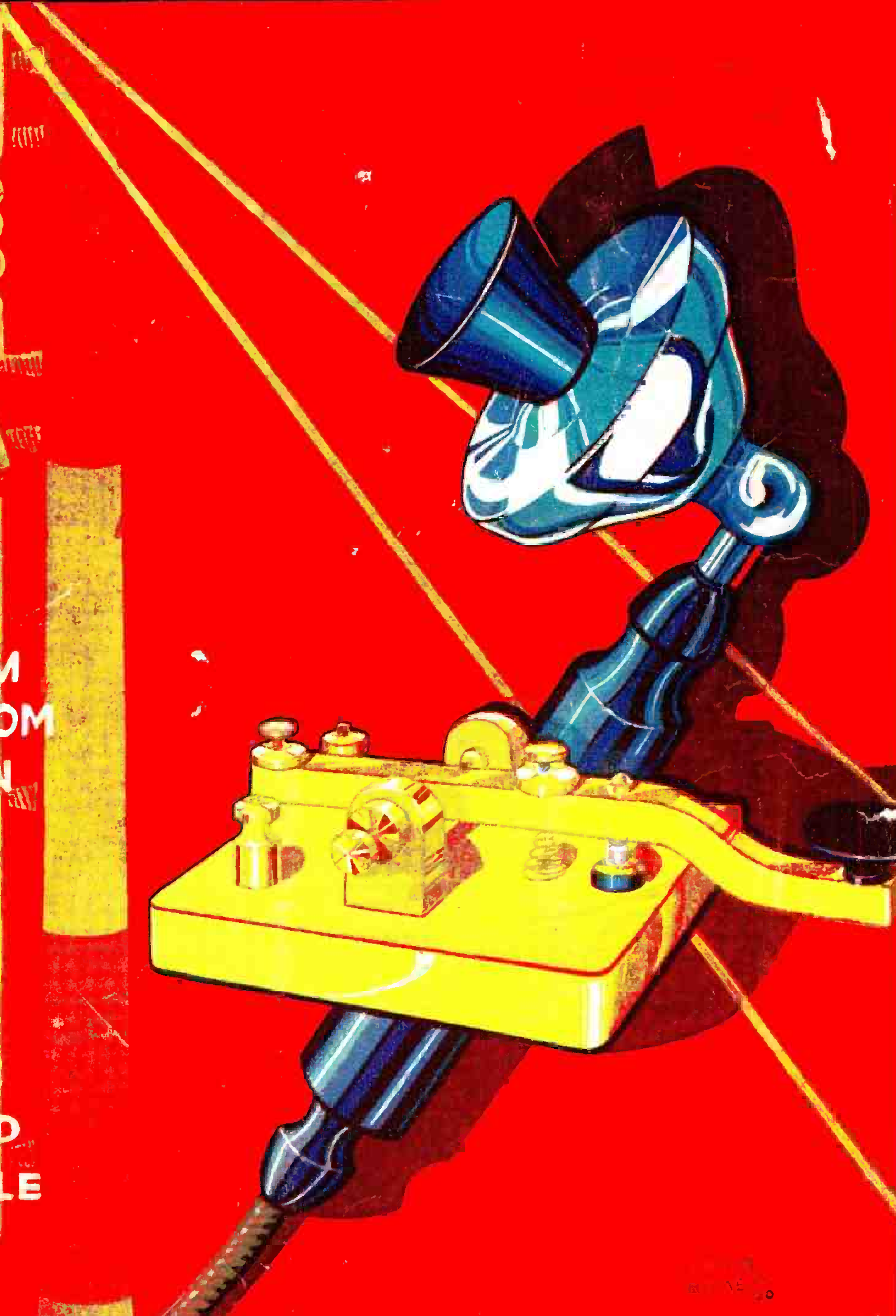
SPECIAL SHORT-WAVE NUMBER

RADIO NEWS

JUNE
25 CENTS



HIRAM P. MAXIM
WM. H. WENSTROM
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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 ....

Address ....

City .... *State* ....

Radio News

Vol. XI — CONTENTS FOR JUNE, 1930 — No. 12

ARTHUR H. LYNCH, Editorial Director
ALBERT PFALTZ, Associate Editor
JOHN B. BRENNAN, JR., Technical Editor
EDWARD W. WILBY, Associate Editor

Radio News for July, out the 10th of June, follows closely on the heels of the Radio Manufacturers' Convention and Trade Show, which this year is being held in the great auditorium in Atlantic City, New Jersey. These yearly shows, intended primarily for the trade, are attended mostly by those intimately connected with the radio business, but so that our readers may know of what's going on RADIO NEWS for July will be devoted largely to a presentation of Trade Show news.

New receivers, loud speakers, automobile radio, television, short-wave radio, accessories, parts—all the new items to be offered to the public this fall and displayed at the show will be illustrated and described in the July Special Trade issue of RADIO NEWS.

* * *

Remote and automatic control devices for radio receivers are to the fore. The trend along these lines, especially in connection with apartment house radio, is on the increase. Mr. S. Gordon Taylor, through a comprehensive survey of this activity, has compiled worthwhile data for the serviceman. The first of a series of articles on this subject will appear in July.

* * *

From RADIO NEWS Laboratory—1. The description of the construction of a short-wave wavemeter-oscillator outfit employing the grid dip method of resonance indication. 2. A "receiving tube," low powered short-wave transmitter for Junior Radio Guilders. 3. Variations in the audio channel of the RADIO NEWS Cornet Short-Wave Receiver.

And don't forget there are more articles by:

- E. H. Loftin and S. Young White
- Fred Jewell
- Volney Hurd
- Benjamin Miessner
- W. H. Bullock
- And other recognized authorities.

Published Monthly by the Experimenter Publications, Inc., at 184-10 Jamaica Ave., Jamaica, N. Y.
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HAMS!

JUST how the name "hams" first came to be applied to radio amateurs is probably one of those things that will always remain a mystery. The term has been applied to poor actors—poor in the sense that their acting did not amount to much—for many years. It was a term expressing dubious worth. In connection with amateur radio, however, the term "hams" is surrounded by a certain feeling of awe, somewhat akin to a halo. Hams themselves are proud of the term and they have every reason to be proud.

As Mr. Maxim outlines in his informative article, which appears in this special short-wave number of RADIO NEWS, these men and young men have done a tremendous amount of good for this country in helping international peace and good-will. Their organization, the American Radio Relay League, is one of the most business-like institutions in this country, and the orderly manner in which their communications and experimental work have been carried on is only a slight indication of the manner in which they may still serve all of those institutions in which radio is coming to be a more and more important adjunct.

A typical and, perhaps, the most recent indication of the value of the work being done by hams has been dramatically brought home to most of us through the newspapers which are appearing on the stands as this editorial is being written. A member of our own technical staff and the managing editor of one of our scientific publications, AERO NEWS & MECHANICS, has just finished a very dramatic flight from New York to Bermuda. Hams here and abroad will recognize Zeh Bouck by the call letters which he has used for the past few years at his own station—2PI.

Bouck's flight to Bermuda was anything but a casual occurrence. It has blazed a trail for a possible establishment of a direct airline between New York and the "Summer Isles." His two companions were Bill Alexander, who has some 7,300 flying hours to his credit and has taken part in some of the most dramatic flights in aircraft history, and Captain Lewis Yancey, who was the navigator on the flight of the "Pathfinder" from Old Orchard Beach, Maine, to Rome, Italy. The "Pilot," the name of the plane used by Mr. Bouck, which is the property of the Pilot Radio and Tube Corporation, includes two transmitters and a combination receiver and its effectiveness has been demonstrated by the fact that the plane was in constant communication with the short-wave station of the New York *Times* right in the heart of New York City from the time it left until it landed in Bermuda.

This very dramatic demonstration of the saving of time in transportation and the value of radio as an aid to air transportation marks another page in the annals of amateur radio history. Is it any wonder that amateurs are proud to be hams?

Arthur H. Lynch

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

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Mr. Schnell, Chief of the R. T. I. Staff, is one of the ablest and best known radio men in America. He has twenty years of Radio experience. First to establish two way amateur communication with Europe. Former Traffic Manager of American Radio Relay League. Lieutenant Commander of the U. S. N. R. Inventor and designer of Radio apparatus. Consultant Engineer to large Radio manufacturers.

Assisting him is the R. T. I. Advisory Board, composed of men prominent in the Radio industry.

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17,000 Ambassadors

Although Cramped by the Entrance
Short-Wave Field He so Courageously
Still Forges Ahead to New Records
nance of Communications During
His Spirit

The History of Civilization Has Been Twentieth Century the Radio Amateur ing Practically Every Barrier of Time tional Ambassador of Good Will Was and Research Spirit. His Efforts Have of That Sole Guarantee of World Peace— of Amateur Radio, Presented Before the Commerce, Mr. Maxim Highlights Some Short-Wave History and Discusses Briefly Under the

By Hiram

AMATEUR radio is unique in history. Nothing quite like it has ever before existed. It is as old as radio, the great Marconi himself having started as an amateur and being truly typical of one. From the earliest days there has been something about communicating across space that has fascinated those of us who are technically inclined. There is a scientific romance to it that profoundly moves certain of us regardless of the social or financial status to which we happen to have been born. Rich and poor, uneducated and educated, old and young, we become more self-respecting men when, with the product of our own hands and our own brains, we are able to reach out into the empty ether and make contact with another intelligence. This irresistible appeal began with the first announcements of Hertz in the '80's, when he discovered and laid down the laws that govern electromagnetic radiations. These were reported in the daily press and inspired hundreds of technically inclined minds to try something themselves. Marconi was one of these and came to be the outstanding figure among us all. The wide-spread character of this peculiar appeal was not suspected at the time. It was not until 1900 or thereabouts, when Marconi had advanced far enough to make a trial of transatlantic communication, that it became known that there were many amateur experimenters who had devised and built their own apparatus and who had listened upon that eventful night along with Marconi for those three dots that would mean the prearranged letter S sent from a spark transmitter in the British Isles.

Long before there was any radio law at all, amateur radio experimenters by the scores were engaged in two-way telegraphic communication with each other. I venture to say that the members of this committee will be surprised to learn that before the first radio law, that of 1912, was two years old this amateur organization which I represent, the American Radio Relay League, was a going concern. I furthermore wonder if this committee realizes that instead of being wholly small boys in short trousers, we amateurs are in many cases men of your own age. The great majority of us, however, are between the ages of 17 and 25. We radio amateurs have absolutely no interest in the pecuniary side of radio. Our interest is 100 per cent. noncommercial. The only reward that appeals to us is the satisfaction and the thrill that accompany the successful achievement of a difficult bit of telegraphic or telephonic two-way communication.

When the West Indian hurricane hit Florida, destroying the regular lines of communication, radio amateurs stepped into the breach and established contact with the outside world, aiding rescue work. The above Miami scene is typical of the widespread destruction

# of GOOD WILL!

of Commercial Interests Into the
Pioneered, the American Amateur
of Radio Achievement. His Mainte-
Hurricanes and Floods Is Typical of
of Service

the History of Communication. In the
Has Played No Small Part in Overcom-
and Space. His Rôle as an Interna-
an Inevitable Outgrowth of His Pioneer
Been Fundamental to the Development
the International Mind. In This Résumé
U. S. Senate Committee on Interstate
of the Outstanding Achievements in
the Position of the Radio Amateur
Present Law

Percy Maxim

From the earliest days we amateurs in the aggregate have been purchasers of considerable quantities of electrical supplies and raw materials. Furthermore, from the beginning our achievements have exerted a very real influence upon the art. From our ranks have been supplied practically all of the skilled personnel for the new industry. A radio amateur is always preferred by the commercial companies. I doubt if there is one single important radio broadcast station or one single radio manufacturing or operating company in the country today that has not at least one ex-amateur in some important position.

By the year 1915 we amateurs had accomplished unbelievable records in transmission and reception for those days. It was about this time that the older of us began seeking the reason for the amateur with home-made equipment, representing an investment of approximately $100, being able in some cases to excel the professional with equipment that represented an investment of many thousands of dollars. We found that reason eventually, and it is worthy of the careful consideration of this committee, for it is fundamental and may portend something of incalculable value to our nation. It is the backbone of the amazing record of amateur achievements down through the years. This reason was, and it still is, that with the amateur, radio communication is a labor of love, whereas with the professional it is labor for a day's pay. There is a tremendous difference between these two. Money return counts for naught with the amateur. It is the whole thing with the professional. No sacrifice is too great for the amateur to make if he can but get his signals through and the answer back. Sitting up all night, sacrificing pleasures in order to save a dollar for the purchase of better equipment, trying innumerable experiments, rebuilding his apparatus time on end, never giving up, are a religion with the amateur. This passionate intensity of purpose is really nothing short of sublime. I shall cite a few instances later to prove this.

H. C. Leuteritz, radio expert of Pan-American Airways, Inc., is shown holding the small portable transmitter outfit that warned off airplanes plying the South American route from possible disaster during the West Indian hurricane

This state of affairs was vaguely known to the authorities when the radio law of 1912 was being considered. The amateurs were beginning to organize at that time and during the hearings they requested to be heard, just as they have requested to be heard here today. Their sincerity and earnestness led the Congress of those days to provide for them in the radio law. The years have proven that it was an infinitely wise step.

The Congress in the radio law of 1912 specifically provided that there should be amateurs and it allocated to them the waves below 200 meters. They were considered the "useless waves" at that time, but there was room enough and the amateurs set about seeing what could be done with them. It was an historic occasion in the art of radio communication for it marked the birth of

A severe river flood such as this, which swept away the Missouri-Pacific Railroad bridge over the Arkansas, has often been an occasion for heroic rescue work by radio amateurs

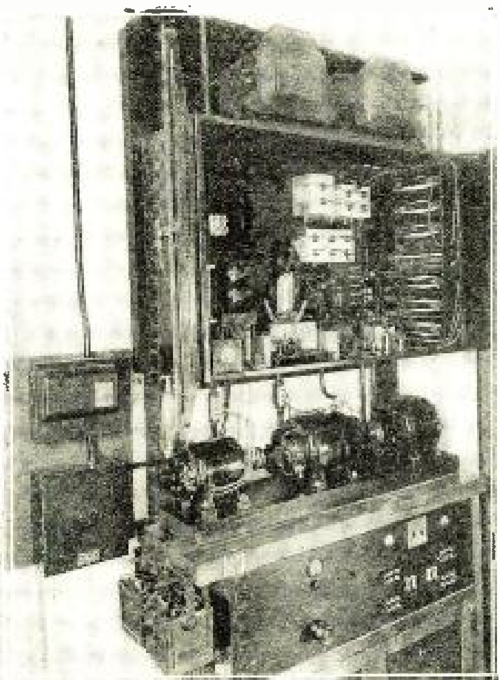
short-wave radio. The amateurs of the country went at their problem with the enthusiasm that only love of the work could arouse. I hope to show you beyond all question of doubt that the legislative act which led to this enthusiasm was one of the wisest steps a Congress ever took, and I submit that if it is wisdom to judge of the future by the past then we here today may safely assert that it will further the art of radio communication during the eighteen years to come just as much as it furthered the art of radio communication during the eighteen years that have passed if this Senate Committee on Interstate Commerce, in working out the details of Senate Bill S. 6, see to it that our radio amateurs are protected, encouraged and adequately provided for.

In the midst of things we entered the World War. The amateur had advanced a long way in learning how to make use of the short waves. His numbers had grown into the thousands. His American Radio Relay League had become a highly successful and efficient organization. Through this organization he had established a network of amateur communication lines that covered the entire United States and the Dominion of Canada. The Canadians, being so close to us, were taken in as brothers and given full representation in League affairs, just as though they were American citizens. When the United States entered the war our Army and our Navy had immediate need for thousands of radio operators. To make them from plumbers, farm hands, clerks and laborers in the time available was an insurmountable task. The organized radio amateurs were appealed to. In sixty days we induced over four thousand of our membership, the most enthusiastic and skillful radio operators the world possessed, to enlist in the Army and Navy. Their record is one of the classics of the war.

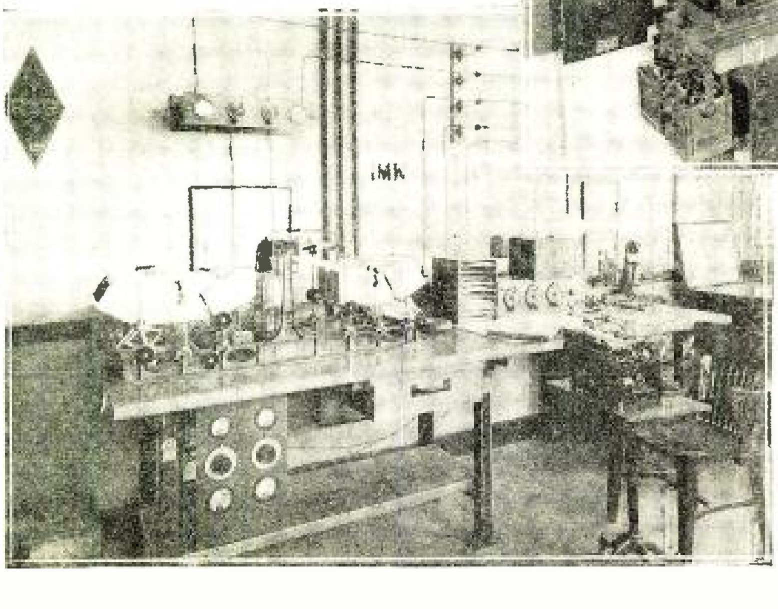
After the war the ranks of the amateurs were augmented by the thousands who had been trained in the two services. Altogether they made of amateur radio an imposing institution. This was proven in the case of various radio bills that were introduced in Congress which threatened the existence of the amateur. The tremendous improvements made in radio apparatus during the war, under the stress of war conditions, were all known to the amateurs, since they had to operate them, and thus it came about that a tremendous increase in amateur interest ensued. Their American Radio Relay League, or their A.R.R.L. as they affectionately term it, was put together again and the conquest of the short waves was taken up with unprecedented enthusiasm. It is difficult for me to convey to those not informed upon this subject of amateur radio the intensity of purpose of these young fellows. They unquestionably are the pick of the land when it comes to mentality and resolute character, or they would not have taught themselves the science of radio and the telegraphic code in the first place. Furthermore their path was no easy one, for they were, in the overwhelming majority of cases, the sons of parents in very modest circumstances. But lack of money only whets the intensity of the amateur. One case that came to my notice is worth the attention of this committee. A certain young man, aged seventeen, in a mid-western city was known to possess a particularly efficient station. Attention became directed to him because of his long-distance records and his superior operating. Investigation disclosed the surprising fact that he was the son of a laboring man in very reduced circumstances. The son had attended the ordinary school until he was able to work and then he had assisted in the support of the family. They were very poor indeed. Surprise was manifested that under these oppressive conditions this young fellow should have such a fine radio station. It was found that this station was installed in a miserably small closet in his mother's kitchen and that every bit of it had been constructed by himself. This meant that such things as head-phones and vacuum tubes were home-made. Asked how he managed to make these products of specialists, he showed the most ingenious construction of head-phones built from bits of wood and wire. In the case of his vacuum tubes he had found where a wholesale drug company dumped its broken test-tubes, where the electric light company dumped its burned-out bulbs, and had picked up enough glass to blow his tubes and enough bits of tungsten wire to make his own filaments and had literally home-made vacuum tubes—and good ones at that.

To exhaust his vacuum tubes he had built his own mercury vacuum pump from scrap glass. His greatest difficulty was securing the mercury for this pump. He finally begged enough of this from another amateur. The greatest financial investment that this lad had made in building his radio station was twenty-five cents for a pair of combination cutting pliers.

This case illustrates the amateur spirit, a knowledge of which I consider it my duty to convey to this committee. No explanations are necessary nor called for. The case points its own moral. (*Cont. on page* 1136)

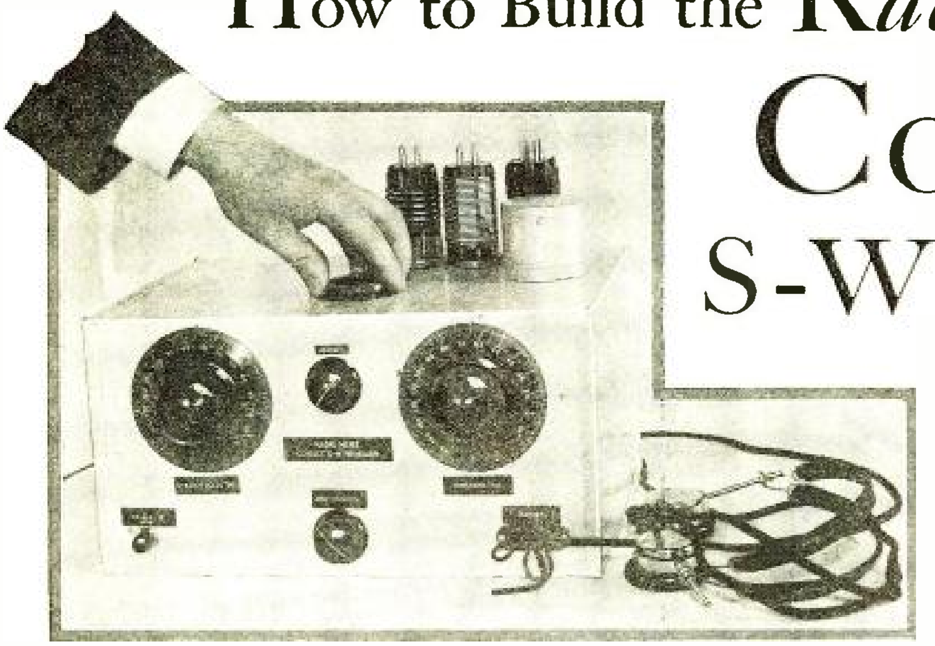


(Above) The battery panel and power supply of W1MK, headquarters station of the American Radio Relay League



The main transmitter of W1MK is rated at 500 watts and is capable of operating on either 20, 40 or 80-meter bands. An auxiliary 250-watt transmitter is located on the shelf under the table

How to Build the Radio News Cornet S-W Receiver



By

Edward W. Wilby

A Dressed-up Version of Lieut. Wenstrom's Original Cornet, the Receiver of Many Wavebands. Well Designed Mechanically, It Embodies Such Features as Plug-in Coils, Complete Shielding, Screen-Grid Resistance-Coupled Audio Amplification and Phone or Loud-Speaker Operation. It Is One That, Without Question, Will Endear Itself to Its Builders

IN his series of articles on short-wave radio, appearing in Radio News beginning with the July, 1929, issue, Lieutenant Wenstrom referred occasionally to the short-wave receiver he had used. So much interest in this receiver was aroused that, to satisfy the demand for particulars about the circuit employed, parts used and so forth, a short descriptive article was prepared by the Lieutenant and published in the March, 1930, issue of Radio News. However, this article only served to whet the appetite of our readers and letters came pouring in asking for more detailed information about the actual construction of the receiver.

It was then that the Technical Staff of Radio News decided to build one of these receivers, using up-to-date parts and employing a type of construction that recently has met with much favor.

The original Cornet, so named because of its ability to cover a wide range of notes (wavelengths), employed two tubes, one a detector in a regenerative circuit, the other an audio amplifier, using transformer coupling. There were a number of refinements incorporated in the design of the receiver which in the present construction have been retained; for instance, control of the detector grid is accomplished by the use of a potentiometer shunted across the filament leads with the return of the grid leak going to the center arm of the potentiometer; antenna coupling to the secondary circuit of the first tube through a coupling condenser instead of through the customary primary coil, etc.

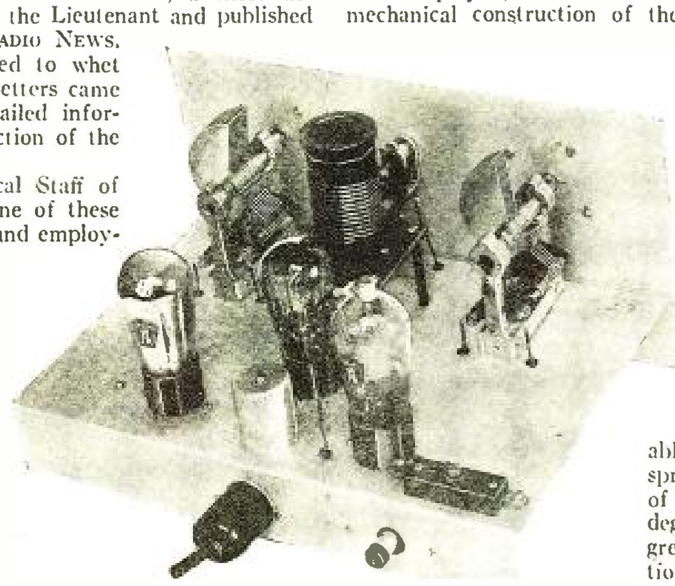


Fig. 1. This behind-the-panel view of the Cornet S-W receiver shows the location of those parts which are mounted on top of the chassis. To keep it away from the influence of the metal walls and base, the coil is mounted on a platform, raised from the chassis by means of four spacers

In redesigning the receiver the same fundamental circuit has been employed, with additions and improvements. Also the mechanical construction of the receiver has been materially refined, as will be apparent from the photographs accompanying. The original receiver used a bakelite panel and bakelite subpanel. The new set employs aluminum sheet throughout, the panel, subpanel and shield box being made of this material.

By means of four plug-in coils a wide wavelength range is obtained, extending from 14 meters at the low end to 225 meters at the high end. Tuning of each coil by means of the variable condenser, instead of being spread over the usual 180 degrees of the dial, is spread over 270 degrees, thus obtaining a much greater separation between stations. The use of a vernier dial for both the tuning and regeneration condenser permits easy control of the receiver.

The receiver itself is built on an aluminum chassis, the three tubes, the tuning and regeneration condensers, the r.f. choke, the coil mount and the antenna condenser being mounted directly on top. Below the chassis are mounted the various filament ballasts, the connector cable receptacle and the coupling condensers and resistors. These latter two items are those having wire pigtail connections enabling them to be wired into the circuit without the aid of separate mountings for each. Below the chassis, but mounted on the main panel are the "first audio-second audio" switch, the grid potentiometer and the tip-jack receptacle for the phone cords.

On the upper part of the main panel are mounted the dials for the two large variable condensers and the trimming condenser, the midget, which is shunted across the main tuning condenser to get a further vernier control of the tuning. The coils for the receiver fit into a regular four-prong socket which is supported from the surface of the chassis by means of a bakelite shelf erected on four tubular spacers. By means of this queer construction a number of features, all advantageous, are obtained. First, the coil, when in use, is equally spaced in respect to the bottom, top and walls of the shield can and is not affected by detuning effects which a mass of metal, in close proximity to the coil, will cause. Second, the coil is raised sufficiently so that when it is desired to shift from one waveband to another it is merely necessary to remove the cylindrical cover on the top of the cabinet, grasp the coil and remove it. If the coil were not raised, then it would be necessary to unscrew the top of the cabinet and reach in for the coil.

In Fig. 1 is shown the general behind-the-panel appearance of the receiver. This photograph will give a good idea of the way in which the various parts have been located and mounted. Fig. 2 gives the details for the construction of the

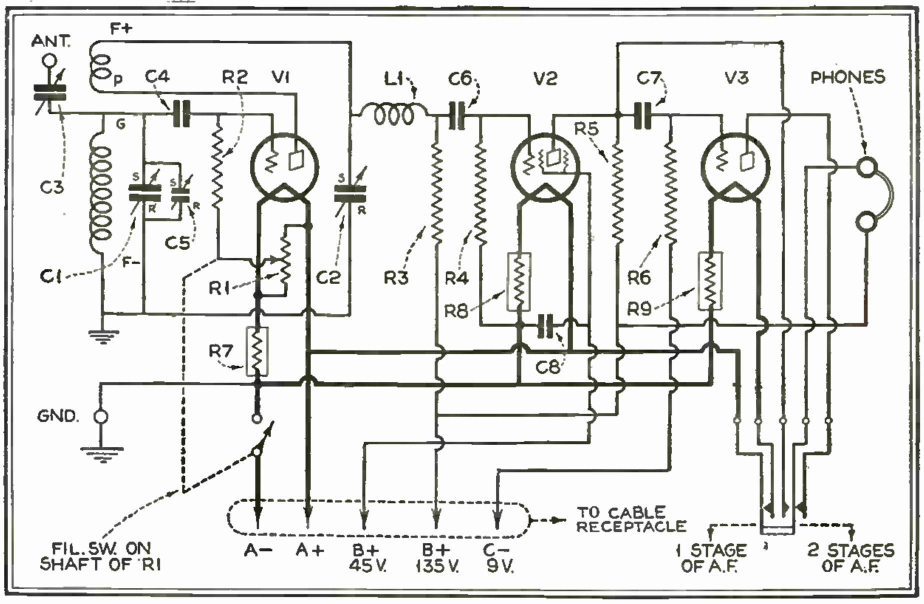
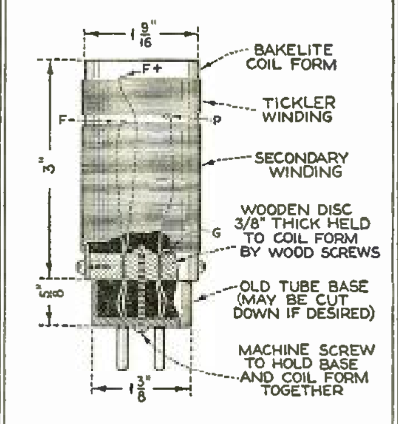


Fig. 4. Three tubes are employed in the RADIO NEWS Cornet short-wave receiver, the circuit of which is given above. The first tube (left) is the regenerative detector. The second tube, a screen-grid of the d.c. type, and the third tube, a -12a, complete the resistance-coupled audio-frequency amplifier. Lettered parts may be identified in the parts list

– DATA FOR COIL CONSTRUCTION –



COIL NO.	WAVE LENGTH RANGE	SECONDARY WINDING	TICKLER WINDING
1	14 TO 30 M.	6 T NO.12 *	6 T. NO. 28 E.
2	29 TO 58 M.	13 T. NO.14 *	13 T. NO. 28 E.
3	54 TO 110 M.	23 T. NO.16 *	16 T. NO. 28 E.
4	103 TO 225 M.	56 T. NO.28 E.	26 T. NO. 28 E.
* BARE COPPER WIRE			
SEC. TURNS ARE SPACE WOUND EQUAL TO THE DIAMETER OF THE WIRE USED			

Fig. 3. For the four coils which are required to cover the wavebands of from 14 to 225 meters the specifications shown above must be adhered to, although any other type of construction will be satisfactory providing the diameter of the tubing as indicated is not altered

shelf for the coils. The bakelite piece is mounted off the base of the chassis, being supported by means of the four brass tubular spacers shown. Next to Fig. 2 we show a photograph of this assembly as actually incorporated in the design of the receiver. This photograph also shows the midget condenser, a 32 mmfd. condenser which has been revamped so as to have only one stator and one rotor plate.

In the receiver we built manufactured short-wave coils were employed first, these being the Octo-coils. However, it is quite possible for those who so desire to wind their own coils. To aid them the information on the construction and winding of suitable coils is presented in Fig. 3.

The actual circuit employed in the improved Cornet receiver is shown in Fig. 4. In addition to the detector, which is the same as that originally employed, there are two stages of audio amplification so that loud-speaker results may be obtained. The first audio stage makes use of the screen-grid tube in a resistance-coupled amplifier. This is followed by a power output stage employing the 112A tube.

Provision is made in the circuit so that, by means of a jack switch, it is possible to switch from the first to the second audio stage without disturbing any of the connections of the receiver. For those who require it the picture wiring diagram of the circuit is given in Fig. 5. Here the parts employed in the construction of the receiver have been arranged in the same position relatively as they occupy in the finished receiver. Connections should be made as short and direct as possible.

To identify the location of the various pieces of apparatus it will be well to study the layout of the top of the chassis as shown in Fig. 6. This photograph should be compared with the pictorial wiring diagram of Fig. 5 for complete

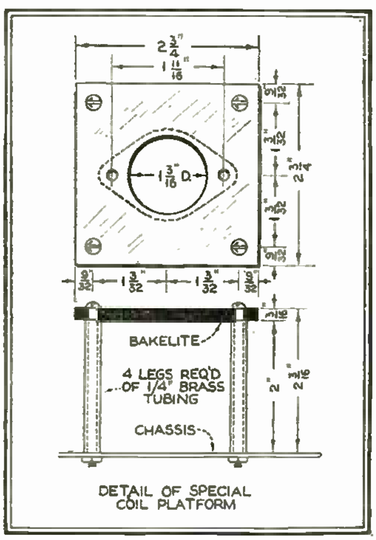


Fig. 2. The assembly and constructional details of the coil platform. Inserted in a hole drilled in the bakelite shelf is the four-prong socket which takes the pins of the plug-in coils. The photograph to the right shows how the platform assembly looks when completed

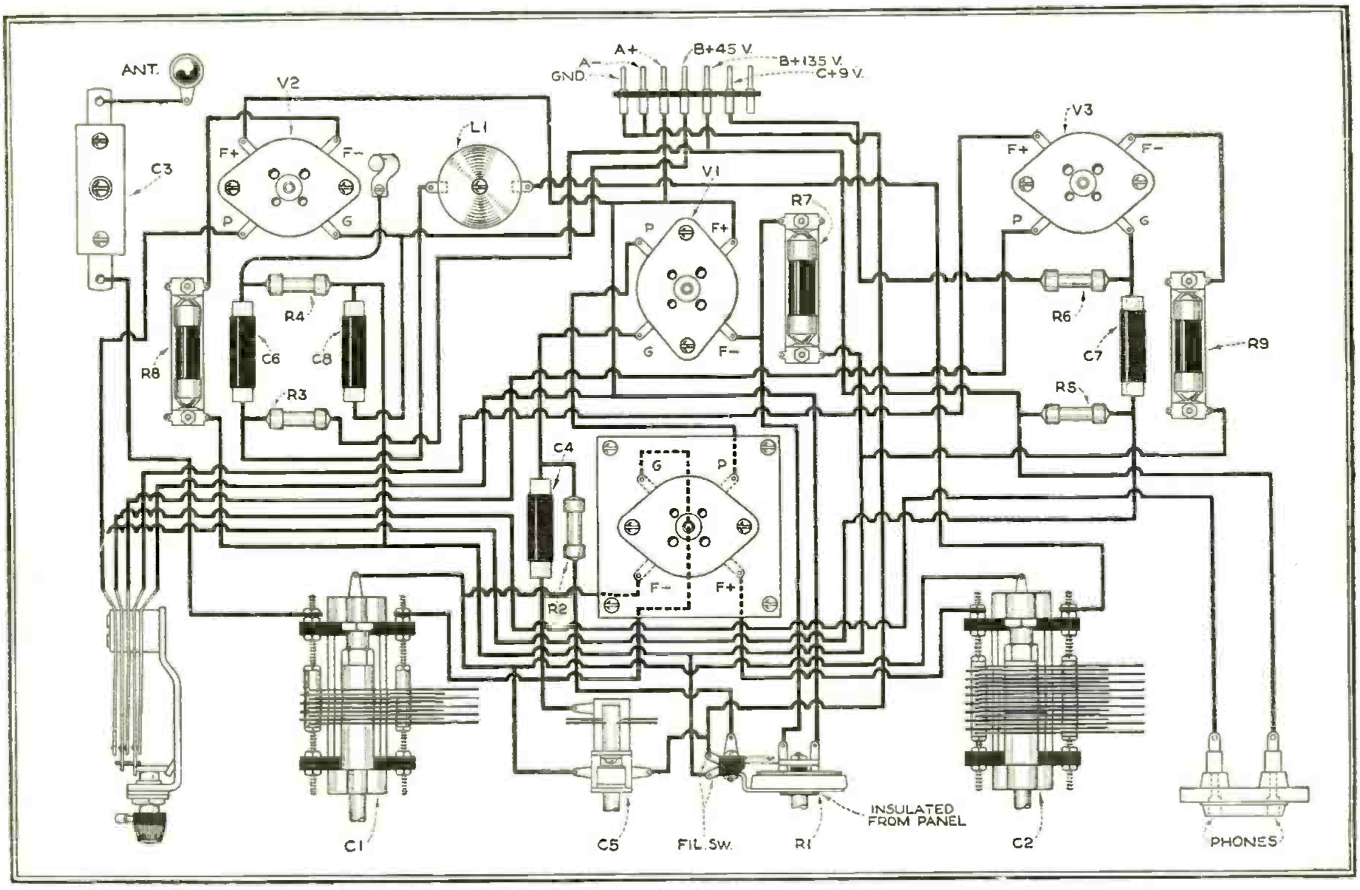


Fig. 5. In this pictorial wiring diagram each part has been placed in the position it occupies in the finished receiver. For the sake of simplicity the wiring has been shown in the manner indicated, but in actual practice some leads can be made much shorter by following the point-to-point system of wiring

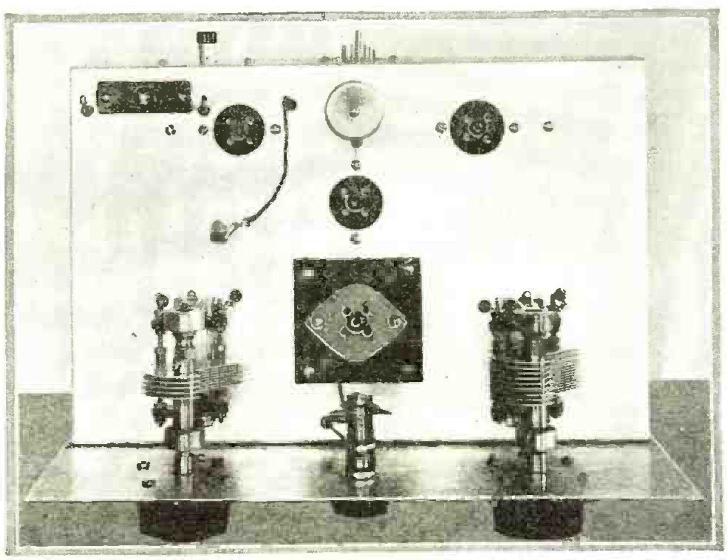


Fig. 6. Looking at the top of the chassis of the RADIO NEWS Cornet S-W receiver. Note that practically all of the wiring is kept off the top of the chassis, eyeletted holes in the chassis allowing passage of the wires from below to those parts located on top

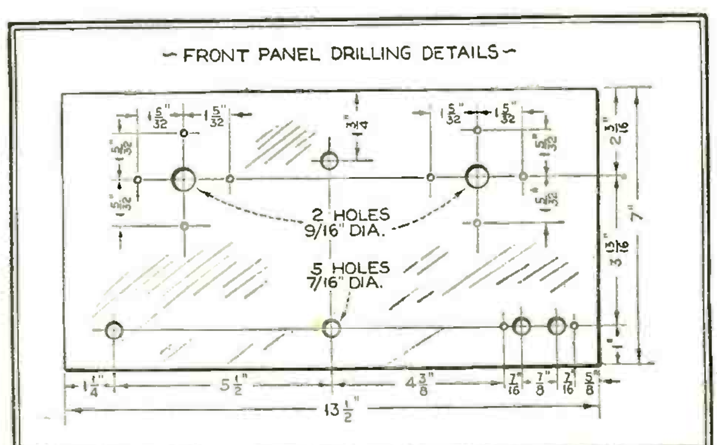
identification. Constructional details indicating how the main panel is to be prepared for mounting the parts are given in Fig. 7 while in Figs. 10 and 11 are shown the drilling and assembly details for the chassis and metal shield cabinet.

Note that practically all of the wiring of the receiver is made underneath the chassis. This is shown in the photograph, Fig. 8. So that short circuits would not occur, due to rough edges of the holes in the chassis cutting through the insulation of the wiring eyelets have been inserted in each of the holes drilled to pass wiring through from the top to the bottom of the chassis.

To make the receiver ready for operation requires nothing more than plugging in the plug of the cable to the receptacle mounted on the back of the chassis. Of course, previously the leads of this cable should have been connected to the various batteries, as indicated in the circuit diagram, Fig. 4.

Only one adjustment will have to be made. That is the adjustment of the antenna series condenser, C3. Best results will be obtained when, by test, you will have found the correct adjustment of this condenser, depending on the length of antenna employed. In Fig. 12 is shown the way in which this adjustment should be made. With a piece of wood, dowel or bakelite rod sharpened to resemble

Fig. 7. The holes for mounting the apparatus on the front panel are spotted and drilled according to the drilling layout shown below. To identify the various holes, comparison may be made with the photograph shown at the head of this article



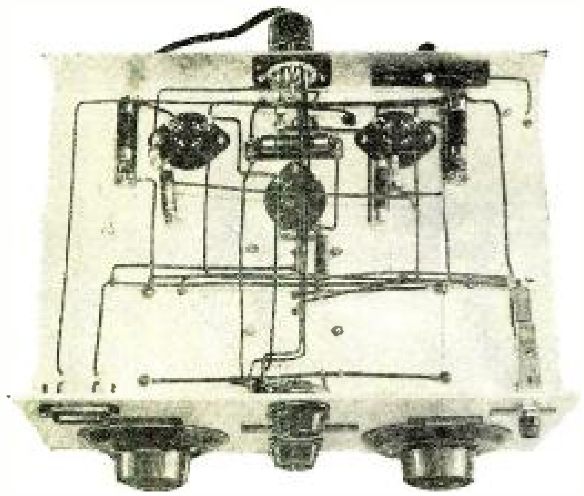


Fig. 8. Practically all of the wiring of the receiver is accomplished underneath the chassis, as shown in the photograph above. A solid insulated wire, such as covered bus-bar, has been employed so as to support rigidly such items as the grid and plate resistors and the coupling condensers. These items have no mounts, but are soldered by means of pigtail connections directly to the wiring

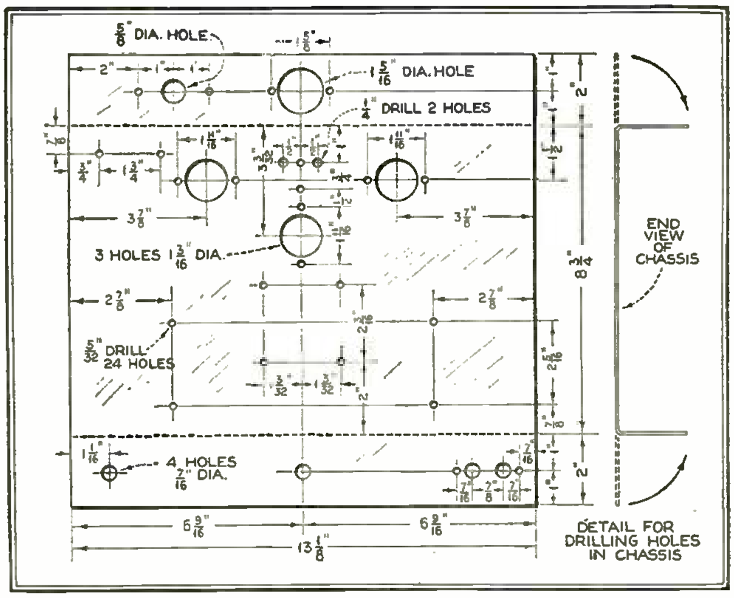


Fig. 10. The chassis is formed from a single piece of aluminum. The dotted lines in the above drawing show where the ends have to be bent to form the sides. Full drilling details are shown

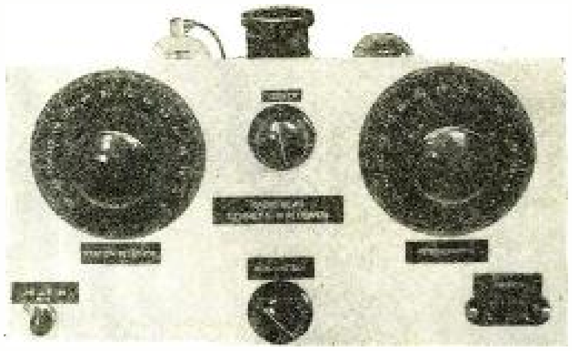


Fig. 9. To the right, the front panel appearance of the RADIO NEWS Cornet S-W receiver. The addition of nameplates to the panel, on which has been engraved the names of the various controls, adds that commercial touch to the finished job

the blade of a screwdriver at one end, the control screw is turned first one way then the other until the best setting of this condenser is obtained.

The parts which we employed in constructing the receiver described are as follows:

Parts List

C1—National equicycle condenser, .00015 mfd.
C2—National equicycle condenser, .00025 mfd.
C3—X-L variodenser, type N, 1.8 to 20 mmfd.
C4—Cornell grid condenser, .0001 mfd.
C5—Hammarlund midget (32 mmfd. revamped)
C6, C7—Cornell coupling condensers, .01 mfd.
C8—Cornell by-pass condenser, .1 mfd.
L1—Hammarlund shielded polarized choke.
R1—Carter potentiometer, with switch, 200 ohms
R2—Durham midget grid leak, 5 megs.
R3—Durham midget plate resistor, .1 meg.
R4—Durham midget grid resistor, .5 meg.

(*Cont'd on page* 1141)

RADIO NEWS for July will be
A Special Trade-Show Number
Presentations of manufacturers at the Atlantic City Convention will be featured

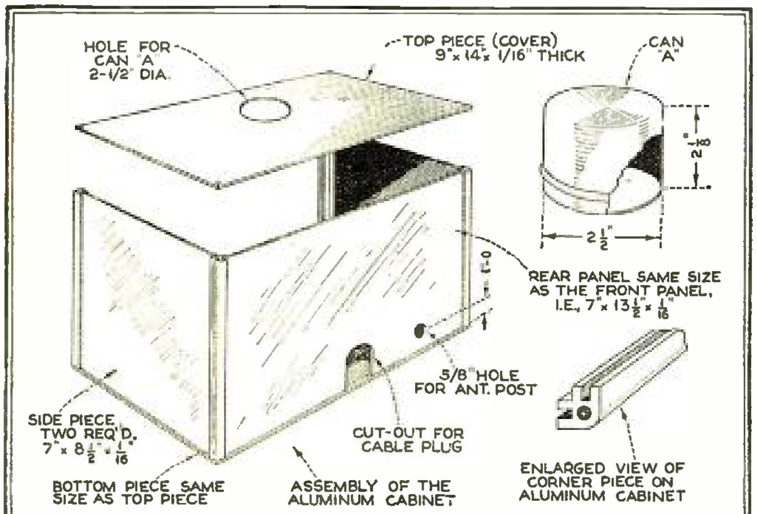


Fig. 11. This sketch shows how the shield box, in which the receiver is contained, is assembled and drilled. The front panel of the receiver provides the front wall of the cabinet. The back wall of the cabinet is drilled and cut away to allow the plug of the connector cable and the antenna post to protrude

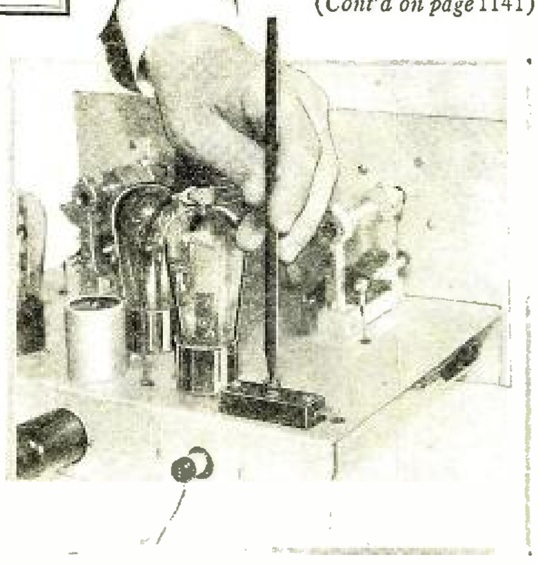


Fig. 12. To electrically adjust the antenna so as to obtain best results in the operation of the receiver, the antenna series condenser, C3, should be adjusted carefully. This is best accomplished by means of a bakelite rod, previously sharpened at one end to resemble the blade of a screw-driver, with which to turn the adjusting screw, as shown

Ralph H. Langley says: Relieve The Monotony of Driving with Auto-Radio

The Auto-Radio Installation Does Much to Lighten the Time We Spend in Driving from Place to Place. Fatigue from Driving Is Due Not so Much to the Physical Effort Expended, But to the Unbroken Roar of the Motor and the Rumble of the Tires on the Road. Radio Provides a Diversion Which Fills the Miles with Variety and Interest

By Ralph H. Langley*

IT was during a recent conversation with one of the best known radio manufacturers in the country. Incidentally, he had been one of the last to become really enthusiastic about automobile radio. "Do you know," he said, "I find myself really looking forward each evening to the ride home, now that I have radio in the car?" I happened to recall that there was an unusually good program on one of the local stations just at this hour, and so I asked if this was the reason. "No," he said. "It isn't so much the program as the fact that radio takes my mind completely off the business of the day and gives me a half hour of real relaxation and relief on the way home. When I get there, I find that I am actually rested up and ready for the evening."

City driving is, of course, increasingly tiresome and monotonous. It is punctuated with traffic signals, and retarded to irritating slowness by the multiplying traffic. A run that can be made in fifteen minutes after midnight often takes three or four times as long during the day. It is no wonder that the tired business man, driving home to save time and "for the fun of it," is embracing the idea of a radio in his car with such enthusiasm. He knows that whether he has one mile to drive or twenty, there will be something on the air to divert his thought from the cares of the day, and to entertain him while he waits at almost every intersection for "red" to change to "green."

We drive almost entirely "by eye," whether it be in the city or on the country highway. Our ears are free for other uses, but all they can do is to keep us constantly aware of the monotonous noise of the motor and the rumble of the tires on the road. The longer the trip, the more oppressive the noise becomes, and by far the greater portion of the fatigue of driving is due to it. The actual physical effort of driving is small indeed, and the noise is very low too, compared to what it was a few years ago, but it is always present, and it wearies us without our knowing it.

Not long ago a friend of mine planned to make a trip which he had made many times before, and which he regarded as an unpleasant task at best. A radio set was installed in his car just before he left, and he was asked to report on his return just what he thought of it. "It's the greatest thing yet," he said as he stepped out of the car several days later. "To begin with, I didn't drive as fast. I know my time on this trip pretty close, and I was almost an hour over on the way up. I couldn't imagine what had slowed me up, but it must have been because we were having such a good time listening to the radio."

I knew that he had finished the run rather late at night, and that he had been working pretty hard before he left. "Did you get sleepy?" I asked him. "I should say not," he replied. "When we got within about forty miles of Cleveland we picked up a station we had never heard before, and they had a real program going. It was one of the best I have ever heard. We weren't even tired when we arrived. And say," he added, "that radio is permanent on my car. I wouldn't drive without it, now that I know what it will do."

But I wanted to know more about his trip. "What happened going through the big towns?" I asked. "Did you keep the radio going?" "We would have missed one of the best parts of the show if we hadn't," he said. "And the little set seemed to work just as well in the towns as it did out on the country roads. We had one station going for over an hour, right through one town after another, without ever touching the set. It certainly performed in great shape."

I wondered how many people had noticed that he had a radio in the car, and I asked him about it. The speaker, of course, was not capable of delivering any great volume of sound.

"In one town," he told me, "we were stopped by a traffic light, and there were two men out in the street waiting to go across. They couldn't have been more than two or three feet from the open window of the car. They heard the set, and looked in to try and see it, but outside of that, the set might as well have been in my den at home. Nobody knew we had it." "Didn't you make any stops?" I asked. "Oh, yes," he said. "The men at a gas station noticed the set, and asked if we were listening to the prize-fight, so when we went on, we tuned in and heard the last two rounds. That was good."

Such reports as these are coming in every day. Even the most enthusiastic boosters for radio in automobiles have failed to realize all the different ways in which radio can contribute to the pleasure of driving. It replaces the dull monotony of the motor noise with a hundred different kinds of pleasant entertainment, and it fills the miles so full of variety and interest, that the driver who might otherwise be wearied to the point of falling asleep at the wheel arrives at his destination hardly tired at all. The fatigue is less, first because of the entertainment itself, and second, because the (*Continued on page 1156*)

*Director of Engineering, Crosley Radio Corporation.

MORE and more the general public, and those intimately connected with aviation are beginning to realize and recognize the immeasurable value of radio in air navigation.

It seems that only yesterday we were heralding the plane-to-ground radio communication and the speeding of a plane along a course marked by a radio beacon.

Yet here comes a development which still further lays the ghost of unsafe flying. As the author points out nothing can quite describe the feelings of a pilot who, arriving over what he believes to be his destination, finds the ground below entirely blanketed with fog or in some other way totally obscured. He can't drop anchor and wait out the fog, and to turn back is almost as dangerous.

Think then what it means to the airplane pilot whose plane is properly radio-equipped to come within the all-protecting tell-tale path of a vertically positioned radio beam.

Yet, such a development is the outcome of some experiments originally undertaken to provide a point-to-point radio communication system between two cities.

Radio

By
Captain John R. Irwin
Air Corps Reserve, U. S. A.

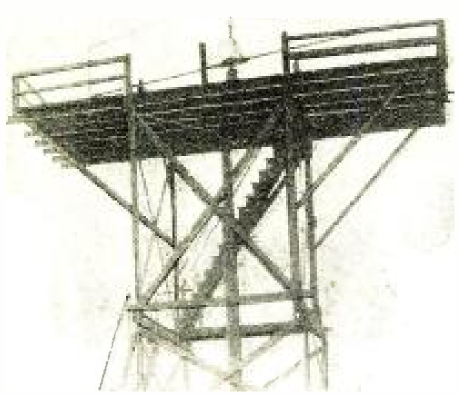
IN a previous issue of this magazine the writer attempted to describe a new aircraft radio compass that would assist an airplane pilot in maintaining his course towards his destination, regardless of weather conditions or the direction of approach. The new device enables the pilot to keep the nose of his ship always headed for the radio beacon which, we assume, would mark the airport for which he is destined. It functions further and gives him an approximate estimate of his drift, or leeway, should a wind prevail at right angles to his course.

The same group of engineers and research workers responsible for the development of this improved radio compass has evolved a radio device that promises to be the equivalent of the well known and indispensable lighthouse or lightship that marks, for the guidance of mariners, the entrance to our harbors. It is a form of radio beam, so concentrated that if it could be visualized it would take the appearance of a vertical searchlight beam. So far the investigation into its usefulness has been confined to its possibilities as an airport "spotter," or flying field localizer, in obscured visibility, such as that caused by fog, snow, rain or forest fire smoke. The greater thought given to its useful possibilities would only enhance its value as an aid to aeronautical navigation and give impetus to further research.

There is no analogy that would adequately describe the state of mind of an airplane pilot who, approaching his destination, finds the surrounding country entirely blanketed with fog, or otherwise totally obscured. The anxiety of a sea pilot feeling his way through a dense fog for a harbor entrance is nothing compared with the responsibilities of the air pilot in an analogous situation. The master mariner can often anchor and wait for the weather to clear before proceeding upon his course. The best an air pilot can hope for under similar conditions is that he will be able to find a landing field elsewhere that is less obscured and that his fuel will hold out until he locates it. The human element in air transportation is still the most important equation.

