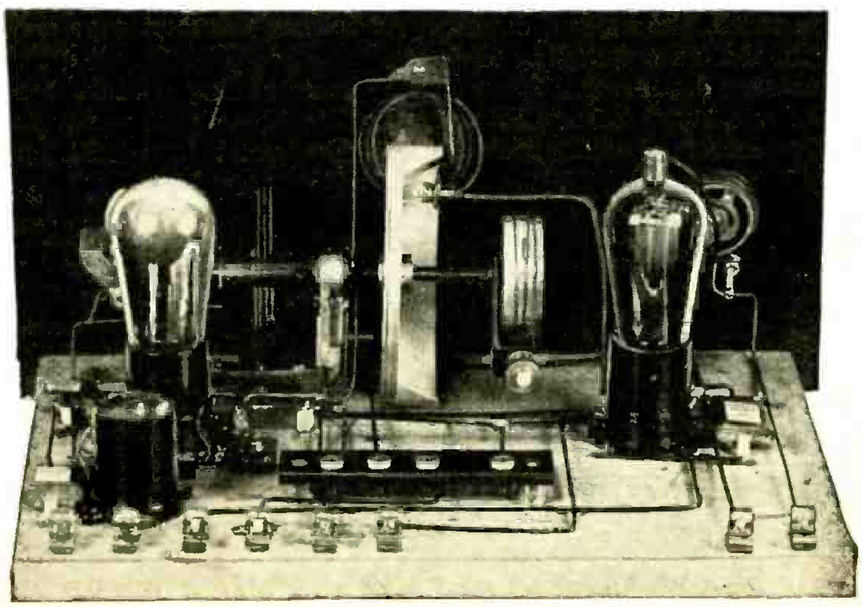
Special Low-loss Coils Used

To tune the grid circuit of the detector circuit as well as the plate of the screen grid tube, a .00014 mfd. variable condenser, C, is used. This value condenser allows easy tuning from 15 to 215 meters with the special Hammarlund plug-in coils.

On short waves there is nothing so important, so vital to successful operation as the use of low resistance coils, with a low distributed capacity.

Since dielectric losses increase very rapidly with the frequency, the absolute minimum must be obtained. This requirement is maintained in these coils by space-winding the turns (even spacing to secure uniform current distribution) over a continuous film of special dielectric 5/1000 inch thick, with No. 16 silk over cotton wire. The coil is wound ten turns to the inch, so that the spacing between the successive turns is slightly more than the diameter of the wire itself. This further reduces the distributed capacity and high frequency resistance.

Coupling the plate of the screen grid tube and the grid of the detector tube is



The simplicity of the adapter-receiver may be seen at once from this view of the chassis; the layout is obvious. Right-angle crossing of high-potential leads lessens undesired coupling.

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SHORT WAVE Adapter-Receiver

a 20 to 100 mmfd., condenser of the screw-control type. That is, the capacity is varied by means of a screw which runs through a phosphor bronze spring plate, a piece of mica and a brass plate and through another piece of mica and a rigid piece of phosphor bronze, all mounted on a bakelite strip, the screw controlling the distance between the spring and the brass plates, both of which are punched to facilitate connections. Its adjustment is not critical.

To eliminate unwanted radio frequency energy the condensers C3, C4 and C5 of .1 mfd. capacity as well as the radio frequency choke L4, with an inductance of 250 millihenries, are used.

Correct R.F. Chokes Important

The use of the correct choke is very important. The distributed capacity must be at minimum, since the frequency range is great and the choke is usually operated below its resonant frequency. That is. it is operating at a frequency where the only radio frequency that goes through passes through the distributed capacity.

Also when the choke is used in a regenerative circuit as here the inductance of the choke must be high. Otherwise the output of the circuit will be shorted at some frequency and thus prevent the circuit from oscillating at that frequency. The Hammarlund RFC250 fully complies with these requirements, having the necessary inductance. the unusually low distributed capacity of only 2 mmfd. and a direct current resistance of 420 ohms.

Wiring and Layout Must Be Watched

As has been stated, the receiver is an unusually sensitive one, capable of consistently picking stations across the seas. But, and a big but too, the wiring must be done carefully and the layout must be followed religiously. Carelessness in either or both will impair the results seriously.

It is imperative that all leads be as short as possible as well as direct. All wires carrying radio frequency currents should cross each other, if at all, at right angles and clear each other as much as possible. The lead length may be increased slightly to permit this.

All connections should be soldered wherever possible. Care should be exercised here not to use too much flux for this causes leakage.

The Wiring

And now as to the wiring.

A lead is connected from the antenna binding post to the resistance terminal of R, the tonatrol. A flexible lead to which has been soldered a tubular piece of phosphor bronze which is connected to the cap of the screen grid tube is also connected here. The other terminal of the tonatrol is connected to the center tap on the fixed resistor R1 and to the ground. One terminal of this resistor is connected to a lug on the by-pass condenser C3 and to the minus F post on the first or radio frequency socket. The other terminal of the fixed resistor is connected to a post on the dial light, to the filament switch and to a terminal of R2. The other terminal of the switch is connected to the third Fahnestock clip from the right and designated as minus A, minus B, plus C.

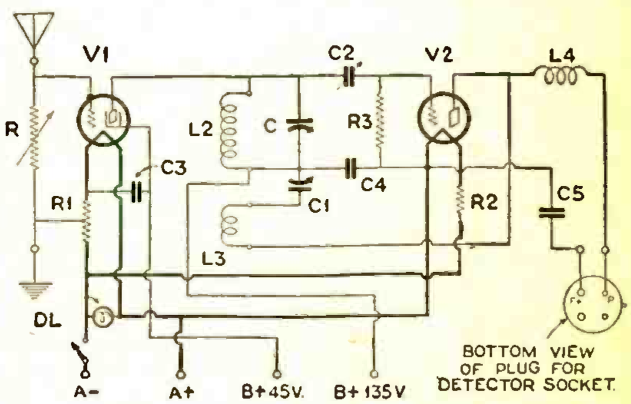

Fig. 1
The schematic circuit of the Hammarlund short-wave adapter-receiver, which may be coupled to any standard audio channel; although, as shown here, the specific design is intended to utilize a broadcast receiver's amplifying stages. It may be used with an A.C. set, but should be operated by battery power to obtain hum-free reproduction. A condenser between the aerial post and lead-in may greatly improve reception: experiment should be made to determine the best value, probably below .0001-mf.

The other terminal of R2 is connected to the plus F post on the detector tube socket.

The F plus and F minus posts of the radio frequency and the detector tube sockets are connected together and then brought to the plus A as well as to the other terminal of the dial light. The fourth Fahnestock from the right is designated as the plus A.

The unconnected terminal of C3 is now connected to the G post on the R.F. socket and to the B plus 45-volt post, which is the fifth Fahnestock clip from the right.

The P post on the radio frequency socket is connected to the first lug from the left on the coil base. It is also connected to the phosphor bronze terminal on the grid condenser C2 and to the stator plate terminal of the .00014 mfd. variable condenser.

The next lug on this base is connected to the sixth Fahnestock clip from the right, which is designated as the B plus 135-volt post. It is also connected to the rotor plate terminal of the .00014 mfd. variable condenser and the .0001 mfd. variable condenser, as well as to a post on the .1 mfd. fixed condenser, C4.

The unconnected terminal of the .0001 mfd. variable condenser is connected to the next lug on the base. The remaining lug on this base is connected to the P post on the detector socket and to one terminal on the radio frequency choke. The other terminal of the radio frequency choke is connected to the second Fahnestock clip from the right. The first Fahnestock clip is connected to a terminal of C5. The other terminal of C5 is connected to the minus F post on the detector socket to one terminal of the grid leak holder and to the unconnected terminal of C4.

The remaining terminal on the grid leak holder is connected to the G post on the detector socket and to the brass terminal on the grid condenser.

Why Shielding Is Not Used

The question of why shielding is not employed undoubtedly comes to the minds of many. It has not been used because of the mechanical difficulty in changing from one coil to another. The layout has been so arranged, however, as to minimize the capacitance between the grid and the plate wires. That is why the layout should be followed so carefully.

The receiver has been designed for battery operation because of its quiet and unfailing action. It is not desirable to use alternating current because of the noises introduced and because the tuning becomes very erratic.

(*Continued on page* 86)

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Kilocycle-Meter Direct-Reading Conversion Table

THERE is increasing tendency in radio practice to use radio frequency in kilocycles rather than wavelengths in meters. "Kilo" means a thousand, and "cycle" means one complete alternation. The number of kilocycles (abbreviated kc) indicates the number of thousands of times that the rapidly alternating current in the antenna repeats its flow in either direction in one second. The smaller the wave length in meters, the larger is the frequency in kilocycles. The numerical relation between the two is given by the following rule. For approximate calculation, to obtain kilocycles divide 300,000 by the number of meters, and to obtain meters divide 300,000 by the number of kilocycles. For example, 100 meters equals approximately 3,000 kilocycles, 300 m equals 1,000 kc, 1,000 m equals 300 kc, 3,000 m equals 100 kc. For highly accurate conversion the factor 299,820 is used instead of 300,000. This rule is based on the fact that wavelength is equal to velocity divided by frequency, and the velocity of radio waves in space, according to the best data available, is 299,820 kilometers per second.

This table gives accurate values of kilocycles corresponding to any number of meters, and vice-versa. The table is based on the factor 299,820, and gives values for every 10 kilocycles or meters. It should be particularly noticed that the table is entirely reversible; that is, for example, 50 kilocycles is 5,996 meters, and also 50 meters is 5,996 kilocycles. The range of the table is easily extended by shifting the decimal point; the shift is in opposite directions for each pair of values; for example, one can not find 223 in the first column, but its equivalent is obtained by finding later in the table that 2,230 kilocycles or meters is equivalent to 134.4 meters or kilocycles, from which 223 kilocycles or meters is equivalent to 1,344 meters or kilocycles.—*Courtesy U. S. Bureau of Standards.*

The Short Wave Find-All Four

By H. G. Cisin, M.E.

(*Continued from page 61*)

as a template. This hole can be made by drilling a number of small holes, finishing off with a round file.

11—Drill a ⅜" hole on the vertical center line, ⅞" from the bottom of the panel, for the control shaft of the Silver-Marshall drum dial.

12—Drill four holes at the bottom of the panel, for fastening panel to baseboard. These holes should be counter-sunk, so that the flat-head fastening screws will be flush with the panel.

13—Mount the various parts on the panel as shown in the illustrations.

14—Fasten panel to baseboard.

Complete List of Parts Required for the Short-Wave Find-All Four

1—.00014 mfd. Hammarlund "Mid-Line" Short Wave Variable Condenser, type ML-7 (7).

1—Hammarlund Short Wave Coil Set, type SWC-3 (9), consisting of 1- SWC-B base and 1- each of the SWT-20, SWT-40 and SWT-80 short wave coils.

2—Thordarson Audio Transformers, type R-300 (18, 21).

1—.00025 mfd. Polymet Grid Condenser, type MC-1207 (12)

1—.001 mfd. Polymet fixed Condenser, type MC-1212 (17-A).

2—½ mfd. Polymet "Hi Volt" Condensers, type C-903 (6, 14).

2—10-ohm Polymet flat Resistances (5, 5A).

1—2 to 10 meg. Polymet metallized resistor Grid Leak, types G-1316 to G-1326 (13).

4—Eby Sockets, UX type (4, 15, 19, 23).

10—Eby Binding Posts (1, 3, 25, 26, 28, 29, 30, 31, 32, 33).

3—Amperites No. 1-A, with M't'gs (16, 20, 24).

1—Silver - Marshall Illuminated Drum Dial, type 810-R, with Dial Window, No. 807 and Dial Light.

1—Silver-Marshall Short Wave R.F. Choke, No. 277 (17).

2—Silver-Marshall Tube Shields, No. 636 (4, 15).

2—Electrad Truvolt 1000-ohm Flexible Wire Resistances (8, 10).

1—Electrad Truvolt Wire Fixed Resistance, type B-100 (22).

1—Electrad Tonatrol, type WS (18A) with Filament Switch (27).

1—Electrad Tonatrol, type P (2).

1—Electrad Potentiometer, 400-ohm (13A).

1—Electrad Royalty Regeneration Control, type H (11).

1—Open Circuit Jack, Small type (20A).

1—Roll Corwico Braidite, Stranded Core Hook-up Wire.

1—Can Kester Radio Solder (Rosin Core) by the Kester Solder Company.

1—Composition Panel, 7" x 18" x 3/16".

2—Composition Binding Post strips.

1—Wood Baseboard, 10" x 17" x ½".

1—Screen Grid Clip.

1—Screen Grid Tube, type 222 (4).

2—201-A type Tubes (15, 19).

1—112-A type Tube (23).

3—45 volt "B" Batteries.

2—4½ volt "C" Batteries.

1—6 volt "A" Battery.

1—Head-Set.

1—Loud Speaker.

NOTE: Numbers in parentheses after each part, refer to corresponding numbers used to mark parts on diagrams.

