THE RADIO EXPERIMENTER'S MAGAZINE

SHORT WAVE CRAFT

Edited by
HUGO GERNSBACK

ARTICLES BY

L. W. Hatry
R. W. Tanner, W8AD
"Bob" Hertzberg
Dr. Erwin Schliephake, M.D.
E. T. Somerset, G2DT
A. H. Haidell
John M. Avery
C. H. W. Nason
H. W. Secor

IN THIS ISSUE

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April—May

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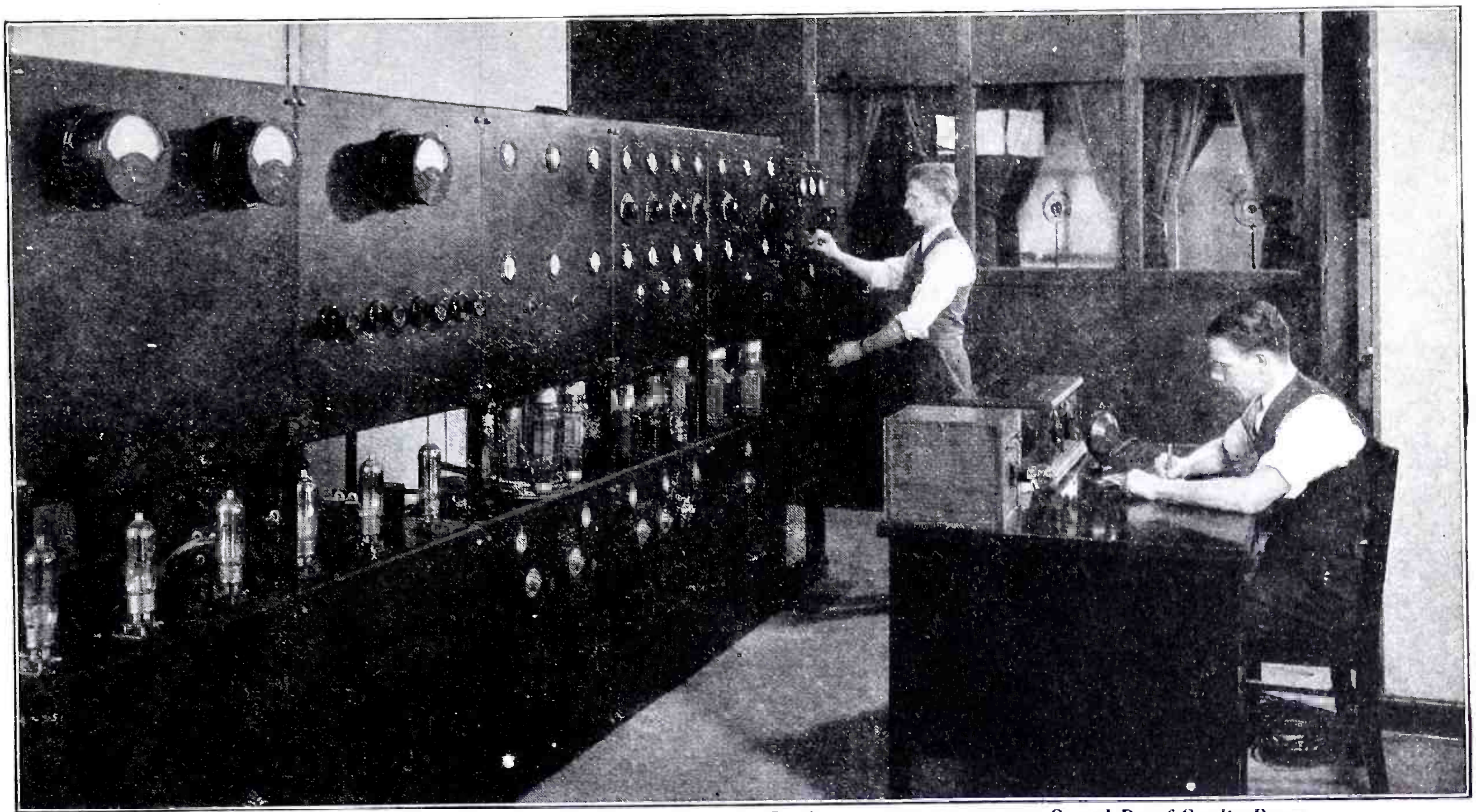

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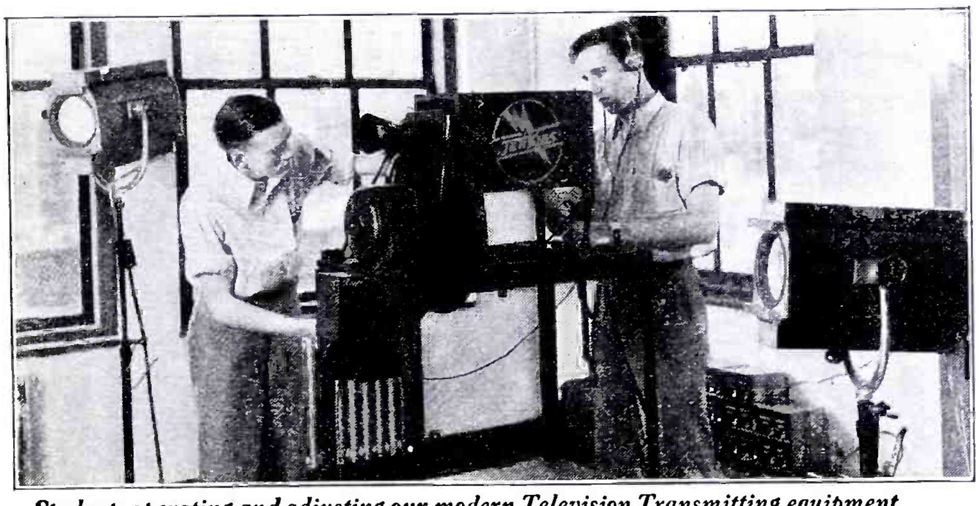

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HUGO GERNSBACK, Editor H. WINFIELD SECOR, Managing Editor

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HUGO GERNSBACK
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SHORT WAVE CRAFT

H. WINFIELD SECOR
MANAGING EDITOR
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Short Waves for the Public

By HUGO GERNSBACK

THE radio industry is noteworthy, in that practically every phase in its development keeps on recurring, in an orderly, cyclical fashion. Even in the spark-and-code days it was not uncommon for the public, although they couldn't read the code at all, to become interested enough to listen to the mysterious messages that floated in through the ether. Indeed, many a radio "ham" was made by listening in to the code messages over the 'phones and electrolytic detector until, finally, through sheer curiosity, he picked up the code. When broadcasting came along and you could hear music and speech, the process was, of course, much simplified; and many a non-technical radio enthusiast started by building his own set in order to listen to the programs.

History is repeating itself again on the short-wave band which, it may be stated, presents to the general public the same interesting difficulties that other forms of radio did in the former cycles.

Now that it is necessary only for the lady of the house to flip on a switch and turn a dial to get radio broadcast programs, the technically-inclined "young hopeful" is apt to sniff at radio; and he is no longer interested from a technical standpoint. Since, however, a little ability and a little brains are required to get short-wave programs from the antipodes, that again is something different, and at once his curiosity becomes aroused.

The present discussion centers, practically, on short-wave converters, which are now becoming the rage all over the country; chiefly because every radio set in the home, no matter what its type, can be used to bring in short waves by means of such a converter.

There are now a great many such converters on the market, while directions for building them are also plentiful; and it is becoming quite the thing to hook up one of these auxiliaries to the home radio set, in order to bring in programs from all over the world. American listeners find no trouble right now, in the afternoons, in listening in to some very fine musical programs originating in Berlin, London, Milan and other European cities; and, when it is possible to bring in these programs on the loud speaker, with volume comparable to local stations, even the most blasé set owners will sit up and take notice.

The fact that no structural changes in the usual broadcast set are necessary, in order to connect it to the short-wave converter, makes the sport all the more interesting; because neither father or mother can object to the converter. Quite the contrary; after they have heard a few foreign programs, they are usually converted easily to short waves.

But what I wish particularly to point out here is that the enterprising radio man can make a small "killing," these days, by means of these short-wave converters. We know of a number of young men out of work each of whom got hold of a converter and demonstrated it in private houses; a sale was then almost invariably the direct result. One young man of our acquaintance sold no less than eight converters in a single week, at a very excellent profit to him. Nowadays, it would seem, few radio men are blessed with an over-extended pocketbook; and the short-wave converter seems to be the answer for the industrious man who is not afraid to do a little work on the outside, even in late afternoons or evenings, in order to demonstrate to friends and acquaintances the marvels of short waves. In addition to the monetary gain, it is also important to make new converts for short waves, and to open up to the general public the wonders of short-wave reception. Of course, the purchaser should be cautioned not to expect too much. For instance, short-wave reception in the Eastern United States is quite poor in the evenings, during the winter months the best reception is to be had in the late afternoon. Of course, there may be exceptions to this statement but, as a rule, evenings are none too good for short-wave reception. The customer should be told these things, so that he will not "go sour" on short waves and pronounce them a fake. Irreparable harm can be done to the confidence of the public in short waves, unless the man who has experimented with the converters knows what can be done and what cannot be expected.

Ultimately, every radio set in the home will no doubt be equipped with its short-wave auxiliary, which will be built right into the set. But, until that time comes, a considerable harvest can be reaped by the enterprising radio enthusiast.

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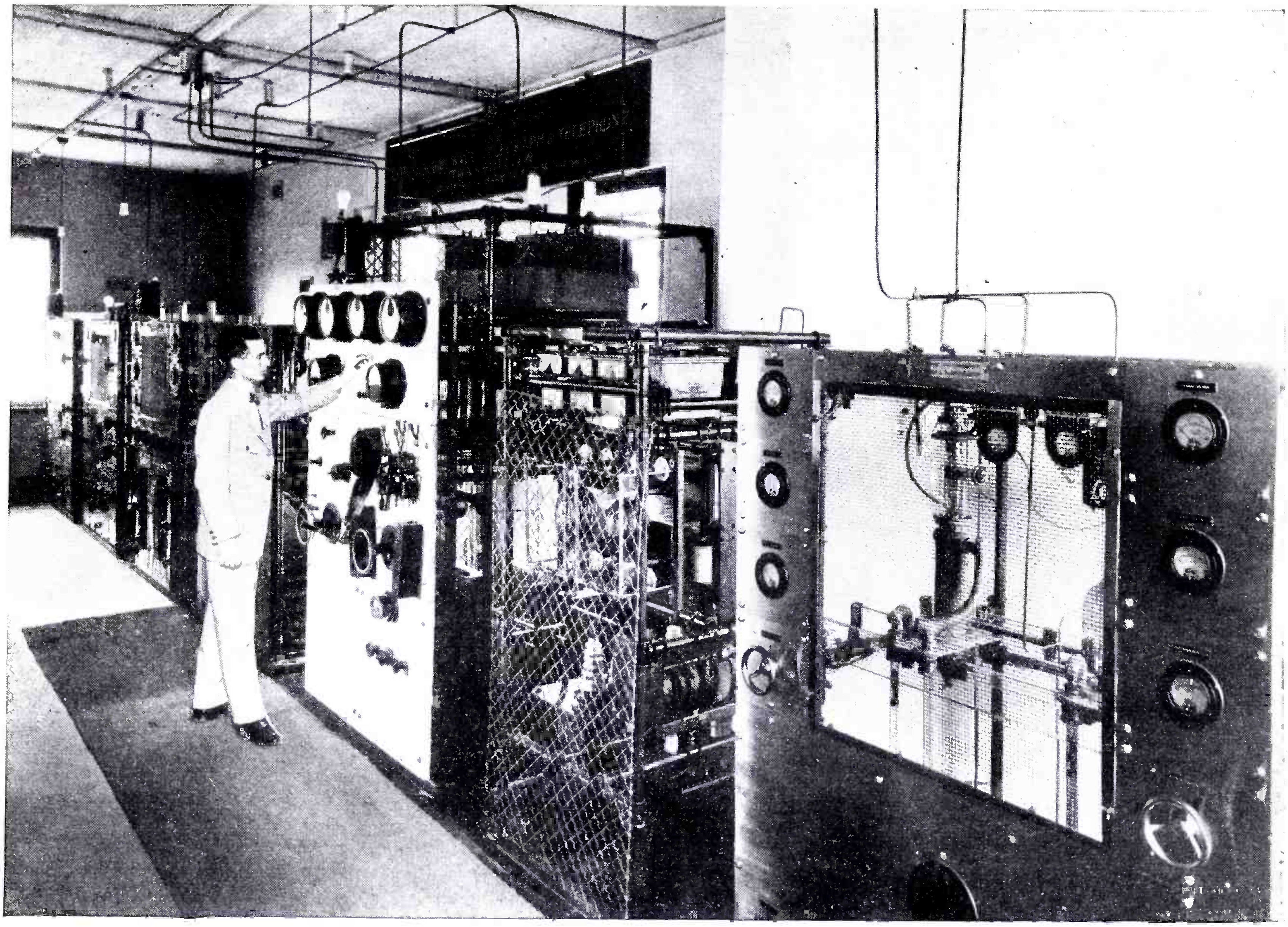


20 K.W. short-wave transmitter, VK2ME, located at Pennant Hills, Sydney, Australia.

S-W NEWS *from* AUSTRALIA

By C. C. FAULKNER
(Australian Correspondent)

Early Radiophone Days in Australia—Some Interesting Side-Lights.

NOW that the trans-ocean Radiophone over the 11,000 miles between Australia and England has become an accomplished fact, and New Zealand is about to add another 1000 miles to the distance covered, there is an interest in looking back on some of the earliest episodes in Australia connected with the development of this service. One recalls the pioneer short-wave efforts with the packing cases, the odd insulators, the coils that bore a suspicious resemblance to upholstery springs, and the patient (but not uncomplaining) valves (vacuum tubes) that constituted the first transmitters early in 1926.

First Link to Noumea

A commercial short-wave service to link Sydney with the French Pacific colony of Noumea, a distance of 1500 miles, was the first essay. The problem looked easy, but there was one snag; the aerial had to be fed from a distance. That is to say, the aerial had to function efficiently though located some hundreds of yards away from the transmitter. Which, in 1926, was rather breaking new ground.

Much laboratory work had, of course, to be done first. The most suitable circuit had to be found, methods of coupling decided on, wavemeters made and calibrated, etc., etc. One particular calibration job is clearly remembered by the Australian engineers. They needed an oscillator that would give a fair output on a wavelength as low as 2½ meters. No valve, in those days, took kindly to that sort of thing; one might be coaxed to function at that terrific frequency for a while, when its glass envelope would suddenly and completely disintegrate and its internal electrodes wrap lovingly round each other—while an agitated storeman three floors below would throw water on the switchboard.

Laboratory Staff Unpopular

The laboratory staff of Amalgamated Wireless (which organization was carrying out the experiments) was not popular at such times. Nor were they more in favor when they eventually transferred their activities to the company's station at Pennant Hills—then a coastal radio stronghold. It was said that the officer-in-charge immediately made, first, his will, and, second, stronger locks for the cupboards wherein he kept his spares; while the Coastal Service put the experimenters in the same category as Continuous Atmospherics and other pests. No wonder—already swinging from the mast which they used for ship's traffic were the 2FC broadcast aerials, the oversea experimenter's aerial and those of the trawler service.

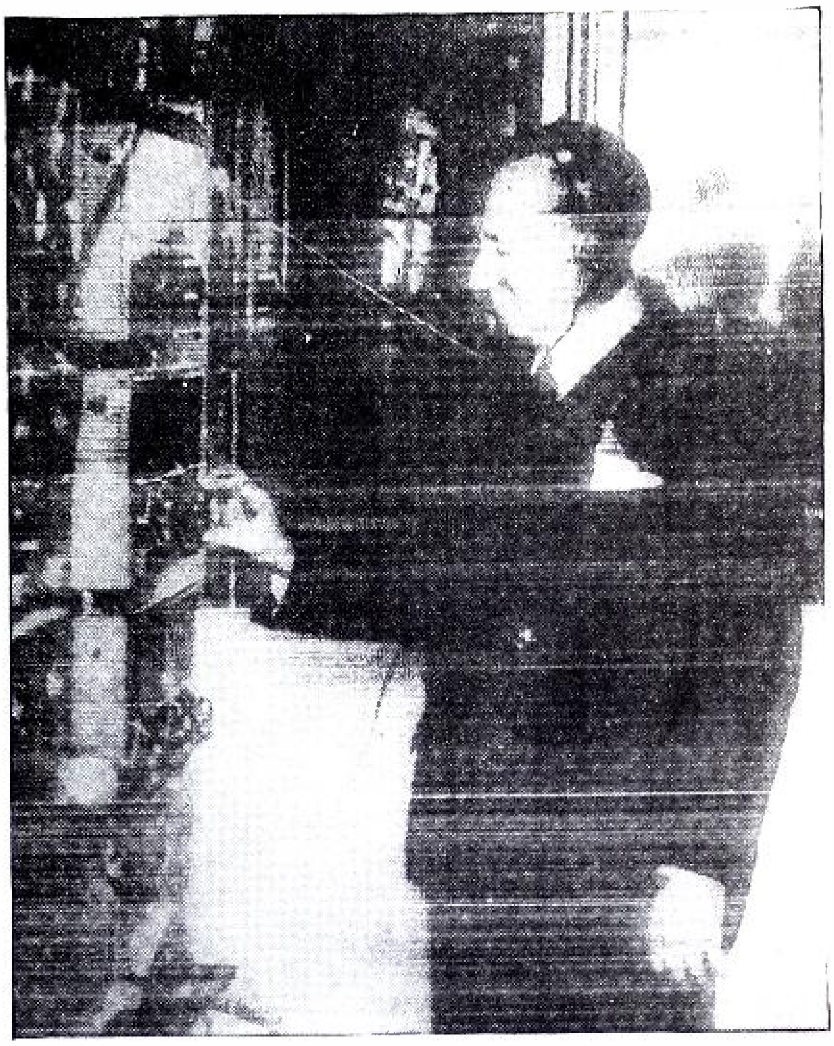
"H V J"

ROME—ITALY

Heard Around the World

By GUGLIELMO MARCONI

The voice of the Pope was heard in practically every country on the globe recently, thanks to the powerful and ultra-modern short-wave transmitting station, installed and presented by Marconi to the Vatican.



This remarkable photo of the Marchese Marconi operating one of the controls in the new short-wave transmitting station "H.V.J." in the Vatican, was transmitted across the ocean by the Bartlane progressive signal process.

THE short-wave broadcast and telephone and telegraph duplex station, which has been supplied by the Marconi Wireless Telegraph Company to the Vatican City for the use of His Holiness, the Pope, and was inaugurated by His Holiness on the twelfth of February, carried out its preliminary tests with America with the valuable assistance of the National Broadcasting Company. This organization, together with its associated stations in the United States, also cooperated in the reception and rebroadcasting of the inauguration speeches.

Transmitting Equipment

The new transmitter, in its main features, follows the design of the Marconi short-wave high-speed beam transmitters which are used in the British Imperial beam stations. The complete transmitter consists of four main panels, and is designed for telephony and high-speed telegraphy on wavelengths of 19.84 or 50.26 meters.

The first of the four panels is the main amplifier unit for both waves. The second panel contains the intermediate amplifiers and the Marconi-Franklin tube master-drive unit for the shorter wavelength. The third panel comprises the intermediate amplifier units and master-drive unit for the longer wave length, while the fourth panel is a combined modulator for telephony and absorber keying unit for high-speed telegraphy.

On telephony, the transmitter is rated to deliver from eight to ten kilowatts of unmodulated carrier-wave energy to the aerial feeder system, the output depending on the wavelength used; the normal degree of modulation is eighty per cent. The rating on continuous-wave telegraphy is thirteen up to fifteen kilowatts to the aerial feeder.

THE most historic community in the Christian world threw its voice across oceans and continents to the homes of American radio listeners on February 11, when National Broadcasting Company engineers, conducting tests with the new short wave station of the Vatican City in Rome, distributed the tests to networks in this country during two morning periods.

The signals from the new radio station of the Holy See were strong and clear, with almost perfect modulation, and National Broadcasting Company engineers couldn't resist the temptation to give listeners an opportunity to hear the impromptu international program. It was the first time that the Pope's new station, HVJ, had actually been heard by a radio audience.

Engineers in New York, London, Montreal, Buenos Aires, Sydney, Bombay and Capetown were listening to the tests, as engineers in the papal city sought to perfect their transmission in anticipation of the formal dedication of their new station Thursday, February 12. On that date, Pope Pius XI addressed a world-wide audience, and millions of people heard the speech over combined NBC networks and "short wave" transmitters operated by associated stations

The international scope of the Vatican audience was graphically shown by two roll-calls in which the English-speaking announcer addressed listening engineers in New York, London, Montreal, Buenos Aires, Sydney, Bombay and Capetown.

Masts and Aerials

Two transmitting aerials of the Marconi uniform type are provided—one aerial for each wavelength. This type of aerial has been recently developed by the Marconi Company and is an improved type of vertical short-wave aerial. Both aerials are suspended and insulated from a *triatic* (Y-shaped guying system) slung between two self-supporting lattice steel towers sixty-one meters (200 feet) in height, placed ninety meters (295 feet) apart.

The energy from the transmitting building is conveyed to the two aerials by two separate concentric-copper-tube feeders, similar to those used in the British Imperial beam stations. The transmitting building itself is situated in a part of the grounds of the Vatican which is surrounded by a Roman wall, forty-five feet high, while the masts are placed outside this wall. In order not to destroy the amenities of the Vatican gardens, a tunnel was constructed under the Roman wall to accommodate the aerial feeders.

Every effort was made to harmonize, as far as possible, the transmitting building and aerial towers with the graceful surroundings of the Vatican City. The transmitting building is of sober but pleasing architectural design; it contains a spacious transmitting room with land-line control tables, amplifier control room, receiving room, accumulator room, machine room, general store and general office. The tops of the masts are finished off to give a bishop's miter

(*Continued on page 478*)

SHORT WAVE PORTABLES
At the Scene of Action

How the Broadcast Announcer with his portable Short Wave Transmitter sends us sport and other news fresh from the scene.

A tense moment during the America Cup Races broadcast. Samuel Wetherill, associate editor of "Yachting" is shown at the microphone aboard the U. S. Destroyer Kane.

THERE was a time when radio coverage of special happenings was largely confined to the banquet hall or athletic field, where nearly everything occurred within easy view of the announcer. Nowadays, a presidential review of the fleet off Hampton Roads, out of sight of land, does not baffle the broadcasters. Talking to a nation-wide audience from an aeroplane is a commonplace. And following the contenders for the America's Cup in a battleship is merely a matter of setting up equipment and getting the Navy's approval to take microphones, engineers and other equipment on board.

Four Short Wave Transmitters Used

The portable short-wave transmitter, used in conjunction with pick-up receivers at the point of land-wires termination, has done the trick. This gives announcers great "cruising range" and greatly broadens radio's power to report at first-hand important special events.

For use on broadcasts which take announcers beyond range of wire lines, NBC maintains four short-wave transmitters—two 50-watt units, one 7½-watt unit, and a tiny 24-lb. transmitter of half a watt. In addition to this equipment, there is the new NBC truck, which carries a fixed antenna, and is surmounted by a manhole through which an announcer can protrude his head while watching in motion any scene he may wish to describe.

The NBC's "station-on-wheels" — the truck used for short-wave broadcasts.

The staff of the truck is usually an announcer, the driver, and two engineers.

But the intricately timed and cued descriptions of happenings which NBC broadcasts today were not accomplished over night. Nor is preparation for them simple, despite the fact that most of the serious technical difficulties have been overcome. And although NBC's use of short-wave transmitters on special jobs is no longer classed on the organization chart as experimental, days—sometimes weeks, are spent by executives, program officials, and engineers in arranging such broadcasts.

Days of Preparation

As a result of their planning and testing, the radio audience may hear a two-hour show, during which three or four widely separated announcers converse with one another and describe what they see from a battleship, an aeroplane, and a vantage point on shore, all with the smoothness of a carefully rehearsed studio program.

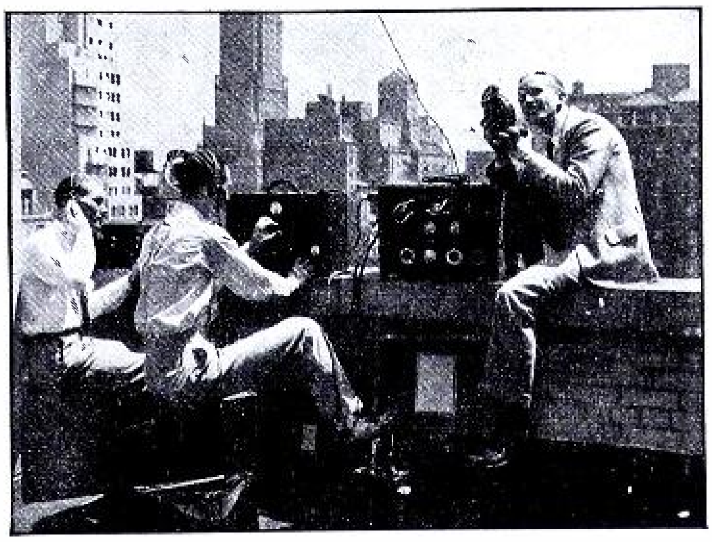
One of the most elaborate jobs of reporting yet undertaken on NBC networks was the three-point coverage of the fleet review off Hampton Roads last summer. One 50-watt short-wave transmitter was stationed on shore, another was placed aboard the U.S.S. *Salt Lake City*, and the 7½-watt unit was carried by the dirigible, Los Angeles. From these three points two NBC announcers and William Burke Miller, in charge of all special events, maintained a three-way conversation concerning movements of the fleet as it passed before the President.

Nine engineers worked two weeks on the set-up for this broadcast. First there had to be a survey of locations for the land equipment, seeking a spot clear of interference either from power lines or heavily travelled roads, and affording height enough for the elevation of antennae. Then came installations on the Navy craft and at the shore base where terminated wire lines would carry the program to New York. Next came the adjustment of the equipment to allotted channels, and finally the tests to prove whether communication could be effectively maintained between the three announcers. Greater distances between origin and pick-up points were achieved during this event than in any previous broadcast of the sort.

Another "first" was accomplished during the reports of the America's Cup races off Newport, R. I., in September of last year, when the only ship-to-ship interview on radio's log book was staged by an announcer aboard one vessel questioning a yachting expert aboard another.

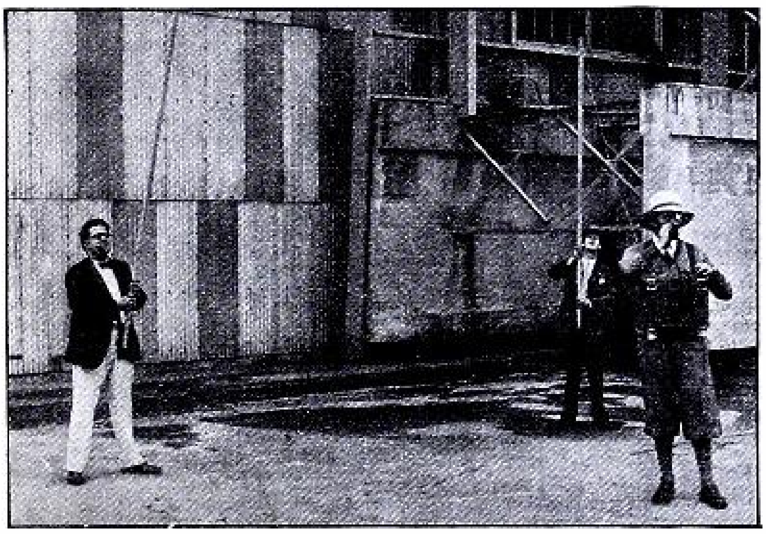
First Short Wave Relay Year Ago

But these present day, complicated special jobs don't cause nearly as much excitement among engineers and program officials at 711 Fifth Avenue as did the first, experimental short-wave relay nearly two years ago. It was on Washington's Birthday in 1929, that NBC staged its now historic "over and under New York" stunt. First, an announcer described the Metropolis from an airplane, while his remarks were picked up on the ground and dispatched over the networks. The same formula was used a few moments later, when another announcer went deep into an excavation under the East River and described his sensations there.



A short-wave set-up atop NBC headquarters during a recent test between airplanes and ground.

This experiment worked so successfully that a more complicated short-wave routine was used two weeks later during NBC's coverage of the Hoover inauguration. The late William S. Lynch, in the cabin of an airplane flying over the capital, called the roll of four other NBC announcers stationed at various points along the parade route below. Lynch's words were transmitted by short wave to the ground below, where each of the other announcers heard them through their receivers.



G. W. Johnstone (left) and Miller, NBC officials, carrying the antenna of the 24-pound portable short-wave transmitter, which Floyd Gibbons (right) is using, at the time of the arrival of the Graf Zeppelin at Lakehurst, N. J., in 1929.

Parachute Transmitter Developed

Next came the development of the parachute transmitter. A miniature broadcasting unit, so compact that it could be carried easily, was built in order that the late Buddy Bushmeyer might describe for listeners the sensations of a parachute jumper during his descent. The stunt worked well until Bushmeyer became entangled in his antenna wires and had to throw a vital part of his equipment overboard. The stunt was later repeated successfully.

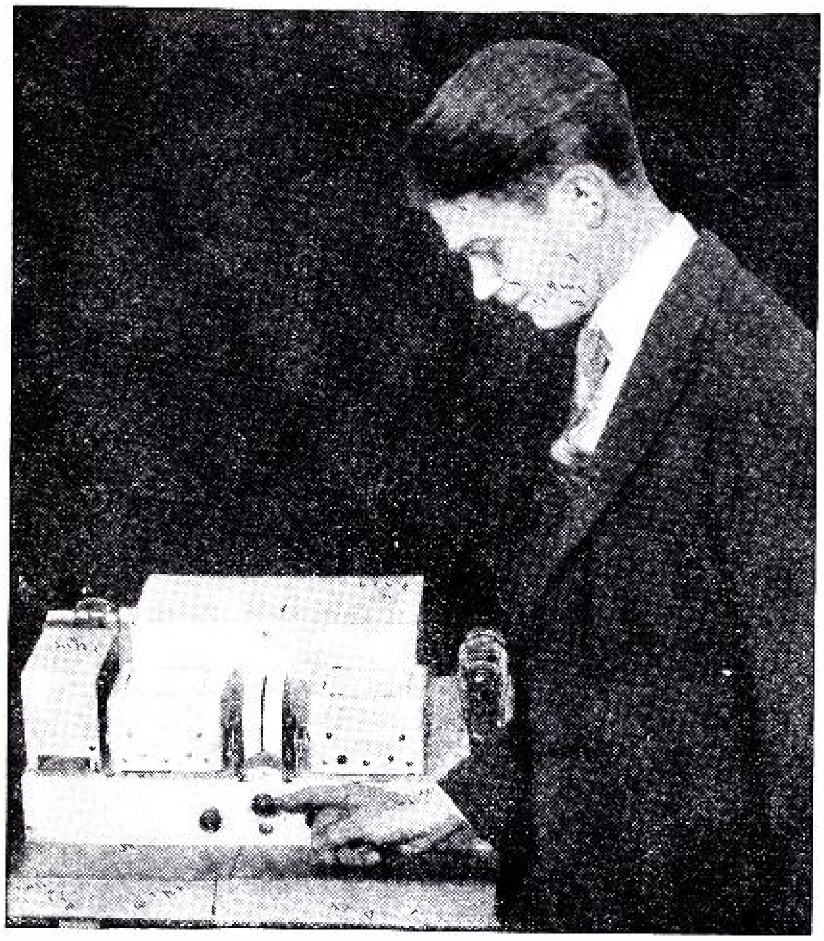
Floyd Gibbons used this parachute transmitter during his description of the *Graf Zeppelin's* arrival at Lakehurst. While he walked around the airport, he was followed by a "walking antenna." The antenna was suspended on poles which were carried.

Broadcasters are a restless and curious crew. They have always rebelled at the fact that wire lines keep them tied tantalizingly to one spot when something important is happening across the field, down the bay, around the corner, up in the air—just beyond the range of eye or ear. It was this desire to be on the scene of action which prompted National Broadcasting Company engineers to develop the

The late Henry (Buddy) Bushmeyer with the 24-pound portable short-wave transmitter

short-wave transmitter for use in describing major athletic and news events.

All these things sound very easy but they represent years of patient experimenting and development. The broadcaster does not stint either time or money when there is a service to be rendered to the listening public. The miracles of yesterday have become the commonplace of today.—*Courtesy RCA-Radiotron "Good News"*.



THE PILOT

15 to 650 Meters Range

By ROBERT ("BOB") HERTZBERG
Short-Wave Engineer, Pilot Radio and Tube Corporation

The "Universal Super Wasp" chassis full assembled, but without its cabinet. Photograph shows Mr. Geloso at right, who has his finger on the knob which drives, through a worm gear, the two rotary-cam switches which change the waveband covered by the tuning knob.

THE new Pilot Universal Super-Wasp fulfills the short wave fan's dream—tuning in all bands without using plug-in coils! It features a novel wave-changing switch which is controlled from the front panel; the set remains closed all the time, and there are no plug-in coils to wrestle with. It has screen-grid (tuned radio-frequency) and detection, a built-in power-pack and a high quality audio system.

An unusual piece of radio construction, this new set is the product of the combined ingenuity of John Geloso, chief engineer of the Pilot Radio & Tube Corporation, who is one of the most capable and unassuming radio geniuses in the country, and David Grimes, who is too well known to need introduction. Mr. Geloso worked out the intricate details of the coil-switching arrangement, which is something altogether new, and all the details of the entire physical apparatus. Mr. Grimes developed the electrical circuit and made it work as few other circuits do. Edgar Messing and Robert Hertzberg, both members of the Pilot staff, contributed numerous suggestions and did much of the testing work.

THE preliminary description of the Pilot Universal Super-Wasp receiver, published in the last issue of SHORT WAVE CRAFT, has aroused an enormous amount of interest; the writer being deluged with inquiries from many parts of the world. As promised in that article, SHORT WAVE CRAFT is publishing herewith a complete description of the new receiver which, undoubtedly, is the most advanced short-wave set presented to date. It is altogether different from anything else that has appeared in the short-wave field.

The outfit is available in complete kit form for home assembly, and it may be obtained completely wired and assembled; kits will be available on the open market by the time this issue appears.

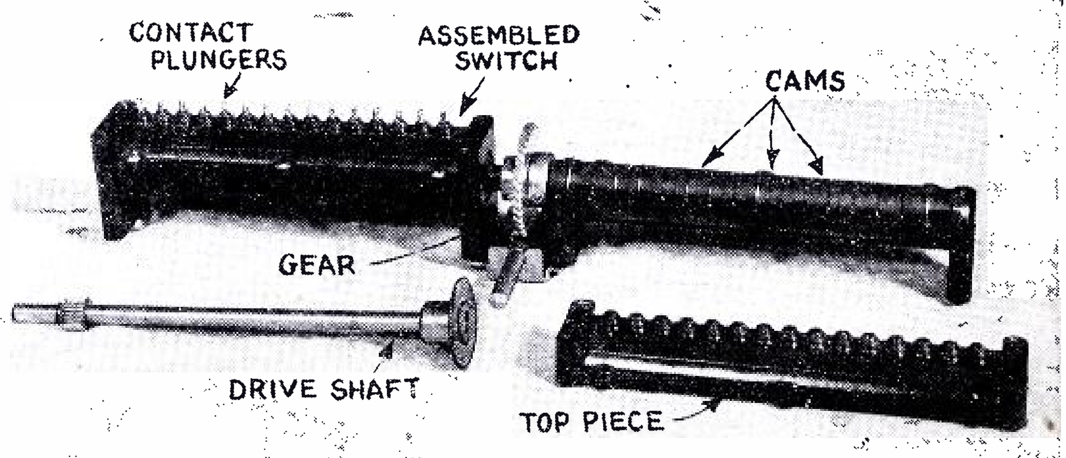
Mere photographs do not do it complete justice; since it is the first short-wave receiver the writer knows of to use the same principles of electrical design and mechanical construction found in the more highly-developed American broadcast receivers.

The standard Universal receiver now uses a total of six tubes, including the rectifier. Its great advantage lies in its wavelength changing switch, which eliminates the plug-in coils that heretofore have been the great nuisance in short-wave work. The coils are fixed inside the set, and are thrown in and out of the circuit by means of a very ingenious pair of rotary cam switches contained in molded bakelite housings. This switch, which is controlled by a simple little knob on the front panel, has seven positions, and covers seven wavelength ranges as follows: (1) 15 to 23 meters; (2) 22 to 41; (3) 40 to 75; (4) 70 to 147; (5) 146 to 270; (6) 240 to 500; and (7) 470 to 650.

This unusually wide wavelength range, probably the widest covered by any short-wave receiver, takes in not only all the short-wave channels, but also the entire broadcast band and even the calling waves used by commercial ship and shore telegraph stations. On the broadcast ranges it brings in stations not audible at all on many regular broadcast receivers, the lowest readings of which are in the neighborhood of about 240 meters.

Wiring Diagram

The complete schematic wiring diagram of the Universal is shown here.



The two rotary-cam switches which change the inductance and capacity relations for the different wavebands. The one at the right is separated to show the component parts.

UNIVERSAL SUPER-WASP

At a Turn of the Wrist—New Switch Eliminates Plug-In Coils

At a first glance this appears to be rather complicated, but a closer study will reveal it to be quite easily understandable. The set uses one stage of screen-grid tuned-radio-frequency amplification, a regenerative screen-grid detector, one impedance-coupled audio stage using a '27 tube, and a push-pull output stage using two '45's. For the sake of simplicity, the four antenna couplers fixed inside the set are represented as a single coil, L-1, and the four detector coils as L-2; each of these coils has two windings. L-1 has a primary and a secondary, and L-2 a combination primary-tickler and a secondary. One end of each winding is permanently grounded, either directly to the chassis or through a non-inductive condenser, as in the case of the primary-ticker. The other ends of the respective coils are brought to contacts on the cam switches, and are connected in the proper sequence as the switches are turned.

The antenna and detector tuning condensers, marked C-1 and C-2 in the diagram, are actually double units; one section has a maximum capacity of 130 mmf. and the ot`er 415 mmf. They have a common rotor connection but separate stators; the latter are also brought out to contacts on the cam switches, there being 15 contacts altogether. For the sake of convenience we will refer to the small condenser section as A and the large section as B, and to a separate fixed loading condenser of .0004-mf., capacity as C. We will also refer to the pairs of coils as 1, 2, 3 and 4.

How Coils and Condensers Are Switched

When the wavelength switch is set to range one, coils 1 and condensers A are connected together; range two, coils 2 and condensers A; range 3, coils 3 and condensers A; range 4, coils 3 and condensers A and B; range 5, coils 4 and condensers A; range 6, coils 4 and condensers A and B; range 7, coils 4 and condensers A, B and C. The shift from one range to another is made in an instant, and it is not necessary to open the set or disturb anything in it.

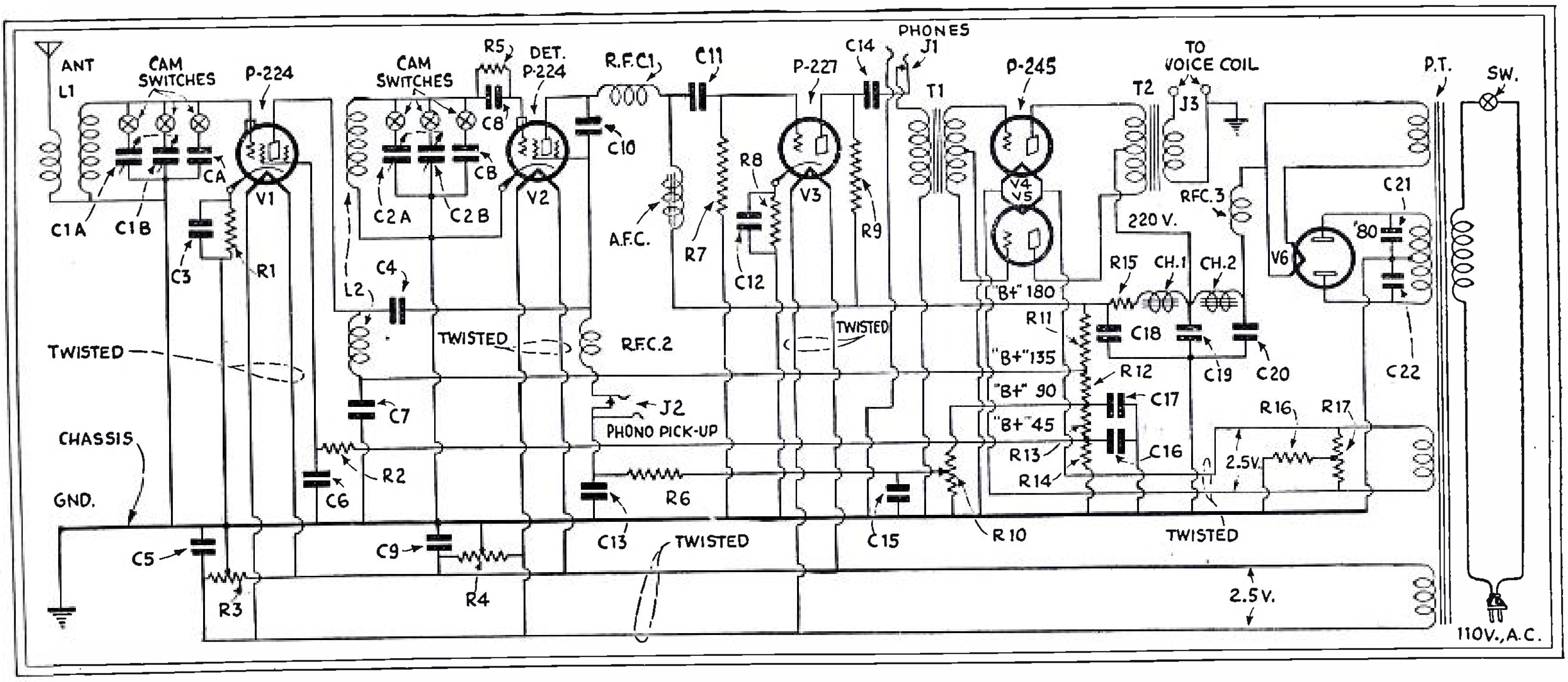
The primary and the tickler windings of the No. 3 antenna and detector coils are tapped in one place; part of the windings being used for wave-range 3 and the whole thing for range 4. The primaries and the ticklers of the No. 4 coils are tapped in two places, for use on ranges 5, 6 and 7.

The method of coupling the radio-frequency stage to the detector, and the system of regenerating through the combination primary and tickler, were adopted after exhaustive investigation by David Grimes and Edgar Messing. It is the logical method of coupling for screen-grid operation on the short-waves and provides very smooth regeneration, the control of which does not affect the tuning circuits. Thus it is possible to log stations very definitely and to duplicate the dial settings at any time.

If you will follow the circuit carefully, you will see that the radio-frequency current from both the plate and the screen of the detector tube is led back to the tickler winding T, through the .00004-mf. condenser between the screen and plate and the .0005-mf. condenser at the lower junction of this circuit. The R.F. choke coils in the plate and screen leads prevent the R.F. current from going any place else. The actual control of regeneration is provided by a 50,000-ohm potentiometer regulating the screen voltage.

Incidentally, a phonograph pick-up jack is connected directly in the screen lead as shown, and the regeneration control potentiometer then acts as a volume control on the phonograph music.

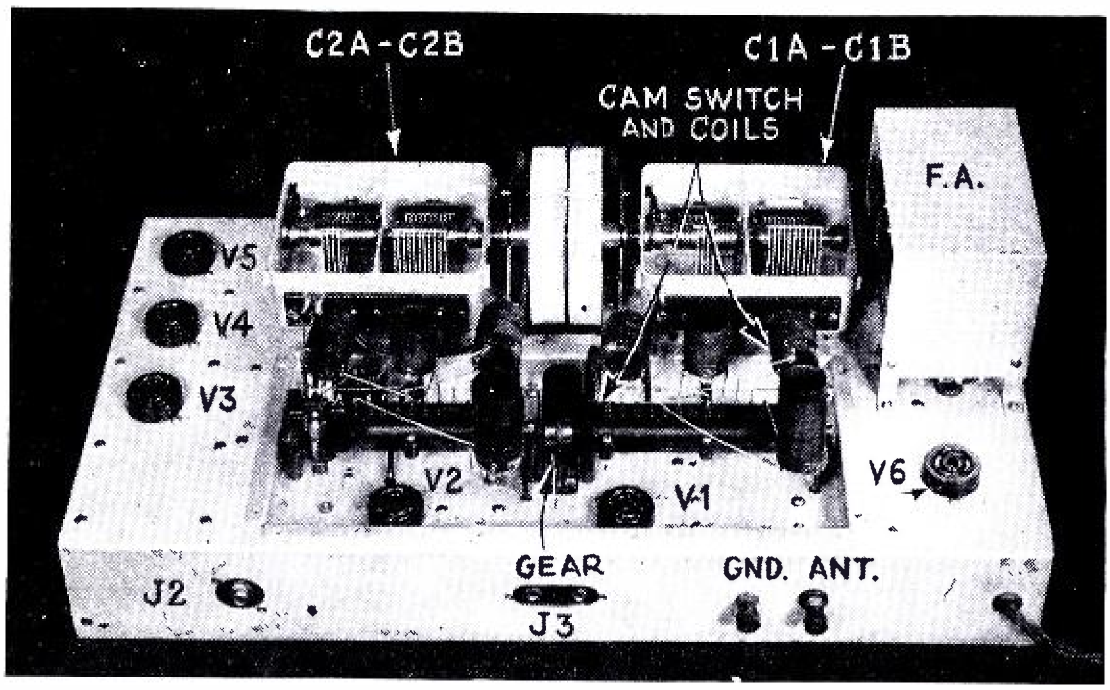
The plate voltage for the detector tube is fed through a high-inductance choke coil, rather than through a fixed resistor. The choke coil allows the plate voltage to assume the value necessary for efficient operation and, at the same time, prevents the audio-frequency component of the plate current from leaking off through the "B" circuit.



Schematic diagram of new "Universal Super-Wasp", the four sets of R.F. coils being represented as one for simplicity. The capacities CA and CB are fixed .0004 m.f. condensers used only to tune the highest waveband, above 470 meters. Note the usual regeneration method. All plug-in coils are eliminated by a simple yet effective switching scheme.

Phone Jack Connection

Because of the high amplification furnished by the screen-grid amplifier and detector, earphone operation is comfort-



Rear of Chassis.—Rear view of the "Universal Super-Wasp" chassis, showing how the "pan" with its R.F. apparatus drops into the frame. The two wave-changing switches run horizontally across the center of the picture with six of the S-W coils behind them.

able only at the first audio stage; so the phone jack is connected in the plate circuit of the '27. A shunt feed arrangement is used for the plate voltage, in order to keep all D.C. off the jack. (If the jack is made "live," the wearer of the phones invariably shocks himself when he touches the aluminum chassis.) The push-pull output stage is of standard design, and will operate a regular dynamic speaker at full efficiency. The terrific "wallop" of this set can be appreciated only by a person who has actually tuned one.

The Universal set is exceedingly quiet in operation, the hum being scarcely noticeable. The designers of the set benefited greatly by their previous experience with the well-known A.C. Super-Wasp. The entire power pack is built directly on one end of the chassis, this proximity having absolutely no bad effects. It was discovered that the '80 rectifier tube was a prolific source of R.F. disturbance; so this part of the circuit is protected by buffer condensers across the high-voltage winding of the power transformer and also by means of an R.F. choke coil in the "B+" lead.

Mechanical Construction Ingenious

The Universal is a marvelous piece of mechanical engineering, being exceedingly simple to assemble, in spite of its apparent complexity. The chassis is made of one piece of heavy aluminum, formed so that all the radio-frequency units are on top and the incidental power and audio units underneath. The general appearance of the completed set, without its cabinet, may be observed in the photograph showing Mr. Geloso. Mr. Geloso is seen pointing to the wave-changing knob, the indicating scale of which is mounted on a small disc directly above it. The two tuning condensers are controlled by individual vernier dials of the drum type. On the left side of the chassis is the choke coil assembly, and just behind it the '80 rectifier tube. On the right side are the three audio amplifier tubes.

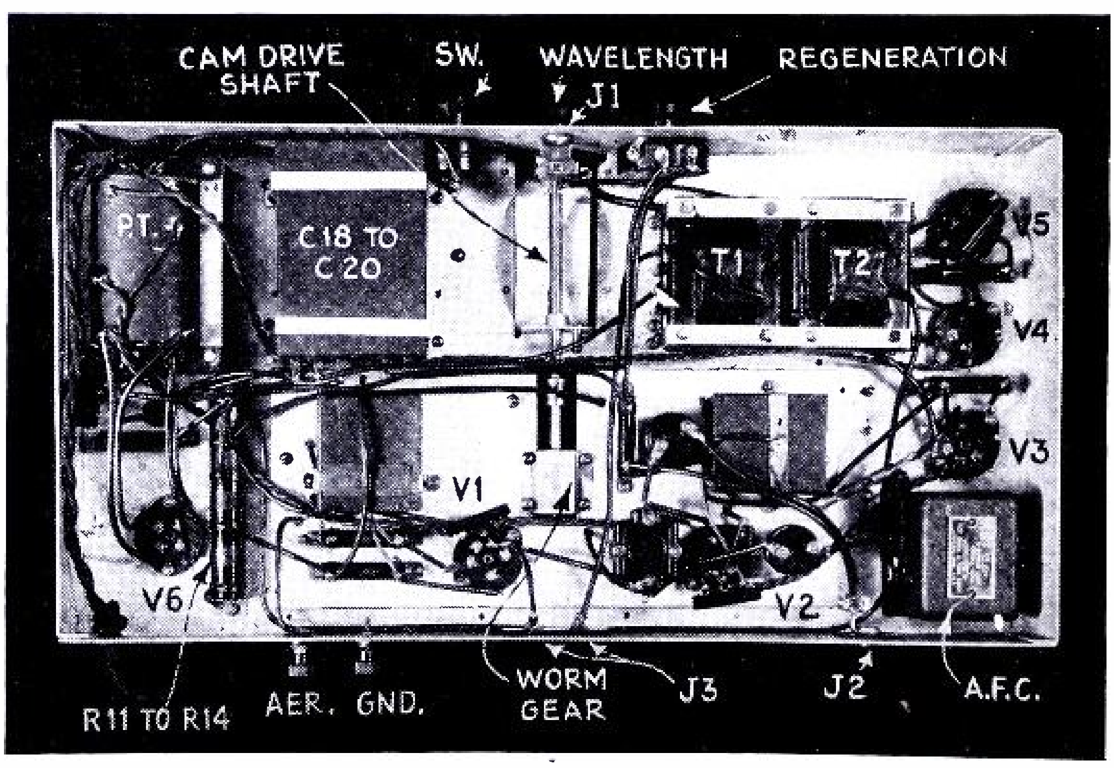
Behind the tuning condensers is the complete R.F. and detector unit, mounted on a tray which slips into a large rectangular cut-out in the top of the chassis itself. The construction of this tray, which holds the coil-and-switch assembly, is made plain in photo above, which shows the set with the covers of both the condensers and the coils removed. The entire tray unit is supplied with the coils and switches already assembled in place and wired; for these parts are the heart of the set and the wiring *must* be done properly.

Below we see the under side of the chassis of a completely wired set. The arrangement of the parts has been worked out very carefully, all the connections being as short and as direct as possible. All the power units are on the left side, and the audio amplifier units on the right, with the R.F. tray in between. The entire tray assembly slips into place very nicely, being held by machine-screws passing into threaded holes. The worm gear driving the cam switches is coupled to the control knob on the front of the set by a universal joint; the connecting shaft is plainly visible between the white indicating scales of the variable condensers.

The Special Cam Switch

A close-up of the interesting cam switches is shown on page 428. The split bakelite housing, which is a beautiful example of the die-maker's art, is especially shaped in the center to accommodate a bakelite rod, on which are mounted thin cams or washers. These cams are not perfectly circular in shape, only small sections of their periphery protruding beyond the surface of the insulating material; they make contact with a series of fifteen tiny plungers set in the top half of the housing like the spark plugs of an automobile. As the switch is turned from the front panel by the worm gears, the cams make contact with the plungers; the combinations having been so worked out as to connect the double tuning condensers to the four fixed coils to give the seven wavelength ranges mentioned. This switch idea is the result of more than a year's experimentation with every imaginable kind of switching device, and is the simplest, most reliable and most efficient scheme for the purpose. The capacity between contacts has been reduced to a minimum, and the losses are so slight as to be negligible.

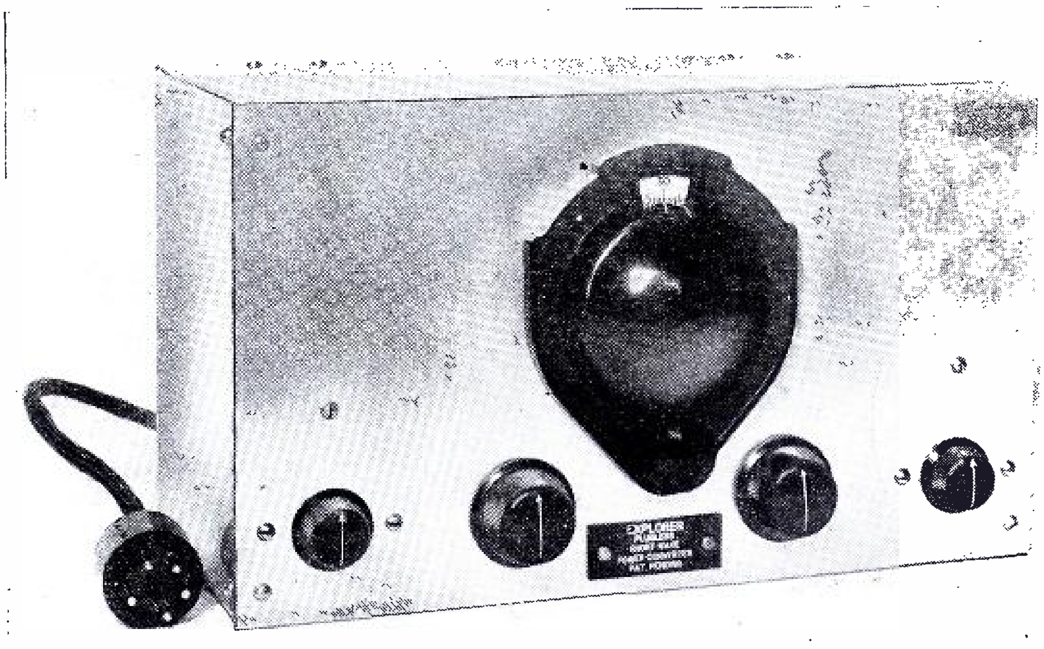
The effectiveness of this switching (*Continued on page* 488)



Underneath view of chassis of the "Universal Super-Wasp"—power units at left; A.F. components at right of tray; worm gear driving wave-change switch at center.

Short Waves for the Broadcast Listener

New Converter Uses No Plug-in Coils



Front view of "Explorer" short-wave converter, which enables one to receive the short waves on a standard broadcast receiving set, whether of the "TRF" or "superheterodyne" type. A twist of the hand on one of the knobs switches the coils in and out of circuit—no plug-in bother.

One of the very latest short-wave converters of the shielded type; a band change switch eliminates plug-in-coils. This converter makes a short-wave receiver of any standard broadcast set.

IN developing the new Explorer, special attention was given to two very important factors which are generally overlooked, in addition to the consideration of the more usual problems of design and construction. First, it had to be considered that a *short-wave converter* makes its appeal primarily to owners of broadcast receivers who have become interested in the possibilities of short-wave reception. Many of these are not technically inclined, and the apparent necessity for using plug-in coils in order to change wavelength bands, with its consequent annoyance and inconvenience, has until now prevented them from enjoying short-wave reception. This problem has been solved in the Explorer by using a special automatic band-selector system, whereby wavelength bands are changed by turning a knob located on the front panel, resulting in the greatest simplicity and convenience of operation possible. More than a year's work was required to perfect the band selector system so that it would be smooth, foolproof, and efficient. It is protected by a patent pending.

The second major problem was to obtain real loud-speaker volume, even on the weakest stations. A short-wave converter is intended for loud-speaker reception, because headphones cannot be readily attached to modern broadcast receivers, and their use is undesirable anyway; whereas short-wave receivers can depend on headphones for the reception of weak stations. The problem of obtaining sufficient loud-speaker volume, which means obtaining sufficient audio amplification, is therefore of even greater importance in a short-wave converter than in a receiver. It was solved by incorporating a stage of audio-frequency amplification in the Explorer itself.

The Circuit Used

The circuit of the regular model of the Explorer is shown in Fig. 1. A wavelength range of 15 to 160 meters is covered by means of the three coils indicated in the diagram as L1-L1', L2-L2', and L3-L3'. These three coils are mounted beneath the bakelite subpanel. One end of each grid winding is grounded, and the other end is connected to a terminal with which one arm of the coil selector can make contact. This arm is connected to the grid side of the tuning circuit.

The tickler windings of each coil are similarly connected, one end of each going to the "B+" side of the detector plate circuit, and the other end to a terminal with which the other arm of the coil selector makes contact. This arm is attached to the plate of the detector tube. Both arms of the selector are moved simultaneously by turning a small knob located on the front panel.

Band-Selector Switching Simple

Turning the band-selector knob to the position indicated in Fig. 3, for example, simultaneously moves the selector arms to make contact with L2 and L2'. Coil 2 is therefore thrown into the circuit, and coils 1 and 3 are effectively cut out.

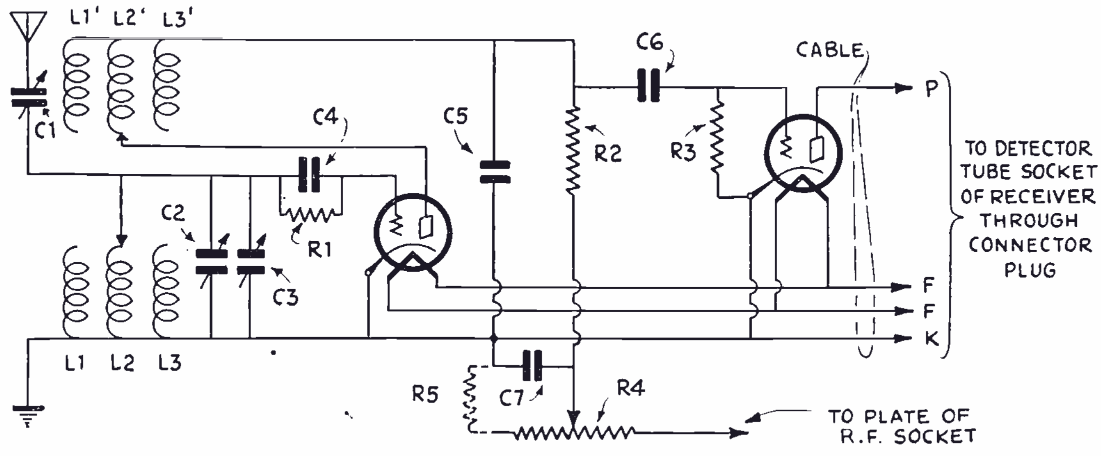


Fig. 1—Circuit diagram of A.C. model "Explorer" short-wave converter for use with "T R F" broadcast receiver. L1, L1'—Coil 1; L2,L2'—Coil 2; L3L3'—Coil 3; C1—15 mmf.; C3—special 2 plate midget; C7—1 mf.; C2—250 mmf.; C4—.0001 mf.; C5—.0005 mf.; C6—.01 mf.; R1—6 megohms; R4—100,000 ohms Centralab potentiometer; R3—.25 megohms; R2—.075 to .5 megohms; R5—5,000 to 50,000 ohms.