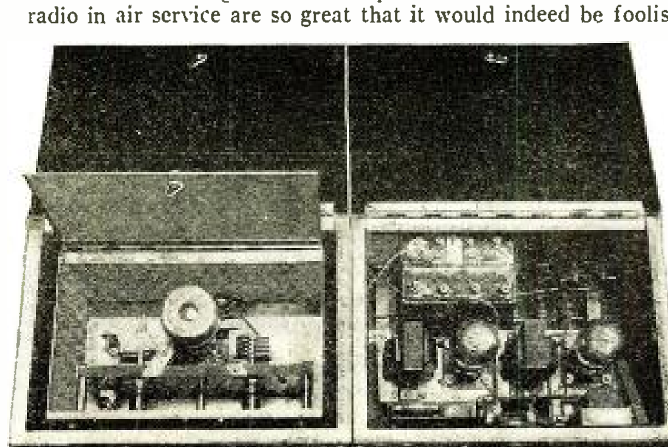
That the "air mail goes through" and aerial passengers are handled with such consistent safety speaks volumes for the intelligent skill, resourcefulness and pluck of our present commercial pilots. With the advent of Federal regulation of aeronautics, accompanied by government aid in the shape of visual and radio aids to air navigation, the uncertainty of air travel during adverse weather conditions promises to be gradually but surely eliminated. It has taken hundreds of years to provide adequate safeguards for seafarers, but it has only been a few months since any thought at all has been given to safeguarding air travelers.

The description that follows, of a device that was unheard of six months ago, is a satisfying example of the scientific aid that is forthcoming for our air pilots. The ramifications of radio in air service are so great that it would indeed be foolish



On this platform, atop a sixty-foot tower, all the field experiments in the measurement of the 4-meter beam transmission took place. The transmitter, located on a beach a few miles south of San Francisco Bay, was virtually aimed at this receiving target

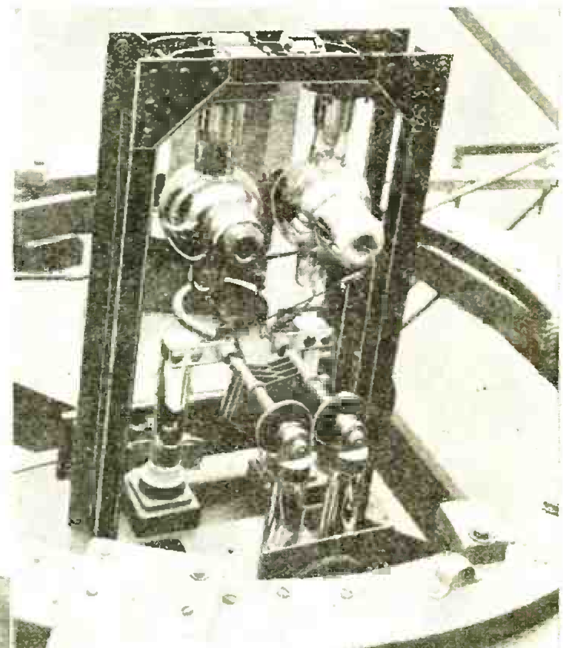
What a laboratory model of a 4-meter receiver looks like. Made in two sections, it consists of a regenerative detector with two stages of transformer-coupled audio-frequency amplification



The 4-meter receiver with the top opened. In the left-hand section is the regenerative detector. Note that besides being in a shielded cabinet the tuning apparatus is further isolated in an inner shield can. To prevent body-capacity effects from detuning the circuit the controls are set back from the main panel. Sturdy construction is the keynote throughout

Lighthouses for Airports

A 4-Meter Beam Transmitter, Aimed Vertically, Helps Pilots to Spot Landing Fields in Fog

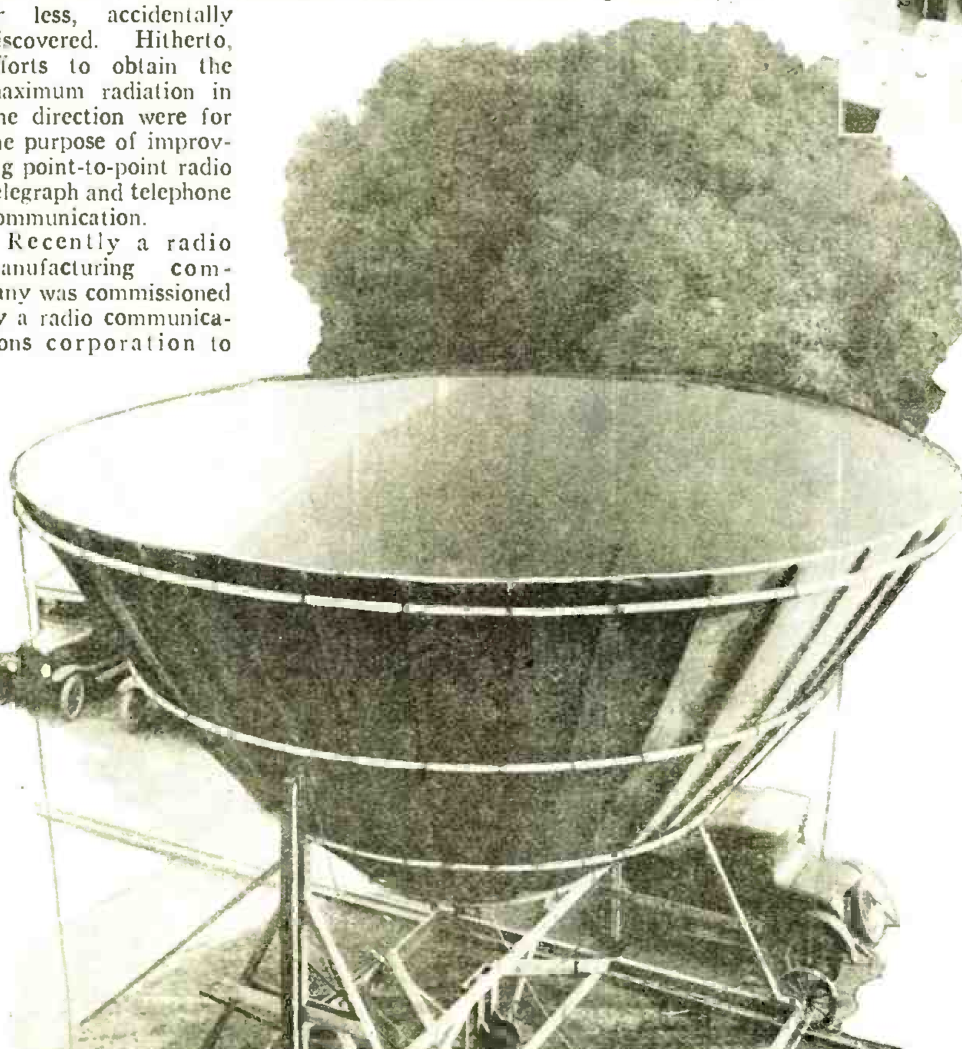


Mounted in the bottom of the paraboloid reflector this 4-meter transmitter embodies some of the finest design features which can be associated with transmitter construction. Every precaution has been taken to insulate and isolate the "hot" parts of the transmitter, as is evidenced by the pyrex supports for the coil and condenser and the frame work for the inverted tubes

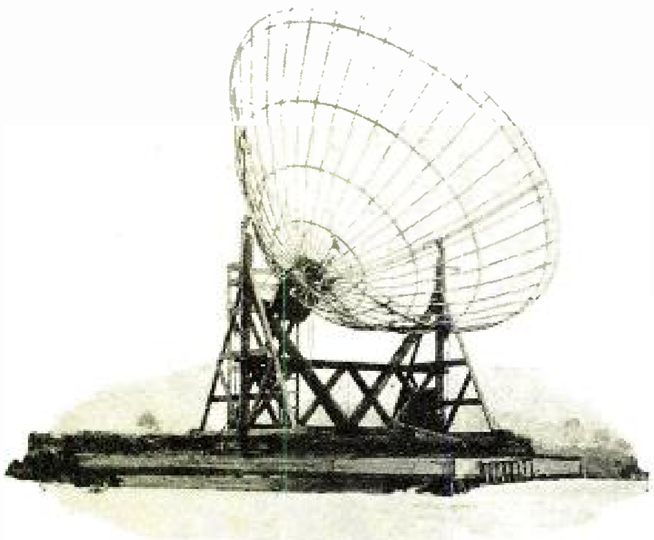
to discount any idea of efforts at "blind flying." Of course, man's inherent repugnance, or fear, to venture out of his element must be primarily overcome. Radio will ultimately accomplish that in much the same manner that it has become synonymous with safety at sea.

The directive characteristics of certain types of radio antennae have long been known. Various methods of concentrating in one direction the output of a radio transmitter have been tried and better methods are still being sought. It was during research work of this character that the value of a vertical radio beam as an aid to aerial navigation was, more or less, accidentally discovered. Hitherto, efforts to obtain the maximum radiation in one direction were for the purpose of improving point-to-point radio telegraph and telephone communication.

Recently a radio manufacturing company was commissioned by a radio communications corporation to produce apparatus that would most efficiently maintain telegraph communication between definite points, mostly over great distances. The chief research engineer of the manufacturing organization, prior to his connection with commercial radio activities, had experimented, more or less, with the idea of directive radio beams utilizing a paraboloid contrivance as a reflector, in much the same manner that light is reflected by a similar arrangement. He decided that further research along these lines would probably solve the problem. For the preliminary work, and for economical



The paraboloid reflectors are mobile, being mounted on trucks set in tracks. Swivel joints permit the reflector to be swung in any direction from the horizontal to the vertical much as with a mobile searchlight. Some idea of the size of the reflector can be gained by a comparison with the automobile shown below it



This is the chicken-wire reflector set up on the beach outside San Francisco Bay. It, too, swivels so that it may be aimed vertically or horizontally

A general view of the field of activities centering around the experiments and investigations into the transmission of a 4-meter beam signal. The mobile reflector is in the foreground while the observation tower is immediately behind it

reasons, it was decided to employ a frequency of 75,000 kilocycles, or a wavelength of 4 meters. This would keep the physical proportions of the paraboloid reflector within reasonable limits and would at the same time provide technical facts that would enable the engineers to determine whether there was merit in the idea that would justify further expense for adequate reflectors of the same type to operate lower frequencies, or higher wavelengths.

The dimensions of the paraboloid reflector used were 24 feet in diameter and 12 feet in depth, corresponding roughly to two wavelengths and one wavelength, respectively. The lining of the reflector was of sheet copper fastened to ribs that extended from the focal point to the outer rim. Two of these reflectors were constructed, one at the manufacturing plant and the other at a site located on the beach a few miles south of the entrance to San Francisco Bay. The reflector on the beach was partially destroyed in a gale of wind and was reconstructed with a lining of galvanized chicken netting. This was found to function, for the purpose, equally as well as the sheet copper. Both reflectors were mounted in gimbals that permitted them to be deflected at any angle desired. They were also placed upon wheels operating in a circular track that enabled them to be oriented, at will.

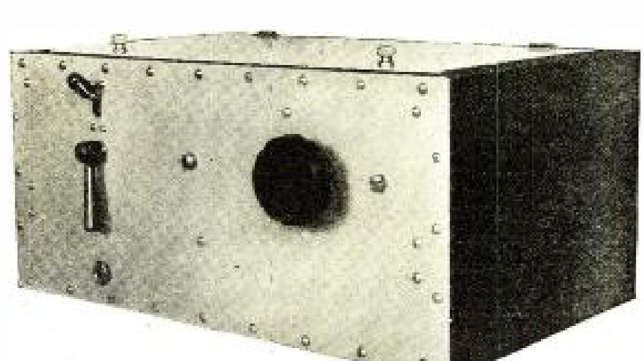
No difficulty was discovered in designing a transmitter for this high frequency and a very compact set, of a conventional circuit, was provided and placed directly in the focal point of the reflector. Tubes for experimental purposes that would function at four meters were readily obtainable, and it was discovered that they operated satisfactorily on even a wavelength as low as approximately three meters. The antenna used in most of the experiments consisted of adjustible metal rods approximating in length half a wavelength, or, in this case, six feet. The power supply and a generator used for modulating purposes were contained in a small nearby shack, flexible cable leads to the transmitter in the reflector permitting portability without any decrease in efficiency.

The receiver used in all the laboratory tests was of the regenerative type. In order to stabilize its operation on such high frequencies great care had to be given to shielding. To eliminate howling double shielding was used.

With transmitter and receiver functioning perfectly, exhaustive tests were run and measurements taken from every angle. In the accompanying photographs that illustrate this article will be seen small shacks on poles. These were used to accommodate the engineers during observations and certain of the measurements taken therein. Other readings of radiation from the beach reflector were taken far out to sea while the reflector was so deflected as to radiate in a horizontal direction. Others were taken in an airplane and it was the study of the aerial observations that led to the thought that radio in this form could be used to advantage for aeronautical purposes. One of the engineers employed in the tests had made some very ingenious cardboard models of various shaped beams, models that were correct in every detail as they were made from positive measurements. With these to assist in determining upon future research from an aeronautical viewpoint, work from this angle was commenced.

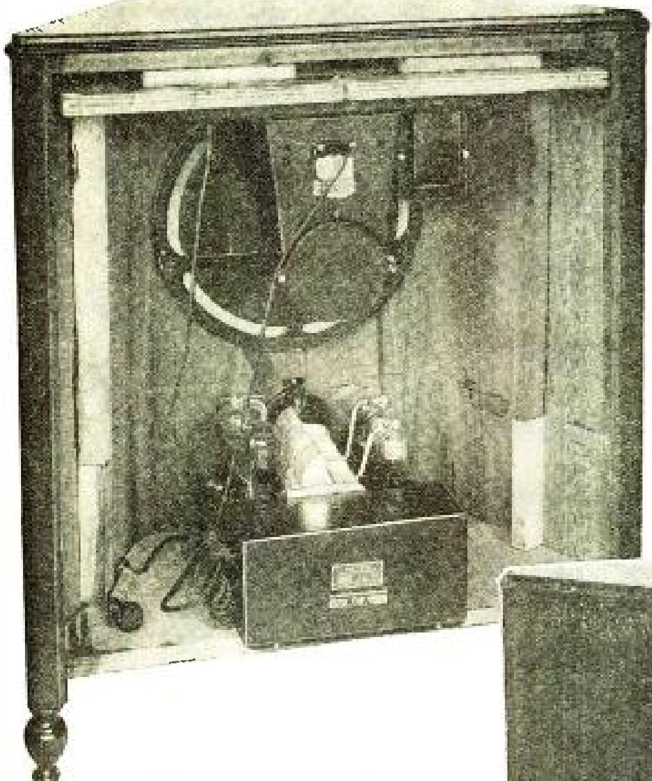
A study of the shape of different beams radiated from the same reflector but with different antenna arrangements provoked much academic discussion as to the most useful form to be used. The shape of the beam, it was discovered in early air tests, could also be governed by the adjustment of the sensitivity of the receiver. For the time being, it was decided that the most useful function of such a device would be for the purpose of enabling a pilot to locate an airport with the surrounding terrain totally obscured. Two beams offered possibilities for this purpose, one being in the form of a perfect circle with a hollow center, or dead spot, and the other a circular solid beam. The latter was finally adopted after consultation with a number of experienced commercial, naval and military pilots.

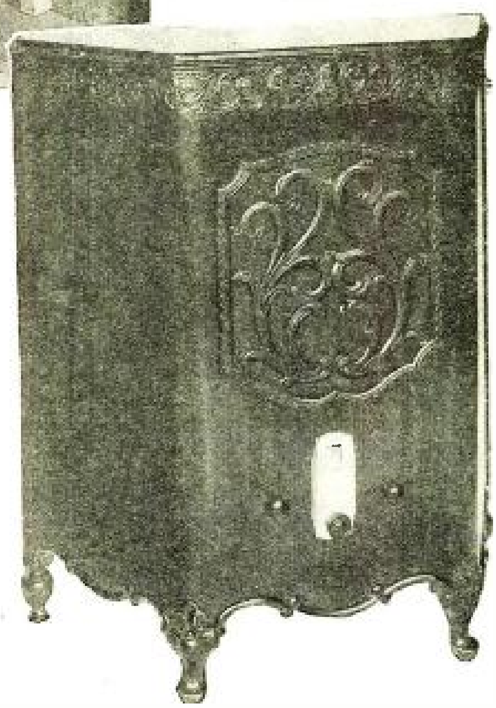
With the definite object in view of providing a "fool-proof" device for airport spotting that would be automatic in operation, exhaustive air and laboratory tests were conducted. It was found that the wavelength employed, of four meters, lent itself for the purpose perfectly. It had the advantage, also, of being in that band of frequencies which were not in use for any other purpose and would cause no interference with any radio activity in close proximity. It is interesting to note, in this connection, that the reflector used in the vicinity of the manufacturing plant was in operation for hours while receiving tests on various other wavelengths (*Continued on page* 1142)



Radio compass stations are being installed along many of the more important national airways. Aviators have found a new safety in flying by its aid. Above is shown a laboratory model of an airplane radio receiver designed especially to receive radio compass signals

Solve that Housing Problem





These two photographs, showing the rear and front of the speaker cabinet, indicate the pleasing layout occasioned by the simple alteration necessary to the installation of a receiver in the speaker cabinet

A Speaker Cabinet Offers a Convenient Location and at the Same Time Provides a Fine Piece of Radio Furniture for the Living Room of Your Home

By John B. Brennan Jr.

AFTER building a tuner or an amplifier, or both, the radio constructor is often at a loss to select a suitable cabinet in which to house the receiver which he has just built. There are many types of excellent cabinet designs which might be selected for this purpose. Some constructors have employed their ingenuity in the housing of their receivers by mounting them in such odd places as book cases, secretary desks, phonograph cabinets, and the like.

The photographs on this page illustrate one way in which this problem can be solved. In a number of the dynamic type of speakers which are now being offered for sale, and particularly the Jensen, the cabinets in which they are housed offer a convenient place for the fellow who is handy with tools, to make a few alterations so that the receiver he has constructed might also be housed in the same cabinet.

By following such a procedure, not only is an initial cabinet expense eliminated, but the complete design of the entire outfit is one of which the builder may very well be proud.

In altering the speaker cabinet so as to take the radio receiver, the procedure outlined as followed should be adhered to strictly:

First, remove the back from the speaker and place it to one side. It will be seen that the dynamic speaker is fastened by means of stove bolts to a shelf located about six inches above the floor of the cabinet. The first thing to do is to unscrew the bolts and then remove the speaker from the cabinet, placing it to one side until ready to use at a later time. An inspection of the shelf will show that it is fastened to the walls of the cabinet by means of cleats which are glued to the shelf and to the wall. Also, along the walls are fastened two upright posts. By means of a sharp chisel carefully remove the cleats from the surface of the shelf and the wall, and also the uprights, trying not to split or break them. Excepting for two dowels, the shelf is now ready to be removed. The dowels are placed in the ends of the shelf at the back and passed through the upright corner posts into the shelf. The best way to remove them is by taking a hacksaw blade and making a saw cut between the edge of the shelf and the upright corner posts, cutting through the dowel so as to make it ineffective.

Take the shelf which has been put to one side and in the same holes originally provided mount the loud speaker to the shelf's under surface. Then turn the entire cabinet upside down and hold the shelf in place so that the speaker is centered directly over the hole in the front of the cabinet. Note the distance between the shelf and the top and cut three or four wooden spacers to support the shelf the correct distance away from the underside of the top piece. So much for mounting the speaker in its new position. The uprights, which also had been removed, may be put in place again, offering additional support to the newly placed shelf.

Mounting the receiver on the floor of the cabinet also requires care. Before any drilling is attempted in the cabinet an accurate drawing should be made showing the location of the various knob and dial holes with the distance of these controls from the bottom of the receiver base noted. Then, still working from the back of the cabinet, accurately lay out these hole positions on the wooden surface. It would be well to make sure that the positions of these holes have been accurately placed by checking back with the diagram. Then drill the holes with a very small drill, say a number 30, so that if any error has been made, it can be rectified without much trouble. When the holes have been drilled, replace the receiver in the floor of the cabinet (*Continued on page* 1141)

Current

By Arthur

In the inset, above, is Carl Dreyer—one of the many prominent men in the radio field who migrated to the talking picture industry. The scene depicts tests being made in a sound studio

FOR the past few months we have been publishing articles in RADIO NEWS, calling attention to the fact that sound recording and sound reproducing in conjunction with the talking movies was a field which would undoubtedly attract a great many radio men.

Floyd Gibbons

Among the first to transfer their energies from the radio to the talking picture field was Carl Dreher, who is now chief engineer in charge of sound recording at RKO. Mr. Dreher has taken with him some of the best men from the amateur ranks as well as from the regular broadcasting studios. A more recent transfer has been undertaken by Eugene Grossman, who was formerly chief engineer of the National Broadcasting Company. Mr. Grossman resigned to take on a commission with the Fox Films as chief sound engineer. J. Z. Maresca, formerly manager of station WRNY in New York, has joined the film crowd and is now with Carl Dreher. Franklin Gates, consulting engineer for the Federal Radio Commission, joined Vitaphone to take care of the sound end of its business about a year ago. The ranks of radio men entering the movies is rapidly swelling and a great many of these gentlemen are receiving extraordinarily large salaries. We comment on this fect in passing, because we believe that these opportunities have just begun and that within the next few months many more similar opportunities will arise.

Auto Radio Aids Driving

During the past few months a number of rather fussy folks in various parts of the country have seen fit to stick their noses in people's business with which they were not only concerned but about which they have apparently been misinformed. As a result of this meddlesome attitude, in Boston, Cincinnati, and New Jersey certain local groups took it upon themselves to promulgate a ruling making it unlawful to use a radio receiver in an automobile while in motion. Some very prominent people in the radio business made it their business to attend the hearing on this proposed legislation and fought the issue very aggressively. The result has been the indefinite postponement of any action in all of the places involved and it is very dubious that any other local body will undertake similar action in view of the rebukes which have been meted out to those who have done so up to now.

A very interesting outline of the opposite view of this situation comes to us from Mr. J. E. Smith, president of the National Radio Institute at Washington, D. C. Mr. Smith says:

"The exploitation of automobile radio is threatened by misguided traffic authorities. There are various officials who would prohibit the use of a radio set in any automobile, on the grounds that the enjoyment of radio programs takes away from driving attention and skill.

"To one unfamiliar with automobile driving, such views might seem quite logical. However, anyone who drives a car knows that in time driving becomes a purely mechanical process. The driver does not stop to analyze each move in operating the car, and even in the face of a sudden emergency the experienced driver reacts automatically. On the other hand, most drivers at some time or another have experienced the trying fatigue of driving alone over great distances, particularly when roads are exceptionally smooth and the scenery is monotonous. Each year many accidents, due to the drivers falling asleep at the wheel, are reported. Indeed, there is greater danger of falling asleep than of failing to react instinctively.

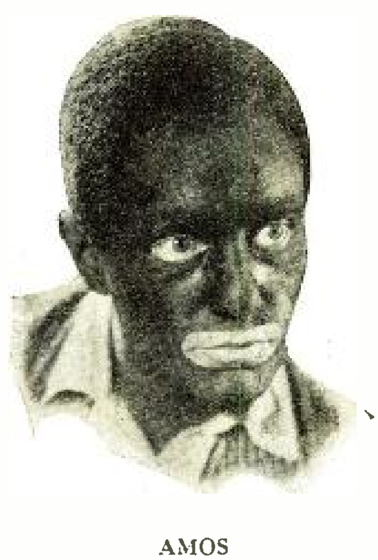
"Automobile radio should not be considered in terms of a menace to careful driving. Rather, this factor may serve to reduce accidents, particularly for those who drive alone. It is to be hoped that the authorities will not condemn automobile radio without considering the experiences of automobile drivers themselves."

"The Headline Hunter"

If there is one broadcaster who really stands out from the crowd, it is, in our humble opinion, Floyd Gibbons. At present Mr. Gibbons is putting fifteen minutes of high-pressure news on the air every night. Every one of his periods seems to be more interesting than its predecessor. We take this opportunity of congratulating Mr. Gibbons, *The Literary Digest* and the National Broadcasting Company for the extraordinary service to the listener which this fifteen minutes an evening brings about. In passing, we believe this is one of the hardest jobs the engaging reporter has ever tackled.

Amos 'n' Andy

Since the Happiness Boys, Billy Jones and Ernest Hare, dashed into prominence by means of the microphone a few years ago, no other pair of comedians have so attracted the attention of the public as the two Southerners who masquerade as negroes under the names of Amos 'n' Andy. These two gentlemen have become famous practically overnight and it is doubtful that there is



AMOS

Comment

H. Lynch

any one radio feature which can boast so large an audience.

In April we published a short article on Amos 'n' Andy and the response to this article has been so great that we have made an arrangement for a story done in their typical dialect, for Radio News, for a forthcoming issue. We believe that this article will appeal to a very great many of our readers.

Television

About two years ago television was given a very serious black eye, by the launching of a lot of unfounded and entirely unwarranted publicity. In the meantime very little on the subject of television has appeared in Radio News. Recent developments indicate that it will not be very long now before we will be able to publish some extremely interesting facts concerning the various systems of television which are now engaging the attention of engineers in various parts of the country. If our plans can be carried out as we have made them, some of this interesting material will begin to appear in Radio News for July.

Broadcasting on Short Waves

The growth of interest in short-wave broadcasting is nothing short of phenomenal. True, the number of short-wave broadcasting stations a year ago was rather limited. Today, as the list and time schedule appearing in this issue of Radio News indicates, it is possible for us to bring programs from almost every foreign country directly into our homes by the simple expedient of turning a knob or two.

People in foreign countries, where the number of broadcasting stations and broadcasting programs is not as great as it is here in the United States, have had, for quite some time, to depend almost entirely upon short-wave reception for programs of any kind. The sale of short-wave broadcast receiving equipment for export was, up to a short time ago, greater than the sale of similar equipment used in this country. This situation has changed and a surprising number of people who were entirely uninterested in radio at all a year ago are now very enthusiastic about the thrill they get listening to a speech or an orchestra in some far-off capital.

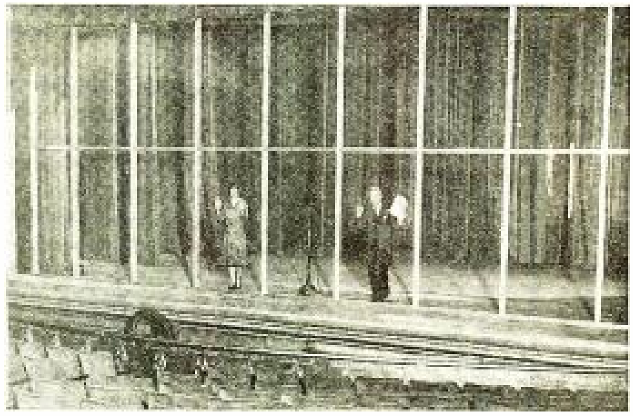
We venture to predict that the de luxe radio receiver of the future will include not only the equipment necessary for standard broadcast reception but also for the reception of short waves.

Questionnaire

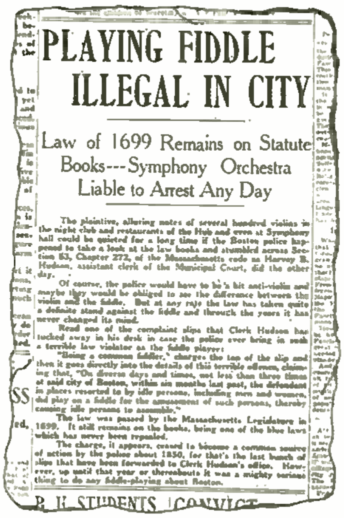
ANDY

A short time ago we sent a questionnaire to approximately 40,000 readers of Radio News. We are extremely grateful to those readers who filled out these questionnaires so thoroughly and by their actions have aided us materially in determining the character of material which is most interesting to the majority of our readers. To these folks we wish to say a great big "We thank you."

As soon as practicable an analysis of the returned questionnaires will be published in Radio News.



The new NBC studio atop the New Amsterdam Roof in New York City is a remarkable combination of acoustics and electrical engineering. The glass curtain, which is shown lowered, weighs six tons



PLAYING FIDDLE ILLEGAL IN CITY

Law of 1699 Remains on Statute Books---Symphony Orchestra Liable to Arrest Any Day

The plaintive, alluring notes of several hundred violins in the night club and restaurants of the Hub and even at Symphony hall could be quieted for a long time if the Boston police happened to take a look at the law books and stumbled across Section 53, Chapter 272, of the Massachusetts code as Harvey B. Hudson, assistant clerk of the Municipal Court, did the other day.

Of course, the police would have to be a bit anti-violin and maybe they would be obliged to see the difference between the violin and the fiddle. But at any rate the law has taken quite a definite stand against the fiddle and through the years it has never changed its mind.

Read one of the complaint slips that Clerk Hudson has tucked away in his desk in case the police ever bring in such a terrible law violator as the fiddle player:

"Being a common fiddler," charges the top of the slip and then it goes directly into the details of this terrible offense, claiming that, "On diverse days and times, not less than three times at said city of Boston, within six months last past, the defendant in places resorted to by idle persons, including men and women, did play on a fiddle for the amusement of such persons, thereby causing idle persons to assemble."

The law was passed by the Massachusetts Legislature in 1699. It still remains on the books, being one of the blue laws which has never been repealed.

The charge, it appears, ceased to become a common source of action by the police about 1850, for that's the last bunch of slips that have been forwarded to Clerk Hudson's office. However, up until that year or thereabouts it was a mighty serious thing to do any fiddle-playing about Boston.

Boston—America's Sleepy Hollow

This appeared in a Boston paper the day after the auto-radio hearing which was held there. It seems shameful for people whose minds are still in the middle ages to have authority enough to embarrass those who are making real progress

Disillusionment

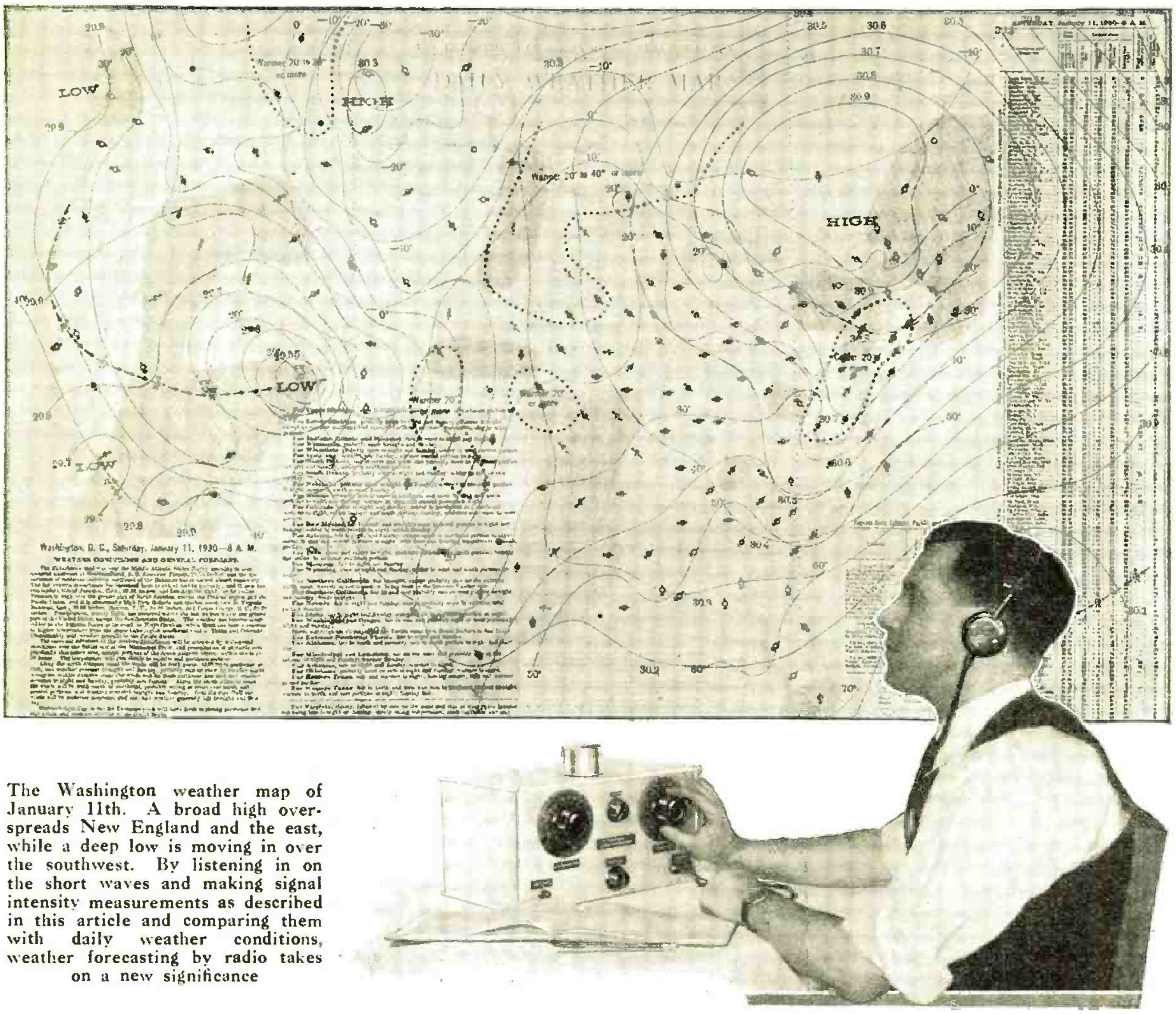
On the evening of March 16th the National Broadcasting Company turned another remarkable page in its remarkable history. A number of radio's élite were invited to the New Amsterdam Roof in New York City to witness the opening of the first radio broadcasting theatre. The theatre itself is a very remarkable combination of acoustics and electrical engineering. In place of the ordinary curtain, a curtain of solid glass weighing six tons has been substituted so that the actors on the stage can see but cannot hear the audience in the theatre. The audience, however, can hear the actors on the stage through loud speakers which have been disposed in what would ordinarily be the orchestra pit.

The first performance in this rather remarkable theatre was one of the regular weekly broadcasts of the Collier Hour. Ordinarily we get a great thrill from the Collier Hour, but it is no reflection on the ability of the performers who took part in the presentation when we say that watching the Collier Hour and hearing it as we watched was somewhat of a disappointment. We found that others in the audience shared this feeling.

For certain types of broadcasting, such as the introduction of some very notable person, or the playing of certain scenes from musical comedies and operas, we believe this type of broadcasting studio would be ideal. However, for the broadcasting of radio dramas in which quite a number of people go to make up the cast and where the action cannot be seen but is suggested, we believe that the presentation behind the glass curtain suffers.

We enjoyed the Collier Hour immensely. It gave us an opportunity for the first time to meet some of the very interesting folks who take part in it. It provided us with one of those few opportunities to contact friends and acquaintances in the radio business, but, as a regular thing, we believe that most folks would really enjoy the hour more as it comes from the loud speaker into their living-room. A much more complete analysis of this sort of reaction may be found by reading Dale Wimbrow's "Don't Peek Behind the Mike," which we published in our March number.

A RESEARCH



The Washington weather map of January 11th. A broad high overspreads New England and the east, while a deep low is moving in over the southwest. By listening in on the short waves and making signal intensity measurements as described in this article and comparing them with daily weather conditions, weather forecasting by radio takes on a new significance

THIS article completes an outline of practical information for those interested in one of the newest and most interesting fields of radio research—studying the various and little-understood relations between sunspots, weather, magnetism and radio. Last month we discussed some methods of solar observation that are within easy reach of the average amateur. As the probable underlying cause of various earthly events the sun is important, but it is only a part of the whole scheme of correlation. In this article we find out, among other things, how to make accurate and systematic observations of the weather. This knowledge is useful in many other fields besides correlation: for example, in the field of reporting and forecasting weather for aviation. It also leads to a better understanding of flying and ground weather forecasts. We describe also some methods of studying the earth's magnetic field—one of the unsolved mysteries of science. And finally, we consider fully the various methods of measuring the received signal strength of radio stations—an interesting study in itself about which a small book could be written. But none of the standard books have much to say about this important subject—one has to seek meagre information scattered through a few technical articles, and do a world of experimenting to find the most suitable methods for any given purpose. This information is worth while in correlation work or out of it—one is enabled to compare accurately the various stations that he hears, or to rate different localities for excellence of reception.

The July issue of
RADIO NEWS
will be a special show number
announcing plans of leading
manufacturers for 1930-1931

Taking Weather Data

The weather is a stock topic of conversation, worn somewhat threadbare by continued use. It would be less so if we all knew more about it; a greater store of facts would save repetition. Meteorology, or the science of weather, climate and other atmospheric phenomena, is a science in itself. For ordinary observations we need consider only four meteorological elements: pressure, temperature, moisture and wind.

Of these elements pressure is undoubtedly the most important, because it governs all the others. It is measured with a barometer, which for accurate work takes the form of a column of mercury in an exhausted tube, opening at its lower end into a pool of mercury upon whose surface the weight of air rests. At the bottom of the world-wide air ocean—at sea level, in

OPPORTUNITY for the Radio Amateur

Point-to-point Communication by Way of Short Waves Provides Plenty of Thrills for the Amateur. But He Can Use His Talents to Greater Advantage in Collecting Useful Data on Weather Conditions and Their Effect on Radio Transmission and Reception. With Simple, Inexpensive, Home-made Apparatus Signal Intensity Measurements Can Be Compared with Existing Weather Conditions so that a Hypothesis May Be Drawn Upon Which Definite Conclusions as to the Forecasting of Good or Bad Radio Weather May Be Based

By Lieut. William H. Wenstrom

other words—the weight of air on the pool surface is great enough to hold up about 30 inches of mercury in the tube. If we take the barometer upward in the air ocean, say to a mountain top three miles high, the weight of air on the pool surface will hold up only 15 inches in the tube; therefore, we say that the air pressure has decreased 15 inches or one-half. Roughly, the pressure is found to decrease about .1 inch for each 100-foot increase of elevation. Here is the standard airplane altimeter in a nutshell; only it is not convenient to use a mercury barometer in airplanes or in many other places, so that an aneroid barometer, consisting of a small collapsible box geared to a needle which moves around a dial, is often used instead.

The dials of aneroid barometers are usually marked "Rain," "Change," and "Fair," labels which mean just about as much as "Dear Sir" in an irate letter. While it is generally true that low pressure indicates rain and high pressure means fair weather, the important thing is not what the needle reads, but which direction and how much it has moved since the last reading. For this reason aneroids are provided with an external needle which may be set by hand above the internal one.

In addition to the changes of pressure with altitude, there is a slight daily variation which appears to have some connection with the apparent daily revolution of the sun. The pressure is low at about 4 A. M., highest at 9 or 10 A. M., lowest between 3 and 7 P. M., and high again around 10 P. M. These variations are less than a tenth of an inch. At 8 P. M. the pressure is usually close to the daily average. Moreover, 8 A. M. and 8 P. M., E. S. T. are the best times for weather observations of any kind, because they coincide with the official Weather Bureau records. But far more important than the daily variations, which one can neutralize by making observations at the same time each day, are the irregular changes caused by the passage of "highs" and "lows" which, as we shall see, control all the rest of the weather. Incidentally, the barometer works just as well inside the house as it does outside, for the smallest cracks are sufficient to equalize the pressure.

THIS article continues the writer's description, begun in the May number, of various simple observation methods in correlating sunspots, weather, changes in the earth's magnetic field, aurorae and radio reception. While the first article dealt largely with primary causes in the sun, this one tells you how to make weather observations, how to note changes in magnetic declination, and how to measure and record radio reception. If you are interested in ground and flying weather forecasts, here is some pertinent information. Similarly, if you wish to make radio signal measurements for correlation work, for comparing reception in different localities, or for any other purpose whatsoever, you will find here described the best ways of making them with simply constructed apparatus.

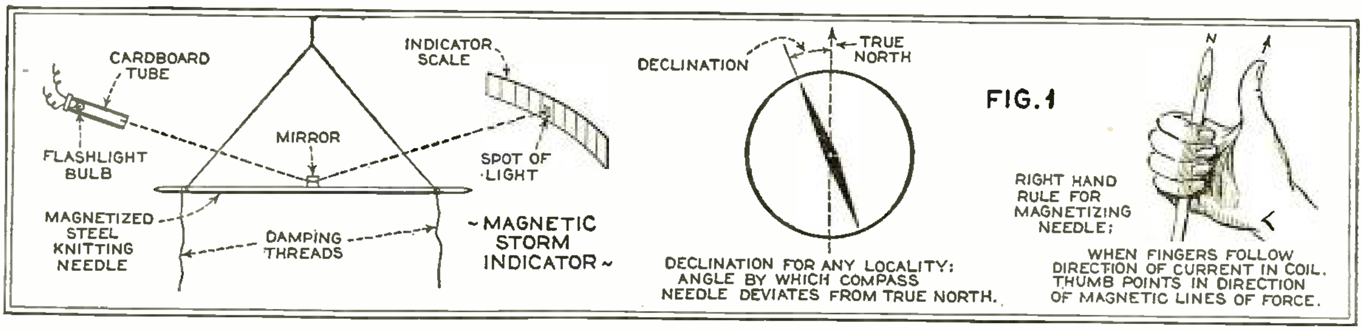
The instrument which measures temperature—the thermometer—is familiar to everyone. It consists of a small glass bulb containing mercury or red-tinted alcohol, connected with a minute tube in which the liquid can rise or fall as it expands with heat or contracts with cold. A scale on or beside the tube gives the temperature, usually in the Fahrenheit scale in the United States. This scale fixes the freezing point of water at 32° and the boiling point at 212°; in the Centigrade scale, used in most scientific work, these points are respectively 0° and 100°. Conversion between the two scales is, therefore, accomplished by the simple formula:

$$\text{Degrees Fahrenheit} = \text{degrees Centigrade} \times \frac{9}{5} + 32$$

The dial thermometers, which operate by the unequal expansion of metals, are usually less accurate than the mercury and alcohol types.

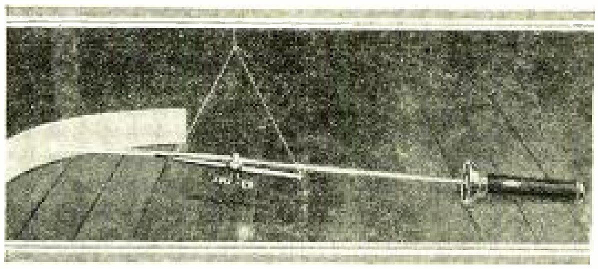
In measuring the outside temperature the location of the thermometer is very important. It must not be too near the wall of a building, which will radiate heat hours after the sun has set, or too near windows which leak hot air in winter. If the bulb is in sunlight, the reading will be far above the actual air temperature. Finally, the air should have free circulation around the instrument. The Weather Bureau keeps its thermometers in little latticed houses built especially for weather instruments; most of us will have to be content with mounting the instrument six or eight feet out from the east wall of a building, with the wooden back of the instrument to the rising sun, as shown in the photograph; or it can be hung in an angle of a north wall where the sun never shines.

Unless the day's temperature curve is disturbed by something, such as a thundershower, there is usually a regular daily variation. Temperature is lowest around 5 or 6 A. M., and highest around 3 or 4 P. M. The variation may range from a degree or two in tropical lowlands to 30 or 40 degrees on mountains. In most places throughout the eastern United States normal daily variations are eclipsed by irregular changes, caused by varying winds which, in turn, owe their origin to



the passage of "lows" and "highs."

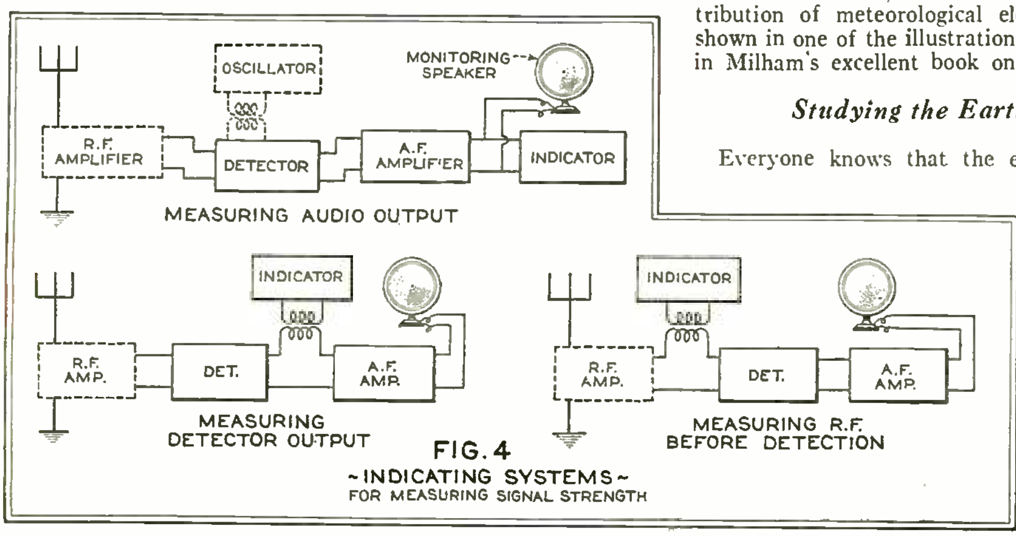
Moisture in the air often makes itself apparent without need of any instruments. There are first of all the clouds, of many forms and varieties. One common kind is the high, wispy cirrus clouds, or "mare's tails," which usually radiate eastward from a "low" and, when they come up out of the west, foretell the approach of stormy weather. Then there are the tufted, wooly cumulus clouds, which often develop into thundershowers on a hot summer day. Still another familiar cloud is the ragged nimbus cloud from which rain or snow is actually falling. In observing moisture indications, or the "state of weather," the following terms are standard. The sky is called "cloudless" if no clouds at all are visible, "clear" if less than 3/10 is covered with cloud, "partly cloudy" if between 3/10 and 7/10 is covered, "cloudy" if more than 7/10 is covered, "overcast" if it is completely covered. Other evidences of moisture are haze, which blurs visibility near the earth and whitens the blue of the sky; and fog, aviation's worst enemy, which may obscure vision beyond a few feet. Fog is simply a great number of minute water droplets (about .001 inch in diameter) suspended in the air. Whenever a large amount of warm, moist air is suddenly cooled, fog results, to be broken up only by winds or a rise in temperature. Still other moisture forms are the familiar rain and snow, dew and frost, sleet (frozen rain), hail (balls formed of ice and snow layers, as in a violent thunderstorm), and glaze (rain freezing as it strikes a cold surface. Glaze causes the ice storms which bring down telephone and telegraph wires, and in another form may dangerously load airplane wings with ice. An instrument for measuring the amount of moisture in the air, or the humidity, is called the hygrometer. In a popular form it is built around a human hair which changes length with variations in relative humidity.



Essentials of a magnetic storm indicator. The needle is wrapped with wire, which is left on for convenient re-magnetization. The light source may be a flashlight bulb in a cardboard tube. The drawing above and the photograph to the left illustrate how the indicator is set up

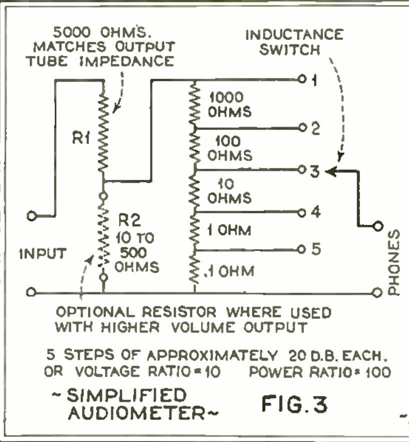
An Aneroid barometer. This is the most important instrument in weather observations. A good one can be bought for five or ten dollars. Under the instrument are the "wind-barometer indications," cut from a weather map

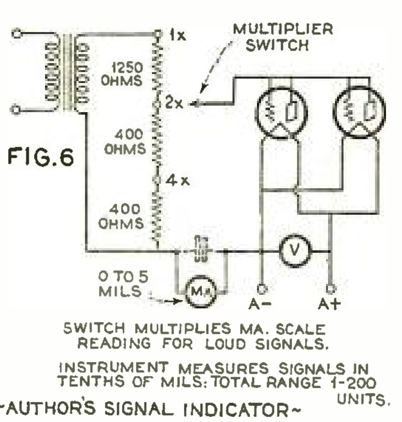
Anyone who observes the weather intelligently should follow the daily maps issued by the Weather Bureau. The large Washington map costs 25 cents per month, and the smaller maps published in many large cities are 20 cents a month. These maps contain a vast amount of weather data, and show clearly the weather changes over the whole country. We can follow on them the successive daily positions of the "highs" and the "lows"—those great hills and valleys of the atmosphere. In the United States they move generally eastward with the prevailing westerly winds, progressing on the average about 900 miles a day in winter and 600 miles a day in summer. The eastward progress of two lows is clearly shown on the Washington weather maps of January 11th and 12th. Air naturally flows into a low (to fill up the "valley") and outward from a high; due to the earth's rotation the currents are somewhat diverted so that the winds blow generally counter-clockwise about a low and clockwise about a high. This means, for any given station, southerly winds with warmer weather when a low is approaching and northerly or westerly winds after it has passed before an approaching high. As the warm air brought up to the south and east of a low is cooled, clouds and rain result. The coming of a low, or the dropping of the barometer, therefore presages stormy weather. More specifically, the southeast quadrant of a low contains rain or snow in winter, and thundershowers in summer. The distribution of meteorological elements about a low is clearly shown in one of the illustrations, which was drawn from a plate in Milham's excellent book on meteorology.



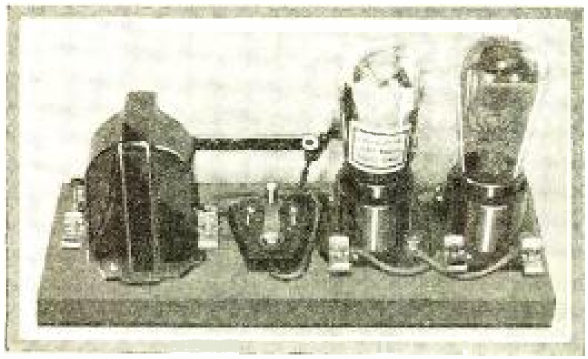
Studying the Earth's Magnetic Field

Everyone knows that the earth is a great magnet whose poles coincide nearly, but not quite, with geographical north and south. The causes of the earth's magnetic field are unknown. If we could show that currents flow around the earth, in ground or air, from east to west the explanation would be easy. But the earth currents noticed on telegraph lines are north-south in direction. Perhaps the great numbers of electrons produced in the upper atmosphere by the day sunlight, "growing" eastward with the earth's rotation, has the effect of an east-west conventional current flow. Possibly the warming of the ground alters its magnetic qualities. In the absence of sufficient data one guess is as good as another, and by the same token here is a chance for the experimenter who really understands electricity and magnetism.



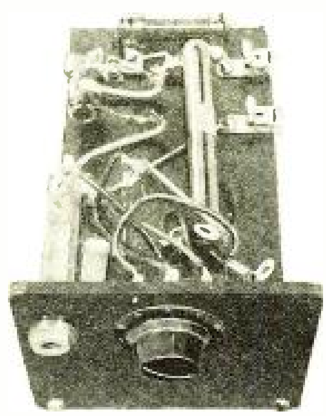


The earth's magnetic poles are misnamed; the north one, on the island of Boothia Felix north of Hudson Bay is really a south pole in the standard sense because it attracts the north pole of a magnet. The standard marine and aviation compass is simply a magnet in convenient needle form, fixed to a dial free to revolve on a pivot, and damped against excessive swinging by some liquid such as alcohol. The needle naturally points more toward the magnetic pole than the geographic one. But this departure of the needle from true north, called the declination, is affected by many local factors, such as iron ore deposits; with the result that the isogonic lines (connecting points of equal declination), while they radiate in general from the magnetic poles, are very wobbly rather than straight as we might suppose. In the United States the declination ranges from 15° west in Maine to 20° east in Oregon. Further, the earth's lines of force are not horizontal anywhere except along a narrow belt near the equator; at a magnetic pole their direction is straight up or down, and in the United States they are inclined downward (toward the north) at angles varying between 60 and 70 degrees from the horizontal. This downward slant is called the inclination or dip, and it was discovered accidentally by an early English instrument maker who could not seem to get his compass needles to balance. The real strength of the earth's field at any one point exists in only one direction, as northward-downward in the United States, but for convenience of measurement the field strength is divided into two components; the horizontal component (in the direction of the declination), and the vertical component (toward the earth's center). Like the atmospheric pressure and temperature, all the magnetic elements (declination, inclination, horizontal intensity and vertical intensity) are subject to small daily variations. The western declination usually reaches maximum in the afternoon, while the inclination reaches a peak in the morning; the daily changes are only a few minutes of arc. In addition there are annual changes, and a slower, so-called secular change. In England declination was zero in 1657, reached a westward maximum in 1816, and is now about two-thirds of the 1816 value and decreasing.

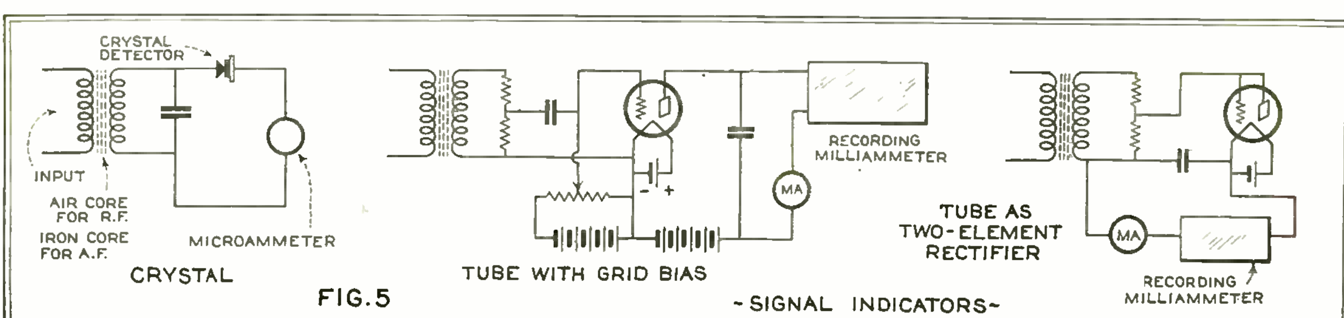


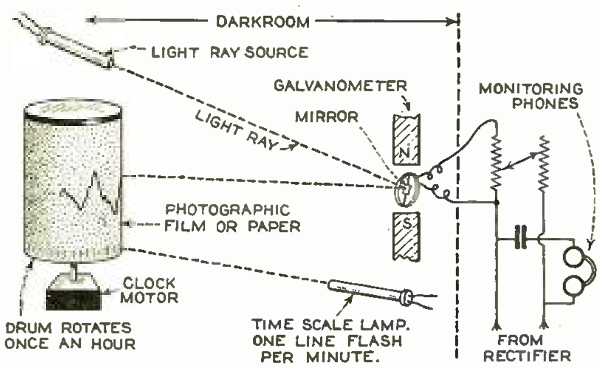
The visual signal indicator used by the writer. The two -71A tubes, with grids and plates connected together in parallel, serve as a low-impedance two-element rectifier

In addition to all these slight changes, more sudden and violent ones occur in magnetic storms, which rage silently, unobserved by our ordinary senses, over the whole earth. The curves of all the magnetic elements become jagged and irregular; the declination may change by two or three degrees in a few hours; and the needle may visibly waver or tremble. The causes of magnetic storms probably lie within the sun; it is well known that sunspot maximum years are magnetic storm maximum years also. Sometimes a large spot pointing toward the earth coincides with a magnetic storm, suggesting an immediate cause-and-effect relation; but large spots may point earthward without noticeable magnetic effects, and magnetic storms may occur when the sun's disk is free of spots. Here then is need for much research and for much discernment. Fig. 1 shows a crude indicator which any amateur can build. It will show the declination (easiest to observe of all the magnetic elements) and will detect a magnetic storm. It is simply a steel knitting needle, wound with small wire for easy magnetization and hung by a thread which divides into two branches near the bottom to hold the needle horizontal. A small mirror about one-fourth inch square (broken from a larger one) is mounted vertically on the center of the needle in some putty. When a light source, such as a flashlight bulb in a narrow cardboard tube, shines on the mirror, a small square spot of light is reflected from it, and falls on a scale placed a few feet away. As the reflected light beam has twice the angular movement of the needle, has no weight, and may be made of any length commensurate with the intensity



The general construction of the audiometer, as wired according to the circuit shown in Fig. 3, is shown here. With it signal intensities can be measured within fair degree of accuracy



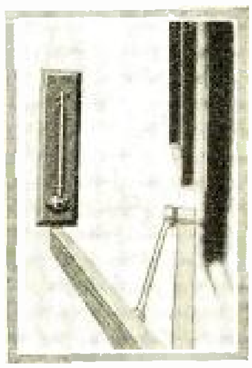


LIGHT RAY TRACES CURVE OF SIGNAL INTENSITY AGAINST TIME ON REVOLVING DRUM.
-PHOTOGRAPHIC SIGNAL RECORDER- FIG. 7

Cirrus clouds or "Mare's Tails." Rising slowly out of the west, they presage the approach of a low and bad weather

of the light source, the instrument may be made as sensitive as one desires. While the principle is simplicity itself, just this extreme sensitivity makes the instrument difficult to operate. No iron can be moved in its vicinity; the string must be broken by rubber band to protect it from house jars; the lamp is preferably turned on by remote control and the scale read with field glasses; the whole suspension should be shielded from air currents.