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TABLE FOR CONVERTING KILOCYCLES TO METERS AND VICE VERSA

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29,982	1,010	296.9	2,010	149.2	3,010	99.61	4,010	74.77	5,010	59.84	6,010	49.89	7,010	42.77	8,010	37.43	9,010	33.28
20	14,991	1,020	293.9	2,020	148.4	3,020	99.28	4,020	74.58	5,020	59.73	6,020	49.80	7,020	42.71	8,020	37.38	9,020	33.24
30	9,994	1,030	291.1	2,030	147.7	3,030	98.95	4,030	74.40	5,030	59.61	6,030	49.72	7,030	42.65	8,030	37.34	9,030	33.20
40	7,496	1,040	288.3	2,040	147.0	3,040	98.62	4,040	74.21	5,040	59.49	6,040	49.64	7,040	42.59	8,040	37.29	9,040	33.17
50	5,996	1,050	285.5	2,050	146.3	3,050	98.30	4,050	74.03	5,050	59.37	6,050	49.56	7,050	42.53	8,050	37.24	9,050	33.13
60	4,997	1,060	282.8	2,060	145.5	3,060	97.98	4,060	73.85	5,060	59.25	6,060	49.48	7,060	42.47	8,060	37.20	9,060	33.09
70	4,283	1,070	280.2	2,070	144.8	3,070	97.66	4,070	73.67	5,070	59.13	6,070	49.39	7,070	42.41	8,070	37.15	9,070	33.06
80	3,748	1,080	277.6	2,080	144.1	3,080	97.34	4,080	73.49	5,080	59.02	6,080	49.31	7,080	42.35	8,080	37.11	9,080	33.02
90	3,331	1,090	275.1	2,090	143.5	3,090	97.03	4,090	73.31	5,090	58.90	6,090	49.23	7,090	42.29	8,090	37.06	9,090	32.98
100	2,998	1,100	272.6	2,100	142.8	3,100	96.72	4,100	73.13	5,100	58.79	6,100	49.15	7,100	42.23	8,100	37.01	9,100	32.95
110	2,726	1,110	270.1	2,110	142.1	3,110	96.41	4,110	72.95	5,110	58.67	6,110	49.07	7,110	42.17	8,110	36.97	9,110	32.91
120	2,499	1,120	267.7	2,120	141.4	3,120	96.10	4,120	72.77	5,120	58.56	6,120	48.99	7,120	42.11	8,120	36.92	9,120	32.88
130	2,306	1,130	265.3	2,130	140.8	3,130	95.79	4,130	72.60	5,130	58.44	6,130	48.91	7,130	42.05	8,130	36.88	9,130	32.84
140	2,142	1,140	263.0	2,140	140.1	3,140	95.48	4,140	72.42	5,140	58.33	6,140	48.83	7,140	41.99	8,140	36.83	9,140	32.80
150	1,999	1,150	260.7	2,150	139.5	3,150	95.18	4,150	72.25	5,150	58.22	6,150	48.75	7,150	41.93	8,150	36.79	9,150	32.77
160	1,874	1,160	258.5	2,160	138.8	3,160	94.88	4,160	72.07	5,160	58.10	6,160	48.67	7,160	41.87	8,160	36.74	9,160	32.73
170	1,764	1,170	256.3	2,170	138.1	3,170	94.58	4,170	71.90	5,170	57.99	6,170	48.59	7,170	41.82	8,170	36.70	9,170	32.70
180	1,666	1,180	254.1	2,180	137.5	3,180	94.28	4,180	71.73	5,180	57.88	6,180	48.51	7,180	41.76	8,180	36.65	9,180	32.66
190	1,578	1,190	252.0	2,190	136.9	3,190	93.99	4,190	71.56	5,190	57.77	6,190	48.44	7,190	41.70	8,190	36.61	9,190	32.62
200	1,499	1,200	249.9	2,200	136.3	3,200	93.69	4,200	71.39	5,200	57.66	6,200	48.36	7,200	41.64	8,200	36.56	9,200	32.59
210	1,428	1,210	247.8	2,210	135.7	3,210	93.40	4,210	71.22	5,210	57.55	6,210	48.28	7,210	41.58	8,210	36.52	9,210	32.55
220	1,363	1,220	245.8	2,220	135.1	3,220	93.11	4,220	71.05	5,220	57.44	6,220	48.20	7,220	41.53	8,220	36.47	9,220	32.52
230	1,304	1,230	243.8	2,230	134.4	3,230	92.82	4,230	70.88	5,230	57.33	6,230	48.13	7,230	41.47	8,230	36.43	9,230	32.48
240	1,249	1,240	241.8	2,240	133.8	3,240	92.54	4,240	70.71	5,240	57.22	6,240	48.05	7,240	41.41	8,240	36.39	9,240	32.45
250	1,199	1,250	239.9	2,250	133.3	3,250	92.25	4,250	70.55	5,250	57.11	6,250	47.97	7,250	41.35	8,250	36.34	9,250	32.41
260	1,153	1,260	238.0	2,260	132.7	3,260	91.97	4,260	70.38	5,260	57.00	6,260	47.89	7,260	41.30	8,260	36.30	9,260	32.38
270	1,110	1,270	236.1	2,270	132.1	3,270	91.69	4,270	70.22	5,270	56.89	6,270	47.82	7,270	41.24	8,270	36.25	9,270	32.34
280	1,071	1,280	234.2	2,280	131.5	3,280	91.41	4,280	70.05	5,280	56.78	6,280	47.74	7,280	41.18	8,280	36.21	9,280	32.31
290	1,034	1,290	232.4	2,290	130.9	3,290	91.13	4,290	69.89	5,290	56.68	6,290	47.67	7,290	41.13	8,290	36.17	9,290	32.27
300	999.4	1,300	230.6	2,300	130.4	3,300	90.86	4,300	69.73	5,300	56.57	6,300	47.59	7,300	41.07	8,300	36.12	9,300	32.24
310	967.2	1,310	228.9	2,310	129.8	3,310	90.58	4,310	69.56	5,310	56.46	6,310	47.52	7,310	41.02	8,310	36.08	9,310	32.20
320	936.9	1,320	227.1	2,320	129.2	3,320	90.31	4,320	69.40	5,320	56.36	6,320	47.44	7,320	40.96	8,320	36.04	9,320	32.17
330	908.6	1,330	225.4	2,330	128.7	3,330	90.04	4,330	69.24	5,330	56.25	6,330	47.36	7,330	40.90	8,330	35.99	9,330	32.14
340	881.8	1,340	223.7	2,340	128.1	3,340	89.77	4,340	69.08	5,340	56.15	6,340	47.29	7,340	40.85	8,340	35.95	9,340	32.10
350	856.6	1,350	222.1	2,350	127.6	3,350	89.50	4,350	68.92	5,350	56.04	6,350	47.22	7,350	40.79	8,350	35.91	9,350	32.07
360	832.8	1,360	220.4	2,360	127.0	3,360	89.23	4,360	68.77	5,360	55.94	6,360	47.14	7,360	40.74	8,360	35.86	9,360	32.03
370	810.3	1,370	218.8	2,370	126.5	3,370	88.97	4,370	68.61	5,370	55.83	6,370	47.07	7,370	40.68	8,370	35.82	9,370	32.00
380	789.0	1,380	217.3	2,380	126.0	3,380	88.70	4,380	68.45	5,380	55.73	6,380	46.99	7,380	40.63	8,380	35.78	9,380	31.96
390	768.8	1,390	215.7	2,390	125.4	3,390	88.44	4,390	68.30	5,390	55.63	6,390	46.92	7,390	40.57	8,390	35.74	9,390	31.93
400	749.6	1,400	214.2	2,400	124.9	3,400	88.18	4,400	68.14	5,400	55.52	6,400	46.85	7,400	40.52	8,400	35.69	9,400	31.90
410	731.3	1,410	212.6	2,410	124.4	3,410	87.92	4,410	67.99	5,410	55.42	6,410	46.77	7,410	40.46	8,410	35.65	9,410	31.86
420	713.9	1,420	211.1	2,420	123.9	3,420	87.67	4,420	67.83	5,420	55.32	6,420	46.70	7,420	40.41	8,420	35.61	9,420	31.83
430	697.3	1,430	209.7	2,430	123.4	3,430	87.41	4,430	67.68	5,430	55.22	6,430	46.63	7,430	40.35	8,430	35.57	9,430	31.79
440	681.4	1,440	208.2	2,440	122.9	3,440	87.16	4,440	67.53	5,440	55.11	6,440	46.56	7,440	40.30	8,440	35.52	9,440	31.76
450	666.3	1,450	206.8	2,450	122.4	3,450	86.90	4,450	67.38	5,450	55.01	6,450	46.48	7,450	40.24	8,450	35.48	9,450	31.73
460	651.8	1,460	205.4	2,460	121.9	3,460	86.65	4,460	67.22	5,460	54.91	6,460	46.41	7,460	40.19	8,460	35.44	9,460	31.69
470	637.9	1,470	204.0	2,470	121.4	3,470	86.40	4,470	67.07	5,470	54.81	6,470	46.34	7,470	40.14	8,470	35.40	9,470	31.66
480	624.6	1,480	202.6	2,480	120.9	3,480	86.16	4,480	66.92	5,480	54.71	6,480	46.27	7,480	40.08	8,480	35.36	9,480	31.63
490	611.9	1,490	201.2	2,490	120.4	3,490	85.91	4,490	66.78	5,490	54.61	6,490	46.20	7,490	40.03	8,490	35.31	9,490	31.59
500	599.6	1,500	199.9	2,500	119.9	3,500	85.66	4,500	66.63	5,500	54.51	6,500	46.13	7,500	39.98	8,500	35.27	9,500	31.56
510	587.9	1,510	198.6	2,510	119.5	3,510	85.42	4,510	66.48	5,510	54.41	6,510	46.06	7,510	39.92	8,510	35.23	9,510	31.53
520	576.6	1,520	197.2	2,520	119.0	3,520	85.18	4,520	66.33	5,520	54.32	6,520	45.98	7,520	39.87	8,520	35.19	9,520	31.49
530	565.7	1,530	196.0	2,530	118.5	3,530	84.94	4,530	66.19	5,530	54.22	6,530	45.91	7,530	39.82	8,530	35.15	9,530	31.46
540	555.2	1,540	194.7	2,540	118.0	3,540	84.70	4,540	66.04	5,540	54.12	6,540	45.84	7,540	39.76	8,540	35.11	9,540	31.43
550	545.1	1,550	193.4	2,550	117.6	3,550	84.46	4,550	65.89	5,550	54.02	6,550	45.77	7,550	39.71	8,550	35.07	9,550	31.39
560	535.4	1,560	192.2	2,560	117.1	3,560	84.22	4,560	65.75	5,560	53.92	6,560	45.70	7,560	39.66	8,560	35.03	9,560	31.36
570	526.0	1,570	191.0	2,570	116.7	3,570	83.98	4,570	65.61	5,570	53.83	6,570	45.63	7,570	39.61	8,570	34.98	9,570	31.33
580	516.9	1,580	189.8	2,580	116.2	3,580	83.75	4,580	65.46	5,580	53.73	6,580	45.57	7,580	39.55	8,580	34.94	9,580	31.30
590	508.2	1,590	188.6	2,590	115.8	3,590	83.52	4,590	65.32	5,590	53.64	6,590	45.50	7,590	39.50	8,590	34.90	9,590	31.26
600	499.7	1,600	187.4	2,600	115.3	3,600	83.28	4,600	65.18	5,600	53.54	6,600	45.43	7,600	39.45	8,600	34.86	9,600	31.23
610	491.5	1,610	186.2	2,610	114.9	3,610	83.05	4,610	65.04	5,610	53.44	6,610	45.36	7,610	39.40	8,610	34.82	9,610	31.20
620	483.6	1,620	185.1	2,620	114.4	3,620	82.82	4,620	64.90	5,620	53.35	6,620	45.29	7,620	39.35	8,620	34.78	9,620	31.17
630	475.9	1,630	183.9	2,630	114.0	3,630	82.60	4,630	64.76	5,630	53.25	6,630	45.22	7,630	39.29	8,630	34.74	9,630	31.13
640	468.5	1,640	182.8	2,640	113.6	3,640	82.37	4,640	64.62	5,640	53.16	6,640	45.15	7,640	39.24	8,640	34.70	9,640	31.10
650	461.3	1,650	181.7	2,650	113.1	3,650	82.14	4,650	64.48	5,650	53.07	6,650	45.09	7,650	39.19	8,650	34.66	9,650	31.07
660	454.3	1,660	180.6	2,660	112.7	3,660	81.92	4,660	64.34	5,660	52.97	6,660	45.02	7,660	39.14	8,660	34.62	9,660	31.04
670	447.5	1,670	179.5	2,670	112.3	3,670	81.70	4,670	64.20	5,670	52.88	6,670	44.95	7,670	39.09	8,670	34.58	9,670	31.01
680	440.9	1,680	178.5	2,680	111.9	3,680	81.47	4,680	64.06	5,680	52.79	6,680	44.88	7,680	39.04	8,680	34.54	9,680	30.97
690	434.5	1,690	177.4	2,690	111.5	3,690	81.25	4,690	63.93	5,690	52.69	6,690	44.82	7,690	38.99	8,690	34.50	9,690	30.94
700	428.3	1,700	176.4	2,700	111.0	3,700	81.03	4,700	63.79	5,700	52.60	6,700	44.75	7,700	38.94	8,700	34.46	9,700	30.91
710	422.3	1,710	175.3	2,710	110.6	3,710	80.81	4,710	63.66	5,710	52.51	6,710	44.68	7,710	38.89	8,710	34.42	9,710	30.88
720	416.4	1,720	174.3	2,720	110.2	3,720	80.60	4,720	63.52	5,720	52.42	6,720	44.62	7,720	38.84	8,720	34.38	9,720	30.85
730	410.7	1,730	173.3	2,730	109.8	3,730	80.38	4,730	63.39	5,730	52.32	6,730	44.55	7,730	38.79	8,730	34.34	9,730	30.81
740	405.2	1,740	172.3	2,740	109.4	3,740	80.17	4,740	63.25	5,740	52.23	6,740	44.48	7,740	38.74	8,740	34.30	9,740	30.78
750	399.8	1,750	171.3	2,750	109.0	3,750	79.95	4,750	63.12	5,750	52.14	6,750	44.42	7,750	38.69	8,750	34.27	9,750	30.75
760	394.5	1,760	170.4	2,760	108.6	3,760	79.74	4,760	62.99	5,760	52.05	6,760	44.35	7,760	38.64	8,760	34.23	9,760	30.72
770	389.4	1,770	169.4	2,770	108.2	3,770	79.53	4,770	62.86	5,770	51.96	6,770	44.29	7,770	38.59	8,770	34.19	9,770	30.69
780	384.4	1,780	168.4	2,780	107.8	3,780	79.32	4,780	62.72	5,780	51.87	6,780	44.22	7,780	38.54	8,780	34.15	9,780	30.66
790	379.5	1,790	167.5	2,790	107.5	3,790	79.11	4,790	62.59	5,790	51.78	6,790	44.16	7,790	38.49	8,790	34.11	9,790	30.63
800	374.8	1,800	166.6	2,800	107.1	3,800	78.90	4,800	62.46	5,800	51.69	6,800	44.09	7,800	38.44	8,800	34.07	9,800	30.59
810	370.2	1,810	165.6	2,810	106.7	3,810	78.69	4,810	62.33	5,810	51.60	6,810	44.03	7,810	38.39	8,810	34.03	9,810	30.56
820	365.6	1,820	164.7	2,820	106.3	3,820	78.49	4,820	62.20	5,820	51.52	6,820	43.96	7,820	38.34	8,820	33.99	9,820	30.53
830	361.2	1,830	163.8	2,830	105.9	3,830	78.28	4,830	62.07	5,830	51.43	6,830	43.90	7,830	38.29	8,830	33.95	9,830	30.50
840	356.9	1,840	162.9	2,840	105.6	3,840	78.08	4,840	61.95	5,840	51.34	6,840	43.83	7,840	38.24	8,840	33.92	9,840	30.47
850	352.7	1,850	162.1	2,850	105.2	3,850	77.88	4,850	61.82	5,850	51.25	6,850	43.77	7,850	38.19	8,850	33.88	9,850	30.44
860	348.6	1,860	161.2	2,860	104.8	3,860	77.67	4,860	61.69	5,860	51.16	6,860	43.71	7,860	38.14	8,860	33.84	9,860	30.41
870	344.6	1,870	160.3	2,870	104.5	3,870	77.47	4,870	61.56	5,870	51.08	6,870	43.64	7,870	38.10	8,870	33.80	9,870	30.38
880	340.7	1,880	159.5	2,880	104.1	3,880	77.27	4,880	61.44	5,880	50.99	6,880	43.58	7,880	38.05	8,880	33.76	9,880	30.35
890	336.9	1,890	158.6	2,890	103.7	3,890	77.07	4,890	61.31	5,890	50.90	6,890	43.52	7,890	38.00	8,890	33.73	9,890	30.32
900	333.1	1,900	157.8	2,900	103.4	3,900	76.88	4,900	61.19	5,900	50.82	6,900	43.45	7,900	37.95	8,900	33.69	9,900	30.28
910	329.5	1,910	157.0	2,910	103.0	3,910	76.68	4,910	61.06	5,910	50.73	6,910	43.39	7,910	37.90	8,910	33.65	9,910	30.25
920	325.9	1,920	156.2	2,920	102.7	3,920	76.48	4,920	60.94	5,920	50.65	6,920	43.33	7,920	37.86	8,920	33.61	9,920	30.22
930	322.4	1,930	155.3	2,930	102.3	3,930	76.29	4,930	60.82	5,930	50.56	6,930	43.26	7,930	37.81	8,930	33.57	9,930	30.19
940	319.0	1,940	154.5	2,940	102.0	3,940	76.10	4,940	60.69	5,940	50.47	6,940	43.20	7,940	37.76	8,940	33.54	9,940	30.16
950	315.6	1,950	153.8	2,950	101.6	3,950	75.90	4,950	60.57	5,950	50.39	6,950	43.14	7,950	37.71	8,950	33.50	9,950	30.13
960	312.3	1,960	153.0	2,960	101.3	3,960	75.71	4,960	60.45	5,960	50.31	6,960	43.08	7,960	37.67	8,960	33.46	9,960	30.10
970	309.1	1,970	152.2	2,970	100.9	3,970	75.52	4,970	60.33	5,970	50.22	6,970	43.02	7,970	37.62	8,970	33.42	9,970	30.07
980	305.9	1,980	151.4	2,980	100.6	3,980	75.33	4,980	60.20	5,980	50.14	6,980	42.95	7,980	37.57	8,980	33.39	9,980	30.04
990	302.8	1,990	150.7	2,990	100.3	3,990	75.14	4,990	60.08	5,990	50.05	6,990	42.89	7,990	37.52	8,990	33.35	9,990	30.01
1,000	299.8	2,000	149.9	3,000	99.94	4,000	74.96	5,000	59.96	6,000	49.97	7,000	42.83	8,000	37.48	9,000	33.31	10,000	29.98

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Ultra Short Waves

Hertzian and Infra-Red Rays as a Means of Communication

By DR. FRITZ SCHRÖTER

This well-known expert explains why it is that waves shorter than eight meters in length, seem to be impracticable for trans-oceanic communication. The ultra-short waves lend themselves very well to concentration in beams or pencils. The latest types of detectors suitable for receiving the ultra-short waves are described.

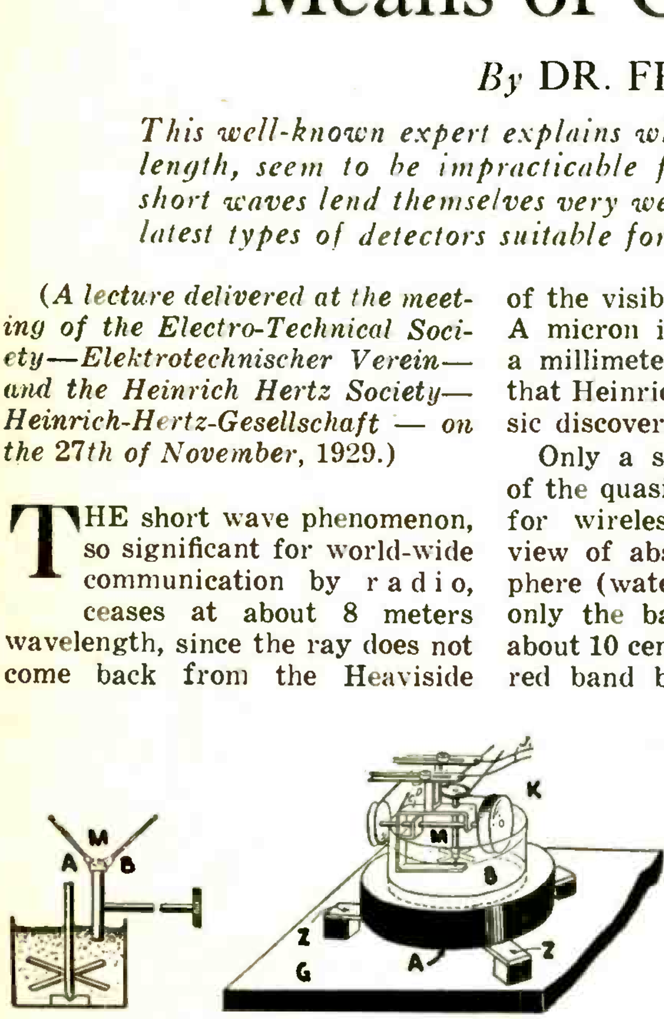
(*A lecture delivered at the meeting of the Electro-Technical Society—Elektrotechnischer Verein—and the Heinrich Hertz Society—Heinrich-Hertz-Gesellschaft — on the 27th of November,* 1929.)

THE short wave phenomenon, so significant for world-wide communication by radio, ceases at about 8 meters wavelength, since the ray does not come back from the Heaviside layer. Waves less than 8 meters in length cannot therefore be used for transoceanic or transcontinental radio work. Since the rays leaving the antenna are propagated in space in a straight line (exceptions are possible for the ground wave in the case of very good conductivity), they can only be used up to distances lying within the horizon of the transmitter. Because of this coincidence with light rays the author suggests the designation "quasioptic waves" for the field lying between 8 meters and .7 of a micron, the borderline of the visible spectrum. (N. B.—A micron is one one-thousand of a millimeter.) It is in this field that Heinrich Hertz made his classic discoveries.

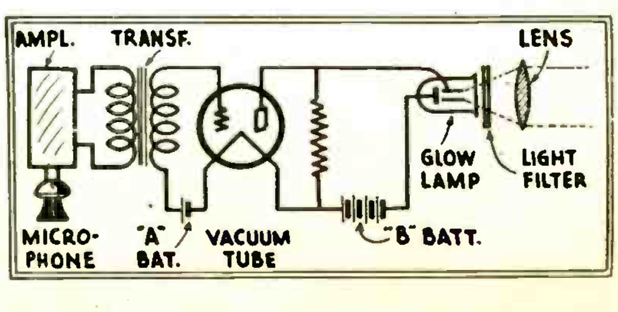
Only a small part of the field of the quasioptic waves is suitable for wireless communication. In view of absorption in the atmosphere (water vapor, ionic content) only the band from 8 meters to about 10 centimeters and the infra-red band between about 2.4 microns and .7 of a micron can be used.

In the former field the waves are produced by electron tubes or spark gaps (microscopic dipoles), in the latter by means of heat rays (molecular dipoles). The transition between the two is formed by the mass-radiation device of Frau Glagoleva-Arkadieva, in which tiny sparks strike through between fine metal filings. The upper oscillations of the microscopic Hertzian oscillators reach into a field in which also radiators of heat, such as highly charged mercury vapor lamps, make emissions in lines or bands.

The field between 8 meters and 1 meter has already been fairly extensively investigated. The first practical applications were the so-called radio beacons (rotary loop ray transmitters for giving bearings), which were intended to replace optical signals in time of fog. Because of the relatively short wavelengths the radiation can be gathered to a considerable extent in pencils, by means of groups of dipoles or reflectors, thus being concentrated. This decreases the number of watts used by the transmitter and at the same time makes possible the attainment of more or less sharply directed radiation in



The mass - radiation apparatus of Frau Glagoleva - Arkadieva, in which tiny sparks strike through between flying metal filings.



Infra-red telephonic transmitter using a modulated helium glow-lamp of high superficial illumination. A suitable light filter is placed in front of the glow-lamp as well as a lens, while the rest of the apparatus comprises the usual microphone and amplifier, transformer, vacuum tube and coupling resistance.

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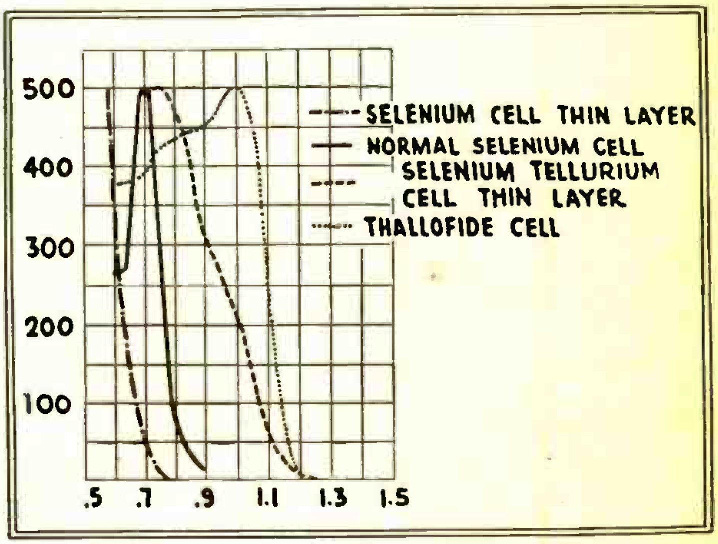
technical navigation, in the case of short distance radio communication, even on occasion for a locally limited continuous wave communication in which pencils of rays of the same wavelength can operate side by side without interference, in so far as there is no cutting into each other of the horizons of the individual transmitters. For reception highly sensitive super-regeneration is used, which to be sure is too noisy for continuous wave work.

For the production of waves of less than a meter there come into consideration electron tubes in the so-called Barkhausen-Kurz hook-up (as used by Bremsfeld) or in the magnetron arrangement (as used by Hull). They provide undamped waves but only slight effective radiation. Spark gaps to be sure send out strongly damped waves but with much more intense radiation in the case of simple hook-ups. The dipole and the spark gap are connected; the whole apparatus is located in the focal axis of a Hertzian mirror of fair size. With such hook-ups W. Ludenia has lately sent audible telegraphy over a distance of 20 kilometers, a crystal detector or an audion (vacuum tube) working in the Barkhausen-Kurz hook-up being used in the receiving mirror. If the transmitter spark gap is fed by a modulated tube generator, telephony may be sent by it (transmitter efficiency about one-tenth of a watt). For high intensity of radiation the combination of the electrode metals is important (steel-aluminum). With such decimeter waves very sharp pencils of rays can be produced and important problems of technical navigation can be solved (rotary loop ray transmitters as radio beacons, to replace optical beacons). Furthermore, one can produce by very slightly diverging pencils lines of radiation which are arranged in chains in relay fashion and serve to transmit by means of relatively cheap apparatus quickly variable amplitudes, for instance for multiple telegraphy, multiple telephony, or television. Such arrangements can replace expensive cables, over which such high frequency processes could not be transmitted at all to great distances, by reason of damping. The dimensions of the mirrors are satisfactory for practical use.

For the production of modulated infra-red rays, which are necessary in signalling for distinction from interfering sources of light and heat, the normal temperature-radiating light sources of science can serve. With the arc light .36 per cent of its total radiation, with the glow lamp (gas filled) 22 per cent, lies in the usable field from .7 of a micron up to 1.1 microns. The light is interrupted or turned away by perforated disks or by special light valves. Particularly suitable is the Kerr cell, with the aid of which telephonic transmission is carried on. Other infra-red light sources are gas discharges. Helium is particularly suitable (resonance line about 1 micron). The telephonic modulation here takes place by modulation of the amplified audio frequency in the feed circuit of the lamp.

For ease in putting the rays into pencils, of concentration, and of distance effect, the same possibilities exist with infra-red rays as with light reflectors. The chief source of weakening with expansion is the scattering on drops of vapor in a fog. It is noticeably less than with light, hence greater distances of effect are to be expected. On the other hand, the infra-red detectors used today are not so sensitive as the human eye, which reacts directly to visible light. The extremely low limit of stimulation of the eye, which might indicate a superiority of the use of luminous rays as against infra-red rays, does not hold true in diffused daylight, when fog prevails. Furthermore, the eye, because of its inertia, cannot recognize the absolutely necessary modulation. To prove this one would be shown a cell in connection with an amplifier, and since it is then only a question of the incident efficiency, infra-red wins back its superiority, since it has the better penetration. Besides, there is in its favor the fact that one watt of radiation efficiency demands much less expenditure of energy than one watt of visible light.

The curves shown in the accompanying chart indicate the apportionment of spectral-sensitivity of the various infra-red indicators or detectors. The Telefunken Company of Germany has developed thin-layer selenium - tellurium cells as well as thallofide cells, the work of the author independently and also with Dr. F. Michelsen. These new cells work sufficiently fast to permit telephonic operation.



As receivers of modulated infra-red radiation there serve substances whose optical-electric sensitivity for this field has been artificially increased. As such Telefunken has developed thin layer selenium-tellurium cells and thallofide cells. (The work of the author independently and with Dr. F. Michelsen) It is shown that the lack of inertia of these cells is sufficient for telephonic transmission. The limit of effect is at about 1.2 microns. Integrant receivers, such as thermo-elements, etc., cannot be used, since in view of selectivity against interference radiation, as we have said, only modulated transmission is in question.

The application will chiefly be in navigation, in view of the fairly short range. For instance, we may assure ships a few nautical miles apart from collision by replacing optical position lights by infra-red radiation sets.