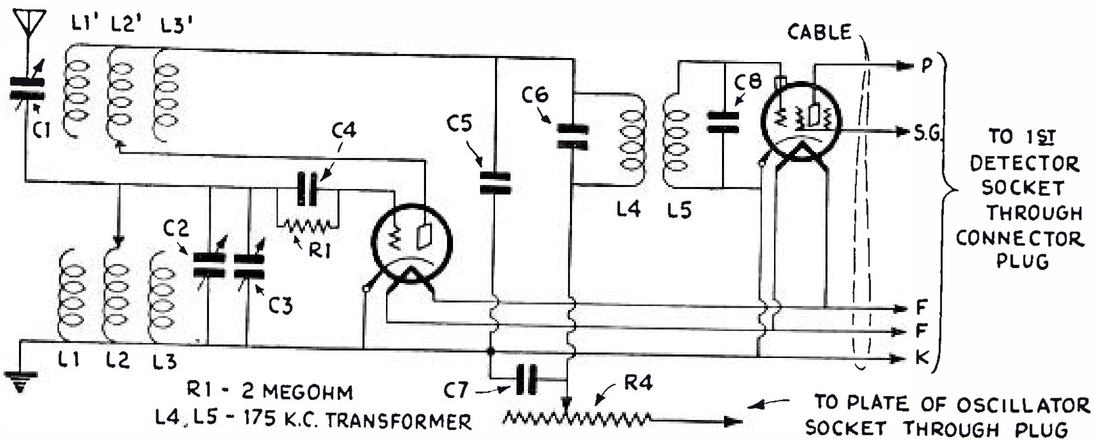


Fig. 6—Wiring diagram of "Explorer" converter for use with Screen Grid Superheterodyne.

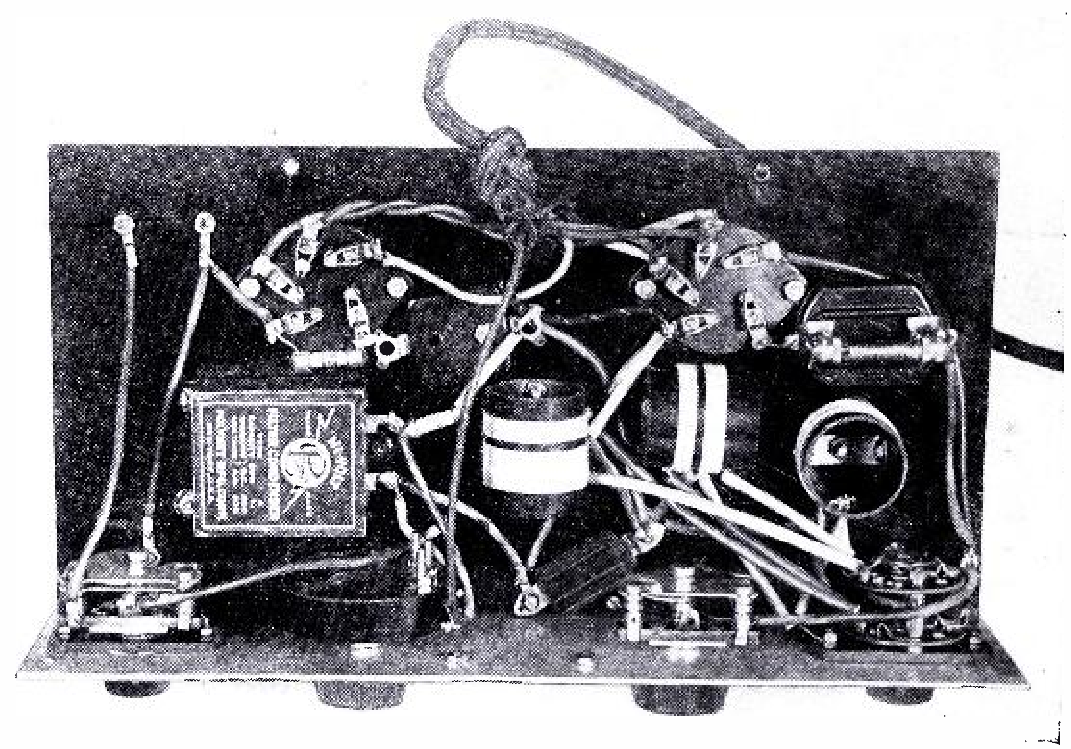
Coil 1 covers a range of 15 to 27 meters, and is selected by turning the selector knob to the extreme left. (Figure 2.) Coil 2 covers 26 to 64 meters; its corresponding selector knob position is vertical, as shown in Fig. 3. Coil 3 covers 62 to 160 meters, and is selected by turning the knob to the extreme right (Fig. 4). Wavelength bands can therefore be changed in less than a second by turning the knob to the proper position. Ample overlap of wavelength is provided on the edges of each band.

The three coils are mounted compactly near the selector, so that connections can be as short as possible. The vertical axes of the three coils lie in the three different planes, to minimize interaction of the electrical fields and prevent the occurrence of oscillation-absorption spots.

Resistance-Coupled A.F. Stage in Converter

As indicated in Fig. 1, the stage of audio-frequency amplification used is of the resistance-coupled type; the output of this audio stage is delivered into the detector socket of the broadcast receiver. Since the great majority of T.R.F. receivers have two stages of audio amplification, this results in the use of a total of three audio stages. The result is satisfactory loud-speaker volume on even the weakest stations; on the more powerful short-wave stations, the volume is comparable to that with which stations in the broadcast band are received.

The plate voltage of the converter's detector tube is drawn from one of the R.F. sockets of the receiver, instead of from the detector socket, as generally the practice. The reason for this is the comparative uniformity of the R.F. plate voltages of different broadcast receivers—in the great majority of cases, between 110 and 180 volts; whereas the detector plate voltages in the same receivers may be anywhere between 15 to 260 volts. With 15 volts on the detector plate oscillation is insufficient; with 260 volts it is terrifically violent and uncontrollable. In either case good results are impossible. Failure to take this factor into consideration accounts to a large extent for the frequently unsatisfactory operation of single-tube, short-wave converters.



Sub-panel view showing short-wave coils connected to wave change switch at right.

The use of resistance-coupled audio amplification was found to be the key to the solution of several serious problems. It assures the supplying of the proper plate voltage to the converter's detector tube; which is absolutely necessary for smooth control of oscillation and, consequently, for good reception. The plate resistor R2 is interchangeable; so that the proper value can be used (according to the voltage of the plate current being drawn from the R.F. socket of the receiver), thereby reducing the supplied voltage to the ideal value for satisfactory oscillation.

Fringe Howl Eliminated

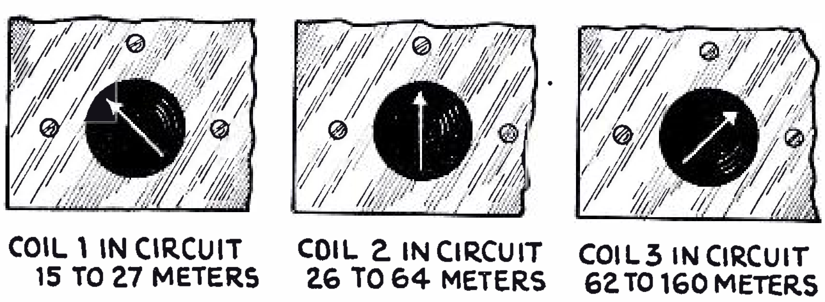
Using resistance coupling eliminates "fringe howl," entirely. It is at the oscillation point that the converter is most sensitive; and howling at this point makes a short-wave converter or receiver practically useless. Short-wave receivers not using resistance coupling employ a resistance of about 0.1-megohm across the secondary of the first audio transformer in order to prevent "fringe" howling. It is obviously impractical and inconvenient to connect such a resistance in a broadcast receiver with which a converter is to be used; and the difficulty must therefore be forestalled in the converter itself. This the Explorer does.

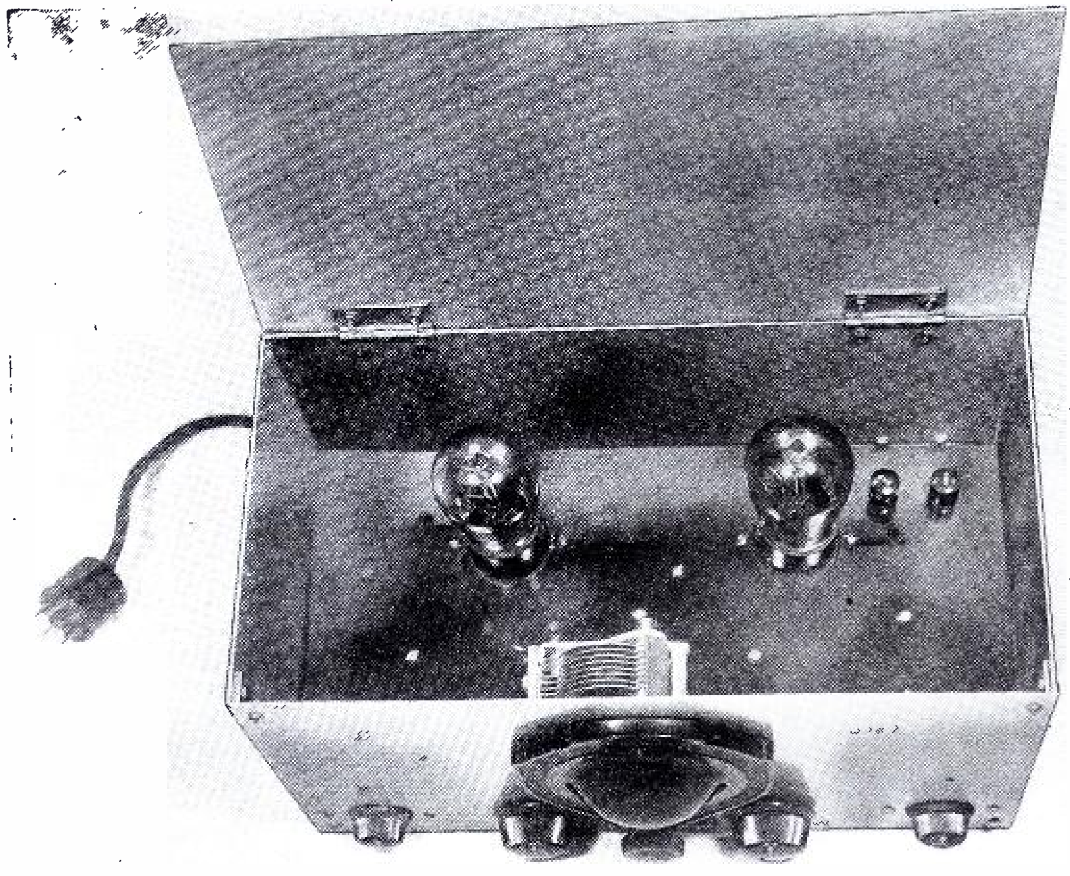
The method used for controlling oscillation was given a great deal of attention. The requirements here are smooth and gentle control of oscillation; a control which is noiseless, and one which does not detune the signal being received when it is varied.

Oscillation Control

Because a variable series resistor in the detector plate circuit meets all these requirements, its use was decided upon. A variable stepless 100,000-ohm potentiometer of high quality is used for this purpose. The movable arm of this resistance is connected to the ground through the 1-mf. bypass condenser *C7*, which smooths out any noises which would otherwise be present, and makes the control noiseless. This method also has the advantage of supplying the detector tube with the minimum voltage at which it will oscillate, regardless of the

Figs. 2, 3 and 4, from left to right—Showing various positions of wave change switch.





A top view of short-wave converter with shield box lid open, showing detector and oscillator tubes.

degree of antenna coupling or frequency to which the converter is tuned; thus assuring the smoothest possible oscillation under all conditions.

When the supplied plate voltage is above a certain value, one end of the potentiometer R4 is grounded through the resistor R5, the value of which depends on the voltage of the plate current supplied by the receiver. The resistors R4 and R5 then form a bleeder resistance, with R4 the variable portion. The value of R5 in each case is selected to obtain the most gradual control of oscillation possible.

The use of the variable resistor and the 1-mf. bypass condenser, and the fact that the plate voltage is drawn from the R.F. socket of the receiver, result in an effective filtering action which confines the R.F. currents to the converter circuit, and also prevents motor-boating. The way in which the filter circuit acts is shown in Fig. 5. The resistance R4, condenser C7, and the primary of the receiver R.F. tuning coil L1 make up the filter circuit.

Ease of Tuning Obtained

Again remembering the "broadcast listener," the question of obtaining ease of tuning was considered. This point is of great importance; since too critical tuning makes the reception of weak stations very difficult or impossible. Extreme ease of tuning is assured in the Explorer by the use of a special two-plate midget condenser, C3, which is connected across the large tuning condenser. Turning the knob of the vernier condenser gives an effective ratio of 200 to 1, as compared to the movement of the knob of the large tuning dial. Stations can therefore be easily tuned and held, even on the low wavelengths. The use of the vernier results in ease of tuning equal to that of a broadcast receiver.

A 15-mmf. variable midget condenser (C1 in the diagram), is used in the antenna lead to compensate for antenna absorption and to eliminate dead spots in the tuning range. The control knob is mounted on the front panel, so that it can be readily varied at any frequency in order to obtain the most effective antenna coupling.

The Explorer employs subpanel construction, most of the parts, including the coils and selector system, the midget condensers, and the oscillation control being mounted underneath the subpanel. A very neat and simple appearance is therefore presented when the cover of the converter is lifted. The panel is of aluminum, and the chassis is enclosed in a satin-finish aluminum cabinet, resulting in thorough shielding.

The method of attaching the converter to a broadcast receiver is very simple. One of the two connector plugs is inserted into the detector socket of the receiver, and the other is plugged into one of the R.F. sockets, usually the last. The aerial and ground wires are then connected to the appropriate binding post, located on the surface of the subpanel.

The chassis is easily removable from the cabinet. When desired, therefore, in many cases it can be installed in the same console with the broadcast receiver, making a permanent installation. The automatic band-selector feature and the construction of the Explorer make this entirely feasible.

Special Model for Superheterodyne Receivers

The circuit of the special model for the screengrid superheterodyne receivers is diagrammed in Figure 6. The special model for the old non-screen-grid superhets is very similar, except that a 227 instead of a 224 tube is used in the second socket.

The model for superheterodynes employs a 175 KC intermediate frequency transformer in place of the resistance coupling of the T.R.F. model. The grid leak R1 used in this circuit has a value of 2 megohms. The signal tuned by the converter is changed to 175 KC by the transformer peaked at this frequency, and is amplified at 175 KC by the second tube.

The output of the converter is delivered through the connector plug into the first detector socket of the superhet. The detector plate voltage of the converter is drawn from the oscillator socket plate, the value of the plate voltage thus acquired being ideal for the purpose in all cases.

The effect of the circuit is to add an additional stage of intermediate frequency amplification to the receiver, resulting in great amplification. The effective total amplification when the converter is attached is therefore greater by an additional intermediate stage than that afforded by the receiver when used alone. Very satisfactory loud speaker volume is therefore assured.

In use, the action of the converter is exactly like that of a single dial broadcast superheterodyne receiver. The setting of the antenna condenser and the variable series resistance R4 are not critical.

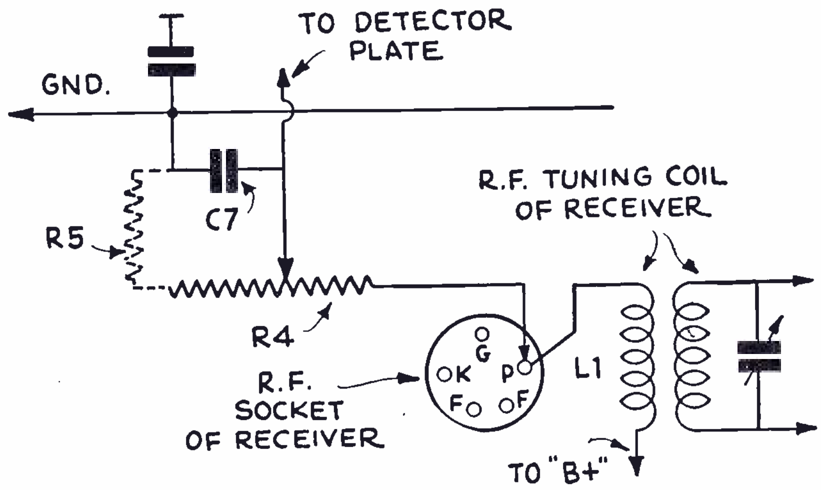
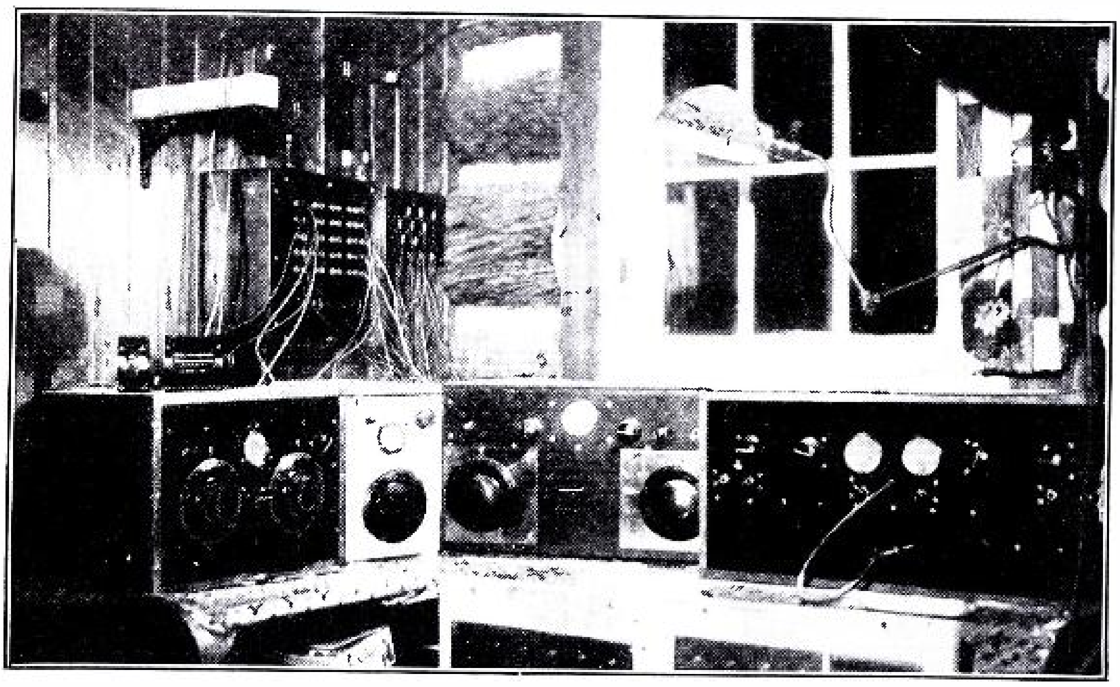


Fig. 5—Showing arrangement of variable resistance to permit adjustment of voltage applied to plate of detector.

AMONG THE "HAMS"



Particularly efficient S-W receiving station of Philip Cass

A "REAL" S-W STATION

Editor SHORT WAVE CRAFT.
Dear Sir:—

Being a subscriber to your magazine, I am enclosing you a photograph of a receiving station, which we had at our camp at Ewan, N. J.

The first instrument at the left is a short-wave adapter, which is cut in through a 4-D W. E. Super Heterodyne Circuit. The second instrument is a shielded stage of screen grid, which is operated ahead of the short wave adapter. The third instrument is a 4-D Western Electric Circuit. The fourth instrument is amplification. All of the instruments are built in 1/16th sheet copper cases, with the exception of the amplification, which is built in a lead coated sheet steel case.

The short-wave adapter is thrown in and out of the primary of the 4-D by a small double pole, double throw switch on the back of the 4-D Receiver. The 4-D Receiver is loop operated, while the short-wave receiver is operated by an outside antenna and ground. Amplification consists of two '12-A tubes, impedance coupled through 210 Push Pull Tubes, driving a dynamic speaker.

Everything is battery operated with the exception of the '10 tubes and the "B" Circuit to the amplifier, for which we use a specially designed Power Pack, which we built for this purpose.

The entire equipment was made in our laboratory, and we have had the pleasure of listening to stations in all parts of the world.

Very truly yours,
PHILIP CASS.

P. S.: G5SW—PCJ—VRY—W6XN—CJRX are all received on the loud speaker, and according to atmospheric conditions, some fade more than others, but as a general rule, they come in with a clarity which permits us to hear announcements and reception with clarity and very good modulation.

Of course, as you know, there are times when static and code interference chop up the reception, but under ordinary conditions, these stations were received during the hot weather. Of course, we expect to reach the far distant stations such as Java and Australia, but so far, we have been unable to raise them.

(Fine business, "O. M." Keep up the good work. Glad to hear from you again.)

WE'LL BE SATISFIED WITH HALF A MILLION

Editor SHORT WAVE CRAFT:

Just a few lines to tell you I am a reader of SHORT WAVE CRAFT and well pleased with it. Wish you the best of success in this undertaking and hope that SHORT WAVE CRAFT will have over a million readers within two years. I hope this letter will be published as a hearty thanks to the editor of the magazine, who has led us to a new field of SHORT WAVES. Thank you.

MR. WILLIAM SHAINLINE,
West Side Apt., Apt. 4,
Hamilton, Canada.

(That's the spirit, William, although we confess privately that we will be satisfied with half a million, right now. This circulation we can get providing that every one of you readers will manifest sufficient interest and talk about the magazine to other readers.

This is not merely charity or even remotely related to it. The point is that you should appreciate the fact that no magazine can make money, unless it has a large and growing circulation. At the present time the net circulation of SHORT WAVE CRAFT is 42,000 and that does not give us leeway to give you readers all the things we have in mind. If every reader would talk only to one other friend interested in short waves, and get him to read the magazine regularly we could immediately give you a magazine almost fifty per cent larger, without charging you any more. Think it over and keep boosting YOUR magazine.—Editor.)

WHAT HE WANTS

Editor SHORT WAVE CRAFT:

I wish to say that articles on three, four, and five tube circuits including R.F. stages of screen grid are greatly welcomed by me.

I wish to report VE9CL, Winnipeg, is testing on 49 meters. They are coming through very good in the East.

Keep up the good work on your Short Wave List. At present you have the best list of short wave stations of any magazine in the East.

Member of "Ye Plug In."

EDWIN AFFLERBACH,
19 Belmont Ave.,
Quakertown, Pa.

(We are glad to print your letter Edwin. The more information we can get on what you fellows want, the better we like it and the quicker you will get it. Yes, we know that our list is reputed to be the best list of short wave stations of any magazine. As a matter of fact it is now in steady use by the largest radio corporations and organizations in the country.—Editor.)

RIGHTO, O. M.

Dear Editor:

I have started to get SHORT WAVE CRAFT and have read two issues so far. As a result I am very keen on getting back numbers. Would you send me information about getting them.

Pretty soon you will receive my subscription for your magazine. I like it so much that it is hard to choose between it and Q. S. T. Of course, you know how we amateurs are, we don't like to turn the "old reliable" down, do we? But for good sensible, downright dope, I sure like your magazine. I still advocate that Q. S. T. is one of the finest magazines for the amateur, ever published. If I were asked to choose between the above mentioned magazine and yours, why to settle it I would take both! I would like correspondents to write me, particularly those just entering the game. I'm just 16 myself, old man. Am interested in anything pertaining to "Radio" and will answer all letters.

Hoping to hear from you when you have time and if possible, please publish this.

Have been glad to hear from the occasional Canadian letters in your magazine. Would like to see many more. Dig in fellows and send 'em in. Thanks for the "info, Old Gent."

Yours till Kilocycles have handle bars,

M. A. MCCOLLUM,
109 Sherwood Ave.,
Toronto, Ont., Canada.

(We can supply all back numbers of SHORT WAVE CRAFT at $.50 prepaid for each copy; any 3 for $1.00. As to your other comment regarding the different magazines, we certainly do like your spirit, M. A., and we sincerely trust that every reader feels the same way.

After all both magazines fill an important mission and as they do not duplicate the same information, all readers should certainly "read both."—Editor.)

CERTAINLY

Editor SHORT WAVE CRAFT:
Dear Sir:

I just bought one of the first issues of SHORT WAVE CRAFT and I want to say here, it is one of the best short wave magazines I have ever read. Put some short wave transmitter diagrams in and tell some of us fellows the different requirement for a short wave license. Keep up your good work and the best of luck to you.

EARL SAGE,
41 Birdsall St.,
Norwich, N. Y.

(Certainly, Earl, we are happy to put in more short wave transmitter diagrams. You will notice some in this issue and you will probably have seen some in the last issue and more to come, is the promise. Just keep on asking for what you want and you will get it as quickly as it can be printed.

The requirements for a short wave license are simple and easy to obtain. Just write to the Department of Commerce, Radio Division, Washington, D. C.—Editor.)

WHAT HE WANTS

Editor SHORT WAVE CRAFT:

Passing a newsstand, the other day, I was attracted by your magazine. I still don't know how it happened, but, anyhow in five seconds I was minus fifty cents, and plus one issue of SHORT WAVE CRAFT. The least I can say is that it is "THE B C L's DREAM". Let's have less theory and more fact. Theory may be all right, but it's fact that builds the receiver, and not theory. I would like more articles on the building, maintenance, and operation of transmitters, or some on radio kinks, as I think that the shortest way, if effective, is the best. I repeat again—SHORT WAVE CRAFT is GOOD, and I'm wishing it a lot of luck. Keep it up. I should like to correspond with any Hams. I'll answer all mail.

LOUIS SELTZER,
2808 W. Lehigh Ave.,
Philadelphia, Pa.

(That's a fine letter, Louis, and we sure thank you for it. You will have seen in the former issues articles on transmitters, and we are here to give you more of this kind of dope if you want it. Again, we repeat our oft-mentioned advice, that SHORT WAVE CRAFT can be any kind of a magazine that YOU make it. It isn't up to us at all. All you have to do is to "holla" and tell the dumb editors what you want and you will get it. Well, Hams, do your bit and let Louis hear from you.—Editor.)

HOORRAH FOR THE RE-READER

Editor SHORT WAVE CRAFT:

I wouldn't miss reading your magazine for anything. I have all the copies and they are read and re-read constantly. Keep up the good work and "yours truly" will be a faithful follower of SHORT WAVE CRAFT forever.

I am an owner of a "Super Wasp." I have logged a great many short wave stations since June 1st, when I built the set. The first month I found that South American stations come in with good loud speaker volume; LSX at Buenos Aires, came in the best. I get that station between 8 P. M. and 10 P. M. I notice this issue has the call listed. KES in California has good volume also. I get them after 8 P. M. at night (irregular). This station communicates with KIO at Hawaii, because I have heard both ends of the transmission.

Of all S.W. stations I find that G5SW at Chelmsford, England, is the most reliable. I don't think I have missed getting them for one day; that is week-days.

This is my first attempt at S.W. Would appreciate hearing from any S.W. fans. Will gladly answer all letters.

Here's for lots of S.W. this spring, and better and bigger SHORT WAVE CRAFT.

RICHARD H. MARR,
99 Broadway,
Hicksville, N. Y.

(That's a lot of good dope you are shooting into us Dick. Keep it up Old Boy. This is the kind of letter we like to receive. You may rest assured it tickled us—without the use of regeneration—to hear that there is at least one reader who keeps on re-reading SHORT WAVE CRAFT. That shows us that we must be giving you fellows what you want.—Editor)

HOW TO DO IT

Editor SHORT WAVE CRAFT:

I want to congratulate you on the best radio magazine published.

Many of your readers complain that the radio manufacturers do not cooperate with them by giving them circuit diagrams of their sets when requested. I am a member of the National Radio Institute and therefore I have quite a number of service sheets on various receivers which are very useful to every radio mechanic.

But a few times I did write to different radio manufacturers requesting diagrams of certain receivers, enclosed one of my business cards and I received the diagram each time I wrote. Maybe some of your readers do not enclose a card or letter-head to show that they are established radio mechanics. We cannot expect manufacturers to give diagrams to everyone that requests them. Show them that you know your business and I'm sure none of you will find any trouble getting them.

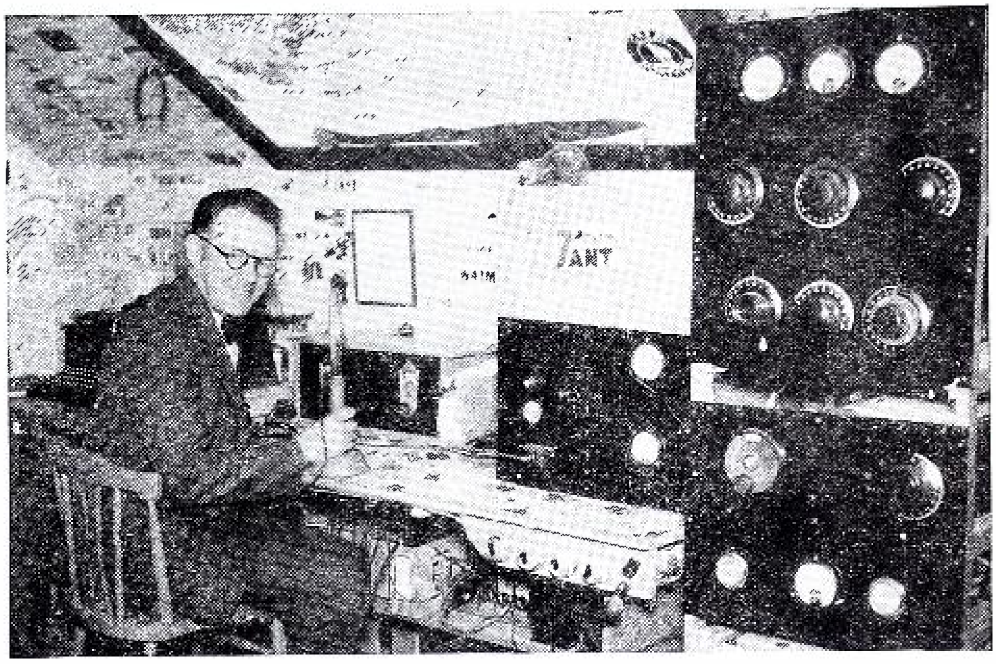
I am 19 years old and would like to correspond with someone about my own age who has built the Pilot Super-Wasp Battery Model Receiver. I will answer and appreciate all answers.

ALBERT J. SANTORO,
203 Tillary St.,
Brooklyn, N. Y.

(This letter is for the benefit of our other readers just to show how it is done.

Mr. Albert J. Santoro certainly gives you some good advice and inasmuch as many other readers have experienced similar treatment, we trust that they will profit by this letter.—Editor.)

$2000.00 Radio Contest



Jack Thompson, who operates the swell looking amateur station W7ANT at Great Falls Mont. At left, below, his Q.S.L. card.

TECHNICAL DESCRIPTION

(Sample for general style only)

Editor, SHORT WAVE CRAFT,
New York, N. Y.

Herewith is a photo of my "Short Wave" phone and code amateur station, together with a photo of my Q.S.L. card. At present my station is operating on 3515-3545 K.C., with crystal control. I have a three-stage speech amplifier, with a 212D modulator, and 852 power amplifier and 510 crystal oscillator. I also use a 865 buffer with 2,000 volts on power amplifier and modulator tubes; 550 volts on the oscillator and buffer. I employ a Thordarson power supply and a Super-Wasp D.C., Short-Wave Receiver. I have worked all districts and 42 states on phone. I will be operating on C.W. (continuous wave-code) in a short time on 3,850 K.C.

Yours very truly, '73s
JACK THOMPSON, W7ANT,
Box 1228, Great Falls, Mont.

$2,000.00 IN PRIZES FOR THE BEST DESCRIPTION, MOST NOVEL "Q. S. L." CARD AND PHOTO OF STATION

IN the last issue of SHORT WAVE CRAFT we announced a $2,000.00 prize contest, open to Short Wave "Hams" and others everywhere. Approximately $2,000.00 in radio merchandise will be awarded in prizes by the editors, who will act as the judges in this contest. The prizes will be awarded to those submitting the most interesting photograph of an amateur station, together with the best short technical description of the set and the most novel "Q.S.L." card. For the benefit of those who did not read the announcement in the last issue of SHORT WAVE CRAFT, we are repeating the rules of the contest, below. We have also advanced the closing date of this contest from April 10, 1931, to June 10, 1931.

The rules of entry are very simple and for one thing we would like to mention, that if you think anything at all of your station, do not attempt to waste your own time and that of the judges, by sending in one of those "foggy" half-out-of-focus photographs, as you will be practically nullifying your chance of obtaining a prize. The old saying is still a good one—to wit: "Anything worth doing at all is worth doing well." If you are not a good amateur photographer you had better call on a friend or a professional photographer to take the picture of your set. The apparatus must show up clearly and distinctly and it is a good idea, if at all possible, to pose yourself with your set, when having it photographed. However this last request is not an absolute requirement.

With further regard to what the judges have in mind for the most novel "Q.S.L." card, no very definite rules can be laid down as the range of ideas will run the entire gamut from the ridiculous to the sublime.

The description of the set need not be more than 150-200 words in length, but it must be written up in an interesting way.

RULES—Send a good (clear) photo of your set, at least 5 x 7 inches; also "Q.S.L." cards and description, including following data: Power in watts (input to last stage) of station? Wavelengths usually used? At what hours (Greenwich Civil Time) do you operate? Crystal control? Phone? You do not have to be a subscriber to compete. Address all entries to: Editor, Radio Amateur Prize Contest, SHORT WAVE CRAFT Magazine, 98 Park Place, N. Y. City.

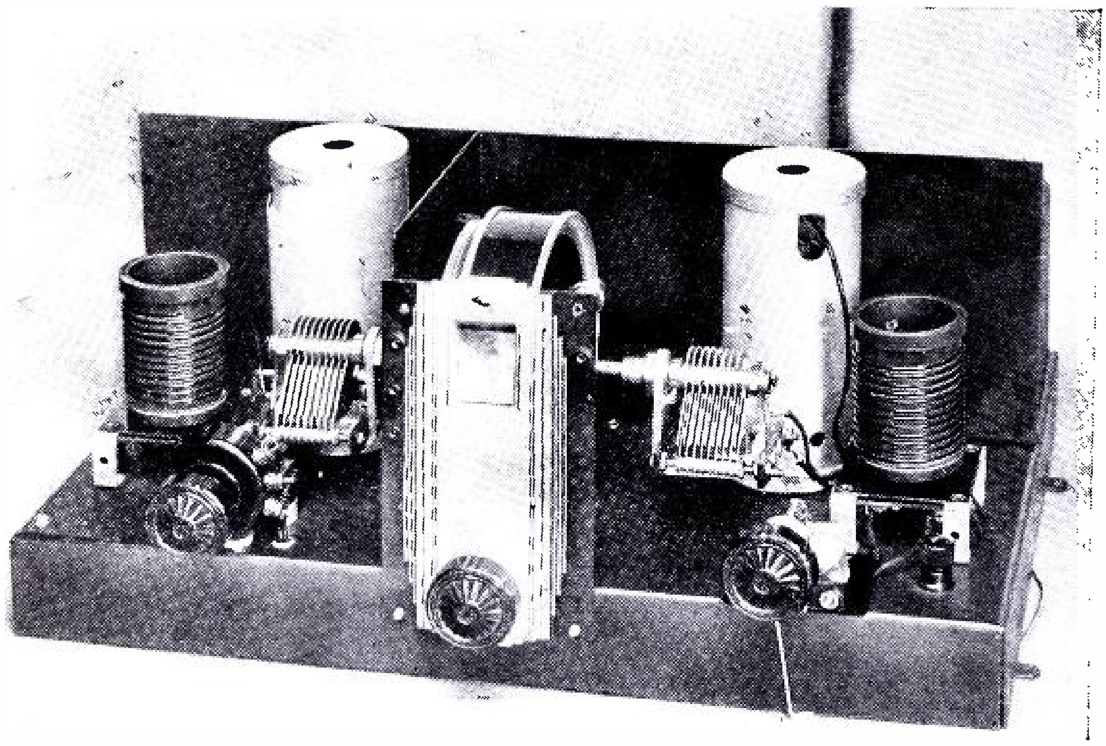
Up to the time the magazine went to press, we are glad to announce the names of the radio manufacturers who have contributed merchandise to be awarded as prizes by the judges of this contest:

Pilot Radio & Tube Corp., Lawrence, Mass.
The Ken-Radio Corporation, Inc., Owensboro, Ky.
Universal Microphone Co., Ltd. Inglewood, Calif.
Electrad Company, Inc., New York City.
International Resistance Company, Philadelphia, Pa.
A. M. Flechtheim & Co., Inc., New York City.
Trimm Radio Mfg. Co., Chicago, Ill.
X-L Radio Laboratories, Chicago, Ill.
Triad Manufacturing Co., Inc., Pawtucket, R. I.
Clarostat Mfg. Co., Inc., Brooklyn, New York City.
Amperite Corporation, New York City.
Ce-co Manufacturing Co., Inc., Providence, R. I.
Hammarlund Manufacturing Company, Inc., New York City.

Details of the New National, 2 Volt,

BATTERY TYPE "THRILL BOX"

By ROBERT S. KRUSE*



Front view of two volt, battery type, short-wave Thrill Box receiver, with metal cabinet removed. This set is ideally suited to operate with the new two volt "breather" battery made by the National Carbon Co.

The new National 2-volt tube type, Thrill Box, intended for battery operation is here illustrated and described, by Mr. Kruse, famous short-wave expert and one of its co-designers. Improved plug-in-coils, having a minimum electrical loss are employed, with ganged tuning condensers operated by a one dial control. The audio output stage is push-pull and the engineering and workmanship on this receiver is of the highest order. Experience has shown that one of its outstanding features is the extremely smooth regeneration control.

MOST short-wave receivers have been altogether too limited in their possibilities. The international short-wave broadcast "fan" needed one sort of receiver, the radio-telegraphing "CW" amateur wanted another and still a third kind seemed necessary to the radiophone amateur. Furthermore, all three kinds of sets seemed to share between them some outstanding shortcomings, which may be listed as follows:

(1)—Lack of a continuous tuning range, or else very cramped tuning at some wavelengths;

(2)—Inability to work with different sorts of antennas without readjustments or even recalibration ("logging");

(3)—Lack of true single control;

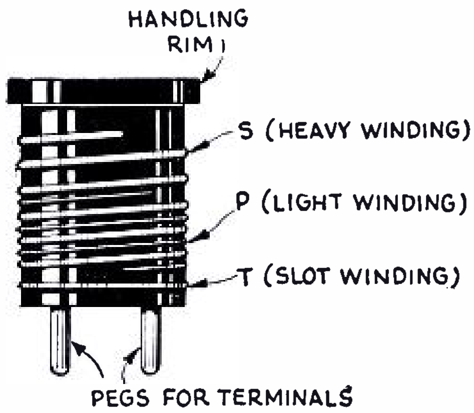
(4)—Poor selectivity;

(5)—Complexity, either by reason of many sorts of coils or else by reason of switch-gear or range-shifting condensers;

(6)—Inflexibility as to "A" and "B" supply;

(7)—Mechanical instability.

A year ago measurements and tests were made with the purpose of arriving at a receiver design which should also be suited to all three sorts of short-wave reception—international broadcasting, amateur phone and amateur radio-telegraphy. The design went through the well-known preliminaries and emerged as a model which, in the hands of the National Company, became a commercial chassis known as the "SW-5." In addition to meeting the requirements previously mentioned this chassis can readily be constructed for either A.C. or D.C. operation; it also provides a degree of sensitivity not usual in short-wave receivers. Other incidental advantages appear in the present form, as manufactured.



This drawing shows how the secondary (S), primary (P), and tickler or slot winding (T) are placed on the coil form.

Importance of Tuned Input

It is practically self-evident that good sensitivity and good selectivity cannot be combined unless one uses tuning ahead of the first tube in the set—that is to say, "selectivity before gain." Should anyone be in doubt, it is necessary only to recall that a few years since we had

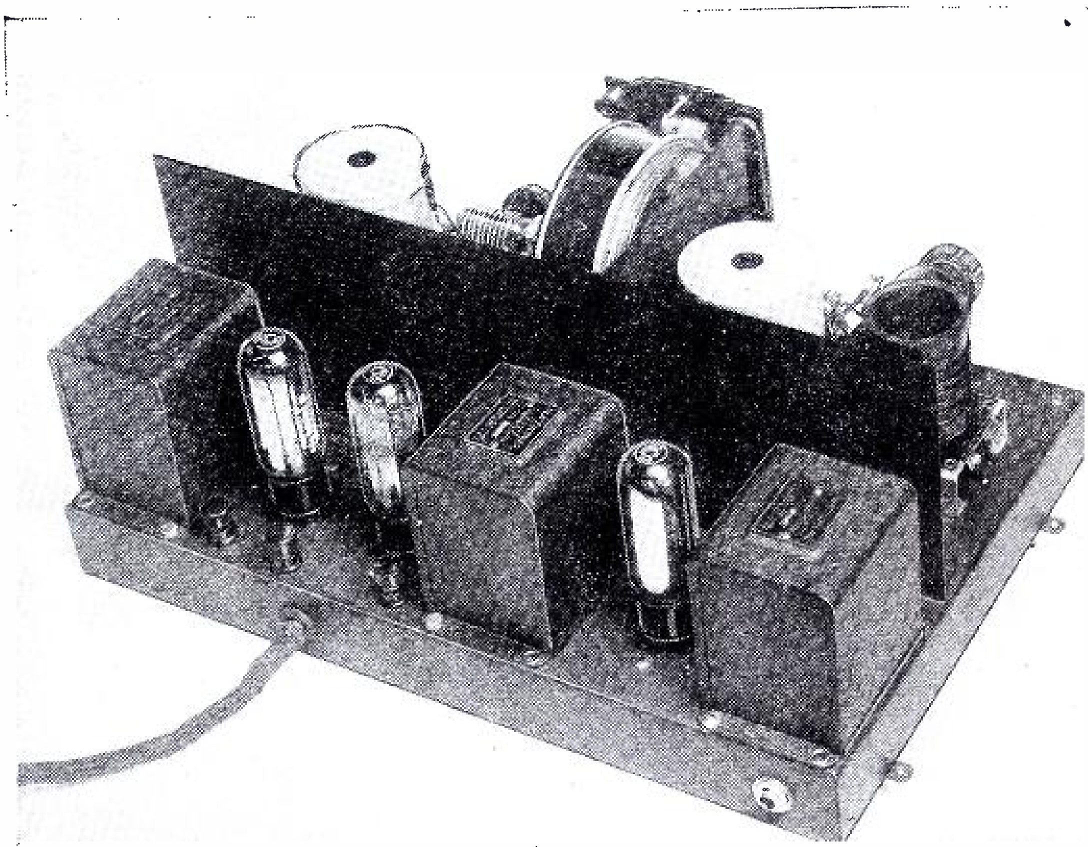
"One dial tuning" National short-wave receiver.

* Consulting Engineer.

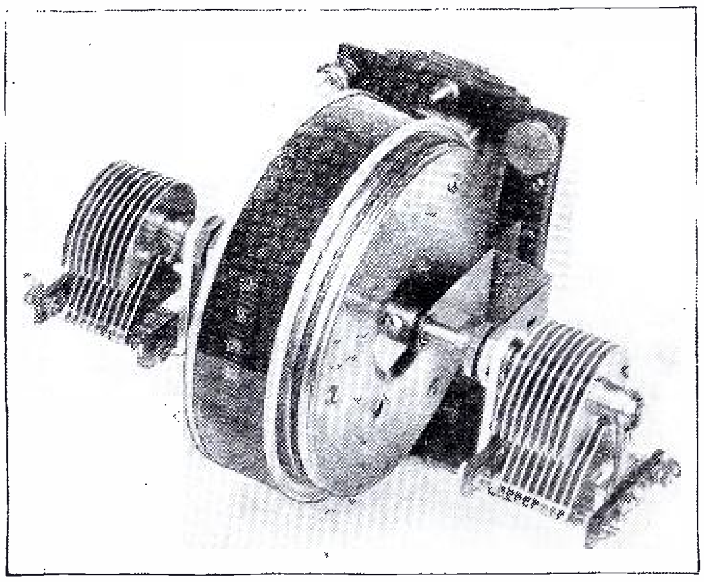
broadcast receivers with such "untuned inputs," "coupler tubes" and the like; but now we have gone to the opposite extreme and put one, two, and even three tuned circuits ahead of the first tube. The only reason broadcast receivers ever tolerated the coupling tube was that it was considered "impossible to produce alignment of the first circuit with the rest because of the association of the first circuit with the antenna." As soon as this was discovered to be a mere superstition all manufacturers dropped the coupling tube in a moment. Why not? Has it any advantages whatever?

Similarly the short-wave receiver has stuck to the "coupling tube" idea because it is "impossible to—" and so on. Some consideration of this belief suggested that it was not altogether sound; indeed, the suspicion arose that it was probably not more than twice as difficult as in the usual broadcast receiver. The ganging problem was accordingly attacked as the heart of the matter. Experiments soon confirmed the suspicion that satisfactory ganging could not be expected from cut-down broadcast condensers. A smaller, more rigid tuning condenser was devised, with due attention to avoidance of all wiping contacts.

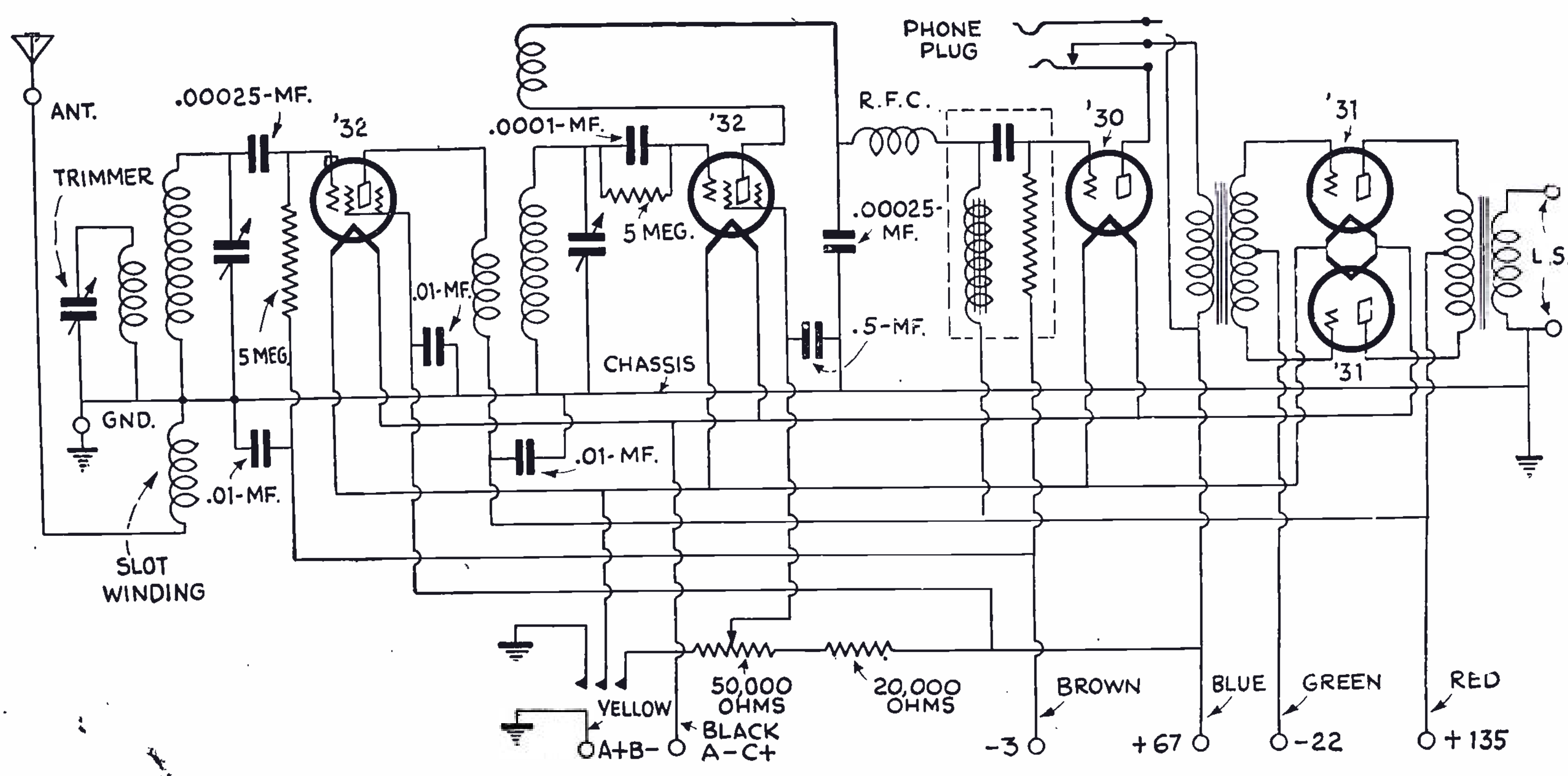
Having found the new tuning gang to maintain alignment it was necessary next to assure the permanence of the coils. This is a thing not quite as simple as it sounds. From the standpoint of mechanical solidity it was desirable to wind the wire in threads, cut in a molded bakelite form. A very few tests confirmed the previous experience that such a coil is very bad on short waves. There remained the choice of using some sort



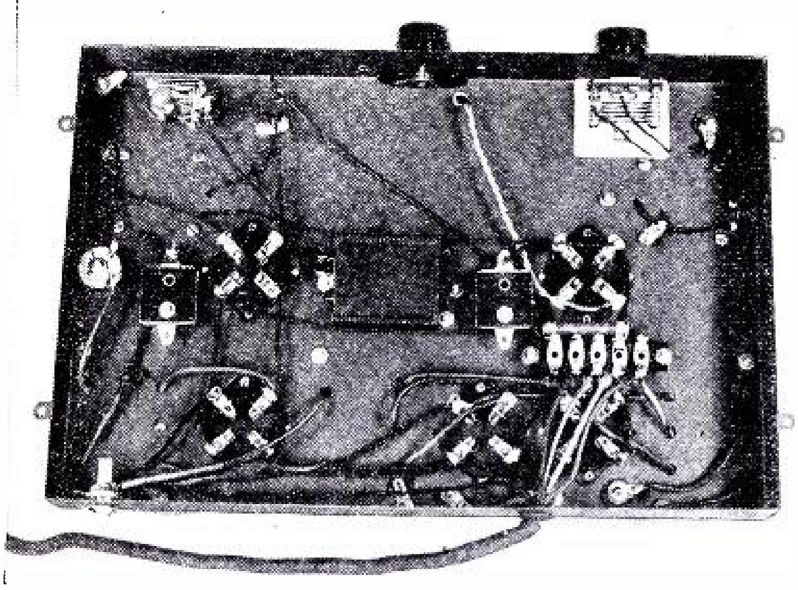
Rear view of the National battery-operated Thrill Box receiver, with new two volt tubes in place. The screen grid tubes are enclosed in the metal shield cans on either side of the tuning dial.



A master-piece in short-wave design is represented by the ganged tuning condensers and the "single control" dial shown above.

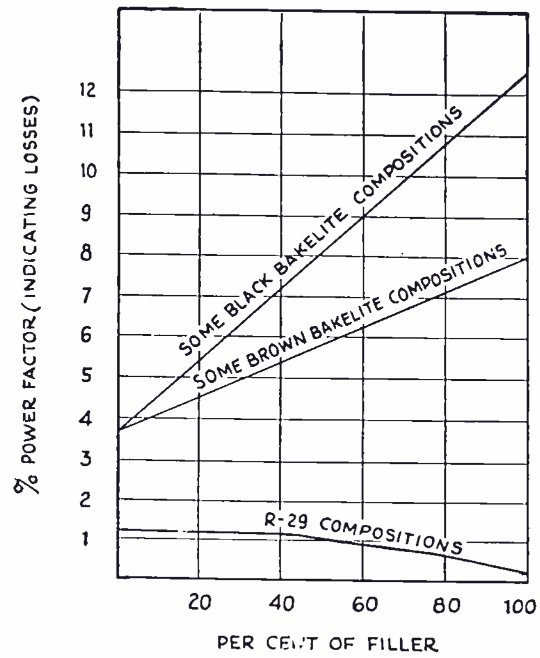


Wiring diagram of new National 2 volt, battery tube type, of the "Thrill Box" S-W receiver. The antenna couples through slot winding (tickler or T1); the primary winding P1 is shunted by compensating condenser C; in the detector coupler, the primary is P2, the secondary L2 and the tickler winding (in slot) T2. The detector tuning capacity is C2; R.F. stage secondary tuning condenser C1.



Left—Neat sub-panel wiring of the National S-W Thrill Box, designed for the new two volt tubes.

The graphs at right show the very low electrical losses occurring in the National short-wave coils, which are wound on R-29 composition.



of a skeletonized or ribbed coil-spool or else going to a better high-frequency material for a threaded spool. It was known from previous work that a good low-loss ribbed spool can be made of black bakelite, but in the present set such a spool would not answer because the wire is supported at the ribs only and can therefore shift slightly during the handling of the coils. This shifting produces alterations of inductance and "raises hob" in a single-control set—though quite harmless in a multi-control one. The coils were therefore wound in cut (not moulded) threads in spools made of a special bakelite called "R-29."

Special Coil Design

The use of a 4-prong coil form to fit the standard UX socket, or a 5-prong socket like the UY standard, was very attractive but was abandoned in favor of a special 6-prong socket, which permits complete independence of the three windings, which appear on each coil form. This independence permits two major advantages. One is avoidance of detector grid-blocking and the other is the ganging trick first described in detail in an earlier part of this article.

The method of ganging with these coils depends on their winding arrangement. The heavy-wire winding is spaced to occupy a length about equal to its diameter. This is not quite the best theoretical form but is one which is conveniently maintained for all the coils of the series, while at the same time it is not far from the ideal. This heavy-wire winding is used as the secondary, regardless of the position in which the coil is used. Putting it differently, the heavy-wire winding is always the tuned winding which feeds the next grid—whether that be the R.F. tube or the detector.

"Inter-wound", with this heavy-wire winding, is a primary winding of fine wire, which has 66% as many turns as the secondary. This ratio gives almost all of the R.F. gain which would be obtained with a primary having as many turns as the secondary. At the same time it does not transfer as much capacity from the plate circuit into the next tuned circuit (grid circuit), where it is not wanted. There are several reasons why it is desirable to keep this capacity-transferring action down. One is that the capacity is not exactly the same for all tubes, and will therefore change slightly when the tubes are changed; thus tending to disturb the calibration or "logging" of the set. Another reason is that the plate-circuit capacity is—for one particular tube—a fixed capacity, and if this capacity is "transformed over" into the secondary one has the effect of a small fixed condenser shunted across the tuning condenser. This is bad, because one must then increase the size of the tuning condenser quite considerably to preserve the same tuning range. Incidentally, also, the power factor and selectivity of the tuned circuit suffer if the primary has more turns than the 2-to-3 proportion, just mentioned.

The third winding on the form is close-wound of small silk-covered wire in a narrow groove at the lower end of the spool. It is normally used as the detector tickler.

Problems of Circuit Alignment

It has been customary in short-wave receivers to use two types of coils, the antenna-coupler or R.F. input coils being without ticklers and having provision for coupling in the antenna through an antenna winding or a small condenser. It was decided in this case to avoid the condenser-coupling method; for the double reason that it tends to cause severe mistuning and that noises, especially power-line noises, appear to be somewhat more severe with such an input than with an antenna coil. A variable condenser in series with the antenna does not provide proper compensation when the antenna is inductively coupled, the series condenser having to be reset with almost every change in tuning. It therefore amounts to another tuning control and spoils the single-control feature entirely. A "vernier" condenser connected across the tuning condenser will give fairly good compensation but will *not quite* maintain alignment across the tuning scale.

The regeneration control is by varying the detector's screen-grid voltage; as this has both a positive action and a wide range which will produce the desired action with any ordinary tube, and with "B" and "A" voltages within about 20% either way from the proper values.

Audio Amplifier Gives High Output

Since short-wave reception sometimes demands the use of the headset, a jack has been provided in all models, directly after the first A.F. tube. This does not monitor across the audio transformer, but is a cutoff jack, removing the transformer completely from the circuit when the headset is jacked in. One is thereby freed from the confusion due to hearing from two sources (headset and speaker); also for weak signals one has slightly (about 3/1) better sensitivity.

The final stage is a push-pull one with an output transformer, so that the output terminals are entirely dead except for signal voltages. In the A.C. set there is used a pair of '27 tubes, which are operated to produce somewhat more output than could be had from a '71- or '71-A, while at the same time producing negligible hum. In the D.C. set there is used a pair of the new '31 output tubes. The biases are provided by cathode drop for the A.C. tubes and by a "C" battery in the D.C. circuit.

The coil ranges are so located that exchanges are not necessary in any band, except the standard broadcast range where rapid traverse is never necessary.

The coils marked ** are standard equipment with the set, either A.C. or D.C.

