THE RADIO EXPERIMENTER'S MAGAZINE

SHORT WAVE CRAFT

DEC 30 - JAN 31

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Dec.—Jan.

IN THIS ISSUE

50c

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The replacing of the old battery operated receivers with all-electric Radios has created a tremendous country-wide demand for expert Radio Service Men. Thousands of trained men are needed *quick!*

$40 *to* $100 *a week* Full Time
$3.00 *an hour* Spare Time

30 Days of R.T.A. Home Training

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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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Radio Service Work gives you the basic experience you need to qualify for the big $8,000, $10,000 to $25,000 a year Radio positions. Once you get this experience, the whole range of rich opportunities in Radio lies open before you. Training in the Association, starting as a Radio Service Man, is one of the quickest, most profitable ways of qualifying for rapid advancement.

If you want to get out of small-pay, monotonous work and cash in on Radio quick, investigate this R. T. A. training and the rich money-making opportunities it opens up. No special education or electrical experience necessary. The will to succeed is all you need.

Mail Coupon for No-Cost *Training Offer*

Cash in on Radio's latest opportunity! Enroll in the Association. For a limited time we will give to the ambitious man a No-Cost Membership which need not . . . should not. . . cost you a cent. But you must act quickly. Filling out coupon can enable you to cash in on Radio within 30 days, lift you out of the small-pay, no-opportunity rut, into a field where phenomenal earnings await the ambitious. You owe it to yourself to investigate. Fill out coupon NOW for details of No-Cost Membership.

The Radio Training Association of America
4513 Ravenswood Ave. Dept. SWC-12 Chicago, Ill.

THE RADIO TRAINING ASSOCIATION OF AMERICA
4513 Ravenswood Ave., Dept. SWC-12, Chicago, Ill.

Gentlemen: Please send me details of your No-Cost training offer by which I can qualify for Radio Service Work within 30 days. This does not obligate me in any way.

Name..............................

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HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

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HUGO GERNSBACK
EDITOR

DEC.-JAN.
1930-1931

H. WINFIELD SECOR
MANAGING EDITOR

VOLUME 1
NUMBER 4

Short Wave Advances

By HUGO GERNSBACK

AT NO other time, perhaps, throughout the entire development of the art of short waves, has there been such rapid advancement as during the past year.

Several books could be written on the great advances which have been made during this time, and the present discussion is only a resumé of more important advances. One of the most important, if not the most important, of recent developments, is the announcement that our larger broadcasters, including the National Broadcasting Company, are seeking permission from the Radio Commission to take on commercial programs to be sent out over short waves. This is indeed great news because, if this does happen, it is certain that short waves will become as universal as the regular long waves are today. All of the big interests now realize that, by means of short waves, they can broadcast to the entire world instead of being satisfied to cover only the United States and Canada and, perhaps, Mexico. At the present time, practically all licensees for short waves have only experimental licenses and none of the broadcasters are broadcasting regularly on schedule on short waves.

All of this, as I have often predicted, will soon change; and broadcasting will no doubt go out on regular schedules on the short waves, just as it is done now on the longer waves. Of course, at the present time the big broadcasters who are operating on the short waves have no income whatsoever from the short-wave transmissions, and the expenses of these are defrayed out of the broadcaster's own pocket. Soon, however, this will be a thing of the past; for there is no question that scheduled commercial broadcasting will soon be heard on short waves. Then we will have the usual sponsored and paid-for programs on short waves, too; and, once the Americans start this, it is certain that the rest of the world will not wish to stay behind.

The set manufacturers have already seen the light; and at least one such manufacturer is now producing commercial broadcast sets that can be used for the short waves as well as regular waves.

During the next few years, it is certain that all receiving set manufacturers must follow suit. All sets, sooner or later, will be equipped for short-wave reception.

Of course, at the present time we have separate short wave sets or, more frequently, our converters to be attached to the broadcast sets. Both of these are more or less makeshifts which, sooner or later, will be replaced by the complete universal construction whereby both sets of waves can be tuned in. Up to now, short-wave reception was no sinecure for the public at large. The difference in tuning-in between short waves and regulation waves is enormous, as every short-wave fan knows only too well. On account of the more-than-hairbreadth closeness of tuning, the short-wave enthusiast must first acquire a tuning technique; but I predict that our technicians will overcome this trouble during the next few years by means of a special condenser-and-vernier arrangement, so that it will be possible to tune a short-wave set with the same ease as the ordinary broadcast set.

I am fully aware that the short-wave "shark" will immediately contradict me and say that, even though the problem may be solved, so far as the tuning is concerned, the vagaries of short waves will still remain; and that, if you do succeed in tuning at a certain point of the dial, the station will not be heard because of the Heaviside-layer effects, fading and other troubles which are supposed to be beyond control in short-wave receivers.

This bugaboo may be dismissed from our minds immediately. While it is true that such reasoning holds true today; they will not do so in the future. The solution of the problem is contained in one word—POWER. Once short-wave broadcasters begin to broadcast with 50 or 100 kilowatts, the fading and skip-distance effects will not be nearly as formidable as they are now. It used to be the same in long-wave broadcasting; when, in 1922 and 1923, we tried to pick up a 500-watt broadcast station 300 or 400 miles distant, if conditions were just right, we could get the station. At other times, it simply could not be heard, no matter what we did. But present-day conditions do away with all these troubles and, when we think of the amount of power that some of the broadcasters now use (as compared to what they did use in 1922) we are apt to laugh at our former disappointments.

Recently, station KDKA announced that they are ready to broadcast on a power of 1,500 kilowatts whenever authorized; and the end is not yet. It is, therefore, probable that history will repeat itself in short-wave progress as well; and I am positive that the time will come when it will be as simple for the layman to receive a short-wave station as it is today for him to receive the present high-power broadcast stations.

In the meanwhile, a tremendous amount of research work remains to be done; but during the next few years there will be indeed a paradise for the short-wave experimenter who is interested in getting results and getting distance. The old days cannot even be compared remotely with what is taking place now. It was one thing to hear a station 300 miles away on earphones in 1922, and it is quite another to receive an antipodal station on the loud speaker today.

And then there is, of course, television too on the short waves. This is coming along so rapidly that, before we realize it, we will be able to "look in" on the entire world; and the time that it will take until we do this is much shorter than you may imagine.

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Photograph Copyrighted by Robert H. Davis

Dr. Alfred Norton Goldsmith, Ph. D.

LOOKING

ALFRED NORTON GOLDSMITH—American electrical and radio engineer, was born in New York City on September 15, 1887. He was graduated from the College of the City of New York in 1907 with the degree of Bachelor of Science and Phi Beta Kappa honors. In 1911, he received his Ph.D. from Columbia University. Upon his graduation from the College of the City of New York, he accepted a position **as instructor in electrical engineering at that institution.**

Dr. Goldsmith became Consulting Radio Expert for the United States Department of Justice in 1912. While teaching at the College of the City of New York, Dr. Goldsmith took a keen interest in the development of radio telephony, and finally persuaded the authorities of the college to establish a course in wireless. He thus gained the distinction of presiding over the first course of this nature ever offered by a collegiate institution of learning in the United States.

From 1915 to 1917, Dr. Goldsmith, in addition to his teaching duties, was Consulting Engineer and Correspondent for the General Electric Company, and in this capacity he cooperated with Dr. Ernst F. W. Alexanderson in the development of vacuum tube radio telephone equipment. In 1915, his work in connection with radio telephony attracted the attention of the American Marconi Company, and two years later he came to this organization as Director of Research.

With the formation of the Radio Corporation of America in 1919, Dr. Goldsmith became Director of Research for the new organization, and devoted much of his time to a study of transmitting and receiving problems. It was not until broadcasting became popular, however, that Dr. Goldsmith came into his own. His researches in radio telephony qualified him superbly for the post of Chief Broadcast Engineer, which he was appointed to fill in 1922, and on January 1st, 1929, he was made **Vice-President and Chief Broadcast Engineer. On April 19, 1929, his** title was changed to Vice-President and General Engineer. Prominent among Dr. Goldsmith's contributions to the field of science are investigations in simplex and duplex radio telegraphy and telephony, tape recorder for high-speed radio reception, the electric phonograph, the **photophone or recording of sound on motion picture films, precision** radio measurements, high power broadcast transmission, and international relay broadcasting. With the formation of the National Broad**casting Company in 1927, Dr. Goldsmith became Chairman of the Board** of Consulting Engineers. He is also Vice-President in charge of technical matters for RCA Photophone, Inc.

IN the present short-wave activities, we have all the uncertainties, thrills and opportunities which once existed in radio broadcasting. Just so long as broadcasting was an experiment, it had much charm for those of an experimental turn of mind. When broadcasting technique attained a sound engineering basis, however, followed by standardization and mass production of popular-priced receivers for living rooms and lay hands, the thrill of experimentation gave way to the sheer joy of practical entertainment.

Present-day short-wave radio, as far as we have gone, is much the same story. Today it has its thrills and trials and tribulations. Tomorrow, when it is reduced to standardized practice for lay as well as professional uses, it will find its place in the growing field of home entertainment. And the experimenters, not to be denied their rights, will turn to still shorter wavelengths which will then represent the frontier of practical radio communication.

Short and Long-Wave Receivers

The question is frequently asked: Why do the leading set manufacturers overlook short-wave receivers in their offerings? Do they realize the interest in and the demand for short-wave sets?

Set manufacturers fully appreciate short-wave possibilities and probabilities —as well as difficulties. The facts, that short-wave reception is the happy hunting ground of "experimenters," and that short-wave reception by simple apparatus is highly erratic, are the main reasons why set manufacturers have purposely avoided the mass production of popular short-wave sets. When and if short-wave reception is reduced to a fool-proof practice, when and if the layman can tune in stations with the same ease as in broadcast reception, and when positive results may be obtained day in and day out, then, and only then, will short-wave sets find their way into the average living room. The practical will then replace the experimental; the main fun will be in tuning in distant, foreign programs, with certainty and genuine entertainment value, rather than in the tuning gymnastics and infinite patience of today. We are very far from this achievement as yet.

The Term "Short-Wave" Is Relative

Let us note that short-wave radio is a relatively recent development, and the term, "short-wave," is a purely relative one. A decade ago, anything below 500 meters was looked upon as short-wave practice. Yet broadcasting made the 200-550 meter band commonplace, and the frontier of radio communication was pushed far down below 200 meters; stopping first at 100 meters, then continuing down to 50, and it is now down to 15 meters in everyday work. The frontier of practical radio communication is now close to 5 meters, and already the wavelengths below that point are being explored. Some experimenters are working even below 1 meter. Obviously, then, short-wave radio is purely relative. In the future we shall have an entirely different conception of real short-wave communication, for the trend is steadily towards shorter wavelengths.

The Heaviside Layer and "Skip-Distance" Effects

The past half-dozen years have served to eliminate much of the uncertainty of short-wave communication, although by the use of elaborate and expensive commercial equipment. The erstwhile pranks of high-frequency signals, once believed unavoidable, have by now been reduced to fairly definite laws or, if you prefer, rules of conduct. The general theory which governs the peculiar behavior of short-wave signals is known as the "Heaviside-Kennelly Layer Theory," which assumes that very short waves do not follow the curvature of the earth (as assumed in the case of longer waves) but are rather reflected, or refracted, by some medium in the upper atmosphere. This medium is held to be a stratum of rarefied air, existing about 100 miles above the earth's surface, and electrically conductive because of its ionized condition.

The height of the ceiling of this upper stratum rapidly changes, as the sun's rays act to vary the "electrical density" of the ionized condition. A low ceiling or ionized atmosphere tends to reduce the distant energy in a radio wave; so that such a wave may disappear entirely after traveling a hundred miles or even less from the transmitting antenna.

The radio wave is thought to be composed of two components; one a *ground wave* which travels along the curvature

AHEAD *With* Short Waves

Virtually a virgin field, high frequency radio affords an ideal opportunity to the experimentally inclined

By ALFRED N. GOLDSMITH, Ph.D.
Vice-President and General Engineer, Radio Corporation of America

SHORT-WAVE RADIO, the experimental field of today, is bound to become the practical field of tomorrow. The short-wave art is rapidly being reduced to standardized practice, based on sound engineering knowledge. In everyday communication, we have harnessed short waves down to 15 meters. Even the shorter waves are now being studied with promise of early commercial application. And, as the frontier of everyday radio is pushed back steadily, down the wavelength scale, the experimenter is always certain to find plenty of opportunities to pioneer and blaze the trail beside the engineers and commercial minds that follow along somewhat different paths, all leading to the continuous progress of radio.

Dr. Alfred N. Goldsmith.

of the earth, and the other a *sky wave* which is projected to the upper ionized stratum or Heaviside Layer. The sky wave is presumably reflected from (or refracted by) the under surface or ceiling of the ionized layer, at an angle towards the earth; this reflection being compared with the reflection of a beam of light by a mirror.

Thus, while the ground wave of a given radio station may be practically absorbed, a short distance from the transmitter, the reflected sky wave may reach the earth at certain points hundreds and even thousands of miles away, thereby accounting for real DX reception. It is this reflection of sky waves which accounts for the so-called *skip distance* in short-wave communication. This phenomenon, fortunately, varies according to the frequency or wavelength employed, the time of day, and the location of the transmitter. It becomes more noticeable at higher frequencies, within limits; and it is also dependent somewhat upon the seasons, the time of day, and the transmission path.

Variations in Wave Reflections Carefully Studied

The reflection by the Heaviside Layer is a matter which has received no end of attention from our commercial radio engineers. The R.C.A. engineers have spent years on short-wave transmission and reception conditions. Transmission and reception records and logs have been kept day in and day out, week by week, month by month. Variations during the twenty-four hours of the day, from season to season, and from year to year, over various circuits, have been carefully noted. Out of these trying and costly observations have been evolved the practical engineering facts of today; whereby engineers know precisely what frequency to employ for a given radio circuit at any time of the day or night, and for any season. The engineers are provided with carefully-computed tables, indicating the frequency most generally suitable for any hour or day of the year. These charts govern the frequency changes at our transoceanic short-wave transmitting stations.

It is common practice to employ a plurality of frequencies for a given transoceanic radio circuit during the twenty-four hours of the day; in order to maintain the desired skip distance between transmitter and receiver. Transmitters are transferred from one circuit to another, in keeping with daylight, twilight, night, and dawn. Precise engineering data, in large measure, supplant the guesswork and just plain "good luck" of the past. Ample safety factors are employed at every possible step in transmitting and receiving practices. Nothing is left to mere chance. That is why short-wave radio is playing such an important rôle in the handling of R.C.A. transoceanic traffic. It has proven practical quite as well as economical.

Why Commercial Stations Receive European Short-Waves Best

Yet, from the standpoint of amateur and lay application, short-wave radio is still largely an interesting experiment. Take the matter of transatlantic radio programs, for instance. Many wonder why programs from England, Holland and Germany are not received direct, by means of short-wave sets, rather than through the intermediary of the R.C.A. short-wave receiving station at Riverhead, on Long Island, and the N.B.C. networks. Unfortunately, few realize the elaborate preparations and equipment necessary for the practical reception and rebroadcasting of overseas radio programs.

Years have gone into the preparation for present-day rebroadcasting of European radio programs. Reception tests have been conducted month after month during many years. Quantitative measurements of intercepted signal strength have been made and filed for reference, under all manner of conditions. Many types of receivers have been designed, built and tried, until the present equipment represents the result of a rigid elimination contest.

Today, overseas programs are received under conditions fairly closely approaching the ideal, so far as our short-wave technique is concerned. The receiving station is located at a carefully-selected site, representing the best compromise between maximum intercepted signal strength and minimum local interference. Further to increase the signal-interference differential, directional antennae, virtually aimed at the distant transmitters, are employed.

Again, in order to combat troublesome fading common to transoceanic short-wave signals, the "diversity antenna" system is used, with a plurality of antennas and receivers; so that one is likely to score a fair average for the intercepted signal strength, at all times, fading or no fading. Finally, an automatic receiver selector (for the best signal at each instant) together with an automatic volume control insures the maintenance of the output at a given level. Is it any wonder, then, that the overseas programs are picked up with sufficient volume, clarity, and uniformity to be broadcast over the N.B.C. networks, while the short-wave fan can at times hardly pick up the same original signals with his own short-wave equipment?

From the standpoint of pure experimentation, overseas programs are a welcome challenge to the radio experimenter. They test his skill, resources, and

(Continued on page 313)

Newspaper Page Reproduced Via SHORT WAVES Across the Country

Recently a successful experiment was conducted between the short wave station W6XN at Oakland, Calif., and Schenectady, New York, when the front page of a San Francisco newspaper was reproduced by a new photo transmission and reception system. Photo at left shows Dr. E. F. W. Alexanderson with C. J. Young, who developed the system, both of the General Electric Company.


TRANSMITTED IN 3 STRIPS

WEATHER

THE CALL BULLETIN

LATEST EDITION

Link Banks in $118,000,000 Julian Plot

WIFE KIDNAPED, BEATEN BY 6 MASKED MEN

GANG IN AUTO CHOKE, ROB WOMAN

4 Trapped on Rock Wait Tide

CITIES CLAIM BUSINESS ON UP GRADE

WAVES BLOCK RESCUE OF YOUTHS

BENNETT TO BARE STOCK TRICKERY

SECRET PHONE PACT SOUGHT

ARRESTS SOLVE 37 ROBBERIES

CENSUS AIDES SEE SUCCESS

FELONS SHOOT 2

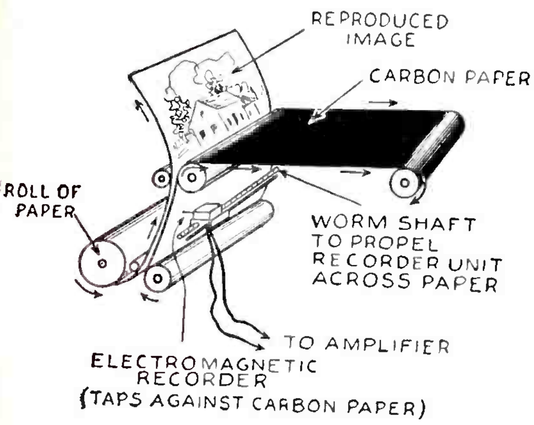
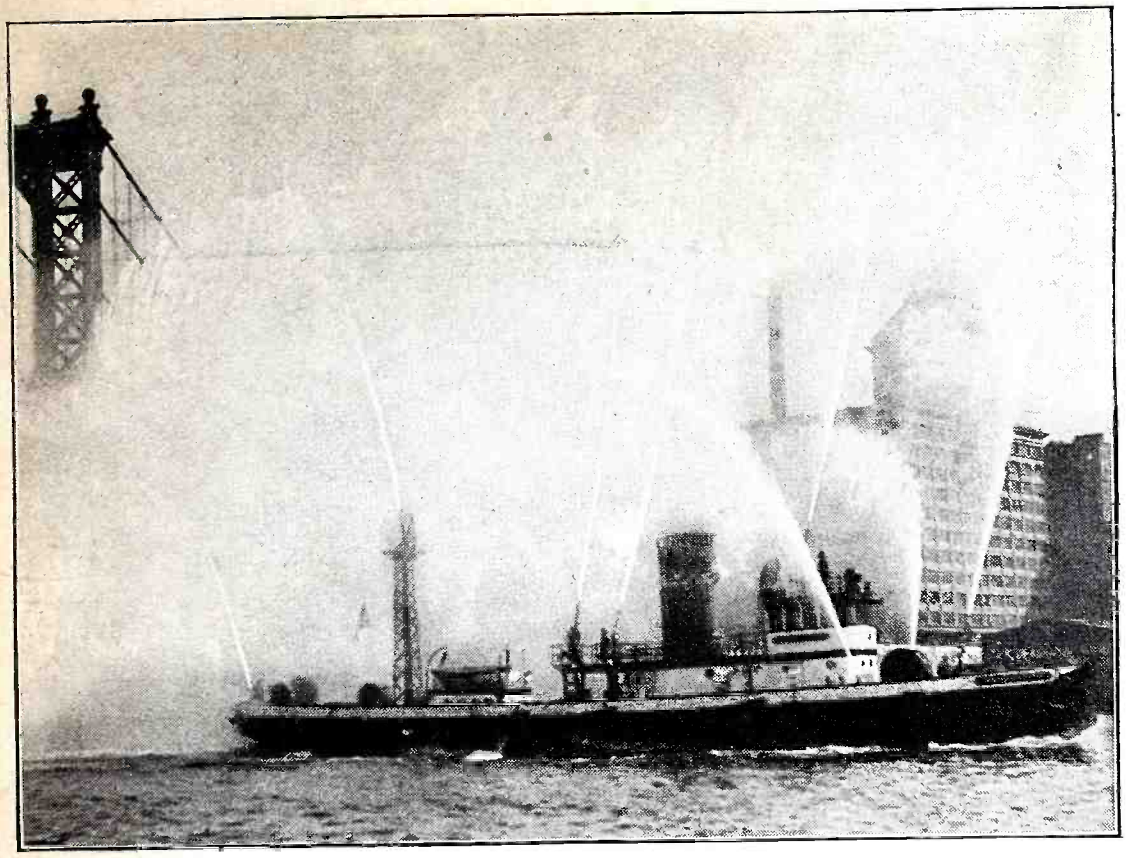


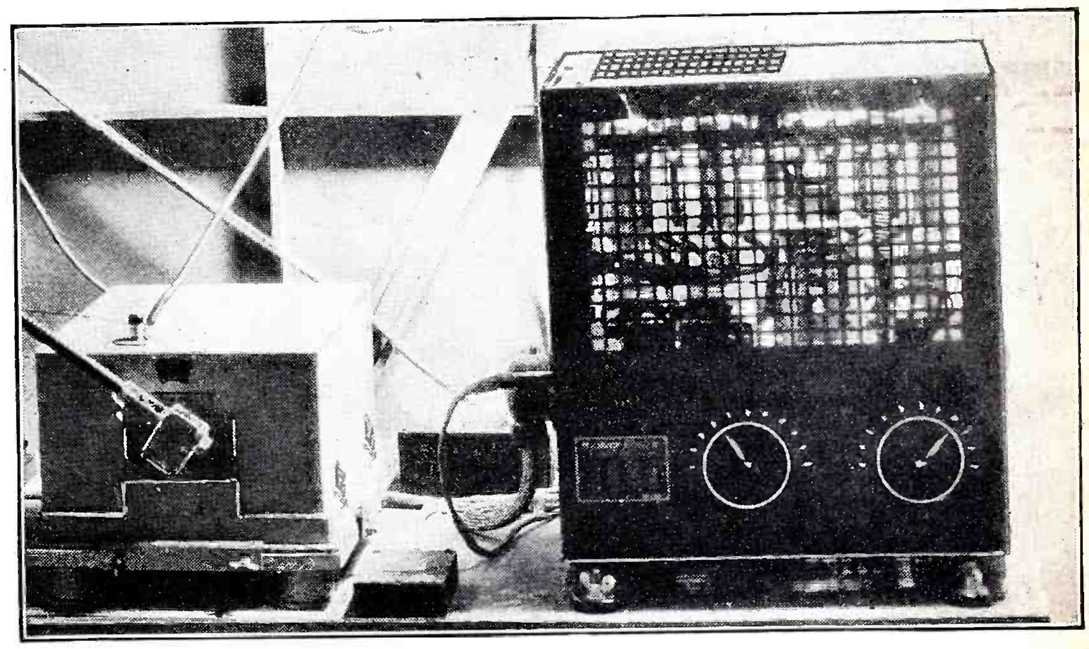
Diagram at left shows method used to translate short wave radio signals into facsimile of newspaper page in recent test over 2,500 miles distance between Oakland, Calif., and Schenectady, New York. The reproduced newspaper page is made up of three strips, the recording machine using paper 8 inches wide. A magnetic recorder taps against the carbon paper, giving an impression on the white paper.

Simultaneous Sound and Image Transmission

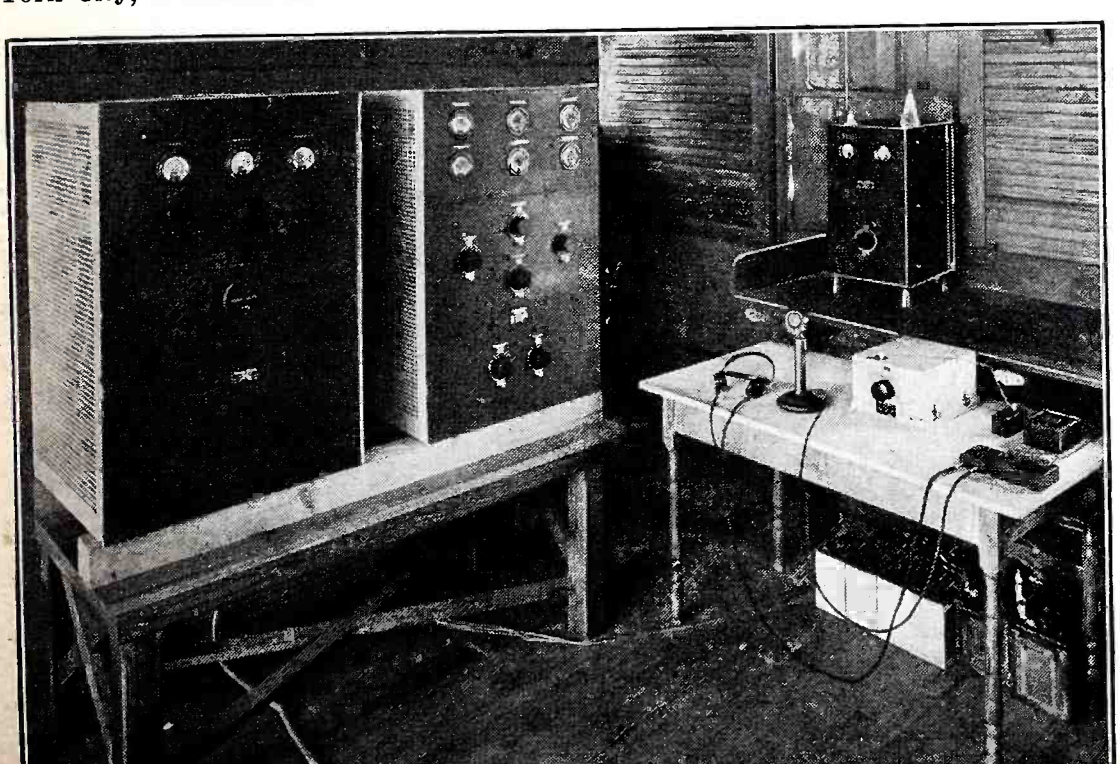
BOSTON recently witnessed one of the most successful demonstrations of the simultaneous transmission and reception of the television image, together with the accompanying voice. The apparatus responsible for this demonstration is illustrated at the left. "Big Brother" Bob Emery had the pleasure of appearing before the televising transmitter, the large photo-electric cells of which are observed in the picture. Behind the photo-electric cells there is a rapidly revolving scanning disc containing a spiral of holes, which causes a pencil of light from the arc lamp shown at the left of the photo, to traverse the speaker's face from top to bottom in rapid fashion many times a second. The speaker's voice was picked up by the microphone seen standing just in front of him. The sound waves were transmitted by Station WEEI on one wavelength, while the television image waves were transmitted by Station W1XAV.

Short Wave Radiophone Keeps FIREBOAT *in Touch with* SHORE





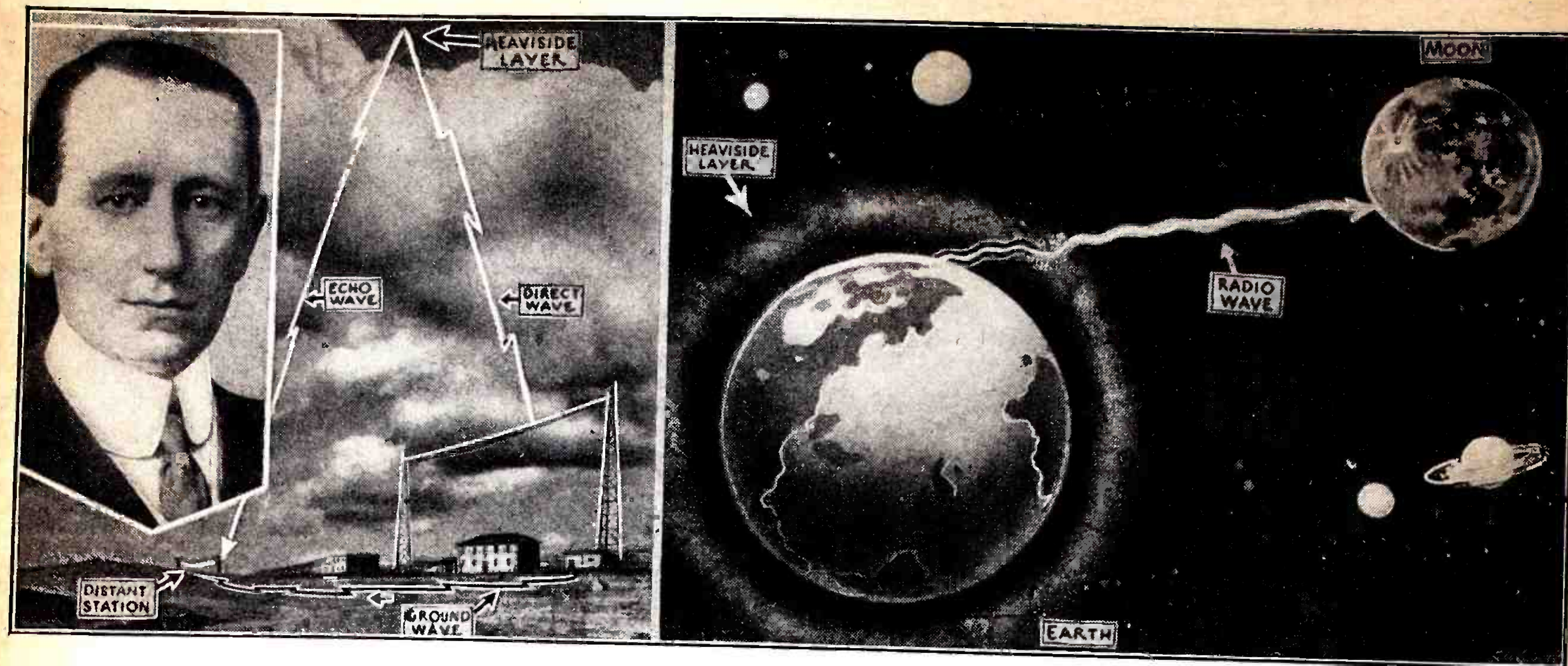
SUCCESSFUL tests were recently carried out with the newly installed short wave radiophone transmitter and receiver installed aboard the New York City fireboat *"John Purroy Mitchel."* The above radio station which communicates with the fireboat, as she cruises around the harbors and rivers adjacent to New York City, is located at the Marine Fire



Top photo shows radiophone equipped New York City fireboat *"John Purroy Mitchell."* Photo above shows Short Wave transmitter and receiver aboard the fireboat, while photo at the left shows shore radiophone apparatus installed at Marine Fire Department Headquarters.

Department Headquarters at the Battery, and has been assigned the call WCS. The radiophone transmitter aboard the fireboat is located below decks and has remote control wires leading to the pilot house above. The photo at the center of the page shows receiver and transmitter used on board the fireboat. Both stations employ a wavelength corresponding to a frequency of 1596 kilocycles (188 meters). The recent tests were very successful and the fire chief's voice was picked up aboard the fireboat as she cruised around the harbor and was reproduced on the loud speaker in the pilot's cabin so that everyone could hear

(*Continued on page* 320)



Guglielmo Marconi recently stated that he believes directed "beam" waves can and do penetrate the Heaviside layer, reaching out into space to distances as great as 48,000,000 miles. Picture at left shows "earth-bound" ground and echo waves, the latter reflected by the Heaviside layer.

CAN We RADIO the

A New Use for Amateur Radio

IF someone had made the statement, forty years ago, that you could send a message clear around the world without the use of wires, even the greatest electrical experts of the day would have strongly doubted the sanity of the man making such an assertion.

We are getting rapidly over the wonderment created by radio and are becoming accustomed to the impossible.

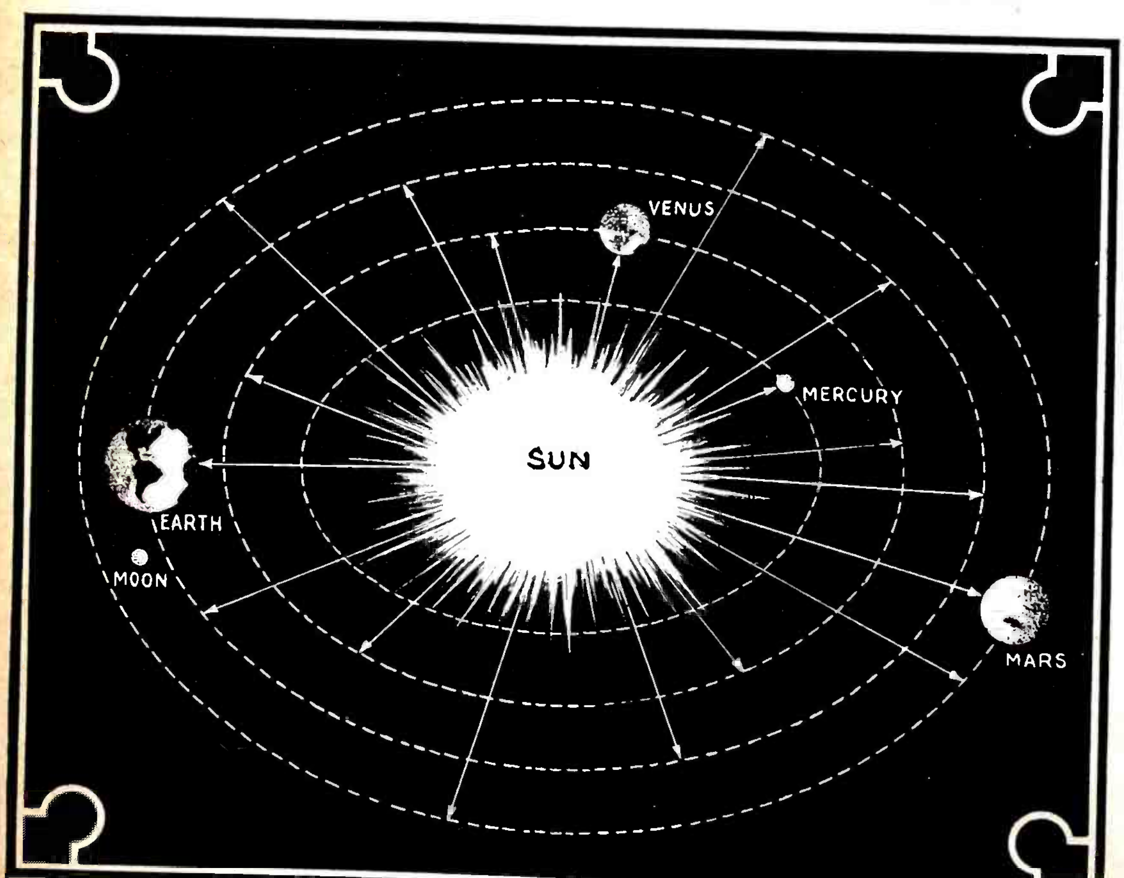


Fig. 2—A "celestial" vacuum tube, in which the sun gives off the electronic stream in the direction of the arrows. The various planets may be taken respectively as plates and grids in a multi-element tube; while the atmospheres of the planets are analogous to the gas adhering to the plate and grid, as shown in Fig. 1.

In the February, 1927, issue of RADIO NEWS (of which I then was the publisher) appeared an illustrated article written by myself and entitled "Can We Radio the Planets?" which is reproduced at the end of the present article.

The 1927 article is chiefly interesting because it came in for a good deal of ridicule at that time; while today Marconi, in conjunction with many other scientists, has reached the conclusion that it will not be long now before it will indeed be possible to send radio signals to the heavenly bodies.

As I said in my former article, again I do not wish to have the meaning misconstrued when I speak of signaling the planets. There is no idea in my mind, at the present time, of communicating with imaginary inhabitants of the Moon, Mars or Venus. The purpose of sending signals is purely for scientific research which will, in due time, give us a much better understanding of radio waves. It is admitted today that we know practically nothing of what happens to the radio wave after it leaves the transmitting aerial and until it impinges on the receiving aerial.

The thoughts which I advance here, I believe to be new so far as radio amateurs are concerned, and I also believe that in due time something will come of them.

No doubt, the radio amateurs will remember that I am the one who in 1910 fought their battles in Washington; and an editorial which I published in the February, 1912, issue of MODERN ELECTRICS became the basis of the present radio law, whereby the radio amateurs

THE author of this article presents some new views on how radio amateurs, with modest equipment, can now actually experiment by sending signals to the Moon, which, reflecting the radio waves, should make it possible to have other amateurs receive them at another point on our planet.

Our front cover depicts this idea graphically. While revolutionary, the idea is by no means new, and recent scientific investigations tend to show that it may already have been accomplished.

Scientists have believed until recently, that the so-called Heaviside layer would serve as a barrier to any radio waves which might try to leave the earth. Recent research and experiments, however, have shown that certain short-wavelengths apparently penetrate the Heaviside layer and are reflected by some heavenly body, or possibly by streams or bands of electrified particles in space, for the simple reason that the signals were received after an unduly long time. There are other theories as to where the delayed signals may have spent their time, but the most plausible is, that they actually penetrated the Heaviside layer, sped outward into space where they struck some heavenly body, for example, and were reflected on a long journey back to earth, where a receiving instrument recorded them.

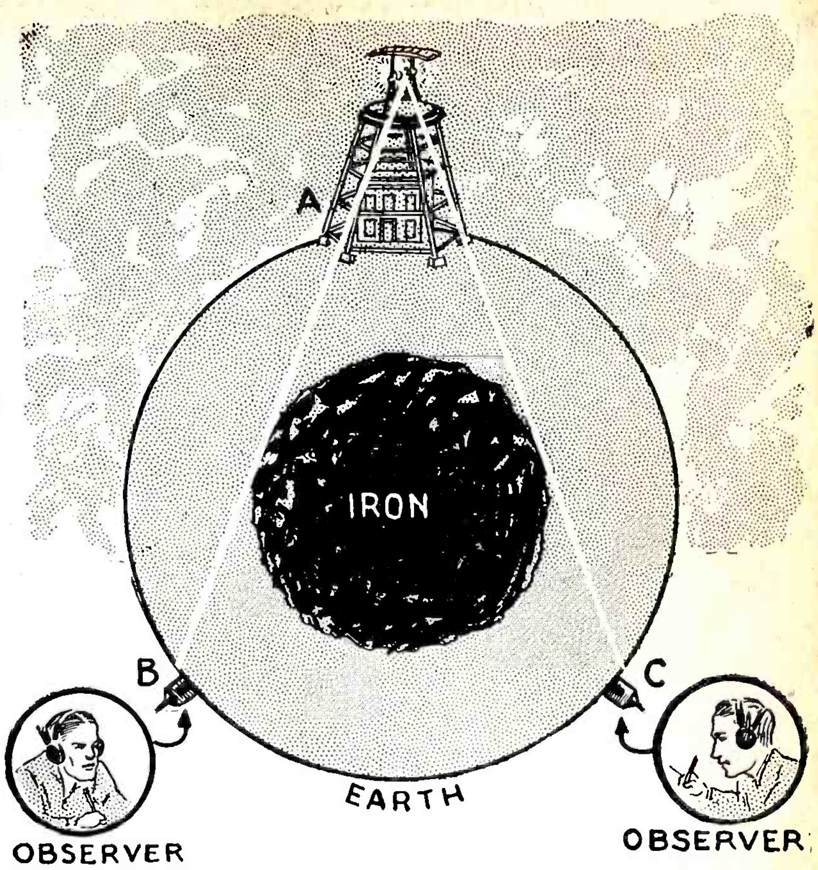


Fig. 4 shows a radio beam-transmitter "A" at some point on the globe, transmitting a beam to "B" or "C". As the angle of the beam is varied, the respective observers will get the signal either strongly or not at all. By this system it will be possible to explore the interior of the earth, to ascertain the size of the earth's iron core.

PLANETS?

By HUGO GERNSBACK

were allotted the territory below 200 meters. At that time, the authorities in Washington thought this was a good joke on the amateurs; because no one knew what to do with wavelengths below 200 meters and they were thought then to be of little use.

It may well be that history will repeat itself and interplanetarian signalling will open up avenues totally unsuspected today.

Fig. 3 shows how, by means of a powerful beam transmitter, located at some point "A" on our globe, we can send a beam of radio waves to the moon, which, being more or less metallic, will reflect the beam at the same angle. An observer, located at "B" on the opposite side of the earth, will receive the signal back from the moon, a distance of 238,000 miles, in two and a half seconds after it leaves the transmitter "A".

I need not tell the transmitting amateur that with very little power it is possible today to literally radio around the world. Five- and seven-and-a-half-watt short-wave transmitters have been heard half-way around the world, repeatedly. Of course, we still have the old "Heaviside layer" bugaboo to contend with; it is even doubted by some authorities that it is possible for any sort of short wave to penetrate the Heaviside layer and leave our planet. I emphatically disagree with these authorities for the following simple reasons: radio waves are electromagnetic waves, like light. Little proof is required that light waves from regions of other worlds do pass through, not only the Heaviside layer, but the atmospheric layer as well. It is admitted that light waves in their passage through these layers are refracted; and this refraction is the counterpart of the "reflection" of radio waves in the Heaviside layer.

When, however, radio waves become sufficiently short, I do not believe that the Heaviside layer will stop them, any more than it stops the light or heat waves. Indeed, we have already joined, in the electromagnetic spectrum, radio waves and heat waves; so that no longer is it possible to distinguish between them, since they merge at some indefinable point.

No one knows, at the present time, what kind of short radio waves will penetrate the Heaviside layer; they may be waves of 5 meters or of 5 centimeters or 5 millimeters. No one knows, because no one has as yet tried it; and here is where

(*Continued on next page*)

the radio transmitting amateur comes in. The problem is not as difficult as we might believe. We know from experience that even minute power makes it possible to communicate over great distances on earth by means of short waves. If the right wave is finally selected, I sincerely believe that, with power from 100 watts upwards, it may be possible to

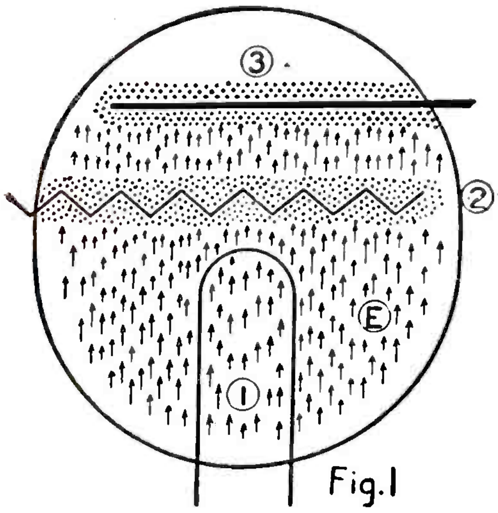


Fig. 1 shows the interior of a vacuum tube where (1) is the filament, E is the stream of electrons going in the direction of the arrows, (2) is the grid, (3) is the plate. The small dots surrounding the grid and plate indicate a layer of gas always adhering to metals, a miniature Heaviside layer, which the electrons must pierce.

send a wave to the Moon, and have it reflected back to earth without undue difficulties.

If this belief is correct, it will then be possible for a group of amateurs to do the following: the system used in Fig. 3 can easily be used. The transmitting amateur, let us say at some point in North America, by means of a direct aerial (as shown also on the front cover of this magazine) directs the radio wave at the Moon when it is at the proper elevation. The Moon, as well as most of our planets, is partly metallic in substance. The Moon, therefore, will serve as a gigantic reflector and, if the wave leaves the earth and penetrates the Heaviside layer, and is enabled to travel the distance of some 240,000 miles, the wave will then be reflected; just as the sun's light rays are reflected from the Moon, making it possible for us to see the Moon.

If, now, another amateur stationed on the other side of the globe, let us say Australia or South America, has also a directive aerial pointed to the Moon overhead, he should be able to record the signal, if this theory is correct.

If the transmitting and receiving amateurs are possessed of chronometers and signals are sent out, let us say, at the beginning of every minute on a pre-selected day, the receiving amateur will note the incoming signals, which should be received by him in about 2½ seconds. The reason is that radio waves, like light waves, travel at the rate of 186,000 miles a second. A little calculation will show, therefore, that for them to go out to the Moon, some 238,854 miles, and return, will take a trifle over 2½ seconds. If a great number of observations are made in this manner, it is possible to come to an exact result; and we will be enabled to learn a lot more about radio than we know today.

I would advise amateurs making these tests that everything is not as simple as it might seem from this rough outline. One thing the amateur should realize is that he should have the assistance of a competent astronomer, who will guide him in minor problems that come up during these experiments. One of the problems, for instance, is that neither the earth nor the moon is at rest, with regard to the other, and that they move constantly. All this must be taken into consideration when tests are made. Another point to remember is that, while ultra-short waves may pierce the Heaviside layer, yet they will be affected by it by some sort of refraction, just as light waves are refracted through the atmosphere. Unless these factors are compensated, serious errors are liable to creep up; and, not only that, signals may be missed entirely, because they may never reach the Moon, which is the target, and therefore they cannot be reflected or received.

Yet, the cost of these experiments is not prohibitive, even to the modest amateur; and the fame that will come to him and his co-workers, when sufficient proof is received that signals have actually been sent to the Moon and back, will compensate them for all the time, money and effort that have been expended on the experiments.

Just what benefits we will derive from turning the trick, no one can even remotely perceive today. It is certain that, sooner or later, man will travel, not only to the Moon, but to other planets, by means of space-fliers; and before that happens, science should certainly be in a position to say whether it will be possible or not to communicate with such fliers, once they have left the confines of the earth.

Can We Radio the Planets?

By HUGO GERNSBACK
Member of American Physical Society

WHEN Jan Lippershey built his first telescope in 1608, he came in for severe condemnation, because it was argued that such an instrument of the devil could never do any good. When our own Percival Lowell first propounded his theory of the Martian canals and Mars as the abode of life, he, too, was greatly ridiculed as a visionary; and even today orthodox astronomers do not share his views. When the first telescope was built, the then intelligentsia could not see any good in it, except as an instrument of the devil; so when I ask the question, "Can we radio the planets?" I know that I shall be subjected to not a little ridicule.

The telescope and spectrum analysis have opened the heavens to us to a tremendous extent, and enriched our scientific knowledge immeasurably. Spectrum analysis has shown us that stars, millions of light years removed from us, are constituted of identically the same matter as that found in our own earth; making it, therefore, reasonably certain that the entire universe is composed of practically identical matter, with little possibility of exception.

As you will see further on, when I propound the question, "Can we radio the planets?" I do not necessarily imply that in doing so we can send intelligence to Mars or to Venus, or to the Moon, with the expectation of getting an answer—although the latter may not be as impossible in a hundred years as it is now. I am simply trying to show that, by making a start, the greater the art of radio and our knowledge thereof will become.

The largest telescopes have been made possible through the generosity of our wealthy people, and it is, therefore, not impossible to hope that what has been done in building telescopes can be duplicated in building super-power stations for radio for research purposes. I might say, right here, that the benefits derived from such a super-power radio station will no doubt be vastly greater than from building a telescope, and for the following reasons:

The telescope is useless when it comes to exploration of our own earth. It is built to explore the heavens. A super-power radio plant can be used, not only to explore the heavens, if I may call planetary space such, but also for tremen-

(*Continued on page* 314)

TABLE OF VIBRATIONS
WHOSE EFFECTS ARE RECOGNIZED AND STUDIED

Octave	Number of Vibrations per Second	
1st Octave	2	
2nd "	4	
3rd "	8	
4th "	16	SOUND
5th "	32	SOUND
6th "	64	SOUND
7th "	128	SOUND
8th "	256	SOUND
9th "	512	SOUND
10th "	1,024	SOUND
15th "	32,768	SOUND
20th "	1,047,576	UNKNOWN
25th "	33,554,432	ELECTRICITY
30th "	1,073,741,824	ELECTRICITY
35th "	34,359,738,368	ELECTRICITY
40th "	1,099,511,627,776	UNKNOWN
45th "	35,184,372,088 832	UNKNOWN
46th "	70,368,744,177,644	HEAT
47th "	140,737,468,355,328	HEAT
48th "	281,474,976,710,656	HEAT
49th "	562,949,953,421,312	LIGHT
50th "	1,125,899,906,842,624	CHEMICAL RAYS
51st "	2,251,799,813,685,248	UNKNOWN
57th "	144,115,118,075,855,872	UNKNOWN
58th "	288,230,376,151,711,744	X-RAYS
59th "	576,460,752,303,423,488	X-RAYS
60th "	1,152,921,504,606,846,976	X-RAYS
61st "	2,305,843,009,213,693,952	X-RAYS
62nd "	4,611,686,618,427,389,904	UNKNOWN

In this table, beginning at the 25th octave and ending with the 45th, we have what may be termed the radio band of vibrations. It is thought that, as we approach wavelengths or frequencies near those of heat, it will be readily possible to pierce the Heaviside layer.

Short Waves for the Broadcast Listener

How to Convert an Ordinary Broadcast Receiver Into

A S-W SUPER-HET.

By CLYDE A. RANDON

The Superheterodyne is occupying the attention of leading short wave fans today and in the present article by Mr. Randon we are taken through a complete course on just how the superheterodyne works, and how we may apply its principle in conjunction with our standard broadcast receiver for the reception of short wave stations. Constructional and winding data for the short wave coils are given. This system allows you to use the high quality audio amplifier in your broadcast receiver.

FOR the broadcast listener there are thrills galore on the short waves. The reception of broadcast programs in the ordinary broadcast range becomes monotonous to experimenters, due to the sameness of the programs, and those who desire to receive distant stations are often disappointed because only under the most unusual conditions is a station thousands of miles away heard in the broadcast range. However, on the short waves the reception of stations from very great distances is the rule rather than the exception, because distance work is more favorable to waves of short length.

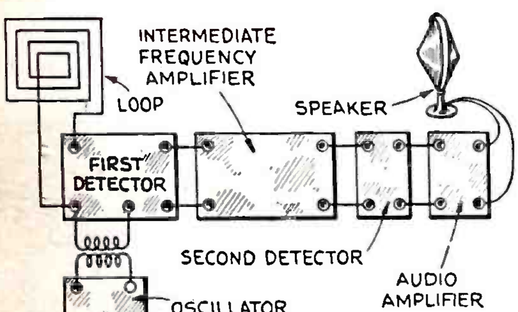


FIG. 1

Arrangement of the units comprising an ordinary superheterodyne receiver.

At ordinary broadcast frequencies the waves return to earth nearer the transmitter. Short waves, however, have the peculiar property of returning to earth at a distance with better signal strength, due to a so-called "skip-distance" effect which becomes more pronounced as the wavelength is shortened.

If the reader has had any experience at all with distance reception, he will realize that nearby stations often cause difficulty in the reception of distant programs on an average receiver. The stations on the short waves are comparatively few and, if one is properly located, one can experiment to his heart's content until the station is finally tuned in. That is one advantage, but there is another and more important one.

For distance work in the broadcast range it is desirable to stay up late at night. Some don't mind so much, but others who prefer sleep to DX (we all do after we lose enough of the former) find that late hours and work the following day simply do not agree. The short waves give exceptional distance even in daytime, to say nothing of the early evening hours, which are undoubtedly those when the experimenter desires to try his luck. It is not uncommon to hear over three thousand miles in daytime (at noon) at a wavelength of 20 meters. The short waves, therefore, are of considerable interest to DX fans.

An important motive which keeps many people away from the short waves is that they simply do not care to put out additional money for short-wave radio sets. Yet the broadcast set you now have can be used in its entirety for short-wave reception, by connecting ahead of it a simple frequency-changer, the construction of which will be described.

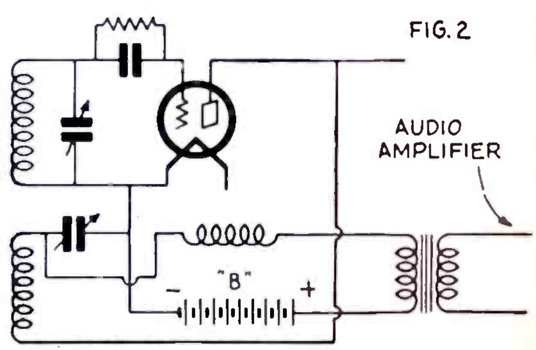


FIG. 2

Circuit diagram of ordinary short wave, regenerative detector system; this is the essential arrangement for an ordinary short wave adapter.

This, by the way, is not an ordinary adapter, but a simplified *superheterodyne* arrangement by means of which all the tubes in your present broadcast receiver can be used to the greatest advantage. Many foreign stations can be brought in on the loud speaker at the hour when

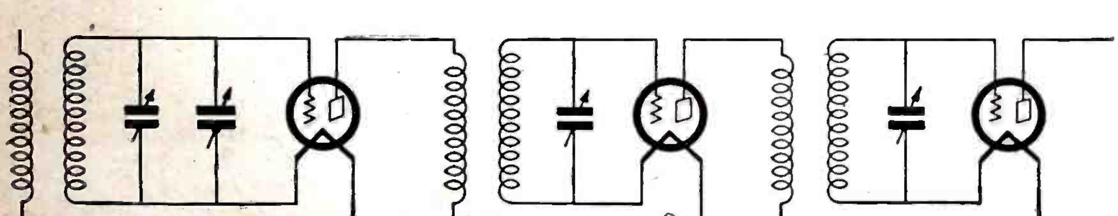


FIG. 3

Typical connections of a tuned radio frequency amplifier for the reception of broadcast wavelengths. Such an amplifier can be utilized as an intermediate frequency amplifier of a short wave superheterodyne, in the manner clearly explained by the author.

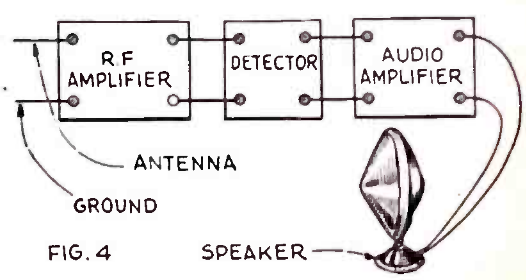


FIG. 4

Set-up of an ordinary broadcast receiver; for short wave reception it is too difficult to change both the R.F. and detector units, so usually the detector tuning unit is changed.