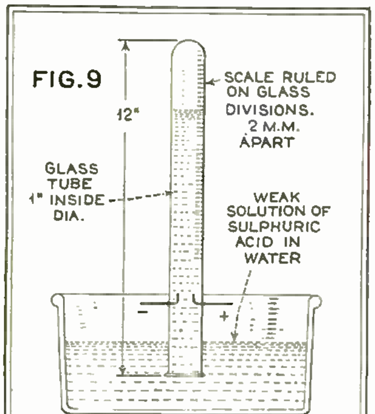
Closely related to magnetic storms and radio reception changes are aurorae. More of them occur in sunspot maximum years, and central spots often appear to cause individual displays. Intense aurorae seemingly never fail to blanket radio reception in some way. Here is an opportunity for experimenters living in the north central United States and in Canada—they have the grandstand seats for the northern lights. As shown in the photograph, aurorae of the northern hemisphere are most frequent and most intense along a band about 23 degrees from the point where the earth's magnetic axis intersects its surface. This point is near Etah, Greenland, and about 700 miles north of the magnetic pole.



Thermometer for reading the open air temperature. This familiar instrument must be carefully placed, out of the sun and away from heat-radiating walls, for accurate results

Measuring Radio Signal Strength

To determine the strength of radio signals most laymen, and even some technical writers, simply say, "Last night I could not get this station; tonight it comes in loudly; reception has improved." In weather observations an analogous procedure is described in Longfellow's line: "Last night the moon had a wedding ring; tonight no moon we see." As the latter judgment would scarcely satisfy the captain of a modern ocean liner, so the former leaves much to be desired for a serious radio experimenter. As a matter of fact one trained in relative evaluation, such as a teacher who constantly grades pupils, can differentiate between five values: Very good, good, fair, poor and very poor. But most of us do well to distinguish between good, fair and poor. In judging radio signals this method has two disadvantages: the memory cannot retain for comparison the exact signal of the preceding day, and the ear itself is insensitive to volume changes as great as two-to-one or even more.



+AND − ELECTRODES ARE PLATINUM WIRES SEALED INTO GLASS WALL OF TUBE
-INTEGRATING SIGNAL RECORDER-

The memory factor, at least, can be entirely eliminated by using an audiometer. This device has long been employed for measuring the relative strength of radio signals. It consists essentially of a resistance in the tube output circuit, across varying portions of which the phones can be connected so as to make a given signal louder or fainter in accordance with a calibrated scale. Nor is memory elimination the only advantage of the audiometer, for the ear is more sensitive to volume changes in very faint signals than in very loud ones. Thus this instrument could be of great use to amateurs in comparing signal strengths during tests with various types of transmitting apparatus.

In its commercial form the audiometer has a compensating series resistance which keeps the input impedance constant as the phones are shunted down the scale. In our simplified design for home construction, however, this refinement is unnecessary because the impedance of the entire shunt resistance is purposely kept low in relation to the impedance of the phones. Continuously adjustable resistors will not do because they vary too much—the best solution is a small Yaxley inductance switch with dependable fixed resistors. Five steps is about right for most uses; ten would perhaps be somewhat better. It is surprising how great the steps must be made to appeal to the ear as real changes of volume. We first set up the audiometer with 10 d b steps; that is, with voltage ratios of 3.16:1 and power ratios of 10:1; but scarcely any difference was noticeable to the ear, and the range with five steps did not include signals loud enough or faint enough. The final design, shown in Fig. 3, has steps of 20 d b each; it will be noted that each step increases the resistance across the phones (and hence the voltage), by the approximate factor 10:1. The power ratio, then, is 100:1; the common logarithm of 100 (and hence the number of bels) is 2; the number of decibels is 10 times this or 20.

In operation a signal is tuned in with the switch on tap 1, where it will be loudest. Then the switch is moved up the scale, putting the phones across smaller and smaller resistances until the signal can barely be heard. If the signal is heard weakly on 3 and goes out on 4, we rate the signal 3 on the 1–5 scale. Of course the figures mean nothing in themselves, but this takes away none of their value in relative measurements. The instrument is designed for a short-wave autodyne detector with two stages of audio; it rates a fair loudspeaker signal 5 and a very weak phone signal 1. The audiometer method is quicker than the more accurate visual methods to follow; and in addition it is practically impossible to measure commercial code signals visually because the needle jumps so rapidly. For this reason the audiometer is used by the writer for short-wave code and, indeed, for all short-wave measurements.

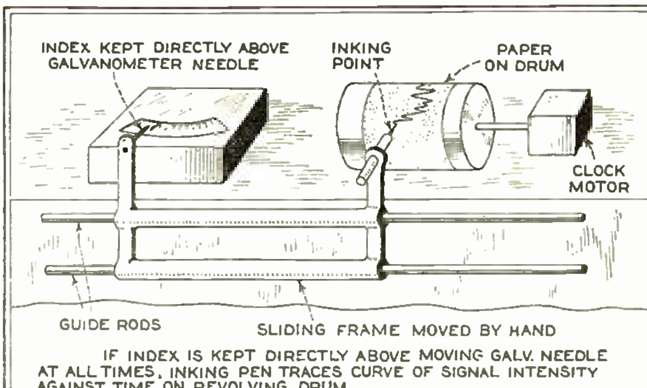
Visual Signal Indicators

The visual methods insure greater accuracy, and they should be used in many measurements, such as those in the broadcast band. They are all alike in general principle; the alternating current induced in the antenna and amplified by the set is rectified before detection at radio-frequency or after detection at audio-frequency; and the direct current resulting from this rectification, when passed through a milliammeter, gives a relative indication of the signal energy received by the antenna, which should be a standard vertical open type rather than a loop or horizontal doublet. In all systems a monitoring loudspeaker should be continuously in the circuit in addition to the indicating device, which can be connected in the radio-frequency circuits, in the detector output circuit, or in the output of the last audio stage.

Putting the rectifier directly in the r.f. circuit gives a steady reading regardless of modulation and permits the use of a very limited rectifier such as a crystal. But such a small amount of energy is available that a very sensitive and consequently expensive milliammeter must be used, so that the method is ill-suited to the average amateur, who will find it better to use a tube rectifier in the final audio output. Although the tube can be run at plate and grid voltages selected to make the given signals fall within the milliammeter scale, it is simpler to connect the grid and plate together, using in effect a two-element tube without any plate or grid biasing voltages at all.

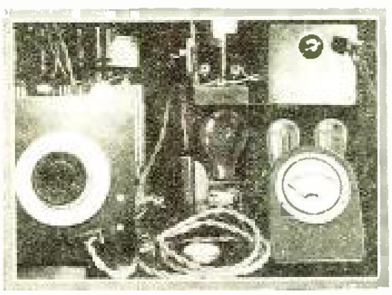
Measuring the music volume will give little indication of carrier strength; the needle jumps with every crescendo, and a brass band would run up more current than a bedtime story. But we can do the thing well enough by introducing constant oscillations into the detector circuit which will beat audibly against the incoming carrier frequency, either by using a separate stable oscillator loosely coupled to the detector circuit or, if the set is regenerative, by making the detector oscillate (well above the critical point for stability). We find a maximum signal indication, slightly disturbed by modulation but steady enough for measurement, when the beat note is about 500 cycles. Of course there should be blocking radio-frequency stages in front of the detector, so that the autodyne will not squeal in other nearby receivers.

The writer's visual signal indicator, designed for measuring broadcast signals of average to high level in the eastern United States, is shown in Fig. 6. It operates, in shunt with a dynamic speaker, from the –71A push-pull output of a three stage transformer resistance coupled amplifier fed by a Radiola 20; all filament, plate and grid voltages come from a d.c. lighting circuit, and are adjusted simultaneously by a series resistor. The rectifier is two –71A's with all grids and plates connected in parallel, having a d.c. plate resistance at low voltages of about 1000 ohms and an a.c. impedance about twice this value. By the multiplying switch the full scale milliammeter reading of 5 mils may be extended to 10 or 20 mils. As the meter can be read to the nearest tenth, the instrument measures signals in relative energy units all the way from 1 or 2 (weak midrange) up to 200 (very strong local). It has a great many uses for the experimenter outside correlation work. One can compare receiving localities, or judge different stations in any one locality. On a short morning test in the Hudson Valley, for instance, we rated some nearby stations as follows: WEAF 46; WJZ 70; WGY 35; WABC 65; WBZ 6. The indicator is also useful in comparing receiving antennæ or the relative performance, on given broadcasting stations, of receivers belonging to your friends.



~MANUAL SIGNAL RECORDER~ FIG. 8

"The Northern Lights have seen strange sights."—*Service.* The black pin marks the north (really south) magnetic pole of the earth on the island of Boothia Felix north of Hudson Bay. The circular band about 23 degrees from the pole outlines the zone in which aurorae are most brilliant and most frequent

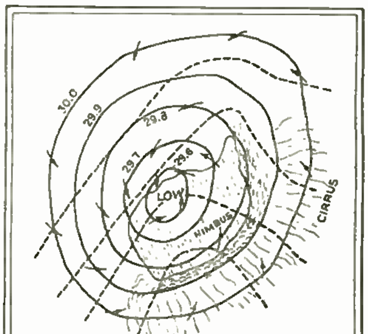


The signal measurement apparatus used by the writer, mounted in a desk with the short-wave receiver. The receiver is at the extreme left, a single stage audio amplifier at the upper left, the audiometer at the upper right, and the visual indicator for measuring broadcast signals below

Recording Systems

Automatic recording systems are used in correlation work by many investigators. One photographic instrument devised by Pickard is shown in Fig. 7. As the galvanometer coil rotates in accordance with the intensity of the incoming signal, it moves a narrow light beam so as to expose a wavy line on the sensitive paper covering the rotating drum. This wavy line, when the paper is developed, gives at once the curve of signal intensity plotted against time. Another method, developed by Shaw, gives a continuous record without any darkroom or after-development. It is illustrated in Fig. 8. The operator watches the galvanometer needle, or its shadow as cast by a light directly above, and keeps the index exactly over it at all times. To the index is connected a sliding frame on which is mounted an inking pen in contact with a revolving drum. It can be readily seen that this pen will trace on the drum the curve of signal intensity against time. It is said that one can follow the needle for an hour or more without undue fatigue.

In practice most of these recording systems are run continuously for an hour or so. To compare the day-to-day performance of a station, the curve is then "integrated," or traced over with an instrument called a planimeter which gives the total area under the curve. This area represents the "work" done by the amplified signal; it is the product of the time by the average signal energy. We have devised a very simple method of integrating electrically, without any need for mechanical integration or complicated photographic recording. It is simply an application of the electrolysis of water experiment of high school physics, and the details of the device are shown in Fig. 9. Platinum electrodes are sealed into the one inch tube and scale divisions are ruled on it 2 m.m. (*Con'td on page* 1138)



~PLAN OF A TYPICAL LOW~ (AFTER MILHAM)

Plan of a typical low (after Milham). This drawing contains a great deal of valuable information, as the lows control most of the weather. When the low is moving rapidly with respect to the observer, many weather changes occur

Lend by Me ah Cople Ears Yat!

Henry Burbig, master of dialect, telling the world some inside "heestory"—and we don't mean maybe. The cartoons shown at the upper left are samples of one of Burbig's avocations

From Three to Ten Minutes a Week on the Air Is All That Is Required by Henry Burbig, Master Comedian and Character Impersonator, to Bring Laughs and Sore Sides to Thousands of Listeners

By Bill Schudt, Jr.

VUNCE opon ah time ago . . . dare leeved in de hold contree, de Peelgrimmees. End dey vas dissatisfactioned from de vay de Kink vas treeting dam, so dey made ah union end wowed dot de Kink vas loosing de pipple's monee on de shock mocket end dey couldn't bear it no shorter. . . .

Thus spoke Henry Burbig. master of a new art on the air, as he opened a recent CeCo Couriers program on WABC and the Columbia Broadcasting System. Henry is now very popular with radio listeners throughout the country.

Burbig might attribute his tremendous popularity of the present day to the fact that he arrived on the radio horizon in a period when the air lacked novelty entertainment. Of course, this is not to minimize Burbig's ability; far from it, for there is no question that he is one of the greatest dialect artists on the air today. The fact that he has mainained his audience throughout the many years he has been on the CeCo programs is proof enough that he has something more to offer than just novelty.

Curiously enough. Burbig's mail far exceeds that of most other radio entertainers who spend much longer periods on the air. Burbig is on the air between three and six minutes. Rarely does his act last ten or more minutes. Yet his fan mail exceeds 6,000 letters every week! One week he received 14,506 letters.

Before radio claimed Burbig. he alternated between the stage and the athletic field. For several years he was a physical instructor in New York. Even before that he was a baseball player possessing great possibilities. In fact. so good was he at baseball that several years later, while in vaudeville, Henry received a flattering offer from a big league manager. However, he preferred his minstrel work on the stage and turned it down.

At fifteen he entered vaudeville and began a Hebrew comedy dialect act, much the same as he now offers radio listeners. The theatre-goers weren't in the mood for it then. The audience seemed too much interested in their "thoughts or something." as Burbig puts it. to pay much attention to this type of act. It was then that he turned to athletics and became a physical instructor. Just before entering radio, Burbig again tried the vaudeville and succeeded. making a big hit with his unusual minstrel shows.

Despite the fact that his radio program for the week rarely requires more than ten minutes of his time. Burbig works day and night throughout the week on some of his sketches. His research work requires many hours spent in some of the largest libraries.

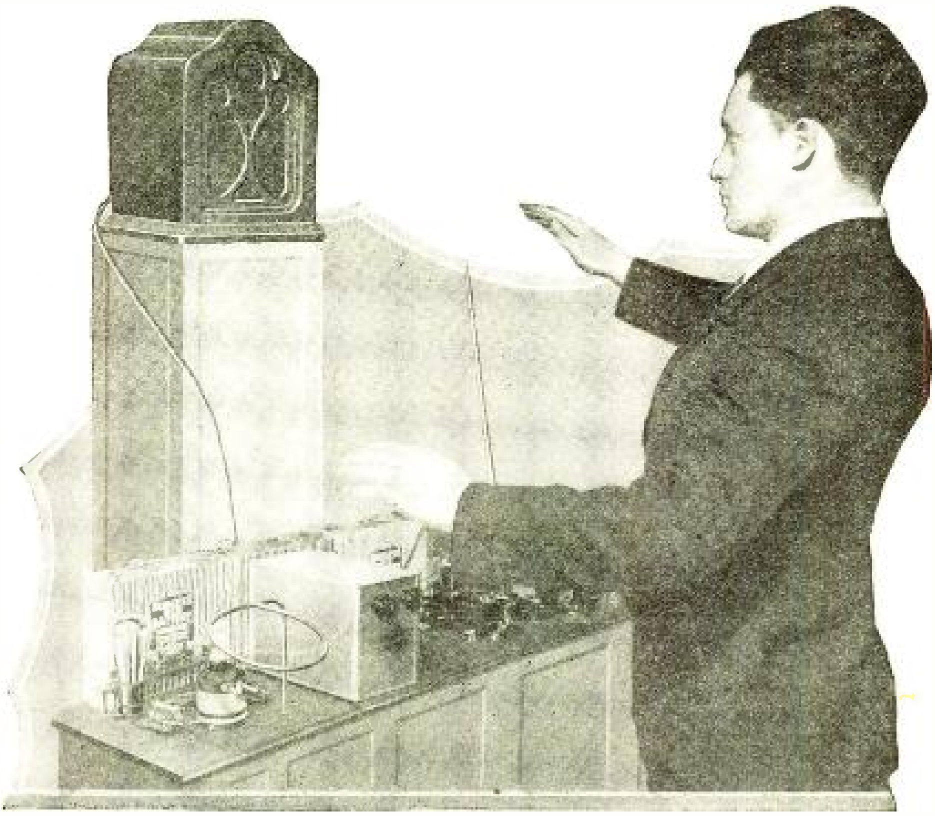
So well does he rehearse his scripts that he never forgets a word of any of them. Visitors have heard this and often endeavored to "catch" him by asking him to recite parts. Henry has yet to fail on a word of the script not only from his book but from his radio presentations as well.

Recently Henry Burbig. Hebrew dialect comedian of the radio, and Fannie Brice, who fills this rôle on the stage. joined forces and presented a comic version of "Romeo and Juliet," written especially for the Philco (*Continued on page* 1148)

Musical Tones

from a Beat-Note Audio Oscillator

By Joseph I. Heller*



This beat frequency oscillator, satisfactory for use as a versatile laboratory instrument, can, with a few additions, be used as a musical instrument. With a bit of practice on the knack of moving the hands you can provide some fair musical accompaniments

IN keeping with the writer's desire to bring before the readers of this magazine a series of articles dealing with different interesting and useful items to be constructed for laboratories or the home workshop, we describe, this month, the construction and operation of an apparatus which can be used either as a single radio-frequency oscillator or as a beat-frequency oscillator for the generation of audio frequencies. In addition, electrodes may be added and the apparatus converting it into an instrument to produce *musical* sounds, as was so cleverly done by the Russian physicist, Theremin. As an ordinary single-tube oscillator, it can be calibrated as a radio-frequency driver over any radio-frequency range wanted. As a beat-note frequency oscillator, it may be made to give frequencies anywhere from 20 cycles per second up throughout the audible range and into the radio-frequency spectrum. It can be seen at once that such a device can make itself very useful indeed in the laboratory, workshop, test room, measurement laboratory, or home. This last sphere of usefulness is quite an innovation for the use of electrical apparatus.

When a tube is biased highly negatively and is run as an oscillator, it will be found that our output is rich in harmonics. If the oscillator is tuned to a 1000 kilocycles, it will mean that frequencies of 1000, 2000, 3000, 4000, and perhaps more will be present in the output. The following will explain the phenomenon of heterodyning.

When two frequencies are impressed upon a circuit, four frequencies, at least, will be present in the circuit. Suppose these two original frequencies to be 1,000,000 cycles and 1,000,500 cycles. We will have in the circuit, therefore, frequencies of 1,000,000 cycles, 1,000,500 cycles, and their sum and difference; nominally, 2,000,500 and 500 cycles. It will be seen that while the two original frequencies are both far above the audible range, one of the beat notes is 500 cycles and lies in the audible range. Ordinarily, this will not, by any means, be the only audible tone, for in most cases, and intentionally in the case under discussion, both of the original frequencies have second, third, fourth and perhaps higher harmonics. These harmonics will beat with each other in exactly the same way as the fundamentals. In Table 1 these fundamentals and harmonics arranged so that, at a glance, we can ascertain each of the frequencies involved. From this table it will be seen that the audible tone of 500 cycles is present *with its harmonics* which take the resulting tone out of the pure pitch class and make it what is normally called a "musical tone." Whether or not this is a desirable condition depends entirely upon the use to which the tone is to be put. If it is intended simply as an aural indication of the

	OSCILLATOR No. 1	OSCILLATOR No. 2	HIGH BEAT-FREQUENCY	LOW BEAT-FREQUENCY
FUNDAMENTAL	1,000,000	1,000,500	2,000,500	500
2ND. HARMONIC	2,000,000	2,001,000	4,001,000	1,000
3RD. HARMONIC	3,000,000	3,001,500	6,001,500	1,500
4TH. HARMONIC	4,000,000	4,002,000	8,002,000	2,000

Fundamental frequencies with their first, second, third and fourth harmonics arranged in tabular form so as to indicate the various audible beat notes which may be obtained by beating one fundamental or harmonic against another fundamental or harmonic

*Chief Engineer, Wireless Egert Engineering, Inc.

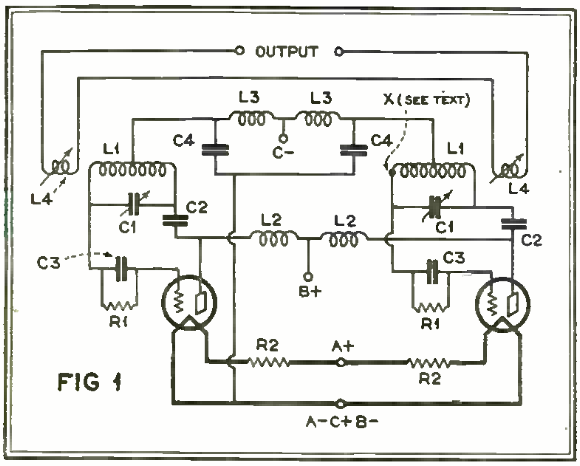


FIG. 3

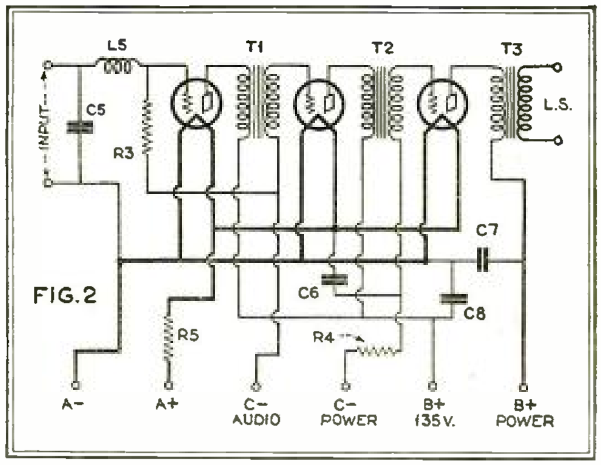
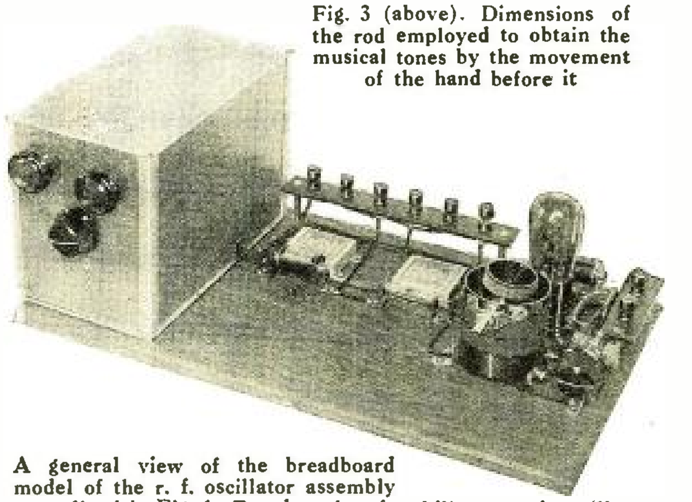


Fig. 1. The two tubes are connected in the circuit as shown, one to generate a constant radio frequency signal which will beat with the r.f. signal generated by the other, so as to produce an audible note

Fig. 3 (above). Dimensions of the rod employed to obtain the musical tones by the movement of the hand before it

Fig. 2. Three stages of transformer-coupled audio frequency amplification are employed to step up the volume of the beat note generated by the two r. f. oscillators

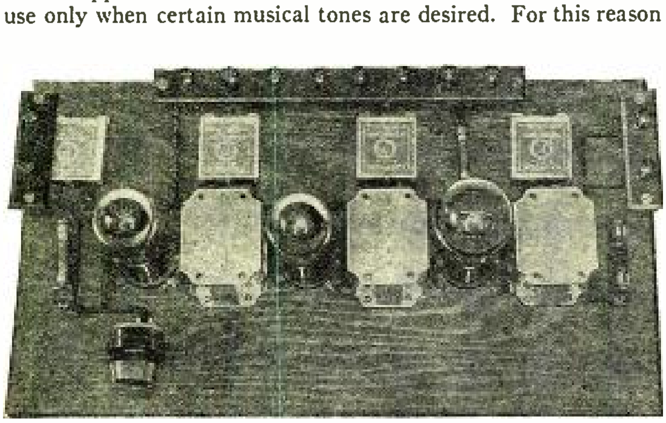


A general view of the breadboard model of the r. f. oscillator assembly as outlined in Fig. 1. For the sake of stability an r. f. oscillator is shielded against the other to prevent undesired external intercoupling

characteristics of a speaker it is desirable to have a musical tone. Also, this condition is desirable when we wish to modulate a continuous-wave transmitter. If, however, the 500-cycle note is intended for measurements requiring a single pure frequency, all the harmonics would have to be filtered out. This can be done by first adjusting the oscillators at that value of bias where the harmonics are rather low, and suitably arranging a trap circuit so that only those harmonics which may be desired in addition to the fundamental are allowed through.

There is another peculiarity present only in vacuum tube oscillators which should be dealt with at this time. If the two heterodyning frequencies differ by a large amount, there will be no trouble at all in causing a beat note to be produced. If the two frequencies are very nearly alike, however, the oscillators will tend to "jump into step," i. e., they will cease oscillating at different frequencies, and will continue oscillating at *only one frequency*, even if the constants of one of the oscillators are slightly different from that of the other. This condition of dropping "into step" depends entirely on the amount of coupling between the two oscillators. As the coupling is decreased, the frequency of the two oscillators may be brought closer and closer. With a coupling sufficiently low oscillations of a fraction of a cycle per second are readily obtainable.

The apparatus to be described in this article is intended for use only when certain musical tones are desired. For this reason it was thought desirable to add to it such arrangements which might be considered necessary in making it suitable for a very novel purpose; making it possible to use the apparatus as a musical instrument. We can assure the reader that many pleasurable hours are in store for him if he learns to play this device.



This is the breadboard model of the three-stage audio frequency amplifier

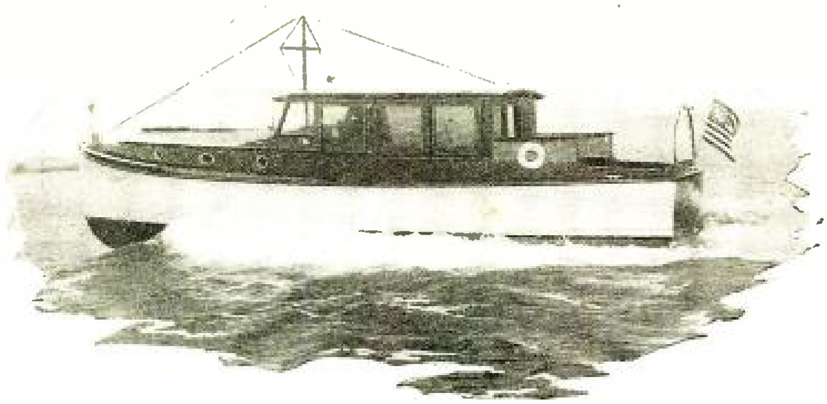
The Circuit

We have designed the instrument so that everything is mounted on breadboards. Fig. 1 is a diagram of the electrical circuit. It can be seen that each oscillator consists of nothing more than the ordinary shunt-fed Hartley oscillator. L1 is the tuned inductance and consists of an ordinary three-circuit coupler. The secondary winding is tapped at its center and a lead brought out through the choke coil, L3 for the C bias. The rotating coil, L4, is used to couple the two oscillators together. C1 is a small vernier condenser. C4 is a 1. mfd. by-pass condenser. C3 is a .002 mfd. grid blocking condenser and C2 is a .002 mfd. plate-stopping condenser. L2 and L3 are 125 millihenry choke coils.

When these oscillators were first put together, it was found that they pulled into step because of close physical relation of one to the other. Since this pulling into step was at a frequency higher than the lowest frequency desired, it was found necessary to reduce the coupling to some value lower than that which existed originally. This was done by shielding one of the oscillators. In actual operation the L4 coils are coupled to an amplifier and the condensers C1 adjusted to give an audible tone. The amplifier, a diagram of which is shown in Fig. 2, was built up for the express purpose of working from this oscillator. It consists of an ordinary transformer-coupled amplifier with a volume-control situated at the imput stage.

In order to operate the device the condensers, C1, are adjusted until a tone is heard and are then varied very slowly until the pitch is exactly the frequency wanted. If one should wish to use the oscillator as a musical instrument, he should supply himself with a rod of either brass, steel, or copper about eighteen inches high and from a quarter to half inch in diameter. A drawing of the one used in the apparatus constructed is shown in Fig. 3. The rod is connected directly to point X in Fig. 1. If the oscillator is now tuned to give an audible beat, the signal heard in the speaker can be varied by movements of the hand in the vicinity of the upright rod. To play the instrument, the right hand should be held about fifteen inches from the rod and the left hand should vary the condensers in the left-hand oscillator to zero beat. It will then be found that moving the hand towards the rod will cause the beat to run up the scale of frequencies. (*Continued on page* 1160)

MR. BULLOCK points out that there is just a bit more to the job of outfitting your boat with radio than choosing any standard make of receiver. Various systems of voltage supply, special consideration of size of the receiver and the space available in the boat for it and harmonizing the finish of the receiver with the interior decoration or woodwork are all problems which require individual attention. Mr. Bullock offers a few hints which should be valuable in this respect.



Enliven that Summer Cruise With Radio

Limited to the Employment of Battery-Operated Receivers for Boat Use, the Skipper Does Not Have a Great Variety from Which to Choose. Building a New Set or Rebuilding an Old One Offers Two Possibilities. In the AK-35, Described Last Month for Auto Use, Rewiring the Circuit for Six, Twelve or Thirty-two Volt Lighting Systems as Filament Supply and Substituting Resistance-Coupling in the Audio Channel Are the Essential Features of This Practical Boat-Radio Installation

By W. H. Bullock

IN studying Mr. Brennan's conversion of the Model 35 Atwater Kent set in the April issue of RADIO NEWS, it occurred to the writer that, while this instrument was well suited for adaptation to automobile use, it had even greater possibilities as a receiver aboard pleasure boats.

The set will be recognized from Fig. 1 as a popular model of the days before batteryless receivers. The man who does not already own one can be supplied by dealers who handle second-hand equipment. The outfit is compact and, therefore, applicable to boats of all sizes. Even small outboard runabouts would easily offer sufficient space for such an outfit and its batteries. On the other hand, its efficiency—if nothing more—gives it a strong bid for a berth on the largest yacht. The boat owner who has other radio apparatus as a part of his equipment can advantageously add an outfit of this type to his facilities for entertainment. It has been proven to be a good idea to have a broadcast receiver where guests may play with it to their hearts' content, without interfering with the adjustment of any instrument which is primarily intended for other purposes. An instance recently came to light where a yacht owner had, in a section of his stateroom, a short-wave receiver with coils for the broadcast range, a 600 to 1200-meter radio direction finder and a 2600-meter time-signal set. The disadvantage with this arangement was that, when the guests wanted a change of program, all of the adjustments of the installation were altered to accomplish the desired purpose. Since the owner in question naturally did not care to have "Don't" signs adorning his boat, he is now installing a converted A. K. Model 35 in his main cabin, where guests can select their programs through the simple manipulation of this independent single-dial outfit.

The numbers and types of tubes employed make the set as economical on precious battery current as a rugged type of instrument can possibly be. In this connection, the instrument offers particular appeal where a 32-volt lighting system is in use. The filaments of the six ¼-ampere tubes can be wired in series and operated directly from the lines, and the current drawn will be less than that consumed by the smallest lamp on the yacht. For those who supply their lights from a 12-volt battery, a series-parallel connection of the six tubes is easily arranged and is quite desirable. As the set originally stands, before any alteration of the filament circuit has been made it draws but 1½ amperes from a 6-volt source.

With a receiver as light in weight as the one under consideration, the chassis can be removed from the case and mounted on a mahogany panel for support. In such shape, the set can be installed in a

Recessed in a bulkhead, as shown above, the mahogany finished panel of the AK-35 harmonizes nicely with the interior woodwork of the boat

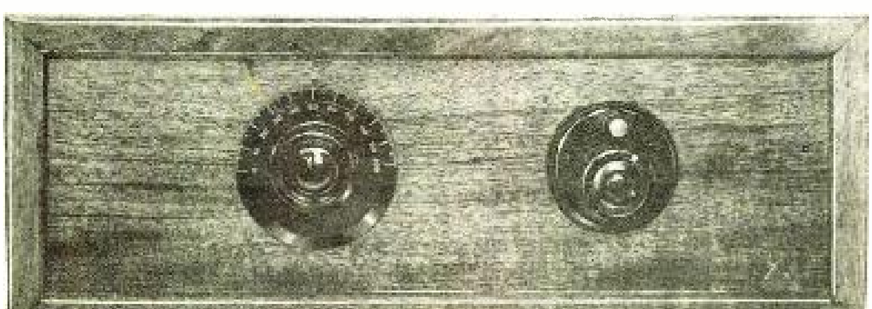


Fig. 1. Dressing up the AK-35 with a mahogany finish panel, as shown, adds materially to its general appearance

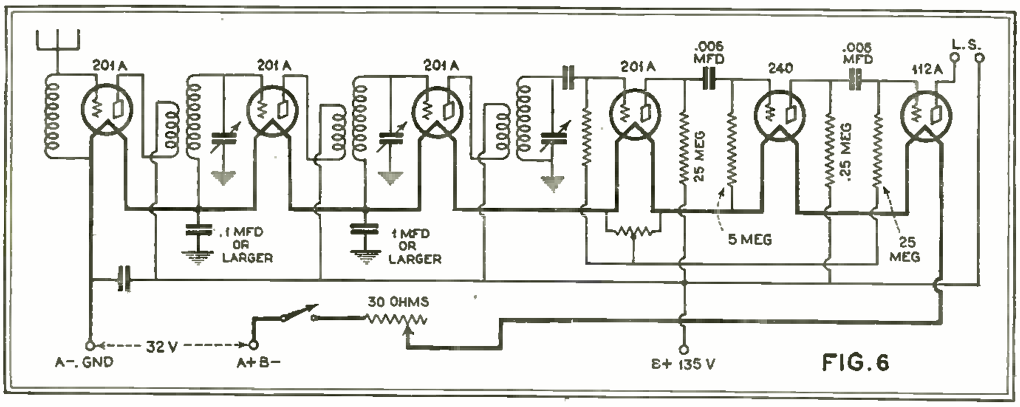
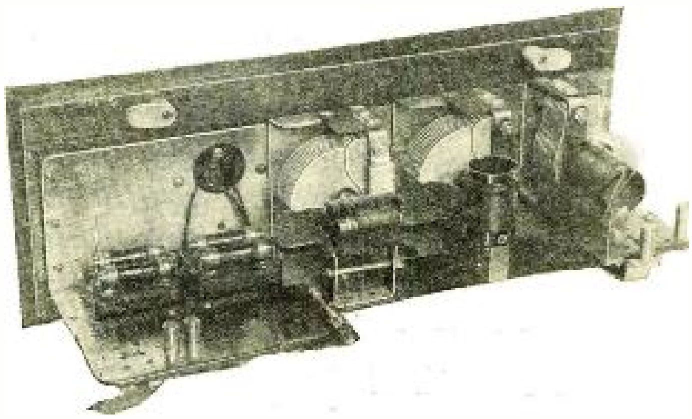


Fig. 6. Rewiring the circuit of the original receiver for use with either a 12 or a 32-volt source entails changes in the circuit as shown above. Note that the filaments of all the tubes are connected in series

drawer, a bulkhead, a locker, or in any other plain or paneled space where the instrument panel will come flush with the woodwork and the apparatus safely stowed behind it. It is a big improvement over setting a table model instrument on a shelf or dresser where space is limited and where the radio outfit does not seem to fit into the scheme of things with reference to physical appearances.

Troubles with Standard Sets

Those who have tried to employ standard broadcast receivers on small boats have found, in most cases, that these instruments give good results for a month or so and then fail. In almost every such instance of failure, phones plugged in the plate circuit of the detector give expected response, but output of the last audio tube is zero or the next thing to it. An inspection of the set will usually reveal such conditions as rusted iron parts, mildewed insulation on exposed connections and inductances, and audio transformers with open primaries—the secondaries are always intact. The rust and mildew (which often cause bad leaks) can be prevented by a coating of varnish, but the open transformer primaries present a more serious problem. The first thought is that they must have burned out, yet you may know of higher plate potentials having been used successfully, and, upon examination, you find that the tubes are as good as ever. When the open circuit does not appear around the soldered terminals where flux might cause corrosion, we open up the winding to look for the difficulty.



For improving the tone quality the regular audio units have been replaced with two resistance-coupled units, as shown above

Before the coil is completely unwound, a break will be located. It frequently happens that there are a number of places where the wire separates when unwrapped. In such instances it is clear that the trouble is not truly a burn-out, as that would produce an open circuit at only one point. Significantly enough, a careful inspection shows that a tiny green spot appears at each break. The spots may even be visible on a layer of insulated paper after the winding has been removed.

This copper corrosion, far from any soldered joint, causes one to strongly suspect the moist salt atmosphere which permeates all space within the water craft. Yet, if this were the only cause, transformer secondaries, as well as primaries, would succumb to its ravishing effects. Since this is rarely true, and because the trouble is found in speaker windings as well as transformer primaries, we must conclude that the cause is a combination of the moist salt atmosphere and the plate current the passes through the windings. Either the atmosphere corrodes the conductors in weak spots and the current finishes the break, or the salt moisture, in conjunction with the current, produces an electrolytic effect that gradually eats the wires in two.

Boiling the transformers in paraffin suggests itself as a remedy, yet it is not a sure cure, and it is doubtful if it is a very great help. Apparently, the paraffin does not always adhere closely, and the minute cracks assist capillary attraction to such an extent that the old trouble soon appears. Black asphaltum seems to be the most effective of several compounds that have been tried. However, just before the last boating season was over, an output transformer so treated developed an open circuit after giving good service over the major portion of the summer. Perhaps it failed for another reason—a reason that might have produced the same results ashore—but that is little consolation when the set has to be removed for repairs, and a search made for another transformer that will fit the space where the old one was taken out. With the uncertainty of transformer performance, it is far more satisfactory to use resistance for our audio coupling, a least until such time as we can buy, at moderate prices, transformers that can be inserted or removed as easily as the present vacuum tubes.

To become a real yacht outfit then, the A. K. Model 35 must have its audio coupling system (*Continued on page 1149*)

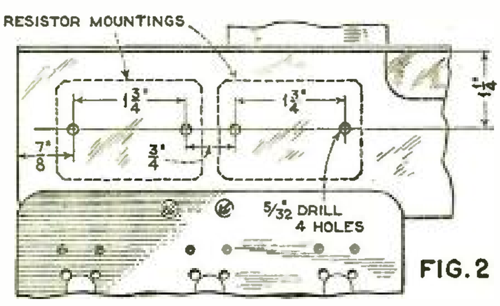


FIG. 2

FIG. 4

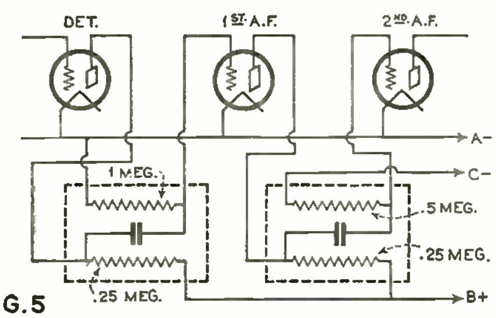
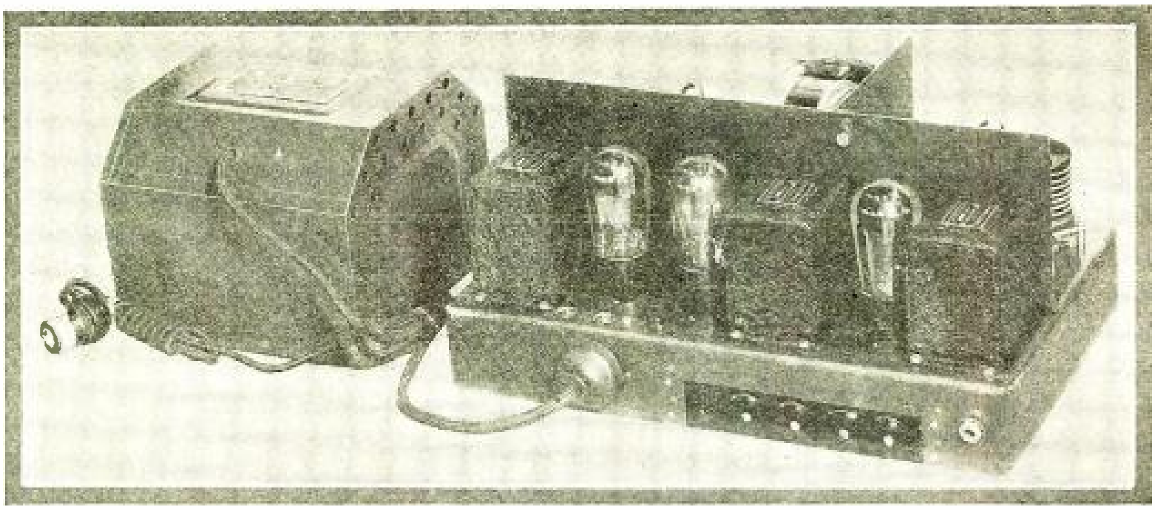


FIG. 5

Fig. 2. Details of assembly showing location of resistance-coupled units behind the tube sockets

Fig. 4. Bend back the lugs on the fixed condensers and make the connections as shown

Fig. 5. The resistance-coupled units are located and arranged in the circuit as shown above



An Analysis of A. C. Operated Short-Wave Receiver Design

It Is Paying Attention to Detail That Counts in Producing a Satisfactory Receiver, Especially When That Receiver Happens to Be of the A.C. Short-Wave Type. Condenser Design, Closed-Loop Circuits, a Suitable Power Supply and Coil Construction Are Only a Few of the Items Which Contribute to the Success or Failure in Operation

By James Millen*
in collaboration with
Robert S. Kruse†

REALIZING that before short-wave receivers could come into popular use they must be made to operate with very nearly the same ease and convenience as a modern broadcast receiver, we made a study of their weak points. A receiver was needed that would not only hold its own against any of the older type battery operated jobs for general amateur and experimental reception, but would also meet every requirement of the non-technical owner who, when he felt so inclined, wanted to hear 5SW in London, 2ME in Melbourne, Australia, or any one of a dozen other foreign broadcasting stations without the necessity of waiting for possible re-broadcasts of these stations.

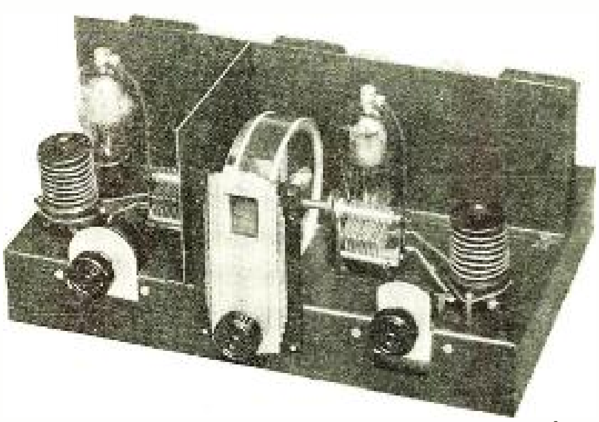
As a result of this survey, the following essentials of a good short-wave receiver were brought to light:

1—Absolutely humless a.c. operation. 2—Single dial control, 3—Loud speaker reception from foreign broadcast stations. 4—Good tone quality, 5—Non-critical tuning, 6—Neat appearance.

Now, after nearly a year of work on the development of such a receiver in the laboratories of the National Company, in collaboration with a number of well-known short-wave authorities (including, in particular, Robert S. Kruse, who spent a great deal of time both in the National Company's laboratory and in his own laboratory at Hartford, in making investigations into the causes of the various types of hum encountered in such receivers), a new a.c. short-wave receiver has been developed.

While the accompanying illustrations will give a good general idea of the commercial result of this research, the circuit diagram should not be taken too seriously, as all the circuit diagrams in the world mean little, if anything, when it comes to short-wave receivers. In fact, the circuit of the new receiver, as given in Fig. 1, is to all appearances quite conventional in every way.

When dealing with short waves, it is not so much the diagram which counts, but the manner in which the circuit is used. Little things, like the order in which the tube heaters are wired, the insulation of the bearings in the variable condensers, the type of material used in the coil forms, and so on without end, is what makes the difference between successful design and one which is a failure.



A front view of National's new a.c. operated short-wave receiver. Special constructional features, as outlined in the text, are incorporated in the design of this receiver to make it exceptionally satisfactory for a.c. operation

*General Manager and Chief Engineer, National Company.
†Consulting Engineer.

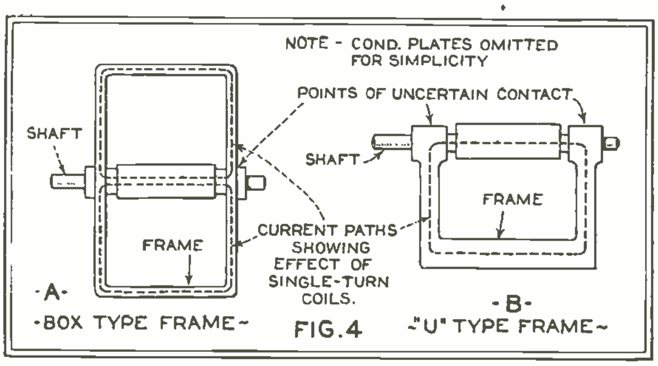
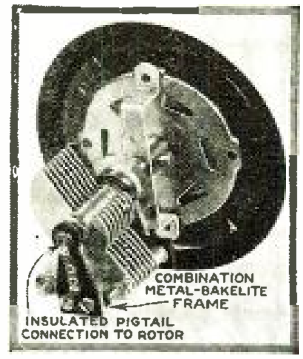
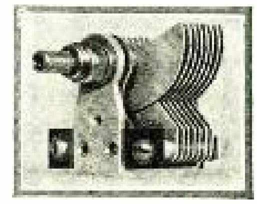


Fig. 4. The frame and shaft of the condenser form a single-turn coil. As the shaft is turned the bearing contacts change and the single turn is partly opened and closed, tending to produce noises in nearby tubes or those coupled to the condenser

This specially designed short-wave receiver (at the right) is unlike other small tuning condensers, in that its frame is part metal and part insulation, thus preventing production of a shorted turn, a feature to be avoided in short-wave receiver construction

Below, a general view of the revamped tuning condenser especially adapted to short-wave use





The circuit itself comprises a tuned screen-grid radio-frequency stage, in which provision has been made, if desired, for the use of the heater type pentode tube, where slight additional gain at the expense of selectivity is wanted; a screen-grid regenerative detector; a two-stage transformer-coupled audio amplifier, employing push-pull in the second stage and with provision for plugging 'phones into the output of the first stage when desired; and a separate power pack especially designed for short-wave work.

Occasionally good hum-free a.c. operation on short waves may be obtained by the mere substitution of the heater type a.c. tubes for the more conventional d.c. types in a standard battery operated short-wave circuit. Such instances, however, are few and far between, as they seem to be the result of an unusually good a.c. line condition, plus a "better than average" set of heater tubes. In most cases the mere use of conventional heater type a.c. tubes results in a quite pronounced and annoying hum that tends to vary somewhat on the different short-wave bands.

Thus, in our work on the development of an a.c. short-wave receiver, we soon found that while we would seem to be securing excellent results on one power line, it was essential that we take the entire outfit to another part of town or to a town in another state which was known to have a particularly poor and troublesome power system, in order to "check and double-check" all results.

After considerable experimentation of the so-called "cut and try" variety, it was found that there were some dozen or so very definite sources of hum trouble to be encountered in the short-wave receiver that would not cause the slightest trouble in a broadcast receiver. It was the identification and the elimination of these concealed sources of hum that finally made possible an a.c. short-wave receiver in which the hum is as low as in a battery powered set.

First, the tubes themselves must not only be of the heater type, but also, for complete freedom from hum, must be carefully selected. This is especially true of the detector tube which may be found to be quite noisy when just on the edge of oscillation, unless it is selected with care.

The cause of hum when using some types of heater tubes is apparently due to two things; one being direct leakage across the ceramic insulating column between one side of the heater and the cathode, and the other to an unneutralized 60 cycle field around the heater.

In general, the -27's, when operated on the verge of oscillation, are less troublesome than the -24's. At first thought this quieter performance of the -27 would tend to recommend its use as the detector. It was soon found, however, that, though more noisy when approaching oscillation, the -24 screen-grid detector was, under practical operating conditions, actually quieter due to its improved sensitivity, eliminating the necessity for full regeneration for the same signal output as obtained with the -27. Improved tone quality was a further by-product obtained from this decreased amount of regeneration.

The second point that must be given careful consideration if successful a.c. operation is to be had, is the power supply unit. This unit should be entirely separate from the receiver itself, completely shielded and located at least three feet from the receiver proper.

It should have exceedingly low inherent hum in its output; (i.e., at least a double section filter using good quality chokes and plenty of condenser capacity must be employed). The power transformer should have an electrostatic shield between the primary and the other windings in order to prevent line disturbances from getting into the power unit and into the set. The rectifier tube must also have an r.f. filter, comprising a radio-frequency choke and by-pass condenser in its output, directly preceding the hum filter. It is this r.f. filter system in the power unit which provides one of the two things necessary to eliminate the so-called "tunable" hum; that is, a hum that shows up only on certain wave-lengths but which nevertheless is quite pronounced. Apparently such hum results from disturbances set up in the rectifier tube itself.

Strange as it may seem, separate heater windings on the power transformer seem to give no improvement over the use of a single winding.

The set proper should be completely enclosed in a steel cabinet in order to exclude stray low-frequency magntic fields. Incidentally, these stray fields seem to be the cause of the "a.c." hum frequently encountered with some battery operated short-wave receivers. In order to make the shielding all the more effective, the power supply potentiometer with its associated by-pass condensers should be located inside the set in order to eliminate any external leads which might contain some radio-frequency currents.

It has been found that almost every .5 mfd. condenser of the conventional paper

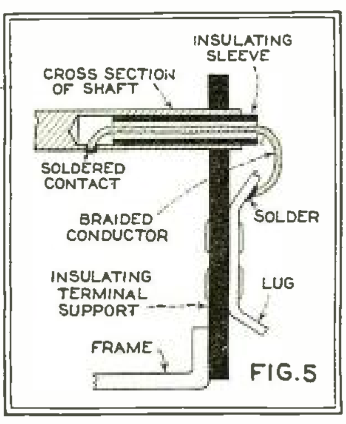


Fig. 5. The new condenser uses one insulated bearing. The connection from the tuned circuit to the rotor is made through a pigtail of the constant impedance type

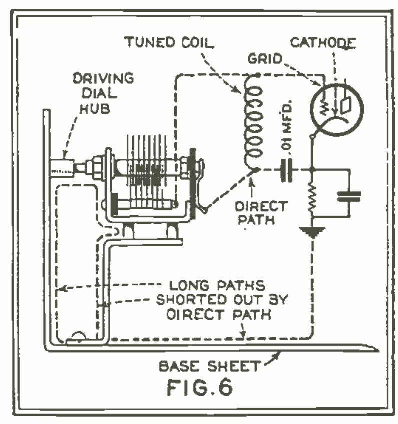
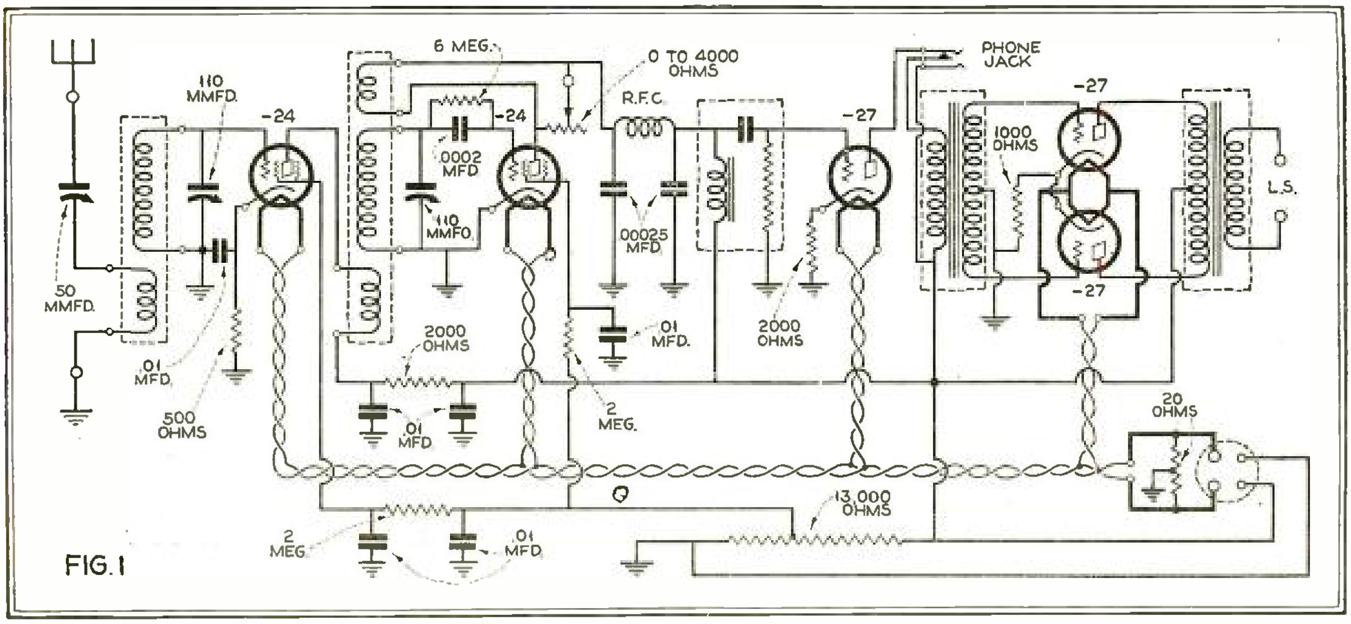


Fig. 6. Note that by means of the connection providing a direct path from rotor to coil, the longer loop circuits constituting short-circuited turns are removed from the immediate vicinity of the tuned circuits thereby nullifying the detrimental effects



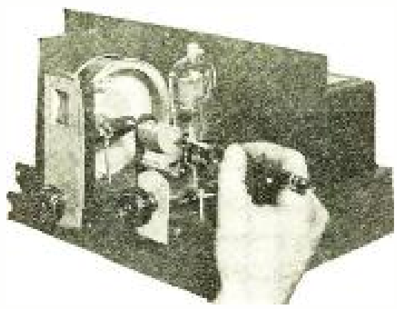


Fig. 1. The circuit comprises a tuned screen-grid radio-frequency stage, with provision for using a heater type Pentode tube; a screen-grid regenerative detector; a two-stage transformer-coupled audio amplifier employing push-pull in the second stage when desired; a separate specially designed power pack supplies A and B voltages

A side view of the receiver showing the method of mounting the specially designed tuning condensers. Shielding is employed not only to isolate the tuned circuit from each other but also to shield the audio channel from the tuner section

variety now on the market has a materially higher r.f. impedance at the lower wavelengths than a good .01 mica condenser. It is evident, therefore, that even though the cost be slightly more, the use of the smaller mica by-pass condenser will prove more effective and in many instances will completely eliminate a hum that is quite pronounced when using the paper condenser (hum resulting from common coupling through impedance of condenser.)