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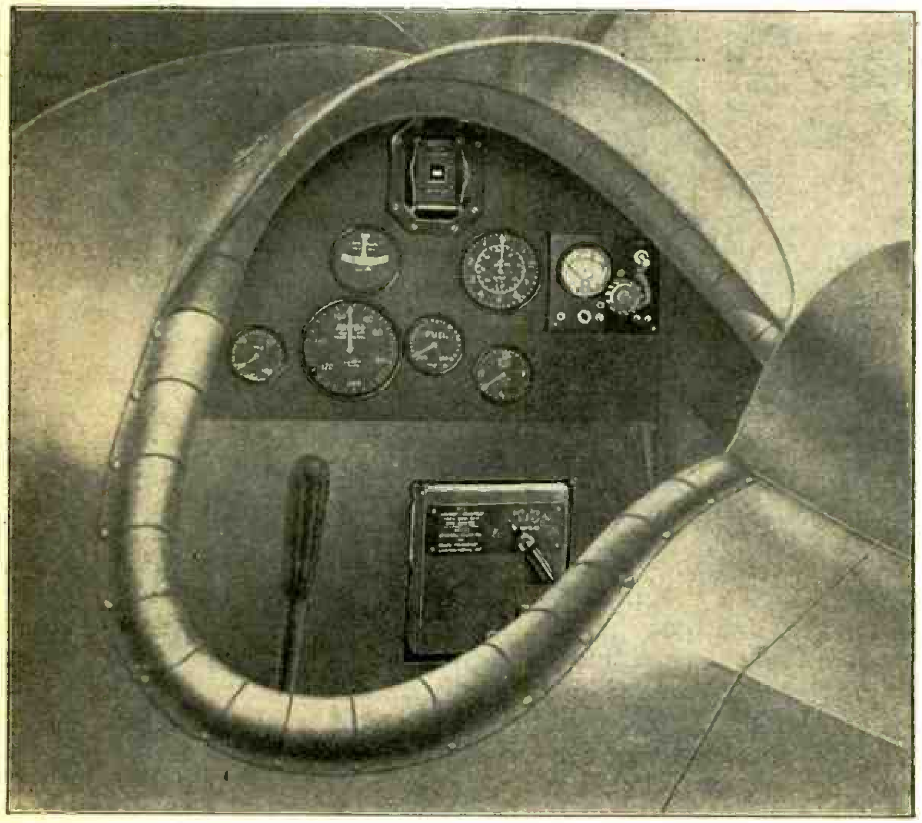
Aircraft Short Wave Sets

Short Wave Radio an Important
SAFETY FACTOR IN AVIATION

By A. W. PARKES, JR.
Field Radio Engineer
Aircraft Radio Corporation, Boonton, N. J.

Some of the interesting results obtained in short-wave transmission and reception are here discussed by Mr. Parkes, who tells how the dangerous trailing antenna has been done away with.



Stromberg-Carlson aircraft radio receiver installed in the pilot's cockpit of an Air Mail plane. Note vibrating reed radio-beacon indicator at top of instrument board.

THE problem of radio equipment for aircraft has been in the process of solution since the World War. Every aircraft operator realizes the tremendous necessity of reliable radio equipment for the increase in safety of air navigation. Great strides have been taken in the development of aircraft radio equipment since the days when the author went through the "observer's" course given at the Miami Naval Air Station; then if the transmitter functioned at all, it was considered a marvel; there were no radio receivers. It was not until the latter days of the war that there were any receiving sets that were worthy of the name. Our Army and Navy have been at work constantly ever since then to perfect both the transmitting and receiving equipment. Almost all the development in aircraft radio was done by or for the Army or Navy up to about three years ago. Then came the great popular interest in aviation and the necessity for a light weight, compact equipment which should be quite simple to operate and inexpensive to maintain.

The Radio Frequency Laboratories, of Boonton, N. J., which had had considerable experience in the design of radio receiving equipment for a number of nationally known manufacturers, undertook to design a light-weight radio receiving set, suitable for the recep-

Close-up of the remote volume and tuning controls for use with Stromberg-Carlson aircraft radio receiver.

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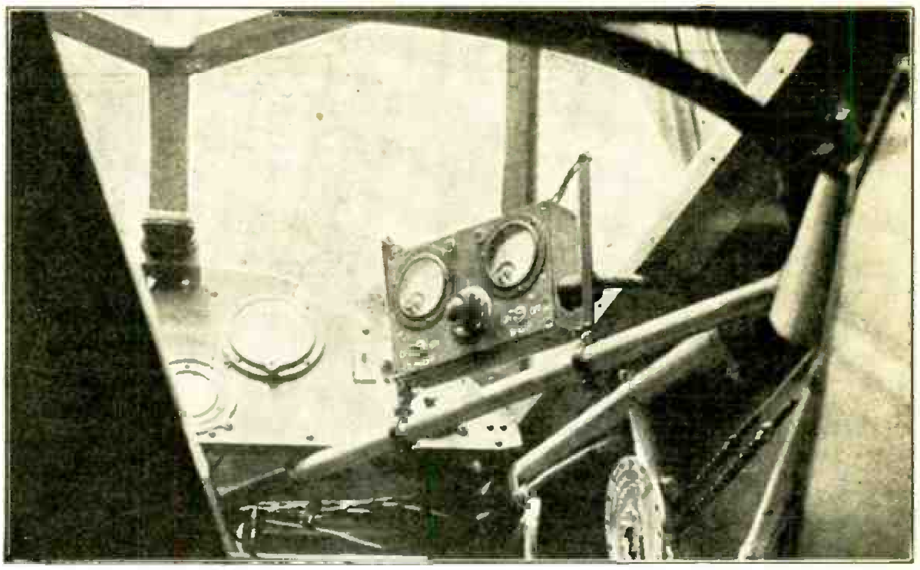
tion of the government weather advices and radio beacon signals. This receiver had to operate on a five to six foot vertical antenna mast. Previous receivers had used from 50 to 300 feet of trailing wire. There was considerable objection to the trailing wire antenna because of the danger in case of a quick landing or in case of low flying, not to mention the added inconvenience of reeling it in and out under ordinary conditions. There was further necessity for a vertical antenna, because errors in radio beacon courses were introduced when a trailing wire antenna was used. Obviously a high rigid antenna is impracticable on the airplane, hence the five-foot mast and the necessary extremely sensitive receiver. Dr. F. H. Drake, well known in connection with the Browning-Drake circuit, was responsible for this development, which was the first commercial aircraft beacon receiver. These receivers are now manufactured by the Stromberg-Carlson Company of Rochester, New York.

The U. S. Department of Commerce has installed radio beacon and weather broadcasting stations along the air-mail routes from Boston to Los Angeles. Others are contemplated covering the principal air-mail routes of the entire country. These stations are so interspersed that a pilot can start a cross-country flight in Portland, Maine, and fly to Los Angeles obtaining half hourly weather information throughout the entire route. Anyone who has flown cross-country in doubtful weather, can readily appreciate the great value of this service. It is inestimable as a safety factor for air navigation.

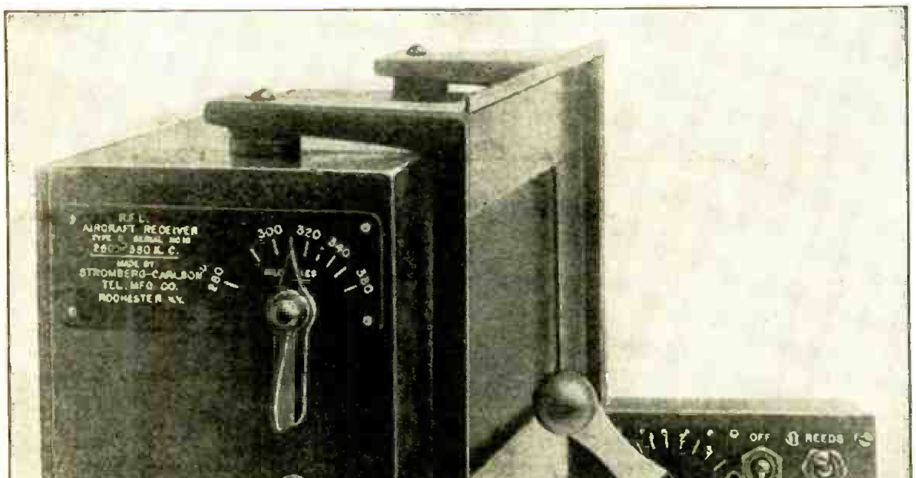


"Radio altimeter" installed in the pilot's cockpit of the Fokker airplane used by the Aircraft Radio Corp. This instrument, by means of radio waves, tells the pilot his height above the ground.

Radio Beacons

Radio beacon stations are not yet quite so numerous but plans are being executed by the Department of Commerce for installation covering the same routes as those by the Weather Broadcast stations. Much has been written concerning the radio beacon for aircraft. It is the most simple to use of all radio guiding devices. The pilot can tell whether he is to the right or left of his course by listening to the beacon signal. This signal indicates the code letter A when to one side, and the code letter N when to the other side of his true course. When on the course these dots and dashes merge, resulting in a succession of long dashes. The pilot is then able to fly directly to the airport. Use was made of the radio beacon by Lieut. James H. Doolittle, in his famous fog flying experiments conducted at Mitchell Field last summer. Instead of using the aural type beacon however,

Mr. F. E. Gray, radio engineer of the National Aircraft Transportation Company, inspecting a Stromberg-Carlson radio receiver installed in a mail plane.



The Stromberg-Carlson Model B aircraft radio receiver, designed to receive weather and radio-beacon signals. It employs 5 tubes and requires only a 5-foot vertical mast for reception; it weighs 12 lbs.

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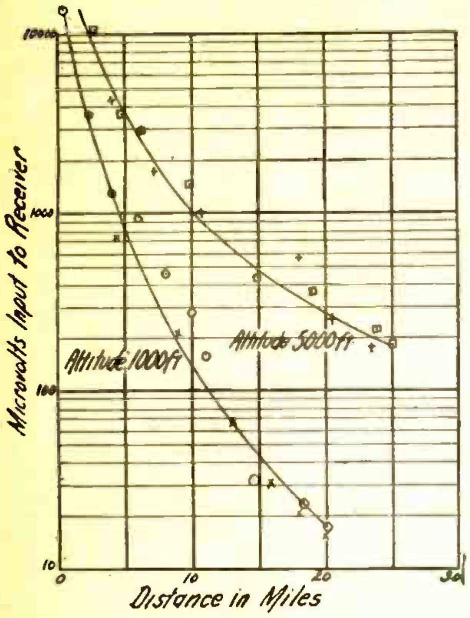


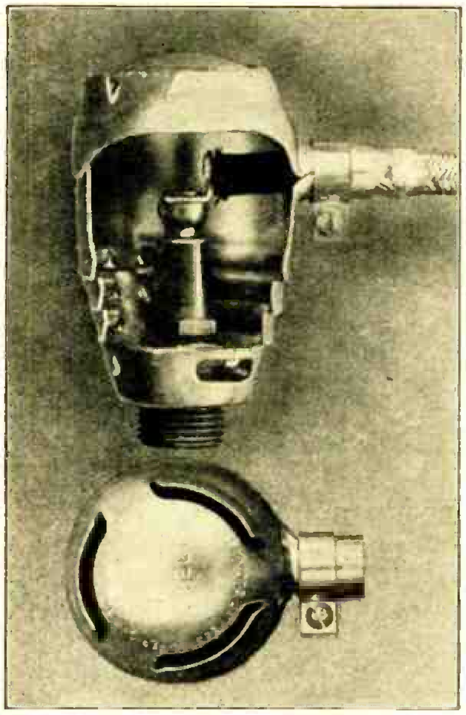
This diagram shows the relation between micro-volts input to receiver at different altitudes and range in miles.

he made use of the visual vibrating reed type, in which the vibration of two reeds indicated the side on which the pilot was off his course. The Stromberg-Carlson Model "B" receiver was used in all these experiments.

Transmitting On 20 to 100 Meters, Without Trailing Antenna

The trailing wire antenna, one of the great bugaboos of aircraft radio, has been eliminated by many aircraft operators through the installation of a horizontal doublet antenna stretched from wing tips to tail. A short wave must be chosen for transmission when using this type of an antenna, and wavelengths from 20 to 100 meters have been chosen by nearly all the major companies of the country. There is but one company making use of the long waves in transmitting from aircraft in this country. When one uses a horizontal doublet antenna for transmitting he can also use the same antenna for receiving without the addition of a switch to change over from transmit to receive. This is done by connecting the wire from the receiving set to the center of the coil, the ends of which are connected to the doublet.

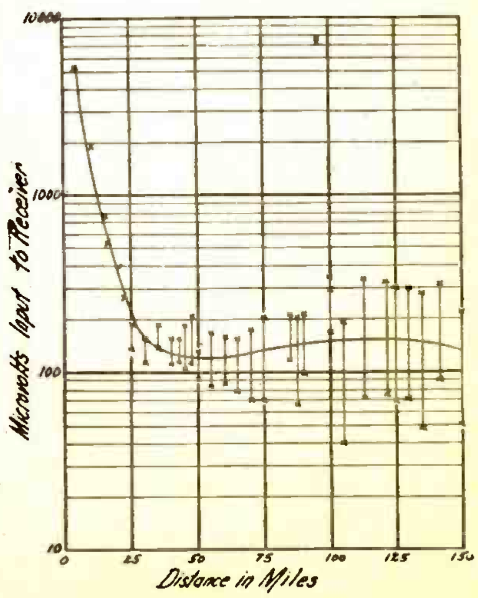
This type of antenna transmits what are known as horizontally polarized waves. They behave differently when received over highly conducting or poorly conducting ground. Considerable work has been done on this at the laboratory of the Aircraft Radio Corporation and an article has been published by Dr. F. H. Drake, and R. M. Wilmotte, "On the Daylight Characteristics of Horizontally and Vertically Polarized Waves from Airplanes," in the December, 1929, issue of the *Proceedings of the Institute of Radio Engineers.* Curves are shown giving the relation of signal strength received on the ground as a function of the length of a horizontal antenna. The graph shows unmistakably that for waves polarized horizontally, the



RFL spark-plug shield, used in connection with metal shielding on all wires to eliminate interference from ignition circuits.

most effective length of antenna used is approximately ½ wavelength long. Experiments were carried out on the intensity of the received signal as a function of the distance of the transmitter from the receiver. At a wavelength of 49 meters the intensity falls off rapidly from 5000 units to 200 units in the distance of 25 miles, at which distance the direct wave from the plane to the receiver begins to be comparable in strength with the wave which reaches the receiver, after having gone up toward the Heaviside layer and thence to the receiver. When the two waves are comparable in intensity, but different in phase, we have the phenomenon of fading until the so-called *ground* wave, which is the direct wave, becomes so highly attenuated that the signal intensity is determined by the strength of the so-called *sky ray.* Quantitative data on the received intensity is given in the article by Drake and Wilmotte. An interesting feature about transmission from aircraft at this wavelength is that at a distance of 600 miles, with only one watt in the transmitting antenna, intelligible signals may be received; whereas at 35 miles communication may be quite unreliable. One of the big problems is this range between 25 and 75 miles, in which fading from a very strong to a very weak, and sometimes inaudible signal, occurs.

If one transmits vertically polarized waves from an airplane at 49 meters wavelength, using a six-foot vertical rod as an antenna, he will obtain different results, though he may use the same receiving equipment. Over poorly conducting ground, horizontally polarized waves will be approximately twice as strong as vertically polarized for the direct ray. Over good conducting ground the vertically polarized waves will be about eight times as strong as the horizontally polarized, in the case of the direct ray. Over bad conducting earth the sky ray is received six times as strong when horizontally polarized as when vertically.



Relation between micro-volts input to receiver and the distance in miles over which signals are received.

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Short-Wave Stations of the World

Kilo-
Meters cycles

4.97-5.35 60,000-56,000—**Amateur Telephony and Television.**

8.57 35,000—**W2XCU**, Ampere, N. J.

11.55 25,960—**G5SW**, Chelmsford, England Experimental.

12.48 24,000—**W6AQ**, San Mateo, Calif. (Several experimental stations are authorized to operate on non-exclusive waves of a series, both above this and down to 4 meters.)

13.04 23,000—**W2XAW**, Schenectady, N. Y.

13.97 21,460—**W2XAL**, New York.

14.06 21,320—**DIV**, Nauen, Germany.

14.50 20,680—**LSH**, Monte Grande, Argentina, after 10:30 p. m. Telephony with Europe.
—**FMB**, Tamatave, Madagascar.
—**PMB**, Bandoeng, Java.

14.62 20,500—**W9XF**, Chicago, Ill. (WENR).

14.84 20,200—**DGW**, Nauen, Germany, 2 to 9 p.m. Telephony to Buenos Aires.

15.03 19,950—**LSG**, Monte Grande, Argentina. From 9 a.m. to 1 p.m. Telephony to Paris and Nauen (Berlin).
—**DIH**, Nauen, Germany.

15.10 19,850—**WMI**, Deal, N. J.
—**SPU**, Rio de Janeiro, Brazil.

15.12 19,830—**FTD**, St. Assise, France.

15.40 19,460—**FZU**, Tamatave, Madagascar.

15.45 19,400—**FRO, FRE**, St. Assise, France.

15.50 19,350—....Nancy, France, 4 to 5 p.m.
—**VK2ME**, Sydney, Australia.

15.55 19,300—**FTM**, St. Assise, France. 10 a.m. to noon.

15.60 19,220—**WNC**, Deal, N. J.

15.85 18,920—**XDA**, Mexico City, Mex. 12:30 to 2:30 p.m.

15.91 18,850—**PLE**, Bandoeng, Java. Broadcasts Wed. 8:40 to 10:40 a.m. Telephony with Kootwijk (Amsterdam).

16.10 18,620—**GBJ**, Bodmin, England. Telephony with Montreal.

16.11 18,610—**GBU**, Rugby, England.

16.30 18,400—**PCK**, Kootwijk, Holland. Daily from 1 to 6:30 a.m.

16.35 18,350—**WND**, Deal Beach, N. J. Transatlantic telephony.

16.38 18,310—**GBS**, Rugby, England. Telephony with New York. General Postoffice, London.
—**FZS**, Saigon, Indo-China, 1 to 3 p.m. Sundays.

16.44 18,240—**FTO, FTE**, Ste. Assize, France.

16.50 18,170—**CGA**, Drummondville, Quebec, Canada. Telephony to England. Canadian Marconi Co.

16.54 18,130—**GBW**, Rugby, England.

16.57 18,120—**GBK**, Rugby, England.

16.61 18,050—**KQJ**, Bolinas, Calif.

16.70 17,950—**FZU**, Tamatave, Madagascar.

16.80 17,850—**PLF**, Bandoeng, Java ("Radio Malabar"). Works with Holland.

16.82 17,830—**PCV**, Kootwijk, Holland. 3 to 9 a.m.

16.88 17,770—**PHI**, Huizen, Holland. Beam station to Dutch colonies. Broadcasts Mon., Wed., Thurs., Fri. 8 to 11 a.m. N. V. Philips Radio, Amsterdam.

16.90 17,750—**HS1PJ**, Bangkok, Siam. 7-9:30 a.m., 1-3 p.m. Sundays.

17.20 17,440—**AGC**, Nauen, Germany.

17.34 17,300—**W2XK**, Schenectady, N. Y. Tues., Thurs., Sat. 12 to 5 p.m. General Electric Co.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental stations.

18.00 16,660—**G2GN**, S.S. "Olympic."
—**G2IV**, S.S. "Majestic."

18.40 16,300—**PCL**, Kootwijk, Holland. Works with Bandoeng from 7 a.m. Netherland State Telegraphs.
—**WLO**, Lawrence, N. J.

18.56 16,150—**GBX**, Rugby, England.

18.75 15,990—....Saigon, Indo-China.

18.80 15,950—**PLG**, Bandoeng, Java. Afternoons.

19.50 15,375—**F8BZ**. French phone to G2GN.

19.56 15,340—**W2XAD**, Schenectady, N. Y. Broadcasts Sun. 2:30 to 5:40 p.m., Tues., Thurs. and Sat. noon to 5 p.m., Fri. 2 to 3 p.m.; besides relaying WGY's evening program on Mon, Wed., Fri. and Sat. evenings. General Electric Company.

19.60 15,300—**OXY**, Lyngby, Denmark, Experimental.

19.63 15,280—**W2XE**, Jamaica, N. Y.

19.66 15,250—**W2XAL**, New York, N. Y.

19.71 15,220—**W8XF** (KDKA) Pittsburgh, Pa. Tues., Thu., Sat., Sun., 8 a.m. to noon.

19.99 15,000—**CM6XJ**, Central Tuinucu, Cuba.
—**LSJ**, Monte Grande, Argentina.

20.00 14,990—**TFZSH**, Iceland.

20.80 14,420—**VPD**, Suva, Fiji Islands.

20.90 14,340—**G2NM**, Caterham, England. 12:30 to 2 p.m. Sundays 1:30 to 3 p.m.

20.97-21.26 14,300-14,100—**Amateur Telephony.**

21.59 13,890—....Mombasa, East Africa.

22.20 13,500—....Vienna, Austria.

22.38 13,400—**WND**, Deal Beach, N. J. Transatlantic telephony.

22.69 13,050—**W2XAA**, Houlton, Me. Transatlantic telephony.

23.35 12,850—**W2XO**, Schenectady, N. Y. Antipodal program 9 p.m. Mon. to 3 a.m. Tues.; noon to 5 p.m. on Tues., Thurs. and Sat. General Electric Co.
—**W6XN**, Oakland, Calif. Relays KGO from 8 p.m., Mon., Thu., Sat., to 2:45 a.m. Tues., 3 a.m. Fri., 4 a.m. Sunday. General Electric Co.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental relay broadcasters.

23.98 12,500—**G2GN**, "Olympic." **G2IV**, "Majestic."

24.41 12,280—**GBU**, Rugby, England.

24.46 12,250—**FTN**, Ste. Assise (Paris) France. Works Buenos Aires, Indo-China and Java. On 9 a.m. to 1 p.m., and other hours.
—**KIXR**, Manila, P. I.
—**GBX**, Rugby, England.

24.63 12,180—**Airplane.**

24.68 12,150—**GBS**, Rugby, England. Transatlantic phone to Deal, N. J. (New York).
—**FQO, FQE**, Ste. Assize, France.

All Schedules Eastern Standard Time: Add 5 Hours for Greenwich Mean Time.