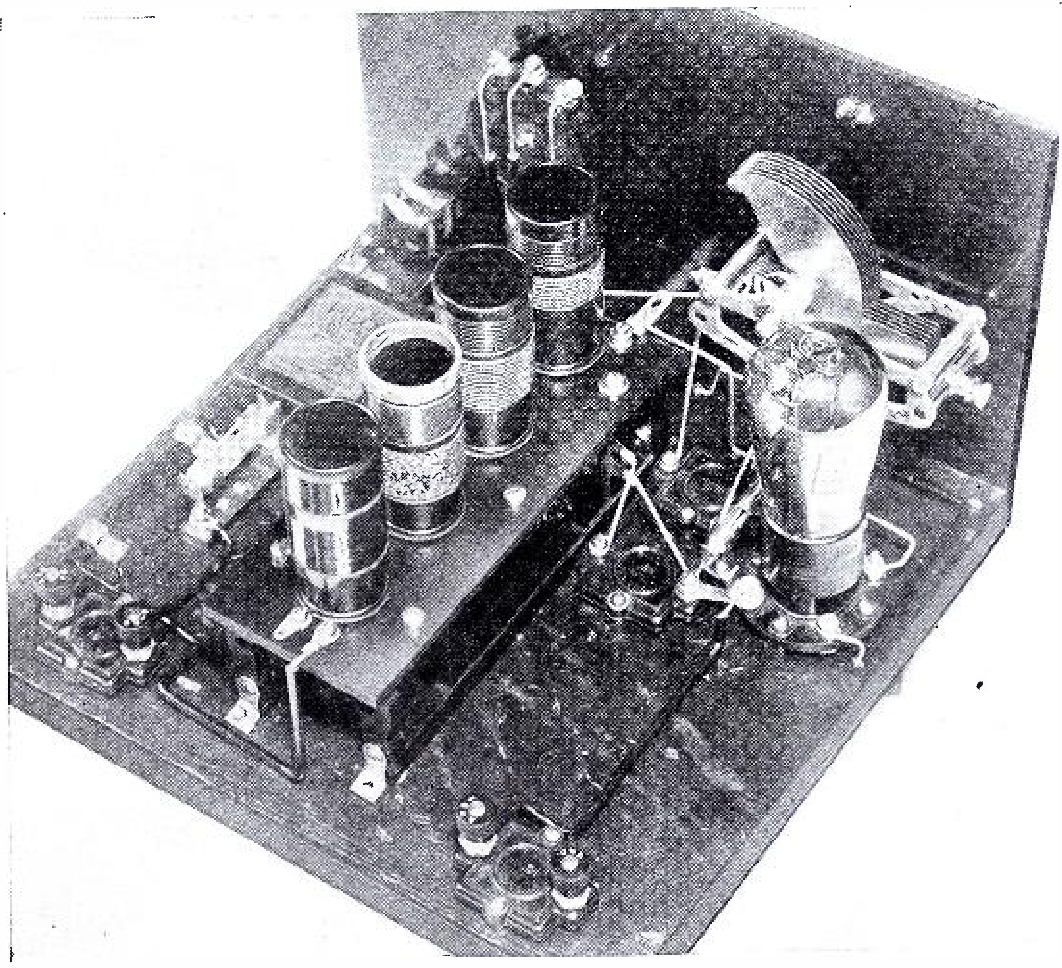
Cat. No.	Wave Range Meters	Purpose
10	9—15	International broadcasts; commercial signals; amateur 28-megacycle band.
11**	14—25	International broadcasts; commercial signals; amateur 14-megacycle band.
12**	23—41	International broadcasts; commercial signals.
13**	38—70	International broadcasts; commercial signals; amateur 7-megacycle or 7,000-kc. band.
14**	65—115	International broadcasts; amateur 3.5-megacycle or 3,500-kc. band.
15	115—200	Amateur 1.75-megacycle or 1,750-kc. band.
16	200—360	Regular broadcasts.
17	350—550	Regular broadcasts.

The Short Wave Experimenter

A "Plug-Less" S-W Receiver

Mr. Avery, well-known radio engineer and author, here describes for our readers his latest brain-child—a "plug-less" short-wave receiver which uses switches to change from one wave-band coil to another. BUT none of the coils are idle, as the coils not in use are "put to work," thanks to the genius of Mr. Avery, and those not utilized for tuning serve as R.F. chokes. This set was built and tested very satisfactorily on both code and phone and showed excellent selectivity as well as fine pick-up range, with no dead spots.

By JOHN M. AVERY



Rear view of the Avery "Plug-Less" short-wave receiver, using special bi-pole switch to change inductances.

EVERY radio experimenter of a few years' experience can recall when "plug-in" inductance coils seemed to be the only available method of efficiency tuning over the regular telegraph waveband (then 200 to 20,000 meters); the "plug-in" coils of that time taking the form of "honeycombs", "duo-laterals", etc.

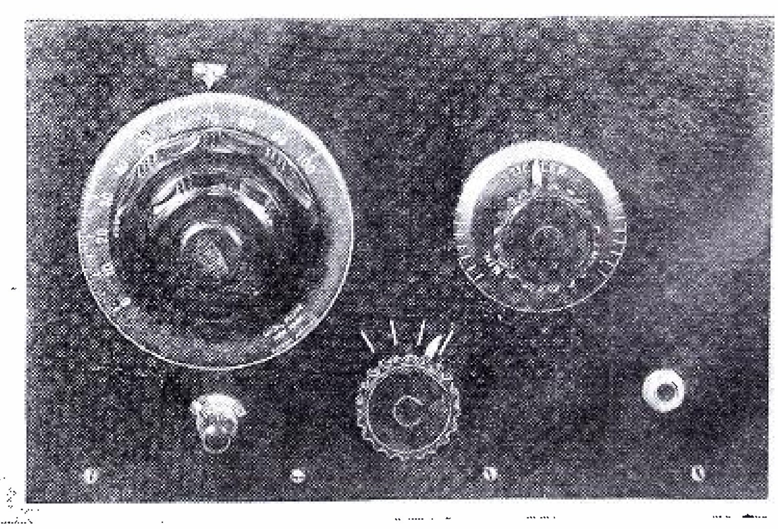
There is as distinct a contrast between the old method of long-wave reception, utilizing a "table full of honeycombs", and a modern commercial all-wave receiver, as lies between the use of many plug-in coils for short waves and any method enabling the tuning of the whole short-wave spectrum without "opening the cabinet". In the writer's belief, perfection of methods to eliminate that nuisance will as surely cause the popularity of the "plug-in" method for short-wave reception to wane.

While it is true that there have been several coil-changing ideas presented in the immediate past, they nearly all present the same drawbacks; complicated, revolving-coil mechanisms with multi-contact switches or brushes; very large space required for installation; or use of parts not readily available to the average constructor. This last, is in my belief, the most serious; as but comparatively few have the facilities to make the special mechanical parts usually required.

No Idle Coils In This Receiver!

The inductance-changing method here presented is readily adaptable to practically all short-wave circuits, whether regenerative, radio-frequency amplifier or superheterodyne; it utilizes simple positive-contact switches for its operation. A most important feature of this method of changing the coils in use is that no coils are idle in the set, acting as energy-wasters. For any given wavelength, the *unused* coils are connected in series, and *add to the circuit's efficiency by acting as radio-frequency chokes.*

In order to make this action quite clear, an elementary fundamental circuit diagram is shown in Fig. 1.



Front view — "tuning" dial at left; "regeneration" control at right; "inductance" switch knob at bottom.

For sake of clarity, but two inductance changes are shown in this diagram; and the circuit is that of the simplest regenerative-detector type, coupled to the antenna through a midget condenser "C-5".

"A-1, A-2", are the two windings of the lowest waveband, while "B-1, B-2" are those of the next higher waveband. "S-1" and "S-2" are ordinary inductance switches, preferably with very low capacity between the points "X" and "Y". An examination of the diagram shows, then, that if the inductance switch "S-1" be placed on point "X", only the coil winding of the shortest waveband is in the plate feed-back or tickler circuit. The R.F. energy finds a path of but a fraction of an ohm's resistance, through condenser C-2 of .01-mf. capacity, to the filament circuit. Coil winding "B-1" has become a radio-frequency choke coil, preventing an escape of R.F. energy over into the phones or audio amplifier. Similarly, with switch "S-2" on its contact "X", only coil "A-2" is in the grid tuning circuit; the grid tuning condenser being placed directly across it, and a low-resistance path provided to the filament through the fixed condenser C-1. This condenser may take any value from about .01-mf., up.

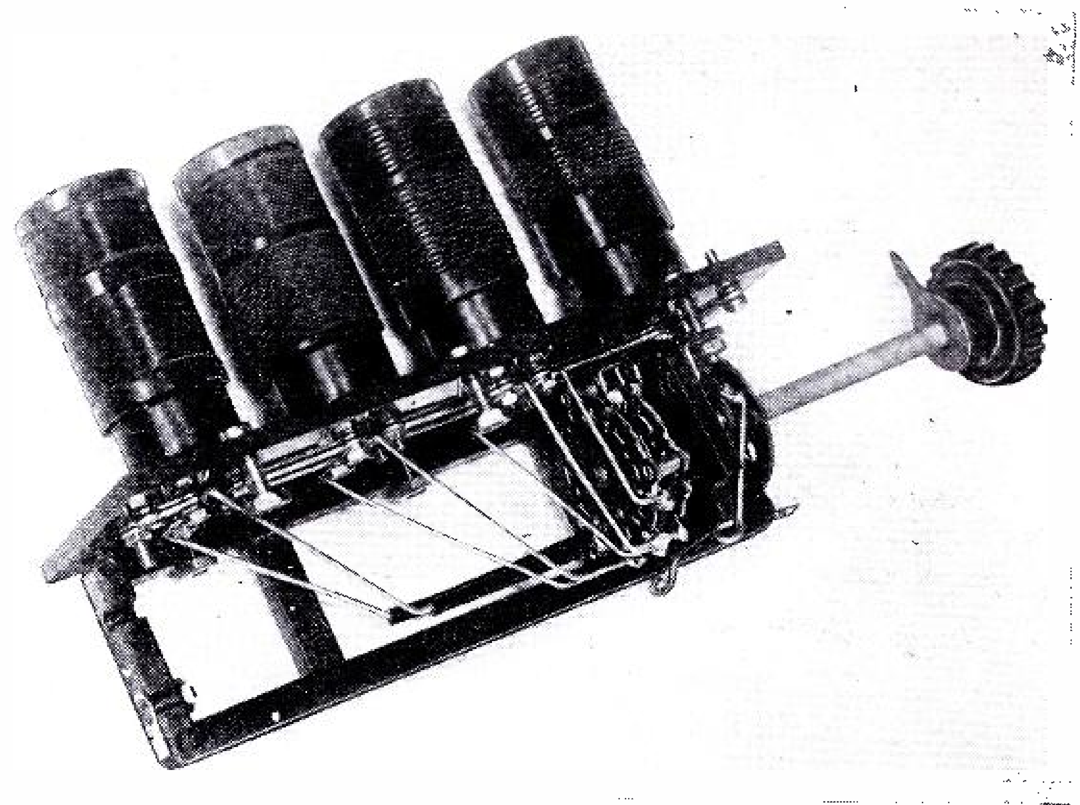
It can readily be seen, that if three or four waveband changes are provided for, efficiency does not decrease; since the unused coils are drafted into active service.

R.F. Stage Can Be Used

Should a radio-frequency amplifier stage be used ahead of the detector, which is common practice at the present time, then the unused coils in the grid circuit perform the same function as chokes, in what then becomes the R.F. amplifier tube's plate lead. It is understood that the R.F. amplifier tube's plate would be connected to the same point in the circuit where midget condenser C-5 connects in this simple diagram, for a series plate feed, and that the R.F. amplifier's "B" potential would be applied at point "Y".

The dotted line in Fig. 1, between point "Y" and the filament, represents a connection that should be made if no R.F. amplifier is used; in order that the unused coils shall not be left on open circuit, where energy might be absorbed.

From the above it can readily be seen that, using the principle outlined, any type of short-wave receiver may be assembled, covering a wide range of frequencies, without resort to manually-interchanged plug-in coils.



Side view of short-wave coil shelf, and double-pole switch with its extension handle.

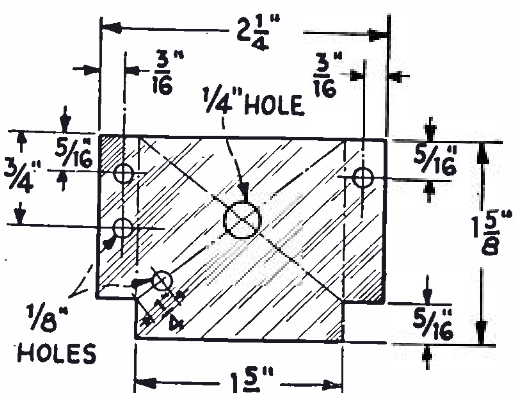


Fig. 2-A.

Fig. 2-A — Switch support member of insulating material.

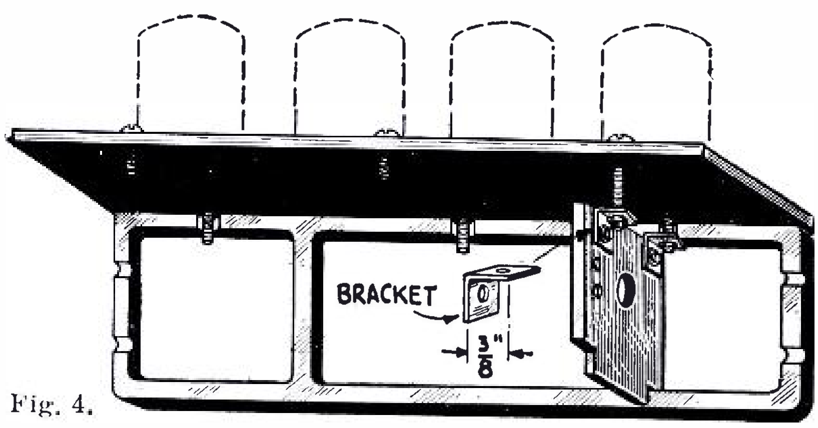


Fig. 4.

Fig. 4—Side view of coil shelf with one of the brackets and switch support.

Fig. 2. Left—below: Drilling layout for bakelite or other insulating shelf on which coil sockets are to be mounted.

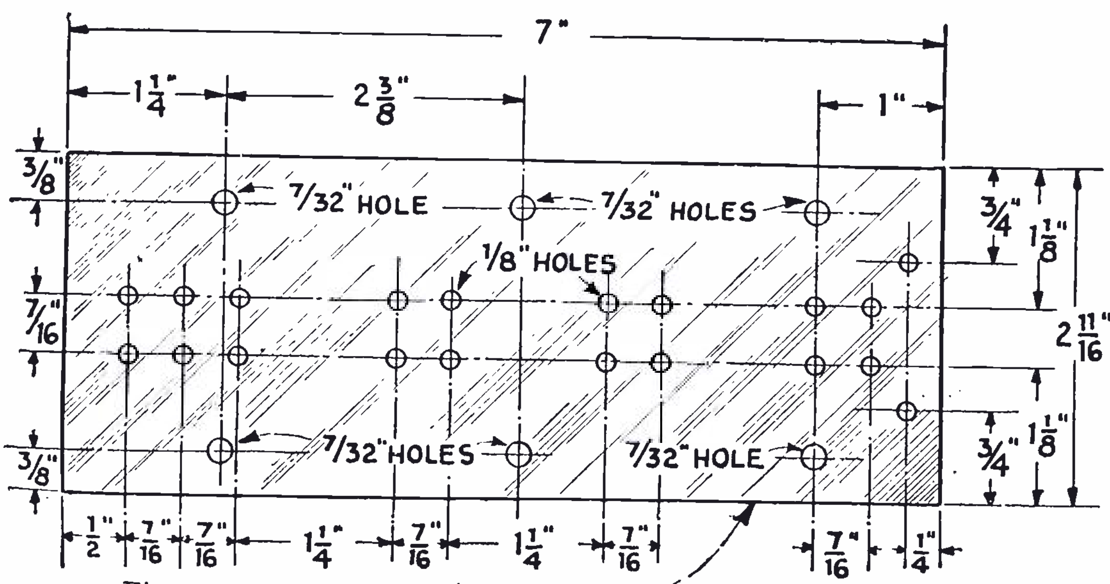


Fig. 2.

Any Standard Plug-In Coils Adaptable

In order to make the new feature available to the greatest number of short-wave enthusiasts, the author has designed the inductance unit shown in the photograph, which can be easily incorporated in any receiver. Regular plug-in coils are used in this unit (which here happened to be the four-prong "Dresner" make) although regular "tube-base" or even five-prong coils can be used. Sockets are provided for each coil; so that the total frequency range of the receiver may be changed at will.

The writer believes that what will be most appreciated is that no special parts are required for the construction of the unit shown; since he has attempted to restrict himself to what can readily be found on the market.

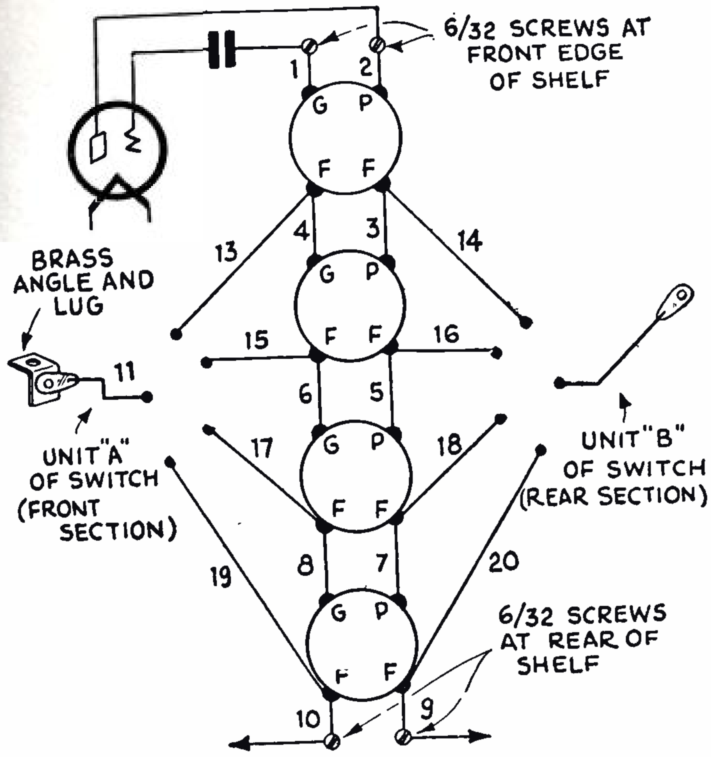


Fig. 3 — Diagram showing wiring of inductance change switches and coil sockets.

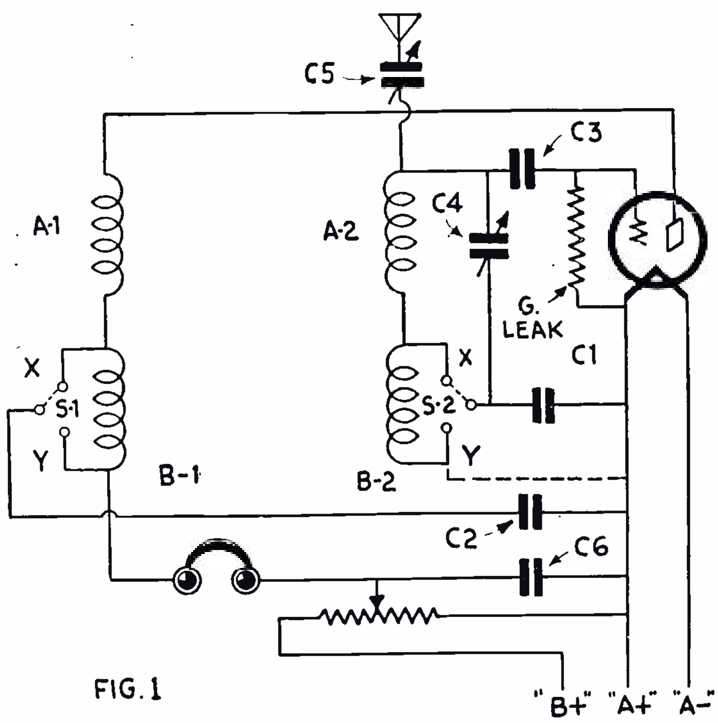


Fig. 1 — Schematic wiring diagram of the Avery "Plug-Less" short-wave receiver.

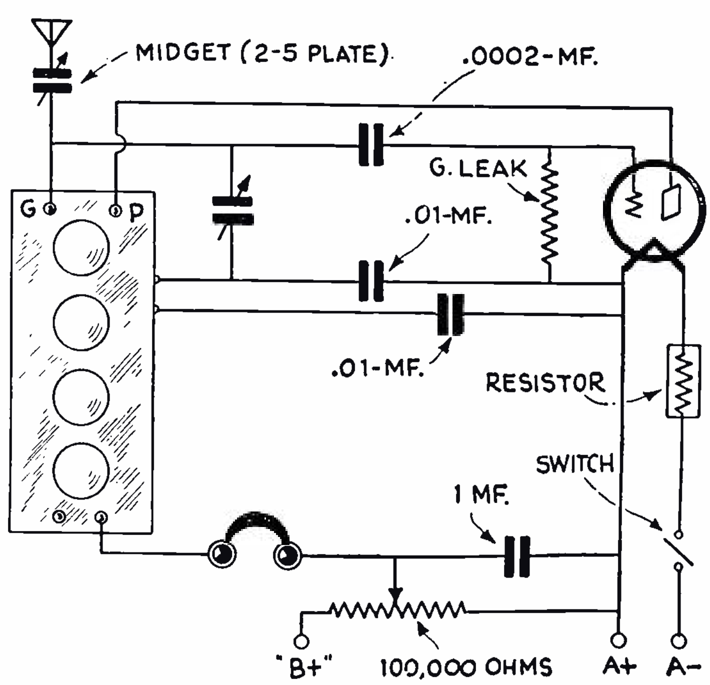


Fig. 5—Wiring external to the short-wave coil panel is shown above.

The following is the complete list of parts required for the construction of the unit:

LIST OF PARTS

One Socket-mounting shelf, drilled as per sketch;

One Switch supporting panel, as per sketch;

Four Pilot No. 214 sockets;

Two I.C.A. bakelite brackets, No. 34, two inches high;

One "Twin" four-point switch. (That made by Best Mfg. Co., Irvington, N. J., was used by the author);

Two ½-inch brass angles;

One Pilot flexible insulated coupling;

Six 8-32 R.H. brass machine-screws and nuts, ¾-inch long;

Four 6-32 R.H. brass machine-screws with nuts, ½-inch long;

Three 6-32 F.H. brass machine-screws with nuts, ½-inch long;

One set of plug-in or other S.W. coils to cover bands desired;

One tube (to suit experimenter's ideas; the author used a '71-A as a detector with very good results).

A few feet of hard-drawn round bus-wire; a few inches of varnished cambric sleeve; 2 doz. lock-washers to fit 6-32 screws; and a few soldering lugs.

Making the Coil and Switch Support

Only two specially cut and drilled pieces of insulating material are required. (See Fig. 2 for dimensions and drilling lay-out.) Bakelite is probably the most acceptable material from which to make these two pieces, because of its strength; although hard rubber, Insuline, etc., are materials more easily worked in the home shop.

Two "I.C.A." two-inch bakelite (Cat. No. 34) sub-panel brackets form the framework around which the unit pictured is assembled. The socket shelf is bolted to these brackets with 8-32 brass machine-screws. If the socket panel has been drilled to the dimensions shown, it will be found, upon assembly, that one end of it will be flush with one end of the bakelite brackets; the other end projecting over about one-fourth inch.

For sake of clarity in describing the assembly from this point on, the "flush" end will be called the "front" end; since in a completed receiver it is the end which is nearest the front panel, and the end to which the grid and plate leads connect.

Assemble the four Pilot four-prong No. 214 sockets in the holes provided; arranging them so that the "G" and "P" terminals are toward the front end of the panel or shelf. Two ½-inch 6-32 R.H. machine-screws are placed in the two holes at the very front edge of this sub-panel.

How to Wire the Set

Using fairly hard-drawn round bus-wire, make two small jumpers or connectors, connecting the two 6-32 screws with the nearest "G" and "P" terminals. In the switch wiring diagram these are connections "1" and "2".

Neatness in making every connection in this unit is of prime importance. "Make haste slowly" is sound advice. Learn to make perfectly round loops at the end of each of the bus-wire connections, and see that the distance between the loops exactly matches the distance to be bridged, resulting in neat, firm connections.

Connect the "F" terminals of the first socket to the "G" and "P" terminals of its neighboring socket; and so on through the series of four sockets, terminating the series with two short jumpers to the two ½-inch 6-32 machine-screws placed in the two holes at the rear end of the socket shelf. These are connections "3" to "10" inclusive.

Mounting the Switch

Assemble the Best twin four-point switch on the small insulating panel, so that the connecting lugs of the switch will face down or away from the socket shelf after assembly. Two ⅜-inch flat-head 6-32 screws are used to mount two ½-inch brass angles to the switch panel; and a third ⅜-inch flat-head screw is placed in the vacant hole immediately below the left angle, secured with a small hex nut, with a soldering lug under its head. A soldering

(*Continued on page* 485)

Ultra Short Waves

NEW WORK IN GERMANY On Ultra SHORT WAVES

By DR. FRITZ NOACK

(Concluded from last issue)

The results of tests on waves as low as 3 meters are discussed by the author, successful tests having been conducted between an airplane in flight and land stations. The ultra short waves seem applicable to aviation beacon requirements says the author, and another use is to replace land telegraph wires.

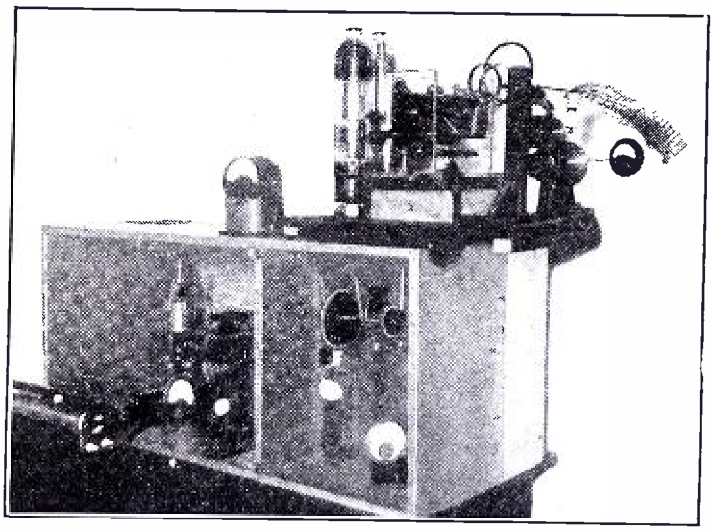


Fig. 8. Appearance of six meter, 600 watt short-wave transmitter.

Range Found Limited by Scattering of Ray

A SECOND series of experiments was carried out with Prof. Esau; on the top of the Brocken (a famous peak in the Hartz Mountains) a transmitter of greater power (see Figs. 8 and 9) was set up at a height of 3,740 feet—above sea level. In this case, reception was chiefly northeast of the Brocken, where the country is fairly flat and whence the Brocken is always visible. Theoretically the possible range might be about seventy miles.

For the transmitter there was used a Telefunken tube (type RS-229G); the transmitting wave was 3.2 meters; the transmitter operated on a vertical Hertzian antenna 1.6 meters (63 inches) in length. The same receiver was used as in the airplane. Reception was obtained either without an antenna, with a horizontal antenna about 2.5 meters (98.4 inches) long or with a vertical antenna about 26 feet high.

At first the transmitter was set up on the ground, on the Brocken. The range was from 46 to 62 miles; within this field the reception strength was practically constant; while, beyond this, it decreased extraordinarily fast. The width of the zone within which the rapid decrease took place was from about four to nine miles. It is to be assumed that in this area, as at the maximum range, we have no longer a question of direct radiation but one of indirect, divergent radiation. (*Like light through a fog.—Editor.*)

In further experiments, the transmitter's power was increased by steps, up to about eighty times the original figure. It appeared that reception was always obtained up to 55 miles, with any amount of energy; though, indeed, at various degrees of reception strength. If one went further than fifty miles from the transmitter, the volume of reception rapidly decreased, and it could be heard beyond 53 miles only when the fullest power of the transmitter was used.

This series of experiments shows that, with ultra-short waves, the range actually corresponds to the theory indicated above: *i.e.*, the wave is essentially limited in its propagation within the horizon. Furthermore, the power of the transmitter has only a slight influence on the range.

During a further series of experiments, the transmitter was set up on the stone tower which is on the peak of the Brocken. In one direction, there could be determined an increase in range of twelve miles beyond what had been obtained before.

It is interesting that, on using antennas in receiving, there was found hardly any improvement in sound strength. To be sure, this is true only of that range within which the energy radiated by the transmitter is directly received. In the so-called "boundary" field (where we have to deal, not with the reception of direct radiation, but with that of apparently divergent radiation), a little increase in range could be established by using antennas in receiving. This increase amounted to about 25 per cent of the range, in the reception of the direct radiation.

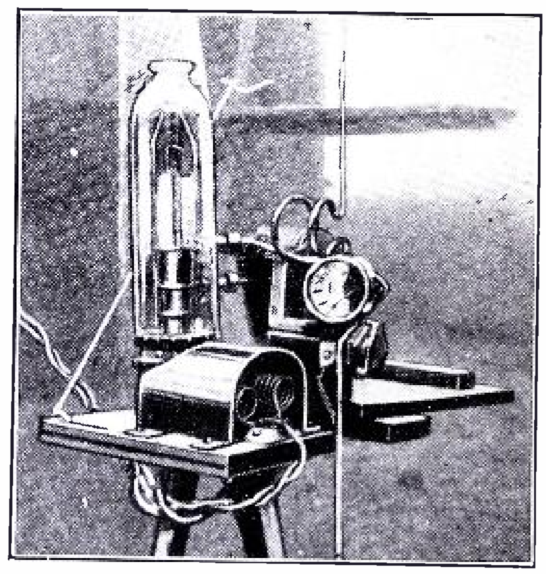


Fig. 9. Here's the three meter transmitter with its dipole antenna, set up on top of the Brocken, (Hartz Mountain peak).

To test the theory further, still another series of experiments was performed. This time the transmitter was placed half-way up the Brocken, that is, about 1,600 feet above sea level and accordingly about 1,100 feet above the surrounding country. It was set up on a 52-foot stone tower, to exclude as much as possible the influence of the ground upon the transmitter. The range within which the sound strength remained approximately constant was about 41 miles. At 49 miles, the reception entirely ceased. Here, too, it was found indifferent whether a receiving antenna was used or not.

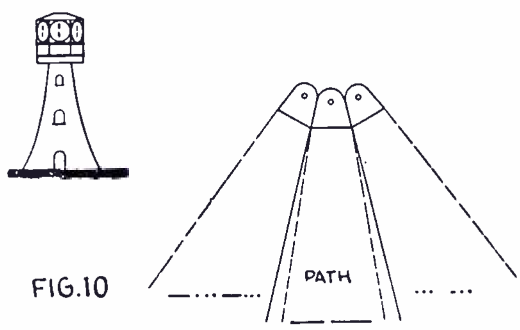


FIG.10

Fig. 10, Proposed ultra short wave radiator (beacon) for navigation, in three sectors.

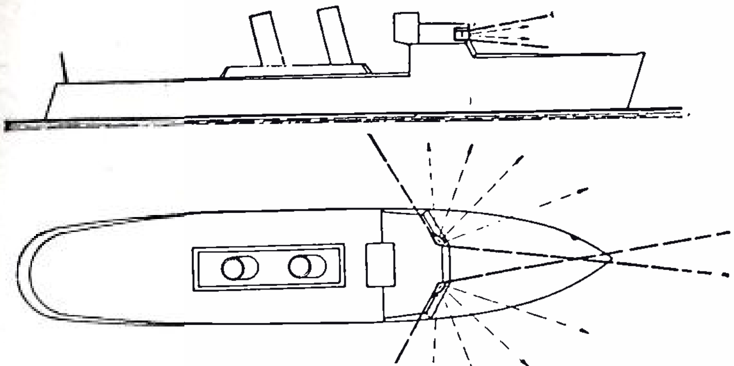


Fig. 11. Arrangement of port and starboard ultra short wave radiation reflectors on shipboard.

All the experimental results are in more or less agreement with the above theory. The significance of this fact in the use of ultra-short waves is extremely great; for, as we see, operation at close range, at least, is extraordinarily dependent on the position of the transmitter and the receiver. How far we can in practice cover, with ultra-short waves, long distances through the reflection of the ultra-short waves at the Heaviside layer, can not yet be tested out.

In the experiments of Dr. E. F. W. Alexanderson at Schenectady, long distances have indeed been covered. This quite evidently is traceable to reflection by the Heaviside layer; for people have been able to receive his transmitter in South America. But it seems as though reflections through the Heaviside layer take place only in the north-and-south direction; in which case the magnetic field of the earth apparently plays a certain part.

The results which have been thus far attained, in the above experiments in the field of ultra-short waves (*i.e.*, range of reception, according to the above theory; insensitivity toward disturbances both of the atmosphere and of local nature; absence of fading, because of the absence of indirect deflected radiation; the possibility of modulation at very high frequencies; and the easy use of directional appliances) all point, as Hahnemann suggests, to the following fields of application.

For aviation beacons, it appears advisable to arrange the transmitters and receivers on towers. At the top of the tower place, say, three transmitters (Fig. 10), radiating by the aid of reflectors out three pencils of rays; each pencil of rays is modulated in the rhythm of Morse signals. If a plane comes within the three pencils of rays, it is guided as definitely as by a lighthouse. For example, one may choose for the middle sector, a signal two equally long "dashes"; for the right sector, three "dots" in succession, and for the left sector a "dash" followed by three "dots". Then it is easy for the plane to keep within the middle sector and accordingly to steer to the tower.

Similarly one can place on a ship two transmitters with reflectors (Fig. 11), one radiating to port and the other to starboard; the two reflectors as before sending out different Morse signals. In this way, there is available a means of replacing the lights of the steamer in foggy weather. Moreover, Hahnemann is confident that it is perfectly possible for ultra-short waves to replace wire lines for land telegraphy. It would be necessary merely to set up radio towers at certain intervals (Fig. 12); each being equipped, in the instance given, with two reflectors placed opposite each other. One of the latter would serve for reception and the other for transmission; making of such a tower a relay station. The intervals between the towers, and their height would be as great as the possible range permits. The ultra-short waves offer the possibility of a sharp focusing of the rays; so that a great degree of efficiency could be obtained for the entire system. Hahnemann believes also that the ultra-short waves offer an excellent possibility of multiple telephony and telegraphy on a single fundamental wave; in which case, by well known methods the carrier is modulated by different telegraphic or telephonic signals. The ability to modulate the ultra-short waves at high frequencies might permit multiple operation without further effort. The sharp focusing and the placing of transmitters and receivers on towers might well make listening-in practically impossible; so that the requirements of secrecy could be most fully met.

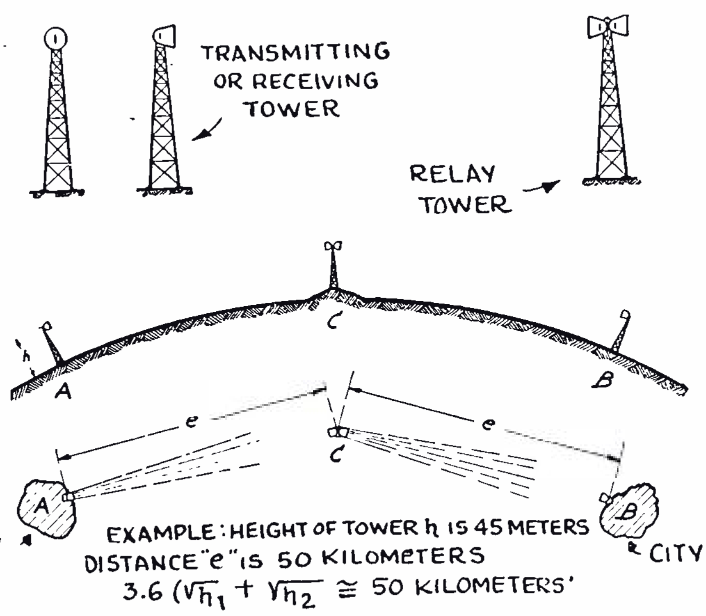


Fig. 12. It is thought that by using high towers as here illustrated, fitted with focussed ultra short wave transmitters and receivers, that they can be employed in place of land telegraph wires.

WHEN TO LISTEN IN

By ROBERT HERTZBERG

Vatican City Station a Success

THE newest sensation on the short waves is unquestionably HVJ, the powerful and very efficient station installed in the Vatican City, Italy, under the personal supervision of Senatore Marconi himself. The tests preceding the formal inauguration of the station on February 12 were heard by delighted listeners all over the country, the signals coming in with remarkable strength and clarity during the early afternoon. The success of the station is now assured.

Two wavelengths are used: 50.26 meters and 19.84 meters. The first just about clears the uncontrolled babel in the 49-meter region, while the second pushes through in daylight like the proverbial "ton of bricks". We understand that the antenna power is about twelve kilowatts.

As the station is intended to have a world-wide appeal, announcements are made in several languages. English is used freely, and short wave set owners are having no difficulty in identifying the transmissions.

Ultra-Short Waves From Germany

The famous Telefunken Company has erected a special ultra-short wave experimental transmitter in the neighborhood of Berlin, and broadcasts regular programs of phonograph music on 7.05 meters. The schedule is from 11.30 a. m. to 1.30 p. m., Eastern Standard Time, on Tuesdays and Thursdays. Here's a chance to do some really short short-wave work, if you have the special but simple equipment.

France Gets Busy

Not to be outdone by the Italians, who now have two very fine short-wave stations, the French are erecting a colonial station of their own. This is nearing completion at Pontoise, a suburb of Paris, and should be in operation about the time this issue of SHORT WAVE CRAFT appears. No definite wavelengths have been announced, but they probably will be chosen after tests have been made with the major French colonies. The government is evidently taking no chances on having the station miss fire (as G5SW did) an antenna power of thirty kilowatts being contemplated.

In passing, it is pertinent to note that Great Britain, with its truly "far-flung"

(*Continued on page* 491)

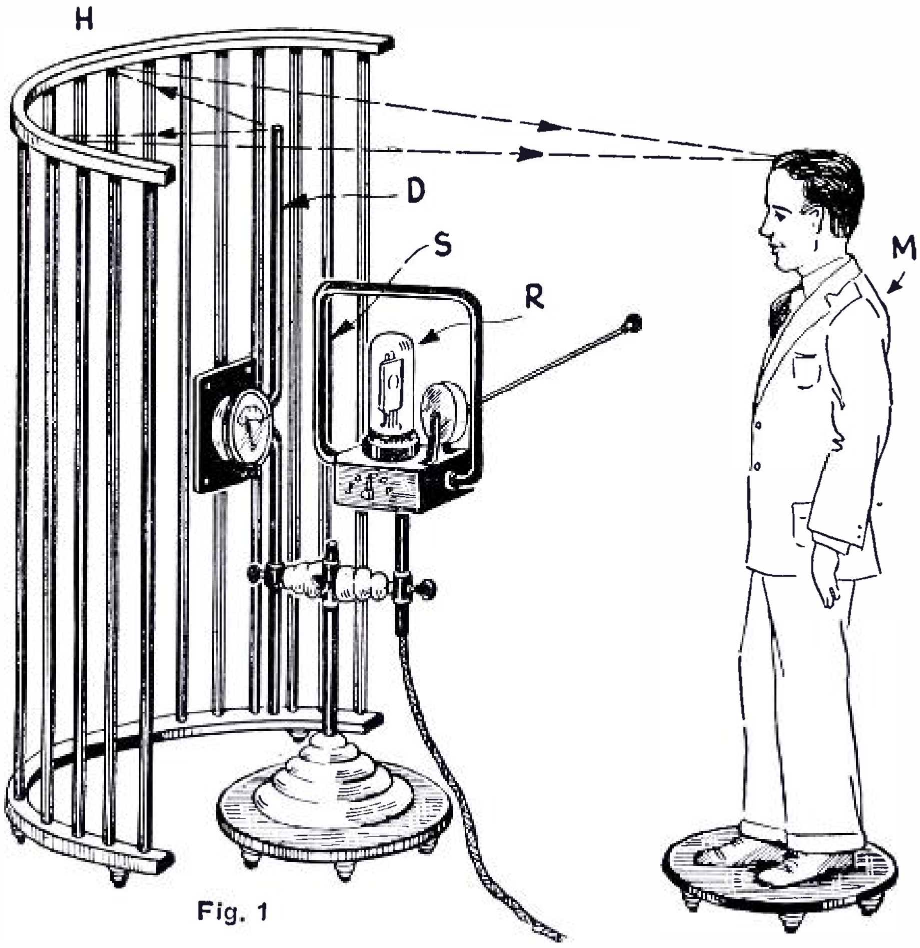


Fig. 1

Arrangement of the apparatus used by Dr. Schliephake in measuring and observing the effects of short waves on the human body, absorption, et cetera. H, parabolic reflector formed of wires; D, antenna, charged inductively by the coil S; vacuum tube at R, and beside it wave changing condenser; subject at M.

HUMAN

By DR. ERWIN SCHLIEPHAKE, M.D.
Of the Jena University Medical Clinic

IF human beings remain in the vicinity of powerful radio transmitters, they are exposed to a very strong electromagnetic field. One must therefore ask what significance these radiations have for the internal organs, and how the body reacts to them. This question is justified by the fact that all other kinds of electromagnetic rays influence the human body more or less strongly.

The character, however, of the reaction is different, according to the wavelengths. Radium rays and X-rays, for example, because of the extraordinary shortness of the waves and the high effectiveness of energy under these conditions, exercise a very strong effect on the structure of atoms; so that serious injuries to the organism can arise (for instance, under certain conditions, cancer). Less serious are the effects of light rays which, however, in the ultra-violet part of the spectrum, can still occasion serious injuries; while the visible light which we perceive is of too low a frequency to injure healthy persons. There are, however, subjects, made sensitive by illness, who suffer serious affections of the skin from strong illumination. Above the optical spectrum, there follow the infra-red and heat waves, whose effect on atoms is relatively slight; in the case of still longer waves only molecular effects are to be expected. Here we are entering the range of the Hertzian waves, electric waves in the stricter sense. Of these, the shortest are about half a millimeter (.02-inch) long, and therefore just above the heat radiations.

From direct analogy, it is to be assumed that the shortest of these waves must be absorbed by human bodies, as in the case of heat rays, and this absorption can be actually demonstrated.

DO YOU KNOW —

¶ What effect short waves have on the hair and scalp in general?

¶ Whether the current in the exciting antenna increases or decreases when a person stands in its field? Why?

¶ If the person stoops will this affect the reading of the antenna current meter?

¶ Whether "cold" or "heat" is produced inside the body by an overdose of the high frequency waves?

¶ The effect of short waves on the nervous system?

Absorption of Radio by the Body

With specially-built transmitters, especially such as those which have been described by Kohl, electric waves only a few centimeters in length can be produced; these waves can be reflected by mirrors, exactly like light rays. If one puts the antenna in the focus of a concave mirror, then there is formed a parallel beam of radiation which can be concentrated again in another concave mirror. By means of a lens placed in the course of the radiation, the ray is made very sharp. If a person steps into this path, reception ceases. Since no reflection by the human body or only a very slight one is demonstrable, absorption of the radiation must have occurred; this effect is, moreover, demonstrable in the case of other organic substances or water. Unfortunately, not much can yet be said about the physiological effects of these radiations; the power of the transmitters of extremely short waves is still too low to produce perceptible changes.

It is otherwise with the wavelengths from three meters up, to the production of which powers of several kilowatts can be applied. Here the above described optical phenomena cannot be so well demonstrated, because the diffraction is much greater; but absorption by the human body can be very well shown.

When an antenna is inductively coupled to a 3-meter transmitter, the oscillations can be indicated by a detector even at a considerable distance away. If however, a person puts himself in the place of the antenna, the detector responds much more weakly, although the power consumed by the transmitter remains the same. Accordingly, a part of the power must have been used up in the body. The same phenomenon can be demonstrated as follows: a closed or open oscillation circuit is inductively coupled with the transmitter (see Fig. 1). The ammeter in the circuit shows a definite current strength. If a person places himself on an insulating stool beside it, the current in the oscillation circuit is reduced. This withdrawal of energy, however, depends on the length of the body; for if the subject stoops, or changes to a sitting position, the current in the other circuit increases (Fig. 2). Therefore, it appears as though, by the tuning of the subject, *to about half the wavelength, the power transmitted to him becomes much greater.*

Concentrating Power by Means of a Reflector

By means of a large concave mirror, one can also collect the transmitted power to a focus. Such a mirror need consist only of parallel wires stretched between two wooden frames. Its height must be equal to the wavelength, the opening one and one-half times the wave-

BEINGS *as* ANTENNAS

The peculiar effects caused by placing a person in the field of a short wave oscillator are here described by one of Europe's leading experts in electro-therapeutics. How the power was concentrated; the dangers and benefits; effects on the blood, and other heretofore little-known physiological phenomena caused by short waves are here described by Dr. Schliephake.

length. It is best to use elliptical reflectors, with the transmitting antenna at one focus; then the reflected radiation is at the other focus of the ellipse. With a "dipole" ("Hertzian" antenna) containing an ammeter, especially strong concentration of energy at this point can be demonstrated. Here a lessening of the current in the dipole is instantly shown if a person steps into the vicinity. Since the human body is to be regarded essentially as an electrolytic system, with regard to the electric wave, and I have tried to demonstrate the effect in the following manner in a model experiment.

A glass tube, of half the wave's length, was filled with an 0.5% sodium chloride (salt) solution, to which gelatine was added to prevent convection. In this jelly the temperature was measured, at different places, by thermo-elements. It was shown that the heating was greatest in the middle and least at the ends; being half as strong at the quarter points of entire length as it was in the middle. Since the maximum strength of the current is at the middle, the greatest heating is therefore connected with this.

Physiological Effect of Short Waves

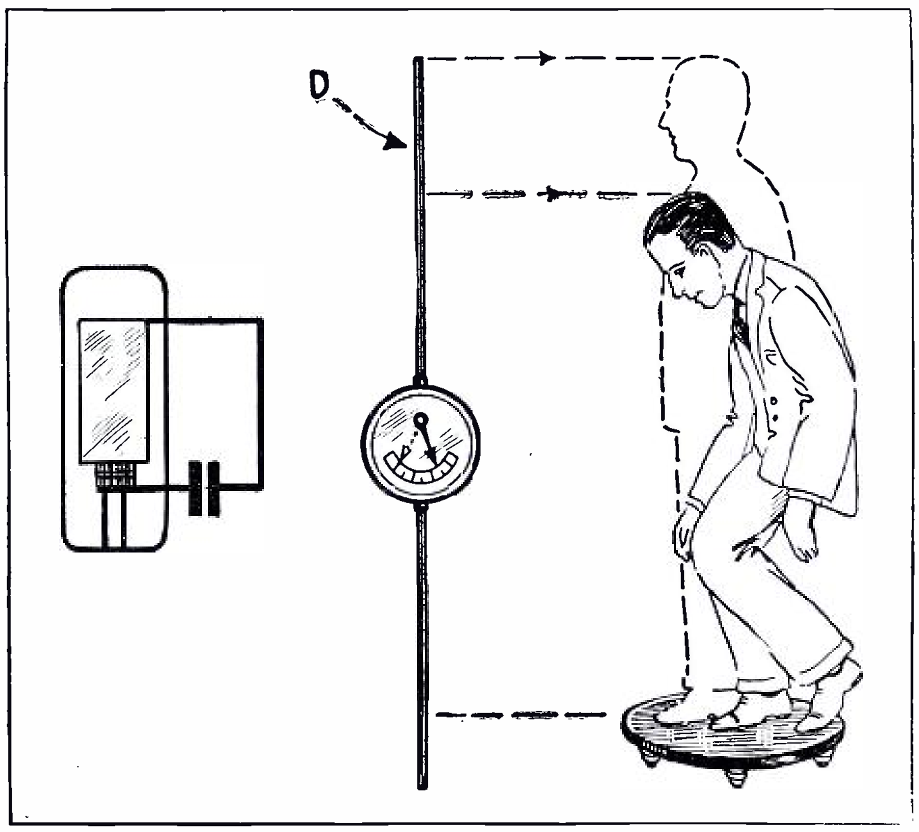
Especially noteworthy, also, was a feeling of vibration, which was particularly evident if the hand was raised in front. We could establish this sensation only at our transmitter, which is operated with 50-cycle alternating current. There must be, therefore, a direct influence on the nervous system. Here too we have, therefore, another proof that the ultra-short radio waves exercised an effect on the nerves.

These vibrations are also felt if the hand is placed in a condenser's field. Many persons who remain close to the transmitter also experience remarkable sensations on the head, near the roots of the hair; these are like a peculiar prickling, the hair likewise standing up a little. In many subjects we could also observe slight increases in bodily temperature, which however did not exceed 0.5 of a degree, Centigrade (0.9 degree Fahrenheit). Since the body contains extremely fine regulators, by which the temperature is always kept constant, and since also the amounts of energy which can be conveyed into the body, even by powerful radio transmitters, give (when translated into heat units) only a relatively low number of calories, this increase in heat is probably not attributable to the received energy alone. As is to be shown later, nervous effects may play an important part in this.

The effect on the nervous system is plainly felt by all persons who work a fairly long time with short waves. The sensations are different with the individuals; there are persons who are relatively insensitive, and others who very soon complain about the disturbances of their health. Usually there is first an increasing sleepiness; they are very tired by day, but at night they sleep badly. Several times a night they start out of their sleep, and they are tired and sleepy in the morning.

These phenomena increase more and more. Often there are also intensive headaches, particularly covering the back of the head. Many persons complain of digestive disturbances and pressure on the stomach. Most of them are furthermore easily excited and irritated, being inclined to complaining and to violence. This increased excitability of the nervous system can also be shown by electrical tests of the nerves.

Fig. 2. One of the most interesting effects of placing a human being in the field of a short wave (high frequency) oscillator is that of absorption. The antenna "D" is excited by the power tube and loop circuit at the left. Do you think the antenna current is increased or decreased by bending the body?



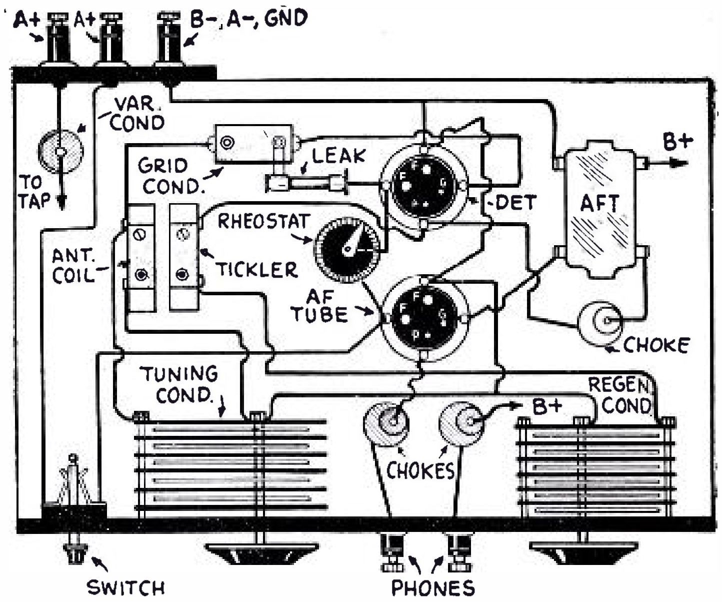
Effects of the Electrostatic Field

It is much easier to study these changes by using the condenser field. Here it is not the electromagnetic wave which is used, but the electrostatic field, which always accompanies it. Here, however, the effect may be much more strongly concentrated. I have generally used plates four inches in diameter, between which the parts of the body in question were treated. The field between these plates suffices to heat 100 cc. of a 0.5% sodium chloride (salt) solution 5 degrees C. (9° F.) in one minute. If parts of the human body are introduced into this field, and the blood is then taken from some part of the body (for instance, from the earlobe) on investigation obvious changes are found.

The number of red corpuscles per cubic millimeter is very greatly increased; i. e., if they formerly amounted to 5 million, the number has risen to 6 million. The same is true of the haemoglobin (a constituent of the blood) and the white corpuscles, the number of which likewise increases. But this is not always true to the same extent, depend-

(*Continued on page* 481)

SNAGS In S-W Receivers *and* How to Overcome Them



Typical short-wave receiver hook-up, showing variable series antenna condenser for curing "dead spots"; R. F. chokes in the phone leads help to eliminate body capacity effects.

How to tell when the set is adjusted to maximum sensitivity; how to overcome "dead spots" on the oscillator dial; swinging signals and their cause, and how to remedy "howling".

SOME short wave sets seem almost alive—they howl when you move near them. Others will only work spasmodically, and the signals are heard at irregular intervals. There are lots of other little drawbacks associated with short-wavers, but all these troubles have definite causes, and we will run over the commonest and see how to avoid them.

The first thing to remember is that you are dealing with wireless waves which because they oscillate several million times a second, will skim along the surface of even a piece of ebonite (hard rubber) to earth. You want them to go through the set first, so see that the set and batteries are thoroughly insulated.

This is easily done by standing both set and batteries on small glass or porcelain insulators—ordinary little glass pots will do. If you cannot get these, use rubber feet.

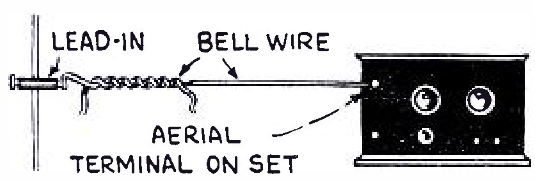
Tuning is always very sharp, so dials must be handled very gently, and a slow-motion dial for the tuning condenser is a great help. To simply swing the dial round will only result in a series of "chirps."

The set is sensitive when you hear a slight hiss in the phones on turning the reaction condenser, and it should be kept in this condition while searching. Often the set refuses to hiss or even oscillate. Here are the remedies.

Try a very small variable condenser, a .0001, or a neutralizing condenser in series with the aerial lead, as shown in the diagram at head of page. Join one end to the aerial terminal of the set and the other to the tap on the aerial coil.

Adjust this until the set will oscillate over the whole range of the tuning dial, when the regeneration condenser is full in.

Instead, you can use two 16-inch lengths of ordinary insulated bell wire, as shown on the right. Join one end of one piece to the lead-in and one end of the other piece to the aerial terminal of the set.



The "simplest" antenna condenser to eliminate "dead spots," is made by twisting two pieces of bell wire around each other as shown.

Then twist them together lengthwise, without letting their free ends touch each other, until the set will oscillate freely. The wires, of course, are really acting as a variable condenser.

If you are using a single coil, moving the aerial tapping one turn to either side will often help.

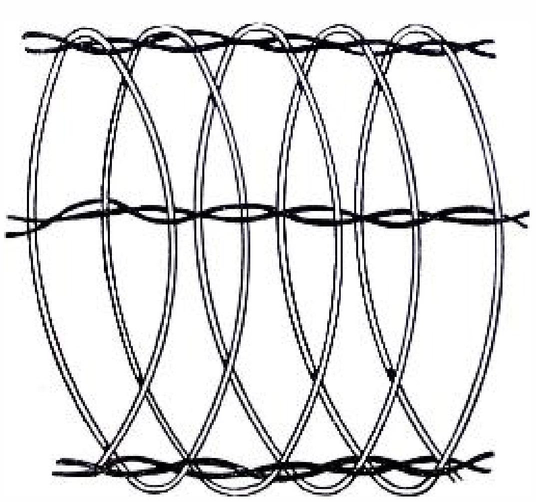
Fierce regeneration may cause trouble, the set going into oscillation with a "plop." This is due to either too large a tickler coil or too much plate-voltage on the detector tube.

Cutting down the filament current of this valve will also help. A rheostat should be used to control the detector tube, as shown above.

Suppose the signals swing in and out quickly. This is not the same thing as fading, when they just die away gradually and slowly come in again.

The causes of the sudden disappearance of signals are swaying aerial, vibrating coils, or shaking of the detector tube.

The remedies are to pack up the base of the valve with cotton-wool, and to see that the coils are quite rigid. The coils may be made rigid by threading string crosswise between the turns, as shown in the coil diagram.



The convolutions of short wave coils may be held rigid by means of string, as the illustration shows.

If your aerial cannot be made taut, use an indoor one. Signals are usually just as strong.

Howling which occurs when a station is almost tuned in is often caused by a too high value of grid leak. Three megohms is a good average value.

If the set howls when you go near it, it is because your body is acting as a condenser and allowing the waves to "earth" through you. The remedy is to isolate the phone by fitting R.F. chokes as shown above.

These chokes are easily made by winding sixty turns of No. 26 DCC wire on a one-inch diameter former. One is placed in series with each phone lead.

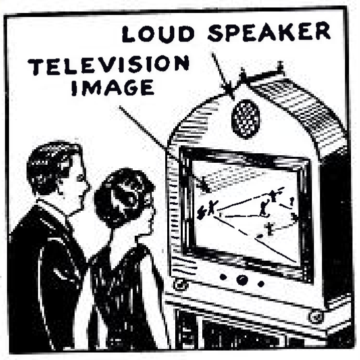
Also, the set may howl when you are tuning-in. See that the connections to the moving plates of the two condensers are good, and that these are properly connected to earth. If it still persists, you must fit long handles to the control knobs.

Use a ground connection if you find it an improvement, but keep it short. With an indoor aerial a length of wire on the floor or under the carpet makes a good ground.—*The Modern Boy.*

THE FUTURE OF RADIO*

By HUGO GERNSBACK

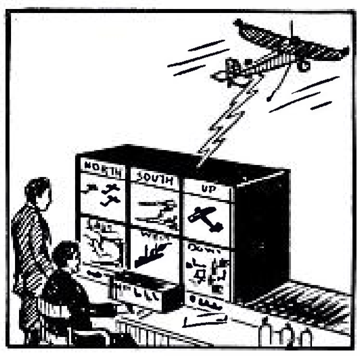
Member American Physical Society; Member Association for the Advancement of Science.



Perfected Television will be a commonplace tomorrow, the author of this article predicts, and in fact the excellent television results so far obtained seem to guarantee the accuracy of his prediction.

IN February, 1910, I published a book entitled "The Wireless Telephone," the first on the subject to appear in print. This was written in a day long before the advent of broadcasting, and while code communication was the only practical application of radio or, as we called it at that time, "wireless." At that time I made the following declaration:

"The author predicts that, in less than ten years, every farmer will be able to operate his wireless telephone, when the



Another of Mr. Gernsback's predictions — the radio-controlled television military plane, which radioes back to headquarters whatever its "eyes" see.

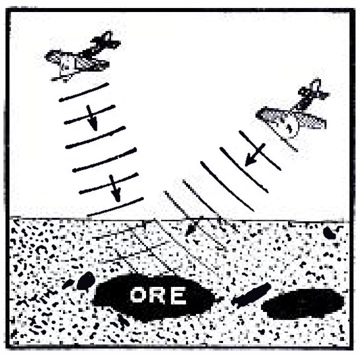
instruments will be housed in a box a foot square." Remember, this was in 1910. Just about ten years later, the technical means available for radio telephony overtook the prophecy; and in 1921, eleven years later, actual broadcasting on a national scale became a reality, when indeed every farmer had his "wireless telephone".

The remarks which I am about to make here are not concerned with what is to happen in radio during the next year, or even five years hence; but I am again venturing a long-range prediction, of what radio will do for us in the years between 1940 and 1950.

Television

This may see quite a long jump into the future; but I am taking it purposely, because we have a pretty good idea of what radio will accomplish during the next few years.