Along with low impedance by-pass condensers, should also be mentioned center-tap resistors of low ohmic value. That is, they should be of not over 20 ohms, rather than the conventional 60 ohm type employed in broadcast receivers. Furthermore, it will be generally found that a noticeable improvement can be obtained, when operating on a poor power line, if this resistor is of the flat type rather than the round type, which apparently has considerable radio-frequency impedance at the extreme high frequency on which we are working. One side of the center-tap resistor had best be by-passed by one of the small mica condensers previously mentioned.

While the jack for headphone reception is located so as to cut out the final or push-pull stage, there is bound to be a time, especially when listening to some of the foreign stations, when it may be desirable to connect the 'phones in place of the loudspeaker and use all of the obtainable amplification. But this possible use of the headphones in the output of the complete receiver is not the reason for the employment of push-pull in the final audio stage. Should a single output tube have been employed in place of the push-pull, an unbalanced drain of considerable magnitude would have been imposed upon the power pack, which, in turn, would have produced an infinitesimal fluctuation in some of the bias resistors, resulting in the introduction of hum in the detector and first audio-frequency circuits, which then would be amplified and passed on to the listener, even though the 'phones were plugged into the first stage jack, and the final stage not in use.

And now comes a method of hum control that will perhaps seem more logical than those already described; that is the location and arrangement of the wiring. As will be seen from the photographs, the receiver is constructed on a (*Continued on page* 1144)

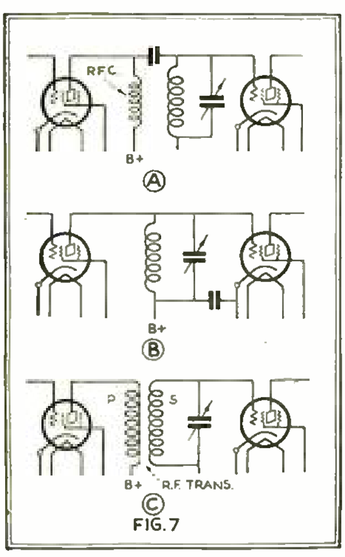


Fig. 7. After using a tuned impedance as the inter-stage coupling device, as shown at left—first as in "A", then "B"—the hum that was developed was found to be objectionable. It was eliminated by the use of a radio-frequency transformer as a coupling medium, as shown in "C"

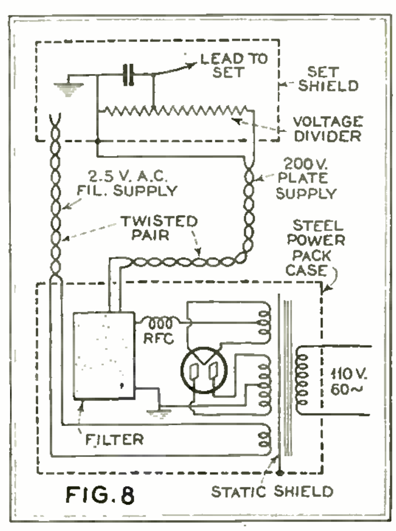
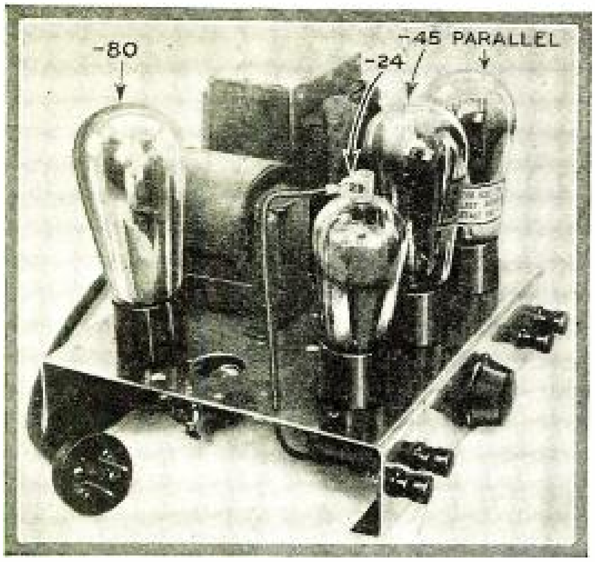


Fig. 8. To make a short-wave receiver operate satisfactorily from a socket powered B supply, it is necessary that extra special precautions be taken in the design and construction of the power unit to incorporate r.f. chokes and bypass condensers so as to make the receiver stable in operation



The Loftin-White amplifier, which employs a pair of -45 tubes arranged in parallel in its output. The circuit shown in Fig. 4 is employed here

And Now—

Push-Pull and *Circuits for the* Loftin-*of* Audio

Data Compiled in the L-W Laboratories Show How the Experimenter May Build Amplifiers. The New Circuits Include -45's a 50-Watter in the Output. Fundamentally, sented in Past Numbers of* RADIO NEWS *and put and Associated Circuits

By Edward H. Loftin

PROBABLY because we have so far mainly confined our introductory descriptive discussions of direct-coupled cascaded tube systems to those having a single type -45 tube in the output position, we have been asked in some quarters if direct-coupling is limited to single -45 tube output operation.

In order to negative any possible erroneous impression of this kind, for there is no such limitation, we discuss in this sixth of our RADIO NEWS articles some of a wide range of variations in output tubes and connections of them around which we have designed and used different systems.

In the February, 1930, issue of RADIO NEWS, we described a system having a type -50 output tube energized from a type -81 rectifier. Of course, all that we have since described of systems around the type -45 tube as output with a type -80 rectifier is applicable to the type -50 tube with a type -81 rectifier, or higher power tubes with suitable rectifiers, when suitable changes in constants are provided in accordance with principles heretofore touched upon by us to take care of differences in currents and potentials required by and encountered with different tubes. And the same is true in the case of output.

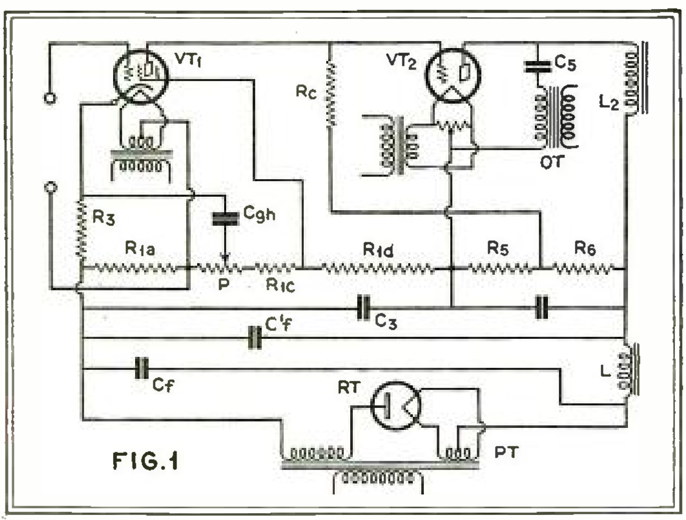


FIG. 1

An L-W circuit which uses a 50-watt tube in the output. Such an amplifier is recommended in cases where extremes of power for working many speakers is required

For emphasis on the matter of output flexibility, we start with the highest powered tube met with in ordinary amplifier uses, a 50-watter (for example the now commercially available, without restriction on use, DeForest type 511, or its equivalent of other manufacture), as output tube for a 2-tube direct-coupled system having a type -24 input tube.

The diagram of one form of connection for such a system is shown in Fig. 1.

The rectifier RT is the type -66 (gas-filled, single wave) supplied from a power transformer PT which, for convenience, may be had in the ordinary full-wave commercial type power transformer designed for supply of type -50 tubes in push-pull arrangement, connected in the present case for single wave supply to the single wave rectifier RT at the full potential of the secondary winding of the power transformer PT. The filter choke should have about 40 henries inductance. A capacity of 1 microfarad in the filter output condenser C'f is satisfactory, but the filter input condenser Cf must have at least 2 microfarads. This much storage capacity is needed for the type -66 rectifier in maintaining the required energy supply for the system, approximately 75 milliamperes at 1250 volts at the output side of the filter. Without sufficient storage capacity in Cf a form of motor-boating will be had, and it may prove rather destructive for the rectifier tube RT. Attention is invited to the fact that the potential is high, so that condensers rated for high potential are necessary, or series connected condensers of low rating in the absence of high rated condensers.

"... Before leaving this 50-watt tube system, a word of warning to those who are not electrically informed may not be amiss. The potentials required are high enough to be positively dangerous, even death dealing, and should be handled with the utmost care."

Since the type -11 so-called 50 watt tube has a 10 volt, 3 ampere filament, and a quite high

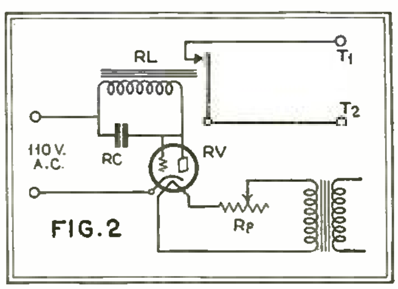


FIG. 2

So that the plate voltage to the 50-watter is not applied until the tube has had a chance to warm up, the relay circuit as shown above is incorporated in the amplifier circuit of Fig. 1

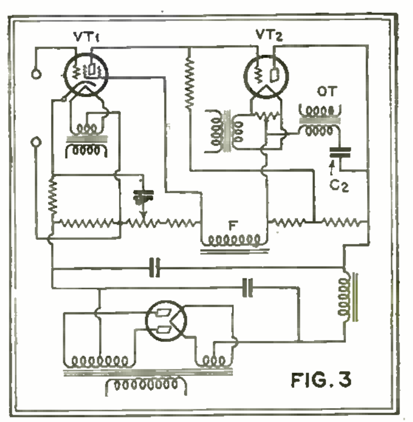


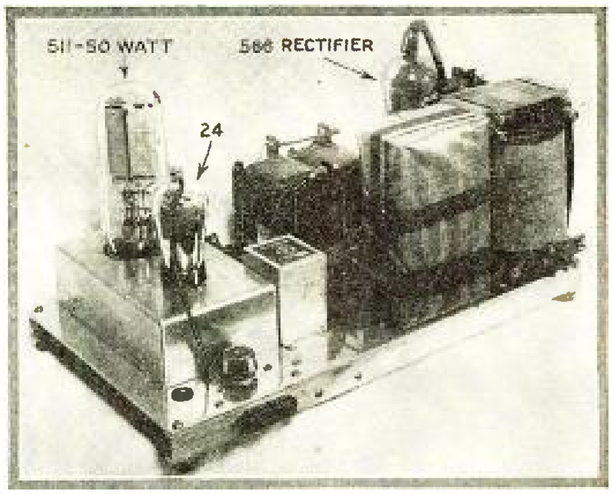
FIG. 3

A method of usefully employing the speaker field as an additional choke is shown in the single -45 L-W amplifier. F in the above circuit indicates the position of the speaker field

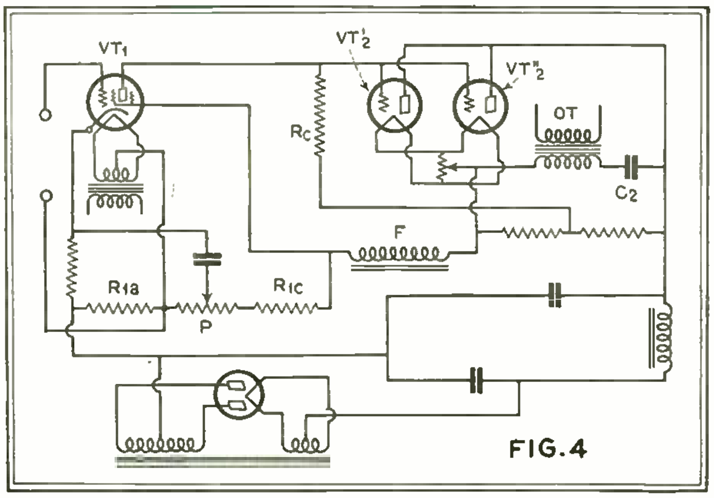
Parallel Output White System Amplification

and Presented Here for the First Time More Powerful Types of Direct-Coupled and –50's in Push-Pull and Parallel and Also the Circuits Are the Same as Those Pre- Differ Only in the Arrangement of the Out-

and S. Young White



The mode of assembly employed in the construction of the 50-watt L-W amplifier is illustrated here



Two –45 tubes may be connected in parallel in the output circuit of an L-W amplifier, providing the other changes as outlined in the text and shown above are made

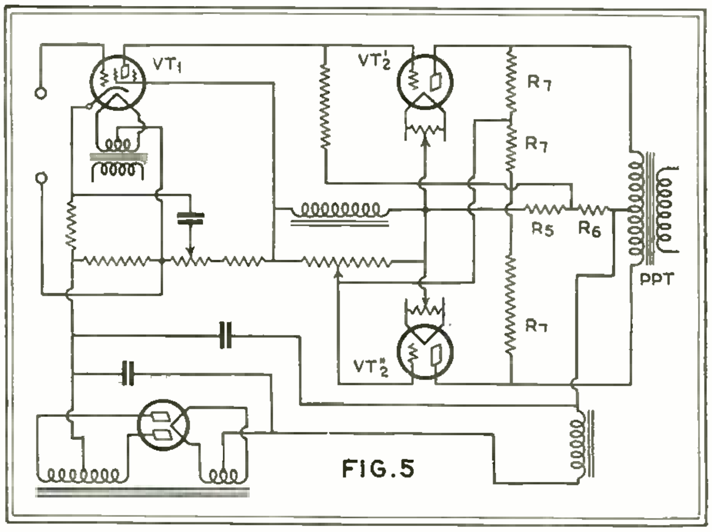
mu, considerable hum may be expected from its a.c. energizing unless the center-tap is accurately adjusted. This makes it desirable to include a closely adjustable center-tap potentiometer instead of relying upon the usual center-tap of the filament winding.

Either a transformer output or a choke and condenser output may be used. Due to the high filament-plate impedance of the type –11 tube, a choke and condenser output, as shown in Fig. 1, is considered preferable, the primary winding of the output transformer OT having about 7,000 ohms impedance, choke L2 about 40 henries, and the output condenser C5 from 1 to 2 microfarads.

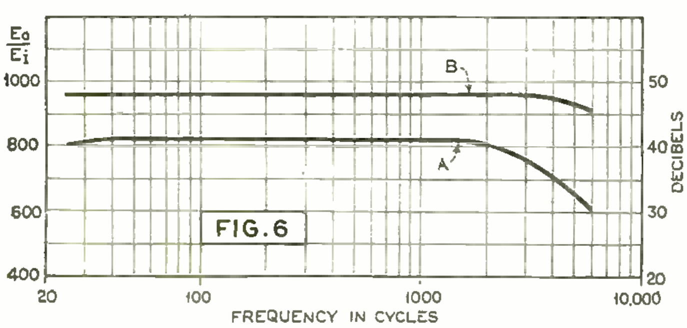
Resistance R1a is about 750 ohms, potentiometer P about 100 ohms, R1c about 300 ohms, R1d about 2,000 ohms, R5 about 20,000 ohms, R6 about 200,000 ohms, R3 about 50,000 ohms and Rc about 200,000 ohms. The shunting condenser C3 should have 4 microfarads and hum-bucking and signal filter condenser Cgh 2 microfarads. The tube VT1 is type –24.

The overall gain of the system may be increased by increasing the coupling resistance Rc and simultaneously reducing the resistance R1a to keep stabilizing correct. For example, when Rc is increased to 500,000 ohms, R1a should be reduced to about 300 ohms. Since the type –11 tube has a mu of about 13 it is apparent that very high overall gain can be had in the system. For example, if the constants are so chosen as to give about 200 gain in VT1, then the overall gain will be of the order of 2,500.

The type –24 tube is capable of completely swinging the type –11 tube throughout its entire undistorted output range before being distorted itself, so that enormous undistorted output energy is available. As many as six dynamic speakers can be nicely operated to full reproducing ability with this system.



A modified form of push-pull output circuit applied to the Loftin-White system of audio amplification. Constants for the various parts indicated are given in the text



In a system employing a single –24 input tube and a pair of –45's in parallel the frequency characteristic and efficiency curves are as shown above. "A" shows the practically flat curve from 35 to 6,000 cycles, while "B" shows the small effect of the falling off in d.b.'s at the high frequencies

It is desirable that the cathodes of the tubes of the system of Fig. 1 be switched on and allowed to warm up to full emission, for about one minute, before high potential is applied to the system, which desirability can be nicely satisfied by some form of delayed action relay to withhold switching-in of plate potential until the cathodes are made ready. The delayed action relay system of Fig. 2 is admirably adapted for the task in question, and is made up as follows:

RL is a small relay of a type used some time ago to switch in a battery trickle-charged as made by Stromberg-Carlson, Yaxley and others. We replaced the original relay winding by one-quarter pound of No. 40 wire, and inserted this converted relay, shunted by a ½ microfarad condenser RC, in series with the cathode-plate circuit, with the grid tied to plate, of a slow heating type –27 tube RV connected across the 110- (*Continued on page* 1146)

An 80-Meter Phone for PORTABLE

On Land, in the Air and at Sea Radio Is Doing Much to Make Every-day Life Safer. This Combination Short-wave Transmitter and Receiver Installation, Designed Especially for Small Motorboat and Other Portable Use, Provides a Measure of Safety in the Navigation of Water Craft Heretofore Unattainable. Operating from a Motor-generator or B Battery Supply, the Transmitter Has a Dependable Code Range of About 100 Miles and a Phone Range of Ten Miles

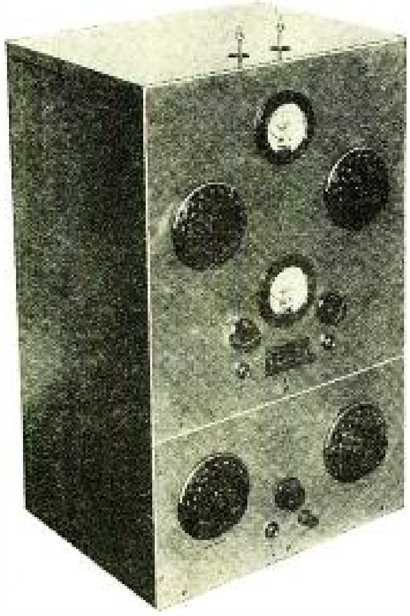


Fig. 1. The transmitter and receiver are housed in one cabinet, the transmitter at the top and the receiver below it. The illustration above will give some idea of the general appearance of the entire outfit

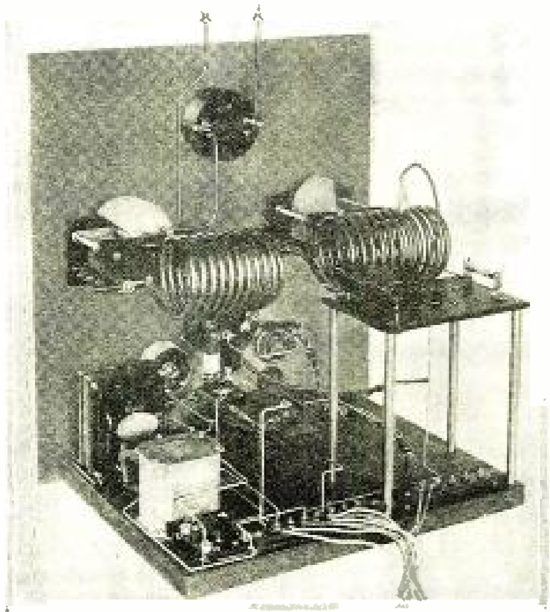


Fig. 2. In this rear view of the transmitter some idea is gained of the general placement of the parts. Note how the platform at the right is constructed so as to support the oscillator tube near the coil, thus obtaining short direct leads

THE days are getting longer and the time will soon come when our boats will be slipped back into the water for their spring cleanings after a winter on shore. Once again warm waters will open their pathways to relaxation and pleasure. Eight years ago the pleasure boat was a thing for the wealthy and radio on a pleasure boat was practically unheard of. Now, in 1930, we find an entirely different state of affairs. Radio has progressed to the point where it is considered a necessity rather than luxury. Today we find the average boat owner taking longer trips than he had taken a few years ago. We find him covering distances in hundreds of miles rather than in tens. The sensible boat owner should, and can, appreciate the value of radio as an item of safety on his craft. This article is dedicated to those who have boats of the smaller type, say less than 50 feet, where space becomes a deciding factor and portability of radio a highly desirable one.

Coöperating with RADIO NEWS in their work of designing radio installations suitable for use in water craft, my associates and I have built a short-wave motorboat transmitter and receiver which we believe can be adapted easily to the modern cabin cruiser. The transmitter and receiver is a small affair and can be placed in some nook of the boat where it will be out of the way. An idea of the size of the complete equipment can be obtained from the accompanying photographs.

A general layout of the transmitter-receiver is shown in Fig. 1. The receiver is placed at the bottom and the transmitter on the top. The complete apparatus as a unit presents an extremely neat appearance and will lend beauty rather than untidiness to a well-furnished motorboat. The front panel of both units is made of aluminum. The apparatus is encased in a solid mahogany box, well seasoned, in order to withstand the corroding effect of the salt air and moisture which is ever prevalent when on the water. There are two posts protruding from the top of the cabinet. These posts are for the antenna and counterpoise connections and hook directly into the antenna inductance of the transmitter. In the transmitter the dial on the left controls the condenser for the tank tuning or oscillator circuit. A .00045 mfd. condenser is used in this circuit. The dial on the right operates the condenser for the antenna wavelength adjustment. This condenser is of the same capacity as the tank condenser. The meter at the top of the transmitter is a radio-frequency meter for indicating the antenna current of the transmitter when it is in operation. The other meter is for indicating the voltages impressed on the tubes. There is a control for microphone gain, a plug for the microphone and a plug for the key. There is also a filament rheostat for voltage control of the filaments of the transmitter tubes. A four-pole double-throw switch is used to change over from operation of the transmitter to the receiver.

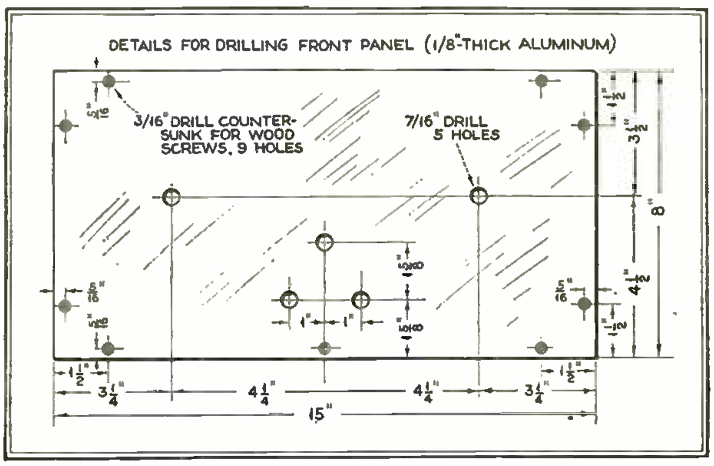


Fig. 3. Before assembling the receiver it is necessary to prepare the aluminum panel, drilling it in accordance with the layout shown above

A back view of the transmitter is shown in Fig. 2. At the right side is mounted

Transmitter and Receiver Use

By Samuel Egert

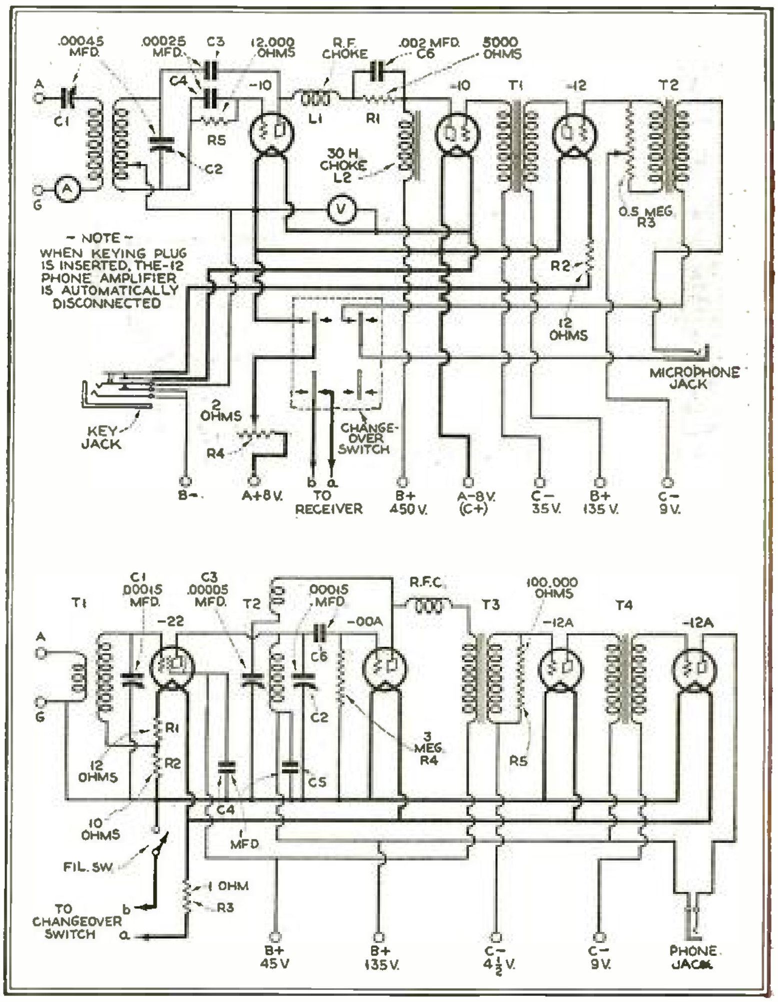


Fig. 4. Here are shown the circuits of the transmitter and receiver. The one at the top is the transmitter. It consists of one oscillator employing a type -10 tube, and a two stage modulation system employing a type -12 in the first stage and a type -10 tube in the second stage. At the bottom is shown the receiver circuit employing four tubes in all. The first is -22 screen grid tube used in the tuned radio-frequency amplifier stage. The second is a -OOA tube used in the regenerative detector circuit; this is followed by a two stage audio amplifier, both stages employing -12A tubes. The change-over switch incorporated in the transmitter circuit permits the operator to shift from "transmit" to "receive" merely by the flip of the switch

the oscillator. This includes the grid leak, radio-frequency choke and socket. In order to concentrate the oscillator system in as small an area as possible, the method of assembly, as shown, is employed. On the base of the transmitter there is mounted the microphone transformer, T1, which is nearest the front panel, and in line with that is another transformer, T2, which feeds the modulator tube from the microphone tube. In the center of the base there is a modulator choke coil, L2, which is hooked in the high-tension side of both the modulator and oscillator tubes. A resistance, R1, is placed in the plate circuit of the oscillator tube in order to apply the correct voltage to the plate of this tube for 100% modulation. The condensers are shown mounted on the front panel, while the inductances are fastened directly to the backs of the condensers by means of bakelite support plates. The illustration also shows the thumb-screws by which, with comparative ease, these inductances, which are made of hollow copper tubing, can be replaced with others for other wavelength bands.

Fig. 3 illustrates a top view of the transmitter. Here again neatness manifests itself. Each part is well placed from an appearance standpoint, yet the electrical design is carried through so as to result in the shortest possible leads, thus tending toward increased operating efficiency. At the back of the transmitter, mounted on the baseboard, are a series of connections for the voltages required.

The electrical design of the transmitter, whose circuit is shown in Fig. 4, is as follows: a Hartley circuit employing a 210 tube is used with both a tuned antenna and tank circuit combination. This is fed by a 210 modulator tube which gives a high percentage of modulation due to the resistance placed on the high-tension lead of the oscillator tube. The first modulator tube is fed by the transformer, T1, which in turn is coupled to a second modulator tube, both standard –12A's. This latter tube is fed by the microphone transformer, T2, whose primary is in series with both the send-receive switch and microphone jack. The gain of the microphone is controlled by a potentiometer shunted across the secondary of the microphone transformer. The filament circuits of the oscillator and modulator tubes are connected in parallel. They connect in series with the send-receive switch which cuts off the filaments of these tubes when the operator wishes to receive, and reconnects their filaments when he wishes to transmit. There is a key jack, as shown in the schematic drawing, which au-

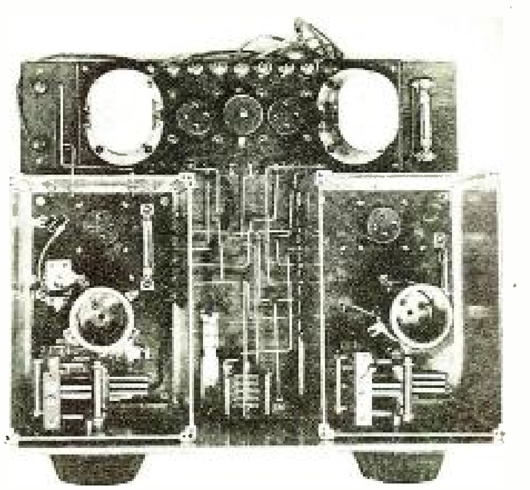


Fig. 5. In this top view of the receiver the location of the two shield can units and the audio amplifier channel along the rear of the base is indicated. Each of the units was wired separately, then mounted in place and finally wired together to form a complete receiver

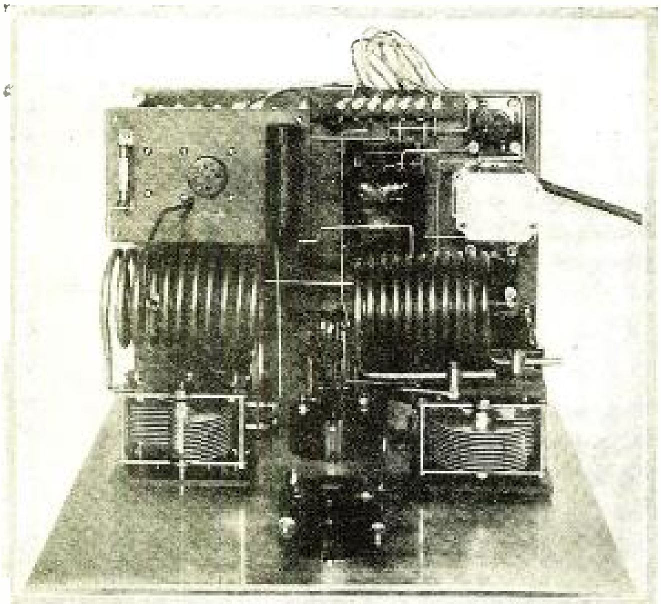


Fig. 6. Note in this top view of the transmitter unit how the antenna coil has been mounted on binding posts allowing it to slide sidewise so as to obtain variable coupling between it and the oscillator coil. The photograph also shows the layout of the other parts of the transmitter

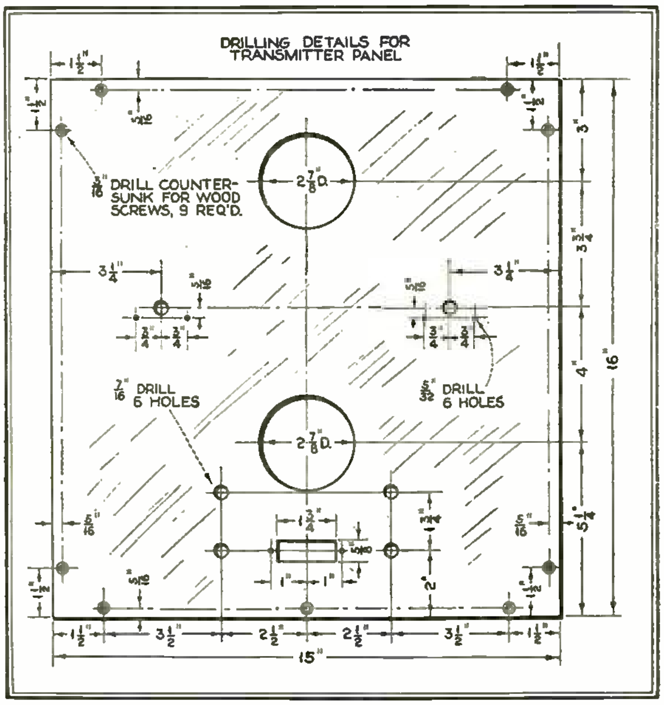
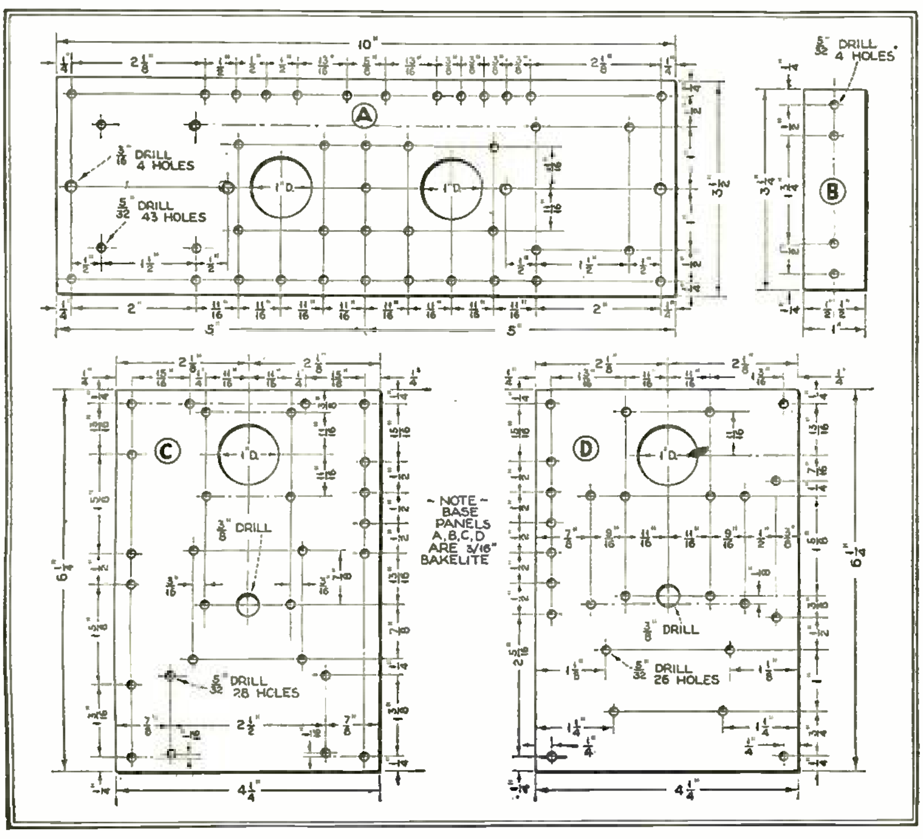


Fig. 7. Those parts which are mounted on the panel of the transmitter occupy the positions as indicated in the above layout. Full drilling details are given here

tomatically disconnects the amplifier when the key plug is inserted. Keying is accomplished by inserting the key in the "B" minus lead. In the diagram there is also shown one blade of the receiving and transmitting change-over switch marked with the letters A and B. These blades are hooked in line with the filament circuits of the receiver, thereby controlling the filaments of the receiver tubes by means of this switch.

A transmitter of this sort is ideal not only for the "ham" but also for the owner of a small boat from the emergency point of view. Short waves have proved themselves to be an ideal means of communication for the man who, because of the limitations of visual or sound systems of communication, cannot maintain his touch with shore points. The combination transmitter-receiver is arranged so that by means of throwing one switch it is possible, in the case of some mishap which might be encountered while on the water to rapidly change over from the operation of the receiver to the operation of the transmitter so as to communicate by code with another station. The transmitter can be adjusted by tuning it to the exact desired wavelength while on shore, and from this point on can be made absolutely stable. Then there is a microphone which is always on hand in case the operator wishes to rely on phone transmission. The range of the transmitter when code is used is reliable at 100 miles and the range when the phone is used is 10 miles.



Power Supply

The power supply for the transmitter can either be obtained by a small motor generator manufactured for just such a purpose at a fairly low cost or from a supply of "B" batteries. The generator is powered from the storage battery on the boat. The batteries or generator can be stowed away in a cupboard or locker out of the way of passengers and protected from sea spray or dampness. As mentioned before, the transmitter is a portable affair and if installed in a boat can easily be brought on land in case of necessity. In this way if forced to leave the boat for any extended period it would be possible to take along the transmitter and maintain touch with the outside world.

Fig. 8. The drawing to the left shows how the bakelite base plates of both of the shield cans and also the subpanel for the audio channel must be laid out and drilled. The drawing labelled "A" shows the drilling layout for the audio channel base; "B" is the insulated strip for the antenna and ground binding posts; "C" the subbase for the r.f. tuner unit, and "D" the subbase for the detector tuner unit

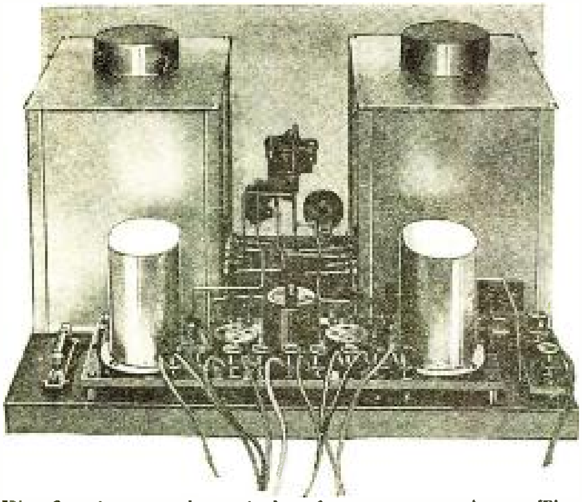


Fig. 9. A rear view of the short-wave receiver. The circular caps shown in the top of the shield can are removed when it is necessary to substitute other plug-in coils for other wave bands

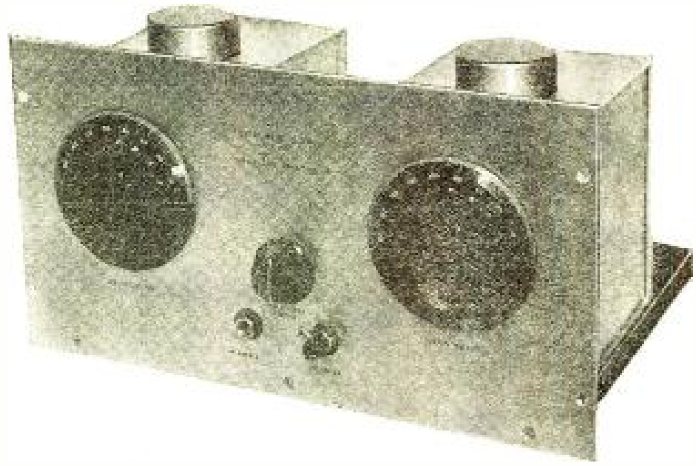


Fig. 10. Whether built separately or as part of the complete transmitter receiver job, either unit is worthy of the attention of a short-wave fan. The photograph above shows the neat panel appearance of the receiver

The tuning of the transmitter is extremely simple. The batteries or motor generator should first be connected to their proper terminals and the change-over switch at the front of the panel thrown to the "transmit" position. The filament voltmeter should then be adjusted to read 7½ volts by means of the rheostat on the front panel. The switch is then thrown to the "off" position and the antenna and ground connected to the posts protruding through the top of the cabinet. Throw the switch to "transmit" once more and turn the tank condenser dial to 90. Insert the key plug and while pressing the key turn the antenna condenser very slowly until a deflection is noticed in the antenna meter. Use a wavemeter or frequency meter to find at what wavelength you are operating. If the wavelength is not within the band assigned for such work by the government, turn the tank condenser a little to one side or the other, depending on whether the original reading was high or low, readjust the antenna condenser once more for deflection, and again read your wavelength. This procedure is followed until the transmitter is adjusted to the desired wave. Turn the transmitter off at this point, disconnect the aerial and counterpoise, raise the cover of the box and reconnect the antenna and ground. With the key, up, vary the tap on the tank coil by one turn and press the key. It may be necessary to retune to the right frequency. Watch the antenna meter and see whether the change has brought any additional antenna current. If it has, move the tap over one more turn and then readjust the tuning, as before. Keep in mind at all times that the plate of the oscillator tube should never be more than dull red in color.

By systematically following the above procedure you can easily find the exact point to tap to give the greatest output of the tube. When this has been done no change should be made in the tap unless the wavelength is varied. With the transmitter turned off, the coupling between the two coils should be varied by loosening the set-screws on the posts holding the antenna coil. Then, with each change in coupling the transmitter should be turned on to note whether any improvement in output has taken place. This should continue until maximum deflection is again noticed in the antenna meter. The maximum antenna current does not necessarily mean that you are getting the best note or the finest modulation. This can easily be tested, however, by operating a shielded receiver at some small distance from the transmitter and varying the coupling of the antenna coil until the note is cleanest when using CW and the modulation best when using voice. In order to test the microphone, plug the microphone in its jack and turn the microphone gain control (*Continued on page* 1154)

Fig. 11. Below are given the coil winding and mounting details for the oscillator and antenna coils of the transmitter. Particular attention is directed to the method of mounting the antenna coil in binding posts so as to obtain a variable coupling feature

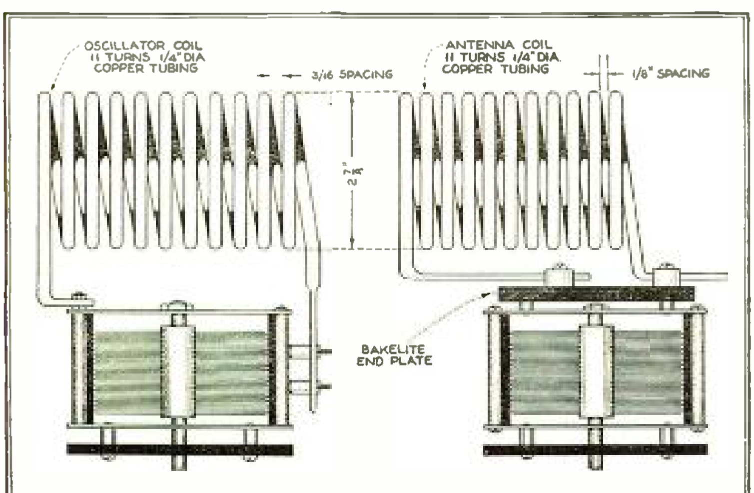
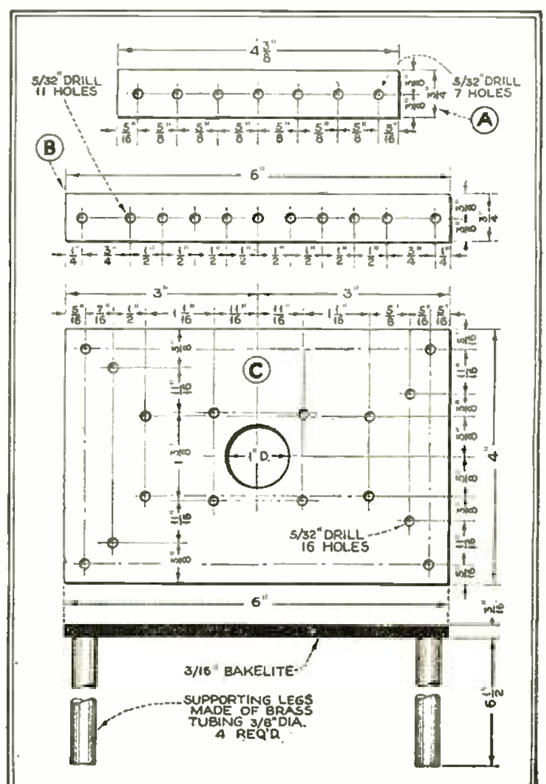


Fig. 12. To the right are given the drilling details necessary to the preparation of the various bakelite parts used in the transmitter. A and B show the two terminal strips, while C shows the oscillator platform strip



Can we Tolerate HUM in A. C. Operated Receivers?

The Answer Is Most Emphatically NO!

One of the Greatest Problems Faced by the Serviceman Is the Locating and Eliminating of Hum. It Is Surprisingly Easy to Solve by a Number of Simple Hum-Measuring Systems. The Ears, Which, in the End, Must Be Satisfied, Offer One Satisfactory Means, While for the Laboratory Man There Are Vacuum Tube Voltmeters and Other Measuring Devices

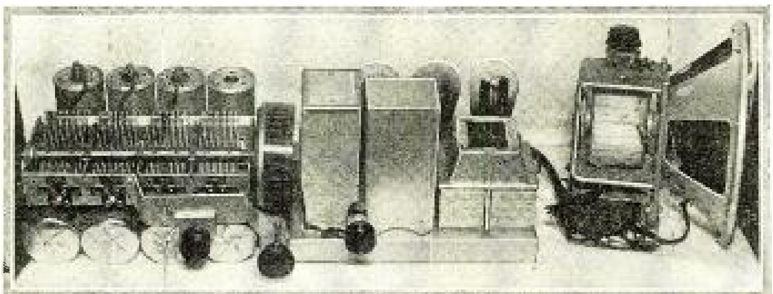
By Benjamin F. Miessner

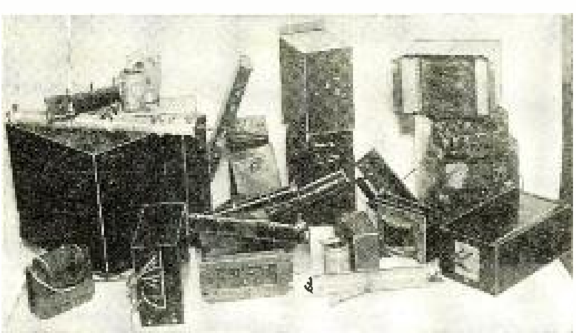
THE unaided ear, while a good comparison device, is quite unreliable as a means for judging hum, mainly because it provides no accurate indication or memory for amplitude, and yet in the end the ear is the sole judge of what constitutes a satisfactorily low hum level in a.c. operated radio receivers.

The audibility meter used with head phones is better, but those of you who have used this method will agree, I think, that it is anything but reliable or accurate.

It may be suggested that the unaided ear is a satisfactory means of measurement, if the distance between listener and speaker be increased to the point where the sound is just over the audibility threshold, and this distance itself, or squared, be used as the intensity factor of the sound. In the first place, such a method requires either an absolutely quiet location, or one with a small and constant amount of sound disturbance of uniform character or quality. In the second place, a location completely free from reflections must be used, as these set up stationary wave systems which hopelessly destroy the use of distance as the measure of intensity. Furthermore, because of the fact that all present speakers have great variations with respect to directional sound distribution from the theoretical point source, demanded by the classical inverse square law, further difficulties are noted. It is evident therefore that this method is beset by a great many difficulties. While the head-phone and audibility meter method eliminates reflections, external noise largely, and directional effects too, there are few who can get consistent results with it.

Microphone measuring apparatus will measure the amplitude of the air waves produced by the hum radiated from the loud speaker, but, as we know, the ear responds to an energy factor proportional to the product of amplitude squared and frequency squared. Since the hum is usually a complex tone, the microphone method provides no satisfactory indication of the normal ear response to the sounds which it measures, inasmuch as the frequency factor is not accounted for in its measurement.





The top photograph illustrates the elements of a well-designed a.c.-operated receiver. There is the r.f. tuner at the left, the audio channel with power supply in the center and the dynamic speaker at the right. The lower photograph shows some of the odd-sized filter condenser blocks, voltage divider resistors and filter chokes of dubious quality which have the disturbing habit of introducing hum in a receiver when not properly selected or used

For the same reason a hum voltage measurement across the loud-speaker terminals is not reliable. Here, in addition to the preceding difficulty, we have another in the fact that no speakers produce sounds over the complete hum frequency range, whose amplitude bears a fixed ratio to the amplitude of the voltage across them. This of course, could be overcome if the frequency characteristic of a given speaker were known. With the hum voltage readings properly corrected by this speaker characteristic, we would arrive at a measurement equivalent to that of the microphone method, but of course, subject to the difficulties of the latter previously described. I have used this voltage measurement method to a considerable extent because of its simplicity, and I find it generally in use where any instrumental method is used at all, for with very good speakers the voltage readings follow, with fair agreement, the judgment of the ear as to loudness. However, with some speakers, a given adjustment, say, of a filament potentiometer, will indicate more hum on the meter, and less hum by the ear. This is usually due to deficient low tone reproduction in this speaker. When this method is used, therefore, the results must be weighted by the pitch and audible intensity of the hum.

Another method is to substitute for the loud speaker a complex circuit to which the measuring vacuum tube voltmeter is connected and which will so regulate the amplitudes of the various hum frequencies in a complex hum current, that the meter reading will be corrected automatically for the frequency response characteristics of speaker and ear. This corrected reading will provide a fairly true indication of the audible hum which that voltage would produce with a given speaker and normal ears. This, it appears, should be a rather good method.

Many Called—Few Chosen

Another method is to interpose a tunable circuit between the voltmeter and the speaker terminals, so that the voltage at each particular frequency from 60 to say its 20th harmonic, or 1200 cycles, may be measured. These separate measurements may then be weighed in accordance with the combined frequency characteristic of speaker and ear, and then added together to obtain a measure of the audible intensity produced by these voltages when acting on the ear through the transforming action of the speaker.

Another method of a similar nature is to make an oscillogram of the hum current, and by mathematical, graphical, or mechanical analysis, determine the frequencies and corresponding amplitudes of the various components. These may then be properly weighed and added together as above described, for obtaining the audible hum producing intensity.

These two last methods are quite evidently too laborious for ordinary use, although giving prospect of reasonable accuracy.

There is still another method which appears to hold considerable promise. This was used by the writer in 1916 for making measurements of airplane noises while engaged by the Navy Department as Expert Radio Aide for Aviation at Pensacola, Florida. In this work I used a pair of radio headphones into which a 500 cycle signal current of known variable audibility could be sent. It was found that the signal current required in the telephones for audibility through the airplane noises was a very good measure of the noises themselves. It also served to indicate just what signal amplitude was necessary for satisfactory reception of signals through those noises under different conditions of flight.

I found that the signal audibility threshold, which was raised sometimes several hundred times the normal threshold value by the airplane noises, was much more sharply defined than when no external noises were present, so that more consistent and reliable measurements could be made. This method could very easily be adapted to hum measurements in radio sets. To do this an audio oscillator of some type of known voltage output together with a potentiometer and watch-case receiver are necessary. The oscillator, say a 1,000 cycle device of the type manufactured by the General Radio Company, which is itself rendered inaudible by suitable sound shielding, has its output connected across the ends of the potentiometer, the output of which is connected to the watch-case receiver. The receiver is mounted as near the humming speaker as possible. The potentiometer is then adjusted until the oscillator signal is just audible through the hum of the speaker. If the observer listens at a distance of about one foot while sound reflecting surfaces are kept at a distance large compared to this, standing waves due to reflections need cause no difficulty.

The voltage across the receiver, as indicated by the potentiometer or as measured directly, will then indicate the hum amplitude. This method is especially good because, in the last analysis, the ratio between signal and hum amplitudes in the receiver is of most importance, much as the static and signal levels are with static interference. If the measuring signal frequency lies in the neighborhood of the mean frequency of the program current, for example, 500 to 1,000 cycles, a very simple, easily operated, and satisfactorily accurate hum measurement method is available.

One experienced in hum problems can, usually with the unaided ear and a few tests, made without disturbing the circuit connections of the receiver, determine the cause of its hum. Sometimes a mere listening test will disclose which of the three types of hum is predominant.

Mr. Miessner Points Out That to Identify and Measure Receiver Hum . . .

¶In the detection of hum by ear, a location completely free from reflections must be used, as these set up stationary wave systems which hopelessly destrny the use of distance as the measure of intensity. Furthermore, because of the fact that all present speakers have great variations with respect to directional sound distribution from the theoretical point snurce, demanded by the classical inverse square law, further difficulties are noted.

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¶If the grid input to the first audio tube be shorted, any induction hum entering the second audio transformer, as well as any hum caused by the first audio tube or its grid or plate supply or its filament potentiometer, if any there be, will appear added to those already noted in the nther tests.

¶It may be noted, however, that in some receivers the hum decreases instead of increases as these steps in this test are taken. This is due tn what I have termed "inter-stage bucking," caused by the neutralization of one hum by another.

Sherlocking Hum

While the audible character of these hums cannot be described accurately, I believe anyone with normal ears can distinguish the low tone with a peculiar singing note added due to a wrongly adjusted potentiometer or to magnetic induction from the power transformer. In receivers with poor low tone amplifiers, only the peculiar singing sound, like the singing of telephone wires, may be heard; this is produced by higher harmonics of the 60 cycle current.

The smooth, sonorous, 120 cycle hum, due to insufficient current filtration, such as a baritone voice might emit in speaking the word hum is also easily identified.

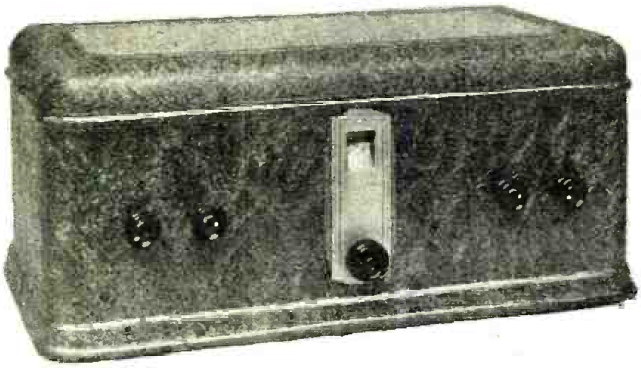
While not so often noticed, the "buzzy" type of hum is easily recognized too, as originating in noisy detector tubes, of which it seems there are a great many, or to electrostatic induction from the rectifier and filter input elements. If you have ever had a wasp or bee buzzing at your ear you will have no difficulty in identifying this one.