Kilo-
Meters cycles

24.89 12,045—**NAA**, Arlington, Va. Time signals, 8:55-9 a.m., 9:55-10 p.m.

24.98 12,000—**FZG**, Saigon, Indo-China. Time Signals, 2-2:05 p.m.

25.10 11,945—**KKQ**, Bolinas, Calif.

25.10 11,940—....Zeesen, Germany. Tests of new Super-power broadcasters.

25.34 11,840—**W2XE**, Jamaica, New York (WABC).

25.24 11,880—**W8XK** (KDKA) Pittsburgh, Pa. Tues., Thu., Sat., Sun., noon to 5 p.m., and Sat. night Arctic programs. Television Mon. and Fri. 2:30 p.m., 60 lines, 1200 r.p.m.
—**W9XF**, Chicago (WENR).
—**W2XAL**, New York (WRNY).

25.40 11,810—**I3RO**, Rome, Italy (Tests)

25.42 11,800—**UOR2**, Vienna, Austria.

25.53 11,750—**G5SW**, Chelmsford, England. 7:30-8:30 a.m. and 2-7 p.m. except Saturdays and Sundays. Also 7-9 p.m. Mondays and Wednesdays. Tests with W2XO 12-1 a.m. Mondays and Thursdays.

25.60 11,690—**CJRX**, Winnipeg, Canada. 5:30 p.m. on till 8:30. Mon., Wed., Fri., 10:30 Tu.; 11:00 Thu.; midnight Sat. Sundays 11:30 a.m. to 1 p.m.; 10-11 p.m.

25.68 11,670—**KIO**, Kahuhu, Hawaii.

26.00 11,530—**CGA**, Drummondville, Canada.

26.10 11,490—**GBK**, Rugby, England.

26.20 11,440—**KIXR**, Manila, P. I. 11:15-12:15 p. m., 2-4 a.m., 5-10 a.m.

26.70 11,230—**WSBN**, SS. "Leviathan" and A. T. & T. telephone connection.

27.00 11,100—**EATH**, Vienna, Austria. Mon. and Thurs., 5:30 to 7 p.m.

27.75 10,800—**PLN**, Bandoeng, Java.
—**GBX**, Rugby, England.

27.88 10,760—**PLR**, Bandoeng, Java. Works with Holland and France weekdays from 7 a.m.; sometimes after 9:30.

28.00 10,710—**VAS**, Glace Bay, N. S., Canada 5 a.m. to 2 p.m. Canadian Marconi Co.

(NOTE: This list is compiled from many sources, all of which are not in agreement, and which show greater or less discrepancies; in view of the fact that most schedules and many wavelengths are still in an experimental stage; that daylight time introduces confusion and that wavelengths are calculated differently in many schedules. In addition to this, one experimental station may operate on any of several wavelengths which are assigned to a group of stations in common. We shall be glad to receive later and more accurate information from broadcasters and other transmitting organizations, and from listeners who have authentic information as to calls, exact wavelengths and schedules. We cannot undertake to answer readers who inquire as to the identity of unknown stations heard, as that is a matter of guesswork; in addition to this, the harmonics of many local long-wave stations can be heard in a short-wave receiver.—EDITOR.)

28.50 10,510—**RDRL**, Leningrad, U.S.S.R. (Russia)
—**VK2BL**, Sydney, Australia.

28.80 10,410—**VK2ME**, Sydney, Australia. Irregular. On Wed. after 6 a.m. Amalgamated Wireless of Australia, Pennant Hills, N. S. W.
—**KES**, Bolinas, Calif.

28.86 10,390—**GBX**, Rugby, England.

29.50 10,160—**HS2PJ**, Bangkok, Siam.

29.98 10,000—**CM2LA**, Havana, Cuba.

30.00 9,995—....Posen, Poland.

30.15 9,940—**GBU**, Rugby, England.

30.20 9,930—**W2XU**, Long Island City, New York.

30.64 9,790—**GBW**, Rugby, England.

30.75 9,750—....Agen, France. Tues. and Fri., 5 to 6:15 p.m.

30.80 9,740—....Posen, Poland. Tu. and Sat. 5-6 p.m. Occasionally noon-8 p.m.

30.90 9,700—**NRH**, Heredia, Costa Rica. 10:00 to 11:00 p.m. Amando Cespedes Marin, Apartado 40.
—**WIXAZ**, Springfield, Mass. Relays WBZ.

31.10 9,640—**7LO**, Nairobi, Kenya, Africa. 11:00 a.m. to 2 p.m. Relays G5SW, Chelmsford, frequently from 2 to 3 p.m.
—....Monte Grande, Argentina, works Nauen irregularly after 10::30 p.m.

31.23 9,600—**LGN**, Bergen, Norway.

31.28 9,580—**VK2FC**, Sydney, Australia. Irregularly after 4 a.m. N. S. W. Broadcasting Co.
—**W3XAU**, Byberry, Pa., relays WCAU daily.
—**VPD**, Suva, Fiji Islands.

31.35 9,570—**WIXAZ**, Springfield, Mass. (WBZ).

31.38 9,550—....Konigswusterhausen, Germany. 10 to 11 a.m., 11:30 a.m. to 2:30 p.m., and 3 to 7:30 or 8:30 p.m. Relays Berlin.
·**PCJ**, Hilversum (Eindhoven) Holland. Thu. 1-3 p.m., 6-10 p.m., Friday 1-3 p.m., 7 p.m. to 1 a.m. Saturday. N. V. Philips Radio.

31.48 9,530—**W2XAF**, Schenectady, New York. Mon., Tues., Thurs. and Sat. nights, relays WGY from 6 p.m. General Electric Co.
—**W9XA**, Denver, Colorado. Relays KOA.
—....Helsingfors, Finland.

31.56 9,500—**VK3LO**, Melbourne, Australia, irregular. Broadcasting Co. of Australia.
—**OZ7RL**, Copenhagen, Denmark. Around 7 p.m.

31.60 9,490—**OXY**, Lyngby, Denmark. Noon to 3 p.m.

31.65 9,480—....Paris, France, 4 p.m. weekdays.

31.80 9,430—**XDA**, Mexico City, Mex.

32.00 9,375—**EH9OC**, Berne, Switzerland. 3-5:30 p.m.
—**OZ7MK**, Copenhagen, Denmark. Irregular after 7 p.m.

Kilo-
Meters cycles

32.06 9,350—**CM2MK**, Havana, Cuba.

32.13 9,330—**CGA**, Drummondville, Canada.

32.40 9,250—**GBK**, Rugby, England.

32.50 9,230—**FL**, Paris, France (Eiffel Tower) Time signals 3:56 a.m. and 3:56 p.m.
—**VK2BL**, Sydney, Australia.

32.59 9,200—**GBS**, Rugby, England. Transatlantic phone.

33.26 9,010—**GBS**, Rugby, England.

33.81 8,872—**NPO**, Cavite (Manila) Philippine Islands. Time signals 9:55-10 p.m.

34.50 8,690—**W2XAC**, Schenectady, New York.

34.68 8,650—**W2XCU**, Ampere, N. J.;—**W9XL**, Chicago.
—**W3XE**, Baltimore, Md. 12:15-1:15 p.m., 10:15-11:15 p.m.
—**W8XAG**, Dayton, Ohio.
—**W6XN**, Oakland.

34.74 8,630—**WOO**, Deal, N. J.

35.00 8,570—**HKCJ**, Manizales, Colombia.
—**RA97**, Khabarovsk, Siberia.

35.02 8,560—**G2GN**, SS. "Olympic."
—**G2IV**, SS. "Majestic."

35.54 8,440—**G2AA**, shore-to-ship phone.

35.48 8,450—**WSBN**, SS. "Leviathan."

36.00 8,330—**3KAA**, Leningrad, Russia. 2-6 a.m., Mon., Tues., Thurs., Fri.

36.74 8,160—....Mombasa, East Africa.

37.02 8,100—**EATH**, Vienna, Austria. Mon. and Thurs. 5:30 to 7 p.m.
—**HS4P**, Bangkok, Siam. Tues. and Fri. 8-11 a.m., 2-4 p.m. Tuesdays.

37.36 8,030—**NAA**, Arlington, Va. Time signals 8:55-9 a.m., 9:55-10 p.m.

37.43 8,015—**Airplanes.**

37.80 7,930—**DOA**, Doeberitz, Germany. 1 to 3 p.m. Reichpostzentralamt, Berlin.

38.00 7,890—**VPD**, Suva, Fiji Islands.

38.30 7,830—**PCV**, Kootwijk, Holland, after 9 a.m.

38.60 7,770—**FTF**, Ste. Assize, France.
—**PCK**, Kootwijk, Holland. 9 a.m. to 7 p.m.

39.70 7,550....SS. "Bremen."

39.15 7,660—**FTL**, Ste. Assize.

39.98 7,500—**TFZSH**, Reykjavik, Iceland.
—**EK4ZZZ**, Danzig (Free State).

40.20 7,460—**YR**, Lyons, France. Daily except Sun., 11:30 a.m. to 12:30 p.m.

40.50 7,410—....Eberswalde, Germany. Mo., Thu. 1-2 p.m.

41.00 7,310—....Paris, France ("Radio Vitus") Tests.
—....Moscow, USSR, 7-7:45 a.m.

41.46 7,230—**DOA**, Doeberitz, Germany.

41.50 7,220—**HB9D**, Zurich, Switzerland. 1st and 3rd Sundays at 7 a.m., 2 p.m.

41.70 7,190—**VK6AG**, Perth, West Australia. Between 6:30 and 11a.m.

42.12 7,120—**OZ7RL**, Copenhagen, Denmark. Irregular. Around 7 p.m.

42.80 7,000—**F8KR**, Constantin, Algeria.

43.00 6,870—**EAR** 110, Madrid, Spain. Tues. and Sat., 5:30 to 7 p.m., Fri. 7 to 8 p.m.
—**CT1AA**, Santos, Portugal, Friday, 4-5 p.m.

43.50 6,900—**IMA**, Rome, Italy, Sun., noon to 2:30 p.m.

43.60 6,875—**F8MC**, Casablanca, Morocco. Sun., Tues., Wed., Sat.

44.00 6,820—**XC** 51, San Lazaro, Mexico. 3 a.m. and 3 p.m.

44.30 6,770—**VRY**, Georgetown, British Guiana. Wed. and Sun., 7:15 to 10:15.

45.00 6,600—....Berlin, Germany.

45.20 6,635—**WSBN**, SS. "Leviathan."

46.05 6,515—**WOO**, Deal, N. J.

46.70 6,425—**W2XCU**, Ampere, N. J.;—**W9XL**, Anoka, Minn.; and others.

47.00 6,380—**CT3AG**, Funchal, Madeira Island. Sat. after 10 p.m.
—**VAS**, Glace Bay, Canada. Tests.

47.35 6,335—**W1OXZ**. **Airplane Television.**
VE9AP, Drummondville, Canada.

48.25 6,215—**FRT**, Fort de France, Martinique.

48.30 6,205—**LON**, Buenos Aires, Argentina.

48.35 6,200—**HKC**, Bogota, Columbia.

48.74 6,155—**W9XAL**, Chicago, Ill. (WMAC) and **Airplanes.**

48.80 6,140—**KIXR**, Manila, P. I. 3-4:30, 5-9 or 10 a.m. 2-3 a.m. Sundays.

48.83 6,140—**KDKA**, East Pittsburg, Pa. Tu., Thu., Sat., Sun., 5 p.m. to midnight.

48.96 6,120—....Motala, Sweden, "Rundradio." 6:30-7 a.m., 11-4:30 p.m. Holidays, 5 a.m.-5 p.m.
—**ARI**, Hongkong, China

49.02 6,120—**W2XE**, New York City. Relays WABC. Atlantic Broadcasting Co.

49.15 6,100—**W3XL**, Bound Brook, N. J. (WJZ, New York). 12 midnight on.
—**HRB**, Tegucigalpa, Honduras. 9:15 p.m.-midnight. Mon., Wed., Fridays.

49.26 6,090—....Copenhagen, Denmark.

49.31 6,080—**W2XCX**, Newark, N. J. Relays WOR.
—**W9XAA**, Chicago, Ill. (WCFL).

49.40 6,070—**UOR2**, Vienna, Austria. 5-7 a.m., 5-7 p.m.

49.46 6,065—....Motala, Sweden. 6:30-7 a.m., 11 a.m.-4:30 p.m.

49.50 6,060—**W8XAL**, Cincinnati, Ohio. Relays WLW.
—**W9XU**, Council Bluffs, Iowa. Relays KOIL.
—**W3XAU**, Byberry, Pa., relays WCAU.
—**HKC**, Bogota, Colombia. 8 to 11 p.m., ex. Sun. and Mon.

49.67 6,040—**W9XAO**, Chicago, Ill. (WMAQ).

49.80 6,020—**W9XF**, Chicago, Ill.
—**W2XAL**, New York.
—**W2XBR**, New York, N. Y. (WBNY).

49.97 6,000—**ZL3ZC**, Christchurch, New Zealand. 11 p.m.-midnight.
—**EAR25**, Barcelona, Spain. Sat. 3 to 4 p.m.
—**RFN**, Moscow, Russia. Tues., Thurs., Sat. 8 to 9 a.m.
—**SAJ**, Karlsborg, Sweden.
—Eiffel Tower, Paris, France Testing 6:30 to 6:45 a.m., 1:15 to 1:30, 5:15 to 5:45 p.m., around this wave.

51.70 5,800—**HK?**, Barranquilla, Colombia. 8:30 to 10:30 p.m., exc. Sun.

52.00 5,770—**AFL**, Bergedorf, Germany.

52.72-54.44 5,690-5,510—**Aircraft.**

54.02 5,550—**W2XBH**, Brooklyn, N. Y. (WCGO)
—**W8XJ**, Columbus, Ohio.

54.51 5,500—**W2XBH**, Brooklyn, New York City (WBBO, WCGH).

(*Continued on page* 94)

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Short Wave Question Box

Edited by R. William Tanner, W8AD

THIS question and answer department is edited by Mr. R. William Tanner, well known operator of short-wave amateur radio station W8AD. Mr. Tanner has written a great many articles for the radio press and has had considerable experience in designing and constructing both short-wave transmitters and receivers. Not more than three questions should be asked and all letters containing questions should be addressed to the Editor Short-Wave Question Box, at the publisher's address. State your questions briefly. Questions cannot be answered by mail.

Best Length of Short-Wave Aerial for Reception

(1) Richard Worth, Cleveland, O., wants to know:

Q. 1. What is the best length of antenna for short wave broadcast reception?

A. 1. There is no such thing as a "best" length antenna for short waves. A long one results in greater distance reception, with less selectivity and vice versa. A short inside wire 15 feet long will give excellent results below approximately 40 meters, but it is not so good on the higher waves. For all-around reception with a regenerative R.F. tuner (i. e., a set using 1 stage of radio frequency amplification ahead of a regenerative detector stage), I would advise a single inside wire, located at the highest point in the house, with a total length from the set, of 50 feet. If a straight regenerative receiver is employed, this may advantageously be increased to 80 or 100 feet.

Q. 2. Is a ground or a counterpoise best for reception?

A. 2. Experience has proven that there is very little difference in a ground or counterpoise from the standpoint of sensitivity; however, when the receiver is located close to high tension lines, power-houses or other sources of man-made interference, the counterpoise comes out way ahead. The noise is not completely eliminated, but rather it is peaked at one or more points on the dial, allowing reception in between. In some cases where a good ground is impossible, as in sandy sections of the country, the use of a counterpoise, about the same length as the antenna, will show greater strength of signals.

Q. 3. Why is the 112A tube considered such a "hot" detector for short waves?

A. 3. The reason why there are so many boosters for the 112A as a detector in short wave receivers is probably due to its extreme quietness in operation and to its ease of oscillation. The filament is much less critical than nearly all other tubes employed as detectors, due to the oxide coating. Signal strength, however, is not as good as with a 201A. If you want a real "hot" detector try the 210. The "RCA" uses these in nearly all of their commercial short wave sets.

Quarter Wave Antennae for Reception

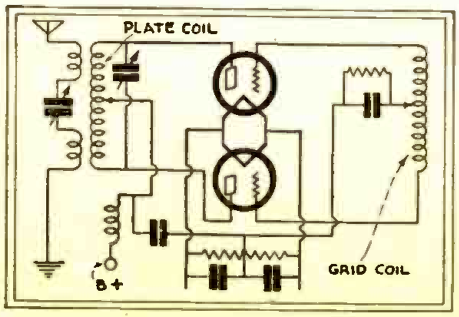
(2) David Wehner, Philadelphia, Pa., asks:

Q. 1. Would it be advisable for the average short wave listener to attempt the construction of a specially-shaped antenna of the quarter-wave and other types as employed by some of the commercial companies?

A. 1. No. Such an antenna works efficiently only over a comparatively narrow band of frequencies and receives better from one direction than another. If the receiver is tuned to some frequency differing to any great extent from the fundamental of the antenna, results will be no better than with even a short indoor wire.

Q. 2. What are the advantages and disadvantages of the use of tickler regeneration in short wave receivers?

A. 2. Some of the advantages derived from the use of a tickler for regeneration in a short wave receiver are: first, a high degree of sensitivity, almost equal to a stage of tuned screen grid R.F. amplification, is possible, making for economy in construction. Second, the sharpness of tuning is very much improved due to the lower losses in the grid circuit, by feeding back some of the R.F. energy in the plate circuit. On the other hand, if regeneration is brought too close to the point of oscillation, some of the higher audio frequencies will be suppressed, resulting in poor quality of reproduction. The regeneration control is usually rather critical, unless some sort of a vernier dial is employed. This might be considered as a disadvantage by some. Unless the plate and grid voltages and the number of turns on the tickler coil are just about of the right value, regeneration will be "cranky" with many howls and squeals reproduced in the headphones or loud speaker.



This diagram shows connections for tuned grid, tuned plate, transmitting oscillator circuit.

Push-Pull Transmitter Circuit

(3) John Kalish, Camden, N. J., writes this department:

Q. 1. Will you kindly publish a circuit for a simple push-pull tuned grid, tuned plate transmitter circuit and give number of turns for the coils and sizes of tuning condensers for use in the 80 meter band?

A. 1. This is shown below. The plate coil consists of 10 turns of No. 12 enamel wire on a 2" form. The grid coil is wound the same. Both of the antenna coils may consist of 6 turns each, 2" in diameter. All three of the tuning condensers have a maximum capacity of .0005 mfd.

Short-Wave Aerial Construction

(4) M. B. Goodwin, New York, N. Y., would like to know:

Q. 1. How high should a short wave receiving antenna be erected and what kind of wire should it be made of?

A. 1. A height of 25 to 30 feet will be sufficient for almost any location, except where high buildings are close by. No. 14 solid copper wire is about the best size to use. Avoid any types of stranded wire as the high frequency resistance will generally be higher than with solid.

Q. 2. How should the lead-in be arranged and should it be insulated?

A. 2. The lead-in should be soldered to the main part of the antenna and brought in along as straight a line as possible to the set. If the antenna is located outside, bring the lead-in through some of the approved lead-in bushings. Contrary to general opinion, insulated wire is not as good as bare or enamel covered wire.

Q. 3. Why are plug-in coils superior to tapped inductances?

A. 3. With plug-in coils, all of the turns are in circuit at any given time; any other coil, such as a tickler or primary, coupled to the main coil is of a useful nature. When a coil is tapped to cover a greater band of wavelengths, then losses resulting from introducing resistance into the tuned circuit by the unused portions, tend to destroy the selectivity. If a tapped coil is connected in the grid circuit of a regenerative detector, tuning holes (points on the dial

(Continued on page 78)

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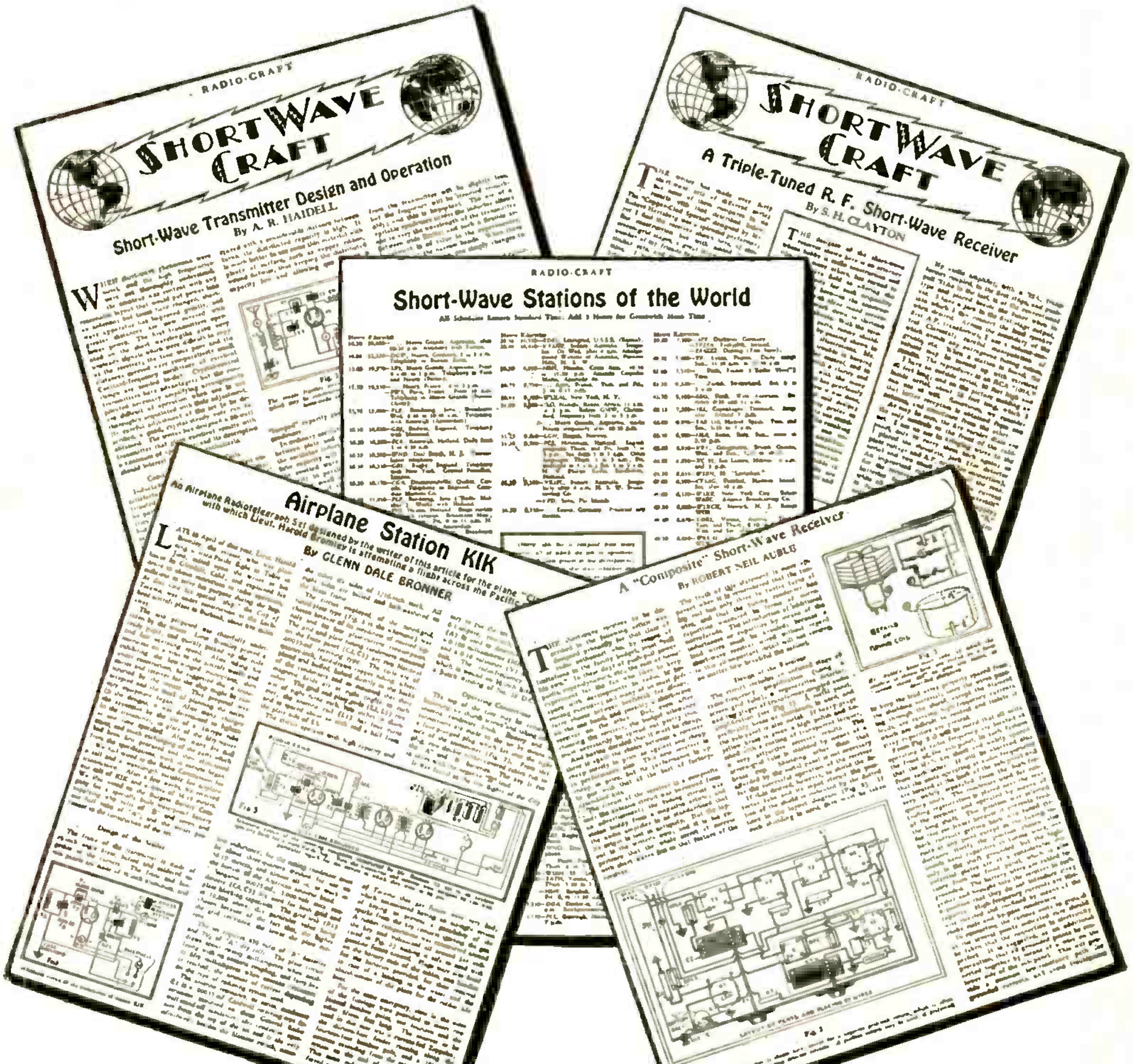
Radio-Craft
for the
Professional-Serviceman-Radiotrician



FOR over a year, RADIO-CRAFT magazine has carried one of the finest short wave departments of any magazine in this country. In its department entitled "Short Wave Craft" you will find the latest short wave data. Articles by world-famous short wave experts appear in RADIO-CRAFT every month. This department alone is worth the price of the entire magazine, as we have been assured by many readers.