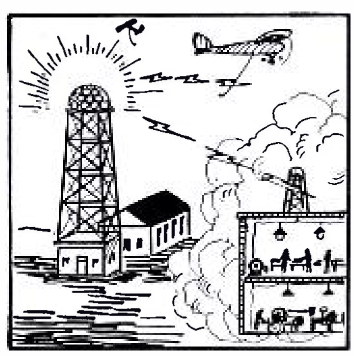
During the years immediately ahead, I do not look for anything very revolutionary in radio. Even *television*, for which we have all been waiting patiently, is just about to break. We are so certain



The author states that tomorrow we shall probably project ultra-short waves from planes to the ground, which, with suitable indicators, will determine for us the presence of unseen ore.

of its advent that it is no longer necessary to "predict it," because it really is already here. While it is still in the laboratory stage, we may say that, during the next few years, television will become as popular as aural radio is today.

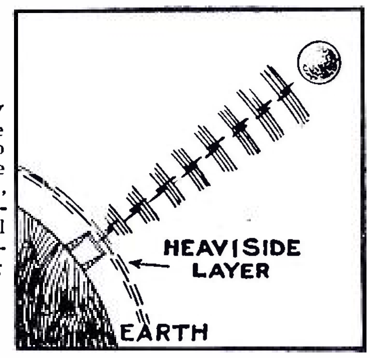
Of course, as I have said many times, I certainly do not believe that the solution of television lies in the perfection of a mechanical scanner. Anything mechanical, relying upon motors, discs, etc., is not the solution of television. It will



Mr. Gernsback believes with Dr. Tesla that in the near future, we will see radio transmission of power an accomplished fact.

be an electronic tube, such as that recently demonstrated by the Californian, Farnsworth, that will do the trick. The electron beam on the inside of a tube has no inertia, no fatigue, and is not likely to get out of order as quickly as a mechanical motor-disc arrangement.

The combination of radio with television will probably be solved completely during the next two or three years. By 1935 it should be possible for a station to broadcast both oral and visual im-



By suitably choosing the wavelength so as to pierce the Heaviside layer, the author believes we will have no difficulty in radioing other planets.

pulses, all on the same carrier wave, without dividing the transmissions as we find it necessary to do today. Television, in my estimation, will never be popular as long as a multiplicity of waves are needed. I know that many engineers will contradict me on this point; they will say that, because of the high frequencies necessitated in television, it is impossible to accomplish the desired results by a single wave. I am quite emphatic in stating my confidence that the future will prove me right on this point also.

Of course, we will have television in the home; and the sets will be made in such a way that you can turn on the switch and get both the audible and the physical programs at the same time. You will have tone control and volume control, just as you have today; but you will have also a television control which will give you the images, not merely in black and white, but in their natural colors.

But television will also enter into the motion-picture house or the theatre where, for the benefit of large assembled audiences, the television screen will display distant events such as (for instance) inaugurations, foot ball games, boxing events, explorations, etc. I can see where a future polar expedition will hook-up with the National Broadcasting Corporation and show us what is going on at the other end of the world.

Radio Controlled Planes of Tomorrow

A few years back I predicted an automatic television-controlled airplane.† When I conceived that idea, it was not yet possible to send an airplane aloft

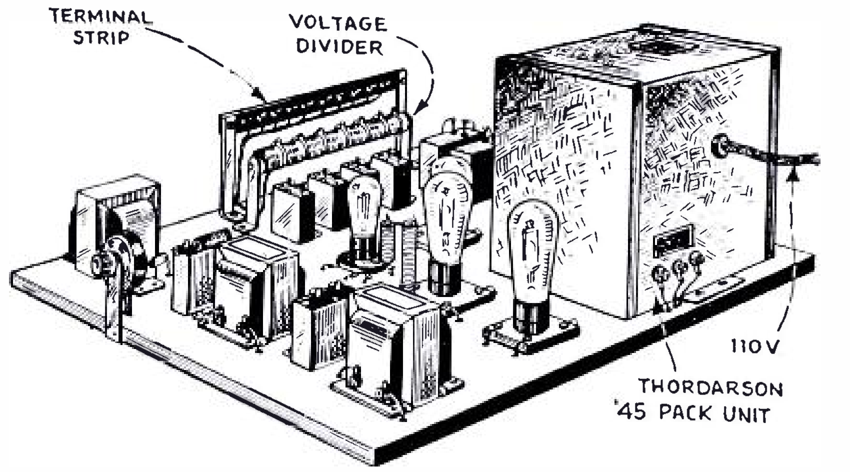
(*Continued on page 479*)

*Lecture delivered before the students of the R. C. A. Institute, December 19, 1930.

† See description and illustration of this idea, page 10, March-April, 1931, issue of "Television News" Magazine.

Ultra-Short-Wave apparatus will undoubtedly be extensively used by the medical profession of tomorrow in the treatment of various diseases, as the results already obtained prove very interesting.

Our great-grandchildren will probably consider interplanetary travel an everyday occurrence, signals as well as power being transmitted to the space-flier by radio.



Appearance of the finished power amplifier.

For the Short-Wave Fans who desire greater power output from the second audio stage, this power amplifier will be found useful. It employs two '45 tubes in the push-pull output stage and '27 first audio tube. This amplifier is to be operated on 110 volt, 60 cycles, A.C., circuit. The plate supply furnishes the "B" current for the tubes in the R.F. and detector stages. Hum is reduced to a minimum by liberal size chokes and transformers.

A POWER AMPLIFIER
for Short Wave Receivers

By H. W. SECOR

POWER AMPLIFIERS suitable for use with short wave receivers have to be very carefully designed and balanced, otherwise there is liable to be an objectionable "hum" noticeable in the loud speaker and not every power amplifier is sufficiently stable to operate on short wave signals.

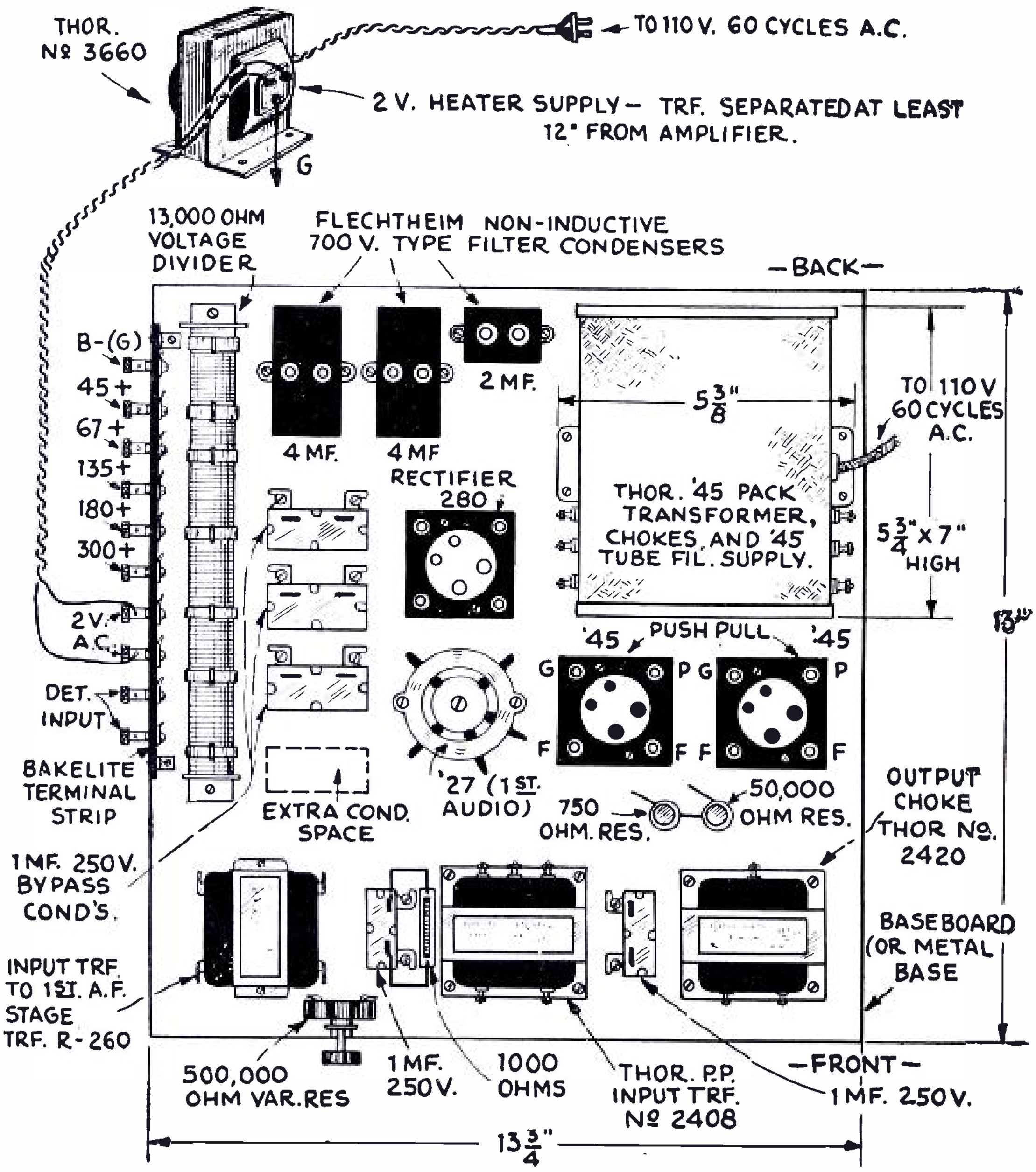
General Requirements

The two-stage, audio frequency, power amplifier here illustrated and described was constructed and tried out successfully, with practically no "hum" audible in the loud speaker and without audio frequency "howls" being set up. It is important to mention perhaps, in passing, that the amplifier was tested in connection with a Hammarlund short wave receiver, employing one stage of tuned R.F. ahead of the detector, with the usual throttle condenser control of the regeneration.

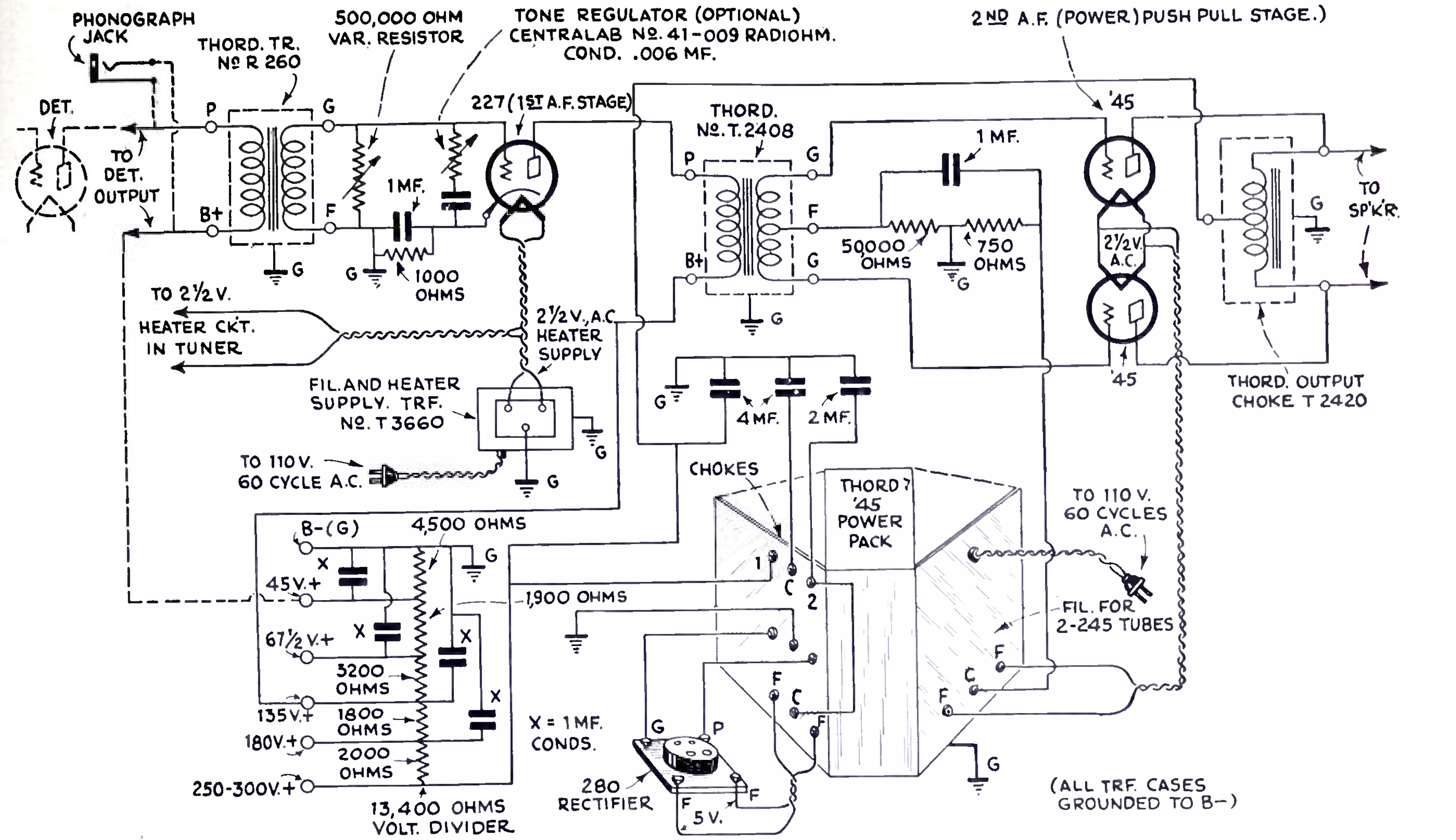
This amplifier is a good all-around piece of apparatus and can be used in conjunction with any broadcast receiver and also for amplifying phonograph pick-up signals, by connecting the output of the magnetic pick-up to the phonograph jack shunted across the input terminals of the first A.F. transformer. One of the most important points to watch out for in building any audio frequency amplifier, particularly those of the power type here described, is the proper positioning of the various transformers, choke coils, etc., so that the magnetic fields of the transformers do not interact on one another and thus constitute one of the frequent causes of an objectionable "hum" or other noise heard in the speaker as a "background" to the signal being received. It is therefore desirable that the inexperienced constructor follow the general layout of the apparatus comprising the amplifier as here illustrated.

The First Audio Stage

Looking at the wiring diagrams presented herewith the reader will see that there are two optional suggestions for building up the first audio stage, the first method involving the use of a Thordarson R260 (or its equivalent) A.F. transformer. The transformer used in



Plan view of power amplifier, showing exact position of the various parts as found best in the author's experiments.



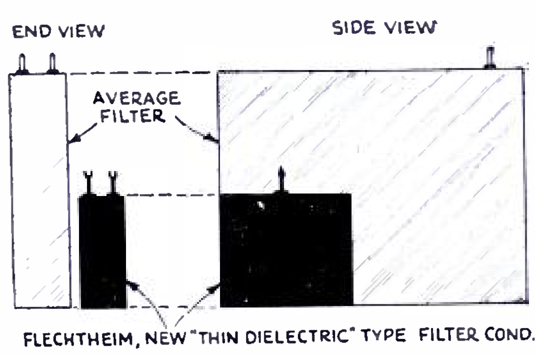
Complete wiring diagram of the A.C. operated power amplifier for short-wave reception, the amplifier using th Thordarson '45 "power compact" for the plate supply.

any case, should have a low ratio between the primary and secondary turns. The second method, and one which has received great favor at the hands of short wave enthusiasts, comprises an impedance or choke coil coupling as the optional diagram herewith delineates. The impedance used in tests by the writer was the Thordarson Autoformer, type R190, the detector plate lead being connected to the "P" terminal of the autoformer, the B plus feed wire to the "B" terminal and the grid terminal ("G") from the impedance connecting to one terminal of a .25 mf., fixed condenser (250 voltage rating). With impedance coupling of the first stage into the '27 tube, a 100,000 ohm potentiometer (Clarostat or other equivalent type), serves to balance the input to this tube. Grid bias for the first audio tube is provided by the 1800 ohm resistance, shunted by a 1 mf. condenser.

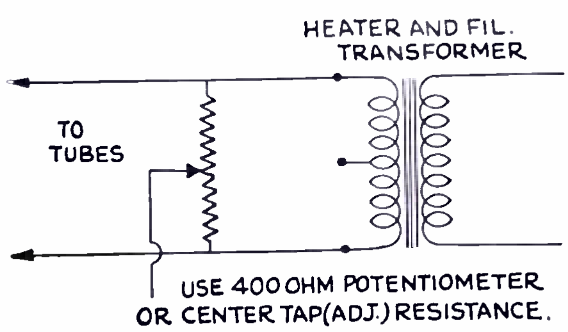
Tone Control Feature

A tone control circuit was tried out very successfully with this amplifier and the one tested comprised a fixed condenser of .006 mf., in series with a specially tapered, variable resistance (Centralab No. 41-009). It may be of interest to many to know that this tone control circuit is the same as that supplied on many of the commercial broadcast receivers, the only difference being that a more elaborate scale for the tone control feature is provided. The tone control regulator comprising the condenser and specially tapered resistance in series, can also be shunted across the two grids of the '45 tubes in the second A.F. push-pull circuit.

A number of ground connections are



Note the remarkable saving in space afforded by the use of the Flechtheim thin-dielectric type filter condensers.



In some cases the center tap on transformers is not at the exact electrical center of the winding, in which case the return lead is best connected as shown to the arm of a 400 ohm potentiometer. This permits adjustment for exact balance.

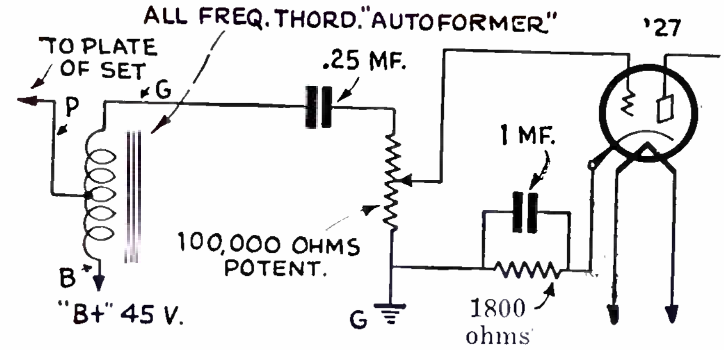
indicated in the diagram and where the various transformers, condensers, etc., are not mounted on a metal sub-base, all of the ground connections indicated are joined to one piece of wire, not smaller than No. 14 B & S gauge, and of course, all joints should be soldered. The outside metal casings of all transformers and condensers should be connected to the common ground wire, so as to minimize all noises or hum in the reproduction at the loud speaker.

Second Audio Stage Is Push-Pull

For building up the push-pull power stage, which involves the use of two '45 tubes, Thordarson input and output transformers or chokes were utilized. The input transformer is a regular Thordarson T2408 push-pull type, with center-tapped secondary, while the output unit was a Thordarson center-tapped choke coil, type T2420.

The grid return circuit from the '45 power tubes has a 50,000 ohm and 750 ohm resistance connected in series with the center-tap terminal "C" of the filament transformer winding, supplying the 2½ volt A.C. to the '45 tubes. One of the Thordarson '45 compact push-pull amplifier plate supply units was employed, as the diagrams show, this unit containing two filament supply windings, the high voltage winding for the plate supply and also the two, high impedance choke coils for the main B supply filter.

A word of caution to those building an amplifier of this type, is to test out all transformers, choke coils and resis-



Instead of coupling the detector output through a regular transformer to the first audio tube, a Thordarson all-frequency "Autoformer" (impedance) may be used as per hook-up herewith.

tances for electrical continuity. Most of these tests can be very well made with a milliammeter and a small B or C battery. If one of the resistances in the grid return circuit, such as the 50,000 ohm unit, should be open-circuited an objectionable hum would be heard in the loud speaker. All of the resistance-coils used in building this amplifier were of the baked enamel type made by the Ward Leonard Company and they have performed very satisfactorily indeed.

Source of Filament Supply

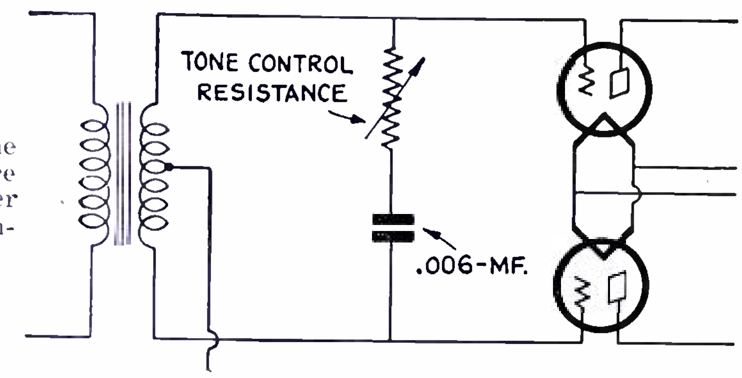
One of the important points about a good audio frequency amplifier is to see that not too many transformer windings are grouped together on one core. As a number of leading short wave experts have pointed out, it is better to have the filament supply transformers split up; so in this amplifier we find this condition. A Thordarson T-3660 filament supply transformer delivering 2.5 volts supplies the heater current for the R.F. and the detector tubes, as well as the first audio stage of the power amplifier. A separate filament transformer winding supplies the '45 tube current and a third separate filament supply winding furnishes the 5 volt current for the '80 rectifier tube. All of these points help to make a quiet operating amplifier and one of the leading radio engineers told the writer, that he never built any set, especially a power amplifier, unless he connected up the transformers on a "bread-board" and moved them around until the condition was found where a minimum hum was noticed in the loud speaker. Sometimes transformers have to be placed at right-angles or in other positions in order to prevent inter-action of their stray magnetic fields. It was found in the present case that in order to reduce the hum to the lowest possible limit that the heater supply transformer T-3660 had to be removed from the general layout of the amplifier and placed at least 12 inches away from the other transformers and amplifier apparatus to prevent pick-up of the magnetic field.

Details of the Filter

Looking at the filter circuit for a moment we see that the two chokes are connected to the terminals 1, C, and 2 at the top of the left side of the Thordarson '45 compact. Three high voltage condensers of the Flechtheim extremely compact type were used, having capacities respectively of 4, 4 and 2 mf. The great saving in space afforded by use of these Flechtheim compact type condensers is shown in one of the diagrams herewith and they only occupy about 1/6 the volume of the average high voltage condenser supplied for filters of this type. In any case the condenser should have a working voltage of approximately 700.

The 13,400 ohm voltage divider resistance shown in the diagram is of the Ward Leonard baked enamel type and performs in very excellent fashion, without getting so hot that one can fry flapjacks on it, as some of these "19c special" resistances are wont to do. A potential of approximately 350 volts was measured with a Flechtheim voltmeter across the output terminals of the filter, or in other words across the end terminals of the voltage divider resistance. Each step or tap on the voltage divider is shunted by a 1 mf. condenser of the Flechtheim 250 volt type, (250 being the working voltage). If you should see the plates of your rectifier tube get red hot, shut off the amplifier and start gunning for a short-circuited filter condenser.

De Forest tubes were used with very gratifying success in all of the stages of the amplifier and very satisfactory performance in amplifiers during the past year has proven that they do stand up and give quality as well as service.



Optional connection of "tone control" variable resistance and its .006 m.f. condenser across the grids of the push-pull tubes.

Hints On Eliminating "Hum"

1—Ground all transformer and condenser cases.

2—Test grid return bias resistors for "continuity" and by-pass condensers for "short-circuits".

3—Center tap on filament transformers may not always be at exact electrical center; connect 400 ohm potentiometer across filament winding and join grid return lead to arm of potentiometer.

4—Measure current in both sides of '45 plate circuits and also in both sides of '80 rectifier tube plate circuits; if these are unequal this trouble should be rectified as it is liable to cause hum. Sometimes a new tube is required in order to eliminate hum.

5—Sometimes the A.C. supply plug, where it fits into the house service receptacle, has to be reversed.

6—In some cases, or with some amplifiers, it may be necessary to employ an extra high voltage filter as one of the diagrams herewith shows; in other cases a greater filter condenser capacity has to be employed.

7—Keep the '80 rectifier tube away from the input transformer, as the field from the tube often reacts on the first A.F. transformer: result = hum.

8—Sometimes a "hum" is picked up from the detector and R.F. tuner stage and is then amplified by the power amplifier. Listen to your detector output with phones to ascertain if it is hum-free.

9—Sometimes an objectionable hum is due to the dynamic speaker itself, necessitating the use of a larger condenser across its field. Don't crowd dynamic speakers on top of R.F. tuners, detector circuits, or power amplifiers if you want hum-free reception.

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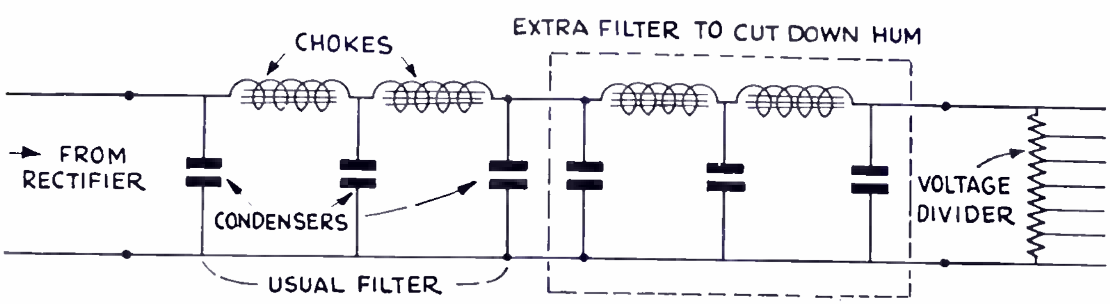

With some "B" eliminators (or when using some power-pack filter circuits) there is still an objectionable "hum"; the circuit herewith shows how to add an extra filter between the usual one and the voltage divider resistance. The chokes and condensers in the extra filter have values identical with those in the usual filter.

This Regeneration Control
Does Not Affect the Tuning

PERHAPS the worst feature of the average short-wave receiver is the fact that the regeneration control generally has a large effect on the tuning of the receiver. That is to say, a slight change of a few degrees on the regeneration condenser dial will probably alter the tuning of the receiver by as much as 400 kilocycles on some points of the dial. Sometimes it may be more than this, and at others it will be less; all depends upon the capacity of the regeneration condenser and the particular wave-range upon which the set happens to be working.

All this, of course, helps to make the tuning of a short-wave receiver a very great deal harder than it should be. We have quite enough to bother about already because the tuning of a short-wave receiver is at the best of times, very, very sharp indeed and always very much sharper than that of the average broadcast receiver. With receivers which play in this manner, it is necessary to keep moving the tuning dial after every adjustment of the regeneration dial, to make up or compensate for the change in tuning caused by small adjustments of the latter dial. The ideal regeneration control should work distinctly as a "volume" control and *should not have the slightest effect on the tuning.* The modern broadcast receiver uses but one dial and two small knobs—the main dial for the tuning, of course, one knob for the volume and the other to switch the receiver on and off. The volume control does not have the slightest effect on the tuning of the main tuning dial, because a modern broadcast receiver does not use regeneration and controls volume by some totally different method, which does not have the slightest effect on the tuning. If some such method could be used in the short-wave receiver, our problem would be solved; but, as mentioned before, we must use regeneration and thus the problem remains as prominent as ever.

By MANDER BARNETT

Short Wave Sets have suffered somewhat from the de-tuning effect caused by changing the regeneration dial — with this system you do not have to "follow" up on the tuning dial.

Series Plate Resistance Not Best Method

In an attempt to provide a satisfactory arrangement which would overcome this very annoying defect—if not to completely cure it, at any rate to lessen it—the writer has been experimenting with various arrangements of regeneration controls. After a while, it was decided to abandon the use of the variable condenser as a means of regeneration control and use some form of resistor control, which appeared to be much more promising. The first method tried was that of putting a variable high resistor in series with the detectors "B+" lead; but although this seems to be fairly popular today, it has rather a bad fault. It is sometimes necessary to reduce the "B" supply to such a low figure, before the set will stop oscillating, that the sensitivity of the detector tube is greatly impaired. This can be overcome to some extent by using extremely small tickler coils; but then the set will very often refuse to oscillate at all on the shortest waves. The writer's demands were for a receiver which would operate to the very lowest of the usual short waves (about 10 meters); so that this method had to be ruled out. Some commercial receivers appear to use this type of control quite successfully but, personally, I have found it not very good, for the reasons described.

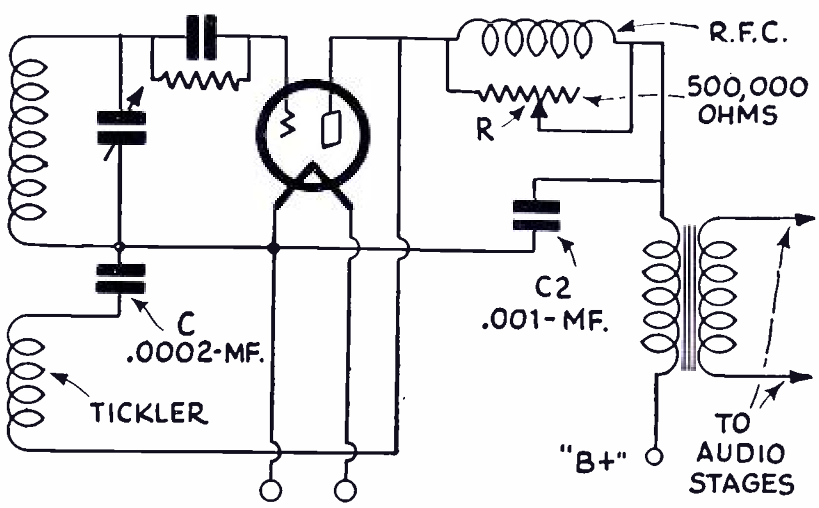

Fig. 2—The "regeneration control" circuit finally evolved by the author; it calls for a 500,000 ohm variable resistance shunted across the radio frequency choke R.F.C. This control does not alter the tuning.

Tickler Shunt Resistance Tried

The next arrangement tried was that shown in Fig. 1; this certainly provided quite a nice control of regeneration, and the effect on the tuning was practically negligible. The only trouble was, however, that this arrangement also would not operate satisfactorily on the very shortest waves. This was due, no doubt, to the fact that the resistance itself was shunted directly across the tickler coil, and thus the tickler coil was too highly damped for operation on very short waves.

The Best Circuit Finally Found

The arrangement finally adopted was that shown in Fig. 2; here the coil itself is not damped at all and the "B" voltage remains constant at all times. An examination of the diagram will soon show how the arrangement works. It will be seen that the resistance R (about 500,000 ohms) is shunted directly across the choke coil RFC. The actual regenerative effect is obtained by the tickler coil and the condenser C, which is a fixed capacity of about .0002-mf. The action is as follows: When the resistance R is at its highest value, the choke

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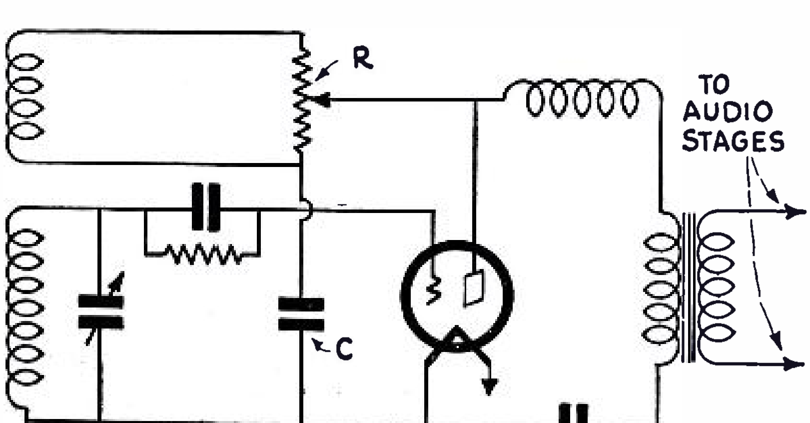


Fig. 1—The tickler "shunt resistance" control of regeneration proves quite satisfactory, having a negligible reaction on the tuning, but it is surpassed by the circuit shown at Fig. 2 above.

How To Build the Latest Type of Amateur

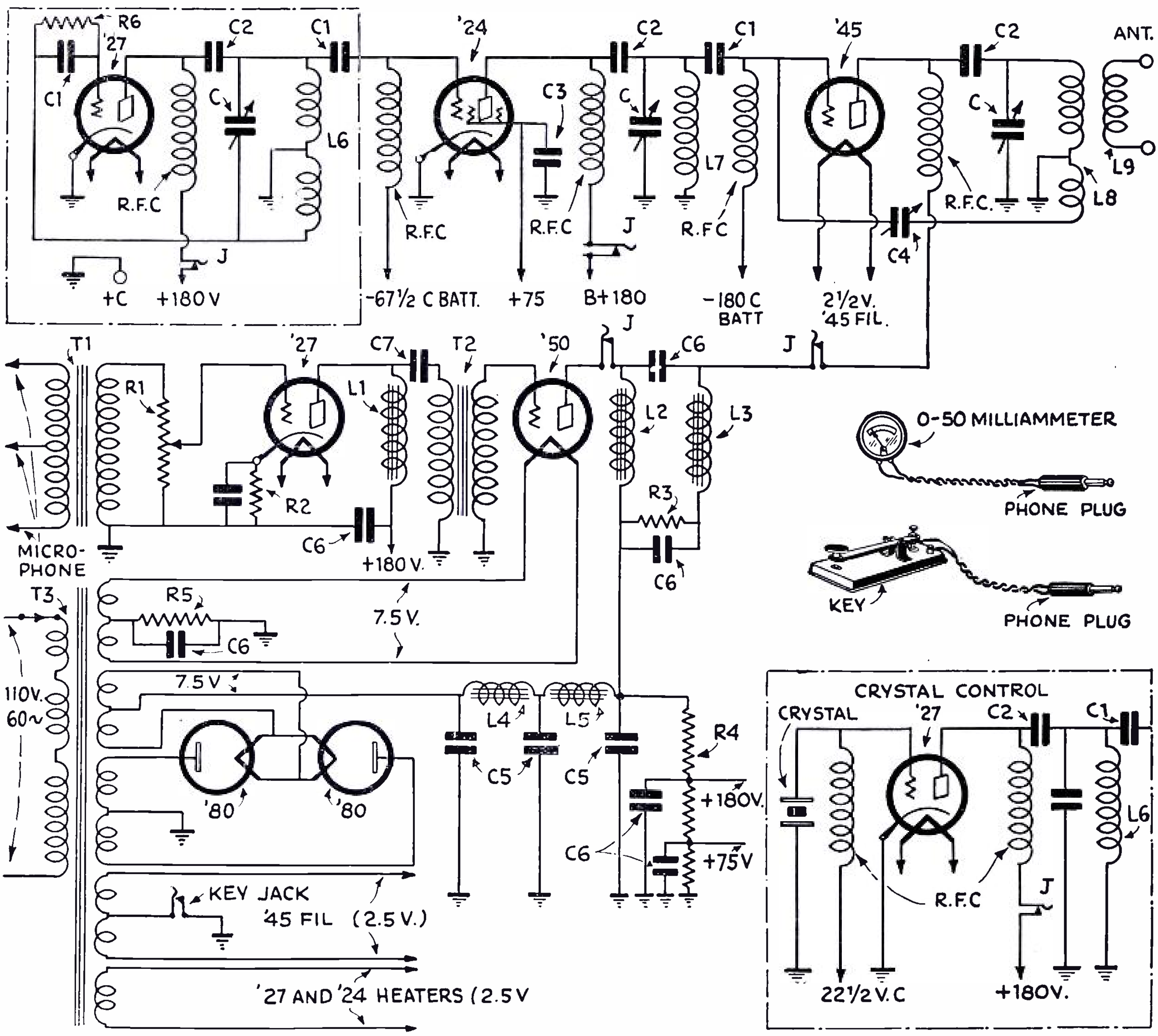
PHONE TRANSMITTER

Employing Class "A", "B" and "C" Amplifiers

By C. H. W. NASON
Short Wave Specialist

This amateur transmitter can be used for phone or code, and operated with or without crystal control.

UNFORTUNATELY for his readers, the present writer is an engineer by profession and an author merely through circumstance. It seems that the writers who fill the pages of America's "fan" papers suffer from either a surprising lack of technical information or from a lack of the pedagogical genius necessary for the transfer of that information to the lay mind. Certain considerations arise in the design of all apparatus, which are best concealed in the author's notes, rather than cluttering up the mind of the "ham." On the other hand, there are some facts which should be retailed "wholesale" to the man who has to do the operating in the last instance.



Phone (also code) transmitter wiring diagram showing crystal control circuit in lower right hand corner. By means of plugs either a Morse key or milliammeter may be plugged is as desired. The microphone (two button) is connected to the three terminal primary of the modulation transformer "T1".

The writer is about to give specifications for the construction of a short-wave 'phone transmitter to operate in all bands open to amateur 'phone transmission. A main consideration in the design has been the availability of the components employed. A glance over the list of materials will show just how closely this requirement has been met, and disclose the fact that the transmitter will cost no more than an excellent broadcast receiver. In order to avoid expense, crystal control has not been made mandatory, and an alternate connection for the use of a simple Hartley oscillator is given. It is assumed that the constructor has had some experience in the construction of radio apparatus—if not, there is little use in his constructing a piece of equipment for the use of which rigid license requirements must be met. Because of this presupposed experience, the writer leaves the construction of the transmitter entirely to the judgment of the builder, and will deal entirely with the theory of its operation.

It might first be advisable to note the fact that vacuum tubes are operated in three fashions as amplifiers. In normal practice an amplifier tube is operated in such a fashion that the change in plate voltage is linear with respect to the voltage applied to the grid. In this mode of operation, no harmonics of the input frequency are evident in the output, and the amplifier is said to be distortionless. In order to secure the highest degree of power efficiency—i. e., the greatest A.C. output for a given D.C. supply power—the tubes used in R.F. power amplifiers are at times operated on portions of their characteristic curves which are not linear. This does not mean that distortion of the modulation will occur; since any harmonics produced prior to modulation will be harmonics of the carrier frequency and will be filtered out in the tuned amplifier circuits. Mark that these high-efficiency amplifier circuits are not used after the modulated stage, unless push-pull circuits are employed; in which case the distortion cancels, according to the well known effects in push-pull circuits. By the following definitions you will become acquainted with the special types of amplifiers and their uses.

"Class A" Amplifiers

In "Class A" amplifiers, the grid bias is so chosen, and the applied signal so limited, that the plate current is never reduced to zero during the negative half-cycle of the signal nor is the grid permitted to draw current nor swing positive during the reverse half-cycle. If the tube is operated at all times along the linear portion of its grid voltage-plate current curve, the distortion produced will be negligible. This mode of operation is used in audio amplifiers, modulators and R.F. power amplifiers following the modulated stage.

"Class B" Amplifiers

In the "Class B" amplifier the grid-biasing voltage is such that the steady plate current is reduced almost to zero. That is to say, it is biased to "cut-off." The biasing voltage required for "cut-off" of the plate current is obtained by dividing the operating plate voltage by the amplification factor of the tube. These amplifiers have the advantage of exceedingly high efficiency, and may be used without incurring distortion as R.F. power amplifiers prior to modulation and as push-pull amplifiers after modulation. In the latter case, any second-harmonic distortion present will cancel out.

They may also be employed as modulators or as A.F. amplifiers, where it is possible to match evenly the opposing circuits in push-pull. When operated after this manner, they are sometimes termed "push-push" amplifiers. The proportions of the input signal should be such that the normal current for the tube, with the operating plate voltage used, is obtained; this will occur when the grid is swung slightly positive during each half-cycle.

"Class C" Amplifiers

A vacuum-tube oscillator represents a special case of a "Class C" amplifier. In this class of operation, the output power varies as the square of the plate voltage and, in consequence, this method of operation lends itself to modulation. Operation in this manner is obtained with the tube operated at twice the bias required for complete "cut-off" of plate current. The grid is fed a healthy "sock" from the preceding stage, in order to drive the plate current up to the value which is normal for the plate voltage used. "Class C" amplifiers are employed in the modulated stage of a 'phone transmitter, and result in linear modulation of field strength with regard to audio-frequency input.

Parts List

T1 Amertran 923-A Mike Input
T2 " DeLuxe 2nd Stage
T3 " PF281A Power Transformer
L1 " 103 Impedance
L2 " 101 Impedance
L3 " " "
L4 " 709 "
L5 " 854 Choke
C Hammarlund TC -12 Condenser 105 mfd.
L6 L7 L8 L9 Hammarlund LWI COILS with bases (LWIB) for Required Band
C4 Hammarlund MC 23 Condenser
RFC Hammarlund RFC 85 Chokes
C1 Aerovox 1456 .0001 Condensers
C2 " 1456 .00025 Condensers
C3 " 1456 .001 Condensers
C5 " B-1000 Block
C6 " 1602 1 mfd. Condensers
C7 " 400S .25 mfd. Condensers
R2 " 992 1800 ohm resistance
R3 " 993 8000 ohm resistance
R6 " 1 meg. 1094 resistance
R4 Electrad 50,000 ohm tapped unit
R1 " 250,000 potentiometer
J Closed circuit telephone jack
M Plate current meter; 0-50 m.a.

Our transmitter will employ all three types of amplifiers: "Class A" in the modulator and speech amplifier circuits; "Class B" in the intermediate or buffer stage; and "Class C" in the modulated output amplifier. If it is desired to increase the power of the transmitter, linear or "Class A" power amplifiers may follow the modulated stage up to any desired output.

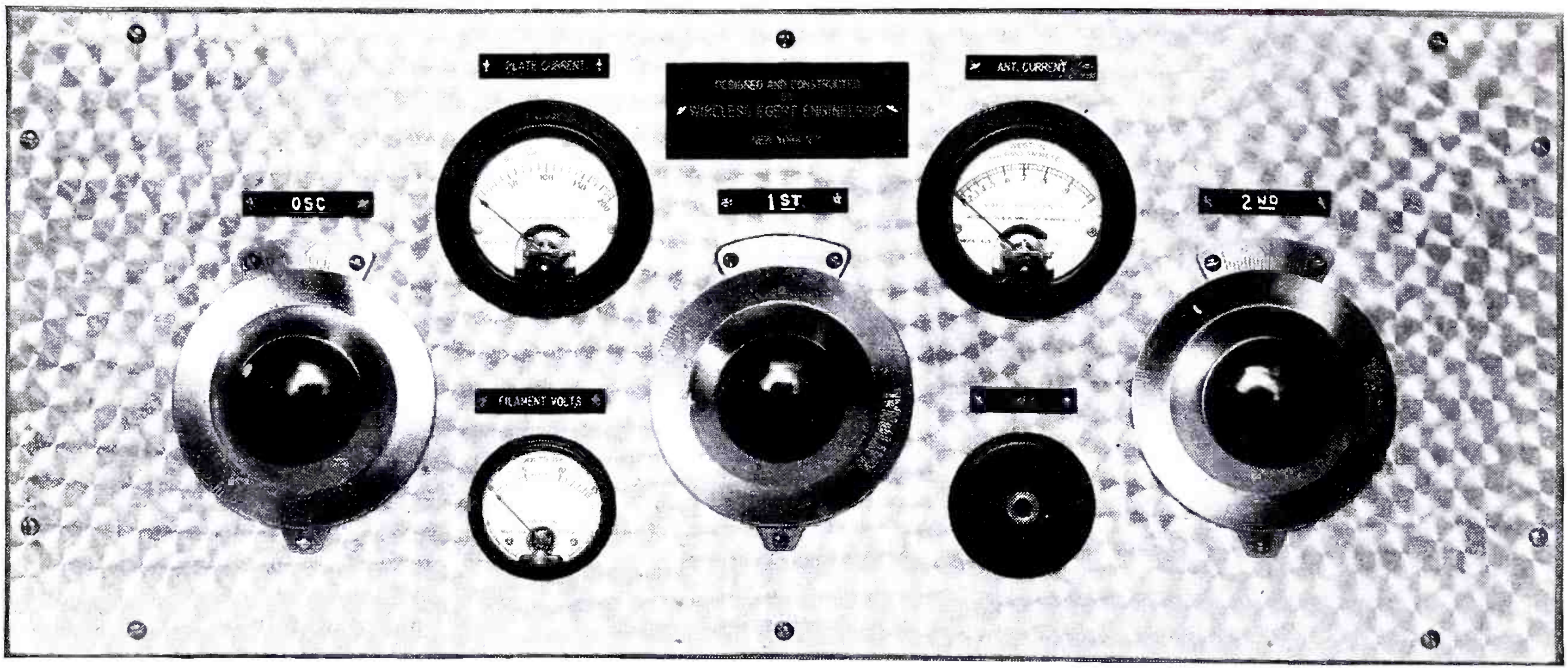
Percentage of Modulation

The ultimate effect in the detector output of a radio receiver is not determined by the amplitude of the carrier but by the relative changes in amplitude during modulation; and for this reason it is important that the carrier be modulated in amplitude to the fullest extent possible without distortion. When a carrier is modulated in amplitude so that its field strength varies from zero to twice the value unmodulated, it is said to be completely, or 100% modulated. This means that power in the antenna circuit ($W=I^2R$) will vary from zero to four times its normal value; which occurs by virtue of the simple "square-law" relationship between current and power contained within the parentheses. According to the operating characteristics of the "Class C" amplifier, this degree of power variation will require that the plate voltage be swung over a range of from zero to twice its normal operating value. In other words, the A.C. voltage output from the modulator must be equal to the D.C. plate voltage supplied the tube. This means that the modulator must have a higher supply voltage than the "Class C" amplifier; and the necessary voltage drop is provided by feeding the R.F. amplifier through a by-passed resistor. With the R.F. amplifier operated at a D.C. potential of 250 volts, and the modulator a '50 with 500 volts on the plate, a drop of 250 volts is required. A '45 tube operated at 250 volts plate draws a plate current of 32 ma., which means that a resistor of 7800 ohms (10-watt type) is required. The '50 is capable of delivering an undistorted power output of about 5 watts. The maximum voltage developed in the output circuit without overload would be sufficient for 100% modulation of the carrier amplitude.

Operation of the Transmitter

The amateur is limited to voice transmissions, and there is little to be gained through the use of a high-quality broadcast microphone. The Universal people make an excellent "mike" for amateur purposes, at a low price, and with a high output which renders it possible to employ a two-stage amplifier for modulation purposes. A three-stage amplifier would barely suffice with a low-output, high-quality microphone.

Operation of the transmitter is as follows: the '45 stage must be neutralized to prevent self-oscillation. The neutralizing condenser is an ordinary midget, as specified in the parts list, with a large fixed condenser in series to prevent damage in case of arc-over. The portion of the inductance in the neutralizer circuit should contain about one-third the number of turns in the balance of the winding. Since inductance varies as the square of the number of turns, the neutralizing coil will have one-ninth the inductance found in the remainder of the



Appearance of Radiophone Transmitter Tuning panel. Vernier dials are used for accurately adjusting the condensers to the desired wave length. The panel on this particular job is of hand-figured aluminum—it can be duplicated by spotting with a piece of emery cloth on revolving mandrel. —*Photo courtesy Wireless Egert.*

circuit. This means that the neutralizing condenser should have nine times the value of the grid-to-plate capacity of the tube; 100 mmf. is about right for a '45. Neutralize by tuning all the circuits to resonance; then, with the "Class C" amplifier's plate voltage off, explore the plate coil with a wavemeter. If any current is present in the circuit, the tube is not neutralized; and the condenser setting should be varied until no indications of R.F. energy in the plate coil of the output stage are apparent.

Before the neutralizing process described above can be carried out, it is necessary that the remainder of the R.F. set-up be adjusted. In order to accomplish this, the plate voltage is removed from all stages succeeding the oscillator by the simple expedient of inserting a dummy telephone plug in each amplifier's plate-current meter jack; this will automatically open each plate circuit. Now adjust the tuning condenser of the crystal or tube oscillator to the correct value.

Where the crystal is not employed to fix the frequency, a wavemeter will be necessary to establish the operating frequency as being within the amateur band. In order to be certain that oscillation is taking place a small flashlight bulb, connected to several turns of bell wire, should be brought close to the tuning inductance. The degree of power output may be judged by the brilliancy of the lamp. The plate current of the oscillating '27 will be about 7 milliamps.

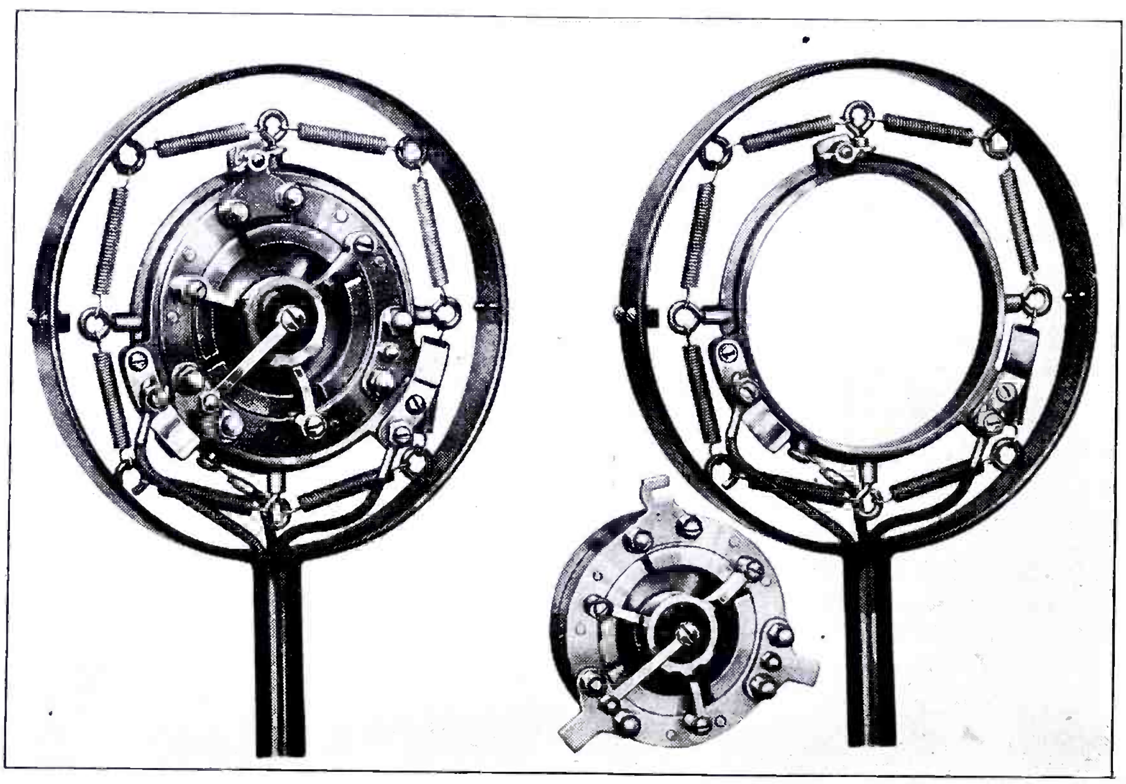
Now apply all voltages to the '24 stage, and tune the condenser until maximum power is reached, as shown by exploration with the flashlight bulb. It is now time to neutralize the output amplifier after the fashion described above; then adjust the tuning of the final stage and go on to the antenna. Antennas for short-wave transmissions, on the various waves allotted to the amateur, have been described previously in these columns and a reference to your files should yield enough information for successful operation on all waves. The antenna current will be below one ampere, and meters of the thermal or "hot wire" type should be provided in the antenna circuit, after the manner noted in the article on antenna design.

New Demountable "PROF" Type Microphones

THE Ellis demountable microphone was designed for convenience and safety—safety from theft and from exposure to the elements. These purposes are attained by making the Microphone unit easily and quickly removable or "demountable" from the supporting fixtures and easily replaceable.

The value of this improvement in the Microphone field will be appreciated by those whose patience has been taxed by the clumsy and burdensome task of removing a microphone, locating a screw driver to disconnect and reconnect the wires, unlacing and relacing a tight set of springs, and being careful to avoid mistakes in reconnecting the cable.

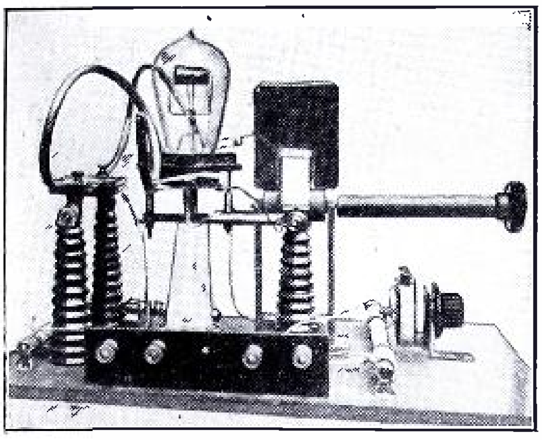
The illustration to the right of the photo shows more clearly how all the cable connections are entirely independent of the microphone unit itself. All the connections and fixtures remain intact when the demountable unit is removed or replaced, a wing nut locking the "mike" in place.



A 5-METER
Transmitter and Receiver

By E. T. SOMERSET, G2DT

Mr. Somerset, owner and operator of the famous short wave experimental station G2DT, is one of Great Britain's outstanding geniuses in this field. You will enjoy his article on 5 meter transmitters and receivers.



Mr. Somerset's 5-meter transmitter that works. For wavelengths of 5 meters and below it is usually necessary to remove the tube base.

A GREAT deal has been learned of late about the ultra-high-frequency radio spectrum, by means of close cooperation between a band of British experimenters and some American friends. It appears, so far, that chance plays a great part in the reception of 5-meter signals over greater distances than thirty miles. Up to this distance, and provided a hill is not in the path between the transmitter and the receiver, there should be no difficulty in effecting two-way communication. It must be realized, however, that tuning on the receiver is excessively sharp at these high frequencies; and therefore a very small variable capacity, 50 mmf. or less, is essential.

For the transmitter I cannot recommend one better than that shown in Fig. 1. In Fig. 2 is shown on a larger scale the variable capacity, which consists of two plates of 4x1½-inch spring brass, mounted on two stand-off insulators and resting upon a bakelite cam, with a shaft fitting *eccentrically* in this cam; so that when the cam is rotated the plates move away from each other and thus vary the capacity by a very small amount.

The inductances for the plate and grid circuits are made of No. 10 gauge copper wire, of 1½-inch diameter; the spacing between the two turns is one inch. An American '10 or British LS5 tube works admirably with a plate voltage of 500, if the milliamperes are kept down to 35.

A very satisfactory antenna is shown

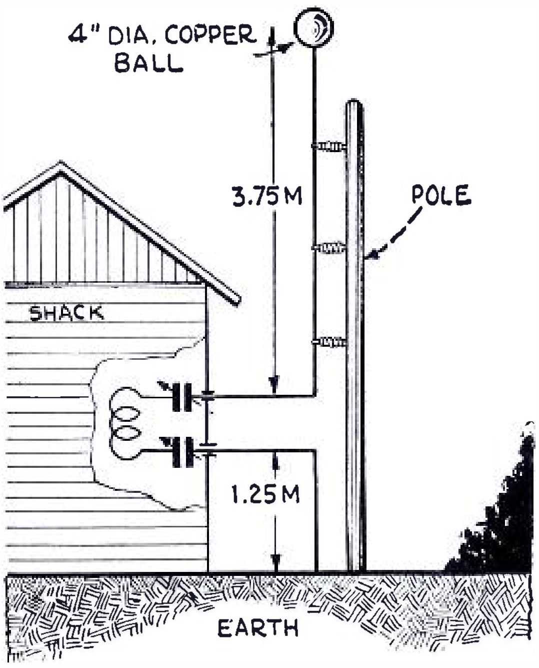
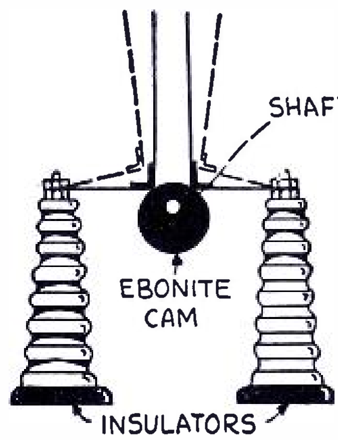


Fig. 3. Showing arrangement of 5 meter radiator.

in Fig. 3; but a much simpler type is the pure voltage-fed Hertzian, fifteen feet long and clipped directly to the plate coil, at a spot about 18 inches from the "D" stand-off insulator. For directional effects, this 15-foot wire may be mounted vertically, with another and similar wire mounted a quarter-wavelength behind it. This simple arrangement of a "beam" antenna will practically double the signal strength, and is well worth experimenting with.

Turning now to the receiver, it will be seen that in Fig. 4 the ultra-audion circuit is shown. When all is said and done, this is the most efficient circuit for five meters but, since both rotor and stator are at high potential, it is imperative to use extension handles for the control of the variable condenser, and also for regeneration control.



Do not omit the 4-mf. capacity in shunt with the variable resistor—this is there to keep out noise and very well does it too.

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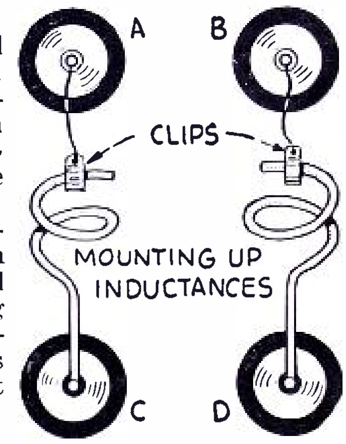
Fig. 2. End view of special variable condenser used in 5 meter transmitter; ebonite (hard rubber) cam varies distance between plates. Method of mounting the inductances is shown at right.