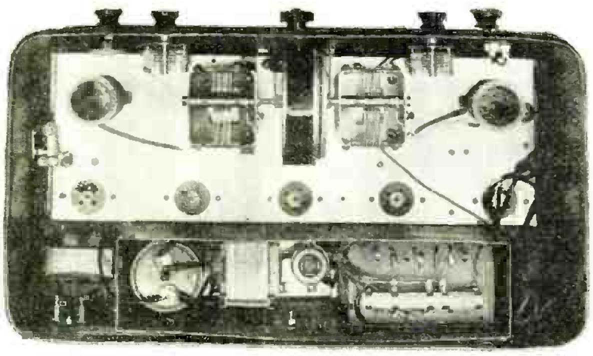
In addition to these unaided ear tests a few circuit changes made externally with a short piece of wire are very helpful. For example, if the speaker or its input transformer be short-circuited, any hum set up in the speaker itself will remain alone; if the grid input to the second audio tube or tubes be shorted without disturbing the "C" bias, the addition of any hum by the output transformer, the second audio tubes, the current supply to grids or plates thereof, or off-set filament return, will appear, added to any hum already shown as caused by the loud speaker. If the grid input to the first audio tube be shorted, any induction hum entering the second audio transformer, as well as any hum caused by the first audio tube or its grid or plate supply or its filament potentiometer, if any there be, will appear added to those already noted in the other tests.

When this short-circuit is removed, the added hum due to the first audio transformer induction, detector tube or detector tube plate current, detector potentiometer, static induction to first audio grid, detector plate, or detector grid, will be added, and thus the entire audio hum of the receiver will be built up step by step. It may be noted, however, that in some receivers, the hum decreases instead of increases, as these steps in this test are taken. This is due to what I have termed "inter-stage bucking," caused by the neutralization of one hum by another. This will be discussed more at length later.

Now, if the detector grid leak be shorted, any static induction picked up by the grid side of this leak will be eliminated, and its effect on over-all hum noted. (*Continued on page* 1141)

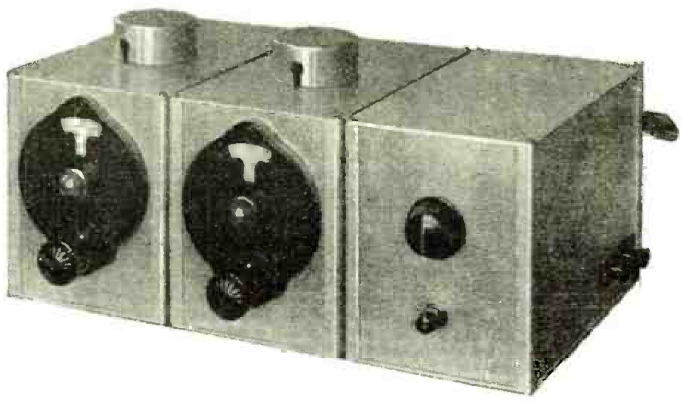
To Bring YOU *The* Thrills *of* Short-



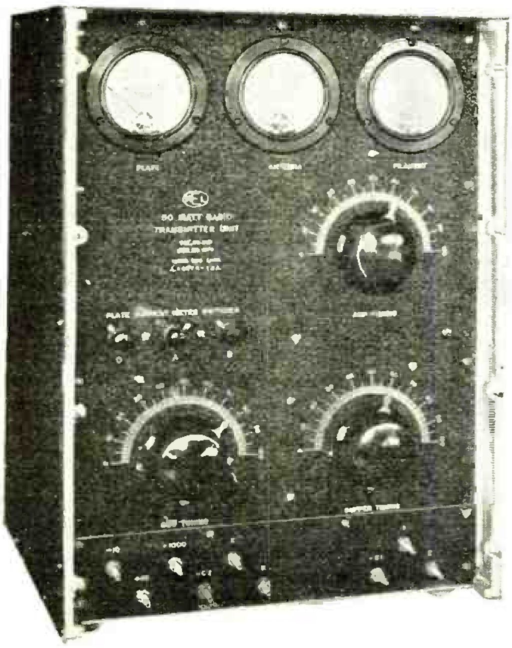


Two views of the Short-Wave and Television Laboratory's one dial a.c. operated short-wave receiver are shown above. The receiver has two tuned circuits, one a tuned radio-frequency stage employing a –24 a.c. screen-grid tube, the other a detector stage employing a –27 heater type a.c. operated tube. Plug-in coils, of course, are employed so as to enable the operator to change from one wave-band to another. The receiver proper is chassis-constructed allowing placement of bypass condensers, resistors, etc., underneath the chassis, while only the tuning elements and tubes are located above. To the rear of the chassis, as shown, is located the power supply unit. Special precautions have been taken in the construction of this unit to reduce the hum to a minimum by the use of husky chokes and electrolytic mershon condensers

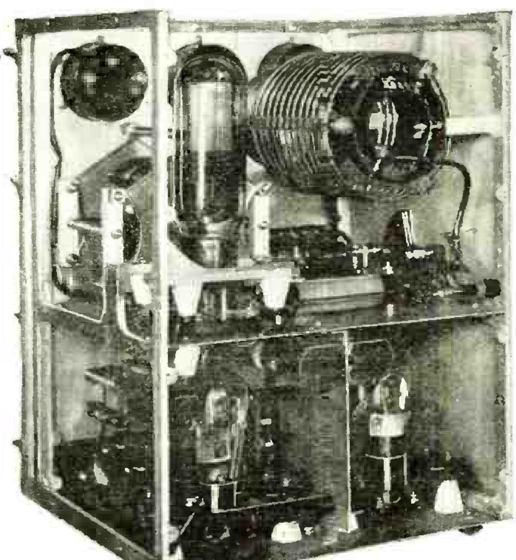
HERE are some of the short-wave transmitters and receivers, complete and in kit form, which you may use in listening to foreign stations. In America you can be a radio neighbor of Argentines, the Portuguese, the Armenians and the Greeks. Whereas, if you live abroad and are not enthusiastic about your local broadcasting, you may have the United States programs literally at your finger tips. The transmitters and receivers illustrated on these pages incorporate the very latest of design features, such as single tuning control, complete a.c. operation, portability and flexibility of wavelength range. Most of the receivers include a stage of tuned radio-frequency amplification employing the screen-grid tube.



One of the most popular short-wave receiver kits, placed on the market by Wireless Egert Engineering, Inc., is their S.W Four. This receiver, built in three sections as shown above, employs one stage of tuned radio-frequency amplification, a regenerative detector and two stages of transformer-coupled audio-frequency amplification. The radio-frequency amplifier stage utilizes a d.c. screen-grid tube thereby obtaining a high order radio-frequency amplification

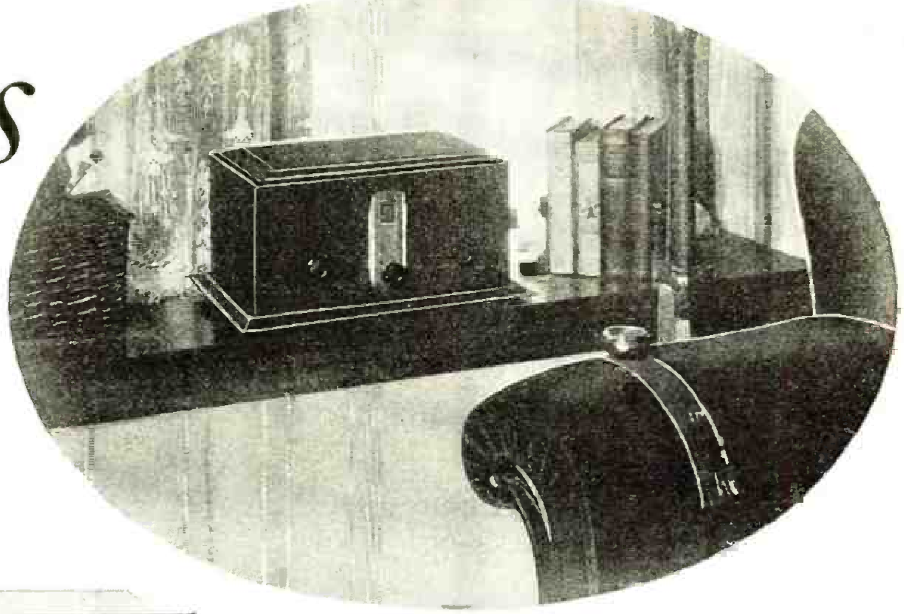


The two photographs immediately to the right and left illustrate a 50-watt short-wave transmitter unit, manufactured by the Radio Engineering Laboratories, Inc., especially designed for aircraft use. The wavelength range of this transmitter is from 45 to 95 meters. The circuit of the transmitter employs a standard master oscillator which may be either crystal-controlled or self-excited

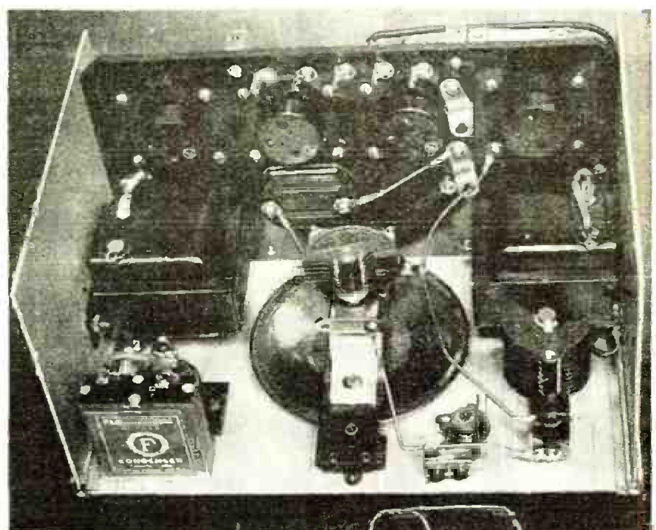


Waves

The National Company, Inc., has both an a.c. and d.c. short-wave receiver kit, known as the Thrill Box. This receiver employs an untuned stage of radio-frequency amplification utilizing a screen-grid tube and a resistance controlled regenerative detector. In addition to the two tuned stages there are two stages of transformer-coupled audio-frequency amplification



Another short-wave kit job, the Pilot A.C. Super Wasp, is also available for home assembly. Its manufacturer is the Pilot Radio and Tube Corporation. The receiver employs one tuned stage of screen-grid radio-frequency amplification, a regenerative detector and two stages of audio-frequency amplification. The two tuned stages are completely shielded, each one being housed in its own metal shield can



An inside view of the DeForest short-wave receiver is shown above. Four tubes are employed. They are: -22, -01A and two -12A tubes. The over-all dimensions of the receiver are: 8 inches long, 6 inches high and 5 inches deep

Another product of the Radio Engineering Laboratories, Inc., is their low-powered combination transmitter and receiver. A rear view of this apparatus is shown above. In the upper compartment is shown the transmitter which employs a type -10 tube in a conventional self-excited circuit. It is modulated either by another -10 or by a -50 modulator tube. Either phone or code transmission is permissible with this transmitter. The receiver of this combination, shown in the lower compartment, employs two tubes, one as the conventional detector circuit and the other as a first-stage audio-frequency amplifier

The DeForest short-wave receiver, shown above, covers a range of from 20 to 200 meters. As indicated, the coil unit plugs into a receptacle mounted on the top of the cabinet. Tuning is obtained by the single dial

Here is the outside or panel view of the Radio Engineering Laboratories, Inc., combination short-wave transmitter-receiver. Only one tuning control is required for the transmitter while for the receiver the regular tuning and regeneration controls are provided

Applying *the* Supersonic Principle to Short-Wave Reception

The First of a Series of Three Articles Dealing with the Theory of Operation, Application and Construction of a Receiver Particularly Adapted to Short-Waves, Embracing a New System of Reception, Which Has Been Used so Successfully in the Broadcast Band

By Volney Hurd*

SHORT waves are the chief topic of conversation among those who still have the spirit of adventure in radio.

Fortunately, there are enough of these short-wave enthusiasts to have made even those outside the group conscious of their existence. But unfortunately, the vehicles for this adventuring, in the form of short-wave receivers, have not kept in step with the increasing membership.

When short waves first appeared, experimenters went into a huddle and came forth with grave faces. They thought no receiver could really be designed that would be very effective for this work. They were merely being kidded by the same bogey that follows all new things.

It was soon found that the simple three-circuit regenerative tuner used in broadcast work would do very nicely for short waves. To be true, the handling of such a receiver requires that one be a radio gymnast. This being achieved, the designers looked back into their broadcast notes, saw the Browning-Drake circuit and tried it on short waves. It, too, worked, and the most successful short-wave receivers up to this time have been those built on that basis, a stage of tuned r.f. feeding into a regenerative detector.

If the operator thought that the old regenerative set was tricky to handle in the early broadcast days, he should try some of the new short-wave jobs. To be sure, for receiving code they are fine, but when it comes to getting voice and music, that is another question. We all know what excessive regeneration will do to quality. Well, it does just the same thing at short waves, and the unfortunate thing about these short-wave receivers is that to get good results usually demands excessive regeneration. Add to this sharp tuning, too sharp for comfort, and you have some idea of the usual short-wave reception problems.

A long time ago the writer decided that something better than these existing arrangements would have to be developed before he would enthuse over short-wave work. At the time he had worked out a satisfactory broadcast receiver known as the Supersonic. This receiver gave good tone quality, high amplification and selectivity with relatively few parts. It was a very simple unit, based on the idea that amplification could be obtained at the broadcast frequencies which was quite high and that by using a slightly different incoming wave to that sent through the amplifier, good selectivity could be obtained without sacrificing tone quality.

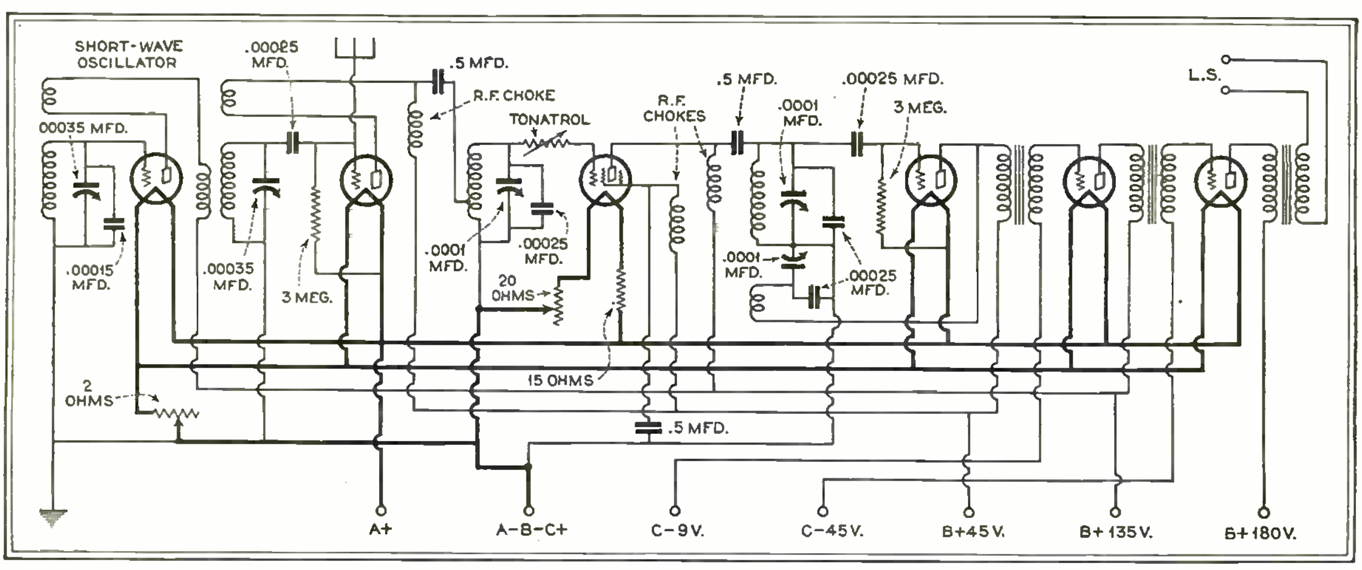
A similar idea is used in the superheterodyne, but this changes the incoming wave to a long wave usually in the neighborhood of 5,000 meters. This usually means a noisy amplifier, a bad cutting of sidebands, thereby spoiling quality and, while it promises high gain, most of the superhets fail to give it and they have always been temperamental creatures. Two-spot oscillator dial tuning was also one of their common faults.

In the Supersonic we got one-spot tuning. Our amplifier was as quiet and capable of as good tone as a good r.f. amplifier and the cost was low. The set consisted of a regenerative first detector, an oscillator, one r.f. stage and a second regenerative detector followed by the usual audio channel.

The widespread success of this set showed that amplification as frequencies in the broadcast band preceded by frequency changing tuning was a very workable idea. The name "Supersonic" was applied to it.

When the short-wave problem presented itself, thought went back to the Supersonic. It was thought that a short-wave receiver based on the same idea would be most effective. In fact, the idea offered many advantages. (*Cont'd on page* 1157)

*Radio Editor, *Christian Science Monitor.*



This fundamental circuit will provide the reader with some idea of the arrangement of the oscillator and two detectors, of the Supersonic system of reception. In a following issue the final circuit with constants will be given

Is Direct-Coupled Amplification a *New Audio System?*

Early Forms of Direct-Coupled Circuits, Dating Back to 1914, Were Unworkable and Impracticable. It Remained for Loftin and White to Produce the First Successful A.C. Operated Direct-Coupled Amplifier System

By George E. Fleming*

VERY few, if any, outstanding inventions have their original inceptions in the mind of the accredited inventor. Take, for instance, the incandescent lamp. Mr. Edison receives credit for this invention, as well he should. However, this does not mean that Mr. Edison was the first one to think of such a source of light. As a matter of fact such a system was conceived twenty years before Mr. Edison's successful experiments. As others had tried and failed before, all the more credit is due to this scientist for his work. He succeeded where others failed.

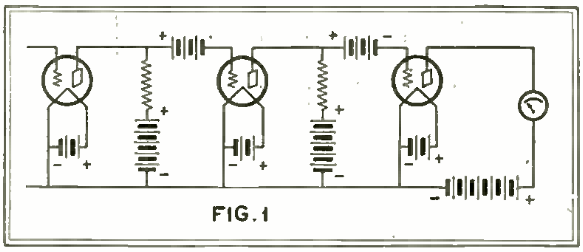


Fig. 1—A direct-coupled amplifier circuit which harks back to the days of 1914! Mr. Fleming points out that, although patented, the system was unworkable, practically, due to an uncontrolled biasing and a "drift effect" which made the circuit quite unstable

Similarly, the Direct-Coupled Amplifier has its "past." Com. Loftin and Mr. White have succeeded in taking a circuit that has been a stumblingblock to a good many inventors and made the system "perk." It is entirely proper that the credit for such success should go to them, and in view of the interest that the circuit has created in the field of audio amplification it is felt that a review of the "prior art" will assist us to appreciate their work.

It would be impossible to fully cover all the ways and means that have been tried, but to get at all a complete picture we must take into account the patents of Arnold and of Dr. Pierce. Let us refer to Figures 1 and 2. These were taken from the Arnold patent, application for which was filed March 28, 1914. We see in the first instance, a multi-stage direct-coupled amplifier, using a separate set of batteries in the plate circuit and in the grid circuit of each stage. Disregarding the negligible resistance of the C batteries in the grid circuits, we have a system where the plate of one tube is conductively coupled to the grid of the succeeding tube. This, of course, constitutes direct coupling. Such a system was impossible to work for reasons that will be explained later, but assuming that it would work, it would require a good-sized room to contain all the batteries necessary to operate it. Figure 2 is practically the same, except that in this instance a common set of batteries is used to furnish a potential to the plates of the first two tubes, with a separate set for the last stage.

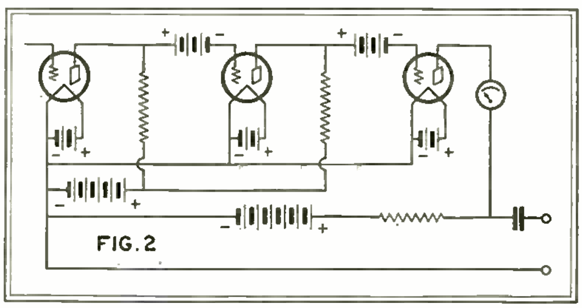


Fig. 2—A circuit very similar to that shown in Fig. 1, except that a common set of B batteries is used to furnish the plate potential to the first two tubes with a separate B block for the last audio stage

Now let us see why such a system is unworkable. It is seen that a common resistance is used in the plate circuit of one tube and in the grid circuit of the succeeding tube. In such a case the entire plate potential, less the drop in the resistance, would be applied to the grid of the next tube, unless the bucking battery were used in the grid circuit. This battery would of necessity have voltage enough to cancel the plate battery voltage, plus whatever grid bias was required. This would all be very well were it not for the fact that in such a circuit the drop across the resistance that is common to both these circuits is not constant. When a signal is applied to the grid of the first tube, its plate current rises, and consequently the drop across the resistance is greater. This upsets the bias on the grid of the next tube, usually sufficiently to throw the second tube off its operating curve. Should the signal get past the second tube, the effect would be even greater in the next stage. Also, in a system of this nature, there was a "drift effect." That is to say, that if for any reason the current through any tube should change, there was no provision made to restore the state of equilibrium. Consequently, after it had been in operation for a moment or so, the various circuits would drift until the entire system was blocked and no signal could find its way through.

Figure 3 shows an interesting departure. It is taken from the patent No. 1,112,655 issued to Dr. Pierce October 6, 1914. This circuit is interesting because it does not show any connection, by resistance or otherwise, back to the low, or ground side of the circuit. Such a return, of course, is a necessity, and the only explanation of its lack lies in the fact that tubes of that vintage were sufficiently gassy to permit a return to ground through their gas content. Whether or not Dr. Pierce was aware of this, of course, the writer has no way of knowing. At least no mention of the phenomena was made in the patent application. Such a system was subject to exactly the same drawbacks. Neither system could possibly work satisfactorily as an amplifier.

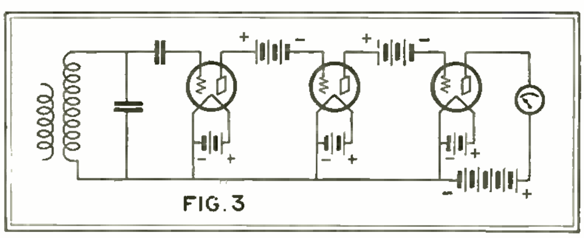


Fig. 3—A direct-coupled circuit patented by Dr. Pierce in October, 1914. It is interesting to note that no connection, resistance or otherwise, is made from the plate battery grid current back to the grounded or low potential side of the circuit. Mr. Fleming points out that this circuit had the same drawbacks as those in Figs. 1 and 2

*Engineer, Loftin-White Laboratories.

Little or no progress towards a successful solution had been made for several years. Some patents were issued showing various usages for the amplifier, assuming that it would work. The Bureau of Standards, it is understood, used such an amplifier, and in a measure overcame its defects by making the grid bias of the first tube manually variable. This accomplished its purpose just so long as an operator stood by and adjusted the controls to meet varying conditions.

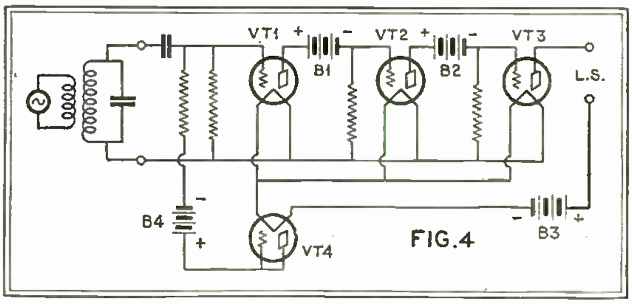


Fig. 4—A circuit diagram of the first workable form of direct-coupled amplifier described in the proceedings of the Institute of Radio Engineers for February, 1928

So such was the state of the art when Messrs. Loftin and White undertook the problem. They, of course, realized that if some means could be evolved whereby the grid bias of the first tube was automatically altered to meet varying conditions, the amplifier could be stabilized. There was no question about the need for an audio system that was capable of the excellent results as regards frequency characteristics, so the problem was attacked from this angle.

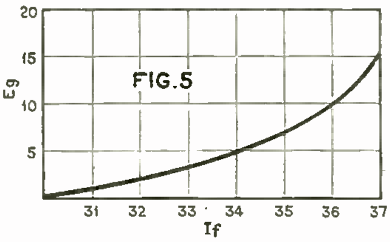


Fig. 5—In the circuit of Fig. 4 it will be noticed that a -99 type tube, Vt4, is used to vary the bias of the first tube of the amplifier system. As shown in the curve above, change in the filament current, If, which varies in accordance with changes of current of the plate circuit of the tube, Vt3, causes a varying change in grid bias, Eg, sufficient to compensate for any tendency which strong received carrier current may have to make the tubes roam away from their operation points

After a year or more of tedious research, the first workable form of Direct Coupling was announced. (See Proceedings of The Institute of Radio Engineers for February, 1928.) Figure 4 is an exact reprint of the diagram released at that time. It will be noticed that a 199 tube is utilized to vary the bias of the first tube. Let us quote from the authors of the paper. "Vt4 is the commercial type 199 so connected that its filament current is the total plate current drain of the radio frequency and power tubes of a receiver, which current usually totals from 30 to 35 milliamperes. Anything tending to make the plate current of the last tube rise will allow this filament to warm up to the electron emitting temperature to make the filament-plate conductive, resulting in placing the potential of B3 on the grid Vt1. This filament to plate resistance of Vt4 is continuously variable from infinity to a comparatively small value with a change in filament current of very few milliamperes and consequently will place just enough negative bias on the grid of Vt1 to compensate for the strong carrier currents that may be encountered in receive nearby or local stations." A glance at the curve, Figure 5, will make this clear. With 34 milliamperes through the filament of Vt4 the bias of Vt1 will be 5 volts. With 37 milliamperes the bias will be 15 volts. So we see that any force tending to make the tubes leave their operating curves will be immediately corrected by a counter force.

Here we have for the first time a direct-coupled amplifier that is actually practical. However, the inventors were not content to rest at this point. Electric receivers had made their appearance on the market and it was realized that to find definite usage the system must be adapted for use on commercially available electric current. To get any appreciable gain, high mu tubes were necessary or the number of stages used must be high. No high mu AC tubes were available so their attention was turned in this direction. A great deal of research was required in this connection, for with high mu tubes the slightest ripple current from the filament was amplified tremendously. Some very interesting tubes were evolved using as low as one-fourth of a volt on the filament with currents in the order of several amperes. The thermal inertia of such filaments was great enough to permit high mus without abnormal hum. Indirectly heated cathode tubes were also designed that operated satisfactorily. Just as this problem had been solved, however, the AC screen grid tube made its appearance on the market. Here was a tube that was ideally suited to the purpose, and it was immediately adopted.

The system of compensation described, it was decided, was unsuitable for practice simply because even a 199 tube costs money and adds another tube to the system that contributes nothing to the amplifying qualities. So research was again directed toward simpler forms of compensation. It would be impossible here to lead the reader through all the complex experiments that were conducted. Several entirely satisfactory methods were evolved, one of which is shown in Figure 6. We see here a simple incandescent lamp used as the stabilizing means. An ordinary lamp filament varies its resistance in proportion to the current flowing through it. A lamp thus used varied the C bias on the first tube directly in proportion to the current flowing through the lamp. If the power tube showed any inclination to vary its plate current such changes were immediately reflected in the grid bias of the first tube and immediately corrected. A point was chosen where the thermal lag of the lamp was such that no correction took place unless an effect arose lasting an appreciable length of time, so even the lowest audio frequencies were not affected by this system. This worked out in an entirely satisfactory manner and has only the minor objection of requiring a small lamp bulb in the system.

Various bridge systems were tried with good success and experiments in this line led to the use of the cathode resistor method finally decided upon as most satisfactory for all around usage.

Figure 7 is a complete diagram of the present day amplifier. This diagram is doubtless familiar to us all through its publication in RADIO NEWS. The resistor, designated "Rk," is used in the cathode circuit of the first tube as a bias resistor. Any tube will have a tendency to increase its plate current when a signal is introduced on the grid. As the plate current flows through the resistor "Rk" the drop across this (*Continued on page* 1157)

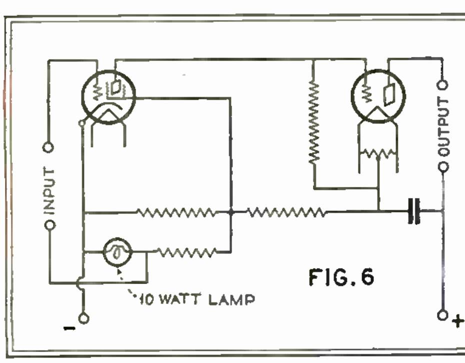


Fig. 6—Because a -99 costs money, some less expensive methods of compensation than shown in Figs. 5 and 6 were tried. One satisfactory method employed an ordinary incandescent lamp used as the stabilizer

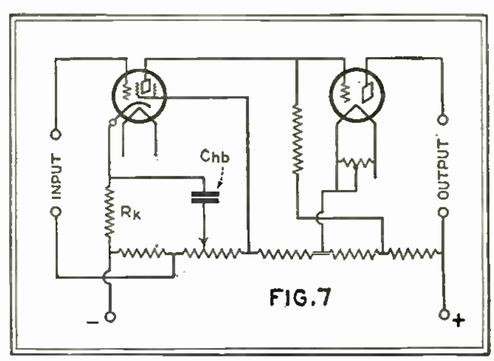
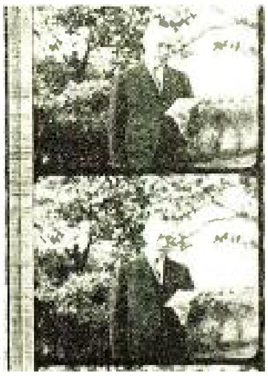


Fig. 7—The complete circuit diagram of a present-day Loftin-White amplifier. Rk is the biasing resistor and Chb the hum balancing condenser. Circuit constants for several types of Loftin-White amplifiers have appeared in past issues of RADIO NEWS, beginning in the January, 1930, number

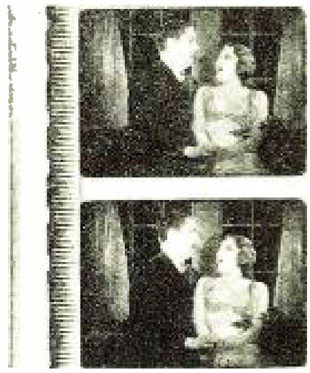
Radio's Husky Offspring—The Talking Movies

While Not at All a New Discovery, Talking Pictures Were Not Successful Commercially Until Adequate Sound-Amplifying Systems and Suitable Synchronizing Methods, as Developed in the Radio Field, Were Utilized

By Fred A. Jewell*

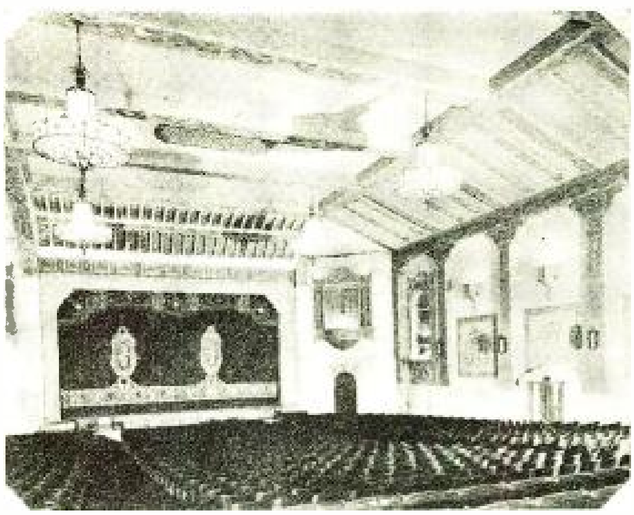


Fox Movietone variable density sound-on-film



RCA Photophone variable area sound-on-film

In the United States there are 22,624 motion picture theatres, of which 6,929 were wired for sound up to December 15, 1929. Between 50,000 and 60.000 projectionists were employed before the addition of sound. Double that number will be required when all the theatres are wired.



BECAUSE of the fact that the motion picture industry has been forced to apply the fundamental principles of audio-frequency amplification to a solution of its particular problems, a new field of service opens up to radio-trained men who are skillful in the ways of sound amplification.

To keep pace with the demand for good talkies has not been the simplest of jobs. Well-meaning radio men who have migrated to this new work have felt keenly the need for authoritative information on the subject.

The acoustical properties of theatres (the photo above illustrates a theatre interior treated to obtain suitable sound-absorbing conditions), the particular vagaries of different systems of sound-with-film and synchronization difficulties are all allied subjects which call for an authentic, well-prepared compilation of data. Mr. Jewell is qualified to present this information. In his first article he merely gives the historical background of this new art. Future articles of the series will deal in detail with the various sound systems now in use.

JUST about a decade ago people were asking one another, "What is this radio music everyone is talking about?" Today these same people are taking as a matter of course one of radio's offsprings—the talking motion pictures.

When the "talkies" were first introduced by Warner Brothers on Broadway in 1926 John Barrymore playing in *Don Juan* was as different from his latest talkie, *General Crack*, as your old blooper of the vintage of '21 was from the screen-grid set you finished building last week. True, the voices and music were in synchronism —sometimes—but the reproduction! *There* was something to be wondered at—and apparently avoided wherever possible.

But times change and much water has flowed under the "Bridge of Sighs" (the directors' —sic!) since the days of *Don Juan*. Yesterday is just history in the eyes of the hard-working "sound man" and directors. Today they learn something brand new and tomorrow they will try this new one on the public. However, even though the talking motion picture has been with us for a comparatively short space of time, people all over the world like them better than the "silents."

Proof? Just watch the crowds that go to see and hear them. Know any other good reason? We don't.

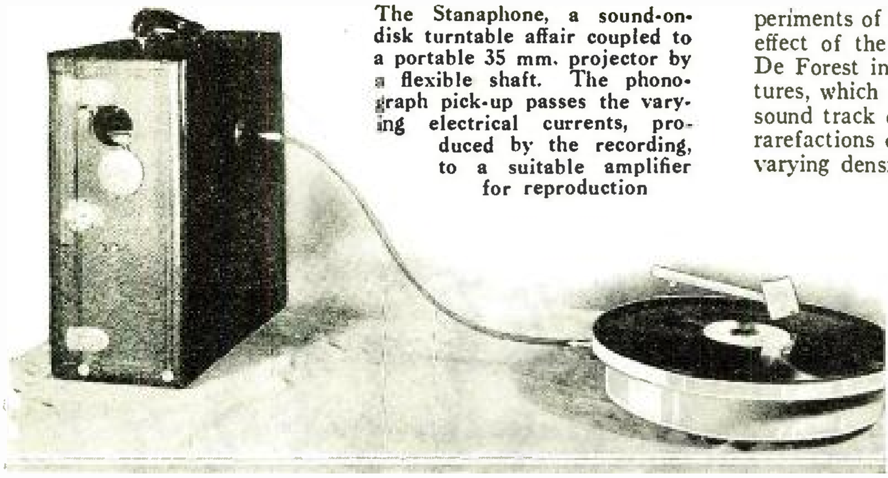
Historical Background

The first important commercial step in the sound field was the attempt made by Thomas A. Edison over twenty-five years ago. At that time the "flickers," which was what the public had dubbed Edison's pictures, were bad enough, but when sound was added, coming from a tinny phonograph placed behind the screen and out of step with the picture most of the time, the public would have none of it, except as a novelty.

Edison's major problems were: first, that of maintaining a constant speed. You all know how a phonograph sounds when it starts to run down. It is absolutely necessary in the reproduction of sound to maintain a speed that is as nearly constant as possible. Twenty years ago the projectors were driven by a crank manually operated by the projectionist, and it was practically impossible to turn a crank with any degree of constant speed.

The second problem was that of synchronizing the projectors with the phonograph. As the phonographs had to be located behind the screen and the picture projector in the booth, the distance between them presented a problem in mechanics that was never successfully overcome. It was realized that the only successful method for synchronization was to have the driving mechanism for both the projector and the record, on which is recorded the sound, in the booth. Then, of course, the problem of getting the sound back of the screen so that both sound and picture

*General Manager, Projectionist Sound Institute.



The Stanaphone, a sound-on-disk turntable affair coupled to a portable 35 mm. projector by a flexible shaft. The phonograph pick-up passes the varying electrical currents, produced by the recording, to a suitable amplifier for reproduction

would come from one point. arose and had to be considered.

The third obstacle was to get faithful reproduction of the speech and music recorded out to the audience. It is entirely unnecessary to hold forth here on the type and quality of music and speech that was recorded a few years ago. You all know it was very, very poor.

Even though Edison was far from successful in his first attempts at synchronizing sound and motion pictures, in 1883 he discovered what was the forerunner of the vacuum-tube amplifier. and without this marvelous device sound pictures, such as we know them today. would be impossible.

In 1904 the English physicist, J. A. Flemming. found that a vacuum tube of two elements could be used for the rectification of high-frequency currents, and a little later Dr. Lee De Forest. by introducing the grid between the filament and plate of Flemming's "valve." brought the "heart of the amplifier" to a state of perfection. The work that laboratory experimenters have done in connection with radio in the field of audio-frequency amplification has made possible the talking motion picture as we know it today. Electricity has been applied to the recording and reproduction of "canned" music, and in the booth of the sound-equipped theater the radio experimenter will find apparatus with which he is quite familiar.

How Electricity Aided

It is due entirely to the application of electricity that the problems of early days have been overcome. In those systems employing the phonograph record it is now possible by the use of a synchronous motor to maintain a speed of the turntable that is constant for all practical purposes. The speed of the turntable can be so adjusted that it will run in perfect synchronism with the film. Of course. the synchronous motor, in driving the mechanism of the projector so that the film travels through at the rate of ninety feet per minute. is turning entirely too fast for the turntable. which rotates at a speed of 33 1/3 revolutions per minute. This is equalized by a very intricate set of reduction gears and an ingenious mechanical governor for maintaining constant speed.

The second method of reproducing sound in synchronism with film had as a forerunner the experiments of Alexander Graham Bell on the photoelectric effect of the selenium cell back in 1880. In 1923 Dr. De Forest introduced his system of talking motion pictures, which he called "Phonofilm." This system used a sound track on the film on which the condensations and rarefactions of the sound waves were photographed with varying density and constant width. However, Dr. De Forest was handicapped by the inadequate methods of amplification.

In August, 1926, the Warner Brothers introduced the "Vitaphone" system of synchronized sound-on-disk and film, and the film mentioned in the first part of this article can be said to be the first really successful showing of synchronized sound and motion pictures. In 1927 Fox-Case introduced the "Movietone." This is also the same type of recording as that developed by Dr. De Forest. RCA Photophone is also a sound-on-film system but different from Dr. De Forest's method, in that the sound recorded on the track has a constant density and varying width.

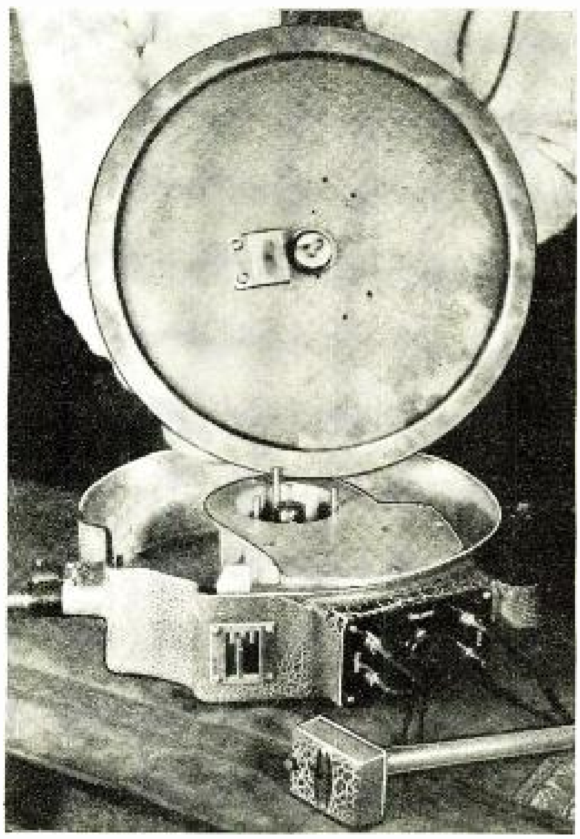
The majority of the installations in the theatres today are equipped to reproduce both of the two methods, *i.e.,* sound-on-film or sound-on-disk. Generally there are two complete projectors in a booth and while one is being run on sound-on-film. for instance, the other can be prepared to follow immediately with the other system. The photoelectric-cell system is incorporated in a housing located immediately under the lenses focusing the picture on the screen. The turntable. with its electrical pick-up, is located on the other side of the projector.

Old Man Acoustics Steps In

These problems, which we have mentioned above and that were overcome by laboratory workers. in turn made new problems for the exhibitors. Theatres that were built especally for the showing of moving pictures were found to be almost totally unfit for the exhibiting of motion pictures with sound. The acoustical properties of moving-picture theatres had not been considered at all when they were built and the result was that in some of them patrons in different parts of these houses could not hear what was being sent to them from the loud speakers. In some cases it was just that in so many words—they could not hear; in other cases reverberation and echoes mutilated the waves to such an extent that the sound which resulted was totally unrecognizable.

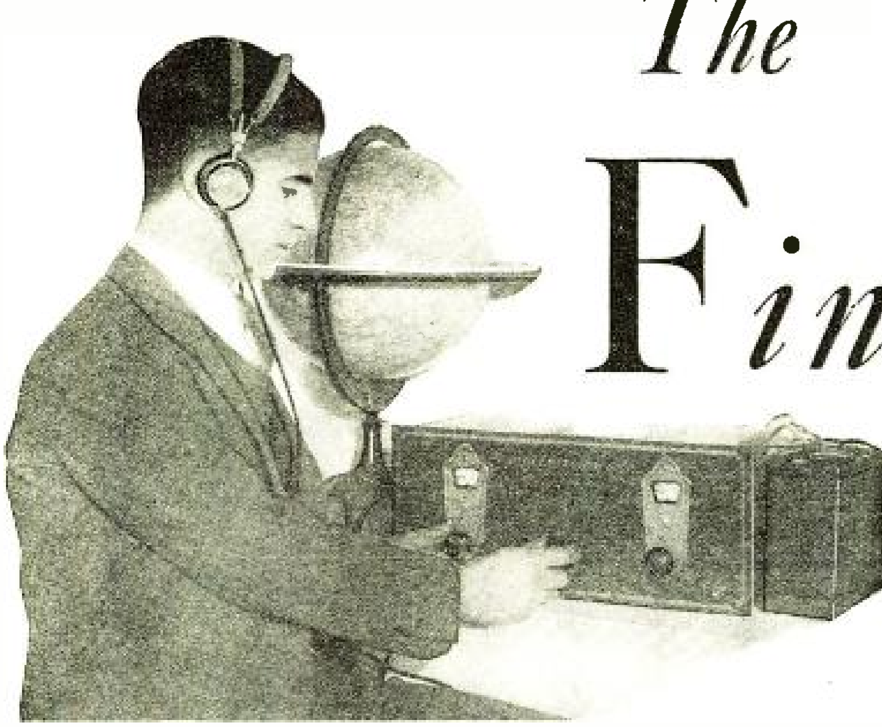
Acoustical engineers then came to the fore and by skilful application of different materials to the walls and ceilings of the theatres reduced these troubles to a minimum. and in the theatres that are now being built as much consideration is being given to the acoustical end as was formerly given to the visual.

The following articles of this series will cover the different methods of sound projection and the various ways of eliminating acoustical troubles in theatres. As we said before. the science of sound projection is changing daily: what we set forth as being the latest today may be. perhaps. discarded tomorrow. but the fundamental principles involved (*Continued on page* 1155)



For home talkies. This turntable is provided with a flexible shaft which is connected directly to the driving shaft of the projector, thus obtaining synchronism. A volume control and terminals for amplifier and pick-up are provided

The author at the dials of his AC Super Wasp receiver



The World at Your Fingertips with a Short-Wave Receiver

By Robert Hertzberg

THERE'S a little more to bringing in those elusive foreign short-wave broadcasters than merely sitting down to your receiver, flipping the filament switch and carelessly twiddling the dials. Yet, many a broadcast listener has been led to believe that it's just as easy as listening to a local program. Not only must the operator of a short-wave receiver exercise greater care in tuning in to a distant station, but he must use his judgment as to when to listen. All the tuning on earth won't bring in a station if it doesn't happen to be on the air. Matters become more complicated in this respect because of the difference of time between the location of the receiver and the transmitter. There's no doubt about it, a fellow's got to use his head when tuning in on the short waves.

To aid you in getting the most from your short-wave receiver, Mr. Hertzberg, who speaks with an authority born of long experience, tells you how to tune and when to tune your receiver. The list of short-wave broadcasters on the following pages is the most authoritative and latest which it has been possible to compile.

ALTHOUGH the reception of foreign short-wave broadcasting stations is no longer an unusual experience for thousands of radio fans, there are still many owners of short-wave receivers who have never heard anything outside of the United States or Canada. Their disappointing failures can be explained usually by either or both of two reasons: they do not exercise enough patience in tuning their sets, or they do not know when and where to listen.

From his contacts with several thousand purchasers of a popular short-wave receiver kit, the writer would say that nontechnical people have been somewhat oversold on the idea that foreign reception is merely a matter of flipping a switch. It isn't at all. Troublesome hand-capacity effects have been pretty well eliminated, but you still have to hang a bit tensely over the dials and wait for the signals to fade in to an understandable level. The advent of short-wave broadcasting (as distinctly distinguished from "ham" radio telegraphy) has revived the fine art of dial twisting, and unless the set owner masters it he will never know the thrill of hearing VK2ME in Sydney, or RA97 in Siberia, or that German jawbreaker at Koenigswusterhausen.

The Fine Art of Tuning

The most important dial or knob is the one that controls the regenerative action of the detector. This is true for all types and makes of short-wave receivers, as they all use a regenerative detector, with and without tuned or untuned r.f. amplification and with one, two or three stages of variously coupled a.f. amplification. Regardless of how good the rest of the receiver is, a crank regeneration control will prevent you from hearing anything other than possibly W8XK, W2XAF and W2XE.

Smooth regeneration is not so difficult to obtain. First of all, do not expect to leave the detector plate voltage fixed for a wide range of wavelengths. Provide the detector "B" plus lead with a 100,000 ohm potentiometer, and adjust it so that with any one plug-in coil (or pair of coils, in a tuned r.f. outfit), and with the tuning condenser all the way in, the set just slides into oscillation when the plates of the regeneration condenser are completely meshed.

If a marked reduction in plate voltage still leaves the control of regeneration very short and abrupt, there are too many turns on the tickler, or the particular detector tube is simply rotten. The grid leak isn't at all as critical as some writers would have you think; 3 megohms with a .0001 mfd. condenser is just about right for most –01A's, –00A's, and –27's.

The actual tuning process, once you have tamed down the regeneration, is quite simple. Simply keep the detector in a continual state of oscillation by rocking the regeneration dial back and forth as you turn the tuning dial a fraction of a degree at a time. When you encounter a carrier wave you will hear a tell-tale whistle. If the signal is fairly strong, you can back down the regeneration until the whistle disappears; if the signal is rather weak, it is best to "zero-beat" it. This is the process of keeping the circuit in oscillation, but tuning it so that the frequency of the local oscillations is exactly the same as that of the incoming carrier wave. Under this condition no whistle is generated, there being no heterodyne action, and the voice or music can be distinguished. The signals will sound rather "mushy" if they are zero-beated, but at least they will be recognizable. Sometimes, after a station is brought in by the zero-beat method, its strength may increase so much that the detector can be thrown out of oscillation; the signals will then clear up considerably. (*Continued on page 1139*)

S-W Broadcasting Stations of the World

(By Wavelengths)†

Meters	Call	Location	Operating Time*
12.2	FZV	Madagascar	
13.4	FZT	Madagascar	
14.0	LSH	Buenos Aires, Argentina	
14.5	PMB	Bandoeng, Java	
14.6	DIV	Nauen, Germany	
14.83	DGW	Nauen, Germany	Daily 14.00 to 16.00
15.02	DIH	Nauen, Germany	
15.03	LSG	Buenos Aires, Argentina	Daily 14.00 to 16.00
15.1	SPU	Rio de Janeiro, Brazil	Daily 23.00 to 4.00
15.04	DIH	Nauen, Germany	Daily 18.00
15.29	DFA	Nauen, Germany	
15.4	FZV	Madagascar	
15.42	FW3	Paris, France	
15.43	ZTM	St. Assise, France	
15.43	FW3	St. Assise, France	
15.5		Nancy, France	Daily 5.00
15.55		St. Assise, France .	
15.68	PCO	Kootwijk, Holland	
15.74	PLE	Bandoeng, Java	Daily 14.00 to 17.00
15.9	XDA	Mexico City, Mexico	
15.94	PLE	Bandoeng, Java	Tues. 13.40 to 15.40
16.01	GBJ	Rugby, England	Irregular
16.11	GBU	Rugby, England	Irregular
16.12	PDM	Kootwijk, Holland	
16.3	PCK	Kootwijk, Holland	Daily 11.00
16.38	GBS	Rugby, England	Irregular
16.4	FZS	Saigon, Indo-China	Sun. 2.00
16.5	CGA	Drummondville, Canada	Irregular
16.54	GBW	Rugby, England	Irregular
16.57	GBK	Bodmin, England	Irregular
16.60	PCS	Kootwijk, Holland	
16.7	FZU	Madagascar	
16.8	PLF	Bandoeng, Java	
16.82	PCV	Kootwijk, Holland	80 K.W.
16.88	PHI	Amsterdam, Holland	Mon. 20.00 to 23.00 Wed., Thurs. and Fri. 19.00 to 23.00
16.88	PHO	Huizen, Holland	Daily except Tues. 12.00 to 14.00
16.88	PLG	Bandoeng, Java	
16.9	HS1PJ	Bangkok, Siam	Sun. 19.00 to 21.30 and 1.00 to 3.00
17.0	PLE	Bandoeng, Java	
17.20	AGC	Nauen, Germany	
17.7	PLF	Bandoeng, Java	Wed. 21.00 to 23.00
18.07	PCL	Kootwijk, Holland	
18.3	G2GN	S. S. Olympic	Irregular
18.56	GBX	Rugby, England	Irregular
18.75		Saigon, Indo-China	
19.5	F8BZ	Agen, France	
19.56	W2XAD	Schenectady, N. Y.	Sun. 21.30 to 5.15; Mon., Wed., Fri. and Sat. 0.00 to 6.00
19.6		Lyngby, Denmark	
19.63	W2XE	New York, N. Y.	Construction permit granted 20.000 watts.
20.0	LSJ	Monte Grande, Argentina	
20.3	FZU	Madagascar	
20.7	VPD	Suva, Fiji Islands	
21.96	W2XO	Schenectady, N. Y.	Mon., Tues. 20.00 to 22.00
23.35	W6XN	Oakland, Calif.	KGO programs, Tues., Wed., Fri.
24.4	FW4	St. Assise, France	Daily 18.00 to 20.00
24.4	FZT	Madagascar	
24.4	KITR	Manila, P. I.	
24.9	NAA	Arlington, Va.	Time signals, daily
25.0		Oporto, Portugal	Daily 20.00 to 21.00 to 4.00 and 6.00 to 9.00
25.34	W2XE	New York, N. Y.	Construction permit granted for 20,000 watts
25.4	W8XK	East Pittsburgh, Pa	KDKA programs daily
25.5	CJRX	Winnipeg, Man.	Weekdays 5.30 to 8.30 Tues. 5.30 to 10.30 Thurs. 5.30 to 11.00 Sat. 5.30 to 12.00 Sun. 23.30 to 1.00
25.53	G5SW	Chelmsford, Eng.	Mon., Tues., Wed., Thurs. and Fri. 13.30 to 14.30 and 20.00 to 1.00

*Only in those instances where reliable information was available has operating time been specified. Time is given in Greenwich Mean Time, or from 0.01 (12.01 P. M.) to 24.00 (12. noon). For example: 13.30 is 1:30 A. M.

†If present arrangements are successfully concluded, after 8 P. M. (E. S. T.) each night all Columbia Broadcasting Company programs are to be re-broadcast by short waves over the De Forest short-wave station W2XCD, on 187.3 meters.