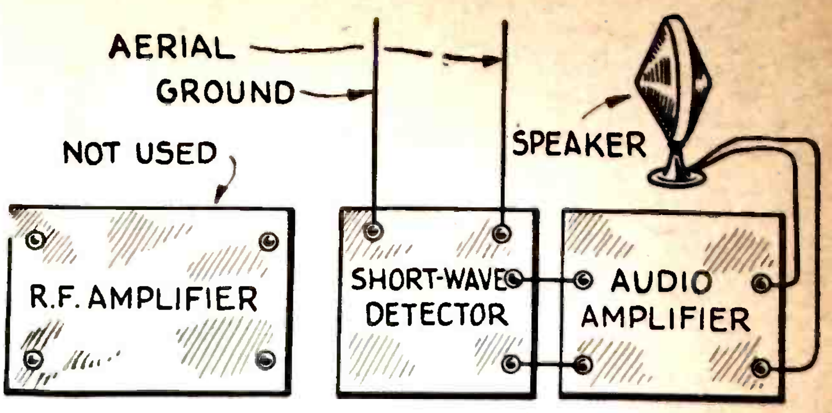
reception is best from the particular country.

Various Receiver Arrangements

The superheterodyne arrangement for reception is the most sensitive yet devised. A good superheterodyne will receive on a loop aerial what an ordinary set requires a full-length outside aerial for.

The units comprising a superheterodyne receiver are shown in Fig. 1, while in Fig. 2 the essential connections of an ordinary adapter are shown. The tube used as detector in the latter will depend upon the tube used in the detector socket of the broadcast receiver. A.C. tubes can be used if desired, the fundamental connections remaining the same. In the detector circuit shown the regeneration is controlled by means of a variable bypass condenser. Some arrangements use resistance control of regeneration; both schemes have their advantages and disadvantages. Unless a variable resistor of high quality is available, the condenser scheme of control is ordinarily to be preferred.

Fig. 5—When a short wave adapter is used, the conventional arrangement becomes that illustrated above; note that the R.F. amplifier is not used.



In Fig. 6 an ordinary broadcast receiving set is indicated at A. When the frequency-changer is put ahead of it, the R.F. amplifier becomes the intermediate-frequency amplifier of the short-wave superheterodyne, as indicated at B. The detector unit of the broadcast set then becomes the second detector and the audio amplifier of course remains the same. Compare this arrangement with Fig. 1.

The short-wave detector of Fig. 2 (construction described later) is converted into the first detector of the superheterodyne, while the oscillator is a separate Hartley arrangement which will be discussed later.

The arrangement shown was designed only for short-wave broadcast reception, but it may be used, with special adjustment, for code work, for which it is necessary to provide a regenerative second detector. A broadcast receiver already provided with a regenerative detector will be best for this purpose; such, of course, can be used for music also.

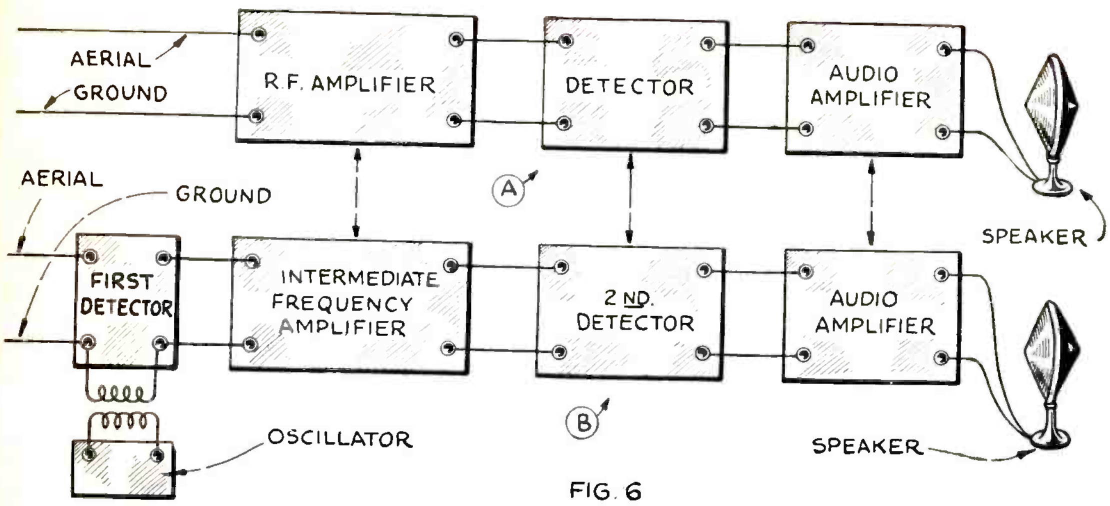


FIG. 6

This diagram shows clearly the development of a short wave superheterodyne receiver from an ordinary broadcast receiving set.

With one additional tube (in the form of a Hartley oscillator) more than is required for an ordinary adapter, the R.F. tubes of the broadcast receiver are utilized as the intermediate-frequency amplifier. Thus, adding only one tube results, really, in the addition of a whole R.F. amplifier (which may be as much as four tubes in some sets). It is readily apparent, therefore, that the additional oscillator is well worth while.

Almost all short-wave sets require two controls. Note that the superheterodyne arrangement uses the same number—one on the oscillator and one on the tuned circuit of the "first detector." The results with an arrangement like this are simply surprising. In some sets the proper conditions do not exist for the short-wave detector when it is plugged in. By using the frequency-changer ahead of the set itself, the conditions can be chosen correctly for the type of tube employed.

Simplicity of the Circuit

The first detector is just an ordinary detector unit consisting of a suitable tube and a tuned input circuit. This detector is non-regenerative and therefore no tickler is required. Since no regeneration condenser or tickler coil are used, the unit is really very simple. The regeneration-control condenser, normally used with an adapter, is now incorporated in the oscillator, so that, all in all, the only extra apparatus required is one lone tube in the oscillator.

Since no tickler is necessary, the arrangement (if plug-in coils are used) can be simplified greatly. There need only be two connections to the coil and thus the plug-in attachments are extremely simple in construction. There is, also, no bother in obtaining the correct directions for winding the coils.

While ordinary small plug-in coils wound on tube bases are easy to construct and use for the experimental sets,

Fig. 3 shows the essential connections of an R.F. amplifier for broadcast work. With an ordinary detector-adapter for short waves, this amplifier is not employed, only the audio channel being used.

When an ordinary adapter arrangement is plugged into the detector socket of a broadcast receiver, one is simply substituting a short-wave detector for the detector ordinarily employed. Evidently the R.F. stages in the broadcast receiver (like those of Fig. 3) are not employed because they do not tune to short waves. The aerial and ground are therefore connected directly to the short-wave receiver.

Fig. 4 shows the arrangement in a typical broadcast receiver "chain," and Fig. 5 the same broadcast outfit after the short-wave detector has been plugged in.

Advantages of the Frequency-Changer

By using a superheterodyne arrangement in front of the entire broadcast receiver, it is possible to use all its R.F. stages, thus building up the signal greatly before impressing it upon the detector.

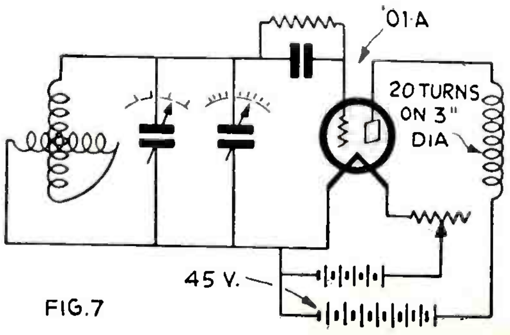


FIG.7

Detector unit using a variometer with two midget variable condensers, the larger one being used for rough tuning.

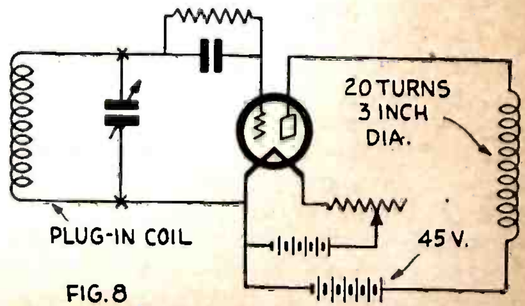
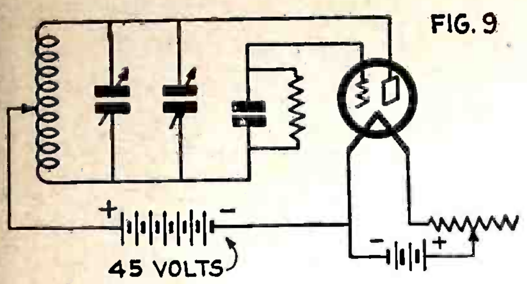


FIG.8

First detector arrangement, using plug-in coils; the plate coil is not necessary in some cases.



Circuit diagram of oscillator used with the short wave superheterodyne receiver.

the reader may desire to use a variometer (See Fig. 7) so that the entire short-wave range can be covered without changing coils. Some of the large variometers formerly used for broadcast work will be suitable for this purpose after some of the turns are removed from both the rotor and the stator. Often it will be necessary to remove both windings entirely and rewind them with spaced turns, in order to keep the losses within reason at high frequencies.

Of course, the ideal construction would be a rotor and a stator with spaced windings, on skeleton forms. The best results will be obtained with a good separation between the windings, because of the capacitive effects, but this should not be too great.

For experimental work one naturally uses the parts available, so that no exact variometer specifications are given. The dimensions also depend upon the detector unit employed. It is well to remember that, when the two windings in a variometer are aiding, the inductance is given by the sum of the windings plus twice the mutual inductance between the two windings. The inductance of a coil increases as the *square* of its turns. The ratio between the number of turns in the coil and the wavelength to which the circuit tunes is therefore direct. Knowing the approximate sizes required when using ordinary single-layer coils and the simple rules of inductance variation, one can get fairly close even without trying.

Choice of Frequency Simple

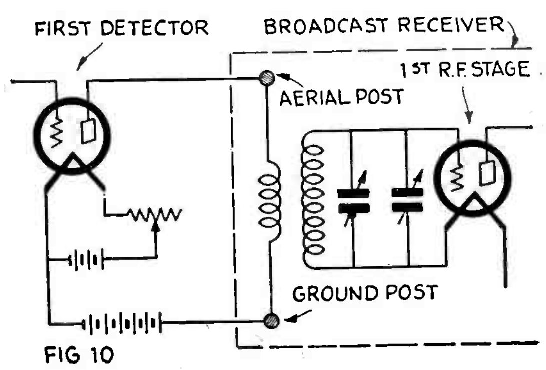
The object to be attained by a first detector is to create, in the plate circuit, an intermediate frequency, lying in the broadcast band, and which should be so chosen so that no station is operating at this frequency. Otherwise, in spite of the fact that the antenna is connected to the first detector, the signals will "ride through" the set, and interference will result between short-wave and ordinary broadcast stations. Especially is this true of powerful locals.

One can easily find on the receiver-dial some point at which there is no station, or may tune the set between two stations should it be desired to use an intermediate frequency in this vicinity. Some receivers give a greater gain in the R.F. amplifier at the lower broadcast wavelengths, due to regenerative effects, so that if a lower wavelength is used the amplification in the intermediate-frequency section will be greater. However, there are also advantages in using the higher wavelengths.

The experimenter will find real enjoyment in experimenting with different values; to change the intermediate frequency the dial of the receiver is simply turned to the desired value. It will be found that by simply changing the aerial connections one can turn from locals to short-wave stations. This is a very interesting stunt to perform on visitors. It is really a spectacular stunt to be able to pull in a very distant station in broad daylight.

Coils Readily Made

A variometer arrangement may be finally used, but for experimental purposes the average experimenter will use an ordinary plug-in arrangement like Fig. 8 (a suggested baseboard layout is shown in Fig. A). This will not be particularly troublesome, because of the simplicity of the input circuit to the first detector. A midget condenser of about 50 mmf. will give good results, and the tuning will not be very sharp. Of course, the smaller the condenser the less the range covered, so the stations will be spread out better on the dial. A vernier dial can be used with the larger condensers, with good results. A very small condenser will require a larger number of coils to cover a given



Typical input circuit to first R.F. stage of broadcast receiver, with connections to first detector shown.

range; a 30-mmf. midget variable condenser will usually give good all-around results.

Although the exact coil sizes will depend upon the tubes used and factors of construction, the following data will be approximately correct for the breadboard arrangement of Fig. A. The coils are wound on UX tube-bases, and the condenser used is 30 mmf.

Turns	*Range in meters*
8	17-25
11	24-34
17	34-43
22	44-64
55	63-100

If coils 2 inches in diameter are used the number of turns will be less for a given range. It is desirable in any case, of course, to have overlapping ranges, to obtain a continuous tuning scale.

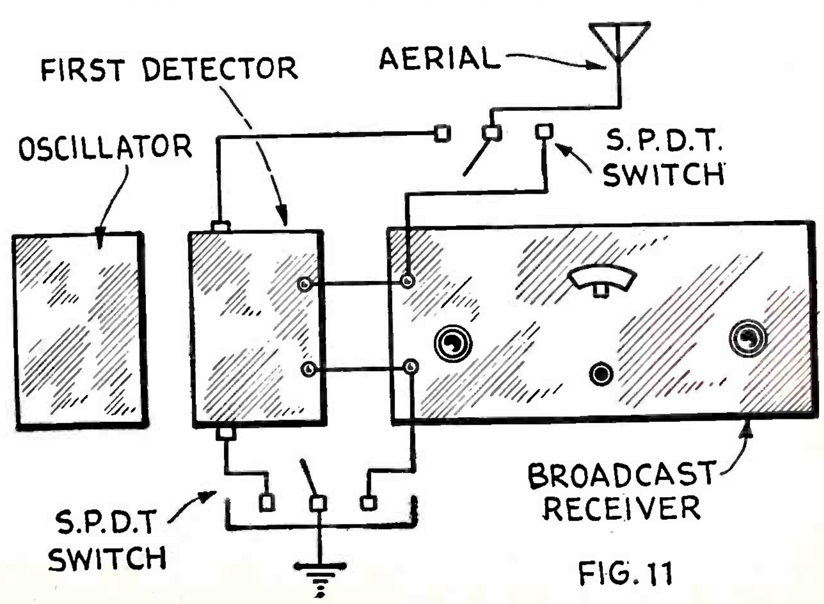
It is unnecessary to provide a coil for coupling the oscillator and first-detector detector together. There will be sufficient pick-up from the oscillator, even at a considerable distance, to give good results. The input circuit of the first detector is tuned to the short-wave station and then the oscillator-dial is operated until the fundamental frequency of the oscillator (or one of its harmonics) differs from that of the broadcast station by the value of the frequency to which the broadcast receiver is tuned. If, for example, the receiver is tuned to 1,000 kilocycles (299.8 meters) and it is desired to receive a 30-meter broadcast station, it will be necessary to tune the oscillator until its fundamental (or harmonic) differs in frequency from the 30-meter wave by 1,000 kilocycles (also called one megacycle). Thirty meters is 9,994 kc., to be exact; the oscillator is adjusted to either 8,994 or 10,994 kc. It is better to tune to the "long-wave side."

Since the two frequencies, beating together, produce a third frequency equal to the exact difference between the two original frequencies (as in any superheterodyne receiver) there will exist in the plate circuit of the first detector a 1,000 kc. signal. Since the broadcast R.F. amplifier is tuned to this frequency, the signal will be amplified still further, and finally appear at the loud speaker with good volume.

Design of the Oscillator

There are some important points regarding the design of the oscillator (Fig. 9, and suggested baseboard layout in Fig. B). An ordinary tube oscillator has ample power for all ordinary purposes; consequently, if any useful result is ob-

Simple switching arrangement utilizing two single-pole, double-throw switches, either of the knife or cam variety, which permit rapid switching of either short wave or broadcast receiving set on to aerial and ground connections.



tained by operating it below maximum efficiency, it is desirable to do so. The only objection (besides that of extremely sharp tuning) to the use of a very large condenser in a short-wave tuned-circuit is that the high capacity results in low efficiency, because of the relatively large currents in the tuned circuit. To apply high voltage between filament and grid of a receiver, a relatively high value of inductance is desirable.

However, an oscillator designed for lower efficiency can be made to cover a very wide range with but a single coil in the oscillator circuit. Naturally the tuning will be sharp, but (as shown in Fig. 9) a vernier can be used for finer adjustment. This vernier should be, preferably, 50-mmf. size, because the range covered by a given vernier is less when the capacity in parallel with it is higher. If the oscillator is shielded, no extension handles will be necessary.

An ordinary 23-plate condenser can be used in the oscillator. It is convenient to mount the oscillator on a baseboard, or in a separate cabinet, so that it can be used for a variety of tests, or wavemeter calibration, in conjunction with the broadcast receiver.

If the condenser values mentioned above are used, a 3-turn coil, on a 3-inch diameter, will cover the lower short-wave ranges, and a 10-turn size will give a complete coverage. It may be necessary to modify these values, slightly, in some constructions. An ordinary grid leak and condenser are used in the oscillator.

This Hartley circuit, by the way, is better adapted for use in a superheterodyne oscillator than all others which have been tested. Some require choke coils, and consequently "dead spots" are discovered at some points. This is very objectionable in receiving work, especially in the oscillator, where a continuous range is highly desirable.

The circuit of Fig. 9 requires no choke coil; notice that the battery is connected between the center-tap on the inductance and the filament.

The tube may be a '99, an 01-A, or (if A.C. is used) a '27. In the latter case the filament supply can be taken from the broadcast set by suitable wiring additions, or a small filament-transformer which gives the desired 2.5 volts at the proper current value is employed.

The oscillator condenser, if provided with a suitable vernier, can be made to cover a rather large range. If a smaller range is desired, without a vernier, the coil sizes suggested for the receiver will serve. If a .00035-mf. receiving condenser is used in an oscillator (a 23-plate size, often found in the junk box, will cover a larger range), coils two inches in diameter will cover the following ranges, if the effective capacity in parallel with the tuned circuit is kept reasonably low:

Turns	*Range (Meters)*
50	270-560
33	200-280
17	100-230
9	50-140
3	17-55

These values are suggested also for a wavemeter to cover the lower ranges.

Coupling the Output to the Broadcast Receiver

Of course, the input circuits to different broadcast receivers differ so much that one should find out the circuit from a nearby radio store, if it is not already known. Service Men usually keep files of the circuits of common radio receivers. Remember, in any case, that the object to be obtained is simply to couple the "broadcast signal" into the broadcast receiver.

The frequency-changer has simply changed the short-wave signal into an ordinary broadcast signal; the object is to impress it into the first R.F. stage. A typical input connection for an ordinary broadcast receiver is shown in Fig. 10. If the first R.F. stage has a primary coil, as shown, it will not be necessary to wind a special coil for this purpose.

In some sets a separate coupling-coil will be necessary. Leads are then run into the set and this coil is set near the coil of the first stage. Any changes in the tuning that may occur and caused by so doing are compensated by means of the trimming condenser.

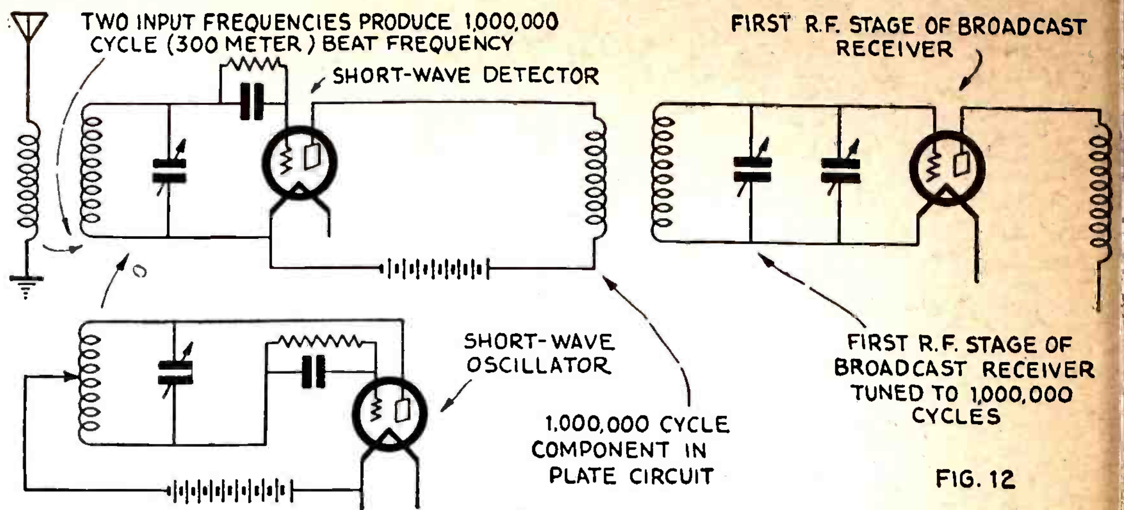


FIG. 12

Circuit connections for a sensitive short wave superheterodyne receiver; all the tubes in the broadcast set are used with this arrangement.

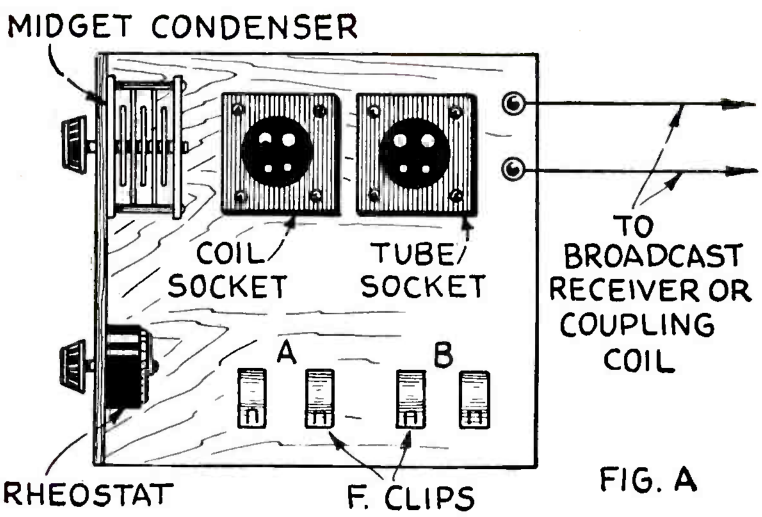


FIG. A

Fig. A, at the left, shows a suggested baseboard arrangement for short wave first detector, employing plug-in coils. It is important to see that all leads are kept as short as possible and the layout shown will be found to work very well, says the author.

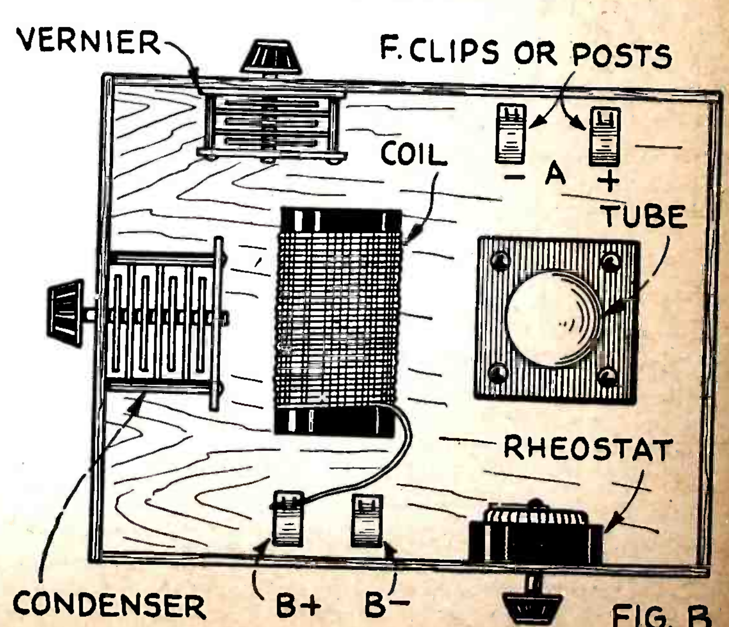


FIG. B

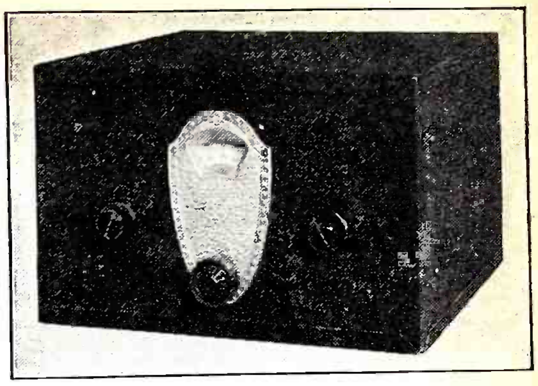
Fig. B, at the right, shows a convenient arrangement of the oscillator parts on the baseboard, which will enable the constructor to use the shortest leads in connecting various component parts. Wood baseboards are commonly used, but when one has constructed such an instrument as this and has it working well, it would be a good idea to use a bakelite or similar baseboard.

How You Can Convert

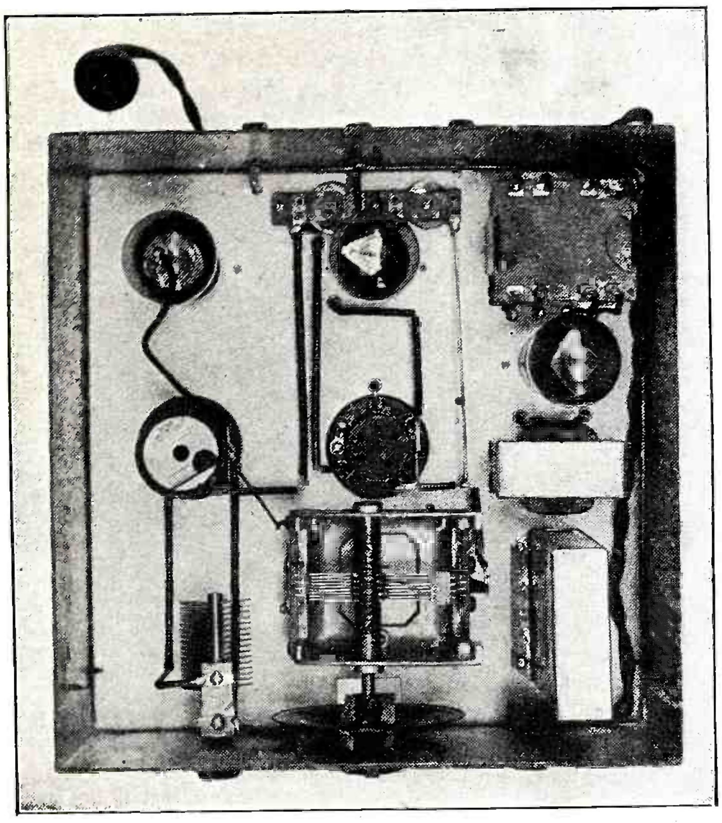
YOUR BROADCAST *RECEIVER* For Short Wave Reception

By McMURDO SILVER*

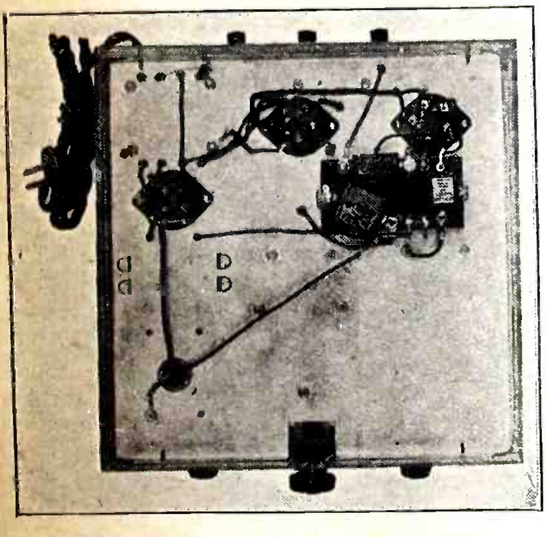
The author explains how to build a new design of converter, which, when connected to your broadcast receiver, enables you to hear short-wave phone stations as well as code signals. The cost of building the converter is low and it has its own plate and filament supply, all from the A.C. lamp socket; no batteries. The converter and your B.C. set form a super-heterodyne, most sensitive and selective of receivers.



Front view of new Silver-Marshall S-W "Converter"



→ Top view of S-W converter, which has its own A, B and C supply.



Bottom view of S-W converter.

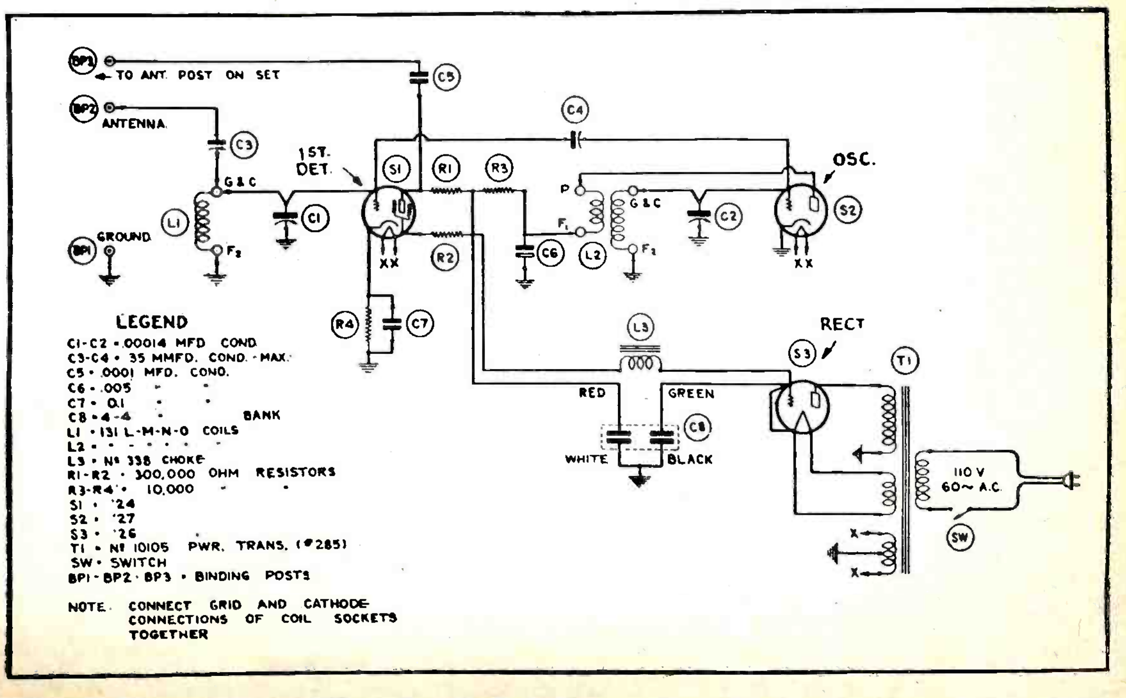
FOR short-wave reception, the superheterodyne system, though sometimes regarded as complicated, unquestionably provides the best and most satisfactory type of receiver. It is the only system permitting any high order of amplification; since practically insurmountable problems are involved in the design of a short-wave R.F. amplifier, with which it is almost impossible to obtain either any fair order of amplification, stability, practically satisfactory or reasonable commercial simplicity. With the superheterodyne, on the other hand, almost any desired order of amplification can be obtained on short waves, and a high order of simplicity attained; since, where it is required to cover a wide frequency band, only two coils need be changed for each band and there is no difficulty of circuit ganging involved.

Herewith is illustrated and diagrammed a short-wave converter, consisting of an oscillator and first detector; which, when placed before an ordinary broadcast receiver, employs the R.F. amplifier of the latter as an intermediate-frequency amplifier, and turns the whole combination into a superheterodyne. This converter is in distinct contrast to previous short-wave converters, which usually consisted of only a regenerative short-wave detector designed to be plugged into the detector socket of a tuned radio-frequency or other set, and utilized only the audio amplifier of the latter. With this converter, all of the amplification of the T.R.F. receiver, with which it is used, is fully utilized, and slightly augmented by the gain resulting from the frequency conversion.

Parts Necessary

The converter consists of a '24 first detector, with plug-in coils which are tuned by a .00014-mf. vernier or midget type of condenser. It was not thought desirable to bring the condenser control out to a vernier dial; since it is not particularly critical in setting, and operation may be more easily mastered when the first detector's tuning is regarded as a

(*Continued on page* 324)



Wiring diagram of the Silver-Marshall S-W converter. It plugs into any A.C. socket.

* President of Silver-Marshall, Inc.

Handsome appearance of the new Colin B. Kennedy combination long and short-wave receiver—the first receiver of this type and showing the future trend of receiver design.

A COMBINATION SHORT and LONG *WAVE SET*

By H. WINFIELD SECOR

The new Colin B. Kennedy broadcast receiver contains a short-wave set which operates in conjunction with the radio and audio frequency units in the broadcast receiver. Plug-in coils are eliminated by a clever switch device.

THE combination short and long-wave receiver just simply had to come, and it has remained for one of the leading builders of high quality receiving sets to point the way. This receiver excited a lot of attention at the recent New York Radio Show as the first instrument of its kind to be shown. Before another year has passed we will undoubtedly see plenty of combination long and short-wave receivers being commercially marketed.

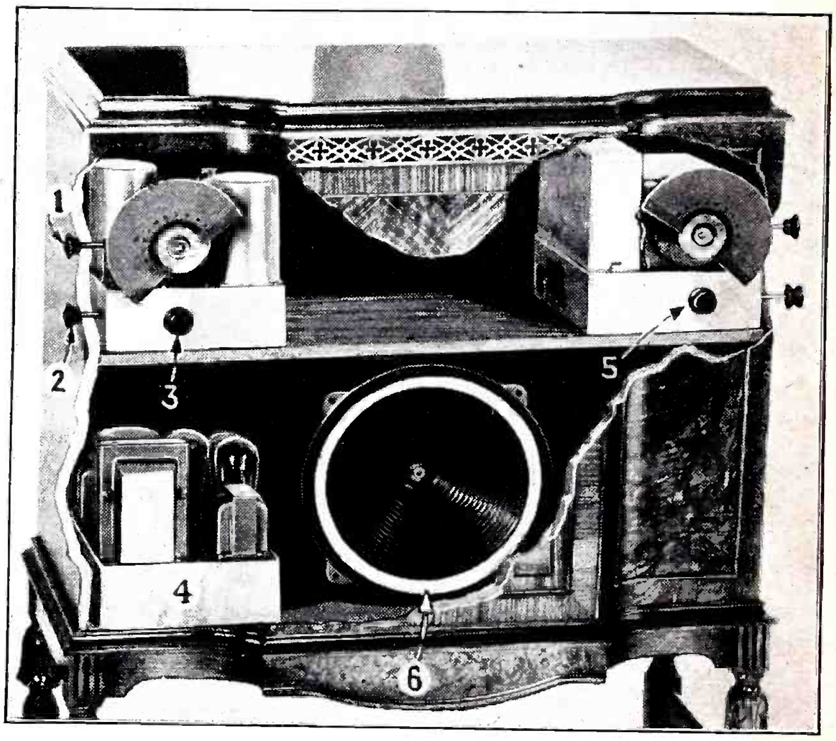
Three short wave coils, covering a band of from approximately 15 meters to 100 meters are provided; two coils being permanently built in and shielded, while the third is of the plug-in type, which permits the owner of the set to remove this coil and insert others.

The long-wave receiver unit employs 4 tuned stages with shield grid tubes, a power detector, 1 resistance-coupled A.F. stage, with the second A.F. stage using 2 '45 tubes in push-pull. As the diagram shows, a dual switch connects the antenna with the long or short-wave set.

The special switch connecting the various short-wave coils into circuit is a three-pole, three-way affair, operated by a single knob on the exterior of the cabinet. The short-wave set has one stage of untuned R.F. ahead of a regenerative detector; and the dynatron oscillator uses a S.G. tube as well. The receiver is not of the super-heterodyne type, but uses a dynatron oscillator, the output being taken from the screen of this tube through a condenser as shown. The frequency of the oscillator is fixed at approximately 1530 K.C., but can be varied.

For short wave reception it is only necessary to once set the dial of the long wave receiver at the output frequency of the short wave oscillator, and then tune the short wave receivers' single dial, as well as operate the regeneration control.

This long and short wave receiver thus employs a total of six screen grid tubes, four being tuned amplifier tubes and thus producing a tremendous overall amplification of the short wave signals. Including the audio stages, a total of 11 tubes are employed for short wave.



Semi-sectional view of the new Kennedy broadcast receiver which is also fitted with a short-wave set; 1—Station Tuning Knob; 2—Wave Band Switch; 3—Regeneration and volume control; 4—Power Pack; 5—Broadcast Wave Receiver Control; 6—Dynamic Loud Speaker.

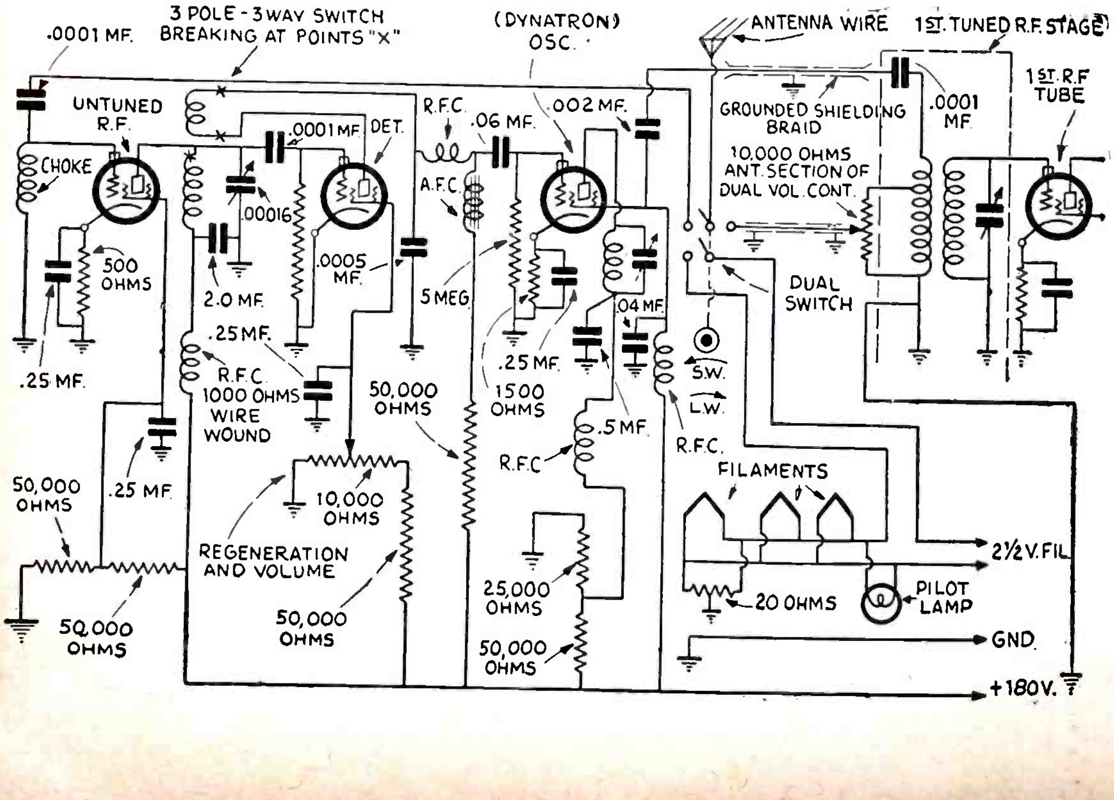


Diagram of short-wave set used in the Kennedy "combination receiver". This is not a superheterodyne—but a dynatron oscillator is used; the short-wave set feeds into the primary of the first tuned stage of the long-wave set.

The Short Wave Experimenter

The Amateur's "Short Wave" Special

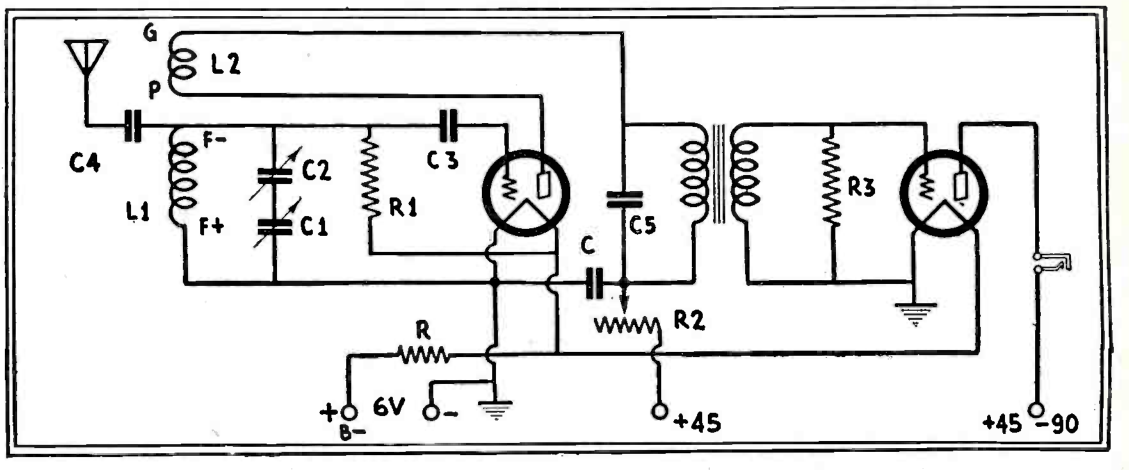
By FRANK SOBIECH

THE two tube receivers illustrated here is one of the simplest types that can be built. It is, however, a thoroughly practical one, which can be depended upon to give readable signals, when conditions permit, even over the greatest distances.

Apparatus Required

Three UX type tube sockets.
C-1 mf., Tobe by pass condenser.
C1-50 mmf., tuning condenser (straight line frequency).
C2-100 mmf., midget variable condenser.
C3-100 mmf., Sangamo fixed grid condenser.
C4-Antenna coupling condenser; two ½" square brass plates, about ⅛ apart.
C5-2,000 mmf., Sangamo, fixed by-pass condenser.
R-½ ampere ballast register (Amperite).
R1-2 or 4 megohm grid-leak.
R3-0.1 megohm fixed, grid-leak type resistor.
R2-50,000 ohm variable resistor.
L1-L2-Tube base coils.
One good audio-frequency transformer.
SW—One battery switch.
Base Board measuring 11" x 6".
Bakelite panel 12" x 6½". One binding post strip.
Phone jack, resistor mounting, miscellaneous wood screws, machine screws, brass strip, etc.

From the circuit diagram it can be seen that two variable condensers are used in series across the secondary L1. The condenser C1 is the main tuning control, and is a high grade condenser of 50 mmf. capacity. The midget condenser C2 is of 100 mmf. capacity. It is used in series with the main tuning condenser to reduce the capacity range of the latter, so that almost full scale coverage can be obtained on any of the amateur bands. When the receiver is operated on the 1,715 or 3,500 kc. bands, the midget condenser is set near its maximum capacity, the exact position being determined experimentally, so that the capacity range of the tuning condenser will be limited to the value necessary to give full scale coverage on those bands. For the 7,000, 14,000 and 28,000 kc. bands, the midget condenser is set at lower values; each value being predetermined experimentally, so that the effective capacity range of the tuning condenser is progressively lower for the higher frequency bands.



One of the features of this short-wave receiver designed by Mr. Sobiech is that a midget condenser, C-2, of 100 MMF capacity is used in series with the main tuning condenser C-1, to reduce the capacity range of C-1 and give greater wavelength coverage.

The Coils

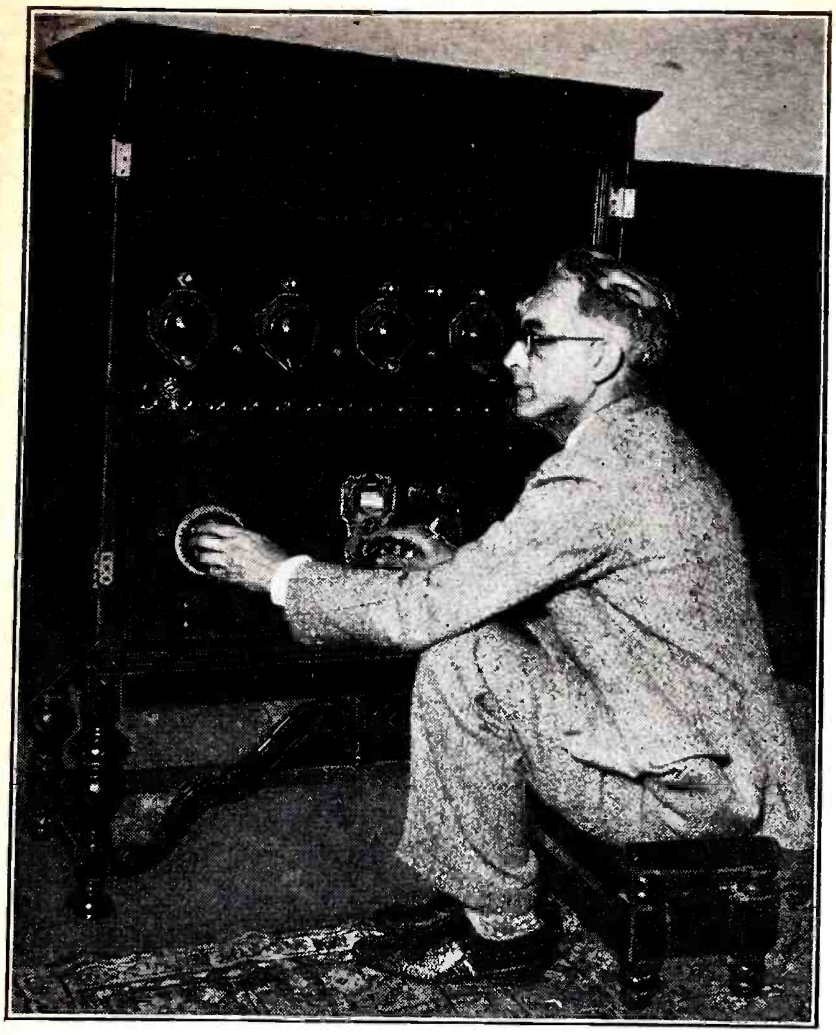
The short wave coils are wound on bases taken off burnt-out tubes. The exact number of turns needed, will depend to some extent on the placement of the apparatus and the arrangement of the wiring.

The tickler coil L2 is fixed in its position with respect to coil L1, and is wound on the same tube base, about ¼" from the filament end of L1. The tube bases are long enough to accommodate the required number of turns of wire for the first four coils; but the fifth base, however, must be fitted with an extension that will make it about three inches long.

Condenser C5, is a radio frequency by-pass condenser, across the audio frequency transformer. Its use is very important: without it the detector could be made to oscillate only by using an abnormally large tickler or very high voltage. The most satisfactory plate voltage for the detector is about 22½. It might be thought from the diagram that 45 volts is used in this set. This is not so, however, since the resistance of R2 at about half-scale setting, is sufficient to drop the voltage to the point where only about 22½ volts are placed on the detector plate.

The fixed resistor R3 is connected across the secondary of the audio-frequency transformer to eliminate a howl or squawk, which is often produced at the point where the detector starts oscillating.

FOR BEGINNERS!
In the next Issue—
ARTHUR G. GREEN
will tell
"How to Operate a Short Wave Receiver."



Mr. Lee tuning the "Rolls-Royce" receiver.

A "Rolls-Royce" SHORT WAVE RECEIVER

By C. STERLING GLEASON

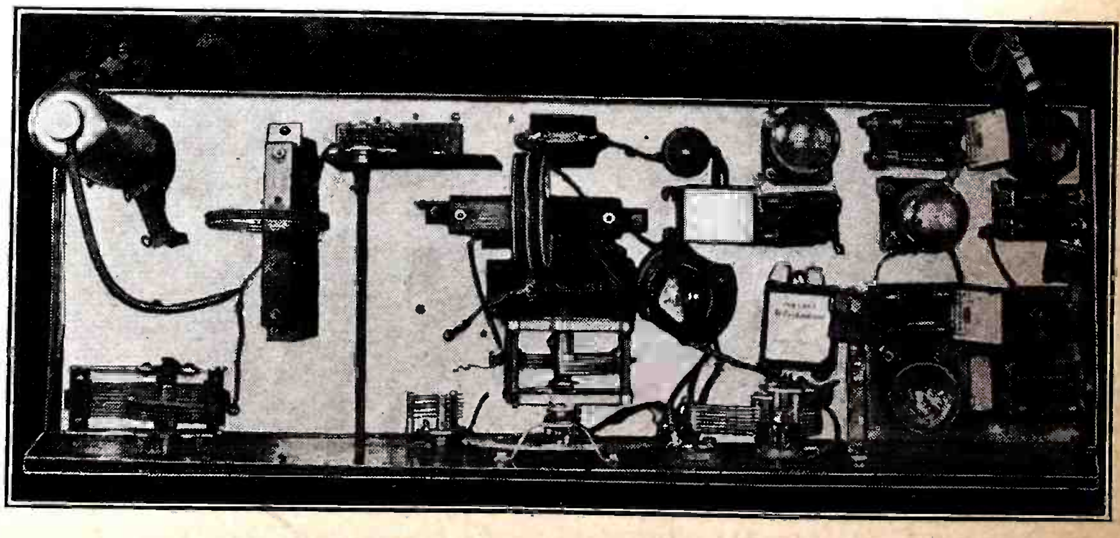
This short wave receiver was specially designed for the superior reception of Television signals and it employs five stages of resistance coupling; these stages being so designed as to pass a wide band of frequencies, essential for the reproduction of a clear television image. This receiver also makes an excellent voice amplifier.

AMONG broadcast receivers, the Rolls-Royce type of set has become fairly common in this day of single-dial control and straight-eight tuned radio-frequency. In the realm of short-wave outfits, however, the lowly three-tube flivver still holds sway. Few builders have mastered the intricacies of multi-stage radio-frequency amplification at the extremely high frequencies; and even the screen-grid tube, which holds out such alluring possibilities, has not been exploited to the extent that it deserves. Nevertheless most constructors undoubtedly long for a receiver of the Rolls-Royce class—for a set above the ordinary in sensitivity, with a reserve of power which may be opened up upon occasion—just as the flivver owner may yearn for the smooth powerful pull of a twin-six motor beneath the hood.

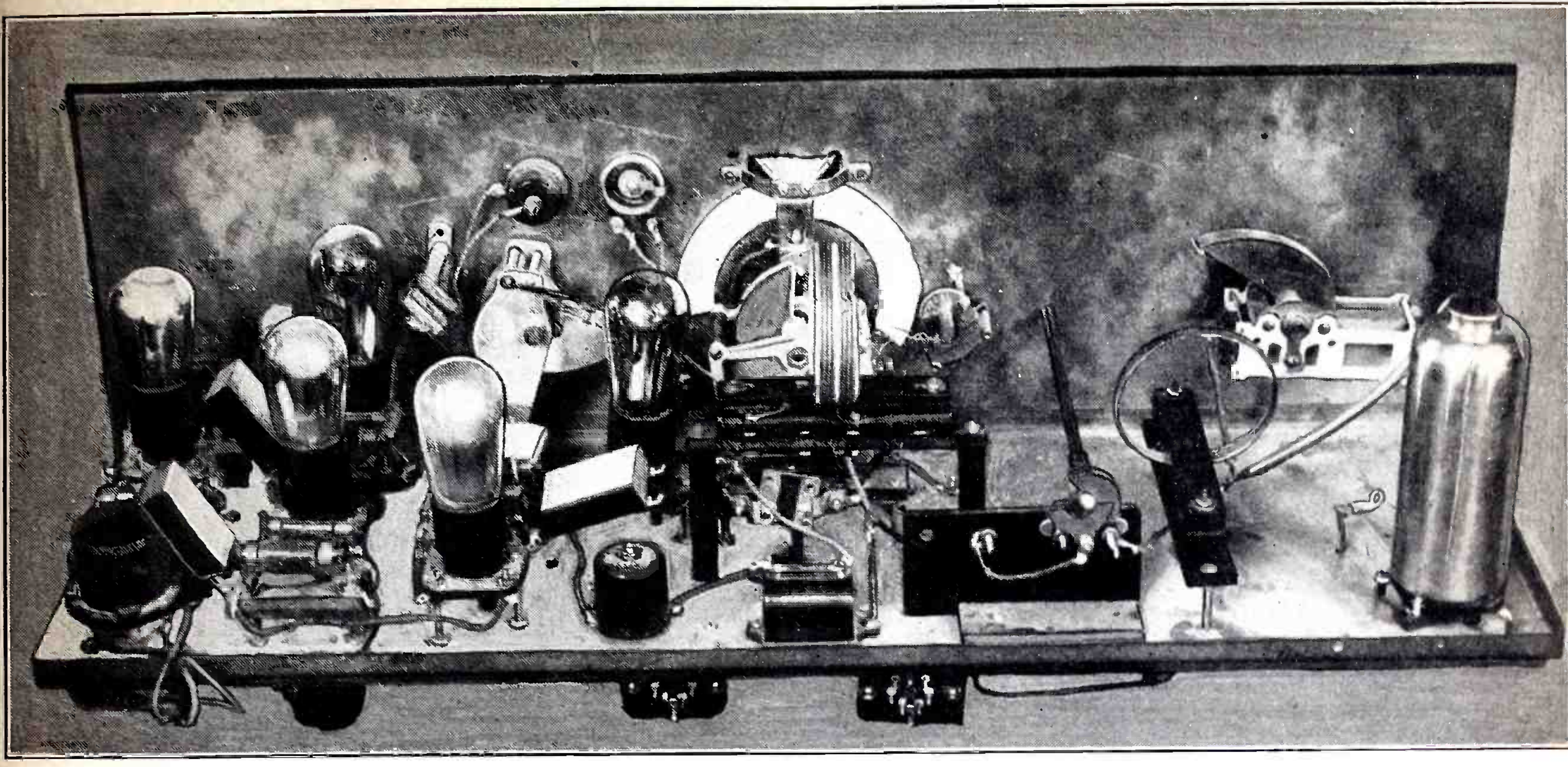
Such a receiver, designed and built by Gilbert C. Lee, a Los Angeles engineer, is the most successful *de luxe* short-wave set that has come under the writer's observation. It is the result of two years' experimentation toward a receiver which would not only yield performance on the short waves comparable with that attained by the best multi-tube broadcast receivers, but would also meet the requirements of television.