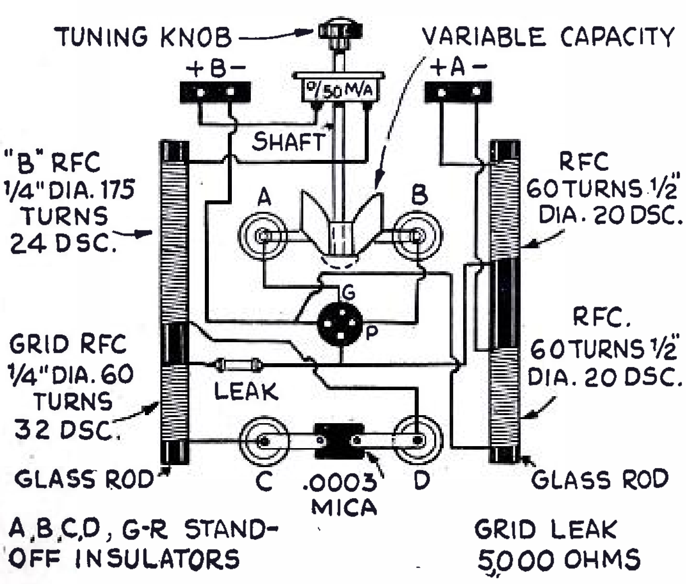
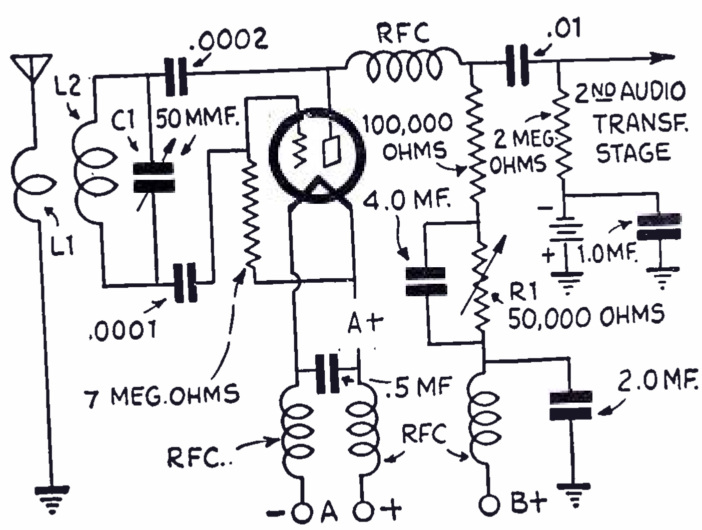


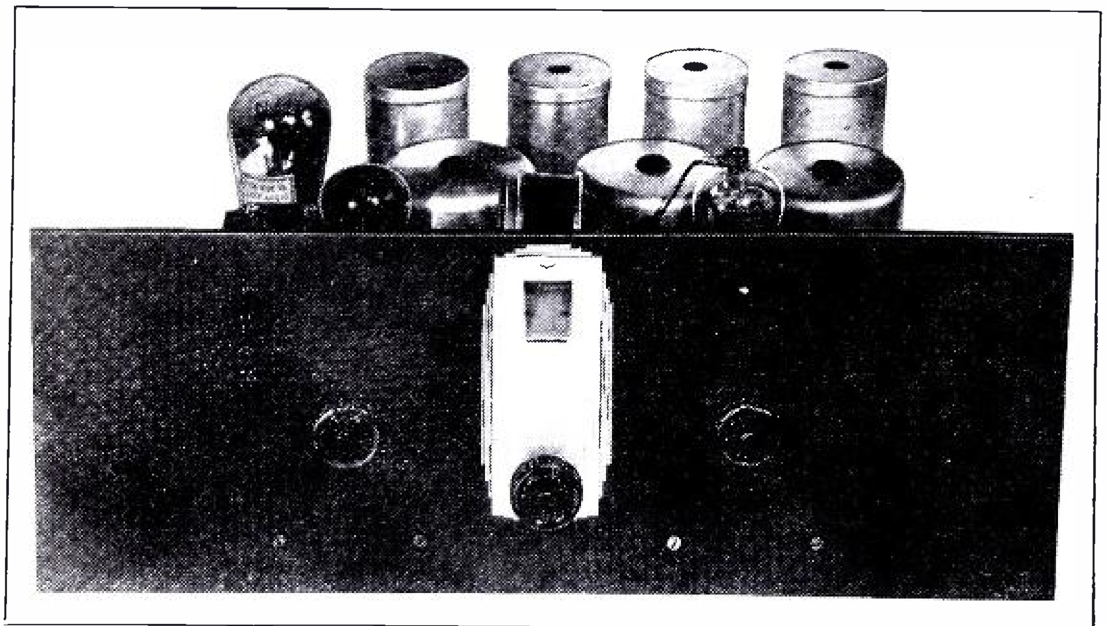
Fig. 1. Left: Top view of 5 meter transmitter with special variable condenser.

Fig. 4. Right: Hook-up of Mr. Somerset's 5 meter receiver used at G2DT. L1 is single turn 2¼" in diameter; L2 is three turns 2¼" in diameter, number 10 wire spaced ⅜" between turns. C1 and R1 must be mounted on bakelite extension handles.



THE HY-7B SUPER-HET for A. C. Operation

By L. W. HATRY*



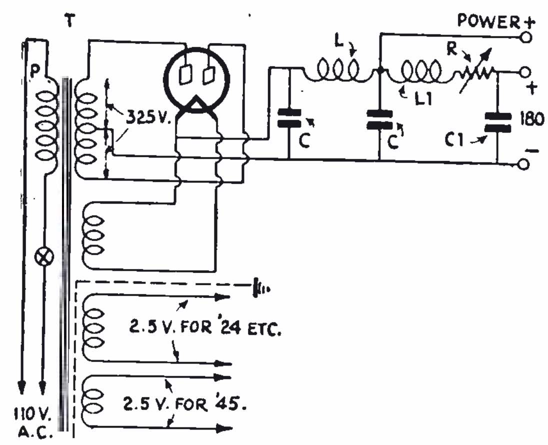
Front view of the single dial control, HY-7B "short-wave" super-het for A.C. operation.

This article describes the Hatry A.C. Super-Het for short-wave reception, and our readers will no doubt be particularly interested in this description as there are relatively few "short-wave" Super-Hets on the market.

TWO main reasons exist for presenting the HY-7B receiver to SHORT-WAVE CRAFT readers; the great interest they took in the HY-7, and the fact that an A.C. form of this short-wave superheterodyne has not appeared in this magazine. The minor reasons are more or less obvious; since they are the differences between the old and new circuits which will be recognized by readers of my first article and, especially, by builders of the HY-7.

* Hatry and Young, Inc., 119 Ann St., Hartford, Conn.

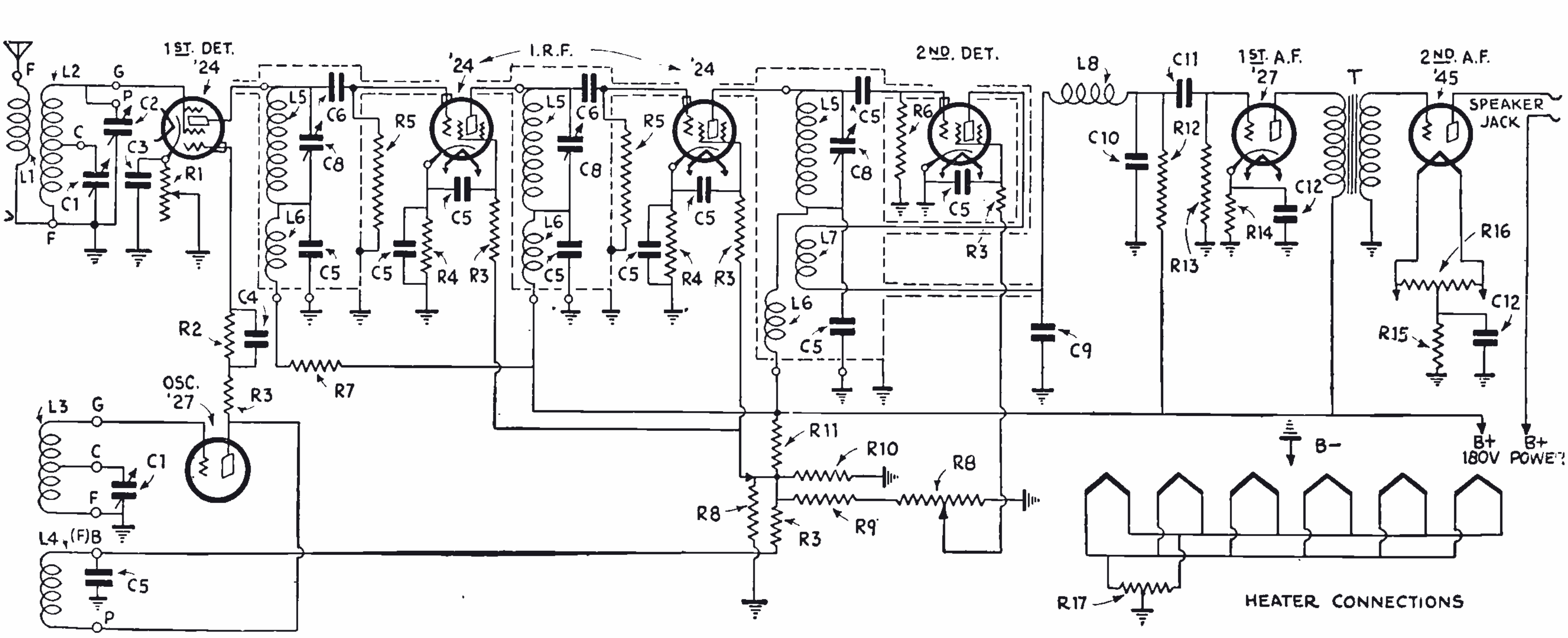
The HY-7 had but one audio stage and, though I tried to explain at some length in the article on the HY-7, that for best loud-speaker performance on broadcast reception a second A.F. stage is needed, many readers absorbed the information not at all, preferring instead to use up postage and time talking about it. Similarly, other design points of some importance escaped the careless observation of hundreds, judging by the correspondence. Hence the brief repetitions that will occur in this story, I feel, are quite necessary.



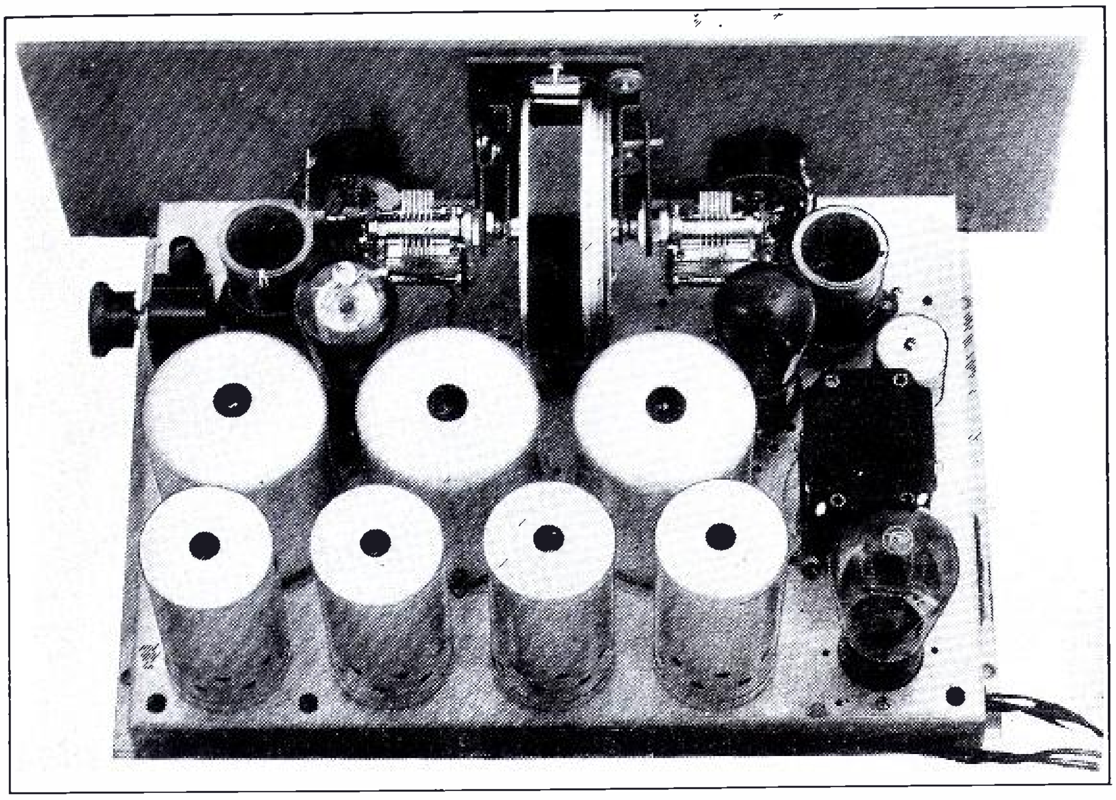
Wiring diagrams of the HY-7B plate, filament and heater supply.

Strictly a "Short-Wave" Super

The HY-7B is strictly a *short-wave* superheterodyne. It will not give satisfactory performance in the 1500-550-kc. broadcast band without the rather radical changes represented by the re-design of the intermediate amplifier for a new operating frequency (preferably in the region of 450-kc.) and the consequent



Complete wiring diagram of the Hatry type HY-7B, short-wave super-het, designed for A.C. operation.



Rear view of the HY-7B super-het, showing shielded coils and tubes.

re-design of the plug-in coils. The standard chassis, however, has not room enough for the variable condensers required, because of their bulk; so that mechanical re-design also is necessary. All of this is possible of course.

The HY-7 is forced to be strictly short-wave by an intermediate frequency of about 1525-kc., which keeps the oscillator's repeat points so far apart that a repeat does not appear on the dial to upset selectivity and confuse the user. This frequency reduces the number of plug-in coils required, by permitting each oscillator coil to cover two short-wave tuning ranges. Such an intermediate frequency also reduces the likelihood of interlocking of tuning controls.

The Tubes Required

No attempt has been made to combine the power-pack and the tuner chassis in one unit. The tuner chassis requires seven tubes, in the HY-7B. These are: first detector—'24; oscillator—'27; two R.F. amplifiers—'24's; second detector—'24; first A.F. amplifier—'27; and second A.F. amplifier—'45.

The essential features of the HY-7 needed no change for this receiver. The first detector arrangement remains "space-charge," after a careful experimental check of several other methods of using the tetrode as a first detector. Similarly, the oscillator R.F. currents are still introduced into the space-charge tube's grid circuit for mixing; although a number of other schemes have since been rechecked and compared. This scheme gives good sensitivity, minimum likelihood of interlocking and the advantages of simplicity.

For the present, the impedance-coupled R.F. amplifier circuit has been retained; although experiments now in progress promise somewhat superior performance with certain R.F. transformers that have resulted from the tests. That a shift will be made to transformer coupling is likely, but not certain until sufficient data prove the desirability of the change. Theoretically, the impedances have certain advantages if amplification only is considered; but, with a regenerative second-detector, theory also indicates slight operating advantages for the transformer. All of this may end in the use of a combination of couplings; which incidentally introduces an opening for the statement that I by no means regard any one HY-7 circuit as final. Experiments with the receiver may at any time introduce changes, advantageous to operation or performance, which, of course, will go into regular models.

The diagram (Fig. 1) shows these features clearly, and represents a complete actual operating circuit of the HY-7B.

Second Detector Uses Grid Rectification

The second-detector is operated screen-grid, with grid rectification (grid condenser and leak). Two reasons exist for using the grid leak and condenser for detection: the system gives maximum sensitivity, and hence reduces the required number of tubes; and it also allows smooth regenerative operation of the second detector, which, of course, means still greater sensitivity and an improvement of I.F. selectivity. A third, efficient stage of I.F. amplification alone would not give the increase in sensitivity obtainable from the regenerative second detector; nor would the extra tuned-circuit increase the selectivity as greatly as regeneration does. If a third I.F. stage is added, it is added before the second detector and is deliberately low-gain to achieve some small operating advantages; which is another matter.

Audio Frequency Stages

As usual, the first audio stage is resistance-coupled to the screen-grid detector, in order to maintain good tone; and it is coupled through a high-grade transformer to the power tube for the same reason—and also to maintain audio sensitivity at a level permitting a grid-rectifier detector to deliver sufficient output without overloading.

The only reason for using one A.F. power tube, rather than a couple in push-pull, is that the general demand among short-wave listeners seems to be as well pleased with one as with two output tubes. It is true enough that push-pull 245's have an output power which most of us do not need for ordi-

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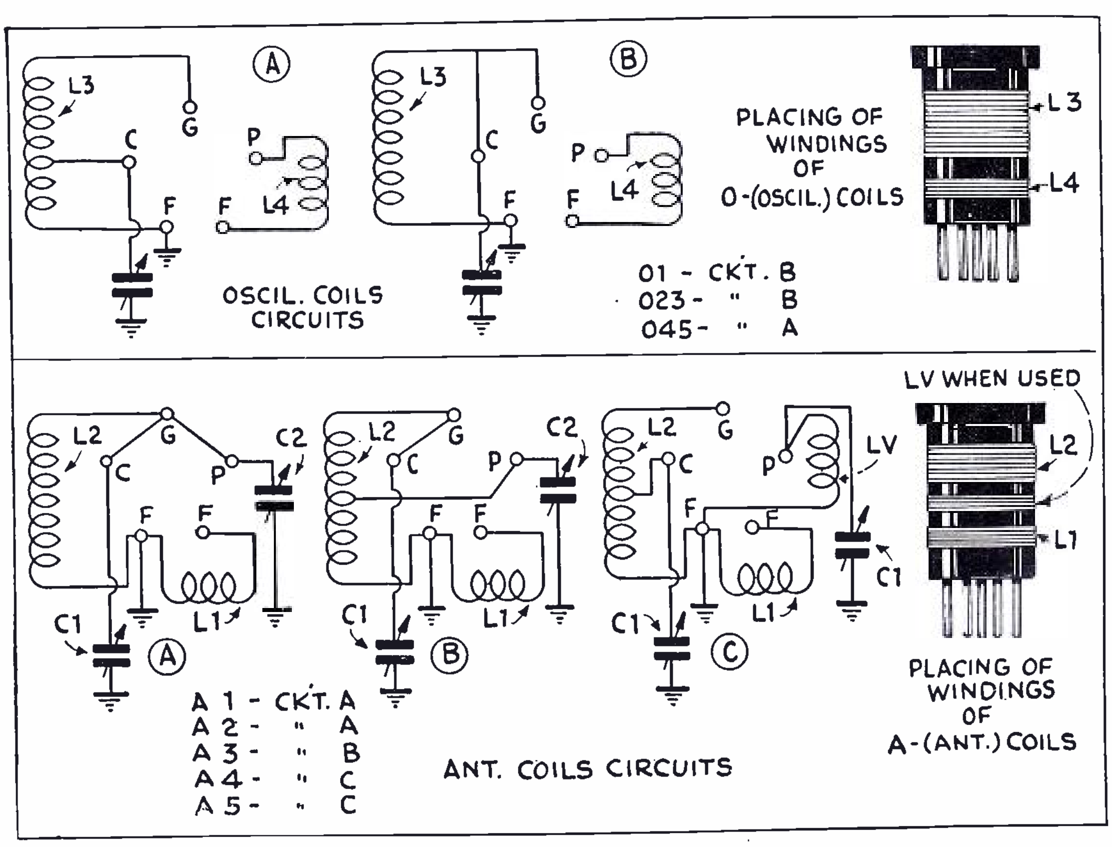

Details of oscillator and antenna coil circuits.

The Question We Hear on Every Hand Is

WHAT TUBE SHALL I USE?

Answered by ROBERT HERTZBERG, Associate I.R.E.

WHAT are the best tubes for short-wave work? This is a rather broad question, but it is asked frequently by the many people who have discovered in short waves the most interesting angle of present-day radio. It must be countered with another question for what specific purpose do you want to use them?

There are at the present time at least thirty-three distinctly different standard vacuum tubes—by "standard" being meant tubes that are produced regularly in recognized factories and that are available on the open American market. They range all the way from the tiny and somewhat disreputable 199, to the pot-bellied and powerful 861. A knowledge of their general characteristics and applications is of great value to the short-wave fan; so this article dealing with them is presented for the edification of those amateurs whose present acquaintance with the vacuum-tube family is limited to the common 201A's, 224's, 227's and 245's.

"Which particular type or number of vacuum tube should be employed for different uses in short-wave circuits?" This seems to be one of the leading questions asked by those uninitiated in short-wave lore. The editors have found the problem of "what tube to use" for R.F., detector, or audio frequency purposes, to be a very important consideration, even for those who have a fairly good acquaintance with radio matters. The editors have therefore asked several leading experts to explain what role each different type of tube performs in short-wave receiving circuits.

The present article has been popularly written by Mr. Hertzberg, so that anyone interested in the problem of what tube to use in any particular case, can gain some practical information, without having to be familiar with involved mathematics or graph curves. More information on tubes in next issue.

Meet Miss '99 and Her Companion, Mr. '20

Starting at the very bottom, let us first discuss the 199, and its companion tube the 120. The 199 was brought out several years ago as the answer to the storage "A" battery problem; its filament being designed to draw only six-one-hundredths of an ampere, at a voltage of 3.3, from ordinary dry-cell batteries. It is a general-purpose detector and audio-frequency amplifier, but is useless as a radio-frequency amplifier below 200 meters. The 120 is simply an audio output tube, intended for the last audio amplifier stage; it draws thirteen-one-hundredths of an ampere of filament juice. The 199 read like an ideal tube; but it proved to be fragile, irregular, and badly microphonic, and was never satisfactory. It is mentioned here because it was made in huge quantities, and many unsuspecting fans still try to use it in short-wave receivers.

The New 2-Volt Tubes

The 199 and 120 have been displaced by the new 230 and 231 tubes, which draw, respectively, the same values of filament current at the lower voltage of (two) 2.0. There is, in this group, a screen-grid tube, the 232, which also draws only 60 milliamperes. Like the 199 and 120, these are dry-cell tubes, but they are far superior and are highly recommended. The 230 is effective either as a regenerative detector or as an audio amplifier; while the 231 is an audio output tube, employed in the last A.F. stage when respectable quality and volume are desired. The 232 is a sensitive radio-frequency amplifier on all the usual short waves and may also be used for detection (regenerative or not) and for high-gain audio amplification with special coupling devices. For the amateur who does not want storage batteries, or does not have an A.C. light-line, these tubes are just the thing. They may be used in any circuits calling for 201A's, 222's, and 112A's. They are also ideal for portable receivers.

The usual "B" batteries are needed for the 230 series; three 45-volt blocks being enough for all purposes.

The Old Reliables

The 201A is our old standby, being the most dependable and rugged tube of them all. The writer has several 201A's that were purchased in the summer of 1924 and have been used constantly in a dozen different sets; and now they are ending their days in a short-wave transmitter with the heathenly potential of 300 volts on their plates!

The 201A works wonders as a short-wave transmitting tube. Many amateurs use it in tuned grid-tuned plate outfits made out of spare receiving parts, with the plate supply usually furnished by an old "B" eliminator, and they communicate all over the world. The stamina of this versatile tube is simply remarkable.

The 201A's filament draws a quarter-ampere at five volts, and it can be operated satisfactorily only on a storage "A" battery. This tube is a fine regenerative detector and a good audio amplifier, but useless for short-wave R.F. amplification, for which purpose it was not designed.

In the same family with the 201A are the 240, the 112A, and the 171A, all taking the same filament current. The 240, which is supposed to have an amplification factor of 30, was designed for use in resistance-coupled audio amplifiers. However, its theoretical advantages cannot be realized in actual practice with ordinary apparatus, and it proved to be what is vulgarly known as a "flop".

The 112A and 171A are primarily audio output tubes, the former having an output of 0.26-watt and the latter 0.7-watt. In addition, however, the 112A is a superlative detector, gliding from regeneration into oscillation with gratifying smoothness; also, like the 201A, it works well as a short-wave oscillator for transmitting work.

For audio amplification or transmission, the filaments of the 201A, 112A and 171A may be heated by raw alternating current, with center-tapped resistors across the filament terminals for the grid and plate return leads.

The last tube of the battery type is the 222 screen-grid. It was the first screen-grid tube on the American market, and as such achieved widespread adoption. Unfortunately, it exhibited some of the same bad features that stigmatized the 199; but the more recent tubes of this design seem to be pretty good. Its filament takes 0.13 ampere at 3.3 volts, which means that a special filament resistor must be provided if it is to be ganged with 201A's, as usually desirable.

The 222 is a radio-frequency amplifier, detector and audio amplifier, like the 232. It is somewhat fragile and should be handled with care.

THE A.C. Tubes and Their Pedigrees

When we approach the A.C. tubes of the 226, 227, 224 and 245 variety, we are dealing with a comparatively new angle of short-wave radio. Until only two years ago, when the A.C. broadcast receivers had already become an established technical and commercial success, the A.C. short-wave set was considered impossible; although the power-supply problem was the same in both cases.

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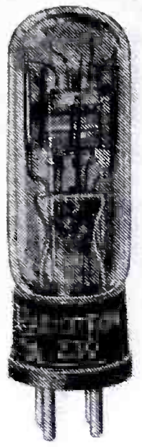
Vacuum Tubes Commonly Used for Short Wave Work



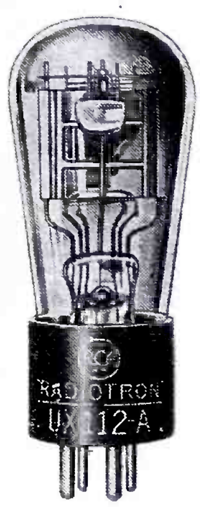
New '30 tube, 2 volt (battery). Draws .06 amp. detector or amplifier.

'31 tube, battery type power amplifier; 2 volts, .13 amp.

'32 radio frequency amplifier; 2 volts, .06 amp. draw; plate 135 volts.

'00A type; special detector; 5 volts, .25 amp. draw; plate 45 volts.

'01A—"Old reliable" detector or amplifier; 5 volts, .25 amp.



'12A tube, detector or amplifier; 5 volts, .25 amp.

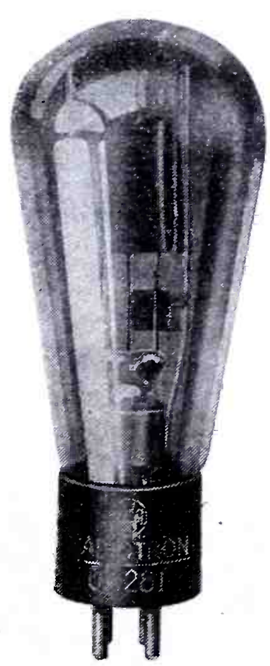
'26—A.C. or D.C.; radio or audio amplifier; 1.5 volts, 1.05 amps.

'27—A.C. or D.C. tube; detector or amplifier; 2.5 volts, 1.75 amps.

'24—A.C. or D.C. tube; screen-grid, R.F. or A.F. amplifier or detector, 2.5 volts, 1.75 amps.

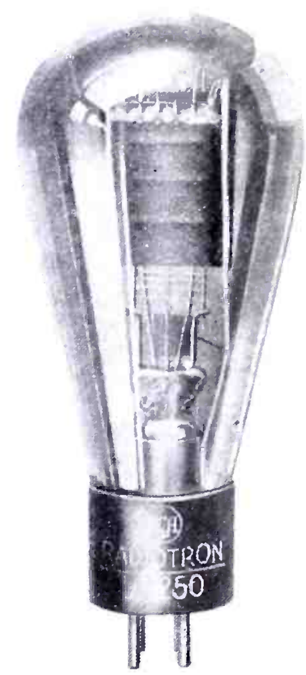
'10 tube; 7.5 volts, 1.25 amp. used as power amplifier, receiver or transmitter.

'80 full wave rectifier; 5 volts, 2 amps. UX base, plate 350 to 400 volts.



'81 half wave rectifier: 7.5 volts, 1.25 amps. Output 85 M.A., A.C. pl. vts. max.=700.

'45 power amplifier; 2.5 volts, 1.5 amps. A.C. or D.C. Plate 180 to 250 vts. rec. or trans. purposes.



'50 power amplifier; 7.5 volts, 1.25 amps. Plate 250 to 450 volts. Rec. or trans.

AUDIO AMPLIFIERS

for Short Wave Receivers

By A. R. HAIDELL

The Theory and Construction of Audio Amplifying Arrangements for Short-Wave Code and Broadcast Reception.

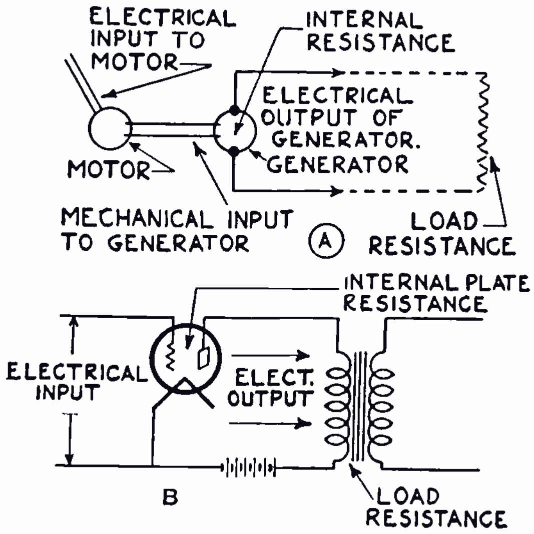


Fig.1-A shows how dynamo with no load resistance develops full voltage with no current flowing. To develop maximum output the external (load) resistance must equal the internal resistance of the dynamo (or tube, Fig. 1-B).

DO you know that there are special kinds of audio amplifiers which give best results, depending upon whether music or code is to be received? For broadcast reception, a flat-response amplifier is desirable; while best results for code (less interference as well as greater amplification) are obtained from a "peaked" amplifier. Any short-wave experimenter will be interested in constructing peaked audio amplifiers of low cost, which can be used for many interesting tests. The principles are first described below; then some practical amplifying transformers, which can easily be constructed; and, lastly, there is explained the figuring of circuit values in advance of constructional work so as to save time and guesswork.

It is interesting to study, first, a little of the theory of audio amplifiers before describing the practical and special types which are used for different purposes. If the underlying principles are understood, it will be found easy to understand the operation of the special peaked amplifiers, the construction of which is described.

Higher Ratio Gives Less Amplification

If a transformer having a turn ratio of 2 to 1 is connected between two ordinary '01A-type tubes in an ordinary audio-frequency amplifying circuit, and the amplification is measured, it will be found that the transformer, alone, gives an amplification factor of about two. This is about equal to the turns-ratio of the transformer, for the average transformer, designed with care; that is, not too cheap. The transformer, plus the last tube, brings the amplification up to about 16, over all. The amplification factor of the transformer alone is 2; that of the tube alone is about 8 (with a '01-A); consequently the total amplification is 2 times 8, or 16, as measurement (with a vacuum-tube voltmeter, for example) will show.

Perhaps it may not be clear to some why the two amplification values are multiplied together to obtain the total amplification. If one remembers that each unit of amplification in the first part of an amplifier is amplified again by the second part (the tube for example) it should be immediately evident that the total amplification must be equal to the product of the two separate amplifications. This is easily seen if one remembers that the word "amplified" really means multiplied; 3, amplified 3 times, means 3, multiplied 3 times. Thus in any chain of amplifying units, the total amplification is given by the product of the separate amplifications.

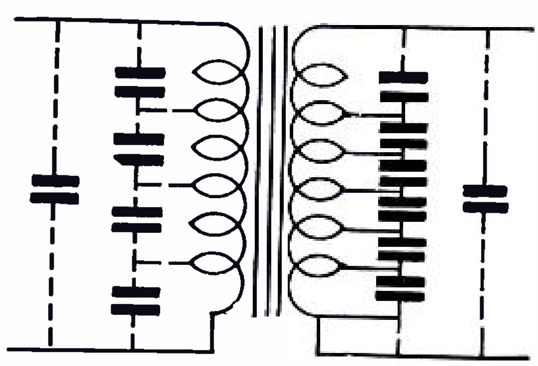


Fig. 2
The distributed capacity and inductance in the windings of a transformer may give resonance or peaks in the amplification curve.

Let us return now to the transformer which we started to discuss above. It had a turns-ratio of 2 to 1, and we found by measurement that it gave, also, a two-fold amplification. Suppose that the cover of the transformer is removed, the core with its associated windings is removed, and a large fraction of the primary turns are taken off. The connections to its terminals are then resoldered and the transformer is again subjected to measurement as before. The turns-ratio has been increased because the primary turns have been reduced, while the secondary turns remain the same. It will be found that, in general, the amplification will be less, even though the turns-ratio is greater. "Certainly," the experimenter says, "this is a peculiar state of affairs. Why for years I have been purchasing transformers with as high a ratio as I could get!"

An Apparent Contradiction Explained

This fact is not generally known, but it is a very important one for the experimenter to understand; so it will be described in detail. Since the amplification, as measured, is found to be less, while the amplification of a tube remains substantially constant over a wide range of conditions, the amplification of the transformer has fallen off. The transformer itself is still essentially the same, except for the reduction in its primary turns; so that there must be some other contributing factor. The turns-ratio has been increased, so the voltage step-up has also been increased. The only possible explanation is that the primary voltage has been decreased. Decreasing the number of turns in the primary results in a decrease in primary voltage; thus, in spite of the greater turn-ratio the amplification falls off.

The reason for the reduction in the primary voltage may not be clear at first. A tube is much like a generator; the output of a tube, like that of a generator, is greatest when the load resistance is equal to the internal resistance. This is not the best way to operate for

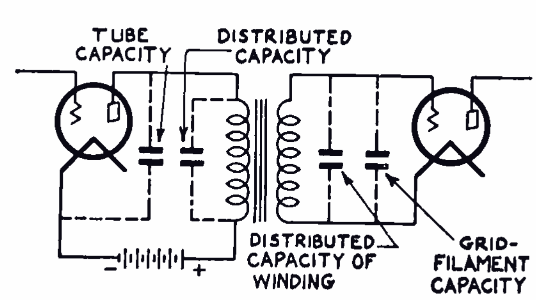


Fig. 3
The distributed capacity of the transformer windings in conjunction with the tube capacities, often give pronounced resonance effects.

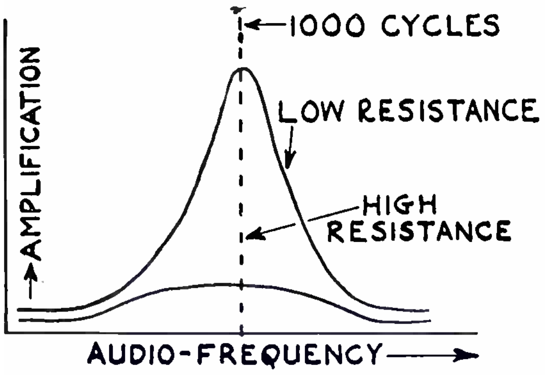


FIG. 4

Amplification curves of audio transformers with and without shunting resistances as in Fig. 5.

maximum efficiency; but the greatest output is obtained, and that is what is highly desirable in an amplifier.

The reason for maximum output at a certain load resistance may not be clear to the reader. If a generator is first operated unconnected, there will exist across its terminals a high voltage; but, since they are not connected, no current flows. (See Fig. 1A.) If the machine is then short-circuited, the current will be extremely high, but the voltage falls to an imperceptible small value; thus, high current, no voltage. In both cases, the power output of the machine is zero; because power is measured by multiplying the current and voltage together. Evidently, if either the current or the voltage is zero, the power (which is the product of the voltage and current) must be also zero. There is, therefore, some intermediate value of load resistance between an infinitely high value (open circuit) and zero (short circuit) which will give the maximum output. This value of load resistance is found to be equal to the internal resistance of the windings of the direct-current generator. In a tube (Fig. 1B) the external resistance must be equal to the internal plate resistance of the tube, for maximum output.

Design of Transformers

Thus, there is a definite value of load resistance (turns in the primary of the audio transformer) which will give the maximum response; the best is that which is equal to the plate impedance of the tube. This requires a large number of primary turns. When turns are taken from the primary, the drop in primary voltage more than compensates for the increase in turns-ratio. The turns-ratio varies directly as the number of turns; but the primary impedance (determined largely by the primary inductance) falls off as the square of the number of turns. If turns are added to the primary, the ratio of turns decreases; if the number of secondary turns are increased, the transformer becomes larger, and more expensive. Thus, any design is a compromise between conflicting factors.

The size of the core and the primary turns are reduced in cheap transformers. Cheap transformers with a turns-ratio of, say, 5 to 1 often give less amplification than a better-designed transformer with a smaller turns-ratio. Some cheap transformers give high amplification at one frequency but relatively little at others. The large amplification at some frequency is due to a resonant effect at that frequency. The windings of a transformer have distributed capacity, and, of course, there is inductance in the many turns of the winding, as shown diagramatically in Fig. 2. The tube capacity is, in most cases, shunted across the windings of a transformer. This capacity, in conjunction with the self-capacity of the winding, results in pronounced resonant effects. (See Fig. 3.) At resonance, the primary impedance, and hence the primary voltage, builds up giving greater amplification at the resonant frequency. Transformers with a lower turns-ratio than 5 to 1 usually have a better frequency-response curve.

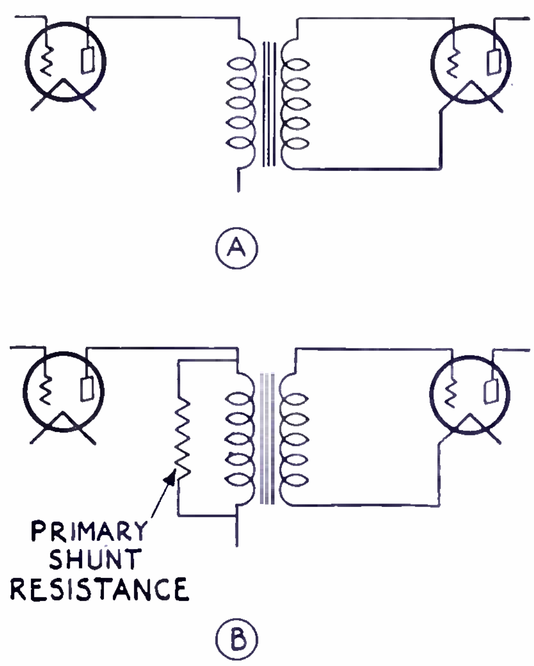


FIG. 5

A. Audio amplifier using ordinary amplifying transformer. B. Same transformer used with a primary shunt resistance. Curves for these amplifiers are shown in Fig. 4.

Overcoming Transformer Resonance

It is well known to radio experimenters that the introduction of losses or of resistance into the tuned R.F. circuits of a radio receiver, results not only in a loss in selectivity but a reduction in amplification. This principle applies also to audio amplifiers. In other words, the way to overcome a pronounced resonant effect (as obtained in a low-loss tuned circuit) is to connect a resistance across it, or to introduce other losses.

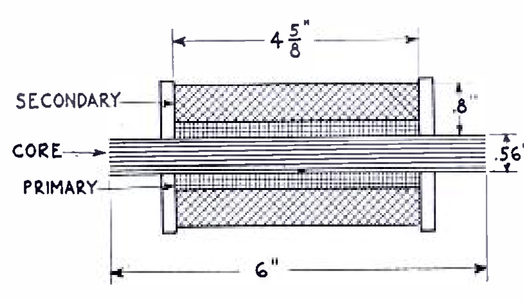


FIG. 7

Details of peaked audio-amplifying transformer.

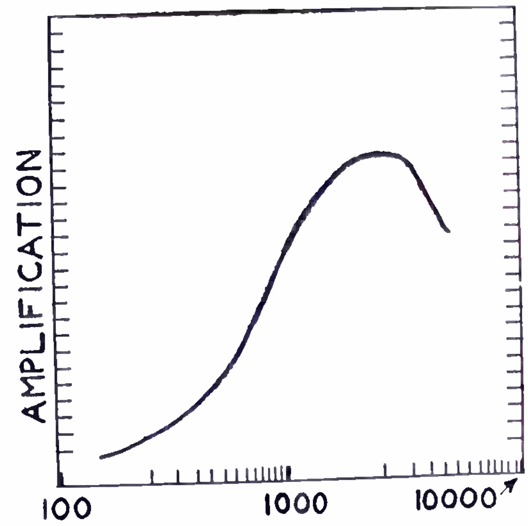


FIG. 6

Amplification curve for a typical "distortion" amplifier. This curve is for a G. E. type 712, many of which, by the way, are still in use.

The resonance effect, shown in the upper curve of Fig. 4, for a transformer, can be prevented by shunting the transformer primary with a resistance. If this is done, the "selectivity" of the audio amplifier as well as its amplification are reduced. "Selectivity" in a broadcast amplifier is exactly what is *not desired;* for some frequencies are favored, resulting in distortion. The connections of an audio amplifier, with and without the shunting resistance, are shown in Fig. 5. In code work, however, a selective audio amplifier is highly desirable, as will appear later.

With the principles described above in mind, the reader will readily understand the reason for the "peaks" in some transformers. These peaks are desirable for code work; therefore no resistance should be used in a code amplifier, because the desired selectivity would be reduced. Experimenters will also be interested in trying peaked amplifiers on broadcast music and comparing results. By shifting the peak to different frequencies, different types of music will be received better; since the more useful frequencies lie between different limits for different musical instruments and for voice.

Code vs. Broadcast Reception

In broadcast reception, it is desirable to have a "flat-response" audio amplifier so that all the different frequencies found in the musical renderings will come through with equal fidelity. It is desirable to reproduce the bass drum as well as the piccolo; but, for code work, a peaked amplifier gives better results. These amplifiers will now be considered.

The curve shown in Fig. 6 gives the amplification *as a function of frequency* with an old G. E. "Type-712" audio transformer, which has a ratio of 9 secondary turns to one primary turn. This transformer was designed for best efficiency on ship receiving sets used to copy 500-cycle spark transmissions, which give a

1000-cycle note in the receiving operator's headset. This transformer was excellent for the purpose and could, of course, be used also for the reception of continuous-wave code, where the beat-note is somewhere near 1000 cycles. The Type-712 transformer described above is the "peaked" model; another transformer of the same type number, also marketed, is better for music. This transformer is designated by a star stamped on the case. A large number of these transformers are in use in amateur stations.

Not only does a peaked transformer amplify better at about 1000 cycles, but it does not allow as much static to get through. Static is, mostly, low-pitched and therefore not favored, as can readily be seen from the curve of Fig. 6. Interference from 60-cycle plate supply, caused by poor rectifiers, is apparently reduced in intensity.

Construction of a Peaked Transformer

A peaked audio transformer can easily be constructed by the experimenter at a very small cost; details of one which is easily assembled are given in Fig. 7. The primary consists of 35,000 turns of No. 36 S. S. C. copper wire; the secondary should have 50,000 turns of the same wire. Ordinarily, no insulation is required between layers of wire but the turns should be wound reasonably in layers. A single layer of "empire" cloth is wound over the primary when it is completed; the secondary is wound over the primary. The core consists of No. 22 or 20 gauge iron wires, approximately 6 inches long, as suggested in Fig. 7. The iron wires should, preferably, be mounted in a tube of fiber or other insulating material; a thin, strong cardboard tube can be used.

The transformer is "tuned" by sliding the core in and out; reversing the secondary connections also has an effect. The desired audio frequency is thus selected while the transformer is in place in the audio amplifier. A typical audio amplifier circuit, which is also used for a peaked amplifier, is shown in Fig. 8. Two peaked stages will give better audio-frequency selectivity.

The curves of Fig. 9 clearly show the performance of a transformer of this type; compared with an ordinary 9:1-ratio amplifying transformer, it produces a very selective audio amplifier. Two stages of transformer-coupled audio, using this type of transformer, will give very fine selectivity. It is not desirable, ordinarily, to make a transformer having a curve much more selective than those shown in Fig. 9. For very sharp and steep curves, only amateur code stations of an extremely constant frequency can be received (such as the signals from a crystal-control transmitter). As the core of the home-made transformer described above is removed, the curves vary from A to B to C. Curve D is for the core entirely within the winding, but with secondary terminals reversed.

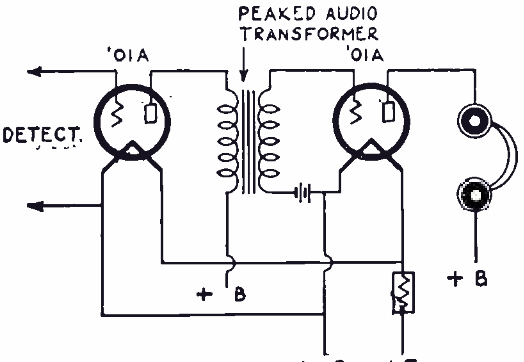


FIG. 8

Two-stage audio amplifier. This circuit works best for code reception if a peaked audio amplifying transformer is used.

Tuning the Transformer

Since removing the core of the transformer reduces the inductance of its windings, it is natural that the peak should shift toward the higher frequencies. Reversing the secondary connections (inside of secondary connected to grid) also changes the peak somewhat.

When transformers of this type are used there are no "ringing" noises or fuzzy signals. Since, ordinarily, it is necessary to reduce the volume by means of a volume control, the fact that the height of the curves becomes somewhat less as the iron is withdrawn is of no practical importance. Increased selectivity, obtained when the iron core is withdrawn, is a main idea of using the transformer. Because of the open construction of these components, it is necessary to separate them on the baseboard of the set, if more than one stage is used.

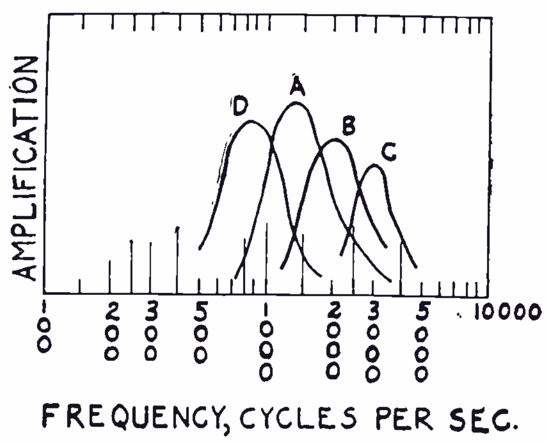


FIG. 9

Amplification curves for the home-made audio transformer, constructional details of which are given.

The peaked audio amplifier answers a real need in a code receiver, especially for the amateur 40-meter band. The usual problem is to arrange, also, for the reception of music. A flat-response audio amplifier, which supplies sufficient volume for a good speaker, is ordinarily used. A switch will allow the use of either type of amplifier. One way to encourage the construction of good, constant-frequency stations, for the amateur bands, is to use receiving apparatus which can receive only such. There would be very little incentive for off-wave operation, or poorly-adjusted sets, if these were not heard.

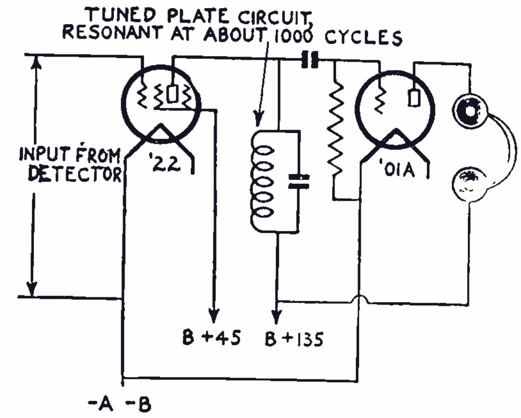


FIG. 10

Peaked amplifier employing screen-grid tube.

A Tuned-Impedance System

Another tuned audio system consists of a shield-grid tube and an impedance, of inductance and capacity in parallel, in the plate circuit, as shown in Fig. 10. It may be adjusted for resonance near 1000 cycles. Relatively large amplification, due to the high impedance, is obtained at the resonant frequency and small amplification at other frequencies; the result is good selectivity. The greater the resistance in the parallel circuit, the lower and broader the peak; the resistance, however, is not of prime importance, since the resistance of ordinary inductances used for this work is sufficiently low for selective results.

There is usually too much guesswork attached to the design of a plate-circuit impedance. The ear is not very reliable, and a few calculations beforehand will save time. Attempting to resonate an impedance to about 1000 cycles by ear, while trying various values of shunt capacity across and inductance, is very rough work indeed. The frequency of resonance of a parallel circuit is, for all practical purposes, given by:

$$f = \frac{159.2}{\sqrt{LC}}$$

Where f is in *cycles per second*, L is in *henries* and C is in *microfarads*. This formula can be written:

$$f^2 LC = 25,345.$$

For example, if f is 1000 cycles, squaring and substituting 1000 for f in the above formula gives:

$$LC = .0253.$$

If an inductance of one henry were available, the above relation shows that a capacity of about .025-mf. would be necessary to resonate it to 1000 cycles. If 2 henries were used, one-half this value of capacity would be necessary, etc.

Calculating Inductance Values

Although an air-core inductance will often give a sharper resonance peak, a much greater number of turns in the winding are required for a given inductance. An audio transformer can often

(*Continued on page* 487)

A Handy Short Wave Converter

WITHOUT PLUG-IN COILS

By C. H. W. NASON

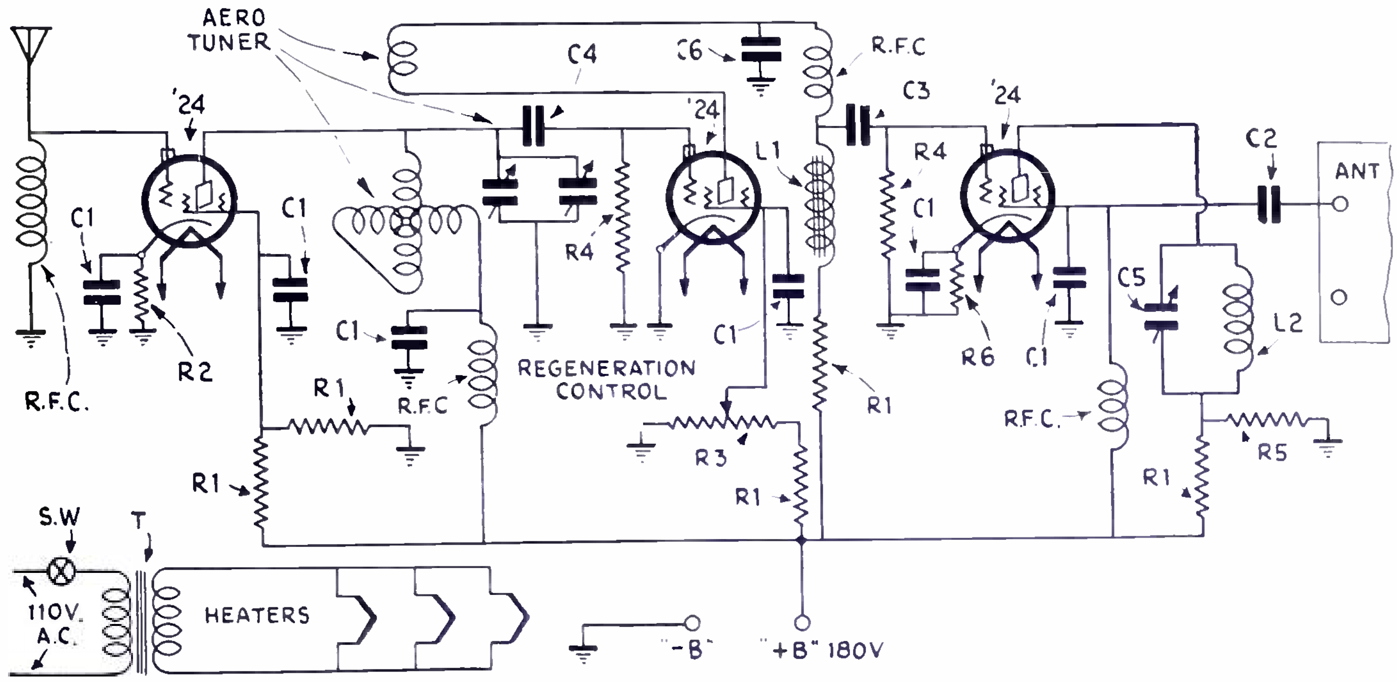
This ingenious converter enables you to receive short waves on your broadcast set. It employs the dynatron oscillator.

THE idea of a continuous tuning unit to cover the entire short-wave spectrum is by no means new. Since the high frequencies first came to the attention of the radio enthusiast any number of developments have been made which purported to accomplish this end—just as there have been many devices for converting the broadcast receiver into a short-wave job. The device which the writer considers to fill the gap is a combination of two recent developments in the radio field. The Aero tuner which covers the short-wave spectrum up to 100 meters, and has a single additional coil to fill the gap between that point and the broadcast band, is employed in combination with the dynatron oscillator; as in the short-wave combination receiver marketed by the Colin B. Kennedy Co. and described in the December-January issue of SHORT WAVE CRAFT. The present writer can claim little beyond the initiative required to co-ordinate the two developments into a form which the enthusiast can readily duplicate.

The practice of drawing filament supply from an A.C. receiver for use in a short-wave converter is to be deplored, because of the danger of overloading the power transformer and either causing a burn-out or lowering the efficiency of the receiver. For this reason the heater supply for the converter is included in the design. The plate supply may be obtained from the batteries; or it may be drawn from the receiver if the constructor is energetic enough to dig into the power supply for the 180-volt tap. The converter acts as a true superheterodyne of the modulation type, and utilizes the gain available in the receiver. The theoretical operation is as follows. (After turning to SHORT WAVE CRAFT'S December-January, and June-July issues, for data on the Kennedy receiver and the Aero unit respectively, refer to the sketch herewith):

A normally connected short-wave R.F. amplifier and detector provide the necessary audio-frequency voltage to modulate the output of a dynatron oscillator adjusted to give a weak output in the broadcast band. If this oscillator is adjusted to some fairly high frequency—let us say 1205 kc.—any incoming signal, whatever its frequency, will be fed into the broadcast receiver as a 1205 kc. signal. There is no reason for making any changes in the broadcast set, or making any connections thereto other than to connect the output of the converter to the antenna post. If this is left connected it will have but slight effect on the operation of the receiver at frequencies in the broadcast band. Three '24 tubes are required in the converter. The job is equally effective for 'phone or code reception.

The writer feels that there is little reason for getting "long-winded" over so simple a proposition. The preliminary articles mentioned fully described the operation of the Aero tuner, and the additional twists involved in the connection of the broadcast set require merely that the broadcast receiver be tuned to the frequency of the dynatron oscillator.



1—Aero tuner
RFC—Hammarlund 85 M. H. R.F. choke
T—2½ volt heater transformer
L1—Amertran 200 hy. choke
L2—100 turns No. 36 d. s. c. wound on 1¼" tube
R1—50,000 ohms
R2—500 ohms
R3—10,000 ohm potentiometer
R4—5 megohms
R5—25,000 ohms
R6—1500 ohms
C1—.25 mf.
C2—.002 mf.
C3—.05 mf.
C4—.0001 mf.
C5—.0001 mf. trimmer
C6—.0005 mf.

In Our Next Issue

The "Ham's Own" Short Wave Receiver, described and illustrated by one of them, Norman B. Krim. This receiver has a "band spreader", a range up to 750 meters, and many other features of unusual interest.

Superior Short Wave Receiver Used at G2DT, described with data and diagrams of the receiver used at the famous English Short Wave Station, owned and operated by E. T. Somerset (G2DT).

What Tube Shall I Use?—Second article on this subject, giving in a popular style what the different tubes do and in what part of the circuit they are best used.

Around the World With a 15-Watt Transmitter, by A. Binneweg, Jr., giving ample constructional details of the transmitter and also a receiver to work with it.

A "Single Control" Short Wave Receiver, by R. Wm. Tanner, W8AD.

Multiple Radio On a Single Short Wave, by Baron Manfred Von Ardenne.

Getting Started on 5 Meters!

Besides dozens of other interesting articles containing data and constructional information on building and operating S-W transmitting and receiving sets, converters to change your broadcast receiver for S-W reception, etc.

How Directive Aerials Work

In this unusually interesting article a clear explanation of one of the principal French systems of directive aerials for short wave transmission over long distances is described and some of the results obtained discussed. As pointed out by the Société Française Radio-Electrique, it is due in large measure to the perfection of this system of directive aerials that it has become possible to obtain the brilliant results achieved in the operation of the radio-telephone circuit between Paris and Buenos Aires.

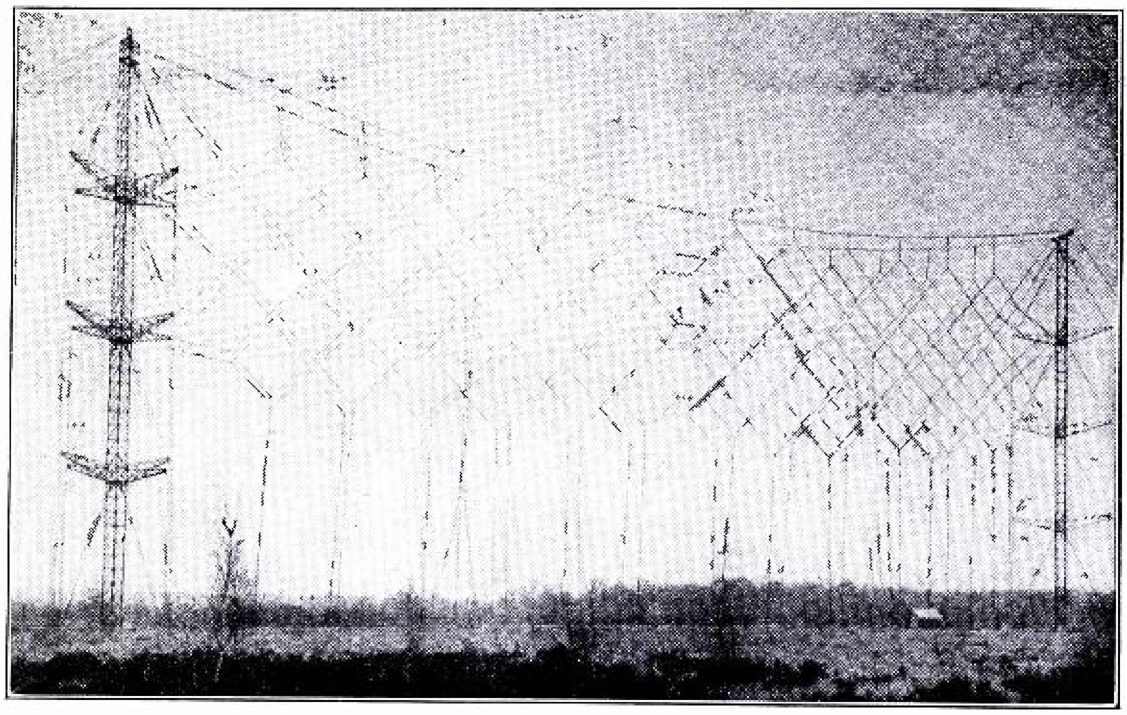


Fig. 7—The photo above shows the elevated, short wave, directive antenna and reflector, supported by two towers 240 feet high.

THE object of this article is to describe the French system of aerials for transmission by short projected waves such as was achieved by the author at the beginning of 1926, and as is now employed by the Société Française Radio-Electrique in its installations in France and foreign countries.

Theoretical Considerations

The general theoretical discussion may be stated as follows:

1—If vertical aerials are placed in line at equi-distant spots, the distance being less than one half wave length, and if these carry currents of equal value and phase (type I) the diagram of the resulting field obtained in the horizontal plane will have the form of figure 1, that is to say, a sharpened "8" together with small symmetrical loops. The maximum radiation takes place in the two directions perpendicular to the line of aerials, and the greater the developed length of the line, the more the principal "8" is sharpened, the greater is the increase in the number of small loops, but the more the importance of these loops is diminished. This case corresponds in fact to the limiting case of a parabolic reflector of cylindrical form whose double focus is situated at infinity.

2—If vertical aerials are placed in a row at equal distances, the distance between each being less than one half-wave length, and if these carry currents of equal value but out of phase by a quantity corresponding to the speed of propagation of electromagnetic waves in air, that is, 180° for each half-wave length (type II), the resulting diagram in the horizontal plane will have the form shown in figure 2, that is to say of a cardioid together with small loops.