Meters	Call	Location	Operating Time
25.65	KIO	M. Kaukuko, Oahu, Hawaii	
26.2	KIXR	Manila, P. I.	
26.22	DHC	Nauen, Germany	Thurs., Fri., Sat. and Sun. 2.00
26.22	PHA	Nauen, Germany	
28.5	VK2FC	Sydney, Australia	
28.5	VK2ME	Sydney, Australia	Daily 18.00
28.69	DGH	Nauen, Germany	Daily 5.00 to 6.00
28.8	PLR	Bandoeng, Java	
29.5	ARI	Hong Kong, China	
29.7	EAR110	Madrid, Spain	
30.	LGN	Bergen	Irregular
30.5	FZT	Madagascar	
30.6	GBW	Rugby, England	Daily 7.00 to 12.00
30.7	EAM	Madrid, Spain	Wed. at 8.00
30.8	NRH	Costa Rica, Cent. America	Daily 7.00 to 9.00
30.9	LS	Monte Grande, Argentina	
30.9	DFF	Nauen, Germany	Mon., Wed. and Fri. 7.00 to 9.00
31.0	SAD	Stockholm, Sweden	Sat. 5 P.M.
31.1	7LO	Nairobi, Br. East Africa	Daily 0.01 to 2.00
31.19	HJQ	Oslo, Norway	Thurs. 11.00 to 12.00
31.2	FW3	Paris, France	
31.28	VK2FC	Sydney, Australia	Wed. 18.00
31.28-	W3XAU	Philadelphia, Pa.	Daily WCAU programs
31.3	BZW	Zuzin, Germany	
31.3	VPD	Suva, Fiji Islands	
31.3		Manila, P. I.	Daily 21.00
31.38		Konigswusterhaussen, Ger.	
31.38		Zeezen, Germany	
31.4	PCJ	Eindhoven, Holland	Tues. 19.00 to 21.00; Fri. 0.01 to 4.00 and 19.00 to 21.00; Sat. 1.00 to 7.00
31.4	7LO	Nairobi, Br. East Africa	Daily 18.30 to 21.30
31.48	W2XAF	Schenectady, N. Y.	Mon., Tues., Thurs., Sat. 0.01 to 6.00
31.5	FL	Paris, (Eiffel), France	Daily 11.30 to 11.45, 18.30 and 22.15 to 22.45
31.5	3LO	Melbourne, Australia	
31.56	VK3ME	Melbourne, Australia	Daily 17.00 to 18.00
31.6	EH9XD	Zurich, Switzerland	
31.6	OXQ	Lyngby, Denmark	Daily 2.00 to 6.00
31.65		Paris (Experimental)	Daily 5.00 to 6.00
31.8		Posen	Mon. and Sat. 13.00 to 20.00
31.8	XDA	Mexico City, Mexico	
31.88		Konigswusterhausen, Ger.	Daily 18.00 to 19.00, 23.30 to 2.30, 3.00 to 10.00
31.9	CM2MK	Havana, Cuba	Daily 6.00
32.0	CJA	Drummondville, Canada	
32.0	EH9XD	Zurich, Switzerland	Daily 4.00 to 6.30
32.0	PHI	Amsterdam, Holland	
32.0	9OC	Bern	Daily 21.00 to 23.30
32.05	2PL	Sydney, Australia	
32.8	SUS	Cairo, Egypt	Irregular, heard in New York at 9 P.M.
33.0		Paris (Radio Vitus), France	Daily 3.30
33.17	CFH	Halifax, Canada	Daily 9.00
33.64	LPI	Monte Grande, Argentina	Mon. and Thurs. 6.00 to 9.00
33.8	NAZ	Managua, Nicaragua	Mon., Tues., Thurs. 5.00 to 6.00
34.64	W8XAG	Dayton, Ohio	
34.69	W2XV	Long Island City, N. Y.	Irregular
34.8	FZV	Madagascar	
34.86	KWT	Palo Alto, Calif.	Daily 6.00
35.0	HKCJ	Manizales, Colombia	
35.0	RA97	Khaborovsk, Siberia, USSR	Daily 3.00
35.0	VER	Ottawa, Canada	Tues., Wed., Thurs. 8.00 to 10.00
35.5	WSBN	S. S. Leviathan	
36.0	G2AA	Rugby, England	
36.0	3KAA	Leningrad, Russia, USSR	
37.0	EATH	Wien	Mon. and Tues. 21.30 to 23.00
37.0		Paris (Radio Vitus)	Sun., Mon., Fri. 21.00 to 22.00
37.0	HS4PJ	Bangkok, Siam	Tues. 20.00 to 22.00, 1.00 to 3.00; Fri. 20.00 to 22.00
37.0	W6XF	Los Angeles, Calif.	Fri. 10.30 to 12.30
37.36	NAA	Arlington, Va.	
38.0	F8BZ	Agen, France	Daily 20.30 to 23.00
38.98	IDX	Rome, Italy	Sundays 4.00
39.1	FZT	Madagascar	

Meters	Call	Location	Operating Time
40.2	YR	Lyon, France	Daily 16.30 to 17.30 and 19.00 to 20.00
40.5		Eberswalde	Mon. and Tues. 19.00 to 20.00
41.0	CGL	Winnipeg, Canada	Daily 7.00 to 9.00
41.45	DOA	Doberitz, Germany	Daily 7.00 to 15.00
41.5	HB9D	Zurich	Every 1st and 3rd Mon. and Sat. 20.00
41.7	VK6AG	Perth, Australia	Sun. 12.30 to 17.00
43.0	EAK	Madrid, Spain	Tues. and Sat. 21.30 to 24.00
43.5		Rome, Italy	Sunday 18.00 to 20.30
43.6	ANH	Kothen	Sun. 10.00 to 12.00; Thurs. 22.00 to 24.00; Tues. 18.00 to 20.00; Fri. 18.00 to 20.00
43.86	VRY	Georgetown, British Guinea	Sun. and Wed. 7.15 to 9.00
47.5	VE9AP	Drummondville, Canada	Daily 8.00 to 10.00
48.00	HKC	Bogata, Columbia	Daily 10.00 to 12.00
48.00		Manila, P. I.	Daily 21.00
48.3	LON	Buenos Aires, Argentina	Wed., Thurs. and Fri. 9.30 to 11.00
48.5	HKT	Bogota, Colombia, S. Amer.	Daily 8.00 to 12.00
49.00		Eiffel Tower, France	Daily 19.30 to 19.45 2.15 to 7.45
49.0	ARI	Hong Kong, China	
49.02	W2XE	New York, N. Y.	Daily WABC programs
49.18	W3XAL	New York, N. Y.	Irregular, WJZ programs
49.36	W9XAA	Chicago, Illinois	
49.4	UOR2	Vienna, Austria	Daily 11.00 to 20.00
49.46		Motola, Sweden	
49.5	W3XAU	Philadelphia, Pa.	Daily WCAU programs
49.5	W8XAL	Cincinnati, Ohio	Daily WLW programs

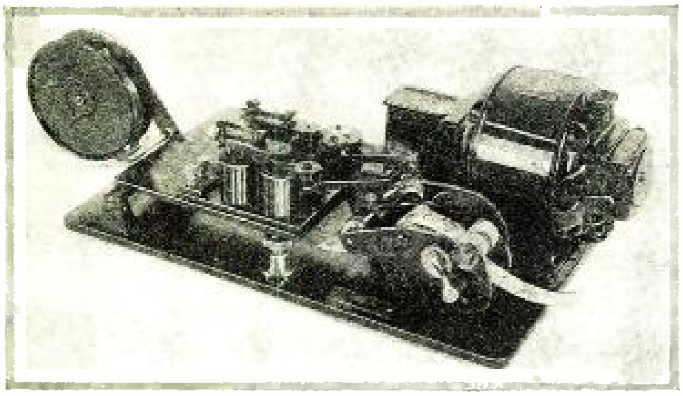
Meters	Call	Location	Operating Time
49.83	W9XF	Chicago, Illinois	Daily WENR programs
49.9	W2XAL	New York, N. Y.	Daily WRNY programs
49.9		Motala, Sweden	Daily 1.00
49.95	HRB	Tegucigalpa, Honduras	Mon., Wed. and Fri. 9.00 to 12.00
50.0	GAJ	Karlsborg	Irregular
50.0	RFN	Moscow, Russia, USSR	Tues., Thurs., Sat. 19.00 to 22.00
50.0	WHP	Harrisburg, Pa.	Daily 7.00 to 12.00
50.0	ZL3CZ	Christchurch, N. Z.	Wed., Fri. and Sat. early evening hours
52.5	VE9CL	Winnipeg, Can.	Construction permit for 1,000 watts.
55.0		Rugles, France	Daily 21.30 and 5.00 to 8.00
58.0		Prag	Tues., Fri. 20.30 to 22.30; Thurs. and Fri. 19.00 to 21.00
59.5	FZU	Madagascar	
62.5	W8XK	East Pittsburgh, Pa.	KDKA programs
67.76	DOA	Doberitz, Germany	Mon., Tues., Fri., time schedule irregular
70.0	OHK2	Vienna, Austria	Sundays at intervals from 0.01 to 7.00
70.0	RA97	Khabarovsk, Siberia, USSR	Daily 3.00
70.1	RFM	Russia, USSR	Daily during forenoon
74.72	NAA	Arlington, Va.	
82.9	DOA	Doberitz, Germany	Daily 7.00 to 15.00
84.25	D7RL	Copenhagen	Tues. and Fri. 23.00 to 1.00
98.9		Motala, Sweden	Daily 18.00
104		Mailand	Daily 20.00
107	W2XCR	Jersey City, N. J.	Weekdays 3.00 to 5.00 and 8.00 to 10.00
139.5	W2XCAW	Schenectady, N. Y.	Television
142.5	W3XK	Washington, D. C.	Weekdays 8.00 to 9.00

(Alphabetically by Call Letters)

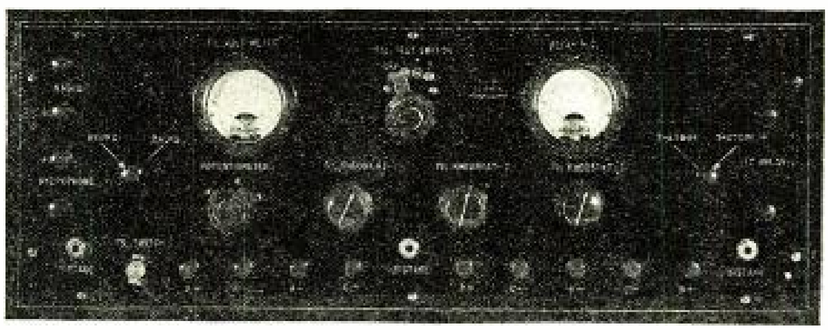
Call	Location	Wave
AGC	Nauen, Germany	17.20
ANH	Kothen	43.6
ARI	Hong Kong, China	29.5-49.0
BZW	Zuzin, Germany	31.3
CFH	Halifax, Canada	33.17
CGA	Drummondville, Can.	16.5
CGL	Winnipeg, Can.	41.0
CJA	Drummondville, Can.	32.0
CJRX	Winnipeg, Can.	25.5
CM2MK	Havana, Cuba	31.9
DFA	Nauen, Germany	15.29
DFF	Nauen, Germany	30.9
DGH	Nauen, Germany	28.69
DGW	Nauen, Germany	14.83
DHC	Nauen, Germany	20.22
DIH	Nauen, Germany	15.02–15.04
DIV	Nauen, Germany	14.6
DOA	Doberitz, Germany	41.45–67.76–82.9
D7RL	Copenhagen	84.25
EAK	Madrid, Spain	43.0
EAM	Madrid, Spain	30.70
EAR110	Madrid, Spain	29.7
EATH	Wien	37.0
EH9XD	Zurich, Switzerland	31.0–32.0
FL	Paris, (Eiffel) France	31.5
FTM	St. Assise, France	15.43
FW3	Paris, France	15.42-31.2
FW4	St. Assise, France	24.4
FZS	Saigon, Indo-China	16.4
FZT	Madagascar	13.4-24.4-30.5 39.1
FZU	Madagascar	16.7–20.3-50.5
FZV	Madagascar	12.2-15.4-34.8
F8BZ	Agen, France	19.5 38.0
GAJ	Karlsborg	50.0
GBJ	Rugby, England	16.01
GBK	Bodmin, England	16.57
GBS	Rugby, England	16.38
GBU	Rugby, England	16.11
GBW	Rugby, England	16.54-30.6
GBX	Rugby, England	18.56
G2AA	Rugby, England	36.0
G2GN	S. S. Olympic	18.3
G5SW	Chelmsford, England	25.53
HB9D	Zurich	41.5
HJQ	Oslo, Norway	31.19
HKC	Bogota, Columbia	48.00
HKCJ	Manizales, Colombia	35.0
HKT	Bogota, Colombia	48.5
HRB	Tegucigalpa, Honduras	49.95
HS1PJ	Bangkok, Siam	16.9
HS4PJ	Bangkok, Siam	37.0
IDX	Rome, Italy	38.98
KIO	M. Kaukuko, Oahu, Hawaii	25.65
KIXR	Manila, P. I.	24.4–26.2
KWT	Palo Alto, Calif.	34.86
LGN	Bergen	30.0
LON	Buenos Aires, Argentina	48.3
LPI	Monte Grande, Argentina	33.64
LS	Monte Grande, Argentina	30.9
LSG	Buenos Aires, Argentina	15.03
LSH	Buenos Aires, Argentina	14.0
LSJ	Monte Grande, Argentina	20.0
NAA	Arlington, Va.	24.9–37.36–74.72
NAZ	Managua, Nicaragua	33.8
NRH	Costa Rica, Central America	30.3
OHK2	Vienna, Austria	70.0
OXQ	Lungby, Denmark	31.6
PCJ	Eindhoven, Holland	31.4
PCK	Kootwijk, Holland	16.3
PCL	Kootwijk, Holland	18.07
PCO	Kootwijk, Holland	15.68
PCS	Kootwijk, Holland	16.6
PCV	Kootwijk, Holland	16.82
PDM	Kootwijk, Holland	16.12
PHA	Nauen, Germany	26.22
PHI	Amsterdam, Holland	16.88–32
PHO	Huizen, Holland	16.88
PLE	Bandoeng, Java	15.74–15.94–17.0
PLF	Bandoeng, Java	16.8–17.7
PLG	Bandoeng, Java	16.88
PLR	Bandoeng, Java	28.8
PMB	Bandoeng, Java	14.5
RA97	Khabarovsk, Siberia, USSR	35.0–70.0
RFM	Russia USSR	70.1
RFN	Moscow, USSR	50.0
SAD	Stockholm, Sweden	31.0
SPU	Rio de Janeiro, Brazil	15.1
SUS	Cairo, Egypt	32.8
UOR2	Vienna, Austria	49.4
VER	Ottawa, Canada	35.0
VE9AP	Drummondville, Can.	47.5
VE9CL	Winnipeg, Canada	52.5
VK2FC	Sydney, Australia	28.5–31.28
VK2ME	Sydney, Australia	28.5
VK3ME	Melbourne, Australia	31.56
VK6AG	Perth, Australia	41.7
VPD	Suva, Fiji Islands	20.7–31.3
VRY	Georgetown, British Guiana	43.86
WHP	Harrisburg, Pa.	50.0
WSBN	S. S. Leviathan	35.5
W2XAD	Schenectady, N. Y.	19.56
W2XAF	Schenectady, N. Y.	31.48
W2XAL	New York, N. Y.	49.9
W2XAW	Schenectady, N. Y.	139.5
W2XCR	Jersey City, N. J.	107.0
W2XE	New York, N. Y.	19.63–25.34–49.02
W2XO	Schenectady, N. Y.	21.96
W2XV	Long Island City, N.Y.	34.69
W3XAL	New York, N. Y.	49.18
W3XAU	Philadelphia, Pa.	31.28–49.5
W3XK	Washington, D. C.	142.5
W6XF	Los Angeles, Calif.	37.0
W6XN	Oakland, Calif.	23.35
W8XAG	Dayton, Ohio	34.64
W8XAL	Cincinnati, Ohio	49.5
W8XK	East Pittsburgh, Pa.	25.4–62.5
W9XAA	Chicago, Ill.	49.36
W9XF	Chicago, Ill.	49.83
W9XU	Council Bluffs, Iowa	49.5
XDA	Mexico City, Mexico	15.9–31.8
YR	Lyon, France	40.2
ZL3CZ	Christchurch, New Zealand	50.0
2PL	Sydney, Australia	32.05
3KAA	Leningrad, Russia, USSR	36.0
3LO	Melbourne, Australia	31.5
7LO	Nairobi, Br. E. Africa	31.1–31.4
90C	Bern	32.0

Charting the Sea

Ingenious Radio Apparatus Sounds Depth of Water and Gives Necessary Indications to Mariners



A chronograph which records the time interval between the bomb explosion and the arrival of the sound waves at the shore hydrophone



The ship-board amplifier and the receiver which picks up the signals from the land hydrophone station

THE imaginary example of a blind man as a surveyor is analogous to the experience of the Coast and Geodetic Survey, United States Department of Commerce, in attempting to make hydrographic surveys in fog, smoke, rain, snow, or other conditions that tend to obscure the shore. Formerly, these unfavorable circumstances interfered with the production of mariners' charts. Now, radio and sound have joined hands in development of the radio-acoustic system of position-finding in making surveys—enabling the Coast and Geodetic Survey to make soundings far removed from the coast, beyond the sight of land or objects on the ground.

Once the noisy oyster threatened to disrupt the radio-acoustic method of ranging—setting up a peculiar form of interference with the sensitive radio and other sound instruments—but this parasitic noise is about to be overcome, and the charting of the waters of the Atlantic and Pacific oceans is proceeding without interruption. The principle involved in the use of radio and sound is as follows: A bomb is exploded in the water, close to the ship, and its impulse is recorded automatically on a chronograph aboard ship. The impulse goes through the water to hydrophones accurately located in geographic position near shore. These hydrophones actuate relays that set off radio signals from shore stations near the hydrophones. These radio signals are received and automatically recorded on the vessel. With knowledge of the transmission time and of the impulse of the explosion through the water, the exact distance of the ship from two or more hydrophones near the land can be determined, and thus the ship's position at the time of the explosion is known.

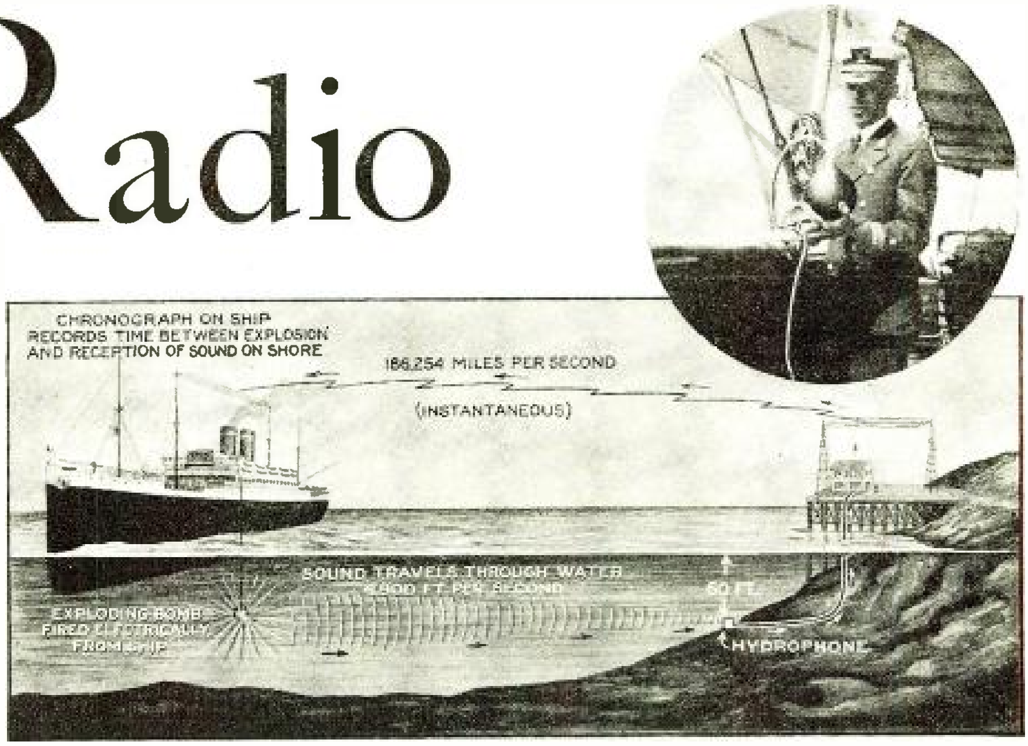
A mariner's chart, in order to fulfill its mission, must show the depth and position of the depth of water for a given area, as determined by soundings. Shores, rocks, and islands are also included on the chart. Moreover, every point on the chart represents a corresponding point on land or sea. The direction joining two points on the chart is as nearly as possible the same as for the actual points, and the distance between them bears the same relation to the actual distance. This charting of the ocean lanes is the function of the Coast and Geodetic Survey, but until radio and sound began to work in double harness, fog, the haze of forest fires, rain and snow interfered with charting operations. These conditions rendered the shore invisible and retarded the progress of hydrographic surveying.

The problem refused to yield to scientific treatment until, during the World War, the submarine menace necessitated thorough study and quantitative measurements of sound as it passed through sea water. Methods of sending and receiving underwater sounds were evolved, and precise instruments for measuring the velocity of sound through water were developed. This study continued after the world conflict, the United States Army creating a sound-ranging section. The latter branch of the government conducted experiments in the firing of small bombs suspended below a target, whose position at time of firing was determined, and recording time of transmission to underwater telephones or hydrophones as known position connected to shore stations by cable. At about this time a physicist, E. B. Stephenson, published his scientific findings in which he admitted that the velocity of sound varies with different conditions, but these variations are governed by well-defined laws. The statement of this principle, together with the sound-ranging studies of the Army, gave the Coast and Geodetic Survey its cue for the development of radio-acoustic ranging.

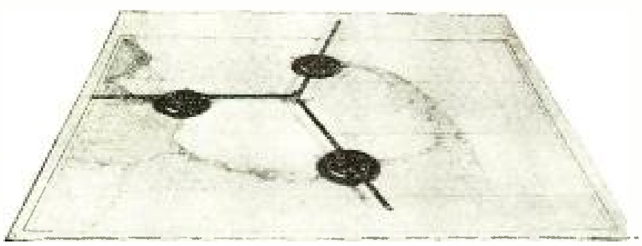
This method of determining the position of a ship is not in accordance with the measurement of angles, but by direct determinations of distances from two or three known points. A sound wave and a radio signal are started at the same time from one point and the interval of their time of arrival is noted at another point. The length of this interval of time depends on the difference between the speeds of sound and radio signals, and on the distance between the two points. For example, the velocity of radio waves is 186.254 miles a second, while sound waves are comparatively laggard, traveling only

by Radio

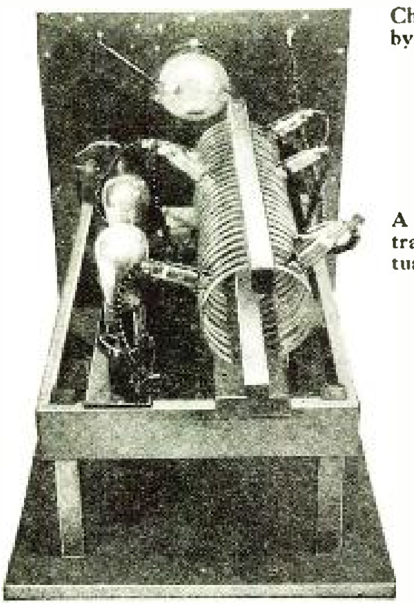
By
J. E. Smith*



A sketch showing how the sound waves generated by the exploding bomb are picked up by the hydrophone and relayed to the ship by radio. (Insert) Officer holding a two-pound T.N.T. bomb which is fired by operating a switch in the radio room



Charting apparatus used by the Coast and Geodetic Surveys



A rear view of the shore transmitter which is actuated by the hydrophone

about one-fifth of a mile a second. In fact, the velocity of the radio signal is of such great celerity that it completes the journey before the sound wave starts. Therefore, if the two signals are sent at the same time from a ship, the observed interval at a shore station is virtually the time in which the sound signal travels from the ship to the shore station.

The source of the sound for this radio-acoustic method of position-finding is a "T.N.T." bomb—of the half-pound, pound or two-pound "tin-can" commercial type. This bit of explosive is fired by operating a switch in the radio room. There is a continuous circuit from the switch to the bomb when in position for firing. A permanent circuit is maintained from the radio room to the stern of the ship, and a safety switch is kept open until time to fire the bomb. The "T.N.T." bomb is suspended by a cable from a float towed by the vessel. A rope, 200 feet long and graduated at 10-fathom intervals, is identified with a twin-conductor-cable. This rope is attached to an upright wire, connecting a 5-gallon oil can, employed as a buoy and a sinker. A 15-pound sounding lead is positioned a short distance from the sinker. The conductor-cable is attached to the rope a short distance from the upright, so that the bomb will be held at the proper depth by the sinker. This is the manner of planting the bomb in the water.

The snap switch that fires off the bomb likewise closes three electrical circuits at the same time—keying the radio transmitter, sending out a radio signal, and operating a chronograph or time-recording pen. The latter keeps tab on the moment the bomb was fired. After firing the bomb the operator on the ship switches his wireless equipment from "transmit" to "receive" position. Thus the radio signal returning from the shore station passes through the receiving set and power amplifier—the signal being boosted in strength sufficiently to actuate a relay. The latter governs the local power employed in operating the signal pen of the chronograph, in such a manner as to record both the departure and arrival of the sound signal.

Obviously radio-acoustic ranging requires the establishment of stations on shore as well as on the surveying ships. Consequently, at a depth of about sixty feet in water and situated at a distance not exceeding three-fourths of a mile from shore a hydrophone is submerged. It is similar to a microphone at a radio broadcasting station—and is an underwater "mike." This underwater device transforms the pressure variations of sound waves, intercepted in the water, into variations of electric current in its circuit. In this particular function it simulates the behavior of a telephone transmitter. These current variations, made possible by the hydrophone, are amplified and boosted sufficiently to actuate a relay. A sound pulse in the water results in the instantaneous closing of this relay. The operation of the latter serves to key the shore station radio transmitter, which emits the wireless signal for reception on the surveying ship. Radio and sound equipment at these shore stations must respond automatically to the receipt of a sound wave by the sending of a wireless signal and, therefore, afford an avenue of communication with the surveying ship.

The telegraph key of the radio transmitter is not actuated directly by the hydrophone-amplifier relay, since this would introduce difficulties. Direct operation (*Continued on page* 1152)

*President National Radio Institute, Washington, D. C.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Frequency Reference Chart

Index No. 534.21

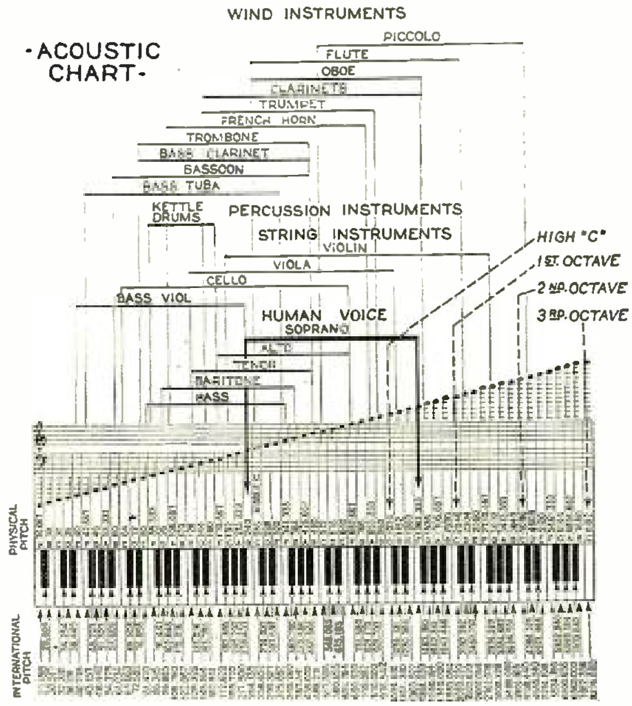
IN calibrating an audio oscillator, determining the "peaks" of a loud speaker and in many other radio measurements it is desirable to have some means of measuring or identifying audio frequencies. This may be done quite accurately with a well-tuned piano and this chart, which shows the frequency of each piano key.

For purposes of comparison, the average ranges of the human voice are also given.

In the physical pitch scale the range of frequencies extends from some 26 cycles to 8291 cycles, a convenient band especially for comparison work in the measurement of characteristic extremes of audio-frequency transformers, amplifiers, loud speakers, etc.

For comparison, the correlated range of various types and kinds of instruments is also given in the acoustic chart.

Musicians generally employ the International pitch scale (A = 435 vibrations per second) while physicists use the physical pitch scale (middle C = 256 cycles per second).



RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

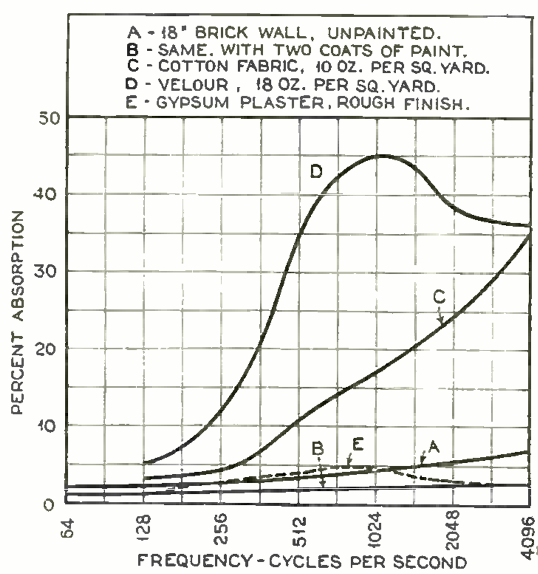
Sound Absorption

Index No. 534.11

SOUND is very similar to light in a great many of its characteristics. Both are commonly thought of as wave motions, and both may be transmitted, reflected and absorbed, though since sound waves are many hundreds of times longer than light waves, these effects take place on greatly differing scales.

The theory of sound absorption has been quite extensively set forth, but yet it is not widely known. Any sound, originating in an enclosed space such as a room, continues to be reflected from wall to wall and from ceiling to floor until it has all been either absorbed or transmitted through the enclosing walls.

The larger part of it in most cases is absorbed by being transformed into some other form of energy—generally heat. The greater part of the energy of the lower audio frequencies is used up by setting in motion the enclosing walls—causing them to vibrate either as a single unit or as several large units of area. Since the wall has mass, it takes energy to set it into vibration, and this energy comes from the sound waves striking it.



The higher sound frequencies, on the other hand, are absorbed mainly by the porosity of the surfaces against which they strike—small holes and openings where the sound waves enter, break up and dissipate.

The accompanying graph shows the absorbing powers of some illustrative examples. The painted brick wall (B) has less surface porosity than the unpainted wall (A) and therefore absorbs less sound, particularly at the higher frequencies. Both samples of cloth are much better, because they are much more porous, and the effect of the velour extends further down into the low frequencies than does that of the cotton because the velour is heavier.

The curve of rough finish gypsum plaster (E) is similar to that of unpainted brick, because the surface porosities of the two materials are similar, and each is heavy, compared to any sort of cloth or draperies.

RADIO NEWS INFORMATION SHEETS

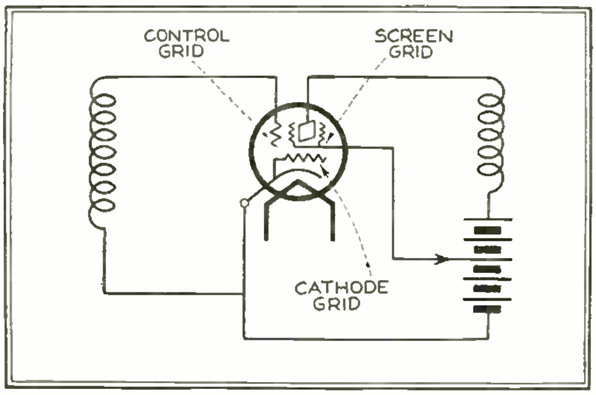
By Elmore B. Lyford

The Five-Element Tube

Index No. R335.1

THE five-element tube, which is beginning to be known as the pentode, is at least fifteen years old in theory, but is just coming to the fore in practice, in this country at least.

The American four-element tubes have been designed primarily for the radio-frequency stages of the receiver, but our pentodes are designed to be used in the audio-frequency stages, for their greatest advantage seems to lie in their ability to handle relatively large amounts of power.



With the four-element tubes, high amplifications may be obtained, but with only very low plate currents, which means only a very small power output. With plate currents which are too large, the "secondary emission" of negative electrons from the plate may seriously distort the passing signal. This secondary emission is caused by the negative electrons from the filament striking the plate at high velocities, and dislodging other electrons from it by the force of the blow.

These electrons, in the four-element tube, may be attracted to the positively charged screen grid, thus subtracting from the total plate current of the tube and distorting the wave form of the signal.

In the pentode, the fifth element may be used to eliminate this unwanted action. If the fifth element is placed between the plate and the screen-grid, and connected to the filament or some very low positive potential, as shown in the diagram, it is at a much lower potential than the plate. This tends to drive the "secondary emission" electrons back to the plate where they belong, and prevent distortion by preventing any subtraction from the total plate current. Thus the pentode has the advantage of high screen-grid amplification, with a large power-handling capacity in addition, which makes it especially suited for power audio amplification.

The final line-up of the five elements in the American pentode, therefore, is as follows: The filament, control grid and plate are used as in the ordinary three-element tube, the screen-grid is used to screen the control grid from the plate, and the "cathode grid" or fifth element is used to screen the screen-grid from the plate.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

The Spectrum of Radiation

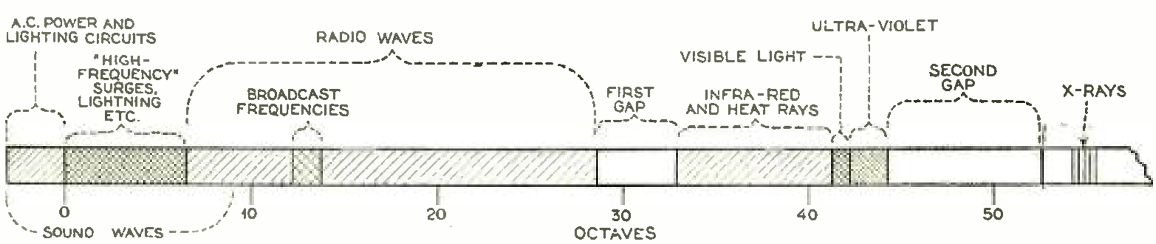
Index No. 537.7

RADIATION and the effects which it produces are known to us in a great variety of ways and throughout an enormous range of frequencies. We are receiving radiation in some form every minute of our lives—directly in the form of light or heat or sound, and sometimes indirectly in the form of telephone or radio communication, to mention only a few of the many forms.

In spite of all its ramifications, all radiation is essentially the same thing in form, the only difference between branches being the frequency of alternation. This difference can also be expressed as a difference in wavelength, since all radiation (except sound) travels at a uniform speed of 300,000,000 meters per second. Sound waves, which travel through air as a conducting medium, average 1,000 or 1,100 feet per second.

The accompanying chart, showing the relation of the various forms of radiation with which we are familiar, is self-explanatory. The octave range of the various radiations is figured from the base 0 = 128 cycles per second—one octave below middle C on the piano.

	CYCLES	WAVELENGTH IN AIR	OCTAVE	NUMBER OF OCTAVES
A.C. FIELD	15 133	12,500 MILES 1,400 "	−3.09 0.06	3.15
HIGH-FREQUENCY SURGES, LIGHTNING, ETC.				6.57
RADIO WAVES	10^4 5×10^{10}	24,000 METERS 0.6 CM.	6.63 28.55	21.92
FIRST GAP				(4.25)
INFRA-RED RAYS	10^{12} 4×10^{14}	0.03 CM. 76×10^{-6} CM.	32.80 41.48	8.68
VISIBLE LIGHT	4×10^{14} 7.7×10^{14}	76×10^{-6} CM. 39×10^{-6} CM.	41.48 42.45	0.97
ULTRA-VIOLET RADIATION	7.7×10^{14} 30×10^{14}	39×10^{-6} CM. 10×10^{-6} CM.	42.45 44.40	1.95
SECOND GAP				8.0
X-RAYS	AROUND 3×10^{18}	0.01×10^{-6} CM.		AROUND 54.4
			TOTAL	57.7
SOUND WAVES	15 8000	66 FEET 1.5 INCHES	−3.1 6.0	9.1



The Radio Forum

A Meeting-Place for Experimenter, Serviceman and Short-Wave Enthusiast

The Experimenter

Why and Where By-Pass Condensers Should Be Used

Although most of the better grades of radio receivers manufactured today are including more and more by-pass condensers, as means of obtaining maximum efficiency, the value of such practice is not appreciated by the average set builder and experimenter.

He does not realize that both the radio and audio-frequency currents should be provided with the path of least resistance instead of through high resistance power units, transformers and batteries, and also that radio-frequency currents should be kept out of the audio circuits and the audio currents out of the radio-

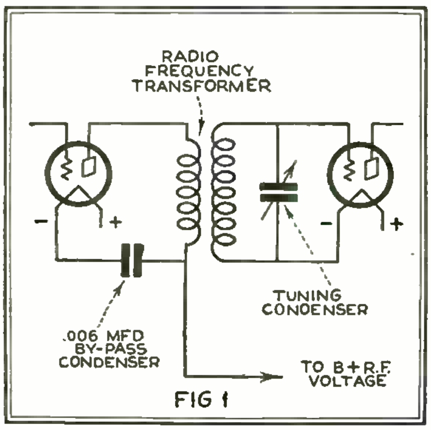


FIG 1

frequency stages. The only way to arrive at this point is by the generous use of condensers.

Fig. 1 is the arrangement in the radio-frequency section found only in late model receivers, yet the increase in volume and sensitivity obtained would benefit the receivers of some of our readers whose complaints are in that direction. The condenser employed is .006 microfarad capacity of the fixed type commonly used in set construction. Fig. 2 is for by-passing the audio transformer, using a standard type of by-pass condenser of 1 or 2 microfarad capacity. This practice is standard on the best of receivers and power amplifiers and will result in the reduction of background noises and better tone quality.

If you have not already thus equipped your present receiver and phonograph amplifier, do so, says D. A. Brown of Marion, Ohio, and note the improvement.

Fig. 3 shows a standard output circuit from the detector to the first audio stage, and the means of keeping the radio-frequency component of the signal out of the audio transformer, and the audio component out of the "B" battery or power unit. The audio currents are by-

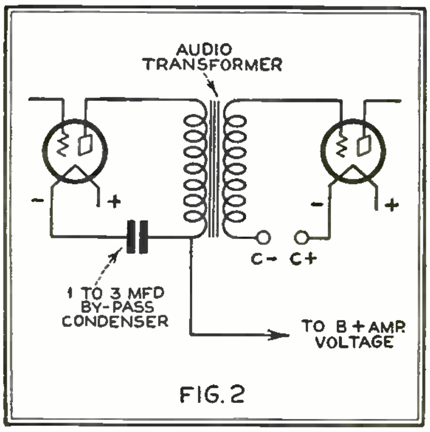


FIG. 2

passed with the one microfarad condenser, of 200-volt rating, connected between the plate supply plus and the filament supply minus and will reduce background noises as well as improve tone quality. The by-pass for the radio-frequency currents will result in more volume and better sensitivity. This condenser is of .0005 mfd. capacity and is also of the type commonly used in set construction.

For those seeking the utmost from their receiver in amplification and reception, the practice of the foregoing will

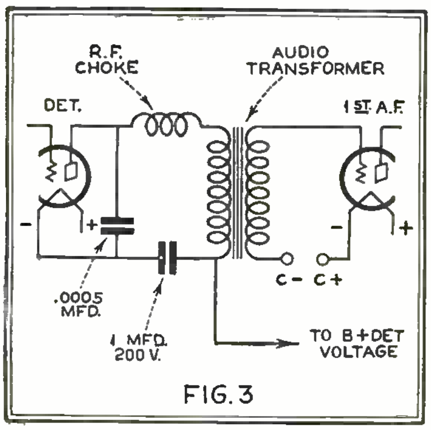


FIG. 3

net good results, since no matter how fine your receiver may seem to you, it will usually be able to stand considerable improvement.

When the Line Voltage Fluctuates

Taking the usual 110 volts lighting circuit at its face value has proved an expensive practice in socket power radio operation. Not only has public and radio industry suffered serious losses from prematurely burnt out radio tubes, but considerable power pack trouble has been experienced. It is no close secret that tens of thousands of broken down power transformers and filter condensers have been traced to excessive line voltage which causes an electrical strain far beyond the safety practice of such employment. Hence, the question of line voltage should receive due attention at a time when socket-power operation is the accepted standard, announces Charles Golentaul, of the Clarostat Manufacturing Company, in a recent interview.

There are many surprises in store for those who come to check up the term "110 volts." In many sections, the usual lighting current measures anywhere from 90 to 130 volts. In some cases localities have voltages dropping as low as 80, while in others the voltage may rise as high as 140. It is a mistaken idea that line voltage fluctuations are greater in the rural sections than in metropolitan areas. While in the former the long transmission

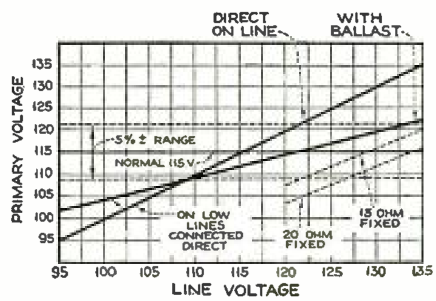


Fig. 4

lines and inadequate transformer facilities may cause chronic low voltages, in the latter, the sudden heavy load frequently taxes even the elaborate transmission and transformer faculties. On the Pacific Coast the line voltages frequently rise to 140 and place an enormous strain on power pack and tube. The replacement figures of radio tube manufacturers indicate a predominance of returns from the far west.

There is little to choose between excessive line voltage and insufficient line voltage. With the former the set may

(*Continued on page* 1158)

The Serviceman

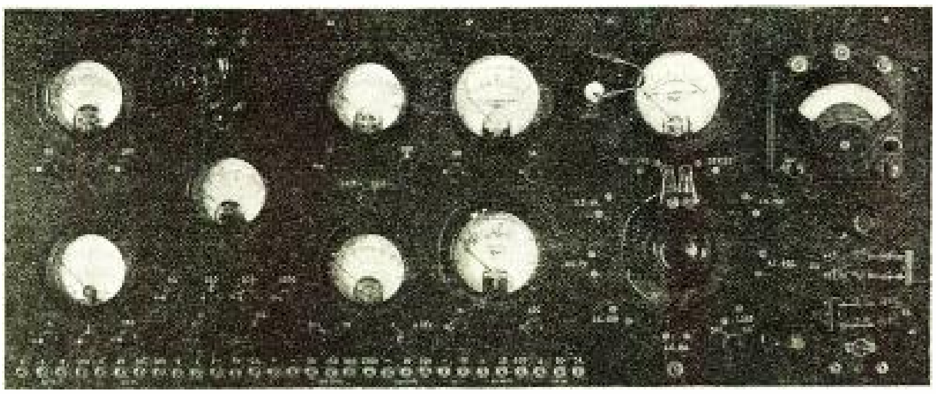
A Practical Test Panel for Servicing

A SUCCESSFUL radio service shop of today must be equipped to do any and every job within its scope with accuracy and speed. In order to meet these two principal requirements it must undergo a complete renovation from time to time to keep up with the latest developments of our youngest and fastest growing industry—"Radio."

Five years ago the serviceman who knew his work needed as tools for his trade only a pair of earphones with a C battery in series for the click test, a pair of pliers, a screwdriver and a small stock of tubes and batteries then being used. With these few items and a soldering iron, he could cope with any situation that might arise in the course of normal servicing, and satisfy the customer.

It was not very important that all work be done according to Hoyle. At that time a battery-driven radio set would play after a fashion if the plate and grid voltages were wrong, as the average customer was after quantity of noise produced and the distance that he could obtain, rather than the quality of reproduction. He had no audible comparison, since his neighbor's set sounded just as bad.

Today conditions have changed. The serviceman, were he to employ the methods in vogue five years ago, not having any visible indicating means with which to test, would find himself stopped beyond



The panel layout of the Tetdwal tester

hope by the very simplest and cheapest a.c. receiver on the market today. The practical service shop operator today must know exactly the conditions he is facing in the receiver under test, and in order to do that he must employ meters—both volt and ammeters of various ranges of the a.c. and d.c. types.

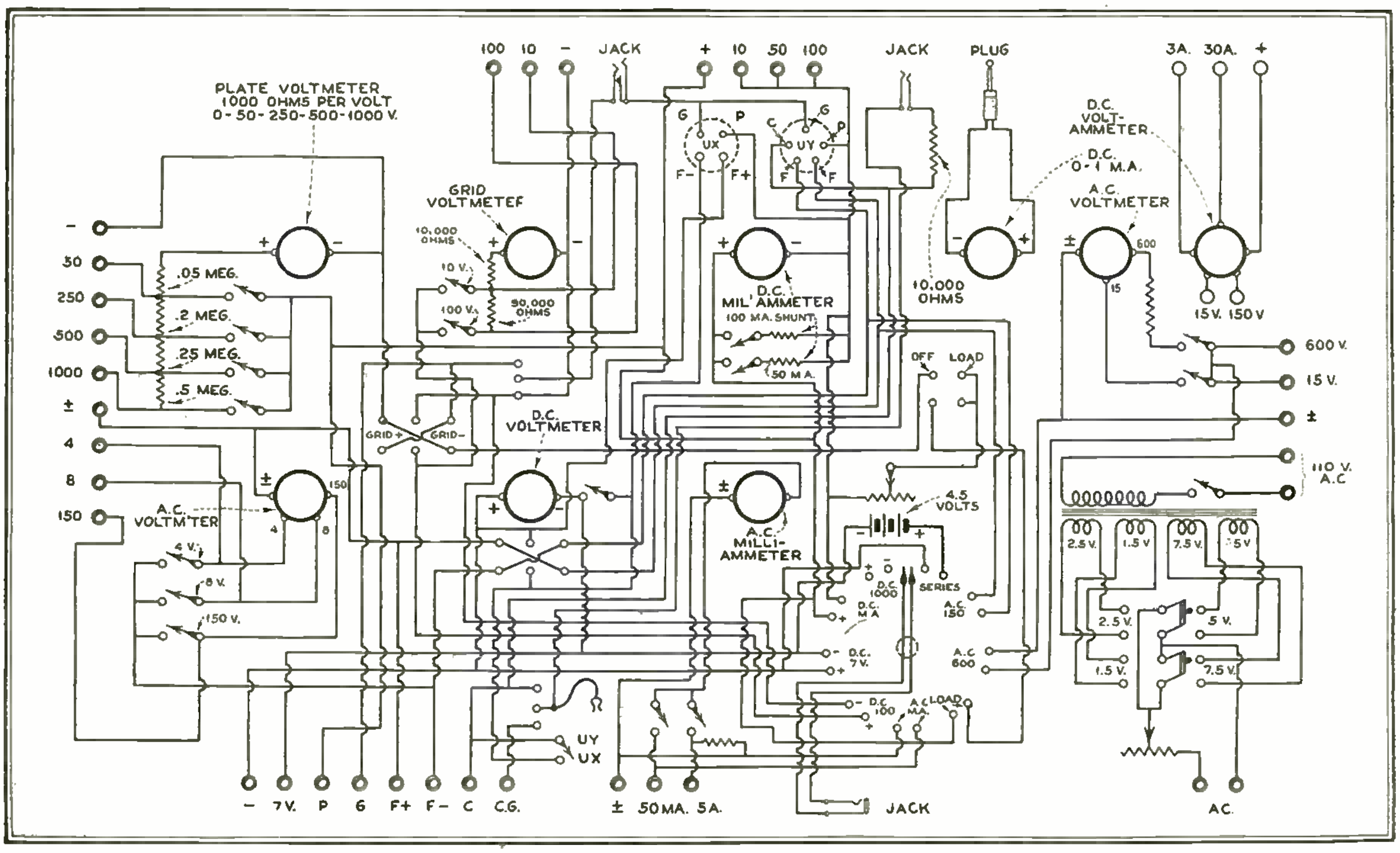
It is the purpose of this article to describe how to group all these meters together so that they can be used either singly or in combination, so as to make every test quickly and accurately on all radio receivers—old or new. Also power amplifiers and all sets employing the newest of the tubes in vogue this year, the a.c. –24.

There are quite a few set analyzers and test kits on the market today. Every one is worth the money you pay for it, the quality of the article being largely determined by the price. For the service shop test men they are not very practical, however, the requirements there being quick accessibility, easy reading on about the level with the operator's eye, and being out of the way of harm when not in use.

The logical answer to this is a test panel. The following one described has answered every purpose in the service shop of Mr. H. C. Tetdwal, of Sacramento, California, for the last three months so successfully that he is passing it on to the other members of the serviceman fraternity, hoping that they can make use of any part or all.

The panel itself is 1/4" bakelite, 12" x 30". It is laid out with the position of every instrument and switch drilled, and the parts mounted on the same to be sure

(*Continued on page* 1160)



The circuit diagram of the apparatus, which will test every type of tube and receiver

With the Short Wave Fans

Short-Wave Editor,
RADIO NEWS.
Sir:

Why don't you have a short-wave correspondence section as the old magazine had? I miss that more than anything else and like it better than any other section in the whole magazine.

I haven't seen any report from readers having built the Candy Box Special. What's wrong? Are they afraid someone will kid them for playing? Well, here is my story of it all in a nutshell. I had not had any success on short waves before I built this little set. but then—. The first night it brought in all the stations loud speaker volume. CJRX, KDKA, three of the WGY stations and nine more which seemed to be on the National Broadcasting hook-up and were not announced often enough to suit my roaming appetite.

I hooked it up as the diagram shows, except that I put five turns of No. 26 d.c.c. around the coil sockets, using this as a primary. C4 was a Hammarlund equalizer; this was used in connection with a Victor taking the B+ from the plate of the –26 tube behind the –27. B minus from the ground post and using a storage battery for the –71A detector.

Hoping to hear from other fans who have built this excellent little short-wave receiver,

I am,
BILL FINCH.

West Palm Beach, Fla.

* * *

Short-Wave Editor,
RADIO NEWS.
Sir:

Regarding Russian stations. both short-wave and broadcast, I would like to inform the many listeners who have been able to receive these programs that any letter, card or package sent to Russia will be returned unopened to the sender unless it bears the complete address such as the following:

RADIO STATION—Moscow,
Union of Soviet Socialistic Republic.

It was only after having some of my mail returned to me unopened that I learned of the correct procedure to take in addressing these stations.

Hoping that the above information will be of interest to my many friends on the short wave,

I am,
C. R. SWENSON.

Hot Springs, Arkansas.

* * *

Short-Wave Editor,
RADIO NEWS.
Sir:

I would like to inform you that I have built the Junk Box short-wave receiver from old parts and I am very satisfied with the results obtained.

For the condensers I used .00035 mfd. capacity for regeneration and for tuning I used a 23-plate of unknown capacity which was cut down to seven plates and double spaced. I find that retuning the grid circuit to the positive side of the filament improves the sensitivity and volume when a –12A tube is used as a detector.

Now as to the results I have obtained in the last two weeks. W6XM, Oakland, California; W8XK, Pittsburg; GBT, Chelmsford, England; CJRX, Winnipeg, Canada; PCJ, Eindhoven, Holland; W2XAF, Schenectady, New York; W2XE, Richmond Hill, New York; W8XL, Harrison, Ohio.

All stations are received regularly here with the exception of PCJ, which I have had twice in the last week. Considering the small amount of time and labor I put into the set, I feel amply repaid for building it. One more thing, I used a bakelite panel and found that hand capacity was very bad, but a few sheets of heavy tinfoil glued to the back of the panel and grounded, completely eliminated this difficulty.

Yours sincerely,
ALBERT E. GLEASON.

Worcester, Mass.

* * *

Short-Wave Editor,
RADIO NEWS.
Sir:

Tonight I bought a copy of RADIO NEWS, as I always do on the 10th of the month. One article published in October's issue certainly deserves some comment. "Breaking Into Amateur Transmitting," by Lieutenant W. H. Wenstrom, is the article to which I refer. In my opinion this is truly a clever article, surely it should be interesting to the prospective amateurs. When I broke into the amateur game I searched every available book, even wrote to the Government, and could not obtain any dope on how to become an amateur. By the way, the Government was temporarily out of literature at that date; finally I was informed by a friend how to obtain the cherished radio operator's and station licenses. But getting back to the article, I sure think you have done a wonderful thing to publish it and I hope you will send me the Lieutenant's address so that I might have the opportunity of thanking him personally. It was great stuff to sit down and read how to break into the game, although I am there already. I like RADIO NEWS very much, always quite interesting to the amateur. In closing merely want to say that you are to be congratulated on this article by Lieutenant Wenstrom.

Wishing you much success and awaiting plenty of articles pertaining to short waves.

I am,
STANLEY STEVENS.

E. Stroudsburg, Pa.

Short-Wave Editor,
RADIO NEWS.
Sir:

I thought you might be interested in hearing from someone who has constructed the Candy Box Special. I constructed this set with the idea of taking it out in the Canadian Rockies on a horseback trip. The cabinet used was an ordinary metal fish tackle box about thirteen inches long, which I subdivided into three compartments, one to hold the batteries, the second for earphones and a coil of bell wire for the antenna, and the third for the set itself. My main trouble was to get this set to oscillate on the low wavelengths. I found that it was necessary to increase the voltage on the plate from 22½ to 45 volts. This, however, enabled me to get down to thirty meters, but to save my neck I could not get below that. As this set was the only one I was taking along with me, I thought it best to wind some coils to take me through the broadcast wave, or up to 550 meters, so that when the set was ready for operation I had quite a range of wave bands to play with.

Now, as for results. On the train bound for Toronto, I could get nothing on my antenna strung inside the steel car. However, on stopping at Bethlehem, I threw a five-foot length out the window and picked up the broadcast station at Allentown, a mile or so away, and W2XE at Richmond Hill, New York. The next day on the train leaving Toronto, I picked up two stations from that city while the train was in motion. That evening on a steamer in Georgian Bay, I pulled in W2XE, although very distorted. The following night in the middle of Lake Superior, on an aerial consisting of bell wire woven back and forth in my tiny cabin, I packed up W2XAF at Schenectady on 31 meters very clearly. On 31.4 meters I could hear the faint whistling of PCJ, but with such a poor antenna could not pick it up. Then the next day the disaster came. Either the C battery, which I was using to light the filaments, got short-circuited on a metal can or were affected from the heat on the train, I do not know, but they were dead as doornails.

For the first part of the trip I didn't have another chance to buy new batteries, so that finished my experiments for the time being. However, on a long antenna at home, I have received many broadcast stations and on short waves have been able to pick up the 80-meter phone station as well as the short wave transmitters of the Pittsburg station and the Bell Laboratory Airplane flying over Newark when they were conducting a number of tests.

Yours truly,
T. W. BROWN.

Newport, R. I.

~RADIO NEWS HOME LABORATORY EXPERIMENTS~

Facts About Antennas

Type, Effective Height, Length and Fundamental Wavelength Measurement Are Some of the Points Discussed Here

THE antenna one uses in conjunction with a modern radio receiver may be of almost any type or form. In most cases, however, use is made of an outside antenna consisting of a single piece of wire from 20 to 100 feet in length suspended in the air by means of insulators. Indoor antennas consist of a single wire wound around the molding of a room or strung up in the attic. Some receivers give excellent results with "light socket" antennas, consisting of a plug which is screwed into a light socket. Inside the plug, as shown in Fig. 1, is a small fixed condenser one terminal of which connects to one side of the a.c. line, and the other terminal of which is brought out to a binding post on the side of the plug. Connection is made between this binding post and the antenna terminal on the receiver. Some sets are designed for the use with a loop antenna, frequently concealed inside the cabinet of the receiver. But no matter what type of antenna is used its purpose is the same—to intercept a small amount of the radio-frequency power radiated through the ether from the broadcasting stations. The antenna used at the broadcast transmitting station must send out through the ether thousands of watts of power—the antenna connected to your receiver must intercept but microwatts of power. A broadcasting station antenna might transmit, for example, say 25,000 watts and the antenna on the set intercepts but millionths of a watt of power! The broadcast station antenna is suspended by means of insulators, and when the station is "on the air" the voltage across these insulators may be 10,000 or 50,000 volts. The voltage across the insulators of the receiving antenna is only millionths of a volt. These figures give some idea of the differences between antennas for transmitting and receiving. In this experiment sheet let us consider some of the characteristics of the receiving antenna.

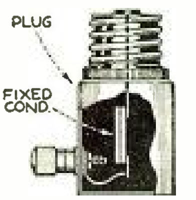


FIG. 1

As we look at an antenna it appears to be a simple sort of thing—just a long piece of wire—but electrically it is far more complicated. Actually an antenna looks like Fig. 2 to an electric current. Here we see a number of coils, all marked L, a number of condensers, all marked C, and a number of resistances, all marked R. These coils, condensers and resistances are the same as the coils, condensers and resistances we use in a receiver — although their values may of course be quite different.

The effect of the coils, L, is produced by the fact that any piece of wire has the property known as "inductance." This is why we sometimes refer to the r.f. transformers in a set as having an inductance of so many henries or millihenries—the henry being the unit inductance, and the millihenry being equal to one-thousandth of a henry. The effect of the condensers, C, is produced by the fact that the antenna wire and the ground under the antenna act like two plates of a condenser. The effect of the resistances, R, is due to a number of factors, including the resistance of the wire, the resistance of the ground and what might be called the "useful resistance," because the antenna must pick up energy from the ether and transfer it to the set. The power actually transmitted to the set can be represented by a resistance and a technical term for this useful resistance is "radiation resistance."