Seven tubes are employed; it was considered better to use a larger number of tubes than is common in short-wave receivers, rather than attempt to exact maximum performance out of a smaller number, all of which must be worked at all times to the limit. Especially in television is a large reserve of power desirable, because of the large momentary demands made upon the amplifier by scanning peaks. With each tube normally delivering a good deal less than its maximum output, a comfortable reserve of power is always available, and distortion from overloading is avoided.

Since the receiver was designed especially for use in television reception, particular attention was given to the peculiar requirements of visual signal transmission. The wide sideband that



Top view of "Rolls-Royce" short wave television and voice receiver.



Rear view of "Rolls-Royce" receiver, showing resistance coupled stages, short wave coils, condensers, etc.

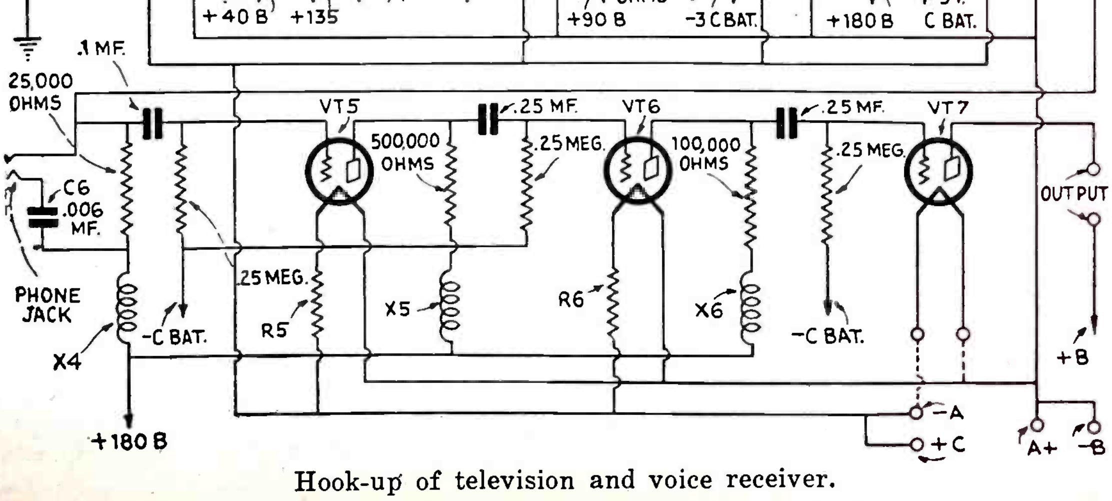
must be transmitted, if good detail is to be obtained, precluded the use of multi-stage cascaded radio-frequency, with the attendant number of tuned circuits. A single stage of high-gain amplification, followed by a detector of sufficient power-handling capacity, and a number of stages of resistance-coupled audio, was deemed the best combination. The temptation to secure single-dial control by gang-condenser tuning was resisted, because of the relatively large loss of efficiency at high frequencies which would be occasioned by a slight inaccuracy in tuning, and the danger of cutting sidebands, with the attendant loss of picture detail.

Coupling to the antenna is obtained through a small variable condenser which can be adjusted to fit the particular antenna, and left. With this condenser properly set, the tuning range is free from "holes," due to resonance at harmonics of the antenna circuit; at the same time, the tuning of the radio-frequency stage is broadened somewhat by the closer coupling of the antenna resistance into the tuned circuit, flattening to a certain extent the "hump" of the resonance peak. This load has also a slight stabilizing effect on the rather exuberant screen-grid tube, which yields the desired high gain of this stage.

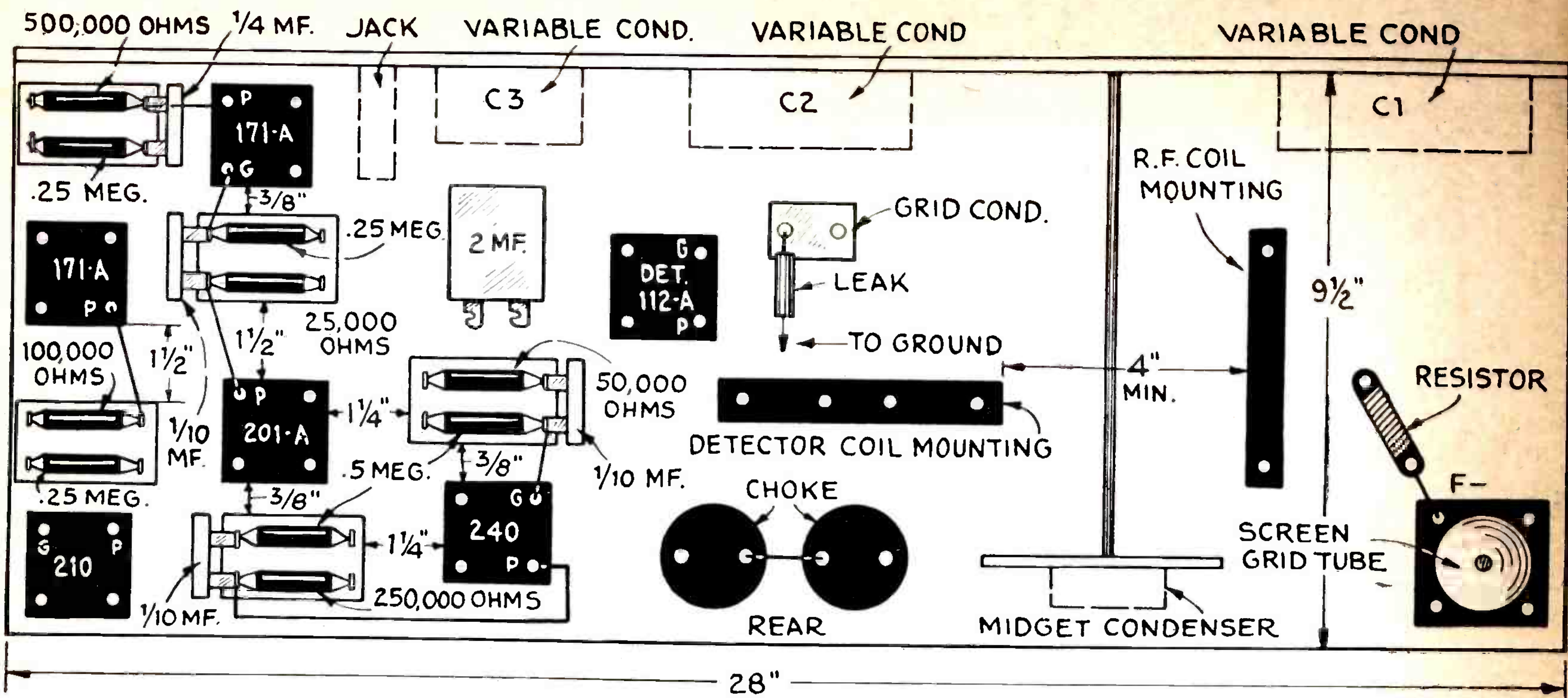
Flexibility of adaptation to various wavelength bands, as well as a favorable L/C ratio and a well-distributed tuning range, is secured by the use of plug-in inductances and small tuning condensers. The construction of R.F. transformers is vastly simplified, and performance improved, by feeding the output from the screen-grid stage directly into the grid of the detector, thus combining primary and secondary windings into one. Since the plate voltage is applied to the lower end of the common winding, the grid leak must be connected from the grid across to the filament, lest the high positive potential of the "B" battery reach the grid. The R.F. current in the grid coil finds a filament return through a 0.25-mf. condenser. The detector circuit thus requires only two windings—grid coil and tickler—which are mounted close together in fixed relation. A "throttle condenser" allows control of feedback, and a 500,000-ohm variable resistor is provided for adjustment of detector "B" voltage to suit the requirements of various frequency bands. On the lower waves a rather high voltage is allowed to reach the plate but, as the higher wavelengths are approached, more resistance can be cut in and smooth operation will be obtained with lower plate voltages. A type '12A tube is used as detector (VT2) and is followed in turn by a '40, an '01A, two '71A's, and a '10.

Five Resistance-Coupled A.F. Stages

In order to get the high signal output desirable for bright, clear pictures, a multi-stage audio amplifier was indicated. Because the television signal where much detail is transmitted consists of many grays and intermediate tones, producing a frequency band of components far above the customary 5,000-cycle range of musical reproduction, transformer amplification was out of the question. Impedance coupling also was regarded by Mr. Lee as less suitable, because at the higher frequencies the distributed capacity of the impedances by-passes much of the signal energy and produces marked



Hook-up of television and voice receiver.



Layout of parts in "Rolls-Royce" S-W receiver suitable for television or voice reception.

attenuation of the higher components essential to pleasing pictorial quality. Multi-stage transformer and impedance coupling in cascade are both difficult to handle, because of interaction between the relatively intense fields surrounding the windings.

Resistance coupling was therefore selected, not only because of the diminished trouble with inductive feed-back, but also because of the fact that the reactance of the coupling condenser, falling as it does with frequency, results in a rising frequency-characteristic peculiarly adapted to the needs of television.

Few experimenters have had the temerity to attempt to operate as many as five stages of audio frequency without either individual stage shielding or special layout with unusually wide separation of equipment. Mr. Lee has, however, succeeded in constructing such an amplifier with perfect freedom from oscillation and with no trouble as regards motor-boating or any of the other common ailments of resistance coupling. This result was attained only after much experimentation and careful checking *by listening in to each stage individually.* Stability of operation is assured, not only by careful design and layout, but also by working each tube at a level well below its maximum output. Coupling through the "B" supply is eliminated by a choke placed in series with each amplifier plate lead. Several engineers have built this set after Mr. Lee's specifications, and have been markedly successful when the layout for the stages was followed implicitly; however, deviation from the placement of parts in the amplifier has generally proved disastrous.

The recipe for success with this amplifier is not new; the secret is merely to have short leads, not parallel, and to keep well in the clear from conductors which may cause stray couplings. No interstage shielding has been found necessary. The panel is shielded by a sheet of copper and the sub-panel also is shelved with copper. All tube sockets, resistor mountings, condensers and wiring are kept clear of the shielding. The sockets and resistor mountings are placed on "stilts" 1½ inches high. It was found that when the apparatus was mounted directly on the sub-panel, the induced currents in the copper floor were sufficient to upset the whole amplifier and throw it into uncontrollable oscillation. A 1½-inch elevation of all parts eliminated this trouble.

In television, freedom from set noises is particularly important for a clean screen, since irregular pulses show up as spots flickering across the picture. For this reason, wire-wound resistors are used in the plate circuits of all resistance-coupled stages. The resistors are placed with the grid and plate ends of the mountings directly opposite the corresponding socket terminals; and the condensers are mounted on end, supported by their terminals, which are soldered directly to the mounting terminals. Thus the length of the leads is reduced to a minimum.

List of Parts

The parts required for the circuit are:

3 variable condensers: 2 tuning (C1, C2); 1 regeneration (C3). Values may be chosen by the constructor;
1 panel, 9 x 29 inches; 1 sub-panel, 9½ x 28 inches; and sheet copper to cover panel and sub-panel;
3 dials;
4 sub-panel brackets;
1 battery cable or cable terminal plug;
1 "midget" variable condenser (C4), capacity 50 mmf.; and 1 bakelite shaft extension to reach to panel;
Hammarlund space-wound tubing stock —at least 60 or 70 turns—and mountings to fit coils (see text below);
1 fixed condenser (C6), cap. .006-mf.;
1 fixed condenser (C5), cap. .00015-mf.;
1 6-megohm grid leak and pair of mounting clips;
1 25-ohm rheostat (R2);
1 series resistor (R1) for '22 tubes;
4 Amperites (R3 to R6 inclusive) to suit tubes used;
1 tube shield for screen-grid tube;
7 cushion sockets;
1 Clarostat (R8), 500,000 ohms;
1 phone jack for headphones (if desired);
Output jack or binding posts;
5 resistance-coupled stage mountings;
5 wire-wound resistors, values as follows: 25,000, 50,000, 100,000, 250,000, and 500,000 ohms;
5 grid resistors: two 0.5-megohm and three 0.25-megohm;
8 fixed condensers of reliable make and reasonably high working voltage: three 0.1-mf., three 0.25-mf., one 1.0-mf., and one 2.0-mf.;
3 1.5-mh. chokes (X1, X2, X4);
1 85-mh. choke (X3);
2 chokes, home-made (X5, X6; see text);
7 tubes: one '22 (VT), one '12 (VT2), one '40 (VT3), one '01A (VT4), two '71A (VT5, VT6), and one '10 (VT7).

Mounting and Wiring

In laying out the apparatus, the disposition of parts upon the panel is not particularly important, except that reasonable care should be exercised to keep as much separation as possible between parts about which there is likely to be a strong radio frequency field. The subpanel shield may be bent up around the edges to form a shelf, if desired. The bakelite base panel underlying the copper shield may be omitted if the shield has sufficient mechanical strength to support the load; however, the bakelite gives a much more rigid layout. All shielding is, of course, connected to ground, and much wiring can be saved by bearing in mind that the shielding is a common circuit between "A+," "B—" and one side of all tube filaments. It is very important to remember that the detector tuning condenser will be at "B+135"

(*Continued on page* 326)

The Short Wave Beginner

How to Gain DETECTOR SENSITIVITY

By MANDER BARNETT

Several important factors bearing on detector operation and sensitivity are discussed; also the cause and cure of "howling".

WITH due respect to all the other parts which go to make up the average short-wave receiver, it can truthfully be said that the detector tube and its component parts, are the most important parts of *any* short-wave receiver and should, therefore, receive first attention. We are all acquainted with the old "bloopers," and fully know that they relied solely upon the smooth working of the regenerative control and the general sensitivity of the detector tube for their reaching out powers. Well, it is practically the same even today, with the short-wave receiver. Ordinary broadcast receivers can use two or three stages of R. F. amplification and, with the modern screen-grid tubes, they get an extraordinarily high amount of amplification out of these pre-detector stages and, therefore, extreme sensitivity of the detector circuit and its component parts is not an essential.

The really modern short-wave receiver certainly employs a stage or two of R. F. amplification, but these stages cannot be made to amplify very much—nowheres near as much as if they were being used in an ordinary broadcast receiver—and therefore, we must again fall back on the detector tube to do practically all the work. Again, the short-wave receiver has to make use of a regeneration control—the average broadcast receiver has none—and, therefore, we have to set about making this control as easy and smooth working as possible:—not always quite so easy as it sounds.

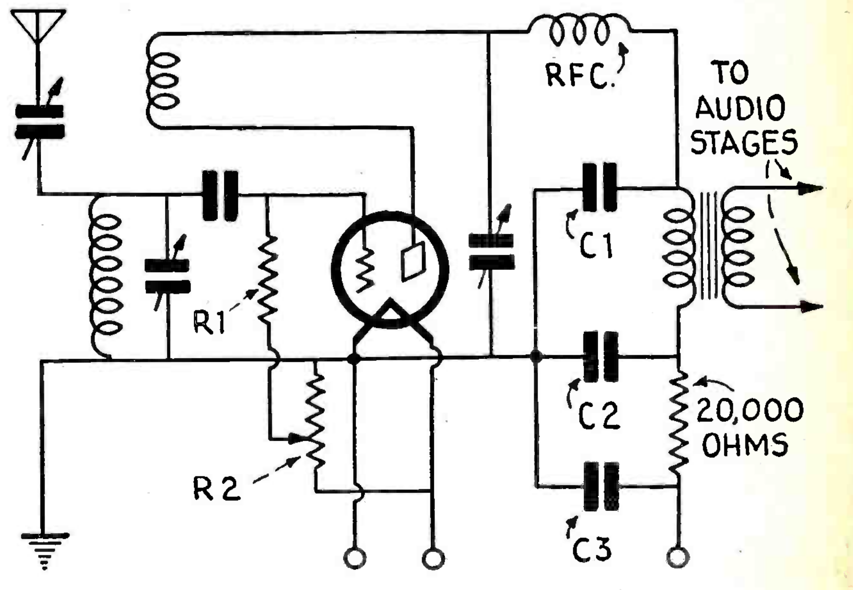
When somebody will design a short-wave R. F. amplifier with, say, three stages which will give as much amplification if they were being used on the ordinary broadcast band, then there will not be so much need to worry about extreme detector sensitivity as far as the short-waver is concerned. Nobody, however, seems to have done this yet, and we must devote our attention to the detector stage and spend much time and temper trying to make it perk.

At some time or other, practically every short-wave fan has met the receiver which stops oscillating at, say, 50 degrees on the regeneration dial (most modern short-wavers don't have the regeneration dial marked in degrees, but, for the sake of argument, we'll assume that they have) and then starts again at about 40. Well, it's absolutely hopeless trying to get China or Europe on a set that plays like that! So, if your own short-waver shows signs of this trouble, get down to it at once and see what can be done about it.

Grid Leak Value a Compromise

The commonest cause of trouble in this direction is the grid leak. Some short-wave fans prefer low resistance such as 2 megohms; while others always support the use of a much higher value, such as a 10 megohm leak. It is certainly true that the high value will practically always give you a smooth regeneration control; but, at the same time it results in a general loss of detector sensitivity and it will be found that the reproduction is not so clear-cut, because the higher notes of the musical range will be missing. The use of a 2 megohm leak cures this, but at the same time, very often introduces unstable regeneration effects. An excellent compromise between these two effects (or defects) is to use a low value (2 megs.) of grid-leak and, instead of connecting it directly to "A—" or "A+" (according to the type of detector used) connect it direct to the moving arm of a 200-ohm potentiometer R 2, the two remaining terminals of which are then connected across the "A" supply. The grid potential is then adjusted so as to coincide with the smoothest regeneration effects. The potentiometer may be of the baseboard-mounting type because, when the best adjustment has been found, it need not be altered very often. Thus, it does not mean an extra panel control, and the symmetrical appearance of the panel dials will not be upset.

A unique arrangement of by-pass condensers are used in this regenerative detector receiving circuit, which Mr. Barnett uses for short-wave reception in his English station. The detector circuit is the real heart of the short-wave receiver, and we recommend all short-wave enthusiasts to read very carefully what Mr. Barnett has to say.



Other Problems of Regeneration Control

Too many turns on the tickler coil will cause unsteady regeneration effects and "regeneration-tuning" also; *i. e.*, a small adjustment of the regeneration control will cause a large change in wavelength, and this effect is *not* wanted in short-wavers!

Too much "B" supply on the detector tube will also prove a ready culprit. In this case, the remedy is obvious, plus a consequent saving in battery costs.

"Threshold howling" is generally prevalent in receivers which use one or more audio stages, if certain points are not observed. Frequently this fault is produced in the audio stages themselves, but sometimes it can be caused solely in the detector stage. A receiver which suffers from this fault is not much use at all, as the howl generally only occurs near the point of oscillation, when the receiver is in its most sensitive condition. The usual cure for this fault is to connect a high resistance across the secondary of the first audio transformer; but sometimes this resistance has to be of a fairly low value before the howl stops and this, of course, cuts down volume.

"Threshold howling" occurs sometimes in the detector stage when the antenna is too tightly coupled. Always have the

(*Continued on page* 313)

The SHORT

By BERYL BAKER BRYANT

This "Junk Box" short wave receiver is a compact little job and well suited to the average experimenter's pocketbook. It utilizes one '22 screen grid tube and two '99 tubes; two "C" batteries supply the filament current.

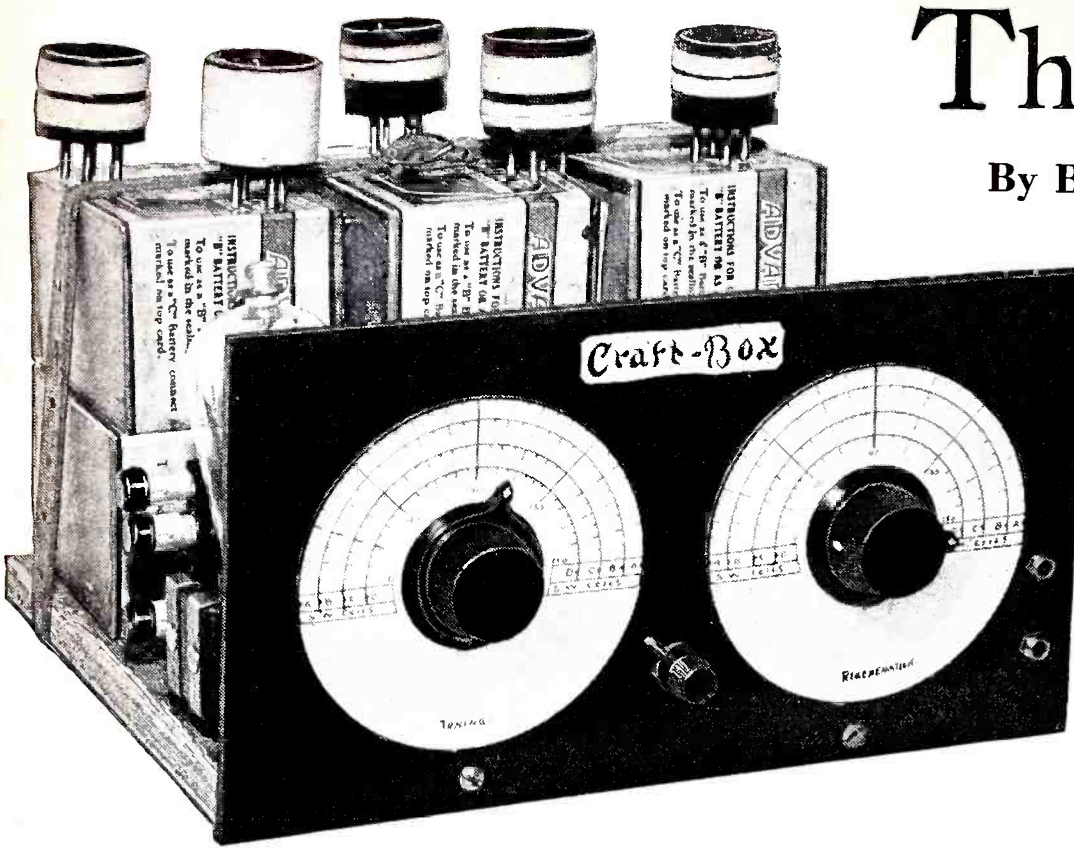


Fig. A. Front view of "The Short Wave Screen-Grid Craft Box." The dials were made for four coils, but five coils eventually were used; dial cut-outs for a five-coil job appear in these columns.

THE unusual development of radio over a brief span of time has left the "junk-box," or drawer, of many radio experimenters well filled with obsolete parts which can no longer be used with any degree of satisfaction in a modern broadcast receiver. These parts have become obsolete not because of their lack of efficiency, but because of the alteration of broadcast conditions.

The vogue of short-wave code and broadcast transmission offers a purpose wherefore the experimenter or short-wave enthusiast may resurrect many of the parts he had relegated to his own private junk heap. With care of design and construction a short-wave receiver may be fashioned that will equal the performance and appearance of apparatus constructed of specially-designed and costly parts.

Junk-Box Craft

With this purpose in mind the author set about to design and construct a real short-wave receiver. The old junk box was fished out of the closet and its contents dumped on the floor. (A word of advice, place papers on the floor first; as this will preserve peace of mind later.) After a few minutes spent in selection of parts that might be used, the following were chosen:

2 seven-plate midget variable condensers, 32-mmf. capacity, with knobs, *C*1, *C*2 (formerly used as compensating condensers in a broadcast receiver).
4 UX-type sockets. (Not necessary that they match.)
1 unmounted A. F. transformer, vintage of 1922. (Although any of recent manufacture might work better) (*TR*).
1 85-millihenry R. F. choke. (There was some doubt as to the probable efficiency but, in any event, it proved without "dead spots"; as regeneration was obtained over all the short-wave bands. The inductance need not be as great as that used, but may be as low as five or ten millihenrys.)
1 battery or filament switch (*S.W.*).
2 mica fixed condensers, .006-mf. (*C*4, *C*5).
1 mica fixed condenser, .0001-mf. (*C*6).
2 grid-leak mountings.
1 grid leak, 2-megohm (*R*1).
1 grid leak, 5- or 6-megohm (*R*4).
3 binding posts.
2 cord-tip jacks (*J*).
1 filament resistor, 15-ohm wire, tapped at 5 ohms to provide grid bias for the '22 R. F. tube (*R*2, *R*3).
1 resistor, 10-ohm wire, for the '99 filaments (*R*5).
5 old tube bases, to be used for coils.
No. 28 D.C.C. magnet wire, ¼ pound, to be used for coils.
1 wooden baseboard, 10 inches long, 9 inches wide, and ½-inch thick.
1 hard-rubber (or bakelite) panel, 10

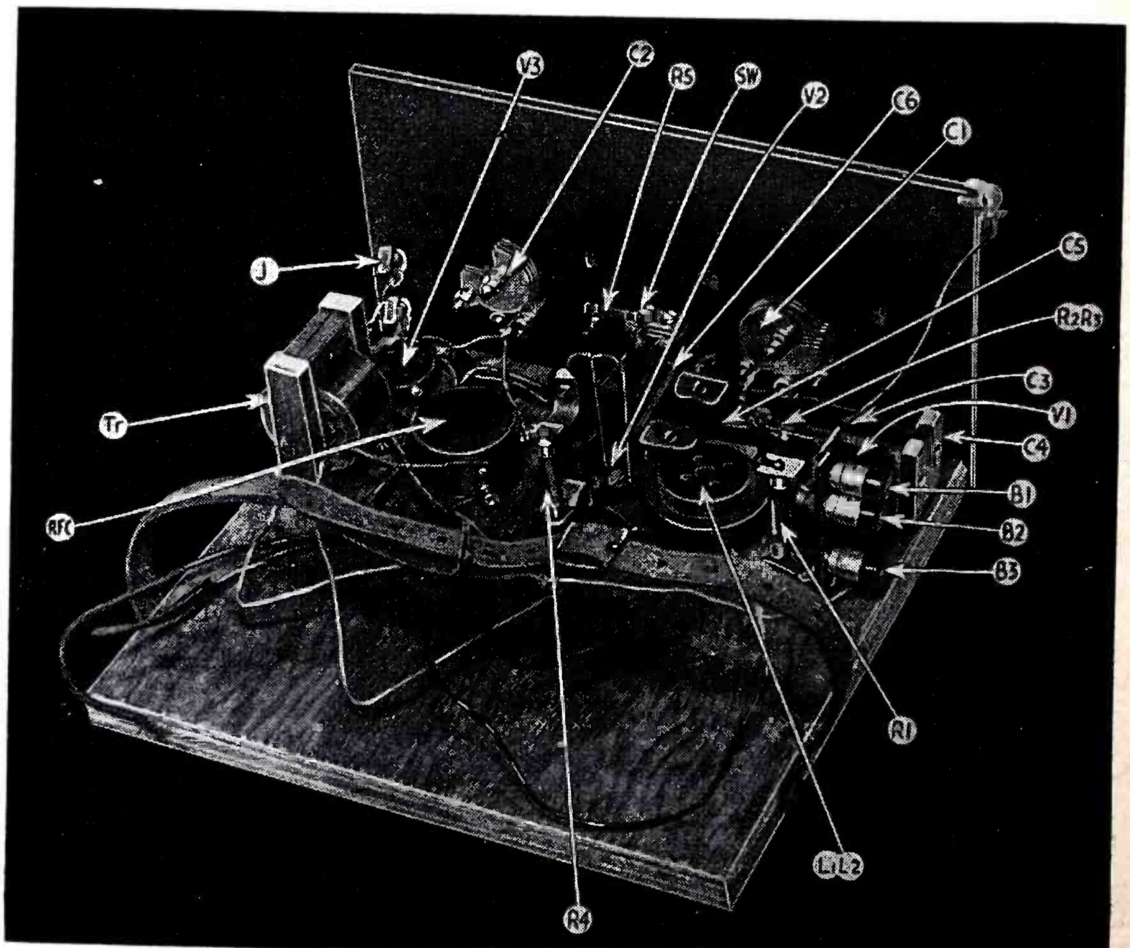


Fig. B. Rear view of the "Craft Box." All the parts, few in number, are easily seen. What parts would YOU use?

WAVE SCREEN GRID CRAFT BOX

inches long, 7 inches wide by 3/16-inch thick.

1 '22 screen-grid tube (*V*1).
2 '99 tubes (*V*2, *V*3).
5 small "B" batteries, 22½-volt portable.
2 "C" batteries, 4½-volt, for filament supply.
Hook-up wire, wood screws and other necessary hardware.

After the parts have been selected the constructor should carefully clean, inspect and tighten all parts as well as test the various parts for shorts or open circuits. Denatured alcohol and ether mixed in equal parts will remove dirt, oil or grease, when applied judiciously with a small, stiff bristle brush. If the parts are not thus inspected and cleaned before assembling into the complete receiver, trouble is apt to appear.

The Short-Wave Circuit

Inspection of the circuit diagram will show the circuit used for this short-wave receiver to be the same old standby—a single circuit regenerative detector preceded by a screen-grid R. F. stage, and followed by a conventional transformer-coupled A. F. stage. In regard to the latter, it was not deemed necessary to use two stages of A. F., as phones would be employed, and for this purpose sufficient volume would be obtained with one. The grid circuit of the R. F. stage is untuned, having a 2-megohm grid leak (*R*1) connected from the control grid cap to the bias tap on the series filament resistor (*R*2-*R*3); the grid leak serves only as a means of blocking the R. F. from the ground circuit, forcing the signal to be impressed on the control grid, while providing a means of applying the 1½-volt "C" bias to the control grid. (Otherwise, a negative charge would accumulate on the control grid, causing the tube to block.) The antenna may be coupled direct or through a small semi-variable homemade condenser (*C*3), to the control grid of the R. F. tube; the choice will depend upon the antenna used.

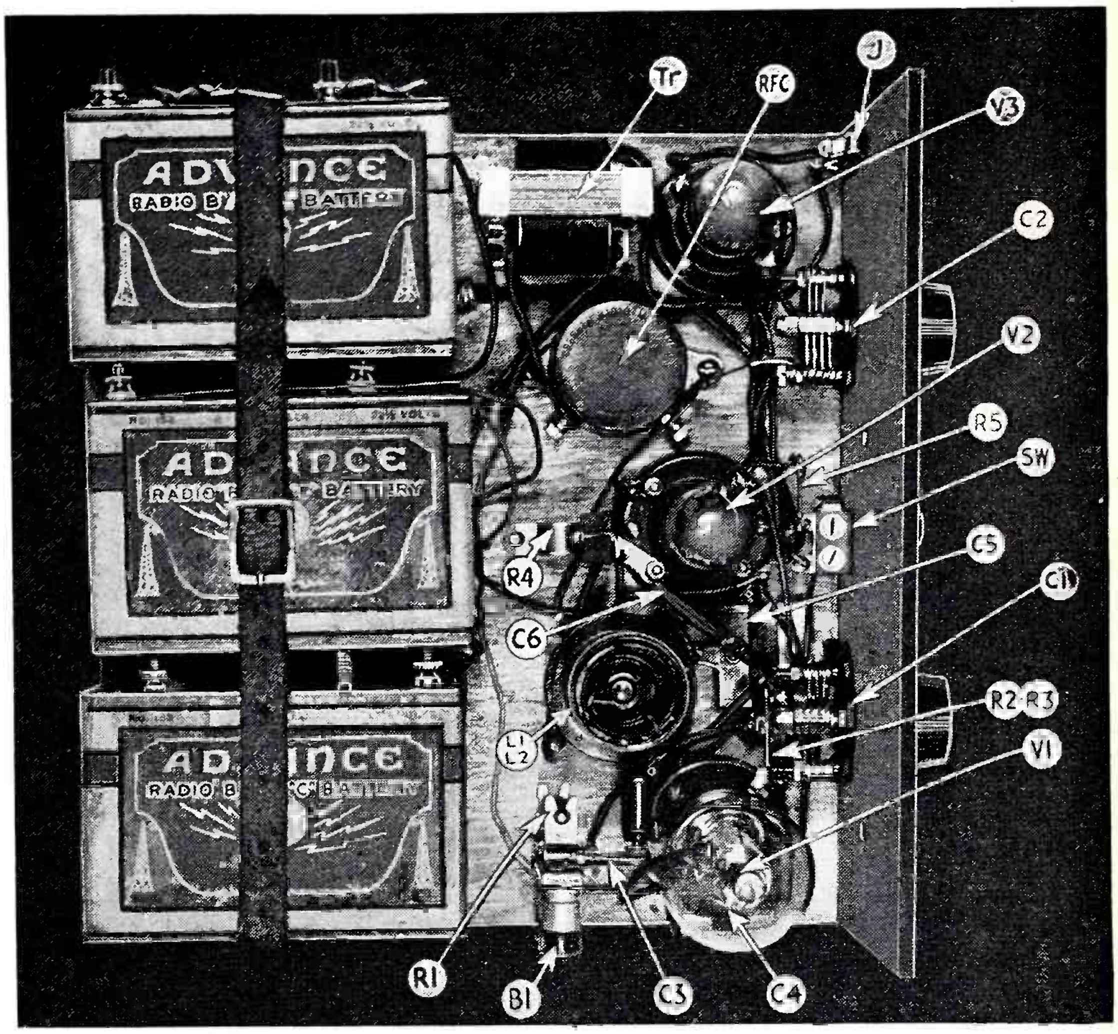


Fig. C. Batteries in place; all leads connected; tubes in their places; with the aerial and ground attached, we are "rarin' to go," whither our old "Craft Box" will take us.

Construction of Coils

The short-wave coils are of the plug-in type; five are used to cover the band from 25 to 100 meters. They are constructed from old tube bases; five of

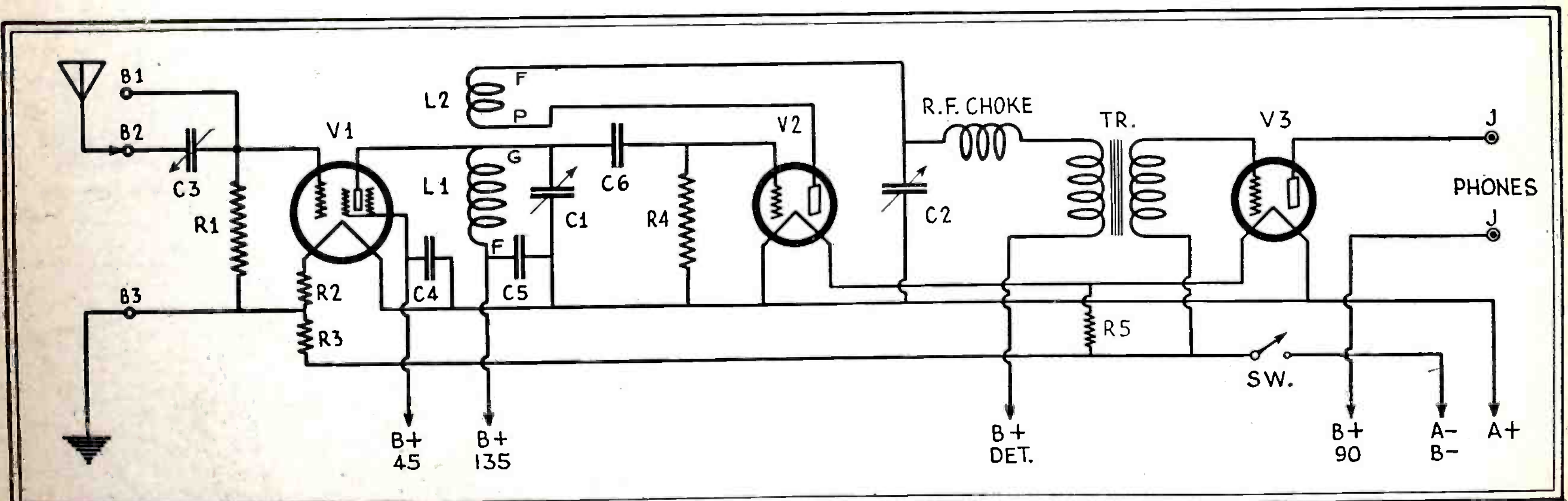


Fig. 1. Schematic circuit to be followed by those who want to dig into their junk box and ride the short waves via the "Craft Box." As 90% of construction is getting started, "it's up to you"; we have eliminated all the mechanical difficulties.

the UX type as listed above. There are two types of tube bases, the short and the long; if possible, the long should be obtained (especially for the "E" coil) as otherwise it will be difficult to accommodate the required turns on the base. If it should prove impossible to obtain the long type, thin cardboard may be wrapped and cemented around the short base to give the required winding space. Follow the winding specifications:

Coil A: Grid winding, 7 turns; tickler winding, 7 turns; shortest band, approximately 18 to 25 meters.

Coil B: Grid winding, 10 turns; tickler winding, 10 turns; tuning range, approximately 25 to 35 meters.

Coil C: Grid winding, 15 turns; tickler winding, 14 turns; tuning range, approximately 35 to 45 meters.

is readily determined approximately as 48½ turns of No. 28 D.C.C. wire may be wound in one inch of space.

To start the grid winding, the end of the wire is passed through the hole drilled at the top of the base, then passed down through the *grid* prong and soldered. The proper number of turns is wound, breaking the wire but leaving about six inches free. The insulation is removed to within ½-inch of the point where the wire enters the hole; the wire is passed through the hole and down through the filament prong on the same side as the grid prong. Start the tickler winding ⅛-inch from the end of the secondary; the wire is again passed through the hole and soldered to the remaining filament prong and the proper turns are wound. Remove the insulation as before and pass the wire through the lower hole, through the plate prong, and solder.

The tickler of the "D" coil is wound double-layer. The tickler for the "E" coil is wound on a small length of cardboard tubing which is placed inside the secondary form. Care should be taken that the beginning of the tickler winding is connected to the filament prong on the side of the plate prong.

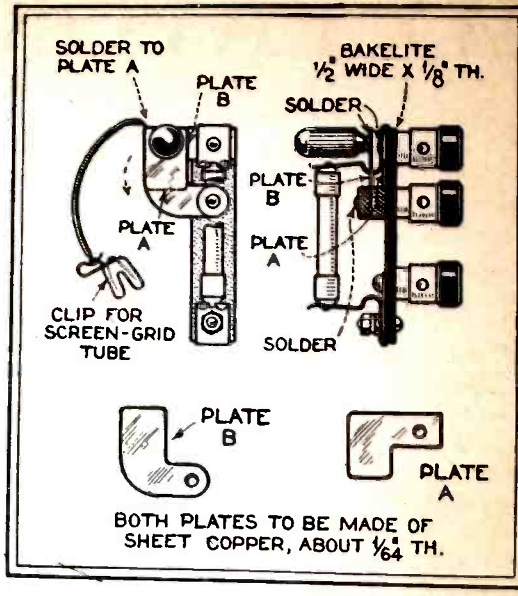
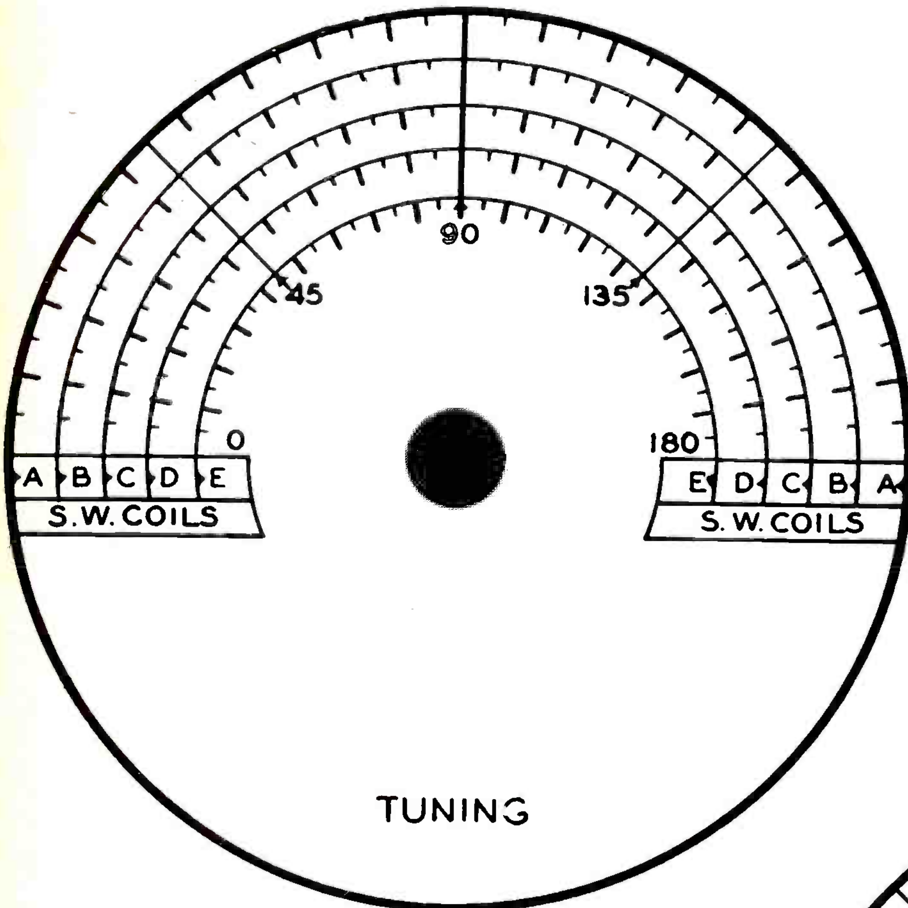


Fig. 2. Detail of the binding post plate in conjunction with which is the antenna variable series capacity.



Dial for the "Craft Box." Copy, cut out and paste on panel. "Regeneration" dial appears below. A red ink dot on the right line and stations are quickly re-tuned in.

Parts Assembly

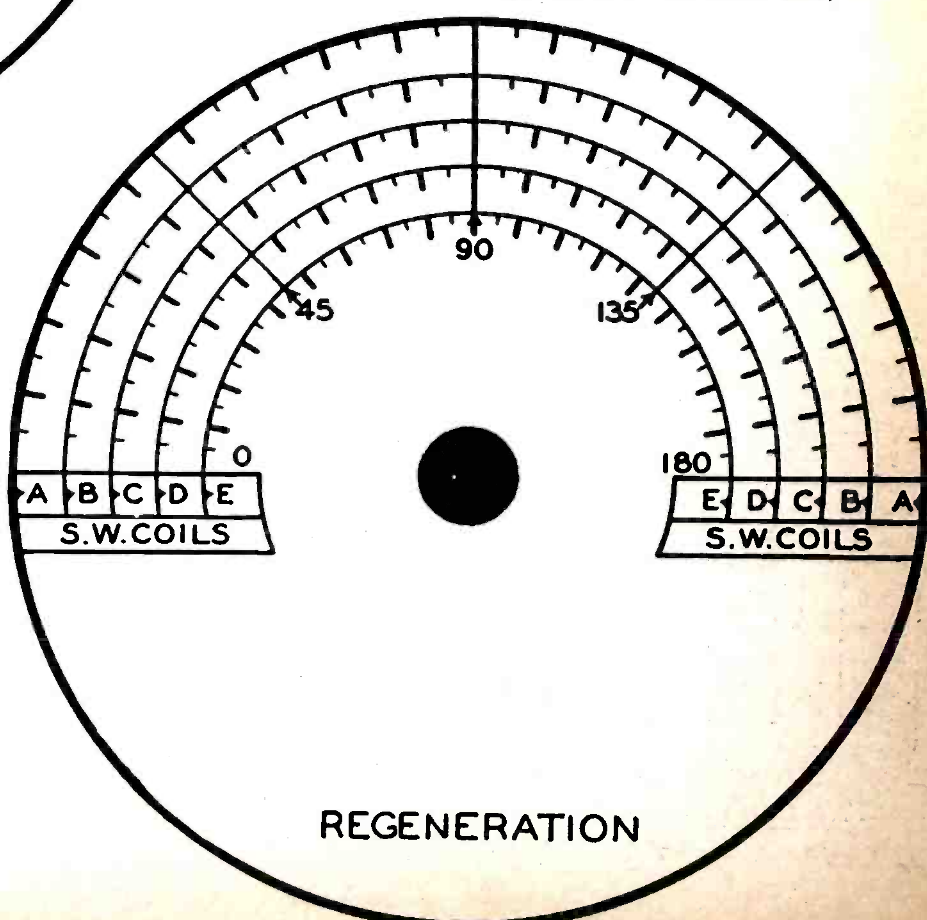
The hard-rubber or bakelite panel is first drilled for the mounting of the two midget variable condensers, the filament switch and the two cord-tip jacks. Two holes are also drilled near the lower edge for fastening the panel to the baseboard, which may be done at this time.

(*Continued on page* 331)

Coil D: Grid winding, 20 turns; tickler winding, 18 turns; tuning range, approximately 45 to 65 meters.

Coil E: Grid winding, 50 turns; tickler winding, 50 turns on a cardboard tube fitted inside the secondary winding; tuning range, approximately 63 to 100 meters.

The cement and glass are removed from the tube bases. (This may be done very easily with a sharp penknife.) Starting about 1/16-inch from the top edge of the form the grid winding ($L1$) is started and wound for the required number of turns; ⅛-inch space separates it from the tickler winding ($L2$). It is a good plan to prepare the bases before winding by drilling the holes to anchor the winding ends, which are also to be soldered to the prongs. The solder and wires should previously be removed from the prongs by the application of a soldering iron and a sharp knock. The distance at which the holes should be drilled



This is the design for the second dial of "The Craft Box." Trace, cut around outside edge and then paste the dial so made on the receiver panel. "Tuning" dial appears above.

MY FAVORITE AUDIO AMPLIFIER

By MANDER BARNETT

AN audio amplifier must, if it is to be used with a short-wave tuner. possess as many as possible of the following features: A really high step-up gain and positively no audio fringe howl; it should be as compact as possible, and should have a really flat amplification curve over the whole audio frequencies. In my favorite audio amplifier, which is used in conjunction with a regenerative detector, an attempt has been made to make it conform to the above ideals as closely as possible. The circuit diagram is shown in Fig. 1. The amplifier itself, of course, comprises only V2 and V3, but, because the first audio tube is resistance-capacitively coupled, a screen-grid detector is used, as shown by V1.

By analyzing the above features set out for our ideal audio amplifier of a short-wave receiver we find that this amplifier has a relatively high gain, considering the small number of tubes used. V1 with the resistance-capacity coupling units R1-C2 and R3 produces a high gain—higher than that obtained with an ordinary tube as detector, of course—and a high-ratio transformer (7:1) can be used between V2 and V3 without detrimental effects on quality. The step-up gain, then, is possibly higher than it would have been if two transformer stages had been used, and the quality is better.

Battery coupling in an audio amplifier can be very annoying and cause motor-boating, as well as fringe-howl effects. So that battery coupling shall not take place between the detector and the audio amplifiers, the detector plate supply is de-coupled from the rest of the circuit by means of R2 and C1. R2 has a value of about 20,000 ohms, and C1 about 2 mf.

The plate resistance R1 is about 80,000 ohms or higher, but if a higher value is used it must not be forgotten that R2 is also in series with it, and this smooth over noisy batteries and also keeps R.F. currents out of the batteries; it has a value of 2 mf. C4 keeps R.F. currents out of the output leads; its value is .001-mf. A larger condenser would tend to cut off the higher audio notes.

The tubes, of course, are all battery

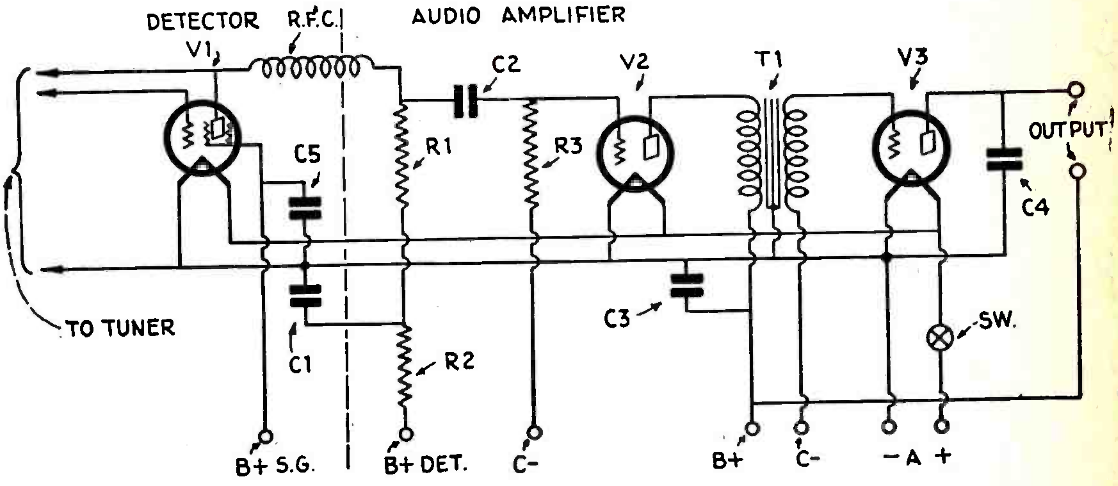


Diagram above shows Mr. Barnett's favorite audio amplifier hook-up for use in short-wave reception. Note that resistance coupling is used in the first audio stage to prevent "fringe howl".

will help to lower the plate voltage so that a higher plate potential than usual will be necessary.

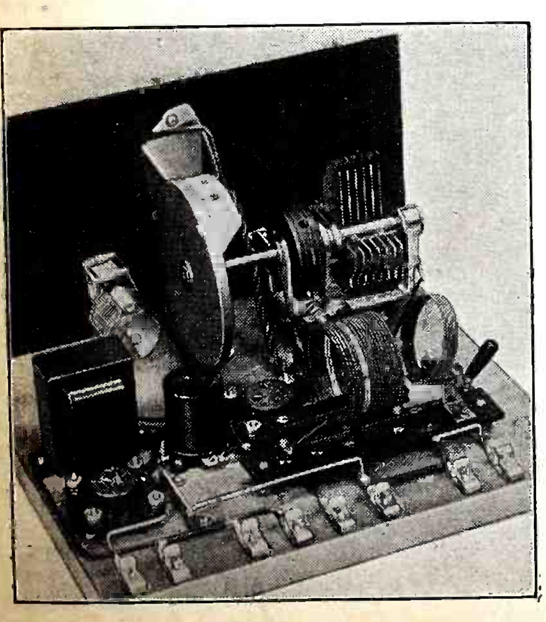
RFC, of course, is an ordinary short-wave R.F. choke. C2 has a value of .004-mf., which is not too large and not too small to pass audio currents. R3 is about 0.5-megohm, but the resistance is not very important and a 2-megohm leak will do, if one is on hand. C3 helps to tubes, V1 being a screen-grid tube, V2 a general-purpose tube, and V3 a small power tube. This amplifier is, of course, built in a metal case along with the tuner.

In practice it will be found that this amplifier actually does fill most of the ideals set out and is certainly a very useful audio channel for use with any type of short-wave tuner.

New Hammarlund S-W Receiver

By LEWIS W. MARTIN

Where in broadcasting, elaborate transmitters and receivers must be used for best results, in short-wave work, ultra simplicity reigns. No banks of tubes, selector systems, multiple amplification methods, need be used. And by simplicity, we not only mean few tubes, but only a major tuning control. Especially is this true with the advent of the new two volt, 230 type tubes. Thus simplicity and efficiency is merged with economy of operation, for only a pair of dry cells are needed.

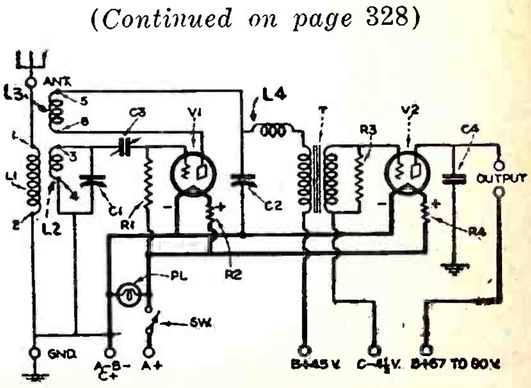


"The Hawk" S-W receiver.

In the detector circuit, L^1 is a variable primary, affording maximum transference of energy throughout the entire spectrum. Tuning the secondary L^2 is a .000125 mfd. variable condenser of special design. This condenser uses non-corrosive Midline shaped, brass plates 1/32" thick, which are double spaced. With a full floating rotor mounted in adjustable cone bearings, positive and permanent capacities, and absence of any plate vibration, are assured. A specially developed insulation "Parmica" which most closely approximates the efficiency of dry air, is used as the insulation medium in this condenser, accordingly reducing the dielectric losses to less than 10% of the ordinary short wave tuning condenser. Further a constant impedance, double wiping contact eliminates all objectionable inductive reactance of the conventional pigtail.

As will be noted, the detector is a regenerative one, using the condenser parallel feed method, the most effective sys-

(*Continued on page* 328)



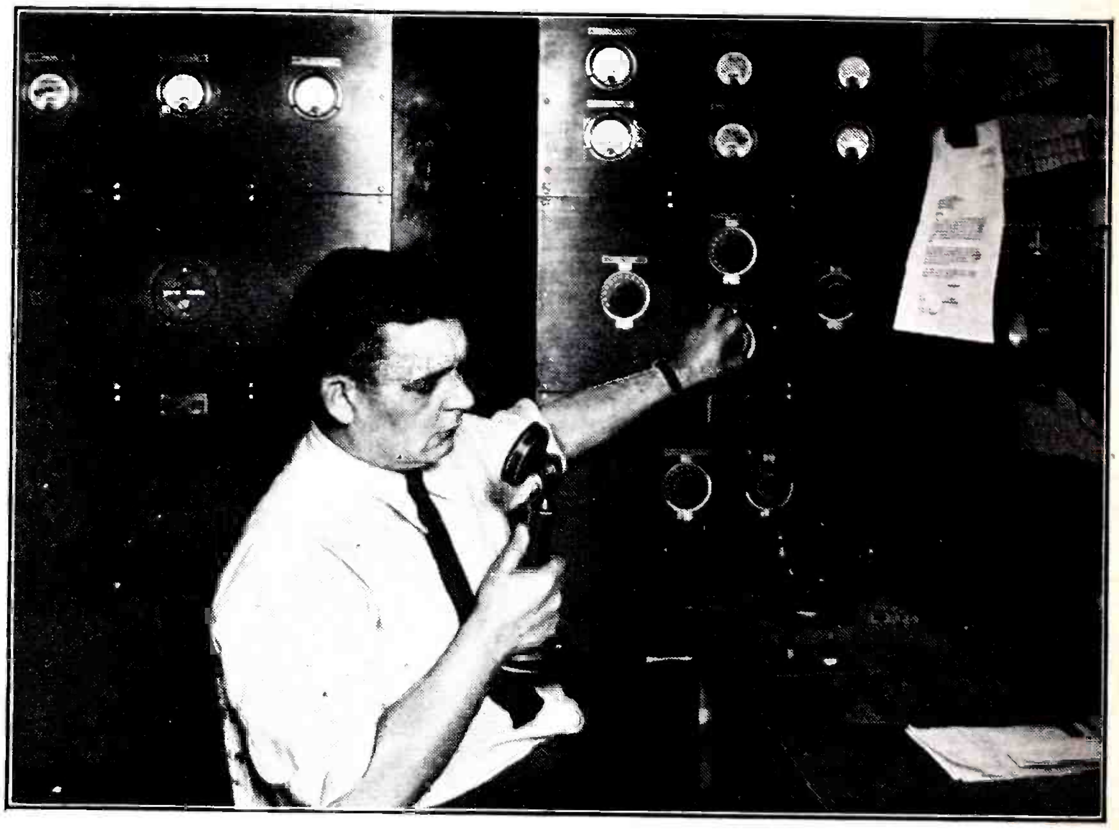
Hook-up of "The Hawk" S-W receiver.