The maximum radiation takes place along the direction of the aerials and in the direction of the phase-lag. In the other direction, the radiation is, on the other hand, very much reduced. The greater the length of the row, the more the principal part will become sharp, and the more the number of small loops will increase while their size will diminish.

This type of alignment corresponds to the limited case of a cylindrical parabola whose focal distance is zero (an infinitely flattened parabola).

3—If nevertheless a comparison be made between these two types of alignment, it is found that the alignments of type I produce very rapidly, that is to say for a moderately developed length, a very sharp diagram, but that they project equally well the energy in two diametrically opposite directions. On the contrary, the alignments of type 2, for a like developed length, give a much broader diagram, but possess the valuable quality of radiating the energy in one direction only, even if they are reduced to two aerials situated at a suitable distance apart.

4—If finally there be combined according to figure 3 suitable parallel and perpendicular alignments such as those of figures 1 and 2, we get the advantage of the characteristic features of each of the two types, and thus obtain in the horizontal plane a general diagram which is at the same time sharp and has but a single direction.

In 1924 the author made special experiments with the system shown in figure 3, based upon these theoretical considerations.

In order to have the entire diagram, that is to say in the space of three dimensions, it is necessary to take account of the directivity of the system in the zenithal plane; this latter directivity being due on the one hand to the proper directivity of the individual aerials in this plane, and on the other hand to their grouping.

Thus if in the case of the alignments of type II, the phase displacement between two consecutive aerials is less than

Fig. 1

Fig. 2

Fig. 3

Fig. 4

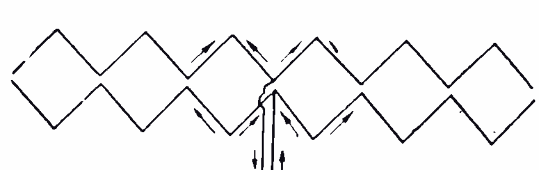


Fig. 5

Diagram showing action range of various directive aerials and flow of currents in special directive antennas.

that which corresponds, for their spacing, to the speed of propagation of electromagnetic waves in the air, (*i.e.*, below 180° for a spacing of one half-wave length), the maximum radiation will take place for a direction which is inclined with reference to the ground, whereas each individual aerial of the group will have its maximum radiation in the direction of the ground.

Principle of Construction

In view of these theoretical considerations which will obviously prevail whether currents are brought by power lines or electromagnetically induced, the author undertook to realize in as simple a manner as possible, both from an electrical and a mechanical standpoint, a wave projecting device, adapted both for transmission and reception, and having the following essential features, viz., a sufficiently sharp one-way diagram in the horizontal plane, and only moderately so

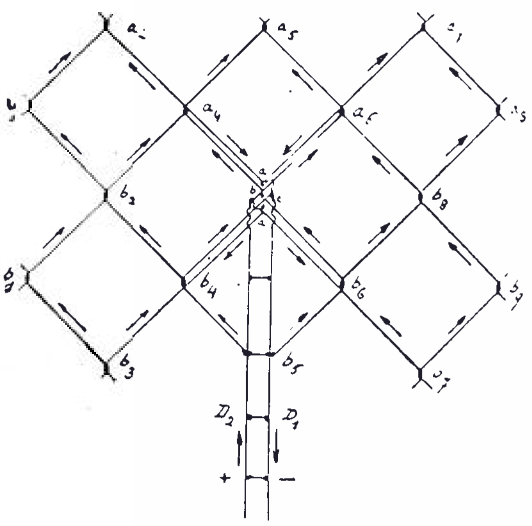


Fig. 8 above shows how power is supplied to the large directive aerial shown above and illustrated in the photograph, Fig. 7.

in the zenithal plane, and projecting or receiving energy along the direction of the ground, or at will, in a direction which is very slightly inclined from the ground.

According to what precedes, these conditions can be realized by constituting two identical alignments or rows, one behind the other. The aerials opposite one another will form a row of the second type. In the following description, one of the rows will be termed antenna and the other, reflector or screen. Since the two rows are identical, either one can obviously serve as an antenna, or as a reflector, according to the direction in which the energy is to be transmitted or received. In what follows, we shall consider mainly the case of transmission, although the developments and results apply equally as well to the case of reception.

Let us consider a wire developed in zigzag (fig. 4) with right angles or elbows and supplied for example at the middle by a feeding wire. If the length of each strand is regulated approximately to a half-wave length, and if the whole device is the seat of stationary waves, the amplitude and instantaneous

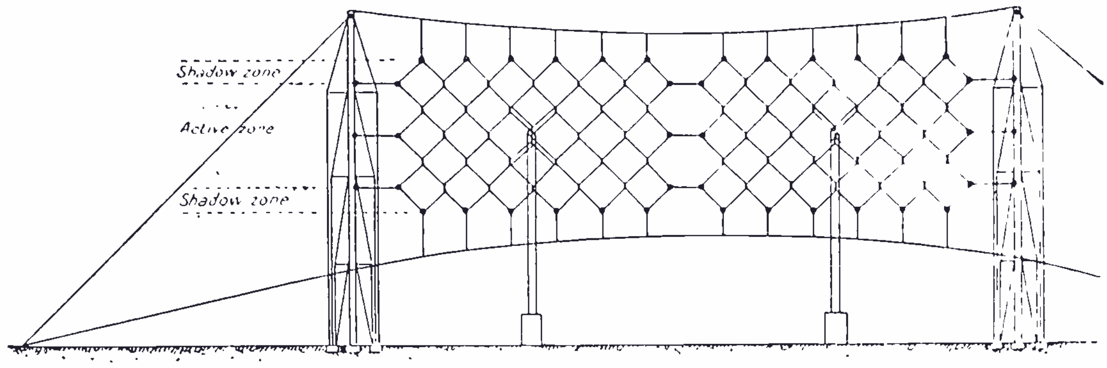


Fig. 6

By elaborating the ideas expressed in Figs. 4 and 5 we finally obtain the practical short wave, directive aerial construction shown above in Fig. 6. The aerial and the reflector, which are exactly alike, consist essentially of a sheet of wires having a network disposition, each unit element of the network being in fact a half-wave aerial.

direction of the current may be shown by the curves and arrows represented on the figure. It will be observed that the aerials 1-2-3-4-5-6 form the first row of half-wave aerials in phase and separated by a half-wave length, and that the aerials 1'-2'-3'-4'-5'-6' constitute a second row of half-wave aerials also in phase between them, but their common phase is in opposition to the common phase of the first row.

The field produced at a distance by each row is separately calculated, and it leads to a diagram of the type shown in figure 1. Since the two rows *are crossed at right angles*, the field due to the vector comprising the two fields, which are equal and at right angles, will be at all points equal to √2 times the field due to one row. That is, the diagram due to the combined action of the two crossed rows will still be of the type shown in figure 1. It will be readily observed that if the general direction of the wire is horizontal, the resulting electric field will be vertically polarised, as in a vertical antenna. By turning the whole system by $\frac{\pi}{2}$ we evidently obtain a horizontal polarisation. Again, since the several unit elements are of half-wave lengths, the maximum radiation will take place perpendicularly to the plane of the wires, that is, to say, horizontally.

This arrangement is of a very simple character and is quite effective in practice. The angles or elbows of the wire coincide with the nodes of the current, and will not cause *any reflection* of the energy, so that the maximum current will only diminish very gradually from the centre to the ends.

If the system shown in figure 4 is doubled as shown in figure 5, it will be seen that if the two power supply wires are, for two opposite points, the seat of equal and opposite potentials (Lecher wires), in the first place the feeding line will not radiate energy (the instantaneous currents being in an opposite direction on the two wires) and in the second place, it will be observed (according to the direction of the arrows showing the instantaneous direction of the currents) that the effects of the second system will be added to those of the first system. The whole is now the equivalent of *two rows crossed at right angles*, of unit aerials constituted by two *half waves in the same direction*. The maximum radiation will thus remain, perpendicular to the plane of the wire, and will thus be horizontal.

Practical Construction

By extending figures 4 and 5, we obtain the practical construction shown in figure 6. The aerial and the reflector which are exactly alike, consist essentially of a sheet of wires having a network disposition, each unit element of the network being in fact a half-wave length aerial. The arrangement is such that all the elements which are inclined to the right are in phase and form the first row of aerials in phase; all the elements inclined to the left are in phase opposition, and form a second row which is crossed upon the first at right angles. The power is supplied at two central points by two-wire lines (see fig. 8 the detail of the central part.) The four middle toothed parts which are superposed form a portion termed active region, and the two extreme toothed parts (upper and lower) form penumbra or shadow regions. These last two parts, of which one is connected to the upper triatic and the other to earth, are not supplied with power, but nevertheless (due to the electrostatic and electromagnetic induction of the adjacent parts) carry currents whose *direction* is such that their action is *added* to that of the active parts. In these conditions, the maximum radiation remains perpendicu-

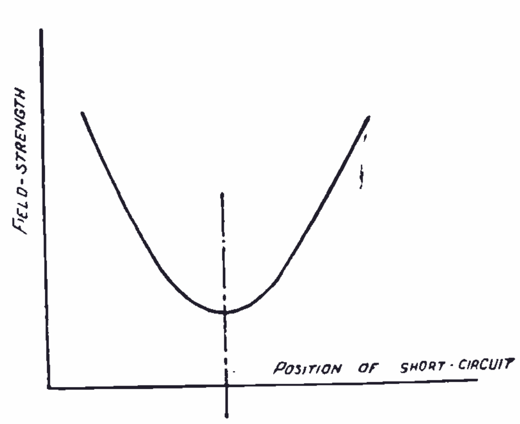


Fig. 9 above shows the manner in which the back-field is modified by the position of the short-circuiting wires of the aerial screen.

lar to the plane of the wires, that is, the maximum energy is radiated in a direction parallel to the ground.

The reflector, of identical construction, is placed at about ¼ wave length in the rear of the aerial, and in normal conditions it is not supplied with current. The feeding lines of the reflector instead of being connected to the transmitter are simply short-circuited at a suitable spot, so as to obtain the "general tuning" of the reflector. This tuning consists in exciting in the reflector currents which are leading by $\frac{\pi}{2}$ in advance to the antenna currents. It is easy to verify this by observing that the *back field* is almost entirely absorbed, while it is doubled in front, for a given current in the aerial.

The normal projector constructed by the Société Française Radio-Electrique will practically concentrate all the energy in an angle of 8° to 10°, on the horizontal plane.

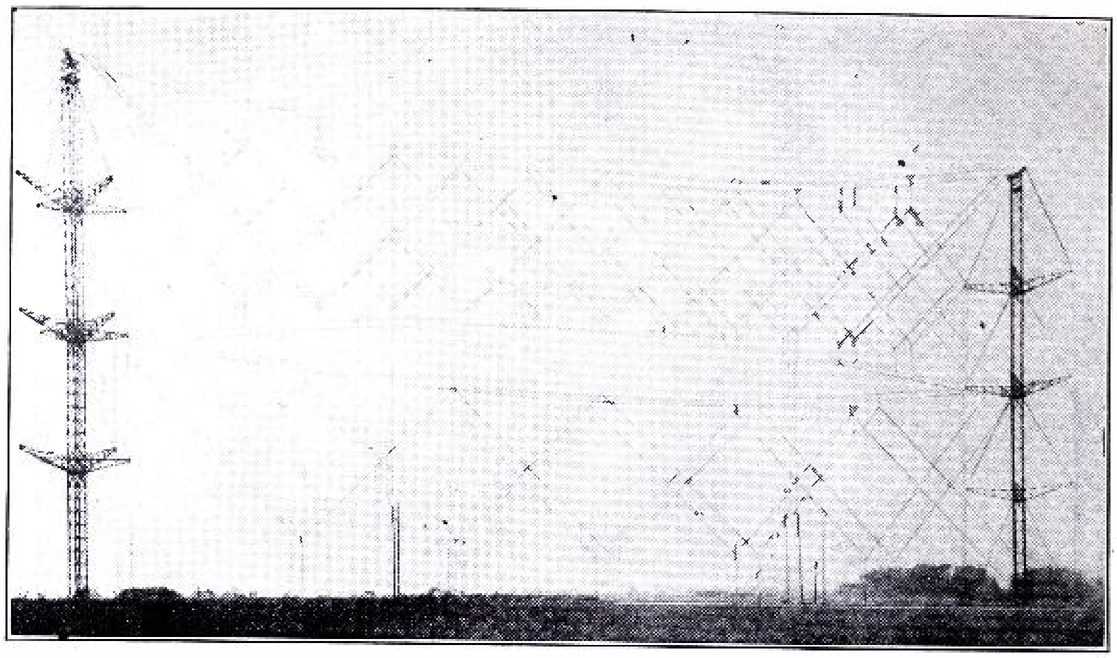


Fig. 10—Photo above shows the short wave directive receiving aerial at Villecresnes, France.

Principal Advantages

1—Owing to their construction, either of the two sheets can serve as an aerial or as a screen, and hence the diagram can be readily turned through 180° by suitable switching.

2—It is an easy matter to tune the screen to the exact wave-length (and to modify this tuning if the wave-length changes) by acting only upon the short-circuiting position of the wires of the screen. Figure 9 shows the manner in which the back field is modified by the position of the short-circuit. We attain practically the figure 20 for the ratio between the front and back fields.

By slightly modifying this adjustment, we may give the beam a slight vertical inclination, as above stated, as we thus change the relative phase of the currents in the aerial and in the reflector.

3—Similarly, owing to this construction, the diagram in the zenithal plane afforded by each sheet will give a maximum effect in the horizontal direction, and this is a very favourable condition, according to tests made principally by Dr. Meissner both for transmission and for reception which tests show that at great distances it is preferable to transmit and receive energy in a practically horizontal direction.

4—Due to its construction, the system is well adapted also for aerials which are high and are well above the ground (see fig. 7), thus raising the whole outfit and particularly the central feeding point. It is in fact observed that the mean value of the current in the different elements may be represented by figure 11 in which the degree of approach of the full lines, gives a certain estimate of the density of the mean current. This density is at the maximum near the center, and by raising the whole sheet of currents, we remove from the ground the whole transmitter or receiver of power. The practical gain obtained in this manner is quite considerable, both for transmission and reception(*).

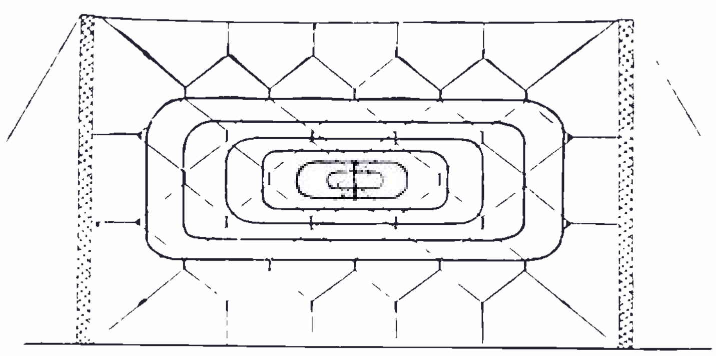


Fig. 11, at left, shows by the degree of approach of the full lines, a fair estimate of the density of the mean current in a short wave antenna of the type here discussed. This density is at a maximum near the center and by raising the whole sheet of currents, we remove from the ground the whole transmitter or receiver.

5—The fact that when proceeding from the central feeding point, the number of one-half wave elements is not great, added to the consideration of the damping due to the radiation, renders this type of antenna hardly critical as regards the wave-length.

In fact, we may allow a total range of 10 to 15 meters.

For greater changes in the wave-length the apparatus can be readily dismounted and installed.

6—From a mechanical point of view, the plant can be readily constructed, and on the other hand, since the number of feeding points is now reduced to two, the feeder system is much simplified, as well as the accessory outfit consisting of transforming or coupling boxes, as will be explained later on.

(*) *Remark*.—The aerial might be constructed for the "day wave" in the form indicated, then using the free space beneath the aerial for a "beam" of reduced value, for the "night wave." This is justified by the fact that the night wave is used for a shorter time than the day wave, and only in the no-load traffic hours. This arrangement has been adopted in practice for the receiving aerials. (See Fig. 10.)

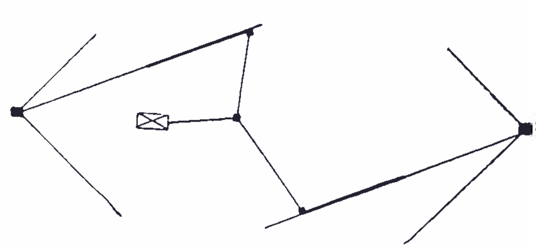


Fig. 13.

Figs. 12 and 13—At the right is shown another arrangement of short wave directive aerials, which is considered very desirable in the case of projectors for short waves and which are to be erected in great centers of transmission, provided with large aerials with long waves. Fig. 13 (top) shows that the plan comprises two aerials, situated in different planes.

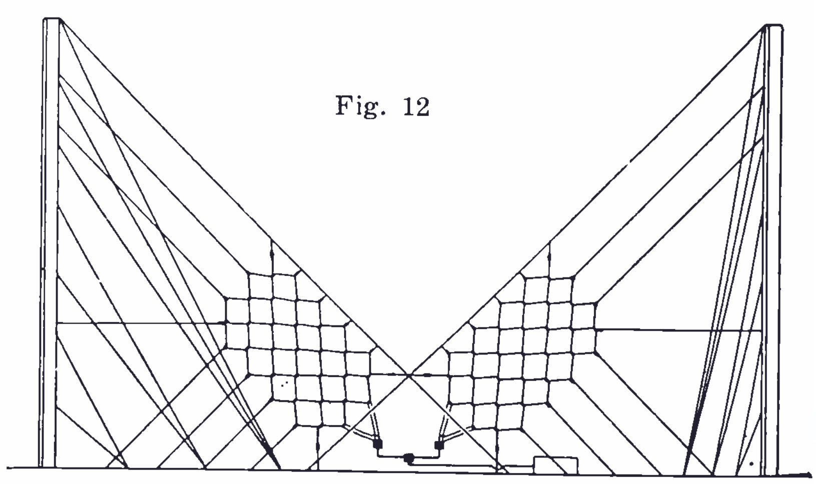


Fig. 12

7—The adjustment is very simple and rapid, since it is limited to the placing in phase of the two sections shown in Figure 6, and to the tuning of the screen. This consideration can well be of great importance especially in plants in the colonies where skilled or competent persons may be lacking.

Other Constructions

Figs. 12 and 13 show another arrangement which is most advantageous in the case of projectors for short wave-lengths to be erected in great centers of transmission provided with large aerials with long waves. The towers already erected are used to support the aerials.

As shown in figure 12, the disposition is practically the same, but the whole plant is rotated by 45°, thus rotating to the same degree the plane of polarisation of the electromagnetic field.

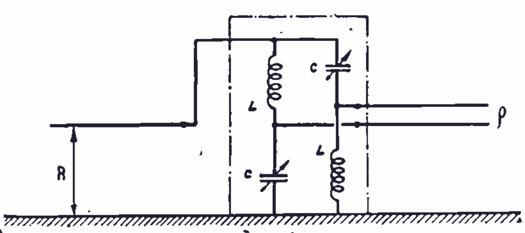


Fig. 15—Wheatstone bridge arrangement of self-inductances and capacities interposed between the output end of the feeder line (P) and the input end of the aerial (R).

Figs. 12 and 13 correspond to an experimental construction for telephone connection between France and Indo-China, and it is observed in figure 13, which is a plan view, that the plant comprises two aerials situated in *different planes*, which was required by the nature of the ground but gave no additional complications, since it is always easy to adjust the relative phases in order to obtain the maximum effect in the desired direction.

Fig. 14 shows the diagram of the corresponding field, which is particularly sharp.

Feeders and Transformation Boxes

Owing to the disposition of the projecting aerials and to the fact that in a great transmitting center it is necessary to use several aerials for the different receiving stations and the various wave-lengths, the feeders must often measure several hundred metres in length, that is, a length corresponding to a considerable number of wavelengths. In this case, care should be taken.

1—That the feeders will not radiate any appreciable amount of energy, which would offer prejudice to the directive properties of the antenna.

2—That there should be a minimum loss in the feeders.

These conditions can be fulfilled by using tube feeders comprising two concentric tubes. The current flows forward through the inner tube which is at a certain potential above earth, and it returns through the outer tube which is at ground potential. In these conditions, the outer tube forms a Faraday cage with reference to the inner field, thus preventing all prejudicial radiation, and on the other hand the metal has a large enough surface to afford a low ohmic resistance in spite of the great skin effect at the usual frequencies of projecting aerials.

Since the minimum loss takes place when the feeders carry currents free from stationary waves, i.e., when the feeder supplies current at its characteristic impedance we thus realize this condition. Referring to figure 5 or figure 8 which represents the arrangement of the wires leading to the central point, it is observed that the two supply wires should possess, in the parts oppositely placed, potentials which are equal and opposite with reference to the ground. These supply wires also carry stationary waves, as there is no transformer at the central feeding point. It is thus necessary to place between the output end of the tubular feeder and the input end of the aerial, a junction box which serves firstly to produce at the input end towards the aerial, potentials which are equal and symmetrical with reference to the ground, and secondly to extinguish the stationary waves in the tubular feeder. This double condition is realized by the Wheatstone bridge arrangement shown in figure 15, which comprises two equal self-inductions and two equal capacities. It can be readily demonstrated that, if ρ (*) is the characteristic impedance of the tubular feeder and R that of the antenna to be connected and if the box is placed at a point so that the antenna will represent at this point a pure resistance (that is a node or an antinode) it can comply with the two conditions in several ways, especially by realizing:

(*) At the frequencies employed, the characteristic impedances become reduced to pure resistances.

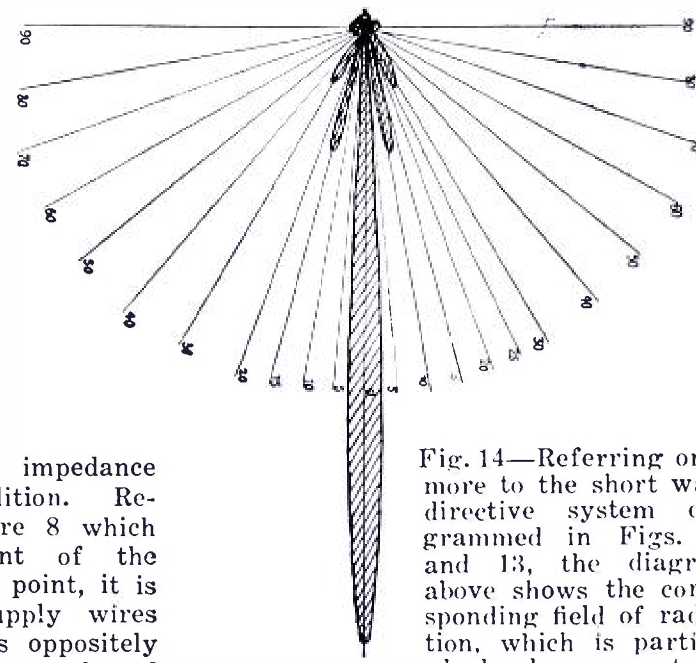


Fig. 14—Referring once more to the short wave directive system diagrammed in Figs. 12 and 13, the diagram above shows the corresponding field of radiation, which is particularly sharp as noted.

(a) the condition of resonance for the given wave.

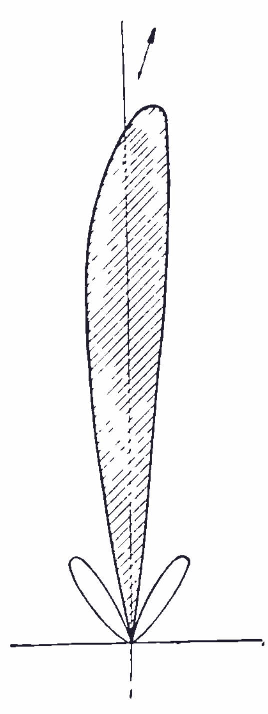
(b) the additional condition $\frac{L}{C} = R\rho$;

otherwise stated, the characteristic impedance of the circuit is made equal to the geometrical mean of the outward and inward impedance. In these conditions, it can be easily verified that the stationary waves are extinguished on the upper side, *i.e.*, in the tubular feeder, by disposing in this tube, and opposite suitable sight holes, three ammeters equally spaced, (at about ¼ or ⅓ wave-length) and by observing the deflections which should then be the same for the three ammeters.

The general diagram of the distribution, starting from the transmitter, and for a two-section aerial, is as follows (fig. 17).

The output takes place in a tubular feeder (1) as far as a branch box (2) at which the single feeder is divided into two tubular feeders (3) and (4).

(To be Concluded)



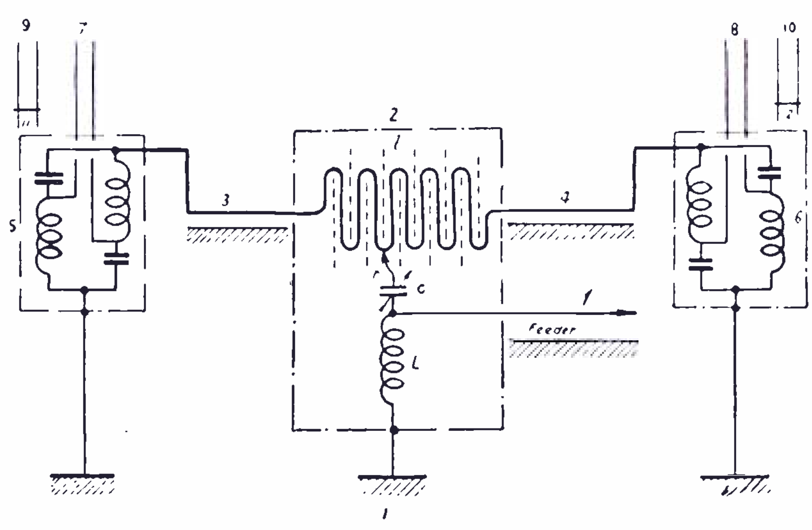
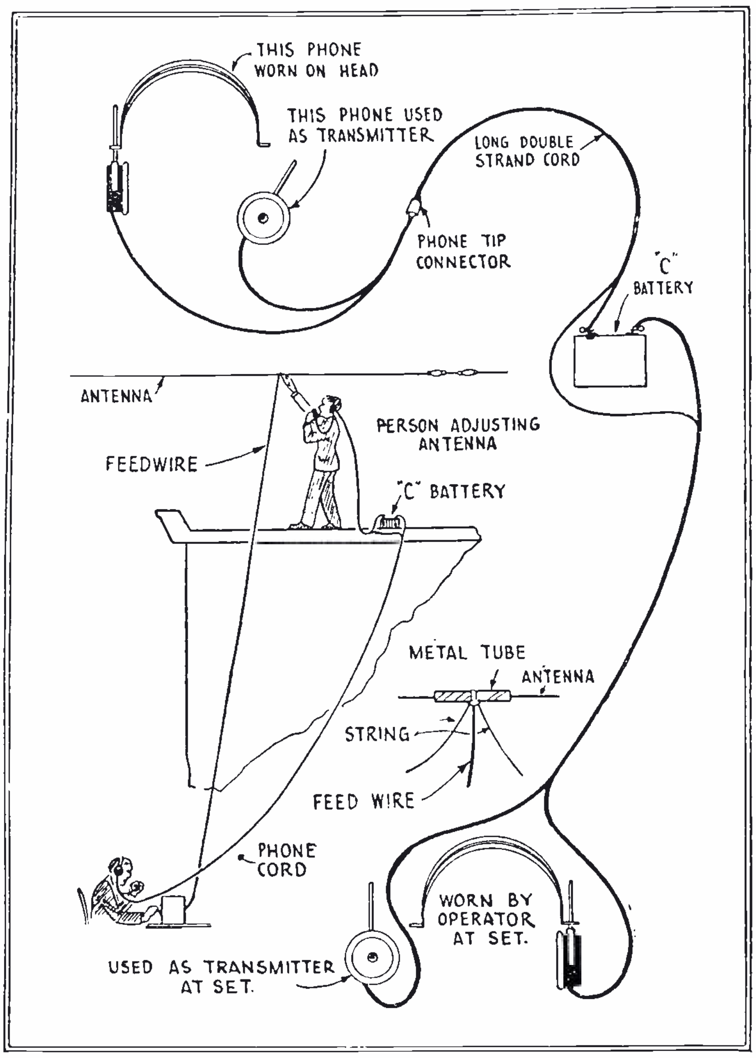


Fig. 17, above, shows the general connection of the short wave transmitter to a two-section aerial. Fig. 18 (left)—If instead of adjusting the two antenna sections so as to have equal phases, we modify the relative phase, the shape of the diagram, Fig. 18, can be somewhat changed, so as to further the radiation in a slightly different direction.



Where to Connect Aerial "Feed"

AFTER one has been initiated into the amateur transmitting game he commences to experiment with antennas, etc., to find the best possible means of radiating his signals. The current- and voltage-feed Hertzian systems seem to be in favor with many amateurs; but the difficulties experienced in locating the proper point for attaching the feed wire from the set seem to present the greatest problem.

The scheme illustrated in the accompanying diagram was used for this purpose and has been found an excellent means of communication between the operator at the transmitter and the one doing the adjusting on the antenna. Usually such antennas are close enough to a roof so the helper can walk along and place the feed wire at the desired point.

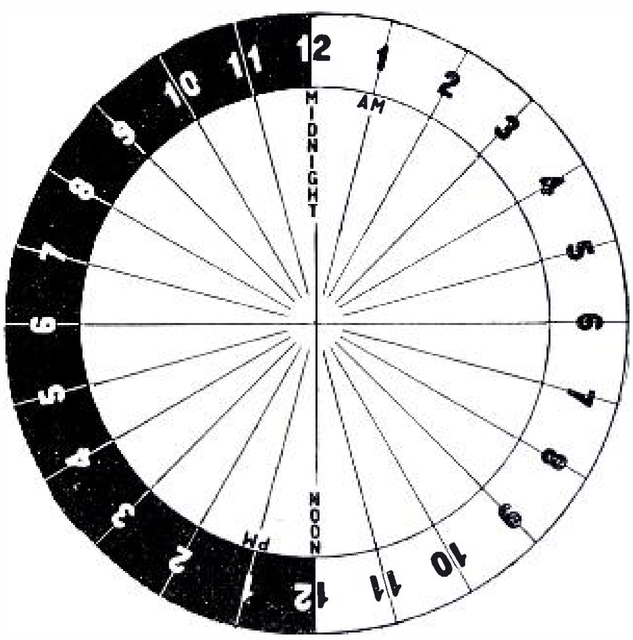
If not, then a short piece of metal tube can be soldered to the feed wire; slid over the antenna; and operated back and forth from the ground by strings pulled either one way or the other.

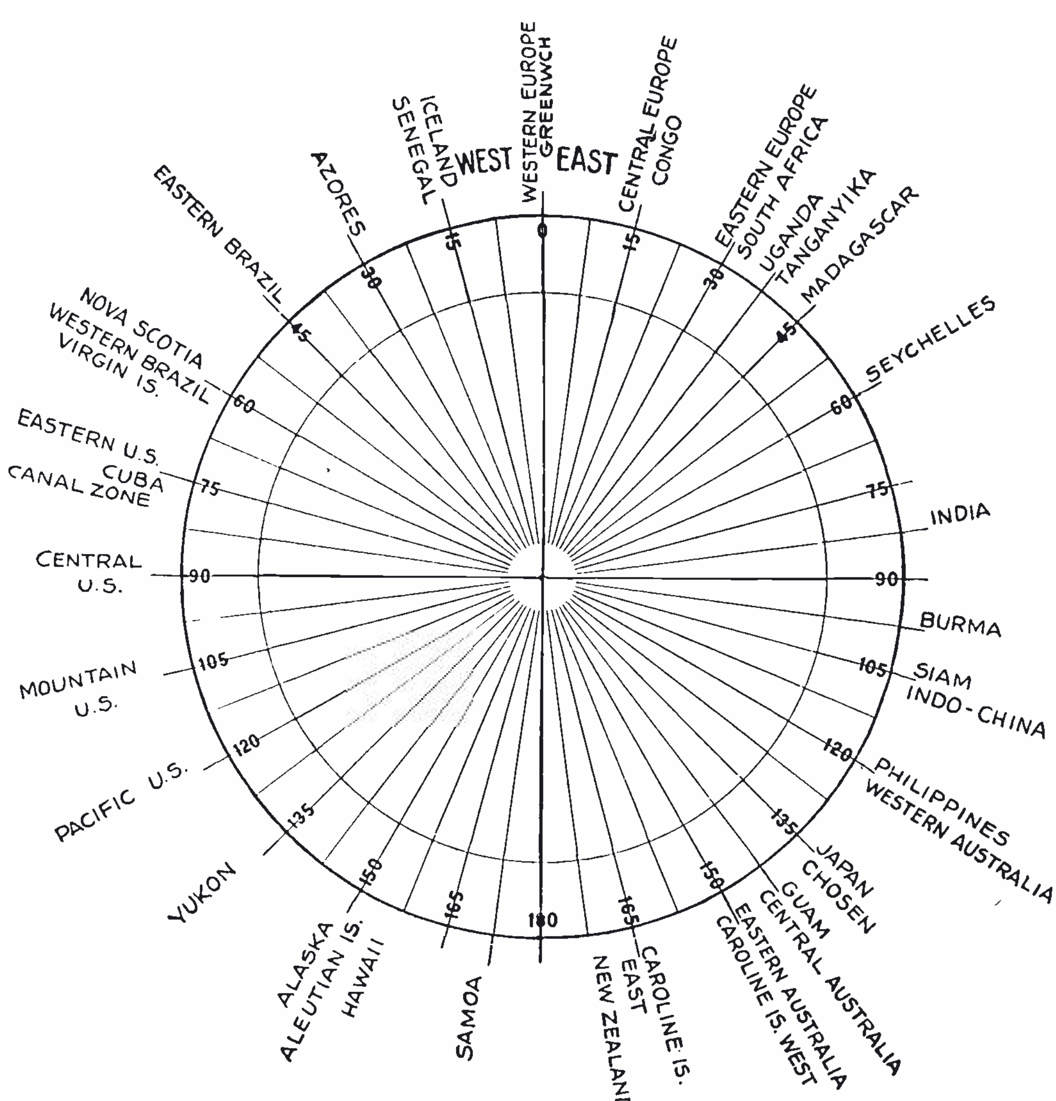
The phone system consists of two regulation headsets, a length of double-strand insulated wire and a "C" battery. Disconnect one phone from the headband at each set. Then connect the phone cords to the long cords by clips or phone tip connectors, and insert the "C" battery somewhere in the line. Run the long cord from the operator's point to that of the helper's, taking care to keep

(*Continued on page* 489)

The telephone scheme shown in the accompanying diagram was used in determining the best location of the feed wire on a short wave aerial. When the best antenna meter reading occurs the "roof" man tells the operator.

International Time-Zone Chart and Converter





A Rotary International Time Chart.

THE two circles shown above, if copied on suitable cards, may be used to find the time at any point in the world the longitude or the "time zone" of which is known. The smaller circle should be trimmed closely; so that, when it is fitted over the larger by a pin passing through their exact centers, it is possible to read the figures on the larger circle.

The small black figures around the edge of the larger circle represent longitudes, east and west from Greenwich, England, from which all map bearings are calculated. The names on the out-

(*Continued on page* 492)

Portable S-W Transmitters and Receivers

By A. H. HAIDELL

A Transmitter and Receiver Utilizing the Same Tube and Tuning Apparatus—Especially Adapted for Use On Automobile or Motor-Boat

PORTABLE transmitting and receiving sets are becoming more popular. The writer has carried out some experiments along the line of combined transmitting and receiving arrangements which will be of interest to those contemplating the construction of portable sets.

In some respects, a portable set is somewhat more difficult to design, because space requirements must be met. At first thought, this requirement is not serious but, when one looks into the construction more attentively, it is found that some rather radical changes must be made in the usual circuits; especially where a large reduction in weight or required space is desired.

A small portable transmitter or receiver is convenient; but, where both a receiver and transmitter are desired in a single case, a combination circuit will give a considerable all-around simplification. In working out combination circuits on paper, one soon runs into difficulty. The tuned plate-tuned grid transmitting circuit, and also the Colpitts transmitting circuit, are usually too complicated to incorporate into a combined arrangement; because these are two tuning controls for the transmitter. That leaves the Hartley circuit, which requires only one tuning condenser.

In the case of the receiver, a simple regenerative circuit would be considered first. The addition of audio amplification complicates matters for a combination circuit; so, unless very strong signals are necessary, one can use only one (detector) tube and make it as sensitive as possible. That means super-regeneration!

The Combined Circuit

Fig. 1 shows an exceptionally simple portable arrangement which can be used for both transmitting and receiving. The main reason for using a combination circuit is to "boil down" the amount of apparatus required, in order to make the complete set easily portable. This circuit is effective for both transmitting and receiving; and is described in detail in what follows.

The set described here was intended for use in an automobile, where the proper batteries can easily be carried. At the same time, however, the set had to be small enough not to consume too much space in the car. It is some thrill traveling along in a car, still keeping in touch with some "land" station!

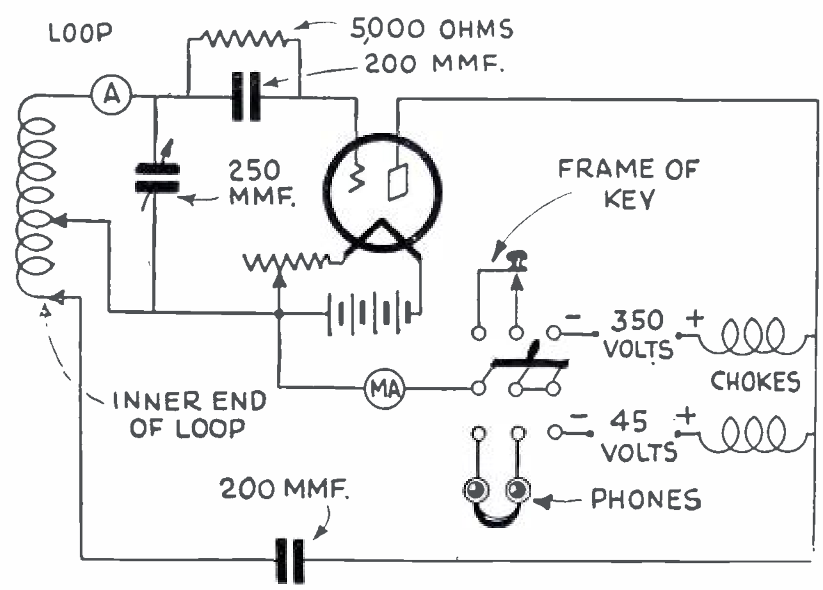
The receiving part of the combined set operates on the super-regenerative principle, in order to obtain sufficient sensitivity when using but the single tube. If it simply oscillates quietly, no signals are heard; for oscillations will be too powerful for receiving very strong signals. When it is operated to give an audio-frequency whistle, which denotes super-regeneration, the received signals will be unusually strong. The pitch of the whistle given by the tube, and the enormous sensitivity of this receiving scheme, can be controlled by changing the filament rheostat's setting, or by using a variable receiving grid leak in series with the 5000-ohm transmitting grid resistor; this grid leak should be shorted during transmission for best results. The constants of the circuit are shown in Fig. 1.

The loop is also the "coil" of the transmitter and receiver. The loop forms the inductance of the familiar Hartley circuit, when used as the transmitting inductance. A clip should be used to change the proportion of turns used in the "coils," to obtain the best operating combination. An 11-plate receiving condenser across the loop will allow efficient operation in the 80-meter band. 350 volts on the plate will give about 0.5-ampere radiation and a plate current of probably 35 milliamperes.

Importance of Choke Coils

The R.F. chokes are important; a poor choke in the transmitter will materially reduce the output. Poor chokes often cause "dead spots" in receivers. A coil about 2 inches in diameter, wound with No. 22 or 24 wire, will prove satisfactory at 80 meters.

Fig. 1.
Circuit diagram for a combined short-wave transmitter and receiver, which utilizes a loop aerial for sending or receiving signals, making the outfit very useful on auto or motor-boat. 3-pole switch "up" for transmitting; "down" for receiving.



Use a panel about 9 by 11 inches. A cover which fits over the front of the set will protect the dials. A suit-case handle will serve to carry the set, if it is moved; with good protection, a set can be moved about without damage.

Loop Used for Short-Wave Work

A loop of flat spiral type, 30 inches on a side, with 6 turns of heavy wire spaced 1½ inches apart, can be used as the receiving and transmitting aerial. (Try one on your present short-wave set; loops give fine results on short waves.) This kind of loop is, perhaps, not the most efficient; but there are other requirements. It consumes small space and offers little wind resistance if an open car must be used, or when it is mounted outside. A loop is a somewhat better radiator when it is placed with one side parallel to the earth's surface, instead of being fixed with one point up; but the difference is, in any case, small. One convenient way to mount the loop is to fasten it on the right-hand side of the car, a little to the rear of the seat and pointing straight ahead.

DX Work In the Automobile

The set will get good distance besides being very reliable for local work. Even on the loop, stations from 1,000 miles away and more, can be copied, and often worked. Results are really very surprising with a super-regenerative rig.

Some practical operating points will help. Better results are often obtained by reversing the "A"-battery leads to the set. The transmitter will work either way; but the receiver may work only one way. If desired, one of the new 2-volt tubes can be used in a portable set.

When measuring the wavelength of

(*Continued on page* 487)

Short-Wave Stations of the World

Kilo-
Meters cycles

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

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

6.89 43,500—**W9XD**, Milwaukee, Wis. **Television.** Milwaukee Journal.

7.05 42,530—....Berlin, Germany. Tu. and Thu., 11:30-1:30 p.m. Telefunken Co.

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

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

9.68 31,000—**W8XI**, Pittsburgh, Pa.

9.93 30,200—**W6XD**, M. R. T Co.

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

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

10.79 27,800—**W6XD**, Palo Alto, Calif. M. R. T Co.

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

11.67 25,700—**W2XBC**, New Brunswick, N. J.
—**W3XA**, Philadelphia, Pa. Norden-Hauck El. Mfg. Co.

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

13.01 23,000—**W2XAW**, Schenectady, N. Y.

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

13.97 21,469—**W2XAL**, New York.

13.99 21,429—**XFA**, Mexico City, Mex. (Authorized to broadcast at any higher frequency.)

14.00 21,420—**W2XDJ**, Deal, N. J
And other experimental stations.

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

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

14.28 21,000—**OKI**, Podebrady, Czechoslovakia.

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

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

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

15.03 19,950—**LSG**, Monte Grande, Argentina. From 9 a.m. to 1 p.m. Telephony to Paris and Nauen (Berlin).
—**DIH**, Nauen, Germany.
Press (code) 6:15 a.m., English; 8:30 a.m. and 11 a.m., French, daily. 8:30 a.m. Sundays, French.

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

15.10 19,850—**WMI**, Deal, N. J

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

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

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

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

15.55 19,300—**FTM**, St. Assise, France. 10 a.m. to noon.
—**PPU**, Rio de Janeiro, Brazil.

15.60 19,220—**WNC**, Deal, N. J.

15.94 18,820—**PLE**, Bandoeng, Java. 5:40-6:40 a.m. and from 2:40 a.m. Tues. and Fri.; 8:40-10:40 a.m. Tues. Also telephony.
—....Saigon, Indo-China.

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

16.11 18,610—**GBU**, Rugby, England.

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

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

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

16.44 18,240—**FRO, FRE**, Ste. Assise, France.

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

16.52 18,150—**PMC**, Bandoeng, Java.

16.54 18,130—**GBW**, Rugby, England.

16.57 18,120—**GBK**, Bodmin, England.
—**W9XAA**, Chicago, Ill Testing, mornings.

16.61 18,050—**KQJ**, Bolinas, Calif.

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

16.80 17,850—**PLF**, Bandoeng, Java ("Radio Malabar").
—**W2XAO**, New Brunswick, N. J.

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

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

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

17.25 17,380—**JIAA**, Tokio, Japan.

17.34 17,300—**W2XK**, Schenectady, N. Y. Tues., Thurs., Sat. 12 to 5 p.m. General Electric Co.
—**W8XL**, Dayton, Ohio.
—**W6XAJ**, Oakland, Calif.
—**W7XA**, Portland, Ore.
—**W7XC**, Seattle, Wash.
—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn., and other experimental stations.
—**VE9AD**, Glace Bay, N. S., Canada.

17.52 17,110—**WOO**, Deal, N. J. Transatlantic phone.
—**W2XDO**, Ocean Gate, N. J. A. T. & T. Co.

18.23 16,440—**GLSQ**, S.S. "Olympic."
—**GFWV**, S.S. "Majestic."

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

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

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

18.56 16,150—**GBX**, Rugby England.

18.68 16,060—**NAA**, Arlington, Va. Time signals, 11:57 to noon.

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

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

19.56 15,310—**W2XAD**, Schenectady, N. Y. Broadcasts 1-3 p.m., relaying WGY.

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

19.63 15,280—**W2XE**, Jamaica, N. Y.

19.66 15,250—**W2XAL**, New York, N. Y.
—**W6XAL**, Westminster, Calif.

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

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

Kilo-
Meters cycles

19.83 15,120—**HVJ**, Vatican City (Rome, Italy), 9:30 a.m.

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

20.50 14,620—**WMI**, Deal, N. J.
—**XDA**, Mexico City, 2:30-3 p.m.

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

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

20.90 14,310—**G2NM**, Sonning-on-Thames, England. Sundays, 1:30-3 p.m.

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

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

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

22.20 13,500—..., Vienna, Austria.

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

22.68 13,220—**GLSQ**, S.S. "Olympic."
—**GFWV**, S.S. "Majestic."

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

23.35 12,850—**W2XO**, Schenectady, N. Y. Antipodal program 9 p.m. Mon. to 3 a.m. Tues. Noon to 5 p.m. on Tues., Thurs. and Sat. General Electric Co.
—**W2XCU**, Ampere, N. J.
—**W2XDO**, Ocean Gate, N. J.
—**W9XL**, Anoka, Minn., and other experimental relay broadcasters.

23.86 12,630—..., Rabat, Morocco. Tues., Thurs., Sat., 8-9 a.m.

23.90 12,550—**VBS**, Glace Bay, Nova Scotia, Canada.

24.23 12,350—**GDLJ**, S.S. "Homeric."

24.41 12,280—**GBU**, Rugby, England.

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

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

24.63 12,280—**Airplane.**

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

24.80 12,090—....Tokio, Japan. 5-8 a.m.

24.80 12,090—....Trieste, Italy.

24.89 12,045—**NAA**, Arlington, Va. Time signals, 11:57 to noon.
—**NSS**, Annapolis, Md. Time signals, 9:57-10 p.m.

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

25.10 11,945—**KKQ**, Bolinas, Calif.

25.24 11,880—**W8XK** (KDKA), Pittsburgh, Pa. Tues., Thurs., Sat., Sun., noon to 5 p.m., and Sat. night Arctic programs. Television, Mon. and Fri., 2:30 p.m., 60 lines, 1200 r.p.m.
—**W9XF**, Chicago (WENR).
—**W2XAL**, New York (WRNY).
—**VUC**, Calcutta, India. 8-10 a.m.

25.34 11,840—**W2XE**, Jamaica, New York (WABC).
—**W9XAA**, Chicago, Ill. 7-8 a.m., 1-2, 4-5:30, 6-7:30 p.m.

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

25.42 11,800—**UOR2**, Vienna, Austria. Tues., 9-11 a.m.; Wed., 5-7 p.m.; Thurs., 5-7 a.m.
—**W2XAL**, New York.
—**W9XF**, Chicago.
—**PK6KZ**, Macassar, Celebes.

25.53 11,750—**G5SW**, Chelmsford, England. 7:30-8:30 a.m. and 2-7 p.m. except Saturdays and Sundays.
—**I3RO**, Rome, Italy (Various wavelengths).

25.68 11,670—**KIO**, Kahuhu, Hawaii.

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

26.10 11,490—**GBK**, Bodmin, England.

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

26.22 11,435—**DHC**, Nauen, Germany.

26.60 11,280—....Brussels, Belgium.

26.70 11,230—**IBDK**, S.S. "Elettra," Marconi's yacht.

27.00 11,110—**XFD**, Mexico City, Mex.

27.30 10,980—**ZLW**, Wellington, N. Z. Tests 3-8 a.m.

27.75 10,800—**GBX**, Rugby, England.

28.00 10,710—**CTIBO**, Lisbon, Portugal.
—....Casablanca, Morocco.

Kilo-
Meters cycles

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

28.44 10,540—**WLO**, Lawrence, N. J.

28.50 10,510—**RDRL**, Leningrad, U.S.S.R. (Russia).
—**VLK**, Sydney, Australia. 1-7 a.m.

28.80 10,410—**PDK**, Kootwijk, Holland.
—**KEZ**, Bolinas, Calif.

28.86 10,390—**GBX**, Rugby, England.

28.97 10,350—**LSX**, Buenos Aires, Argentina. 7-9 p.m. Transradio Internacional, San Martin 329, Buenos Aires.

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

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

29.54 10,150—**DIS**, Nauen, Germany. Press (code) daily: 6 p.m., Spanish; 7 p.m., English; 7:50 p.m., German; 2:30 p.m., English; 5 p.m., German. Sundays: 6 p.m., Spanish; 7:50 p.m., German; 9:30 p.m., Spanish.

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

30.15 9,940—**GBU**, Rugby, England.

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

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

30.50 9,830—**NRH**, Heredia, Costa Rica. 5-6 and 10-11 p.m. Amanda Cespedes Marin, Apartado 40.

30.64 9,790—**GBW**, Rugby, England.

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

30.90 9,700—**WMI**, Deal, N. J.

31.10 9,640—....Monte Grande, Argentina, works Nauen irregularly after 10:30 p.m.
—**VVB**, Bombay, India. Testing.

31.23 9,600—**LGN**, Bergen, Norway.

31.26 9,590—**PCJ**, Hilversum (Eindhoven), Holland. Wed. 1-3 p.m., Thurs. 1-3, 6-10 p.m., Fri. 1-3, 7 p.m. Sat. 1 a.m. Philips Radio.
—**K1XR**, Manila, P. I.

31.30 9,580—**W3XAU**, Byberry, Pa., relays WCAU daily.
—**VK2ME**, Sydney, Australia.
—**VPD**, Suva, Fiji Islands.

31.33 9,570—**W1XAZ**, Springfield, Mass. (WBZ). 7 a.m.-11 p.m. daily. Westinghouse Elec. & Mfg. Co.

31.36 9,560—....Konigswusterhausen, German. 10 to 11 a.m., 11:30 a.m. to 2:30 p.m., and 3 to 7:30 or 8:30 p.m. Relays Berlin.
—**NAA**, Arlington, Va.
—**KIXR**, Manila, P. I.
—**ZL2XX**, Wellington, New Zealand.

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

31.56 9,500—**OZ7RL**, Copenhagen, Denmark. Around 7 p.m.
—**VK3ME**, Melbourne, Australia. Saturdays 5-6:30 a.m. Amalgamated Wireless, 47 York St., Sydney, Australia.

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

31.70 9,460—...Radio Club of Buenos Aires, Argentina.

31.89 9,430—...Posen, Poland. Tues., 1:45-4:45 p.m.; Thurs., 1:30-8 p.m.

32.00 9,375—**EH90C**, Berne, Switzerland. 3-5:30 p.m.
—**OZ7MK**, Copenhagen, Denmark. Irregular after 7 p.m.
—**3UZ**, Melbourne, Australia.
—**W8XAO**, Detroit, Mich.

32.06 9,350—**CM2MK**, Havana, Cuba.

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

32.26 9,290—....Rabat, Morocco.

32.40 9,250—**GBK**, Bodmin, England.

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

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

32.80 9,110—**SUS**, Cairo, Egypt.

33.00 9,091—**XFD**, Mexico City, Mex.

33.26 9,010—**GBS**, Rugby, England.

33.81 8,872—**NPO**, Cavite (Manila), Philippine Islands. Time signals 9:55-10 p.m.
—**NAA**, Arlington, Va. Time signals 9:57-10 p.m., 2:57-3 p.m.

33.95 8,830—**GLSQ**, S.S. "Olympic."
—**GFWV**, S.S. "Majestic."

33.98 8,810—**WSBN**, S.S. "Leviathan."

34.00 8,820—**VK3UZ**, Melbourne, Australia. Mon., Wed., 3-5 a.m.

34.50 8,690—**W2XAC**, Schenectady, New York.
—**HKF**, Bogota, Colombia.

34.68 8,650—**W2XCU**, Ampere, N. J.
—**W9XL**, Chicago.
—**W3XE**, Baltimore, Md. 12:15-1:15 p.m., 10:15-11:15 p.m.
—**W2XV**, Long Island City, N. Y.
—**W8XAG**, Dayton, Ohio.
—**W6XN**, Oakland.
—**W4XG**, Miami, Fla.
—And other experimental stations.

34.74 8,630—**WOO**, Deal, N. J.
—**W2XDO**, Ocean Gate, N. J.

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

35.70 8,400—**VBS**, Glace Bay, N. S., Canada.

35.89 8,350—**WSBN**, S.S. "Leviathan."

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

36.74 8,160—....Mombasa, East Africa.

36.92 8,120—**PLW**, Bandoeng, Java.

37.02 8,100—**EATH**, Vienna, Austria. Mon. and Thurs., 5:30 to 7 p.m.
—**JIAA**, Tokyo, Japan. Tests 5-8 a.m.
—**HS4PJ**, Bangkok, Siam. Sunday 8-10 a.m.

37.43 8,015—**Airplanes.**

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

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

(Continued on page 494)

How to Use R. F. Chokes

By R. WILLIAM TANNER, W8AD

When is a choke not a choke? It might easily be answered—"When it is used incorrectly." Mr. Tanner gives us some very practical information about radio frequency choke coils in this article, both as to their design as well as their position in various circuits.

MUCH has been written on the subject of coils, condensers, circuits, etc., as applied to short-wave transmitters and receivers; but the R.F. (radio-frequency) choke has been given little or no attention. Generally the experimenter, and

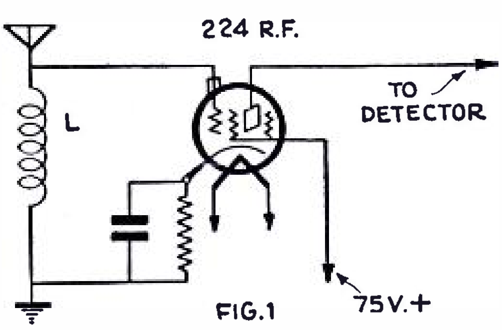


Fig. 1—Above shows usual form of circuit utilizing an untuned stage of R.F. amplification; "L" represents the choke coil.

often the manufacturer, winds some fine wire on a form and places it in circuit as a *radio frequency choke*, believing that it will block all of the R.F. energy, merely because it has many turns of wire.

Radio-frequency chokes are rated by their inductance, such as 10 mh., 85 mh., etc. Very little consideration is given to the distributed capacity upon which depends, almost entirely, whether the choke will be good or bad. The ideal choke would have zero distributed capacity and extremely high inductance—an impossible condition to attain.

This article is written with the idea that it may help the short-wave set-builder in the selection or construction of suitable R.F. chokes for various uses.

Antenna R.F. Chokes

The antenna R.F. choke will be discussed first. In Fig. 1 is shown the circuit of an untuned R.F. stage of amplification, which precedes a regenerative detector; the arrangement employed in the majority of present-day short-wave tuners. The coil L may be thought of as an R.F. choke although, in reality, it is an untuned R.F. impedance or conductively-coupled transformer. Coils having inductance values as high as 85 mh. are specified for most circuits; but almost any coil of 30 turns or so (on a form one inch or more in diameter) will prove fairly effective on all waves from 10 to 200 meters.

Since the capacity of the antenna is in parallel with L, an inductance of .05-mh., or more (assuming an antenna capacity of .00025-mf.) will preclude the possibility of a "peak" occurring at some intermediate portion of the short-wave spectrum.

It is possible to utilize the effect of the shunt antenna to good advantage and increase sensitivity materially; this is accomplished by bringing out taps from the coil L to a multi-point switch; the exact number of turns in each section is an individual problem. The number of taps used should be the same as that of the different detector plug-in coils.

Determining Proper Number of Turns

In order to determine the number of turns, the experimenter may wind, say, 7 turns of No. 30 enamelled wire on a 1½-inch form, and plug in the 20-meter detector coil. Shunt the 7-turn coil with a small midget condenser (capacity not over .000025-mf.) and tune in a station,

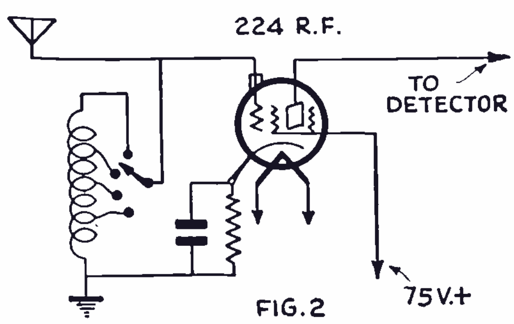


Fig. 2—This diagram shows the use of a tapped antenna choke coil, which greatly increases the sensitivity of the receiver. The tube indicated above serves as an R.F. amplifier.

either code or radiophone, at nearly the full capacity of the detector tuning condenser. Now, remove a half-turn at a time from the 7-turn coil until signal strength is greatest, with the plates of the midget condenser all out. If a higher setting of this condenser is required for maximum gain, more turns are needed.

Then plug in the next largest detector coil; wind 3 to 6 more turns close to the 7 turns, and proceed in the same manner as before. Continue this procedure on through the largest coil. When the coil is completed, solder the taps to the switch, which may be mounted on the front panel.

The R.F. stage then acts as a "peaked" amplifier, and will result in far greater sensitivity than the usual form of untuned R.F. stage. There is still another advantage; that the gain and selectivity will be more nearly uniform over the range of each band. This is because, in the detector tuned circuit, gain falls off as the wavelength is increased; while the effect is just the opposite in the "peaked" stage.

The coil L and the R.F. tube will, of course, require complete shielding, exactly as would a tuned stage.

Series-type Chokes

The next type of R.F. choke under discussion is what is generally referred to as the "series" type, such as are employed in plate and screen grid leads of R.F. amplifiers, as shown in Fig. 3.

These help to keep the R.F. currents out of the "B" supply, thereby reducing feedback. Such chokes are needed *only* when two or more R.F. stages are employed. With one R.F. stage, their absence can only increase feedback in the detector, where it is beneficial. The bypass condensers C are, of course, required without regard to the number of stages.

For series R.F. chokes, almost anything with a sufficient number of turns may be employed. Since the bypass condensers shunt most of the R.F. currents to ground, the chokes are not called upon to do much work. For this reason, distributed capacity is not so important.

Shunt-type R.F. Chokes MUST be Good!