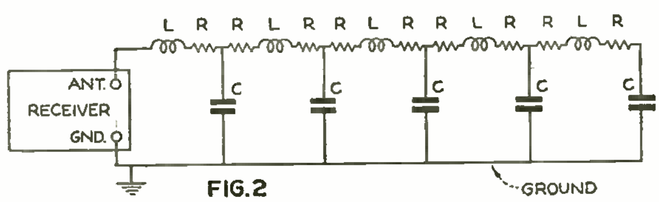


FIG. 2

FUNDAMENTAL WAVELENGTHS OF A SINGLE WIRE ANTENNA	LENGTH IN FEET OF HORIZONTAL PORTION OF ANT.			
ANTENNA HEIGHT IN FEET	METERS 30 FT.	METERS 60 FT.	METERS 75 FT.	METERS 100 FT.
20 FT.	59	95	113	143
30 FT.	69	104	121	151
40 FT.	80	113	128	162
60 FT.	102	136	157	185

We learned in the April Experimenter Sheet that when we tune a receiver what we do actually is to adjust the capacity of the tuning condenser so that the circuit will be in "tune" with the desired signal. Now since the antenna has all the characteristics of a coil-condenser combination in a receiver it follows that the antenna will tune to some particular frequency of wavelength. And the frequency or wavelength to which an antenna naturally tunes is known as its *fundamental wavelength*—just as for a 200-meter wave greatest current will flow through them if we tune the coil-condenser circuits in a receiver to 200 meters. The table gives an approximate idea of the natural wavelengths of simple single-wire antennas of various heights and lengths. This shows, for example, that an antenna 30 feet high and 60 feet long has a fundamental wavelength of 104 meters.

Fig. 3 shows exactly what we mean by the terms in the table "horizontal portion" and "vertical height."

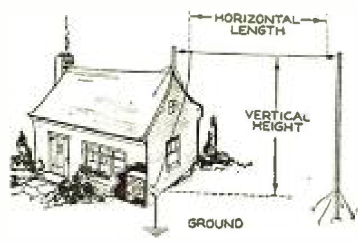


FIG. 3

It is not very difficult to measure the fundamental wavelength of an antenna. Suppose we have in our laboratory a simple r.f. oscillator, that is, an oscillator that can be used to produce currents of various wavelengths say, from 25 to 300 meters. If we built the modulated oscillator described in the February, 1929, issue of RADIO NEWS, we have an instrument ideally suited for experiments of this sort. To measure the natural wavelength of the antenna we proceed as follows: turn on the oscillator and then bring the antenna lead-in close to the coil on the oscillator — perhaps taking a quarter turn or so around the pick-up coil on the oscillator. See Fig. 4. Then gradually vary the tuning dial on the oscillator, at the same time watching the meter. As the funda-

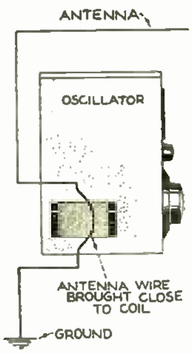


FIG. 4

mental wavelength of the antenna is approached the needle of the meter in the oscillator will begin to decrease and the maximum decrease will occur when the oscillator is producing a current of exactly the same wavelength as the fundamental wavelength of the antenna. If it is found that a very great dip of the meter needle is obtained move the antenna lead farther away from the oscillator, for the measurement will be most accurate when just a slight dip is obtained. Having located the point where the feeble change in the meter reading is produced simply determine the dial reading of the oscillator, look up the corresponding wavelength from the tuning chart and there you have the natural wavelength of the antenna. Now if you want to continue your experiments you might connect a small fixed condenser, say 0.0001 mfd., in series with the antenna and again determine the fundamental wavelength. Connecting a condenser in series with a circuit decreases its capacity and you would therefore find that the antenna with a condenser in series would tune to a shorter wavelength than it did when no condenser was used. Similarly, if you connect a coil in series with the antenna you increase its wavelength.

These points can be proved, using the broadcast receiver. Most sets use a primary on the antenna coil consisting of about 10 turns or so, and with ordinary antennas the circuit will have a fundamental wavelength slightly below the broadcast band. Now if you connect a coil in series with the antenna it ought to increase the fundamental wavelength. You can check this as follows. Accurately tune the set to some station broadcasting on some wavelength between 400 or 500 meters. Note the volume of the signal. Now disconnect the antenna and place in series with it an ordinary r.f. coil, some 50 to 100 turns wound on a piece of tubing. The circuit is shown in Fig. 5. Now turn on the set again and readjust the first tuning condenser, if necessary. It will be noted that the signal is considerably louder than it was before the coil was connected with the antenna circuit. This is due to the fact that the antenna is now more nearly in tune with the signal we are receiving. That is, placing the coil in series with the antenna increased its fundamental wavelength so that the antenna circuit was more nearly in tune with the signal the set was tuned to. Thus more current flowed through the circuit and louder signals were obtained. This test can only be made on a receiver which uses a separate dial to tune the first condenser, because the coil in the antenna circuit causes the reading of the first condenser to change somewhat, and it can only be correctly tuned if it is operated by a separate tuning control. In many receivers, old ones especially, the same effect as adding a coil in series with the antenna is obtained by the use of a tapped antenna coil as shown in Fig. 6. In this case the tap-switch is adjusted so as to bring the antenna roughly into tune with the wavelength of the desired signal.

As a result of these experiments you will have learned, first, how to measure the natural wavelength of an antenna; second, the effect of placing a condenser or a coil in series with an antenna, and from the table accompanying the article you will have a fairly definite idea of the fundamental wavelength of ordinary receiving antennas.

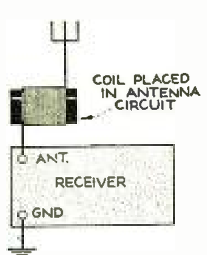


FIG. 5

Another antenna characteristic of fundamental importance is the "effective height." The effective height of an antenna, usually stated as so many meters, gives us an idea of its efficiency in the interception of the radio waves. We say that an antenna has an effective height of two meters or four meters or ten meters and so on. The effective height of an antenna bears little relation to the actual height in meters of the antenna. The effective height depends on many things—how well the antenna is insulated, the kind of soil over which it is located, etc. Knowing the effective height of an antenna is important for the following reasons: the amount of radio-frequency energy existing at any point in the ether is rated as so many volts-per-meter—the meter being equal to a length of about 3 feet. Actually because the strength of radio fields is very small, the more convenient term "microvolt-per-meter" is usually used. A microvolt is equal to a millionth of a volt. Now if an antenna has an effective height of two meters we mean that if this antenna is placed where there is a field strength of, for example, ten microvolts per meter, then the total voltage induced in the antenna will be 10 x 2 or 20 microvolts. That is, to get the total induced voltage we simply multiply the field strength of the radio signals in microvolts per meter by the effective height in meters. Knowing the effective height, it is therefore possible always to determine how much voltage will be induced in our antenna at various values of field strength.

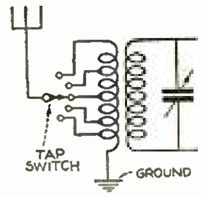


FIG. 6

Whenever tests are made on a broadcast transmitter they involve making measurements at many points of the field strength to determine if it is sufficient for satisfactory reception, over the territory to be served by the transmitter. Also when engineers test radio sets they use an antenna which is taken to have an effective height of four meters. So this term becomes of importance in the determination of how well a broadcast transmitter covers a given section, in the laboratory measurement of radio receivers, in the determination of how efficient is a particular antenna, and in determining the voltage supplied to the antenna circuit of a radio receiver.

An antenna acts like a simple condenser at all wavelengths *longer* than its fundamental wavelength. As shown in table 1 the ordinary antenna has a wavelength *shorter* than those used for broadcasting (the shortest wavelength in the broadcast band is 200 meters). It follows, therefore, that in dealing with the antenna at broadcast wavelengths we can think of it as a simple condenser. A fair approximation to the antenna capacity can be obtained in a manner similar to that used to determine fundamental wavelength. To determine the capacity, however, we must connect in series with the antenna a fairly large coil (say 50 turns on a three-inch tube), so that the antenna and the coil will tune to a long wavelength, say 500 meters. To determine the capacity we bring the coil near our oscillator, as shown in Fig. 7-A. Then tune the oscillator until we get a dip on the meter. Now remove the antenna and place it as shown in Fig. 7-B, across a variable condenser having a maximum capacity of 0.0005 mfd. Without changing the setting of the condenser (remember we do not touch the oscillator setting) until we again get a dip in the meter. The capacity of the condensers connected across the coil is then equal to the antenna capacity. If our variable condenser is calibrated we can read the capacity directly. If we have no calibration we can usually get it by writing to the condenser manufacturer.

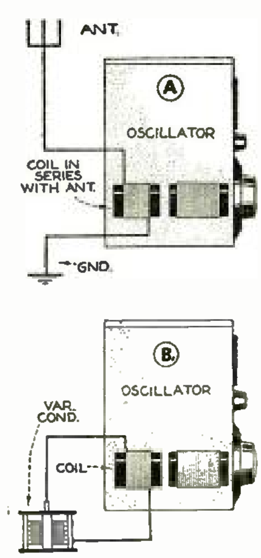


FIG. 7

17,000 Ambassadors of Good-Will

(*Continued from page* 1078)

The short waves gradually reached out so that direct contacts could frequently be made all over the country. This led to the casting of wistful glances at the broad Atlantic. One of the results of the war had been the establishing of friendships with English, French. Belgian and Italian amateurs. There grew up an ever-increasing ambition to communicate with them. And be it realized that the "useless waves" below 200 meters were to be used.

Radio Laws Restrictive

The radio laws in European countries were very restrictive upon amateurs and as a result short-wave communication was very backward. Tests were organized, nevertheless, and a concerted effort made by American and European amateurs. Contacts could not be made, however, and something had to be done. After careful planning, what has been termed "the greatest sporting event in the history of science" was pulled off. With their own hard-earned funds the American amateurs sent one of their number to Europe with American home-made apparatus. His name was Paul F. Godley. After looking the ground over. Godley set his little station up at Ardrossan. Scotland, amid the skeptical remarks of the Europeans. When the appointed night and hour arrived for the tests to be made. a terrible storm arose and Godley, located in a tent, faced the most discouraging conditions that could be imagined. Cold and wet. but jealously protecting his instruments, he maintained his night-long watch and established dozens of contacts with his American brothers. . The Englishmen were forced to listen for themselves and generously acknowledged the superiority of the American amateur methods. The tests were repeated every night for a week and every amateur in America had his chance to get his signals overseas. At the end of the test transatlantic communication on the "useless" short waves with apparatus representing less than $200 was an accomplished fact.

Things went furiously from here on. It began to be suspected that waves as short as 100 meters might be controlled. I remember vividly one of the early 100-meter tests in the Fall of 1923. A French amateur named Deloy had agreed to call an American amateur in Hartford. Conn., on precisely 100 meters at precisely nine o'clock, Eastern Standard Time. on a certain Sunday evening. The receiver in Hartford was set at precisely 100 meters and the American amateur had sufficient confidence in the precision of amateur methods to make no preparations for searching around on other waves. Exactly as the second hand of a carefully set watch indicated nine o'clock the little signals from faraway Nice. France. began, calling Hartford, Conn.. U. S. A.

It is difficult to explain the thrill that accompanies an experience such as this. It is sublime and carries with it a sort of uplift that makes us better and deeper-thinking men. The precision of it all, the picture of the Frenchman sitting in his little den in France, waiting for the precise second to come around, hand on key, the Americans sitting in their little shack in a little street in New England. silently listening and watching the time, the miles and miles of lonely black ocean over which the little electro-magnetic oscillations must travel, are utterly compelling to us amateurs.

It did not take long to find that 100 meters was marvelously better than 200 meters. And it did not take long to find that 80 meters could be controlled and was even better than 100 meters for certain conditions. Then a way was found to keep 40-meter oscillations steady, and unbelievable records in long-distance communication in daylight were hung up. Then 20 meters was tamed and the amateurs in the Antipodes—in Australia, New Zealand, South Africa, the Philippines and Japan—were brought within reach. By 1926 the amateur on his short waves and his home-made apparatus bridged the ultimate of terrestrial distance.

Thus was short-wave radio developed by the amateurs. They had been given these super high frequencies in 1912 as the "useless" end of the spectrum and they turned them into useful channels for the longest distances we have on earth.

Channels Withdrawn

As radio spread into wider popularity and new channels become desirable for commercial uses, the amateur was made to give up part of the territory he had pioneered. This did not sit comfortably, especially since his numbers had grown to many thousands in the United States alone. More and more continued to be taken from him until the International Radio Conference in 1927, when he was all but sacrificed by a conference of delegates from some eighty countries, colonies and protectorates. most of which had no radio amateurs and where every form of communication is a State monopoly. Our American delegates from our Army and Navy and Department of Commerce fought valiantly for their American amateurs but they were in the hopeless minority. All that was left of the territory the amateur had so brilliantly chiseled out of the solid were extremely narrow bands of frequencies around 160, 80, 40 and 20 meters. Here we find him today, 16.928 in number in the United States as of July 1. 1929, crowded beyond all conception and almost beyond endurance. suffering from what he feels is injustice and ingratitude and in constant danger of losing even the little that he still retains.

By dint of the most careful management and team-play the amateur as a whole is still constantly training himself, and those new amateurs who constantly join. to become expert radio operators. to take positions in the industry and to be available to our Government in time of need. The War Department and the Navy Department both have offered every encouragement and are fully aware of the incalculable value of the amateur. For many years not a single major breakdown in general communication has occurred that amateurs have not played a major part in providing radio communications for summoning and directing relief. Some of these are probably not suspected by the members of this committee.

To refer to recent emergencies which can be easily remembered: There were two hurricanes in Florida. one in 1926. the other in 1928. The first one completely wrecked a good share of the city of Miami. When the gale was at its height and after every means of communication, including amateur radio, had been completely wiped out, two amateurs, realizing the situation, located a few dry batteries and some automobile ignition batteries, salvaged such of the wreck of their radio stations as could be used, and in the midst of the hurricane improvised and erected an emergency radio transmitter and receiver and got into communication with fellow amateurs beyond the storm-torn area. They relayed a telegraphic message to the Governor of Florida, giving the state of affairs, advising what was most needed and giving information as to the best route to get into the city. Day and night these two young heroes kept that little miserable collection of apparatus in operation and handled hundreds of the most important messages. They of course had the whole-hearted coöperation of their fellow amateurs outside the stricken zone, and these are only second in deserving our gratitude.

At Tampa a group of amateurs borrowed a motor truck, equipped it with some of their home-made apparatus, drove to the devastated area below Tampa and established themselves as a communication station.

Amateurs to the Rescue

When the second hurricane struck, again every kind of communication was wiped out, including the amateur stations. This time, when it became evident that trouble was again brewing, Forrest Dana, a young civil engineer, and Ralph Hollis, a fireman. each an amateur, started at 1:30 a. m. to prepare an emergency radio station. The hurricane came, and this time carried away the building in which the emergency station had been housed. In the worst of the storm these undaunted heroes started in all over again. This time they found a place where their antenna would remain up. and with a station erected under the conditions that can be imagined they carried on without a break from Monday until Thursday, handling all the communications that went out or came into West Palm Beach. Everything that the Red Cross did and everything the Army did was from information handled by Dana and Hollis. Surely the special

(*Continued on page* 1137)

Ambassadors of Good Will

(*Continued from page* 1136)

knowledge that these young men had been induced to acquire, which enabled them to improvise a radio transmitter and receiver from miscellaneous material that could be picked up in an emergency, was of value to the nation.

The Vermont flood came in 1927. Every means of communication was obliterated. The amateurs were sought out by the authorities. They were ready—like the Marine Corps the radio amateur is always ready. They had rebuilt their stations, expecting to be called to serve, and were actually organizing outside amateurs to handle the expected traffic when their aid was sought. Red Cross, Army, press, railroads and general public were furnished communication for several days.

Santa Paula, California, had a terrible flood and here again the amateur and his splendid country-wide organization were ready and provided the Army and Red Cross communications. There was the terrible Mississippi Valley flood, also in 1927. Again did the amateur supply the emergency communications. In all there have been sixteen major disasters in the past decade when the amateurs and their organization supplied for days at a time the only communications.

Does it not mean something that this invaluable service has been developed by the amateur voluntarily? There is nothing in any amateur's federal license that requires him to perform this service. He serves without compensation, he desires none. He works for the pure love of the thrill of doing a public service by means of his beloved radio. Is this 100 per cent. altruism or no? Is it worth preserving, or no?

Emergency Network

These records of achievement in public emergency so aroused the War Department Signal Corps that arrangements were made for an affiliation whereunder our amateur stations are joined in a country-wide network for emergency communications under the direction of the Army in its constitutional duty of caring for the population when there occurs a general breakdown of the civil authorities' abilities to cope with the situation. Thus some thousands of the best amateurs of the country are today joined in the Army-Amateur Radio System. Are the members of this committee aware of this official government recognition of the value to the nation of amateur radio?

In the case of the Navy, the latter has opened a special classification for radio amateurs and already has enrolled some thousands as Naval Reservists in various grades from enlisted operators to commissioned reserve officers up to the rank of Lieutenant-Commander. The writer has the honor of holding a Lieutenant-Commander's commission in the U. S. N. R.

This picture of amateur radio is not complete without a word about the amateur's organization, his American Radio Relay League. This League is sixteen

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A Research Opportunity for the Radio Amateur

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apart. The tube is then filled with a 5% solution of sulphuric acid in water and inverted in a dish of the solution. Atmospheric pressure will cause the solution to fill the inverted tube until the hydrogen and oxygen bubbles liberated by the current begin to force it down along the scale. The amount of gas is closely proportional to the total amount of electricity passing through the solution; and dividing this gas volume (relatively indicated on the scale) by the time, we obtain a number indicating the relative average current. This device is therefore useful whenever we wish to measure for any purpose the average of a fluctuating current, and makes an interesting experiment as well. The constants in the figure were chosen for one hour runs with d.c. values between .1 mil and 10 mils, representing various broadcast signals as rectified by the two -71A's of the writer's rectifier.

In any of these methods of signal measurements, if the receiver and its amplifiers do not perform constantly great inaccuracies will result. Some research workers use a calibrating signal from a local modulated r.f. oscillator loosely coupled to the receiver. But these instruments are difficult to build and expensive to buy and, unless their filament and plate voltages are carefully checked, may vary themselves. Austin has found that if receiver filament voltages are kept constant within ± 1% and plate voltages within ± 10%, the overall sensitivity will not vary more than ± 10%, a value reasonably small in comparison to probable errors from static, interfering signals, etc. A simple and satisfactory solution is to run all apparatus from the lighting circuit, keeping the line voltage constant with a series resistance and voltmeter. It goes without saying that fairly new tubes must be used.

Of course in day-to-day work the signals from a given station should be measured at the same hour each day; only in this way can the diurnal change in signals be eliminated. The daylight broadcast's measurements are easy—what little fading one does find is quite rapid, and the measurement can be accurately made in a minute or so. But at night it is a different matter, and the measurement should extend through at least five or ten minutes. During this period one should take readings on the milliammeter at half-minute intervals. The means of the ten or twenty readings thus copied down, found by adding up the total and dividing it by ten or twenty as the case may be, will be a close approximation of the average current value.

Pickard has found that, while the morning value may be steadily twice the afternoon value, the night fields may vary in a few minutes by the ratio of 1000 to 1. Usually a bad night for one station is a bad night for all: and often weak signals at one receiver mean weak signals all over the United States. For an amateur there is little use in measuring long-wave reception, for the broadcast band (particularly the lower half), will show about the same variations with greater intensity. So the broadcast band should be covered, say by morning measurements on a station about 100 miles away, and by night measurements on a station between 600 and 1000 miles distant.

Short-wave results are very much up in the air at present, and here is a chance to do some valuable work. Any waves below 50 meters should show puzzling results here; perhaps the channels around 40, 30 and 20 meters will especially bear watching. Dependable and distant short-wave broadcasters are hard to find in New York, and amateurs who live at great distances from WGY and KDKA are fortunate in this regard. G5SW on about 25 meters usually comes in during the late afternoon; Australian VK2ME on about 28 meters is sometimes heard in the morning, as well as a German station on 17 meters. On about 50 meters KDKA is only 300 miles away and shows rather slight variations. There are many short-wave commercials, but their schedules are somewhat irregular, particularly over the week-ends. Some of these stations logged here are: PPW Brazil 28 m., LS1 England 30 m., DFE Germany 30 m., XDA Mexico 32 m., KEZ California 28 m., DHA Germany 28 m., FTL France 30 m., EAQ Spain 30 m. These commercials can be recognized when they send several "Vs", followed by their call letters.

Conclusion

So much for the description of radio's latest and most puzzling field of research. In summarizing the elements which should be studied, we might append the daily list of measurements being made here, as a suggestion for interested experimenters. At 8:00 A.M. we read the temperature, the pressure, the relative humidity, note the state of weather, condition of ground, kind and height of clouds, sketch the sun noting extent of spotted area and any spots or groups approaching center, look at the magnetic storm indicator, measure WGY broadcast, KEZ 28 meter, and KDKA 50 meter reception, note static and fading. At 10:00 A. M., YVF on 28 meters is measured, and at 6:00 P. M., G5SW on 25 meters. At 8:00 P. M. all the weather observations are repeated, static and fading are rechecked, WLW records its broadcast signal, KDKA and DHA on the short waves are measured. In addition we receive from other observers monthly reports of sunspots, magnetic activity, aurorae and earth currents. How well the full schedule can be maintained is a question, but first results show that the measurements might be still more extensive. Work? Yes, plenty of it, but what results of importance are to be painlessly gained?

List of Parts for Audiometer

1 Yaxley 7-point inductance switch.
1 Ward-Leonard 5000 ohm resistor.
1 Electrad type "B" resistor, 1000 ohms.
1 Yaxley 800 resistor, 100 ohm.
1 Yaxley 800 resistor, 10 ohm.
1 Yaxley 800 resistor, 1 ohm.
1 Homemade resistor, .1 ohm (1 foot 6 inches of No. 28 wire wound on small wooden dowel).
Panel, baseboard, Fahnestock clips.

List of Parts for Visual Signal Indicator

1 Kelford type 200 output transformer (any approximately 1:1 transformer will do).
2 Cheap UX or Navy sockets.
1 Single pole-triple throw battery switch.
1 Electrad type "B" resistor, 1250 ohms.
2 Yaxley 800 resistors, 400 ohms.
2 UX-171A tubes.
1 Weston type 301 milliammeter, 0-5 mils.
Baseboard, Fahnestock clips.
Voltmeter, 2 mfd. condenser, optional.

The above are the components that were used by the author. However, any others having similar electrical and physical characteristics may be substituted.

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The World at Your Fingertips

(*Continued from page 1119*)

Having a good receiver in good operating condition is only half the battle. You have to know when to listen, and at what points on the dials. The accompanying list of stations, with their hours of operation in Eastern Standard time, should be of great assistance to you in this respect.

One thing many people cannot seem to get into their heads is that time is different in different places in the world. Many short-wave set owners finish their suppers at 7:00 or 7:30 in the evening and then sit down to their receivers with the innocent expectation that there will be short-wave stations to hear all evening. This is not always so. Seven o'clock New York time is midnight in London, and G5SW, the famous British Broadcasting Company's short-waver, is just signing off for the night. The writer has read hundreds of letters from people who complain of their inability to bring in London for their bridge guests—at nine o'clock. This is an age of scientific achievement, but even a dozen short-wave sets won't bring in a station that isn't transmitting.

Right now the best times to hear foreign stations are early in the morning and about the middle of the afternoon. Between four and about eight a. m. the stations in Australia, Siam, Siberia, the Dutch East Indies and Holland are quite active, and they deliver astoundingly strong signals. VK2ME, in Sydney, is testing pretty regularly with Schenectady and with the British Post Office stations in England, and comes through with fair reliability. He is not on every morning, but if you don't get him one day you probably will the next.

Those Dutch stations are by far the best ones. PLE and PLF, in Java, working with PHI, PCO and PCK in Holland, operate powerful transmitters, and if you tune way down low on your smallest coil, you can get them loud enough to wake up the family next door.

If you have always confined your listening hours to the early evening, you won't know your set in the early morning. The air is comparatively clear and quiet and the very low-wave stations skip in without much coaxing.

During the afternoon the German stations get busy, and come through just a little under WGY. In England G5SW starts at 2:00 p. m. E. S. T., and is an old stand-by.

As you know, skip distance effects vary with wavelength time of day, and the condition of the atmosphere. Therefore, divide your listening schedule something like this: 14 to about 20 meters, best from daybreak to about 2:00 p. m., and then fades out as darkness approaches; it is useless to listen below 20 meters after dark. 20 to 35 meters, Europeans from 1:00 p. m. to about ten in the evening (if they happen to be putting on late programs). 35 to 75 meters, best between twilight and daybreak.

You can locate many of the foreigners by spotting some of the American sta-

(*Continued on page 1140*)

17,000 Ambassadors of Good Will

(*Continued from page* 1137)

years old next May. It is a vast organization of substantially every worth-while radio amateur in the United States and Canada. It publishes its own magazine, and it is appropriate to the rest of this story that this amateur magazine is recognized internationally as leading the radio industry in the short-wave field. The A.R.R.L. is strictly non-commercial. No person may serve as an officer nor as a director who has any business connection with the radio industry. Its Board of Directors is elected by the membership from each of 14 divisions in the United States and Canada. It meets annually, the expenses of all directors being borne by the League. It maintains a volunteer communications field force that numbers several hundreds, who supervise the practical operating activities, and insuring at all times a smoothly-working communications machine. The present President of the United States when he was Secretary of Commerce personally presented cups to be competed for by the amateurs annually. The amateur accomplishing the outstanding radio feat of the year was awarded the Herbert Hoover Cup. Radio amateurs for many years have been very proud of the type of person whose respect they have gained.

This finishes an abbreviated summary of the radio amateur. He is the product of the wise Act of 1912 which gave him a standing under the law. This act, I submit, was one of the most constructive and valuable bits of legislation that a Congress has ever enacted. Permitting those of our young men who have the natural attainments, regardless of their status in life, to pursue amateur radio, has contributed to the placing of our country in the present position at the head of the radio communication art; it added to our national wealth in providing encouragement and opportunities to thousands of young Americans who probably would never have possessed them otherwise. As their leader I appear before you now in 1930, as I have appeared many times before, to plead that at all hazards you look out for the amateur of today and also for those amateurs who are to come.

Provide for the Radio Amateur

We have no comment to make upon the wisdom of the provisions of S. 6. We wish merely to point out that whether it is a Radio Commission, or the Department of Commerce, or a Communications Commission that is given jurisdiction over radio, provision should be made for the amateur.

We have fared very well under the administration of the 1927 law by the Federal Radio Commission and the Radio Division of the Department of Commerce. They both appreciate the value of the radio amateur. The Federal Radio Commission has put at our disposal the maximum of the facilities made possible for radio amateurs by the 1927 international treaty and in a recent analysis of the high-frequency spectrum publicly expressed regret that the treaty so limited it that it could not continue the previous more extensive allocation of channels to this important group, the radio amateur.' We shall be very well satisfied if the government communications commissions of the future deal with us as fairly as have the existing agencies.

However, any governmental regulative agency will be besieged by commercial interests to grant ever greater numbers of channels to them. It will be urged upon such an agency that the amateur channels are worth thousands of dollars in earning ability. Let me entreat that you believe that those few radio channels which have been left the amateur constitute a value to our nation incalculably greater than any possible money earnings that could conceivably be developed from them by any commercial company.

Finally, in considering a means of regulating communications let me urge you with all the force and sincerity I can command that you bear in mind the radio amateur and make possible his continuance. To do less would be nothing short of a national catastrophe.

The World at Your Fingertips

(*Continued from page* 1139)

tions. For instance, you can get W2XAF (WGY) pretty easily on 31.48 meters; crawl just under him and look for PCJ, NRH, and the German station at Koenigswusterhausen. Little NRH, in Costa Rica, is about two degrees below these. You can spot this group of stations because they are about ten degrees below a very powerful code station on about 33 meters. This is XDA, in Mexico City, which also occasionally uses voice. When it does it sounds just about as WJZ does to a receiver located in Bound Brook.

There is a whole mess of stations around 48 and 49 meters. Generally the American stations fill up the ether pretty well in this band, but if your set is selective you can cut between them and pick out some interesting stations in Central and South America. First locate W3XAU (Philadelphia), and tune just above him for that station, HRB, in Honduras. Log KDKA (W8XK) on its new 49 meter wave, and just below him find HKT, in Bogota, Colombia. After tuning in the powerful American telephone transmitter WND, on 44.4 meters, hang on close and listen carefully for VRY, in Georgetown, British Guiana. The operating hours of these South Americans are given in the list. It is quite easy to identify them, as they obligingly announce in English as well as in Spanish.

Short-wave reception conditions have the habit of changing quickly and without apparent provocation. If you don't hear a single foreign station for a week don't feel discouraged; the next week you may hear a dozen at a time.

Solve That Housing Problem

(*Continued from page* 1087)

and note whether the holes check up with the positions of the controls. When you are satisfied that everything is quite all right, then the holes may be enlarged so as to allow the controls to be adjusted without binding. The large hole for taking the faceplate of the dial should be drilled with a circle-cutter or provided by making a series of small drill holes. When the set has been finally located in its correct position, it may be fastened to the floor of the cabinet. The photographs accompanying illustrate the points brought out in this description and will show the very fine pleasing appearance of the entire assembly, once the receiver has been finally mounted in the bottom of the cabinet. Objection may be raised to the fact that the receiver is mounted quite low and near to the floor, but considering the saving by mounting the receiver in the same cabinet speaker, this objection is not a serious one.

Can We Tolerate Hum?

(*Continued from page* 1111)

Finally, if a strong unmodulated carrier is tuned in, any hum causes present in the r.f. amplifier will bring in hum, caused by carrier modulation in the receiver. This may also increase or decrease the all-over hum of the receiver, depending on whether or not, after detection, its phase with respect to the audio hum of the receiver is zero or some other value, and whether or not its waveform corresponds to that of the audio hum. It is possible to neutralize a strong audio hum by a strong carrier hum in this way if the circuit is properly arranged.

Cornet S.-W. Receiver

(*Continued from page* 1082)

R5, R6—Durham midget plate and grid resistor, .25 meg.
R7, R9—Amperites, type 1A
R8—Amperite, type 622
Two National velvet vernier dials, 4-inch
One National grid grip
One Yaxley jack switch, type 45
One Yaxley cable connector and plug, No. 660
One Yaxley phone
One Yaxley twin jack for phones
Four Eby wafer sockets, 4-prong
One platform assembly for coils
One set Octo coils or home-made according to specifications given in Fig. 3
One X-L binding post and insulated strip.
Metal for chassis and cabinet, as shown in Figs. 7, 10 and 11
Bus bar, solder, etc.

The above are the components that were used in the RADIO NEWS model. However, any others having similar electrical and physical characteristics may be substituted.

FREE New Radio Trouble Finder and Service Manual—See page 1164

Radio Lighthouses for Airports

(*Continued from page* 1086)

were being conducted in a laboratory a few yards away and caused no interference. This four-meter wave also kept the physical proportions of the equipment within reasonable bounds for erection at, or near, an airport.

The air experiments have progressed rapidly. The laboratory model of the receiver was further stabilized. By the control of regeneration and sensitivity it was discovered that the shape of the beam could be made to conform to different shapes at various altitudes. This feature permitted an observer, in a flight across the beam, to receive tremendously strong signals for a period of several minutes, which would vary with the speed of the ship used in any particular flight. The flexibility of this feature of altering the width of the beam at will, within quite wide limits, made it a most desirable one.

Signal Strength Great

One of the most astonishing results of the air tests was the demonstration of the efficiency of this type of reflector for the concentration of radiation in a given direction yet confined to relatively narrow beams. Early tests proved that with a vertical beam the signal strength was tremendous at all altitudes. At various times we had as many devices as two milliammeters, two flashlights and a loudspeaker operating on the output of the receiver simultaneously with no decrease noticeable, and at no time could we operate the receiver at maximum efficiency without running the meters off scale. This gratifying result enabled the researchers to have great latitude in the selection of a receiving circuit for the ultimate design of the receiver, and gave a wide choice as regards the rectifier. The thought most prominently in mind was that the receiver must be automatic and, beyond flicking on the filament switch, the pilot would have no adjustment to make. This would permit the receiver to be installed in some remote part of the ship and not take space that would be valuable for other purposes.

Great care was taken to keep the apparatus in the airplane as simple as possible, and the great signal strength greatly assisted this problem. It was found that it was possible for the airship to fly through the beam without receiving any indication whatever. This was due to the relation of the receiving antenna to a polarized transmitter. Those making the tests, owing to the intrusion of a patent situation, were compelled to avoid the simplest method of correcting this situation and adopt one of two alternatives; either complicate the simple, exceptionally short antenna on the airship or provide some means of emitting a non-polarized beam. A satisfactory compromise was effected by adding another antenna to the transmitter, at right angles to that already described, and by means of a rapidly rotating commutating device or antenna switch, transfer the output of the oscillator first to one antenna and then to the other. This arrangement kept the requirements in the airplane to a minimum.

After numerous "kinks" from a radio viewpoint had been straightened out in extensive tests, the apparatus was submitted to demonstrations for the criticism of Army and Navy pilots. Later numerous commercial aviation experts witnessed the elementary tests and, in all, perhaps fifteen or more experienced pilots and radio experts have flown across the beam, each, in turn, contributing useful hints that progressively improved the apparatus from a practical aeronautical point of view.

The commanding officer of one of the naval air bases, after personally making thorough air tests, was so impressed with its possibilities that he drew the attention of the Navy Department to the matter. He has recommended that it could, perhaps, be used to advantage by airplane carriers in guiding returning pilots to their mother ships after scouting patrols or other naval operations. The Air and Signal Corps of the United States Army, after similar practical tests, are closely investigating the military possibilities.

As far as commercial aviation interests are concerned, and it was primarily for commercial purposes that the research was aimed, the reaction was very gratifying. It was realized that the device must be placed in experimental operation under actual service conditions to ascertain the best means of utilizing the idea. One of the largest air transport companies in the United States co-operated with the radio company whereby two of these paraboloid reflectors would be installed at two of their air terminals and several of their air liners equipped with receiving apparatus in order to accurately try out the many theories. However, due to changes in certain policies made necessary within the radio organization concerned, it was found this plan must be abandoned, at least, for the time being. But the air transport company has engaged the engineer who was most instrumental in bringing this work to the present interesting stage, and announced, through its chief of radio, that they will continue the research within their own organization.

Future Uses

Although the ramification of the beam in aeronautics offers much promise, it was only used in present experiments as a device for localizing an airport in fog or other obscurity. It is planned to use it as a companion device with the aircraft compass. The first theory of operation, that seemed most practical, took into consideration that the aircraft radio compass would bring the pilot along his course, flying upon a radio beacon in the vicinity of his destination, the exact location of which he would be aware of. He would also have information as to the relative position of the compass beacon to his airport. If the area surrounding the beacon and airport is totally obscured

(*Continued on page* 1143)

Radio Lighthouses for Airports

(*Continued from page* 1142)

he would then turn on the switch of his beam receiver. This receiver, arbitrarily adjusted to the wavelength of the beam, would function as he passed through it.

Visual Indications

Two methods of indication would be used, both visual. As he entered the radio field of the beam a small light flashes on, closely followed by the rising deflection of his meter. Dependent upon the speed of the ship, this meter needle will very gradually increase its deflection until a maximum reading is reached and will then just as gradually decrease as the ship passes toward the other limit of the beam. The maximum reading will be recorded at the time the ship is immediately above the transmiter. As this is written, practically all transport lines are either equipping their airplanes with two-way voice radio apparatus, or have ordered the equipment. Long before the pilot nears his destination he will have information regarding the "ceiling" at the field for which he is bound. If it is of sufficient height to permit a landing, with the definite knowledge of the location of the airport given him by the beam device, he could come down through the fog and under the ceiling would have the needed visibility to make his landing. Under present general operating conditions, with a totally obscured area surrounding his destined airport, a pilot has no way of locating that field even though he knows there is sufficient ceiling to land. He hesitates to come down through the obscurity to search for the field under the ceiling because of his lack of faith in the altimeter now in use as there would be too great a risk from surrounding high obstacles. But with positive knowledge of the location of the field and of his own whereabouts, with his information as to ceiling accurate, he can come through in comparative safety. The radio two-way voice apparatus will also have given him the direction of the wind, if any, and his approach be governed accordingly.

Blind Landings

No consideration has been given, so far, to the beam being used in some way that would permit a blind landing with the field obscured right to the ground, with no ceiling at all. In present practice it is customary for the pilot to seek an unobscured field under such circumstances, if the condition has arisen while he was in flight. This writer knows of no pilot who would deliberately attempt a landing on a field in a congested area under such circumstances. It is true that a celebrated military flier has demonstrated the possibilities of a blind landing. However, in the present stage of air transportation, he doubts if any commercial pilot would even think of it under the same circumstances. Devices for blind landing must be infallible in action and so automatic in operation that a pilot will have implicit trust in them, and so accustomed to them that he would use them almost subconsciously. Our present pilots are trained in a school that makes them distrustful of anything but their own senses. There is no group of human beings who must be so thoroughly "sold" upon anything new, as airplane pilots now in command. It is to be reasonably expected that new schools will create instrument-minded pilots who will succeed the old boys. It behooves those who would intelligently assist in the work to keep foremost in their minds, that the modern pilot's duties and responsibilities are so many and heavy that anything that is devised must be of incalculative value. He has little time for further jobs requiring manual operation and therefore a device must preferably be automatic. The twisting of radio dials is an abhorrence to the average pilot. The pay load of an airplane is not sufficiently large that valuable weight may be displaced for instruments that have relatively little value. The aircraft radio compass described in a previous issue, in addition to its guiding value, also serves as a receiver of weather reports and, where the same intermediate frequencies are employed, as a receiver for inter-communication. It is a necessity. The beam receiver is so small and weighs so little that its inclusion is negligible as an addition to the load. It works from the same batteries as the other receiver. It is also possible to utilize the same audio amplifier for both, all that is needed is suitable switching facilities. It is hardly possible that both receivers will be used simultaneously.

Radio of Primary Importance

The interesting experiments described have proved in a practical way that such beams are most useful in aeronautics. It remains to be determined by experiments in practicable application where and how they must be used to best advantage. They demonstrate one thing, beyond doubt, that radio will be one of the most important factors in the new aviation industry. The most intriguing problems yet remain to be solved and radio investigators will uncover them. What about a new radio altimeter? What can be done with a radio bank and turn indicator, or inclinometer? They are around the radio corner somewhere. The above beam equipment, useful as it may be in this initial form, requires only further thought and development to render it a valuable aid to aeronautics in a variety of uses. However, close co-operation between radio and air transport organizations is vitally essential before its full possibiilties can be realized. The time is not far distant when these two great industries will come to realize how one is dependent upon the other.

Short-Wave Receiver Design

(*Continued from page* 1103)

metal sub-panel to which is also added a metal bottom shield. By being careful to see that practically all of the radio-frequency leads are located above the sub-panel, while all of the power supply leads are located in the enclosed compartment beneath the sub-panel, much is done to eliminate troubles from so-called modulation hum.

Another important point to be considered in the construction of the receiver, is the order in which the heater circuits of the various tubes are connected together. In fact, it will be found that running individual sets of twisted pairs from the power unit terminal plug at the back of the sub-panel directly to each socket will give the most satisfactory results. A single set of twisted pairs run around the sub-panel and hooked on to each socket in turn almost invariably causes considerable difficulty.

And now for the final and perhaps least expected of all sources of hum trouble—the interstage r.f. transformer. In order to simplify construction, an attempt was at first made to use a tuned impedance as the interstage coupling device, first as shown in Fig. 7-A and then as in Fig. 7-B, where the stopping condenser is located in the grid return circuit of the detector rather than in the plate circuit of the screen-grid amplifier. In both of these instances the receiver not only lacked the sensitivity obtainable when using a transformer but also suddenly developed a new hum.

Interstage R.F. Transformer

Apparently both of these r.f. coupling devices were capable of passing on to the grid of the detector tube some of the hum frequencies developed in the r.f. circuit. The loss of sensitivity was due seemingly to the fact that there is no such thing as an r.f. choke of infinite impedance at all frequencies, which spoiled the effectiveness from a "gain" point of the circuit. The stopping condenser in the grid return circuit at "B" apparently had considerable impedance at some frequencies which also prevented that circuit from performing at par.

The solution is obviously a radio-frequency transformer as shown at "C", Fig. 7, in which not only is the sensitivity of the receiver kept up where it belongs, due to the complete omission of shunt radio frequency chokes and series blocking condensers, but also all low-frequency coupling between any part of the r.f. amplifier circuit and the detector tube grid is completely eliminated.

There are quite a number of regeneration control systems, each of which seems to have some particular short-wave band in which it operates to best advantage. Where the plug-in coils are used, as in this case, to cover an extremely wide frequency range, it is necessary to find some means of regeneration control that will be smooth at all times and not result in uncontrollable fringe howl, bad hand capacity effects and interlocking.

Of the four most generally used methods, namely, variable plate by-pass condenser, series plate resistor, tickler shunt resistor, and screen-grid voltage control, the tickler shunt resistor method, when accompanied by other circuit details, such as a fringe howl elimination resistor across the audio transformer secondary, results in uniformly satisfactory performance at all wavelengths.

In eliminating body capacity detuning troubles when employing the shunt tickler variable control system, it is essential that the by-pass condenser be located just as close to the variable resistor as is physically possible. When such a precaution has been taken and the receiver is enclosed in a metal cabinet, as shown in the illustrations, no trouble at all will be had with hand capacity detuning effects of any sort.

Tuned Circuits

Good tuned circuits are at the bottom of a good receiver of any sort. Since a tuned circuit comprises a coil and condenser, let us consider both of these units in turn.

Until recently there have been no proper high-frequency tuning condensers, designed for that purpose. The practice has been rather to use some sort of a broadcast-range condenser with a few lonesome plates providing the small capacity actually needed. Some improved designs have appeared quite lately, also some of the more recent "vernier" condensers have by good fortune been well adapted to some high-frequency needs and have been much used for such purposes.

One of the early steps taken in the development of the new receiver, therefore, was the design of the special short-wave condenser. Unlike other small tuning condensers it may be mounted in all of the regulation manners—screwed to a panel, screwed to the base or secured to a panel by the hexagon nut on the front bearing in conventional "single hole mounting" style. At high frequencies any condenser with two bearings tends to be noisy, either at once or else after it has had some use. This tendency can be decreased by the use of a good jumper from rotor to frame and by the use of spring tension to secure good bearing contact. Both devices have in the past been used with varying success. Single-bearing condensers of the "vernier" type, however, are noticeably quieter than 2-bearing types and the difference grows with frequency until at about 60,000 kc. (5 meters) the 2-bearing type has become nearly useless. There are several possible reasons for this trouble. Prominent among them is the effect shown in Fig. 4. The frame and shaft of the condenser form a single-turn coil. As the shaft is turned the bearing contacts change and the single turn is partly opened and closed, tending to produce noises in nearby tubes or those coupled to the condenser. At ordinary frequencies the effect is not serious and therefore need not be worried about, but

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S-W Receiver Design

(*Continued from page* 1144)

at high frequencies it is well worth avoiding. The new condenser accordingly uses but one bearing and that bearing is insulated. The connection from the tuned circuit to the rotor is made through a pigtail of the patented constant impedance type. (See Fig. 5.) The pigtail does not go to the frame, but to a terminal lug on an insulating support at the rear end of the condenser. The stator terminals are close to this terminal, permitting very short leads if desired.

The attractive appearance alone was not the only reason for the selection of the projector type drum tuning control. This dial has two inherent characteristics that make its use particularly valuable in short-wave work. The first is that the projection feature eliminates parallex in the scale reading which prevents accurate logging at the various dial settings without being extremely careful at just what angle the dial is being viewed. The other is the electrically silent vernier drive which is obtained by the use of a non-metallic cord. The silent drive feature, as in the case of the insulated condenser bearing, is very important when tuning in on wavelengths below 20 meters.

Book Review

The Fundamentals of Radio. By R. R. Ramsey. Ramsey Publishing Company. Bloomington, Ind. 372 pages. $3.50.

Like his earlier and popular book "Experimental Radio," Professor Ramsey's "Fundamentals of Radio" covers many theoretical and practical points which have not found their way into radio books. It is a study of the basic theory of radio as it is exemplified in modern practise.

The author considers that "if the fundamentals were limited in number to two they might be given as the resonant, or wave meter circuit, and the three-electrode vacuum tube." His book is largely based upon these two conceptions, and comprises such subject-matter as Electricity, Alternating Current, Inductance, Aerials, Radio Resistance, Long-Wave Transmitters, Radio Telephone, Balanced Circuits, Receivers and Amplifiers. The greater part of the discussion is given over to Vacuum Tubes and their various uses and applications.

A logical and well-developed treatise, this book is perhaps not wholly one for the amateur. A basic knowledge of electricity is required, and Mr. Ramsey occasionally resorts to higher mathematics to explain his theories. All of the modern circuits and "hook-ups" are not explained —only a few typical ones being given to show how the fundamentals are applied in modern practice.

No reader can fail to be struck by the thoughtfulness and logic of the entire volume. Excellent diagrams and pictures of radio apparatus accompany the text.

Push-Pull and Parallel Output Circuits

(*Continued from page* 1105)

volt line as shown. The heater winding is on the filament transformer, if one is used, or else on the main power transformer PT of Fig. 1. The terminals T1, T2 of the relay switch may be connected in at a convenient place in the output or input of the filter system of Fig. 1 if the filament windings are included in the main power transformer PT, but may be connected in the primary side of the main transformer if the filament windings are on a separate transformer.

A single line switch may connect the system of Fig. 1 and the associated relay system of Fig. 2 to the line. Because the cathodes and filament are all cold at first, the winding of relay RL is not energized until the slow heating tube RV of the relay system emits sufficiently to form a rectifier for the 110 volt a.c. When this takes place, the cathode of VT1 and filament VT2 have in the meantime become ready, so that the closing of contact of relay RL to apply plate potential is nicely delayed as desired. A selected resistance R8 in series with the heater of tube RV of the relay system will delay the action any desired time, say 2½ minutes, though the 40 seconds of the usual slow heating type -27 tube is usually quite satisfactory.

The push-pull amplifier in outward appearance is much like the conventional single output tube amplifier. In the above, two -45's are used in push-pull

It is apparent that should there be occasion to switch off the system for but a few seconds, the relay will then require but a few seconds to come into action after switching on again, since the tubes will still be hot and also ready to take the load immediately. It is further apparent that the contact of the little relay does not have to break under high voltage when the system is switched off since all potential is first removed by opening the main switch, and it is the removal of this potential that causes the relay contact to open.

Before leaving this 50-watt tube system, a word of warning to those who are not electrically informed may not be amiss. The potentials required are high enough to be positively dangerous, even death dealing, and therefore should be handled with the utmost care.

Returning now to the safer and more popular type -45 tube as output, the system of Fig. 3 shows a way of usefully employing the speaker field in the additional function of output choke while, at the same time, the field is adequately energized without additional drain on the filter or without requiring a separate energizing source.

Referring to Fig. 3, the new features are injected as modifications in the system described in detail in our March, 1930, RADIO NEWS article. F is a 4700-ohm field winding of a dynamic speaker taking the place of the 4700-ohm resistance, Rld, in the March article. This field is thus energized with the 32 milliamperes of current through tube VT2. By placing the speaker output transformer OT in series with the signal by-pass condenser C2 in Fig. 3, and the figure of the March article, the speaker field, so located, acts as a choke to direct signal current through output transformer OT and signal condenser C2. This, diagrammatically considered, seems to leave the plate circuit of tube VT2 more or less deserted, but a little thought tells that everything is all right just the same. The speaker field is most effective as an audio choke, as is proven by the very good frequency characteristic obtainable with the system. In spite of the rather large distributed capacity of the field coil the characteristic does not fall off materially at the high frequency end.

Because of the very high cost of the type -50 tube and its required type -81 rectifier, it is more economical to use two type -45 tubes with a single type -80 rectifier when the next step above the output ability of the single type -45 tube is wanted, this irrespective of the type of audio amplifier. Fig. 4 shows the manner of connecting two type -45 tubes in parallel in the direct-coupled system of Fig. 3 to increase available output energy.

Since this parallel connection of the tubes doubles the current through the resistances R1a, P and R1c, the values of these resistances should be about one-half those given in our March, 1930, RADIO NEWS article. Also the resistance of the speaker field F should be halved to about 2,300 ohms, and at this will be excited with about 10 watts. This wattage dissipation increases the resistance of the field to about 2,500 ohms when warm, which fact must be taken into consideration when designing the resistance network.

The internal resistance of the output circuit is halved by the parallel connection of the output tubes, so that for efficiency reasons the primary impedance of the output transformer should be reduced to about 2,000 ohms, and the capacity of the signal condenser C2 may be increased to about 2 microfarads to advantage.

This parallel connection of the output tubes does not cut the overall amplification of the system in half as is had in the usual push-pull systems through having to split the input potential between two tubes.

Now considering the subject of push-pull as to which we have been asked much in connection with direct-coupled systems, about the only advantages in push-pull not inherent in direct-coupling, and which we might therefore seek to benefit, are first, that the output transformer in push-pull has no polarizing or saturating current to upset its characteristics and, second, that the low frequency signal currents do not have to squeeze through a condenser in order to be effective on the speaker.

There is no difficulty in working direct-coupled systems in push-pull fashion through two high impedance input tubes, but there is difficulty in working push-pull, by either resistance or direct-coupling from a single high impedance tube, and so far we have not accomplished the latter to our satisfaction as an engineering matter.

It has been said that necessity is the mother of invention. Wishing to bring into direct-coupled systems the two advantages

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Push-Pull and Parallel Output Circuits

(*Continued from page* 1146)

of push-pull above mentioned as not inherently possessed thereby, we followed the dictates of necessity and invented something. In doing so we went push-pull better by about four times without using its practices, but, at the same time, sweeping in the two advantages sought. The system is extremely interesting and decidedly capable.

Fig. 5 shows one arrangement for using two output tubes with direct-coupling and a single input tube to obtain the two advantages learned from push-pull and sought by us. Because of the length of the present article we will do no more than briefly outline the features of the system and indicate its results at this time, leaving the details for a later date.

The basis of the system, as will be seen from inspection of Fig. 5, is the working of a single direct-coupled amplifier comprising tubes VT1 and VT'2 into one-half of a push-pull transformer PPT, and using the output tube VT'2 as a signal current phase reversing element for introducing signal energy of proper phase onto the grid of a second output tube VT"2 connected to deliver energy to the other half of the push-pull output transformer. This is done by taking some of the output signal energy of tube VT'2 from the resistance R7 and introducing it onto the grid of a second output tube VT"2 in proper phase and such magnitude as to cause tube VT"2 to deliver substantially the same amount of signal energy to its half of the push-pull transformer as is delivered to the other half by tube VT'2.

It is seen that the push-pull transformer is relieved of direct current effect and that there is no signal current condenser in the output system. There is no splitting of the input signal potential into two halves for delivery to two tubes to reduce the overall gain to one-half, but a full delivery to the grids of each of the two output tubes to double the overall gain.

The graphs of Fig. 6 show the efficiency and good frequency characteristic of a particular Fig. 5 system having a type –24 input tube at VT1 and two type –45 output tubes at VT'2 and VT"2. The logarithmic abscissae represent frequency in cycles per second, the linear ordinates at the left the ratio of potential of signal output to potential of signal input for graph A. and the linear ordinates at the right transmission units in so-called decibels for graph B. Graph B is a conversion into transmission units (decibels) of the results of graph A. Graph A shows a substantially uniform gain in excess of 800 from the neighborhood of 35 cycles to 2,000 cycles. The transmission unit, graph B, shows the small effect of the falling off at the high frequency end of the audio range.

The July issue of

RADIO NEWS

will be a special show number announcing plans of leading manufacturers for 1930-1931.

IN AERO NEWS AND MECHANICS
for June-July

Several choice glider articles covering every phase of this popular art are to be found in the forthcoming June-July issue.

Capt. Robert A. Smith, Manager of Fairchild Aerial Surveys, Inc., tells most interestingly of the troubles that beset the pioneer aerial photographers, taking us through the war days right up to the present.

A most comprehensive story about the possibilities of steam power for aircraft has been prepared by Alfred M. Caddell, who has investigated the field for this little known power plant.

"*Vacations in the Air*" carries its own appeal, and inasmuch as this was written by Capt. Frank M. Hawkes, holder of both the west to east and east to west trans-continental air records, it may be depended upon that this story is good.

Capt. Lewis A. Yancey, of trans-Atlantic flight fame, has gone thoroughly into the elements of flying meteorology, and when we have an expert to diagnose weather, the chances are that the reader will learn something about it.

"*Flying the Timber Trail,*" by James Nevin Miller, is a most interesting account of the forest fire air patrol.

And "Dawn Patrol"—a true story of the Royal Flying Corps in the war, simply takes the reader's breath away.

"*The Aircraft Diesel Makes Its Bow*"—the story of the development of the Packard Diesel, by Capt. L. M. Woolson.

"*Air Ferries, Ltd.*"—the shortest airway in the world is also one of aviation's progressive stories.

Junior Radio Guild

(*Continued from page* 1134)

Much of the equipment necessary for the construction of a code practice outfit can be built by the fellow who is handy with tools. A block of wood, some screws and a strip of spring brass will provide quite a serviceable key and an ordinary door buzzer can be adjusted so as to give a high-toned sound.

Many fellows, however, will want a more elaborate outfit than that described here, and for him several manufacturers have placed on the market automatic code-sending machines which require no more attention than starting and stopping them.

One type of a code learning device. A spring motor equipped with a regulator permits the operator to adjust the transmitting speed

These machines are operated by a spring motor which pulls a perforated tape past two contacts. As the perforation passes the contact they are caused to close the key circuit. Some of the perforations are dots, while others are dashes. Thus the code characters are transmitted. By a governor the speed of the machine can be set to any desired value. An illustration of one of these automatic senders accompanies.

Lend by Me ah Cople Ears!

(*Continued from page* 1096)

Hour by Milt Gross. What a trio and what a hit this bit of foolery made with millions of enthusiastic radio listeners!

When enjoying a little spare time—which is not often—Burbig retreats to his hunting lodge near Danbury, Conn. Hunting and fishing are his hobbies. His home is in Riverdale, New York.

Burbig's book, "Leffin' Ges," has reached a nation-wide audience. It has been revised and reprinted. Jeff Spark, radio announcer and cartoonist, illustrated both editions.

Biographically speaking, Burbig is a New Yorker. Thus he has ample opportunity to observe New York in all its varying phases; to study the types of entertainment people of the lower and middle classes prefer. By this study and by adapting his burlesques to the stories and myths best known to the largest number of people, Burbig has come out on top.

Enliven That Summer Cruise with Radio

(*Continued from page* 1100)

altered to overcome this one great bugbear. A change to resistance coupling, while solving the major problem, has the added advantage of improving the quality of the reproduced sound. Of course, with other conditions being equal, this type of coupling is not as efficient as that used originally, but on the average boat we obtain a fairly good pick-up, great volume is not required in the limited cabin space, and we can regain part of the loss through the use of high-mu tubes in place of -01A type. The use of a -22 screen-grid tube for the first audio stage will solve the problem, but, in the interest of rigidity and simplicity of filament wiring, a -40 will be preferable and will give almost as much volume.