Two Los Angeles officers of the law ready for business—note the loud speaker mounted on the wind shield and which connects with a short-wave receiver.

SHORT

Short waves have proven a godsend in many large cities where police officials are using them for broadcasting alarms. Short-wave receivers are fitted into automobiles, police launches, and other craft in many cases also carry short-wave equipment.

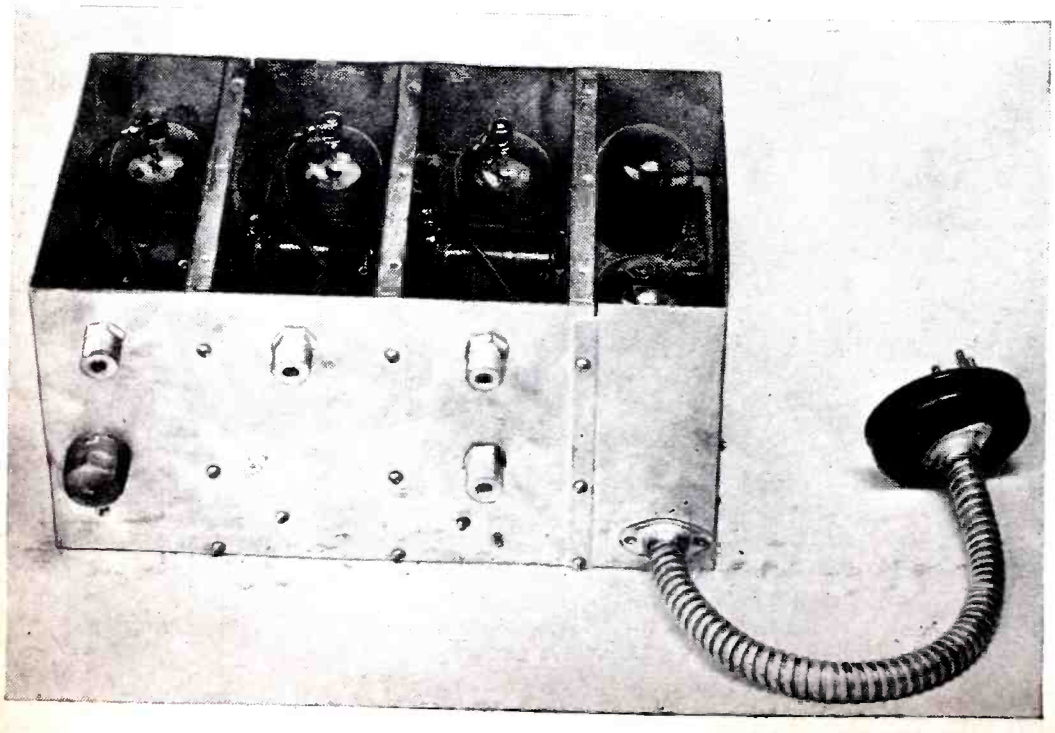
SHORT WAVES are rapidly coming to the front in police work. They are very useful for broadcasting alarms, either general or special, the reports being picked up easily by short-wave receivers installed on automobiles carrying "cruising" patrols, fire and police boats, etc. Eventually the officer on beat or traffic duty will pick up important alarms by means of a small short-wave receiver carried on his person, or perhaps installed at convenient spots where he is likely to notice a visual signal for attention or else hear it. Important alarms could be indicated by a special signal which would command instant attention by all policemen, wherever seen or heard. A traffic officer might be very busy but if he heard the "Attention" code signal, denoting a special alarm being broadcast, he would concentrate on the message.



Sending out an alarm from a short-wave transmitter at Los Angeles police headquarters.

General Installation Features

The first thing to decide when making a police radio installation is the type of aerial to be used. The following instructions are given by the makers of the Delco police radio apparatus:

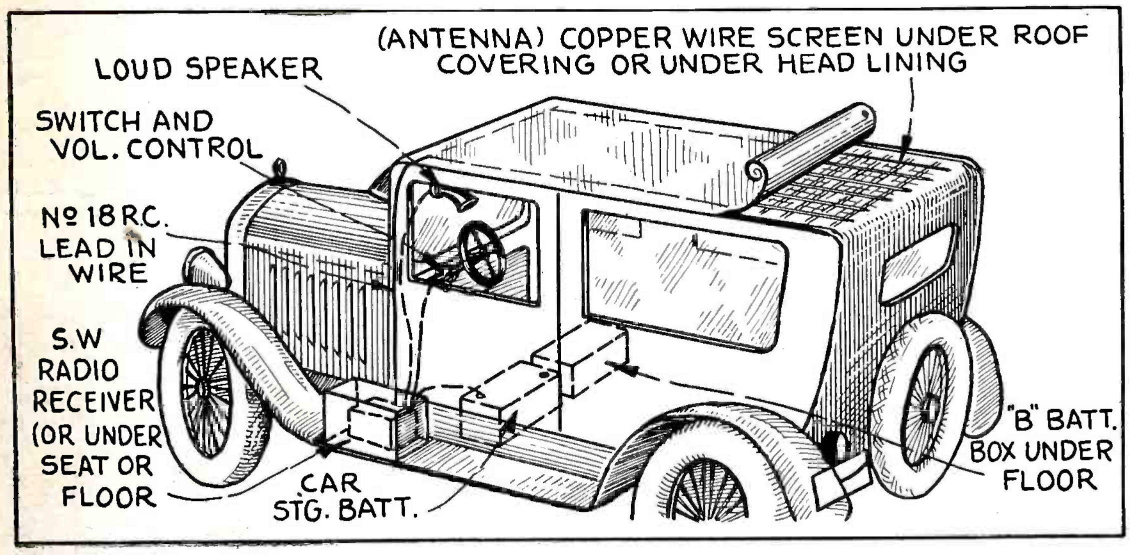


The Delco short-wave police radio receiving set which is fitted in a con- ← venient location on an automobile.

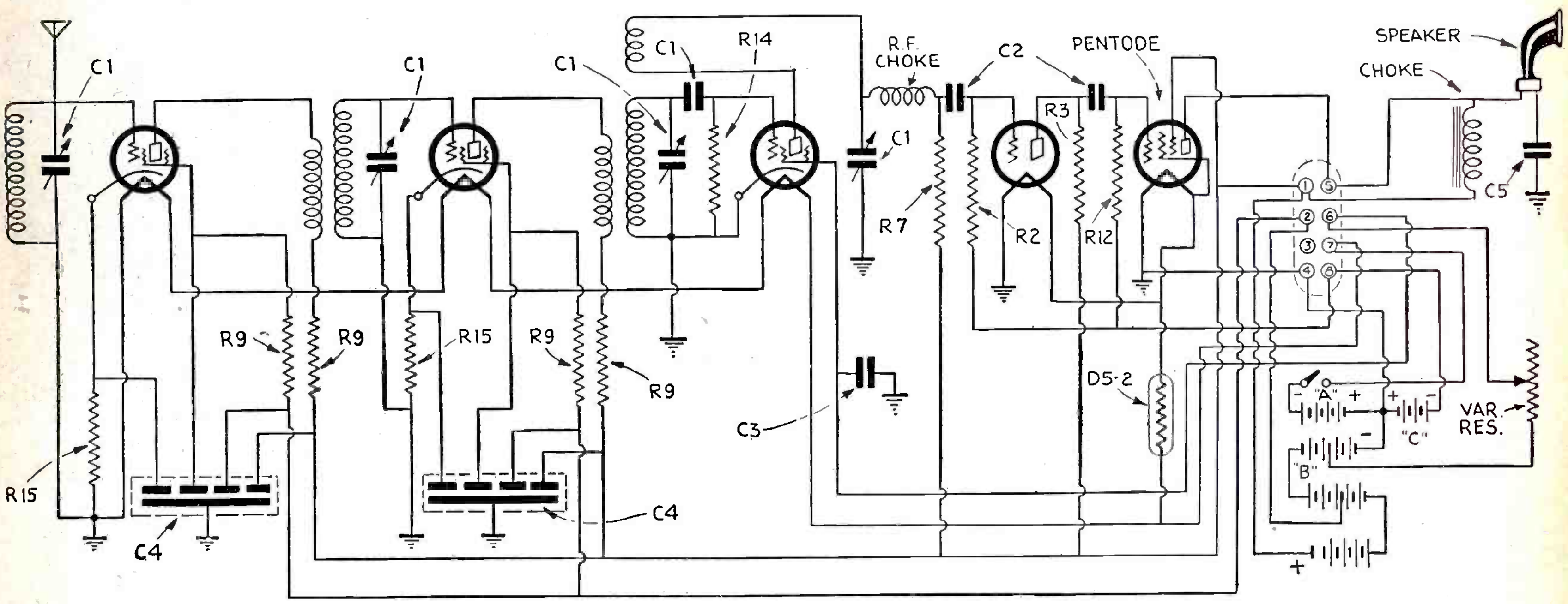
Closed Car Aerial—To install an aerial on a closed car, the headlining must be removed so that the aerial screen wire can be fastened under the bows. Use copper screen wire and keep six inches from the metal of the car. Solder a cross wire to the screen at the point where the lead-in is attached.

In car tops where wire netting is used as part of the construction, the netting should be connected to a cross wire, soldering each wire to the cross wire. Make sure that the netting is *not grounded.* This may be determined by connecting a lead to the wire netting and touching it to the battery side of the ammeter; if no spark occurs the wire

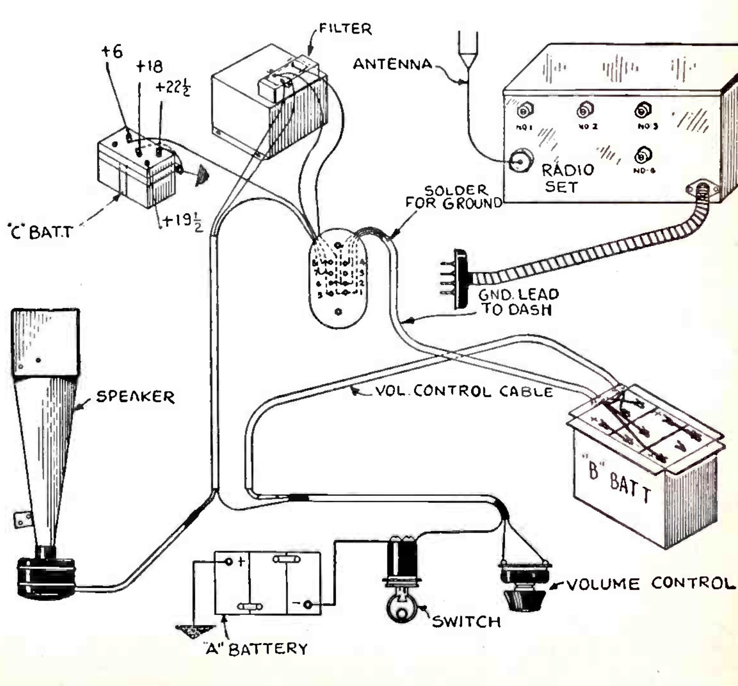
WAVES TRAIL the CRIMINAL TO HIS LAIR



←Arrangement of short-wave receiver and antenna on police automobile.



Above: Hook-up for Delco short-wave police receiver, which uses a Pentode tube in the last amplifier stage. Values of Resistors: R2—1 meg.; R3—250,000 ohms.; R7—500,000 ohms.; R9—10,000 ohms; R12—2 megs.; R14—5 megs.; R15—400 ohms. Condensers: C1—.0001 m.f.; C2—.002 m.f.; C3—.25 m.f.; C4—four .25 m.f.; C5—1.0 m.f.



is not grounded and is suitable for use as an aerial. If it is grounded, the top deck must be removed and the wire investigated to determine the point at which it touches the metal of the car.

In cases where the netting wire construction is used, it *must* be used as the aerial. Never attempt installation of a different type of aerial.

Open Car Aerial—Use copper screening, placing it over the bows and under the top deck. Fasten the front end to the front cross bow and the rear end to the rear bow. Solder a cross wire to the screen at the point where the lead-in is attached.

Lead-in Wire—Use rubber covered insulated No. 18 wire for lead-in. Connect the lead-in to the aerial at a point nearest the location of the aerial terminal on the radio set. The wire should be just long enough to reach the set and should be kept as far away as possible from other wires.

Radio Set—The set may be installed in almost any location on the car, depending upon the design. A very efficient installation is made by mounting the set on the running board, in which case a special waterproof case is furnished with the set. The switch and volume control are mounted on a special panel which is fastened to the steering column.

Install a spark plug resistor in series with each spark plug and a coil resistor in series with the high tension coil lead.

A condenser is used to eliminate spark interference, and should be fastened under the generator cutout relay bracket screw The lead on the generator condenser should be fastened to the main brush relay terminal. Tubes: 3—224's; 1—112A and 1 Pentode.

AMONG THE "HAMS"

Station W3CDQ Operated by Miss Elizabeth M. Zandonini

Miss Zandonini's transmitter is a 50-watt Hartley, with mercury arc rectifier; receiver employs detector and 2 stages of A.F.

Miss Elizabeth M. Zandonini, 3320 19th St., N. W., Washington, D. C., operates this very business-like looking station, licensed under the call letters W3CDQ. This station is heard in all corners of the world.

YOUNG HAMS, NOTE

Editor, SHORT WAVE CRAFT:

I have received the following stations on the "Composite Short-Wave Receiver" (described in the February issue of *Radiocraft*): Winnipeg, Canada, is back upon their old wave of 25.60 meters and their call is CJRX. PHI, Huizen, Holland, comes in here with good volume. A new station in New Jersey is W2XAM, New Brunswick, on a wavelength of 35 meters and also heard around 46 meters, testing with Montreal on Tuesdays and Fridays. W6XN is on 23.34 meters, or 12,850 kc., on Tuesday and Friday from 8 P. M. to 2 A. M. W3XAL, Bound Brook, New Jersey, puts over a terrific signal. G5SW doesn't seem so loud lately for some unknown reason. Monday, April 7th, I had G2IV of the S.S. *Majestic;* they were calling G2IR. They are also on during the evenings, around 66 meters. W2XAM is also heard testing around 4 and 5 o'clock in the evening with VE9AP of Drummondville, Canada, who is on around 23 meters. On Sunday, April 2nd, I picked CGA of the Canadian Marconi Company at Drummondville, Quebec, Canada, on 16.501 meters, and also VZA on 23.7 meters at 11 P. M. Their 16.50-meter transmitter shut off at this time. The two were giving music and news reports to GBK at Bridgewater, England, and GLDJ of the *Homeric* on the route from Southampton to New York. They continued until noon.

I trust this will help other fans. I would like to correspond with any short-wave fan of my age (15) or older.

RALPH WYMER,
1438 Chester Street,
Toledo, Ohio.

(Here is a typical letter from a young ham. This is the kind of a letter the editor likes to receive and we can't get too many of them. It is the kind of information that is needed to keep other readers posted. How about it, hams? Send in your letters!—Editor.)

FROM PORTO RICO

Editor, SHORT WAVE CRAFT:

Your previous activities as an editor in the radio field were a success. I refer of course to your writings. I venture to predict that SHORT WAVE CRAFT under your leadership will be just that, this time also. A magazine devoted entirely to short waves was greatly needed in the whole world. The lack of extensive information on this field, especially for the lay public, not only for the amateur, or the veteran enthusiast, to be found in an exclusive magazine, was plain. Therefore, your sentence in the last paragraph of your editorial "The Short Wave Radio Field," in Vol. 1, No. 1, page 5, in your June-July number, "I pledge my word that . . . SHORT WAVE CRAFT will contain 100 per cent short wave material—nothing else," is a good policy.

The first number is splendid. I congratulate you for this achievement. If the U. S. is leading the world as a broadcaster (for local consumption) I do not see a good reason why it should not lead, too, in short wave broadcasting, if we have the three things needed for the attainment: the engineer, the laboratory, and the money. Short waves belong to the world, and the nation that is prepared in the future to penetrate the homes of the neighbors (and the five continents will be neighbors) with short wave broadcasting, will lead in the selling of all necessities in the foreign commerce.

R. DEL VALLE SARRAGA,
Vice-President, Radio Club,
P. O. Box 935,
San Juan, Porto Rico, W. I.

(As our correspondent states, short waves belong to the world, and these are exactly our feelings. We aim to cover the entire short wave field from every angle. If our correspondent keeps on reading SHORT WAVE CRAFT *he will find that all of his desires, as far as his short wave inclinations are concerned, will be fulfilled.—Editor.)*

FROM AN OLD TIMER

Editor, SHORT WAVE CRAFT:

Congratulations and sincerest wishes for the success of your latest new magazine, SHORT WAVE CRAFT.

The writer has been a charter subscriber to each and every new magazine you brought out from *Modern Electrics* since

1908 and each new magazine has been outstanding in its field and much enjoyed.

May I suggest a subject that I would like to read about in the next issue, namely, some experimental information, medical data, and suggestions on "Ultra Short Waves from the medical point of view."

The General Electric Company and many of the college and medical research laboratories are carrying on studies in this field, and if only some inkling of this data written from the experimenter's point of view could be presented, who knows but what it may lead to another amateur's triumph such as the present short wave success in telephony and telegraphy.

HARRY W. KRUG,
873½ Dewey Ave.,
Rochester, N. Y.

(Here is a real old-timer who has been in the game since the coherer and spark gap days, and he may be presumed to know his stuff. It is a pleasure to hear from our old friends. Incidentally, Mr. Krug's request has already been fulfilled. We are going to have more to say about "Ultra Short Waves from the medical point of view." A tremendous amount of this kind of work is now being done in Germany and we are getting a good supply of articles right along.—Editor.)

MORE HAM STUFF

Editor, SHORT WAVE CRAFT:

I want to offer you my heartiest congratulations for starting such a wonderful radio magazine as SHORT WAVE CRAFT is. It is the *best short-wave magazine* ever published, in my opinion. I have a few suggestions to offer. Why not have the section "Among the Hams" enlarged to a full page or even more? Very few magazines have ever published constructional details for a real good short-wave super-heterodyne. Why not publish a few of these? In closing, I wish to say that I am sure that a great many short-wave enthusiasts hold the very same opinion that I hold in regard to your magazine and will back it up from the start.

ALBERT SOBEL,
9 Cuthbert Place,
Kew Gardens, L. I.

(Well, Albert, your wish has been fulfilled. Here we are with two whole pages and we hope it makes you happy. We will have, with your help and the help of other hams, a page or more a month, but it is up to you to keep on shooting the material to us. Remember, this is your own page, but we can't publish it unless you shoot along the dope. As to the short-wave superheterodyne, you will notice we have published several articles along this line already and will continue to publish more.—Editor.)

English Amateur 5-Meter Station, G2DT

Mr. E. T. Somerset, English short wave amateur, operates this station G2DT, and experiments with wavelengths as low as 5 meters. Left to right —5 meter receiver; G.R. frequency meter type 558-P; full dial spread 9 to 90m receiver; 20 meter Hartley HI-L transmitter; frequency monitor; 40 meter Hartley transmitter; 5 meter transmitter (not visible in photo); M-L dynamotor; D.C. power supply.

MORE DOPE

Editor, SHORT WAVE CRAFT:

WSBN, the *S.S. Leviathan*, is now on about 75 meters.

G2GO, the *S.S. Americ*, is on 70 meters. This station was testing with WOO, May 20th, and was 400 miles off shore. It came in with good volume and cut right through a lot of code interference.

WOO, at Deal, N. J., is now on 62 meters.

A Drummondville, Canada, station on 62.70 meters came in here with plenty of volume. They were sending a program to the *S.S. Larentic* and the *S.S. Duchess of Richmond*. I could not understand the call letters and I think they were in French. I would like to know the call letters of this station. If anyone understood them I will appreciate it if a fellow reader will send them to me.

W. GOSCH,
296 Peck Street,
New Haven, Conn.

(This is the kind of dope that the hams want, and again we say, keep on shooting it in. We will publish as much of it as space permits.—Editor.)

Station Photos Wanted!
Send in photos of your short-wave station and one of yourself. Give brief description of apparatus used and results achieved.

"RED" BROADCASTS!

Editor, SHORT WAVE CRAFT:

I enjoy your magazine very much. I think it is the very best radio magazine published. I would like to correspond with short wave fans, especially constructors of the Super-Wasp. I will answer all the letters I receive.

RICHIE THOMAS (RED) HEPBURN,
Rogers, Ohio.

(No comment needed on the above, either. Now, you hams, get busy and snow-under "Red" with your letters and postal cards. Serves him right.—Editor.)

HE WANTS TELEVISION ON S. W.

Editor, SHORT WAVE CRAFT:

I have read the first copy of SHORT WAVE CRAFT and I kind of think I'd like to get it regularly, so you'll find a money order for a dollar and a half to cover a year's subscription.

The first number is fine, except that I couldn't find any television, but there will probably be some in the subsequent numbers—I hope so. Maybe there will even be an article or two on facsimile. Why is it that there is so little reading matter on these two interesting subjects?

I'm very glad to find that I am a "S. W. P. H.," having sent some dope to *Radiocraft* some time ago.

Yours for the best of success with your new enterprise, I am.

PAGE TAYLOR,
3790 Ashland Ave.,
Detroit, Mich.

(*Continued on page* 334)

The Influence of the Earth's Atmosphere on the

PROPAGATION of RADIO WAVES

By DR. J. FUCHS

PART II—Conclusion.

Dr. Fuchs, famous European expert on short-wave phenomena, explains in an interesting way such important subjects as —Skip Distances—The Echo Problem—What Wave Velocity Shall We Use?—Signals That Encircle the Earth Three Times.

IF THE radio waves coming from the earth, which penetrate the ionosphere, are there deflected, and return again to the earth at a distant point, actually follow this path, according to this diagram they should not be detectable at a place on the earth lying on the line between the transmitter and the receiver. Under certain conditions this is the case. Fig. 6 shows the curve of the signal-strength under such circumstances. In the immediate vicinity of the transmitter we have great signal-strength; then for a certain distance they are not to be detected, since they are high up in the strata of ionized air, while further on the intensity of the signal begins to rise again, reaches a maximum, and then slowly but finally decreases.

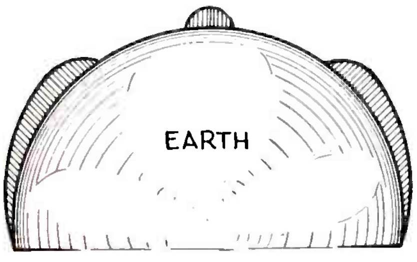


Fig. 6
The principle of the behavior of short waves.

Here the same phenomenon occurs that is found in the propagation of sound; namely, a "dead zone," also called a "zone of silence." The area of this dead zone often varies extraordinarily for all possible reasons, but from the previous explanations we know that a change of the dielectric constant is at the bottom of them all.

The figure No. 7 shows conditions which may occur, for instance, during a winter night. From this, one can plainly deduce that the location of the dead zone is governed by the time of day as well as of the wavelength. By day the ionization is greatest. This corresponds to a great difference between the angle of incidence and the angle of reflection; accordingly a wide deflection. The waves cannot reach great heights, but come down again instead after a short distance. Therefore, the dead zone is always smaller by day than by night.

If, for example, we compare the dead zone of the 20-meter wave by day and at night, we plainly see a marked difference, for it is a matter of thousands of miles. But a dependence on the wavelength is also plainly evident in this case. In fact, for the same time of day the dead zone becomes wider as the wavelength used is shortened.

In the case of wavelengths of more than 50 meters, the deflection is for the same reason already so great that a really dead zone, where nothing at all is heard, no longer exists. The effect is shown merely by a slight decrease of the signal-strength, but it disappears almost entirely in the case of still greater wavelengths. In the case of telephonic wavelengths of a few hundred meters it is still marked, as appears from a work by Captain Round (Fig. 8).

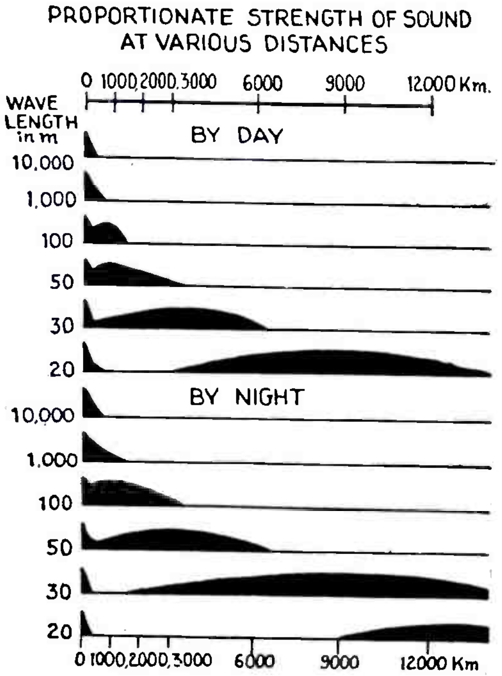


Fig. 7.
The audibility of short waves under various conditions.

From Fig. 7, moreover, there is another conclusion to be drawn, of practical significance: if wireless communication is to be kept up over a certain distance for the 24 hours of the day, it will be necessary to change the wavelength at least once. For a distance of 4,400 miles—for instance, that from Vienna to New York—one will use by day the waves under 20 meters, but by night the 30-meter wave will provide the greatest energy at the place of reception.

It is a practical advantage, of using the wavelengths under 100 meters, that by this means one may cover longer and shorter distances equally well, merely by the correct choice of the wavelength, without having to alter the power of the transmitter, while in using waves above 100 meters, increases in range can be attained only by increasing the energy.

Aside from the proved dependence of the extent of the dead zone upon the wavelength and time of day, it is dependent also upon the time of year. In general, the deflection in summer is much greater than in winter, because of the strong solar radiation, and consequently the dead zones are much smaller. The propagation conditions on a summer night are, occasionally, the same as those on a winter day. For this reason Fig. 7 represents also very well the difference in propagation on a summer night and a winter night.

The Echo Problem

Very remarkable situations and phenomena occur if still shorter wavelengths are used for transmission. It is to be expected, from studies of other wavelengths, that in such a case the deflection by the influence of the ionized atmosphere will be a slight one. The wave will, accordingly, remain a very long time in the higher atmosphere before coming down again; the dead zone will become larger, and the question now arises whether—with even shorter wavelengths—the dead zone would not become so large that the wave simply could not return to the earth at all, but would circle above it, be lost in space.

Through observations made in the last few years this problem has suffered a very peculiar complication.

If the wavelength is shortened to 20 meters, the dead zone and with it the range as well become so great that the signals of station A (Fig. 9) are heard

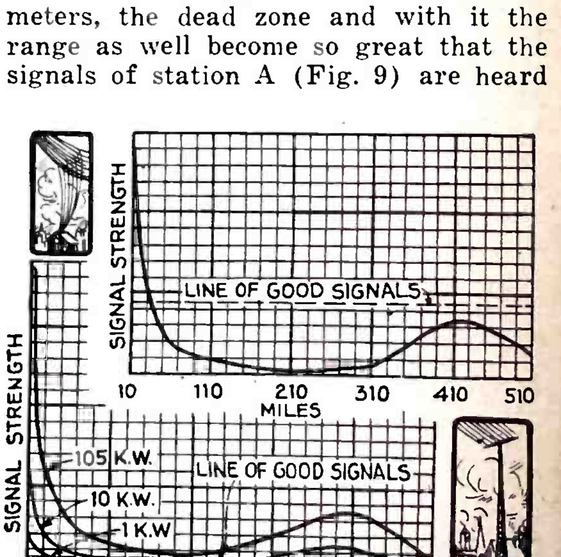


Fig. 8.
The audibility of radio waves at various distances.

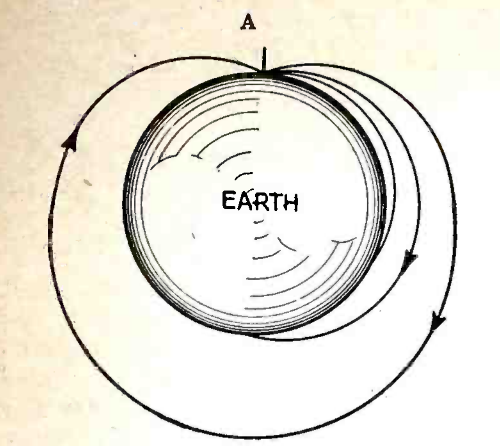


Fig. 9.
Radio waves which encircle the entire earth.

not only at the antipodes, but also are heard again at A after a complete circuit of the earth. This fact was first observed in the year 1926.

Signals Encircle Earth Three Times!

An observer in the vicinity of station A will therefore first receive the direct signal sent out from the station and about one-seventh of a second later the signal which has encircled the entire earth. In the case of later and more exact investigations, it was possible to establish the fact that signals were also perceptible two-sevenths, and even three-sevenths, of a second after the main signal. These were signals which had gone around the earth two and three times and were nevertheless still strong enough, in spite of the great distance traveled (some 75,000 miles), to be recorded at the receivers.

The multiple arrival of such signals is very undesirable for radio telegraphers. The signal arriving later has, of course, the same character as the first signal (being therefore either a dot or a dash) and acts exactly like an acoustic echo. Under certain conditions of rapid telegraphic transmission, it can happen that the signals run into each other and become impossible to read. Because of its correspondence to acoustic echo, this electrical phenomenon is called "echo." It corresponds to a single, double or triple echo, according as the signal has encircled the earth once, twice or three times.

In Fig. 10 you see such an echo signal, which was received by means of a cathode-ray oscillograph. One plainly recognizes the principal signal, then the first and the second succeeding signals. As a time marker a 500-cycle alternating current is impressed on the record, by which one can measure exactly the interval of time between the main signal and the echo.

Another kind of echo formation, shown in Fig. 11, indicates the conditions under which (as, for example, in the winter months daily at about 3 o'clock) the signals of American transmitters, operating on about a 20-meter wavelength, can be heard with a very strong echo effect. One impulse of the New York transmitter comes on the direct path across the Atlantic, its dead zone and its range, however, being relatively small, since the whole distance is in daylight. The part of the wave which goes around the other side of the earth, however, finds night there; its dead zone and range are then so great that it too reaches Vienna, but somewhat later than the direct one. The result is the formation of an *echo*.

Another echo occurs if the original wave can again be propagated further over the dark side of the earth and afterward be received again in Vienna from the same direction. One speaks of direct and indirect echo in terms of the direction of the principal path.

For the interval of time between the main signal and the first echo, it makes a difference whether the radio wave has traveled at great heights or close to the earth, because great differences in the distance covered may result. Attempts have been made to calculate, from the actually-measured time and the velocity of light, the average height at which the

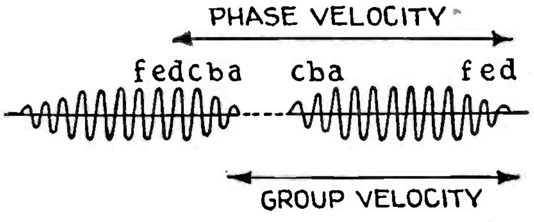


Fig. 12.
Illustrating phase velocity and group velocity.

radio waves had followed their course over the surface of the earth. There resulted an estimated height of 120 miles. Although this figure fits in with our previous considerations, it cannot be regarded as a confirmation of them, however.

What Wave Velocity Shall We Use?

It is in fact highly questionable whether one can use for this purpose the figure obtained for the speed of light waves in a vacuum (the latest value is 299,790 kilometers, or 186,282 miles, a second). A. Lambert, by very extensive research, has been able to confirm and re-determine the conclusion that the speed of radio waves differs considerably from that of light waves, amounting in fact to 247,000 kilometers a second plus or minus 9,000 (that is, from 160,000 to 149,000 miles a second). Independently of this, the Japanese, M. Hasimoto, has moreover calculated that the velocity of propagation in summer

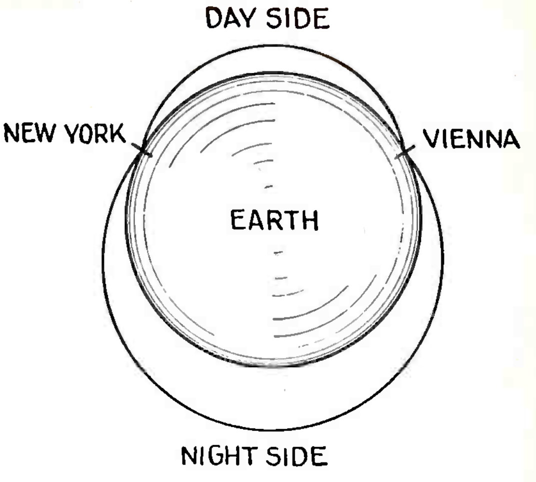


Fig. 11.
How the "echo" occurs.

is 240,000 kilometers (150,000 miles) a second; in winter, 269,000 kilometers (168,000 miles); there therefore appears to be a dependence on the time of year. These figures agree well with Lambert's, so that probably there can be little doubt about the whole matter.

The reason for this interesting fact, as already mentioned, can be now assigned; it is that radio waves travel in very high strata of the terrestrial atmosphere, which makes the velocity of propagation come out smaller. In the case of Lambert's figure, however, these waves must have penetrated to a height of about 3,000 kilometers (over 1,800 miles), which would seem very improbable in view of all we formerly thought we knew.

There is a further possibility of explanation in the fact that radio waves en route from transmitter to receiver have to do some work, be absorbed, and therefore suffer a diminution of their velocity. In the past three years increased attention has been directed to this question, and work upon it has been characterized by two conceptions long current in other fields of physics: phase velocity, and group velocity.

The Group Velocity

We can only measure the *group velocity*. Therefore Lambert's result, that the propagation of radio waves occurs at a velocity of 247,000 kilometers (154,000 miles) a second, is at any rate a group velocity, even if we do not yet know how it has come about. The group velocity is that which controls the transfer

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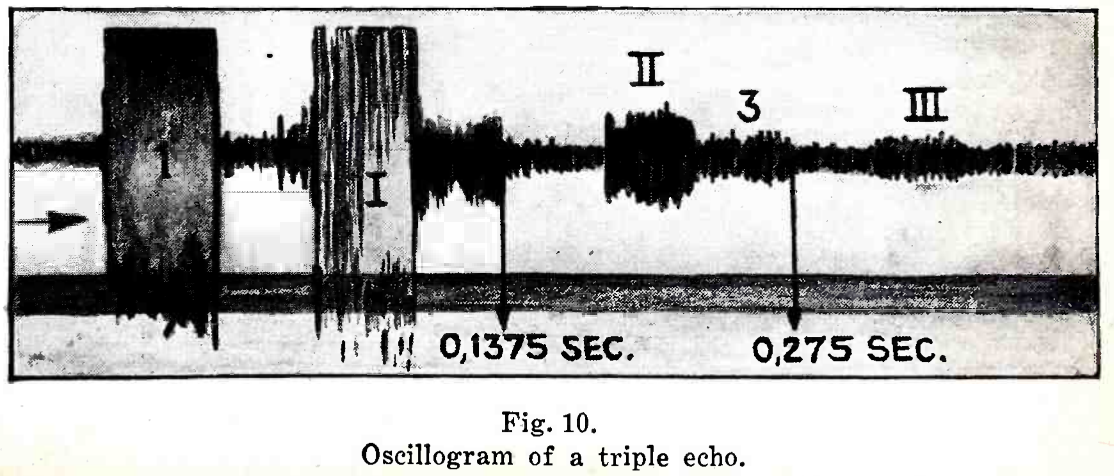


Fig. 10.
Oscillogram of a triple echo.

AN 85 METER PHONE *Transmitter*

By R. WILLIAM TANNER, W8AD

This 85 meter phone transmitter operates without a crystal control. The output is 15 to 25 watts; range up to 1,000 miles; 100 per cent modulation possible; bias-variation system of modulation employed. Master oscillator-power amplifier system used, ensuring freedom from swinging antenna effects. Cost of complete transmitter, including tubes and microphone, can be held down to $70.00.

NO DOUBT many of the experimentally-inclined broadcast listeners using short-wave receivers have tuned in on *amateur 'phone stations* and wished that they too could transmit by voice. The greatest obstacle to the beginner is the lack of really authoritative data on the subject.

The purpose of this article is to submit sufficient details to enable the novice, who is capable of constructing a successful multi-tube broadcast receiver, to build and operate a phone station.

It should first be impressed upon the mind of the would-be operator that, before placing any type of transmitter on the air, it will be necessary for him to obtain both a station and an operator's license from the district Supervisor of Radio.

When designing this efficient little transmitter, the writer took into consideration the many types of circuits available. Considerable experimenting was done to determine the best layout for one not familiar with the radiation of electromagnetic waves. The circuit shown in the diagram (Fig. 1) proved to be comparatively simple in construction and operation, giving a high output at a relatively low cost. The tubes required are all of the receiving type, and the plate supply is obtained from an '80 rectifier. The power output to be expected is in the neighborhood of 15 to 25 watts on the modulation peaks. Under favorable conditions, distances up to 1,000 miles may be covered.

The circuit is a self-excited master oscillator-power amplifier, which eliminates any effect of a swinging antenna upon the frequency of oscillations. The oscillator employs a '12A tube in a "high C" Hartley circuit tuned to half the frequency of the emitted wave. The second harmonic excites the grid of a '12A frequency-doubler, operated considerably below the plate current cutoff. The output of this tube is amplified by a pair of '45 tubes connected in a push-pull arrangement, the grid-plate capacities being neutralized to prevent oscillations. The constancy of frequency with this combination is comparable to that of a crystal-controlled outfit, and due mainly to the second-harmonic oscillator.

The bias-variation system of modulation, developed by the writer about two years ago and described in *QST*, is employed. Properly adjusted, 100 per cent.

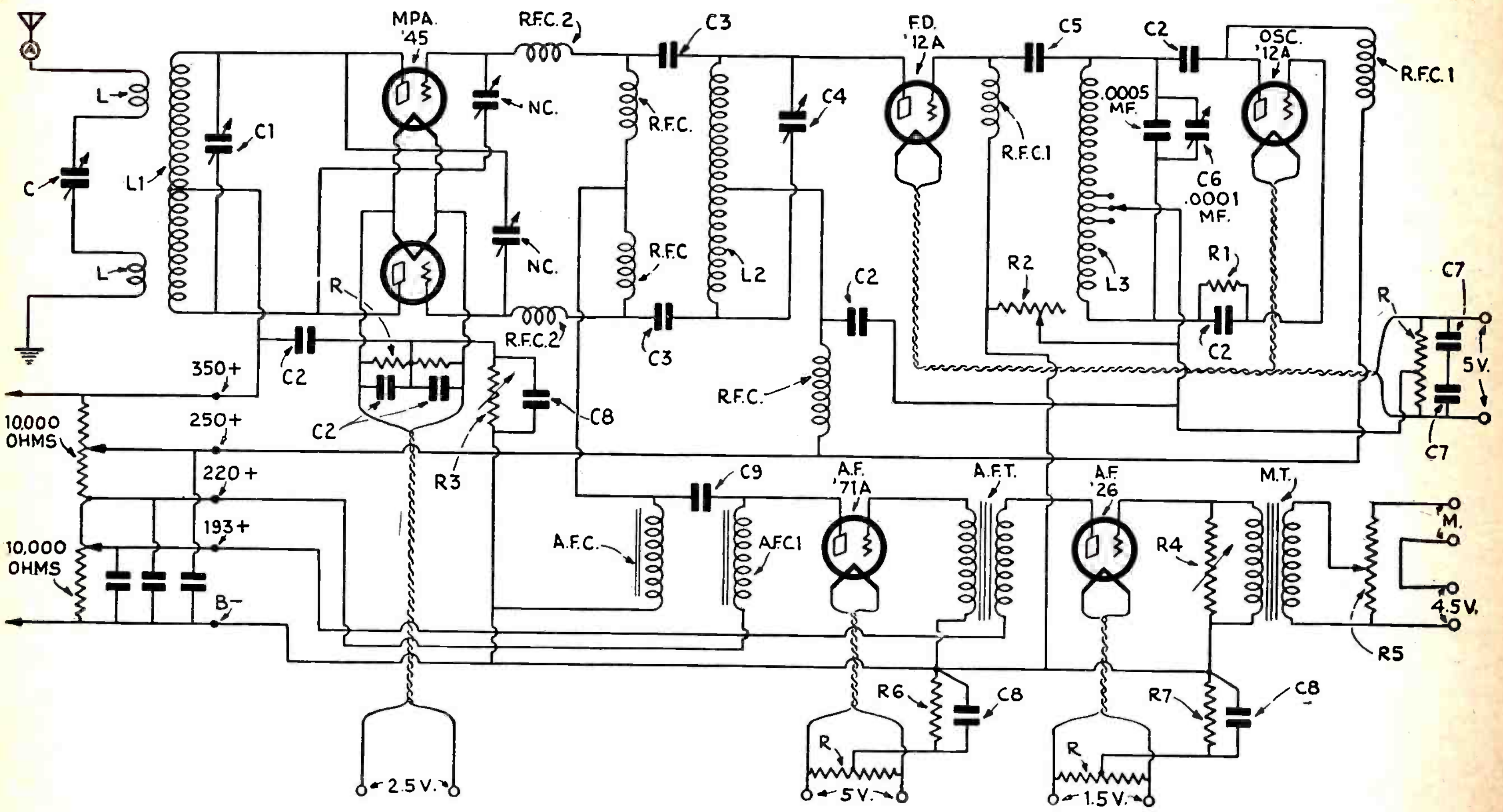
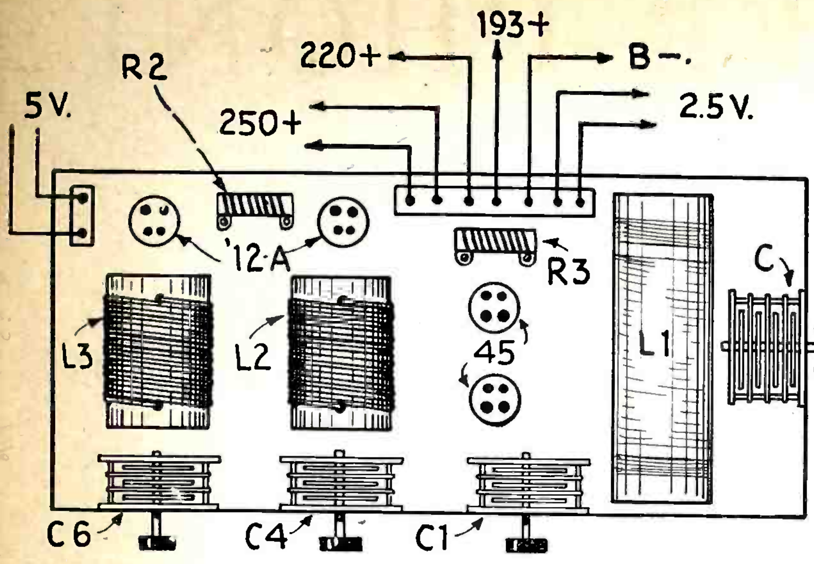
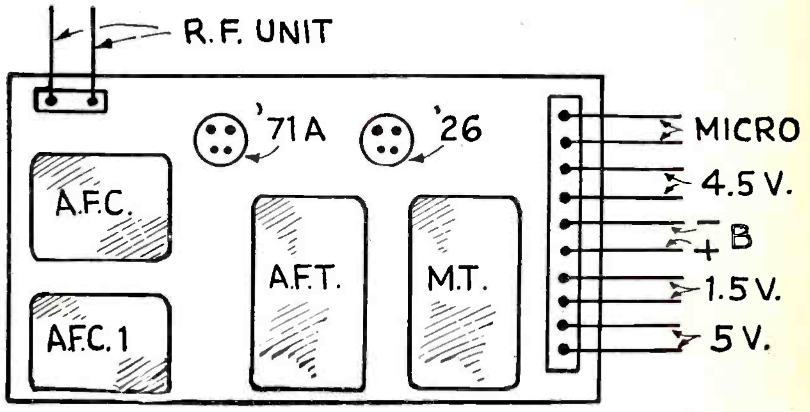


Fig. 1—Shows complete hook-up of 85 meter phone transmitter, with microphone modulator circuit in lower right hand part of diagram, the microphone being connected to terminals marked M.



←Fig. 3—Layout of radio frequency section of the 80 Meter Phone Transmitter.

Fig. 4—Shows recommended audio frequency layout of the transmitter.



modulation is possible. A two-stage audio amplifier, using a '71A and a '26 tube, steps up the weak microphone currents to the correct value.

The plate voltages for all tubes is obtained from a 700-volt center-tapped transformer, a full-wave '80 rectifier, and an efficient filter. The total cost, including tubes, power supply, microphone, etc., will not exceed approximately $70.

The entire transmitter is built into three separate units: the radio-frequency, audio-frequency, and power supply. This makes it possible to place the units in the most convenient locations; say, the speech amplifier on the table with the receiver, key, microphone, etc. The power supply may be underneath the table, out of the way, and the R.F. unit close to the antenna and counterpoise lead-ins.

The Oscillator

The oscillator employs a shunt-feed Hartley circuit of the "high-C" type. The inductance (L3) consists of 20 turns of No. 16 D.C.C. wire, spaced slightly. Taps are taken off at the 4th, 5th and 6th turns from the grid end for the purpose of adjusting the excitation to the required value for maximum efficiency and purity of output. The end leads are soldered to lugs which are held to the form by machine screws. A short brass strip, ½-inch wide, is fastened to both ends of the form and attached to two General Radio upright insulators.

The inductance is tuned by means of a fixed .0005-mf. and a .0001-mf. midget condenser (C6) connected across the whole coil. A great amount of care should be given to the selection of the fixed condenser, because any heat here will cause the frequency of oscillations to "creep" badly during operation, as well as reduce the output. Only one made of mica and copper, or brass, should be employed; a dollar for this item is money well spent.

The grid and plate blocking condensers (C2) have each a capacity of .001-mf. The grid leak (R1) may be practically anything with a resistance of 5,000 ohms, the currents through this being at a very low value. The R.F. choke (RFC1) consists of a one-inch bakelite tube (cardboard tubing boiled in paraffine will do just as well) wound for 3¼ inches with No. 36 enameled wire. (Some of the manufactured chokes will, no doubt, function satisfactorily.)

Frequency-Doubler

This stage also employs a '12A tube with an abnormally high negative bias on the grid. The inductance (L2) has 22 turns of No. 20 D.C.C. wire on a two-inch tube. The turns are spaced by their own diameter. A tap is taken off at the exact center for connection to the "B+." This type of balanced inductance is an absolute necessity, in order to provide a high radio-frequency voltage at both ends of the coil, so that the grids of the push-pull output stage will be excited 180 degrees out of phase. If the usual untapped coil were used, one of the grids would receive all of the excitation and the other would be at ground potential. This inductance is mounted in the same manner as L3.

The coupling condenser (C5) has a capacity of .0001-mf. The R.F. choke in the grid circuit is wound like the one in the oscillator; however, that in the "B+" lead (RFC) should be designed to function in the 80-meter band, because frequency multiplication in frequency-doublers occurs in the plate circuit rather than in the grid circuit. This latter choke consists of 200 turns of No. 36 enameled wire on a ¾-inch form.

A bypass condenser of .001-mf. capacity (C2) is connected from the center tap of L2 to the center of the filament resistor.

For a '12A, a grid bias of 25 volts negative is approximately correct for plate current cut-off when it is supplied with a plate voltage of 200. Frequency-doublers are generally operated considerably below the cut-off point; this makes the correct biasing value somewhat experimental. However, 35 to 45 volts will be very nearly right; this is supplied through a resistor of 2,250 ohms (R2) in the "B—" lead to both '12A tubes. A 2,500-ohm, 25-watt "Truvolt" resistor is ideal for this purpose; when fitted with a slider, it is possible to vary the bias for the best operation after the outfit is placed in operation.

Modulated Power Amplifier

The output of the frequency-doubler is fed to the grids of the modulated power amplifier through two .00025-mf. fixed condensers (C3). These condensers should be matched within 1 per cent., in order to provide equal excitation to both grids. The R.F. chokes (RFC) are exactly like the one in the frequency-doubler's plate circuit. It will be noticed also that an R.F. choke (RFC2) is connected in the grid lead to each of the '45 tubes. These are employed to eliminate ultra-high-frequency oscillations, and, to be most effective, should be placed as close as possible to the sockets. Both chokes are wound with 20 turns of No. 26 D.C.C. wire, on a ½-inch form.

The plate coil (L1) and antenna coils (L) are wound on the same form, which is 10 inches long by 2 inches in diameter; No. 12 enameled wire is used for all three coils. One antenna coil should

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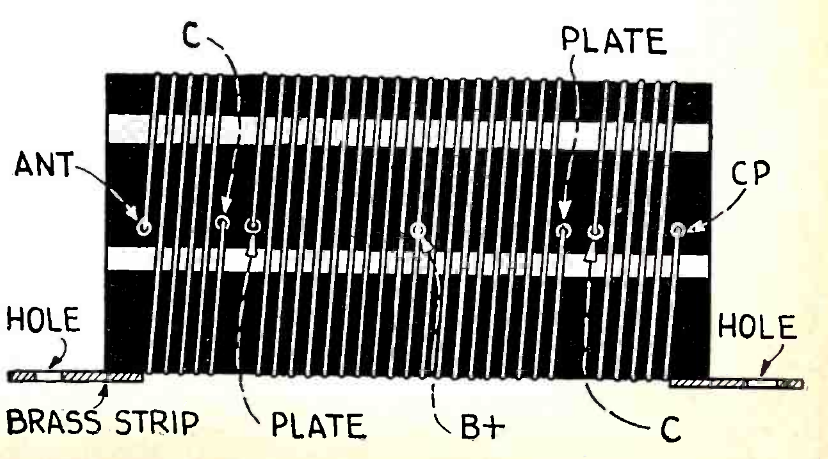
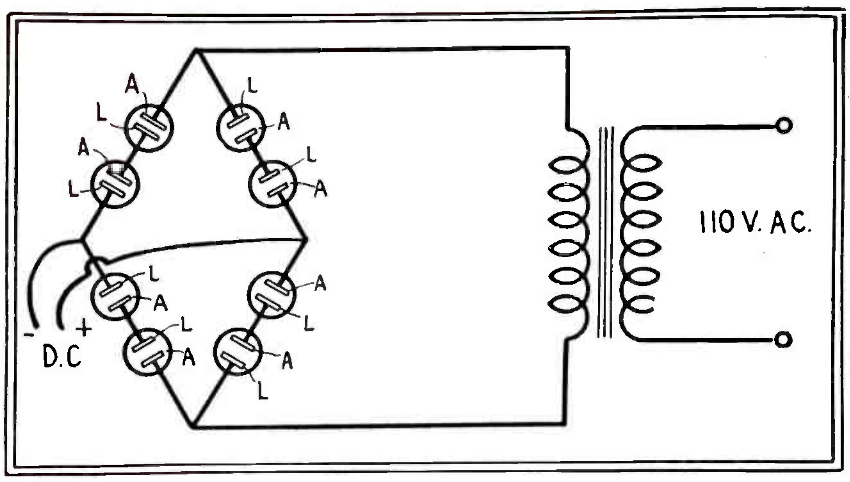
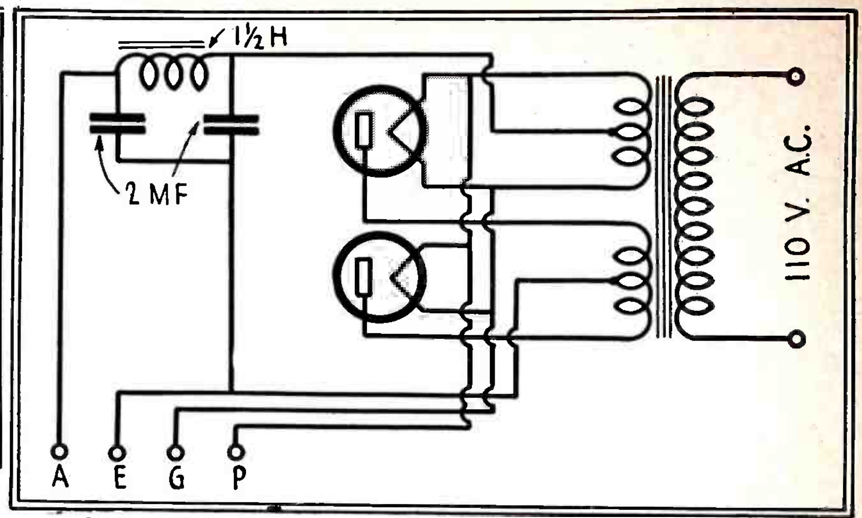
Fig. 2 — Shows details of antenna and plate coil.





For the plate supply 20 rectifier jars are required for 500 volt transformer, connected in bridge fashion as indicated.



Optional full-wave rectifier hook-up employing two vacuum tubes of the half-wave type.