The "shunt" type of R.F. choke *must* be good. High distributed capacity cannot be tolerated, since one end is at a

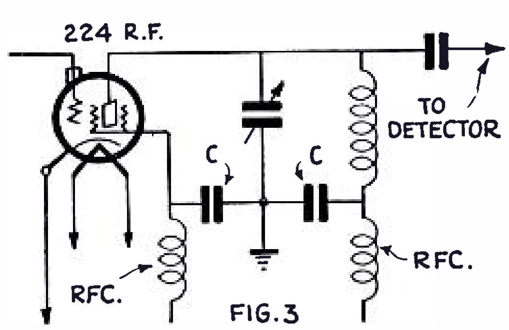


Fig. 3. Above—Series type of R.F. choke connection.

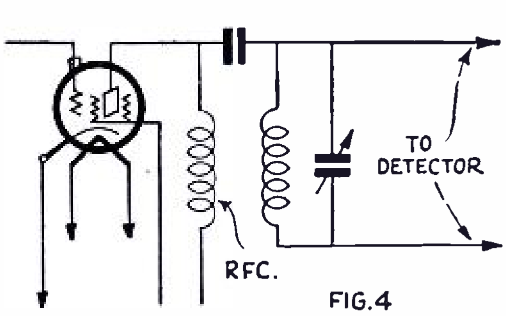
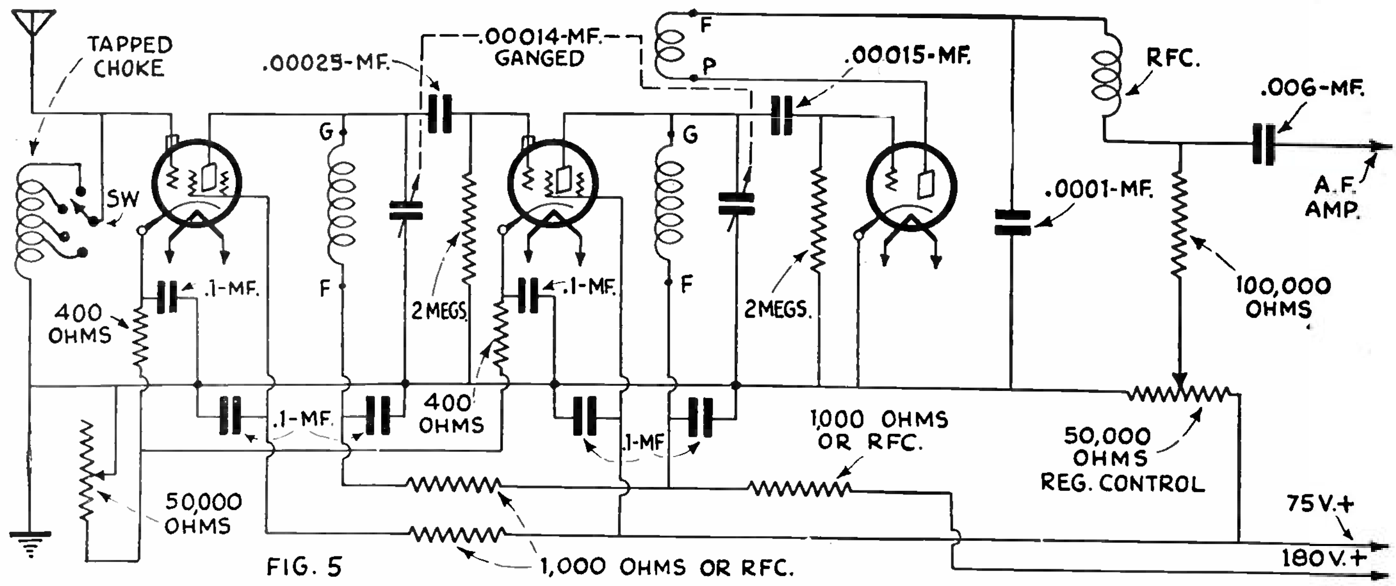


Fig. 4—Here we have the shunt type of R.F. choke.

Fig. 5—Schematic circuit of short-wave tuner using a peaked R.F. stage, a tuned stage and a regenerative detector with de-coupling resistors. Chokes may be used in place of the 1000 ohm resistors if desired.



relatively high R.F. potential. The connection for a shunt choke is shown in Fig. 4. A choke for use at this point would be, preferably, wound in a single layer; but this would take up too much space for a compact receiver; therefore a "pie" or sectional winding is required. Not less than three sections should be used.

A very efficient choke can be constructed by cutting six slots, separated ⅛-inch, in a ¾-inch wooden dowel; these should be about $\frac{3}{16}$-inch deep. A total of 600 turns of No. 36 enamelled wire is required; 100 turns per slot.

While the R.F. choke employed in the detector plate circuit is not of the shunt type, it should be just as effective; since even the slightest amount of R.F. energy, if allowed to reach the A.F. amplifier, will result in *howling*.

Use of "De-coupling" Chokes

Many short-wave fans are constructing tuners with more than one R.F. stage. Some connect an untuned stage ahead of the tuned stage, while others prefer to tune the antenna circuit. In either case, feedback is apt to be great enough to cause oscillation. The use of "decoupling" chokes will prove far more effective than merely placing chokes in the individual screen-grid or plate leads. In nearly every case, resistors of 1000 ohms can be used in place of chokes for this purpose, thus producing a more compact and less expensive layout.

Fig. 5 shows the use of decoupling chokes (or resistors) for reducing feedback through the "B" supply; all bypass condensers have a value of .006- to 0.1-mf. Volume is controlled by means of a 50,000-ohm variable resistor in the R.F. cathode circuits. This control is in series with 400-ohm resistors, the latter being used to limit the bias to a low value (about 2 volts) as well as to prevent the R.F. currents from one tube feeding back into the other.

The regeneration control is another 50,000-ohm variable resistor between "B+75," "B—," with the return from the detector plate connected to the contact lever. This type of control has little reaction upon the detector's tuning.

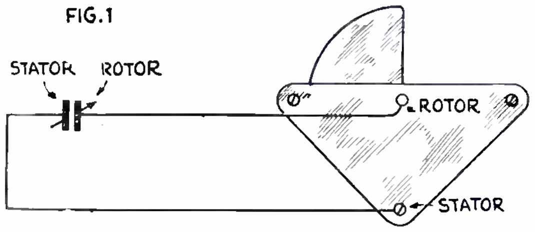
It is well for the set-builder to remember, when purchasing R.F. chokes for use either in *shunt* circuits or in the *detector plate* circuit, *to select those designed especially for short-wave use!* For *series* circuits, almost anything will do.

Practical Hints on Reception

Smooth Regeneration

EVEN though the use of a variable condenser for controlling the regeneration in a short-wave receiver is considered best, there is a still finer degree of smoothness to be obtained in the following way. A small three or five-plate midget condenser is connected in parallel with the regeneration condenser; stator to stator, and rotor to rotor. When you have located the carrier wave of a station with the rotor plates of the midget clear of the stators, turn the main regeneration condenser until the set has stopped regenerating. Then slowly turn the midget, and you will notice how nicely and smoothly the volume builds up until you come to the regeneration point, which can be passed very smoothly. I have used this idea for a long time and have been able to receive stations without zero-beating them, even though the carrier wave was so weak it was barely audible in the phones.

FIG. 1



Regeneration control is made very smooth indeed by connecting a three-plate midget condenser, or its equivalent, across the usual regeneration control condenser as shown above.

To Eliminate Dead Spots

After considerable experimenting, I found that dead spots in the tuning range of a regenerative short-wave set were due to the type of antenna used and the method of coupling it to the receiver proper. For a three-tube receiver, using a condenser for coupling, I have found the best aerial, a seven-strand wire 45 feet, 4 inches long, at least twenty feet from the ground, with the lead-in coming in 2 feet 6 inches from one end. With a cold-water-pipe ground, this works with any set comprising one detector and any number of audio stages. But if the set is coupled with a condenser, this component should be of two copper plates, as shown; it should be experimentally adjusted, so that each coil can be used from the lowest wave-length to the highest. The best separation I have found is from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch.—Paul Skitzki.

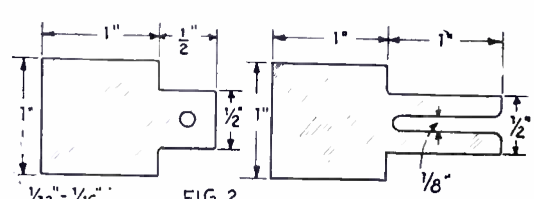


FIG. 2

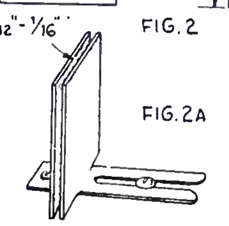


FIG. 2A

How to make a very small capacity condenser suitable for connecting in series with the antenna for short-wave reception. The two condenser plates are made out of copper, but brass or other non-magnetic metal will do.

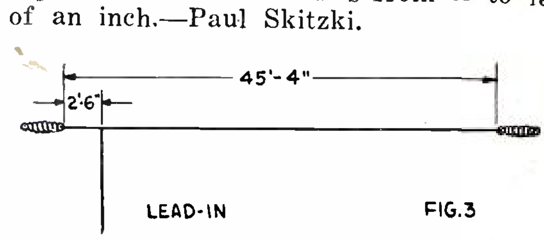


FIG. 3

Dimensions of the best form of short-wave receiving antenna, as determined by the author, are shown above.

An Efficient HARTLEY OSCILLATOR

By VALERIO GATTARI

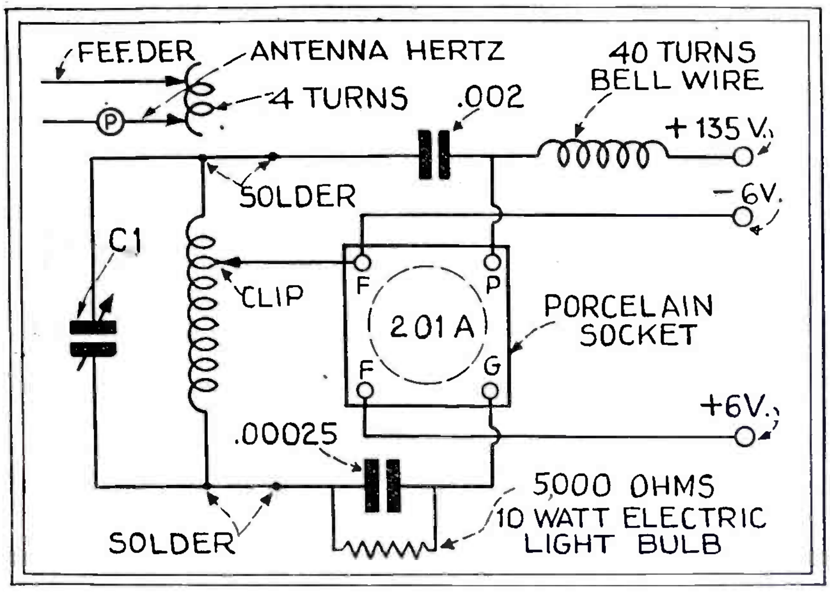


Fig. 1. General plan of the oscillator which utilizes '01A tube.

WHEN at our request Señor Sandalia Sosa drew us a plan of a Hertzian antenna of 40 meters and a Hartley modulation circuit, to be used with dry batteries, we were very far from anticipating all the satisfaction which has come to us in the course of time from this little idea. We were truly surprised that in our first attempts we communicated with an amateur 600 kilometers away (360 miles).

The Circuit

An excellent Hartley modulator in one of its many arrangements of parts is the circuit we shall describe. Fig. 1 represents the oscillator circuit. We use a single H.C. type choke with 40 turns of bell wire, the coil being 8 cm. (2.5 cm. = 1 inch) in diameter. C1 is a Pilot variable condenser, rectilinear type, with 23 plates. The grid resistance is an M.Q. of 5,000 ohms. We have also used with excellent results a common electric light bulb for grid resistance, a bulb for 220 volts at 10 watts (resistance in ohms 4,800). The plate or block condenser is .002 mf. That of the grid is .00025 mf. The oscillator coil is composed of 10 turns of coarse bare copper wire. The internal diameter is 10 cm. The antenna coil consists of 4 turns of the same diameter.

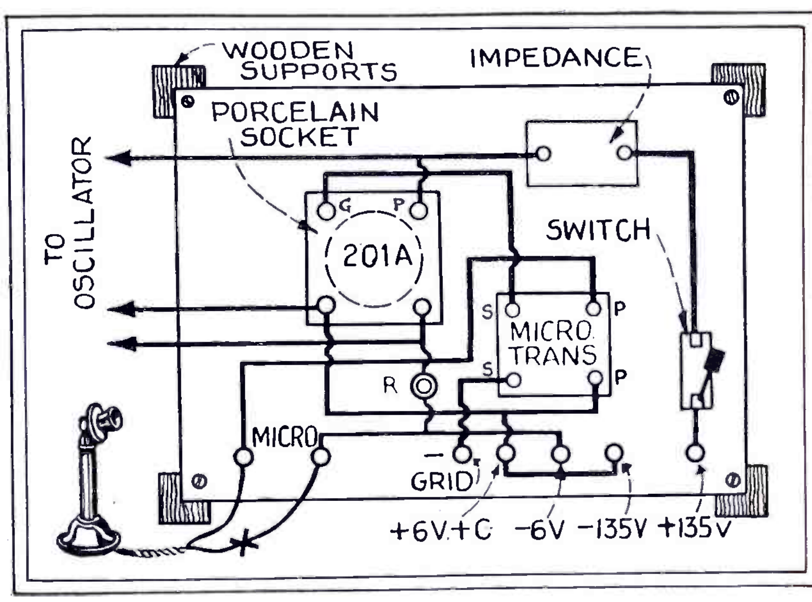


Fig. 2. Wiring diagram of the modulator. At the point "X" in the microphone circuit a rheostat may be inserted to prevent overheating of the microphone. The parts used are as follows: 1 microphone transformer (material from Ford spark coil); 1 impedance; 1 porcelain socket; one '01A tube; 1 microphone; 1 rheostat, 30 ohms; 1 switch (for plate); terminals and wire.

The Modulator

Fig. 2 represents the modulator. It is built on hard rubber panel 30 x 30 cm. It can be put alongside the oscillator when desired or on the receiving table or can be clamped to the wall. The impedance or plate reactor we use is homemade. It consists of 2,800 turns of No. 26 wire on an iron core. The microphone transformer is also homemade, using the material of a Ford coil. When put in the circuit, the microphone uses the same battery as the modulator tube. It is well to use an adequate rheostat to prevent overheating the carbons. The grid battery is preferably of 45 volts potential, with branches at 12, 16, 21, 25 and 30 volts.

The Oscillator Set Up

Fig. 3 shows the oscillator set up. This design, with the arrangement of the parts, the ease of con-

(*Continued on page* 482)

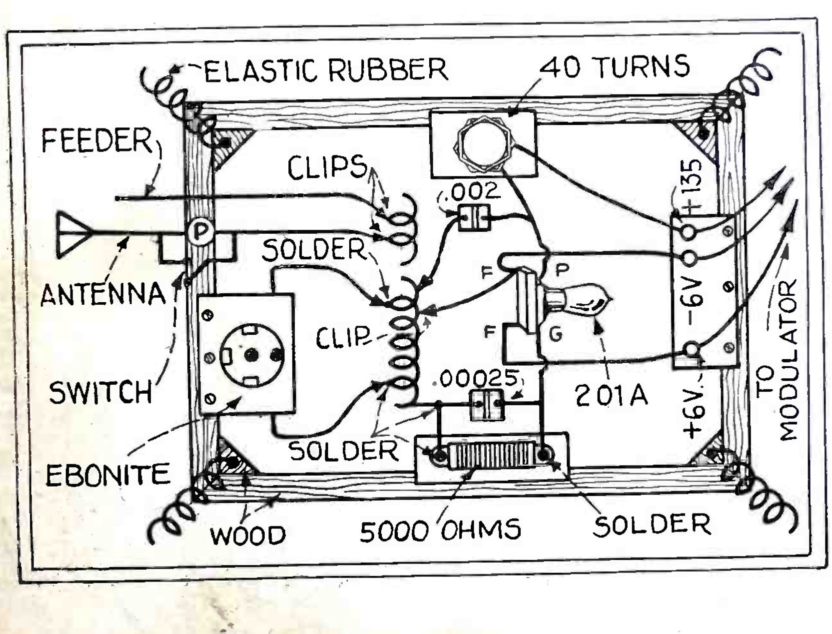
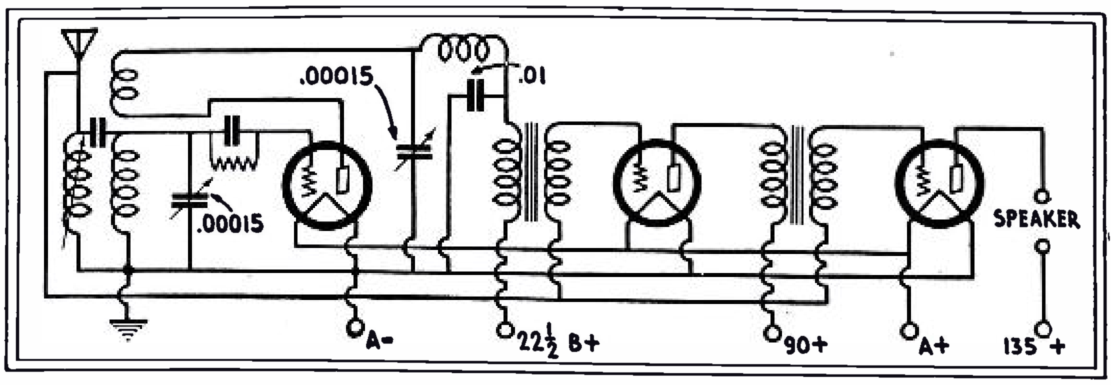


Fig. 3 shows the oscillator set-up. The parts are as follows: 1 oscillator coil; 1 5,000-ohm resistance; 1 23-plate condenser; 1 .00025-mf. condenser; 1 porcelain socket; 1 pilot socket; 3 terminals; 1 antenna coil; 1 choke with 40 turns of bell wire; 1 .002-mf. fixed condenser; 1 4-volt bulb; one '01A tube; 1 switch for pilot; 4 pieces of hard rubber.

Works on 12 Meters Without Shielding

I'LL start off by giving a hook-up of my set which is built after the well known "Junk Box." I have made some changes that improved my set 150 per cent. I used water or steam hose (which just fits into the tube bases), and wound my coils on these. I mounted my tube bases, grid condenser and leak, and other parts on old rubber soles and I have eliminated body capacity entirely. I don't use any shielding whatever and I am working to about 12 meters! I also use a B-eliminator.

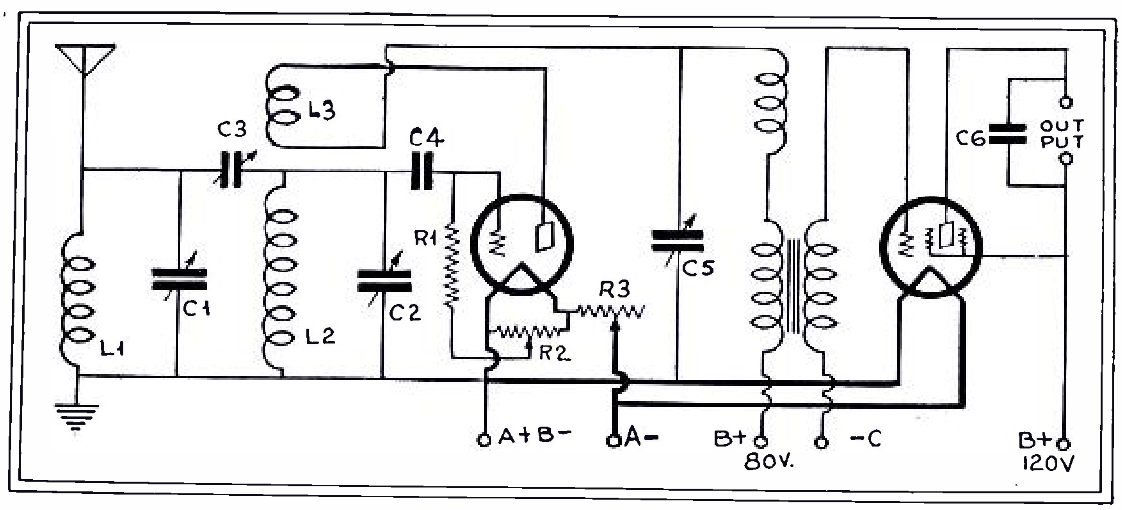


Hook-up of short wave receiving apparatus including three vacuum tubes for the reception of 12-meter signals without the use of shielding. Mr. McAllister also uses a B eliminator without undue disturbance.

I have logged the following stations, many with good loudspeaker volume: CJRX, CGA, CJA, CF (Canada), G5SW, GBK, GBS (England), PCL, PCJ, PHI (Holland), FW (France), DGW, DGA (Germany), PLE (Java), A2ME (Australia), and LP3 (Argentine) and many in this country.

These I have logged since April 1st, 1929, so I did not get much of the winter D.X. I have letters of verifications from many of these and some to come from the others. —*Contributed by J. R. McAllister.*

1930 Short Wave Receiver



A European radio experimenter's idea of "the" 1930 ideal short wave receiver.

FOR those who have the idea of getting a short wave receiving set and either are planning to improve their old set, or are desirous of building a new, the receiver described here is recommended.

As shown in the diagram, there are two tuning circuits. This gives more selectivity and also it is surprising what an effect this tuning arrangement has, with regard to the intensity of sound. One need not worry about this extra equipment. "Another knob to turn," you say. In case you object to turning knobs, you can let it be. Stations in fact come in with the strength to which one is accustomed in short wave sets, but the moment one tunes with circuit L_1 C_1, one hears the advantages of the extra equipment. The intensity of sound rises about 50 per cent and the receiver is much easier to tune.

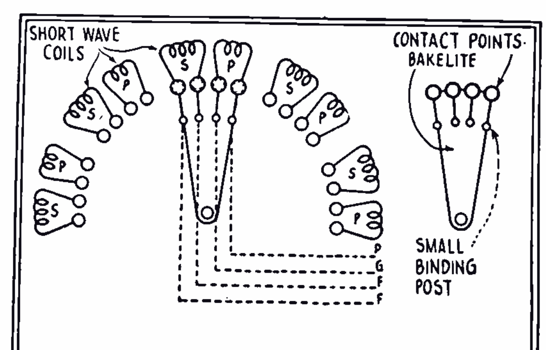
Circuit L_1 C_1 is really a "wave trap," which is coupled to an ordinary short wave receiver. The moment the wave trap is brought into resonance with the tuned wave, the receiver stops oscillating. Circuit L_1 C_1 is kept independent of the tuning of L_2 C_2, and consequently it is much easier to tune in telephonic stations. One gets music, et cetera, without any after-regulating of the regeneration. Coils L_1 and L_2 should be as loosely coupled as possible. They must be at least 2 inches apart.—*Norsk Radio.*

SHORT WAVE EXPERIMENTERS

EXPERIMENTERS invariably have a lot of good ideas which they discover in building and trying out short wave apparatus. The editor will be very glad to have them send a brief description of some of their pet ideas, together with sketches of them. We are willing to pay for these ideas. All articles accepted and published will be paid for at regular space rates. Photos are also welcome.

A Short Wave Coil Switch

THE drawing shows a device for shifting short-wave coils quickly, the apparatus being a four-pole switch as indicated, to which two coils are connected, P being the primary and S being the secondary.—*Contributed by W. C. Lowe (a 15-year-old experimenter.)*



Mr. Lowe's suggestion for a short wave change-over switch, whereby short wave coils comprising primary P and secondary S can be cut into and out of circuit by the special four-point switch shown. The dotted lines indicate flexible cable.

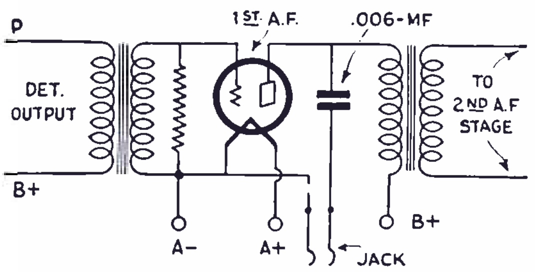
Short Wave Question Box

Edited by R. WILLIAM TANNER, W8AD

Connecting a Phone Jack

Joseph Kennedy, Alliance, Ohio, would like to know:

Q. How to place a telephone jack between the first and second A.F. stages, in the hookup on page 233, October-November issue.



Showing how to connect a jack for headphone reception between a first and second audio stage.

A. A diagram is given in these columns, showing how this is done. An .006-mf. condenser is connected in series with the jack to keep the direct current out of the phones.

Q. What changes would be necessary to employ the R215A "peanut" tubes?

A. No changes other than a reduction of the filament voltage would be required. The 10-ohm rheostat is large enough to adjust the four filaments to the required value of 1.1 volts.

"C"-bias Query

William Kemp, Worcester, Mass., asks the following questions:

Q. How is "C" bias obtained for the adapter shown on page 66 of the June-July issue?

A. The "C" bias for the R.F. tube is obtained through a part of the resistor R1, between the ground and the tube filament.

Q. Is the R.F. stage tuned or untuned?

A. The R.F. stage is of the untuned type, generally described as a coupling stage.

Q. Can the new tubes be used with equal results?

A. I assume that you refer to the 230 and 232 two-volt tubes. Results with these will be practically the same as with the 201A and 222 tubes.

Cause of Howling

John Cranke, Detroit, Mich., writes as follows:

Q. Will a short-circuit in an audio transformer cause a set to break into a loud howl at certain points on the dial?

A. No. The howling probably is due to other causes, such as excessive detector plate voltage, incorrect value of grid leak or too many turns on the tickler coil.

"Double Detector"

George A. Flynn (address unknown) wants to know:

Q. What voltages are needed for the circuit of the "Double detector," page 233, October-November issue?

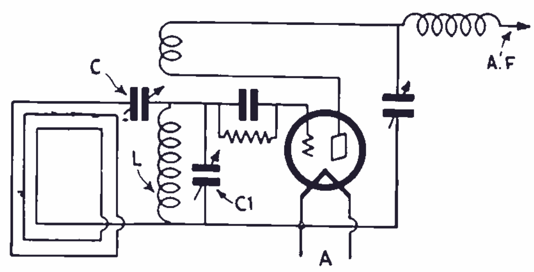
A. The voltages should be 6 on the filament, 45 for detector plate and 90 for amplifier plate.

Q. A tuning condenser of .00014-mf. capacity is specified. Can one having a value of .00016-mf. be used with equal results?

A. Yes. The only difference will be a very slight increase in the tuning range.

Q. Will results be the same if 199 tubes are substituted for 201A's?

A. The 199 tubes will give very nearly the same signal strength, if this is what you mean.



Connections for a loop aerial to use with a short-wave regenerative tuner. The distance range will be rather low.

Range of Set

E. Versaw, Pasadena, Calif., wants to know:

Q. Can the "Sensitive and Selective Receiver" described in the December-January issue reach out and pick up east coast stations?

A. Tuning in "east coast" stations should be possible with a good antenna and suitable location.

Loop Aerial for S.W. Reception

F. Schumann, San Francisco, Calif., desires the following information:

Q. Can a loop aerial be employed with a short-wave receiver for portable use?

A. Yes, such an aerial can be used; but signals will not be very good. A diagram showing the connections is given in these columns. The series condenser C, which should have a capacity of .000025-mf., is used merely to couple the loop to the coil L. All tuning is accomplished in the usual manner by means of C1 and the regeneration control. The loop is untuned and may consist of 3 to 5 turns, one to three feet square.

Q. Would a loop be as good as a small single wire stretched 8 feet from the ground?

A. The single wire would give greater signal strength.

Transmitter Hook-ups

M. Maroni, Chicago, Ill., would like to know:

Q. Where to obtain a list of amateur radio calls in the U. S. A.?

A. The Superintendent of Documents, Government Printing Office, Washington, D. C., will supply the official list of *Amateur Radio Stations of the United States* upon receipt of 25 cents in *coin* (not stamps).

Q. What is the power output of a 250 tube, when used in a master oscillator-power amplifier circuit for code transmission?

A. If provided with sufficient grid excitation and a plate voltage of 450, the output is approximately 25 watts.

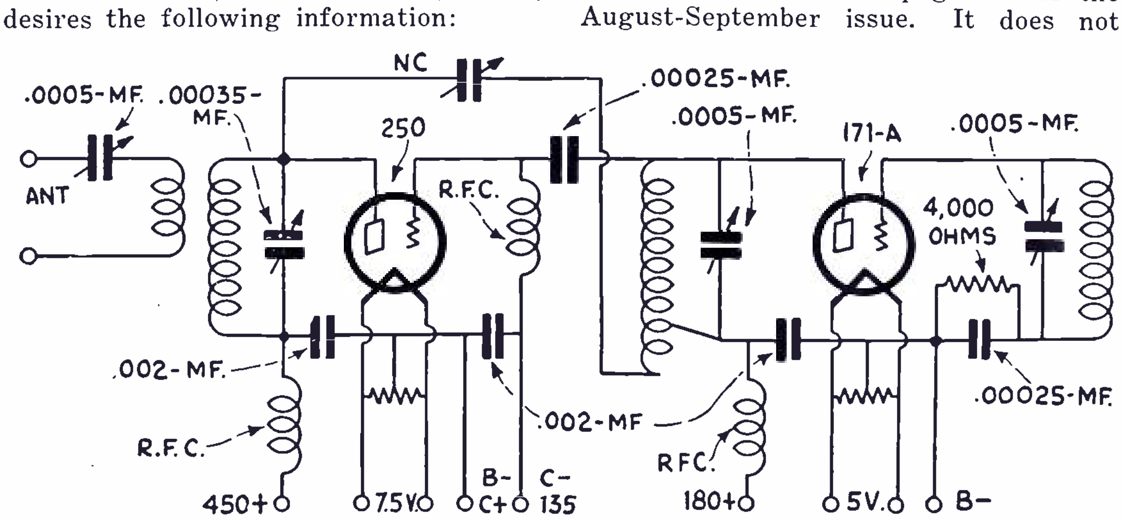
Q. Kindly print a circuit showing a 250 output amplifier and a suitable oscillator.

A. The circuit you request is given in these columns.

Trouble with S.W. Converter

J. T. Allis, E. Durham, N. C., writes as follows:

Q. I have built a short-wave converter as described on page 130 of the August-September issue. It does not



Circuit for a code transmitter using a 250 output amplifier and a 171A oscillator. The key may be placed wherever desired.

seem to have much volume; but the distance range is good, except at the lower waves. Is there anything I can do to improve this condition?

A. The lack of volume is due to the broadcast receiver with which the converter is used. Changing this to give greater volume is a problem to be solved by you, since no specifications were submitted. The loss in distance range is due entirely to the use of a three-electrode tube as a coupling stage. At waves below approximately 50 meters, this type of tube acts as a "losser"; that is, amplification actually decreases. This can be easily understood when it is considered that an untuned, screen-grid, coupling tube has a gain of only 2 or 3 at the higher frequencies. A three-electrode tube is not suitable as a radio-frequency amplifier at short wavelengths.

S.W. Wavemeter Query

E. J. Hanks, Buffalo, N. Y., writes as follows:

Q. I am building a simple short-wave wavemeter. What size condenser should be used, and how many turns of wire on the plug-in coils?

A. An ordinary .00014-mf. condenser may be used. The coils should be on 1½-inch forms and wound with 6, 12, 23 and 45 turns of No. 24 enameled wire for the 20-, 40-, 80- and 160-meter bands respectively. The turns should not be spaced.

Oscillator for 'Phone Transmitter

A. D. Emory, Galveston, Texas, wants to know:

Q. Can a 245 power tube be employed as a master oscillator in a radiophone transmitter?

A. A 245 tube, contrary to general opinion, makes a very fine oscillator in an M. O. P. A. radiophone; particularly when the output or modulated amplifier is rated at 50 watts or more. The 171A is better suited for lower powers, such as 245, 210 or 250 tubes in the output amplifier.

Q. There seems to be considerable interest shown in the "bias-variation system of modulation" among *Radiophone Amateurs* in the South. Can you supply me with any data on this subject?

A. This system was described in the December-January issue in the article on an 85-meter radiophone.

Q. Would a 5-meter radiophone reach out as well as one operated on 85 meters?

A. No. Operation in the 5-meter band is extremely erratic and only short distances can be covered.

More About

PLUG-LESS SHORT WAVE RECEIVERS

In the Next Issue

Proportions of S.W. Coils

E. E. La Fouche, Windsor, Ontario, Canada, requests the following:

Q. Is there any advantage in winding short-wave coils on large forms 3 or 4 inches in diameter?

A. No. The advantages lie in making the coils smaller. To be sure, larger wire may be employed on the 3- or 4-inch forms, decreasing the D.C. resistance, but the field of such coils is much greater, tending to increase the losses when located in close proximity to metal objects. The editor of this department has just constructed a short-wave tuner *in which the coils are only ½-inch in diameter and wound with No. 34 enameled wire! Results are practically the same as with coils of larger diameter.*

Q. How does a superheterodyne compare with a tuned R.F. receiver, as far as distance range is concerned?

A. As stated many times, a one-tube tuner will bring in stations from all over the world, but not as consistently as a multi-tube set. Tests have definitely proven that a screen-grid, tuned R.F. amplifier cannot result in a gain factor of more than four or five at wavelengths of 20 meters; in which case a two-stage R.F. amplifier would result in an over-all gain of 16 to 25. In the case of a superheterodyne, the R.F. amplifiers are operated at a frequency where a gain of 50 to 100 per stage is possible. A two-stage I.F. amplifier would give an over-all gain of at least 2500. The resulting sensitivity of a super would be very much greater than that of a two-stage tuned R.F. arrangement, even with considerable losses in the frequency-changing process.

Suitable Wire for Chokes

S. Kanzius, Langloth, Pa., sends in the following questions:

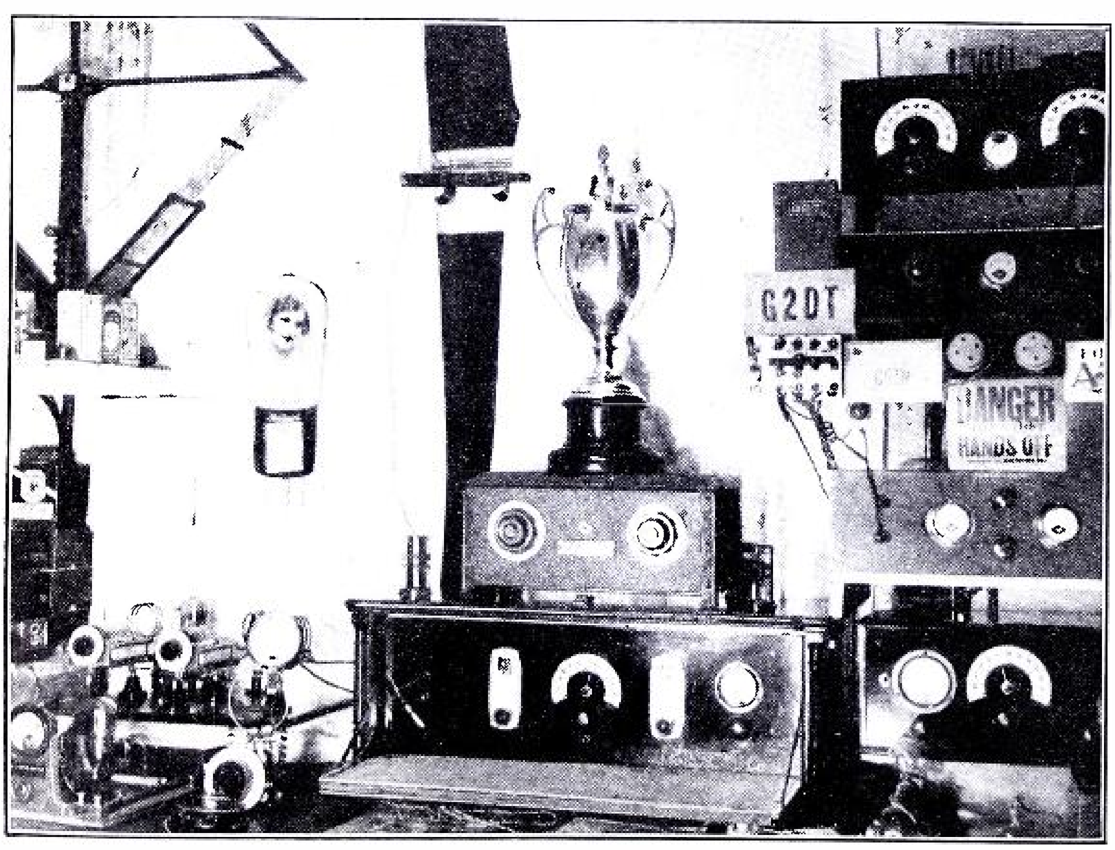
Q. Can wire taken from ordinary audio transformers be used to wind satisfactory R.F. chokes?

A. Yes, providing the enamel is not damaged.

Q. How many turns would be required for short-wave R.F. chokes?

A. A suitable R.F. choke may be constructed by cutting eight slots in a wooden dowel ¾-inch in diameter. The slots may be cut with a hacksaw. In each slot, wind 50 turns of fine enameled wire, such as that obtained from audio-transformer windings. The slots will, however, have to be cut deep enough to hold the turns.

Famous Experimental Short Wave Station G2DT (England)



IN the centre is the "Dr. Wortley-Talbot" challenge cup, awarded by the Radio Society of Great Britain for pioneer work on the 56/60-Megacycle amateur band. Below this is the totally-shielded frequency-monitor, and below this the T.R.F. "1-V-2" receiver using shield-grid detector. At the back on the left is seen the "medium-C" tuned-plate tuned-grid 14-mc. transmitter, while in front of this is the 58-mc. transmitter. Alongside reposes the 5-meter wavemeter. At the top on the right is the Hartley 7-mc. transmitter and below the control panel to the dynamotor; while below this is the 28/30-mc. "1-V-1" receiver. Other apparatus, such as frequency meter, dynamotor, filters, supersonic heterodyne, etc., could not all be got into the photograph.

An interesting QSL Card is proudly displayed to the left of the "DANGER" sign: it is a 57,000-kc. QSL of G6TW, whose station is situated approximately 170 miles from G2DT; and this card bears the date May 19, 1929.—*E. T. Somerset.*

THIS MONTH'S SPECIALS!

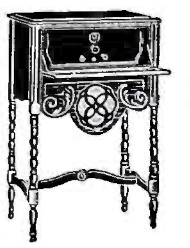
ALL merchandise listed is BRAND NEW and is shipped in the original, factory sealed cartons and carries the same guarantee of ABSOLUTE SATISFACTION! Due to the demand for this seasonable merchandise actually exceeding the available supply, ACT IMMEDIATELY! In most instances, our SALE PRICES ARE LOWER THAN THE ACTUAL MANUFACTURER'S COST!
Join the ever swelling ranks of our 100 per cent SATISFIED CUSTOMERS. ORDER DIRECT FROM THIS PAGE TODAY. NEW LOW PRICES.

Dry Electrolytic Condensers

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

No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	¾ in.	2⅛ in.	$0.28
1802	2	1 in.	2⅛ in.	.45
1804	4	1½ in.	2¼ in.	.85
1808	8	1⅜ in.	4½ in.	1.25
1816	16	3 in.	4¼ in.	2.12
1824	24	3 in.	4¼ in.	2.75
1832	32	3 in.	4¼ in.	3.33

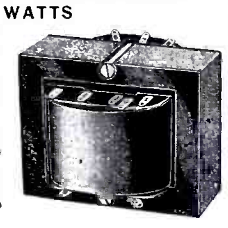
Cavalier Model 159 Console With Peerless Speaker



This beautiful and distinctive cabinet is sold with the built-in Peerless Speaker. It is designed to provide a maximum cabinet at a minimum price. Veneers of Figured Walnut with attractive carvings and unusual turnings. Set Compartment, 21¾ in. wide x 10½ in. deep x 8 in. high. Height, 38 in. Shipping weight 65 lbs. Packed in original crate. **Complete with Speaker.**
No. 159—YOUR SPECIAL PRICE $9.95

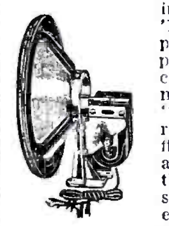
Thordarson Standard Replacement Power Transformer

70 WATTS



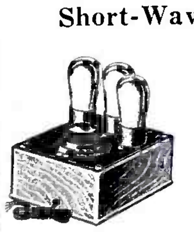
This transformer may be used in building up inexpensive chassis; or for replacement in such standard combinations as three '24's, two '27's, two '71A's or two '45's, and an '80 rectifier. Suitable for the home - built rack- and-panel public address amplifier, or cabinet-type phonograph power amplifier. Just the foundation unit for an audio amplifier to be used as a standard of comparison. Well designed. Connections are made to soldering lugs on the two end plates. Dimensions: 3¼ x 3½ x 4 inches. For 110-120 volts, 50-60 cycles. Shipping weight 5¼ lbs.
List Price. $12.50.
No. 1405—YOUR PRICE........ $2.55

Kolster Speaker Chassis



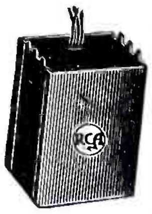
May be connected directly in the plate circuit of type '12A tubes; or to higher-power tubes through an output device. In push-pull circuits, speaker may be connected from plate to plate. "9-inch cone" type. Paper-rattle is prevented by a flannel damper; bass notes are well reproduced due to the "free-edge" effect. Its small dimensions make it eligible for use in home-constructed midget sets. Comes with 6 ft. cord. Dimensions: 10 x 5½ x 9½ inches. Shipping weight 6½ lbs.
List Price. $18.00.
No. 1500—YOUR PRICE........ $2.85

Short-Wave Converter



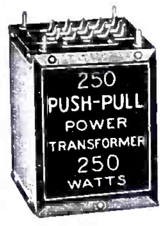
Build a short-wave converter at lowest price on record, but with which excellent results are obtainable nevertheless. The voltage for the three 227 tubes used may be obtained from an external filament transformer or from a secondary winding of 2½ volts in a power pack. Wavelength from 30 to 110 meters. No plug-in coils; coil switch is used to cover wave band. Single dial tuning, no grunting, no body capacity, no squeals. Leak-condenser modulation. Converter consisting of all parts (less filament transformer) including cabinet, panel, diagram and 4-page instruction sheet (less tubes).
No. 1619—YOUR PRICE........ $4.85
No. 1615—6-Volt Battery Model, same price.

R.C.A. Double Filter Chokes



This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 15 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5¼ x 3¾ x 2⅞. Shipping weight 6 lbs.
List Price $10.05.
No. 8336—YOUR SPECIAL PRICE.. 95c

"250" A.C. Power Transformer



This power transformer supplies currents for five 15 - volt Arcturus tubes drawing 5 Ma. and ½ amp. on filaments: one 2.5 V. tube; two '50's, and two '81's. Two 227 or 224 (if suitable resistance is used) and 750 volts. Full wave "B" and "C." A line ballast resistor, such as the Amperite, in conjunction with the special 85-volt primary, will maintain even voltage over 105 to 125 volts. Entirely shielded in metal. 4¾ x 1¾ x 6½ inches high. Weight 15 lbs. For 110-120 volts, 50-60 cycles. **List Price. $20.00.**
No. 1412—YOUR PRICE........ $3.75

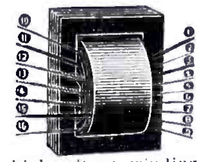
2.5 Volt Filament Transformer

60 WATTS

Has 2 center-tapped windings. Both deliver 2.5 volts. One winding gives 3 amperes; the other, 11 amperes. Pigtail leads. Heavy iron case, beautifully finished in brown crackle. 110 to 120 volts, 50 to 60 cycles. Dimensions: 3½ x 5 x 4½ inches. Shipping weight 9 lbs. **List Price. $6.00.**
No. 1414—YOUR PRICE........ $3.45

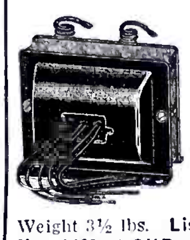
Earl Power Transformer

70 WATTS



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. **List Price $7.50.**
No. 1410—YOUR SPECIAL PRICE $1.75

Shielded "A" Transformer

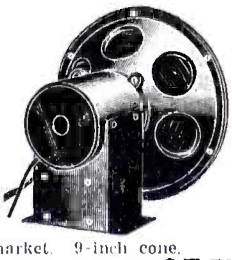


Modernize storage battery receivers by replacing '01A's with '26's and '27's heated by this filament transformer. Supplies 1.5, 2.5, and 5 volts; 2.5-volt winding center-tapped. Heats three '26's, two '27's, and two '12A's or '71A's. 3x3x4 inches. For 110-120 volts, 50-60 cycles.
Weight 3½ lbs. **List Price. $4.50.**
No. 1400—YOUR PRICE........ $1.75

A.K. 37 Filter Choke Condenser

Contains two filter chokes, a speaker output choke, two high-voltage filter condensers, a detector by-pass condenser, and an R.F.-A.F. by-pass condenser, each connecting lead being identified by colors. To make up efficient power pack for a receiver using a type '71A output tube you need only a rectifier tube socket, a voltage divider, a power transformer, and this filter block. 3¼x1½x5 inches. Shipping weight 6 lbs.
List Price. $7.50.
No. 1800-283—YOUR PRICE.... $4.95

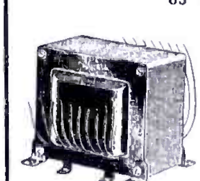
Utah Dynamic A.C. Power Speaker—Model 33A



110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.
List Price $50.00.
No. 1506—YOUR SPECIAL PRICE $7.50

Kolster Power Transformer

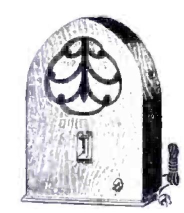
85 WATTS



Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '81 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '24 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 90 Ma. Primary is tapped for low line voltage. Has eight feet drilled for mounting to base of pack. Generous iron core assures cool performance under heavy load. For 110-120 Volts, 50-60 Cycles. Dimensions: 1½ x 1½ x 4½ inches. Shipping weight, 12 lbs. **List Price. $19.50**
No. 4336—YOUR PRICE........ $5.75

The SONOLA 1931 A.C. Model Midget Receiver

RCA LICENSED



This Midget Receiver will outperform many of its larger brothers. Uses 5 tubes: 3 screen grid, 245 power tube, 280 rectifier. Rola dynamic. Large capacity filter. Perfectly shielded. Selectivity obtained by use of three tuned stages. High amplification is assured by screen grid RF, screen grid power detector and '45 output. Rola Dynamic gives wonderful reproduction. So small you can put it anywhere yet it will fit. **There may be cheaper midgets on the market. We are fully aware of this. That's exactly why you should have a SONOLA. There is NO GRIEF with this high grade set.** For 50 to 60 cycle, 110 volts. Dimensions: 14 x 9 x 18 inches high. Shipping weight 30 lbs. **List Price, $59.50.**
No. 2500—Your Price (less tubes) $29.85

6 MONTHS GUARANTEED NEONTRON TUBES

Sold on a **6 MONTHS** FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	280	210
171A	199UV-120	171	250
201A	224		281
63c each	**70c each**	**80c each**	**$1.60 each**

Genuine Magnavox Microphone

Do Your Own Home Phonograph Recording

Made by the world-famous Magnavox Co. While originally made to strap on the head, it is easy to screw a handle onto one of the side brackets. The side brackets are covered with soft rubber and place the microphone at the best speaking distance from the mouth. Comes with 6 feet of cord. **The biggest mike bargain in America!** Complete with straps and buckle to fit around head. Brand new, in original factory packing. Shipping weight 1 lb.
List Price, $10.75.
No. 1610—YOUR SPECIAL PRICE $1.55

FREE

We have just issued our new "RADIO SERVICE TREATISE." It's red hot all the way through. 52 new hookups and circuit diagrams. 110 illustrations.

Partial contents: Modernizing old radio sets. How to convert battery to power sets. Selection of tubes. The detector tube. The power tube. Changes in grid or "C" bias circuits. Push pull amplifiers. Replacing audio transformers. Phono. attachments. How to choose power transformers. Voltage dividers. Wattage of power transformers. Selecting and installing replacement parts in radio sets. Filter condensers. Repairing "B" eliminators. ALL BRAND NEW DOPE—NOT A REPRINT. Chuck full of REAL radio information all the way through. Even the catalog section has dozens of hookups—never found anywhere before.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

"RTC" High-Voltage "Puncture Proof" Filter Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.45
1703	1	.30	1707	2	.75
1704	2	.40	1708	4	1.10
1705	4	.60			

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"H-V-J"
Technical Description of the New Vatican S-W Transmitter

By GUGLIELMO MARCONI

(*Continued from page 425*)

effect, which greatly enhances their appearances in silhouette.

Reception

A special receiver, partly made of standard parts of the normal telephone and high-speed Marconi receiver and telephone terminal, four wire-two wire equipment will secure good telephone and telegraph duplex communication between Vatican City and any part of the world. This receiver is situated in one of the rooms of the transmitting station, and utilizes the vertical antenna situated at a distance of only a few yards from the sending antenna. This receiving antenna is suspended to the same triatic which carries the sending aerial, and its length is adjustable from the receiving room.

The new radio station, which may be considered to represent the latest word in short-wave technique, will provide the Vatican City with a radio-telegraph and telephone link with distant parts of the earth, as well as enable the voice of His Holiness, the Pope, to be broadcast throughout the world.

A Power Amplifier for Short Wave Receivers

By H. W. SECOR

(*Continued from page 450*)

List of Parts for Power Amplifier

1—Thordarson '45 power compact unit (Includes 2 chokes, high voltage plate winding, 5 volt fil. winding for rectifier, and 2.5 volt fil. winding for 2 '45 tubes.
1—Thordarson No. R260 input transformer.
1—Thordarson No. R260 push-pull transformer.
1—Thordarson No. T2420 push-pull output choke.
1—Thordarson No. T3660 filament-heater transformer.
2—4 mf. (700 volt working voltage) Flechtheim compact filter condensers.
1—2 mf. ditto.
7—1 mf. Flechtheim by-pass (250 working voltage) condensers.
1—13,400 ohm, Ward Leonard, voltage divider resistance.
1—50,000 ohm Ward Leonard resistance.
1—750 ohm Ward Leonard resistance.
1—1,000 ohm Ward Leonard resistance.
1—2 circuit (or other to suit builder's idea) jack for phonograph pick-up.
1—Baseboard (or metal sub-panel).
1—Terminal post strip—bakelite.
1—Set Terminal posts (X-L push posts used by author).
1 Coil No. 14 soft rubber covered wire for connecting apparatus.
1—.006 mf. condenser—tone control (Sangamo).

The Future of Radio

By HUGO GERNSBACK

(*Continued from page 447*)

without an aviator. This can now be accomplished; France, in fact, the United States, Japan, and other countries already have done so. The trouble with the pilotless airplane is that, if you send it by radio-controlled impulses beyond the horizon, the operator at the air-base will not be able to follow its flight. The airplane might crash into a mountain or into a forest without anyone's being the wiser until the damage is done. Here television comes to the rescue; for it is in this service especially that television will prove of tremendous value for war purposes.

I pictured, some years ago, in one of my magazines, a radio operator sitting at general headquarters, and in front of him a screen divided into six panels. The airplane is provided with six television cameras which see to the left, to the right, backwards, forwards, up, and down. Whatever these six television scanners encounter is then transmitted back to the operator at general headquarters. The radio operator, therefore, sees exactly what happens to the airplane at any second during its flight. No enemy can approach the plane without the operator's seeing it from the ground far better than if he were on board the plane itself; for the simple reason that no aviator can look every way at once. On the contrary, the television operator, sitting in his dugout one hundred miles away, can see in these six directions simultaneously; and he will be able to steer his bombing airplane and guide it to its destination by radio impulses.†

The same method will be used for submarines as well or, perhaps, I should say for television-controlled torpedoes, each equipped with a televisor-periscope that can see in four directions at once. The torpedo, progressing at a slow speed (so that it will not leave too much of a wake) can dive whenever its distant operators wish it to do so; and it can then attack a battleship with the minimum risk of life—for its operators—because there is no human life in the robot torpedo.

Radio Robots

The radio science of tele-kenetics, or remote control of machinery, of which I have just given two examples, as yet is very new; but, with the aid of television, we may have all sorts of robots, and this new science, during the next fifteen or twenty years, will become a most important one.

As a matter of fact, when I speak of "Radio in the Future," I am aware of the fact that, even today, radio is such a big subject that it is difficult for any one man to know all about it. Radio has already become sub-divided; making it necessary for most of the engineers in the profession to become specialists in one, two, or at most, three subjects. The average broadcast radio engineer knows little or nothing about the technicalities involved in the manufacture of vacuum tubes, and vice versa. The radio set expert is not, as a rule, an expert in ultra-short waves.

By all of this, I mean to say, that during the next fifteen years radio will become a highly specialized art with hundreds of different branches, most of them only remotely related to each other; exactly as the electrical art is today so diversified that it becomes necessary for engineers to devote themselves to one branch. Thus, for instance, the lighting expert has only a hazy understanding when it comes to the manufacture of dry cells or storage batteries, etc.

Locating Ore By Short Waves

During the next ten years, short-wave radio in its various applications will probably claim most of the attention of our research scientists; because in this domain of radio the surface has not as yet been scratched. Tremendous discoveries, of far-reaching import in the short-wave field, will be made during the next fifteen years. Just recently short waves have become useful in medicine; so that it is now possible to create, by means of short waves, beneficial radio fevers which actually cure a number of diseases ranging from pneumonia to certain forms of insanity.

In the mining industry, short waves will help us even more than they do already in discovering hidden ore. This particular art is yet so new that not a great deal is known about it. But I predict that, during the next fifteen years, all of the remaining big deposits of oil and ore will probably be discovered by means of short-wave radio. I anticipate the introduction of a method (so far, to the best of my knowledge, not tried out), whereby two or more airplanes, sending ultra-short waves earthward by a simple triangulation method, while merely flying over the country, can discover hidden ores or hidden oil fields.

During the next twenty-five years, I am equally certain, the now theoretical project of transmitting power by radio will have been accomplished.

Why Not Distribute Power By Radio Waves?

There is no good reason why we cannot send and distribute power by means of electro-magnetic waves as well as we can now send it over a wire system. If you think it is impossible to send power by wireless or by radio, look at the sun and realize the tremendous amount of power which that luminary is sending down to us every second of the day. (It

† See description and illustration of this idea, page 10, March-April, 1931, issue of "Television News" magazine.

is bridging, incidentally, the highest vacuum imaginable.) The solar rays are electro-magnetic radiation, exactly as our radio waves are, but of somewhat shorter wavelengths. It will be possible to have central stations, from which certain waves will be launched or directed towards the sky to penetrate the Heaviside layer. It is well-known that, in the Heaviside layer, we have a highly-ionized atmospheric stratum which is an excellent conductor. I can see also an airplane equipped with a projector of a ray or beam penetrate the Heaviside layer overhead; and thus to tap this radio power which may be used to propel the airplane itself.

While this may, of course, appear fantastic today, it is no more fantastic than if you had told someone thirty years ago, that it is possible to telephone without wires across the Atlantic Ocean—which is now a daily occurrence.

There may be discovered, of course, other means than the scheme just mentioned to send power by radio over the surface of the globe. What the instrumentality will be, it is difficult for me to imagine as yet; but I have no hesitation in stating that it will be accomplished in the not-too-distant future. That it will be accomplished by the utilization of short waves, I have but little doubt.

Interplanetary Travel

The next great stage in the progress of the world—one greater, by the way, than that immediately following the discovery of America by Columbus—is just about at hand. By this I refer to interplanetary travel. When I spoke of these things twenty years ago, I was usually laughed at, and my writings on the subject were never taken serious, anywhere. So, twenty years ago, when I originated the now widely-used term "space-flier," it was looked upon as another "Baron Münchhausen" tale.

Today, scientists are no longer laughing or even smiling at interplanetary travel. Many a country already has its interplanetary society; we have the Interplanetary Society of Germany, Interplanetary Society of France, and more recently, the Interplanetary Society of America. In Germany, particularly, this movement has taken a tremendous impetus under the direction of such daring pioneers as Hermann Oberth, Fritz von Opel and Max Valier. The last-named scientist, unfortunately, was recently killed in experimenting with a rocket-propelled craft.

During the next fifteen years, attempts to land a space-flier on the Moon, either with or without passengers, will result successfully, I hope. When it does come, when this great achievement is accomplished, its success will probably be due primarily to the instrumentality of radio.

To those who have not followed the science of interplanetary travel, concerning which there is today a considerable amount of technical literature in foreign languages, let me point out that the travel will be accomplished by a space-flier driven by the so-called rocket method of propulsion. That is, a series of enormous rockets will propel the vehicle forward at great speeds, enabling the space-flier to overcome the gravitational influence of the earth. In order to do so, it must acquire a velocity of some seven miles a second; to attain this, the speed is stepped up, or accelerated, gradually. Once the space-flier has attained its "speed of liberation," no further power will be required; and it will go on to its objective, which may be the Moon or the next planet.

The first space-fliers, no doubt, will be mere robots, equipped with television apparatus, like my television-controlled airplane. The scientists, while remaining on the earth, will see everything, just as an operator would if on board; and, incidentally, they will encounter no dangers. The space-flier will send back its television signals, and it will even be enabled to land safely upon the Moon, all by means of radio-controlled impulses.

Puncturing the Heaviside Layer

I know that some of you will immediately start objecting to me that there is such an obstacle as the Heaviside layer, through which no radio impulses can pierce.

This is perfectly true of radio waves at low frequencies, (such for instance, as wavelengths as are used today for broadcasting); but ultra-short wavelengths, from two meters downward, suffer no such complete reflection from the Heaviside layer. At such high frequencies they approach the characteristics of the solar radiation, which (as we can see by looking at the sun), effectively pierces the Heaviside layer. It is all a matter of getting the right wavelength; and experiments, even now being conducted in various countries by sending off rocket-propelled test machines, will soon prove the correctness of the theory. In any event, no future Columbus of the open space will think of venturing into the void without using radio in one form or another.

It is even not impossible that, in the far distant future, a space-flier may be powered by radio sent from the earth itself. By this I mean that power can be supplied to the space-flier in some manner, say by means of a radio power beam; making the flier independent of the heavy fuel which it would now be necessary to carry. Indeed, at the present time, the most difficult problem of space flying is the tremendous weight of the rocket fuel that a flier would have to carry at the start. Substitute a "weightless fuel," such as radio power would provide; and space-flying becomes immediately possible.

Of course, some of these problems are yet entirely in the future; but I believe that many now living, of the younger generation, will see all or nearly all these applications of radio accomplished in their lifetimes.

Human Beings As Antennas

By Dr. Erwin Schliephake, M.D.