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where oscillation cannot be obtained) will develop on the intermediate taps.

Best Form of Detector Coupling

(5) Hope Jones, Pittsburgh, Pa., asks:

Q. 1. Why is it advisable to use a resistance or impedance coupler between the detector and first audio amplifier in a short wave receiver?

A. 1. It is not always advisable to do so. With transformer coupling in any regenerative receiver, a loud howl is generally found at the point of oscillation. In technical circles, this is called "fringe howl." At the starting point of oscillation, the grid circuit seems to be in a highly critical condition. By employing a very low value of grid leak, the howl may be completely eliminated, but this is a very inefficient way to do the trick. A better method, one which has been in use by the "Amateur Fraternity" for a number of years, is to shunt a 100,000 ohm resistor across the secondary of the first A.F. transformer. Then by the proper choice of plate voltage, no howl should be heard. The amplification with a transformer is considerably greater than with resistance coupling, and far superior in every way when a three electrode detector is employed.

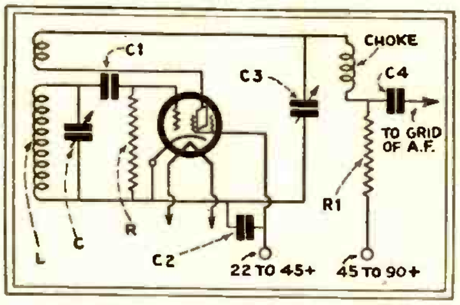
Screen Grid Detector Circuit

(6) G. C. E., Springfield, O., inquires:

Q. 1. Will you kindly print a circuit for a screen grid detector for use on short waves, using a 224?

A. 1. This is shown above. L, C is the regular plug-in coils and tuning condenser. C1 is the grid condenser of .00015 mfd. R is a grid leak of 1 to 3 megohms. C2 is a 1 mfd. bypass condenser and C3 the regular regeneration control. The plate resistor R1 may have a value between 250,000 and 500,000 ohms. The output of the detector is coupled to the audio amplifier through an .006 mfd. condenser C4. Different screen grid voltages up to 45 volts should be tried until best results are secured.

Q. 2. Does an untuned screen grid R.F. stage in a short wave receiver result in much gain?



Hook-up of screen-grid tube in short-wave detector circuit, showing choke coil, condensers, etc.

A. 2. It is doubtful if the gain is more than 2 or 3. A tuned stage will give a gain of possibly 5 or 6 at waves under 25 meters.

Q. 3. I have noticed in the various magazines that some circuits show a 1500 ohm resistor and some a 1600 ohm resistor for obtaining the grid bias for a 245 power tube. Which is correct?

A. 3. The E. T. Cunningham engineering bulletin on this type of tube advises the use of 1600 ohms with a plate voltage of 250 and 1350 ohms when the plate voltage is 180.

Choice of Tubes

(7) H. L. Stanton, Louisville, Ky., writes us:

Q. 1. What are the best tubes to use in both battery and A.C. operated short wave receivers?

A. 1. The only D.C. tube now available for short wave R.F. amplification is the type '22 and the only A.C. tube is the type '24. A 201A or 199 makes the best detectors from the viewpoint of volume for D.C. sets. If extreme quietness is desirable, the 112A should be employed. Only two A.C. tubes are available for use as detectors in A.C. operated receivers. These are the 227 and 224 types. The 227 is a very quiet tube and a ready oscillator. However, some brands seem to have a pronounced A.C. hum at the critical point of regeneration, but with the proper values of grid and plate voltages, it may be reduced to a negligible quantity. For volume, no other tube can compare with the 224. The detection factor is in the vicinity of 5 to 6. Either the space charge or screen grid connection may be employed, the latter giving somewhat greater volume and the former, better quality. This tube cannot, however, be employed as a regenerative detector much below 15 to 18 meters, due to the high plate to screen grid capacity. The 222 screen grid tube does not show up well as a detector, due to the microphonic noises produced. These noises are much worse than in either the 199 or 201A.

Q. 2. What are the best methods for smoothing out the regenerative control?

A. 2. See article on page 50.

Solving Frequency, Wave Length and Capacity Problems Without Mathematics

By Sylvan Harris

(*Continued from page 64*)

Knowing the Frequency, What Is the Inductance Value?

Suppose we have this problem: Our frequency assignment is 3000 kilocycles and we wish to tune with a condenser whose capacity is 50 micromicrofarads. How much inductance do we require?

Start at the point marked a in Figure 3, which indicates our 50 micromicrofarads. Then travel horizontally to the 3000 kc. curve, meeting it at the point b; then drop down to the point c, which indicates the required inductance, 56 microhenries. This is the same answer we obtained before, but this time we did it in one operation. What could be easier?

Another problem which often arises is this: The inductance of our coil is 40 microhenries (μ h); the maximum capacity of our tuning condenser is 100 micromicrofarads (μ μ f) and the minimum is 30 micromicrofarads. Over what frequency range can this combination tune?

This problem is solved in the same way. First take the combination of 100 $\mu\mu$f and 40 μh. This gives us the point d on figure 3, which lies on the 2500 kc. curve. Then take the combination of 30 $\mu\mu$f and 40 μh. This gives us the point e, which we see lies on a curve of frequency slightly higher than 4500 kc. The tuning range is then 2500 kc. to about 4600 kc.

As we have stated, the curves of Figure 4 are the same as those of Figure 3, excepting that wavelength is used instead of frequency. The problem often arises of determining the values of inductance and capacity to use for tuning over a certain narrow range. For example, the 40 meter band is quite popular, and also quite crowded, so it is desirable to be able to tune over a narrow band which has 40 meters as its middle, and to have the tuning adjustment so fine that stations crowded about that wavelength can be easily separated. In other words, we have a micrometer adjustment for tuning, and not an adjustment which causes the wavelength to jump 10 or 20 meters at the slightest motion of the tuning dial.

Suppose the inductance of our tuning coil is 20 microhenries. On the curves of Figure 4 we find that in order to tune 20 μh to 40 meters we require a capacity of 22.5 $\mu\mu$f. It is a simple matter then, to use a fixed condenser of 15 $\mu\mu$f in parallel with a variable condenser whose capacity at the middle of the dial is about 22.5 — 15 or 7.5 $\mu\mu$f. This means a maximum capacity of 15 $\mu\mu$f for the vernier condenser, and 40 meters will come in at about the middle of the dial. The capacity range will then be about 15 $\mu\mu$f to 15 + 15 or 30 $\mu\mu$f, and by looking up the wavelength range on Figure 4, it will be found to be about 33 to 46 meters.

Many other problems of this sort can be solved very easily by means of these charts, and it is hoped that our short wave fans will quickly become accustomed to their use.

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Short Wave Possibilities and Probabilities

By LEE DE FOREST, Ph.D.

(*Continued from page* 10)

But little by little the radio amateurs succeeded in simplifying short-wave requirements. They learned how to make short-wave inductances, and the data was made available to the public at large. Condenser manufacturers, taking advantage of processes developed by amateurs, soon made the necessary low-capacity variable condensers. Standard vacuum tubes or audions, with their bases intact, became available for short-wave reception. And today, as a consequence, excellent short-wave receivers are available, permitting the layman to tune in the short-wave stations of the world without previous experience or undue patience.

The short waves hold the greatest thrills of radio just as the parachute jump from a burning plane is the greatest thrill of aviation. For short waves are the emergency waves of radio. Only a few years ago, we knew comparatively little about waves below 100 meters. We may even have questioned their practicability. We did not understand why a powerful short-wave transmitter could barely be heard at a distance of a few miles, yet came thundering in half-way round the world. We looked upon fading and swinging as jests of a Fate which could not be circumvented.

Today, short-wave radio is mastered to a large degree. Still, there is a thrill in having tamed the trickiest of radio technique. Based on mountains of data, we know precisely what frequency or wave length to employ for a given distance, time of day, and season. Indeed, we can practically make the skipping short wave land precisely where we will, which accounts for commonplace long-distance communication with ridiculously small power. No longer are we particularly thrilled with the 7½ watt transmitter, using an ordinary receiving set power tube, transmitting signals to the opposite side of the earth. With a given frequency and other perfected details, we almost expect such perform-

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ance. Swinging, or the wandering or wabbling of a signal from its determined frequency, is to a large measure overcome by the employment of rigid antenna systems at the transmitting end. Fading, the last remaining obstacle, is minimized by the use of multiple antennas, working on the good old rule of probabilities, as explained further on.

Europe and Asia Become Our "Neighbors"

The greatest thrill for the layman, however, is in the matter of distance and foreign radio tours. The usual layman, perhaps grows a bit blasé with the simplicity of the broadcast receiver tuned in to domestic stations, is certain to have thrills aplenty when the careful flip of the dial draws in England, Germany, Holland, Soviet Russia, Australia, India, Japan and other overseas countries now become radio neighbors. Frankly, short-wave radio is loaded with subject matter interest. It may be enjoyed by the layman who simply turns the dials, just as much as by the experimenter who is interested in the arrangement and re-arrangement, *ad infinitum*, of the components. While short-wave radio has heretofore been limited to the experimenter, due to the lack of knowledge and the unwillingness of radio set manufacturers to engage in what appeared to be a budding experiment, today many short-wave sets are available which insure positive results from the start.

What subject matter is interesting? One may ask. Well, various countries are now set up for an exchange of broadcast programs. The United States, for instance, has arrangements with British, German and Dutch radio interests, whereby our networks and independent stations operate supplementary short-wave transmitters, which fling the usual broadcast programs out into space, in return for which our overseas friends do likewise. For the present, most of the transmitters are approximately 5 to 50 kilowatts, most of them being no higher than 20 kilowatts. Although excellent results are being obtained even in the supreme test of rebroadcasting overseas programs, the power is yet too modest for consistent results. The writer firmly believes that once again the radio world has underestimated the task, as was the case in broadcasting, transoceanic and marine radio. Doubtless the power ratings will be increased several fold in the future, so as to establish more positive signals in distant lands.

However, it must be noted that the larger short-wave broadcasters are interested mainly in having their signals picked up by overseas broadcasters, fully equipped with the necessary facilities. In other words, they may not be particularly concerned with having the usual amateur or layman pick up the signals under trying conditions. Even so, before overseas broadcast features can be positively scheduled in advance, from one end of the year to the other, a notable increase in power will be required.

What lay and amateur short-wave reception may come to is perhaps reflected in the work of the broadcasters themselves. Thus our American broadcast networks have the most elaborate short-wave receiving stations, located at the most advantageous points. Let us see just how the obstacles of good short-wave reception are eliminated.

Eliminating Short Wave Obstacles

First, there is background noise or inductive interference, which is particularly annoying in short-wave reception. Usually electric bells, telephone ringers, domestic appliances, sparking motors, and even automobile ignition systems prove somewhat troublesome. But the short-wave receiving station for rebroadcast purposes, is established at a remote location especially selected because of ideal reception conditions. The station is some distance away from the nearest highway, as well as from stores, shops and homes. Thus there is little or no opportunity for inductive interference, and a clean background is assured.

Second, there is the question of swinging, or frequency wobble. The short-wave transmitters are now arranged with rigid antenna systems, minimizing any such tendency of the signals.

Third, fading, the greatest obstacle facing the usual short-wave enthusiast, is overcome by what is known as "diversity reception." In other words, fading is not a universal phenomenon. A signal may fade at one particular location, only to be received with full volume a few hundred feet distant. Hence the broadcasters make use of several antennas, usually three, spaced about one thousand feet apart, yet connected to a common receiving equipment. By the law of probability, the signals are not apt to fade simultaneously at all three antennas, so that a good signal is possible from a collection of antennas. Also, several receivers are employed, connected with the collection of antennas. Each receiver may have an automatic volume control, which maintains the output at a given level. Lastly, the outputs of the several receivers pass through an automatic (vacuum tube) selector, which draws a varying signal quota from each receiver and strikes a predetermined uniform balance or level for the entire output.

Little wonder, therefore, that the broadcasters are in position to intercept, amplify, distribute and rebroadcast European programs over their networks with really good results, while the layman or radio amateur may barely hear the same programs direct. Yet as time goes on there is every indication that lay and amateur short-wave

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MAKING A LONG WAVE SHORT

Britannia May Rule the Waves—But the Radio Hams and S.W. P.H. Rule the Short Ones

MARCELLUS GERNSBACK, a New York S.W.P.H., who gets a short-wave fit when he doesn't receive Big Ben of London on G5SW daily, just fell heir to a soft graft. Camp Iroquois for Boys, Willetts Bay, Vermont. It invited him, ALL EXPENSES PAID for the summer, to catch short waves at the camp for the edification of the 60 odd boys. Let's hope the static treats him well.

The latest sport is this one, boys. We know several otherwise normal S.W.P.H. who now amuse themselves daily by listening to the transatlantic phone over short waves. They hear only the American side, therefore they listen in on a one-way conversation. Then they take it all down in shorthand. Next they try to fill in what the fellow over in Europe said. A cracked sort of a cross-word puzzle, we call it.

"Long may she wave" should be brought up-to-date with "May she short-wave."

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reception will be steadily improved, making use of the same general principles used by the rebroadcasters, though necessarily on a more modest scale. We are only in the infancy of short-wave radio reception.

Of course there are some who like to "talk" quite as well as "listen." In other words, there is transmission as well as reception. Transmission is more intricate than reception for the simple reason that it calls for an operator's license, as well as a station license. An amateur radio license may be readily obtained by the average person, after a short course of practice in code work. The thrills of reception are multiplied a thousand fold when one can transmit as well, thereby being at once audience and orator in the short-wave radio world.

As the writer views this question of short-wave radio, he notes a woeful lack of constructive literature in the past. Therefore, the appearance of this publication is most opportune at this time, when the public at large, depending more and more on usual broadcasting for certain program features, is necessarily seeking other means of satisfying the sporting instinct based on chance and uncertainty, as well as a means of self-expression through radio transmission. In short-wave radio, the public may well find the indoor sport which it seeks.

How to Build a 2 in 1 Receiver

By LOUIS B. SKLAR

(*Continued on page* 57)

14. .00015 Variable Condenser.
15. .00035 Variable Condenser.
16. 1st Audio Stage Socket.
17. 2nd Audio Stage Transformer.
18. Detector Stage R.F. Coil with Fixed Tickler.
19. 2nd Audio Stage Socket.
20. Loud Speaker Binding Posts.
21. Dial Illuminating Bulbs.
22. Battery Switch.
23. Dials.
24. Knobs.
25. First Audio Jack.
    Rheostat for Detector Tube.
    Set of Short-Wave Coils, Tubes, Batteries, Coupling, etc. Condenser Couplings, one insulating, and one metallic. (Hammarlund and Pilot are concerns making them.)

Using the '22 Tube

There will be little difficulty in adapting this circuit to the use of Type '22 tubes.

It will be necessary to shield the input circuit of the screen grid tube, to realize maximum amplification with the least regeneration. It was not necessary to shield the original receiver as it did not incorporate the screen grid tube.

Secondaries *S*1 and *S*2 will consist of a certain number of turns as determined by the capacity of the particular variable condensers used.

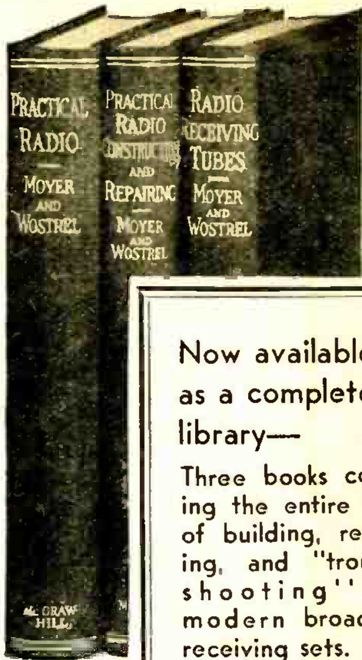
Primary *P*1 must be made with very small wire, as the coil must have very small dimensions. It is wound at the filament end of the secondary, as is primary *P*2. The number of turns in coil *P*1 is controlled by local reception conditions and the particular aerial used.

Primary *P*2 is also wound with very fine wire and contains about one-third the number of turns on the secondary.

It is to be noted that the filament resistance indicated as *R*, must be about 10 to 15 ohms. Additional resistance may be cut into the positive "A" lead to reduce the "A" voltage at the tube filament to the required value. The necessity for having a certain resistance value for *R* is the "C" bias requirement of the tube; resistance *R* supplies this and a special battery for the purpose is not needed.

Condenser *C* may have a value of about one-quarter microfarad.

For satisfactory short-wave reception it will be necessary to arrange the aerial so that it does not swing badly, or the result will be pronounced fading and swinging of signals. Fading is a rise and fall in volume, at one wave length, compensated by variation of the volume control.—(*Courtesy Radio-Craft.*)



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A section is devoted to the identification of common faults in receivers and methods of making workmanlike repairs.

The three books are profusely illustrated with understandable diagrams of hookups, connections, loud speaker units, installation work and antenna erection—as well as numerous photographs, tables and charts which clarify the text.

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A Complete Portable Transmitter and Receiver for Short Waves

(*Continued from page* 54)

No. 18 bell wire on a 3" form. Due to the slight difference in makes of condensers a definite number of turns for these coils cannot be given but in the set shown 7 turns are used for the antenna tuning and 8 turns for the regeneration control.

The coil mounting table is a piece of panel stock 4½ inches long by 2¼ inches wide with a pair of side hole binding posts at each end 1½ inches apart. These are wired to the circuit as indicated and the table raised above the base by four insulating washers just high enough for other wiring to pass under it. Spaghetti is used in all wiring because the set is so compact; consequently, grid and plate leads must be short and placed with care to prevent capacity coupling. A binding post strip is placed along the rear edge of the base. The first audio stage is in circuit with a two circuit jack while the second stage is connected to a filament jack which automatically controls the last tube when the plug is inserted. The panel is shielded with tinfoil shellacked on and the shield grounded.

For the receiver, one 22½ volt "B" battery of the same size as the ones in the transmitter is wired direct to the "B" circuit while three regulation size dry cells are wired to the filament circuit through the toggle switch.

The antenna consists of a 33 ft. length of small gauge braided insulated wire with an insulator at one end and carefully scraped to bright copper at the other. The counterpoise can be about the same length. The writer carries each one on an old fishline reel thus making them convenient for carrying. A hook or cord at the insulator end makes it convenient for fastening to a tree or other support.

A simple resonance indicator was made as illustrated in the cut. This consisted of a single pole double throw switch, a rheostat, a single cell of flashlight battery and the smallest flashlight bulb obtainable, with socket. When arranged as shown it acts as a shunt across the counterpoise lead with the switch thrown in one direction but cuts it out of the circuit with the switch thrown in the opposite direction. The switch blade is connected to the counterpoise lead direct, and the counterpoise itself to the lower contact of the switch. With the flashlight in shunt, turn on the rheostat until the light just glows. Then when the transmitter is brought in tune and is in resonance with the antenna the light will brighten up. With this determined, throw the switch to the opposite side and the output will go out direct. This saves the expense of buying an antenna meter. A double pole double throw switch at the other end of the board serves to transfer counterpoise and antenna from receiver to transmitter as needed.

Antenna and counterpoise are switched over to the transmitter side and the transmitter tuned to resonance by the indicator at the desired wave length; after, of course, lighting the tube by means of the toggle switch. After the CQ is given, the tube is switched off and the antenna and counterpoise switched over to the receiver. This is switched on and the reply hunted for as usual. When contact is established the same procedure with the antenna-counterpoise switch is repeated as replies are given and answers received. When finished the entire outfit can be packed up in five minutes for transport.

Acknowledgment

In justice to the Burgess Battery Co. of Madison, Wis., it should be stated that this transmitter circuit was developed by them and has shown wonderful results in actual practice. The writer has also found it very efficient although making several minor changes in the design.