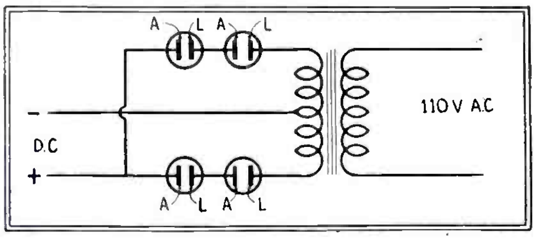
The Hartley
Short Wave Transmitter

By
LESTER C. KIRSCH

HERE is a short-wave transmitter that will cover a great distance, and can be built out of old parts lying around on your work bench. It is used for code work. The inductance can be made out of copper gas tubing ¼-inch in diameter, or copper ribbon. The primary inductance (4) consists of eight turns; the secondary inductance (5) of two and two-thirds turns, 5 inches in diameter and 6 inches long, spaced about ¼-inch. The choke coil (1) can be constructed by winding 150 turns of No. 28 or No. 30 D.C.C. wire on cardboard or wooden tubing ¾-inch in diameter. An '01A or a '10 tube may be used in this transmitter.

Power Supply

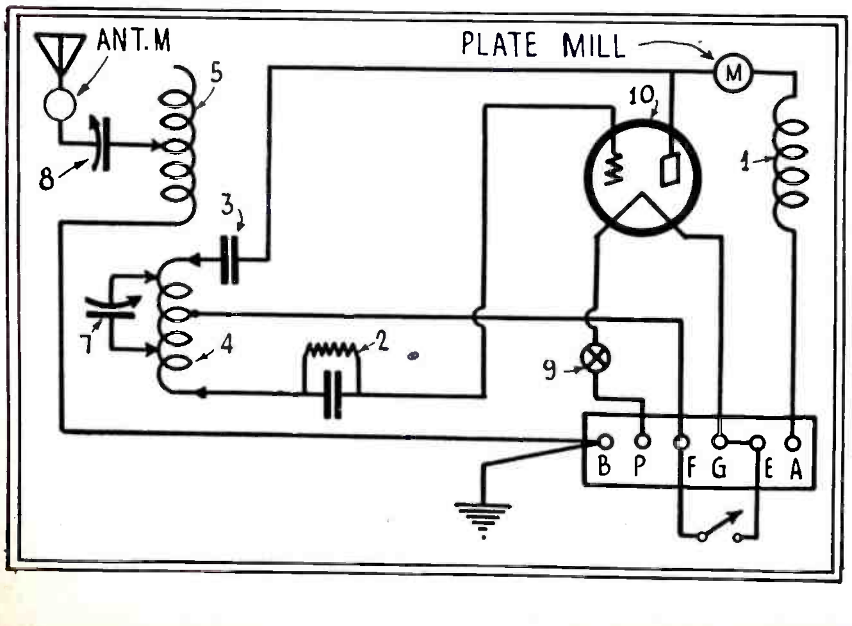
If the builder contemplates using the '10 type of tube, it would be best to use a step-up transformer and some scheme of rectification, instead of trying to employ "B" batteries. The '10 tube draws approximately 60 milliamperes at 350 volts on the plate and it would be much better to use rectified alternating current for the plate supply instead of batteries, as the batteries will not stand up under this heavy drain for a considerable length of time.

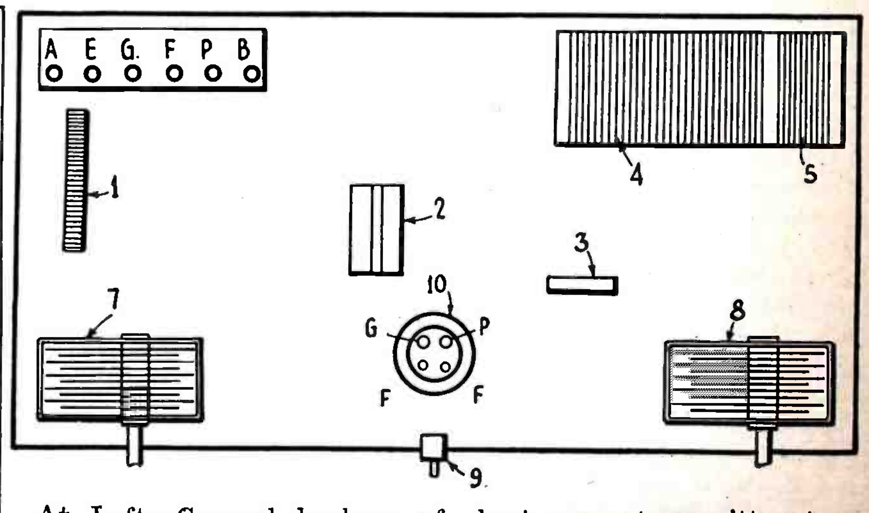


Center—Tap transformer with electrolytic rectifiers to give full wave rectification.

If it is desired to work the '10 tube at full capacity, it will be necessary to have a power transformer with a center tap on the secondary so that 500 volts are supplied on each half of the secondary. The rectifier tubes can be of the UX-216B or UX-281 type, or any other which will satisfactorily handle this voltage and current. The filament secondary winding is used to supply the current for the filament of the rectifier tubes and the oscillator tube. This winding is tapped in the center as shown in figure. Voltmeters may be connected so as to indicate the A.C. filament voltage and the D.C. plate voltage respectively. These may or may not be used; however, they are valuable adjuncts to the power-supply set.

The audio-frequency choke coil shown in diagram and marked 1½ H should have an inductance of 1½ henries and be capable of carrying 150 milliamperes. The filter condensers may be either 2- or 4-mf. capacity and must be capable of operating above 500 volts. The whole power supply can be mounted as a separate unit; or you may build the power supply and use jars for a rectifier, which





At Left—General hook-up of short wave transmitter to aerial and ground. Right—Suggested arrangement of apparatus on sub-panel.

saves rectifier tubes and serves the same purpose. The jars can be glass tumblers, or ½- or ¼-pint size mayonnaise jars. The aluminum can be cut from an old aluminum kettle (be sure to clean the aluminum with sand paper) or shields out of an old radio set may be used. The lead should be sheet lead. If you have a transformer that puts out 500 volts, or less, use the bridge-type rectifier.

When you have finished the rectifier and turned on the power, watch your transformer and do not let it get hot, or a burn-out is probable.

Use a '01A and put five volts on the filament and from 90 to 425 volts on the plate; if you use 400 volts on the plate of the tube a great distance can be covered.

Baking soda can be used for the solution in the rectified jars, 1½ tablespoonsful to one gallon of water. The aluminum plates will form white. If a transformer puts out 500 volts, twenty jars should be used.

List of Parts

(1) Radio-frequency choke coil;
(2) .001-mf. grid condenser (receiving type) and one 5,000-ohm "Lavite" transmitting grid leak;
(3) .002-mf. plate condenser, receiving type;
(4) Primary inductance;
(5) Secondary inductance;
(6) Two brass angle supports for inductances;
(7) .0005-mf. variable condenser (receiving type will do);
(8) .0005-mf. variable condenser (receiving type may be used);
(9) Filament switch;
(10) UX-type socket.

Power Supply

(1) Step-up transformer;
(2) Audio-frequency choke, 1½ henries, 150 milliamperes;
(3) Two- or four-mf. filter condensers;
(4) Rectifiers;
20 glass jars;
20 lead strips;
20 aluminum strips;

Aluminum and lead strips should be one inch wide and as long as the depth of the jar.

Assembly and Wiring Data

Just a word regarding a few of the parts which may not show up very clearly: one terminal of the choke coil (1) is soldered directly to the lug of binding post A on the binding-post strip. This will rigidly support this coil.

The grid condenser (2) and the plate blocking condenser (3) are elevated from the baseboard by means of short, stiff wires to which they are connected.

The inductance coils (4 and 5), are fastened to the baseboard by means of brass brackets. It is necessary for the builder to realize that, although they are mounted in one unit, they are in reality two separate coils. The one with the greater number of turns of wire (4) is mounted towards the left; this is the primary or closed-circuit coil. The other coil (5), which has a small number of turns, is the secondary or antenna coil. Connections to these coils are made by means of the clips supplied with leads of flexible rubber covered wire.

The wire coming from the binding post (B) is permanently soldered to the inside turn of the inductance coil (5). In like fashion, the wire coming from the condenser (3) is soldered to the inside turn of coil (4). All other connections to the coils are made with flexible wire and clips, so that they may be shifted from turn to turn, to correspond to the wavelength required.

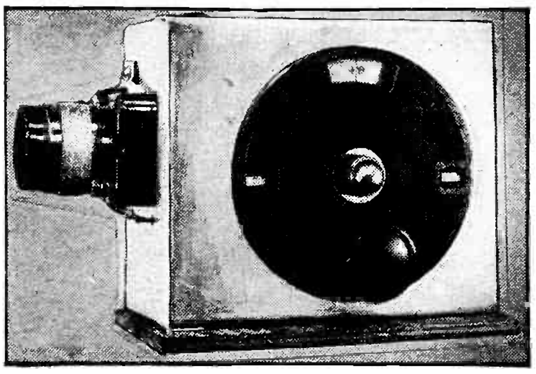
All wiring except that going to the inductance clips should be made with bus-bar wire of the usual type, and covered with black cambric tubing or spaghetti.

For the low-power tube, a thermocouple radio-frequency meter reading 0-to-100 or 0-to-500 milliamperes will be satisfactory. But if a '10 tube is used, it is necessary to employ a 0-to-1 thermocouple radio-frequency ammeter, and a plate D.C. milliammeter of 0-to-100 ma.

How to Use Short Wave Wavemeters

By A. Binneweg, Jr.*

TO greatly facilitate the location of proper dial settings for foreign broadcasting stations and thus popularize the new all-electric A.C. receiver kits recently placed on the market, the Delft Radio Co. is manufacturing a special inexpensive short-wave wavemeter. This was briefly described in the last issue of SHORT-WAVE CRAFT. However, due to the fact that few short-wave listeners understand how to operate a wavemeter, its use will be described here in more detail. The wavemeter, representative of a good design, is shown in the illustration herewith.


The Delft short wave wavemeter.

A wavemeter in its simplest form is a calibrated tuned circuit. To use it, couple it closely to the tuned-circuit of the detector (which must be oscillating weakly for most accurate results). When the dial of the wavemeter is varied (and the proper plug-in coil is used so that the wavemeter will tune to the wavelength of the receiver), the detector tube will stop oscillating when the wavemeter is tuned exactly to it. By varying the coupling between receiver and wavemeter coils, a very sensitive position is soon found which yields very accurate results.

As soon as the point at which the wavemeter causes a click in the receiver (as heard in the head phones or loudspeaker) is found, the dial of the wavemeter is read and the wavelength to which the receiver is tuned is thus accurately found.

Although changes within a short-wave receiver may influence to considerable extent its dial settings, the calibration of a wavemeter is constant and always ready for use.

If an accurate wavemeter is desired, it must be calibrated from accurate standards. To design one of these instruments to cover the range of 15 to 125 meters with the required overlap between coils, and such that the calibration remains constant, is a problem for specialists with the required laboratory apparatus. Careful shielding is also necessary to prevent hand-capacity effects.

Users of wavemeters should take care to see that the detector tube is oscillating. Be sure to couple to the secondary coil in the detector otherwise no results will be obtained. It would be of no use to couple the wavemeter to coils in the R.F. amplifier because the sensitive condition does not obtain there.

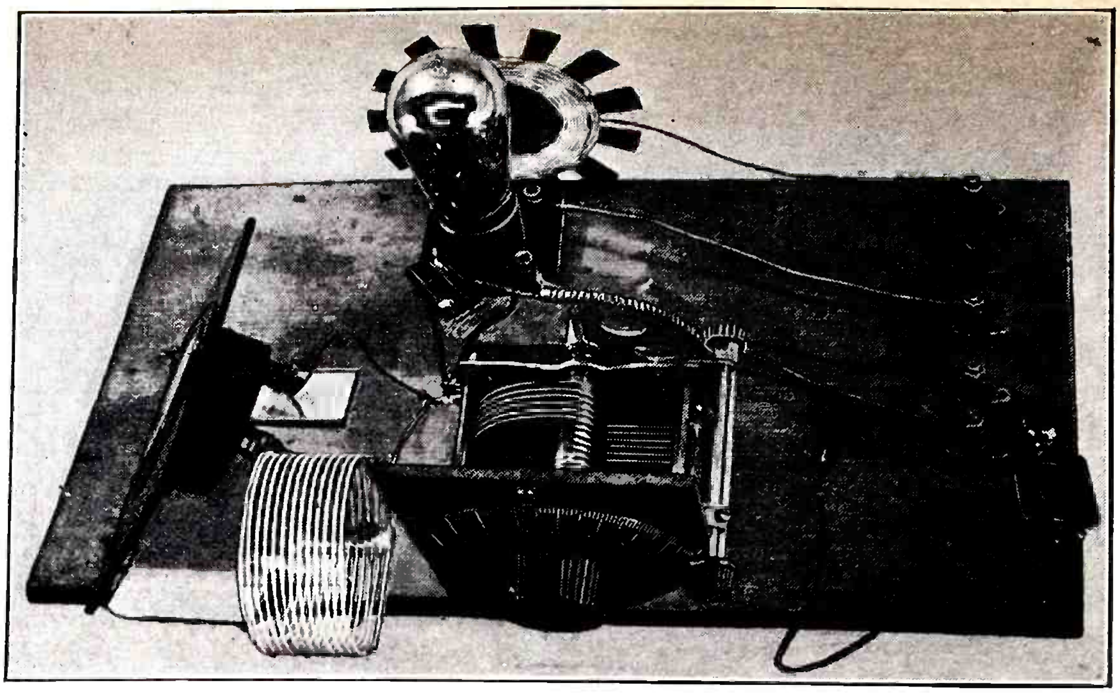
Wavemeter Problems

Suppose that you wanted to locate beforehand a certain receiver dial-setting so that you could hear a certain station when it came on. This is the reverse process of finding the wavelength to which your receiver is tuned.

First look up the wavelength of the station in SHORT-WAVE CRAFT. Next select the particular coil which, when plugged into the wavemeter, will allow the wavemeter to tune to this wavelength. Then set the dial of the wavemeter to that wavelength. Bring the wavemeter close to the secondary of the receiver and vary the receiver dial until you get the familiar click. When obtained, your receiver is tuned exactly to the proper wavelength and the desired station is then heard. It sounds long, perhaps, but its all very easy, especially if you have a good wavemeter to start with and all necessary instructions.

The technical and practical considerations, as well as the matter of popular price have here been admirably met.

* Short-Wave Radio Engineer, Delft Radio Co.



Inexpensive power-amplifier for 80 meter operation. The clip connects with the oscillator inductance.

Explaining the Simple Relation of the

Oscillator, Amplifier and Crystal

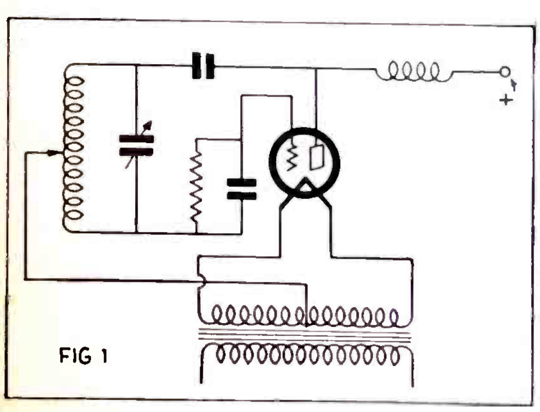
By A. BINNEWEG, Jr.

What is a master oscillator? A power amplifier? How does one connect a quartz crystal control to provide constant frequency transmission?

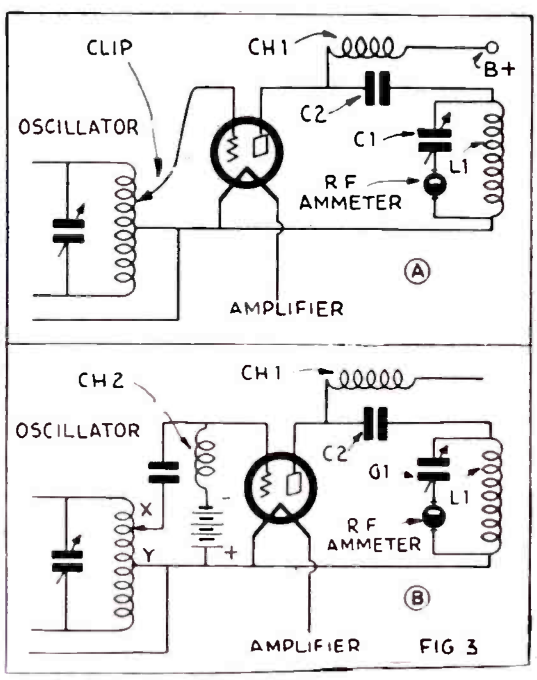
ONE of the most important considerations in the design of modern transmitters is that the frequency must remain constant within narrow limits. The days of "climbing" and "frequency-modulated" signals are over. A low-power transmitter, properly operated and adjusted, is better than a high-power rock-crusher that takes up too much space. The use of screen-grid tubes in short-wave receivers has made the low-power transmitter unusually effective.

We are not insinuating that high power is not good. High power is a wonderful thing—if you know how to use it—but the great majority of transmitters will be of necessity low powered. A good low-power outfit is another wonderful thing.

There are two requirements, therefore, for a story that will interest the majority of "hams." These are: first, a constant-frequency transmitter, and, secondly, low power. The practical sets discussed here are not only low-powered, but they furnish a remarkably constant frequency and are simple to adjust and operate. Circuits are developed which can be used with any power, of course.



Hartley circuit used in the master oscillator.



Developing a suitable amplifier for transmitting a constant-frequency signal.

"Constancy" Is Relative

When one speaks of "constant frequency," a little grain of salt must be consumed, for there is no such thing. What we are thinking of is the most constant frequency that can be economically obtained, within the limits allowed by the state of the art. That makes reasoning simpler from the start. Self-excited oscillators are all right, but to get a good, steady signal out of them for a certain length of time is often a tricky occupation. A good master oscillator with a power amplifier is even better (who said they are more complicated?). Crystal control (discussed later) is even better, but let's start with the master oscillator-power amplifier, which is less expensive, though when we speak of master oscillators we mean good ones.

A master oscillator is simply an oscil-

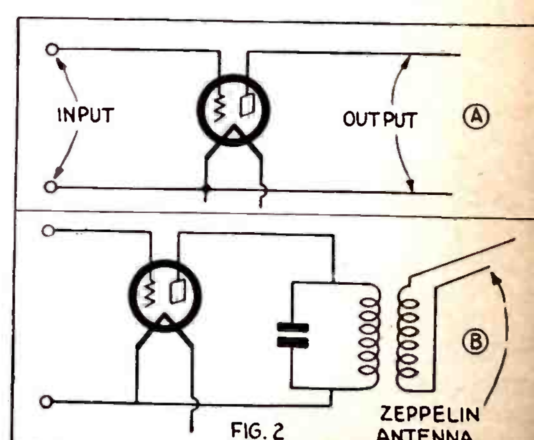


Fig. A—Simple amplifier. Fig. B—Theoretical amplifier feeding a Zeppelin antenna.

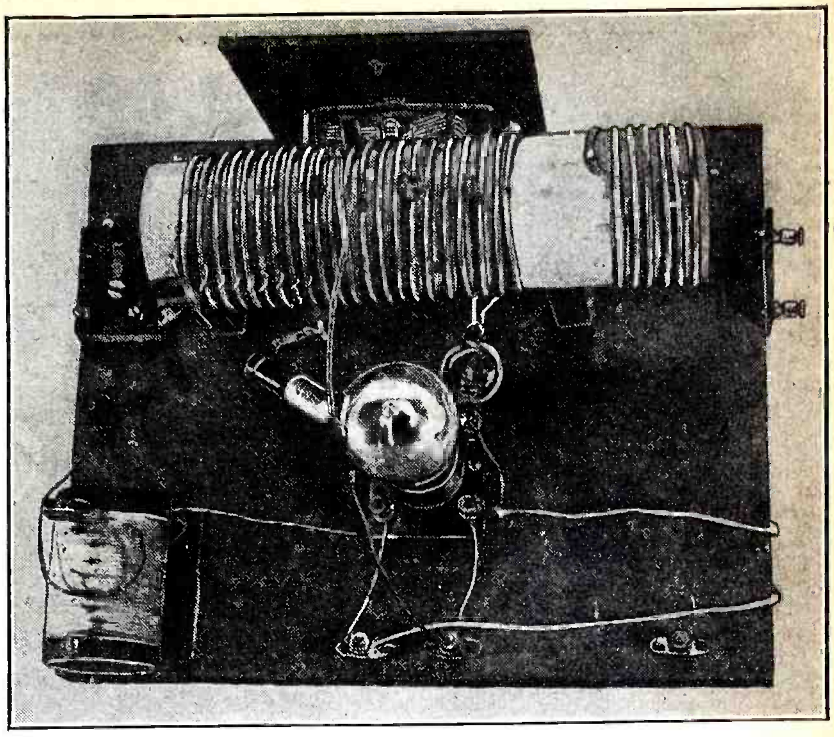
lator that behaves. It is separated from the transmitting antenna by an R.F. amplifier and there are, therefore, certain advantages similar to those obtained by introducing an R.F. amplifier between the detector and the antenna in a short-wave receiver. (We assume that the reader can read circuit diagrams backwards. Most amateurs shy at the terms "master oscillator" and "power amplifier." A master oscillator is simply an ordinary good oscillator, and a power amplifier is simply an R.F. amplifier.)

Having cleared up the most obvious difficulties, we can make it even simpler. Fig. 1 shows about the simplest circuit that one can assemble; this is our master oscillator. In order that its frequency shall remain constant, during prolonged CQ's, a relatively large amount of capacity must be used in the oscillating circuit, and the blocking condensers must be small. This means that a good .0005-mf. receiving condenser will serve for 40- and 80-meter operation; such a condenser will require for an inductor about eight turns of copper tubing, on a 2-inch diameter, at 40 meters (or its equivalent, as will appear later) and about twice the number of turns, or equivalent inductance, for 80-meter operation. Work at 20 meters requires about three turns. Blocking condensers of 100 mmf. capacity are needed; the grid leak is 10,000 ohms. A type '10 tube and socket, and the choke about finish the oscillator. Use about two hundred turns of No. 26 wire, on a 1½-inch diameter, for the choke; a hundred turns either way won't make enough difference to worry over, at these frequencies.

Operating a Power Amplifier

A power amplifier simply amplifies the signal from the master oscillator, which should, of course, be of constant frequency. Fig. 2A shows the simplest tube amplifier; it is not exactly what we want but stirs the imagination. Fig. 2B is more nearly what we want, because it has a tuned circuit in the plate circuit, gives fair amplification and can be coupled readily to a Zeppelin antenna without any special arrangements at all. Like all theoretical arrangements, Fig. 2B has to be modified when we put it into our amateur station. Let's do this.

It will be necessary to add the condenser C2 (Fig. 3A) to prevent short-



Appearance of a low-power master-oscillator designed for 80 meter operation.

circuiting the power supply. When C2 is added, a choke, Ch1, must be used so that the plate can be supplied with high voltage without shorting the R.F. generated by the tube; the choke keeps the R.F. energy out of the power supply.

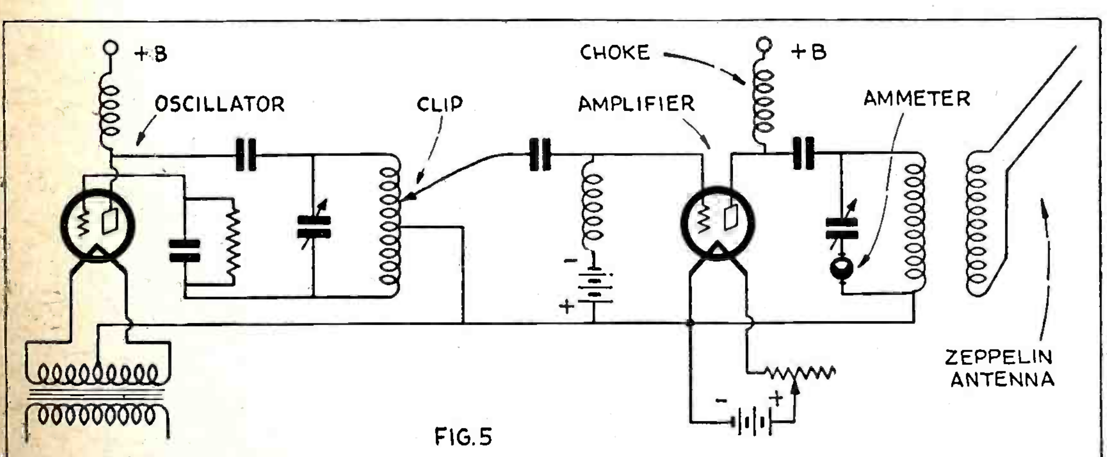
It will be found that a clip on the grid lead to the power amplifier, as shown in Fig. 3A, is very convenient. The filament-lead to the amplifier connects with the filament clip of the oscillator.

Let's start playing with the set and get it to work right; much in general is learned about practical procedure by trying everything, within limits and within reason, that you have time for.

We connect the amplifier to the oscillator as shown in Fig. 3A and turn on the power. Wow! The amplifier plate certainly is red! What's the trouble? We quickly turn off the power and draw a circuit diagram and investigate. We locate the trouble; the grid is at filament potential with respect to D.C., so the tube draws a heavy plate current. (Easy enough—after you *try* it!)

Anyway, let's bias the grid; hot plates are unnecessary. We try it again; this time, no results at all, no deflection in the plate circuit R.F. ammeter. The choke, Ch2 (Fig. 3B), was forgotten. We also find that the combination is more stable when we use fewer turns between "X" and "Y" on the oscillator inductance.

Don't for a minute think that we are dumb; we are just in a hurry to get things over before we have to study. But watch *your* step.



Our first master-oscillator, power amplifier that put power into an antenna.

A Practical Amplifier Design

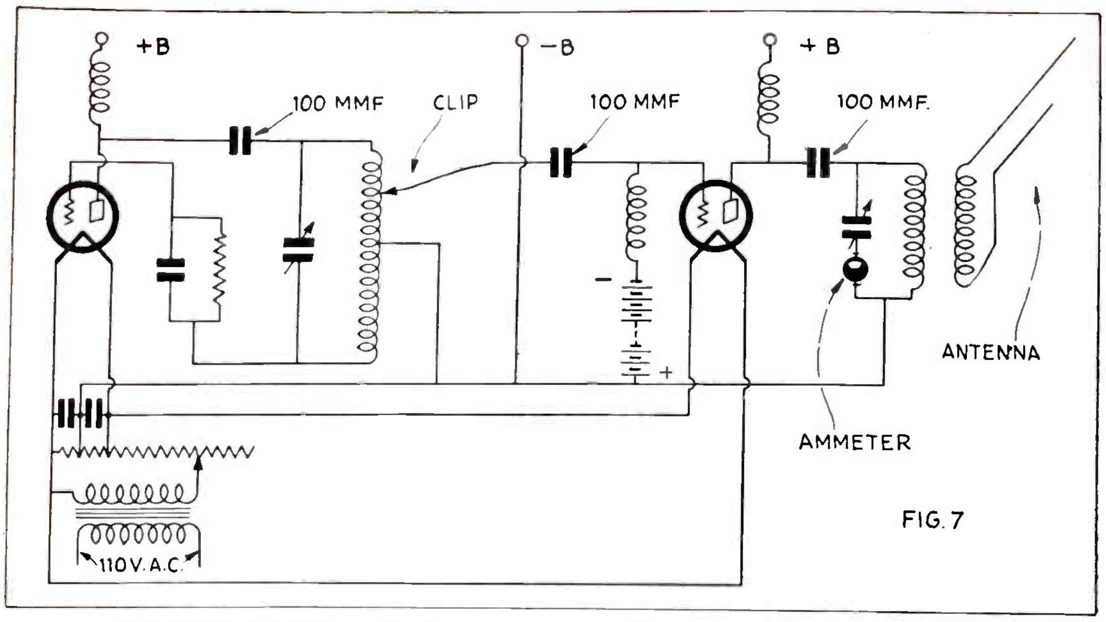
Now that we know something about these interesting sets, let's connect up a practical one and put some power into a transmitting antenna. Following the circuit diagram and using the sizes of parts already suggested above, we construct the 80-meter master oscillator-power amplifier, shown in Fig. 4.

The coil consists of 22 turns of No. 10 copper wire wound on a piece of cardboard tubing. Strips of celluloid (from an auto side-curtain) are first laid lengthwise, then the turns of wire are wound over these and cemented to the celluloid with collodion. Another convenient method is also suggested at the left of the coil in Fig. 4; the turns can be "sewed" in place with string. Taps should be provided at each turn for experimental purposes; pieces of thin copper are soldered to scraped positions along the wires; there are two rows of taps and the distance between successive taps is two turns, to allow space for the clips.

The baseboard arrangement suggested by Fig. 4 is very convenient and efficient; all parts can be readily reached and all leads are short and direct. Two vertical uprights support the oscillator inductor.

A tapped choke was used in this oscillator, so that the best value of turns may be selected at any wavelength employed; this looks good but it isn't absolutely necessary. A good mica fixed condenser must be used for plate blocking. The heavy leads at the right are for filament supply.

Of course, if one has already a perfectly good oscillator, built to modern specifications (about the only difference between old and modern sets is the L/C ratio in the tuned circuit, the size of the blocking condensers and the design of the R.F. choke coil), it will *not* be necessary to build up a new set; use the one you have, though it may need adjustment, and add a power amplifier to it.



Complete master-oscillator power-amplifier transmitting circuit.

Fig. 5 shows how a power amplifier can be added to a simple Hartley oscillator for preliminary adjustments and experiment. A storage battery is used to supply the filament of the amplifier. This is the one we used first to feed a Zeppelin antenna.

A Very Good Layout

A suggested power amplifier arrangement is shown in Fig. 6. This experimental set gave remarkably constant signals, compared to those from the usual self-excited oscillators, when a good master-oscillator was used. An ordinary 13-plate condenser and a space-wound coil can be used if low power is employed.

The R.F. ammeter reads the current in the plate tuned-circuit of the power amplifier. The plate choke used is a spider-web coil, although a single-layer winding gave results as good. The "C" battery (45 volts gave good results with 350 volts D.C. on the plate of both tubes) and grid choke are not shown in this picture. The grid condenser is necessary to prevent short-circuiting the "C" battery. The clip connects with a tap on the oscillator inductance. A good mica condenser should be used for plate blocking.

Fig. 7 shows complete connections for the low-power master-oscillator and power amplifier. Both tubes use the same filament transformer. A center-tapped 300-ohm resistor is shunted across the filament to provide a center-tap independent of rheostat setting.

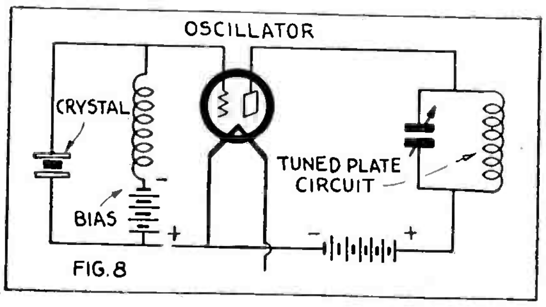
Adjustment is simple. The same voltage can be applied to both plates for simplicity. With the grid clip in place, a few turns from the center tap connection, tune the amplifier plate circuit until the R.F. current in the plate tuned-circuit is at maximum. If the oscillator becomes overloaded and stops, use fewer turns between filament tap and grid clip and less grid excitation.

The antenna is coupled to the plate coil of the amplifier in the usual way. Meters can be used in the oscillator if desired. The plate meter will show an increase when either the amplifier plate circuit or the antenna consumes power, but even a small neon lamp can be used to adjust a set like this. The antenna circuit is now removed from the oscillator and cannot affect its frequency.

Applying Crystal Control

Crystal control is the last word when it comes to constant-frequency transmission. A crystal oscillator is quite simple in principle. If you know anything about radio at all, you know why a tube oscillates. The plate circuit supplies sufficient energy not only to excite the grid, but to keep things going in general.

A tuned plate-tuned grid circuit is a good example of an oscillator for the



Simple quartz crystal-oscillator circuit.

purposes of illustration. An ordinary crystal oscillator is simply a tuned plate-tuned grid oscillator in which the grid circuit is "tuned" mechanically instead of electrically. The crystal has its own natural, mechanical vibrating period just as, in an ordinary tuned plate-tuned grid circuit, the grid tuned circuit has its own natural electrical vibrating period. The advantage of a quartz crystal is that the frequency furnished is extremely steady. By the mechanical vibration of the crystal, alternating electrical charges which operate the grid are produced.

Thus one can replace the grid tuned circuit by a crystal and still have an oscillator with a very constant frequency. A simple crystal oscillator is shown in Fig. 8.

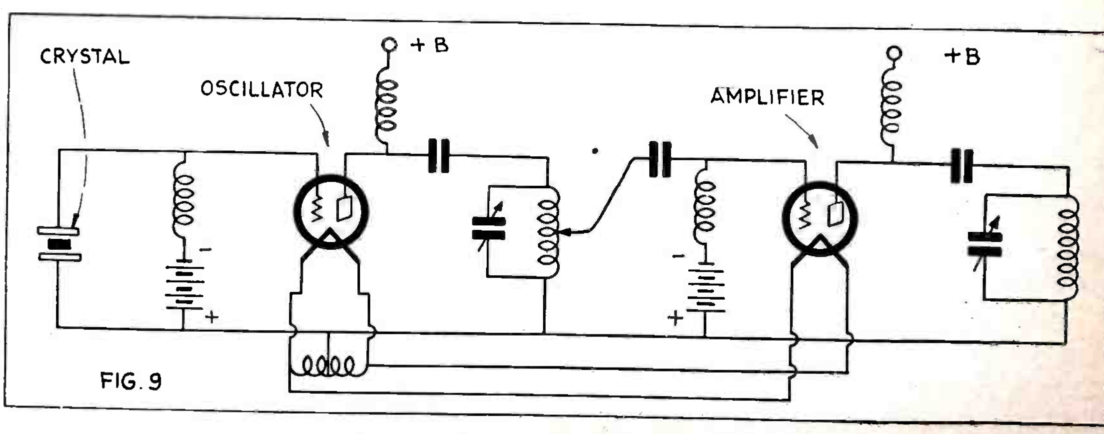
Let's add a power amplifier to the crystal oscillator of Fig. 8. A crystal cannot be used directly in a high-power oscillator; one always requires amplifiers to give higher-power signals. High voltages will cause a crystal to vibrate with excessive amplitude, soon destroying it. With care it is possible to use 350 volts on a crystal-oscillator tube, although 250 volts is usually a safe maximum. If a lower voltage is used than 350 (assumed here as the voltage applied to the amplifier tube) a series resistor in the plate lead will reduce the voltage to the crystal tube.

Fig. 9 shows a crystal oscillator with power amplifier. The adjustment is simple; it is otherwise the same as for the master oscillator-power amplifier arrangement previously discussed for operation at the fundamental of the crystal. It is usual, however, to tune the amplifier plate to the second harmonic of the crystal for several obvious reasons.

For example, a 160-meter crystal will furnish a 160-meter wave to the grid of the crystal-controlled oscillator; the plate circuit is tuned to the same frequency. The power amplifier plate circuit is tuned to 80 meters, and so is the aerial for 80-meter operation. For operation at 40 meters with an 80-meter crystal, the procedure is similar; another stage of amplification will be required to operate at 40 meters with a 160-meter crystal. It is usually best to purchase a crystal having a fundamental as near to the desired operating frequency as possible, which saves apparatus and expense.

WANTED!

Articles on Short Wave Transmitter and Receiver Ideas. Have you some?



Quartz crystal oscillator with power-amplifier.

Ultra Short Waves

Can We Use Ultra Short and

Infra-Red Rays for Communication?

By DR. FRITZ SCHRÖTER

(Based on a lecture by Dr. Fritz Schroter at the meeting of the Electro-technical Society and the Heinrich Hertz Society.)

The transmitters and receivers for ultra short waves as well as infra-red rays are discussed and some of the possible applications of these systems to everyday problems.

SHORT wave communication has already won for itself a considerable share of the communication field. In the main, the band from 20 to 100 meters is in question; still shorter waves have been known for years and have occasionally been tested experimentally, but thus far they have not been given serious use for communication purposes.

It now seems as though the band from .7 of a meter to 8 meters might also be especially suitable for communication. For these very short waves other physical laws are in part valid than for longer "short waves". While the longer waves are reflected by the Heaviside layer, which is a partial explanation for their extraordinarily high efficiency for long-distance transmission, this is manifestly not the case with waves less than 8 meters in length. Since these are radiated from the antenna in straight lines, they can (unless there is a very good conduction for the ground wave) only extend to distances lying within the horizon of the transmitter.

It is especially noteworthy that these very short waves, for which Dr. Schröter proposes the designation "quasi-optical waves", lie in the spectrum in which Heinrich Hertz made his classic discoveries. These very short waves are very strongly absorbed by the atmosphere.

It seems as though the band from 8 meters down to about 10 centimeters, and the infra-red short wave band, between about 2.4 microns and .7 of a micron are in particular the ones which can be given practical use. The former band is produced by electron tubes and spark gaps (macroscopic dipoles), the infra-red band by radiators of heat (molecular dipoles). Between these two bands lie the waves which are produced by the so-called mass-radiators of Frau Glagdeva-Arkadieva, in the form of tiny sparks made between fine metal filings. Hereby are attained over-oscillations which already extend into the field of heat-ray producers, for example the highly charged mercury vapor lamp.

IN THE NEXT ISSUE:
New Work in Germany on Ultra-Short Waves by *Dr. Fritz Noack*

The wave band from about 8 meters down to 1 meter has been especially investigated by Dr. Schröter, Dr. Michelssen, and W. Ludenia, of the Telefunken concern, in order to get practical applications for radio "lights" (radio beacons, rotary direction indicators), which particularly in the case of fog, are intended to replace optical signals. Since the wave lengths are in this case relatively small, the rays can be gathered into pencils by groups of dipoles or by reflectors and therefore concentrated. Consequently the watt-power of the transmitter can be small, still being used in the sharply directed radiation needed in navigation. Even a locally limited radio operation (*i.e.* by several stations), in which pencils of rays of the same wave length can operate close at hand without interference. is directly possible, at least if the horizons of the individual transmitters do not cut each other.

Likewise at the receiving end the apparatus needed is not very complicated. For telegraphy the very sensitive super-regeneration can be used, which for radio telephony has to be replaced by other proper systems on account of its extreme noisiness.

For the production of waves less than a meter in length, there comes into question either the Barkhausen-Kurz Bremsfeld hook-up or the Hull magnetron-tube hook-up. Moreover, spark-gaps can be used, which can be built extremely simple, but which send out only damped waves; to make up for that, they have a very intensive radiation effect. The resulting arrangement is similar to the classic, basic arrangement of Hertz. Dipole and spark-gap are set in the focal axis of a parabolic mirror of small dimensions. It is with such a hook-up that Dr. Schröter was able to give a demonstration in his lecture, transmitting audible telegraphy and radio.

In the similarly arranged receiving mirror there is used either a crystal detector or a vacuum tube operating in the Barkhausen-Kurz hook-up.

In telephonic transmission the spark-gap is fed by a modulated tube generator, the sending power being about .1 of a watt. Analogous with the Hertz experiments, with this hook-up one can nicely

(*Continued on page* 328)

THE SCREEN GRID FIVE SHORT WAVE RECEIVER

By EDWARD G. INGRAM

This short-wave receiver described in detail by Mr. Ingram is designed to operate on A.C. and employs the '24 screen grid tube for R.F. detector and first A.F. stages; fringe howl is eliminated by resistance coupling.

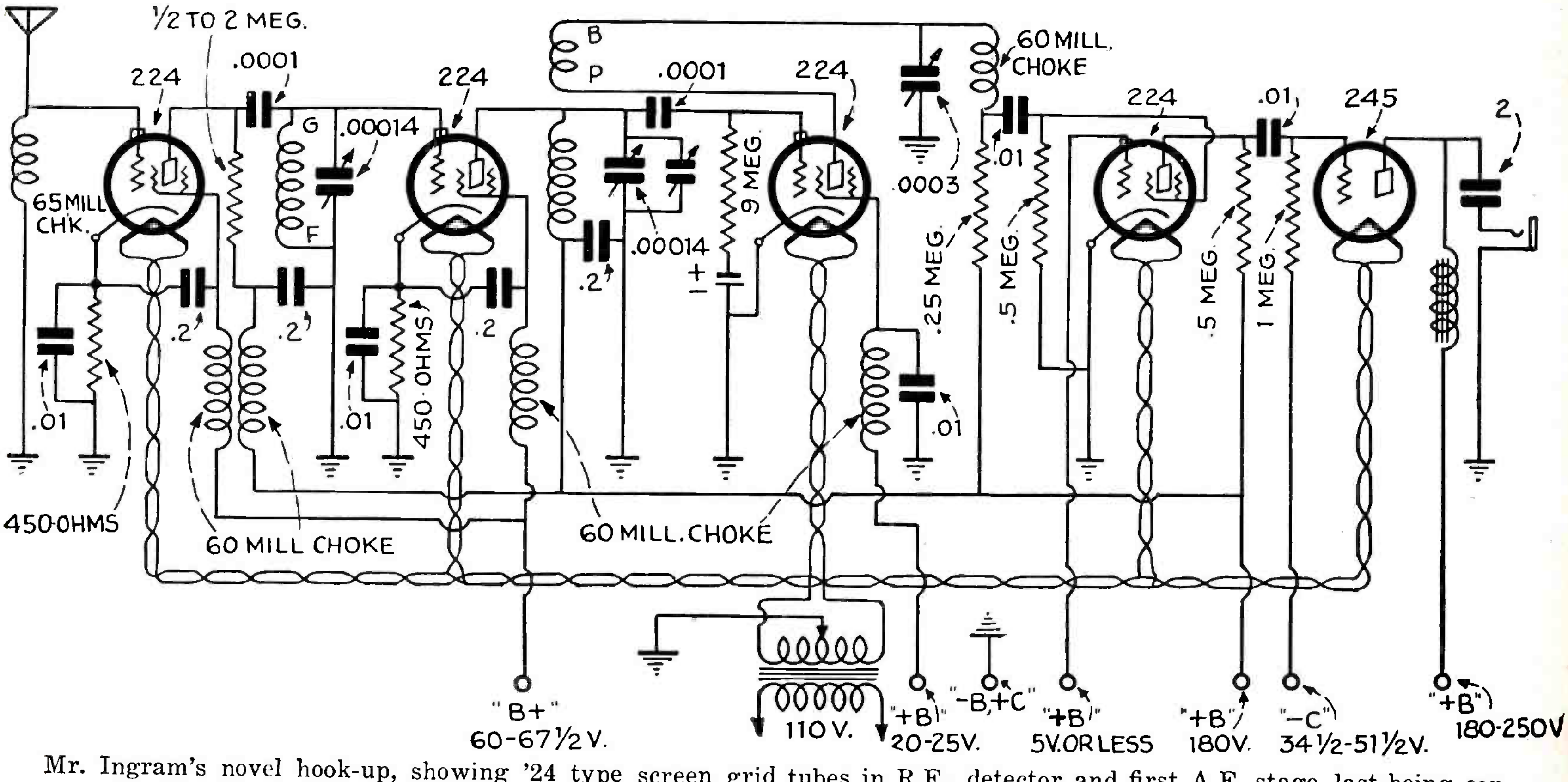
WHILE marked progress has been made recently in short wave receiver design, those who have had experience with the performance of receivers meant primarily for the reception of distant phone stations will admit there still is room for further improvement. It is not an easy matter to obtain sufficient volume and sensitivity for consistent loud-speaker reception of distant stations in Europe and other foreign countries without too much complication and expense.

In the audio-frequency end of the receiver, also, difficulty was experienced because of the effect of the first stage on loss in amplification due to the low gain of the resistance stage.

Advantages of '24 Tube

Recently attention has been focused on the A. C. tube for short wave work, and improved results have been obtained; but, in the writer's opinion, the full possibilities of the type '24 screen-grid tube have not been taken advantage of, and this is the chief reason for the present article.

The '24 screen-grid tube, used as a radio-frequency amplifier, has an amplification constant of 420 as against 300 for its D. C. companion; this means greatly increased sensitivity. The A. C. type '27 tube shows some superiority over D. C. tubes (like the '01A) for the detector and audio stages; so that sets recently placed on the market, with '24s in the tuned R. F. stages and '27s in the detector and audio stages, show a very marked improvement in performance over like sets with D. C. tubes.



Mr. Ingram's novel hook-up, showing '24 type screen grid tubes in R.F., detector and first A.F. stage, last being connected as a space charge amplifier. Second audio stage uses '45 tube with choke and condenser output filter.

While foreign stations often are receied with good loud-speaker volume on very simple sets (such as those with an untuned R. F. stage, a regenerative detector and two stages of A. F. amplification), frequently reception conditions are such that the need of more amplification keenly is felt.

Until recently all of the developmental work on short wave receivers has been done with D. C. tubes. The advent of the '22 type D. C. screen-grid tube with its low grid-plate capacity made stable, R. F. amplification at high frequencies a possibility and brought about a marked gain in sensitivity. But the gain with one tuned stage of radio frquency was still not enough, and the addition of more stages required too many controls; for ganging of the tuning condensers was not found very practicable.

what is known as "threshold oscillation" in the detector tube. Threshold oscillation, or "fringe howl," is the rasping howl which sets in just as the detector goes into oscillation when advancing the regeneration control. This usually occurs when the detector is worked into a transformer stage of audio frequency amplification. It can be prevented frequently by the use of a certain amount of resistance across the secondary of the transformer; but if this has to be less than 500,000 ohms, as usually is the case, sensitivity is impaired. The best solution is to make the detector work into a resistance-coupled stage of amplification, which is now done extensively. With the detector plate potential supplied through a high resistance, the oscillation difficulty is overcome; but unfortunately there is a

But human nature is not easily satisfied and we still seek for further improvement. The resistance-coupled stage, even with a '27 tube, is still a weak point in the A. F. end of the receiver; and if this could be improved upon, and a further gain also obtained in the radio frequency-detector without additional controls, we would be approaching a type of receiver with a

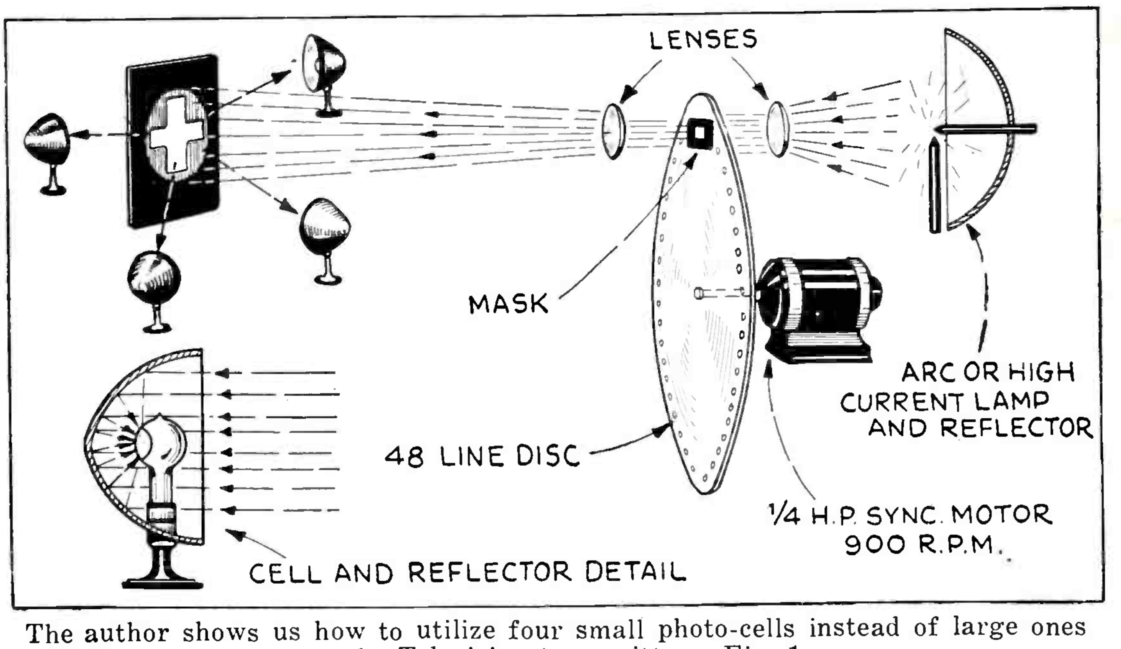
(*Continued on page 330*)

Possibilities in Amateur

Television on Short Waves

By C. H. W. NASON

The Transmitter—how to use small photo cells and details of the amplifier to pass a wide band of frequencies.



The author shows us how to utilize four small photo-cells instead of large ones at the Television transmitter. Fig. 1.

I BELIEVE that there will be none to contradict me when I say that none of the major radio developments have come out of the research laboratories of the larger corporations. Television offers an unparalleled opportunity to the amateur investigator, not only as regards satisfaction from results obtained, but also from pecuniary return.

Regardless of the present state of the art, television will sooner or later become an integral part of the nation's entertainment. When that time arrives, the field will undoubtedly be controlled, as broadcasting is now, by some few large interests who will be willing to purchase any patents belonging to independent investigators and the lack of which might lay them open to suit in the prosecution of their plans. Regardless of all that has been said of the helplessness of the little fellow, it has been proven, time and again, that the larger organizations would much rather pay a fair price for a valuable idea than to risk the loss of a suit or the loss of the public's good will through the adverse publicity which might result.

There are two reasons why the amateur should be interested in the problems of television transmission. The obvious one is that ideas, which might be developed in the field of transmission, might need experimental research with equipment readily available; the other is that, in developing an idea regarding reception of the television signal, it is not always possible or convenient to utilize the signals available. By this I do not mean that an actual carrier must be propagated; for the same results may be attained by modulating a low-powered oscillator not capable of reaching beyond the walls of the laboratory, or by wire-line transmissions within the walls of the laboratory.

Contrary to the general view, the best medium for the amateur is not the transmission of film but the actual pick-up of persons or objects. The equipment necessary for the construction of an "indirect pick-up" or beam-scanning system is far simpler mechanically than that required for the transmission of film, where an arrangement to provide a constant speed of advance for the film is required. For amateur work, other than in the most pretentious installations, the employment of "direct pick-up," where the subject is brilliantly lighted and we scan an image projected on the disc by a high-quality photographic lens, is entirely out of the question, because of the highly developed lighting system required.

Amount of Amplification Required

It is not necessary to employ large and expensive photoelectric cells in such an installation; as exceedingly fine work can be done with smaller cells placed at the focal point of fairly large parabolic reflectors. An elementary arrangement for such a system is shown in Fig. 1. The voltage output from the cells, under normal conditions of lighting, will be in the neighborhood of 5 microvolts. This means that, in order to modulate a low-powered transmitter, or operate a neon tube for monitoring purposes, we must employ amplifiers having a combined gain of about twenty million. Without recourse to any calculations, the writer hazards the estimate that this might be done with about eight stages of amplification.

Shielding for such a system (except for that mechanical shielding found necessary in avoiding microphonic disturbance) would not be difficult; and the normal method of accomplishment would be through the use of a photo-cell amplifier of two stages, an intermediate or low-level amplifier of three stages, and a main amplifier employing another three stages. These would, preferably, be separately shielded and provided with their own power sources. No great difficulty would be experienced in operating the final amplifier from A.C.

In order to avoid picking up extraneous disturbances, it is advisable to employ a low-impedance tube in the output of each of these amplifiers; so that the leads interconnecting them will constitute a low impedance circuit and be less apt to pick up strays. The amplifier circuit

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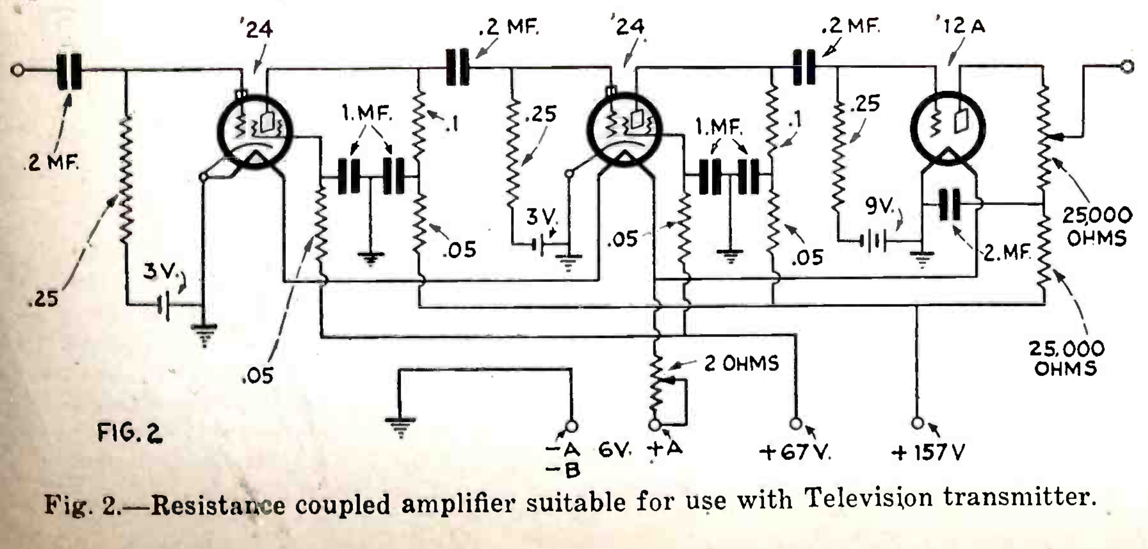

Fig. 2.—Resistance coupled amplifier suitable for use with Television transmitter.

A 19 TUBE SHORT WAVE RECEIVER Used for TRANS-ATLANTIC RECEPTION

By DR. FRITZ NOACK
(Berlin)

Interesting details of German Commercial S-W Receiver, used for phone, code and picture reception. It has trans-Atlantic range and many novel points of value to all S-W students.