(*Continued from page* 445)

ing upon the strength of the radiation and the place treated. One frequently sees instead a lessening of these amounts, which would therefore correspond to a thinning of the blood. Likewise, the albumens of the blood undergo certain changes which I cannot discuss here.

In the case of these strong effects it is to be assumed that the tissues of the body also undergo changes; which, however, cannot be directly proved in a subject.

Results of Experiments on Animals

In experiments with animals, on the contrary, such changes are plainly recognizable. They occur particularly strong in projecting parts of the animals, such as in the ears and tips of the tails; since there the electric field is distorted. Very often, one sees, some time after the treatment, that the parts in question are dying and falling off. In the case of a rabbit whose leg had been too strongly exposed to the electrostatic field, I noticed a complete disintegration of the flesh in a ring-shaped region, so that only the bone remained; but then, after a while, that also fell off.

That the nervous sytem of the animals is also influenced is shown by the fact that many of them shudder on the switching on or off of the field, at a time when there can be no question of a strong heating effect.

Also very interesting are the disturbances of the internal heat regulation, which one can produce in animals. If the region of the neck and the back of the head of a rabbit are exposed to a limited capacitative field and the temperature is afterward measured, one can soon note a permanently increased temperature, which often lasts for some weeks. If a very powerful dose of "irradiation" is administered the opposite can occur: the bodily heat falls more and more, often below 35 degrees C. (95° F.), until these low temperatures are no longer compatible with life. At the same time, it is interesting to observe that almost all animals which have had such disturbances of their heat regulation after a few weeks developed inflammation of the lungs and pleurisy, afterward dying. It seems as though, by the disturbance of the heat regulation, the resistance of the animals to disease had suffered greatly; so that in this path throughout the central nervous system there was created a special susceptibility to colds. On investigating the spinal marrow of such animals microscopically, serious injuries to the nerve cells have been observed.

Dangers and Beneficial Possibilities

After these experiences, I have not dared to expose entire human beings to a condenser field and in this way produce artificial rises in temperature. The responsibility seemed too great. At the same time, effective heating of the body can be accomplished equally well in other ways; such as with the well-known Apostoli "condenser bed," which can be connected to any diathermal apparatus. With the method previously described, only serious dangers for the patients treated would have been conjured up, without the possibility of producing a fundamentally new effect.

On the other hand, the disturbances of the physical health, which we could observe in the field of free radiation of powerful transmitters, have never been serious. After a period of recovery of a few weeks, with no irradiation, all effects have been observed to vanish. For four years now, I have almost daily worked for several hours at a transmitter with 1½ kw. plate dissipation; and the effects, often very unpleasant, have always gone back to normal on stopping the work.

In these things the wavelength is also certainly of importance, and in fact we have the impression that the disturbances to health became stronger as the wave was shortened. Anyway, the unpleasant sensations appear much quicker with a three-meter wave than with longer ones.

From all these experiences, it is at any rate clear that treatment with electric waves can in no way be regarded as always harmless for the human body. It is plain that their incorrect use can cause serious injuries to health. Certainly such injuries are to be expected only when the frequencies are very high; that is, with ultra-short waves; even then there is nothing to fear except with fairly high transmitter power.

On the other hand, with proper use, the short electric waves seem to be a valuable means of treatment. According to our experiments to date, with bacteria cultures and infected animals, the germs of disease can be killed. There is the added point that certain defensive processes are stimulated in the body. I have also already repeatedly treated human beings; and, in about a hundred cases, I have been able to attain an extraordinarily quick cure of suppuration (pus formation).

An Efficient Oscillator

(*Continued from page 473*)

struction, its extreme stability, its very short connections going along the shortest courses, seems to have the basic principles of short wave efficiency. Using wooden slats 1 inch by 2 a frame is made, 40 x 50 cm. inside measurements. Four pieces of hard rubber 10 x 15 cm. serve to support the variable condenser, the choke, the grid resistance, and the filament terminals, respectively.

As a current indicator we use a little flashlight lamp of 4 volts. It is indispensable to use a switch for cutting it out when transmitting.—(*Revista Telegráfica.*)

What Tube Shall I Use?

By ROBERT HERTZBERG

(*Continued from page* 458)

However, several radio engineers with unusually analytical minds attacked the problem, and they soon succeeded in chasing all those troublesome hums out of the circuits. Today the A.C. short-wave receiver, with its appealing feature of operating convenience, is a fully accepted and satisfactory instrument.

The 224 screen-grid tube, properly used, is an excellent R.F. or A.F. amplifier or regenerative detector. The 227 is good for detection or A.F. amplification, and also for "flea power" transmitting sets. The 226, having a raw-A.C. filament operating without benefit of cathode, is of no use at all.

For the final audio stage of an A.C. short-waver, the 171A or 245 is recommended. The 171A is sufficient if the set is used exclusively for the short-waves and has no provision for regular broadcast reception, as some sets have. If the receiver develops powerful signals and is of the combination short- and long-wave type, the 245 may be used. The 245 is also popular for use in low-power transmitters because it can be used with ordinary receiving-set power packs; which are comparatively cheap, as transmitting power equipment goes.

The 250 tube, used as an audio output tube in early A.C. broadcast receivers, has little application today. It finds occasional employment as an audio-frequency modulator tube in amateur short-wave telephone transmitters.

With the Transmitter Tubes

Beginning with the 210 tube, we get into the transmitting class. The 210 is undoubtedly the most widely used amateur transmitting tube, having a power output of 7.5 watts and being rugged and dependable. A single 210 is usually used in a Hartley or a tuned-grid-tuned plate hook-up, or a pair of them in the more effective master oscillator-power amplifier arrangement.

The next size tube is the 852, a 75-watt "bottle", used by the more affluent amateurs. This is a peculiar looking affair, consisting of a round bulb with three necks sticking out of it. On one neck is a regular four-prong base, but only the filament pins are used. The grid lead comes out separately through the top neck, and the plate through that on the side. This separation of the leads is necessary, because the tube operates normally with 2000 volts on the plate.

The 860 and the 861 are similar in appearance to the 852; but they are of the screen-grid type, and therefore require no neutralization when used as radio-frequency amplifiers following an oscillator stage. The 860 is rated at 75 watts, and the 861 at 500 watts. They are only for the advanced amateur who has had considerable experience with smaller outfits.

There are a number of other transmitting tubes designed for special purposes, and they allow the amateur a wide choice for experimental work. There is the 865 screen-grid amplifier, which looks like an overgrown 224 and has a rating of 7.5 watts; it is intended for use as an intermediate R.F. amplifier, with a larger tube like the 203A or 860 following it. The 203A, which now has a rating of 75 watts, was formerly known popularly as a "fifty-watter"; it is a long, tubular affair, fitted with a special large base. The 204A is another old-timer, having an output of 250 watts and being designed for use as R.F. amplifier or speech modulator.

The foregoing are the tubes in common use among amateurs; and they are mentioned here so that the short-wave fan may familiarize himself with their designations.

The Rectifiers

A very important class of vacuum tubes takes in rectifiers. For receiving sets, the rectifier most used today is the 280, which is of the full-wave type; this will supply enough current for two 245's and seven or eight smaller tubes. For transmitting purposes, a pair of 281 half-wave rectifiers is commonly used for small outfits having one or two 210's. For the larger tubes, of the 75-watt size and up, special mercury-vapor rectifiers like the 866 and 872 are employed. With the plate voltages to these rectifiers running around 5000, the handling of the power system involves a great deal of care, and unusual precautions must be taken to prevent accidents. Five thousand volts is just nothing to fool with!

The HY-7B Super-Het

By L. W. HATRY

(*Continued from page* 457)

nary room volume. Also, power-pack and receiver costs are reduced appreciably by limiting the output amplification to one tube.

This last surprisingly general attitude of finding one output power tube adequate is probably typical of some return to good sense on the part of the fad-ridden. They have come to realize that what determines the satisfactoriness of tone or performance is not so strictly the "ideas" incorporated in the so-called design, so much as what comes out of the loud speaker. This has come to the same pass as the matter of sideband cutting; nearly every broadcast receiver certainly cuts sidebands but no one worries over a bit of lost sideband, if the A.F. characteristics of the audio amplifier and loud-speaker permit sufficient compensation to please the guardian ear.

Some persons admit this attitude unconsciously; they will tell of better than 10-kc., selectivity in picking out broadcast stations and, in the same breath, brag of the tone of their receiver. Obviously, if better than 10-kc., selectivity is obtained, sidebands are certainly being cut; but if the ear likes it—. Some day we'll have the general realization that a radio receiver is a unit and that, even if 1-kc. goes in, just so that 10-kc. comes out, the over-all and final receiver selectivity is not 1 but 10-kc. Nothing can change that fact, nor its corollary that, if selectivity is 5-kc. by loud-speaker report, then that tuner is cutting sidebands!

Plug-in Coils and Tuning Ranges

Avoiding further diversion, let's take up the plug-in coils and tuning ranges of the HY-7B. These are different from those described for the original HY-7, different for two reasons: to get rid of the gaps that some persons did not like in the original coil set-up, and also to even-up tuning ranges throughout the general short-wave region. The tuning ranges are about as follows for the HY-7B:

Range	*Extent of Range*	*Coils*
2,000- 3,600 kc.	1,600 kc.	A1-01
3,400- 6,600 kc.	3,200 kc.	A2-023
6,450- 9,650 kc.	3,200 kc.	A3-023
9,200-12,400 kc.	3,200 kc.	A4-045
12,000-15,250 kc.	3,200 kc.	A5-045

As in the HY-7, the tuning ranges are prevented from taking the usual jumps in breadth. They have been limited, where possible, to 3,200 kc.; since otherwise A5, for example, would tune easily from 12,000-18,000 kc.—a range of 6,000 kc. and therefore one crowded and more critical in tuning. By this means tuning at 20, 40 and 80 meters is equally critical; not more critical as the wave is reduced. And, since oscillator coils 023 and 045 do double duty, two plug-in coils are eliminated, keeping the total number for five tuning ranges to eight only.

The circuit of Fig. 1 shows the regeneration-control scheme for the second detector; it permits putting the detector in and out of oscillation for either C.W. or phone reception. When a regeneration control is not wanted on the HY-7B, and tone-control is desired, a non-oscillating degree of regeneration for the second detector is adjusted, so that good sensitivity without beat-note reception is obtained. The panel-regeneration control is then omitted and replaced by the tone-control.

For those who want them, I have given the HY-7B plug-in coil dimensions as a table. However, because of the trouble winders of HY-7 coils experienced, I doubt the usefulness of these coil-dimensions. Unfortunately, chang-

ing the sizes of the tapped coils has effects upon frequency ranges confusing to persons inexperienced in the use of these types of windings. THe table should be used only as a guide.

Table of Coil Turns

OSCILLATOR COILS

Coil	L3*	L3 Tap	L4
01	28	None	14
023	18	None	10
045	10	6	5

ANTENNA OR DETECTOR COILS

Coil	L1	L2*	L2 Tap	Lv
A1	5	35**	None	None
A2	3	19	None	None
A3	2	12	5	None
A4	2	9	7	6
A5	2	7	4	4

* L3 and L2 are wound with No. 22 D.S.C.; all other windings are No. 30 D.S.C.

Windings are placed not more than an eighth-inch apart on National coil-forms and are wound as close to the bottoms of these forms as is reasonable.

** For this coil L2 is 35 turns of 30 D.S.C. instead of 22 gauge.

Parts List for Hatry A.C. Super-Het.

Legend for Fig. 1 Circuit.

L1—Antenna winding of A coils.
L2—Grid winding of A coils.
L3—Grid winding of O coils.
L4—Plate winding of O coils.
L5-C6-C8-C5-L6-R5 comprise an intermediate R.F. transformer and are all included in one can. L5-C8 must tune to 1,500 kc. or slightly higher. See original HY-7 article for suitable dimensions.
L6—R.F. choke.
L7—Tickler in Detector I.F.T. which also includes L3-C8-L6-C5-C7.
L8—R.F. choke such as Hammarlunds 85mh. or SPC.
C1—National 50 Mmfd. midget short-wave condenser, ST- or SE-50.
C2—Same as C1 but used as vernier and range extender.
C3—Sangamo .01.
C4— .00025 Mfd.
C5— .25 Mfd. non-inductive 200v., Sprague.
C6— .0005 Sangamo.
C7— .0002 Mfd. Sangamo.
C8—100 Mmfd. Hammarlund equalizer EC-80.
C9— .0001 Mfd. Sangamo.
C10— .0005 Mfd. Sangamo.
C11— .01 Sangamo.
C12—1 Mfd. Flechtheim, 250v.
R1—5000 ohms Clarostat potentiometer.
R2— .25 megohm Electrad metallic leak.
R3—2000 ohms Electrad flexible.
R4—400 ohms bias resistor.
R5—2 megohm Electrad metallic leaks.
R6—3 megohms Electrad metallic leak.
R7— .1 megohms Electrad metallic leak.
R8—50,000 ohms Electrad Royalty potentiometer.
R9— .15 Megohms Electrad metallic leak.
R10— .01 Electrad metallic leak.
R11—5000 ohms Electrad Truvolt type B50.
R12— .25 Megohm Electrad metallic leak.
R13—1 Megohm Electrad metallic leak.
R14—2700 ohms 2 watt Durham resistor.
R15—1500 ohms Electrad B15.
R16—20 ohms centertapped, Clarostat.
R17—10 ohms centertapped, Clarostat.

A Plug-Less S-W Receiver

By JOHN M. AVERY

(*Continued from page* 441)

lug is also placed under the head of the hex nut holding the angle.

Before going further, connect a short jumper between the soldering lug connecting to the arm of the switch unit which is nearest the panel, and the lug which was placed on the front of the switch panel, under the head of the screw holding the small angle. This is connection "11" in the diagram. Connection "12" is from the soldering lug connecting to the arm of the rear switch unit to the other soldering lug which was placed on the front of the switch panel.

(When the assembly is completed, the two lugs mentioned just above, on the face of the switch panel, will be the plate-coil and the grid-coil's R.F. return leads, connecting via the .01-mf. fixed condensers to the filament circuit.)

Having made these last two connections, the switch and its small panel are put into place under the socket shelf and between the two bakelite brackets. Two of the 8-32 screws used to hold the socket-panel to the bakelite brackets are passed through the ½-inch brass angles on the switch panel; whereupon it will be found that the entire unit fits neatly together, making an extremely rigid job. (See Fig. 4.)

From this point, wiring becomes quite a simple matter. The complete unit is turned upside down, its rear end nearest the constructor. Starting with what is then the left switch contact of the switch unit marked A in the diagram (the unit nearest the panel), a rigid bus-wire connection is made to the "F" terminal of the first socket as shown (Connection 13). This is followed by a similar connection from the left contact of switch unit marked B in the diagram, to the other F terminal of the first socket. A small hole is provided through the switch panel to pass lead "13", to simplify spacing of wires. Now the remaining connections are made, completing the wiring. (Nos. 13 to 20.)

Maintain wide spacing between all sub-panel connections, particularly between "G" and "P" leads. Make all connections as short as possible, and use only rosin-core solder in connecting to soldering lugs. Make *sure* your iron is good and hot before attempting to solder the connections to the switch; as the small space here might result in disaster if difficulty is found in causing the solder to flow freely. The switch's insulating material is of bakelite-dilecto, unaffected by the iron's heat.

Extending the Switch Shaft

A Pilot flexible insulated coupling is the most satisfactory means of extending the switch shaft, so that the inductance range can be controlled from the front panel. Note that the Best switch has a "key", set into its shaft at the front, acting both to key the control knob to the shaft, and to serve as a stop limiting the motion of rotation. Rather than remove this key (which is easily done), I suggest that the constructor spend the slight additional effort required, and with a small rat-tail file, cut a slot to fit the key in the Pilot coupling.

For a shaft to extend to the front panel, an insulating material should be used, and while ¼-inch round bakelite or fiber rod is obtainable, it has not much advantage to be found over ordinary ¼-inch dowel-stick, which can be purchased at any hardware store.

Switch Unit Adaptable to Any Set

The completed unit may now be mounted in any type of set. The photograph shows a simple regenerative detector type, without R.F. or A.F. amplification. It will be noted that resistance control of regeneration is utilized; and in smoothness of operation that method leaves nothing to be desired. The control is a Pilot 100,000-ohm Volumngrad, in a potentiometer connection, shunted by a Pilot 1-mf. by-pass condenser. The tuning condenser is a Pilot .00025 mfd. "Capacigrad."

The standard set of "Dresner" four-prong coils were used, as purchased, without alterations of any kind. The smallest coil is placed in the socket at the front of the sub-panel, and the larger sizes progressively down the line.

Of course, tube-base coils are just as effective as coils purchased, although they may not look quite as neat. In winding tube-base coils, I suggest that at least ⅛-inch space be left between the tickler and grid windings.

Tuning Chart*

STATION	Range 1	Range 2	Range 3
CMA	—	8	—
WOO calling GMJQ.	28	—	—
WML	48	—	—
XDA	88	14	—
W2XE	—	37	—
WKI	—	39	—
Amateur W2AHB...	—	—	26
GBC phone to GDLJ	28	—	—
WSC	30	—	—
40-Meter Amateurs..	—	19	—
XDA to WNU......	—	46	—
FUT	27½	—	—
WNU to RXC......	—	24	—
KWT	18	—	—
FYC	—	59	—
20-Meter Amateurs..	15	—	—
40-Meter Amateurs..	91	19	—
TIR	7½	—	—
9XAA	38	—	—
WENR, Chicago (SW)	—	39	—
XAM	—	52	—
Toledo P. D........	—	—	71
WSBN	32½	—	—
80-Meter Amateurs..	—	93	10
WBBC, Brooklyn...	—	—	**66
PPW	49	—	—
LQA	59	—	—
WPN	—	29	—

* This chart is by no means complete, and merely represents about two hours "listening-in", using detector and phones only. It is presented merely to give the constructor an idea as to where to tune for results, and to show the tuning overlap of the various ranges if the standard Dresner coils are used.

** Range 4.

The total wavelength spread of the unit can be reduced, with correspondingly increased "dial-spread", by altering the coils.

Audio Amplifiers for Short Wave Receivers

By A. R. HAIDELL

(*Continued from page* 462)

be resonated to 1000 cycles by connecting a condenser of suitable value across one of the windings. If an audio transformer core, or one with an open primary, is available, it can be pressed into service; the core can easily be rewound.

It is of value to know approximately the inductance value of iron-core chokes. Some approximate figures are given below.

Core cross-section ½ by ½ in.; No. 33 enameled wire; "core-type" construction (window size b by c); sheet silicon steel.

Inductance (Henries)	Approx. air-gap	No. of turns	Dimension b	c
0.5	.017	1600	.42	.28
1.0	.019	2300	.50	.33
5.0	.023	5200	.75	.50
10.0	.030	7600	.90	.60
15.0	.035	9500	1.00	.68

The inductance varies about as the square of the number of turns; so that half the number of turns will give one-fourth the inductance. The core material should be silicon sheet steel (the thinner the better); and the laminations should be insulated from each other by oxide or shellac, to reduce losses. The lower the losses, the sharper the peak.

The "trap" can be "tuned" by varying the air-gap to obtain the proper value; adjustments can be made also by trying various values of capacity, as first determined by formula. The standard sizes will allow an approximate adjustment; it may be convenient to connect a large variable condenser in parallel for finer adjustment.

In some cases it is desirable to measure the inductance values. If the resistance is small in comparison, the current through a choke, when connected across an A.C. source, is given by

$$I = \frac{E}{2\pi f L}$$

Where I is current in *amperes*, E is potential in *volts*, f is frequency in *cycles per second* and L is inductance in *henries*.

The inductance can thus be determined roughly by measuring the current through it, knowing the voltage of the source. A step-down transformer can be used to supply E. The actual inductance will depend upon the current strength through the winding in the case of iron-core inductances; as the core becomes saturated with many ampere-turns. An air gap keeps down the flux density.

If it is necessary to connect a resistance in series to limit the current, the relation:

$$I = \frac{E}{Z} = \frac{E}{\sqrt{R^2 + (2\pi f L)^2}}$$

should be used. For a 2-henry inductance of small resistance, the current is about 146 milliamperes, assuming constant inductance, when the choke is connected across 110 volts A.C.

Since the effects of inductive reactance and resistance are at right angles, and are not simply additive, a series resistance (total) of 100 ohms will reduce the current only about 1% roughly. When measuring inductive reactance values with a milliammeter, care should be taken that the current does not exceed the carrying capacity of the choke, or milliammeter, which provides plenty of excuse for the above table and formulas. The chokes in the table will handle about 50 milliamperes; which necessitates keeping the voltage *low* in the measuring circuit.

Portable Transmitters and Receivers

By A. H. HAIDELL

(*Continued from page* 469)

the transmitter, couple the coil to the "loop". At high power, be careful not to use too close coupling; otherwise the flashlight-lamp indicator (if used) will be burned out, since the field of the coils is comparatively great.

The meters suggested in Fig. 1 are useful, but flashlight lamps will serve if the proper shunts are used. The ammeter "A", shown in the tuned circuit only, shows that the set is oscillating and can be omitted if desired.

The ignition noises in various types of automobiles will differ. Shielding is almost always necessary, although sometimes there is only intense noise when the car is starting. Perhaps one may not desire to operate the outfit while the engine is running, anyway, which is the case if there is only one operator. The ignition system can be shielded by means of heavy rubber-covered wire wrapped around the various leads and grounded to the car's frame; there are perhaps simpler ways, but noises are usually not troublesome.

The auto battery will furnish filament current. It is important to have the frame of the key connected on the filament side of the circuit, otherwise a severe shock may be obtained from the plate supply if any part of the metal of the car is touched at the same time.

To operate this type of set, tune it to the wavelength of the station being received. One can thus operate on the same wavelength with a good chance of working it. When interference is heavy, the wavelength can be shifted easily.

This Regen. Control Does Not Affect Tuning

By MANDER BARNETT

(Continued from page 451)

RFC operates in the normal manner and the receiver oscillates violently, owing to the fact that the condenser C is at its maximum always. However, when the value of R is reduced, the choking effect of RFC becomes less and less, and the R.F. currents are by-passed direct to earth through the resistor and the condenser C2, instead of through the tickler coil and C. When R is at its minimum value, there is no choking effect at all, and the R.F. currents go directly through C2 to ground.

Thus, it will be seen, R provides a very effective control of regeneration but, at the same time, it does *not* effect the tuning; at least, not to any appreciable amount that would cause any annoyance.

It will be seen that, although we have a complete control over the regenerative effect, the capacity existing between the tickler and grid coils remains constant; because the distance between the two coils is not varied and neither is the condenser C. Therefore, a large change of capacity in the circuit is impossible and the tuning remains unaffected. C2 should have a value of about .001-mfs. and should not be larger; otherwise audio notes will suffer.

The writer has found this circuit arrangement to be quite as effective in practice as it is in theory and it is well worth trying. *(The editors have tried this stunt and it works very well.)*

The Pilot Universal Super-Wasp

(Continued from page 430)

stunt is simply great. You sit down to the Universal, snap on the switch, and you sweep back and forth from low waves to high waves quickly and comfortably, without wrestling with recalcitrant coils or loose shield cans. If one waveband seems dead, you turn in a second to another; there is always something to be heard, at any time.

The eight coils used in the Universal are wound in the factory, assembled in place on the edges of the switch housings, and wired properly to the contacts. The rest of the wiring, to be done by the individual purchaser, is no more complicated than that of an ordinary plug-in coil outfit. The set is a sure-fire outfit, and will work the first time it is turned on. As long as the cams are not disturbed no trouble will develop.

The Universal is available with or without a cabinet. The cabinet that is supplied is a plain, handsome walnut affair, and will not detract from the appearance of any home. It might be said that the advent of this receiver marks the graduation of the short-wave set from the cellar or attic den to the respectability of the living room. It is a really fine broadcast receiver and, while it does not have the sensitivity or knife-like selectivity of regular broadcast sets using multi-stage R.F. amplification, it is altogether satisfactory for home entertainment; it has an excellent audio system, and it may be used with a phonograph pick-up. This is a set that will produce endless hours of diversion, for the possibilities of the short waves are unlimited. There are many hundreds of stations of different kinds to be listened to, and a new thrill awaits the owner every time he tunes in.

Initially, the Universal Super-Wasp will be an all A.C. job, for various line-voltages between 110 and 240 and for 50-60 cycles only. A battery model is definitely scheduled for production, and will be designed to use either '01A type tubes on a storage "A" battery or '30 type tubes on dry cells. The battery set will have all the features of the A.C. model.

Where to Connect Aerial "Feed"

(*Continued from page* 468)

it as far as possible out of the field of the feed wire.

Each person uses the free phone as a transmitter and holds it in one hand for the purpose. Of course the antenna has the usual meter or light bulb in its center for adjustment readings. As the best meter-reading occurs, the operator converses with the operator at the set and vice versa; and thus they are able to keep in constant touch with each other. This enables them to get the most efficient readings at the transmitter as well as at the antenna, and insures the most efficient operating point.

The "C" battery can be provided with a switch to cut it out of the line when not in use, if desired, and thus prevent running it down sooner than necessary.

After the best operating point is obtained the feed wire should, of course, be soldered permanently to the antenna. —*Courtesy Radiocraft.*

A 5-Meter Transmitter and Receiver

By E. T. SOMERSET, G2DT

(*Continued from page* 455)

The '24 has a mutual conductance of 1,050-micromhos and will make quite a satisfactory detector *if "debased."* Since its plate impedance is of the order of 400,000 ohms, it is necessary to use a 300,000-ohm plate load resistor to get efficient amplification; and this involves an applied "B" potential of 300 volts or more to allow for voltage drop.

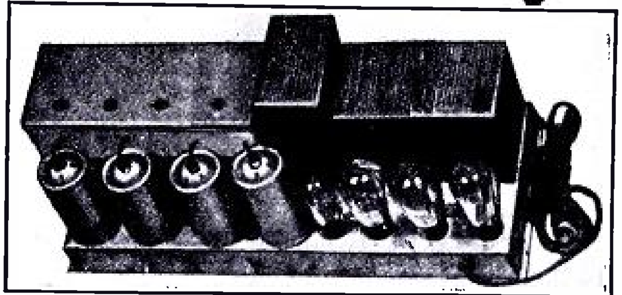
For reception an antenna is a *sine qua non* and, so far as can be ascertained, its length is immaterial. It has not been found possible to pick up five-meter signals at only a mile away without an antenna! Loose coupling of a single turn of wire is quite satisfactory.

NOTHING IN RADIO EVER APPROACHED THESE VALUES!

SONORA! Known everywhere as QUALITY Radio. Now offered to you in LIMITED QUANTITY at Prices LESS than the Actual cost to manufacture. A ready market awaits your sale of these famous sets.

Sonora CLEAR AS A BELL

These Sonora Chassis are of the very latest design and construction—Screen Grid — 245 Push Pull Amplification. Totally shielded. Battleship Construction, with oversized transformers and condensers assuring long, faithful performance. Chassis measures 21 in. long, 8 in. wide and 8 in. high. NOTE: Do not confuse this genuine Sonora built Radio chassis with similar type models offered elsewhere.



RADIO CHASSIS WITH MATCHED ELECTRO DYNAMIC SPEAKER

LATEST MODELS SCREEN GRID 45's IN PUSH PULL

SONORA Model A31

7 TUBES—3 SCREEN GRIDS

Uses:
3—224, 1—227,
2—245 & 1—280 Tubes

OUR PRICE **26.50** Net

SONORA Model B31

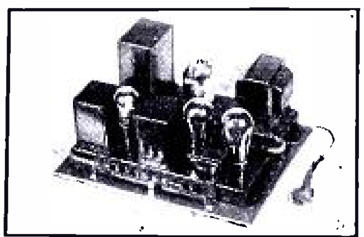
8 TUBES—4 SCREEN GRIDS

Uses:
4—224, 1-22
2—245 & 1—280 Tubes

OUR PRICE **29.50** Net

Sonora CLEAR AS A BELL

Super Power 245 and 250 Push Pull Amplifiers And "A-B-C" Power Supply



SONORA CONCERT Power Amplifier

2 STAGE 245 Push Pull With "ABC" Supply POWERFUL

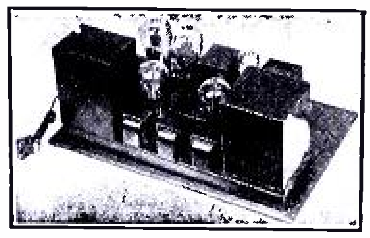
Faithful Reproduction

Here is a **truly fine amplifier** affording **volume galore** with **astonishing faithfulness and realism.** Constructed of the highest quality parts, to give long life and the finest performance.

PHONOGRAPH AND RADIO INPUT

The Concert Power Amplifier supremely efficient for reproduction of phonograph records, radio programs and speeches. Operation requires: Two x 245 Power Tubes, one Y227 AC tube, and one X280 Rectifier tube.

Regular Value **$85.00** OUR PRICE **22.50** Net



SONORA AUDITORIUM Theatre Amplifier

2 STAGE 250 Push Pull With "ABC" Supply Enormous Volume

QUALITY OF REPRODUCTION IS AS NEAR PERFECT AND LIFE-LIKE AS POSSIBLE! ITS POSSIBILITIES CAN BE SUMMED UP IN THREE WORDS: ABSOLUTELY DISTORTIONLESS VOLUME! The full benefit of the 450 volts produced is obtained, using this as a **PHONOGRAPH AMPLIFIER —PUBLIC ADDRESS AMPLIFIER SYSTEM—RADIO TUNER AMPLIFIER.** Self-contained unit. Supplies all necessary A, B and C power to its own tubes. Operation requires two type X250 power tubes, one Y227 A.C. tube, and two type X281 rectifier tubes.

Regular Value **$145.00** OUR PRICE **29.50** Net

Genuine TUNG-SOL HANG-UP REPLACEMENT CONDENSER SECTIONS

FOR GENERAL REPAIR AND POWER-PACK WORK

Every Service Man should always have on hand several units of each capacity and voltage to meet every emergency!

Working Capacity	Voltage D. C.	Our Price
½ Mfd.	500 V.	$0.35
1 Mfd.	300 V.	.40
1 Mfd.	450 V.	.45
1 Mfd.	500 V.	.50
1 Mfd.	600 V.	.60
1 Mfd.	700 V.	.70
1 Mfd.	800 V.	.80
1 Mfd.	1000 V.	.90
2 Mfd.	300 V.	.60
2 Mfd.	400 V.	.70
2 Mfd.	500 V.	.80
2 Mfd.	600 V.	.90
2 Mfd.	700 V.	1.00
2 Mfd.	800 V.	1.10
2 Mfd.	1000 V.	1.25
3 Mfd.	300 V.	.85
3 Mfd.	400 V.	.95
3 Mfd.	500 V.	1.05
3 Mfd.	600 V.	1.15

ISN'T THIS WHAT YOU'VE BEEN WANTING?

At Last A Real Noise and Hum Eliminator

No More Hum-m!

CUT DOWN USELESS SERVICE CALLS: You will find this article to be a money-saver, as well as a money-maker, for you. The majority of your service-calls are due to line-noises. How much time and material has been wasted by your Service-Department making special apparatus to cut down line-noises? Now a simple installation of the "MAXIM FILTERAD" and your troubles are over. Works on all currents—Automatic—Requires no adjustments—Take advantage of this offer now!

Heavy Duty Model

OUR PRICE **2.65** Net

SONORA ABC POWER TRANSFORMER For Models A-31 and B-31

For 5—224 or 227, 2—245 and 1—280 Tubes. For Models A-31 and B-31, 6¾ in. wide, 6¾ in. long, 4 in. tall. Also Furnished for 25 Cycle Current for $5.50.

OUR PRICE **3.75** Net

KODEL STEP-DOWN TRANSFORMERS

HEAVY DUTY

Primary 110-120 Volts, 50-60 Cycles AC current. Output 14 Volts AC at 2½ Amp Suitable for A Eliminators, Dynamic Speakers, Trickle Chargers, Bell Ringing and Toy Transformers.

OUR PRICE **75c** Net

All offers are F.O.B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Or, deduct 2% if full amount is sent with order.

DO NOT WRITE FOR CATALOG!

GRENPARK CO., Dept. WC 245 Greenwich Street, New York, N.Y.

When to Listen In

By ROBERT HERTZBERG

(Continued from page 443)

empire, has had the rottenest kind of luck with the short waves as a means of cementing the ties of the colonies with the home country. Holland has PCJ; Italy has 13RO; the United States has W8XK and W2XAF—all reliable and highly successful stations that penetrate to the far corners of the globe. Great Britain has G5SW, but its single, inflexible wave of 25.53 meters has failed utterly to reach the very places where it is most wanted. Other stations operate on a sliding schedule of frequencies to meet different transmission requirements, but not G5SW.

The British have become considerably "het up" over the matter, and a change for the better seems imminent. In fact, we understand that the present experimental transmitter at Chelmsford will soon be replaced by a duplex outfit situated near the long-wave station at Daventry, and that at least two different waves will be employed.

Bombay, India

An experimental short-wave station has opened at Bombay, India; but it is on 49.1 meters, which is just too bad as far as American listeners are concerned. As with the Calcutta station, VUC, announcements are made in both English and the native tongues.

Java for Breakfast Again!

In addition to the government stations listed in the last issue, there are now a number of amateur stations on the island of Java broadcasting musical programs. They are on usually between 6.00 and 11.00 a. m., Eastern Standard Time, with power varying from a half to one kilowatt. These stations are identified as follows:

PMY, Bandoeng, 58 meters; PK1AA, Weltevreden, 75 meters; PK3AN, Sourabaya, 49.7 meters; PK2AF, Djokjakarta, 50 meters; PK6KZ, Macassar (Celebes), 25.5 meters; and PK2AG, Samarang, 95 meters.

Java is truly the "isle of the short waves".

Hot Stuff From Africa

A short-wave broadcast station at Rabat, Morocco, is on the air Tuesdays, Thursdays, and Saturdays, between 8.00 a. m. and 9.00 a. m., E. S. T., on 24 meters, and on Saturdays and Sundays between 4.00 and 5.00 p. m. on 48 meters. Announcements are made in French. Interval signals between programs are produced by a metronome, and the programs end with the playing of the French national anthem, **La Marseillaise**. This station has been reported by a number of American listeners.

Details of the Saigon Station

This article is turning out to be a lesson in geography. We will now take the class to Indo-China (get out your maps and globes), where an exceedingly powerful short-wave transmitter broadcasts regularly. This station, F3ICD, is located in Chi-Hoa, a few miles out of the city of Saigon, and is operated by the Compagnie Franco-Indochinoise de Radiophonie. A power of 12 kilowatts is used, with a wavelength of 49 meters. The announcements are "Hello, hello, this is Radio Saigon" (**Allo, Allo, ici Radio Saigon**). Programs are transmitted on Wednesdays and Sundays, but you have to be an early bird to catch them. Between 4.00 and 7.00 in the morning, on the West Coast, they are heard quite well.

There are two other stations in Saigon: a government station on 24.91 meters operating on a telephone and telegraph circuit to France and Japan, and a small private station on 31.5 meters.

Cincinnati Returning With Plenty of "Push"

We are glad to publish some authentic "dope" about W8XAL, the short-wave unit of WLW, Cincinnati, Ohio. This station formerly used a power of 250 watts on a frequency of 6060 kilocycles (try your conversion charts on this), but this outfit is being replaced by a new one of ten kilowatts rating. It should be on the air by the time this issue reaches you.

Wellington, New Zealand

The writer is indebted to John Clark, of San Francisco, Cal., for a bit of news about a station ZL2XX, in Wellington, New Zealand. It is working on 62.8 meters, but has permission to also use 19, 26 and 31.4 meters. The station is still in the experimental stage, and has not been heard yet in the United States.

Time Signals

We have some more data on time-signal transmissions. The full details on NAA, Arlington, Va., are as follows: waves, 12,045 kc., or 24.9 meters; 8,870 kc., or 33.82 meters; 4,015 kc., or 74.7 meters; 690 kc., or 434.5 meters; and 113 kc., or 2,653 meters. Times of transmission in Eastern Standard Time: 9:57-10:00 p. m. on all of the foregoing frequencies except 12,045 kc.; 2:57-3:00 a. m. on 8,870 kc. and 113 kc.; 11:57 a. m.-noon on all wavelengths and also on 16,060 kc., or 18.68 meters.

Station NSS, Annapolis, supplements this service with additional transmissions, as follows: 17.8 kc., or 16,840 meters; 12,045 kc., or 24.9 meters; and 16,060 kc., or 18.68 meters. Times (E. S. T.): 9:57-10:00 p. m., 0300 on 17.8 and 12,045 kc.; 2:57-3:00 a. m., on 17.8 kc.; 11:57 a. m.-noon on 16,060 kc. and 17.8 kc.

International Time-Zone Chart and Converter

(*Continued from page* 468)

side of the circle indicate the countries lying in these longitudes; so that the position of a foreign station may be judged without reference to a map.

To find the hour at any place, take the time at your own station (use a clock or watch which is keeping *Standard Time*) and bring the corresponding hour on the rim of the inner circle to the place of your station, as marked on the larger card. The time at any place in the world, whose position is known, is then that on the smaller card at the point opposite the proper time zone or longitude on the outer card.

For instance, you are in San Francisco, California. It is 3 o'clock in the afternoon. When you set the white figure 3 (in the dark half-circle indicating afternoon) opposite "Pacific U. S.—120" on the larger card, you will find that the black 11 is opposite "Western Europe—Greenwich" at the top of the card. That is to say, it is 11 p. m. in England, France and Spain. This is also 1100 Greenwich Civil or Mean Time—which is the international time used by short-wave amateurs and others to standardize their schedules.

At the same time, you will find the black figure 8 (indicating morning) opposite "135-Japan, Chosen" on the larger card. That means it is 8:00 a. m. in Tokio, Japan.

SWAPPERS

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

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

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

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

—EDITOR.

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c/o Paul's Radio Service, 33 Chaple St., Putnam, Conn.

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OSWALD H. WIK
725 No. Sixth St., Montevideo, Minn.

Short-Wave Stations — When to Listen

(*Continued from page 470*)

Meters / Kilocycles

38.00 7.890—**VPO**, Suva, Fiji Islands.
38.30 7.830—**POV**, Kootwijk, Holland, after 9 a.m.
38.60 7.770—**FTF**, Ste. Assise, France.
—**PCK**, Kootwijk, Holland. 9 a.m. to 7 p.m.
39.15 7,660—**FTL**, Ste. Assise.
39.70 7,550—.. S.S "Bremen."
—**HKF**, Bogota, Colombia. 5-7 p.m., 11 p.m. to 1 a.m.
39.80 7,530—..."El Prado," Riobamba, Ecuador. Thurs. 9-11 p.m.
40.00 7,500—...."Radio-Touraine," France.
40.20 7.460—**YR**, Lyons, France. Daily except Sun., 10:30 to 1:30 a.m.
40.50 7.410—....Eberswalde, Germany. Mon., Thurs., 1-2 p.m.
—**JIAA**, Tokio, Japan (Testing).
41.00 7,310—....Paris, France ("Radio Vitus") Tests.
—....Moscow, USSR, 7-7:45 a.m.
41.46 7,230—**DOA**, Doeberitz, Germany.
41.50 7,220—**HB9D**, Zurich, Switzerland. 1st and 3rd Sundays at 7 a.m., 2 p.m.
41.70 7,190—**EAR58**, Canary Islands (Spain). Testing.
—....Singapore.
5:30 p.m.
42.12 7.120—**OZ7RL**, Copenhagen, Denmark. Irregular. Around 7 p.m.
42.50 7,060—....Liakov Islands (north of Siberia).
—**XFA**, Mexico City, Mex.
42 70 7.020—**EAR125**, Madrid, Spain 6-7 p.m.
42.80 7,000—**F8KR**, Constantin, Algeria.
43.00 6,980—**EAR110**, Madrid, Spain. Tues. and Sat., 5:30 to 7 p.m.; Fri., 7 to 8 p.m.
—**PT1AA**, Santos, Portugal. Friday, 4-5 p.m.
—**HKX**, Bogota, Colombia. 9-11 p.m.
43.50 6,900—**IMA**, Rome, Italy. Sun., noon to 2:30 p.m.
43.60 6,875—**F8MC**, Casablanca, Morocco. Sun., Tues., Wed., Sat.
—**D4AFF**, Coethen, Germany. Sundays, 4-6 a.m.; Tuesdays, Fridays, noon to 2 p.m.; Thursdays, 4-6 p.m.
43.70 6,860—**KEL**, Bolinas, Calif.
43.84 6,840—**VRY**, Georgetown, British Guiana. Wed., 7:15-9:15 p.m.; Sun., 5:45-8 p.m.
44.40 6,753—**WNO**, Deal, N. J.
—**XFO**, Mexico City, Mex.
45.00 6,600—....Berlin, Germany.

Meters / Kilocycles

46.05 6.515—**WOO**, Deal, N. J.
—**W4XG**, Miami, Fla.
46.60 6,430—**REN**, Moscow, U.S.S.R. Tues., Thurs. and Sat., 6-7 a.m.
46.70 6.425—**W2XCU**, Ampere, N. J.
—**W9XL**, Anoka, Minn.
And others.
47.00 6.380—**CT3AG**, Funchal, Madeira Island. Sat., 5-7 p.m.
—**HC1BR**, Quito, Ecuador. 8-11 p.m.
47.35 6,335—**W10XZ**, **Airplane Television.**
—**VE9AP**, Drummondville, Canada.
—....Casablanca, Morocco.
47.81 6,270—**HKC**, Bogota, Colombia. 9:45-11:30 p.m.
48.00 6,250—...."Radio-Maroc," Rabat, Morocco. Sat., Sun., 4-5 p.m.
—**MTH**, Rio de Janeiro, Brazil.
48.62 6.170—**HRB**, Tegucigalpa, Honduras. 5-6, 9-12 p.m., Mon., Wed., Fri., Sat. Int. S. W. Club program. Sat., 11:30-12 p.m.
48.74 6,155—**W9XAL**, Chicago, Ill. (WMAC), and **Airplanes.**
—**VE9CL**, Winnipeg, Canada. 5:30-11 p.m.
—**W2XDE**, Bell Telephone Laboratories, New York.
48.83 6,140—**K1XR**, Manila, P. I. 3-4:30, 5-9 or 10 a.m. 2-3 a.m. Sundays.
—**W8XK**, East Pittsburgh, Pa. Tues., Thurs., Sat., Sun., 5 p.m. to midnight.
48.99 6,120—....Motala, Sweden, "Rundradio." 6:30-7 a.m., 11-4:30 p.m. Holidays, 5 a.m. to 5 p.m.
—**F3ICD**, Chi-Hoa (Saigon), Indo-China. 6:30-10 a.m.
—**W2XE**, New York City. Relays WABC, Atlantic Broadcasting Co.
—**FL**, Eiffel Tower, Paris. 5:30-5:45 a.m., 5:45-12:30, 4:15-4:45 p.m.
—....Toulouse, France. Sunday 2:30-4 p.m.
—**MTH**, Rio de Janeiro, Brazil. 5-7 p.m.
—**EAR25**, Barcelona, Spain. 3-4 p.m.
49.15 6,100—**W3XAL**, Bound Brook, N. J. (WJZ, New York). 5-6:30 p.m., 11 p.m. to 1 a.m.

Meters / Kilocycles

49.17 6,095—**VE9GW**, Bowmanville, Ontario, Canada. Daily, 1:45-5 a.m., noon to 7 p.m. Sundays, 5 a.m. to 7 p.m. Gooderham & Worts, Ltd.
49.26 6.090—....Copenhagen, Denmark.
49.31 6,080—**W2XCX**, Newark, N. J. Relays WOR.
—**W9XAA**, Chicago, Ill. (WCFL). 6-7 a.m., 7-8 p.m., 9:30-10:15, 11-12 p.m. Int. S.-W. Club programs. From 10 p.m. Saturday to 6 a.m. Sunday.
—**W6XAL**, Westminster, Calif.
—**HS2PJ**, Bangkok, Siam. 6-6:30 a.m.
49.40 6,070—**UOR2**, Vienna, Austria. 5-7 a.m., 5-7 p.m., Tues and Sat.; 9-10 a.m., Thurs.
49 46 6,065—**SAJ**, Motala, Sweden. 6:30-7 a.m., 11 a.m. to 4:30 p.m.
49.50 6,060—**W8XAL**, Cincinnati, Ohio. Relays WLW. 6:30-11 a.m., 1:30-3 p.m., 6 p.m. to 1 a.m. daily.
—**W9XU**, Council Bluffs, Iowa. Relays KOIL.
—**W3XAU**, Byberry, Pa. Relays WCAU.
49.67 6,040—**W9XAQ**, Chicago, Ill. (WMAQ).
—**W2XAL**, New York.
—**PK3AN**, Sourabaya, Java. 6-9 a.m.
49.80 6,020—**W9XF**, Chicago, Ill.
—**W2XBR**, New York, N. Y. (WBNY).
49.97 6.000—**ZL3ZC**, Christchurch, New Zealand. 10 p.m. to midnight, Tuesdays, Thursdays and Fridays.
—**7LO**, Nairobi, Kenya. 11 a.m. to 2 p.m.
—**HRB**, Tegucigalpa, Honduras. 9:15 p.m. to midnight, Mon., Wed., Fri. From 11 p.m. to midnight, Sat. Int. S. W. Club programs.
—**EAR25**, Barcelona, Spain. Sat., 3-4 p.m.
—**RFN**, Moscow, Russia. Tues., Thurs., Sat., 8-9 a.m.
—Eiffel Tower, Paris, France. Testing, 6:30 to 6:45 a.m., 1:15 to 1:30, 5:15 to 5:45 p.m., around this wave.
—**PK2AF**, Djokjakarta, Java.
50 23 5,970—**HVJ**, Vatican City (Rome). 10:30-11 a.m.
52.00 5,770—**AFL**, Bergedorf, Germany.
52.50 5,710—**VE9CL**, Winnipeg, Canada.
52.72-54.44 5,600-5,510—**Aircraft.**
52.80 5,680—**OCTU**, Tunis, No. Africa.
54 02 5,550—**W8XJ**, Columbus, Ohio.
54.51 5,500—**W2XBH**, Brooklyn, New York City (WBBC, WCGU).
58.00 5.170—**OK1MPT**, Prague, Czechoslovakia. 1-3:30 p.m., Tues. and Fri.
—**PMY**, Bandoeng, Java.
—**PMB**, Sourabaya, Java.
59.96 5,000—....Bratislava, Czechoslovakia.
60.30 4.975—**W2XAV**, Long Island City, N. Y.
60.90 4,920—**LL**, Paris, France.
61.22-62.50 4,800-4,900—**Television.**
—**W8XK**, Pittsburgh, Pa.
—**W1XAY**, Lexington, Mass.
—**W2XBU**, Beacon, N. Y.
—**WENR**, Chicago, Ill.
62.50 4,800—**W2XV**, Long Island City, N. Y.
62.56 4,795—**W9XAM**, Elgin, Ill. (Time signals.)
—**W3XZ**, Washington, D. C.
—**WSXDD**, portable. Bell Telephone Laboratories, New York.
—**W9XL**, Chicago, Ill.
62.69 4,785—**Aircraft.**
—And other experimental stations.
62.70 4,785—**VZA**, Drummondville, Canada.
62.80 4.770—**ZL2XX**, Wellington, New Zealand.
63.13 4,750—**WOO**, Deal, N. J.
—**WXOO**, Ocean Gate, N. J.
63.79 4,700—**W1XAB**, Portland, Me.
65.22-66.67 4,500-4,600—**Television.**
—**W6XC**, Los Angeles, Calif.
67.65 4,430—**DOA**, Doeberitz, Germany. 6-7 p.m., 2-3 p.m., Mon., Wed., Fri.
68.30 4,340—**WSBN**, S.S. "Leviathan."
70.00 4,280—**OHK2**, Vienna, Austria. Sundays, first 15 minutes of hour from 1 to 7 p.m.
70.20 4,273—**RB15**, Khabarovsk, Siberia. 4-7 a.m.
—**GOLJ**, S.S. "Homeric."
71.75 4,180—**GLSQ**, S.S. "Olympic."
—**GFWV**, S.S. "Majestic."
71.77-72.98 4,180-4,100—**Aircraft.**
72.87 4.116—**WOO**, Deal, N. J.
72.90 4,110—**WSBN**, S.S. "Leviathan."
74.72 4,105—**NAA**, Arlington, Va. Time signals, 9:57-10 p.m., 11:57 a.m. to noon.
—**PK1AA**, Weltevraden, Java.
80.00 3,750—**F8KR**, Constantine, Tunis, Africa. Mon. and Fri.
—**I3RO** (Prato Smeraldo), Rome, Italy.
—....Turin, Italy.
82.90 3,620—**DOA**, Doeberitz, Germany. (Television.)
84.24 3,560—**OZ7RL**, Copenhagen, Denmark. Tues. and Fri. after 6 p.m.
84.46-85.66 3,550-3,500—**Amateur Telephony.**
86.50-86.00 3,490-3,460—**Aircraft.**
92.50 3,256—**W9XL**, Chicago, Ill.
—**W6XBA**, S.S. "Metha Nelson," Fox Film Corp.
—**W2XOD**, portable.
—And other experimental stations.

92.5-94.9 3,244-3,160—**KFR**, **WJE**, City of Seattle, Wash., Light Dept.
94.20 3,184—**KQS**, **KQT**, City of Los Angeles, Calif., Water Dept.
95.00 3,156—**PK2AG**, Samarang, Java.
95.48-97.71 3,142-3,070—**Aircraft.**
96.03 3,124—**WOO**, Deal, N. J.
97.15 3,088—**W10XZ**, **Airplane Television.**
97.53 3,076—**W9XL**, Chicago, Ill.
98.95 3,030—....Motala, Sweden. 11:30 a.m.-noon, 4-10 p.m.
101.7 to 105.3 meters—2,850 to 2,950 kc. **Television.**
—**W1XAV**, Boston, Mass.;—**W2XR**, New York, N. Y., 1-6:30, 7:30-10 p.m.
—**W9XR**, Chicago, Ill. (21 lines).
104.4 2,870—....Milan, Italy. After 2 p.m.
105.0 2,855—**W1XY**, Tilton, N. H.
105.9 2,833—**W6XAN**, Los Angeles, Calif.
—**W7XAB**, Spokane, Wash.
—**W2XAO**, Yacht "MU-1," New York.
105.3 to 109.1 meters—2,750 to 2,850 kc. **Television.**
—**W2XAB**, New York City. Atlantic Broadcasting Corp. (60 lines).
—**W2XBO**, Long Island City, N. Y.
—**W9XAA**, Chicago, Ill.
—**W9XG**, West Lafayette, Ind.
110.2 2,722—**Aircraft.**
112.1 2,938—**W6XAF**, Sacramento, Calif. State Dept. of Agriculture.
121.5 2,470—**Police and Fire Departments.**
—**KGOZ**, Cedar Rapids, Ia. — **WRDQ**, Toledo, Ohio.
122.0 2,458—**WPDG**, Youngstown, Ohio.
122.3 2,452—**WRBH**, Cleveland, O. — **KGPP**, Portland, Ore.
—**WPDK**, Milwaukee, Wis. — **KGPH**, Oklaroma City, Okla.
123.0 2,440—**WPDF**, Flint, Mich. — **WNDA**, Miami, Fla. — **WPDP**, Philadelphia, Pa.
—**WPDM**, St. Petersburg, Fla. — **WPDL**, Lansing, Mich.
—**W3XB**, Portable.
123.9 2,422—**WMJ**, Buffalo, N. Y. — **KGPE**, Kansas City, Mo. (Mo. State).
124.2 2,416—**WPDI**, Columbus, O. — **WPDE**, Louisville, Kentucky.
—**KGPB**, Minneapolis, Minn. — **WPDJ**, Passaic, N. J.
—**WPDS**, St. Paul, Minn. — **WPDA**, Tulare, Calif.
124.5 2,410—**WCK**, **WRDR**, **WMO**, **Detroit** (Belle Isle, Grosse Pointe, Highland Park, Mich.
—**KGPD**, San Francisco, Calif.
124.5 2,410—**KGPG**, Vallejo, Calif. Police Dept.
125.1 2,398—**W9XL**, Chicago, Ill.—**W2XCU**, Ampere, N. J.—And other experimental stations.
—**W2XAD**, **W2XAF**, Schenectady. — **WPDT**, Kokomo, Ind. Police Dept.
125.4 2,392—**W10XAL** and **W10XAO**, Portable. National Broadcasting Co.—**W2XCZ**, Portable. N.B.C.
128.0-129.0 —**Aircraft.**
129.0 2,325—**W10XZ**, **Airplane Television.**
130.0 2,306—**DDDX**, S.S. "Bremen" and "Europa" testing.
135.0 2,220—....Stockholm, Sweden.
—....Oslo, Norway.
136,4 to 142.9 meters—2,100 to 2,200 kc. **Television.**
—**W2XBS**, New York, N. Y., 1,200 R.P.M., 60 lines deep, 72 wide. — **W2XR**, Long Island City, N. Y.
—**W3XAD**, Camden, N. J. (60 lines).
—**W2XCW**, Schenectady, N. Y.
—**W3XAK**, Bound Brook, N. J. (Portable, 60 lines).
—**W8XAV**, Pittsburgh, Pa., 1,200 R.P.M., 60 holes, 1:30-2:30 p.m., Mon., Wed., Fri.
—**W9XAP**, Chicago, Ill. (45 lines).
142.9 to 150 meters—2,000 to 2,100 kc. **Television.**
—**W2XAP**, Jersey City, N. J.
—**W2XCR**, Jersey City, N. J. 8:10 p.m., Mon., Wed., Fri., 3-5 p.m.
—**W3XK**, Wheaton, Maryland. 8-10 p.m.; Mon., Wed., Fri., 3-5 p.m.
—**W2XBU**, No. Beacon, N. Y. (1-2 p.m.)
—**W2XCD**, Passaic, N. J. 10:00 a.m.-noon, 3:30-5 p.m.; 9-10 p.m.
—**W9XAO**, Chicago, Ill. (45 lines).
150 2,000—**RA72**, Smolensk, USSR.
149.9-174.8—2,000-1,715—**Amateur Telephony and Television.**
174.0 1,723—**ZL2XS**, Wellington, New Zealand.
175 1,715—**W9XAN**, Elgin, Ill.
—**W6XK**, Los Angeles, Calif. And other experimental stations.
175.2 1,712—**Municipal, Police and Fire.**
—**KGKM**, Beaumont, Texas. — **WKDT**, Detroit, Mich. — **WEY**, Boston, Mass.
—**WPDB**, **WPDC**, **WPDD**, Chicago, Ill. — **WKDU**, Cincinnati, O.
—**KSW**, Berkeley, Calif. — **WKDU**, Cincinnati, Ohio.
—**KUP**, Dallas, Texas. — **WMDZ**, Indianapolis, Ind.
—**KGPC**, St. Louis, Mo. — **KGOY**, San Antonio, Texas.
—**KGJX**—Pasadena, Calif., (Police Dept.)
—....St. Quentin, France.
—**F8FY**, Cannes, France. 5 p.m. Wed.; 4 a.m. Sunday.
176.5 1,700—....Orly, France.
178.1 1,684—**WKDX**, New York, N. Y., Dept. Plant & Structures.
—**KOX**, Honolulu, T. H. Mutual Telephone Company.
180.0 1,662—**WMP**, Framingham, Mass. (State Police).
—**WRDS**, Lansing, Mich. (State Police).
186.6 1,608—**W9XAL**, Chicago, Ill. (WMAC) and **Aircraft Television.**
—**W2XY**, Newark, N. J.
187.0 1,604—**W2XCU**, Wired Radio, Ampere, N. J.
—**W2XCD**, DeForest Radio Co., Passaic, N. J. 8-10 p.m., synchronized with television broadcasts.
—**W1XAU**, Boston, Mass.
—**W2XAD**—**W2XAF**, Schenectady.
—**W9XX**, Cartersville, Mo.
—**W5XN**, Dallas, Texas.
—**W2XDD**, Portable.
—....Ornskoldvik, Sweden.
—And other experimental stations.
187.9 1,596—**WCF**, New York, N. Y. (Fire Dept.)
—**WKDT**, Detroit, Mich. (Fire Dept.)
—**KGKM**, Beaumont, Texas.
—**KGPA**, Seattle, Wash., fire & police depts.
189.4 1,584—**W10XAL**, **W10XAO**, Portable (N. B. C.)
192.3 1,560—. . .Scheveningen, Holland.
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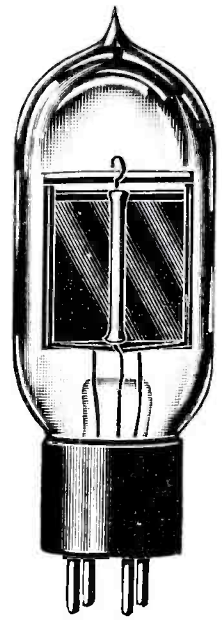

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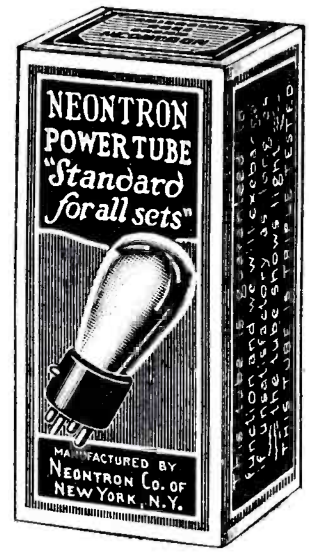

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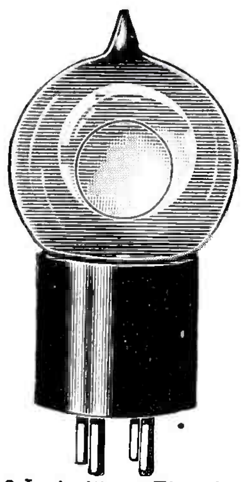

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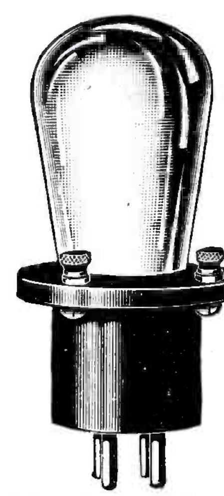

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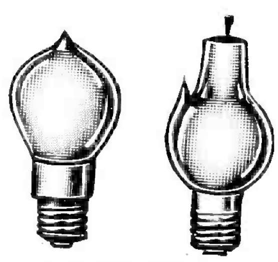

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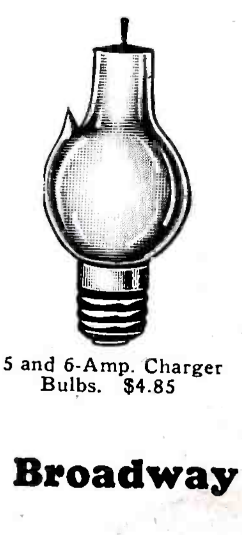

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