Receiver reference data — Antenna series coupling condenser, ½ in. sq. plates; G—Grid leak and condenser, 2 megs. and .00025; At—Antenna coil, 7 turns; Rg—Regeneration coil, 9 turns; S—Filament switch; A—4½-volt C battery; B—45-volt B battery; C1—5-plate variable condenser; C2—11-plate variable condenser; T—Three 199 tubes; Tr—Two 3½ to 1 transformers; J1—Double circuit jack; J2—Filament control jack; R—Filament rheostat, 125 ohms.

Transmitter reference data: A—4½-volt C battery; B—67½-volt B battery; Cg and CP—Two .00025 variable condensers, 9-plate; CS—.001 mica condenser; Lg and Lp—Two 7-turn coils, 3 in. in diameter; La—Antenna coupling coil, 5 turns; T—199 type tube; R1—5,000-ohm grid leak; R—Filament rheostat, 125 ohms; RFC—Two 40-turn chokes; K—Key; AI—Antenna indicator; DT—Double pole double throw switch; F—Filament switch.

—(*Courtesy Radio-Craft.*)

FIVE METERS OR BUST!

By CLYDE RANDON

(*Continued from page* 59)

be taken into consideration when a receiver for these extreme frequencies is constructed.

The inductance and capacity in the tuned circuit of a five-meter receiver are necessarily quite small; so that it is very essential to use the shortest possible leads. It is desirable, also, to use a tube of low internal capacity, so that a comparatively large value of inductance can be used externally; thus obtaining better sensitivity. Since the circuit constants are extremely small, the type of tube used and other factors of construction will have much to do with the size of coil required. In one receiver used by the writer, two turns an inch in diameter served as a secondary, the tickler being of the same size; a '99 tube was employed.

A small choke (RFC) consisting of about 30 turns, an inch in diameter, will be suitable in a receiver at these frequencies. The tuning condenser C1 is a small midget variable, cut down to two plates; and a 50-mmf. midget serves as a throttle control C2. One should be sure not to use too large a tuning condenser; for the range covered will be excessive and the dial cramped. A grid condenser of about 20 mmf. will serve for C3, and a grid leak of 5 megs.

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The Pilot A.C. Super-Wasp

By ROBERT HERTZBERG

(*Continued from page* 44)

months, and has established an international reputation for general effectiveness.

The use of a tuned screen-grid R. F. stage gives sensitivity and selectivity far beyond anything obtainable from a straight regenerative set. Many radio men still doubt the effectiveness of T. R. F. on the short waves, but they forget that not so many years ago T. R. F. on waves as high as 300 meters was considered impracticable, and engineers were forced to use beat-frequency receivers, in which the wavelength of the signal was raised, in effect, to a higher value at which R. F. amplification could be accomplished more easily. This was the super-heterodyne idea, if you recall. Radio engineers have learned a few things, and R. F. amplification on 14 or 15 meters is no longer an uncertainty. The R. F. short-wave receiver is just as far ahead of the "hay-wire" straight regenerator as the modern R. F. broadcast receiver is ahead of the old three-circuit tuner.

Shielding Used to Stabilize Tuning

Note that the components of the R. F. and detector stages, respectively, are enclosed within individual shield cans, which in turn are mounted behind a metal panel. The tuning inductances take the form of coils which plug into regular tube sockets.

The tuning of the Super-Wasp is like that of the famous Browning-Drake, there being two tuned circuits and one regenerative control. The usual tricks of "zero-beating" and regenerative operation are readily learned.

No detailed instructions about the assembling or operation of the set need be given here, as they are furnished in detail with each kit by the manufacturer.

A question that naturally arises is: "How much hum is there present?" The answer is that the hum has been reduced to the point where it is hardly noticeable. The sources of many mysterious hums that were not due to the power supply were located after much experimenting, and cures applied. These consisted mostly of by-pass condensers, which broke up local oscillating circuits consisting of the filament-to-cathode capacity of the detector, and audio tubes and the inductance of the center-tapped resistances and the connecting leads. The residual hum due entirely to the A. C. filament current and the rectified plate current is exceedingly slight, due to the use of tubes with "hairpin" filaments, and also to an efficient filter system in the "B" pack. The "hairpin" type of filament in cathode tubes has practically no magnetic field, and hence does not cause periodic upheavals in the electron emission, as do straight filaments. A 227 tube is used in the last audio stage for this reason, an acceptable compromise between the impedance of the tube and the impedance of the loud speaker being readily obtainable by means of an output transformer. The 227 is necessary for headphone reception; a 171A or 245, with its raw A. C. filament, produces a hopeless growl.

Many of these A. C. Super-Wasp sets are actually quieter than battery sets.

Effect of Magnetic Storms

By C. W. HORN

(*Continued from page* 23)

proved, as is evidenced by the results of the experimental work that is going on. As nothing is ever perfect we are in the position of striving for that time when sufficiently practical results can be guaranteed in order to begin regular service suitable for rebroadcasting. From then on improvements will take place until the public will come to accept this service for its real value, rather than because of the novelty of the thing.

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By JOHN F. RIDER

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package number 1 supplement to John F. Rider's "Trouble Shooter's Manual" is now ready for distribution. Here is an opportunity to secure wiring diagrams of the modern screen grid receivers at a ridiculously low price. 115 wiring diagrams, size 8½ in. x 11 in. punched three holes suitable for loose-leaf binding, covering screen grid receivers produced by such manufacturers as Grebe, Crosley, Stromberg-Carlson, Fada, Stewart-Warner, Edison, Eveready, Silver - Marshall and others. Price, $2.50 postpaid. Write for list of diagrams and books.

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How to Obtain Smooth Regeneration

By ROBERT (BOB) HERTZBERG

(*Continued from page* 51)

It is best to provide a potentiometer P in the "B" circuit, as shown in Fig. 2. This should be of the 100,000 ohms size. One end goes to "B" plus 45, the other to "B" minus, and the arm to the "B" post of the audio transformer primary.

Right Tube Important

In some cases the detector will continue to drop into oscillation violently even with only a few volts on the plate. This may be due to an abnormally large tickler winding, or merely to the fact that the tube itself is a poor one for the purpose. First try different tubes; if they all behave alike, the trouble undoubtedly is in the tickler. Remove one-half a turn at a time, and carefully vary the potentiometer until a satisfactory balance is achieved.

Speaking of tubes, do you know that some 112A's are very much better detectors than 201A's? Of course the 112A is intended to be a semi-power tube for the last audio stage of battery-operated receivers, but it so happens that it also makes a beautifully smooth regenerative detector. It may be used interchangeably with 201A's in the detector socket, as it takes the same filament current. The plate voltage, of course, must be adjusted by means of the potentiometer. If you happen to have a 112A tube on hand, by all means try it. You may be pleasantly surprised to hear how smoothly it works.

Resistance Control of Regeneration

Two resistance control methods are illustrated in Fig. 3. In one case the resistance is R1, and is connected directly across the tickler coil. In this position it acts as a variable short-circuit. When the resistance is high, most of the plate current flows through the tickler and as a result produces feed-back and regeneration. When the resistance is low, less current flows through the tickler and more through the resistance elements, so little regeneration is produced. This is a good system, but the resistance R1 must be a perfect one; if it isn't it will produce a lot of noise that will overbalance the advantages of the method.

The second system makes use of the resistance directly in the "B" plus lead, as shown by R2 in Fig. 3. Here the resistance actually regulates the effective plate voltage. Again it is subject to noise effects.

Why Some Sets Have "Dead Spots"

Many straight regenerative short-wave receivers have what are known as "dead spots" in the tuning range. The reason for it is simple; absorption by the antenna circuit. The remedy is to adjust the antenna coupling condenser C1 or to use a smaller one.

A better way of eliminating dead spots is to use a stage of screen grid radio-frequency amplification ahead of the detector, as shown in Fig. 4. This stage is of the so-called "untuned" type, the aerial being connected to the grid of the 222 tube through an R. F. choke coil. The first audio stage following the detector is resistance coupled, to eliminate the bad "fringe howl" present in transformer stages. The values of the various parts are indicated.

An Improved Screen-Grid S-W Converter

(*Continued from page* 65)

squeals from going out to the neighboring sets.

Our short-wave converter makes use of suitable coils, such as the National short-wave kit for screen-grid and regenerative detector. Tuning is accomplished by a single variable condenser. The point of departure is the stepless or micrometric variable resistance in the plate lead of the detector circuit, in the form of a volume control clarostat. This serves to provide the much desired threshold regeneration adjustment so essential for short-wave DX work.

A second point of departure is the adjustable voltage applied to the screen grid of the 222 tube. This is accomplished by means of a duplex clarostat, which also places a small bias on the control grid of the tube, as indicated in the diagram. This duplex resistor has screw adjustments, so that once it is set with a screwdriver, it may be left alone without the necessity of further tinkering.

Contrary to general opinion, the voltage applied to the screen grid is important if maximum efficiency is sought. Particularly in short-wave work, which is essentially DX, it is a critical voltage of real importance, although this practice is also recommended in broadcast receivers intended for DX work.

After making this simple converter, as described, one has merely to remove the detector tube and insert the plug of the converter in its place. The detector tube is then placed in the converter, and one can tune-in virtually around the world.

The list of parts follows:

1—National Short Wave Kit (consisting of front and sub-panels, set of plug-in coils, tuning condenser and choke.)
1—Clarostat Grid Leak.
1—Tobe 8 meg. Tipon Leak.
2—Tobe 5 mfd. By-Pass Condensers.
1—Tobe 2000 ohm. Veritas Resistance.
1—Tobe .00025 Vacuum Condenser.
1—Tobe .001 Vacuum Condenser.
1—622 Amperite.
1—1-A Amperite.
1—Yaxley Switch.

Any discarded tube may be used for the plug-in socket base. The glass bulb and stem should be broken, and the other material in the base cleaned out.

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A Simple Short Wave Frequency Meter

By JOHN L. REINARTZ

(*Continued from page* 27)

Coils for twice the frequency band will be found to need approximately half of the number of turns used for the 3,300 to 4,300 kc. band. It will be found possible to juggle the number of turns to suit the requirements of the particular tuning condenser that you use. Once you have sealed the coils into the bases they will remain as fixed values for a frequency range determined only by the size of your tuning condenser. A change in voltage from 22.5 to 45 volts, will make a change in beat note of only a hundred cycles.

Laying Out the Parts

The physical layout of the parts should be in a progressive manner, first the tuning condenser, then the socket used for the coils, then the socket used for the tube and after that the batteries; this will insure the coils from the proximity of the battery or even a change in relation thereto. Even though the field of the coil is reduced to the smallest value, it is well to keep this point in mind; it will be found that with this arrangement one may take out the coil and replace it, without changing the calibration of the meter.

Whatever you make the case out of, be it aluminum, copper or brass, be sure you make it large enough to hold all the parts. It is much better to have it a few inches too large than one inch too small. You may "doll" this case up by tacking a large rubber stopper to a dowel, which is inserted in a bit brace, and after placing emery powder on the metal sheet, turn the brace briskly in one place, until the sheet takes on the outline of the rubber stopper. Repeat this on all parts of the sheet and wash off; after drying you will find the sheet to have taken on a beautiful appearance.

Calibration of this meter can be accomplished in several ways, the best of which is to listen to the standard frequency signal transmissions by W1KV and W9XL, stations of Mass. Inst. of Tech. and Northwestern Broadcasting, Inc., Anoka, Minn., respectively.

A De Luxe Short Wave Receiver

(*Continued from page* 45)

The tuning is accomplished with a horizontally mounted, illuminated drum dial control, which rotates the ganged condensers. The dial is turned with a touch of the thumb. Special low-loss condensers are used and these are totally shielded and the receiver may be tuned by the zero beat method. The antenna coupling condenser is adjustable so as to give maximum efficiency on all frequencies and with different antennae. The regeneration control works very smoothly and has a minimum effect on the tuning circuits and there are no hand-capacity effects. All parts of the set are properly shielded, wherever it has been found necessary. This set can be used with the ordinary magnetic type loud speakers, or phones may be used by means of the phone jack fitted on the set. If the specially designed dynamic loud speaker is used in connection with the set, the field current for the dynamic speaker is supplied by the set itself. This set is a laboratory type instrument in its quality of workmanship and performance, and each one is tested on the air.

Some of the interesting general features of this de luxe short-wave receiver are as follows: Grid leak mounting accessible; primary line voltage adjustment; RF chokes of special design; headphone jack provided; modernistic panel design; all aluminum cabinet, satin finished or walnut; Gorton engraved bakelite escutcheons; individual calibration chart furnished; quick and accurate location of stations; accuracy within two per cent; air tested by engineers; full operating instructions furnished; selected tubes supplied if desired, and the tubes furnished are tested in receiver.

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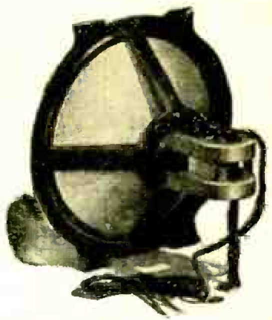

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The Hammarlund S-W Adapter-Receiver

By LEWIS WINNER

(*Continued from page* 67)

The set, however, can be used with alternating current receivers, batteries being used for the adapter. To do this it is only necessary to disconnect the plate lead from the eliminator, B battery plus supplanting it. The minus post of this B battery is connected to the minus of the eliminator. The A supply is, of course, also separate, the plus and minus being connected in the standard way.

Either the 112-A or the 201-A may be used in the detector circuit. The 112-A is more sensitive, having a lower plate impedance. It is also a more stable oscillator.

Although the 200-A is more sensitive than either it is too noisy. A 199 tube may be used, but the regeneration is poor at the lower wavelengths.

Simple Tuning

While the tuning of this receiver requires exactness, it is not difficult. The Hammarlund drum dial (knob control) with its 5 to 1 reduction ratio permits this necessary precision adjustment.

The regeneration condenser is an important tuning factor. When tuning it should be turned until a hissing sound is heard, which is an indication that the detector tube is just beginning to oscillate. This point should be kept throughout the tuning. The station can then be tuned in by the larger condenser. The volume is, of course, controlled by R.

The oscillating state of the detector tube can be learned by touching the stator plates of the larger condenser. A sharp click will be heard if the tube is oscillating.

The value of the grid leak varies from 2 to 9 megohms, although the best results are usually obtained with a 5 megohm value.

No Special Audio Is Needed

Any type of audio amplification may be added. It is only necessary to connect the plate and the B plus leads of the amplifier to the same respective posts in the detector tube output circuit of the adapter.

Be sure that the filaments are so connected that a switch will turn them all off at the same time, *e. g.*, the audio as well as the R.F. and the detector.

When using the Hammarlund SWAP adapter plug its red lead is connected to the Fahnestock clip which is connected to the choke. The gray lead is connected to the extreme right-hand clip, which, in turn, is connected to the condenser C5.

A point about the antenna. Best results are obtainable with an antenna twenty to sixty feet long and as high as possible.

For ultra simplicity in tuning it is well to know just what stations are on the air, their time on the air, etc., which also contains a wealth of information on short-wave hook-ups, induction charts, etc.

(The author of this article will be only too glad to answer any queries as to this receiver or its component parts.)

List of Parts

C—One Hammarlund .00014 mfd. variable condenser, type ML-7.
C1—One Hammarlund .0001 mfd. midget variable condenser, type MC-23.
C2—One Hammarlund equalizing condenser, type EC-80.
C3, C4, C5—Three Sprague .1 mfd. fixed condensers, type F.
L2, L3—One set of Hammarlund short wave coils, type SWC-3, and one special short wave coil, type SWT-120.
L4—One Hammarlund radio frequency choke coil, type RFC-250.
R—One Electrad Tonatrol, type P.
R1—One Yaxley 20-ohm mid-tapped fixed resistor, type No. 820C.
R2—One Yaxley 4-ohm fixed resistor, type No. 804.
R3—One Durham metallized grid leak, 2 to 9 megohms.*
One Yaxley midget battery switch, type 10.
One Hammarlund knob control drum dial with light, type SDW.
One Hammarlund adapter plug and cable, type SWAP.
Three Hammarlund walnut knobs, type SDWK.
Two Eby sockets, type No. 12.
One Westinghouse micarta panel, 7 by 14 inches.
One baseboard, 9 by 13 by ¾ inch.
One package containing necessary hardware.

*See last paragraph under "Simple Tuning" head.

How Short Wave Receivers Differ

By DAVID GRIMES

(*Continued from page* 34)

the inductance is proportional to the square of the number of turns in the coil, the number of turns should only have to be reduced theoretically by one-half at each octave. As a matter of fact, no tuning coil is a perfect inductance, as almost every shape of coil has some magnetic leakage. Hence, the number of turns has to be decreased somewhat more than one-half in order to cut the inductance to one-quarter each time. This explains the drop from 100 to 40 turns in running from the 200 meter range to the 100 meter range. Following this same Table, it will be noted that a cut to 18 turns places the coil in the 50 meter scale, while a reduction to eight turns runs it down to 25 meters. Then to reach the lowest range of 12 meters the coil must have only four turns. Now four turns is a very definite number of turns and something quite physical.

The Compromise in S-W Receiver Design

The actual system incorporated in most short wave receivers is somewhat of a compromise with the above arrangement. The same tuning condenser is employed clear on down, but it is a slightly smaller one than the ordinary broadcast condenser. This enables us to make the last coil a little larger and less critical, because you can easily see when it comes to only a few turns that even fractions of a turn might throw out the tuning of the coil considerably. Of course this runs all the other coils a little higher in number of turns, and sometimes results in the broadcast coil having too many turns, so that the self-capacity of the coil prevents the tuning condenser from completely covering the higher wavelength broadcast stations.

There is still another reason for using the rather large tuning condenser when the lower wavelengths are received. You see, the best regenerative detector for short wave reception today is the grid leak type. This operates with either *no bias* or a *plus bias* on the grid, which is equivalent, as previously brought out in this article, to a resistance being placed directly across the tuning circuit. And resistances across tuning circuits are noted for their broadening effects. Now the more this tube capacity becomes part of the tuning circuit, the worse this loss becomes and the broader the tuning. Thus it is highly desirable to keep the actual tuning condenser large, as compared with the tube capacity. Figure 1 should be consulted for the resistance effect.

Why Regeneration Is Used in S-W Sets

There is one more factor which needs to be considered at this time, and which is so important that you must not overlook it at the start. This has to do with the whole subject of regenerative detectors in short wave receivers. You may wonder why we are still sticking to regeneration in these sets when it has been dropped long ago in good broadcast design. Well maybe it will in the future in short wave practice, but just at present we are still in the "blooper" stage of short wave reception. This should be all the more encouraging to the experimen-

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ter—perhaps you will be the one to offer the missing links in this new phase of the art. Short wave reception is waiting for its Hazeltine, Armstrong, or DeForest.

Meanwhile you must know why regeneration is being used. First, it gives us greater amplification, when properly adjusted, and we need the maximum amount of amplification because we are limited to one stage of tuned radio frequency! This latter point should be obvious because of the number of coils that would have to be switched in and out for each octave, with more than one stage of tuned R.F. Next, the stability of these extremely high frequencies in more than one stage of R.F. is still very much of a closed book. Finally regeneration is required so that we may have a source of controllable oscillation for actually whistling with a station in first picking up a broadcaster and in finally receiving a telegraph station.

For this purpose a grid-leak detector circuit is used similar to the partial sketch shown in Figure 6. The tickler coil is left fixed for commercial convenience, while the feed-back is controlled by the variable condenser in the tickler circuit. The tickler must be connected in what is known as reversed phase in order to oscillate. If the tickler coil is connected up with the wrong polarity there will be a cut in signal, and it will be impossible to get the tube to oscillate. And by "reversed polarity" is meant that the plate of the detector is connected back to the end of the primary farthest away from the grid connection, when both the primary and the secondary coils are wound in the same direction of rotation. Anyway, there is one consolation if this sounds complicated. If your set does not oscillate and does not amplify when the regeneration condenser is turned around, merely reverse the connections on the primary of your tickler coil and everything should be satisfactory. It is best also to work the detector into a resistance coupling stage to prevent the tendency of the oscillating tube to "squawk" just at the critical point of oscillation. This is most annoying in the average short wave receiver that operates the detector directly into a transformer coupling, for reaching the first audio tube.

Why Grid-Leak Detector Is Essential

At the present stage of the art the regenerative detector must be of the grid-leak type or it will not oscillate. One would think in our cry for sharper tuning on the short waves that the first step would be to replace the grid-leak detector with the "C" bias principle. Such a circuit would remove the effective resistive resistance loss from off the detector tuning circuit, but at short waves the "C" bias tube doesn't want to oscillate. The explanation of this may be found in Figures 7 and 8.

Figure 7 shows the grid leak tube and the operating characteristics right below it. In addition to its rectifying properties, the tube is a fair R.F. amplifier, because it is operated well up on its plate current where the amplification is good. On the other hand the "C" bias tube operates on the bottom of the plate current curve as shown in Figure 8, in order to rectify the R.F. currents. Naturally, in this process, the R.F. amplification is sacrificed, and we must have R.F. amplification in a regenerative tube, in addition to the detection, in order to have R.F. currents to feed back through the tickler coil. Figure 5 shows how the setting of the regeneration dial tends to shift the tuning position on the tuning dial with no rhyme or reason. This makes it hard to calibrate the tuning of a set, because a station may come in anywhere within ten degrees on the dial depending on the position of the regeneration control at the time. Many engineers argue that this is due to the electrical shift in the tickler circuit being reflected back into the tuning circuit, but recent experiments tend to refute this.

Any way, you are interested in how to accustom yourself to this shift. A close study of Figure 5 will aid you. As the regeneration is advanced more and more, there is a definite tendency for the tuning dial to retard so that the tuning condenser becomes less. In other words, as we increase the tickler condenser, we must decrease the tuning condenser. Engineers are now trying to solve this peculiarity. Maybe you will have a solution, and this is only one of the many trying things that are now worrying the short wave design profession. In a later article I hope to discuss more of them.