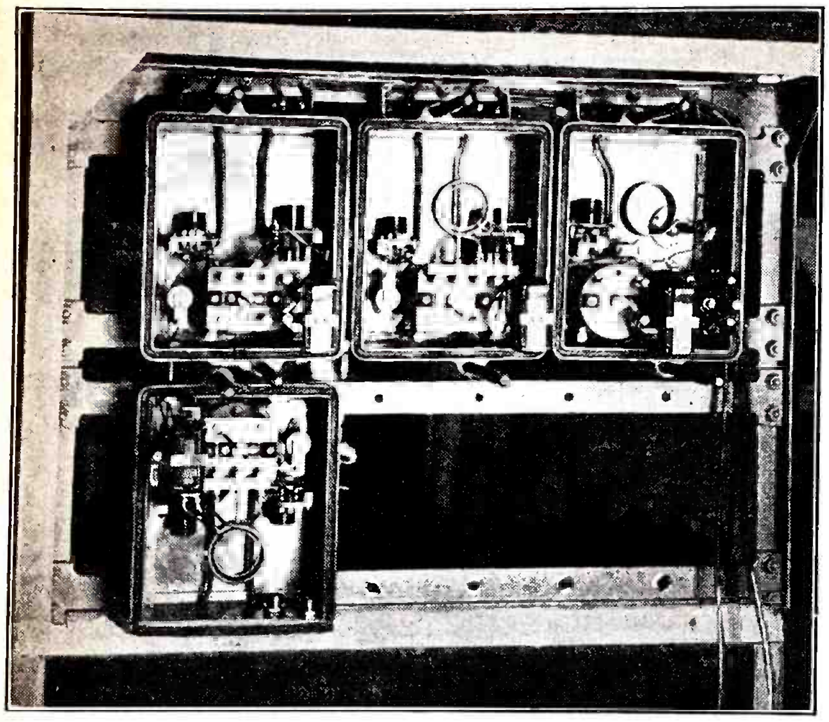

Fig. 2—Rear view of the four short-wave, radio frequency stages in their separate stage shields.

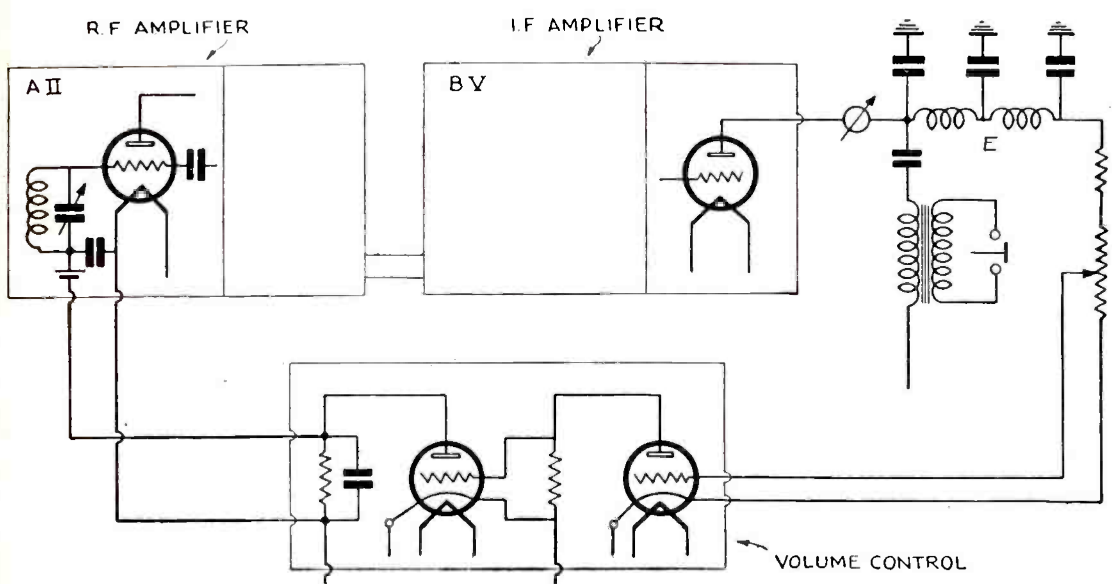

Fig. 5—Circuit of automatic volume control as used in 19 tube S-W receiver.

IN a preceding issue of SHORT WAVE CRAFT the writer gave a brief account of the new receiver which has been developed by the Telefunken Co., for overseas radio traffic. This set, a super-heterodyne with four stages of short-wave R. F. amplification ahead of the first detector, and four stages in the intermediate-frequency amplifier, is intended to amplify the lowest perceptible signals to full volume; while an automatic volume control compensates for unduly loud signals and gives an even output. In addition to this, a special device brings out code signals strongly while interference is suppressed.

This very interesting receiver is illustrated here, and its schematic circuit is shown for the interest it will arouse in all short-wave enthusiasts—whether they will attempt so ambitious a feat of construction or not. Fig. 1 is a front view of the complete receiver, and Fig. 2 shows the radio-frequency amplifier in its separate stage shields.

The schematic circuit is shown in Fig. 3, and the keying arrangement used for telegraphy in Fig. 4; while the connections of the automatic volume regulator control used for phone work are given in Fig. 5.

Frequency-Changing System

The first R. F. stage, A-I takes the signal from the antenna; whence it passes through the succeeding three R. F. stages, A-II-III-IV, to the first detector A-V, and is then modulated with the local frequency generated by the oscillator unit A-VI. Each of the latter stages, like the R. F. stages illustrated, is cased in a separate large bronze shield can.

The unit A-VI comprises two tubes, connected in parallel and operated from a small oscillator, whose radio-frequency energy is amplified by them; while a neutralizing connection prevents feedback into the oscillator, which might affect the constancy of its frequency. The coupling from the unit to the first detector is variable, for better adjustment of the over-all amplification of the receiver.

The intermediate-frequency output of the first detector is then amplified by the four stages B-I-II-III-IV, which are tuned to 300 kilocycles; these stages are separately shielded by copper boxes; and the coupling filters pass a band of 6,000 cycles, so that the audio frequencies ac-

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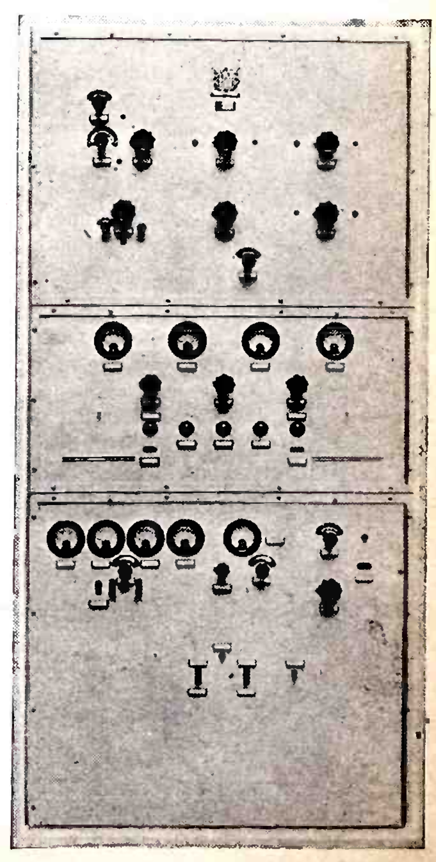
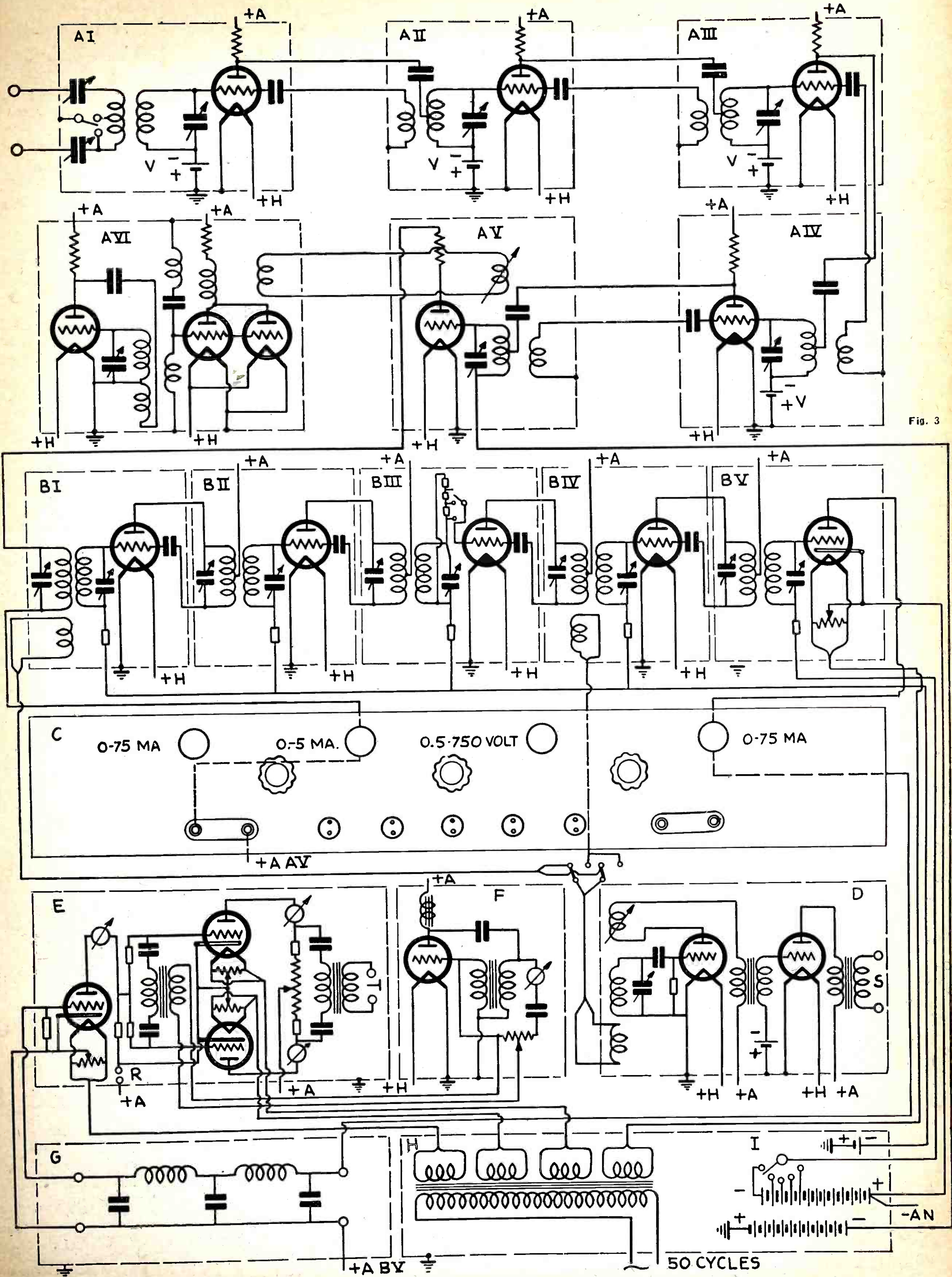


Fig. 1—Front view of 19 tube trans-Atlantic S-W receiver.



Short-wave radio frequency amplifier, 4 stages A I, II, III, and IV. First detector at A V; oscillator at A VI; four intermediate amplifier stages B I, II, III, and IV with second detector at B V; control panel at C; listening circuit at D; E—photo recorder and amplifier; F—tone generator; G—band pass filter; H—transformer supplying heater current; I-C—bias battery; —AN is B—.

A Sensitive and Selective
Short Wave Receiver

By R. WILLIAM TANNER (W8AD)

Mr. Tanner, well-known designer and builder of short-wave transmitting and receiving sets, here presents us with one of his newest ideas—a short-wave receiver provided with switches for changing to the various wavelength bands instead of having to bother with plug-in coils. This set has a stage of shield grid R. F. amplification ahead of the detector to improve the sensitivity. The wavelength range of this set is 15 to 550 meters. The set is designed for A.C. operation.

ONE of the most sensitive and selective short wave receivers ever built by the writer consisted of only four tubes with a screen grid tube as a regenerative space charge detector. In place of the usual set of four to five plug-in coils, an arrangement of stationary inductances was employed, shifting to the various bands being accomplished by means of multi-point switches. In order to be of the greatest possible service, a two section variable condenser was used for tuning, regular 200 to 550 meter broadcasting being received on the largest inductance by connecting both sections in parallel.

The experimenter who desires a receiver capable of tuning from 15 to 550 meters and giving good quality, sensitivity and selectivity with incomparable ease of adjustment will do well to consider this outfit. For the benefit of such experimenters a detailed description will be given.

First let it be stated that shielding will not improve the operation in the least except, possibly, to decrease the pickup of the coils, wiring, etc. Stage shielding is needed ONLY when the R.F. amplifier is tuned.

In the diagram in Fig. 1 is depicted the complete schematic circuit. It will be noticed that this is an A.C. hookup. If good standard makes of tubes are employed, the amount of hum present in the phones or loud speaker will be negligible. The first tube is a type 224 in an untuned stage with a variable grid bias resistor for controlling volume, a necessity in the broadcast band. The second tube is the space charge detector. A high degree of selectivity is obtained by connecting the R.F. plate to taps on the main coils. A close examination of the coil arrangement will reveal the fact that only one coil is in circuit at a time, thereby overcoming the old horror of dead-end losses.

General Features

The detector employs plate detection to improve the tone quality of broadcasting, and also to increase selectivity by raising the input impedance of the tube. The

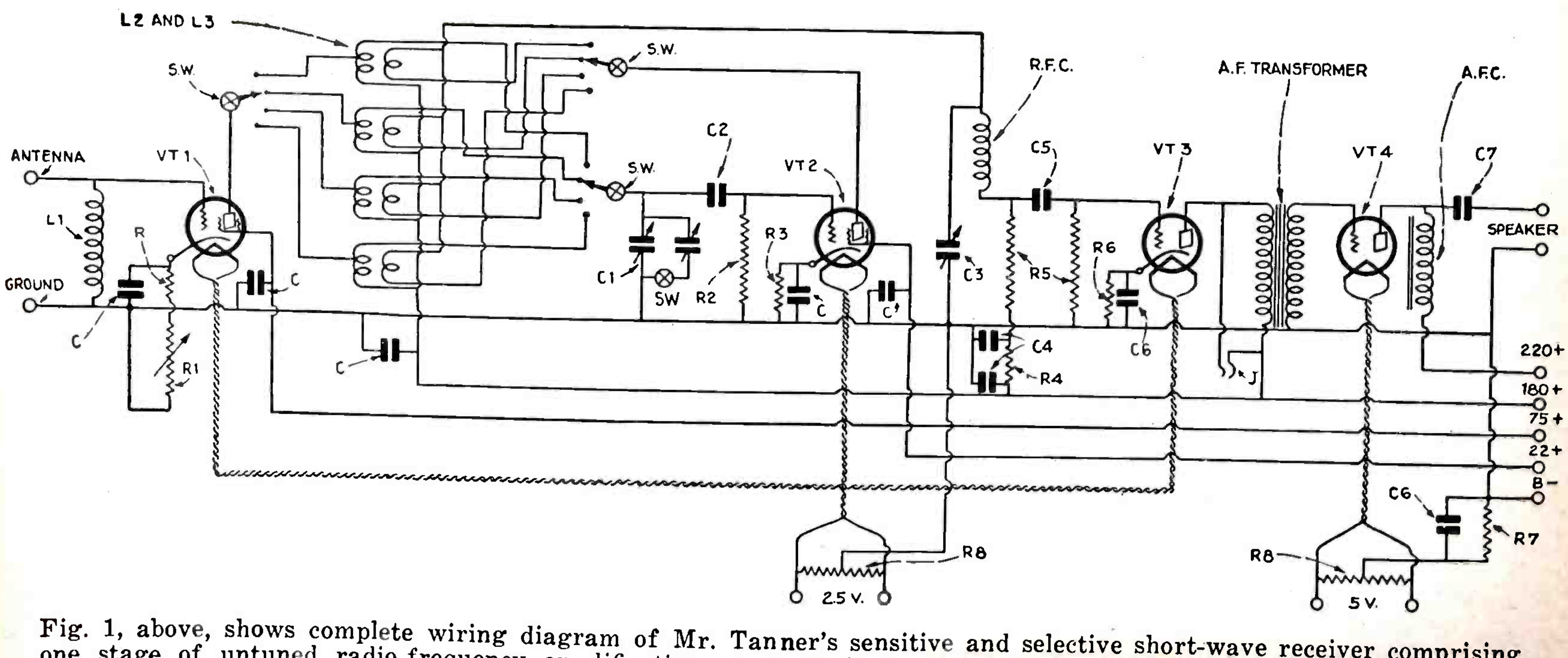


Fig. 1, above, shows complete wiring diagram of Mr. Tanner's sensitive and selective short-wave receiver comprising one stage of untuned radio-frequency amplification, regenerative detector and two stages of audio amplification.

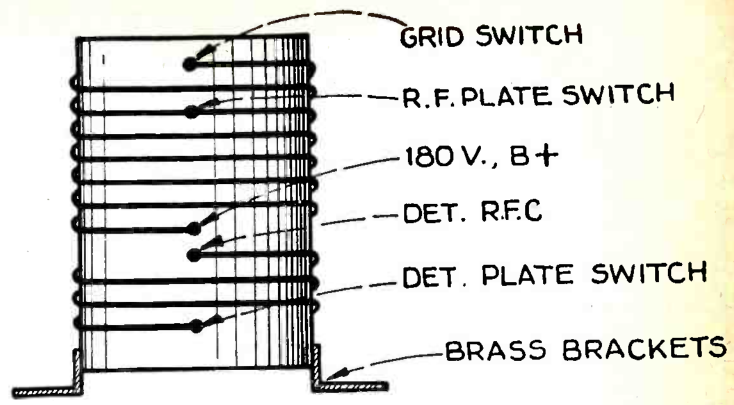
negative bias is not great enough to appreciably effect the sensitivity. Regeneration is obtained by the "throttle" or bypass condenser method and, when the screen grid voltage is of the correct value, is very smooth, in fact, it is almost impossible to notice the oscillation point due to the absence of regenerative hiss, so prominent in other detectors. The space charge connection is superior to the screen grid connection from tone quality standpoint although slightly less sensitive. Regeneration can be obtained down to approximately 15 meters. Below that the tube becomes rather unstable due to the high plate to screen grid capacity.

The detector output is resistance-coupled to a type 227 first A. F. stage. The A. F. transformer coupling this tube to the 171A power stage has a telephone jack across the primary to provide headphone operation, always desirable in short wave receivers. A "motor-boating" preventer is used in the B positive lead to the detector and is quite an important item although not absolutely necessary in all sets. This consists of a resistor R^4 and two bypass condensers C^4.

All of the parts are mounted on a 7" by 18" metal panel and a 17" by 8" wooden baseboard ½" thick. A cabinet was not used on the original model but one is desirable to keep out dust. A pair of 1" bakelite sub-panel brackets are employed to allow space underneath for the bypass condensers, resistors, etc., for the sake of compactness and ease of wiring.

The antenna R. F. choke L1 is easily wound by the constructor. It consists of 350 turns of No. 36 enamel wire scramble wound on a common thread spool ¾" or 1" in diameter. The 500 ohm resistor R limits the bias to a low value of approximately 2 volts. The variable 50,000 ohm resistor R1 controls volume by increasing the bias. All of the bypass condensers C have a capacity of .1 mfd. It will be noted that no R. F. choke is shown in the R. F. screen grid or B positive leads. It has been worked out in practice that such chokes in a single R. F. stage, whether tuned or untuned, are unnecessary. The only effect of their absence would be feedback in the detector and increasing regeneration. If these items are not needed, then why use them?

Fig. 2 shows how windings for radio-frequency transformer are placed on the supporting tubes, together with brass brackets for mounting the coils.



The Short-Wave Coils

The four coils are, perhaps, the most difficult parts of the whole receiver to construct. Three 4 point switches and four 1½" bakelite tubes are needed together with a small quantity of wire, a few brass machine bolts, soldering lugs, eight small brass angles and two ⅛" bakelite plates 5" square. In the interest of economy the four coil forms are of different lengths. These are given in the coil table accompanying this article. A 6¼" length may be purchased and cut to the required sizes by the individual.

The grid coils are wound first, slightly spacing the turns of the 20 and 40 meter coils. The ticklers are started ⅛" from the grid windings and close wound with No. 30 enamel wire. Detuning effects of the regeneration control will then be considerably less than if large wire was used. The windings should not come within ⅜" from the edges of the forms in order to allow sufficient space for the connecting screws and angle brackets. The leads are soldered to lugs held to the forms with machine bolts. Details are shown in Fig. 2.

The layout of the four coils is given in Fig. 3A. The coils are assembled on the base with the grid ends up so that the grid leads to the switches will be short and direct. The layout for the three band switches is shown in Fig. 3B. Exact dimensions cannot be given as so many types and sizes are available. The levers should have a radius of not more than 1¼". Both plates have holes drilled in the corners for four ⅜" brass pillars, which are drilled and threaded for 8/32 bolts. This unit is assembled, after the wiring is finished, by placing a pillar at each of the four corners.

Tuning Condenser

Now for the tuning condenser. The back section of a two-gang .00035 mfd condenser is cut down to the required capacity by removing some of the rotor plates. The exact number needed will depend upon the size of the plates; however three will usually be sufficient, the resulting capacity then being in the vicinity of .000125 to .00016 mfd. To connect the two sections in parallel for broadcast reception, merely cut a slot and drill a hole in a brass strip ⅜" wide to fit over the terminal posts of each section.

The detector bias resistor R3 has a value of 10,000 ohms and may well be semi-variable to provide smooth oscillations. A 25 watt Truvolt resistor fitted with a slider is ideal for this purpose. The

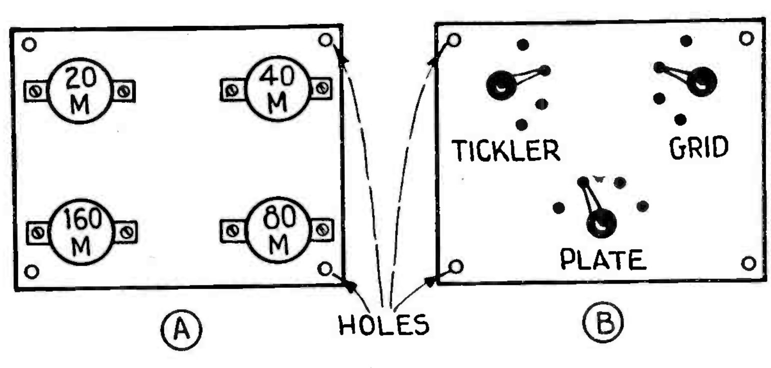


Fig. 3 shows how tapped coils are mounted and the wavelength change switches arranged.

higher the resistance the greater will be the number of turns required for each tickler.

Now for just a word in regard to the choice of the .0005 mfd regeneration condenser C3; oscillations are more easily controlled if this is of the straight line capacity type rather than of the modern straight line frequency type due to the slower capacity increase at the high end of the scale. Then tuning in on short wave broadcasts or other telephone stations, zero beat tuning is sometimes beneficial towards both sensitivity and selectivity. For this work the advantages of a vernier dial on the regeneration condenser is readily apparent.

or speaker filter consists of a 30 Henry B-eliminator choke and a 2 mfd, 600 volt condenser. A negative bias of 13 volts is applied to the grid of the 227 by taking the voltage drop across R6, of 2000 ohms resistance, in the cathode load. This is bypassed with a 1 mfd condenser. The 171A obtains a bias of approximately 40 volts from a 2100 ohm resistor, also bypassed by a 1 mfd condenser, connected from the center tap of the 5 volt filament resistor to B negative.

A suggested arrangement of parts is shown in Fig. 4. All of the bypass condensers, resistors (except the resistance coupler) and detector R. F. choke are located under the baseboard. It is a good plan to run all R. F. current carrying wires first, making them as short and as direct as possible. Then run the filament, B and C wires wherever they will fit in without coming too close to R. F. wires. In the model it was found unnecessary to use twisted pair for the filaments, however, it seems to be good practice to do so.

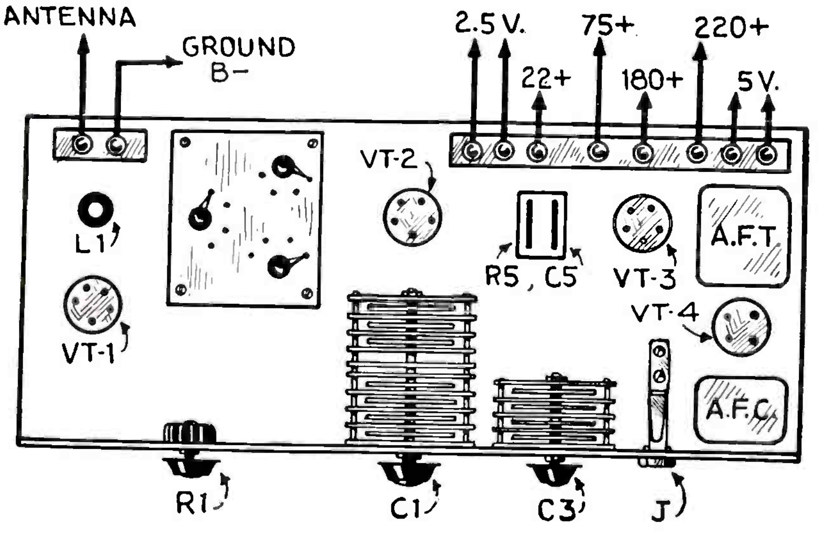


Fig. 4 shows the author's arrangement of the various instruments comprising the sensitive and selective short-wave receiver described in the accompanying article. The wavelength change switch box and its coils are shown at the rear left of sub-panel.

The R. F. choke RFC, used to keep the R. F. currents out of the audio amplifier, should have an inductance of approximately 85 MH. The resistor R4 and condenser C4 comprise the audio filter and is very effective in preventing motorboating, a condition which causes much trouble when employing a screen grid tube as a detector in a short wave receiver. A resistor of 25,000 ohms with 2 mfd bypass condensers are about the right values.

Audio Amplifier Details

The two stage audio amplifier is of the conventional type, the first stage using a 227 tube resistance coupled to the detector. The last stage is transformer coupled and employs a 171A for loud speaker operation. An open circuit telephone jack is connected across the primary to allow the use of headphones when desired. The output

After the parts are all mounted and the wiring completed, the tubes may be inserted in their respective sockets and the external connections made. As all brands of tubes do not have exactly the same characteristics, it will probably be necessary to modify the tickler coils somewhat but first turn on the filaments and test the plate voltages at the terminal posts. The values should be very close to those specified in the diagram in Fig. 1.

Checking Up Regeneration

To determine if the ticklers have the correct number of turns, first throw the switches to the 20 meter coil and set the tuning condenser C1 at maximum capacity with only the small section in circuit and slowly increase the capacity of the regeneration condenser. If oscillations start below 50 degrees on the dial, the tickler is too large and one turn must be removed or else audio howling will be the result when C3 is increased. One turn will be enough to take off from this coil.

The same procedure is followed with the other coils. If the tube refuses to oscillate with any of the four coils when C3 is at maximum, the tickler leads may be reversed. If such is not the case more turns will have to be added. It will take a pretty poor detector tube to refuse to oscillate at some point on the regeneration condenser with the tickler turns as specified, providing the connections are correct. In order to provide sufficient regeneration with the largest of the coils in conjunction with both sections of C1 for broadcast reception, oscillations may start below 50 degress on the regeneration dial when only the small section is used, however, audio howling should not be troublesome at these waves.

If it is at all possible to vary the detector screen grid voltage, regeneration can be made very smooth. This is not extremely critical but requires a little care in getting the right value.

Alternating current hum should be at a very small minimum even when using headphones on the low waves. A fixed condenser of from .006 to .01 may be found necessary connected across one-half of the 2.5 volt filament resistor. The hum should not increase at the point of oscillation if good tubes are employed.

Tuning is accomplished in the usual manner, however, with the space charge detector, the resulting sensitivity is rather high, and selectivity may be improved by setting the volume control at a high value. Then tune in the station with the detector oscillating. Reduce the regeneration control to

(*Continued on page* 329)

Short-Wave Stations—When to Listen

Kilo-
Meters cycles

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

5.83 51,400—**W2XBC**, New Brunswick, N. J.

7.32 41,000—**W8XI**, East Pittsburgh, Penna.

8.57 35,000—**W2XCU**, Ampere, N. J.

8.67 34,600—**W2XBC**, New Brunswick, N. J.

9.68 31,000—**W8XI**, Pittsburgh, Pa.

9.96 30,105—....Golfo Aranci, Sardinia. Telephone to Rome.

10.51 29,190—**PK313**, Sourabaya, Java, Wed. and Sat., 5:50-7:50 a.m.

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

11.67 25,700—**W2XBC**, New Brunswick, N. J.

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.

13.92 21,540—**W8XK**, Pittsburgh, Pa.

13.97 21,460—**W2XAL**, New York.

14.01 21,400—**WLO**, Lawrence, N. J., transatlantic phone.

14.06 21,320—**DIV**, Nauen, Germany.

14.15 21,130—**LSN**, Monte Grande, Argentina.
—**W2XAO**, New Brunswick, N. J.

14.50 20,680—**LSN**, Monte Grande, Argentina, after 10:30 p. m. Telephony with Europe.
—**FMB**, Tamatave, Madagascar.
—**PMB**, Bandoeng, Java.
—**FSR**, Paris-Saigon phone.

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

14.89 20,140—**DGW**, Nauen, Germany. Tests 10 a.m.-3 p.m.

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.

15.07 19,906—....Monte Grande, Argentina. 8-10 a.m.

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.

15.94 18,820—**PLE**, Bandoeng, Java. 5.40-6:40 a.m. and from 2:40 a.m. Tues. and Fri.; 8:40-10:40 a.m. Tues. Also telephony.
—....Saigon, Indio-China.

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—**FRO, FRE**, Ste. Assise, 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").
—**W2XAO**, New Brunswick, N. J.

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

16.87 17,780—**W8XK**, Pittsburgh, **Pa.**

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

17.10 17,350—**G2IV**, S.S. "Majestic."
—**G2GN**, "Olympic."

17.34 17,300—**W2XK**, Schenectady, N. Y. Tues., Thurs., Sat. 12 to 5 p.m. General Electric Co.
—**W8XL**, Dayton, Ohio.
—**W6XN**, Oakland, Calif.
—**W6AJ**, Oakland, Calif.
—**W7XA**, Portland, Ore.
—**W7XC**, Seattle, Wash.
—**W2XCU, Ampere, N. J.**
—**W9XL**, Anoka, Minn., and other experimental stations.

17.52 17,110—**WOO**, Deal, N. J. Transatlantic phone.

18.10 16,560—**G2AA**, ship phone.

18.37 16,320—**VLK**, Sydney, Australia. Phone to England.

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

18.50 16,200—**FRE**, Saigon, Indo-China.

18.56 16,150—**GBX**, Rughy, England.

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 1:30 pm., relaying WGY.

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.

19.72 15,210—**W8XK** (KDKA) Pittsburgh, Pa. Tues., Thu., Sat., Sun., 8 a.m. to noon.

19.83 15,120....Vatican City (Rome).

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

20.00 14,990—**VK6AG**, Perth, Australia.

20.50 14,620—**WMI**, Deal, N. J.

20.70 14,480—**W8XK**, East Pittsburgh, Pa.
—**GBW**, Rugby, England.
—**WNC**, Deal, N. J.

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

20.90 14,340—**G2NM**, Sonning-on-Thames, England. Sundays 12:30-2 p.m.

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

21.50 13,940—....Bucharest, Roumania, 2-5 p.m. Wed., Sat.

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

22.20 13,500—....Vienna, Austria.

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

22.50 13,325—**G2IV**, S.S. "Majestic."
—**G2GN**, S.S. "Olympic."

23.00 13,043—**OBE**, La Punta, Peru. Time Signals 2 p.m.
—...."Radio-Maroc," Rabat, Morocco, 8-9 a.m. Tues., Thurs., Sat.

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

Kilo-
Meters cycles

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.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental relay broadcasters.

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.
—**GBS**, Rugby, England.

24.63 12,280—**Airplane.**

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

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.
—....Oporto, Portugal.

25.10 11,945—**KKQ**, Bolinas, Calif.

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).

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

25.36 11,820—**KIXR**, Manila, P. I., 5-6 p.m., 11:15 a.m.-12:15 p.m., 2-4 a.m., and (except Monday) 5-10 a.m.
—....Calcutta, India.

(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.)

25.42 11,800—**UOR2**, Vienna, Austria. Tues., 9-11 a.m.; Wed., 5-7 p.m.; Thurs., 5-7 a.m.

25.53 11,750—**G5SW**, Chelmsford, England. 7:30-8:30 a.m. and 2-7 p.m. except Saturdays and Sundays.

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.

26.22 11,435—**DHC**, Nauen, Germany.

26.70 11,230—**WSBN**, SS. "Leviathan" and A. T. & T. telephone connection.
—**IBDK**, S.S. "Elettra," Marconi's yacht.

27.75 10,800—**GBX**, Rugby, England.

28.20 10,630—**PLR**, Bandoeng, Java. Works with Holland and France weekdays from 7 a.m.; sometimes after 9:30.

28.44 10,540—**WLO**, Lawrence, N. J.

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

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.
—**LSX**, Buenos Aires, Argentina, 8-10 p.m.

29.00 10,340—....Paris, France. 1:30-3 p.m. daily; 9 a.m. Sundays.

29.50 10,160—**HS2PJ**, Bangkok, Siam. Sun., Tues., Fri., 8-11 p.m.

29.70 10,095—...."Radio Experimental," Paris, France. From 5:45 p.m. daily: Sunday at 7 a.m. and 2 p.m.

29.98 10,000—**CM2LA**, Havana, Cuba.
—....Belgrade, Jugoslavia. Monday 3-4 p.m.

30.15 9,940—**GBU**, Rugby, England.

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

30.30 9,890—**LSN**, Buenos Aires, phone to Europe.

30.50 9,830—**NRH**, Heredia, Costa Rica. 5-6 and 9-10 p.m. Amando Cespedes Marin, Apartado 40.

30.64 9,790—**GBW**, Rugby, England.

30.75 9,750—....Agen, France. Tues. and Fri., 3 to 4:15 p.m.
—**WNC**, Deal, N. J.

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.

31.26 9,590—**PCJ**, Hilversum (Eindhoven) Holland. Wed. 5-9 p.m.; Thu. 7-9, 11-12 p.m.; Fri. 7-9 p.m., 1-4 a.m. Sat. 1-7 a.m., N. V. Philips Radio.

31.28 9,580—**W3XAU**, Byberry, Pa., relays WCAU daily.
—**VPD**, Suva, Fiji Islands.

31.35 9,570—**W1XAZ**, Springfield, Mass. (WBZ).

Kilo-
Meters cycles

31.36 9,560—....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.
—**NAA**, Arlington, Va.
—**KIXR**, Manila, P. I.
—**ZL2XX**, Wellington, New Zealand.

31.48 9,530—**W2XAF**, Schenectady, New York. Mon., Tues., Thurs. and Sat. nights, relays WGY 5:30-11 p.m., daily. General Electric Co.
—**W9XA**, Denver, Colorado. Relays KOA.
—....Helsingfors, Finland.

31.56 9,500—**OZ7RL**, Copenhagen, Denmark. Around 7 p.m.

31.60 9,490—**OXY**, Lyngby, Denmark. 1 p.m.

31.80 9,430—**XDA**, Mexico City, Mex.
—....Posen, Poland. Tues. 1:45-4:45 p.m.; Thu. 1:30-8 p.m.

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

32.06 9,350—**CM2MK**, Havana, Cuba.

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

32.40 9,250—**GBK**, Bodmin, England.

32.50 9,230—**FL**, Paris, France (Eiffel Tower) Time signals 4:56 a.m. and 4:56 p.m.
—**VK2BL**, Sydney, Australia.

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

32.80 9,110—**SUS**, Cairo, Egypt.

33.25 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.
—**HKF**, Bogota, Colombia.

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.
—**W2XV**, New York City.
—**W8XAG**, Dayton, Ohio.
—**W6XN**, Oakland.
—**W4XG**, Miami, Fla.
—And other experimental stations.

34.74 8,630—**WOO**, Deal, N. J.

35.00 8,570—**RB15**, Khabarovsk, Siberia. 5-7:30 a.m.

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.
—**HS4PJ**, Bangkok, Siam. Sunday 8-10 a.m.

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

37.43 8,015—**Airplanes.**

37.65 7,980—**VK2ME**, Sydney, Australia.

37.80 7,930—**DOA**, Doeberitz, Germany. I 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. Assise, France.
—**PCK**, Kootwijk, Holland. 9 a.m. to 7 p.m.

39.15 7,660—**FTL**, Ste. Assize.

39.70 7,550—....SS. "Bremen."

40.00 7,500—...."Radio-Touraine," France.

40.20 7,460—**YR**, Lyons, France. Daily except Sun., 10:30 to 1:30 a.m.

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

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 5:30 and 10 a.m.

42.12 7,120—**OZ7RL**, Copenhagen, Denmark. **Irregular.** Around 7 p.m.

42.50 7,060—....Liakov Islands (north of Siberia).

42.70 7,020—**EAR125**, Madrid, Spain. 6-7 p.m.

42.80 7,000—**F8KR**, Constantin, Algeria.

43.00 6,980—**EAR 110**, Madrid, Spain. Tues. and Sat., 5:30 to 7 p.m., Fri. 7 to 8 p.m.
—**CTIAA**, 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.
—**D4AFF**, Coethen, Germany, Sundays 4-6 a.m.; Tuesdays, Fridays, noon-2 p.m.; Thursdays 4-6 p.m.

44.40 6,753—**WND**, Deal, N. J.

44.60 6,720—**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.
—**W4XG**, Miami, Fla.

46.70 6,425—**W2XCU**, Ampere, N. J.;—**W9XL**, Anoka, Minn.; and others.

47.00 6,380—**CT3AG**, Funchal, Madeira Island. **Sat.** 5-7 p.m.
—**HC1BR**, Quito, Ecuador, 8-11 p.m.

47.35 6,335—**W1OXZ. Airplane Television.**
—**VE9AP**, Drummondville, Canada.

48.00 6,250—...."Radio-Maroc," Rabat, Morocco.

48.30 6,205—**HKC**, Bogota, Colombia. 9:45-11:30 p.m.

48.62 6,170—**HRB**, Tegucigalpa, Honduras. 8:15-11 p.m., Mon., Wed., Fri., Sat. Int. S. W. Club program. Sat. 11:30-12 p.m.

48.74 6,155—**W9XAL**, Chicago, Ill. (WMAC) and Airplanes.

48.83 6,140—**KIXR**, Manila, P. I. 3-4:30, 5-9 or 10 a.m. 2-3 a.m. Sundays.
—**W8XK**, East Pittsburgh, Pa. Hu., Thu., Sat., Sun., 5 p.m. to midnight.

48.99 6,120—....Motala, Sweden, "Rundradio." 6:30-7 a.m., 11-4:30 p.m. Holidays, 5 a.m.-5 p.m.
—**NAA**, Arlington, Va.
—....Chi-Hoa (Saigon), Indo-China. 6:30-7:30 a.m.
—**W2XE**, New York City. Relays **WABC.** Atlantic Broadcasting Co.
—**FL**, Eiffel Tower, Paris, 5:30-5:45 a.m., 5:45-12:30, 4:15-4:45 p.m.
—....Toulouse, France. Sunday 2:30-4 p.m.
—**MTH**, Rio de Janeiro, Brazil. 5-7 p.m.
—**EAR25**, Barcelona, Spain. 3-4 p.m.

(*Continued on page 329*)

How to Make and Raise
A 60 Ft. Wood Tower

By RICHARD CARMAN

This tower, constructed of light wood strips, is surprisingly strong and easily erected. Shorter towers of the same design can readily be built. Suitable rope guys should be fastened to the tower to steady it during high winds.

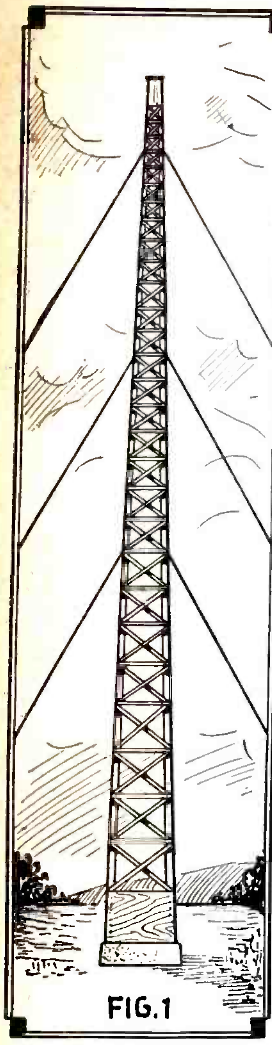


FIG. 1

Appearance of the finished 60 foot radio tower. Of course the tower can be built in any size desired. Rope guys can be used.

HOW many amateur radio operators look at, or hear about, somebody's 60-foot wooden mast with a great deal of awe and admiration, and yet hesitate to make one because of the supposed difficulties in building and erecting it? As a matter of fact, it is a quite simple, inexpensive and easy job, and one which you can be justly proud of when completed. The advantages of a wooden mast are, of course, obvious and much to be desired by the amateur who is collecting those real DX cards.

The mast consists of four longerons, each 60 feet in length, made up of 2 x 1 inch clear pine, and is braced with ordinary lath or wood of similar dimensions, and some of the 2 x 1 pieces are shown in Fig. 3. The highest five feet of the mast are covered with plywood and with one piece of wood at the top, as shown in Fig. 4; this is made as waterproof as possible. It is advisable to paint the entire mast with creosote or some tar-content roof paint. It will simplify the painting very much if the longerons and each section are painted as they are completed. A concrete base must be (or should be) prepared for the mast to rest on, and should extend well below the frost line, be absolutely level and mixed to procure the hardest stone possible.

The first operation in making the mast is to build up the longerons. Secure 2 x 1-inch lumber, dressed and knot-free, and 15 feet long. Take one 15-foot piece and cut it exactly in half; take another piece 15 feet long and place it side by side with the first, even at one end, so that the two form a combined piece of wood 2 x 2 inches. Nail them firmly together. (If possible, it will produce a much better job to glue and nail them together.) Note Fig. 2.

From this start, build up the entire length of the spar, lapping one piece of wood over the other till you have the 60 feet. At the top you will be able to use the other 7½-foot piece of wood that you sawed off to start the bottom section of the longeron. Make four of these spars 60 feet long. If you use glue, be sure to clamp them together long enough for them to set.

When the four are completed, take two of them and lay them on something as flat as possible, such as a sidewalk or a series of wooden horses that are absolutely level with one another. Place the bottom ends 3 feet 6 inches apart, measuring from the outermost sides, and place the tops 2 inches apart from each other. Now establish two string lines on each longeron and pull tight, so that you will have a guide to keep the tower absolutely straight as you build up the braces. Nail temporary braces every few feet up the mast to assist in keeping the longerons in the proper position as you nail and glue the permanent braces. At the bottom of the mast fit a board 1 inch thick by 15 inches wide for a base, as shown in Fig. 5, and then put on the braces by gluing and nailing them. Put them in in the order numbered, and thus up the entire length of the mast, except the last 5 feet, which will be braced with a single piece of plywood.

A very simple way to keep the mast absolutely symmetrical all the way up is to use a bevel protractor. Make the first "criss-cross" brace as nearly square as possible; then set your protractor to this angle, as shown in Fig. 6. By using the protractor for a guide for the "criss-

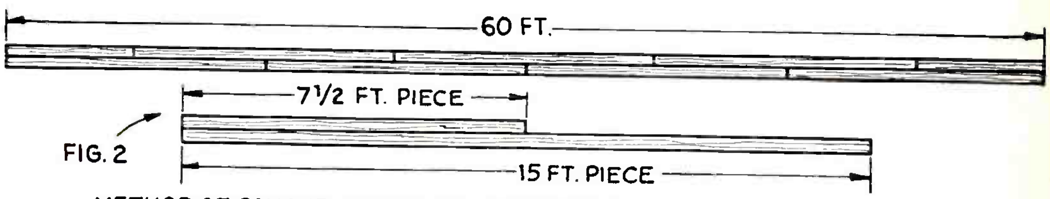


FIG. 2

METHOD OF CONSTRUCTION OF LONGERONS

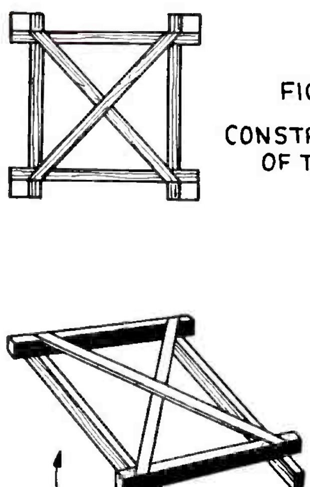


FIG. 3

CONSTRUCTION OF SQUARE BRACES

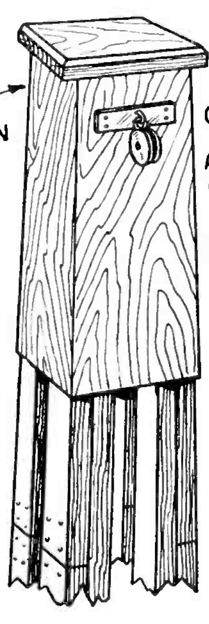


FIG. 4

CONSTRUCTION OF TOP

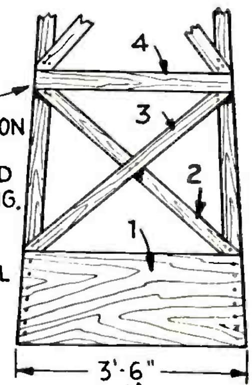


FIG. 5

CONSTRUCTION OF BASE AND METHOD OF STARTING. ATTACH PIECES IN NUMERICAL ORDER

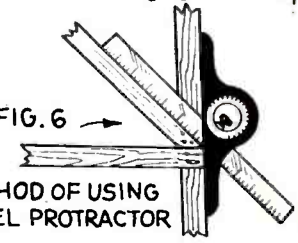


FIG. 6

METHOD OF USING BEVEL PROTRACTOR

Fig. 2 above shows how longerons are lapped; other details of construction are shown by Figs. 3, 4, 5 and 6.

crosses" along the entire length of the mast, you will obtain a very perfect looking job. When you have criss-crossed up to within 5 feet of the top, fit a piece of plywood over the remaining distance, as shown in Fig. 4. When this is completed you have finished one section of the mast.

Assembling the Two Sections

Now take the other two longerons and duplicate exactly the section you have just completed. When these sections are finished and painted stand them on their sides, absolutely parallel to each other, with the braces facing outward. Establish temporary braces and string lines the entire length of the mast, so that when you nail and glue the braces on the sides they will exactly duplicate the sides you have just completed. At the bottom place a brace, as shown in Fig. 3, using pieces of the 2 x 1 for the square braces and the laths for the criss-cross. Place one of these at the bottom, and others approximately every 8 feet, all the way up. These braces will look better if you space them evenly with one of the horizontal braces between the "criss-crosses" each time.

When you have placed all the "square-braces" you are ready to fit your board on the bottom on one side and proceed up to the top as before with the horizontal braces and the "criss-crosses." When you have finished this side, turn the mast over and finish that side. When you have thus completed the four sides, finish off the tip with plywood (which may be taken from an old packing box). Glue and nail this in place and finish off the top as shown in Fig. 4.

Now take a ring bolt long enough to reach through the top of the mast, and reinforce its hold with a brass or metal strip which will extend far enough to get the support of the longerons. Drill one hole in the strip to pass the bolt, and several small holes so that you may place small screws into the plywood to make it fast. Now attach the best weatherproof pulley that you can buy, and through this pass the rope (also of excellent quality) to be attached later to your antenna. Finish painting the mast.

Guy wires or ropes must be used, either two or three sets, according to the amount of bad weather in your particular locality. They are secured directly around the longerons at a point where the square braces are in place. The top guys need not be attached any higher than the beginning of the plywood, if you have been careful in constructing this top part so that it is firm and weatherproof.

Construct a concrete base that will extend 8 or 10 inches over and beyond the dimensions of the base of the mast.

The concrete should extend well below the frost line and must be perfectly level. The mast may be fastened to it by placing pieces of 2 x 4 wood around its base and nailing these to the mast, and using anchor bolts to hold the 2 x 4's to the concrete base.

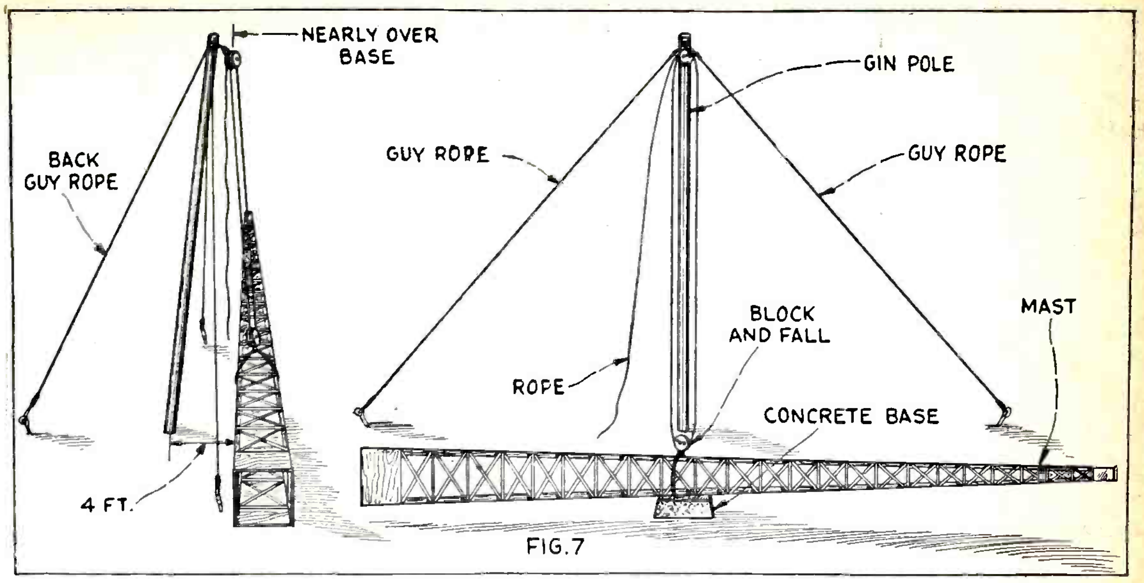
Another method is to put several bolts or pieces of metal bracing in the original base and let the concrete harden with the bolts protruding at points that will not interfere with the mast coming to rest on the concrete. Be sure the base of the mast is well waterproofed; then place it on the concrete base and pour concrete around the edges and center and let it harden. The protruding bolts or braces will then firmly hold it in place.

Raising the Mast

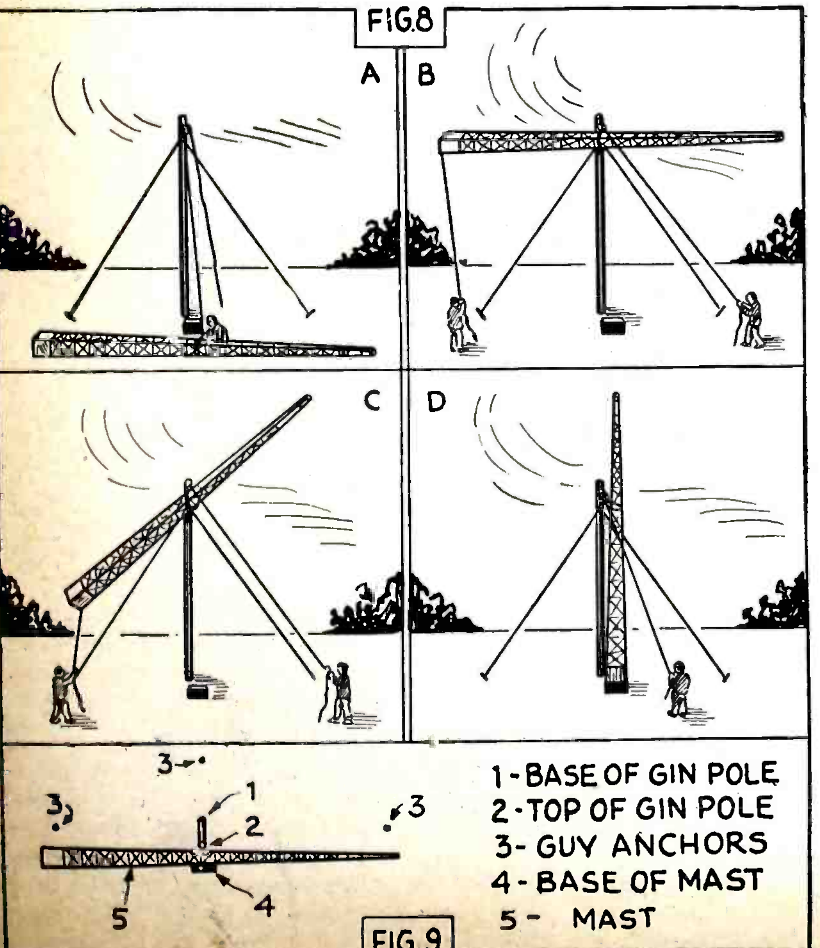
There may be many ways in which to raise a tall mast or tower, but the easiest and safest is described below; this is known as the "gin-pole method." Not only is it very easy, but only two or three persons are needed to operate the entire equipment. At no time is the mast in danger of slipping or getting beyond control, as may happen with other methods of erecting it.

Place the mast so that the center of balance is directly over the base on which it is to rest. Attach all the guy wires, and place the rope in the pulley, being sure that all are sufficiently long. Now place the gin pole (which must be at least 2 feet taller than the distance between the center of balance of the mast and the base of it) with its foot at a point about 4 or 5 feet away from the concrete base, and its top almost over the concrete base. Fasten the base of the pole so that it will not slip; then place the three guy wires or ropes so that the two on the side are well forward of the base (as shown in Fig. 9) and the rear one is back far enough so that the gin pole will be held in place quite firmly with no danger of slipping. Now place a block and fall at the top of the gin pole, and attach the other end to the mast by passing a rope around the body of the mast two or three times.

(*Continued on page* 316)



Above we see the author's suggested method of raising the 60 foot tower by means of a gin pole.



Figs. 8 and 9 here show progressive stages in the raising of the 60 ft. radio tower. When the tower has been hoisted by the means of block and fall as at B, the rope attached to the base is used to pull the mast to the vertical position in D.