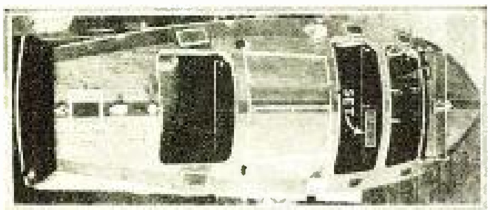
In making the old table set sea-going, we will replace the audio amplifier, mount the chassis on a mahogany panel, and—where other than a 6-volt supply is to be used for the filament—arrange the "A" battery circuit to work most economically.

the drawing Fig. 5. Cut four pieces of wire about 1⅛ inch in length, and solder an end of each to the condenser lugs, pointing the wires of each condenser in opposite directions. Press the condensers in the resistor bases, with the lugs inward and to the sides of the blocks. The connections are bent upward through the hollow rivets, which hold the resistance clips, and soldered connections are made on the top.

Now, as a step to prevent rusting, varnish over that part of the sheet-iron chassis where the resistor mounts are to rest. Secure the units in place with 6-32 machine-screws and nuts with spring washers to provide firmness without the danger of cracking the bakelite.

Using Fig. 3 as a guide, wire the amplifier in accordance with the layout shown in Fig. 5. The connections are few and quite direct.

There is no need of changing the filament circuit unless the most convenient



Left shows the placement of the revamped receiver in an open or displacement speed type of motorboat. A speaker may be an integral portion of the bulkhead, while a second speaker, of a portable type, may be found necessary for beach parties, etc.

Tackling the amplifier job first, we remove the set from the metal case, disconnect and discard the two metal cases containing the audio transformers. This gives us a clear space between the bakelite socket panel and the metal panel which carries the controls. In this space we drill four holes in the locations shown in Fig. 2. These are to accommodate ¾-inch 6-32 R.H. brass machine-screws which bind the Aerovox double resistor mounts in the position shown in Fig. 3. Before these units can be permanently placed, we must remove the interfering metal strip used to hold the battery cord to the under side of the base. The simplest means is to discard the strip entirely, move the cord to some other position, and drill and tap the base for an 8-32 thread. The ends of the machine-screws can be filed off even with the base, if necessary.

With each resistor mount we require a .006 mfd. coupling condenser. The units can be purchased with such condensers in the hollow base, but, for marine use, moulded condensers are so much to be preferred that they should be purchased separately. The manufacturer of the hollow-base double resistor mount turns out a moulded condenser of the capacity we want and of such dimensions that it can be made to fit into the base.

To accomplish this we bend the terminal lugs tightly around the bakelite body, as shown in Fig. 4. For securing the most direct wiring of the units, we connect the condenser to diagonally opposite terminals rather than to adjacent clips, as we usually do. This is illustrated in

filament-supply source is a 12-volt or 32-volt battery. To accommodate a 12-volt system, clear the sockets of their parallel connections and wire the six tubes in three parallel groups, each of two tubes connected in series. The first two pairs are connected in parallel and to the rheostat or volume control resistance before being joined in multiple with the last two tubes. Grid-return leads are brought to the negative sides of their respective tubes except in the case of the detector, where this connection is allowed to remain at the mid-point of a shunt resistance.

Where the yacht employs a 32-volt electric system, the whole "A" battery circuit of the receiver can be wired in series and supplied directly from the line. With this hook-up, the current drain is only ¼ ampere, or only half that of one of the smallest electric lamps ordinarily used. Consequently, the operation of the set can be accomplished without an extra 6-volt battery, and quite economically at that. As in the case of the 12-volt wiring, grid returns are made to their respective tubes. But in this network of every filament in series, we can no longer use the rheostat that comes with the set as a volume control. It is entirely too low in resistance. A filament control of at least 30 ohms is essential if the sound intensity is to be regulated by this means; or a 400-ohm potentiometer can be shunted across the filament bank, and the variable tap used to change the grid potential on one or more of the radio-frequency tubes. Still another possibility is

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Enliven That Summer Cruise with Radio

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to employ a variable 0 to 500,000 ohm resistance in place of the grid leak of the first audio amplifier tube. There are few variable resistances available of a size so small as to fit in the bakelite housing which carries the switch and rheostat. But it is entirely feasible to mount the resistance on the rear of the metal panel and connect it to the original knob by slotting the end of one shaft and cutting the other so as to fit in the slot.

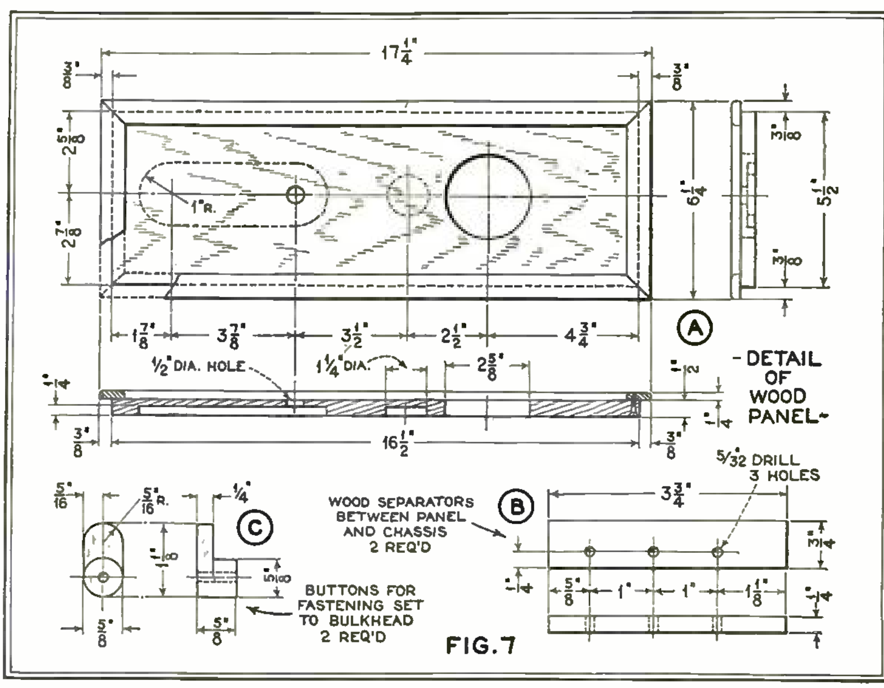
In small boats it is not uncommon to find a battery cable so saturated with moisture that there is an electrical leakage between conductors sufficient to gradually run down the "B" battery. As a guard against this condition, coil the cord and place it in a container of hot paraffin. Continue to heat the paraffin while the cord is immersed, as this will increase the penetration and, consequently, the desired waterproofing.

As we find that the average yacht seldom has table room for a broadcast receiver, we attach our converted outfit to a panel in such a way that it can be mounted flush with a bulkhead, cabinet or drawer. The interior trim of ninety-nine per cent. of pleasure boats is of mahogany, so we have little reason for selecting any other stock for our radio panel. Instead of a thickness of 3/16 inch, as we are accustomed to use in bakelite or hard rubber, our mahogany panel will measure ½ inch. More correctly, it will be ordered as ½-inch stock, but its actual thickness may be somewhat less as the result of planing. Purchase enough wood to make a panel 5½ x 16½ inches, and 44 inches of moulding ¾ inch wide. Fig. 7-A gives the panel dimensions, location and size of holes and recesses, and details of the moulding. The large hole is cut by boring a series of ½-inch holes with a wood bit, and smoothing up the circle with a chisel and half-round file. During the boring and chiseling operation, the work should be clamped against another piece of wood to prevent the mahogany from breaking out. The recesses are marked and drilled at random with a twist drill of perhaps ⅜ or ½-inch diameter. A wood bit cannot be used here, as the leading screw point would penetrate the other side of the panel. The holes are drilled only closely enough to facilitate the chiseling of the depressions.

The wood used for the border or moulding is planed down to a thickness of ¼ inch, and the corners on one side are rounded. With a fine tooth saw, mitre the ends so as to make tight, right-angle corners. Be sure to allow lengths sufficient to have the moulding extend over the edges of the panel by ⅜ inch all around. Secure these pieces of trim by means of ¾-inch No. 6 flat-head woodscrews. The long sections take four screws and the shorter ones two each. The screws are put in from the back, and, since they are slightly long, they should be turned in for all but ⅛ inch of their length, then removed, ⅛ inch of their tips filed off, and, finally, reinserted and turned down until the heads are flush with the back of the panel. This procedure will prevent the screws breaking out the front of the moulding, and hold much better than shorter screws.

Fig. 7-B gives details of two wood spacers or separators that are clamped between the chassis and the panel. Like the panel trim, these pieces are of ¼-inch stock. Being thin and comparatively short, the No. 27 holes are drilled to accom-

(*Continued on page* 1151)



Above are the details for the new panel, as well as the button fasteners and separators for the revamped A. K. 35

Summer Cruise

(*Continued from page* 1150)

modate screws and to avoid the danger of splitting the pieces.

The fasteners shown in Fig. 7-C are secured to the rear of the panel in such a way that they can be turned to clamp the set to a bulkhead or other support. The dimensions given are more for the purpose of illustrating the idea than to supply exact sizes. Obviously, one measurement will depend upon the thickness of stock to which the receiver is to be fastened. This method of mounting eliminates the necessity of using any screws between the instrument and the bulkhead.

With the woodwork now in proper shape, the next step is the finish. Each piece is sanded with the grain, using No. 1 sandpaper, until all scratches or depressions disappear. Of course, the front of the panel requires the most attention. After the No. 1 sanding, the outward surfaces are gone over again with No. 0 paper. Particular care should be exercised at the corners where the grains of the pieces run at right angles. And sanding cross-wise of the grain will leave scratches which, if not removed, will be visible under the varnish coating.

Dust thoroughly after sanding, and apply the first coat of finish. Yachtsmen as a rule are lovers of nice wood, and do not care to have the material's color changed by the use of stains or wood dyes. The finish is merely to protect the delicate—and usually beautiful—grain. If the set is likely to be exposed to moisture, no shellac can be used as a filler, as it is likely to turn white under certain conditions. It is safer to employ a spar varnish throughout. Give the work a thorough coat. By that it is meant to strike every little corner with the brush rather than to put the varnish on too thickly. Even though the so-called "four-hour" varnishes may be used, the first coat should not be sanded for at least 24 hours. Then No. ½ and No. 0 paper are used to smooth down the surfaces showing, so that practically all of the varnish remaining is in the pores of the wood. The second coat is applied even more carefully than the first, and, when dry, the surface is sanded lightly with the No. 0 paper. For the third coat, the varnish brush must be cleaned of any dust particles, the work thoroughly wiped off, and the varnished pieces placed to dry where there is least likelihood of dust being raised to settle on the tacky surfaces. With some mahogany, three coats of varnish is sufficient to give the desired glass-like surface. The builder can best judge what is required for his particular case.

Details of installation being beyond the scope of this article, Figs. 8 and 9 are given to show typical installations aboard well-known water craft. As for accessories, the "B" supply can be limited to 135 volts, the speaker will in most cases be of the magnetic type, as it is seldom that the boat's capacity is sufficient to accommodate a dynamic, and the tubes should be -01A's for radio-frequency and detector, -40 for first audio and -12A for the final stage.

Charting the Seas by Radio

(*Continued from page* 1123)

of the telegraph key necessitates close association of the high potentials of the transmitting set with the amplifier, and all of the three shore stations must respond with a radio signal—a condition to be avoided. To prevent this a clock-work mechanism at each shore station is put in motion by the radio amplifier used in conjunction with the hydrophone. This clock-work or automatic key rotates a code-wheel governing the sending of radio signals at well-defined intervals after the clock-work begins to function. This arrangement simplifies the identity of signals from the three different shore stations. The lag in this automatic key must be computed and compensated for in calculating the travel period of sound.

The receiving set proper used in this radio-acoustic system of charting may be adapted to the reception of short waves, frequencies within the broadcast band, or even long waves. Ordinarily two stages of audio-frequency amplification are employed—the stage amplifier having windings of a relay in the output circuit. The output of the receiving set proper goes to this amplifier. By an adjustment of the grid potential of the two vacuum tubes the circuit is resolved into such a state that there is an absence of current flowing in the plate circuit of the output tube. Thus no current obtains passage through the relay windings unless a signal is admitted, when the strength of the current is adequate to actuate the relay. A meter indicates the amount of current available to operate the relay, and also the correct operating condition of the amplifier.

The chronograph or time-recording unit was designed to meet the special operating conditions encountered on board ship. The instrument derives its power from a series motor whose speed is controlled by a centrifugal governor. The speed of the motor is 1,800 revolutions a minute and the drum of the chronograph completes one revolution in either one or one-half minute. This variation in speed is effected by a reducing gear train, which includes a gear shift. The drum may also be set at "neutral," where it can be rotated by hand for the convenient mounting of the recording sheet of paper. The gear train and governor, turtle-like, are enclosed in a shell or house as a protection against dust, and as a safeguard from sparking. The motor, being series wound, is inclined to do marathon sprinting. When it reaches a critical speed the governor, with human-like behavior, functions to open a contact which previously has short-circuited a resistance unit in the form of an incandescent lamp. The switching of this bulb into the circuit cuts down the voltage across the motor terminals and slows it down. The contact is then closed, the motor speed increased, and the cycle is repeated—normally some 30 or 40 times a second. The incandescent lamp flickers with uniformity when the governor contact is operating correctly.

The radio amplifier employed in conjunction with the hydrophone or under-

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Four Radio Books at Magazine Prices
See page 1158

Charting the Seas by Radio

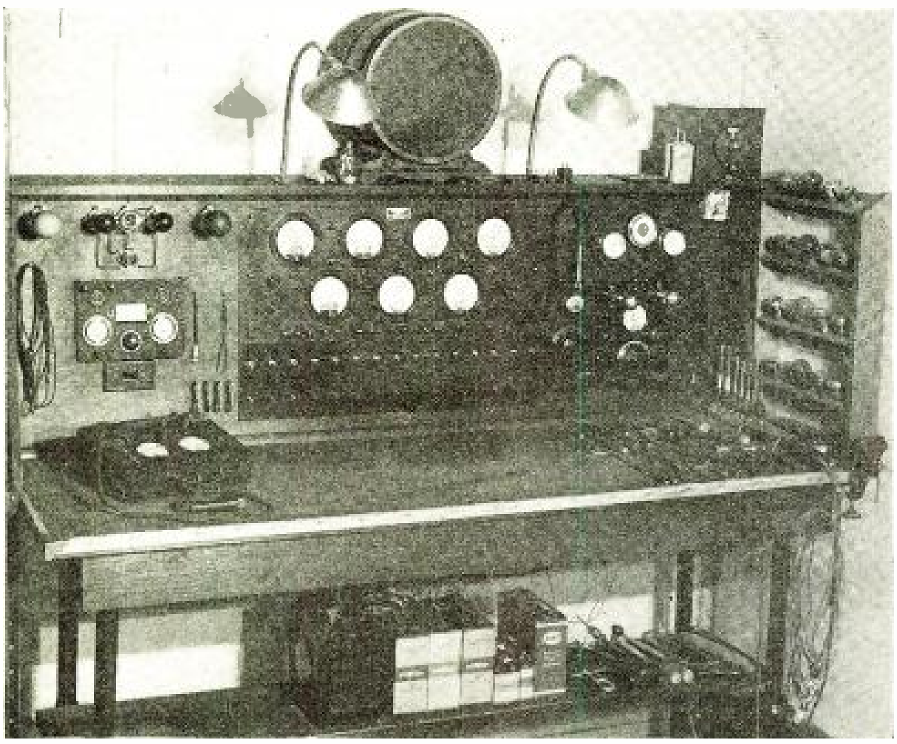
(*Continued from page 1152*)

water microphone serves a two-fold object. It boosts the strength of the current variations in the hydrophone circuit when a sound wave passes over the underwater microphone. This boosted signal serves to actuate a relay. A second function of this radio amplifier is to boost the current variations in the radio receiving set proper. The switching from one of these functions to the other is effected by throwing a triple-pole switch on the front panel of the apparatus. The equipment (illustrated) is described by the Coast and Geodetic Survey as follows:

The terminals for the underwater microphone supply battery, the control rheostat, the current-indicating meter, and the single-pole switch for opening the hydrophone circuit are shown in the left of the photograph. By plugging a telephone into the jack, the amplified effects of disturbances in the hydrophone circuit may be heard. Another jack is employed to connect the radio receiving set to the amplifier. In the middle of the apparatus is shown the triple-pole switch, the position of which determines whether the amplifier relay response is to a sound or a radio signal. The meter on the right indicates the current in the relay circuit, and the switch and rheostat serve to control the filament current in the vacuum tubes. In the extreme right of the picture are the output terminals which connect the automatic key.

The grid elements of the vacuum tubes are adjusted to a potential which is negative with relation to the filament elements. Thus there is an absence of current-flow in the relay circuit when the underwater microphone current is steady, or in the "lag" switch position when no signals are entering the receiving set. This grid bias affords opportunity to operate the relay when adjusted at its greatest sensitivity. There is an additional advantage from this grid biasing in that it may be rendered more negative if water noises or other extraneous disturbances trip the relays. However, for a time, the noisy oyster, off the coast of the Atlantic Ocean, near Morehead City, North Carolina, thwarted the efforts of Coast and Geodetic Survey surveyors in charting by the radio-acoustic ranging system. These bivalves set up a form of interference entirely new to radio reception.

Ten Dollars for a "Lab." Photograph!



The photograph above, submitted by Mr. L. F. Lyon of Syracuse, New York, illustrates the rather complete test bench which he employs in the servicing of radio receivers. Tubes, tools, test meters and instruments, together with batteries and portable test equipment, are kept in neat array ready for immediate use. RADIO NEWS will pay $10.00 for photographs illustrating test laboratories, test benches, etc., accepted for publication which are submitted by bona fide servicemen. Let us know what equipment you use and what makes of sets are serviced most

An 80-Meter Installation

(*Continued from page* 1109)

full on. By listening in on a receiving set, as mentioned before, you can tell at what value the microphone gain control should be left for good modulation.

The Receiver

The next topic for discussion is the receiver, which is located in the same cabinet as the transmitter, just below the latter, as shown in Fig. 1. It is of the standard type but made highly efficient both from the standpoint of mechanical and electrical design.

In Fig. 10 it is seen that the two dials in the front represent the tuned radio-frequency control (at the left) and the detector tuning stage (at the right). The knob in the center controls the regeneration condenser while directly below it is the phone jack and filament switch. The front panel is made of aluminum and presents an extremely fine appearance, being set off nicely by the jet-black dials which cover its face. A heavy, well-seasoned board of 5-ply oak constitutes the base of the receiver. On it are mounted practically all the parts of the set.

In Fig. 9, which is a back view of the receiver, you can see the general layout. At the right is the can which houses the entire tuned radio-frequency unit and on the left is a can which contains the detector tuning unit. Fig. 5 shows the top view of the receiver and illustrates the extremely neat construction in the inside of these shielded units. Rugged condensers are used, they being of the same standard type which is employed in the S-W Four receiver described in the August, 1929, RADIO NEWS. Mounting of the coils is accomplished by supporting the coil sockets on brass pillars extending from the bakelite base mounted in the bottom of the shielded units. The plug-in coils permit change over from one waveband to another, ranging from 14 meters up to 550 meters. At the back of the receiver you can see the audio unit which is mounted on the base as a separate unit. All the main connections interconnecting the radio-frequency unit, the detector unit and the audio unit are made directly from a series of connection blocks mounted at convenient places on each unit. Mounting these independent connections on the shielded units is accomplished with the aid of insulated strips which isolate the connections from the metal cans. This method of connection is necessary in order to insure complete shielding in each of the units. All the wiring of the individual units is made underneath their respective base panels, thereby making for short direct connections and an all-around neatness of the receiver.

The schematic circuit of the receiver is shown in Fig. 4. It employs four tubes, the first being a -22 d.c. screen-grid tube, used in the tuned radio-frequency amplifier circuit, and the second a -00A, used in the regenerative detector circuit. This

(*Continued on page* 1155)

An 80-Meter Installation

(*Continued from page* 1154)

tuner is followed by two stages of transformer-coupled audio-frequency amplification, in which two -12A tubes are employed. As has been explained before, the receiver is turned on and off by means of the change-over switch which is located on the lower part of the panel of the transmitter. Method of connecting the filament circuit of the receiver to the change-over switch is indicated in the circuits of the transmitter and receiver.

Some idea of the general assembly of the receiver will be obtained from the photographs which accompany, while specifications for drilling the front panel and the bakelite pieces for the bases of the shield cans and also the audio unit are contained in Figs. 3 and 8 respectively. Each of the units of the receiver, namely, the r.f. unit, the detector unit and the audio unit, should be assembled and wired separately; that is, one at a time, and then when completed should be wired one to the other to make a complete receiver.

To listen in on the receiver, it is necessary first that the change-over switch of the transmitter be in the "receive" position. Also, the filament switch on the panel of the receiver should be turned to the "on" position. Then, turning the regeneration knob so that the plates of this condenser are completely meshed so as to produce an advanced state of regeneration, slowly turn the tuning dials in easy stages. That is, the dial for the tuned radio-frequency unit should be set at say 50, and then the detector condenser dial should be moved over a small arc at approximately the same position. Then, if no signal is heard at this point the radio-frequency dial should be moved a few more points, either one way or the other, and the swinging of the detector dial repeated. In this way you are sure to cover the entire range of the receiver, working from the low end of the dial to the high end. Of course, it is assumed that previous to listening in, the receiver has been properly connected to its various batteries and the headphones inserted in the phone jack. As a signal is tuned at any one of these settings, a loud squeal will be heard, due to the fact that the regeneration control has been fully advanced. Therefore, to clean up the signal, whether it be code or phone, it is necessary to retard the regeneration control until the squeal disappears. At this point, after the squeal has been eliminated, it may be necessary to retune both the r.f. and the detector dials so as to keep the signal in tune.

For two-way communication, once another station has been picked up on the receiver, it is merely necessary to flip the change-over switch from the "receive" to the "transmit" position.

The parts employed in this portable transmitter-receiver are as follows:

Transmitter Parts

1 Set of tuning inductances (See Fig. 11)
1 R.E.L. r.f. choke coil, L1
1 Amertran audio choke, 30 henries, L2
1 Amertran Deluxe audio transformer, 1st stage type, T1
1 Ferranti transformer, type S57-2, T2
2 Cardwell variable condensers, .00045 mfd., C1, C2
2 Sangamo mica condensers, .00025 mfd., C3, C4
1 Sangamo mica condenser, .002 mfd., C6
1 Ward Leonard resistor, type No. 507, 5000 ohms, R1
1 Yaxley 12 ohm fixed resistor, R2
1 Electrad potentiometer, type E, 0-500,000 ohms, R3
1 General Radio heavy duty rheostat, 2 ohms, R4
1 Carborundum resistor, 12,000 ohms, R5
1 Jewell thermocoupled ammeter, type No. 68, 0 to 1.5 amperes, A
1 Jewell d.c. voltmeter, type 88, 0 to 8 volts, V
1 Yaxley single-circuit phone jack, No. 1
1 Yaxley Junior jack, No. 706
1 Federal anti-capacity switch
3 Benjamin sockets (1 No. 9036 and 2 No. 9040)
2 Four-inch dials
1 Aluminum panel, 16 by 15 inches
4 Brass supporting legs, 6½ inches long by ⅜ inches diameter (See Fig. 12)
Bakelite, 3/16 inches thick for subpanels and connector strips (See Fig. 12)
1 Eureka clip for oscillator coil
2 ft. No. 10 hard copper wire (antenna and ground connections)
Hook-up wire, screws, nuts and washers

Receiver Parts

2 Plug-in coils, type 131V—T1, T2
1 Aero R.F. choke coil, No. 60—R.F.C.
2 Amertran audio transformers, type A.F.8—T3, T4
2 Cardwell taper-plate variable condensers, .00015 mfd., C1, C2
1 Pilot midget variable condenser, .00005 mfd.—C3
2 Flechtheim by-pass condensers, 1 mfd.—C4, C5
1 Sangamo fixed condenser, .00015 mfd.—C6
2 Dejur 5-prong sockets (for coils)
4 Benjamin sockets (subpanel type No. 9036)
1 Yaxley 12 ohm resistor—R1
1 Yaxley 10 ohm fixed resistor—R2
1 Yaxley 1 ohm fixed resistor—R3
1 Aerovox 3 megohm resistor and holder—R4
1 Aerovox 100,000 Metalohm resistor and mount—R5
1 Yaxley filament switch, No. 10
1 Yaxley single circuit phone jack
8 Eby binding posts engraved
1 Panel aluminum, 15 by 8 by ⅛ inches
2 Alco shield cans, 7 by 5 by 6 inches, with cylindrical tops
4 Brass supporting legs, 3½ inches long, ⅜ inches diameter (for coil socket support)
12 Brass supporting legs, ½ inch long, ⅜ inches diameter (for shield can subpanel spacing)
Plywood baseboard, hook-up wire, screws, nuts and washers
1 Audio channel bakelite subpanel, insulation strips, etc.

The above are the components that were used by the author. However, any others having similar electrical and physical characteristics may be substituted.

Radio's Husky Offspring

(*Continued from page* 1118)

do not change, and we intend to deal mainly with these.

The combination of sound and motion pictures is so new and the public demand so great that the results up to very recently have given a wrong idea of the possibilities that exist. That some sound pictures have been poor there is no doubt, but diligent investigation and research by competent radio engineers who have gone over to the sound field indicate that better sound reproduction is in store. It is the same condition that existed in the radio field six or seven years ago. Everybody from the man "on the lot" to the projectionist in the booth has had to learn a new job, and we venture to say that before very long it will be possible to enjoy the talking motion picture as much as a play presented on the stage today.

Relieve Driving Monotony With Auto-Radio

(*Continued from page* 1083)

driver has been content to go just a little slower, and thus with less strain on his nerves.

Not long ago, five of us made a run of something under a hundred miles. and for three of the five. it was the first ride in a radio equipped car. As we started off, there was a lot of conversation about the route we were to take, what time we would arrive, and about the program in the distant city, which we were all looking forward to with considerable anticipation. Naturally I was watching to see just what the effect of the radio would be. Several questions were addressed to the driver, and each time. in answering, he turned his head, and for a moment at least, took his eyes off the road. We were soon out of town and on the highway, and it happened that there was a very good band concert coming from one of the local stations. There was a real pleasure in driving along to the tune of a good march number. It was no time at all before all conversation in the car ceased, and we rode for almost two hours. with hardly a word spoken. Everyone seemed contented to ride and listen. and the driver (for I was watching him) hardly took his eyes off the road. At one point we had a rather close call with a truck coming suddenly out of a side road, and I wondered just what might have happened if we had all been talking. Without question, the radio was less diverting than conversation would have been, to the driver.

Today hundreds of thousands of us are driving back and forth to business in our cars. We cannot drive and read our morning paper at the same time, for both reading and driving require the constant attention of the eyes.

But now we can have a radio in the car, and we can fill this driving period with pleasant diversion. Perhaps some of our broadcasters will take advantage of these morning and evening hours to give us brief flashes on the topics of the day, leaving us to read the important details of the matters that interest us most in our newspapers at the office or at home.

Not so long ago, traveling men made their trips always by train. They spent long hours in Pullmans and Parlor Cars reading and talking. Today a great proportion of them are riding day after day alone in automobiles. They can tell us, better perhaps than any other group, just what radio equipment in a car really means. Only a small proportion of them, of course, are driving radio-equipped cars, but the number will rapidly increase, for the enthusiasm of those who have equipped cars knows no bounds. An entirely new wave of appreciation for the broadcast programs is coming from these men who must spend many hours with nothing else to do but drive.

Some of the very best short programs come between seven and eight o'clock in the evening. It is by no means un-

(*Continued on page* 1157)

Relieve Driving Monotony

(*Continued from page* 1156)

usual that we must make a choice between going to see an excellent talking picture, and hearing the worthwhile programs that come just at the time we must be on our way. But with radio in the car we can "eat our cake and have it" and every minute that we can give to entertainment can be filled with it, whether we are at home, or on the way to or from the theatre.

If you will observe the cars parked along the streets in any city, you will be surprised to see how many of them are not empty. Perhaps the driver is waiting while someone shops, or the passengers must wait while the driver does an errand. All of us do some of this waiting, sitting in a car, with nothing to do but watch the world go by. Give us a radio to listen to, and waiting will not be the tiresome and irritating process it now is. It won't make so much difference whether we wait ten minutes or half an hour.

Thus, in a thousand ways, automobile radio is filling minutes and hours that would otherwise be empty and dull, if not actually tiresome and fatiguing.

Applying the Supersonic

(*Continued from page* 1114)

At that time we discussed the thing with Manson E. Wood, a radio engineer of Boston, who had been an early follower of the writer's original Supersonic. He, too, had been following out the same line of reasoning and started to work on it soon afterward.

This idea, however, goes even further than the usual new idea in that it fits into the existing picture with ease. In the original Supersonic we had been able to use a Browning-Drake receiver tricked up a bit for the intermediate amplifier. In this new Short-Wave Supersonic we found a most happy condition, and that is the millions of owners with good broadcast receivers which would serve perfectly well as the intermediate amplifiers and audio ends of this new job. Thus anyone having a broadcast set and wishing to listen to short waves could feel that they were getting full return from their radio equipment investment since it would all be in use. This in turn meant that but a small amount had to be expended to turn the broadcast receiver into a perfectly good Short-Wave Supersonic. Present-day broadcast receivers, particularly the a.c. shield-grid models, have a terrific kick and make wonderful intermediate amplifiers for our purpose.

This brings us down to the remaining apparatus; namely, a frequency changing and tuning mechanism which could be conveniently placed ahead of the broadcast set. It meant building a short-wave oscillator and detector unit which would be so simple it could be used by anyone. Incidentally, while it sounds simple, it is a difficult engineering job.

Mr. Wood had much radio courage and started in. He found many problems confronting him, but this is not a story of the development. Enough to say that a few weeks ago he brought us a finished model which we tried and found out that for once a theory worked out exactly in practice as it had on paper. This little frequency changing panel didn't have a squeal in it.

It is as different from tuning the usual short-wave receiver as tuning a present-day broadcast set is against the forty-four knob supers of the old days. There are no squeals or whistles. Two dials, one tuning quite broadly, are slowly turned and the stations just pop in like they do on a good night on a broadcast set. There is no critical tickler to juggle. Best of all, the tone quality does not sound squeezed, as it usually does in voice and music reception with regeneration.

In fact, this system is much like the one broadcast listeners now have when the big broadcasting chains relay a short-wave program from Europe. In the latter case the signals are received and amplified at a short-wave receiving station, then sent along to a broadcast transmitter and then picked up on the broadcast set. In this instance, the waves are received and changed to a broadcast wave with the short-wave signals on it which is in turn put into the broadcast receiver, where it is amplified and finally comes forth from the loud speaker.

Thus you have your own short-wave pick-up and re-broadcasting system right in your home, and instead of having to amplify twice, the amplification in your radiocast set takes care of the whole thing. Here is high quality, efficient and simple short-wave reception. Our next article will go into the technical details of the Wood Supersonic Short Wave Panel.

Is Direct-Coupled Amplifier a New Audio System?

(*Continued from page* 1116)

resistor will increase with the input of signal. This is true of any self-biased tube but ordinarily the effect is insufficient to maintain the grid negative when the input signal is large. However, if we considerably over-bias this tube by making "Rk" very large and placing a positive bias on the grid tube of slightly less magnitude than the positive bias on the cathode, we may readily choose constants that will keep the grid negative irrespective of the signal input. Any drift effect is also compensated for by this method, as the grid bias of the last tube is controlled by the plate current of the first tube.

In closing, the writer wishes it understood that this article was not intended to be a thorough technical discussion of the circuit, but rather to give the reader a glimpse of the work that was necessary to bring this circuit up to its present state of perfection.

In July RADIO NEWS Mr. Fleming will describe how the S-W amplifier system is used for public address and speech amplifier systems.—*Editor.*

The Experimenter

(*Continued from page* 1126)

operate satisfactorily with less amplification, but the radio tubes and power-back are under considerable strain. The radio tubes burn out in short order, resulting in costly operation.

Frequently the power-pack breaks down, resulting in a big item of expense. In the latter, insufficient line voltage, the radio set operates with weak volume and poor tone quality.

Now, if the line voltages are constantly "high" or "low," the problem would be comparatively simple. Instead, however, line voltages may fluctuate from "high" to "low" throughout the day and at indefinite intervals. Within a few minutes there may be an enormous difference in line voltage.

Fortunately, there are ways and means of meeting both the steady "high" and "low" voltages, as well as the fluctuating voltages. In the case of the former, the excessive line voltage is compensated for by one of two methods, namely, a plurality of primary taps on the power transformer, or a fixed resistor. There are several, so called, line voltage regulators now available, which are simply fixed resistors of 15 or 20 ohms, serving to reduce excessive voltage. By referring to the accompanying graph, Fig. 4, it will be noted that the fixed resistor reduces the applied voltage. The short diagonal line indicates the radio set placed directly on the line without compensation. It will be noted by glancing at the bottom row of figures, indicating line voltage, and at the side, figures indicating applied or primary volts, that the two keep in perfect step. In the case of a fixed resistor, as shown in the dash line, the curves are parallel to the "direct on line" curve with the uniform drop of 15 or 20 volts. Obviously, the fixed resistor can be employed only to reduce the line voltage. Being fixed, it cannot compensate for lowered voltage. Therefore, when the line voltage drops below 105, the resistor should be taken out of the circuit and the set operated directly on the line. In some sets the use of various transformer taps permits compensation for lowered voltage, manually and preferably with an accurate voltmeter to determine an exact line voltage. The ear is a poor guide in this matter.

More recently the automatic line voltage regulator, or line balance clarostat, has appeared. This device makes use of a special resistance winding, the resistance of which rises rapidly with increased applied voltage, thereby striking the desired balance and maintaining primary voltage within the five per cent plus or minus specified by the two radio tubes guaranteed. The second heavy line represents what happened when the line balance is employed. It will be noted that the curve is considerably flattened out as contrasted with the direct "on line" and the fixed resistor curves. Thus the line voltage may drop as low as 95 and rise as high as 135, while the primary voltage remains practically within the five per cent plus and minus of the 115 volt mean. There are, at present, several ad-

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The Experimenter

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vanced models of broadcast receivers now provided with automatic line voltage regulators.

Troublesome Voltages

There are still many beginners in radio, and also many who are just starting to change from battery to a.c. operated receivers. To them the following may be of some assistance:

So many of the present-day sets have screen-grid tubes, it is felt that it would be well to start with the voltage as applied to the control grid of this tube as in A of Fig. 5. The grid of this tube is of the same potential or electrical level

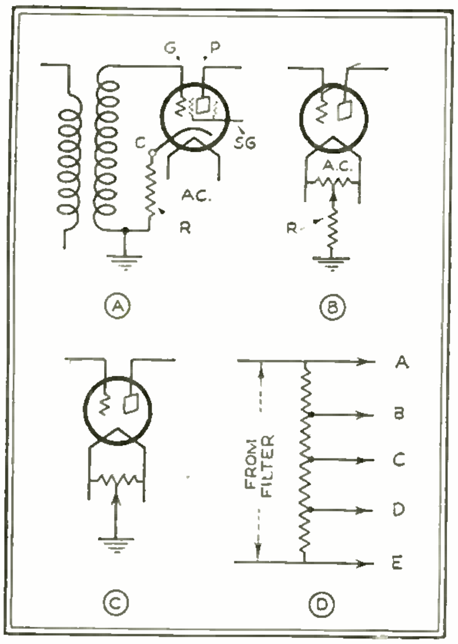

Fig. 5

as ground, because the grid is connected to ground through the secondary of the radio-frequency coil. In order to place any negative voltage on this grid it is necessary to raise the cathode of the tube in a positive direction. The cathode in a.c. tubes takes the place of the filament return in the old d.c. tube.

It must be remembered that the plate current passes through the plate to the cathode and then to the ground, but first it must pass through the resistance R. It will be necessary to use Ohm's law in arriving at the correct value of R. E=I.R.; E stands for electrical voltage drop, I stands for the current in amperes, while R stands for the resistance in ohms. Let us assume that with the above tubes that 4 milliamperes flow (.004 amperes) and that the resistance R is equal to 400 ohms. Then, by simple multiplication we find the product of .004 times 400 is equal to 1.6 volts.

The cathode of the tube is then 1.6 volt positive above ground, and also the grid, as they both are at the same potential. The same method of calculation is used with the –27 tubes, which, for an example, we will say draws 6 mils with the cathode resistor of 1,500 ohms (.006 times 1500 equals 9 volts).

It will be noticed that all voltages are thus taken from the cathode and, to be correct, should be measured from there. With a small grid bias, as on most radio-frequency tubes the error is slight, but many sets now employ power detection where the grid bias of 20 to 30 volts may exist.

The grid bias for power tubes is obtained in the same manner, but in this case the power tube only has four prongs. The cathode has been omitted, as the filament furnishes the return for the plate current. To prevent hum, a 10 ohm center-tapped resistor, in the case of a –45 tube and a 20 ohm resistor for a –71 a is placed in shunt across the filament and is either connected to a resistor to ground as in B or directly as in C of Fig. 5.

In A of Fig. 5 the action is identical with the screen grid tube as explained above, but in C, voltage must be applied to the grid as the filament return is of the ground potential. This does not mean that the filament has any a.c. voltage. It merely means that the a.c. voltage of 2.5 or 5 volts, depending upon the type of tube employed, is kept at the ground potential, d.c., or raised to a certain d.c. voltage above ground. This may be more plainly realized by taking an electric light bulb furnished by 110 volts a.c. and carrying it up a ladder. This does not change the a.c. voltage, but it does change its direct position (potential in respect to the ground).

In order to supply C in Fig. 5 with a grid bias we must go to the power supply of the set. The power rectifier tube supplies a d.c. voltage of a certain potential, which is in accordance with the a.c. voltages applied to the plate. This d.c. voltage, which is usually in the neighborhood of 300 volts, passes through the rectifier system of the set and then is placed across the voltage divider, which does just as its name implies, it divides the voltages to those required for the proper operation of the radio receiver.

In D, Fig. 5, A to E represents the voltage divider with various taps at B, C and D. If ground and B negative is at E, then the potential between the tap A and E will be in the neighborhood of 300 volts, with intermediates at the other three points. Such will be satisfactory when operated with a power tube as in B, but will not be satisfactory for C, Fig. 5. It will be necessary, therefore, to move the ground and B minus to tap D, allowing the proper amount of resistance between this tap and tap E to provide 45 volts minus in respect to the ground.

The July issue of

RADIO NEWS

will be a special show number announcing plans of leading manufacturers for 1930-1931.

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Musical Tones

(*Continued from page* 1098)

Before you try to play any selections on the oscillator it is very strongly recommended that you be alone in the room with all the doors and windows shut tightly; because of all the unearthly shrieks and howls that can be generated known to man, a beat note oscillator takes the prize by a great deal. Don't let this frighten you, since it should not take more than several hours to make the results acceptable to the ear. If you have an ear for music, learning to play one of these instruments should give you a great deal of pleasure.

The volume control for the instrument, while not elaborate, is sufficiently complicated to require separate treatment. It will be described in a later issue of RADIO NEWS. This volume control is so arranged that bringing the hand nearer to a control rod will cause the volume to decrease, taking the hand away will cause it to increase. Thus the right hand controls the pitch of the music and the left hand regulates the volume. With the exception of the volume-control details you now have all the information necessary to build this set—Go to it . . . and don't forget what we said about keeping the doors and windows closed.

Serviceman

(*Continued from page* 1127)

that there has not been any mistake made. Then it is sandpapered and oiled to give it a flat finish appearance that will remain free from finger-prints. That being completed, it is placed face up on a clean sheet of paper the full size of the panel and all holes are outlined with pencil, after which the orders for the engraving are marked on the paper in the position you wish the engraver to follow, allowing, of course, enough room for flanges on the meters and other clearances.

By the intelligent use of shunts and resistors, the various meters can be made to read over a number of scales other than that for which they were originally intended. The first meter to be dealt with is the Weston 0-10 milliammeter. The 3" scale size is preferable to the smaller models, due of course to the greater ease in reading the scale. It is necessary to make two shunts for this meter, raising the reading to 50 and 100 milliamperes. The wire used for this can be 15 mil manganum wire, or ordinary No. 22 nichrome wire (which is easier to obtain). The procedure of finding the correct length of nichrome wire to be used as the shunt is the cut-and-try method, using a second milliammeter of the required range for comparison; or with a clarostat, a 4½-volt C battery and the 10 milliammeter which is to be used. The clarostat is adjusted until the meter reads "full 10 mils." The nichrome wire shunt is now connected across the terminals of the meter, and ad-

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Serviceman's Department

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justed so that the meter reads "2 mils." When this is done with a little care, the result will be a 50 mil shunt. The length of wire used may now be wound on a strip of bakelite and fastened with screws and bolts at each end, along with soldering lugs for connecting. The 100 mil shunt is now constructed in the same manner, using the 10 mil range full deflection, but adjusting the shunt so that the meter reads 1 mil. The meter scales may now be lettered on the face of the meter, making it a triple scale, or a complete new scale may be drawn and glued over the old one. With ordinary care the constructor will now have a very accurate three-range d.c. milliammeter.

The second meter, 0-250 volts high-resistance voltmeter, should be of the 1,000 ohms volt type. The meter used on the finished panel (see photograph—the one directly below the two sockets) is a Weston high-resistance voltmeter with a double scale of 0-5-250 volts. To raise the scale, place in series with the meter 250,000 ohms for the 500-volt range and 500,000 ohms for the 1,000-volt range. As an alternative, we can proceed according to the schematic diagrams. The meter used there is 0-1 milliammeter in series with four resistance values of 50.000 ohms, 200.000 ohms, 250,000 ohms and 500,000 ohms, all connected in series. Again the original scale is removed, and a hand-drawn scale of 0-50-250-500-1,000 volts is substituted. Both methods are equally accurate and the resistance used was the Electrad type C. On the Electrad type C resistance the end clamps may be loosened and, by shifting, any deviation may be corrected.

Next in order is the grid voltmeter with a scale of 0-10-100 volts, 1.000 ohms per volt. Here again we make use of the 0-1 milliammeter which is raised to the voltage required with resistors, a value of 10.000 ohms for the 10-volt range and 90,000 ohms for the 100-volt range will be found correct. The a.c. filament voltmeter which is also used to test line voltages is a standard Weston three-range a.c. voltmeter or its equivalent. The d.c. filament voltmeter, likewise, is of the standard 0-7 volts scale.

The fifth meter in this group is a Weston 0-1 milliammeter, used with the original scale, the two terminals ending in a plug so that this meter may be employed with respective jacks as shown in the circuit diagram. This meter plays an important part in the measurement of screen-grid tubes.

It may also be used in conjunction with the 10,000-ohm resistor in series with one of the jacks as a 0-10 volts high-resistance voltmeter.

A few words may not be amiss as to the construction of the panel and the wiring arrangements.

The two push-buttons on the lower half of the panel marked "G" and "FG" are grid and screen grid, respectively, and were made from the compact arrangement of a single-pole double-throw jack. The frame of this jack is removed and the springs are clamped to the panel with bolts. Between the long center spring which usually engages the tip of the plug and the hole on the panel right above the same, a push-button, made from a bakelite rod with a collar on the lower end, is placed between the spring and the panel in such a manner that the spring holds it against the panel and always closes the upper contact as the button is depressed. The same construction applies to the shield-grid tube button.

Two sockets are placed so that no adapters are necessary, on the right for five-prong tubes and on the left for the four-prong type.

The Yexley switch right below the tube sockets is used to connect the cathode to the negative filament lead, or to disconnect it, as required. A baseboard is attached to the panel, with suitable angle brackets, the length of the baseboard being the same as the panel and about eight inches wide. It serves to mount the C battery, transformer, resistors and shunts.

The two jacks used are placed one above the other—one of them being shown on the panel, the other having been added since the photograph was taken, shown in the circuit diagram. These jacks are used for screen-grid and distortion of radio amplifier tests, one being of the open-circuit type, while the other is a single-circuit, closed jack. The reason for the closed-circuit jack is that the extra contact prevents the grid circuit from being left open at any time through accidental partial insertion of the plug during the testing of tubes of the –45 or –50 type, permitting excessive current flow in the plate circuit in ends of any grid bias. An eight-conductor cable is used with this test panel, four of the heavier wires being used for the filament pup jacks on the panel, two each in parallel. The remaining four are connected to the plate, grid, cathode and the screen-grid control grid. It is well to make the cable at least seven feet in length so as to allow a sufficiency to handle anything on or near the bench. To complete the cable assembly, connect seven of these wires to a five-prong tube base. After soldering the wires to the prongs wrap heavy waxed thread about the cable for a distance of about four inches to prevent excessive wear of the cable at the socket. Melt some battery wax, pouring into the socket about the cable, filling it full and allowing time enough for it to cool without jarring. The eighth wire, which was attached to the pup jack marked "control grid," is left out of the plug. This wire is soldered to a cartridge fuse plug end, and is used to attach to the screen-grid clip which goes to the control grid terminal of the tube in the set under "test." The panel itself has a short length of wire between the socket with a screen-grid terminal clamp tip attached to complete the circuit when the tube is placed in the socket in the panel. For all a.c. sets the switch below and to the right of 0-7 d.c. voltmeter (see photograph) remains in the off position, elimi-

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Serviceman's Department

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nating this meter from the circuit. For a test on d.c.-operated receivers the switch is thrown on, and the switch to the right of the meter, which is in a series-parallel connection, is thrown in position where the filament voltmeter indicates correct polarity, all the switches on the a.c. filament meters on the right naturally being in the off position.

For the d.c. –22 tube, when the grid switch is thrown to the grid position, the grid voltmeter will register the screen-grid voltage that is being applied to the tube. For the grid swing test, the button marked "SG" is depressed. All other d.c. tests are similar. There is only one precaution to be observed which applies to both a.c. and d.c. alike, and that is in keeping one rule in mind at all times. Always have M.A. meter switch at 100 M.A. position and the voltmeters at their highest position, first making a test, later adjusting the multiple switches for meter readings on lower scale.

A feature of this test panel is that checking the meter range switches for voltages required for the particular type of tube, whether radio-frequency, detector or audio, there are no buttons to press or any switches to change. By merely plugging in this socket a complete reading is obtained. The test panel is particularly valuable when making tests on the new –24 tube. Here the meters will show a.c. filament voltage, plate current, plate voltage and screen-grid voltage. By merely throwing the screen-grid bias switch to the grid "up" position, and furthermore, merely plugging the d.c. milliammeter plug in the upper jack, screen-grid current in fractions of milliamperes may be read, and by plugging the same meter in the lower jack the grid bias voltage, by reading the scale of milliamperes in volts, each tenth of a mil representing one volt, is also obtained. A few notes in testing the amplifier circuit will come in handy. The meters will not show true values for a plate and grid voltage. The rule applies in all cases where the amplifier plate and grid circuits are filtered. Rather high resistances are encountered in the grid lead, generally on the order of 20,000 to 50,000 ohms and it is not practicable to measure screen-grid bias through the tube sockets on the amplifier. The only way to ascertain the correct voltages is by applying independent leads for respective tubes ahead of the filtering resistors. A high resistance in the grid circuit has no appreciable effect on the potential applied to the grid as long as there is no current flow, but even the best 1,000-ohm per voltmeter will draw anywhere from one-quarter to one mil of current for partial and full-scale deflection, and even that small amount of current is sufficient to cause a large voltage drop when applied through a grid resistor. This will also affect the plate voltage and plate current meters, so whenever there seems to be any appreciable increase in plate current when switching the grid meter in the circuit, be sure and take plate voltage and current readings with the grid voltmeter switched off.

The 0-150-600 a.c. voltmeter was made by loading a 0-15 Jewel meter with sufficient non-inductive resistance to read the scale 40 times its original value. The top scale reading of 600 volts was sufficient to test most power packs of today and is very useful in measuring the secondary voltage of power transformers.

The combination Weston volt-ammeter has a scale range of 0-3 amperes in 1/10 ampere divisions, and 0-30 amperes in 1 ampere divisions; as a voltmeter it has 0-15 volts in 1-volt divisions and 0-150 volts in 5-volt divisions. Only the ammeter portion of this meter was used, and it was found extremely handy in testing chargers from the trickle to the large 5-ampere type.

The a.c. milliammeter is a Jewel 0-50 mil, shunted to 5 amperes. Attention must be drawn to the fact that the 0-50 scale division will not apply to the 5-ampere range. The instrument must be calibrated with a standard meter of sufficient range, and the readings noted on the face of the scale.

Parts Used in the Panel

1 Weston 0-1 milliammeter
2 Jewell 0-1 milliammeters
1 Jewell 0-10 milliammeter
1 Weston a.c. voltmeter, 0-4-8-150
1 Weston d.c. voltmeter, 0-7
1 Jewell a.c. milliammeter, 0-50
1 Jewell a.c. voltmeter, 0-15
1 Weston volt-ammeter; amps 0-3, volts 0-15-150
18 Yaxley filament switches
2 Yaxley d.p.d.t. switches
1 Yaxley d.p.s.t. switch
1 Yaxley a.c. switch
1 G. R. a.c. filament rheostat
1 UX socket
1 UY socket
18 switch point contacts
32 Yaxley pup jacks
1 Universal clarostat
1 4½-volt C battery
1 G. R. filament transformer, volts 1.5, 2.5, 5, 7.5
1 single-circuit closing jack
1 single-circuit open jack
2 Electrad resistances, 10,000 ohms
1 Electrad resistance, 90,000 ohms
1 Electrad resistance, 50,000 ohms
1 Electrad resistance, 200,000 ohms
1 Electrad resistance, 500,000 ohms
1 Electrad resistance, 250,000 ohms
1 rotary switch, two contacts (has to be made up)
1 phone plug
1 50-mil shunt (has to be made up)
1 100-mil shunt (has to be made up)
2 grid-bias push-button switches, to be made from jacks
1 8-conductor cable, about 7 feet
1 5-prong tube base
1 4-prong tube base
1 5-prong top of Benjamin socket for adapter
1 clamp for shield-grid tube top

The above are the components that were used by the constructor. However, any others having similar electrical and physical characteristics may be substituted.

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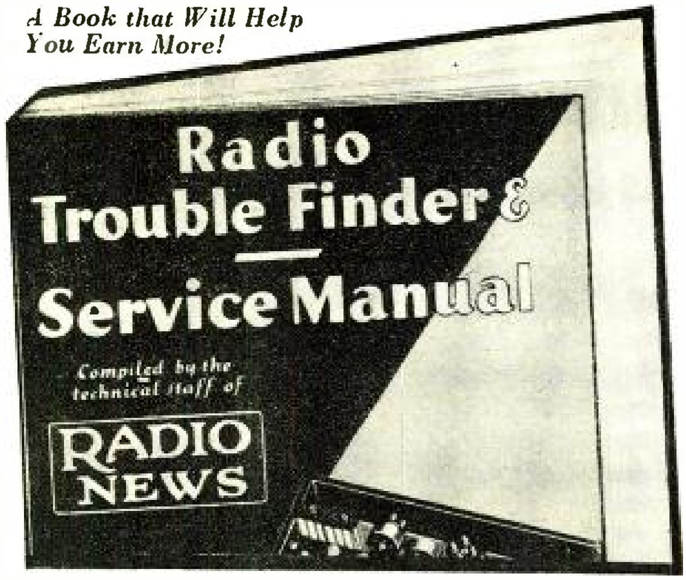

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HOW TO USE TEST EQUIPMENT—SERVICE PRELIMINARIES, The Jewell Analysis Chart—NO SIGNALS, General Causes, Localizing Trouble, Power Supply, Loudspeaker.

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JOHN F. KIRK,
1514 No. Main St., Spencer, Iowa.

My Free book gives you many more letters of N. R. I. men who are making good in spare time or full time businesses of their own

I will show You too

how to start a spare time or full time Radio Business of Your Own on extra money you can make while learning

J. E. Smith, Pres., National Radio Institute

The world-wide use of receiving sets for home entertainment, and the lack of well trained men to sell, install and service them have opened many splendid chances for spare time and full time businesses. You have already seen how the men and young men who got into the automobile, motion picture and other industries when they were young had the first chance at the key jobs—and are now the $5,000 $10,000 and $15,000 a year men. Radio offers you the same chance that made men rich in those businesses. Its growth is opening hundreds of fine jobs every year, also opportunities almost everywhere for a profitable spare time or full time Radio business. "Rich Rewards in Radio" gives detailed information on these openings. It's FREE.

So many opportunities many make $5 to $30 a week extra while learning

Many of the ten million sets now in use are only 25% to 40% efficient. The day you enroll I will show you how to do ten jobs common in most every neighborhood, that you can do in your spare time for extra money. I will show you the plans and ideas that are making as high as $200 to $1,000 for others while taking my course. G. W. Page, 107 Raleigh Apts., Nashville, Tenn., writes: "I made $935 in my spare time while taking your course."

Many $50, $60 and $75 a week jobs opening in Radio every year

Broadcasting stations use engineers, operators, station managers, and pay $1,800 to $5,000 a year. Radio manufacturers continually need testers, inspectors, foremen, engineers, service men, and buyers for jobs paying up to $15,000 a year. Shipping companies use hundreds of operators, give them world-wide travel at practically no expense and pay $85 to $200 a month. Radio dealers and jobbers are continually on the lookout for good service men, salesmen, buyers, managers, and pay $30 to $100 a week. Talking Movies pay as much as $75 to $200 a week to the right men with Radio training. My book tells you of other opportunities in Radio.

I will train you at home in your spare time

Hold your job until you are ready for another. Give me only part of your spare time. You don't have to be a high school or college graduate. Hundreds have won bigger success. J. A. Vaughn jumped from $35 to $100 a week. E. E. Winborne seldom makes under $100 a week now. The National Radio Institute is the Pioneer and World's Largest organization devoted exclusively to training men and young men, by correspondence for good jobs in the Radio industry.

You Must Be Satisfied

I will give you an agreement to refund every penny of your money if you are not satisfied with my Lessons and Instruction Service when you complete my course. And I'll not only give you thorough training in Radio principles, practical experience in building and servicing sets, but also train you in Talking Movies, give you home experiments in Television, cover thoroughly the latest features in sets such as A. C. and Screen Grid.

My 64-Page Book Gives the Facts

Clip and mail the coupon now for "Rich Rewards in Radio." It points out the money-making opportunities the growth of Radio has made for you. It tells of the opportunities for a spare time or full time Radio business of your own, the special training I give you that has made hundreds of other men successful; and also explains the many fine jobs for which my course trains you. Send the coupon to me today. You won't be obligated in the least.

Get my new book It points out what Radio Offers You

You'll get practical Radio Experience with my new 8 Outfits of Parts that I'll give you for a *Home Experimental Laboratory!*

Rear view of 5-tube Screen Grid Tuned Radio frequency set — only one of the many circuits you can build with my parts.

My course is not all theory. You use the 8 Outfits I'll give you, in working out the principles, diagrams and circuits used in modern sets and taught in my lesson books. This 50-50 method of home training makes learning easy, fascinating, interesting. You get as much practical experience in a few months as the average fellow who hasn't had this training gets in two to four years in the field. You can build over 100 circuits with these parts. You experiment with and build the fundamental circuits used in such sets as Crosley, Atwater-Kent, Eveready, Majestic, Zenith, and many others sold today. You learn how these circuits work, why they work, how they should work, how to make them work when they are out of order.

Get the facts on my Lifetime Employment Service to all Graduates

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