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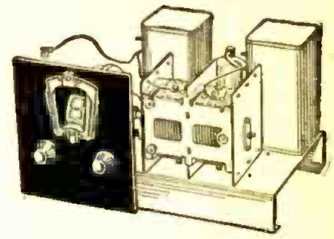

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Bringing Old S-W Receivers Up-to-Date

By ROBERT (BOB) HERTZBERG

(*Continued from page* 49)

and one large section. A condenser C9 in the grid return of L1 prevents the grounded tuning condensers C2 and C6 from short-circuiting the filament supply. The shunt feed arrangement of Fig. 3 is used for getting the plate voltage on the UX-222.

The detector and audio portions are familiar. An output transformer is shown, and should be used, if the last audio tube is a 112A or a 171A. If a 201A is used it may be omitted.

The values of the various parts are as follows: Condensers C2 and C6, .00016 mf.; C3, C4, C5, C9, all .01 mf.; C7, .0001 mf.; C8, .00025 mf. Resistors: R1, 15 ohms, tapped at 10; R2, 3 megohms; R3, 6 ohms; R4, 100,000 ohms.

As special steps must sometimes be taken with particular receivers, the writer will be glad to advise owners of old short-wave sets as to how they may best "revamp" them. He can be addressed in care of this publication.

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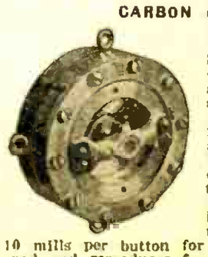

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Short Waves in Medicine

By DR. ERWIN SCHLIEPHAKE

(*Continued from page* 37)

the oscillator can become so strong that the oscillations completely break off. The best value for coupling is generally determined empirically, in order to obtain the maximum current in the secondary circuit.

Peculiar Effect Upon Humans

Before I go into my experimental results with this process, I return to the direct effect upon the human being of the space waves leaving the transmitter.

Thus, with persons who were occupied for some time in the neighborhood of powerful radio transmitters, the most varied complaints came up. Complaint was especially made about heat flashes in the head and also headaches. There was also a strong inclination to sleep. After prolonged series of experiments there appeared increasing nervous exhaustion, expressed in easy excitement, bad sleep, and languor. It should be especially stressed that, after a short suspension of the experiments, all the complaints disappeared.

With a number of persons, after a fairly long stay near the active transmitter, there was likewise demonstrated a slight rise in temperature, from .5 to .7 of a degree Centigrade. But to speak of a "radio fever" seems to me absolutely unwarranted. No higher rectal temperatures than 38 degrees Centigrade were ever observed. Even when the radiation leaving the antenna was collected in the focal line of concave mirrors, higher temperatures could never be obtained.

Insects and Mice Killed

Thus it was natural for me to devote my whole attention to the electric field between the condenser plates. The powerful effect of this arrangement was shown by the fact, that insects died in an extremely short time, often even in fractions of a second; mice died after a few seconds; while larger animals remained alive a correspondingly longer time. In this process great excitement and terror mostly set in at the start of the treatment. Breathing and heart action became extremely fast. Finally there set in a condition of torpor, in which the animals were entirely put to sleep and scarcely reacted any more. Measurements of bodily temperature shortly after switching off the field, showed a considerable rise in bodily heat, temperatures of 43 degrees Centigrade being not uncommon.

Physiological Experiments With 3 Meter Waves

The physician is much more interested in the specific behavior of individual bodily substances in the electric field. Experiments which I undertook in this respect with the three meter wave gave a different degree of strong heating of equal volumes of various dead tissues. First came the bones and liver, then followed fat and brain, finally skin and muscles. These relations are very important, especially for comparison with the usual diathermic process, in which currents of a frequency of one million cycles are conducted through the body, by means of contact electrodes, to produce a warming of the parts effected by the current. But in this process the fat warms up very strongly (twelve times as strongly as liver tissue), and so it results that the greatest part of the current is transformed into heat in the subcutaneous fatty tissues below the electrodes. The deep effect is proportionately much less. To attain a marked deep effect, the current must be made stronger, which, however, is limited by the increased feeling of heat. Also within the individual parts of the body the diathermic current, according to Ohm's law, must seek out the paths of least resistance. It will therefore often flow around the deep-seated organs, which are frequently insulated by fatty coatings, so that no warming effect worthy of mention can occur in them.

While therefore the relative deep effect of the diathermic current is only slight (from a fifth to a twentieth, according to the thickness of the layer of fat), the deep heating in the condenser field is just as great as on the surface. The heat produced in the individual layers depends solely on the physico-chemical make-up of the substances in question, apparently on the ionization. The especially strong heating of bony substance in the three meter field, was shown by this point as well as others, namely; that in the case of a rabbit, the upper part of the skull of which was exposed to the field for some time, there was an isolated injury to the bone, without any noteworthy change in the other tissues.

In the treatment of the parts of the body it has furthermore been shown that in the condenser field, the distance of the plates from the object, plays a great part in producing an even warming of superficial and deeper layers.

Short Waves Very Penetrating

That these principles hold not merely in the case of dead tissue, but are valid in a much higher degree in the living, was demonstrated in further experiments. By thermoelectric measurements it could be established in the case of living animals and human beings, that here too the strong relative *deep effect* of the condenser field far surpasses that of diathermy. Here the veins and arteries, with their content of good conducting material, form shunts which turn aside the diathermic current and divide it soon after its entrance through the skin, so that the effect on deep-seated organs is naturally much less. As has already been mentioned, the effect of the condenser field is entirely independent of such influences, it's imparting of warmth depending only on the chemical make-up of the individual organs and upon the wave length.

For the treatment of illnesses, it seems important to note the fact that foci of infection are more strongly warmed in the electric field, than the neighboring sound

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tissue. This is comprehensible from the fact that in such places no blood circulates, and that therefore the carrying away of heat by the blood does not occur. In this way a selective effect upon the site of the illness may be produced.

Fig. 3 shows these proportions clearly. At a distance of a few centimeters on each side, the warming in the middle of an object can become even greater than on the surfaces toward the plates, wherein we must certainly take into account the greater radiation of heat from the surfaces.

Medical Results Obtained

I have also undertaken experiments on the direct healing effect of the electric waves, first in the case of infected animals, then too with sick human beings. Even though the results thus far are not numerous, favorable effects have appeared, especially in abscesses. Boils, for example, have been entirely removed by one or two treatments with the waves. Also chronic illnesses of individual joints, which had hitherto defied all treatment, could be favorably influenced in most cases. The final word, however, can only be said after longer experience.—*Funk Bastler.*

The Latest Push-Pull S-W Transmitter

By LAURENCE COCKADAY

(*Continued from page* 26)

The Feeder Antenna

In Figure 3 is shown the feeders and the half-wave antenna found to be suitable for use with the push-pull circuit described. The antenna meter may be read for maximum energy by a small hand-telescope or by opera glasses, while someone else is making adjustments on the transmitting apparatus.

With push-pull apparatus of this type the modern short-wave systems are able to cover great distances with a minimum of fading and swinging and receivers tuned to their signals do not have to be constantly readjusted to keep them tuned in with the same intensity.

Practical Short Wave Receiver Design

By ROBERT S. KRUSE, E.E.

(*Continued from page* 30)

per row of Fig. 3 are excellent when enough space is available. We accordingly turn to smaller coils as shown in the lower row. Of these the familiar tube-base coil at the left is bad in all ways but one—it *does* make contact when put into place. However the coil is too short, too close to the hardware in the base, and of high resistance because it lies flat against the low-grade material of which the tube base is made. To retain the one advantage and remove the defects of this coil there was introduced by Pilot the type of coil next to the right. The shell is of good bakelite, made thin and ridged so to place little material near the winding. It is tall enough to permit spaced windings of low self-capacity, well removed from the terminals and finally has a pull-out ring at the top.

The "silk hat" coil form next to the right minimizes losses in another manner. The wire lies directly on the form, but this is moulded of "R-29" a special Radio Frequency Laboratories bakelite, using mica and silk filler instead of the customary wood flour, and thereby reducing the losses about 90 per cent.

The resistor indicated in Fig. 4, should be of the Frost type, which has a small roller running on the resistance strip. Sliders and compression resistors are bad. Fig. 5 shows condenser suited to high-frequency tuning. They are all photographed to the same scale and their size is indicated by the familiar 4½-inch Velvet Vernier dial on which one of them is mounted. All three condensers have standard ¼ inch shafts and plates may readily be removed from them to reduce

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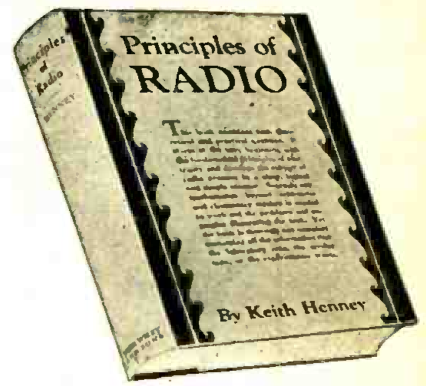

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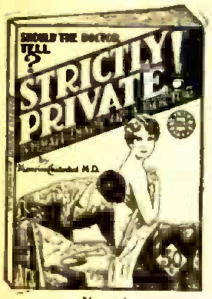

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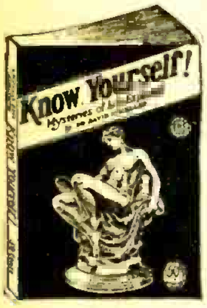

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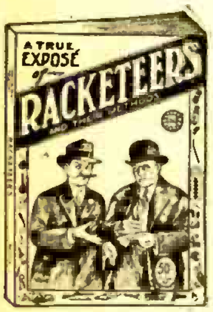

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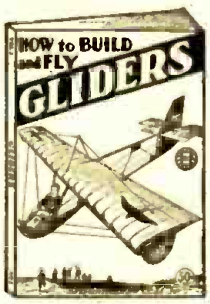

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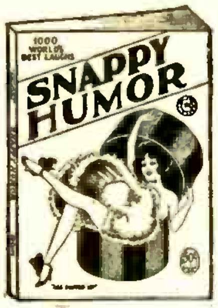

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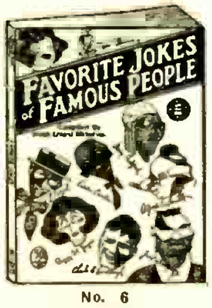

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capacity. With all plates in place the two larger condensers have a maximum capacity of 125 pfds., while the small one has 25 pfds. In the two Pilot condensers shown above each other, the rotor contact is provided by a straight bronze spring which also removes bearing slack.

Since the detector-input coil is coupled to two tubes, it is loaded somewhat by the capacity of both. The R.F. (radio-frequency) tube is usually coupled very closely to secure maximum gain and may contribute as much as 25 picos of capacity. The coil feeding the R.F. tube must therefore be loaded with the same amount of capacity AND NO MORE, else they will not tune together. Fig. 2 shows how this may be done. The capacities are in pfds., i.e., in micro-micro-farads.

Shielding is of two sorts, static or capacity shielding and magnetic or current shielding. The chassis of Fig. 1 shows fences used as static shielding to prevent capacity coupling between the two screen-grid tubes and their equipment. The tuned circuits have been so located that magnetic shielding is not necessary. Static shielding can be of almost any metal, even steel.

Where two tuned circuits are close together, or where a tuned circuit is close to anything else, it is impossible to avoid induced currents. One must then use current shielding. The purpose is NOT to prevent secondary currents but to provide them with a harmless path of low resistance, entirely closed around the troublesome coil or R.F. stage so that the primary and secondary currents will "buck" and weaken the stray field. In Fig. 6 are shown a test coil and some coil shields of different materials, but all raising the coil resistance *by the same amount.* They are all .012 inches thick, the one at the left being of steel, the next of aluminum and the smallest of copper. The steel can is too large, the copper one fits too closely and raises the self-capacity. The aluminum can is best but a still better one would be a copper can of this size, or else an aluminum one .020 inch thick. Similarly the thickness and size of any current shield must be chosen to combine reasonable cost, reasonable losses and reasonable size. Copper for coil shields and aluminum for other

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shields is generally best—steel for pure static shields.

Bypass and Stopping Condensers

In Fig. 7 are shown at A and B a pair of ¼ microfarad paper by-pass condensers which act as *inductive resistances* at 20 meters. The set was improved by throwing them out! Most commercial condensers act more or less the same way at these wavelengths. The paper condensers C, D and E are wound non-inductively—i.e., with the entire edge of the foil brought out and bunched. C and D are condensers used in the Model A Ford ignition system. The capacity is 1/10 microfarad and the condenser is very good for both audio and radio bypasses.

Stopping condensers to be placed in tuned circuits should be non-inductive, also without metal cases. Suitable forms are the Pilot condensers shown in Fig. 8, also the mica condensers of .01 capacity at F and G of Fig. 7. When voltages above 180 or 200 are being used, the 500 volt test Sangamo condensers such as shown at H are excellent.

An R.F. filter, consisting of a resistor and two .01 mica condensers is shown at K in Fig. 7. The resistor should have a value between 300 and 2,500 ohms. The condenser nearer the B supply, may be one of the Ford type.

A New Magnifying Tuner

(*Continued from page* 41)

We have C2A, L1, SF represented as set for the lowest wave-band in Fig. 1A; the lowest wavelength in this band is then obtained with R set at R1A (the plates of SF and R being spaced the distance indicated as A1). Advancing R to position R2A meshes the 21 plates of SF and R over the area A2; and the balance of the 1,500-kc. tuning is accomplished with R turned to position R3A (SF- and R-plates are meshed for the area A3). All this time C2A and L1 have not changed position; but the maximum frequency established by the self- and distributed-capacities and inductances of all the instruments and the wiring has been diminished through a band of only 1,500 kc.

After we have scoured this first tuning-band (which is only about one meter wide at about 19 meters) SW is shifted to a position SF2, a considerably higher wavelength-band, as shown in Fig. 1B; and the 1,500-kc. tuning process is repeated by obtaining mesh-areas A1, A2 and A3 through tuning R to positions R1B, R2B and R3B. (Thus deriving a tuning band from about 50 meters to about 65 meters.)

Fig. 1C is a repetition of this procedure, with SF at 100.

Alternate Circuit Arrangements

A better idea of the manner in which the "Automatic Tuner" may be wired into a circuit may be had from Fig. 4, which shows a simple one-tube circuit, in which regeneration is controlled by the variable resistor R2.

An adapter is readily made by following a different circuit. (See Fig. 5.) Condensers C1 and C2A may be connected to regular solenoid inductor of the plug-in type (a convenience for 200- to 550-meter tuning) if desired, instead of L1 and L2, by wiring the usual coil-receptacle as shown in the diagram; a low-capacity D.P.D.T. switch changes the connections. The rotor of L1 will continue to turn as before.

Of course, the fundamental ideas in the circuit of this adapter may be adapted to any other amplifier or detector arrangement. The approximate wavelength range afforded by the longer-wave inductance unit (which may be arranged either as a plug-in unit or permanently wired in) is given in the following table:

S. D. Degrees	*Wavelength Meters*	*Frequency Kilocycles*
0	88— 92	3410—3265
16	92—115	3265—2610
33	115—146	2610—2050
60	146—185	2050—1620
100	185—204	1620—1460

The schematic circuit for an easily-built A.C. short-wave receiver using the "Automatic Tuner" is Fig. 6; any A.F. channel design may be followed. (*Cont. on page 94*)

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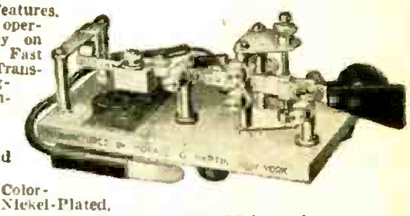

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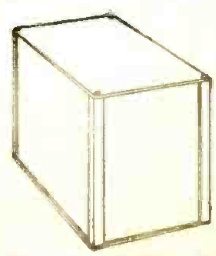

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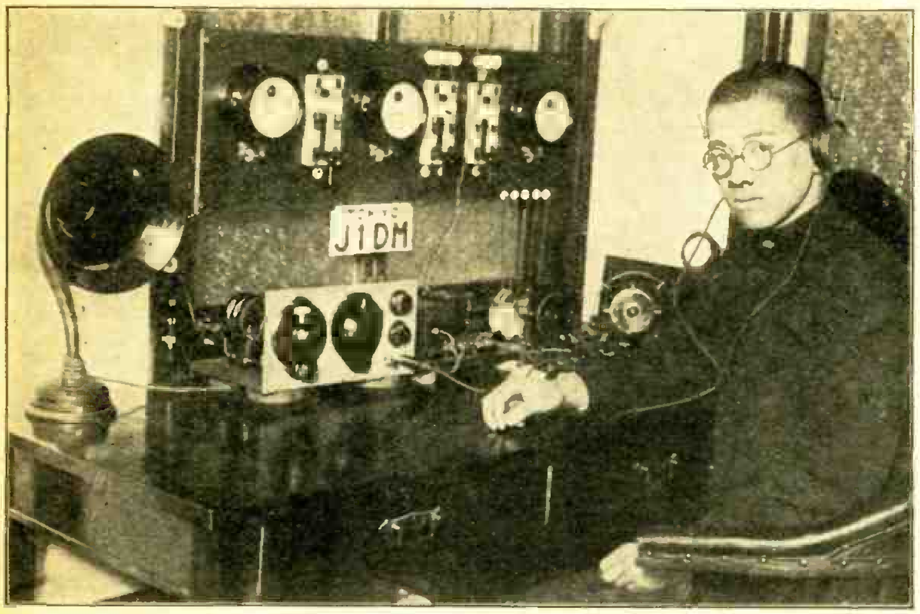
Among the "Hams"



Japanese Amateur Radio Station. Fifteen-year-old Seiichiro Handa, a Japanese student, who built a radio station of his own in his home.

Editor:—In the Radio-Craft short-wave list they list a station (HKT Bogota S.A.) and state that it comes in at 3XAU. This is incorrect as it comes in at about 38 meters, and the correct call numbers are HKC Bogota S.A. I have made a study of this station and I find this information to be exact.—Edwin Offerbach, 19 Belmont Ave., Quakertown, Pa.

Editor:—Your readers may be interested in knowing that I hear CJRX every night on 25.6 meters. Their schedule follows: Mondays, Wednesdays, and Fridays, 5:30 to 8:30 p. m.; Tuesday, 5:30 to 10:30 p. m.; Thursday, 5:30 to 11:00 p. m.; Saturday, 5:30 till midnight, and Sunday, 11:30 a. m. till 1:00 p. m., and 10:00 till 11:00 p. m.—Page Taylor, 3790 Ashland Ave., Detroit, Mich.

Editor:—It may be of some interest to you that I have received a letter from D.H.C. 26.22 m., Nauen, Germany, which tells me that this station has stopped telephone experimenting.

All German transmissions are going over Königswusterhausen, Berlin, 31.38 m. I found Königswusterhausen on the air till 6:30 p. m., at inter-

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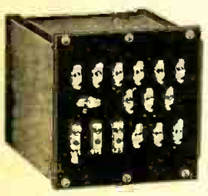

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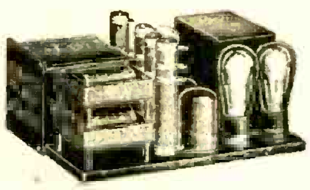

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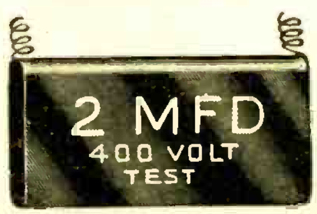

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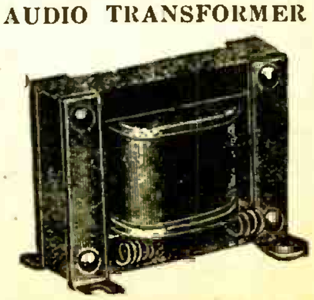

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vals to 7:30 p. m. But I found too, that W3XAU, Philadelphia, and some code station quite often ruin all reception.—Emil Husemann, W. Hazleton, Pa.

Editor:—I am giving here several points of information which I have heard short-wave fans ask for:

1. There is not and never was a short-wave station at Johannesburg, South Africa. The station officials claim that this started by some fan picking up a harmonic and not realizing what he had.

2. I have not received 7LO in all my tuning and I have tried enough to discourage anyone. But the last two letters on them give the wave as 31.10 meters, daily from 11 to 2 p. m.

3. A station on 25.3 has been heard several times lately talking Italian and giving call as 3RO. Through the NBC I learn that this is 3RO at Cecchignola, Italy, and is the new Marconi transmitter built by B.B.Co., for Radio Roma, Rome. Waves are 25.4 and 80 and only testing. I have heard them saying in English: "3RO". However, I have run across two other stations near there, one calling Buenos Aires in French, and the other very much like a ship station, as they spoke both English and some foreign language.

4. A station on about 31.48 (WGY's) was heard here many times near 5 p. m. EST. This seems to check up with Eiffel Tower, although I had taken it to be OXY, Lyngby, Denmark. Under close examination I find this station quite a bit under XDA, which would make it more than likely the Eiffel station.

5. VK2ME says that GBX is on 27.73 meters. They also verify my reception of their 15.55 wave. So that is correct.—Arthur J. Green, Klondyke, Ohio.

Editor:—I like to know what others are hearing and if I read of something I haven't heard I begin to fish for it.

I notice in the Magazine the new station at Drummondville, Quebec, is listed VE9AT; this should be VE9AP, a letter from them says the test transmissions, which are now concluded, were on a wavelength of 46.7 meters with 2 k.w. in the antenna.

Their letter was dated Feb. 11th, and in about ten days the tests were repeated on around 33 meters; it is only experimental, not intended for broadcasting and no schedule is followed.