Short Wave Question Box

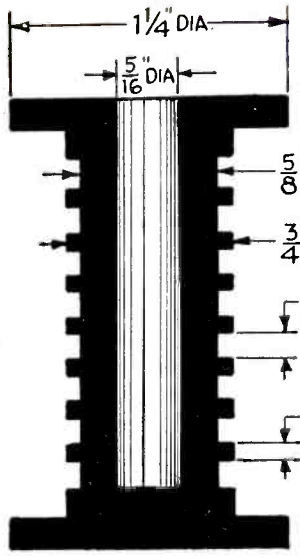
Edited by R. William Tanner, W8AD

THIS question and answer department is edicted 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 publishers' address. State your questions briefly. Questions cannot be answered by mail.

R. F. Choke Winding Data

(22) A. F. Gagen, Southold, N. Y., asks:

Q. 1. In the description of Fig. 6 (page 49, June-July issue of SHORT WAVE CRAFT) mention is made of a blocking condenser C9, used to prevent shorting the "A" battery. What is to prevent a short-circuit occurring through the metal shield, "A+," and parts of R1 and R3 back to "A—"?



Radio frequency choke coil winding form.

A. 1. The diagram you mention shows the lower end of L1 connected to ground; this ground is not required since the coil L1 is already grounded through the .01-mf. condenser C9.

Q. 2. The accompanying sketch shows a bakelite form which was originally a de Forest R.F. transformer. Can this be used for an R.F. choke? If so, how many turns will be needed for short waves?

A. 2. This type of form is suitable for winding an R.F. choke. A total of 650 turns of No. 36 enamel wire should be wound, 25 turns in the first slot, 50 in the second, 75 in the third, 100 in each of the remaining slots. The lead from the 25-turn section is to be connected to the point of high R.F. potential.

Rheostat Question

(23) Chas. Vogel, Bronx, N. Y., wants to know:

Q. 1. Is a rheostat necessary in the circuit shown in Fig. 4 (page 51, June-July issue of SHORT WAVE CRAFT)?

A. 1. If the filament supply is 6 volts, a 2- to 6-ohm rheostat should be connected in the "A+" lead.

Q. 2. Can I use a 100,000-ohm "Volumgrad" for the detector potentiometer?

A. 2. Yes, this will be suitable.

Q. 3. Can common ¼-megohm grid leaks be used for the detector plate and A. F. grid resistors?

A. 3. Yes, if they are of a reliable make. It would be well to try other values than ¼-megohm.

Adapter

(24) Sam Cohn, San Francisco, Calif., wants to know:

Q. 1. Which type of adapter would be best for use with a "Model 52" Atwater Kent all-electric receiver?

A. 1. The Super Short-Wave Converter will give greater distance, selectivity and volume than any other type of adapter. The schematic circuit is shown in the diagram herewith. This unit converts any broadcast receiver into the intermediate-frequency amplifier of a super-heterodyne, but using all of the tubes (in the broadcasting set) instead of just the audio amplifier, as with other adapters. Foreign stations can be brought in at a volume almost equal to regular broadcasts.

Calculating Inductance

(25) E. S. Banta, Roselle, N. J., writes this department:

Q. 1. I would like to know a formula for computing the inductance of short-wave coils.

A. 1. Nagaoka's formulae is given herewith:

$$L = \frac{.00987 \times d^2 \times N^2}{b} \times K$$

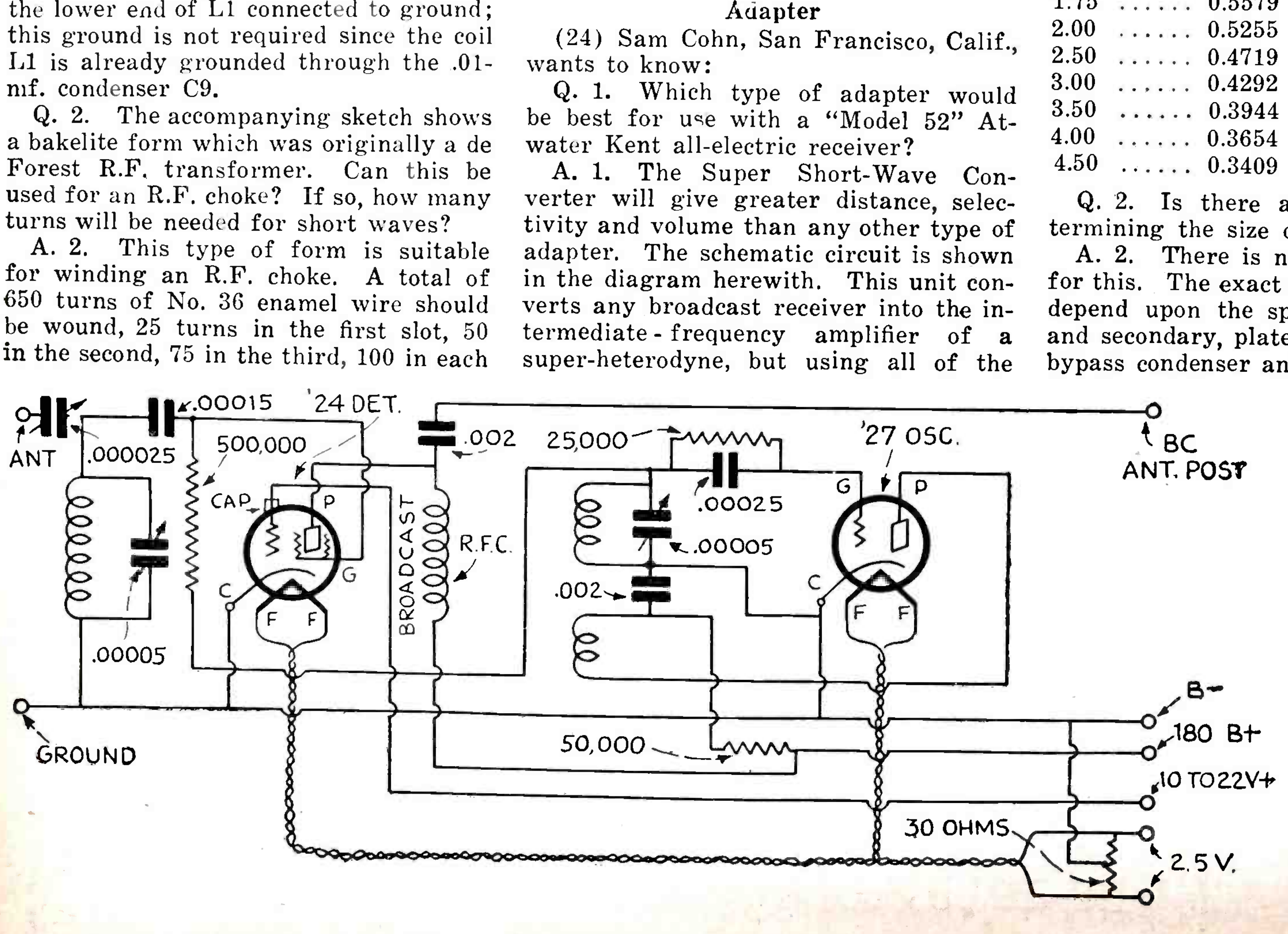
Where L is in microhenries.
d is the diameter of the coil in centimeters (an inch equals 2.54 cm.)
N is the total number of turns.
b is the length of the coil in centimeters.
K is a fraction whose value for any ratio of d/b must be taken from the accompanying table.

TABLE OF K

d/b	K	d/b	K
1.00	0.6884	5.00	0.3198
1.25	0.6381	6.00	0.2854
1.50	0.5950	7.00	0.2584
1.75	0.5579	8.00	0.2366
2.00	0.5255	9.00	0.2185
2.50	0.4719	10.00	0.2033
3.00	0.4292	12.00	0.1790
3.50	0.3944	15.00	0.1527
4.00	0.3654	20.00	0.1236
4.50	0.3409	25.00	0.1045

Q. 2. Is there any formula for determining the size of ticklers?

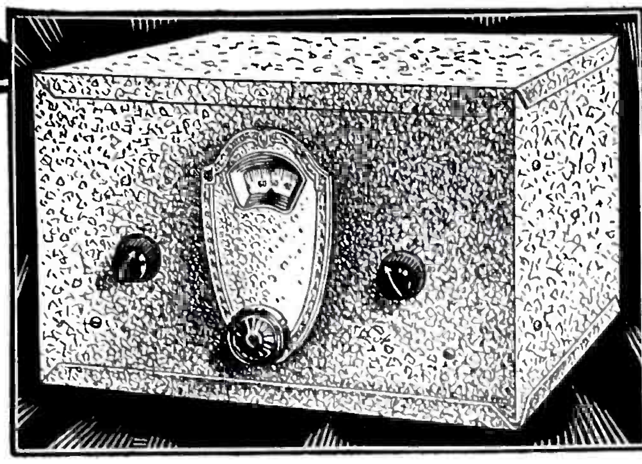
A. 2. There is no particular formula for this. The exact number of turns will depend upon the spacing of the tickler and secondary, plate voltage, capacity of bypass condenser and value of grid leak.



Special short-wave adapter designed for use in conjunction with the Model 52 Atwater Kent A.C. Receiver.

SM

Foreign Programs in Your Own Living-Room!



The S-M 738 is a self-contained converter that makes a powerful short-wave superheterodyne when attached to *any* broadcast set.

There is nothing that the finest commercial short-wave receiver (costing three times as much) will do, that the 738 will not duplicate and beat if your broadcast receiver has any punch at all. Under favorable weather and local receiving conditions, it will give you every American short-wave broadcaster and the principal foreign stations—for to *every bit* of the sensitivity and selectivity of your broadcast set is added the additional power of a 224, and a 227 tube!

The 738 Converter is built in a beautiful black crystalline case with a hammered silver dial escutcheon—a credit to any living-room.

The wired model can be hooked up in three minutes—you merely remove the antenna lead from the broadcast receiver and connect it to the antenna post of the converter; then run two leads from the 738 to the antenna and ground posts of the broadcast set. That's all.

It tunes by a single dial, (which tunes the oscillator circuit) and an auxiliary midget condenser.

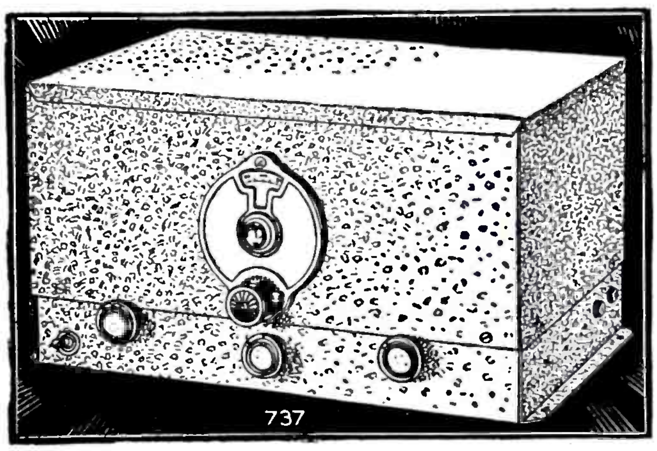
It will give, in addition to short-wave broadcasting, phone and i.c.w. where there is any carrier modulation at all.

Included in the list price are eight coils (four pairs) which cover the wave length range of from 18 to 206 meters. Tubes required: 1—'24, 1—'26, 1—'27.

Price, completely factory-wired, tested and RCA licensed, less only tubes..................$69.50 *List*
Component parts total.........................$59.50 *List*

S-M 737 Bearcat

5,000 to 10,000 Miles



The Bearcat is a self-contained, a. c., short-wave receiver that *is* a bearcat. Operated with an S-M 850, 870 or any other above-average speaker, it will give loudspeaker code and short-wave broadcast programs ranging up to 5,000 or even 10,000 miles, depending on weather and local receiving conditions.

The Bearcat consists of one stage of tuned a. c. screen-grid r. f. amplification using a '24 tube followed by a '27 detector of the regenerative type. The detector is resistance-coupled to a '24 screen-grid first audio tube which in turn feeds through a stage of resistance to a '45 power output tube. The power supply, operating from any 105-120 volt, 50-60 cycle alternating current lighting circuit, uses an '80 rectifier and provides all A, B and C power for the receiver.

One of the 737's outstanding points of superiority is the built-in midget condenser that allows spreading of the amateur bands over 180 degrees by a turn of the wrist. In addition, it gives very satisfactory vernier control on short-wave broadcasting—particularly foreign stations that are so difficult to tune in on the average short-wave receiver.

Price, completely factory-wired, tested and RCA licensed, less tubes and speaker..........$139.60 *List*
Component parts total...........................$119.50 *List*

And *Superheterodyne* Broadcast Receivers

Ask your nearest jobber about the two finest broadcast receivers ever built — the *nine-tuned-circuit* 724 superheterodyne and the *eleven-tuned-circuit* 714 superheterodyne tuner — or write for your copy of the new SILVER-MARSHALL GENERAL PARTS CATALOG.

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----Send your NEW 1931 CATALOG with sample copy of the RADIOBUILDER. Also Data Sheets as follows: (*Enclose 2c for each Data Sheet desired.*)
----No. 21. 737 Short-Wave Bearcat.
----No. 23. 738 Short-Wave Superhet Converter.
----No. 24. 724 Screen-Grid Superhet Receiver.
----No. 25. 714 Screen-Grid Superhet Tuner.

Name..

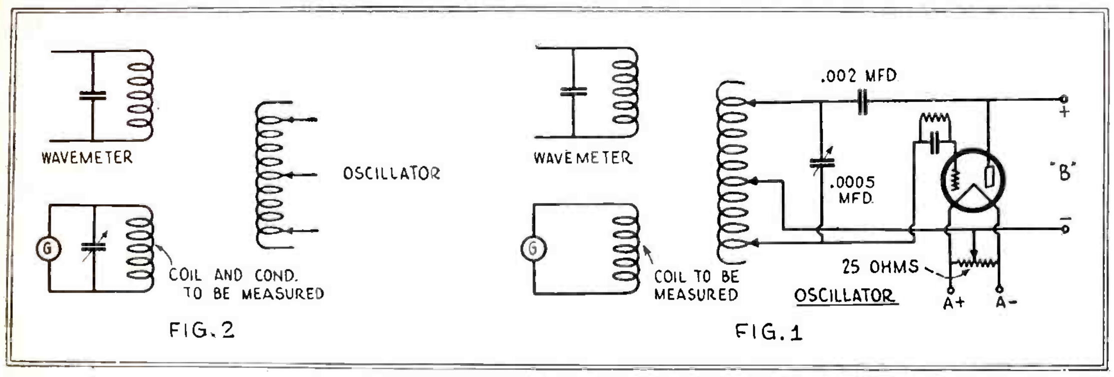
Address..

Measuring the Fundamental Wavelength *of* A Coil *or* Coil *and* Condenser

By MELVERN H. BERRY

EVERY Radio Fan has known of a time when he would give a portion of his anatomy to have some means to test the fundamental wavelength of his coils before placing them in his set to see what they would do. For real accurate results it is impossible to obtain the information without some laboratory testing apparatus.

Most every radio fan has an oscillator and a wave meter. If you have a calibrated oscillator, it will be much better.



The two schematic arrangements above indicate the proper connections and coil relations to be observed when determining the wavelength range of a particular coil, or coil-and-condenser.

A neat and accurate galvanometer can be made for a few cents by winding a few turns of fine wire on a form one inch square. Hang this solenoid between the poles of a horseshoe magnet, allowing the ends of the coil to support it.

Place the galvanometer across the ends of the coil to be measured, Fig. 1, and bring the coil in close proximity to the coil of the oscillator. Rotate the dial of the oscillator until there is resonance between the two coils. When the wave-length of the oscillator is the same as that of the coil to be measured a current will be noted to flow in the galvanometer. The indication may be very slight. The amount of deflection of the galvanometer depends upon its sensitivity and the coupling of the two coils. If your oscillator is calibrated the fundamental wave-length can be read right from the curve.

If your oscillator is not calibrated it will be necessary to employ a wavemeter to get the wavelength of your coil. This can be done by bringing your wavemeter (absorption type) close to the coil to be measured, and when the resonance of the meter is adjusted to coincide with the frequency of the oscillator there will be a second deflection of the galvanometer *towards zero*. The actual maximum fundamental can be read directly from the meter or from the curve.

When using as a test for the wave-length of a coil and condenser combination, refer to Fig. 2.

It will be necessary to put a radio frequency choke coil in the lead from "B" plus to plate. Otherwise, the battery resistance would probably be so low there would not be sufficient radio frequency voltage drop to cause circuit oscillation. This choke may be of any convenient size. On an ordinary thread spool, 250 turns of 30 to 36 gauge wire with almost any kind of insulation would work well.

It must be noted that incorrect coupling of the absorption circuit to the circuit under test will result in double hump resonance,—the indicating device will register at two different wave lengths quite close together. To remedy this it is only necessary to loosen the coupling until the two resonance points merge into one. (It might be of interest to point out that this phenomenon is harnessed to furnish the circuit selectivity of the Hammarlund Hi-Q29 receiver, where the coupling has been reduced to one per cent.)

Instead of the 25-ohm potentiometer diagrammed, it is suggested that a 300- or 400-ohm one be used if a battery type tube is used rather than one of the A.C. type.

Also, the oscillator may work more smoothly if the grid leak connects to filament of the tube. The negative "A" is the correct side for an oscillator.

The .002 mfd. fixed condenser must be of high grade as the "B" potential is impressed on it at all times.

It must be remembered that loose coupling must be maintained between coils, if maximum accuracy is to be realized. As it is necessary to have a frequency or wavelength standard from which to work, such a standard must be built or purchased. A simple method for calibrating a home-constructed unit is to use the tuned circuit as an absorption trap in conjunction with a regular radio set, setting the eventual wavemeter so that it "tunes out" the carrier of a broadcast station using crystal control; these stations can be depended upon to be adjusted to their assigned frequency. Once the dial readings for these frequencies have been determined, the rough calibration of a "wavemeter" has been accomplished. Plotting these values on graph paper will supply intermediate values.—(*Courtesy Radio-Craft.*)

Looking Ahead With Short Waves

By DR. ALFRED N. GOLDSMITH

(*Continued from page* 265)

patience. Most assuredly he wants to tune in the overseas signals direct, without the intermediary of the R.C.A. and N.B.C. facilities. But from the standpoint of enjoying the overseas programs, *as reliable programs*, there can be no other choice than the retransmitted signals available to all broadcast listeners tuned in on the N.B.C. networks.

Can Short Waves Extend Over Broadcast Spectrum?

Another moot point is that of using short-wave signals for multiplying the number of broadcast channels. At a glance, the suggestion appears logical. Upon study, however, it represents many and serious drawbacks. While a few suitable channels might be added directly below the present 200-meter broadcast band, the shorter waves are hardly applicable to broadcast requirements. Thus, with standard broadcast wave lengths, engineers can closely determine the coverage of a transmitter. Range, service area, and probable number of listeners become subject to mathematical computation. And, since a broadcaster lives by the audience he commands, such precise information is much to be desired. With short waves, however, it is entirely different. There is the skip distance. There is absorption. There is the echo effect. There is a dead local area. In fact, practically nothing is certain about the service range of a short-wave transmitter employed for mass communication purposes. Ostensibly, the field of short-wave radio (between 15 and 100 meters) is for radio relays or connecting links between broadcasting systems, as a means of interchanging programs.

Future of Short Waves for Television

In radio television, short waves are certain to be employed in the future as well as at present. Where else can the television broadcaster hope to find the necessary elbow room for his necessarily wide signals? Here again, short-wave transmission presents many problems.

Thus, the higher frequencies are quite unsuitable for an area nearer than a hundred miles. Signals approaching the broadcast band must be employed for the purely local area; while shorter waves might be used to reach distant points. Then, it is necessary to employ carefully chosen wavelengths to overcome excessive absorption of signals, particularly in crowded localities. Different wavelengths may be employed during different hours of the day and night for distant work. Today, queer "echo" effects or double images, due to the reflection of the signals by the Heaviside layer, are obtained at the receiving end.

The idiosyncrasies of the higher-frequency signals are not the least of the many practical difficulties that stand in the way of radio television progress beyond the purely experimental status of today. And yet the very short waves below 10 meters may show extremely practical capabilities for television after further research.

Short-wave radio, the experimental field of today, is bound to become the practical field of tomorrow. The short-wave art is rapidly being reduced to standardized practice, based on sound engineering knowledge. In everyday communication, we have harnessed short waves down to 15 meters. Even the shorter waves are now being studied with promise of early commercial application. And, as the frontier of everyday radio is pushed back steadily, down the wave-length scale, the experimenter is always certain to find plenty of opportunities to pioneer and blaze the trail beside the engineers and commercial minds that follow along somewhat different paths, all leading to the continuous progress of radio.

How to Gain Detector Sensitivity

By MANDER BARNETT

(*Continued from page* 281)

antenna as loosely coupled as may be consistent with good results. This will also help to smooth out "dead spots" in the tuning, which are caused by the natural wavelength of the antenna. This trouble, of course, does not appear in receivers using a screen-grid tube in front of the detector.

In the accompanying diagram is shown a super-sensitive detector circuit in which every effort has been made to make it as smooth working as possible. R1 is a 2-meg. grid leak, and R2 is the 200-ohm potentiometer. C1 is a small by-pass condenser, about .0002-mf.; a larger capacity would possibly by-pass R. F. currents better, but would cause a cut-off in the notes of the higher musical scale. C2 is a 2-mf. condenser and this, together with the 20,000-ohm resistor, effectively decouples the detector circuit from the other audio and R. F. stages. C3 is merely for R. F. by-passing purposes and must be kept very small—.0002-mf. will do again here. This must be kept very small or otherwise it would tend to cancel out the effects of C2. Both R. F. and A. F. stages may, of course, be added to this detector circuit as required, and the owner of such a receiver will have the satisfaction of knowing that he is, at least, getting the best possible results from his detector stage, provided, of course, that high-quality components are used.

Can We Radio the Planets?

By HUGO GERNSBACK

(*Continued from page* 270)

dously important radio research work between points on our own planet.

Penetrating Short Waves

I am fully aware of the criticism that will at once be raised, that it is not possible for us to send a radio beam beyond the confines of our own atmosphere, due to the so-called Heaviside reflecting layer effect, which is supposed to exist a hundred or so miles above the surface of the earth. According to the researches of the eminent scientist, Oliver Heaviside, the upper layers of our atmosphere are supposed to be so conductive electrically, due to the ionizing effect existing at such heights, that the radio waves are reflected; and it would thus seem impossible that we could project a radio beam outside of the confines of the earth.

This may be perfectly true when it comes to the usual radio waves, such as have been used in the past varying from some 15 meters up to 25,000 meters; although I maintain, along with many other physicists, that the Heaviside effect has never been proven conclusively. I am equally certain that at lower wavelengths, say from two meters downwards, entirely different conditions appear, for the following reasons:

We know that radio waves are nothing but an electromagnetic activity, the same as light waves or heat waves. It is believed that, the lower down we go in the wavelength scale (that is, the higher the frequency), the easier it becomes to penetrate the Heaviside layer, if we grant its existence at all. Light comes to us, from the sun and the planets, through the Heaviside layer; so we know that the Heaviside layer cannot stop light waves. To be sure, the frequency of light waves is enormously higher than that of even the shortest radio waves; but it still seems reasonable that for waves of the length of two meters, or even less, the Heaviside layer should not cause us undue worry.

Incidentally, interplanetary conditions are about the same as we find in our present vacuum tubes. Fig. 1 shows a vacuum tube, in which (1) is the filament; (2) the grid; (3) the plate. Electrons are given out by the filament (1), and shoot in the direction of (3); but, surrounding the grid and the plate, there is a miniature Heaviside layer, composed of a slight amount of gas, which surrounds all metallic and other matter, and which the electrons must first pierce before they can reach the grid or the plate.

In the Interplanetary Vacuum

Given a reasonably strong bombardment of electrons, this internal tube "Heaviside layer" can be broken down as is well known. Conditions on earth seem to be similar. If we employ the right radio wave, with sufficient power behind it, it should be possible to pierce the supposed Heaviside layer and shoot the waves out into free space. In this we would be assisted by the force of the solar radiation itself. This is made plain in Fig. 2, which shows that our own planetary system is nothing but a vacuum-tube arrangement on a large scale. We have the sun in the center, with the planets outside, which in this case become the plate and grid of our celestial vacuum tube.

It will be noted that the solar radiation is in the direction of the arrows. It would seem, therefore, that a beam of the correct radio wave sent, let us say, from the earth to Mars, when in "conjunction," would stand a better chance of being transmitted than vice versa. For that reason, it would seem that a supposed signal emanating from Mars earthward would find it necessary to work against the stream of solar emanations, and encounter more resistance than if the case were reversed and the signal were sent from earth to Mars.

Marconi, in his recent researches, has shown that it is possible to conserve a great deal of energy by using his so-called "beam system." The beam system is nothing but a reflector arrangement whereby practically all of the energy is sent in one direction to the exclusion of other directions.

A Super-Reflector

Suppose we should now erect a tremendous power plant, which would use, let us say, 100,000 kilowatts, radiating the power on a wavelength of 2 meters or less, using the beam system of reflection. What would happen if such a tremendous amount of energy were let loose into the ether, we do not know today.

The question of sending intelligible messages to Mars or Venus need not be dealt with here at all, although it opens up interesting speculations. To the contrary, this discussion confines itself to practical scientific research, as will be apparent from a study of Fig. 3. It is known that radio waves can be reflected, just as light can be reflected, by means of a mirror. Hertz was the first to point this out, and Marconi is making use of the system by reflecting his beam, using metallic-screen reflectors to do so.

Scientists today are pretty well agreed upon the fact that the interior of the earth is composed largely of iron; practically every meteor that falls from the heavens is composed of iron; and practically every star investigated shows a large proportion of iron in its makeup. The conclusion, therefore, may be drawn that the moon, for instance, must therefore be largely composed of iron. It would therefore make an excellent reflecting medium.

Suppose now, that we proceed to erect our 100,000-kilowatt radio beam-transmitter at a point somewhere, indicated at A, on our globe. It will now be possible to direct a beam towards some point on the moon, where the angle of incidence will be suitable. The radio beam reflected, therefore, would come back to earth somewhere, shown at point B. It would be a simple matter for an astronomer to calculate the exact angle at which the beam should be sent, and it should be possible for an observer at B to detect the reflected beams, if reflected they are. This could be easily proven as follows:

The distance between the earth and the moon is, on the average, 238,854 miles.

Radio waves travel at the rate of, roughly, 186,000 miles each second. If both observers, at A and B, were using chronometers, and if a signal were sent from A at a certain time, the signal going out to the moon and reflected from it would be found to return to the earth in a little more than two and a half seconds. This would afford, therefore, a complete proof of the theory.

The same method might be used, perhaps, with other heavenly bodies, such as Mars or Venus; and would be of tremendous assistance to science in general, if found practical. What immediate benefits would be derived, in dollars and cents, I am in no position to state; although I believe many valuable discoveries, incidental to the effects produced, would no doubt be made sooner or later.

It has often been proposed to use the well-known Goddard rocket to explore the heavens, and have this rocket equipped with radio instruments which could send back a signal, thereby proving or disproving the Heaviside theory. It is possible, by means existing today, to construct such rockets. Indeed, the Society for the Exploration of the Universe, which is now being founded in Vienna, Austria, proposes to build such a rocket. Dr. Franz Hoeff, the noted Viennese scientist, and chief promoter of the plan, states that the first experiment, which is to be followed by others, can best be carried out with the rocket containing several kilograms of explosive flashlight as the only load. The shock accompanying the landing on the moon would bring the flashlight to explosion and, with the help of the modern telescopes, the explosion would be noticeable from the observatories of the earth.

It would seem quite simple to incorporate a radio set in such a rocket, at no excessive cost. Of course the radio set would no doubt be smashed to atoms when the rocket landed on the moon; but this need not worry us. The experiment is supposed to be made only to prove or disprove the Heaviside theory; and the signals, providing the apparatus functioned properly, could be sent back to the earth for a distance of some 238,000 miles, until the rocket actually struck the surface of the moon, when the signals would cease.

Analyzing the Earth's Interior

Aside from its utility in exploring the heavens, our super-power radio beam plan may, in addition, be used for terrestrial radio work; as the beam could, of course, be sent horizontally for scientific radio purposes. Important experiments could be carried out for underground radio by reflecting the beam earthward, as shown in Fig. 4. If, as many scientists have conjectured, the interior of the earth is an iron core, as shown in this illustration, the following important experiments can be made:

For many reasons it is desirable, today, to know the exact composition of the interior of our planet. If there is an iron core at the inside of the earth, as tentatively shown in Fig. 4, a power plant shown at A could project a beam in the direction of the arrow, emerging at B. By pointing the beam in various directions, it should be possible to ascertain the thickness of the metallic core quite accurately.

Many other important facts, would surely be discovered through experimentation of this kind on a large scale; and might, in time, be translated into dollars and cents, bringing great returns to the builders.

And last, but not least, the subject of communication between the planets can then be undertaken in earnest. If we find out, by experiment, that we can reflect a radio beam from the surface of the moon, we can be reasonably certain that, given sufficient power, the same beam system can be used to send signals to either Mars or Venus; as these two planets hold forth the greatest hope of being the abode of some sort of life.

I am of the opinion that, if interplanetary communication by radio waves becomes possible, it will be only through the instrumentality of short waves. I do not believe that our present radio instruments have been brought to such a state of perfection that they can intercept such signals; but I do believe that, during the next fifty years, the sensitivity of short-wave receivers will be made so great that it will be possible to receive the necessarily faint signals, which may have their origin millions and hundreds of millions of miles away.

At the present time it would seem no more foolish to build such a radio plant for the benefit of the radio art, than to build one of our tremendous telescopes.

How to Make a 60-Foot Wood Tower

By RICHARD CARMAN

(*Continued from page* 309)

You now tie to the base of the mast a light rope or clothesline long enough so that, when the mast is pulled up to the top of the gin pole, you may pull the base down to the ground and swing it to the concrete base.

Now pull up the mast to the top of the gin pole, with one person guiding the rope attached to the base. When it is at the top of the gin pole, pull the rope attached to the base and gently place it in position on the concrete base. Fasten the base down, and stay the guy wires for the mast itself.

If you cannot easily secure a gin pole strong enough (about 6 x 6, or two floor beams 2 x 8 inches nailed together in the same manner as your longerons of the mast), you may use a substantial ladder or extension ladder as a gin pole.

The writer will gladly give you any information you desire if you will address him, care of this magazine, and ENCLOSE A STAMPED AND ADDRESSED ENVELOPE.

A 19 Tube S-W Receiver

By DR. FRITZ NOACK

(*Continued from page* 302)

cepted are sufficient for telephone communication.

While a much narrower band would suffice for telegraphic work, the same coupling is used for this purpose; particularly as added certainty of reception is thus afforded, and also because telegraphic transmission of pictures is also contemplated. If desired, the frequency-band passed by these filters can be widened by adjusting the coupling of the individual filter circuits; for which purposes a calibration is provided.

Surplus Amplification Provided

The amplification factor of the R. F. amplifier is from 600 to 6,000 times, and that of the intermediate amplifier about 20,000; so that, under the most unfavorable signal conditions, the over-all amplification before the second detector is about 12,000,000. To permit a coarse adjustment of the factor of amplification, a potentiometer which can be turned completely off is incorporated in the in-

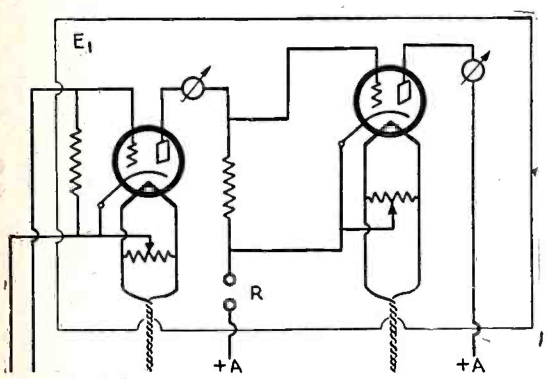


Fig. 4. For receiving code this circuit is used, with two tubes direct coupled, which work in opposite phases. Automatic high speed recorders are used, one being connected at R.

termediate stage B-III; by means of this, a signal strength varying from 30 to 50 volts is maintained on the grid of the second detector B-V. The direct-current intensity of the detector output is then about 6 milliamperes. For telephone reception, the potentiometer is so adjusted that the detector is relieved of half this load.

The R. F. amplifier uses interchangeable coils, each set covering a frequency band in the ratio of about 1:1.4; that is, the respective ranges are from 10 to 14, 14-20, 20-29 and 29-41 meters. To make the change, the covers of the shield cans are taken off; each coil is fixed to its mounting by the use of five thumbscrews. These coils are of the usual short-wave type, in number of turns.

From the second detector, the output is led to the relay unit E. For telephony, or picture reception, the switch "E-Bild" (picture) is used; for code, the key "E-Telegraphie" (Fig. 4). The former employs a final stage of push-pull amplification, the latter two direct-coupled tubes, which, because of their connection,

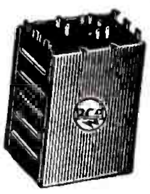
RADIO'S GREATEST VALUES!

ALL merchandise listed is BRAND NEW and is shipped in the original, factory sealed cartons and carries the same guarantee of ABSOLUTE SATISFACTION! Due to the demand for this seasonable merchandise actually exceeding the available supply, ACT IMMEDIATELY! (We reserve the right to return remittances, as soon as the supply of any one item is exhausted.) In most instances, our SALE PRICES ARE LOWER THAN THE ACTUAL MANUFACTURERS' COST! Join the ever swelling ranks of our 100% SATISFIED CUSTOMERS—WE HAVE YET TO RECEIVE OUR FIRST COMPLAINT.

Stewart-Warner Magnetic Chassis

New 1930 Self-Baffled Dyphonic Type. Do not confuse with earlier and cheaper models. An ultra-sensitive, loud speaker. Produced by one of radio's greatest companies. Extremely sensitive, tremendous volume without distortion or rattling. Reproduces with absolute fidelity. Speaker uses a power action unit avoiding chattering even under unusual volume. Oversize magnet. We guarantee satisfaction. Cone diameter 9 in. In factory sealed carton. Shipping weight 6 lbs.
List Price $10.00.
YOUR PRICE.................. **$2.75**

R.C.A. Filter Condenser and Output Choke No. 8346

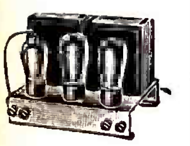


This unit has 7 condensers and an output choke. Condenser values include four 0.5-mfs. capacities and three 2-mfs. capacities—total 8-mfs. Used in Radiola No. 60. Size 6 x 4 x 3 inches. Shipping weight 5 lbs. List Price $16.50.
YOUR SPECIAL PRICE.. **$5.75**

R.C.A. Filter Cond. No. 8289

This condenser unit of 6 condensers includes two 1.0-mfs., two 3.5-mfs., a 2-mf. and a 3-mf. condenser—total capacity 14-mfs. Used in Radiola No. 17 and Radiola No. 50. Size 6 x 4 x 3 inches. Shipping weight 4½ lbs. List Price $19.20.
YOUR SPECIAL PRICE........ **$5.75**

Loftin-White Direct Coupled 2-Stage Power Amplifier



A very fine phonograph or radio tuner amplifier. Gives auditorium volume! Uses one 224, one 245, one 280 tubes. 6¾ x 8½ x 9 inches. Self-contained power supply — for 110 volt, 60 cycle, A.C. Shipping weight 20 lbs.
List Price $35.00.
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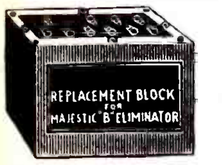
Replacement Power-Pack Condenser Blocks



Exact duplicate, physical size, placement of connection terminals, and electrical specifications of original blocks. For Majestic 171 type receivers.. **$5.85**

Shipping weight, all types, 7 lbs.

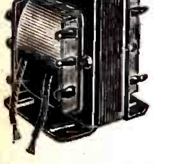
For Majestic 250 type receivers.. **$5.85**

For Majestic 245 type receivers.. **$5.85**

For Majestic "B" Eliminators.. **$2.90**

The above can be used with any similar power packs — fully guaranteed for ONE YEAR! (All other types can be supplied. Write for prices.)

245 A.C. Power Transformer

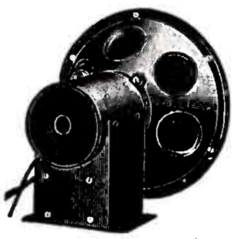


For five 224 (or five 227), two 245, one 280 A.C. tubes, OR ANY COMBINATIONS OF 2½-VOLT TUBES. All secondary windings CENTER TAPPED. 600-VOLT HIGH VOLTAGE SECONDARY. 75 WATT CAPACITY. Size 5¼ x 4¼ x 3½ inches. For 110 volt, 60 cycle, A.C. Shipping weight 12 lbs.
List Price $15.00.
YOUR SPECIAL PRICE........ **$4.45**

600 Volt Condenser Sections

Impregnated in pitch. Flexible lead terminals.
.5 mfd.......25c 2. mfd.......40c
1. mfd......30c 4. mfd......60c

Utah Dynamic A.C. Power Speaker—Model 33A

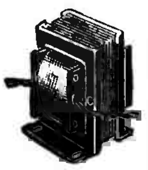


110-volt, 60-cycle A.C. light socket supply for field excitation using Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.
List Price $50.00.
YOUR SPECIAL PRICE........ **$7.50**

R.C.A. Double Filter Chokes (No. 8336)

This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 30 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5¼ x 3¾ x 2⅞. Shipping weight 6 lbs.
List Price $10.05.
YOUR SPECIAL PRICE........ **95c**

2½ Volt A.C. Fil. Transformer



Two windings, both center tapped. One "lights" six 227 or six 224 2½-volt tubes, and the other lights two 245 tubes (not used with Webster amplifier). Total: 14 amps. For 110 volt, 60 cycle, A.C. Size 4¼ x 2⅝ x 3¼ inches. Shipping weight 6 lbs.
List Price $10.00.
YOUR SPECIAL PRICE........ **$2.75**

1½-2½-5 V. A.C. Transformer

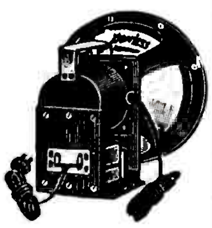
Lights five 226, two 227 (or 224) and two 171 A.C. tubes. Permits conversion of battery sets to A.C. operation, using Raytheon type "B" eliminator. For 110 volts, 60 cycles, A.C. Shipping weight 5 lbs.
YOUR SPECIAL PRICE........ **$3.95**

Dry Electrolytic Condensers

Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

Mfd.	Numb. Anodes	Diameter	Length	YOUR PRICE
1	1	¾ in.	2⅛ in.	28c
2	1	1 in.	2⅛ in.	45c
4	1	1½ in.	2⅛ in.	85c
8	1	1¾ in.	4½ in.	$1.25
16	2	3 in.	4¼ in.	2.12
24	3	3 in.	4¼ in.	2.75
32	4	3 in.	4¼ in.	3.75

Peerless 15" 110 Volt D.C. Concert Dynamic Speaker



The largest and most powerful dynamic speaker made! Gives tremendous volume—deep and sonorous, as well as fully vibrant over entire musical register. Contains push-pull output transformer (adapts speaker to any receiver output!) and two D.C. field coils, one 800 ohms and the other 4,000 ohms. Ideal for use with Webster amplifier listed below. Shipping weight 25 lbs.
List Price $75.00.
YOUR SPECIAL PRICE...... **$16.95**

R.C.A. 600 Volt Replacement Condenser Block (No. 8333)

For Radiolas 18, 33 and 51. Over a half a million of these different types of Radiola receivers are on the market. Every serviceman needs these blocks, but they can of course be used for other purposes, such as experimental or converting battery sets for power. Size 3¾ x 2¾ x 3½ inches. Shipping weight 4 lbs. List Price $7.40.
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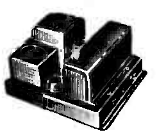
Freed-Eisemann Block

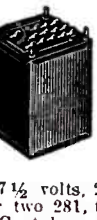
Contains 1—4 mfd.; 2—.1 mfd.; 2—1 mfd.; 1—.5 mfd.; 1—2 mfd. 5¼ x 3½ x 2½ inches. Flexible leads. Shipping weight 6 lbs. YOUR PRICE...... **$1.95**

Webster Push-Pull Power Amplifier and "B" Supply



Uses two 226, two 210 and one 281 tubes! Super powerful PUSH - PULL amplifier. GIVES AUDITORIUM VOLUME! Also furnishes 110 volt D.C. speaker field voltage (A.C. speakers can also be used!) and 45, 67, 90, 135 volts "B" current. FOR USE AS PHONOGRAPH, SPEECH AND RADIO TUNER AMPLIFIER! 16 in. long, 10½ in. wide, 6¾ in. high. Use 2½-volt A.C. filament transformer shown at left to supply "A" current to tubes in tuner, to which it will be coupled. FULLY GUARANTEED! For 110 volt, 60 cycle, A.C. Shipping weight 40 lbs. List Price $100.00.
YOUR SPECIAL PRICE....... **$20.25**

250 Push-Pull A.C. Power Transformers



Ideal for use in short wave transmitters, public address amplifier systems, super-power amplifiers, A.C. receiver power packs, etc. EMPLOYS HIGHEST GRADE MATERIALS AND LABOR — FULLY GUARANTEED! Has FOUR CENTER TAPPED secondary windings: 2¼ volts, 8.75 amps.—7¼ volts, 2½ amps, —7½ volts, 2½ amps.—1200 volts: designed for two 281, two 250 and five to six 2½-volt A.C. tubes (224's or 227's) or 226 tubes if a suitable resistance is used. FULLY SHIELDED! Soldering lug terminals. CAPACITY: 135 WATTS. Size 6¼ x 4¾ x 4¾ inches. For 110 volt, 60 cycle, A.C. Shipping wgt. 18 lbs. List Price $20.00.
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R.C.A. Loud Speaker 103

A beautiful speaker in appearance. Superb in its ability to reproduce music and speech most faithfully. The frame and pedestal are mounted to resemble hand-carved oak, while the beautiful tapestry medallion conceals the mechanism and completes the decorative design of the instrument. Magnetic unit. Corrugated cone. Height 15 in., width 13½ in., depth 6¾ in. In factory sealed carton. Shipping weight 14 lbs. List Price $22.50.
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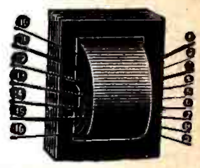

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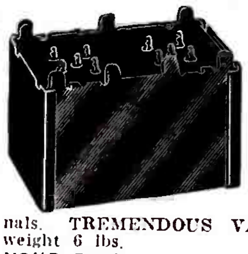

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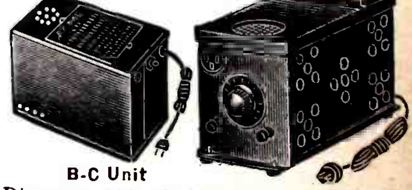

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A 19 Tube S-W Receiver

(*Continued from page* 317)

work in opposite phases. That is to say, in one the plate current flows on the signals, and in the other on the "spaces"; so that the signal output of B-V is recorded on two sets of automatic high-speed instruments, at a uniform amplitude. This makes for the most favorable operating conditions.

Remote-Control Operation

Since the output of the second detector B-V is pulsating direct current, a local oscillator is provided at the operating (remote-control) station. If the wire lines between the receiver and operating station are not suitable for this purpose, the D. C. output must be changed to alternating current. For this purpose the special audio-frequency oscillator F (Fig. 3) is provided; this is operated by one of the tubes of the telegraph unit. The signals are then sent out over the line as an audio-frequency current of constant amplitude.

To prevent key noises from being carried over the line, the second stage of the "E-Bild" relay apparatus is constructed in push-pull. There is also provided a filter system G, so tuned that no stray modulating current can escape from the second detector B-V into the relay unit.

Telephone reception is accomplished through an audio transformer, the primary of which is connected into the plate circuit of B-V. To effect suitable equalization of the signal, an automatic volume control (Fig. 5) is connected in the plate circuit of B-V; the choke coils G (see Fig. 3) block the audio frequencies, so that only direct current passes, and the output voltage of the volume control, which varies with the strength of the received signal, is applied to the grids of the amplifier tubes. The result is to give constant reception strength at the output of the second detector, regardless of fading in the signal.

To facilitate the operation of the receiver, and observe the characteristics of the received signal, a monitoring device D is provided; this (Fig. 3) consists of a regenerative detector and a stage of audio-frequency amplification, which can be connected ahead of the second detector B-V by a switch. This apparatus can be used also for observation of the characteristics of the first detector's output, by connecting it into the output of this tube, by another adjustment of the switch.

Batteries and Tubes Employed

The receiver contains also a filament transformer H and the grid-biasing battery I. The plate potentials are taken from batteries. Since the plate potentials of the various tubes differ, and some are specially coupled, it is necessary to use three separate batteries ("A," "B" and "C") for each tube or pair of tubes.

The tubes used (*German types*) are RE-194 types, except for B-V and in the relay apparatus, where four REN-1104 types are used. The former are battery-operated, using 0.2 ampere at 4 volts across the filaments, and drawing 5 milliamperes each at 100 volts on the plate. The latter are A. C. tubes, using 1.1 amperes at 4 volts of 50-cycle A. C. current on their heaters; and drawing 10 milliamperes with 100 volts on the plate.

Possibilities in Amateur Television

By C. H. W. NASON

(*Continued from page* 301)

shown in Fig. 2 is typical of the circuits employed; this is the intermediate amplifier specified above.

The photo-cell amplifier should have but one stage of screen-grid amplification, and the output tube employed in the final amplifier feeding the modulator tube, or the neon monitor, should be a '50 type. With these two exceptions the three circuits for the amplifiers are identical.

The amplifier circuit as shown has a gain-frequency characteristic essentially flat from fifteen to thirty thousand cycles, which is correct for 48-line images, since the highest frequency encountered does not exceed this figure. Where experimental arrangements require amplifiers of higher quality, this may be taken care of by the introduction of tuned chokes into the plate circuits of the various stages. For the time, these would be unnecessary complications.

Problems of Illumination

To return to the mechanical arrangements for the scanning mechanism it might be well to go into detail as to the apparatus required. If a second-hand motion-picture arc housing is available, it would serve our purpose better than anything else obtainable at a reasonable price on the open market. With the changes that have been made in motion-picture theater equipment within the past few years, such arcs should be available at a very reasonable figure. Care must be taken in ventilating the arc housing; for the gases given off by the arc are extremely injurious to health.

The scanning disc employed may be a regular receiving disc of the requisite proportions. If motion-picture projection lenses are available, they will serve admirably for the optical portion of the apparatus. A study of the dimensions of a standard projector will give some idea as to the positioning of the disc and lenses.

The disc would, preferably, be built so that the dimensions of each frame are those of a standard motion-picture film. That is — .720-inch by .969-inch or, roughly, three-quarters of an inch by an inch. A mask should be provided in close proximity to the disc, to limit the light transmitted to these dimensions at the scanning point. In positioning the subject the disc should be held motionless while the lenses are adjusted, until the image of the disc aperture as projected on the scanned object is sharply defined.

The photocells should be mounted on a rack quite close to the scanned scene, and no attempt should be made to accurately position the reflectors until the apparatus is functioning and an image of a geometric figure, drawn on a large piece of paper, is visible in the monitoring televisor. Then the reflectors (which may be automobile headlamp mirrors or parabolic mirrors such as are obtainable from scientific supply houses) may be adjusted for the best received image. These reflectors will operate in the same manner as the mirrors used by photographers in obtaining highlights; and some adjustment may be necessary before the maximum signal with the minimum shadow is obtained. In connection with these mirrors, it might be well to mention that the chromium-plated reflectors now obtainable are less subject to breakage and are more efficient in reflecting blue light than are the old-style glass mirror.

The action of the Federal Radio Commission in opening up the 1715-2000- and 56,000-60,000-kilocycle bands to amateur television and facsimile experimentation has failed to produce the required stimulus. Without any doubt the amateur who first gets "on the air" with a creditable television signal is going to find considerable of a path beaten to his proverbial doorway. It stands to reason that the transmission of a television signal is not for the tyro. Only those who have become familiar with the operation of high-quality 'phone equipment may expect success in such an undertaking. The writer has been out of the field of amateur transmission for some years, but has spent considerable time in the development of commercial television systems; and he has employed an arrangement such as that shown with considerable success.

No attempt has been made here to show structural details as the sole purpose of this paper is to stimulate a degree of interest in the problem, sufficient to warrant the work which would be necessary in preparing a series of articles covering the entire problem.

It may be noted that the lower frequency band, mentioned above, borders on that used by the commercial television services. Receivers constructed or purchased for the reception of the commercial transmissions will be capable of receiving the amateurs also. Your attempts, then, will reach, not a limited few amateurs, but the entire television audience within the range of your equipment.

Short - Wave Radiophone Keeps Fireboat In Touch With Shore

(*Continued from page* 267)

it distinctly. The shore station has a power output of 1 kilowatt; the receiving set is a standard aircraft type, having three stages of screen grid R.F. amplification. A microphone and headphone sets form part of the equipment.

The fireboat's radiophone transmitter is of the aircraft type and has a power rating of 100 watts. For receiving purposes aboard the fireboat, headphones are supplied as well as a loud speaker.

An 85 Meter Phone Transmitter

By R. WM. TANNER, W8AD

(*Continued from page* 293)

be wound first with 5 turns, spaced slightly. When this is done, start the plate coil 1 inch from the last turn of the antenna coil, and continue space-winding for 22 turns. A tap is taken off at the exact center for connection to the positive of the high voltage. The other antenna coil, having the same number of turns as the first, is wound 1 inch from the plate coil. The coupling between each antenna coil and the plate coil must be exactly the same, or the push-pull amplifier will be unbalanced, with one tube supplying most of the energy.

The leads are soldered to lugs which are fastened to the form with ½-inch, 8/32 machine-screws. If the turns have a tendency to run together, a little collodion applied now and then will keep them in their proper position. Details of this unit are shown in Fig. 2.

An engineer would, in all probability, hold up his hands in horror at the use of fixed one-inch coupling. However, it has been worked out in practice that with such small coil diameters one-inch coupling is sufficient. Therefore, why not make it fixed and simplify the adjustment and operation processes?

The plate inductance is tuned by means of an .0001-mf. midget condenser (C1). The neutralizing condensers (NC) have each a maximum capacity of .000025-mf. An .001-mf. mica bypass condenser (C2) is connected between the "B+" and the center of the filament resistor.

The antenna tuning condenser (C) is of the receiving type, with a capacity of .0005-mf. maximum. Although not absolutely necessary, an 0-to-1 amp. hot-wire or thermocouple ammeter (A) may be placed in the antenna lead to indicate resonance.

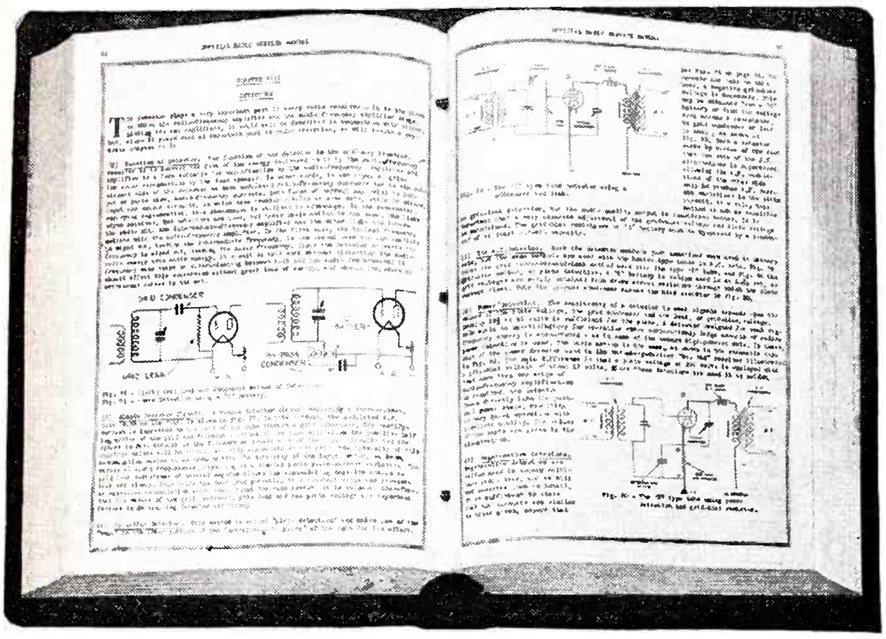
The center-tapped resistors (R) shunted across the filaments are 60-ohm, and bypassed with .001-mf. (C2) and .002-mf. (C7) fixed condensers.

Audio (Speech) Amplifier

Now we come to the audio amplifier, upon which the quality of the transmitted speech depends almost entirely. The microphone and a 4.5-volt battery are connected directly across a 200-ohm potentiometer (R5) employed as a gain control. The contact lever goes to one side of the primary of the modulation transformer (M.T.). The secondary, across which is a 250,000-ohm grid-leak-type resistor (R4), feeds the grid of the '26 tube. A negative bias is supplied through a 1,500-ohm resistor (R7) bypassed with a 1-mf. condenser (C8). A voltage of 135 to 180 is applied to the plate.

The audio transformer (AFT) is a high-quality type, with a 3½:1 ratio; this furnishes voltage sufficient to swing the grid of the '71A stage to full output.

"Official RADIO SERVICE MANUAL



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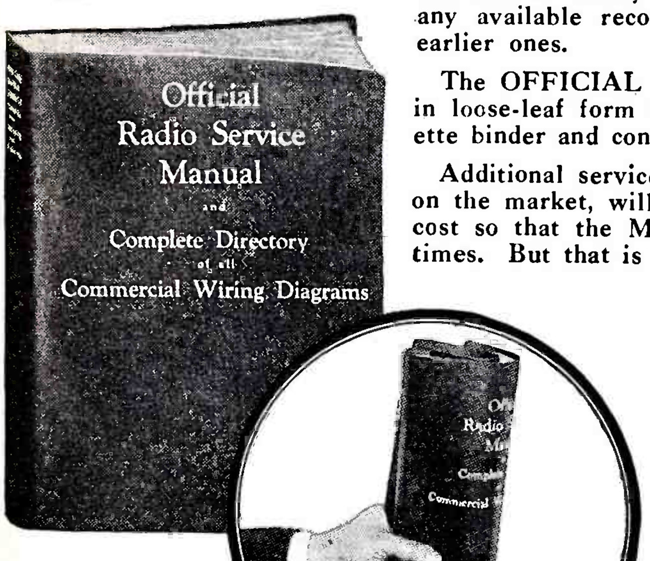

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An 85 Meter Phone Transmitter

(*Continued from page 293*)

The 2,000-ohm resistor (R6) biases the grid of the '71A; this is also bypassed with a 1-mf. condenser (C8).

Either a transformer or a choke-condenser combination may be used in the output of the audio amplifier, to apply the amplified speech currents to the modulated power amplifier; but, as an extremely high voltage is not necessary, better quality will result with the choke-condenser arrangement.

Two chokes will be needed: one (A.F.C.1) with an inductance of 30 henries at 20 ma. for the plate circuit of the '71A audio stage, and one (A.F.C.) of 50 to 100 henries (low current) for the grid circuit of the modulated power amplifier. The coupling condenser (C9) cannot be too large, or the higher audio frequencies will be cut off; a capacity of approximately .01-mf. will suffice.

The grid choke is connected from the "B—" to the common lead to the grid R.F. chokes, as clearly shown in Fig. 1. The biasing voltage for the modulated power amplifier is rather critical, and is supplied through a 4,000-ohm adjustable resistor (R3) bypassed with a 1-mf. condenser (C8). Battery bias is preferable with a potentiometer for fine adjustment, if cost is not a consideration.

Power Supply

Very little will be said about this, for some constructors may prefer to use a manufactured unit, which costs practically the same as one of home construction. The high-voltage winding should supply 700 volts, center-tapped to the '80 rectifier. As the total current drain is about 100 ma., the filter chokes must be able to carry this amount. The power transformer, usually, has a 2.5- and a 5-volt winding, which can be used for the R.F. filaments. Another 5-volt winding is needed for the '71A, and should be supplied from a separate transformer which also gives 1.5 volts for the '26 tube.

Mounting and Wiring

The diagram in Fig. 3 shows the layout of parts for the oscillator, frequency-doubler and modulated power amplifier. All R.F. chokes, blocking and bypass condensers, grid leak, etc., are placed underneath the baseboard. The two biasing resistors (R2 and R3) are on top where they are readily accessible. A 1½-inch wooden baseboard, 20 x 10 inches, will just about hold all the parts without overcrowding. The three tank condensers (C1, C4 and C6) are mounted on a bakelite panel 6 x 20 inches. The radiation meter, if one is used, may also be placed on this panel. Vernier dials are not necessary; plain ones serve the purpose just as well.

It is advisable first to run all wires carrying R.F. currents, in order to keep them as short and direct as possible. The connecting wires in both halves of the push-pull amplifier must be of equal length.

The layout of parts for the A.F. unit is shown at the right; the baseboard is 10 x 6 inches. As in the R.F. unit, the resistors and bypass condensers are placed underneath. Both baseboards are mounted on bakelite sub-panel brackets, 2 inches high.

Adjustment and Operation

The initial adjustments of this transmitter are rather complicated, but if they are made in accordance with the following directions no trouble should be experienced. Before going into details it is well to call attention to the fact that the unusual voltages required for the plates of the various tubes are not generally available from manufactured "B" substitutes. It is advisable to connect two 10,000-ohm, 75-watt "Truvolt" resistors in series across the output terminals, and disregard the regular taps. Three sliders will be needed to supply the intermediate voltages. The sliders should be bypassed to the "B—" by 0.5-mf. condensers.

First connect an 0-to-100-ma. meter in the "B+" lead to the oscillator, and light the filaments of all tubes except the audio amplifier. (Leave all "B+" but the oscillator disconnected.) Place the oscillator filament tap on the sixth turn on L3, and vary C6 to the desired wave (twice the working wave) as determined by means of a wavemeter. Now listen-in on an oscillating receiver for one of the many C.W. "squeals" that will be found in the 80-meter band. Reduce the number of turns between grid and filament until the squeal has the least amount of A.C. modulation. Under these conditions the oscillator plate current will be from 10 to 12 ma.

Now set the slider on R2 to nearly full resistance, and connect the "B+" together with the milliammeter to the frequency-doubler. Tune C4 slowly, until the plate current takes a pronounced dip downward and then increases as C4 is increased. The center of this dip indicates resonance and is the correct adjustment of C4.

Remove the milliammeter and place it in the "B+" lead to the modulated power amplifier. Do not connect the high voltage at this time, but set R3 at about two-thirds its resistance, and couple three turns of bell wire in series with a 2.5-volt flashlight bulb to one end of L1. Tune C1 so that the bulb lights brightest, and then vary both neutralizing condensers *together* until the light goes out. Readjust C1 slightly. If the bulb shows no signs of light, the tubes are completely neutralized, and the high voltage may now be connected and C1 tuned for the plate current dip, exactly as done with the frequency-doubler. It is well to use a low voltage on this stage when making initial adjustments, for detuning C1 may cause the tubes to draw excessive plate current.

The antenna and counterpoise may now be connected. Each should have a length of approximately 65 feet, and the antenna should, of course, be as high as possible. The condenser C is varied for maximum radiation; as it is tuned to resonance, the power amplifier's plate current will increase.

Now readjust R2, C6, C4, C1 and C for greatest output. At this time the audio unit may be connected. With the microphone idle, decrease the resistance of R3 until the increased antenna current with additional reduction is negligible. Then set the bias at a value which gives half the plate current obtained at the point of maximum antenna current. Under these conditions, modulation will be symmetrical and 100 per cent. on the peaks. It will be found that the plate current is around 40 ma., depending upon the exact value of plate voltage.

The microphone may now be spoken into with the assurance that good quality will be transmitted.

Parts List

C—.0005-mf. antenna tuning condenser;
C1—.0001-mf. midget amplifier tuning condenser;
C2—.001-mf. bypass condensers;
C3—.00025-mf. coupling condenser;
C4—.0001-mf. midget "tank" condenser;
C5—.0001-mf. coupling condenser;
C6—.0005-mf. oscillator tuning condenser (fixed) and .0001-mf. midget;
C7—.002-mf. bypass condensers;
C8—1-mf. bypass condensers;
C9—.01-mf. condenser;
R—60-ohm filament resistors;
R1—5,000-ohm grid leak;
R2—2,250-ohm, 25-watt "Truvolt" frequency-doubler biasing resistor;
R3—4,000-ohm, 75-watt "Truvolt" M.P.A. biasing resistor;
R4—250,000-ohm grid-leak type resistor;
R5—200-ohm gain control;
R6—2,000-ohm biasing resistor;
R7—1,500-ohm biasing resistor;
RFC—R.F. chokes (see text);
RFC1—R.F. chokes (see text);
RFC2—R.F. chokes (see text);
AFC—50-henry grid choke;
AFC1—30-henry plate choke;
AFT—Silver-Marshall type 255 (3½-1) audio transformer;
MT—Silver-Marshall type 255M modulation transformer;
Tubes, sockets and miscellaneous hardware.

Converting Your Broadcast Receiver for S-W Reception

By McMURDO SILVER

(*Continued from page* 275)

vernier or trimmer adjustment rather than as a regular tuning control. The oscillator circuit, however, is extremely sharp; employing a somewhat similar coil to that of the first detector, it is tuned by a .00014-mf. condenser controlled by a vernier dial. A '27 tube is the oscillator, and power supply for both tubes of the converter is obtained from a small, self-contained power unit.

While it might be feasible to obtain all power for the converter directly from the receiver by which it is employed, this would involve pulling leads out of the latter, and thereby complicate the connection of the converter to the set; it has been felt, therefore, that it is wiser to incorporate a complete power supply unit directly in the converter for simplicity and, particularly, in view of its low cost.

A '26 tube is used as a rectifier, being fed by a small transformer which also supplies filament current for the '24 detector and '27 oscillator. Filtration is provided by one high-inductance choke and two 4-mf. dry-electrolytic, semi-self-healing condensers.

The whole construction and design of the converter is so ridiculously simple that little comment is necessary; the circuit diagram is self-explanatory, as are the photographs. The antenna is coupled to the first detector through a small trimmer-type condenser which, upon installation, is initially set to provide the most satisfactory results; as also is the similar small trimmer condenser used to couple the oscillator to first detector grid circuit. The first detector is coupled to the antenna binding post of the broadcast receiver through a 300,000-ohm resistance and a .0001-mf. fixed condenser.

How to Connect Converter to Your B.C. Set

To install the converter, it is necessary only to insert its power-supply plug into a 110-volt, 50- or 60-cycle light socket, remove the antenna lead from the receiver and connect it to the antenna post of the converter; then connect the two posts on the converter to the antenna and ground posts of the receiver. To disconnect the converter, it is necessary simply to shift the antenna lead from the converter back to the receiver's antenna post. In operation, the receiver's volume control is used exclusively; since it is contemplated that the converter will be placed on top of, or beside, the regular broadcast receiver which, in turn, is tuned to some low frequency (around 600 kc.) on which normally no station can be heard. If, when the converter is used, the receiver tuning dial is always set at exactly the same position, the oscillator dial on the converter may be logged definitely; which will be, of course, a great convenience.

In actual operation, it has been found that the results obtained from this converter, in conjunction with a good broadcast receiver, were distinctly superior to those obtained from any short-wave receiver which it has been the writer's privilege to play with—including a number of short-wave superheterodynes. The selectivity is extremely satisfactory, indeed, and the television problem (image-frequency selectivity) is not troublesome. This is due, first, to the use of a very high intermediate frequency—that to which the broadcast receiver is tuned, which generally places the image-frequency 1,000 kc., or further away from the wanted station; coupled with the fact that the short-wave channels upon which the converter will be operated, are not as crowded as are the American broadcast channels. Consequently the possibility of image-frequency interference is much less than on a superheterodyne operating in the broadcast band.

This short-wave converter may be employed with a broadcast band superheterodyne receiver, in which case the resultant combination might be termed "double-suping," due to the fact that two intermediate frequencies are employed—one in the broadcast band, that to which the superheterodyne broadcast receiver would be initially tuned, and the other the superheterodyne's L.F. amplifier.

How to Hear C. W. Signals

When the converter is adjusted, in conjunction with the broadcast receiver, for reception of short-wave telephone or broadcast signals, it does not permit the reception of short-wave C.W. signals. It is a very simple matter, however, to adapt it to C.W. telegraph reception by the simple process of so tuning the broadcast receiver, with which the converter is used, that it is set very close to a local broadcast station; which is then used as a local oscillator to heterodyne the short-wave telegraph signals. It is assumed, however, that the broadcast receiver is sufficiently sensitive to pick up at least one high-wave local station, either directly upon its coils or on the small length of connecting wire between its antenna post and the converter. Of course, if preferred, a separate local oscillator, set to beat with the intermediate frequency or the wave to which the broadcast receiver is tuned, may be used for short-wave reception and, since this will be unmodulated, it is somewhat preferable to the use of a local broadcast signal as a heterodyne.

A Rolls-Royce Receiver

By C. STERLING GLEASON

(*Continued from page* 280)

potential, and hence *must not be allowed to come into contact with the shielding.* This condenser is the exception to the general rule that condenser rotor plates go to filament circuits.

The sub-panel allows considerable latitude in layout, so far as the R.F. stage and detector are concerned—care being taken, of course, to mount the coils at right angles and as far apart as possible. The screen-grid tube with its enclosing shield is well placed at the extreme left-hand corner at the rear. The antenna coupling condenser should be at the back and, if adjustment from the panel is desired, it may be regulated by means of a bakelite extension shaft running to the front.

The most exacting part of the set is the resistance-coupled amplifier. The layout diagram for this portion of the receiver *must be followed exactly;* deviation is almost certain to make trouble. The "stilts" may consist of 2-inch screws or of threaded rod of corresponding length, placed so that they elevate all parts of the resistance-coupled amplifier at least 1½ inches above the metal sub-panel. The chokes in the plate leads may be placed beneath the sub-panel, care being taken to insulate the wire well when passing it through the copper base, as this is at filament potential and the entire 180 volts is therefore in danger of short-circuit at this point. Two 1.5-mh. chokes are placed in series in the lead coming directly from the detector plate; since the purpose of these is to keep the R.F. out of the amplifier and force it instead back through the tickler circuit, these two should be close to the detector circuit and preferably above the sub-panel.

The two home-made chokes, X5 and X6, are wound as follows: Upon a form 1 inch in diameter, with a piece of bakelite or celluloid clamped on each side to make the width of the winding ¼-inch, wind at least 150 turns of No. 32 wire. "Scramble-winding" is best, because it results in less distributed capacity than layer-wound coils. The exact number of turns should be determined by experiment, and one may stop at the 150th turn and test or may wind on more turns and then strip them off until the optimum value is found. Factory-made chokes may be utilized, but different values may profitably be tried.

Coil Values Are Optional

Unless only a small range of tuning is desired, plug-in inductances are necessary. Any set of factory-made coils of appropriate tuning ranges may be used; the variable condensers in such a case being chosen to match. As used by Mr. Lee, the coils are cut from Hammarlund 3-inch coil stock, which comes in 30-inch lengths and may be cut up into sections of any desired size. The coils are clamped between pieces of bakelite, and the leads run to pin-plugs extending from the under side of the clamps. The detector coil should be of a piece long enough to include both grid and plate windings, plus one extra turn. The wire is cut between the two sections, care being taken not to injure the celluloid body of the stock; and a single turn is carefully unwound between the two segments, leaving a slight separation between the plate and grid windings thus formed. When the coils are thus arranged, the correct relationship for regeneration is assured if the outer ends of the two coils go to plate and grid respectively. The mounting strip, bearing the pin jacks into which the coils fit, is a single piece of bakelite mounted upon bakelite pillars which should be several inches high.

The following turn values are employed in the set of coils used by Mr. Lee to cover the short waves:

	Detector	*Winding*
R.F. Coil	*Grid*	*Plate*
2 turns	2 turns	1 turn
3 "	3 "	3 turns
4 "	4 "	4 "
8 "	8 "	4 "
15 "	15 "	6 "

If higher wavelength ranges are desired smaller coils are advisable, since the bulk of the larger coils is considerable if this space-wound stock is used. If the above values are used, one plate should be removed from the detector tuning condenser.

Television the Proof of Quality in the Amplifier

The audio stages are supplied with filament voltage through Amperites, and the screen-grid tube operates through a series fixed resistor (R1) which drops the six volts to the specified value. Only the detector tube has a rheostat. The automatic control for the audio circuits is more satisfactory than hand adjustment, because the temptation to use the filament rheostat as a volume control is conducive to reduced filament emission which will produce distortion, especially on peaks—an effect very undesirable in television reception.

Book Review

RADIO SERVICE MAN'S HANDYBOOK WITH ADDENDA DATA SHEETS. Flexible covers, size 9" x 12", pages 200, price $2.00. Published by Gernsback Publications, Inc.

This remarkable book contains several hundred illustrations with wiring diagrams and charts covering every conceivable subject, including radio sets, tubes, etc. The book is strictly up-to-date and contains the newest practical information which every radio man must absolutely have.

THE ELEMENTS OF RADIO-COMMUNICATION, by O. F. Brown, M.A., B.Sc. Cloth covers, size 9" x 5½", pages 216, illustrations 146, price $3.50. Published by Oxford University Press.

An authoritative treatise which explains in plain English with practically no mathematics, the properties of high frequency alternating current; oscillations and radiations; transmission of damped waves; crystals and thermionic valves; receiving circuits; generation of oscillation by vacuum tubes; radio telephony; reproduction in radio telephony; directional reception; with a chapter on "short wave" transmission and reception; and the propogation of waves through space.

FUNDAMENTALS OF RADIO, by R. R. Ramsey, Professor of Physics, Indiana University. Cloth covers, size 5½" x 6", pages 372, illustrated, price $3.50. Published by The Ramsey Publishing Company.

Dr. Ramsey gives us a very refreshing treatment of the fundamentals of radio, including battery and dynamo action; alternating currents; inductance; vacuum tube constants; aerials of different kinds and how they operate; radio frequency instruments and apparatus; audio amplification and receivers in general.

RADIO TELEGRAPHY AND TELEPHONY, by R. L. Duncan and C. E. Drew. Cloth covers, size 9½" x 6", pages 950, illustrations 468, price $7.50. Published by John Wiley & Sons, Inc.

This 950 page book forms indeed a most complete treatise on radio facts. The authors treat thoroughly the magnetic circuit; Ohm's law; transformers and induction; motor generators and starters; storage batteries; alternating currents; capacity and inductance formulae. Other chapters cover thoroughly vacuum tubes as detectors and amplifiers; oscillographs; radio compass; wavelength measurements and "short wave" receivers.

DRAKE'S RADIO CYCLOPEDIA, by H. P. Manly. Cloth covers, size 6" x 9", pages 1035, profusely illustrated, price $6.00. Published by Frederick J. Drake & Co.

This massive cyclopedia covers radio apparatus; 1,735 subjects in alphabetical order ranging from A-battery to Zero-beat. The volume contains 1,110 illustrations, diagrams, etc. There are 414 illustrations and articles on the building and designing of radio sets, alone; 110 articles with 383 illustrations on the methods of repair, service and adjustment of radio sets. Every conceivable type of amplifier is given. Short wave receivers are also covered.

RADIO TRAFFIC MANUAL AND OPERATING REGULATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9" x 6", pages 186, price $2.00. Published by John Wiley & Sons, Inc.

This valuable hand book starts off with instructions on how to learn the code in considerable detail, with a list of abbreviations. Then comes operating rules and regulations of the Radiomarine Corporation of America with operator's report forms; followed by the rules of the International Radiograph Convention; United States Radio Act of 1927 and the Ship Act of 1912.

(*Continued on page 333*)

CAN WE USE
Ultra Short and Infra Red Rays?

(*Continued from page* 299)

demonstrate the sharply directional rays gathered in pencils.

For producing modulated infra-red rays, which for giving signals are necessarily from other sources of light and heat, we can use the ordinary technical sources of light which radiate heat, such as arc lights or glow lamps. In this case the light is directed through light disks or light valves, or else is interrupted. We can also use discharges of gas, for example in potassium. Telephonic modulation is done by modulating the amplified frequency in the feed-circuit, an arrangement which was demonstrated by Dr. Schröter in his lecture with striking success.

As detectors for modulated infra-red rays the Telefunken experts uses specially designed, highly-sensitive devices, for example, very thin-layered selenium-tellurium cells or thallofide cells.—*Das Funkmagazin.*

New Hammarlund S-W Receiver

By LEWIS W. MARTIN

(*Continued from page* 285)

tem for efficient, consistent results. The tickler, L^3, is a fixed one, a .0001 mfd. midget variable condenser tuning the plate. With this system, the tuning is very smooth and gradual over the entire scale. There are no dead spots or tuning dips.

In the standard set, four plug-in coils are provided, these covering the 14 to 105 meter range. These coils, known as the 20, 30, 40 and 80 meter coils, are all built along the lines just mentioned, their difference being in the number of turns and size wire used. The variable primary, however, which is a part of the base, is accordingly the same for all wavelengths.

To provide steady grid control, a special grid condenser having a variable capacity of from 20 to 100 mmfd. is used, in conjunction with a 3 megohm grid leak, R^1.

To isolate the plate circuit, and thus afford better reproduction a radio frequency choke is used, L^4.

We now enter the audio channel, where a special type low ratio audio frequency transformer is used, this feeding into a 230 type tube. It will also be noted that this circuit is well by-passed.

A Sensitive and Selective S-W Receiver

By R. WM. TANNER, W8AD

(*Continued from page 306*)

just below the oscillation point and increase the volume to the desired audibility by means of the volume control.

LIST OF PARTS

L1...... Antenna R.F. choke
L2, L3.. Tuning inductances
C....... .1 mfd bypass condensers
C1...... 2-gang tuning condenser (see text)
C2...... .00025 mfd grid condenser
C3...... .00035 or .0005 mfd regeneration condenser
C4...... 2 mfd filter condensers
C5...... .01 mfd audio coupling condenser
C6...... 1 mfd bypass condensers
C7...... 2 mfd. speaker coupling condenser
VT1.... Type 224 screen grid tube
VT2.... Type 224 screen grid detector tube
VT3.... Type 227 first audio tube
VT4.... Type 171A power audio tube
J....... Open circuit phone jack
R....... 500 ohm R. F. bias resistor
R1...... 50,000 ohm volume control
R2...... 1 megohm detector grid leak
R3...... 10.000 ohm detector bias resistor
R4...... 25,000 ohm audio filter resistor
R5...... 500,000 ohm plate and grid resistors
R6...... 2,000 ohm bias resistor 10MA
R7...... 2,100 ohm bias resistor 20MA
R8...... 60 ohm filament resistors center tapped

COIL TABLE

Band	Grid		Tickler		Plate Tap	Length of Form
20	7	#18 enamel	6	#30 enamel	6	1¼"
40	13	#18 "	8	#30 "	10	1½"
80	25	#22 "	11	#30 "	20	1¾"
100—550	53	#28 "	21	#30 "	35	2"

Short-Wave Stations—When to Listen

(*Continued from page 307*)

Meters Kilo-cycles

49.15 6,100—**W3XAL**, Bound Brook, N. J. (WJZ, New York). 5-6:30 p.m., 11 p.m.-1 a.m.
49.17 6,095—**VE9GW**, Bowmanville, Ontario, Canada. Daily, 1:45-5 a.m., noon to 7 p.m. Sundays, 5 a.m. to 7 p.m. Gooderham & Worts, Ltd.
49.26 6,090—....Copenhagen, Denmark.
49.31 6,080—**W2XCX**, Newark, N. J. Relays WOR.
—**W9XAA**, Chicago, Ill. (WCFL). 6-7 a.m., 7-8 p.m., 9:30-10:15, 11-12 p.m.
—**W6XAL**, Westminster, Calif.
—**HS2PJ**, Bangkok, Siam. 6-6:30 a.m.
49.40 6,070—**UOR2**, Vienna, Austria. 5-7 a.m., 5-7 p.m. Tues. and Sat., 9-10 a.m. Thu.
49.46 6,065—**SAJ**, Motala, Sweden. 6:30-7 a.m., 11 a.m.-4:30 p.m.
49.50 6,060—**W8XAL**, Cincinnati, Ohio. Relays WLW. 6:30-11 a.m., 1:30-3 p.m., 6 p.m.-1 a.m., daily.
—**W9XU**, Council Bluffs, Iowa. Relays KOIL.
—**W3XAU**, Byberry, Pa., relays WCAU.
49.67 6,040—**W9XAQ**, Chicago, Ill. (WMAQ).
—**W2XAL**, New York.
—**PK3AN**, Sourabaya. Java. 8-9 a.m.
49.80 6,020—**W9XF**, Chicago, Ill.
—**W2XBR**, New York, N. Y. (WBNY).
49.97 6,000—**ZL3ZC**, Christchurch, New Zealand. 10 p.m.-midnight, Tuesdays, Thursdays and Fridays.
—**HRB**, Tegucigalpa, Honduras. 9:15 p.m.-midnight, Mo., Wed., Fri. From 11 p.m. to midnight Sat., Int. S. W. Club programs.
—**EAR25**, Barcelona, Spain. Sat. 3 to 4 p.m.
—**RFN**, Moscow, Russia. Tues., Thurs., Sat. 8 to 9 a.m.
—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.
50.23 5,970....Vatican City (Bome).
51.40 5,833—**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—**W8XJ**, Columbus, Ohio.
54.51 5,500—**W2XBH**, Brooklyn, New York City (WBBC, WCGU).
56.70 5,300—**AGJ**, Nauen, Germany. Occasionally after 7 p.m.
58.00 5,170—**OKIMPT**, Prague, Czechoslovakia, 1 to 3:30 p.m., Tues. and Fri.
—**PMB**, Sourabaya, Java.
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.
—**W3XZ**, Washington, D. C.
—**W9XL**, Chicago, Ill.
—And other experimental stations.
62.69 4,785—**Aircraft.**
62.70 4,785—**VZA**, Drummondville, Canada.
62.80 4,770—**ZL2XX**, Wellington, New Zealand.
63.13 4,750—**WOO**, Deal, N. J.
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.
70.20 4,273—**RB15**, Khabarovsk, Siberia. 5-7:30 a.m.
—**G2GL**, S.S. "Homeric."
72.70 4,120—**G2GN**, SS. "Olympic."
—**G2IV**, SS. "Majestic."
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.
—....Turin, Italy.
82.90 3,620—**DOA**, Doberitz, Germany. (Television.)
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.**
92.50 3,256—**W9XL**, Chicago, Ill.
—**W6XBA**, **S.S. Metha Nelson, Fox Film Corp.**
—And other experimental stations.
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**, Wheaton, Md., 8 to 9 p.m. except Sunday;—**W2XR**, New York, N. Y.;—**W9XR**, Chicago, Ill.
104.4 2,870—....Milan, Italy. After 2 p.m.
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.;—**W8XAV**, Pittsburgh, Pa.;—**W1XB**, Somerville, Mass.;—**W7XAO**, Portland, Ore.;—**W9XAP**, Chicago, Ill.;—**W2XAP**, Jersey City, N. J.
—**W2XCR**, Jersey City, N. J. 8-10 p.m., Mo., Wed., Fri., 3-5 p.m.
—**W2XBO**, Long Island City, N. Y.
110.2 2,722—**Aircraft.**
124.2 2,416—**W7XP**, Seattle, Wash., Police and Fire Depts.
125.1 2,398—**W9XL**, Chicago, Ill.;—**W2XCU**, Ampere, N. J.—And other experimental stations.
128.0-129.0 —**Aircraft.**
129.0 2,325—**W10XZ, Airplane Television.**
130.0 2,306—**DDDX**, SS "Bremen" and "Europa" testing.
135.0 2,220—....Stockholm, Sweden.
—....Oslo, Norway.
136.4 to 142.9 meters—2,100 to 2,200 kc. **Television.**
—**W2XBS**, New York, N. Y., 1,200 R.P.M., 60 lines deep, 72 wide.
—**W1XAV**, Boston, Mass.
—**W2XCW**, Schenectady, N. Y.
—**W3XAD**, Camden, N. J.
—**W3XAK**, Bound Brook, N. J. (Portable.)
—**W2XR**, Long Island City. New York. 4-6:30, 7:30-10 p.m., daily.
—**W8XAV**, Pittsburgh, Pa., 1,200 R.P.M., 60 holes, 1:30-2:30 p.m., Mon., Wed., Fri.
142.9 to 150 meters—2,000 to 2,100 kc. **Television.**
—**W1XAE**, Springfield, Mass.
—**W1XY**, Lawrence, Mass.
—**W2XBO**, Long Island City, N. Y.
—**W3XK**, Wheaton, Maryland. 8-10 p.m.; Mo., Wed., Fri, 3-5 p.m.
—**W2XBU**, No. Beacon, N. Y. (1-2 p.m.)
—**W2XCD**, Passaic, N. J. 8-10 p.m., exc. Sat. and Sun.
—**W8XAV**, Pittsburgh, Pa.
—**W9XAA**, Chicago, Ill.
—**W9XAC**, Chicago, Ill.
—**W9XG**, West Lafayette, Ind.
—**W10XU**, Wheaton, Md. (Airplane.)
150 2,000—**RA72**, Smolensk, USSR.
149.9-174.8—2,000-1,715—**Amateur Telephony and Television.**
174.0 1,723—**ZL2XS**, Wellington, New Zealand.
175.2 1,712—**WKDU**, Cincinnati, Ohio. (Police Dept.)
—**WMP**, Framingham, Mass. 11 a.m., 1 and 5 p.m. daily. Music and police reports.
—**WRBH**, Cleveland, O., (Police Dept.)
—**KGJX**—Pasadena, Calif., (Police Dept.)
—....St. Quentin, France.
—**F8FY**, Cannes, France. 5 p.m. Wed.; 4 a.m. Sunday.
176.5 1,700—....Orly, France.
178.1 1,684—**WDKX**, New York, N. Y. (Police Dept.)
180.4 1,662—....Michigan State Police.
186.6 1,608—**W9XAL**, Chicago, Ill. (WMAC) and Aircraft Television.
—**W2XY**, Newark, N. J.
187.0 1,604—**W2XCU**, Wired Radio, Ampere, N. J.
—**W2XCD**, DeForest Radio Co., Passaic, N. J. 8-10 p.m.
—....Ornskoldvik, Sweden.
—And other experimental stations.
187.9 1,596—**WRBC**, New York, N. Y. (Fire Dept.)
—**WKDT**, Detroit, Mich. (Fire Dept.)
—**W7XP**, Seattle, Wash. (Police and Fire Depts.)
196 1,530—....Karlskrona, Sweden.
(Standard Television scanning, 48 lines, 900 R.P.M.)

The Screen Grid Five

By EDWARD G. INGRAM

(*Continued from page* 300)

uperlative degree of efficiency.

Now, with regard to the first audio-requency stage of the receiver, recent esearch has revealed that, if the '24 type tube is used as a space-charge amplifier (that is, with the two grid connections reversed so that the signal is impressed on the outer screen grid) with resistance coupling the extremely high gain of about sixty can be obtained.

The use of an untuned stage of radio-frequency amplification has been found very desirable in short-wave receivers; for it provides better coupling to the antenna, so that variations in the lengths of the latter are unimportant, and also gives a distinct gain in amplification without adding any controls. For this reason, the first radio-frequency stage incorporated in the receiver is of this type, provided with choke-coil coupling and a '24 type tube. This is followed by a tuned radio frequency stage, a regenerative detector and a resistance coupled audio stage, all provided with type 24 screen-grid tubes, the audio frequency tube being used as space charge amplifier with the grid connection reserved for this purpose.

The second audio-frequency stage also is of the resistance type, but provided with a type '45 power tube.

Thus, by the addition of an untuned R.F. stage and a screen-grid detector we greatly increase the sensitivity of the set, as compared with the usual modern short-wave receiver with a single tuned stage, without increasing the number of controls; and, by the use of a screen-grid resistance-coupled audio stage, we increase the audio-frequency amplification without losing the stable regenerative control obtained with resistance coupling.

Biases for the R.F. tubes are obtained through resistors, by-passed with fixed capacities. The detector gets a positive bias by means of a 1½-volt battery; the *negative* battery terminal being grounded.

Maximum amplification from the '24 audio tube is obtained when no biasing resistor is connected between the cathode and ground. Unless a separate transformer winding is used to supply the filament of the power tube, the grid bias must be furnished by "C" batteries. The correct voltage is 34½, with 180 volts on the plate, or 51½ with 250 volts on the plate.

The plates of the first three tubes may be operated on 180 volts. While a detector plate voltage of 180 sounds high, it is not; for this tube may be operated on even 200 volts to advantage.

The screen grids of the R.F. tubes should be supplied with 60 to 67½ volts. For the screen grid of the detector, 20 to 25 volts is enough. The space-charge grid of the first audio tube should be kept at 5 volts, or less.

A little experimenting may be necessary with the resistance values used in this stage. The plate resistor should be from ¼ to ½ meg., and the grid resistor from 1/10 to 1 meg.

The writer expects to supply the plates of all but the power tube from a 180-volt storage battery. Plate current for the power tube will be taken from a "B" power unit. Separating the two sources of plate supply has the advantage of eliminating the possible danger of interstage coupling. Also, when using earphones on the first stage, freedom from line noises is assured.

The Short-Wave S-G Craft Box

By BERYL BRYANT

(*Continued from page* 284)

A metal tab is soldered directly to the clip of the grid leak as shown in Fig. C. A similar piece is made and drilled with a hole in the tab to pass a 6-32 brass machine screw. A hole is drilled ¾-inch from the screw fastening the clip to the bakelite mounting strip of the grid-leak mounting. The second strip is now arranged in such manner as to be variable in the surface exposed to the fixed strip, being pivoted by the same screw used for the mounting of the binding post as shown (Fig. 2). The binding post (*B*1), used to connect the antenna directly to the grid of the R. F. tube, is fastened to a screw soldered to the one which fastens the clip to the bakelite strip. The ground binding post (*B*3) is mounted on the bakelite strip in the same manner as the series-condenser binding post (*B*2) and its screw is soldered to the lower clip of the mounting. On the rear of the baseboard should be left a space 1¼ inches wide by 9 inches long for the "A" and "B" batteries, which are held in position by a strap of fibre or "fish" paper. This strap should be an inch wide and strong enough to prevent tearing.

Adjustment and Operation

To operate the receiver the batteries are first placed on the rear of the baseboard but not fastened down until connected; all are connected in series, to provide 135 volts. Two 4½-volt "C" batteries connected in parallel are used for the "A" battery, or, if longer life is desired, three dry cells connected in series may be used. "A—" and "B—" are connected together and to the lead from the filament switch. The "A+" is connected to the "A" battery, "B+ Det." and the R. F. screen-grid lead to 45 volts positive. It was found by experiment that a slight increase (not over 67½ volts) on this grid improved signal strength to a noticeable figure. The "B+90" and "B+135" are also connected to the proper battery terminals.

Caution: do not connect the batteries, especially the "B" batteries, until the constructor is positive that all connections have been properly made in the receiver.—*Radiocraft.*

Propagation of Radio Waves

By DR. J. FUCHS

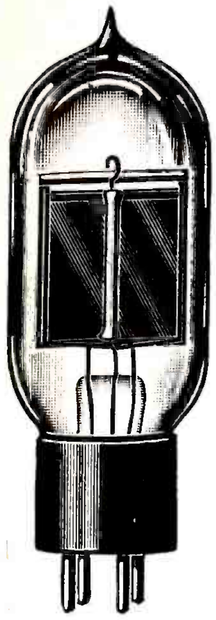
(*Continued from page* 291)

or in a vacuum, is equal to that of weak radio signals in receiving apparatus.

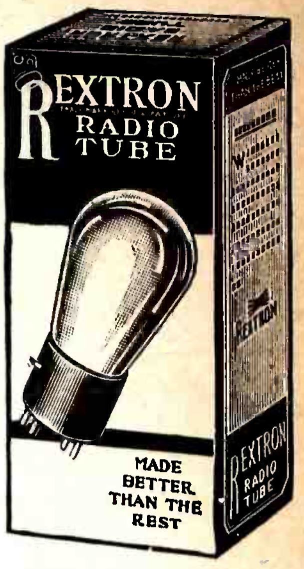
(*To be concluded*)

GUARANTEED RADIO TUBE SALE

All Tubes Guaranteed for 6 Months



Telion Television Tube $3.85



All tubes come in this attractive carton.

FOR THE FIRST TIME, a standard brand of radio tubes is sold at extraordinarily low prices, yet each and every one of the tubes is guaranteed in all respects for 6 months.

All tubes are date stamped and any tube that fails to make good for ANY reason will be replaced free of charge within 6 months.

Radio tube users have become wary of so-called cheap tubes. Such tubes are nearly always **"seconds"**; that is, tubes that have failed to pass the manufacturer's tests. These tubes do not give good service and therefore are never guaranteed for any length of time.

REXTRON tubes are manufactured by one of the oldest, reliable Eastern tube manufacturers and we have made special arrangements for this unparalleled sale. You will find here tubes that you cannot buy elsewhere, yet the price is low when you figure the long service that these tubes will give you. There are no better tubes made than **REXTRON**, regardless of price.

Order from this page and please note particularly the following terms.

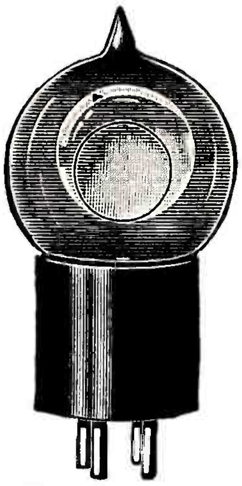
No orders accepted for less than $3.00.

All prices are F. O. B. New York.

No replacements after six months.

If you wish a tube replaced, it is necessary to return it to us and we will send you a new one immediately.

It is not necessary to send full amount of cash with order, so long as you send 20% of the value with your order.



2-Inch Photo-Electric Cell. $4.50

High Grade (Hi Mu) 201A Type—better vacuum — works and fits in any set. $1.00

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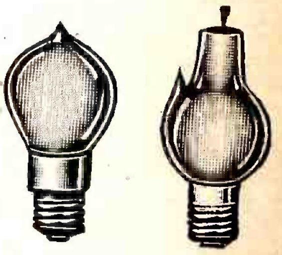

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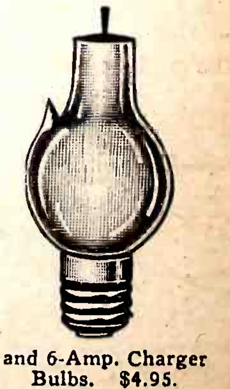

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Book Review

(*Continued from page 327*)

TELEVISION TO-DAY AND TO-MORROW, by S. A. Moseley, and H. J. B. Chapple. Cloth covers, sixe 8" x 5½", pages 130, profusely illustrated, price $2.50. Published by Isaac Pitman & Sons.

This up-to-the-minute work on television describes in detail the apparatus used by Baird. The student will learn all about scanning discs; the best type of motor; reverse effects and how to overcome them; isochronism and synchronism; various ways of synchronizing the receiving discs; photocells and neon tubes; radio receivers for television signals; noctovision. The author handles the subject of Television in a comprehensive and interesting manner.

RIDING THE AIR WAVES, with Eric Palmer, Jr. by himself. Cloth covers, size 7½" x 5½", pages 328, price $2.00. Published by Horace Liveright.

Short Wave Fans cannot miss reading this highly entertaining and informative book which tells the story of youthful Mr. Palmer and his remarkable achievements in amateur radio. "Around the World with 5 watts" and many other interesting subjects appear between the covers of this book. The author also handles the subject of short wave transoceanic rebroadcast; the recognition of amateur radio service by the government, etc.

A POPULAR GUIDE TO RADIO, by B. Francis Dasheill. Cloth covers, sixe 5½" x 8½", pages 286, profusely illustrated, price $3.50. Published by The Williams & Wilkins Company.

The author starts off with an excellent section on electricity and magnetism; the use of radio aerials and grounds; the fundamental principles of radio; the electron tube and crystal rectifiers—how they work; the principle of radio amplification; radio inductance coils and condenser; fundamental radio receiving circuits; electrical reproduction of sound; the atmosphere and radio phenomena, etc. The subject matter is adequately handled by the author and makes very interesting and informative reading matter.

RADIO RECEIVING TUBES, by Moyer and Wostrel. Cloth covers, sixe 7½" x 5½", pages, 298; illustration, 181; price $2.50. Published by McGraw-Hill Book Company, Inc.

Every radio student or operator cannot do without this authoritative book on the radio vacuum tube. The various chapters include construction of vacuum tubes; electrical fundamentals; elementary action taking place in the vacuum tube with graphs; reactivation of tubes; testing of tubes including determination of amplification factor; plate resistance; grid resistance, etc. Other valuable chapters cover detector action; V. T.'s as amplifiers; oscillation generators; followed by specifications for vacuum tubes and their industrial application in many rôles.

ELEMENTS OF RADIO COMMUNICATION, by Professor John H. Morecroft. Cloth covers, size 9" x 6", pages 270, illustrations 170, price $3.00. Published by John Wiley & Sons, Inc.

Professor Morecroft explains in an authoritative and clearly understood manner, such important radio phenomena as—current flow in circuits containing capacity and inductance; propagation of radio waves; vacuum tubes as detectors and amplifiers; fading of radio waves and its causes; neutralization; "superheterodynes for short waves," etc.; audio frequency amplifiers; how filters work.

RADIO MOVIES, by C. Francis Jenkins. Cloth covers, size 9" x 6", pages 144, profusely illustrated, price $2.50. Published by Jenkins Laboratories, Inc.

An absorbing history, handsomely illustrated, of the Jenkins system of transmitting and receiving movies by radio. One of the chapters give constructional details and drawings for building your own radio-visor or machine for making the radio movies visible in your home. Diagrams of amplifiers are given with much other valuable information.

OFFICIAL RADIO SERVICE MANUAL, by Hugo Gernsback, Editor; Clyde Fitch, Managing Editor. Flexible covers, size 9" x 12", profusely illustrated, pages 352, price $3.50. Published by Gernsback Publications, Inc.

Commercial wiring diagrams for all the regularly manufactured receiving sets are included in this manual and no radio service man or student who builds and repairs radio sets can be without this tremendously useful compilation of circuits and their descriptions. This book is worth $100.00 to anyone who has a use for it. The Manual is indexed so that any commercial receiving circuit can be found instantly. One of the most valuable radio books ever published.

Among the Hams

(Continued from page 289)

(Our correspondent will have noticed that his demand has already been granted. We have had several articles on television on short waves, beginning with the second issue, and we will have some more right along. All we want of you hams and short wave enthusiasts, including "S. W. P. H.," is to let us know what you want to read, and it will be published if it can be secured. Remember, the editor has no preference as to the various articles; he is not publishing the magazine for himself but for you fellows. So shoot along the suggestions and you will find we will pay close attention to them.—Editor.)

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Short Wave Craft, published bi-monthly at Mt. Morris, Illinois, for Oct. 1, 1930.

State of New York, County of New York, ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the editor of the Short Wave Craft and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Popular Book Corporation, 98 Park Place, N. Y. C.; Editor, Hugo Gernsback, 98 Park Place, N. Y. C.; Managing Editor, H. Winfield Secor, 98 Park Place, N. Y. C.

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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is (This information is required from daily publications only).

H. GERNSBACK.

Sworn to and subscribed before me this 30th day of September, 1930.

(Seal.) ROZELLA BENNETT,
(My commission expires March 30, 1931.)

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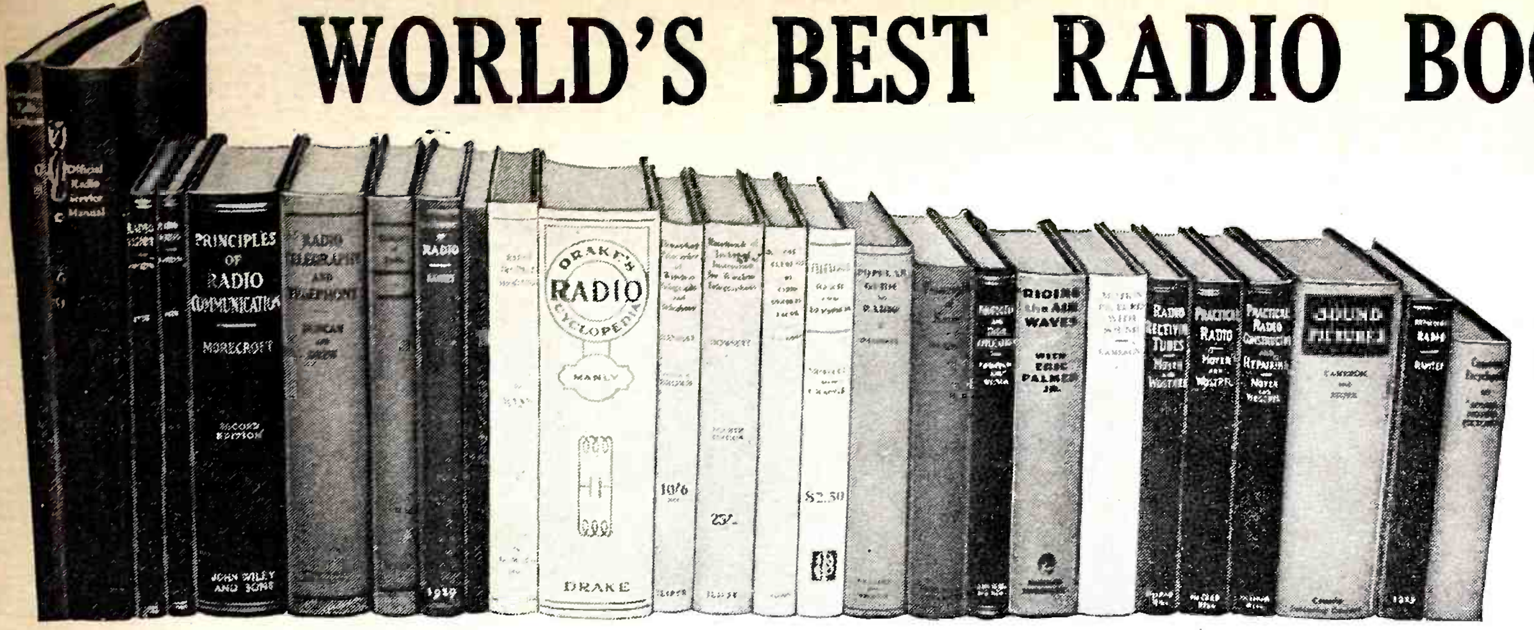

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EXPERIMENTAL RADIO, by R. R. Ramsey, Professor of Physics, Indiana University. Cloth covers, size 7½x5½", 256 pages, 168 illustrations. Price, postpaid **$2.75**

This book by Professor Ramsey is written in the nature of an experimental radio course and contains 128 experiments, illustrated and described in a clear and interesting style. The experiments cover such valuable subjects as: A test on a loud speaker; the impedance of coils; construction of a filter, screen grid tube; beat note audio oscillator; etc.

PRINCIPLES OF RADIO COMMUNICATION, by J. H. Morecroft, Prof. of Electrical Engineering, Columbia University. Cloth covers, size 9½x6", 988 pages. Profusely illustrated. Price **$7.50**

A radio classic, indeed, is Professor Morecroft's very complete text-book which covers such important radio phenomena as: the action in condensers; self and mutual induction in a circuit; phase and phase difference; effect of condensers and coils on wave shape; resonance frequency of coupled circuits; skin effect in coils; antenna resistance; transformers; vacuum tubes; radio frequency alternators; modulation and circuits; amplifiers and filters.

RADIO TRAFFIC MANUAL AND OPERATING REGULATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9x6", 186 pages. Price **$2.00**

This valuable handbook starts off with instructions on how to learn the code in considerable detail, with a list of abbreviations. Then comes operating rules and regulations of the Radiomarine Corporation of America with operators' report forms; followed by the rules of the International Radiograph Convention; the United States Radio Act of 1927; the Ship Act of 1912; etc.

PHOTOCELLS AND THEIR APPLICATION, by V. K. Zworykin, E.E., Ph.D., and E. D. Wilson, Ph.D. Cloth covers, size 5½x8", 210 pages, 97 illustrations. Price **$2.50**

Photocells today occupy a very important place in radio and talking pictures, as well as other branches of applied science, and these two experts have provided the very latest information as to the action taking place in various types of photocells. The theory on which these different cells operate, including color sensitivity, together with amplifier and scanning discs used in picture as well as television transmission, etc.

PRINCIPLES OF RADIO, by Keith Henney, M.A. Cloth covers, size 8x5½", 478 pages, 306 illustrations. Price **$3.50**

The author is well known in radio and he has here provided a very complete and clearly written discussion of radio circuits and apparatus, including such important topics as: condensers; transformers; determination of inductance; vacuum tube action, including Screen Grid and Pentode; wave meters, their calibration and use; modulation; amplifiers; long wave receivers; and different types of rectifiers.

HOW TO PASS U. S. GOVERNMENT RADIO LICENSE EXAMINATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9½x7", 170 pages, 92 illustrations, appendix. Price **$2.00**

The authors are thoroughly conversant with their subject and all of the most important information including hook-ups; types of antennae and receivers with wiring diagrams of both small and large receivers and transmitters of commercial type, including ship sets are given.

RADIO RECEIVING TUBES, by Moyer and Wostrel. Cloth covers, size 7½x5½", 298 pages, 181 illustrations. Price **$2.50**

No radio student or operator can do without this authoritative book on the radio vacuum tube. The various chapters include construction of vacuum tubes; electrical fundamentals; elementary action taking place in the vacuum tube, with graphs; reactivation of tubes; testing of tubes including determination of amplification factor; plate resistance; grid resistance, etc.

PRACTICAL RADIO—INCLUDING THE TESTING OF RADIO RECEIVING SETS, by James A. Moyer, S.B., A.M., and John F. Wostrel. Cloth covers, size 8x5", 378 pages, 223 illustrations. Price **$2.50**

Everyone will find this volume of the utmost practical value as the authors have explained in text and diagrams, for the practically-minded student, such interesting subjects as telephone receivers and crystal sets; various types of aerials; current sources for vacuum tubes; audio and radio frequency amplification with hookups; loud speakers and how they work; various radio receiving sets with diagrams and just how they work.

PRACTICAL RADIO CONSTRUCTION AND REPAIRING, by J. A. Moyer, S.B., A.M., and J. F. Wostrel. Cloth covers, size 8x5", 354 pages, 163 illustrations. Price... **$2.50**

This handbook is one that every radio set tester and general student will want to read carefully. These experts have given a very complete description of instruments used to test and repair modern radio sets, together with complete diagrams of many modern receiving sets, with explanations on how to test the radio and audio frequency stages for faults.

ELEMENTS OF RADIO COMMUNICATION, by Professor John H. Morecroft. Cloth covers, size 9x6", 270 pages, 170 illustrations. Price... **$3.00**

Professor Morecroft explains in an authoritative and clear manner such important radio phenomena as current flow in circuits containing capacity and inductance; propagation of radio waves; vacuum tubes as detectors and amplifiers; fading of radio waves and its causes; neutralization; superheterodynes for short waves, etc.; audio frequency amplifiers; how filters work, etc.

RADIO TELEGRAPHY AND TELEPHONY, by R. L. Duncan and C. E. Drew. Cloth covers, size 9½x6", 950 pages, 468 illustrations. Price **$7.50**

This 950 page book forms indeed a most complete treatise on radio facts. The authors treat thoroughly the magnetic circuit; Ohm's law; transformers and induction; motor generators and starters; storage batteries; alternating currents; capacity and inductance formulae. Vacuum tubes as detectors and amplifiers; oscillographs; radio compass; wavelength measurements and short wave receivers.

RADIO SERVICE MAN'S HANDYBOOK WITH ADDENDA DATA SHEETS. Flexible covers, size 9x12", 200 pages, 200 illustrations. Price, prepaid **$1.75**

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Commercial wiring diagrams for all the regularly manufactured receiving sets are included in this manual and no radio service man or student who builds and repairs radio sets can be without this tremendously useful compilation of circuits and their descriptions. This book is worth $100.00 to anyone who has a use for it. The Manual is indexed so that any commercial receiving circuit can be found instantly. One of the most valuable radio books ever published.

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FUNDAMENTALS OF RADIO, by R. R. Ramsey, Professor of Physics, Indiana University. Cloth covers, size 9½x6", 372 pages, illustrated. Price, prepaid **$3.50**

Dr. Ramsey gives us a very refreshing treatment of the fundamentals of radio, including battery and dynamo action; alternating currents; inductance; vacuum tube constants; aerials of different kinds and how they operate; radio frequency instruments and apparatus; audio amplification and receivers in general.

RADIO TROUBLE SHOOTING, by Ennor R. Haan, E.E. Flexible covers, size 6x9", 323 pages, 257 illustrations. Price **$3.00**

This is a well illustrated and intensely practical handbook for all radio service men and operators, as well as set builders and testers. Some of the practical problems illustrated and discussed are, interference and noise problems—how to locate and remedy them; antenna circuit troubles and their effect on radio; batteries, chargers and eliminators.

DRAKE'S RADIO CYCLOPEDIA, by H. P. Manly. Cloth covers, size 6x9", 1035 pages, profusely illustrated. Price **$6.00**

This massive cyclopedia covers radio apparatus—its operation and maintenance, the various subjects being alphabetically arranged. There are 1735 subjects in alphabetical order ranging from A-battery to zero-beat. This volume contains 1110 illustrations, diagrams, etc. There are 414 illustrations and articles on the building and designing of radio sets, alone; 110 articles with 383 illustrations on the methods of repair, service and adjustment of radio sets.

S. GERNSBACK'S RADIO ENCYCLOPEDIA, by S. Gernsback. Stiff leatherette covers, size 9x12", 168 pages, profusely illustrated. Price **$1.45**

Radio apparatus, inventors and terms are all illustrated and described in this remarkable book which required the efforts of several engineers in its compilation. The subjects are alphabetically arranged and the illustrations are especially fine and clear.

TELEVISION TO-DAY AND TOMORROW, by S. A. Moseley and H. J. B. Chapple. Cloth covers, size 8x5½", 130 pages, profusely illustrated. Price, prepaid **$2.50**

This up-to-the-minute work on television describes in detail the apparatus used by Baird. The student will learn all about scanning discs; the best type of motor; reverse defects and how to overcome them; isochronism and synchronism; various ways of synchronizing the receiving discs; photocells and neon tubes; radio receivers for television signals; noctovision.

SOUND PICTURES AND TROUBLE SHOOTER'S MANUAL, by Cameron and Rider. Cloth covers, size 8x5½", 1120 pages, profusely illustrated. Price **$7.50**

This useful volume will appeal to all radio as well as "talkie" trouble-shooters. The first chapters deal with fundamentals of electrical circuits, including Ohm's law, A.C. and D.C. circuits, rectifiers, amplifiers, mixers and faders; various types of loud speakers and how to arrange them; photocells; electric motors; various types of talkie projectors; also commercial amplifiers with diagrams are given.

RIDING THE AIR WAVES, WITH ERIC PALMER, JR., by himself. Cloth covers, size 7½x5½", 328 pages. Price **$2.00**

Short wave fans cannot miss reading this highly entertaining and informative book which tells the story of youthful Mr. Palmer and his remarkable achievements in amateur radio. "Around the World with 5 Watts" and many other interesting subjects appear between the covers of this book.

A POPULAR GUIDE TO RADIO by B. Francis Dashiell. Cloth covers, size 5½x8½", 286 pages, profusely illustrated. Price, prepaid **$3.50**

The author starts off with an excellent section on electricity and magnetism; the use of radio aerials and grounds; the fundamental principles of radio; the electron tube and crystal rectifiers—how they work; the principle of radio amplification; radio inductance coils and condensers; fundamental radio receiving circuits; electrical reproduction of sound; the atmosphere and radio phenomena, etc.

RADIO VISION, by C. Francis Jenkins. Cloth covers, size 9½x6", 144 pages, profusely illustrated. Price, prepaid **$1.25**

A beautifully printed and interesting illustrated history of transmission of images by radio; particularly covering the apparatus and successful demonstrations of the Jenkins system. Other apparatus illustrated and discussed are the Braun tube receiver; the R. C. A. Photo-radio apparatus; the A. T. & T. Company system; and the Belin machine.

RADIO MOVIES, by C. Francis Jenkins. Cloth covers, size 9½x6", 144 pages, profusely illustrated. Price, prepaid **$1.25**

An absorbing history, handsomely illustrated, of the Jenkins system of transmitting and receiving movies "via radio." One of the chapters gives constructional details and drawings for building your own Radiovisor or machine for making the radio movies visible in your home. Diagrams of amplifiers are given, with some other very valuable information.

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