I also hear G2GN on the S.S. Olympic, and G2RD but can't hear where he is.

HRT in Colombia, South America, comes in here loud and clear, but it is hard to identify; also the station at Tegucigalpa, Honduras, is very plain.

Have verifications from several European stations and have written the South and Central American stations.—Roy E. Goad, Filbert, W. Va.

"HAMS" ATTENTION!

Since it is the purpose of SHORT WAVE CRAFT to help every angle of the entire craft along, we are pleased to call attention of all short-wave enthusiasts to the following publications: "Ye Brass Pounder" is a newsie, regular he-man ham dope sheet, and while it only contains four pages, yet it is chuck full of meat.

Name and address is as follows: "YE BRASS POUNDER," 1836 Hone Avenue, Bronx, N. Y. There are two numbers a month, and the subscription price is 50c. for six months (12 issues).

Then there is another little dope sheet which should also be of great interest to all short-wave enthusiasts whether "hams" or not. Its name is International Shortwave Club. It is a little publication (some twelve pages in the latest issue) and the little booklet contains all sorts of live short-wave phone material. It is well edited and is chuck full of short-wave news, phone schedules, etc. It has several departments including "Tuning In," "On the Air," "Trade Notes," etc. Fees of the club are $1.00 a year, which includes a subscription to the magazine. The address is as follows: "INTERNATIONAL SHORT WAVE CLUB," Box 713, Klondyke, Ohio.

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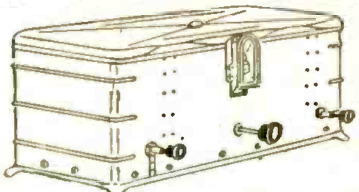

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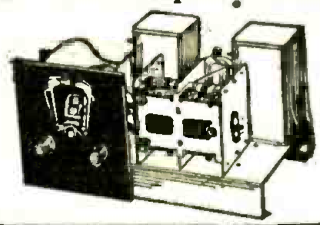

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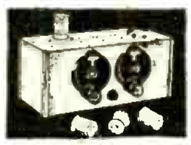

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Please enroll me as a charter member to SHORT WAVE CRAFT for which I enclose herewith $1.50 for one year's subscription ($1.75 CANADA AND FOREIGN). I understand that the full subscription price is $3.00 a year.

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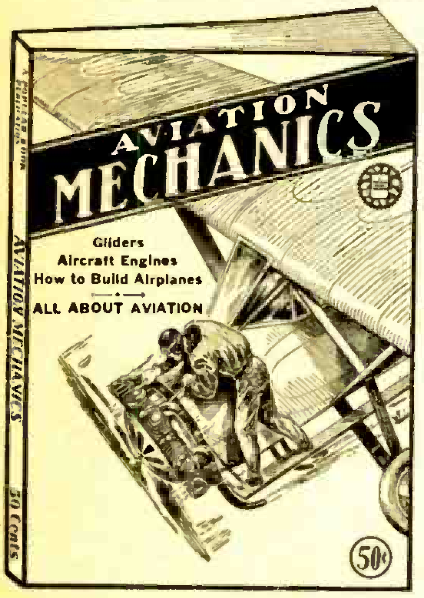

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(Continued from page 91)

Screen-grid hook-up in shown in Fig. 7. When the best results are obtained from this wiring arrangement, chokes Ch1 and Ch2 will be found to have different constants from Ch3. Whether R1 will be required depends considerably on the insulation-resistance of C4A. The use of R8 is recommended where smooth control of regeneration is found difficult to obtain. Tubes of different types should be tried in position V1. The idea of regeneration control by using R2 may be retained, unless the experimenter has a different preference. Evn though the input be untuned, the use of a blocking-tube V4 is recommended.

Preceding the new tuning unit with such a tube may alter the tuning slightly, as the following table shows:

S. D. Degrees	*Wavelength Meters*	*Frequency Kilocycles*
0	19.00—20.35	14750—15750
4	20.00—21.42	15000—14000
6	21.05—23.07	14250—13000
8	23.07—25.00	13000—12000
10	24.00—26.65	12250—11250
13	26.65—29.90	11250—10125
17	28.55—32.86	10500— 9125
22	31.56—36.34	9500— 8250
30	35.25—42.58	8500— 7125
43	41.35—52.14	7250— 5750
63	49.97—66.63	6000— 4500
88	63.62—83.28	4750— 3600
100	70.59—99.94	4250— 3000

An A.C. 4-tube short-wave receiver is shown in Fig. 8; a circuit variation worth special mention is the manner of connecting the return leads of the Automatic Tuner (L1, C1, C2A) to a point of low potential. This will reduce hand-capacity effects.

The following constants are suggested for the various circuits that appear in this article:

C1, 150 mmf.; C2A, C2B, 135 mmf., variable; C3, .0005-mf.; C4A, C4B, .00015-mf.; C5A, C5B, 1.0 mf.; C6A, C6B, C6C, C6D, C6E, C6F, C6G, .002-mf.; R1, 10 megs.; R2A, R2B, 10,000 ohms ("Bradley-ohms"); R3, 20 ohms; R4, 600 ohms; R5, 15 ohms; R6 2-tube ballast; R7, 100,000 ohms; R8, 400 ohms; R9, 2,000 ohms. Ch1, Ch2, Aero No. C-60 low-impedance R.F. chokes; Ch3, Aero No. 65 high-impedance R.F. choke. L1-L2, special short-wave variometer (described in text). T1, T2, Aero AE-300 (peaked for code reception), or Thordarson R300 (for phone reception) A.F. transformers.

In Fig. 5 is shown the use of a panel-mounted (Yaxley No. 760) switch to connect an Aero "INT-104" inductance into circuit to increase the wavelength range to 200 meters.

Short-Wave Stations of the World

(*Continued from page 75*)

Meters Kilo-cycles

56.70 5.300—**AGJ**, Nauen, Germany. Occasionally after 7 p.m.

58.00 5.170—**OKIMPT**, Prague, Czechoslovakia. 11 a.m.-4 p.m.

60.90 4.920—**LL**, Paris, France.

61.22 to 62.50 meters—4,800 to 4.900 kc. **Television.** —**W8XK**, Pittsburgh, Pa.;—**WIXAY**, Lexington, Mass.; **W2XBU**, Beacon, N. Y.; —**WENR**, Chicago, Ill.

62.56 4.795—**W9XAM**, Elgin, Ill.
—**W9XL**, Chicago, Ill.

62.69 4,785—**Aircraft.**

65.22 to 66.67 meters—4,500 to 4.600 kc. **Television.** —**W6XC**, Los Angeles, Calif.

67.65 4.430—**DOA**, Doeberitz, Germany. 6 to 7 p.m. 2 to 3 p.m. Mon., Wed., Fri.

70.00 4.280—**OHK2**, Vienna, Austria. Sun., first 15 minutes of hour from 1 to 7 p.m.
—**RA97**, Khabarovsk, Siberia. 5:30-7 a.m.

71.77-72.98 4,180-4,100—**Aircraft.**

72.87 4.116—**WOO**, Deal, N. J.

74.72 4,105—**NAA**, Arlington, Va. Time signals 8:55-9 a.m., 9:55-10 p.m.

80.00 3,750—**F8KR**, Constantine, Tunis, Africa. Mon. and Fri.
—**I3RO**, Rome, Italy. (Testing)

84.24 3.560—**OZ7RL**, Copenhagen, Denmark, Tuesday and Fri. after 6 p.m.

84.46-85.66 3,550-3,500—**Amateur Telephony.**

86.50-86.00 3,490-3.460—**Aircraft.**

(Continued on page 606)

92.50 3.256—**W9XL**, Chicago, Ill.

94.76 3.166—**WCK**, Detroit, Mich. (Police Dept.)

95.48-97.71 3.142-3.070—**Aircraft.**

96.03 3,124—**WOO**, Deal, N. J.

97.15 3,088—**W10XZ**, **Airplane Television.**

97.53 3.076—**W9XL**, Chicago, Ill.

98.95 3.030—....Motala, Sweden. 11:30 a.m.-noon, 4-10 p.m.

101.7 to 105.3 meters—2,850 to 2.950 kc. **Television.** —**W3XK**, Silver Springs, Md., 8 to 9 p.m. except Sunday; **WPY**, Allwood, N. J.—**W2XR**, New York, N. Y.—**W3XL**, Bound Brook, N. J.

104.4 2.870—**6WF**, Perth, Australia.

105.3 to 109.1 meters—2,750 to 2.850 kc. **Television.** —**W2XBA**, Newark, N. J., Tues. and Fri. 12 to 1 a.m.;—**W2XCL**, Brooklyn, N. Y.; —**W8XAU**, Pittsburgh, Pa.; — **WIXB**, Somerville, Mass.;—**W7XAO**, Portland, Ore.; —**W9XAP**, Chicago, Ill.
—**W2XCR**, Jersey City, N. J. 8:15 and 9 p.m.

109.1 to 113.1 meters—2,650 to 2,750 kc. **Television**—**W9XR**, Chicago, Ill.

110.2 2.722—**Aircraft.**

113.5 2.645—**W2XBO**, New York Central R.R. train. (Exp.)

124.2 2,416—Seattle, Wash., Police and Fire Depts.

125.1 2.398—**W9XL**, Chicago, Ill.;—**W2XCU**, Ampere, N. J.

128.0-129.0 —**Aircraft.**

129.0 2,325—**W10XZ**, **Airplane Television.**

131.3 2,285—**W2XBO**, N. Y. C. R.R. (Exp.)

136.4 to 142.9 meters—2,100 to 2.200 kc. **Television.** **W8XAU**, Pittsburgh, Pa.;—**WIXB**, Somerville, Mass.; — **W2XCW**, Schenectady, N. Y.;—**WIXAU**, Boston, Mass.

142.9 to 150 meters—2.000 to 2,100 kc. **Television.** —**W2XCL**, Brooklyn, N. Y., Mon., Wed., Fri., 9 to 10 p.m.;—**W9XAA**, Chicago, Ill.;—**W2XBS**, New York, N. Y., frame 60 lines deep, 72 wide, 1.200 R.P.M.;—**WIXAE**, Springfield, Mass.;—**W8XAU**, Pittsburgh, Pa.; **W6XAM**, Los Angeles; —**W2XBU**, Beacon, N. Y.;—**W3XAK**, Bound Brook, N. J.;—**W3XK**, Washington, D. C. Daily except Sun., 8 to 9 p.m.;—**WPY**, Allwood, N. J.;—**W10XU**, Airplane.

150 2.000—**RA72**, Smolensk, USSR.

149.9-174.8 2,000-1,715—**Amateur Telephony and Television.**

175.2 1.712—**WKDU**, Cincinnati, Ohio. (Police Dept.)
—**WRBH**, Cleveland, O., (Police Dept.)
—**KGJX**—Pasadena, Calif., (Police Dept.)
—....St. Quentin, France.

178.1 1,684—**WDKX**, New York, N. Y. (Police Dept.)

186.6 1.608—**W9XAL**, Chicago, Ill. (WMAC) and Aircraft Television.

187.0 1,604—**W2XCU**, Wired Radio, Ampere, N. J.
—**W2XCD**, DeForest Radio Co., Passaic, N. J. 8-10 p.m.

196 1,530—....Karlskrona, Sweden.

187.9 1.596—**WKDT**, Detroit, Mich. (Fire Dept.)

(Standard Television scanning, 48 lines, 900 R.P.M.)

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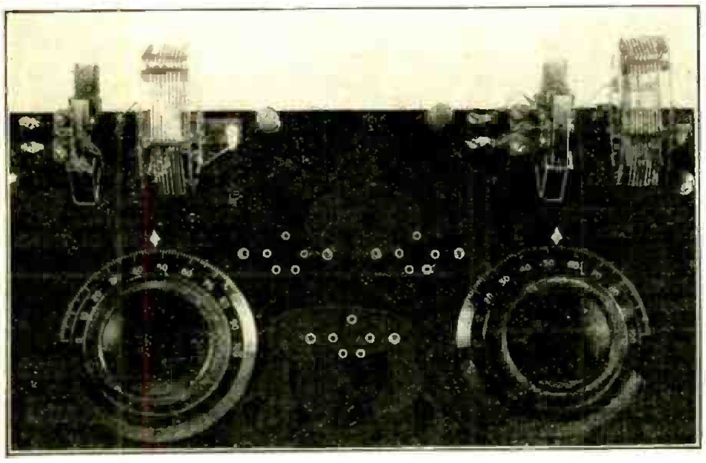
A Short-Wave Converter

That Works on Any Broadcast Receiver



HOW would you like to have a short-wave converter to connect to your present broadcast receiver, so as to use every stage of amplification in that broadcast receiver, applying that amplification to short waves? It CAN be done! It is really very simple. If you put the proper kind of short-wave tuner ahead of your entire broadcast receiver, connecting the output of the short-wave tuner to the input of the broadcast receiver, you will solve the riddle that has been engaging the attention of scientists for many years.

There is one best way of doing this. and you will want to learn the full details, and from the pen of the very man who worked out this system to such a high point of achievement.

Here is a glimpse of what is done to accomplish the result: A short-wave tuner is constructed. consisting of one untuned stage of radio frequency amplification, and two tuned stages. Three tubes are used in the short-wave tuner. The circuit then is wired to permit the output of the short-wave tuner to be received and amplified by your broadcast receiver. All the radio frequency amplification in your broadcast receiver is used to its fullest, also the broadcast receiver's detector, and all the audio-frequency amplification, in a word, your present receiver, as it is. Therefore the new device is a converter, in that it converts your entire broadcast receiver to short-wave reception and is not a short-wave adapter. as an adapter uses only the audio frequency amplification, and none of the radio frequency amplification, of the broadcast receiver.

Doubles the Value of Your Present Broadcast Receiver

THE NEWLY perfected short-wave converter is called the Universal Converter because it is universally useful. It works on *any* broadcast receiver, including all tuned radio frequency receivers, screen grid or otherwise. Neutrodynes, Super-Heterodynes. and all or any other types. If a set brings in broadcast stations it will bring in short waves when this converter is used.

There are three ways of receiving short waves. (1)—You may use a receiver designed for short-wave reception exclusively. (2)—You may use an adapter, which is usually of a low order of sensitivity and can not be relied on to work on all receivers, or (3)—You may use a converter.

Suppose you have an AC or other high-powered receiver for broadcast reception. If you want a short-wave receiver of equal standing you will have to provide the same amount of radio frequency and audio frequency amplification. You will have to spend as much, again. as you did for your broadcast receiver. If you use a mere adapter you take your chances of results—you may get no results. But if you use a converter, like the Universal. you capitalize on your investment in your broadcast receiver, and now for the first time have a receiver that will do *more* on the short waves than it does on broadcast waves. Therefore you double the value of your present broadcast receiver.

NOW you may choose at any time to receive short waves. just as you have been able to choose at random the broadcast stations you desired to hear, with the exception that your distance-getting is rather restricted on broadcast wavelengths, whereas on short waves you may hear stations from anywhere on earth.

It is not at all uncommon in one evening to tune in three or four foreign stations, even more. when you use the Universal Converter. as well as receiving stations across the width of the Continent. The uncanny penetration of short waves is yours to enjoy to the utmost, and in a manner that uses all of your broadcast receiver—all tubes, all coils, all condensers, B supply, speaker, baffle, console—everything!

You take what you've got. and add a little to it by connecting two wires to the antenna and ground posts of your broadcast receiver, and one wire elsewhere, and a magic transformation has been made.

You don't need batteries for the converters.

You will want to read all about this efficient and compact converter —this fascinating circuit that. with few parts. turns the trick that has teased scientists for year. You will find the subject treated thoroughly in the May 3d. 10th. 17th and 24th issues of RADIO WORLD, the first and only national radio *weekly*, now in its ninth year.

Read All About This Marvelous Converter

RADIO WORLD publishes all the latest circuits and news of radio. Its technical presentations are highly authoritative. Construction of ultra-sensitive circuits and a wide range of superior power amplifiers is featured regularly. Have you heard of the Six-Circuit Tuner? If not. you'd better inform yourself at once of this remarkable circuit for broadcast reception. and by the way. a circuit that gives you the utmost radio frequency amplification, with band pass filter besides. It's discussed in the same four issues. Read RADIO WORLD and follow the development on short waves, the Loftin-White amplifiers. pentodes. band pass filters, pre-selectors, Super-Heterodynes. sidebands. screen grid tubes. and push-pull. Enjoy the lists of stations. published frequently both broadcast and short waves.

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THOSE who know nothing or next to nothing about radio, or experts who want to make a present of a book to the veriest novice, will be interested in "Foothold on Radio," by J. E. Anderson and Herman Bernard. Nobody who reads this book need know a single thing about radio, yet when he finishes reading it he will have a good foothold on the subject. There have been many other books for novices. but all such books require some fundamental knowledge of radio or allied electrical knowledge. This book takes nothing for granted, and yet it presents the picture of radio in its technical side without resort to mathematics, and without requiring anything other than that the reader be able to read the English language.

"Foothold on Radio," published in May, 1930, is just the volume the merest novices, thirsting for some technical insight into the wonders of radio, have been awaiting.

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You may obtain the short-wave converter blueprint, also "Foothold on Radio," also "The Super-Heterodyne" (*all three*), by sending $6 for a year's subscription for RADIO WORLD (52 issues, one each week). Present subscribers may extend their subscriptions under this offer, too.

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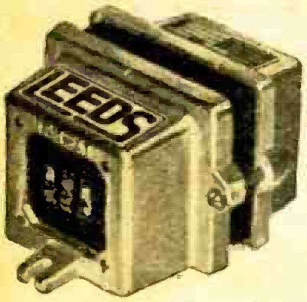

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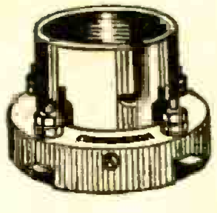

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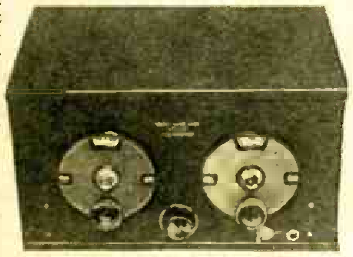

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Coil D	37.0 to 43.0 Meters
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The accuracy of calibration is to within 0.25%.

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Make your own transmitting and receiving coils. Copper tubing transmitting inductance.

Inside Dia.	Size of tubing 3/16"	1/4"	5/16"
2¼"	9c	10c	12c*
2⅜"	9c	10c	15c*
3⅛"	10c	12c	17c*

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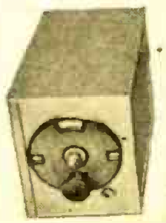

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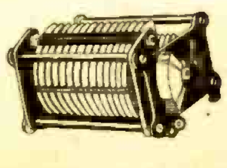

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New LEEDS 7½-watt Hartley Transmitter. Ideal for the beginner or anyone desiring a transmitter extremely simple to adjust and operate. Will operate with a 201-A tube, with 90 volts on the plate, up to a UX-210, with 30 watts imput; has plug in transmitting coils. List price—kit $55. Completely constructed $70.

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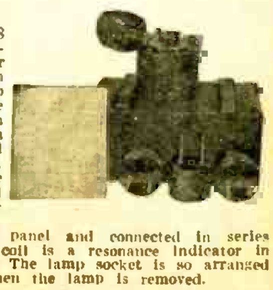
GENERAL RADIO TYPE 358 WAVEMETER



The General Radio Type 358 Wavemeter is designed particularly for experimenter use. It covers a wave-length range of approximately 14 to 220 meters, covering the short-wave bands in common use. The wavemeter consists of a mechanically rugged coil of low-loss construction, mounting directly on the binding posts of a shielded condenser. The condenser capacity is 125 MMF. Mounted on the condenser panel and connected in series between the condenser and coil is a resonance indicator in the form of a small lamp. The lamp socket is so arranged that it is short-circuited when the lamp is removed.

The wavelength range is covered by means of four coils. Each wavemeter is individually calibrated with an accuracy of within 1%. A calibration curve is plotted for each coil and the curve sheet mounted on a substantial metal backing. The coil ranges, providing adequate overlaps, are as follows:

Coil A	14 to 28 Meters
Coil B	26 to 56 Meters
Coil C	51 to 114 Meters
Coil D	105 to 220 Meters

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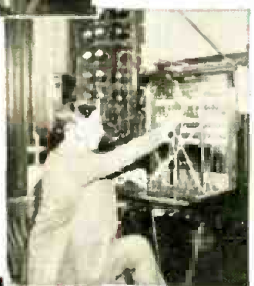

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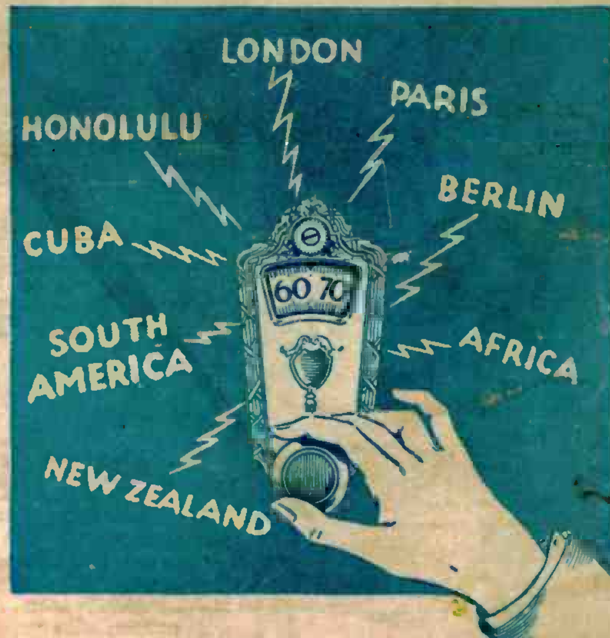

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